Integration (*and Assessment*) of Uncertainty in Satellite Profile Cal/Val (NPROVS)

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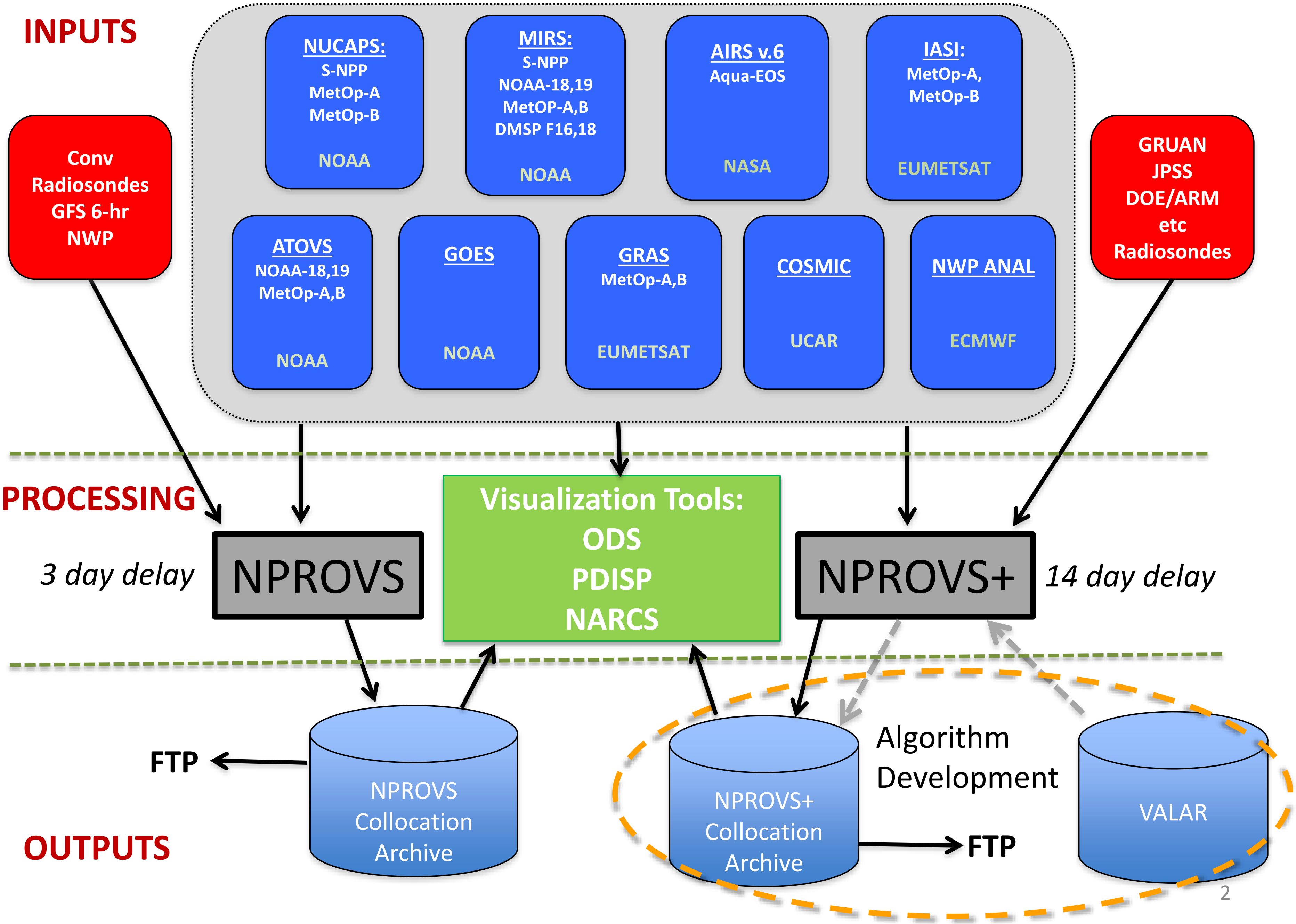
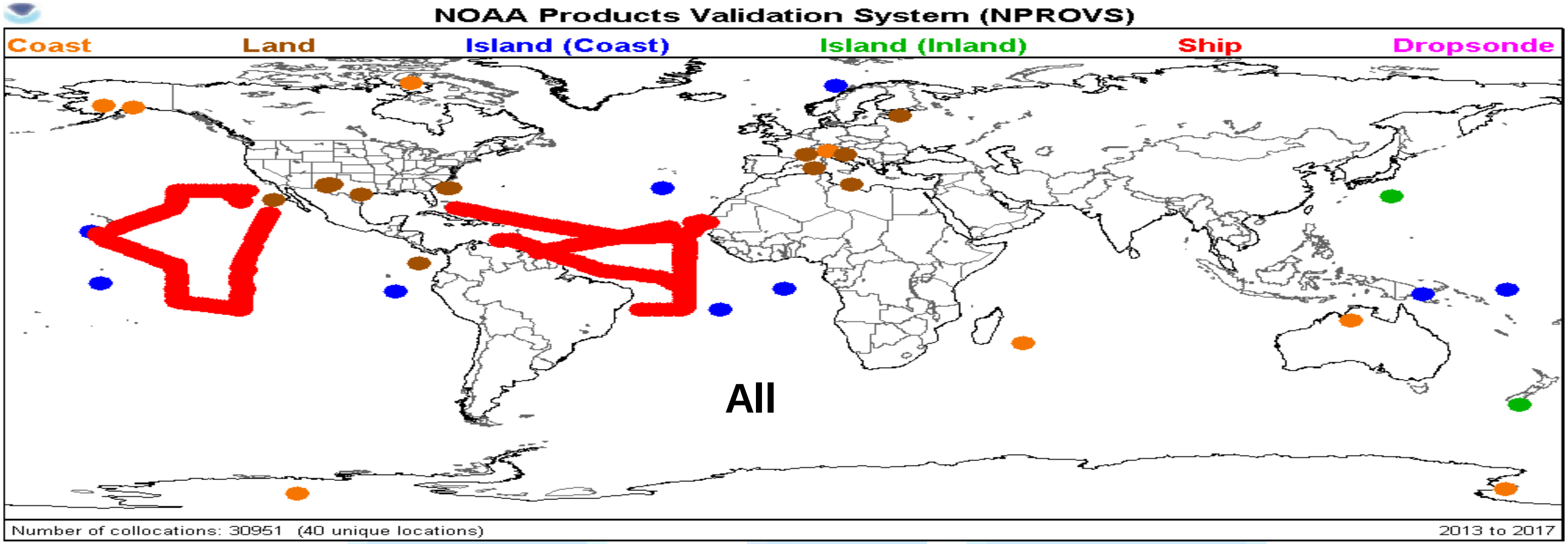
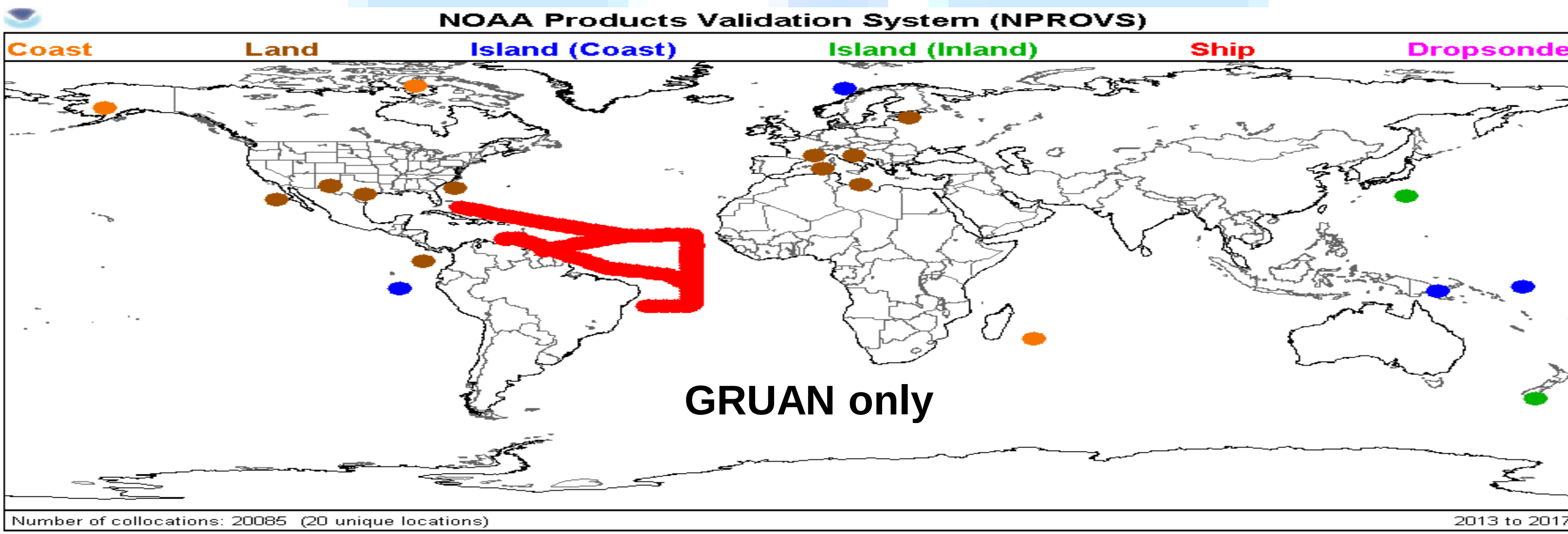
GRUAN ICM-9
June 12-16, 2017
Helsinki, Finland

NPROVS/NPROVS+ Data Management Schematic




NOAA Products Validation System (NPROVS)
Coast
Land
Island (Coast)
Island (Inland)
Ship
Dropsonde
All
Number of collocations: 30951 (40 unique locations)
2013 to 2017


NOAA Products Validation System (NPROVS)
Coast
Land
Island (Coast)
Island (Inland)
Ship
Dropsonde
GRUAN only
Number of collocations: 20085 (20 unique locations)
2013 to 2017

Observations can be used to “test’ the uncertainties… ?

from Immler :

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

for k.le.2, in more than 95% of cases, the uncertainties are likely to be smaller than estimated …

likewise, if k .gt. 2, the uncertainties are likely to be larger than estimated …

If k< 1 …

Approach

1) **ABS (m1 – m2) > k $(\sigma^2 + u1^2 + u2^2)^{1/2}$**

2) **"k" = ABS (m1 – m2) / u2**

for k=2 … agreement:

3) $\sigma^2 + u1^2 = ((\text{"k"}/2)^2 - 1)\,(u2)^2$

4) **$u1 = ((\text{"k"}/2)^2 - 1)^{1/2}\,(u2)$**

… given u2, quantify the $(\sigma^2 + u1^2)$ required for consistent observations … or worst case estimate of u1

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for moisture:

1) u2 = u2 (RH) x Saturation (MR @T)

2) MR (%) = (SAT (MR)-minus-GRUAN (MR)) / GRUAN (MR)

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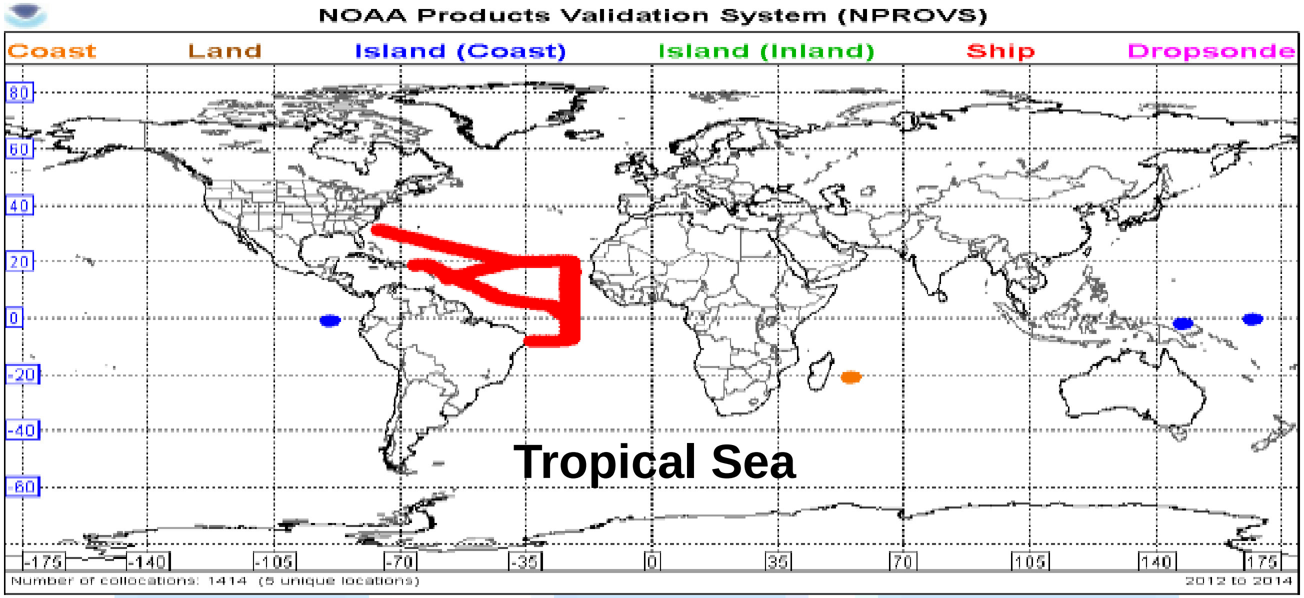
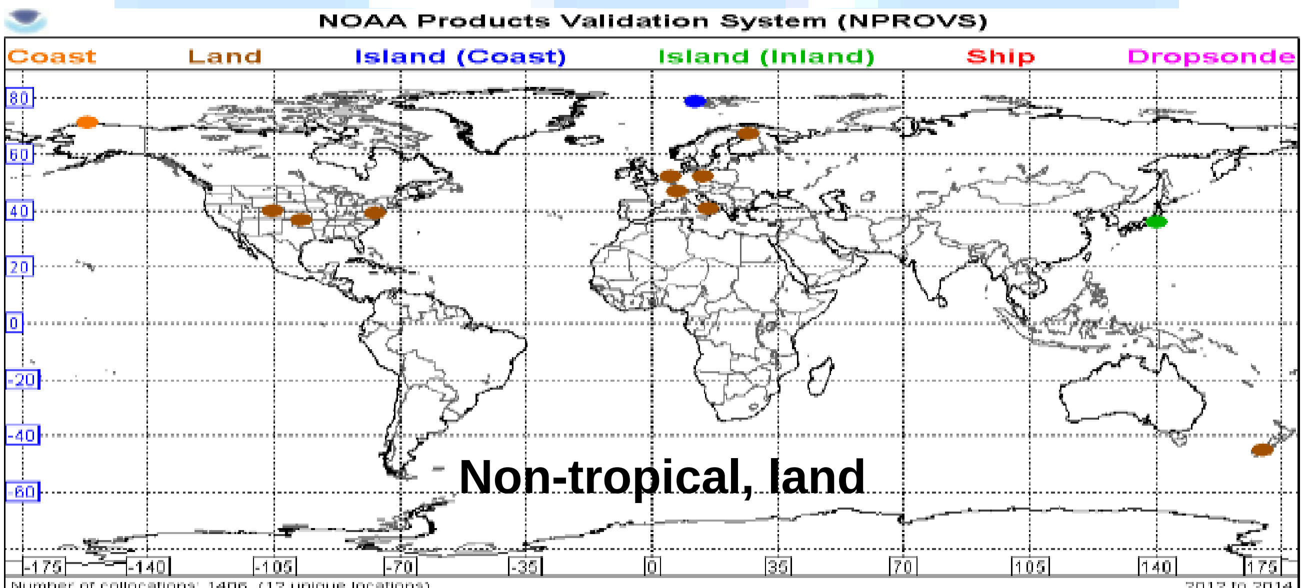




