2nd European Conference on Applied Climatology

19 to 23 October 1998

Vienna, Austria

ECAC 98

Proceedings of the
2nd European Conference
on Applied Climatology
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FOREWORD

ECAC 98 is the second European Conference on Applied Climatology and it gives clear evidence that the field of applied climatology has grown considerably. At the first conference that was held in Norrköping, (Sweden) there were 130 papers, in Vienna, there are over 200 contributions on the program.

In the last years the area of applied climatology has widened by the uncertainties of the climate-change issues and the increased emphasis on traditional applications. The climatologists are demanded to explore the relationship between climate on the one side, the environment and society on the other, both in sense on more immediate effects because of current weather events and climate fluctuations, and potential future effects that could be induced by climate-change. The variety of these topics is documented by the contributions of this conference. There are sessions with more traditional problems, like wind-energy, agriculture, urban climate, and data-development. The predominant part of the sessions deals with the potential effects of future climate-change.

On behalf of the Local Organising and Program-Committee of ECAC98 I would like to thank all of the authors for submitting a wide variety of high quality contributions.

ACKNOWLEDGEMENTS

In the present abstract volume the short abstracts of all contributions, oral presentations as well as poster presentations are published. The extended proceedings of the conference are published on a CD-ROM. This electronic form gives many advantages to the publisher and the user. The production is much cheaper especially using colour pages and the format and the length of the abstracts are not so limited than in a printed version. The CD-ROM will enable users to conduct more efficient and timely searches than the printed issues. One can search the tables of contents electronically and display the preprint pages on the screen or just print them.

Ernest Rudel
Program Chairperson

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IDENTIFYING THE USER'S NEEDS AND REQUIREMENTS - THE COMMISSION FOR CLIMATOLOGY'S (CCL) POINT OF VIEW

Yadowsun Boodhoo, Mauritius

It is being increasingly recognised that climate data is one of a prerequisite in planning. This paper reviews the actions of the CCL concerning the identification of user's needs and requirements in climate-related fields. These are:Urban and building climatology, human health and comfort, agriculture, renewable energy, tourism and recreation and climate change detection methodologies. Other fields such as seasonal to interannual climate forecasting and consideration of climate in determining building codes are under consideration. Consequences of global warming on these same parameters are also mentioned.

RESULTS OF THE EUMETNET-ECSN WORKSHOP COMPRISING THE APPLICATION AREA WITH SPECIAL EMPHASIS ON EUROCLIPS

Volker Vent-Schmidt, Peer Hechler, Germany

held at Offenbach, 22nd and 23rd of June 1998

The EUMETNET Optional Programme ECSN (European Climate Support Network) has begun officially this year after all the 18 members have signed the contract. The main objective of ECSN is ‚*to organise improved co-operation of it's members in the field of climate and related activities...*`. This has to be realized mainly by appropriate projects. Following the first meeting of the ECSN-Advisory Committee the projects are grouped in four areas:

- Data

- Climatological Applications

- Climate Research

- Exchange of Information

As a first initiative Germany invited to hold a workshop covering the Application Area of the new ECSN with the initial aim to prepare a set of project proposals to be tackled.

Considering the structure of WMO/WCP the Application Area of ECSN comprises activities towards the development of advanced methods of climatological applications as well as the provision of best possible services .

Recalling the noncommercial focus of ECSN it has to be emphasized that the projects realized within the Application Area will be dedicated to the NMHSs itself as users to improve the capabilities regarding climatological applications. Possible commercial activities of NMHSs on the basis of the results achieved are not part of ECSN activities.

THE ECONOMIC IMPACT OF CLIMATE VARIABILITY, AND OF CLIMATOLOGICAL INFORMATION

J. M. Nicholls, United Kingdom

A review is given of the economic consequences of major floods and droughts in Europe over the last few years, and of how the incidence and costs of such catastrophes have grown. In some other parts of the world, the use of climate predictions, including short- and long-lead seasonal forecasts has been shown or predicted to reduce losses, especially those related to drought. However this is probably only the case, at present, where there are known large-scale influences on climate variability such as the En Nino/Southern Oscillation. The economic value of seasonal forecasts is reviewed, as is the value of monthly forecasts and of climatological statistics based on past data.

CIRCULATION PECULARITIES OF THE PERIODS WITH POSITIVE AND NEGATIVE ANOMALIES OF MEAN MONTHS TEMPERATURES AND PRECIPITATION IN BULGARIA

Teodosia Andreeva, Bulgaria

In the paper we examine the features of temperatures and precipitation in Bulgaria during the perioth 1966-1995. A tendency has been established of the forming of periods with relatively homogeneous temperature conditions in a given month. The mean durations and mean anomalies of the periods with positive and the periods with negative anomalies during each month of season and during the whole season are found. The prolonged periods with comparatively homogeneous and low temperature variations are replaced by shorter periods of great consecutively changing positive and negative anomalies of temperature. Some relations have been obtained in regard to the succession and probability of change of one with another month, in view of its temperature characteristics.

The annuel course of the baric relief over Bulgaria is investigated, separetly for both basic forms: the antiyclonic and cyclonic. The singularities of the cyclonic and anticyclonic baric relief during the separate months, seasons and years have been inyvestigated. The probabilities are also obtained for a considerable over-normal anticyclonality and cyclonality of the baric field on earth during the months and the respective inferences made in regard to the conditions for over-normal and sub-normal precipitations in the country during the separate months.

TEMPERATURE AND PRECIPITATION IN MACEDONIA FROM 1920 TO 1997

Suzanna Alcinova Monevska, Pandora Stojanovic, Macedonia

On the basis of normal climatic data sets it will be presented charts with climatic classification of Republic of Macedonia according Koppen. Representative data from meteorological station in some climatic region will be graphically presented:

1. Ohrid-C_2sb(Hs=760, ϕ=41°07', λ=20°48')

and Gevgelija-C_3sa'(Hs=59, ϕ=41°09', λ=22°30')

2. Stip-C_2fsax''(Hs=326, ϕ=41°54', λ=22°11')

and Kriva Palanka-C_1fsbx''(Hs=691, ϕ=42°12', λ=22°20')

3. Bitola-C_1fsb(Hs=586, ϕ=41°03', λ=21°22'

Graphical presentation of the air temperature data for a) winter and spring; b) summer and autumn and c) mean annual air temperature data from 1920 to 1997 will be shown. Similar presentation will apply for the precipitation data.

Leveling of the relatively homogenized data is done using the method of years running mean.

A STATISTICAL DOWNSCALING METHOD: DESCRIPTION, VALIDATION AND APPLICATION: FIRST HIGH RESOLUTION CLIMATE CHANGE SCENARIOS FOR SPAIN

Jaime Ribalaygua, Rafael Borén and Luis Balairón, Spain

An statistical method to obtain high resolution climate change scenarios of precipitation and near surface temperature from coarse resolution Atmospheric Ocean Coupled General Circulation Model (AOCGCMs) outputs has been developed and validated.

The downscaling method estimates high resolution surface meteorological fields for a day "X", in two steps: in the first step , the "n" days more similar to the "X" day, attending to their low resolution atmospheric fields, are chosen from a reference dataset. In the second step high resolution surface information is obtained in a different way for precipitation and temperature.

The surface dataset is a gridded dataset (203 gridpoints covering the Peninsular and Balearic Spain) with daily values for accumulated precipitation and maximum and minimum temperature. The atmospheric dataset used is the NCAR/NCEP Reanalyses with an spatial resolution of 2,5º x 2,5º similar to those offered by AOGCMs outputs. Both reference (surface and atmospheric) datasets expands over the period 1961-95 (12.783 days).

Precipitation is known to present strong non-linear relationships with its potential predictor variables, what makes analogical techniques, specially indicated for its diagnosis. Precipitation diagnostic capability of the 1000 and 500hPa geostrophic flux fields are owing to their relationships with important precipitation forcings (frontal and topographic forcings implicit in 1000hPa flux and middle troposphere dynamic forcing related with 500hPa flux). The estimation procedure for temperatures requires, after the selection of the "n" analogous days described above, a further diagnosis by multiple lineal regression. The regression procedure used is performed in two steps in order to reduce the non-linear influence of cloudiness over the surface temperatures.

The performance of the downscaling method is assessed by an estimation of daily surface fields of precipitation and maximum and minimum temperatures for the 80's decade and the whole downscaling method is applied to the climate simulations of one transient AOGCMs experiments: HADCMSUL of Hadley Center to the future decades (2000 to 2100 years). This experiment have been chosen because it start running on 1890 and it consider recent past evolution of greenhouse gases and sulphate aerosols forcing conditions.

POSSIBLE INFLUENCE OF CLIMATE CHANGE ON THE SPATIAL DISTRIBUTION OF SOIL MOISTURE DEFICIT AREAS IN SLOVENIA

Klemen Bergant, Lucka Kajfez-Bogataj, Slovenia

Long term mean monthly and annual precipitation and air temperature data (1961-1990) were used for estimating the present soil moisture deficit areas. Data for average air temperatures for 108 locations were used for calculating the potential evapotranspiration using Thornthweite's method. Combining annual and monthly precipitation data for 366 locations and calculated values for monthly and annual potential evapotranspiration, the maps of soil moisture balance items: water deficit, water runoff and soil moister content, were made. The warm and dry climate change scenarios were applied and the entire procedure for estimating soil moisture balance items and their spatial visualization was repeated. Comparing the present state and predictions, some conclusions for the possible influence of climate change on soil moisture deficit areas in Slovenia can be made.

POSSIBILITIES OF MULTI ELEMENTAL CLIMATE TIME-SERIES RESEARCH: FIRST RESULTS OF PROJECT ALOCLIM (AUSTRIAN LONG-TERM CLIMATE)

Ingeborg Auer, Reinhard Böhm, Martina Hagen and Wolfgang Schöner

The first goal of project ALOCLIM has been to produce a consistent and homogeneous data-set of long-term climate time series covering the region of Austria. Each series contains all measured elements (about twenty), three series reach back into the second half of 18th century. The procedure, the problems and the results of homogenisation are discussed at this conference in the paper of Schöner et.al. This paper deals with first results of time series analysis. Special attention is paid to a combined analysis of different elements as well as to the aspect of spatial representation, correlation range and vertical differences. The latter can be studied within a vertical range of nearly 3000m, having a number od stations within and and also above the Alpine boundary layer. The 1 to 2 deg warming from the mid 19th to the late 20th century, which is observed in Austrian time series, is used to study the reaction of a number of climate elements to this temperature increase which is comparable to that estimated for the 21st century by climate models. The sensitivity of some climate elements to temperature changes can be shown quantitatively. This may be used for further climate scenarios of 21st century Alpine greenhouse climate.

PREDICTIVE POTENTIAL OF NORTH ATLANTIC OSCILLATION

Roxana Bojariu, Romania

The predictive potential of North Atlantic Oscillation (NAO) for the seasonal variability is investigated using a multifield analog prediction method based on geopotential height, sea surface temperature (SST), surface air temperature and precipitation anomalies over the Atlantic/European region for the seasons spanning the interval 1950-1992. A hindcast experiment has been performed for the interval 1979-1992. The results reveal the tendency of the NAO years to occurr more frequently among the analogs. It seems that these analogs are preferred modes of the analysed system all over the year suggesting that the NAO phenomenon might have a predictive potential related to the entire annual cycle.

THE ROLE OF THE NORTH ATLANTIC SST ANOMALIES IN THE INTERDECADAL CLIMATE VARIABILITY OVER THE ATLANTIC EUROPEAN REGION

Constanta Emilia Boroneant, Romania

To establish the role of the North Atlantic SST anomalies in the climate variability over the Atlantic European region at interdecadal time scale the outputs of the 700 year integration of the ECHAM3 atmospheric general circulation model (T21) coupled to LSG ocean model have been analysed. Our analysis aimed to identify: 1) the relationships between the SST anomalies and various atmospheric fields (SLP, 500 mb geopotential height, precipitation, 10 m zonal and meridianal wind, 2m temperature) over the Atlantic European region by using simple statistical methods (correlation maps and composite maps), 2) the interdecadal coupled and atmospheric modes in this area (CCA analysis), 3) properties of time evolution of theses modes (periodicities).

The most prominent atmospheric mode identified in the variability of various atmospheric fields at the interdecadal time scale is the North Atlantic Oscillation. Its phase and amplitude is related to the SST middlatitude anomalies. Periodicity of 40-50 years has been identified in the time evolution of NAO mode.

SEASONAL PREDICTION OF CLIMATE ANOMALIES IN ROMANIA

Aristita Busuioc, Romania

A multivariate linear statistical technique to predict the seasonal climate anomalies in Romania by using the large-scale predictors is tested. This technique is based on the Canonical Correlation Analysis which selects pairs of spatial patterns of two space-time dependent fields (predictors and predictants) such that their time components are optimally correlated.

As predictants, the temperature and precipitation seasonal anomalies at 14 stations in Romania at various steps in the future are considered. As predictors, the prior values of the predictants themselves as well as the values of the mean sea level pressure and geopotential height are used. Besides, the North Atlantic sea surface temperatures are also used, giving the so-called external forcing that possibly leads to short-term climatic variations. All data set are considered over the 1901-1990 interval.

The predictive skill is obtained by means of cross-validation. Combinations of predictors for various predictants have been tested in order to maximize the predictive skill.

THE CLIMATE OF THE FAROE ISLANDS - VARIABILITY AND TRENDS

John Cappelen, Denmark

To detect climate trends and changes above the fluctuating background, accurate and systematic observations with calibrated instruments are required from all around the world. These observations form the basis for preparation of data series and calculation of standard normals to be used in climate studies, a increasingly important task both nationally and internationally.

The poster presents the observed climate of the Faroe Islands, mainly from 1961, based on climatological data series and normals, but a more general description of the weather and climate is also included together with trends in temperature, precipitation and sunshine in the capital Tórshavn from the beginning of the 1920s.

The Faroe Islands are located in the North Atlantic between Scotland, Iceland and Norway and their climate is greatly influenced by the ocean.

Besides the above mentioned descibtion of the climate in general terms with an overview of the "normal" climate of the Faroe Islands based on observations from the normal period 1961-1990 the treatment of station history, metadata and the problems of studying long series of data and calculating long-term averages in cases where instruments, observation sites etc. have changed are also covered.

Conclusions concerning the observed climate and the variations are finally presented.

Available on the poster session will be a full report in digital format (pdf-format) and floppy disks which contain the climatological standard normals 1961-90, all monthly values on which calculation of the normals is based (144 data series) and information concerning the different measuring sites.

STRUCTURE AND VARIATION OF 500 HPA GEOPOTENTIAL HEIGHT FIELD FOR TWO TIME SCALES IN THE WINTERTIME NORTHERN HEMISPHERE EXTRATROPICAL REGION: A COMPARISON OF ECMWF RE-ANALYSES WITH SIMULATIONS OF CLIMATE MODELS

M.J. Casado, A.Pastor, F.J. Doblas, Spain

Atmospheric circulation of extratropics in winter is dominated by low-frequency fluctuations existing a strong relationship between low-frequency variability and synoptic activity for a wide range of low frequency-phenomena. It is thus becomes important to understand and analyze intraseasonal atmospheric variability that can affect the extratropical climate.

This study focusses on the identification of teleconnections in two bands: intramonthly (20-30 days) and intermonthly (>30 days) and the analysis of the ability of climate models to reproduce it and its dependence with resolution.

Teleconnection patterns have been computed by the method of digital filtering and spatial correlation analysis. A comparison of the teleconnection patterns of both bands with the patterns described by Wallace and Gutzler(1981), Esbensen(1984), Blackmon et.al(1984), Barnston and Livezey(1987) are also presented.

Teleconnection patterns in re-analyses are very similar to those documented in the literature.The high resolution version retrieves more patterns than the low resolution version.

The Pacific-North-American (PNA) pattern is the only pattern found in both the intramonthly and intermonthly bands for low and high resolution versions. Dipole patterns are found over the Atlantic Ocean and over the Pacific Ocean, although there is no agreement in both bands.

GLOBAL PATTERNS OF ATMOSPHERIC INTERANNUAL VARIABILITY BASED ON THE NCEP REANALYSIS DATASET

J. M. Castanheira, C. C. DaCamara, A. Rocha, Portugal

The study of modes of atmospheric interannual variability is usually performed by means of statistical analysis on a selected meteorological field (e.g. geopotential height) defined over a limited region of the globe. However, in the case of low frequency modes, such as interannual variability, one might expect that spatial organisation of atmospheric circulation has a global scale character of its own.

In this study we look for northern winter patterns of interannual variability of the vector field (u,v,h) defined over the whole globe, u and v being the zonal and meridional components of horizontal wind and h the geopotential height. Performed analysis is based on a three-step scheme defined as follows. First, the vector (u,v,h) is projected onto normal modes, taking as reference state the mean NCEP reanalysed atmosphere for the period 1973-96. Next, a complex principal component analysis (CPCA) is performed on obtained time series of projections onto barotropic and baroclinic modes; it is worth noting that the sum of squared diagonal elements of covariance matrix is proportional to the amount of transient total energy. Finally, global patterns defined in real space are recovered from obtained empirical orthogonal functions (EOF) in the transformed domain.

Obtained results reveal, on the global scale, barotropic patterns like PNA and NAO, PNA structure being also detected on the fourth baroclinic mode. On the other hand, patterns resembling the northern winter Polar Vortex are also obtained in the cases of first and second baroclinic modes.

VARIABILITY OF PRECIPITATION IN THE WESTERN CARPATHIAN

Elzbieta Cebulak, Poland

Data and method

Temporal analysis in precipitation is based on data in the period 1951 - 1995 for selected couples of stations for Polish and Slovak part of the Carpathians. The selected stations for comparison are as follows: Lesko & Habura; Bielsko - Biala & Lazy pod Makytou; Jablonka & Liptovský Hrádok; Obidowa & Oravská Lesná; Krynica & Chmelnica; Zakopane & Poprad (Tatranská Lomnica); Hala Gasienicowa & Štrbské Pleso. Annual and seasonal precipitation series have been used for detailed analysis. The seasons were defined in a standard way: Spring (III - V), Summer (VI - VIII), Autumn (IX - XI) and Winter (XII - II). Data smoothed by 5- year moving averages were used as well. The comparison of the long-term precipitation series (1881 - 1995) for stations on the Carpathian forelands (Krakow, Košice and Hurbanovo) was examined. The comparison expressed as percentage deviations from annual and seasonal precipitation on the northern and southern side was made. The comparison of two series for the periods 1931 - 1960 and 1961 - 1990 is presented in the map.

Conclusion

Overall precipitation totals in the Polish Carpathians show downward trends, what is well demonstrated in summer and winter, but it contrasts with opposite trends in spring and autumn. The largest declines in precipitation totals were observed in summer, a phenomenon especially well pronounced in the western part of the Carpathians, while smaller declines have occurred in winter, mainly in the eastern part of the Carpathians. Spring and autumn precipitation was increasing in the Carpathians, but there is an agreement between trends and courses of precipitation in the whole Carpathians.

CLIMATE SIMULATIONS WITH THE HIRHAM LIMITED AREA REGIONAL CLIMATE MODEL OVER SCANDINAVIA

Ole Bøssing Christensen, Denmark

Regional atmospheric climate models are often used as a tool to downscale fields from coarser-resolution GCM simulations. Experience shows that even resolutions down to 50 km do not resolve spatial detail to adequately describe effects of mountains and other geographical features essential to principal climatological and hydrological parameters like surface air temperature, precipitation, snow cover, or runoff.

For this reason a very-high resolution regional climate model has been used to investigate the hydrological balance over Scandinavia, a region quite well described by observations. We present results from simulations with the HIRHAM4 model, which is based on the HIRLAM weather-forecast model, but with the physical parameterization used in the ECHAM4 global model of the Max-Planck Institute in Hamburg.

Ten years of output from the recent control experiment performed at the Max-Planck Institute with the coupled ECHAM4/OPYC global model in T42 resolution have been used as boundary conditions for HIRHAM in 56 km resolution in a region covering the North Atlantic and Europe. Output from this simulation has been used as boundaries for the present very-high-resolution simulation (19 by 19 km) in an area over Scandinavia and the North Sea. Results from this control run are presented, with special emphasis on the hydrological cycle. The results compare favorably with climatological values from the Scandinavian countries.

POTENTIAL TROPICAL CYCLONE LOSSES DUE TO CHANGES IN SEVERITY CAUSED BY GLOBAL CLIMATE CHANGE

Graham Cook, U.S.A.

This study is to determine how potential global climate change affects the loss potential of future tropical cyclones in the North Atlantic region. A change in climate could impact the sea-surface temperature, El Nino-Southern Oscillation (ENSO), the Quasi-Biennial Oscillation (QBO), the West African rainfall, the Caribbean Basin sea-level pressure, and the upper-level zonal winds. These factors are amongst the strongest predictors of tropical cyclone activity in the North Atlantic basin.

The patterns of tropical cyclone activity are similar to patterns that have occurred in the past and variations are related to other known variations in the climate systems. On the average, there are just under five hurricanes that form in the Atlantic with less than two making landfall per year. The two areas of concern regarding tropical cyclone activity are frequency and severity. The factors that govern the intensity of hurricanes appear to be different from those controlling their frequency of occurrence

Two scientists investigating the impact of global climate change on tropical cyclones are Dr. William Gray of the University of Colorado and Dr. Kerry Emanuel of the Center for Meteorology and Physical Oceanography at the Massachusetts Institute of Technology. Dr. Gray is credited with quantifying the influence of several factors on tropical cyclone frequency, and Dr. Emanuel has researched the influence of several factors on severity.

The 1995 assessment of impacts of climate change on financial services done by the Intergovernmental Panel on Climatic Change (IPCC) concluded that property insurance was the financial sector most vulnerable to climate change. Since 1985, tropical cyclone events have cost property insurers and reinsurers in excess of $40 billion. People continue to live and move into areas prone to tropical storms, so any change in the frequency and the intensity with which these storms strike is of concern. In addition, the IPCC report on the science of climate change stated that "In conclusion, it is not possible to say whether the frequency, area of occurrence, time of occurrence, mean intensity, or maximum intensity of tropical cyclones will change." Each of the strongest predictors for tropical cyclone severity will be described, and then their possible effect on tropical cyclone activity (severity and locational frequency) and subsequently their effect on the potential property losses will be investigated. This study is the second of a series and looks at the effect of each component individually. Worst case scenarios are considered, but these scenarios may not actually happen with climate change. It should be noted that the effect on tropical cyclone frequency was considered previously and the correlation and interaction of the individual predictors will be considered in a future study.

VARIATIONS AND TRENDS IN EXTREME EVENTS IN THE USA

David Easterling, USA

Climate model estimates of the potential impact of increases in radiatively-active trace gases in the atmosphere suggest that the globe will likely experience a warming of 1 to 4 °C, with attendant increases in the vigor of the hydrologic cycle over the next century. Much of this change will likely manifest itself in the form of increases in the frequency of extreme events. In this paper observed trends in global and U.S. temperature and precipitation will be discussed, both in terms of mean values and extreme temperature and precipitation events. Recent work indicates that 10 of the last 15 years (through 1997) have been the warmest global temperatures on record, and that North America has experienced a precipitation increase of 10-20% over the 20th century. In the U.S. much of this increase can be attributed to increases in extreme precipitation events.

Lastly, the U.S. has experienced a significant decline in the number of days where the temperature dips below freezing, particularly in the spring. This appears to be related to recently observed decreases in spring snow cover over North America.

LONG-TERM VARIABILITY OF THE SNOW COVER IN THE WESTERN CARPATHIANS

Malgorzata Falarz, Poland

The purpose of this study is the investigation of a long-term variability of the snow cover in the Western Carpathians, with particular emphasis put on the comparison of the variability features on the northern and southern slopes of the mountains and the recognition of the snow cover variability dependence on the thermal and precipitation conditions changes. The long-term variability of the number of days with snow cover, maximal depth and the sums of the snow cover's daily depths for 8 pairs of stations located in the northern and southern parts of the Western Carpathians and for the station on the Kasprowy Wierch were the analysis subject. These stations represent all climatic vertical zones of the Carpathians, except the high mountainous coldest one, and their selection enables to detect the features of the snow cover variability, both in the meridional and parallel profiles of the mountains (one pair of stations was selected in the Eastern Carpathians). Basic investigation was carried out for the 1951-1996 period. In the case of 6 stations the period of analysis was extended to at least 70 winter seasons. The dependence of basic characteristics of the snow cover on the average and maximal air temperature and precipitation in the winter season were examined at selected stations.

The obtained results enable to conclude that there is a slight downward tendency in the snow cover long-term variability in the Western Carpathians, which has been more evident for the last 30 years. There have also been noticed slightly different features of the variability of the snow cover in the Eastern Carpathians (e.g. a positive trend with reference to the number of days with snow cover). The most significant correlation have been found in the number of days with snow cover and maximal temperature ($r = -0.84$ for Cracow, $r = -0.82$ for Hurbanovo, in Winters 1951-1996) and seasonal sums of daily snow cover depths and the sums of solid and mixed precipitation for the period from December to February ($r = 0.59$ for Zakopane, $r = 0.59$ for Štrbské Pleso, in Winters 1951-1996).

LONG-TERM VARIATIONS IN EXTREME 1-DAY RAINFALL IN THE NORDIC COUNTRIES

Eirik J. Forland, Norway

Changes in the frequency or intensity of extreme rainfall events are likely to have profound impact on society and the environment. In the Second Assessment Report of IPCC, Nicholls et.al (1996) attempted to answer the question: Has the climate become more variable or extreme? The few studies available indicated that in some areas there was evidence of increase in the intensity of extreme rainfall events, but no clear large-scale pattern had emerged. One of the main aims of the REWARD-project was to study whether the observed global warming has caused any increase of extreme climatic events in the Nordic countries (Denmark, Faeroe Islands, Finland, Iceland, Greenland, Norway, Sweden).In large parts of Northern Europe the annual precipitation has increased by more than 10% during this century. Analysis of the 85 long-term REWARD series of maximum 1-day precipitation (RX1d) show no distinct large-scale trend patterns in the Nordic region. Trend patterns in RX1d at neighbouring stations differ substantially, and it is concluded that single station RX1d-series is no ideal indicator of changes in extreme rainfall intensity.

Regionalised maps show that in South-western Norway, Northern Fennoscandia and Southern Iceland, the mean value of RX1d is more than 10% higher during the recent (1961-90) than the previous (1931-60) standard normal period. In southern Fennoscandia and around the Baltic, RX1d has decreased. However, for the last 15 years RX1d is more than 10% higher than the long-term mean for most of the Nordic region. Because of the large year-to-year variations, these differences in mean values are not statistically significant.

To study possible changes in frequencies of extreme rainfalls, the number of occurrences of <extraordinary> RX1d-events (i.e. events with a return period exceeding 5 years) were calculated on a decadal basis for the 85 REWARD-series. The analyses show that except for Western Norway, the highest frequencies of <extraordinary> rainfall events in the Nordic region occurred in the 1930's and in the two latest decades. This part of the Nordic region usually experience extreme RX1d-values in weather situations with convective cells during the warm season, and the decades with maximum frequencies of extraordinary rainfall coincides with decades with high regional summer temperatures.

For Western Norway however, there was no local maximum in the 1930's;- the two latest decades have evidently had the highest number of extraordinary rainfall events. During this period, Western Norway has experienced a substantial increase in orographic precipitation during autumn, winter and spring.The documented changes in annual precipitation and maximum 1-day rainfall in the Nordic region, is to a large extent caused by variations in atmospheric circulation (cf. Abstract by Hanssen-Bauer).

TREND OF TEMPERATURES AND PRECIPITATION IN ITALY FROM 1880 TO 1996

Guiseppe Millilo, Alfio Giuffrida, Italy

Temperatures in Italy are increasing, as is happening globally to the rest of the planet; precipitation, on the contrary, is extremely variable, with general decreasing amounts.

The data of a sample of Italian meteorological stations were collected from 1880 to 1996 and subjected to different tests to investigate the presence of trends.

In particular, the Mann-Kendall and Spearman's tests, which operate on ranks instead of values themselves, were adopted.

In the case of temperatures, both tests indicate a positive trend, with a significance level of 95%. The linear regression coeffizient is 0.005, and it corresponds to a global increase of 0.58°C in the 117 year period under investigation. The shape of the plot shows great oscillations within a variable period ranging from 8 to 24 years. The increasing amount of greenhouse gases in the atmosphere and the comparison with sunspot activity were examinated among the possible cause of this trend.

Precipitation shows a general decreasing tendence, however both applied tests reject the null hypotesis to the significance level of 95%. The linear regression coefficient is -0.267, and it corresponds to a global increase of 31 mm. The shape of the plot is quite regular between 1880 and 1915, showing great oscillations in the rest of the period.

PRECIPITATION IN THE SOUTHWEST OF EUROPE: HOMOGENEITY AND TRENDS

J.F. Gonzáles-Rouco, J.L. Jiménez, V. Quesada, F. Valero, Spain

A quality control process involving outliers corrections, homogeneization and interpolation has been applied to 95 monthly precipitation series from the Iberian Peninsula, south of France and noth of Africa. This observational precipitation data constitute a first version of a new dataset (SED, Southwestern Europe Dataset) developed at UCM and spans the period 1899-1989. One and two-phase regression analysis were applied to SED and to the NCAR sea level pressure (SLP) dataset in order to check for agreement of pressure and precipitation long terms trends.

The spatial structure of outliers shows a possible climatic origin related to extreme events rather than human induced errors. Standard homogeneity test has been applied in combination with an objective methodology to select reference series. 40% of the series were found to be homogeneous, 49.5% became homogeneous after one adjustment and 9,5% ofter two corrections. About 28% of the inhomogeneities could be traced to information in the scarce station history files. The regional distribution of precipitation trends as well as agreement of precipitation and SKP trends provides confidence on the homogeneization procedure.

DERIVATION OF STATISTICAL RELATIONSHIPS BETWEEN CENTRAL-WESTERN MEDITERRANEAN SEA SURFACE TEMPERATURE ANOMALIES AND CLIMATIC FEATURES IN TUSCANY (ITALY) ON A MONTHLY BASIS

Bernardo Gozzini, Italy

Several recent studies have demonstrated both the value of sea surface temperature anomalies as medium-long range predictors for weather anomalies and the relative sensitivity of prognostic models after the first 10 days of the forecasts.

Data produced from the NOAA Global Area Coverage (GAC) for Central-Western Mediterranean for the period 1981-1991 is employed to derive statistical relationships between monthly average sea surface temperatures (SST) derived from NOAA AVHRR observations and climatic anomalies in Tuscany (Italy), in terms of rainfall and temperature during the same time period.

Besides conventional statistical techniques, neural algorythms are tentatively applied.

The analysis is performed on a regional basis, i.e. it accounts for possible inhomogeneities of the atmospheric responses over the (complex) study area.

A technique based on an ARIMA stochastical model is suggested to operationally forecast sea surface temperatures with lead times up to three months.

SECULAR VARIABILITY OF THE NORTH ATLANTIC OSCILLATION

Hans-F. Graf, Germany

The North-Atlantic-Oscillation, a large scale teleconnection pattern determined by the strength of the main centres of action in this region, the Icelandic low and the Azores high, is part of a larger North polar mode of coupled tropospheric and stratospheric variability. This mode, together with a second one involving the Pacific-North-America scheme, represents a large part of interannual and decadal variability of circulation, temperature and precipitation over the North Atlantic and Eurasia.

In the paper the origin of these modes is discussed and several external and internal forcings to exaggerate the modes are presented, including greenhouse gas concentrations, stratospheric aerosols from volcanic eruptions and tropical sea surface temperature anomalies.

The representation of these modes in climate models is a crucial parameter for their ability to compute climate variability in the right structure. Some current model version's results are given. A method is proposed to overcome biased model predictions, e.g. of temperature anomalies over Eurasia, by application of the predicted mode strength to the observed anomaly fields connected with the mode strength.

DYNAMICAL SEASONAL PREDICTABILITY OVER EUROPE

R.J. Graham, A.D.L. Evans and M.S.J. Harrison, United Kingdom

The skill of 9-member ensemble integrations of the UK Met Office Unified Model (UM) V3.4 for dynamical seasonal prediction has been assessed for every season over the 15 year period December 1979 - March 1994. In each 4-month integration Sea Surface Temperatures (SST) were updated with observed values; hence the skill attained is an estimate of that which might be achieved with the best-possible prediction of SST. Atmospheric initial conditions for the ensemble are the 12UTC analyses, from the ECMWF Re-Analysis (ERA), on the 9 days before each season; observed SST boundary conditions are UKMO GISST analyses until October 1981 and Reynold's OI analyses for the remaining period. The runs form part of the European cooperative project PROVOST (PRediction Of climate Variations On Seasonal to interannual Timescales) in which similar experiments, using the same initial conditions and SSTs, are being run with the ECMWF T63 model and the ARPEGE model, the latter being run at T42 by Me,te,o-France and T63 by EDF (French Electricity Department).

In addition to assessing UM skill, a main objective is to evaluate the benefits of constructing ensembles from two or more of the participating models. Such "multi-model" ensembles have been shown to have substantial benefits for medium-range predictability which may extend to seasonal time-scales.

Skill is assessed both from a deterministic (ensemble-mean) and probabilistic perspective. In the latter, the forecast probability of anomalies exceeding specified thresholds are determined from the distribution of the ensemble. Results so far indicate that the skill of ensemble-mean forecasts of 500 hPa height and 850 hPa temperature over the European area is relatively low (as expected), with highest skill in autumn and spring and lowest in summer. Higher levels of predictability exist over other areas of the globe, particularly, but not exclusively, in the tropics and subtropics. Assessment of probability forecasts of 850 hPa temperature below/above normal indicate that the area over which predictability exceeds that of a random or climatology forecast is largest for March-April-May for both tropical and extratropical regions. A specific investigation of probabilistic skill for the European area is currently in progress (results will be presented at the conference).

Initial results suggest substantial benefits are available from "multi-model" ensembles. In an initial test, an 18-member combination of the UM and ECMWF ensembles improved on single-model performance for ensemble-mean Root-Mean-Square Skill Scores (stratified against persistence) and spread-skill relationships. The combined ensemble also exhibits greater spread than the individual ensembles for every season over the North Atlantic and Europe, suggesting coverage of a wider range of possible future atmospheric states by the joint system. Evaluation of the benefits of multi-model ensembles to probability forecasts is currently in progress. Results presented at the conference will have emphasis on the potential skill of probabilistic seasonal forecasts for the European area and will include an assessment of the potential benefit of using multi-model ensembles.

CHANGES OF WIND WAVES IN THE NORTH ATLANTIC OVER THE LAST 30 YEARS

Sergey Gulev, Russia

In order to evaluate long-term climatic changes in the wind waves height, visual wave estimates available from the Comprehensive Ocean-Atmosphere Data Set (COADS), were updated for the period from 1964 to 1993. Climate changes obtained in significant wave height computed on the basis of the voluntary observing data, are quite consistent with those shown by the instrumental records at OWS L, Seven Stones Light Vessel and NDBC buoys. Then the linear trends in significant wave height, as well as in the wind sea and swell heights were computed for the entire North Atlantic. Significant wave height increases by 10 to 30 cm per decade over the the whole North Atlantic expert for the western and central subtropics. Changes in the swell height are very consistent with those seen in significant wave height. Nevertheless, wind sea indicates strong upward tendency only in the ventral mid-latitudinal North Atlantic and does not show any significant trends in the North-East Atlantic where instrumental records of Bacon and Carter (1991) report secular changes of 2% a year. Wind waves of different percentiles exceedances show even significantly negative changes in the North-East Atlantic, than is in agreement with the wind sea periods changes. Possible mechanisms driving the swell changes with no pronounced increase of the sea height and wind velocity are discussed. Changes in the intensities of intramonthly variability in different synoptic ranges are considered as the major agent of the increasing swell.

TEMPERATURE AND PRECIPITATION VARIATIONS IN THE NORWEGIAN ARCTIC: CAN THEY BE EXPLAINED BY VARIATIONS IN THE SLP-FIELD ?

Inger Hanssen-Bauer and Eirik J. Forland, Norway

Temperature and precipitation series from Norwegian Arctic areas have recently been homogenised. The present analyses of these homogenised series focus on the temporal variability of monthly, seasonal and annual temperature means and precipitation sums from 1912 to present. The temperature curve for the Norwegian Arctic areas shows largely the same periods of temperature increase and decrease as the similar curves for the Northern Hemisphere: There is a statistically significant positive temperature trend from the beginning of the series to the 1930s, there is a negative trend from the 1930s to the 1960s, and there is a positive trend during the last 3 decades of the series. However, the present level of annual temperature in the Norwegian Arctic is slightly below the temperature optimum in the 1930s, and there is not a statistically significant trend in the series as a whole. The autumn and winter temperatures show similar features as the annual curve, with an optimum in the 1930s or the 1950s. The spring temperatures show a more steady temperature increase, and spring is the only season which shows a positive trend throughout the period as a whole. The summer temperatures show little variation and no trend. Annual precipitation has increased in the Norwegian Arctic during the time with instrumental measurements. Measurements from Svalbard show statistical significant increase in all seasons except winter.

Monthly averaged mean sea level pressure (SLP) from 4 grid points (10oE 70oN, 10oE 80 oN, 20oE 70oN and 20oE 80oN) was used in order to develop linear models for monthly mean temperature and monthly precipitation sum at specific stations. The conclusion was that 30-50% of the interannual variance in seasonal mean temperature at Svalbard Airport and Bjlrnlya could be explained by variation in SLP. More of the variance could be explained during autumn and winter than during spring and summer. Some decadal scale and long-term features were explained, e.g. the temperature increase from the 1960s to the 1990s seems to be explainable by variation in the SLP field. The temperature increase before the 1930s, on the other hand, cannot be explained by SLP variations alone.

Concerning precipitation at Svalbard Airport, only 20-40% of the interannual variance in seasonal sums could be explained by variations in SLP. Still, the decadal scale variability, and especially the positive long-term trends in observed precipitation during spring, summer and autumn were satisfactory modelled by the SLP variations alone.

THE POSSIBLE IMPACT OF CLIMATE CHANGE ON THE HYDROLOGY OF AN AUSTRIAN ALPINE CATCHMENT

K. Hebenstreit, H.P. Nachtnebel, Austria

The objective of this study is to analyse the impact of a possible climate change on the water balance of an alpine catchment area (Upper Enns; 2400 km²). For this purpose a statistical relationship between large scale distributions of air pressure and local meteorological variables, especially temperature and precipitation , is established. The downscaling analysis is based on daily values of the hydrometeorological variables which are used as input for a continuous rainfall runoff model to simulate runoff and storage at the surface, in the soil and in groundwater. Because of the importance of snow cover and storage in form of snow for alpine catchments a snowmelt routine is integrated. The hydrological model was calibrated by using historical hydrological data.

The downscalingapproach was tested for two CO_2 scenarios. First, the pressure distributions for the historical situation, characterized by recent CO_2 concentrations was used to simulate local time series for rainfall and temperature. The statistical parameters were in good agreement with the respective parameters derived from the observed data.

Then, the simulations from the Global Circulation Models (GCM's) for the double CO_2 concentrations, from the Max Planck Institute in Hamburg were used. Under the assumption that the downscaling approach is valid for the 2^*CO_2 scenario too, it is possible to estimate the effects for local climate for this scenario.

The results are analysed on a seasonal and monthly interval. Days with frost and the length of frost periods decreases; for late summer and fall significant warming is calculated. The amount of precipitation increases a little bit in winter and does not alter much in summer but the variability of rainfall becomes more pronounced. The simulated daily time series are used as input for the hydrological model and the components of the water balance are calculated. Discharge increases in the winter period because a smaller part of snow is stored and the snowmelt process starts earlier in spring. For the period from June to October lower runoff values are calculated. Due to the higher variability of precipitation probability of floods increases. Additionally the water compartments surface runoff, soil moisture and groundwater are analysed. Consideration of evapotranspiration generally results in higher values for the 2^*CO_2 scenario.

