Satellite Sounding Characteristic Performance Versus Radiosonde, *Impact of Local Overpass Time and Uncertainty*

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(Lihang Zhou … JPSS)
12/04/2017

International ATOVS Study Conference (ITSC-21)
Nov 29 to Dec 5, 2017
Darmstadt, Germany

OUTLINE

- NPROVS collocations of satellite and radiosondes provide an "enterprise" validation approach … "historical ITOVS function"

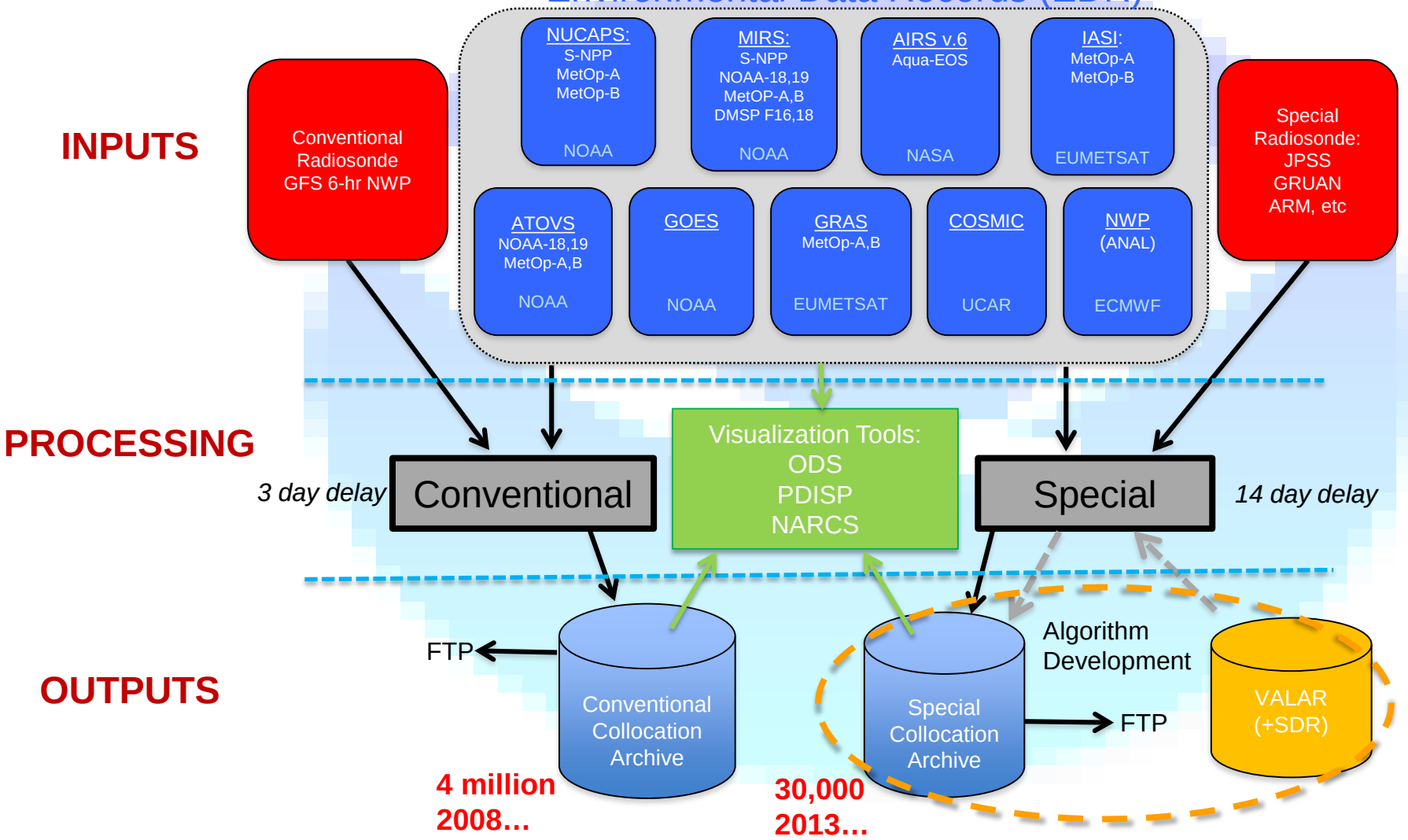
- Impact of local satellite overpass on sounding product assessment (bias) using synoptic radiosonde

- Sounding product assessment (uncertainty estimate) using GCOS Reference Upper Air Network (GRUAN) radiosonde …

- Summary

NPROVS Data Management Schematic

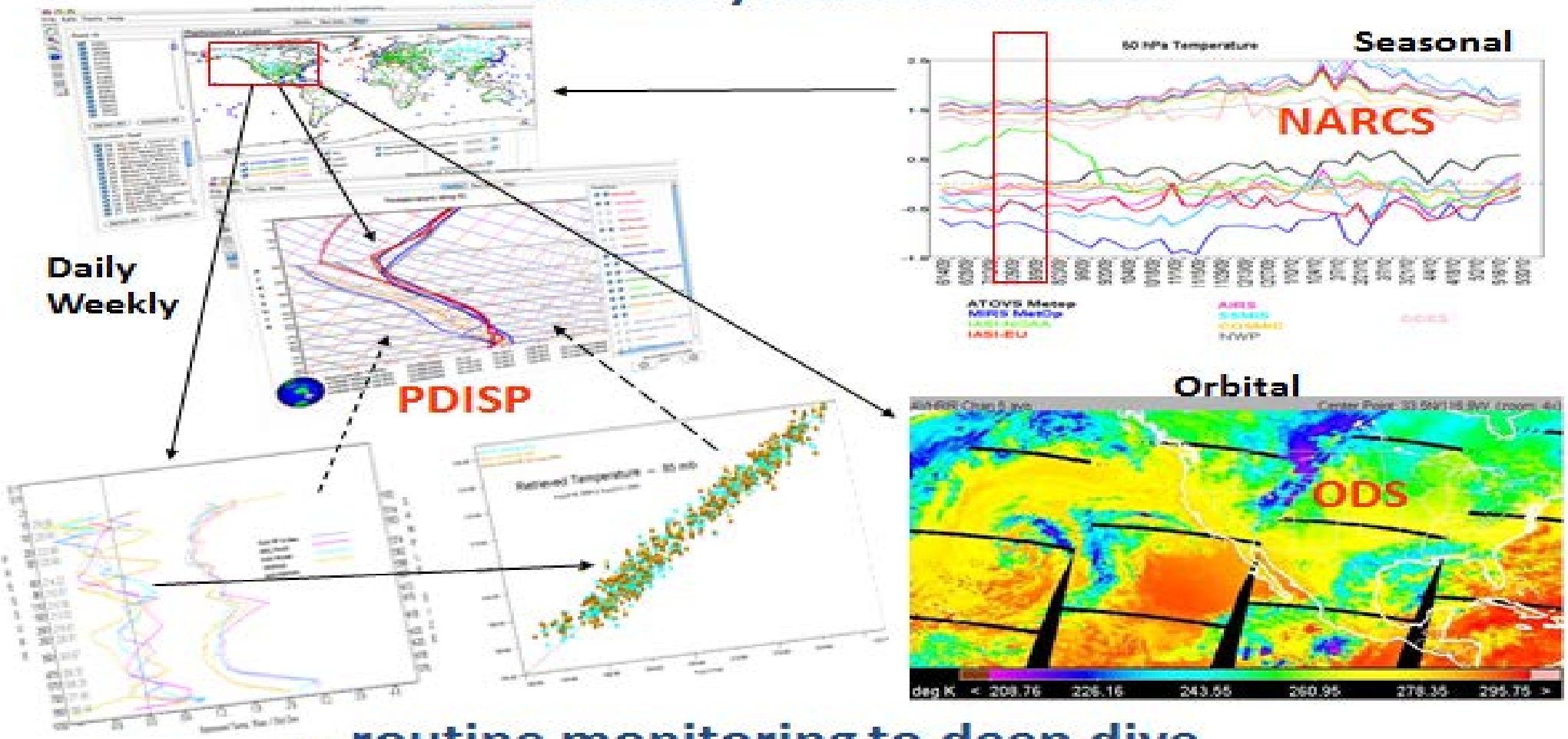
Environmental Data Records (EDR)



