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On the accuracy of Vaisala RS41 and RS92 humidity observations in both radiance and geophysical spaces

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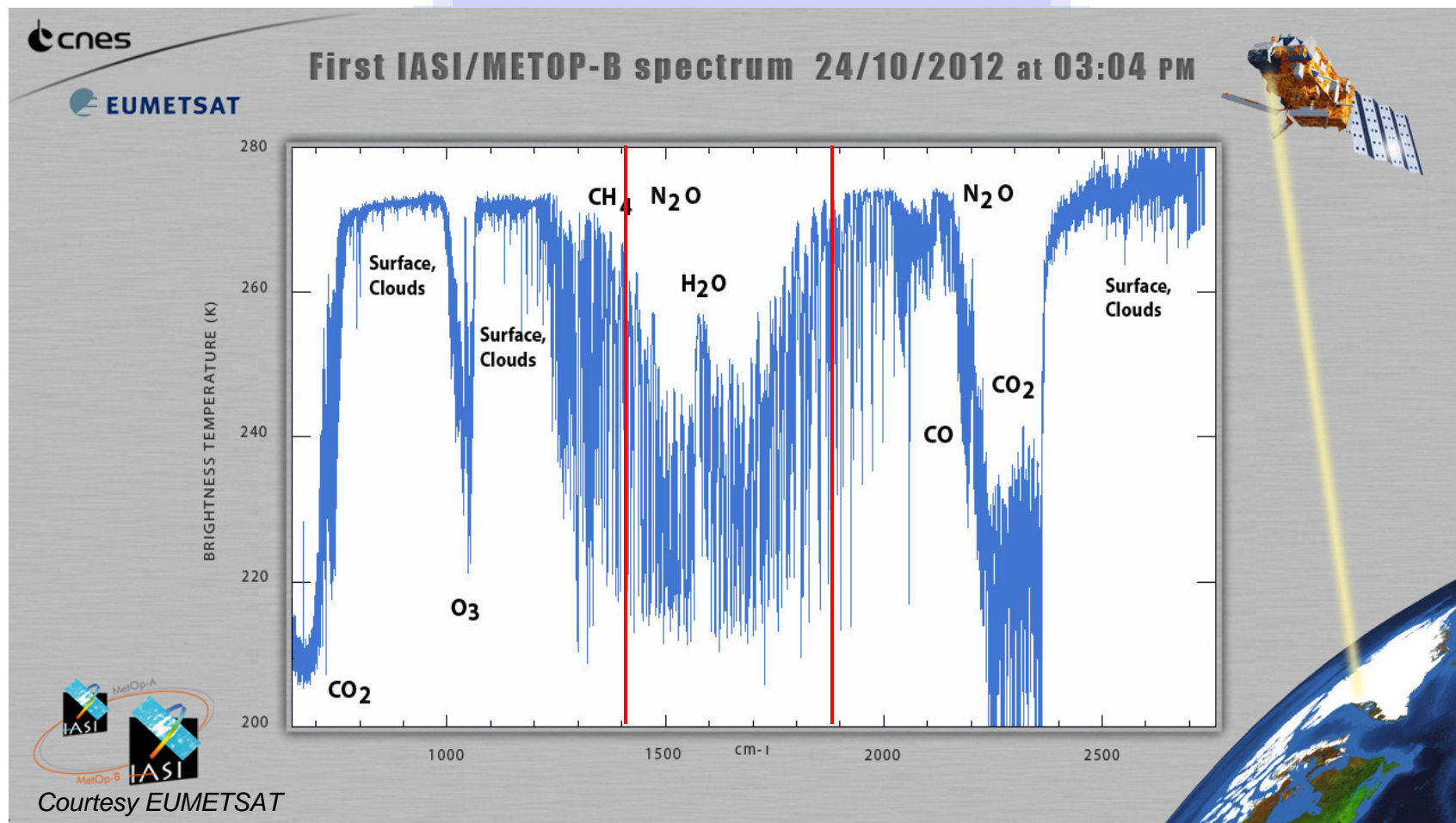
Background and Goal

- “Consistency between GRUAN sondes, LBLRTM and IASI” by Calbet et al. (2017)
 - GRUAN nighttime observations (RS92) are consistent with Infrared Atmospheric Sounding Interferometer (IASI) measurements.
 - GRUAN RS92 data still have a dry bias.
 - *Based on one site (Manus) and 27 launches of RS92 sondes.*
- To understand the accuracy of current GRUAN observations
 - RS41 has replaced RS92.
 - A lot more sites/campaign data and their collocations with satellite/NWP are available via NPROVS.

Method

- Find radiosondes that are closely matched with IASI pixels that are “cloud-free”.
- Compute radiance for the radiosonde profiles using Line-by-Line Radiative Transfer Model (LBLRTM).
- Assess the consistency of the radiosonde-computed radiance with IASI measurements.
- Determine the absolute accuracy of GRUAN sondes using iasi as the ref.

