Dropwindsonde Moisture Data

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RH sensors have historically been unable to accurately measure at low temperature.

Modeling centers automatically reject observations at low temperature and pressure because of this.

Operational center	Temperature	Pressure
European Centre for Medium-Range Weather Forecasting (ECMWF)	< -40 ^{o}C	< 300 hPa
United Kingdom Meteorological Office (UKMET)	< -40 ^{o}C	
National Oceanic and Atmospheric Administration (GFS)		< 300 hPa

Sensors have improved, and these data may now be quite accurate.

Last year, a software bug leading to a dry bias in the RD94 and mini dropsonde (NRD94) humidity measurements from 2010 to 2015 was discovered. The technical note (https://www.eol.ucar.edu/system/files/software/Aspen/Windows/W7/documents/Tech%20Note%20Dropsonde_Dry_Bias_20160527_v1.3.pdf) describes the background of the dry bias, how to identify impacted files, how to correct existing data, and how to implement a correction in AVAPS; code is now available to correct these data. Data starting from the 2016 hurricane season was not impacted.

As a result of this bug correction, moisture data that were previously reported cannot now reliably be reported. During the 2016 season, these data were reported as missing. NHC requested that these missing values be reported as having 0.1% relative humidity. The true values could, in reality, be between 0% and 12% relative humidity. As the dropwindsonde data are quality controlled, the 0.1% relative humidity values will be filtered with other data and transmitted in real time via TEMP DROP and eventually via BUFR; some will likely be indistinguishable from data that the dropwindsonde can reliably report.

No tests of the impact of this change to operational models was conducted.

|	# of Dfiles	# data lines (4 Hz)	# moisture data lines (2 Hz)	# of lines with 0.1% RH	% of RH data that are synthetic
GH	217	927,363	423,510	67,581	16%
G-IV	892	3,446,496	1,662,097	48,147	3%

100% of sondes released by the Gulfstream-IV and Global Hawk have these synthetic humidity data.

16% or GH sonde RH data and 3% of G-IV sonde RH data are synthetic.

No P3 (low-level) sondes are impacted.
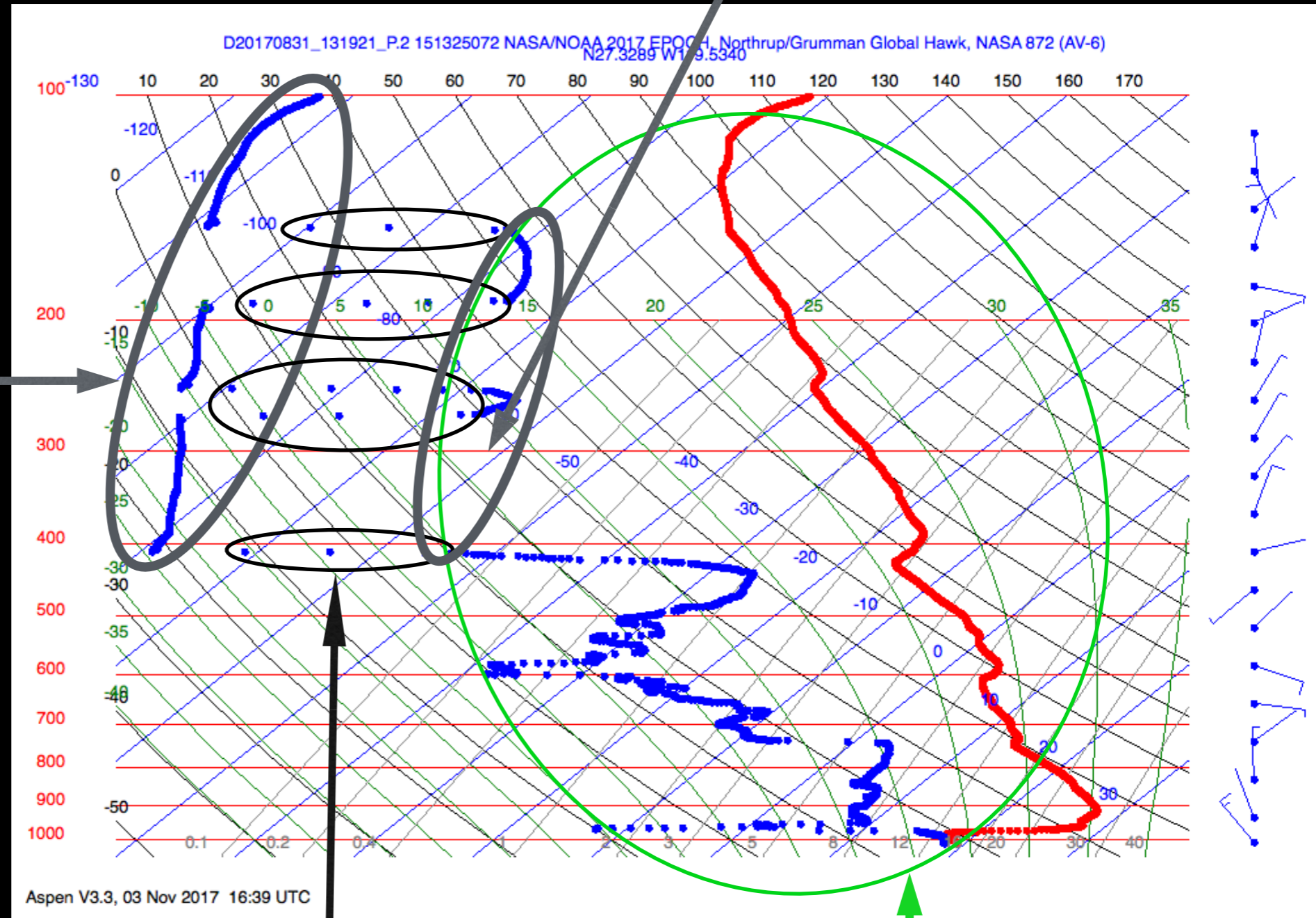
AF sondes not yet available.

