Automated Longterm Measurement of Atmospheric Dimethylsulfide at Barrow, Alaska

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Dimethylsulfide (DMS) is a trace gas produced by life in the surface ocean. Its somewhat sweet smell at very low concentrations along the ocean shore accounts for the commonly recognized "smell of the sea." The production of DMS is so predictably linked to biological processes that certain species of sea birds (petrels and albatrosses) follow the smell of DMS to locate patches of prey on the broad ocean. They use their sense of smell to generate an "olfactory landscape" on what is otherwise visually monotonous from horizon to horizon.

Dimethylsulfide originating from the surface ocean is the major source of non-sea-salt aerosols in the air-sea boundary layer. Feedbacks between DMS and climate have long been hypothesized. Although DMS is typically present at concentrations less than one-millionth the concentrations of carbon dioxide (CO_2), DMS contributes to Earth's radiation balance as a "cooling gas" by reflecting incoming sunlight back out to space. One thing that makes DMS quite different from the more prominent climate gases (e.g., carbon dioxide and methane) is its short lifetime in the atmosphere. The global dynamics of longer-lived gases can be quantified by measuring at a few locations around the globe and for relatively long intervals; however, this is not possible for a short-lived gas like DMS. As a result, understanding the contribution of DMS on a global scale requires measurements at multiple locations at much more frequent intervals – 15-minute intervals is imperative for modeling a gas that resides 1-2 days in the atmosphere. Moreover, this is data that atmosphere and climate scientists increasingly want to include in their models.

The most prominent and possibly only long-term data sets for atmospheric DMS were measured in the Southern Hemisphere at Tasmania, Australia, and at Amsterdam Island in the southern Indian Ocean. Samples were taken by collecting DMS from large volumes of air onto the surface of gold wool (like the more familiar steel wool), stored and measured within days of collection. Measurements by these groups were not automated. It required considerable personnel time to collect and transport samples for subsequent analysis in laboratory settings.

With support from the Clark Arctic Research Initiative and in conjunction with Professor Clara Deal of the University of Alaska, I have developed and deployed an automated system for measuring the dynamics of atmospheric DMS at the Barrow Alaska Observatory (BRW), a facility managed by the National Oceanic and Atmospheric Administration's Climate Monitoring and Diagnostics Laboratory (Figure 1). Barrow is an ideal place to measure DHS, because it has excellent exposure to marine air and is the focus of a range of other atmospheric measurements – including aerosols. The system I developed for

Figure 1: Barrow, Alaska Observatory (BRW), part of NOAA's Climate Monitoring and Diagnostics Laboratory.

BRW is designed so that large portions of the program can be loaded and modified, and data can be accessed through the Internet. It is also possible to run extensive diagnostic tests over the Internet to narrow the focus on any problem before contacting on-site personnel.

Figure 2 shows data collected during September 2009. The pulses in DMS correlated with winds from the West and Northwest off the Chukchi Sea, and also from the town of Barrow. The low DMS concentrations coincided with winds from the South (the land of the North Slope of Alaska) and from the East (off the Beaufort Sea). Because we were hampered in the first year of operation by the prohibitive cost of delivering compressed gases by air freight to the site (a necessary component of the system), we stopped operating the system at the end of September 2009. In addition, brief measurements taken in late December and late March 2010 indicated that DMS levels were below detection limit. However, DMS became easily measurable in June and July; and, in late August, the system was redesigned, thus eliminating the need for compressed air to be delivered. The system now requires only 110V AC power, occasional additions of distilled water, and a link to the Internet for long-term operation.

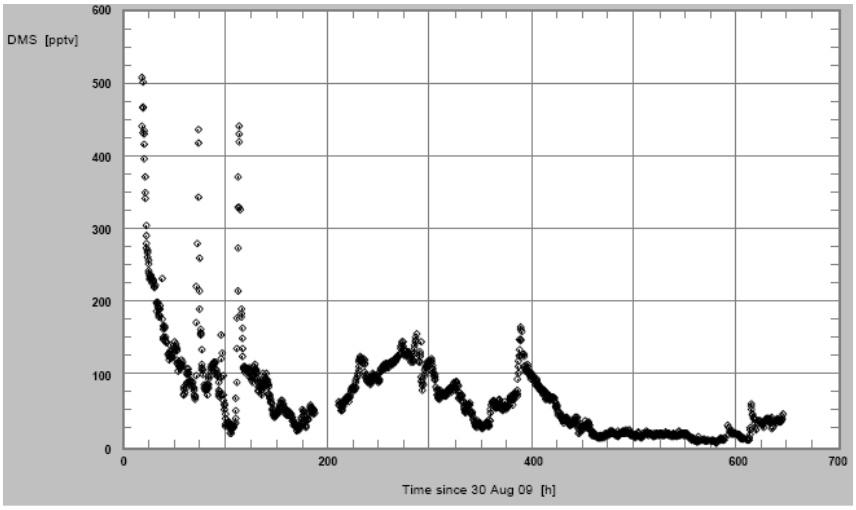

Figure 2: Atmospheric DMS at the BRW during the month of September 2009.

Results of our data have been well received. The data collected from the Southern Hemisphere shows 2,822 points collected over almost 10 years; but, our automated system in Barrow can exceed that number of analyses in one month. By taking advantage of automation to increase the sampling rate, we are creating a time-series of high resolution data that modelers need. Moreover, as a consequence of the work begun at Barrow, I have been invited to be a project partner with a team from the United Kingdom that is planning to further investigate the role of aerosols in Arctic climate interactions. In addition, I have been awarded funds to build a similar system in Bermuda and have submitted a proposal to the National Oceanic and Atmospheric Administration (NOAA) to develop a system at its Trinidad Head observatory in northern California.

I am grateful to the donors of the Clark Arctic Initiative for their support in the development of this automated system that may further advance our understanding of climate change.