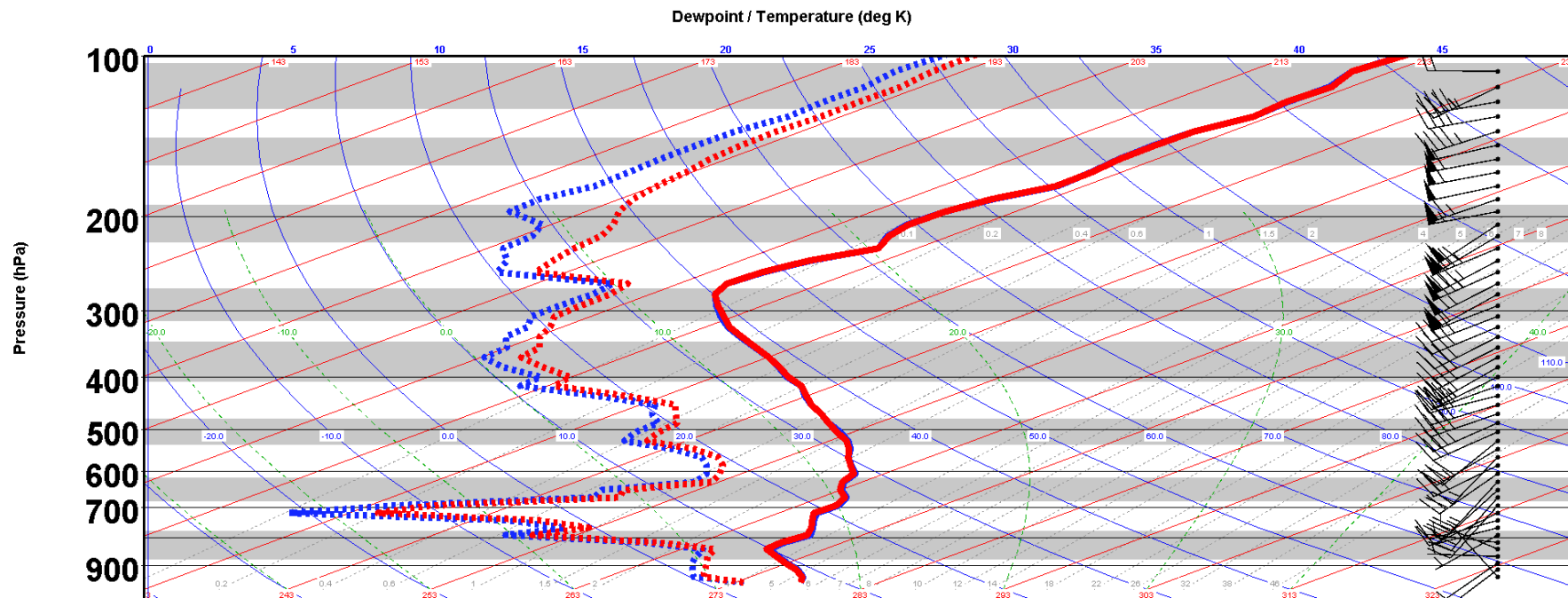
Upper tropospheric water vapor spectrum (1400-1900 cm^{-1})



More/less water vapor in the upper air , less/more radiation arriving at satellite

Lauder, dual launch, 0.5hr before iasiB overpass vendor-RS92 vs vendor-RS41

NOAA Products Validation System (NPROVS)



RAOB RS41 LAUDER (141) RAOB RS41
RAOB RS92 93817 (114) RAOB RS92

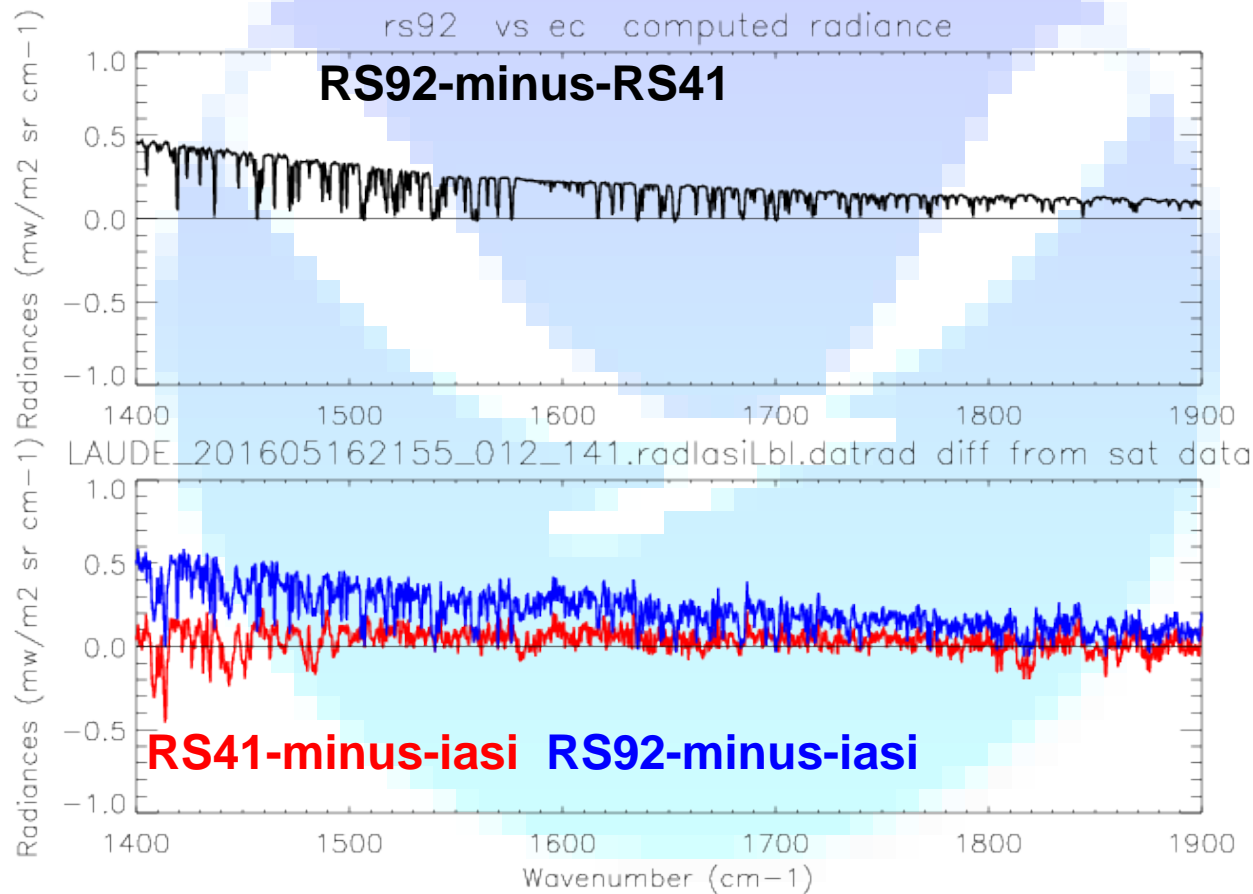
5/16/2016 21:55:00Z
5/16/2016 21:55:00Z (0 hours)

