



Status of **RIVAL** Field Campaign GSICS ...

Radiosonde **I**ntercomparison & **V**ALidation

May 2019

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Outline

- ❖ RIVAL (and other) campaign(s)
- ❖ Global Space-based Inter-Calibration and Validation System (GSICS)
- ❖ EUMETSAT Dedicated Radiosonde Program

2018-2019 Radiosonde Intercomparison and VALidation (RIVAL)

- Collaborators include DOE-ARM, GRUAN, SSEC (Univ Wisconsin), *GSICS* ...
- Leverages ARM / JPSS Dedicated Radiosonde Program at the 3 ARM sites
- **“Twin”** radiosonde soundings (RS92 & RS41 on same balloon) synchronized with NOAA-20 overpass performed **“weekly”** since February 2018
- Two years proposed; first year funded, second year pending
- Supports Vaisala RS92 to RS41 transition management ensuring continuity of ARM radiosonde record
 - Transition management of high interest nationally/internationally across satellite, weather forecast and climate communities
- Benefits of Twin Soundings:
 - Provides unique, reliable support for NOAA-20 EDR assessment ... *“two truths are better than one”*
 - Provides unique SDR and associated Radiative Transfer Model assessment opportunities ... [supports Global Spaced based Inter-Calibration System \(GSICS\)](#)
 - Cost Sharing: JPSS provides RS41 (via dedicated program) & ARM provides RS92
 - Radiosondes processed by GRUAN into “traceable reference” data ...
 - Supports JPSS NOAA-20 mission deployment



ARM /JPSS Dedicated Radiosonde Program (\$100K)

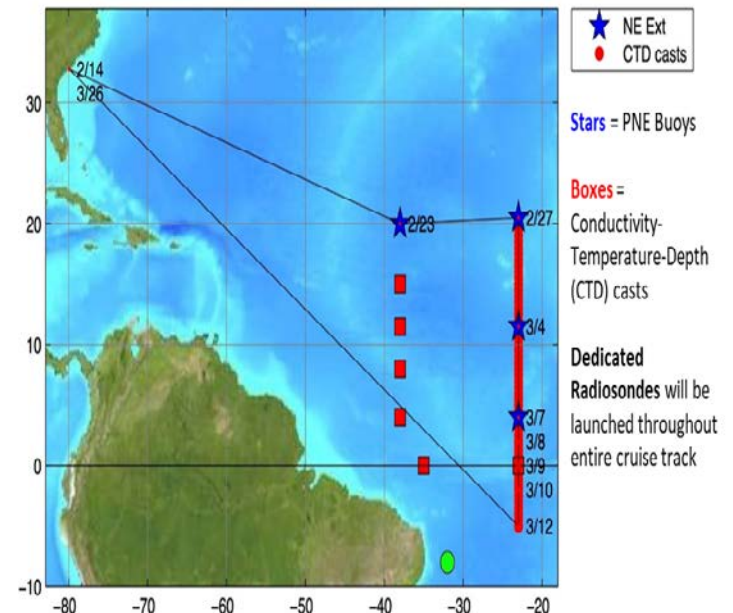
- **In collaboration with DOE Atmospheric Radiation Measurement (ARM) and SSEC (UW)**
 - Southern Great Plains (SGP)
 - Eastern North Atlantic (ENA)
 - North Slope of Alaska (NSA)
- **Dedicated Radiosonde** (Vaisala RS92, RS41) performed *"twice weekly"* at NOAA-20 (SNPP) overpass times since 2012
 - Vaisala RS92 replaced with RS41 beginning September 2017
 - Single (-30 minute) or Sequential (-40 minute, -10 minute) launch(s) synchronized with Satellite Overpass
- **GCOS Reference Upper Air Network (GRUAN) processing**
 - Radiosondes converted into :*"traceable reference"* observations
 - Value added process includes fully characterized uncertainty
- **Collocated with multiple satellite sounding EDR suites**
 - NPROVS Special operated at STAR
 - Used to validate sounding EDR and support development
 - Reference Observations facilitate EDR accuracy and uncertainty assessments
 - Spatial/temporal impact assessments (using Sequential)
 - Site Atmospheric State Best Estimates (SASBE)



NOAA Aerosols and Ocean Science Expedition (\$30K) (AEROSE)

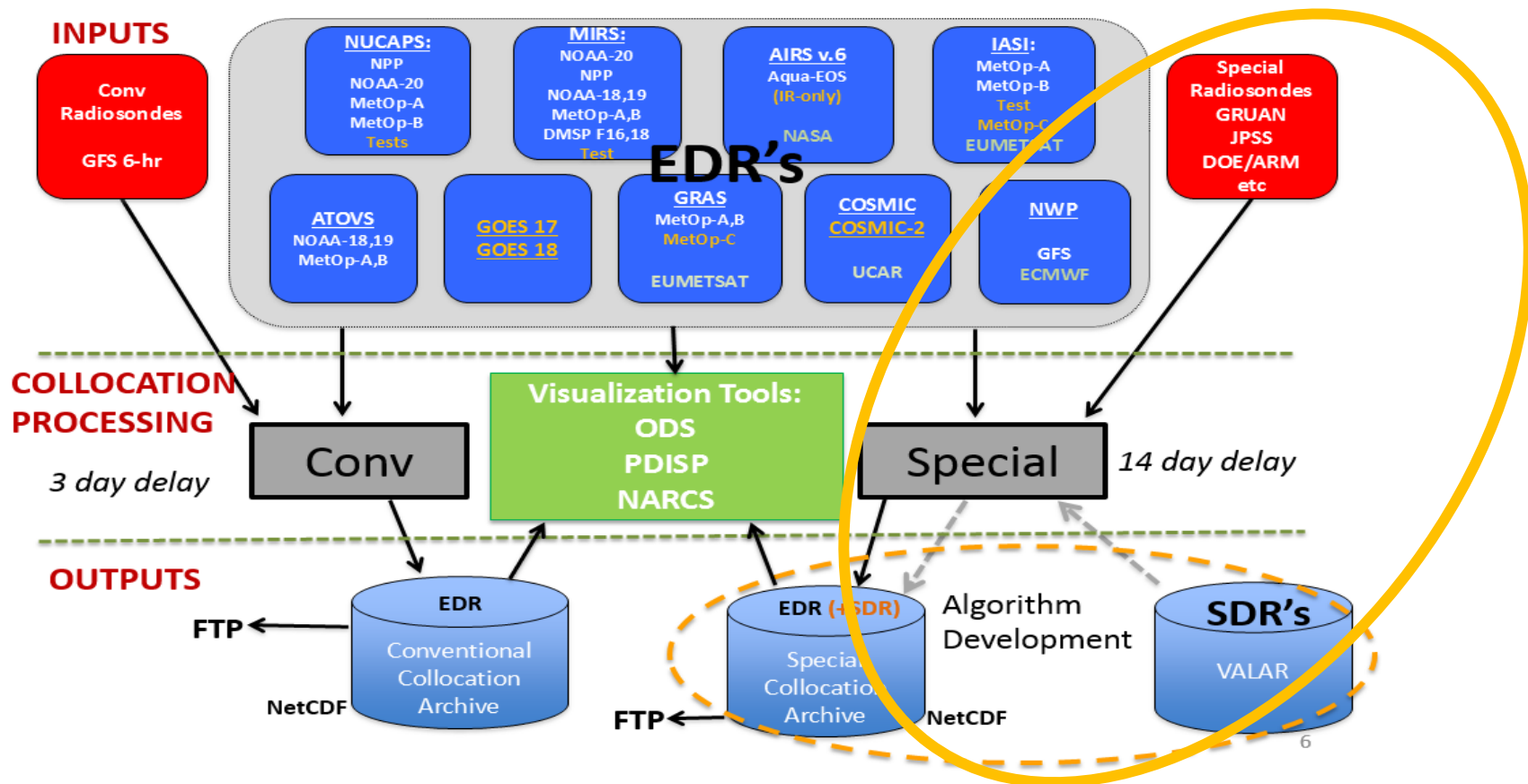
- AEROSE is Trans-Atlantic intensive campaigns onboard NOAA research vessel Ronald H Brown to study aerosol transport from the Sahara
- JPSS/STAR has participated in 4 campaigns (supporting S-NPP) since 2013, next scheduled for 14 February through 25 March, 2019
- Collaborators include NOAA/ESRL, GRUAN Beltsville, NRL (Monterey) ...
- JPSS funds up to "4 single radiosonde launches per day" synchronized with NOAA (and MetOp) satellite overpass
- 2019 campaign first to synchronize Vaisala RS41 radiosonde and NOAA-20
 - Currently in danger of not receiving "allotted" funds to purchase radiosondes!
- Provides unique, tropical, open ocean record supporting:
 - NOAA-20 CrIS/ATMS SDR and associated NUCAPS sounding EDR Cal/Val
 - The population of Tropical, Open Ocean locations lacking in NPROVS Special
 - Saharan Air Layer (SAL) tracking using EDR ... supports JPSS Proving Ground and Risk Reduction Initiatives
 - Truly independent data ... not assimilated into NWP
- Cost-Effective ... for a relatively small "buy-in" we gain access to
 - Dedicated ozonesondes (needed for validation of NUCAPS IR ozone profile EDR)
 - Marine Atmospheric Emitted Radiance Interferometer (MAERI) data
 - Microtops sunphotometer data
 - Other ship-based datasets

