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Modelling Anthropogenic Aerosol Radiative Impacts on Oceanic Surface Energy Fluxes

Tanja Dallafior (1, 2), Doris Folini (1), Ana Sesartic (1), Martin Wild (1), Reto Knutti (1)

(1) ETH Zurich, Institute for Atmospheric and Climate Science, Zurich, Switzerland
(2) C2SM, Centre for Climate System Modeling, Zurich, Switzerland

Corresponding author's e-mail address: tanja.dallafior@env.ethz.ch

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Numerous studies show through observational as well as modelling evidence that changes in anthropogenic aerosol emissions likely affect the Earth's radiative budget and hydrological cycle through direct (e.g. scattering, absorption) and indirect effects (e.g. acting as cloud condensation nuclei). To what degree aerosol radiative forcing can affect sea surface temperatures (SSTs) is debated. Model results suggest, for example, that anthropogenic aerosols may alter Indian Ocean SSTs, which in turn can affect precipitation patterns. Modelling studies over the North Atlantic using coupled ocean-atmosphere model runs suggest that anthropogenic aerosols are an important driver of SSTs. However, these results are still subject to debate. Thus, the question remains, to what extent SSTs variability is the result of either aerosol radiative forcing or internal ocean variability.

The aim of the present work is part of the regional to global research cluster within the second stage of the Collaborative, Highly Interdisciplinary Research Projects (CHIRP II) of C2SM. The work aims at furthering the understanding of potential anthropogenic aerosol effects on climate (climate forcing) with emphasis on remote and fairly pristine regions such as oceans. The radiation balance in regions with low aerosol content is particularly sensitive to an increase in aerosol burdens, since even small amounts of aerosol can induce large relative changes through aerosol-cloud interactions. We performed sensitivity experiments with the global climate model ECHAM5 combined with the interactive aerosol module HAM using prescribed sea surface temperatures (Hadley Centre), and run at a resolution of T42L19 for the years 1870-2000. We compared ensembles of simulations using transient anthropogenic aerosol emissions (from NIES, National Institute for Environmental Studies, Japan) with ensembles using pre-industrial anthropogenic aerosol emissions, i.e. emissions held constant at levels of 1870. This allows us to quantify the transport of anthropogenic aerosols to

remote regions and identify regions where the radiation balance was significantly affected by anthropogenic aerosol burdens during the last century. The aerosol transport capabilities of the model are assessed by comparing present day model results to satellite observations.

Our findings serve as basis for future modelling efforts using a coupled atmosphere-ocean modelling framework. In doing so, we aim to gauge the potential radiative impacts of anthropogenic aerosols on sea surface temperatures, and the hydrological responses thereof.