GRUAN and Satellite Collocation

Xavier Calbet - EUMETSAT

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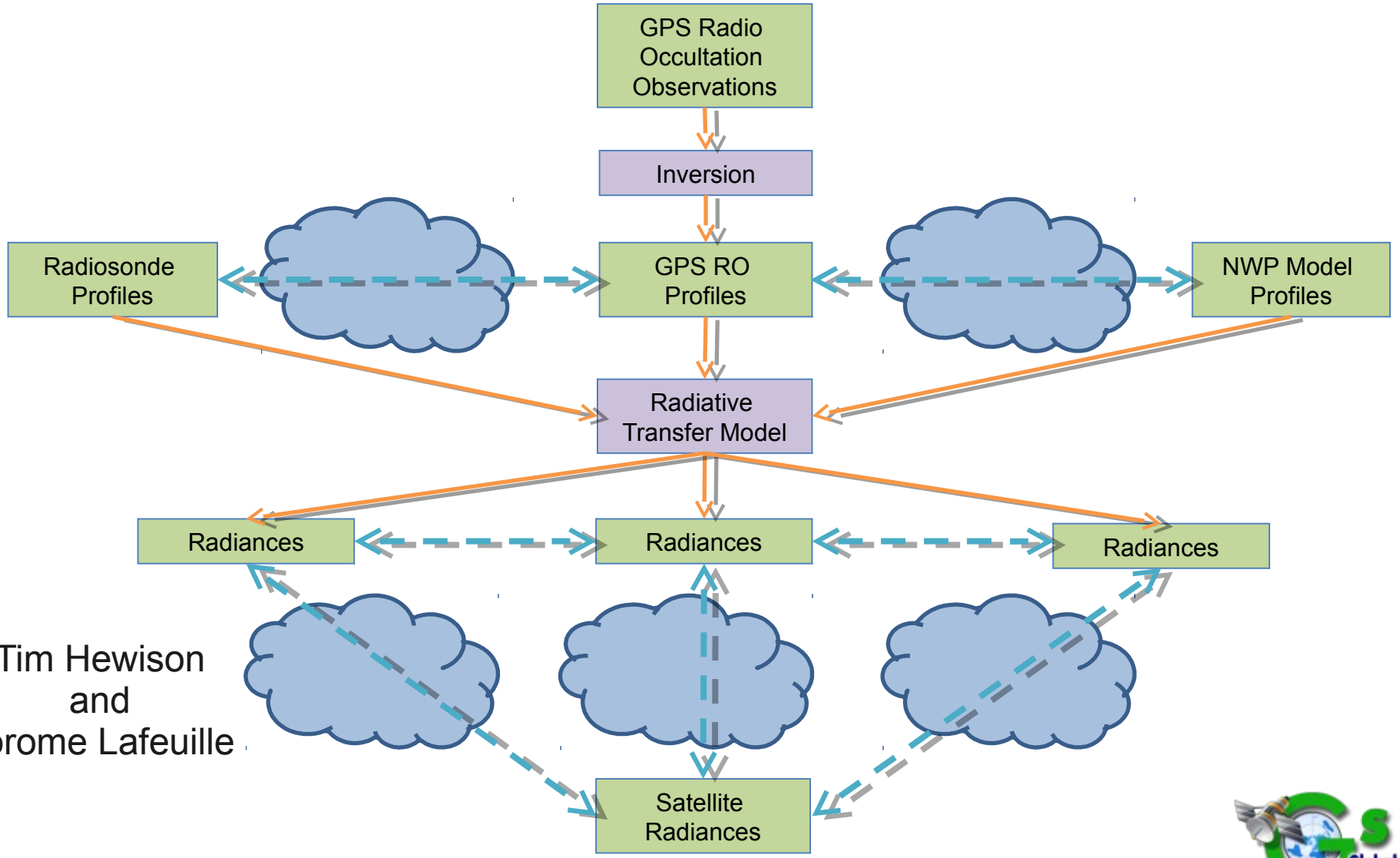
Why GRUAN?

1. GRUAN stand for GCOS Reference Upper-Air Network
2. Are providing uncertainties with the measurements
3. But, most importantly, they have made a great effort to reduce systematic errors from the measurements → Humidity measurements are very much bias free

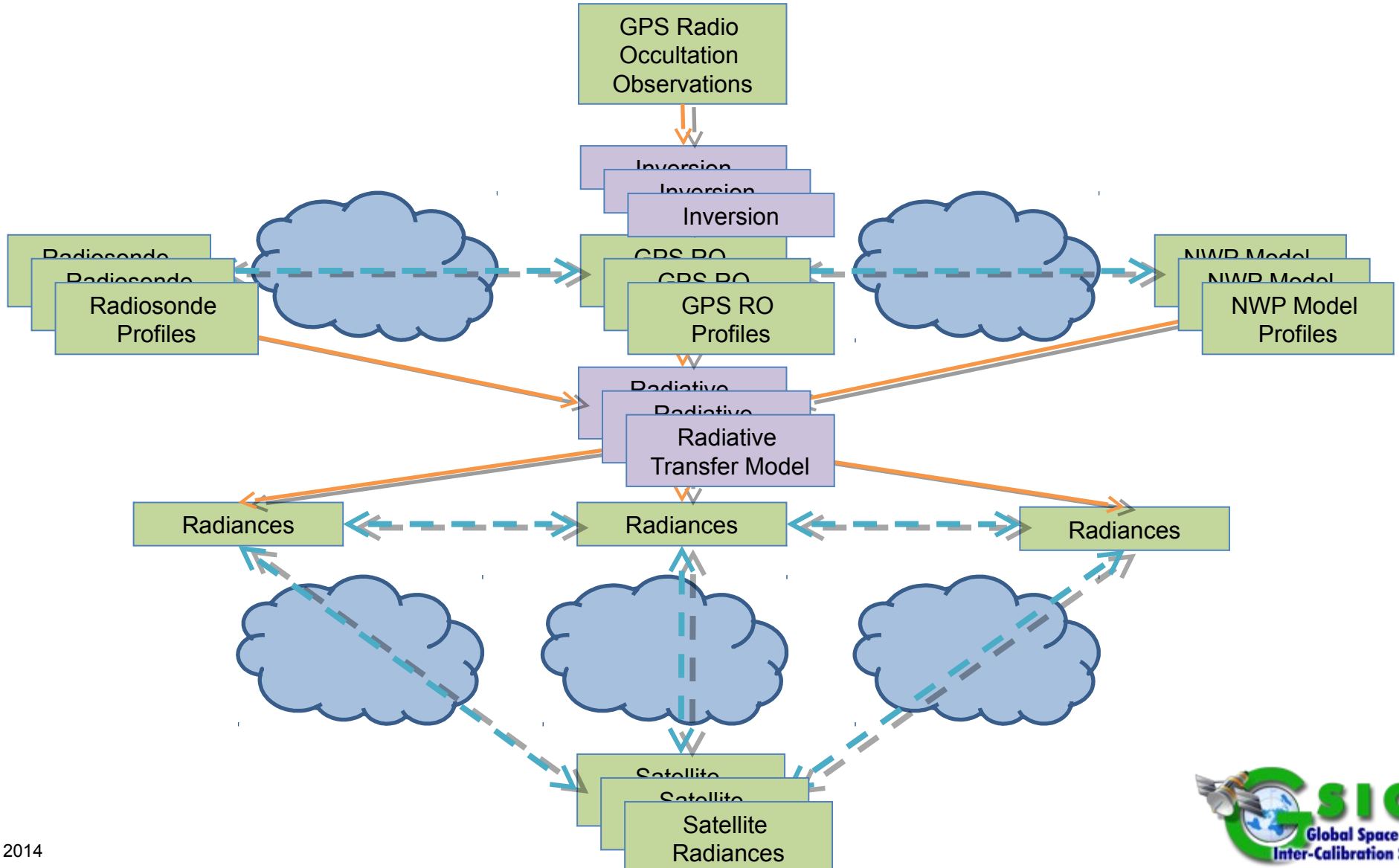
GRUAN-GSICS-GPSRO-NWP Interaction Concept



