Systematic RS41-DFM17 dual flights at Potenza station

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Motivation

New GRUAN data products (GDPs) are currently under development for the GRAW DFM-17 radiosonde model, used worldwide by weather services and research institutes

GDPs development for DFM-17 radiosondes requires characterizing their measurements errors and related uncertainties, by manufacturer-independent laboratory tests, but also **their differences with respect to radiosondes in use within GRUAN (e.g. RS41) in terms of GDPs,** both for validation/intercomparison of these GDPs and their homogenization, which is a GRUAN requirement for using DFM-17 radiosondes as an alternative or replacement to those already in use at GRUAN sites.

The above differences should also be characterized in terms of manufacturer data products (MDPs), for their homogenization and use in any climatological study or dataset (involving non GRUAN stations operating these different radiosonde models)

A long term campaign of RS41-DFM17 dual soundings in progress at Potenza, **in order to characterize the differences (both GDPs and MDPs) between the measurements of the two radiosonde models sampling the same atmospheric column.**

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Radiosondes' specifications

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VAISALA RS41 SG

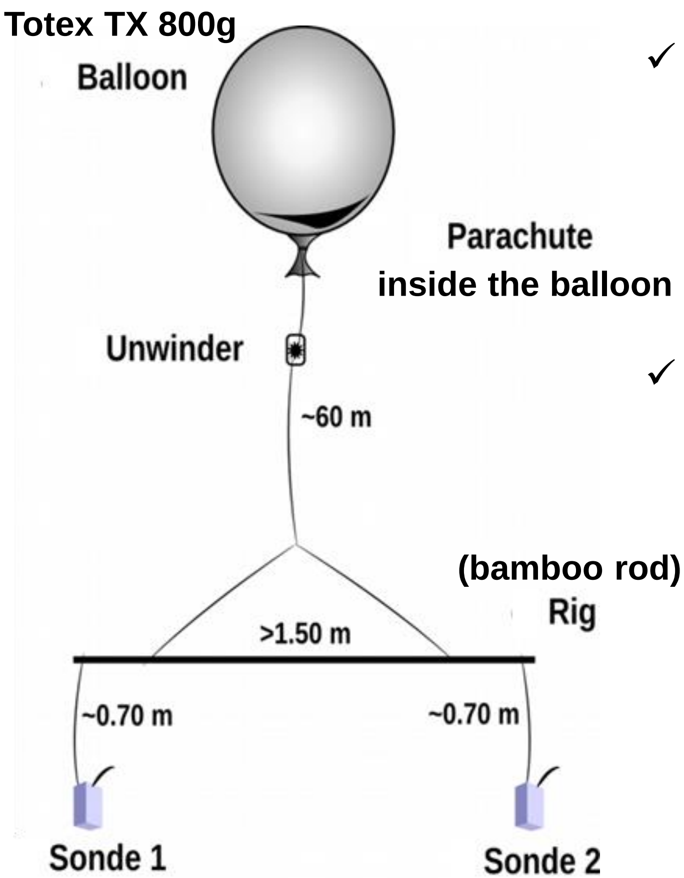
Sonde		Sensors	
Weight	80 g	T	Platinum resistor Pt1000
Body size (H/D/W)	(155/46/63) mm	U	Heated capacitive thin-film polymer + T (Pt1000)
Boom length	111 mm	p	No
Housing	EPS	*GNSS*	D-GPS, L1 C/A

GRAW DFM-17

Sonde		Sensors	
Weight	65 g	T	Thermistor
Body size (H/D/W)	(99/45/68) mm	U	Heated capacitive thin-film polymer + T-sensor
Boom length	$\approx$ 128 mm	p	No (calculated by GNSS height)
Housing	Styrofoam	*GNSS*	Multi-GNSS, (L1; GPS, GLONASS, Beidou)

Payload configuration

GRUAN-TN-7: Rigging Recommendations For Dual Radiosonde Soundings (C. von Rohden et al., 2016)



- ✓ minimize heat and humidity contamination by the setup (rig and balloon) of the air sampled by the sensors during ascent.
- ✓ distances between the sondes and between the sondes and the rod ensure both radiosondes sample the same air column, while preventing the sondes from too strong pendulum motions or collisions with each other, as well as possible telemetry interferences and radiative interaction from their housings.

