NPROVS Utility in a Variety of Meterological and Cal/Val Scenarios

Tony Reale
STAR

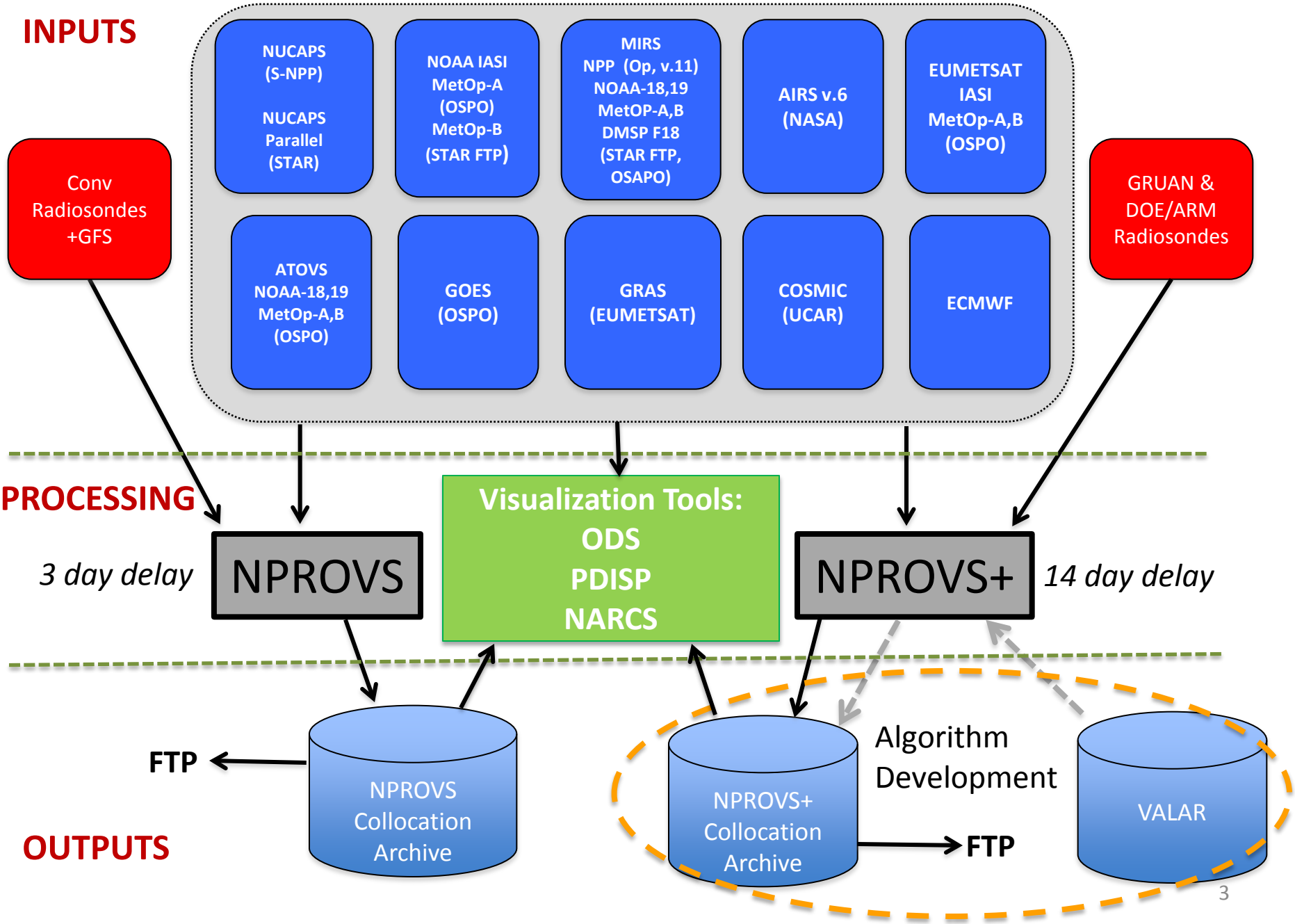
(Bomin Sun, Frank Tilley, Mike Pettey and Nick Nalli)
(IMSG)
June 2015

STAR /JPSS
2015 Annual Science Team Meeting
24-28 August 2015
NCWCP, College Park, Md.

Outline

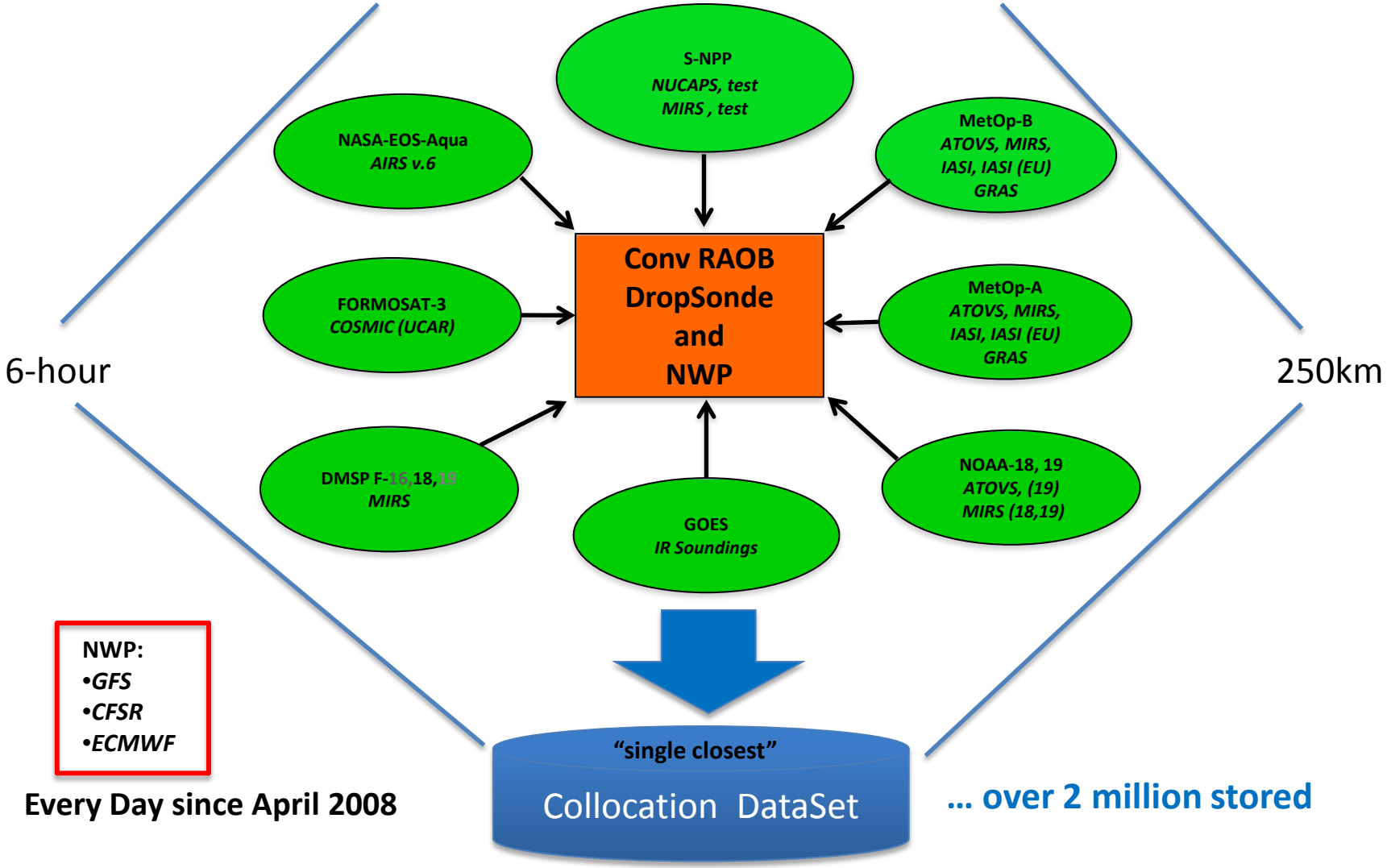
- About NPROVS
- Long Term Monitoring (LTM-NARCS)
- 10-day Collocation datasets (PDISP)
- AWIPS-2 Coordination
  - Cold Core
  - CALWATER
- Uncertainty

NPROVS/NPROVS+ Data Management Schematic



NOAA Products Validation System (NPROVS)

Centralized RAOB and Satellite Product Collocation

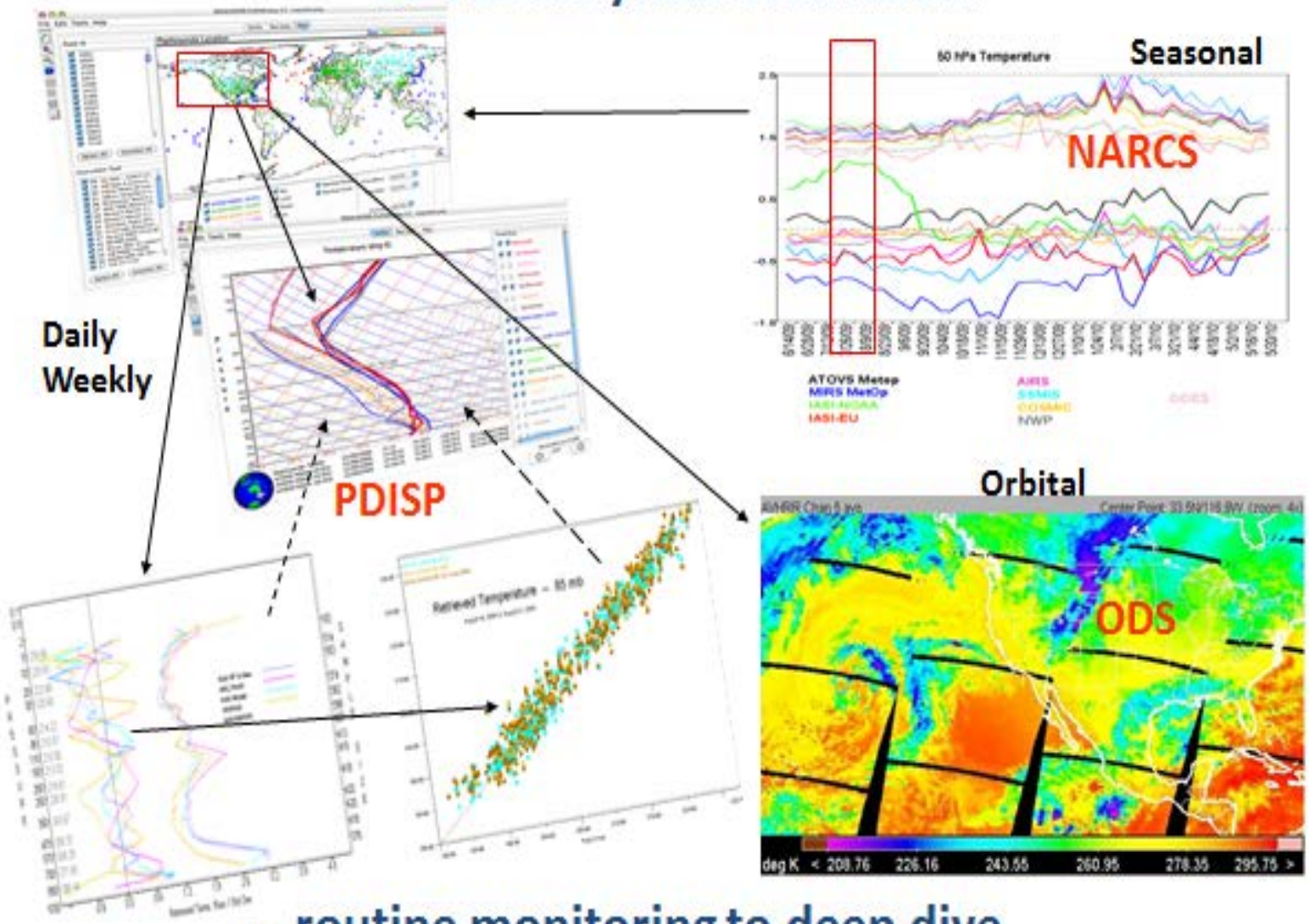


Every Day since April 2008

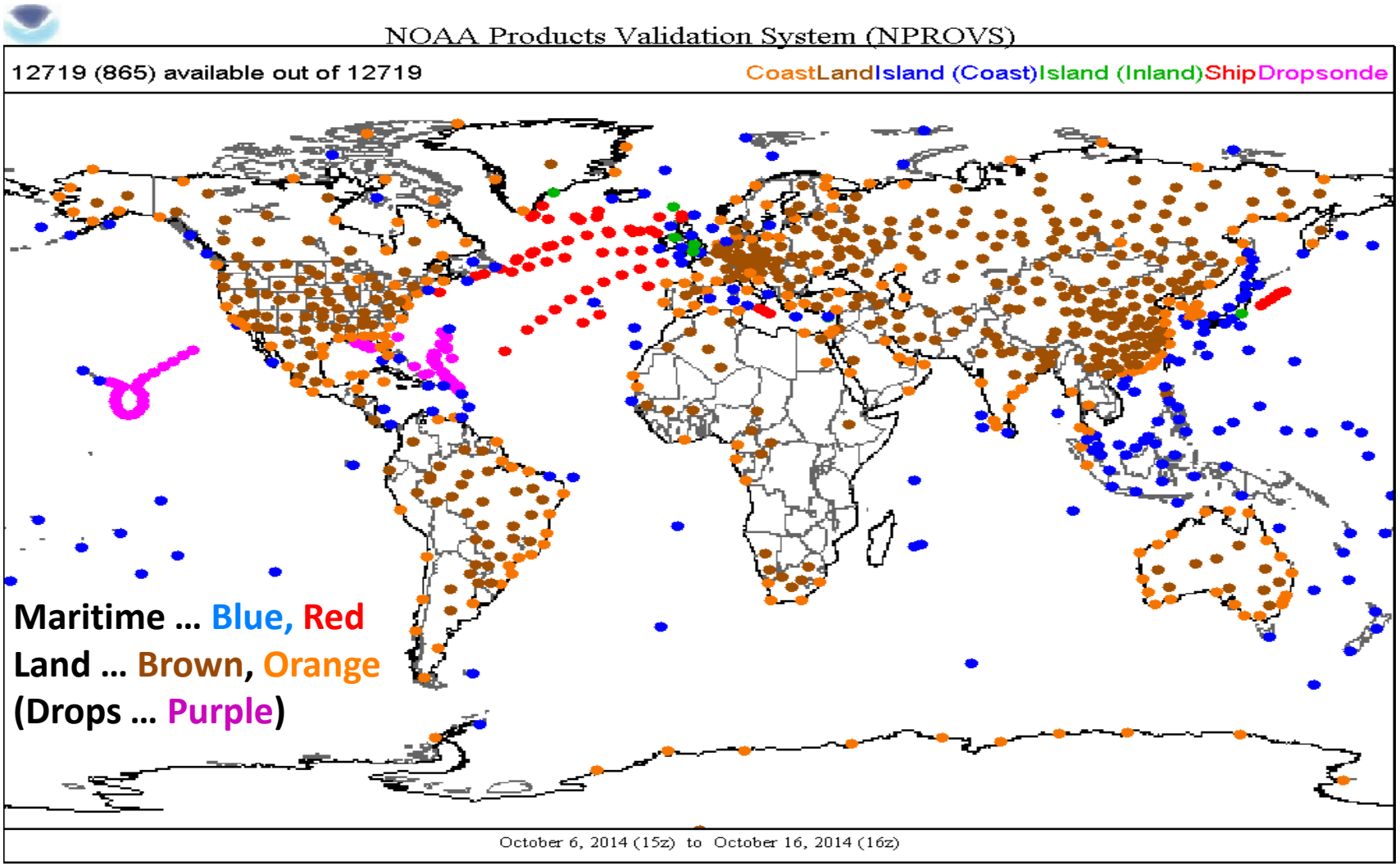
… over 2 million stored

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

EDGE Analytical Interface …

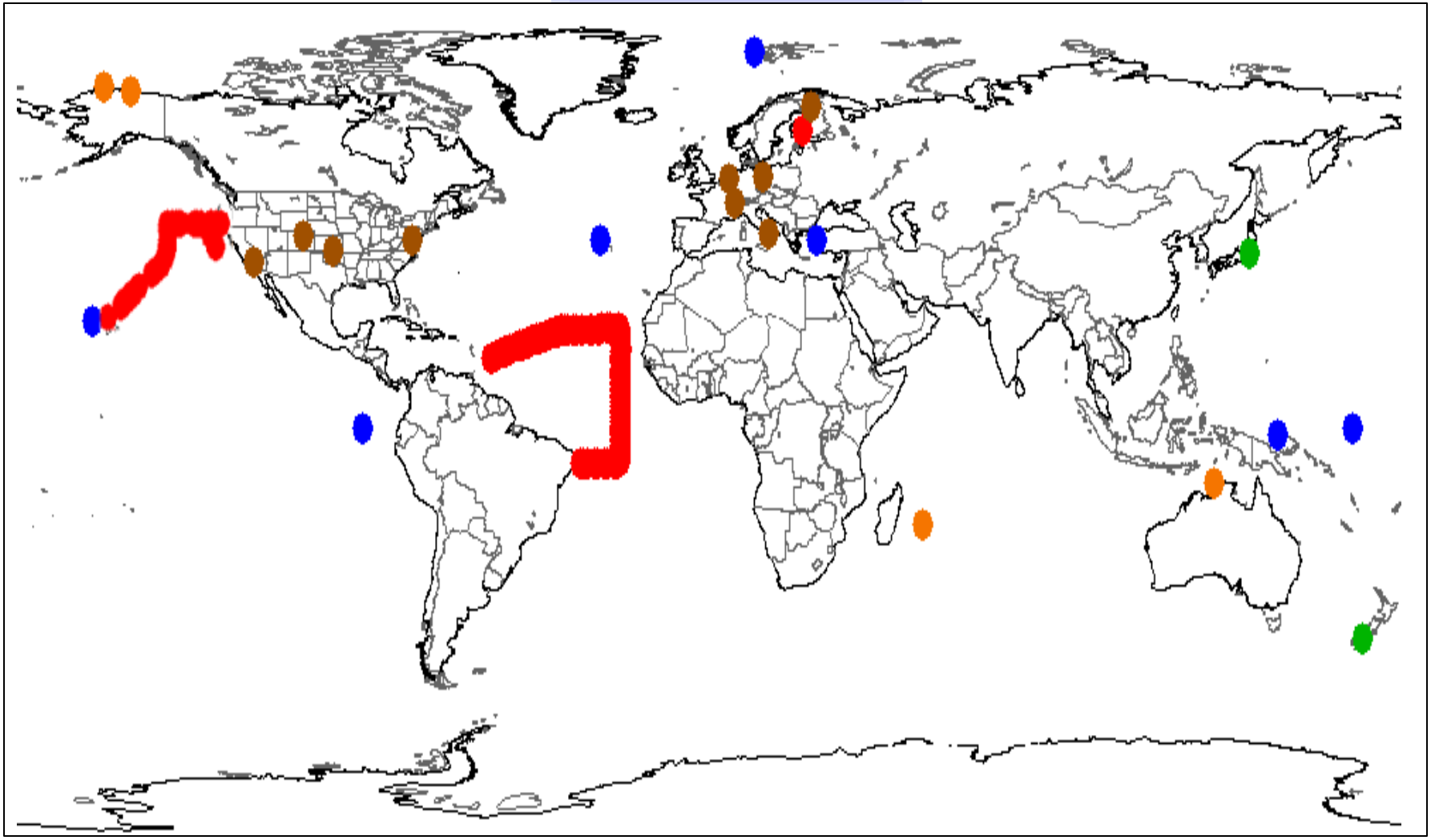


… routine monitoring to deep dive



Typical NPROVS Global Collocation Dataset
(1000 collocation records per day)

NPROVS+



GRUAN and JPSS funded Dedicated (S-NPP) RAOB Sites
Over 10,000 RAOBS (1000 Dedicated) available since July 2013

N P R O V S +



Global Climate Observing System (GCOS) Reference Upper Air Network (GRUAN)

NOAA/GRUAN Coordination Committee

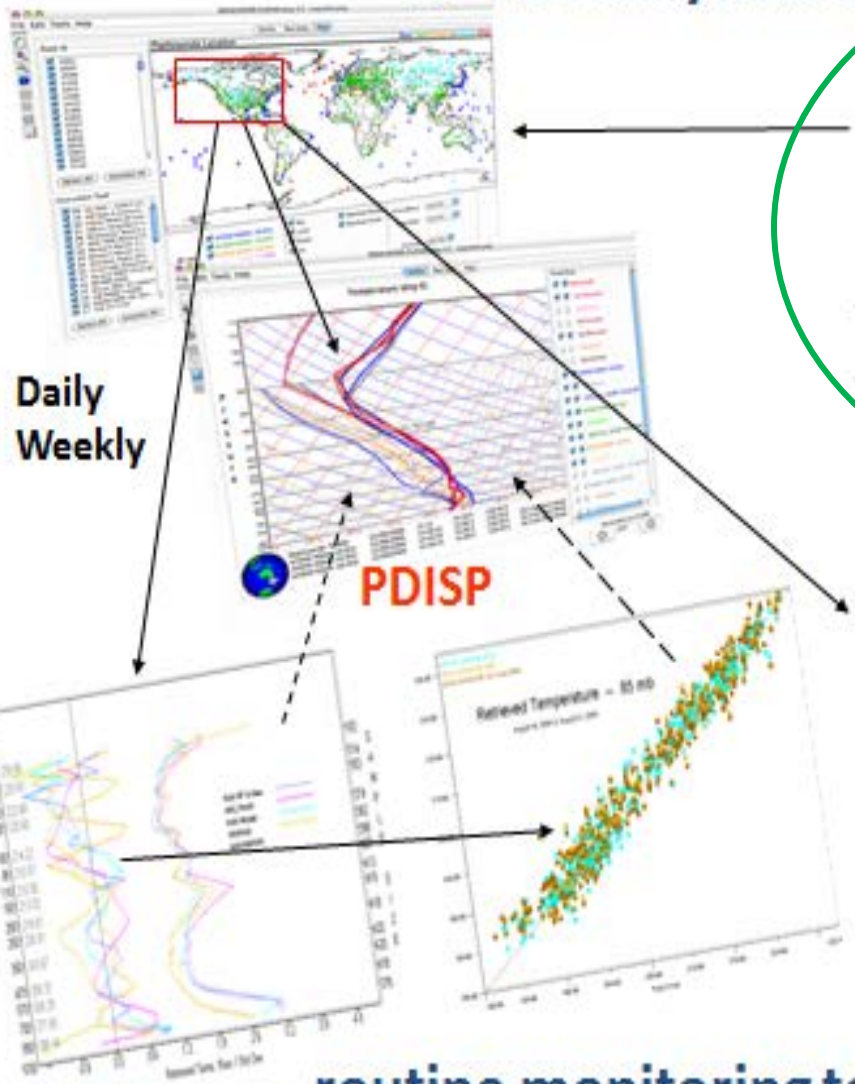
JPSS Funded Dedicated RAOB

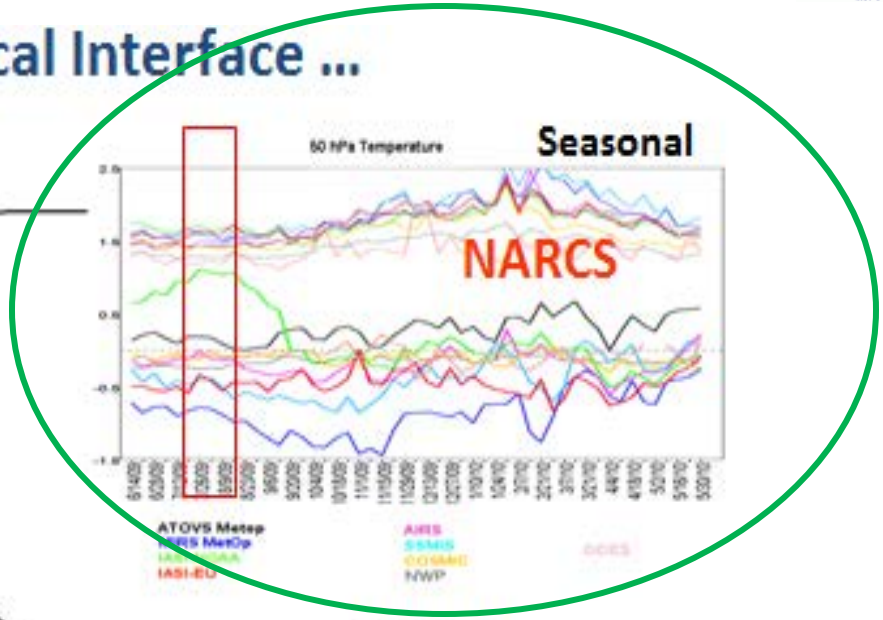
- DOE ARM (SGP, NSA, ENA)
  - ✓CIMSS
  - ✓(2) per week
  - ✓**GRUAN processed**
  - ✓ dual vs single, etc
- AEROSE
- CALWATER
- PMRF …

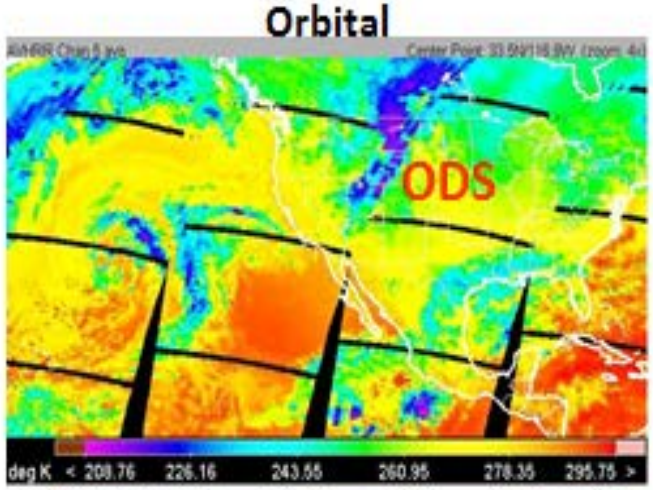
Request coordination with "other" intensive field experiments particularly is synchronized with S-NPP

Independent (Enterprise) Validation of Sounding Products at STAR

EDGE Analytical Interface …







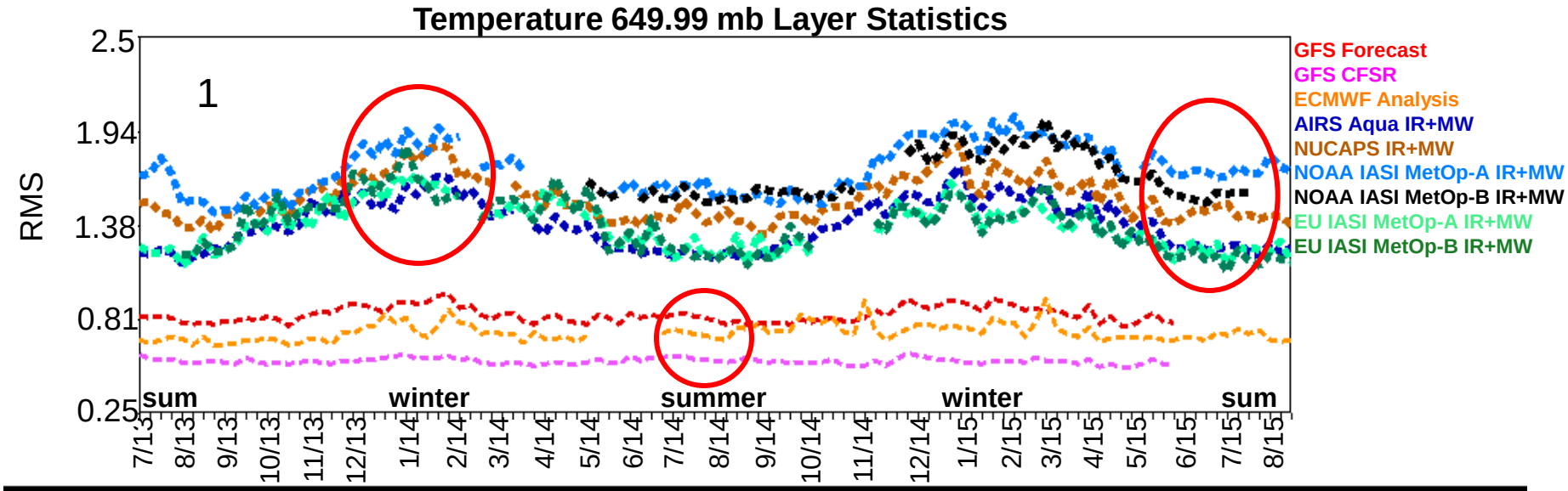
… routine monitoring to deep dive

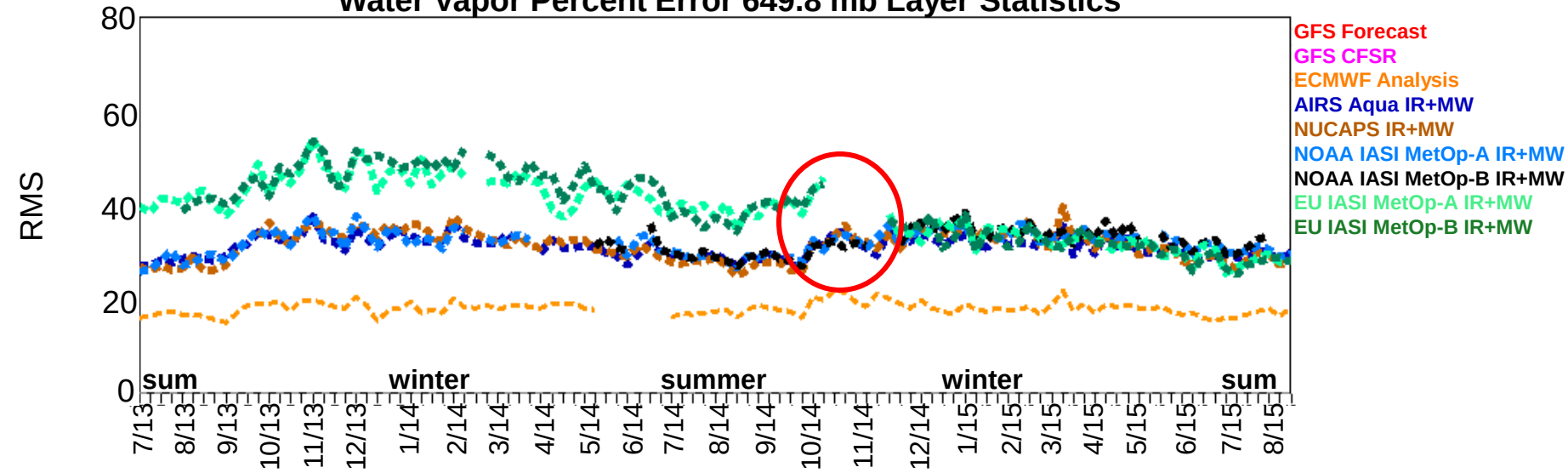
NOAA Archive Summary (NARCS)

