Results from radiosonde GDP comparison soundings

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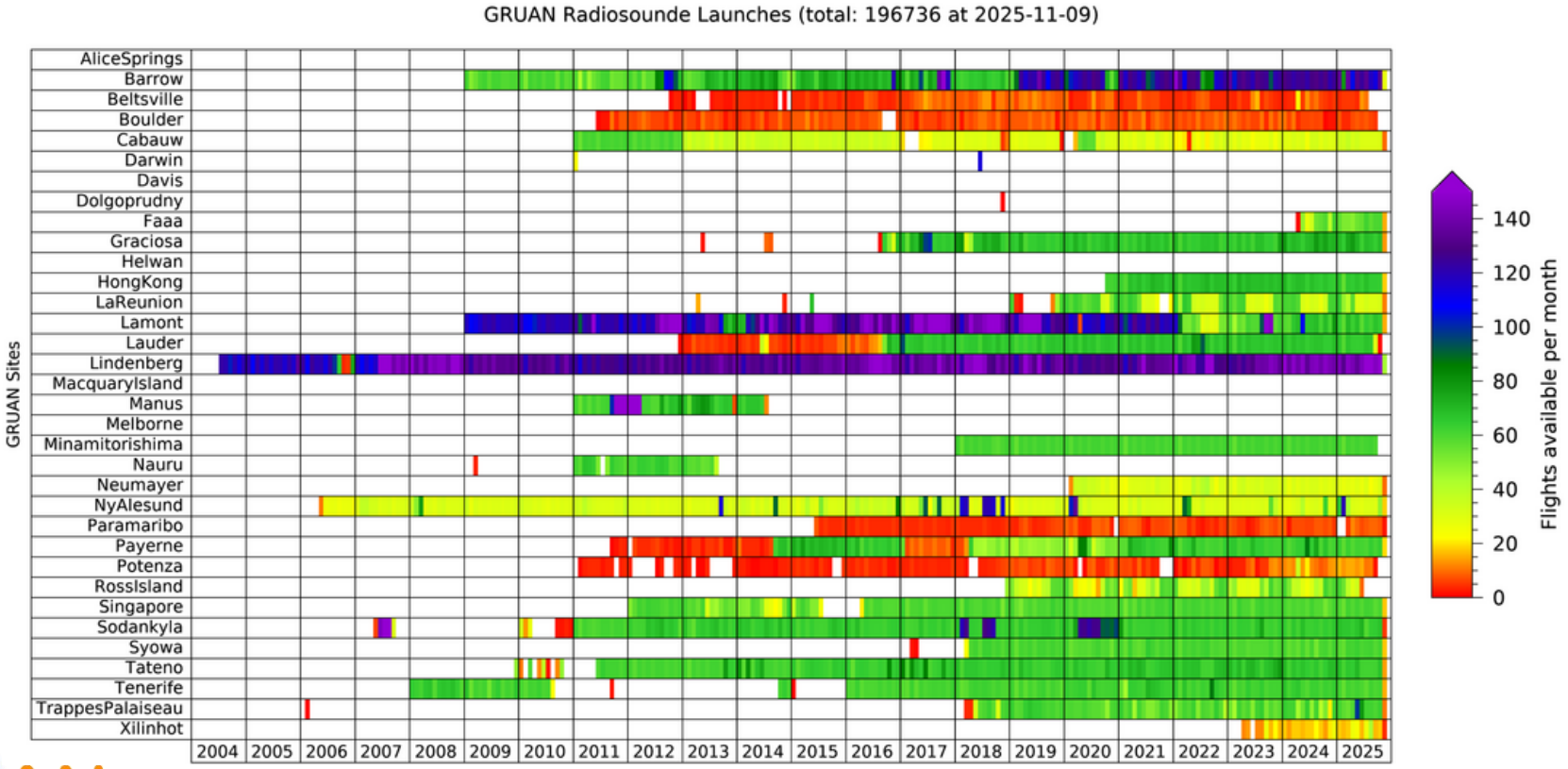
Motivation

- Continuous RS measurements over 10-15 years at some GRUAN sites
- Covered time spans increasingly suitable for trend analyses
- Sites use different RS models; model changes
  → Comparison soundings as tool to validate data quality and consistency, and validate uncertainty estimates



Outline

- LC carries out regular RS comparison soundings about once per week since May 2023 of RS with existing or envisaged GDPs:
  - 116 launches, 4 RS, including twin flights for some RS
  - Day and night, all seasons

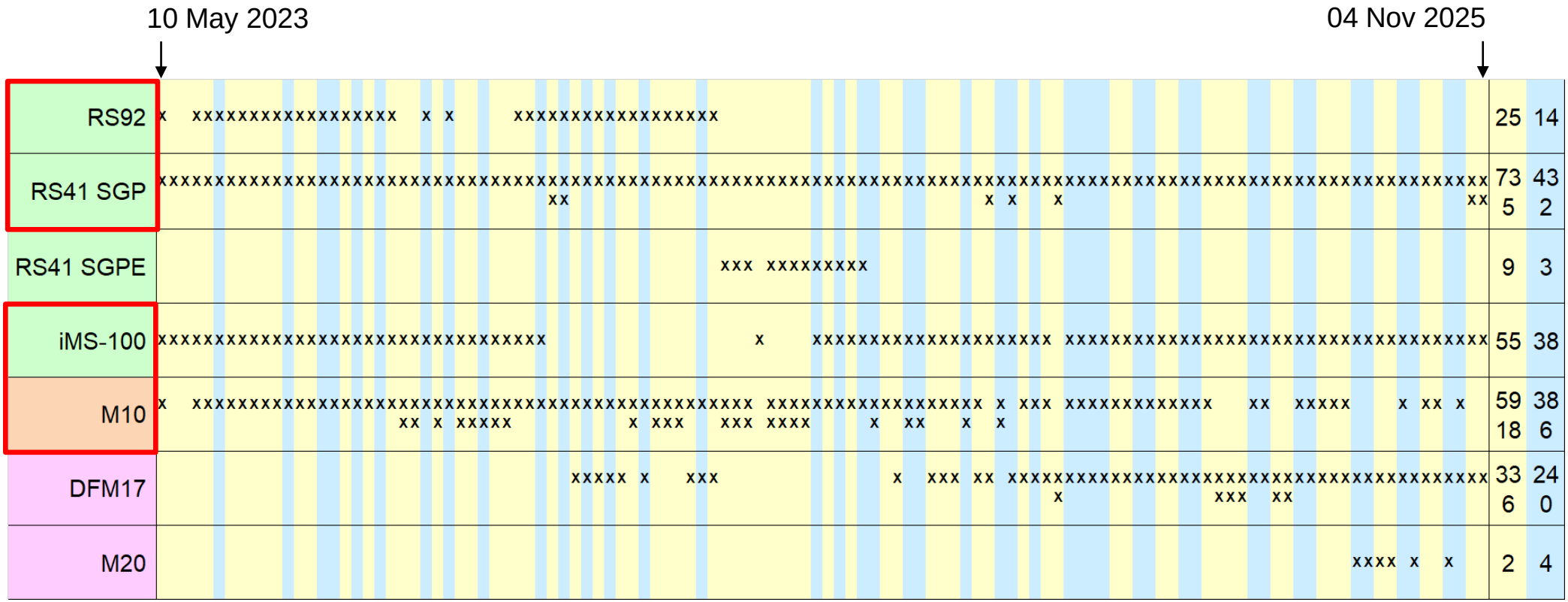
- **Preliminary analysis** of comparison profiles:
  - Mainly LIN, including flights from UAII2022,
    but also some results from comparisons performed at other sites
  - Limited to T und RH; no seasonal resolution
  - GDP uncertainties not (yet) included
    (no uncertainty-based analysis of significance of biases)

  → First insight into main characteristics and variability of differences

GDP comparison program, Lindenberg

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- 116 launches (May 2023 to Nov 2025), 73 daytime, 43 night-time



GDP comparison program, Lindenberg

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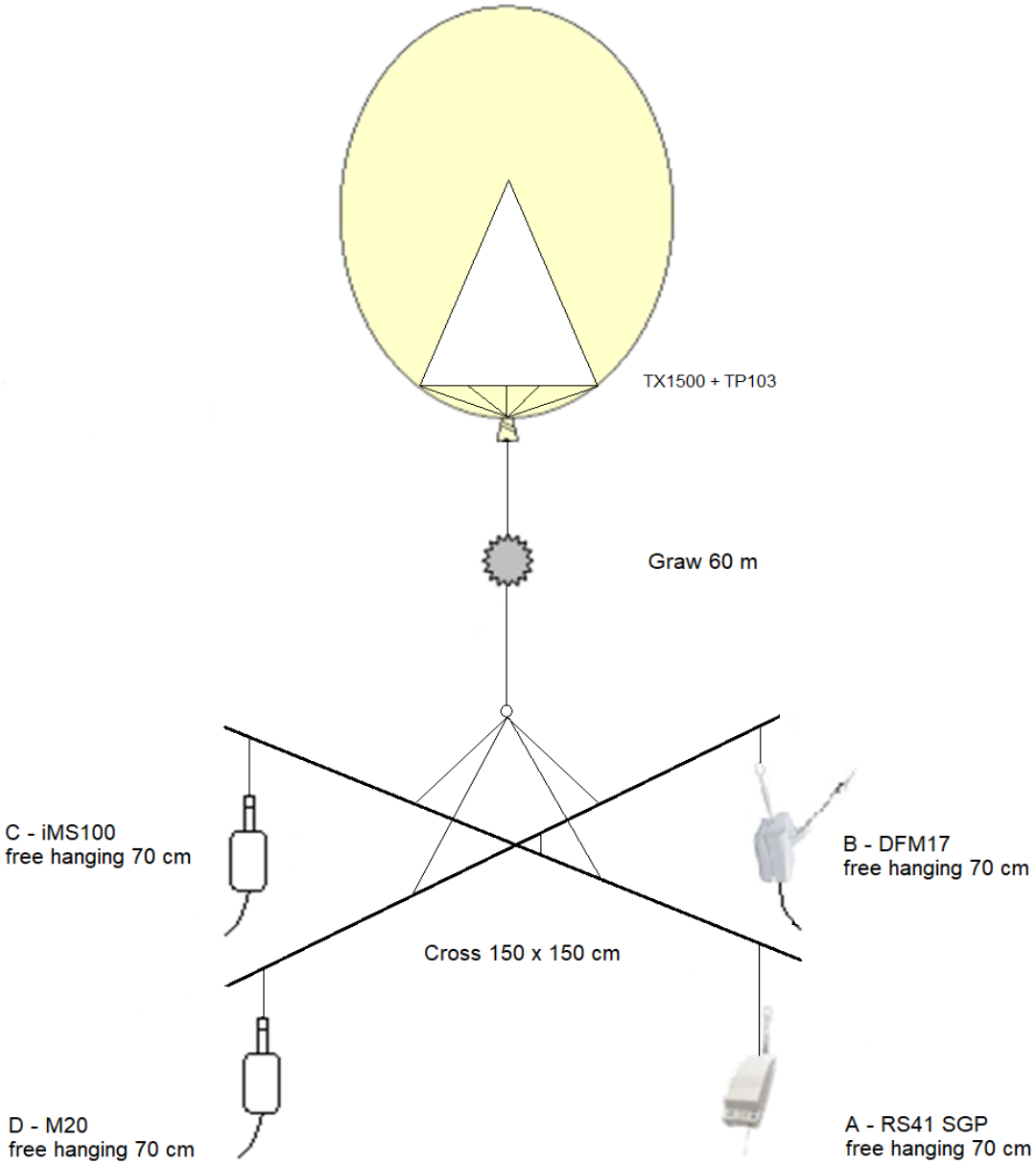


