AMB Verification and Quality Control monitoring Efforts involving RAOB, Profiler, Mesonets, Aircraft

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Observations we verify against

- RAOBs at 0 and 12 UTC
  - Temperature, Relative Humidity, Wind, Height
- METARs -- every hour
  - Temperature, Dewpoint, Wind
  - Ceiling
  - Visibility
- Wind profilers – every hour
  - Wind
- Results available *within a few hours* of model run time
- Results for individual stations and for pre-defined regions

Models in our verification database (upper air, compared with RAOBs):

NCEP operational models in blue

Real-Time:

Regional:

Op20 (Operational 13 on 20km grid)
Bak13 (Bakup RUC on 13km grid)
isoBak13 (isobaric Bak13)
Bak20 (Backup on 20km grid)
Dev13 (development RUC)
Dev1320 (Dev13 on 20km grid)
RR1h (1h cycling RR)
isoRR1h (isobaric vsn of above)
RR1h_dev (dev. version of RR1h)
RR1h_dev130 (130 grid)
RRnc (non-cycling RR)
RRncRLL (rotated lat-lon)
HRRR
HRRR_dev
isoDev1320 (dev 13 iso on 20km grid)
NAM (North America 32 km)

Global:

GFS
FIM
FIM_prs (from isobaric files)
FIMX
FIMY
FIM9TACC (GSI initialization)
F9EMTACC (EnKF initallization)
F0EMTACC (10km grid)

Retrospective:

177 (so far) retrospective model runs
Testing different model configurations,
assimilation methods,
combinations of data

Web interface

- Time-series and Vertical profiles of ob-forecast differences
- For pre-defined regions (regional to global) and individual stations
- Hourly to 60-day averages routinely available
- Summary statistics and per-observation differences
- Products are experimental; designed for the specific needs of our group

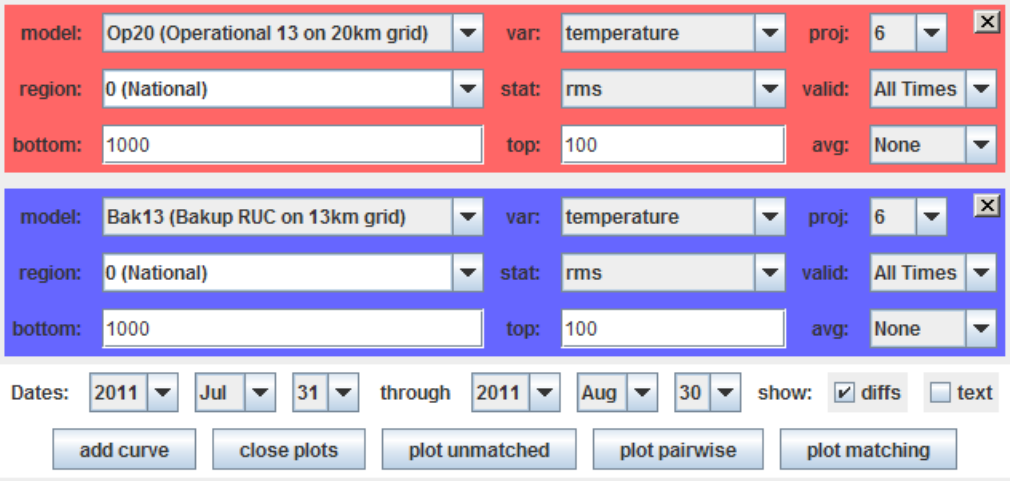
Upper air verification

- Bias (forecast minus ob)
- RMS (forecast minus ob)
- Of Temperature, Relative Humidity, Wind, Height

Interactive Model-RAOB Statistics

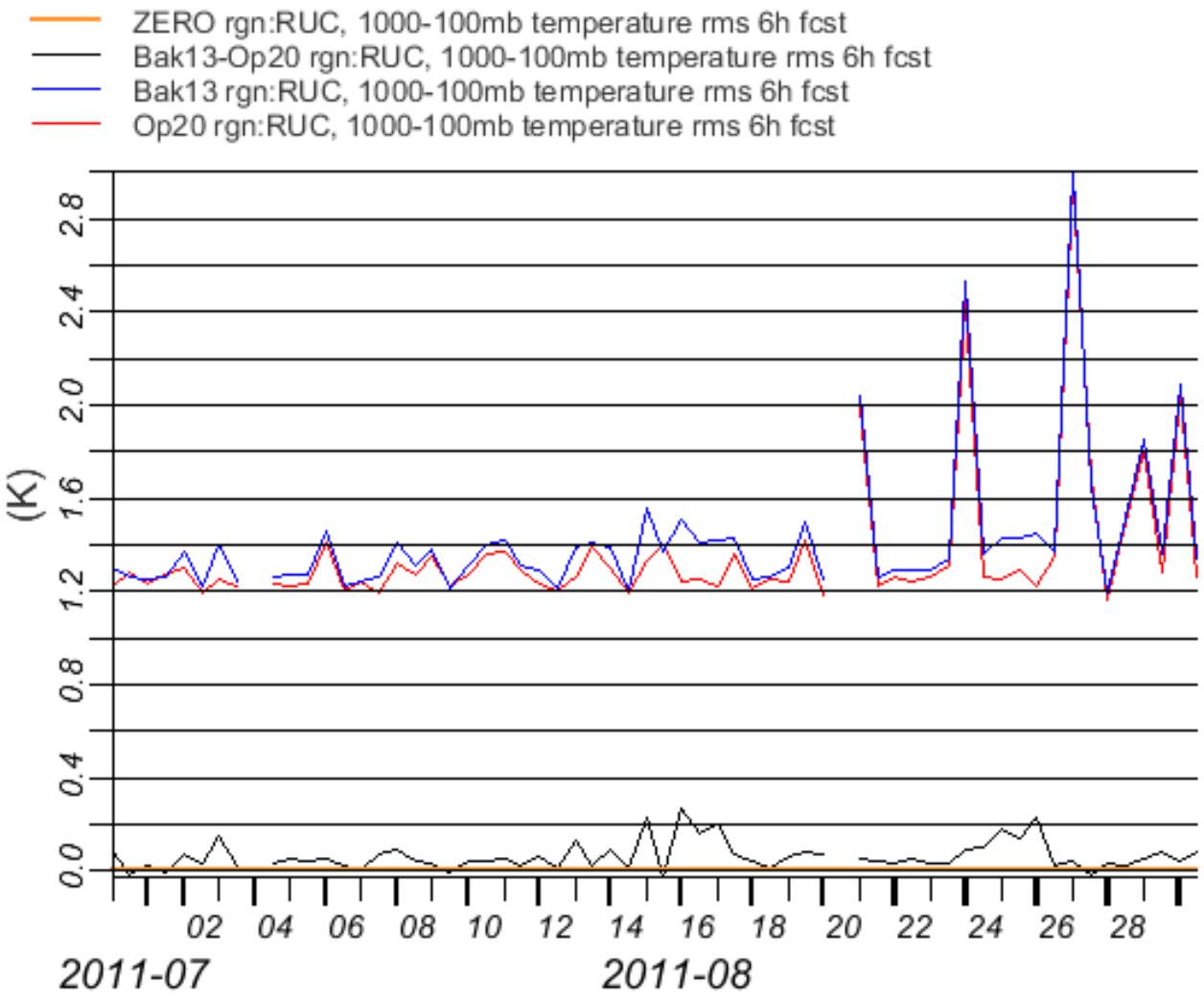
- To **zoom** any plot, **click and drag across** the region of interest.
- To change how a curve appears, double-click (or right-click) on the curve's legend.
- To change an axis, right-click on the axis.
- **Plot matching** matches all curves against each other; only times for which all requested models produced forecasts are included in the plots, and in any averages requested. Each curve after the first is compared against the first curve, and difference curves are generated.
- **Plot Pairwise** matches each pair of curves against the other in the pair; for each pair only times for which both requested models produced forecasts are included in the plots, and in any averages requested. Within each pair the curves are compared, and a difference curve is generated.
- **Plot Unmatched** plots all available data for each curve requested. Difference curves are not generated.

