Contents:

1. *Dataset Overview*
2. *EOL Sounding File Format and Data Specifics*
3. *Data Quality Control*
4. *Special problems to note (Important information for users)*

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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, D. Lauritsen and C. Martin, 2011: WISPAR 2011 quality controlled dropsonde data set.

Version	Date	Author	Change Description
1.0	06-15-2012	*K. Young*	Initial Document Release
2.0	04-06-2017	*K. Young*	A dry bias in the RD94 and mini-dropsonde (NRD94) relative humidity measurements was discovered in data collected from 2010 to present, including all of the HS3 dropsonde datasets. The dry bias is strongly temperature dependent. It is considered small at warm temperatures and it becomes stronger at cold temperatures. This RH dry bias has been corrected, with dewpoint recomputed. The dropsonde files that have received this correction contain an indicator in the header of the file, 'TDDryBiasCorrApplied'

1. Dataset Overview

The Winter Storms and Pacific Atmospheric Rivers (WISPAR) field campaign took place over Pacific Ocean from February 11 to March 10, 2011. The primary scientific objective of WISPAR is to evaluate the capabilities of the unmanned NOAA/NASA Global Hawk (GH) aircraft and NCAR/NOAA dropsonde system for NOAA operations and research. It included three science flights. The first one on February 11-12 targeted atmospheric rivers to observe and characterize an atmospheric river with a strong tropical connection near Hawaii. The second one on March 3-4 was a winter storms reconnaissance flight with the primary objective of obtaining targeted observations in support of forecasted cyclogenesis in the Midwest on 6 March. The third one on March 9-10 was an Arctic flight with objectives of operational demonstration of the GH and dropsonde system in the Arctic environment, comparison with ground observations from Barrow site, sampling within the Arctic vortex, and making two high-density transects of an atmospheric river. The detailed summary of three flights is shown in Table 1.

The Global Hawk (GH) is a high-altitude, long endurance aircraft flying at altitudes of 65,000 feet for more than 31 hours at a time. Creating a dropsonde capability for this aircraft has provided unique capabilities for research and for NOAA's operational needs. The NCAR/NOAA GH dropsonde system was developed and installed on the GH to make vertical profiles of atmospheric thermodynamic and wind parameters. The development and deployment of the GH dropsonde system was a collaborative effort between the Earth Observing Laboratory (EOL/NCAR) and NOAA. The development built on NCAR/EOL's experience with our driftsonde system and resulted in a fully-automated dropsonde system where all operations are remotely administered from the ground, literally with the click of a mouse. The GH dropsonde system, which was successfully tested in January 2011, can dispense up to 88 Miniature In-situ Sounding Technology (MIST) sondes during a single flight, and the data system installed on the aircraft can process up to eight sondes in the air at once. WISPAR was the first field deployment of the GH dropsonde system. During WISPAR, total 177 MIST soundings were collected during 3 research flights departed from NASA Dryden Flight Research Facility in California; 162 of them are contained in the final quality controlled data set (Figure 1) since fifteen of them contain either no sonde data or very little data at the top. The GH dropsonde soundings collected during WISPAR provide unprecedented measurements of atmospheric profiles over Pacific Ocean and Arctic from the lower stratospheric to the surface (see an example for temperature in Fig. 2)

Table 1 Summary of three science flights.

RF#	Name	Dates	Sondes deployed	Soundings in the archive
RF01	Atmospheric rivers	Feb. 11-12	37	32
RF02	Winter storms	Mar. 3-4	70	69
RH03	Arctic weather	Mar. 9-10	70	61