GEWEX Water Vapor Assessment … GVAP-5 … ***Schroder et.al***

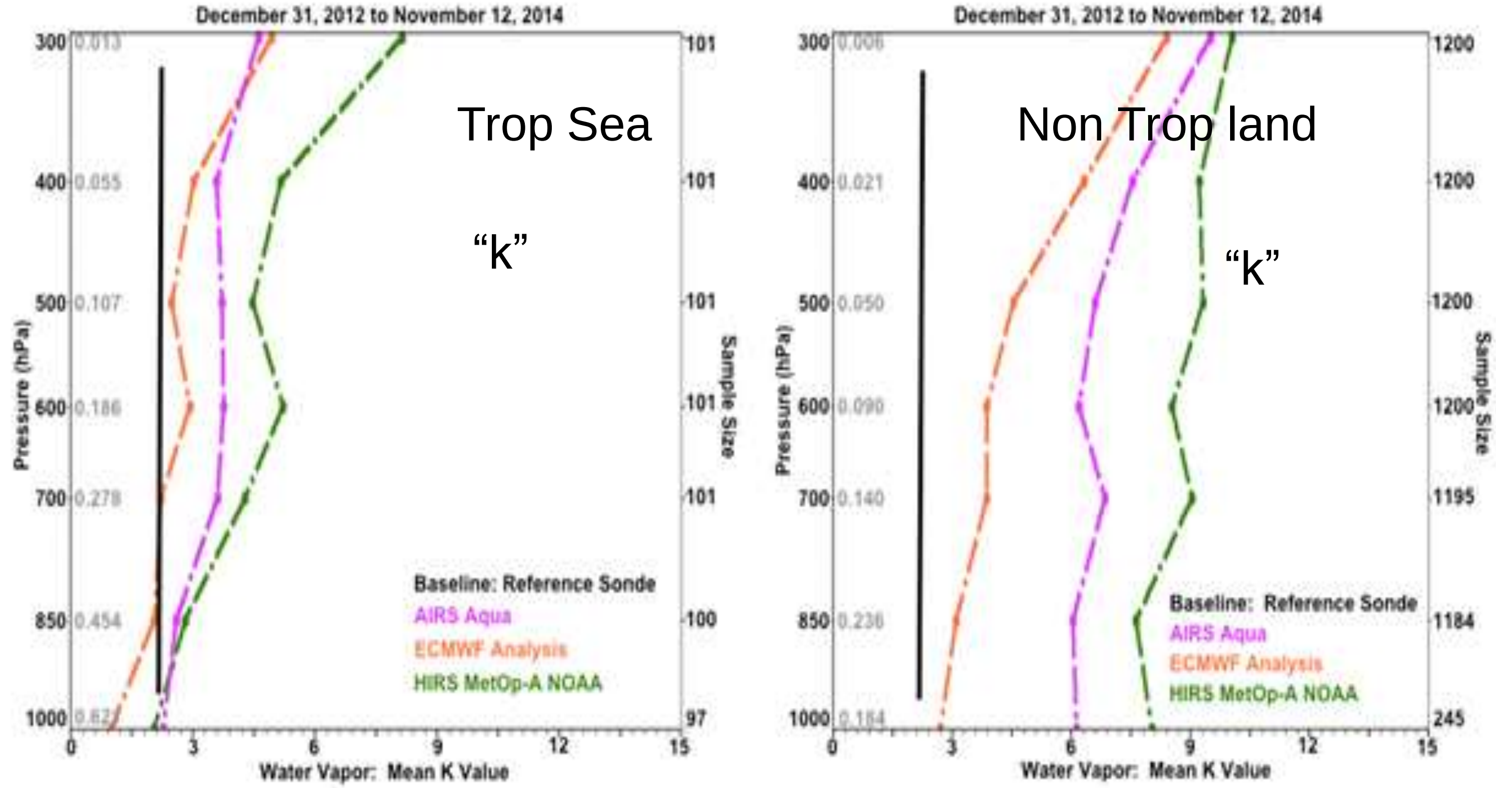
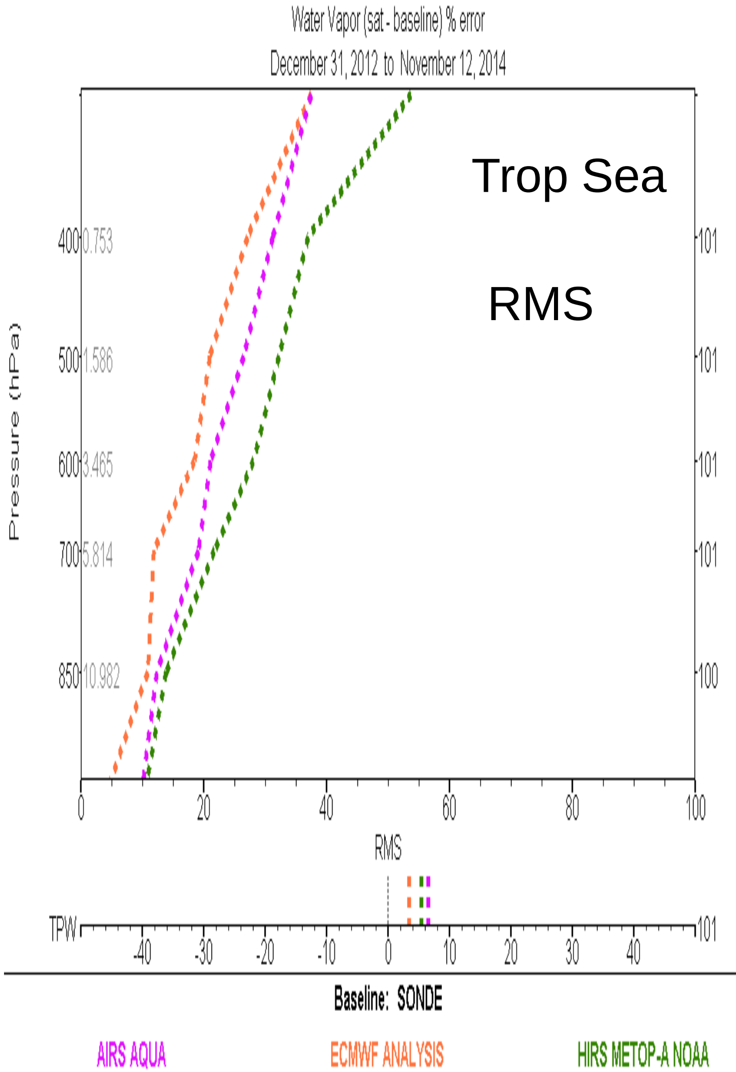
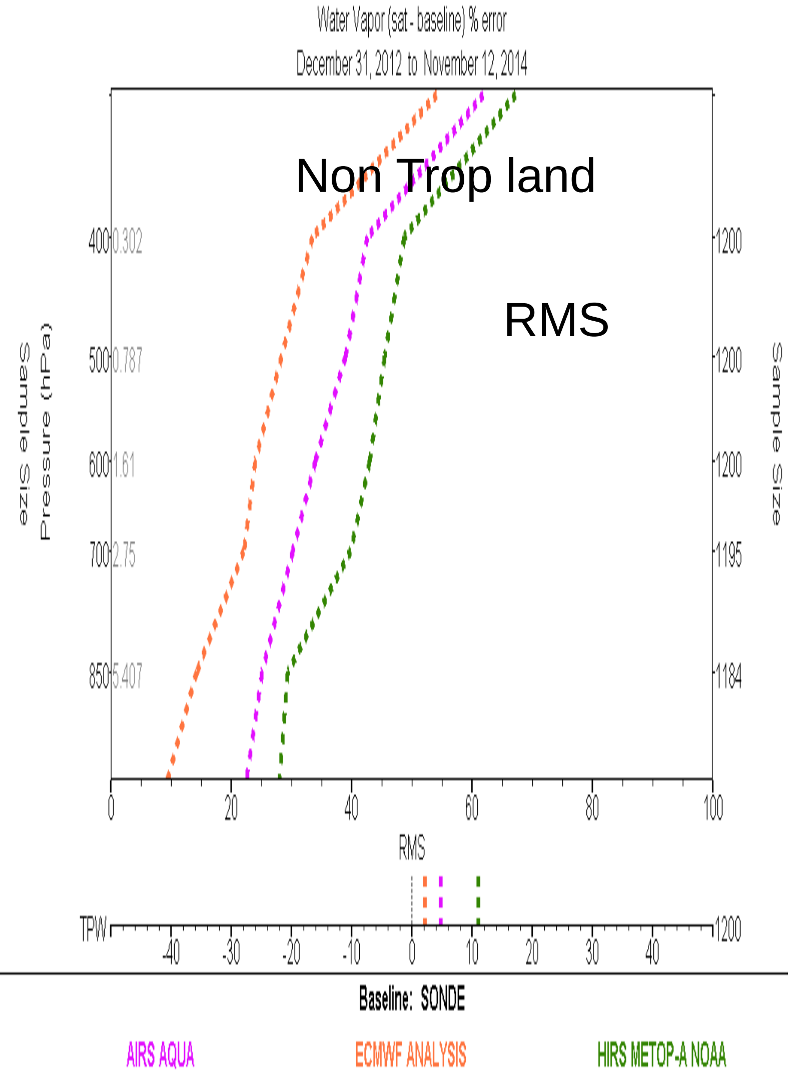


Figure 6: Mean “k” vertical profile using equation (3) for collocated GRUAN radiosonde, HIRS from Metop-A (green), Aqua AIRS v.5 which passed QC (purple) and the ECMWF Analysis (orange) over tropical sea (left) and non-tropical land (right) with GRUAN mean MR uncertainty along inside left and sample size along right axes; black line denotes k=2

GEWEX Water Vapor Assessment … ***GVAP-5 Final Report, Schroder et.al***


Water Vapor (sat - baseline) % error
December 31, 2012 to November 12, 2014
Trop Sea
RMS
Pressure (hPa)
Sample Size
400 0.753
500 1.586
600 3.465
700 5.814
850 10.982
101
101
101
101
100
RMS
TPW
101
Baseline: SONDE
AIRS AQUA
ECMWF ANALYSIS
HIRS METOP-A NOAA


Water Vapor (sat - baseline) % error
December 31, 2012 to November 12, 2014
Non Trop land
RMS
Pressure (hPa)
Sample Size
400 0.302
500 0.787
600 1.61
700 2.75
850 5.407
1200
1200
1200
1195
1184
RMS
TPW
1200
Baseline: SONDE
AIRS AQUA
ECMWF ANALYSIS
HIRS METOP-A NOAA

Uncertainty summary table (tropic sea)

Tropical, Sea	HIRS	IASI / HIRS	AIRS / HIRS / ECMWF
300 hPa	0.061 0.175 0.014 9.0	0.051 / 0.061 0.172 0.013 8.1 / 9.6	0.025 / 0.052 / 0.028 0.166 0.013 4.4 / 8.3 / 4.8
500 hpa	0.23 1.87 0.115 4.5	0.18 / 0.23 1.68 0.113 3.8 / 4.5	0.18 / 0.20 / 0.09 1.59 0.107 3.9 / 4.4 / 2.3
700 hpa	0.59 5.51 0.272 4.8	0.46 / 0.56 5.52 0.268 4.0 / 4.6	0.46 / 0.53 / 0.16 5.63 0.273 3.9 / 4.4 / 2.3
1000 hPa	--- 16.6 0.651 1.9	--- / 0.49 12.9 0.537 1.6 / 2.7	0.20 / --- / --- 16.0 0.626 2.1 / 1.7 / 1.0

Table 1: Each element (box) includes four sets of mean values for:

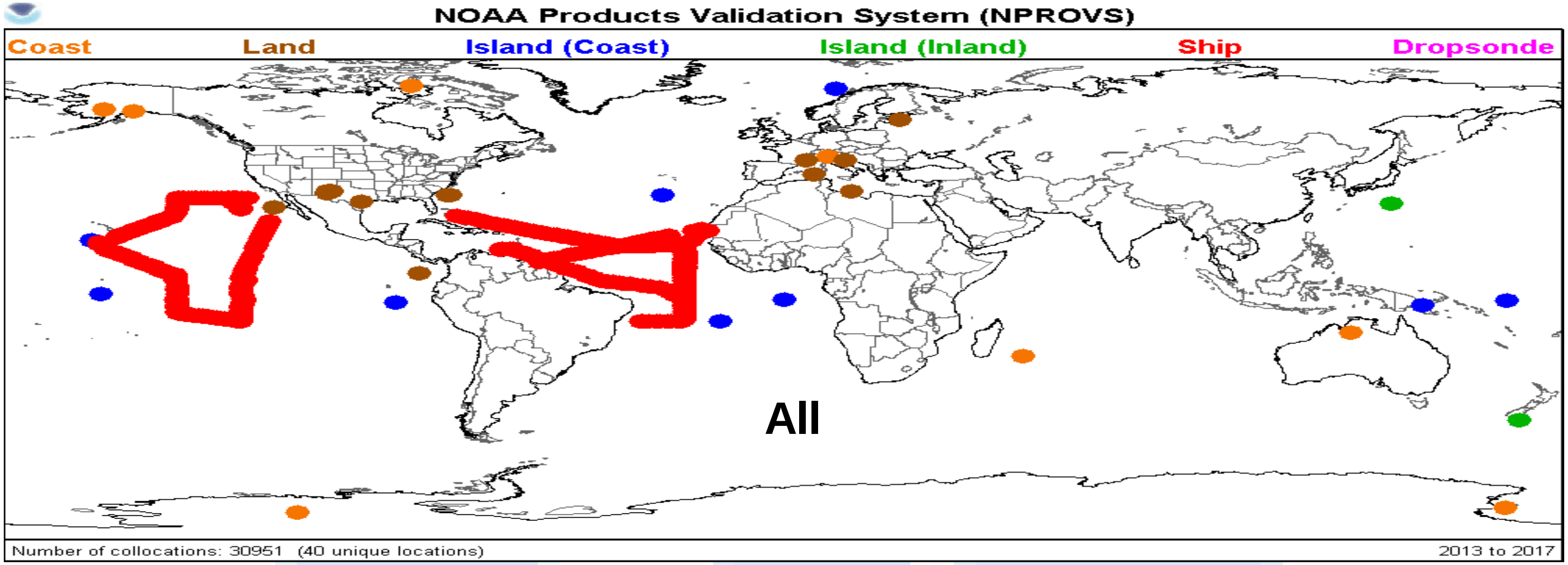
Satellite (and ECMWF) MR uncertainties using (6),

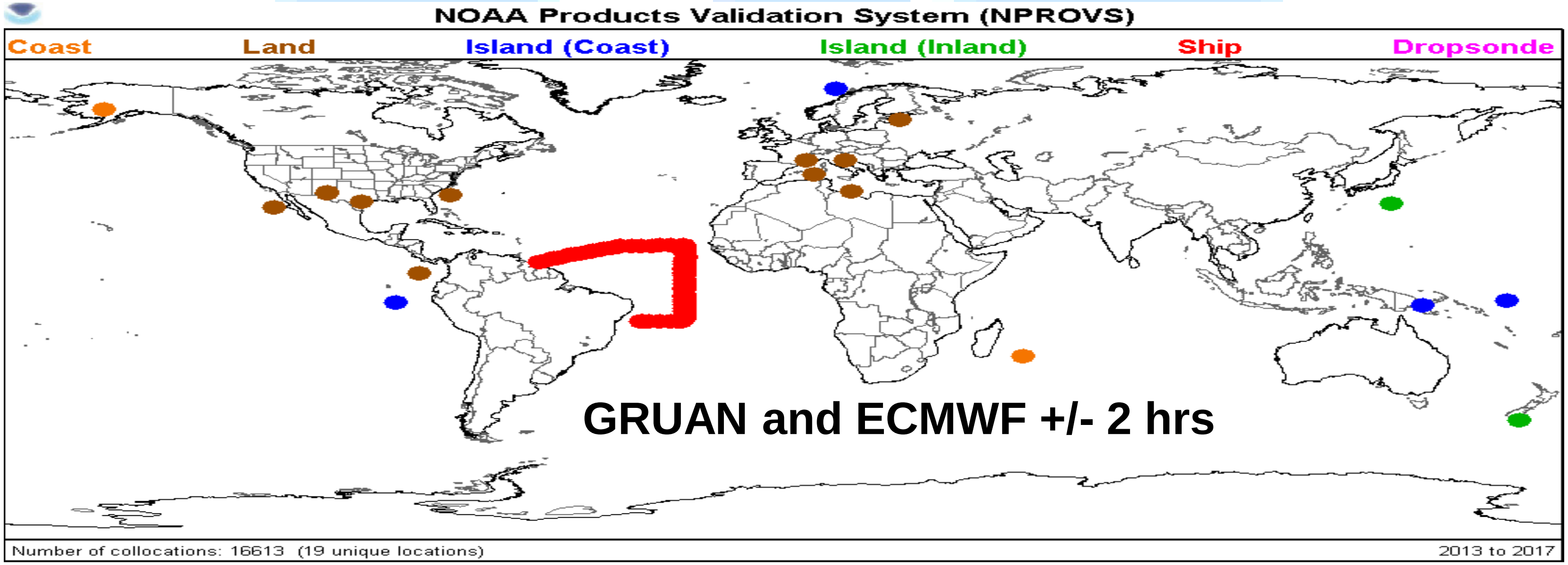
GRUAN MR (g/kg),

GRUAN MR uncertainty

“k” value

GEWEX Water Vapor Assessment … *GVAP-5 Final Report, Schroder et.al*





ECMWF Uncertainty Assessments using NPROVS+)

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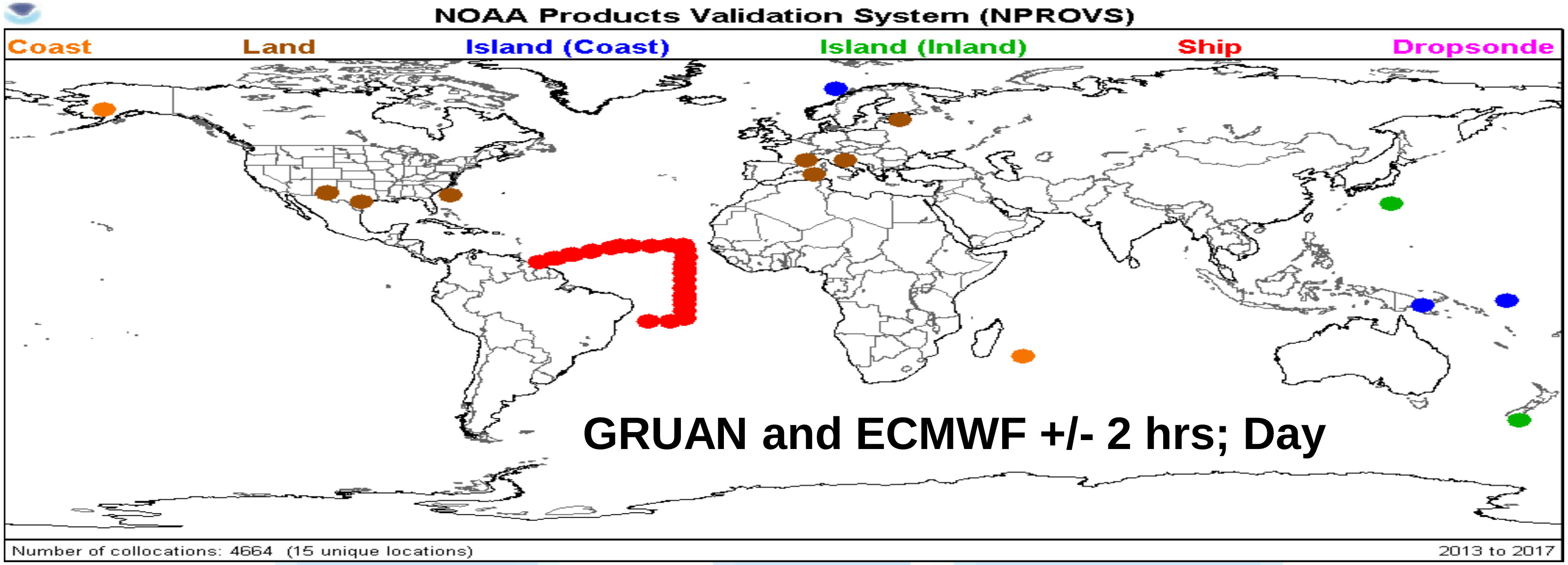

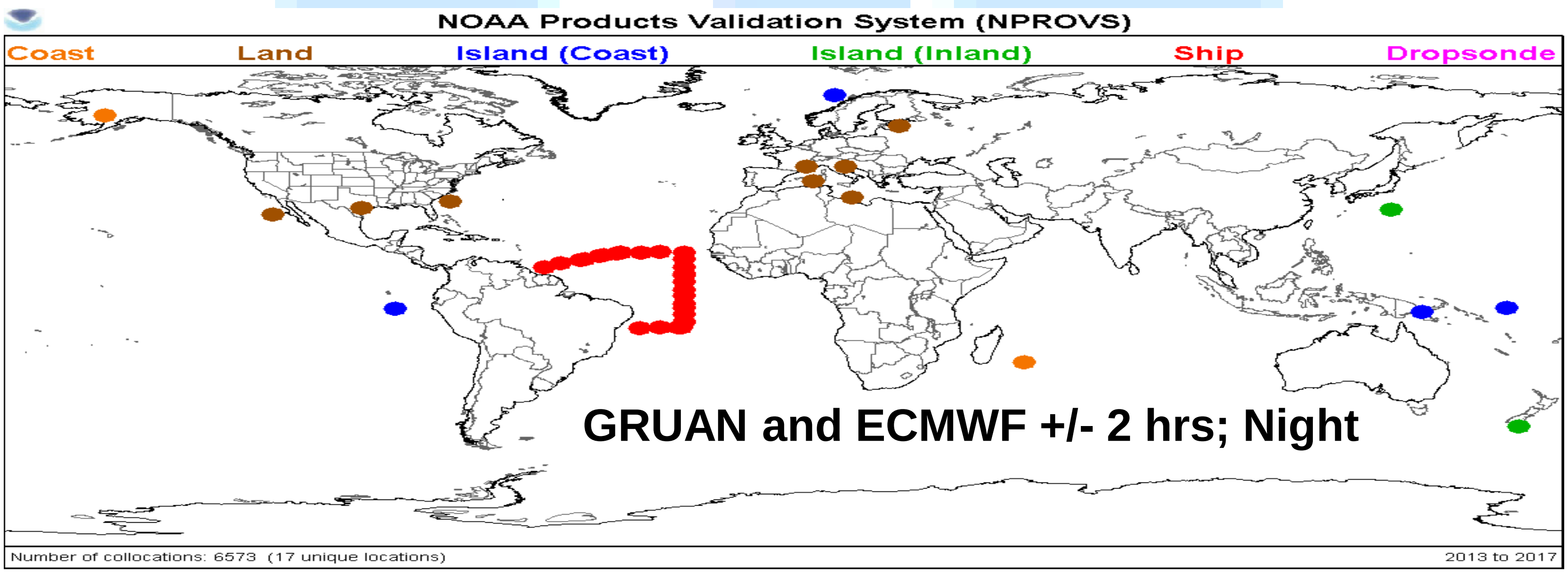

ECMWF Uncertainty Assessments using NPROVS+)