Examples
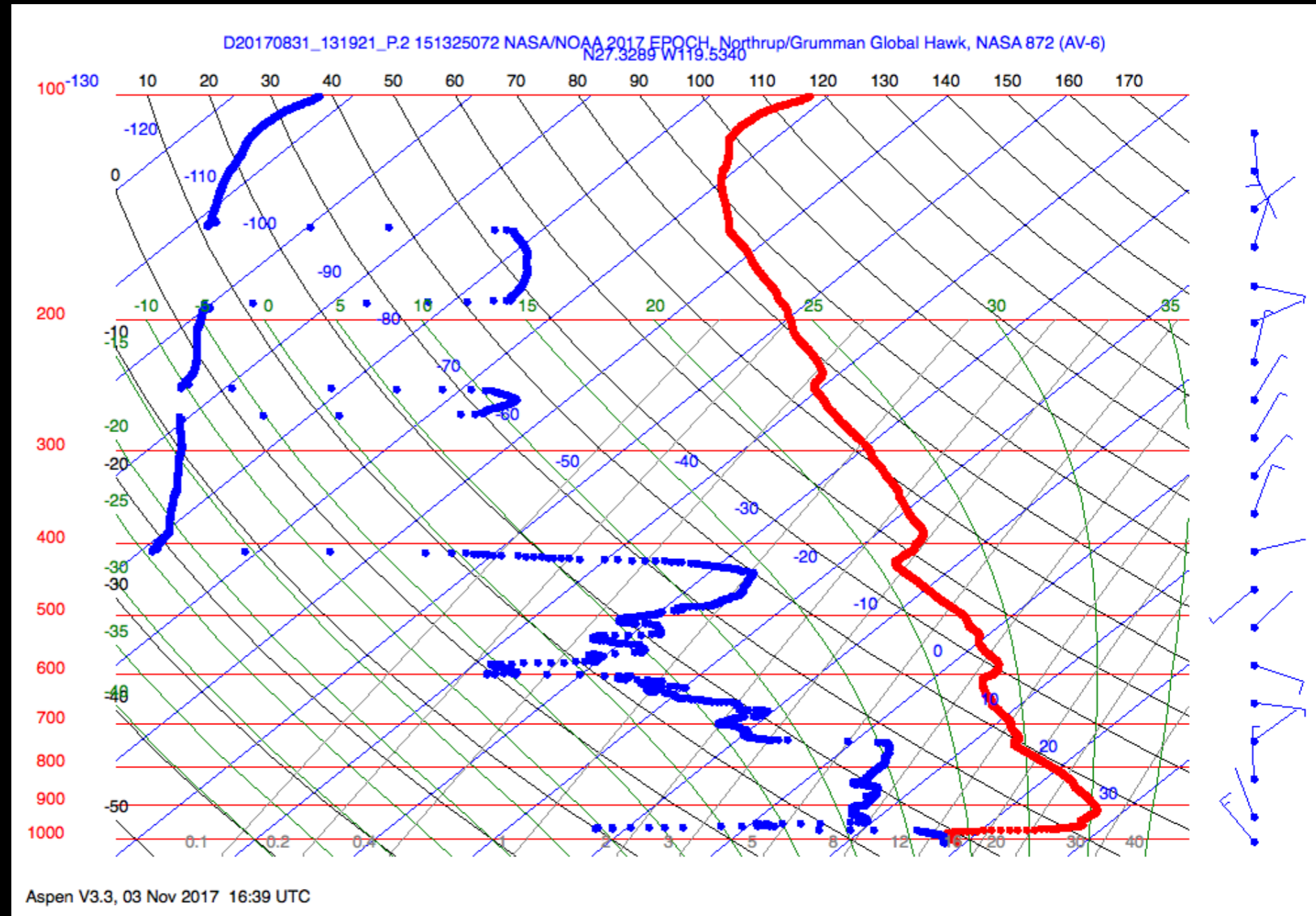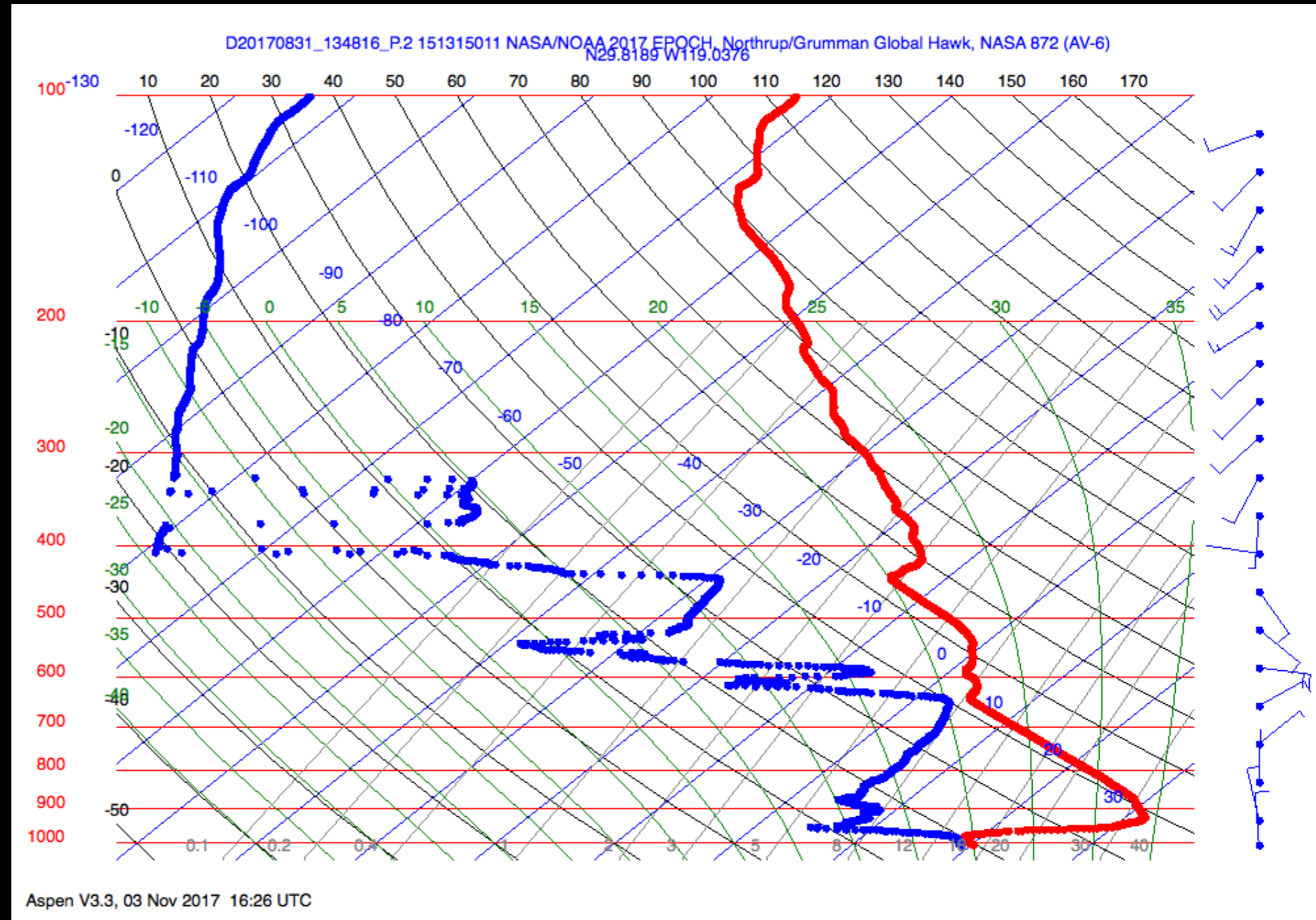
