Regional and local variability of precipitation in Europe

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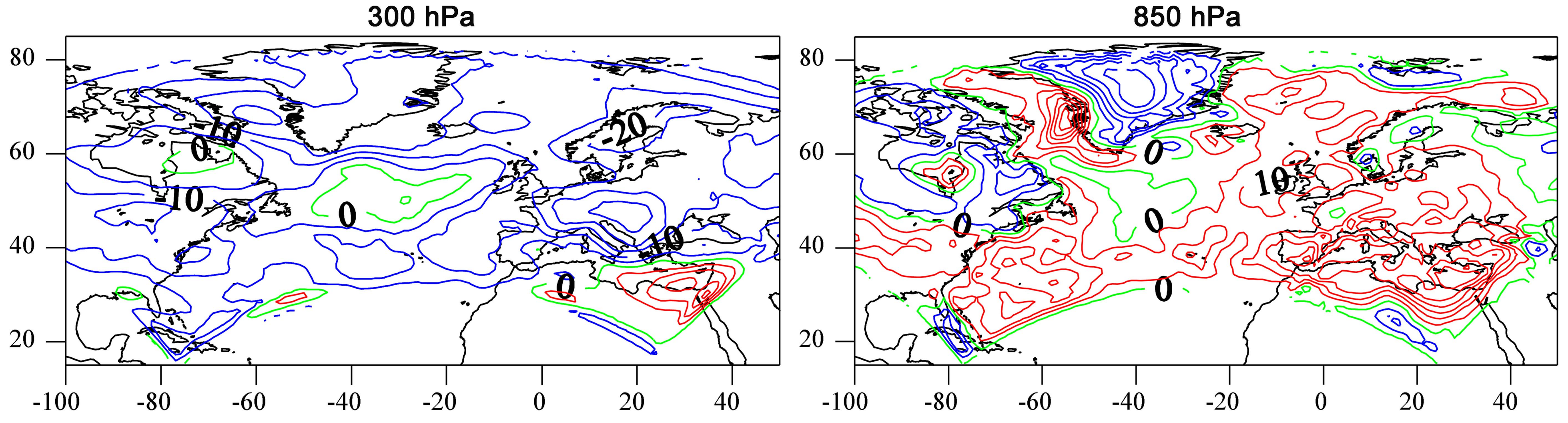
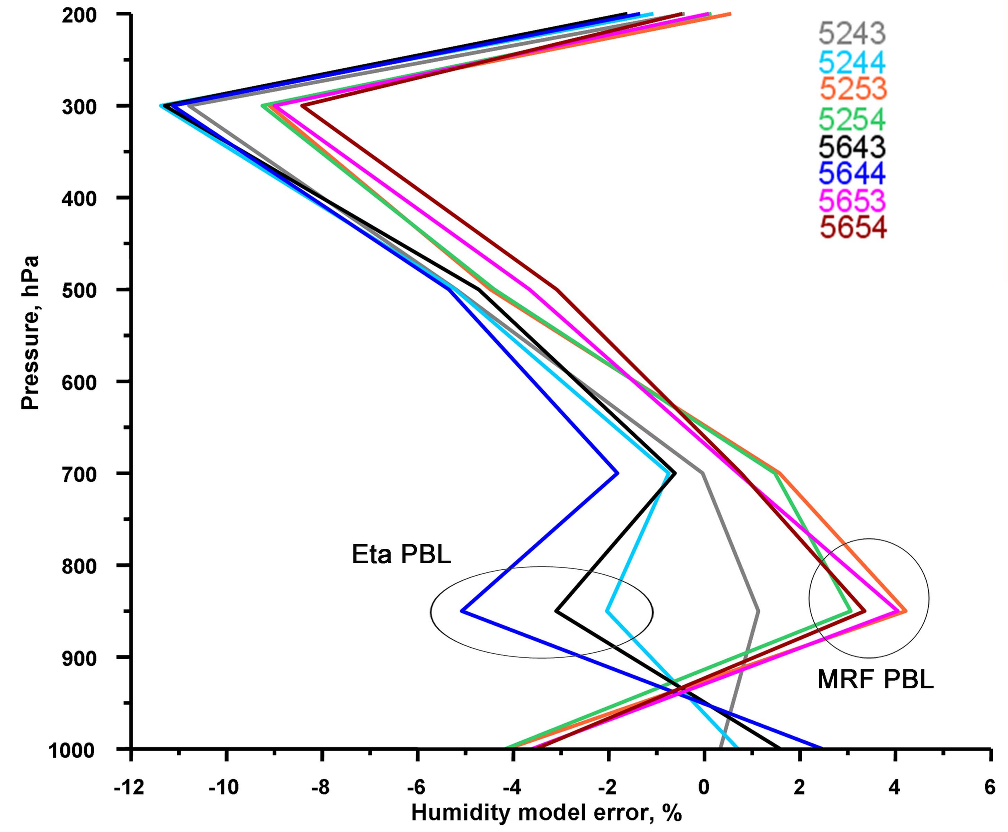
Outline of MM5/WRF climatic output

