Utilization of GPSRO in the NOAA sounding Products Validation System (NPROVS)

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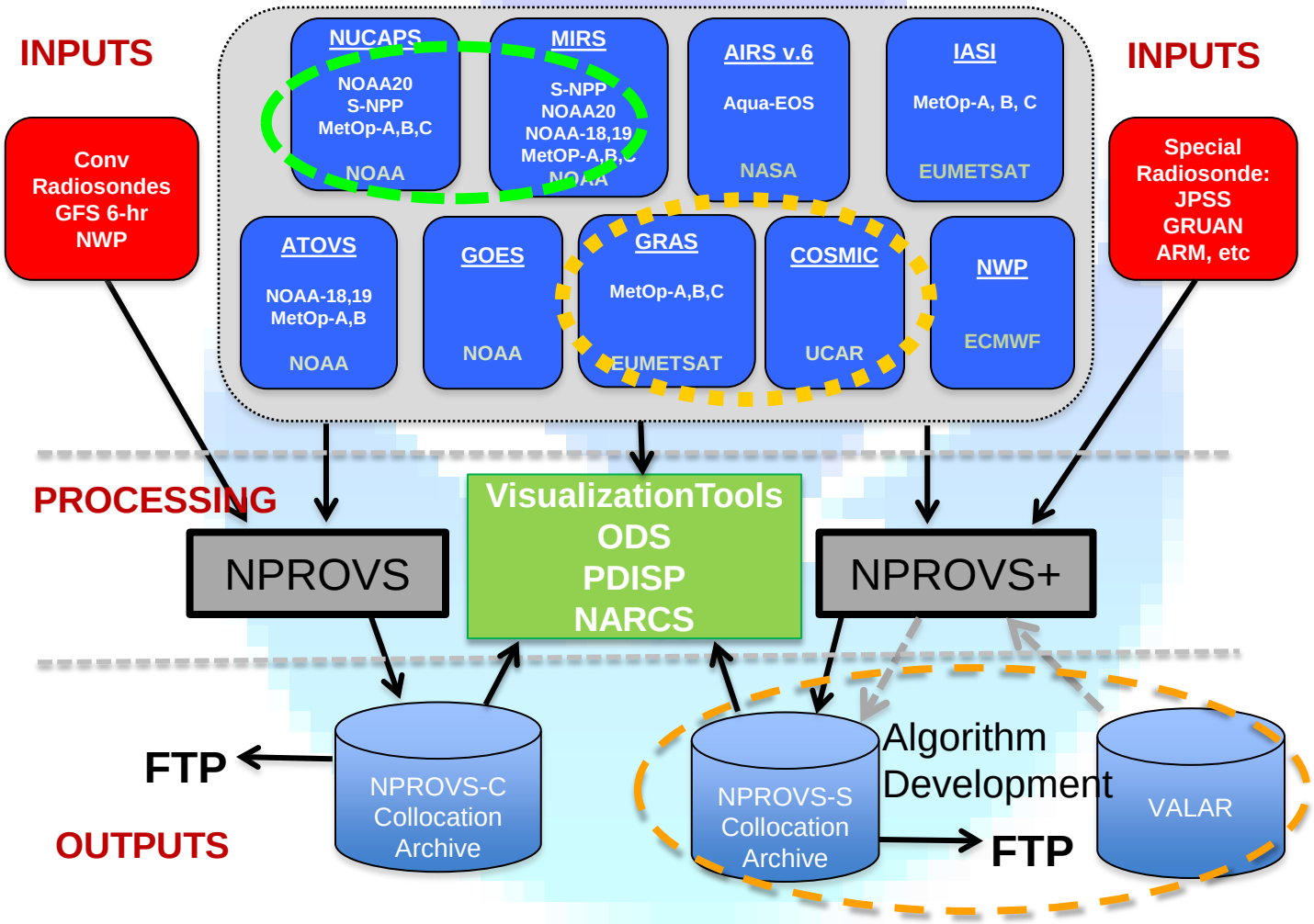
Konventum, Helsingor (Elsinore), Denmark

Outline

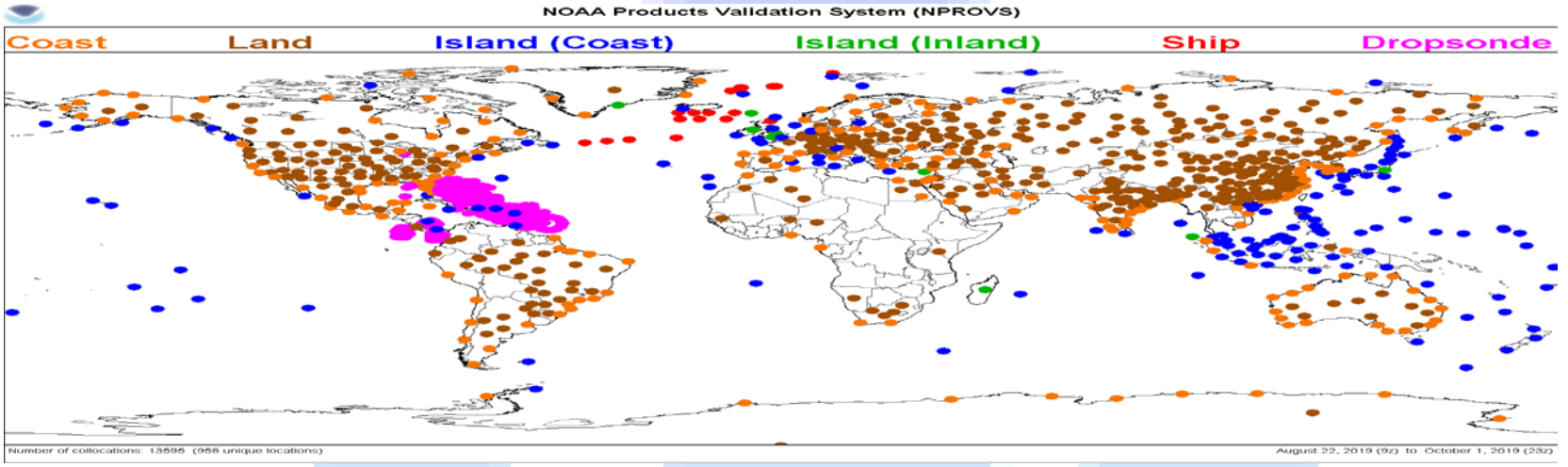
- NOAA sounding Products Validation System (NPROVS) introduction
- Demonstrate GPSRO application
  - GPSRO in Vaisala RS92 to RS41 transition
  - GPSRO in 3G (GRUAN, GSICS, and GNSS-RO) climate monitoring
  - NPROVS utility to routinely access and assess atmospheric profiles from COSMIC-2 (and commercial)

NOAA Products Validation System (NPROVS)

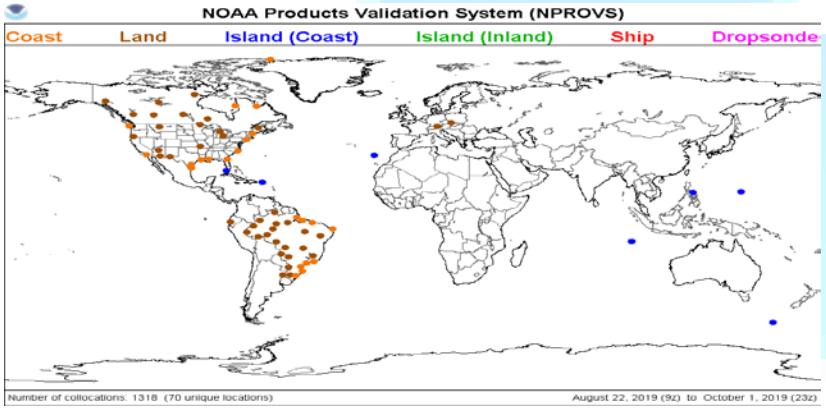


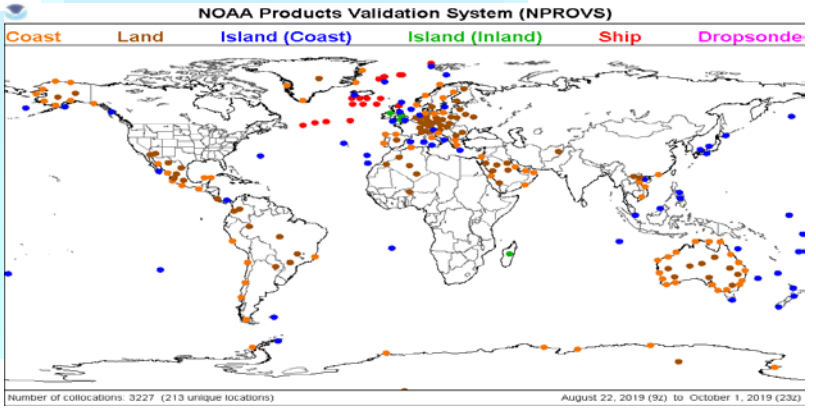
Funded by JPSS Cal/Val program and supports NOAA EDR Retrieval Algorithm Development
https://www.star.nesdis.noaa.gov/smcd/opdb/nprovs