Examples
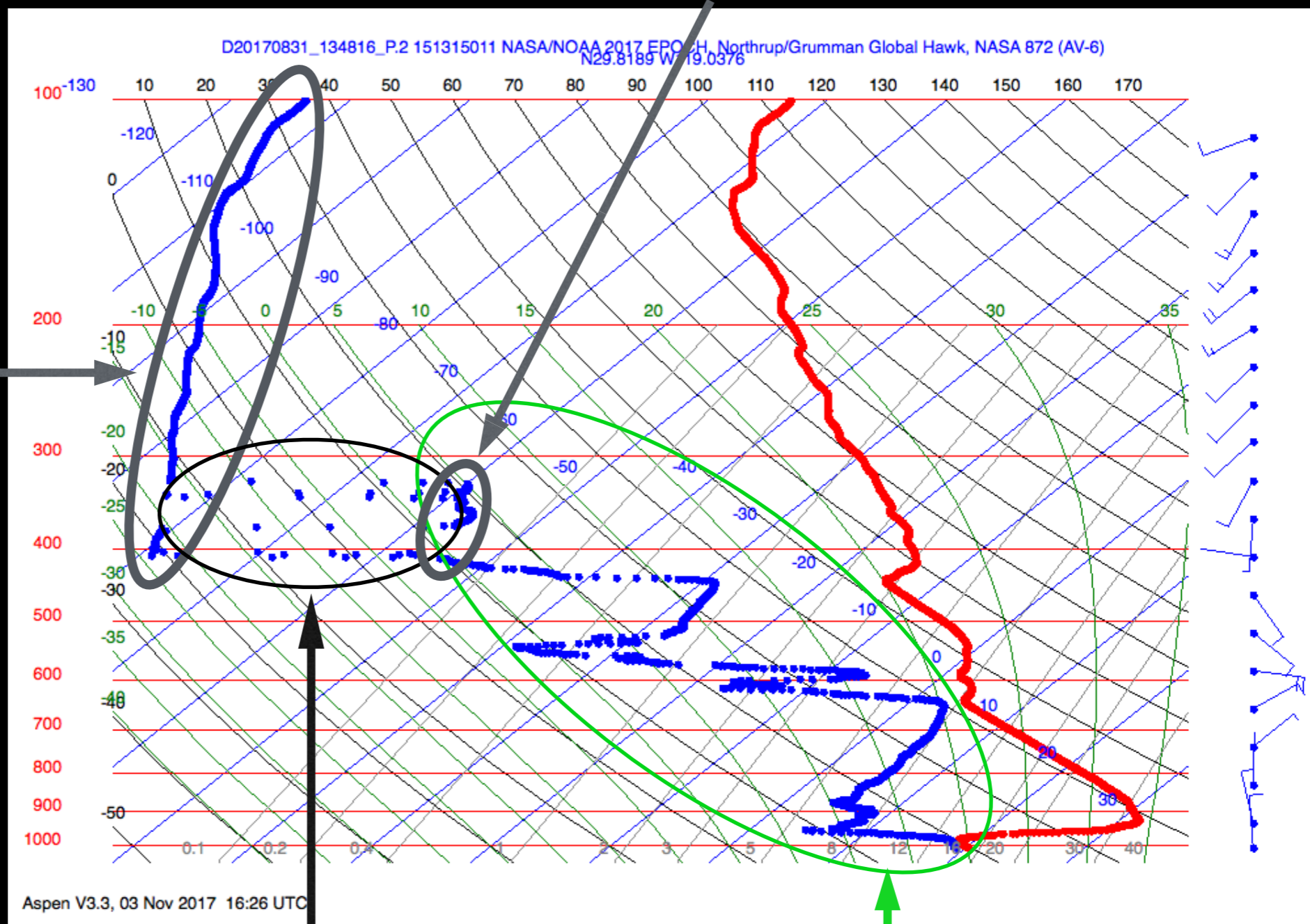