Tim Hewison
and
Jorome Lafeuille

GSICS Global Space-based Inter-Calibration System

GRUAN-GSICS-GPSRO-NWP Interaction Concept



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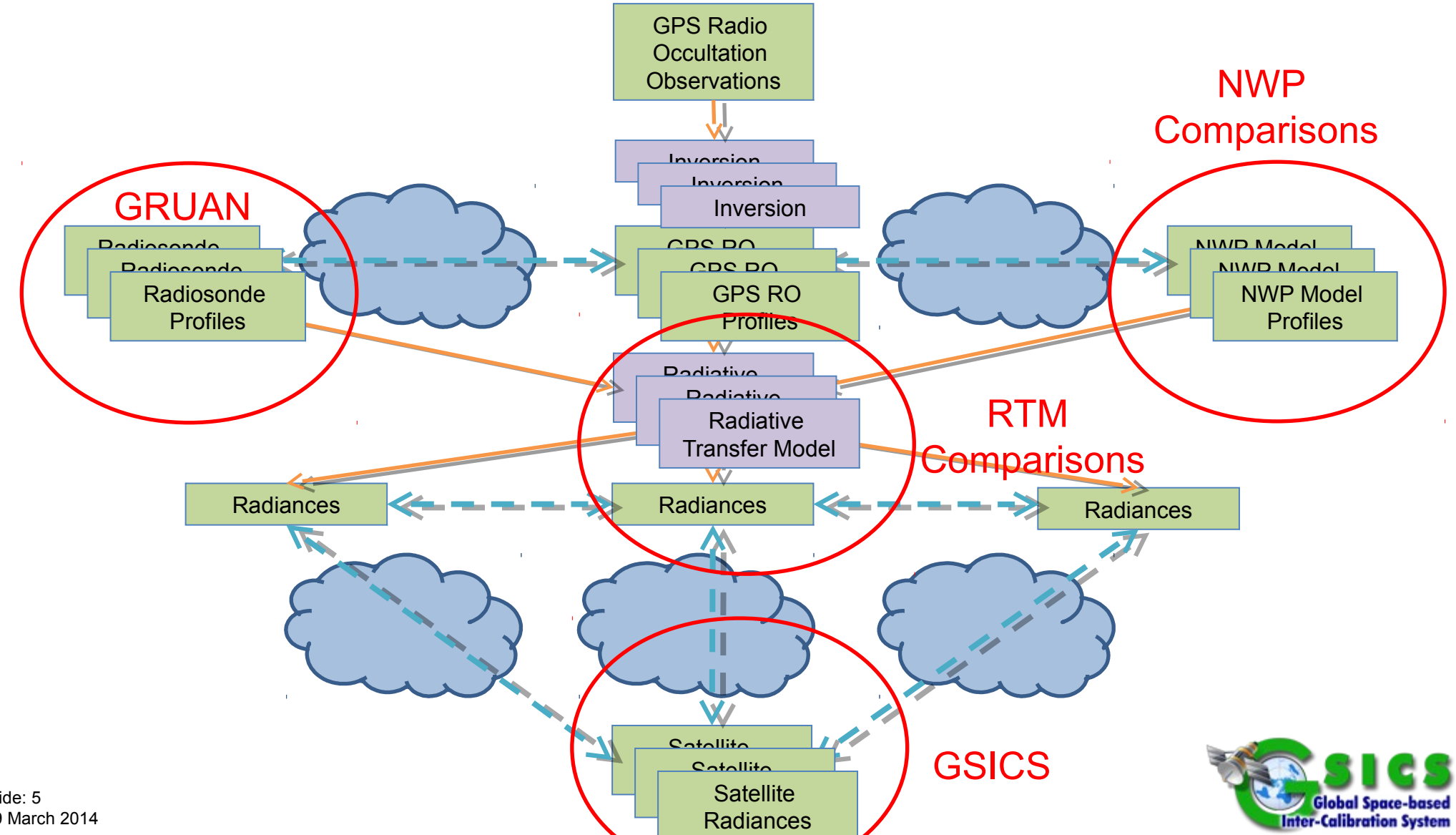
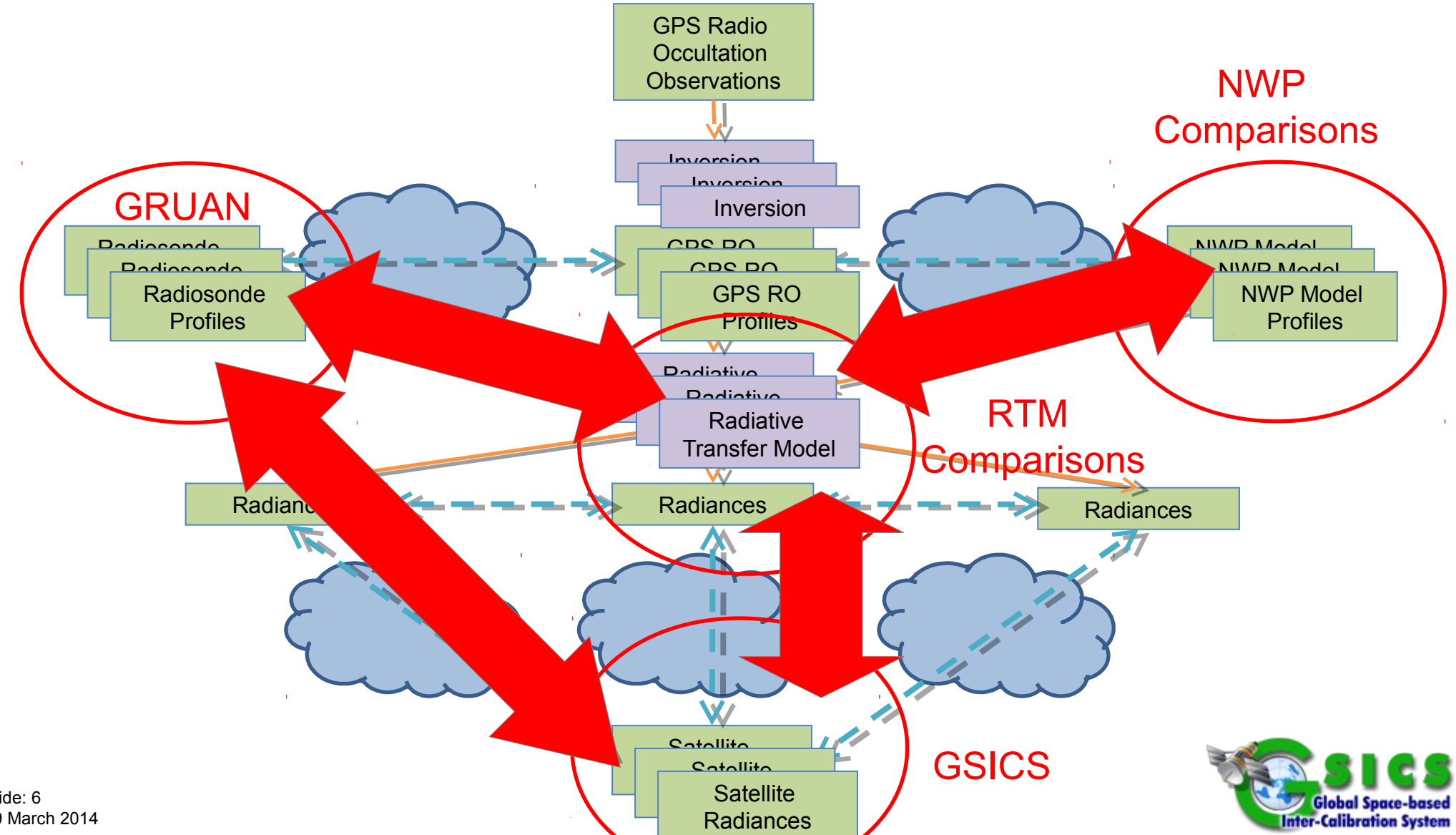


To Fully Understand the Problem more interaction between groups are necessary!!



