Consistency and uncertainties of GDPs

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General thoughts

Very few thoughts to foster the discussion on the:

- Requirements for uncertainties of GDPs
- Quality assurance system
- Monitoring of GDP time series homogeneity

These slide do not include anything on parallel soundings (FORUM3 shall discuss the topic)

GCOS requirements for temperature

For PBL and FT

Required Measurement Uncertainty (2-sigma)	K	RMS	G B T	0.1 0.5 1	These values are inferred based on the standard deviations of 6-hourly analysis with respect to the monthly climatolcgy. (T) corresponds to regions of high variability, (B) of medium variability and (G) of low variability. RMS departures of observed values from first guess field values, in accordance with the practical verification schemes applied by the GUAN Monitoring Centre for upper-air observations.
Stability	K/decade		G B T	0.01 0.05 0.1	These values are based on the need to detect temperature trends such as those observed in recent decades (IPCC 2013). (T) corresponds to regions of large trend or 50% of observed global-mean trend, (B) regions of medium trend or 20% of global-mean trend, and (G) regions of small trend or 10% of global-mean trend.

For the UT/LS

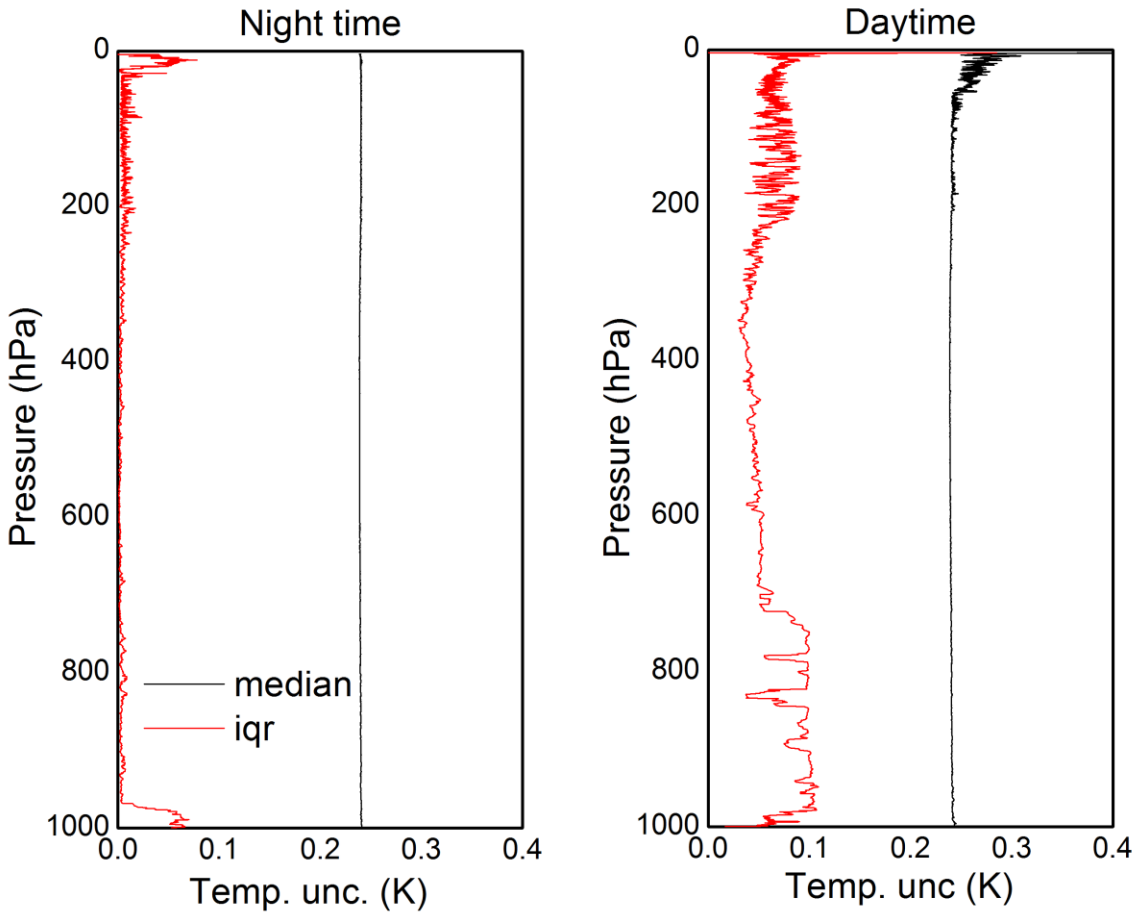
Stability	K/decade		G B T	0.01 0.02 0.05	These values are based on the need to detect temperature trends such as those observed in recent decades (IPCC 2013; Lübken et al. 2013). (T) corresponds to regions of large trend or 50% of observed global-mean trend, (B) regions of medium trend or 20% of global-mean trend, and (G) regions of small trend or 10% of global-mean trend.
Required Measurement Uncertainty (2-sigma)	K	RMS	G B T	0.1 0.5 1	These values are inferred based on the standard deviations of 6-hourly analysis with respect to the monthly climatolcgy. (T) corresponds to regions of high variability, (B) of medium variability and (G) of low variability. RMS departures of observed values from first guess field values, in accordance with the practical verification schemes applied by the GUAN Monitoring Centre for upper-air observations.