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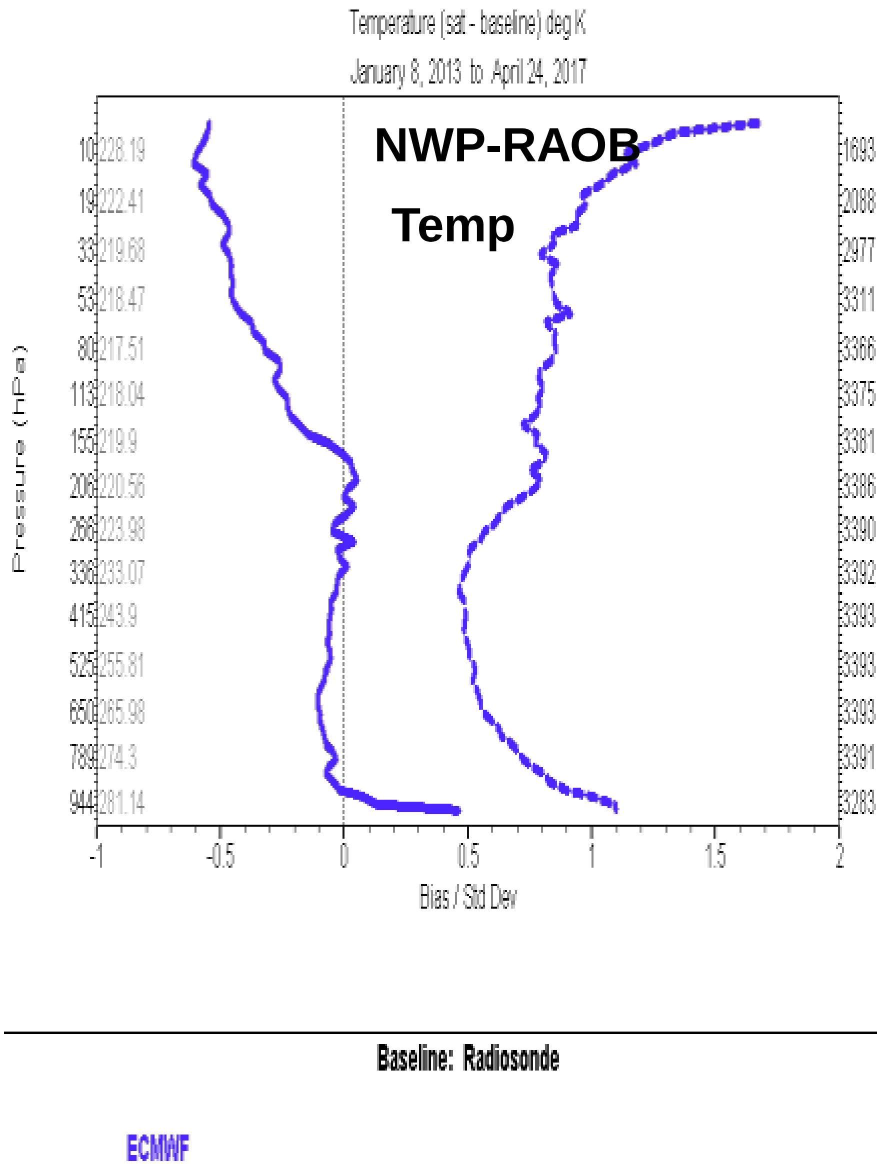
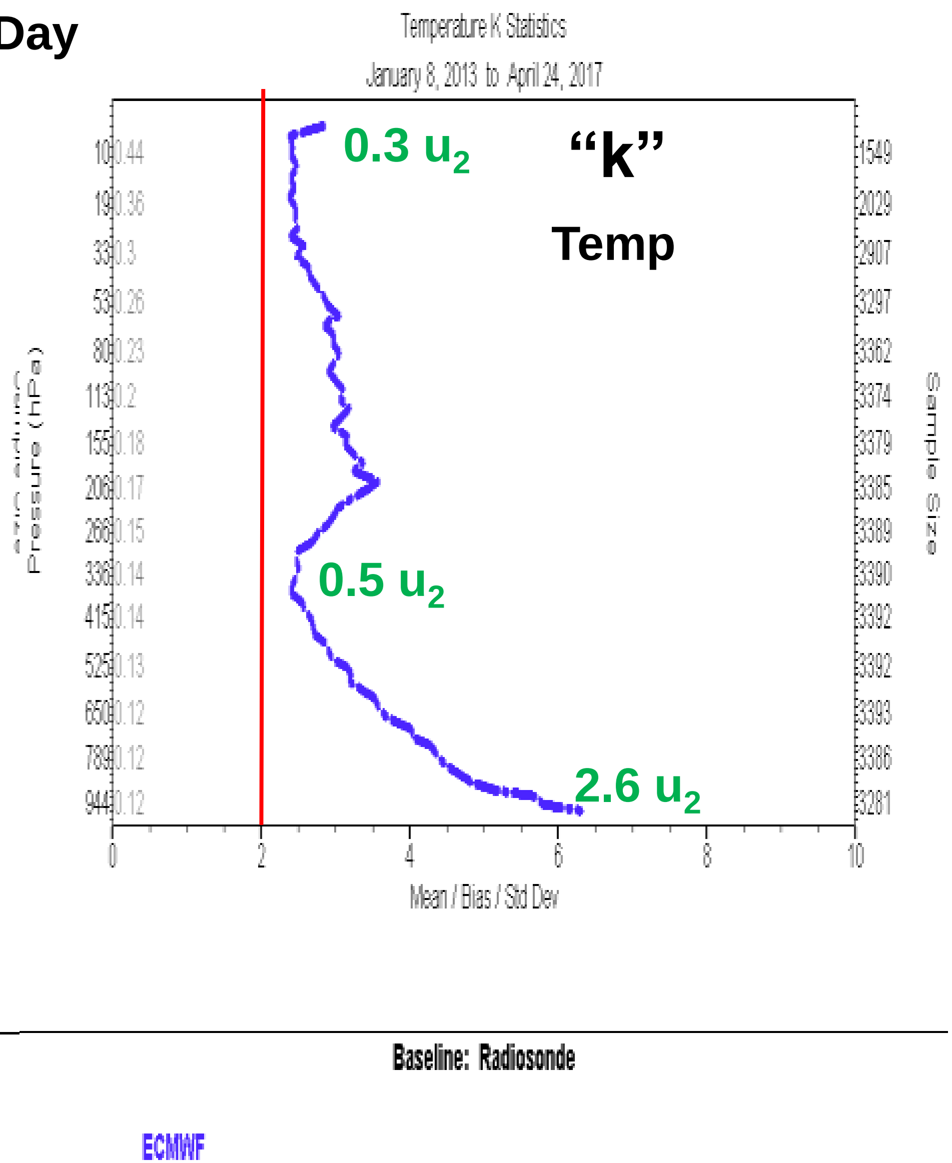
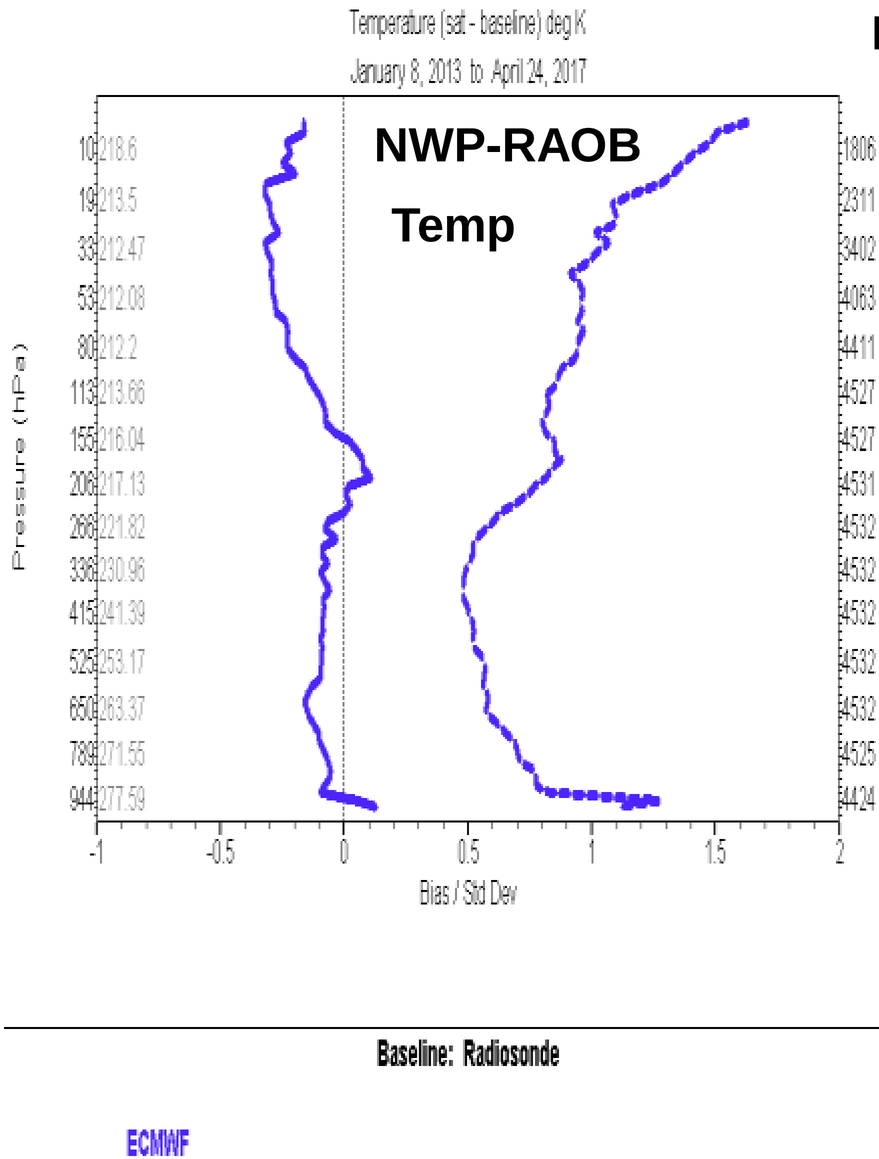


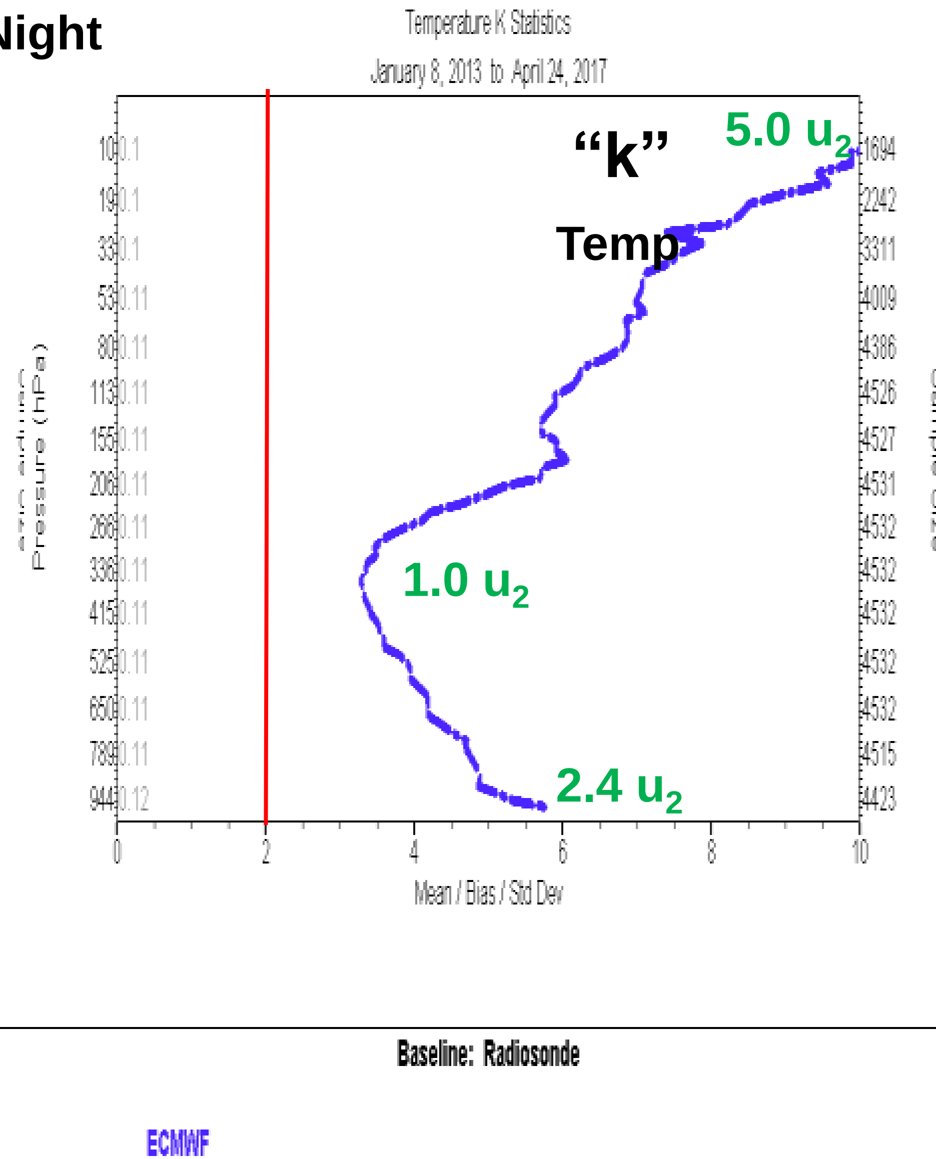
Day



ECMWF Uncertainty Assessments using NPROVS+)

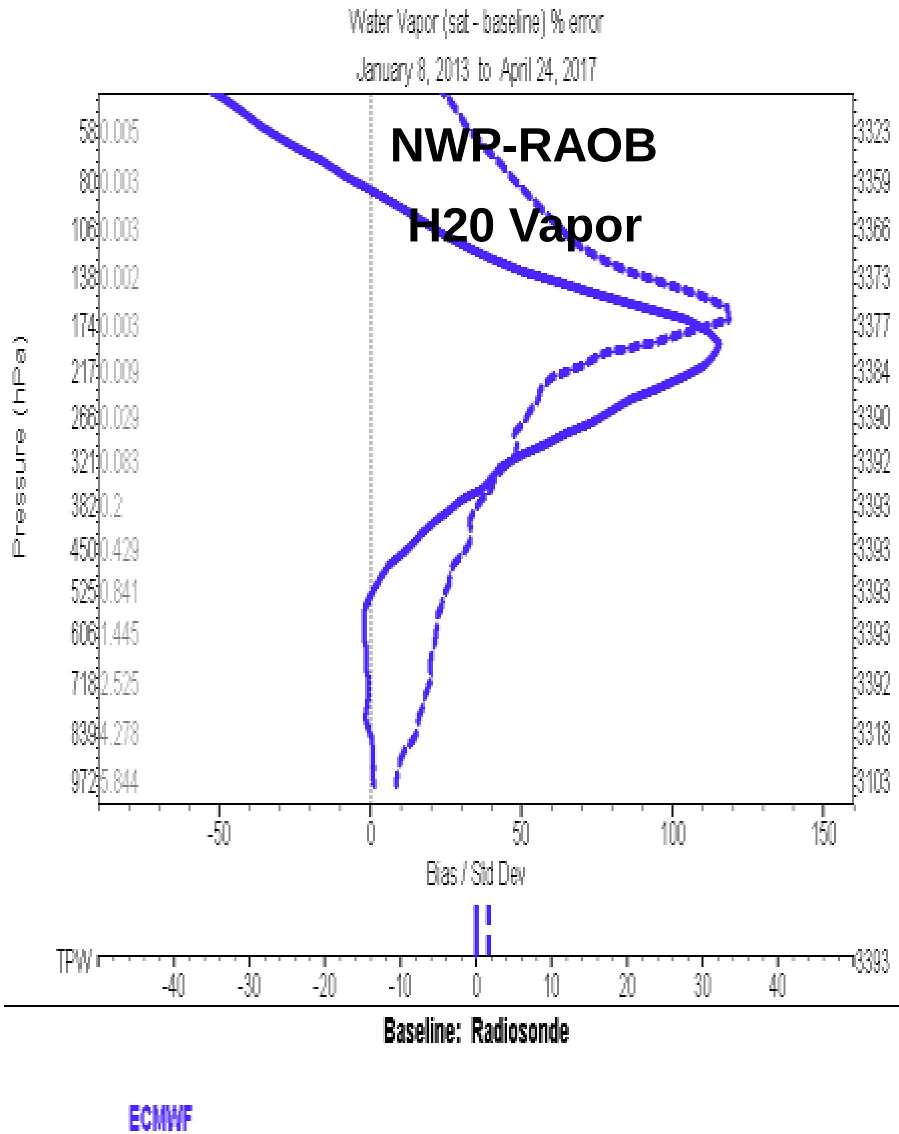
Night

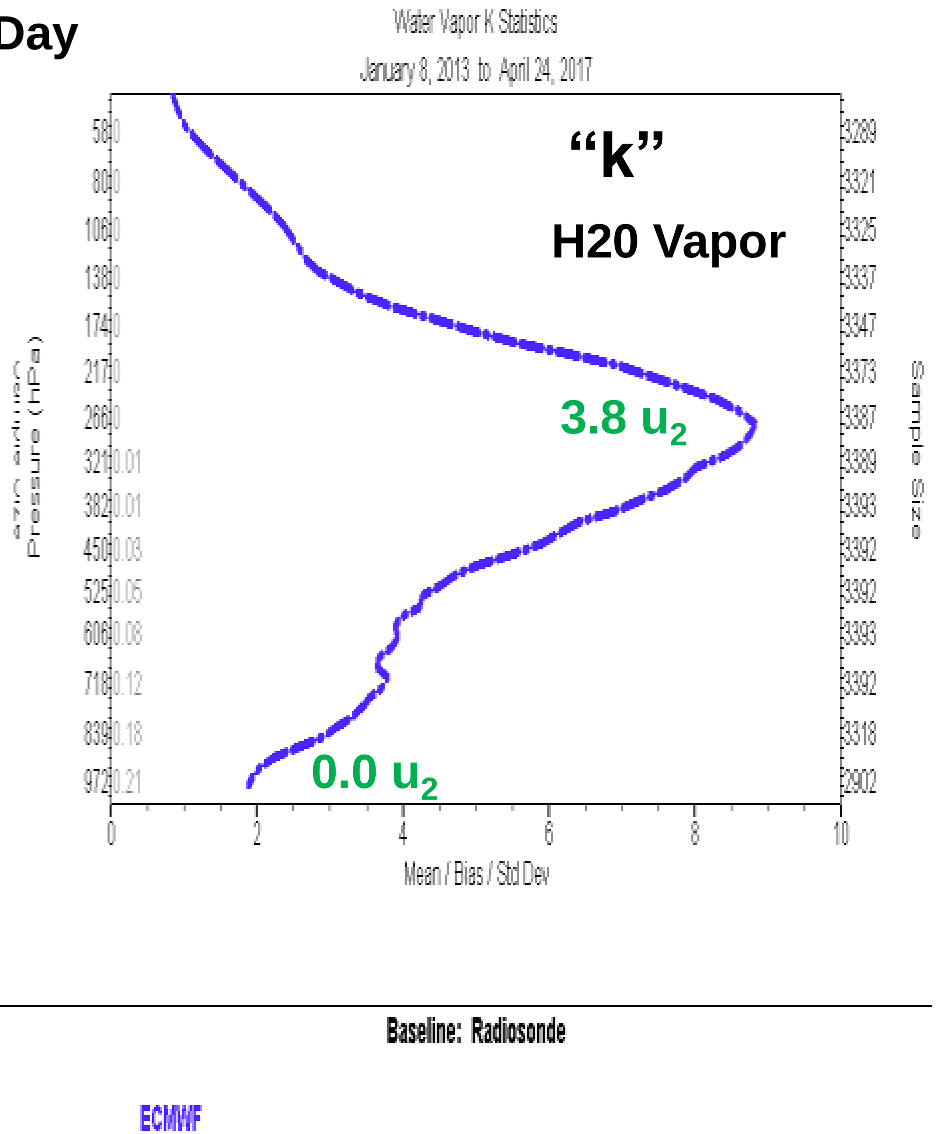




ECMWF Uncertainty Assessments using NPROVS+)