Assessment criteria

WMO (OSCAR) requirements for the observation of geophysical variables (GCOS-245, 2022)
Application Area: *Atmospheric Climate Monitoring*
https://space.oscar.wmo.int/observingrequirements

Variable	Atmospheric layer	'Threshold'	'Breakthrough'	'Goal'
T / K	PBL, FT, UTLS, MUS	0.5	0.25	0.05
RH / %RH	PBL, FT	0.5	0.25	0.05
	UTLS	1.0	0.5	0.25

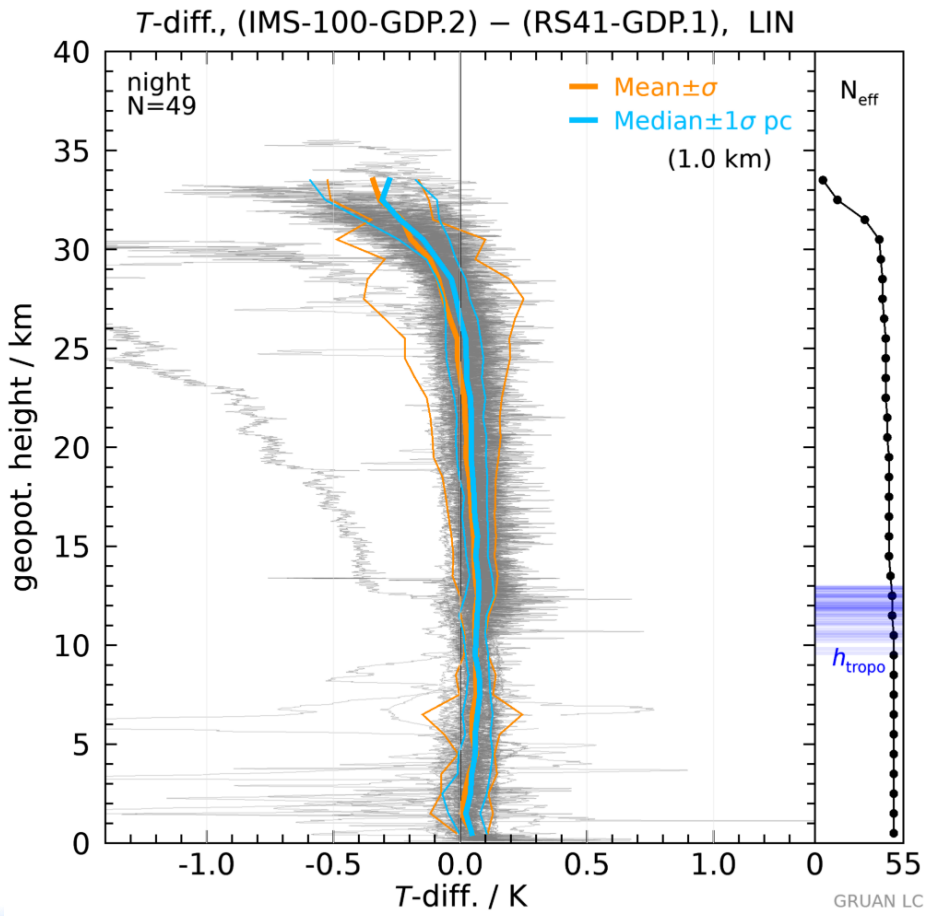
Estimated range of observation errors (RMSE) with a 68 % (1σ) confidence interval.

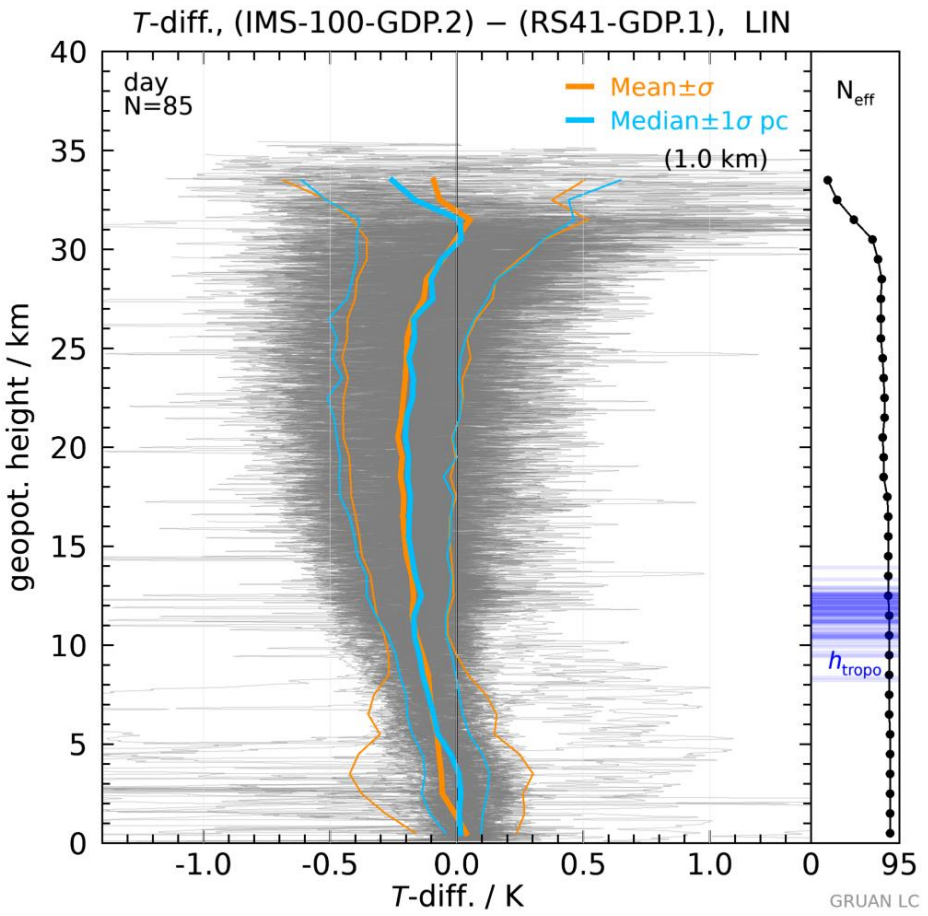
'Threshold': Minimum requirement to be met to ensure that **data are useful**
'Goal': **Ideal** requirement above which further improvements are not necessary
'Breakthrough': **Intermediate level** between "threshold" and "goal" (significant improvement for the targeted application)

iMS-100-GDP.1 – RS41-GDP.1 (LIN), Temperature

- Lindenberg GDP comparison program + UAII 2022 (CWS)
- Night: $|\Delta T| \leq 0.1$ K, >28 km bias (LW effect?), $\sigma_{\Delta T} \approx 0.1$ K
- Day: $|\Delta T| \leq 0.25$ K, $\sigma_{\Delta T} \leq 0.3$ K

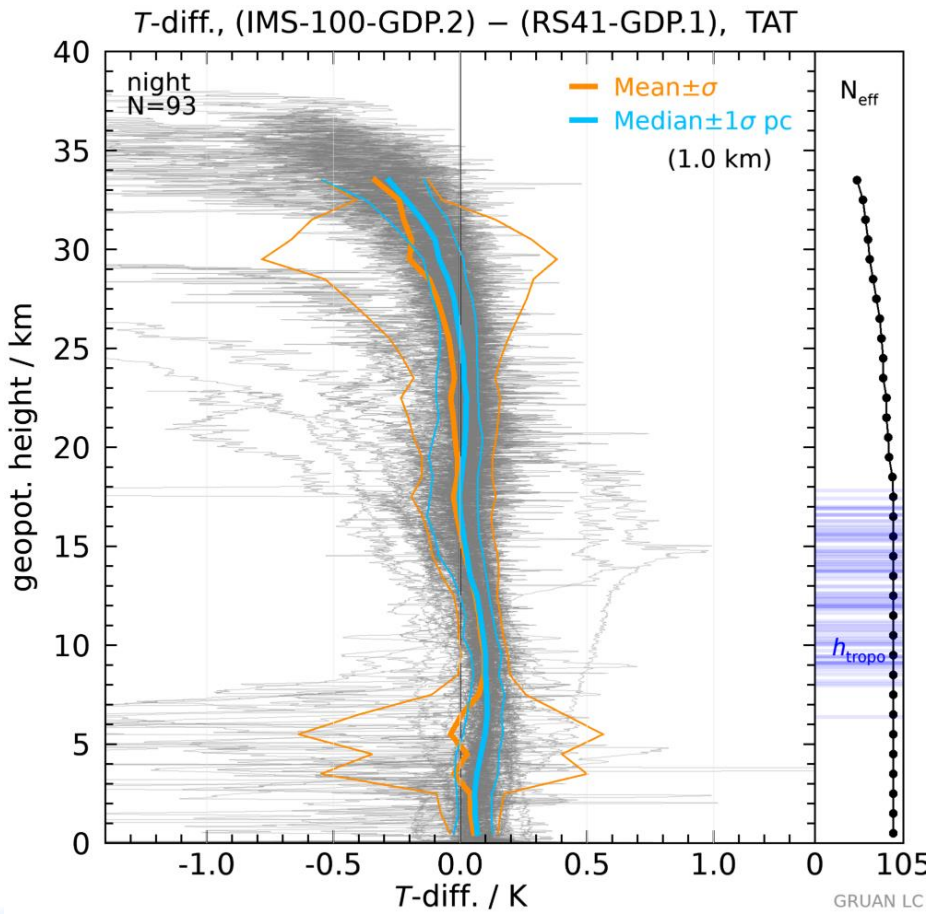
1σ pc: 0.159 and 0.841 percentiles, corresponding to σ of normally distributed data at large N