GCOS requirements for RH

For PBL and FT

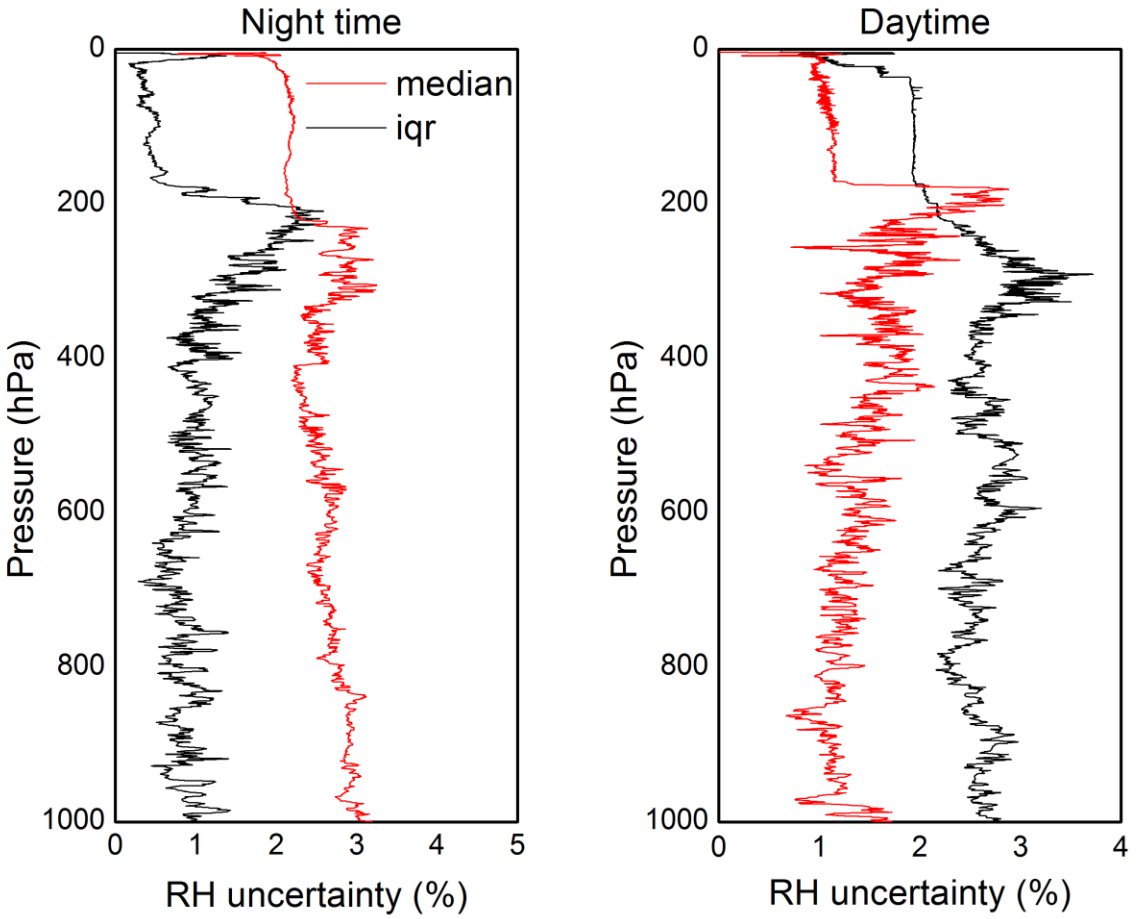
Required Measurement Uncertainty (2-sigma)	%RH		G	0.1	
			B	0.5	
			T	1	
Stability	%RH/decade		G	0.1	
			B	0.5	
			T	1	
Standards and References	McCarthy, 2007 https://doi.org/10.1002/joc.1611				

Temperature uncertainties



- Median and IQR uncertainties on a subset (20%) of measurements at all GRUAN stations using RS41.
- Temperature uncertainties suitable for the study of medium-small climate variability.

RH uncertainties



- Median and IQR uncertainties on a subset (20%) of measurements at all GRUAN stations using RS41.
- RH uncertainties unsuitable for the study climate variability according to the GCOS requirements for the free troposphere.

Quality checks: stability and homogenneity

To check the stability and homogeneity of the time series different approches may be applied.

Options to implement are:

1. Annual standard deviation/interquartiles of the time series
2. Day/night differences of 00 and 12 UTC profiles within a same day
3. Comparison among GDPs
4. Mutiple quality checks (e.g. see IGRA approach)

Day - night differences of GDPs

Diurnal temperature variations up to 10 hPa (ca 35km) are nowadays well observed from several observing platforms. RO data are an excellent independent dataset to compare with. From Leroy and Gleisner (2021) difference must be within 0.5 K in upper-air data.