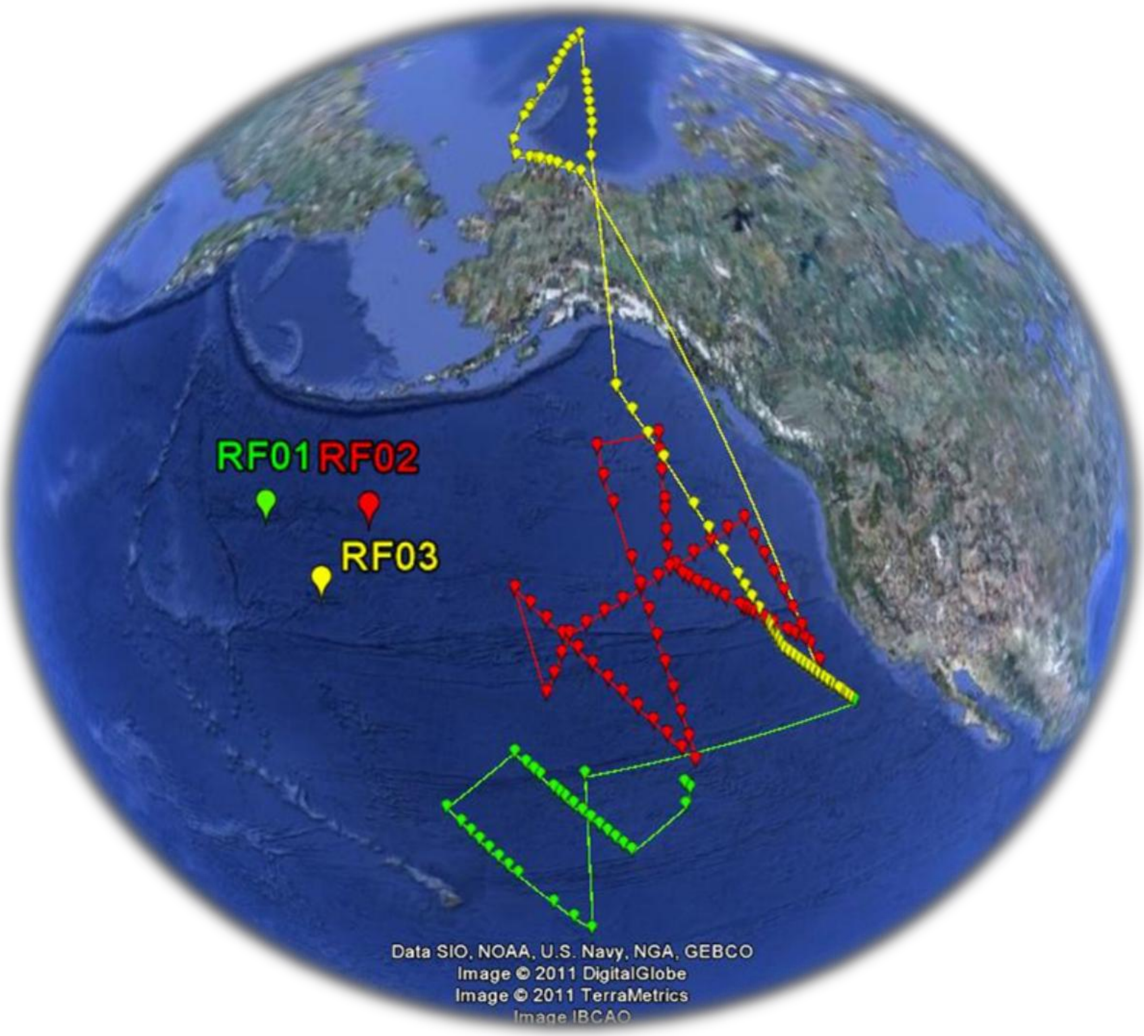

Figure 1 Map of 162 MIST sonde launch locations for three flights.

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_PQC.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), and "QC.eol" refers to the EOL file format type. For RF#2, "_recomp4" was added before "_PQC.eol" to represent recomputed D files.

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. For the eight 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.