https://www.star.nesdis.noaa.gov/smcd/opdb/nprovs

NPROVS Graphical Analysis Tools

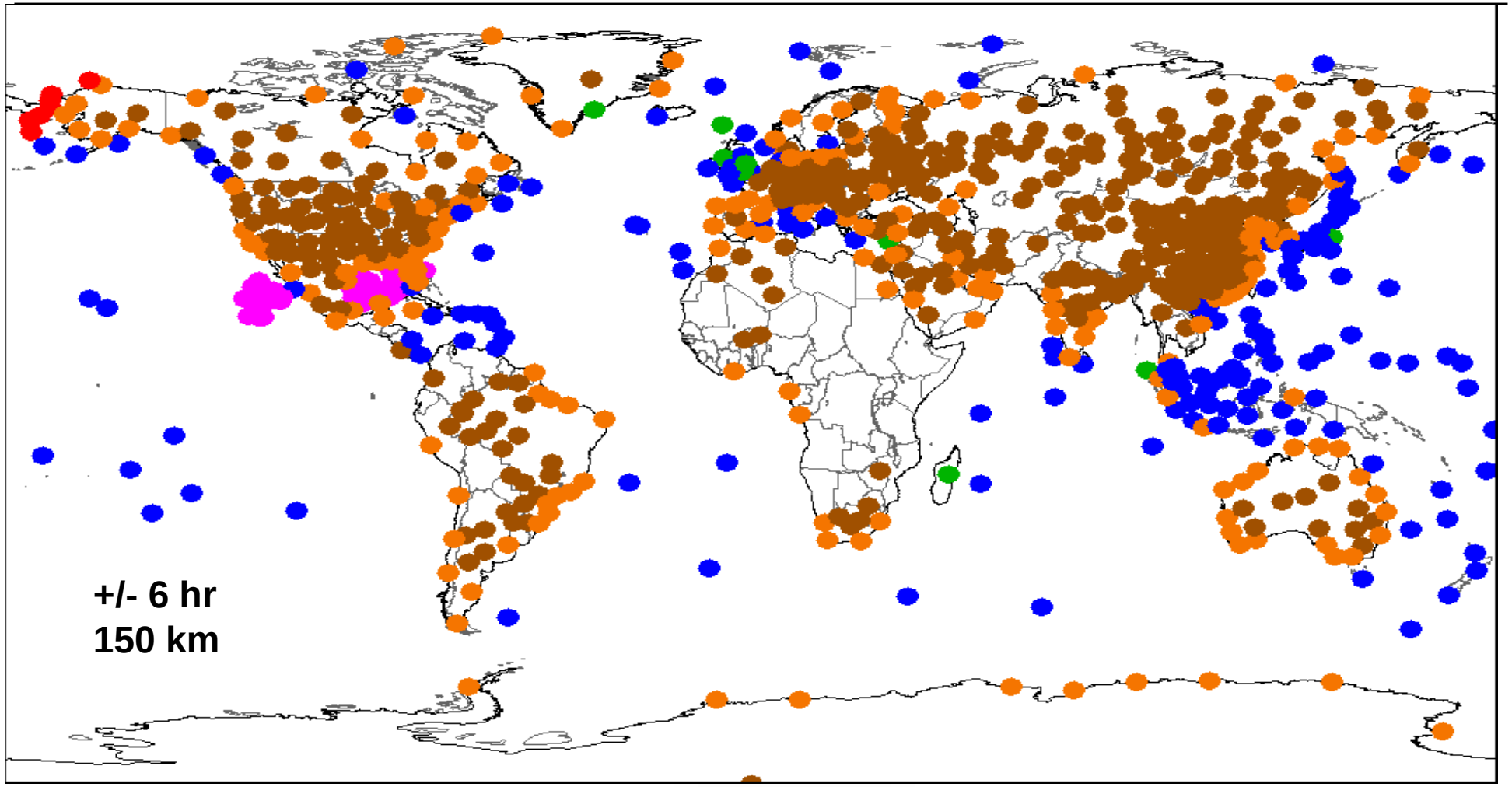
EDGE Analytical Interface …



… routine monitoring to deep dive

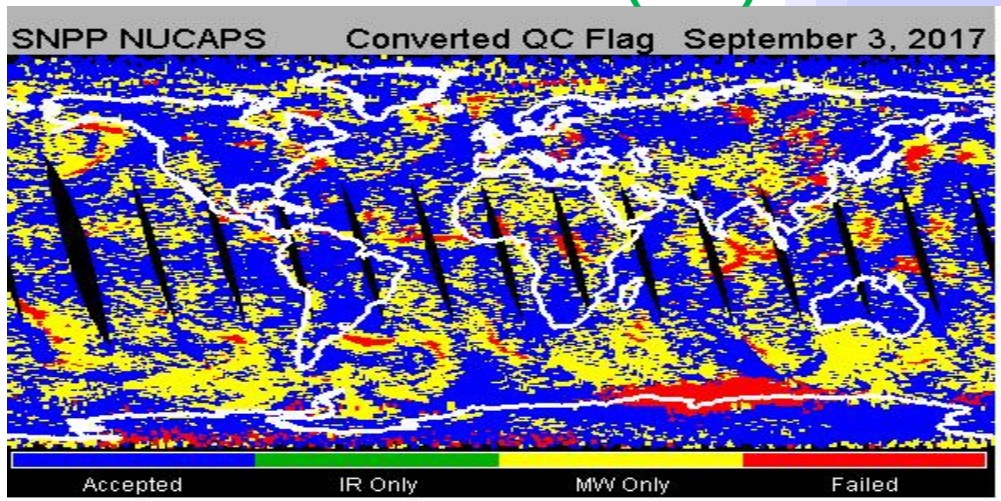
https://www.star.nesdis.noaa.gov/smcd/opdb/nprovs

Coast Land Island (Coast) Island (Inland) Ship Dropsonde

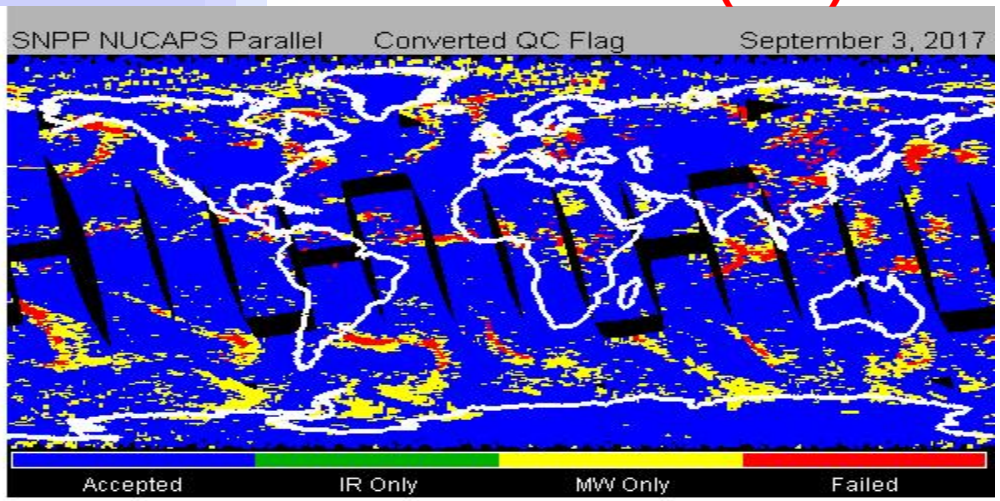


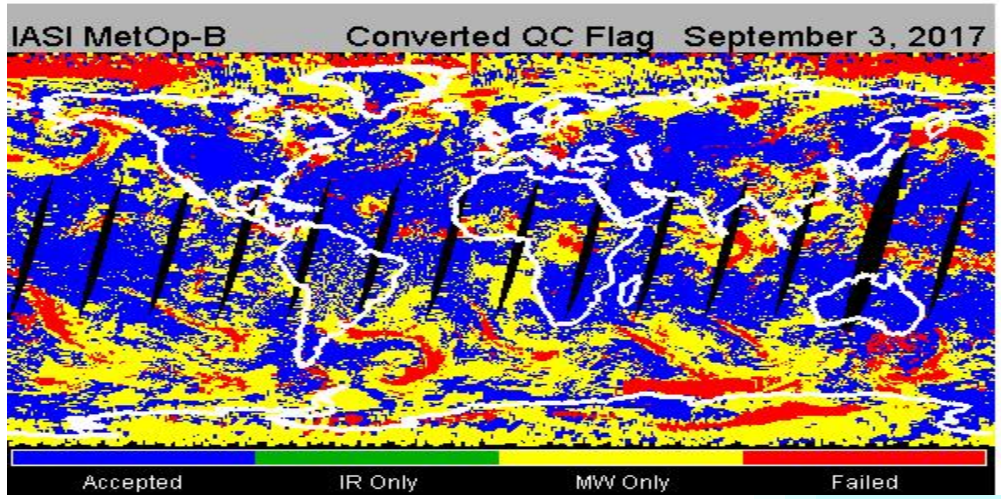
Conventional Synoptic Radiosonde

NUCAPS S-NPP (NSR)

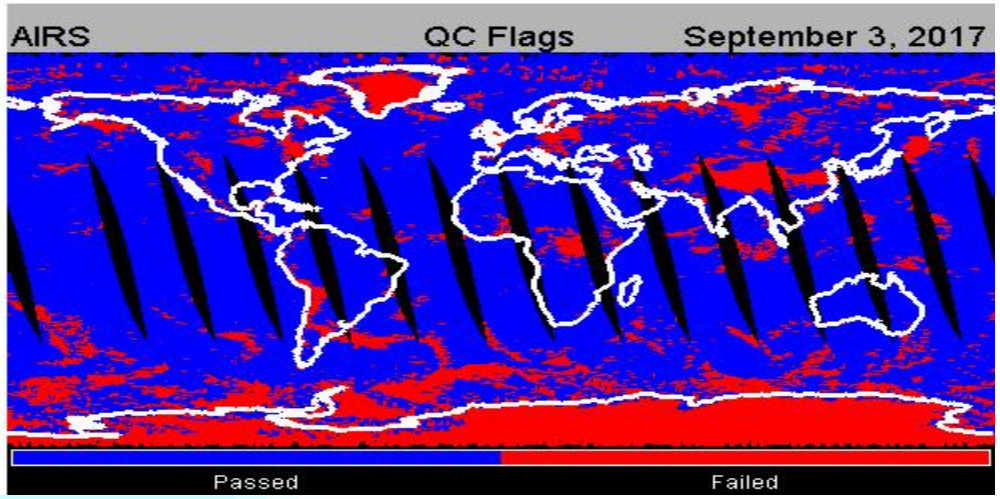


NUCAPS S-NPP (FSR)



