Geophysical Research Abstracts
Vol. 17, EGU2015-5525, 2015
EGU General Assembly 2015

Determinants of Low Cloud Properties - An Artificial Neural Network Approach Using Observation Data Sets

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This contribution studies the determinants of low cloud properties based on the application of various global observation data sets in machine learning algorithms.

Clouds play a crucial role in the climate system as their radiative properties and precipitation patterns significantly impact the Earth's energy balance. Cloud properties are determined by environmental conditions, as cloud formation requires the availability of water vapour ("precipitable water") and condensation nuclei in sufficiently saturated conditions. A main challenge in the research of aerosol-cloud interactions is the separation of aerosol effects from meteorological influence. To gain understanding of the processes that govern low cloud properties in order to increase accuracy of climate models and predictions of future changes in the climate system is thus of great importance.

In this study, artificial neural networks are used to relate a selection of predictors (meteorological parameters, aerosol loading) to a set of predictands (cloud microphysical and optical properties). As meteorological parameters, wind direction and velocity, sea level pressure, static stability of the lower troposphere, atmospheric water vapour and temperature at the surface are used (re-analysis data by the European Centre for Medium-Range Weather Forecasts). In addition to meteorological conditions, aerosol loading is used as a predictor of cloud properties (MODIS collection 6 aerosol optical depth).

The statistical model reveals significant relationships between predictors and predictands and is able to represent the aerosol-cloud-meteorology system better than frequently used bivariate relationships. The most important predictors can be identified by the additional error when excluding one predictor at a time. The sensitivity of each predictand to each of the predictors is analyzed.