Real (~8.5%) RH

Synthetic (0.1%) RH

The result of filtering between real and synthetic RH

Real RH

Examples

Real (~2.5%) RH

Synthetic (0.1%) RH

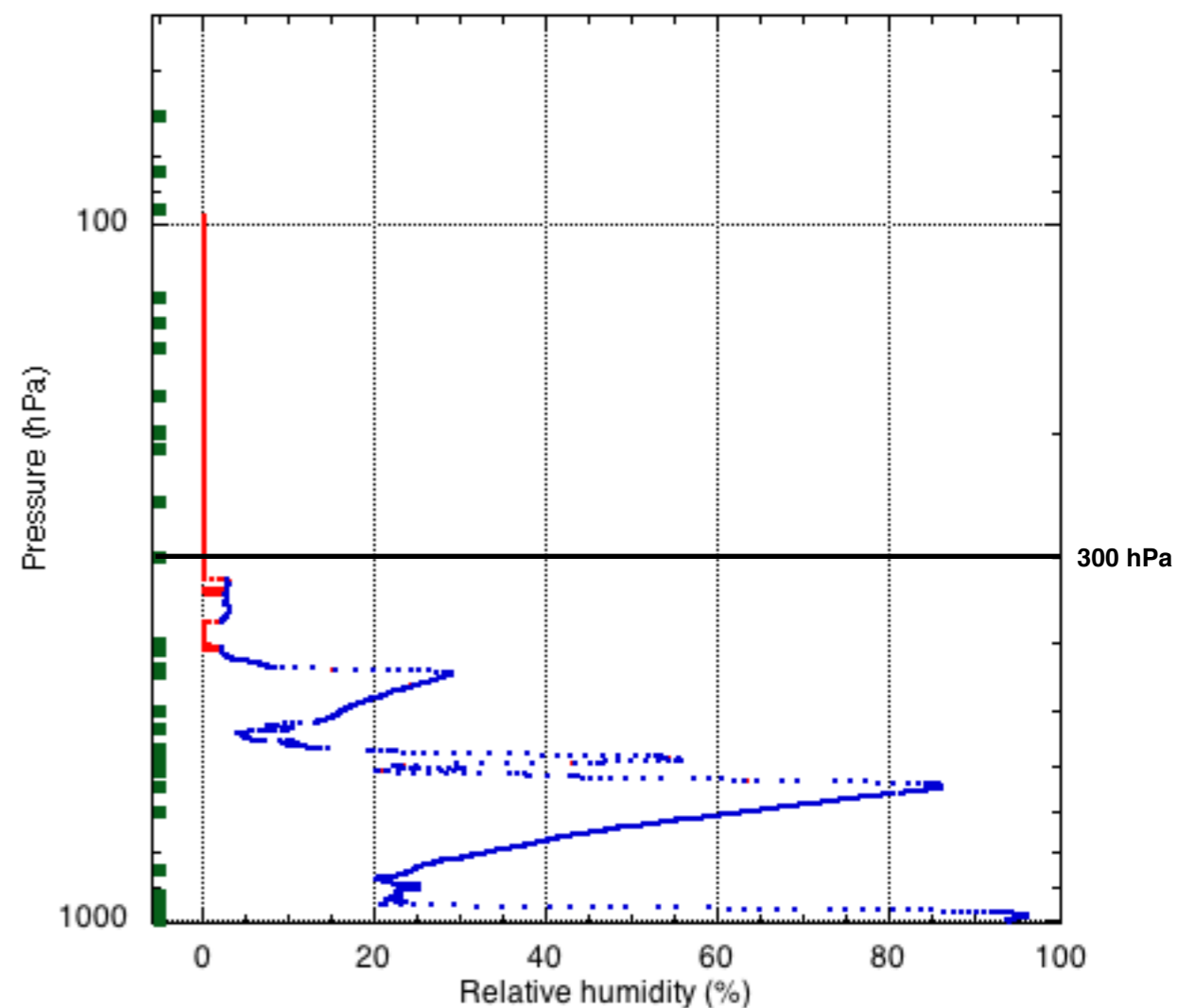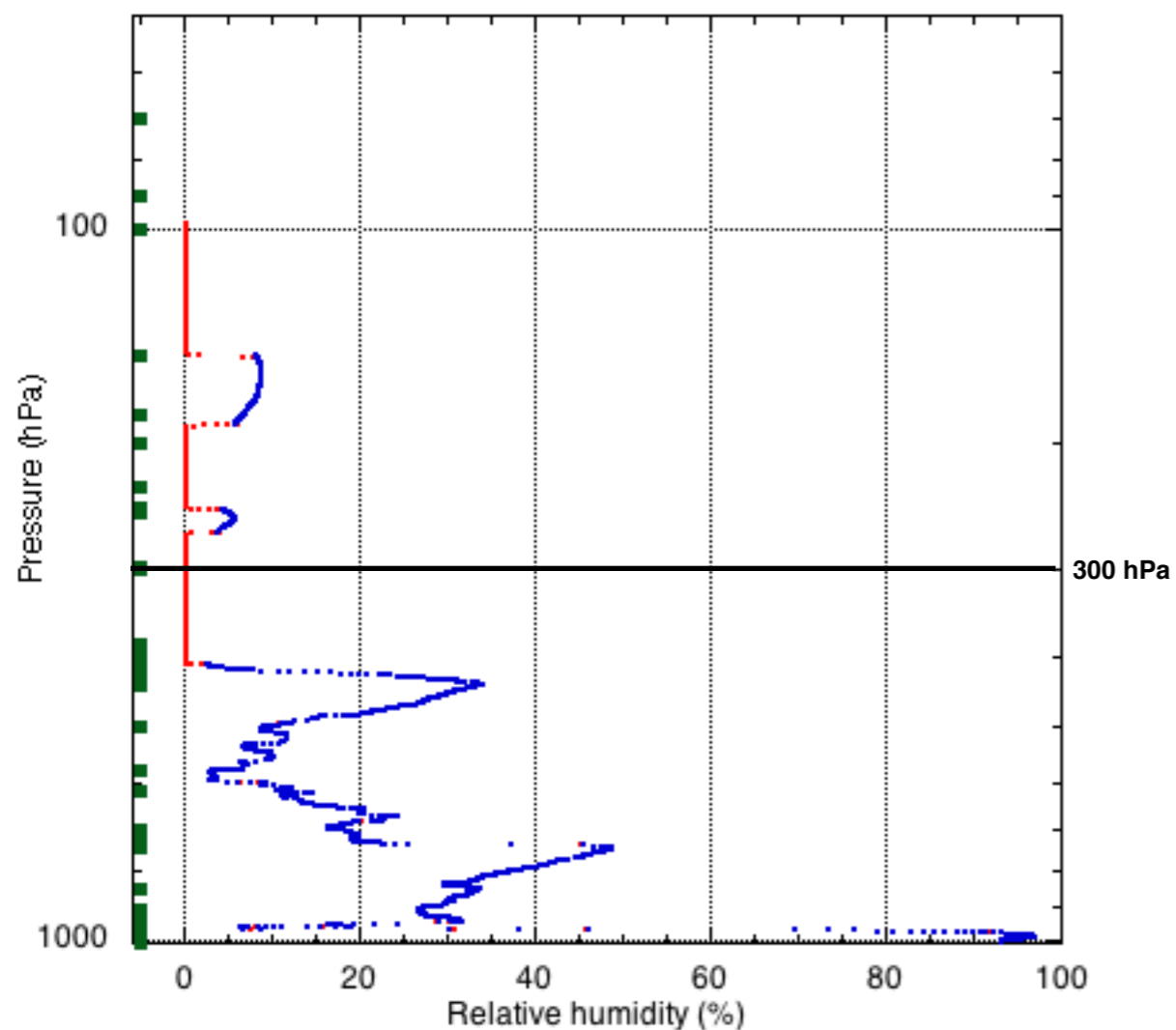The result of filtering between real and synthetic RH

