NOAA Products Validation System + (NPROVS+)

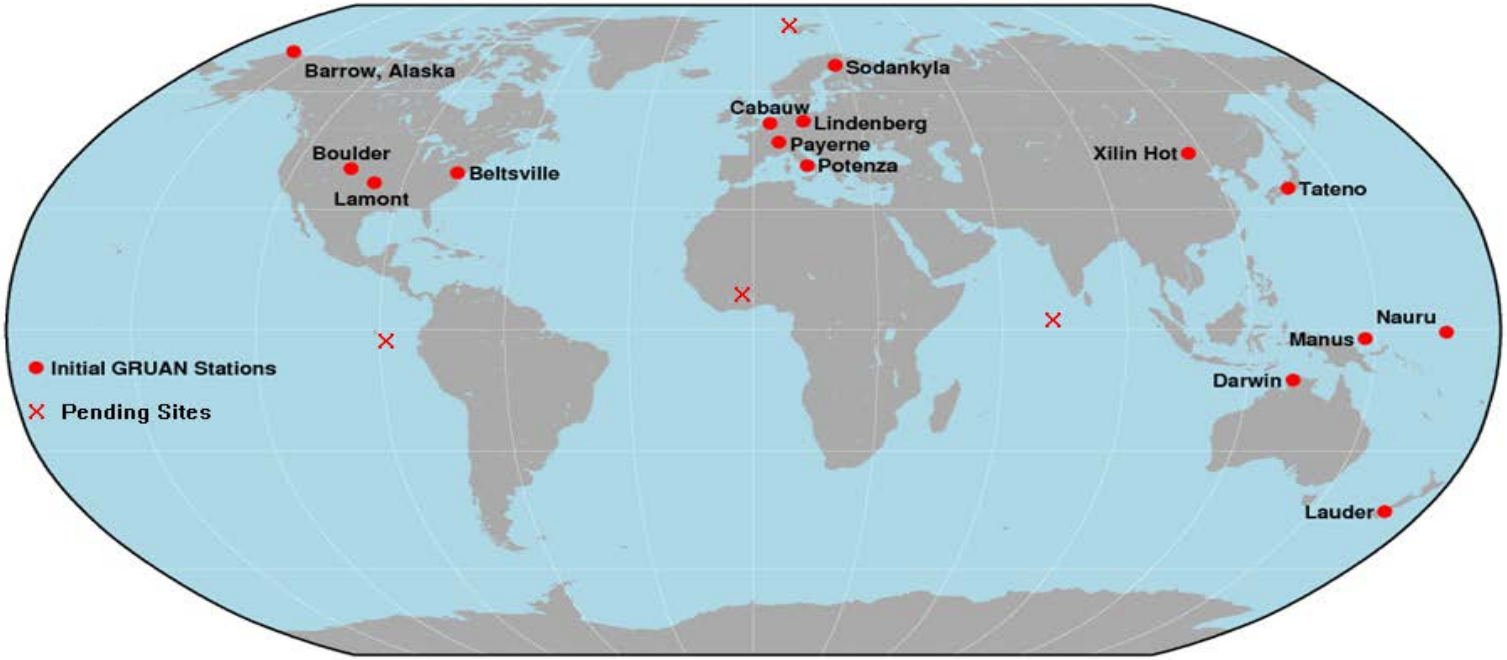
Tony Reale

Bomin Sun, Michael Pettey, Nick Nalli

Outline

- GRUAN data
- Dedicated Data
- Routine Processing
- EDRs and SDRs
- Analytic Interface (EDGE)
- Collocation Strategy
- “K” uncertainty Analysis
- Results / Outreach

GCOS "Reference" Upper AIR Network (GRUAN)



GRUAN 6th International Coordination Meeting (ICM-6) March 10-14, GreenBelt, Hilton

… special Tuesday session on satellite synergies

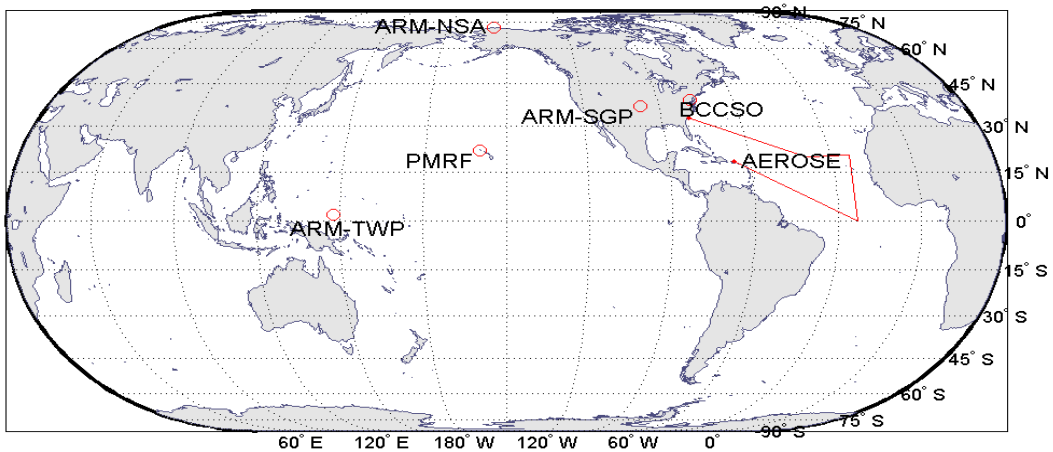
… sites provide reference radiosonde (RS92) plus ancillary ground (lidar, MWR, FTIR …) observations, adherence to best measurement practices GRUAN Manual and Measurement Guideline documents) including specification of "**Measurement Uncertainty**" with plans for up to 40 sites (5+ years)

EDR Validation

Dedicated S-NPP RS92 RAOB funded by JPSS CrIMSS Project

	ARM-TWP	ARM-SGP	ARM-NSA		ARM-TWP	ARM-SGP	ARM-NSA	PMRF	BCCSO	NOAA AEROSE
Location	Manus Island, Papua New Guinea	Ponca City, Oklahoma, USA	Barrow, Alaska, USA	Location	Manus Island, Papua New Guinea	Ponca City, Oklahoma, USA	Barrow, Alaska, USA	Kauai, Hawaii, USA	Beltsville, Maryland, USA	Tropical North Atlantic Ocean
Regime	Tropical Pacific Warm Pool, Island	Midlatitude Continent, Rural	Polar Continent	Regime	Tropical Pacific Warm Pool, Island	Midlatitude Continent, Rural	Polar Continent	Tropical Pacific, Island	Midlatitude Continent, Urban	Tropical Atlantic, Ship
Planned N	90	180	180	Planned N	90	180	180	40	—	≈ 60–120
Launched n_1	**42**	**92**	**93**	Launched n_1	**42**	**92**	**93**	**40**	**23**	**2**
Launched n_2	—	**88**	**90**	Launched n_2	—	**88**	**90**	—	—	**0**
Time Frame	Aug–present	Jul–present	Jul–present	Time Frame	Aug–present	Jul–present	Jul–present	May, Sep	Jun–Jul, Sep–present	Jan–Feb 2013

NPP CrIMSS EDR ICV Dedicated RAOB Sites

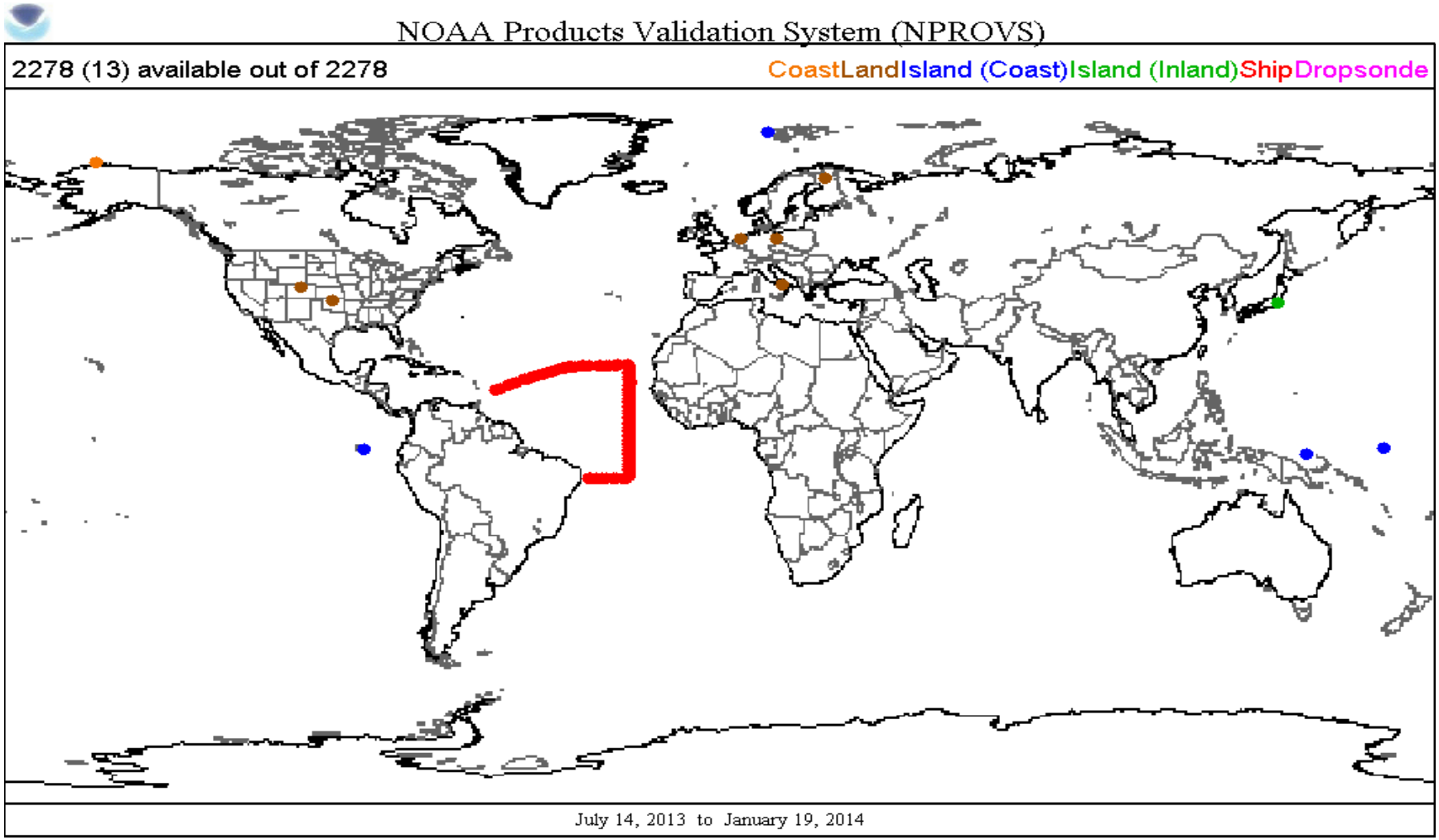


… ongoing re-structure of ARM scheduling to provide "sustained" year round coverage

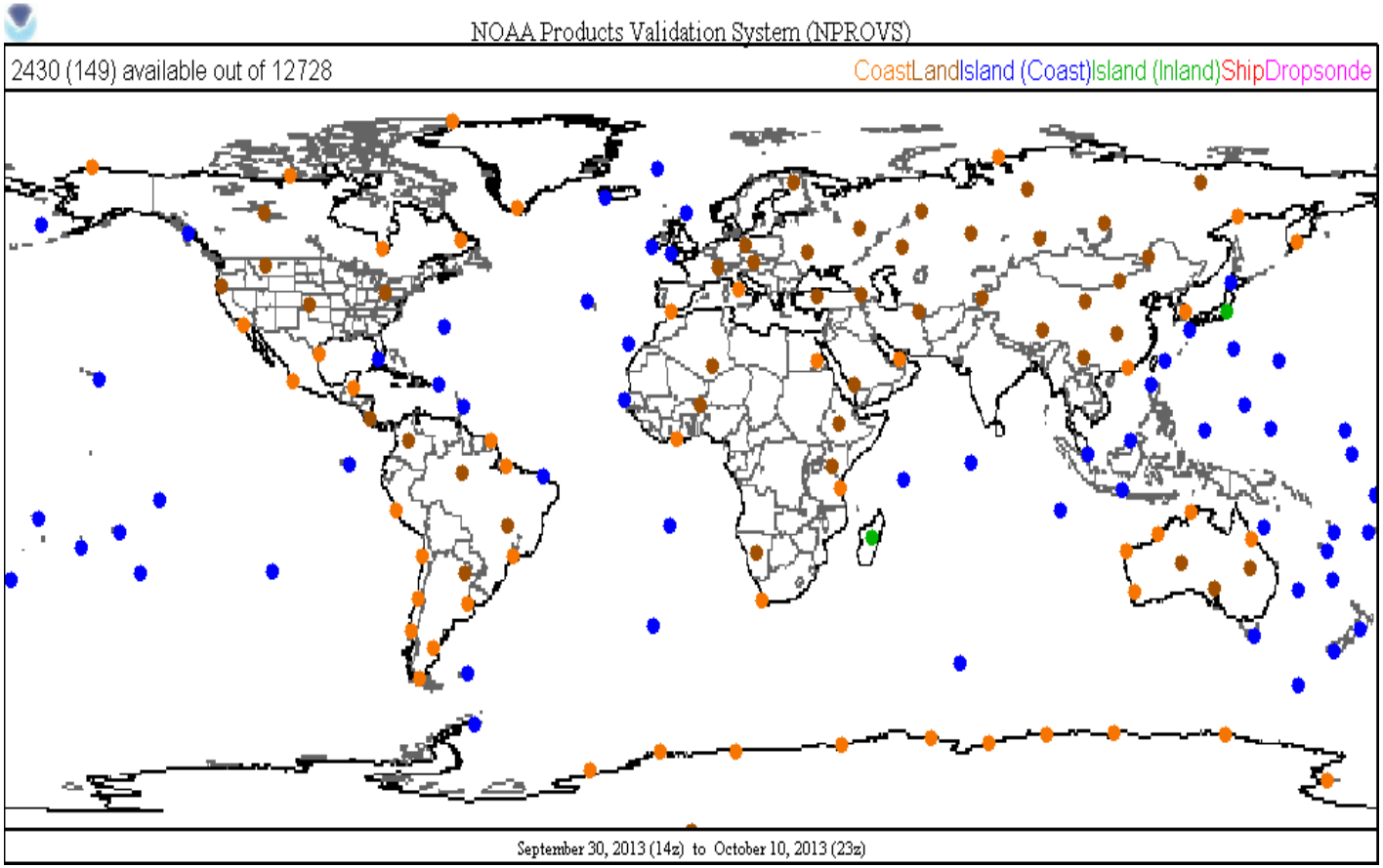
STAR (Tilley) and LC (Sommer) coordinate on access of RS92 from ARM and their access for NPROVS+ via LC

STAR and CIMSS (Tobin, Borg) oversee the scheduling and launches of dedicated launches at ARM sites, recently modified to provide year round coverage; JPSS funded provided through sounding product cal/val program

Similarly, JPSS supports AEROSE campaign (and PMRF) launches (N Nalli)

