UNIVERSITY OF GOTHENBURG

Simulated and observed change of precipitation and temperature in Europe with focus on the Greater Baltic Area

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Abstract

The regional climate of the Greater Baltic Area is complex and varies at a multitude of scales in space and time. This thesis contributes to increased understanding of climate change and climate variability in this area focusing on four significant research topics.

Droughts have a considerable ecological and socio-economic impact. The occurrence of rainfall is strongly controlled by large-scale atmospheric circulation. The observed summer North Atlantic Oscillation (SNAO) was correlated to a gridded dataset of the self-calibrating Palmer Drought Severity Index. A more positive circulation index is strongly linked to dry conditions over large parts of Southern Fennoscandia and northern Central Europe. Less distinct but still significant is the coupling to wetter conditions in the eastern Mediterranean. Using tree-ring based SNAO and precipitation reconstructions over 550 a, the relationship was investigated back in time in a multicentury perspective. Prior to the instrumental period the coupling is generally less pronounced but holds for distinct periods of drought.

A database of up to 121 daily more than century-long instrumental records of precipitation and temperature over Europe was analyzed for trends in climate extremes. Over the 20th century a clear increase of warm extremes and a decreasing trend in cold extremes could be detected. Precipitation extremes became slightly more frequent and precipitation amounts increased, especially during winter.

The ongoing warming resulted in a significantly extended thermal growing season in the Greater Baltic Area has extended significantly during the last century. An analysis of 48 long-term daily mean temperature records over this area revealed an overall lengthening of about one week between 1951-2000 mostly contributed by an earlier start in spring. The strongest change was observed at stations adjacent to the Baltic Sea in the South and the weakest in the North East. The 100-year records at Danish stations reveal a maximum shift in start (-22.8 d), end (12.6 d) and growing season length (33.5 d).

The sub-daily precipitation characteristics in the region are not very well understood yet. By studying hourly observations for 1996-2008 from 93 stations all over Sweden, a distinct summer season diurnal cycle with an afternoon peak mainly contributed by convective activities during summer was identified for inland stations. Along the East coast the influence of the Baltic Sea is evident showing a weaker cycle peaking in the early morning. The observed diurnal cycle was compared to simulations from the Rossby Centre regional climate model (RCA3) run at 50, 25, 12 and 6 km grid resolution. In general the model tends to simulate too frequent convective precipitation events of light intensity. The simulated peak timing is about 2-4 hours too early and the amplitude too high. The model performance varies depending on the spatial resolution. The 6-km simulation most realistically captures the peak timing and the diversity in the spatial pattern. With increasing model resolution the fraction of large-scale (convective) precipitation is increasing (decreasing). The results indicate the need for improvement of the convection parameterization scheme.

Keywords: observations, precipitation and temperature extremes, thermal growing season, drought, hourly precipitation, diurnal precipitation cycle, regional climate model, summer NAO, Greater Baltic Area