Real RH

Two sondes from last slides processed with and without synthetic data

QC with all data

QC with synthetic RH removed

Green squares represent
TEMP-DROP levels

217 D-files from Global Hawk flight received
927,363 lines of data (4 Hz)
423,510 lines of humidity data (2 Hz)
67,581 lines have 0.1% relative humidity
1804 of these lines have 0.1% RH with no temperature
16% of the humidity data have synthetic information

Equilibration

potential inclusion in TEMP DROP and BUFR

potential assimilation into GFS and ECMWF models

100

300 hPa

-40°C

1000
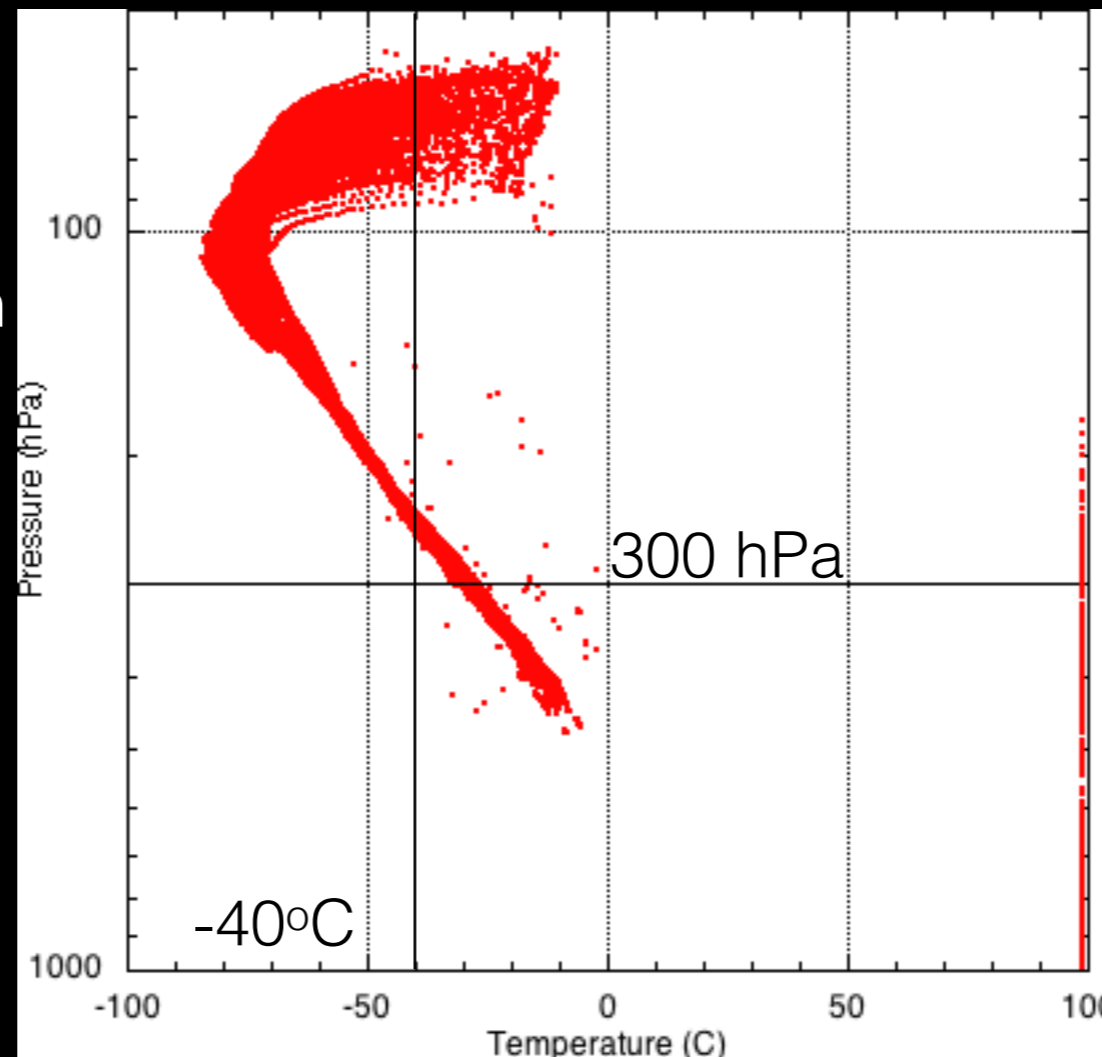
Missing temperatures ?

potential assimilation into UKMET model

892 D-files from NOAA G-IV flights received
3,446496 lines of data (4 Hz)
1,662,097 lines of humidity data (2 Hz)
48,147 lines have 0.1% humidity (all from G-IV)
3% of the humidity data have synthetic information