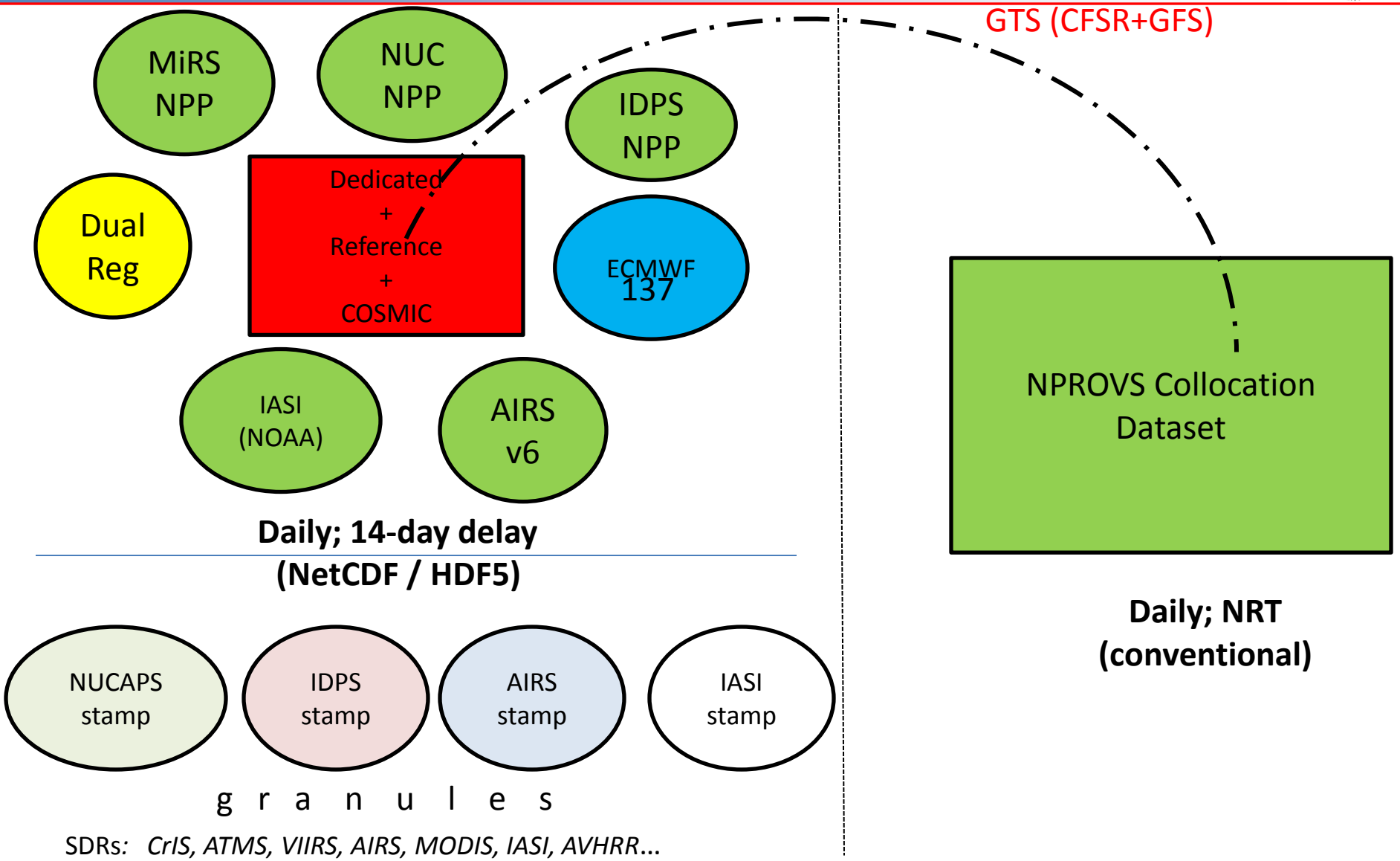


378 dedicated , 1900 GRUAN



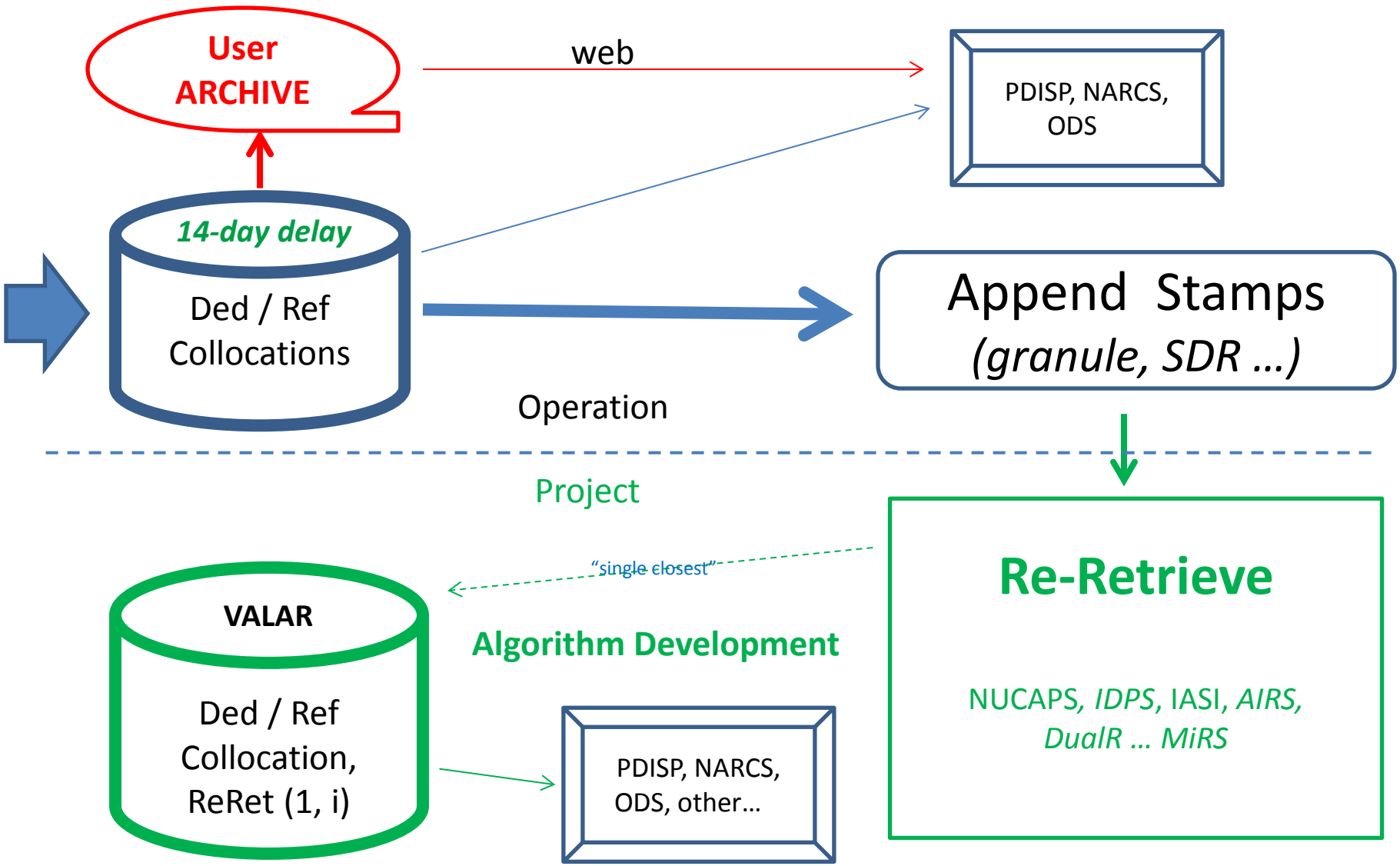
GUAN Monitoring

EDR Validation

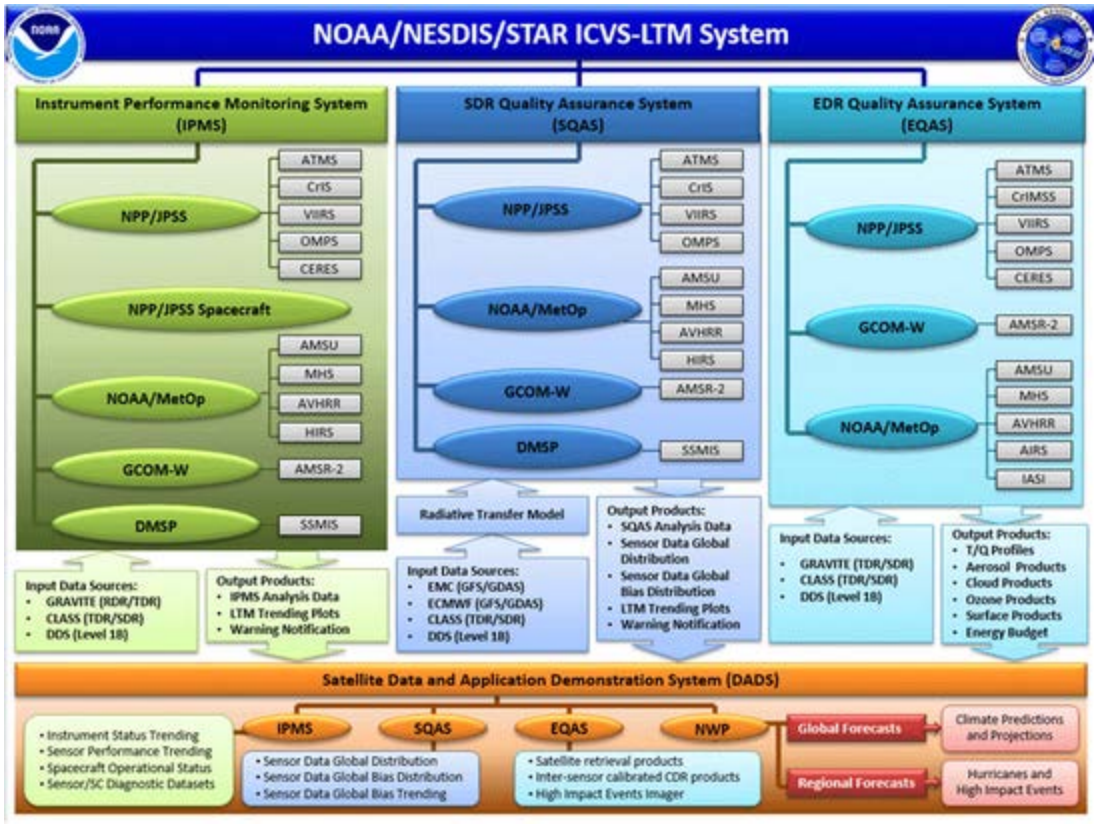


NPROVS+

EDR Validation



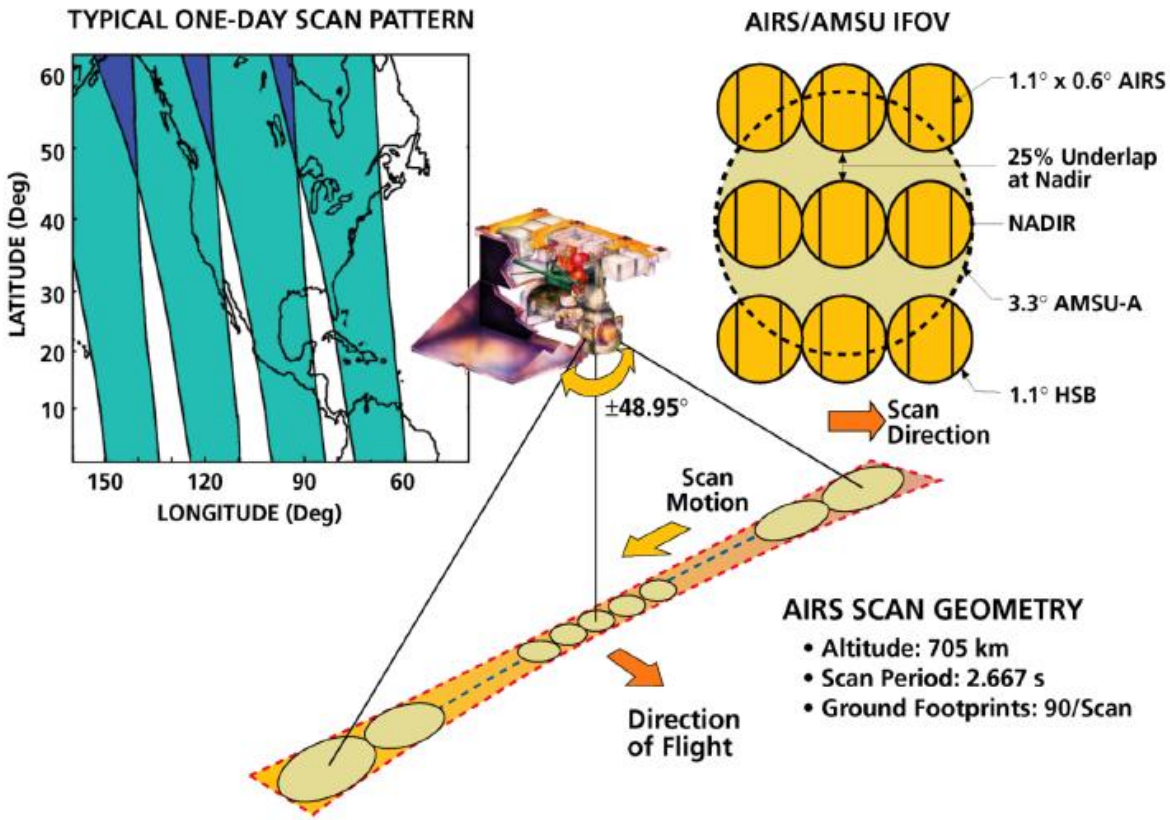
NPROVS+ ... unified validation and development



ICVS: Long-Term Sensor Calibration/Validation Monitoring (SDR) from Space
(http://www.star.nesdis.noaa.gov/icvs/index.php)

Overview of EDR Data Products (3/4)

- **Sounding is performed on 50 km field of regard (FOR).**
- **FOR is currently defined by the size of the microwave sounder footprint.**
- **IASI/AMSU has 4 IR FOV's per FOR**
- **AIRS/AMSU & CrIS/ATMS have 9 IR FOV's per FOR.**
- **ATMS is spatially over-sampled and can emulate an AMSU FOV.**

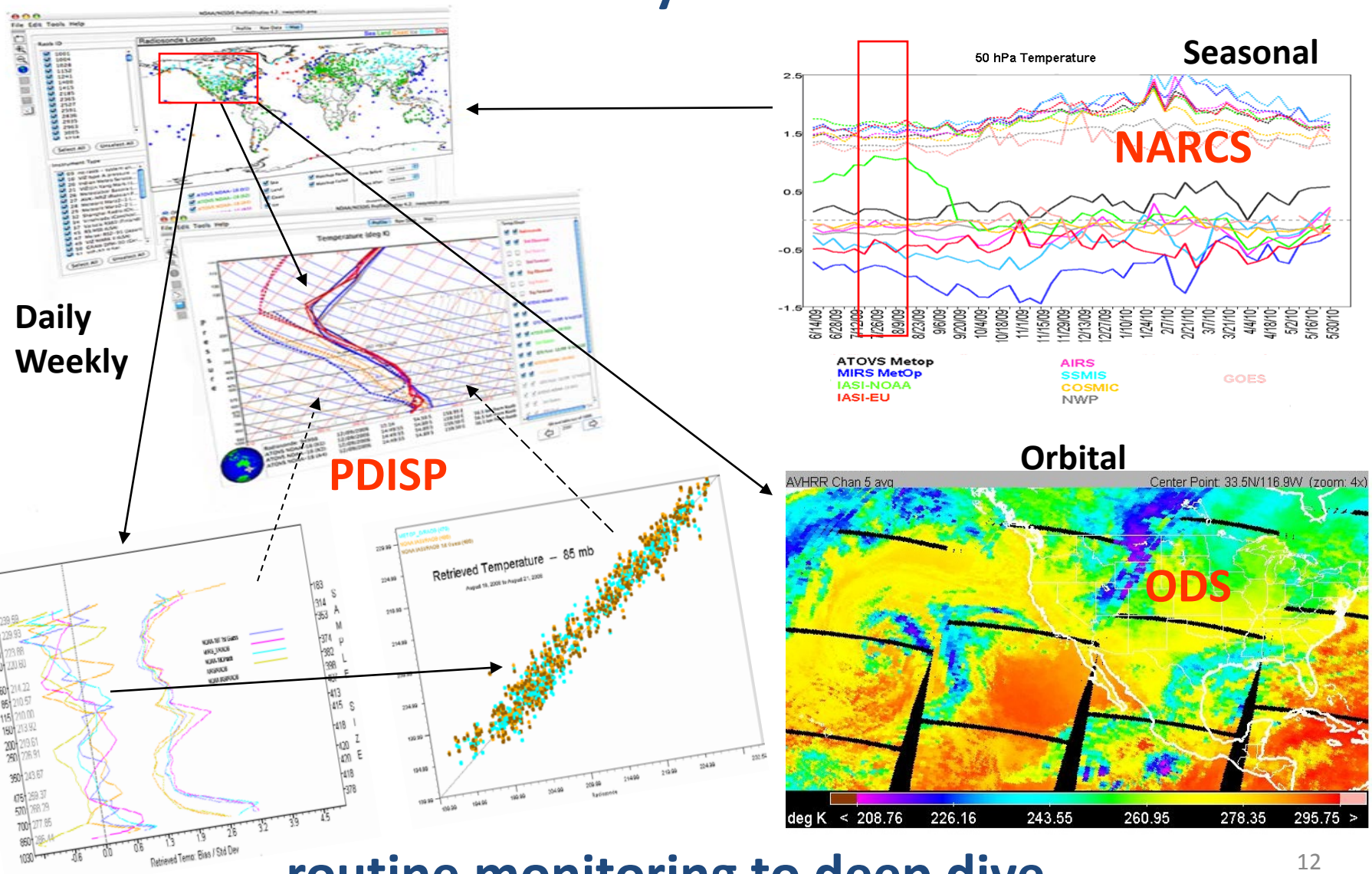


… additional stamp info (500km area centered at RAOB) supports development

Barnet, Prov

EDR VALIDATION

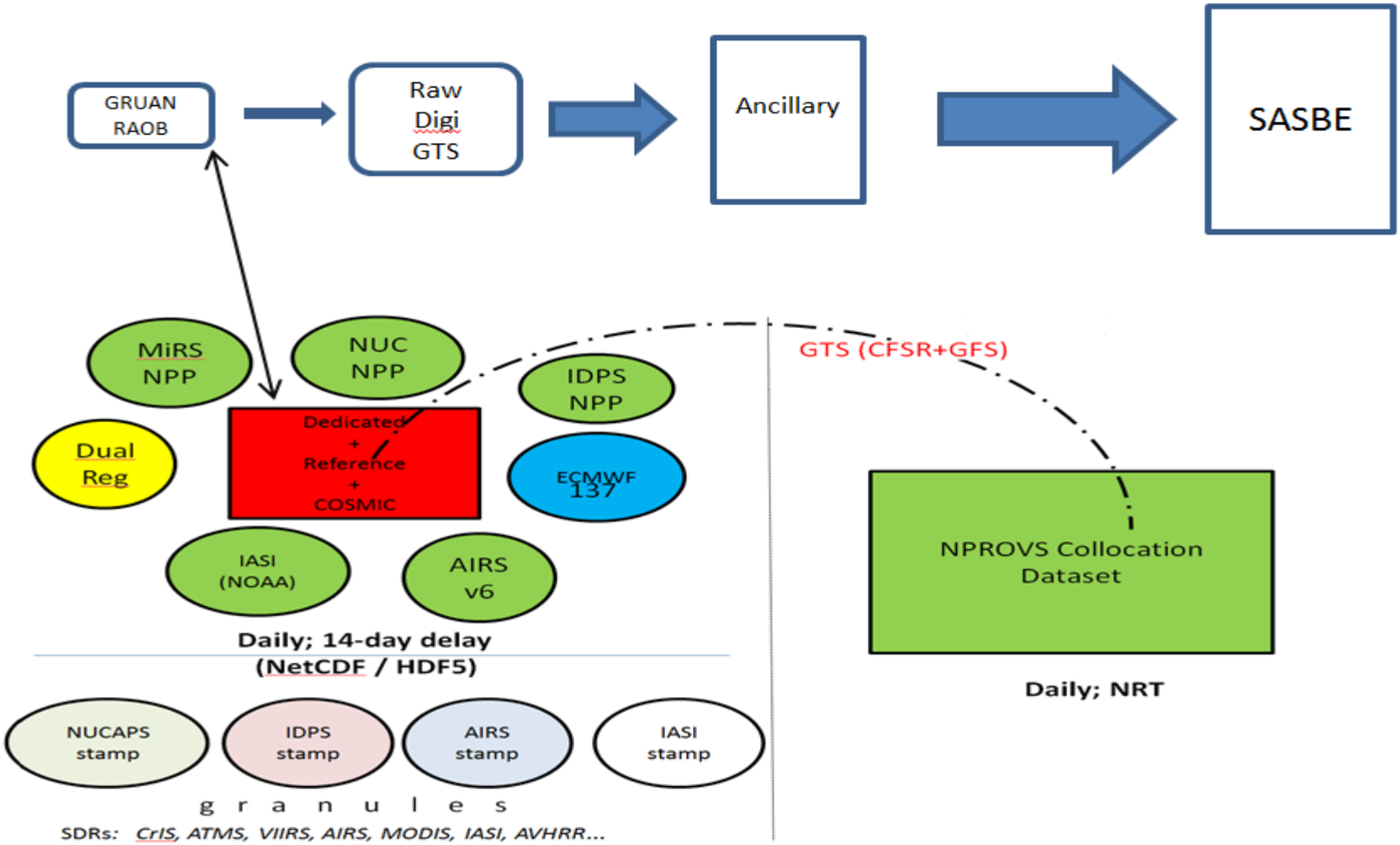
NPROVS Analytical Interface …



… routine monitoring to deep dive

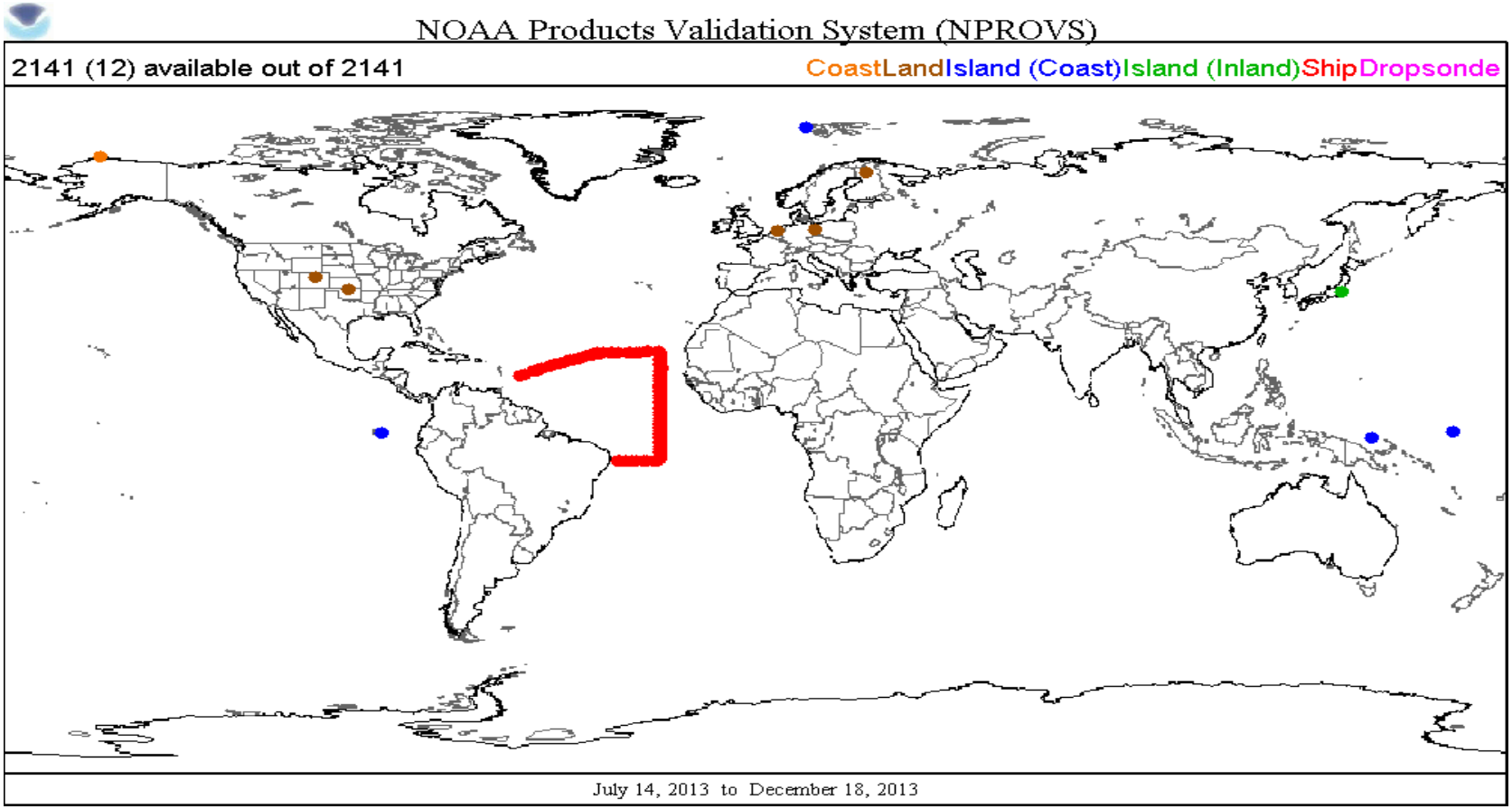
Collocation Strategy

- Reference/dedicated RAOB (RS92) is anchor
- Raw, Digicora, GRUAN, GTS (4 flavors)
- Append Ancillary
- Compress to 1km layers (also retain original hi-density)
- Single closest satellite EDR
- NWP (GFS 6-hr, CFSR and ECMWF Anal) …
- For hyperspectral (S-NPP, MeTop, Aqua) append all EDRs within 500km of RAOB
- Append SDR (traceable to ICVS) within 500km