Flight information

Flyght number	Date	Time of day	Launch time Vaisala (UTC)	Launch time Graw (UTC)	Burst gph height Vaisala (m)	Burst gph height Graw (m)	Burst pressure Vaisala (hPa)	Burst pressure Graw (hPa)
1	21/11/2024	daytime	**12:02:14**	**12:02:00**	**33476**	**33476**	**6.65**	**6.60**
2	21/11/2024	nightime	**16:28:49**	**16:28:00**	**33884**	**33880**	**6.27**	**6.27**
3	19/12/2024	daytime	**12:06:53**	**12:07:00**	**33426**	**33425**	**6.46**	**6.43**
4	19/12/2024	nightime	17:12:23	**17:12:00**	**34013**	**34011**	**5.86**	**5.86**
5	23/01/2025	daytime	11:57:43	**11:57:00**	**35112**	**35108**	**5.09**	**5.08**
6	23/01/2025	nightime	**16:41:52**	**16:41:53**	**34648**	**34633**	**5.45**	**5.55**
7	20/02/2025	daytime	**12:07:40**	**12:07:00**	**32994**	**33003**	**7.84**	**7.87**
8	20/02/2025	nightime	**17:01:06**	**17:01:00**	**32342**	**32336**	**8.65**	**8.64**
9	27/03/2025	daytime	**13:10:25**	**13:10:00**	**33402**	**33401**	**6.81**	**6.79**
10	27/03/2025	nightime	**18:01:13**	**18:01:00**	**33320**	**33315**	**6.86**	**6.86**
11	23/04/2025	daytime	**10:19:45**	**10:19:00**	**28817**	**28819**	**14.04**	**13.97**
12	23/04/2025	nightime	**18:44:24**	**18:44:00**	**34553**	**34555**	**5.99**	**5.99**
13	29/05/2025	daytime	**12:34:01**	**12:34:00**	**33083**	**33080**	**7.80**	**7.75**
14	29/05/2025	nightime	**19:04:42**	**19:04:46**	**34365**	**34369**	**6.51**	**6.51**
15	12/06/2025	daytime	**12:17:34**	**12:17:00**	**31550**	**31559**	**9.85**	**9.74**
16	12/06/2025	nightime	**19:11:54**	**19:11:00**	**33289**	**33279**	**7.69**	**7.72**
17	31/07/2025	daytime	**12:18:52**	**12:18:00**	**33338**	**33344**	**7.72**	**7.72**
18	31/07/2025	nightime	**19:07:27**	**19:07:00**	**34614**	**34615**	**6.43**	**6.43**
19	28/08/2025	daytime	**13:08:45**	**13:08:00**	**33627**	**33625**	**7.21**	**7.18**
20	28/08/2025	nightime	**18:23:11**	**18:23:00**	**35108**	**35109**	**5.82**	**5.83**

Comparison methodology

- **Geophysical variables:**
  - geopotential height (m)
  - atmospheric temperature (K)
  - relative humidity (%RH)
  - atmospheric pressure (hPa)
  - horizontal wind direction (° clockwise from geographic North)
  - horizontal wind speed (m s^{-1})

- **Measurement time resolution:** 1 s for both RS41 and DFM-17 (same for RS41 GDP)