45 S / 169.7 E
45 S / 169.7 E (0 km)

Vendor-RS92 is drier than vendor-RS41

Lauder, dual launch, 0.5hr before iasiB overpass

vendor-RS92 vs vendor-RS41

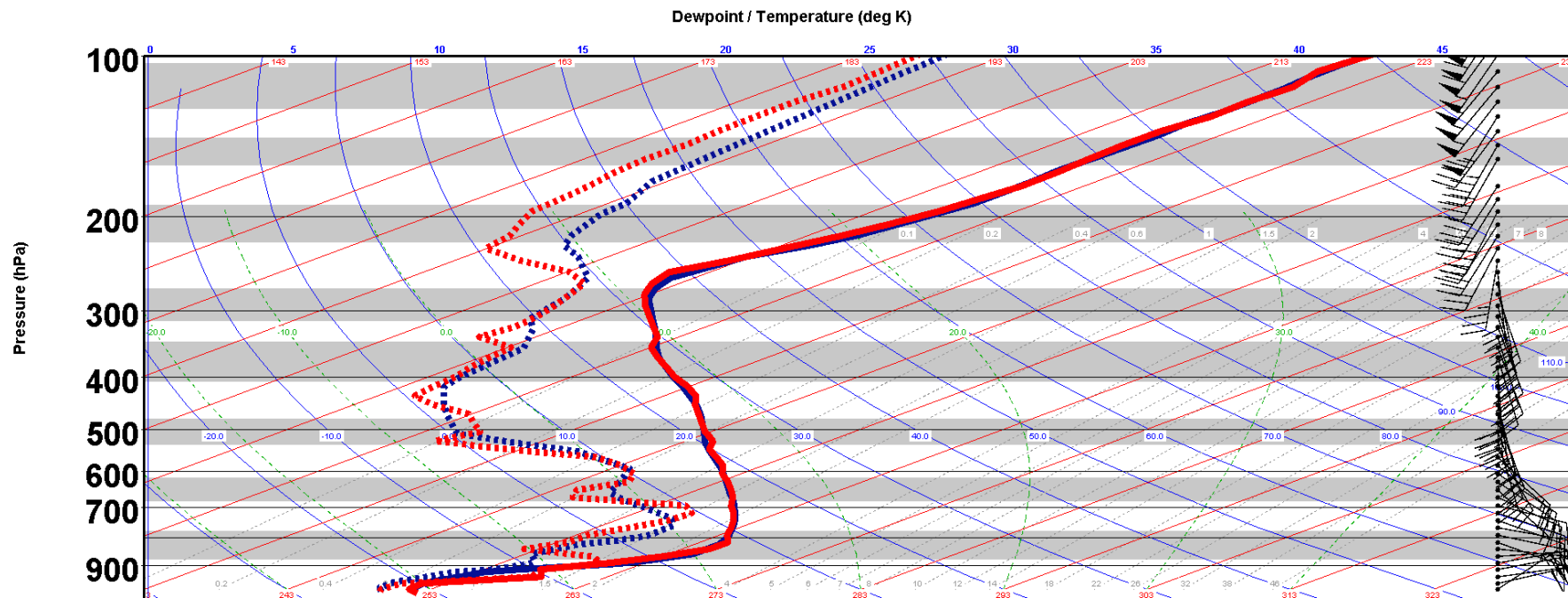


Vendor-RS92 is 5-6% drier relative to iasi

North Slope of Alaska (NSA), single launch, 0.2hr before iasiB overpass

ECMWF vs gdp-RS92

NOAA Products Validation System (NPROVS)