GRUAN
RAOB
Raw
Digi
GTS
Ancillary
SASBE
MiRS
NPP
NUC
NPP
IDPS
NPP
Dual
Reg
Dedicated
+
Reference
+
COSMIC
ECMWF
137
IASI
(NOAA)
AIRS
v6
Daily; 14-day delay
(NetCDF / HDF5)
NUCAPS
stamp
IDPS
stamp
AIRS
stamp
IASI
stamp
g r a n u l e s
SDRs: CrIS, ATMS, VIIRS, AIRS, MODIS, IASI, AVHRR...
GTS (CFSR+GFS)
NPROVS Collocation
Dataset
Daily; NRT

EDR Validation

NPROVS+



2050 collocations (350 Dedicated, 1700 GRUAN) … 5mos

GRUAN Reference Measurement Principles

Consistency in a Finite Atmospheric Region

Co-location / co-incidence:

Determine the variability (σ) of a variable (m) in time and space from measurement or model

Two observations on different platforms are consistent if

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

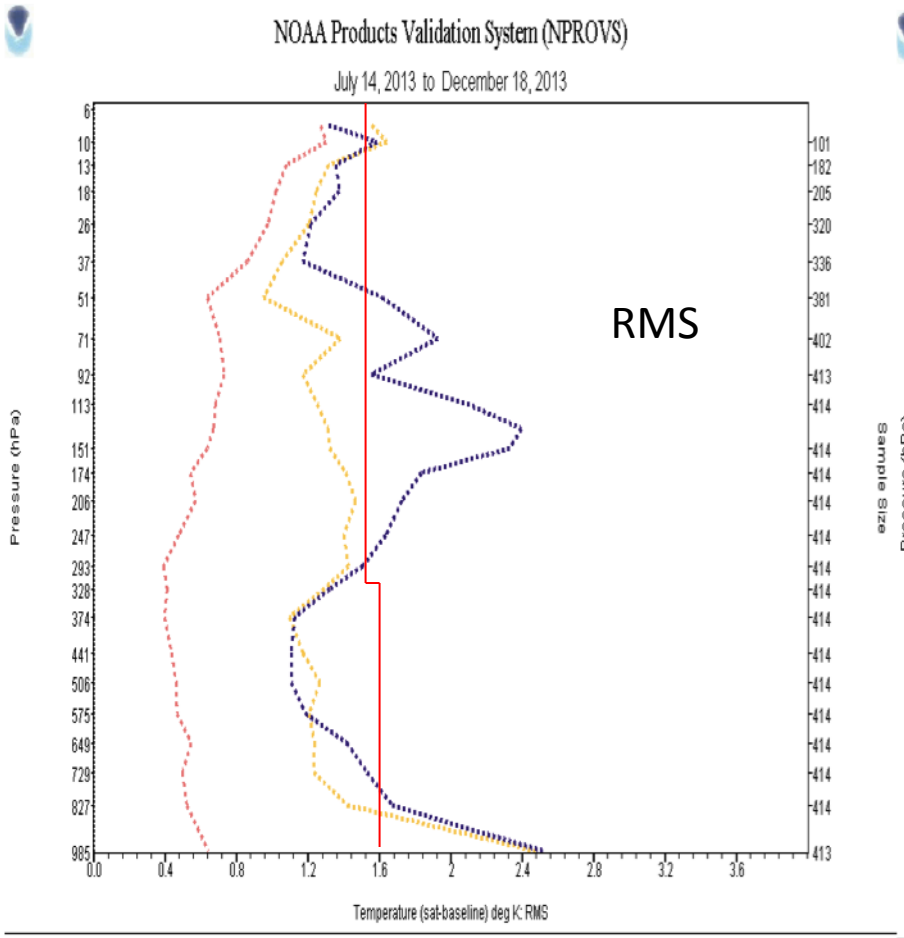
... at this preliminary stage:

K = ABS(X – GRUAN) / Uncertainty (u1)

where "X" either SAT or NWP

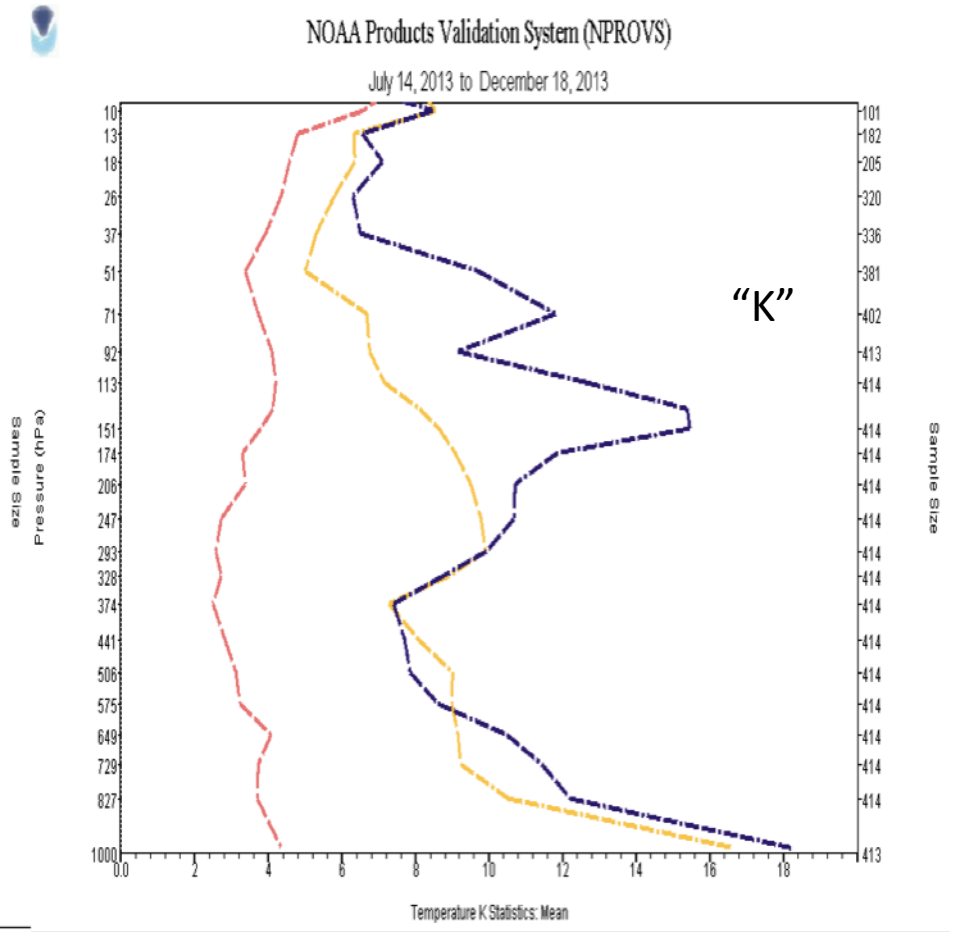
"need uncertainty estimates for EDR"

EDR Validation Results



Baseline: REFERENCE SONDE GRUAN RAOB

CRIMSS NPP Infrared (IP) **ECMWF ANALYSIS** **NUCAPS NPP TEST**



Baseline: REFERENCE SONDE GRUAN RAOB

CRIMSS NPP Infrared (IP) **ECMWF ANALYSIS** **NUCAPS NPP TEST**

GRUAN only … Include Uncertainty Estimates … *"K" Profiles*

EDR Validation Results

COSMIC / GRAS

(Stratosphere Reference from Space …)

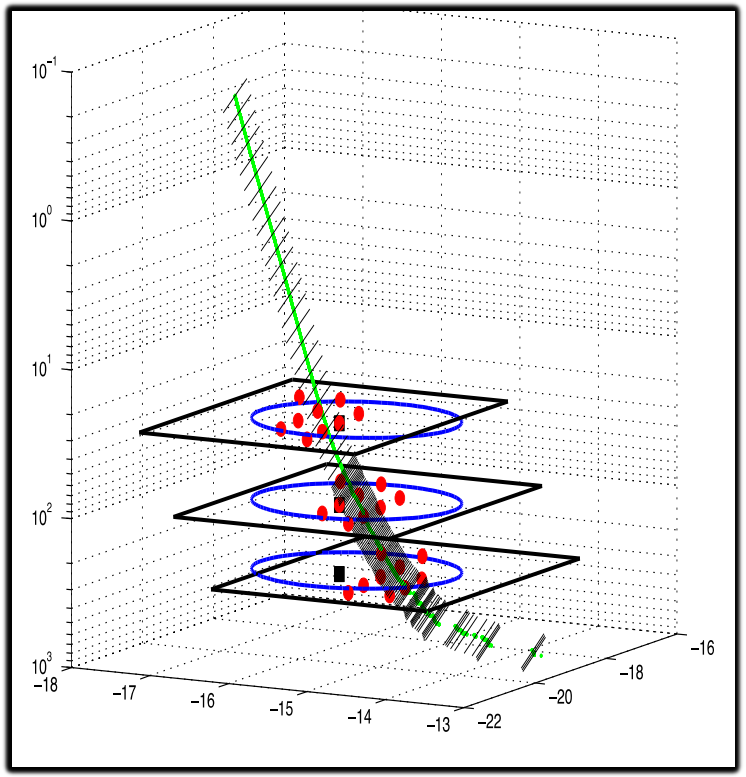
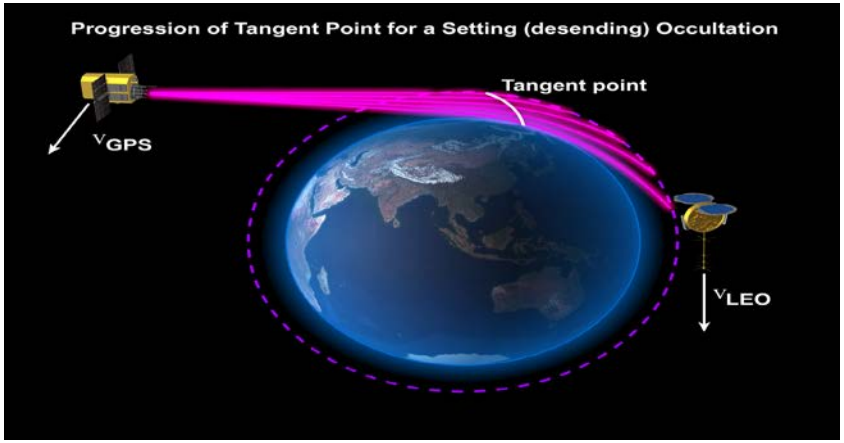
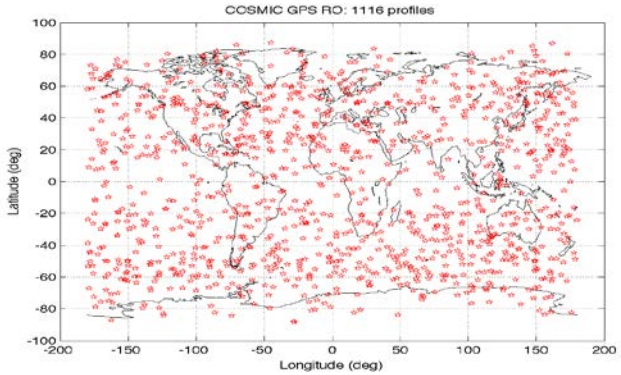


Illustration of the closest (black square), circular (blue circle), and ray path (red dots) methods for a single GPS profile (green) for the circle centered at the GPS RO level of 100 hPa



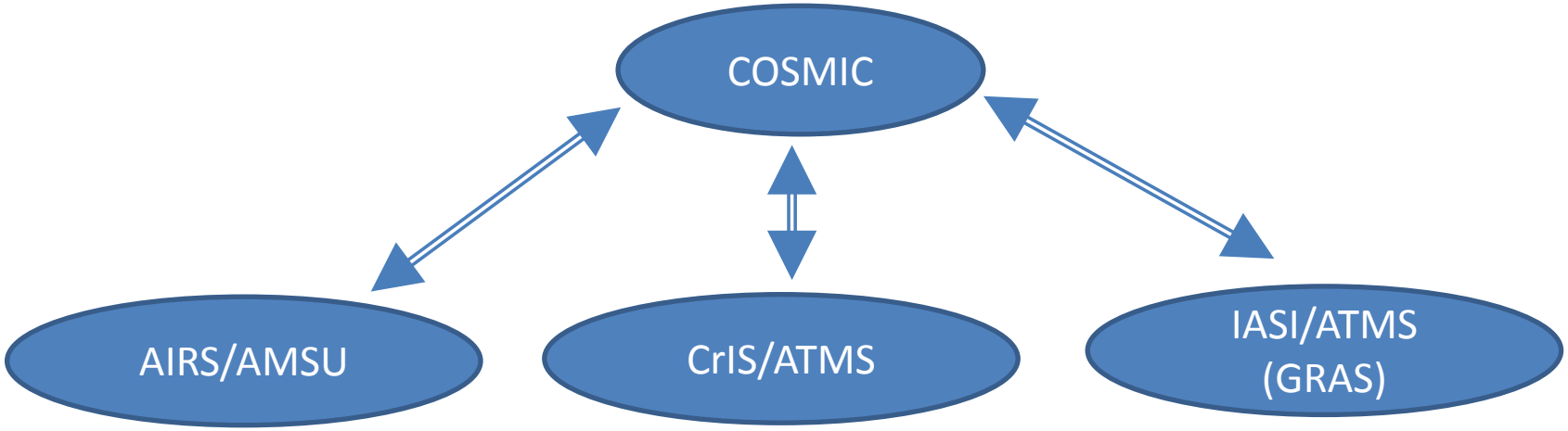
http://www.cosmic.ucar.edu/launch/GPS_RO_cartoon.jpg



One Day of COSMIC Profiles

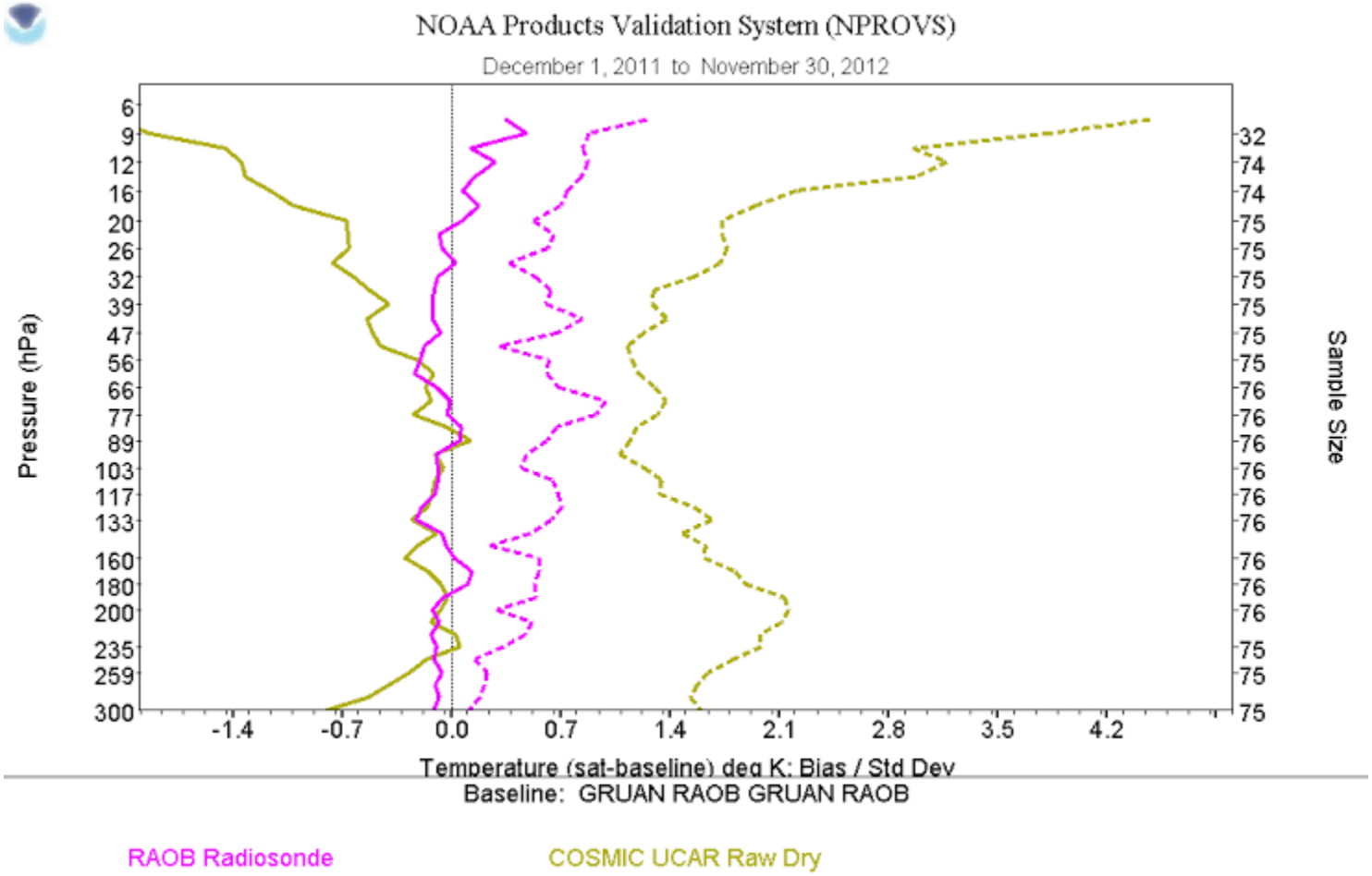
courtesy Knuteson / Feltz CIMSS

EDR Validation Results



GPSRO Anchored Collocation

- Integrate STAR (Weng, Reale) and CIMSS (Knuteson / Feltz) approaches
- EDR and SDR
- GPS RO provides Reference for EDR, SDR and RTM


