GRUAN / NPROVS+ / GSICS

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GSICS Microwave Sub-group
July 26, 2016

Outline

- Motivation
- NPROVS+ and GRUAN
- 3-G Connection
- GRUAN Uncertainty and Analytical Integration
  - o EDR cal/val … SDR cal/val
  - o GPSRO
- Summary

GRUAN reference observations are calibrated through an unbroken traceability chain to SI or community standards with the uncertainty interval in each step in the chain fully characterized, meaning the resulting estimates can be used with high confidence that the true measurement is within the interval.

Among the primary objectives of GRUAN is the constraining and inter-calibration of data from other more spatially extensive observing systems such as satellites and the current radiosonde network.

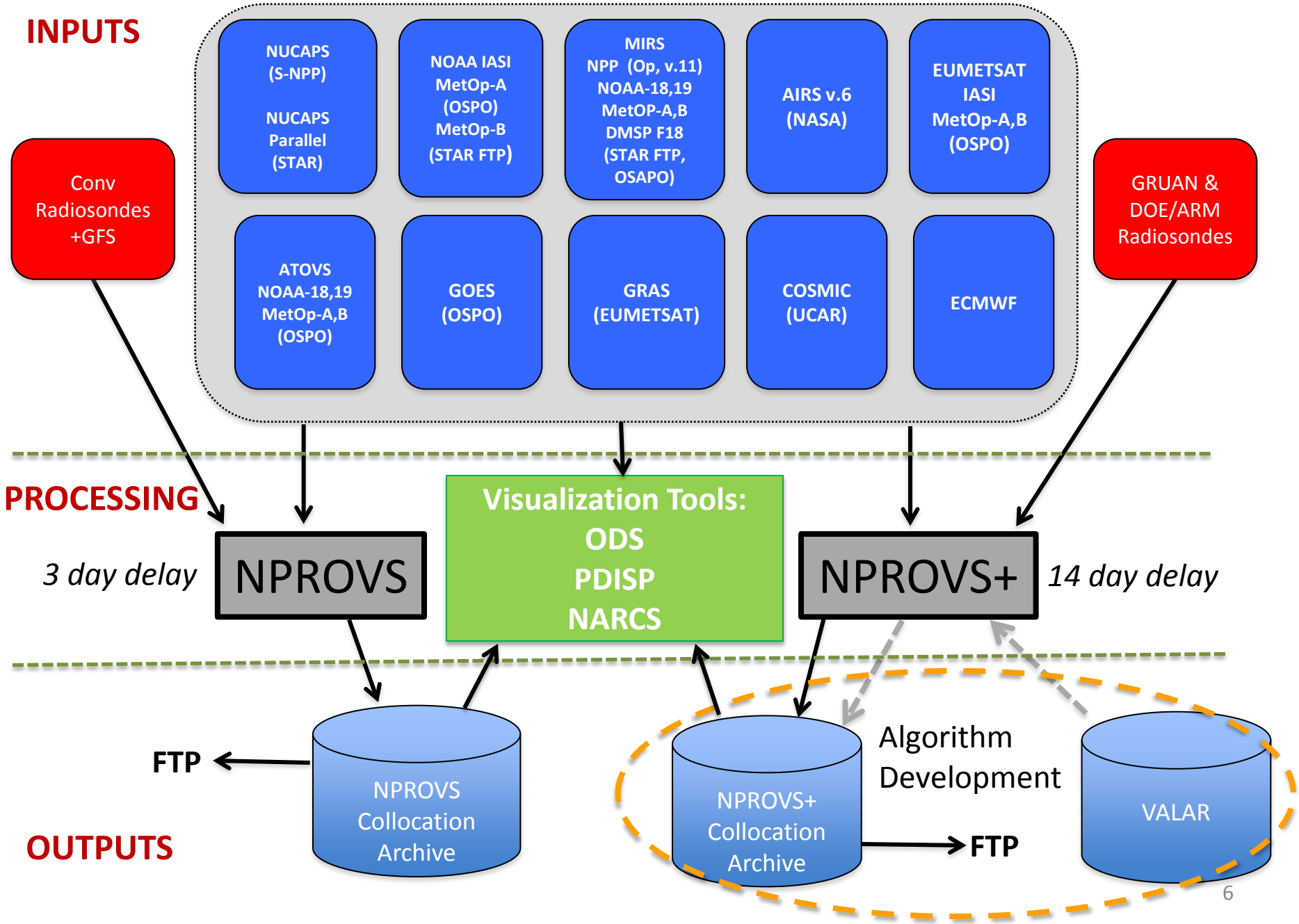
connect between GRUAN and GSICS could be:

"GSICS could provide travelling reference (in space, eg CrIS, ATMS) standards for GRUAN stations, while GRUAN with Radiative Transfer Models (RTM) could provide references for MW, IR *calibration"…* *and accuracy assessment (TR)*

highlighted by Mitch Goldberg in GSICS Executive Panel meeting …

Times	file	Topic
	--	Thursday: GSICS Users Workshop (Chairs: Larry Flynn and Manik Bali)
8:30	--	Introduction
8:35		Introduction to GSICS Workshop
8:45		GSICS Past Present and Future
9:00		GSICS Research Working Group
9:15		GSICS Data Working Group
9:30		GCC GSICS Products and Deliverables
9:45		GSICS User Survey
10:00		Break
10:15		Instrument landing pages, OSCAR,
10:30		ICVS
10:45		ICVS
11:00		ICVS
11:15		Ralph Ferrao-MW Session
11:20		Investigating Shortcomings of Radiative Transfer Models at Microwave Frequencies
11:40		Stability and Interconsistency of Passive Microwave Water Vapor Products for Weather and Climate
12:00		What Happens to Radiances after They Leave Home: Precipitation
12:20		Toward a Long-Term Climate Change Monitoring in the JPSS Era
12:40		Ralph Ferrao-Closing
12:45 PM		Lunch 12:15-13:50 (or 13:30)
13:30		Fred Wu-IR Session
13:45		Fred Wu-IR
14:00		Masaya Takahashi- IR
14:15		Dave Doelling -VIS Session
14:30		Jack Xiong- VIS
14:45		Andy Heidinger-VIS
14:45:00		Break+Poster
15:15:00		Preliminary SCIAMACHY Lunar observations as intercalibration source
15:30		Grant Matthew-Lunar
15:30		Andy Harris-SST- User Feedbacks
15:45		Asim Mitra - INSAT
16:00		KMA- SST
16:15		UV
16:30		UV
16:45		Discussions and Conclusions

NPROVS/NPROVS+ Data Management Schematic



Collocation Criteria:

