Lower atmosphere studies

Antarctic automatic weather stations, austral summer 1984 – 1985

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The automatic weather stations (AWS) in Antarctica measure air temperature, wind speed, and wind direction at a nominal height of 3 meters above the surface, and air pressure at the electronics box. The system is under the control of a microcomputer, which at 10-minute intervals updates the data and at 200-second intervals transmits five data points for each sensor to polar-orbiting satellites equipped with the Argos systems (Stearns and Weidner 1983; Weidner and Stearns 1985).

The AWS units provide surface weather observations for the following studies:

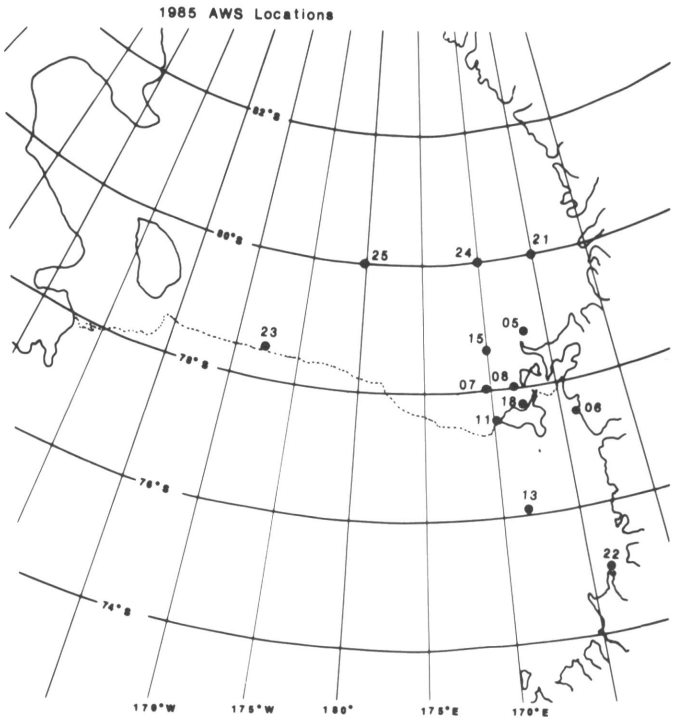
- Barrier wind along the Transantarctic Mountains and the Antarctic Peninsula.
- Katabatic flow down the Adelie coast, the Byrd Glacier, and the Reeves Glacier.
- Mesoscale circulation on the Ross Ice Shelf.
- Climatology of Dome C, Byrd Station, and Siple Station.
- Sensible and latent surface heat fluxes on the Ross Ice Shelf.
- Oceanographic support.
- Meteorological support for aircraft operations at McMurdo.

Some of the AWS units may be used for three or more of the above studies.

The table gives the AWS identification number, location, and start date for the installed units. An AWS unit that fails and is repaired may go to a different location with a different identification number, or the identification number may stay the same. Attempts are being made to keep the identification number the same at each site to minimize confusion, but this is not always possible. As of 1 May 1985, 18 AWS units were operating satisfactorily, one was transmitting incorrect data, and three deployed units were not being received (although AWS 8921 is received occasionally and the data are correct). The figure is a map of the AWS units in the vicinity of McMurdo Station.

During 1984, AWS units 8906, 8907, 8908, 8910, 8915, 8921, and 8922 ceased being received by the Argos system. These needed to be retrieved, repaired, and reinstalled with the B-data format introduced in austral summer 1983 – 1984 (Stearns 1984).

Improvements to the AWS units included a waterproof box for the electronics, a shorter boom with the aerovane mounted directly over the supporting tower, and a ground-plane antenna. The waterproof boxes are necessary because if any snow enters the box and melts on the electronics, corrosion eventually breaks a connection and the unit stops working. This happened to AWS 8906. The aerovane had been mounted on the end of a 1.8-meter boom with the antenna on the other end. With high winds perpendicular to the boom, the tower-boom-box system could oscillate and break. The shorter 0.9-meter boom with the aerovane in the middle is less subject to oscillation in high winds. The old antennas were fully enclosed and impossible to inspect visually for internal failures. Vibration could and had broken internal connections. The ground-plane antenna has minimal exposure to the wind, can be visually inspected, and is received well by the Argos system. All booms, boxes, and antennas will be replaced with the newer units when possible. Although winds above 40 meters per second were encountered at several sites, no damage was noted on power, signal, and antenna wiring.



Automatic weather station units in the vicinity of McMurdo, Antarctica, as of 7 February 1985. The numbers by the dot are the last two digits of the automatic weather station identification number. The location of McMurdo Station on Ross Island is indicated by x.

The AWS units 8906, 8907, 8908, 8915, and 8922 were repaired and reinstalled. The moisture sensors on 8908 and 8911 were recalibrated and the one on 8909 was replaced. Two new units, 8924 and 8925, were installed on the Ross Ice Shelf east of Byrd Glacier using a ski-equipped Hercules airplane for transportation.