(Long Term Monitoring (LTM) of
SAT-minus-RAOB
2008-present)

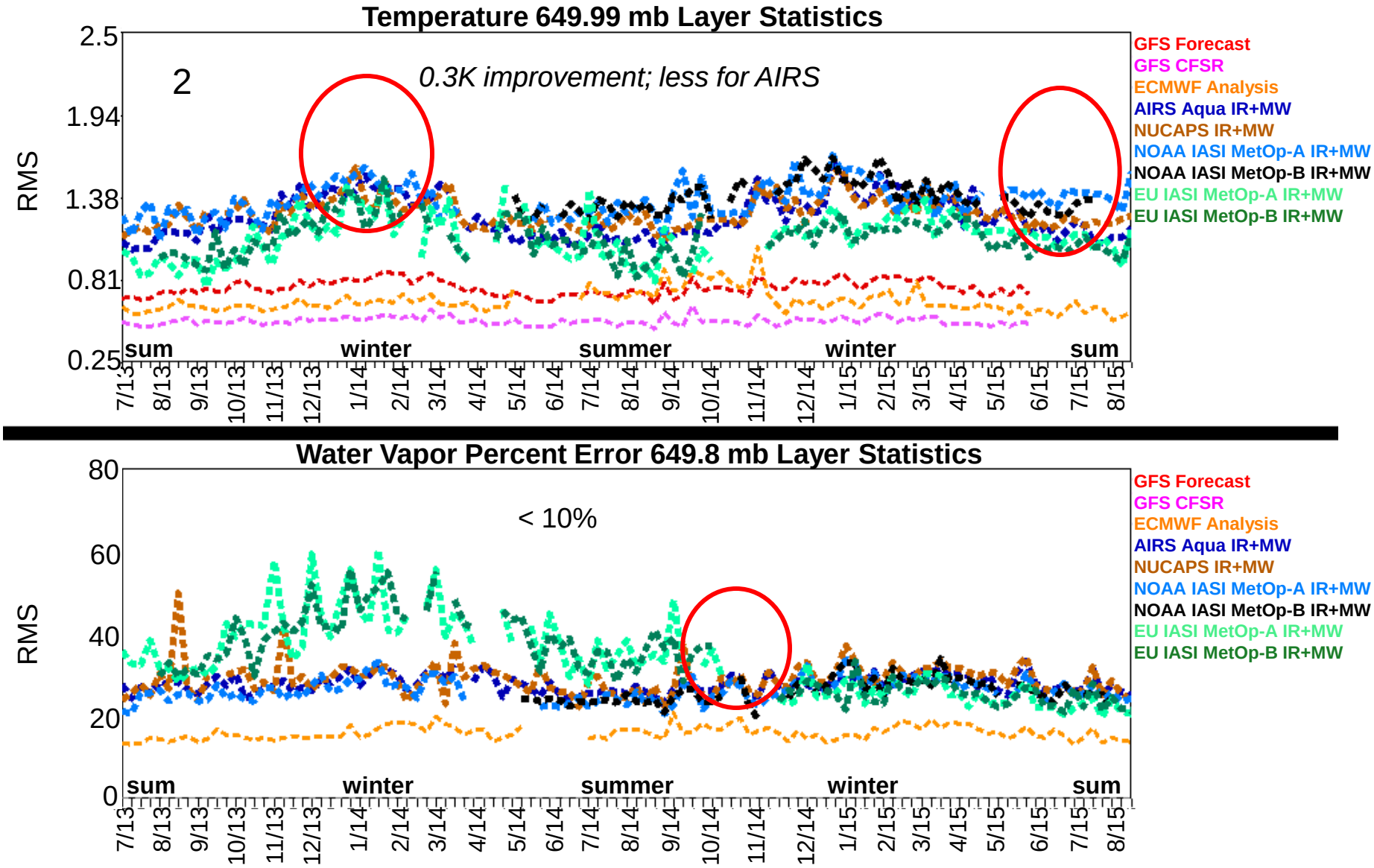
optimal sample per system

- ✓ 2013 to present
- ✓ Maritime vs Continental … Global
- ✓ NUCAPS, IASI (NOAA and EU), AIRS v.6, MiRS, NWP
- ✓ IR vs MW
- ✓ QC'd products
- ✓ Weekly average differences
- ✓ RMS
- ✓ 650 hPa
- ✓ T and H20 vapor fraction (W2)

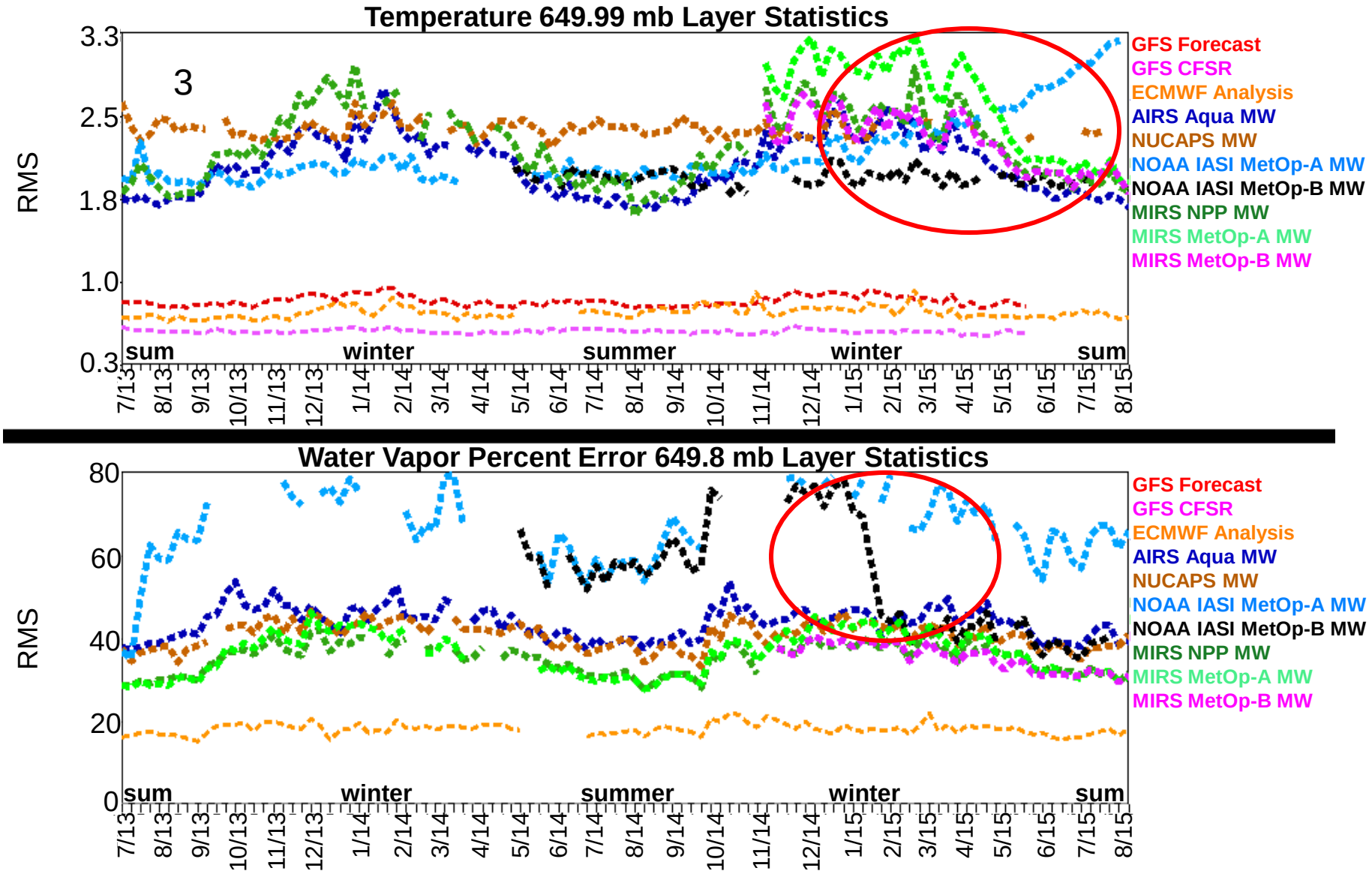




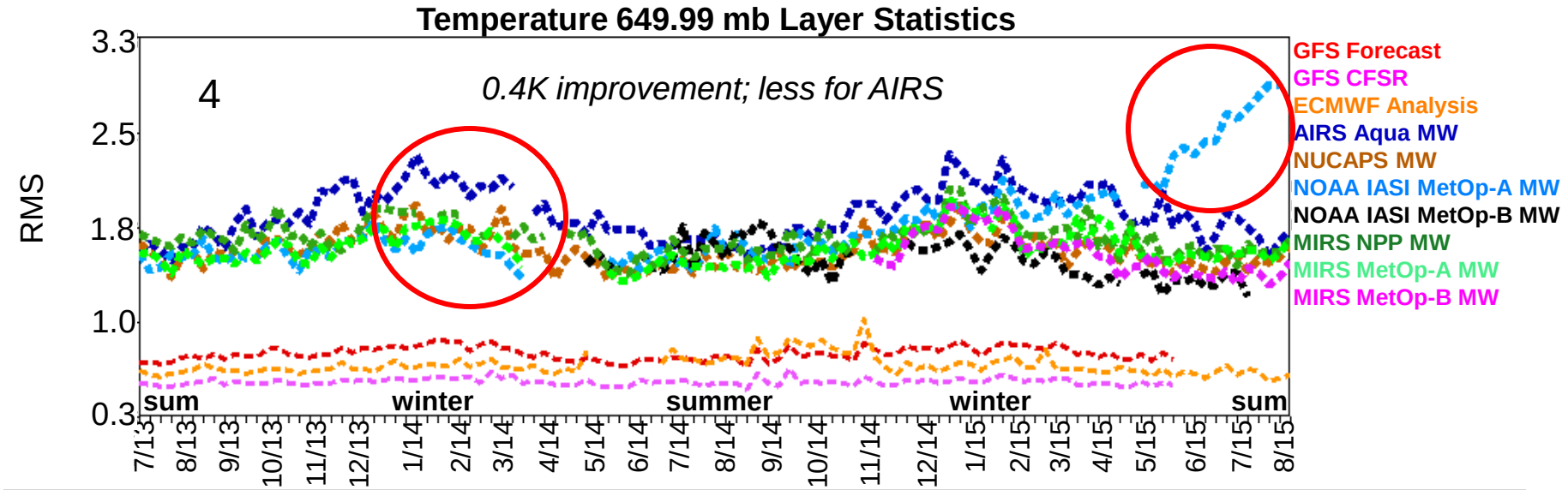
Continental IR

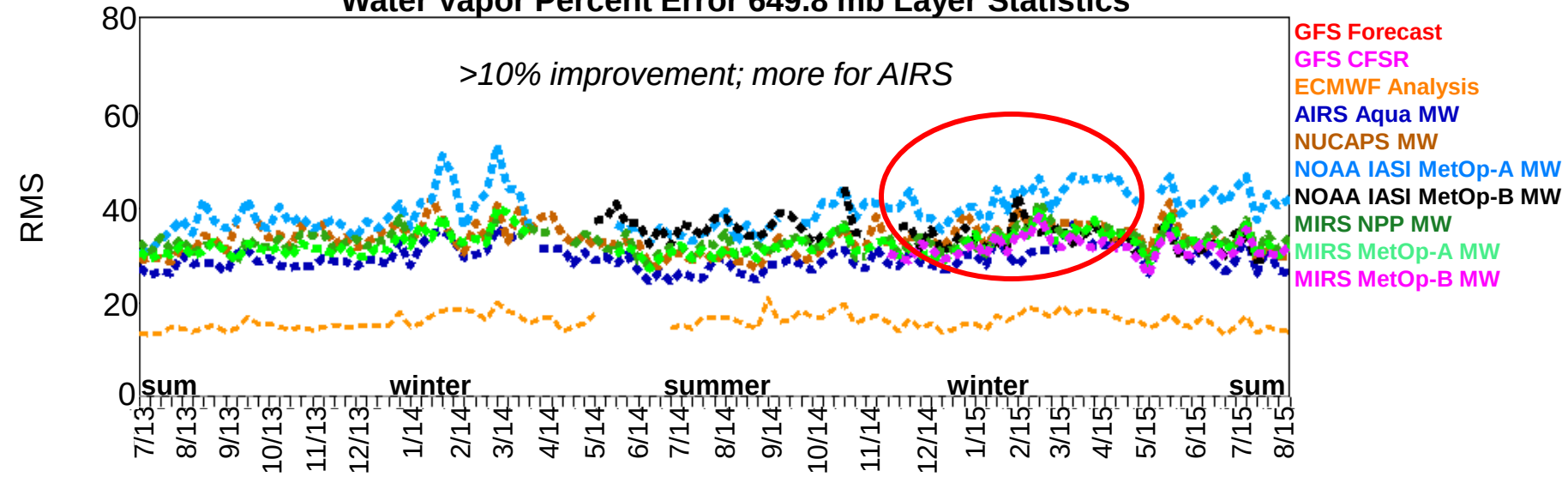

Temperature 649.99 mb Layer Statistics
RMS
2.5
1.94
1.38
0.81
0.25
2
0.3K improvement; less for AIRS
sum
winter
summer
winter
sum
7/13
8/13
9/13
10/13
11/13
12/13
1/14
2/14
3/14
4/14
5/14
6/14
7/14
8/14
9/14
10/14
11/14
12/14
1/15
2/15
3/15
4/15
5/15
6/15
7/15
8/15
GFS Forecast
GFS CFSR
ECMWF Analysis
AIRS Aqua IR+MW
NUCAPS IR+MW
NOAA IASI MetOp-A IR+MW
NOAA IASI MetOp-B IR+MW
EU IASI MetOp-A IR+MW
EU IASI MetOp-B IR+MW
Water Vapor Percent Error 649.8 mb Layer Statistics
RMS
80
60
40
20
0
< 10%
sum
winter
summer
winter
sum
7/13
8/13
9/13
10/13
11/13
12/13
1/14
2/14
3/14
4/14
5/14
6/14
7/14
8/14
9/14
10/14
11/14
12/14
1/15
2/15
3/15
4/15
5/15
6/15
7/15
8/15
GFS Forecast
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ECMWF Analysis
AIRS Aqua IR+MW
NUCAPS IR+MW
NOAA IASI MetOp-A IR+MW
NOAA IASI MetOp-B IR+MW
EU IASI MetOp-A IR+MW
EU IASI MetOp-B IR+MW

Maritime IR

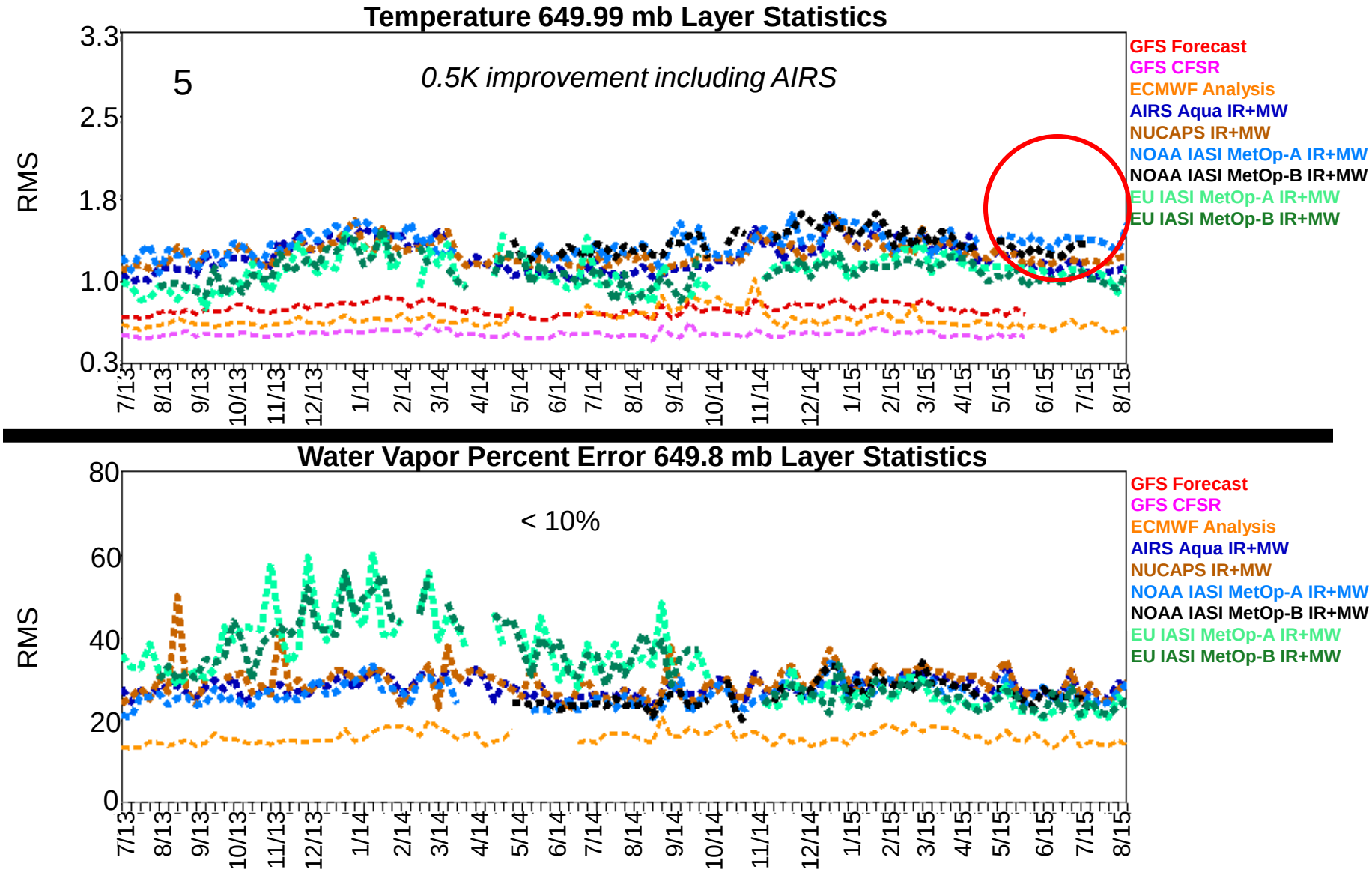


Continental MW

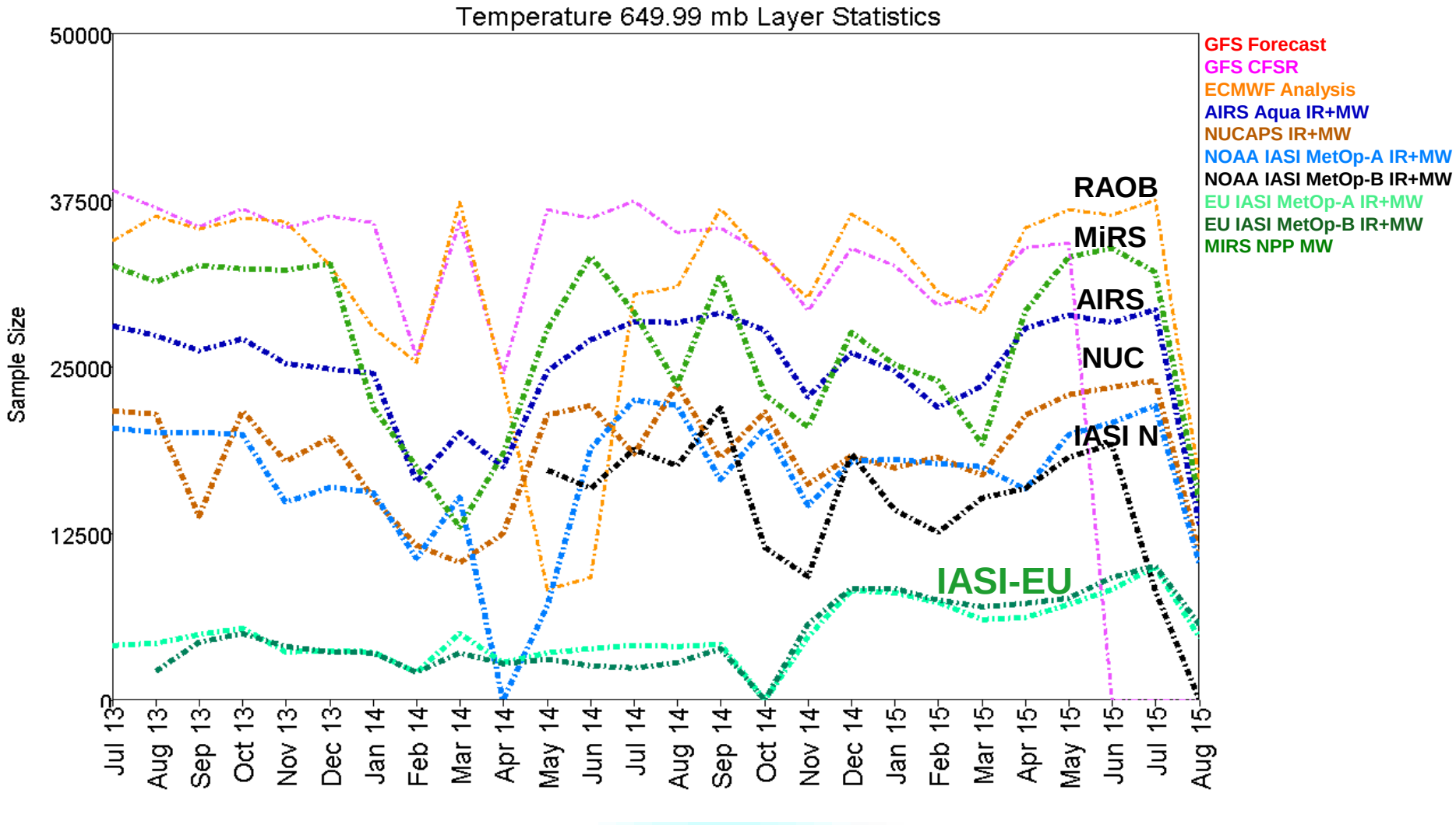

Temperature 649.99 mb Layer Statistics
4
0.4K improvement; less for AIRS
RMS
3.3
2.5
1.8
1.0
0.3
sum
winter
summer
winter
sum
7/13
8/13
9/13
10/13
11/13
12/13
1/14
2/14
3/14
4/14
5/14
6/14
7/14
8/14
9/14
10/14
11/14
12/14
1/15
2/15
3/15
4/15
5/15
6/15
7/15
8/15
GFS Forecast
GFS CFSR
ECMWF Analysis
AIRS Aqua MW
NUCAPS MW
NOAA IASI MetOp-A MW
NOAA IASI MetOp-B MW
MIRS NPP MW
MIRS MetOp-A MW
MIRS MetOp-B MW


Water Vapor Percent Error 649.8 mb Layer Statistics
>10% improvement; more for AIRS
RMS
80
60
40
20
0
sum
winter
summer
winter
sum
7/13
8/13
9/13
10/13
11/13
12/13
1/14
2/14
3/14
4/14
5/14
6/14
7/14
8/14
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8/15
GFS Forecast
GFS CFSR
ECMWF Analysis
AIRS Aqua MW
NUCAPS MW
NOAA IASI MetOp-A MW
NOAA IASI MetOp-B MW
MIRS NPP MW
MIRS MetOp-A MW
MIRS MetOp-B MW

Maritime MW


Temperature 649.99 mb Layer Statistics
5
0.5K improvement including AIRS
RMS
3.3
2.5
1.8
1.0
0.3
7/13
8/13
9/13
10/13
11/13
12/13
1/14
2/14
3/14
4/14
5/14
6/14
7/14
8/14
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NOAA IASI MetOp-B IR+MW
EU IASI MetOp-A IR+MW
EU IASI MetOp-B IR+MW
Water Vapor Percent Error 649.8 mb Layer Statistics
< 10%
RMS
80
60
40
20
0
7/13
8/13
9/13
10/13
11/13
12/13
1/14
2/14
3/14
4/14
5/14
6/14
7/14
8/14
9/14
10/14
11/14
12/14
1/15
2/15
3/15
4/15
5/15
6/15
7/15
8/15
GFS Forecast
GFS CFSR
ECMWF Analysis
AIRS Aqua IR+MW
NUCAPS IR+MW
NOAA IASI MetOp-A IR+MW
NOAA IASI MetOp-B IR+MW
EU IASI MetOp-A IR+MW
EU IASI MetOp-B IR+MW

Maritime IR



Monthly Global Collocation Sample Size Yields Reflect Global Product Yields

STAR Center for Satellite Applications and Research
formerly ORA — Office of Research and Applications

WEB Site

NOAA STAR CENTER FOR SATELLITE APPLICATIONS AND RESEARCH
intranet - Contact - Skip navigation
Search STAR Go

- NOAA PROducts Validation System (NPROVS) >>
- Summary Plots
- User Interface
- Daily Data Monitoring
- Documentation
- Links
- Personnel
- OPDB Polar Products

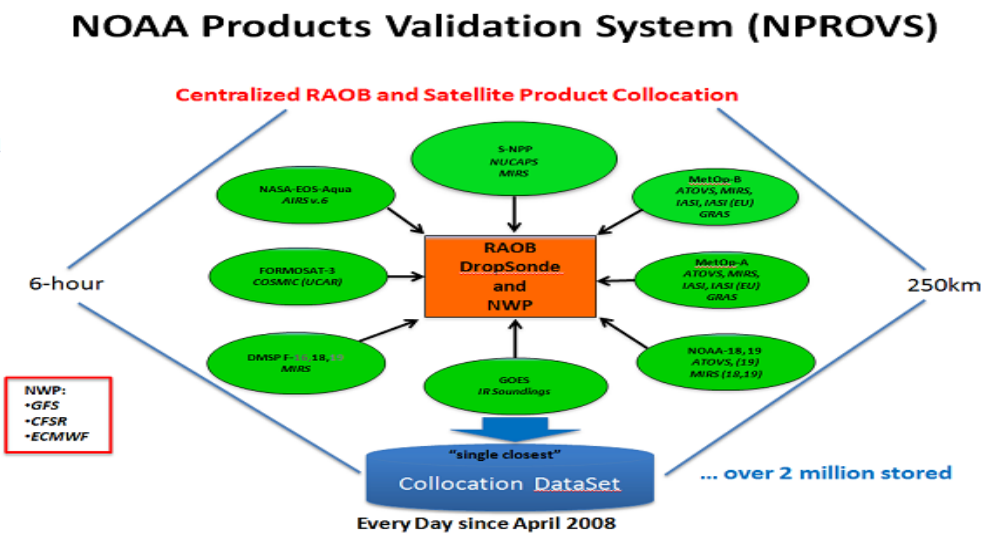
Data and images displayed on STAR sites are provided for experimental use only and are not official operational NOAA products. More information>>

STAR / SMCD / OPDB - NOAA Products Validation System (NPROVS)

NPROVS Overview

NPROVS routinely (daily) compiles datasets of collocated radiosonde, dropsonde and numerical weather prediction (NWP) collocated with the following satellites and sounding product suites:

- Suomi-NPP (S-NPP)
  - NOAA Unique CrIS and ATMS Processing System (NUCAPS)
  - Microwave Integrated Retrieval System (MIRS)
- MetOp A and B
  - Infrared Atmospheric Sounding Interferometer (IASI)
  - IASI from EUMETSAT
  - MIRS
  - ATOVS
- NOAA-18,19
  - MIRS
  - ATOVS
- Defense Meteorological Satellite Program (DMSP) F-16, F-18 , F18
  - MIRS
- NASA-Earth Observing System (EOS)-Aqua
  - Advanced InfraRed Sounder (AIRS) (NASA v6 beginning April, 2013)
- GOES 11 and 13 (clear sky only)
- Constellation Observing System for Meteorology Ionosphere and Climate (COSMIC) Global Positioning System Radio Occultation (GPSRO) from University Corporation for Atmospheric Research (UCAR) Infrared Atmospheric Sounding Interferometer (IASI)



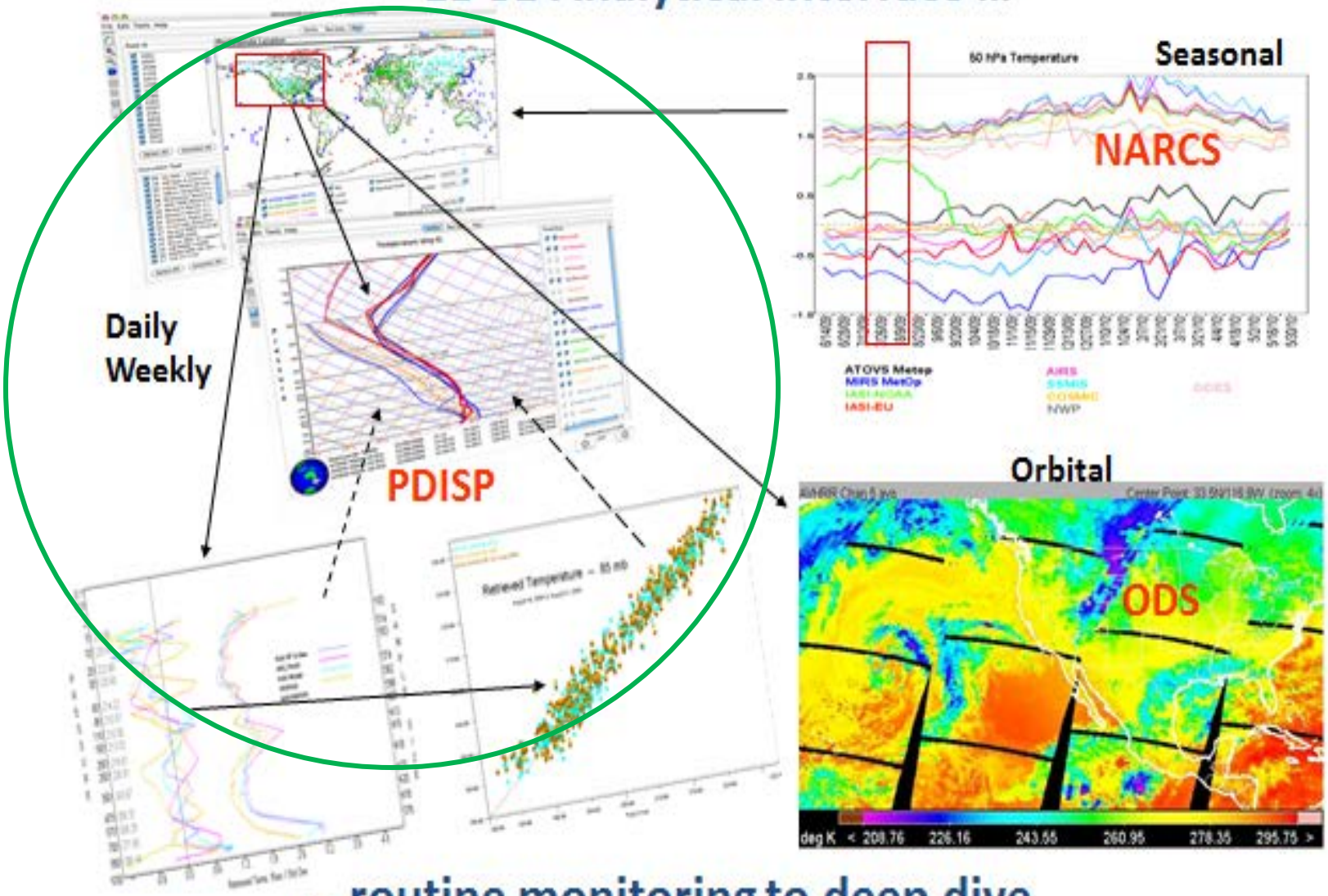
Collocation datasets are used for product monitoring and support of scientific algorithm development.