2019 PNE/AEROSE Cruise Track



GRUAN processing of "All" AEROSE Radiosondes ... ?!

NOAA Products Validation System (NPROVS)





RIVAL Overview



What is RIVAL?

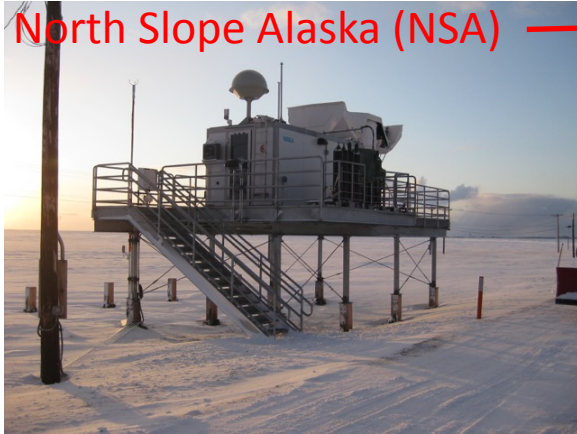
- **R**adiosonde **I**ntercomparison and **V**ALidation field campaign
- Dual radiosonde soundings (RS92 & RS41 on same balloon) being performed weekly at 3 ARM Sites; ENA, NSA, & SGP
- Campaign idea was the result of discussions from ICM-8
- Campaign approved July 2017 & launches began February 2018
- Funding provided by ARM and JPSS programs and equipment loaned from Vaisala

Goals:

- Assess RS92/RS41 differences
- Use RIVAL to assess/integrate ancillary data-streams for
 - Site Atmospheric State Best Estimate (SASBE)
 - Delivery of satellite data to GRUAN

ARM Sites

North Slope Alaska (NSA)



Southern Great Plains (SGP)



Eastern North Atlantic (ENA)



Datastreams Collected for RIVAL

ARM:

- Vaisala processed radiosondes (sondownpnC1.b1) & raw sondes
- Microwave radiometer (mwrlosC1.b1 or mwr3cC1.b1)
- Ceilometer (ceilC1.b1)
- AERI (aeriengineerC1.b1, aerich1C1.b1, sgpaerisummaryC1.b1)
- CFH (cfhC1.b1)

Satellite:

- SNPP, NOAA20 (MetOp); CrIS (IASI), ATMS (AMSU); EDR, RDR, SDR; ... VIIRS, AVHRR (Cloud)

GPSRO:

- RO dry temperature products (if they occur)

GRUAN:

- GRUAN (vendor)processed RS92 & RS41 sonde files

Notes:

- ARM Data available from ARM archive
- Data also available to RIVAL team (via UW ftp site)
- Data-streams in red will be integrated into NPROVS