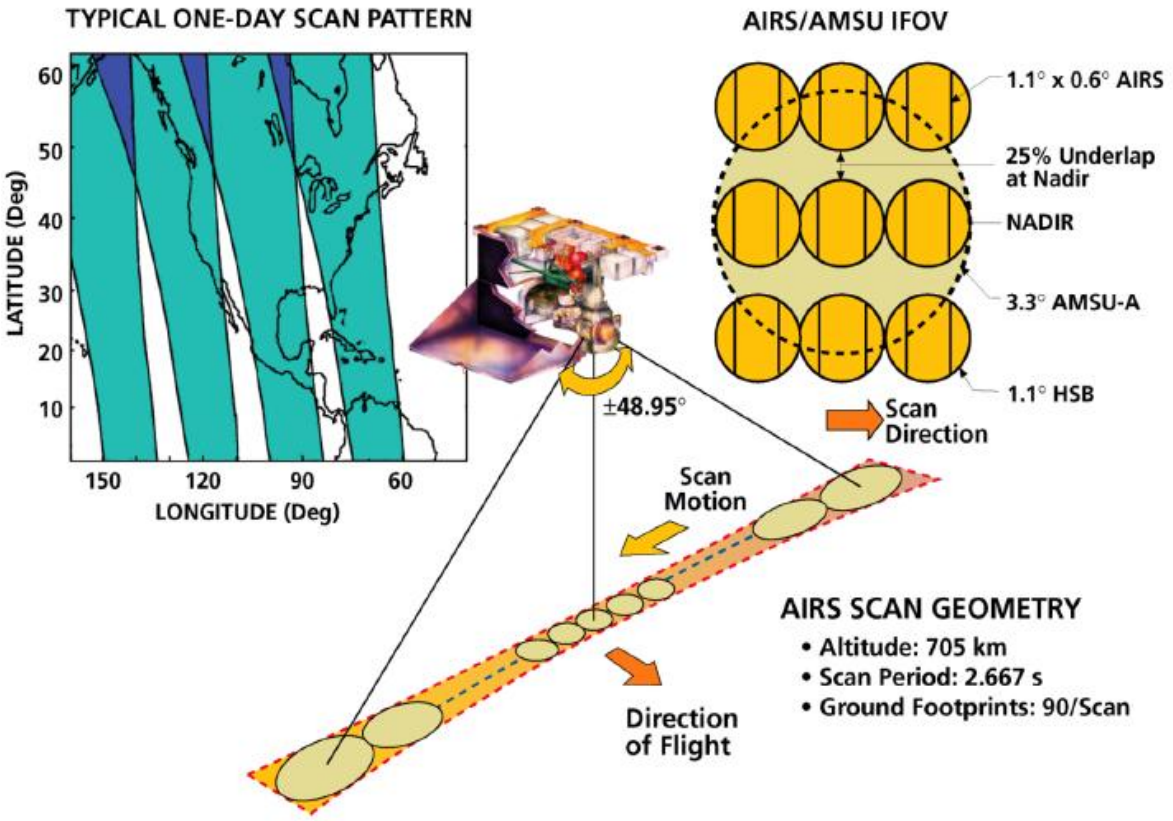
+/- 6-hour

250 km

Single Closest

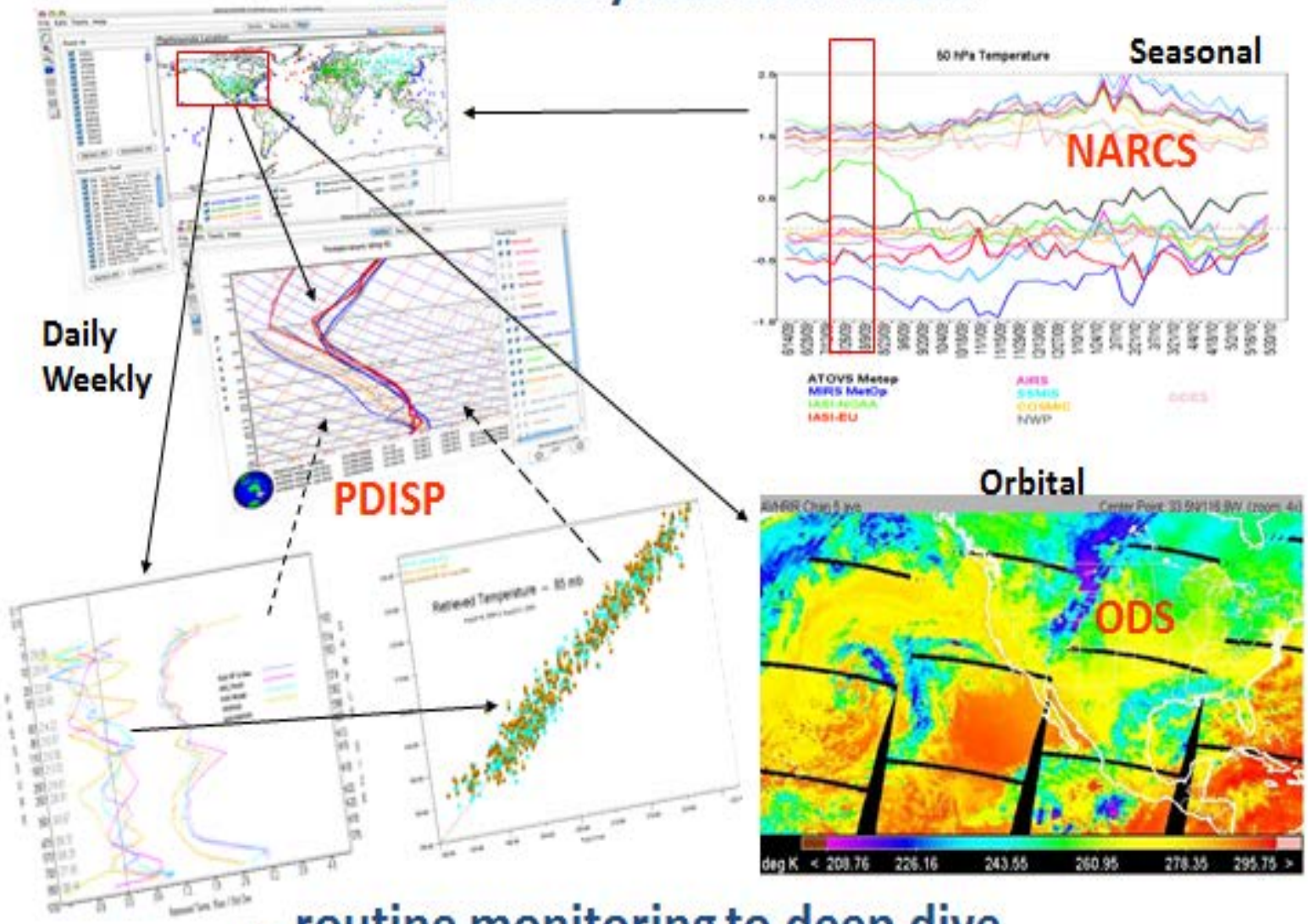
Overview of EDR Data Products

- **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.**



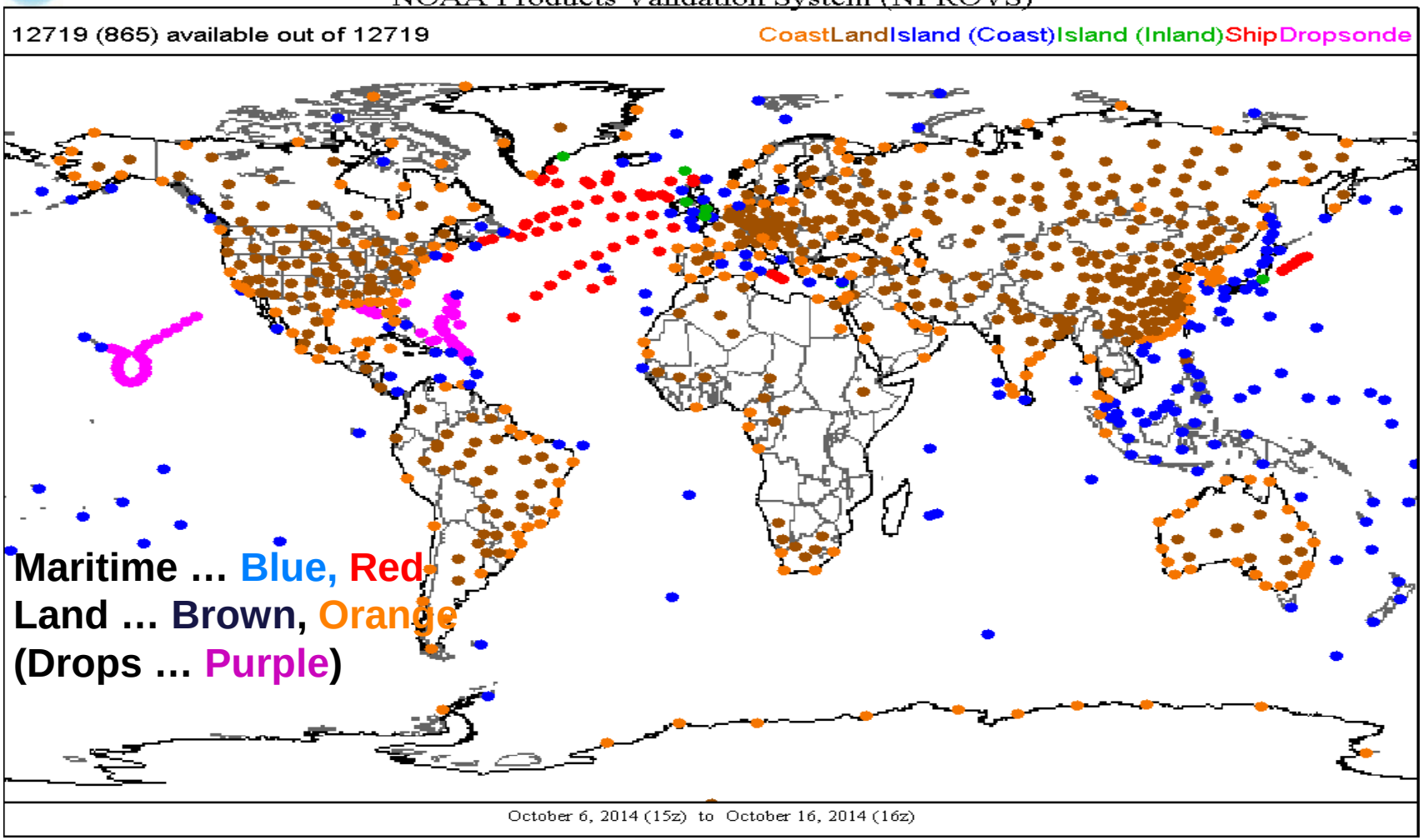
Barnet, Prov

EDGE Analytical Interface …

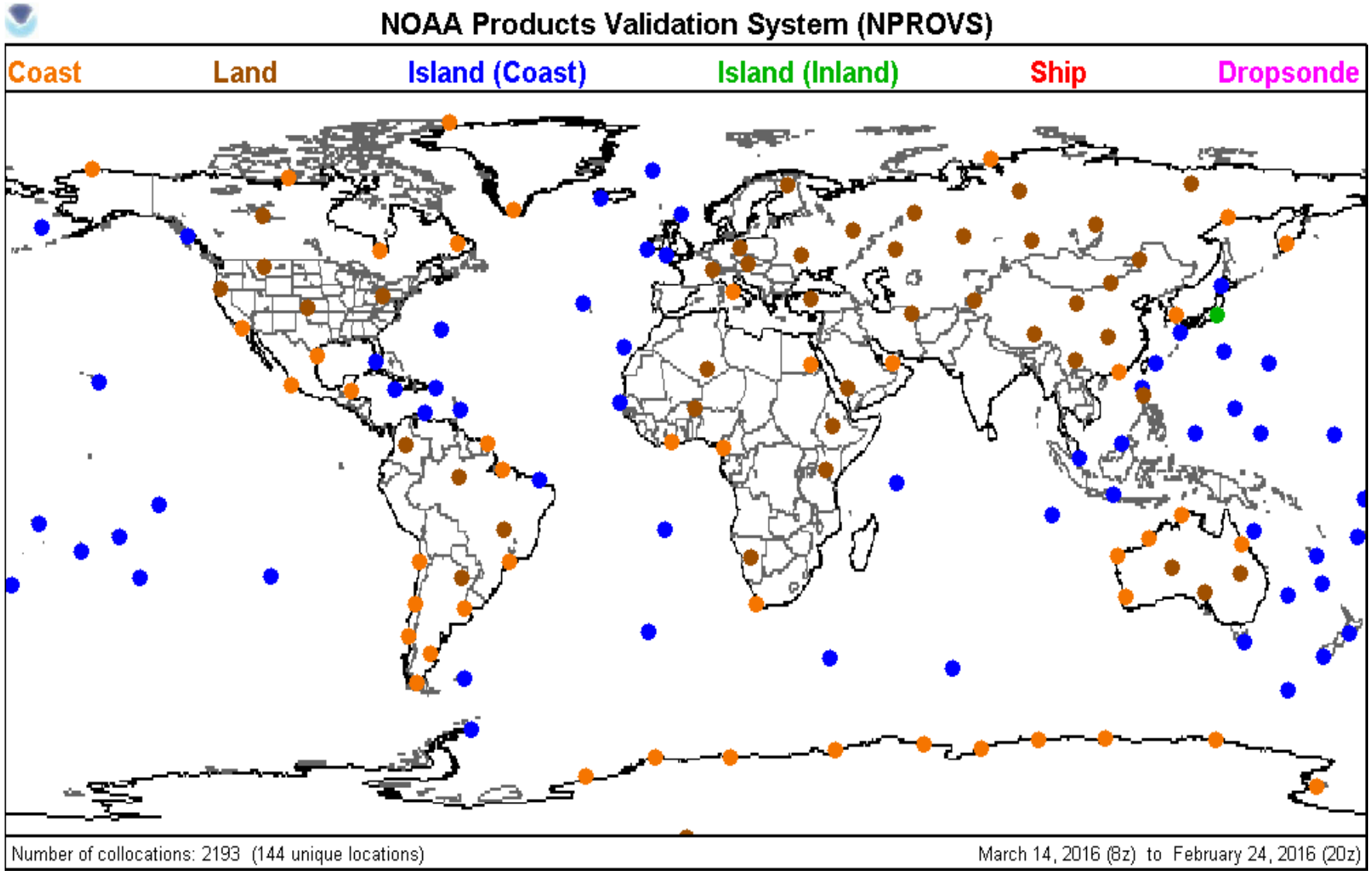


… routine monitoring to deep dive

N P R O V S

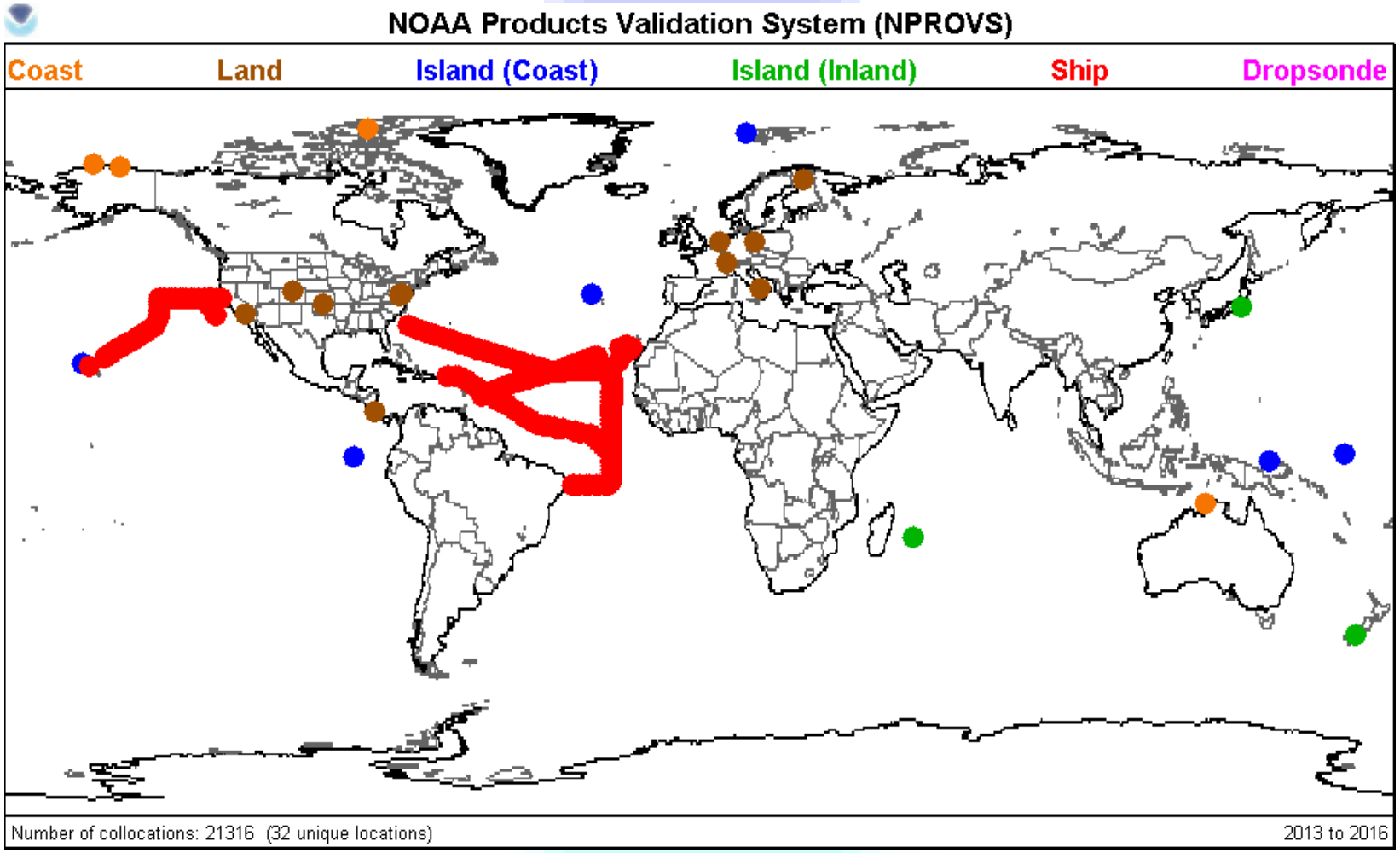


Typical NPROVS Global Collocation Dataset
(1000 collocation records per day)


NOAA Products Validation System (NPROVS)
Coast
Land
Island (Coast)
Island (Inland)
Ship
Dropsonde
Number of collocations: 2193 (144 unique locations)
March 14, 2016 (8z) to February 24, 2016 (20z)

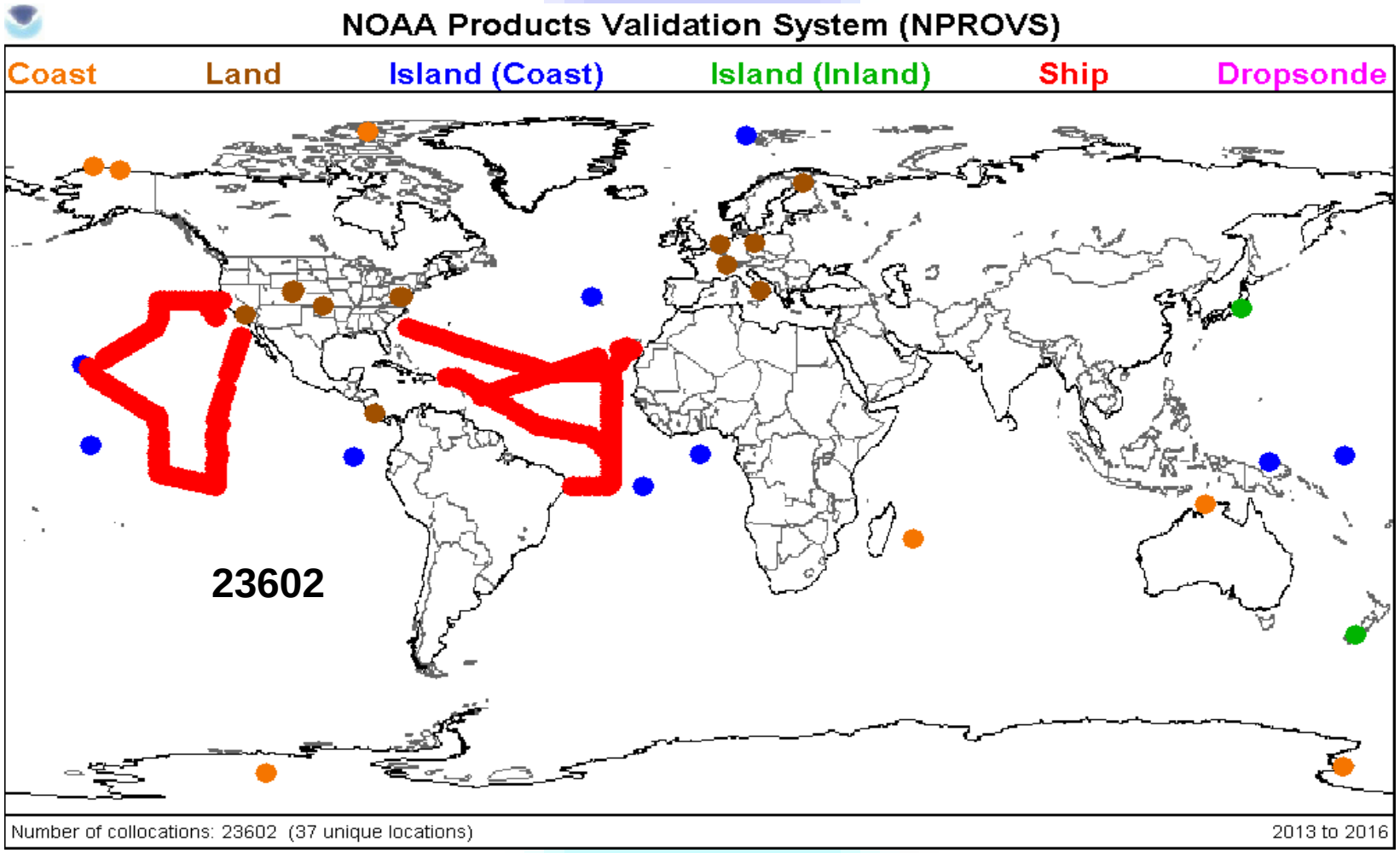
GCOS Subset

N P R O V S +



GRUAN and JPSS funded Dedicated (S-NPP) RAOB Sites
Over 20,000 RAOBS (2000+ Dedicated) available since July 2013 thru April 2016

N P R O V S +



GRUAN and JPSS funded Dedicated (S-NPP) RAOB Sites
5597 synchronized RAOBS (1373 via JPSS/ARM) since January 2013 thru June 2016

N P R O V S +

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

JPSS Funded Dedicated RAOB

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

GAIA-CLIM Coordination

3G Coordination (GRUAN, GPSRO, GSICS)

GEWEX-GVAP

2015 inputs to NPROVS+ via LC and/or respective site

Site	within 7 days	60-days+	Received from site
BAR	523	819	851
BEL	0	0	53
SGP	1172	1534	1752
BOU	8	47	
CAB	344	375	
ENA			390
LAU	8	15	50
LIN	1382	1446	
NYA	350	363	
OLI			274
PAY	20	53	
POT	28	32	
REU	5	19	
SCR	17	17	
SOD	161	693	
Sterling			252
TAT	53	53	

… feedback to GRUAN

"3G" workshop convened by the World Meteorological Organization in May, 2014 (http://www.wmo.int/pages/prog/www/WIGOS-WIS/reports/3G-WIGOS-WS2014.pdf).