NOAA Products Validation System (NPROVS)
December 1, 2011 to November 30, 2012
Pressure (hPa)
6
9
12
16
20
26
32
39
47
56
66
77
89
103
117
133
160
180
200
235
259
300
-1.4
-0.7
0.0
0.7
1.4
2.1
2.8
3.5
4.2
Sample Size
32
74
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76
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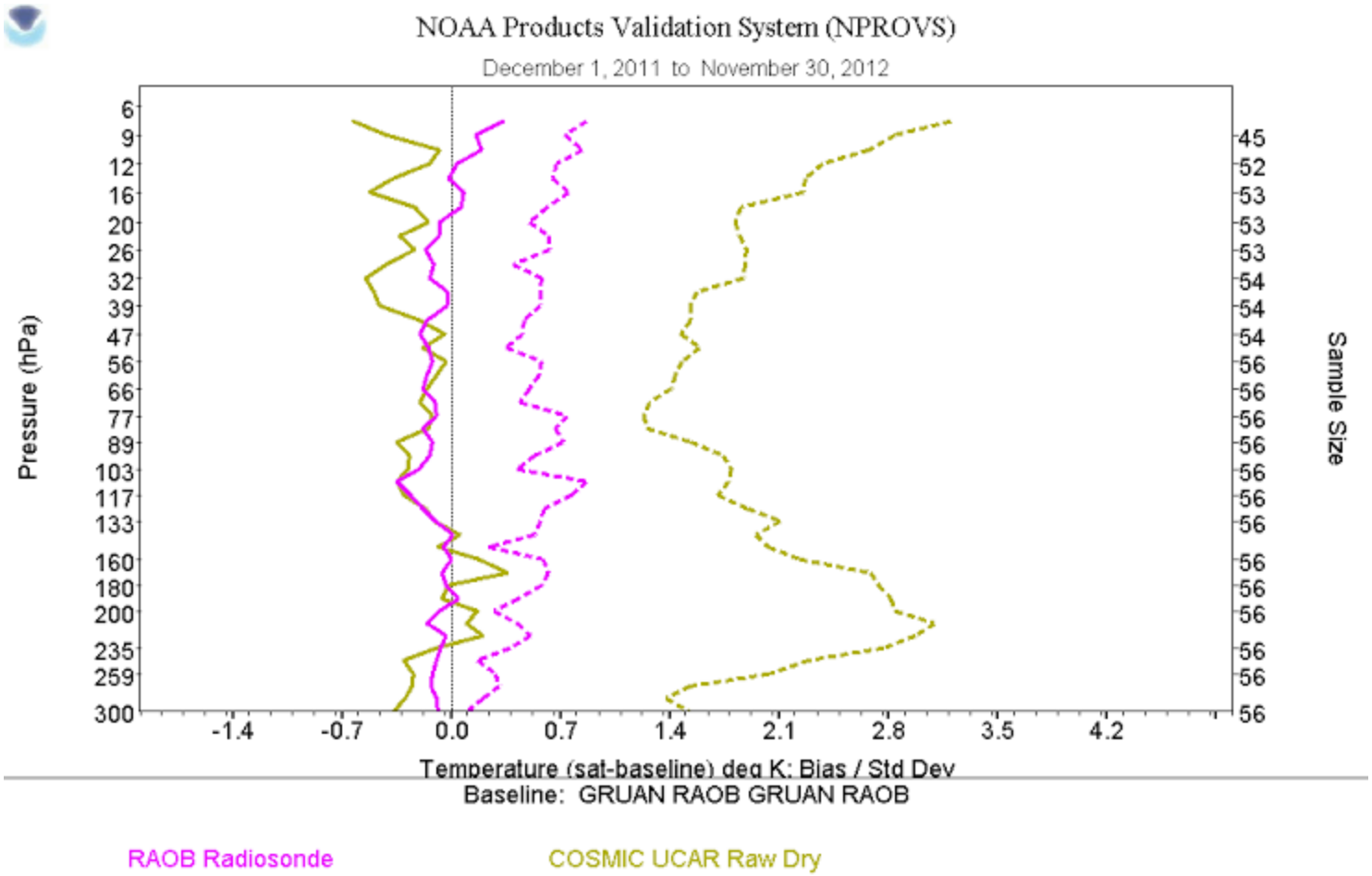
76
76
75
75
75
Temperature (sat-baseline) deg K: Bias / Std Dev
Baseline: GRUAN RAOB GRUAN RAOB
RAOB Radiosonde
COSMIC UCAR Raw Dry

Lin, 12Z, day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-1.4
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Sample Size
45
52
53
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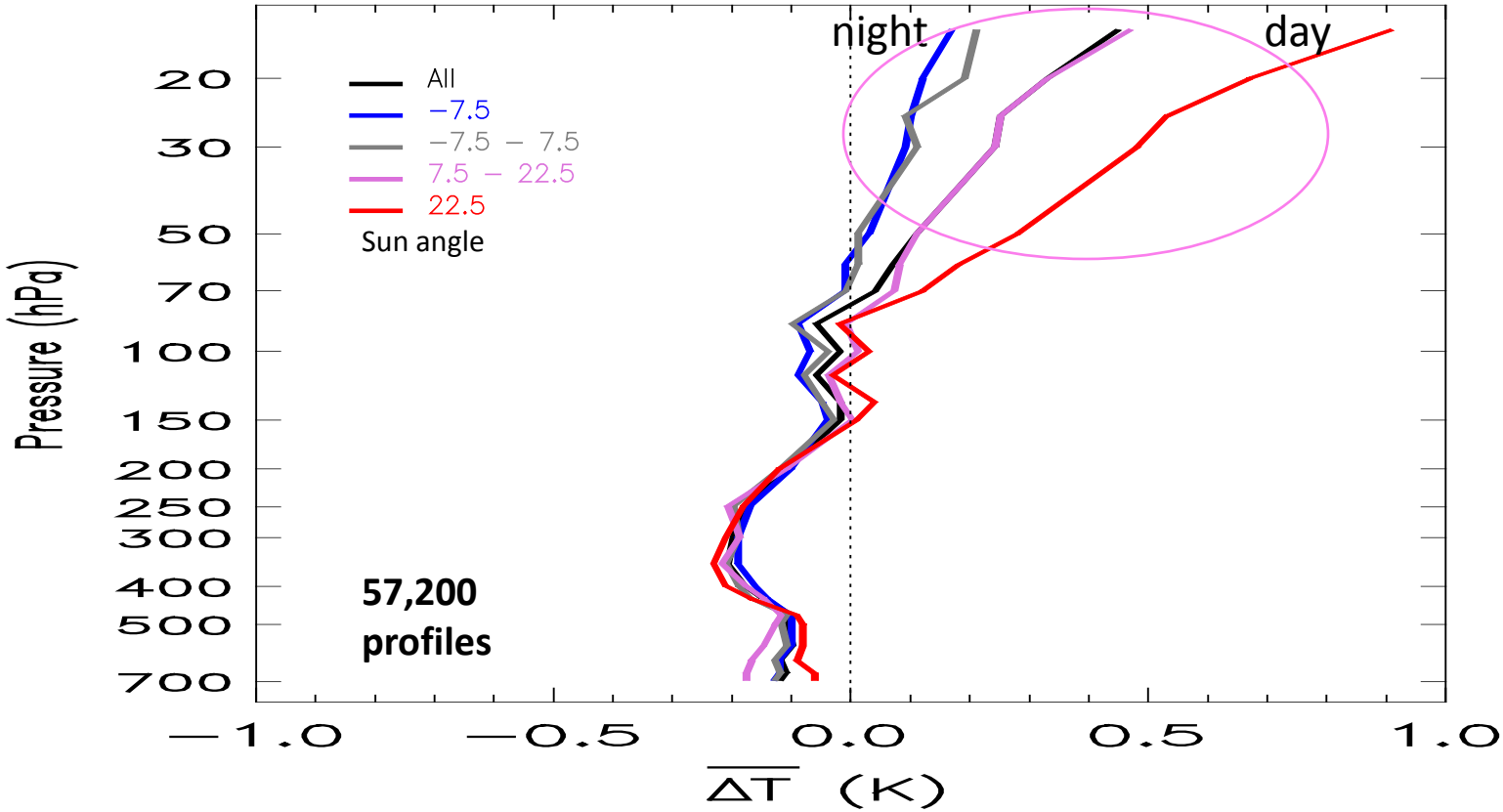
56
56
Temperature (sat-baseline) deg K: Bias / Std Dev
Baseline: GRUAN RAOB GRUAN RAOB
RAOB Radiosonde
COSMIC UCAR Raw Dry

Lin, 0Z, nite

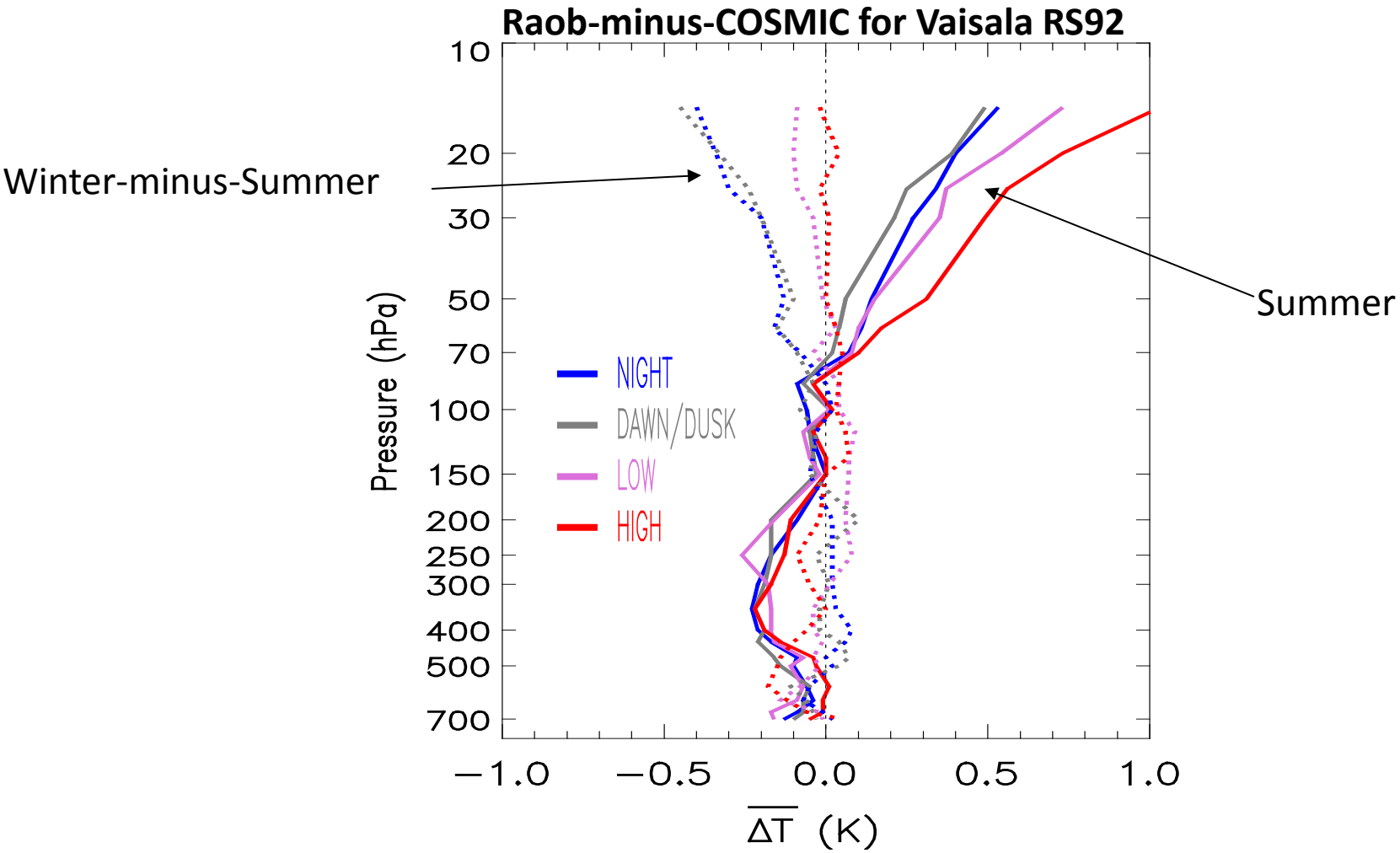
Vaisala RS92

difference from COSMIC T

All sample



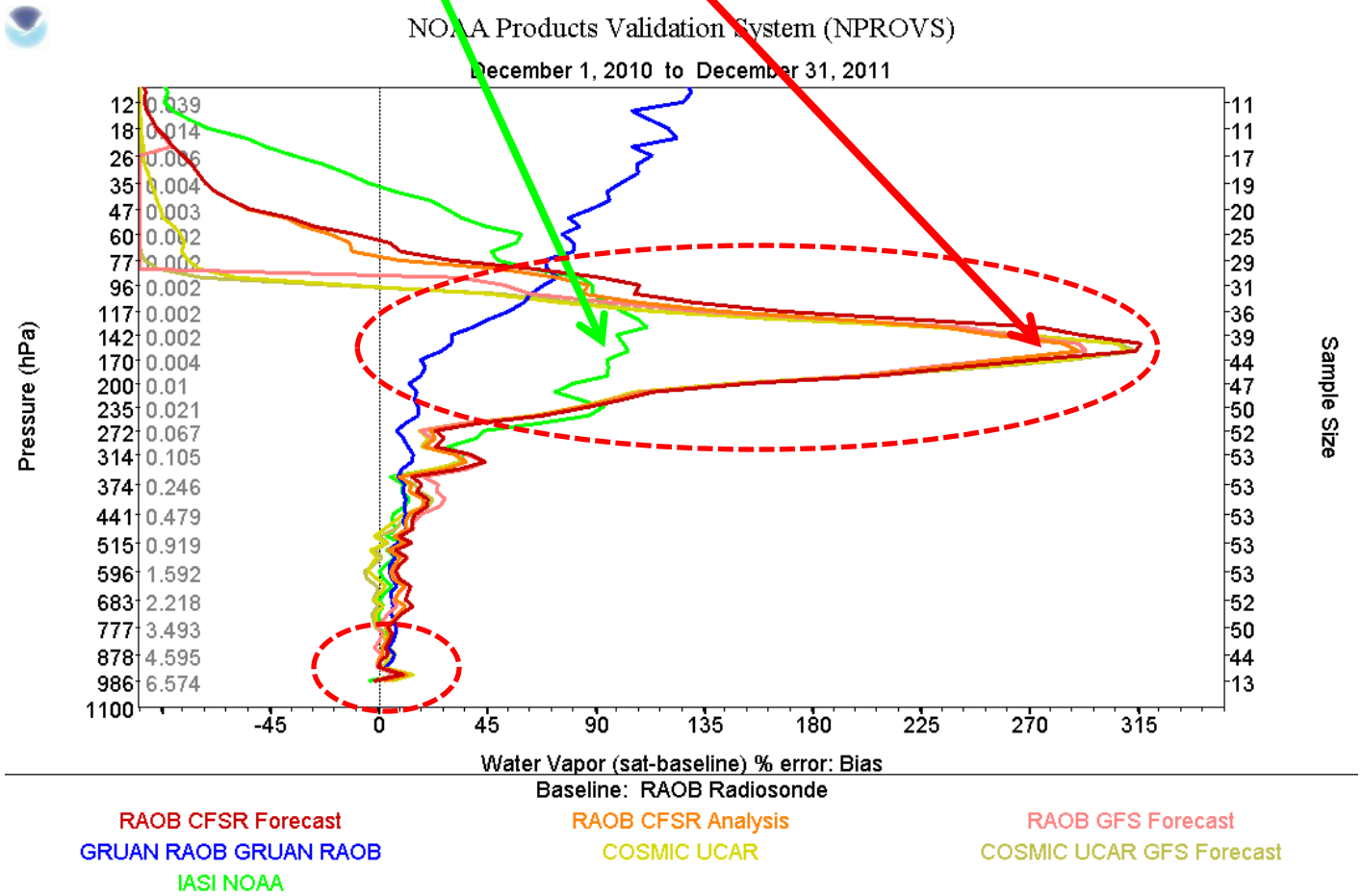
Raob-minus-COSMIC



Seasonal variation in bias is bigger at nighttime:
Summer relatively warmer than winter
NPROVS

Profile evaluation

- **Comparison of IASI and NWP forecast with RAOB.**



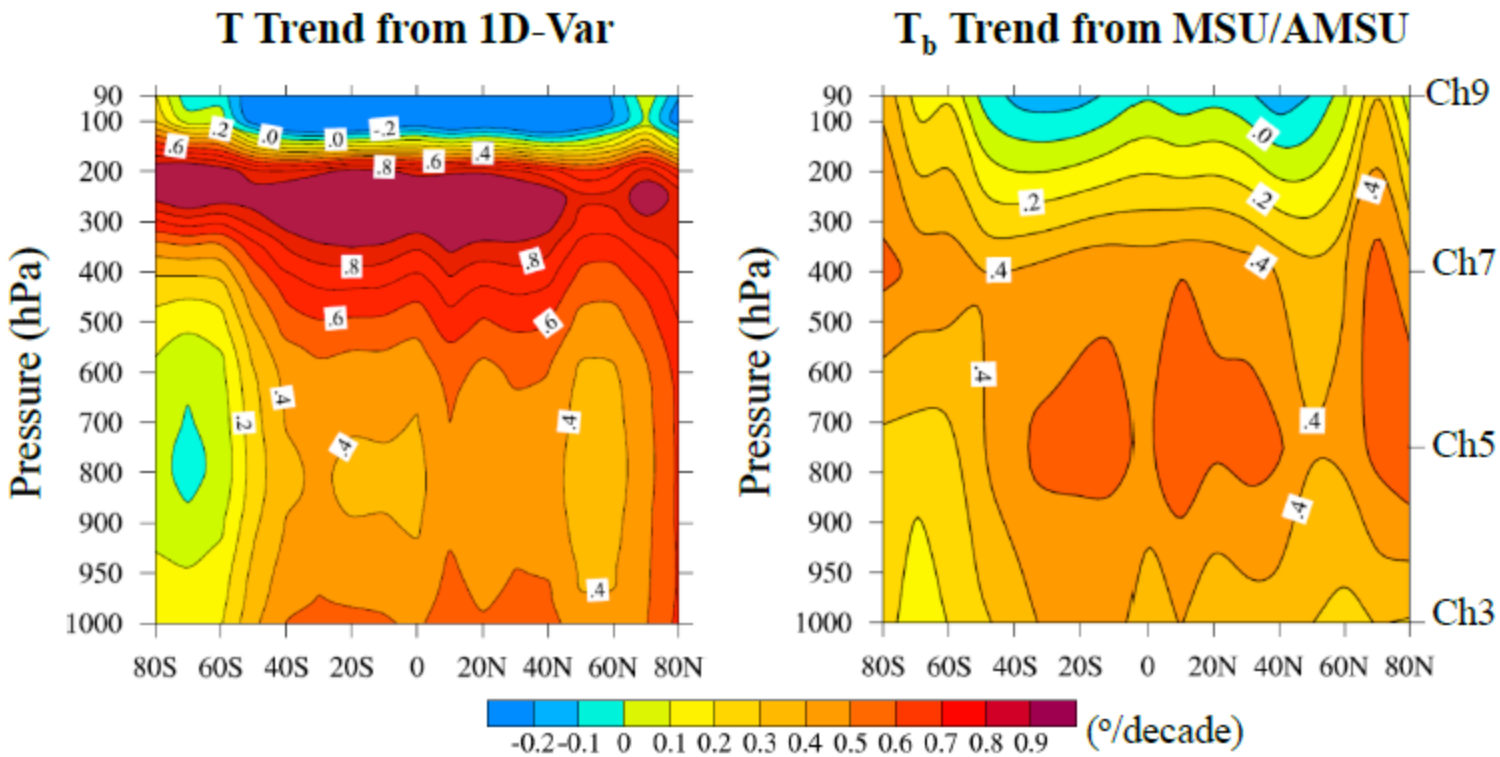
Courtesy: Tony Reale et al., NOAA, presented at GRUAN ICM5