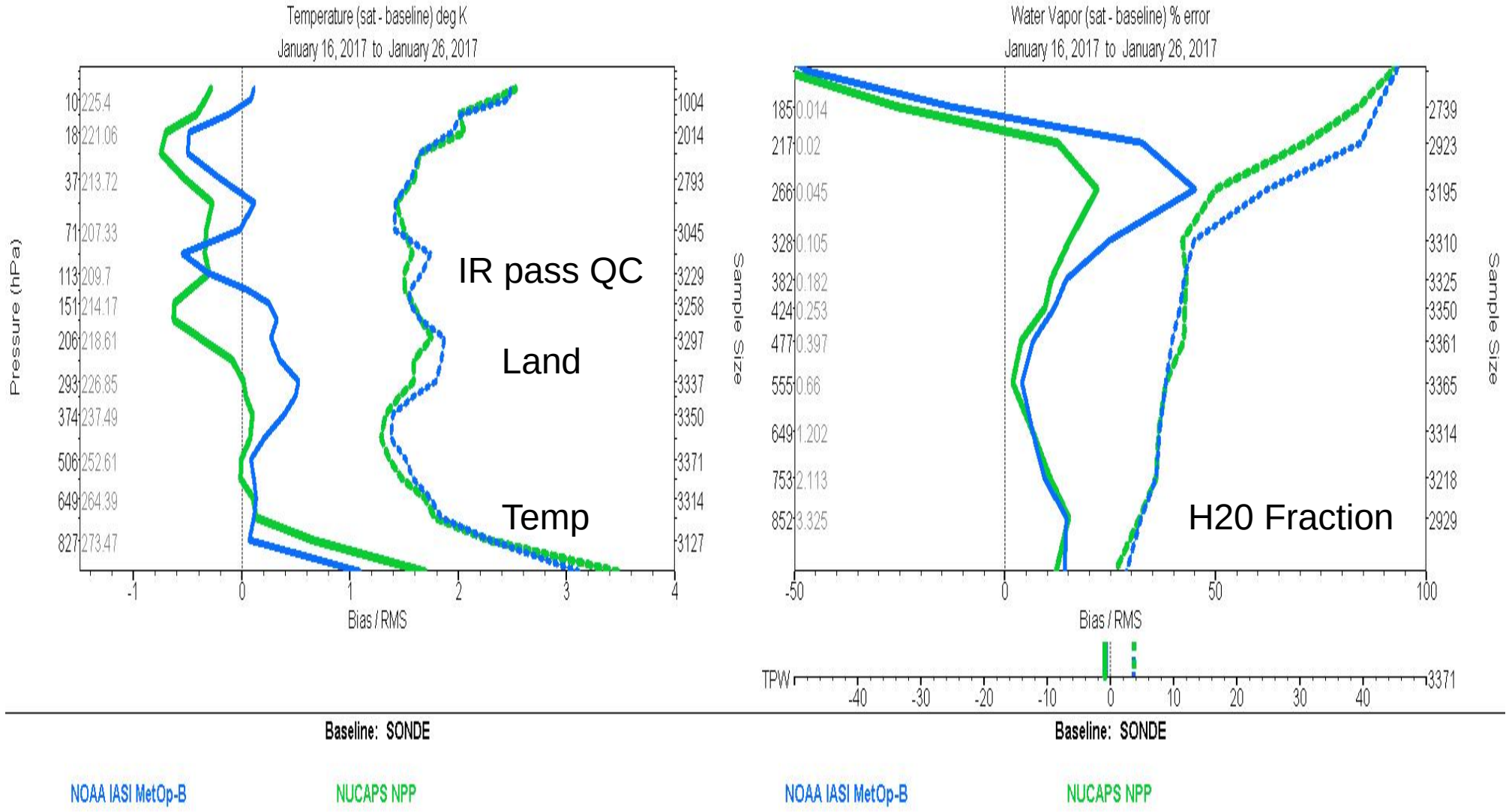


NUCAPS MetOp-B

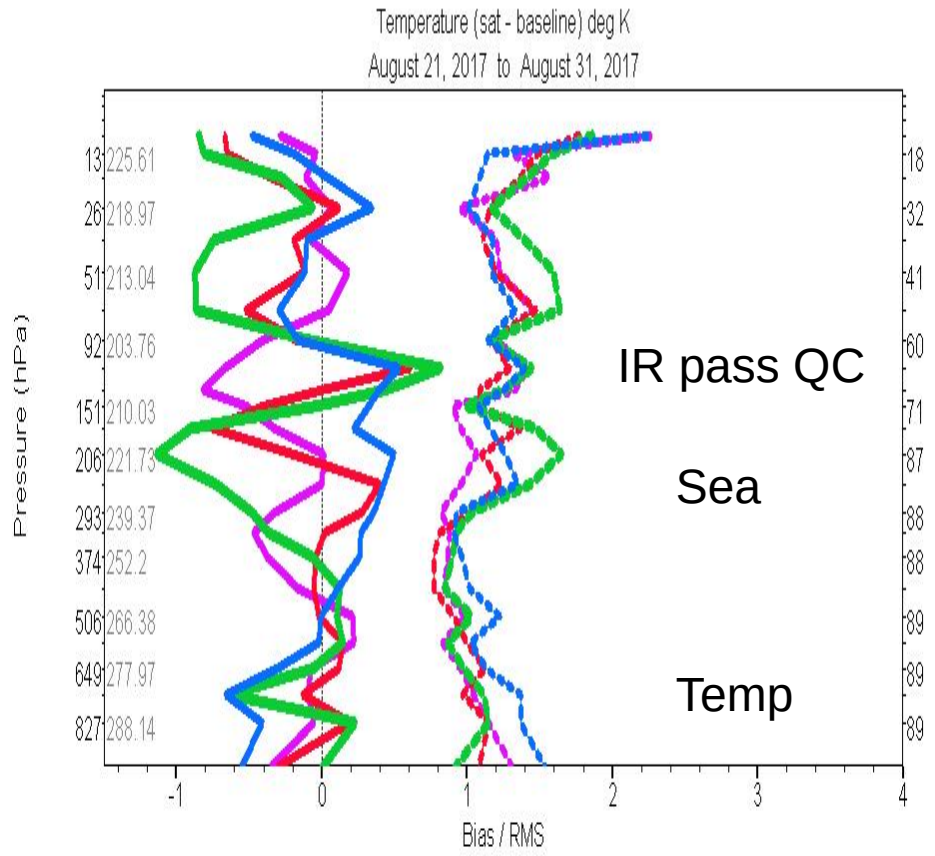


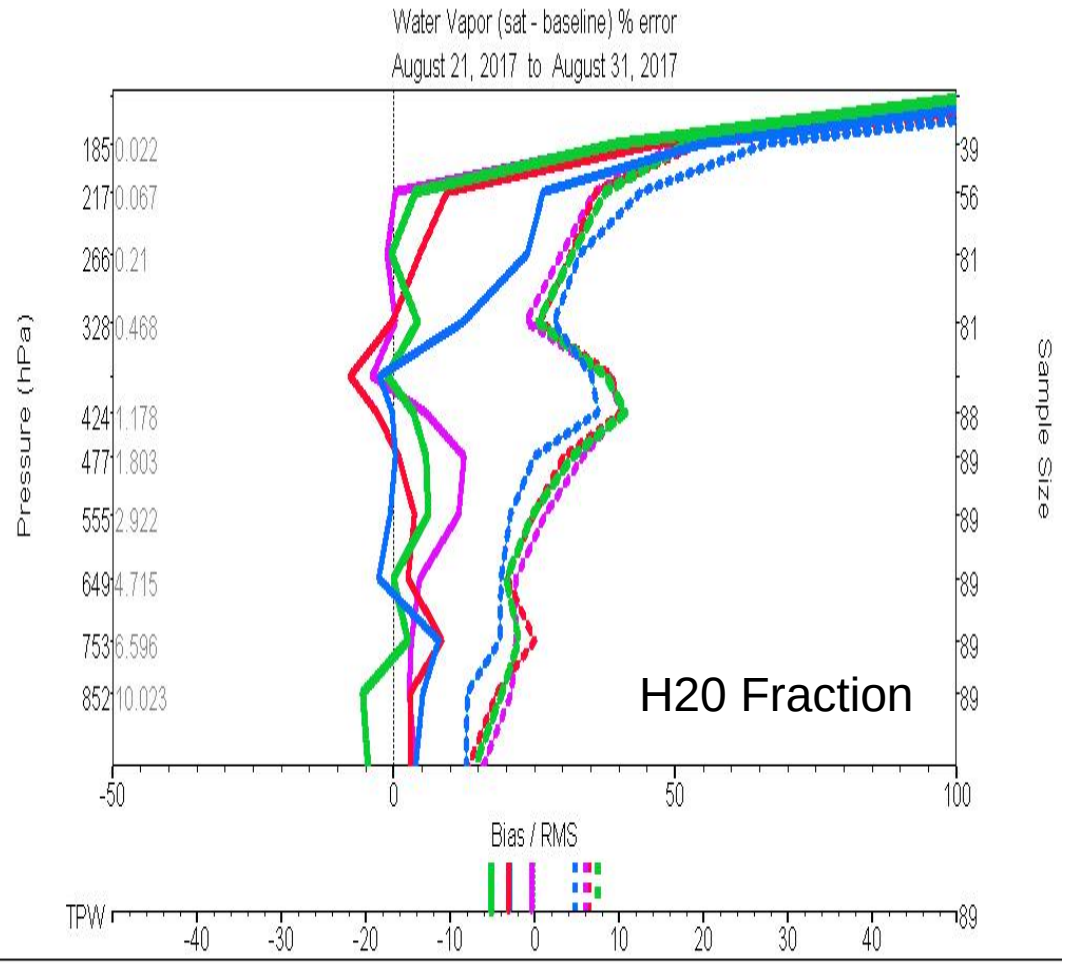
AIRS v6 … IR-only

NOAA Unique Combined Atmospheric Processing System … NUCAPS



January 2017





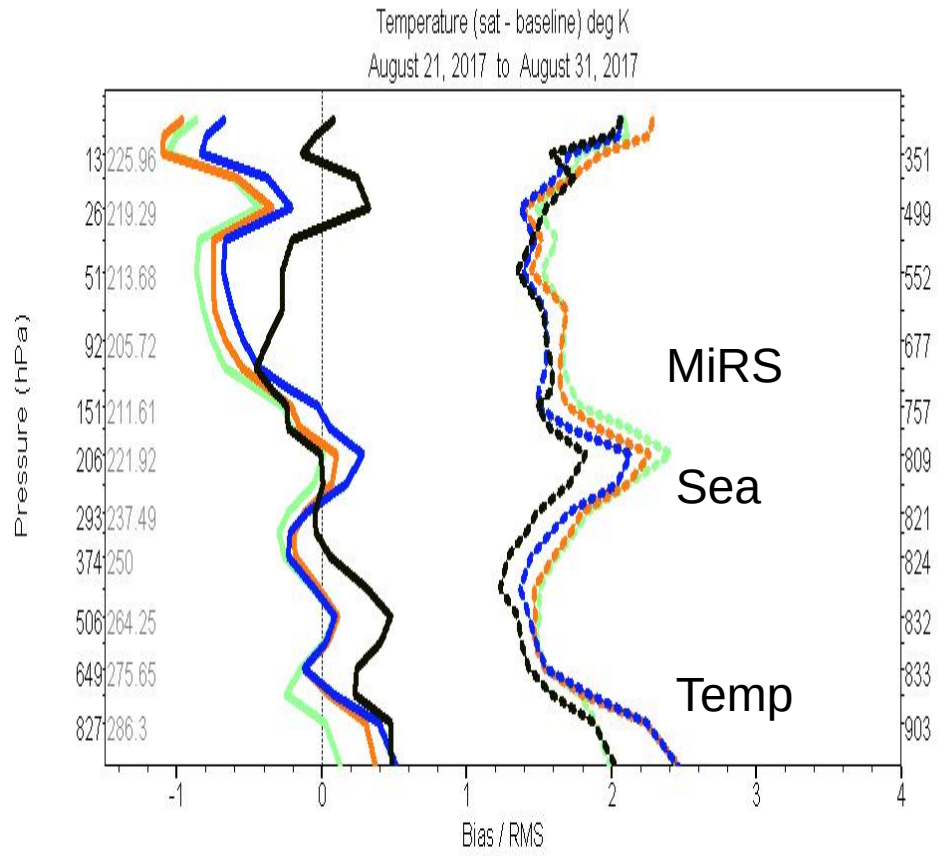
Baseline: SONDE

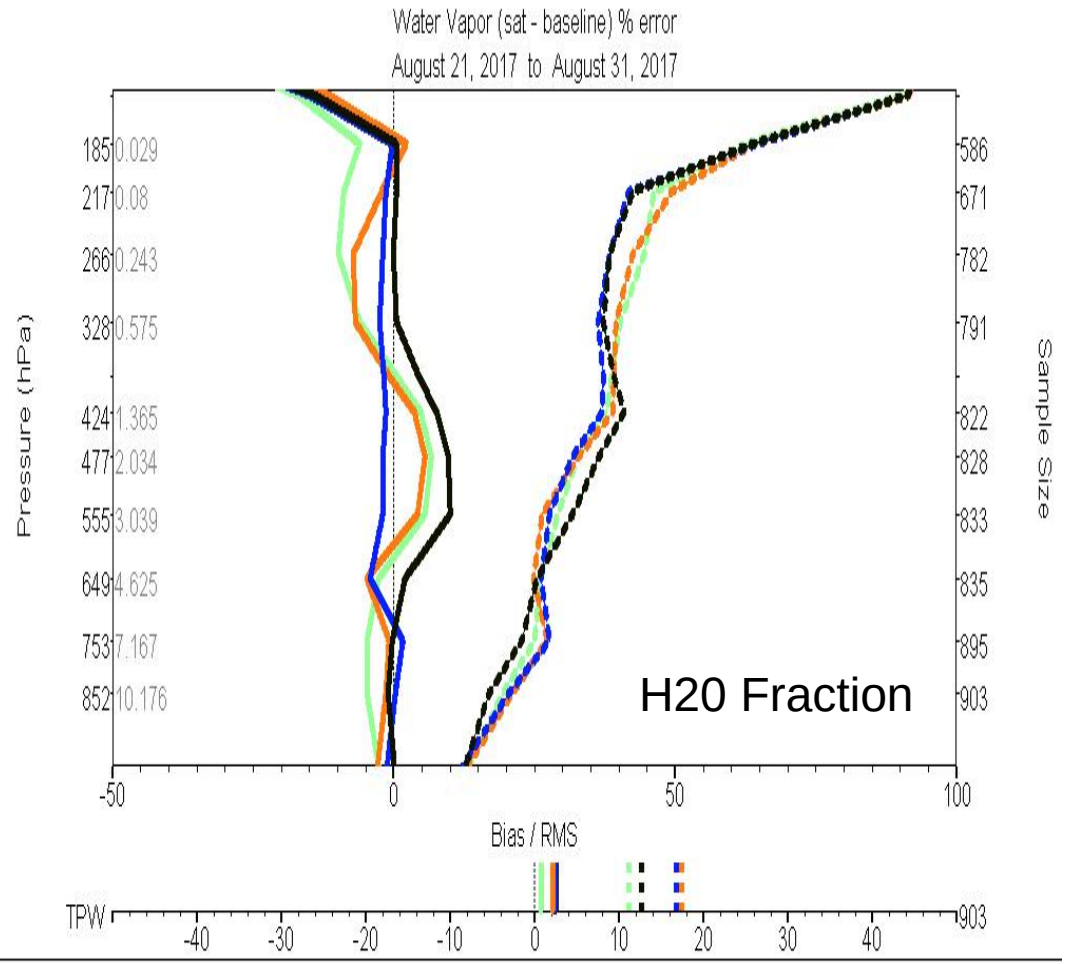
NOAA IASI MetOp-B
AIRS AQUA
NUCAPS NPP
NUCAPS NPP TEST