"3G" denotes:

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

Global Space-based Inter-Calibration System (GSICS)

Global Navigation Satellite System Radio Occultation (GNSSRO).

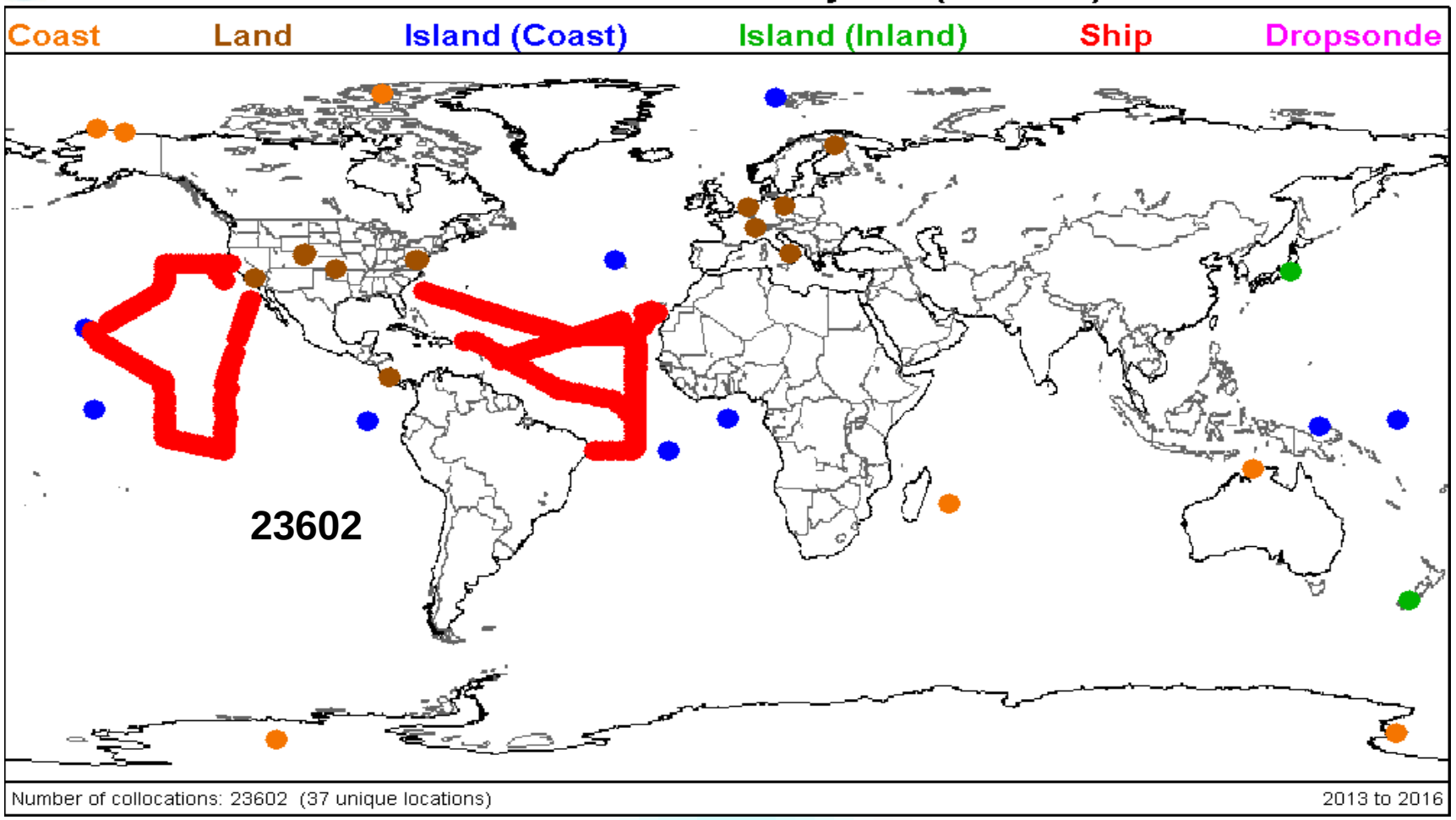
"3G" / STAR Coordination

- JPSS funds dedicated RS92 RAOB at ARM, Beltsville, AEROSE …
  - RAOBS are GRUAN processed (v2)
  - V3, RS41 transition …
- Append SDR's to EDRs collocated in NPROVS+ … VALAR …
  - STAR initiative (ATMS focus …)
- *Facilitate launch schedules GPSRO (COSMIC) overpass to better target timely GPSRO, GRUAN and polar satellite collocations*
  (VonEngeln, (Eumetsat), Nielson (DMI), Borg (SSEC))
  - *GRAS*
  - *Polar / GPSRO golden cases (Calbert, Reale, Sun for IASI / AMSU)*
- *Install RTM in "PDISP" analytic interface (STAR, GRUAN, GAIA-CLIM …)*
  - *CRTM, RTTOV*
  - *GRUAN processor (Carminati et al., 2016)*

Uncertainty integrated in

NPROVS+ analytic interface (PDISP)

NPROVS+



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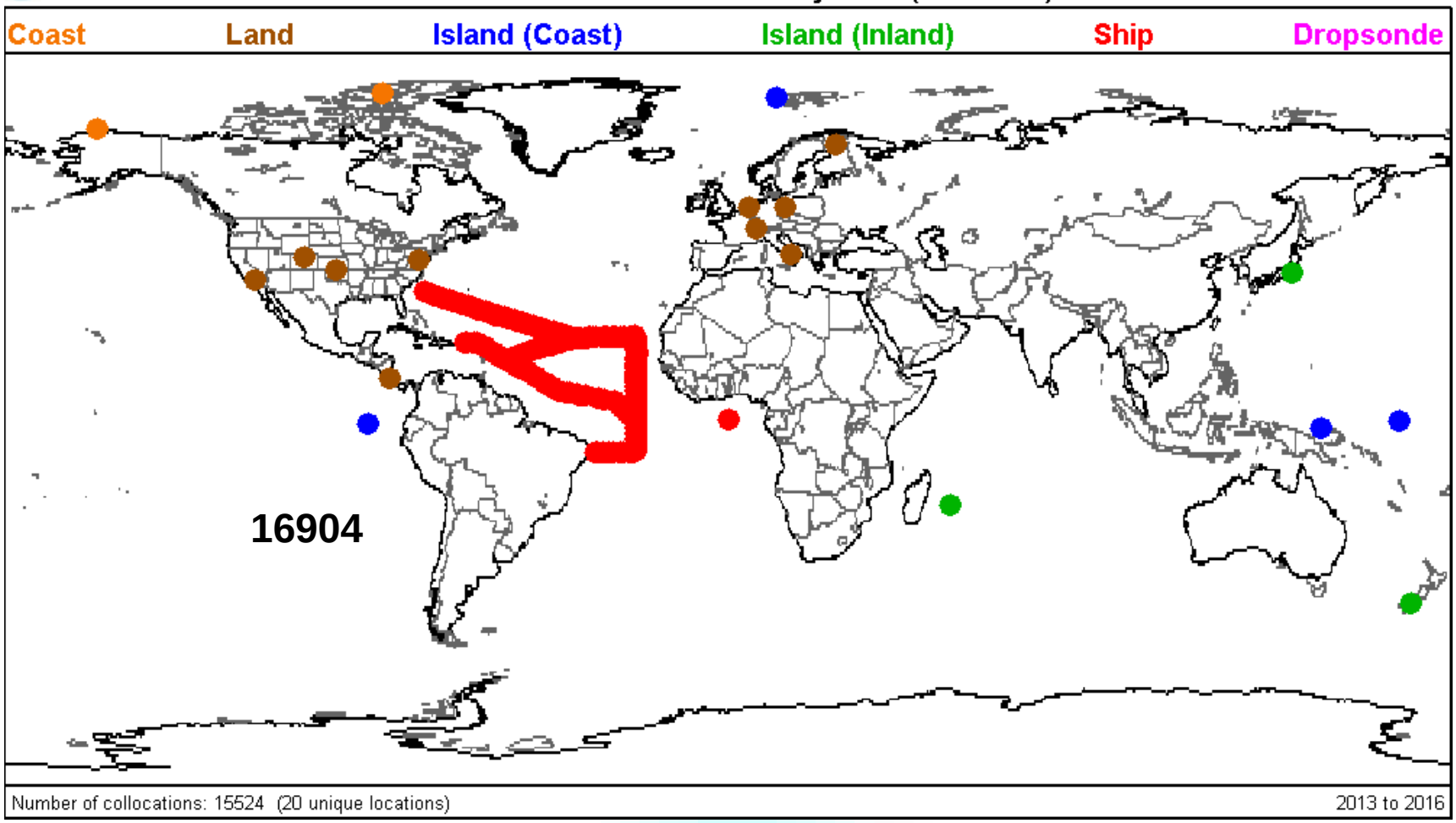


NPROVS+ Subset that are GRUAN processed RAOB

GRUAN Reference Measurement Principles

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 :

