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Globally significant oceanic source of organic carbon aerosol

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Significant abundances of organic carbon (OC) aerosol are observed in the marine atmosphere, and the potential of an oceanic OC source has been recognised for some time. Despite this, the global oceanic OC source is poorly quantified and not included in any global model of climate or atmospheric composition. We demonstrate that the GEOS-CHEM global chemical transport model (CTM) significantly underpredicts monthly-mean OC aerosol at oceanic surface sites (Amsterdam Island, Azores and Mace Head) with a normalised mean bias (NMB) of 67%. During periods of high biological productivity model underprediction is a factor of 5-20. The same CTM reproduces observed concentrations of elemental carbon, sulfate and methane sulfonic acid. At extra-tropical oceanic sites, observed OC correlates well (R-squared =0.61-0.77) with back-trajectory weighted oceanic chlorophyll-a, suggesting an OC source driven by biological activity. We use a combination of remote sensed chlorophyll-a, back trajectories and observed OC timeseries to derive an empirical relation between chlorophyll-a and the primary OC emission flux. Using the CTM we attempt to reproduce remote marine OC observations using the chlorophyll-dependent OC flux. A global oceanic OC emission of 8 Tg / year is required to match observations (NMB 7%) and results in 20% increase in the global atmospheric OC burden. This emission represents a significant flux of OC to the global atmosphere which is missing from models, comparable in magnitude to the fossil fuel OC source.