The geographical region of research includes the North Atlantic and European continent extended to Ural Mountains with grid resolution 81 km. The intercomparison was performed between model output field (with different combinations of parameterization schemes) and ERA-40 reanalysis data. Here digits correspond to schemes as they are explored in user files of the model (more details see http://www.mmm.ucar.edu/mm5/mm5-home).

Relative humidity errors on levels





[Difference] = MM5 {5653 (optimal)} – ERA40

MM5 – ERA40 < 0 model Underestimation

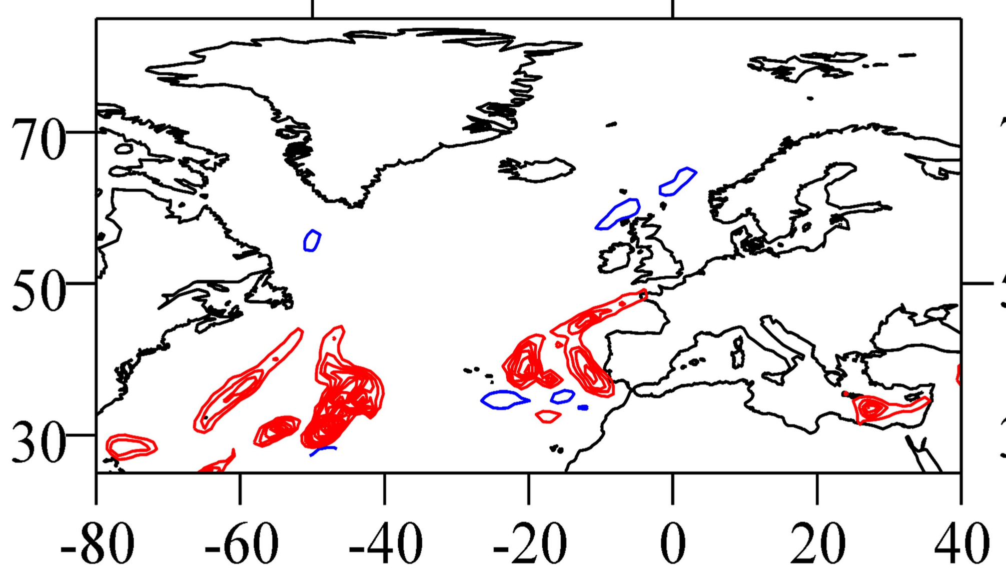
MM5 – ERA40 > 0 model Overestimation

The Eta PBL scheme underestimates humidity in the boundary layer, while the MRF scheme overestimates it.