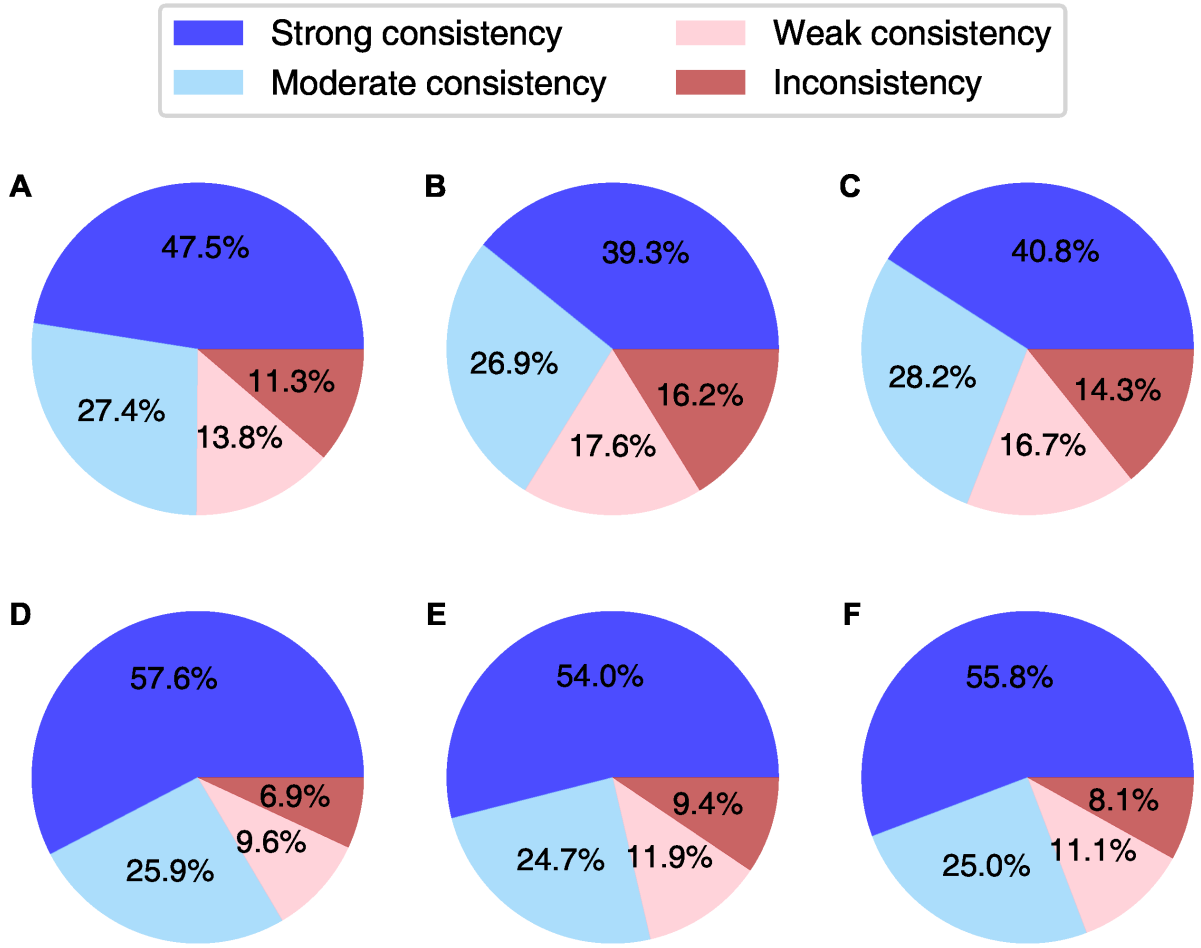
- Example of average 00-12 UTC temperature variations for three GRUAN station (with sufficient statistics)

Day-night mean difference in K at 20hPa

Station	GRUAN	RHARM	CUON
LIN	-0.28	-0.38	-0.20
TAT	-0.02	-0.14	-0.05
TEN	-0.15	-0.45	-0.43

- Having two measurements night&day in 12 hours at each station allow applying this check (could it become a recommendation for the site measurement scheduling?)

Consistency between IPW from upper-air and GNSS



(A–C) Nighttime and (D–F) daytime consistency between (A,D) IGS vs. RHARM, (B,E) IGS repro3 TUG vs RHARM and (C,F) IGS repro3 COD vs RHARM according to the approach proposed by Immler et al.

From Rannat et al., 2023

Possible approach to perform systematic comparison once the GNSS IPW GDP will be available

Final message

- Need to discuss what are the requirements for the uncertainty of GRUAN measurements
- Many options to setup a quality assurance framework
- From the technical point of view, there are already work completed within this community that can be made available to GRUAN for further improvement/implementation