

Comparison of GRUAN profiles with radio occultation bending angles propagated into temperature space

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Study performed as EUMETSAT Radio Occultation Meteorology Satellite
Application Facility Visiting Scientist project

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- Both GRUAN and RO¹ data are assumed to be of reference quality
→ they should be consistent
- A comparison can reveal uncorrected biases, retrieval problems, and underestimated uncertainties

¹Radio Occultation

Methodology

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- The method used here was developed to calculate RS² temperature bias corrections on a station-by-station basis [Tradowsky, 2015]
- Met Office NWP system used as transfer medium
 - co-locate background for each measurement
 - use of departures (O-Bs) for RO and RS

$$\overline{O_{RO} - O_{RS}} \simeq \overline{O_{RO} - B_{RO}} - \overline{O_{RS} - B_{RS}} \quad (1)$$

- Assumption: B_{RO} and B_{RS} are equally representative of true values at RO/RS locations
 - NWP forecast bias does not vary over separation distance

²Radiosonde

Uncertainty estimation in the RO retrieval

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- Sampling uncertainty (see [Tradowsky, 2015])
- Structural uncertainty in a tangent linear RO retrieval (see [Tradowsky et al., 2017])
 - Calculated from the spread of the departures for different cut-off impact heights in the RO retrieval
 - Individual for every upper-air station
- Comparison of structural uncertainty is similar to the structural uncertainty in more conventional RO retrievals (see [Steiner et al., 2013, Ho et al., 2012])

Analysis of GRUAN RS92 data product

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- Calculated GRUAN RS92 departures for the years 2014 and 2015
- GRUAN uncertainties propagated into the departure uncertainties
- RO departures include sampling uncertainty and structural uncertainty in the retrieval (see [Tradowsky, 2016, Tradowsky et al., 2017])
- Consistency ($k = 2$) or agreement ($k = 1$) is tested based on [Immler et al., 2010]

$$|m_1 - m_2| < k\sqrt{u_1^2 + u_2^2} \quad (2)$$

- Comparison performed for **Lindenberg**, Cabauw, **Barrow**, **Southern Great Plains**, **Sodankylä**, Nye Alesund

GRUAN - RO comparison Lindenberg

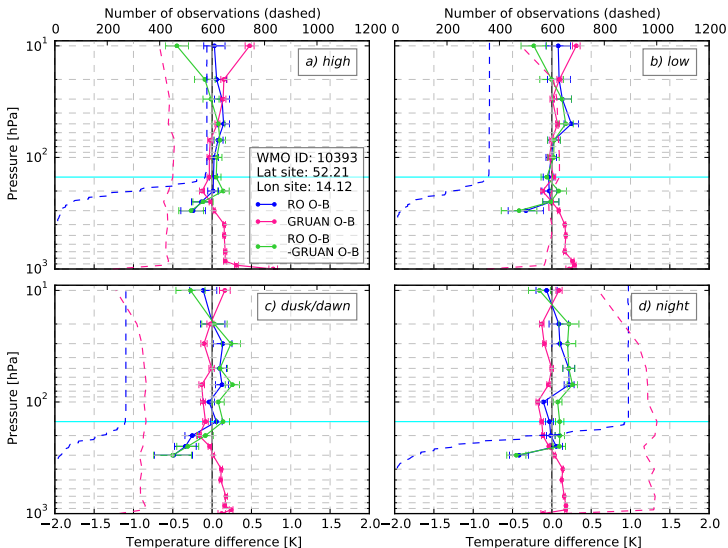
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GRUAN - RO uncertainties Lindenberg