N P R O V S: Conventional RAOB



Typical Global Radiosonde Launches (1000 per day)
August-September 2019

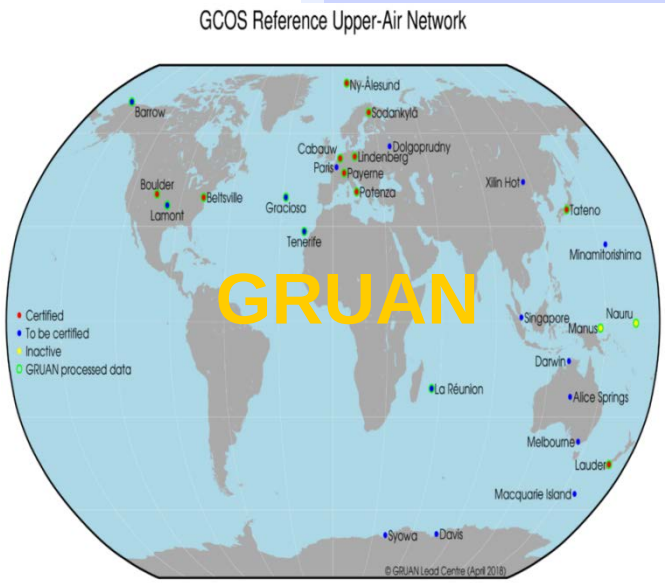




Vaisala RS92 (10%)

Vaisala RS41 (25%)

GRUAN & JPSS-funded Dedicated RAOBs: NPROVS Special



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

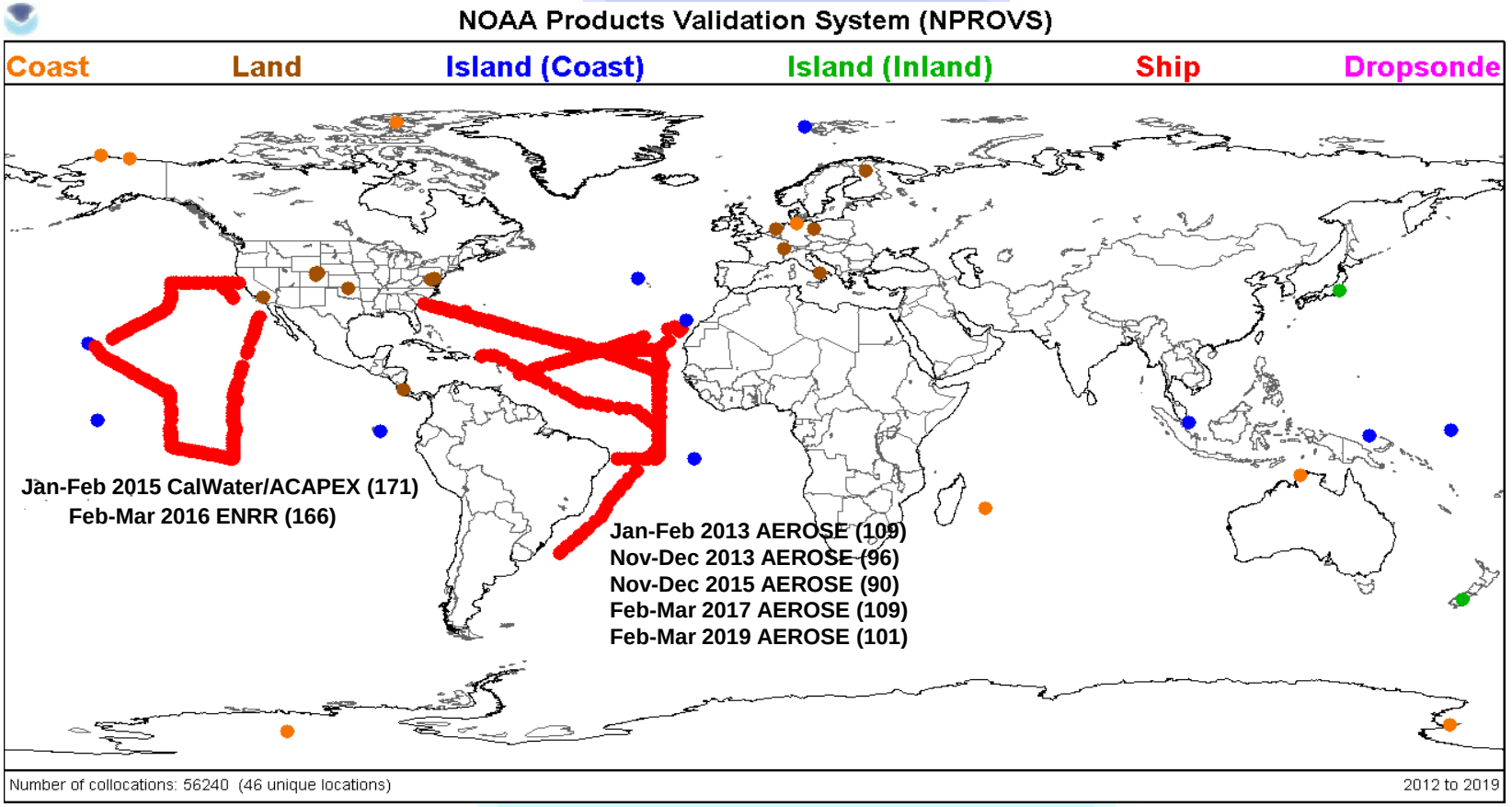
JPSS Dedicated RAOB

- DOE ARM (SGP, NSA, ENA)
  - ✓SSEC/Madison …
  - ✓(2) per week
  - ✓ dual vs single, etc
- AEROSE
- CALWATER
- El Nino Rapid Response
- RIVAL (DOE funded)

Ongoing coordination with "other" field experiments

- Sterling Test Site
- ARM Mobile Sites
- CIRA/CSU

N P R O V S: Special Radiosonde



GRUAN and JPSS funded Dedicated (S-NPP) RAOB Sites (Jan 2013 thru Mar 2019)
Of 56,500 RAOBs, 9000 are synchronized (4000 via JPSS/ARM)
Half of the raobs from ocean campaigns are synchronized with MetOp

