3.003 Effects of ocean warming and coral bleaching on aerosol emissions in the Great Barrier Reef, Australia.

Early Career Scientist

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Abstract:

It is proposed that emissions of volatile sulfur compounds by coral reefs contribute to the formation of a biologically derived feedback on sea surface temperature (SST) through the formation of secondary organic aerosol and subsequent changes in local cloud cover. Yet the direction and strength of this feedback remains uncertain and constitutes a fundamental constraint on predicting corals ability to adapt to future ocean warming. We investigated the effects of elevated SST and coral bleaching on satellite-derived fine-mode aerosol (AOD) throughout the Great Barrier Reef, Australia (GBR) from 2000 to 2017, a period which included six mass coral bleaching events. AOD and SST were positively correlated, with AOD increasing up to 2-fold during spring and summer with high frequency variability. The correlation was strongest at low wind speed when advection of aerosol and the influence of non-biogenic aerosol was minimal, thus suggesting that the 2,300km stretch of coral reefs are a substantial, local source of aerosol under calm conditions. Importantly however, sharp declines in AOD were recorded during mass coral bleaching events. Recent evidence shows that corals shut down emissions of aerosol precursor gases when laboratory temperature perturbations exceed their physiological limits. It is thought that corals instead utilize these compounds intracellularly to cope with oxidative stress. This study agrees with those results and provides the first large-scale evidence of this phenomenon in the natural environment. We therefore posit that corals exhibit a two-stage stress response whereby elevated temperatures increase the production of biogenic aerosol and potentially lower SST through direct and indirect aerosol radiative effects. However, when continued SST rise pushes corals beyond their tolerance range, emissions of precursor compounds are shut down, resulting in a positive feedback on SST and potentially exacerbating coral bleaching.