Investigation of Sulfur Chemistry in the Antarctic Troposphere (ISCAT)

This page can also be found at: https://www.eol.ucar.edu/isf/projects/iscat2000/

Atmospheric Research Observatory building and tower at the south pole.

NEW: Early June 2001

- New version of the 5 minute statistics are now available from this page.
- High-rate time series (1 or 20 samples/sec) are also available.

Introduction

This document is a standard product of NCAR/ATD/RTF which gives an overview of the measurements taken using the Integrated Surface Flux Facility (ISFF) and conditions during the ISCAT2000 field experiment. This document can be obtained in hard copy from RTF upon request.
The ISCAT Proposal and ISFF Request are available to describe the scientific goals and experiment design. We went into even greater detail planning the sensor placement for ISCAT.

Status of 5-minute Statistics

June, 2001

- 5 minute statistics have been rerun, with some minor corrections.
- 5 minute statistics available on web in netcdf or ascii form.

Location

NCAR/ATD installed instruments on an existing scaffolding tower situated ~400m, bearing ~70 degrees (South pole grid) from the Geographic South Pole (see map). NOAA/CMDL (see below) has been making measurements from this tower. A layout of our sensors is available.

Chronology

- 3 Oct: Equipment shipped from Boulder.
- 8 Nov: Steve Semmer leaves to begin setup.
- 16 Nov: Steve arrives at the Pole.
- 18 Nov: Equipment arrives at the Pole

- 19 Nov: Steve begins equipment check-out at Atmospheric Resarch Observatory (building 23).
- 22 Nov: Sensors moved from building to tower.
- 23 Nov: All T/RH sensors in intercomparison mode.
- 24 Nov: NO system connected.
- 25 Nov: T/RH sensors in profile configuration.
- 25 Nov: Data system crashes (fiber optics fixed, power also rerouted).
- 26 Nov: Data system back at the building for testing for ~12 hours.
- 29 Nov: Data system crashes again (card swaps, moved to "ground", not RFI)
- 4 Dec: Steve Semmer back, operations maintained by Georgia Tech.
- 9 Dec: NO system removed (probably earlier).
- 27 Dec: T/RH sensors back in intercomparison mode (4 sensors at a time).
- 28 Dec: Tear down.
- Feb: Equipment back to Boulder.

Table of Variables

ISCAT2000 Data Access

The NCAR ISCAT00 data are available for download in the following forms:

- 5-minute statistics in ASCII form for the entire measurement period (Java not needed). Produced 25 Nov 2001.
  - Pressure, Temperature, and Humidity data (low-rate sensors)
  - 3.1m sonic anemometer turbulence measurements
  - 7.0m sonic anemometer turbulence measurements
- 5-minute statistics in NetCDF form

Also available is a computer-readable logbook of comments noted by NCAR/ATD and other personnel. MANY PEOPLE MISS THIS IMPORTANT SOURCE OF PROJECT INFORMATION -- PLEASE LOOK HERE!

ISCAT2000 Photographs

Images were taken by Steve Semmer. Some of these may duplicate those that he took upon arrival. He also took photos of equipment packaging (to aid in return shipping) and of Christchurch, NZ. Images from 1999 are available courtesy of Russ Schnell (NOAA/CMDL).

Sensors and Data Processing

General Data Processing

The sensors were labeled with heights chosen prior to actual deployment. Based on several

measurements taken in the field, these heights were lower by typically 20cm. The variables in the data and in the discussion below use the actual heights. (But old names were used in the logbook.)
Also, data were taken near Building 23 and in the T/RH intercomparison array in addition to the normal operations array. To avoid confusion, we have decided in post-processing to split these different operations periods. Variables with a ".blg" suffix were measured near the building and with a ".ic" suffix were measured in the intercomparison array. All other data were taken in a normal mode.

