The ongoing collaboration between GRUAN and the radio occultation community

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Motivation

- GRUAN-GSICS[1]-GNSS-RO[2](3G) workshop in Geneva
  - better connect GRUAN with satellite community
  - compare methods for uncertainty estimation, cal/val
  - discuss how to better serve climate/meteorological application
  - discuss future observing system design
- Comparison of entirely independent measurement techniques can reveal biases and uncertainties in measurements/retrieval
- In the recent years there is an increased exchange between the communities!

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[1] Global Space-based Intercalibration System

[2] Global Navigation Satellite System Radio Occultation

Comparison of RO and GRUAN data at Lindenberg

GRUAN - radio occultation collaboration

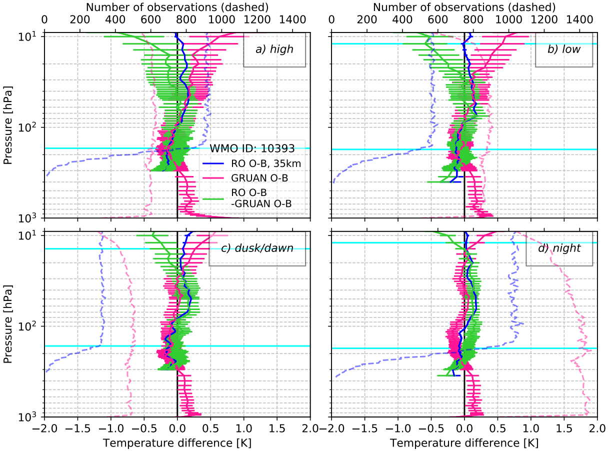
Jordis Tradowsky

Motivation

GRUAN - RO comparison

GRUAN uncertainty propagation

I have been working as a visiting scientist within the Radio Occultation Meteorology Satellite Application Facility and compared GRUAN and RO data as part of the project.



Propagating the GRUAN uncertainties

Propagation of uncorrelated uncertainties:

$$\overline{u_{uncorr}} = \frac{1}{N}\sqrt{\sum_{i=1}^{N} u^2_{uncorr,i}} \quad (1)$$

where the uncertainty decreases with $1/\sqrt(N)$.
Propagation of correlated uncertainties:

$$\overline{u_{corr}} = \frac{1}{N}\sum_{i=1}^{N} u_{corr,i} \quad (2)$$

The total uncertainty on the mean temperature is calculate from the correlated and uncorrelated component as:

$$\sigma_{\overline{T_{GRUAN}}} = \sqrt{\overline{u_{corr}}^2 + \overline{u_{uncorr}}^2} \quad (3)$$

Uncertainty components

Parameter	Value	(Un)correlated	Data field in product
Repeatability of calibration of the T sensor $u_c(\mathrm{cal})$	0.15 K	correlated	
Absolute uncertainty of T sensor calibration $u_{\mathrm{c,\,cal}}(T)$	$\sqrt{u_c(\mathrm{cal})^2 + (\Delta T_{\mathrm{GC25}}/3)^2}$	correlated	u_cor_temp*
Uncertainty in T due to spike removal	0.05 K	correlated	
Uncertainty in T due to sensor time-lag	$<$ 0.03 K	correlated	
$\sigma(T)$	Statistical standard deviation	uncorrelated	u_std_temp*
Random uncertainty of temperature $u_\mathrm{u}(T)$	Statistical uncertainty $\sigma(T)/\sqrt{N'}$	uncorrelated	
Uncertainty of ΔT due to rotating radiosonde $u_{\mathrm{u,\,rot}}(\Delta T)$	$2 \cdot \Delta T/\sqrt{3}$	uncorrelated	
Uncertainty of I_a due to albedo $u_\mathrm{c}(I_\mathrm{a})$	$\frac{1}{2\cdot\sqrt{3}}\lvert I_\mathrm{a}^{\text{clear sky}} - I_\mathrm{a}^{\text{cloudy}}\rvert$	correlated	u_swrad*
Uncertainty in ΔT due to uncertainty in albedo $u_{\mathrm{c},I_\mathrm{a}}(\Delta T)$	$\Delta T \cdot u_\mathrm{c}(I_\mathrm{a})/I_\mathrm{a}$	correlated	
Uncertainty in ventilation velocity $u(v)$	$1\,\mathrm{m\,s^{-1}}$	uncorrelated	
Uncertainty in ΔT due to ventilation uncertainty $u_{\mathrm{u,\,vent}}(\Delta T)$	$\Delta T \cdot u(v)/v$	uncorrelated	
Uncertainty in ΔT due to uncertainty in parameters a and b $u_{\mathrm{c,RC}}(\Delta T)$	$<$ 0.2 K	correlated	
Total uncertainty	$[u_{\mathrm{c,\,cal}}(T)^2 + u_\mathrm{u}(T)^2 + u_{\mathrm{u,\,rot}}(\Delta T)^2 + u_{\mathrm{c},I_\mathrm{a}}(\Delta T)^2 + u_{\mathrm{u,\,vent}}(\Delta T)^2 + u_{\mathrm{c,RC}}(\Delta T)^2]^{1/2}$	–	u_temp*