GRUAN and Satellite collocation White Paper

1. White Paper addressing the (open) issues of GRUAN and Satellite collocation. Mainly with Infrared Hyperspectral Sounders (IASI).
2. Currently very “EUMETSAT centric”. More contributions welcome.

Cal/Val Strategy the Standard way

1. Collocation
2. Pre-processing
3. Comparison

Cal/Val Strategy the Standard way

1. Collocation
2. Pre-processing
3. Comparison

… but …

- Collocation errors???
- Sonde humidity errors???

Alternative Cal/Val Strategy

1. Collocation
2. Pre-processing
3. CONSISTENCY CHECK!! Assess their co-location and quality by doing an Observed versus Calculated radiance comparison
4. Comparison

Nomenclature

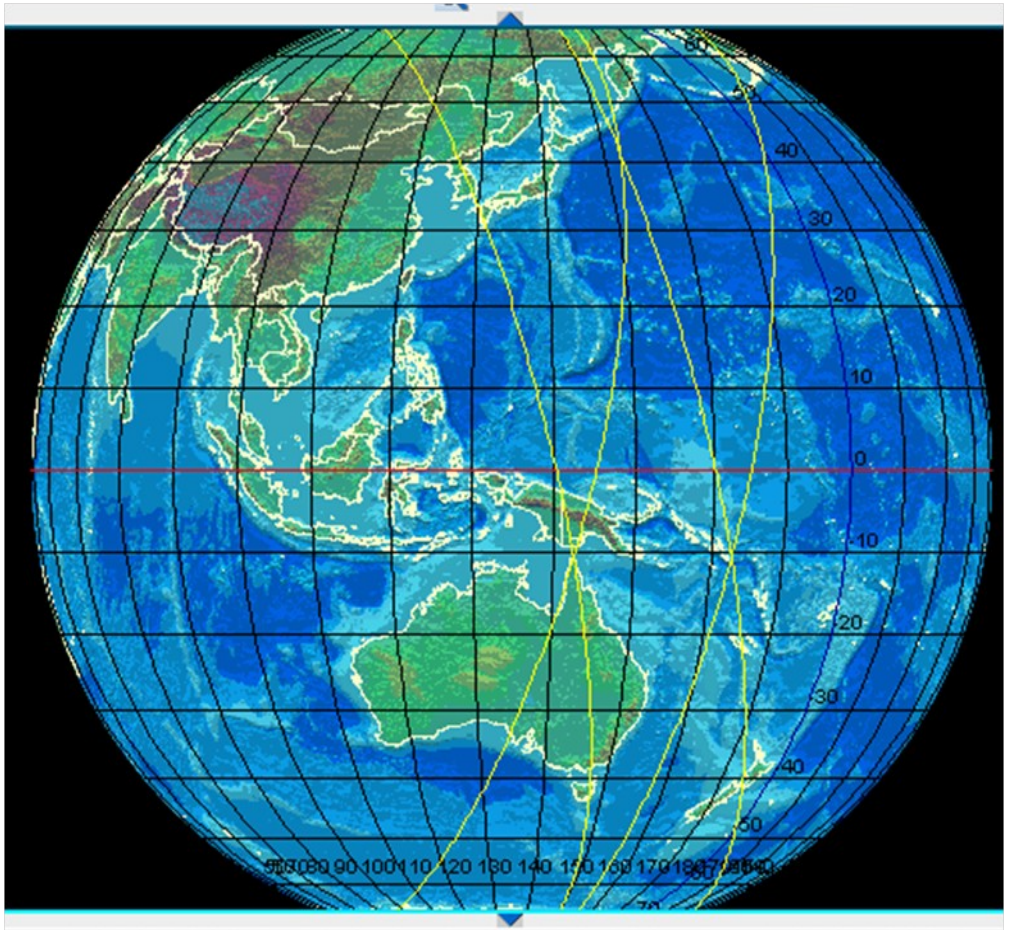
- Reference profile: ground based Remote Sensing, GRUAN Sondes, NWP profiles, etc.

- Satellite observations: microwave, infrared hyperspectral (IASI), etc.

GRUAN: Collocation

1. Collocation

- Orbits close to 00Z and 12Z
- IASI FOVs less than 25 km and 30 min apart from Manus
- With above criteria met, searched for IASI FOVs 500 km away



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	HIRS	HIRxxx1B	2011/06/05 00:27:58	2011/06/05 02:09:56
	HIRS	HIRxxx1B	2011/06/05 02:09:56	2011/06/05 03:54:54
	HIRS	HIRxxx1B	2011/06/05 03:54:54	2011/06/05 05:36:59

GRUAN: Pre-processing

2. Pre-processing

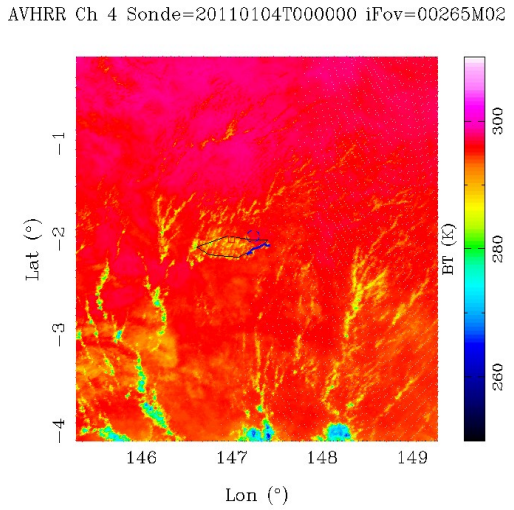
- No interpolation
- Humidity bias corrections for the Calculated radiances: GRUAN + 3% RH (most likely coming from RTM)