The website is broken into 3 major sections:

- Summary Plots of product monitoring for selected product suite combinations
- Graphical Interface (JAVA applications) for user analysis of collocation datatsets (i.e., weekly) and longer term trends (seasonal) are available.
- Daily Data Monitoring Images on this page show 24 hour data coverage for each system that is input into NPROVS.

http://www.star.nesdis.noaa.gov/smcd/opdb/nprovs/index.php

EDGE Analytical Interface …



… routine monitoring to deep dive

Profile Display (PDISP):

(Monitoring/Analysis of (10-day) NPROVS collocation datasets)

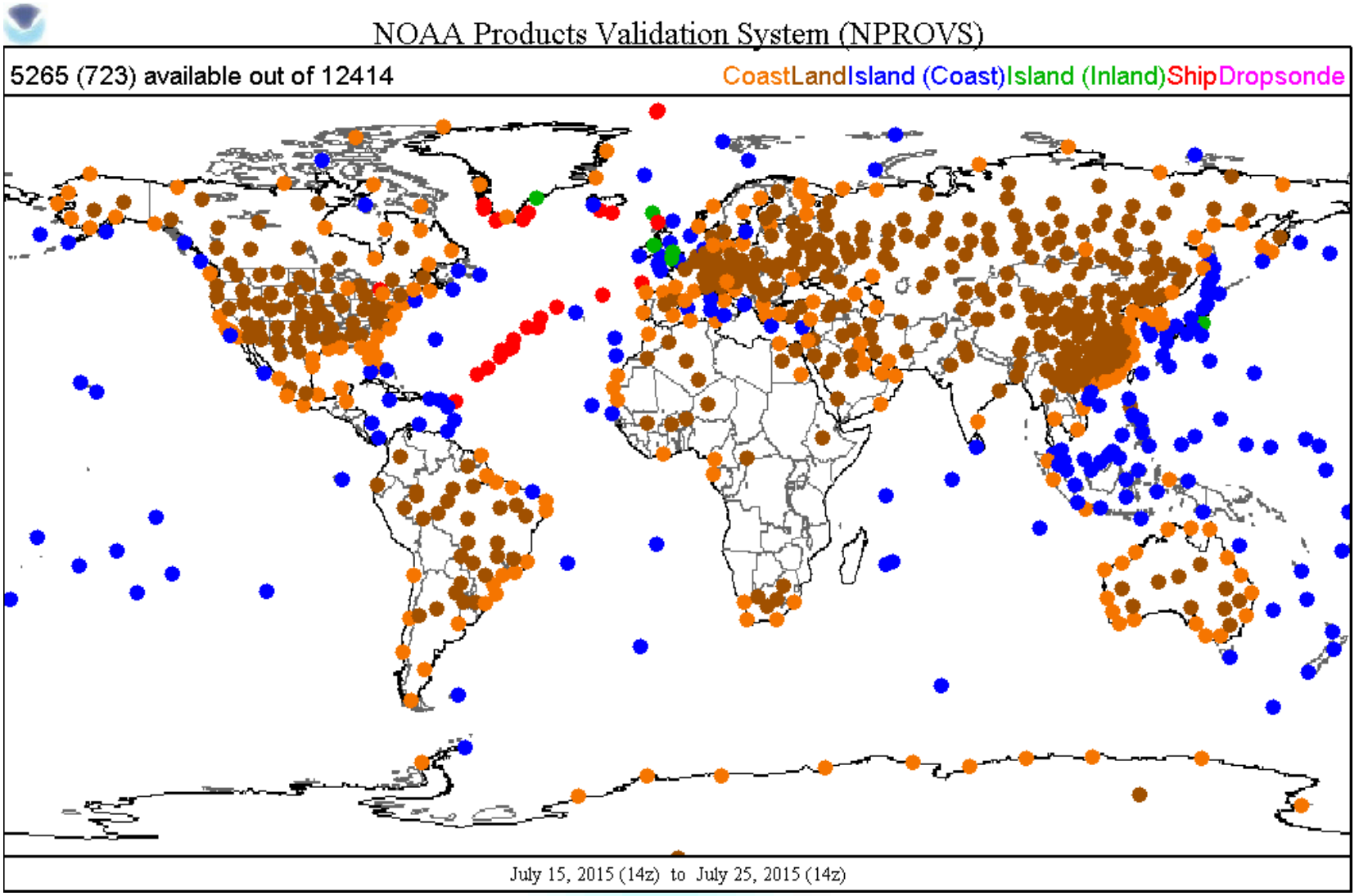
Common Samples

Analytical options:

- Collocated profile display and statistics
- Sampling options (space / time windows, region, weather, satellites, instruments, day/nite, qc …)

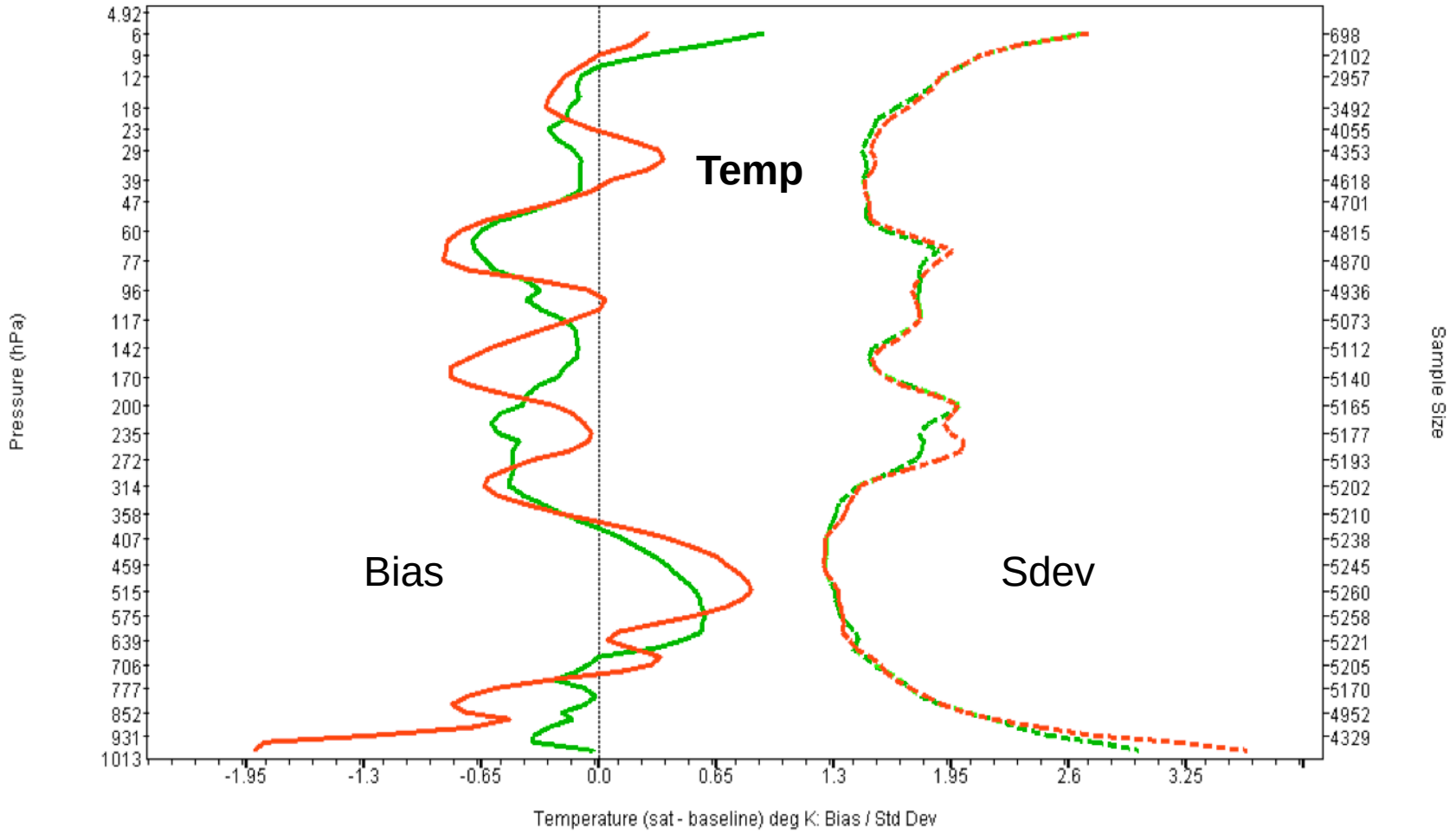
Assessments:

- *NUCAPS upgrade (oper vs parallel test)*
- *MiRS upgrade (oper vs parallel test)*
- *Retrieval vs First Guess Convergence*
- *Moisture Statistics Weighting*



10-day sample of collocations containing NUCAPS test and Oper IR+MW soundings which pass QC

NOAA Products Validation System (NPROVS)



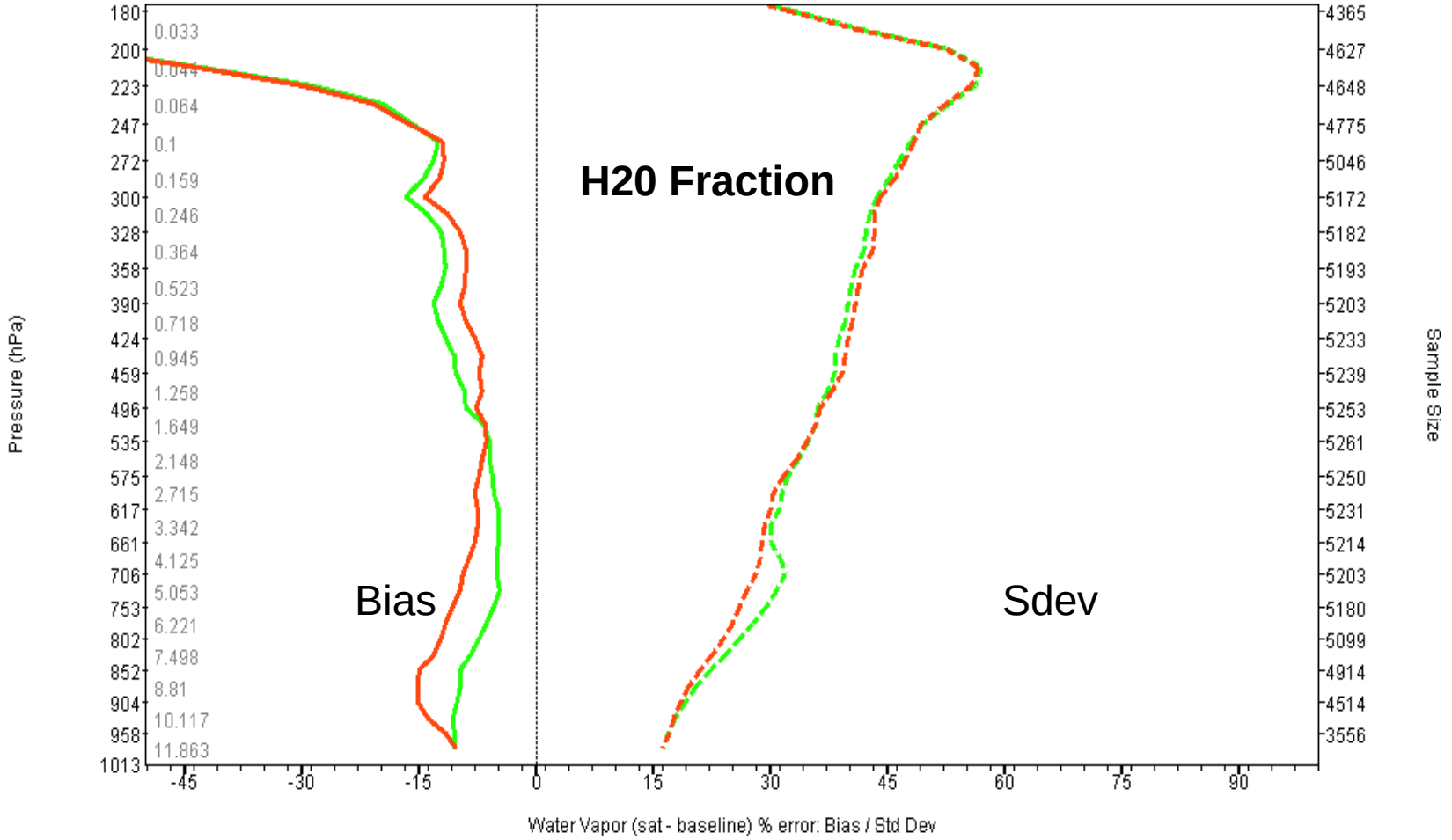
Baseline: Radiosonde Radiosonde

NUCAPS

NUCAPS Test

NOAA Products Validation System (NPROVS)

