Introduction

Iron (Fe) is responsible for limiting marine phytoplankton productivity and primary production in high-nutrient low-chlorophyll areas of the ocean. The principle source of bio-available Fe to the open ocean is mineral dust transported from the atmosphere. Therefore, future ocean biogeochemistry strongly depends on changes in dust emissions and aerosol chemistry in dust that determines solubility thus bio-availability of dust Fe to phytoplankton under future climate states. In the CMIP5 Earth System models, information about Fe dissolution along the pathway from dust source regions to the oceans remains incomplete. There is large variability in the predicted atmospheric deposition of Fe among models (Figure below). Here we present a dust Fe dissolution scheme that can be implemented into the CESM to link the bio-availability of Fe inputs to aerosol chemistry. Sensitivity of soluble Fe deposition to Fe sources, dust mineralogy and emissions are examined.

Dependence on dust chemical composition

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Dependence on dust source function

The impact of dust size distribution in several source functions is examined for soluble Fe deposition (Ito et al., 2012). Large differences between Kok (2011) and Zender et al. (2003) are found in regions where the concentration of acidic gases is not sufficient to promote Fe dissolution, such as the South Atlantic downwind of the Patagonian desert.

Conclusions and future work

We demonstrate a modeling framework that can test our understanding of the temporal and spatial variation in atmospheric Fe input to the ocean, driven by human-induced pollution perturbations overlaid with climate- and land-use-driven dust emission changes. We have shown that the supply of bio-available Fe varies considerably from near-source regions to open sea, depending on chemical speciation of Fe and alkaline dust minerals, and dust source functions. Next step is to implement Fe dissolution schemes in the CAM model that distinguish different dust mineralogy, and couple it with the ocean biogeochemistry model to examine the impact of Fe deposition on marine biogenic emissions under future climate states. Organic acids, or cloud processing of dust may also need to be considered.

References: