On [improving] the use of AMVs in NCEP GSI

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Yangrong Ling, Dennis Keyser

13th IWWG, Monterey, CA, 27 June – 1 July 2016

Outline

HIMAWARI winds examination

VIIRS winds Data Assimilation investigation

“GOES-R-like” winds evaluation

Steps towards overall AMV Quality Control (QC) revision

Study of the complimentary nature of AMVs and Doppler Wind Lidar winds

Outline

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Himawari winds examination

HIMAWARI-8 winds have been distributed in parallel with MTSAT-2 winds since July 2015 till ~March 2016.

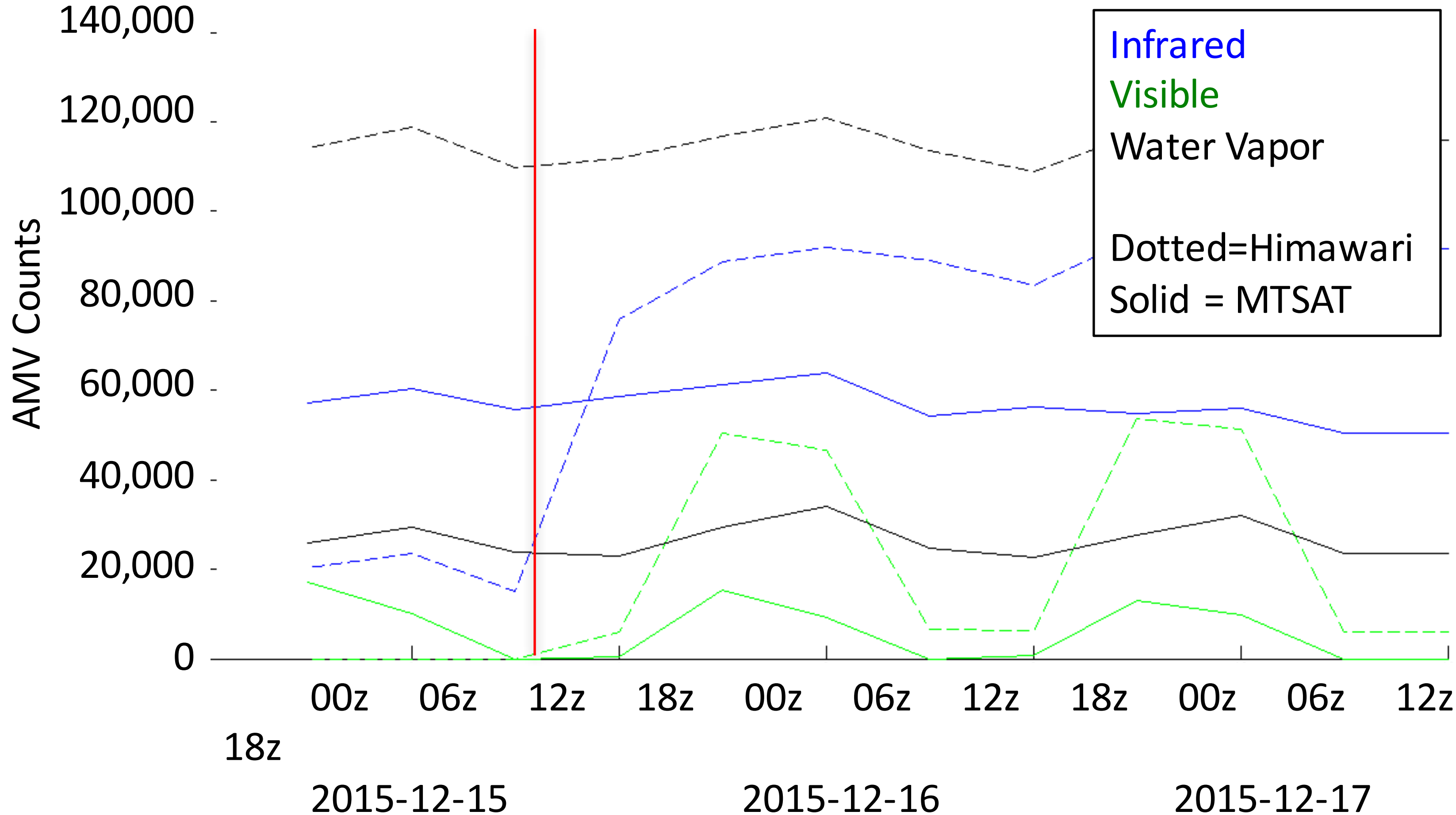
Available in VIS (0.64), IR (11.2), WV(6.2μm, 6.9μm and 7.3μm) channels, and extracted with a new AMV algorithm (Shimoji, 2014). They use the current BUFR table.

Himawari-8 is assigned SatID=173 and the following lines are added to fix/global_convinfo.txt to control the usage of Himawari-8 winds in GSI:

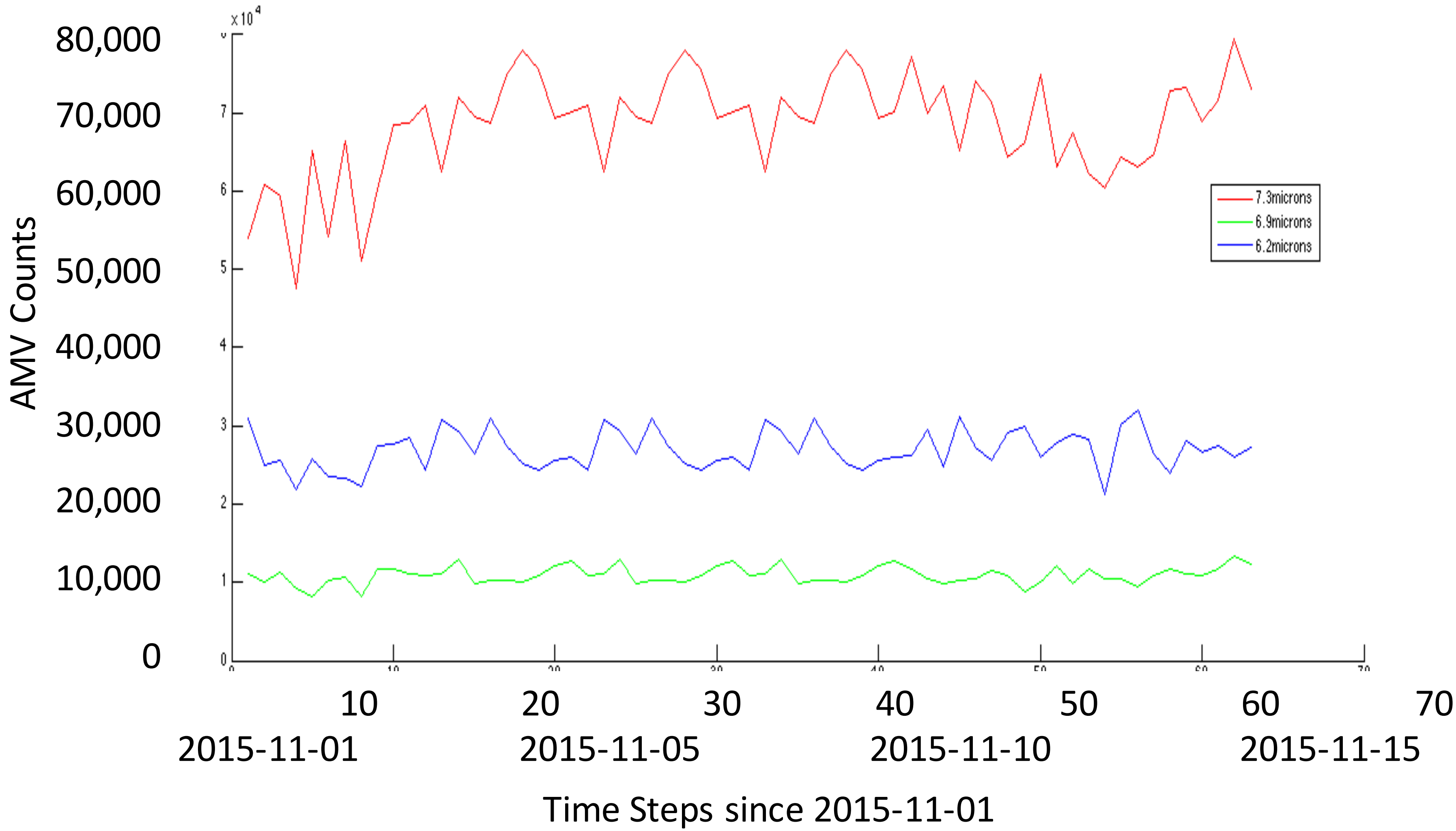
```
uv 242 173  1 3.0 0 0 0 2.5 15.0 1.4 2.5 0.055000 1 200. 100. 0 0. 2.
uv 250 173  1 3.0 0 0 0 2.5 20.0 1.4 2.5 0.050500 1 200. 100. 0 0. 2.
uv 252 173  1 3.0 0 0 0 2.5 20.0 1.4 2.5 0.050050 1 200. 100. 0 0. 2.
```

Himawari-8 winds counts are higher than MTSAT's due to higher spatial resolution and additional channels. JMA winds are spatially thinned in DA. Observation Error is kept 'as is'.

AMV counts before and after NCEP ingest fix (15 Dec 2015)



Monitoring the AMV counts in each of the Himawari-8 WV channels (6.2μm, 6.9μm and 7.3μm)

