CONTRASTING WINTER AND SUMMER PRECIPITATION VARIABILITY OVER EUROPE

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Changes in precipitation patterns over Europe have serious consequences for a wide range of human activities in this densely populated region. For example, during the 2002 Summer, extremely dry conditions in central European Russia resulted in extensive forest fires, while anomalously high precipitation caused floods in central-eastern Europe and the southern part of European Russia. On the other hand, in July through early August 2003, almost all of western-central Europe suffered from deficient precipitation and extremely high temperatures that caused catastrophic forest fires in southern France, Spain and Portugal. Thus, in successive years both deficient and excessive precipitation resulted in significant damage to many European economies. Despite the above facts, little attention has been given to summer climate variability in the Atlantic-European sector.

A gridded monthly and pentad precipitation product for 1979-2001 from the Climate Prediction Center (CPC) Merged Analysis of Precipitation (CMAP) data set (Xie and Arkin, 1996) and terrestrial monthly gauge-based precipitation from the Climatic Research Unit (CRU), University of East Anglia (CRU) data set (New et al., 1999) were used to investigate and to compare winter and summer precipitation variability over Europe.

Prominent seasonal differences are detected both in precipitation climatologies and in characteristics of precipitation variability. Figure 1 depicts winter (DJF) and summer (JJA) seasonal mean precipitation climatologies, their interannual standard deviations (STDs) and ratios between seasonal climatologies and STDs.

The climatological winter precipitation pattern (Figure 1a) demonstrates relatively large values (2-5 mm/day) of precipitation over western Europe. Evidently, coastal orography greatly affects the climatology of winter precipitation. Lower (1-1.5 mm/day) precipitation is observed over eastern Europe-European Russia. Interannual variability (expressed by STDs) of winter precipitation (Figure

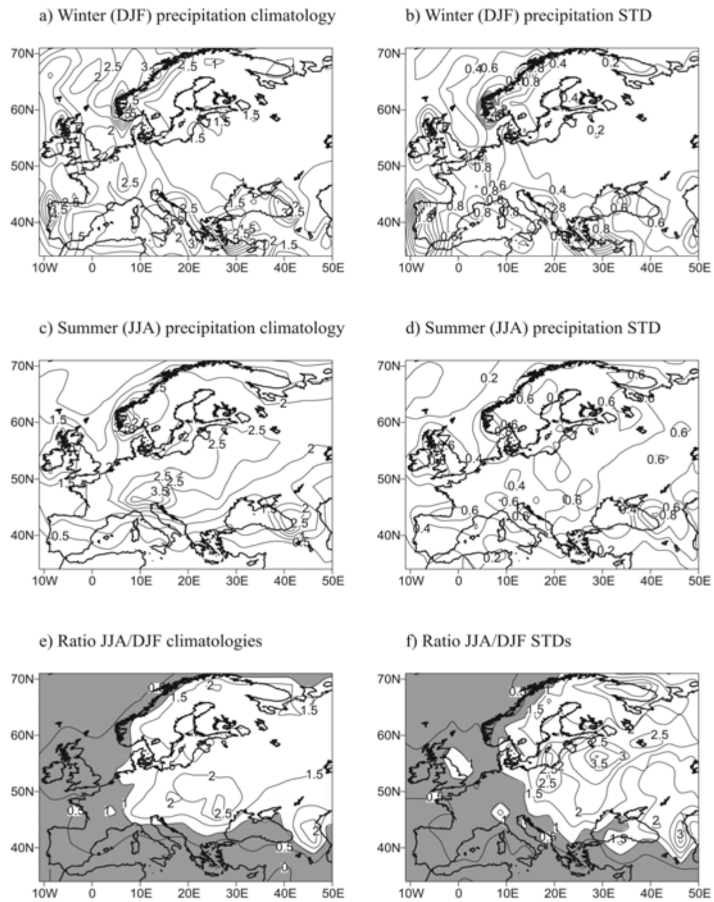

Figure 1. Climatologies (a,c), standard deviations (b,d), and ratios (e,f) of the winter (a,b) and summer (c,d) CMAP precipitation (1979-2001). Climatologies and standard deviations are presented in mm/day. In e) and f) shading indicates regions where the summer characteristics are lower than the winter ones.

1b) is large (0.6-1.8 mm/day) over the regions of greater precipitation (e.g., western Scandinavia, Portugal), and is lower (0.2-0.4 mm/day) over the regions with lower precipitation (Figure 1a). In general, the winter STD pattern is very similar to that of the winter precipitation climatology.