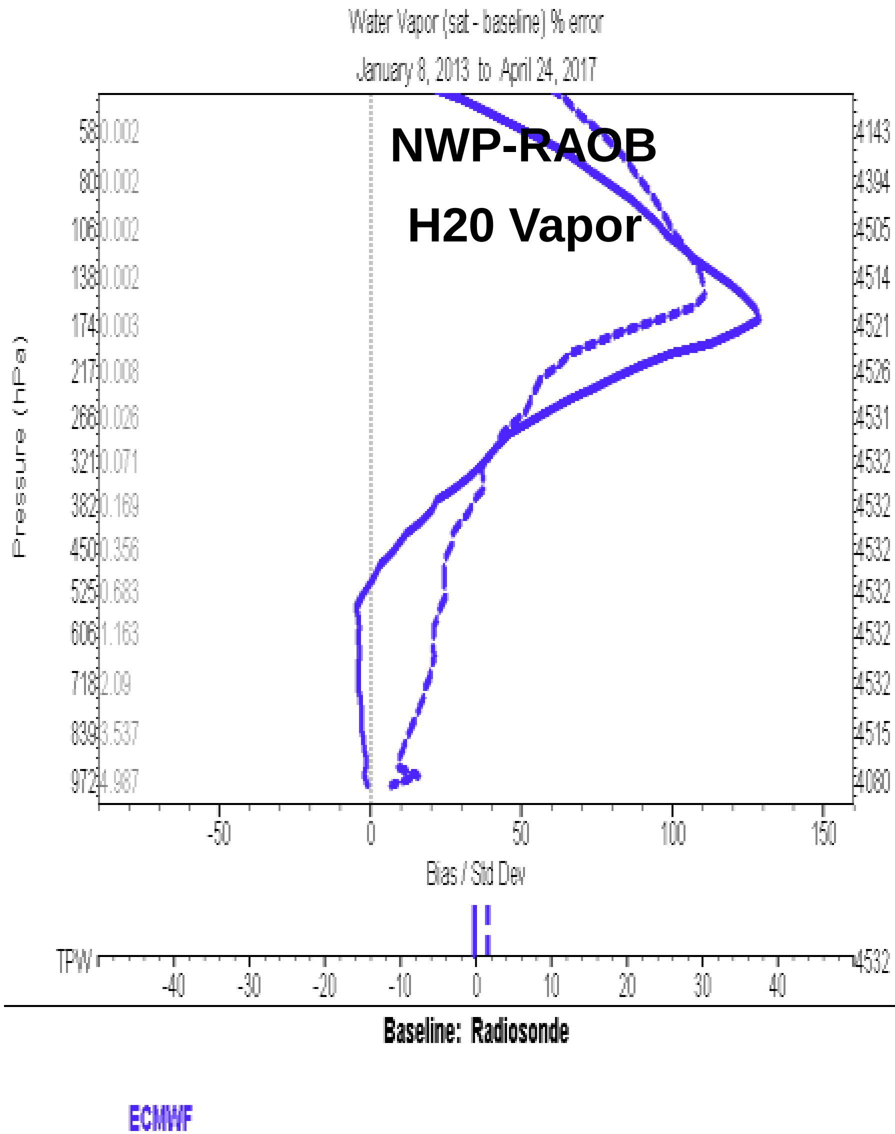
Day

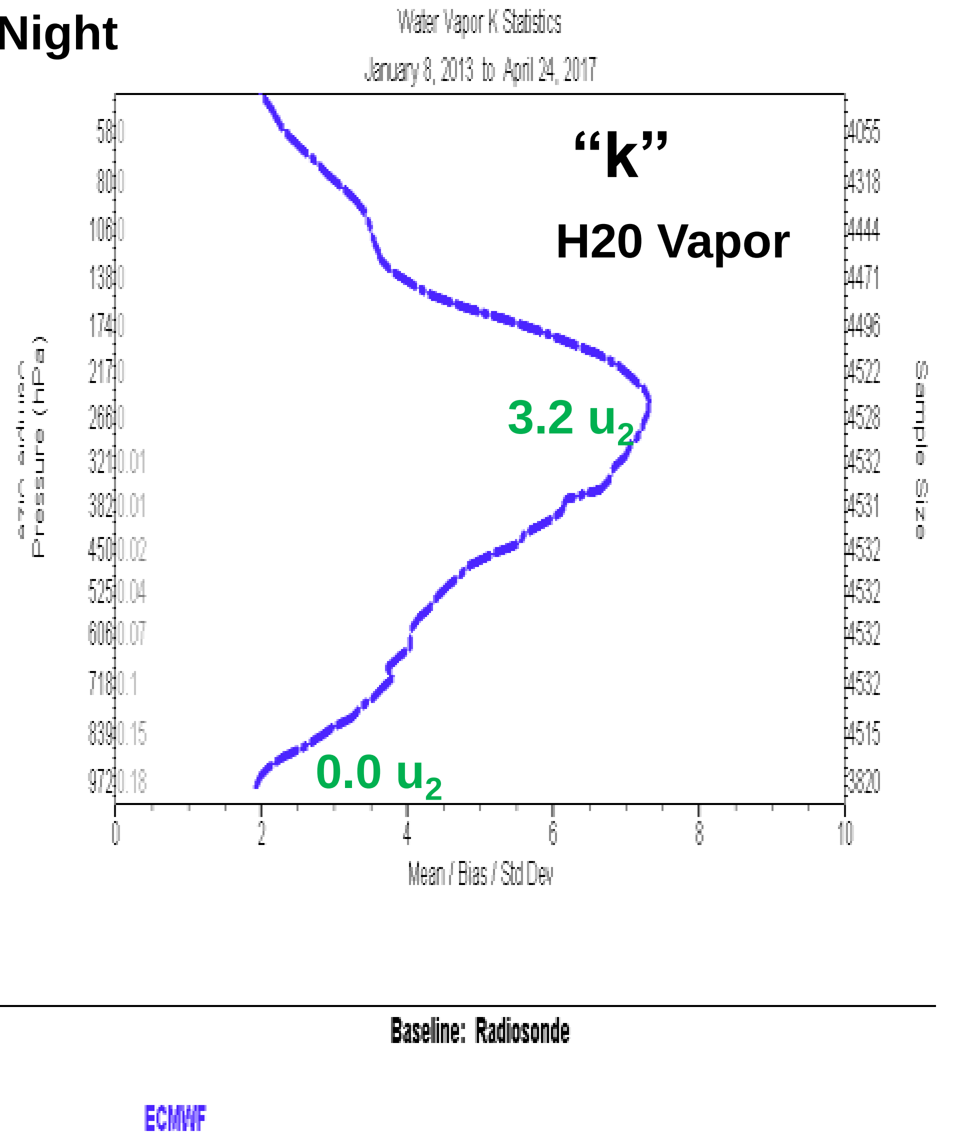




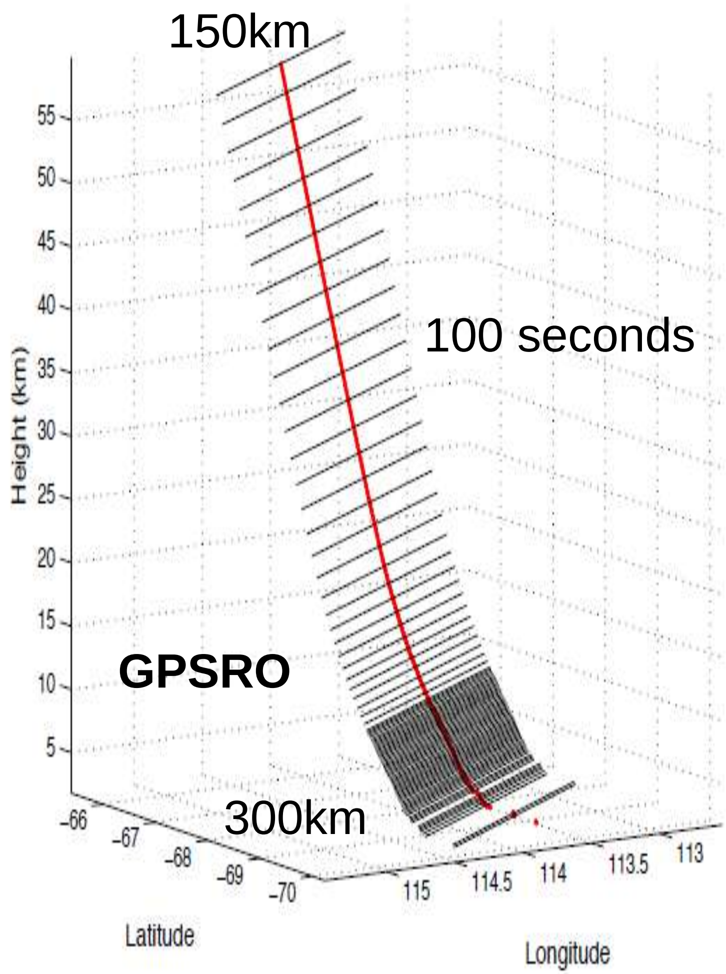
ECMWF Uncertainty Assessments using NPROVS+)

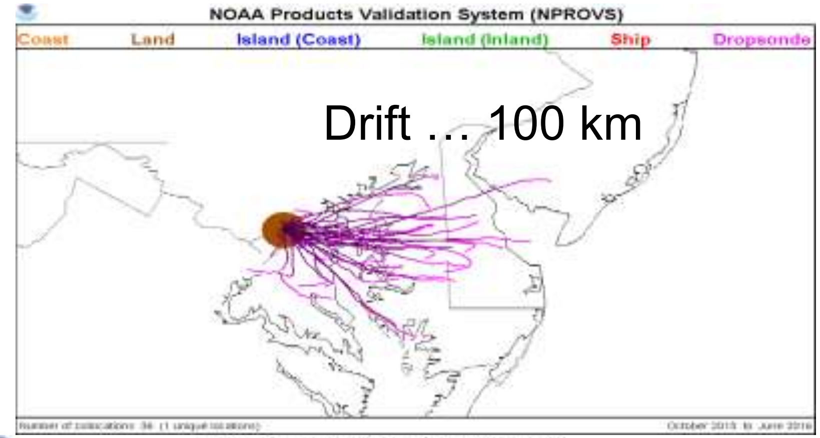
Night

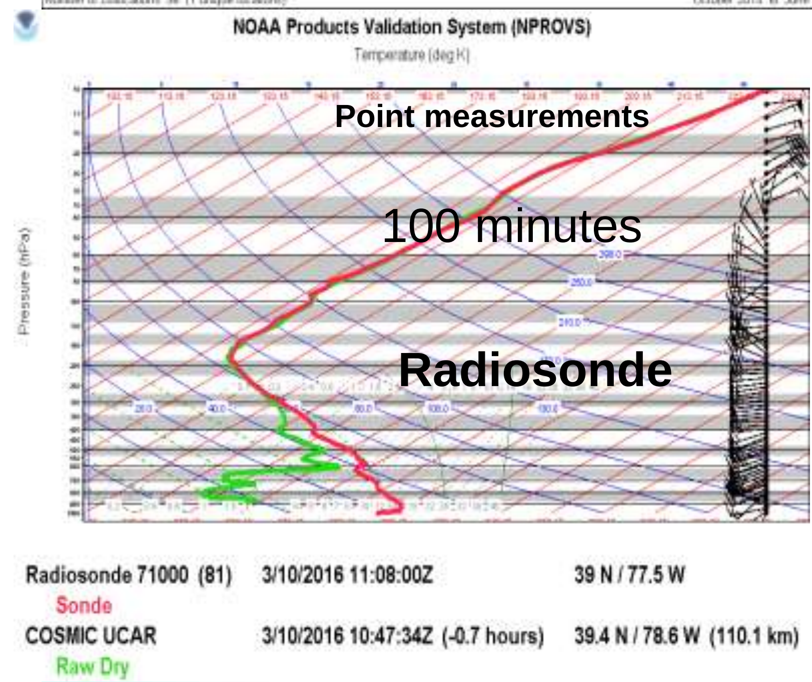




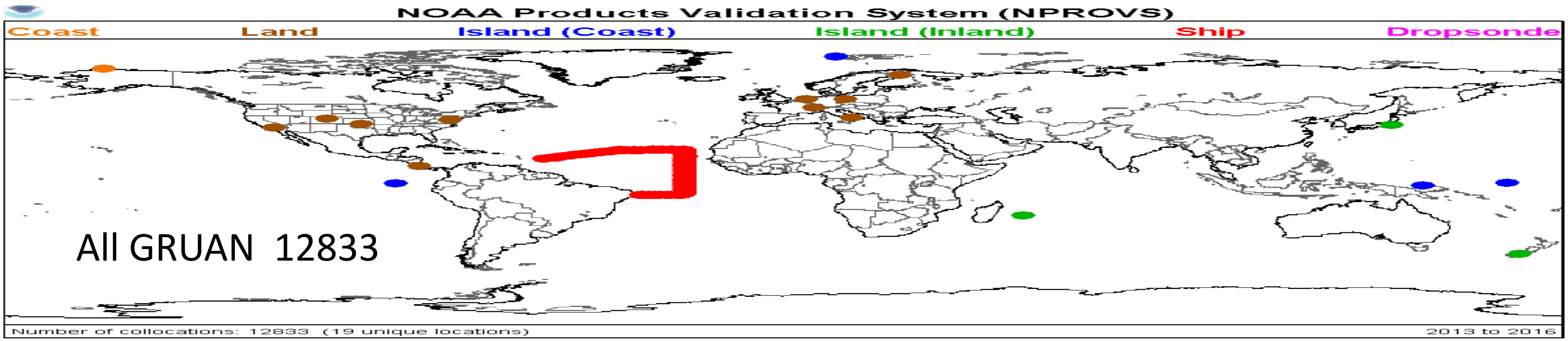
ECMWF Uncertainty Assessments using NPROVS+)