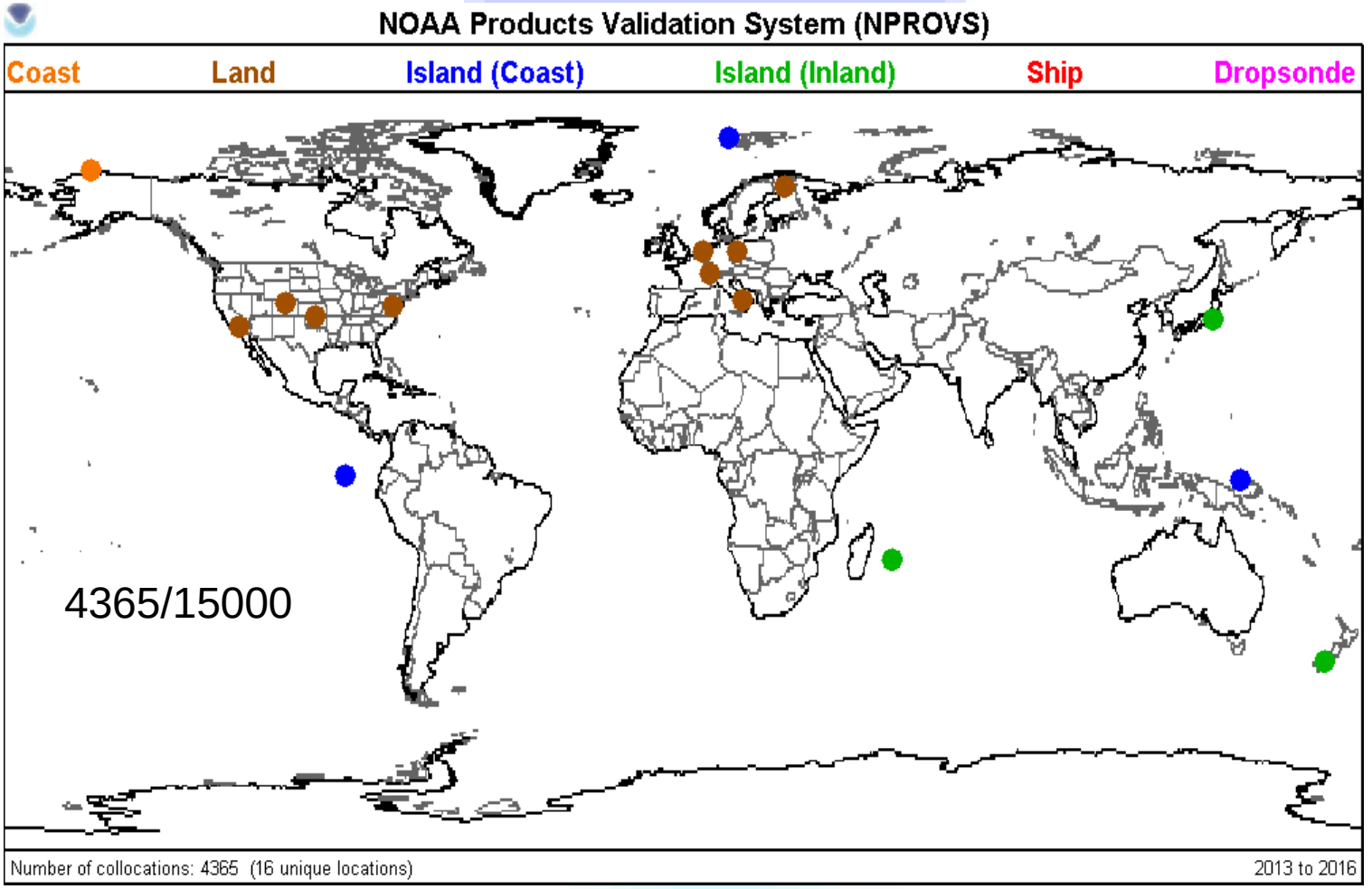
"k" = ABS(X – GRUAN) / u2

where u2 is GRUAN uncertainty

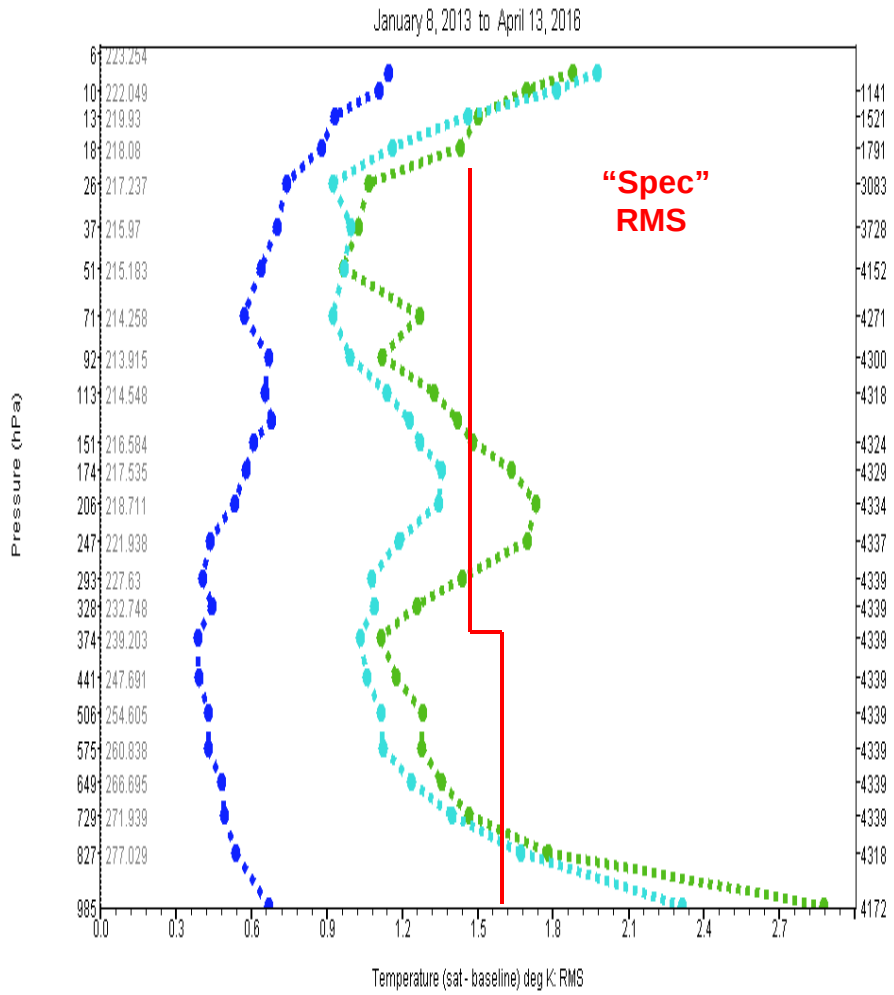
$\sigma^2 + u_1^2$ ~ (("k"/2)^2 –1) (u2)^2 ; $u_1 = a(u_2)$