Baseline: SONDE

NOAA IASI MetOp-B
AIRS AQUA
NUCAPS NPP
NUCAPS NPP TEST

August 2017





Baseline: SONDE

MIRS NPP v11 MIRS MetOp-B MIRS NOAA-18 MIRS NOAA-19

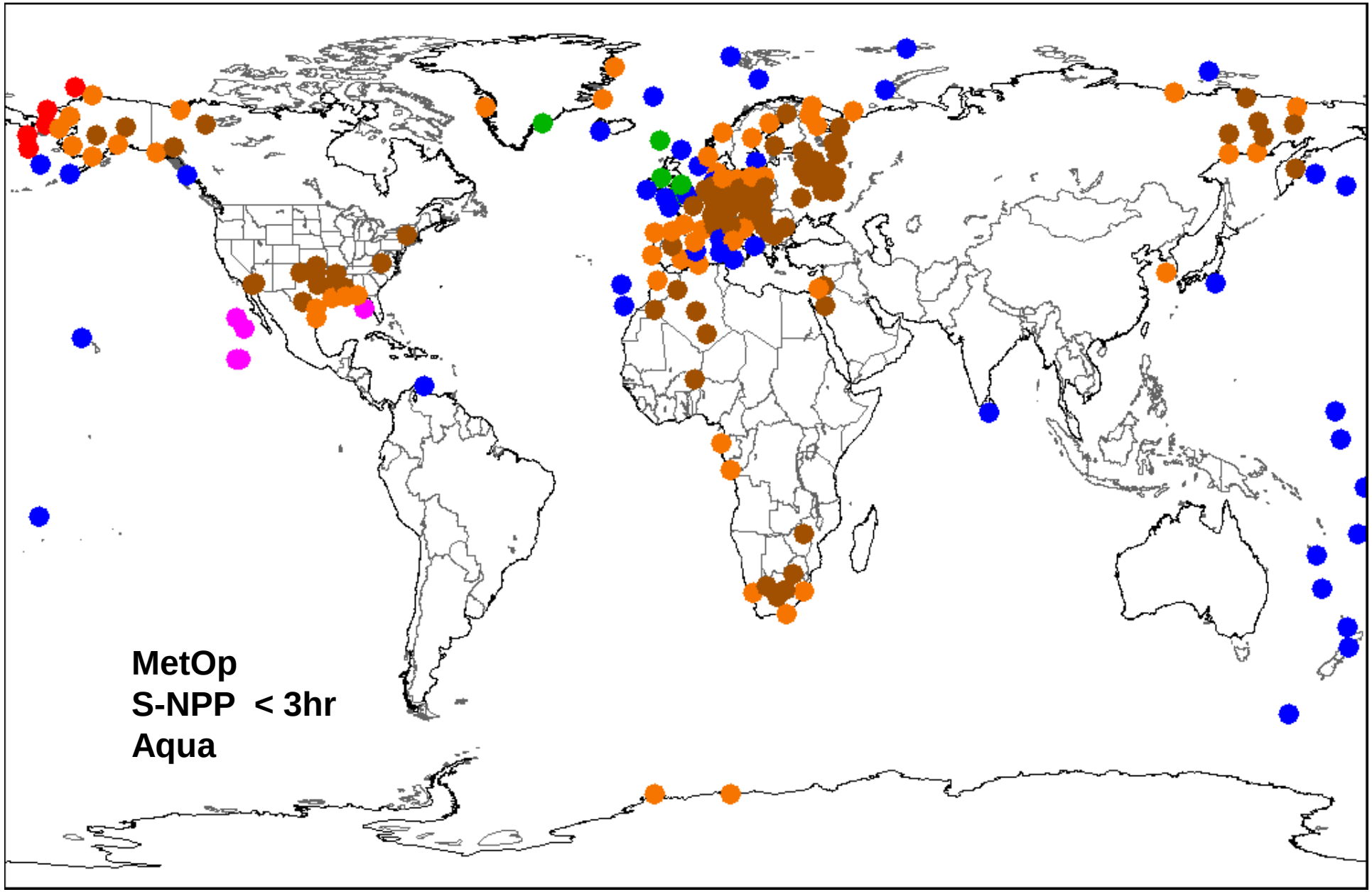
Baseline: SONDE

MIRS NPP v11 MIRS MetOp-B MIRS NOAA-18 MIRS NOAA-19

August 2017

NOAA Products Validation System (NPROVS)

Coast Land Island (Coast) Island (Inland) Ship Dropsonde

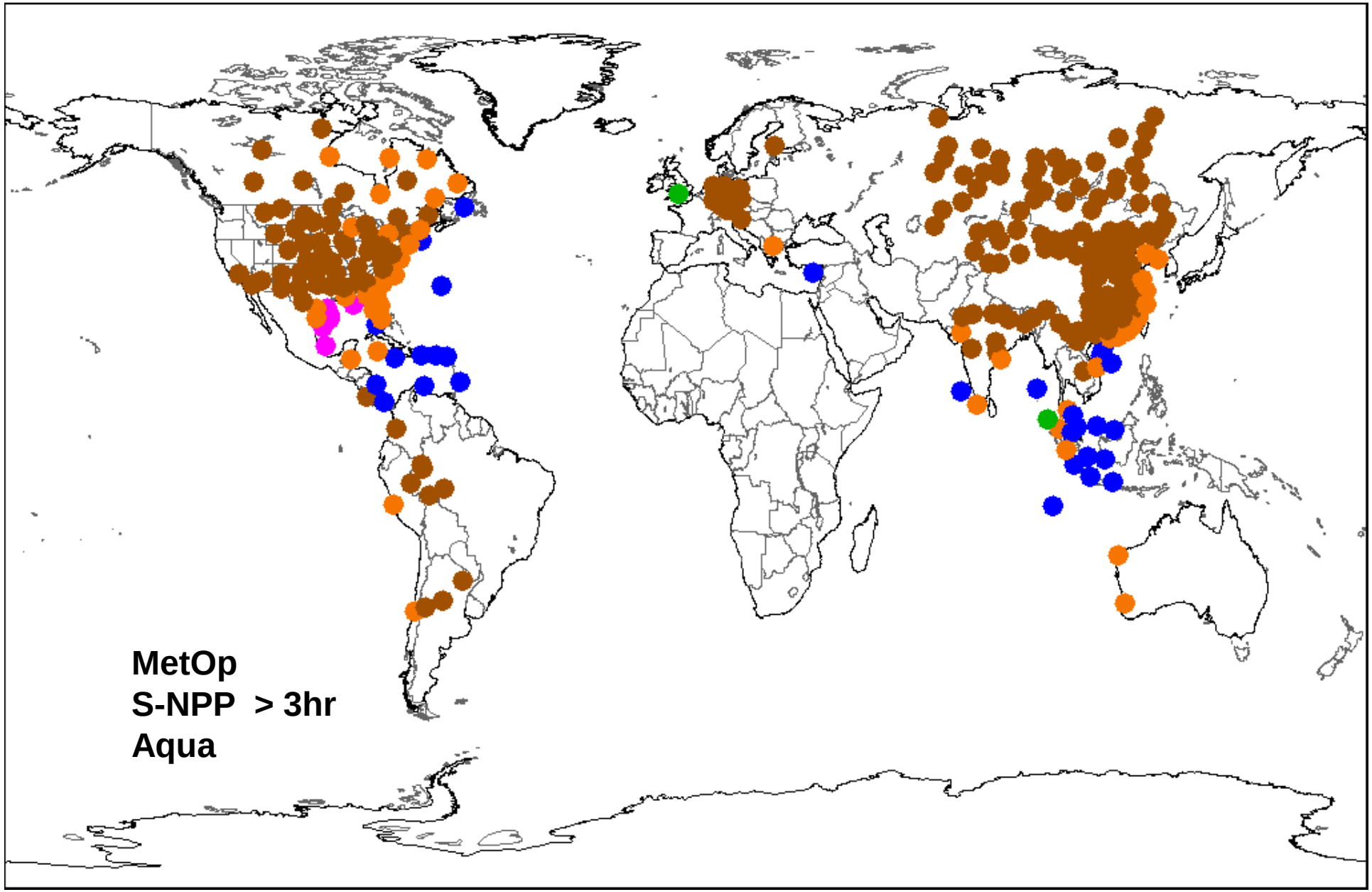


Number of collocations: 828 (185 unique locations)

August 21, 2017 (8z) to July 31, 2017 (23z)

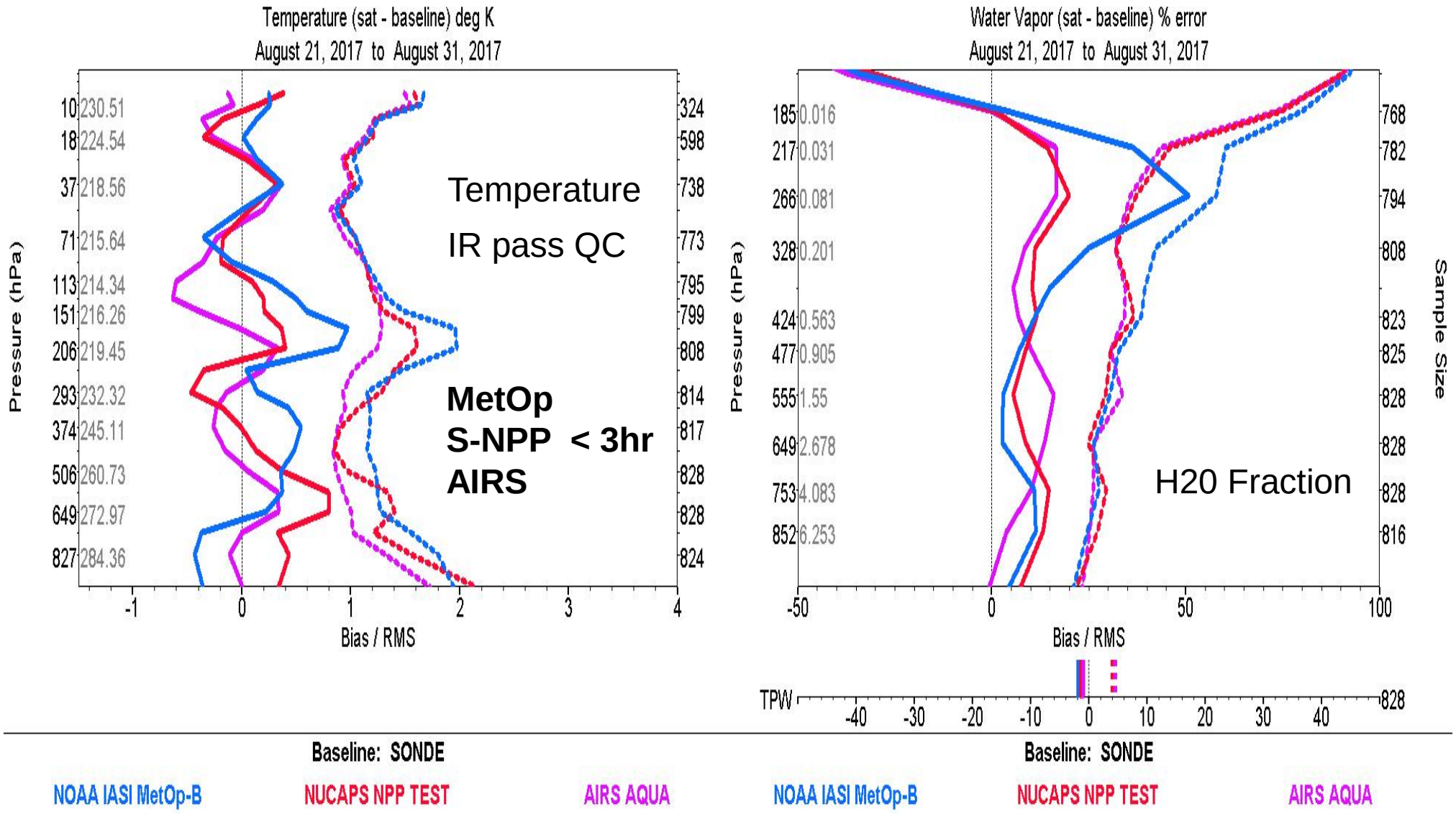
NOAA Products Validation System (NPROVS)

