European precipitation regions and their relationships with atmospheric circulation

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Precipitation is one of the most important climatic variables and, among them, the most variable in space and time. European precipitation pattern is very sporadic. It has formed under the influence of a number of factors. On one hand, surface determines the amount of precipitation very much. The Atlantic Ocean and surrounding seas are important sources of air moisture and precipitation in Europe. Mountains cause redistribution of precipitation between windward and leeward slopes. On the other hand, atmospheric circulation plays a leading role in formation of precipitation regime.

The main objective of this study is to create a regionalisation scheme i.e. a spatial classification for Europe based on precipitation using principal component analysis (PCA), and to analyse relationships between atmospheric circulation variables and precipitation at different regions in Europe.

There are many principles for classification and regionalisation. It is possible to group stations by the total amount of annual precipitation, by similar annual curve on monthly precipitation etc. In this study, the main principle for regionalisation is similarity in precipitation fluctuations. Accordingly, the main task is to identify regions with coherent fluctuations.

Gridded precipitation data for land regions over Europe (excluding Iceland) are obtained from the dataset created by the Climate Research Unit, University of East Anglia. There are used 88 grid points of the 5 by 5 degree grid. The selected grid points cover the land area between 35-75˚N and 10˚W-60˚E. Time series of 97 years (1900-1996) was used.

Different data matrices were used as initial data for PCA. It was not reasonable to use annual precipitation data for classification because the seasonal variations were eliminated in that case. The classification and regionalisation of the European precipitation field was realised mostly on a base of two data matrices containing successive monthly (first matrix) and seasonal (second matrix) precipitation at 88 grid points. The seasonal values were obtained by summing precipitation of three months as usual (MAM, JJA, SON, DJF). The grid points were used as variables and precipitation at different months and seasons were cases. Consequently, a S-mode PCA using the Statistica 7 software was applied for classification of variables. In addition, PCA was

applied for precipitation data of different seasons separately.

The output of PCA consists of eigenvalue, loadings and scores of every component. Usually, only some first components are used that describe the majority of total variance. The loadings express correlation between every component and precipitation time series at the corresponding grid point. The grid points are grouped according to which component has the highest correlation with precipitation at that point. For every component, two groups are distinguished that have opposite correlation.

Relationships between the European precipitation pattern and atmospheric circulation are estimated by the use of correlation analysis between time series of scores of the first components and characteristics of atmospheric circulation. The following circulation variables are used: frequencies of the circulation forms W, E and C according to the Vangengeim-Girs classification, frequencies of the zonal, meridional and half-meridional circulation groups by the Hess-Brezowsky classification, NAO indices, AO index, NAO, East Atlantic, Polar/Eurasia, East-Atlantic/West Russia, East Atlantic Jet, Scandinavia and Asia Summer teleconnection indices.