Ceilometer



MWR

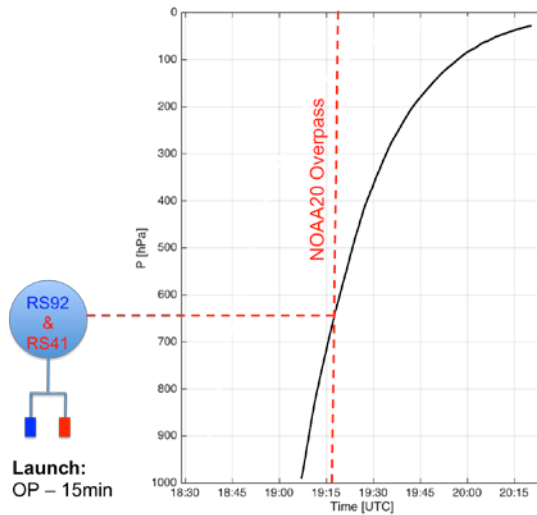


RIVAL Launch Status

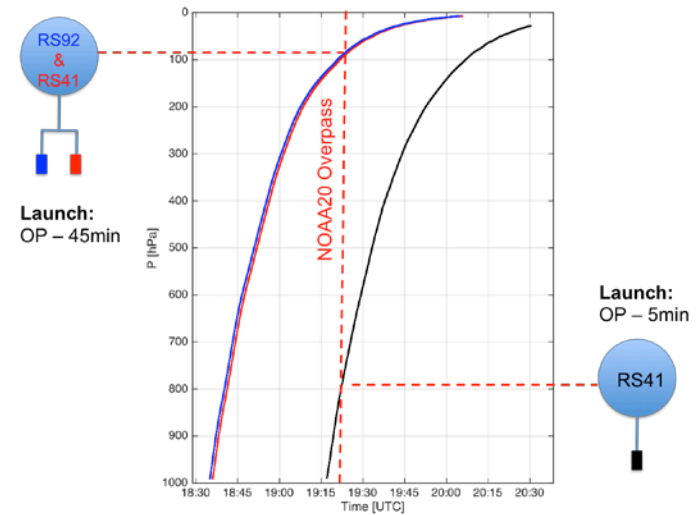
Site	ENA	NSA	SGP
RIVAL Start Date	26 Apr 2018	20 Jun 2018	13 Feb 2018
Launches Completed through 20190512	36	12	55
Single Balloon (day/night)	36 (17/19)	5	21 (11/10)
Twin Balloon (day/night)	---	7	34 (18/16)
Launch Projection by end Summer 2020	104	52*	104
Single Balloon (day/night)	104 (52/52)	26*	52 (26/26)
Twin Balloon (day/night)	---	26*	52 (26/26)

* NSA - RIVAL launches occur at 'daytime' overpass, but Nov-Jan civil twilight. Unlikely to complete all 52 launches.

Single Balloon Launch



Twin Balloon Launch





RIVAL Path Forward

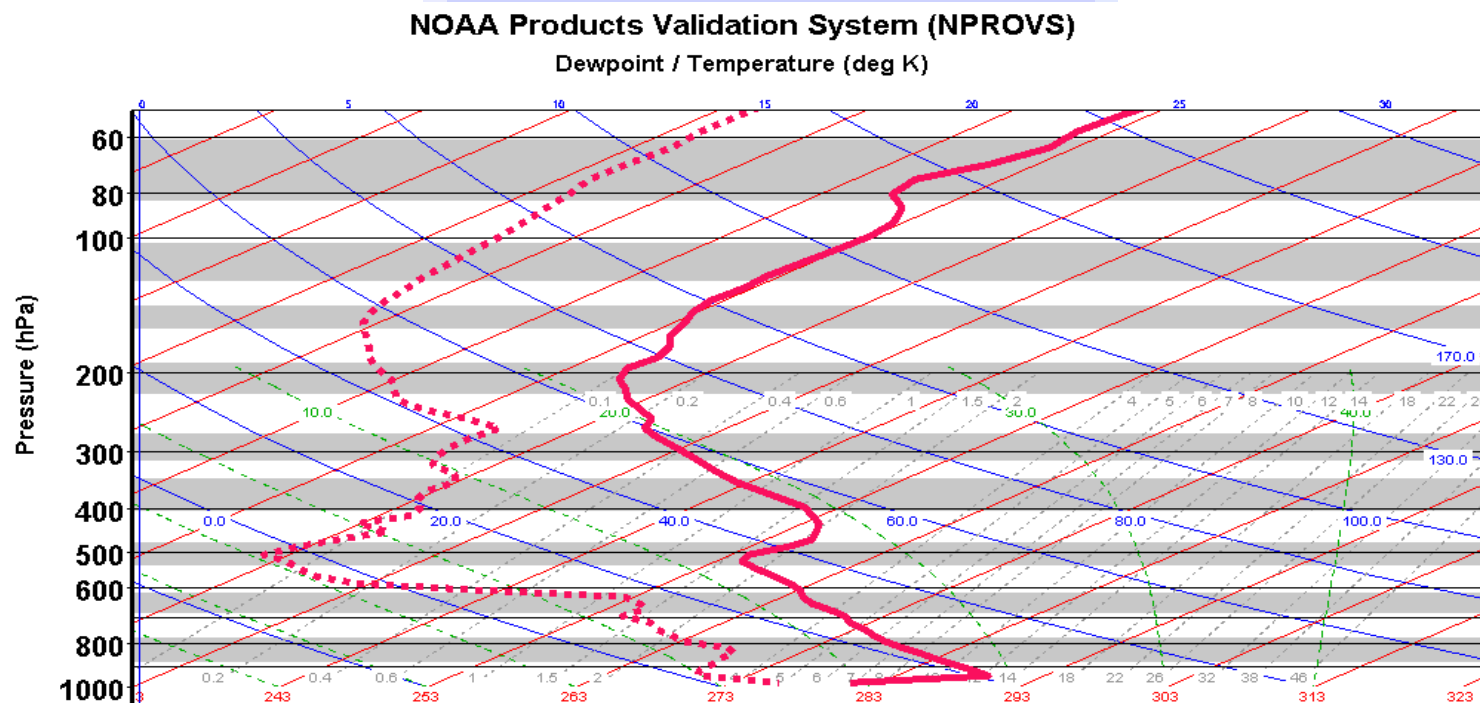
- Append NOAA-20 (SNPP) radiances ... 80%+ of launches
- Coordinate with LC wrt storage/access of relevant satellite data (SDR...) from RIVAL
- Cloud information ...
- Coordinate with Scheduling TT to assess/integrate ancillary TTAM into RIVAL
- Integrate SGP CFH launches coordinated with MetOp (Martin Steufer) ;
address CFH processing (Holger?)



Begin Access New GRUAN Data Inventory (thanks Michael Sommer)

Site Name	RS41 (Vaisala Vendor)	RS41 (GDP Alpha2)	RS92 (Vaisala Vendor)	RS92 (Beta MW41 GDP)	RS92 (Official GDP)	Meisei RS-11G (GDP)
Barrow	✓	✓	✓	✓	✓	✗
Beltsville	✓	✓	✓	✓	✓	✗
Boulder	✓	✓	✓	✗	✓	✗
Cabauw	✓	✓	✓	✗	✓	✗
Darwin	✓	✓	✓	✗	✓	✗
Graciosa (ENA)	✓	✓	✓	✓	✓	✗
Lauder	✓	✓	✓	✓	✓	✗
Lindenberg	✓	✓	✓	✓	✓	✗
Manus	✗	✗	✓	✗	✗	✗
Nauru	✗	✗	✓	✗	✗	✗
Ny-Alesund	✓	✓	✓	✓	✓	✗
Payerne	✓	✓	✓	✗	✓	✗
Potenza	✓	✓	✓	✓	✓	✗
La Reunion	✓	✓	✓	✓	✓	✗
Singapore	✓	✓	✗	✗	✗	✗
Southern Great Plains	✓	✓	✓	✓	✓	✗
Sodankyla	✓	✓	✓	✗	✓	✗
Syowa	✗	✗	✗	✗	✗	✓
Tateno	✓	✓	✓	✗	✓	✓
Tenerife	✓	✓	✓	✗	✓	✗
Table Mountain	✓	✗	✓	✗	✗	✗