CHANGES IN FREQUENCY OF HEAVY RAINFALLS AT PRAGUE-KLEMENTINUM SINCE THE 19TH CENTURY

Libor Hejkrlik, Czech Republic

Measurements of precipitation at Prague-Klementinum (14° 25' E, 50° 05' N) have been carried out since 1805. Despite difficulties due to changes in approaches to the measurement the whole series of annual precipitation was homogenised by Køivský (1953). In the same paper a long-term variation having an opposite trend to the secular curve of solar activity (90-year rhythm) was presented. Using extrapolation of the physically justified correlation between the two phenomena a prognosis of the course of the annual precipitation up to the year 2000 was defined.

Analysis of the 48hr totals of precipitation from the Klementinum series since 1805 indicates, that the apparent depression on the curve of the annual amounts in the 1860s-1870s was possibly caused by a deficit in heavy rainfalls. The association with changes in weather types is difficult to establish because an appropriate typing scheme did not exist at the time but it could be subject of further investigation on the basis of Lamb typing for the British Isles. The paper also discusses the results of the precipitation forecast from the study of Køivský.

GERMANY THE IPCC DATA DISTRIBUTION CENTRE: PROVIDING CLIMATE SCENARIOS FOR THE THIRD ASSESSMENT REPORT

Michael Lautenschlager, Dr Mike Hulme, United Kingdom

The purpose of the Data Distribution Centre is to set the stage for the rapid uptake of more recent climate change science by researchers in the impacts community, and for improved consistency in the scenarios adopted in different assessments. Enhanced compatibility between impacts studies is of great importance when evaluating and synthesizing results across regions and sectors which is a major goal of Working Group II of the IPCC for ist Third Assessment Report (TAR). The DDC, by distributing climate scenario and related information to climate change impacts researchers throughout the world, will ensure that all researchers have the possibility of working with a consistent set of scenarios. This co-ordination will allow climate change impacts research to be better integrated globally, thus enhancing the value of the IPCC TAR.

Through the DDC, impacts researchers will have access to data from recent transient climate change experiments. These represent an advance over older equilibrium experiments, which have been used in the majority of previous impacts assessments. Improved observed global baseline climate data will allow both a better calibration of impact models and an examination of the effects of natural climate variability on impact sectors. Consistent scenarios of other concurrent environmental changes, such as atmospheric carbon dioxide concentration and global sea-level, will also be provided. Socio-economic scenarios will accompany these climate datasets and provide a reference scenario for the future without climate change.

CONSTRUCTING SITE-SPECIFIC CLIMATE CHANGE SCENARIOS USING STATISTICAL DOWNSCALING METHODS

Radan Huth, Czech Republic

The presentation deals with the statistical downscaling of local daily temperatures in Central Europe from large-scale upper-air circulation and temperature fields. Its aim is to compare the performance of several downscaling methods on the observed data, and to apply the selected method to the GCM control run (validation) and GCM 2xCO2 run. The ECHAM3 GCM is used in the study.

The gridded daily fields of 500 hPa heights, 1000/500 hPa relative topography and 850 hPa temperature over Europe and the adjacent part of the Atlantic Ocean are used as predictors; predictands are daily mean temperatures at stations in the Czech Republic, Slovakia, Germany, Austria, Switzerland and Belgium. The statistical downscaling methods examined are multiple linear regression (MLR), canonical correlation analysis (CCA) and singular value decomposition (SVD).

The application of the downscaling methods to the observed data shows that the performance of the downscaling is improved if temperature variables are added to the purely circulation ones (500 hPa heights). The methods treating the predictand field as a whole, not as a set of single points (i.e., CCA and SVD) appear to perform better. The SVD method is then selected because of its relative computational simplicity relative to CCA.

The SVD method is then applied to the predictors from the ECHAM3 GCM control run. Since the method is tuned so as to retain both the mean and variance of the time series, the downscaling is validated in terms of day-to-day persistence and spatial consistency. The downscaled temperatures are much closer to the observed characteristics than the temperatures taken directly from the GCM output. Finally, the downscaling method is applied to the 2xCO2 run. This results in time series of daily temperatures for the changed climate at each station, i.e., site-specific climate change scenario for daily temperature.

CLIMATIC VARIABILITY OF ICE COVER OF BALTIC SEA ALONG ESTONIAN COAST

Svetlana Jevrejeva, Estonia

Estonia is situated over the Baltic sea. The coastal areas of the Baltic sea are covered with ice during the winter season. The low salinity and shallowness assist freezing. Ice observations have a long tradition in Estonia. The first long series of ice conditions began in the late 19th century. These early observations have contributed greatly to our knowledge of climate variation. The present day climate can be seen just as a fleeting picture in a long chain of changes; and we cannot still ordinarily define the fundamental variability of the climate. If we would like to get our own climate and our ideas about ongoing changes in the climate into perspective, it is useful to look back in time.

The objective of the study is to investigate the temporal variability of sea ice conditions of Baltic sea along Estonian coast during the period 1890-1990 and to give a brief description about ice climate changes. The study includes theoretical work and investigations aimed at a comprehensive research with an objective of revealing causes of the changes of sea ice regime formation of Baltic sea. The time series are considered as periodically correlated stochastic processes. Variations as stochastic processes are treated in the framework of both the spectral and values statistics.

Results of this analysis will be used for the development of ice forecasting of various time spans.

MULTIVARIATE STUDY OF THE VARIABILITY OF LOCAL CLIMATES. A CASE STUDY

E. Sanchez, A. Rodriguez, J.P. Montávez, J.I. Jimenez, Spain

Analysis of the monthly mean maximum and minimum temperatures, precipitation, atmospheric pressure, relative humidity and sunshine duration in 2 stations in the souts of Spain have been studied in a multivariate analysis to find variability patterns.

The method used to make this work has been the principal component analysis to reduce the dimensionality of the series in the data base, the hierarchized cluster analisis and a technique called the "subjective method" by Blasing et al, based on the design of an algorith to stablish the patterns by comparison of the multivariate anomaly vectors.

The most important question in using this method is the selection of the estimator, usually the correlation coefficient, and the characterisctics of the algorithm.

In this work we show the five major anomaly patters found using the correlation coefficient as estimator, andl also using an estimator introduced by Ballester and Jimenez (1985) based upon the distance of the representative pojnst of the anomaly vectors projected on the hipersphere unity. We study the consistency of the estimator and compare the resuls of both methods.

The first two anomaly type patters are the representatives of the mediterranean climate in the eastern of the Andalousian Region and in according with the principal component results. For the other patterns we try to make a physical explanation of its origin and consequences.

DEVELOPMENT OF A DOWNSCALING METHODOLOGY FOR ASSESSMENT OF CLIMATE-INDUCED CHANGES IN ACIDIC DEPOSITION OVER EUROPE

Julie M. Jones, Trevor. D. Davies, United Kingdom

Climate exerts a well-researched influence on transport and deposition of atmospheric pollutants. One potential outcome of anthropogenically-induced climate change is alteration of atmospheric circulation patterns. This work seeks to address how circulation changes, as modelled by the transient integration of the United Kingdom Meteorological Office coupled ocean-atmosphere model (UKTR), may influence acidic deposition over Europe.

A circulation classification has been derived using principal components analysis of observed sea level pressure for an area covering the North Atlantic sector. Multiple linear regression analysis was used to develop relationships between component scores and monthly mean concentrations of acidic ions in precipitation for five European stations. Validation of these functions against an independent period of data confirmed that they performed adequately.

An identical classification undertaken for model years 66-75 of the control and perturbed integrations of the UKTR was then developed. Acidic deposition scenarios were derived by applying the regression equations, using their equivalent control and perturbed components, and considering the differences between the two.

Precipitation appears to be of potentially greater importance in determining future acid deposition than do circulation changes. When compared to critical loads levels, the modelled deposition changes were substantial enough, at all sites except one, to influence the possible degree of ecosystem damage. Areas of future research highlighted by this work are the need for improved representation of circulation, and especially precipitation in climate models.

ON THE STUDY OF THE PRECIPITATION INTENSITY OVER THESSALONIKI, GREECE

Peter J. Pennas, Theodore S. Karacostas, Greece

The maximum precipitation intensity is studied at the meteorological station of Thessaloniki, during the second half of the 20th century (1950-1997). Emphasis is given on the quality of the data, the length of the examined period, and most importantly, on the characteristics of the data used, which objectively describe the precipitation intensity at a site.

The analysis of this study is based on data, such as: the total amount and the time duration of the precipitation event, and most importantly, the amount of precipitation received during the 10 minutes that correspond to the maximum precipitation intensity of the event.

The precipitation intensity trend is estimated and studied, throughout the examined period as a total, and for each decade. Comparisons among them are performed. Moreover, annual and seasonal trends are analyzed and their time variability is discussed.

CLOUD CLIMATOLOGY OF THE ALPINE REGION
FROM LONG TERM NOAA-SATELLITE DATA

Martina Kästner, Germany

The present understanding of moist atmospheric processes and the role of clouds in the hydrologic cycle shows severe gaps of knowledge. Clouds play an important part in atmospheric dynamics. The release of large amounts of latent heat, due to the condensation in convective clouds, plays an important role in the general circulation. Knowledge of the distribution of clouds and its transport is essential to understand atmospheric dynamics. Clouds can have a positive as well as a negative contribution to the greenhouse effect.

A 5-year cloud climatology in a 15 km grid resolution has been retrieved by means of the APOLLO (AVHRR Processing scheme Over cLouds, Land and Ocean) algorithm using the 5 calibrated AVHRR channels. APOLLO uses 7 tests to determine a pixel-by-pixel cloudmask in 1-km-resolution, in which the information of totally cloudy, partially cloudy, and cloudfree pixels over land, snow or ice is stored. Maps of daily, monthly, seasonally, and annual cloud cover of a 550 x 560 km2 region over the Alps and their forelands are available. The monthly mean cloud cover has been compared to conventional ground observations at many synoptic stations. The satellite derived data are about 10-15 per cent too high over land, mainly due to bad results of the ratio-test over bare soil and to some extent due to the diurnal course of cloudiness, as the satellite data are from midday to early afternoon daily. The classification of clouds, snow, and ice is successful in many cases.

The high resolution cloud cover maps show topometeorological features like Foehn on single days but not in monthly means, because these events are too rare. Luff regions with increased cloud cover and cloud sparse regions like Lake Garda or the Swiss Rhone valley are detected in monthly means of cloud cover. Different annual cycles of cloud cover in the temperate, Alpine, and Mediterranean climates are displayed in the cloud climatology. For example, the cloud cover over the Alps is remarkably smaller in winter than in the mostly foggy northern and southern forelands. A singularity like the Indian summer in southern Germany or South Tyrol is seen as a cloud sparse region in the annual cycles of cloud cover.

CASE STUDY OF A CLIMATE-SENSITIVE LAKE: CLIMATE CHANGE AND THE NEUSIEDLER SEE (FROM THE BEGINNINGS OF THE "ANTI-INUNDATION" WORKS THROUGH THE 19-20TH CENTURIES)

Andrea Kiss, Hungary

The Neusidler See, the second largest lake (322 km^2) of the Carpathian Basin is situated in the border territory of Austria and Hungary. In spite of the wet continental climatic conditions, it is the most western sodic stagnant water of Europe. This apparent contradiction is caused not only by the hydrological conditions of its small chatchment area, but also by the sulfureous springs and mineral waters inside and around the lake which can explain the unusual mineral components of the water.

On the other hand, the average depth of the Neusidler See is only 0.5 m, therefore it is very sensitive too for the hydrological and precipitation changes of its catchment area, and small climate variabilities can cause large changes on the shoreline of the lake. Moreover, the catchment area of the lake is extremely small: only one significant stream and some other even smaller ones, along with the annual precipitation sustain the lake. It has no natural outflow, but there is a canal which was made in the late eighteenth century, and continously enlarged until the fist half of the twentieth century. Therefore, the water balance and the actual waterlevel and shoreline of the lake strongly depend on the changing climatological conditions (mainly on the proportion of precipitation and evaporation), and the growing human influence.

There is another factor which occasionally has a large influence on the lake: the prevailing wind directions (especially the southern and northwestern ones). Their sustained presence can have crucial effects on the waterlevel of specific parts of the lake which cause the mass extinction of fish, as happened e.g. in 1932 when - because of the prolonged southern winds - water disappeared from the southern basin of the lake for some days.

For the above-mentioned reasons, the Neusidler See is ideal for an examination of the connections between recent climate (especially precipitation) changes and a climate sensitive region, and the human influence on the water-balance of a changeable lake. In this area, systematic meteorological observations started in the middle of the nineteenth century, but there are many detailed descriptions for earlier times as well.

On the bases of earlier works and my own examinations, I study the climate changes of the region in connection with the shoreline and water balance changes of the lake and its close environment. I also try to compare these results with the previous, more or less natural situation (before the beginnings of the "anti-inundation" works at the end of the eighteenth century) of the lake and to indicate the changes in the last two centuries until the present time (1995).

In my poster I would like to present and emphasise how this "regulated" lake responds to the climate changes of the last two centuries.

VARIABILITY OF AIR TEMPERATURE AND PRECIPITATION IN BULGARIA AND ALBANIA

Ekaterina Koleva-Krasteva, Bulgaria

The seasonal and annual air temperature and precipitation in Bulgaria and Albania was analysed for the period 1901 – 1996. These countries are situated on western and eastern part of Balkan Peninsula. The spatial distribution of temperature and precipitation was examined. A regional anomaly index was used for the study and assessment of climatic variability during the last 95 years. The preliminary results indicate that in annual precipitation and temperature the decreased tendency persists. In order to emphasise the trend in the time series the statistical tests ate applied. An evaluation was made of the contribution of each season for the annual temperature and precipitation along the thirty years periods of 1931-1960 and 1961-1990.

FLUCTUATIONS IN THE LONG-TERM ANNUAL MEAN AIR TEMPERATURE DATA OF TURKEY: AN ANALYSIS FROM CLIMATIC VARIABILITY PERSPECTIVE

Ali Umran Komuscu, Turkey

It may become very important to understand nature of the regional temperature variabilities for countries like Turkey which has enormous agriculture and water resources potential. This paper presents a time series analysis of fluctuations in long-term annual mean air temperature series of Turkey for non-randomness by autocorrelation function and power spectrum methods, Power spectral estimates are computed with the purpose of finding evidences of cyclic component with the series. The analysis covered period of 1930 to 1995 and included 71 stations in seven geographical regions.

For most series, the correlograms revealed no apparent patterns of cyclicity. Arithmetic average of the positive correlation values is about 11 years, and that well corresponds with the sun-spot cycle effect on the temperature occurrence. A further analysis of the series by power spectrum indicated little evidence for statistically significant differences from the white-noise spectrum. In most cases the spectral densities above the white-noise level tended to peak at frequencies corresponding to 2.4 - 3.1 and 3.3 - 4.3 years, pronounced particularly in the regions of the East, Mediterranean, Central, and Southeastern Anatolia. The 3.3 - 4.3 year peaks in the Central and Southeastern Anatolia regions were significantly different from the white-noise at 95 per cent level. Roughly two groups of regions with different spectral shapes are identified. The coastal regions almost exhibited white-noise spectrum while the inland regions tended to approximate gray-noise type spectrum.

SUMMER RAINFALL CLIMATOLOGY AND ITS PREDICTABILITY OVER ETHIOPIA

Diriba Korecha, Ethiopia

Three rainy seasons are identified in Ethiopia among which the Bega (October - January) considered as the period of little rain, windy, warm days and cool nights over northern half of the country. The other two seasons; Belg (February - May) and Summer "Kiremt" (June - September) account for 20% & 70% of national annual rainfall budget respectively.

As many tropical countries, Ethiopia's rain-producing systems are global & regional in nature and hence highly affected by global atmospheric and oceanic circulation. Thus El Nino/La Nina, warming/cooling of tropical equatorial Pacific Ocean contributed much for the failure/success of Summer rain over Ethiopia.

Through extensive statistical works that based on rainfall data of 1950-96, the results revealed that there were strong correlation between the occurrence of past droughts over Ethiopia & warming of sea surface temperature over aforementioned Ocean.

In this paper attempts have been made to identify those areas of the country which had high probability of vulnerable for drought during the past four decades. Based on the findings some climatological trends and their predictability will be constructed & introduced.

CLIMAT VARIATION IN BULGARIAN PART OF THE DANUBE PLANE

Loutchian Krastev, Bulgaria

Climatic data from 10 Bulgarian stations representative for the different parts of the Bulgarian part of the Danube plane are used. The basic period is from the beginning of the 20th century till 1997. The variation and trends of the temperature and precipitation time series and related events like Danube icing and snow cover is studied. The extreme events and their occurrences are emphasized on. It is found that there are considerable differences in variations and trends of the main climatic elements in different seasons and different parts of this, comparatively small region.

INTERNATIONAL PROJECT ON CLIMATE CHANGES AND VARIABILITY IN THE WESTERN CARPATHIANS

Milan Lapin, Danuta Limanowka ,Tadeusz Niedzwiedz, Elena Nieplová, Slovakia

Mutual collaboration of Polish and Slovak climatologists is dated for several decades. The monography "Climate of the Tatras" published in 1974 (856 p.) was one of the most expressive results. In 1994 a new project titled "Climate Changes and Variability in the Western Carpathians" was established. Climatologists from the Polish Institute of Meteorology and Water Management (IMWM) branch in Cracow and the Slovak Hydrometeorological Institute (SHMI) in Bratislava took part in this project. The main subject of the presented study is the science of climatic changes and variability in the Western Carpathians during the 1951-1995 period. The investigated mountains with the highest range of Tatra Mts., with a typical alpine landscape and altitudes exceeding 2600 m, are situated in the Central Europe and they are lying parallel with a latitude. Due to its orientation it is also a climatic boundary. The crestline of the main ridges is the frontier between Poland and Slovakia so that a full account of the mountain climate required the collaboration of climatologists from both countries.

The climatic conditions in the whole investigated area are very differentiated with typical vertical climatic zones and large spatial contrasts between the southern and the northern regions (Danube and Vistula valleys, respectively). In these both sides the long meteorological series exist since 1792 at Cracow and since 1872 at Hurbanovo. All used stations represent different morphologic locations (from the mountain peaks: Lomnický Štít, Kasprowy Wierch, to the valley bottoms: Poprad, Zakopane). The most of the study is based on monthly data calculated from observations in 3 daily (climatological) terms. Because of different observation terms in Poland and Slovakia some intercomparisons and data recalculation was needed. Meteorological stations Cracow, Hurbanovo and Košice represent the southern and northern edge of the Carpathian chain. On the background of the data from mentioned stations, long term climate variability is presented (air temperature, precipitation, snow cover, wind, cloudiness, sunshine duration, air humidity). The circulation conditions over that area, based on the synoptic maps of Europe since 1873, have also been considered. Results of the research suggest that climatic changes resulted from the increasing influence of air mass advection from the Atlantic Ocean during the last 20 years. In all elements 1980 was the "turn point" year when the course of tendencies significantly changed.

The more detailed studies were done on the basis of several (10-25) stations situated on the both sides of the Carpathians, including two summit stations: Lomnický Štít (2635 m) and Kasprowy Wierch (1991 m). In the first stage the data base of daily and monthly values has been prepared. The special attention was paid on the homogenisation of the raw series which belong to both national meteorological networks. Final data were based on the period 1951-1995 and concerned to the climatic elements as follows: air temperature, precipitation, snow cover, cloudiness and sunshine duration, wind conditions and air humidity. Workshops on preliminary results and methods have been organised annually in Poland and Slovakia. A set of papers with final results is planned to be published in 1998 and 1999. Results of these particular problems are presented in separate ECAM papers (posters).

TEMPERATURE VARIABILITY IN THE WESTERN CARPATHIANS

Danuta Limanowka, Poland

The paper aims at a cognition of the fundamental characteristics of atmospheric circulation in the Western Carpathians and their influence on air temperatures. Atmospheric circulation, besides radiation factors, plays a key role in the Carpathian climate. Therefore, knowledge about time variability of circulation forms helps to explain genesis of change in particular elements of climate over a given area. The presented paper contains temporal and areal analyses of the thermal conditions in the Carpathians during the 1951 - 1995 period. Particular attention has been paid to showing the influence of continentality and oceanity on tendencies in the course of air temperature in various parts of the Carpathians. Selected stations represent different morphologic locations (from the mountain peaks: Lomnicky Štít, Kasprowy Wierch, to the valley bottoms: Poprad, Zakopane). Meteorological stations Krakow and Hurbanovo represent the Southern and Northern edge of the Carpathian chain. Variability in mean temperatures in relation to monthly, maximum and minimum values was studied for a year and for seasons defined in a standard way: winter (December-February), spring (March-May), summer (June-August) and autumn (September-November). In the variability analysis, short-term fluctuations have been eliminated by smoothing, using the method of 5-year moving averages. The analogous criterion has been used in the case of circulation index P and S which is depicted in each figure.

ANALYSIS OF STREAMFLOW DATA IN THE BULGARIAN REGION WITH RESPECT TO CLIMATE VARIABILITY

Bernardo Lizama Rivas, Bulgaria

The river discharges reflect the areally integrated climate inputs and therefore provide more pertinent information on climate variability and less local "weather" type variability than station records of precipitation and temperature. On the basis of the set of data from some gauge stations with more than 35 years of observations was studied the time variability of the streamflow data in the bulgarian streams. The number of time series of river flows that have not been influenced by man is very limited, while time series of precipitation have been less subject to such influence. It should be noted that, wherever mention is made to the influence of man, the reference is to man's direct impact on the element concerned in the local area.

The aim of this paper is to analyse the streamflow variability with respect to climate variability, as river basins integrate local meteorological variability, there is also the consideration that flow data represent filtered climate data. The time variability was investigated using the technique developed in WMO/TD-No 224. The reference hydrological state was defined for a period of 30 years. A comparison was made of the the differences between the statistical parameters of the hydrological states for various equal lenth periods. For this purpose the record was divided into "n" periods each of "m" years. The basic statistics were computed for the "n" periods. Using the above mentioned methodology was possible to offer indications whether the time series have normal variability, trends and jumps related to man's activity or related to local specific natural causes.

COMMON MODEL OF CLIMATE VARIATIONS AND ASSESSMENT OF PREDICTABILITY OF ITS PARAMETERS

Vladimir Lobanov, Russia

The common model of climate variations has been developed for the description of fluctuations of meteorological characteristics on the intra-annual as well as inter-annual scale. This model has a linear structure to connect the average long-term conditions with the conditions of the particular year and 3 parameters: b1 and b0 coefficients, that characterize the difference of climatic conditions (amplitude and level of intra-annual function) in the particular year and S-parameter that characterize the intensity of macro-synoptic processes in the particular year. The linear kind of the model has been checked for different meteorological characteristics, such as air temperature, precipitation, etc.

Linear temporal common model of climate variations has been extended forspatial modelling too. In this case b1 and b0 coefficients characterizethe gradient and level of the field of any meteorological characteristicin the particular year and S-parameter characterizes the temporal-spatialintensity of macro-synoptic processes during the particular year over the region.

The common models of temporal climate variations have been developed for the longest time series of monthly air temperature and precipitation in Europe. Three different-scale processes have been obtained in time series of b1 and b0 coefficients and non-stationarity for S-parameter during the long-term period. The empirical relationships between coefficients and parameters of different meteorological characteristics have been established. Spatial common models of climate variations have been developed for different parts of Europe (Northern, Central, Western, Eastern and Southern) on the basis of information in the points of regular grid. Different kinds of trends have been obtained for different European parts and different spatial model coefficients and parameters and they are explained.

Method of super-long-term forecasting has been developed on the basis of different-scale conception. This method allows to predict of every scale process separately, to predict the characteristic of cycle addition to the every-year value, to correct the predict result in some times and to make the complex assessment of forecast efficiency and stability. The application of suggested predict method has been given for parameters and cofficients in the case of common temporal and spatial variations model. The positive possibilities of the prediction on the period 5-15 years are discussed.

SPATIAL MODELING OF MONTHLY PRECIPITATION PATTERNS FOR AUSTRIA OUT OF RESPONSE MODELS APPLIED USING NEURAL NETWORKS AND EXPLANATORY VARIABLE SURFACES

Wolfgang Loibl, Austria

Overview

Precipitation modeling is performed using empirical response models with explanatory variables that reflect the influence on precipitation. Based on assumptions referring to local affect on rainfall amount, several more explanatory variables besides altitude are modeled as surfaces and integrated into the modeling process. Instead of regression functions artificial neural networks (ANNs) are applied.

Assumptions to model spatial patterns of monthly rainfall

While modeling spatio-temporal variation of rainfall in Austria one has to consider various spatial influences on rainfall. The Eastern Alps act as barrier to the European continental climate system The intersection of 4 climate zones divides Austria into different climate regions with different rainfall patterns; these influences are: marine (W,NW region), continental (E), "illyric" (SE) and (at higher altitudes) boreal/nival. Because of different local climate influences, one has to consider *the importance of the respective location within the Alpine valley-ridge system*. Several assumptions regarding to locally based rainfall influences have to be made, which are later "translated" to explanatory variable surfaces:

    a. Altitude is still one main influence on rainfall amount,

    b. different regional exposure to main large-scale weather patterns lead to local precipitation variation

    c. different location within the Alpine valley-ridge system are exposed to different rain shadow effects

    d. large scale oceanicity - continentality gradients lead to general W-E directed precipitation decrease

EMPIRICAL ORTHOGONAL FUNCTION ANALYSIS OF MEAN SEA LEVEL PRESSURES FOR THE NORTHERN HEMISPHERE AND THE EARTH

László Makra, Hungary

Long-range weather forecasts, for the duration of 1-3 months require to use at least hemispheric-scale meteorological data.

In the present study seasonal and monthly mean sea level pressure fields have been analysed to examine spatial patterns of variability of circulation for the Northern Hemisphere and also for the whole Earth. Furthermore it is studied that how spatial patterns of variability are modified over the Northern Hemisphere by those of the Southern Hemisphere. Predictability of some aspects of these patterns is also studied.

The data basis stem from 247 meteorological stations which are approximately evenly distributed on the earth. Empirical orthogonal function (EOF) analysis of monthly and seasonal sea level pressure anomalies is used to determine the dominant modes which explain most of the variance for the period 1958-1980. Eigenvectors of January, April, July and October, moreover those of each season

HARMONIC ANALYSIS OF THE MEAN ANNUAL VARIATION OF THE AIR TEMPERARURE OVER THE EUROPEAN AND MEDITERRANEAN AREA

Timoleon Makrogiannis, Greece

The mean annual variation of the air temperature over European and Mediterranean area has been studied, using Harmonic Analysis Method. Basic data consists of the mean monthly values of air temperature , during the period 1961-1990, reporting by 113 stations through the studied area.

The geographical distribution of these values has been examined for four representative months of the year. Using the Harmonic Analysis, as method -in order to study the mathematical function of this mean annual variation- has been found that the first two harmonic terms contribute, altogether, to the total variance >95%.

The amplitude values of the first harmonic term, that is connected with the solar energy balance, vary between 5 and 10 degrees Celsius and they increase from West to East. They are maximized, over the studied area, between 14 July and 15 August.

The values of the amplitude of the second harmonic term compared with those of the first one are considered negligible. They are maximized during January and February.

VARIABILITY HIDRO-CLIMATE IN THE BACIN HYDROGRAPHIC TO DUERO RIVER

M Dolores Manso Orgaz, Portugal

-The domain concerning this study is located betwen, northern latitudes of 40º 20´ and western longitudes of 1º 14´and 8º 40´, cutting longitudinaly a 97170 km2 area of the Iberian Peninsula, with an East-West dominant orientation.

-Our study focus on the water variability and on the variability of each component of the system accounting for the water budget: precipitation, evapotranspiration and the mean river flow observed at 40 stations during more then 30 years.

The methodology of this study is as follows:

-Application of an hydrographic model based on the laplacian of the altitude and on the distance from the sea, in order to empirically estimate the precipitation, the runoff and therefore the hydrographic budget.

-Study of the common oscillation of the resulting series with the Fast Fourier Transform methods as well as application of the method of principal components to emphazise regions whit similar climates.

COMMON ELEMENTS IN THE SHORT-RANGE CLIMATE VARIABILITY OVER EUROPE AND AT ROMANIA'S SCALE

Ileana Mares, Romania

For the local scale, the monthly mean temperatures and the precipitation monthly totals have been considered from 31 stations, for the interval 1950-1993, and separately, two stations with the longest observational sequences, Sibiu (1851-1993) and Bucharest (1857-1993). At the regional level, the geopotential at 500 hPa has been analyzed, defined in the sector (500W-400E) and (350-650N) during the period 1945-1993. Further more, for the 500 hPa geopotential a blocking index has also been calculated over the entire above mentioned sector as well as on 2 other sectors (Atlantic and European).

The climate change points have been detected and their statistical significance has been tested by means of the nonparametric statistical tests and of the value of the signal-to-noise ratio. Although the processing has been carried out also on months, the results in the paper are presented only for the averaging on seasons and year. For example, for the annual values, 1981 is a change point in the precipitation and geopotential fields represented by EOF1 as well as by blocking indices.

The precipitation decreasing in Romania is determined by the geopotential increase in the southeastern part of Europe. As regarding the seasonal fields, significant change points have been obtained in Summer and Autumn during the period 1965-1968 and for the Winter, during 1970/1971.

VALIDATION OF A STRETCHED-GRID CLIMATE MODEL

Pascal Marquet, France

The climate model can be used at Meteo-France either for global or for regional simulations. The global version is based on the Arpege-IFS spectral model and validation was obtained through an AMIP run (Deque et al., Clim. Dyn., 1994). The more recent improvements are: the linear grid method, a semi-lagrangian scheme, a statistical cloud scheme, a 4-layers soil scheme.

When regional impacts are concerned, it is possible to use a stretched coordinate version of the same model (Deque and Piedelievre, Clim. Dyn., 1995). The resolution varies continuously from more than T200 around Europe (50 km) to less than T30 at the antipodes (Australia). There is no problem with lateral boundaries like for nested models method: the stretched model is global too.

New validations of both global and regional versions will be presented, with a special attention paid to the Europe climate and to the expected improvements caused by the changes in the parameterizations.

EVIDENCE OF RECENT CLIMATIC CHANGE IN THE WESTERN ITALIAN ALPS: A REGIONAL ANALYSIS

Luca Mercalli, Claudio Castellano, Italy

A data base was created using daily observations of temperature, precipitation and snow depth registered from original paper records, some dating back to as much as 100 years. The data came from approximately 50 stations located in the Western side of the Italian Alps (Piedmont and Val d'Aosta) most of them from mountainous areas not affected by urban development.

A territorial synthesis was developed with the aim of detecting climatic changes during the last century by means of a regional anomaly index.

The temperature analysis shows temporal anomalies with respect to the long term mean and also a trend toward higher values during the last decade. A study of precipitation behaviour indicates alternate periods of dry and wet weather with no evidence of any particular trend. Concerning snowfall, the series shows a general reduction in annual amounts starting from 1980 which reflects itself in the annual evolution of the average snow depth and duration.

CHOOSING A LINEAR MODEL WITH CHANGE-POINTS: APPLICATION TO THE HOMOGENIZATION OF PORTUGUESE TEMPERATURE SERIES

Olivier Mestre, France

Many long instrumental climatological records are available and might provide useful informations in climate research. But these series are usually affected by artificial shifts, due to changes in the measurement conditions. The comparison with surrounding weather stations allows to check the reliability of the series, since the climatic signal has to be removed prior to any analysis. An adapted penalized log-likelihood procedure is used to detect an unknown number of breaks and outliers. The example of portuguese temperatures series confirms that a systematic comparison of the series together is valuable and allows to get rid of the reference series previously used.

RANDOM TREND IN SECULAR CLIMATOLOGICAL TIME SERIES

Ladislav Metelka, Czech Republic

The secular climatological time series are an important source of information about the behavior of the climate system in the decadal and centennial time scales. One of the most important secular time series at the Czech Republic territory originates from Cáslav (49°55'N, 15°25'E) and it covers the period of time from 1876 to the present. Monthly mean temperatures and precipitation sums from Cáslav station were processed with the help of Box-Jenkins methodology.

SARIMA$(1,1,1)$x$(0,1,1)_{12}$ model has been identified for the temperature time series. It suggests that both simple and seasonal differentiations were needed to transform the original unstationary time series (with significant trend and seasonal components) into the near-stationary series. Statistical tests indicate that the properties of the residual component are close to the white noise with $N(0,1.97)$ distribution function. Therefore it is possible to „extend" the residual component of Box-Jenkins model using generated time series with $N(0,1.97)$ distribution. Twenty $N(0,1.97)$ time series have been generated and the Box-Jenkins model residual component was „extended" with the help of these series. Since the Box-Jenkins model is autoprojective, all the values involved in the time series are given only by the residual component series and by several values at the beginning of the time series. Both model and the values at the beginning of the time series were the same in all 20 simulations.

Some of these simulations revealed very interesting features of the „extended" parts of temperature time series; quasiperiodical oscillations, trend shifts, increasing or decreasing trends etc. The only factor influencing the behavior of the „extended" part of the time series is the random component (generated time series). Many of these simulations produce so called „random trend" (systematic or quasisystematic changes in heating or cooling rate).

From the physical viewpoint we could assume that a deterministic trend exists and that it is caused primarilly by the global heating and the greenhouse effect. However, the random trend can take place within some periods of time causing some short-term deviations from the prevailing long-term trend.

The precipitation data set had to be transformed first of all, because the original time series didn't match the normal or near-normal distribution. Box-Cox transformation was used for this purpose. Then Box-Jenkins model SARIMA$(0,0,1)$x$(0,1,1)_{12}$ has been identified for the transformed time series. The seasonal differentiation was needed due to the significant annual course in the original time series. The distribution of the residual component was close to $N(0,25)$. 20 series with $N(0,25)$ distribution have been generated to „extend" the transformed precipitation time series.

Because the long-term trends are not so evident in precipitation time series as for example in temperature time series, simple differentiation was not needed. In the case of the Cáslav precipitation series the AR_1 term is negligible that suppresses the possibility of random trend occurence. The behavior of simulated parts of time series corresponds well to this presumption; only some variations of data variability or mean level but no long-term „random trends" were detected. In this case the residual (or random) component may not induce the random trend.

ASSESSING THE CLIMATE CHANGE IMPACT ON AGROCLIMATIC RESOURCES OF THE FORMER SOVIET UNION USING GCM GENERATED SCENARIOS

Olga Nasonova, Russia

Assessing the climate change impact due to doubling of carbon dioxide (CO_2) on heat and water resources of the European territory of the Former Soviet Union, Western Siberia, Kazakhstan and Middle Asia is carried out. Heat resources are characterized by the sums of surface air temperature above 5 and 10 C and by the length of the periods with air temperature above 5 and 10 C. Water resources are described by the hydrothermal coefficient by Selyaninov. Seasonal and local changes in surface air temperature and precipitation due to doubling CO_2 simulated by the two high resolution general circulation models, namely, GFDL (Geophysical Fluids Dynamics Laboratory, USA) and CCCM (Canadian Climate Center Model), are used as climatic scenarios. For these scenarios the expected changes in heat and water resources and in the boundaries of agroclimatic zones were obtained, plotted and analyzed. The regions subjected to the greatest changes in agroclimatic resources were revealed. Averaged over the whole area, relative increments of the sums of surface air temperature above 5 and 10 C are expected to be equal to 40% (CCCM) - 45% (GFDL) and 48% (CCCM) - 55% (GFDL), respectively; relative increments of the duration of the periods with air temperature above 5 and 10 C can reach 22% (CCCM) - 26% (GFDL) and 35% (CCCM) - 41% (GFDL), respectively. The obtained changes in heat and water resources are favorable for most of the territory.

OBSERVED AND GCM-SIMULATED VARIABILITY IN TEMPERATURE SERIES

Jaroslava Kalvova, Ivana Nemesova, Czech Republic

General Circulation Models (GCMs) are the tools most widely used to generate projections of climate change for impact assessments which can be particularly sensitive to the variability of climate elements and the occurrence of extreme events. The variability in terms of standard deviations, trimmed standard deviations, interdiurnal variability and frequencies of changes between two consecutive days are examined in daily series of mean and extreme temperatures simulated by ECHAM3/T42 (1) (individual gridpoints and means) and observed in south Moravia (individual stations and area means), and two small basins in Bohemia. 30-year series are compared between both the real data and control run, and $1xCO_2$ and $2xCO_2$ experiments. Tests for differences in variances make use of jackknife method. The temporal behaviour of simulated 30-year series ($1xCO_2$) cannot be identified with that of the series measured during 1961-90. However, mean characteristics of both sets should correspond to a certain degree.

The ECHAM overestimates/underestimates daily minimum/maximum temperatures according to seasonal trimmed averages, the differences between the reality and simulations being mostly significant. Thus, the daily temperature range is reduced.

The simulated daily series of mean and extreme temperatures are more persistent than those observed. The model underestimates variability of temperatures (trimmed deviations) in all seasons, the highest differences being found for winter. Average interdiurnal variability is lower in the model as well. The values of differences in temperatures between two consecutive days and their frequencies show that the model prefers small day-to-day changes at the expense of larger changes observed in the series measured. The mean duration of the heat waves, e.g., is doubled in the simulations.

The mean seasonal values of trimmed averages of extreme temperatures are found larger in the perturbed run ($2xCO_2$), the highest (lowest) increase being in summer (winter). The differences between variances of the datasets are statistically significant only for summer extreme temperatures. The average interdiurnal variability of maximum temperatures increases, and relative frequency of day-to-day changes up to $2\,°C$ decreases by about 9 %.

The main finding of this study is that the ECHAM series are more persistent than the real ones, with respect to both interseasonal and interdiurnal variability. The feature is in accord with estimates of autocorrelation functions (2), and does not seem to be of local character. A plausible explanation may be, e.g., a stronger zonal circulation simulated by the model in our region.

DEVELOPMENT OF 0.5 DEGREE LATITUDE BY LONGITUDE OBSERVED DATASET OF MONTHLY SURFACE CLIMATE FOR THE PERIOD 1901-1996

Mark New, Mike Hulme, Phil Jones, United Kingdom

Long-term, high resolution global datasets of surface climate are necessary for a number of applications in climatology and global change studies, including evaluation of General Circulation Model and Limited Area Model control simulations, comparison with satellite-derived equivalents and biogeochemical modelling.

We have developed a dataset of 1901-1996 monthly climate from weather station observations for a suite of climate variables: precipitation, wet-day frequency, mean temperature, diurnal temperature range, vapour pressure and sunshine and ground-frost frequency. The monthly climate surfaces are at 0.5 degree latitude and longitude resolution and cover global land areas.

The dataset was constructed in three stages. First, a 1961-1990 mean monthly climatology for each variable was constructed from an entirely new dataset of station climatological normals. Station network densities varied from 20,000 for precipitation to 6,000 for vapour pressure and sunshine. These data were interpolated using trivariate thin-plate splines, as a function of latitude, longitude and elevation. After the construction of these "baseline" climatologies, surfaces of monthly anomalies relative to the baseline period of 1961-1990 were interpolated from a more limited dataset of station monthly time-series covering the period 1901-1996. Station network densities for this anomaly interpolation varied from 11,000 for precipitation to 6,000 for diurnal temperature range. Finally, the anomaly surfaces were added to the baseline climatology to arrive at grids of monthly surface climate.

This dataset represents a significant advancement over existing gridded climate datasets, in that:

· it is a high resolution dataset,

· it comprises a comprehensive range of variables,

· it covers the entire 20th century,

· it explicitly captures the effects of elevation on climate, and

· it separates the spatial and temporal variability components of climate in its interpolation strategy which allows the maximum information about the spatial variability of mean climate from later, data-rich years to be incorporated into the entire time series.