July 15, 2015 to July 25, 2015

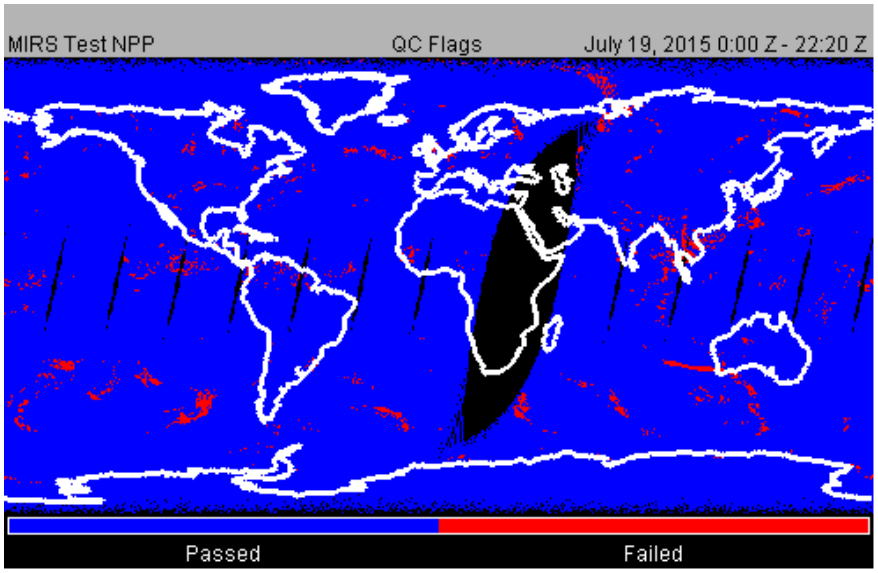


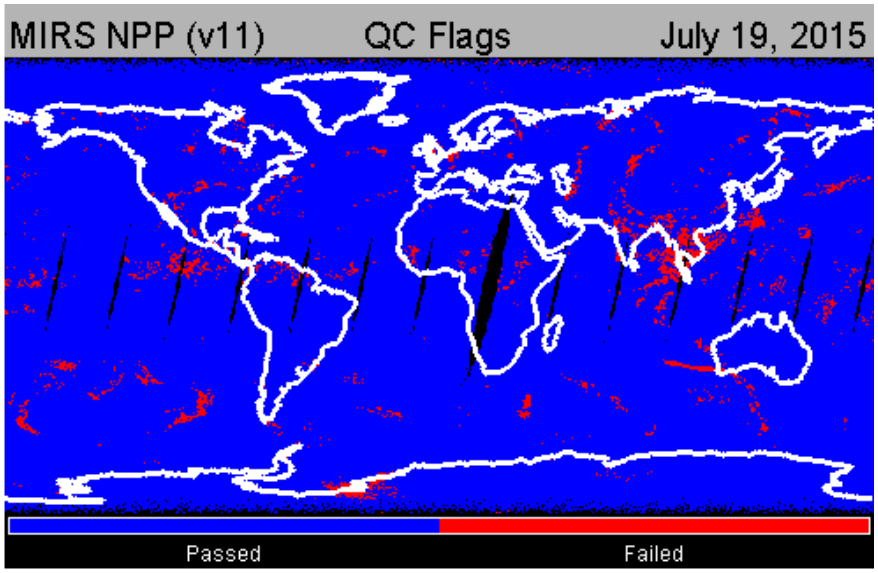
Baseline: Radiosonde Radiosonde

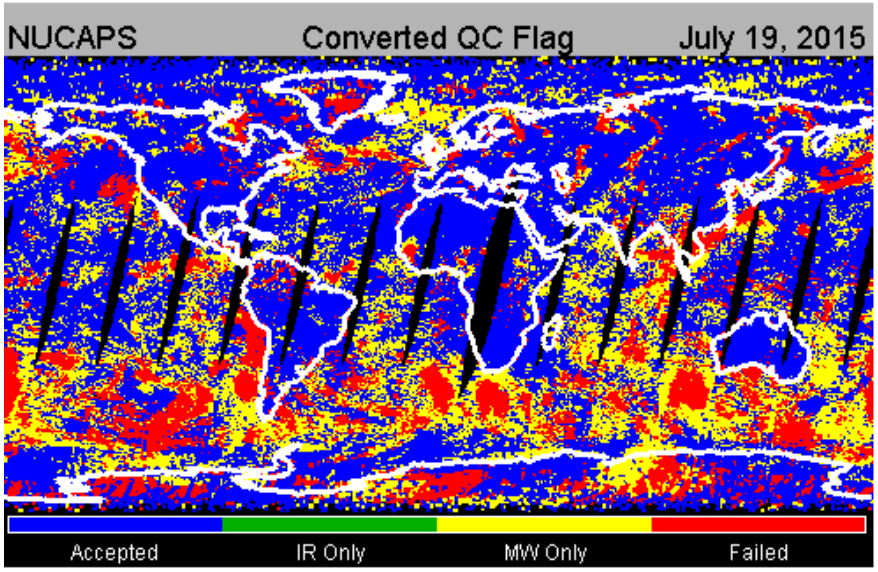
NUCAPS

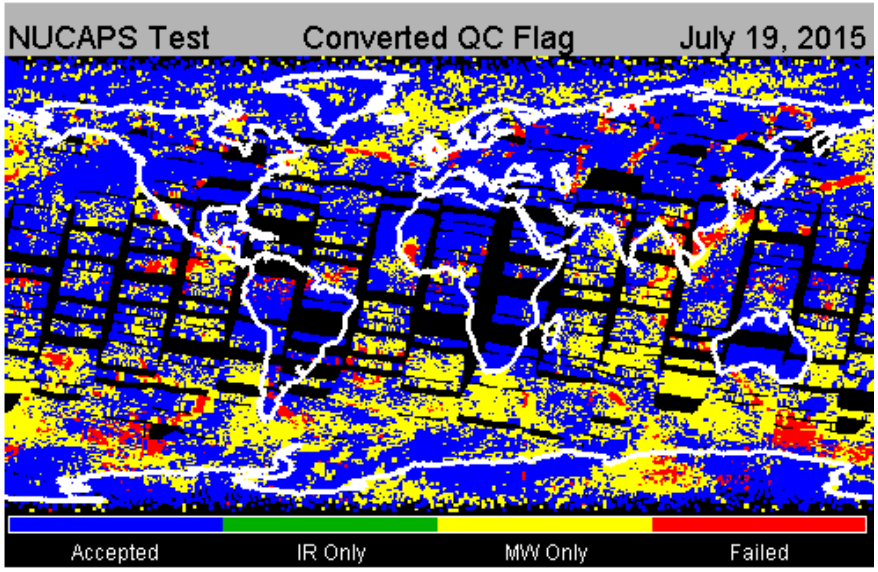
NUCAPS Test

ODS

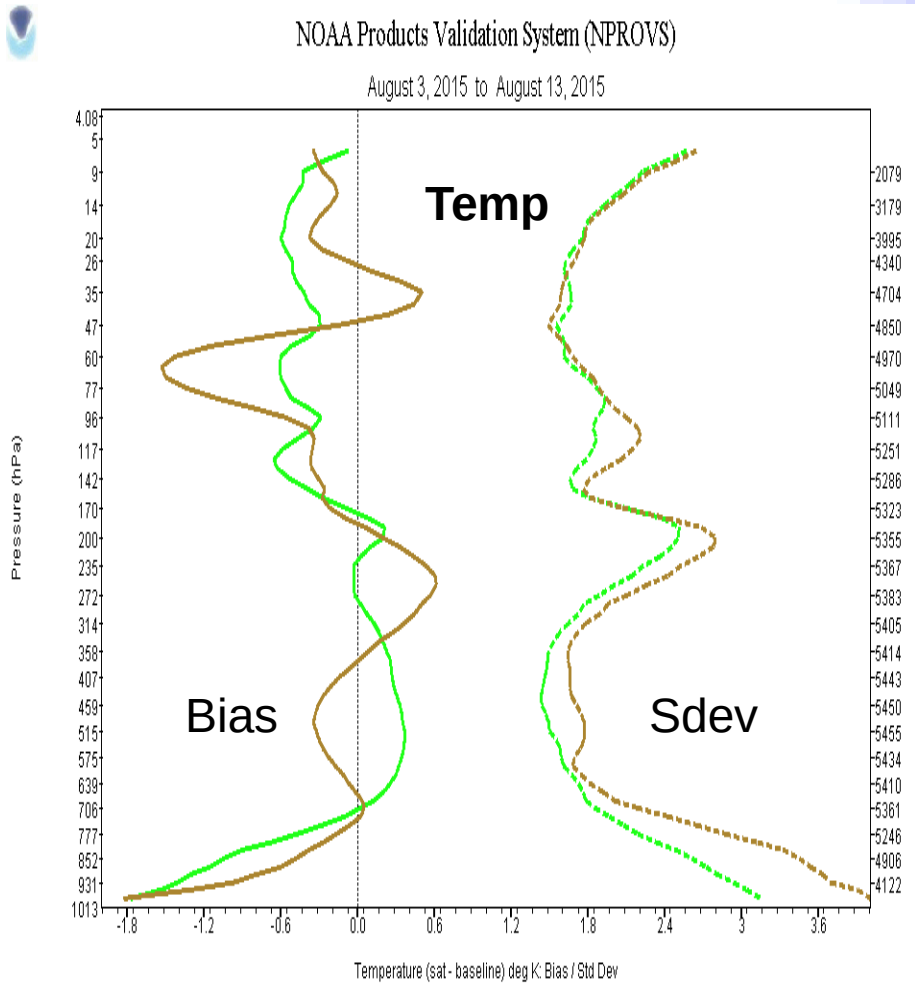






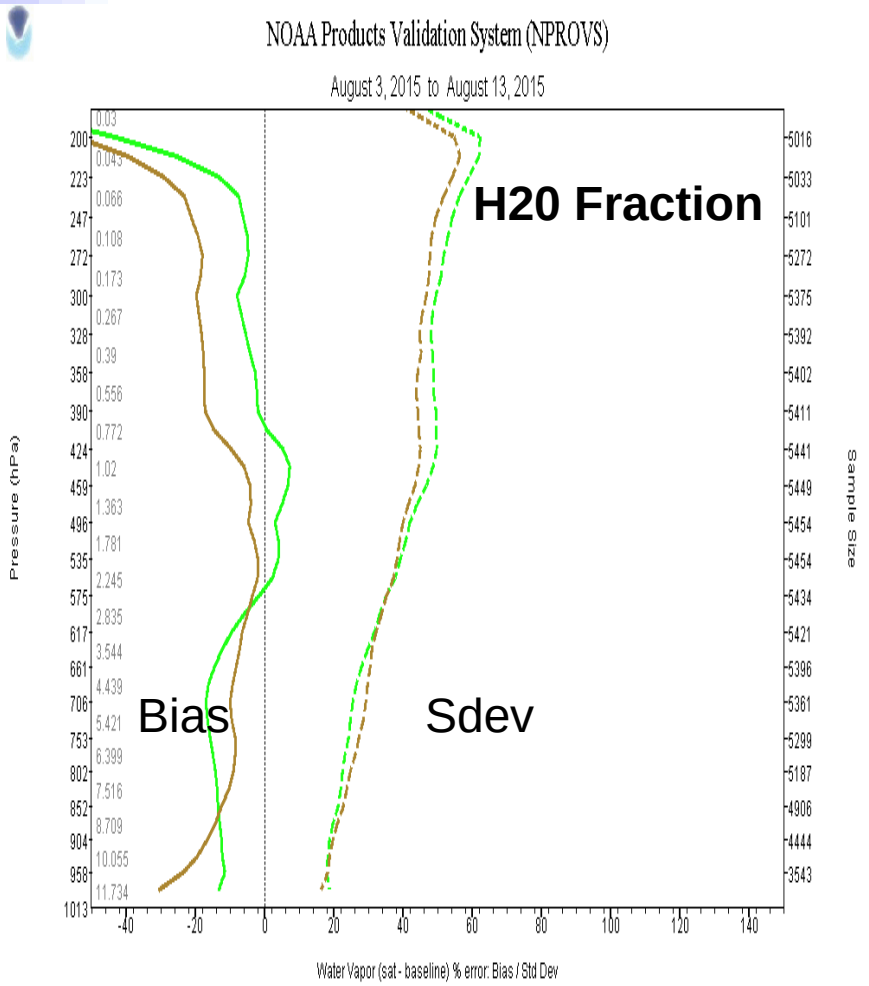


QC flags … red means MiRS (upper) and both NUCAPS (lower) failed



Baseline: Radiosonde Radiosonde

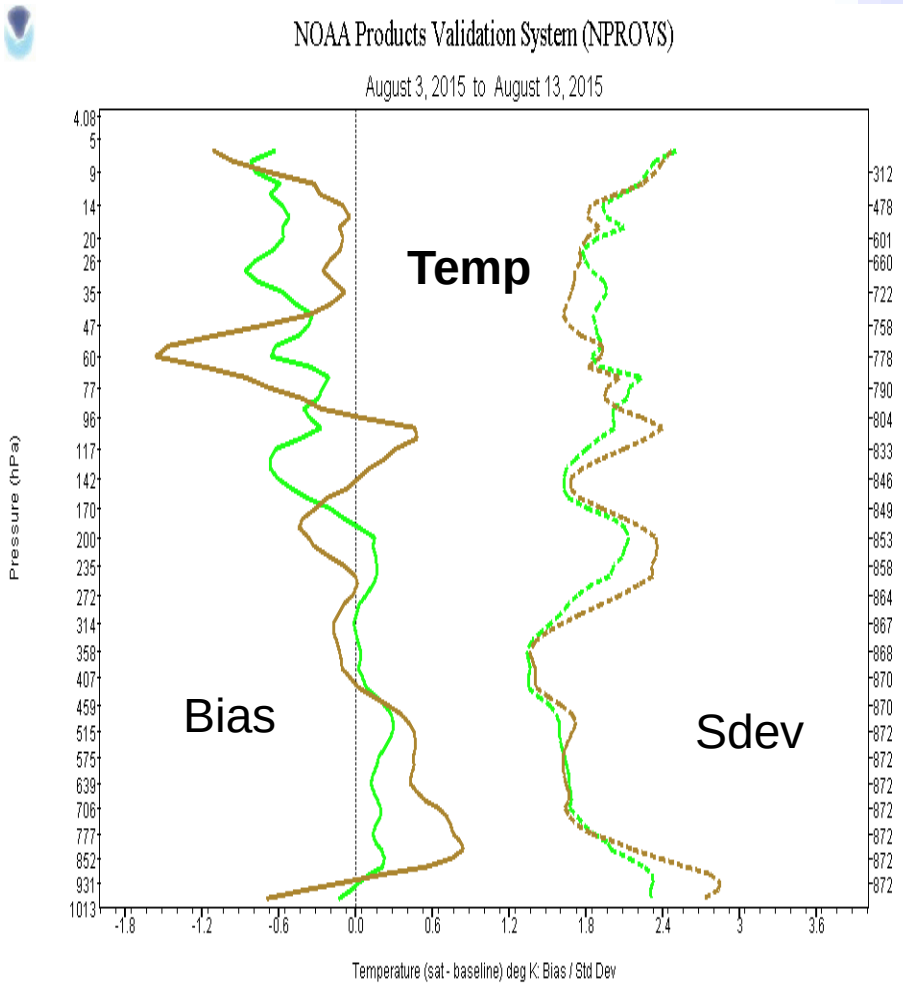
MIRS NPP MIRS NPP V11



Baseline: Radiosonde Radiosonde

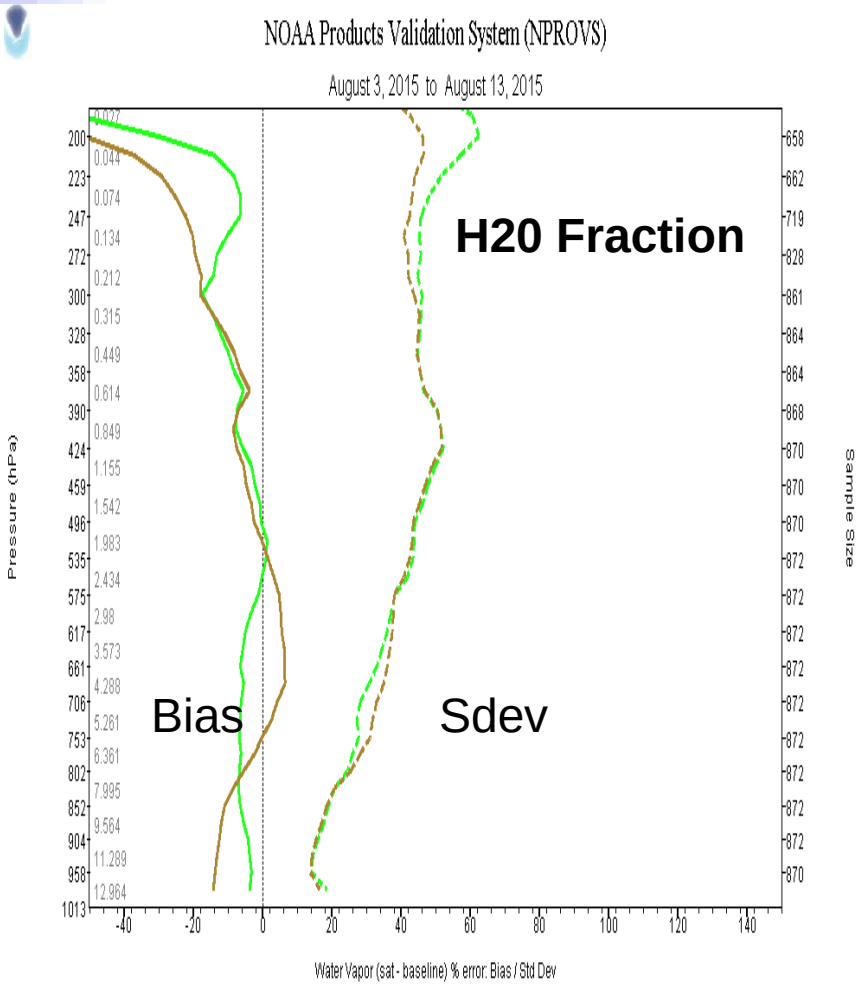
MIRS NPP MIRS NPP V11

Land



Baseline: Radiosonde Radiosonde

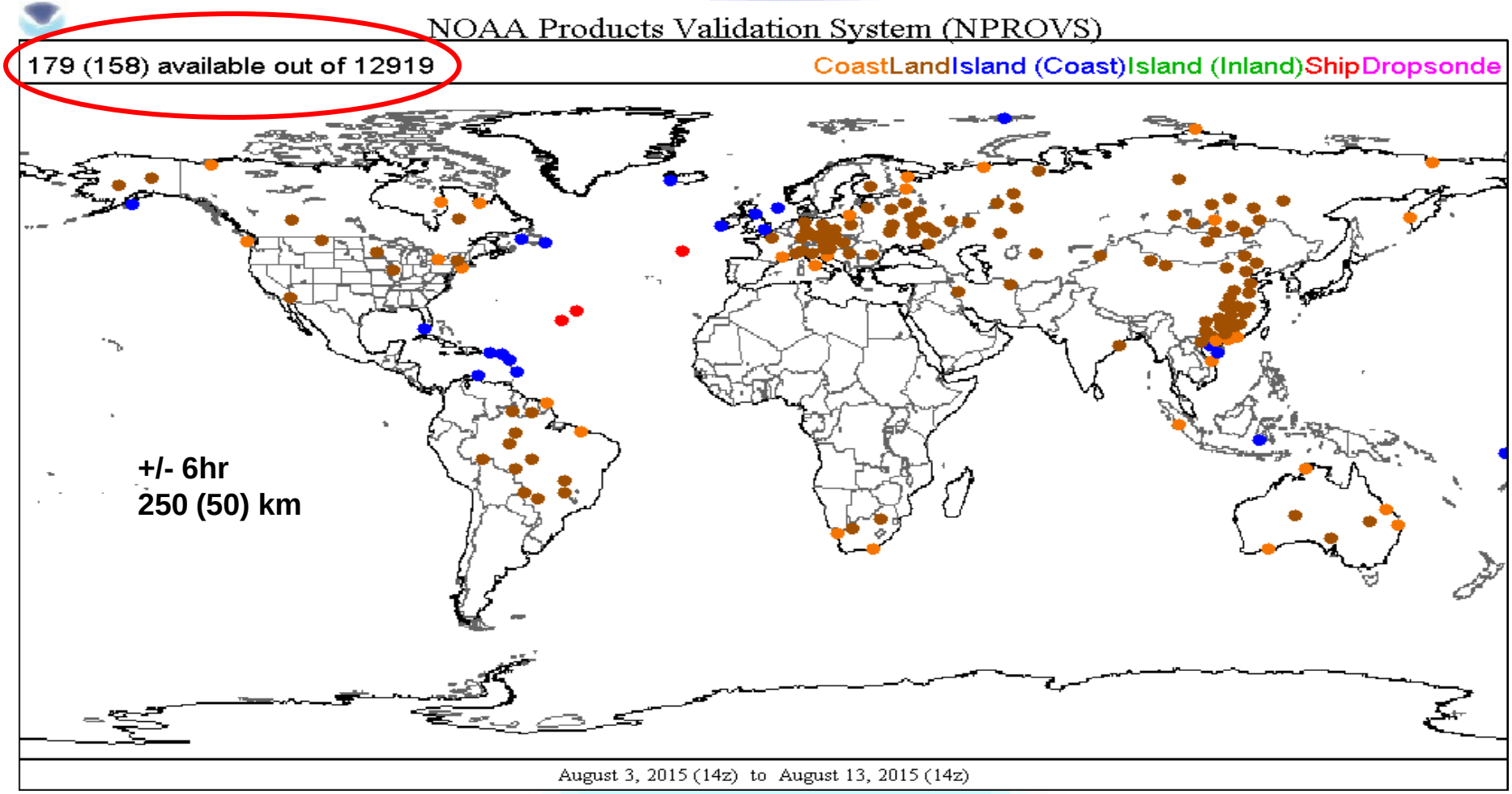
MIRS NPP MIRS NPP V11



Baseline: Radiosonde Radiosonde

MIRS NPP MIRS NPP V11

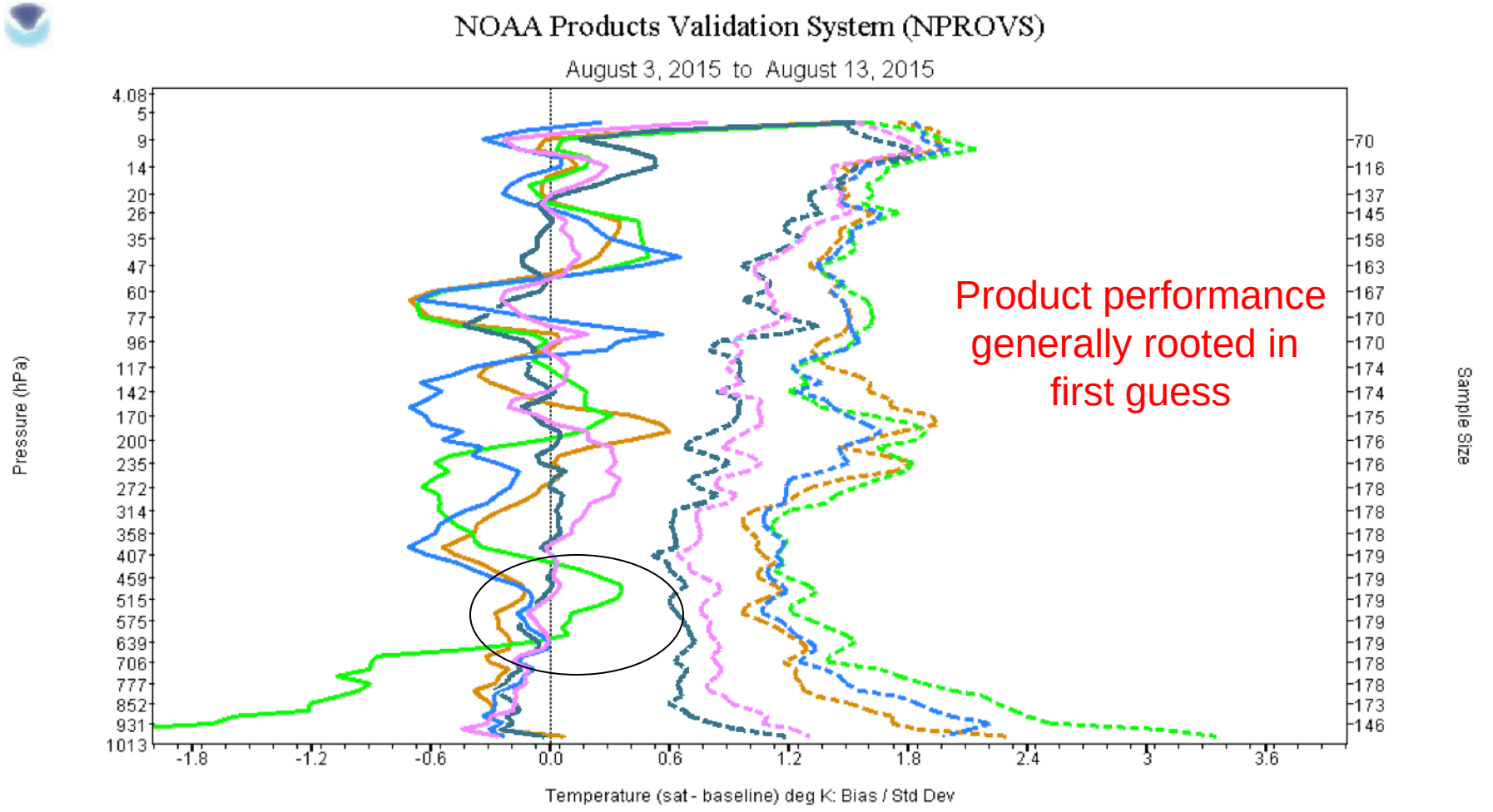
Sea



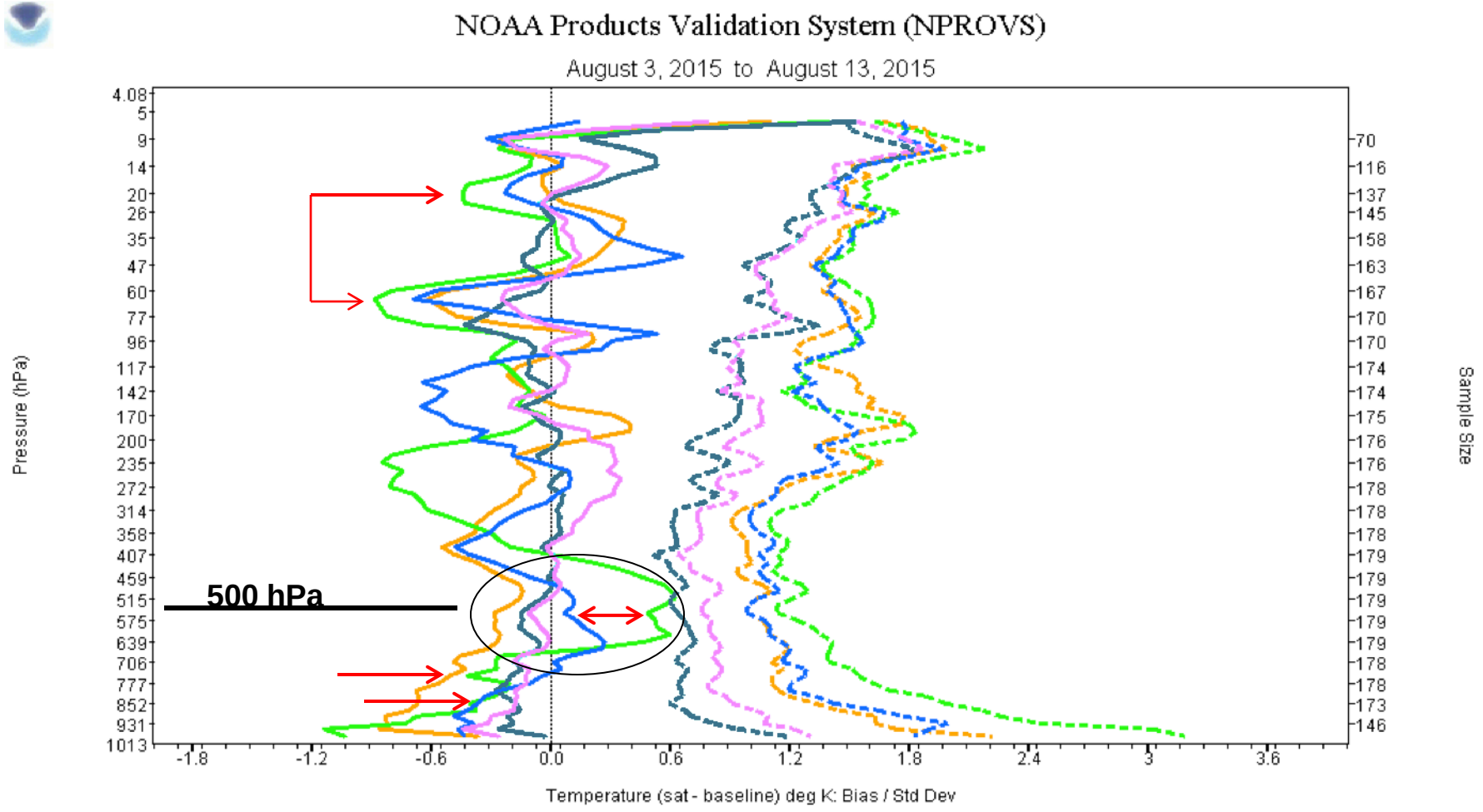
10-day sample of collocations containing:

1) NUCAPS Test 2) AIRS 3) IASI-EU … all pass respective QC

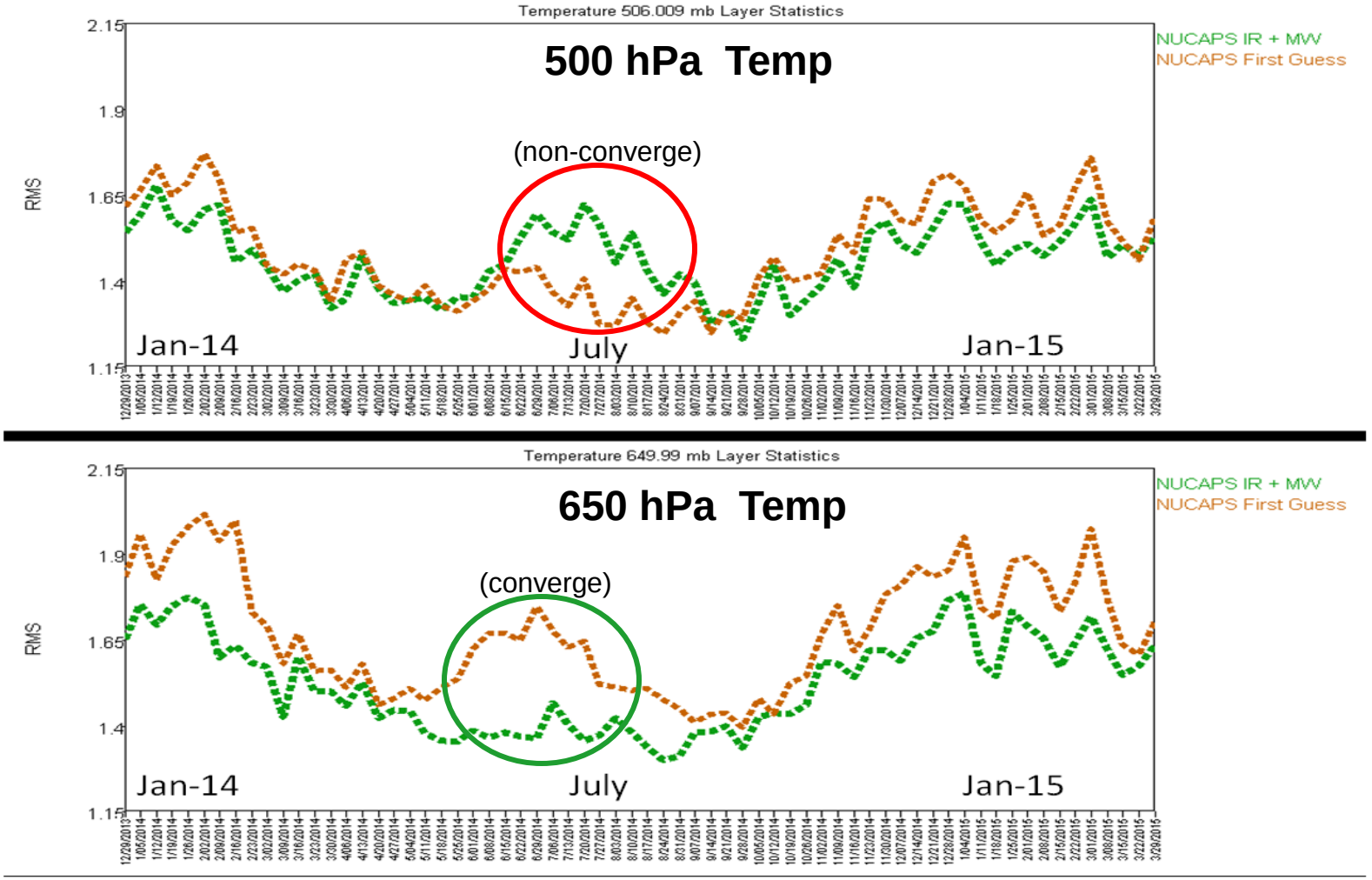
4) ECMWF



First Guess Temp

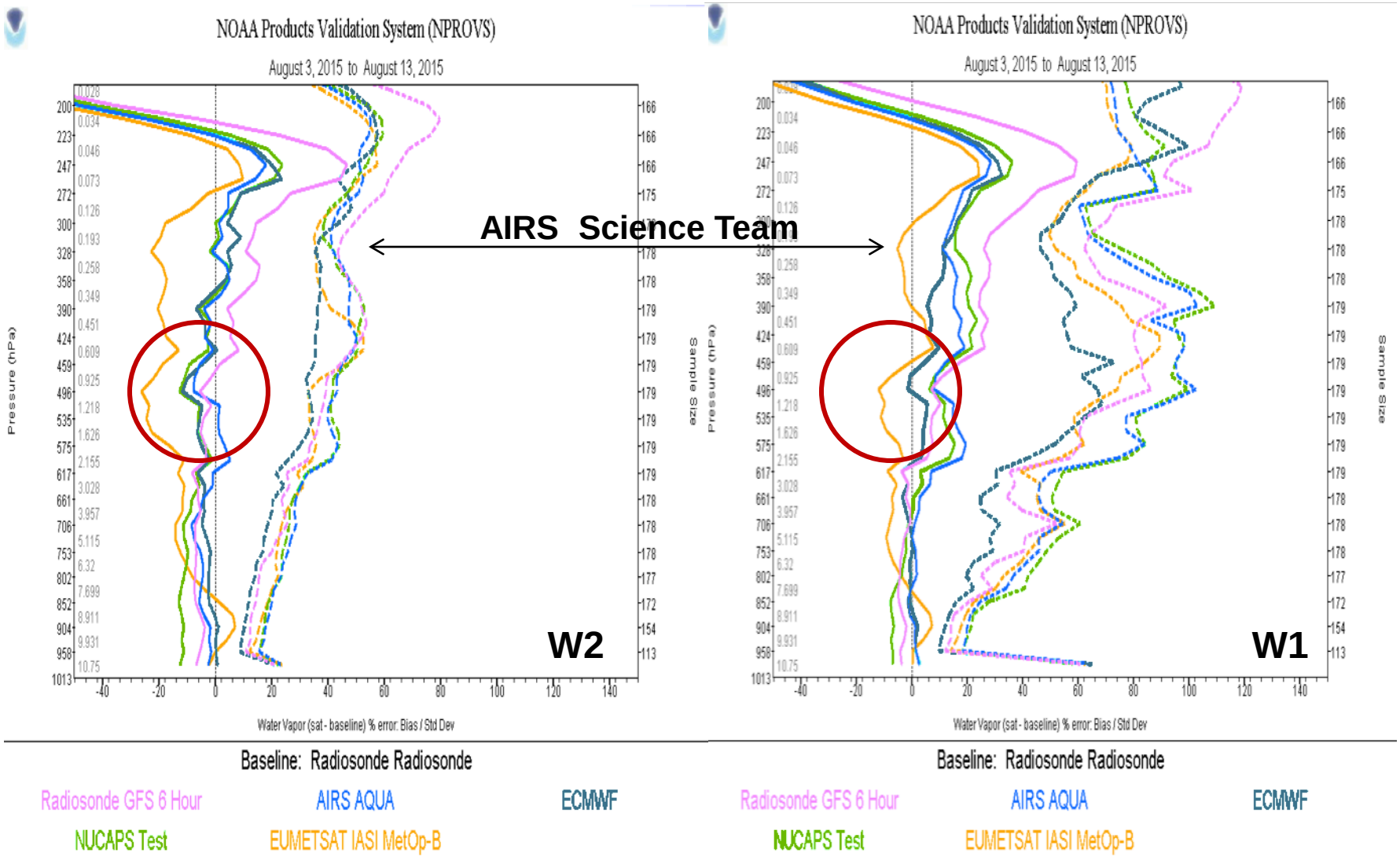


Retrieval Temp



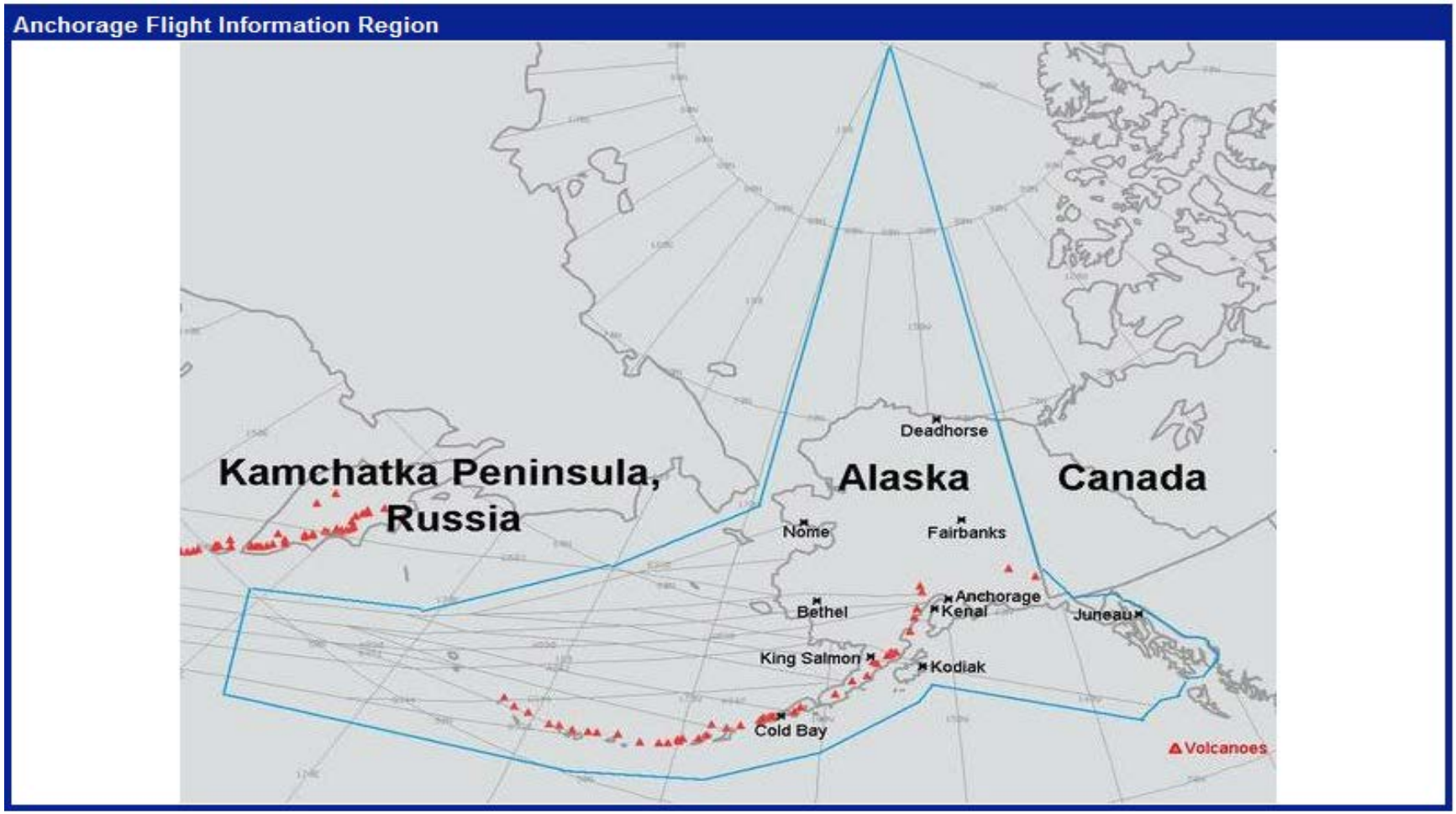
NARCS LTM of NUCAPS (Oper) retrieval vs 1st guess:

(NUCAPS IR+MW show seasonal (summer) non-convergence vicinity 500 hPa mainly continental cases; not evident at 650 hPa)



Moisture weighting makes a difference

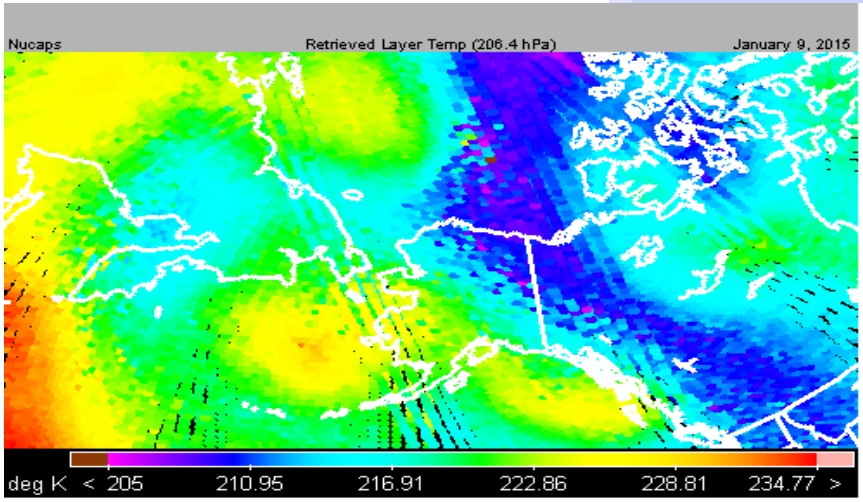
See Poster

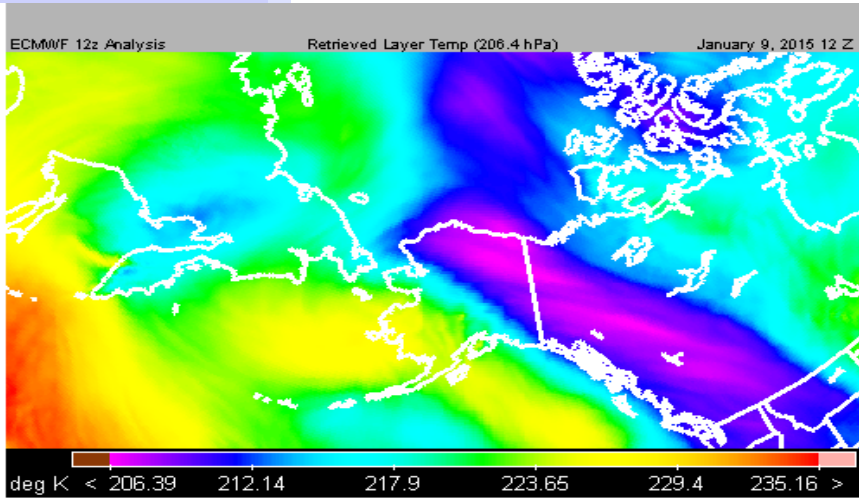


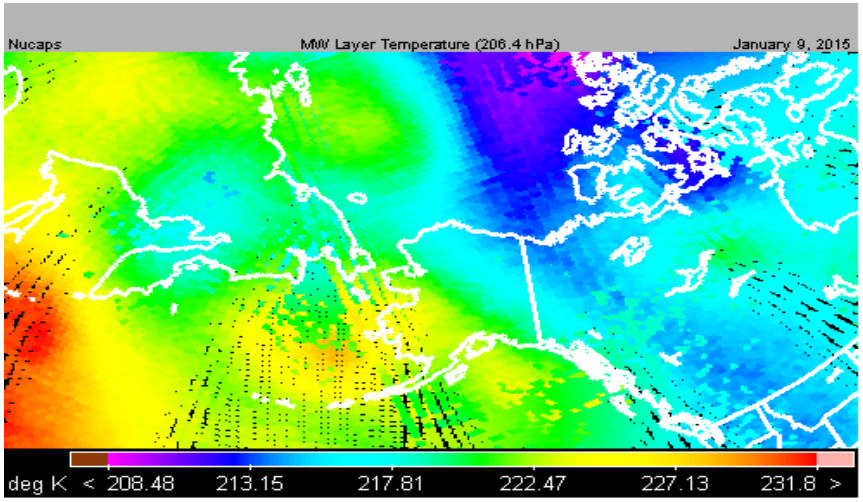
AWIPS-2 WG Cold Core Analysis

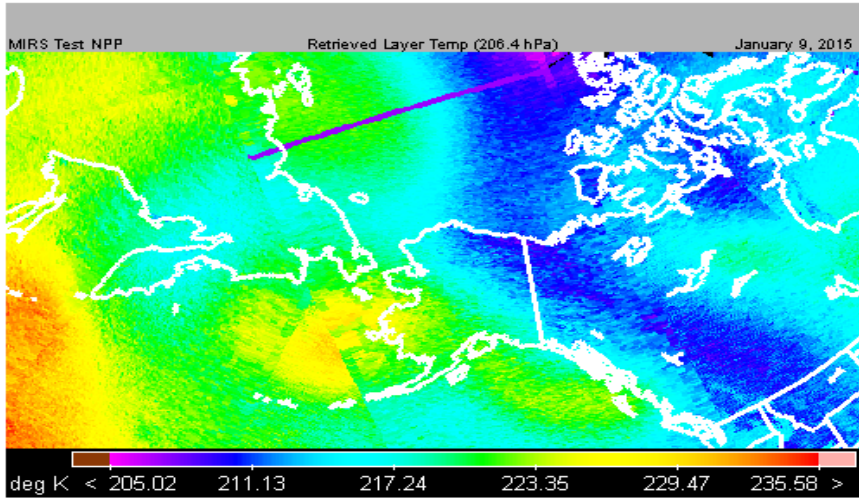
(fuel freezes below -60C)