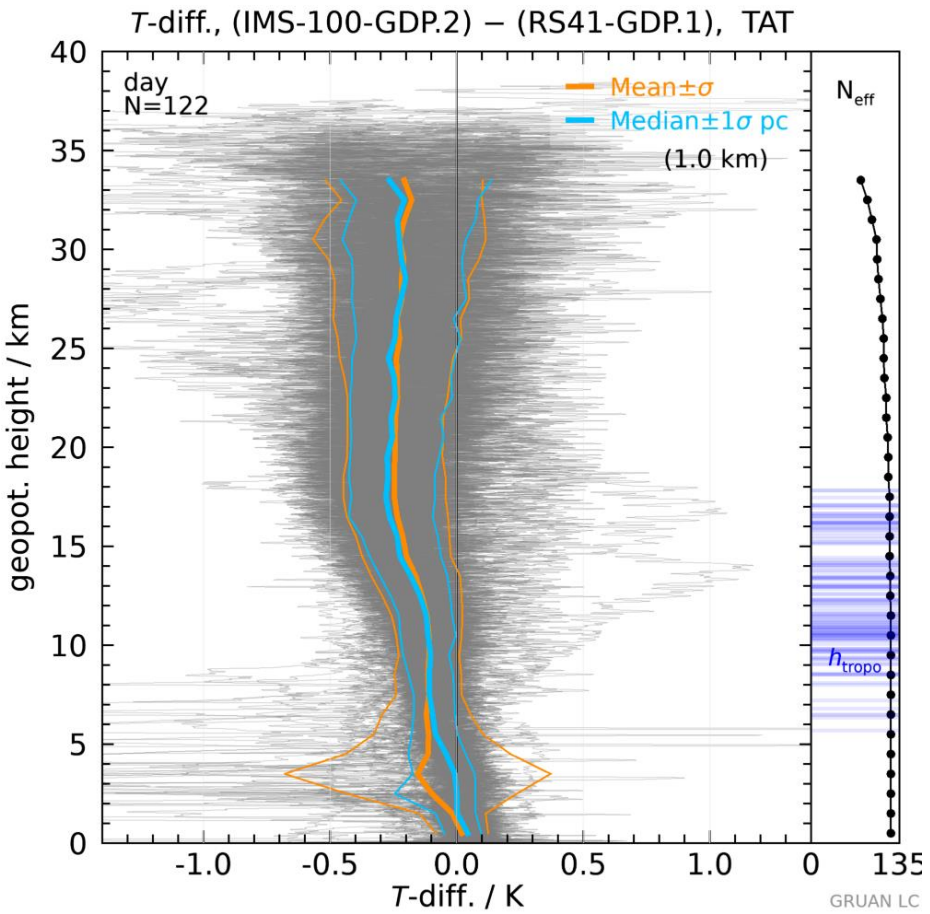




iMS-100-GDP.1 – RS41-GDP.1 (TAT), Temperature

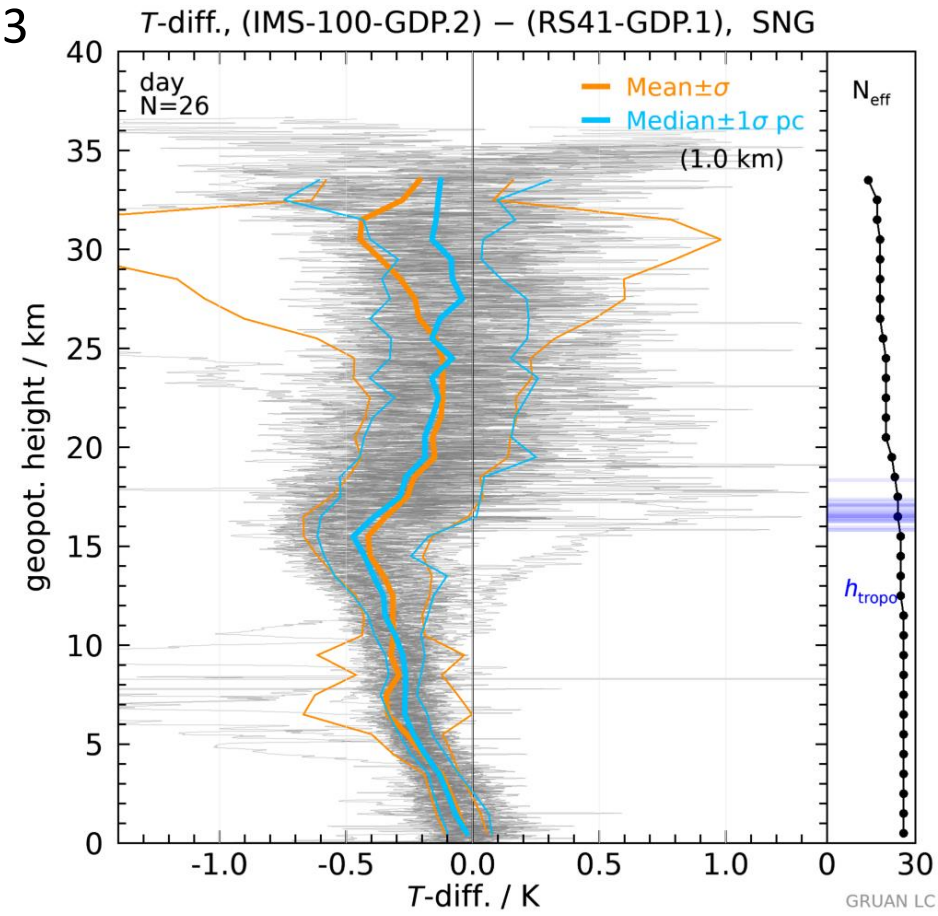
- Tateno comparison soundings since 2020
- Night: $|\Delta T| \leq 0.1$ K; >28 km bias (LW effect?); $\sigma_{\Delta T} \approx 0.1$ K
- Day: $|\Delta T| \leq 0.25$ K; $\sigma_{\Delta T} \leq 0.3$ K





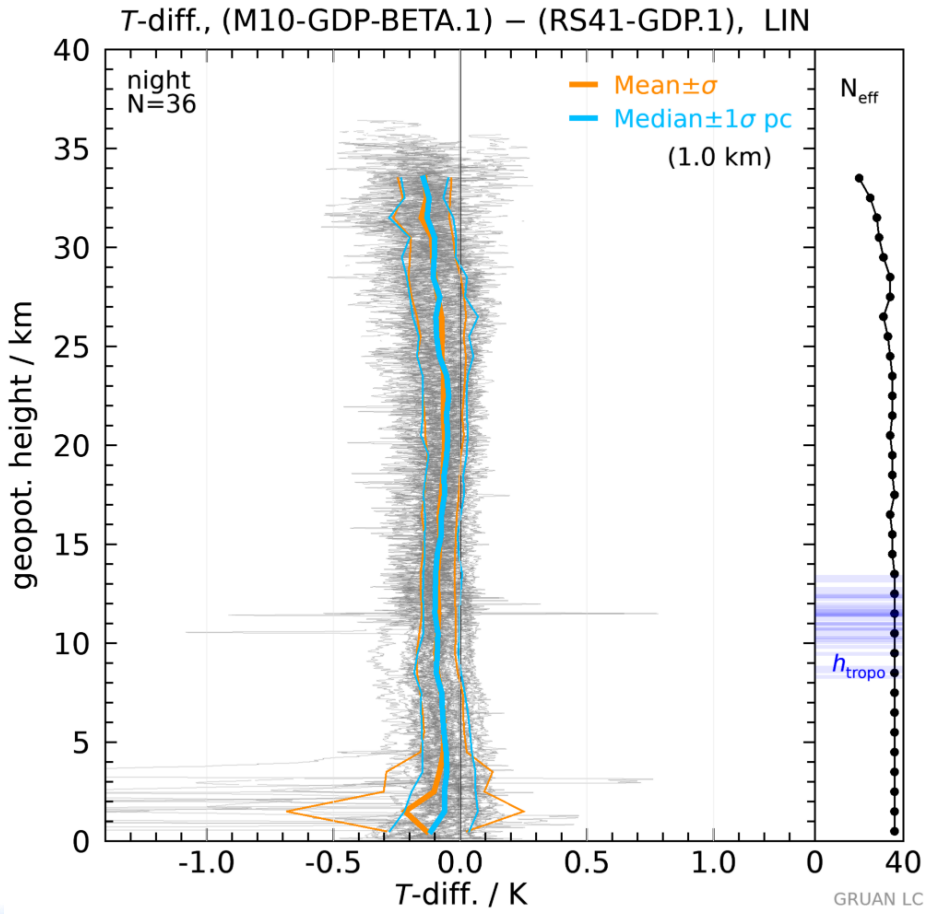
iMS-100-GDP.1 – RS41-GDP.1 (SNG), Temperature