VARIABILITY OF ATMOSPHERIC CIRCULATION INDICES ABOVE THE WESTERN CARPATHIANS

Tadeusz Niedzwiedz, Poland

The study presents variability of different circulation indices above the Western Carpathians for the long period 1873-1997. They were used to estimate the changes of atmospheric circulation over the investigated area. For that purpose some synthesis in the materials dealing with the frequencies of 21 different circulation types had to be done. The results have been obtained using the simple circulation indices P (progression or W - westerly), M (meridional), S (southerly), C (cyclonicity) as proposed by R. Murray and R. Lewis. The author calculated these indices for the year and the particular seasons.

The most important seems to be the W index. For the investigated area its mean value reaches 120. The largest intensity of the westerly flow was observed during 3 periods: 1891-1904, 1924-1932 and from 1983 to 1994. The highest annual values were noticed in 1990 (245) and in 1899 (239). The negative values which point the prevalence of the easterly air flow frequency have been notified only in: 1963 (-41), 1972 and 1996 (-18). That index is very well correlated with the winter temperature.

Variability of the S index was oscillated a little less than the previous one. Generally the highest intensity of the southerly airflow was observed during the 1920-1940 but highest values of the index reached 100 in 1960 and 99 in 1951. Before 1920 the negative values of this index (prevailing of the northern advection), with minimum -99 in 1899, were appeared. The second such period occurred in 1940-1949 (-57 in 1945) and the third one after 1980. Especially the last year (1997) was distinguished by the low S index value (-63).

Western Carpathian area is under more frequent anticyclonic influences than cyclonic. Thus can be seen in the negative average value of the C index (-60). Its minimum happened in 1921 (-228) when the highest frequency of the anticyclones has been observed over the Central Europe. However in the period 1965-1975 the analysed index was positive with the relatively large maximum in 1970 (102). After 1975 the distinct decreasing trend was observed (e.g. -142 in 1990 and -101 in 1997). Cyclonicity index together with the S index play the important role in the origin of the orographic precipitation causing the flood situation over the investigated area.

STUDY OF THE EFFECTS OF DOMAIN SIZE AND LATERAL BOUNDARY CONDITIONS FOR REGIONAL CLIMATE SIMULATIONS OVER THE IBERIAN PENINSULA.

Dolores Olmeda, Spain

A second-generation regional modeling system (RegCM2) from the "National Center for Atmospheric Research" in Boulder (Colorado), has been used to asses the impact of domain size and lateral boundary condition, on the simulation of sea level pressure, 500-hPa geopotential height and precipitation over the Iberian Peninsula.

Sensitivity experiments included simulations with increasingly large domain and different boundary condition specifications have been carried out. The results from these simulations revealed that while the model performance in simulating sea level pressure and 500-hPa geopotential height patterns showed an asymptotic behaviour with domain size, the simulated precipitation did not, and tended to continually increase.

THE NORTH ATLANTIC OSCILLATION: OBSERVATIONS, MODELS AND PALEODATA

Timothy J Osborn, Keith R Briffa, Simon FB Tett and Philip D Jones, United Kingdom

The North Atlantic Oscillation (NAO), one of the major modes of the Northern Hemisphere atmosphere, has strong and wide ranging impacts on westerly flow, Atlantic storms, Atlantic wave size, temperature, precipitation, icebergs, zooplankton and fisheries. It is currently of particular interest because the winter NAO index increased from the 1960s to the 1990s, coinciding with a strong winter warming of the Northern Hemisphere land masses relative to the oceans (both trends being the largest interdecadal signals in their respective records). Since this pattern of warming is similar to that expected when either the NAO index increases or greenhouse gases increase, important questions are raised. Is the greenhouse effect causing the warming, or is the observed warming simply due to a natural fluctuation of the climate system? Or perhaps the greenhouse effect is manifesting itself by amplifying the natural modes of the climate system? Are the recent changes in the state of the North Atlantic Oscillation and the winter warmth of the Northern Hemisphere land unusual?

These questions must ultimately be answered by global climate models, but to do so requires models that can produce faithful simulations of the NAO. Results will be presented evaluating both the spatial and temporal aspects of the North Atlantic Oscillation in a 1400-yr integration of the Hadley Centre's climate model. The anomaly patterns of pressure, synopti

MANAGING NATURAL CATASTROPHES BY HISTORICAL DATA SETS

Emanuela Piervitali, Italy

The global environmental variations, that in general are agreed to be of natural, non-anthropic, origin, are normally concerned with time ranges that extend much beyond the instrumental period. The historical data sets can be considered as the output of a peculiar monitoring instrument, i.e.mankind, for collecting some specific proxy data record. We show how a suitable use of such a database, eventually correlated with other datasets, can sometimes (although not always) result useful even for issuing long range forecasts. A prevision is characterized by time and space co-ordinates. For example, a seismic risk map is a prevision with a reasonably detailed space co-ordinate, and a vaguely defined time co-ordinate. But, on other circumstances, a prevision can be made with some better time resolution. We will show a few such examples (such as the successful prevision of the floods of northern Italy occurred in November 1994, or the prevision of the next catastrophic explosion of Vesuvius, that was used for preparing the evacuation plan of the interested area). We will also show how several different data sets are mutually consistent with an explanation of the transition between the Little Ice Age and present climate. The approach does not require considering altogether the entire sum of evidences got from a huge ensemble of data series. Rather, it requires dealing, in a step by step study, with every data series becoming eventually available, as every such set requires a careful analysis of its own for getting rid, whenever possible, of the drawbacks of the uneven distribution of the information and of its intrinsic, although often unknown, error bars. In fact, every such set must conform with some self-consistency properties, by which e.g. the 22 century data series of the Tiber floods in Rome resulted basically useless, unlike a 6 century data set in northern Italy that allowed for issuing successfully the afore-mentioned flood prevision.

There is no unique and general mathematical test, or rule, or else. Every data series is a case histories of its own. The physical inferences are one possible additional basic methodological criterion, the prime rationale being basically only common sense.

ENSO RELATED PNA/NAO SIGNAL COMPARISON

Judit Pongracz, Hungary

It has been demonstrated that large scale oscillation phenomena (e.g., ENSO, NAO, PNA,...) have a great importance in determining many climatic variables at different regions of the Earth. These phenomena do not take place independently, however, the mechanisms and inter-relationships are not completely understood so far. The main idea of this paper is to develop a statistical relationship between indices of these atmospheric oscillations and large-scale patterns of atmospheric circulation over the area examined. Then, an analysis of atmospheric circulation patterns (CPs) is used to explain the linkage between large-scale forcing and local climatic response via a conditional probability framework. Given such a relationship the accuracy of estimating local climatic variables from ENSO and other atmospheric oscillations can be expected to increase. The following procedure is used for midlatitudes in the Northern hemisphere (Atlantic European and Western U.S. region). First, the CPs will be deined and the CP time series will be described. Then, the time series of large-scale circulation will be compared for the different oscillations events. The frequency distributions of time series of CP types under different phases of large-scale oscillations will be examined.

TEMPERATURE PATTERNS DURING CLOUDY SITUATIONS

Ulrika Postgard, Sweden

During the latest twenty-year period several countries with severe winter road climate have developed models to be able to decide when and where maintenance action need to be done to prevent road slipperiness. Most of these models give up to 24-hours predictions of road surface temperature at a specific location and are based on the energy balance equation. The Local Climate Model (LCM) that has been developed at Physical Geography in Göteborg, Sweden instead gives now-casting of the surface temperature along the road. The model therefore provides more diversified information compared to if only field stations are used and makes the right maintenance decision easier. The model uses surface temperature, wind speed and cloud cover from field stations in the Road Weather Information System (RWIS) as input data. An algorithm chooses the prevalent temperature pattern by comparing different reference stations in the area and then finally extrapolate the surface temperature for the whole road strech.

Until today the local climate model have distinguished four different temperature patterns: 1.Clear and calm night, 2. Clear day, 3. Cloudy and windy situations and 4. Cloudy/calm and partly cloudy/calm/windy situations. The question is however, if this division into four situations are optimal or if it is possible to distinguish more patterns.

Frequency analysis of synoptic data from the MET-office station, Jönköping airport (57°27´N, 12°42´E), in the county of Jönköping in the south-central part of Sweden show that 56% of the night situations during a winter season will be sorted to the cloudy/calm and partly cloudy/calm/windy class. Since such a large part of the situations will be classified into this category it is interesting to study this weather type more closely. In order to find new temperature patterns during this situation seven field stations close to the MET-office station Jönköping airport in the county of Jönköping have been studied during January to March 1996 and 1997. The result of this study will be presented.

ABRUPT CLIMATE CHANGES IN HOLOCENE.
SHOULD WE EXPECT THE SIMILAR SITUATION IN THE FUTURE?

O. M. Raspopov, O. I. Shumilov, V. V. Kochegura, V. A. Dergachev, Russia
B. van Geel, J. van der Plicht, H. Renssen, Netherlands

Terrestrial, marine, and ice core data recently obtained demonstrate sharp climatic changes during the warm interglacial period of the last 11,500 years. Moreover, a 2300 - 2400 years periodicity in the development of the most sharp climatic variation was recorded. This periodicity is consistent with a secular solar activity fluctuation. One of such events took place between 2800 and 2600 BP (conventional radiocarbon age). Analysis of the geophysical situation has shown that at 2800 - 2600 BP a unique combination of external factors (solar activity, cosmic ray enhancement and geomagnetic field excursion) took place which together forced abrupt climate change. At that time a deep minimum of the 2400 years solar activity cycle occurred.

During this minimum of solar irradiation, cosmic ray enhancement took place. In addition, between 2800 - 2600 BP a noticeable excursion of the geomagnetic field occurred. During this excursion the geomagnetic field intensity was decreased by three times, which also will have led to cosmic ray flux increase. Actually this situation was reflected in a sharp increase of the atmospheric 14C concentration.

Some experimental data recently observed demonstrate that the galactic cosmic ray intensity influences optical properties and the radiation balance of the atmosphere. The evidence indicates that cosmic ray enhancement leads to a global temperature decrease. Thus the sharp temperature decrease observed around 2700 BP could have been caused by acumulation of external geophysical factors: solar activity decrease, solar irradiation decrease connected to less solar activity, and a weaker geomagnetic field intensity. These factors led to a solar radiation decrease near the Earth surface and thus created conditions for sharp climatic cooling. The mentioned above situation of sharp climate change could be repaet during the next deep minimum of solar activity.

LARGE-SCALE VARIABILITY OF THE SYNOPTIC REGIMES OF THE ATMOSPHERE CIRCULATION OVER THE ATLANTIC-EUROPEAN REGION IN WINTER

Olga A. Razorenova, Russia

This paper considers the atmosphere circulation types of the synoptic scale and their seasonal and interannual variability for the winter period from 1950 to 1990. We have used data set prepared by NMC re-analysis (500 hPa heights and surface pressure). We investigated simple circulation mechanisms (as proposed by Dzerdzeevsky, 1946), calculated such circulation characteristics as indexes of the atmosphere circulation, estimations of the vertical component of the speed vortex. Analisis of the results allowed to pick out predomimant periods of the zonal and meridional circulation forms in the Atlantic and European sectors for the time scales from one week to some years. We considered modern climate changes in the Atlantic-European region as an interaction of the atmosphere circulation types of the different scales.

GLOBAL TO REGIONAL FIRE WEATHER FORECASTS

John Roads, U.S.A.

A modeling system, developed at NCEP for making short-range global to regional weather forecasts, is being used to make global to regional, monthly fire weather forecasts. The system uses a regional spectral model (RSM), which is a high resolution regional spectral model nested within NCEP's MRF or GSM (global spectral model). The nesting is done by first integrating the GSM which thus provides initial and low spatial resolution model parameters as well as lateral boundary conditions of the RSM. The RSM then predicts regional variations influenced more by the higher resolution orography and other land distributions within the limited but high resolution domain.Both models use the same 28 terrain following sigma layers, the same comprehensive set of physical parameterization modular packages, and the same diagnostic packages, which provide land surface parameters (e.g. soil wetness, soil temperature, etc.), sensible and latent heat fluxes, radiation fluxes, cloudiness, various three dimensioal heating and moisture distributions, max/min temperatures, etc. Global to regional forecasts of the fire weather index and precipitation are currently displayed on our Experimental Climate Prediction Center web site for several regions (Global, U.S., California, S. California, Hawaii) and several forecast times up to 72 hours after the intial date. The entire globe is shown at 100 km resolution; the entire U.S., including Alaska is shown at 50 km resolution; California is shown at 25 km resolution; Hawaii is shown at 10 km resolution. This global to regional modeling system can be easily moved anywhere else in the world. An experimental mesoscale model is now under development and experimental emergency forecasts at 2 km resolution will also soon be available. Also under development are long range monthly (individual weeks) global to regional forecasts. Examples and validations of these forecasts of fire weather will be provided at the meeting.

THE SIGNATURE OF LARGE-SCALE ATMOSPHERIC PHENOMENA ON THE SEASONAL PRECIPITATION OF THE IBERIAN PENINSULA

Alfredo Rocha, Portugal

In this study we investigate the seasonal rainfall variability over the Iberian Peninsula at time-scales greater than one year, and its relation to well known large-scale atmospheric low-frequency variability phenomena. Previous studies have used either station data covering smaller spatial or temporal domains.

The rainfall data consist of gridded land-based monthly rainfall for the 1900-1996 period, obtained from the University of East Anglia. These data have been previously subjected to quality control. Atmospheric indices include, amongst others, the Southern Oscillation Index (SOI) and the index of the Northern Atlantic Oscillation (NAO) supplied by the Climate Prediction Centre (NOAA).

The most important modes of rainfall variability are obtained, for each season, through PCA. These modes are correlated with the atmospheric indices at various lags. Results show that ENSO is only moderately related to Autumn precipitation in most of the region. Winter precipitation is not significantly correlated to ENSO.

Contrary to the SOI, the NAO appears to be strongly linked to rainfall variability in the region.

In order to identify oscillations, and related oscillations in the different time series, spectral and cross-spectral analysis is performed. The validity of the obtained relationships is tested by performing similar analyses for different sub-periods of the 1900-96 period.

SOURCES OF PRECIPITATION VARIABILITY OVER THE IBERIAN PENINSULA FOR WINTER AND SPRING SEASONS

Concepcion Rodriguez-Puebla, Spain

In the present paper we explore differences in precipitation climatologies for Winter and Spring over the Iberian peninsula. Some teleconnection circulation indices and the Southern Oscillation Index are considered to explain some "signals" that are included in the spatial and temporal precipitation patterns. Statistical models depending on the interannual variability and circulation indices are proposed to reconstruct and predict seasonal precipitation variability.

INFLUENCE OF INCREASED AND CLOUDINESS ON AIR TEMPERATURE IN ESTONIA

Viivi Russak, Estonia

The observed air temperature increase in Europe is usually explained by continuos increase of anthropogenic greenhouse gases. Possible changes in general circulation should be considered as another factor. An analysis of time series of air temperature an cloudiness in Estonia for the period 1955-1995 has shown the greatest changes in early spring. In March the monthly mean air temperature has increased on the average by 5°C, the increase in monthly mean low cloudiness et different meteorological stations was 2-3 tenths during these years. The observed changes in cloudiness conditions are in great part the result of the changes in general circulation and increased frequenci of cyclones moving from the Atlantic Ocean over Estonia. The observed warming in winter and early spring is mainly caused by the increased advection of warmer air accompanied with cyclones, as well as by the diminishing of radiational cooling due to increased low cloudiness. The influence of the formation of temperature regime is less important during this season.

PRECIPITATION VARIABILITY: LARGE-SCALE AND MESOSCALE ATMOSPHERE INTERACTION

Paolo Michele Ruti, Italy

This work has been addressed to the study of the interaction

between extratropical atmospheric flow in the Euro-Atlantic and the mesoscale precipitation variability. As observed in recent years the ocean-atmosphere system performs a wide range of variability, varying from the interannual to the interdecadal affecting the tropospheric flow up to the mesoscale phenomena. A more satisfactory mesoscale climatic characterization should take into account this space-time variability of the large-scale climatic parameters. Furthermore, the association between ground weather and large-scale synoptic patterns can more objectively be made after the identification of ground weather regimes has been completed.

The availability of a high resolution data base built up for the MAP program over the Alpine Region made possible to study the dynamics and statistical connection between the Euro-Atlantic regimes and the mesoscale rain patterns using several multivariate statistical techniques (EOF, SVD) and cluster analysis.

Other European (CRU) and Italian (UCEA) data-set have been analyzed and compared; the precipitation field analysis (variability and large-scale connection) in Southern Italy knew insights in the desertification processes.

SOME DIAGNOSTIC AND PROGNOSTIC ASPECTS BASED ON OBSERVATIONAL STATISTICS OF EUROPEAN CLIMATE VARIATIONS

Christian-D. Schönwiese, Jörg Rapp; Andreas Walter, Sirus Meyhöfer, Germany

Climate varies significantly in time and space, and these variations have their impact on both nature and human activities. Vice versa, human activities influence climate. In this contribution, first a statistical analysis is presented which describes the spatial structure of climate trends in Europe focussed on surface air temperature and precipitation. This analysis cover approximately the recent 100 years and specifies climate trends, including their confidence, for all seasons or month of the year, respectively. A more large-scale consideration up to global aspects deals also with the year-to-year variability.

However, it is not justified to extrapolate climate trends into the future without an understanding of the causes of this variability. Therefore, second a variety of possible forcing mechanisms is taken into account and it is tried to separate and to quantify anthropogenic effects in the observed climate variations. This is don by means of various time series analysis techniques, in particular regressions and neural networks. It turns out that only in case of temperature a predominant part if the observed climate variations can be explained in this multiple way and than, based on certain scenarios, only anthropogenic variations may be extropolated into the future. Keeping in mind theses caveats, some future projections of European climate and their possible applications are discussed.

EXPERIENCES OF HOMOGENIZATION OF MULTI-ELEMENTAL CLIMATIC TIME SERIES IN AUSTRIA

W. Schöner, I. Auer, R. Böhm, M. Hagen, Austria

In 1997 the project ALOCLIM (Austrian - Central European Long-term Climate) has started. One of the major aims of this project is to homogenize about 15 Austrian long term climatic series for 21 different elements on a monthly base. For the practical work of homogenization the software-package HOCLIS (Homogenization of Climate time-series) was developed. The paper focuses upon the possibilities, the methodical background and problems of the homogenization procedure for the individual climate elements. The homogeneity procedure was not applied before for most of these elements . Our results show very clear that the use of non homogeneity-tested climate time series can cause incorrect results, especially in the respect of climate change. The work with an inhomogeneous climate data set can shift, mask or invert the climate-change signal. The practical work within the ALOCLIM project demonstrates clearly that homogenization (in respect to different accuracy for individual climatic elements) is possible for most of the climate elements. A careful interpretation of meta-data as well as a fast working relative homogeneity-test and homogenization procedure are the fundamental basis for a successful homogenization of such a enormous data base.

DEVELOPMENT OF A COUPLET ATMOSPHERE-LAKE NUMERICAL CLIMATE MODEL FOR RESOURCE MANAGEMENT OVER THE LAKE VICTORIA CATCHMENT

F. Semazzi, L. Xie, L. Sun, M. Indeje, Y. Song, G. Pouliot, U.S.A.

The National Center for Atmospheric Research (NCAR) numerical Regional Climate Model (RegCM2) is employed to simulate both the interseasonal and interannual variability of precipitation over the Lake Victoria catchment of East Africa during the period 1982-1993. The model uses the Mercator conformal projection, with a domain of 5580 km x 3700 km centered over the Lake and has a horizontal grid spacing of 60 km. The model initial and boundary conditions are taken from European Center for Medium Range Weather Forecasting (ECMWF) re-analysis. Lake Victoria in East Africa is the second largest fresh water lake in the World and it supports over 35 million people over its catchment for food supply, hydroelectric energy and transportation.

The model captured well the interseasonal and interannual variability of precipitation over the catchment areas of Lake Victoria. It simulates the large-scale characteristics over the region as well as local features such as dominant precipitation maxima and the diurnal reversal in the lake/land breeze circulation over the lake. The simulated interannual variability of precipitation over the lake catchment is closely related to the warm El Nino events and the Sea Surface Temperature anomalies over the adjacent Indian and Atlantic oceans which agrees well with the observations.

Earlier studies have shown that the lake level is related to the catchment rainfall by a simple linear relationship to observed rainfall. We envisage that this relationship may be exploited to forecast the lake levels and subsequently its discharge at the primary outlet of the lake at the source of river Nile in Uganda. The hydro-electric power plant, at the source of the Nile at Jinja in Uganda, supplies nearly all the electricity for Uganda and about 30% of the neighboring Kenya's consumption. In this paper we discuss a chain of physical linkages that support the prospects of exploiting the ability of the regional climate model coupled to the 3-dimensional lake Victoria model to simulate interannual variability of precipitation for the prediction of the fluctuations in the water level. The current version of the model has several unique features including a 3-D Lake Victoria model with completed hydrodynamics and thermodynamics. Coupling of the lake model to the regional atmospheric prediction model will open up new prospects for other resource management applications such as: (i) prediction of fish environments to manage fish populations in Lake Victoria (ii) prediction of lake transportation of highly toxic chemical affluent from the food processing, textile production, leather tanning, and cement industries around Lake Victoria shores, (iii) design of field campaigns to predict and subsequently control the spread of the Water Hyacinth (Eichornia Crossipes) which begun invading the lake during the late 1980's and (iv) designing of strategic special experiments for monitoring various aspects of lake Victoria.

THE ASSOCIATION BETWEEN THE CASPIAN SEA LEVEL VARIABILITY AND EL NINO/SOUTHERN OSCILLATION (ENSO)

Vladimir Semenov, Russia

Caspian Sea (CS) level (CSL) and water balance components were correlated with observed sea surface temperature (SST) worldwide for the 1903-1994 period. The most significant correlation with the CSL increments was found in the equatorial Pacific shaping the area similar to the region of the El Nino related SST anomalies. The similar pattern is exhibited when the Volga (the main contributor of the total river runoff to the CS) river runoff is correlated. The visible evaporation (E-P) from the CS teleconnection map shows somewhat opposite pattern to that of the river runoff with centres of negative correlations in the equatorial Pacific and with a region of relatively strong positive correlations in the northern Atlantic.

The ECHAM4 atmospheric general circulation model (AGCM) long-term simulation with observed SST (1903-1994 GISST data) was used to verify the model capability to reproduce the hydrological cycle variability over the CS catchment area. The observed and simulated river discharges show similar inter-decadal variability. The teleconnection map of the model river discharge looks similar to that of the observed shaping the same significant correlations region in the equatorial Pacific. The model river discharge derived from the data of the simulation for the last 40 years using variable observed SSTs only north of 30N does not reproduce the observed inter-decadal variability.

The seasonal structure of the found correlation is examined. The distinguished seasonality of the response of the precipitation over CS basin to the SSTs anomalies is found.

The results obtained confirm the hypothesis of SST variability as an important factor for the hydrological cycle changes in the CS region. The successful modelling of the Volga river runoff interdecadal variations with ECHAM4 AGCM shows a capability of the best AGCMs to reproduce not only features of regional climate characteristics but also their variations. The location of the most significant correlation area in the equatorial Pacific points at the connection between El Nino/Southern Oscillation phenomenon and CS level variations.

MODERN CHANGES OF THE CLIMATE IN THE BARENZ REGION, POSSIBLE CONSEQUENCE

Yuri Shvartsman, Russia

The reconstruction of the regional climate temperature characteristics is made on the base of meteorological and geothermal data. We used the meteorological observations of the air and soil temperatures from the meteorological stations of Arkhangelsk and Narjan-Mar.

According to the geothermal data (measured by L. Tsibulya, developed by K. Sukhorukova) we reconstructed the characteristics of the last two centuries and, less trustworthy, of the last ten centuries. According to the geothermal data one longthermal drop of temperature, which is comparable to the Little Glacier Period (LGP), with its maximum in 1540-1560. is singled out, at least from the year 1000. The Little Glacier Period ended approximately in 1850. On the European North of Russia, as everywhere in the North Europe and northern part of the West Siberia, the highest rise of temperature is recorded in 1920-1950. The positive anomaly of the temperature in Arkhangelsk in 1930-1940 reached 1, 2 °C, in Narjan-Mar -0,9°C, and in the neutral layer -0,3°C. Up to the year 1970 the temperature drops to the temperature level of the beginning of the 20 century, after this year it rise again. Temperature rise is observed up to 1995 inclusive. In 1981-1992 the average anomaly in soil and air was up to +0,6°C. According to the geothermal data the temperature keep dropping, probably due to the large inertionness of the processes in the crust.

Analysis of the short-period changes of the climate processes lets us presuppose that 80-year periods are most characteristic for the region of Arkhangelsk. It means that the present day warming may continue approximately to the year 2020 due to natural processes as well as to antropogenic ones. The fact is that even such comparatively short warming periods of 150 years lead to considerable (up to 50-60 km) retreat of the southern border of the permafrost zone in the north of the Arkhangelsk region to the north and border of the forest-tundra too.

UV 'CLIMATOLOGY' OF A HIGH ALTITUDE ALPINE SITE

Simic, Weihs, Austria

We look in this work at different characteristics of the solar UV radiation in high mountainous areas.

For this purpose routine measurements of broadband and spectral UV radiation performed by IMP_BOKU at Sonnblick Observatory (3106 m) and in Vienna (200 m) are used.

We firstly investigate the enhancement of the UV radiation with altitude due to the 'altitude effect' by comparing measurements at Sonnblick Observatory with measurements performed in Vienna.

The enhancement of the UV radiation is mainly due to much lower Rayleigh scattering in higher elevations. Additionaly to that the alpine atmosphere is mostly free of anthropogenic particles.

We secondly analyze the fluctuations of UV radiation at Sonnblick Observatory. Beside the influence of the solar elevation and of clouds we look at the fluctuations of UV irradiance due to changes in column ozone.

At last we raise the question whether any conclusions concerning a trend of the stratospheric ozone concentration in the last years may be drawn.

CLIMATE INSTABILITY AT THE GLOBAL SCALE

Raymond Sneyers, Belgium

Climate modeling for prediction purposes is a risky task due to uncertainties affecting the estimation of many parameters involved in the models as much as to the kind of differential equations defining the underlying dynamics of the weather evolution.

If, at short range level, calibration of the models by comparison of prediction with observed weather evolution make improvements possible, at the very long range, such comparison needs a rigorous statistical analysis of the reference climatological time series used for this purpose.

Actually, climate seems to be statistically neither completely homogeneous nor chaotic, but is characterized at all time scales by homogeneous sequences separated by abrupt changes occurring in an undetermined manner.

It follows that the way to validation of models goes unavoidably through the rigorous search for the statistical properties of the longest climatological time series.

In this paper, an appropriate procedure for this search is shortly outlined and justified. Applied to the global land and sea surface temperature averages prepared by P.D. Jones for the North and South Hemispheres, climate instability is characterized at that scale for the period 1856-1995. Moreover, through some examples, the degree of connection of the global climate instability with the one at regional or local scale is measured.

STATISTICAL DOWNSCALING OF CLIMATE MODEL OUTPUTS IN CENTRAL EUROPE

Arne Spekat, Germany

A sustained demand of climate impact modellers and decision makers for high resolution data required for the assessment of regional consequences of global change has led to the development of strategies to add value to the output of Global Climate Models (GCMs). Two basic approaches prevail: (i) dynamical downscaling by a fine-mesh circulation model adapted for the region in question, using full model physics and (ii) statistical downscaling by developing statistical relationships between large scale phenomena and local weather elements and applying them to climate projections. In the study presented here a _statistical_ approach is chosen, because of its computational efficiency and its ability to explain a major portion of the local variance.

Based on the assumption that GCMs reproduce the flow regime well and that they produce a shift in those regimes under scenario conditions a clustering method was developed to identify recurring and temporally stable patterns in daily climate data. Results from a GCM control run and $2xCO_2$ scenario were then used to determine the frequency of these objectively derived main patterns and to test whether changes were occurring. In order to extract further information from the "learning set", i.e. the climate data, a multiple screening regression was performed, identifying beneficial combinations of predictands from a pool of dynamical properties, including wind components, thickness, advection, and vorticity. Pattern-dependent reconstructions of local time series led to downscaled data for the climate regions.

Even though the study focuses on climate regions in Germany (e.g. coastal, lowlands, elevated terrain, alpine region) they may be looked upon as being representative for larger areas in Central Europe. A main finding was that 10 circulation patterns are sufficient to describe the flow regime. In terms of explained variance the application of the clustering and regression method yielded an amount of >80% for temperature, ~50% for relative humidity, cloudiness and sunshine duration, and <30% for precipitation for present climate data. Furthermore, the patterns found interpret well and the pattern-specific mean values of the weather elements are in excellent agreement with synoptic experience.

GCM results from ECHAM4 showed a tendency to reproduce more pronounced westerlies in the control run and a further shift in that direction in a $2xCO_2$ scenario. A temperature increase of 1.5C between control run and scenario proved to be the prominent signal. Results for the humidity regime were less well pronounced. However, there are clear distinctions between the consequences derived from scenario data for individual climate regions. Since these results will contribute to studies of the regional aspects of climate change they are shown and interpreted in detail.

RECENT CHANGES IN PRECIPITATION PATTERNS ALONG THE MEDITERRANEAN COAST

Shlomit Paz, Eva H. Steinberger, Haim Kutiel, Israel

In this study monthly and annual precipitation amounts were analyzed for theperiod 1950/51 - 1989/90 in 19 stations located along the eastern part of the Mediterranean coast. The study area includes stations from Lybia, Egypt, Israel, Lebanon, Syria, Turkey and Greece, with fairly continuous records in the selected study period.

In order to detect changes in rainfall amounts the 40 rainfall years were divided into two periods of 20 years. Then average rainfall amounts were computed for the two periods and compared. For the annual rainfall trend values were also computed. The results show that the general tendency in rainfall amounts is negative and the largest losses occur during the winter, in the months December, January and February. On the other hand, summer rains, where applicable, increased, but this increase was not nearly enough to compensate for the winter losses.

ALTERATION OF THE STATISTICAL STRUCTURE OF THE WIND FIELD IN HUNGARY IN CONNECTION WITH THE CLIMATIC CHANGE

Károly Tar, Hungary

Global increasing of the temperature near the surface possibly involves an alteration of the air pressure zones and centres, and this fact may change the European circulation system. According to studies of Schönwiese et al., in the winter half-year sea-level pressure has increased in the southern part of Europe, and has decreased in the northern part, but there is not significant alteration of the average structure of the pressure field in summer. Therefore, increase of frequency of the southern winds should possibly be considered. Other researchers (Metaxas et al.), however, suggest that more indirect signs indicate an increase of the average intensity of the summer cold advection from NW and N to SE areas of Europe. However, their analyses also show that these changes of the summer circulation have a relatively lower effect on Central Europe.

The main purpose of our study to decide whether the above mentioned changes are reflected by the statistical structure of wind field in Hungary. Results concerning the supposed significant changes of different parameters of wind direction and speed happened in the last 20 years are presented. The database is formed by hourly data series of wind direction and speed registered in 1968-1972 and 1991-1995 in three Hungarian synoptic meteorological stations (Szombathely, Budapest and Debrecen). Winter and summer subset of the data were analysed.

Our preliminary results have not indicated an increase of intensity of the summer cold advection,

VARIABILITY OF AIR TEMPERATURE AND CIRCULATION AT SELECTED STATIONS IN EUROPE

Zbigniew Ustrnul, Poland

The study contains the concise analysis of the mean temperature variability in the Europe for the period of 1901-1995. It was completed on the basis of the circulation conditions and their time fluctuations. The new automatic synoptic type classification was applied based on the geostrophic wind vector. Temperature data origin from 15 stations in Europe mainly situated in its central part. All of them are located in the urban areas. Simultaneously the circulation conditions in all these points have been studied. The increasing tendency of the annual and winter temperature was observed in nearly all stations. That element is well correlated with the circulation conditions, which have been analyzed by using the circulation indices. They are rather simple but depict quantitatively the value of the zonal circulation (W index), meridional circulation (S index) and non-advection conditions (A index). The analysis confirmed that at stations where the distinct temperature increase was observed, simultaneous positive trend of the zonal (westerly) index was notified during the investigated period.

VARIABILITY OF CLOUDINESS AND SUNSHINE DURATION

Oliver Bochnicek, Viera Horecká, Z. Ustrnul, Poland

Analysis of the mean monthly and annual cloudiness at 24 stations situated on both northern (11) and southern (13) slopes of the Western Carpathians was carried out. At the beginning, detailed homogeneity studies of the raw Polish and Slovak data have been done. Comparison of the considered series shows that the same tendency can be noticed at different stations located in the similar altitudinal zones. In the period of 1951-1995 rather large variability of the mean cloudiness was observed. The lowest mean annual cloudiness cover appeared in 1982, the highest in 1970 and 1980. In the next step analysis of the sums of sunshine duration has been done (22 stations, 13 in Slovakia and 9 in Poland). Homogenisation of these data was easier, although in some cases comparison of daily values was necessary (e.g. in some periods for Lomnicky Štít and Kasprowy Wierch). The lowest sunshine duration was observed on the turn of the 70s, while the highest in 1982. For both mentioned elements the data for much longer period (1901-1995 and 1881-1995) have been applied for two stations (Hurbanovo and Krakow) which are located at the southern and northern edge of the Carpathian chain. The general trends are also similar, what suggests that cloudiness and sunshine are under dominating influences of the large scale factors in the central part of Europe, mainly circulation. Spectral analysis did not detect any distinct periodicity in the course of the considered elements.

LOCAL SCALE TEMPERATURE SCENARIOS FOR THE AGRI BASIN, ITALY

Sarah J. Watkins, Jean P. Palutikof, United Kingdom

For impacts analysis, climate change scenarios with high spatial and temporal resolution are required. Output from three-dimensional climate models (GCMs) is usually of insufficient accuracy to be used directly for this purpose although it can, as in the method described here, form the basis for scenario construction.

For the EC-funded MEDALUS (Mediterranean Desertification and Land Use) project, high resolution scenarios of daily temperature were required for study of the effects of climate and socio-economic changes on hydrological processes in the Mediterranean region. An approach is described here for a target area in southern Italy, based on output from the Hadley Centre second generation GCM.

First, temperatures from the nearest grid point of the GCM are compared with observations at three stations. It is shown that the model performs badly at this scale, an expected result since GCMs were not designed for use at these scales. Then, a method is developed to produce more realistic temperature time series using regression analysis with free atmosphere variables as the predictors. We hypothesise that the free atmosphere variables are better simulated by GCMs than surface variables. This approach improves the representation of the present-day climate, although a cold bias is present in these downscaled results. A method to correct for the cold bias is discussed.

Finally, the downscaled time series are analysed with respect to the future occurrence.

THE OCCURRENCE OF THE CHANDLER EFFECT IN THE ATMOSPHERIC PRESSURE FIELD OVER EUROPE

Andrzej Wróbleweski, Poland

The Chandler effect is caused by variations in the Earth's rotational axis. The free oscillations of the poles have a mean period of 427 days. This effect has been extensively described in the oceanographic literature, since the variations in the axis of the Earth's rotation give rise to changes in seawater dynamics that are detectable principally in sea-level oscillations. After these variations had been discovered, a search was undertaken to find the effect of atmospheric forcing on the dynamics of seawater, as it had been found that these sea-level oscillations were far greater that those due to centrifugal force under equilibrium conditions. The research yielded a variety of results. One of these was that the Chandler effect was present in the zonal component of the wind over the North Sea. Other workers, however, did not find any influence of this effect on the atmosphere. The present paper covers that part of Europe bounded by the coordinates 0 - 20°E and 50 - 60°N. Over this area the mean monthly atmospheric pressures were given at grid nodes located every 5° of latitude and 10° of longitude. The computations cover the period from 1901 to 1980, as the measurement grid in those years was sufficiently dense and the resolution of the spectral computations was adequate for the purpose. The computations were performed by means of Empirical Orthogonal Functions (EOF) determined from the meridional and zonal components of the horizontal atmospheric pressure gradients, which were calculated between the nodes of the computation grid. The narrow-band periodic structure of the EOFs with a dominant annual period amplitude was similar in both components. For the first EOFs the Chandler effect amplitudes made up ca 25 - 30% of the annual period amplitudes and corresponded approximately to the half-yearly amplitudes. The computations of the periodic structure performed for the mean pressure field over the area covered by the grid showed a band of amplitudes reduced in comparison with those of the pressure gradient components. In this case the Chandler effect was responsible for 56% of the annual period amplitude. The significance of the oscillation amplitudes was determined by the bootstrap method.

RAINFALL CLASSIFICATION, VARIABILITY AND PREDICTION IN ETHIOPIA

Abebe Yeshanew, Ethiopia

Spatio-temporal high variability mode characterizes Ethiopian Rainfall. This spatio-temporal variability results to different rainfall characteristics and regionalization.

The spatial structure and of the monthly rainfall is studied using Fourier and principal Component analysis. The region-alization of monthly rainfall using Fourier and Eigenvector analysis reveals the tree principal rainfall regions in Ethiopia, namely, a single peak region, a double peak region and a transitional rainfall region which shares the attributes of both a single and a double regions.

The time evolution of seasonal and annual rainfall variability is also investigated using eigenvector analysis. The result of this investigation reveals the salient spatial mode of the eigenvector configuration characterized by coherence and dipole structure. The time evolution of the eigenvectors, the principal components, are attributed by trend and oscillatory signal.

A global sea surface temperature is used to predicted the seasonal rainfall variability of Ethiopia making use of s-mode principal component and canonical correlation analyses. The result of this study strongly indicate that the rainfall variability over most parts of the country can be predicted in a linear mode with a significant skill at various lead time upto twelve month lead.

AIR TEMPERATURE AND ATMOSPHERIC CIRCULATION TRENDS OVER TIME IN CENTRAL EUROPE AT THE 20TH AND 21ST CENTURIES

Elwira Zmudzka, Poland

The purpose of this study is to establish time trends of the air temperature in Warsaw, representative of Central European climatic conditions, with a forecast for the nearest decades of 1991-2000 and 2001-2010.

The J. Boryczka model, simulating natural (periodic) and anthropogenic climate changes, was used. The author states that climate models approximate trends which simulate their periodic variability. These trends are achieved by superposing relevant cycles set by oscillation spectrums of the analysed clement. Air temperature periods were established using the „regression sinusoid" method.

An attempt was made to describe cyclical changes of circulatory conditions. The Polish classification of B. Osuchowska-Klein was used during research. The established fluctuation periods of macrotype circulation were used to determine their time trends, forecast until 2010.

The periodic thermal and circulatory characteristics were determined in season and year terms, using figures from 1951-1990.

Research results indicate a slight cooling in the few coming years. This is due to overlapping of correlated natural temperature cycles with changes in atmospheric circulation. The correlative dependence of air temperature from types of atmospheric circulation indicate that thermal fluctuations result from oscillation of circulatory factors.

The natural cooling will be opposed by a gradual anthropogenic temperature increase (connected with the increasing tendency of atmospheric concentration of CO_2), considered a genuine feature of contemporary Polish and European climate.