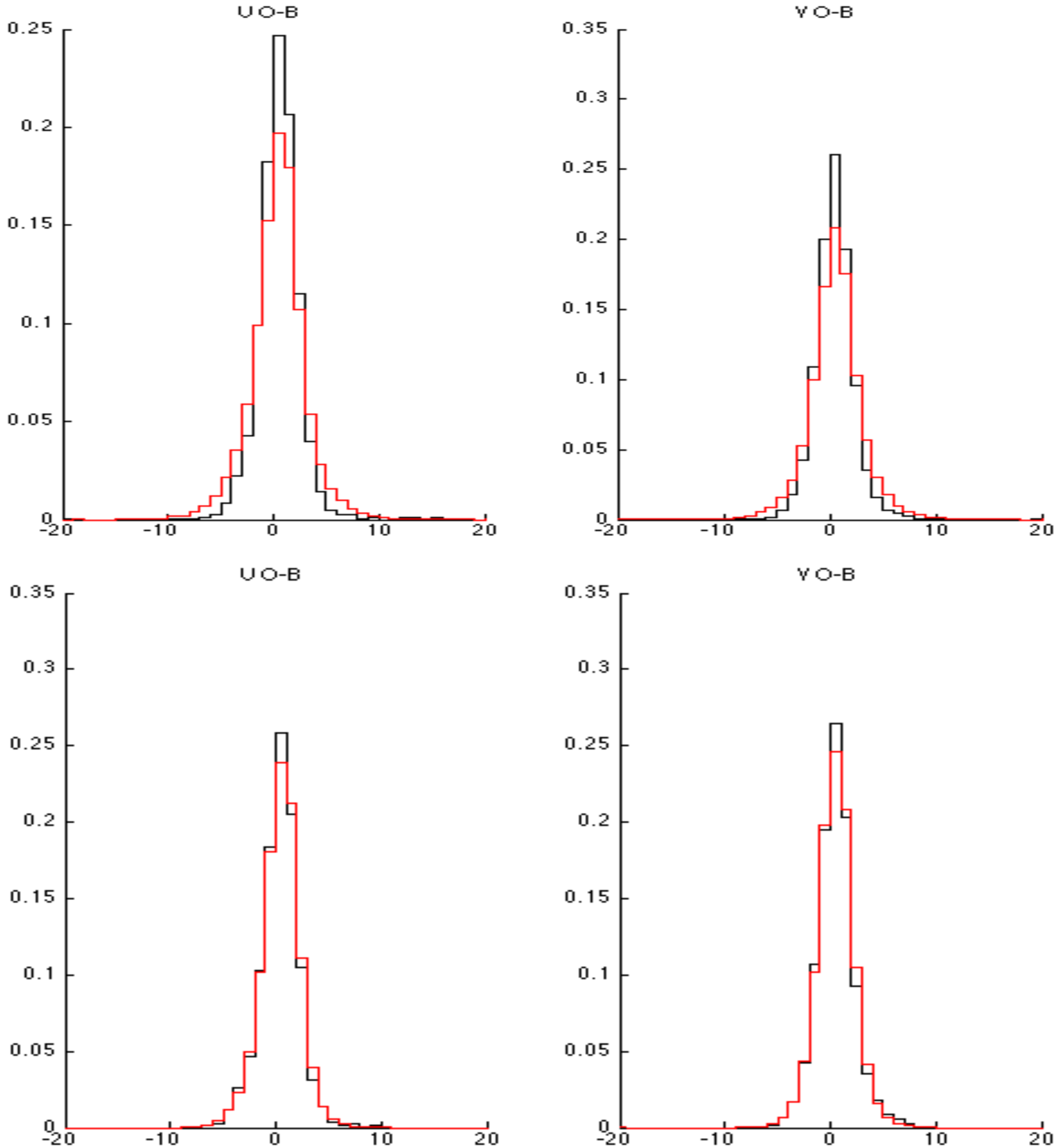


VIS O-B (m/s) PDF

All winds

BLACK=MTSAT-2
RED=HIMAWARI-8

Used winds

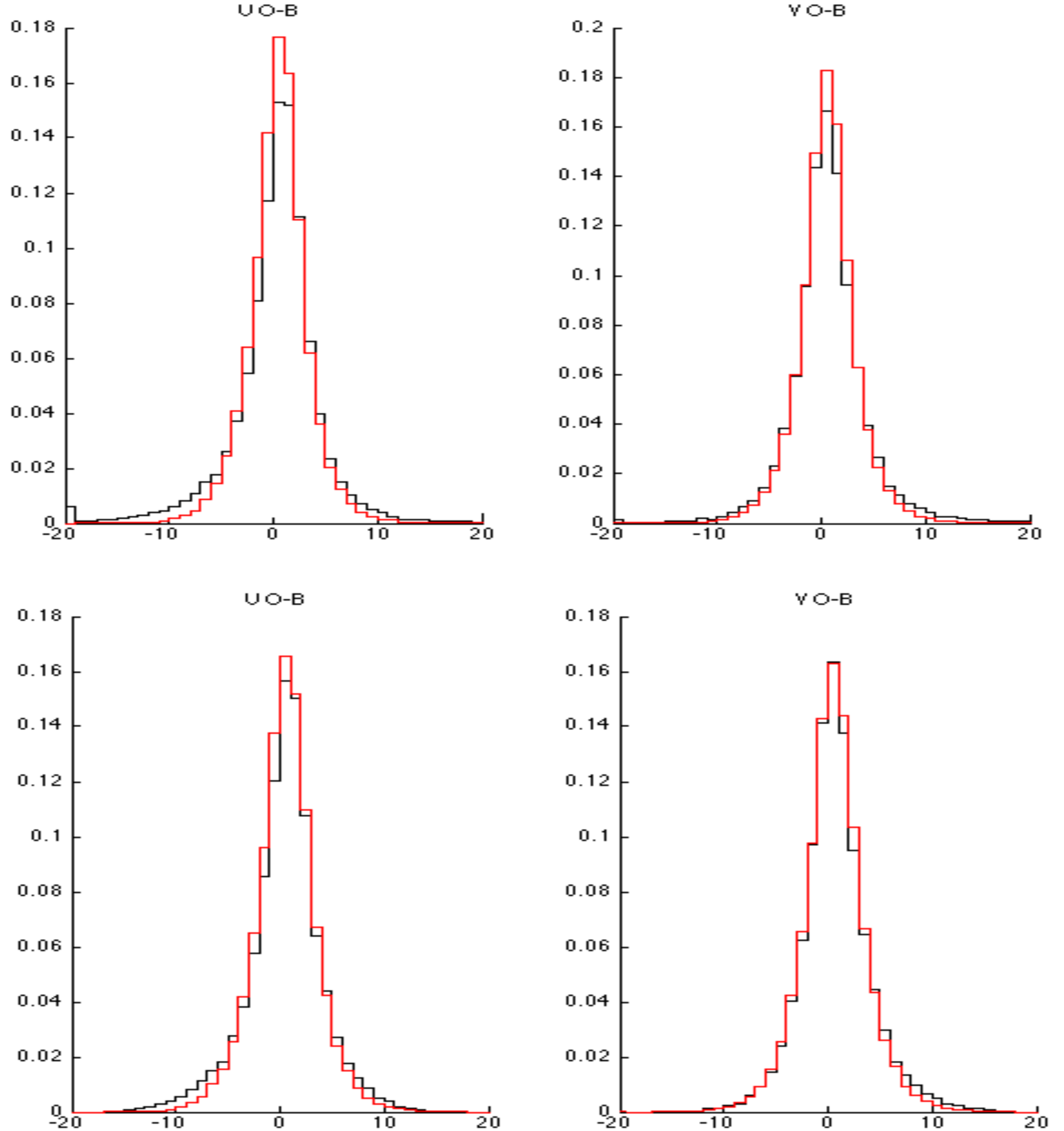


IR O-B (m/s) PDF

All winds

BLACK=MTSAT-2
RED=HIMAWARI-8

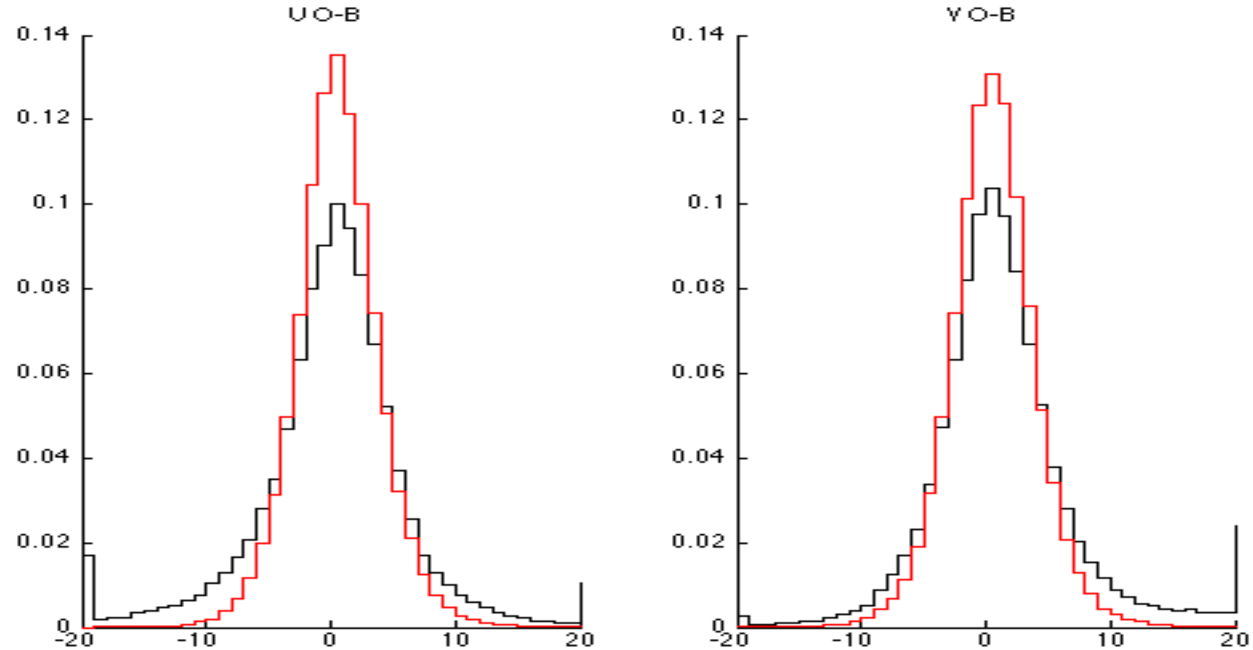
Used winds



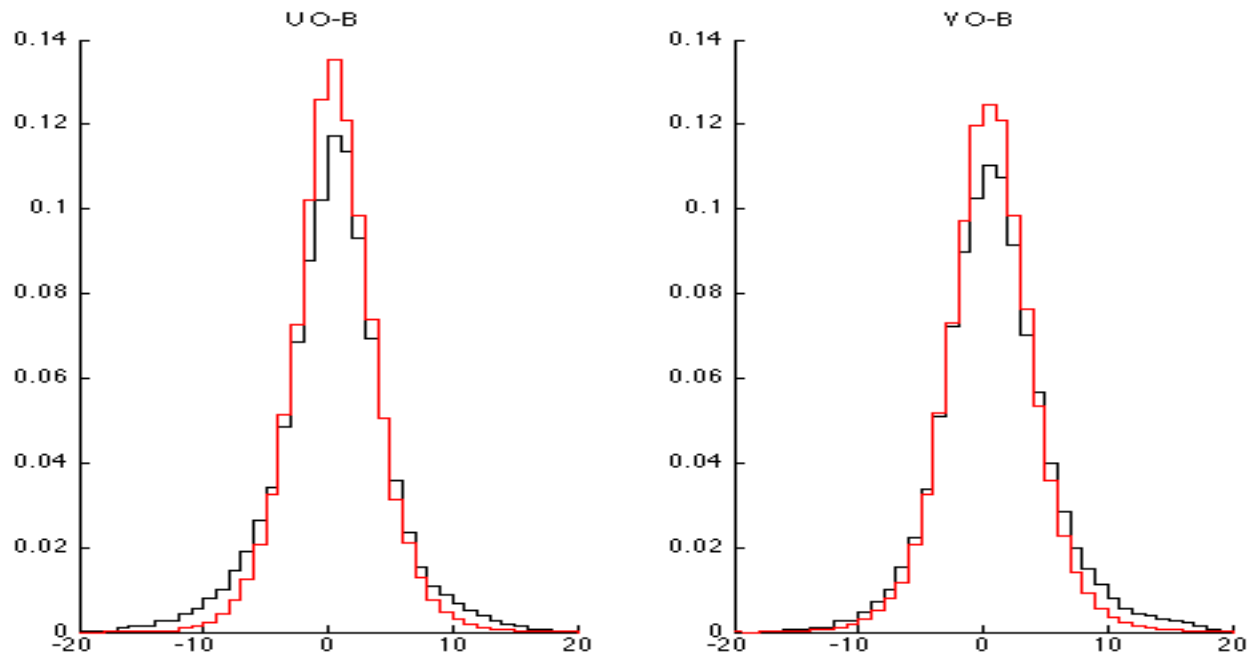
WV O-B (m/s) PDF

All winds

BLACK=MTSAT-2
RED=HIMAWARI-8



Used winds

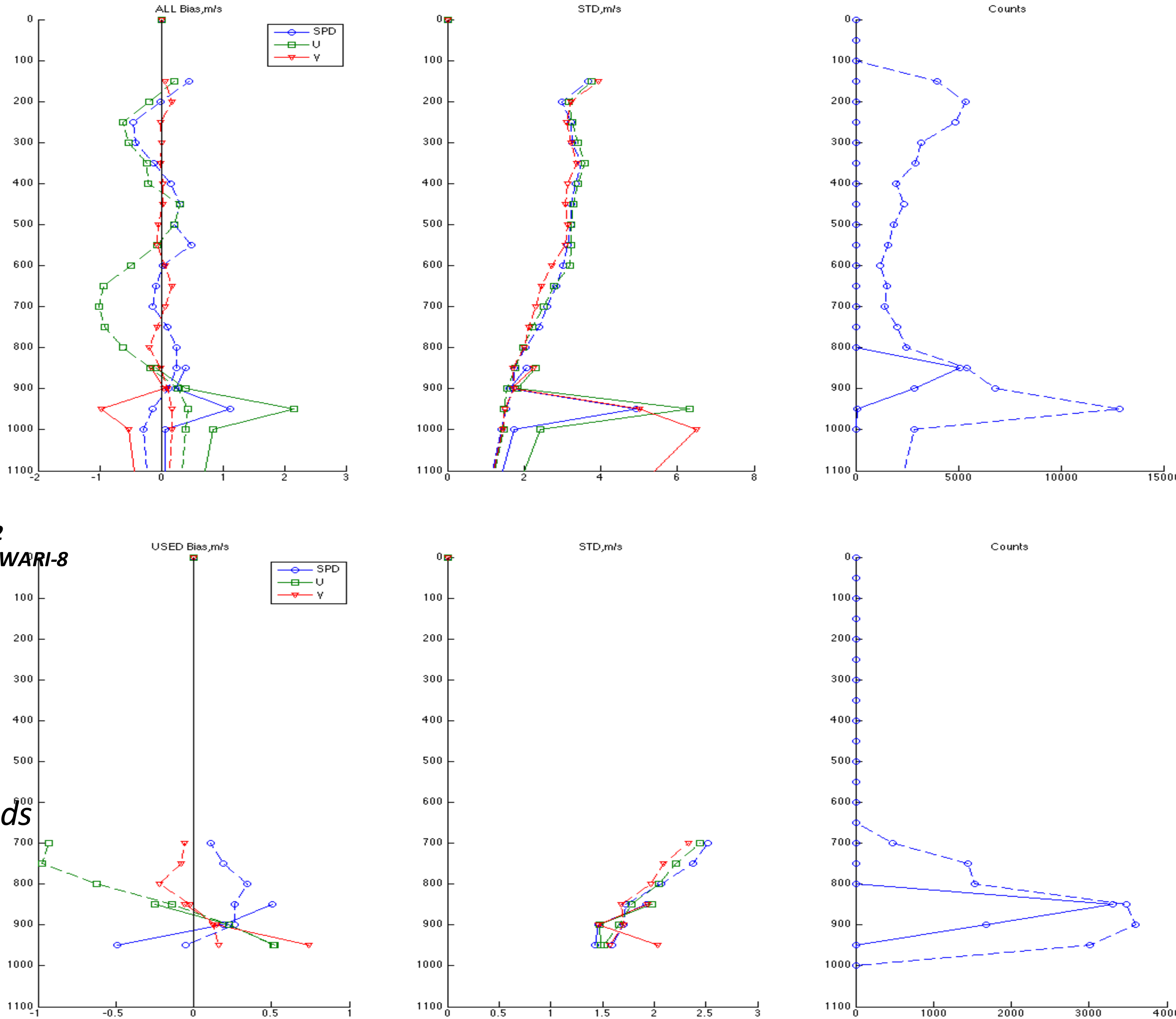


VIS O-B

All winds

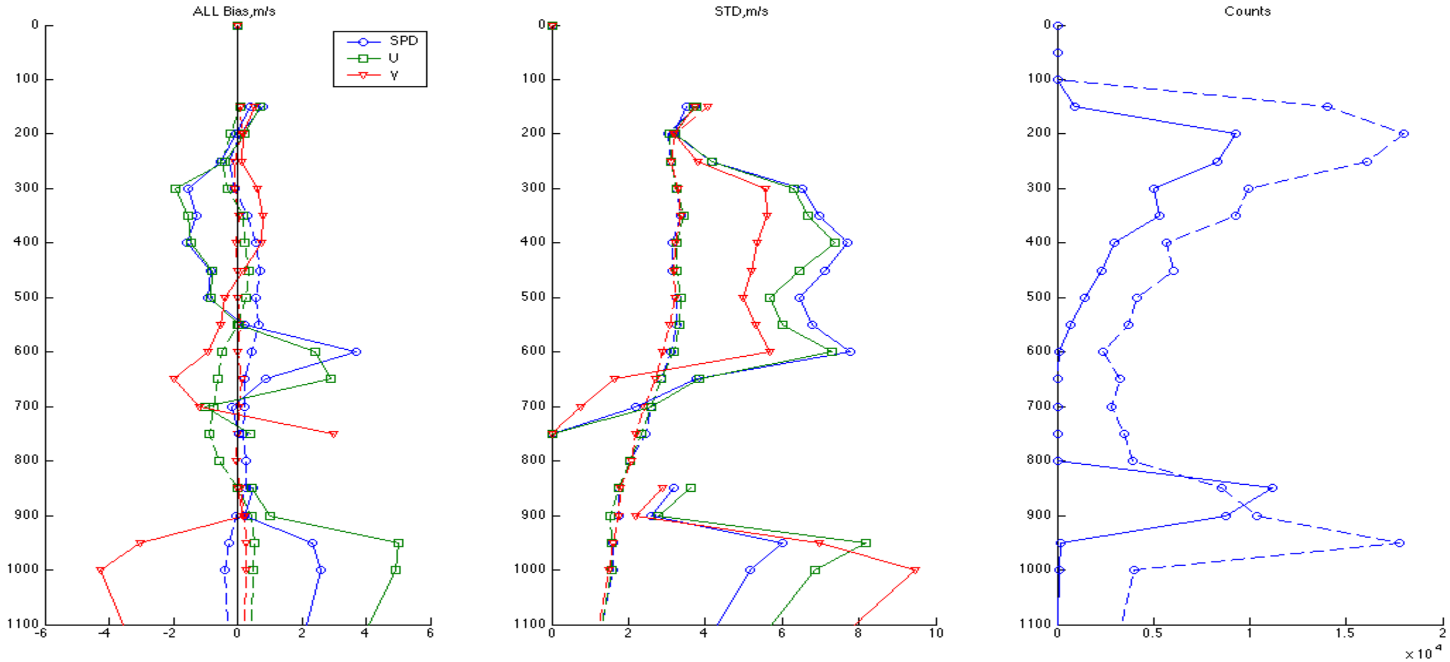
Solid=MTSAT-2
Dashed=HIMAWARI-8

Used winds



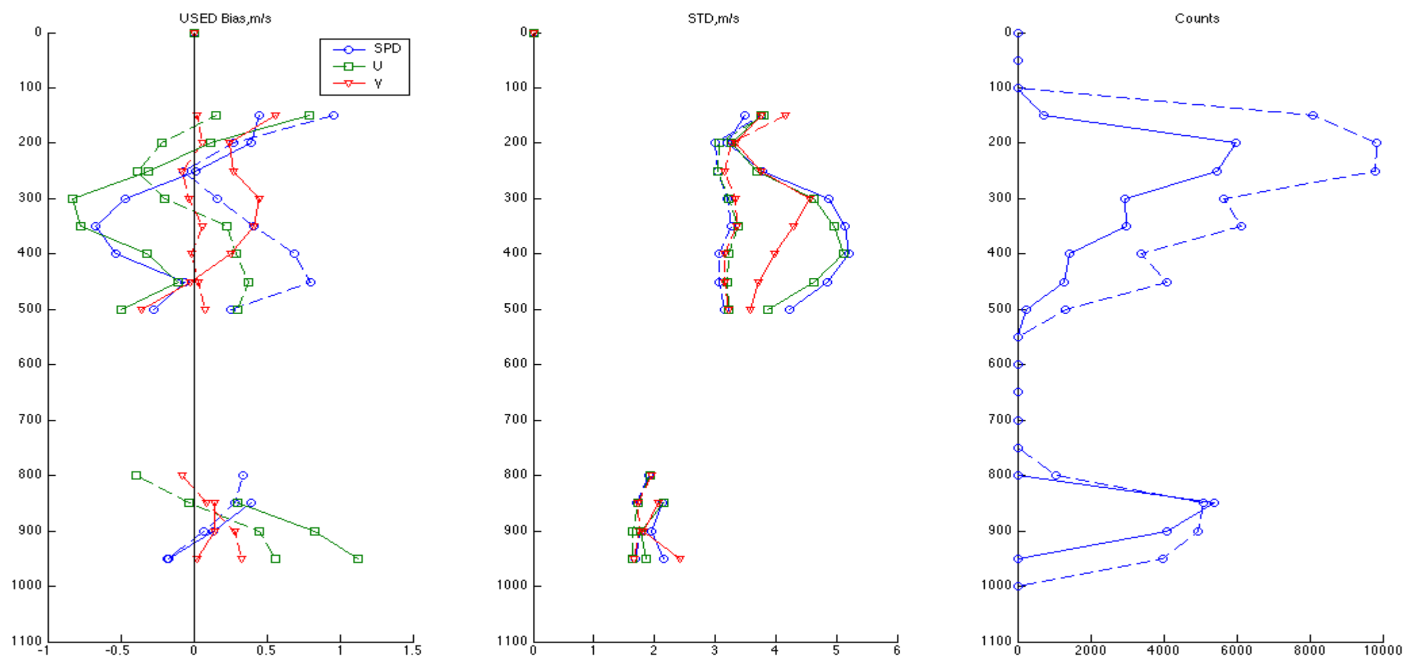
IR O-B

All winds



Solid=MTSAT-2
Dashed=HIMAWARI-8

Used winds

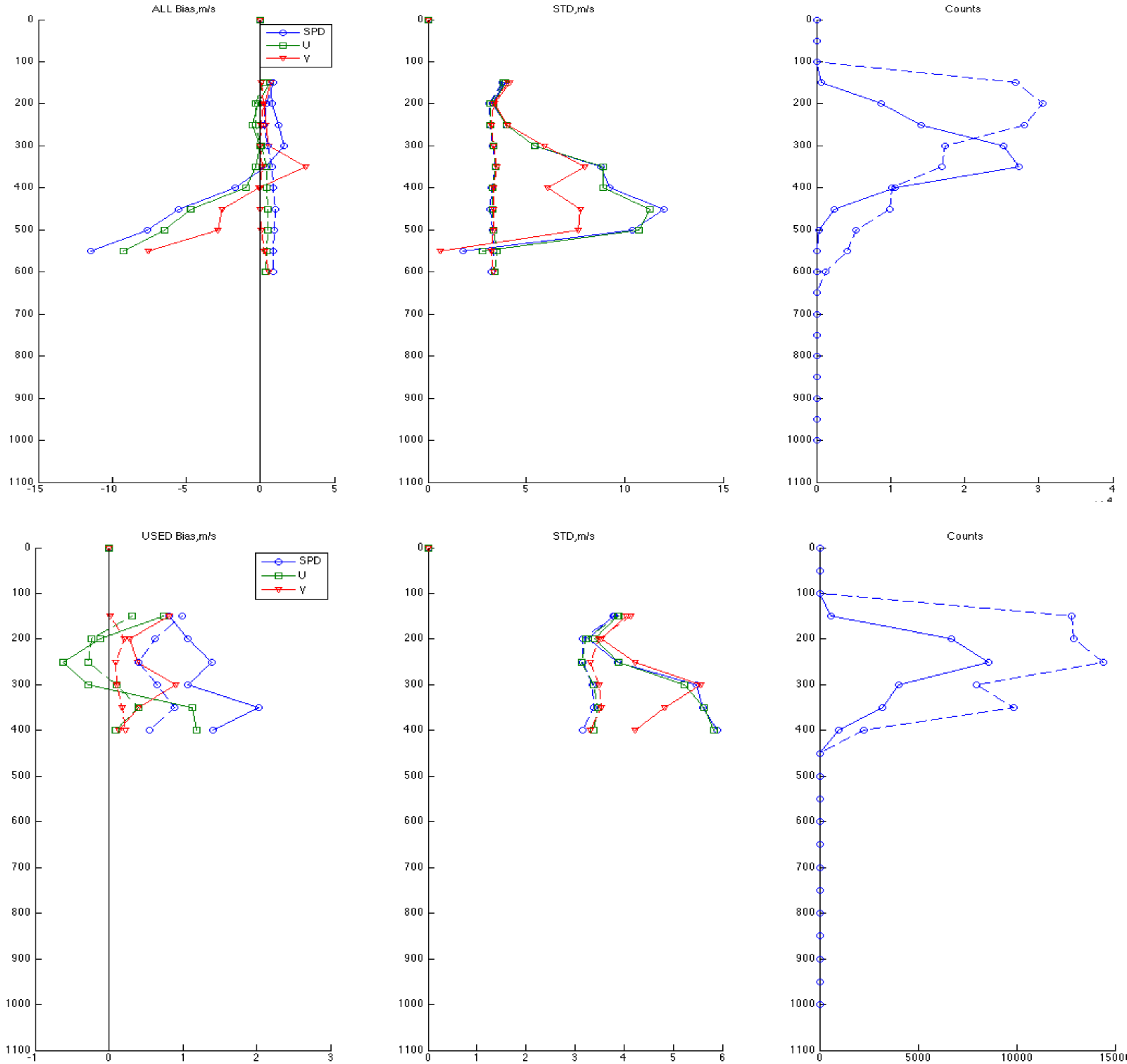


WV O-B

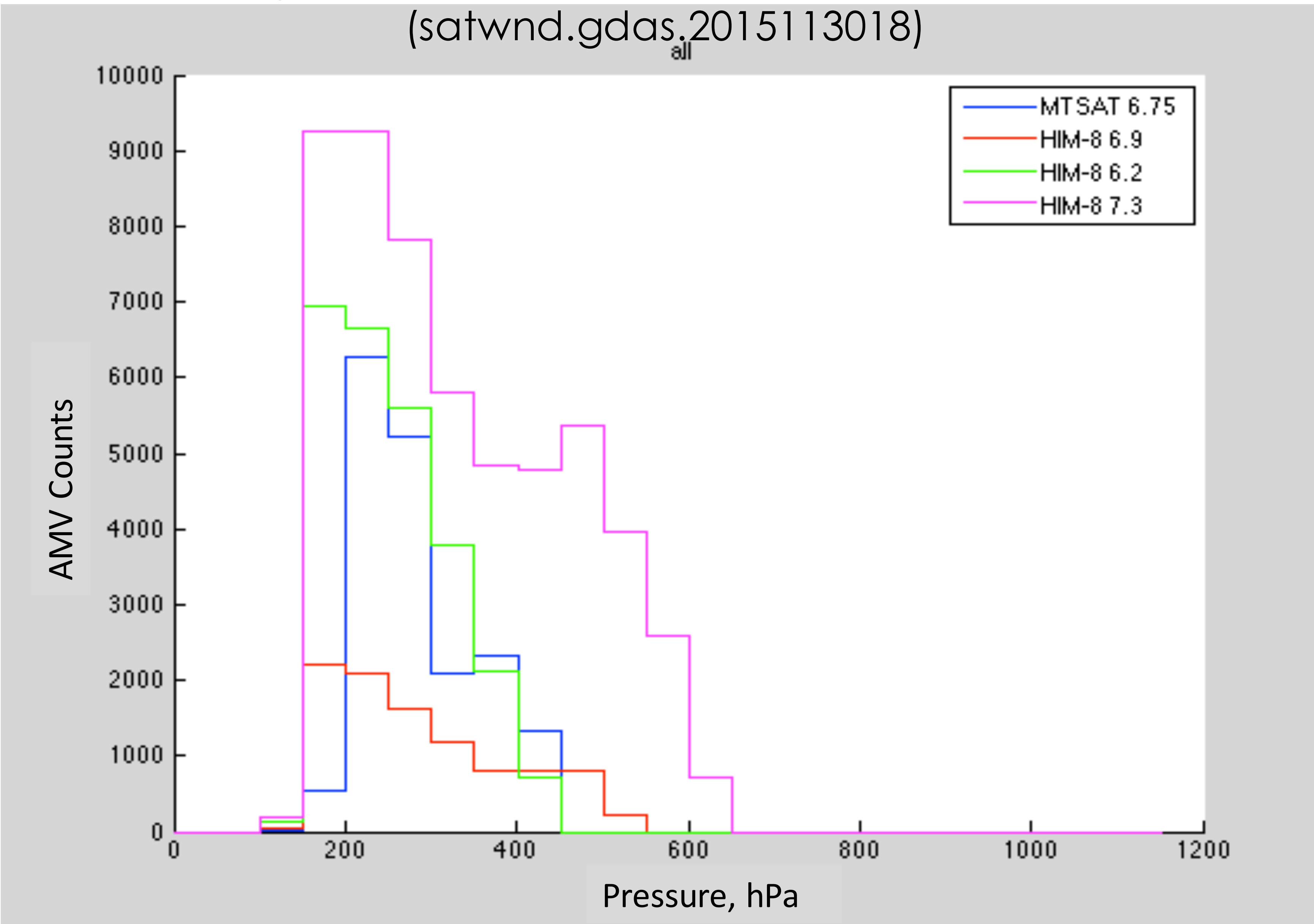
All winds

Used winds

Solid=MTSAT-2
Dashed=HIMAWARI-8



Vertical coverage improvement due to additional Himawari-8 channels



Himawari winds examination – Summary

Overall the new winds quality is better (reduced O-B STD) or comparable (reduced or similar O-B bias) than the MTSAT-2 AMVs

Our quality assessment agrees with findings at JCSDA and ECMWF

FC impact experiments were not run due to time and (temporary) computational resources constrains, however based on this evaluation it was determined that it would be safe to switch from MTSAT to Himawari-8 winds.
In operations since mid-May 2016

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VIIRS winds Data Assimilation investigation

VIIRS is an imaging radiometer, a cross between MODIS and AVHRR. It has resolution of 750 m for most bands and 375 m for some. VIIRS has a wider swath (3000 km) than MODIS (2320 km) and AVHRR (2600 km), and a constrained pixel growth (better resolution at edge of swath)

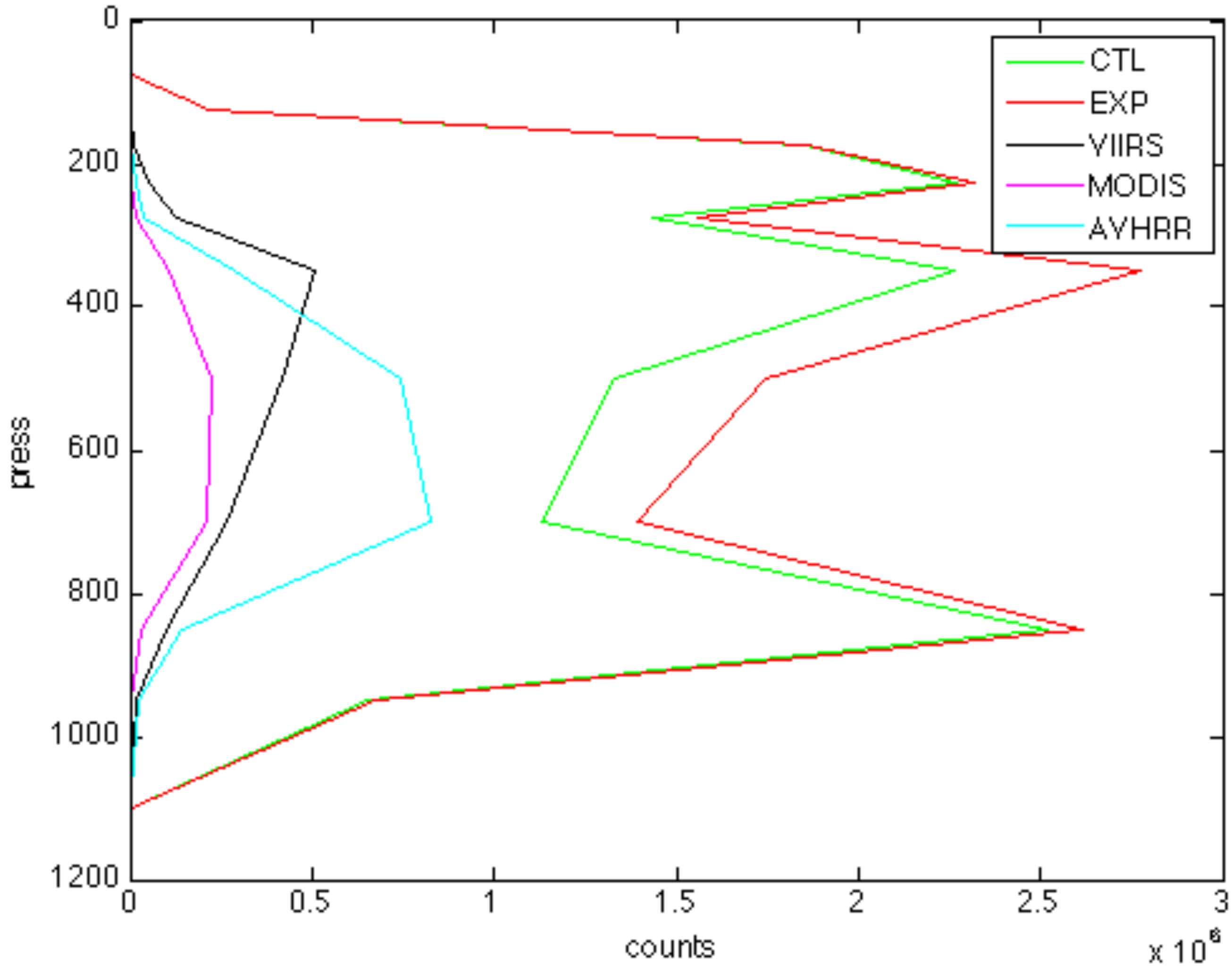
VIIRS winds (IR) are extracted with the GOES-R-like (so called 'nested tracking') algorithm, but reported in the current BUFR format (not the new GOES-R BUFR)

VIIRS AMVs are assigned type=260, subtype (SATID) =224, they use MODIS AMVs' OE profile, no thinning is applied, they undergo a LNVD check (first introduced by D.Santek for AVHRR winds DA, operational since May 2017)

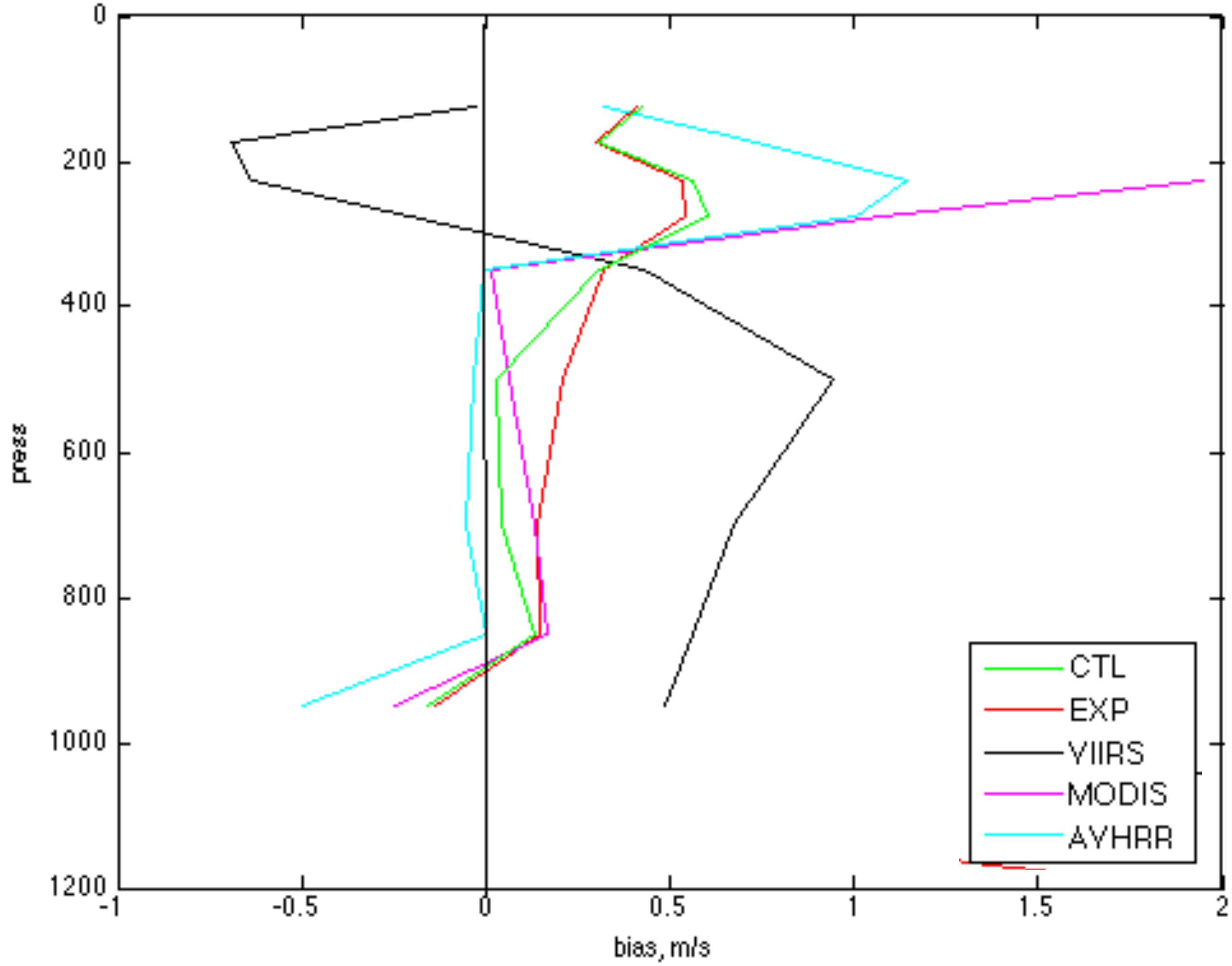
```
                 Log Normal Vector Departure Check
SQRT[ (UAMV – UGFS)^2 + (VAMV – VGFS)^2 ] / LOG(SpeedAMV) < 3
```

DA Experiment: 3D-Hybrid run, GFS at T670, GSI at T254, EnKF at T254,
64 Pressure levels 14 Sep 2014 - 12 Nov 2014

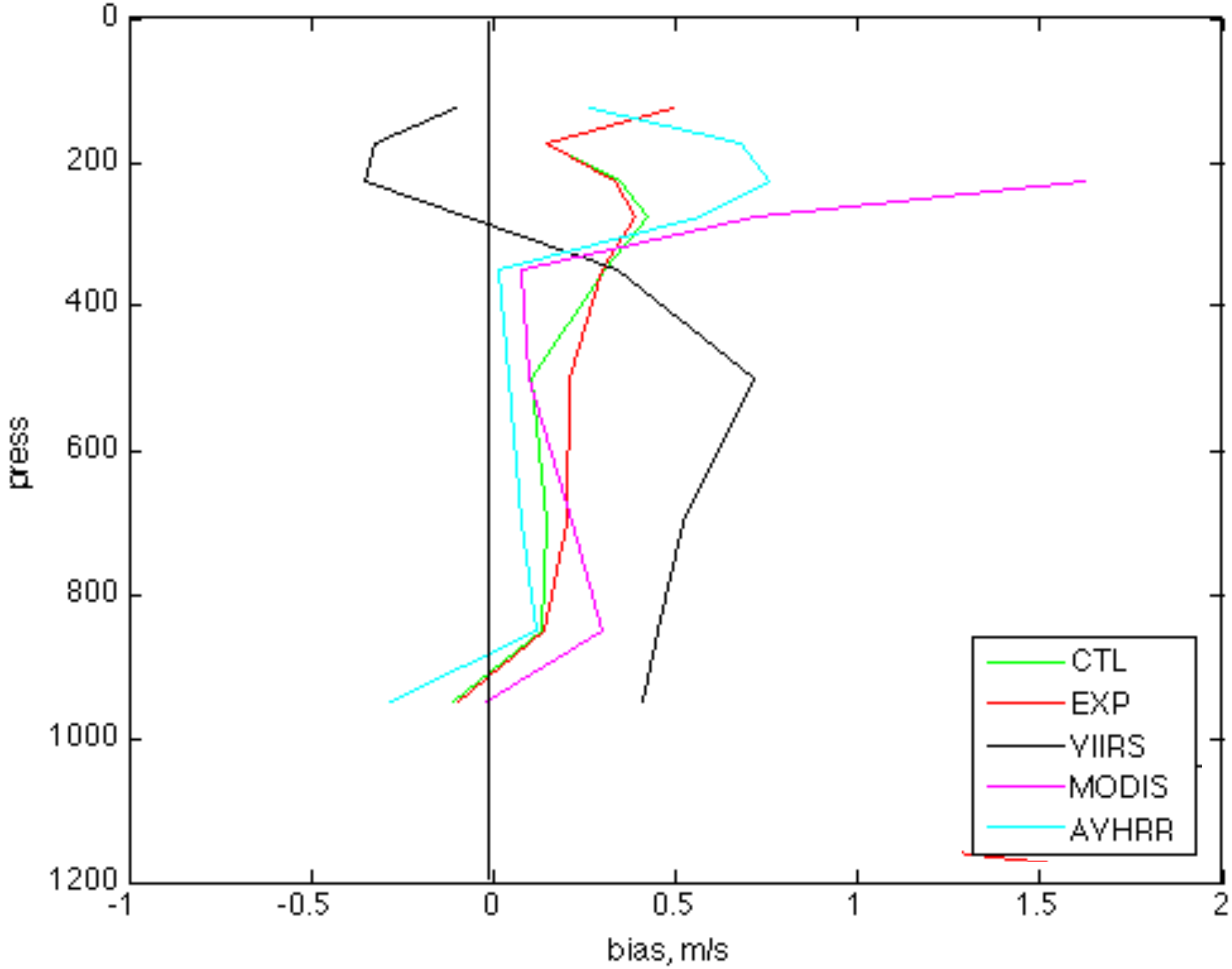
Counts of **USED** AMVs in the control and experiment runs
(2014-09-14 till 2014-10-07)



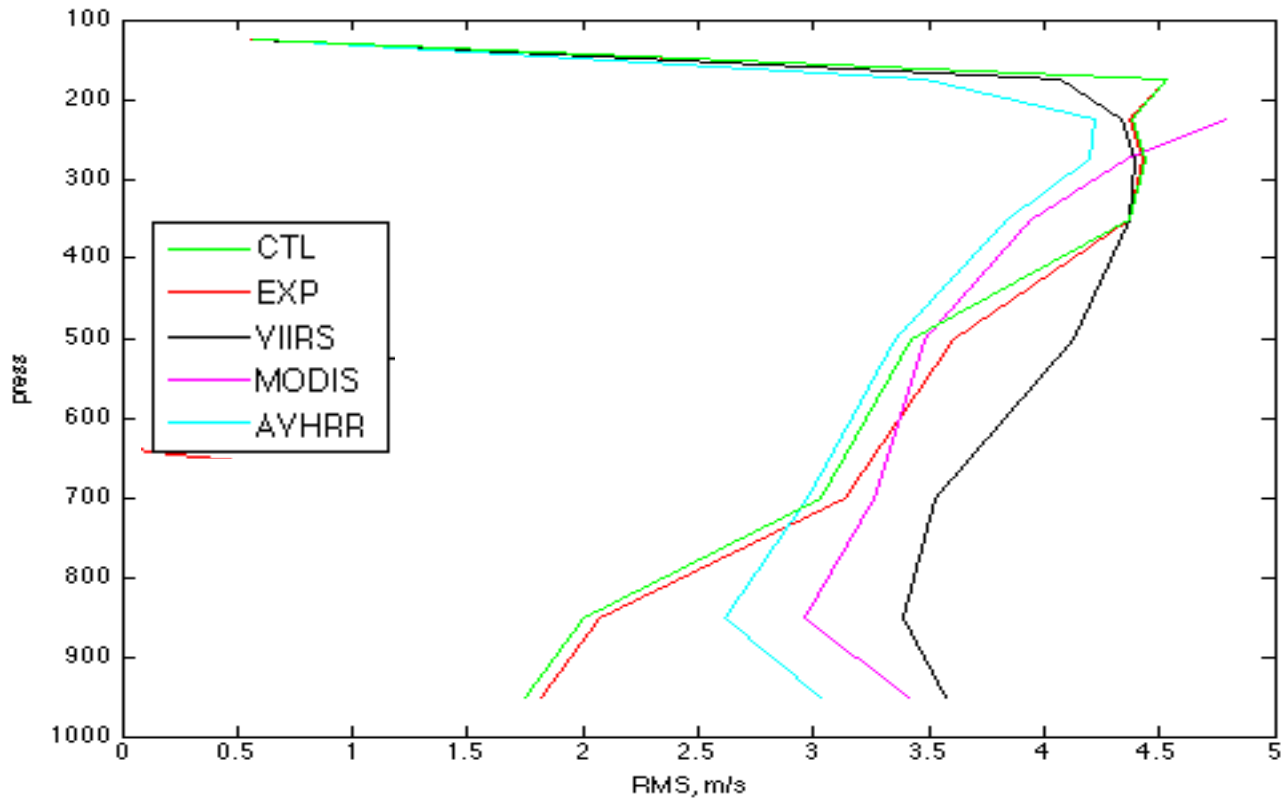
O-B Bias of **USED** AMVs in the control and experiment, and polar winds in experiment