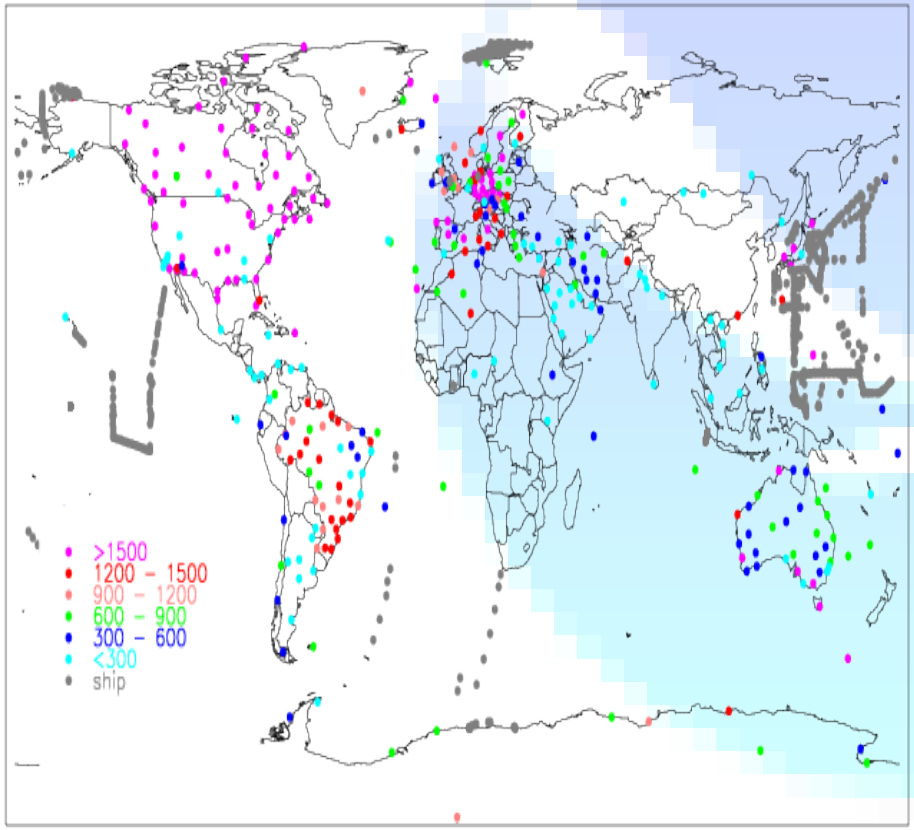
RS92 to RS41 Transition Study

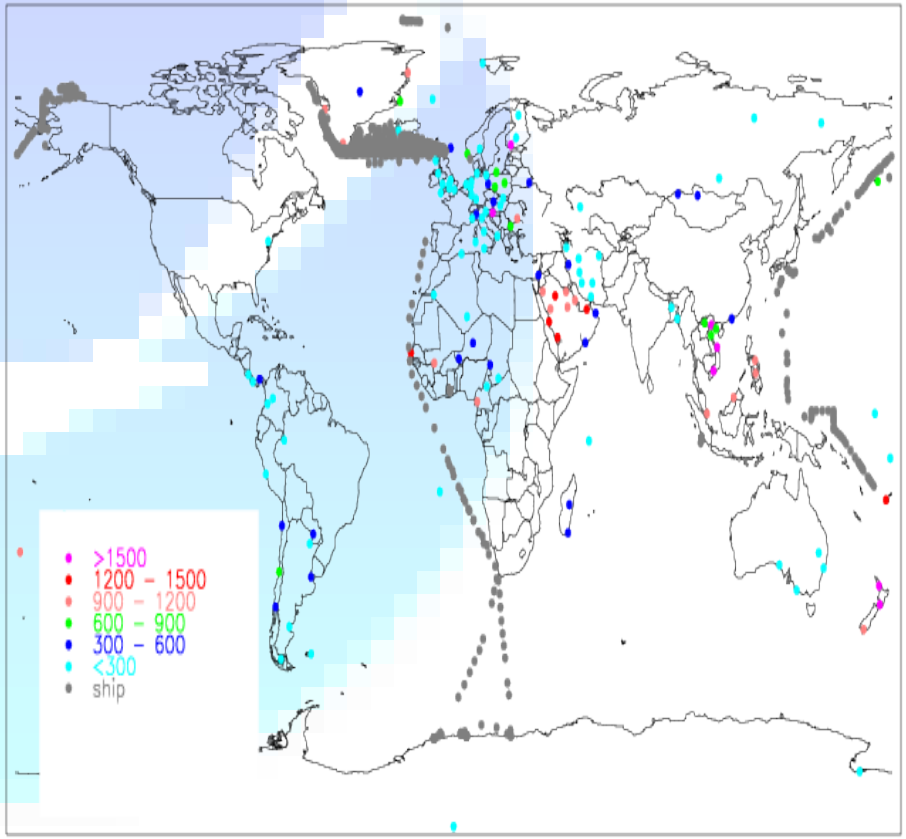
- Accuracy assessment of RS41 vs. RS92 using January 2015-March 2019 data
  - NWP (CFSR BG and ANAL; ECMWF ANAL)
  - Dual (41/92) launches at 6 GRUAN sites
  - **GPS RO "Tdry" (UCAR COSMIC and ROM SAF DMI GRAS)**

"*On the accuracy of Vaisala RS41 versus RS92 upper air temperature observations*"; Sun et al., (2019), J. Atmos. Ocean. Tech.

- **Implications for satellite data cal/val**

Spatial distribution of RS41 vs RS92 (4 yrs of collocation data)

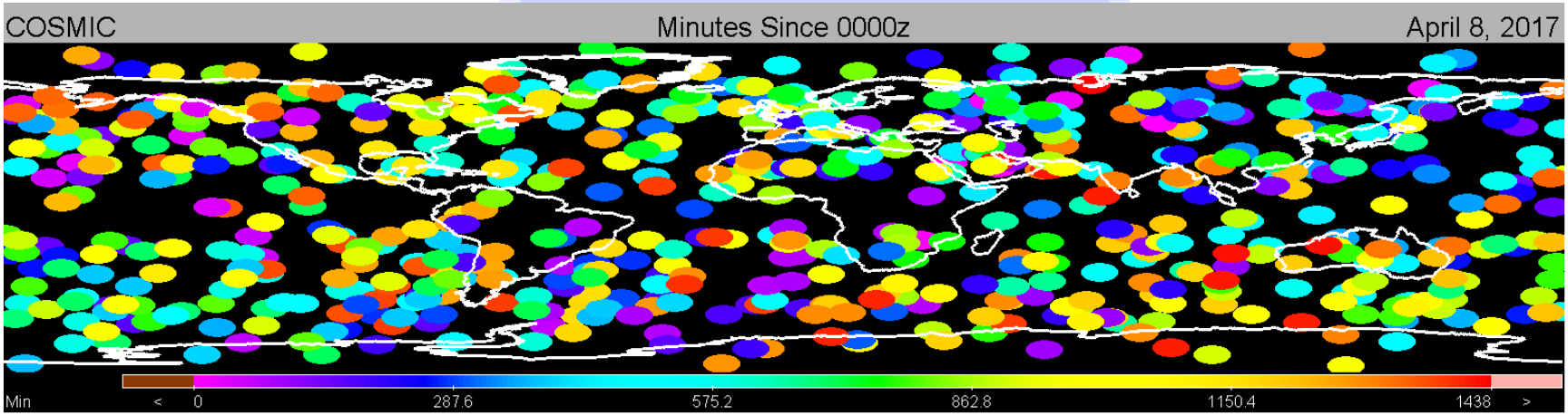


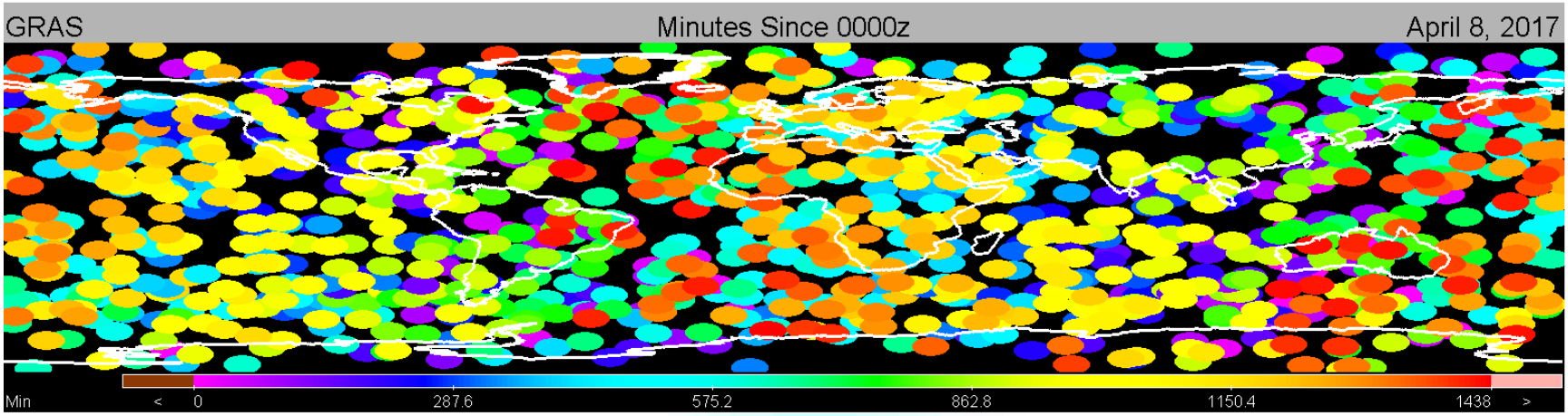


RS92: 311,489 launches

RS41: 65,876 launches

COSMIC-1 (UCAR) and GRAS (ROM SAF DMI) RO (April 8, 2017)