INTERDECADAL CHANGES OF SYNOPTIC ACTIVITY AND ANNUAL CYCLE IN SEA LEVEL PRESSURE FIELDS OVER THE NORTH ATLANTIC

Igor Zveryaev, Russia

Based on the National Centers for Environmental Prediction (NCEP) data set analysis of the climatic changes of winter mean anomalies of sea level pressure (SLP), its intramonthly root mean square deviations (RMSD) and amplitudes and phases of annual cycle is carried out. Climatic changes are considered in terms of linear trends, low-pass filtered anomalies and decadally averaged anomalies. It is demonstrated that linear trends of winter RMSD anomalies are in a good agreement with SLP trends attributed to the periods of decrease (increase) of NAO index. Analysis of the detrended and low-pass filtered anomalies of winter SLP revealed both propagating and standing patterns. The standing patterns have a period of about 8 years. There is no good agreement with related changes of RMSD. On the contrary, we defined the periods with high (low) values of NAO index, which accompanied by negative (positive) anomalies of RMSD. Decadally averaged RMSD anomalies are not linked to the North Atlantic storm track. Spatial distribution of both winter SLP and RMSD anomalies demonstrates meridional dipole-like patterns. For the period 1981-1990 which is characterized by the high value of NAO index, the negative anomalies of RMSD over the most of the North Atlantic are observed. Anomalies of amplitudes and phases are estimated for four decades (1951-1990). Spatial distribution of the anomalies of amplitudes of SLP is in a agreement with that of the anomalies of decadal mean SLP and positive (negative) anomalies of amplitudes are related to negative (positive) anomalies of decadal mean SLP. During 1951-1960 and 1971-1980 anomalies of phases are not great (approximately 10 days). But decades with the lowest (1961-1970) and highest (1981-1990) values of North Atlantic Oscillation Index demonstrated the great growth of phase anomalies and their spatial differentiation. Positive (negative) anomalies of phases mean here that, for instance, winter comes later (earlier) than usual. During 1961-1970 the negative phase anomaly (-15 days) is located in the western Atlantic and the positive one (+35 days) near North Africa. During 1981-1990 the situation is reversed - positive (+25 days) anomaly in the western Atlantic, and the negative (-50 days) one near North Africa.

DEVELOPMENT AND IMPLEMENTATION OF HEAT WATCH/WARNING SYSTEM FOR LARGE URBANIZED AREAS

Tanja Cegnar, Laurence S. Kalkstein, Slovenia

Human beings comfort is primarily determined by the thermal environment. Extremes of temperature can cause physiological disturbance and organ damage, leading to illness or death. The increase in mortality during hot weather can be very significant; some studies has shown that during unusually hot episodes, deaths from all causes can rise over 50% above normal baseline levels. Concerning climate change it is difficult to predict the effect of temperature increases on man health. However, there is no question that increased heat stress in many urban areas could claim many more lives than at present.

The extent of heat-related mortality varies according to geography. Mortality data for many cities in temperate regions, where hot weather is severe but infrequent, show sharp rise in total mortality during unusually hot weather conditions. Duration of heat stress is also a critical determinant of thermoregulatory failure.

A watch/warning system for heat was instituted for the summer in Philadelphia and some other cities in USA. The system is based on the predicted arrival of "offensive air masses" historically associated with elevated mortality levels. The health impact of hot weather has been studied predominantly in relation to the most serious health outcome, i.e. death. A major reason for this is that mortality data sets are readily available. Because of diversity of causes of death, the number of heat-related deaths is considered to be the number of deaths occurring in excess of the number that would have been expected for that population in the absence of heat wave. Time-series analyses have been used to analyse daily weather characteristics in relation to daily mortality, and applied widely to establish associations between these variables.

Methodology and possibilities to apply such watch/warning systems in major cities in south Europe will be presented.

ARTIFICIAL HEAT EMISSION IN THE URBAN AREA OF POLAND (AFTER THE ECONOMIC TRANSFORMATION) BY THE EXAMPLE OF THE CITY OF WROCLAW

Dariusz Chudzia, Maria Dubicka, Poland

Wroclaw with a population of 710 thousand is the main town of the south-west part of Poland, located in the immediate vicinity of the Polish-Czech-German borders. Political and economic transformations in Poland in 1989 have brought changes in the dominant form of the city economy, that being a transition from industrial production (mainly machine and heavy industry) to service activity. They have caused also changes in the authorities' attitude towards environmental protection (e.g. more rigorous pollutant limits regulations, investments reducing air pollution etc).

The poster presents information on the space dis

SPATIAL STRUCTURE OF THE CITY HEAT ISLAND IN WROCLAW

Maria Dubicka, Dariusz Chudzia, Poland

City climate in Wroclaw has been monitored since 1996. The studies are aimed at ascertaining the diversification of climatic conditions in the area of city agglomeration, depending on the time of day and season of the year, kind of the weather, type of settlement and distance from the city centre. Measurements are taken in different parts of the city settlement with the use of five automatic weather stations produced by Campbell Scientific. The measurements include 6 basic climate elements: air temperature and relative humidity, intensity of total solar radiation, radiation balance and wind speed and direction. Besides these measurements of structure and variation of temperature and certain weather situations, along earlier established routes.

The analysis of frequency of occurrence of the city heat island in diurnal cycle includes the warm season (April - September) of the year. In the night (8p.m. - 6a.m.) the city heat island in Wroclaw occurs in over 90% hours among compact downtown settlement and among tall buildings, while among low detached houses it is observed by 15 - 20 % less often. The highest intensity of the city heat island is observed during cloudless and windless weather, but was also noted at a complete cloudiness and wind speed of 3-5 m/s during cool advection.

In daytime (7 a.m. - 7 p.m.) the frequency of occurrence of the city heat island is al

SIMPLE MODELLING OF THE UHI INTENSITY AND SPATIAL DISTRIBUTION - A LODZ EXAMPLE

Krzysztof Fortuniak, Kazimierz Klysik, Poland

Urban heat island (UHI) belongs to the most intensively studied modification of the local climate by urbanisation and industrialisation. Numerical simulation of this phenomena based on solution of governing equations for atmospheric surface layer is extremely difficult because of complexity of the urban geometry. On the other hand simple statistical models may provide valuable information on UHI temporal development and spatial distribution. The main purpose of this work is to construct such model for Lodz. Lodz is the second biggest city in Poland (population - 850 000), its area is relatively flat (the ground level differences in the densely built over area amount to only 55m), and the urban arrangement is very regular with well defined urban canopy-layer. These features cause Lodz a favourable place for study on the urban climate. The model bases on one-year observation at three station. The first one (rural) is a regular meteorological station provided by Polish Meteorological Service giving data from sub-urban airport. Two others are located in dense build-up area in the city centre. Temperature sondes are situated in standard meteorological shelter and give records every 10 min. The main idea of the model is that, during the nights with well developed UHI, the urban temperature decrements (in some time unite here taken as 10 min) are linearly connected with the rural temperature decrements. The proportionality factor depends on the ratio of urbanisation, wind speed, cloudiness and many other. It allows to calculate nocturnal urban temperature course disposing a rural temperature course.

City may be treated as some kind of entirety or divided on sectors with different urban structure. Physically, such approach disregard the detailed urban canopy-layer processes consolidating all city influences into a single parameter increased heat capacity. The increased heat capacity has here a complex meaning including not only greater thermal admittance of construction materials but also dynamical factors like redistribution of the energy in the relatively thick atmospheric mixing layer over the city or altered radiative processes caused by atmospheric pollution and urban geometry. In spite of simplicity the model quite well represents a temporal evolution of the UHI intensity as well as spatial temperature distribution in the city. For windless condition UHI takes a multicellural form with well distinguishable peak, cliff and plateau. For moderate wind UHI posses a more simple general form and vanish for higher winds. Modelled temperature courses at measurement points are also in good agreement with the observation.

METEOROLOGICAL STUDY FOR WATER-MANAGEMENT PURPOSES

Marjana Gaijic-Capka, Croatia

The intention of this paper is to present the concept of the climatological analyses deduced in 19904s in Meteorological and Hydrological Service of Croatia necessary for the project "Water management basis for Zagreb region" prepared by Croatian Public Water - Management Enterprise.

This paper deals with the analysis of the climatological elements which should be incorporated in hydrological and hydrotechnical calculations for the purpose of water management basis for an urban area. The results point at the similarities and differences of the climate characteristics in the city, and the surrounding area that influence the hydrological regime of the city. The relevant climatological elements analysed were: precipitation, air temperature, air humidity, sunshine duration or cloudiness, evaporation, relative humidity, water vapour pressure, soil temperature. The analyses and presentations applied were: annual course of mean monthly values of all elements, spatial distribution of monthly and annual precipitation, probability distribution of monthly precipitation, extreme-value distribution of maximum daily precipitation, as well as short-term precipitation maxima, IDP curves (intensity, duration, return period) for precipitation rate durations of 10 minutes to 24 hours, fluctuations and trend of secular annual and seasonal precipitation and temperature data sets for one location in city centre, and long-term changes of the relations of June, July, August and summer precipitation between urban and suburban as well as urban and rural stations.

URBANIZATION EFFECTS ON THE REGIONAL CLIMATE CHANGE IN TURKEY

Mehmet Karaca, Mete Tayanc, Turkey

The purpose of this study is to detect the urbanization effects on the regional climate in Turkey. To estimate the regional climate change and its urban-induced bias temperature and precipitation data of 54 climate stations are used.

By classifying stations urban and rural, several statistical techniques such as the linear regression and the sequential version of the Mann-Kendall test are applied to analyze the climate data in terms of the urban heat island intensity and the urban growth in Turkey. The normalized Mann-Kendall trend test coefficients with a spatial prediction scheme, Kriging, are used to construct spatial patterns of the climatological variables. Results show that a significant cooling in mean temperatures in the northern regions and warming in minimum temperatures, particularly in the large urban cities. The seasonal analysis of the urban heat island intensity has a maximum in spring rather than in winter. But cooling in mean temperatures occurs in the summer. An overall average cooling rate is found -0.07C per decade in mean temperatures. The air pollution emissions, possibly SO_2, may cause the unexpected cooling.

CLASSIFICATION OF MESOSCALE CIRCULATION OVER AN URBAN MEDITERRANEAN BASIN. RELATIONSHIP WITH AIR QUALITY STATUS

P. A. Kassomenos, H. A. Flocas and S. Lykoudis, Greece

In this study mesoscale circulation over the Metropolitan Athens is classified day by day for a period of thirteen years. A formulated methodology is proposed on the basis of surface wind measurements that identifies eleven distinct mesoscale patterns. The frequency analysis of the mesoscale categories reveals that the weak flow patterns being characterised by topographic influence prevail throughout the whole year and more pronounced in May and June. Due to the complex topography and the distribution of industrial and anthropogenic activities in the examined area, the day by day relationship between the mesoscale categories and the air quality conditions is further investigated in spatial terms. It was found that the severe and bad air quality conditions over the Metropolitan Athens Area are mainly associated with weak southerly flows. The most serious pollution problem is attributed to O_3 in the warm period when it is favoured even by intense notherly flow, affecting principally the northern zone of the Athens Metropolitan Area.

CLIMATE OF MODENA (ITALY): TEMPERATURE AND RAINFALL TIME SERIES

Mauro Boccolari, Paolo Frontero, Luca Lombroso, Sergio Pugnaghi, Renato Santangelo, Italy

The Geophysical Observatory of Modena University (Italy) was founded by the Duke Francesco IV d'Este in 1826. Its meteorological daily time series is one of the older in Italy. Also in the past observation were very accurate although carried out by manual instruments and the reading were written in large volumes. Such instruments and volumes belong now to the Astronomical and Geophysical Museum.

In 1970 reading in volumes were converted to a Data Bank. Since 1988 a new automatic instruments were installed, maintaining at the same time an intercomparison with the old one in order to have homogeneous data. This long time series of daily temperatures in a central point of a growing town shows a long term trend due to a global warming and to effects to increase of the heat island. A comparison with observations in a rural station (about 10 km from the centre of Modena) will be presented.

I.P.C.C. estimates an increase of temperature of the order of 0.3 to 0.6°C since 1860. Our records shows an increase of 0.7°C. This larger value may be due to a warming caused by heat island effect. Distribution of extremes in temperatures appears to be different in the last 10-15 years then previously. Same anomalous events and the temperatures trends will be presented.

Also the precipitation distribution appears to be evolved recently: in average decrease; a shift of the seasonal distribution towards Summer and Autumn. The distribution in the last 10-15 years is quite different then the previous one. A preliminary investigation, using Wavelet analysis, on rainfall time series, will be presented. From contours plots of wavelet power spectrum it appears a dominant mode of variability on a time scale of 10-20 years.

COMPLEX STUDIES ON URBAN NATURAL ENVIRONMENT FOR DECISION-MAKING PURPOSES

Romana Koczorowska, Ryszard Farat, Poland

The poster presents a diagnosis of some selected aspects of the natural environment of the city of Poznañ with a particular emphasis on the role of the distinct climate of urban agglomeration.

In 1990s, in the city of Poznañ, investigations of the urban natural environment have been initiated and are still in progress, the aim of which was to:

- recognize some selected aspects of the condition of this environment,

- elaborate methods of their monitoring and effective utilization,

- establish a system of warning, prognostication and appropriate solutions for the purpose of balanced development of the city and protection of life of its citizens.

The current population of Poznañ is about 650.000 inhabitants which means that in the last two centuries this number increased 30 times. Changes in the urban environment represented by such factors as: natural disasters (droughts and floods), water availability, environment contamination and climate changes are of prime importance.

The condition of the environment was assessed from the point of view of the above mentioned threats carrying out the following works:

- inventory of water courses and water reservoirs of the city of Poznañ,

- hydrologic characterization of water reservoirs,

- limnologic characterization of water reservoirs,

- determination of water resources of the city of Poznañ,

- purity evaluation of surface waters of the city of Poznañ,

- studies of the urban climate,

- determination of the chemical composition of atmospheric precipitation.

In the assessment of the condition of the environment, not only current measurement data were used, but also comprehensive historical data covering 150-year body of air temperature measurement and 175-year series of water state recordings. The obtained diagnosis of the environment condition allowed, in the first phase of studies, to work out a model of prognostication of urban contamination and later, of the program of protection of the city of Poznañ until the year 2010.

URBAN AIR QUALITY OF SZEGED - CASE STUDY

Laszlo Makra, Hungary

The aim of the study is to establish how the concentration of NO2 and SO2 change at traffic junctions in Szeged, during the day. Measurements were made by aeromat gas analysers at various traffic junctions of the City, in various days. The data basis, obtained in this way, was completed with data of an automatic instrument found along a highway going through the town. At each point of measurements - at the same time with the measurements - traffic census were made, too. Furthermore connection of daily average concentrations of NO2 and SO2 with the large-scale weather situation at the given day was examined.

ANALYSIS OF URBAN TEMPERATURE DIFFERENCES (IN THE CASE OF BUDAPEST)

Katalin Molnar, Hungary

One of the best known climatic effects of the urbanization process is the development of an urban heat island. The increase of air temperature in cities is a „result" of the urban structure. Depending on the built up areas the air temperature differences show an urban heat island which is a typical phenomenon for every city but it has a lot of specific features, according to the geographical positions of a town (high or low latitudes, humid or dry climates), to the size of the town (number of inhabitants), to the season and hour of the day or night, the weather conditions (cloudiness) and to surface covering (pattern of parks and built up areas).

The first monograph of great significance on the climate of Budapest (1949) can be considered as the first so called urban climate book in Hungary. In the early 1970s urban climate investigations with data from stations of different energy budgets were performed (Probáld, 1974).

The latest research at the National Meteorlogical Service about the specification of the urban heat island covers: 1: the extension and temporal change of heat island (Szalay, S., Molnár, K.) and 2: the comparison of data on urban heat island between the capital and the rural land surrounding of Budapest (Szentimrey, T.).

On the base of subsidiary measurement at 10 locations in Budapest we tried to characterize the extension and temporal change of heat island. The sites of in situ measurements at 30-minute intervals over a period of several warm days were designed to represent the categories of built-up areas in the capital properly.

Measurement of expeditional nature record air temperature and relative humidity are measured from 14 hours, or from most of the sites from 16 hours, in every hour and between 18 and 20 hours at 30-minute intervals. In addition, from the 1970s, measurement along selected routes were also performed. In a way similar to the one above, they record air temperature and relative humidity at the same time of the day and readings are made in the same hours. In the morning and in the early afternoon the measurements revealed minor variations between the various neighbourhoods of the city. The hottest are broad streets and squares with favourable insulation conditions. In the morning heating is also considerable on the built-up SE slopes of Buda Hills. At the same time in shady, narrow lanes air temperature was found to be 0.5-0.8°C lower than even the lee side of more extensive city parks. Major green areas are 0.7-1.2°C cooler than the most intensively heated surfaces and they show 2-3 percent higher relative humidities. For instance, Margaret Island, in average, is 1.5°C cooler and has 3-6 percent more humidity than other parts of Budapest (Gajzágó, L. 1993). In Buda with hilly topography, the roads leading to forest have 1-3°C lower air temperatures and 3-5 per cent less humidity than open, sunny roads. In the afternoon (in summer after 17 or 18 hours, in autumn after 15 or 16 hours) the gradually increasing cooling of green areas highlights the urban heat island. The heat island, which extends over the inner city and its environments is 4-5°C warmer after sunset than the parks along the margin of the heat island and shows 25 per cent lower relative humidity. In the evening hours the intensive cooling of Buda Hills and the opening of the valleys toward the city is remarkable. The valley also contribute to the flow of cold air towards the city.

A SIMPLE MODEL OF LONG-WAVE RADIATION IN URBAN CANYONS

J.P. Montávez, E. Sánchez, A. Rodríguez and J.I. Jiménez, Spain

This simple model explains in a qualitative way how important the role of canyon structure of streets is for the UHI formation. We must not forget that our results are refereed at surface temperature, and the results of Oke are obtained for air temperature. Far the city centre, however, where the effects of air mixing are minimal, and the relationship between surface and air temperatures and is linear (approximately), our estimation can be a good approximation. In fact our results reproduce good Oke's function.

THE CITY AS A GOOD EXAMPLE THROUGH WHICH WE CAN TRY TO UNDERSTAND THE VARIOUS FORMS OF MAN'S CONTROL OVER THE ATMOSPHERE – A CASE STUDY OF OPORTO (PORTUGAL) HEAT ISLAND

Ana Monteiro, Portugal

It not being our intention that this article be an expression of *nostalgia* for the *Paradise Lost*, it is only our wish to emphasise some of the severe consequences which have resulted from the progressive and effective distancing of Man from his environmental support.

The economic system in which we live, based on profit has transformed the cities into indispensable components, as artificial support for the "exchange" of goods, services and information. Exchanges these which are not done according to what is necessary but depend only on what already exists.

The maintenance of this type of relationship is only possible due to a diverse set of solid units of management of international economic systems, like the EC, the OECD or the World Bank. These large international organisations constantly on the alert so that the system in force functions, i.e., that the exchanges continue to take place in accordance with the rules imposed by those who have the largest quantity of resources. If we could detach ourselves from the whole socio-economic and political conjuncture in which we live and were reduced to our humble position as one more element in the Ecosystem, we would see that these institutions and, above all, the aims which justify their existence are incomprehensible, unnecessary and generators of the "noise" in the Ecosystem. It is precisely this knowledge of our fragile position in the Environment which assails our conscience, individually and socially, and which makes us feel guilty for the uncountable situations of Starvation in the world. It is only the respect for the acquired right some have to the property of resources which impedes that the others satisfy a basic necessity - nourishment. A problem which other elements of the Ecosystem resolve in much more simple and harmonious ways.

The cities, entirely artificial projections in an area where the exchange of surpluses demands new necessities, gave Man a greater possibility of controlling his habitat. This control unleashed and stimulated attitudes of progressive irreverence in relation to the Environment. The environmental support came to be seen as a "separate" entity. The idea of "cohesion" was completely lost in favour of a pretentious concept of Man's immunity when confronted with the consequences of his actions.

THE PART PLAYED BY LAWN AREAS IN SHAPING URBAN TEMPERATURE AND HUMIDITY CONDITIONS

Krzysztof Olszewski, Poland

The aim of the paper is to determine the role of the lawns in shaping urban temperature and humidity conditions. The series of the experimental measurements on lawns of various dimension have been made. These data have been correlated with measurements made nearby on surfaces of sidewalks, parking sites, open squares, etc. The following conclusions may be drawn:

- the effect of a lawn upon temperature conditions is confined to cooling street surfaces, squares, etc. This cooling may attain mean values up to 2°C and, separate and especially sunny days, even a few degrees higher. However, unfavourable is that on evenings and during night hours a temperature inversion occurs on top of lawn surfaces.

- the effect of a lawn upon air humidity is reflected by increases in relative humidity (averaging 4-7%).

- a mitigation of temperature and humidity conditions on top of lawn surfaces, causing temperature decreases and increases in air humidity, can easily be observed even on fairly small lawns (of some 1300 sq. M). This effect can be observes in the near-ground air layers (0.25 m); but higher up this effect is lost. Only where larger lawn surfaces (from 3000 sq. m upwards) are coming into play, the effect of verdure is also noticeable at greater height above ground (1.5 m). Where greenland surfaces are very large, their effect is even felt at some distance (up to several meters) from a street.

- it would seen that these experiences might be taken advantage of by arranging foot paths parallel with and near traffic arteries, provided the width of the adjacent lawn strip is no less than 60 m. This arrangement would be highly beneficial to the inhabitants of the given urban district, especially during hot summer days.

MODELING URBAN HEAT ISLAND: THE CASE OF A MEDITERRANEAN TOWN AND THAT OF A CONTINENTAL ONE

P. Castracane, D. Costantini, A.M. Siani, S. Palmieri, T. Cegnar, T. Vrhovec, Italy, Slovenia

Results of the application of an energy budget model, together with the available observational data, are used to study the heat island phenomenon in the case of Rome (a Mediterranean climate town) and Ljubljana (a continental climate town) . The dimension and intensity of the heat islands in radiative scenarios are analysed and compared , taking into account the differences in the structure and radiative response of the urban tissue .

TEMPERATURE TRENDS TROUGH URBANIZATION IN A TROPICAL CONTINENTAL CITY OF CUIABÁ-MT, BRAZIL, 1920 TO 1992

Gilda Tomasini Maitelli, Brazil

This study investigates the annual and seasonal changes of the mean temperature in Cuiabá city (15º10' S, 54º50' W) caused by the growing in the size and population, analysed for the period of 1920 through 1992. It considers not only the temperature trends but also the humidity and precipitation behaviour, and the magnitude of heat island (urban minus surburban temperature) combined with energy balance of the downtown site. The size and population of the city is increasing: in 1920 the population was 33,000 while in 1991 was about 402.000. The analysis indicated that the annual mean temperature has increased by about 1.8 ºC from 1920 to 1990. The chief contributors to the increase are an increase in the minimum temperature from the same period.The temperature and precipitation trends was positive, while the humidity trends was negative. The maximum intensity of the heat island is 5º C in the nightime of the dry season. The higher solar radiation is 800 Wm with 646 Wm average in the 9:00h-14:00h local time; the albedo average is 0,24 with the smaller values of 0,17. The net radiation is positive in the 6:00h -16:00h local time, with 276 Wm average and Bowen Ratio is usually 1.02 with some days higher to 5.8. The evapotranspiration variation is very closed with a precipitation amount and urban green space irrigation. The heat storage in the urban fabric is an important term in the balance and the nature of the energy balance may help to explain some of the features of the heat island.

CLIMATOLOGY OF THE STABLE BOUNDARY LAYER

Jaroslav Svoboda, Czech Republic

The atmospheric boundary layer (up to the 80 m above terrain) was measured in the territory of the norh/west Bohenia, Kopisty near town Most, during two years in an industrial area. Trere is in inhomogeneous Earth's surface around the site measured. The vertical structure of the dispersion of the wind velocity was studied. The frequency of small values of dispersion of the wind velocity was compared with results of a simple model of the atmospheric boundary layer. The observed fluctuations of wind velocity was greater than ones predicted by a simply model. This fact should be used if the simply model of atmospheric boundary layer will be applied to a task of air pollution.

URBAN HEAT ISLAND AND SOME OF ITS EFFECTS

Janos Unger, Hungary

The development of an urban heat island has several effects on its environment. This study investigates some influences of higher urban temperature on vegetative and human lifes, as well as on heating demand in Szeged, Hungary in a 3-year period when urban climatological measurements were carried out in the city. The mean annual numbers of special (winter, frost and summer) days which have limitations for daily maximum or minimum temperature, mean durations of frost-free period, mean dates of the latest and the earliest frosts reveal that there are significant alterations caused by the urban heat island and they are mostly advantageous for inhabitants and vegetation. The presence of the heat island reduces the number of heating days (HD) and heating degree-days (HDD) thus it reduces the quantity of energy consumption in the city. Monthly means of the numbers of urban and rural HD and HDD values show that in the central urban area the heating season is more than 3 weeks shorter than in rural surroundings, with a maximum difference in October. The energy demand in the centre is approximately 10% and 20% lower than in rural areas in the winter months and in the whole heating season, respectively and the differences are most significant in the transitional months.

Keyword: urban climate, meteorological special days, heating day, heating degree-day, Szeged, Hungary.

DAY-TIME EFFECTS OF URBANIZATION ON RELATIVE HUMIDITY AND VAPOR PRESSURE IN AN EUROPEAN MIDLATITUDE CITY

M. Unkasevic, Yugoslavia

In this paper, suburban/rural - urban relative humidity and vapor pressure differences at fixed hours in larger Belgrade area will be analyzed. Also, we will tested Clausius-Clapeyron equation for prediction of relative humidity temporal changes according to the observed values of the Belgrade Observatory.

The Belgrade basin with an estimated population of 2,5 million in 1995 covers approximately 3221km2 area with the fairly high mountain Avala to the south and two great rivers (Sava and Danube) and lowlands to the east, north and the west. Measurements of three times per day (07, 14, 21 LTC) at three suburban, two rural and one urban station during period 1976-1980 years will be used.

ON A RECENT URBAN EFFECT IN THE TIME SERIES OF THE TEMPERATURE IN DIFFERENT STATIONS IN BELGIUM

Marc Vandiepenbeeck, Belgium

The aim of this paper is to examine the possibility of an urban effect in the synoptic stations near an important city in Belgium. To achieve its aim, we compare the mean value of the temperature computed into the 16 directions of the wind (N, NNE, NE, ...).

The first step is to determine a possible abrupt change in the frequencies of the direction of the wind. The methodology used is this presented in 1995 at Galway (Vandiepenbeeck M.). The behaviour of time series is studied with two tests: Mann-Kendall-Sneyers and Pettitt.

A previous study has shown that we have at Uccle a non-significatif abrupt warming in 1987 in winter and spring, in 1981 in summer and autumn (Vandiepenbeeck M., 1996).

For two periods (1966-1990 and 1981-1995), we calculate the mean temperature into the 16 directions of the wind. We compare the behaviour of these two periods at the stations near a town (Uccle and Zaventem for Brussels, Deurne for Antwerp) with stations in rural environment (Chièvres, Beauvechain, Kleine-Brogel, Bierset and St-Hubert).

The behaviour of the series of mean temperatures will permit to give conclusions about a recent urban effect.

CLIMATE MAPS FOR URBAN DEVELOPMENT

Peter-Hinrich Voss, Germany

The climate of an urban (or suburban) area will be described by the mean state of a variety of climate elements resp. climate phenomenas.

Conventional climate maps are restricted to the spatial representation of an individual climate element, e.g. air temperature, atmospheric humidity, wind velocity and direction (so-called analytical maps), and thus represent only a partial aspect of the overall climate.

In many planning areas, however, there is a need for a combined view of several climate elements so as to be able to produce statements of relevance to the planning.

VARIATIONS OF THE TEMPERATURE IN A BIG TOWN AND IN A FREE LANDSCAPE

Petr Zacharov, Czech Republic

The aim of the contribution is to compare the air temperature trends in relatively free landscape and in an environment influenced by human activities for instance in the centre of the big town, Prague. For comparison we have used the climatological station Praha-Klementinum lying practically in the center of the town 191 m a.s.l. and the station Milešovka lying approximately 60 km north-west from Prague at 837 m a.s.l. According to different elevation above sea level the trends and relative values with regard to long-termed means of both stations will be compared.

ASSESSMENT OF POLAND OVERALL CLOUDINESS

Ryszard Farat, Romana Koczorowska, Przemyslaw Mager, Poland

Assessment of cloudiness in Poland has been done by using the results of the latest overground researches related to this element. Diagnosis of cloudiness range is basic for the elaboration of climate changes forecasting in future.

Characteristic of claudiness range has been done with using data: monthly average, seasonal and yearly in a 10-degree scale. The data were calculated on the base of data coming from 8 terms for each 24-hours, for 55 synoptic stations from the period 1966-1990.

Range of overall cloudiness is characterized by: quantile of a designed range (p=10, 25, 50, 75, 90), number of days with designed daily mean values which occur in designed time periods.

These calculated quantiles which characterize cloudiness during winter period decreases towards the south direction. The highest quantiles occur in western part of the S³owiñskie Coast and in the middle part of Pomeranian Lake District. In southern Poland the lowest quantiles are noted in the Tatra Mountains. In summer period the highest quantiles were noticed in upper parts of the Tatra Mountains and the Karkonosze Mountains. Spatial distributions of this element show features common with spatial distributions of average multiannual data of cloudiness.

The numbers of days in accepted classification according to Mr. Oko³owicz (fair days, moderately fair days, cloudy days, very cloudy days) show a clearly seen variability during a year period. The highest and the lowest data occurred mainly during winter and summer periods. Going from maximum to minimum takes place in spring and rapidly in Autumn. In Poland the areas with the lowest cloudiness are: the Sandomierska Valley and areas near Ko³o and Œwinoujœcie towns. The areas very big cloudiness are upper parts of maintains. Not stabile cloudiness conditions occur along the Polish Baltic Coast, what should be taken into consideration.

For obtaining the complex assessment of cloudiness range, the authors at present take into account also the height of occurring clouds. The researches are continuing now.

GROUND LEVEL ULTRAVIOLET IRRADIANCE (UV-B), OZONE AND INCIDENCE OF SKIN CANCER AT THE TROPICS

Ignacio Galindo, León Loya, Rubén Sahagún' Ramón Solano' Mexiko

A detector measuring biologically effective solar ultraviolet radiation (UV-B) was operated between October 1995 and June 1996 at the campus of The University of Colima. A regression model is used to relate simultanously measured global solar radiation with UV-B thus expanding the data set from June 1995 to December 1997. Daily ozone data obtained by means of our satellite ground station from the Tyros Operation Vertical Sounder (TOVS) from NOAA orbitters are also used. A skin cancer (without melanoma) data base incidence obtained at the Civil Hospital of Colima from 1992 to 1996 has been analyzed in terms of age, sex and tumors site. The results show that there is a non linear relation between global solar radiation and UV-B, the best fit (+ 15% error) is for a polynomial of degree 2. Ultraviolet irradiance flux depends of joint astronomical and meteorological factors, highest fluxes are received during March-April during the dry season, then June (-11% with respect to March) ranks in the second place together with September whereas December shows 44% incident flux reduction with respect to March. The medical data base shows that skin cancer (without melanoma) occupies the second place (24.7%) of incidence in this part of Mexico. Basal cell carcinoma is always found in exposed parts of the human body. Taking as reference its incidence in 1992, it shows a very pronounced positive trend (93% in 1996). On the other hand, squamous cell carcinoma occurs also in non exposed parts of the human body and shows no trends. Therefore, it seems that basal cell carcinoma is more dependent on UVB exposure. To mitigate this regional problem, there is an urgent need to continue monitoring UV-B fluxes in different places of the state of Colima and to study outdoor habits, exposure times, etc.

CLIMATE AND HUMAN HEALTH

Gerd Jendritzky, Germany

There are numerous impacts of climate, i.e. the atmospheric environment, on human health and well-being. Some influences are effective on a direct path, e.g. the complex atmospheric conditions of heat exchange between the human body and its surroundings in order to maintain thermal equilibrium, air pollution (NO_x, HCs, O_3, PM 2.5), and UV-radiation. Not all effects are adverse, some atmospheric conditions have benefical effects and can be used e.g. in recreation, rehabilitation and prophylaxes. Often merely the knowledge and consideration of possible effects facilitates an appropriate adaptation of the human being to stressful conditions. Indirect health effects are e.g. vectorborne and non-vectorborne infectious diseases, the poor quality of drinking water and insufficient food production, extreme weather events (e.g. floods and droughts) and other climate-induced disasters killing people and destroying their social-economic network.

Climate data require an appropriate assessment with respect to health and well-being. Air pollution standards are good examples for such tools. For UVR the UV-index has in the meantime been introduced internationally. The state-of-the-art description of the thermal environment consists of an application of complete heat budget models which provides thermophysiologically significant information. Using GIS-techniques it is possible to compute bioclimate maps for numerous questions in all relevant scales in the wide range from micro to global.

There are many applications for bioclimatological knowledge in the wide field of precautionary planning, e.g. urban development and regional planning, tourism incl. health resorts, residential areas. The impacts of climate change is assumed to be subject of increasing importance. Thus the climate/climate change and human health issue is just as relevant for authorities, urban planners, health professionals, and other decision-makers in the area of environment protection as it is for individuals. It is no longer just a fascinating subject for multi-disciplinary research.

RELATIONSHIP BETWEEN SYNOPTIC CLIMATOLOGY AND POLLUTION EVENTS IN ATHENS

Basil-Vassilios Katsoulis, Greece

Across the Athens area pollution days both high and moderate, were greater in number in the early and mid 1980s than in the late 1980s and early 1990s. The Greek Ministry of the Environment (PERPA) thought this was caused by a decrease in pollutants emitted due to more stringer emission controls. However, an examination of forecast pollution potential also showed a decrease over the period. The question therefore arose as to what extent the observed pollution decrease was a function of the synoptic situations and whether there were any identifiable long - term changes in these synoptic patterns. Results from this work include:

- Identification of the main synoptic situations covering the southeastern Greek region for winter and summer with moderate to high pollution episodes in Athens.

- Relationships between number of pollution days to the amount of time anticyclones are located in a region (anticyclonicity) or to slow anticyclone movement (immobility of an anticyclone) across the region.

- Correlations between anticyclonicity with high pollution registrations for

the period 1982-1994.

THE IMPACT OF WINTER CLIMATE ON ROAD TRANSPORTATION

Jonas Norrman, Sweden

A large part of all road transports are affected by the climate seasonal variations. In areas where road surface temperature drops below 0°C during winter time, the effect for the road user can be very dangerous driving conditions, and may cause large delays in traffic. These hazardous road conditions are best described with type of road slipperiness, e.g. rime or snow. In Europe and North America, much work is done by the national road administrations to improve winter-time road conditions and thereby decreasing the accident rate and increasing the traffic ability. These type of actions are, in Sweden, called winter road maintenance.

The personnel responsible for road maintenance must have meteorological information, with high temporal and spatial resolution, on the road conditions in their area. To get this information, several countries have constructed a Road Weather Information System (RWIS) which they today use. A RWIS have four main components: i) a spatial analysis of road microclimate, ii) meteorological field stations along the roads, iii) computer and communication networking and iiii) road weather forecasts.

The Swedish National Road Administration have around 700 field station in their system. These field stations are equipped with sensors measuring air temperature, relative humidity, road surface temperature, precipitation, wind speed and wind direction. The system runs from first of October until late April. During this period there is a risk for slippery road conditions through out the country.

The influence from the weather may result in several different types of slipperiness and to optimise the winter road maintenance in an area, it is very important to know which types that are most common to occur. This study investigates the frequency and distribution of different types of slipperiness on roads in southern Sweden, from RWiS data. Only conditions related to meteorological processes are considered. All the different types of slipperiness on roads are described from a meteorological point of view and from this description, criteria's for detection are constructed.

The work is not only important to optimise the RWiS but also to provide the developers of the future traffic system with basic information about winter road conditions. One possibility in the future would be automatic speed adjustment of all vehicles on the road during periods of bad road conditions.

TOTAL BIOCLIMATIC STRESS OVER THE ROMANIAN TERRITORY

Rodica Tomozeiu, Romania

The paper synthesizes the variability of the total bioclimatic stress index as resulted from summing-up the skin and lung stress as well as the distribution of its values over the territory.

The date base was made up of the mean monthly multiannual values (1961-1995) for air temperature (C),vapour pressure (mb) wind speed (m/s)from 26 meteorological stations uniformly distributed over the country's territory.

Stations were choesen depending on their balneoclimatic assets,specific to the representative physico-geografical units (plain, hill, mountain).

Key words : cooling power, skin climatic stress, vapour pressure, lung climatic stress, total bioclimatic stress

THE MEANING OF BOUNDARY LAYER CLIMATE IN REGARD TO TOURISM PLANNING ACTIVITIES WITHIN THE PARISH OF WERFENWENG (FEDERAL STATE OF SALZBURG)

Herbert Weingartner, Gabriele Rupnik, Austria

Since many years the community of Werfenweng takes measures in order to improve sustainable development in tourism (Räumliches Entwicklungskonzept 1996). So far significant improvements concerning internal and approaching traffic, reduction of air pollution etc. have been made. Now possibilities are discussed about how to use knowledge from regional scientific studies for tourist planning purposes (WEINGARTNER et al. 1997).

In this context scientific analysis about boundary layer climate within the parish of Werfenweng, which leads from the karst plateau of the Tennengebirge (>2000 m) down to the main valley (<1000 m), could contribute substantially to future tourism related measures (e.g. nature trails), recreation offers and leisure activities.

Because of the specific position of the parish Werfenweng (NE-margin of the Tennengebirge), different environmental and landscape units exist:

Zone above timberline (>1800 m): This part covers the borders of the karst plateau with steep lateral slopes. Main Exposition: SE-NW. Climatic properties: Convective slope winds, high radiation, rather low temperatures. Compared to other areas rather less dependent from surface qualities.

Region between timberline and high mountain valleys (1400-1800 m): Due to the geological situation (Werfener Schichten) hilly rounded relief with incised valleys. Main alpine pasturing zone. Climatic properties: Main exposition NE-S, thermal favoured, high radiation. Situated above the zone of temperature inversion. Rather balanced daily temperature amplitudes. Rather short snow cover.

Area of mountain valleys (<1400 m): U-shaped pre-quaternary valleys. Glacially and holocene transformed. The valleys are deeply cut into the surrounding landscape. Main residential area. Climatic properties: Temperature-inversion zone, high relative humidity during nights and wintertime, long-lasting daily heating (radiation cauldron due to valley shape). High amplitudes of daily temperatures. Rather soon freezing events in autumn and late ones in spring.

The environmental properties of the three main landscape units, especially their different boundary layer climate, suggest an intensified consideration of climatic aspects in respect to further tourism planning intentions.

USE OF WEATHER ROUTING IN THE NORTH ATLANTIC FOR INCREASING THE SAFETY OF NAVIGATION

Adam Wolski, Poland

Shipping routes across the North Atlantic are either climatic, established on the charts showing mean wind and current velocities, the currents of fog, ice limits and the frequency of gales, or are recommended by weather routing agencies on the basis of medium and long-term weather forecast and the performance curves of the ship in question.

In the United States and Western Europe weather routing in this sense began in 1954 and in the Soviet Union in 1964. The first Polish shipowner to apply optimum weather routes was the Polish Steamship Company of Szczecin which, in 1974, started providing its ships with weather route advice.

This paper evaluated from the author's own research the hydrometeorological conditions experienced in the North Atlantic during 52 voyages on 32 000 d.w.t. cargo vessels belonging to the Polish Steamship Company.

The hydrometeorological conditions encountered point to the superiority of recommended routes over climatic ones. Taking advantage of the routes recommended by routing agencies, the ships sailing from Europe to North America reduced the number of days spent in the stormy area from 21 per cent to 3.9 per cent of the voyage for waves and 29.2 per cent to 10 per cent of the voyage for wind.

On the way back from North America to Europe the efficiency of the recommended routes was also considerable. The length of time spent in areas of wave height above 5 m was lowered from 20.5 per cent to 5 per cent and for wind from 39.5 per cent to 27.1 per cent of the whole voyage as compared with the climatic routes.

AIR PRESSURE DATA FOR ESTIMATION OF NATURAL VENTILATION IN A TUNNEL

Ksenija Zaninovic, Croatia

This paper represents calculation of air pressure differences between entrances of a tunnel supposed to be located in the mountainous area of the Dinaric Alps, with an altitude difference of 49 m between entrances. Data from the regular network of stations were used for the calculation and they had to be reduced to the entrances values while there are no data measured in situ. Regional characteristics of a horizontal air pressure distribution and its variations with altitude are taken into account. The results, distribution of air pressure differences between the entrances, can be used in estimation of a natural ventilation in a tunnel and in calculation for ventilation constructions.