RAOB 70027 (272) RAOB

3/21/2015 5:30:00Z

71.3 N / 156.6 W

ECMWF ANALYSIS

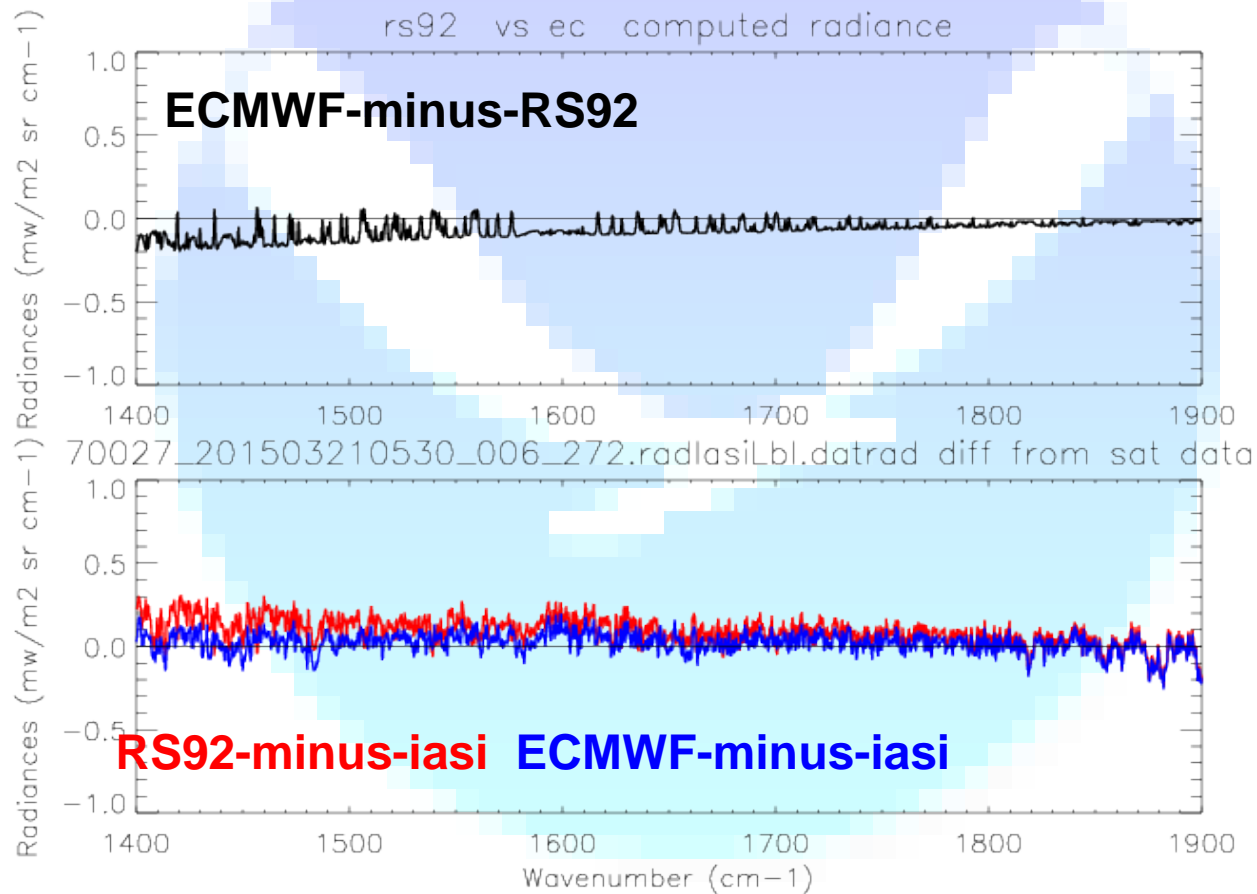
3/21/2015 6:00:00Z (0.5 hours)

71.2 N / 156.5 W (8.9 km)

ECMWF is slightly wetter than gdpRS92

North Slope of Alaska (NSA), single launch, 0.2hr before iasiB overpass

ECMWF vs gdp-RS92



gdpRS92 is 1-2% drier relative to iasi

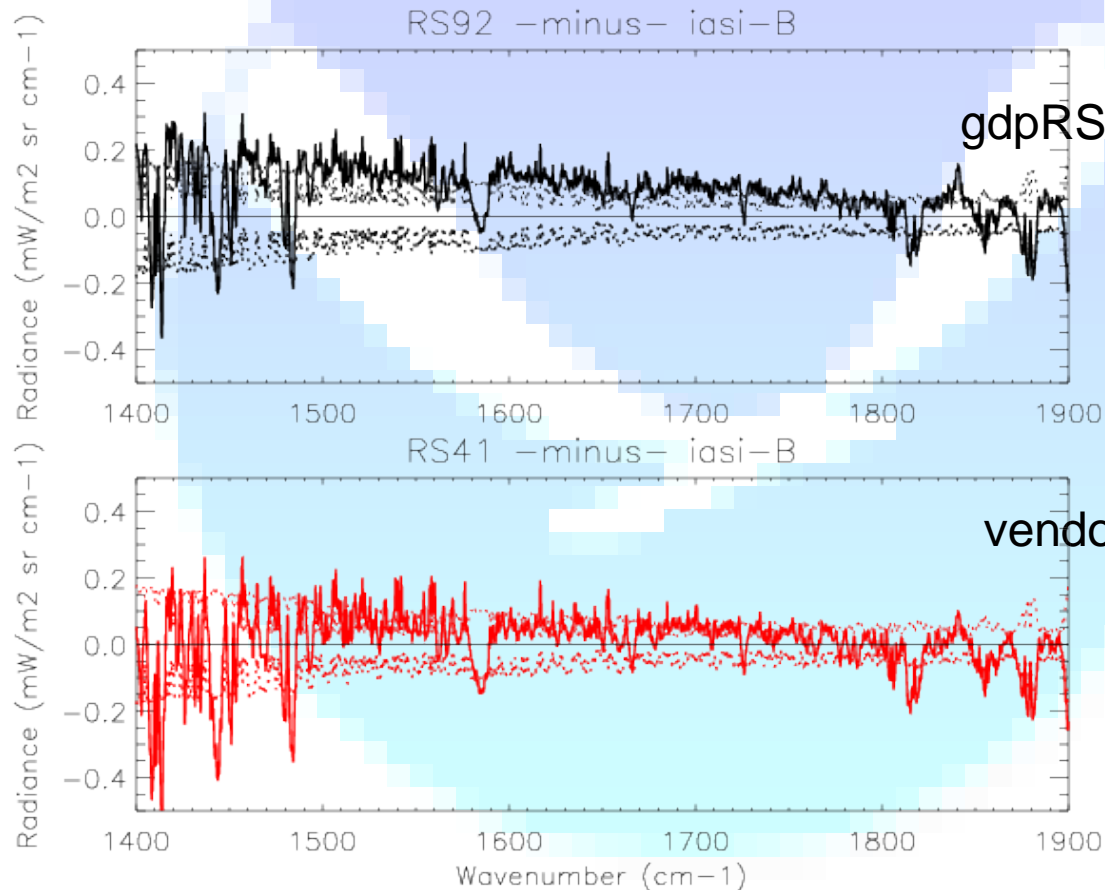
Consistency of RAOB vs IASI in radiance space