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

```
Data Type/Direction:                     AVAPS SOUNDING DATA, Channel 1/Descending
File Format/Version:                     EOL Sounding Format/1.1
Project Name/Platform:                    GH - WISPAR, GH -Science Flight 1/Global Hawk, NASA 872 (AV-6)
Launch Site:
Launch Location (lon,lat,alt):           146 28.47'W -146.474492, 19 07.75'N 19.129230, 18080.60
UTC Launch Time (y,m,d,h,m,s):           2011, 02, 12, 01:56:46
Sonde Id/Sonde Type:                     101645105/
Reference Launch Data Source/Time:        IWGADTS Format (IWG1)/01:56:46
System Operator/Comments:                 Remote Operator/none, none
Post Processing Comments:                Aspen Version 3.0; Created on 10 Jun 2011 17:10 UTC; Configuration GHdropsonde
/
  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
-------- -- -- ----- ------- ------- ------- ------- ------- ------- ------- ------- ------- -------- ----------- ----------- --------
   -1.00  1 56 45.00   76.30  -66.40 -999.00 -999.00   -4.22   -8.40    9.40   26.70 -999.00 18049.91 -146.474492    19.129230 18080.60
    0.00  1 56 46.00 -999.00 -999.00 -999.00 -999.00 -999.00 -999.00 -999.00 -999.00 -999.00  -999.00 -146.477141    19.131582 18070.77
    0.25  1 56 46.25 -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
    0.50  1 56 46.50 -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
    0.75  1 56 46.75 -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
    1.00  1 56 47.00 -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
    1.25  1 56 47.25 -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
```

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) Flight #2 experienced a hardware configuration problem. The problem was fixed by recomputed the values from the binary files. New raw data files (D files) were created. It did not cause data loss or degrade the data quality at all.
b) Profiles of the raw pressure, temperature, RH, wind speed and fall rate from raw D files and time series plots 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.
c) The raw soundings files were run through the Atmospheric Sounding Processing ENvironment (ASPEN) software, which analyzes the data, performs smoothing, and removes suspect data points. There were eight 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).
d) 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 (Fig. 3).
e) Profiles of temperature, RH and winds from the quality controlled soundings are visually evaluated for outliers, or any other obvious issues.
f) 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
   https://opensky.ucar.edu/islandora/object/technotes%3A542

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) Fifteen sounding files were removed from the final archive for one of the following reasons: the dropsonde was started up but never launched, the file contained no data, or the files contained very little data of poor

quality.

2) **Data not transmitted to the surface:** Eight sondes experienced a loss of signal and failed to transmit data to the surface (Fig. 3). The geopotential altitude in these soundings was calculated from the flight level downward.
3) **Fast fall or partial fast fall:** Two soundings were classified as "fast fall drops", and eight were "partial fast fall drops", meaning the parachute failed to deploy or deployed late (Fig. 3). Failure of the parachute to deploy results in dropsondes falling at a faster rate (and sometimes tumbling) causing wind speed and direction to be unreliable. For these soundings, wind speed and direction and U/V winds are set to missing.

4) **Significant data gaps:** Fifteen soundings contain significant data gaps (see Table 2). Majority of them (11) are from Flight #1. The data gap issue in Flight #1 was due to the sonde transmitter problem, was resolved by new modifications to the sondes, and did not occur in Flight #2 and #3.
5) **No GPS data:** There were five soundings with no GPS data, so there were no wind and position (lat, lon and GPS height) data in the final QCed files.