RIVAL Dual / Sequential Example

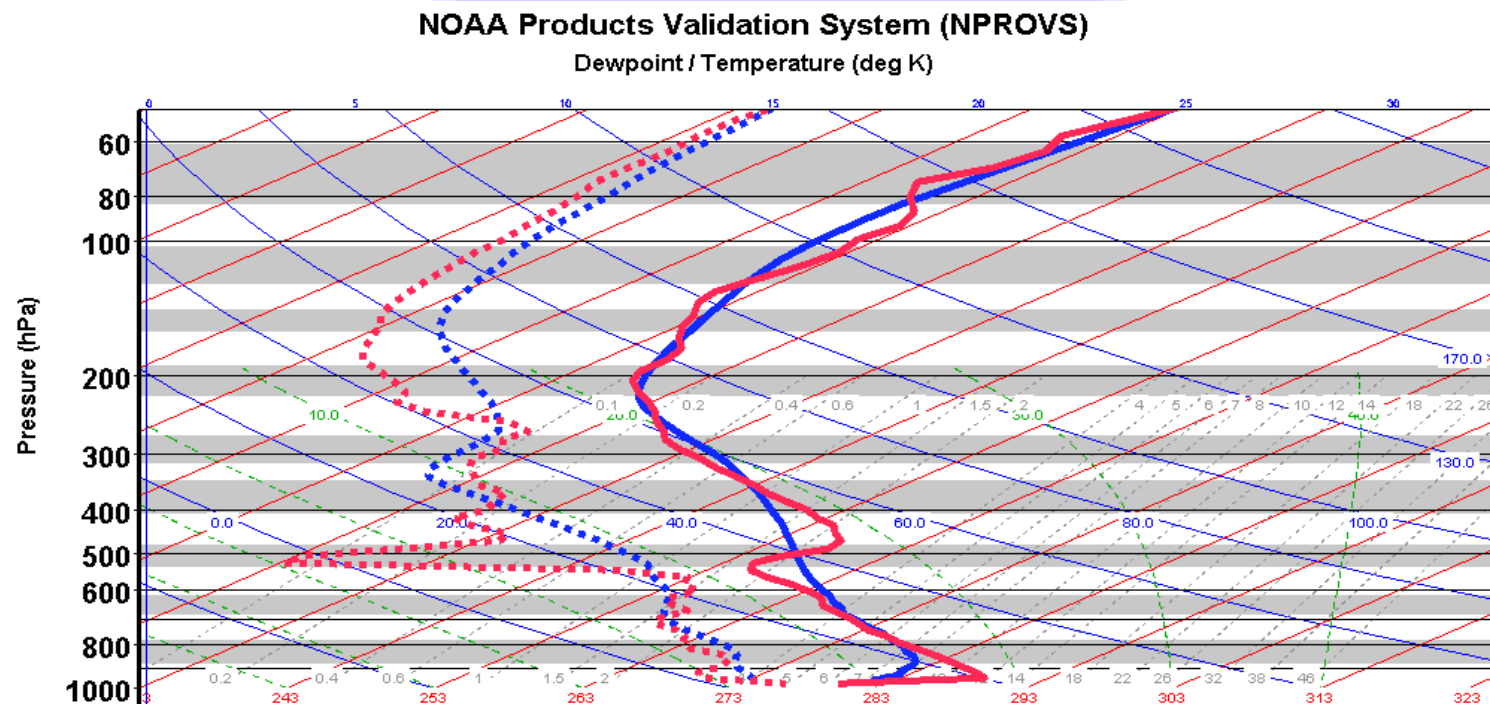


Reference/Dedicated 74646 (256) Reference/Dedicated 11/6/2018 6:37:00Z 36.6 N / 97.5 W

RS41 Alpha 2

6:37

RIVAL Dual / Sequential Example



Radiosonde 74646 (141) Radiosonde
NUCAPS NOAA-20

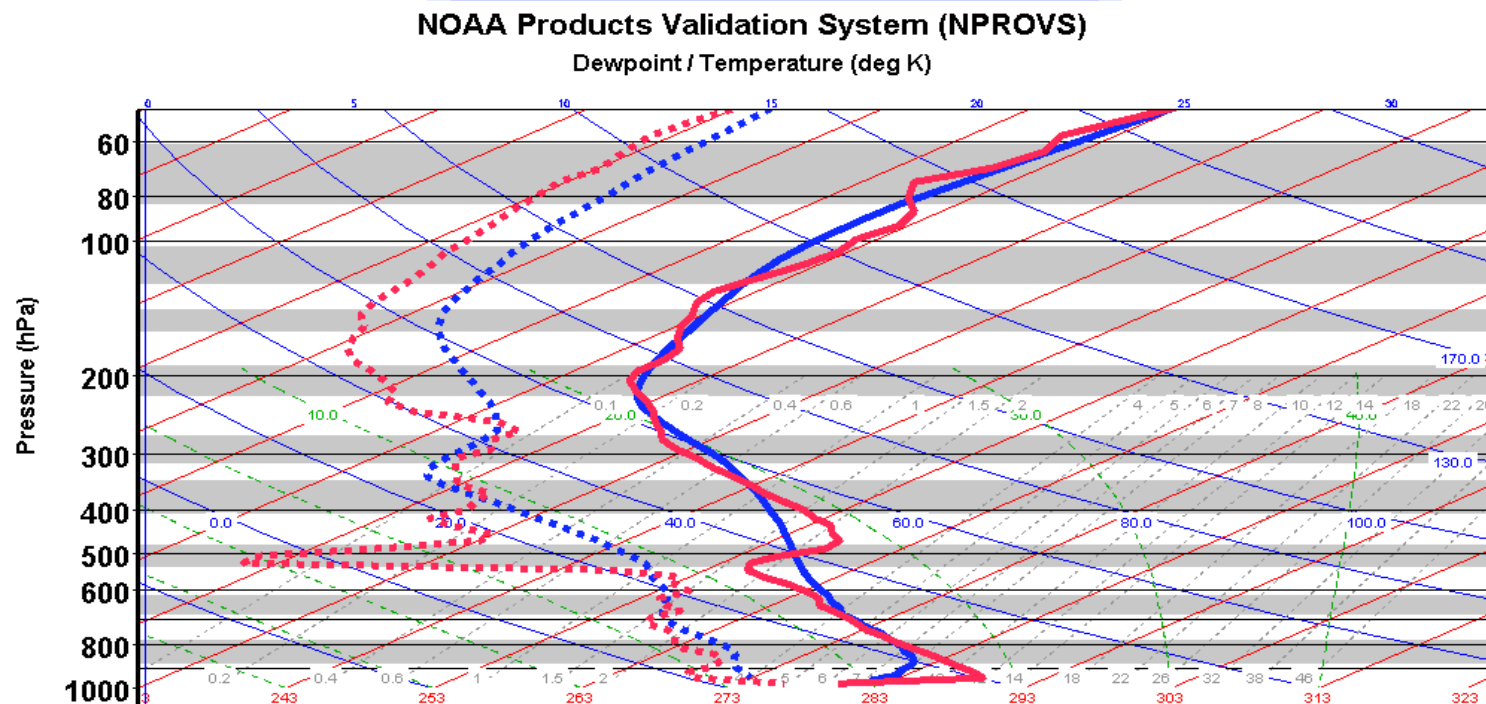
11/6/2018 7:31:00Z
11/6/2018 8:14:35Z (0.7 hours)