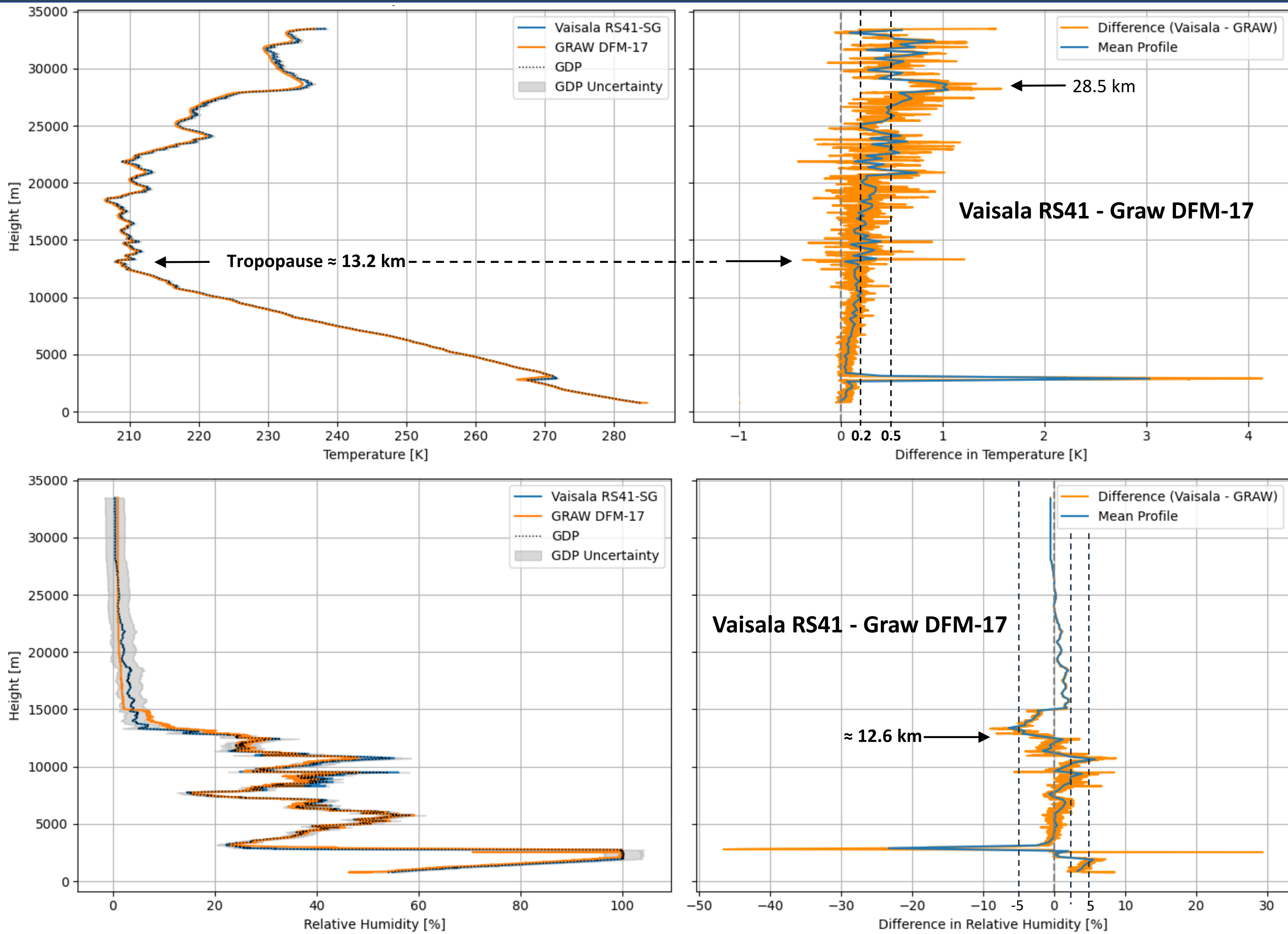
- **Removal of inconsistencies in MDPs:** filling missing time steps with NaN values, removing duplicate and decreasing time steps, as well as removing physically not plausible values of variables

- **Profiles synchronization (DFM-17 MDPs and RS41 MDPs/GDPs):** same approach of WMO 2022 UAII campaign, based on geopotential height, rather than the GNSS time measurements, given the differences between UTC launch times mentioned above.