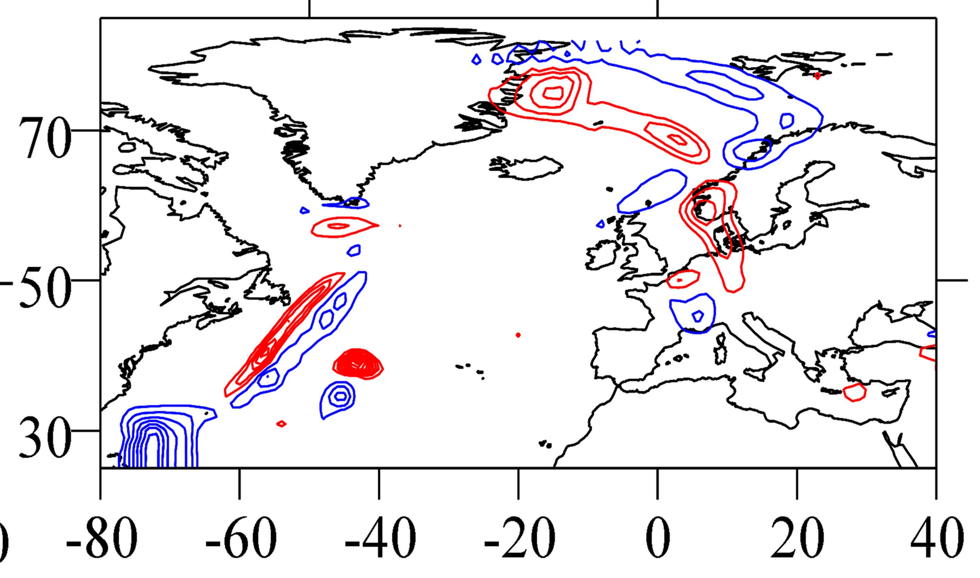
The model properly reproduces the precipitation patterns, but shifts their location in the upstream direction.

Convective precipitation is often overestimated over both the warm and cold sea surface.

Differences in **convective** precipitation



Model phase error in **large scale** precipitation



Motivation

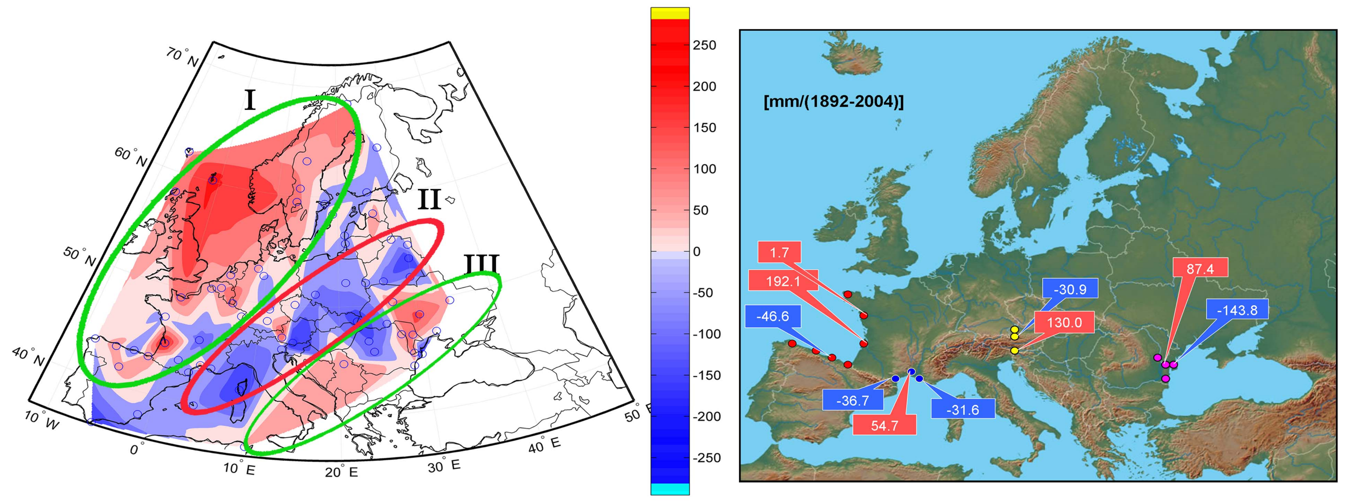
Climate variability during the last several decades is characterized by changes in both regional and seasonal precipitation as well as in the frequency and intensity of extreme events across the entire Europe. Heat waves, forest fires, and floods associated with those changes cause significant economical losses and claimed human lives.

Contemporary global and regional climate models (GCMs and RCMs) are based on established physical principles and demonstrate reproduction of climate features similar to observed. They provide credible quantitative estimates of climate variability at the global, hemispheric, and continental scales for some atmospheric variables, such as the three-dimensional temperature field.

