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Impacts of climate change on air pollution levels in the Northern Hemisphere with special focus on Europe and the Arctic

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Abstract. The response of a selected number of chemical species is inspected with respect to climate change. The coupled Atmosphere-Ocean General Circulation Model ECHAM4-OPYC3 is providing meteorological fields for the Chemical long-range Transport Model DEHM. Three selected decades (1990s, 2040s and 2090s) are inspected. The 1990s are used as a reference and validation period. In this decade an evaluation of the output from the DEHM model with ECHAM4-OPYC3 meteorology input data is carried out. The model results are tested against similar model simulations with MM5 meteorology and against observations from the EMEP monitoring sites in Europe.

The test results from the validation period show that the overall statistics (e.g. mean values and standard deviations) are similar for the two simulations. However, as one would expect the model setup with climate input data fails to predict correctly the timing of the variability in the observations. The overall performance of the ECHAM4-OPYC3 setup as meteorological input to the DEHM model is shown to be acceptable according to the applied ranking method. It is concluded that running a chemical long-range transport model on data from a "free run" climate model is scientifically sound. From the model runs of the three decades, it is found that the overall trend detected in the evolution of the chemical species, is the same between the 1990 decade and the 2040 decade and between the 2040 decade and the 2090 decade, respectively.

The dominating impacts from climate change on a large number of the chemical species are related to the predicted temperature increase. Throughout the 21th century the ECHAM4-OPYC3 projects a global mean temperature increase of 3 K with local maxima up to 11 K in the Arctic winter based on the IPCC A2 emission scenario. As a consequence of this temperature increase, the temperature dependent biogenic emission of isoprene is predicted to increase significantly over land by the DEHM model. This leads to an increase in the O_3 production and together with an increase in water vapor to an increase in the number of free OH radicals. Furthermore this increase in the number of OH radicals contributes to a significant change in the typical life time of many species, since OH are participating in a large number of chemical reactions. It is e.g. found that

more SO_4^{2-} will be present in the future over the already polluted areas and this increase can be explained by an enhanced conversion of SO_2 to SO_4^{2-}.

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