gdp-RS92 vs. vendor-RS41

- Lauder, New Zealand
 - gdp-RS 92 vs vendor-RS41 dual launches, daytime
- Payerne, Switzerland
 - gdp-RS92 vs vendor-RS41 dual launches, daytime and nighttime
- NOAA AEROSE over the tropical and subtropical Atlantic
 - single vendor-RS41 launches targeted for NOAA and EUMETSAT sat
- Uncertainty components
 - GRUAN sonde
 - IASI instrument
 - RTM
 - Collocation mismatch

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

Lauder, duals of gdpRS92 vs vendor RS41 (19 daytime pairs of duals are used)

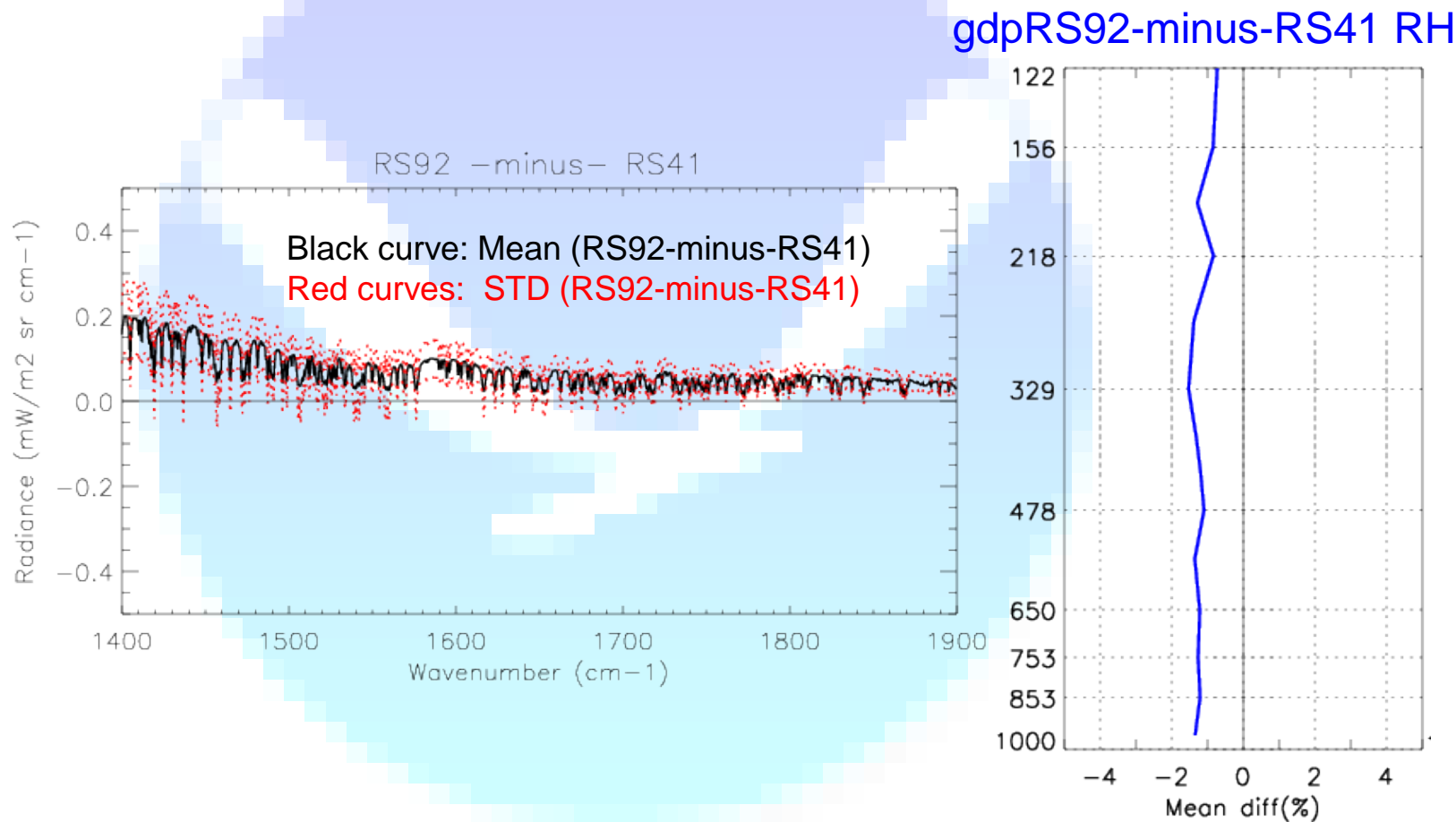


~2.5% dry bias
In RH

~1.5% dry bias
In RH

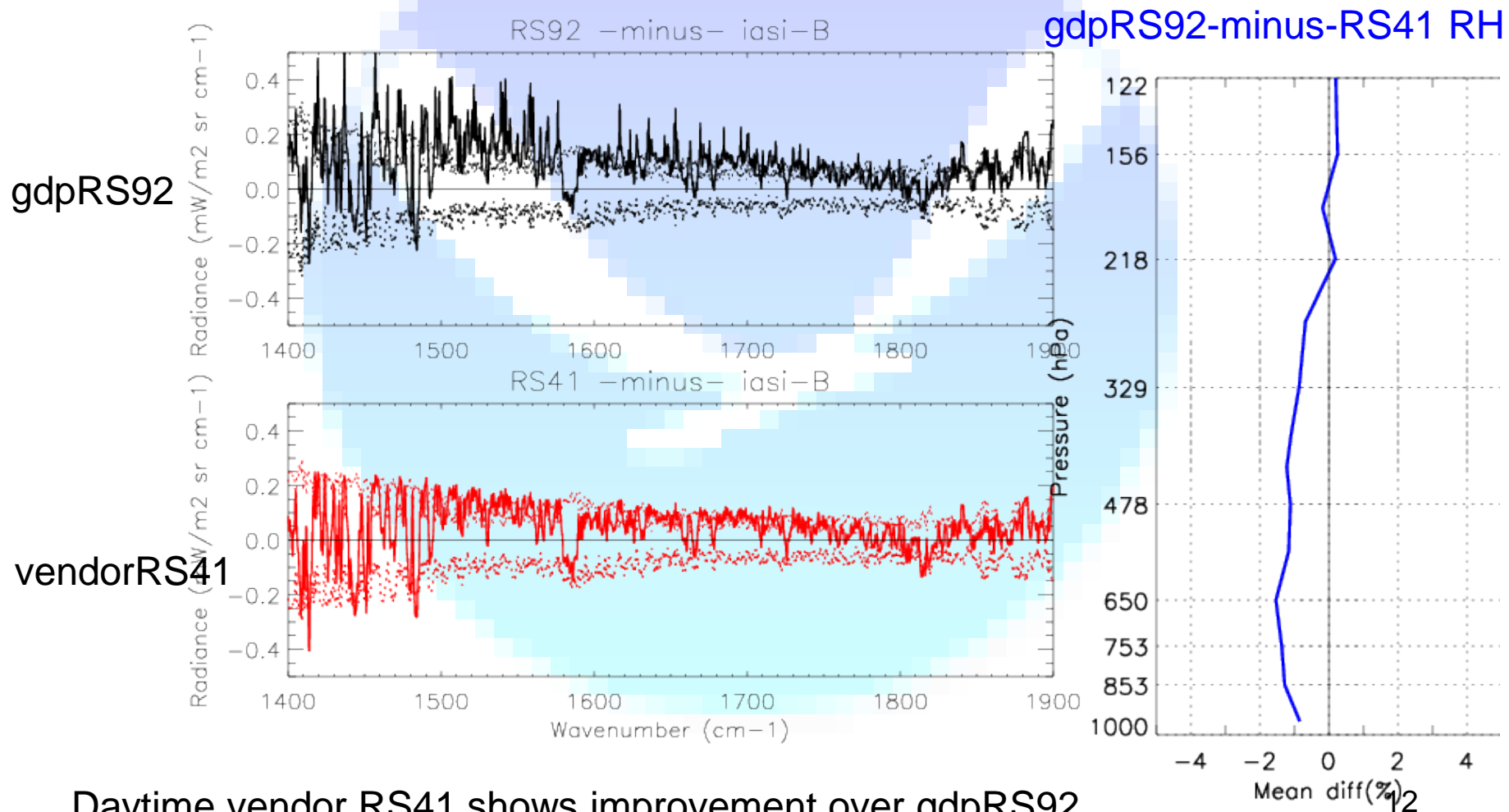
Dotted curves: 2 x (GRUAN, IASI and collocation uncertainty)

Lauder, gdpRS92-minus-RS41 (19 pairs)