Finally, one data sample at 06:40:00 on 27 Nov from the 3.1m sonic anemometer was bad, so statistics were manually recomputed for the 5-minute period contining this sample using the routine: /net/aster/isff/src/sfun/ISCAT00/fixnov27.q.

Sonic Anemometers

Sonic anemometers (ATI K-probes) were used to determine the sensible heat flux (the flux of latent heat was presumed to be small at the Pole) using the eddy-correlation technique. These direct flux measurements would be used by the modified Bowen ratio method to determine the NO flux. We deployed anemometers at two heights to determine the flux divergence close to the surface, and thus be able to linearly interpolate to a surface flux value.
We start with a comparison of wind speed and wind direction (using our lower sonic as a reference). To obtain a bit more information, I have added the CMDL prop-vane data. (From photographs, it appears that their prop-vane was mounted at ~9.2m.) The speed from the 7.0m sonic is usually larger than those from 3.1m, as expected. The only exceptions are a few periods when the speeds are mostly less than 2.5 m/s. The CMDL prop also generally agrees with the sonic data, though the speeds are lower than expected by ~0.5 m/s. (The wind speed at 9.2m should be larger than at 7.0m.) I also note that the average speed from a prop is the average of the scalar speed magnitude, whereas the average from a sonic is the magnitude of the wind vector. Thus, the prop speed should have been even higher than the sonic speed. There is a hint in the data that the differences are largest in low winds.

To obtain agreement in wind direction, I have had to assume that the sonic anemometers were pointed in the direction of 38 degrees (rather than 70 degrees as noted in the logbook). (By scaling off a photograph and map, I obtain values from 37-40 degrees -- no, I didn't cheat!)

We can also examine our spike detector, which flags the number of data samples which are questionable. (See our Despiker documentation.) I have presented these flags as a histogram (black for 3.1m data and red for 7.0m). Only 8 5-minute periods had more than 1% of the samples flagged from the 3.1m sonic. The 7.0m sonic was significantly worse, but still only had 3 5-minute periods with more than 3% flagged as questionable. I note that our despiking algorithm can be fooled when the skewness of the data is large, which could be the case in the stable conditions during ISCAT.

Thus, at least for mean quantities, the sonic anemometer data appear to be reasonable.

We can now produce the tilt plots for the 3.1m and 7.0m sonics. Note that these plots are in actual wind direction coordinates (rather than our normal sonic coordinates). The resulting lean angles are 1.4 and 1.3 degrees, respectively, which is acceptable. The lean azimuths in this plot were computed using a (wrong) boom angle of 70 degrees, which is 160 degrees clockwise of the instrument "boom angle" of 270 degrees. Since lean azimuth is defined counterclockwise from the sonic u-vector, we must add 160 to what was computed. Thus, the lean azimuths for 3.1m are 79 deg -> 239 deg and for 7.0m are 118 deg -> 278 deg. After applying these corrections, the tilts are nearly zero for 3.1m and 7.0m.

T/RH

Standard NCAR temperature and humidity sensors were deployed in a vertical array up the tower. The primary purpose was to provide a scalar gradient measurement to be used in the modified Bowen ratio method to determine the NO flux. A secondary purpose was to identify the height of the stable boundary layer. Heaters were attached to the aspirating fans to allow them to be restarted in case of inadvertent shutdown (e.g. power loss).
Since a good gradient measurement was needed, the sensors were operated in an intercomparison mode at the beginning and end of the project. During the beginning IC, some sensors were exchanged (also with the spare) to obtain the best comparison. The residuals from the default calibrations were at most 0.06 C and 6% RH. However, these residuals were quite consistent during the ICs, so manual correction to 0.01 C and 1% RH probably is possible. The post-experiment ICs were done 4-channels at a time, with sensors 704 and 007 in both sets. From these two, I arbitrarily chose to reference all sensors to sensor 704 for processing the IC data.