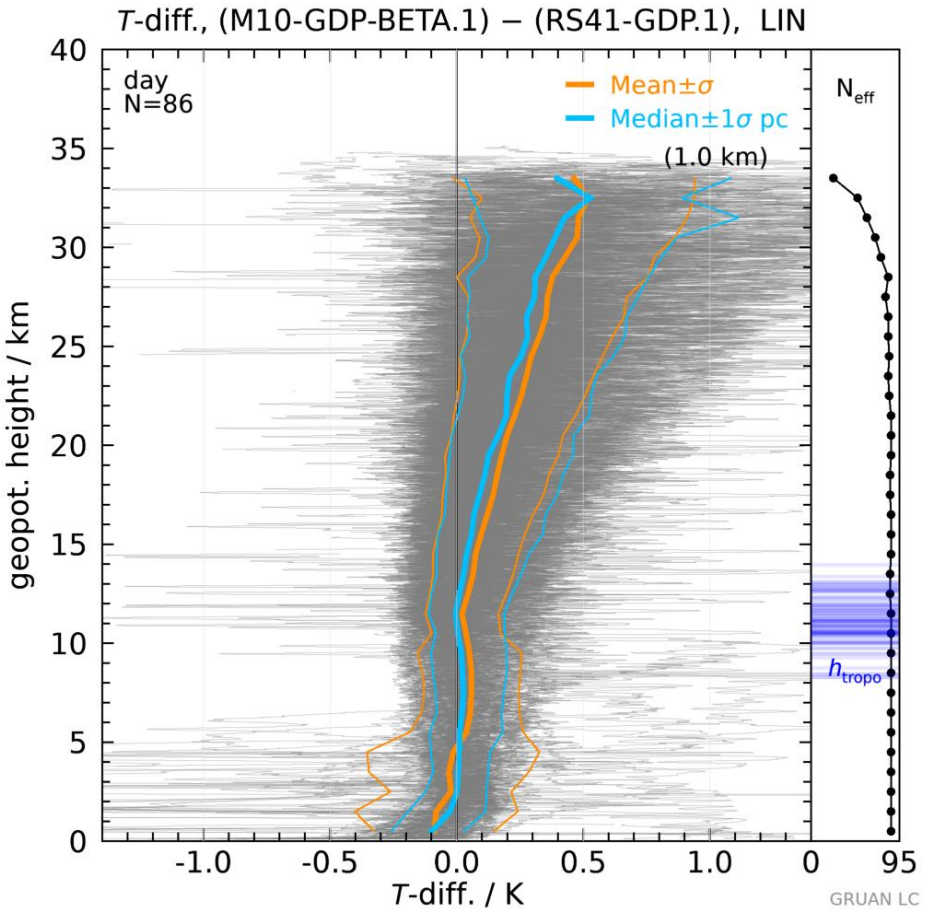
- Singapore comparison soundings 2021-2023 (no night time flights)
- $|\Delta T| \leq 0.25$ K; $\sigma_{\Delta T} \leq 0.3$ K
- 0.45 K peak in tropopause: T-calibration of iMS-100 (?)



M10-GDP-BETA.1 – RS41-GDP.1 (LIN), Temperature

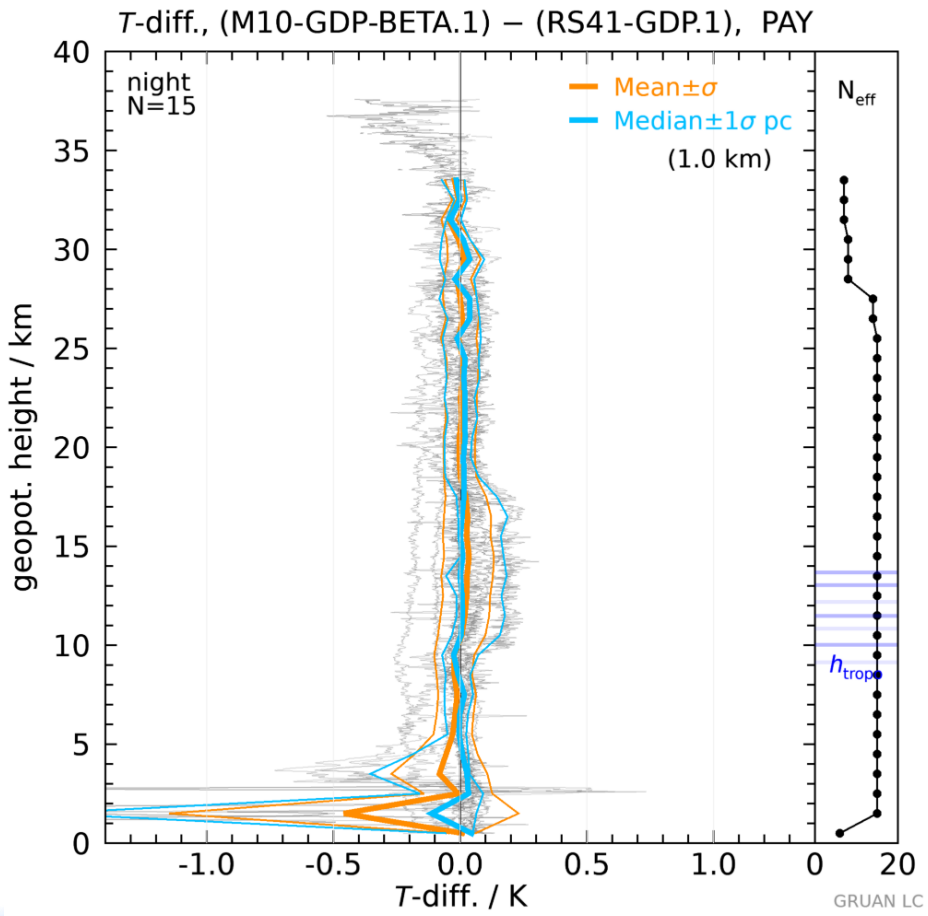
- LIN GDP comparison program + LIN dual soundings in 2021/2022
- Night: constant $|\Delta T| \approx 0.1$ K; $\sigma_{\Delta T} \approx 0.15$ K
- Day: $|\Delta T| \leq 0.4$ K in stratosphere; $\sigma_{\Delta T} \leq 0.35$ K

