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Change of climate pattern in the Baltic States using principal component analysis

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The aim of this work is to compare the climate of past and future in the Baltic States. The regional climate model (RCM) data from project ENSEMBLES was used and bias correction procedure was carried out. Monthly average temperature and monthly total precipitation values were chosen as the variables that best capture the climate features important for the society.
In the first part of our work we used principal component analysis (PCA) on data for years 1961-1990 to reduce the number of initial climate variables and create indices that represent the main features of the climate in the Baltic States. Standardization of variables was done using a modified approach.
The first three principal components explained most of the variation in the initial variables and were analyzed further. We calculated the correlation coefficients between the retained principal components and initial variables, plotted them for the study region and compared the spatial patterns with the climate features reported in literature. It could be observed that the first component (PC1) is highly positively correlated with the temperature and precipitation in winter, which means that high values of PC1 correspond to warm winters with a lot of snow. Also PC1 values have east-west gradient with warmer winters at the shores of the Baltic Sea. PC1 values are also similar to the start date of the winter reported in literature.
The second principal component (PC2) has a strong negative correlation with the autumn precipitation and shows a significant positive correlation with all temperature variables. This means that high values of PC2 correspond to a year that is warmer than average and to years with dry autumns. The PC2 pattern is similar to the spatial distribution of the start of the spring and summer phenological events and growing degree day values. The changes to PC2 therefore imply possible changes in the plant suitability for a specific region.
The third principal component (PC3) is mainly correlated with the precipitation variables in spring and summer but also with the temperature in spring. High values of PC3 imply wet regions – with more prominent rain and rapid snow melt in spring. The spatial distribution shows similarities to the yearly precipitation patterns reported in literature.
In the second part of work we analyzed the climate for years 2071-2100. First, it was observed that in the future the precipitation variation is increased and the temperature variation is decreased. Second, we used the loadings of the principal components from the first part of this work (past climate) to calculate the climate indices for the future periods. The indices acquired using this approach had similar correlation coefficients with the initial variables. When compared with the past climate, the PC2 values in future mainly increase in the seaside region and in the northern part of Baltic countries while slightly decrease in the southern part. The PC3 also mainly shows increase in the coastal region with very minimal changes for the rest of the map. There is little change for the PC1 component.