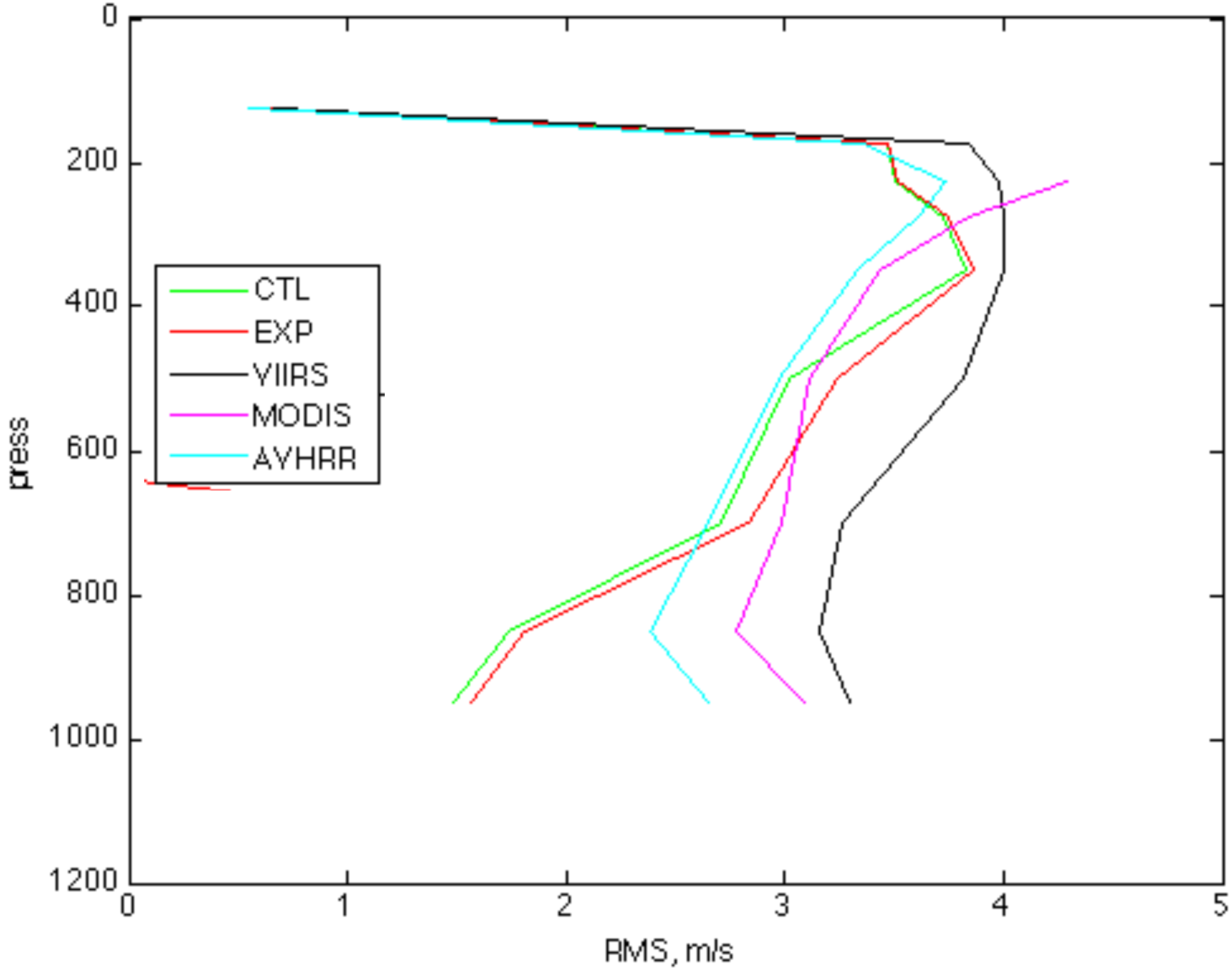
O-A Bias of **USED** AMVs in the control and experiment, and polar winds in experiment



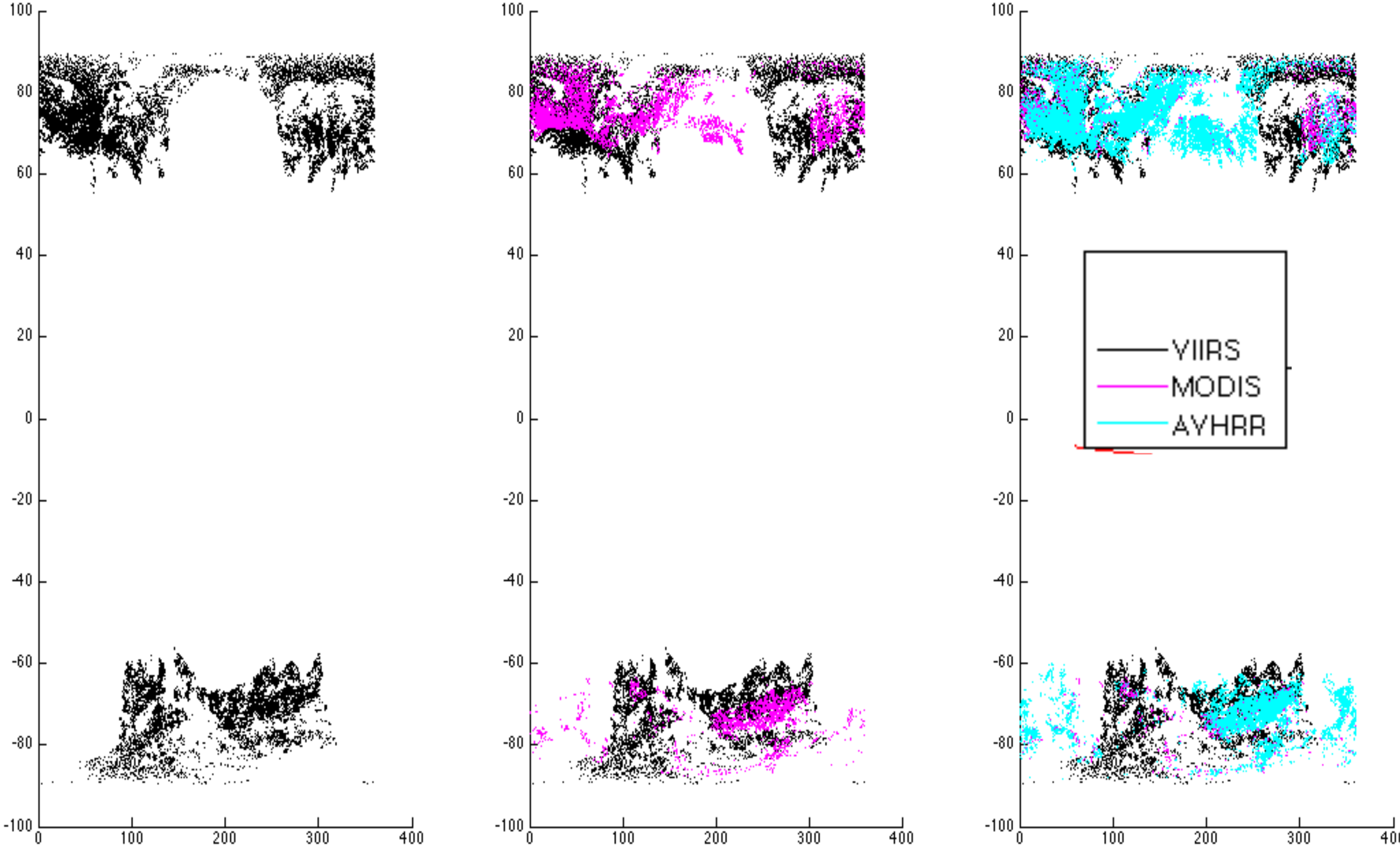
O-B RMS of **USED** AMVs in the control and experiment, and polar winds in experiment

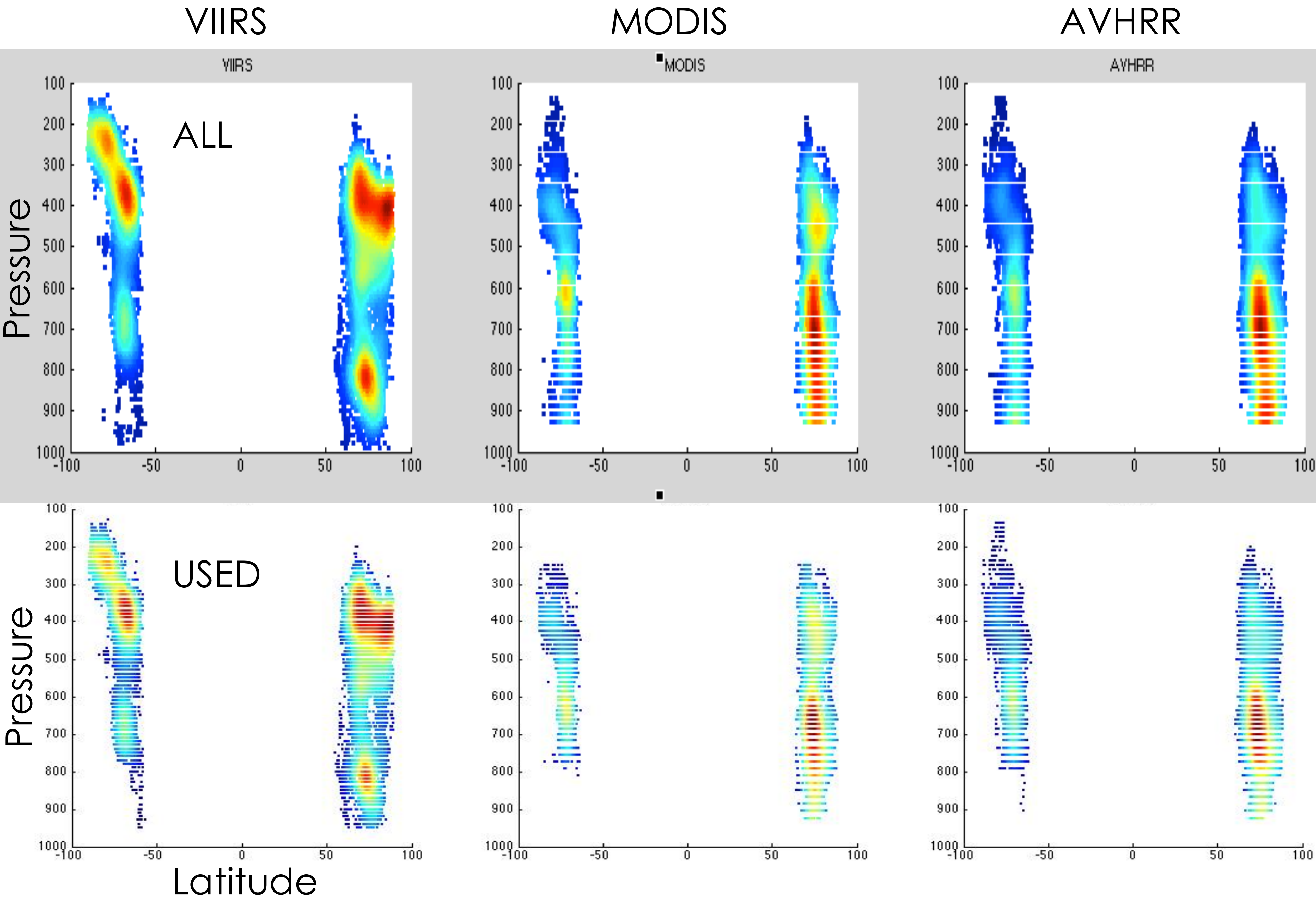


O-A RMS of **USED** AMVs in the control and experiment, and polar winds in experiment

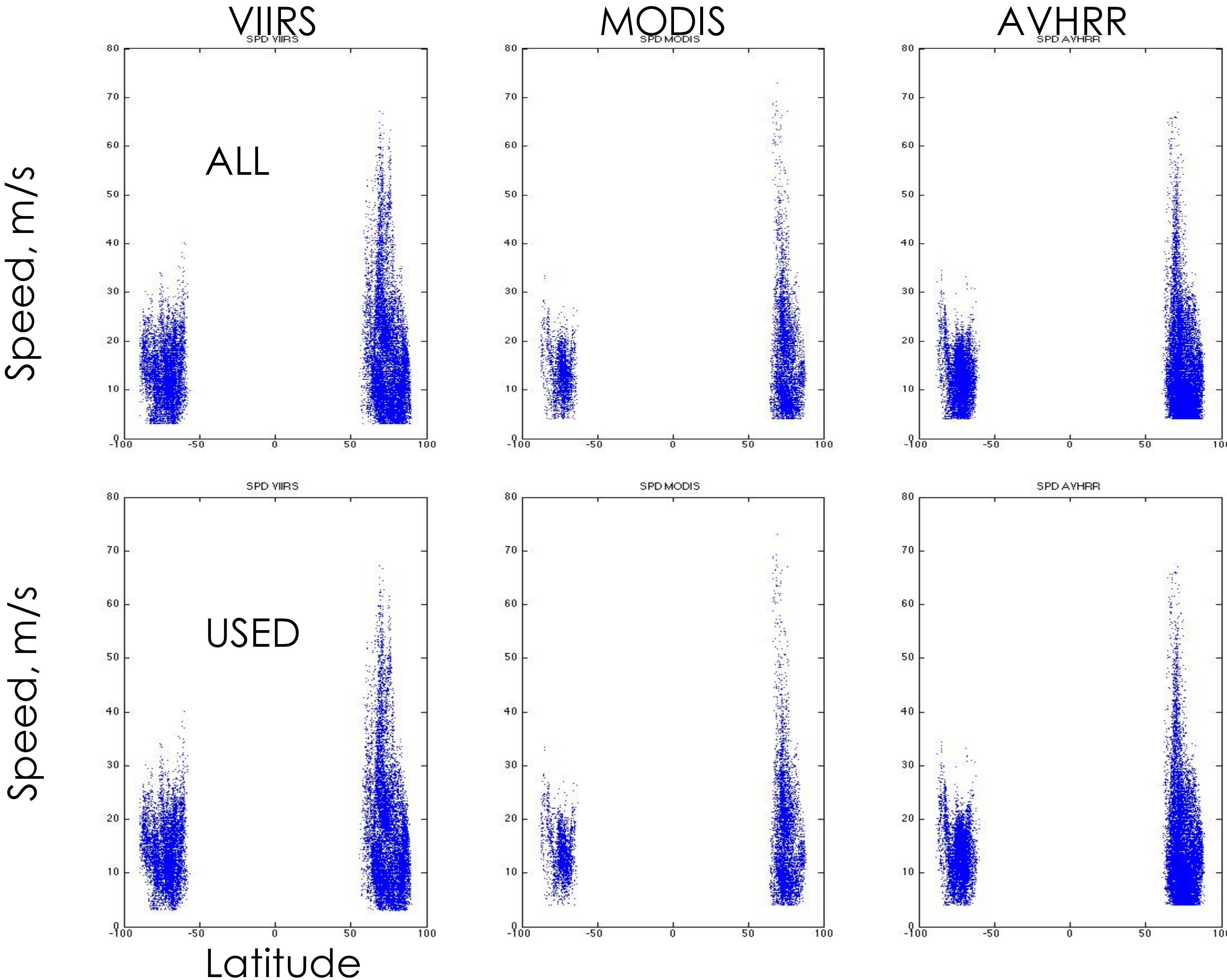


Spatial distribution of USED polar winds in the experiment with VIIRS winds

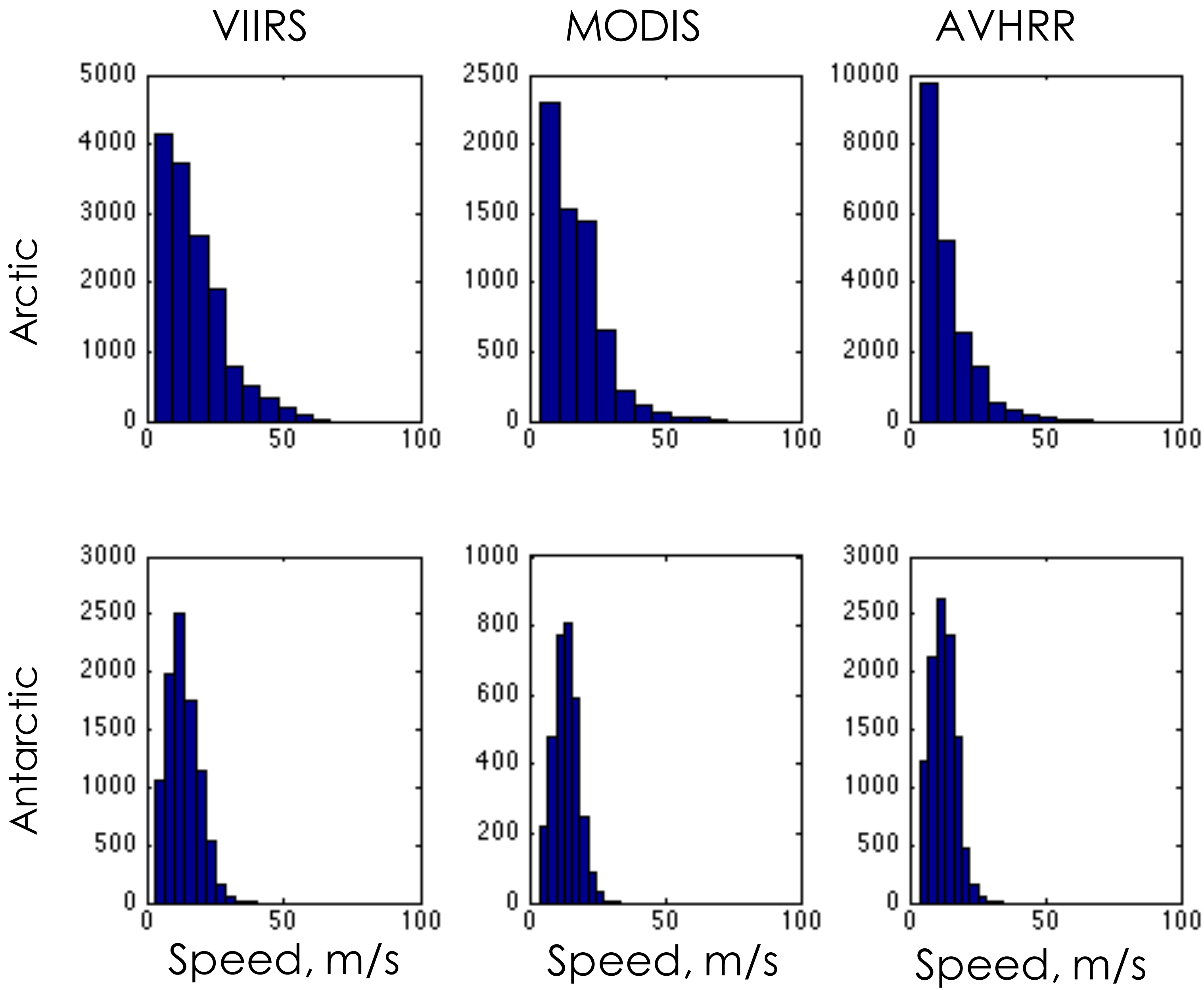


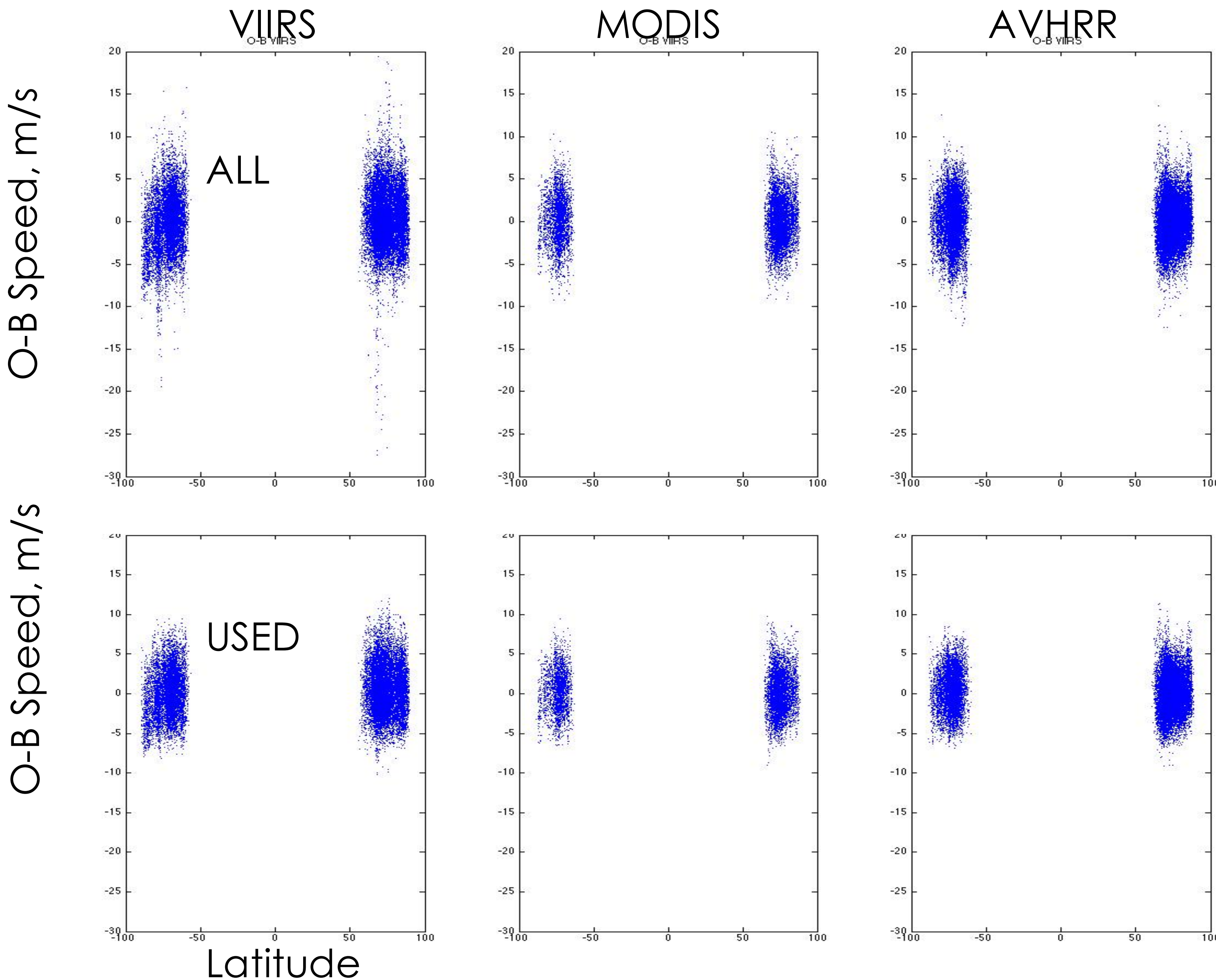


VIIRS
MODIS
AVHRR
ALL
USED
Pressure
Pressure
Latitude
100
200
300
400
500
600
700
800
900
1000
-100
-50
0
50
100



VIIRS
MODIS
AVHRR
SPD VIIRS
SPD MODIS
SPD AVHRR
ALL
USED
Speed, m/s
Speed, m/s
Latitude
80
70
60
50
40
30
20
10
0
-100
-50
0
50
100


VIIRS
MODIS
AVHRR
Arctic
Antarctic
5000
4000
3000
2000
1000
0
2500
2000
1500
1000
500
10000
8000
6000
4000
3000
2500
800
600
400
200
0
50
100
Speed, m/s
Speed, m/s
Speed, m/s


VIIRS
MODIS
AVHRR
O-B VIIRS
O-B Speed, m/s
ALL
USED
Latitude

D.Santek, J.Key

Polar AMVs Intercomparison

Closest within 15 km; 0.5 hrs; IR-only

Sat BUFR code	VIIRS ops 224	VIIRS DB —	Metop-1 3	Metop-2 4	NOAA-15 206	NOAA-18 209	NOAA-19 223	Aqua 783	MODIS 784
VIIRS ops	Bias Matches								
VIIRS DB	1.6 9600[1]	X							
Metop-1	2.7 5000	1.3 1500[1]	X						
Metop-2	3.0 7300	1.4 900[1]	0.07 35000[1]	X					
NOAA-15	2.3 1500	0.7 600[1]	-0.6 3400[1]	-0.3 4400[1]	X				
NOAA-18	2.6 1800	0.6 800[1]	-0.2 4100	-0.7 3500	0.2 1400[1]	X			
NOAA-19	2.6 3000[1]	0.7 300[1]	-0.5 1000	-0.4 1300	-0.2 1100[1]	-0.3 1100	X		
Aqua	2.1 1000	0.4 200[1]	-0.3 4800	-0.3 7400	0.3 1000	0.6 950[1]	0.4 400[1]	X	
Terra	3.2 1900	-1.2 2000[1]	-0.4 1000	-0.2 750	0.8 650[1]	0.6 700[1]	-0.6 830[1]	0.2 260[1]	X

[1]delta time = 0.9 hrs

Procedure: For each IR vector in column header find the nearest vector from the row header (distance < 15km). Compute the speed differences. Positive bias indicates the column header data is faster than row header.

Data: 30 wind sets covering 5 days (19-23 Sept 2015).