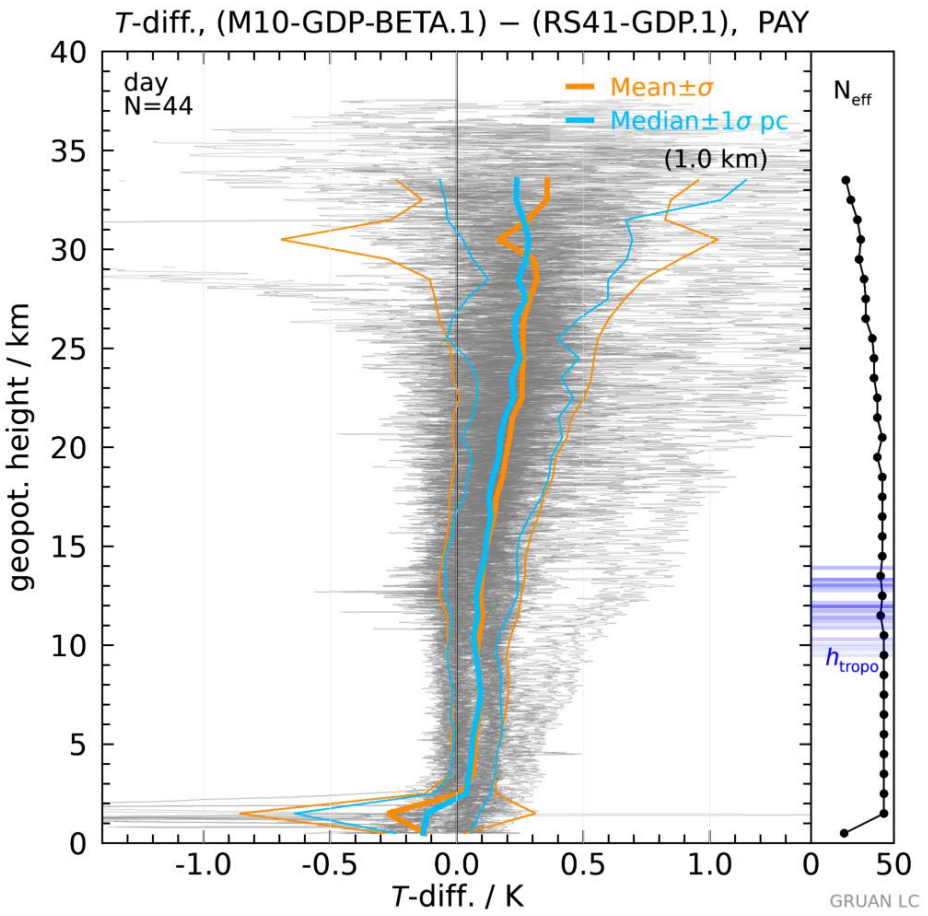




M10-GDP-BETA.1 – RS41-GDP.1 (PAY), Temperature

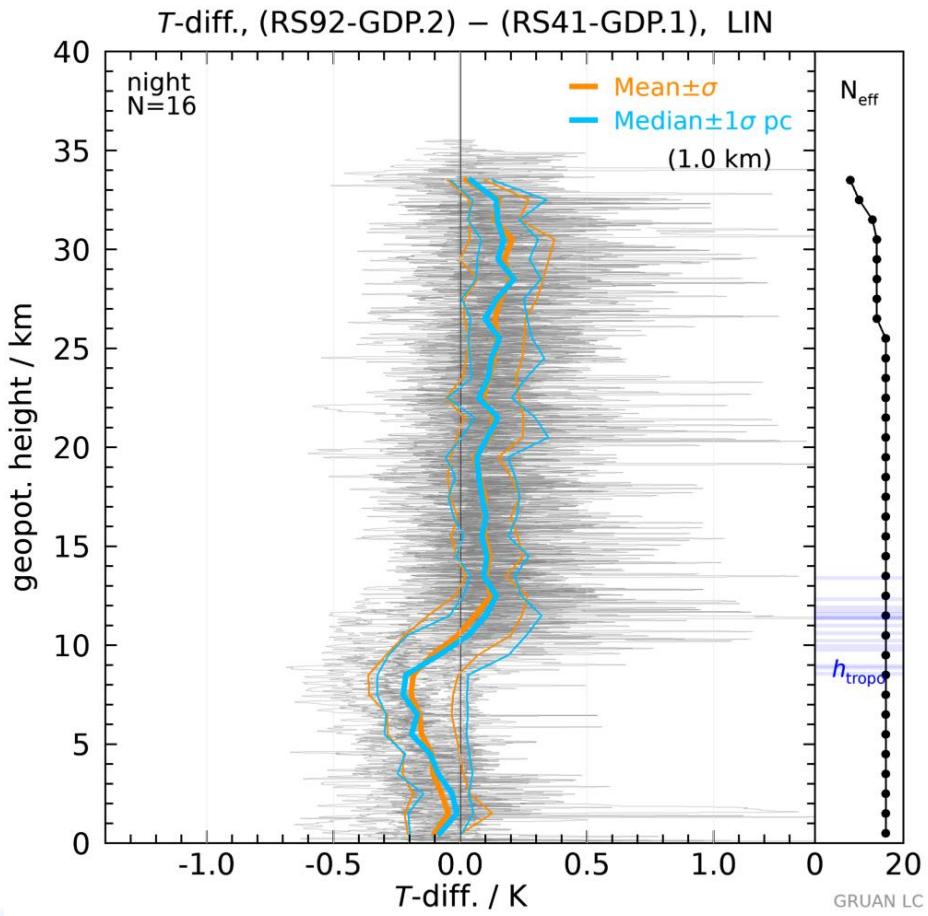
- Payerne comparisons 2021-2024
- Night: $|\Delta T| < 0.1$ K; $\sigma_{\Delta T} \approx 0.15$ K
- Day: $|\Delta T| \leq 0.25$ K in stratosphere; $\sigma_{\Delta T} \leq 0.35$ K

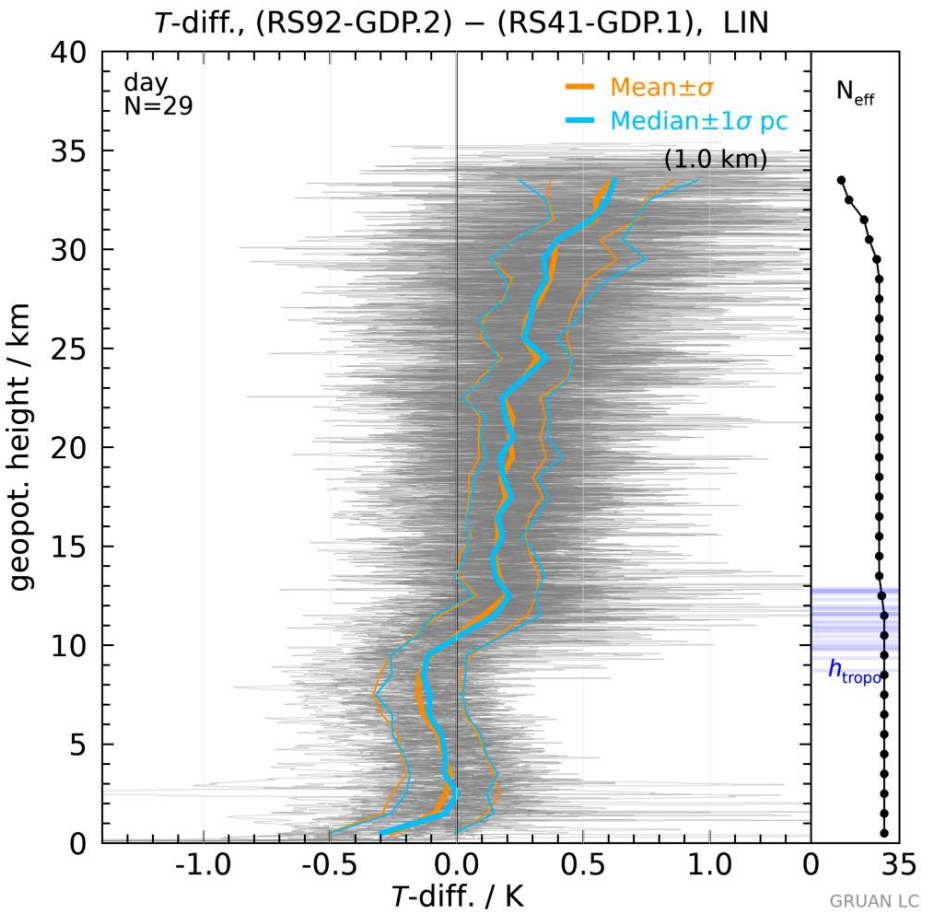




RS92-GDP.2 – RS41-GDP.1 (LIN) Temperature

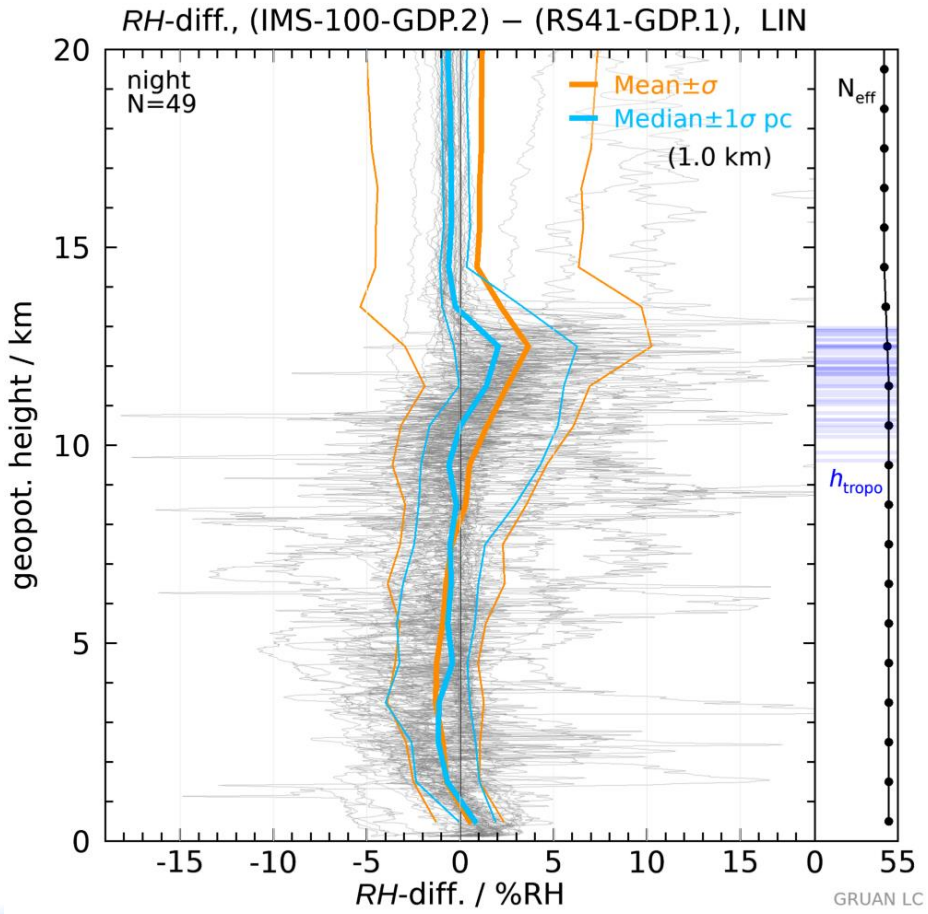
- LIN GDP comparison program
- Night: $\Delta T = -0.1$ K …-0.2 K tropo. → timelag (?); $+0.1$ K … $+0.2$ K strato.; $\sigma_{\Delta T} \approx 0.15$ K
- Day: $|\Delta T| \leq 0.4$ K in strato.; $\sigma_{\Delta T} \leq 0.25$ K