$\rightarrow$ separate correlated and uncorrelated uncertainties as far as possible and propagate them individually

Thank you for your attention!

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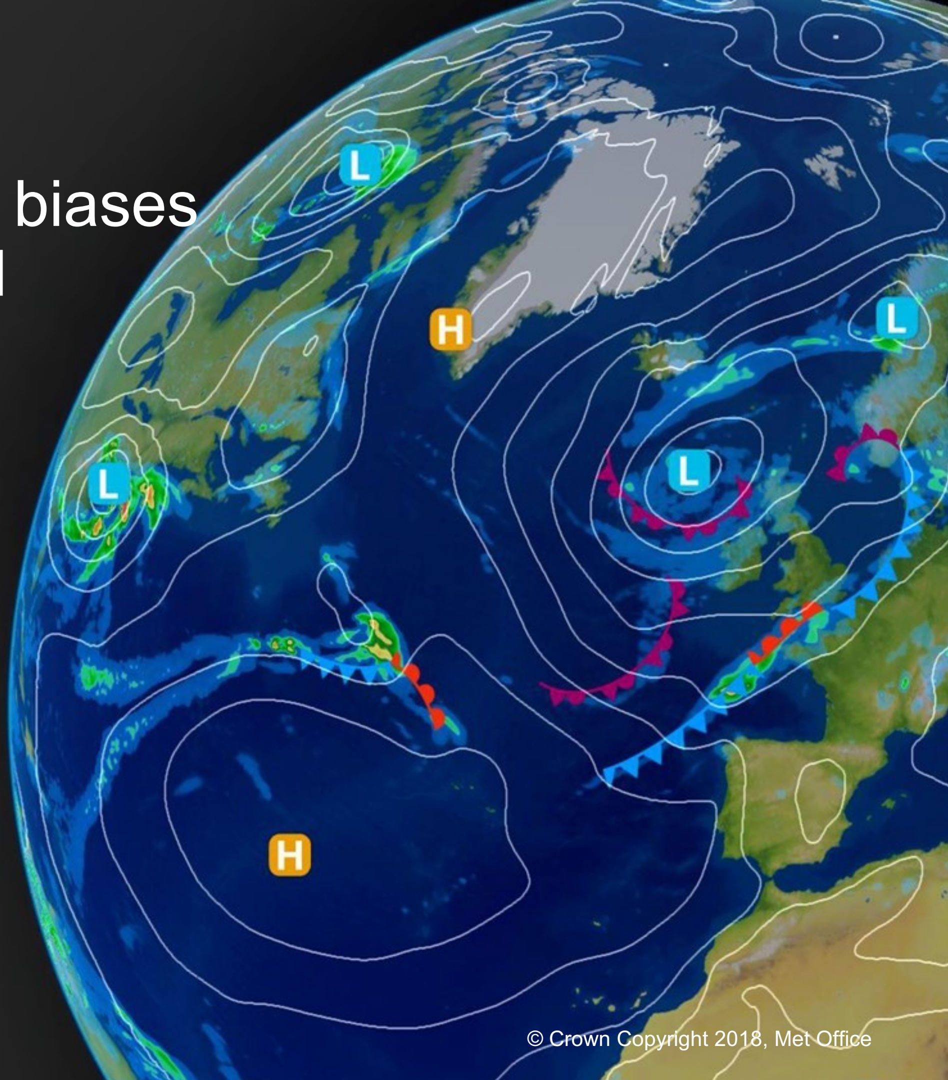
Characterisation of NWP model biases and uncertainties using GRUAN radiosondes