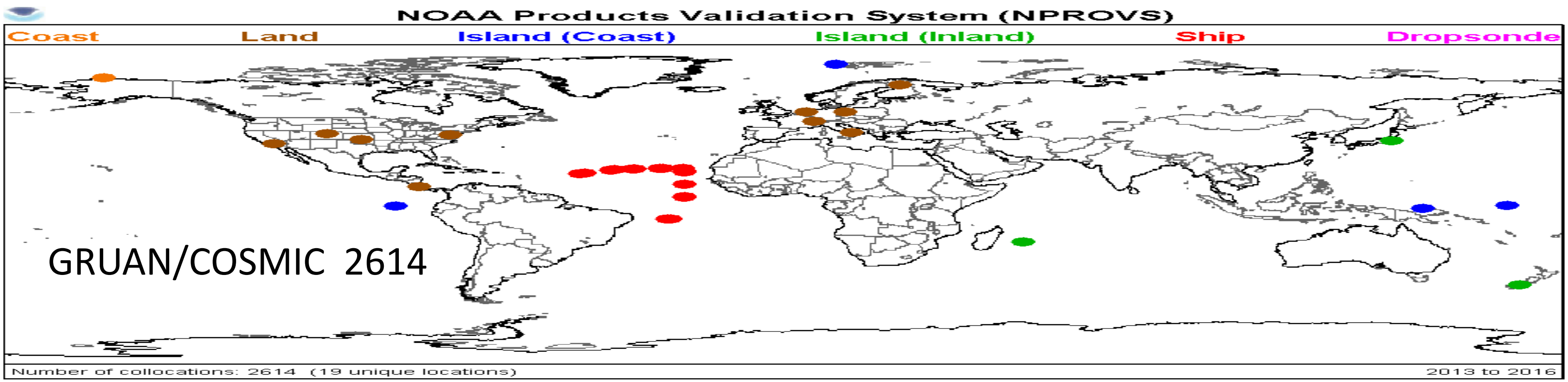


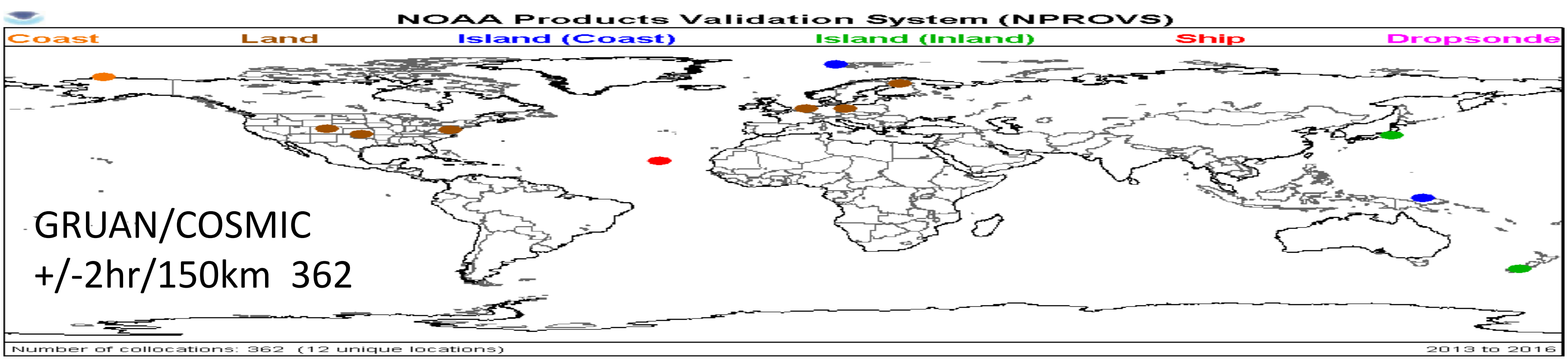




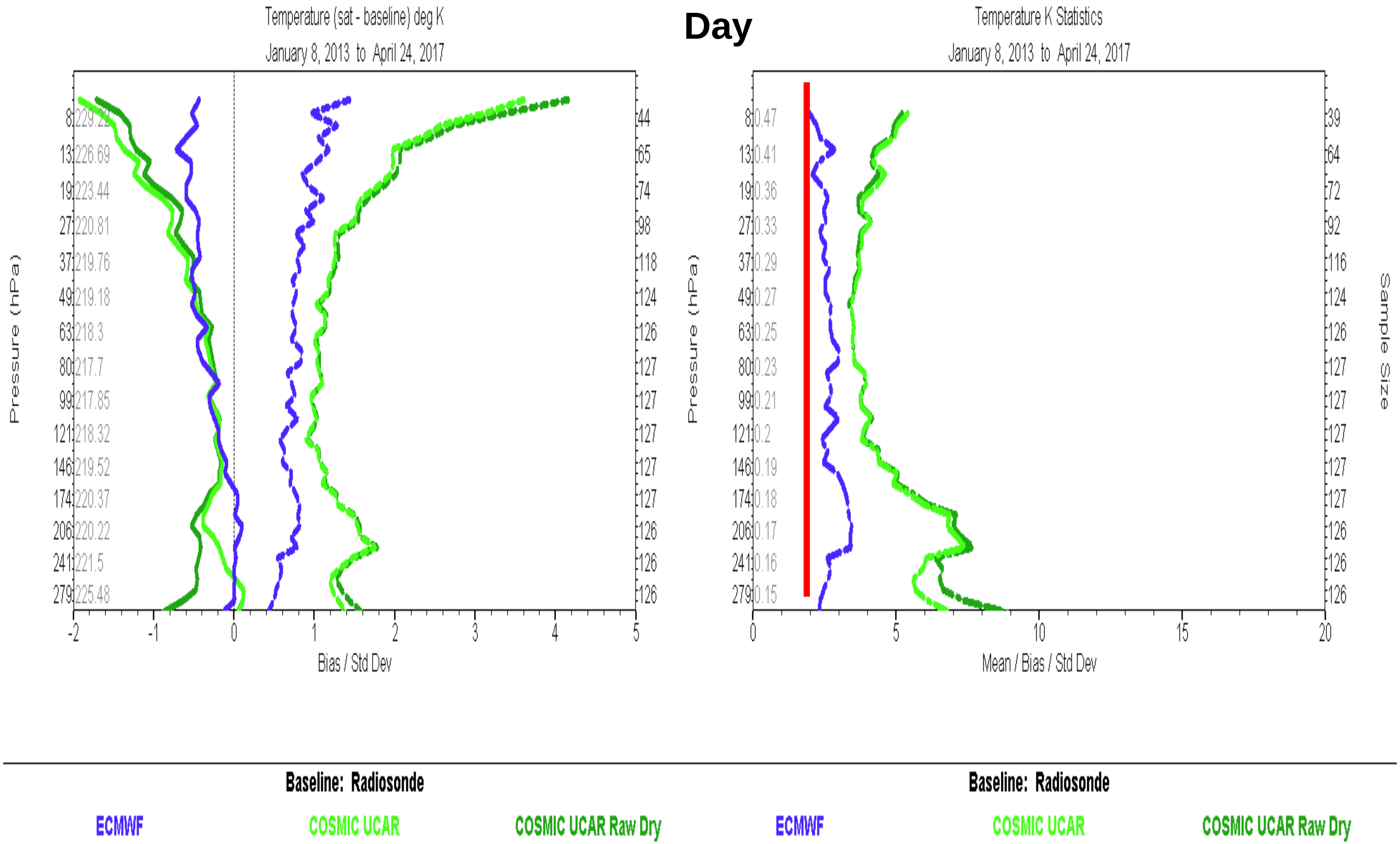
" σ "   term for RAOB vs satellite platforms can be significant even if observations timely







GRUAN collocations with COSMIC GPSRO (*or GRAS*)



GRUAN collocations with COSMIC GPSRO (*or GRAS*)

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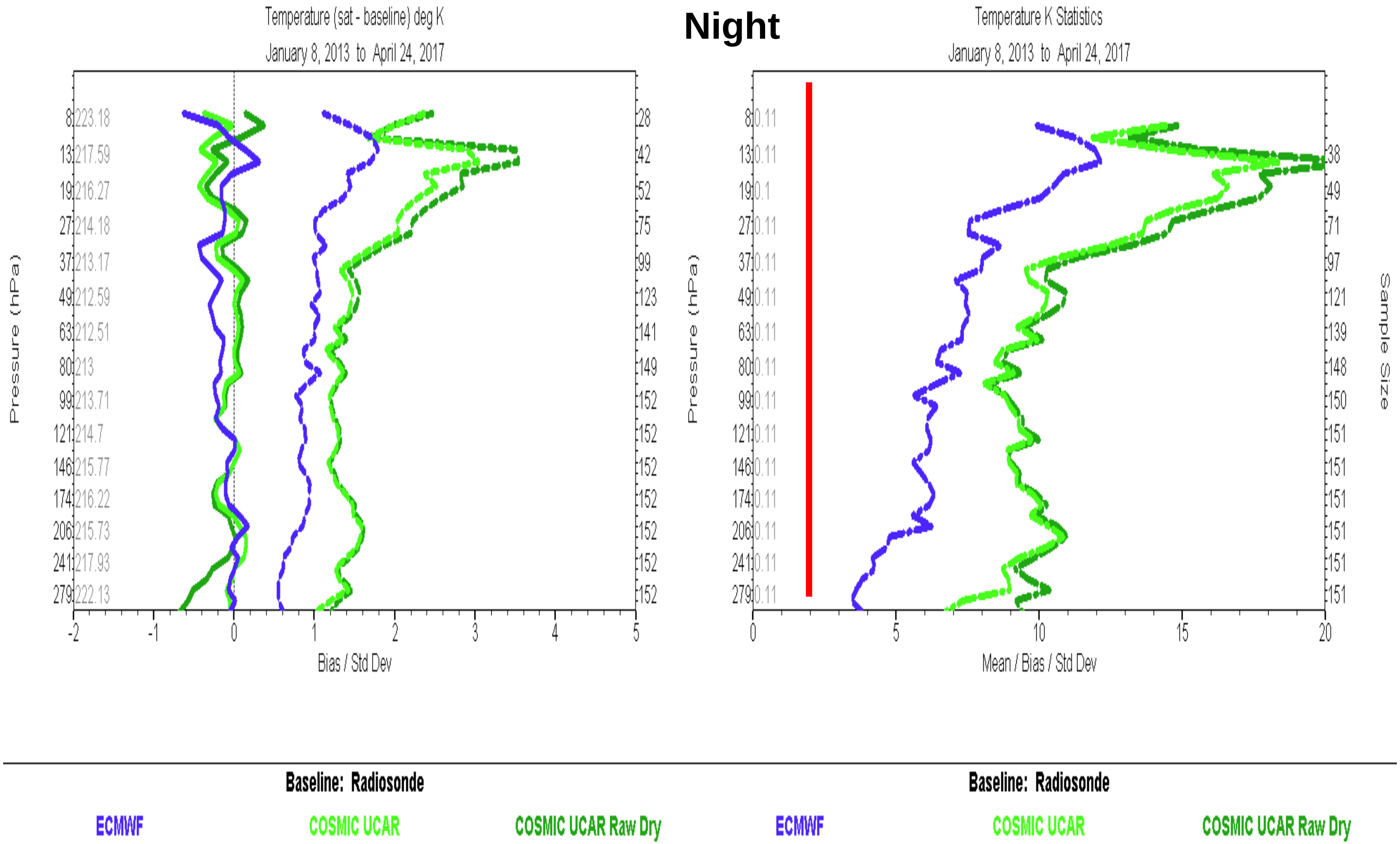
Night



GRUAN collocations with COSMIC GPSRO (*or GRAS*)

GSICS/GRUAN Actions from March 2017 Annual GSICS Meeting

Action: GMW.2017.6f.2: Tony Reale (NOAA) to provide a draft of uncertainty analysis examples to monitor satellite microwave instruments using GRUAN observations (radiosonde) – *by the next annual meeting*
Cheng-zhi Zou, Bomin Sun, Isaac Moraldi, Viju John, Vinia Mattioli, Mark Liu, Ralph Peterson …

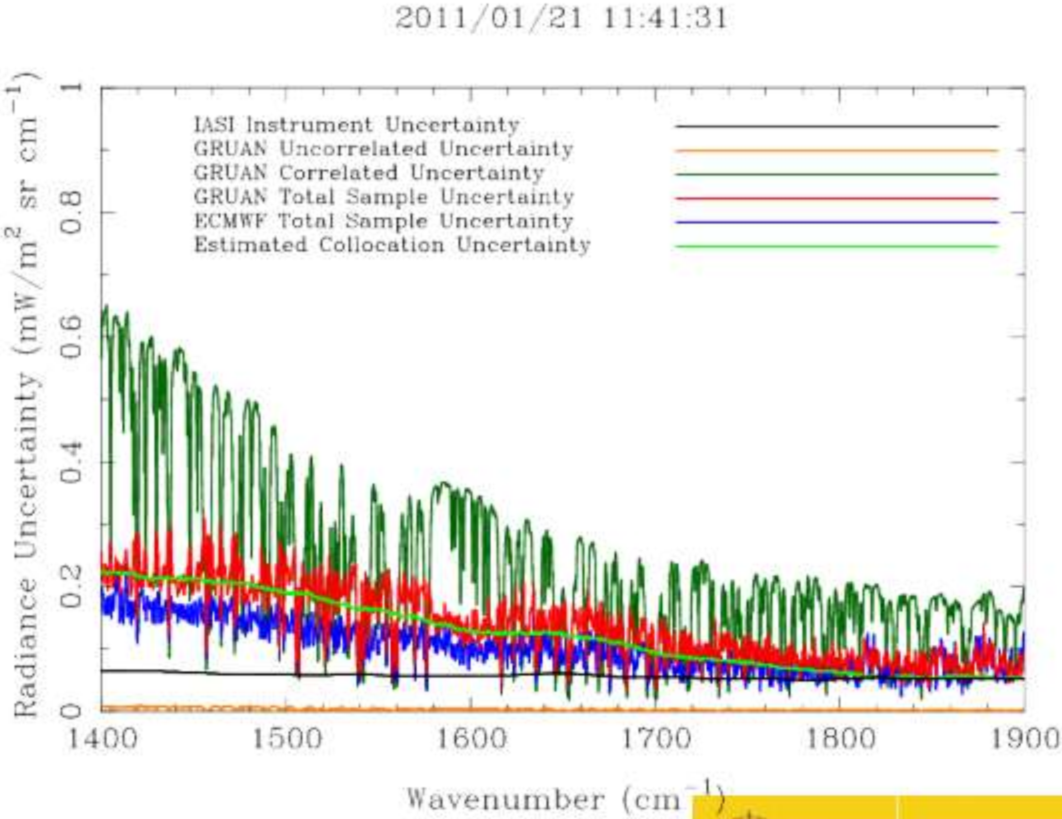
Action: GIR.2017.7d.1: Tony Reale (NOAA) to provide a draft of uncertainty analysis examples to monitor satellite infra-red instruments using GRUAN observations (radiosonde) – *by the next annual meeting*
Xavier Calbet, Bomin Sun, Isaac Moraldi, Tim Hewison, Nick Nalli …

Volunteers from GRUAN community solicited

UPDATE on: Consistency for water vapour of GRUAN, LBLRTM and IASI

Xavier Calbet (xcalbeta@aemet.es)

Radiation Uncertainties



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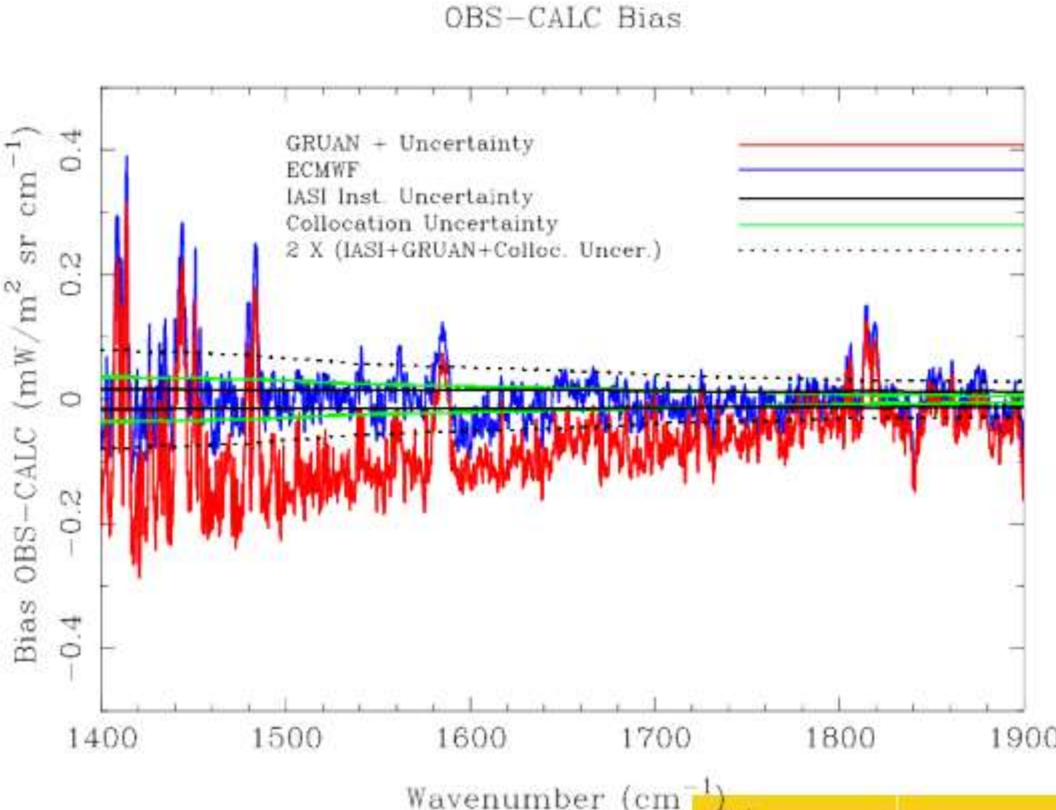
MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

AEMet Agencia Estatal de Meteorología

Radiation Bias: Final Result Day-time



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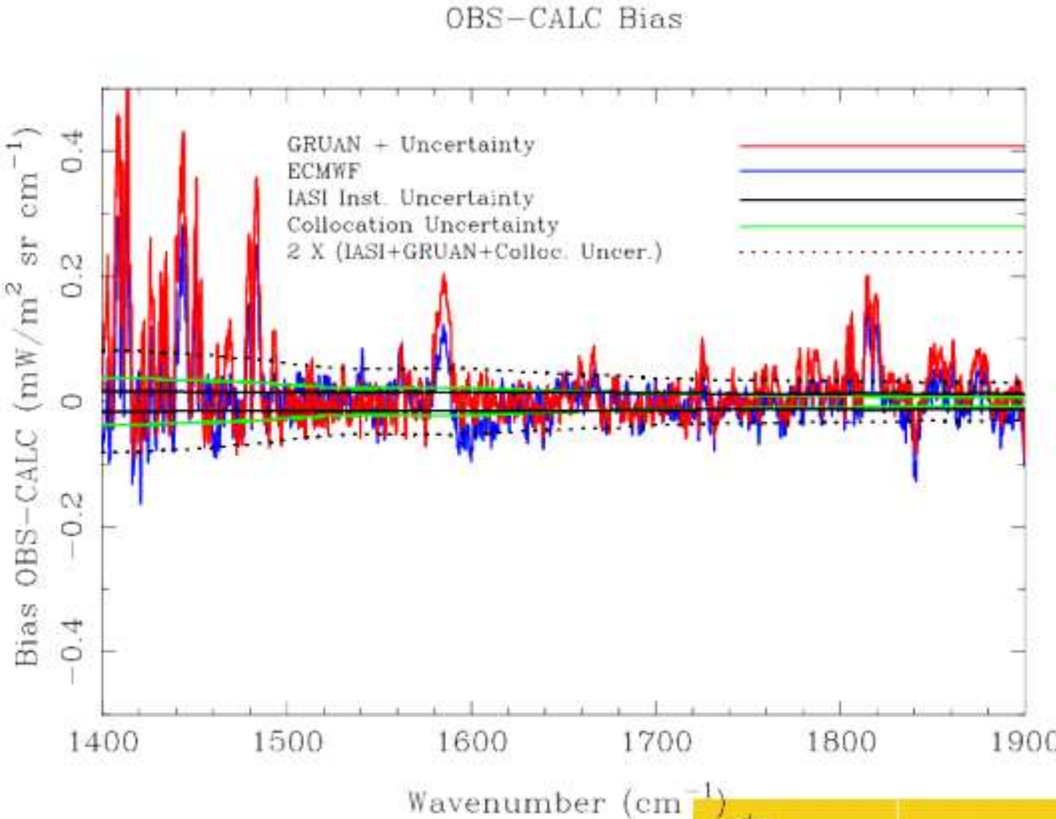
MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

AEMet Agencia Estatal de Meteorología

Radiation Bias: Final Result Day-time + 2.5% RH



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MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE
AEMet Agencia Estatal de Meteorología

Gap Analysis for Integrated Atmospheric ECV CLImate Monitoring

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 640276.

WP3

Full name:
WP3 – Comparison error budget closure – Quantifying metrology related uncertainties of data comparisons

This workpackage is concerned with improving our quantification of irreducible uncertainties that arise from inevitable non-coincidence of satellite and non-satellite measurements. The measurements may occur at slightly different times or locations or measure different volumes. Because the atmosphere is a dynamic fluid system any mismatch will lead to a difference that arises from changes in the atmospheric state. These differences must be accounted for in any meaningful comparison between the satellite and non-satellite measurements if reliable inferences are to be made. The workpackage shall:

- Characterise the uncertainties arising for single instruments (Task 3.1).
- Characterise the uncertainties arising for more spatially comprehensive network comparisons (Task 3.2).

