Overview of the Antarctic Circumnavigation Expedition: Study of Preindustrial-like Aerosols and Their Climate Effects (ACE-SPACE)

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Uncertainty in radiative forcing caused by aerosol-cloud interactions is about twice as large as for CO2 and remains the least well understood anthropogenic contribution to climate change. A major cause of uncertainty is the poorly quantified state of aerosols in the pristine preindustrial atmosphere, which defines the baseline against which anthropogenic effects are calculated. The Southern Ocean is one of the few remaining near-pristine aerosol environments on Earth, but there are very few measurements to help evaluate models. The Antarctic Circumnavigation Expedition: Study of Preindustrial-like Aerosols and their Climate Effects (ACE-SPACE) took place between December 2016 and March 2017 and covered the entire Southern Ocean region (Indian, Pacific, and Atlantic Oceans; length of ship track >33,000 km) including previously unexplored areas. In situ measurements covered aerosol characteristics [e.g., chemical composition, size distributions, and cloud condensation nuclei (CCN) number concentrations], trace gases, and meteorological variables. Remote sensing observations of cloud properties, the physical and microbial ocean state, and back trajectory analyses are used to interpret the in situ data. The contribution of sea spray to CCN in the westerly wind belt can be larger than 50%. The abundance of methanesulfonic acid indicates local and regional microbial influence on CCN abundance in Antarctic coastal waters and in the open ocean. We use the in situ data to evaluate simulated CCN concentrations from a global aerosol model. The extensive, available ACE-SPACE dataset () provides an unprecedented opportunity to evaluate models and to reduce the uncertainty in radiative forcing associated with the natural processes of aerosol emission, formation, transport, and processing occurring over the pristine Southern Ocean.
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