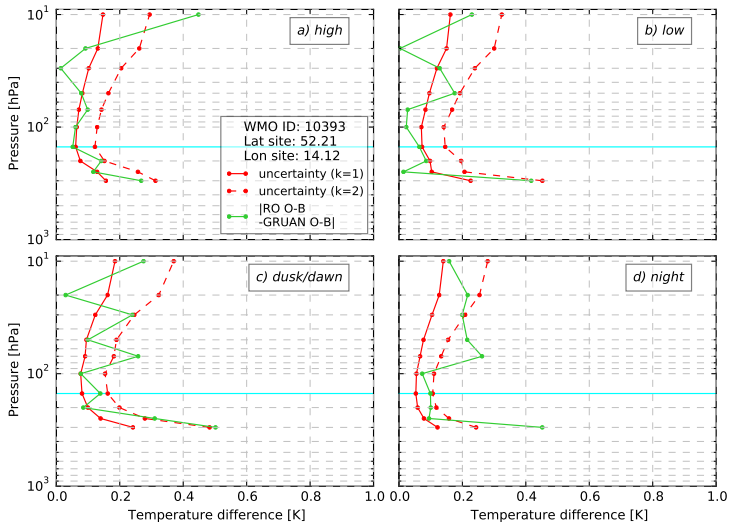
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GRUAN - RO comparison Barrow

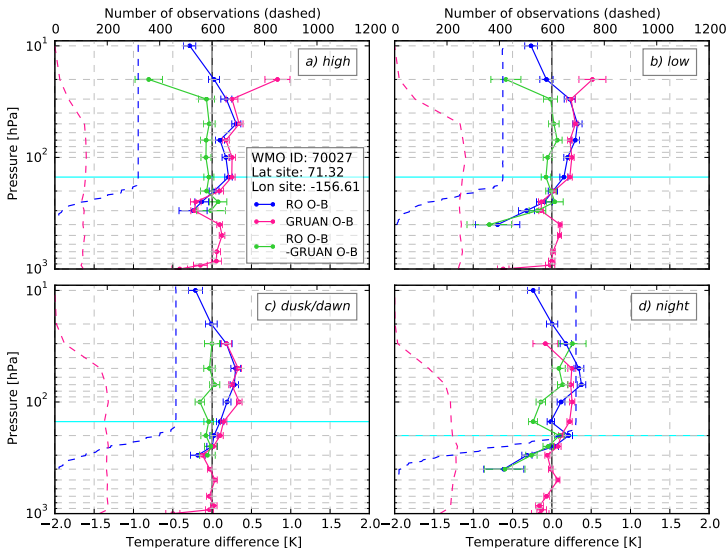
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GRUAN - RO uncertainties Barrow

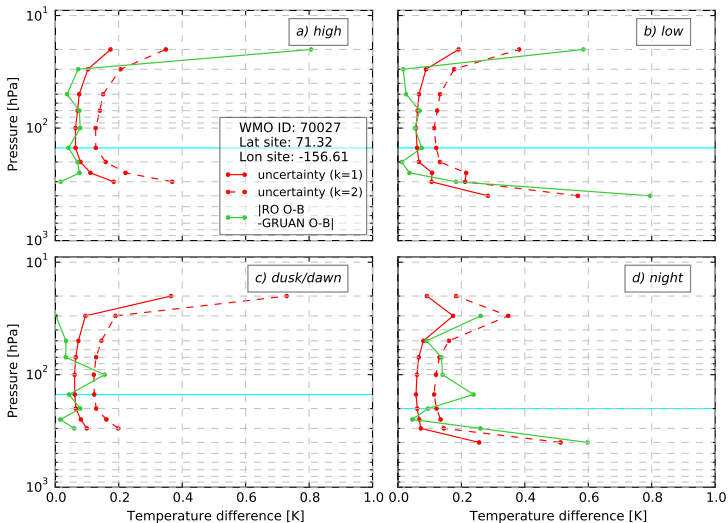
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GRUAN - RO comparison Southern Great Plains