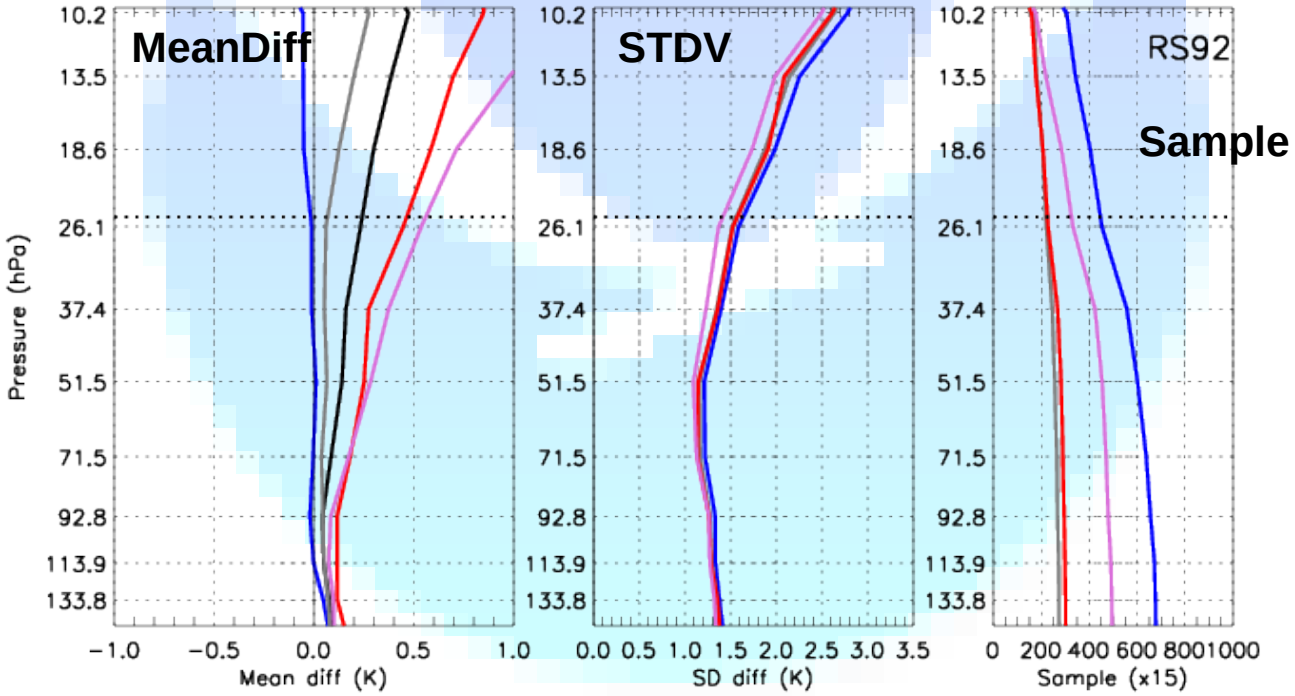


UCAR COSMIC RO profiles: 618 (top)
ROM SAF GRAS RO profiles: 1200 (bottom)

RS92-minus-RO COSMIC 2015.01-2019.03

Solar Elevation Categories

- NIGHT (<−7.5 deg)
- DAWN/DUSK (−7.5 – 7.5 deg)
- LOW (7.5 – 22.5 deg)
- HIGH (>22.5 deg)



Solar Elevation Categories

RS92-minus-RO GRAS 2015.01-2019.03

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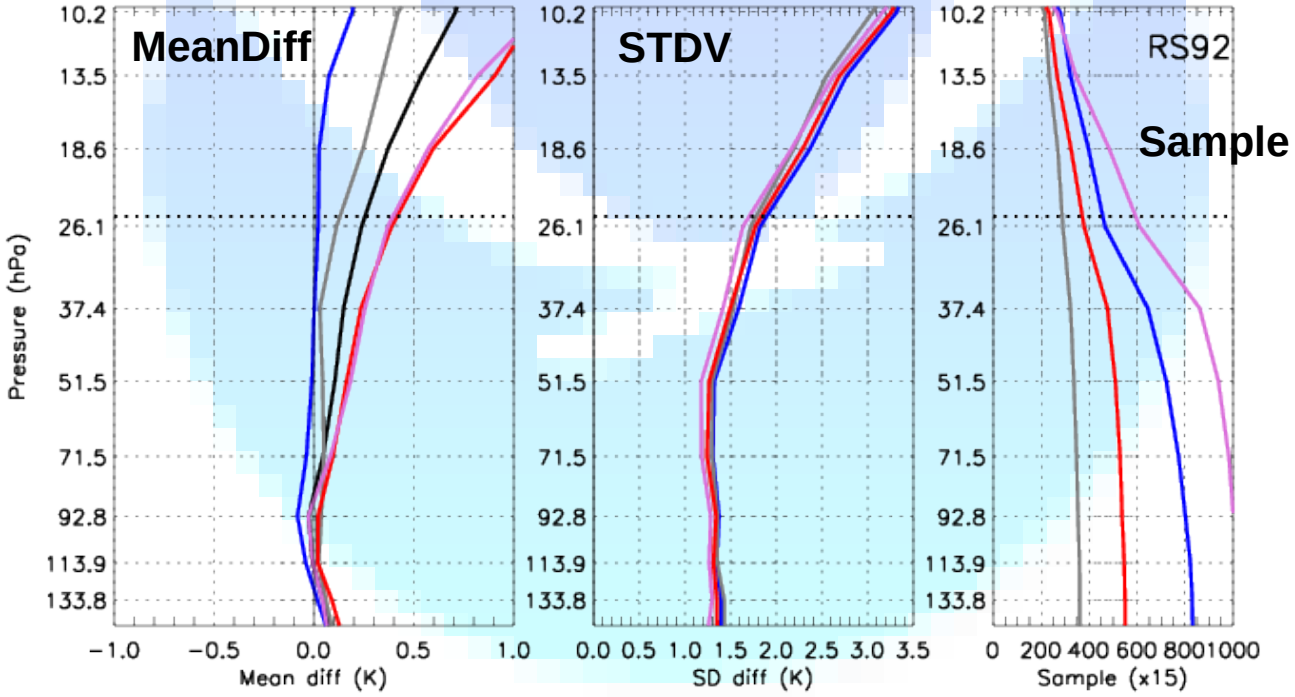
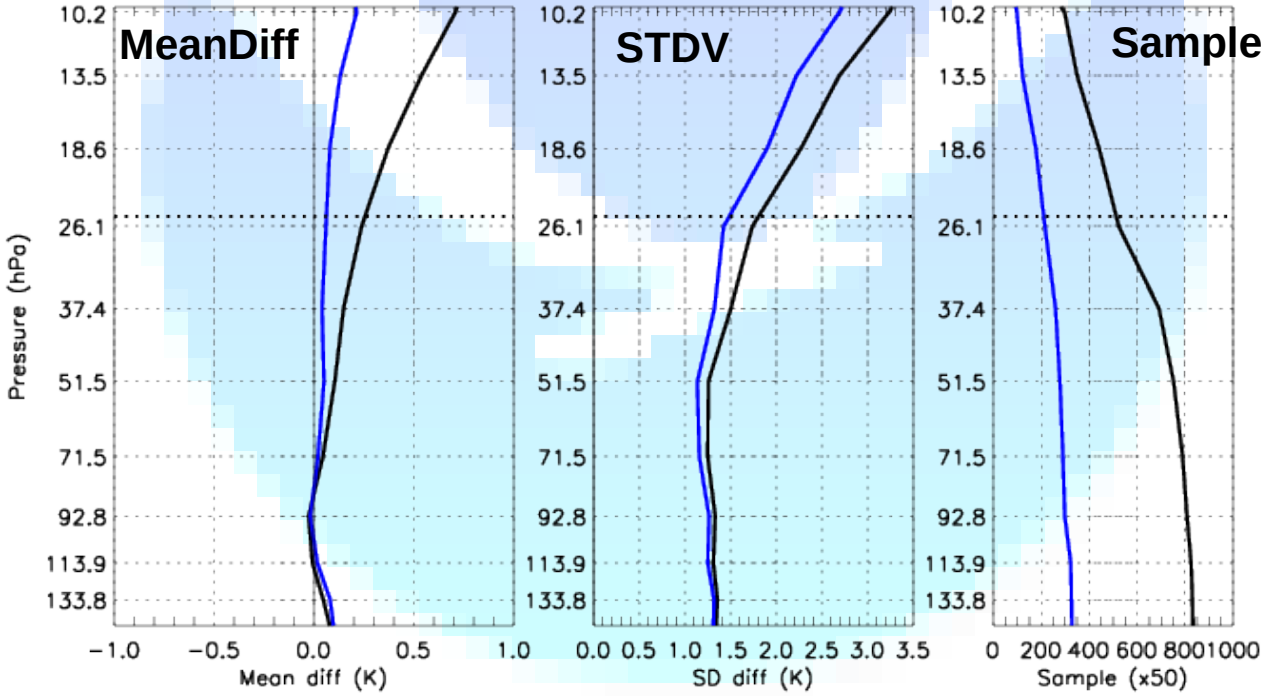