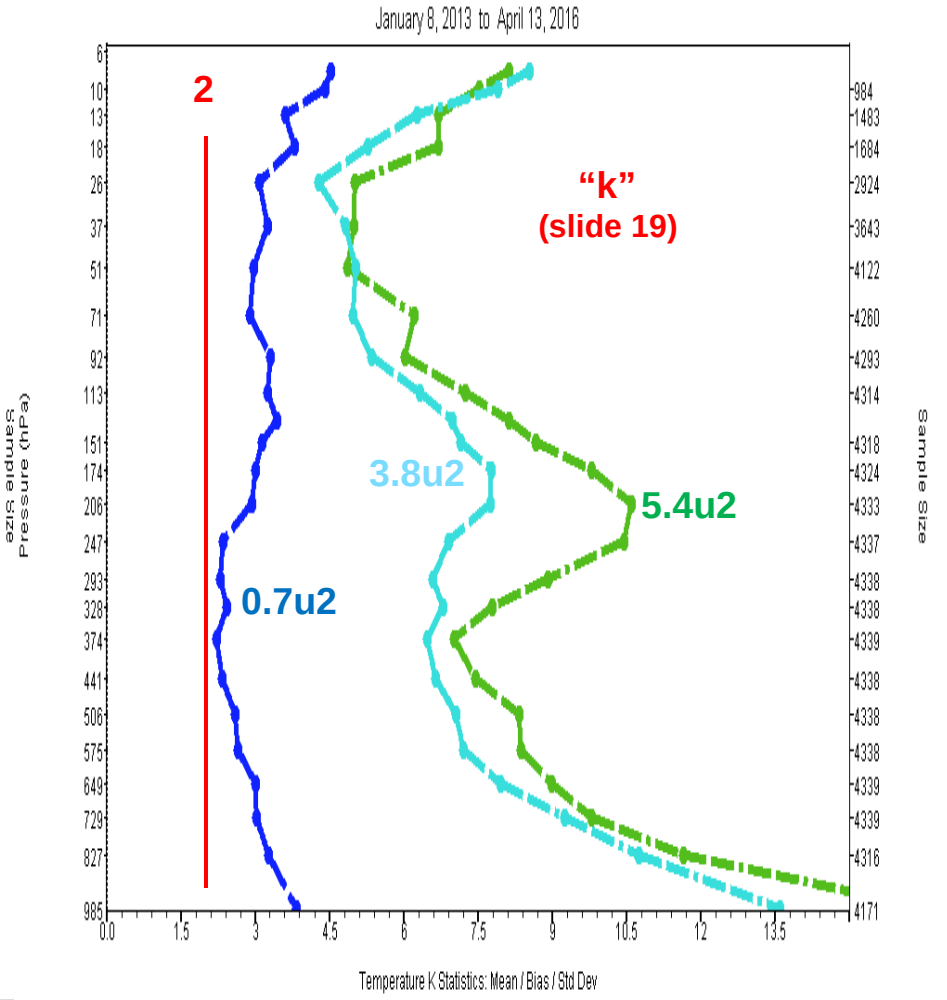
σ^2 ~ (("k"/2)^2 –1 – a^2) (u2)^2

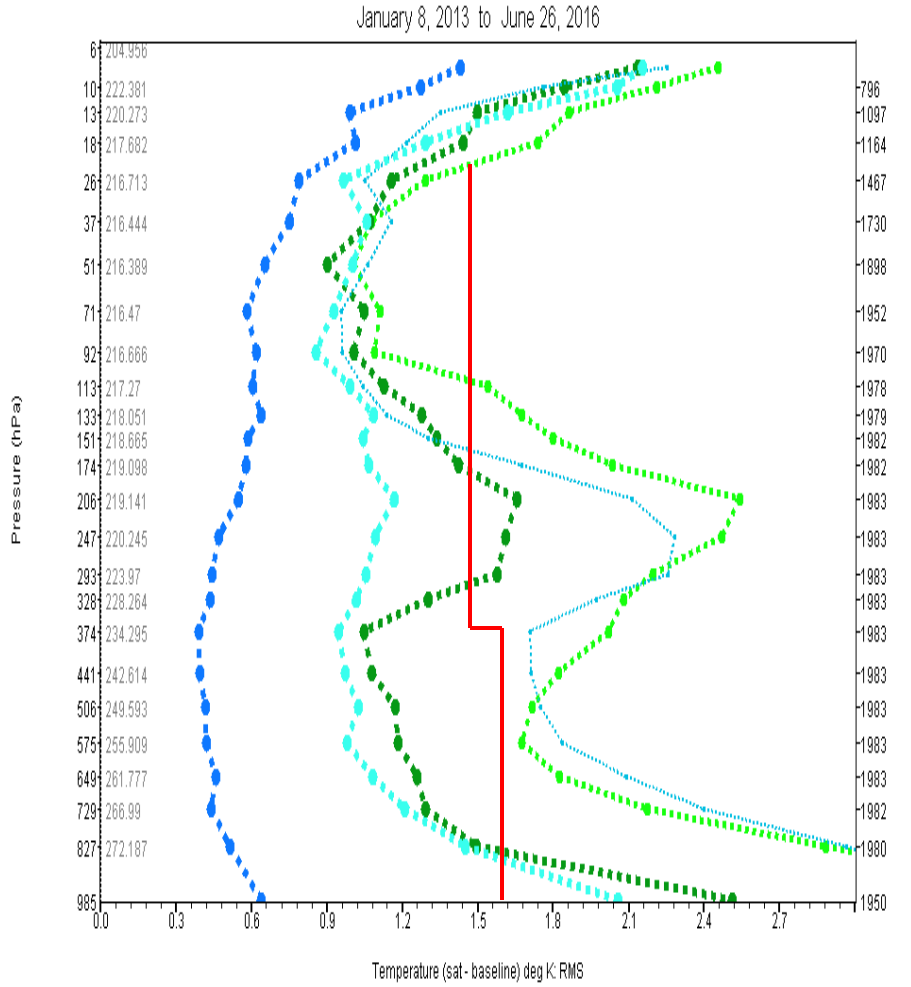
… more robust satellite product Cal / Val

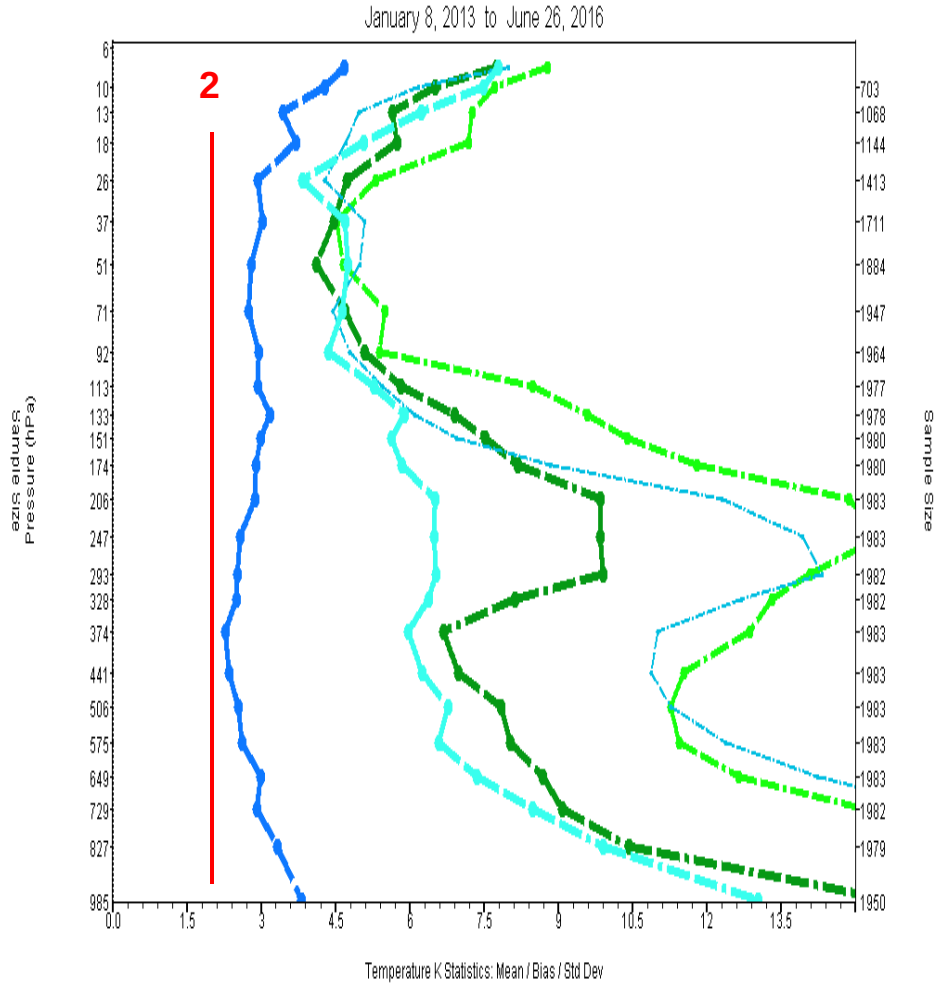


GRUAN collocations with high quality satellite derived Sounding (NUCAPS, AIRS and ECMWF)


January 8, 2013 to April 13, 2016
"Spec" RMS
Pressure (hPa)
Sample Size
Temperature (sat - baseline) deg K: RMS
Baseline: Sonde
AIRS AQUA
ECMWF
NUCAPS NPP


January 8, 2013 to April 13, 2016
2
"k" (slide 19)
3.8u2
5.4u2
0.7u2
Pressure (hPa)
Sample Size
Temperature K Statistics: Mean / Bias / Std Dev
Baseline: Sonde
AIRS AQUA
ECMWF
NUCAPS NPP