  - ✓ Each profile is first shifted by an integer number of time steps s_0 by syncing the measurements closest to the geopotential height of 5000 m
  - ✓ Using RS41 GDP profiles as reference, DFM-17 and RS41 MDP profiles are further shifted by an integer number of time steps s_1 chosen to minimise the mean value of:

$$S(i) = \left|1 - \frac{h_{RS41(gdp)}(i)}{h(i+s_0+s_1)}\right|$$ with $h(i)$, $h_{RS41(gdp)}(i)$ $\in$ [4000 m; 6000 m] and $s_1 \in$ [-20;20]

21/11/2024 daytime



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21/11/2024 daytime

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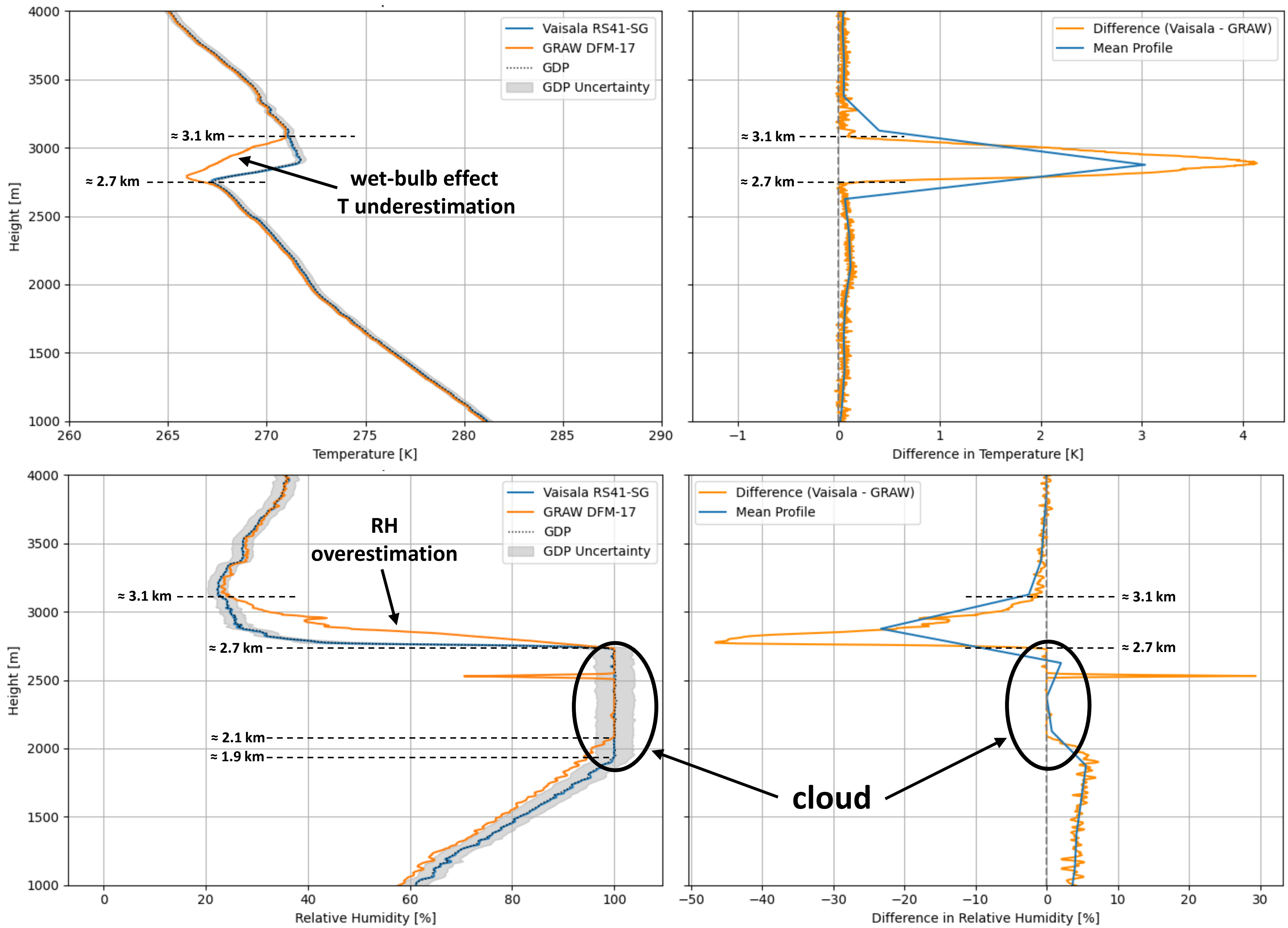