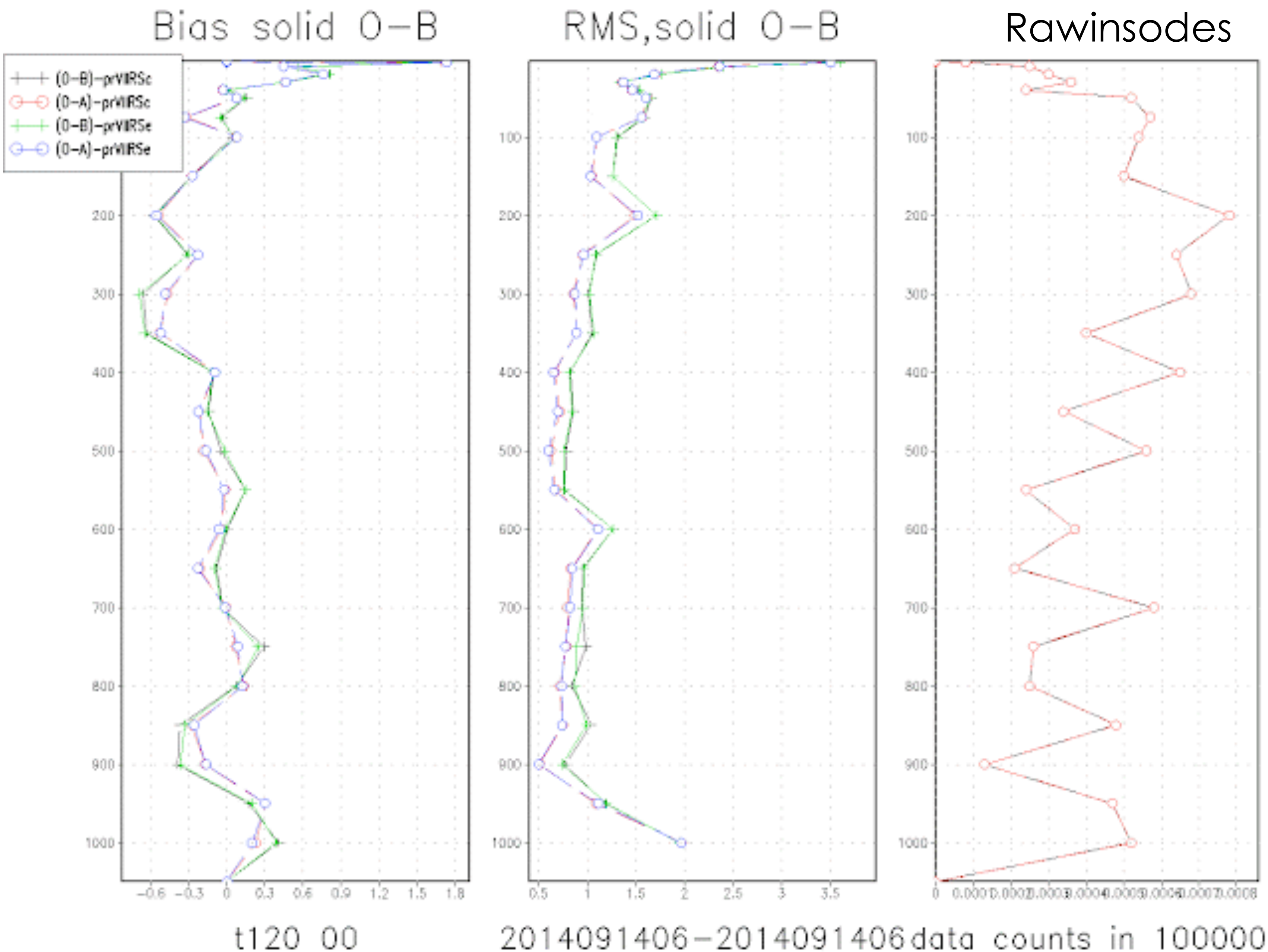
D.Santek, J.Key

Polar AMVs Intercomparison

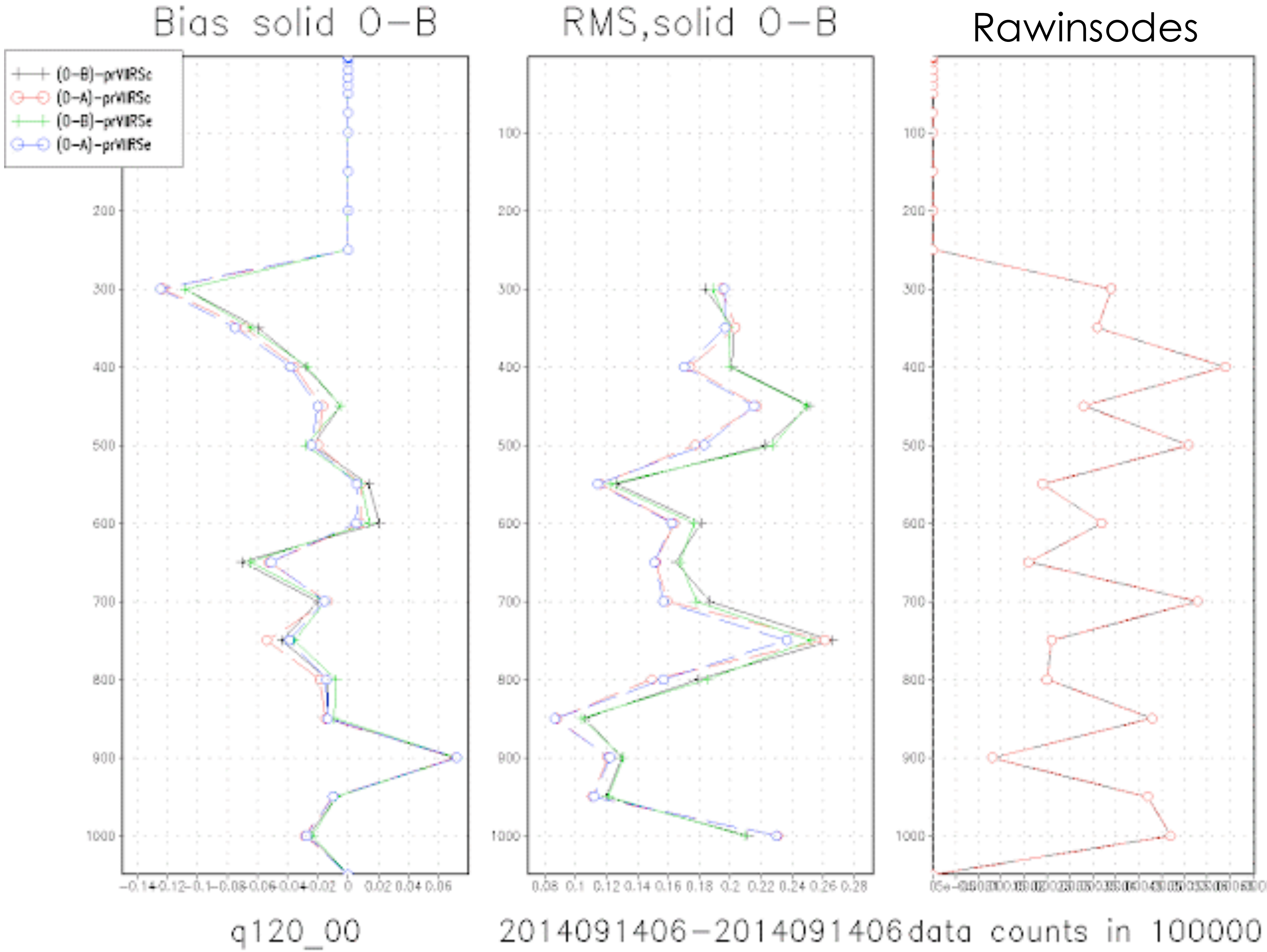
Closest within 15km; 20 hPa; 0.5 hrs; IR-only

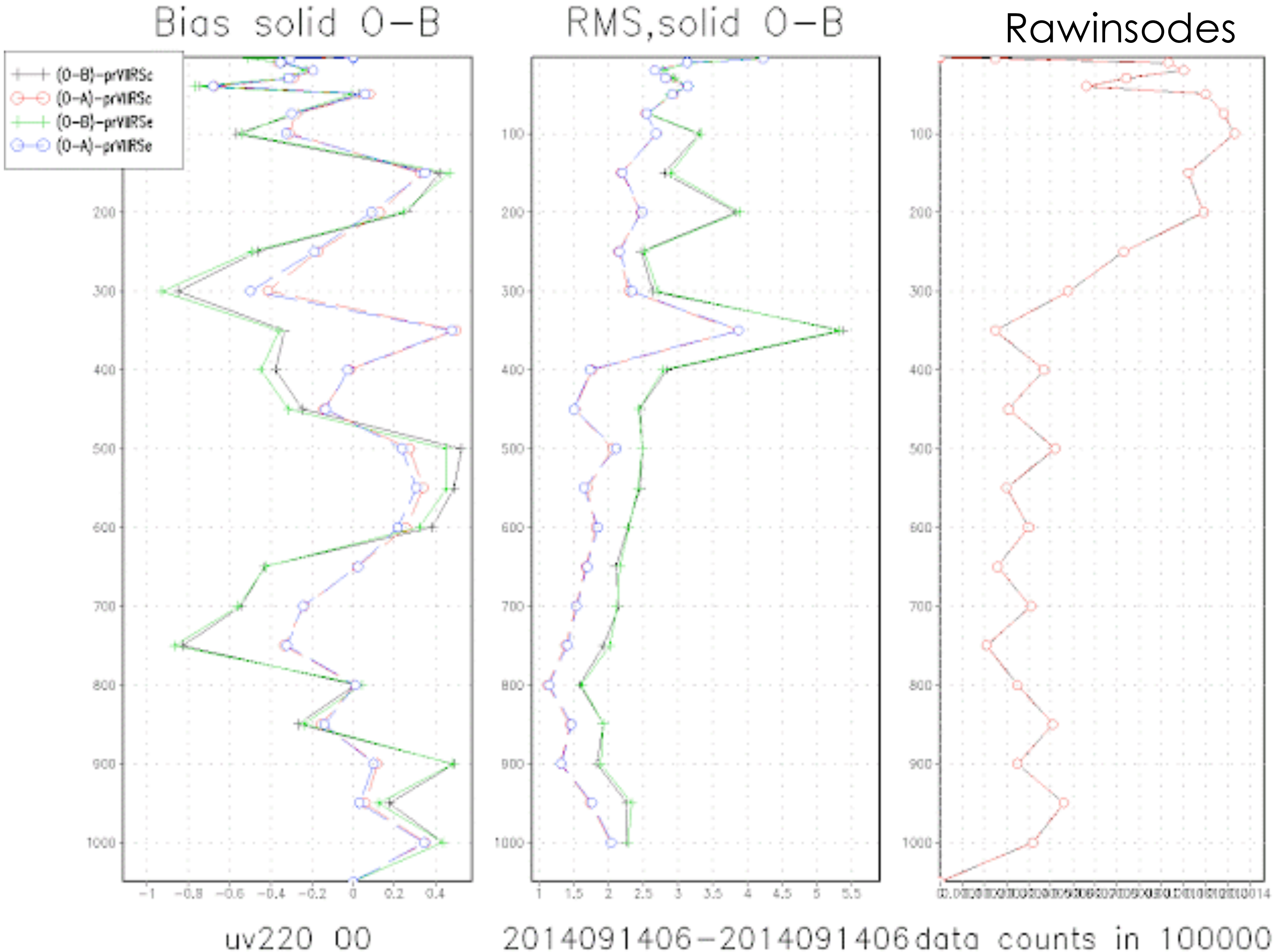
Sat BUFR code	VIIRS ops 224	VIIRS DB —	Metop-1 3	Metop-2 4	NOAA-15 206	NOAA-18 209	NOAA-19 223	Aqua 783	MODIS 784
VIIRS ops	Bias Matches								
VIIRS DB	1.2 2900[1]	X							
Metop-1	1.3 ----	0.3 600[1]	X						
Metop-2	1.1 ----	0.3 300[1]	0.05 16000[1]	X					
NOAA-15	1.2 ----	0.03 200[1]	-0.1 ----[1]	0.04 ----	X				
NOAA-18	1.1 ----	0.2 400[1]	0.05 ----	0.05 ----[1]	0.01 ----[1]	X			
NOAA-19	1.0 ----[1]	0.4 100[1]	-0.2 ----	-0.1 ----	-0.4 ----[1]	-0.08 ----	X		
Aqua	0.9 ----	-0.1 70[1]	-0.1 ----	-0.2 ----	-0.06 ----	0.1 ----[1]	-0.2 ----[1]	X	
Terra	1.3 ----	0.1 700[1]	-0.3 ----	-0.3 ----	-0.2 ----[1]	0.07 ----[1]	-0.2 ----[1]	0.0 ----[1]	X

[1]delta time = 0.9 hrs

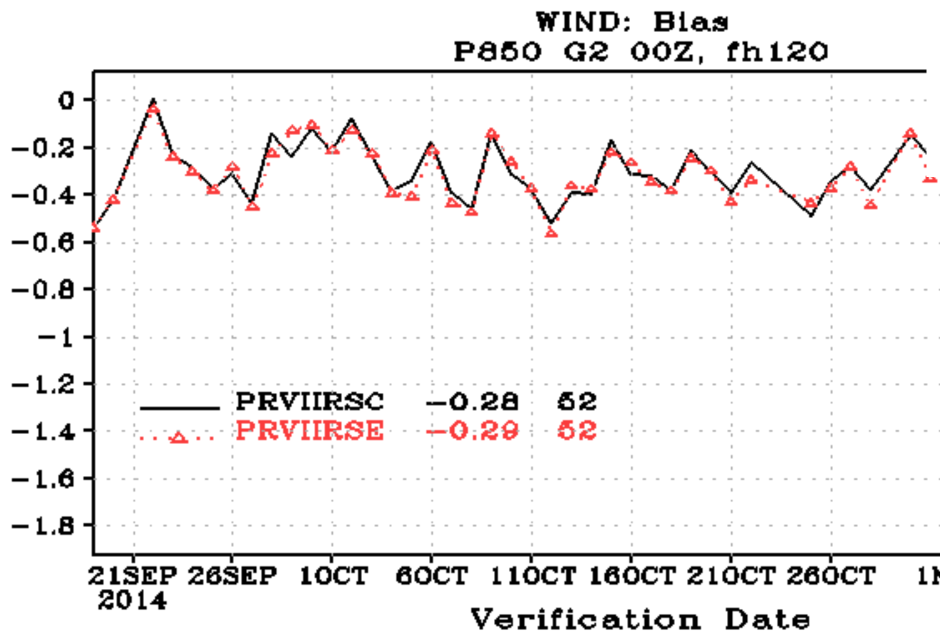


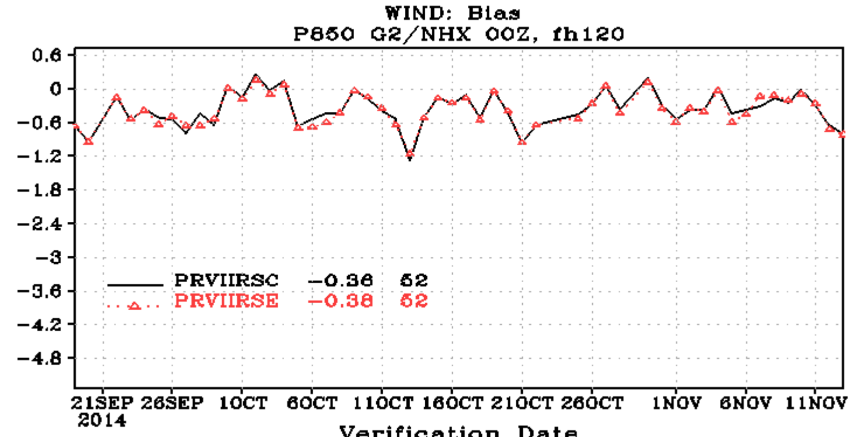
Bias solid O-B
RMS,solid O-B
Rawinsodes
(O-B)-prVIIRSc
(O-A)-prVIIRSc
(O-B)-prVIIRSe
(O-A)-prVIIRSe
t120_00
2014091406-2014091406
data counts in 100000

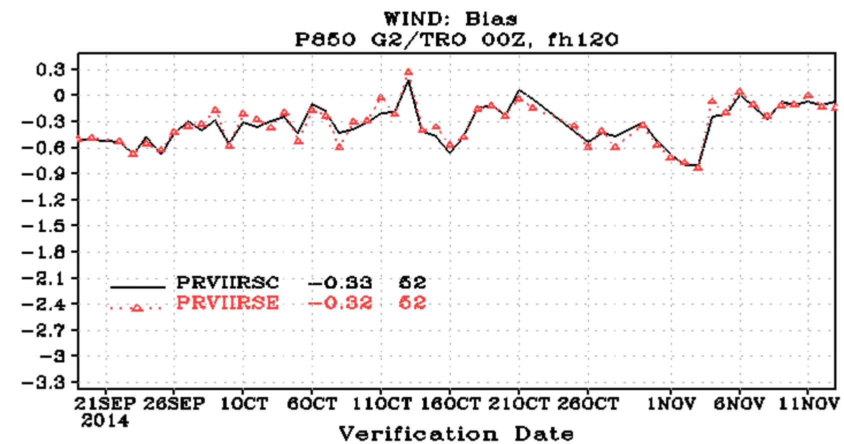

Bias solid O-B
RMS,solid O-B
Rawinsodes
(O-B)-prVIIRSc
(O-A)-prVIIRSc
(O-B)-prVIIRSe
(O-A)-prVIIRSe
q120_00
2014091406-2014091406
data counts in 100000

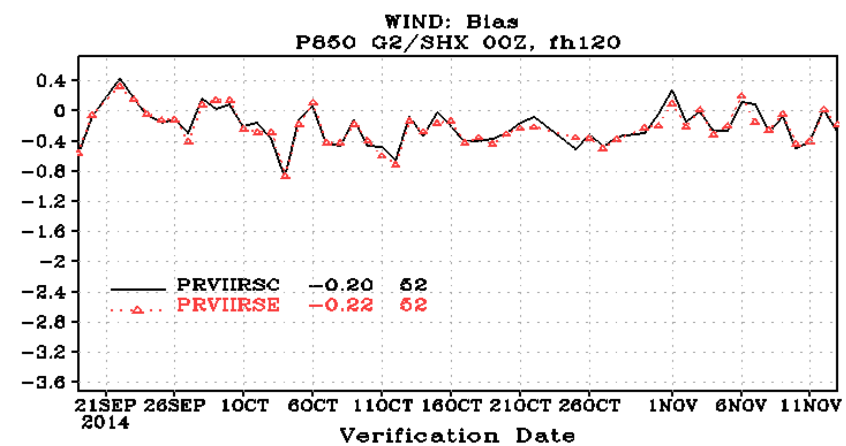


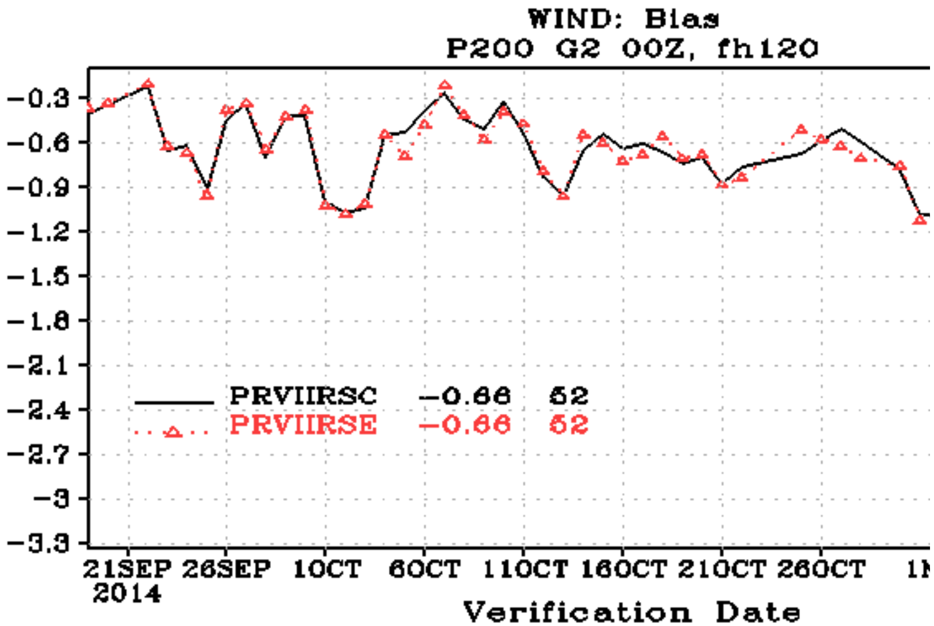
Bias solid O-B
RMS,solid O-B
Rawinsodes
(O-B)-prVIIRSc
(O-A)-prVIIRSc
(O-B)-prVIIRSe
(O-A)-prVIIRSe
uv220_00
2014091406-2014091406
data counts in 100000

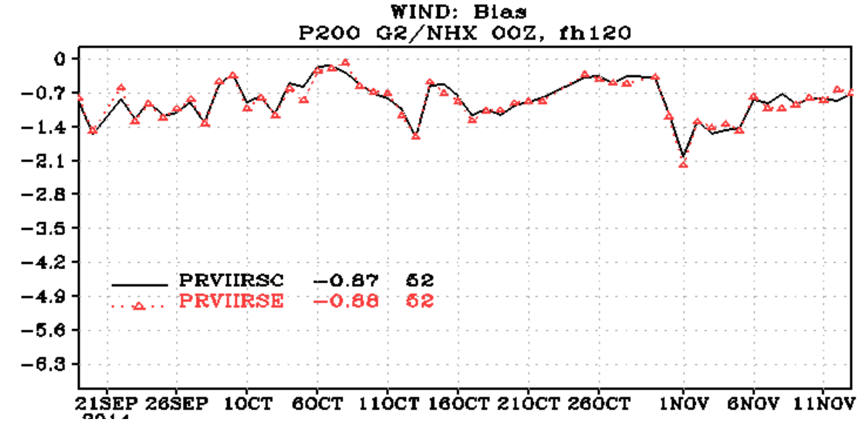

WIND: Bias
P850 G2 00Z, fh120
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2
−1.4
−1.6
−1.8
PRVIIRSC −0.28 52
PRVIIRSE −0.29 52
21SEP 26SEP 1OCT 6OCT 11OCT 16OCT 21OCT 26OCT
2014
Verification Date

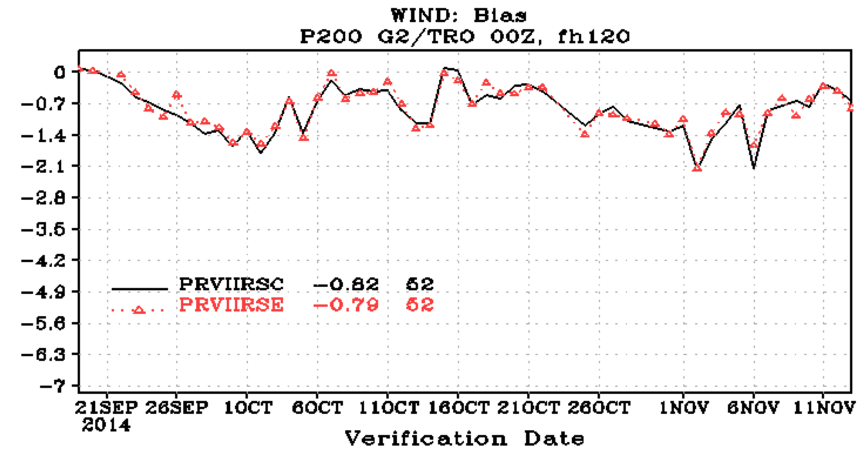

WIND: Bias
P850 G2/NHX 00Z, fh120
0.6
0
−0.6
−1.2
−1.8
−2.4
−3
−3.6
−4.2
−4.8
PRVIIRSC −0.36 52
PRVIIRSE −0.38 52
21SEP 26SEP 1OCT 6OCT 11OCT 16OCT 21OCT 26OCT 1NOV 6NOV 11NOV
2014

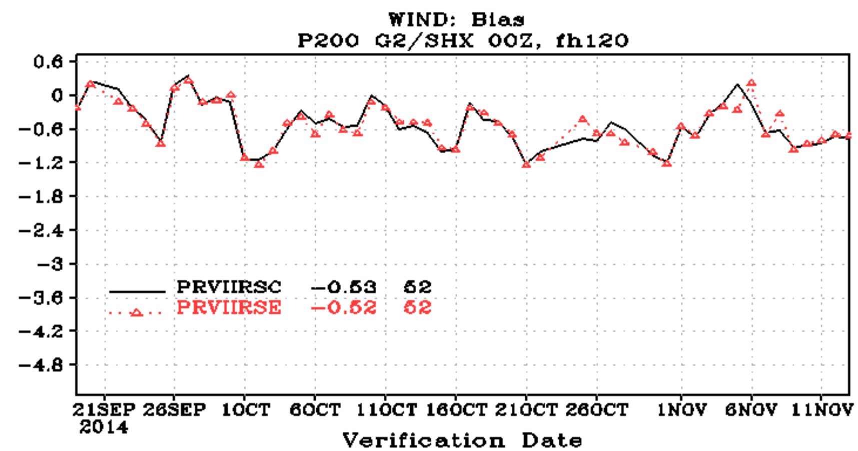

WIND: Bias
P850 G2/TRO 00Z, fh120
0.3
0
−0.3
−0.6
−0.9
−1.2
−1.5
−1.8
−2.1
−2.4
−2.7
−3
−3.3
PRVIIRSC −0.33 52
PRVIIRSE −0.32 52
21SEP 26SEP 1OCT 6OCT 11OCT 16OCT 21OCT 26OCT 1NOV 6NOV 11NOV
2014
Verification Date

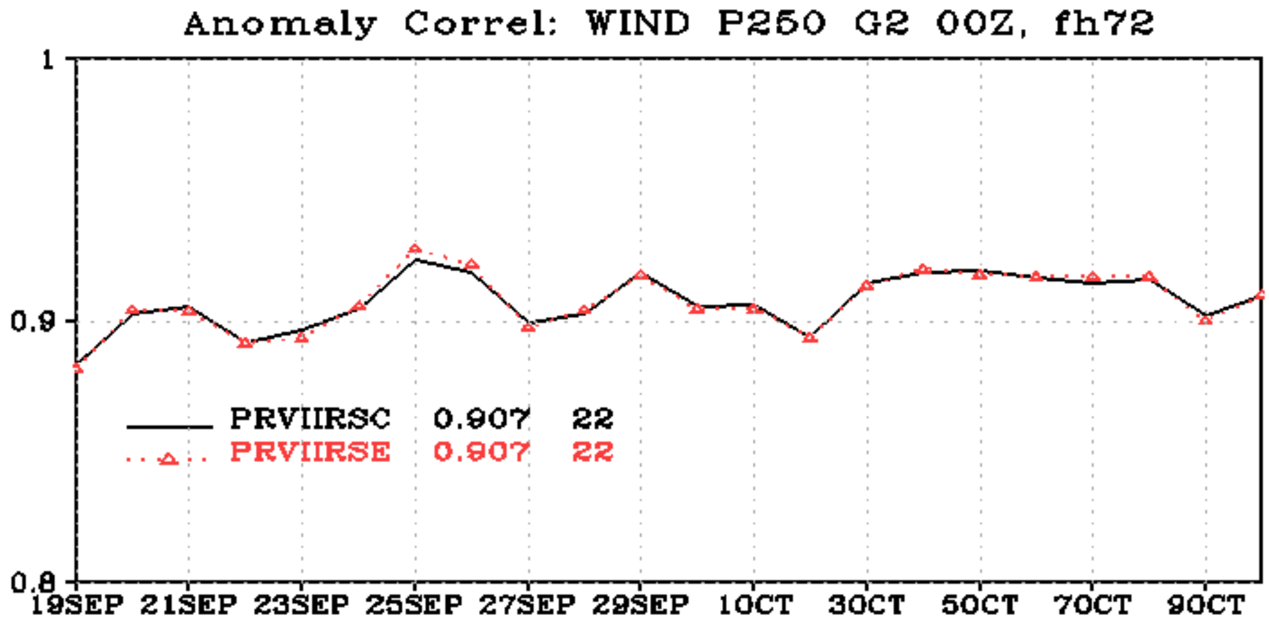

WIND: Bias
P850 G2/SHX 00Z, fh120
0.4
0
−0.4
−0.8
−1.2
−1.6
−2
−2.4
−2.8
−3.2
−3.6
PRVIIRSC −0.20 52
PRVIIRSE −0.22 52
21SEP 26SEP 1OCT 6OCT 11OCT 16OCT 21OCT 26OCT 1NOV 6NOV 11NOV
2014
Verification Date