36.6 N / 97.5 W
36.5 N / 97.4 W (12.2 km)

RS41 Vendor

7:31

RIVAL Dual / Sequential Example



Radiosonde 74646 (114) Radiosonde
NUCAPS NOAA-20

11/6/2018 7:31:00Z
11/6/2018 8:14:35Z (0.7 hours)

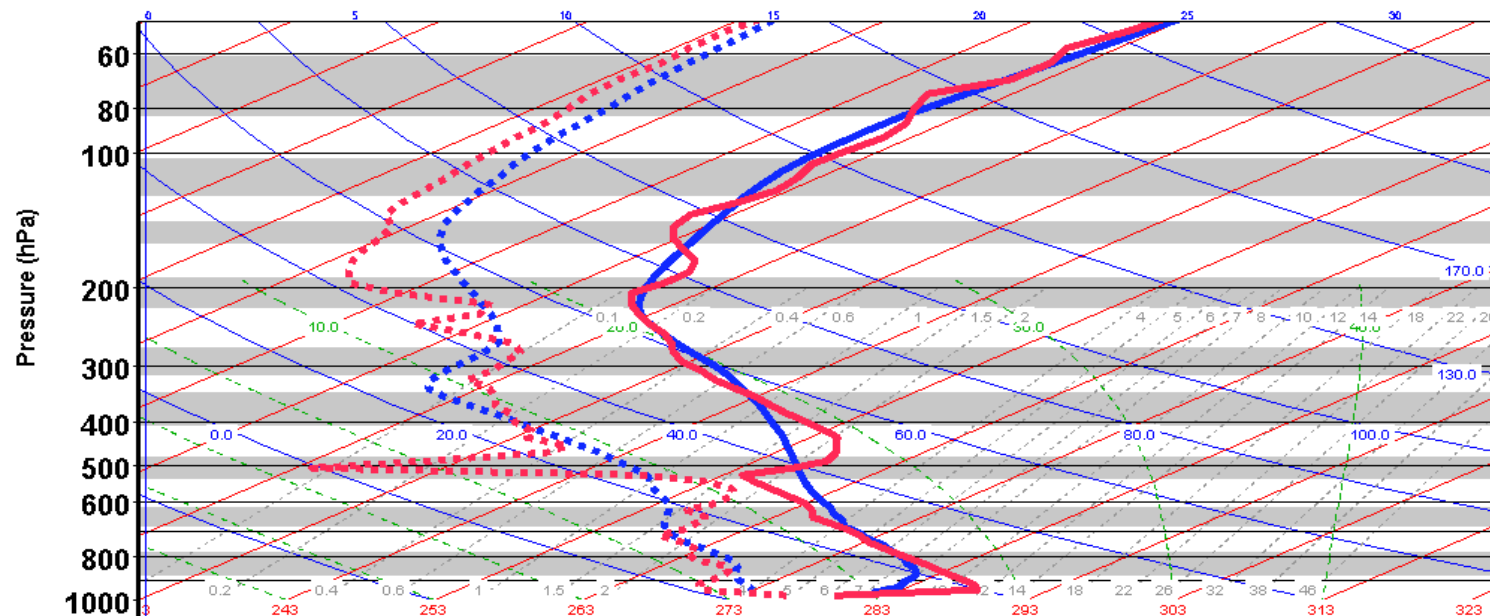
36.6 N / 97.5 W
36.5 N / 97.4 W (12.2 km)

RS92 Vendor

7:31

RIVAL Dual / Sequential Example

NOAA Products Validation System (NPROVS)
Dewpoint / Temperature (deg K)



Radiosonde 74646 (141) Radiosonde
NUCAPS NOAA-20

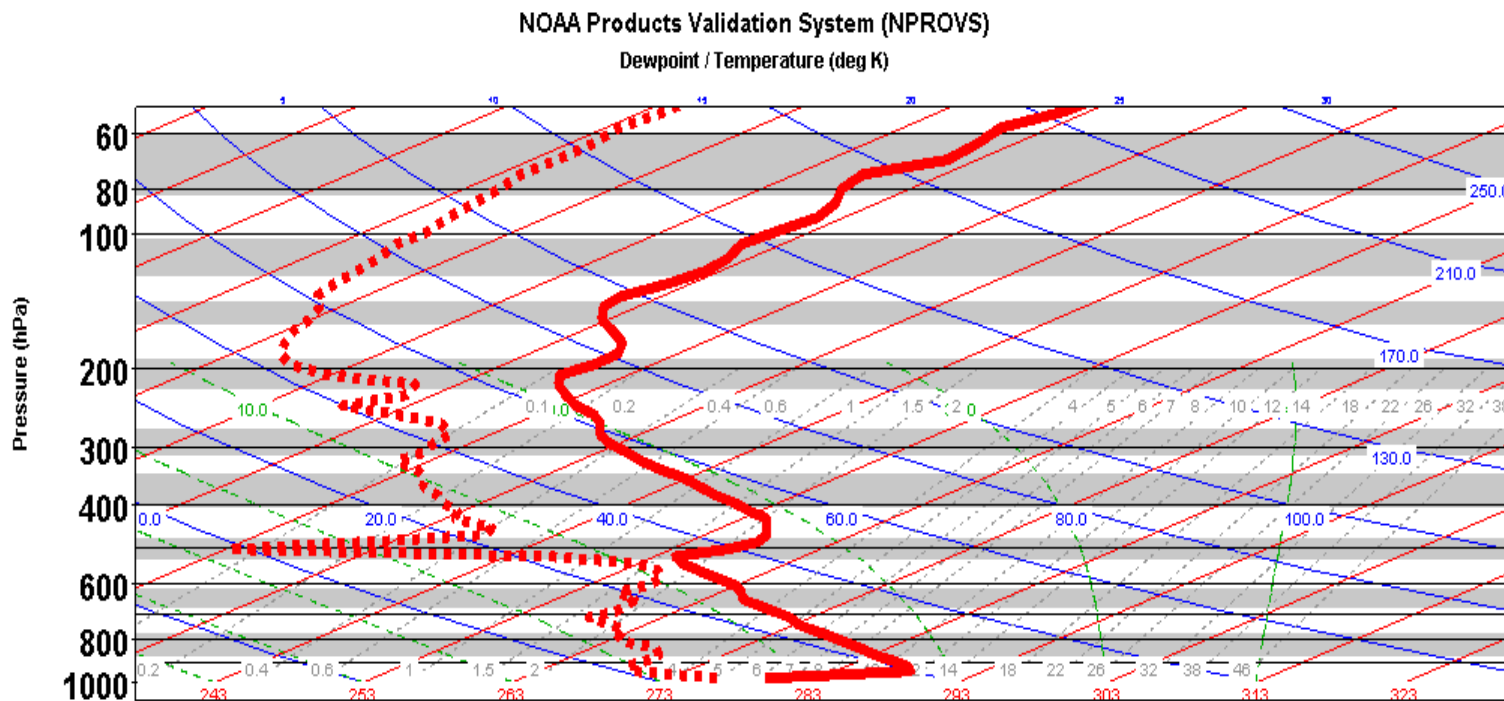
11/6/2018 8:13:00Z
11/6/2018 8:14:35Z (0 hours)