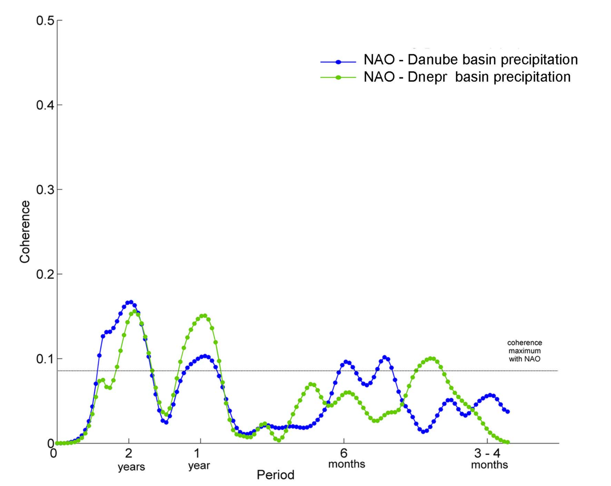
However, confidence of those estimates is lower at smaller scales and for other climatic variables, including precipitation. This requires that the climate models be subjected to more comprehensive evaluations on scales from days to years in order to illuminate processes affecting climate projections.

Microphysics and cloud feedbacks are among those processes being considered among primary sources of mis-reproducing climate variability, with low clouds and vertical humidity distribution in the boundary layer making the largest contribution. The relatively poor simulation of boundary-layer clouds and to a lesser extent mid-level clouds is a reason for some concern.

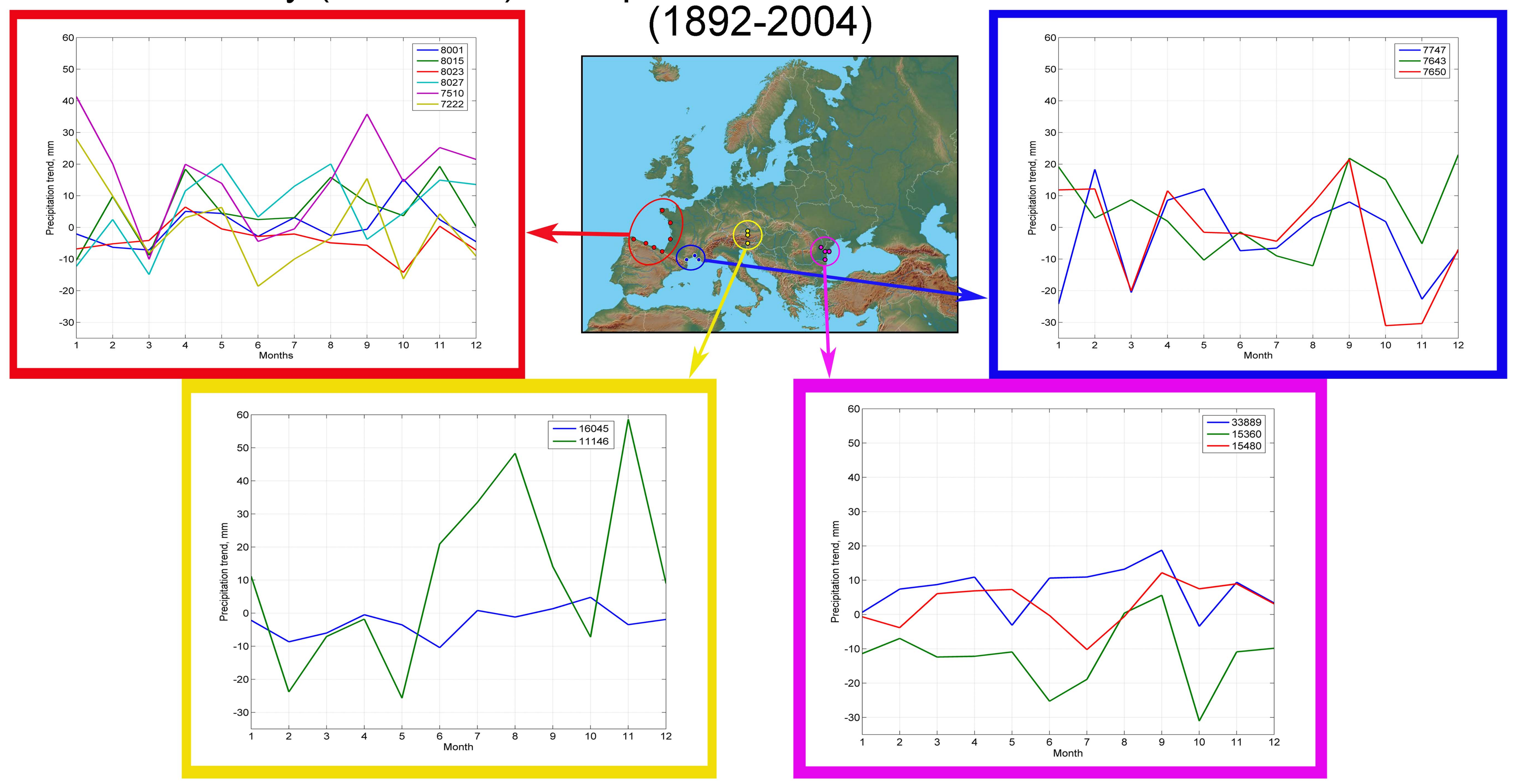
Regional versus Local Annual Precipitation Trends (1892-2004)