Fabien Carminati, Stefano Migliorini, Bruce Ingleby (ECMWF), Heather Lawrence (ECWMF)

Special thanks to Jordis

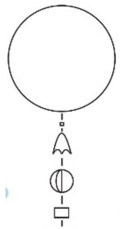
ICM-11 2019



How can we “robustly” characterise model biases and uncertainties?

By assessing the model fields with a well characterised reference measurements:
GRUAN

But this need to be done in the same space as that of the O-Bs, i.e. in **radiance space**.



P, T, q
& uncertainties

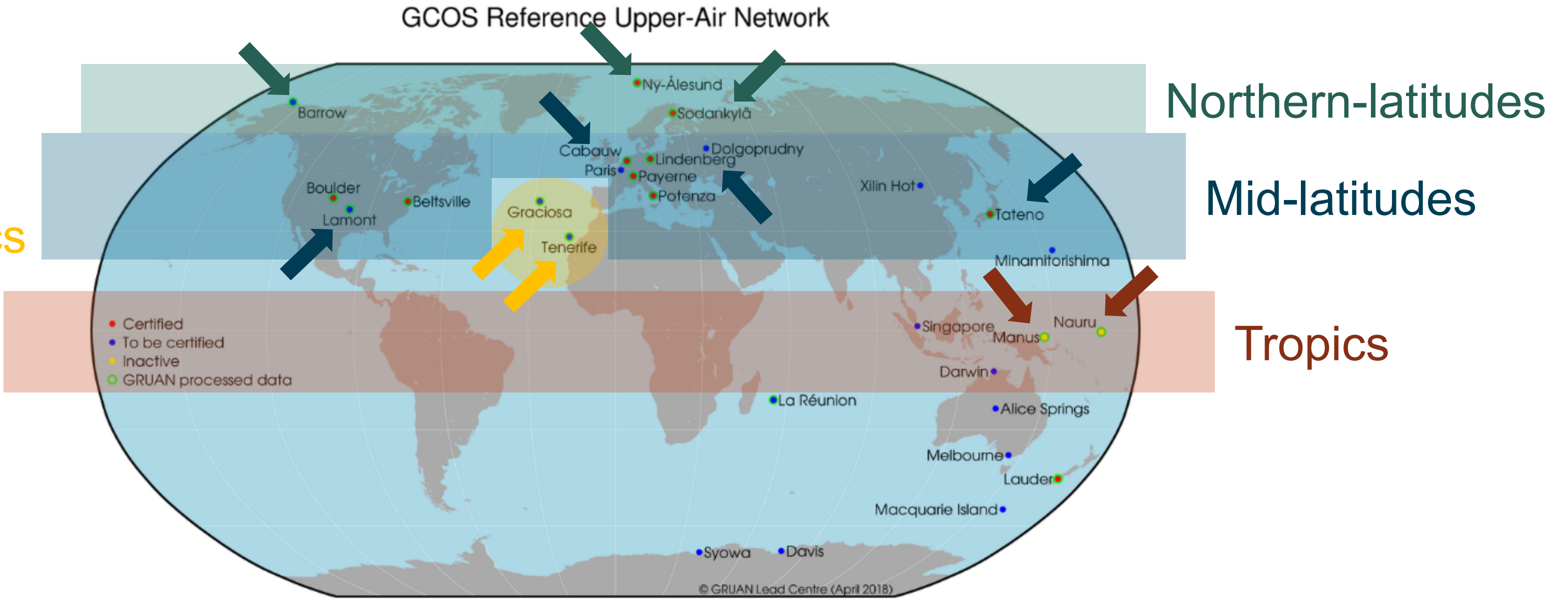
P, T, q
& uncertainties

GRUAN Processor
(Radiance Simulator + RTTOV +
GRUAN processing capability)