Baseline: Sonde

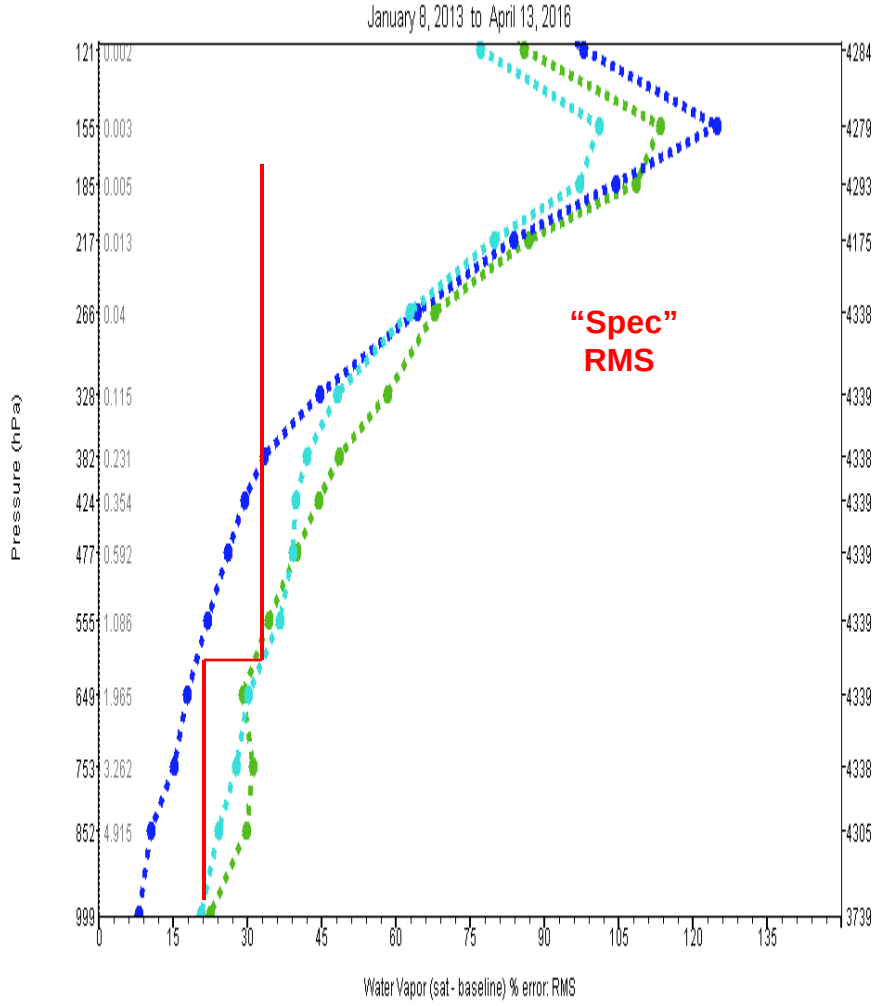
AIRS AQUA | AIRS AQUA MW-Only | ECMWF

NUCAPS NPP | NUCAPS NPP MW

Baseline: Sonde

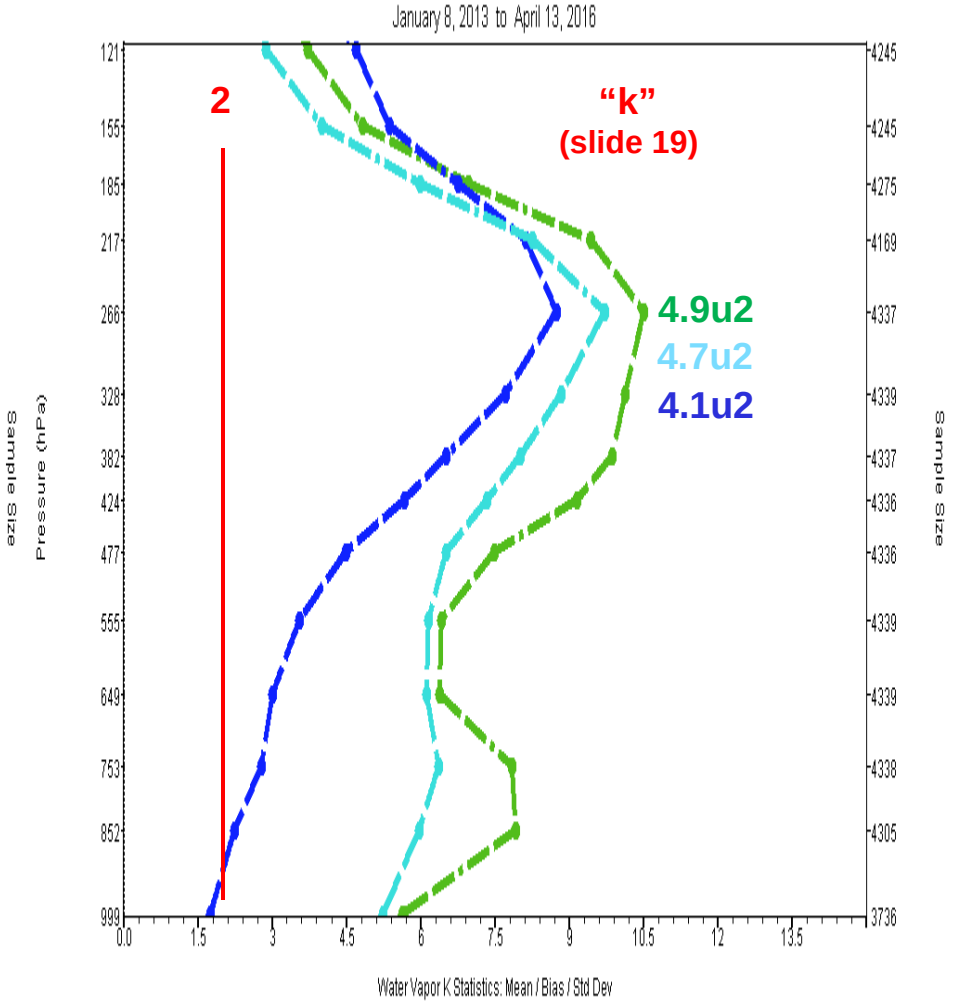
AIRS AQUA | AIRS AQUA MW-Only | ECMWF

NUCAPS NPP | NUCAPS NPP MW



Baseline: Sonde

AIRS AQUA ECMWF NUCAPS NPP



Baseline: Sonde

AIRS AQUA ECMWF NUCAPS NPP

Characterize GRUAN RAOB and GPSRO (Tdry)

GSICS Quarterly
Global Space-based Inter-Calibration System
Newsletter – Summer 2015 Issue
Volume 9 Number 2
2015
doi: 10.7289/V5XK8CHN
Manik Bali, Editor

CMA • CNES • EUMETSAT • IMD • ISRO • JAXA • JMA • KMA • NASA • NIST • NOAA • ROSHYDROMET • USGS • WMO

Quantifying uncertainty when comparing Space-based and Ground Observations

By Tony Reale, NOAA and Xavier Calbet, AEMET

A problem in satellite product cal/val is that uncertainty budgets are typically overlooked. Uncertainty originates in the native measurement space, for example the radiances from satellites or temperature from radiosonde observations (RAOB). Uncertainty is not solely an "intrinsic" property of the observations, but also has "secondary" components that are introduced when comparing measurements with different spatial and/or temporal characteristics including mismatch. Quantifying these components is needed for robust inter-comparison, validation and integration, for example, in WMO Integrated Global Observing System (WIGOS). Addressing such issues through strict comparison of reference RAOB, satellite IR/MW sounding

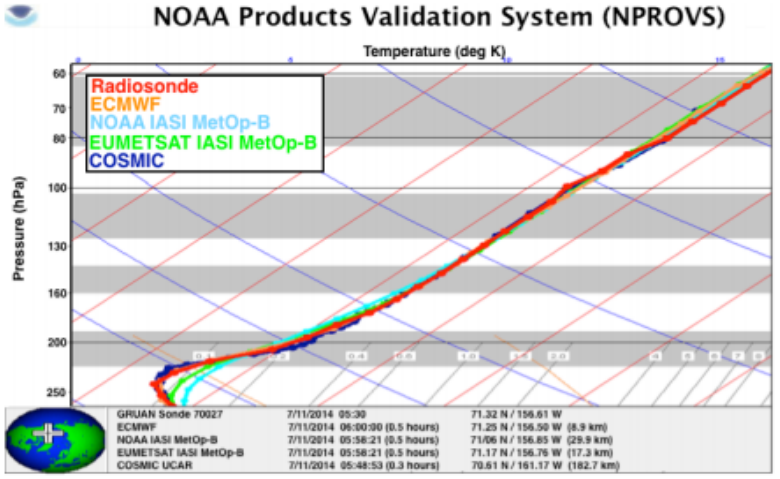
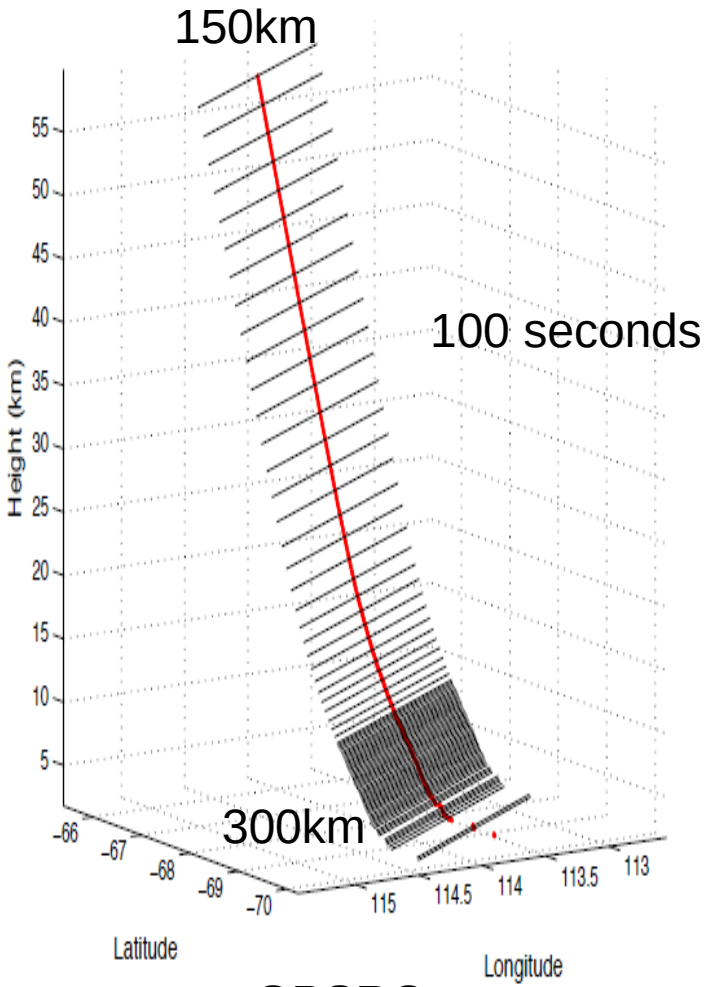
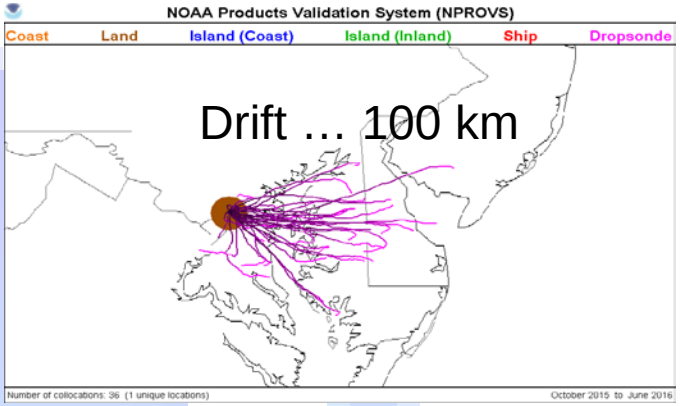
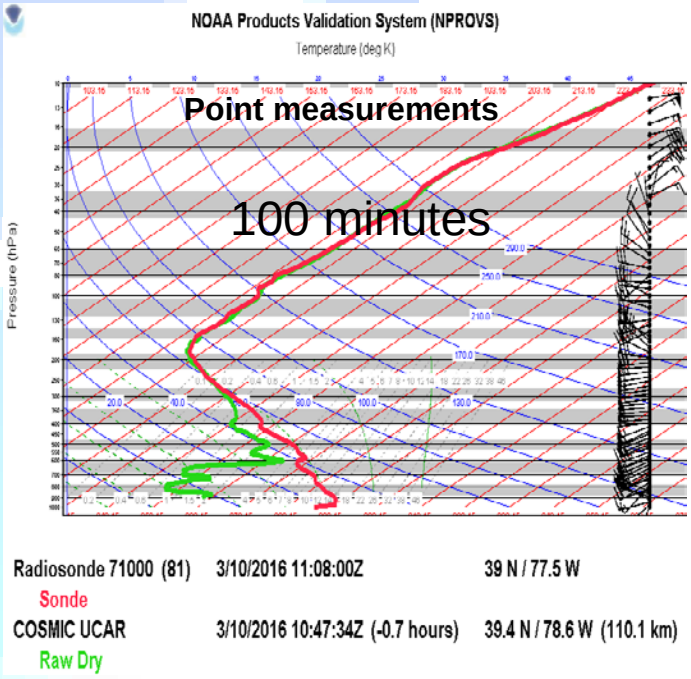


Figure 1: Collocated temperature profiles from GRUAN RAOB, COSMIC (Tdry), MetOp-B IASI soundings from NOAA and EUMETSAT and European Center for Medium-Range Weather Forecasts (ECMWF) analysis within 30 minutes and 30 km of RAOB except for COSMIC at 183 km.