NUCAPS IR+MW **206 hPa (35000 ft)** ECMWF

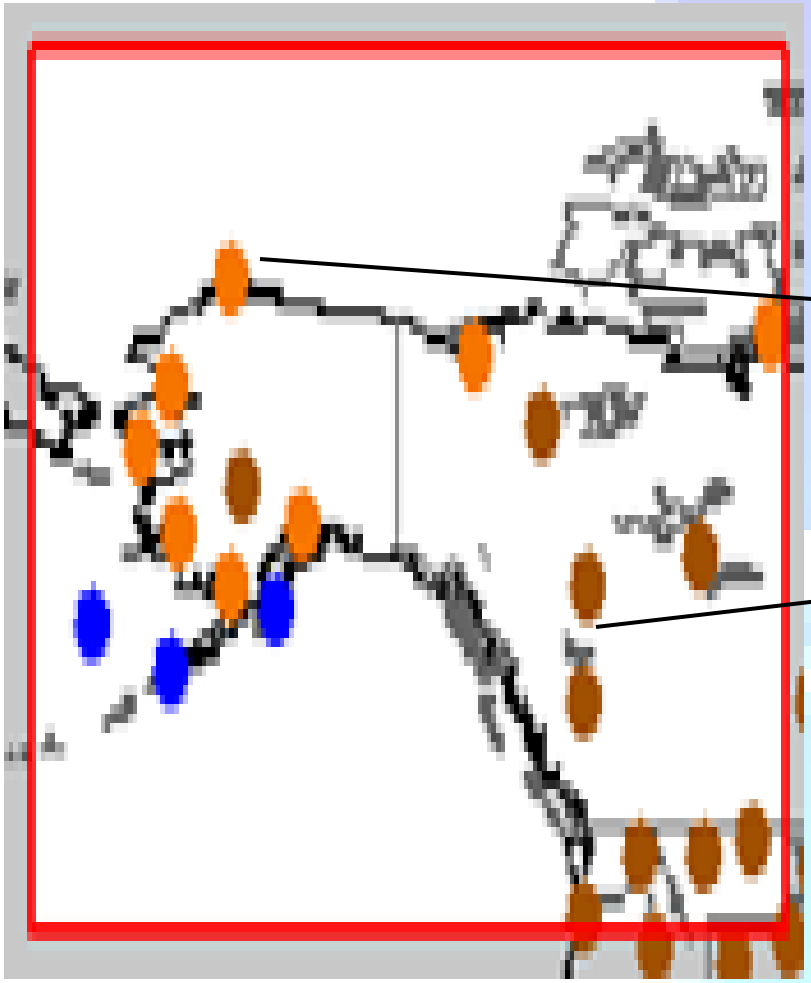


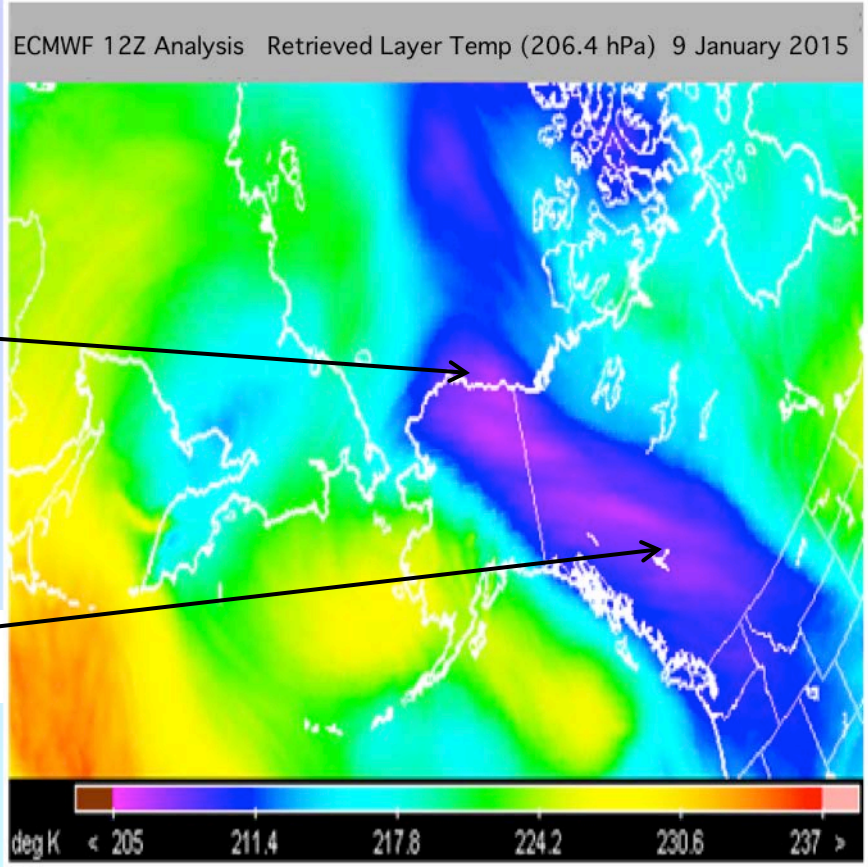


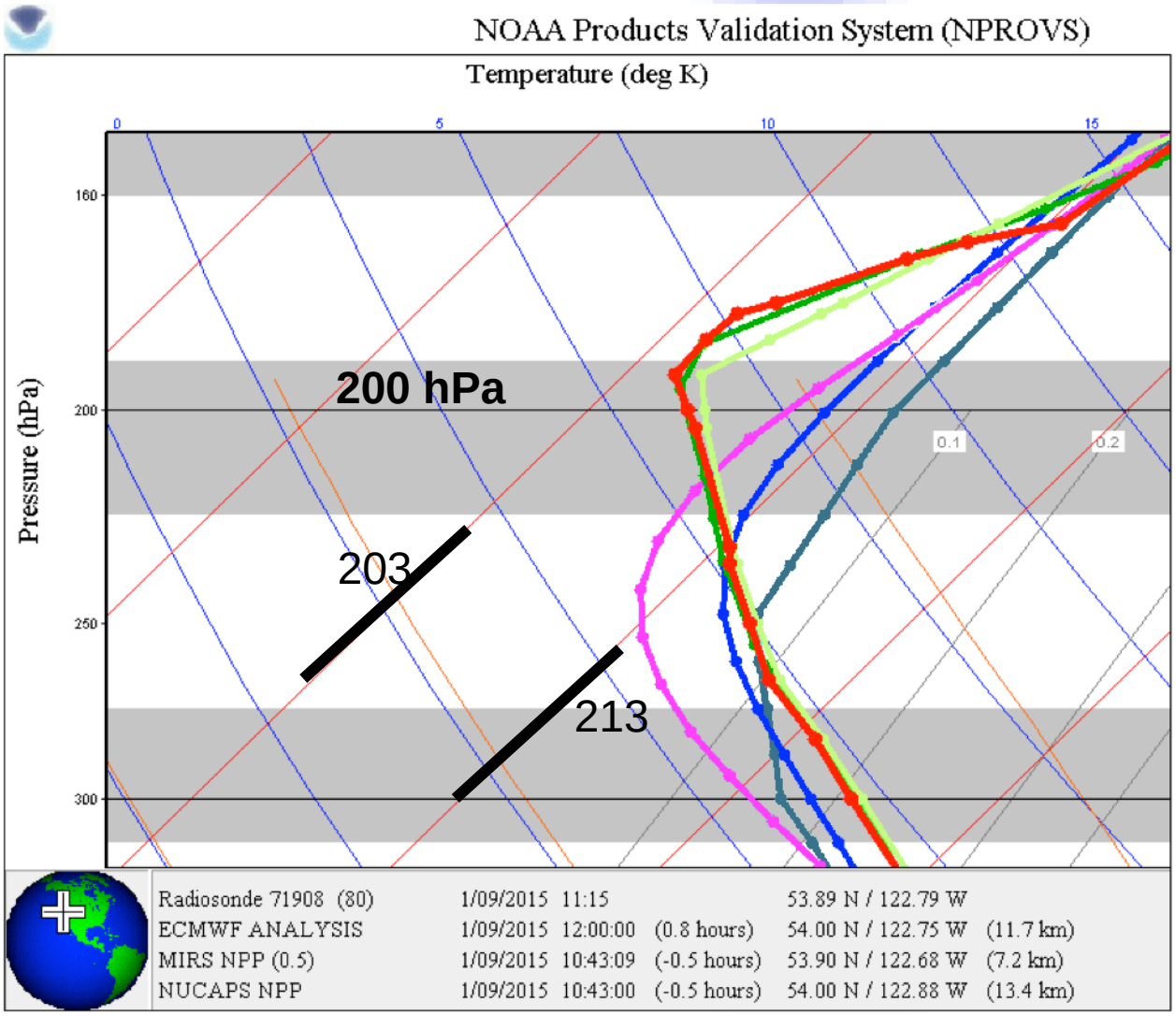




NUCAPS MW **Temp** MiRS NPP

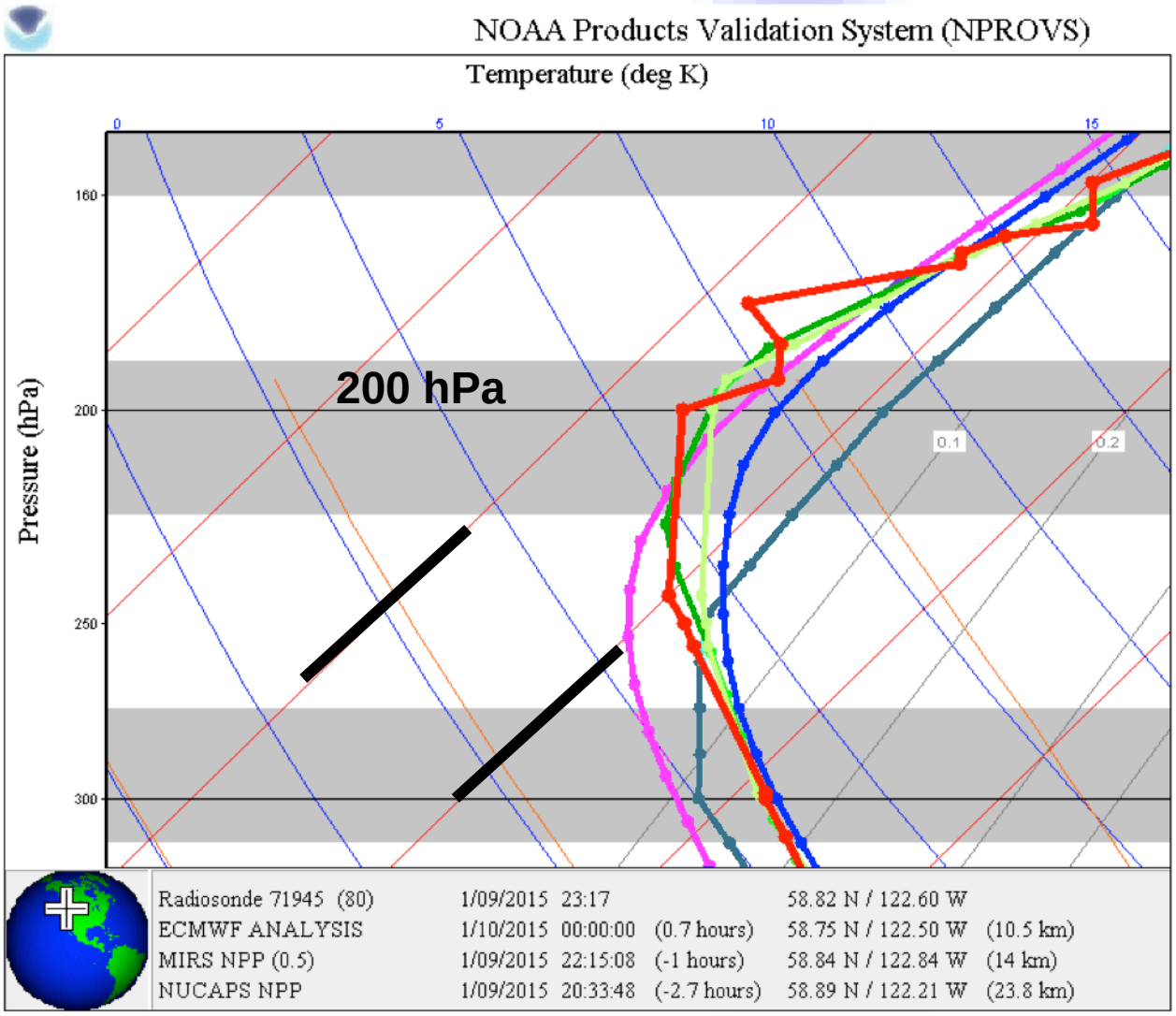



ECMWF 12Z Analysis Retrieved Layer Temp (206.4 hPa) 9 January 2015
deg K « 205 211.4 217.8 224.2 230.6 237 »



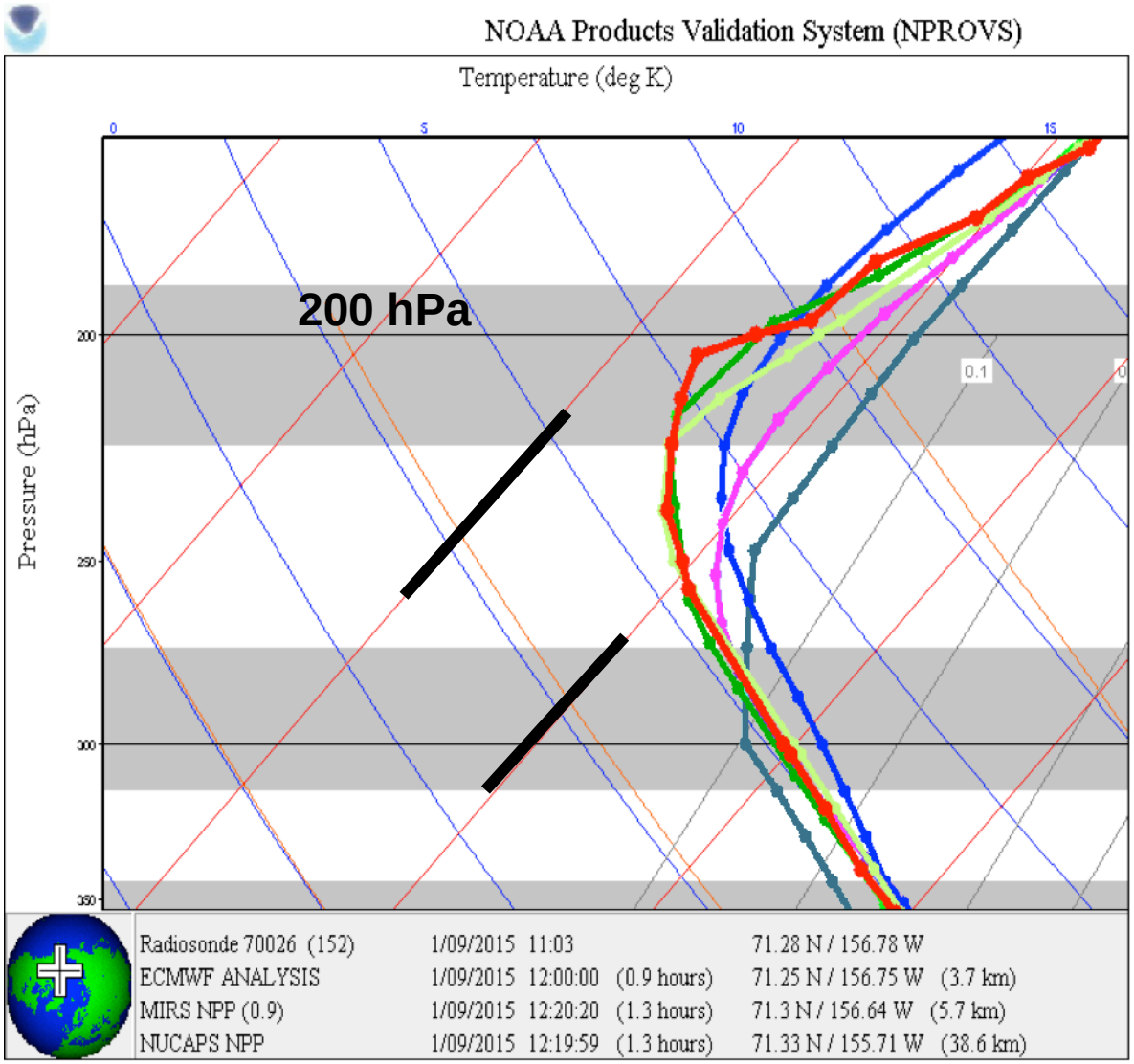
Radiosonde
GFS 6 Hour
ECMWF Analysis
MIRS NPP
NUCAP NPP
MIT

Canada (S)
IR+MW pass QC



Radiosonde
GFS 6 Hour
ECMWF Analysis
MIRS NPP
NUCAP NPP
MIT

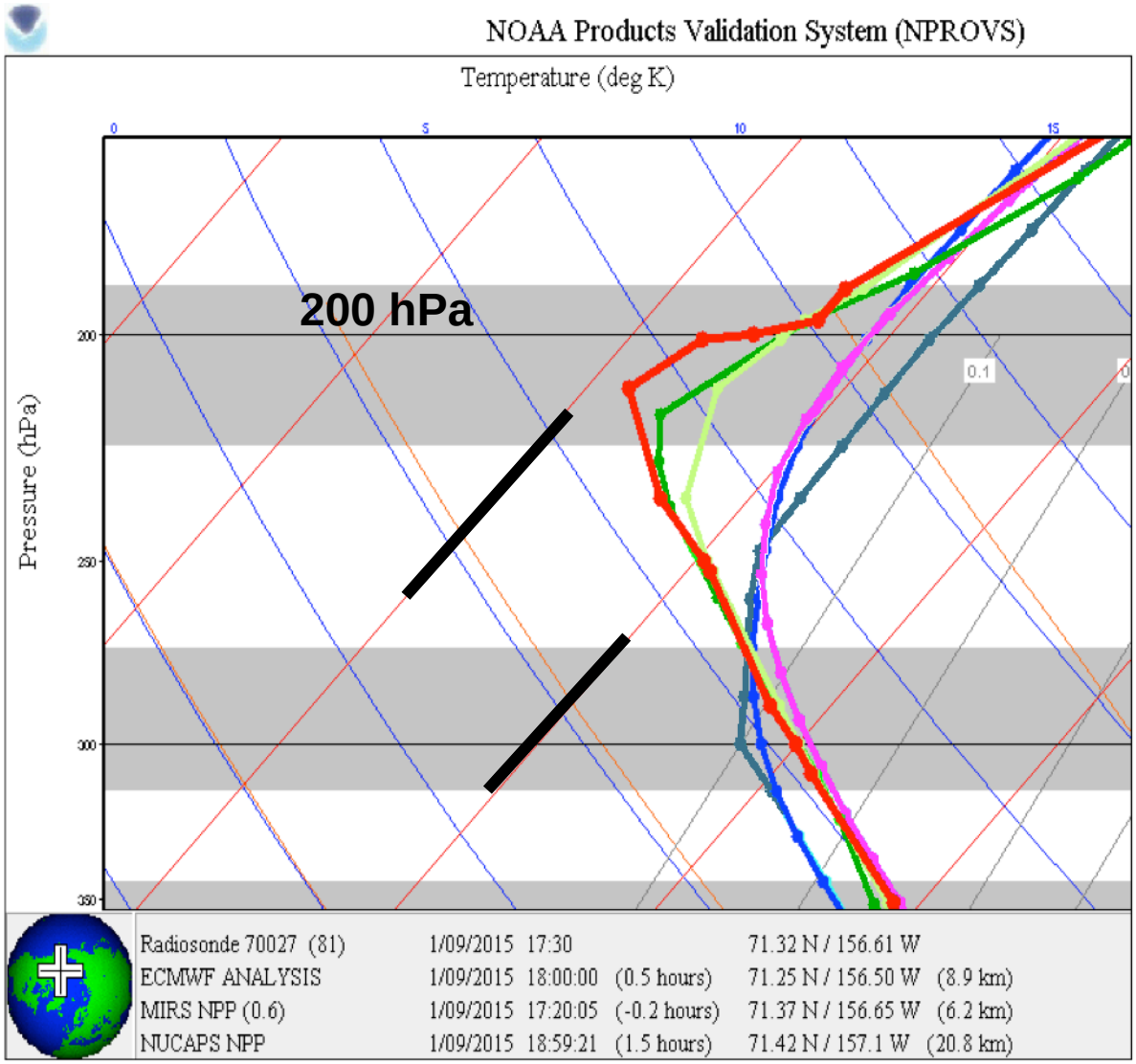
Canada (N)
IR+MW pass QC



Radiosonde
GFS 6 Hour
ECMWF Analysis
MIRS NPP
NUCAP NPP
MIT

NSA

IR+MW pass QC



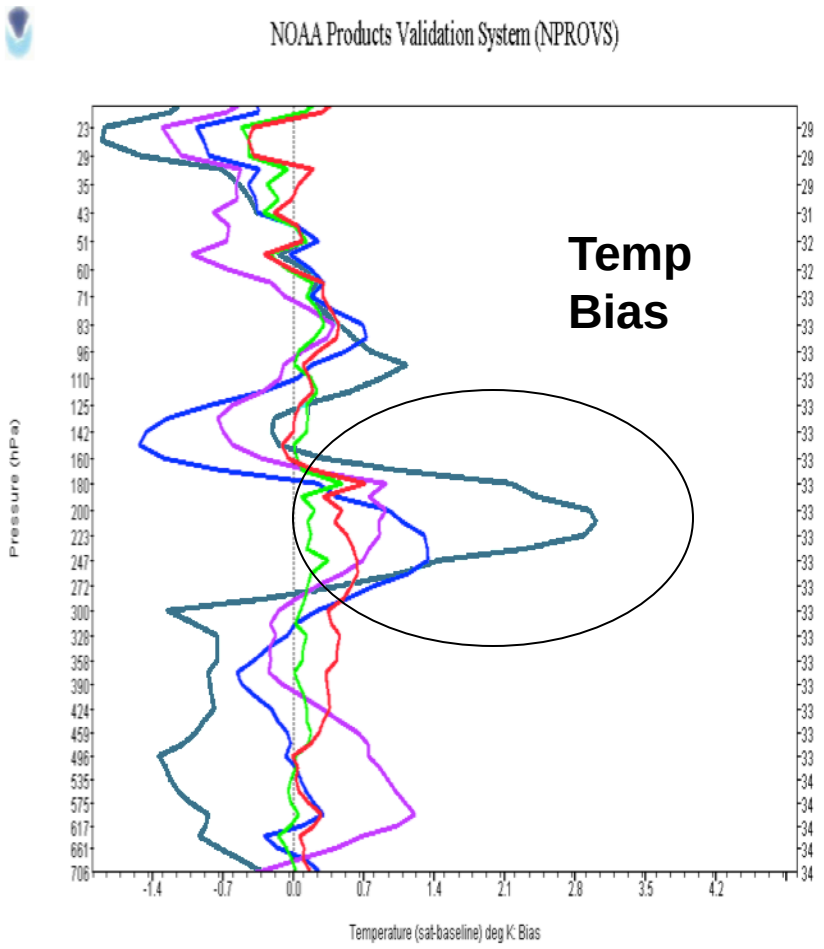
Radiosonde
GFS 6 Hour
ECMWF Analysis
MIRS NPP
NUCAP NPP
MIT

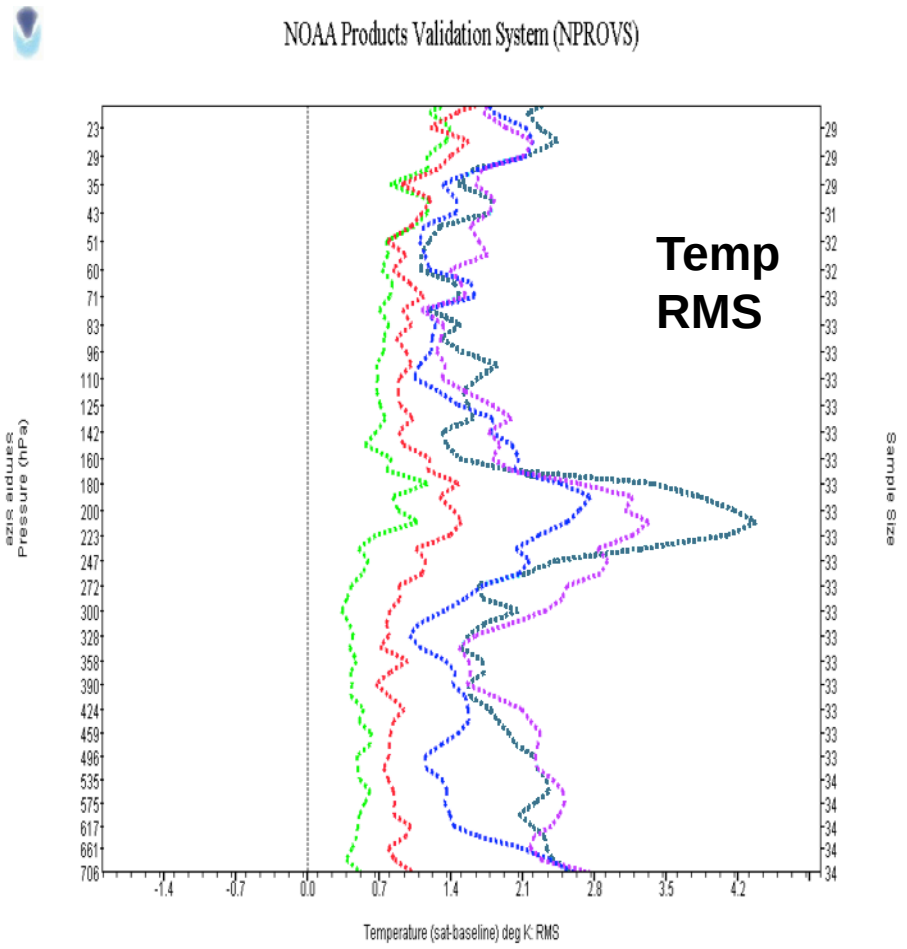
NSA

IR+MW pass QC

SAT-minus-RAOB Statistics

1. Case Study Day Jan 9 (Alaska Region)
2. Case Study Period Jan 5-15 (Alaska Region)
3. Case Study Period Jan 5-15 (CONUS)





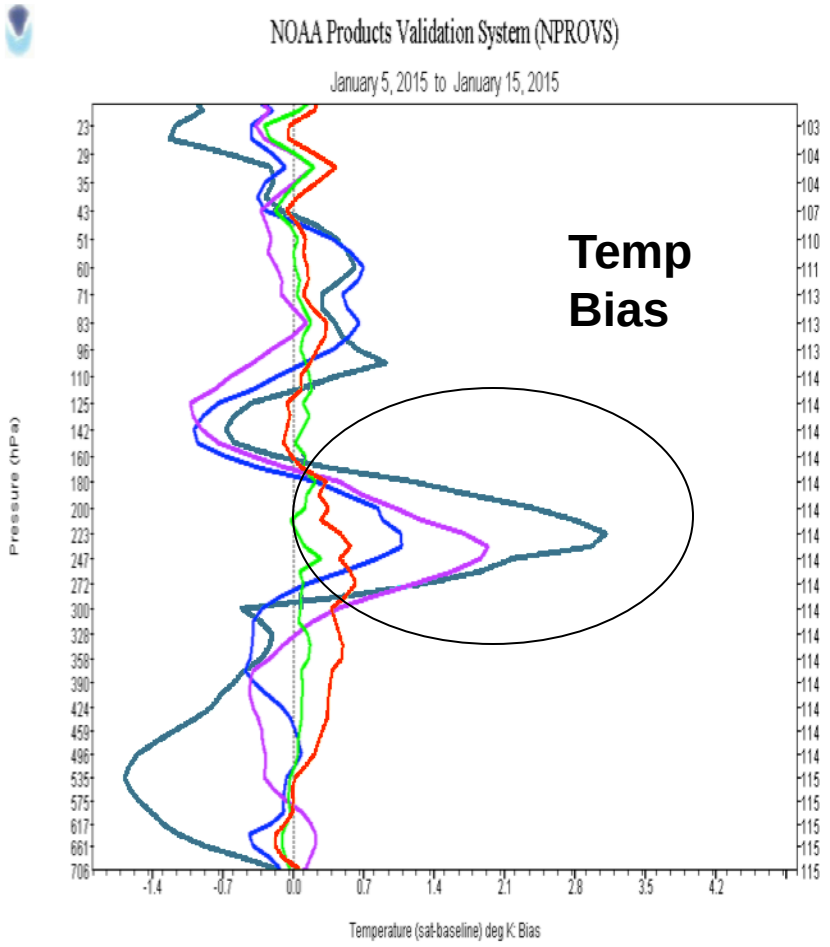
Baseline: Radiosonde

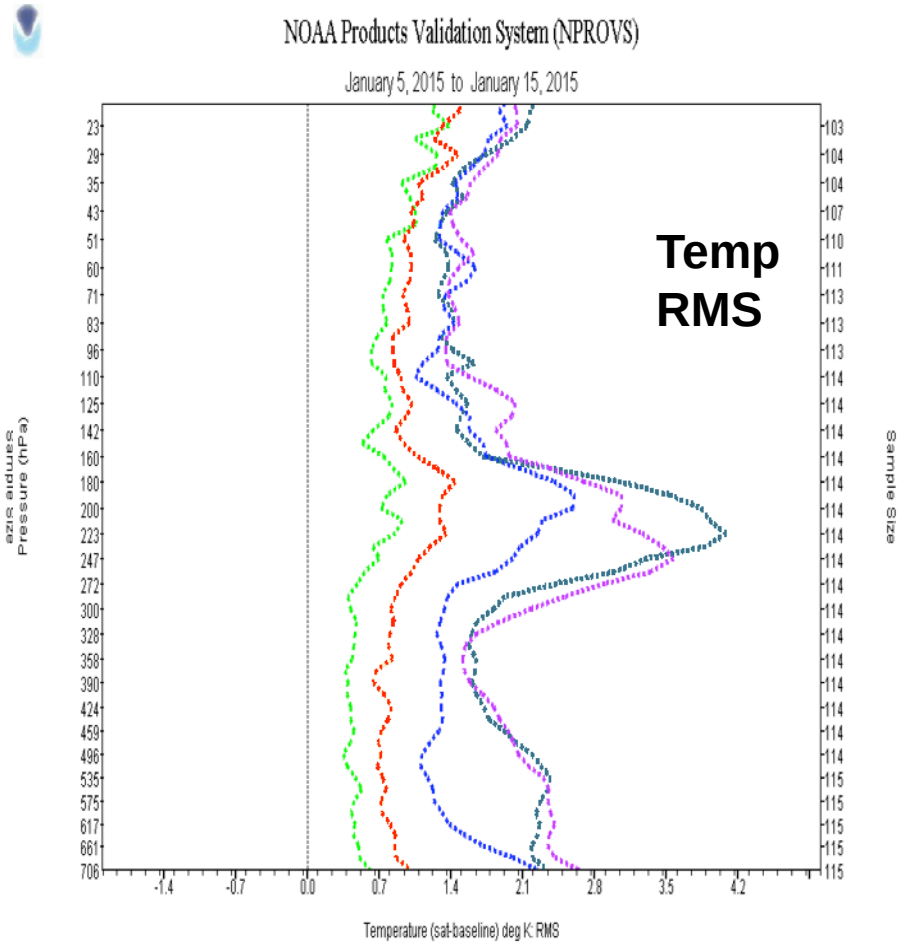
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Radiosonde GFS 6 Hour **ECMWF Analysis** **MIRS NPP ***

