Concordiasi 2010 Quality Controlled Driftsonde Data Set

Contents:

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Version	Date	Author	Change Description
1.0	2011	*J. Wang*	Initial Document Release
2.0	04-12-2017	*K. Young*	A dry bias in the RD94 dropsonde and driftsonde, and mini-dropsonde (NRD94) relative humidity measurements was discovered in data collected from 2010 to present. The dry bias is strongly temperature dependent. It is considered small at warm temperatures and it becomes stronger at cold temperatures. The RH dry bias has been corrected for, and the dewpoint has been recomputed. The data files that have received this correction contain an indicator in the header of the file, 'TDDryBiasCorrApplied'.

UCAR/NCAR - Earth Observing Laboratory. 2011. NCAR Driftsonde Sounding Data. Version 1.0. UCAR/NCAR - Earth Observing Laboratory. https://doi.org/10.5065/D6C24TN0. Accessed 12 Apr 2017.

For more information on the NCAR Driftsonde System please visit the following site: http://www.eol.ucar.edu/instrumentation/sounding/driftsonde

Disclaimer: The driftsonde data for this project were quality controlled and are maintained by the Earth Observing Laboratory at the National Center for Atmospheric Research (NCAR). NCAR is sponsored by the National Science Foundation (NSF). In the event that information or plots from this document are used for publication or presentation purposes, please provide appropriate acknowledgement to NSF and NCAR/EOL and make reference to Wang et al. (2011, J. Wang, K. Young, T. Hock, N. Potts and C. Martin, 2011: Concordiasi 2010 quality controlled driftsonde data set. Available at http://www.eol.ucar.edu/projects/concordiasi/

1. Dataset Overview

Concordiasi is a joint French-United States initiative that began during the International Polar Year (IPY). The Concordiasi field experiment in 2010 took place over Antarctic from September to December 2010. The scientific objective of Concordiasi is to combine innovative measurements and modeling components for better analysis and prediction of weather over Antarctica. Concordiasi was the third deployment of the NCAR/EOL driftsonde system, which was developed in an effort to produce a low-cost measurement system capable of capturing vertical profiles of in-situ measurements in forecast sensitive regions, and filling critical gaps in data coverage over remote locations.

The development and deployment of the driftsonde system was a collaborative effort between the Earth Observing Laboratory (EOL/NCAR) and the Centre National d'Etudes Spatiales (CNES). The driftsonde system consists of a stratospheric super-pressure balloon attached to a gondola that houses up to 56 Miniature In-situ Sounding Technology (MIST) dropsondes. The Super Pressure balloon used for Concordiasi floats along with the wind currents in the lower stratosphere or upper troposphere typically at 18 kilometers, and can remain airborne for between 50-120 days. The MIST sondes are released upon command via the ground operations center. During Concordiasi, total 648 MIST soundings were collected during 13 research flights launched from the McMurdo station between September 23 and December 8, 2010; 639 of them are contained in the final quality controlled data set (Figure 1) since nine of them contain either no sonde data or only ~10-20 hPa data at the top. The driftsonde systems deployed during Concordiasi remained operational from 43 to 94 days. They archived unprecedented spatial and temporal coverage of Antarctica, with high quality atmospheric profiles.

