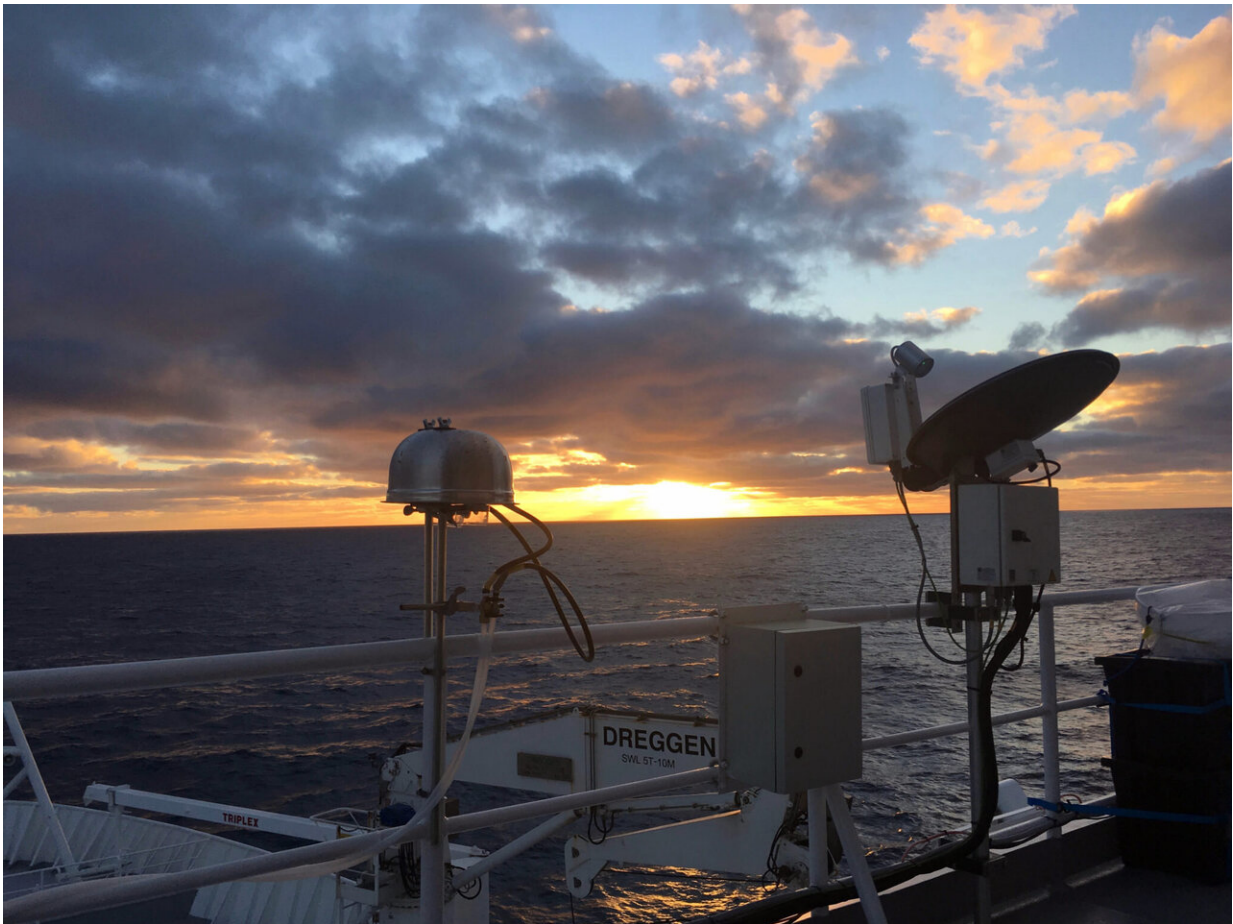


Atmospheric scientists identify cleanest air on Earth in first-of-its-kind study

June 2 2020, by Jayme Deloss



Aerosol filter samplers probe the air over the Southern Ocean on the Australian Marine National Facility's R/V Investigator Credit: Kathryn Moore/Colorado State University

Colorado State University Distinguished Professor Sonia Kreidenweis and her research group identified an atmospheric region unchanged by human-related activities in the first study to measure bioaerosol composition of the Southern Ocean south of 40 degrees south latitude.

Kreidenweis' group, based in the Department of Atmospheric Science, found the boundary layer air that feeds the lower clouds over the Southern Ocean to be pristine—free from particles, called aerosols, produced by anthropogenic activities or transported from distant lands. Their findings are published in *Proceedings of the National Academy of Sciences*.

Weather and climate are complex processes connecting each part of the world to every other region, and with climate changing rapidly as a result of human activity, it's difficult to find any area or process on Earth untouched by people. Kreidenweis and her team suspected the air directly over the remote Southern Ocean that encircles Antarctica would be least affected by humans and dust from continents. They set out to discover what was in the air and where it came from.

"We were able to use the bacteria in the air over the Southern Ocean as a diagnostic tool to infer key properties of the lower atmosphere," said research scientist Thomas Hill, coauthor on the study. "For example, that the aerosols controlling the properties of SO clouds are strongly linked to ocean [biological processes](#), and that Antarctica appears to be isolated from southward dispersal of microorganisms and nutrient deposition from southern continents. Overall, it suggests that the SO is one of very few places on Earth that has been minimally affected by anthropogenic activities."

Samples were collected during the NSF-funded SOCRATES field campaign, led by research scientist and coauthor Paul DeMott. Graduate student Kathryn Moore sampled the air in the marine boundary layer, the

lower part of the atmosphere that has direct contact with the ocean, aboard the Research Vessel Investigator as it steamed south from Tasmania to the Antarctic ice edge. Research scientist and first author Jun Uetake examined the composition of airborne microbes captured from the ship. The atmosphere is full of these microorganisms dispersed over hundreds to thousands of kilometers by wind.

Using DNA sequencing, source tracking and wind back trajectories, Uetake determined the microbes' origins were marine, sourced from the [ocean](#). Bacterial composition also was differentiated into broad latitudinal zones, suggesting aerosols from distant land masses and human activities, such as pollution or soil emissions driven by [land use change](#), were not traveling south into Antarctic air.

These results counter all other studies from oceans in the subtropics and northern hemisphere, which found that most microbes came from upwind continents. Plants and soil are strong sources of particles that trigger freezing of supercooled cloud droplets, known as ice-nucleating particles. This process reduces cloud reflectivity and enhances precipitation, increasing the amount of sunlight reaching the surface and altering Earth's radiative balance.

Over the Southern Ocean, sea spray emissions dominate the material available for forming liquid cloud droplets. Ice-nucleating particle concentrations, rare in seawater, are the [lowest recorded anywhere on the planet](#).

The air over the Southern Ocean was so clean that there was very little DNA to work with. Hill attributed the quality of their results to Uetake and Moore's clean lab process.

"Jun and Kathryn, at every stage, treated the samples as precious items, taking exceptional care and using the cleanest technique to prevent

contamination from bacterial DNA in the lab and reagents," Hill said.

More information: Jun Uetake et al, Airborne bacteria confirm the pristine nature of the Southern Ocean boundary layer, *Proceedings of the National Academy of Sciences* (2020). [DOI: 10.1073/pnas.2000134117](https://doi.org/10.1073/pnas.2000134117)

Provided by Colorado State University

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