9.2 OBSERVATIONS OF ANTARCTIC FOG PARTICLES

Matthew A. Lazzara*, Pao K. Wang, and Charles R. Stearns
Antarctic Meteorological Research Center, Space Science and Engineering Center,
and Department of Atmospheric and Oceanic Sciences, University of Wisconsin-Madison
Madison, Wisconsin

1. INTRODUCTION

A leading factor affecting the logistic support efforts in the Antarctic is weather. Significant weather impacts air operations that deploy scientists to Antarctica and deep field camps, and that supply the main stations, such as McMurdo Station, Antarctica. Of the several hundred flights that are planned to and from McMurdo Station each year, a significant number are aborted due to bad weather conditions. Fog is the number one problem related to flights aborted. Despite this fact, few studies have been undertaken on Antarctic fog.

One of the first steps to improving our understanding of Antarctic fog is to make observations of the actual fog particles (liquid droplets or frozen ice). This information may be critical to forming improved means of detecting fog from advanced satellite platforms. With regards to Antarctic fog, the physical characteristics of fog particle sizes, shapes and concentrations are unknown. This paper reviews the attempts made during the 2002-2003 Antarctic field season to collect, observe, and learn about fog particles and some of their characteristics. The simple, inexpensive method used to collect the particles and initial findings is presented here.

2. COLLECTION METHOD

The method employed to facilitate collection of fog particles during a fog event in the McMurdo Station area was a set of petri dishes filled with DC-200 fluid or Silicon oil (donated from Chemcentral Corporation of New Berlin, Wisconsin), placed out in the open during an event. Fog particles will fall into the petri dish (by wind and/or gravity) and then be captured and collected in the fluid. The viscosity of the fluid is fairly close to that of water (1.5 centistokes) so as to preserve the particle's shape and size. The DC 200 fluid was stored in a -20 Celsius freezer to attempt to ensure that the fluid would not melt any possible frozen or ice fog particles. The particles were then studied at the Crary Science and Engineering Center (CSEC) at McMurdo Station, where microscopes are available to make measurements and take photographs. An invert microscope was utilized to view the samples collected in the petri dishes.

* Corresponding Author: Matthew A. Lazzara
947 Atmospheric, Oceanic and Space Science Building,
1225 West Dayton Street, Madison, Wisconsin 53706
Phone: 608-262-0436 Fax: 608-263-6738
Email: mattl@ssec.wisc.edu

3. REVIEW OF TWO FOG EVENTS

During the 2002-2003 field season, personnel deployed during January, the month of typical maximum fog occurrence (Cayette, pers. comm., 2002). Unfortunately, weather and ice conditions were such that only two fog events took place during deployment (7 Jan 2003 and 5 Feb 2003). Sampling was attempted during both these events along the side and atop Observation Hill, located next to McMurdo Station, Ross Island, Antarctica.

The first event took place on 24 January 2003 at approximately 1 UTC (2 p.m. local time). At Williams Field, ten kilometers from McMurdo, fog in the area with reduced visibility was reported during this brief event (See Table 1). At the same time, fog was rapidly developing around McMurdo Station itself. Due to the rapid development of the event, it was decided to attempt to collect fog at nearby Observation Hill, rather than miss the opportunity while attempting to travel to Williams Field.

Decoded METAR reports Williams Field, Antarctica

Time UTC	T [C]	Td [C]	Dir [mps]	Spd [mps]	AltSet [mb]	Vis [km]	Weather	Clouds [cover/m]
23:55	2	0	080	3	999.0	11.27		5/002
00:55	2	0	090	3	999.0	4.83	F	8/001
01:55	2	0	090	5	999.3	11.27		5/001
02:20	2	-1	090	5	999.0	11.27		5/002

Table 1. A listing of weather observations from Williams Field Antarctica, roughly ten kilometers from McMurdo Station, showing the short duration of this fog event.

The first sample was taken at a location approximately two-thirds of the way up Observation Hill at 1:30 UTC for 5 minutes. A second and third sample were taken at 1:45 UTC for 5 minutes and 2:07 UTC for 20 minutes, respectively. After this, the fog event quickly came to an end.

The second event took place on 3 February, however this event came with high winds that prevented this collection system from working - the petri dish nearly lifted away with the wind in the one attempt made during the event.

A case study of the meteorology for these events was not complete at the time of submission of this abstract. An initial review of weather observations from the McMurdo Station and Ross Island region (See Figure 1) confirms the weather conditions during these two events with high relative humidity reports and fog in the observations from the nearby airfield (See Table 1).

