

***Interactive comment on “Aerosol optical depth over the Arctic: a comparison of ECHAM-HAM and TM5 with ground-based, satellite and reanalysis data” by J. von Hardenberg et al.***

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*This manuscript is crucially lacking a much more thorough section on interpretation and discussion of results*

We expanded considerably our discussion, please see our replies to reviewer 2.

*First I missed a description of how Bourgeois and Bey (2011) modified the aerosol deposition in the ECHAM5-HAM model. Did these modifications change the aerosol simulations only over high latitudes or globally?*

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We have included a paragraph explaining more in detail the wet scavenging parametrization in HAM, the changes by Bourgeois and Bey 2011 and their effects at the end of section 2.3:

"In the following we also explore a simple change in the model wet scavenging parametrization introduced recently by Bourgeois et al. (2011) to better reproduce the observed optical properties and concentrations of aerosols in the Arctic region. HAM parametrizes wet scavenging using the precipitation formation rate of the ECHAM5 cloud scheme and computing the fraction of tracer that is embedded in cloud water using simple size-dependent and cloud-type dependent scavenging coefficients, based on measurements from Henning et al (2004). Bourgeois et al (2011) explored reducing these coefficients, based on a re-evaluation of the results in Henning et al (2004) and following papers, leading to an increase in BC and sulfate lifetimes and to increased burdens in the Arctic, while the global and annual scavenged masses remained similar. We apply this modification using the same parameters as described in their paper."

*When comparing aerosol optical depth at stations the models are unable to capture the optical depth and its seasonality at 3 stations: Alert, Barrow and Summit. The reasons why the models are so far off from the measurements is poorly discussed. It is suggested that both the deposition and the elevation of these stations play a role but how so and what tests were done to come to pinpoint this lack of agreement to these 2 reasons?*

As we discuss in section 3.1, the agreement in terms of AOD using ECHAM-HAM and TM5 is poor for all stations, except, for some aspects, for the southernmost stations ALOMAR and Sodankyla. As we show in the following chapter this underestimation is also confirmed by spatial maps of AOD compared with currently available satellite and reanalysis products. The latter are highly uncertain in polar areas, but together with the station measurements they confirm an underestimation of AODs and burdens by the models over most of the Arctic. While specific properties of individual measurement stations such as their position and elevation may of course play a role, the satellite and reanalysis comparisons suggest that the problem is mainly over the entire region and in the following sections we focus on the global mechanisms (such as transport and

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scavenging processes) which may be at the origin of this mismatch.

We added these considerations in the final discussion. We also added the following considerations when discussing the daily timeseries of AOD:

"In evaluating these plots it is important to recall the extreme intermittency observed in Arctic haze, fire smoke or Asian dust transport episodes, which often take place over few days. While the model simulations are based on realistic wind fields (with TM5 using ERA-Interim fields and ECHAM nudged to the same), and may be able to reproduce correctly transport episodes from low latitudes, aerosol emissions used here are based on monthly climatologies, so that the daily variability of local sources and the interaction for example between fire episodes and particular transport patterns may not be reproduced."

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