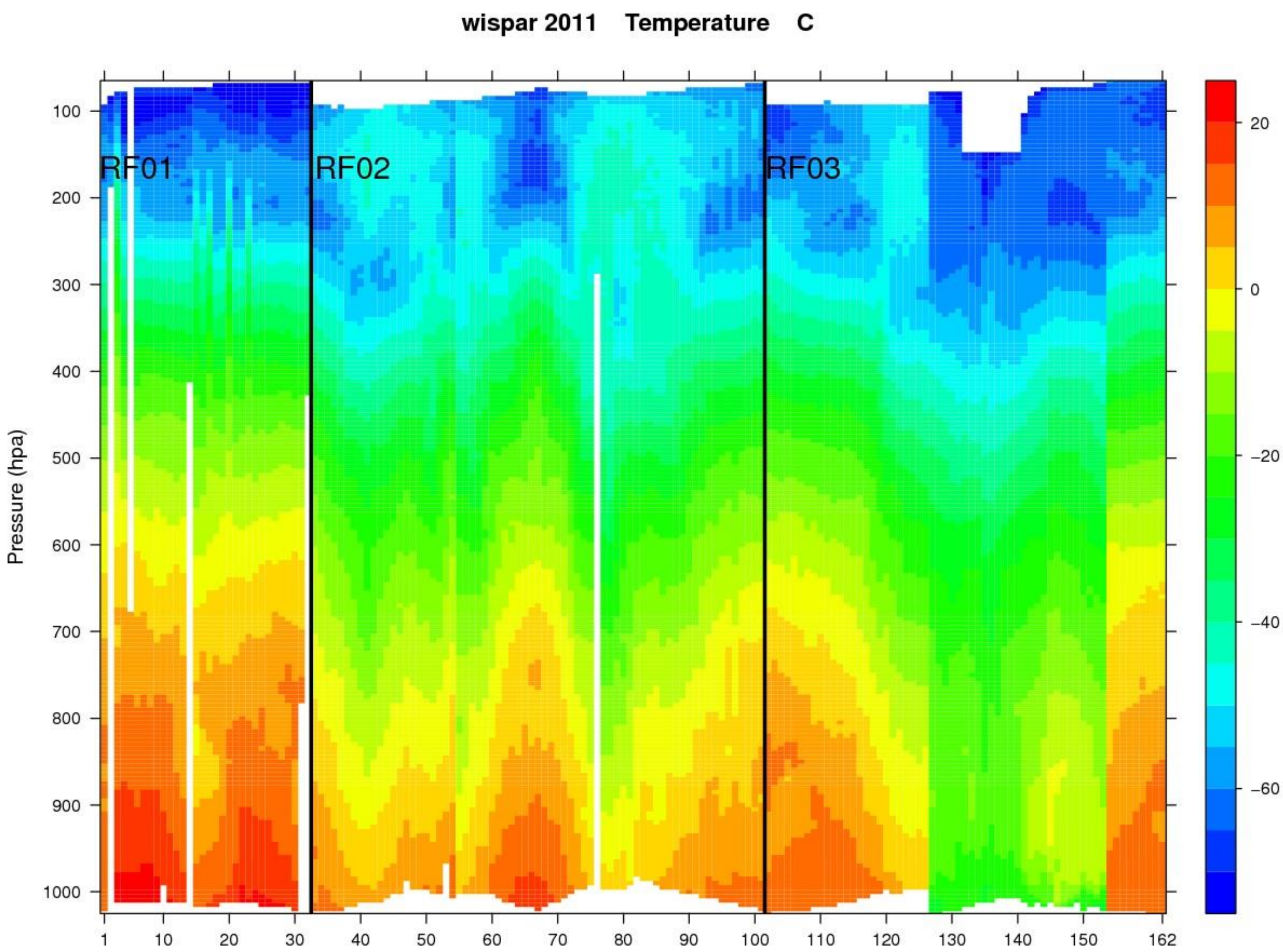

Fig. 2 Temperature (in °C) profiles for all 162 soundings.