Change history | RESIDUALS | SOUNDINGS | Profiles



Time Series

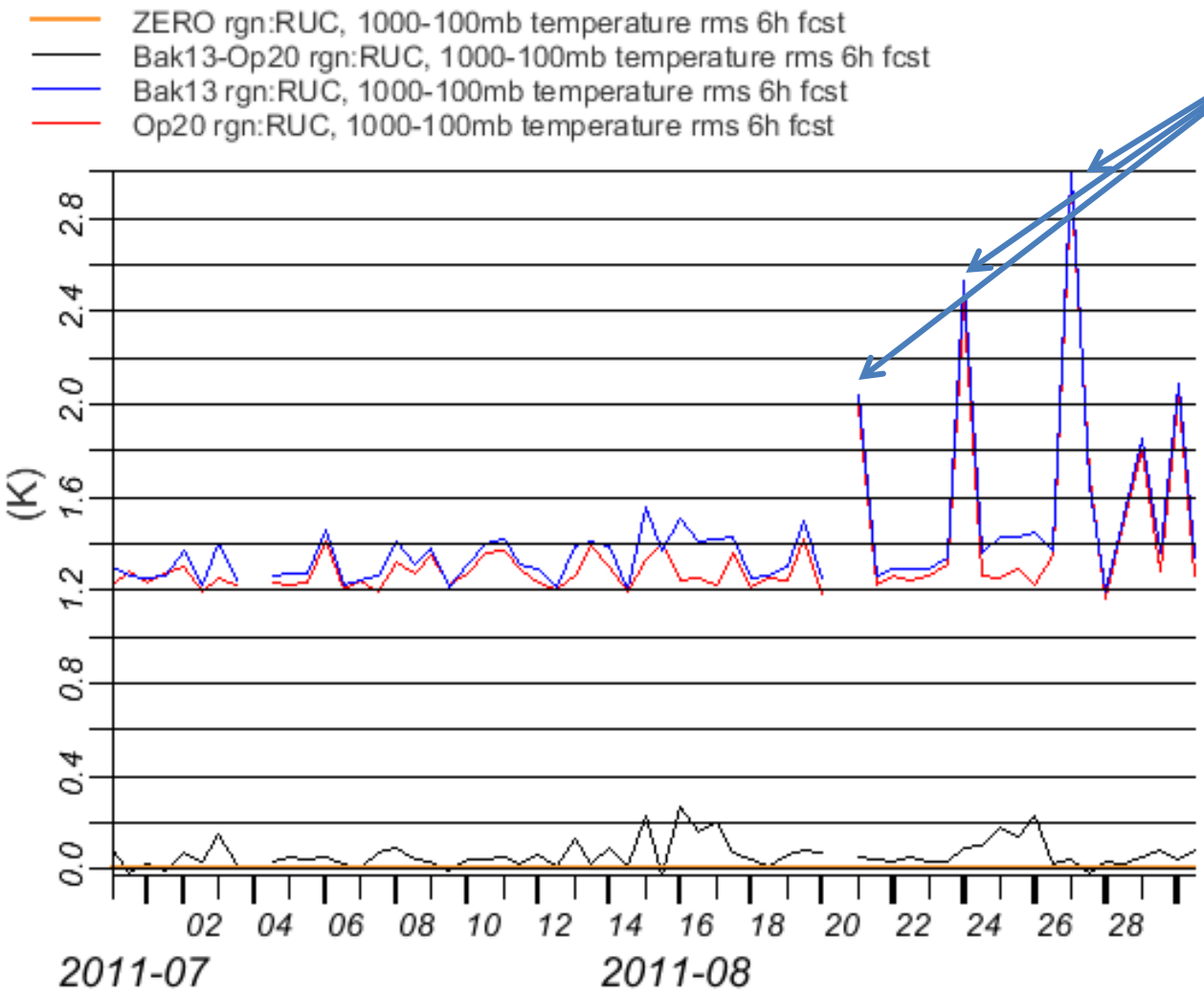
Time-series of **RAOB** data against Operational and Backup RUC models
For entire RUC region
Results every 12 h (0 and 12 UTC)
Averaged from 1000 – 100 mb
(No time averaging here)



