Evidence for a Consistent Methanethiol-Dimethyl Sulfide Ratio in the Southern Ocean Region

Caleb Mynard

Monash University, Australia. Climate Atmosphere and Ocean Interactions, CSIRO Environment, Australia

Author list (excluding presenting author)

Erin Dunne, Emily Franklin, Ruhi Humphries, Marc Mallet, Joel Alroe, Steven Siems, Antonio Patti

Abstract

The persistent radiative energy biases represented in Southern Ocean climate models are largely due to a lack of understanding on how clouds form and evolve over this region (IPCC AR6). Sulfate aerosols, formed from the oxidation of sulfur-containing compounds are important for cloud formation and properties, affecting albedo and cloud lifetime. Dimethyl sulfide (DMS) has long been recognised as a key precursor to sulfate aerosol formation. DMS is oxidised to form methanesulfonic acid and sulfur dioxide (SO_2), subsequently oxidising to sulfuric acid, an important contributor to particle formation and growth. Efforts to regulate SO_2 budgets are inconsistent with the known products from DMS oxidation based on laboratory studies. This has prompted speculation about the abundance of other unknown marine sulfur species, such as methanethiol (MeSH), that could contribute to SO_2 production. DMS and MeSH both originate from the degradation of dimethylsulfoniopropionate (DMSP) in marine microorganisms, highlighting the importance of understanding their relationship, atmospheric abundance, and behaviour. We made continuous proton transfer reaction time-of-flight mass spectrometer (PTR-ToF-MS) measurements in the Southern Ocean region. This included observations during pristine conditions, at Kennaook/Cape Grim (KCG) in Tasmania, Australia over spring 2023. PTR-ToF-MS measurements were also made aboard the RV Investigator during a 60-day summertime Southern Ocean voyage as part of the Multidisciplinary Investigations of the Southern Ocean (MISO) campaign. We observed a strong correlation and linear relationship between DMS and MeSH across the Southern Ocean, consistent with previous Southern Ocean datasets indicating MeSH concentrations at around 10% of DMS concentrations. These findings suggest that MeSH could be a significant sulfur source in the Southern Ocean atmosphere, which is consistent with the high yields and increase in marine SO_2 production from MeSH oxidation modelling.

Early Career Scientist

YES, I am an early career scientist.

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