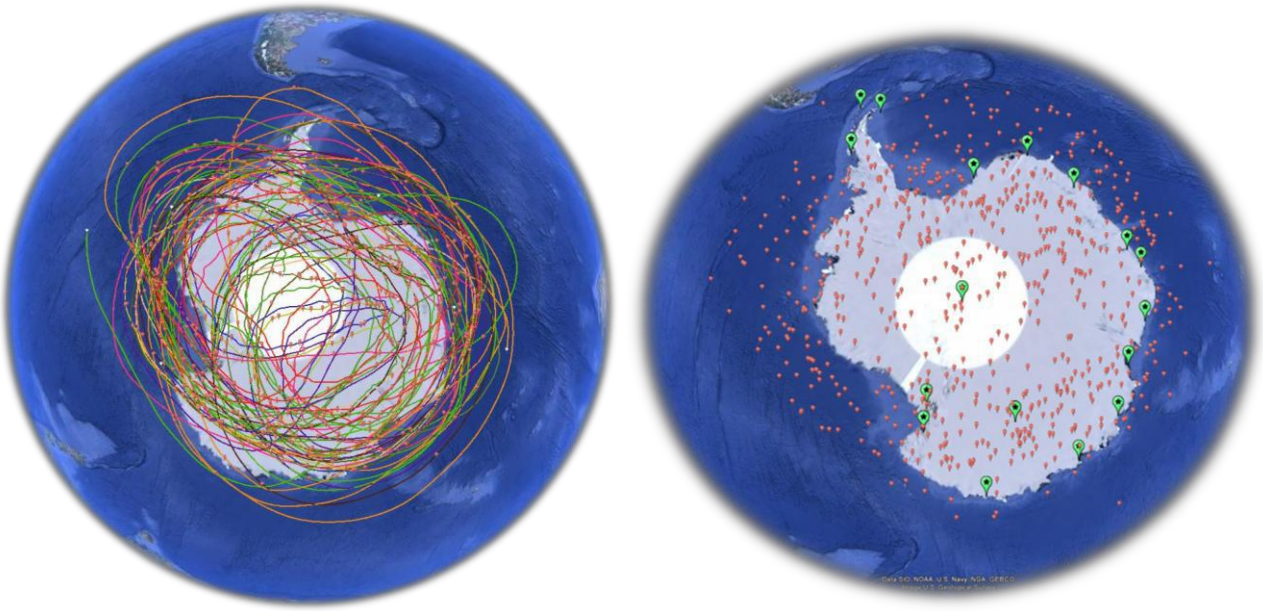

Figure 1 (Left panel) Flight tracks of the 13 Driftsonde flights around the polar vortex and (right Panel) map of the 648 MIST sonde launch locations (red balloon) and operational radiosonde stations (green balloon).

2. EOL Sounding File Format and Data Specifics

The EOL format is an ASCII text format that includes a header, with detailed project and sounding information, and typically seventeen columns of high resolution data (Table 1). The "QC.eol" files are quarter-second resolution data files with appropriate corrections and quality control measures applied. Note that the thermodynamic data (pressure, temperature and humidity, PTU) are only available at half-second resolution and wind data is available at ¼ second resolution. The naming convention for these files is "D", followed by "yyyymmdd_hhmmss.MSDxx_zzzzzzzz.1QC.eol" where yyyy = year, mm = month, hh = hour of the day GMT, mm = minute of the hour, ss = second of the hour (which refer to the launch time of the sonde), MSDxx = driftsonde flight number, zzzzzzzz is the MIST sonde ID, and "QC.eol" refers to the EOL file format type.

The header records contain information including data type, project name, site location, actual release time, and other specialized information. The first seven header lines contain information identifying the sounding. The release location is given as: lon (deg min), lon (dec. deg), lat (deg min), lat (dec. deg), altitude (meters). Longitude in deg min is in the format: ddd mm.mm'W where ddd is the number of degrees from True North (with leading zeros if necessary), mm.mm is the decimal number of minutes, and W represents W or E for west or east longitude, respectively. Latitude has the same format as longitude, except there are only two digits for degrees and N or S for north/south latitude. The following three header lines contain information about the data system and auxiliary information and comments about the sounding. The last 3 header lines contain header information for the data columns. Line 12 holds the field names, line 13 the field units, and line 14 contains dashes (--- characters) signifying the end of the header. Data fields are listed below in Table 2.

The files contain data collected at quarter-second intervals. The variables pressure, temperature, and relative humidity are calibrated values from measurements made by the MIST sonde. The dew point is calculated from the relative humidity and temperature. The geopotential altitude value is calculated from the hydrostatic equation from the surface upward by using surface elevations extracted from the Global Land One-km Base Elevation Project (GLOBE) database (GLOBE Task Team and others, 1999[1]) (see details in Section 3d). For the six soundings that failed to transmit data to the surface, we integrate from the flight level down. The descent rate of the MIST sonde is computed using the time-differentiated hydrostatic equation. The position (lat, lon) and wind data come directly from the GPS sensor.

[1] *GLOBE Task Team and others (Hastings, David A., Paula K. Dunbar, Gerald M. Elphingstone, Mark Bootz, Hiroshi Murakami, Hiroshi Maruyama, Hiroshi Masaharu, Peter Holland, John Payne, Nevin A. Bryant, Thomas L. Logan, J.-P. Muller, Gunter Schreier, and John S. MacDonald), eds., 1999. The Global Land One-kilometer Base Elevation (GLOBE) Digital Elevation Model, Version 1.0. National Oceanic and Atmospheric Administration, National Geophysical Data Center, 325 Broadway, Boulder, Colorado 80305-3328, U.S.A. Digital data base on the World Wide Web (URL: http://www.ngdc.noaa.gov/mgg/topo/globe.html) and CD-ROMs.*

Table 1 Example of EOL format used for both dropsonde and radiosonde sounding files.