Coast Land Island (Coast) Island (Inland) Ship Dropsonde

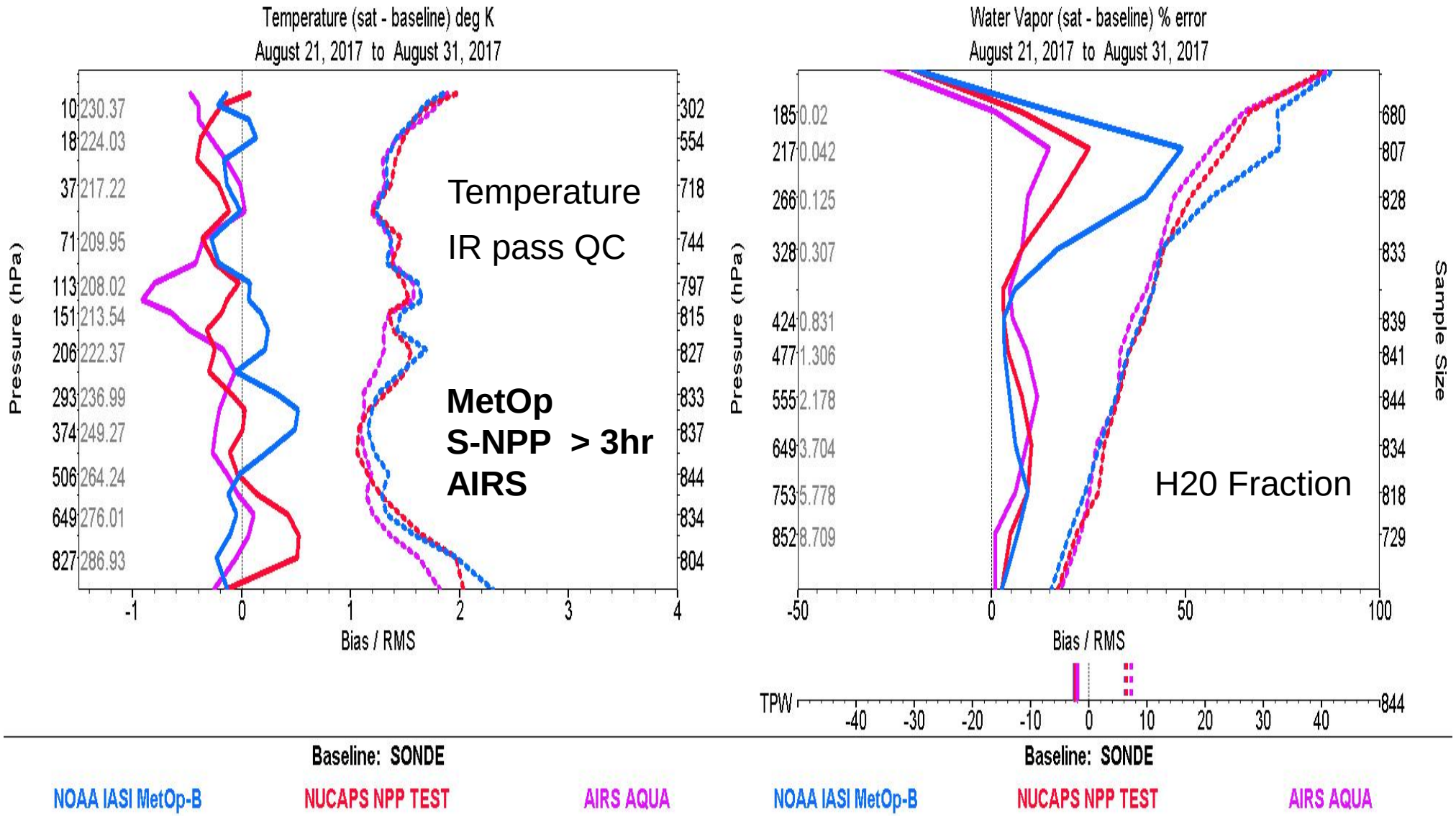


Number of collocations: 844 (265 unique locations)

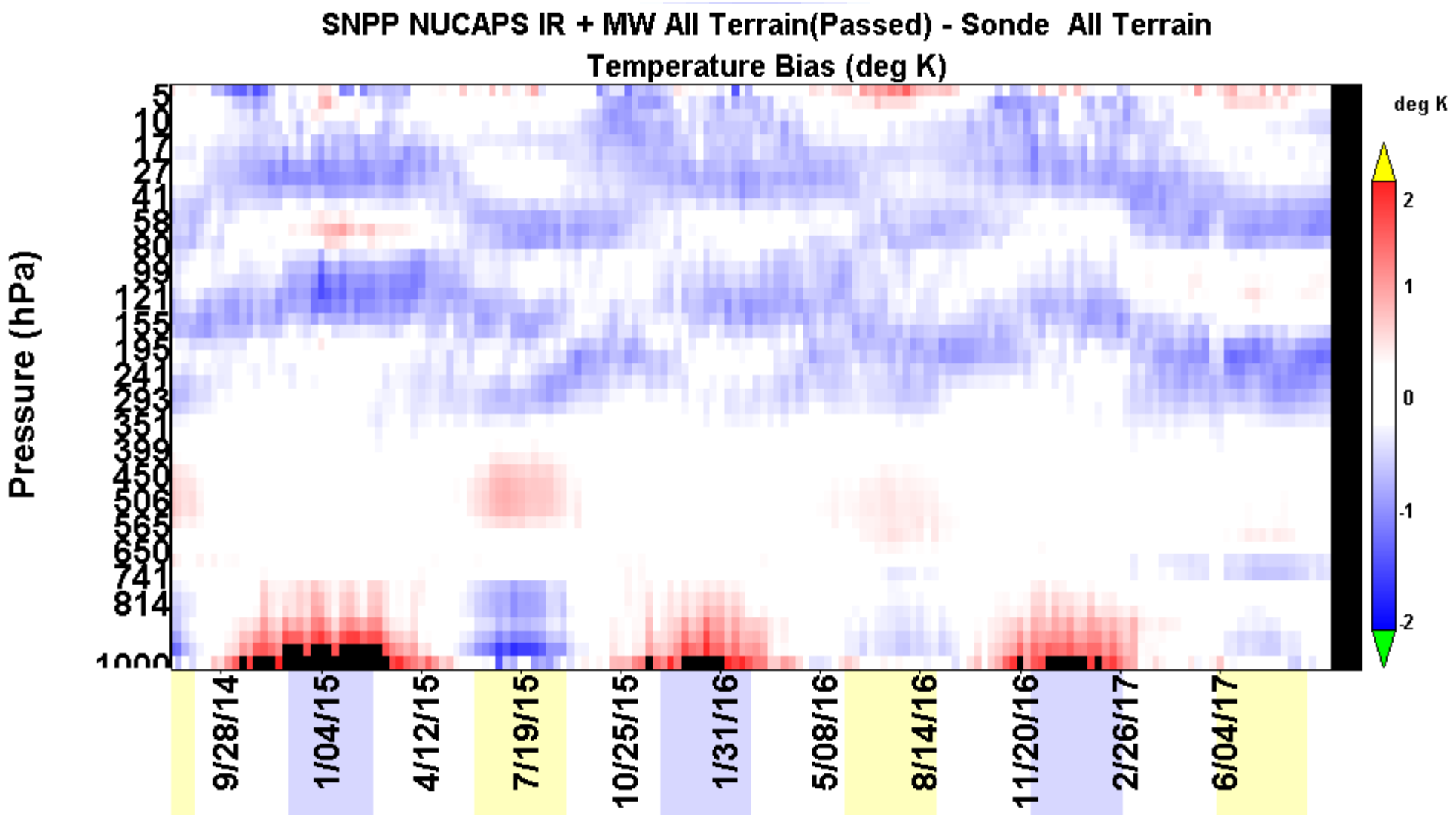
August 21, 2017 (8z) to July 31, 2017 (23z)


Temperature (sat - baseline) deg K
August 21, 2017 to August 31, 2017
Pressure (hPa)
10 230.51
18 224.54
37 218.56
71 215.64
113 214.34
151 216.26
206 219.45
293 232.32
374 245.11
506 260.73
649 272.97
827 284.36
324
598
738
773
795
799
808
814
817
828
828
824
-1
0
1
2
3
4
Bias / RMS
Temperature
IR pass QC
MetOp
S-NPP < 3hr
AIRS
Water Vapor (sat - baseline) % error
August 21, 2017 to August 31, 2017
Pressure (hPa)
185 0.016
217 0.031
266 0.081
328 0.201
424 0.563
477 0.905
555 1.55
649 2.678
753 4.083
852 6.253
768
782
794
808
823
825
828
828
828
816
Sample Size
-50
0
50
100
Bias / RMS
H20 Fraction
TPW
828
-40
-30
-20
-10
0
10
20
30
40
Baseline: SONDE
NOAA IASI MetOp-B
NUCAPS NPP TEST
AIRS AQUA
Baseline: SONDE
NOAA IASI MetOp-B
NUCAPS NPP TEST
AIRS AQUA