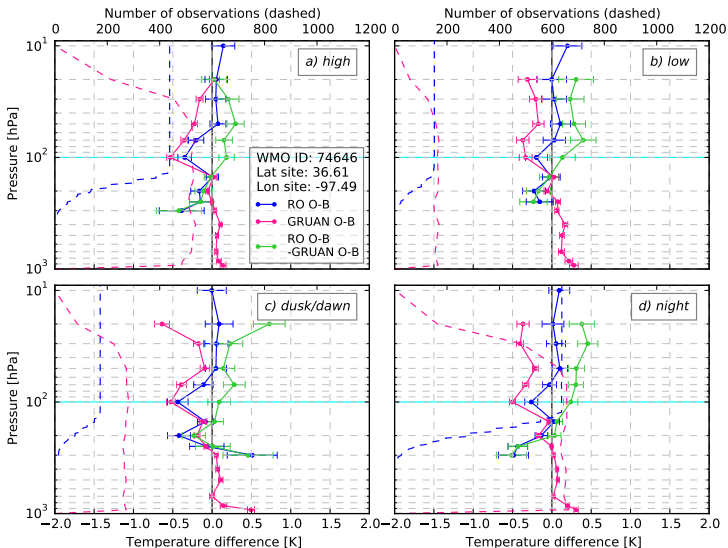
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GRUAN - RO uncertainties Southern Great Plains

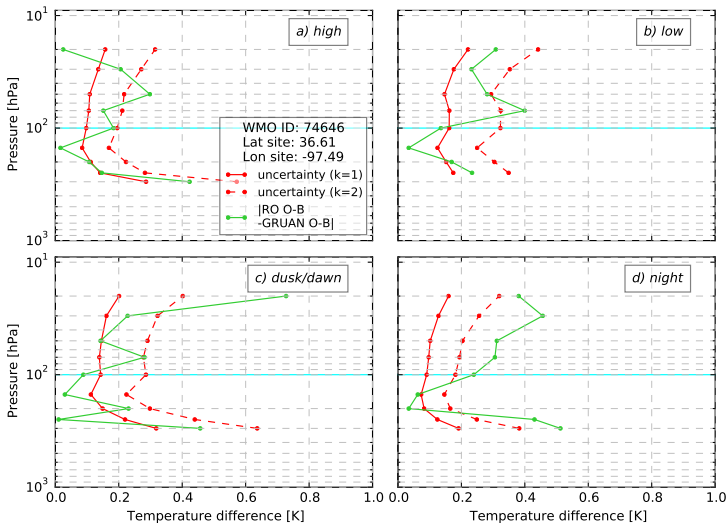
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GRUAN RO comparison Sodankylä

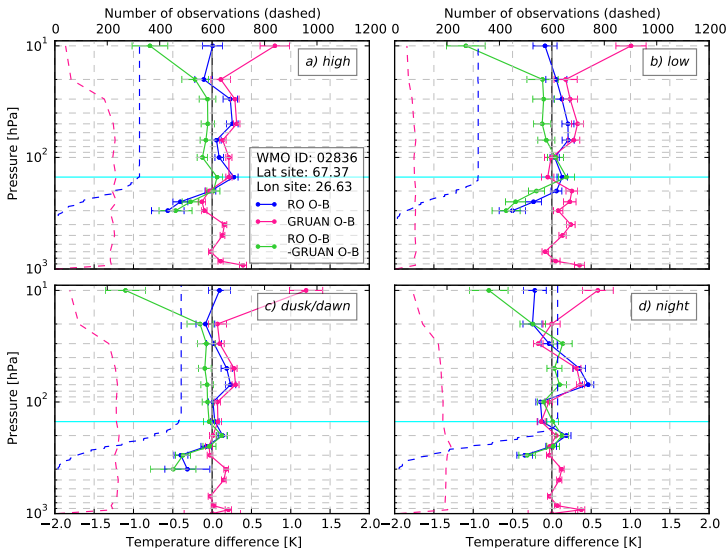
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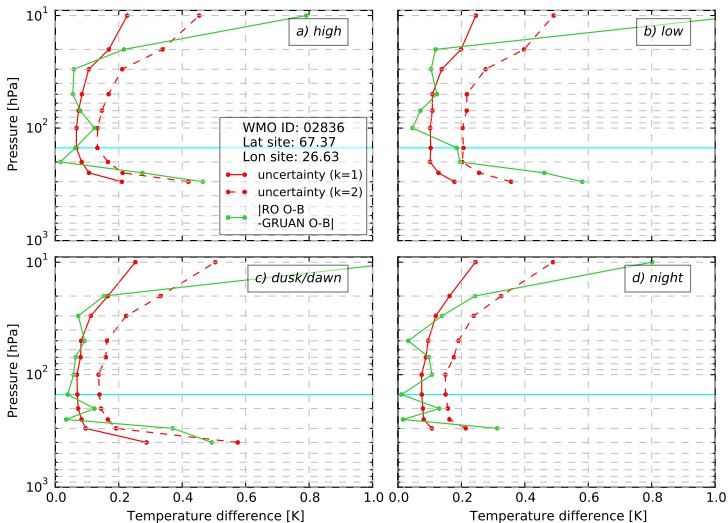
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- GRUAN and RO consist or in agreement at many levels
- Reason for differences at nighttime at highest levels unclear. Any suggestion?
→ from the discussion at ICM-9: this could be caused by a sampling bias in the radiosonde record at the highest levels or by the vicinity of the polar jet
- At many stations: GRUAN warmer than RO at the highest level during daytime → a warm bias in the GRUAN RS92 version 2 data?
- GRUAN temperature higher than RO at top of the profile was also found by [Ladstädter et al., 2015]
- Same analysis with GRUAN RS92 version 3 data would be interesting