RS92-minus-RO GRAS
RS41-minus-RO GRAS

(Day and night…all the data)

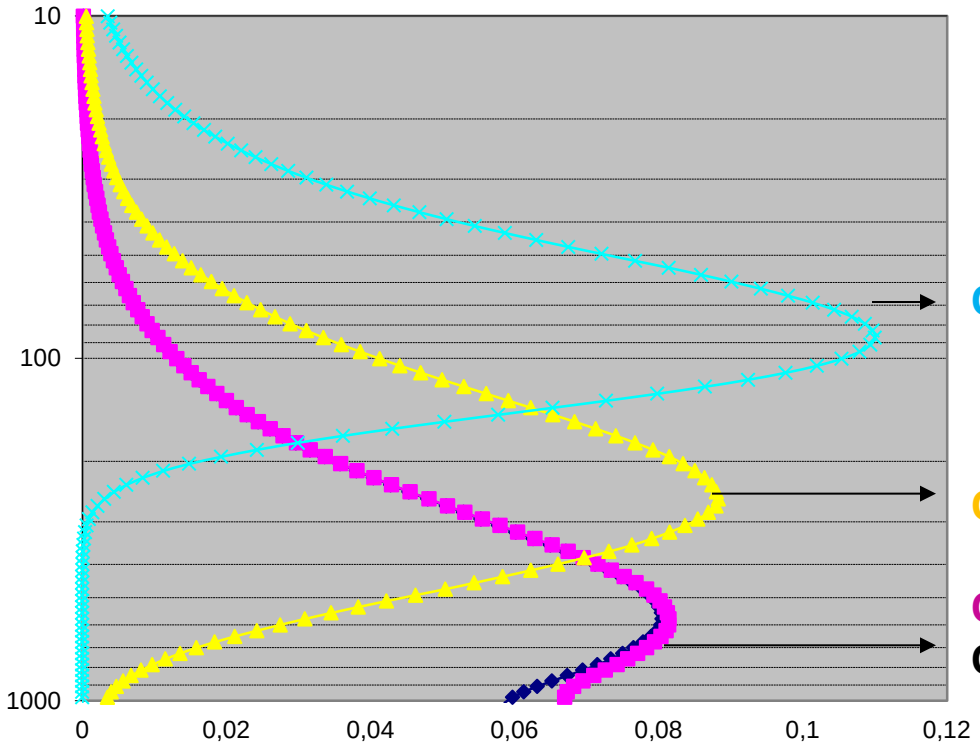


Consistency of different observing systems in climate monitoring

- GRUAN
  - GDP (Dirksen et al., 2014)
- Polar Satellite Microwave
  - FCDR (NOAA/STAR, Cheng-Zhi Zou et al., 2018)
- GPSRO
  - CDR (ROM SAF DMI, Joe Nielsen 2018)

- Sites used as examples
  - Lindenberg, Germany
  - Barrow, AK, USA

Microwave Sounding Unit (MSU) Weighting Functions (nadir)



Lindenberg

GRUAN, Satellite Microwave, GPS RO

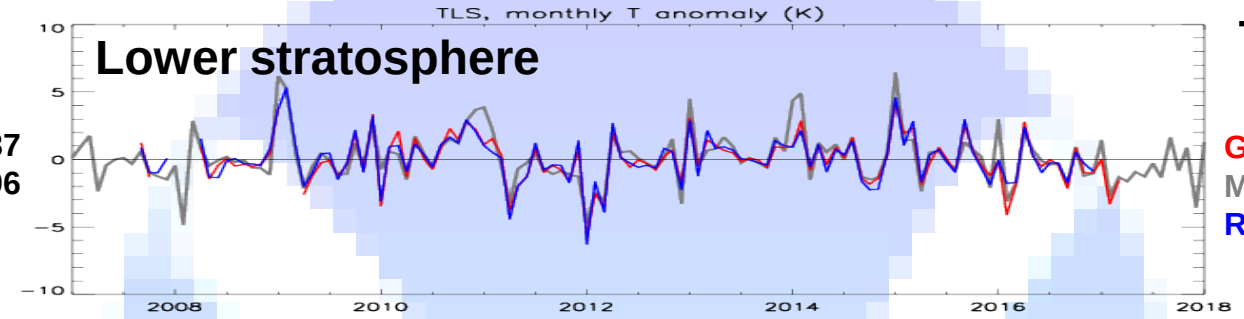
Correlation

Trend (K/yr)

Lower stratosphere

MW vs GRUAN: 0.87
RO vs GRUAN: 0.96

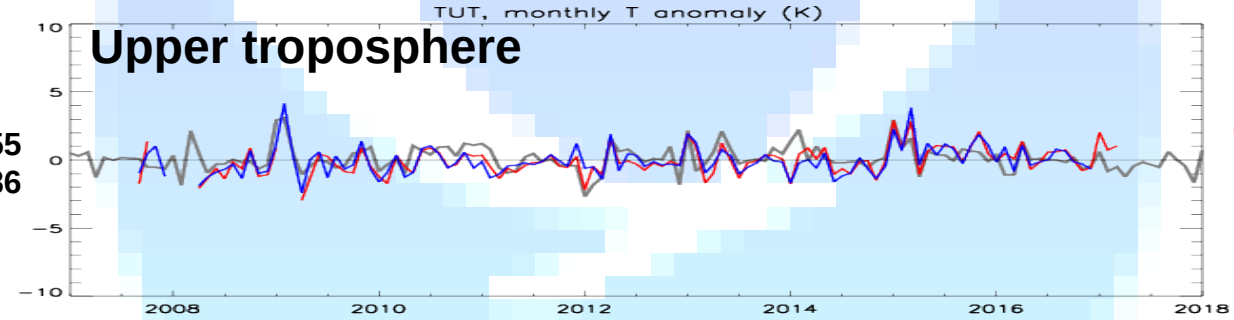
GRUAN: 0.004(0.00)
MW: 0.015(0.00)
RO: 0.004(0.00)



Upper troposphere

MW vs GRUAN: 0.55
RO vs GRUAN: 0.86

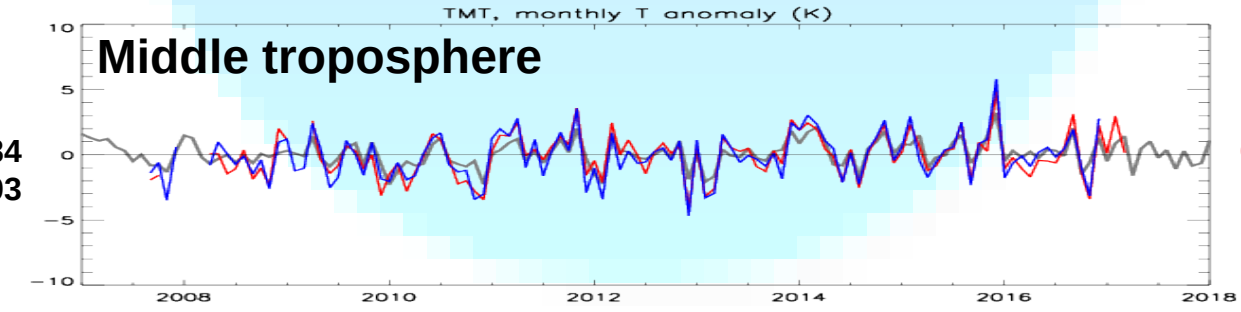
GRUAN: 0.127(0.11)
MW: 0.038(0.01)
RO: 0.108(0.08)