RMS of temperature difference with respect to RAOBs in the RUC region

Difference between the two models

Time-series of **RAOB** data against Operational and Backup RUC models
For entire RUC region
Results every 12 h (0 and 12 UTC)
Averaged from 1000 – 100 mb
(No time averaging here)



Some apparent bad RAOBs on Aug 21st 24th and 27th effect both models equally, as indicated by the difference curve

RMS of temperature difference with respect to RAOBs

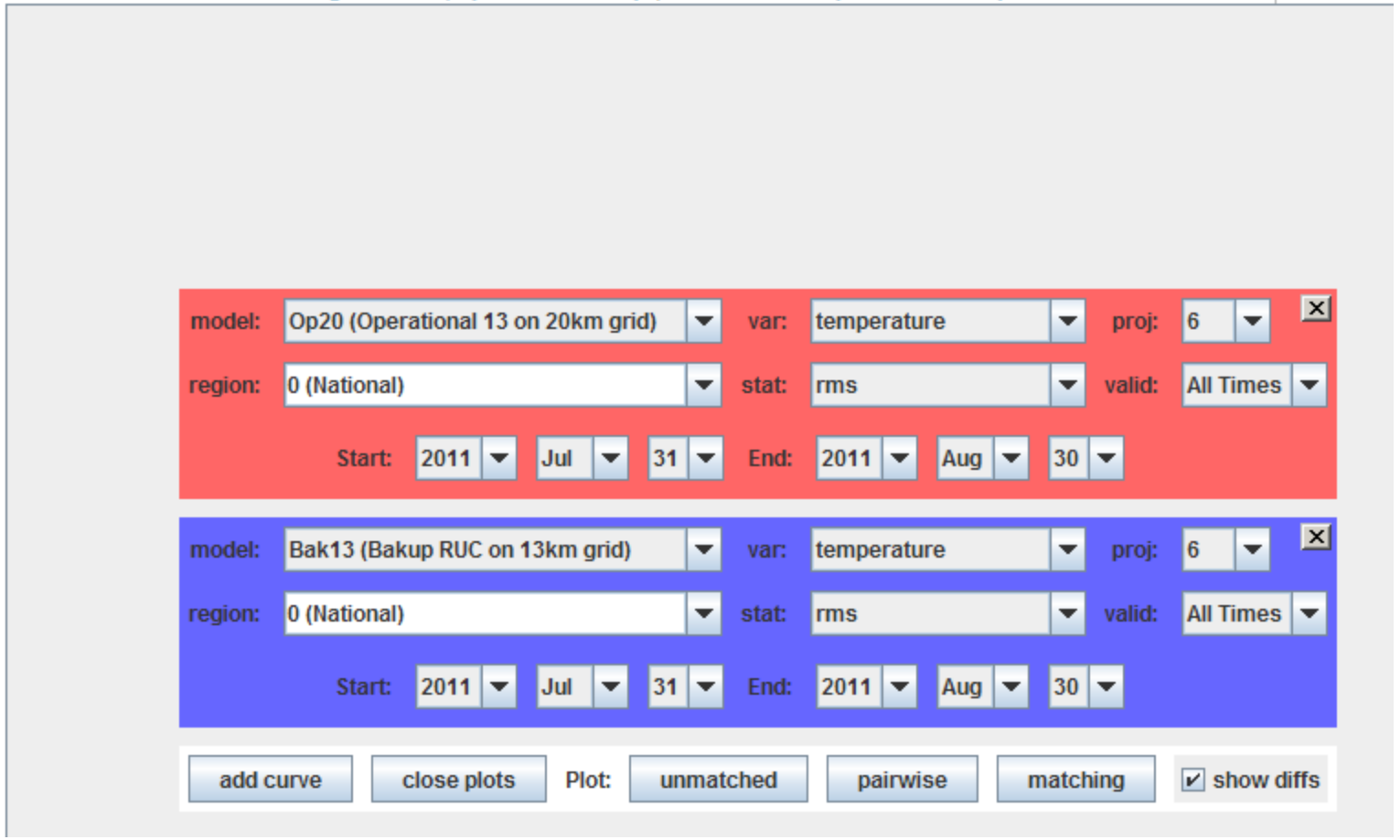