The climatology of the summer precipitation over Europe is depicted in Figure 1c. The largest precipitation amounts, exceeding 2.5 mm/day, are found over the Alps, western Scandinavia and the Caucasus. Enhanced precipitation is also detected over central-eastern Europe. In general, distribution of summer precipitation is more zonal compared to that of the winter season (Figure 1a). Also, the pattern (Figure 1c) features some continentality of the summer precipitation, showing large precipitation over the central part of the region, and lower precipitation at the periphery (e.g., Mediterranean region, Scandinavia except its western part). The largest precipitation variability (STDs reaching 0.8 mm/day) is detected over western Scandinavia, the British Isles, and the Caucasus. Over the major portion of Europe, however, STDs vary in the range 0.4-0.6 mm/day. In general, STDs of JJA precipitation over eastern Europe – European Russia are slightly higher compared to those over western Europe. Over western Europe the summer precipitation climatology and its interannual variability (expressed by STDs) are lower than those of the winter precipitation (Figures 1e,f). Major seasonal differences are found over central-eastern Europe. In this region, the summer precipitation climatology and magnitudes of its interannual variability exceed respective winter characteristics by a factor of 2-3.5. Similar relationships are found for the summer and winter magnitudes of intraseasonal fluctuations of precipitation. It should be noted that comparisons in the magnitude of winter precipitation are affected by the procedures used to correct the measurements of solid precipitation in both CMAP and CRU products.

Figure 2 shows spatial patterns and respective principal components of the first Empirical Orthogonal Function (EOF) modes of winter and summer seasonal mean precipitation. The first EOF modes of both summer and winter seasonal mean precipitation over Europe are associated with the North Atlantic Oscillation (NAO). However, they explain very different fractions (42% for winter, and 25% for summer) of total precipitation variability, and form different spatial patterns (Figures 2a,b). Temporal behavior of their principal components (Figures 2c,d) is also essentially different (correlation between respective time series is 0.07). It is worth noting that the first EOF mode of summer precipitation shows stronger links to the NAO index correlation of 0.81 with summer (Barnston and Livezey, 1987) compared to that for the winter season (correlation is 0.63). The first EOF mode of the winter magnitudes of intraseasonal precipitation fluctuations (not shown) is also associated with the NAO. The second EOF mode of the seasonal mean winter precipitation (not shown) is linked to the East Atlantic teleconnection pattern.

These results, based on the analysis of the relatively short-time series of the CMAP precipitation, were confirmed and complemented by an analysis of the longer time series of the winter and summer seasonal mean precipitation from the CRU data set for the period 1958-1998. They

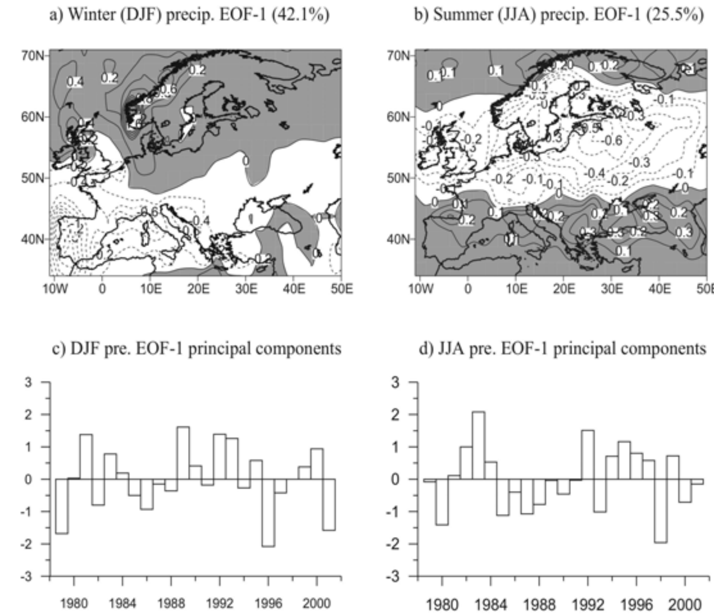

Figure 2. Spatial patterns (a, b) and the respective principal components (c, d) of the first EOF modes of the winter (DJF) and summer (JJA) CMAP precipitation (1979-2001). Principal components are normalized by their standard deviations. In a) and b) shading indicates positive values.

imply that more attention should be paid to further analysis of summertime precipitation variability in the region. A complete description of these results can be found in *Zveryaev* (2004).

References

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