Building High-Quality Climate Data Records from Operational Satellites

Fuzhong Weng
NOAA Center for Satellite Applications and Research

Seminar at ESSIC/UMD
March 5, 2014, 12:00pm - 01:00pm

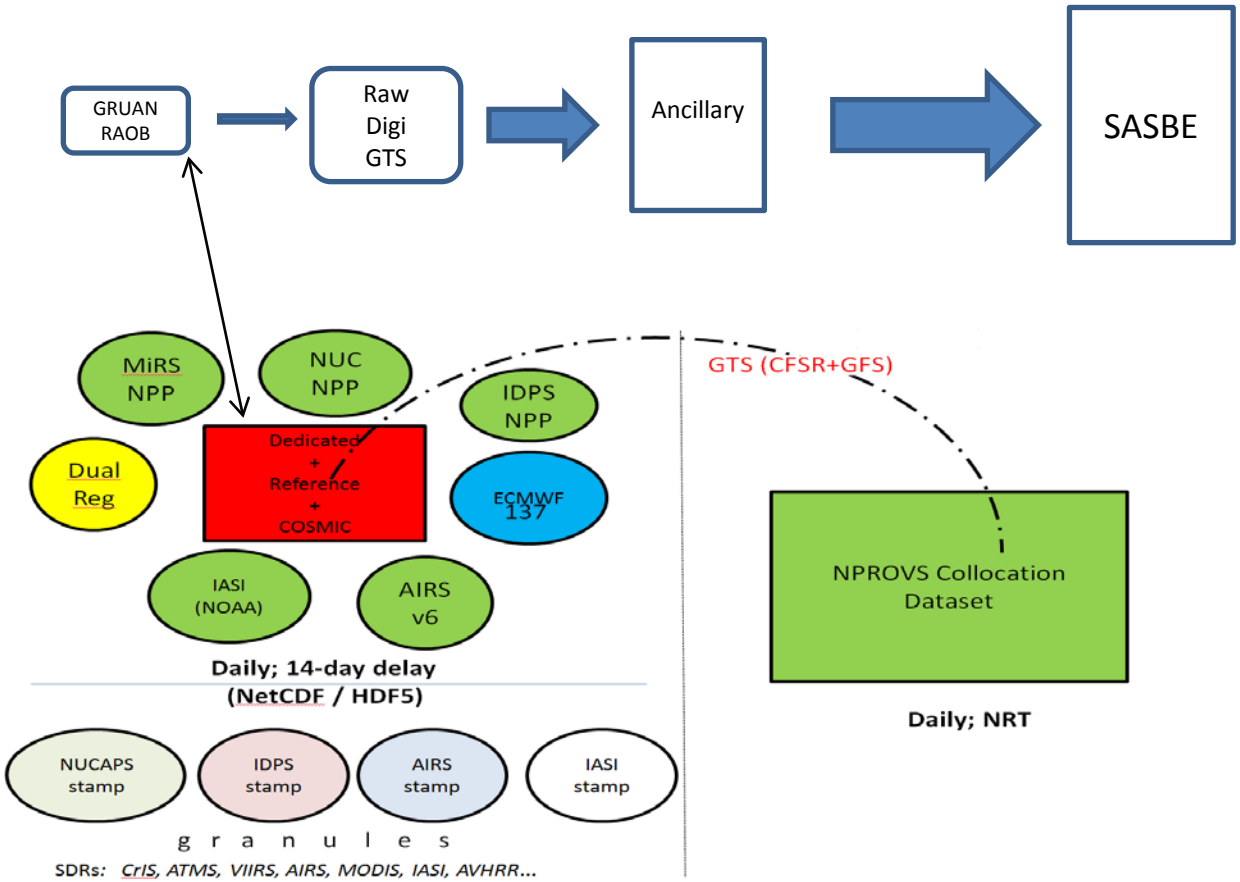
1D-Var Derived Temperature Trend

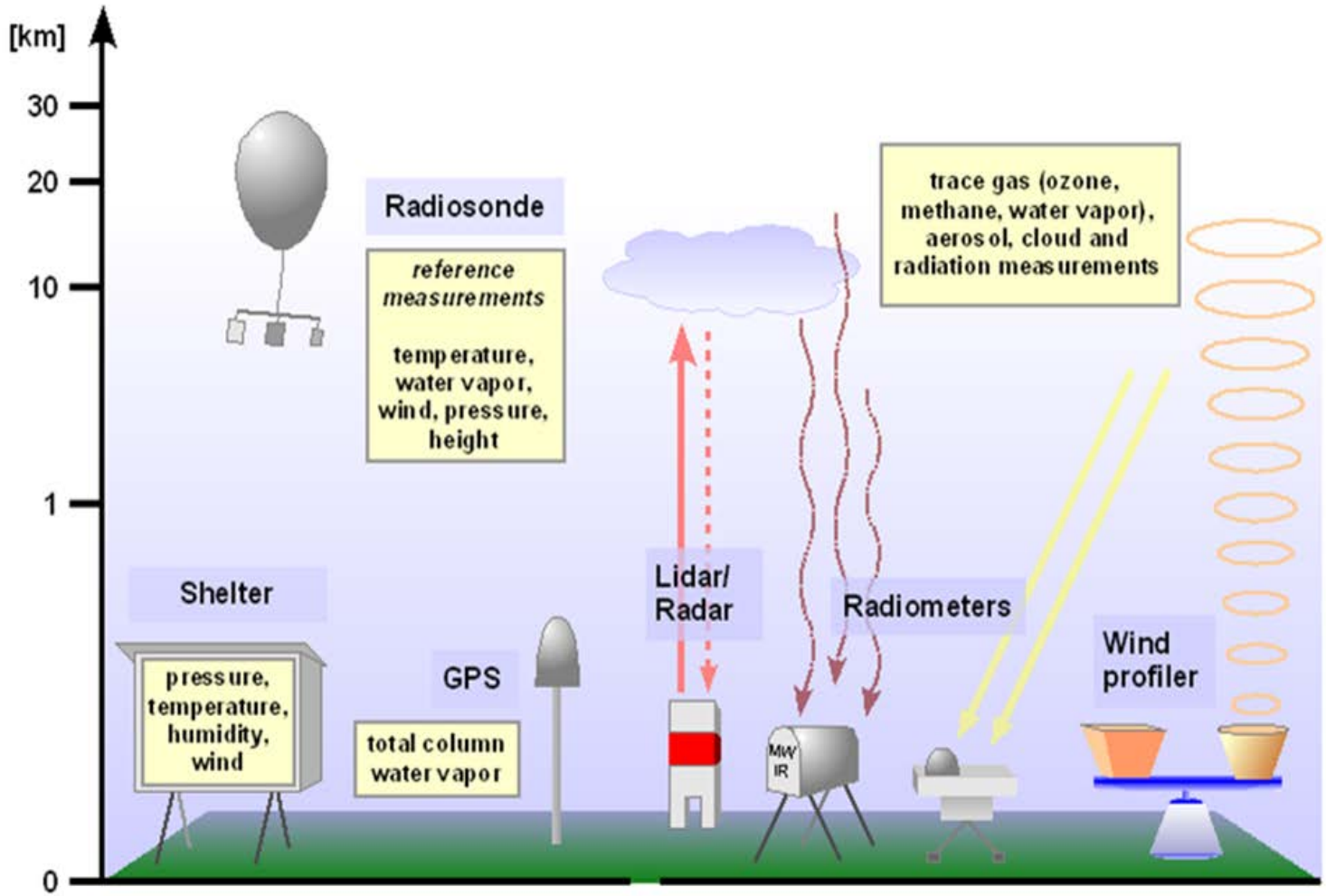


Weng, F. and X. Zou, 2013: 30-year atmospheric temperature trend derived by one-dimensional variational data assimilation of MSU/AMSU-A observations. *Clim. Dyn.*, DOI: 10.1007/s00382-013-2012-5.

Summary

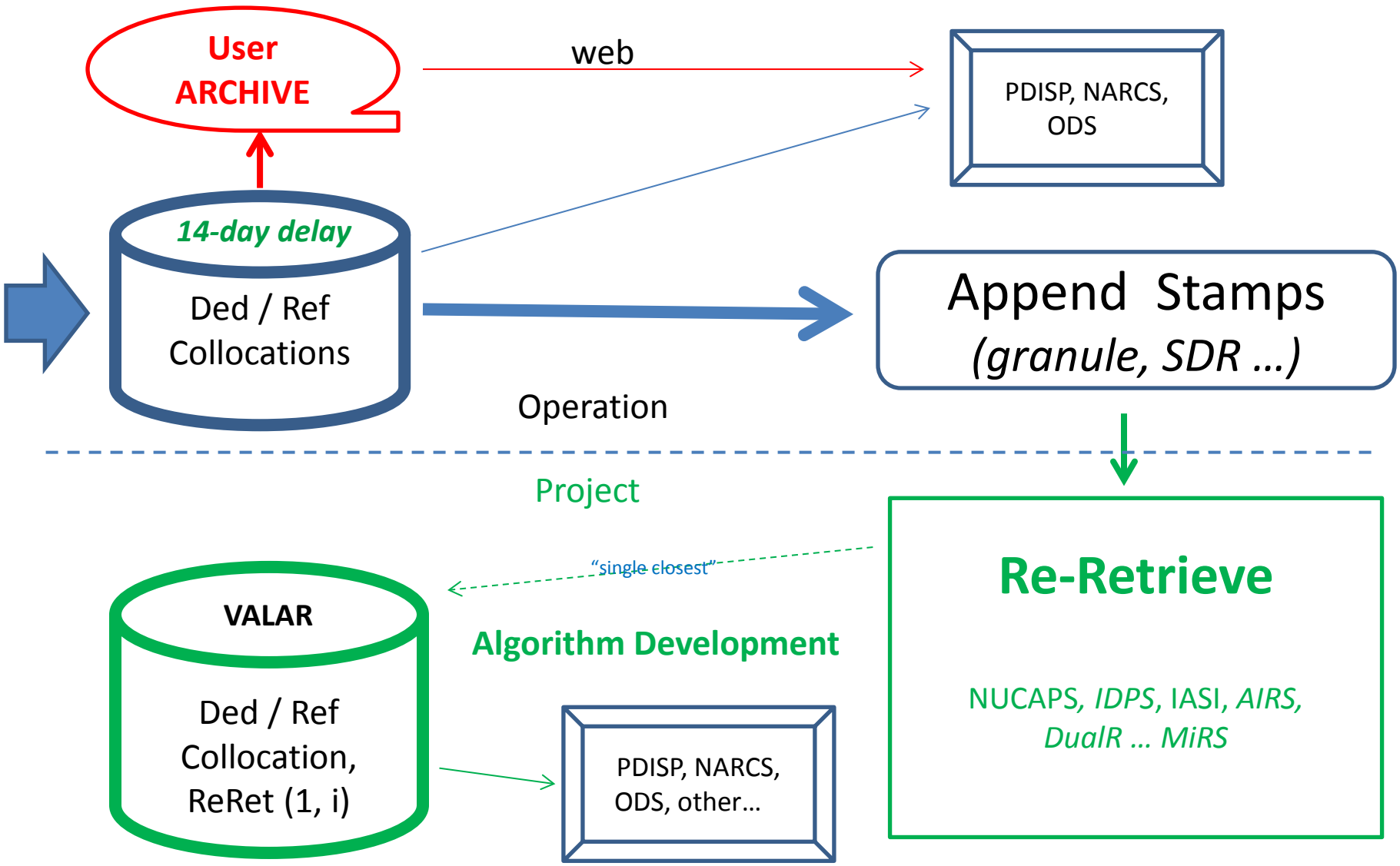
- NPROVS+ on 14-day delay
- EDR and SDR collocated to each Reference
- Open to expansion
- Collocation sampling through
- Results


GRUAN
RAOB
Raw
Digi
GTS
Ancillary
SASBE
MiRS
NPP
NUC
NPP
IDPS
NPP
Dual
Reg
Dedicated
+
Reference
+
COSMIC
ECMWF
137
IASI
(NOAA)
AIRS
v6
Daily; 14-day delay
(NetCDF / HDF5)
GTS (CFSR+GFS)
NPROVS Collocation
Dataset
Daily; NRT
NUCAPS
stamp
IDPS
stamp
AIRS
stamp
IASI
stamp
g r a n u l e s
SDRs: CrIS, ATMS, VIIRS, AIRS, MODIS, IASI, AVHRR...



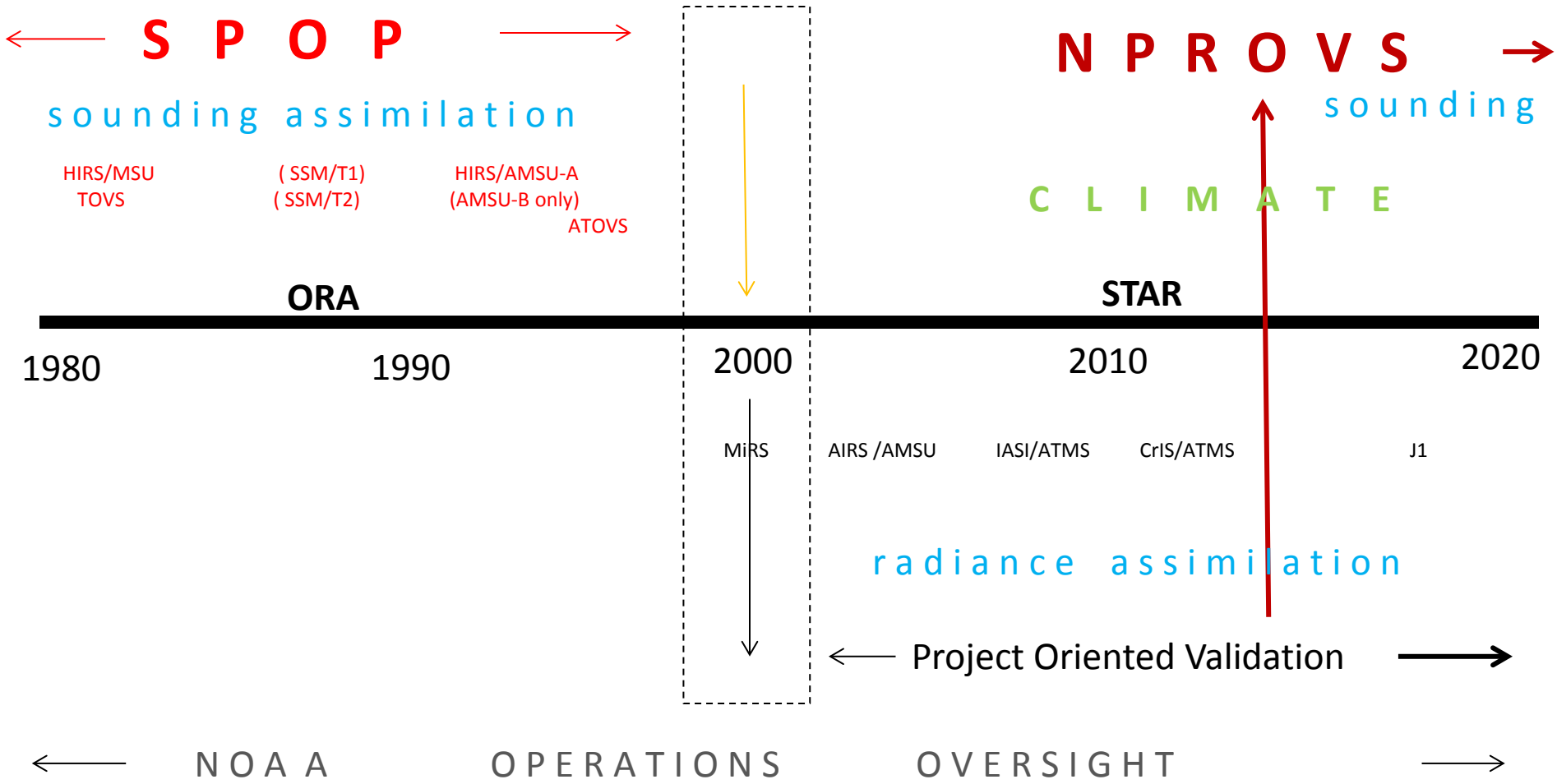
Characterization of atmospheric column well suited to assess satellite product

EDR Validation



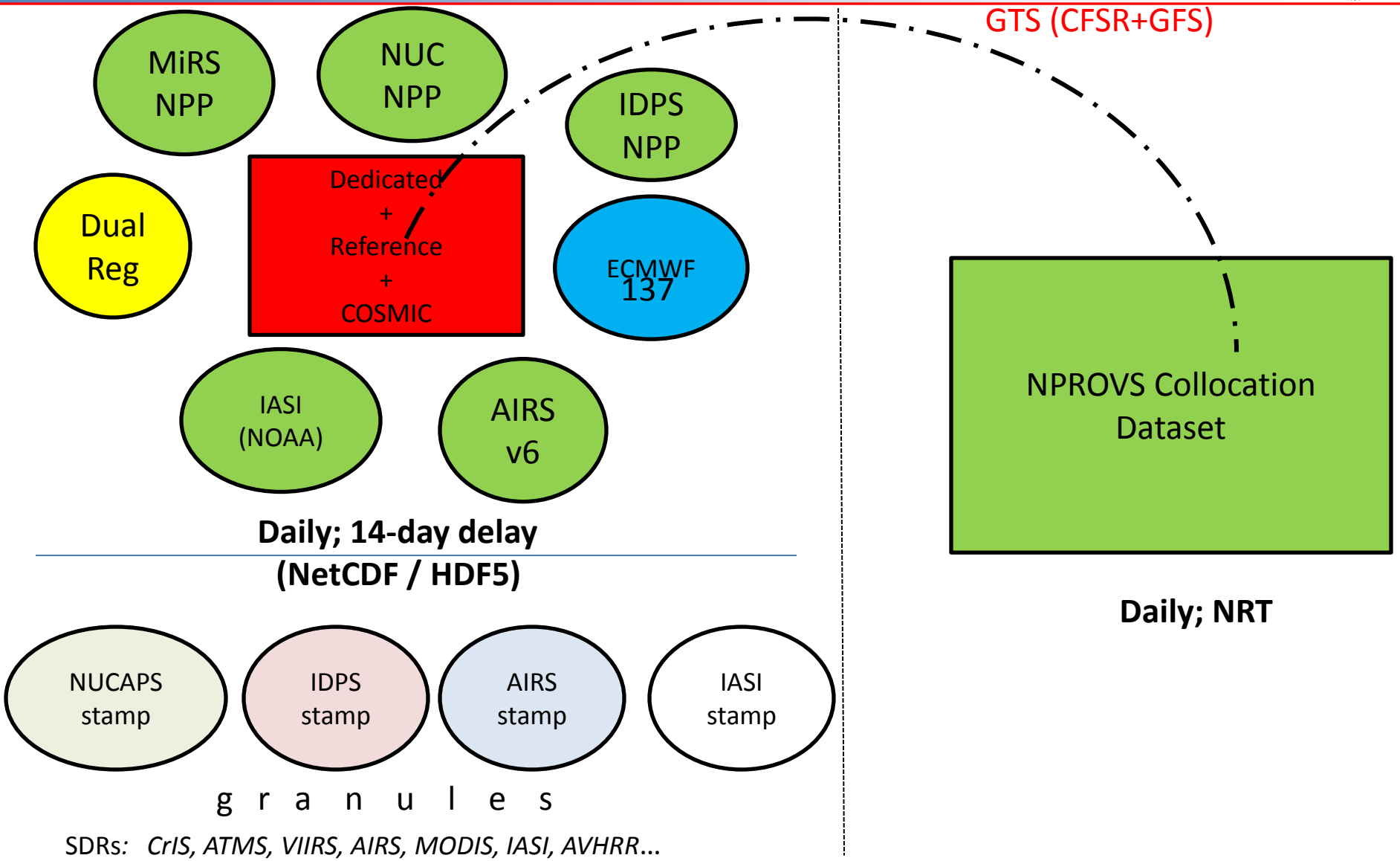
NPROVS+ ... unified validation and development