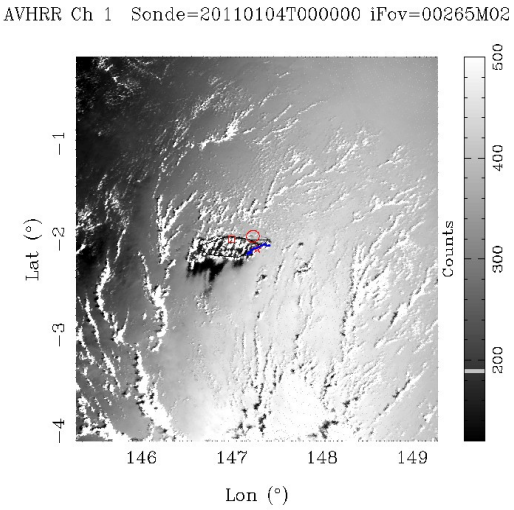
Cal/Val Strategy: Consistency check

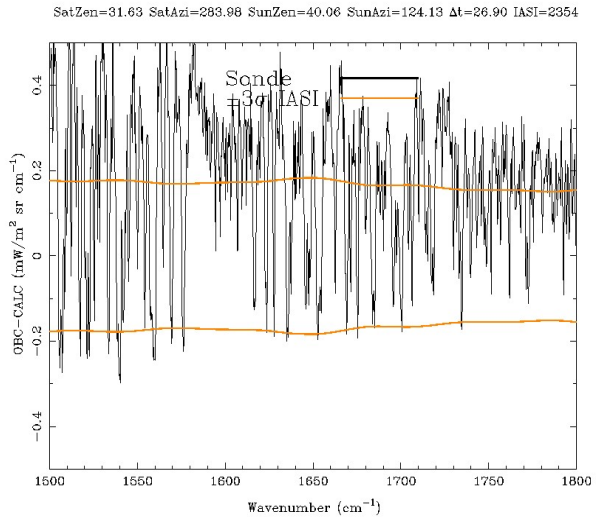
3. Consistency check

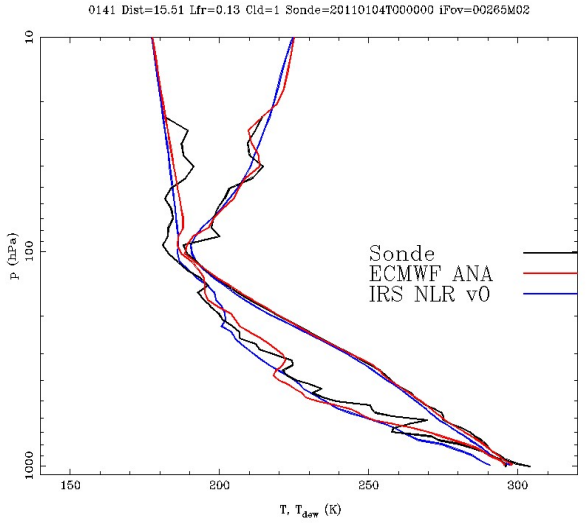
- New proposed step which seems pivotal
- Observed IASI radiances (OBS) are compared to
- Calculated radiances (CALC) using Sonde profile + Radiative Transfer Model (RTM)
- OBS-CALC should fall within ±3σ IASI instrument noise
- Necessary, but not sufficient condition!
- Ideally not to be used as a further selection criteria! == Do not include in pre-processing, if possible.