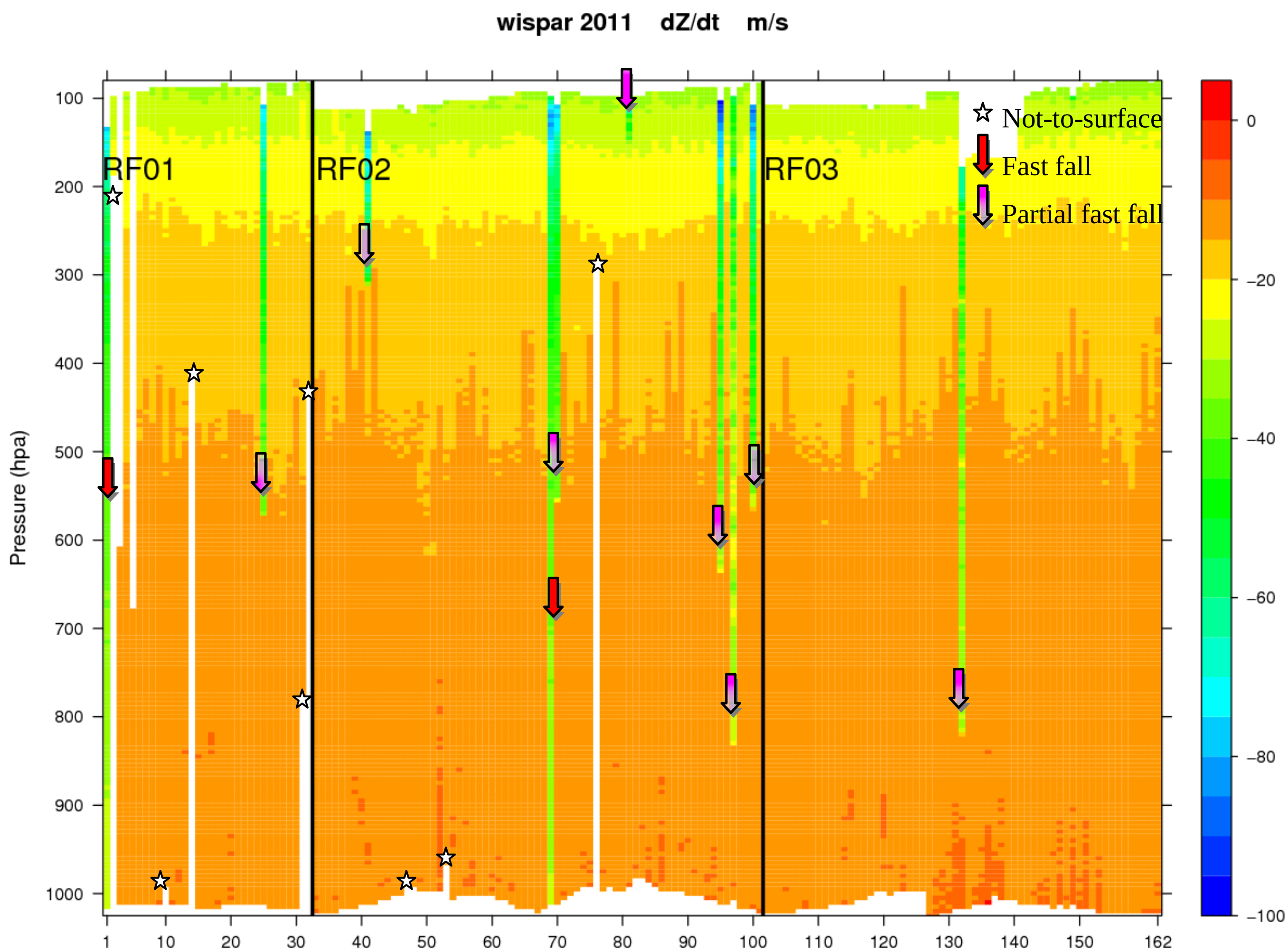

Fig. 3 Fall rate (in m/s) profiles for all 162 soundings. It clearly shows the soundings that did not transmit data to the surface, and have partial or full fast fall problem.

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**
Data not transmitted to surface	8	Geopotential height integrated from flight level upward	D20110211_223657 D20110212_032637 D20110212_041142 D20110212_084851 D20110212_085506 D20110303_225908 D20110304_002708 D20110304_081032
Fast Fall	2	Wind data are set to missing	D20110211_184120 D20110304_054328
Partial fast fall	8	The part of wind data with partial fast fall are set to missing.	D20110212_065422 D20110303_213105 D20110304_060130 D20110304_100058 D20110304_120308 D20110304_131958 D20110304_135648 D20110310_070559
Significant data gaps	15	none	D20110211_223657 - only to ~190 hPa D20110212_013835 - Data loss above 606 hPa D20110212_013835 - Data loss above 678 hPa D20110212_041142 - Data loss below 410 hPa D20110212_053557 - Data loss between ~160-576 hPa D20110212_054556 - Data loss between ~192-575 hPa D20110212_055252 - Data loss between ~158-570 hPa D20110212_061616 - Data loss between ~124-650 hPa D20110212_063826 - Data loss between ~165-546 hPa D20110212_084851 - Data loss below ~781 hPa D20110212_085506 - Data loss below ~426 hPa D20110304_081032 - Data loss below ~287 hPa D20110310_115653 - Data loss below ~650 hPa D20110310_190823 - Data loss below ~700 hPa D20110304_081030 - Data loss below ~300 hPa
No GPS data (wind and position)	5	None	D20110212_065422 D20110304_050210 D20110304_060130 D20110304_081032 D20110310_183504