Bachelor project (15 ECTS): Investigate long-term changes in temperature and AOT for the Baltic Sea region

Global warming is primarily a problem of too much carbon dioxide (CO_2) in the atmosphere, which acts as a blanket, trapping heat and thus warming the planet. Beside anthropogenic emissions of CO_2 man-made aerosols highly impacts the Earth's radiation balance as well and the climate (IPCC, 2013). The impacts from aerosols results on the whole in a cooling of the Earth system. Anthropogenic emissions of aerosols and precursors have increased significantly since pre-industrial time (e.g. Smith et al., 2011). However, due to air quality mitigations in Europe and North America from the 1980s onwards have led to regional reduction in anthropogenic emissions of aerosol precursors, e.g. for SO_2 in Europe with 73% between 1980 and 2004 (Hand et al., 2012).

IPCC (2013) pinpoint regions at high latitudes to be highly sensitive for climate changes. Global warming has already had observable effects on the environment: glaciers have shrink, Arctic sea ice is withdrawing, accelerated sea level rise, earlier onset of melting season and later onset of freezing season at high altitudes, and longer, more intense heat periods. Thus, the global warming and likely positive feedbacks influences the air quality/weather/climate and hence the life, both the flora and fauna, in the Nordic countries. Note that the spring and snow smelt in Abisko start one month earlier than 20 years ago.

In the present study reanalysis data, temperature at 2 m asl and sea ice cover, from European Centre for Medium-Range Weather Forecasts (ECMWFs) will be investigated and combined with satellite aerosol optical thickness (AOT), derived from the MODerate resolution Imaging Spectroradiometer (MODIS) sensor, for the Baltic Sea region. MODIS Aqua and Terra (two different satellites) Collection 5 level 2 standard product of AOT for best quality retrievals (quality flag = 3) over ocean surfaces (Remer et al., 2005) will be investigated here. MODIS is a nadir viewing instrument on a sun-synchronous near-polar orbit. The radiometer scans the Earth's surface 90º left and right to the ground-track and produces scenes with a swath width of 2330 km at ground level.

The meteorological data, which are available for the period 1979 – 2016, give the grade of climate change in the Baltic Sea due to the global warming. Investigating MODIS AOT, which is available for April to September of the period 2000 -2016, will let us know if the air quality mitigation has led to a continues decrease in AOT for northern Europe, also after 2004. In addition, by combining possible trends in AOT with meteorological data means that we may be able to qualitatively determine the impact from the aerosols on the change in temperature.

The main objectives of this study are the following:

1. Estimate trends in temperature, sea ice cover and AOT for the Baltic Sea region

2. Investigate if trends in temperature are different for the southern, middle and northern parts of the Baltic Sea

3. Qualitatively determine the role of aerosols on the temperature trends in the Baltic Sea region

The bachelor candidates should have a background in atmospheric/aerosol chemistry or physics. Basic knowledge in meteorology as well as in programming is an advantage. An introduction to remote sensing of aerosols will be provided.

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Suggested literature

Hand, J. L., et al., Atmos. Chem. Phys., 12, 10353–10365, doi:10.5194/acp-12-10353-2012, 2012.
IPCC, 2013, 1535 pp, doi:10.1017/CBO9781107415324.
Remer, L. A., et al., J. Atmos. Sci., 62, 947–973, doi:10.1175/JAS3385.1, 2005.
Smith, S. J., et al., Atmos. Chem. Phys., 11, 1101–1116, doi:10.5194/acp-11-1101-2011, 2011.