Cal/Val Strategy: Consistency check

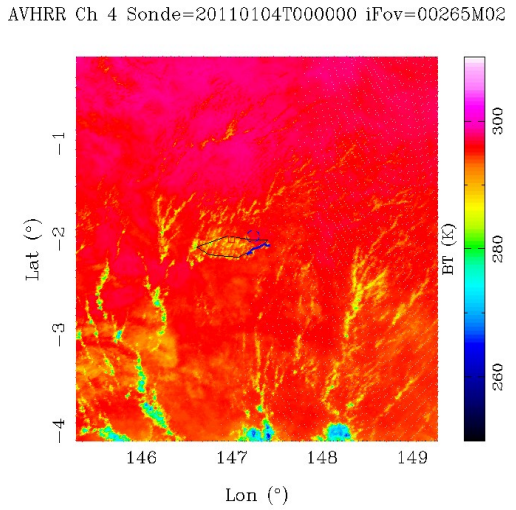


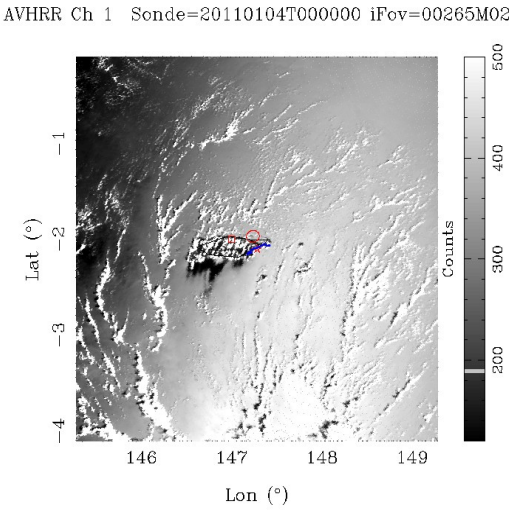


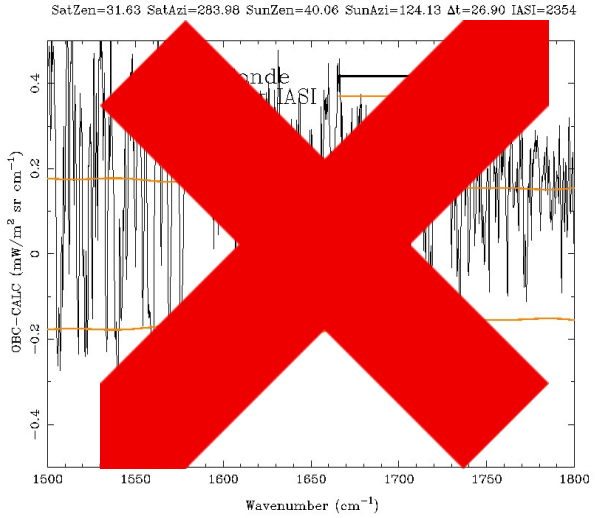


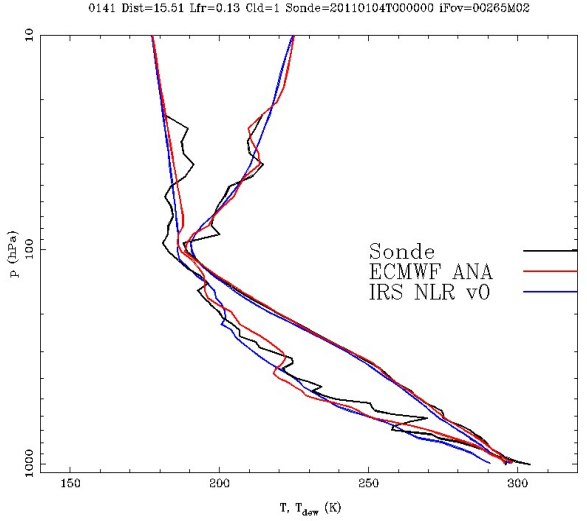


Cal/Val Strategy: Consistency check









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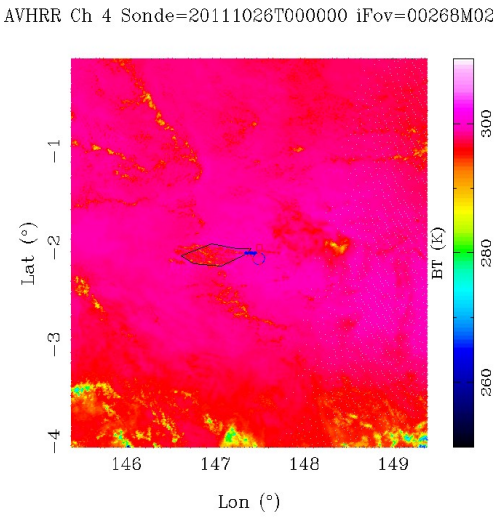
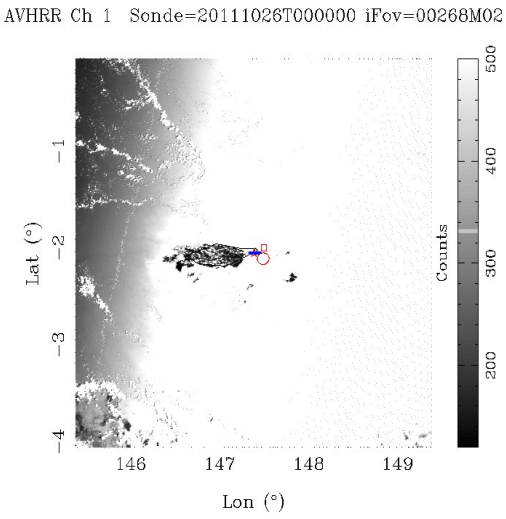
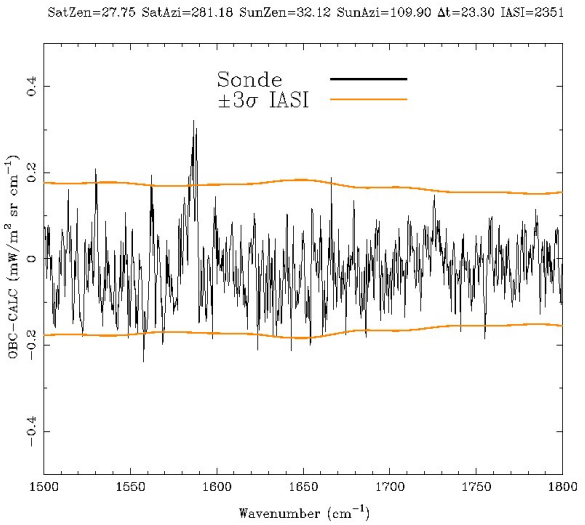
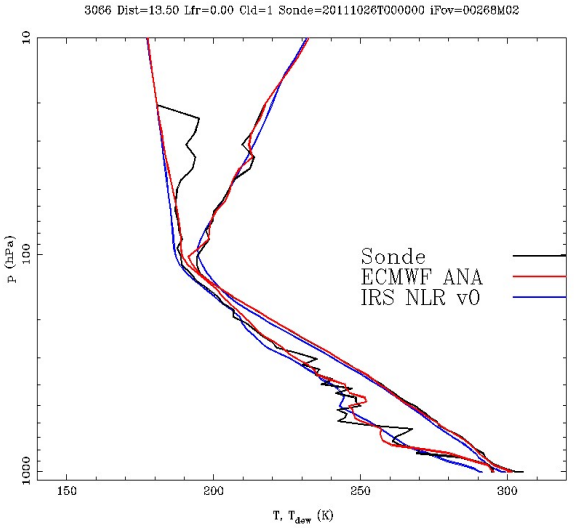
Cal/Val Strategy: Consistency check









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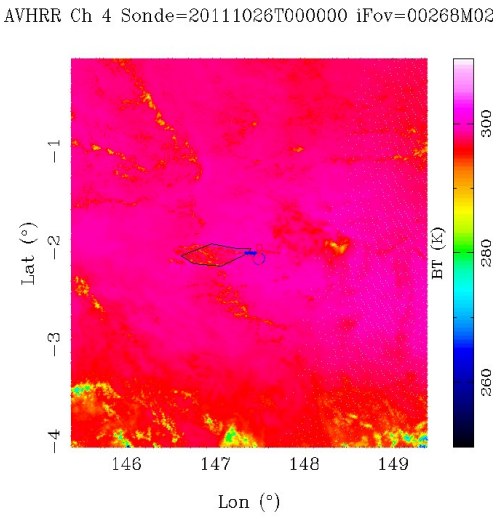
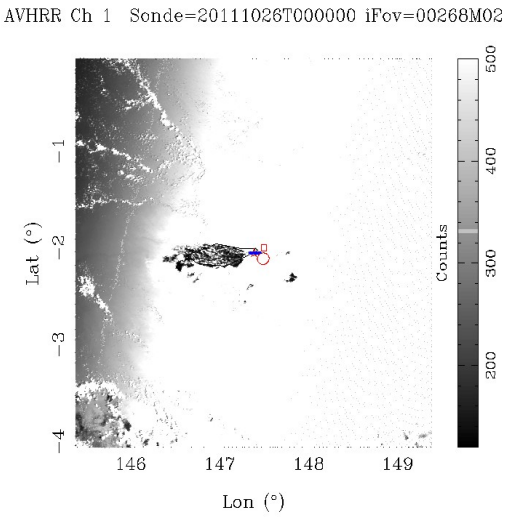
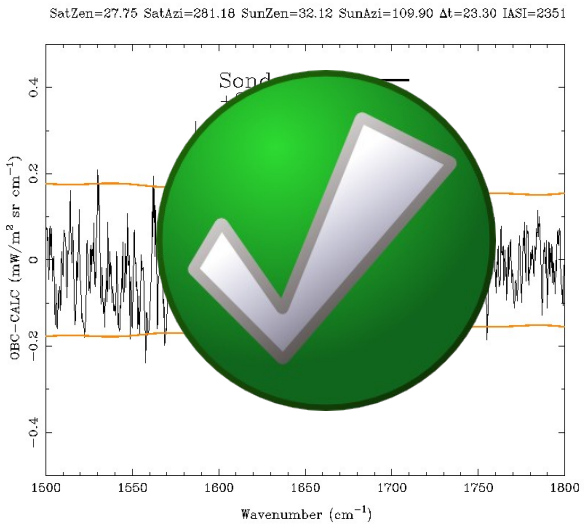
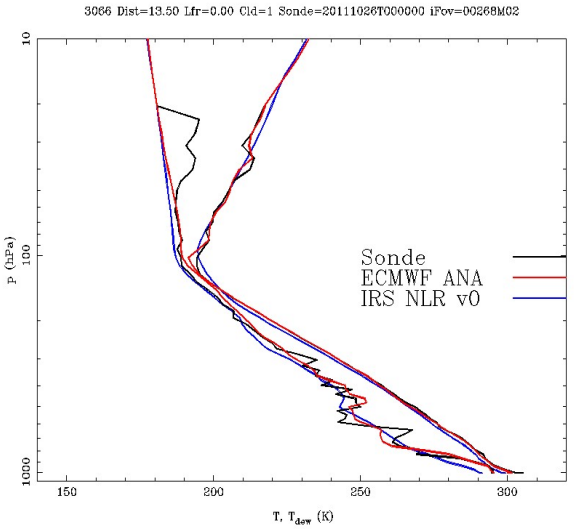
Cal/Val Strategy: Consistency check