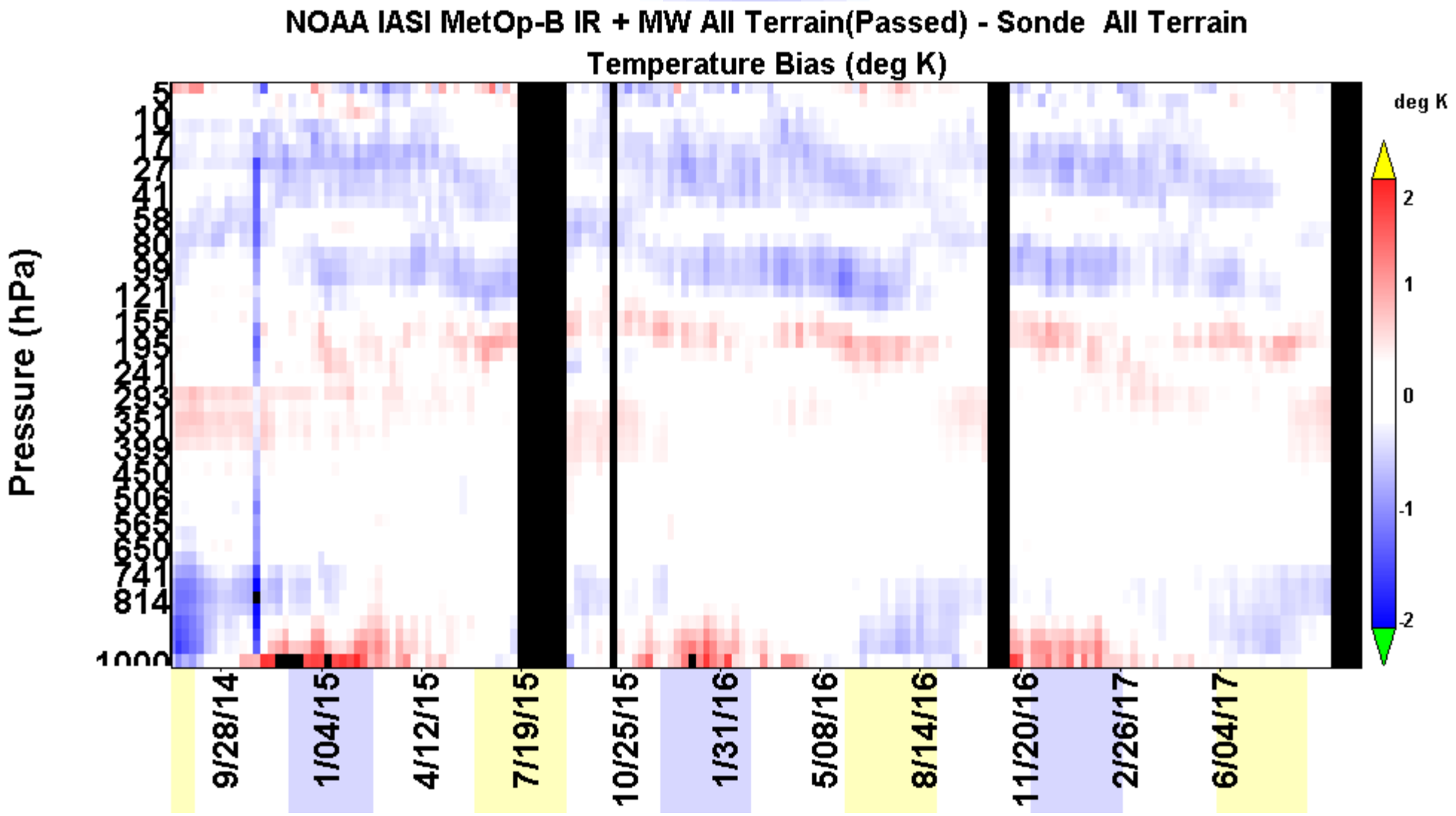
August 2017


Temperature (sat - baseline) deg K
August 21, 2017 to August 31, 2017
Pressure (hPa)
10 230.37
18 224.03
37 217.22
71 209.95
113 208.02
151 213.54
206 222.37
293 236.99
374 249.27
506 264.24
649 276.01
827 286.93
302
554
718
744
797
815
827
833
837
844
834
804
-1
0
1
2
3
4
Bias / RMS
Temperature
IR pass QC
MetOp
S-NPP > 3hr
AIRS
Water Vapor (sat - baseline) % error
August 21, 2017 to August 31, 2017
Pressure (hPa)
185 0.02
217 0.042
266 0.125
328 0.307
424 0.831
477 1.306
555 2.178
649 3.704
753 5.778
852 8.709
680
807
828
833
839
841
844
834
818
729
Sample Size
-50
0
50
100
Bias / RMS
H20 Fraction
TPW
844
-40
-30
-20
-10
0
10
20
30
40
Baseline: SONDE
NOAA IASI MetOp-B
NUCAPS NPP TEST
AIRS AQUA
Baseline: SONDE
NOAA IASI MetOp-B
NUCAPS NPP TEST
AIRS AQUA

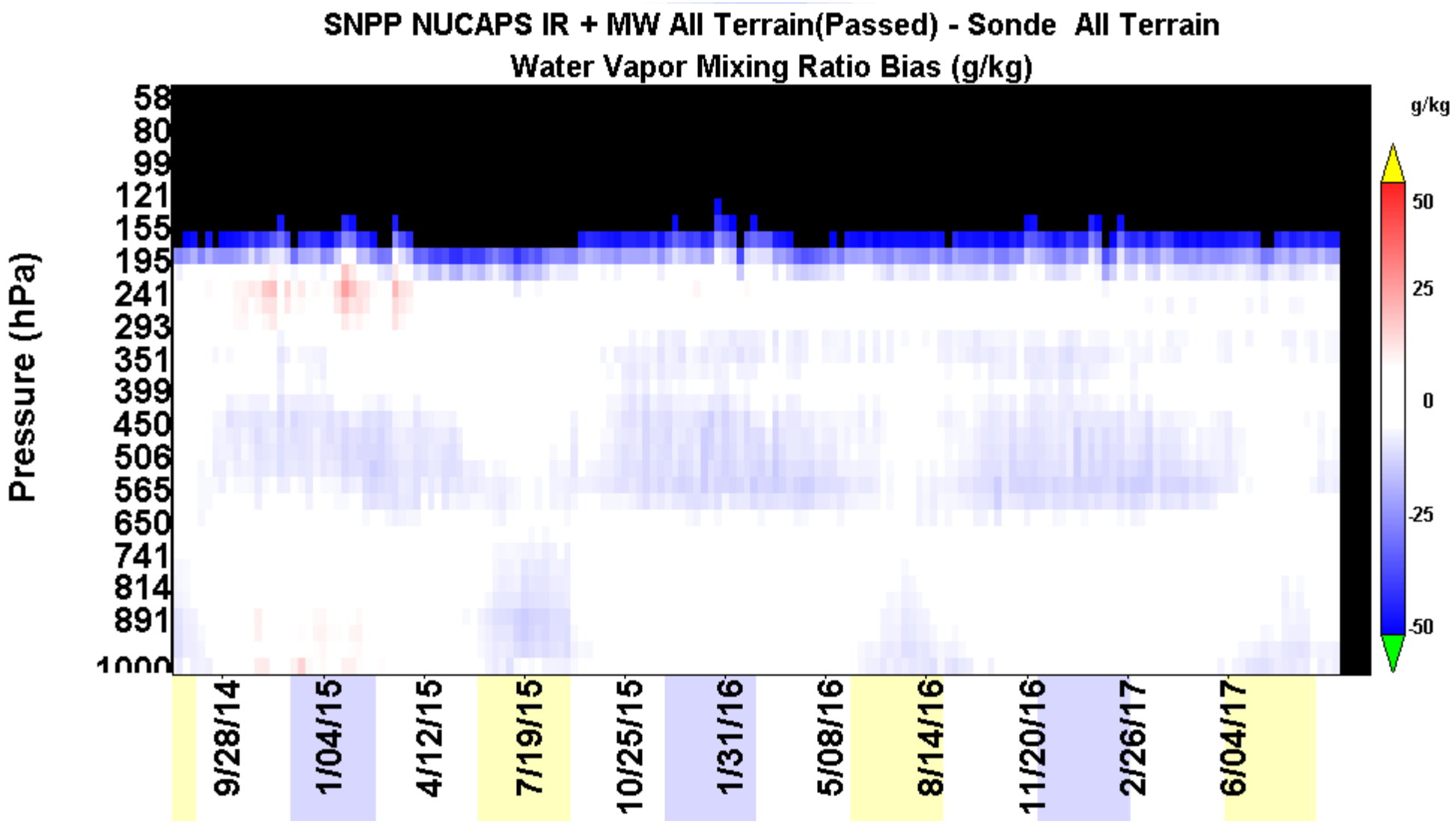
August 2017



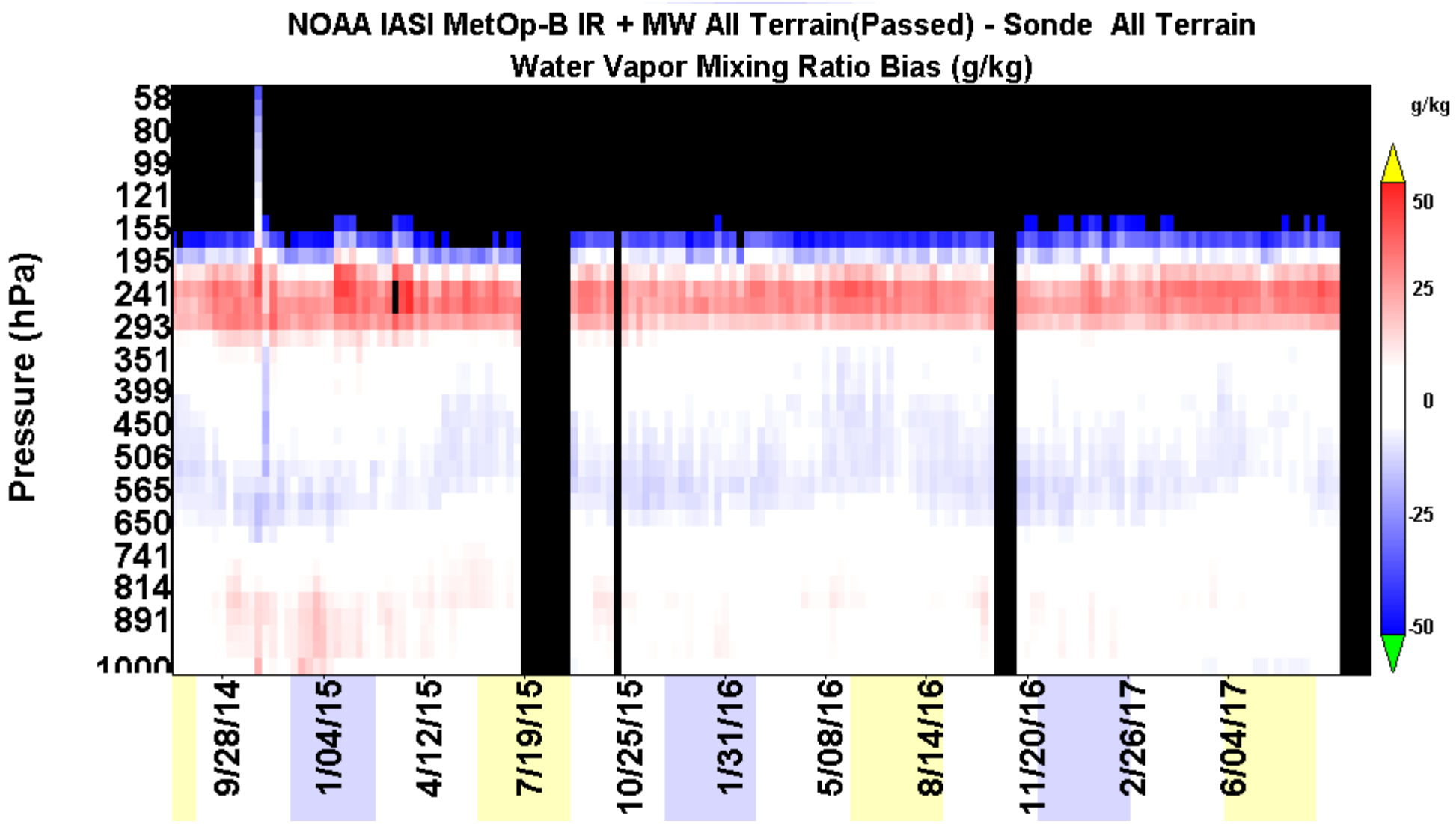
NUCAPS S-NPP (NSR)