ΔTb
& uncertainty

(see Carminati et al., 2019, for details) https://www.atmos-meas-tech.net/12/83/2019/amt-12-83-2019.html

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



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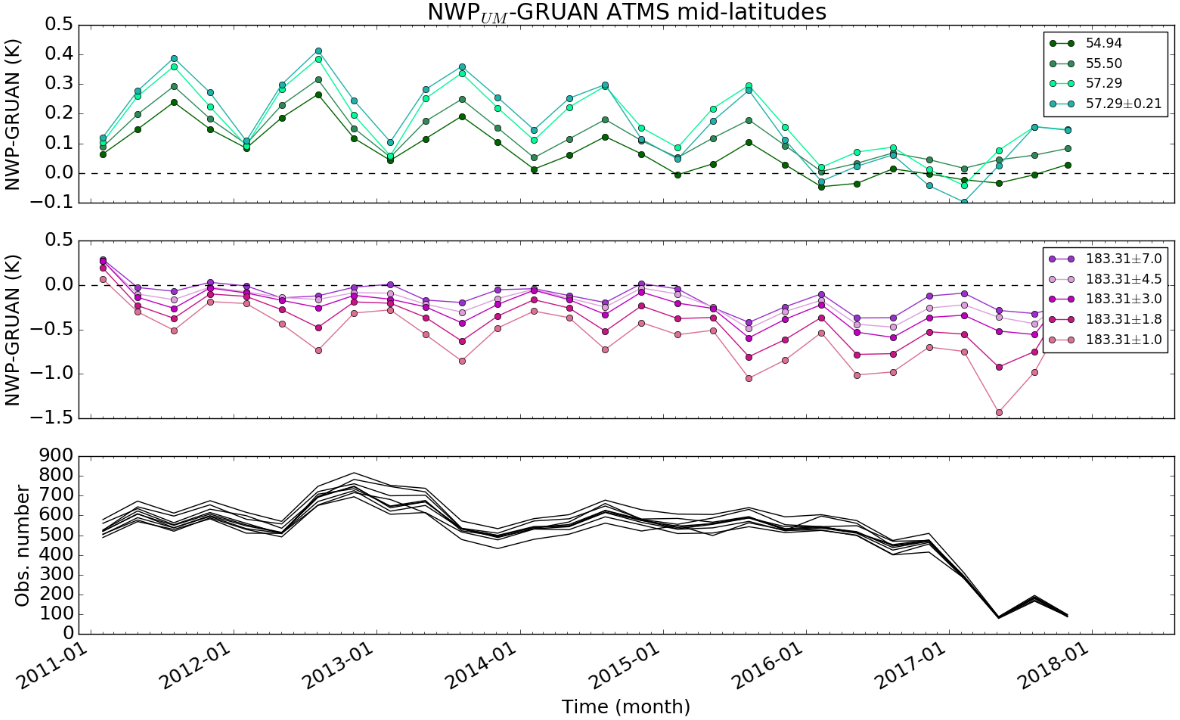
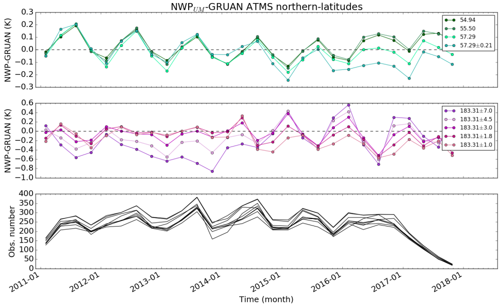
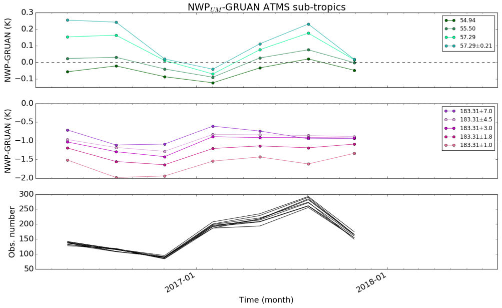
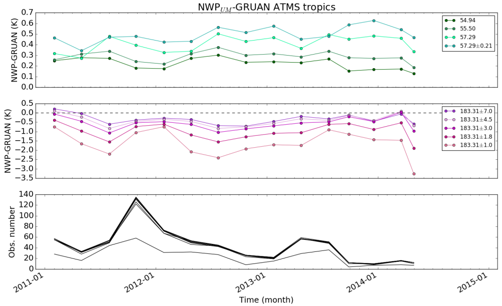
Time series (Met Office)