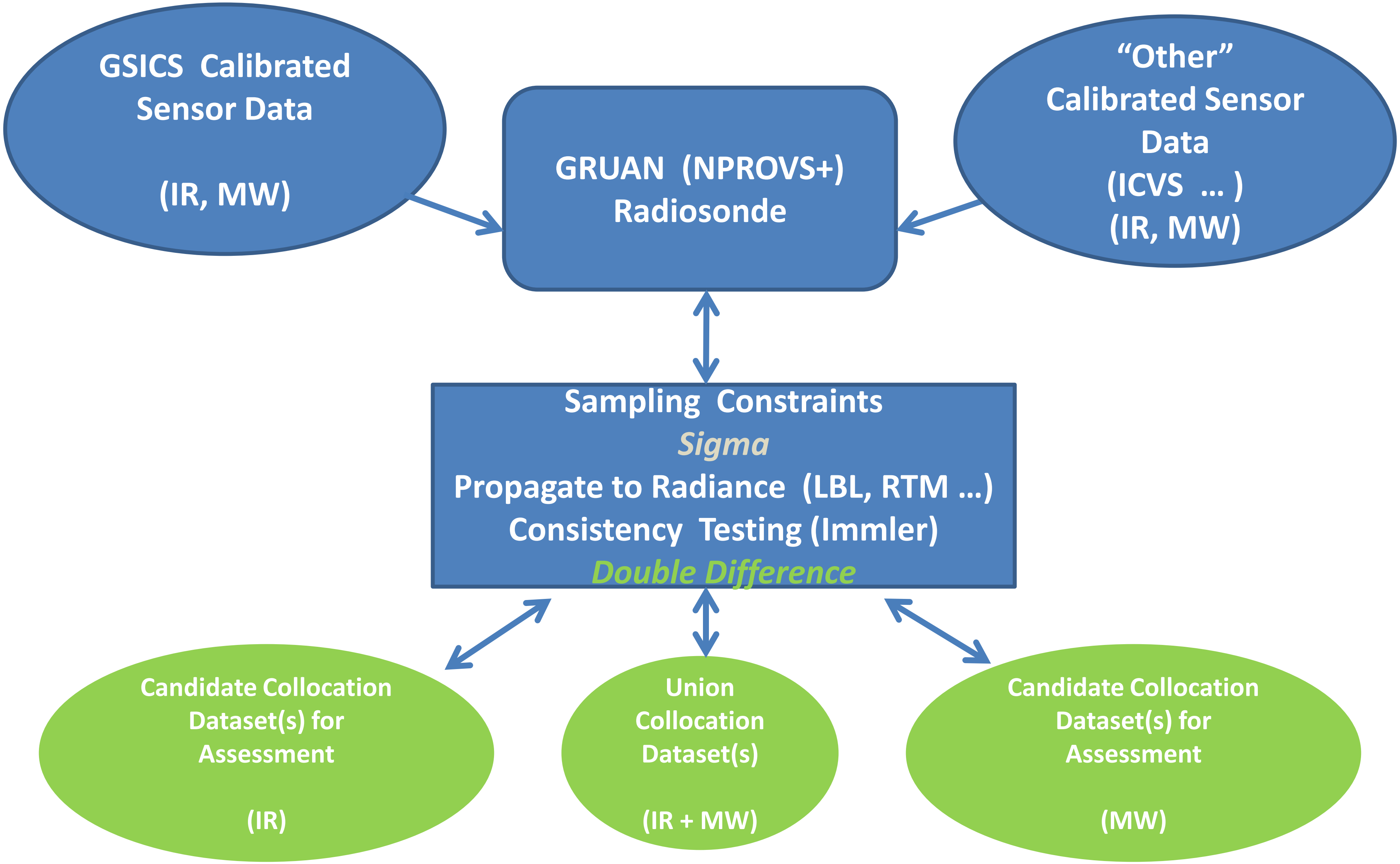
WP5

Full name:
WP5 – Creation of a 'Virtual Observatory' visualization and data access facility

This workpackage is concerned with enabling user access to and use of satellite to non-satellite data comparisons through a "Virtual Observatory" facility. A range of visualisation and analysis tools will be developed to enable users to explore, analyse, and interact with the data. The Virtual Observatory shall be built to showcase potential methods by which the underlying scientific advances in workpackages 1 through 4 can be realised. It will be built in such a way that it could subsequently become an operational service, but within this project shall only serve as a proof-of-concept facility. The workpackage shall:

- Create a collocation database of reference-quality non-satellite measurements and satellite measurements (Task 5.1).
- Build a graphical user interface and user tools (Task 5.2).

Preliminary Experiment Straw-man



Objective: Can GRUAN help verify the "accuracy/uncertainty" of GSICS adjustments

Summary

NPROVS+ and the integration of GRUAN uncertainty (Immler) leading to satellite product and NWP "worst-case" uncertainty estimates *… is the approach appropriate?*

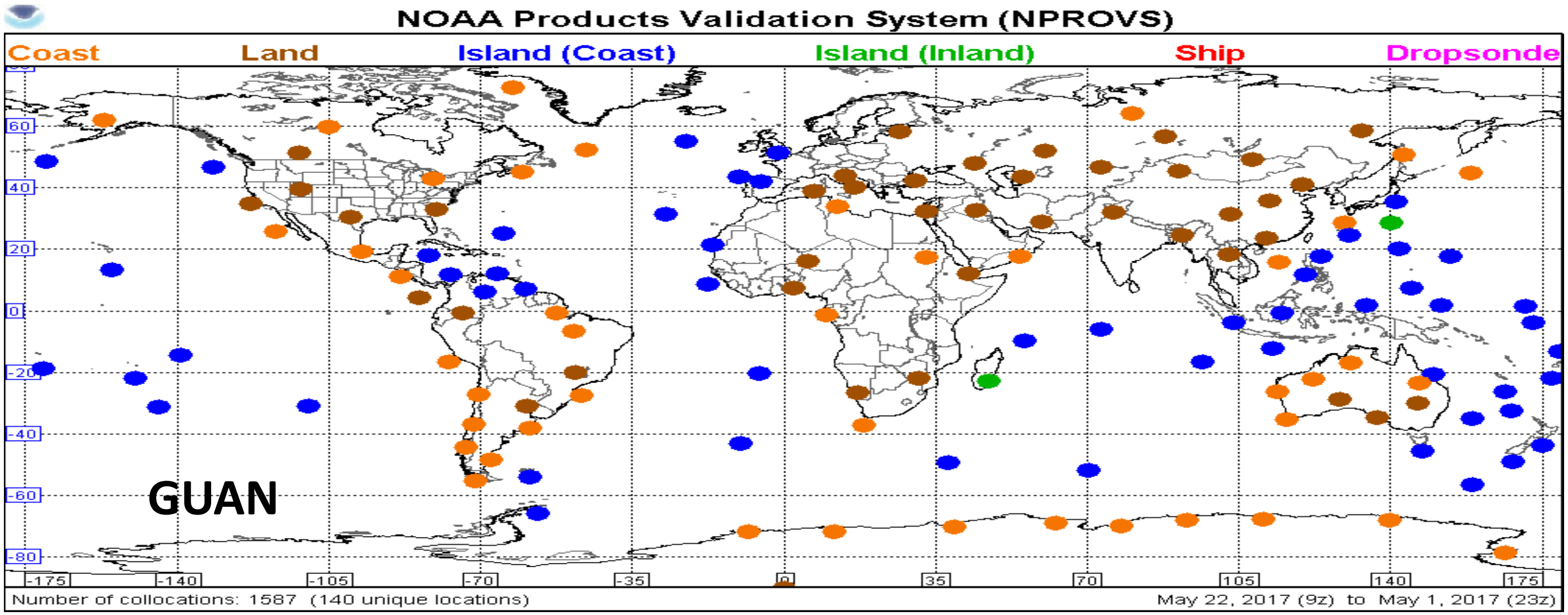
This is a robust addition to routine satellite product cal/val

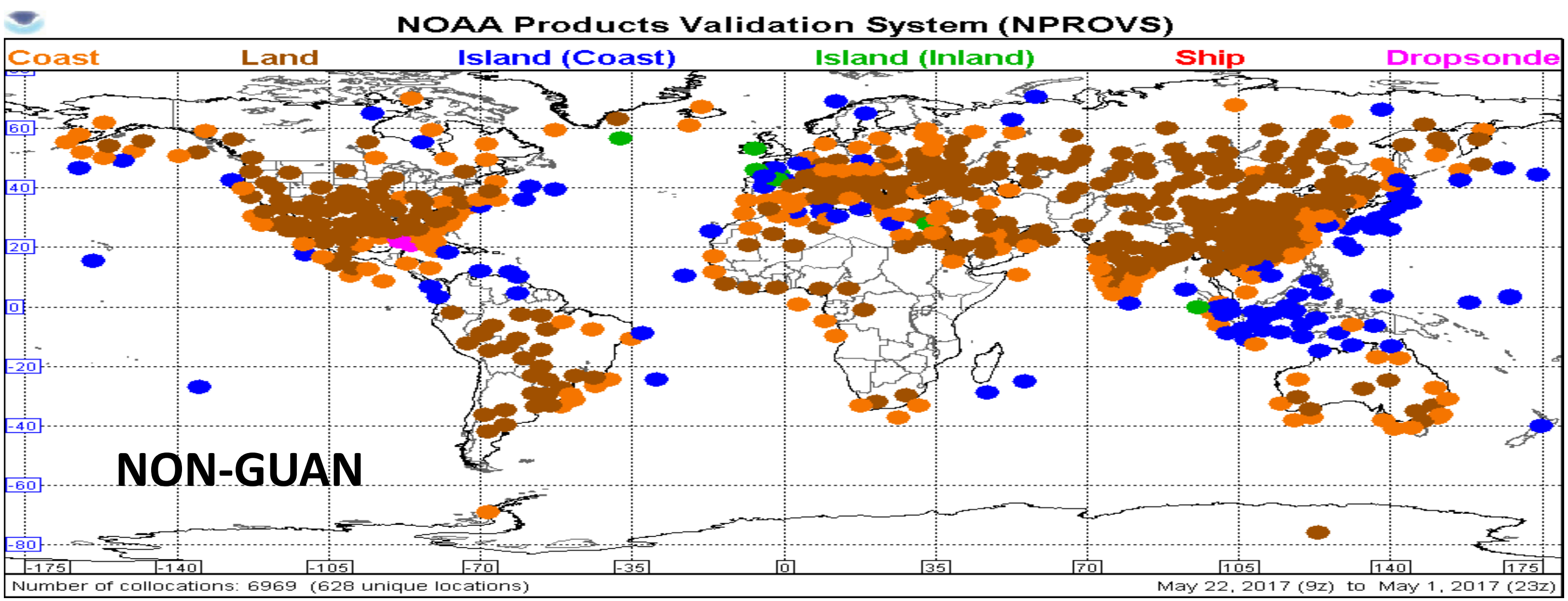
Results suggest possible cases of suspicious GRUAN uncertainty estimates associated with cases of high moisture content and daytime radiation corrected observations … *Tom Gardiner talk Thursday*

Suspicions (for radiation correction) appear confirmed using collocations of GRUAN and GPSRO

GSICS action items initiated to test whether GRUAN (and uncertainty) can be used to assess/monitor satellite IR and MW sensors (and associated GSICS uncertainty estimates) … ***propagation to the radiance space***