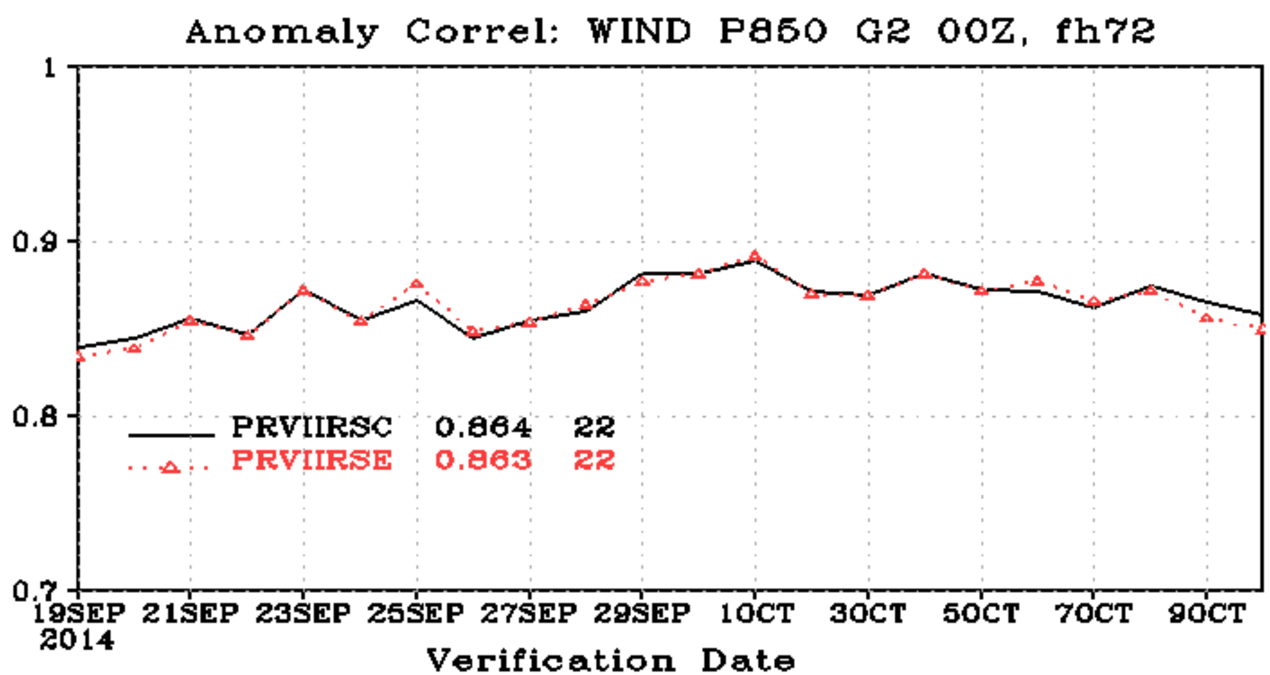

WIND: Bias
P200 G2 00Z, fh120
PRVIIRSC −0.66 52
PRVIIRSE −0.66 52
21SEP 26SEP 1OCT 6OCT 11OCT 16OCT 21OCT 26OCT 1N
2014
Verification Date

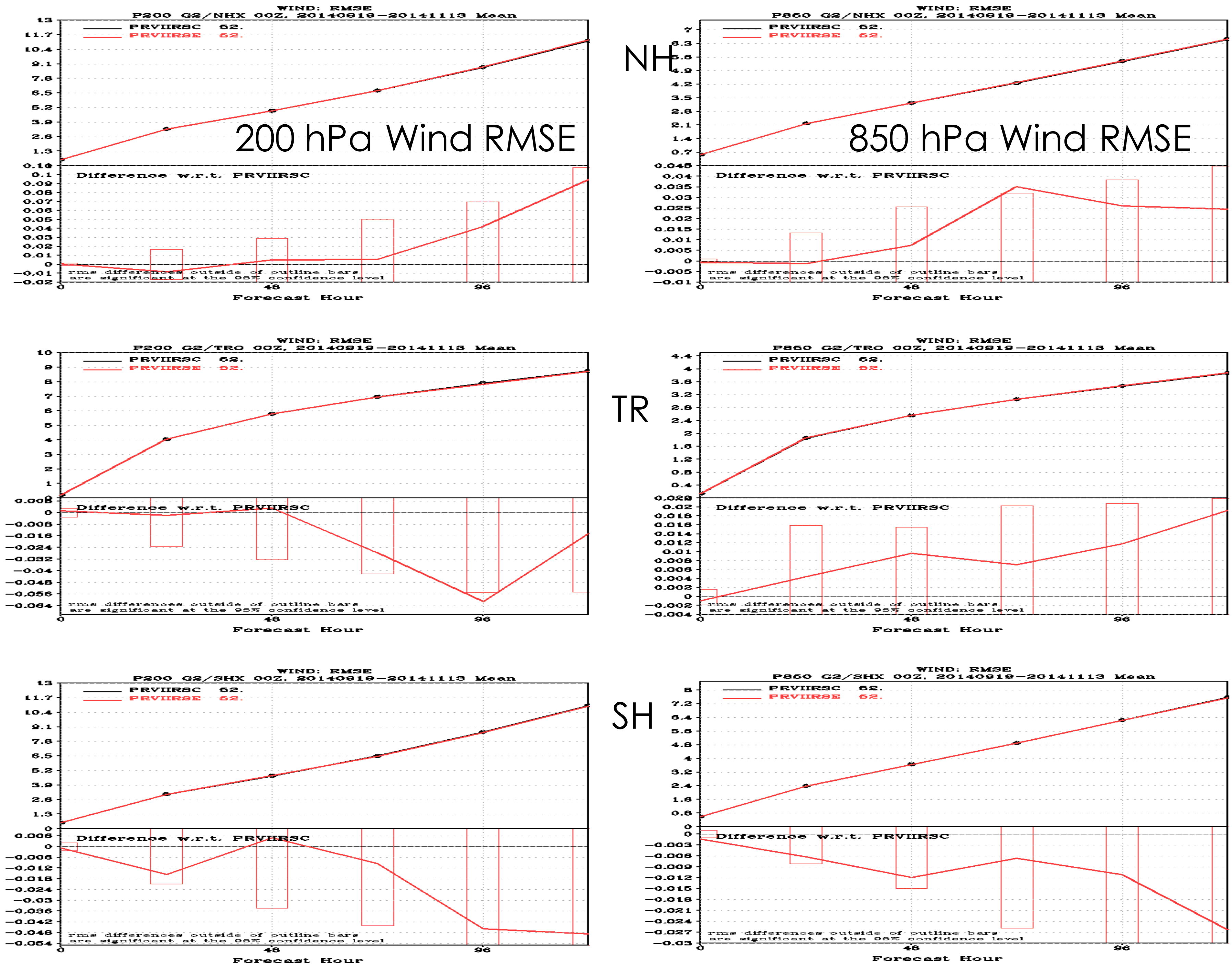

WIND: Bias
P200 G2/NHX 00Z, fh120
PRVIIRSC −0.87 52
PRVIIRSE −0.88 52
21SEP 26SEP 1OCT 6OCT 11OCT 16OCT 21OCT 26OCT 1NOV 6NOV 11NOV


WIND: Bias
P200 G2/TRO 00Z, fh120
PRVIIRSC −0.82 52
PRVIIRSE −0.79 52
21SEP 26SEP 1OCT 6OCT 11OCT 16OCT 21OCT 26OCT 1NOV 6NOV 11NOV
2014
Verification Date


WIND: Bias
P200 G2/SHX 00Z, fh120
PRVIIRSC −0.53 52
PRVIIRSE −0.52 52
21SEP 26SEP 1OCT 6OCT 11OCT 16OCT 21OCT 26OCT 1NOV 6NOV 11NOV
2014
Verification Date


Anomaly Correl: WIND P250 G2 00Z, fh72
1
0.9
0.8
PRVIIRSC 0.907 22
PRVIIRSE 0.907 22
19SEP 21SEP 23SEP 25SEP 27SEP 29SEP 1OCT 3OCT 5OCT 7OCT 9OCT


Anomaly Correl: WIND P850 G2 00Z, fh72
1
0.9
0.8
0.7
PRVIIRSC 0.864 22
PRVIIRSE 0.863 22
19SEP 21SEP 23SEP 25SEP 27SEP 29SEP 1OCT 3OCT 5OCT 7OCT 9OCT
2014
Verification Date


200 hPa Wind RMSE
850 hPa Wind RMSE
NH
TR
SH
WIND: RMSE
P200 G2/NHX 00Z, 20140919-20141113 Mean
P850 G2/NHX 00Z, 20140919-20141113 Mean
P200 G2/TRO 00Z, 20140919-20141113 Mean
P850 G2/TRO 00Z, 20140919-20141113 Mean
P200 G2/SHX 00Z, 20140919-20141113 Mean
P850 G2/SHX 00Z, 20140919-20141113 Mean
PRVIIRSC 52.
PRVIIRSE 52.
Difference w.r.t. PRVIIRSC
rms differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour

VIIRS winds examination – Summary

Consistent O-B bias (larger than for other polar winds) is observed, but its magnitude is not alarming

Our quality assessment agrees with findings at MetOffice and ECMWF

FC impact experiments show mostly neutral to slightly positive impact, therefore we suggest that VIIRS winds are assimilated, but monitored closely.

Outline

HIMAWARI winds examination

VIIRS winds Data Assimilation investigation

“GOES-R-like” winds evaluation

Steps towards overall AMV Quality Control (QC) revision

Study of the complimentary nature of AMVs and Doppler Wind Lidar winds

Preliminary GOES-R-like winds evaluation in GSI

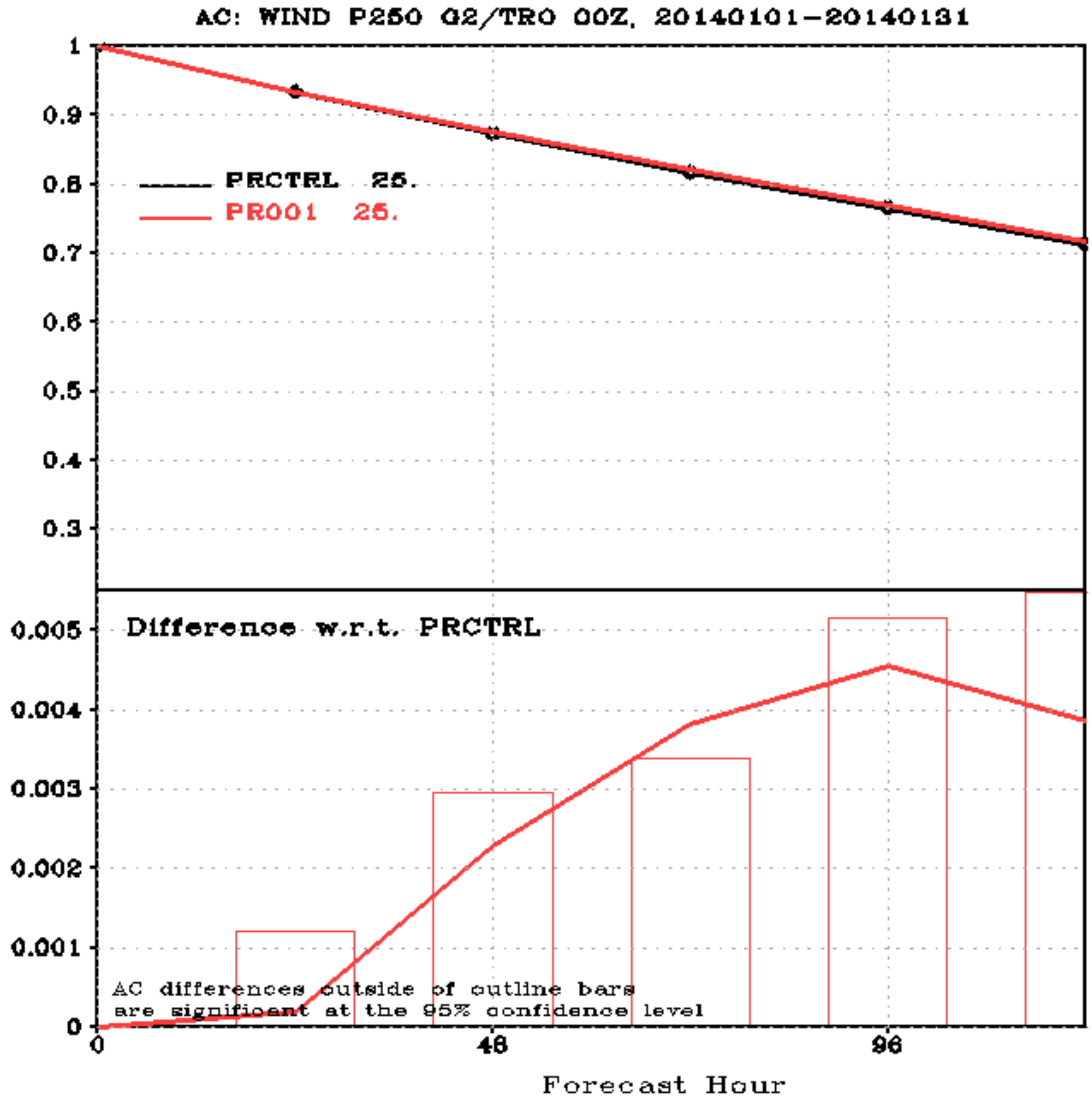
GOES-R-like winds – retrieved with Nested Tracking algorithm
(developed for GOES-R) from GOES-13/15 imagery
– observations from NESDIS STAR

Setup:
3D-Hybrid run, GFS at T670, GSI at T254, EnKF at T254
64 Pressure levels
20140101- 20140201
Verification against operational analysis

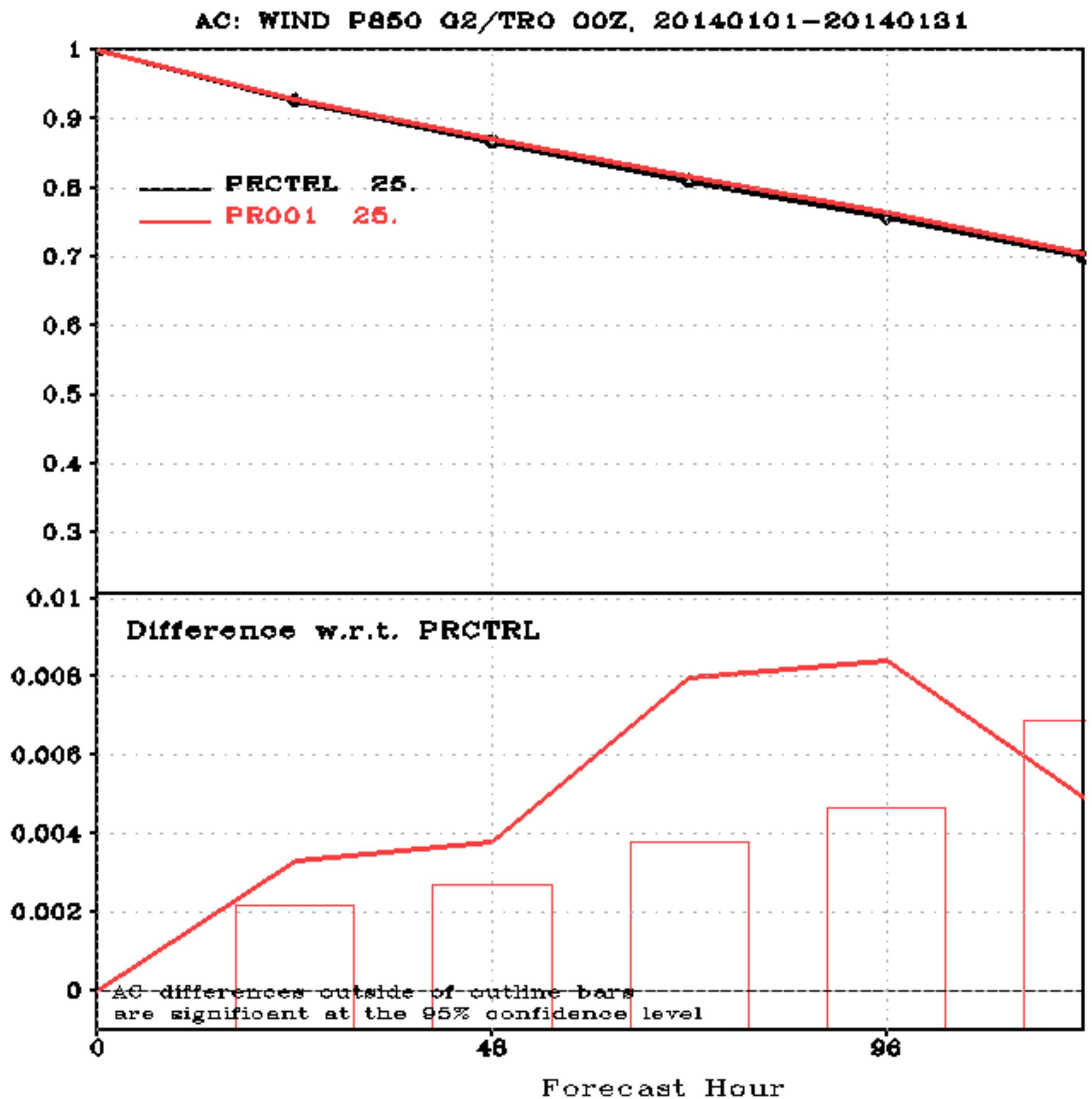
Used AMVs:
Meteosat, MTSAT-2 and MODIS

New:
GOES-R-like winds replace GOES-13/15 winds for synoptic times 0, 6, 12, 18 Z
ObsError_GOES-R = ObsError * 0.5

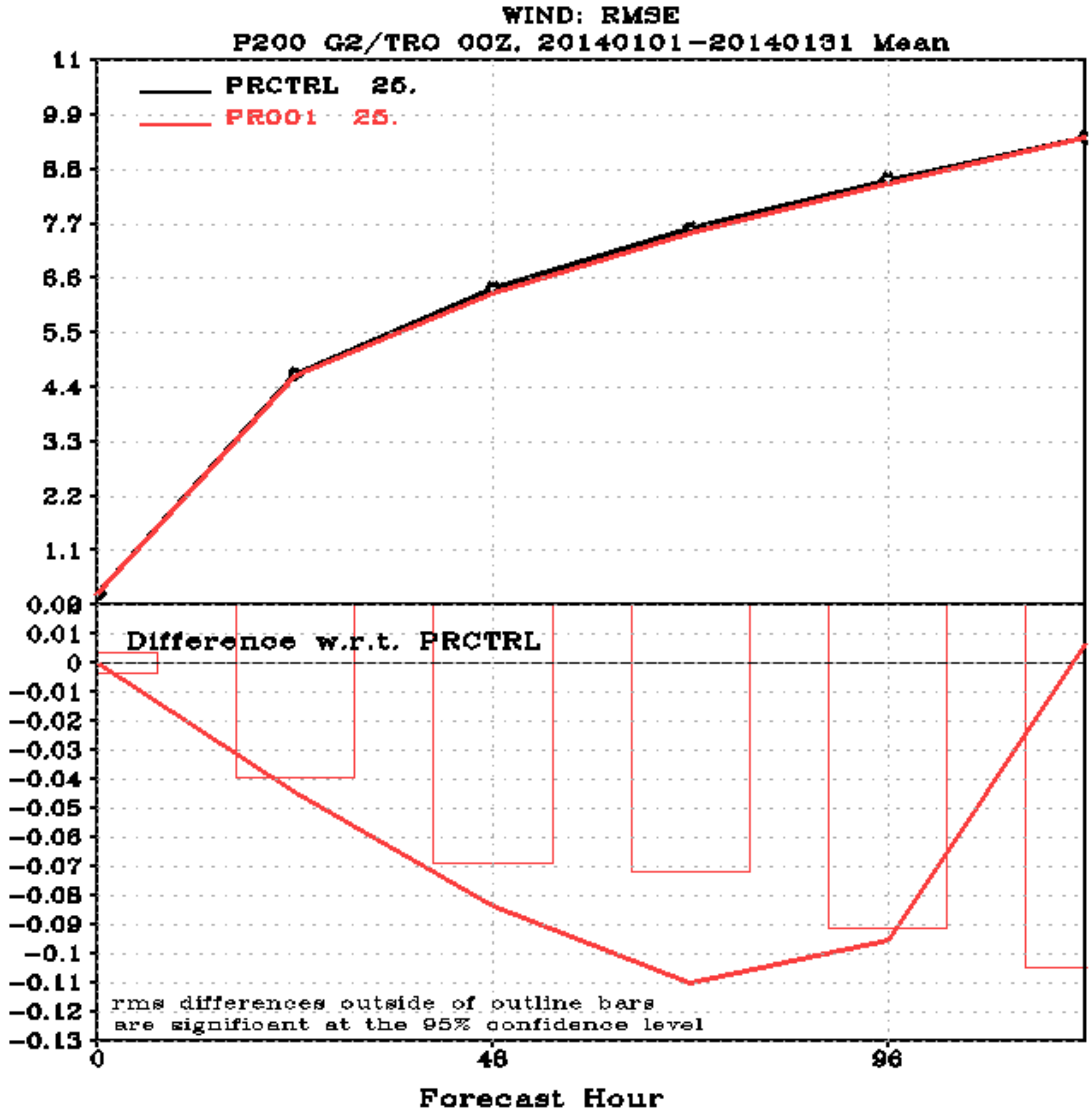
All winds subject to quality control and thinning as in operations
(read_satwnd.f90, setupw.f90, prepobs_errtable.global, global_convinfo.txt)

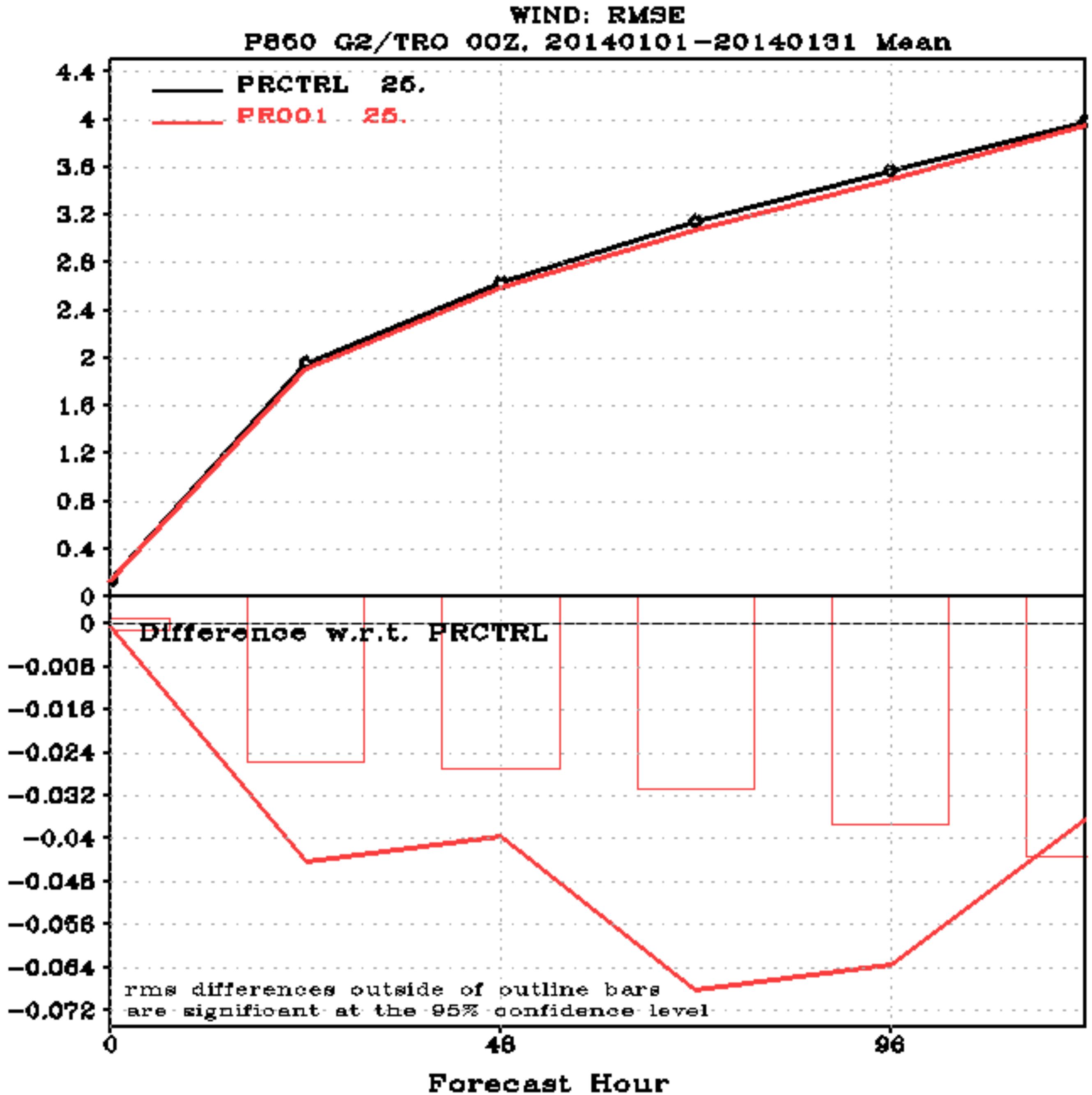


AC: WIND P250 G2/TRO 00Z, 20140101-20140131
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
PRCTRL 25.
PR001 25.
Difference w.r.t. PRCTRL
0.005
0.004
0.003
0.002
0.001
0
AC differences outside of outline bars
are significant at the 95% confidence level
0
48
96
Forecast Hour

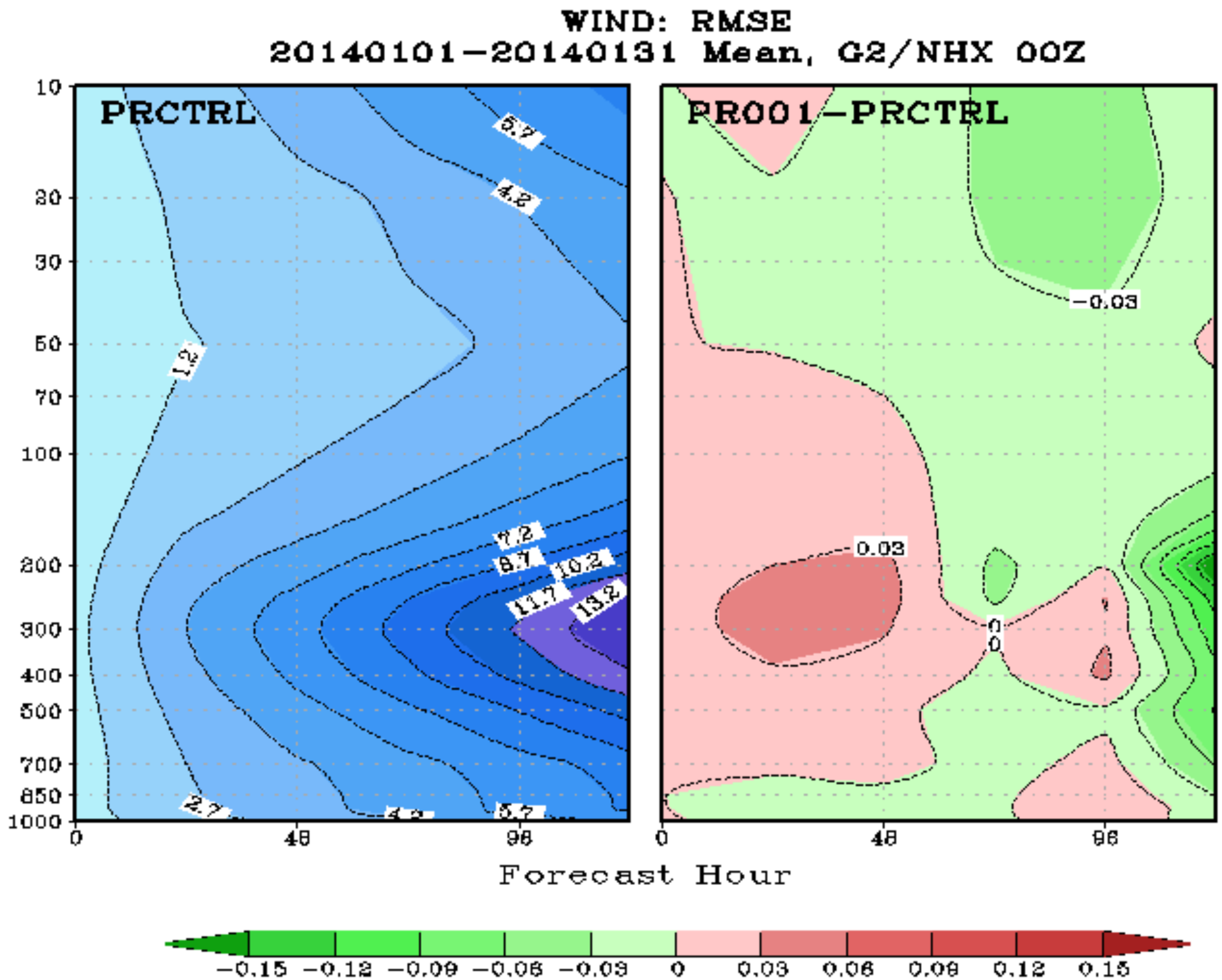


AC: WIND P850 G2/TRO 00Z, 20140101-20140131
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
PRCTRL 25.
PR001 25.
0.01
Difference w.r.t. PRCTRL
0.008
0.006
0.004
0.002
0
AC differences outside of outline bars
are significant at the 95% confidence level
0
48
96
Forecast Hour