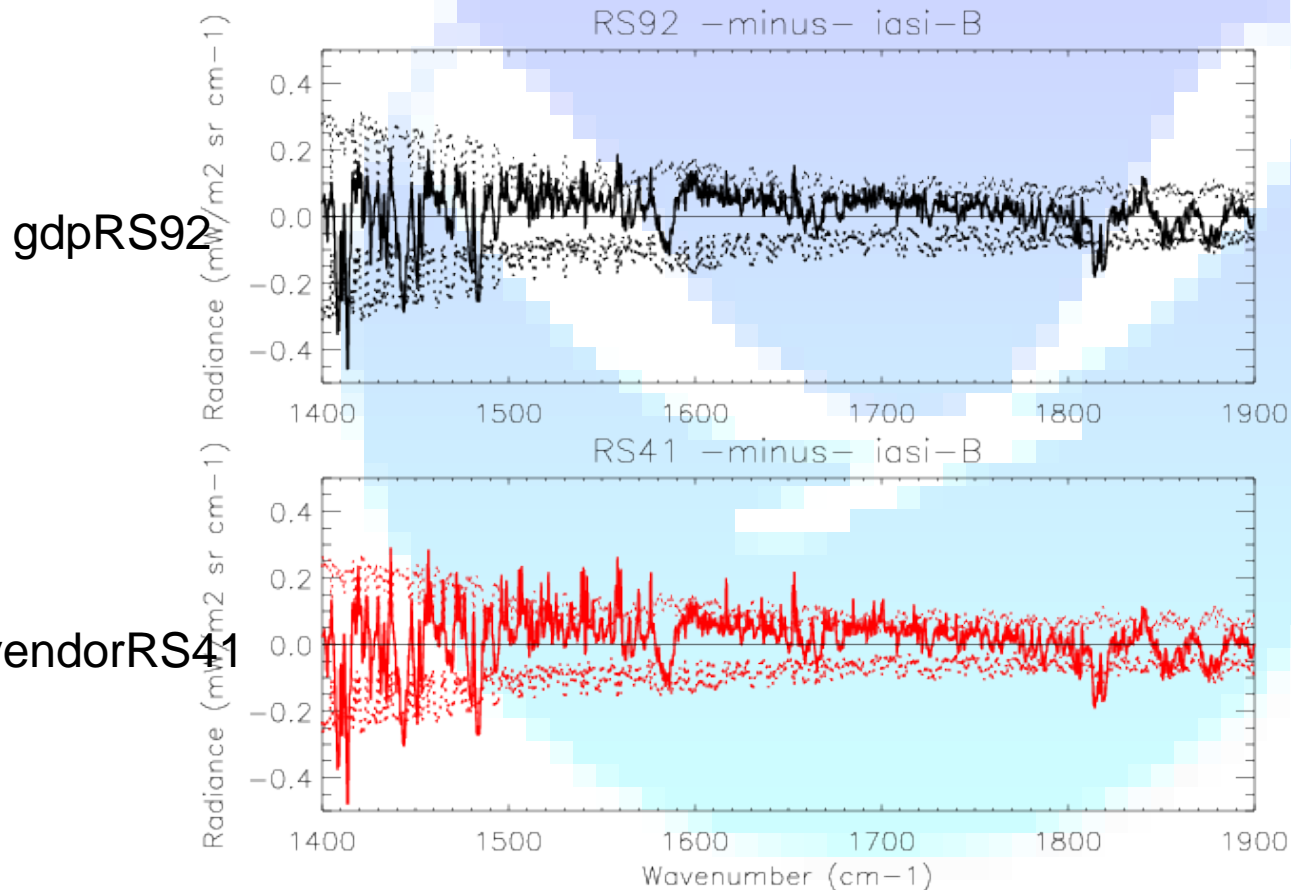
Payerne, duals, 7 launches, daytime, gdpRS92 vs vendorRS41