Equilibration

potential inclusion in TEMP DROP and BUFR

potential assimilation into GFS and ECMWF models

300 hPa

-40°C

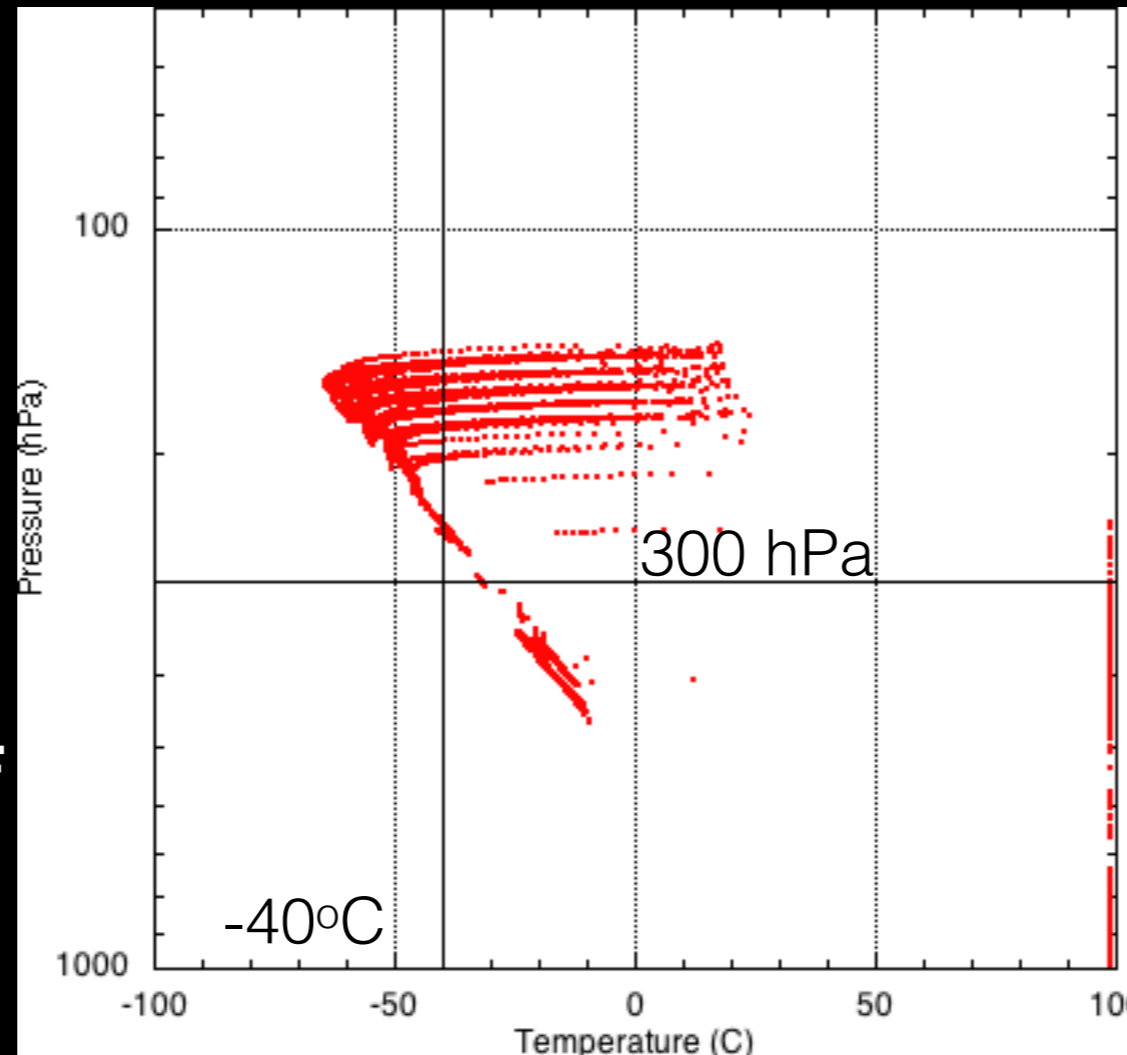**Missing temperatures ?**

potential assimilation into UKMET model

Reports of relative humidity with no temperature

				Air	Air	Rel	Wind	Wind	Vert	GPS	GPS	Geopoten	GPS	Sonde	Sonde	GPS	Wind	GPS
		UTC	UTC	Press	Temp	Humid	Dir	Spd	Veloc	Longitude	Latitude	Altitude	Wnd	RH1	RH2	Snd	Error	Altitude
	Sonde ID	Date yymmdd	Time hhmmss.ss	(mb)	(degC)	(%)	(deg)	(m/s)	(m/s)	(deg)	(deg)	(m)	Sat	(%)	(%)	Sat	(m/s)	(m)

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AVAPS-T02 STA 163335243 170925 202836.37
AVAPS-T02 COM                UTC     UTC       Air    Air    Rel    Wind   Wind   Vert      GPS         GPS     Geopoten GPS  Sonde  Sonde GPS Wind     GPS
AVAPS-T02 COM               Date    Time     Press   Temp  Humid   Dir    Spd    Veloc  Longitude    Latitude  Altitude Wnd  RH1    RH2   Snd Error  Altitude
AVAPS-T02 COM    Sonde      UTC     UTC
AVAPS-T02 COM     ID      yymmdd  hhmmss.ss   (mb)   (degC)  (%)   (deg)  (m/s)  (m/s)    (deg)        (deg)      (m)   Sat  (%)    (%)   Sat (m/s)    (m)
AVAPS-T02 COM --------- ------ --------- ------- ------ ------ ------ ------ ------ ----------- ---------- -------- --- ------ ------ --- ----- --------
AVAPS-T02 LAU 163335243 170925 203404.00