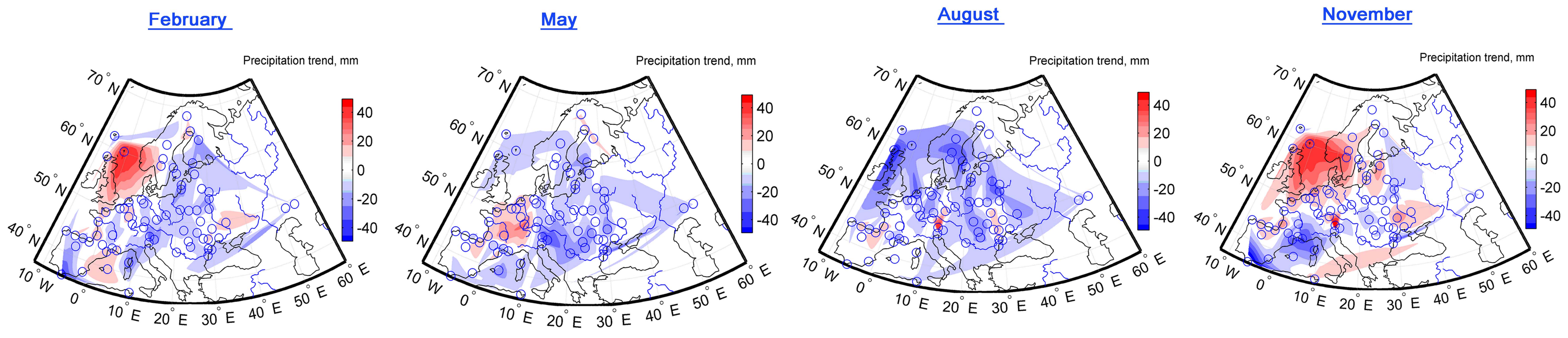
General Atmospheric Circulation and Regional Precipitation



Monthly (Seasonal) Precipitation Trends of Near Located Stations (1892-2004)



Seasonal Precipitation Trends for the observation period 1892-2004



Conclusions

1. Model output is sensitive to parameterisation, in particular to the boundary layer scheme. Verification of the regional climate models' simulations show the vertical redistribution of atmospheric water in model runs, with humidity being underestimated in the upper atmosphere and overestimated at the lower layers.
2. Incorrect simulation of cloud characteristics results in the systematic phase error for large-scale precipitation and overestimation of convective precipitation over the sea surface.
3. In present investigation was not found a single general circulation parameter (index) that can unilaterally relate atmospheric and precipitation patterns.
4. During the cold season atmospheric water vapor transfer changes caused a decrease in precipitation over the southern Europe, while precipitation over both the Nordic Countries and Eastern Europe increases.
5. During the warm season, a weak general tendency of increasing precipitation and its temporal inhomogeneity is observed.
6. Precipitation variations 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 coasts. The 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.