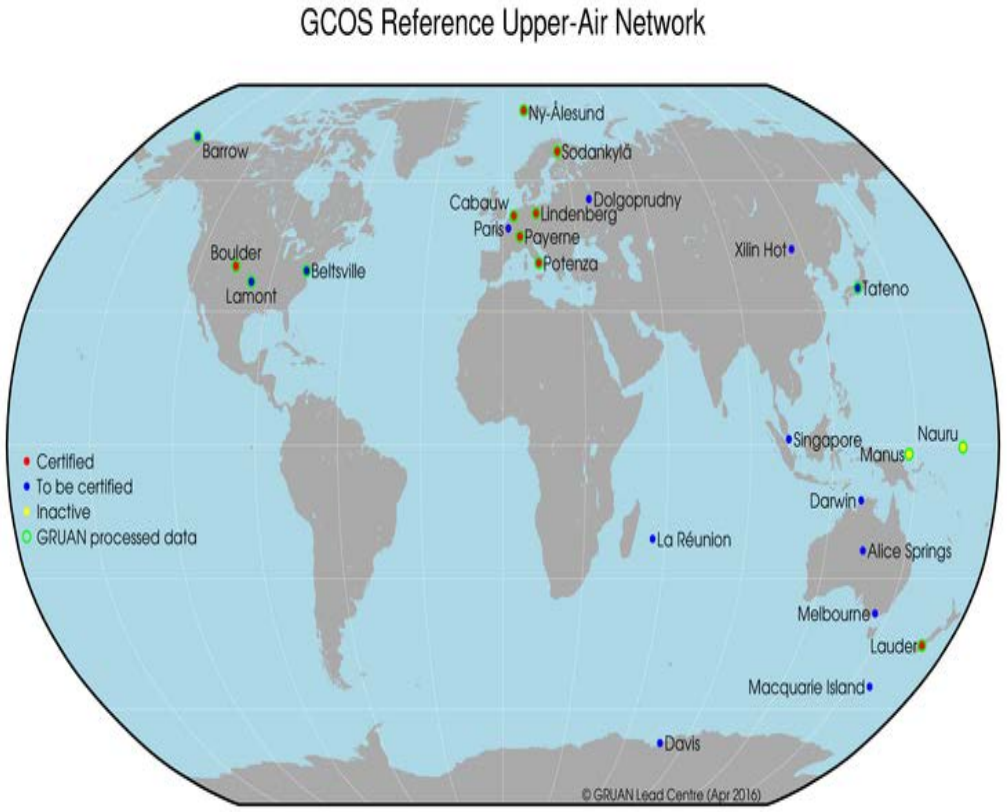
NUCAPS MetOp-B



NUCAPS S-NPP (NSR)



NUCAPS MetOp-B



Global Climate Observing System (GCOS)
Reference Upper Air Network (GRUAN)
www,gruan.org

JPSS Funded Dedicated RAOB

(Lihang Zhou (STAR), Lori Borg (SSEC) …)

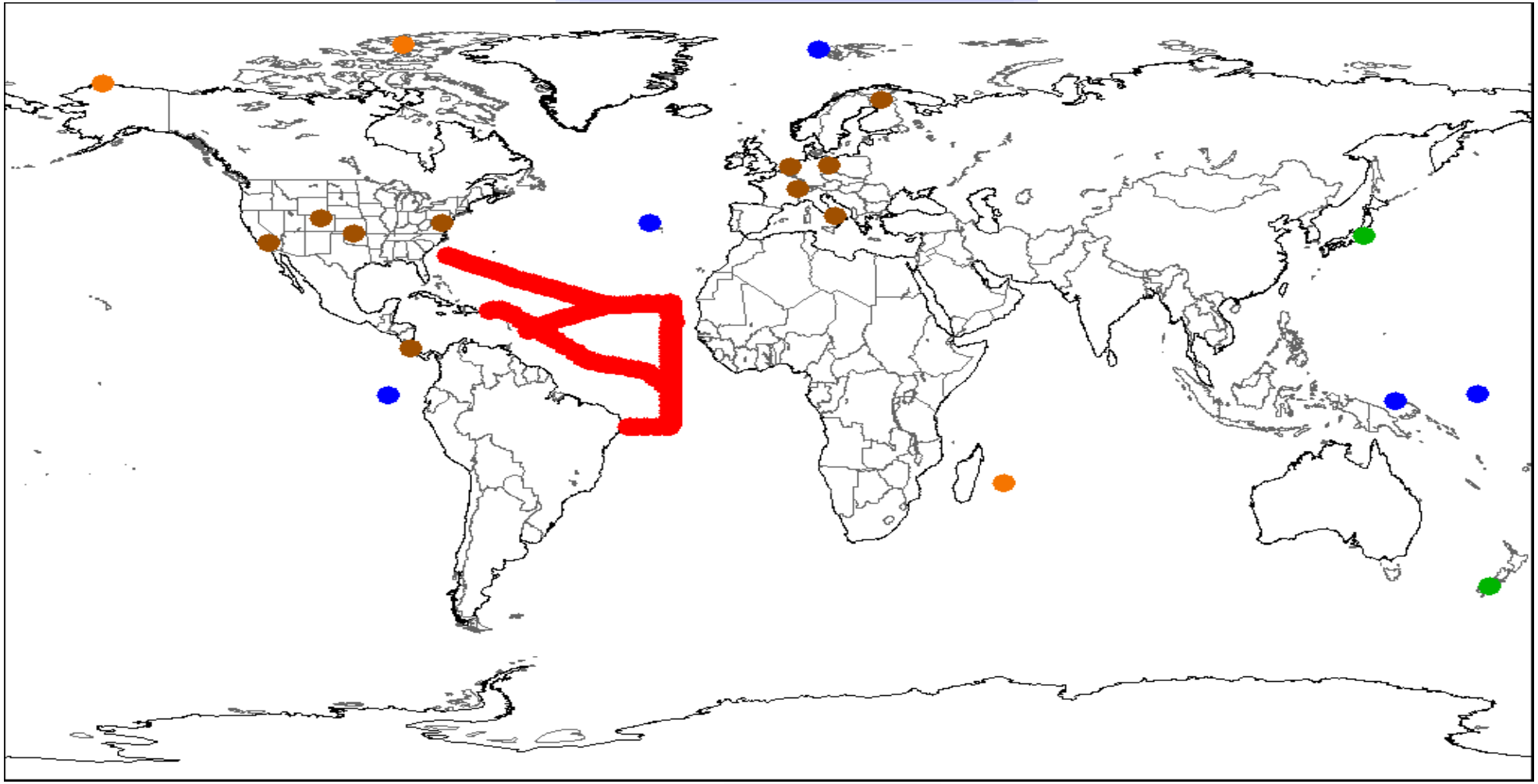
- DOE ARM (SGP, NSA, ENA)
  - ✓(2) per week,
  - ✓**GRUAN Processed (GP)**
  - ✓ includes dual sequential …
- AEROSE **(GP),**
- **C**ALWATER, El-Nino RR,

Beltsville,
ARM Mobile
Sterling Field Support Center
CIRA (Ft Collins),
PMRS

RIVAL, RS41/RS92 Dual including
GPSRO Targeting
(ARM, JPSS, GRUAN …)

Special Observations

Coast Land Island (Coast) Island (Inland) Ship Dropsonde



2013 to 2017

Special Radiosonde … subsample containing GRUAN

Guidelines for Uncertainty Measurements (GUM)

Given two measurement (m1, m2), their uncertainty (u_1, u_2) and uncertainty due to spatial / temporal mismatch (σ), then two observations are in statistical agreement if **"k" .le. 2:**

$$|m_1 - m_2| < k\sqrt{\sigma^2 + u_1^2 + u_2^2}$$

Immler et.al
Atmos. Meas. Tech., 3, 1217–1231, 2010
www.atmos-meas-tech.net/3/1217/2010/
doi:10.5194/amt-3-1217-2010

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u2 is GRUAN (m1) uncertainty … given
u1 is "m2" uncertainty … needed

σ is combined mismatch and inter-platform uncertainty … needed

Strategy

1) ABS (m1 – m2) < k ($\sigma^2 + u1^2 + u2^2)^{1/2}$

2) "k" = ABS (m1 – m2) / u2

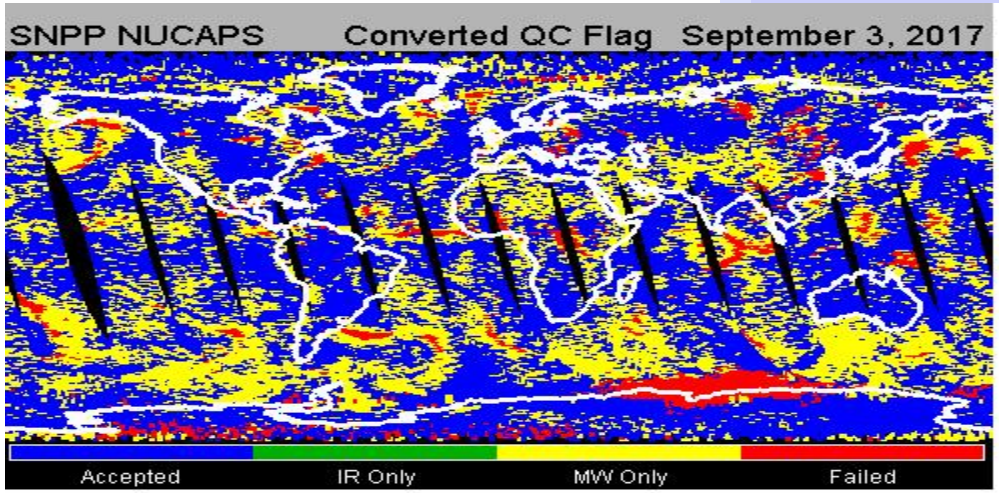
for k=2 … statistical agreement

3) $\sigma^2 + u1^2 = (("k"/2)^2 - 1)\ (u2)^2$

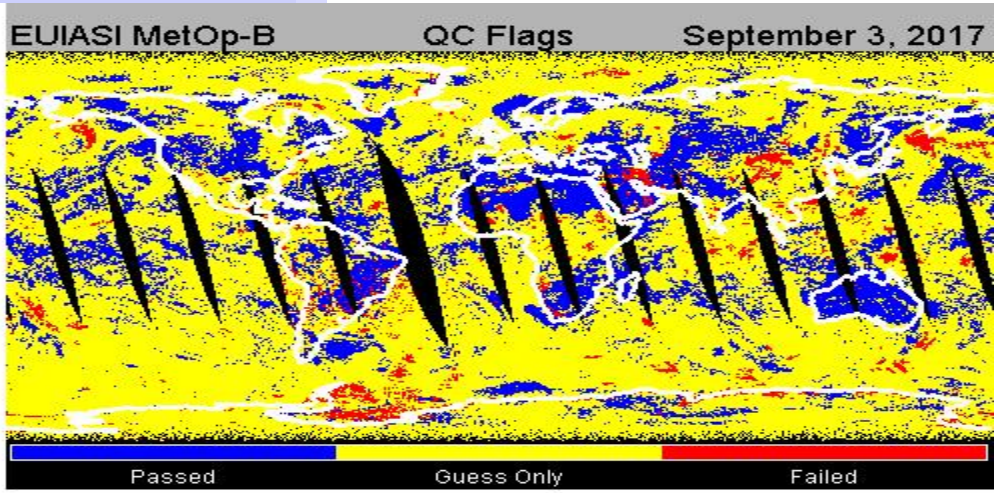
4) $u1 = (("k"/2)^2 - 1)^{1/2}\ (u2)$

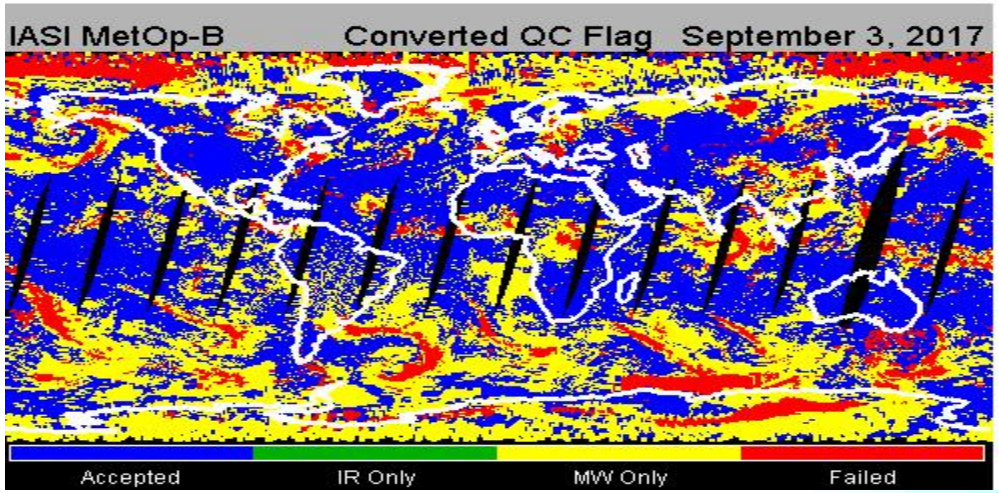
… given u2, quantify the ($\sigma^2 + u1^2$) required for "agreement"
… worst case estimate of u1