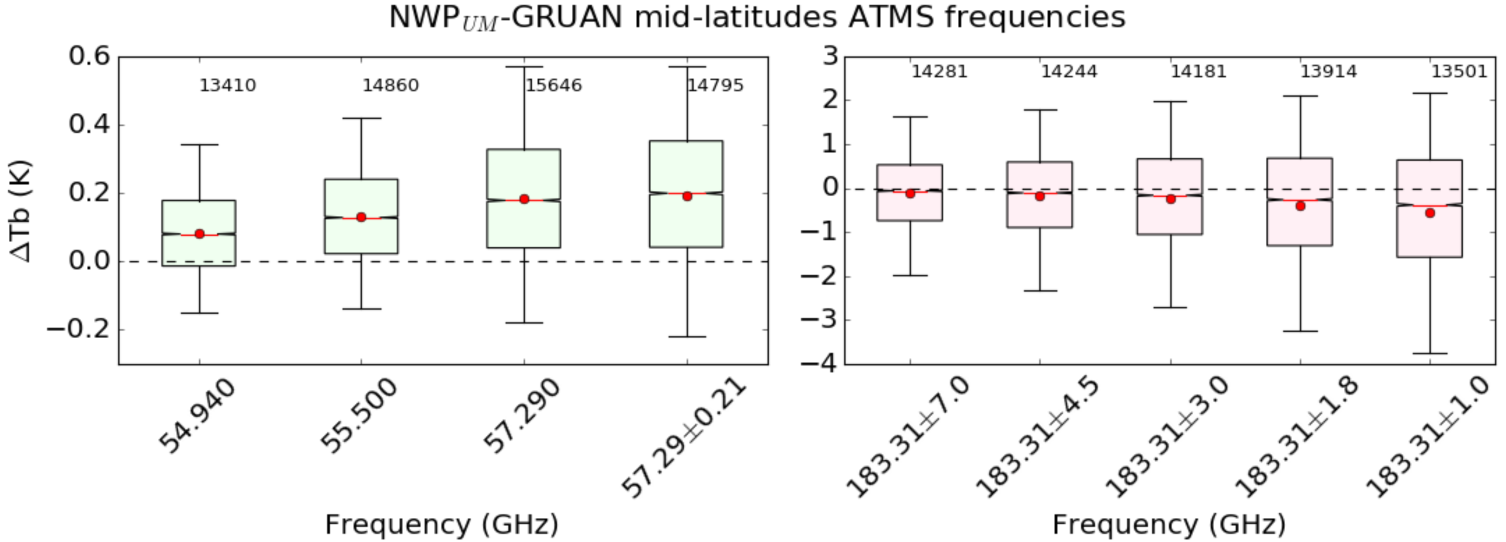


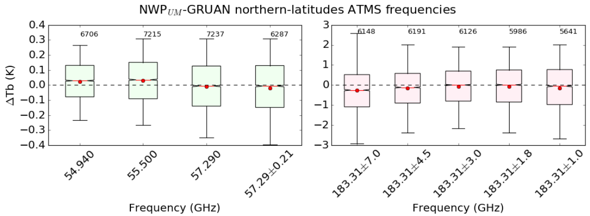


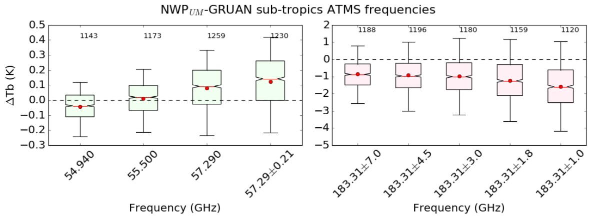


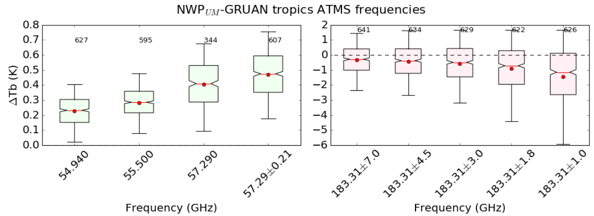


Box plot (Met Office)