CLIMATOLOGICAL SURVEY IN AUSTRIA – A REGIONAL PRECIPITATION STUDY OF VORARLBERG THE WESTERNMOST PROVINCE IN AUSTRIA

Ingeborg Auer, Austria

In a 3 years project the climate of Vorarlberg the westernmost province of Austria is investigated in collaboration between the Central Institute for Meteorology and Geodynamics in Vienna and the Vorarlberger Landesregierung. For the precipitation study a network of more than 100 stations was available including data from Germany, Switzerland and Liechtenstein, the temporal data densitity varied from minute intervals up to monthly or annual sums. The presented poster concentrates to the possibilities for the application of the results in the fields of economy and agriculture.

USAGE OF COMMERCIAL RDBMS-TOOLS FOR PROCESSING AND PRESENTATION OF CLIMATOLOGICAL DATA

Johannes Behrendt, Germany

The Deutscher Wetterdienst (DWD) as German national meteorological service has the responsibility for the collection of the national climatological data. All relevant climatological data including - as far as possible - historical data back to the last century have been put on computer readable archives organized as time series. During the last years new datatypes like data from automatic stations, numerical model fields and remote sensing data with increasing data volumes are becoming more and more important for climatological applications. Also the requirements for the availability of the data are increasing rapidly. To meet these new challenges the existing operational file orientated data base system on a mainframe is being changed towards a modern data management system in an open environment using relational database management systems (RDBMS), the related tools and new communication technology like internet/intranet interfaces.

Since 1995 at the DWD a project is running to implement a relational data base management system (RDBMS) for all meteorological data, named MIRAKEL (" Meteorologische Informationen in einem RDBMS ablegen und komfortabel und effektiv lesen"). In the end we shall be able to handle both - the data used for the operational weather forecast and the climatological data - by the same database management system. The DWD has decided to use the ORACLE RDBMS and the related ORACLE tools. The MIRAKEL system will be implemented on a client/server environment with SGI servers and clients using X11, WINDOWS NT and WINDOWS 3.11.

MIRAKEL uses the ORACLE tools as far as possible for the development of applications. The access to the MIRAKEL database is realized by applications developed with DEVEL-OPER 2000 containing the modules FORMS, REPORTS and GRAPHICS. The ORACLE

tools DESIGNER 2000 (for the database design) and DISCOVERER 2000 (for data browsing and construction of SQL statements) are used as well. The construction of dynamic HTML pages for the usage in a intranet/internet environment will be supported by the new

DEVELOPER 2000 releases using automatically generated JAVA-scripts. So an access to the MIRAKEL-Database by internet/intranet-technology will be supported at least for the internal access. Dynamic as well as static HTML-pages are used for the description of the content of the database and of the applications for the access to the database. In order to support the existing climate applications, MIRAKEL will provide an interface for the existing sequential file formats. The migration of the existing file orientated databases to MIRAKEL will be performed by software using C and embedded SQL.

At least the key databases for historical monthly, daily and hourly data as well as for the present and often used metadata are migrated into the database. The database is updated operationally with recent data. The design for the integration of other then conventional climatological data (e.g. maritime data, phenological data, chemistry data or grid data) is not yet accomplished.

STATISTICAL SPATIAL COHERENCE OF THE DAILY PRECIPITATION ON ROMANIA'S TERRITORY

Liana-Victoria Cazacioc, Romania

The mutual influences of the precipitation sequences measured at meteorological stations in Romania are dealt with by using the correlation analysis.

The primary data file includes the daily amounts of precipitation measures at 99 meteorological stations with continuous observation series distributed rather evenly on Romania's territory during the period 1.01.1961 - 31.12.1990.The influence domain of the stations has been first studied.

The simplest statistical relation index is the empirical Pearson correlation coefficient. For the spatial analysis of the daily precipitation field in Romania, the correlation coefficients between the 99 stations have been calculated, during the considered interval, resulting in the correlation matrix of dimension (99,99). It is impossible to carry out a global study of all the correlational interrelations described by these coefficients. Therefore, an information planning procedure contained by the correlation matrix has been used, that is: for a fixed station, the correlation has been used between the precipitation amount from it and the precipitation amounts from all the other stations.

Another research direction was related to the preferential ordering of the stations used in this study. The ordering principle was based on the study of the inner redundancy of the system of stations. In meteorology, the studied (observed or predicted) data are generally correlated in space and time. That is why, a decreasing or increasing ordering of their correlational redundancy is intended, expressed by the multiple correlation coefficient between each station and all the others. The representation degree of a station can be appreciated by a subassembly of other stations, within a multiple linear regression model.

An attempt has been also made to study the correlation (or proximity) coefficient variation according to the distance, as well as the variation of a distance coefficient between the daily precipitation sequences at the stations, in terms of the distance between stations.

Several metrics have been chosen, such as Minkowski distances of various ranks or distances built on the basis of the correlation coefficients between the daily precipitation amounts at the stations.

The matrices containing these distances can be afterwards used to define the climatology of the precipitation field, based on searching homogeneous areas where the precipitation affects the stations similarly.

AN EUROPEAN CLIMATOLOGICAL DATA BASE IN THE XVIII CENTURY: THE "METEOROLOGICAL SOCIETAS PALATINA"

Michele Colacino, Italy

The birth of the synoptic meteorology is fixed in 1872, when the International Meteorological Organization was created. Actually the origin is more ancient since it can be connected to the activity of many different academies and scientific societies. Among them in the XVII century must be remembered the Italian "Accademia del Cimento", that realized the first meteorological network and in the following century the "Meteorologica Societas Palatina". This one was created with the aim to improve the science of meteorology by setting up a network covering the Europe. In addition the data coming from all the stations were gathered and printed in the Ephemerides, that in this way represent the first reliable data base of climatological information for our continent. In this paper the birth and the activity of the "Meteorologica Societas" is described together with the instruments and rules for the data collection. Some samples of the data are also shown, concerning the patterns of pressure and temperature.

RETRIEVAL OF AEROSOL PARAMETERS FROM SURFACE RADIOMETRIC MEASUREMENTS

Steven Dewitte, Belgium

Radiative transfer calculations are used to model clear sky solar radiometric surface measurements in function of water vapour absorption and scattering, in function of aerosol absorption and scattering and in function of ozone absorption.

In Uccle, Belgium, surface solar radiometric measurements are available since 1951 (global and direct solar radiation measurements), water vapour measurements are available since 1931 and ozone measurements are available since 1971. By combination of these measurements (for cloudless days) with the radiative transfer derived model, an historical aerosol data set is retrieved.

The same technique can potentially be applied to historical measurements obtained routinely by various meteorological institutes in Europe, thus leading potentially to a historical aerosol climatology over Europe for the past 40 years.

The correctness of the derived aerosol data set is checked by comparison with aerosol data retrieved from accurate spectral measurements obtained in Uccle during 1980.

ESTIMATION OF UV RADIATION OVER SPAIN

R. Garcia, E. Weatherhead, E. Hernandez, J. Diaz, Spain

The evaluation of the UV radiation reaching the earth's surface is a matter of increasing interest during the last years due to environmental and health reasons. Direct measurement of incident solar UV radiation is an expensive and difficult task, since UV radiation is only a small fraction of total solar radiation. For this reason, different model must be used to evaluate the behavior of this radiation. This paper presents the results of a 14 year climatology for biologically active UV radiation over Spain. It has been elaborated from results of a radiative transfer model supplied with data from the NIMBUS 7 TOMS, satellite data. These values have been scaled through two different procedures using as reference local measures from Madrid.

The calibration provides an excellent agreement between measured and modeled values. The study allows the evaluation of the UV levels incident over the different parts of Spain. Four regions have been identified according to the average values. Finally, the time behavior of the series representing every region is described.

LINKING LARGE SCALE AIR PRESSURE FIELDS WITH REGIONAL PRECIPITATION

Wolfgang Diernhofer, Austria

The purpose of this paper is to investigate the linkage of regional precipitation to large scale air pressure distributions in a selected alpine basin in Austria. Therefore a statistically based downscaling approach is applied in the upper Enns basin. The first goal is to identify and explain the driving forces generating the precipitation in the basin. Especially wind directions and wind forces describing the dominating weather conditions are focused at. Then, considering air pressure data derived from large scale pressure distributions the downscaling technique can be applied to simulate local precipitation events.

In the following large scale air pressure data are analyzed to obtain parameters linking pressure gradients with local precipitation regimes in the Enns basin. The parameters reflect large scale wind directions and wind forces. Additionally parameters considering the distances to neighboring low and high pressure areas are considered. The estimated parameters are physically based and directly drawn from large scale weather conditions on a daily basis. The data basis applied is derived from the National Center for Atmospheric Research (NCAR). It contains time series of observed air pressure heights on various pressure levels corresponding to a octagonal grid comprised of 1977 points in a 47 by 51 array. The points are equally spaced when viewed on a polar stereographic grid, centered on the North Pole and rotated such that 10 degrees East Longitude is a horizontal line to the right of the Pole (see Figure 1). For this purpose the pressure heights corresponding to the 500 hPa pressure surface on a 16 x 21 grid over Europe are considered for a time period from 1970 to 1989.

The application of the described methodology mainly focuses on quantitative precipitation modeling . Further, using data from general circulation models predictions on possible impacts of climate change on the hydrology in the Enns basin are accomplished.

Results are given reflecting the statistical parameters of temperature and rainfall in the Enns basin under observed and simulated conditions Further precipitation probabilities as well as durations of wet and dry periods are presented.

TEMPERATURE-HUMIDITY CONDITIONS IN BULGARIA DURING XX-TH CENTURY

Anelia Gocheva, Bulgaria

A comparative analysis of temperature-humidity conditions on the territory of Bulgaria from the beginning of the century up till present days was carried out. Data series from stations located in different orographical and climatic conditions (plain, mountain, alpine, on a river Danube, maritime, in the extreme north and south, in the central part of the country, etc.) were used. Different characteristics of Temperature-Humidity Complex (THC) - mean, maximum and minimum air temperature, absolute and relative humidity, partial pressure, moisture content and enthalpy were examined. The statistical structure of their monthly, seasonal and annual distributions was investigated for the periods 1901-1930, 1931-1960, 1961-1990 separately as well as for the whole period and the last decade (1987-1996). The basic statistical parameters, standard normals and quantiles were calculated and the appropriate approximating functions of the examined empirical distributions were established. A statistical extrapolation of the integral distribution curves was performed and the values with different integral probability including at different probability of the repetition periods were estimated. A special attention was paid to the climate variability of the complex parameters moisture content and enthalpy (heat content) of the surface air compared with the climate variability of other meteorological elements. The contemporary temperature-humidity conditions in the country was described against the background of these ones from the beginning and the middle of the century.

THE METHOD OF SPATIAL GENERALIZATION OF CLIMATIC INFORMATION

Ludmila Gueiko, Ukraine

The information about statistical structure of meteorological fields is necessary for decision of number theoretical and practical problems. Research of the spatial structure is based mainly on application of the statistical character of random fields - structurative, covariance and correlative functions. The spatial correlation functions are calculated for surface fields as a rule. It gives possibility to judge about regularity of change connection of meteorological parameters with a distance, to evaluate mistakes of approximation, to elaborate optimal methods of interpolation, extrapolation and smoothing, to evaluate of accuracy area average. Forecasting methods of mean productivity of agricultural plants for region have a wide application for hydrometeorological service of agriculture of Ukraine. These methods based on the construction of dynamic and statistical models. The area values of hydrometeorological parameters are used in these models as entranced parameters. The objective method of evaluation of accuracy area values of hydrometeorological parameters, which based on the spatial statistic structure of hydrometeorological fields, is presented in this work. The method of area correlation function was applied for study of statistical structure.

The area correlation functions of monthly mean air temperature (t(C), monthly amount of precipitation (f,mm) and hydrothermal index (HTI=10(f/(t)) were calculated during warm period of year for Ukraine territory/for plains. The date of observations of 130 hydrometeorological stations has been used for this calculation. These correlation functions decrease with a distance and are approximated exponential dependence.

The fields of all indexes have a clear expressing statistic structure, the considerable correlation connections have traced to long distances. Statistic structure of HTI mainly is determined of the statistic structure of precipitation.

The evaluation of accuracy area average of pointed indexes, when different density of hydrometeorological stations, based on the statistic structure of the temperature, precipitation and HTI fields. The mean relative quadratic mistake of area average, according to method of R. L. Kagan, is depended on parameters of correlation function, area and quantity of observation points on this area.

The diagrams of the mean relative quadratic mistakes of area air temperature, amount of precipitation and HTI were constructed for all considering territory. It is easily to determine the necessary quantity of observation points for area average, if the permissible mistake for amount of precipitation and HTI is 10%, for air temperature - 0.1°C.

The practical recommendations for objective area average of air temperature, amount of precipitation and HTI have been prepare for all regions of Ukraine, according to administrative division.

THE USE OF SATELLITE DATA FOR CLIMATOLOGICAL APPLICATIONS: THE SAF ON CLIMATE MONITORING

Peer Hechler, Germany

After recalling some background information regarding the SAF-idea in general the proposed lecture will give further details on the implementation of a 'SAF on Climate Monitoring':

In August 1997 the WMO-Commission for Climatology stated: 'Noting the growing use of satellite data the commission urged it's members ... to give greater consideration to the quality and use of this valuable source of climate information'.

This statement fits in very well with an European EUMETSAT-initiative hosted by DWD: The Satellite Application Facility on Climate Monitoring ('SAF on Climate Monitoring').

 Established mainly as a joint effort of the NMS's of Finland, Sweden, Netherlands, Belgium and Germany the 'SAF on Climate Monitoring' forms the basis for the long term monitoring of some important components of the climate system. It will focus mainly on the energy cycle. This challenge will be tackled by generating and archiving high quality data sets and information resulting from quality monitoring activities on a continuous basis.

Therefore the 'SAF on Climate Monitoring' will provide temporally and spatially consistent homogeneous high resolution data sets of cloud- and radiation parameters for Europe and the North Atlantic as well as global data sets of Sea Surface Temperature and Sea Ice Coverage.

In addition statistical evaluations of vertical profiles of temperature and humidity will be performed on a global scale in order to assess the quality as well as the climatological content of the profiles.

Finally the presentation will outline in which way the 'SAF on Climate Monitoring' serves multinational monitoring activities.

GCOS - TOOLS TO IDENTIFY CLIMATE DATASETS

Raino Heino, Finland

Since its establishment, the Global Climate Observing System (GCOS) was intended to be built on existing operational and scientific observing systems, data management and information distribution systems and further enhancement of these systems as required.

The work has taken place in the following standing panels:

- GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC)

- GCOS/GTOS Terrestrial Observation Panel for Climate (TOPC)

- GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC)

- Global Observing Systems Space Panel (GOSSP).

The data and information issues associated with all the foregoing observing elements are being pursued through the

- GCOS/GOOS/GTOS Joint Data and Information Management Panel (JDIMP).

The JDIMP has prepared a plan for information management which called for a comprehensive distributed data system with established procedures for collection, quality control, comparison of observations from different sources, dissemination, and utilisation. It is to be based on the acceptance of appropriate quality assurance principles and calls for close co-operation with existing data centres (e.g. ICSU World Data Centres). The architecture accommodates data and products from GOOS, GTOS, and operational systems such as the WWW.

The JDIMP has also developed a series of projects to provide support to the global observing systems. Examples include: establishing links with data centres, workshops to address technical issues with data sharing and to obtain data needed for indicators of climate change. In addition, the GUAN (GCOS Upper-Air Network) and GSN (GCOS Surface Network) have been developed to ensure that appropriate atmospheric and surface observations will be available.

It has been regarded as appropriate for the JDIMP to register datasets based on the available metadata associated with each dataset. The datasets would be selected from the domains of all the three observing systems but should not be tagged as being associated with anyone of them. Also, national and regional datasets that are not global in nature but are of global interest will be included. This proposed dataset registration process will be viewed in three stages or levels:

- creation of a high level cataloguing system for datasets on the World Wide Web;

- an appended guide to potential users of the datasets; and

- a set of guidelines for the preparation of detailed metadata that would be held with the datasets.

A pilot project is going on to conduct a feasibility test on registration of selected existing datasets based on the development of a directory level of metadata.

In the (oral) presentation the above GCOS-activities will be reviewed with their latest updates.

THE SPECIFICATION OF WAVE CLIMATE
FOR THE SAFETY CLASSIFICATION OF PASSENGER VESSELS

J. S. Hopkins, C. R. Heaton, United Kingdom

Two significant marine disasters in Europe - "Herald of Free Enterprise" (Zeebrugge, 1987) and "Estonia" (Baltic, 1994) - stimulated effort by marine safety bodies to develop a clearer classification system for passenger vessels. At the EU level, it was agreed that such a safety classification scheme should depend, at least in part, on the wave climate which a vessel would be expected to encounter during its service. The responsible body in the UK - the Marine Safety Agency - commissioned the UK Met Office to undertake a study of wave climate in waters around the UK, to provide up-to-date quantitative guidance on wave conditions which would be used in the safety classification process. The significant wave height which is likely to be exceeded for only 10% of the time was chosen as the variable to characterise the wave climate.

Traditionally, wave climate statistics have been produced from observations made by vessels passing through the area of interest. For busy sea areas, this may be satisfactory, but many areas, including relatively-sheltered locations where local ferries tend to operate, have an inadequate sample of reports. Therefore, although ship reports provided a valuable reference, the main part of the study made use of hindcast wave data generated at 3-hourly intervals over the last decade by the UK Met Office's European Waters Wave Model.

The wave model's spatial resolution (25 km) allowed local detail to be established in many areas, which would not have been possible from ship data. Examples will be shown of the good spatial consistency of the model results, plus instances of additional local detail which has been obtained. The model domain covers the Baltic and Mediterranean Seas at the same resolution as the Northwest European Continental Shelf area, and so the same methodology could be used to define wave climate in these areas.

THE OBSERVED CLIMATE DATABASES OF THE HADLEY CENTRE

Briony Horton, United Kingdom

An overview of the Hadley Centre climate database will be given, with particular emphasis on:

Mean Sea Level Pressure (GMSLP): Developed in collaboration with the Commonwealth Science and Industrial Research Organisation (Australia), National Institute for Water and Atmospheric Research (New Zealand) and Climatic Research Unit (UK), GMSLP is an historical gridded monthly dataset covering the period 1871-1994. It can be used to analyze climate variability as well as to validate climate model output. It was developed by blending a combination of existing gridded mean sea level pressure analyses with marine and land observations, using Laplacian interpolation techniques. A range of quality controls was used to remove random and systematic errors from the observations. Future improvements will include the addition of recently digitised historical observations, the use of a form of Optimum Interpolation that uses eigenvectors instead of covariance functions, and updating in near-real time.

Sea Surface Temperature (MOHSST/GISST): MOHSST is the UKMO historical gridded monthly observed Sea Surface Temperature dataset, beginning in 1856. The data are collated, quality controlled, and converted to a 5° latitude by 5° longitude grid in real time. They can be used for monitoring and analysis of global climate, and, when blended with the land surface temperature data described by Jones (1994) form a key dataset for monitoring global climate change.

GISST is an extension of MOHSST - it is higher resolution spatially, and is also available on a monthly time scale from 1871. It includes ice concentration data, and missing SSTs have been filled using similar methods to those planned for mean sea level pressure. Its main use is to force General Circulation Models, but it can be used, with caution for analysing climate variability.

Upper Air Temperature (HADRT): HADRT is a dataset of monthly radiosonde-based standard level upper air temperatures on a 5° latitude by 10° longitude grid. The radiosonde temperatures have been made more homogeneous using Microwave Sounding Unit (MSU) retrievals to adjust station data worldwide to compensate for instrument changes since 1979, wherever stations' metadata were available. The monthly data have been converted to seasonal and annual fields using an eigenvector reconstruction method to filter noise. One version is interpolated with guidance from the National Centers for Environmental Prediction (NCEP) Reanalysis. Future improvements will include bias-adjustments independent of MSU, and interpolation using field statistics based on the most recent, reliable, NCEP Reanalysis fields.

CLIMAT Station Datasets: The CLIMAT datasets continue to be updated monthly, and the surface temperature data, when gridded onto 5 degree resolution, provide a major input to monitoring of climate change. Much of the initial quality control of these data is hampered by coding errors because the new CLIMAT code which was introduced in November 1994, is still causing confusion in many countries. Such coding errors need to be identified and rectified before extensive automatic quality control can be performed.

CLIMATE CONDITIONS IN THE SANDANSKI-PETRICH PILOT ZONE FROM MEDIMONT PROJECT

Anna Tzenkova, Julia Ivancheva, Bulgaria

The climate is one of the basic factors causing the Mediterranean character of the environment (soils, plants etc.) The pilot zone belongs to the South –Bulgarian part of the Continental Mediterranean climatic area. In particular, it belongs to the following climate regions: A - Petrichko-Sandanski; B - Malashevsko-Pirinski;

C - Mountain region.

For more detailed description of the climate in this zone, we consider separately the winter and summer conditions according to the regions A, B, C. The mountain nature of the zone leads to significant changes of the meteorological elements with altitude. Correlation and regression analysis are used to find significant statistical relations between major the meteorological parameters and altitude.

The climate conditions have a complex influence upon nature both, animate and inanimate. It means that climate acts not trough the separate meteorological elements but trough complexes of them. This is a good reason to describe climate on the base of the complex indexes but using single meteorological parameters. In this case the „climate of the combination of meteorological elements" will be discussed in advance by adequate correlation formulas. Most of these formulas result from empirical studies and are not a result of theoretic considerations. For this reason, there is no universal indicator to characterize the climate and that is why we discuss two different indexes. We have studied the De Martonne and Malmstrom indexes in present paper.

SPATIAL AND TEMPORAL INTERCOMPARISON OF PRECIPITATION DATASETS

Julie M. Jones, Mike Hulme, United Kingdom

A knowledge of the observed spatial distribution of precipitation, and its changes on both shorter and longer timescales, is fundamental to an understanding of climate trends and variability, and for climate model evaluation. A number of global precipitation datasets now exist, either land and ocean, ocean-only, or land-only. It is important to determine the magnitude of the differences between these datasets, so that users understand the uncertainties contained within them. Differences may arise because of different gauge networks, different interpolation methods, and/or different satellite observing sensors. Ten datatsets shall be used in this analysis. These are constructed from either gauge (e.g. New et al., 1997; Xie et al., 1996) , satellite (e.g. the Microwave Sounding Unit (MSU) of Spencer, 1993), or combined satellite and gauge (e.g. Global Precipitation Climatology Project (GPCP) of Huffman et al., 1997) data. Analysis at three levels shall be presented: spatial patterns of mean precipitaion, spatial patterns of mean precipitation variability and precipitation trends. The proposed outcome of this analysis should be an estimate of the level of uncertainty contained in measurements of global precipitation, and if and how this varies regionally and temporally.

OPERATIONAL HOMOGENIZATION OF LONG TERM CLIMATE DATA SERIES AT SMI AND SHMI

M. Begert, M. Giroud, R. Kegel, G. Seiz, V. Koehli, C. Haeberli, Switzerland
O. Bochnicek, M. Fukasz, E. Nieplova, L. Sramo, Slovakia

The last step in the treatment of climate data sets at the Swiss Meteorological Institute (SMI) and the Slovak Hydrometeorological Institute (SHMI) is the homogenization of monthly climate data series, which is realized at irregular intervals. The homogenization is operationally achieved thanks to a graphical user interface depending on the computer operational system with access to a library of mathematical functions. The package allows to perform every necessary step in homogenizing data series, including basic graphical and statistical analysis of the data, selection and calculation of reference series, a variety of homogeneity tests and the adjustment of shift and trend inhomogeneities. Various homogeneity tests are used since their ability to detect shifts and trends in time series depends on the structure of the examined data and on the unknown number of inhomogeneities.

Monthly and annual standard climate normals can be calculated from the homogenized data series. If the series do not cover the whole standard normal period, mean values are adapted to the longer time period with the help of a reference series.

The described tool provides a flexible working method for the homogenization of climate data series in a user-friendly way.

NEW TREATMENT OF REAL TIME CLIMATE DATA SETS FROM SMI WEATHER STATIONS

Thomas Konzelmann, Switzerland

The Swiss Meteorological Institute (SMI) maintains various climate networks with sampling rates from 10 minutes to 12 hours, including all relevant meteorological parameters. The measured and eye-observed parameters are transmitted continuously from the sites of observation to the central computing system. A rough data-check is made immediately after polling to detect sensor failures. The automatic quality control of each parameter of the data sets is made daily including tests of completeness, tests of physical and site-specific limits, tests of consistency, variability and regional homogeneity. These tests are used on the original resolution of the data and on several aggregation levels. On daily and monthly mean values there is a first use of homogeneity tests ("online homogeneity tests") to detect systematic changes in each data series. After every step suspicious data are flagged and treated either automatically or manually to provide a full set of reliable data. From time to time all

Monthly mean series are tested for homogeneity and are homogenized accordingly. The relational database offers the opportunity to use station "metadata" in the whole process of data treatment. Finally, homogeneous long-term climate data sets are provided, e.g. for trend analysis and the calculation of standard normals.

GEKIS, A DATA QUALITY MANAGEMENT AND VISUALISATION SYSTEM OF CLIMATE DATA SETS BASED ON THE DESKTOP GIS

Wolfgang Lipa, Roland Potzmann, Austria

The Goal was, to increase the quality of the climate data through a new method of the control procedure. Through the application of affordable Hard - and Software an efficient and inexpensive solution should be found. The name of this solution: GEKIS (Geographical Climate-Information-System)

This was achieved on the client side by PC´s under Windows/NT 4.0. The tabular data representation and treatment is performed with Microsoft ACCESS, which is connected over ODBC (open Database Connectivity) with Sybase data bases (Sun servers under Solaris 2.6) within a LAN (Local Area Network) as well as a WAN (Wide Area Network).

The graphic and spatial representation and treatment takes place with the desktop GIS ArcView, which communicates by DDE (Dynamic Data Exchange) with ACCESS and other programs.

The storage of the data is done within a four-table-structure (original -, final -, flag - and suggested values) in SYBASE data bases as well as in ACCESS.

The climatological data sets are linked with

> DHM (Digital Elevation Model)
>
> satellite images
>
> radar images
>
> Lightning-data
>
> additional geographical information like roads, streams, boundaries ...

The system is presented on Pc's on the spot.

STUDY OF THE TEMPORAL EVOLUTION OF PRECIPITATION REGIMES IN SPAIN BY MEANS OF SOME QUANTITATIVE INDICES

José Antonio López Díaz, Spain

Some quantitative indices describing relevant features of the distribution of precipitation through the hydrological year are introduced in an attempt to characterize the evolution over the years of the annual precipitation regime. These indices correspond to four properties: the degree of concentration of the amount of total annual rainfall around some point of the year, the lag of the onset of precipitation, and the relative degree of fitting of the precipitation distribution to a one-maximum (or monomodal) pattern (associated in Spain with the atlantic influence) or to a two-maxima (or bimodal) pattern (associated with mediterranean influence).

For the stations with mainly atlantic rainfall regime long-term significant trends appear in the concentration index, and also, related to this, in the degree of accumulation of precipitation in the winter season, although a reversal of this tendency can be appreciated in the more recent years. These fluctuations are well synchronized with changes in the relative weight of the mono versus bimodal type of distribution, thereby pointing towards shiftings in the atlantic/mediterranean areas of influence.

This study has been carried out over a set of stations with long homogeneous series of precipitation (going back to the past century) representative of the main precipitation patterns in Spain.

STOCHASTIC MODELS OF CLIMATOLOGICAL TIME SERIES. AN APPLICATION TO THE TEMPERATURES TIME SERIES IN THESSALONIKI-GREECE

Timoleon Makrogiannis, Greece

As it is known the time series analysis of temperature is always interesting. In this paper we study the mean annual and seasonal temperature time series (1950-1997) of Thessaloniki Greece. Using several tests, parametric and non parametric, a strong negative trend is detected in the annual, summer and autumn values. Regression models with autocorrelated errors and ARIMA prediction models were applied and gave rether good results. These results show that the negative trend will continue untill the year 2000.

VALIDATION AND COMPARATION OF TWO DOWNSCALING APPROACHS FOR RAINFALL ON A HIDROGRAPHIC BASIN SCALE

J.M. Martin, L. Balairón, J. Pastor, Spain

Two specific methodologies of precipitation down-scaling with hidrographic basin resuls from AOGCM outputs, has been validated and applied on Spain, and has been compared for winter season.

The first one is based on the circulation indices behaviour, which have been computed month by month on each grid point of a select Atlantic area.

The developed circulation indices (J.M°Martin) are bases on a objective classification of Jones et al. (1993), previously based on the Lamb's Classification and on the Murray & Lewis indices (1996). Jones keeps the Lamb's classification, but he computes flu and vorticity values in one singular grid-point. Instead of that, the values are computes on all grid point of selected area. The Fig. 1 show an example of this, and, at same time, the working-grid. The originally developed indices by Murray and Lewis was: S and M (South and Medional), C (Cyclonic) and P (Progressing or blocking). So, we get a data set with four monthly and annual indices, for each grid point. The correlations between a particular index or a combination of them and the monthly or seasonal precipitation in a particular basin are higthly significants and give us a method for the stimation of future local precipitation from AOGCM geopotential fields (fig.2).

The second one method adapted from von Storch, Zoria and Cubasch (1993) perform a canonical correlation analysis (CCA) between the SLP anomalies vector and the winter mean rainfall volume anomalies of each Spanish hydrographie basin, previous a dimension reducing process by principal component analysis (PCA). For the winter peninsular-Spain time evolution of canonical variables vs. Corresponding precipitation volume.

Both methods present the same kind of problems over the mediterranean area on autumn season: It is necessary to develop a specific approach for these area and period.

MULTIANNUAL VARIABILITY OF THUNDERSTORMS AND CB CLOUDS OCCURRENCE IN CRACOW BASED ON THE OBSERVATIONAL SERIES FOR THE PERIOD 1906-1995

Dorota Matuszko, Zuzanna Bielec, Poland

A thunderstorm consists of sudden electrical discharges manifested by a flash of light and a sharp or rumbling sound inside a Cb cloud or between the cloud and the ground (Janiszewski, 1988). The formation of a thunderstorm depends on the Cb cloud presence, therefore it seems reasonable to study the two elements jointly. The paper aims to define the variability of thunderstorms and the Cb clouds occurrence in the multiannual, annual and diurnal course in Cracow. It is also a methodical attempt of characterizing one of rather complicated meteorological phenomena, difficult to describe. Thunderstorms are not continuous in time and space and the Cb clouds form rarely, in local scale. Moreover visual nephological observations are often questionable. Therefore neither thunderstorms nor Cb clouds are often described in the literature.

Cracow is one of few cities in Europe where cloudiness and electrical phenomena have been observed for over a century. The paper presents very unique data, considering the unity of observation place, continuity and length of the series. They consist of daily climatological observations carried at the Climatological Station of Institute of Geography, Jagellonian University in the years 1906-1995.

The calculated indices include the numbers of Cb cloud occurrence cases in months, years and multiannual periods, separately for every climatological term and also number of days with thunderstorm for the same periods. As the comparison of yearly and multiannual course turned out to be unsatisfactory, the number of days with Cb cloud was calculated, meaning days with Cb cloud occurrence at least at one observational term. Afterwards the number of days with Cb clouds was correlated with number of days with thunderstorm in multiannual, yearly and daily course.

The multiannual course of thunderstorms and Cb clouds occurrence in Cracow show a significant increasing trend. The rise in intensity of thunderstorm phenomena, also in winter, was observed especially for recent 30 years. The Cb clouds and thunderstorms occur most often in June and July, more often in spring than in autumn, and hardly ever in winter. The frequency of Cb clouds occurrence is low in the morning for the whole year, while at noon it is much higher for the warm half-year. The impact of synoptic situations on the frequency of Cb clouds and thunderstorms occurrence was studied according to the Catalogue of Synoptic Situations in the Upper Vistula River Basin (1981).

Two types of situations were found to be favourable for the Cb cloud and thunderstorm formation: Bc (through of low pressure, neutral field of low pressure or the axis of the low pressure through) and NWc (cyclonic situation

with an advection of air masses from the North-West).

CLIMATE OF THE BALTIC SEA BASIN - PROJECT OF THE RA VI WMO

Miroslaw Mietus, Poland

The increasing demand for the exploration of climatic conditions in relatively small sea-basin areas due to the expansion of industry, the intensification of shipping and off-shore activities and the expansion of nuclear power plants was the impetus for representatives of several countries from the Baltic Sea Basin to carry out a joint study on the climate of that region.

In order to properly characterize the climate of the Baltic Sea region, data from the coast as well as from the sea must be analyzed. Services from the countries involved in the project were requested to offer climatological tables from selected coastal stations, prepared using uniform criteria, for the last WMO normal climatological period 1961-1990. The data from sea areas originated from weather observations conducted on ships and stationary platforms during the same period. On the basis of these data, a climatological analysis of the Baltic Sea and adjacent coasts was carried out. Political changes in the early 90s, i.e. the unification of Germany and the collapse of the Soviet Union, affected some of the countries involved in the project. As a result, the following national services participated in the final stage of the project: the Danish Meteorological Institute, the Deutscher Wetterdienst, the Institute of Meteorology and Water Management, Poland, the World Data Center B1, Russia, the Estonian Meteorological and Hydrological Institute, the Finnish Meteorological Institute and the Swedish Meteorological and Hydrological Institute.

Climatological data for sea areas originate from weather observations onboard of moving ships like merchant ships, ferries as well as research and fishery vessels and from stationary platforms, e. g. light houses, light vessels, drilling and research platforms. Except of the latter two, all kinds of data sources were used for this climatology of the Baltic Sea. For the production of climatic charts for the Baltic Sea, some problems had to be solved to get an as homogeneous as possible data set for sea areas. Ship observations are not evenly distributed in space and time: They concentrate on the main shipping routes and are more frequent in summer than in winter, when ships are impeded by gales or sea ice. Therefore it was necessary to get as many data as possible to cover also the data sparse regions and months.

The climate of the coastal area of the Baltic Sea reflects the geographical extent of the region, ranging longitudinally from Skrydstrup (09o16' E) to St. Petersburg (30o18' E) and latitudinally from Szczecin (53o24' S) to Haparanda (65o50' S). The climatological description of this region comprises chapters on distribution of air pressure, air temperature, precipitation, winds, cloud amount, sunshine duration, relative humidity and visibility in the years 1961-1990. Meteorological services from the countries involved in the project delivered about one thousand climatological tables of coastal data. Finally, 69 stations carrying out 8 observations per day and located no further than 30 km from the coast, were accepted for the climatological analysis. Denmark is represented in this publication by 10 stations, Germany by 6 stations, Poland by 8 stations, Russia by 2 stations, Lithuania by 1 station, Latvia by 3 stations, Estonia by 4 stations, Finland by 12 stations and Sweden by 28 stations.

NUMERICAL PRODUCTION OF CLIMATIC MAPS FOR PARAMETERS WITH SIGNIFICANT CORRELATION TO TOPOGRAPHY

Gerhard Müller-Westermeier, Germany

A simple numerical method to produce maps of climatological parameters, which show a significant correlation with topography, is presented.

Data from measuring stations are reduced to a common reference niveau using spatially variable regression functions. The reduced values are interpolated and subsequently retransformed into values in the actual topography.

Results for several analytical parameters as well as synthetic parameters like water balance based on a topographic grid of 1 km for Germany are shown.

Time series of grid fields of temperature and precipitation on a monthly basis have been computed for Germany dating back to the beginning of the century making it possible to show climatic tends in elevations for different regions of Central Europe.

PRECIPITATION PATTERNS IN THE CENTRAL WESTERN MEDITERRANEAN BASIN, WITH PARTICULAR REFERENCE TO THE ALPINE REGION

Emanuela Piervitali, Italy

Many researches have been devoted to the problem of the possible climatic changes, probably related to the anthropogenic enhancement of greenhouse effect. Particular attention has been reserved to the variation of the hydrological cycle, because it could produce a reduction of the water resources, as a consequence of long drought periods. Since greenhouse concentration is increased of 30% from the industrial revolution, signals of climatic change could be found, analyzing the pattern of climatic parameters.

With reference to the precipitation field, several authors indicate a rainfall reduction for latitudes lower than 50° and an increase for higher latitudes, in the Northern hemisphere; however the quantitative results are different. In the Southern hemisphere the paucity of data allows evaluations even more uncertain. Some studies have been performed also at the regional scale and, in the Mediterranean area, only few of them give quantitative results. In the present work, the Central Western Mediterranean basin has been considered and particular attention has been devoted to the Alpine region, which, located in the Northern limit of the Mediterranean area, can influence climate of the whole basin. Annual and seasonal precipitation data have been analyzed in the period 1951-1995, using the basic statistical techniques. Precipitation trends have been detected and the Standardized Anomaly Indices (SAIs) have been calculated, in order to evaluate the statistical significance of the results. The obtained patterns generally show a rainfall reduction, that is more strong in the Southern regions and in the cold season.

AN INTEGRATED APPROACH TO IMPROVING CLIMATE DATA QUALITY

Neil Plummer, Dean Lockett, Kelvin Wong, Chong Hu, Rod Hutchinson and Tony Guymer, Australia

Historically, operational and climate data management activities have generally been pursued independently in national meteorological centres. Much research has been undertaken to improving operational analysis systems and develop Numerical Weather Prediction models for weather forecasting. Improving quality control methods for use on data in the national climate archives has generally been the responsibility of data centres which, while attempting to derive similar information on data quality, have developed techniques independently of those developed for operational (e.g. short-term forecasting) needs. The result has been that much valuable information on the quality of observational data, as well as the observation systems and networks which produce these data, has been lost to the national climate archives.

The need for high quality climate data has never been greater. The increased acceptance of the potential impacts of climate change and the El Niño Southern Oscillation phenomenon, and the benefits of seasonal to interannual climate prediction, are raising the value of long, homogeneous climate datasets. Climate research over the past few decades has also shown that a greater range of climate data is required to understand the complexities of the climate system. A greater number of clients are requiring more accessible and higher quality data in near real-time.

The Bureau of Meteorology in Australia are in the process of developing a more integrated data quality improvement system based on the philosophy of Total Quality Management. The key Bureau of Meteorology sections with interests in data quality (and data quantity) are working to ensure that their information needs are satisfied by a range of tools developed, by a team comprising of members from all key stakeholder groups. These sophisticated graphical and statistical tools, including physical and dynamical models, will output a range of data quality information to satisfy the individual needs of the key data stakeholders. As well as improving the quality of data for operational purposes (including forecast validation) and for the climate record, the Observations section will receive better data for monitoring the performance of observation systems and networks. Such a system is also consistent with the need to establish key performance indicators in an environment of greater accountability for national meteorological centres and their parent government departments.

While developments are very much in their formative stage, these will be discussed and examples provided of improved methods to examine data quality.

GENERATION OF HOMOGENEOUS DATASETS OF DIURNAL PRECIPITATION IN A MESOSCALE GRID

Thomas Reich, Germany

BONIE is a procedure to estimate areal precipitation by means of groundbased measurements. Irregular distributed raingauge data are interpolated to a regular, area covering grid of 4' latitude x 6' longitude (i.e. ca. 7 km x 7 km) width.

The procedure is composed of three steps. First, the actual data are classified into the most similar of some predetermined spatial precipitation distribution pattern, the so-called background field, which is defined both at the raingauge locations and at the grid point. Second, the anomalies from the background field are interpolated by means of the well-known method of statistical (or optimal) interpolation. The concluding step merges background field and interpolated anomalies at the grid points.

Primary aim of BONIE was a operational application in flood forecasting and flood warming. For that purpose it has been used in Baden-Württemberg since 1997 (Project BONIE-BW).