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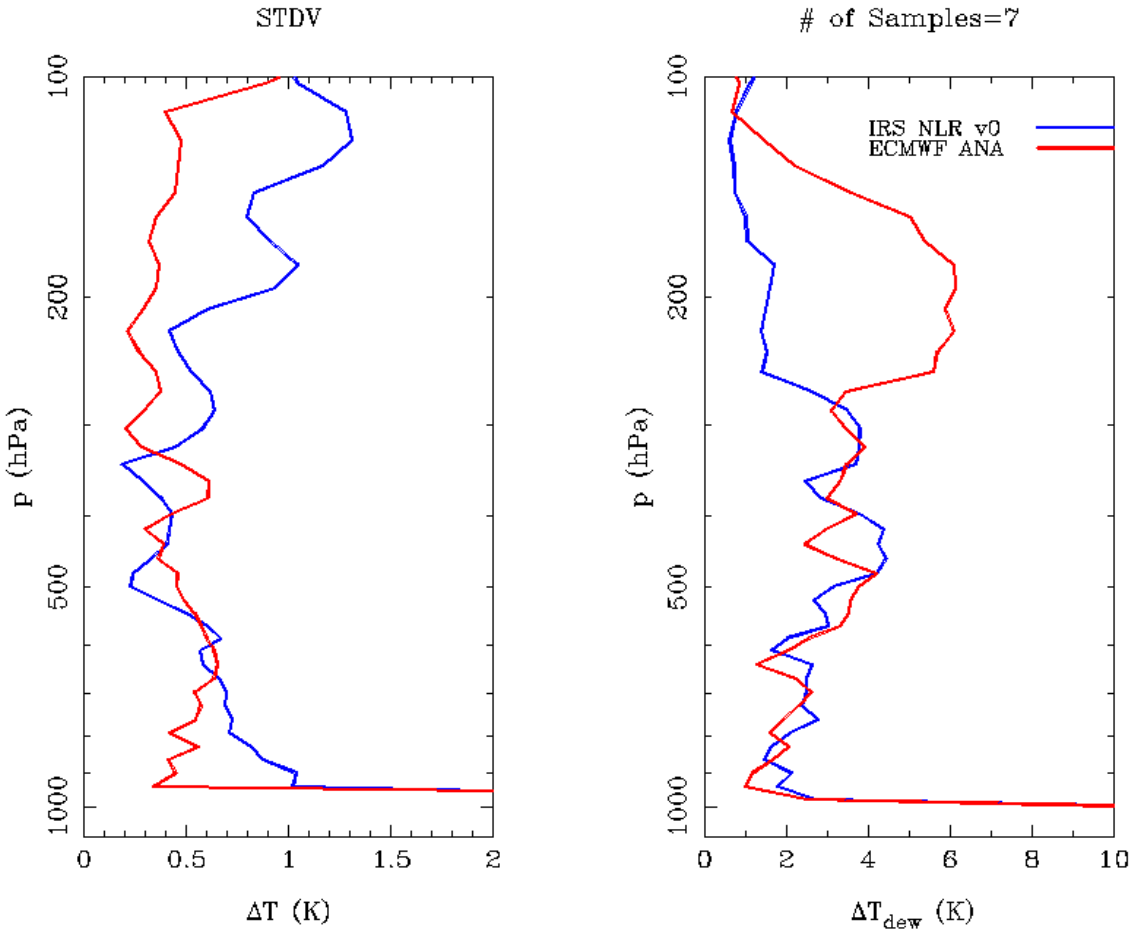
Cal/Val Strategy: Comparison

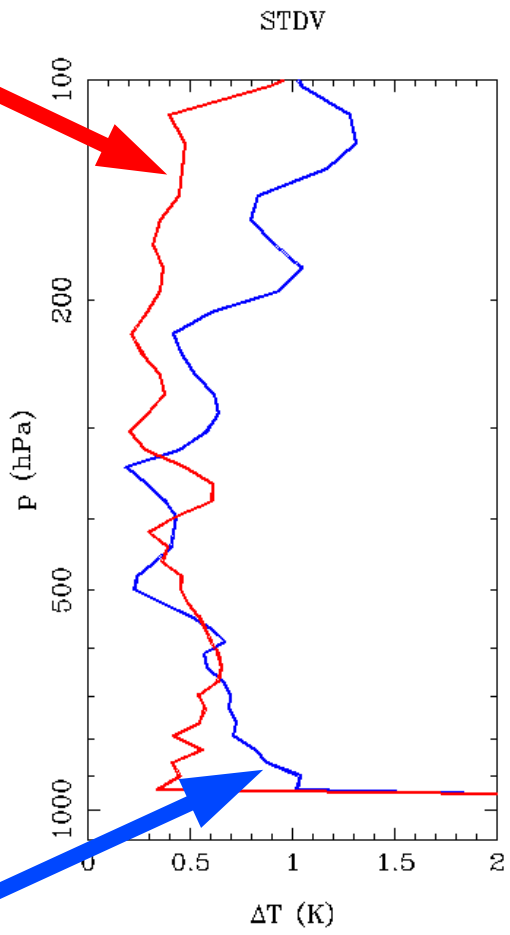
4. Comparison
   - Comparison of both measurements can be made
   - Conclusions can be drawn. Examples:
     - Statistics of IASI retrieved profiles versus Sondes
     - Its variation with increasing collocation radius
     - Potential issues with Sondes
     - Problems from RTM