Difference between the two models

Vertical Profiles

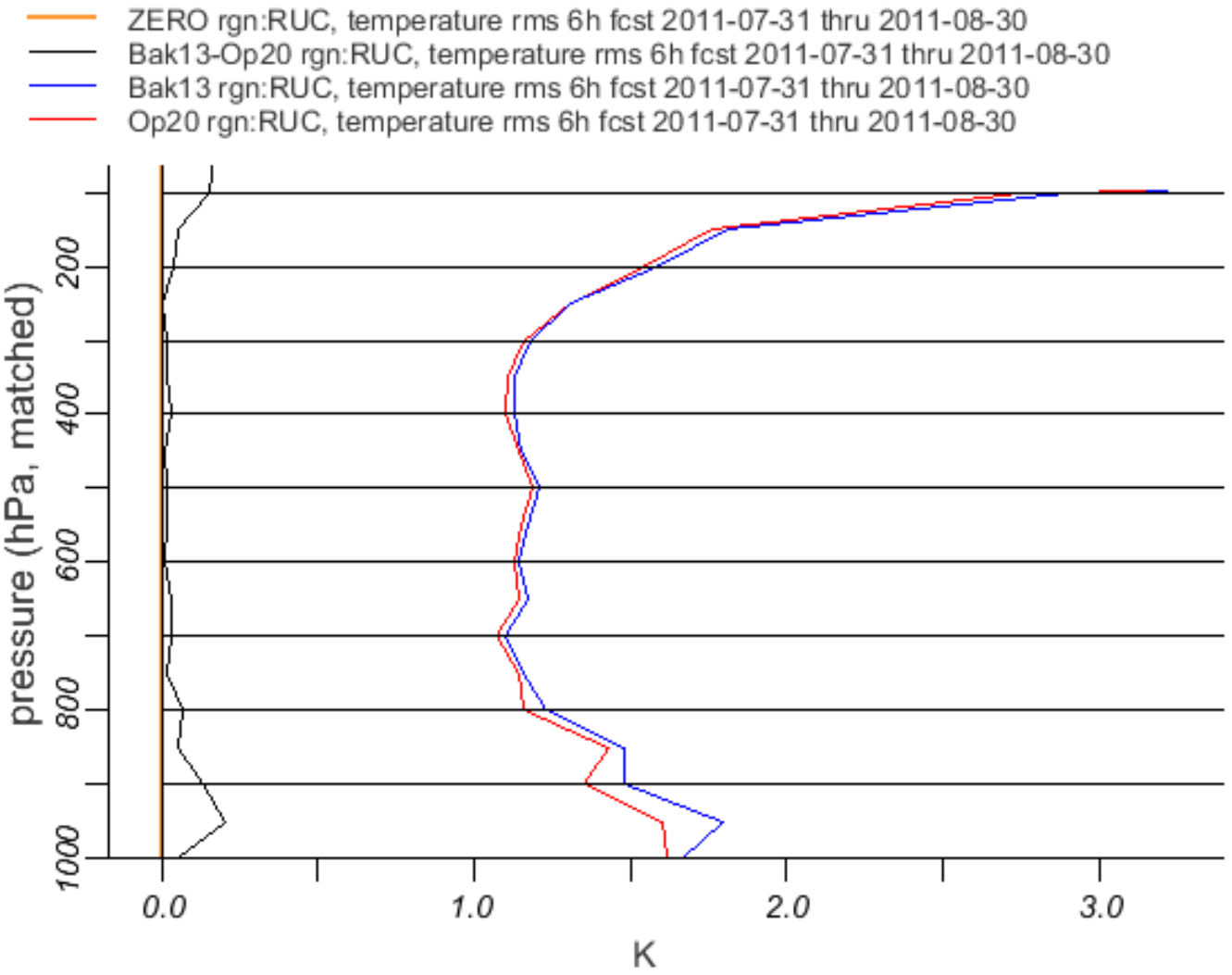
Profile RUC-RAOB Statistics

Plots come up in a new window when you press **plot curve(s)**.
To **zoom** any plot, **click and drag across** the region of interest.
To change how a curve appears, double-click (or right-click) on the curve's legend.
To change an axis, right-click on the axis.

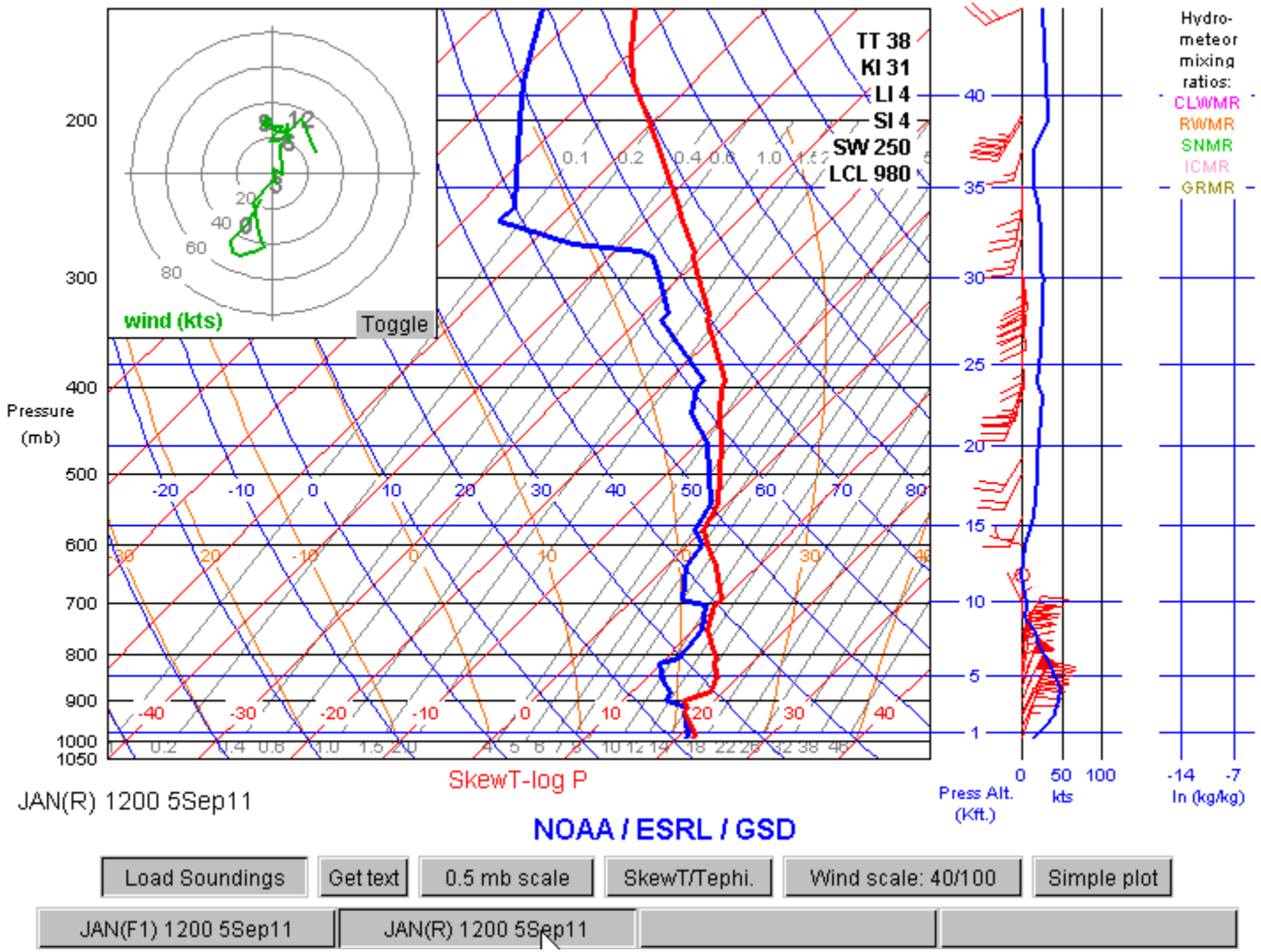
Change history (new window) | Time Series (new window)



