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Anthropogenic Aerosol Effects on Sea Surface Temperatures: Mixed-Layer Ocean Experiments with Explicit Aerosol Representation

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Anthropogenic aerosols affect the Earth's radiative balance both through direct and indirect effects. These effects can lead to a reduction of the incoming solar radiation at the surface, i.e. dimming, which may lead to a change in sea surface temperatures (SST) or SST pattern. This, in turn, may affect precipitation patterns. The goal of the present work is to achieve an estimate of the equilibrium SST changes under anthropogenic aerosol forcing since industrialisation.

We show preliminary results from mixed-layer ocean (MLO) experiments with explicit aerosol representation performed with ECHAM6-HAM. The (fixed) MLO heat flux into the deep ocean was derived from atmosphere only runs with fixed climatological SSTs (1961-1990 average) and present day (year 2000) aerosols and GHG burdens. Some experiments we repeated with an alternative MLO deep ocean heat flux (based on pre-industrial conditions) to test the robustness of our results with regard to this boundary condition. The maximum surface temperature responses towards anthropogenic aerosol and GHG forcing (separately and combined) were derived on a global and regional scale. The same set of experiments was performed with aerosol and GHG forcings representative of different decades over the past one and a half centuries. This allows to assess how SST patterns at equilibrium changed with changing aerosol (and GHG) forcing. Correlating SST responses with the change in downward clear-sky and all-sky shortwave radiation provides a first estimate of the response to anthropogenic aerosols. Our results show a clear contrast in hemispheric surface temperature response, as expected from the inter-hemispheric asymmetry of aerosol forcing

The presented work is part of a project aiming at quantifying the effect of anthropogenic aerosol forcing on SSTs and the consequences for global precipitation patterns. Results from this study will serve as a starting point for further experiments involving a dynamic ocean model, which aims at quantifying transient responses to anthropogenic aerosol forcing.