Four new AWS units were sent to the British Antarctic Survey (BAS) for installation along the Antarctic Peninsula. Damage to the landing gear of two twin otter airplanes prevented the installation of the units during austral summer 1984 - 1985.

AWS 8922 at Inexpressible Island was visited by ice breaker and helicopter. The electronics had been returned to McMurdo in early January 1985 and the power supply was repaired. The location may be one of the windiest places on Earth near sea level. The March 1984 average wind speed was 18.6 meters per second with a maximum of 45.1 meters per second. The constancy of the wind was .98 from 295 degrees which is the direction from the Reeves Glacier and normal to the boom. Several cross braces and one leg of the tower were broken indicating twisting of the tower. The shorter boom was installed with the aerovane located in the middle of the tower. The limber tower was left in place as a replacement was not available. The electrical wires did not show any damage. The new box with the repaired unit was installed.

The AWS units at D-10, D-47, and D-57 along the line from Dumont d'Urville Station toward Dome C had batteries and new battery voltage regulators installed. The ground-plane antennas arrived too late for installation at D-47 and D-57 but one was installed at D-10. AWS unit 8923 had new batteries and a voltage regulator installed.

AWS 8910 and 8921 were not visited during austral summer 1984 – 1985 so repairs will have to wait until austral summer 1985 – 1986. AWS 8921 is occasionally received by the Argos system.

George Weidner and Charles Stearns were at McMurdo from 4 January 1985 to 1 February 1985.

Mark Lewis of the BAS was prepared to install AWS units along the Antarctic Peninsula. The AWS unit at Inexpressible Island was returned to McMurdo for repairs by members of Bundesanstalt für Geowissenschaften und Rohstoffe under the direction of Franz Tessensohn. Didier Simon of the Expéditions Polairs Françaises went on a traverse to D-10, D-47, and D-57. J. Ardai assisted at Inexpressible Island and did the work on the Ross Ice Shelf at 172.5°W (AWS 8923). The support we received from ITT/Antarctic Services, the National Science Foundation staff, VXE-6 pilots and crew and the Naval Support Force Antarctica was outstanding. Special thanks go to Lt. Commander Littke and Lt. Gill.

Automatic weather stations, Antarctica

Identification	Geographic location	Latitude	Longitude	Elevation (in meters)	Start date	Status as of 7 February 1985
8900	D-80	70.02°S	134.72°E	2,500	14/01/83	Operating satisfactorily.
8901B[a]	D-10	66.70°S	139.80°E	240	15/01/84	Operating satisfactorily.
8902B	Rothera					Ready for deployment in austral summer 1984–1985 by the British Antarctic Survey.
8903	Byrd	80.00°S	120.00°W	1,530	02/80	Operating satisfactorily.
8904	Dome C	74.50°S	123.00°E	3,280	13/01/84	Operating satisfactorily.
8905	Minna Bluff	78.77°S	166.85°E	66	25/11/80	Operating satisfactorily.
8906B	Marble Point	77.43°S	163.75°E	121	02/80	Operating satisfactorily.
8907	Ross Ice	78.02°S	170.80°E	44	10/12/80	Operating satisfactorily.
8908B	White Island	77.95°S	168.17°E	25?	10/12/80	Operating satisfactorily. This unit has relative humidity and temperature difference detector.
8909B	Madison					Not deployed. Currently stored at Madison, WI.
8910B	Siple	75.90°S	84.30°W	900	26/11/83	Not being received.
8911B	Cape Crozier	77.55°S	170.09°E	27	14/01/84	Operating satisfactorily. This unit has relative humidity and temperature difference detector.
8912	Larsen Ice	67.00°S	60.47°W	50?	07/02/83	Transmitting incorrect data.
8913	Franklin Island	76.24°S	168.66°E	274	23/01/82	Operating satisfactorily.
8914B	D-47	67.38°S	138.72°E	1,560	10/01/84	Operating satisfactorily.
8915B	Ross ice	78.52°S	170.18°E	52	04/12/80	Operating satisfactorily.
8916B	D-57	68.18°S	137.52°E	2,103	06/01/84	Operating satisfactorily.
8917B	Rothera					Ready for deployment in austral summer 1984–1985 by the British Antarctic Survey.
8918	Windless Bight	77.75°S	167.67°E	44	09/02/83	Operating satisfactorily.
8919B	Madison					Not deployed. Currently stored at Madison, WI.
8920B	Rothera					Ready for deployment in austral summer 1984–1985 by the British Antarctic Survey.
8921B	Byrd Glacier	79.98°S	165.03°E	75?	16/01/84	Not being received. This unit has relative humidity and temperature difference detector.
8922B	Inexpressible Island	74.92°S	163.60°E	80	06/02/84	Operating satisfactorily.
8923B	Ross Ice	78.31°S	172.50°W	42	01/02/84	Operating satisfactorily.
8924B	Byrd Glacier	79.56°S	169.45°E	50?	01/24/84	Operating satisfactorily. This unit has relative humidity and temperature difference detector.
8925B	Byrd Glacier	80.00°S	179.00°W	50?	01/24/84	Operating satisfactorily. This unit has relative humidity and temperature difference detector.
8926B	Rothera					Ready for deployment in austral summer 1984–1985 by the British Antarctic Survey.

