Constraining the Surface Flux of Sea Spray Particles from the Southern Ocean

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Abstract

Modeling the shortwave radiation balance over the Southern Ocean region remains a challenge for Earth system models. To investigate whether this is related to the representation of aerosol-cloud interactions, we compared measurements of the total number concentration of sea spray generated particles within the Southern Ocean region to model predictions thereof. Measurements were conducted from a container laboratory aboard the R/V Tangaroa throughout an austral summer voyage to the Ross Sea. We used source-receptor modeling to calculate the sensitivity of our measurements to upwind surface fluxes. From this approach, we could constrain empirical parameterizations of sea spray surface flux based on surface wind speed and sea surface temperature. A newly tuned parameterization for the flux of sea spray particles based on the near-surface wind speed is presented. Comparisons to existing model parameterizations revealed that present model parameterizations led to over-estimations of sea spray concentrations. In contrast to previous studies, we found that including sea surface temperature as an explanatory variable did not substantially improve model-measurement agreement. To test whether or not the parameterization may be applicable globally, we conducted a similar regression analysis using a database of in situ whitecap measurements. We found that the key fitting parameter within this regression agreed well the parameterization of sea spray flux. Finally, we compared calculations from the best model of surface flux to boundary layer measurements collected onboard an aircraft throughout the Southern Ocean Clouds, Radiation, Aerosol Transport Experimental Study (SOCRATES), finding good agreement overall.