NUCAPS NSR

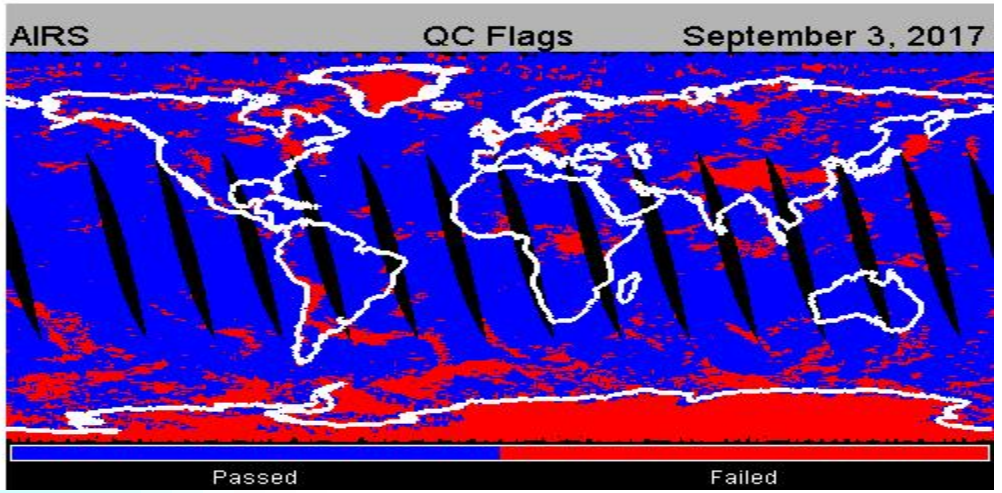


IASI EUMETSAT





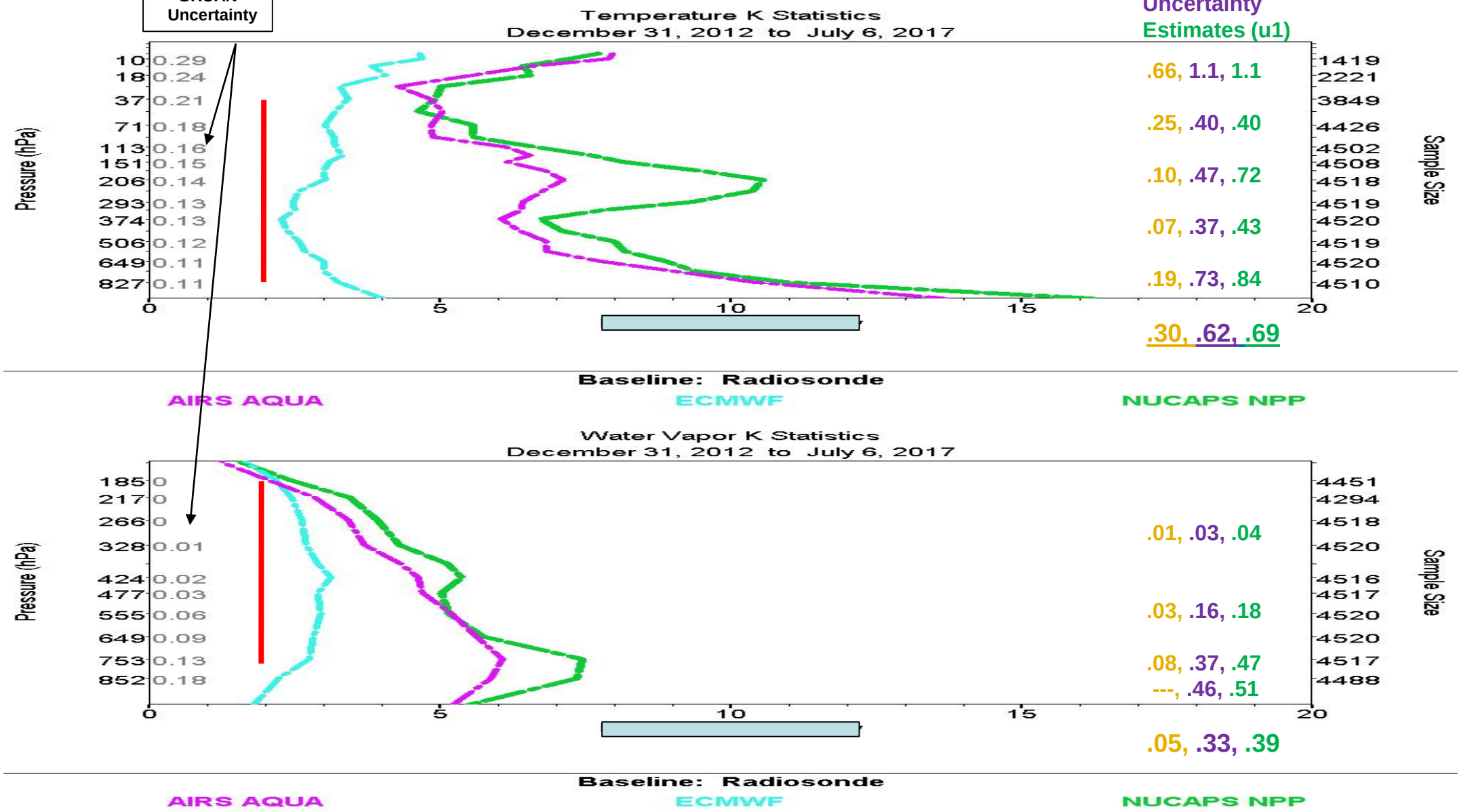
IASI NSR



AIRS v6 … IR-only

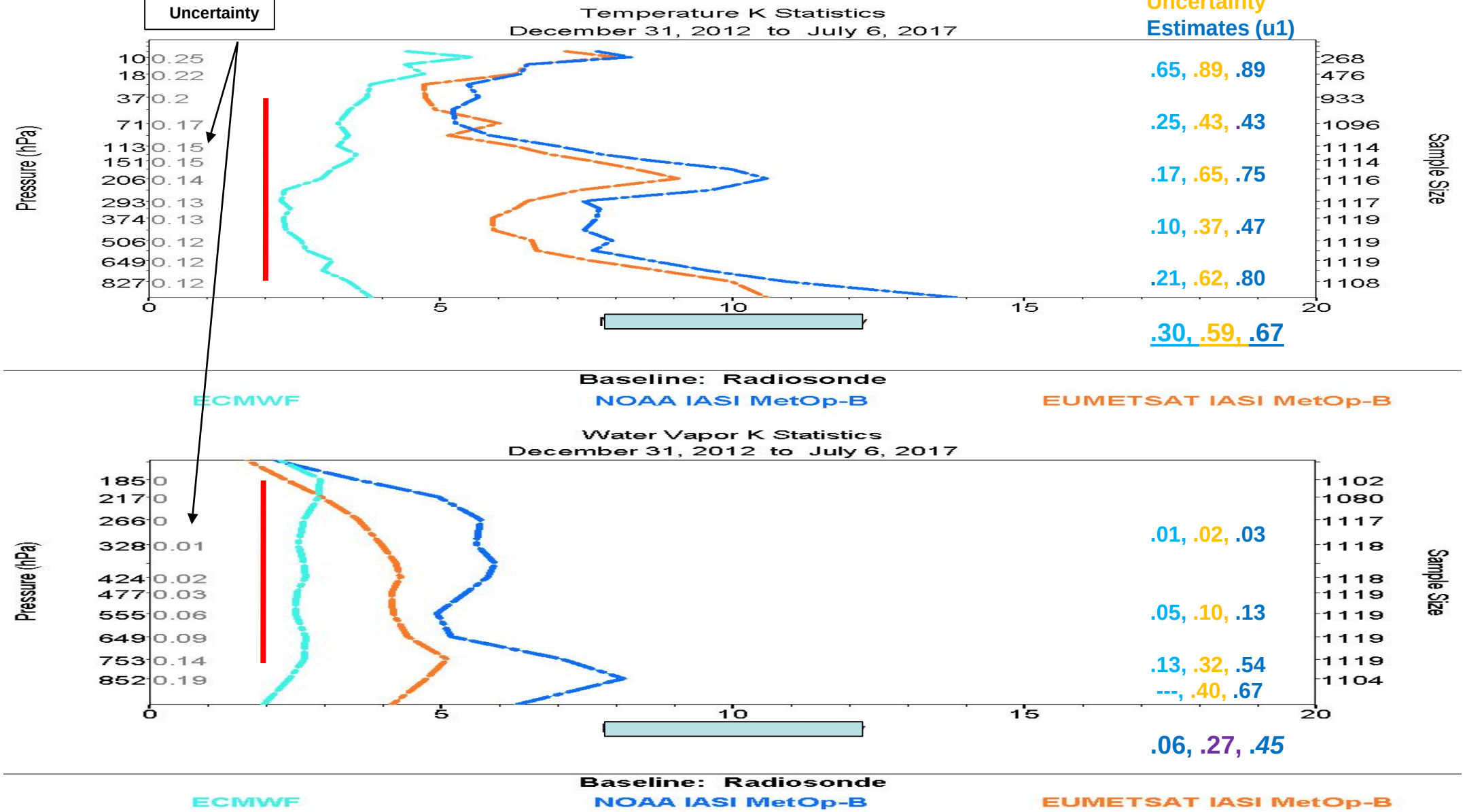
Validation data-sets in following slides are for “common” samples of ”IR” satellite soundings which Pass QC … “blue”

GRUAN Uncertainty



GRUAN @ +/- 3 hour and 50 km

GRUAN Uncertainty



GRUAN @ +/- 3 hour and 50 km

Summary

- **NPROVS provides "enterprise" assessment for satellite derived atmospheric sounding products … past, current, future … legacy "ITSC" function … goal to expand product suites accessed.**

- **Strategy and results on sounding product characteristic performance and impact of systematic local satellite overpass / synoptic radiosonde time differences**

- **Such systematic differences (bias) when observed are more likely "internally" rooted (tuning)**

- ***Examples of strategy to estimate satellite product (and nwp) uncertainty traceable to GRUAN across NUCAPS, IASI EU, AIRS and ECMWF … GUM***

- ***Special "RIVAL" Campaign (ARM, GRUAN, JPSS), GPSRO Targeting … Sharing with ITSC (Climate) community***