Data Type/Direction: DRIFTSONDE SOUNDING DATA, Channel 1/Descending
File Format/Version: EOL Sounding Format/1.0
Project Name/Platform: CONCORDIASI, MSD01/DRIFTSONDE, drift19
Launch Site:
Launch Location (lon,lat,alt): 169 10.66'E 169.177713, 78 37.90'S -78.631735, 16971.12
UTC Launch Time (y,m,d,h,m,s): 2010, 09, 23, 02:19:02
Sonde Id/Sonde Type: 091232461/Mistsonde
Reference Launch Data Source/Time: Gondola/None/
System Operator/Comments: Remote
Launch/None/
Post Processing Comments: Aspen Q/C standalone test; Created on 08 Apr 2011 19:46 UTC; Configuration Concordiasi
/

Time	-- UTC	--	Press	Temp	Dewpt	RH	Uwind	Vwind	Wspd	Dir	dZ	GeoPoAlt	Lon	Lat	GPSAlt
sec	hh	mm	ss	mb	C	C	%	m/s	m/s	m/s	deg	m/s	m	deg	deg	m
-1.0	2	19	1.00	65.80	-80.27	-999.00	-999.00	7.97	-9.85	12.67	321.01	-999.00	17039.62	169.177713	-78.631735	16971.12
0.0	2	19	2.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	169.174146	-78.630858	17332.01
0.2	2	19	2.25	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.000000	-999.000000	-999.00
0.5	2	19	2.50	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	169.174313	-78.630903	17318.66
0.8	2	19	2.75	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.000000	-999.000000	-999.00
1.0	2	19	3.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	169.174478	-78.630949	17303.26

Table 2 Lists data fields provided in the EOL format ascii soundings.

Field No.	Parameter	Units	Measured/Calculated
1	Time	Seconds	----------
2	UTC Hour	Hours	----------
3	UTC Minute	Minutes	----------
4	UTC Second	Seconds	----------
5	Pressure	millibars	Measured
6	Dry-bulb Temp	Degrees C	Measured
7	Dewpoint Temp	Degrees C	Calculated
8	Relative Humidity	Percent	Measured
9	U Wind Component	Meters/Second	Calculated
10	V Wind Component	Meters/Second	Calculated
11	Wind Speed	Meters/Second	Measured
12	Wind Direction	Degrees	Measured
13	Descent Rate	Meters/Second	Calculated
14	Geopotential Altitude	Meters	Calculated
15	Longitude	Degrees	Measured
16	Latitude	Degrees	Measured
17	GPS Altitude	Meters	Measured

3. Data Quality Control

a) Profiles of the raw pressure, temperature, RH, wind speed and fall rate from raw D files are first examined to determine if all of the files contain data, and to ensure that nothing looked

suspicious. Doing this allows us to determine if a sounding was started up, but not launched, or if the data contains any features that warrant further investigation.

b) One of the complications with the Concordiasi driftsonde data is that the sondes were found to have been dropped over land or over ice. In many cases, these sondes continued to collect data after hitting the surface, and this data must be discarded as it does not represent the atmosphere, and the surface data quality may be questionable due to damage of the sensors. We developed a scheme to remove most of the bad surface data in the raw D files by evaluating pressure and fall rate changes.

c) The Flight Level (FL, the first data line in QC.eol file) was the first available sonde data after launch and after sensor equilibration had been reached. There were no accurate FL sensors available on the gondola.

d) We have two methods to calculate geopotential altitude, integrating from the flight level downward or from the surface upward (which is typical for dropsondes deployed over the ocean). For those that landed on the ice/land, we had to obtain the surface elevation information from the GLOBE 1-km database. The database represents the Antarctic topography correctly based on Google earth map. We evaluated both methods of integration and concluded that the upward integration was the most appropriate. The comparison of FL geopotential altitude calculated using upward integration with that calculated from the sonde GPS height is shown in Fig. 2. Eighty-eight percent of soundings have absolute differences less than 100m, with a median difference of 40 m.

e) The raw soundings files were run through the Atmospheric Sounding Processing ENvironment (ASPEN) software (with the option of upward geopotential height integration) which analyzes the data, performs smoothing, and removes suspect data points. There were six sondes that did not transmit the data to the surface. For these soundings, the downward integration was used to calculate geopotential altitude (see Table 3).