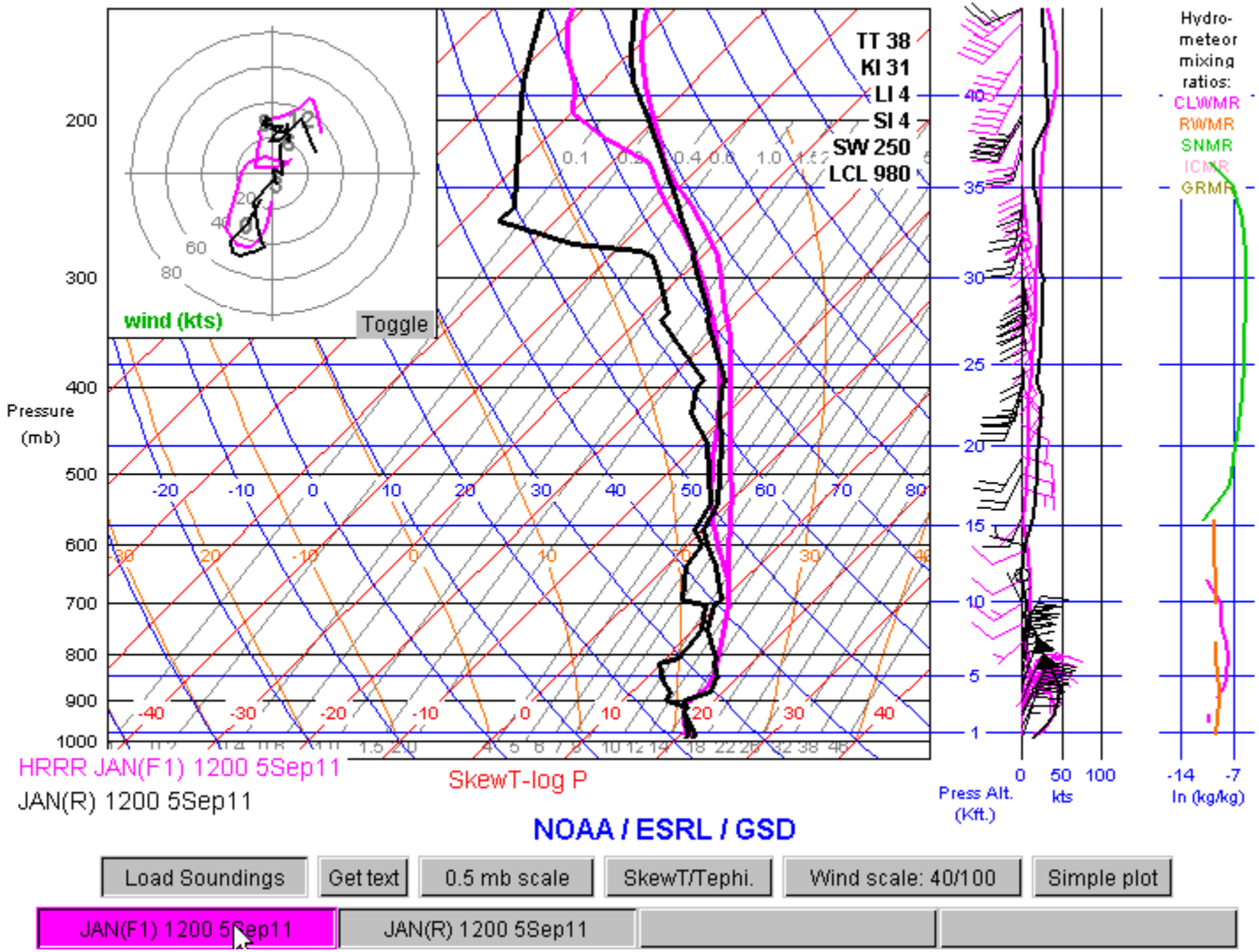
Profile of **RAOB** data against Operational and Backup RUC models
For entire RUC region
Results every 12 h (0 and 12 UTC)
Averaged for the month of August 2011