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19/12/2024 nighttime

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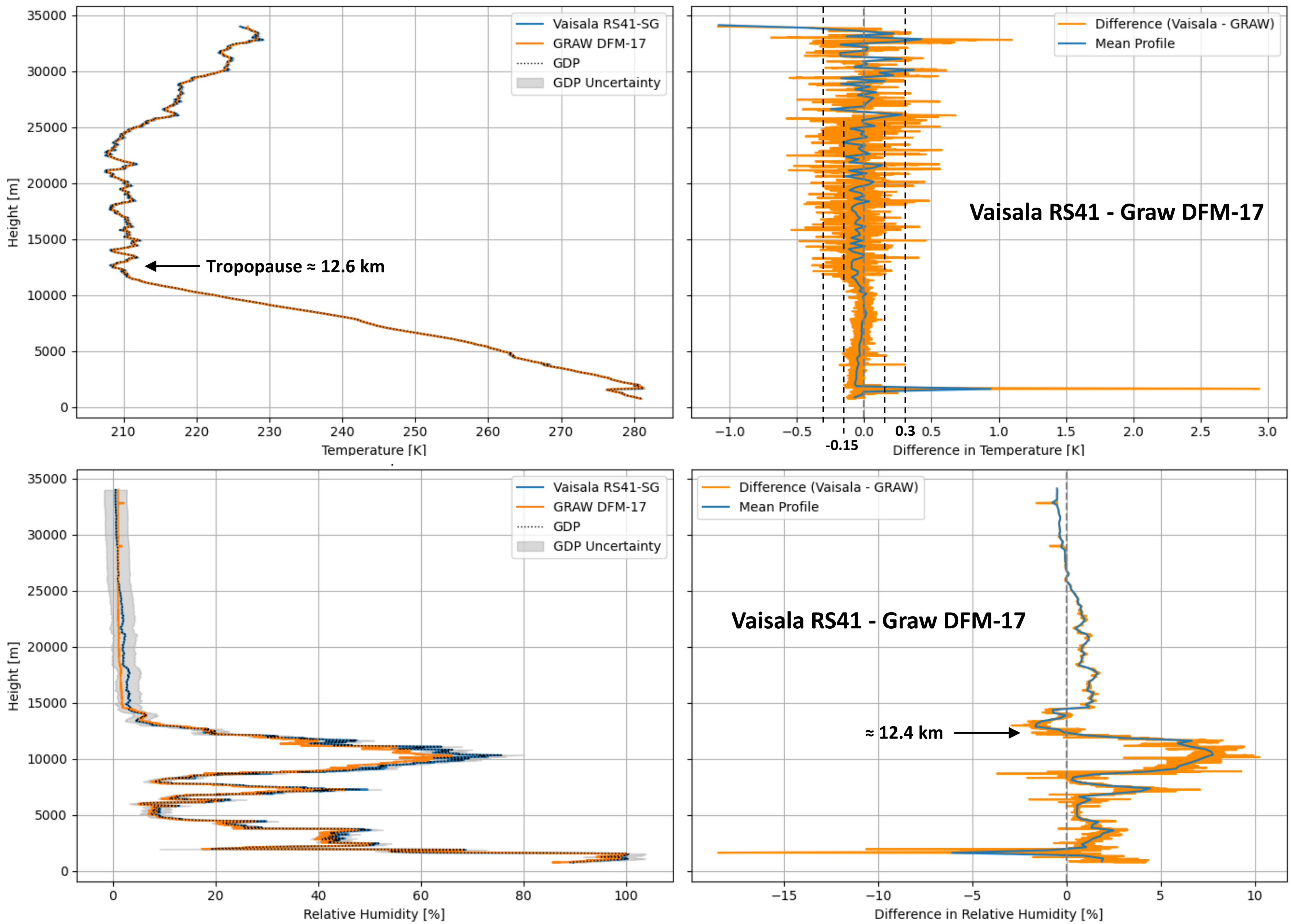
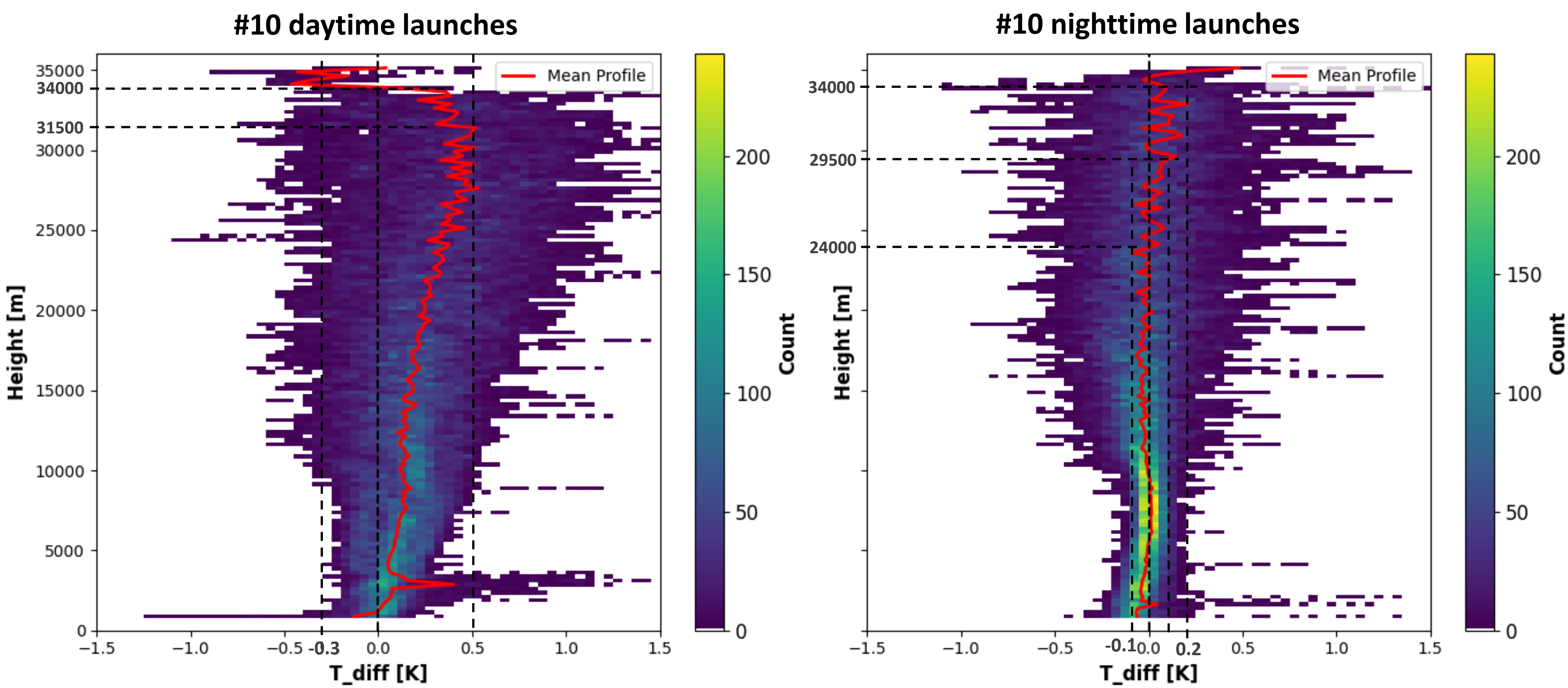