On the other hand, BONIE may be used to generate homogenous series of grid point precipitation data for the purpose of climatological studies. Within the frame of project BONIE-K, which will start 1998, it is intended to carry out step by step, basin by basin an extensive statistical analysis of the entire precipitation data and to estimate diurnal precipitation grid point data starting with 1951. At last BONIE-K will provide more than 7000 grid-oriented time series covering the whole area of Germany.

Time series of precipitation data created in this way will be less affected by single station inhomogeneities (e.g. changes in location and/or exposition, growing trees etc.) and therefore will be qualified in a higher degree for climatological studies.

The proposed poster will present

- basic principles of BONIE,
- first results of BONIE,
- a preview of future activities.

THE "ANNUAL BULLETIN ON THE CLIMATE IN WMO REGION VI" A CONTRIBUTION TO EUROPEAN CLIMATE MONITORING

Gudrun Rosenhagen, Germany

Climate monitoring in Europe used to be done mainly on a national scale. As scientific interest is more and more focusing on the regional implications of a possible climate change, routine monitoring of regional climate is becoming more and more important. The need for a more co-ordinated approach to the preparation of climate system monitoring information led the idea to publish an annual regional CSM Bulletin. The eleventh session of the WMO Regional Association VI (RA VI), which took place in Oslo in May 1994, approved the proposal.

It is intended that the Bulletin be a comprehensive publication to include recent information on climate in RA VI, covering the whole of Europe and the Middle East, as well as information on achievements in climate analysis and research during the year. Thus, it serves as regional contribution to global climate system monitoring.

In 1995, the first issue of the "Annual Bulletin on the Climate in WMO Region VI" appeared. The Bulletin has been co-sponsored by WMO, the European Climate Support Network (ECSN) and Deutscher Wetterdienst, the national German Weather Service. Moreover, Deutscher Wetterdienst co-ordinates and prepares the document.

There is a very good response to the Bulletin which is reflected for instance by an excellent support of an increasing number of national weather services of the Region. For 1996, 37 WMO member countries provided input. In this respect, the Bulletin should be also acknowledged as a successful step towards effective European collaboration in the field of climatology.

THE GCOS SURFACE NETWORK MONITORING CENTRE FOR PRECIPITATION

Stefan Rösner, Germany

Within the framework of the Global Climate Observing System (GCOS), stations were selected, partly from existing networks, for the global monitoring of the climate. In addition to the GCOS Global Upper Air Network (GUAN), stations were selected for a GCOS Surface Network (GSN). In the lecture a short explanation on the objectives of the GSN, as well as the criteria for the selection of the GSN stations, will be given, followed by a short presentation of first results from the German stations and their observation data.

The stations selected for the GSN transmit SYNOP and CLIMAT reports via the GTS. In order to monitor the availability and quality of these reports, the DWD has committed itself to setting up a GSN Monitoring Centre for precipitation. This will be based on the know-how of the Global Precipitation Climatology Centre (GPCC), which is also run by the DWD. The lecture will present the background and tasks of the GS_MC_PRECIP as well as the results of the MC.

A MODEL FOR SPATIAL REPRESENTATION OF GLOBAL RADIATION IN COMPLEX TERRAIN FOR ECOSYSTEM RESEARCH

Helfried Scheifinger, Austria

The atmospheric environment constitutes a decisive factor controlling ecosystem processes. Apart from temporal changes of the atmospheric environment also spatial differences can cause large spatial differentiation of ecological systems in complex terrain, like the Alps. In order to investigate and quantify possible relations between temporal and spatial distributions of ecosystem and atmospheric parameters, ecosystem and atmospheric datasets have to be brought to similar temporal and spatial scales and resolutions.

Here a tool will be presented which helps to create the required atmospheric information for ecological research needs. Alpine forest ecosystems will be the first object of application. A scheme was developed, which allows a spatial assessment of potential atmospheric stress factors for forest ecosystems in small catchment areas with a size of a few 10 km2. Emphasis was laid on atmospheric processes.

As soil water balance is thought to be a chief factor governing plant stress, which, as a complex factor, summarises a number of physical and plant physiological parameters:

- Global radiation as monthly and daily sums are calculated with a model based on a parameterisation scheme prepared for Austrian conditions and a digital elevation model (DEM).
- Information about the spatial distribution of temperature and moisture is extracted from vertical profiles of a selected set of climate stations relevant for the area of interest, plus a scheme, which modifies temperature and moisture measured at the climate stations for specific locations in the complex terrain as a function of the global radiation sums.
- Similarly vertical profiles for precipitation (rain, snow, snow cover) are applied via a DEM to the area of interest. Alternatively residuals are interpolated with geostatistical methods.
- Interception is taken into account with a model, which calculates rain and snow interception rates as a function of leaf and stem area index and interception evaporation according to a Penman-Monteith formulation.
- For modelling the snow cover a degree day approach was used, which takes into account new snow, cold content and mean temperature of the snow cover, maximum water in the snow cover, snow melt and density of forest stands.
- It is known that bucket models of soil moisture can deliver unrealistic results in complex terrain. Therefore a simple Darcy-flow scheme is applied for a single soil layer to simulate lateral soil moisture movement in a catchment
- Transpiration is modelled with a Penman-Monteith approach.

Other potential stress parameters, like late and early frost events, potentially harmful temperature amplitudes, sudden temperature drops, can be deduced from components calculated above.

Validation will be done with gauge flow measurements in a catchment and with atmospheric data, which were collected at a few sites within the areas of investigation.

MONITORING FREEZE-THAW CYCLES OVER NORTHERN CANADA

Klaus Scipal, Austria

A study will be presented, showing the capability of ERS Satellites monitoring Thaw/Freeze Cycles over Northern Canada.

The system is based on the fact that the Scatterometer Signal (in the C-Band Range) is sensitive to soil moisture. Observations by several researchers have shown that a frozen soil leads to a much lower backscatter signal than an unfrozen due to the lower amount of free water in the frozen soil. In spring when the soil is thawing a significant increase in the signal can be observed. It was stated that it should be possible to monitor thaw and freeze cycles by ERS1 and ERS2 Scatterometer observations.

In this paper the possibilities and limitations of this method over northern Canada will be presented.

LOCATING CLIMATE DATA ON THE INTERNET:
THE ROLE OF INTERNATIONAL DIRECTORIES

Karsten Shein, U.S.A.

The rate at which climate data is being collected and made available electronically is increasing at an exponential rate. It is now possible to obtain vast amounts of international, interdisciplinary data from any on-line computer. However, the quantity of data available on-line, coupled with non-specific indexing engines, means that researchers searching the Internet for data often are overwhelmed by the results of their queries. A simple query on air temperature data returns over three million web sites. Furthermore, since many data sets reside in data archiving centers, a climatologist may have to search several data centers before locating data of relevance.

One solution to locating climate data electronically is to use a metadata directory. Directories such as the CEOS IDN provide searchable, on-line descriptions of data sets available from researchers, institutions and data centers worldwide. As data are made available, their metadata descriptions are placed in these directories. Subsequent researchers may then identify and locate relevant data via a search of the directory, eliminating the need to search either the Internet or multiple data centers for the information. Since all records in these directories are related to existing and available data, there is little danger of a query returning useless information.

Keywords: Climate Data, Internet, Metadata

AREA MEANS OF PRECIPITATION CALCULATED FROM ISOLATED MEASUREMENTS

P. Lorenz, G. Skoda, Austria

We interpolated the observations to the points of a grid by means of inversely squared weighting, starting from observed monthly sums of precipitation (data obtained from the Austrian Hydrographical Service). Each value represents an estimation inside a quasi-rectangular area, and each area is situated in a region between 46 - 49,5 ° North and 9 - 18 ° East. The rectangular area has the size of 1/12 ° longitudinally and 1/20 ° meridionally.

At these very gridpoints we have obtained smoothed data from a highly dissoluted topography, and also typical sums of upslope respectively upslide precipitations lasting 24 hours. The latter calculations were carried out by means of a model for forecasting of stratiform precipitation. This model was developed in the frame of the programme IDNDR (a research project of the Austrian Sciences Academy), which was installed at the CIMG. The adaptation of boundary conditions (wind force, wind direction, humidity, temperature) within the seasons make clearly visible the spatial structures in the field of precipitation, which are caused by topography. Resulting from these informations we calculated correlations between topography and precipitation. In order to achieve regression of upslope precipitation with the height a polynome of the third degree proved its worth; for the dependence on altitude of convective precipitation we chose an approach from relevant literature (exponential function with negative argument). The relative share of upslope and convective precipitation to the total precipitation in the course of the year are estimated by means of statistics on weather types during precipitation and by help of experiences with results from LAMs: Thus we obtain a continuous climatological information about precipitation´s dependency on altitude.

In the following we corrected the data, which we had interpolated from observations, described above: Their contribution is the bigger, the stronger the variation of precipitation with the altitude in the region in question is, and the bigger the difference in altitude at the gridpoint and in the altitudes of the surrounding observation stations at the same time is.

We can calculate means of optional area sections and time spans from the modified precipitation data taken from the grid. All programm algorithms have been installed in the computer system of the Central Hydrographic Service, and a comparison with corresponding hydrological parameters has been carried out.

WIND VARIABILITY IN THE WESTERN CARPATHIANS

Danuta Czedierda, Poland, Pavel Stastný, Slovakia

Analysis of the anemological conditions in the Western Carpathians was done on the basis of 1951-1995 data originating from 10 meteorological stations (5 Polish, 5 Slovak). These stations represent different morphologic localisation (from the mountain peaks: Lomnicky Štít, Kasprowy Wierch, to the valley bottoms: Poprad, Zakopane). The study is based on the 3 daily observations and 8 main wind directions. For the comparative purposes only 4 main sectors have been used (N, S, E and W). Frequency of the winds from particular directions was unstable during the investigating period. This was noticed at the same stations as well as between selected points in the whole period. For example Kasprowy Wierch, Zakopane and Lesko have very similar courses of the frequency distribution, especially winds from the W sector. The highest percentage of that sector was observed in the large valleys: Krakow, Poprad. Calm and mean wind speed depend basically on the local relief conditions so these characteristics are being the most differentiated.

UPPER TROPOSPHERIC HUMIDITY FROM METEOSAT

C. Geijo, L. van de Berg, J. Schmetz, S. Tjemkes, Germany

Knowledge of the atmospheric branch of the hydrological cycle is important for our understanding of the atmospheric response to an initial radiative forcing of the climate system by the increase of carbon dioxide content of the atmosphere. Space borne observations have proven to be a valuable tool, to study the atmospheric branch of the hydrological cycle. The proposed poster presentation will describe the upper tropospheric humidity derived from METEOSAT observations.\par

METEOSAT is a three channel radiometer, of which one channel can be used to infer information on the moisture content of the upper troposphere. Since METEOSAT is in geostationary orbit, the earth can be observed with a repeat cycle of 30 minutes. The length of the program (METEOSAT observations of the upper troposphere started about 15 years ago), makes these observations ideal to study not only diurnal but also the annual and interannual cycles.

In addition to the methodology to derive upper tropospheric humidity from METEOSAT observations, the proposed poster presentation will also describe results from a spectral analysis of one year of observations. The study presents climatological features of the diurnal variation of the UTH and studies the large-scale variability of the UTH fields associated with the Madden Julian oscillation. Also the potential of a global upper tropospheric humidity field from the combination of observations by four different geostationary satellites will be discussed.

INITIAL RESULTS OF THE GVAP-UTH WORKSHOP

Stephen Tjemkes, Johannes Schmetz, Brian Soden, Germany

At present there are several space borne sensors, which measure radiances containing information on the moisture content of the upper troposphere. The derivation of upper tropospheric humidity from these observations is being done at different institutes throughout the world. UTH climatologies from satellites are being used for climate model validation. Since UTH is largely determined by the large scale circulation it can also serve as a proxy for this quantity.

Common to all UTH retrieval methodologies is a dependence on radiative transfer calculations. At present it is unclear how the existing differences in the different radiative transfer codes affects the UTH fields. It is even unclear how large these differences in the radiative transfer codes are. These issues are of considerable importance for both climatological assessment of UTH, as well as operational utilization of water vapor radiance measurements.

At the June 1997 meeting of the GVaP (GEWEX Water vapor Project) International Working Group on Science and Data held in Silver Springs, it was therefore recommended that a workshop be held to help quantify the existing uncertainties in satellite measurements of upper tropospheric water vapor.\par

This workshop will be held from on June 2-3, 1998 in Darmstadt, Germany.\par

In addition to the transmittance model comparison the workshop will also perform an initial inter-comparison of existing UTH climatologies. Such inter-comparisons may involve UTH climatologies obtained from separate satellite sensors (e.g. GOES, HIRS, SSM/T2) or measurements obtained using different retrieval strategies.

During the proposed oral presentation, background and initial results of the workshop will be presented.

THE STATIC DATA QUALITY PROCESS AS PART OF CLIDATA APPLICATION

Radim Tolasz, Lubomir Coufal, Czech Republic

The CLIDATA application is a new climatological RDBMS (Relational Data Base Management System) for small climatological services around the world. This application has been developed at the Czech Hydrometeorological Institute as a replacement for CLICOM, and its primary purpose is the management of climatological data. Its general description was published in (1).

The process of data quality control is divided into two parts in the application - static and area quality control. Static quality control means statistical control of each station separately. There is no problem in comparing one element with another element (for example, maximum temperature must be higher than minimum temperature, etc.); however, there are problems with identifying unrealistic extreme values found in measurements or observations. We looked for a robust method of error identification in climatological series, provided the same method would apply for most data types (temperature, humidity, wind speed, precipitation etc.). These time series are known to have different types of theoretical distribution and we have therefore tested the use of empirical distribution. The full paper describes the application of empirical distribution for identification of unrealistic extremes at three levels (soft warning, hard warning and error). This approach is useful for all users to correct values in a clmatological database.

HOMOGENEITY OF PRECIPITATION AND TEMPERATURE TIME SERIES IN SERBIA

Miroslava Unkasevic, Yugoslavia

The original time series of meteorological elements are often unsuitable for climate change studies, so the production of a consistent and homogeneous dataset was one of main goals. Most of the inhomogeneities are caused by relocation of stations, changes in the immediate environment (trees, buildings) and changes in instruments. About 80 % of the inhomogeneities could be traced to information in the station history files (Hanssen-Bauer and Forland, 1994). Homogeneity testing and station history archives are essential tools for finding the real trends and fluctuations in precipitation and temperature series.

The standard normal homogeneity test (SNHT) was selected as the main tool for precipitation homogeneity testing (Alexandersson, 1986). For detection of non-homogeneties in temperature time series a new test of Alexandersson and Moberg (1997) and Moberg and Alexandersson (1997) are applied.

This paper will present a summary of experience gained by testing annual precipitation sums and the annual mean temperature from 23 Serbian series of 45 years or more, using the described procedures.

PROTOTYPE OF A METADATA INFORMATION SYSTEM

Henk van Dijk, Netherlands

The modelling and interfacing of metadata in the climatological database in order to achieve a smooth retrieval of data without exact knowledge of the datasets.

The use of metadata standard CEN TC287 in association with national and international developments is deciding for the implementation.

The interface for all users is an Internet application.

SOURCES OF CLIMATE DATA SETS

Evgeny Vyazilov, Russia

For the past period of 40 years since the founding of World Data Centre (WDC) and the beginning of the first set creation of climatical as punch cards file the number of information types on computer media has increased. The rate of the data bases creation has risen sharply in recent decade. Only in WDC-B the number of data bases has increased from several tens based on second generation computers to several thousands on third generation computers and the volume has amounted to tens terabits. The annual data delivery amounts to 2-3Gb. Major increase of the archives number occurred in 80s. It is related both to carrying out international experiment GATE (FGGE, ATEX, ALPEX, MUSSON), WOCE, TOGA and other, and rewriting data archives from magnetic tapes of the second generation computers.

Information on data bases can be widely used both inside organisation and outside it. The available information reference systems (MEDI, INFOCLIMA, NEDRES, EDMED, etc.) do not always meet the users' requirements, since information on data bases is insufficient for them; they also need information on the instruments, observation techniques, data storage formats, the space coverage, etc. Access information concerning data bases would make it much easier for the user to orient in the large flow of information.

Sources of climatical data are: information on organisations; information on data bases; information on international and national experiments; information on referral systems; information.

RECENT VARIATIONS IN ATMOSPHERIC CIRCULATION IN EUROPE AND NORTH ATLANTIC SECTOR IN WINTER

Joanna Wibig, Poland

Recent variations in atmospheric circulation in Europe and North Atlantic sector in winter season are analysed and discussed. The mean monthly values of sea level pressure (SLP) from the period 1873-1990 in the grid points from 60 W to 50 E with a step of 10 degrees and from 30 N to 70 N with a step of 5 degree are used. Data are taken from World Climatic Disc prepared at University of East Anglia.

At the beginning the raw data are analysed. The maps of mean monthly SLP and their standard deviations are drawn. Then the maps of deviations from long-term mean in following decades are prepared and decades with strongest anomalies are chosen.

In the next step the trend coefficients in each grid point is calculated and appropriate maps are drawn for whole analysed period and 30-year subperiods. On that ground the course of the circulation variability is analysed and discussed.

The principal component analysis with Varimax rotation is used to distinguish the most pronounced circulation patterns in Europe - North Atlantic sector. In each month four to five such patterns are found. The temporal variability of scores connected with these patterns are analysed and compared with most popular circulation indices (zonal index, NAO index by Hurrell, EA index by Wallace and Guetzler and SENA index by Kutiel and Kay).

Some examples of the impact of circulation variability on other meteorological factors are presented.

TRANSFORMATION OF METEOROLOGICAL STATION OBSERVATIONS TO APPLICATION LOCATIONS

Jon Wieringa, Netherlands

Weather stations most often have been established to provide data for synoptic-scale forecasting, as part of a network with other comparable stations at typical distances of 50 km or more. Climatological application of observed data ant their operational provision for small-scale applications, however, require physical insight about spatial transformation of weather information at a variety of scales. Insufficient knowledge about terrain- and scale-dependent changes of observed atmospheric properties can only partly be compensated by increasing the station network density, assuming that more stations can be financed at all.

Methods to determine weather properties at places, where they are not measured, have been developed in great number for the parameter precipitation, but these are mostly interpolation procedures. Extrapolation of other parameters to location far away from the stations is a less-modelled item, and for these a review will be given of those existing methods which are not just local regression equations. For wind, extrapolation is based on boundary-layer dynamics and knowledge of terrain roughness (e.g. Quart. J.R.M.S. 112. 867). For thermal parameters, other terrain characteristics need to be known. It is put up for discussion, to what extent for non-synoptical extrapolation purposes we need more background information (on station exposure, observation procedure etcetera) than is usually routinely known for NWS stations.

IMPACTS OF THE EXCEPTIONALLY HOT WEATHER OF 1995 IN THE UK

M. D. Agnew, J. P. Palutikof, S. Subak, United Kingdom

The 1995 summer in the UK was the warmest and driest on record. The mean July and August Central England temperature was 3°C higher than the average recorded between 1961 and 1990. Total England and Wales rainfall for July and August was only 47 mm compared to a 1961-1990 average of 139mm. The twelve-month period from November 1994 to October 1995 was also the warmest in a record which extends back to 1659.

A study has been made of the economic impacts of this extreme period. The most obvious impact is seen in the energy sector, with net savings to the consumer over the whole twelve-month period estimated at £355 million. Negative impacts were experienced by the agriculture (net losses around £180 million), water supply (additional costs of around £96 million) and buildings insurance sectors. The number of outdoor fires was 54% higher than in 1994. The net effect on health was beneficial, with the reduction in mortality in the mild winter exceeding any increase in deaths in the very hot summer weather.

Large impacts were sustained in some areas of economic activity as a result of the hot summer of 1995. However, for many human activities, such as transport and the construction industry, greater impacts resulted from the mild winter weather, in the sense that there was less disruption of these activities. In tourism, the indication is that people take their annual summer holiday regardless of weather conditions, but the decision to take a short winter break may be weather-dependent.

Comparing the impact of the summer of 1995 with earlier hot dry summers such as 1976 indicates that changes in sensitivity to climatic variability have occurred over time. Some of these changes arise from factors unrelated to climate, such as technical innovations, a shift in the source of raw materials etc. For example, the growth in gas-fire domestic heating has made gas consumption much more sensitive to unusual weather conditions. But some changes arise from deliberate adaptation to a perceived increase in the frequency of hot summers. Such precautionary steps were found in the transport, insurance and water sectors: standards have been modified to ensure that road surfaces will withstand higher temperatures; insurance companies are developing data bases of properties at risk of subsidence and water companies are developing supplies for use under drought situations.

The evidence from 1995 reinforces the view that the UK economy is sensitive to climatic variations and indicates the importance of further developing our understanding of the potential effects of climate change. However, the impacts of the extreme weather of 1995 arose from unexpected anomalous events and are therefore not directly comparable with the possible impacts of a warmer climate.

EVALUATION OF EXTREME PRECIPITATION EVENTS IN THE CARPATHIAN BASIN

Judit Bartholy, Hungary

Time series of precipitation amounts will be examined on different time and spatial scales. Measurements from 162 precipitation stations in Hungary will be used in monthly scale evaluation, and daily precipitation series measured at 8 climate stations will also be analyzed. First, monthly precipitation values of all 162 measuring locations will be interpolated into 1200 gridpoints. Spatial distributions will be mapped for minimum and maximum precipitation amounts during winter and summer half-year as well as during January and July. Upper and lower deciles will be determined and plotted for all seasons (winter, spring, summer, autumn), these precipitation values define extremness of rainfall in our evaluation. Then time series will be analyzed separately as robust and extreme. Anomaly values will be defined as differences between monthly average and monthly robust average precipitation amounts, these interpolated values will be mapped. Distributions of full, robust and extreme time series will be compared. Precipitation trends evaluated during last decades are inconsistent, even signs are different. Therefore extreme precipitation amounts during the last 100 years will be analyzed by decades. Variability and fluctuation will be determined.

WINTER SMOG LOOKED FOR - OZONE PRODUCTION FOUND

Kathrin Baumann, Austria

In the research project "air quality simulations in an urban area - taking the city of Graz as an example", an intensive winter field campaign was planned in order to study the impact of inversion layers and winter smog on the urban air quality at the Alpine city of Graz.

The field campaign took place from January,9th to 13th 1998, a period with mainly clear skies and unusual high temperatures for this season. Instead of winter smog, even ozone production could be observed these days. Thus, the measured meteorological and chemical data reveal the impact of exceptionally warm winter periods as were experienced several times in the last years.

AN ANALYSIS OF MAXIMUM DAILY WIND GUSTS IN SLOVAKIA

Oliver Bochnicek, Slovak Republic

The task of the scientists is to study complicated regularities of the physics and chemistry of the atmosphere, balance of the atmospheric circulation and the chaos theory to solve the problem, why the only one storm can release more energy, than the atomic bomb, which dropped down at Hiroshima.

With the exception of the polar areas, the tornadoes can arise wherever above the ground of our planet, although we know that genesis of them are most frequently above the territory of the Great Plains of the North America. Such tornadoes cause desperately damages on properties and human bodies. In spite of the lower intensity of tornadoes in the Middle Europe, the damages are much more worse. Insurance companies, year by the year, are more interested in their more detailed evaluation.

Weather seems to be the weather more and more extreme and in many cases impenetrable.

Contribution analyses distribution of maximum daily wind gusts at the territory of the Slovak Republic from the viewpoint of speed and direction frequency in time series with demonstrating of some synoptic situations when the events occured.

The results of maximum daily wind gusts implies a differences between some classes of wind speed and wind direction in vertical profile at the selected stations on the Slovak territory. The results will be later compared with other outputs of the Middle Europe stations.

EXTREME RAINFALLS IN POLAND IN THE LAST 30 YEARS

Magda Bogucka, Poland

In the paper extreme daily and extreme 6-hours precipitation totals and also the selected instantaneous extreme rainfalls in their natural duration from the last 30-years period (ending in 1995) were analysed. The data from 56 meteorological stations located in the territory of Poland were taken. Statistical analysis of extreme daily and 6-hours (6h) precipitation was done.

The analysis showed that the highest daily sums of precipitation were very often observed at more than one station on the same day, and the same was observed also for rainfalls measured for shorter time intervals (6h, 12h and 18h). The analysis of meteorological situation and synoptic conditions in such days was performed.

The investigations proved that:

- in the regions of Poland with the highest annual precipitation totals (mountain regions) also the highest daily and highest 6h totals are observed and, similarly, in the regions of lowest yearly precipitation (central part of Poland) the absolutely daily- and six-hour sums are the lowest as-well,
- the highest observed 6h totals are about 40-60% of diurnal rainfall recorded on that days,
- in the case of occurrence of extreme rainfall the largest part of it precipitates during the first six hours of rainfall event,
- a half of analysed events (according to classification of Chomicz) were classified as torrential and about 40% as driving rains (storms),
- the highest six-hour totals were connected with cold fronts or thermal thunderstorms,
- very close relationship between occurrence of the highest six-hour sums and the rise of water level in rivers and local floods was observed. The floods in these cases were very sudden but have only local extent,
- the rising tendency of maximal six-hour sums during last 30 years wasn't claimed. In contrary, the significant (at 0.05 level) decrease of maximal six-hour sums in four stations.

SUMULATION OF EXTREME PHENOMENA OVER BELGIUM USING A THREE-DIMENSIONAL MESOSCALE MODEL

Olivier Brasseur, Belgium

Extreme phenomena are an important concern in the framework of climatic changes at regional and global scale. The challenge consists to determine the impact of a climatic change on the occurence and the intensity of such phenomena. As a first step in this approach, we present short range simulations in order to check the ability of MAR - Modele Atmospherique Regional developed at the UCL – to represent some extreme phenomena. Long range simulations will be investigated in further works.

In this study, several situations including phenomena such as frosts (mostly during springtime), storms and thunderstorms have been examined over Europe, and in particular over Belgium. The MAR is initialized and forced at its boundaries with the ECMWF data. The horizontal resolution is between 5 and 25 km, depending on the examined event.

The model reproduces accurate minimum and maximum temperatures for clear sky situations. Stormy situations and explosive cyclogenesis are also correctly simulated, and a good agreement with observations is found for surface pressure filed and location of fronts. Besides, a method has been developed to extimate the maximum gust wind speed. Thunderstorms are represented using a convective associated to cold fronts, and the simulated amount of precipitation is satisfying.

WEATHER AND CLIMATIC EXTREMES IN EUROPE

Rudolf Brazdil, Czech Republic

Introduction. In connection with the observed global warming, hypotheses about a possible increase in weather and climatic extremes have been formulated. But the majority of available climatic change investigations was oriented towards the average climate.

Weather and climatic extremes. They can be defined as values of characteristics of meteorological elements or events, which lie above or below specific threshold values and occur with relatively low probability or which have significant impacts on society or ecosystems. The corresponding threshold values can be determined more or less objectively by using any theoretical distribution of the given characteristic or subjectively, based on experience or knowledge of any interrelations.

Data. Series of many climatic extremes can be derived or calculated from existing climatic databases (mainly temperature and precipitation). Corresponding METADATA, mainly information about changes in instruments, terms and methodology of observations, station relocations etc., are necessary for decision about relative homogeneity of such series which must be proved by enough powerful statistical tests. But using tests can be limited by smaller spatial correlation and sometimes random occurrence of extremes (e.g. weather events such as tornadoes, hailstorms, thunderstorms etc.). Only high quality stations with professional observers (not volunteers) should be selected for corresponding analyses.

Results. Fluctuations and trends in occurrence and intensity of climatic extremes should be studied by corresponding statistical apparatus, dealing also with rare phenomena. Besides the most frequent investigations of temperature and precipitation extremes also further weather elements and events should be taken into consideration. Although European weather services have available a number of utilizable data, there is no marked progress in the study of climatic extremes in Europe.

Impacts. Despite the overall progress the vulnerability of the human society is increasing due to weather and climatic extremes. Since, however, not every extreme means necessarily losses of lives and material damage, it is necessary to evaluate the shares of these particularly destructive extremes. Data about damage due to weather and climatic extremes are, however, recorded at weather stations rather accidentally, so that certain series of this type are available only with insurance companies. Although papers of the case study character can be found dealing with the evaluation of the individual disasters (such as floods, gales), long-term monitoring and analyses are rather missing.

Future. Workshop on Indices and Indicators for Climate Extremes (Asheville, 3-6 June 1997) was the first international meeting trying to formulate needs for further research on the field of climatic extremes. Such research has primarily importance for diagnostics of changing climatic system as well as for users of climatological records (e.g. insurance industry). Recommendations formulated during the above worskhop are important for thematical orientation and content of the future new studies and for filling the existing gaps in the study of climatic extremes.

CLIMATE VARIATIONS AND CHANGES IN THE CLIMATE EXTREME EVENTS IN RUSSIA

O. N. Bulygina, V. N. Razuvaev, N. N. Korshunova, N. V. Shvets, Russia

To analyze variations in the space-time distribution of extreme temperatures and precipitation at individual stations in the European part of the Russia for the last few decades, daily temperature (mean, minimum and maximum) and atmospheric precipitation data for the period 1931 - 1995 from 51 stations were used .

The total number of days for winter (December-February) and summer (June-August) seasons, when daily air temperatures (precipitation) were found to be higher or lower than some of the fixed limiting values, was used in this case as an index of climatic extremes. All values falling within the intervals ranged from the lowest percentile to the 5th percentile and from the 95th percentile to the highest percentile for the time period of interest were considered as daily extremes. The number of days, N, when daily temperatures or precipitation were within the above-mentioned intervals, was determined for the two seasons (winter and summer) of each year. Linear trends in the number of days were calculated for each station for the time period of interest.

Preliminary analysis of data from 51 stations in the European part of the Russia indicates that the number of days with abnormally low daily air temperatures is decreasing in both winter and summer seasons for most of the stations in question; the number of days with heavy precipitation is observed to increase in summer period.

Changing in difference between maximum and minimum temperature may produce a variety of effects on biological systems. Usually this characteristic of climate is described by diurnal temperature range (DTR), the difference between maximum and minimum temperatures during twenty-four hours from the beginning of night and the end of the day. This difference is connected with the increasing of temperature from its minimum value in night time to maximum value in day time.

The other characteristic of temperature change is connected with the decrease of temperature from its maximum value in the given day to minimum value of the next day and can be defined as a DTR1.

It is clear that DTR1 should be considered in addition to DTR for complete description of variations of the full difference between maximum and minimum temperatures on a daily scale. It can be supposed too, that impact of increasing and decreasing of air temperature during twenty-four hours on biological systems may be different.

Distribution functions DTR1 for winter and summer for period 1931-1995 were found and 95% and 5% borders were defined. Number of days with DTR more than 95% border value and less than 5% border value were calculated for every year and each season. Linear trends in the number of days were calculated for each station.

STORM WEATHER SITUATIONS IN THE GERMAN BIGHT IN AN ATMOSPHERE WITH INCREASING CO_2 CONCENTRATION

Udo Busch, Germany

In this study, a new objective classification routine for detecting single strong wind and storm weather situations (Bft 7 and more) in coarse resolution model is presented. The routine is able to detect singel strong wind and storm weather situations of two flow regimes. The criteria of this classification routine are laid down using the evaluation of strom weather situations in observations of the period 1949 to 1996. In order to achieve this, surface and upper level weather maps of the area of the North Atlantic and Europe as well as observations and measurements of several weather stations in the German Bight are considered. The routine is applied to the ECMWF Re-Analysis (T42 resolution) and to climate simulations of the Northern Hemisphere, which were performed with the atmosphere model ECHAM3/T42 from the MPI/DKRZ-Hamburg. In order to decide whether a weather situation is one which causes a stgrom wind or storm weather situation several meteorological large-scale parameters are considered. Only if all the criteria laid down in observations are fulfilled is the decision positive.

The estimation of the selected model runs shows a significant decrease in the frequency of occurrence for storm weather situations of the northwesterly flow regime in an atmosphere with double and three-fold CO2 concentration for the area of the german Bight. These storm weather situations give ideal conditions to force a storm surge in this area. An example for such a storm surge is the so-called "Hambrug storm surge" on February 16/17th, 1962. The European large-scale weather condition on these days was NWZ (Cyclonic Northwest Weather Condition). The storm cyclone within the northwesterly flow regime resulted in northwesterly winds with Bft 9-11 for 48 hours. These are ideal conditions to force a storm surge in the German Bight.

The frequency of occurrence for storm weather situations of the westerly flow regime increases in an atmosphere with double CO2 concentration and decreases in an atmosphere with three-fold CO2 concentration. In general the frequency of occurrence for storm weather situations in the German Bight increases in an atmosphere with double CO2 concentration and decreases in an atmosphere with three-fold CO2 concentration.

At present we examine a new model run (T42 resolution) from the MPI/DKRZ-Hamburg. This model run (ECHAM4/OPYC) has a period of 240 years. It started in the year 1860 and ended 2100. The application of the new objective classification routine should show whether there is a maximum in the frequency of occurrence for storm weather situations in the German Bight before the expected time of doubled atmospheric CO2 concentration or not.

REGIONAL ANALYSIS OF UNCERTAINTIES ON DESIGN STORMS IN TUSCANY (ITALY) AND EFFECTS ON FLOOD RISK

Alfonso Crisci, Italy

A comprehensive regional analysis of extreme rainfall and related design storms in Tuscany, Italy, is carried on to derive uncertainties in the estimates through the application of the Generalised Extreme Value (GEV) distribution.

Detection of possible cycles and trends in the extremal data are performed through suitable transformations in the time and frequency domains and tests, besides the fitting of an integrated stochastic autoregressive - linear model.

A preliminary regionalisation of both cycles and trends is performed.

Hydrological consequences of such observed uncertainties and trends are inferred in terms of flood risk and hydraulic design in small-medium size rural basins.

CENTENNIAL VARIATIONS OF INTENSE PRECIPITATION IN SWITZERLAND

Christoph Frei, Christoph Schär, Switzerland

Global and regional climate models suggest that a greenhouse-gas induced climate warming could be accompanied by an increase in precipitation intensity, primarily at middle to high latitudes and during synoptically active seasons. The magnitude of this effect is remarkable and some signal might already exist in recent precipitation data, partially reflecting the warming during this century.

In this study we examine centennial precipitation series for long-term trends in the occurrence of intense precipitation events. Records of daily precipitation at 114 Swiss observing sites are used for the analysis. The time-period considered is 1901-1994. 'Intense' precipitation is defined by the selection of an excess threshold of the daily precipitation. The threshold corresponds to an average return period of 30 days. This selection is based on statistical considerations indicating that the probability for the trend detection becomes very low for more rare events. The threshold is site and season dependent. For the statistical testing of the observed linear trends careful account is made of the statistical distributions of the quantities and the serial correlation of the time-series.

For autumn and winter the frequency of 'intense' precipitation exhibits a positive linear trend at more than 90% of the stations. The trend attains a magnitude of 20-50% (increase during this century), and is statistically significant for roughly one fourth of the sites. No coherent picture is evident for the trends of spring- and summer-time. The observation of increasing trends at moderate intensity (together with theoretical conceptions and results from climate models) may indicate possible effects of the expected global warming upon the frequency of extreme events. An increase of such events could have major repercussions on living conditions, hydrological impacts and a variety of engineering tasks.

CLIMATE OF THE EXTREME VALUES OF THE K-DAYS PRECIPITATION AMOUNTS OVER BELGIUM

Daniel Gellens, Belgium

Daily precipitation observed at a selection of 165 climatological stations spread over the Belgian territory are used to assess the precipitation amounts cumulated over continuous periods of 1 through 30 days. Their maximum values are constituting the data base of a statistical analysis devoted to estimate the return periods of these events or reversely to rate the precipitation amounts corresponding to given return periods.

The framework of this study will be first presented. Some spatial correlation properties and the stationarity of the extreme precipitation values will then be outlined. As missing values can induce some inhomogeneities in the data set used to fit the extreme values distribution (Jenkinson's distribution), a procedure based on the fractile method will be applied to fill in the gaps. So a homogenized data set on the 1951-1995 reference period can be built. An attempt to evaluate the efficiency of this procedure will be carried out by creating random gaps in complete series and analysing the rebuilt data sets. As illustration of this work, the precipitation at the origin of the December 1993 and January 1995 floods of the Meuse river will be tackled to fix the exceptional precipitation regions.

EXTREME VALUE ANALYSIS OF NORWEGIAN WIND DATA

Knut Harstveit, Norway

40 Norwegian wind stations are analysed. First the Weibul distribution, $W(u>U) = \exp(-U/b)^a$ of the parent wind speed data, u (recorded 3 or 4 times a day) is found, such establishing the shape parameter, a and the scaling parameter, b. Using the shape parameter, the yearly maximum wind speed values, Um are transformed to $V = (Um)^a$ which are the input data to the Gumbel - parameter estimation, using the modified Gumbel - Lieblein technique.

The Gumbel - distribution, also named the Fisher-Tippet Type I distribution, is given by $P(v>V) = \exp(-\exp(-k(V-m)))$ where k and m are parameters to be optimized. The record lengths are typically 30 years. The maximum 10 min wind speed as well as the 3-5 sec. highest gust are used. Output parameters are wind speeds of return periods 2 - 100 years. For example, giving P=0.02, the corresponding wind speed, Um(50 years)=Sqrt(V) (50 years).

15 of the stations are lighthouse stations at the outer part of the coast. 25 stations are situated on freely exposed airports from all over the country. The output data are used to

prepare the 50 year return reference wind speed map of Norway which are suitable for building design. However, the reference wind speed may in many cases lead to wrong conclusions in Norway, even when international accepted topographical modification methods are used. The reason is the many steep mountains which sometimes strengthen the leeward wind gusts. Storm episodes at 10 stations exposed to such effects are analysed.

The most famous and strongest wind episode in modern time in Norway is the hurricane of the 1. January 1992. A short report of the wind speeds and damaged areas from that episode is given.

THE INCIDENCE OF EXTREMES IN WORLDWIDE AND CENTRAL ENGLAND TEMPERATURES

E. B. Horton, C. K. Folland, D. E. Parker, United Kingdom

In a warmer climate, extremes of climatological variables may change. This may have implications for agriculture e.g. marginal crops may flourish or become unsustainable and core crops may become marginal. But before it is possible to assess whether climate variables are becoming more extreme, a reliable method of determining exactly what is extreme is required.

We have developed global fields of 5° latitude × 5° longitude resolution temperature anomalies corresponding to various percentiles. These values are found by fitting anomalies from the 1961-90 base period to 3-parameter gamma distributions. An empirical method is also used to check the validity of the results. Fields of percentiles created using this technique can be used to map the distribution of rare temperature anomalies across the globe for any month, season, year or period of years up to a decade, from 1851 onwards. We focus on the calculation of annual temperature anomaly percentiles. We document and interpret changes in the incidence of extreme annual temperatures since the end of the 19th century. Although we recognise that changes in daily extremes are very important to agriculture and society generally, there is a lack of global datasets of proven quality preventing a global analysis of daily temperature extremes at present. However, we can gain some appreciation of changes in extremes on the daily timescale for existing more local daily datasets. Accordingly we also apply a similar technique to assess changes in the incidence of extreme daily Central England temperature anomalies.

The technique can be adapted for other climatological variables, for example rainfall and mean sea level pressure. The flexibility of the gamma distribution allows many more variables (with or without Gaussian distributions) to be analysed.

LOW FLOW FORECAST IN ESTONIA

Svetlana Jevrejeva, Estonia

Over the last years a low flow was observed in Estonia. The water level decreased till critical point for main water bodies (Vortsjarv and Peipsi lakes, Emajogi river, etc.), that attract everybody's attention. In order to get a continuous and instant overview of the hydrological conditions in Estonia the HBV model was used. The Kasari river basin, as an example, was selected for the runoff long range forecast. The model parameters obtained from its application to the Kasari river basin were used. A long range forecast was made from October 1997 to October 1998. Precipitation and temperature data from corresponding dates during the period 1981-1990 and five dry years during the period 1930-1990 were used as input. The results of 15 different simulations with tabulated values of the minimal discharge for each simulation were received.

