Project: **883**

Project title: **Modelling of Saharan mineral dust**

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Progress Report

The project aims to evaluate and further improve the representation of mineral dust in the aerosol climate model ECHAM6-HAM2. An important aspect of the dust cycle is the quantification of dust emissions originating from anthropogenically-disturbed soils (e.g., cropland and rangeland in semi-arid regions) in contrast to natural sources. Climate forcing of dust originating from such sources are considered anthropogenic effects. The fraction of anthropogenic dust, however, is highly uncertain. Estimates provided in the IPCC climate reports (IPCC, 2013) are currently at 20% anthropogenic dust compared to total dust emissions, but the uncertainty range lies between 10 and 50%. Since dust emissions are highly sensitive to surface wind speeds, an important part of this uncertainty may be due to uncertainty in simulated surface winds by different models. To quantify this uncertainty range in global models a currently ongoing dust model intercomparison within the AeroCom framework is taking place. Hereby, the dust source areas for the contributing models are set to the natural and anthropogenic dust source fractions provided by Ginoux et al. (2012), while the dust emission fluxes, transport and deposition are computed by the individual models according to their own parameterizations.

For this dust aerosol intercomparison study dust was computed within this project with the setup of ECHAM6.1-Ham2.2 at resolution T63L31. The anthropogenic dust source areas provided by Ginoux et al (2012) were estimated from the MODIS Deep Blue aerosol product, and the anthropogenically-disturbed soil was determined for cropland and rangeland according to Klein Goldewijk, K. (2001). The resulting anthropogenic fraction of dust source areas is depicted in Figure 1. Four model experiments were carried out in nudged mode for the years 2010 to 2012. Computed were dust emissions and atmospheric distribution (including dust optical thickness) of dust aerosol from natural and anthropogenic sources (Figure 2), as well as anthropogenic dust emissions for sensitivity cases, in which the threshold velocity for dust emission were increased and decreased by factors of 1.5 and 0.5, respectively. This prescribed change in emission threshold is due to the assumption that disturbed soils may be more or less efficient dust sources compared to natural soils.

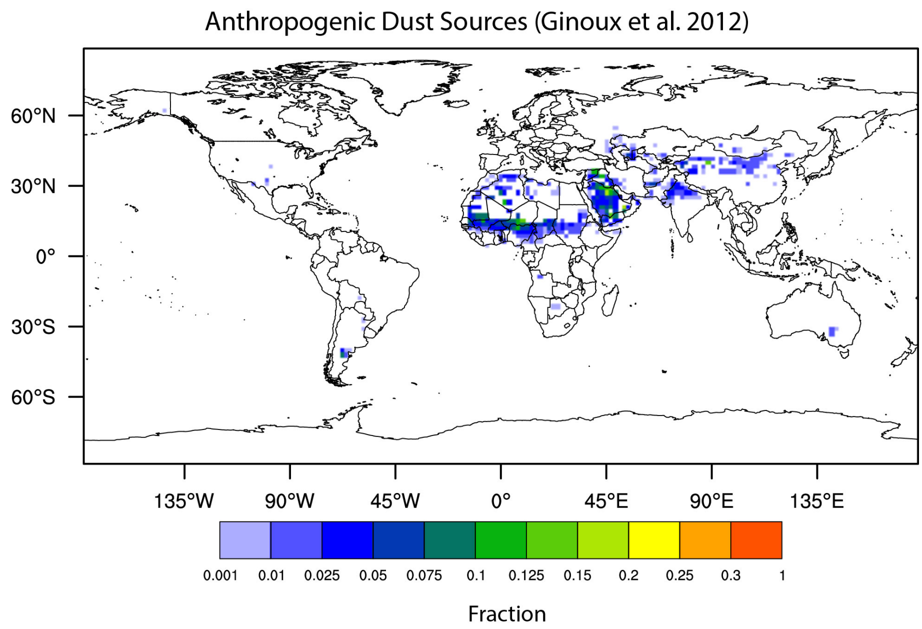

***Figure 1**: Fraction of dust source areas that correspond to anthropogenic dust sources according to the MODIS Deep Blue aerosol Product (Ginoux et al., 2012).*

The results indicate that in the 'standard setup' anthropogenic emissions according to these data is about 30 % of global annual emissions. The anthropogenic dust AODs are unusually high in the Arabian Peninsula (Figure 2), due to the prescription of this region as mostly anthropogenically disturbed. The results of increased and decreased emission thresholds are clearly unrealistic (not shown), with near-zero emissions from anthropogenic soils with increased threshold, and increased emissions by about a factor of five with reduced emission threshold. This shows the strong sensitivity of dust emissions to the emission threshold, which needs to be carefully adjusted in dust models.

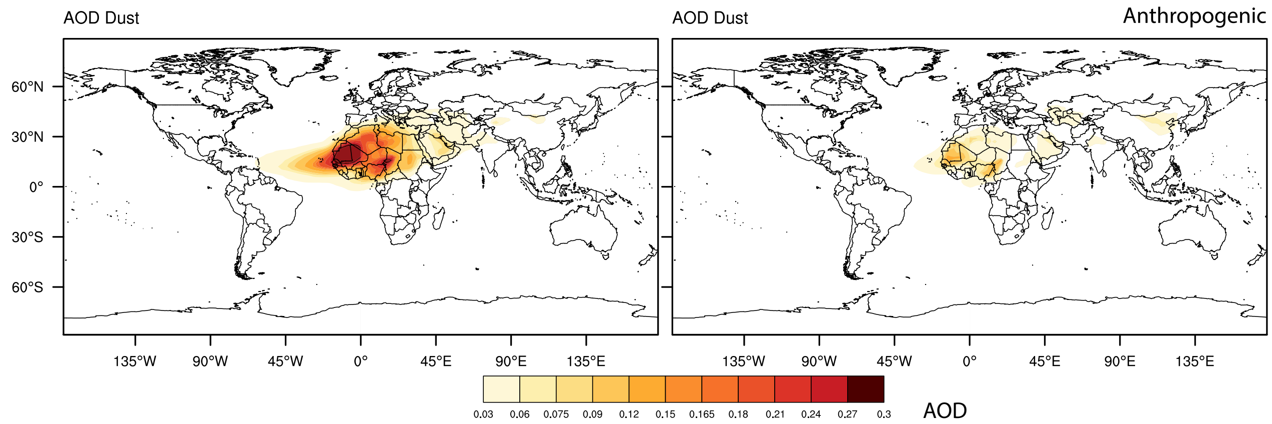

***Figure 2**: Annual mean dust optical thickness for the year 2010 computed with ECHAM6-HAM2, left: natural sources, right: anthropogenic dust sources.*

Perspectives

The ECHAM6-HAM2 simulations of natural and anthropogenic dust in this study help better characterise dust feedback mechanisms and climate forcing. It will be interesting to compare these results, which are based on a fixed set of current natural and anthropogenic dust source fractions, to the findings by Stanelle et al. (2014), who used a model version of ECHAM6-HAM2 online coupled to an interactive land-surface model. After careful evaluation, one could consider including the set of anthropogenic dust sources by default for recent time periods.

Utilisation and Publication

The results are a valuable contribution to and will be published in the context of the current phase of the AeroCom model intercomparison initiative. All relevant model developments and required input data are made available to the scientific community through the HAMMOZ website (https://redmine.hammoz.ethz.ch) and repository.

References

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