The time periods of these ICs were:

Pre IC#1	**24 Nov 12:00 - 24 Nov 15:15 (NZDT)**
Pre IC#2	**24 Nov 17:00 - 25 Nov 12:40 (NZDT)**
Post IC#1	**27 Dec 17:00 - 28 Dec 09:00 (NZDT)**
Post IC#2	**28 Dec 09:45 - 28 Dec 17:45 (NZDT)**

The temperature differences (in C) from sensor 704 (the 2.1m sensor) values are:

Sensor ID	Height Deployed	Pre IC #1	Pre IC #2	Post IC #1	Post IC #2	Used
007	4.7m	+0.02	+0.04	0.00	+0.02	+0.02
101	0.5m	+0.02	+0.03	+0.02		+0.02
104	0.9m	+0.03	+0.04	+0.03		+0.03
502	21.8m	+0.06	+0.06		+0.02	+0.02
703	10.1m	+0.03	+0.03		+0.00	+0.00

and the humidity differences (in %RH) are:

Sensor ID	Height Deployed	Pre IC #1	Pre IC #2	Post IC #1	Post IC #2	Used
007	4.7m	+1	+1	+2	+1	+1
101	0.5m	-3	-3	-3		-3
104	0.9m	+2	+2	+2		+2
502	21.8m	-4	-4		-4	-4
703	10.1m	+6	+6		+6	+6

We plan to remove the biases shown in the last column from the statistics (using Splus) [applied fixTRH.q, 6 Jun 01] and also from the time series processed using Java [not yet done].

Please note that the performance of our RH sensors in very cold conditions has been questioned. In particular, our sensors tended to indicate subsaturation conditions during SHEBA when conditions were thought to be saturated. A report of laboratory testing of this problem (without a satisfactory conclusion) was written for SHEBA.

Barometer

A Vaisala PTB100B barometer was mounted inside our data acquisition system (ADAM) box at ~1m on the tower. The pressure port was our standard single plate mounted near this box (see photo). The primary purpose for this sensor is to allow the computation of specific humidity or water vapor density from the measurements of T and RH.
The data from this sensor appear to be normal, with an average value of ~690mb. There are several data glitches early in the program (see plot), notably on Nov 22, 25, and 29, associated with data system moves and crashes (see Chronology above).

Obviously bad values will be set to NA in the final statistics data set [ran fixP.q, 7 June 01], but glitches during the above periods will still be seen in the time series. Values outside the range 675-700mb should be considered data system glitches.

Daily Weather Plots

Click on the following to obtain once/day plots for several important measured variables. Each plot represents 24 hours of data. Please read the scales carefully for more details.

November

19	20	21	22	23	24	25
26	27	28	29	30		

December

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	

Other plots

For the four-day period Nov 26 11:30 - Nov 30 22:30 NZDT, I have computed the NO flux from our data. A flux plot shows the heat flux from our sonic, the NO flux computed from the heat flux using a modified Bowen ratio, the difference in temperature between the 4.8m and 0.5m and the difference in NO concentration between these levels. [This plot now has the most recent data, including the sonic tilt correction and T and RH bias corrections. I also now have a version of this flux plot using NO values from Marty Buhr.] A mean plot shows the wind speed, wind direction (in instrument coordinates), temperature and humidity during this period. The NO flux appears to be best correlated with wind speed, shown in a scatter plot
For the same period, I've also plotted the 22m NO concentrations along with the measurements at 0.5 and 4.65m. I've also plotted a typical profile of several quantities. In this case, the height of the boundary layer ("H") has been found by extrapolating the NO concentration or fluxes to a value of 0. The values found, respectively, are 91, 25, and 46m. This is one of the best cases. At Don Lenschow's suggestion, I've also tried to calculate H from the peak in the horizontal wind speed spectra. For this case, it also works out to ~40m. Using all of these methods, I have a plot comparing all H estimates.

Other Data

NOAA/CMDL makes a lot of observations at their South Pole Observatory. These include radiation data and meteorological data.
Current snow and ice conditions, courtesy of the University of Illinois. (I thought this was interesting!)