GPSRO



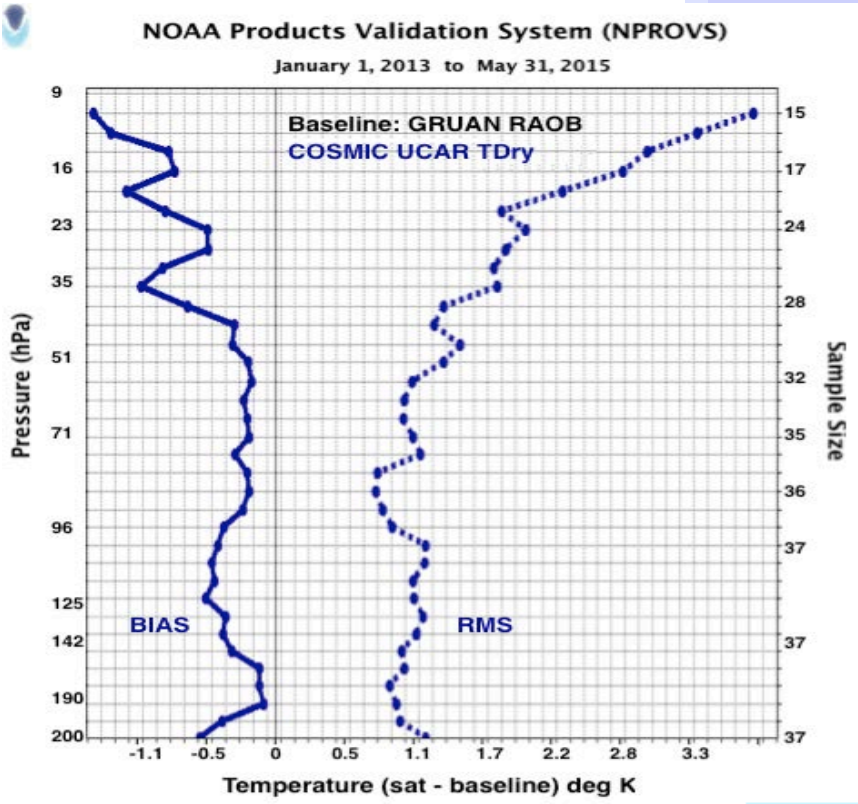


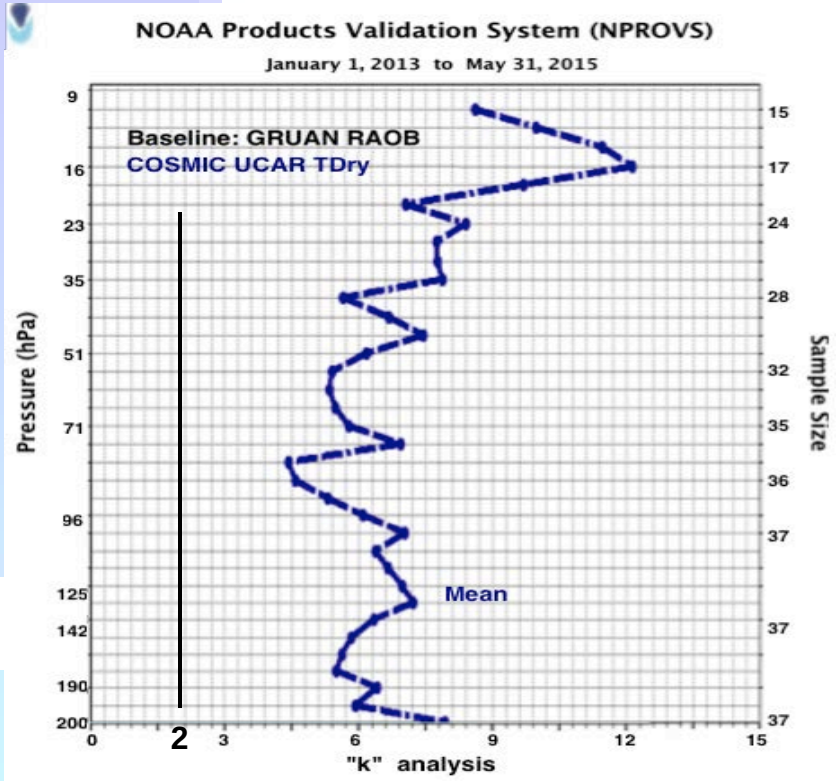
RAOB

"Sigma" for RAOB vs GPSRO can be significant even if observations timely

COSMIC-minus-GRUAN

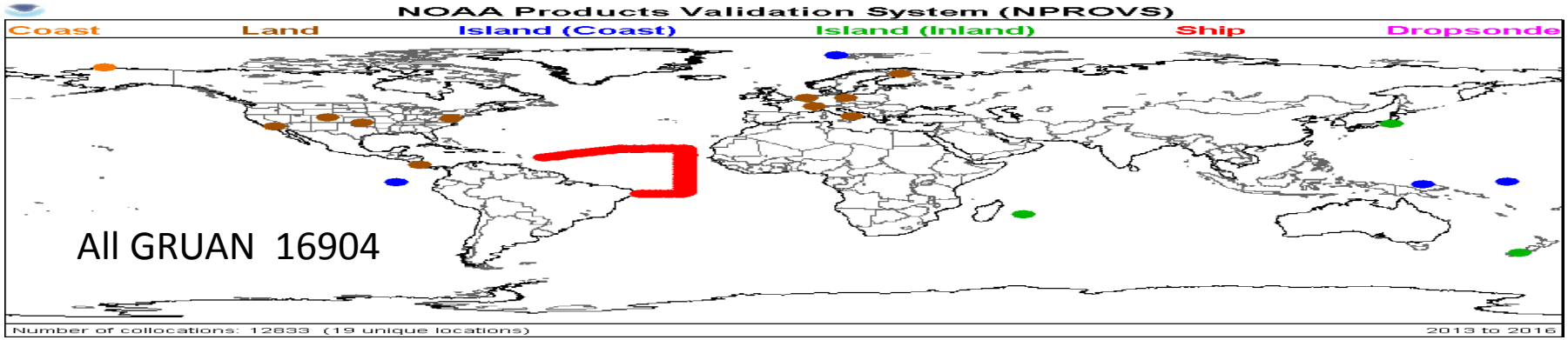
"k" profile analysis … slide 19

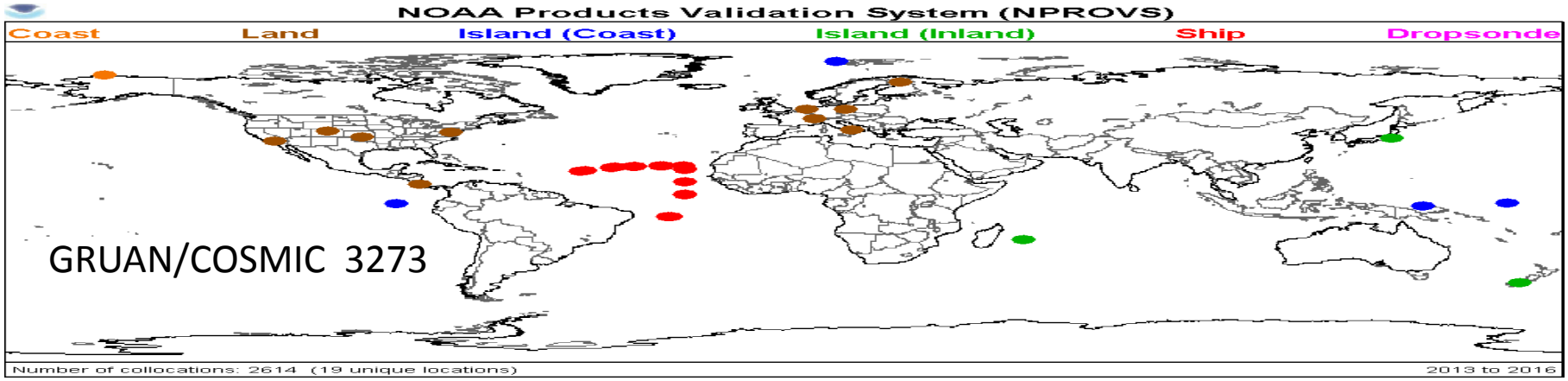


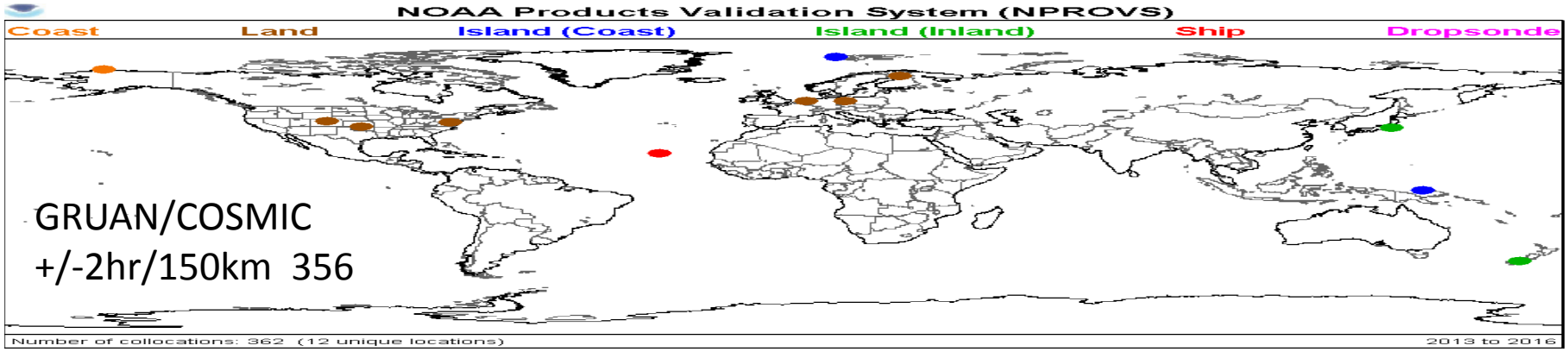


… assuming that u1 is some multiple of u2 simplifies an estimation of the more elusive σ. For example, setting u1 equal to u2, and substituting the mean u1 for the 18 profiles, approximately 0.15 K**, yields an order of magnitude estimate of 0.40 K for σ ("k~6") over the layer 100 to 50 hPa (see slide 19**).

Given these, Fig (2) suggests that 1.1 K RMS difference is within the margin of consistency for GRUAN RAOB and COSMIC temperature profiles collocated within one (1) hour and 100 km for the layer







Need to better target GRUAN collocations with GPSRO (and polar satellites)

Summary

- NPROVS + provides stewardship of GRUAN reference RAOB and satellite collocations since January 2013
- GRUAN RAOB and Satellite Collocations especially those synchronized with (multiple) satellite overpass most useful (for GSICS) including absolute accuracy
- Synergy with ongoing 3G and STAR ATMS cal/val initiatives (ICVS, RTM)
- Examples of potential expansion to satellite product (sensor) cal/val illustrated
- Example (GSICS article) suggests order magnitude estimate of 0.4K for SIGMA for GRUAN and GPSRO within 1 hour and 150km
- NPROVS+ datasets and analytic interface openly available