f) Time series plots of temperature, RH, wind speed, and fall rate profiles, are used to examine the consistency of soundings launched during each flight, and to show the variability of soundings from different missions. These plots are also used to determine if the sounding did not transmit data to the surface, or if there was a "fast fall" caused by failure of the parachute to properly deploy.

g) Profiles of temperature, RH, wind speed and vertical velocity from the quality controlled soundings are visually evaluated for outliers, or any other obvious issues.

h) A dry bias in the relative humidity measurements was discovered, in the Spring of 2016, in all RD94 dropsondes from 2010 to present and all mini-dropsondes (NRD94) collected. This dry bias is strongly temperature dependent and most significant at cold temperatures. It is considered small at warm temperatures. All sounding files undergoing post-processing have been corrected for this error and contain the flag, 'TDDryBiasCorrApplied', in the last line of the header to confirm that this correction has been applied. For more information on the dry bias, please access the technical note, linked below, which contains information on the origin, magnitude and impact of the dry bias.

NCAR/EOL Technical Note: Dropsonde Dry Bias

http://opensky.ucar.edu/islandora/object/technotes:542

4. Special problems to note

During the post-processing, we encountered a few problems. Only those that need the users' attention are summarized in Table 3. They have been corrected where possible. Data that could not be corrected and were deemed unusable were changed to missing. Files containing questionable data were kept in the final archive. We have provided details regarding these questionable soundings and, caution users about the use of these data files below. The following problems were found:

1. **Sondes with sensor cover on:** Eleven sondes were dropped with the protective temperature and relative humidity cap left on. The cap is meant to protect the sensors before flight, but when left on, it prevents the thermometer and hygrometers from accurately measuring the atmosphere. The measured temperature profiles are too smooth and too warm (especially in the

upper troposphere and stratosphere), and the RH profiles are too drier (Fig. 3). For these files, temperature and relative humidity were set to missing, but pressure and GPS data remain.

2. **No GPS data:** There were two soundings with no GPS data, so there were no wind and position (lat, lon and GPS height) data in the final QCed files.
3. **Fast fall:** One sounding was classified as "fast fall", meaning it fell at twice the expected speed, likely due to failure of the parachute to properly deploy. Their wind data were not reliable and were changed to missing values.