Middle troposphere

MW vs GRUAN: 0.84
RO vs GRUAN: 0.93

GRUAN: 0.108(0.03)
MW: 0.095(0.06)
RO: 0.106(0.02)



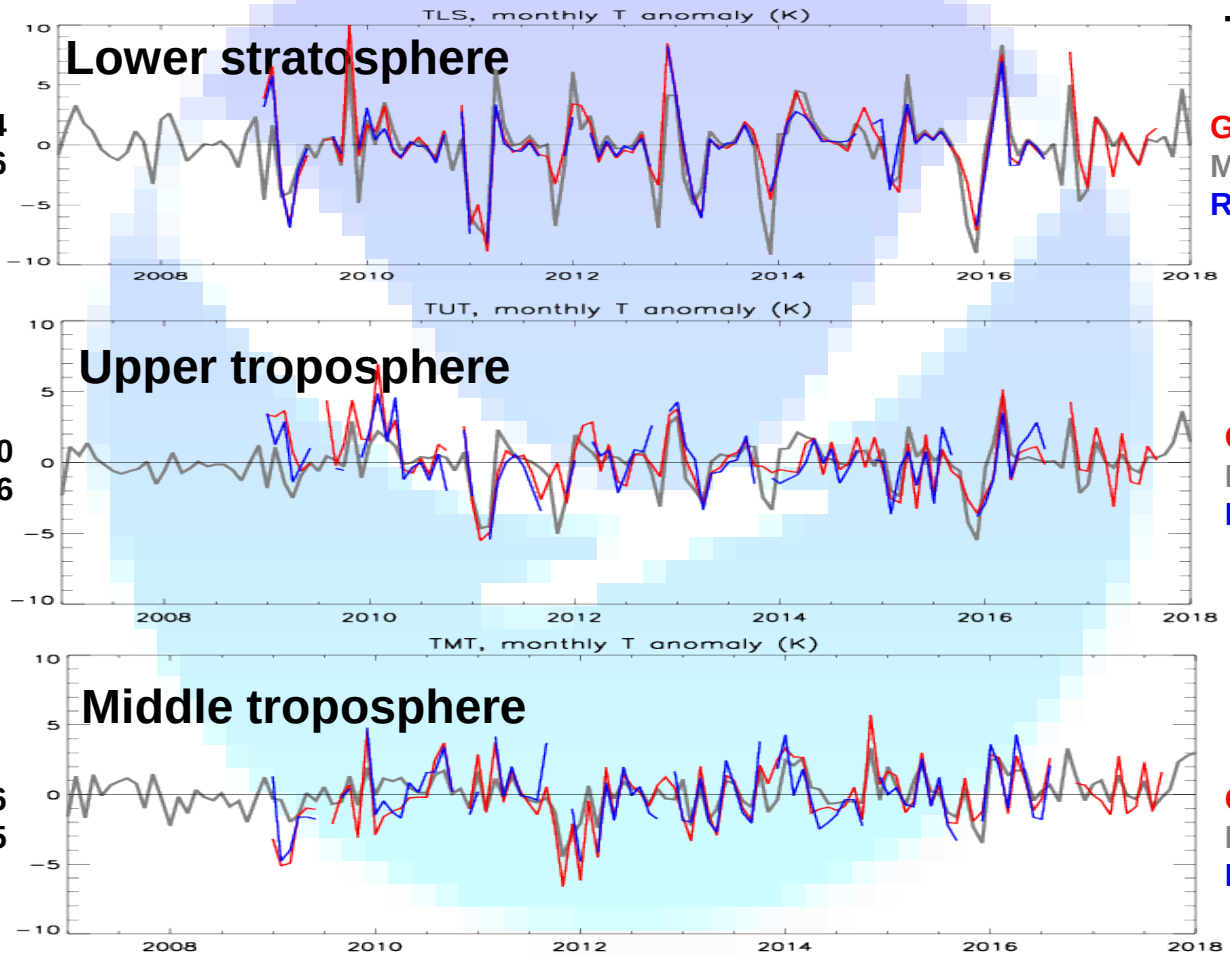
Barrow, GRUAN, Satelite Microwave, GPS RO

Correlation

MW vs GRUAN: 0.84
RO vs GRUAN: 0.96

MW vs GRUAN: 0.60
RO vs GRUAN: 0.86

MW vs GRUAN: 0.76
RO vs GRUAN: 0.85



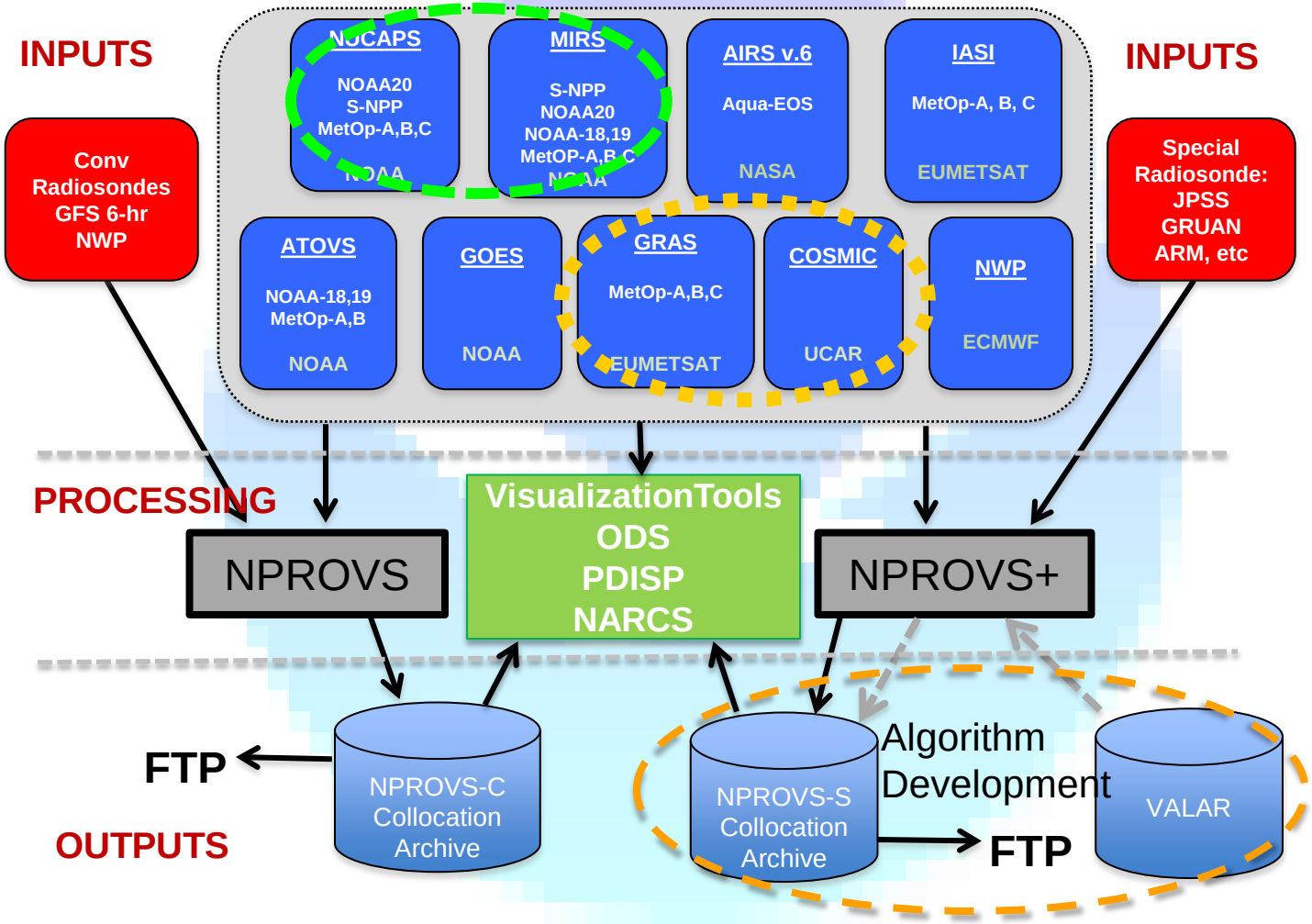
Trend (K/yr)