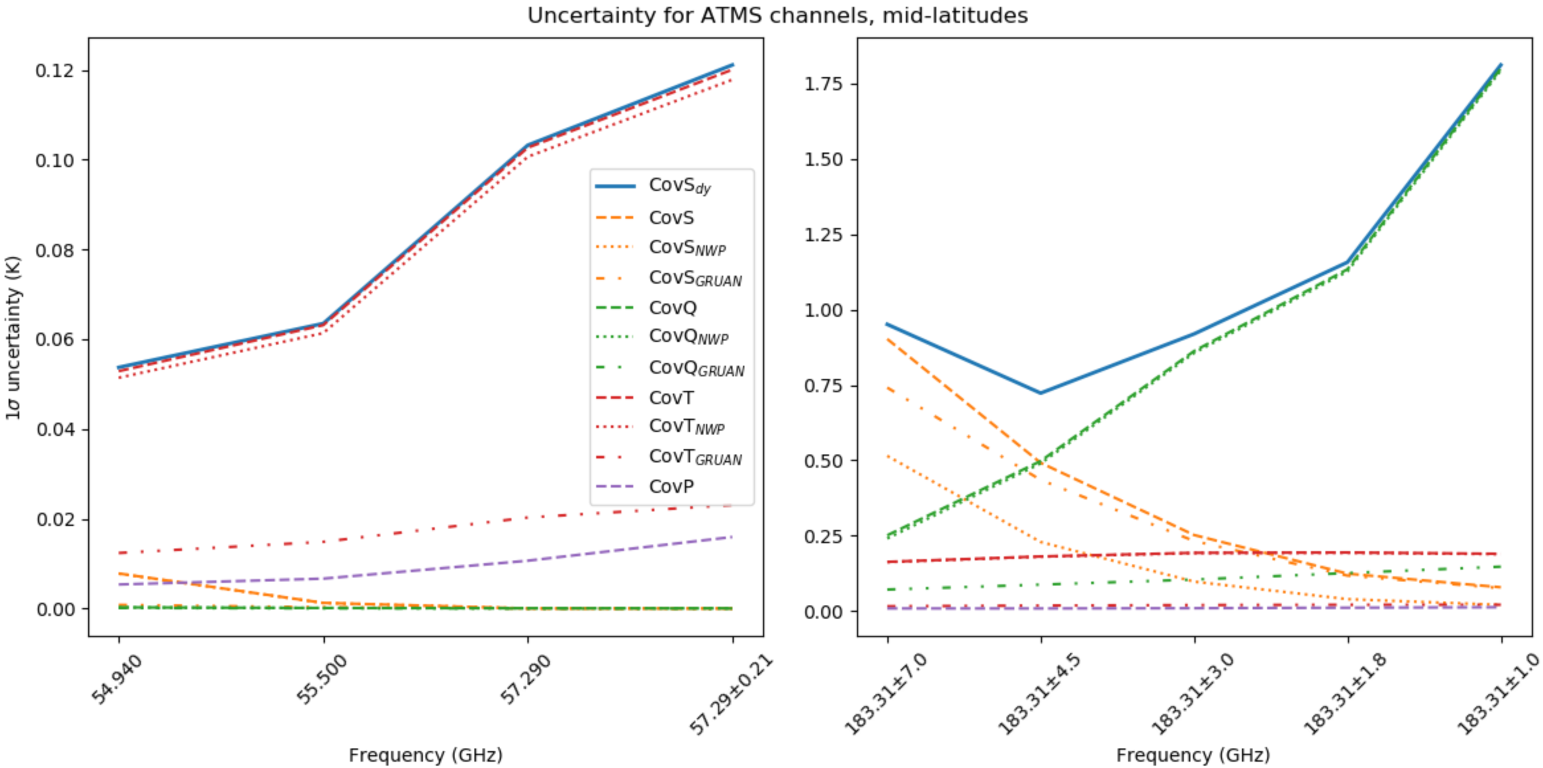








Uncertainty estimation work in progress (Met Office)



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Thank you