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Underlying uncertainty in future projection of marine ecosystem feedbacks to climate change

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It is widely recognized that uncertainty in the deposition flux of bioavailable iron to the ocean is large and that the value assumed can influence the air-sea carbon dioxide fluxes and thus radiative forcing significantly. Global models have been used to deduce atmospheric iron supply to the ocean, but uncertainty in the deposition flux remains large, in part because of uncertainty in the size distribution of mineral aerosols. We used a global chemical transport model to investigate the effect of the estimated size distribution of dust on the bioavailable iron deposition. Simulations are performed with six different size distributions for dust aerosols at emission using similar aerosol optical depths (AODs) to constrain the total emission flux of dust. The global dust emission rate using a recent theoretical estimate for the dust size distribution at emission is about two times larger than the average of estimates using the other four empirical size distributions. In contrast to the large differences in total emissions, the dust emission of fine particles is relatively robust, due to the strong constraint of AOD on clay emission. Our model results indicate that soluble iron (SFe) deposition is relatively invariant to the dust size distribution at emission in significant portions of the open ocean, where fine particles play a dominant role in soluble iron supply. In contrast, the use of the theoretical size distribution suggests a larger deposition of SFe (by a factor of 1.2 to 5) in the South Atlantic. These results could have important implications for the future projection of marine ecosystem feedbacks to climate change and highlight the necessity to improve the dust size distribution.

Keywords: mineral aerosol, atmospheric chemical transport model, soluble iron supply, size distribution, air pollutant, climate change