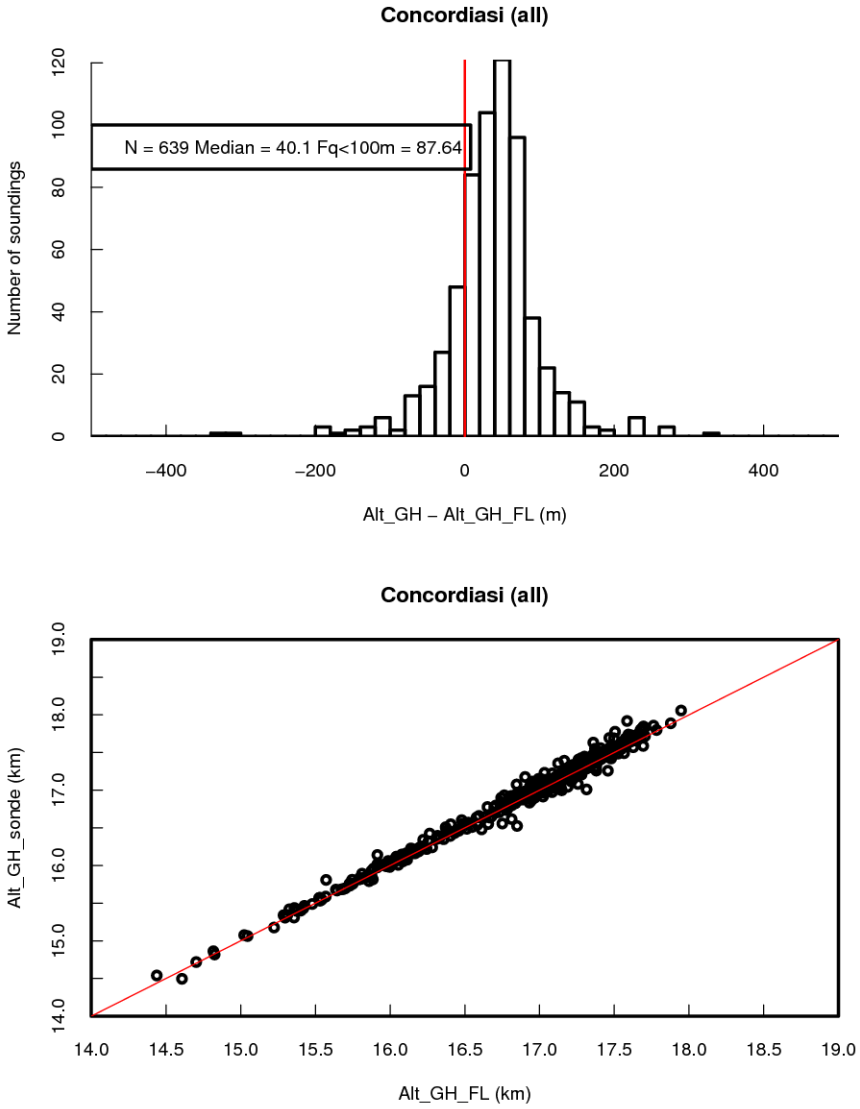

Fig. 2 (Upper panel) Histogram of differences in geopotential altitude at the flight levels between that calculated from the hydrostatic equation integration upward and that derived from the measured GPS altitude. (Lower panel) Scatter plots of two geopotential altitudes at flight level.

Table 3: Special problems in the data. They are either corrected or need to take precautions when they are used. See the text for more details.

Problems	#	Corrections	Notes
Sondes with sensor cover on	11	Temperature and RH are set to missing	No T, RH and geopotential height D20101002_021811_MSD06_057014FC.1QC.eol D20101004_220707_MSD06_05701505.1QC.eol D20101006_210709_MSD06_0570187E.1QC.eol D20101008_020712_MSD06_05701888.1QC.eol D20101009_130410_MSD06_057018F0.1QC.eol D20101012_040310_MSD06_05703AAA.1QC.eol D20101015_010308_MSD06_05703D58.1QC.eol D20101024_130806_MSD10_05703BD6.1QC.eol D20101030_000806_MSD10_05705DD5.1QC.eol D20101106_180512_MSD10_05706361.1QC.eol D20101107_180410_MSD10_057063C3.1QC.eol
No GPS data (wind and position)	2	None	D20101006_125212_MSD05_057018A2.1QC.eol D20101031_182112_MSD08_05703C42.1QC.eol
Fast Fall	1	Wind data are set to missing	D20101027_040804_MSD10_05705D8B.1QC.eol
Data not transmitted to surface	6	Geopotential height integrated from flight level upward	D20100929_015101_MSD01_057018CB.1QC.eol D20101001_175003_MSD01_05703A96.1QC.eol D20101012_134613_MSD05_05706239.1QC.eol D20101012_204612_MSD05_05706235.1QC.eol D20101103_195115_MSD03_057063A1.1QC.eol D20101105_180510_MSD10_05706220.1QC.eol

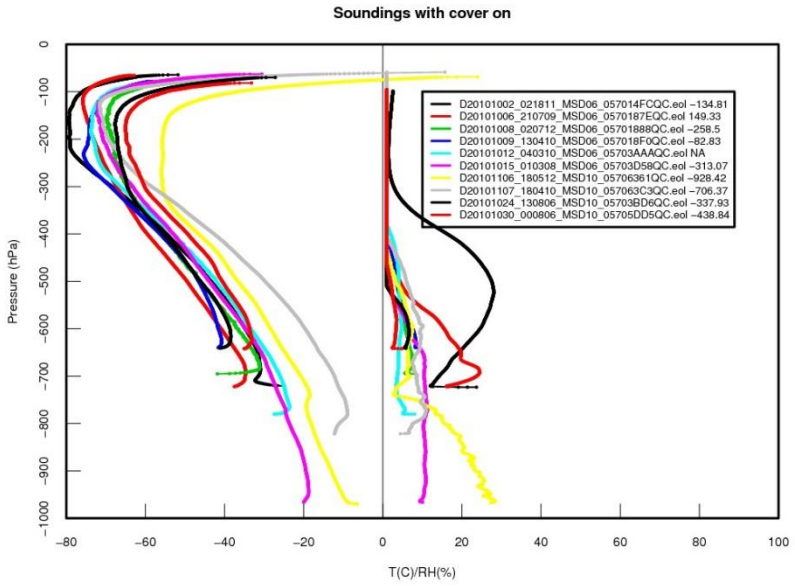

Fig. 3 Temperature and RH profiles of eleven soundings with sensor cover on.