[a] The "B" after the identification number indicates that the transmitted data word was modified to include five values of wind speed and direction.

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Air chemistry monitoring at Palmer Station

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Regression data for weekly averages (4 April 1982–27 April 1985)

Compound	Intercept	Slope	r^2	n	Annual trend
F-11	183.0±0.2	0.182±0.002	0.985	139	+5.17%
F-12	300.3±0.5	0.341±0.005	0.971	137	+5.91%
Methyl chloroform	113.2±0.3	0.120±0.004	0.885	142	+5.51%
Carbon tetrachloride	146.5±0.2	0.037±0.002	0.783	142	+1.31%
Nitrous oxide	299.7±0.2	0.015±0.002	0.224	140	+0.260%

The 1984 – 1985 season was the third year of operation for the Washington State University Palmer Station air chemistry facility. A paper describing some of the results of the first 2 years of the program has been published (Robinson et al. 1984) and the establishment and operation of the program have been described in previous *Antarctic Journal* reports.

The original program goal was to document time trends, seasonal variability, and meteorologically influenced changes in the concentrations of various atmospheric trace gases which have implications for stratospheric ozone depletion and climate change. The two-fold objective for the 1984 season was to continue the atmospheric trace chemistry monitoring and to measure the chemical composition of precipitation.

The atmospheric trace gases measured hourly were ozone (O_3), methane (CH_4), carbon dioxide (CO_2), carbon monoxide (CO), fluorotrichloromethane (F-11 or CCl_3F), difluorodichloromethane (F-12 or CCl_2F_2), carbon tetrachloride (CCl_4), methyl chloroform (CH_3CCl_3) and nitrous oxide (N_2O). These gases are measured using gas chromatographic techniques with the exception of ozone (UV-photometry). Typical meteorological variables and condensation nuclei are also measured continuously.

Figure 1 shows the concentrations as a function of time for nitrous oxide F-12, F-11, carbon tetrachloride, and methyl chloroform, respectively. Missing data result both from periods of equipment failure and unreduced data. The data cover the period from 4 April 1982 through 27 April 1985. The table shows the preliminary results of the time trend regression analysis for five of the atmospheric components based on 3 years of preliminary average weekly concentrations. As can be seen in the table, the trends for F-11, F-12, methyl chloroform, and carbon tetrachloride continue to show increasing concentrations of 5.2 percent, 5.9 percent, 5.5 percent, and 1.3 percent per year, respectively. The nitrous oxide increase is only 0.26 percent per year. These trends are similar to the trends seen by others (Weiss et al. 1981; Cunnold et al. 1983-a, 1983-b; Prinn et al. 1983; Simmonds et al. 1983).

Carbon dioxide and methane are not included in the table because simple linear regression analysis is inadequate because of the pronounced seasonal fluctuations. However, preliminary weekly average concentrations as a function of time beginning 31 January 1982 and ending 27 April 1985 are shown for carbon dioxide and methane in figure 2. Carbon monoxide (CO) data for 1984 has not yet been reduced.

There is a report on the first austral summer season precipitation chemistry program by Robinson, Cronn, and Bamesberger (1984) in the 1984 *Antarctic Journal*. In the second season of the precipitation program, precipitation events were sampled between 1 January and 20 April 1985. As in 1984, the modified Hubbard-Brooks rain and snow samplers were located between Palmer Station and the adjacent glacier. In addition, a new automatic sampler was placed between the old Palmer Station and the surrounding glacier, and a sampler was placed on the *Polar Duke* to collect samples while the ship was cruising the waters surrounding Anvers Island. Rain samples were analyzed for pH and acidity, anions (e.g., chloride and sulfate), and cations (e.g., potassium, calcium, magnesium, and ammonium). Preliminary results of the pH measurements gave volume-weighted means for the Palmer Station samples only of 4.68, 4.98, and 5.13 for January, February, and March 1985, respectively. These values are lower than the pH of 5.65 expected from equilibrium with atmospheric carbon dioxide and therefore might be considered "acid" rain. Analysis and interpretation of the precipitation chemistry data will be accomplished following receipt of the entire data set currently in transit from Palmer Station.

The field program at Palmer Station was carried out by Tom Ferrara, the 1984 wintering scientist, and Connie Rauen, who was responsible for the 1983 – 1984 and 1984 – 1985 austral summer precipitation measurements. Assistance was provided