Cal/Val Strategy: Comparison: Profile Statistics

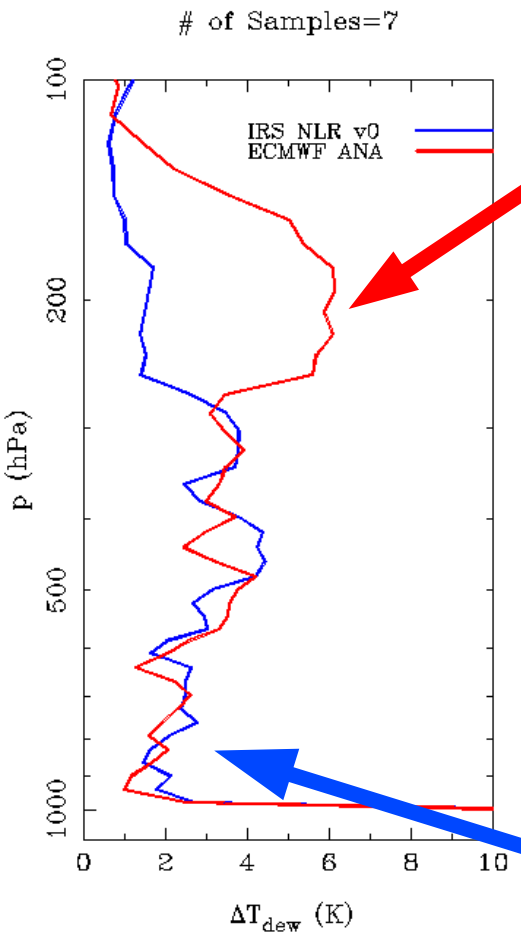


Cal/Val Strategy: Comparison: Profile Statistics

ECMWF T matches very well



ECMWF Humidity off in upper Tropo



IASI T very well for mid Tropo, good for the rest

ECMWF and IASI Humidity good for mid and low Tropo

Dependency of Statistics with Collocation Radius

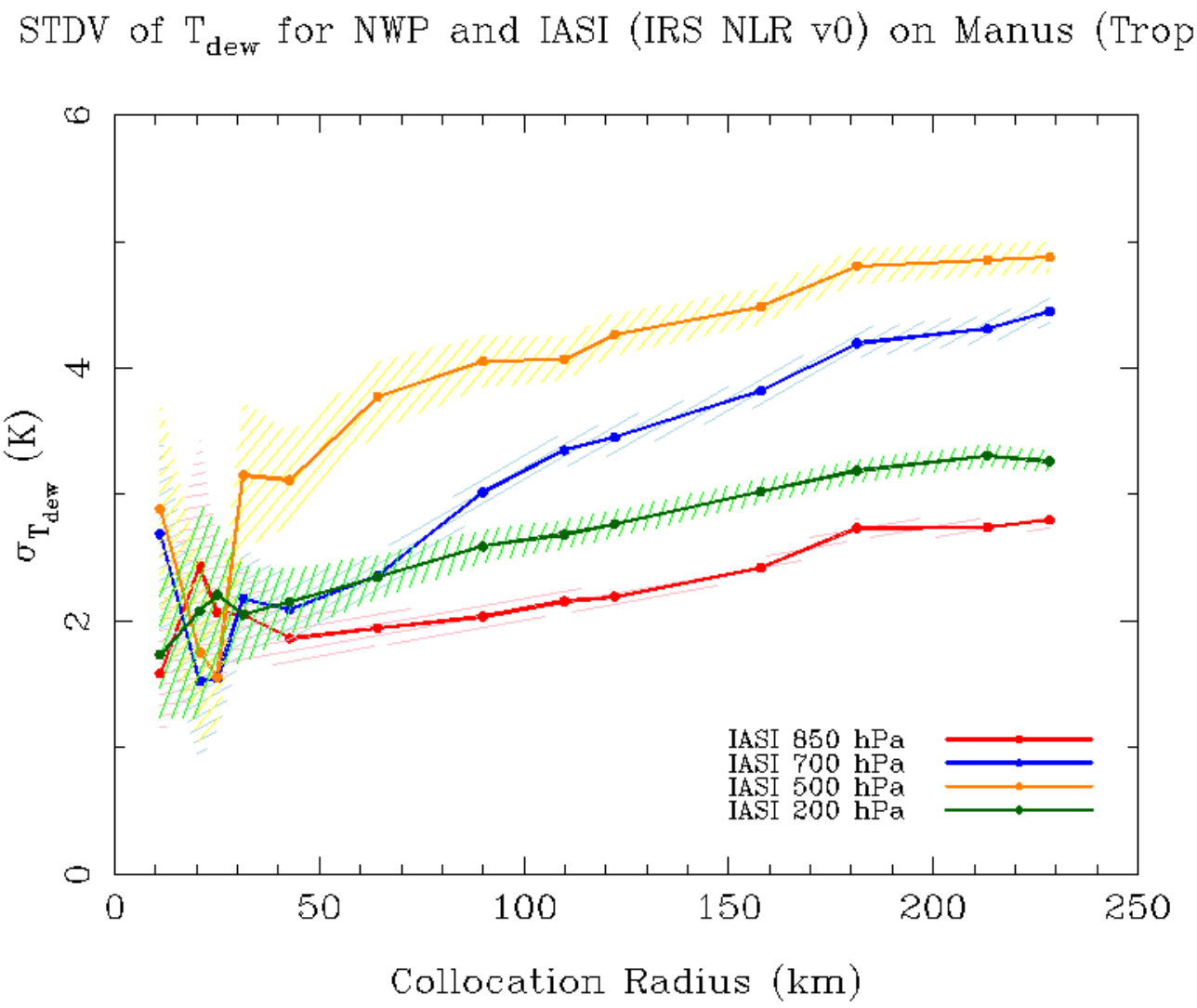
Perfect Measurement. Bias Random Error

$$\text{IASI: } H_I(x_I) = H(x_I) + \mu_I + \sigma_I$$

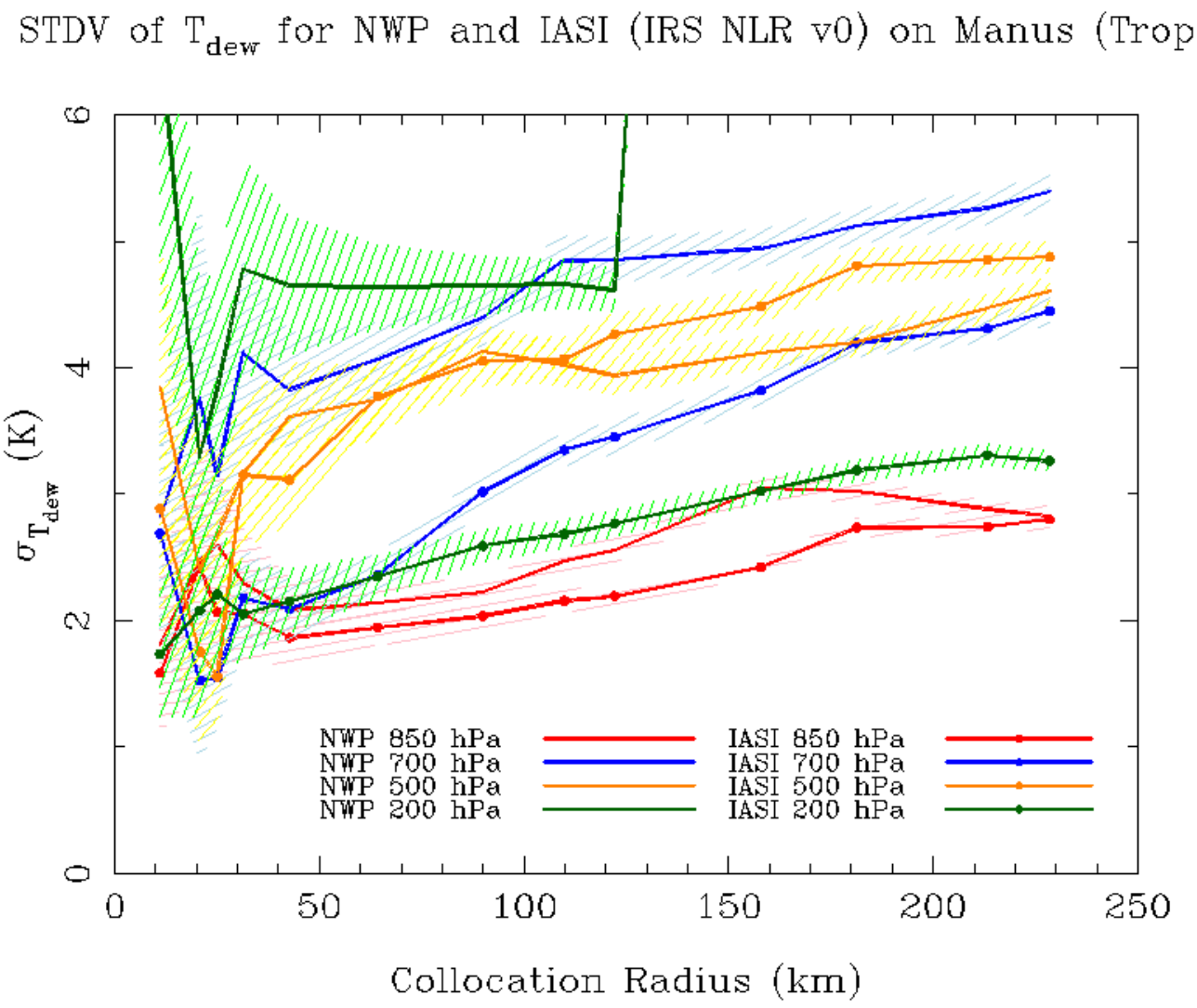
$$\text{GRUAN: } H_S(x_S) = H(x_S) + \mu_S + \sigma_S$$

$$\text{Validation: } \sigma^2(H_I - H_S) = \sigma^2_C + \sigma^2_I + \sigma^2_S$$

