

## Detection and attribution of climate change for the Baltic Sea Region

Hans von Storch and Armineh Barkhordarian

The climate in the Baltic Sea Region (BSR) has seen changes in terms of air temperature and precipitation amounts, in recent decades. We have examined if these changes are within the range of natural variations, as given by my multi-millennial "control" simulations with conventional climate models. It turns out that temperature has seen an increase in all seasons, as well as annually, which is beyond this range, so that we may conclude that we "detect" a change, which needs explanation by anthropogenic factors. Similarly for precipitation amounts, even if the pattern in different seasons and for the year is variable. When we compare these changes "which need explanation" with what climate models suggest as responses to elevated greenhouse gas concentrations (GHG), we find that the induced temperature change fits the sign of the observed change, but is too weak. In terms of precipitation, we find sometimes inconsistency, i.e., opposite sign, and different magnitudes. Thus, the change may be in part related to elevated GHGs, but not entirely so.

To shed further light on the attribution issue, we fitted a regression model, which describes BSR annual temperature and precipitation amounts as a response to Northern Hemisphere temperature and BSR aerosol emissions. The predictor "Northern Hemisphere temperature" is supposed to describe mostly the GHG related change, but it includes also global aerosol effects, global volcanic effects as well as cosmic effects such as solar activity. The regression models fit the observed records rather well, even if the year-to-year variability is underestimated, as was to be expected. Then, we modified the BSR aerosol emissions in the regression model – being constant at low levels since 1920, and being constant at high levels since 1980. It turns out that constant emissions lead to a reduced temperature increase in recent decades and to a positive trend in precipitation amounts. Thus, regional aerosol emissions together with global GHG atmospheric accumulation together may be "attributed" as causes of the recent trends in BSR climate change, at least qualitatively.