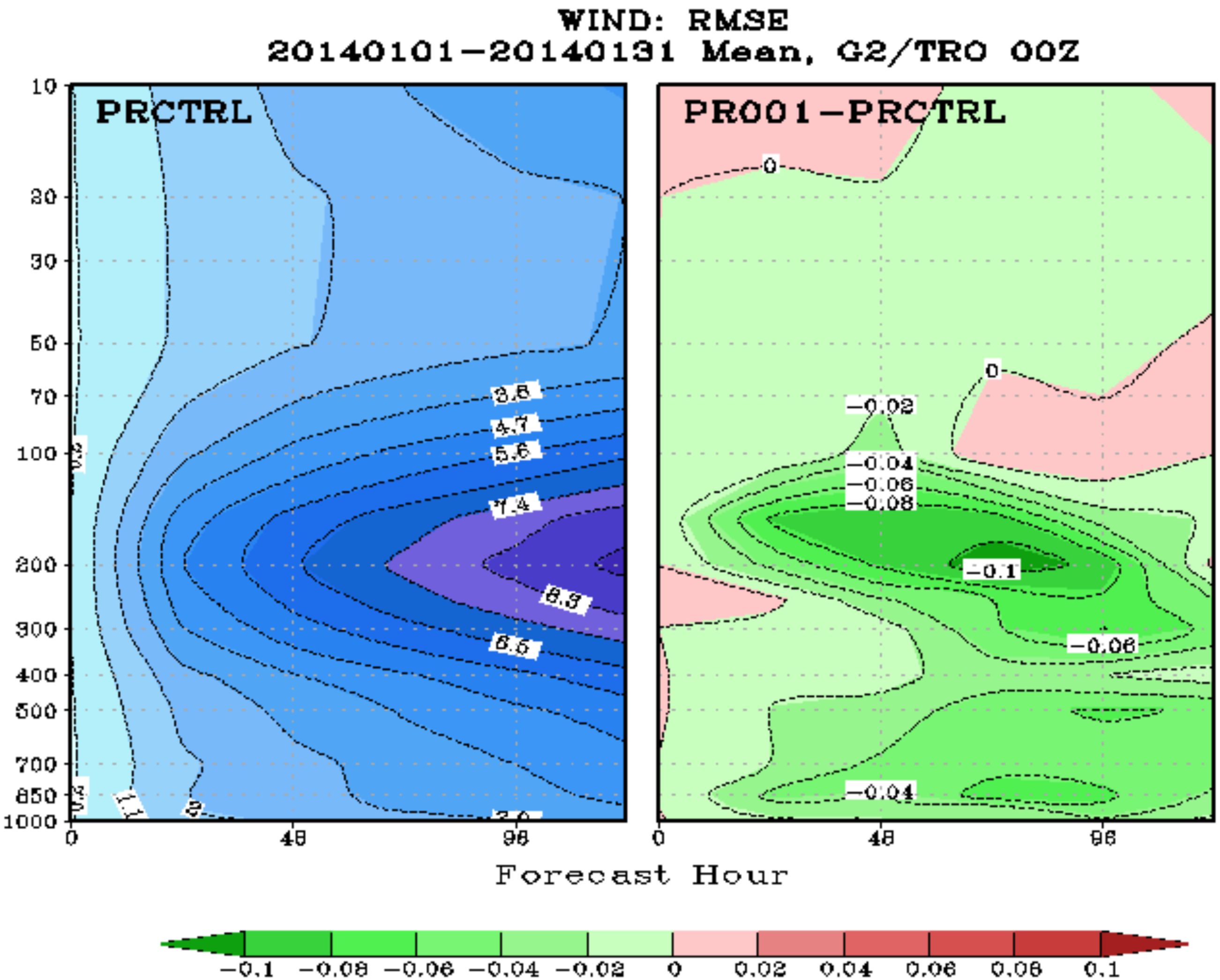

WIND: RMSE
P200 G2/TRO 00Z, 20140101-20140131 Mean
PRCTRL 25.
PR001 25.
Difference w.r.t. PRCTRL
rms differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour

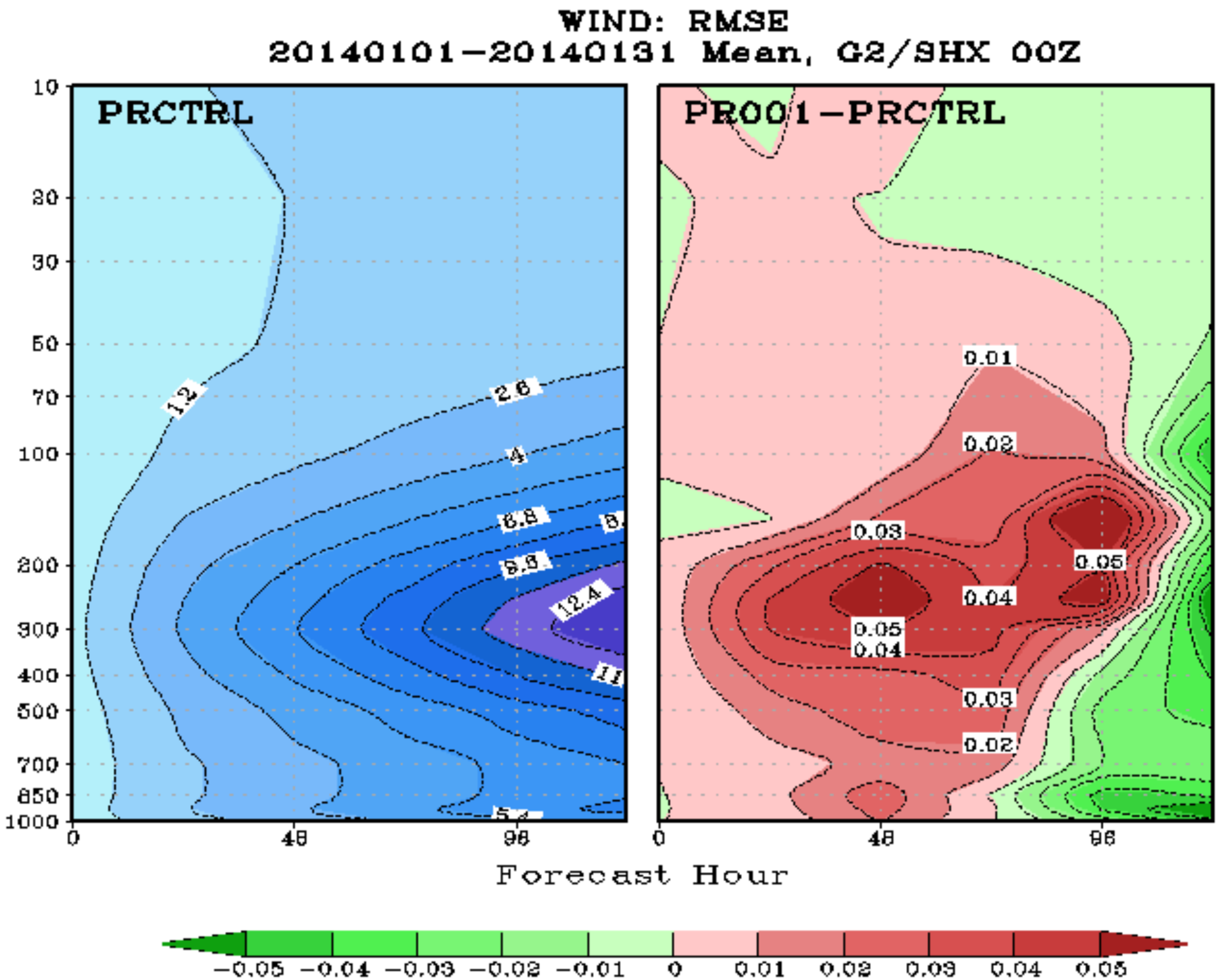


WIND: RMSE
P850 G2/TRO 00Z, 20140101-20140131 Mean
PRCTRL 25.
PR001 25.
Difference w.r.t. PRCTRL
rms differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour
0
48
96
4.4
4
3.6
3.2
2.8
2.4
2
1.6
1.2
0.8
0.4
0
0
-0.008
-0.016
-0.024
-0.032
-0.04
-0.048
-0.056
-0.064
-0.072



WIND: RMSE
20140101-20140131 Mean, G2/NHX 00Z
PRCTRL
PR001-PRCTRL
5.7
4.2
1.2
7.2
8.7
10.2
11.7
13.2
2.7
4.2
5.7
-0.03
0.03
0
0
10
20
30
50
70
100
200
300
400
500
700
850
1000
0
48
96
0
48
96
Forecast Hour
-0.15
-0.12
-0.09
-0.06
-0.03
0
0.03
0.06
0.09
0.12
0.15


WIND: RMSE
20140101-20140131 Mean, G2/TRO 00Z
PRCTRL
PR001-PRCTRL
10
20
30
50
70
100
200
300
400
500
700
850
1000
0
48
96
Forecast Hour
3.8
4.7
5.6
7.4
8.3
6.5
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.06
-0.04
-0.1 -0.08 -0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1



WIND: RMSE
20140101-20140131 Mean, G2/SHX 00Z
PRCTRL
PR001-PRCTRL
10
20
30
50
70
100
200
300
400
500
700
850
1000
0
48
96
Forecast Hour
1.2
2.6
4
6.8
8.8
12.4
0.01
0.02
0.03
0.04
0.05
−0.05
−0.04
−0.03
−0.02
−0.01

“GOES-R-like” winds evaluation – Summary

New algorithm’s winds perform well in these experiments

Some of the addition winds information is used – PCT1, NEE

Encouraging positive impact in the Tropics

“GOES-R-like” winds evaluation – Next Steps

Can we explain the positive impact in the Tropics?

What causes the slight worsening in the Southern Hemisphere?

Run experiment with operationally produced GOES-R-like and **hourly** winds

Relax the strict quality control for mid-level winds

Utilise now available cloud information

Steps towards overall AMV QC revision

Relaxing the blacklisting in the vertical

Transition towards situation dependent OE

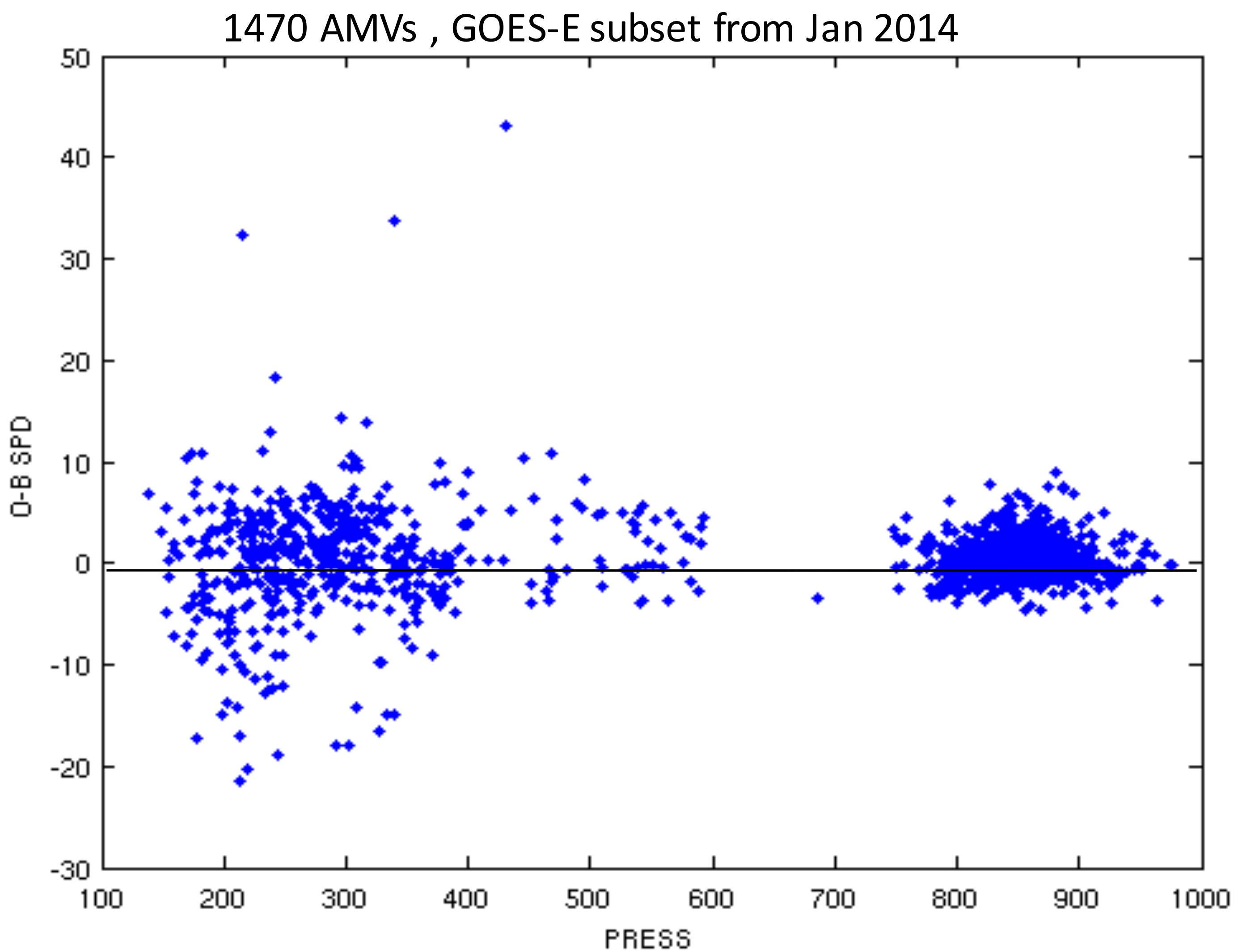
Relaxing the blacklisting in the vertical

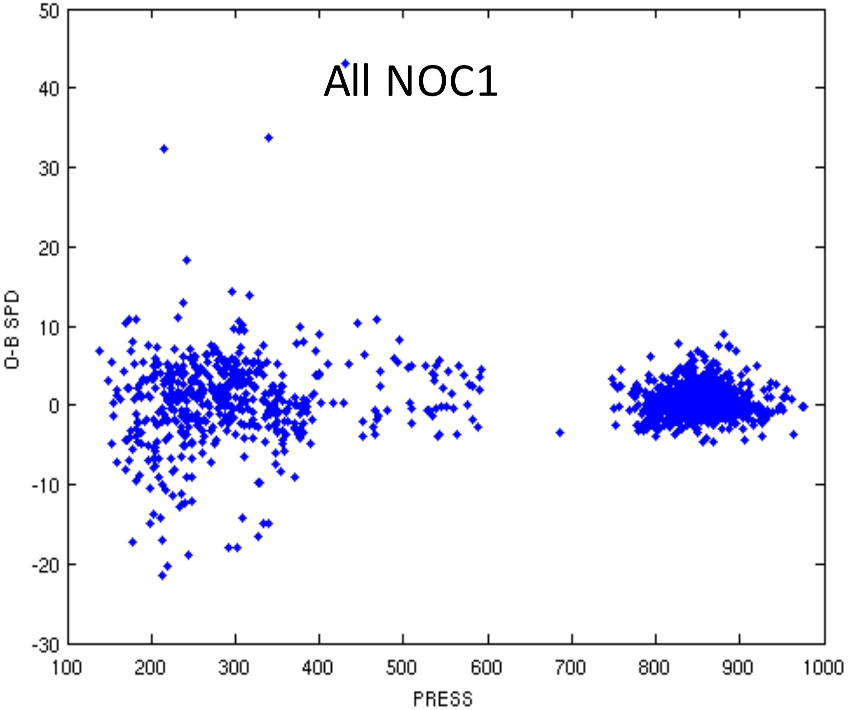
Using old and new algorithms' output to investigate mid-level winds quality

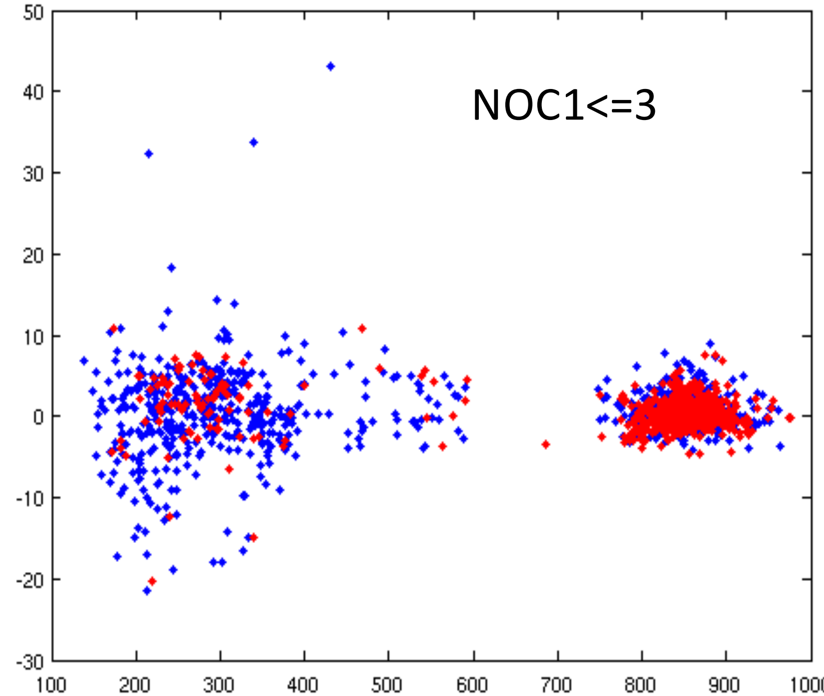
Old: Channel, Lat, Speed, Pres, O-B Speed
New: CMASK, CTYPE,LAND, NOC1, NOC2, PHASE, SD1, SD2, PERR, PBFT

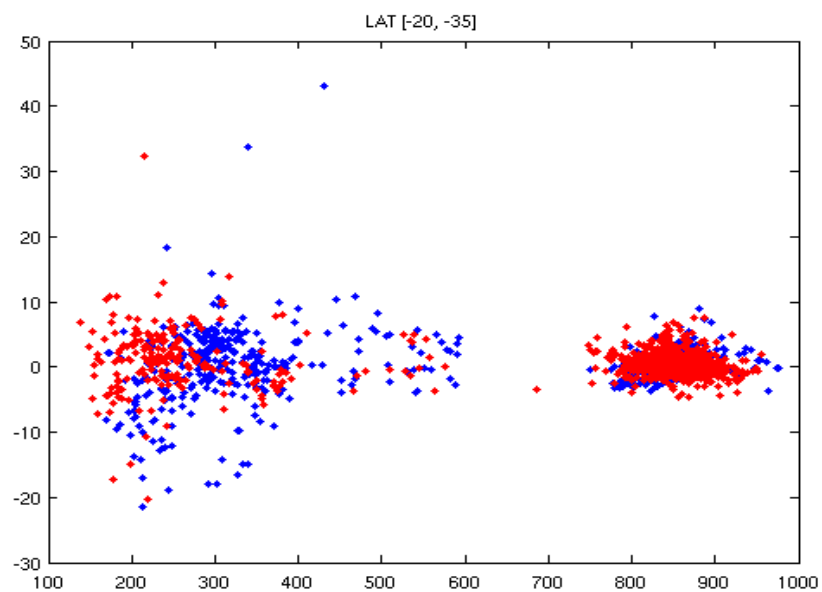
Idea: One “compound” flag (made of multiple variables) to be passed
From read_satwnd.f90 to setupw.f90

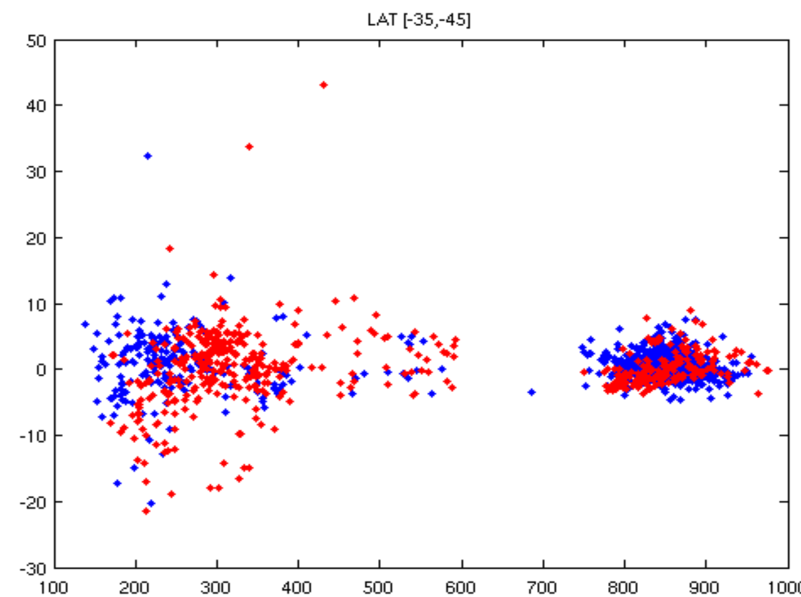
Preliminary results: Mid-level winds are not found to be of worse quality than low and high winds, therefore more of then can be assimilated, if certain QC criteria are still met


1470 AMVs , GOES-E subset from Jan 2014
O-B SPD
PRESS
50
40
30
20
10
0
-10
-20
-30
100
200
300
400
500
600
700
800
900
1000


All NOC1
O-B SPD
PRESS
50
40
30
20
10
0
-10
-20
-30
100 200 300 400 500 600 700 800 900 1000


NOC1<=3
50
40
30
20
10
0
-10
-20
-30
100 200 300 400 500 600 700 800 900 1000


LAT [-20, -35]
50
40
30
20
10
0
-10
-20
-30
100 200 300 400 500 600 700 800 900 1000


LAT [-35,-45]
50
40
30
20
10
0
-10
-20
-30
100 200 300 400 500 600 700 800 900 1000

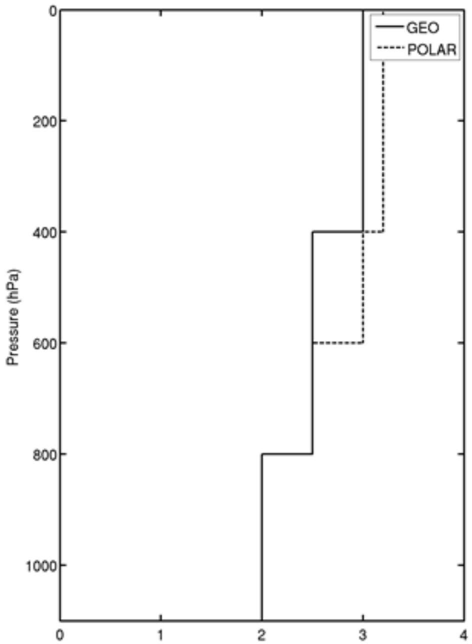
Transition towards Situation Dependent OE

Using the Nested Tracking algorithm's output to investigate what a Situation Dependent OE profile would look like

SHEAR, PERR, PBFT

Situation dependent AMV observation errors

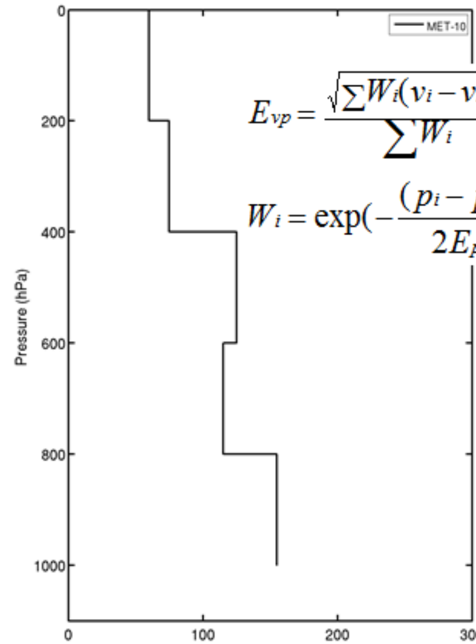
sqrt(



Tracking error (m/s)

2

+



$$E_{vp} = \frac{\sqrt{\sum W_i (v_i - v_n)^2}}{\sum W_i},$$

$$W_i = \exp\left(-\frac{(p_i - p_n)^2}{2E_p^2}\right) * dP_i$$

E_p, Height error (hPa)

2

)

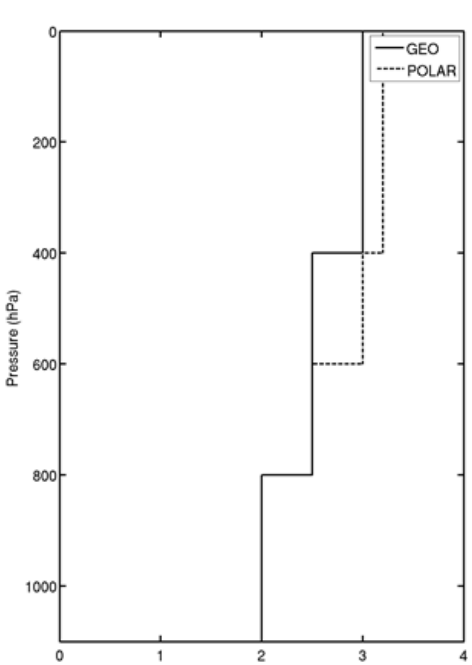
[Tracking error]^2 + [Error in u/v due to error in height]^2 = [Total u/v ObsError]^2

Forsythe M, Saunders R, 2008: AMV errors: A new approach in NWP. Proceedings of the 9th international winds workshop.

Salonen et al., 2015: Characterising AMV height assignment error by comparing best-fit pressure statistics from the Met Office and ECMWF data assimilation systems. JAMC, 54, 225-242.