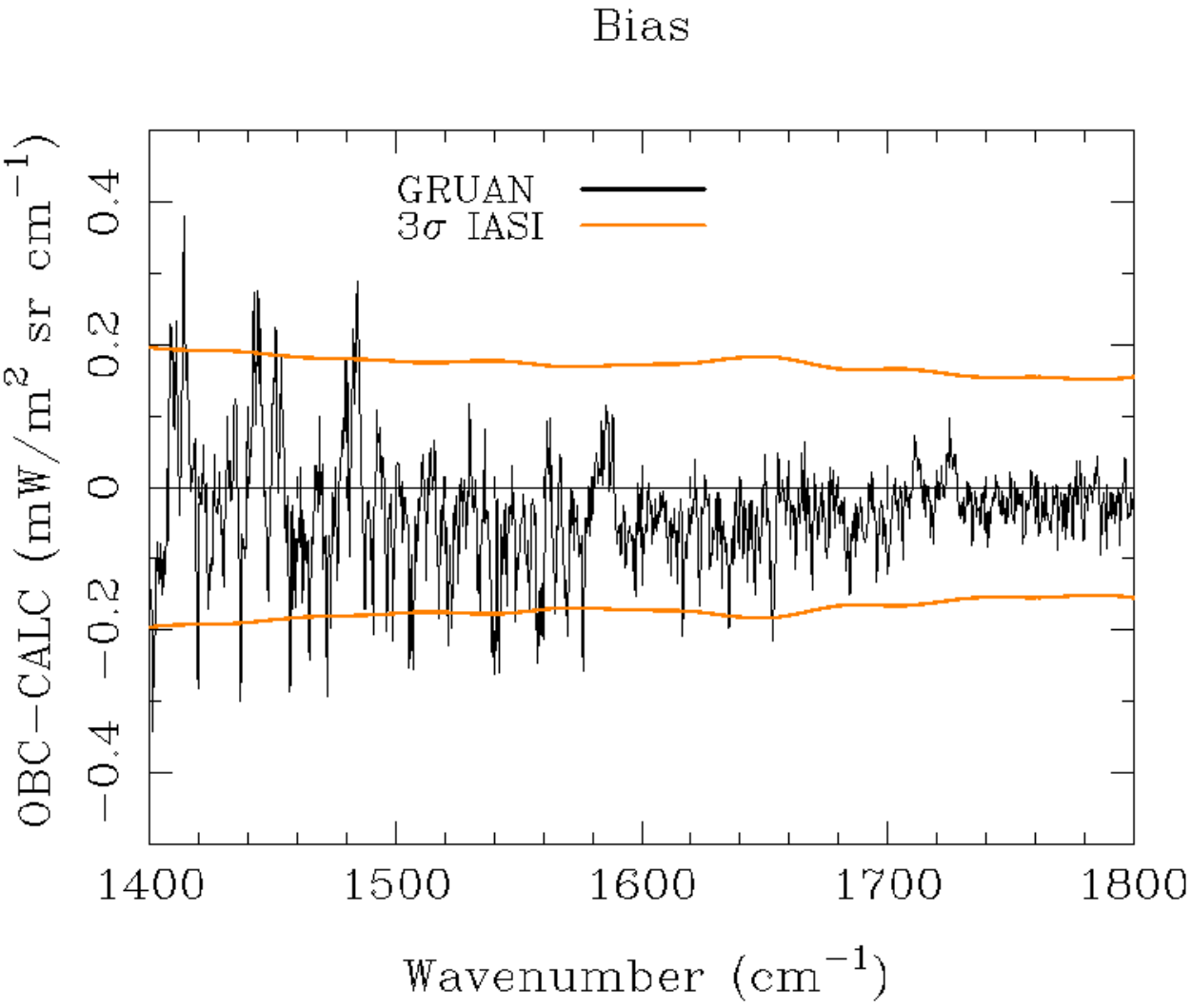
Dependency of Statistics with Collocation Radius



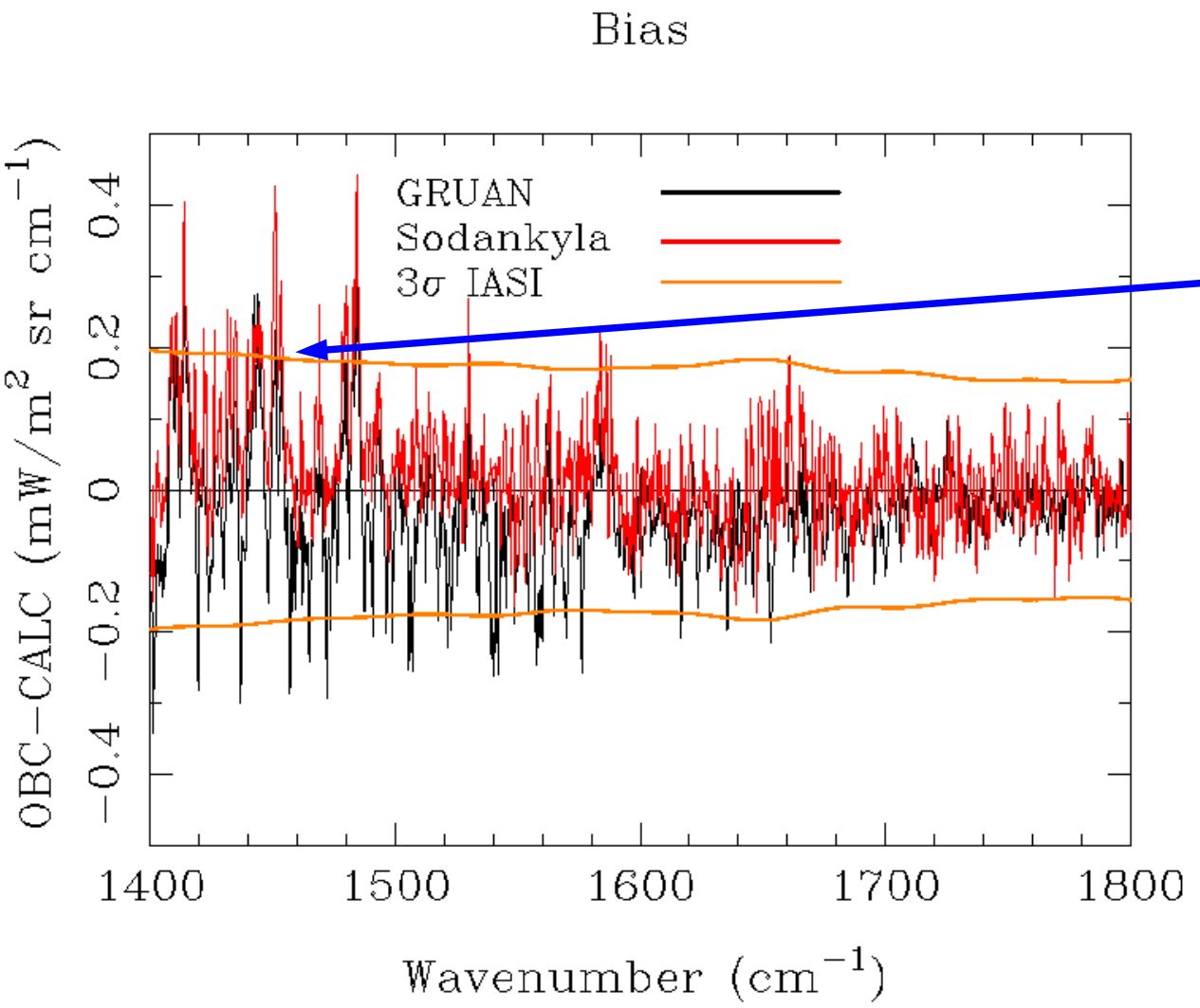
Dependency of Statistics with Collocation Radius: can this be modelled with ECMWF?



Cal/Val Strategy: Comparison: Radiance Bias



Cal/Val Strategy: Comparison: Radiance Bias



RTM WV Continuum problem?
S. Newman

Other Examples

Reference	Instruments	Collocation	Pre-processing	Consistency check	Conclusion
Sodankylä	•RS92+CFH -1 hour •RS92 -5 min	25 km 30 min	•Time interpol. •In situ bias correction •Clear cases	•Passed 4 out of 4	•Good measurement strategy and processing
SALSTICE	•RS92 type Dropsondes approx. IASI collocated	25 km 30 min	•No interpol. •Kivi RH bias correction •Clear cases	• Not all passed (~15/30)	•Needs further work
GRUAN	•RS92 Sondes at 00 and 12 UTC (Manus is IASI collocated)	25 (500) km 30 min	•No interpol. •Direct GRUAN data •Clear cases	•Passed 7 out of 8	•Good measurement strategy and processing

CONCLUSIONS

- Only Manus is well located with launches at 00 and 12 UTC to collocate well with IASI. Only 8 clear sky collocations in one year.
- GRUAN humidity needs to be corrected with RH+4%. An issue most likely from the RTM, but...?
- RTM issue with the Water Vapour Continuum?
- Consistency check reduces collocation errors to a minimum.
- For most atmospheric levels, the collocation error for humidity, in Manus, can be modelled with ECMWF.
- ECMWF humidity not accurate at 200 hPa in this region.
- More interaction possible between RTM, Sat and Sonde groups?