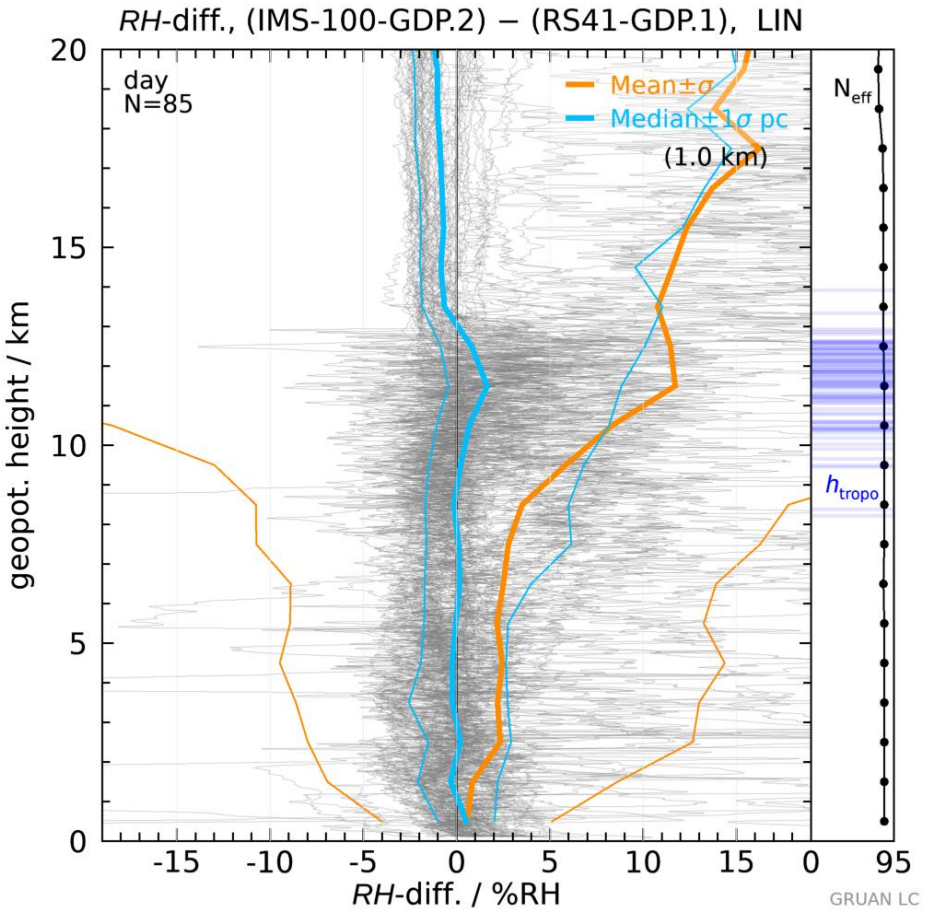




iMS-100-GDP.1 – RS41-GDP.1 (LIN), Relative humidity

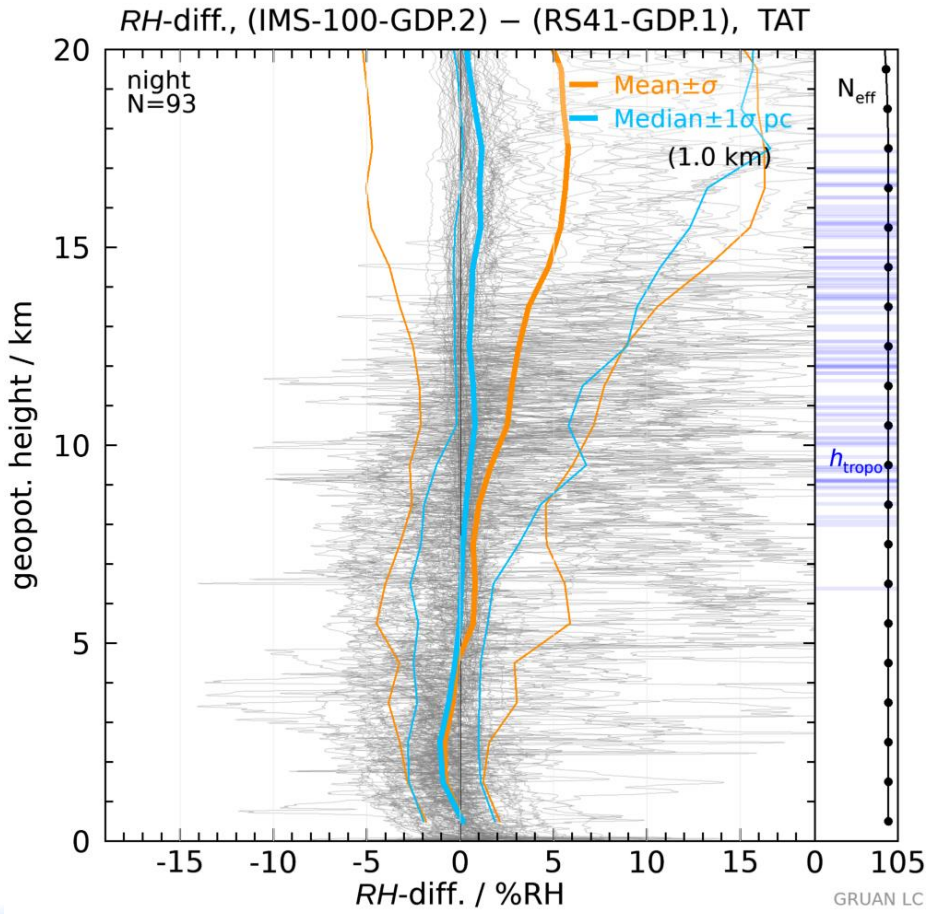
- LIN GDP comparison program + UAII 2022 (CWS)
- Night: $|\Delta\mathrm{RH}| \leq 1.5$ %RH; small %RH peak tropopause; $\sigma_{\Delta\mathrm{RH}} \leq 6$ %RH
- Day: $|\Delta\mathrm{RH}| \leq 1$ %RH; $\sigma_{\Delta T} \leq 0.3$ K

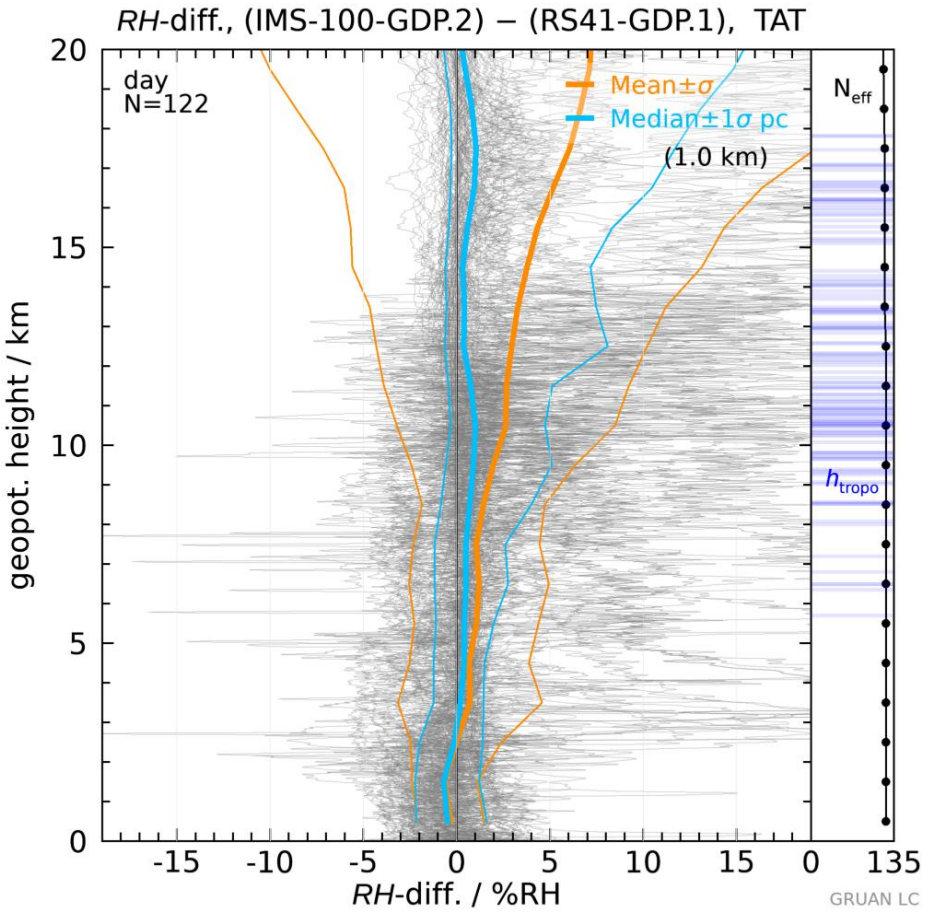




iMS-100-GDP.1 – RS41-GDP.1 (TAT), Relative humidity

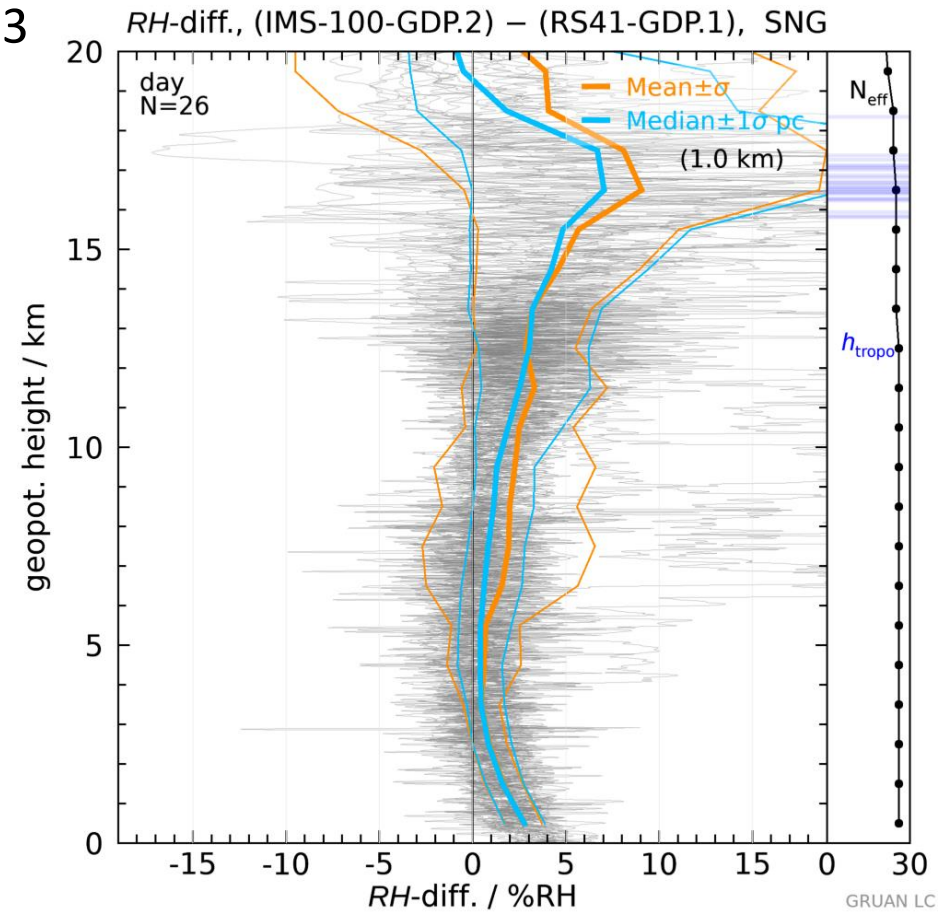
- TAT comparison soundings since 2020
- Night: $|\Delta\mathrm{RH}| \leq 1.5$ %RH; $\sigma_{\Delta\mathrm{RH}}$ variable
- Day: $|\Delta\mathrm{RH}| \leq 1$ %RH; $\sigma_{\Delta T}$ variable





