Atmospheric circulation patterns associated with extreme precipitation amounts in Greece

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The main synoptic conditions associated with extreme precipitation amounts in Greece are examined by using a multivariate statistical methodology comprising S-mode Factor Analysis and k-means Cluster Analysis. The data used consists of: i) daily precipitation amounts (measured at 6UTC) for the meteorological stations of Hellenikon (Athens), Thessaloniki (northern Greece) and Ioannina (western Greece) and ii) daily (18UTC) 2.5x2.5 grid point values of 500hPa geopotential height, sea-level pressure and 1000-500hPa thickness at 273 grid points over Europe (10W to 40E and 30N to 60N), for the period 1970-2002.

The dates corresponding to the upper quintile (5%) of the frequency distribution of precipitation are selected for each one of the three stations. In total 369 dates are used, some of them being common among the stations. The corresponding 369x273 data matrices of 500hPa geopotential height, sea-level pressure and 1000-500hPa thickness are constructed. The rows refer to the 369 extreme precipitation cases and the columns refer to the 273 grid points. The three matrices are unified into one 369x819 matrix. In order to reduce the dimensionality of the data set, S-mode Factor Analysis is applied to the unified matrix, revealing 7 factors accounting for 85% of the total variance. Finally, k-means Cluster Analysis is applied to the factor scores matrix, classifying the 369 cases into 9 clusters.

For each one of the 9 clusters revealed, the mean 18UTC patterns of the above parameters are constructed and presented. These patterns correspond to the main distinct atmospheric circulation structures favoring extreme precipitation amounts in Greece. Most of the patterns are characterized by enhanced cyclonic activity over or near the Greek area. The differences among the 9 circulation structures refer mainly to the position and the intensity of the surface and the upper air synoptic systems involved. Some of the 9 synoptic conditions favor extreme precipitation amounts mainly at one or two of the three stations while the rest of them equally affect the three stations.