GRUAN: 0.110(0.01)
MW: 0.172(0.02)
RO: 0.128(0.01)

GRUAN: -0.186(0.04)
MW: 0.057(0.01)
RO: -0.072(0.01)

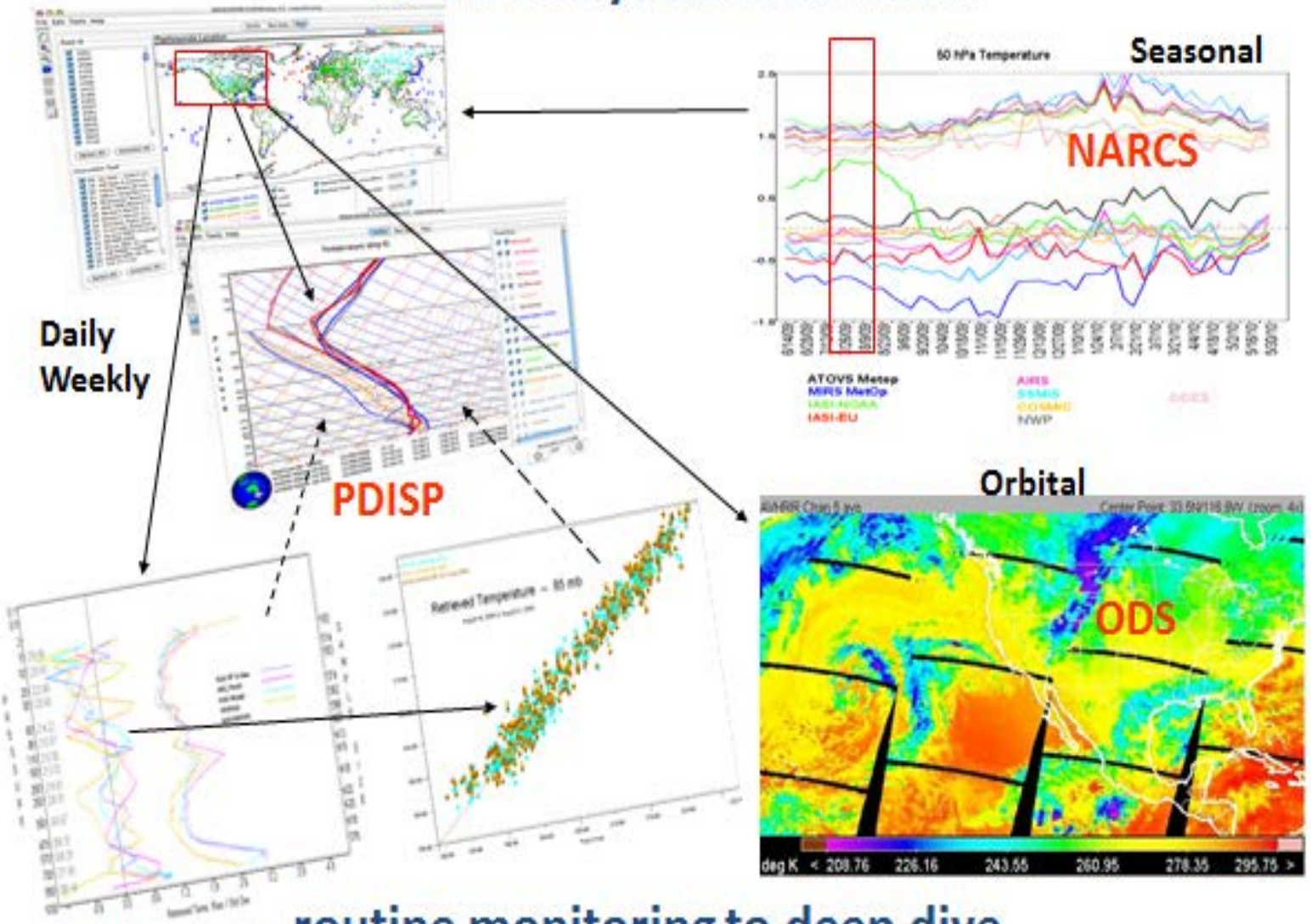
GRUAN: 0.168(0.03)
MW: 0.051(0.01)
RO: 0.038(0.02)

NOAA Products Validation System (NPROVS)



Ready to "add" COSMIC-2 to this collocation validation system

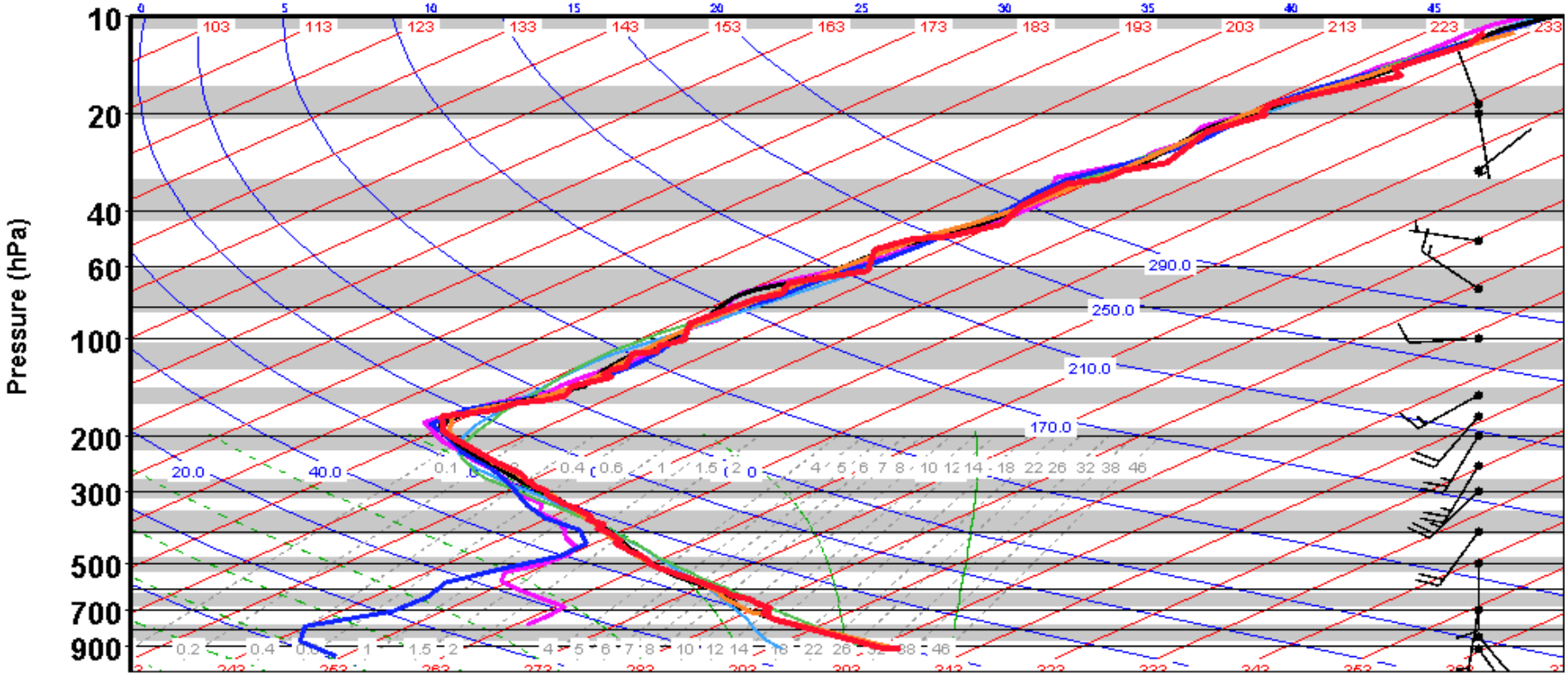
EDGE Analytical Interface …



… routine monitoring to deep dive

NOAA Products Validation System (NPROVS)