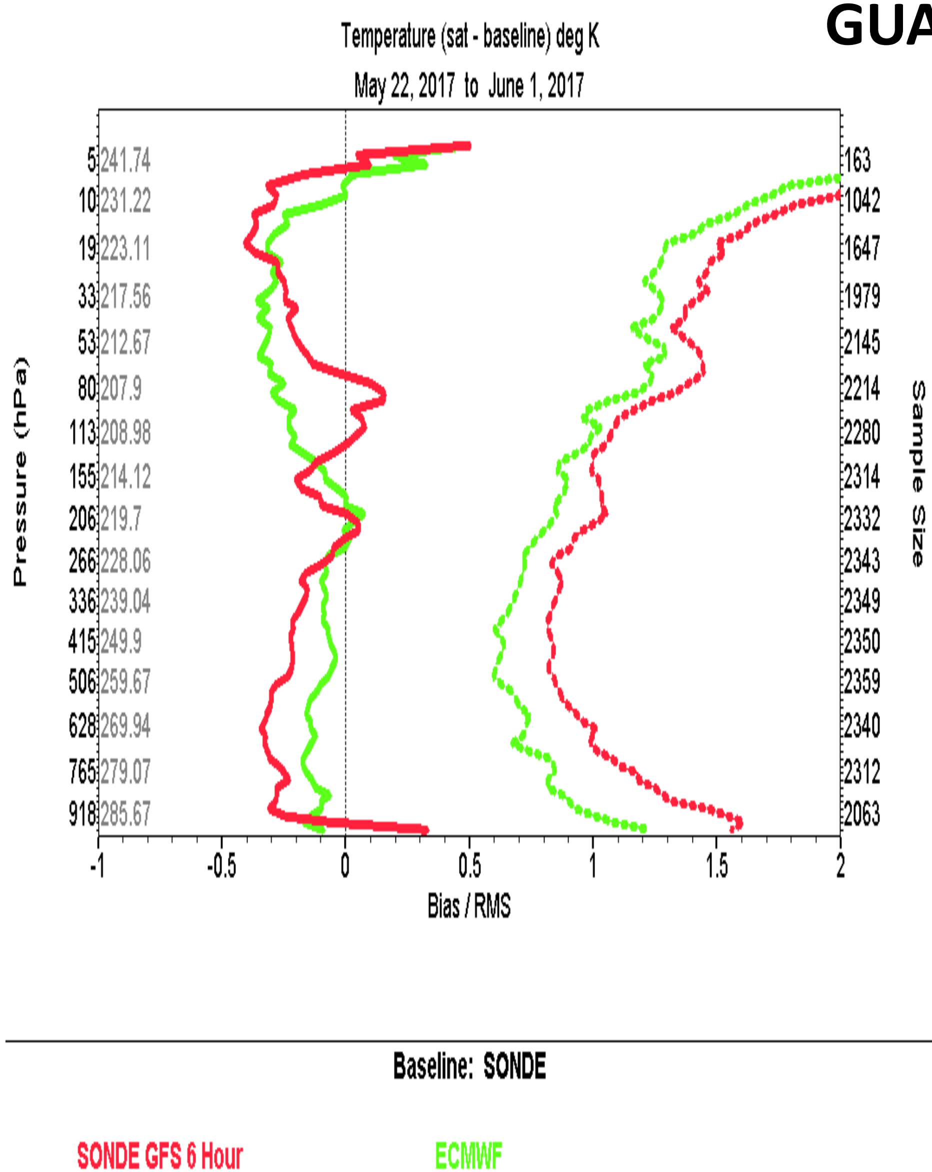
Extras

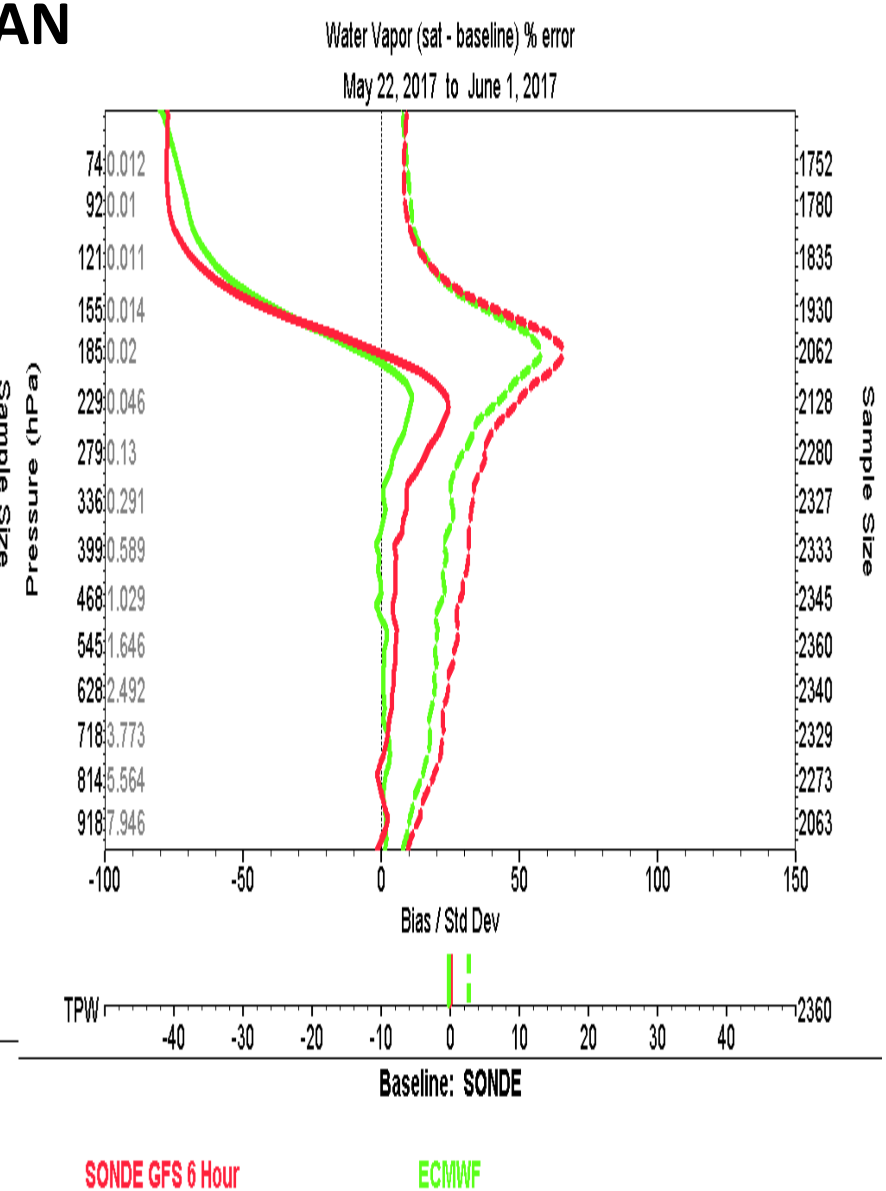




ECMWF collocations with Conventional RAOB … NPROVS

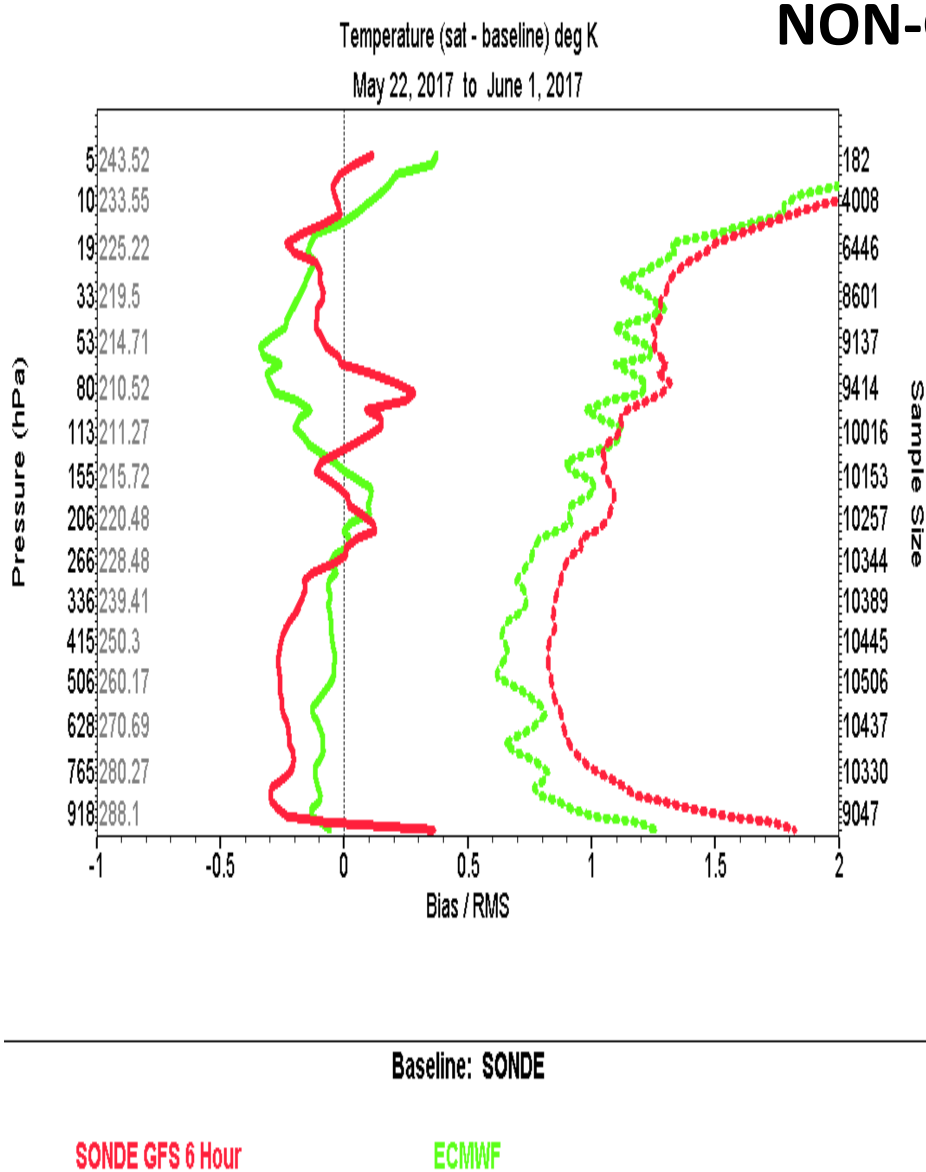
GUAN

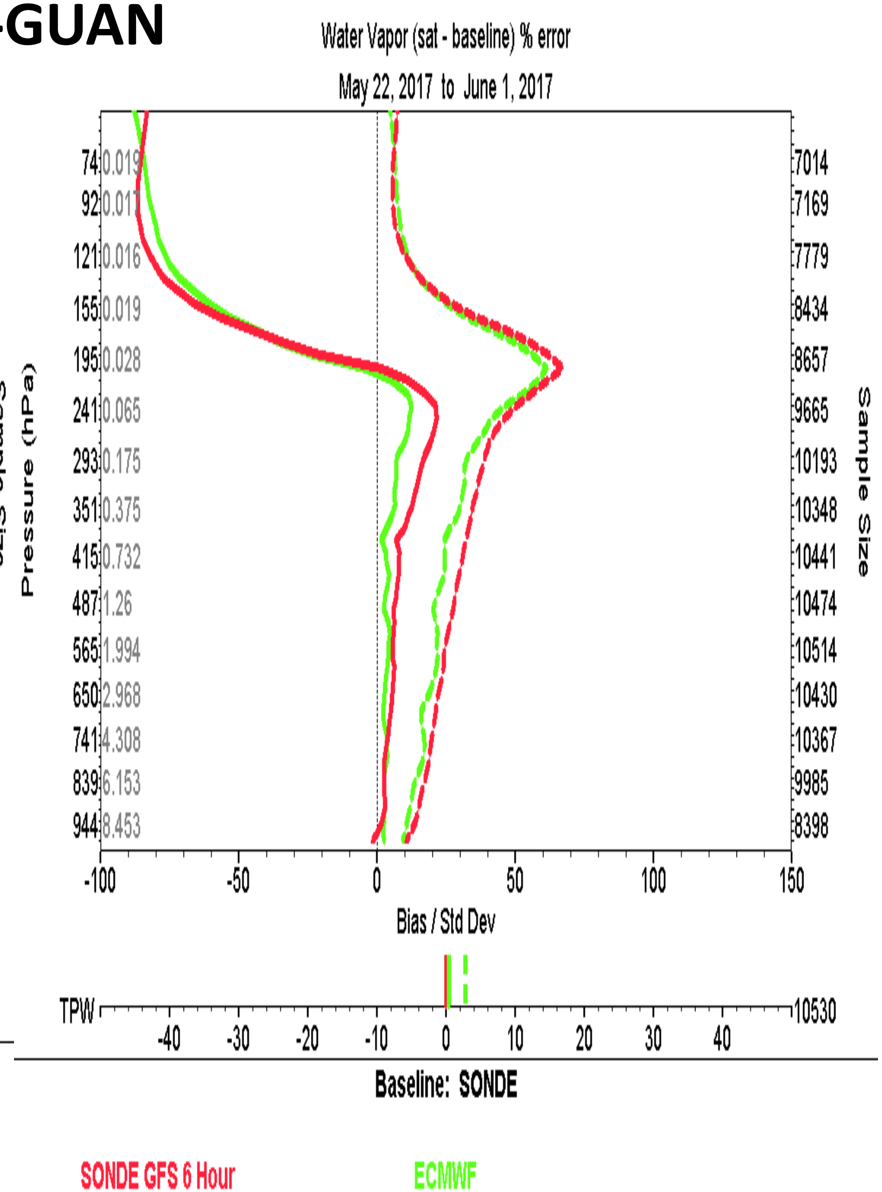




NWP characterization using NPROVS)

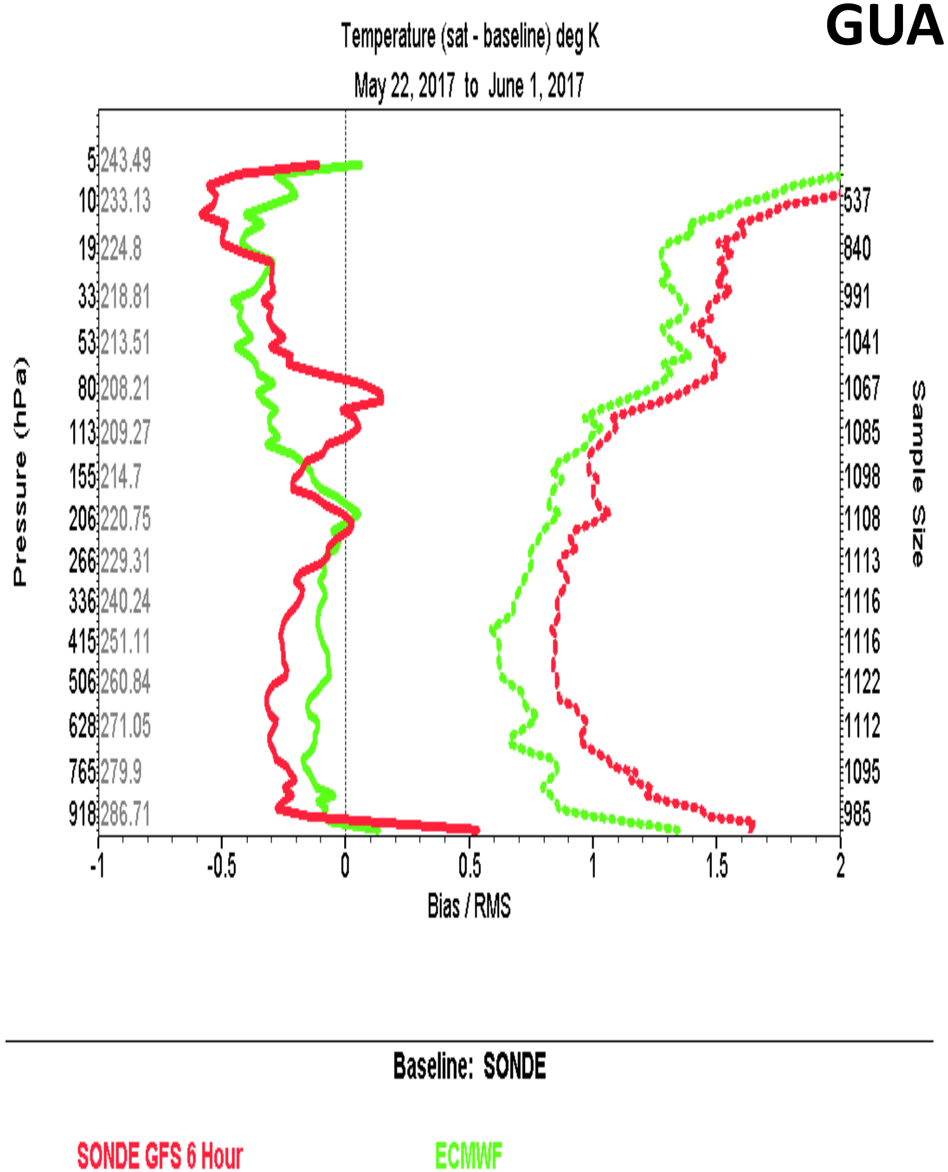
NON-GUAN





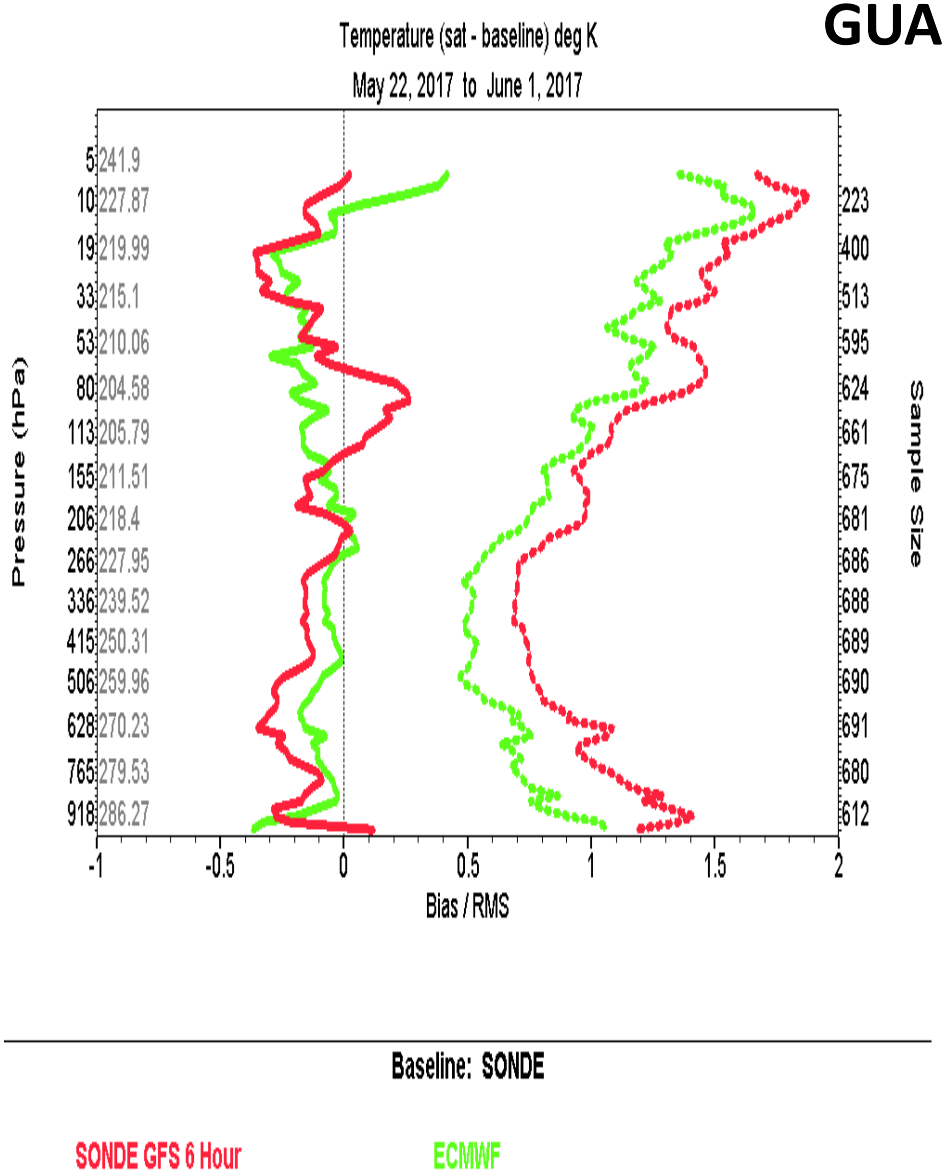
NWP characterization using NPROVS)

GUAN Day



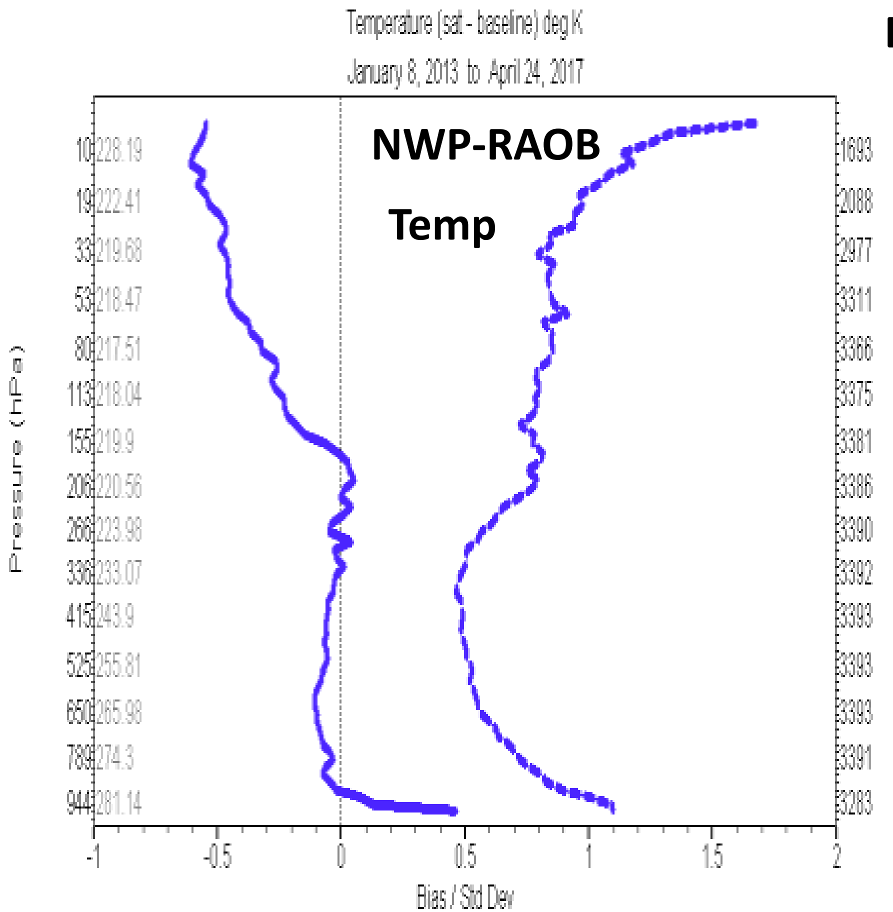
NWP characterization using NPROVS)

GUAN Night



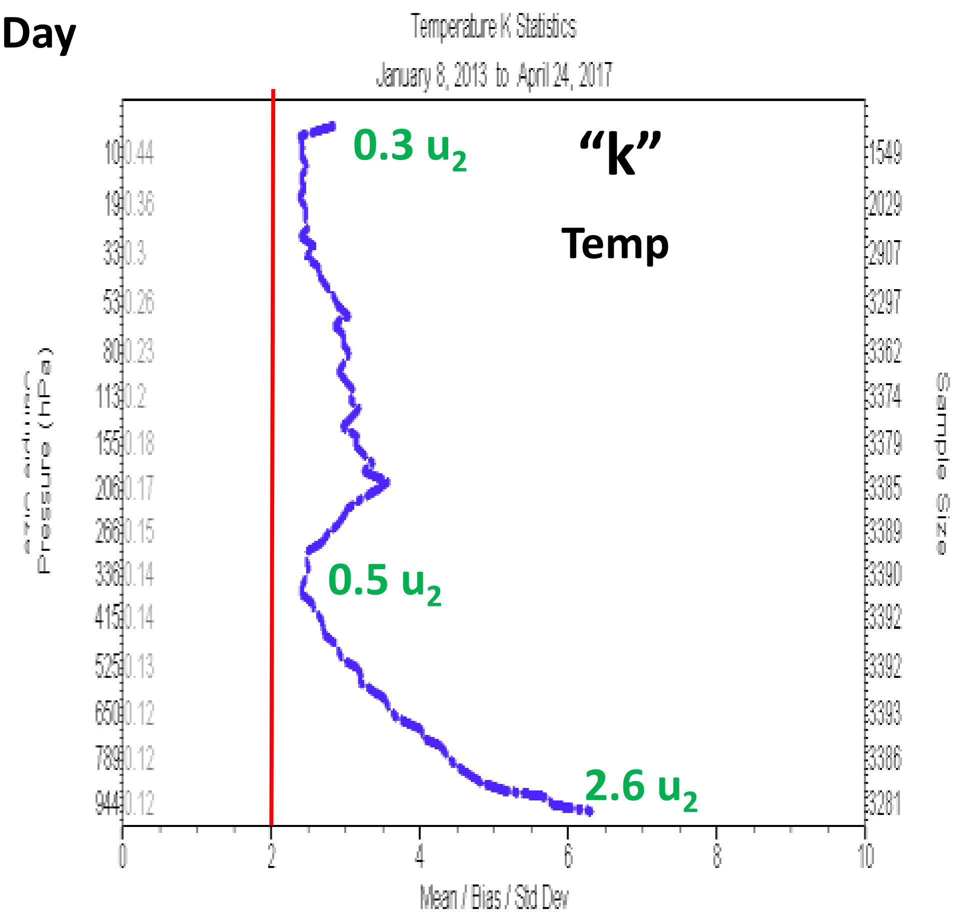
NWP characterization using NPROVS)