Brief History NOAA Program for Soundings

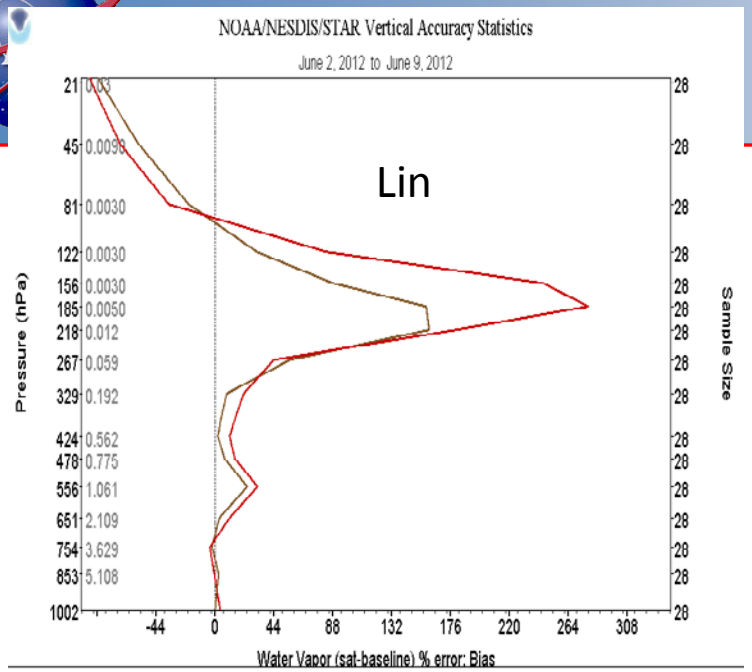


Restore Project Independent **N**OAA **PRO**duct O**V**er**S**ight

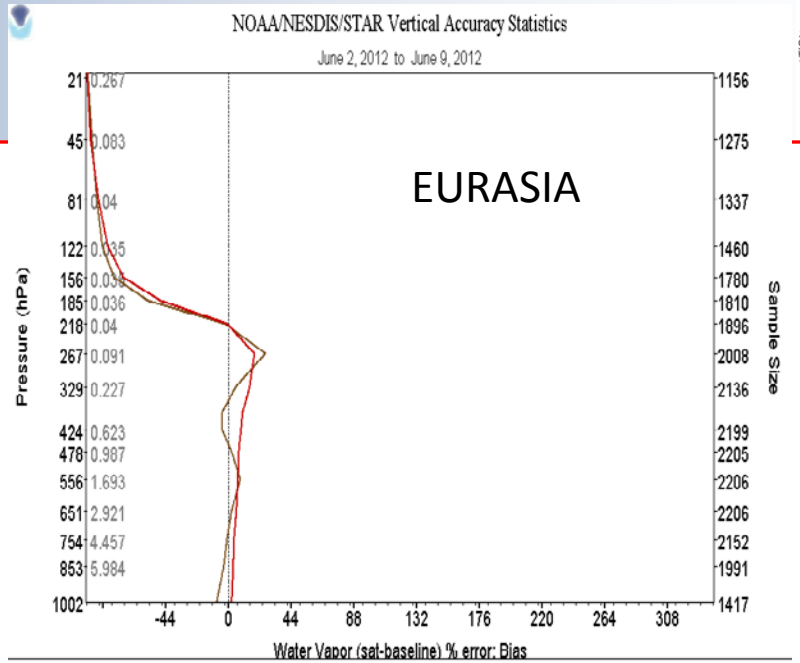
EDR Validation Results



… exclusive anchor to Ref / Ded RAOB and GPSRO….



Baseline: Radiosonde Radiosonde



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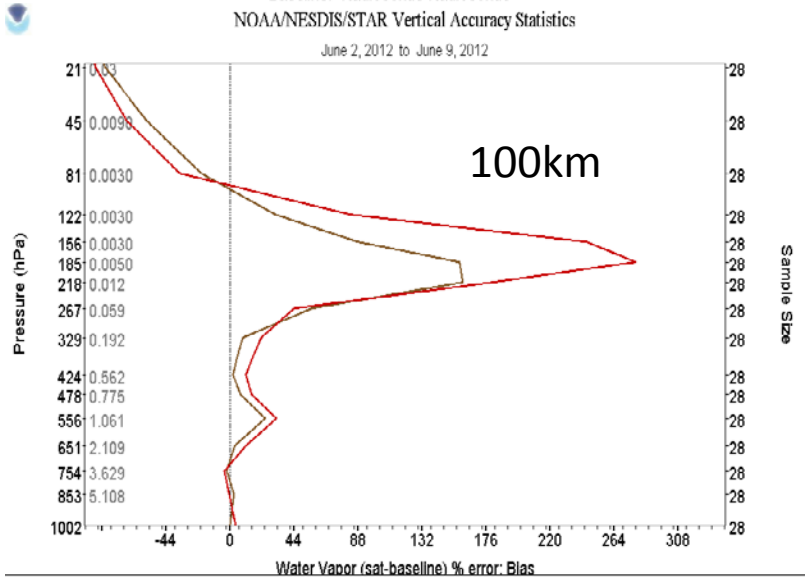

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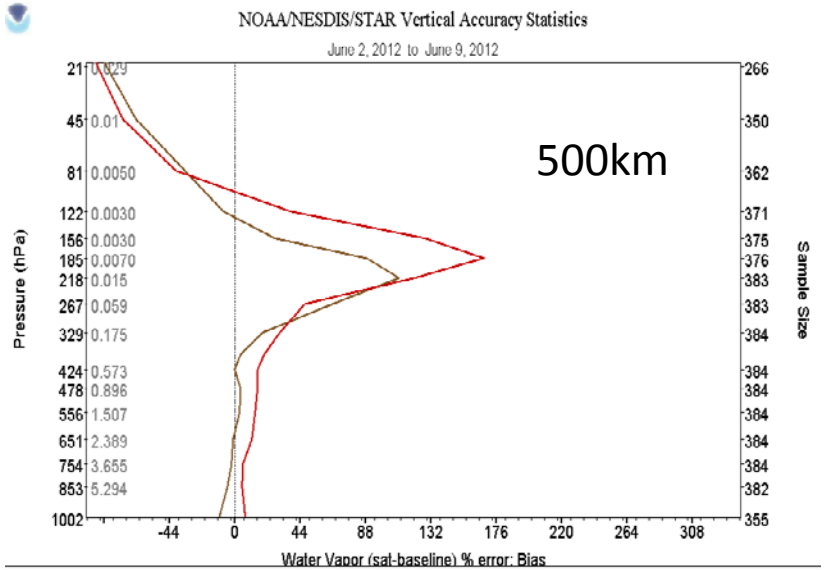