Situation dependent AMV observation errors

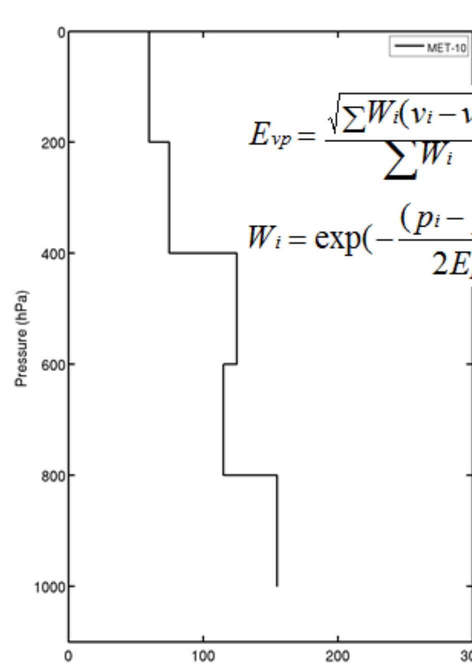
sqrt(



Tracking error (m/s)

2

+



$$E_{vp} = \frac{\sqrt{\sum W_i (v_i - v_n)^2}}{\sum W_i},$$

$$W_i = \exp\left(-\frac{(p_i - p_n)^2}{2E_p^2}\right) * dP_i$$

E_p , Height error (hPa)

2

)

[Tracking error]^2 + [Error in u/v due to error in height]^2 = [Total u/v ObsError]^2

|Pamv – PBFT| < 30 hPa

$$E_{vp} = \frac{\sqrt{\sum W_i^{\,2}\left(v_i - v_n\right)^2}}{\sum W_i}$$

$$W_i = \left[e^{-\frac{(p_i - p_n)^2}{2E_p^{\,2}}} \right] * dp_i$$

i = model level

v_i = wind component on model level

v_n = wind component at observation location

p_i = pressure on model level

p_n = pressure at observation location

E_p = error in height assignment

dP_i = layer thickness

$$E_{vp} = \frac{\sqrt{\sum W_i^2 (v_i - v_n)^2}}{\sum W_i}$$

PBFT (Level of best fit)

$$W_i = \left[e^{-\frac{(p_i - p_n)^2}{2E_p^2}} \right] * dp_i$$

1.5*(p_i-p_n)

Ep, hPa	50	75	100
Shear,m/s	<8	8-20	>20

i = model level

v_i = wind component on model level

v_n = wind component at observation location

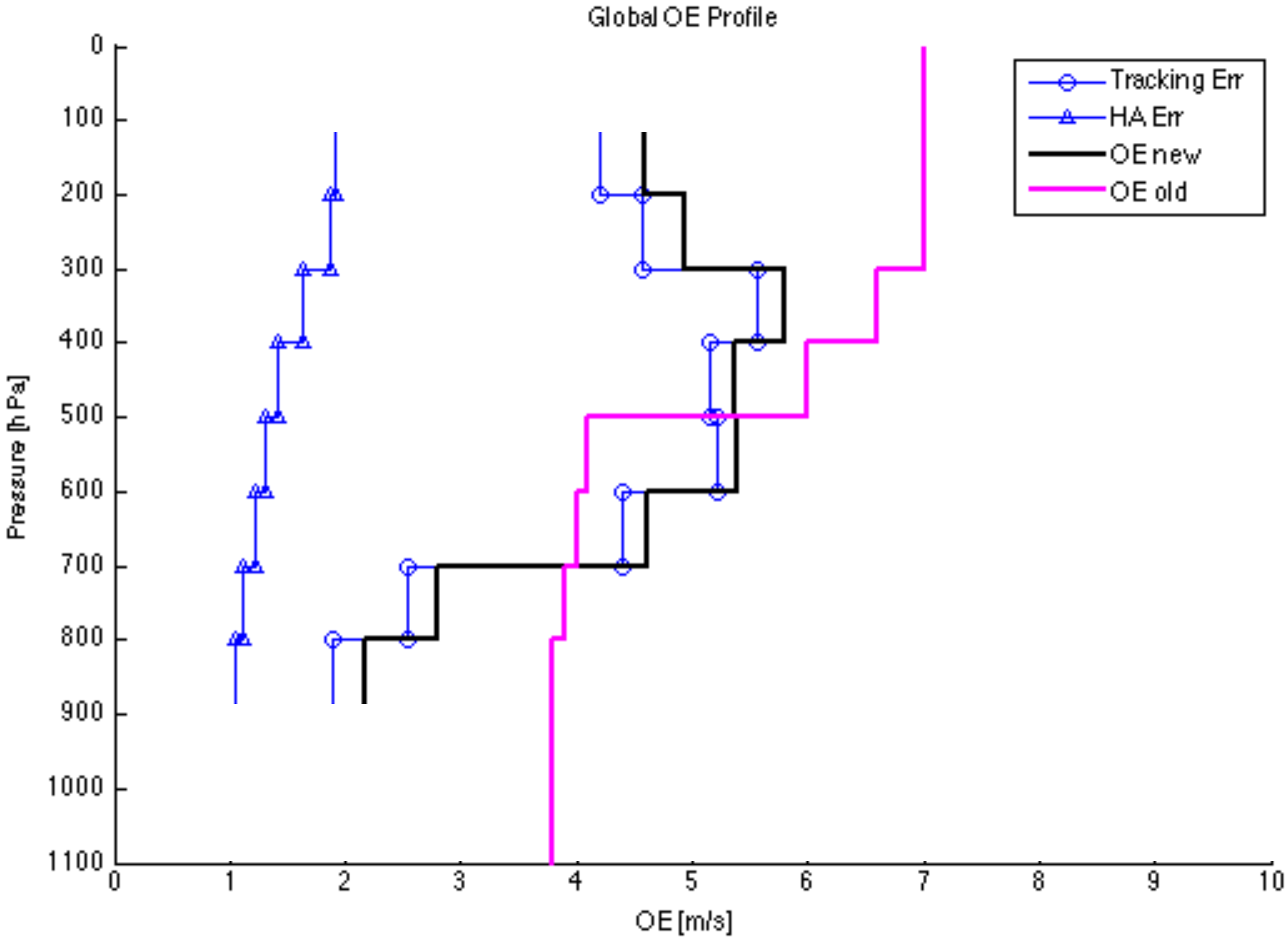
p_i = pressure on model level

p_n = pressure at observation location

E_p = error in height assignment

dP_i = layer thickness

AMV observation errors – preliminary profiles (GOES 13/15, IR)



Outline

HIMAWARI winds examination

VIIRS winds Data Assimilation investigation

“GOES-R-like” winds evaluation

Steps towards overall AMV Quality Control (QC) revision

Study of the complimentary nature of AMVs and Doppler Wind Lidar winds

Investigating the complementary nature of satellite atmospheric motion vectors (AMVs) and Doppler lidar winds

Iliana Genkova, Martin Weissmann**, Steven Wanzong***, Chris Velden***, Kathrin Folger***

**IMSG, Rockville, MD, USA **Ludwig-Maximilians-Universität, Munich, Germany, ***UW-CIMSS, Madison WI, USA*

"A US Effort for ADM-Aeolus Calibration and Validation", Michael Hardesty and 15 co-PIs

Proposed Work: **Comparison of ADM-Aeolus winds to conventional Atmospheric Motion Vectors (AMVs)**

Team: **Iliana Genkova and Chris Velden (UW-CIMSS)**

• ***Compare ADM-Aeolus global-coverage line-of-sight wind profiles with current state of the art feature-tracked AMVs****. The AMVs are operationally produced from several geostationary satellites and polar orbiters, yielding global tropospheric wind vector coverage with consistent quality. Imagery from passive remote sensors is used to deduce AMVs by tracking clouds or water vapor gradients. By comparing the ADM wind profiles with this global AMV data set, ADM vector coverage, quality and differences with AMVs will be documented, thus assessing the complementary value of the ADM winds to the existing upper-air winds observing system.*

• ***Investigate how ADM-Aeolus wind profiles can be used to assess the uncertainty introduced by the assumption that cloud and water features are ideal tracers****, and additionally interpret* ***how the ADM cloud top heights and cloud-independent wind vector altitudes correlate****. Such study would be most valuable over ocean where limited RAOBs are available for similar type studies.* ***Further analysis to improve utilizing the U and V winds components separately in NWP models****.*

Questions to answer:

1) How do feature tracked AMVs and Doppler lidar winds compare?

2) How can Doppler lidar winds help us address the uncertainties in AMV height assignments?

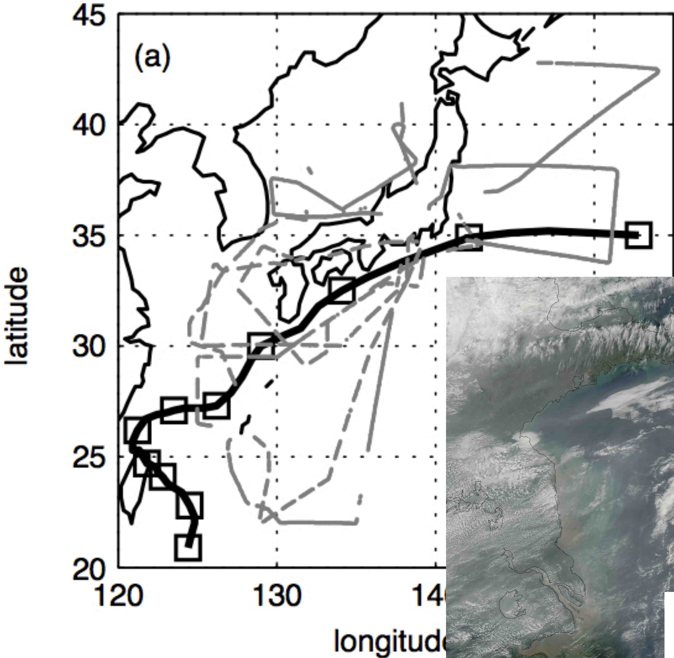
3) How can ADM-Aeolus wind profiles be used to assess the uncertainty introduced by the assumption that cloud/ water vapor features are ideal tracers?

4) Further analysis to improve utilizing the U and V winds components separately in NWP models

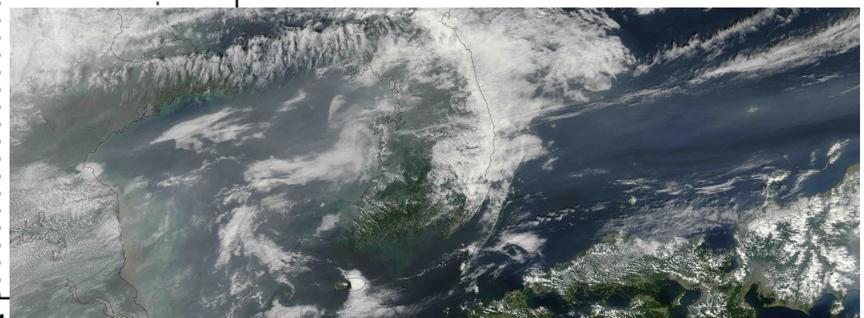
Data and Method

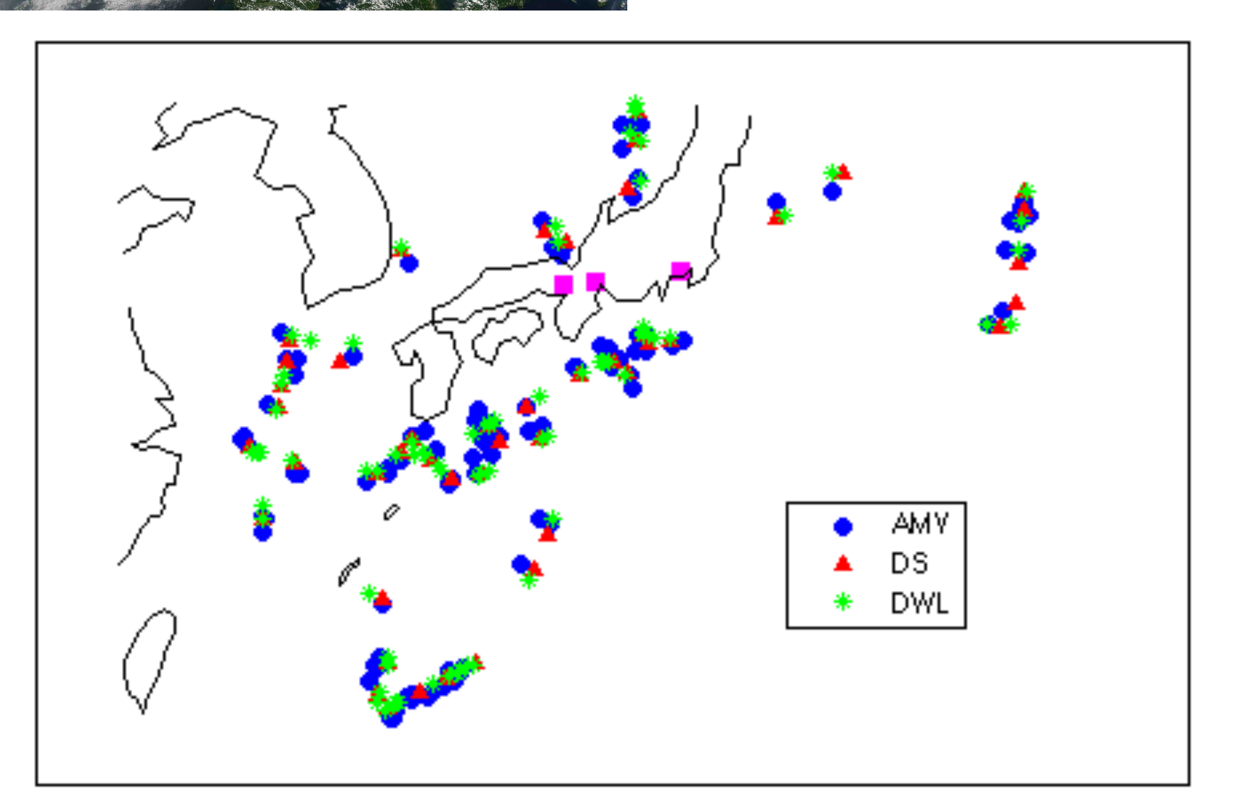
- THORPEX Pacific Asian Regional Campaign (T-PARC) 2008 - airborne Doppler wind lidar (DWL) profiles (~2500) measured by the DLR Falcon aircraft during the life cycle of Typhoon Sinlaku in the western North Pacific (11 – 21 September 2008) with a 2 µm scanning coherent DWL;
- DWL profiles with a horizontal resolution of about 5 km and a vertical resolution of 100 m ; On average, every DWL wind profile during T-PARC provided wind information for about 20 – 25% of the vertical profile (Weissmann et al., 2005). The highest coverage of DWL observations occur between 250 and 300 hPa and the second highest coverage in the atmospheric boundary layer due to higher aerosol concentrations, whereas the coverage was particularly low between 500 and 800 hPa; Only profiles, which pass data assimilation's quality control are used
- Dropsondes (DS) every 3h
- Satellite AMVs from MTSAT imagery and CIMSS retrieval - produced every hour; quality controled;

- Triple Collocation (DWL, DS, AMV) : ± 60 min, 0.5 deg; ±50 hPa (WMO: ±90 min, 150km)
- 122 collocated points in all vertical bins (low, mid, high)

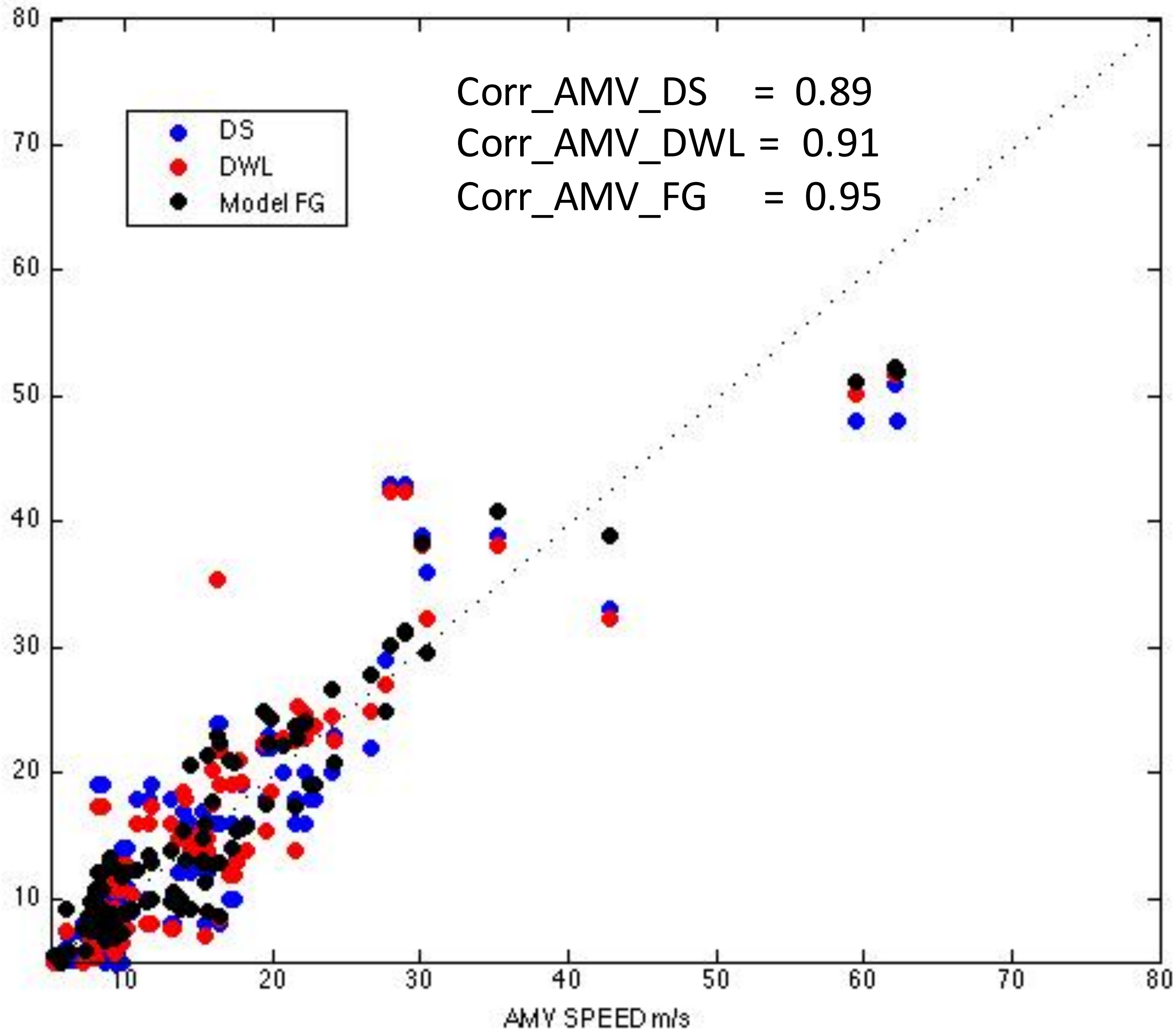


<- Location of DWL profiles (grey) and Typhoon Sinlaku (black line - according to the JMA best-track) for 11–21 September 2008; ‘Squares’ at 00UTC;

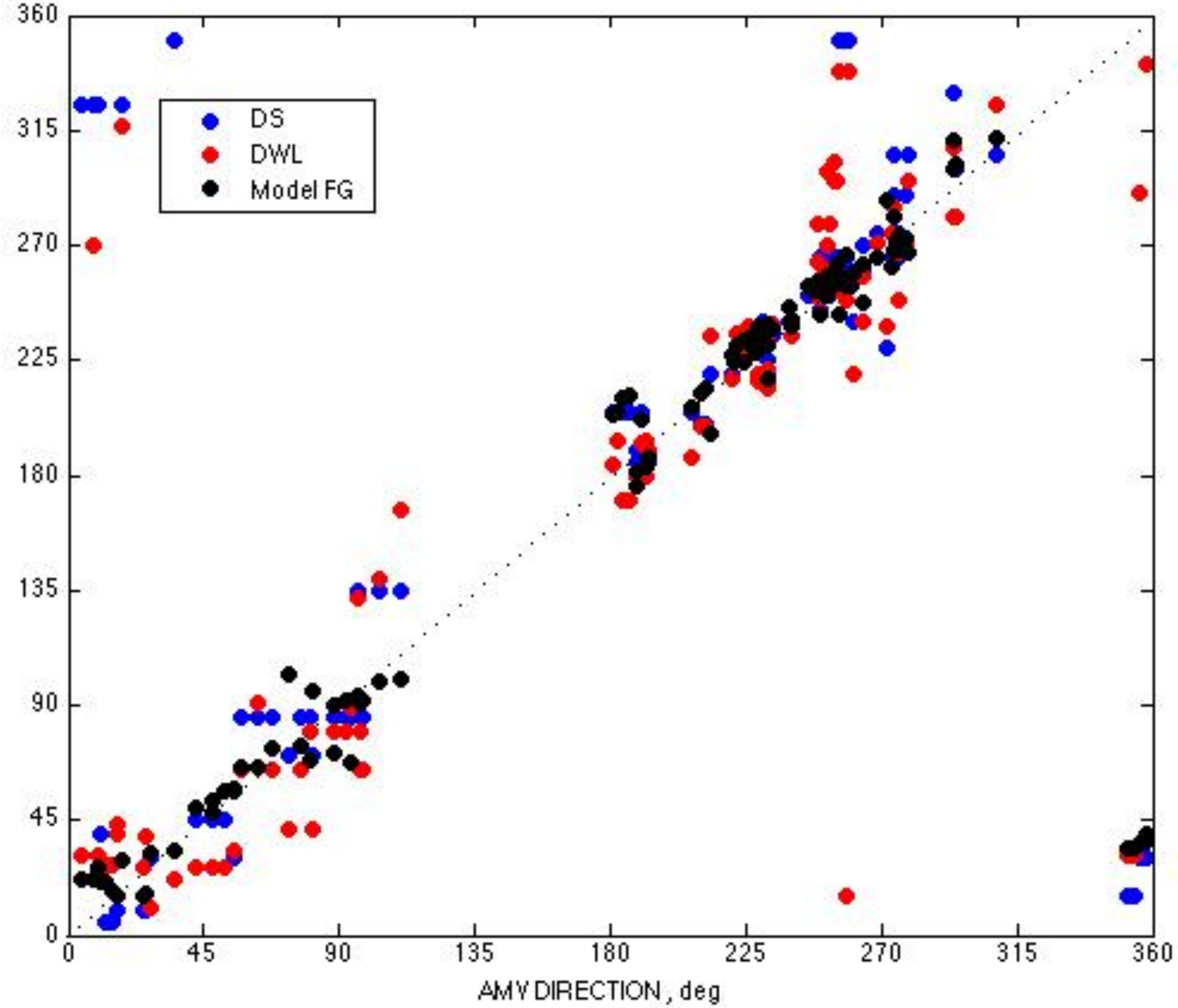




->
Sinhaku
09/19/2008



AMV Speed (x) vs. Dropsonde Speed/DWL/Model (y) , [m/s]



AMV Direction (x) vs. Dropsonde Direction/DWL/Model (y) , [deg]

Collocated data set statistics

Speed [m/s]	Count	Mean	STD
AMVs	122	14.24	10.54
Dropsondes	122	13.89	10.95
DWL	122	14.03	11.09
Model FG	122	13.68	10.31

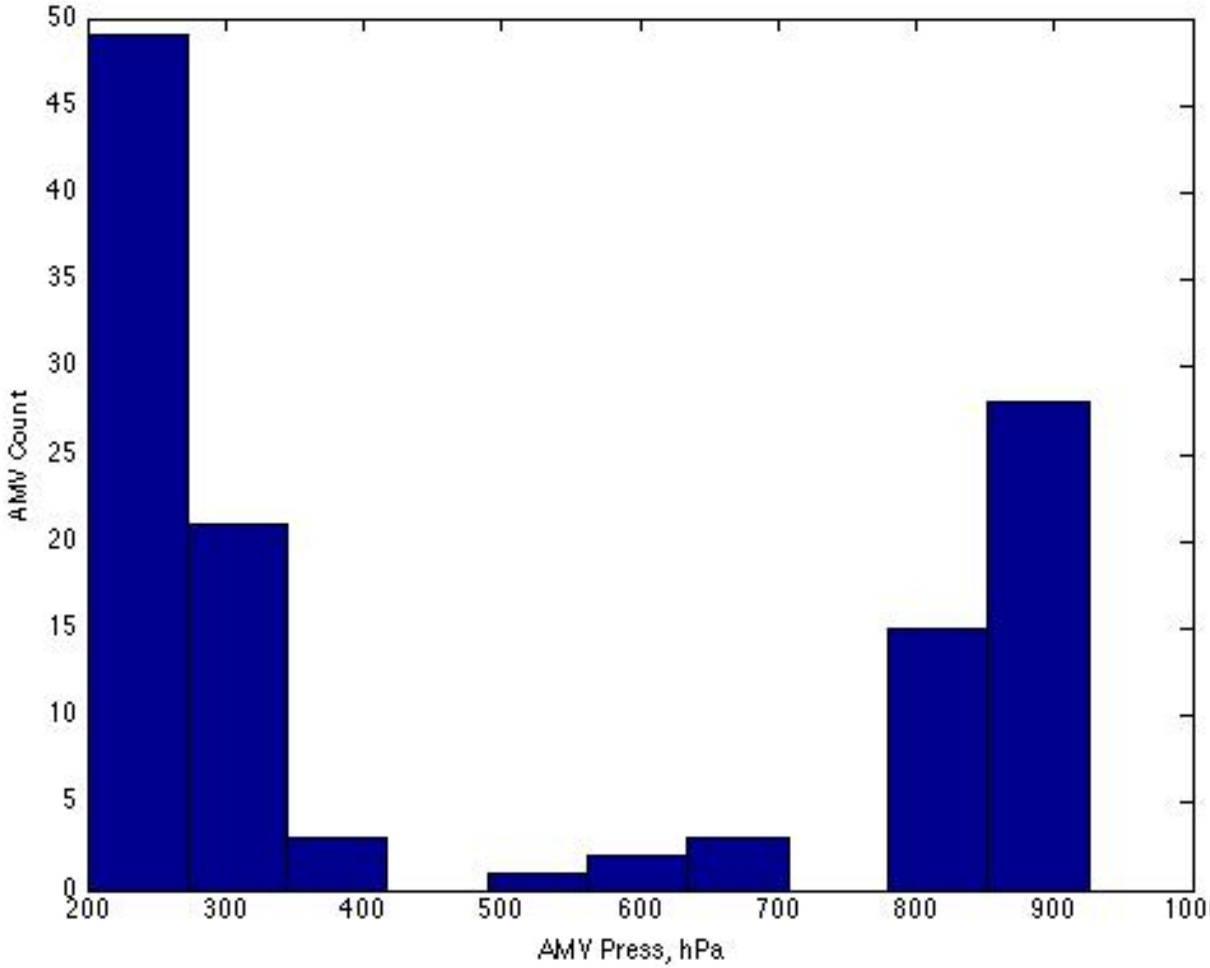
Model First Guess departures (Obs-Mod)

Speed [m/s]	Count	Mean	STD
AMVs - FG	122	0.55	3.27
Dropsondes - FG	122	0.78	2.63
DWL - FG	122	0.63	2.72

Speed Bias and RMS between the various data

	Count	SPEED Bias	SPEED RMS
AMV - Dropsondes	122	0.35	6.14
AMV - DWL	122	0.21	6.58
AMV - Model	122	0.55	3.79
DWL – DS	122	0.13	4.38

		Spectral type		Altitude			Height Assignment Method			
	All AMV-DWL	VIS+SWIR	IR+WV	LOW	MID	HIGH	H2O	HIST	WIN	BASE
Bias	0.21	0.19	0.23	-0.11	1.83	0.25	-0.47	0.7	-0.41	0.47
RMS	6.58	4.52	7.41	4.17	4.92	7.79	8.08	7.8	4.5	4.08



