Background: The concept of anthropogenic global climate change has been established in recent years (IPCC, 2007; Fig. 1) but little is established on the detection of systematic changes on regional scales. The Baltic Sea area (BSA; Fig. 2) is directly linked to influences of the global climate and as a consequence to global climate change. Additionally large seasonal and inter-annual variation exist in the BSA with complex causes resulting from geographical location, land-sea contrast and variable topography. This implies impacts on the ecosystem while the affect on species composition, distribution and interaction is only partly understood at present time. Consequently the major question is how the BSA may respond on future changes: first steps of changes in the dynamical parameters but secondly and more important in terms of biological processes such as secondary and tertiary production.

Goals of the newly launched project CAVIAR:

- Set up high-resolution numerical model (HRBSIOM) of the Baltic Sea area with updated forcing fields and refined topography
- Generate hindcast data set of hydrographic fields for the period 1970-2008 with focus on water mass exchange, sea ice evolution and changes in the ocean condition relevant to the spatial distribution of central Baltic fish and zooplankton populations
- Conduct set of runs with HRBSIOM using downscaled regional atmospheric forcing data from different climate scenarios (A1B & B1) utilised for coupled bio-physical modelling to investigate the potential impact of future climate change
- Conduct observational hydrographic field studies for evaluation and assimilation/re-initialisation

Trends/Indicators:

- Warming trends in surface temperatures (Fig.3)
- Decrease of sea ice coverage and length of ice season
- Change in extreme events

Analysis of meteorological forcing fields: We use the SMHI meteorological data base from 1970-2008 covering the whole Baltic Sea area. The analysis of meteorological forcing fields at Kiel, lighthouse (54°30’N, 10°16.5’E) confirms general warming trend seen in the BSA not only in near surface air temperature but also in changes of wind direction.

- The 2-m air temperature anomalies with respect to the seasonal and annual mean (Fig.7), confirm positive trend of about 0.3°C/decade for winter season (JUF) as reported by Lehmann et al., 2008.
- Number of strong winters reduced to 6 events (less than 30%) in the 21 year period after 1985 (Fig.7), suggesting the begin of a different mode in the regional climate system.
- Increased frequency of westerly/south-westerly winds in winter time (JUF) for the later period, as a result mild humid air is advected leading to warmer temperatures and higher precipitation in some areas (Fig.8, left).
- Decreased frequency of south-westerly winds in autumn (SON) with additional increase in the occurrence of easterly winds leading to an advection of warm and dry air (Fig.8, right).
- Strong correlation of BSI and JUF on the 95% confidence level between the NAO and Baltic Sea Index (BSI, Lehmann et al., 2002) with winter indices showing largest impact on changes in the characteristics of the atmospheric fields (Fig.9).

Biological application: From numerical model output it is possible to evaluate relationships between habitat utilisation and physical conditions of the environment.

- Relationship between recruitment variability of Baltic fish populations and abiotic environmental conditions (e.g. temperature, wind field and transport patterns) affecting larval and juvenile stages (Baumann, 2006; Fig.5).
- Possible causes for the distribution or growth/reduction in population of invasive species in recent years such as the ctenophore (“comb jelly”) Mnemiopsis leidy (Lehmann, 2008; Fig.6).

The 4-dimensional data sets of realistic climate scenarios and reference runs could forecast variability of Baltic Sea zooplankton and fish population dynamics and as a result could provide useful information for setting up Marine Protected Areas.

Analysis of observational hydrographic field: Consistent to results of near surface air temperatures are the results from the analysis of water temperature profiles from the ICES data base from 1969 to 2005 (Hinrichsen et al., 2007; Lehmann and Hinrichsen, 2007; Fig.10).

- Large seasonal and inter-annual variability exist at the surface with a trend of 0.45°C/decade between 1969-2005 while for the whole water body the warming is only 0.09°C/decade.
- Separately looking at the period 1985-2005, the situation is much more distinct with a warming of 0.52°C/decade.

References:

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