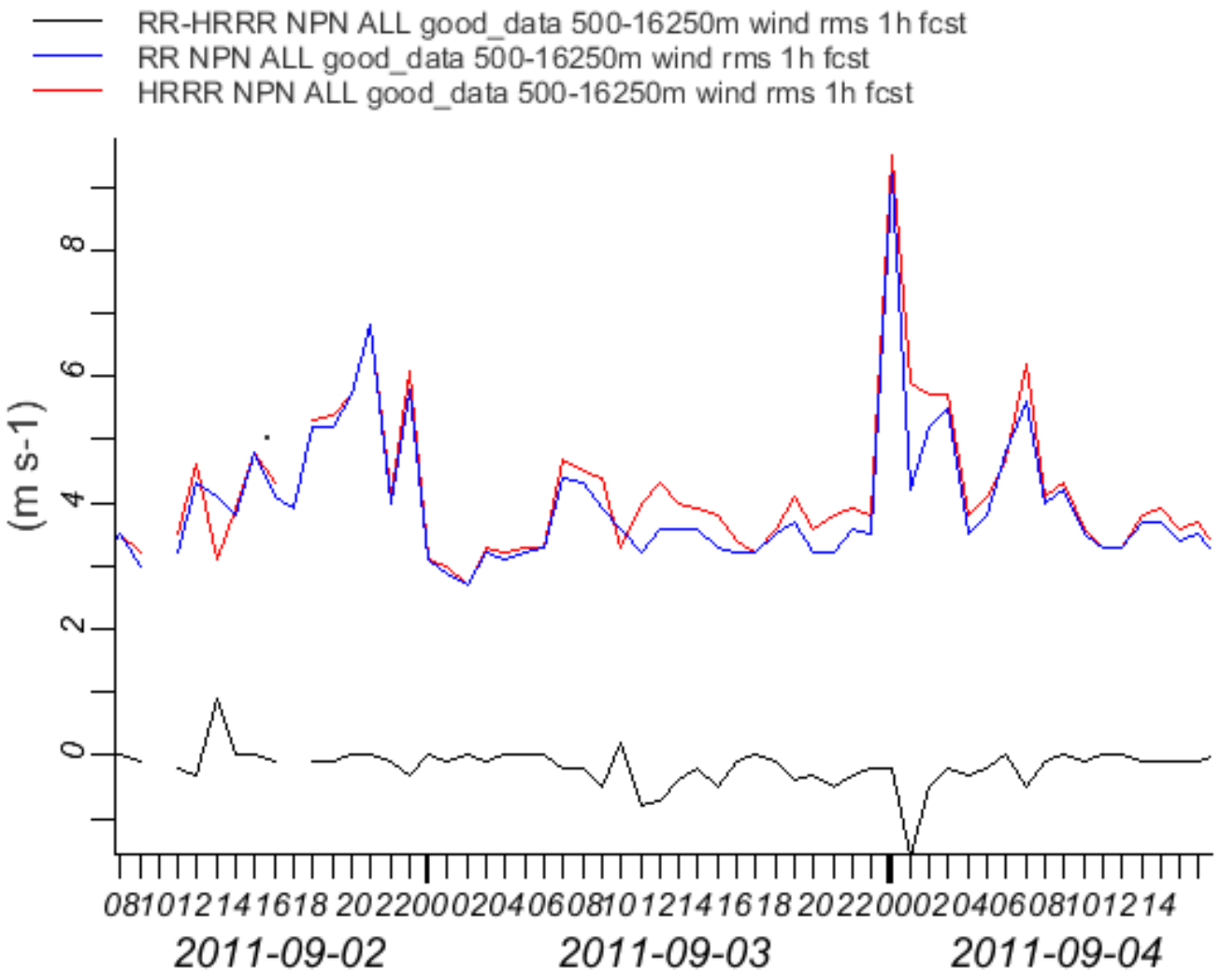
We can look at the individual soundings these statistics are based on. Here's RAOB from Jackson, MS…



Overlaid with HRRR 1h forecast for the same location
Includes hydrometeors (Cloud, Rain, Snow, Ice, Graupel)



Time-series of **Wind Profiler** data against HRRR and RR models
For entire NPN profiler network
Note results are available for **every hour** (instead of every 12h with RAOBs)



Surface verification

- Week-long statistics of mesonet sites against Rapid Refresh 1-h forecasts
- Used to generate ‘use lists’ of good surface sites, used at GSD and NCEP.

Surface data minus RR1h RR 1-h forecast.

abs(bias_T) > 2.2°C shown in red
std_T > 4.4°C shown in red
abs(bias_S) > 0.9 m/s shown in red
std_S > 3.6 m/s shown in red
abs(bias_D) > 20° shown in red (when S > 2.2 m/s)
std_D > 90° shown in red (when S > 2.2 m/s)
rms_W > 4.5 m/s shown in red (vector wind difference, when heading is known)
abs(bias_Td) > 2.2°C shown in red
std_Td > 5.6°C shown in red

detailed descriptions of summary statistics (in another window)

For the period 2011-08-15 00:00:00 to 2011-08-21 23:59:59
(Click on a column header to sort by that column)

line	GSD_ID	name	N_T	avg_T	bias_T	std_T	N_S	avg_S	bias_S	std_S	N_D	bias_D	std_D	rms_W	N_Td	avg_Td	bias_Td	std_Td	network	first	last
														V							
1	13051	OH024	1	0.0	-21.2	0.0	121	60.7	58.4	5.5	44	-119	56	61.7	121	0.0	-18.5	2.5	OHDOT	2011-08-15 00:57:00	2011-08-21 23:58:00
2	52103	AT552	107	0.2	-21.1	26.9	107	34.9	31.6	48.5	37	72	126	61.6	107	-3.0	-17.1	25.5	APRSWXNET	2011-08-15 00:08:20	2011-08-19 21:18:02
3	106478	D6032	158	75.7	41.8	14.8	158	44.6	40.1	16.9	114	-6	91	47.3	158	33.0	14.6	7.9	APRSWXNET	2011-08-15 00:58:35	2011-08-21 23:58:27
4	50608	AN322	62	23.6	0.4	1.5	62	38.2	35.5	1.4	30	68	77	38.3	0	0.0	0.0	0.0	AIRNow	2011-08-15 00:00:00	2011-08-21 23:00:00
5	36911	D0257	146	21.9	-0.2	1.0	146	31.9	28.5	2.8	90	52	65	31.8	146	15.1	-0.8	1.3	APRSWXNET	2011-08-15 00:00:12	2011-08-21 23:57:31
6	52965	AN724	73	25.0	4.6	15.1	81	13.0	10.3	25.8	27	-12	66	29.1	0	0.0	0.0	0.0	AIRNow	2011-08-15 00:00:00	2011-08-21 21:00:00
7	3937	AR726	145	25.1	-0.3	2.1	145	25.0	21.0	1.9	108	-88	64	26.0	145	18.5	-1.8	1.5	APRSWXNET	2011-08-15 00:00:13	2011-08-21 23:00:13
8	107369	D6467	144	38.2	12.9	24.3	144	14.6	11.4	21.5	42	12	48	25.1	144	12.7	9.5	11.9	APRSWXNET	2011-08-15 00:57:03	2011-08-21 23:57:05
9	110801	P0865	45	8.0	-10.8	22.9	45	5.0	3.0	18.0	5	54	99	19.3	45	-9.3	-13.9	26.9	AWS	2011-08-16 21:40:00	2011-08-21 20:58:00
10	34285	SMIGL	63	13.2	-1.3	1.7	60	18.7	10.8	13.3	55	-10	39	18.3	63	10.6	-3.0	1.7	MesoWest	2011-08-15 12:00:00	2011-08-21 23:00:00
11	10489	AP415	90	18.6	-1.5	1.9	90	2.6	0.2	16.9	1	157	0	17.5	90	15.4	-0.7	2.0	APRSWXNET	2011-08-15 01:21:34	2011-08-21 22:56:39
12	47051	P0018	71	20.8	-1.2	1.3	71	4.6	0.3	13.1	29	3	33	13.8	71	12.5	-0.2	0.9	AWS	2011-08-15 02:25:00	2011-08-20 01:00:00
13	21834	PTREY	81	10.9	-0.7	1.0	81	8.7	3.0	1.6	77	129	51	13.7	81	10.4	-1.0	1.0	MesoWest	2011-08-15 00:00:00	2011-08-18 19:00:00
14	31999	VC675	93	8.2	2.8	1.2	93	8.2	0.6	2.5	90	103	47	13.3	93	6.8	1.7	0.7	Maritime	2011-08-15 00:00:00	2011-08-21 23:00:00
15	40117	ATKA2	152	10.5	-0.7	1.1	150	6.6	1.0	2.0	114	-64	136	13.2	0	0.0	0.0	0.0	NOS-NWLON	2011-08-15 00:42:00	2011-08-21 23:00:00

