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Preface

The Southern Hemisphere marine Aerosol Characterization Experiment (ACE 1) was the first of a series of experiments organized through the International Global Atmospheric Chemistry (IGAC) Program designed to quantify the chemical and physical processes controlling the evolution and properties of the atmospheric aerosol relevant to radiative forcing and climate. ACE 1, which was conducted from November 15 to December 14, 1995, over the southwest Pacific Ocean, south of Australia, quantified the chemical, physical, radiative, and cloud nucleating properties and controlling processes of the aerosol in this minimally polluted marine atmosphere. The experiment involved the efforts of scientists from 45 research institutes in 11 countries. Measurements were made from the National Center for Atmospheric Research (NCAR) C-130 aircraft, the National Oceanic and Atmospheric Administration (NOAA) Research Vessel *Discoverer*, the Australian Fisheries Research Vessel *Southern Surveyor*, and ground stations at Macquarie Island and Cape Grim, Tasmania.

The first collection of 33 ACE 1 papers appeared in the *Journal of Geophysical Research, 103*(D13), 1998. This second collection of 12 papers further expands our understanding of marine atmospheric chemistry and the atmospheric aerosol in this remote part of the planet. *Griffiths et al.* [this issue] describe the characteristics of the four different water masses in the ACE 1 study area and how the biological, physical, and chemical properties of these water masses affected the atmosphere. Biologically, the ocean was a source of dimethylsulfide (DMS) [*Bates et al.*, 1998b; *Curran et al.*, 1998; *Jones et al.*, 1998], hydrocarbons [*Pszenny et al.*, this issue], methyl nitrate [*Blake et al.*, this issue], and methyl halides [*Moore et al.*, 1996; *Murphy et al.*, 1997; *Groszko and Moore*, 1998; *Blake et al.*, this issue] to the atmosphere. The ocean may also have been a source of biogenic calcium carbonate which enhanced the alkalinity of sea-salt aerosol water and in turn enhanced ozone oxidation of sulfur dioxide in sea-salt aerosol water [*Gurciullo et al.*, this issue; *Sievering et al.*, this issue]. Physically, the different water masses affected the structure [*Wang et al.*, this issue (a)] and turbulence [*Wang et al.*, this issue (b)] of the atmospheric boundary layer. Physically generated sea-salt particles dominated the mass of both submicron and supermicron marine boundary layer (MBL) aerosol particles in this region during ACE 1 [*Quinn et al.*, 1998; *Huebert et al.*, 1998]. Single particle analysis revealed that over 90% of the aerosol particles with diameters >130 nm [*Murphy et al.*, 1998] and up to 70% of the particles with diameters >80 nm [*Kreidenweis et al.*, 1998] contained sea salt. Organic species were detected in over 50% of the particles with diameters >160 nm and were associated with sea salt [*Middlebrook et al.*, 1998]. The dominance of sea-salt aerosol in this region clearly shows the need to include sea salt in climate models. In the ACE 1 study area, sea salt controlled the magnitude of aerosol light scattering [*Quinn et al.*, 1998; *Carrico et al.*, 1998; *Murphy et al.*, 1998] and the number of cloud condensation nuclei [*Covert et al.*, 1998].

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Although the intent of ACE 1 was to study the background marine atmosphere, gas and aerosol measurements showed that even this remote region is impacted by anthropogenic activities. Layers containing continental air characteristic of aged biomass burning emissions were observed above 3 km over the remote southern Ocean [*Blake et al.*, this issue]. Transmission electron microscopy of samples throughout the troposphere in the ACE 1 study area showed that between 11 and 46% of the sulfate particles with diameters >100 nm contained soot [*Posfai et al.*, this issue]. The source of this soot was most likely South African biomass burning and aircraft emissions [*Posfai et al.*, this issue].

A major emphasis of the IGAC Aerosol Characterization Experiments is to identify and quantify processes controlling aerosol distributions. Measurements in the vicinity of Macquarie Island during ACE 1 provided a unique opportunity to study, in situ, the role of biogenic species on the formation and growth of newly formed particles [*Weber et al.*, 1998]. The photochemical production of new particles from sulfuric acid gas also was clearly observed in cloud outflows [*Clarke et al.*, 1998]. The growth and evolution of these particles aloft was evident over periods of hours to a day [*Clarke et al.*, 1998]. In regions of post-frontal subsidence, these ultra-fine and Aitken mode particles were mixed into the MBL [*Bates et al.*, 1998a, b; *Brechtel et al.*, 1998].

The evolution of particles in the MBL was studied using both Eulerian and Lagrangain strategies. Diurnal cycles and photochemical box model calculations were used to show that 30–50% of the DMS was converted to SO_2 [*De Bruyn et al.*, 1998]. A major sink (approximately 35%) for this SO_2 appeared to be through ozone oxidation in sea-salt aerosol water [*Sievering et al.*, this issue]. In summer, 35 ± 10% of the non-sea-salt (nss) sulfate was associated with supermicron sea salt, while in winter this fraction increased to 58 ± 22% [*Andreae et al.*, this issue].

The Lagrangian measurement strategy continued to evolve during ACE 1 [*Bates et al.*, 1998a; *Huebert and Lenschow,* 1999]. The balloons tracking the air masses were improved with the capability to adjust their own buoyancy in response to drizzle [*Businger et al.*, 1999], and new techniques were implemented to measure entrainment velocities [*Russell et al.,* 1998; *Lenschow et al.,* 1999; *Wang et al.,* this issue (b)]. Measurements of OH [*Mauldin et al.,* 1998], CO [*Kok et al.,* 1998], and hydrocarbons [*Pszenny et al.,* this issue; *Wingenter et al.,* this issue] were used to constrain the oxidative capacity of atmosphere. Repeated measurements of aerosols and gas phase precursors over a 30-hour period made it possible to follow the evolution of gas phase photochemistry [*Mari et al.,* 1998; *Suhre et al.,* 1998] and the formation of methane sulfonate and nss sulfate [*Huebert et al.,* 1998; *Mari et al.,* this issue]. The repeated measurements combined with a one-dimensional (1-D) model provided sufficient constraints to better quantify the processes controlling the sulfur budget in this area [*Mari et al.,* this issue].

ACE 1 (`http://saga.pmel.noaa.gov/ace1.html`) was the first in a series of IGAC aerosol experiments. The data are available in a central archive (`http://www.joss.ucar.edu`) and on CD (contact bates@pmel.noaa.gov). The understanding gained in this experiment is being used to study progressively more complex environments. The Tropospheric Aerosol Radiative Forcing Observational Experiment (TARFOX) focused on clear-column closure experiments off the East Coast of the United States in July 1996 [*Russell et al.,* 1999]. ACE 2 extended the process and closure studies to the eastern North Atlantic Ocean in June/July 1997 and focused on the anthropogenic aerosols from the European continent and mineral dust from the African continent (`http://rea.ei.jrc.it/~vandinge/ace2/ace2main.html`). Planning is now underway for the next ACE that will focus on the region downwind of the rapidly increasing pollution sources in eastern Asia (`http://saga.pmel.noaa.gov/aceasia/`). We hope the papers presented in this special section will serve as a further stimulus to join both in the process of interpreting the unique ACE 1 data set and in future ACE.

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