NUCAPS NPP **NUCAPS NPP MIT**

SAT-minus-RAOB for Jan 9, 2015: Alaska Region
(NUCAPS IR+MW and MiRS pass QC)

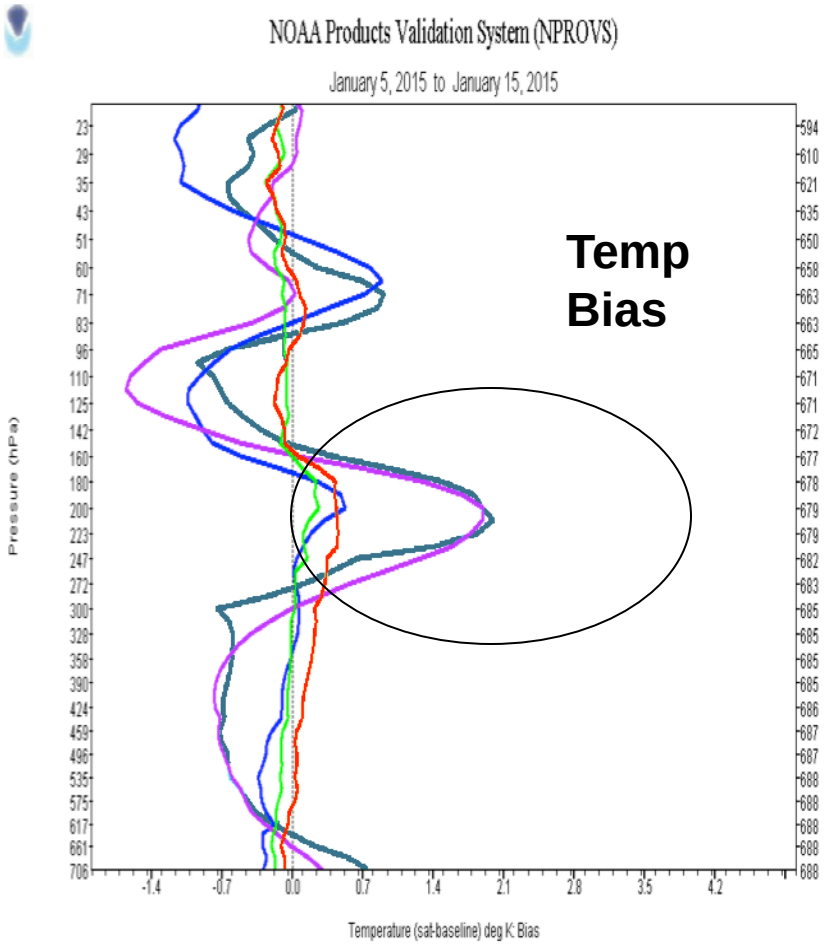


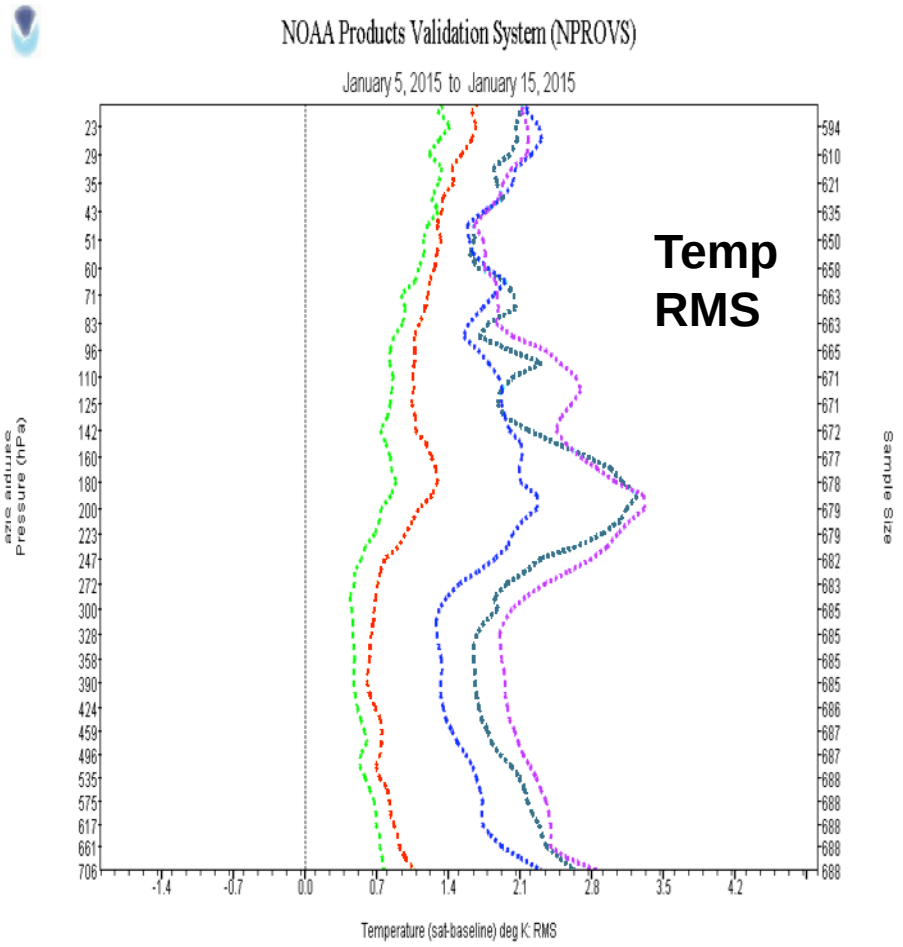


Baseline: Radiosonde

Radiosonde GFS 6 Hour **ECMWF Analysis** **MIRS NPP ***
NUCAPS NPP **NUCAPS NPP MIT**

SAT-minus-RAOB for Jan 5-15, 2015: Alaska Region
(NUCAPS IR+MW and MiRS pass QC)





Baseline: Radiosonde

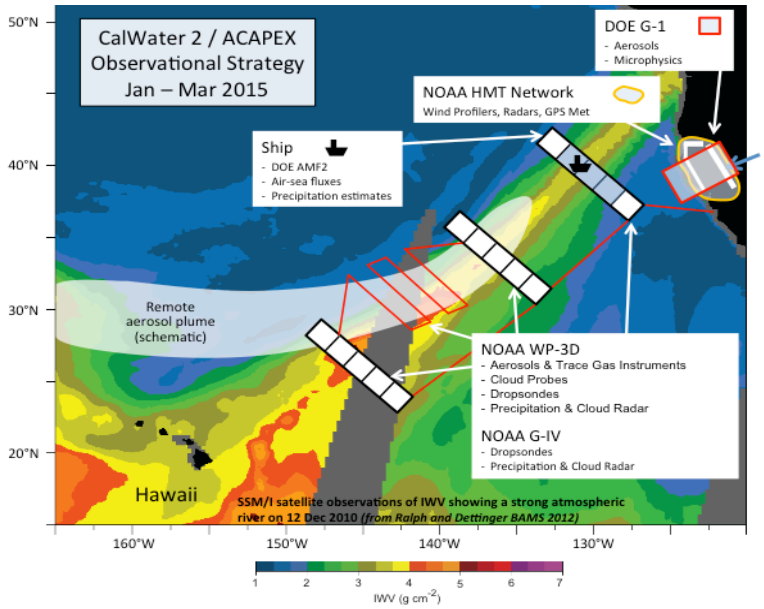
*

Radiosonde GFS 6 Hour
NUCAPS NPP
ECMWF Analysis
NUCAPS NPP MIT
MIRS NPP *

SAT-minus-RAOB for Jan 5-15, 2015: CONUS
(NUCAPS IR+MW and MiRS pass QC)

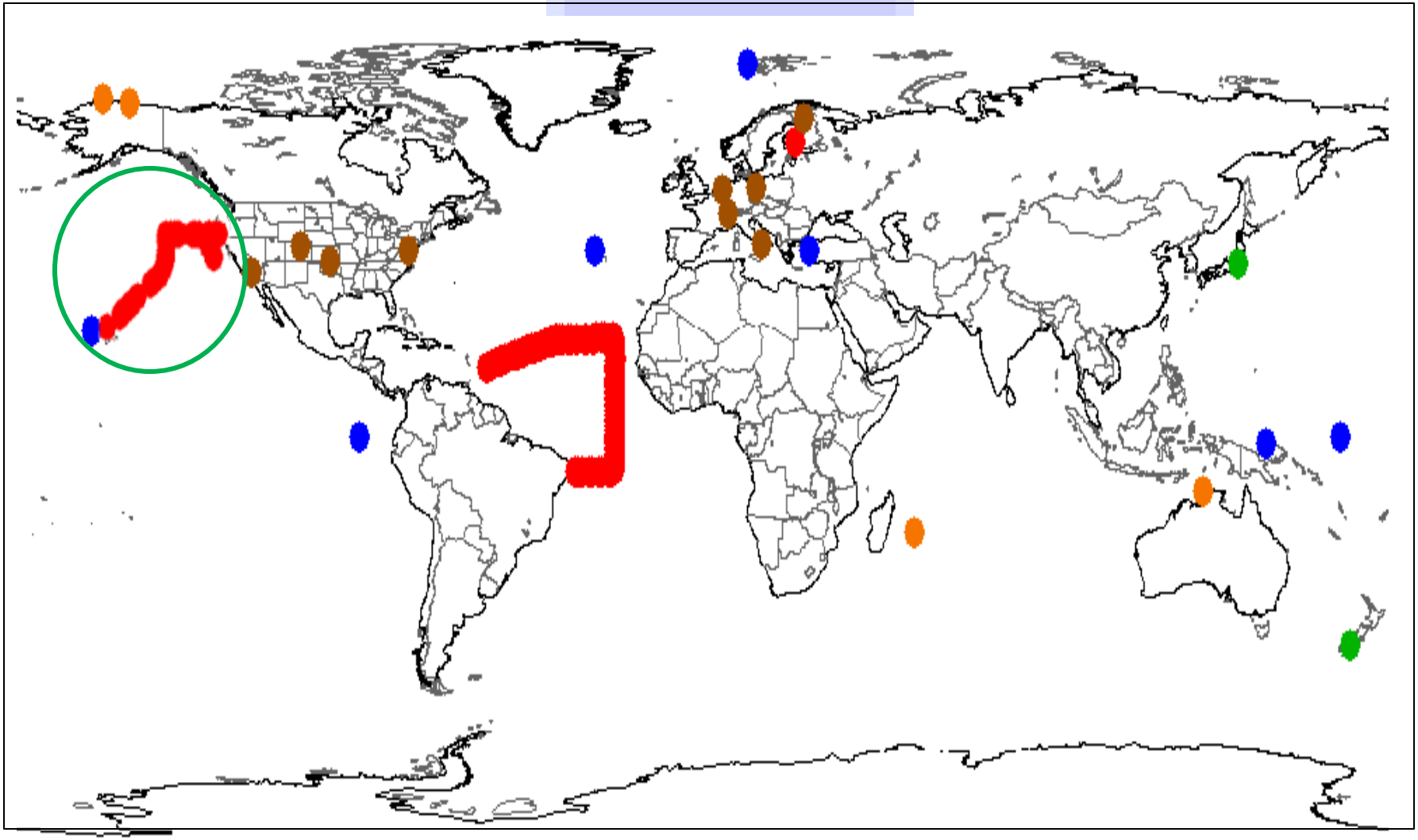
CalWater 2/ACAPEX Field Campaign

- Interagency Campaign:
  - Scripps (Marty Ralph, Kim Prather)
  - NOAA (Allen White, Ryan Spackman)
  - DOE (PI: L. Ruby Leung) ACAPEX = ARM Cloud Aerosol Precipitation Experiment
- White paper at
- http://esrl.noaa.gov/psd/calwater

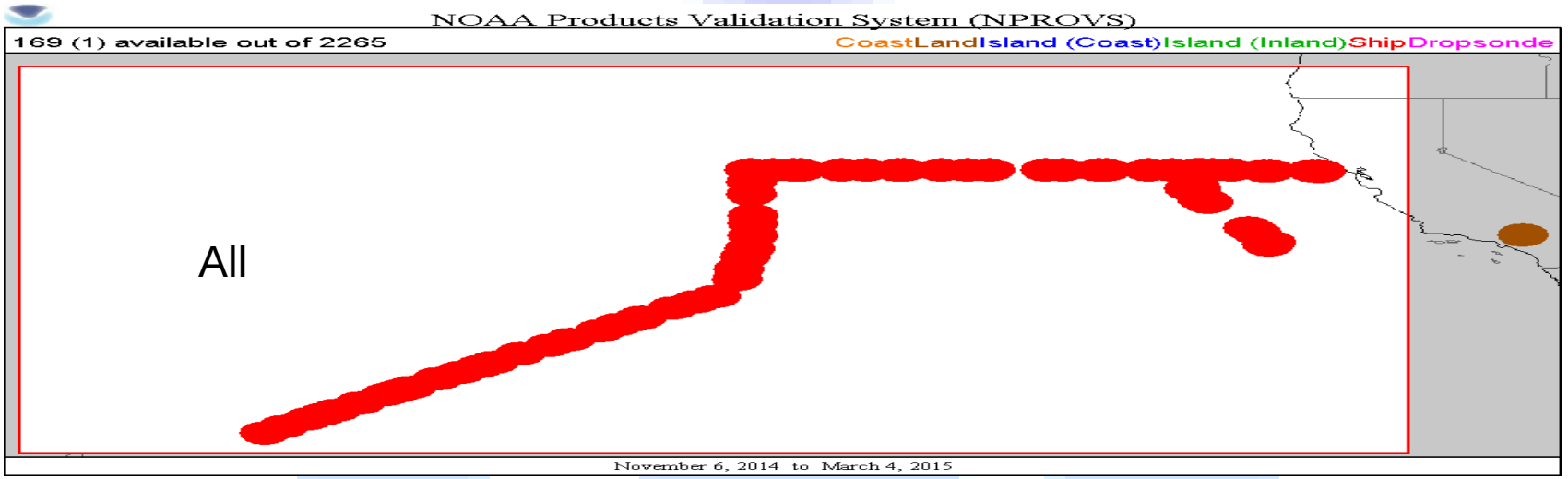


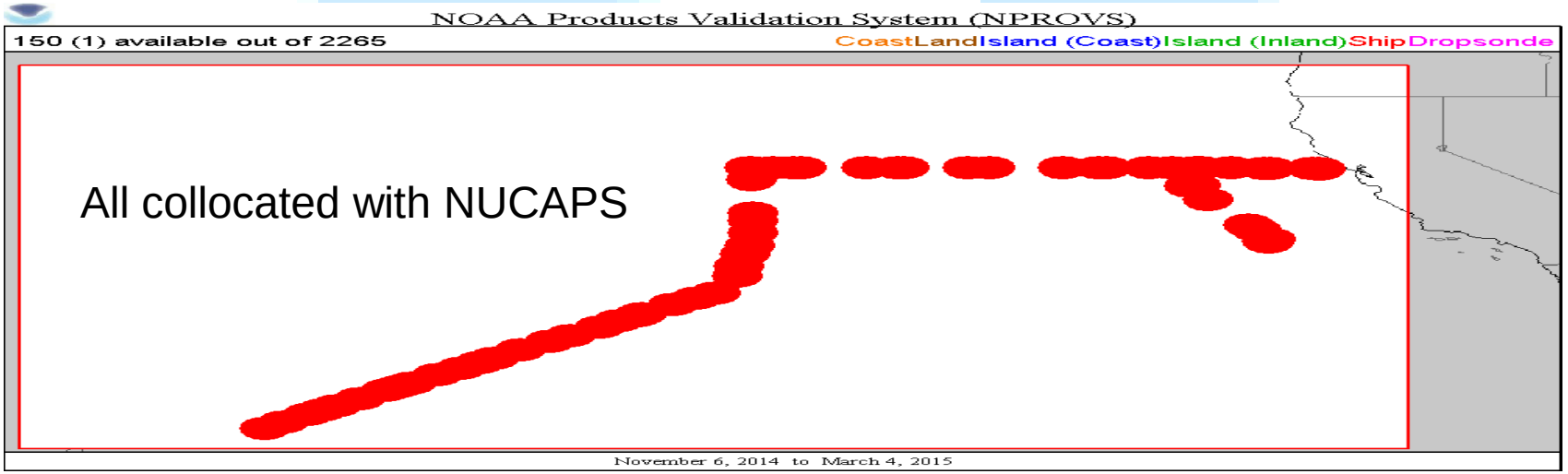
Platform	Range of Obs	Duration	Types of sensors
AR Observatories and Hydro-Met Testbed	ARO sites: CA(4), OR(2), WA(1)	Full campaign	Snow level radar (S-band), 449 MHz wind profilers, soil moisture, 10 meter surface tower
NOAA WP-3D	1-22 kft, 4000 km range	80h over 4 weeks	~150 dropsondes, W-band radar (clouds), IWRAP Radar, Tail Dopper Radar, Cloud Probes, SFMR
NOAA G-IV	1-45 kft	90h over 6 weeks	~300 dropsondes, Tail Doppler Radar, NOAA O3, SFMR
DOE G-1 with ~40 instruments	1-23 kft	120h over 8 weeks	Cloud properties (Liq/water content, size), aerosol properties (concentration, size, CCN), trace gases (H2O, O3, CO)
NOAA R.H. Brown	Can move ≤ 5 deg/day to stay within AR	30 days	AMF2: Aerosol Observing System, Ka ,X, W-Band Cloud Radars, DOE, Micropulse LIDAR, Wind Speed, Rain Guages RS-92 Sondes: ~260 (~half dedicated overpass time)

N P R O V S +

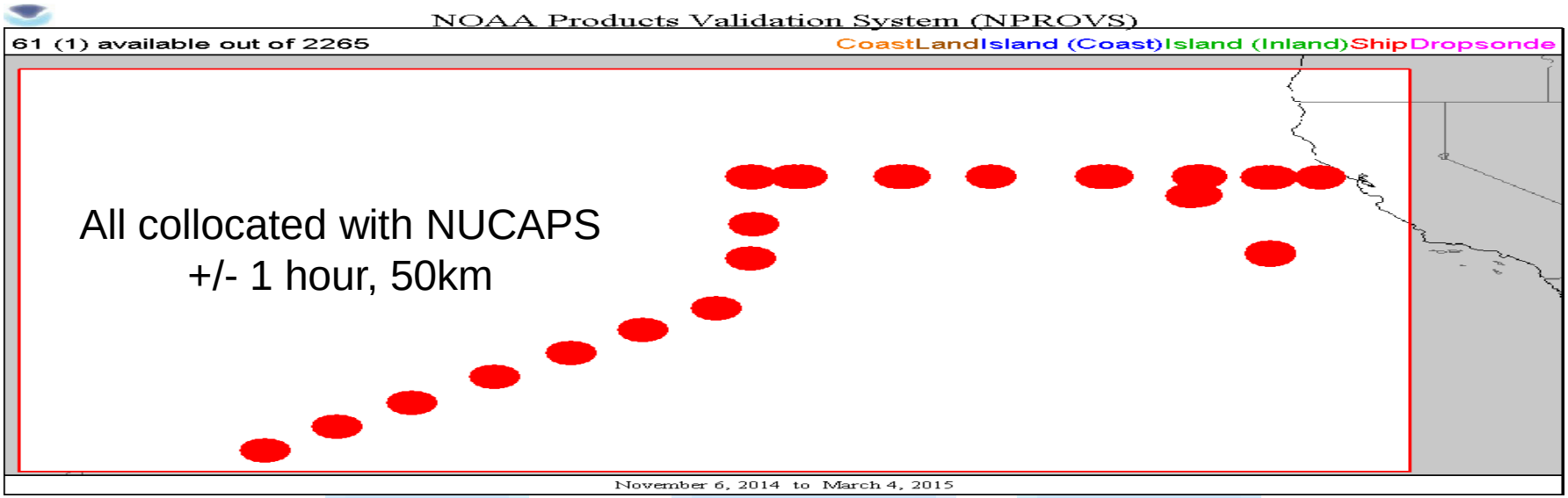


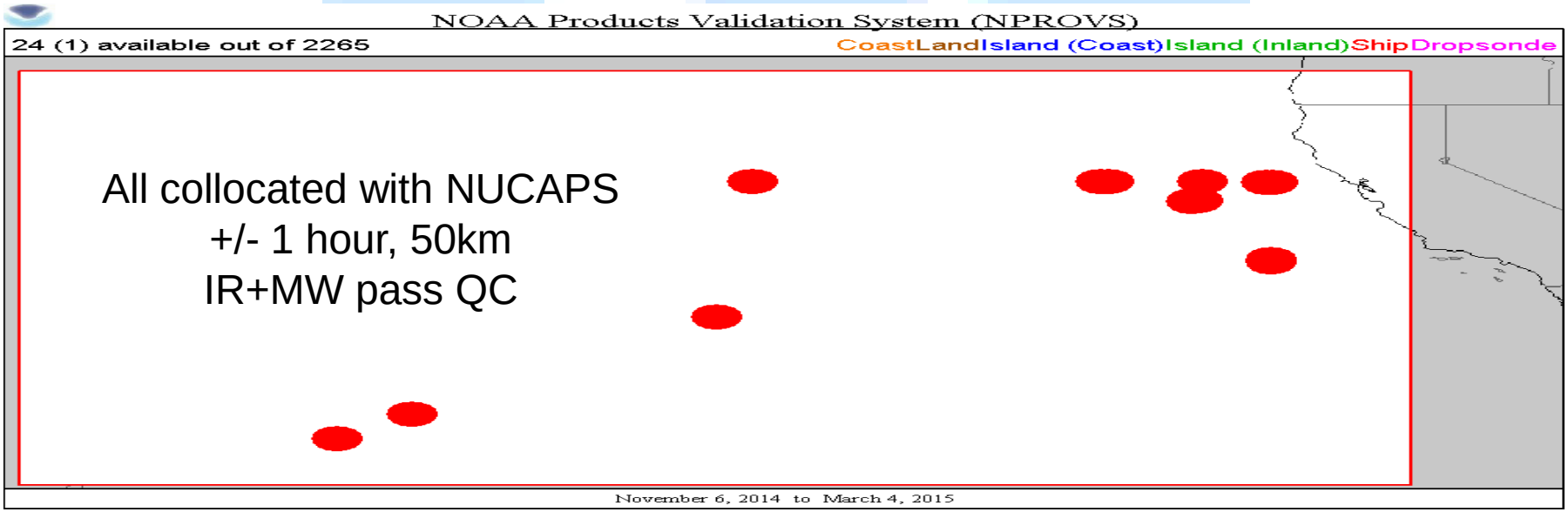
GRUAN and JPSS funded Dedicated (S-NPP) RAOB Sites
Over 10,000 RAOBS (1000 dedicated) available since July 2013