Day



Baseline: Radiosonde

ECMWF

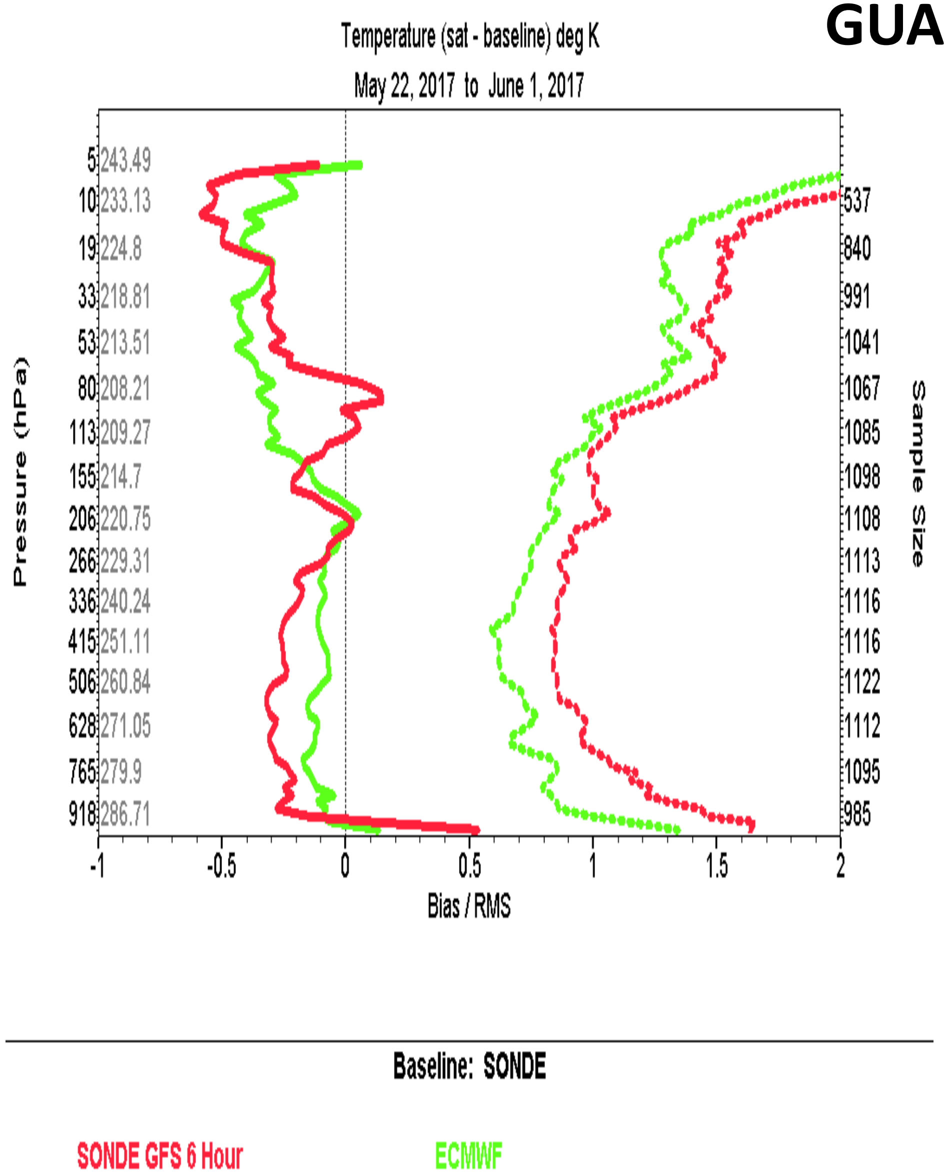


Baseline: Radiosonde

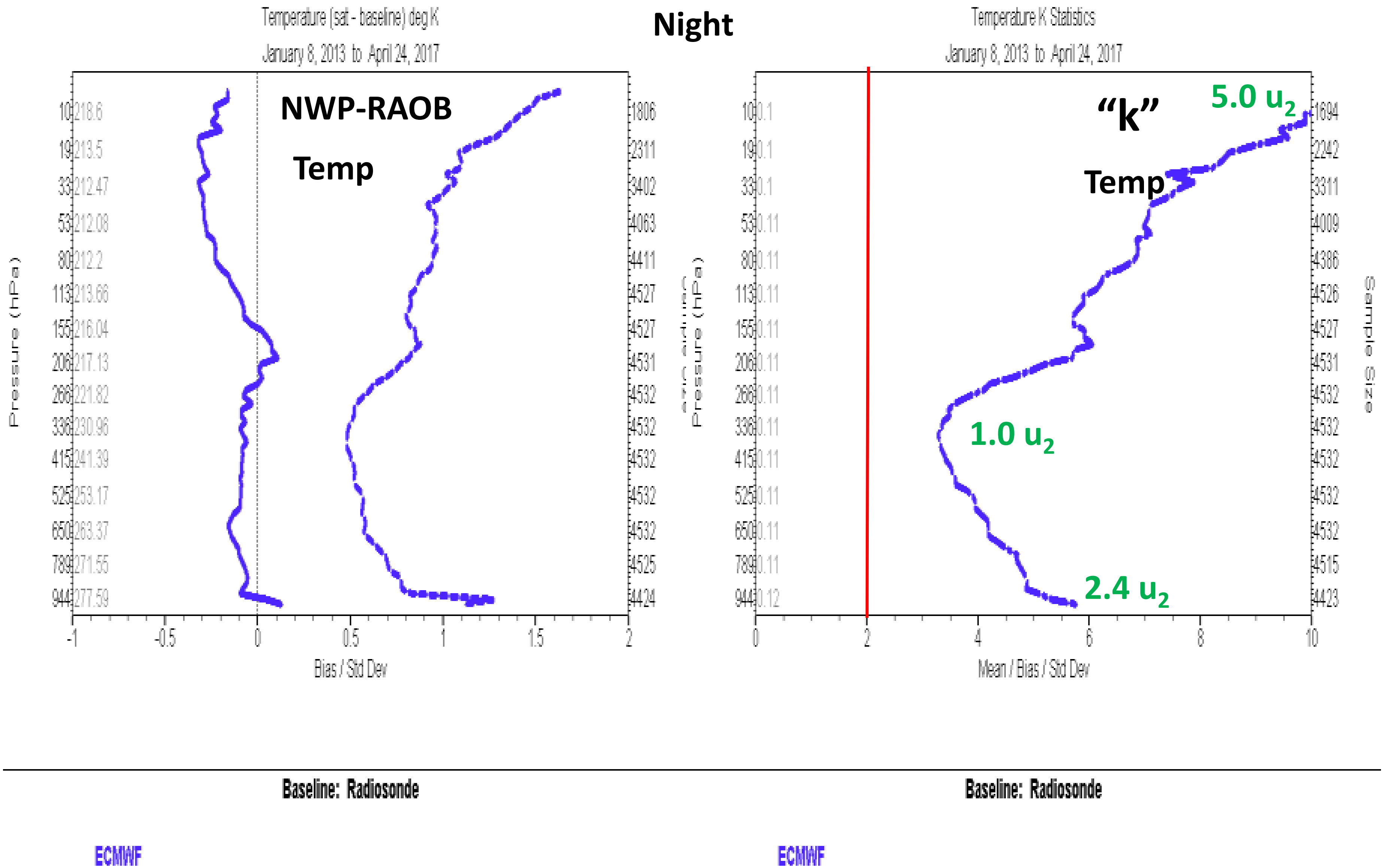
ECMWF

ECMWF Uncertainty Assessments using NPROVS+)

GUAN Day

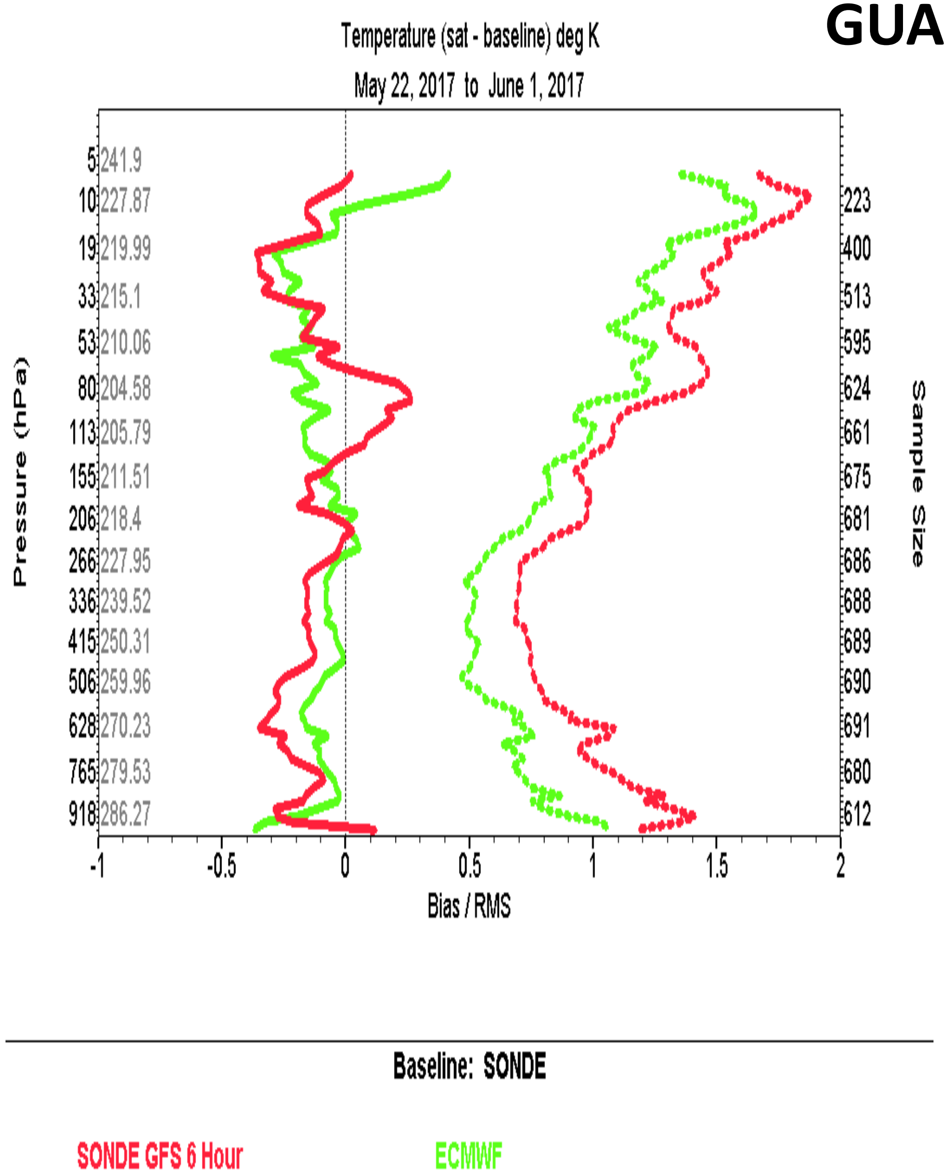


NWP characterization using NPROVS)

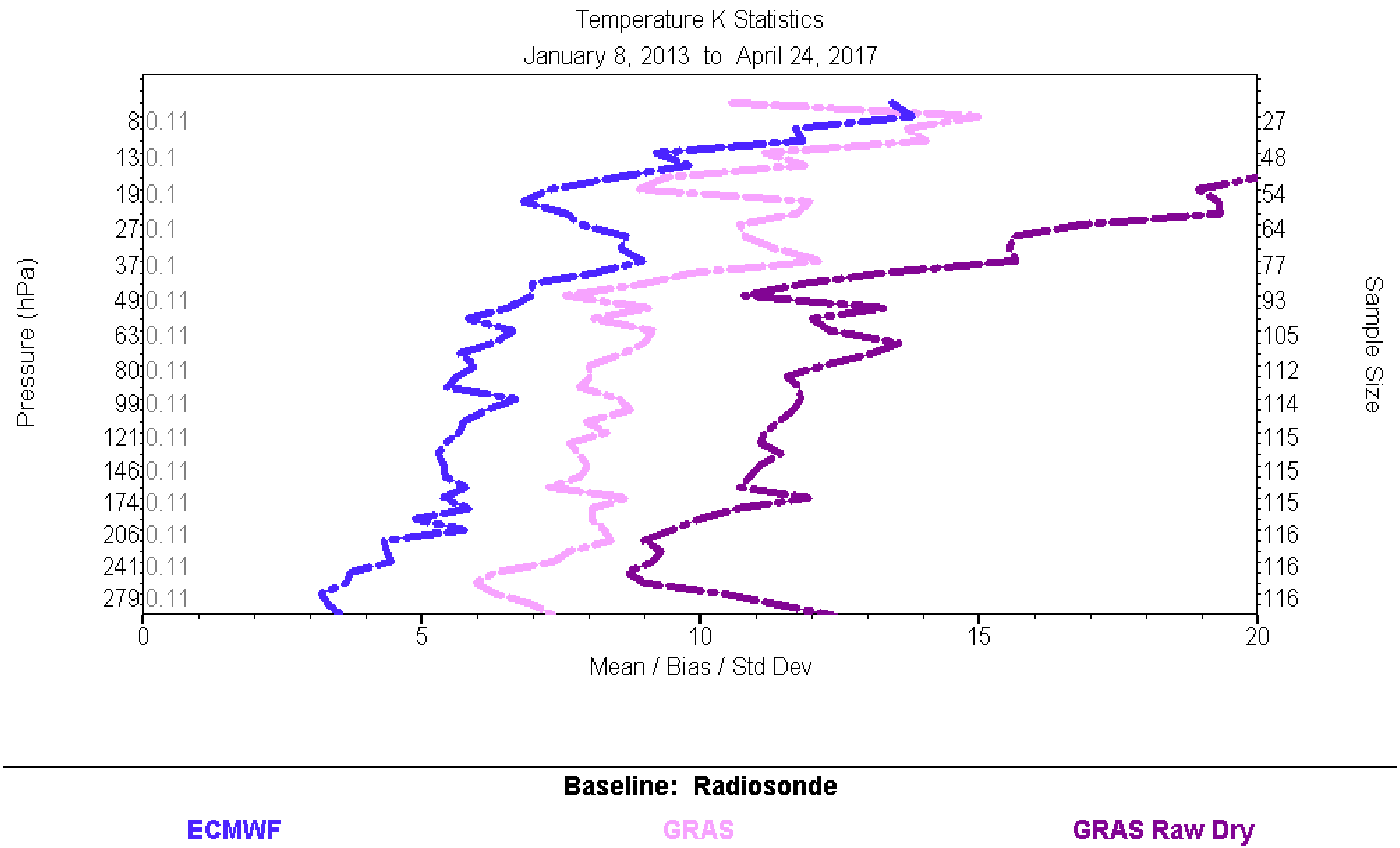


ECMWF Uncertainty Assessments using NPROVS+)

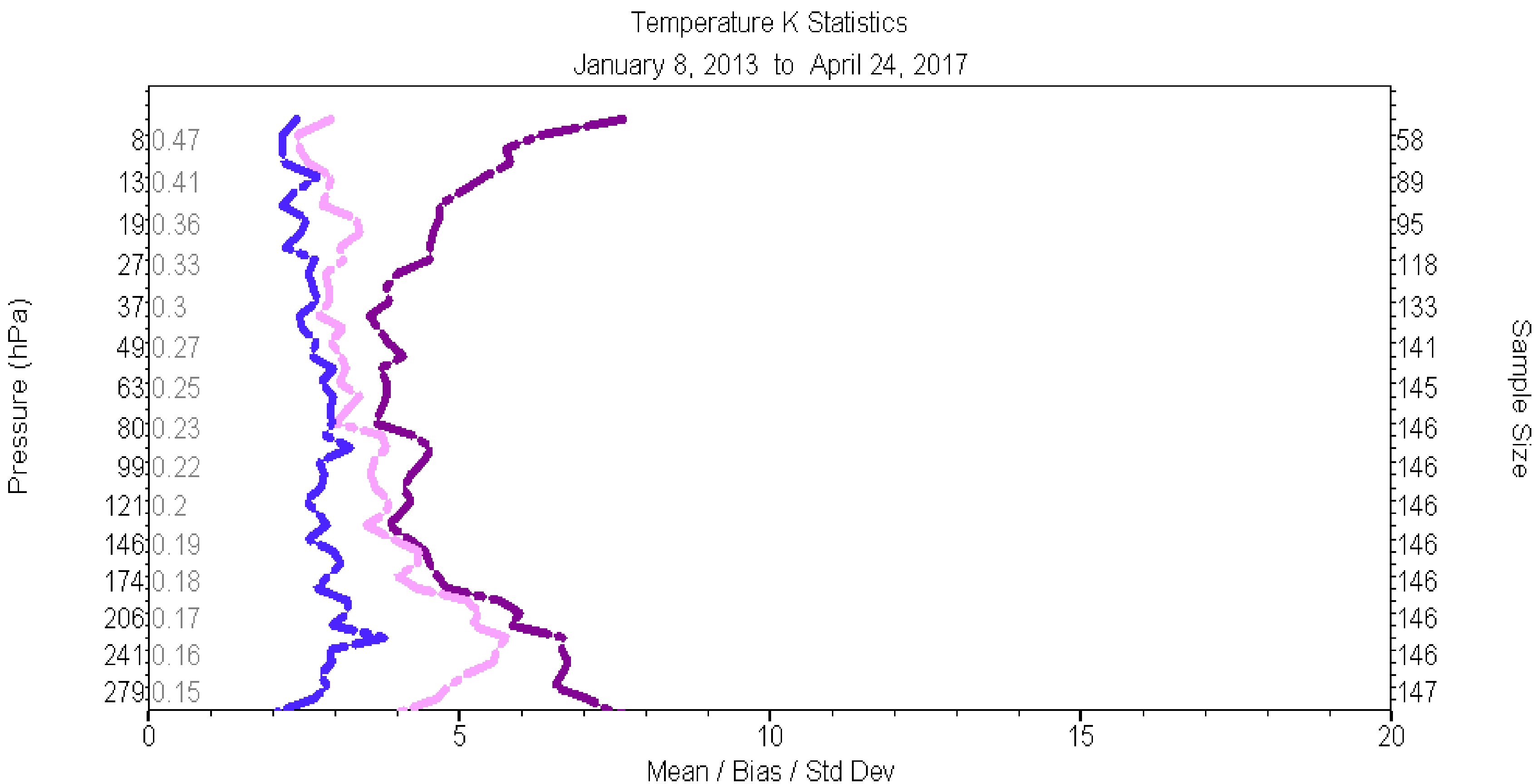
GUAN Night



NWP characterization using NPROVS)



Temperature K Statistics
January 8, 2013 to April 24, 2017
Pressure (hPa)
8
13
19
27
37
49
63
80
99
121
146
174
206
241
279
0.11
0.1
0.1
0.1
0.1
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0.11
0
5
10
15
20
Mean / Bias / Std Dev
Sample Size
27
48
54
64
77
93
105
112
114
115
115
115
116
116
116
Baseline: Radiosonde
ECMWF
GRAS
GRAS Raw Dry



Baseline: Radiosonde

ECMWF | GRAS | GRAS Raw Dry