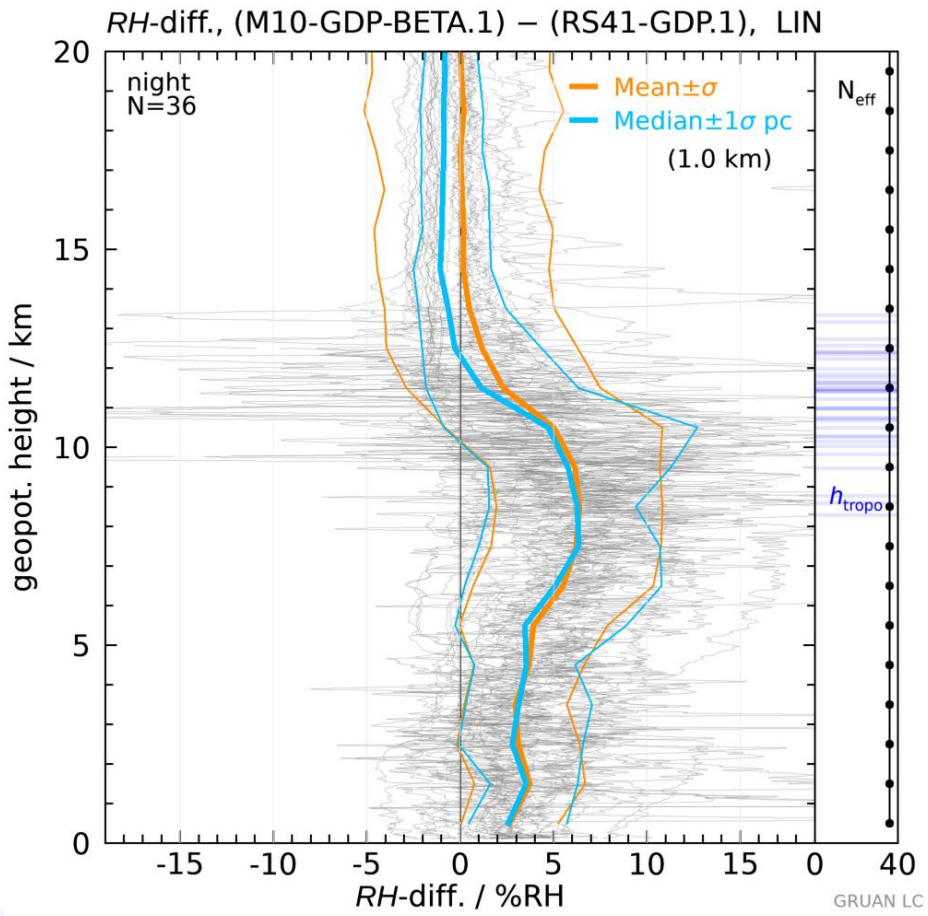
iMS-100-GDP.1 – RS41-GDP.1 (SNG), Relative humidity

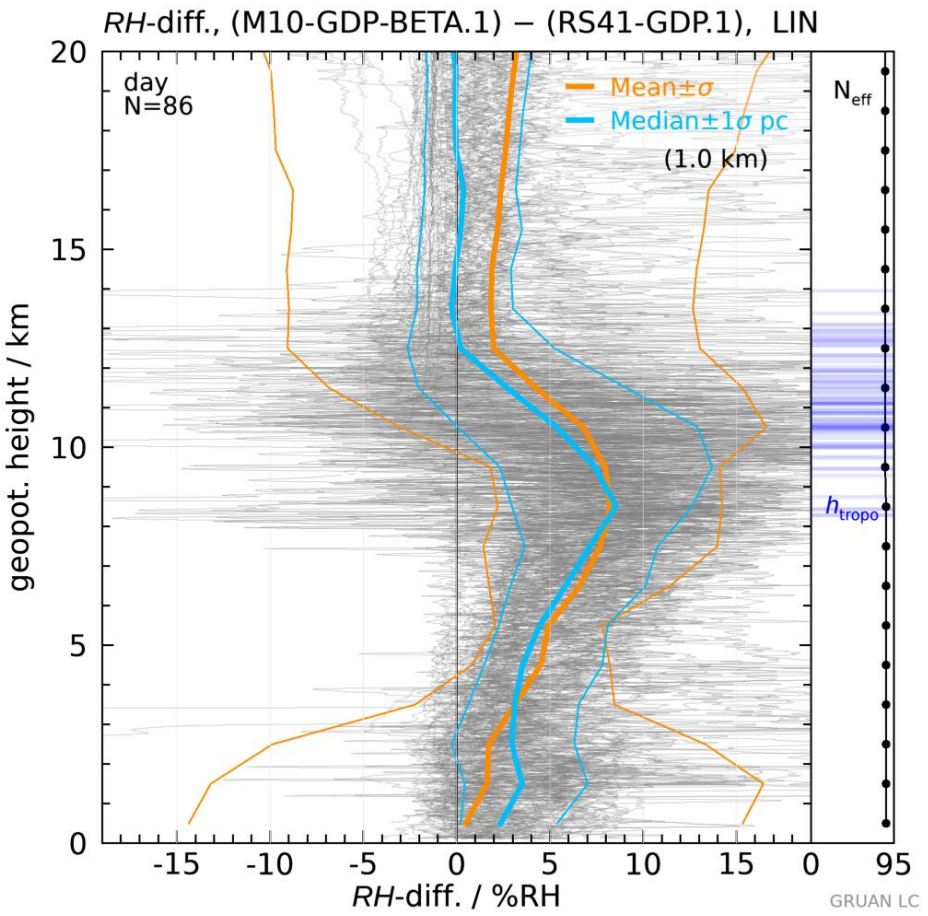
- Singapore comparison soundings 2021-2023 (no night-time flights)
- $|\Delta\mathrm{RH}| \leq 3$ %RH; $\sigma_{\Delta\mathrm{RH}} \leq 3$ %RH (LT to MT)
- ≈7 %RH peak in tropopause



M10-GDP-BETA.1 – RS41-GDP.1 (LIN)
Relative humidity

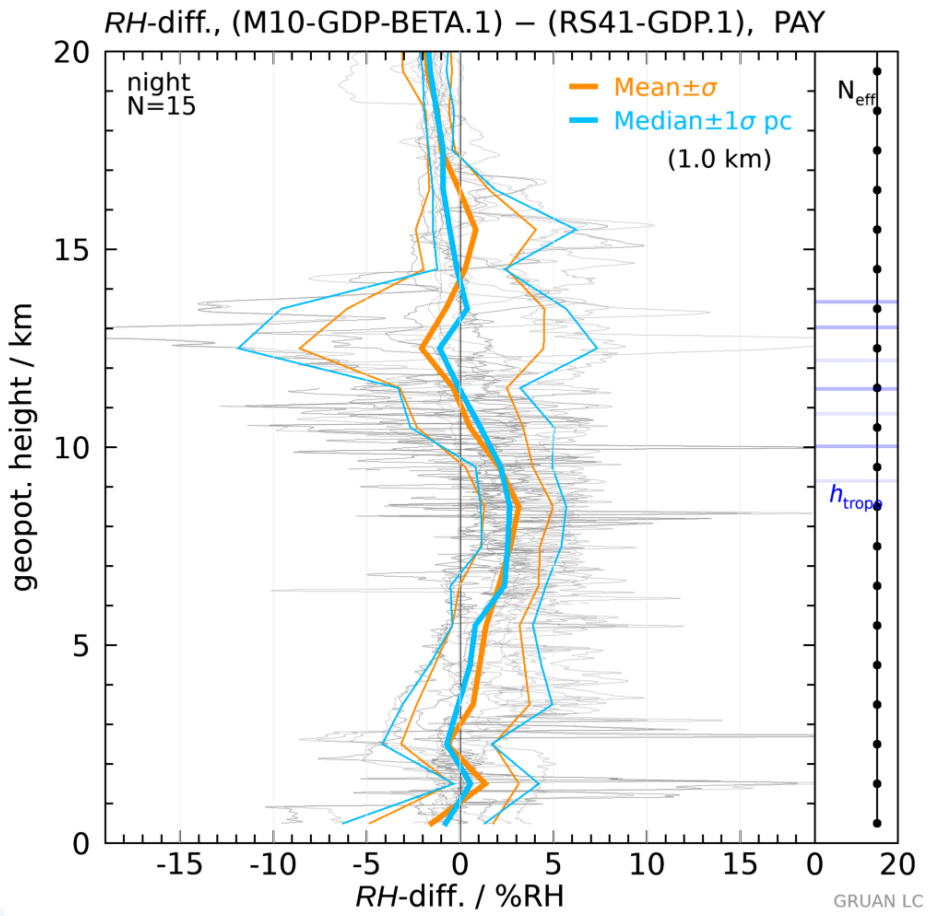
- LIN GDP comparison program + LIN dual soundings in 2021/2022
- Night: $|\Delta RH|$ peak 6 %RH near tropop.; $\sigma_{\Delta RH} \approx 4$ %RH
- Day: $|\Delta RH|$ peak 9 %RH near tropop.; $\sigma_{\Delta RH} \approx 4$ %RH