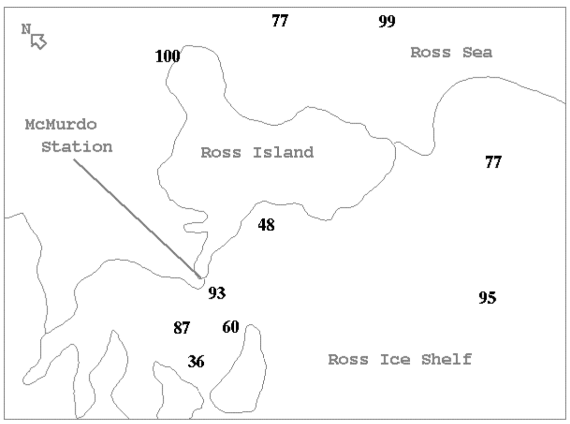

Figure 1. A plot of relative humidity from the University of Wisconsin-Madison Automatic Weather Station (AWS) network shows high relative humidity measurements in the Ross Island region during the fog event of 24 January 2003 at 1 UTC.

4. INITIAL RESULTS AND DISCUSSION

Of the three samples taken during the first fog event, an examination under the microscope revealed that only the first of the three samples held fog particles, and in this case they were indeed liquid droplets. Figure 2 shows the two droplets found in this sample as seen under the microscope at 60X power. Measurements and calibration of the microscope using a micrometer estimate that each division (minor) in these images is approximately 2.5 to 3.8 microns. Thus, these droplets appear to be approximately 7.5 to as much as 10 microns in size. Only three droplets in total were found in this sample.

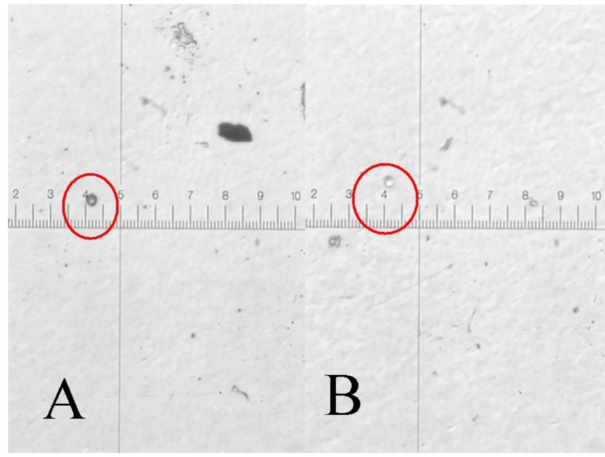

Figure 2a. and b. This figure shows two of the fog particles found in a sample taken during the first fog event on 24 January 2003. The fog droplets are circled in red, and the scale in each figure has one subdivision equal to approximately 2.5 to 3.8 microns.

Although the second fog event did not produce any samples, it did offer some key information. This fog event came with both high winds and a light rime ice on any feature above the ground, including buildings, rocks, antenna towers, etc. This rime ice indicates that the fog is indeed in liquid form rather than frozen form. This helps to reinforce that in the austral summer, liquid fogs are perhaps more likely than ice fogs which are indeed found in the Ross Island area during the austral winter (ATS, 1999; Cayette, 1998 and 1999).

5. FUTURE WORK

Clearly this work, as ground breaking as it may be with the first documented fog droplets over the Antarctic, is very rudimentary. A more formal method for fog particle collection needs to be proposed and funded. Perhaps following the example set in the SPARCLE project (Walden et. al. 2003) a balloon-borne replicator (Miloshevich and Heymsfield, 1997) was used to observe cloud particle sizes, shapes and characteristics over South Pole Station. Such a device will allow the entire fog layer to be sampled for fog particles, rather than the lower portion of the fog as conducted here. Additionally, this device may offer a way to collect even in higher wind fog events, which appear to take place in this part of the Antarctic (Cayette, per. comm. 2000; Thompson, per. comm., 2002)

In addition to completing the case studies for these two fog events and a more comprehensive review of ground based observations of fog, the information determined from this field work can now be employed to simulate how fog might be seen from advanced satellite platforms. This foundation allows for future innovations to be built with possible means to not only improve our understanding of Antarctic fog, but to open the door to improved forecasting of these events, cost savings and greater safety for aviation and other logistical operations.

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