References I

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References II

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Journal of Applied Meteorology and Climatology, 56(6):1643–1661.

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Thank you for your attention!



GRUAN - RO comparison Cabauw

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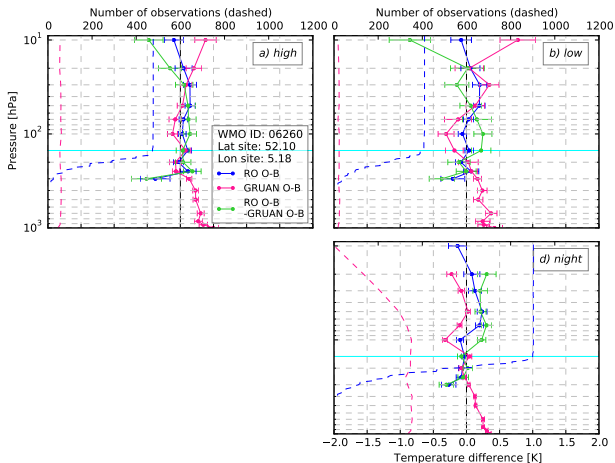


Figure 1: As Fig.??, but for the GRUAN site Cabauw.

GRUAN - RO uncertainties Cabauw

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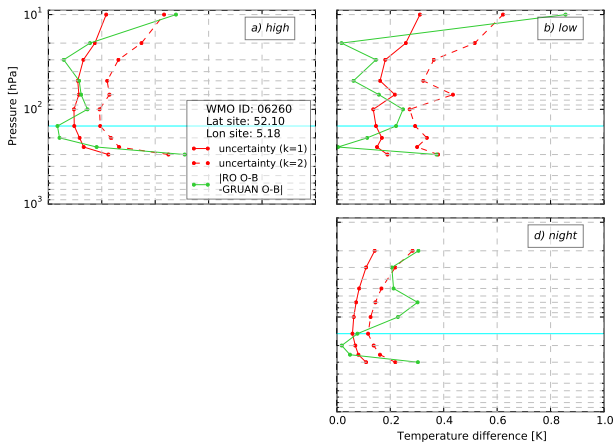


Figure 2: As Fig ??, but for Cabauw.

GRUAN RO comparison Ny Ålesund

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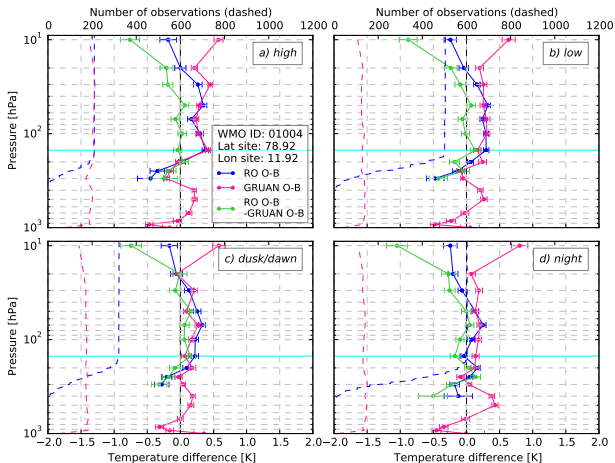