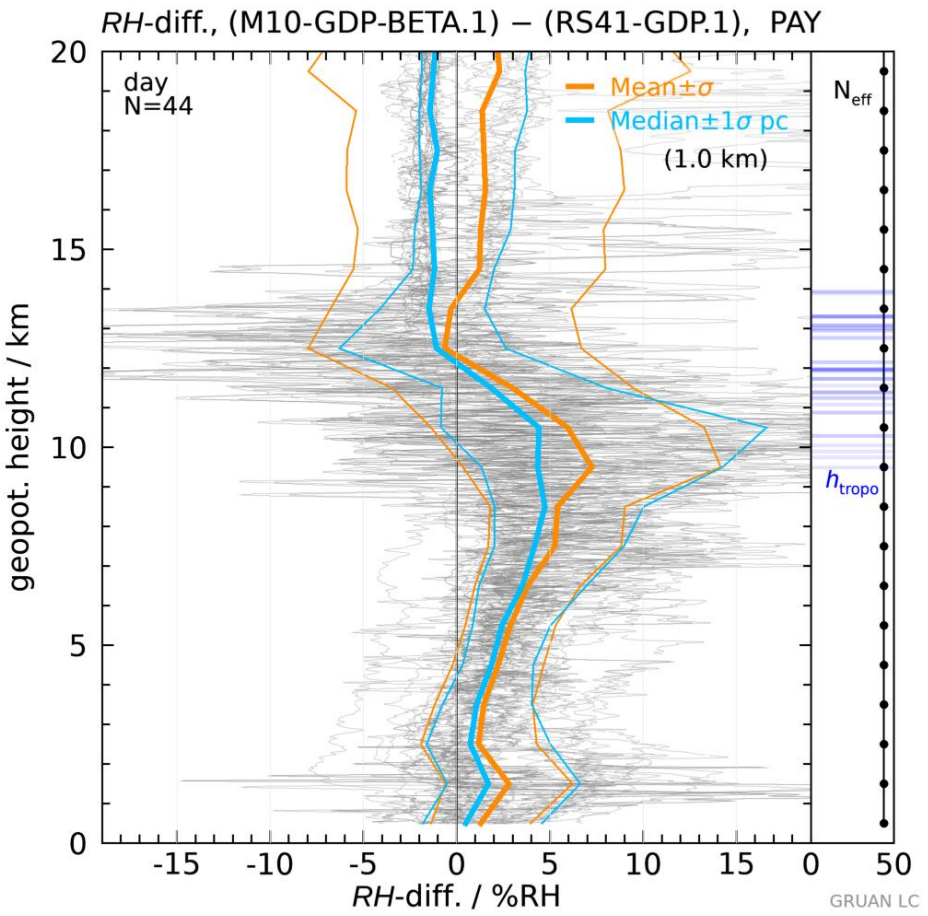




M10-GDP-BETA.1 – RS41-GDP.1 (PAY)
Relative humidity

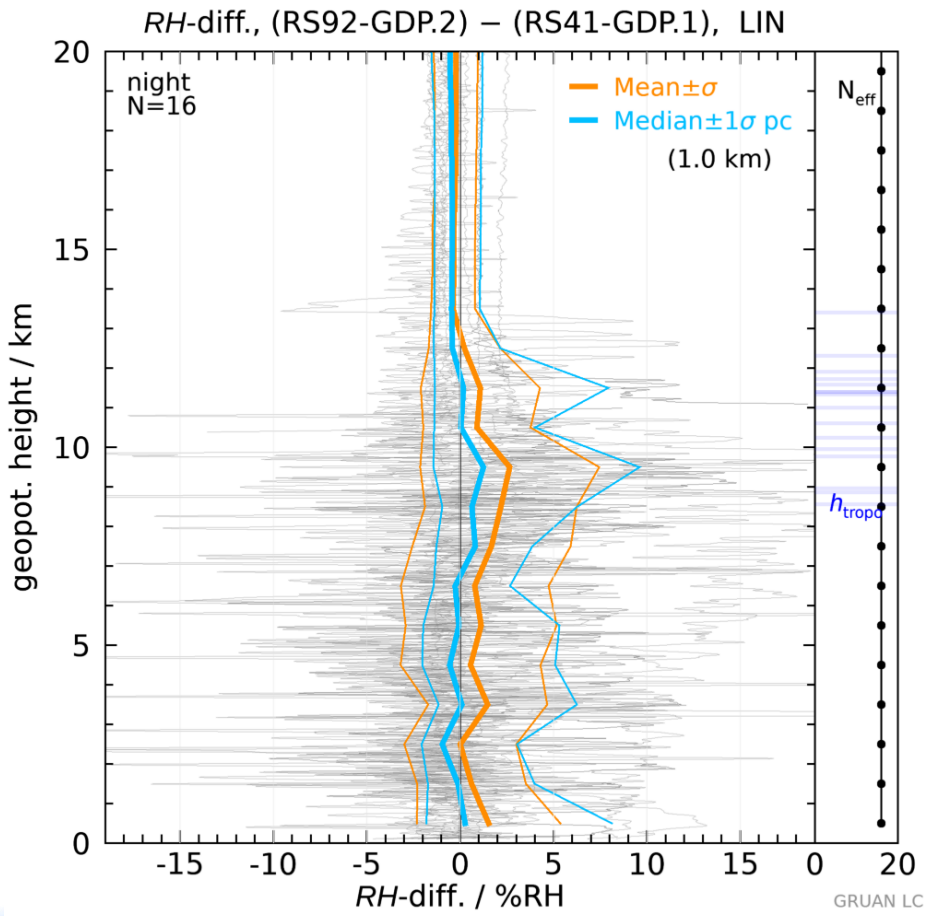
- Payerne comparisons 2021-2024
- Night: $|\Delta\mathrm{RH}|$ max. ≈ 2.5 %RH UT; $\sigma_{\Delta\mathrm{RH}}$ ≈ 3 %RH
- Day: $|\Delta\mathrm{RH}|$ peak ≈ 5 %RH near tropop.; $\sigma_{\Delta\mathrm{RH}}$ ≈ 5 %RH

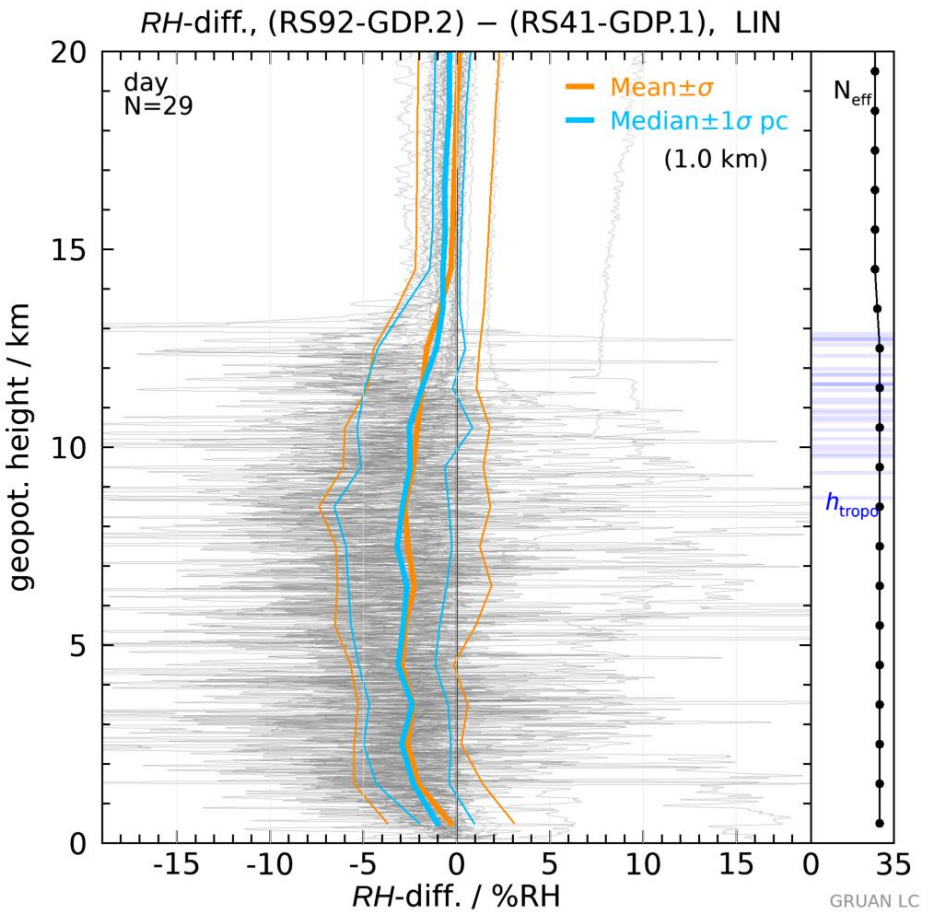




RS92-GDP.2 – RS41-GDP.1 (LIN)
Relative humidity

- LIN GDP comparison program
- Night: $|\Delta RH| < 1$ %RH; $\sigma_{\Delta RH} \approx 4$ %RH (low statistics)
- Day: $|\Delta RH| \approx 3$ %RH in tropos.; $\sigma_{\Delta RH} \approx 4$ %RH

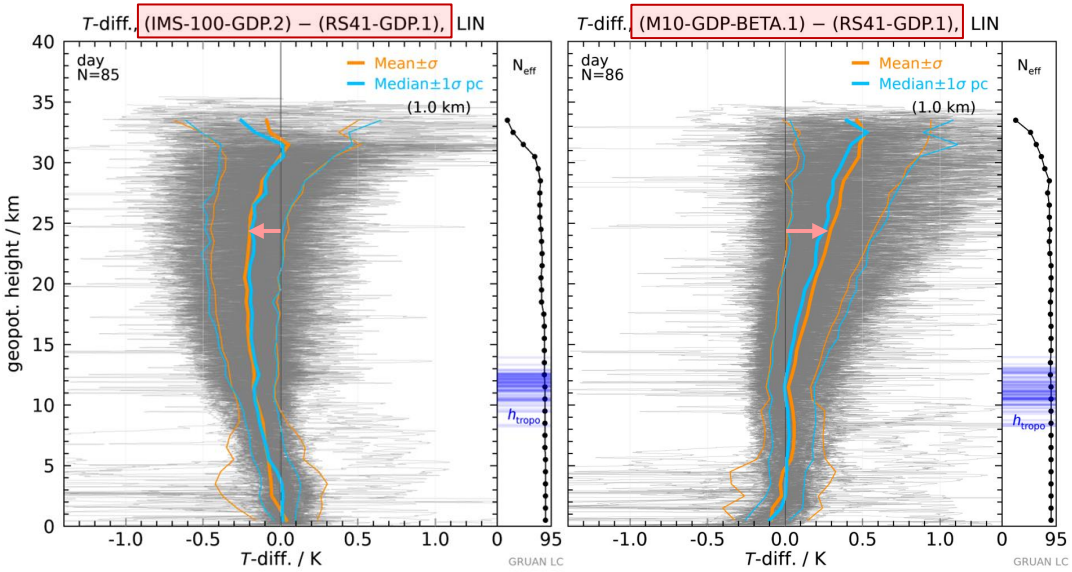




Summary & Conclusion

Where are we in terms of consistency across GDPs of different RS models?

- Observation:
  - Temperature
    Night: typically $\Delta T < 0.1$ K; max. 0.2 K
    Day: $|\Delta T| = 0.0$ K … > 0.5 K
  - Relative humidity
    Night: typically < 2 %RH; max. 6 %RH
    Day: typically < 2 %RH; max. 8 %RH; greater variability



- Instrument changes; example GRUAN site Tateno:

→ Differences will be reflected in GRUAN RS time series data (discontinuities).
To what extent will this influence trend analyses?

Thank you for your attention!