Baseline: Radiosonde Radiosonde

Radiosonde Forecast IASI NOAA

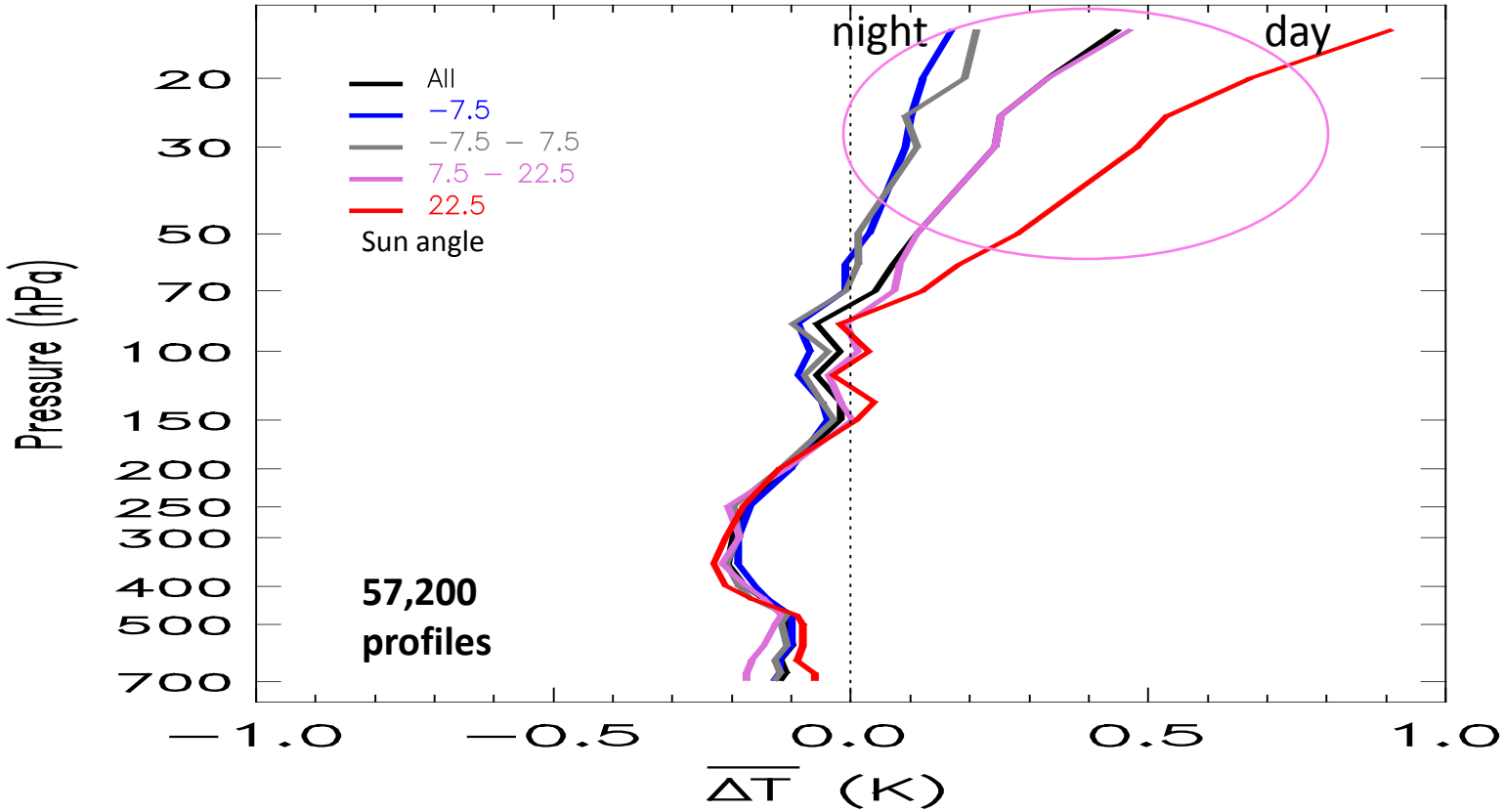
Radiosonde Forecast IASI NOAA

June 2-9 2012

Vaisala RS92

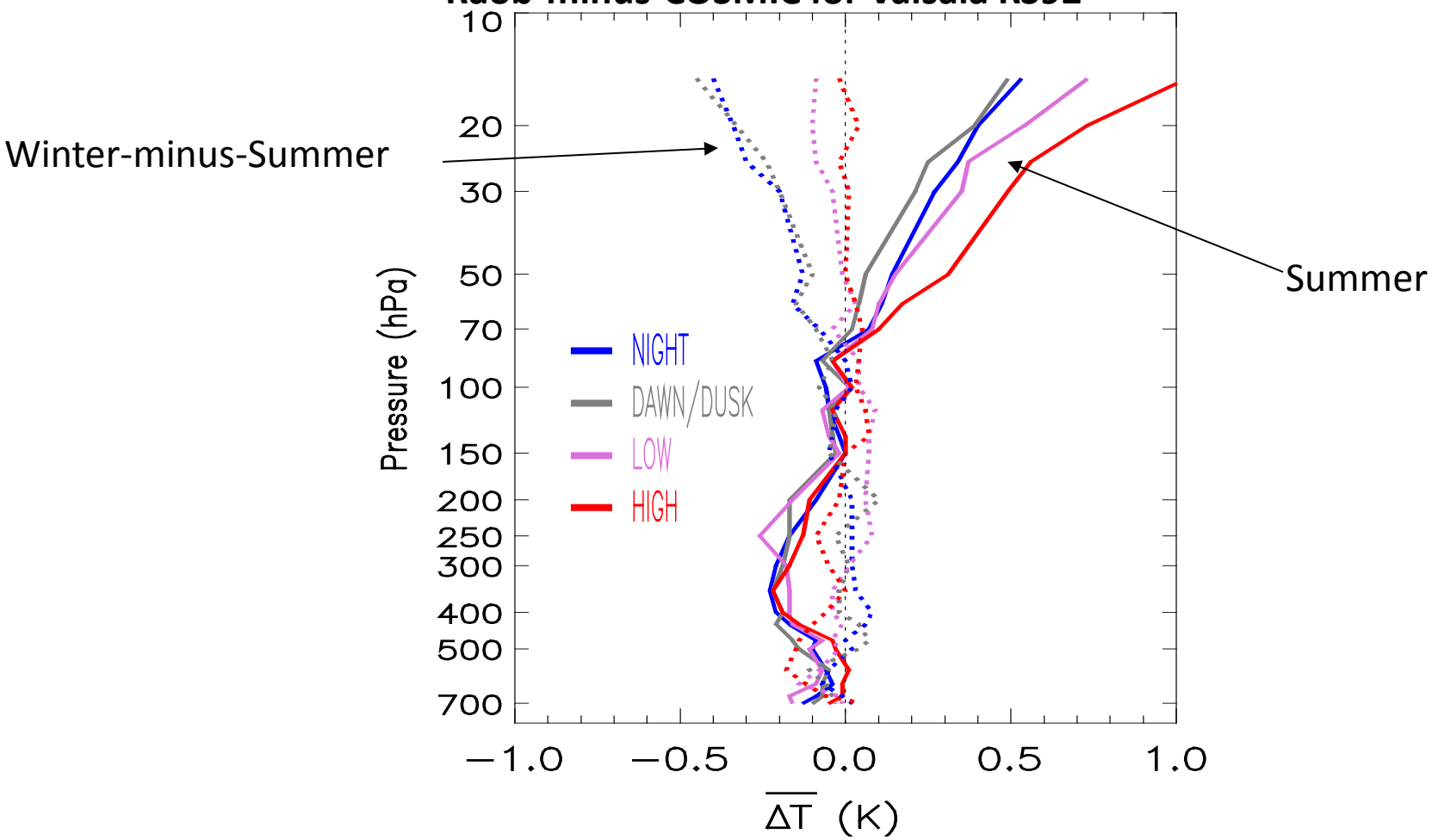
difference from COSMIC T

All sample

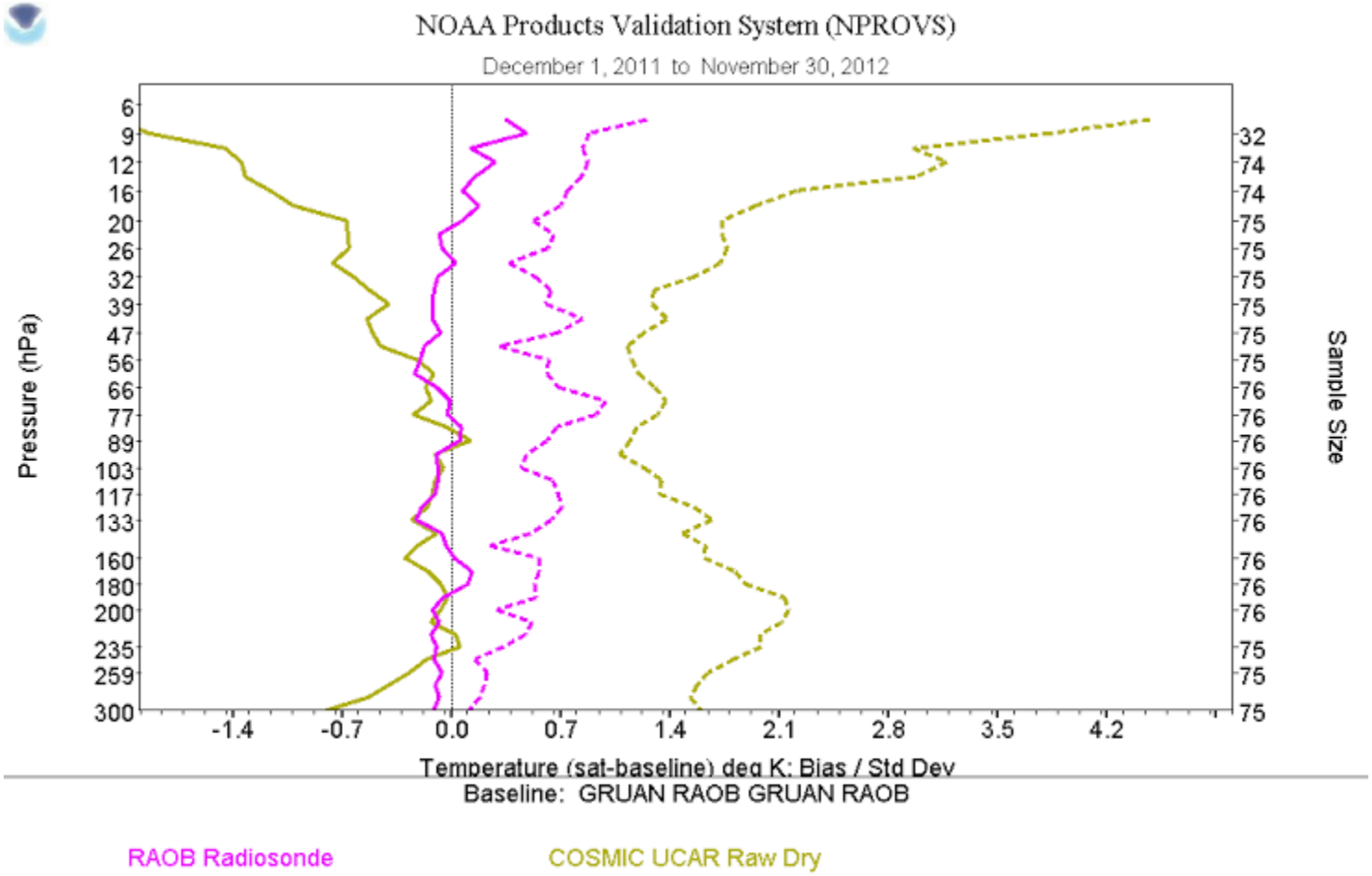


Raob-minus-COSMIC

Seasonal Variation in Raob-minus-COSMIC for Vaisala RS92



Seasonal variation in bias is bigger at nighttime:
Summer relatively warmer than winter?
GRUAN interest …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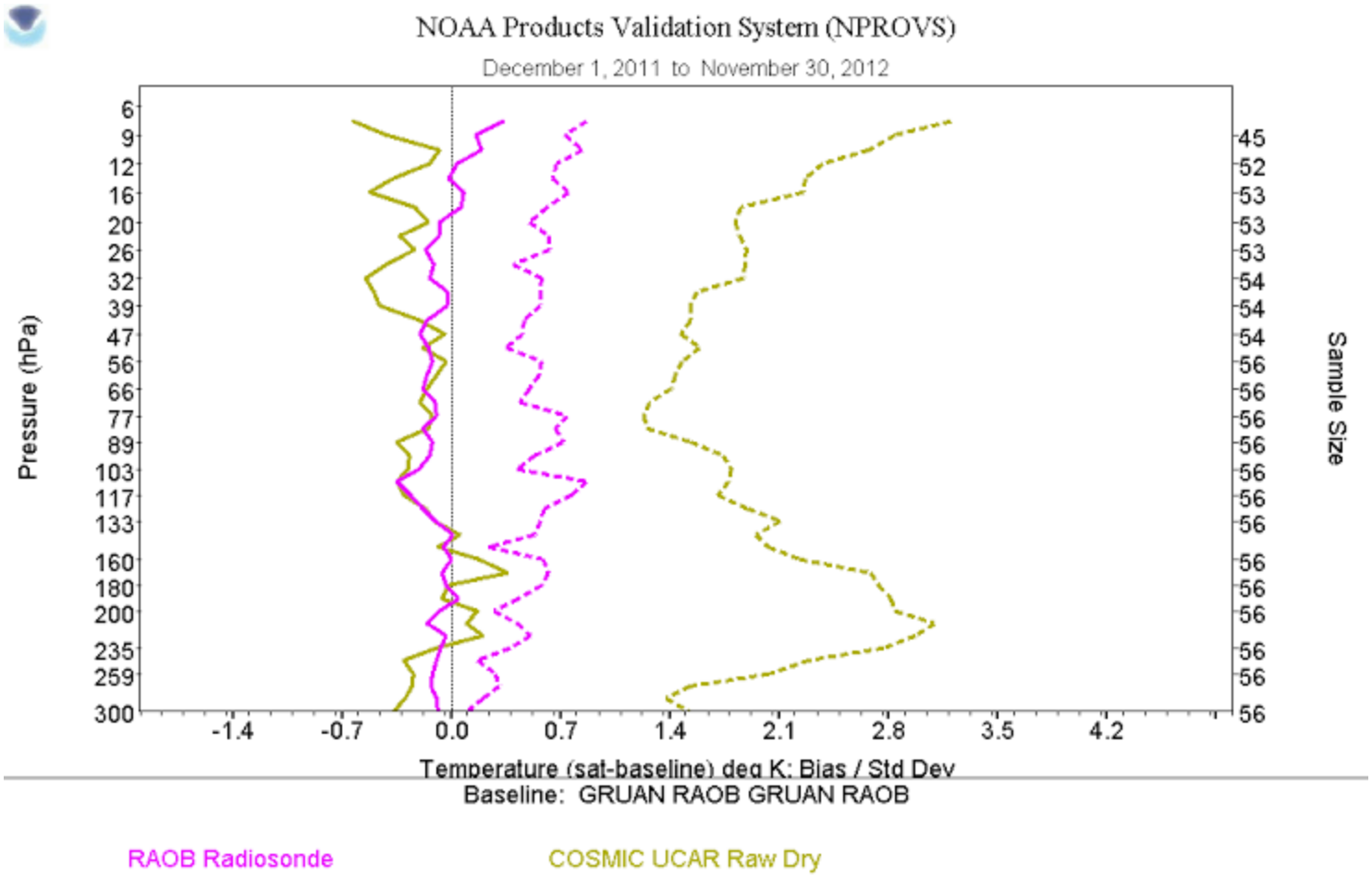
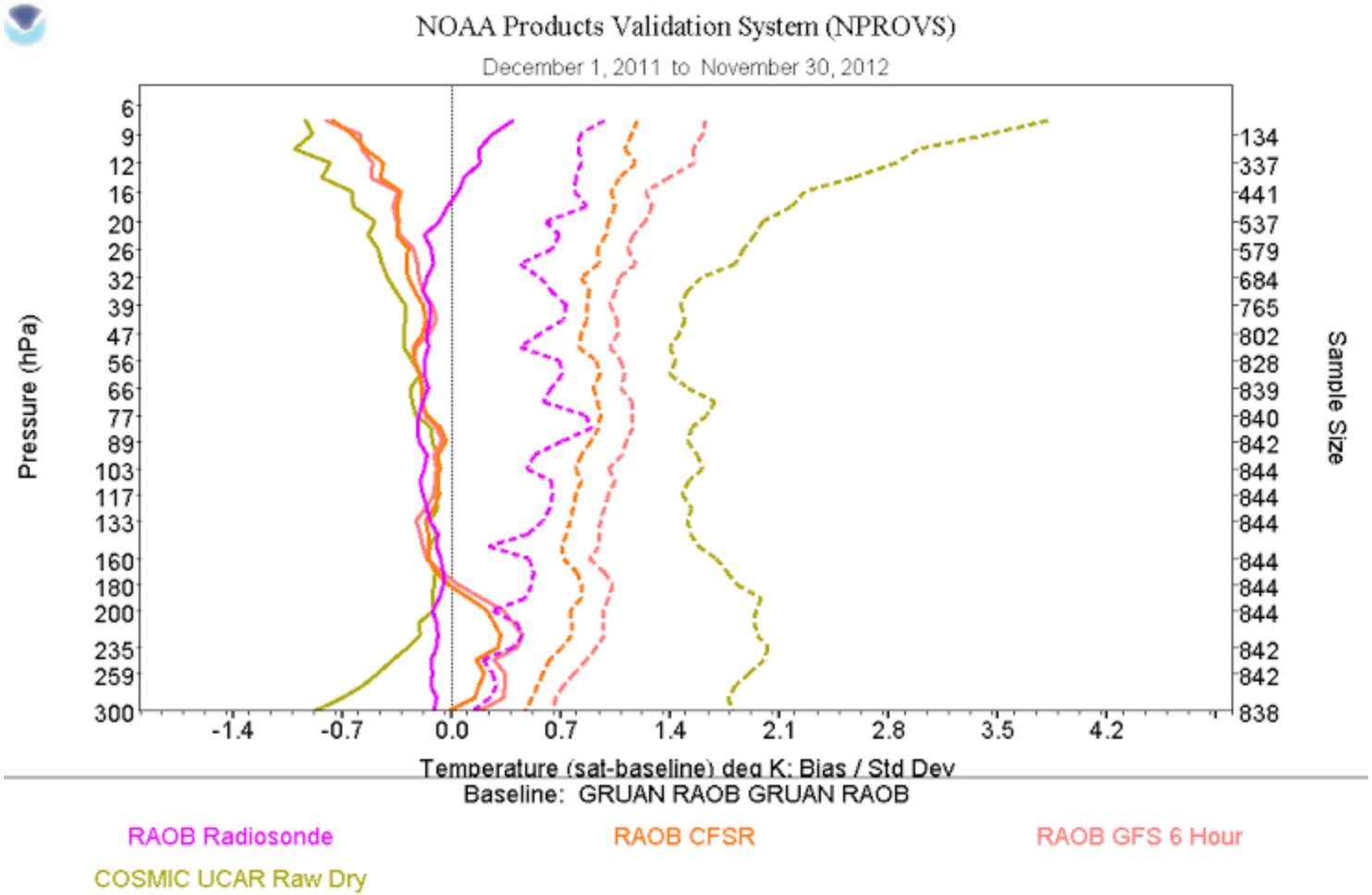
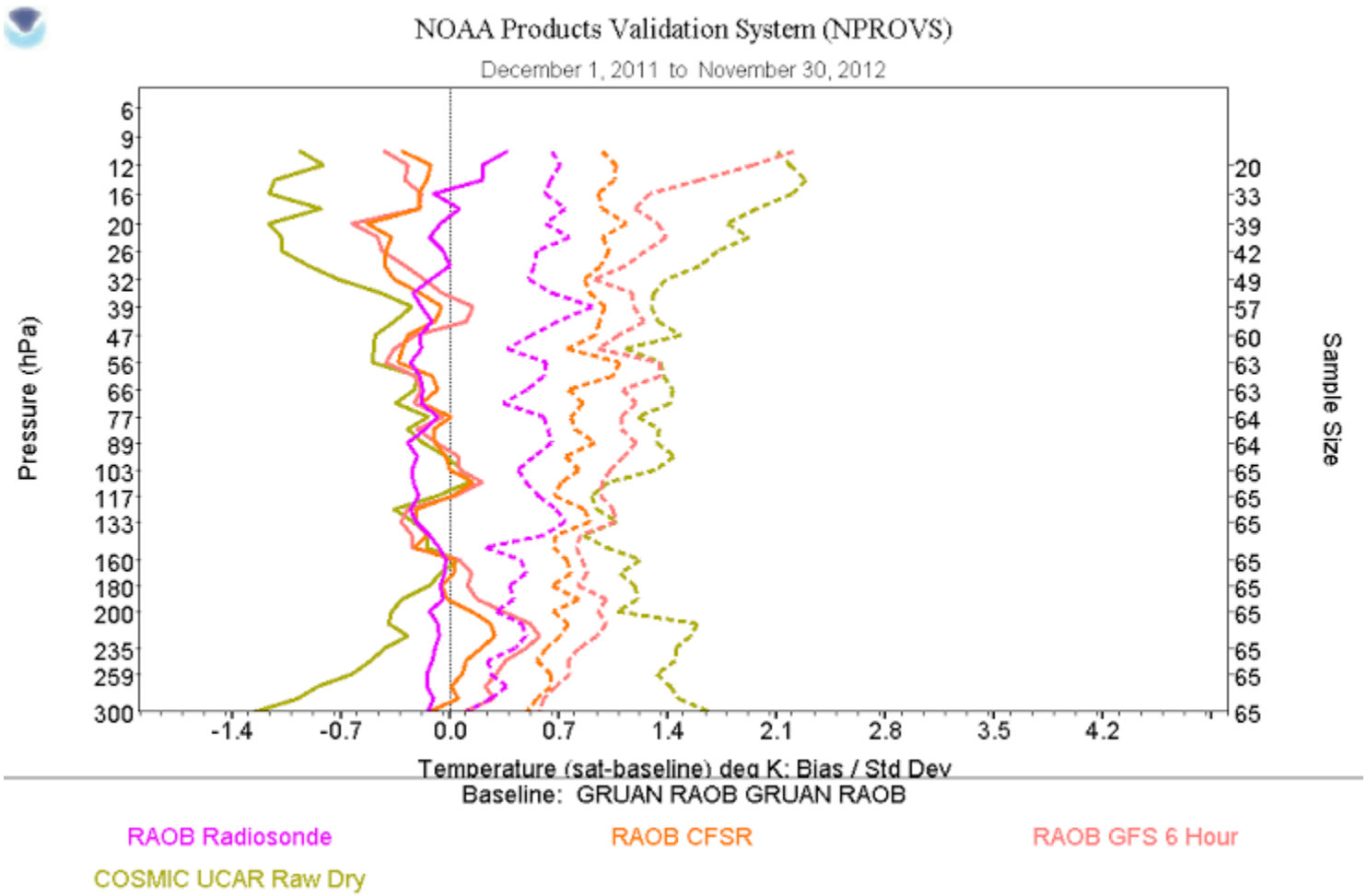
300
-1.4
-0.7
0.0
0.7
1.4
2.1
2.8
3.5
4.2
Sample Size
32
74
74
75
75
75
75
75
75
76
76
76
76
76
76
76
76
76
75
75
75
Temperature (sat-baseline) deg K: Bias / Std Dev
Baseline: GRUAN RAOB GRUAN RAOB
RAOB Radiosonde
COSMIC UCAR Raw Dry

Lin, 12Z, day


NOAA Products Validation System (NPROVS)
December 1, 2011 to November 30, 2012
Pressure (hPa)
6
9
12
16
20
26
32
39
47
56
66
77
89
103
117
133
160
180
200
235
259
300
-1.4
-0.7
0.0
0.7
1.4
2.1
2.8
3.5
4.2
Sample Size
45
52
53
53
53
54
54
54
56
56
56
56
56
56
56
56
56
56
56
56
56
56
Temperature (sat-baseline) deg K: Bias / Std Dev
Baseline: GRUAN RAOB GRUAN RAOB
RAOB Radiosonde
COSMIC UCAR Raw Dry

Lin, 0Z, nite


NOAA Products Validation System (NPROVS)
December 1, 2011 to November 30, 2012
Pressure (hPa)
6
9
12
16
20
26
32
39
47
56
66
77
89
103
117
133
160
180
200
235
259
300
-1.4
-0.7
0.0
0.7
1.4
2.1
2.8
3.5
4.2
134
337
441
537
579
684
765
802
828
839
840
842
844
844
844
844
844
844
842
842
838
Sample Size
Temperature (sat-baseline) deg K: Bias / Std Dev
Baseline: GRUAN RAOB GRUAN RAOB
RAOB Radiosonde
RAOB CFSR
RAOB GFS 6 Hour
COSMIC UCAR Raw Dry


NOAA Products Validation System (NPROVS)
December 1, 2011 to November 30, 2012
Pressure (hPa)
6
9
12
16
20
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39
47
56
66
77
89
103
117
133
160
180
200
235
259
300
-1.4
-0.7
0.0
0.7
1.4
2.1
2.8
3.5
4.2
Temperature (sat-baseline) deg K: Bias / Std Dev
Baseline: GRUAN RAOB GRUAN RAOB
Sample Size
20
33
39
42
49
57
60
63
63
64
64
65
65
65
65
65
65
65
65
65
RAOB Radiosonde
RAOB CFSR
RAOB GFS 6 Hour
COSMIC UCAR Raw Dry

+/- 3 hr / 150km

Building High-Quality Climate Data Records from Operational Satellites

Fuzhong Weng
NOAA Center for Satellite Applications and Research

Seminar at ESSIC/UMD
March 5, 2014, 12:00pm - 01:00pm

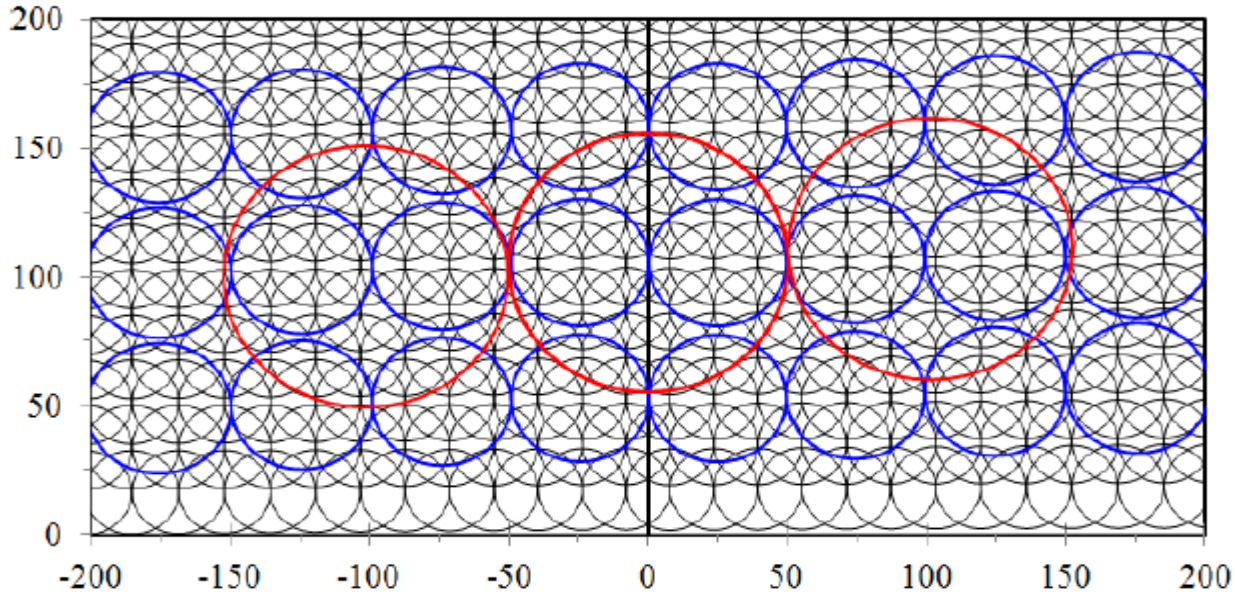
Outline

- Background on Climate Trend Analysis
- Instrument CalVal for Advanced Weather and Climate Reserach
- New Analysis of Atmospheric Temperature Trend from MSU and AMSU through non-Linear Trending
- Effects of Clouds and Precipitation on AMSU Derived Climate Trending
- Atmospheric Temperature Trend from 1DVar Retrieval
- Summary and Conclusions

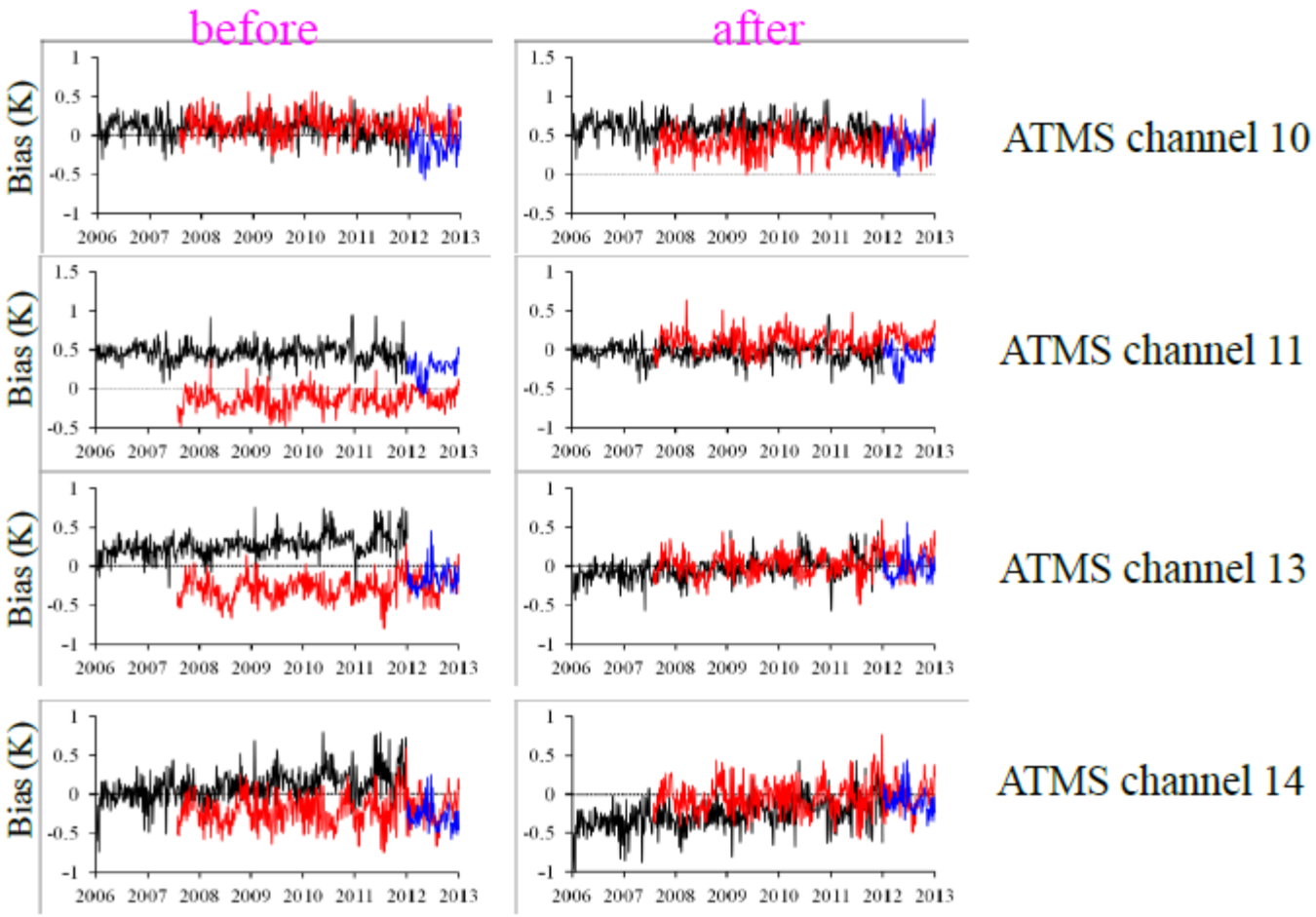
Three Generations of Microwave Sounding Instruments from MSU to AMSU/MHS to ATMS