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AVAPS-D02 S10 163335243 170925 204354.50  623.50  99.00   0.10 160.84   2.48 -12.62  -69.035512  42.767964 99999.00 12   0.10   0.10  12  0.25  4158.98
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AVAPS-D02 S10 163335243 170925 204357.50  626.38  99.00   0.10 158.17   3.10 -12.50  -69.035543  42.768037 99999.00 12   0.10   0.10  12  0.22  4121.26
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AVAPS-D02 S10 163335243 170925 204420.50  648.68  99.00   0.10 165.60   3.36 -12.15  -69.035848  42.768682 99999.00 12   0.10   0.10  12  0.24  3836.37
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Missing temperature

Synthetic relative humidity

The current National Hurricane Operations Plan (Appendix G) for TEMP-DROP messages states

Dew-point depressions for relative humidities less then 20% are encoded as 80. When air temperature is below –40C report Dnn //.

This appears to be a legacy of the way NOAA encoded RAOB messages during the mid-20th century. Sensors, specifically those in the NCAR dropwindsonde, can now measure relative humidity at low temperature accurately, and NCAR engineers suggest that this practice may be outdated. In fact, this rule was never followed for dropwindsonde data since the advent of the NCAR dropwindsonde in 1997.

Recommendation: Remove this wording from the National Hurricane Operations Plan