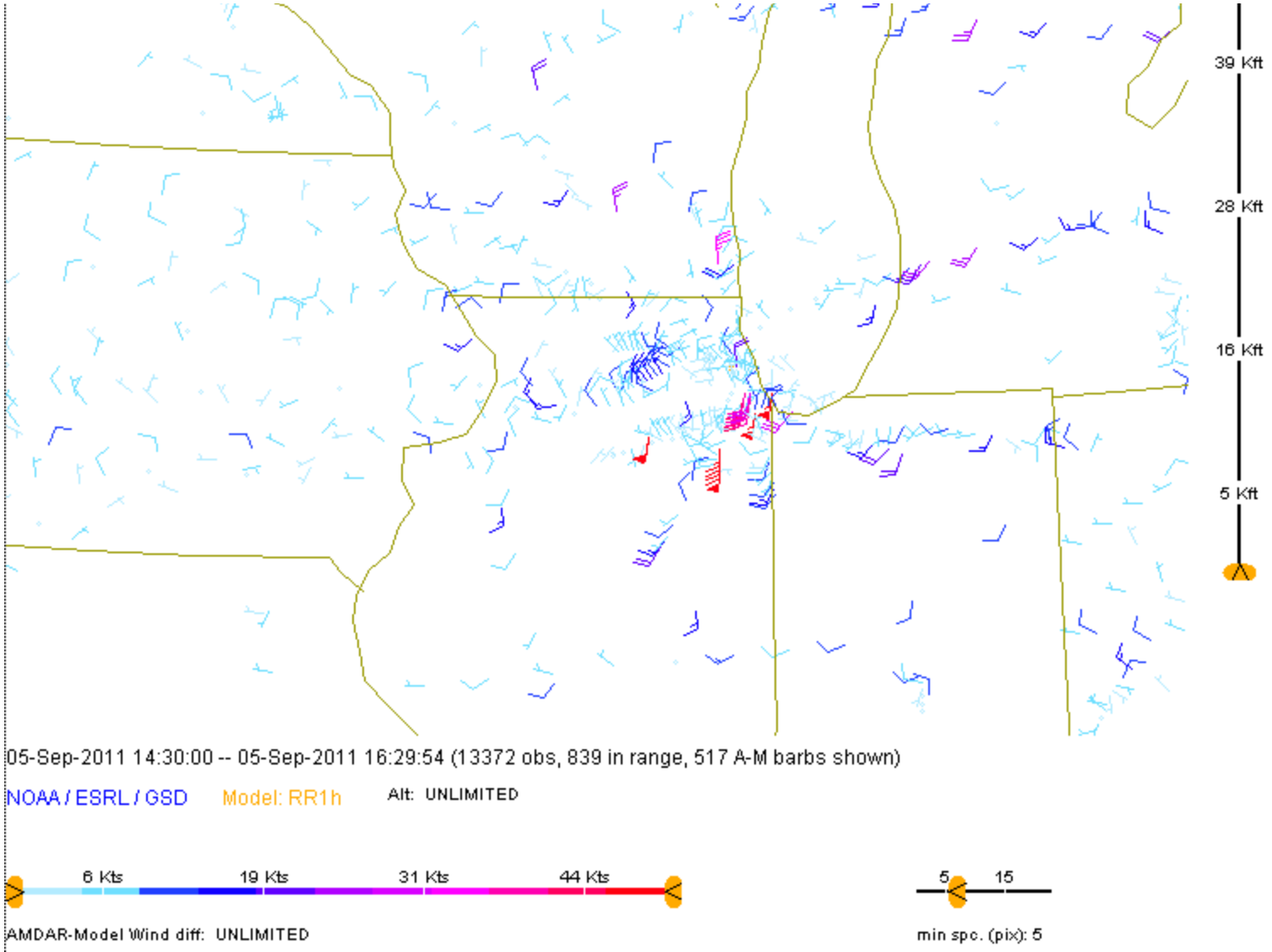
This list sorted by RMS of vector (forecast – ob) wind difference

Mesonet corrections

- We plan to use our long-term observation-model statistics to *experimentally correct* surface observations where possible
- We generate ob-model wind biases
  - For each model wind octant
  - For most sites, biases are relatively constant month-by-month
  - So we can potentially correct for these biases
- The test will be if these “corrected” winds improve model forecasts
- We plan a similar effort for correcting Temperature and Dewpoint

Aircraft – Model differences

This shows vector wind difference between AMDAR obs and RR 1h forecasts.
Shows some obvious bad aircraft winds near Chicago.
(Used by NWS to help identify bad aircraft data.)