ATMS Field of View Size for the beam width of 2.2° – black line

ATMS Resample to the Field of View Size for the beam width of 3.3°- blue line

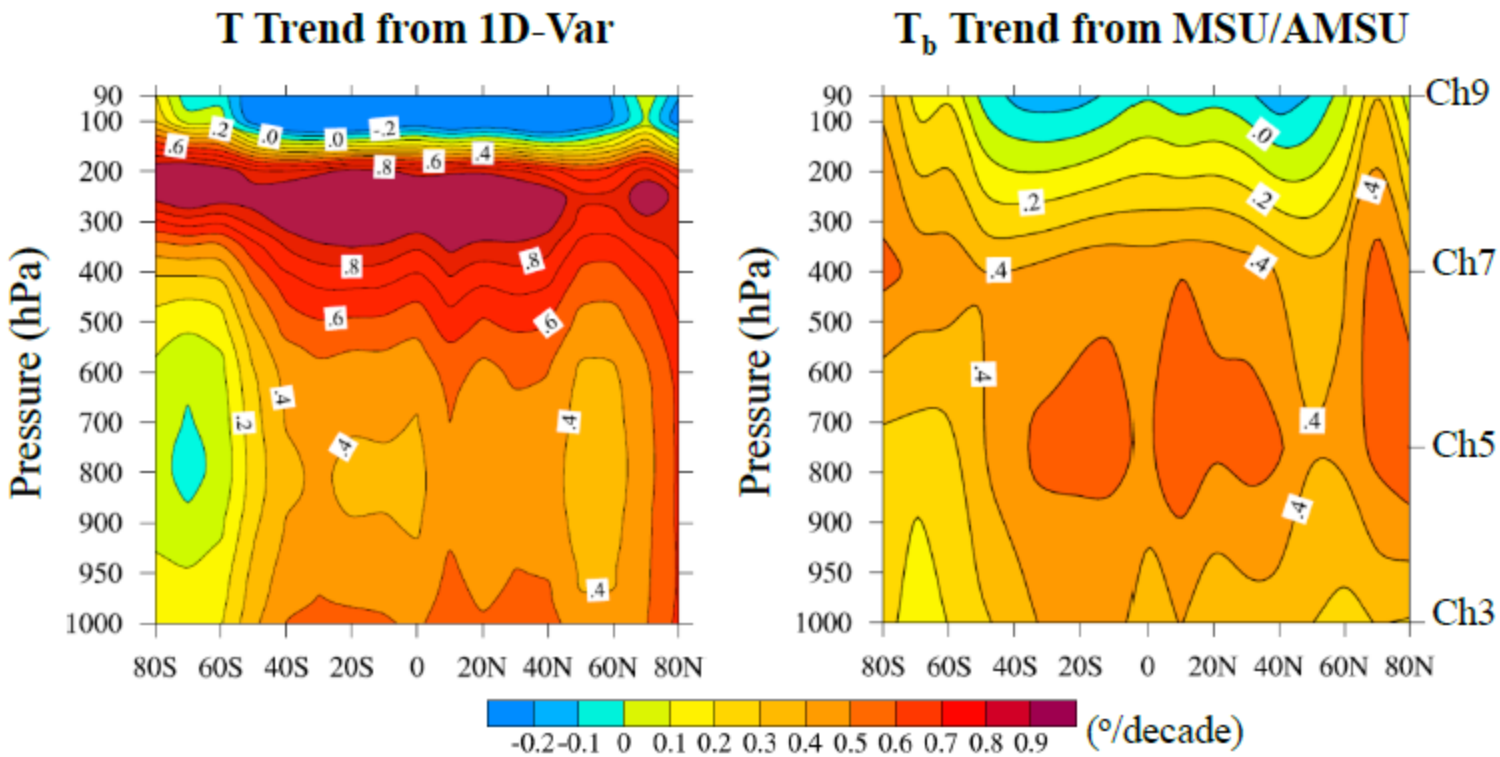


Biases in the Tropics (NOAA-15, MetOp-A, SNPP)



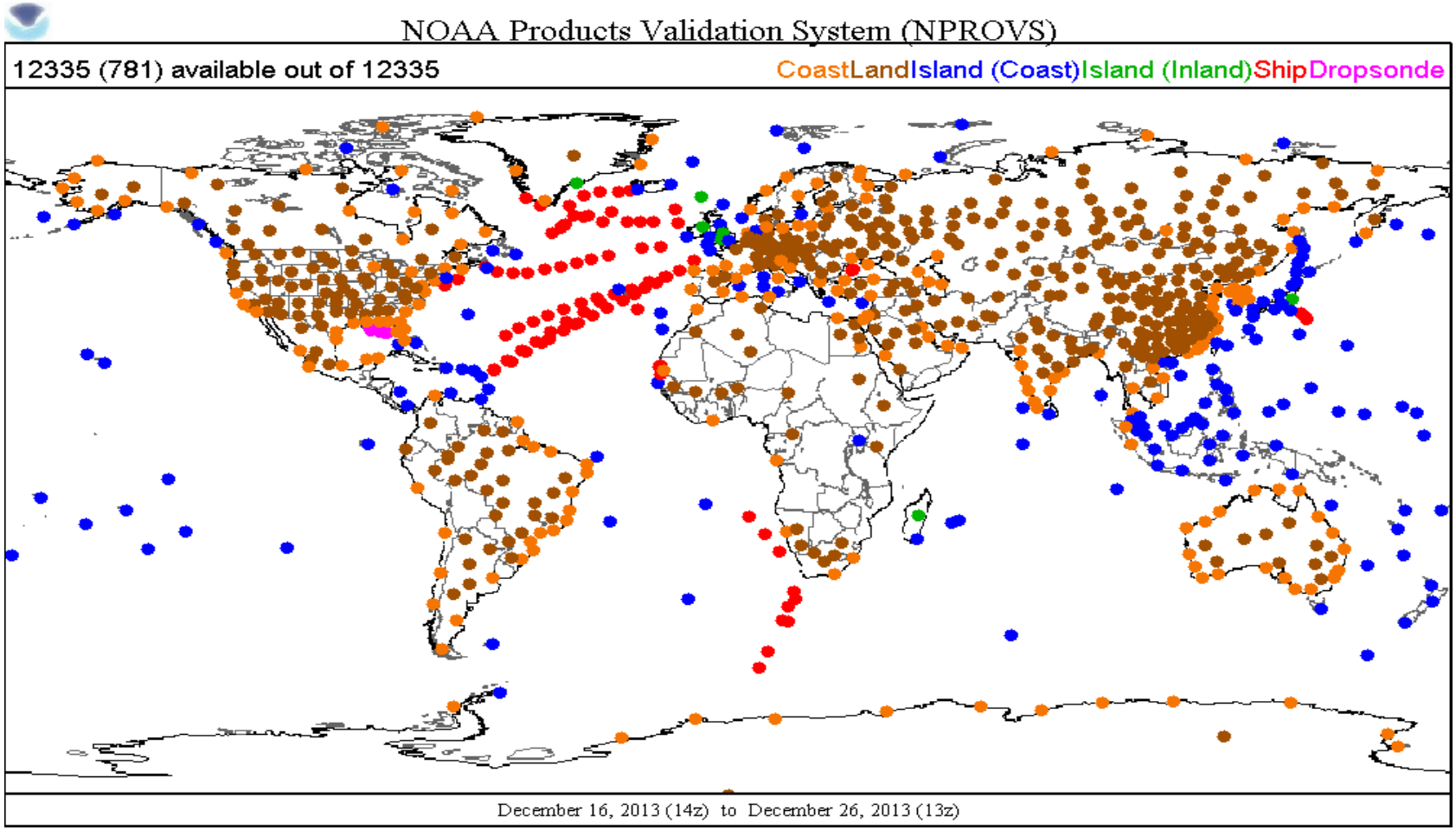
NOAA-18 is subtracted. The pentad data set within ±30° latitudinal band.

1D-Var Derived Temperature Trend



Weng, F. and X. Zou, 2013: 30-year atmospheric temperature trend derived by one-dimensional variational data assimilation of MSU/AMSU-A observations. *Clim. Dyn.*, DOI: 10.1007/s00382-013-2012-5.

EDR VALIDATION



NPROVS Collocations 12/16 to 12/26 2013 … 12,335

EDR Validation Results

GRUAN Reference Measurement Principles

Consistency in a Finite Atmospheric Region

1) Determine the variability (σ) of a variable (m) in time and space from measurement or model
2) Two observations on different platforms are consistent if

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

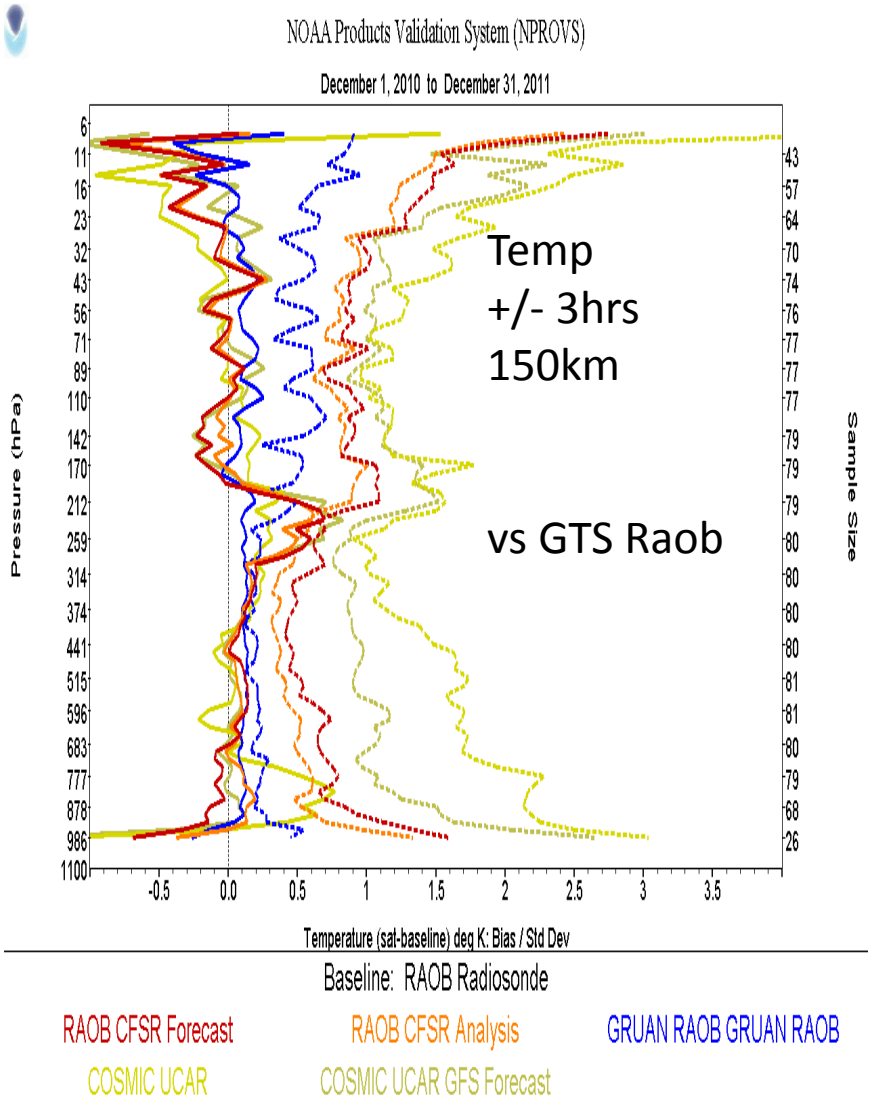
… at this preliminary stage:

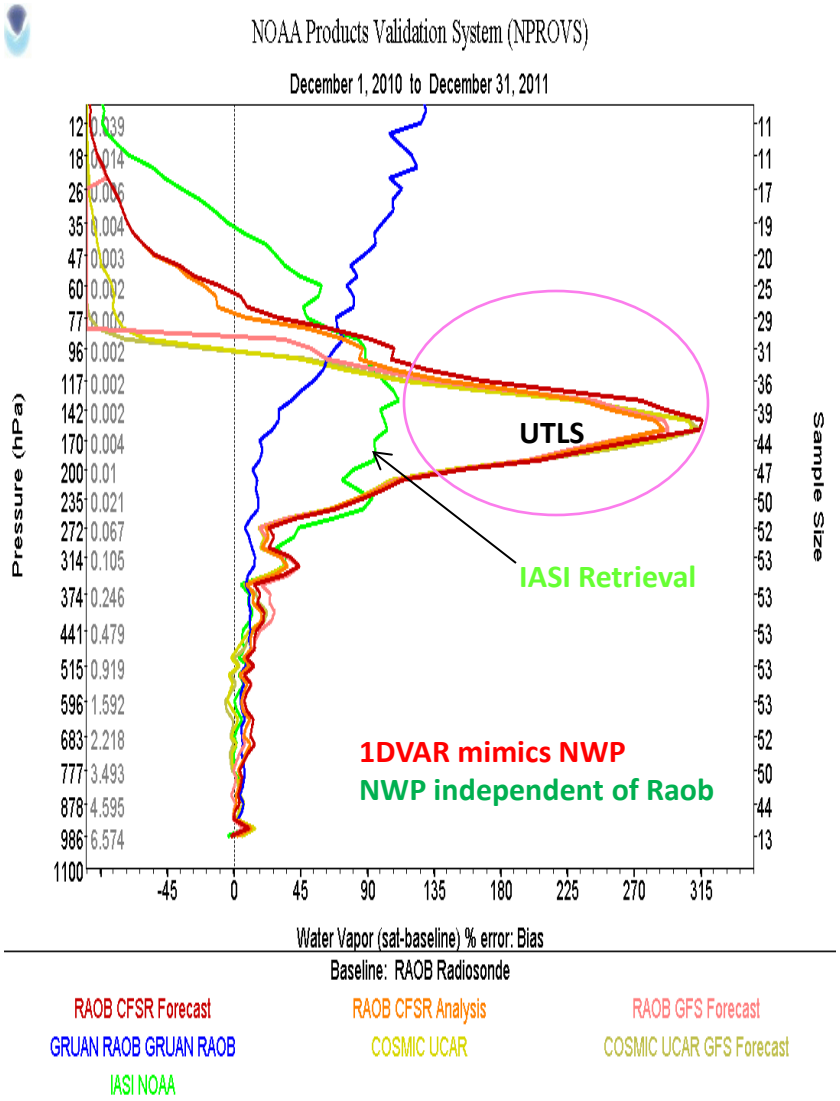
K = ABS (X – GRUAN) / Uncertainty (u1)

where "X" either SAT or NWP

"need uncertainty estimates for EDR"

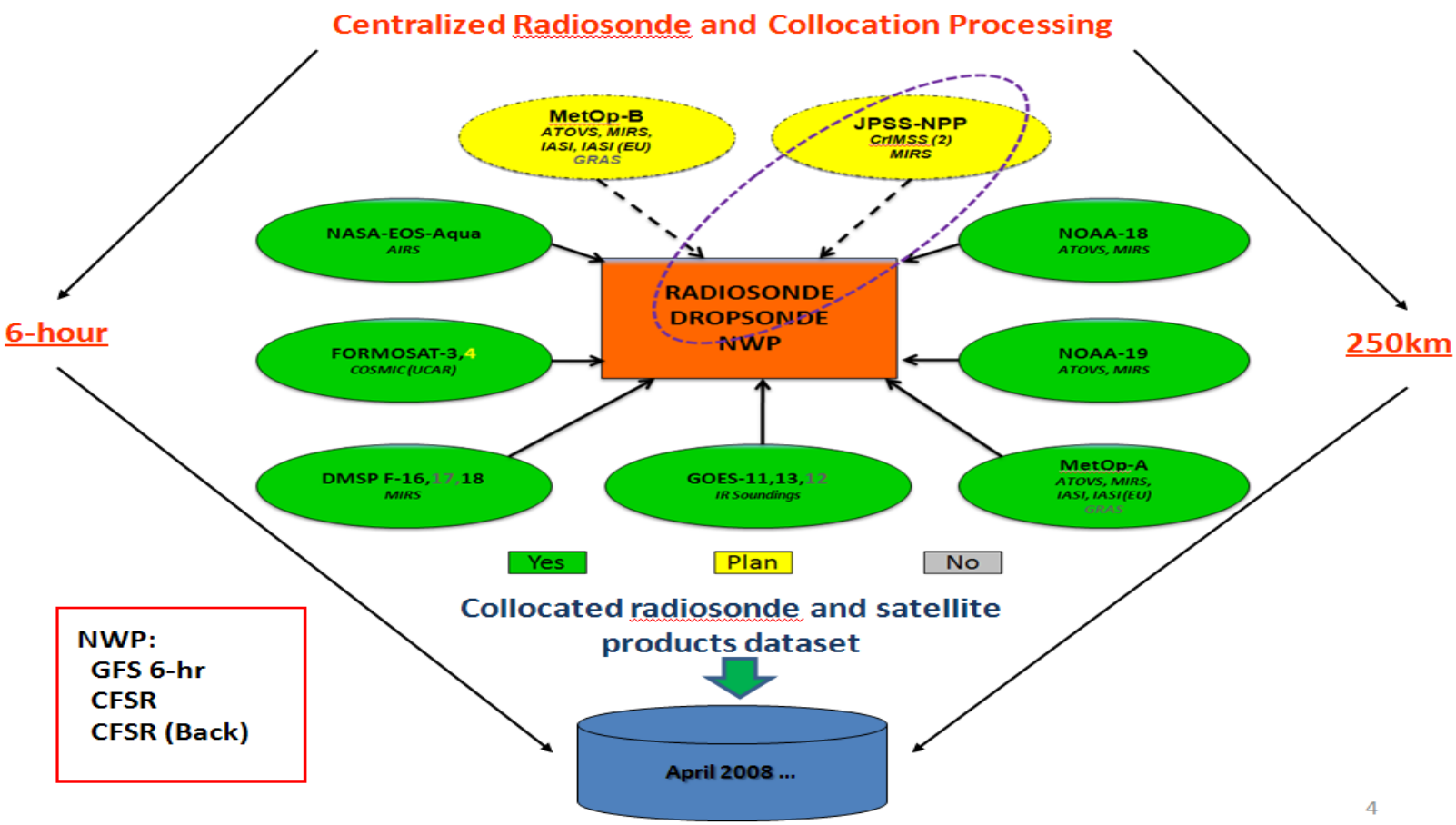
Mainly Vicinity of Lindenberg, Germany





GRUAN Sonde and COSMIC-minus- GTS Sonde

EDR VALIDATION



Conventional RAOB

NOAA Products Validation System (NPROVS)