Daytime vendor RS41 shows improvement over gdpRS92



Payerne, duals, 8 launches, nighttime, gdpRS92 vs vendorRS41



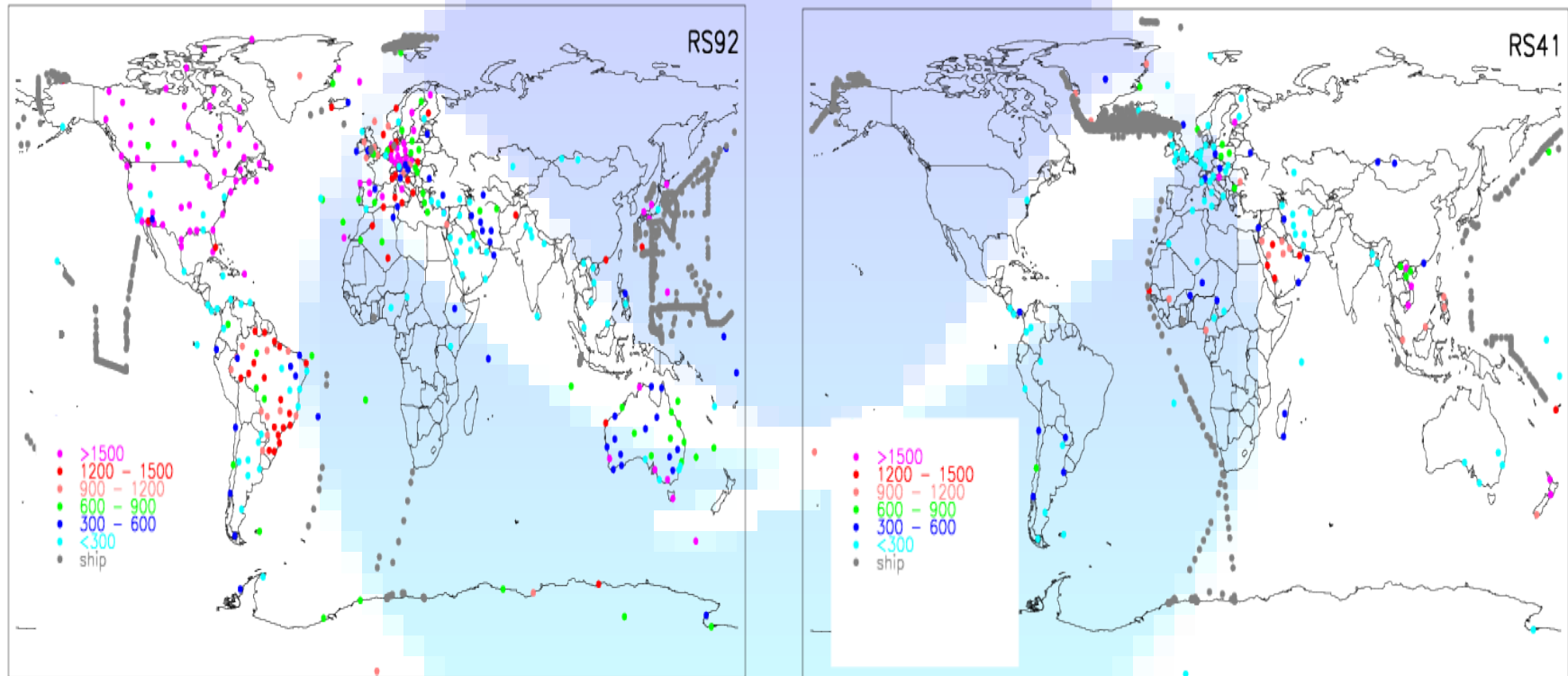
Both sondes are
<1% dry bias in RH

Nighttime VendorRS41 and gdpRS92 show improvement over the daytime ¹³

Summary and path forward

- A robust method to assess GRUAN vs satellite sensor and assess different sonde types in radiance via RTM
- Vendor-RS41 appears to have a dry bias ($\sim 1.5\%$) in the upper troposphere during daytime but shows improvement over gdp RS92 (by $\sim 1\%$ in RH)
- Vendor-RS41 is consistent to iasi measurement especially for nighttime data.
- Analyze gdp- RS41 vs vendor-RS41.
- GRUAN vs. the Cross-track Infrared Sounder (CrIS) on-board NOAA satellites (SNPP, NOAA20).

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