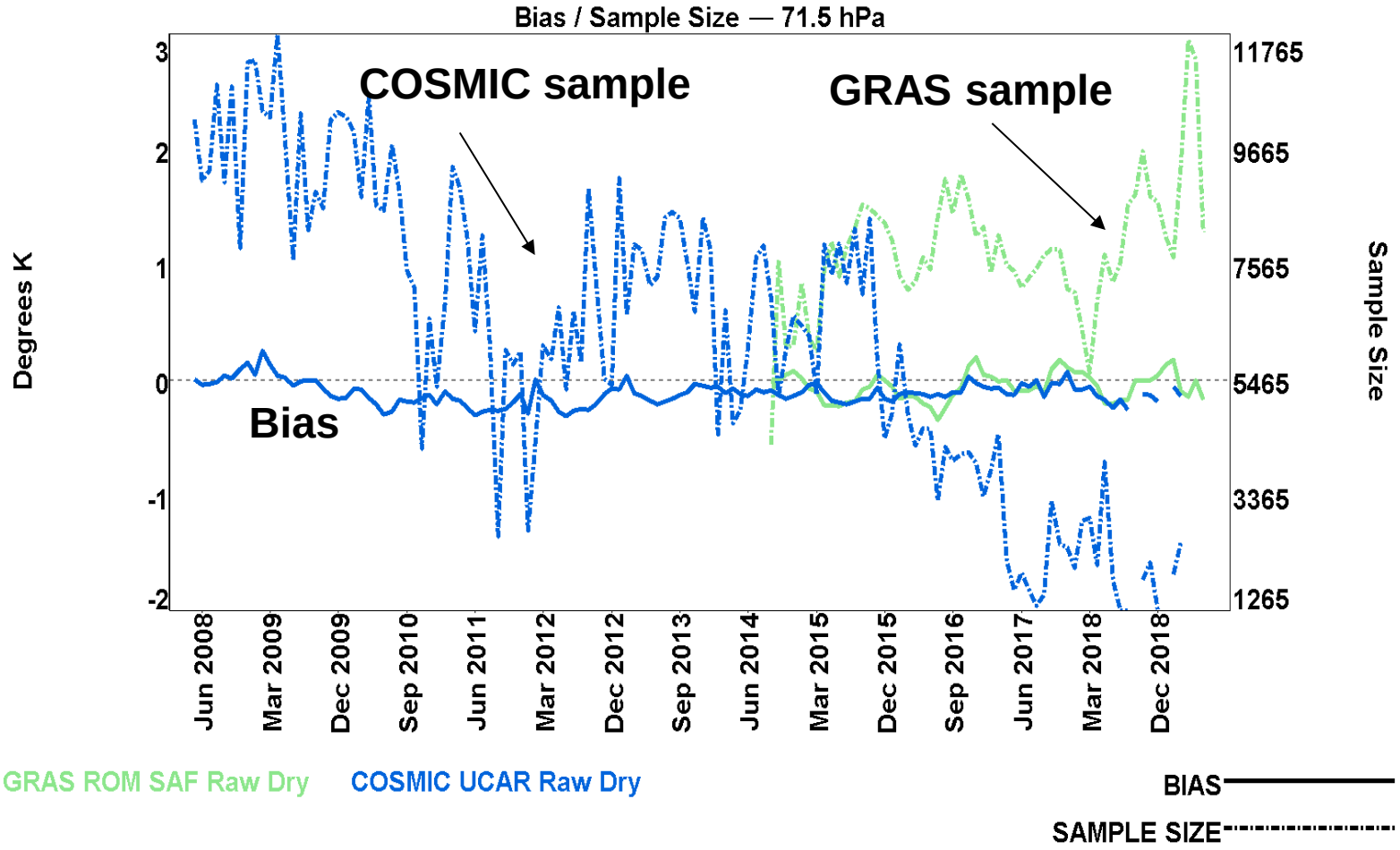
Dewpoint / Temperature (deg K)



SONDE 72768 (182) SONDE	8/22/2019 23:04:00Z	48.2 N / 106.6 W
SONDE 72768 (182) GFS 6 Hour	8/22/2019 23:04:00Z	48.2 N / 106.6 W
ECMWF	8/23/2019 0:00:00Z (0.9 hours)	48.2 N / 106.8 W (9.7 km)
COSMIC UCAR Raw Dry	8/22/2019 21:31:24Z (-1.5 hours)	49.8 N / 105.7 W (193.2 km)
NUCAPS NPP	8/22/2019 20:10:44Z (-2.9 hours)	48 N / 106.6 W (19 km)
MIRS NPP (0) MIRS NPP	8/22/2019 20:10:47Z (-2.9 hours)	48.2 N / 106.6 W (5.3 km)
GRAS	8/23/2019 01:36 Z (2.5 hour)	50.1 N / 104.9 W (249.7 km)

GRUAN, GFS, ECMWF, COSMIC Tdry, GRAS Tdry, NUCAPS and MiRS Profiles

Tdry at 71.5 hPa vs global RAOBs

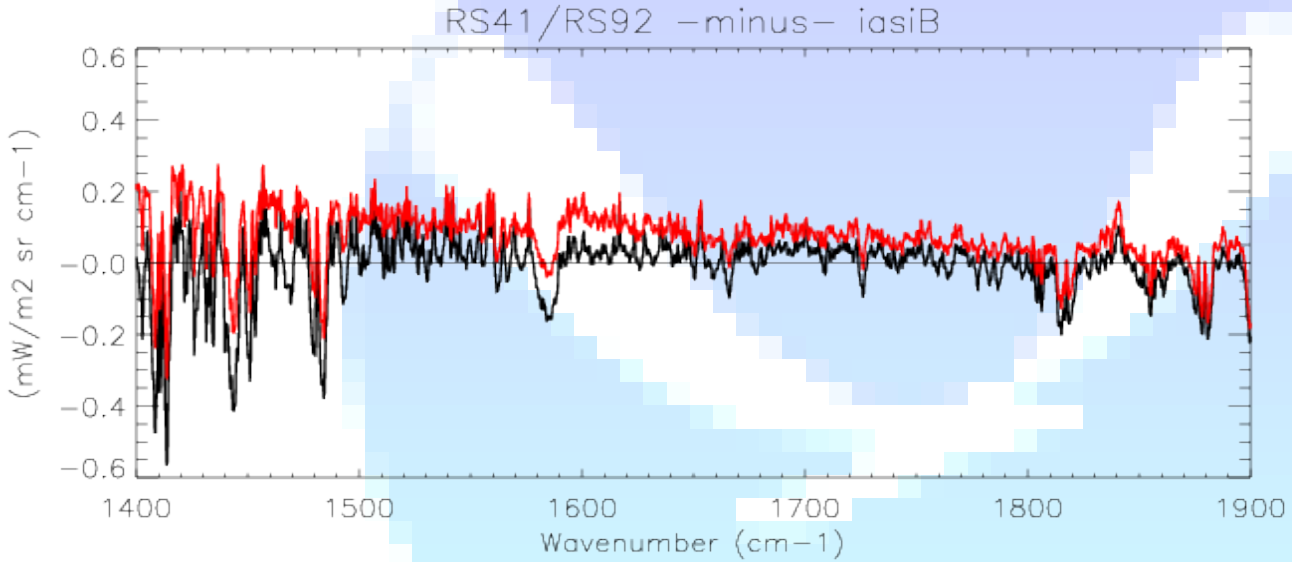


Summary / *Path forward*

- Utilization of GPSRO in NPROVS:
  - RO Tdry used in assessment of RS92-to-RS41 radiosonde transition
  - Consistency of climate monitoring: support 3G [GRUAN, GSICS (polar satellite microwave), GPSRO] activity
- NPROVS supports COSMIC-2 implementation; ongoing

- *Bring ROM SAF CDR, UCAR (and other agencies) reprocessed GPSRO profiles into NPROVS*
- *Monitor, assess, facilitate feedback among agencies*

On the accuracy of humidity observations assessed in hyperspectral infrared radiance space



RS92-minus-IASI
RS41-minus-IASI

Cited from “GSICS use of GRUAN humidity observations in the context of satellite sensor assessment” by Sun, Calbet, Reale, and Bali, GSICS Quarterly Newsletter, Vol. 13, No. 3, 2019, doi:10.25923/63j6-sb72

RS41 is less dried (by ~1.5%) than RS92 (GDP) during daytime.