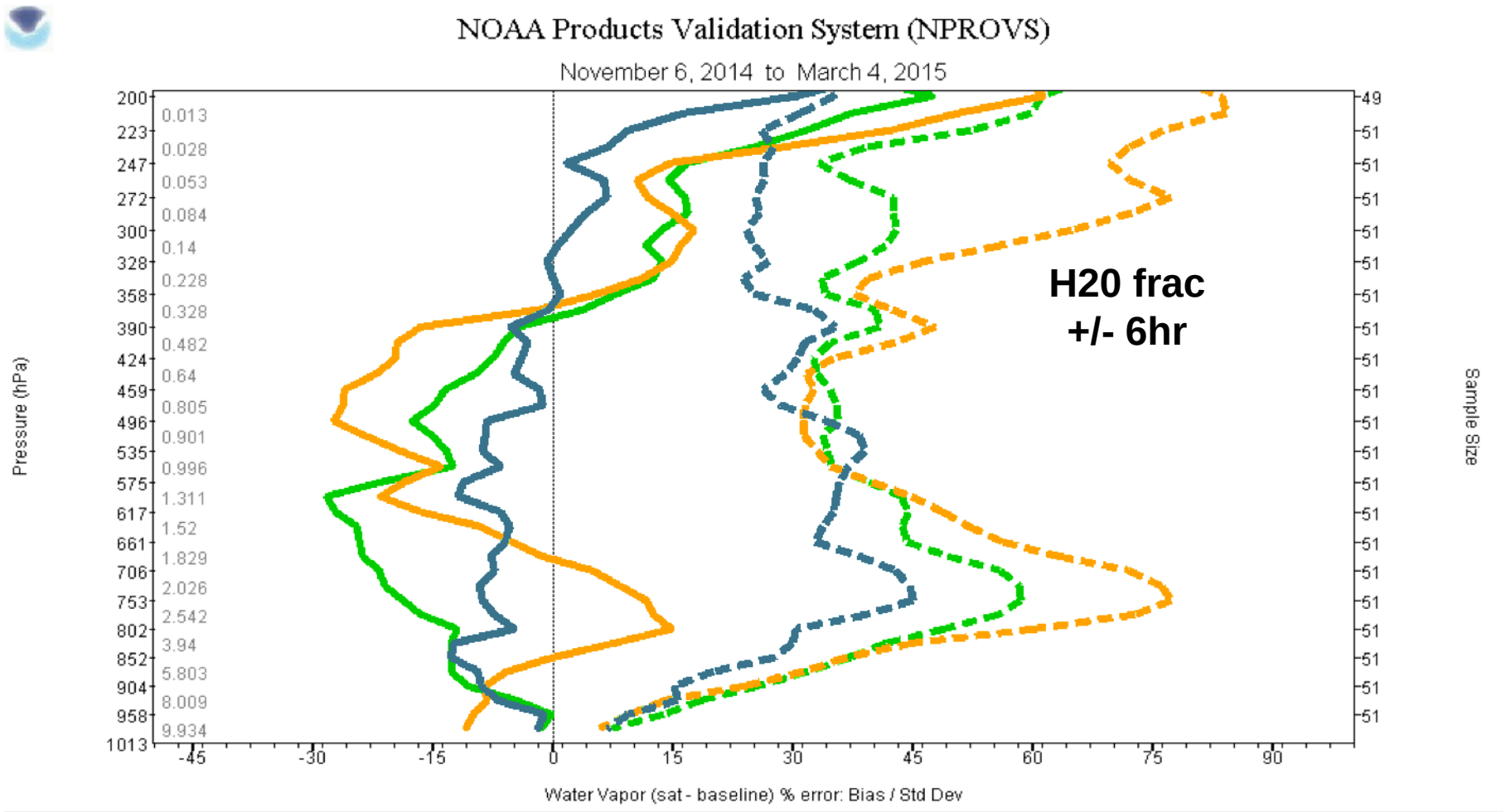


CALWATER RAOB collocated with NUCAPS





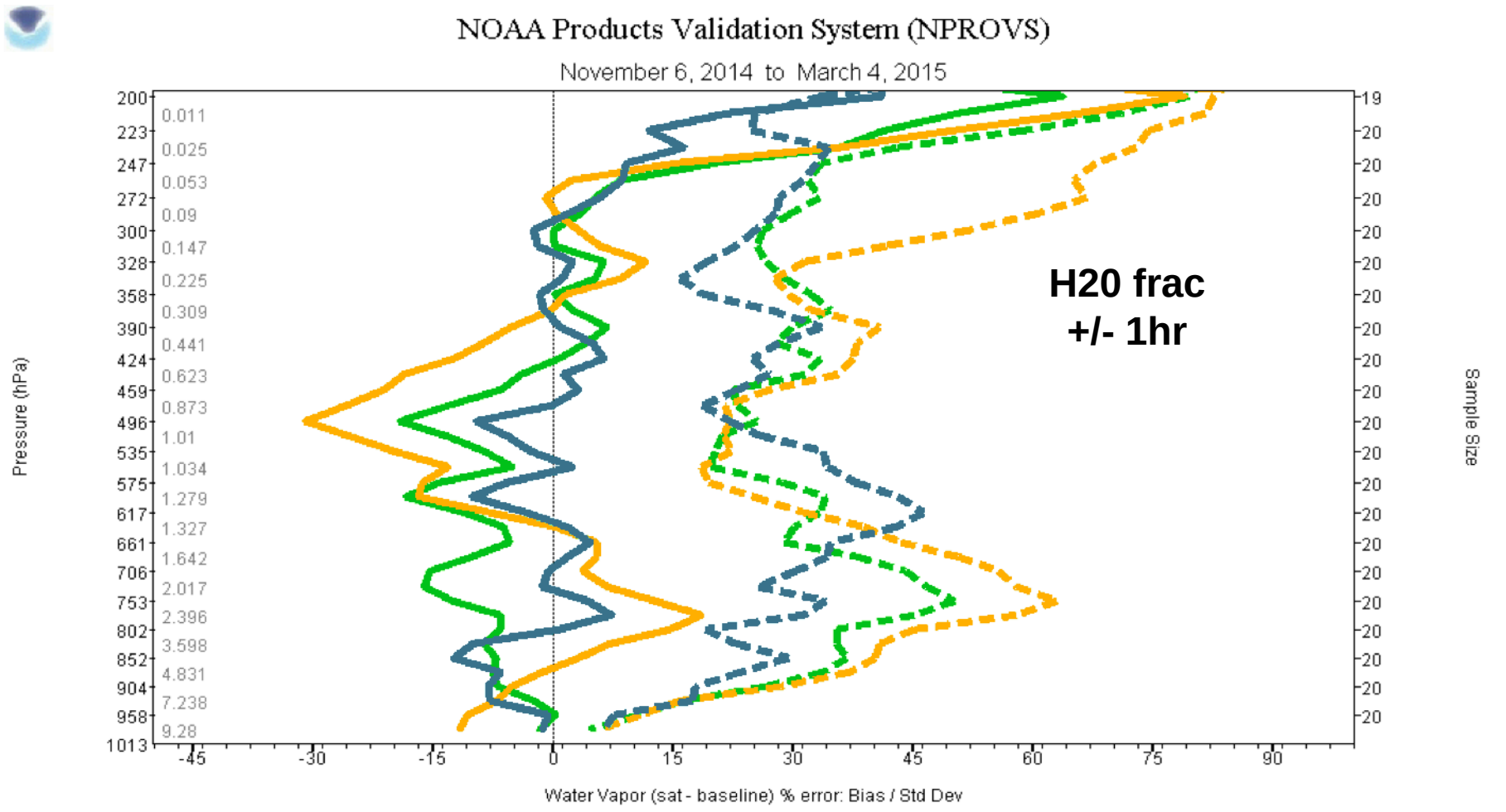
CALWATER RAOB collocated with NUCAPS



Baseline: Reference Sonde GRUAN RAOB

ECMWF Analysis **MIRS NPP Test** **NUCAPS NPP**

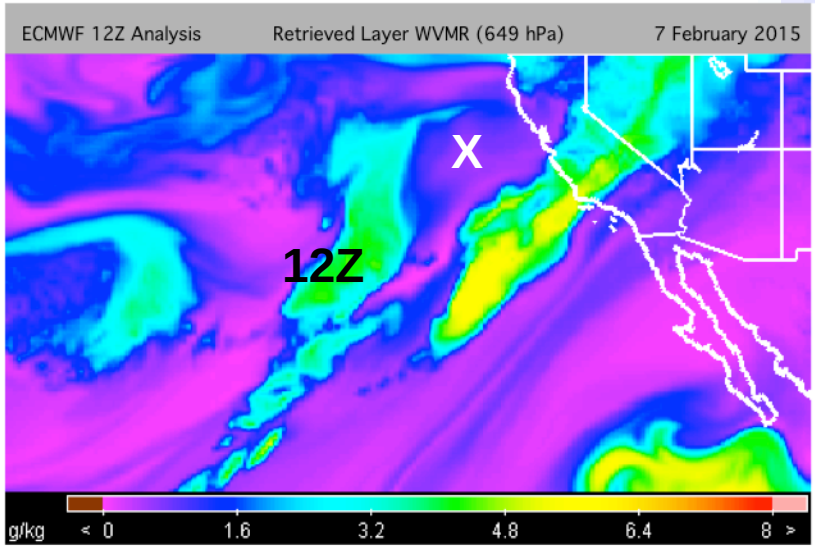
Sample of NUCAPS IR which pass QC

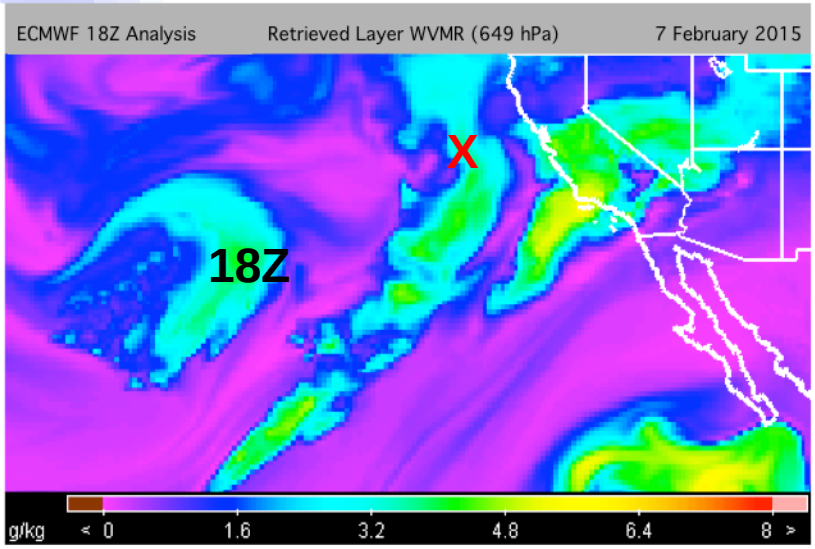


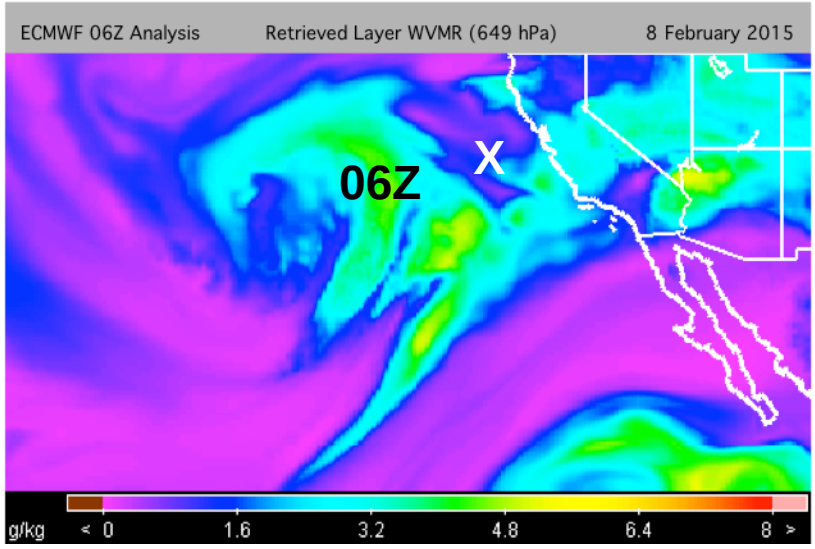
Baseline: Reference Sonde GRUAN RAOB

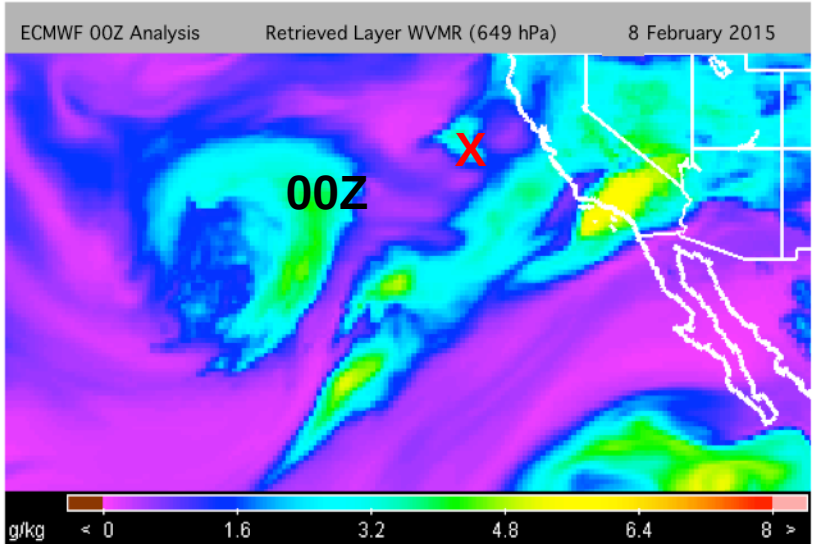
ECMWF Analysis **MIRS NPP Test** **NUCAPS NPP**

Sample of NUCAPS IR which pass QC

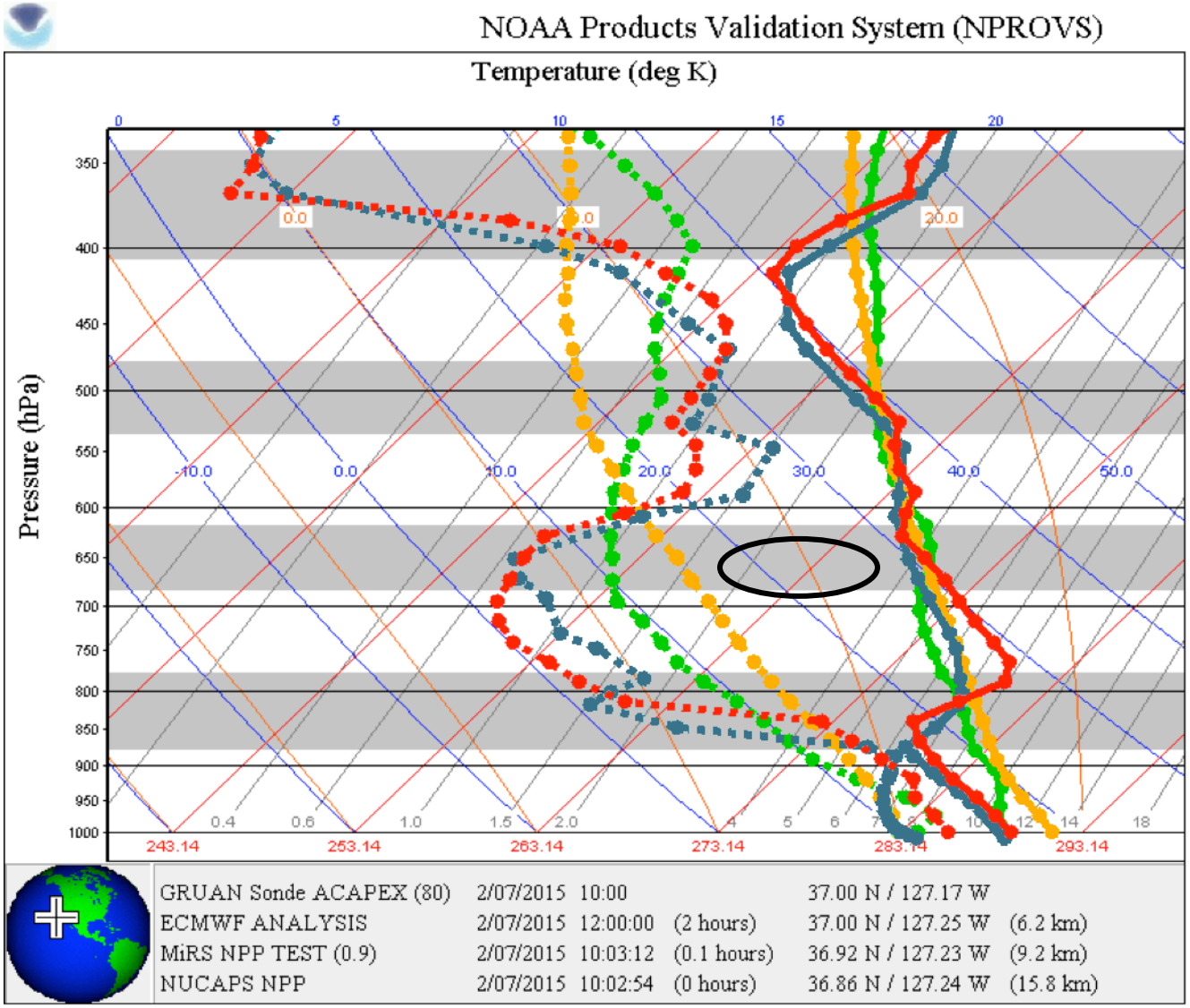








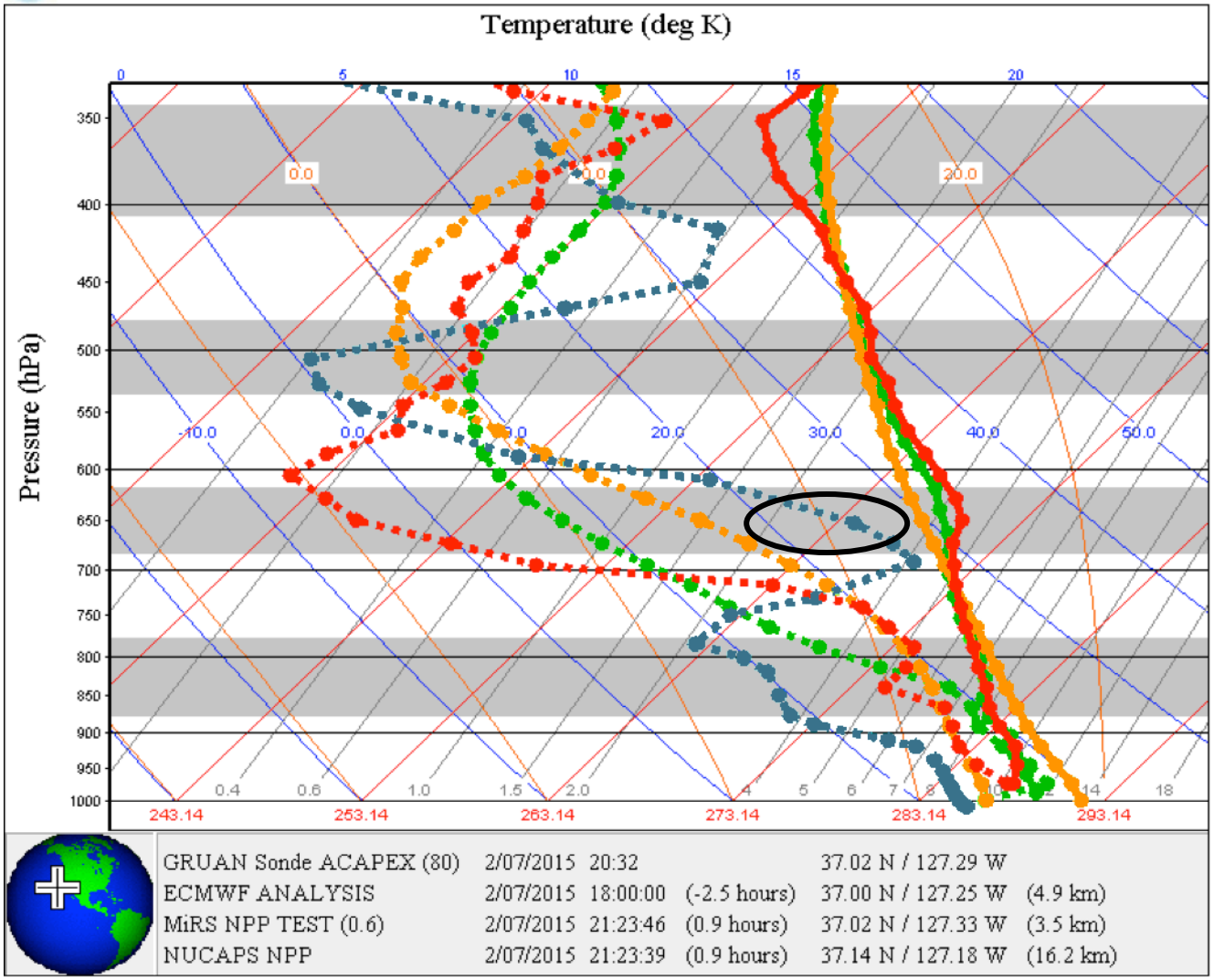
ECMWF 12Z (Feb 7th) to 6Z (Feb 8th)



Reference Sonde
ECMWF Analysis
MIRS NPP Test
NUCAPS NPP

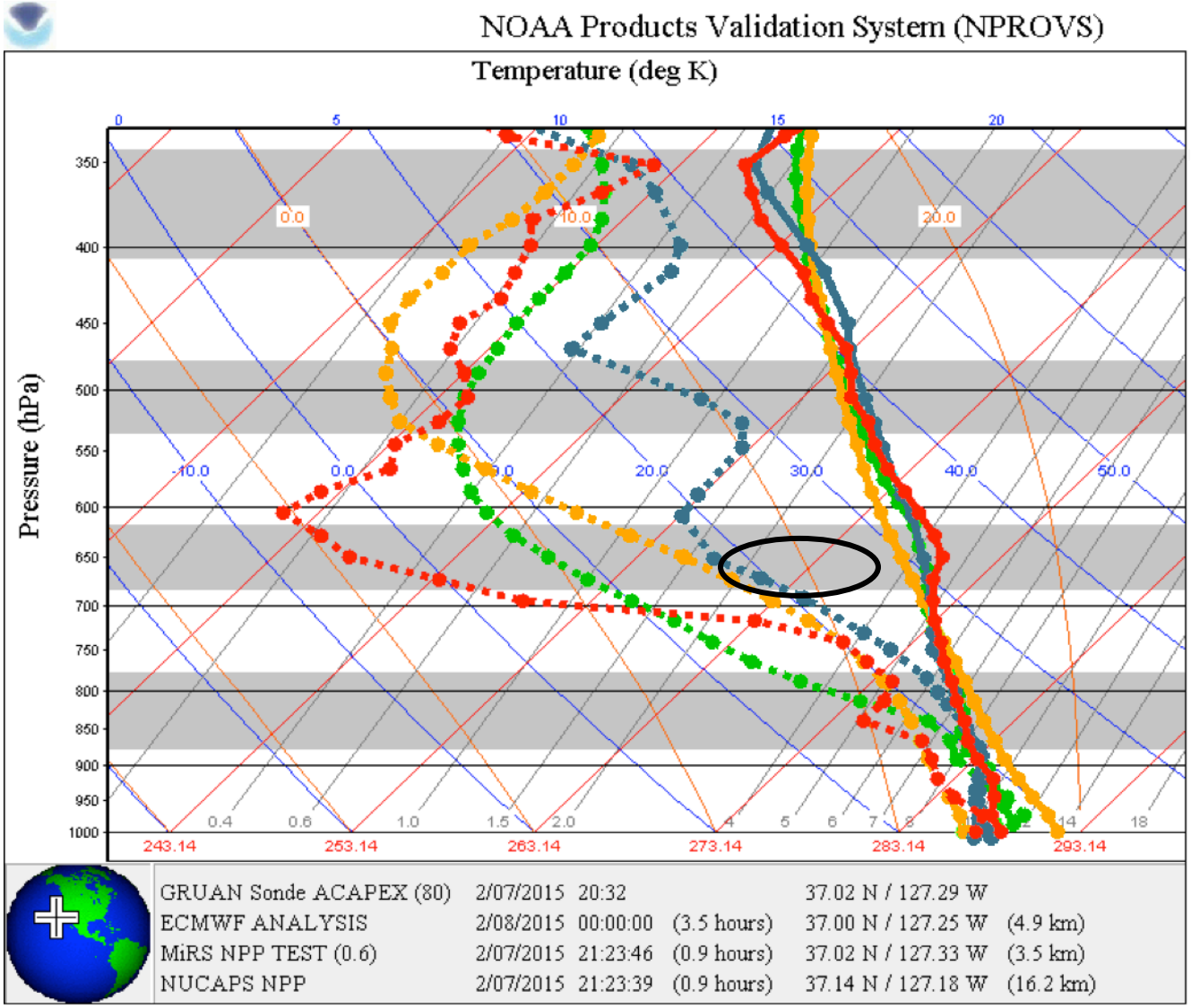
SAT @ 1003Z … ECMWF @ 12Z … RAOB @ 1000Z

NOAA Products Validation System (NPROVS)



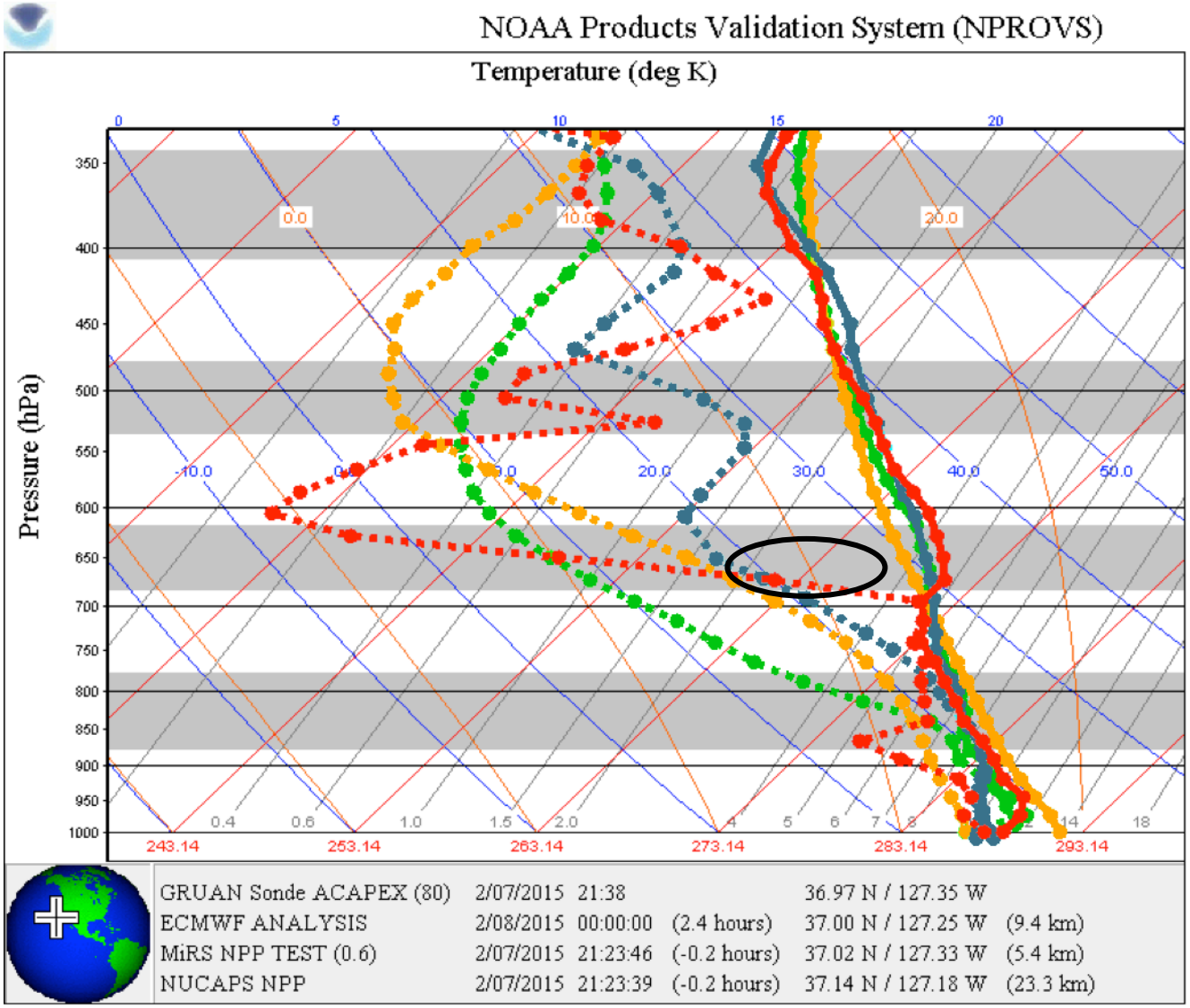
Reference Sonde
ECMWF Analysis
MIRS NPP Test
NUCAPS NPP

SAT @ 2123Z … ECMWF @ 18Z … RAOB @ 2032Z



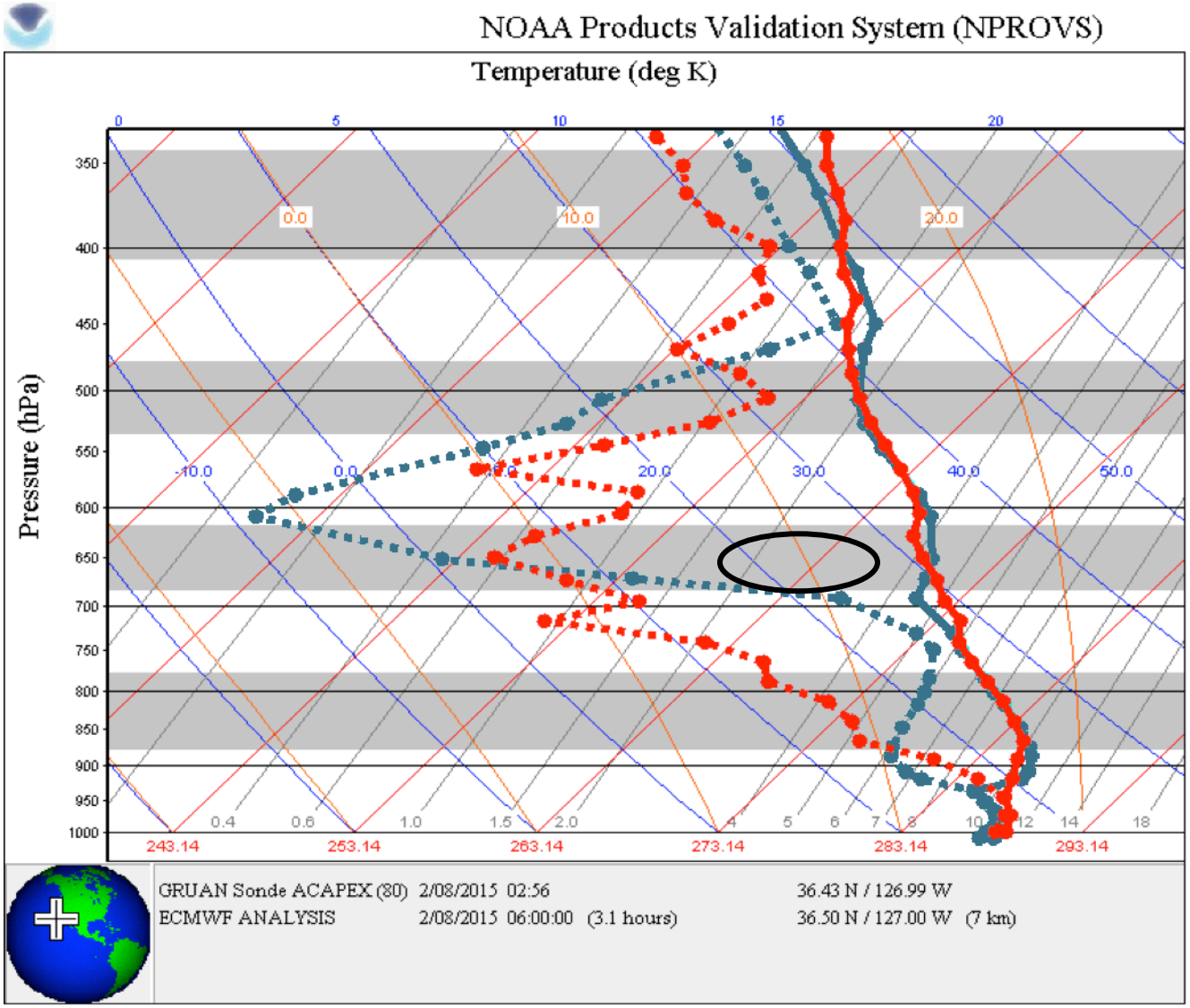
Reference Sonde
ECMWF Analysis
MIRS NPP Test
NUCAPS NPP

SAT @ 2123Z … ECMWF @ 00Z … RAOB @ 2032Z



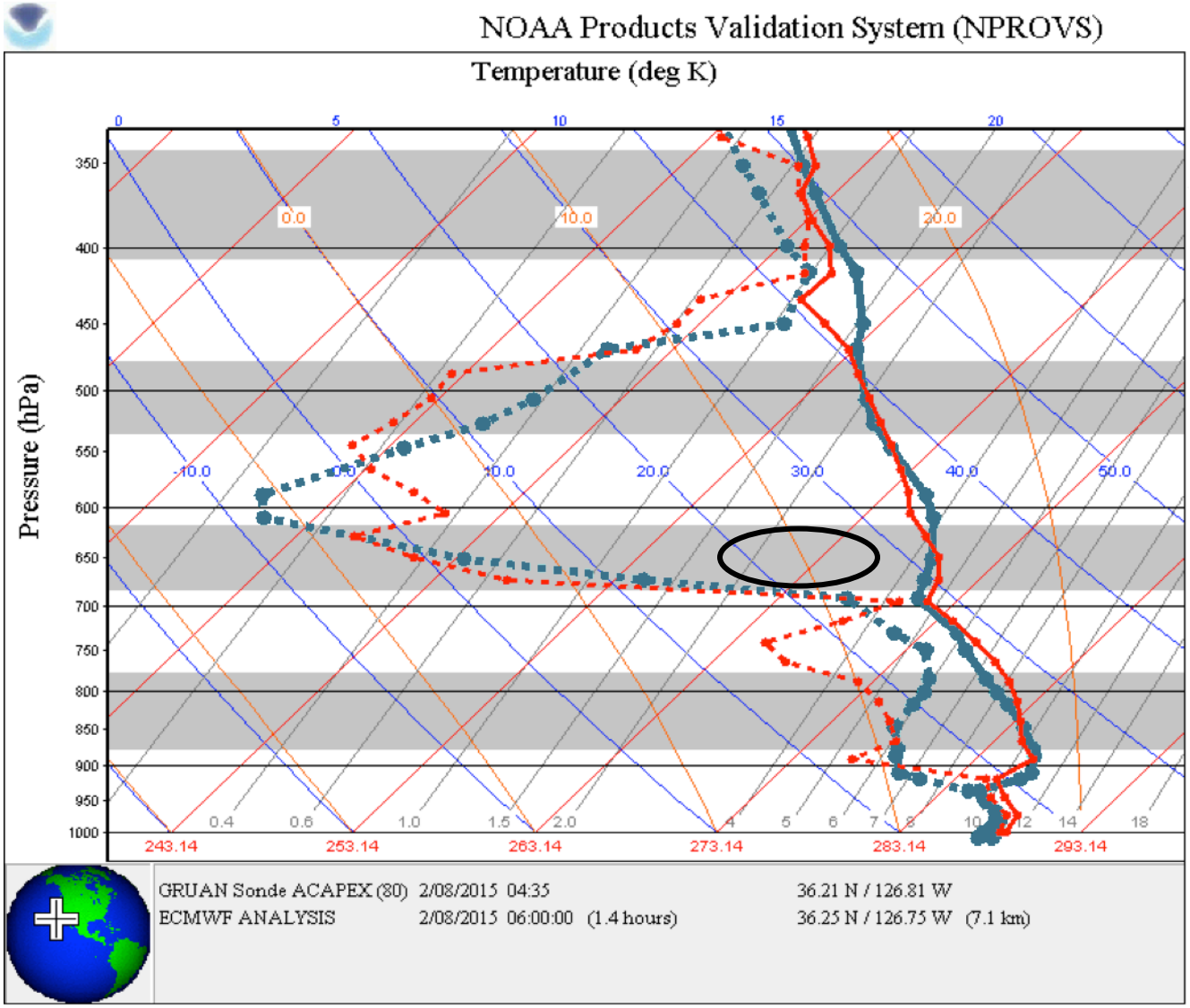
Reference Sonde
ECMWF Analysis
MIRS NPP Test
NUCAPS NPP