50
45
40
35
30
25
20
15
10
5
0
AMV Count
200
300
400
500
600
700
800
900
1000
AMV Press, hPa

Christopher S. Velden and Kristopher M. Bedka, 2009, *Identifying the Uncertainty in Determining Satellite-Derived AMVr Height Attribution. JAMC., 48, 450–463.*

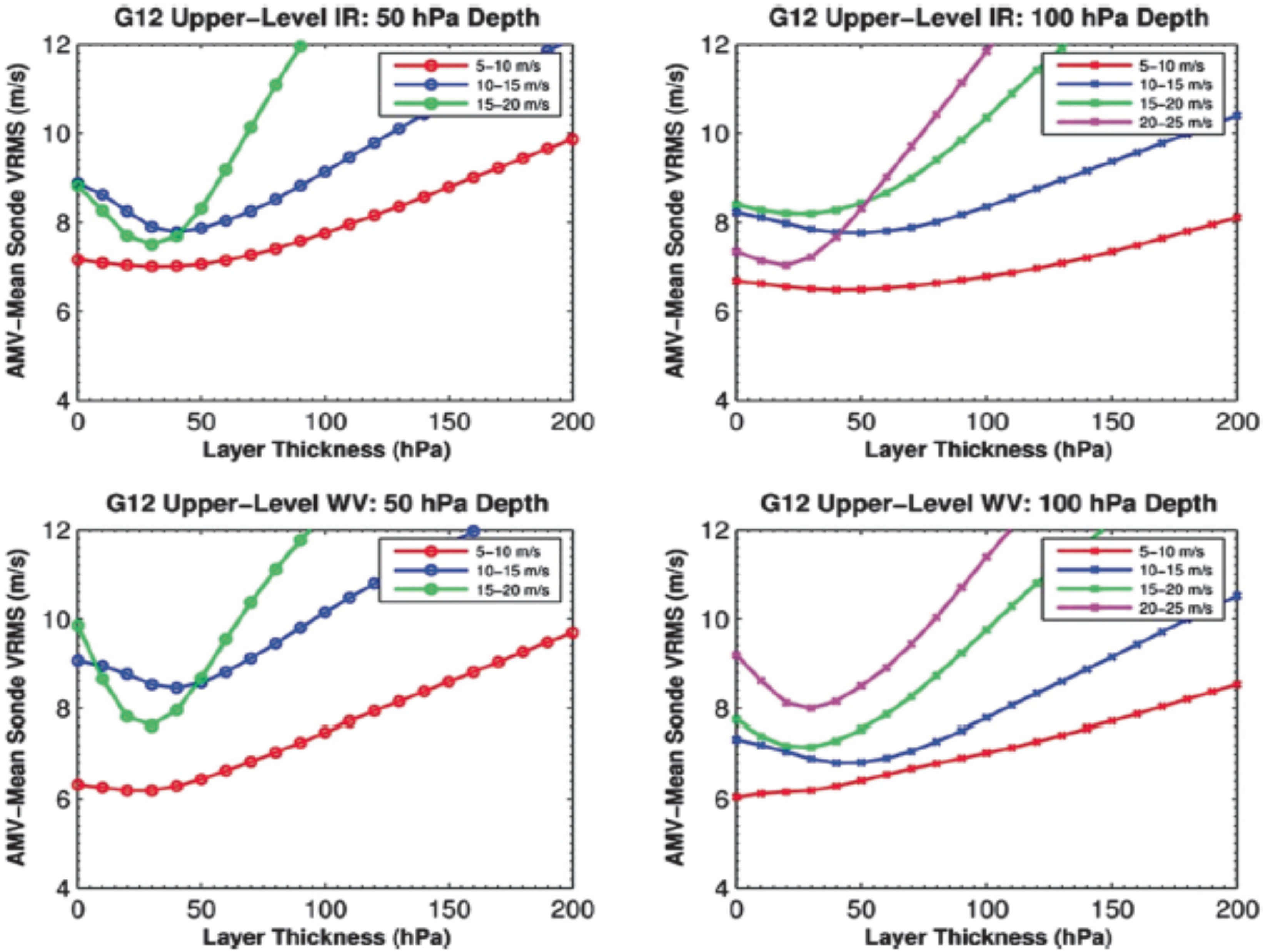
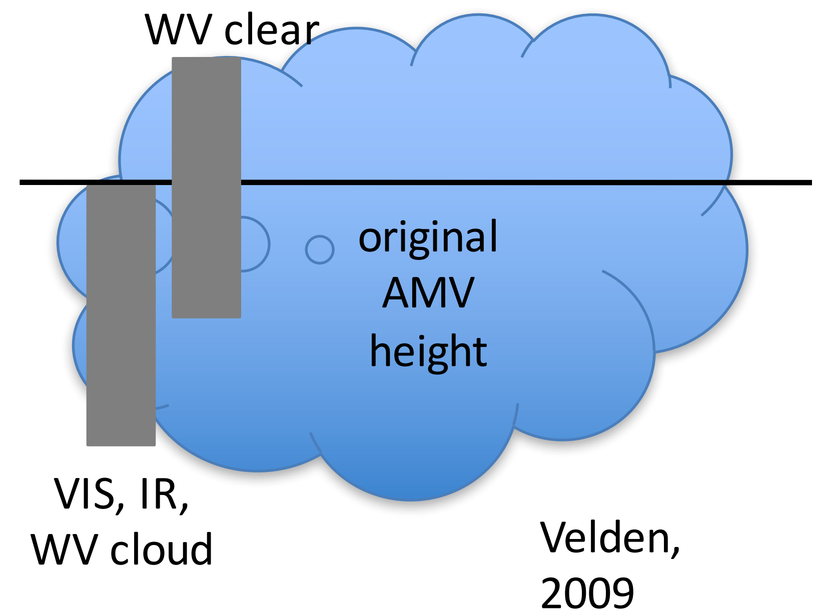


FIG. 8. VRMS differences between GOES cloudy upper-level (top) IR and (bottom) WV AMVs and layer-averaged SGP rawinsonde data for varying layer thickness (10–300 hPa, in 10-hPa increments) are represented by the colored curves [with the corresponding single-level-based VRMS values (adjusted heights) plotted on the *y* axis]. The analyses are with respect to varying vertical wind shear regimes (curve colors). The term "vertical wind shear" here refers to the vector difference between the rawinsonde value at the AMV height assignment level and two other selected rawinsonde levels [at either (left) 50 or (right) 100 hPa from the AMV height assignment level].



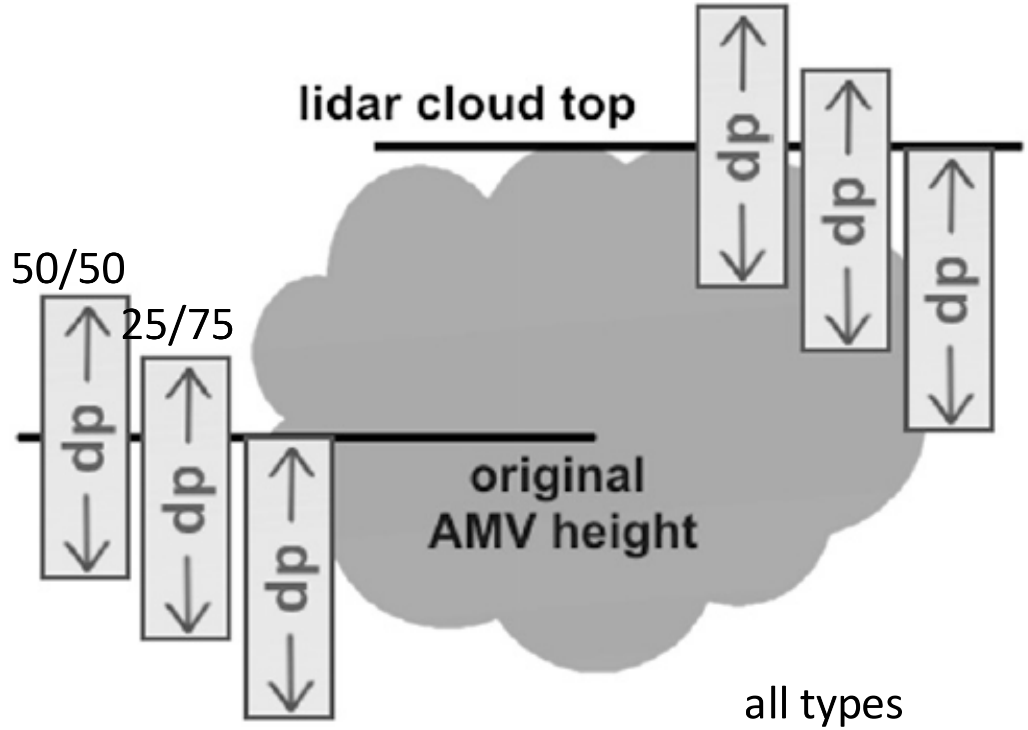
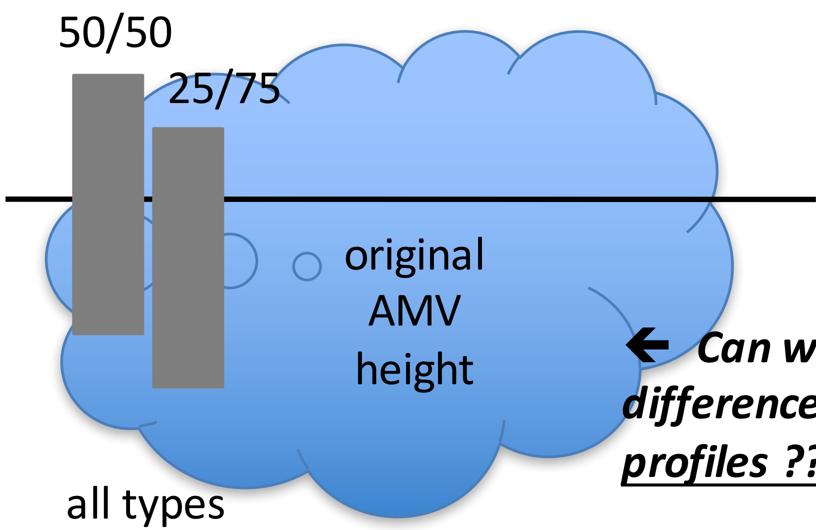


FIG. 3. Schematic illustration of the height-correction method, using three layer positions (centered, 25%/75% above/below, and below) relative to the original AMV height and relative to the lidar cloud-top height for layers of varying depth *dp* ranging from 0 to 200 hPa.



🡐 ***Can we evaluate the Mean VRMS and winds Speed Bias of differences between AMVs and layer-averaged <u>Doppler wind profiles ???</u>***

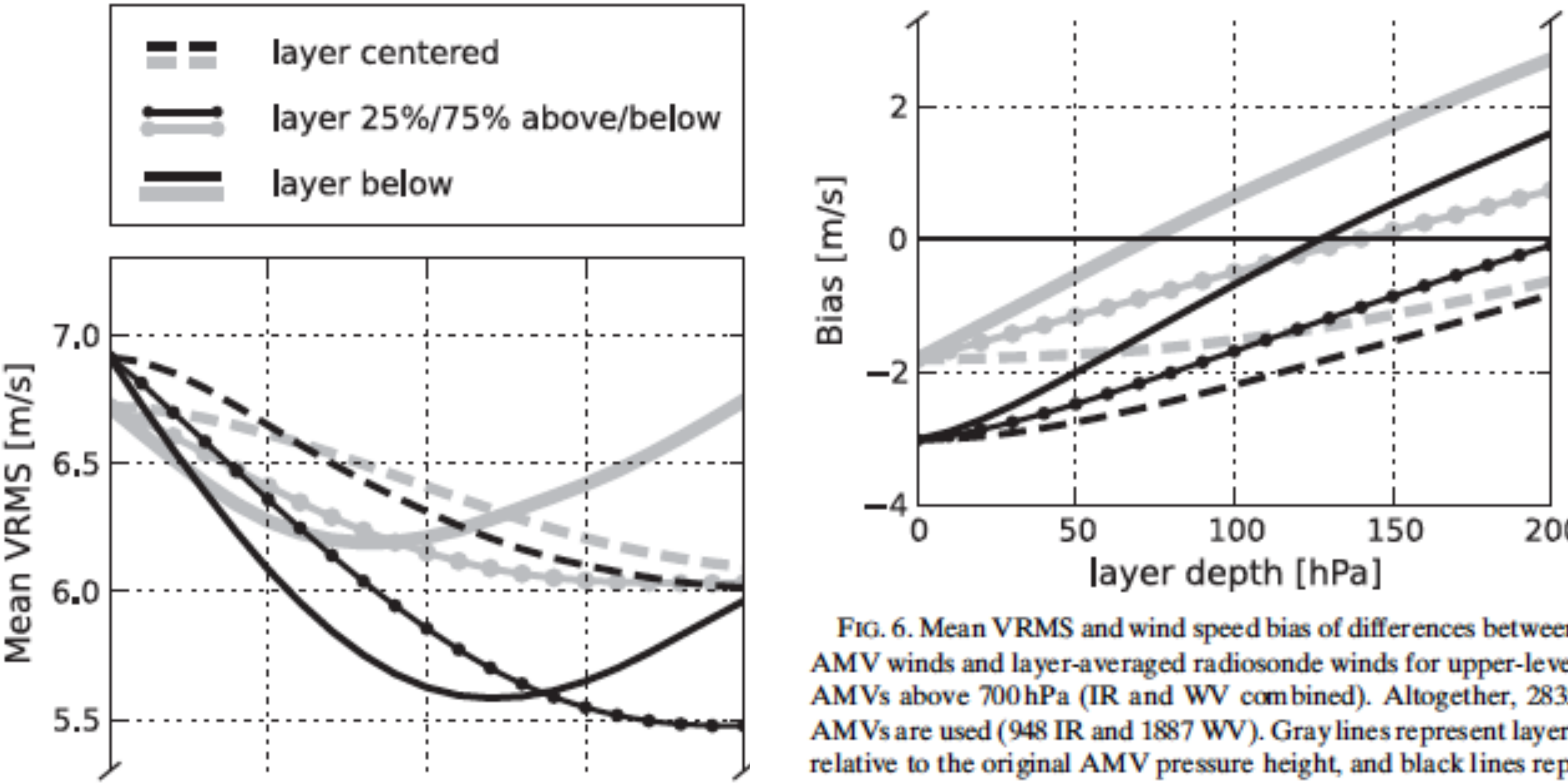
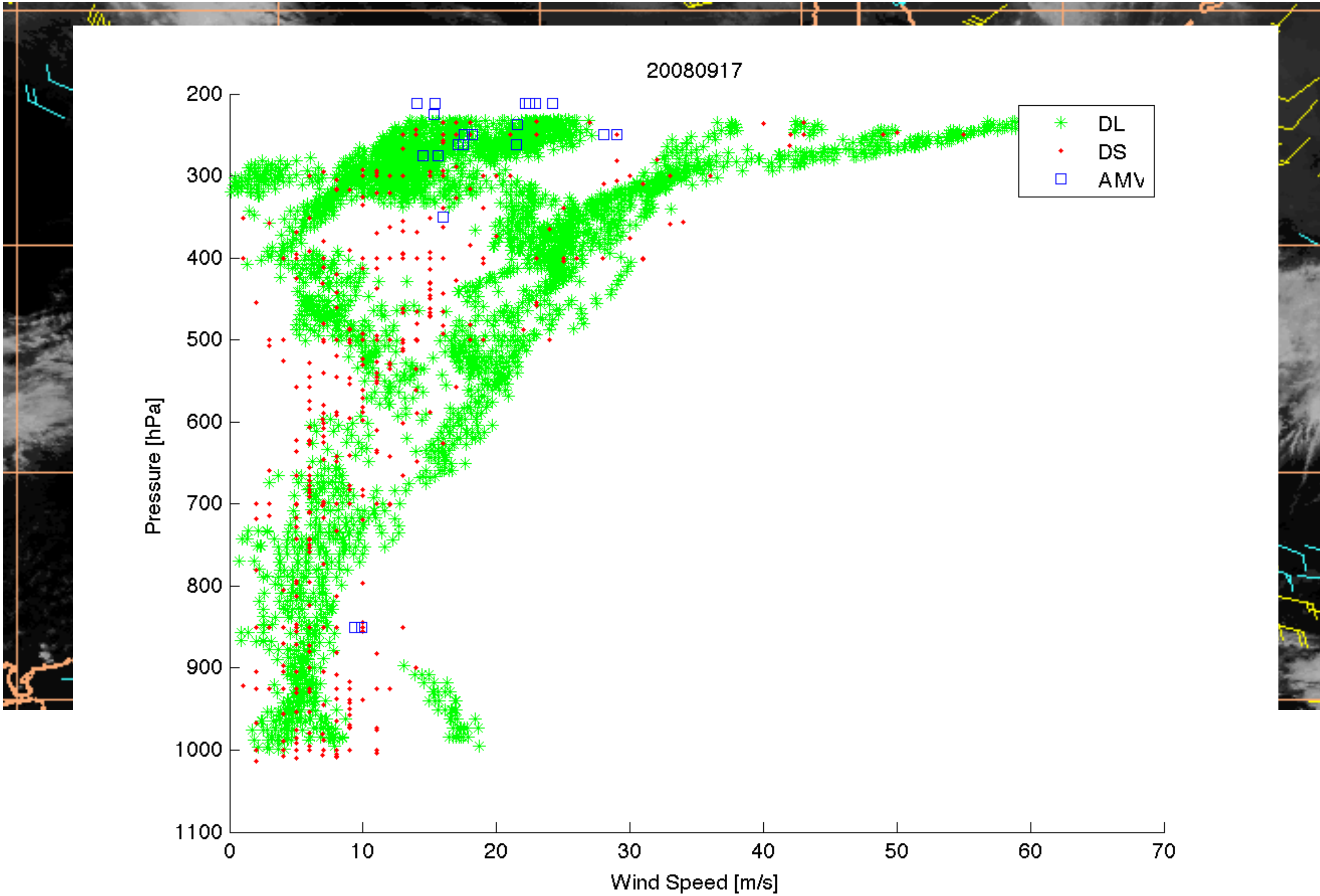


FIG. 6. Mean VRMS and wind speed bias of differences between AMV winds and layer-averaged radiosonde winds for upper-level AMVs above 700 hPa (IR and WV combined). Altogether, 2835 AMVs are used (948 IR and 1887 WV). Gray lines represent layers relative to the original AMV pressure height, and black lines represent layers relative to the lidar cloud-top height. Note that the scales for bias and mean VRMS values are different.

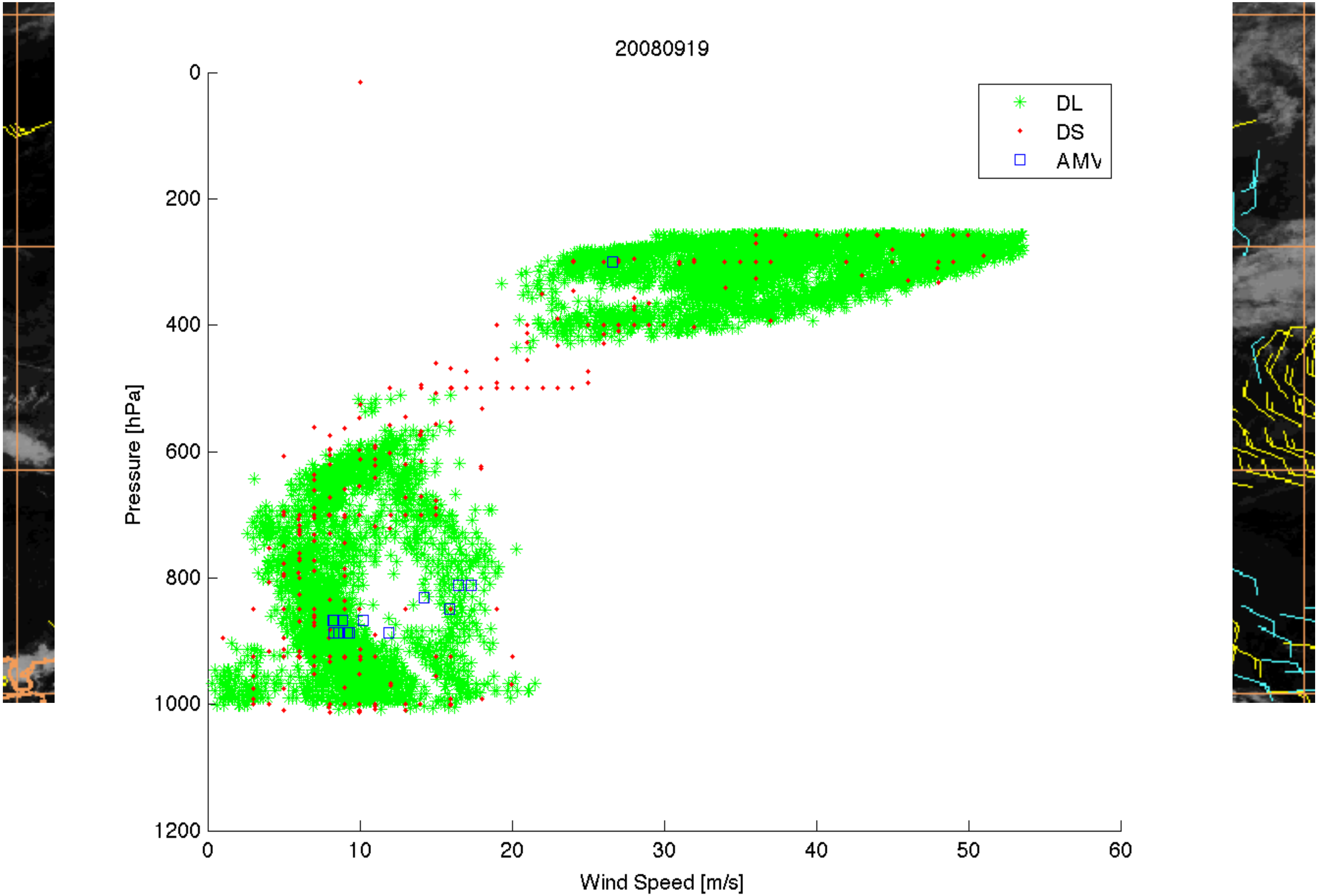
Kathrin Folger and Martin Weissmann, 2014
Height Correction of AMVs Using Satellite Lidar Observations from CALIPSO
J. Appl. Meteor. Climatol.,, 1809-1819

Examples of AMV - Doppler wind profiles collocations

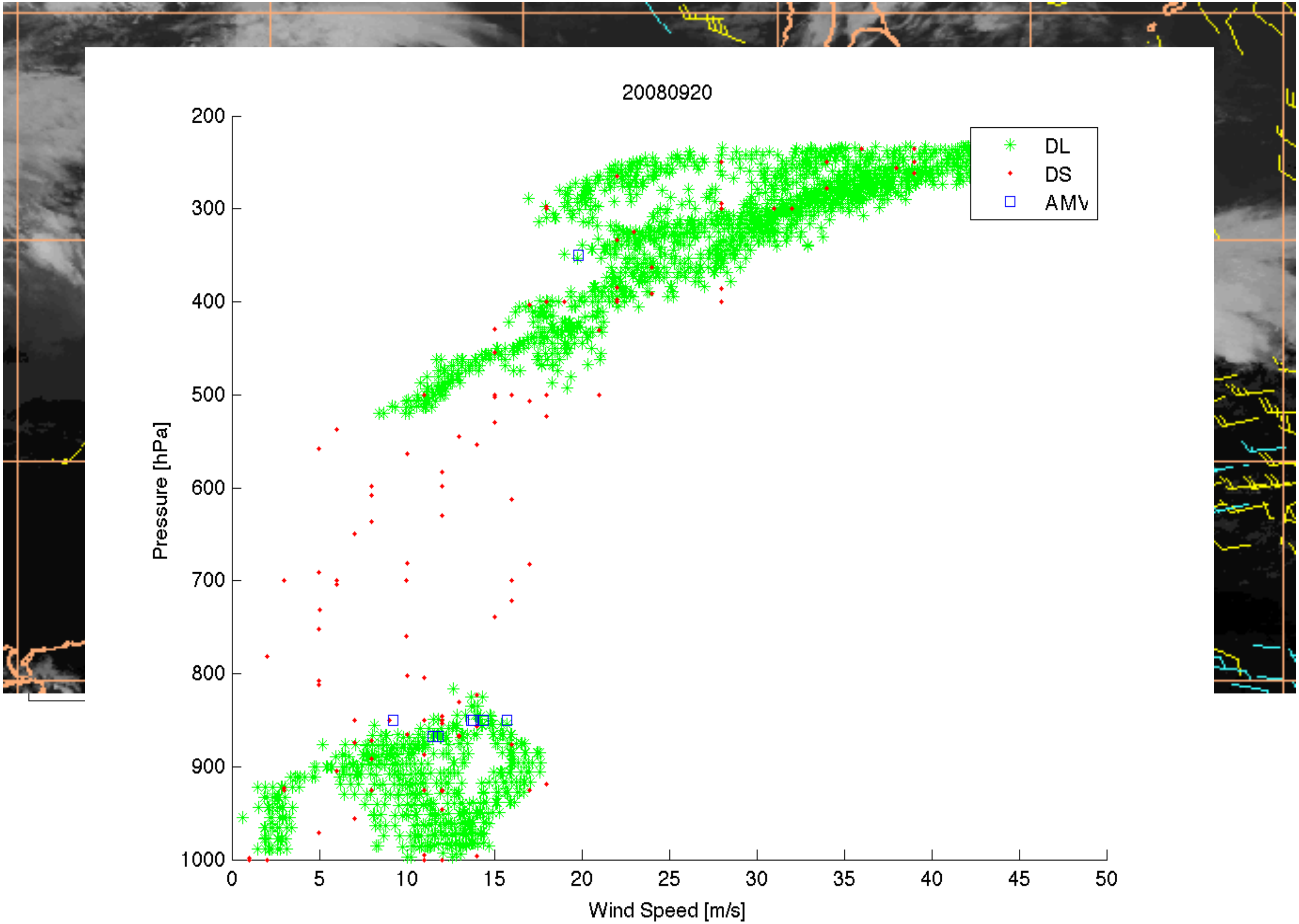
20080917


20080917
DL
DS
AMV
Pressure [hPa]
200
300
400
500
600
700
800
900
1000
1100
0
10
20
30
40
50
60
70
Wind Speed [m/s]

20080919


20080919
DL
DS
AMV
Pressure [hPa]
0
200
400
600
800
1000
1200
0
10
20
30
40
50
60
Wind Speed [m/s]

20080920


20080920
DL
DS
AMV
Pressure [hPa]
200
300
400
500
600
700
800
900
1000
0
5
10
15
20
25
30
35
40
45
50
Wind Speed [m/s]

AMVs and Doppler Lidar Winds - summary

- Preliminary results show that AMVs and DWL winds are not that different when strict collocation criteria are applied
- DWL winds can be used to revise the AMV's HA and/or Observation Errors
- It is feasible to use DWL wind profiles for 'best fit' AMV height correction
- Doppler lidar wind profiles may be useful for assigning an AMV to a layer instead of a level. Some AMV producers will soon report relevant cloud information along with each AMV vector, thus facilitating the transition level-to-layer when using AMVs in NWP models

Summary

HIMAWARI winds are now assimilated at NCEP

VIIRS winds Data Assimilation is expected to happen soon

"GOES-R-like" winds evaluation show encouraging results, to be repeated with up-to-date Nested Tracking algorithm's winds

Next on the 'to do' list is AMV Quality Control (QC) revision

Looking forward to the launch of ADM Aeolus for first Doppler Wind Lidar winds from space