A frequency analysis of the computed low flow was carried out. On the basis of the results a conclusion of a possible low flow tendency was done.

IDENTIFICATION OF AGRICULTURALLY SIGNIFICANT EXTREME TEMPERATURE EVENTS

Theodore Karacostas, Greece

The objective on this study is to identify and characterize the agriculturally significant extreme temperature events for winter wheat, at thirteen specific sites located in different agricultural and climatic zones throughout Europe. To meet this, the 30-year baseline climate period of 1961 to 1990 is adopted and daily climatic data is used. The AFRCWHEAT phenological model was applied to ascertain dates of the various developmental stages of winter wheat, for each site, and for every year of the baseline climate period.

The objective is accomplished through the adaptation of three independent methodologies: (i) the implementation of the Extreme Statistical Model (EXAM), (ii) the application of meteorological alarm criteria during specific wheat developmental phases, and (iii) the use of the percent normalized degree anomaly of the agroclimatic index Growing Degree Days (GDD). These three methodologies have been implemented at the sites of: Athens, Sevilla, Montpellier, Bologna, Debrecen, Gyor, Munchen, Manhain, Bonn, Wageningen, Rothamsted, Oxford and Jokioinen.

This combined procedure was considered useful and scientifically necessary, for the production of integrated results, in order to interpret the full impacts of climate change for winter wheat in Europe.

CONTEMPORARY CHANGES OF THE BALTIC SEA LEVEL AND SEA ICE

Krzysztof Kozuchowski, Poland

Rising of sea level is one of the most significant aspects of environment transitions resulting from global warming. Expansion of water threatens seashores with their population and economics. In Poland a rise of the Baltic sea level for 0.3 m is dangerous for the area of 845 km^2. Dramatic increase of storm water on the Polish coast is very likely.

The observed changes of sea level at Swinoujscie since 1811 have shown gradual rise on the Southern Baltic which has been however, partly conditioned by lowering of the earth´s crust. For the recent two decades the expansion of water (thermal and/or eustatic) become a dominant factor. Annual maxima of sea level increase by more than 3 mm per year; the strongest rise occurs in autumn and winter.

In consequence of conspicuous warming after 1970, especially in years 1987-1998 the freezing phenomena on the Baltic Sea have tended to decrease. On average only 11 days with ice cover have occurred during last 10 mild winters, comparing to the mean of 59 ice-days observed in the Szczecin Lagoon in the period beginning from 1888/89.

Variations in the two analysed climate indicators include oscillations with distinguished periods of 5-6 and 7-8 years for sea level and ice cover respectively.

ARE SEASONAL HAILFALLS PREDICTABLE?
RELATIONSHIP BETWEEN THE SOUTHERN OSCILLATION INDEX AND THE ANNUAL HAILFALL ACTIVITY IN THE SYDNEY REGION

Ivan Kuhnel, Australia

The extremes of climatic variability in the eastern parts of the Australian continent are known to be a function of the strength of the El Nino-SouthernOscillation (ENSO) phenomenon. In the Sydney region roughly one third of all severe weather events is accounted for by hailstorms which are the major climatological cause of damage to property in this area.

Although the Sydney area lies on the perimeter of the ENSO core-region and hailstorms are rather complex climatological phenomenona an attempt has been made to investigate any possible relationships between the interannual variability of these potentially damaging hail events and the Southern Oscillation Index (SOI).

In contrast to other climatological variables (e.g. pressure, precipitation) no linear association (correlations close to zero) was found between the actual SOI and hailstorms. However, it was possible to develop a new multifactor SOI-related index, which shows a strong relationship with the annual hailfall activity in this region. The new index is based on two (spring and autumn) SOI gradients and the absolute value of the SOI average for the second half of the year. It can explain a substantial part of the total interannual variability of hail events in this region. It is shown that the multifactor index displays a pronounced annual cycle, which can be partly associated with SOI-related changes in geopotential height anomalies over the area.

Furthermore, the hailfall data were subjected to principal component and wavelet analyses in order to determine their dominant spatial and temporal modes, respectively. The characteristics of this multifactor hailstorm indicator and thus, the link between the hailfall activity in the Sydney region and large-scale circulation and teleconnection processes, as well as the major spatial and temporal hailstorm modes, will be discussed.

REGULAR PROPERTIES OF CLIMATE VARIABILITY AND CLIMATE CHANGE IN TIME SERIES OF HYDROLOGICAL EXTREME EVENTS (ON THE EXAMPLE OF LOW FLOW)

Helen V. Lobanova, Russia

Problem of modern anthropogenic climate change was found more difficult and complex than it seemed at the first. The main reason of wide range in future assessments of antropogenic changes for regional meteorological characteristics is non-sufficient knowledge about the dynamics of natural fluctuations. Therefore, in modern climate programs (CLIVAR, for example) much attention is given for analysis and determination of the regular properties of natural fluctuations of different time scales, as a rule, scale of climate variability and scale of climate change. The same climate variability and climate change fluctuations take place in time series of hydrological extreme events too.

The suggested paper deals with the determination and analysis of climate variability and climate change components in time series of hydrological extreme events on the example of low flow time series. For this aim the longest time series of observed winter and summer monthly and daily low flow have been chosen over the Russian and European area.

New model of long-term fluctuations has been developed for the conditions of non-homogeneous and non-stationary process and the main features of this model are: - the observed long-term fluctuations of low flow are presented as a sum of processes of different time scales (scales of climate variability and climate change); - the cyclic characteristics (such as periods and amplitudes of cycles, etc) are used for the description of dynamic properties of every scale component. New effective method of decomposition based on homogeneous conditions has been developed for determination of different-scales processes.

The following main results have been obtained under the research:

- - three different-scale processes have been determined in the longest time series of observations (about 100-150 years) and they are: two processes of climate variability (with average periods of cycles 3-4 and 13-17 years accordingly) and process of long-term climate change scale;
- the quantitative assessment of the every scale process has been given in the common fluctuation of observed time series and it was established that the value of climate change process has reached 25-35%;
- also it has been established that the processes of different scales have no the significant relations;
- analysis of stability of main cycle parameters has shown that the average periods and amplitudes of cycles for the processes of climate variability have small difference between two parts of observation time series and their ranges are given too.

THE METEOROLOGICAL CAUSES, MAGNITUDE AND EFFECTS OF DISASTROUS RAINFALLS IN POLAND IN JULY 1997

Halina Lorenc, Poland

In the paper the height and territorial extent of precipitation causing floods in Poland in July 1997 has been studied. The comparison of scale and magnitude between them and precipitation occurred in 1000-years history of Poland was made.

The detailed analysis of synoptic situations over Poland and central Europe in July 1997 was also performed. Photographs showing the effects of damaging flood caused by these rainfalls will be attached to the poster.

The movie made during flood in 1997 in Poland may be presented upon request.

COMPARISON OF SEA SURFACE TEMPERATURE ANOMALIES AND SEVERE WEATHER OUTBREAKS IN TUSCANY (ITALY). EVALUATION OF REGIONAL EFFECTS OF CLIMATIC CHANGE IN TERMS OF EXTREME RAINFALLS AND HYDRAULIC DESIGN

Francesco Meneguzzo, Italy

Data produced from the NOAA Global Area Coverage (GAC) for Central-Western Mediterranean for the period 1981-1991 and further data collected during 1997, are employed to derive statistical relationships of monthly average sea surface temperatures (SST) anomalies derived from AVHRR observations and severe weather outbreaks in Tuscany (Italy), in terms of excessive rainfall.

Severe weather forecasting at the local scale depends on the ability to assess the detailed thermodynamic character of low level atmospheric flows, and some studies have related SST especially to low level moisture, based on the concept of the equilibrium state between sea surface and convective boundary layer.

Understanding the quantitative role of SST anomalies and local severe weather is also needed for the assessment of the effects of global change on extreme rainfalls. Based on several scenarios, such effects are inferred and the hydrological consequences, in terms of the design of hydraulic works, is studied with some detail for small and medium size basins in Tuscany.

EXTRAORDINARY CLIMATE CONDITIONS DURING LAST TWO YEARS IN CROATIA

Marina Mileta, Croatia

In this paper the extraordinary climate conditions during the last two years in Croatia (based on the data from the weather watch stations Zagreb Gric and Hvar where measurements started respectively in 1861 and in 1858) has been analyzed. In the first part of June 1996 the exceptional values of the air temperature were registrated. The result reveals that highest daily temperature of 34.0 was registrated in Hvar (12.VI.). It was the highest observed value in this part of June since the beginning of measurements. Also, the daily temperatures registrated in period 10 12 June at Zagreb Gric station were the highest for this period of year. On the other hand it has to be emphasized that in 1997 April was marked as extremely cold month with the mean monthly temperature of 11.2 C in Hvar and that was the minimum in the long term values. The mean monthly temperature of 9.3 C registrated on Zagreb Gric was the lowest temperature since the 1938. At Zagreb Gric station the yearly amounts of precipitation in 1997 were below the average, with the greatest anomalies in September, when the precipitation conditions were estimate as "extremely dry".

RIME ICING ON TECHNICAL EQUIPMENT IN THE ALPINE REGIONS OF BULGARIA

Emil Moralijski, Bulgaria

Rime-icing is a phenomenon observing annually in the alpine regions of Bulgaria. Using data from observations in 5 alpine meteorological stations, the frequency, the beginning, the end and the duration of the process of rime-icing were investigated. Correlationships between the above mentioned characteristics and the altitude above sea level were established.

Estimation of the meteorological conditions determining the process of icing air temperature, wind direction and velocity and horizontal visibility in the fog was made. Vertical profiles of the mean values of some of these characteristics were framed out. The synoptic conditions when icing were analyzed too.

A physics-statistical method for computation of the radius and mass of the deposited rime was worked out. The air temperature, the wind direction and velocity, the horizontal visibility in the fog as well as the duration of the process of rime-icing were used as input information for the calculation. Using quasi-stationary approach, calculations for metal conductors with diameter from 5 to 30 mm with different orientation (correspondingly vertical, North-South and East-West) were carried out. The wind pressure and the combined rime- and wind loading were also computed. The values of the basic parameters of the deposition with repetition periods once in 2, 5, 10, 15 and 20 years were determined. When the meteorological conditions are favorable the mass of the deposition can exceed even 50 kg per linear meter.

CLIMATOLOGICAL EXTREME EVENTS WITH RESPECT TO THE VERTICAL STRUCTURE OF THE BOUNDARY LAYER

Martin Piringer, Austria

The continuous recording of the vertical structure of the boundary layer e. g. by remote sensing devices like sodars or windprofilers is still at its beginning, and therefore inversion or windshear climatologies hardly exist. Detailed investigations of the boundary layer are still restricted to field campaigns using tethersondes, sodars, airplanes, etc., which last only a few days because of the large amount of manpower needed and the changeable weather conditions in mid-latitudes. These field campaigns usually do not allow for climatological statements. However, they turn out to be especially interesting if they are conducted under extreme weather conditions or if extreme values can be detected by vertical soundings. The presentation will contain an example for each situation using vertical sounding data from Allentsteig (October 1997) and Graz (January 1998). The results underline the need for continuous vertical monitoring in the future especially for the purpose of more accurate dispersion calculations and local forecasts.

DEVELOPMENT AND ANALYSIS OF DAILY TEMPERATURE AND PRECIPITATION DATA SETS FOR APPLICATIONS AND MONITORING CHANGES IN CLIMATE EXTREME EVENTS IN RUSSIA

Vyacheslav Razuvaev, O. N. Bulygina, R. A. Martuganov, M. Z. Shaimardanov, Russia

Research on the frequency of extreme meteorological values and climatic events is one of the most important problems in studying climatic change and climate applications. A large part of work in this direction is associated with the analysis of long time-series of meteorological observations. Until recently, because of the lack of high- quality meteorological data of hourly and daily resolution on computer-compatible media, we had to deal with monthly, seasonally and annually averaged values of meteorological elements. It imposes substantial limits when determining of climatic change indicators.

At present, the RIHMI-WDC (Russia) is conducting works to create hourly and daily meteorological data series which can be used to form climate variability indices. Daily mean, maximum and minimum air temperature and daily precipitation data for 223 USSR stations for the period from the beginning of observations up to 1995 have been prepared as the first stage of work. This data set has already been used to analyze the asymmetry in minimum and maximum air temperature variations over the European part of Russia (Razuvaev et al.,1996).

The main problem now is to extend the data set by increasing the number of stations. Data from Russian synoptic stations which are registered at the WMO and included in the international exchange of SYNOP messages (approximately 470 stations) will be added to this data set. The problems arising in studying precipitation variability over Russia are in many respects caused by changing procedures for precipitation observations, absence of high-quality data sets on computer-readable media, and by an insufficient density of the observation network. The development of data processing techniques and the use of advanced computing facilities and computer-readable data media make it possible to create a baseline precipitation data set for Russia. This data set can be used both for studying precipitation within Russian national climate research and climate change programs and for various international projects. In this connection the baseline data set is supposed to contain primarily daily precipitation totals for the period of 1966 up to the present day from the stations included in the WMO list of observational stations (containing about 1000 Russian stations). Provision is also made for updating the basic data set by including data for the earlier period (the onset of regular precipitation observations). These data sets are extremely useful for investigation of the changes in the temperature-humidity regime in the different parts of Russia and for the numerous applications, especially in agriculture, human health and insurance business.

DAILY RAINFALL VARIABILITY IN THE SPANISH MEDITERRANEAN AREA

Romualdo Romero, Spain

The Spanish Mediterranean region offers an interesting scenario for mesoclimatological studies on temporal and spatial rainfall variability. The region is characterised by important coastal relief units and complex distribution of sea and land masses, leading to different exposures to the rain bearing maritime winds. In addition, it is a transition zone between the mid-latitude low-pressure belt and the subtropical highs, leading to accentuated differences between the warm and cold seasons.

We have constructed a daily precipitation date base, extending from 1964-1993, including 410 rain-gauge stations of Mediterranean Spain. An iterative method has been applied to complete and homogenise the precipitation series. A first pluviometric characterisation of the area, with special emphasis on extreme rainfalls, has been conducted based on yearly and seasonal means and recurrence intervals. The highest frequency of extreme events occurs in autumn, and this frequency is maximised in the Valencia region, south-west of Andalucia and the Balearic Islands.

In second place the main spatial patterns controlling significant and extreme daily rainfalls in the area have been derived. This has been done by applying cluster analysis on the most relevant principal directions extracted from a principal components analysis of the between-day correlation matrix (T-mode). Patterns for significant rainfalls (11) and those for the subgroup of torrential days (8) display very similar spatial characteristics, and are strongly linked to the topography. However, a tendency of enhancing the importance of coastal zones is observed for torrential events.

Finally, the data base has been used to produce a regionalisation of Mediterranean Spain. The method has been cluster analysis on the most relevant principal directions extracted from a principal components analysis of the between-site correlation matrix (S-mode). We have obtained 12 daily rainfall affinity areas, which are strongly defined by the main topographic units present in the area. A second regionalisation, allowing overlap of the affinity areas, has been obtained by mapping the obliquely rotated principal components. The rotated principal components (by Oblimin method) have revealed very simple structures. Both regionalisation methodologies have given similar results.

LIGHTNING STROKE DENSITY OVER AUSTRIA

Otto Svabik, Austria

Data of lightning location systems should be integrated in synoptical and climatological investigations. Objective documentation of thunderstorm activities and frequencies are a useful tool for application in nowcasting. On the other hand further evaluations of regional lightning stroke densities own economical importance (they seem to be highly correlated with possible damages). The distribution of lightning stroke density over Austria is shown using registrations of ALDIS (Austrian Lightning Detection &Information System) from the period 1993 - 1997.

APPLICATION OF DROUGHT INDICES IN MONITORING DRY CONDITIONS AND PROVIDING UNSER WITH INFORMATION

Csaba Szinell, Hungary

Drought is a recurrent feature of the Hungarian landscape. Since the early 1980s, droughts have resulted in severe losses in the agricultural sector with serious consequences on the national economy. Therefore, providing reliable information on drought severity, length and spatial extent is valuable for the Hungarian agricultural sector. On the other hand, these severe droughts have coincided with the transition of the economy towards a market-based economy with widespread private ownership. This process has changed the targeted information users, which urges the modification and update of the current agrometeorological information system. Among the first steps, capability of several drought indices have been evaluated to monitor drought conditions and quantify its severity. Besides traditional indices like soil moisture and the Palmer Drought Severity Index (PDSI), the Standardized Precipitation Index (SPI) was also used. The SPI was developed in 1993 by researchers at Colorade State University in response to their need for a simple, flexible drought index to monitor moisture conditions. Since then, the SPI has been widely applied at national, regional, and local levels throughout the United States. One of the big adventages of the SPI is its multiple time scale capability that allows monitoring of different water resources. Time series of the SPI at different time scales and locations are examined and compared with the Palmer Drought Severity Index (PDSI). Characteristics of Hungarian droughts are identified, and recent droughts are put into a historical perspective. These analyses demonstrate that the SPI can become a valuable tool for drought early warning and monitoring in Hungary. Inclusion of products like soil moisture maps, precipitation updates or drought indices into the modernized agrometeorological infomation system will help agricultural producers make timely decisions aimed at reducing the effects of drought. This paper will report on the objectives and progress to data in the development of this agrometeorological information system.

PRECIPITATION IN THE SNIEZNIK KLODZKI MASSIF IN JULY 1997 - THE BEGINNING OF THE FLOOD

Jacek Piasecki, Mariusz Szymanowski, Josef Rehak, Poland

In July 1997 a disastrous flood took place in south-west Poland. The most intensive events and dramatic effects occurred in the K³odzka Valley Basin in the Eastern Sudety Mountains, mainly in the foothills of the Œnie¿nik K³odzki Massif and the Bialskie Mountains. Many cities (K³odzko) and villages were destroyed in the catchments of the Nysa K³odzka and Bia³a L¹decka rivers. Also in this region a flood wave was created that contributed to the subsequent disaster in the foothills of the Sudety Mountains and on the Silesian Lowland below the outlet of the Nysa K³odzka river to the river Odra.

The progress and intensity of the flood dependent on certain conditions:

- general synoptic situation that induced heavy rainfalls in two periods: first, 5 to 8.07.1997, when there was the heaviest precipitation event in all of Poland in the Œnie¿nik Massif and second, 18 to 21.07.1997 with heavy rainfalls in the Western Sudety Mountains,
- orographic enhancement of precipitation on the mountain barrier,
- nature of weather and precipitation distribution in May and June 1997,
- character and shape of hydrologic net and h

SURFACE THERMAL FORCING AND SEA ICE CONDITIONS

Heino Tooming, Estonia

Snow cover is of great importance to the climate of the Earth. The surface albedo is sensitive to the duration of snow cover and vice versa. In Estonia, snow cover duration and surface albedo show large year-to-year variations mainly in late winter and early spring (Tooming, 1981,1984). These variations are reflected by the later heat accumulation near the surface in spring. Therefore a significant correlation between the early summer warmth index and late winter surface albedo exists (Tooming, 1981,1984). This means that different states of surface characterized mainly by the presence or absence of snow cover during the early spring period give different kinds of impulses to the surface radiation budget and subsequently release a series of processes called by us surface thermal forcing (Tooming et al, 1995, Keevallik and Tooming 1996). We show that the surface thermal forcing upon the Estonian territory depends on the ice conditions on the Baltic Sea and the Gulf of Finland, and to some extent, on those of the Peipsi Lake. The dependence of mean air temperature and the warmth index in May and June on the duration of snow cover happens to be weaker in the inland Estonia than in the coastal areas. In the present paper we demonstrate that surface conditions (duration of snow cover and warmth index) are in correlation with the duration of sea ice period. This correlation is more pronounced in the coastal areas than in the inland areas. This means that the variations in the duration of snow cover and thermal surface forcing are caused mostly by the sea ice conditions. Besides, we specify the surface thermal forcing schemes for the extreme years.

(1) Years with short sea ice and snowy period and low albedo in early spring:

High temperature in winter-> short ice period on the sea -> high impact of heat from the open sea to the snow cover -> early snow reduction - > low surface albedo -> high shortwave radiation budget -> high evapotranspiration ->exhausted soil moisture storage -> high sensible heat -> high heat accumulation.

(2) Years with longlasting sea ice and snow period, high early spring albedo:

Low temperature in winter -> longlasting ice and snow period, cold air masses near the surface -> high surface albedo -> low shortwave radiation budget -> late ice breaking and snowmelt -> high water storage in soils -> long lasting evapotranspiration -> low sensible heat -> low heat accumulation.

SPECTRAL CHARACTERISTICS OF THE WIND "KOSHAVA"

Ivana Tosic, Yugoslavia

The wind "Koshava" is the largest meso-scale phenomenon on the Balkan.

"Koshava" is a gusty wind of moderate to strong intensity, blowing from the south-eastern direction, over the area of Serbia, Romania and Bulgaria. It is caused by the interaction between the synoptic circulation and the orography of the Carpathian and the Balkan mountains.

Perhaps, the most important single descriptive characteristic of stationary random data is the power spectral density function, which defines the frequency composition of the data. Power spectra measurements yield information concerning the dynamic characteristic of the system. Also, power spectra is used for the detection of periodicity. Periodic and/or almost periodic components will appear as sharp peaks in power spectra.

Several authors analyzed speed spectra of turbulent winds (Kaimal et al.1972;Lee, 1996).The focus of this paper is analysis of spectral characteristics of the wind "Koshava". Spectral analysis is a powerful tool in revealing information about the scales of "Koshava". This paper takes into account the data measured at three stations in the area of the maximum "Koshava" speed, during 6 December 1995, every ten minutes. The analysis is limited to horizontal spectra of the ten minutes mean wind speed, the corresponding maximum wind speed and the gustiness factor.

CLIMATE AND LOW FLOW

A. Vladimirov, Russia

In the paper the influence of extreme climatic events has been analysed on the extreme characteristics of river runoff in reduced water phaze. As an example, summer season has been chosen in 1972 in Eastern Europe, when the extreme exclusive drought took place. In June, July and August air temperature was significantly higher than long-term average value, especially in Central and South parts of this territory. It was less than the maximum air temperature observed for the above 90-200 years in different regions of Eastern Europe only on 0.3-1.4 degrees C, i.g. it was very closely to the absolute maximum. Precipitation was significantly less than the average value for this period. For example, in July no more than 20% of average amount have fallen. On the wide territory the climatic conditions have become homogeneous. Rivers had only underground inflow from the perennial deep water aquifers. Runoff variations were not significant under the constant tendency of runoff decreasing. Long absence of precipitation and large losses by evaporation according high air and soil temperatures were the reasons of sharp decreasing of underground inflow into the rivers. The period of low flow in the rivers of Eastern Europe has began significantly earlier than usually. Low flow data for 850 hydrological sites with the period of observation more than 10 years have been analysed. Regions with different types of low flow periods have been chosen corresponding the time of its manifestation and values of probabilistic water discharges. Regions of droughts and watersheds areas with runoff absence have been determined. The correlation has been established between minimum monthly and daily discharges. For the region with the smallest water content the years have been determined in which river runoff was less than in 1972.

THE EFFECT OF CLIMATE VARIABILITY AND CHANGE ON AGROCLIMATIC RESOURCES AND CROP PRODUCTIVITY IN BULGARIA

Vesselin Alexandrov, Bulgaria

Data of air temperature and precipitation during the last 100 years (1891-1993) were gathered from 14 meteorological stations across the country. 125 meteorological stations with elevation below 800 m were selected for the simulation study. Values of air temperature, sunshine duration, air vapor deficit and precipitation from these stations during the period 1960-1993 were used. Agrometeorological data from 21 experimental variety stations across the country were also assembled from 1970 through the end of 1993. Some impacts assessed in this study were those expected to occur under a number of possible scenarios of climate change. Some of the climate change scenarios were created by changing observed daily data from the current climate (1961-1990) according to doubled CO_2 simulations of 3 general circulation models (GCMs) available in this study. The GCMs used were those from the Goddard Institute for Space Studies (GISS), Geophysical Fluid Dynamics Laboratory (GFDL), Canadian Climatic Centre (CCC), United Kingdom Met. Office (UK89), Oregon State University (OSU) and Hadley Centre in United Kingdom (HCGG and HCGS which integrates the negative forcing effect from sulphate aerosols. Long-term variations and trends of agroclimatic resources during the last 100 years were investigated. Long-term fluctuations of the beginning, end and duration of the potential growing season and accumulated temperatures above a base of 5° and 10°C were determined. Long-term fluctuations of precipitation during the potential and actual growing season and non-growing season were also studied. Regression relationships that appear to exist between meteorological conditions and grain yield of maize and winter wheat were established. Multiple linear regression equations were derived between monthly or phenological period values of precipitation and air temperature and grain yield of maize and winter wheat. The statistical models developed can be used to assess the expected grain yield of maize and winter wheat a month before physiological maturity of these cereal crops. Dynamic crop-weather models which simulate growth, development and yield formation of maize and winter wheat were adapted to agrometeorological conditions in Bulgaria. The results obtained under the procedure of calibration and validation showed that these models give a reasonable estimate of yield. These models provide opportunity to assess potential risks and plan strategies under climate change. The influence of climate change on agroclimatic resources and productivity of maize and winter wheat was investigated assuming crop management, technology, and distribution of cultivated land to be constant. Under equilibrium $2xCO_2$ the climate change scenarios projected increased agroclimatic potential, however warming caused decreases in yield of winter yield and especially maize. The changes of agroclimatic resources and crop productivity of these main cereals under transient and incremental scenarios of warm, cool, dry and wet climate relative to the current climatic conditions were also investigated. Adaptation measures and an potential action plan in agriculture under expected climate during the next century were considered in the study, as well.

DYNAMICS AND FORECAST OF AGRI-CLIMATIC RESOURCES IN THE BALTIC SEA REGION

Arunas Bukantis, Lithuania

Temperature changes and changes in soil moisture from altered precipitation are likely to put pressure on agricultutral activity on regional scales. These changes are likely to alter the range of a number of major food crops. The result need not be global strains on food supply, especially if the fertilisation effect of higher carbon dioxide levels in the atmosphere is taken into account.

Nevertheless, regional climatic shifts will alter the distribution and intensity of farming and require compensation to maintain agricultural productivity. Compensation includes continued research and dissemination of knowledge regarding crop strains suited to changed climate (e. g., more drought-tolerant wheat); removal of regulatory and institutional barriers to more efficient farm practices (e.g., reduction of distorted prices for crops, water, and fertilizer; regulations that encourage monoculture; and trade restrictions); and better contingency planning for natural disasters, which may increase in severity with a changed climate (Toman and Bierbaum, 1996; Parry and Carter, 1988).

The dynamics analysis of agri-climatic conditions in Baltic Sea region in XX century was made in this work and forecast of some changes of agri-climatic parameters in first half of XXI century was created.

USE OF REMOTE SENSING DATA IN THE DETERMINATION OF FROST AREAS

Isabelle Donet, Anne Couzinier, Nathalie Barsanti, Victorine Pérarnaud, France

In 1997, a study was realized in the agrometeorological subdivision of Meteo-France, in order to map out frost areas, on a limited region but at a highest resolution (1 km) than the one reached through the ground observation network of Meteo-France.

This project followed a first study, achieved in 1996 to answer to the request of AFOCEL (Forest research association), who asked on the frost risks in south-west of France for new implementations of Eucalyptus trees. The results were based on the return periods of the minimum air temperature and used ground observation network data, since 1973.

In order to obtain a map at a highest scale, the land surface temperature, estimated from the NOAA satellite and available at a 1 km resolution, was introduced to compensate the scattering and the lacks of the ground data. A set of 47 frost occurrences, by clear sky, was selected, between December 1991 and December 1995 (1991 squares with the start of the storage of land surface temperatures pictures at the spatial meteorological center of Lannion).

In a first step, the validation of the land surface temperature data was realized through the determination of the linear regressions between the two sets of data (time and spatial scales).

Then, the minimum air temperature was interpolated at a 1 km mesh-grid scale, through four methods: simple kriging, standard AURELHY method, modified AURELHY methods where new predictors, such as land surface temperature and NDVI, can be introduced.

The best method was chosen for each of the 47 situations and then, a dynamic clustering automatic classification method was applied in order to determine the areas with the same behaviour in a frost context.

Finally, the frost areas map obtained at the end of this study was compared, for validation, to the local return period data of the first study for AFOCEL.

MODELLING CLIMATE CHANGE IMPACTS ON MAIZE YIELDS IN THE CZECH REPUBLIC

Martin Dubrovsky, Zdenek Zalud, Milada Stastna, Czech Republic

Crop growth model CERES-Maize was used to simulate maize yields in present and changed climate conditions. The input daily weather series (precipitation, solar radiation and extreme temperatures) were synthesised by stochastic weather generator Met&Roll whose parameters were derived from observed weather series and then modified in accordance with climate change scenario.

The contribution will address following points:

1) Validation of weather generator Met&Roll: The stochastic structure of synthetic vs. observed weather series was compared.

2) Validation of CERES-Maize growth model: The grain yields simulated by CERES-Maize with use of measured site-specific pedological, physiological, cultivation and meteorological data were compared with observed grain yields.

3) Validation of variability of grain yields simulated by CERES-Maize. To examine how the weather generator's imperfections affect the model yields, the distributions of grain yields simulated with use of observed vs. synthetic weather series were compared.

4) Sensitivity of model grain yields to selected characteristics of weather series. To gain a notion on possible errors resulting from inaccuracy of climate change scenarios and from ambiguities in projecting climate change scenario into parameters of weather

generator, the sensitivity of model yields to selected characteristics of daily weather series (including variability and persistency of the series) was studied.

5) Modelling maize yields for prognosed climate change: Parameters of the generator were modified according to the GCM-based (ECHAM) climate change scenario related to increased CO_2.

HAIL DAMAGE CLIMATOLOGY IN NORTHERN AND CENTRAL GREECE

Dimitrios Foris, Greece

Hail constitutes a major threat for agriculture in Greece, producing extensive damage to crops, especially in northern and central Greece during the warm season. In order to minimize the damage and the corresponding payouts a National Hail Suppression Program (NHSP) is running since 1981. Hail supression is accomplished by seeding hail-bearing storms with silver iodide (AgI) The seeding material is delivered by aircrafts, which are directed from ground-based weather radars.

The program is running from mid April to the end of September, and each day is characterized by an index CDC (Convective Day Category) representing hail threat. The climatology of thin instability index (yearly and monthly variability) is first examined in the present study.

Radar characteristics of convective clouds are examined next, with emphasis to their maximum top and intensity (measured as radar reflectivity) in relation to hail size. Radar data are collected continuously throughout the hail season, in both a manual and digitized form, and analyzed after the end of each operational season.

The pre-storm environment plays a key role in forecasting thunderstorm occurrence and severity. Several indices and environmental parameters are considered to this end. Among others the role of Convective Available Potential Energy (CAPE) as a measure of latent instability is investigated, as well as the effect of Bulk Richardson Number (BRN), which comprises also the influence of wind shear.

Finally, an attempt is made towards relating storm features with insurance payouts for hail damage. This aspect is particularly important to the Greek Agricultural Insurance Organization, under the auspices of which the above mentioned weather modification program is running.

ARIDIFICATION AND THE FUTURE ECOLOGICAL VALUE OF THE HUNGARIAN LANDSCAPE

Gábor Mezösi, Ilona Kevei-Bárány, Róbert Géczi, Hungary

In this study climatic and hydrological information are used to analyse the probable changes in ecological value of one of the most characteristic landscapes in the Carpathian Basin, the Danube-Tisza Interfluve, in the next 50 years. A dark future is often predicted for the Danube-Tisza landscape, due to direct and indirect human effects, the growing aridity, the falling groundwater level and the impoverization of the local population.

The analysis involves an assessment of the changing value of the future landscape through modification of the ecological value. The ecological value is a category used in geography, it can mean the condition of the ecotopes, the productivity of the landscape or the utility factor of the landscape. During the analysis, an attempt was made to calculate the change in the ecological value from all three aspects, which therefore fulfilled a controlling role for one another.

The essence of the applied method is the estimation of the consequences due to the ecological values of the 20 and 50 - year climatic and water turnover data sequences in the Carpathian Basin and the Danube - Tisza Interfluve as the test area.

Aridity is chiefly caused by the changing features of the climate, water utilisation and drainage, and land use. If these factors are analysed separately, false results may be obtained. Ecological and economic changes are jointly responsible for the modifications, and thus an inaccurate record would be obtained if an attempt were made to establish the exact ecological change rate brought about by privatisation, for example. Ecological factors automatically involve changes in utilisation, which induce further processes. If the changes in the system of land utilisation - albedo - groundwater are analysed, it can be concluded that the numerous factors modify the use value both positively and negatively.

To summarise the results of the climatic changes, it may be concluded in general that a) certain species of plants will disappear due to their insufficient competitive ability and adaptability, while others will take over; still existing plants will be transformed genetically, and the proportion of weeds will increase; b) because of the increasing danger of drought, agrotechnology must utilise the changing conditions of soil moisture, and this must be reflected in the crop structure, e.g. potato growing will reach a critical situation, while viniculture will improve; c) the resistance of the vegetation against environmental risks must be improved: this involves biodiversity, as well as irrigation, melioration and changes of species of trees; d) it is most important to consider the different consequences of a value-oriented planning strategy and one based on principles of equity; the former is based on a modern value judgement system, and the latter on a projected one, with the aim of ensuring the maintenance of development.

AN ALGORITHM FOR EVALUATING THE TEMPERATURE SUMS IN POLAND

Tadeusz Gorski, Poland

The Fourier coefficients have been determined using a standard harmonic analysis for many series of monthly values of mean temperature. After some simplification, the coefficients may be also calculated from four derivative parameters of temperature (mean, amplitude, phase shift, kurtosis) for any series of appropriate data. In the absence of such data, the Fourier coefficients may be considered as multiple functions of the geographic coordinates. The yearly course of temperature is obtained after summation of particular functions.

An algorithm for easy calculation of daily values of mean temperature as well as of aggregated values was constructed. Using a PC equipped with a spread-sheet, one can obtain immediately mean values of degree-days with any temperature threshold for any desired period.

ASSESSING THE CLIMATE CHANGE IMPACT ON EVAPOTRANSPIRATION IN ASIA AND GRAIN PRODUCTION ON NORTH CHINA PLAIN BY 2030

Yeugeniy M. Gusev, Russia

The aim of this work is development of simplified method for predicting a response of such important component of the water balance as evapotranspiration to the climatic changes and application of the method for estimating the expected changes in evapotranspiration in Asia by 2030. A methodology for estimating the expected changes in evapotranspiration is based on empirical relations between annual values of actual evapotranspiration, potential evapotranspiration and precipitation, as well as between potential evapotranspiration and annual sums of positive daily values of air temperature. Prognostic sums of positive values of the air temperature and precipitation were estimated on the base of the results of equilibrium climate change simulations by the three high resolution general circulation models, namely, CCCM (Canadian Climate CenterModel), GFDL (Geophysical Fluids Dynamics Laboratory, Princeton, USA) and UKMO (Meteorological Office, United Kingdom). These results were modified according to the socio-economic global scenario A ("Business-as-Usual") developed by the Intergovernmental Panel on Climate Change and used for the calculation of the expected changes in evapotranspiration in Asia by 2030. The calculated changes in evapotranspiration were plotted and analyzed. According to all scenarios an increase in annual sums of evapotranspiration by 50-100 kg m-2 can take place to the north of 40N. Southward the results differ widely for the three scenarios due to a great difference in predicted changes in air temperature and precipitation. On the whole, the expected changes in annual evapotranspiration within this area range between -100 and +150 kg m-2.

Forecasted values of evapotranspiration and potential evapotranspiration have allowed us to estimate the possible changes of wheat and corn yield on the North China Plain by 2030. The technique of estimation of change of grain yield based on empirical relation between actual grain yield, potential yield, actual evapotranspiration and potential evapotranspiration. Herewith, it is necessary to know the dependence of potential yield on potential evapotranspiration. This dependence was derived using the data on evapotranspiration, potential evapotranspiration and yield of wheat and corn in different countries, including the China. Obtained results on forecasting changes of production of agricultural ecosystems have shown that, according to all the considered climatic scenarios, conditions of grain production on North China Plain will be more favorable by 2030 than at present. On more part of the territory, it is possible the increase of grain yields by 500-1000 kg hm-2. In several places of the region the increment of the yield can attain to 1000-1500 kg hm-2.

CLIMATOLOGICAL METHODS IN THE OFFICIAL AUSTRIAN SOIL EVALUATION

Otmar Harlfinger, Austria

The official Austrian soil evaluation has the task to determine the natural fertility of the soil. It is based on detailed soil parameters as well as the climatic conditions of each Austrian local community according agro-climatological aspects. It reports on the bases and methods of climatic evaluation.

THE FREQUENCY OF HAILDAYS IN FRIULI - VENEZIA GIULIA: RANDOM OR ORGANIZED PHENOMENON?

Fulvio Stel, Andrea Cicogna, Italy

The Italo-Slovenian Hail Project was born in 1982 (at that time it was called Italo-Yugoslavian), as a consequence of the Osimo Agreements between Italy and Yugoslavia. The aims of that project were to study the possibility of applying high altitude rockets with silver iodide to prevent, or reduce, the formation of the hail, in a region that encompasses the border of Friuli -Venezia Giulia and the western part of Slovenia. In recent years the early aims of the Project have been changed but, during this period,

the Project has continued to collect data on the hail activity and has developed a powerful framework of meteorological instruments and data (18 mesostations over an area of 5000 km^2, a 5 cm polarization-doppler radar, surface and upper air data over all of Europe from 1974 to the present) to study the climatology of the region across the border between Italy and Slovenia. In particular there are two data sets on the hail activity in Friuli - Venezia Giulia, one from 1974 to 1981(hereafter HAIL7481) and the other from 1988 to 1997 (hereafter HAIL8897).

The HAIL7481 sample was collected by volunteers (mainly farmers) distributed over the plain of Friuli - Venezia Giulia, on an almost regular grid. They reported the time and duration of the hailfalls in the proximity of their farms.

The HAIL8897 sample has also been collected by volunteers, but using hailpads. In this way we have information not only about the date time and duration of the hailfall, but also on the hailstones' diameters. This sample will increase in the coming years because the data are still being collected by the farmers.

The aim of this paper is to study some aspects of the climatology of the hail in the plain of Friuli - Venezia Giulia and, in particular, the frequency of the hailfalls in different parts of the plain. The two samples are studied separately, and then they are joined to produce an 18-year sample of the frequency of the haildays.

The approach used to spatialize the hailfalls' frequencies is the *kriging method* (Cressie, 1990), since, with the use of the variogram (Wackernagel, 1995), it can give some interesting information on the spatial behavior of hail in Friuli - Venezia Giulia.

SENSITIVITY OF CROP PRODUCTION TO DISTRIBUTION OF CLIMATIC VARIABLES

Marta Hunkar-Zemankovics, Hungary

Mechanistic crop models often use daily meteorological data as input variable or even shorter time step is applied. If high resolution data are not available the application of that really sophisticated crop models is restricted. This is the case in studying climate change impacts on agricultural crop production.

General Circulation Models use to give monthly data as output for temperature radiation and precipitation. These outputs are required as inputs in crop models. The different resolution of "demand and supply" is overbridged by the process of downscaling in time which means simple addition or multiplication of observed daily meteorological data with the expected change or a bit more complex way of creating and using weather generators.

But what is the situation on the other side. How sensitive are the plants on time scaling of meteorological variables. Is there any characteristic response time of the crop. This is the question to be studied. CERES-Maize crop model is used. At the Agrometeorological Research Station of the Hungarian Meteorological Service at Keszthely a long time experiment on maize production provides data for the investigation.

