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Regional and local variability of precipitation in Europe

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Climate variability during the last several decades is characterized by changes in both regional and seasonal precipitation as well as in the frequency and intensity of extreme events across the entire Europe. Analyzing observational data for the past century and the regional climate models' output (using the last decade of the 20th century, for model errors evaluation and performance tests), we assessed the relationships between the large-scale atmospheric characteristics and regional precipitation in Europe and evaluated systematic model errors in simulating atmospheric humidity and precipitation. Verification of the regional climate models' simulations (both, MM5 and WRF) versus observations show the vertical redistribution of atmospheric water in our model runs, with humidity being underestimated in the upper atmosphere and overestimated at the lower layers. This resulted in the systematic phase error for large-scale (frontal) precipitation and overestimation of convective precipitation over the sea surface. During the cold season (autumn-winter), atmospheric water vapor transfer changes caused a decrease in precipitation over the southern Europe including Western Mediterranean and Balkans, while precipitation over both the Nordic Countries and Eastern Europe increases. During the warm season (spring-summer), a weak general tendency of increasing precipitation is observed. However, the most important features of the warm season over Europe are significant changes in (a) rainfall intensity (increase of heavy and very heavy daily rainfall totals) and (b) temporal inhomogeneity of the warm season precipitation (increase of the prolonged no-rain periods, possibly associated with more persistent blocking anticyclones). Precipitation variations also show local tendencies, which may be opposite to regional trends due to local features of the atmospheric circulation pattern, complex orography, and atmosphere-surface interactions along the coast of the Baltic, Black, and Mediterranean Seas. In particular, significantly opposite trends in precipitation occur at neighbouring stations located on the different sides of the Alps, on the northwestern coast of the Black Sea, and along the Biscay Bay Coast. The last fact may be associated with the shift in the Atlantic storm-track trajectories.