



## **Attributing causes of regional climate change in the Baltic Sea area**

Jonas Bhend (1), Marie-José Gaillard-Lemdahl (2), and Hans-Christen Hansson (3)

(1) MeteoSwiss, Federal Office of Meteorology and Climatology, Switzerland, Zurich, Switzerland, (2) Department of Biology and Environmental Science, Linnaeus University, Kalmar, Sweden, (3) Department of Applied Environmental Science (ITM), Stockholm University, Stockholm, Sweden

Here we assess to what extent the effect of forcing mechanisms on the observed climate change in the Baltic Sea area can be detected. In particular, we assess the effect of factors causing large-scale warming (mainly anthropogenic greenhouse gases) and the regional effect of atmospheric aerosols and land-cover and land-use changes. Unfortunately, only very few targeted analyses for the Baltic catchment area are available at the moment, but findings at the regional scale are generally qualitatively consistent with global or hemispheric analyses.

The observed warming in summer cannot be explained without human influence (in particular the warming effect of increasing atmospheric greenhouse gas concentrations). In other seasons and for other aspects of regional warming, findings are mixed or not significant as of yet. In addition, large-scale circulation and rainfall changes in the northern hemisphere and the Arctic have been detected to exceed natural internal variability. Other aspects of regional climate change including changes in storminess, snow properties, runoff and the changing physical properties of the Baltic Sea have not been formally attributed to human influence yet. Scientific understanding of the effect of aerosols on regional climate is still accumulating. It is likely that the major emission changes in Europe have had an effect on the climate in the Baltic region, the magnitude of which, however, is still unknown. Development of the modelling capability and targeted analyses are urgently needed to reduce the uncertainties related to the effect of aerosol changes on regional observed climate change. Historic deforestation and recent reforestation are the major anthropogenic land-cover changes affecting the Baltic Sea area. From all studies at hand it can be concluded that there is no evidence that anthropogenic land-cover change would be one of the forcings behind the recent warming in the Baltic region. However, past anthropogenic land-cover change may have influenced regional climate significantly already more than two thousand years ago.