36.6 N / 97.5 W
36.5 N / 97.4 W (12.2 km)

RS41 Vendor

8:13

RIVAL Dual / Sequential Example

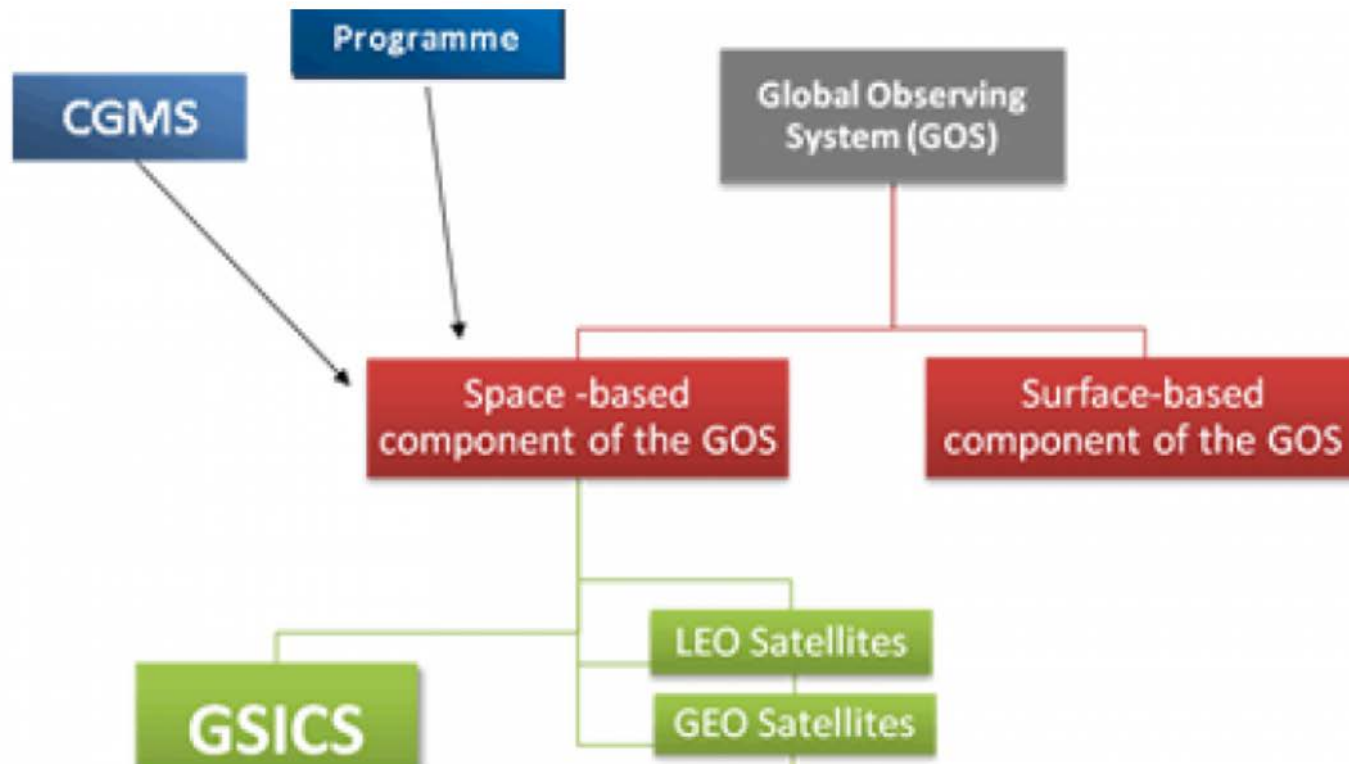


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RS41 Alpha 2

8:13

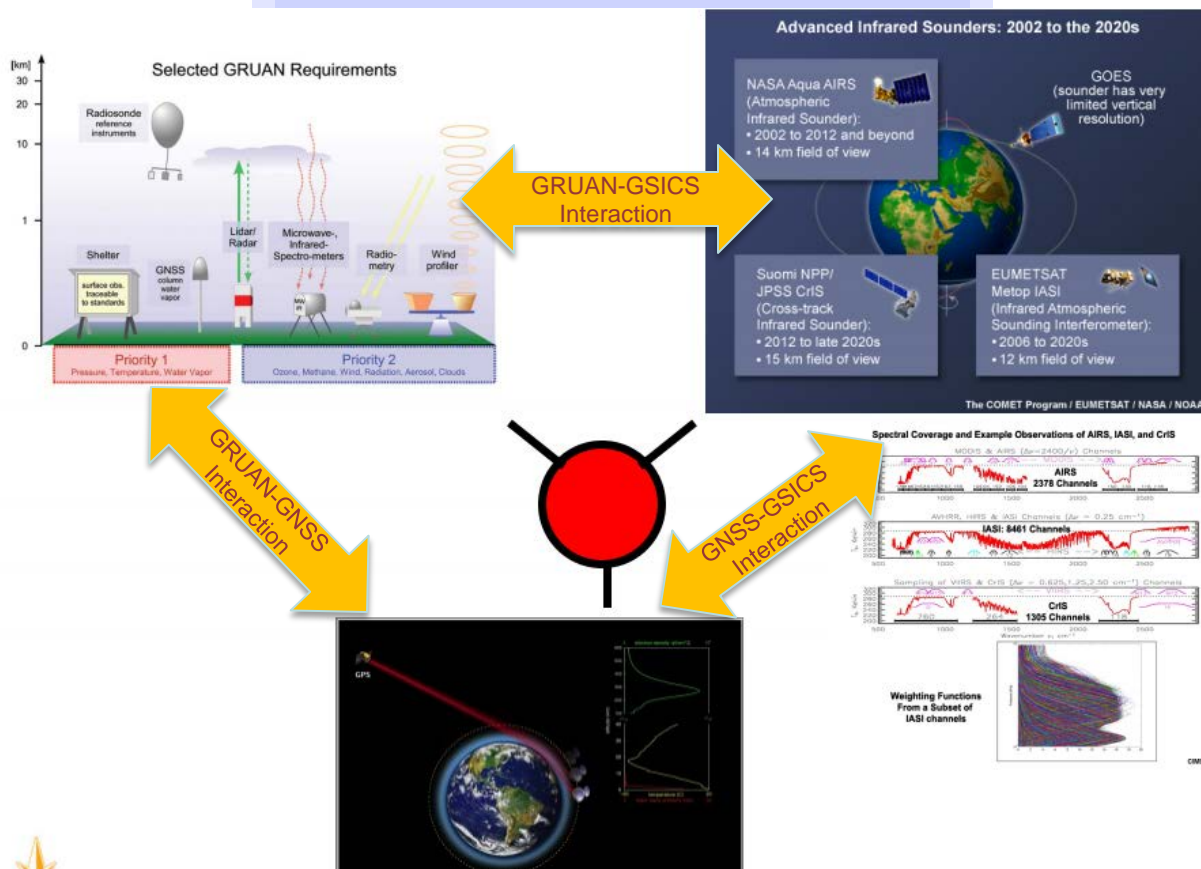
Global Space-based Inter-Calibration and Validation System (GSICS)