Based on the analysis of 311 500 RS92 and 65 800 RS41 profiles and their collocations with GPSRO (UCAR COSMIC, EU GRAS), and NWP (ECMWF Analysis, NCEP CFSR) for 2015 -2017

RS41 and RS92 agree to each other within 0.1 – 0.2 K in the lower stratosphere.

RS41 appears to be less sensitive to solar elevation change.

Both NCEP and ECMWF data are cold-biased (by 0.3-0.5K) in the lower stratosphere

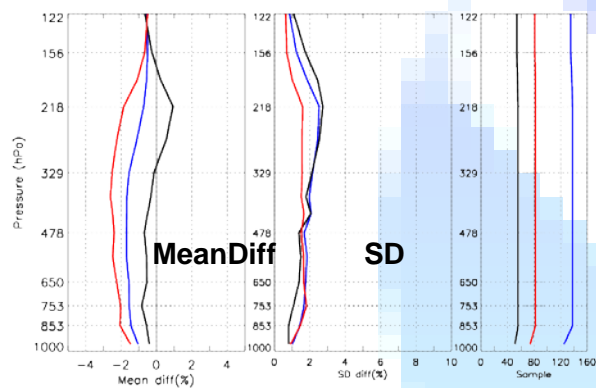


- Many thanks to GRUAN and all the sites performing radiosonde measurements

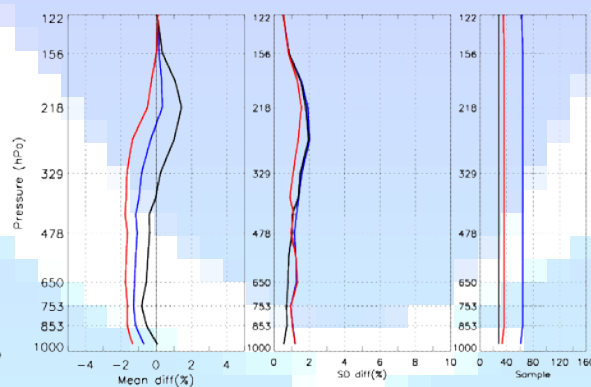
RH RS92-minus-RS41 from duals

— NIGHT (< -7.5 deg)
— DAY (> 7.5 deg)
— ALL

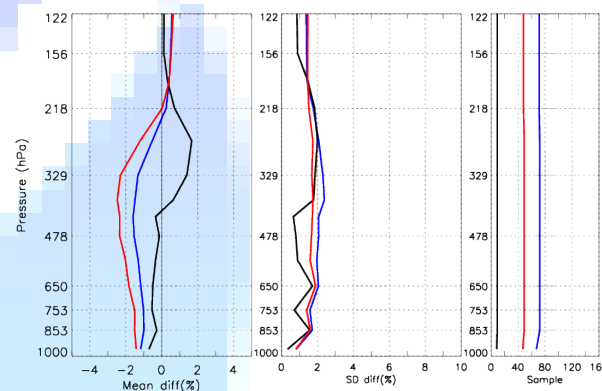
Lindenberg



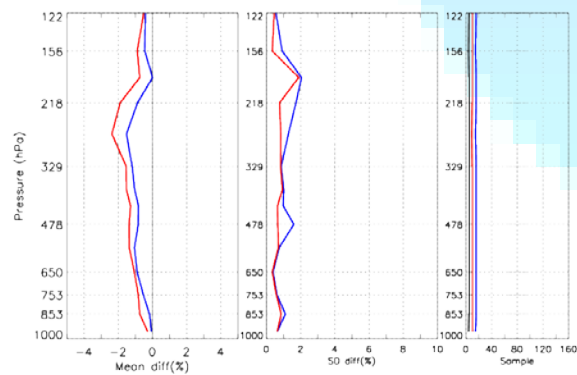
Payerne



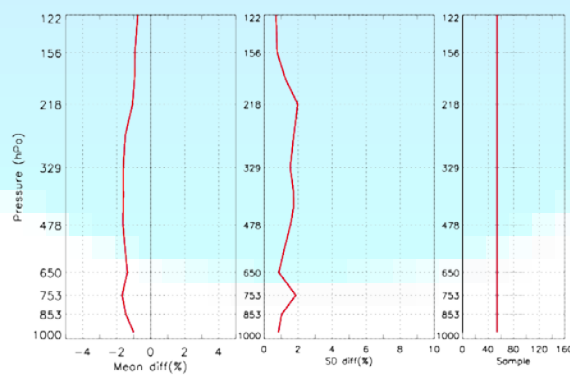
Ny Alesund



Lamont



Lauder



Beltsville