Figure 3: As Fig.??, but for the GRUAN site Ny Ålesund

GRUAN - RO uncertainties Ny Ålesund

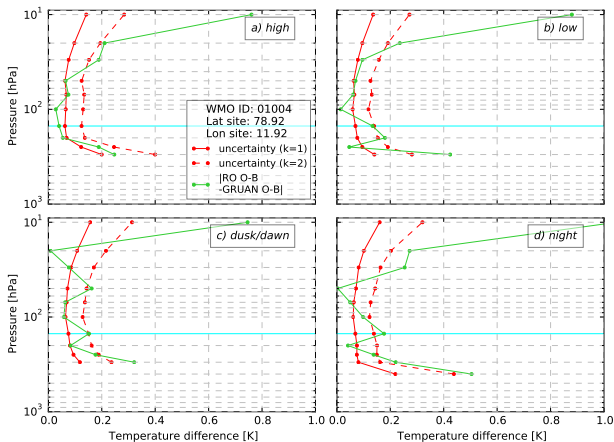


Figure 4: As Fig ??, but for Ny Ålesund.

Uncertainty estimation in the RO retrieval 2, see [Tradowsky et al., 2017]

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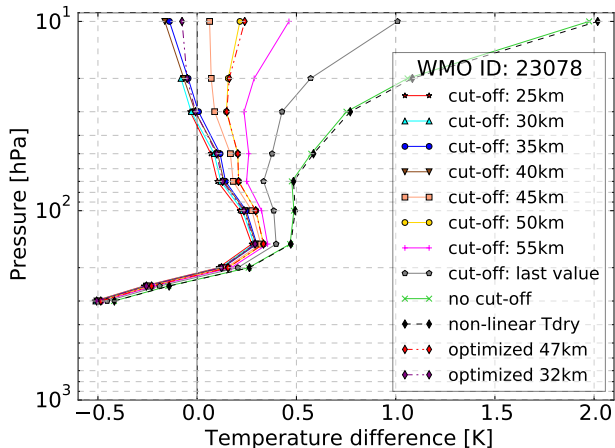


Figure 5: Sensitivity of the mean Tdry departure to different upper cut-off impact heights. The mean Tdry departure is calculated from up to 842 RO profiles within a 500 km radius around the example site 23078 in western Russia. Also shown is Tdry departure calculated with the non-linear retrieval (black dashed) and the Tdry departures calculated using statistical optimization with 50% of the background BA used at 32 km (purple dash-dotted) and at 47 km (red dash-dotted), respectively.

Uncertainty estimation in the RO retrieval 3, see [Tradowsky et al., 2017]

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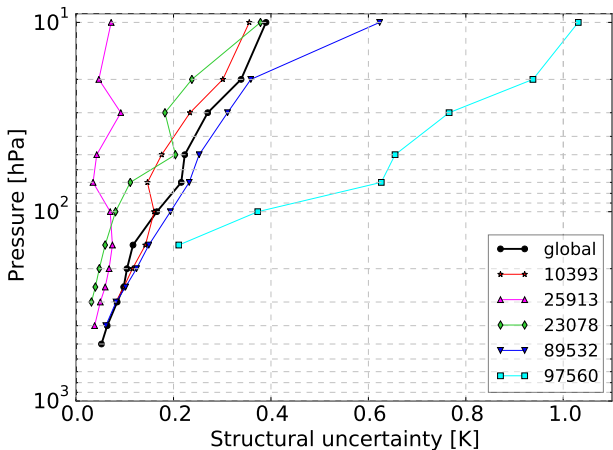


Figure 6: Basic estimate of the structural uncertainty in the RO departures based on the range of the Tdry departures calculated from BA departures with different upper impact height cut-offs between 20 km and 50 km.