Global Space-based Inter-Calibration System (GSICS) is an international collaborative effort initiated in 2005 by the World Meteorological Organization (WMO) and the Coordination Group for Meteorological Satellites (CGMS) to 1-monitor, 2-improve and 3-harmonize the quality of observations from operational weather and environmental satellites of the Global Observing System (GOS).

GSICS aims at ensuring consistent accuracy among space-based observations worldwide for climate monitoring, weather forecasting, and environmental applications.

GSICS / GNSS / GRUAN (3G) Framework



GRUAN supports GSICS ... GSICS supports GRUAN

GSICS / GRUAN Actions

- IR: “Consistency between “fully characterized” GRUAN Sondes and Sensor: LBLRTM, IASI, CrIS ... *Bomin Sun talk*
 - Cloud Free Requirement
 - Leverage GRUAN, RIVAL ...
- MW: “Consistency between “fully characterized” GRUAN Sondes and Sensor; CRTM, AMSU, ATMS
 - Precipitation free ...
 - Leverage RIVAL, GRUAN ...
- *Commercial Small Sats ... MWave, GPSRO ...*



STAR

Center for Satellite Applications and Research

formerly ORA — Office of Research and Applications



Preliminary Example for GRUAN vs AMSU CDR (and GPSRO)

Lindenberg: Ch4 -TLS (lower-stratosphere) GRUAN at 89.5 hPa level

Microwave

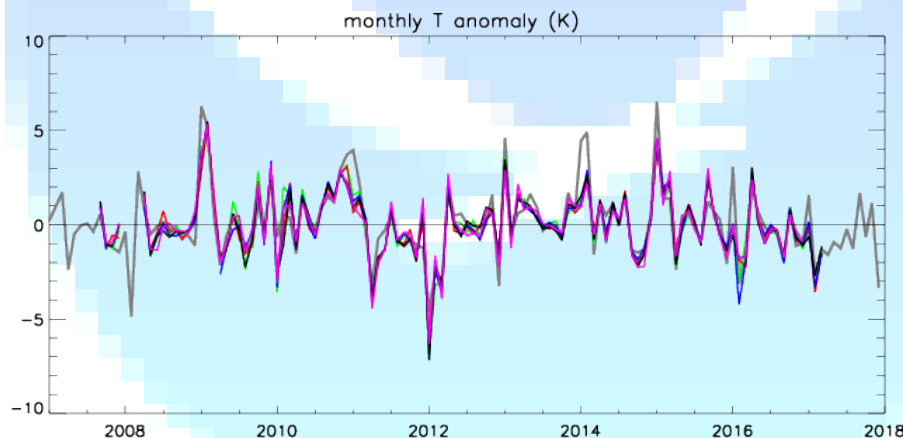
GRUAN 00Z

GRUAN 06Z

GRUAN 12Z

GRUAN 18Z

GPSRO



GRUAN trend: 0.013 (0.06) K/yr

Microwave trend: 0.016 (0.07) K/yr

GPSRO trend: 0.004 (0.07) K/yr

Correlation:

Microwave vs. **GRUAN** 0.86

GPSRO vs. **GRUAN** 0.96

Trend: GRUAN (RS92) vs MWave CDR



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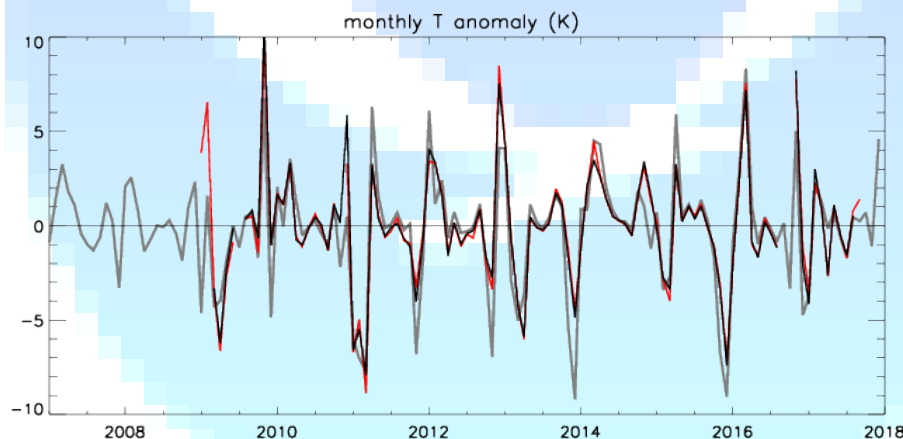
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Barrow: Ch4 -TLS (lower-stratosphere)
GRUAN at 89.5 hPa level