SAT @ 2123Z … ECMWF @ 00Z … RAOB @ 2138Z



Reference Sonde
ECMWF Analysis

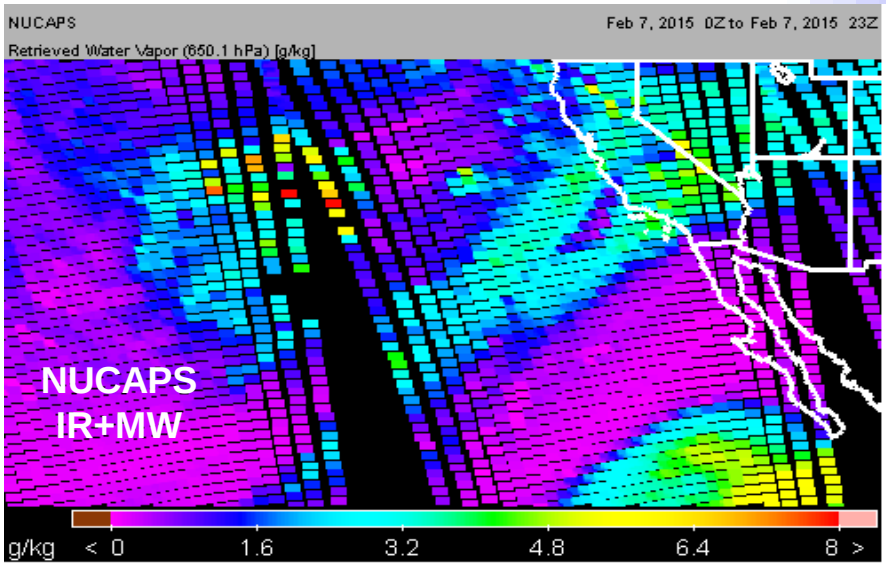
SAT @ … ECMWF @ 06Z … RAOB @ 0256Z

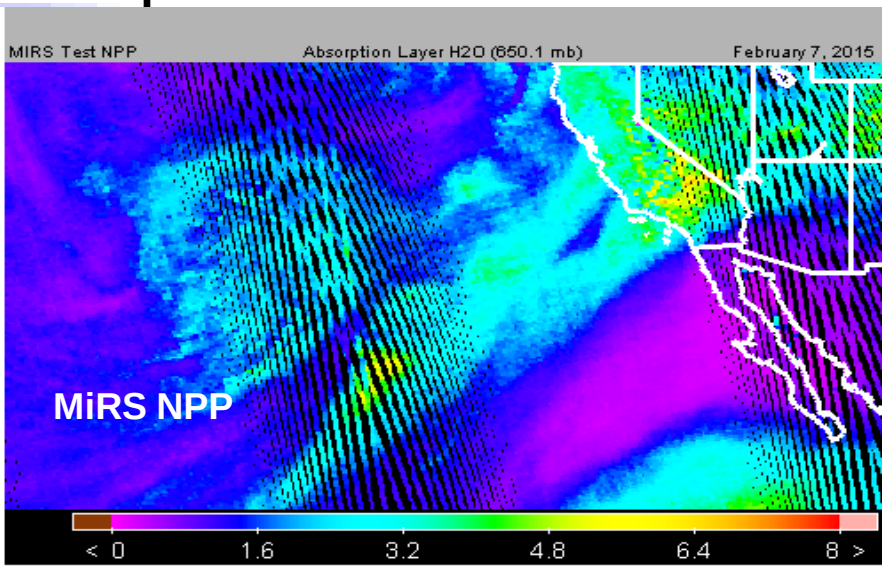


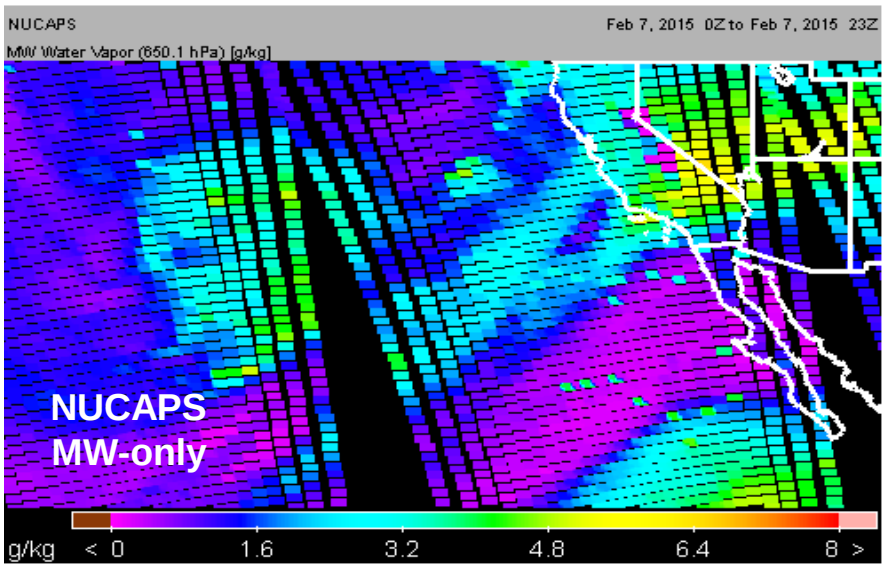
Reference Sonde
ECMWF Analysis

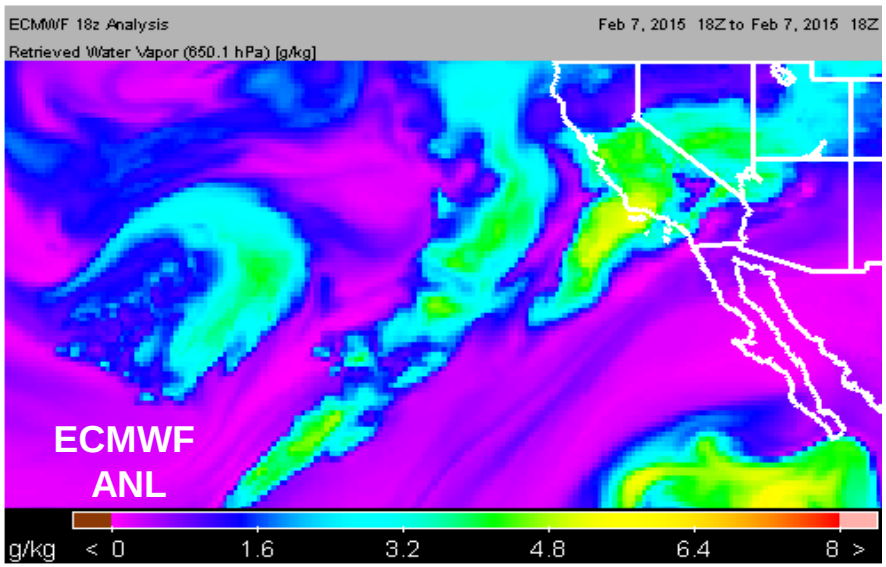
SAT @ … ECMWF @ 06Z … RAOB @ 0435Z

650 hPa H20 Vapor









SAT @ 21Z Feb 7th … ECMWF @ 18Z

Special session on users

featuring

ongoing AWIPS-2 activities

top utilize NUCAPS (etc) sounding

at

at NWS field office

Thursday

10:30

GRUAN Reference Measurement Principles (see Poster)

Given two measurement (m1, m2), their uncertainty (u_1, u_2) and variability (σ), then two observations are **consistent** if k .le. 2:

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

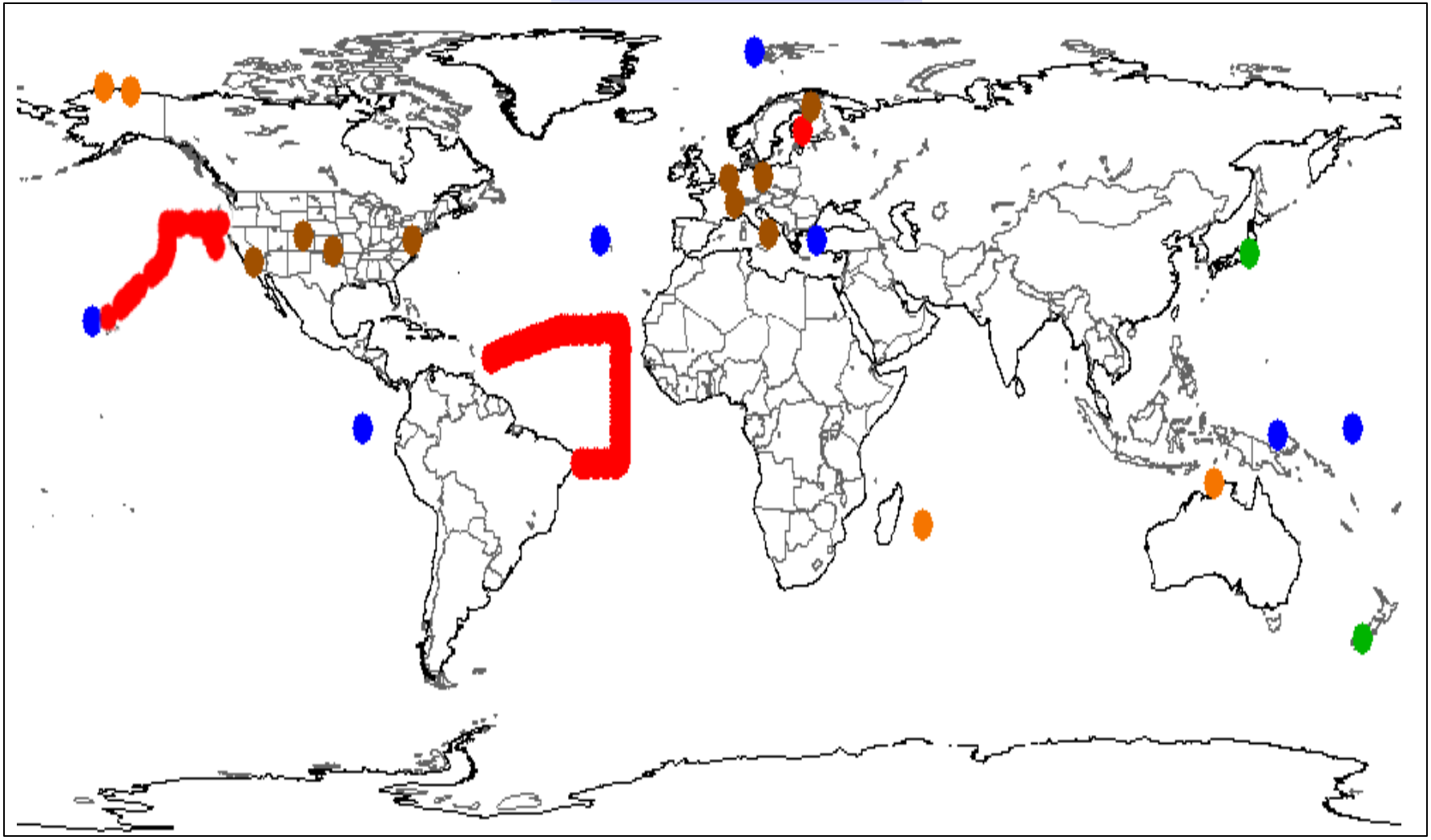
… in following plots :

K = ABS(X – GRUAN) / u

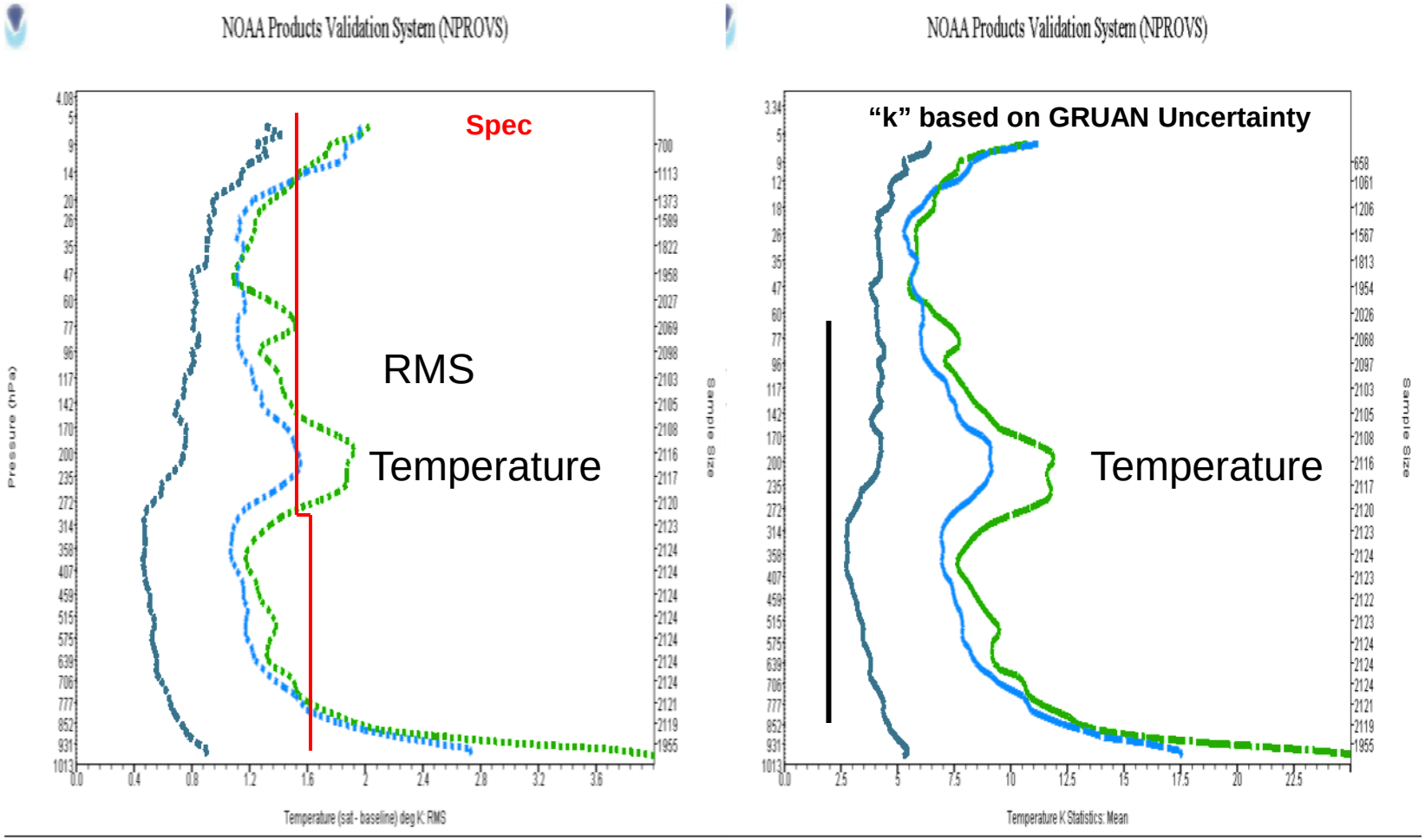
where u is GRUAN or NASA v6 uncertainty

"need uncertainty estimates for EDR" !!

NPROVS+

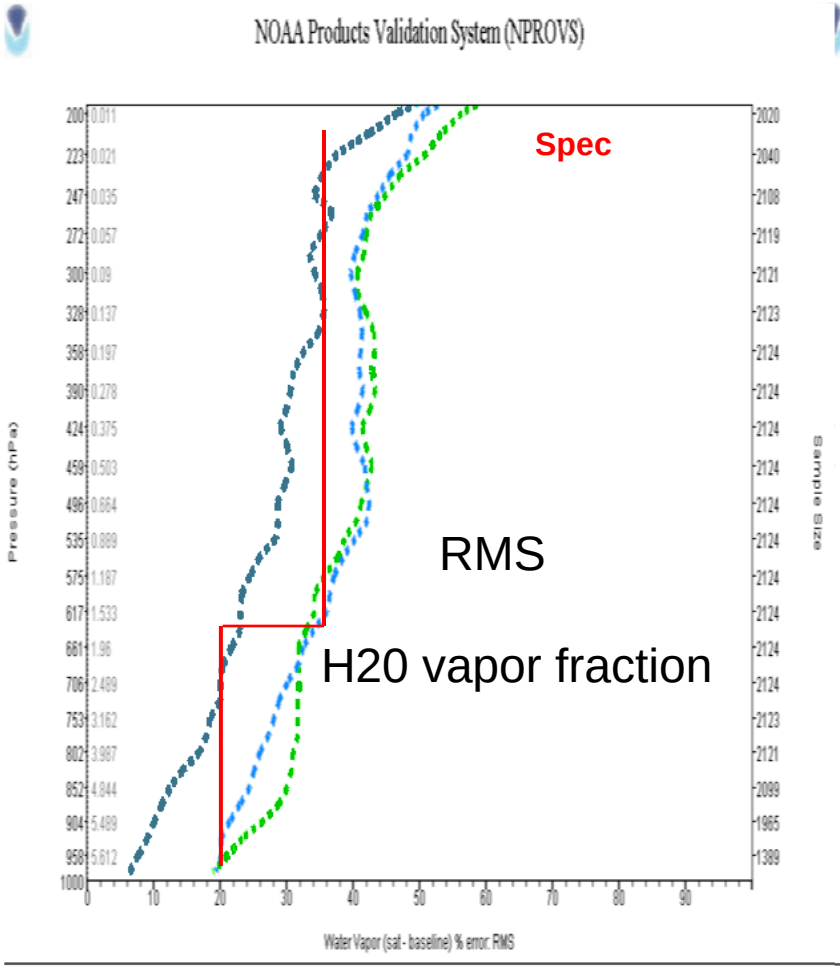


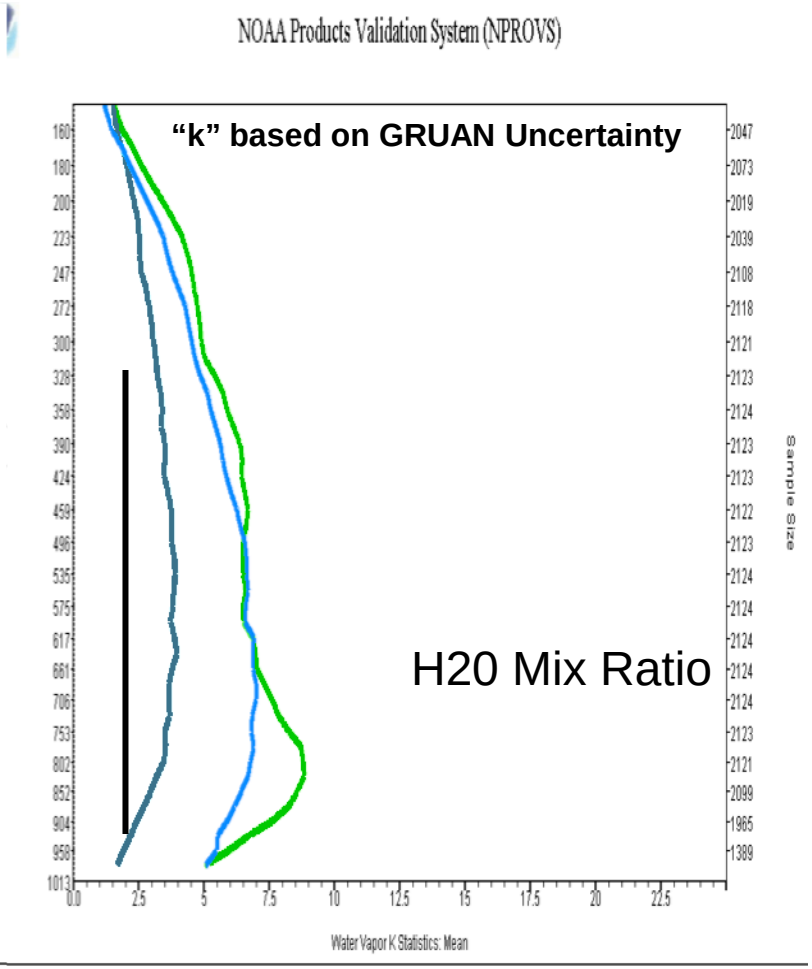
GRUAN and JPSS funded Dedicated (S-NPP) RAOB Sites
Over 10,000 RAOBS (1000 Dedicated) available since July 2013



Baseline: GRUAN Radiosonde

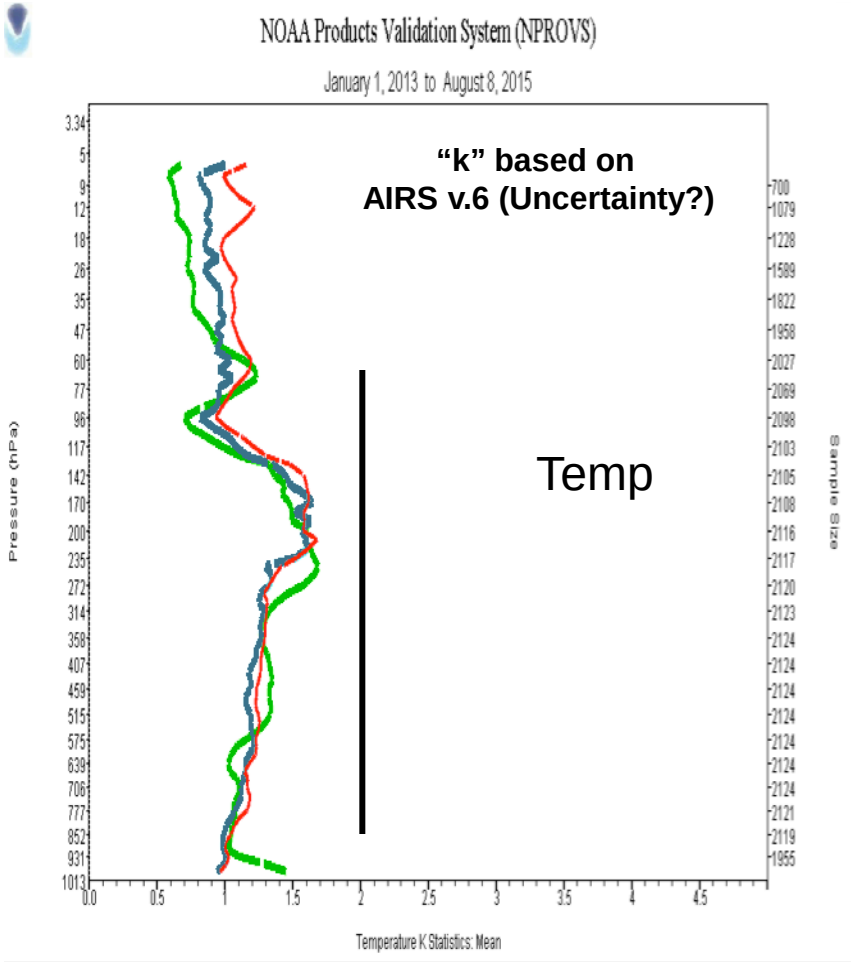
AIRS AQUA **ECMWF** **NUCAPS NPP**

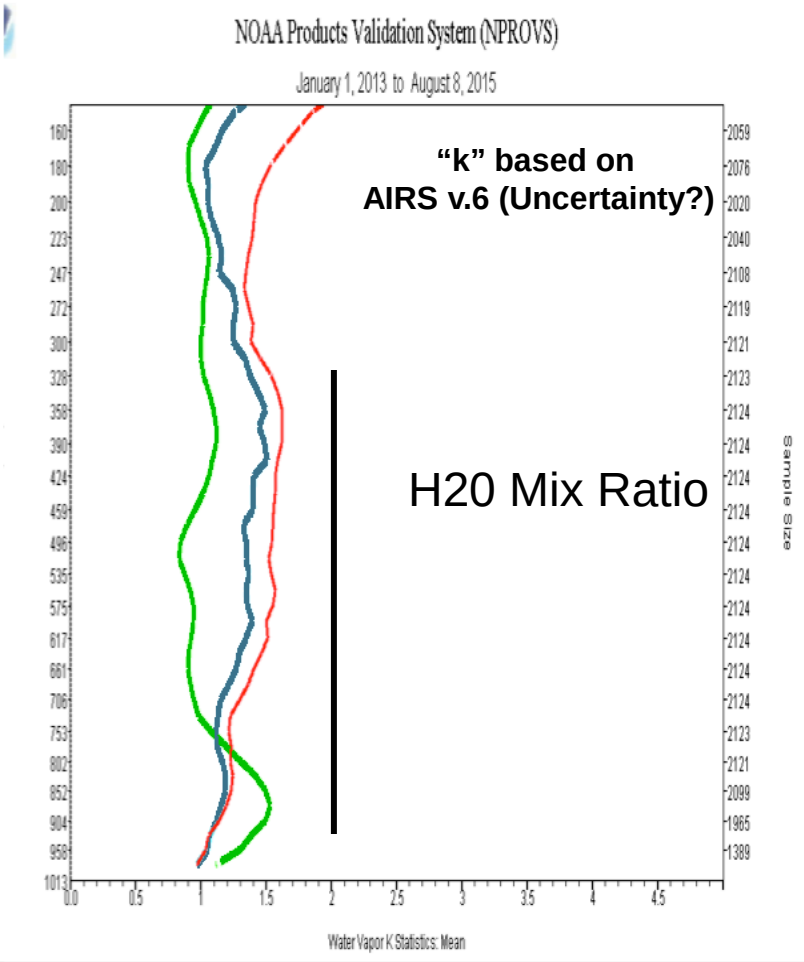




Baseline: GRUAN Radiosonde

AIRS AQUA **ECMWF** **NUCAPS NPP**





Baseline: AIRS AQUA

GRUAN Radiosonde **ECMWF** **NUCAPS NPP**

"k" based on AIRS v.6 (Uncertainty?)

SUMMARY

- Independent validation of multiple product system performance provided by NPROVS/NPROVS+ (see Poster; Pettey)

- LTM tracks overall characteristic performance and targets areas of improvement for respective systems

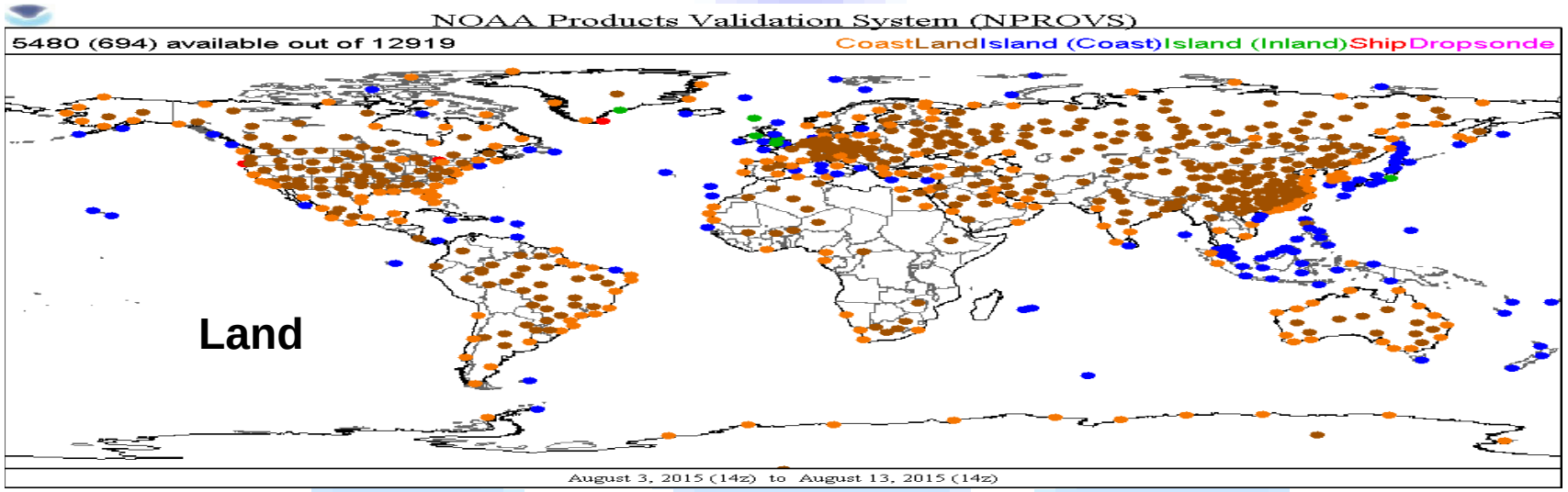
- Analysis of collocations with conventional and reference/dedicated RAOB provides more detailed assessments down to “deep dive” (see Poster; Sun)

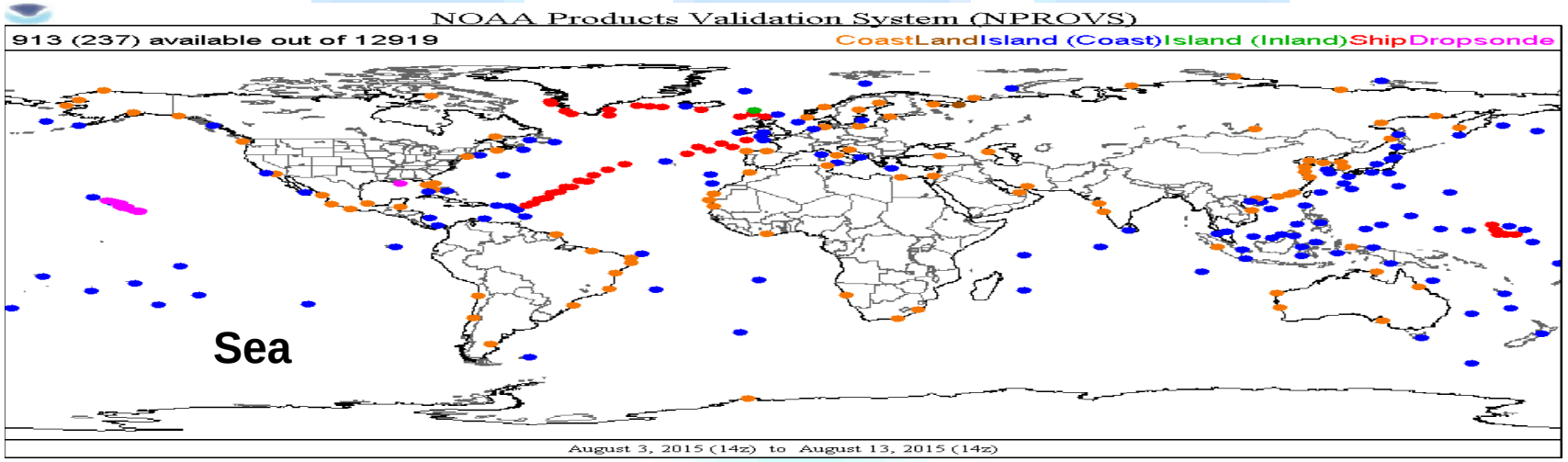
- NUCAPS and MiRS test products appear better than respective operations

- Product performance generally rooted in first guess; moisture weighting

- Performance in unique weather environments (Cold core and CALWATER) justifies ongoing *AWIPS-2* efforts to disseminate (NUCAPS) soundings to NWS field offices (See Poster; Sounding user session Thursday)

- Providing uncertainty estimates for soundings opens door to more robust validation against GRUAN RAOB (see Poster)





10-day sample of collocations containing MiRS v.11 and Oper MW soundings which pass QC