Aircraft weekly statistics

Aircraft data minus RR 1-h forecast.

abs(bias_T) > 2°C shown in red
std_T > 2°C shown in red
abs(bias_S) > 2 m/s shown in red
std_S > 5 m/s shown in red
abs(bias_D) > 7° shown in red (when S > 10 m/s)
std_D > 30° shown in red (when S > 10 m/s)
rms_W > 7 m/s shown in red (vector wind difference, when heading is known)
abs(bias_RH) > 10% shown in red
std_RH > 20% shown in red

For the period 2011-08-29 00:30:00 to 2011-09-04 23:59:59
All altitudes. Aircraft with > 200 observations.
(Click on a column header to sort by that column)
(Click on a GSD_ID to get a time series in a separate window)

GSD_ID	N_T	avg_T	bias_T	std_T	N_S	avg_S	bias_S	std_S	bias_D	std_D	rms_W	N_RH	avg_RH	bias_RH	std_RH	model	airline	first	last
8600	2291	-11.0	-0.2	0.7	2291	10.8	0.2	2.2	0	8	3.2	2291	41.5	-1.8	19.5	737	SW	2011-08-29 00:58:00	2011-09-04 20:58:00
9018	2228	-9.8	-0.0	0.9	2228	11.9	0.1	2.5	-1	9	3.6	2228	41.4	-0.8	18.1	737	SW	2011-08-29 00:30:00	2011-09-04 23:56:00
9466	2216	-8.1	-0.8	0.8	1916	11.3	0.3	2.2	-0	7	3.1	2216	30.6	4.2	15.6	ERJ-145	TAM-Chautauq	2011-08-29 00:30:00	2011-09-04 23:41:42
8603	2194	-10.6	-0.0	0.8	2194	12.8	0.6	2.3	1	12	3.5	2192	37.2	-1.6	16.2	737	SW	2011-08-29 01:33:00	2011-09-04 23:42:00
10580	2161	-6.9	-0.4	1.0	2161	10.9	0.5	2.3	0	9	3.5	2161	33.2	-1.1	17.7		SW	2011-08-29 00:30:00	2011-09-04 20:59:00
8493	2128	-8.2	-0.2	0.9	2128	11.2	0.3	2.4	1	18	3.9	2102	36.4	-2.7	16.9	737	SW	2011-08-29 00:31:00	2011-09-04 23:51:00
8492	2084	-9.7	-0.0	0.7	2084	11.1	0.3	2.1	2	9	3.1	2084	42.1	-0.9	17.2	737	SW	2011-08-29 00:31:00	2011-09-04 23:56:00
8490	2067	-8.8	-0.2	0.9	2067	10.1	0.2	2.1	-0	9	3.3	2067	32.3	-1.0	15.5	737	SW	2011-08-29 00:30:00	2011-09-04 23:35:00
9929	1967	-11.0	-0.1	0.8	1967	14.3	0.7	2.3	-0	12	3.8	1966	34.8	-1.2	15.7		SW	2011-08-29 00:35:00	2011-09-04 23:59:00
10371	1935	-6.6	-0.2	0.8	1935	9.9	0.6	2.2	0	8	3.2	1932	40.6	0.4	18.2		SW	2011-08-29 00:39:00	2011-09-04 23:51:00
9095	1927	-12.9	-0.2	0.7	1927	10.5	0.1	2.3	-1	10	3.4	1927	42.7	0.6	15.2		SW	2011-08-29 13:10:00	2011-09-04 23:54:00
9096	1924	-8.4	-0.2	1.0	1924	10.4	0.4	2.3	-1	14	3.6	1924	32.8	1.5	16.6	737	SW	2011-08-29 00:30:00	2011-09-04 23:49:00
10597	1923	-13.0	-0.2	0.7	1923	11.1	0.1	2.4	1	11	3.6	1923	40.9	-3.7	17.7		SW	2011-08-29 00:54:00	2011-09-03 19:54:00
8450	1904	-11.5	-0.4	0.7	1904	11.3	0.7	2.2	-1	9	3.3	1902	35.5	1.0	16.0	737	SW	2011-08-29 00:30:00	2011-09-04 23:57:00
8505	1882	-7.1	-0.2	0.8	1882	9.6	0.3	2.1	-1	8	3.3	1882	31.0	-1.5	15.2	737	SW	2011-08-29 17:02:00	2011-09-04 23:55:00
8471	1874	-5.9	-0.2	0.8	1874	9.5	0.2	2.3	0	9	3.4	1874	37.9	-2.8	17.6		SW	2011-08-29 00:33:00	2011-09-04 23:42:00
10581	1829	12.5	-0.3	1.0	1351	6.3	0.8	2.7	-1	13	4.2	1829	50.6	-0.7	14.1	DASH-8	TAM-Piedmont	2011-08-29 10:51:07	2011-09-04 22:58:39
10586	1757	12.3	-0.6	1.0	1268	6.8	0.7	2.8	-4	13	4.3	1757	56.4	-3.5	14.2	DASH-8	TAM-Piedmont	2011-08-29 13:30:04	2011-09-04 23:58:14
9537	1738	6.3	-0.5	1.4	1426	7.6	0.3	2.5	-0	10	3.8	1735	45.9	3.8	14.9	DASH-8	TAM-Horizon	2011-08-29 00:31:31	2011-09-04 23:58:51

- Week-long statistics of aircraft obs against Rapid Refresh 1-h forecasts
- Used by us to generate **daily aircraft reject lists** for RR, HRRR and backup RUC
- Used actively by NWS and AirDat

Verification infrastructure

- MySQL database
  - MyISAM tables – good for our ‘data warehousing’ application
  - Currently about 300 G in size
- C, Perl, Java, Python used to populate the database via cron on jet and other computers
- Java web pages for data display
- Perl and Python cgi scripts provide data from the database to web pages

Thank You

Questions?