Microwave

GRUAN 06Z

GRUAN 18Z



Trend: GRUAN (RS92) vs MWave CDR



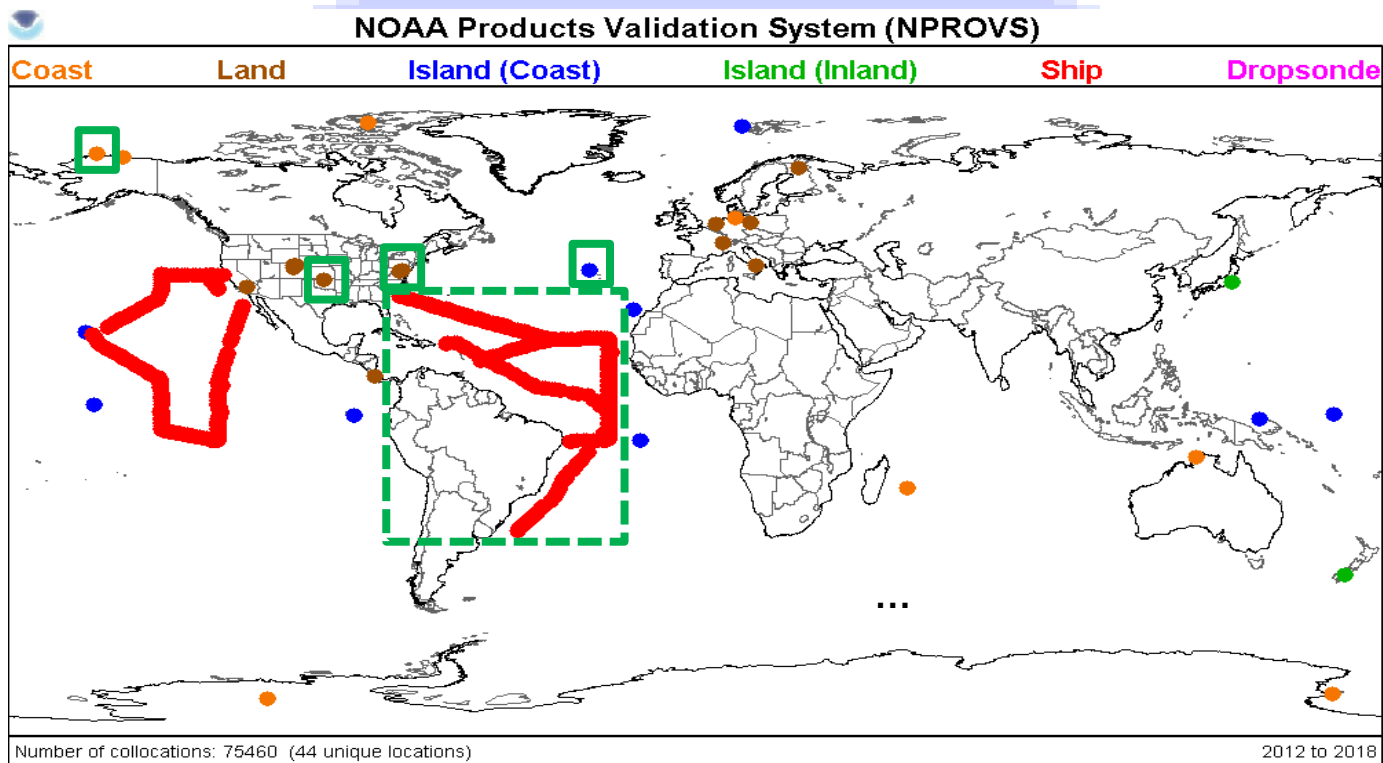


Proposed EUMETSAT Dedicated Radiosonde Program at GRUAN Sites

- ☐ Minimum one per week; MetOp-C
- ☐ Beltsville, SGP, Lindenberg, New Zealand ...
- ☐ Follow JPSS Program protocol
 - Launch Schedules, scheduling (MetOp ...)
 - Single (*and sequential ...*)
 - Cloud-free
 - Day/night
 - GPSRO (*golden ... 3G*)
- ☐ Special Campaigns (ie, AEROSE ...)
- ☐ Ancillary (GRUAN scheduling) ... SASBE

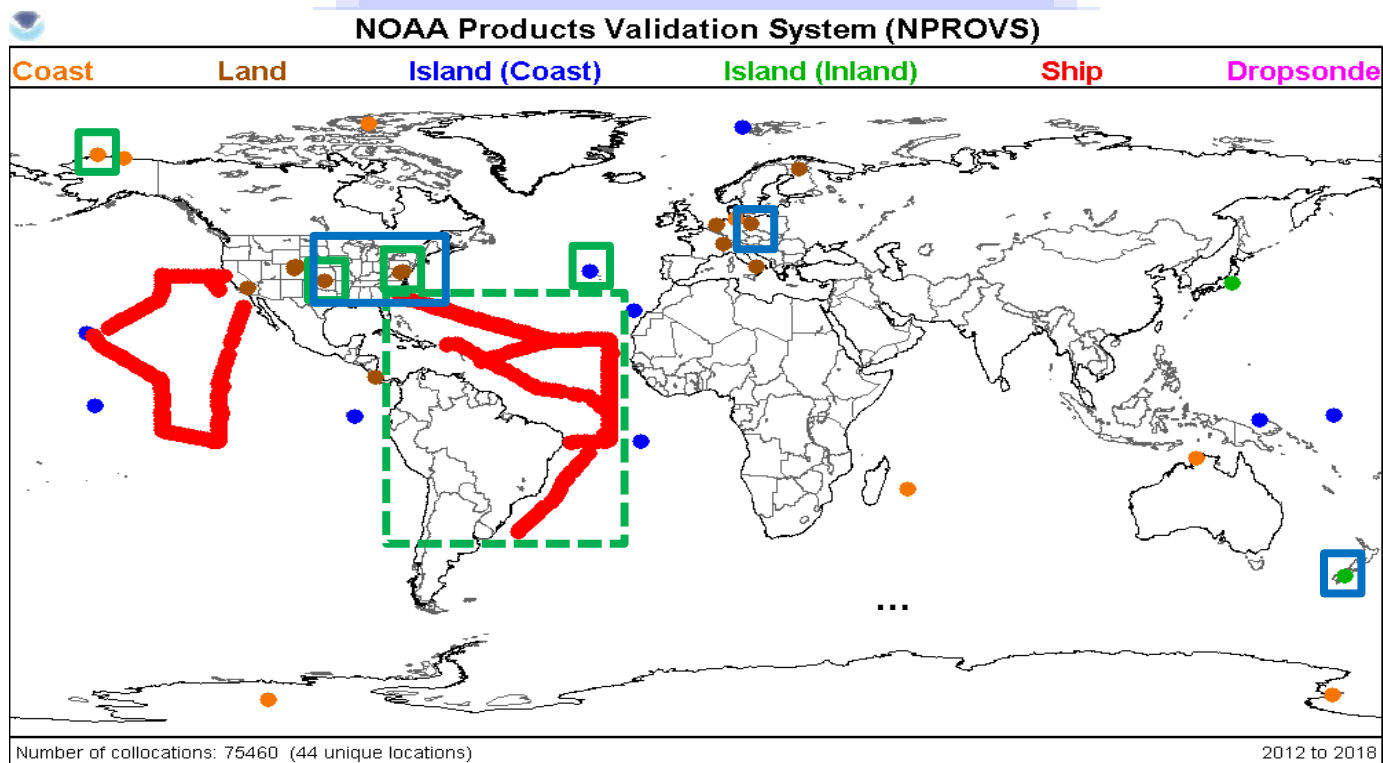


NPROVS Special Operated at STAR



Global datasets of collocated Special RAOB and Satellite EDR; 50,000 since 2013
(ARM sites, AEROSE campaign in Green Boxes)

NPROVS Special Operated at STAR



Global datasets of collocated Special RAOB and Satellite EDR; 50,000 since 2013
(ARM sites, AEROSE campaign in Green Boxes)
with proposed EUMETSAT dedicated Raob



Summary