T differences' distributions

Vaisala RS41 – Graw DFM-17



Altitude/Temperature bins: 250 m/0.05 K

The larger T differences in daytime measurements, particularly in the stratosphere, are presumably due, at least partially, to different corrections for the solar radiation warm bias.

RH differences' distributions

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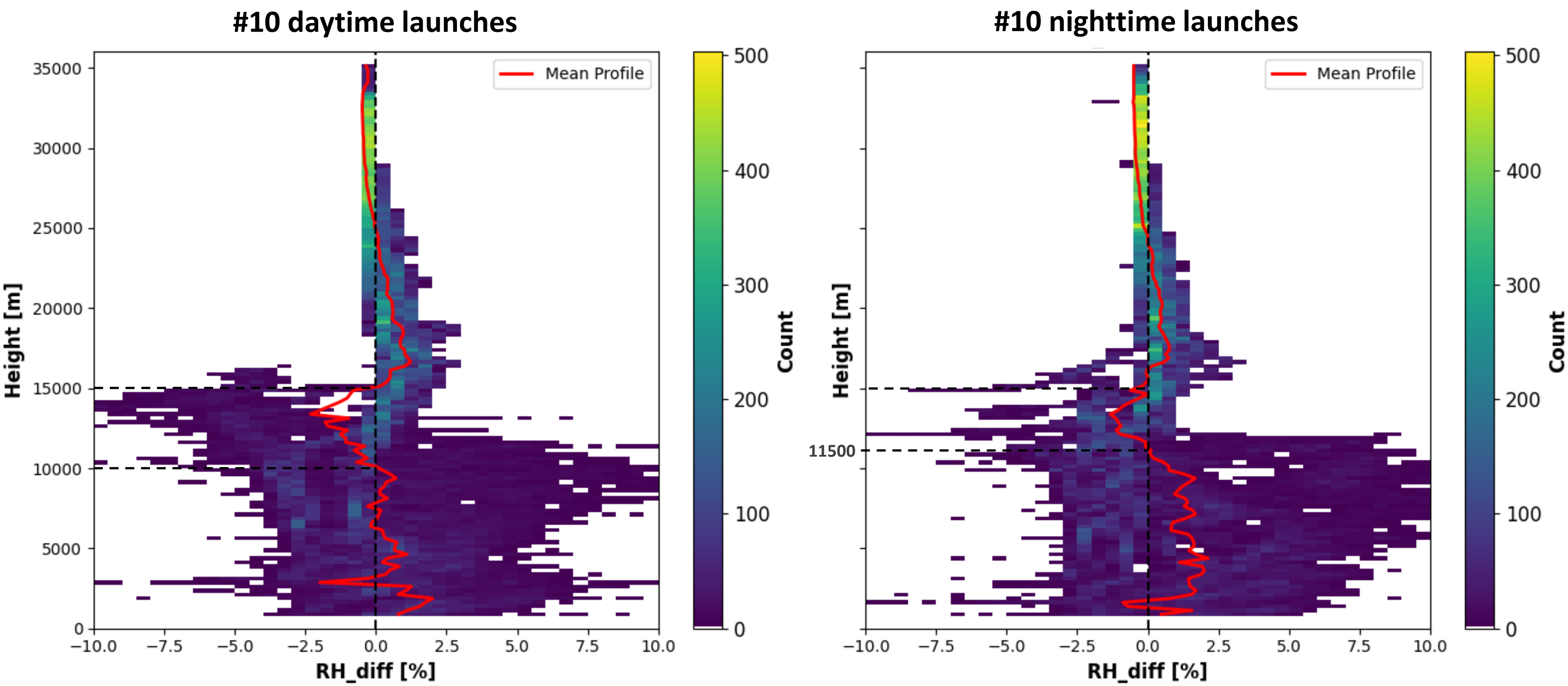
Vaisala RS41 – Graw DFM-17



Altitude/Relative Humidity bins: 250 m/0.5 %RH

The higher RH values of DFM-17 compared to RS41 above the tropopause up to 15km, are presumably due to a longer time lag of the DFM humidity sensor or its insufficient correction, making DFM less capable of accurately measuring the steep water vapor drop-off occurring in this altitude layer

Outlook

- ✓ Consolidate data analysis over a longer period (at least 2 years) and more dual launches (at least 20 daytime and 20 nighttime), for assessing radiosondes' difference depending on seasons and various weather conditions

- ✓ Extend the data analysis to geophysical variables other than T and RH: atmospheric pressure, horizontal wind (speed, direction, zonal/meridional components)

- ✓ Characterize the differences between RS41 and DFM-17 in terms of GDPs (when available for DFM-17), which may differ from the differences between MDPs, being GRUAN corrections and algorithms different and independent from manufacturers' ones

- ✓ Possibly, extend data analysis to locations other than Potenza, in order to assess radiosondes' difference depending on regional climate.

Thanks for your attention!