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Influence of climate change on atmospheric transport of persistent organic pollutants to the Arctic

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We have applied the Danish Eulerian Hemispheric Model (DEHM) to study the impact of climate change on atmospheric transport of Persistent Organic Pollutants (POPs) to the Arctic as well as investigating the major source areas for the transport to the Arctic. The study represents a sensitivity analysis in order to investigate the response of the model system due to climate change.

DEHM is a 3-D atmospheric chemistry-transport model modelling the atmospheric transport of four chemical groups: a group with SOx-NO_x-VOC-ozone chemistry, a group with primary particulates group, a mercury chemistry group, and finally a group with Persistent Organic Pollutants (two HCH isomers and 11 PCB congeners). The model domain covers the Northern Hemisphere and thus includes all important source areas for the Arctic. The spatial horizontal resolution of the model system in this work is 150km x 150km and the model includes 20 vertical levels up to approximately 15km above the surface.

The model system was run with meteorology obtain from ECHAM5/MPI-OM (SRES A1B scenario) for two decades: 1990-1999 and 2090-2099. In this climate scenario the global mean temperature is predicted to increase by 3ºC by the end of 2100 relative to the period 1971-2000. The same emissions where applied for the two simulations. It is thus possible to investigate the response of DEHM to a changed climate on e.g. the atmospheric transport of POPs to the Arctic. Higher temperature leads to a shift of POPs from the surface media to air.

Higher temperatures also lead to larger degradation in air as well as in the surface media. This results in lower modelled masses for the 2090s than for the 1990s within the entire model domain for all modelled species. The higher atmospheric concentrations also result in larger atmospheric transport to the Arctic. For the least chlorinated PCB congeners the increased transport is counteracted by the increased degradation and the result is thus approximately 10% less mass within the Arctic in the 2090s compared to the 1990s. The mass of the more chlorinated PCB congeners with a larger affinity to aerosols (and thus less degradation) is up to 20% higher in the 2090s than in the 1990s. The mass of the HCH isomers within the Arctic is up to 30% higher in the 2090s than in the 1990s due to a larger ice free ocean and increased wet deposition.