SPATIAL DIFFERENCES IN CLIMATIC SEASONS IN ESTONIA AND THEIR INFLUENCE ON PHENOLOGICAL DEVELOPMENT OF NATURE

Jaak Jaagus, Estonia

The main objective of this study is to estimate spatial variability in parameters of climatic seasons in Estonia and to determine its influence on pattern of phenological development of nature. The following climatic seasons and criteria for the determination of their beginning dates are used: *spring* (begins after permanent rise of diurnal mean air temperature above +5°C); *summer* (begins after permanent rise of diurnal mean air temperature above +13°C), *autumn* (begins after permanent drop of diurnal mean air temperature below +13°C); *late autumn* (begins after permanent drop of diurnal mean air temperature below +5°C); *early winter* (begins after the first formation of snow cover); *winter* (begins after the formation of permanent snow cover); *late winter* (begins domination of melting days, tmax>0°C); *early spring* (begins after final disappearing of snow cover). Beginning date and duration of the climatic seasons at 19 stations during 1946-1996 are determined. Phenological database consists of observation data obtained from the Estonian Naturalists Society (1951-1996) and the Estonian Met. and Hydr. Inst. (1947-1996). In this study times series of the *beginning of blossoming of five tree species*, and the *stalk formation and pollination of autumn sown rye* in 17 observation points are used. Preliminary results demonstrate a significant spatial variability in parameters of climatic seasons in Estonia. Rather high correlation between beginning dates of climatic seasons is typical for stations in the continental part. Correlation with coastal stations is much lower. Climatic seasons in springtime in South Estonia begin some days earlier than in North Estonia. The difference increases from 3 days in the beginning of late winter until 7-9 days in the beginning of summer. Cooling in autumn starts from the inland parts of North Estonia but differences in south-north direction are less than during spring period. The most remarkable territorial inhomogeneities are caused by the thermal influence of the Baltic Sea. On the islands of West-Estonian Archipelago, autumn begins 1-2 weeks later, late autumn - 1.5-2.5 weeks, early winter - 1.5-3 weeks and winter - 2-4.5 weeks later than in East Estonia. The highest values are obtained from stations located on the western coast of the islands that are under the influence of the central ice-free part of the sea during the whole winter. Even late winter begins there 5-8 days earlier, in the average. But warming in spring time is much slower due to the influence of cold sea-water. For example, summer begins up to 17 days later. The analysis of spatial variability of phenophases shows great differences between regions of marine and continental climate in Estonia. The largest deviations in blossoming dates occur in the coastal regions. The blossoming of the five tree species studied was spread over about 35 days in the coastal regions and over 26 days in the more continental inland regions. In the case of a very early climatic spring (winter without sea-ice), the phenological spring, especially blossoming of Corylus avellana and Acer platanoides, start in the coastal regions earlier than in continental area. The correlation between climatic seasons and phenological data is the highest in continental southern Estonia and in case of late spring/early summer phenophases, such as blossoming of Syringa vulgaris and Sorbus aucuparia, stalk formation and pollination of autumn sown rye.

CLIMATIC SIGNATURE OF A REGION FOR IRRIGATION PURPOSES

J. Jorge, C. Hervada, L. Solé, Spain

Along Los Monegros, an extended sector of north-eastern Iberian Peninsula, the landscape is changing due to the grow of irrigable areas. The apparent climatic signature of that region do not coincide with this increase of water consuming. We have tried to characterise the region starting from a set of rainfall and temperature data (1961-1990 period) corresponding to boundary and internal ground stations in the area.

Some different models to estimate the evapotranspiration have been applied and they denote opposed tendencies for the hydrological balance. Some of those results can justify economical inversions to irrigate the cultures, but when we compare the climatic signature with agricultural use of soils, superimposing climatic maps to remote sensing products (e.g. maps starting from TM images), we detect a partial bad correlation between wet and irrigables areas.

ON THE STUDY OF WHEAT DROUGHT CONDITIONS OVER EUROPE

Theodore Karacostas, Greece

An attempt is made to analyze and study the broadscale features of the spatial distribution of drought and wet conditions over Europe, during the growing season of winter wheat. For this reason, the 30-year baseline climate period of 1961 to 1990 is adopted, and the daily climatic data is used, at 5085 grid points extended all over Europe.

The characteristics of the intensity and spatial coverage of the wheat drought conditions are calculated through the application of the well-known and widely used indices, such as: the soil water deficit, the Palmer drought severity index and the hydrothermal coefficient. It is believed, that this dense grid point network, can provide sufficient information and systematically characterize: the drought severity conditions, the moderate and extreme wet conditions and the excessive humid conditions, in a temporal and spatial sense.

In spite of the inherited limitations and deficiencies encountered in the computational procedures of the aforementioned indices, the applications of these illustrate their abilities to identify severe conditions, dry and wet, in a temporal and spatial sense.

THE CONTRIBUTIONS OF AGROCLIMATOLOGICAL INFORMATION TO AGRICULTURE MANAGEMENT

Olga Karpova, Ukraine

Climate is one of natural conditions necessary for agricultural activity and provides different amount of energy and matter resources such as light, heat, water and air, and thus represents one of the most fundamental natural resources for agriculture. Knowledge and application of climatic factors are very important prerequisite for successful agricultural production. Analysis of weather for two last decades shows that they are observed quite different from year to year. Such situation led to changeability of indices of extreme agroclimatic parameters and their probability. The necessity of preparation and new editing of scientific-applied reference book on climatic resources of Ukraine was occurred. Scientific-applied Reference Book on "Agroclimatic Resources of Ukraine" (further Reference Book) prepared by a panel of experts in agrometeorology is of scientific as well as practical nature with purpose of enhancement of agricultural efforts and development of farming, its scheduling and management. The Reference Book consists of two parts. Agroclimatic resources of growing season are presented in 42 tables of the Part 1. Agroclimatic conditions of growth and development of main agricultural crops are contained in 89 Tables of the Part 2. Agroclimatic indices of heat, moisture, light and others had been determined on the basis of regular meteorological and phenological observations. The processing of long-term data series of observations consists in calculation of multi-annual means of some climatological indices and their probability. The processing of long-term data has been done by using the methods of mathematical statistics. Multi-annual means of average values allow to characterize agroclimatic peculiarities of territory to be conditioned by geographical location. Average values of climatological data are presented in Part 1 and 2 of the Reference Book by means of recurrence, probability, frequencies to give temporary and spatial characteristics of variability of any meteorological elements. Such approach in calculating gives users opportunity to make practical decisions more easily by using available current information and average values. Empiric frequences of probability of agroclimatic indices are given in some tables. Data series not less than 20-years period was used to calculate the probability. Part 2 elucidates 7 types of identical tables that represent multi-annual means the dates of beginning of crop development stages during the growing season, elements of crop's productivity, availability of water in different soil layers and so on. Besides, probabilities of freezing injuries happen to major crops for cold period of year is included in tables. Different indices were applied to crops being produces in Ukraine to demonstrate the main features of conditions for yield formation. Totally data from 162 meteorological stations for 35-years period of observation had been proceed and calculated. Some data have been determined by using nomograms. Information is made available for customers on their request not only in paper-table format but also on the diskettes.

AGROCLIMATOLOGICAL STUDY ON THE WHEAT CROP DEVELOPMENT IN BULGARIA

Ivanka Koleva-Lizama, Bulgaria

The influence of agrometeorological factors on wheat development stages and the impact of climatic variability on crop production are discussed in this paper. On the basis of meteorological and phenological data from 20 agrometeorological stations which are situated in the important wheat-crop regions of Bulgaria, with more than 30 years of observations, have been done an attemp to determine the climatic elements that have the greatest influence on growth and development of the wheat crop. The agroclimatic indexes and their statistical parameters for various stages of the growing season are determined. Using statistical procedures, such as multivariable regression analysis are found models which describe the phenological crop development. The models adequacy are verified by means of statistical tests.

IMPROVEMENT OF WEATHER GENERATOR WGEN FOR AGRICULTURAL APPLICATION IN POLAND

Leszek Kuchar, Poland

In the paper evaluation and improvement of WGEN procedure generating daily values of solar radiation, maximum and minimum temperature, and total precipitation is presented. Weather generator was examined using a ten stations of Southwest Region of Poland by comparing observed and generated means, variances and correlations in different time period as annual, vegetative period (March - October), bimonthly and monthly. Evaluation of methods shown low errors for means and variance of generated data, and not acceptable errors for lag, cross and cross-lag correlations. Modification of methods takes into consideration climatology of region and annual course of correlations by introducing Fourier approximation. Above modification reduced absolute errors about three times; new correlations were statistically examined (at 0.05 level) and accepted in 95% for all 7560 computed tests.

CLIMATE AND PHENOLOGICAL PHASES OF SPRUCE (PICEA ABIES (L.) KARST.) IN SLOVAKIA

Viera Luknarova, Slovak Republic

Climate changes, which characterize present period, will influence on the environment, where forest ecosystems have the important role. These changes of climate are so fast, that forests, which are on the same stand several decades, will be not able to adapt so fast.

Spruce (Picea abies (L.) Karst.) belongs to the most represented forest trees in Slovakia, what is different from the original state. Spruce has demands on water and is sensitive on the high air temperature.

In this work is evaluated the impact climate, air temperature and precipitation, on the date of the phenological phases of spruce. Climate changes can shift the date of phenological phases towards earlier or later period and can influence on the next evolution of spruce. For the analyse were chosen phenological stations in Slovakia, which have the longest observations of this tree. There are processed the mean date of first May sprouts and first flowers in the given period. It is showed the trends of phenological phases and chosen meteorological elements. The basis for elaboration were observed a measured data according to accepted methodics of Slovak Hydrometeorological Institute.

CRITICAL PERIODS OF SELECTED CROP PLANTS AND OCCURRENCE OF DROUGHTS IN POLAND

Przemyslaw Mager, Malgorzata Kêpiñska-Kasprzak, Poland

The paper characterizes space and time variability in the frequency occurrence of atmospheric droughts in Poland in the period 1951-1990 during the occurrence of critical periods of selected crops or their groups. The performed analysis employed one of the complex indices for the estimation of the atmospheric drought called 'degree of climatic dryness' (climatic water balance). The climate dryness index was calculated as a difference between precipitation and potential evaporation. Data covering the period from 1951 to 1990 collected at 52 points (meteorological stations) evenly distributed throughout Poland was used in this analysis.

Negative values of the analyzed parameter occurred most frequently in the southern part of the South-Baltic Lake District, and these values were least frequent along the coast of the Baltic Sea and along southern boarders of Poland. In many regions of central-west Poland a decline in the frequency of this phenomenon was observed from the highest values in June to lowest - in August. Relative wide space variability in the frequency of occurrence of atmospheric droughts, especially in June and July, observed in Poland, when considered against the background of critical periods of crop plants, indicates that it is necessary to take this factor into consideration when working on a project which aims at proper regionalization of plant production, application of appropriate agrotechnical treatments, evaluation of economical effectiveness of investments in the area of irrigation and sprinkling equipment.

AGRO-CLIMATIC CLASSIFICATION OF TUSCANY BY THE USE OF NOAA-AVHRR NDVI PROFILES

Giampiero Maracchi, Italy

Climatic classifications are very useful for territorial planning and in particular for optimising the management of agricultural and forest resources. These classifications are commonly generated by extrapolating from or interpolating local measurements, commonly taken at meteorological stations. Unfortunately, the process of extending point estimates on the land surface is often complex and nearly impossible in very irregular terrain. Recent investigations have demonstrated that data taken by the Advanced Very High Resolution Radiometer (AVHRR) mounted onboard National Oceanic and Atmospheric Administration (NOAA) satellites are useful for agro-climatic classifications, thanks to the abundant environmental information contained in the Normalized Difference Vegetation Index (NDVI).

The extent to which these data can be used to directly estimate the most important parameters for the climatic zonation of complex areas is however mostly unknown. In particular, it has not been clearly established how the images can assist in extending the main mean climatic parameters computed at some ground stations (temperatures, lengths of growing and arid seasons, etc.) over the land surface. The present work aims to address this issue with reference to a region in Central Italy with complex environmental characteristics (Tuscany). In particular, a series of NOAA-AVHRR NDVI monthly images have been processed by a fuzzy classification method to extend three main agro-climatic parameters from some training stations over the regional surface. The results, evaluated by comparison to the values measured at independent test stations, showed the high potential of the methodology which is presently being applied also to other environmental parameters.

ESTIMATION OF GLOBAL CLIMATE CHANGE IN THE REPUBLIC OF ARMENIA AND ASSESSMENT OF VULNERABILITY OF ECOSYSTEMS

H. Melkonyan, Armenia

The empiriq-statistical analyses of long-term (1894-1896) observations (it was used dates of 53 meteostations) of hydrometeorological elements throught Republic of Armenia (from 400 m to 4000 m above sea-level) showed that meteoelements have taken inequal variations due to global climate changes:

- The mean annual temperature during last 60-100 years have increased 0.4°C. In some areas temperature heating reached 1°C, and in other areas -0.6°C. There were also seasonal temperature changes.

- Precipitations during the same period have decreased 10-15% in arid regions and have increased in humid areas. It was studied also the seasonal dynamic of precipitation for hot (4-10 month) and cold (11-3 month) periods.

- By IPCC's scenarios it was calculated the vulnerability of soil moisture, evaporation, river's debit and runoff due to temperature and precipitation changes.

- The studies of frequency and dynamic of dangerous hydrometeorological phenomenons speed winds (>25 m/sec), hails (≥20 mm in diameter), heavy rainfalls (≥20mm during 12 hours), frosts (temperature below 0°C during vegetation period of agricultural crops) showed that in Republic of Armenia speed wind have increased, the amounts of frost haven't taken any changes. Heavy rainfalls, hails have increased.

The snow cover's studies showed that its duration have taken seasonal changes. In some areas snow cover's duration have enlarged toward both in autumn and spring. In other areas it have decreased toward winter. It was estimated the vulnerability of water resources by snow coarse dates.

- By using of forecasting methods for strategic agricultural crops of Republic of Armenia (grape, apricot, potatoes, wheat, grass crop yield) it was estimated the vulnerability of crop due to temperature and precipitation changes.

COMPARISON OF INTERPOLATION METHODS OF THE DAILY MINIMUM TEMPERATURE IN THE SOUTH EAST OF FRANCE

Sylvie Paniagua, France

To take decisions farmers have a great need of meteorological parameters fitting with their parcels of land. The meteorological network density can not allow to reach information at this small scale. In particular interpolation of the minimum daily temperature would be helpful to determinate frost areas.

The goal of this study is to test two interpolation methods of the daily minimum temperature in the south east of France on a 1993 - 1994 data set. The input data used to run the interpolation methods belongs to Météo France synoptic and automatic station network (called « real time » network in the study). The final aim is to obtain a daily minimum temperature field on a mesh grid scale on an operational way.

The two tested methods are a simple kriging and a method developed at Météo France called AURELHY. This second one takes into account the possible statistical relationship between the field to analyse and the regional topography. A principal component analysis concerning the French relief is followed by a regression equation on some selected relief predictors. Then the field of residuals is interpolated by kriging method. Adding up the regression and the residual parts allows to estimate the minimum daily temperature on a mesh grid field or on some selected points.

In a first step, a validation process had to be defined to choose objectively the most adapted interpolation method between kriging and AURELHY. The first idea consisted in running each method with real time network data set to estimate the value on each climatological measurement point. In this way a learning file data set made of data collected by synoptic and automatic stations had to be used in input, a test file data set made of data collected by climatological stations had to be compared with the interpolated values. Nevertheless, the data analysis showed that the two networks of the selected area were not statistically comparable on the study period : on a monthly scale the data set of climatological one is colder.

To solve this problem it was decided to divide the test file data set into two parts made of points distributed with regularity. A first part is mixed with the learning file data set to build a climatological field for each month. The second one (called « Test stations ») is still used to test the difference between reality and interpolation. But now interpolation is applied on the gap between daily data and the monthly climatological field.

At the end, the daily minimum temperature is finally calculated for each « Test stations » adding the monthly climatological value of the station to the gap interpolated previously in this point. To evaluate an interpolation method, this calculated value is compared to the observation.

In this way, in a second step, the two interpolation methods are run on the seven hundred and thirty days of the study period. The results of the estimation of the daily minimum temperature on the Test stations with the two methods are compared to observations.

GEOGRAPHICAL DISTRIBUTION OF DAYS WITH HAIL EVENTS IN THE NORTHERN PART OF CROATIA

Damir Pocakal, Croatia

This paper is dealing with geographical distribution of teh mean number of days with hail events in the northern part of Croatia (25 177 km2), a region where hail suppression is operational since more then 20 years.

The evaluation is based on 5011 observational reports which are prepared by the crews of the nearly 450 rocket lancing stations of the Croatian hail suppression system during the period 1981-1990.

The map clearly shows regions with higher frequency of days with hail, which are correlated with the main trajectories of thunderstorm cells and with the orography.

There are useful results for the running hail suppression system itself and for agriculture and insurance companies, too.

APPLICATION OF THE DYNAMIC MODEL OF CHILLING PORTIONS FOR FRUIT TREES ENDODORMANCY RELEASE ASSESSMENT IN TEMPERATE CLIMATIC CONDITIONS

Ana Maria Roman, S. Ninomiya, V. Cuculeanu, V. Cociu, Anca Ristici, Romania

The interest of the present investigation is due to the necessity of an annual assessment of dormancy completion process, especially for trees with a short rest period, in the South Romanian climatic conditions. n this purpose, a two - steps model, describing the response of dormant buds in deciduous fruit trees to temperature, with an hourly basis, defined under conditions of controlled chambers and also in field experiments was analysed. According to the original source program of the dynamic model (U.S.-Israel Binational Agricultural Research and Development), the first step produces a reversible intermediate and the second one fixes the effect by irreversible transition. The irreversible transition is assumed to occur only when a critical mass of the intermediate is reached, after exposure to low temperature. The upper temperature value giving a positive result, as critical temperature, is assumed to be 13-140C; 60 C represents the optimum temperature in view to accumulate a critical portion of dormancy breaking factor. The phenological data used concerning peach vegetative and floral bud breaking - Redhaven variety were registered in the field of Laboratories for Trees Genetics and Breeding - Stations of Research and Production in the South East part of Romania. The parameter used by us for running the program was 60 C. A special methodology was worked out in order to run the program in Romanian climatic conditions. The adapted program for Romanian climatic conditions is based on a daily expression of two average temperatures of "cold" and of "warm" instead of the daily average temperature. The number of hours with the average cold temperature and with the average warm temperature is also taken into account. By running the program, with specific meteorological data, the results have evidenced the possibility of using it, in the adapted form, for determining the moment of peach buds breaking rest, in Romanian climatic conditions. The performing of this important agrometeorological parameter of endodormancy release, based on the biometeorological model of the chilling portions, in conformity with the dynamic model, is suitable for the deciduous fruit trees species, evidencing the complex connection with the temperature regime (daily and night hourly values). Function of species, varieties, the specific weather condition in a certain year, the moment of dormancy breaking, especially in case of early blooming Prunus Genus, can be followed by frosts, damaging the flowers and the setting fruit; other ecophysiological aspects can also occur, in the future climatic conditions. The attempt to apply the dynamic model of chilling portions in Romanian climatic conditions will provide the fruit tree researchers, breeders, farmers, with specific instruments of assessment. Forecasts, in the frame of agricultural meteorology operational activity, will be substantiated as well. Consequently, specific information for Agricultural Extension Services will be supplied.

A STUDY ON THE EFFECTS OF EXTREME EVENTS FOR WINTER WHEAT

Elena Savin, Romania

Romania is located in central Europe, in the Balkan Carpatian area. The climatic conditions in Romania are favorable for agriculture. However the weather is variable and extreme events which pose risks to agriculture are common. The work aims to focus on the risk of weather extremes, such as very high temperature, severe frost and persistent drought and their consequences to the winter wheat crop. For this

purpose the interaction of climate with crop development state was studied The scope of this analysis is to quantify the current risks of climatic extremes to production at Fundulea station. To identify the risk of agriculturally significant climatic extreme events in specific developmental stages of wheat the meteorological alarm criteria and the growing degree day index were used. The extreme threshold values, which are known to cause damage to the development and growth of wheat, were selected based on information in wheat knowledge base (Russell and Wilson, 1994). The damage caused by a particular extreme event is highly dependent in the development stage of the wheat plant. A wheat model (Arcwheat) was run for each year of the baseline climate data. For each variable related with one alarm criteria, the frequency and intensity were calculated. The meteorological alarm criteria may be divided into two categories: one, which is based on temperature and the another on precipitation. The agroclimatic index growing degree days (GDD) is the excess of mean daily temperature above base temperature, during the growing season. The arithmetic mean values of the GDD and the standard deviation were calculated. For each year the quantitative characteristics and the percent normalized anomalies were estimated.

DROUGHT EARLY WARNING IN MALI BASED ON ERS-SCATTEROMETER INFORMATION

Klaus Scipal, Austria

The Institute for Photogrammetry and Remote Sensing (IPF) is part of a joint European research group, establishing a Drought early warning system for the African Sahel.

In this paper the project ,Application Service Demonstrator for Drought Early Warning in Mali based on Scatterometer information', will be presented. The scope of this project is to develop, demonstrate and evaluate a service for draught early warning in the African Sahel.

The task of the IPF is to derive soil moisture information from ERS1 and ERS2 Scatterometer Data. Several studies have demonstrated the capability of the scatterometer for retrieving soil moisture over regions with typically short vegetation. A comparison of ERS Scatterometer retrieved soil moisture values with field observations has shown that the soil moisture content can be retrieved with an accuracy of about 10%.

The algorithms developed for this study are presented and the results for the last 6 years will be shown.

ON NORMAL EVAPOTRANSPIRATION FROM AGRICULTURAL FIELDS AND CATCHMENT BASINS

Nadezhda Shumova, Russia

The aim of this work is to show that the normal evapotranspiration from the agricultural fields during the frost-free period is approximately equal to the normal annual evapotranspiration from the catchment basins estimated by water balance method (namely as the difference between precipitation and runoff).

The normal evapotranspiration from the agricultural fields of the forest-steppe and steppe zones of the Former Soviet Union during the frost-free period was calculated using standard observational data of agrometeorological stations.

The maps of the normal annual evapotranspiration from the catchment basins in the same region which foundation is water balance method constructed by (i) P.S.Kuzin using measured precipitation and (ii) N.N.Dreier using precipitation including correction to measured precipitation were used.

The results of the comparison between the calculated values of the normal evapotranspiration from the agricultural fields during frost-free period and the water balance data for normal annual evapotranspiration from the catchment basins are as follows.

In the first case the calculated values of the evapotranspiration from agricultural fields are somewhat more than the water balance data for evapotranspiration from the catchment basins by P.S.Kuzin. The reason has to do with underestimating of the winter precipitation being used.

The water balance data for evapotranspiration from the catchment basins by N.N.Dreier far exceed the calculated values of the evapotranspiration from agricultural fields. The reason is that the correction to measured precipitation is essentially overestimated.

The comparison have been carried out led us to propose thatthe normal evapotranspiration from the agricultural field during frost-free period is approximately equal to the normal annual evapotranspiration from the catchment basins.

NUMERICAL MAPS OF TEMPERATURE SUMS IN POLAND

Andrzej Zaliwski, Poland

Life-cycles of plants are often determined according to the method of temperature sums reached within a certain period. In order to present geographic distribution of these periods as affecting selected agricultural plants a computer program and an application have been developed. The program takes advantage of the algorithm for calculating air temperature on the basis of geographic coordinates for a given set of points. The point data are then used by an Arc/Info application to generate coverages of polygons that describe the distribution of period lengths over which particular temperature sums are reached. On the basis of the coverages thematic maps for Poland have been made.

ON THE EVALUATION OF WIND ENERGY POTENTIAL OVER ALBANIA

E. Demiraj Bruci, Albania

The aim of the paper is the assessment of a current situation in Albania, regarding the possibility of using wind energy (the evaluation of the natural wind potential, the definition of the promising areas for using of energy over Albania). The evaluation of national energy policies, development of a common strategy for the exploitation of the regional energy sources are represented as well.

The wind regime in Albania is closely connected with the regime of baric centres, with its position relating to these centres, with the direct influence of Adriatic and Ionian Seas, with the relief and vegetation cover, etc. So that, every region, in spite of the general circulation hat its specifics.

There are considered all the meteorological stations within the territory, measuring wind velocity and direction. It is taken a special care in the study of the site, equipment and the data processing. Due to some nonregularities and interruptions in the data series, are not taken into consideration the data for 6 stations. So, the long term time series for 9 synoptic (hourly data) and 31 climatological stations are the object of analysis. The time series for most of the stations cover the period 1961-1990.

The climatological parameters of wind regime, such as wind speed and direction roses, distribution of the average monthly wind speed after the direction, daily and interannual march of wind speed are analyzed by using WaSP. The distribution of wind speed over Albania is prepared.

The wind energy may be used in many parts of the country, especially in the mountainous regions northeastern part (southern part od the Albania Alps), along the hilly part of the coastal area, in south (Xarre) and southeastern (Sheqeras) areas, Gilave, etc.

THE ENERGY RELATED IMPACT ON CLIMATE AND THE IMPACT OF CLIMATE CHANGE ON ENERGY SECTOR: AN CONCEPTUAL ANALYSIS FOR THE PURPOSES OF ENERGY POLICY DEVELOPMENT

Antoaneta Iotova, Bulgaria

The analysis of the climate and energy interaction as a specific complex task within the whole climate change problem can be of essential use for the development of relevant policy for the future development. The analysis presented in this paper is made within the general framework of the climate change problem. Some last results from research in this large field are considered. As a kind of methodological (conceptual) analysis it could be of use in the sense of better understanding the causes and impacts, and adaptation to, possible climate change in the near future.

The efforts are directed to answer the following questions:

1/ distinction and interrelation between the energy related impact on climate (ERIC) and the impact of climate change on energy sector (ICCE);

2/ how to analyze the impact;

3/ how to use the obtained results from the analysis for the purposes of energy planning and decision making.

The distinction between ERIC and ICCE is of considerable use for their analysis and evaluation. More attention is paid to the ERIC in the paper because it has being realized already since the beginning of the industrialization period in the human history, and it has being continued now and in the future. The ICCE mostly concerns the future because we could not be sure whether, and in what extent, climate change is really happening today. The ERIC can be of different spatial scales - global, and regional or even local. On the other hand, the accumulation in time of any small-scale impact could result, sooner or later, in a certain global effect and impact. This means that if we want to analyze and evaluate the entire energy related impact on climate as a reason for man-made induced climate variability and change we have to take into account all kinds of influence and impact being of different spatial and temporal scales as well as magnitude. All this makes the task for an analysis of ERIC very difficult. Nevertheless, its evident importance is a good argument to deal with. Models for analysis and estimation of both- the ERIC and the ICCE, are reviewed and their specific application is briefly commented in the paper. In the paper terms and concepts used in the classical climatological research are linked with these of the traditional energy planning to support finding of the most suitable approach for analysis of the ERIC for the purposes of energy planning and decision-making as necessary for the design of sustainable energy strategies. The performed analysis could provide some new and additional understanding and considerations to energy planners as main consumers of such information.

BULGARIA RENEWABLE ENERGY POTENTIAL AND POSSIBILITIES FOR MITIGATION OF CLIMATE CHANGE

Peter Ivanov, Bulgaria

Recently the interest in renewable energy sources (RES) has grown mainly in connection with the changes in the field of energy policy around the world and particular in Bulgaria. The results presented in the paper are based on the investigations carried out in the frame of the Country Study Project supported by the US DOE and the PHARE programs.

SOLAR RADIATION. The total solar radiation reaches 1600 kWh/m^2 in the southern part of the country and Black sea coast and 1500 kWh/m^2 in the north. In July these values are 230 kWh/m^2 and 220 kWh/m^2 in the south and in the north, respectively.

WIND. The energy potential of the ground wind defined as flow density at a height of 10 m above the ground shows that three wind energy zones can be specified on the territory: up to 100 W/m^2 in the plane part of the country, from 100 to 200 W/m^2 in the Dobrudga plateau and Black sea coast and exceeding 200 W/m^2 in the mountain regions and capes on Black sea coast. BIOMASS: The biomass energy is concentrated mainly in agriculture, forestry, urban wastes and stock-breeding. The total annual mean energy equivalent of rural wastes is approximately 33 TWh. The energy equivalent of wood wastes varies around 16 TWh. The energy potential of biogas (methane) obtained by manure fermentation is about 7 TWh and domestic wastes - 4 TWh. HYDROPOTENTIAL. The total hydroenergy potential is accessed at 21 TWh (for small scale water power station with a capacity less then 2 MW is accessed at 1.5 TWh). GEOTHERMAL ENERGY resources are accessed at 0.003 TWh. The total (theoretical) energy received from all RES in Bulgaria is assessed at 300000 TWh. About 58 per cent of this energy comes from solar radiation, about 42 per cent - from wind and less that 1 per cent from the rest. Solar radiation and wind are distributed allover the country while other RES are spotty distributed. Accessible resources of RES are assessed at 160 thousands TWh. About 60 per cent of this energy comes from solar radiation, about 39 per cent - from wind. Reserve resources of RES are assessed accepting different assumptions. Concrete technologies, as well as legal preconditions of energy consumption are not taken into consideration. Reserve resources of the total solar radiation is about 214 TWh, direct solar radiation - 130 TWh, wind - 30 TWh, biomass - 38 TWh, hydro - 12 TWh and geothermal - 0.003 TWh. Three scenarios were developed for future application of RES - basic scenario (BC), energy efficiency scenario (EE) and European community joining scenario (EC). The market penetration of RES will grow within one and two per cent, up to 5 per cent and up to 8 per cent of primary energy consumption toward the year 2020 according to the BC, EE and EC scenarios respectively.

The market penetration of the RES will create new jobs -120 thousands toward 2010 and 220 thousands toward 2020 cumulatively. Basically these jobs will be created in the field of biomass utilization (energy crops, waste burning). The negative employment will be created for wind utilization and PV as these technologies are maximum automated. RES utilization will decrease CO_2 emission up to 13% (10 million tons) toward 2010 and 20% (16 million tons) toward 2020. Total investments for RES were estimated at 1.6 billion ECU toward 2010 and 2.7 billion ECU toward 2020.

GLOBAL RADIATION MAPS AND RAINFALL MAPS THROUGH METEOSAT IMAGES

J. Jorge, J. Mercadé, R. Tarruella, Spain

The use of satellite data to estimate climatic aspects like solar irradiance at ground level and rainfall is a valid alternative to ground measurements, specially for developing countries where pyranometer and raingauge networks do not exist. The analysis of data derived from the spectral channels of geostationary satellites can generate useful meteorological information. That information corresponding to a time series of images allows us to build global radiation maps and rainfall maps.

We show the results to apply the C model (a statistical model developed by Cano and subsequently slightly modified by other authors) of estimating the solar irradiance in western Mediterranean area from one year of Meteosat satellite data. The steps of the model are : (i) to construct a map of the reference ground albedo ; (ii) to drawn a cloud cover index map from the comparison of the current satellite image and the reference albedo map; (iii) to compute the atmospheric transmittance factors using pyranometric data, and a statistical linear regression is then perfomed between these fatcors and the cloud cover index at some different locations; and (iv) to construct the global irradiance map by means the atmospheric transmittance factors, computed for every pixel.

For hydrological and agricultural purposes, rainfall must be known. Two satellite infrared methods of estimating rainfall based in a threshold temperature have been applied (the GOES Precipitation Index and the Negri-Adler-Wetzel technique) for the Spanish Mediterranean coast in winter and spring seasons. The comparison between the original methods and the ground measurements show a bad correlation similar to their application over south-eastern Japan. To minimise the errors in an easy way, we have introduced new values of threshold isotherm to define clouds and new values of mean rainrate assigned to the coldest areas.

WIND ENERGY POTENTIAL OF VIENNA AND ITS SURROUNDING

Georg Kury, Austria

Maps of the wind energy potential on an area of 54x67 km^2 including the city of Vienna, parts of the hilly Wienerwald and the plains of Wiener Becken and Marchfeld were made for the electric utility WIENSTROM. The average wind speed and wind power density were calculated by means of the WASP and ZAWIMOD windfield models for various heights between 30 and 60 m above ground level with a grid cell size of 1x1 km, resp. 100x100 m for regions of special interest.

The model input includes windfield data from the period 1967-97 at various heights ranging form 10 to 250 m above ground, digital elevation data from a 150x150 m grid, digital maps of roughness length and the spatial obstacle distribution around the measuring sites. The roughness length was determined by terrain classification, which again was defined by a synthesis of published values and values, which were calculated from geometric parameters of the roughness elements.

As a consequence of relief complexity and roughness inhomogenities the available wind power densitiy varies significantly on horizontal distances less than 2 km, ranging from less than 50 W/m^2 to more than 400 W/m^2. The results of the model calculation were used to compare the calculated and actual output of wind turbines in operation.

WIND WAVE ENERGY RESOURCES IN SHELF OF SOME RUSSIAN SEAS

Leonid J. Lopatoukhin, Alexander Boukhanovsky, Russia

During the last years the interest to the renewable energy resources is increasing. For the shelf zones of the seas it becomes especially important, as utilization of oil and gas from the sea bottom may lead to essential pollution of the environment. The wind waves are one of the alternative sources of energy. In particularly, important attention to this energy was paid in 70-ties in the U.K. In the last years the General Direction of European Union funded the investigations of the wave Energy in the Mediterranean and part of N. Atlantic. The participants from 6 countries were involved (Portugal, Greece, Italy, UK, Norway and Ireland). As the result the WERATLAS was elaborated. It is may be said, that this Atlas is the last achievement in wave energy investigations. However, the obtained results do not concern the Russian seas, especially Barents and Baltic, where international activity, connected with the oil and gas, is in a full progress. Besides, the used method of calculation is complicated and consuming.

The alternative approach and method are elaborated: the climatic wave spectra, which itself are of a great interest for many applications are calculated and then the wave energy resources are estimated. The method is based on the stochastic (Monte-Carlo) simulation of wave climate. The input: long-term two-dimensional probability distributions of wave heights and periods; long-term two-dimensional probability distributions of wave heights and their directions; the approximation of frequency wave spectra. The output: climatic wave spectra, confidence intervals to climatic wave spectra, wave energy resources estimates. The calculations were made for Barents, White and Baltic seas.

POTENTIAL OF WIND ENERGY ON THE POLISH SIDE OF BLACK TRIANGLE REGION

Agnieszka Lukomska, Poland

Black Triangle region covers near border zones of Poland, Czech Republic and Germany affected by expansive human activity. It belongs to the areas with especially bad airsanitary conditions. Conventional coal power stations located there mainly are responsible for this effect. Gathering clean energy from renewable resources can improve current state of nature in this region. Mountains and forefields seems to be especially rich in renewable energy resources like wind and water. As conducted researches made in Saxony (Germany) shown that the potential of wind energy in that area is similar to potential which is measured at the Baltic and North sea coasts. There is estimated that it is equal from 270 to 360 W/m^2 in Saxony. Similarities in geographical location and relief between german and polish zones of Black Triangle region give bases to predict that the same wind conditions are on the polish side of this region. Three year wind data collected in Czerniawa (Izeskie Mountains), where the measuring point as placed at the 650 m a.s.l., prove that. Annual mean wind speed in period 1993-1995 was 6,5m/s at 50 m a.g.l. what means that wind energy potential was at the level of 300-340 W/m^2. The highest wind speed appears during foehn which blow

DOWNSCALING OF WIND STATISTICS

Heinz-Theo Mengelkamp, Germany

A statistical-dynamical downscaling approach is applied for an investigation into the availability of wind power over a region of 80x87 km which covers flat and hilly terrain. The procedure is based on the statistical coupling of a regionally representative wind climate with a numerical atmosopheric mesoscale model. The large-scale wind climatology is calculated by a cluster-analysis of a time series of radiosonde data over 12 years. Any of the resulting 143 clusters represents a particular combination of geostrophic wind components and the vertical temperature gradient. For each cluster, a highly resolved steady-state wind field is simulated with a non-hydrostatic mesoscale model. These wind fields are evaluated by weighting them with the corresponding cluster frequency. The resulting three-dimensional wind field and the frequency distributions of windspeed and direction are compared with observations at synoptic stations. In combination with power curves of wind turbines the frequency distribution allows an estimate of the mean wind turbine power output. These data are compared with the output of operational wind turbines.

HIGH LATITUDE GLOBAL AND DIFFUSE RADIATION ESTIMATED FROM METEOSAT DATA

Jan Asle Olseth, Norway

Images taken by geostationary satellites are a valuable source to retrieve solar irradiance data with an almost continuous spatial coverage. With increasing latitude, however, the accuracy of such retrievals declines due to the fact that geostationary satellites see the earth's surface at an increasingly unfavourable angle. This limitation is not shared by the sun-synchronous polar orbiting satellites, but the retrieval of solar irradiation from these satellites is hampered by their incomplete temporal coverage.

The present note compares some high latitude hourly ground observations (9 stations between 58N and 63N) with global radiation estimated from the geostationary satellite Meteosat (using the Heliosat Version 8 method). For two of the stations, diffuse radiation data are also compared. In addition to looking at the mean bias errors, our note focuses on how well frequency distributions of hourly irradiance at the surface are reproduced by corresponding data retrieved from Meteosat data.

During snow free conditions in the period March 27. - December 31. 1995, hourly observations of global irradiance at the 9 ground stations show approximately the same frequency distribution as do corresponding data derived from Meteosat data by the Heliosat method. Besides, there was only a weak solar elevation dependency of the conformity between surface observations and Heliosat data.

The Heliosat data reasonably well reproduce the day to day variation in clear sky index, and even the observed spatial variation between 9 high latitude ground stations. The occurrence of snow cover, however, significantly reduces the agreement between surface observations and satellite derived data.

Hourly diffuse irradiances derived from Heliosat data combined with a diffuse fraction model vary over a somewhat more narrow range than do the corresponding observed (ground truth) values at two northern stations, and they even show a more bimodal distribution pattern than do the ground truth data. The average diffuse irradiance and the day to day variation of diffuse irradiation is, however, nicely reproduced by the Heliosat data.

Heliosat derives surface global irradiance from actual satellite counts along with corresponding cloud-free, respectively overcast, reference counts. The success of Heliosat critically depends on an adequate predetermination of these cloud-free/overcast reference counts. Our data demonstrate that a variable snow-cover strongly hampers an adequate predetermination of cloud-free reference counts, particularly in rural areas.

THE STUDY OF WIND ENERGY POTENTIAL OVER HUNGARY

Kornélia Radics, Judit Bartholy, Hungary

Between the alternative energy sources, wind is perhaps the most suitable and cost-effective for applications such as electric power production and water pumping. Still it is a question: in a medium-low wind region - as it is the Carpathian basin - using wind power generators could be cost-effective? And if the answer is yes: how to site them, which types are suitable for this area? How to design energy storage systems, and some environmental considerations?

In order to examine this problem we started wind speed measurements in Budapest and in a Hungarian village (Perbál). The available experimental wind measurement data set of sonic anemometer are suitable for estimating the contractible wind energy. Using different average period of wind speed, the available wind energy for different generators was estimated. The experimental data set and the standard meteorological measurements were compared too. Using the digital terrain model of Hungary were determined the map for roughness length and displacement height and estimated the vertical profiles of wind speed.

The wind energy resource is variable both time and space, and it is very sensitive to variations with topography and weather patterns. We are using two factors: available wind energy and extractable wind energy to characterise the geographical area from the view point of the potential wind power and of the most relevant wind turbine type. Results of the wind energy measurements and the statistical analyses of wind characteristic are presented.

LONG TERMED BEHAVIOR OF THE WIND SPEED AND ENERGY OF THE WIND AT THE MILEŠOVKA HILL

Josef Stekl, Czech Republic

Homogenization of measurements. Acceptability of one hour averages for wind energy calculation. Long termed averages of the wind speed per month and annum. Variation of the wind speed and energy. Standard deviations occurring during the calculation of the power output of wind turbines from short termed measurement.

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