NPL Activities within WP3 : Mismatch uncertainties for radiosonde and reanalysis profiles

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NPL

Gaia-Clim General Assembly
ECMWF, Reading, 6th Feb 2017

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 640276.

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Quantification of temperature and humidity mismatch

- Goal is to enable estimation of the increased uncertainty due to non-simultaneous temperature and humidity measurements due to atmospheric variability.
- Utilises the available reference data set with traceable uncertainties: the GRUAN RS92 sonde data.
- Previous work (*Butterfield, D. and Gardiner, T.; AMT 8, 463-470, 2015*) provided estimates for temperature from high frequency sonde datasets, as a function of time of day, altitude and season – but only available for very limited number of sites.
- Gaia-Clim work is extending this analysis spatially using ECMWF re-analysis data and in coverage to include humidity results.
- Assessing comparability between sonde and re-analysis data for sites studied previously, using knowledge of sonde measurement uncertainties (*Dirksen et al; AMT 7, 4462-4490, 2014*).
- Then extending analysis to other (GRUAN) sites to provide specific results for these locations and to look for any general behaviour.

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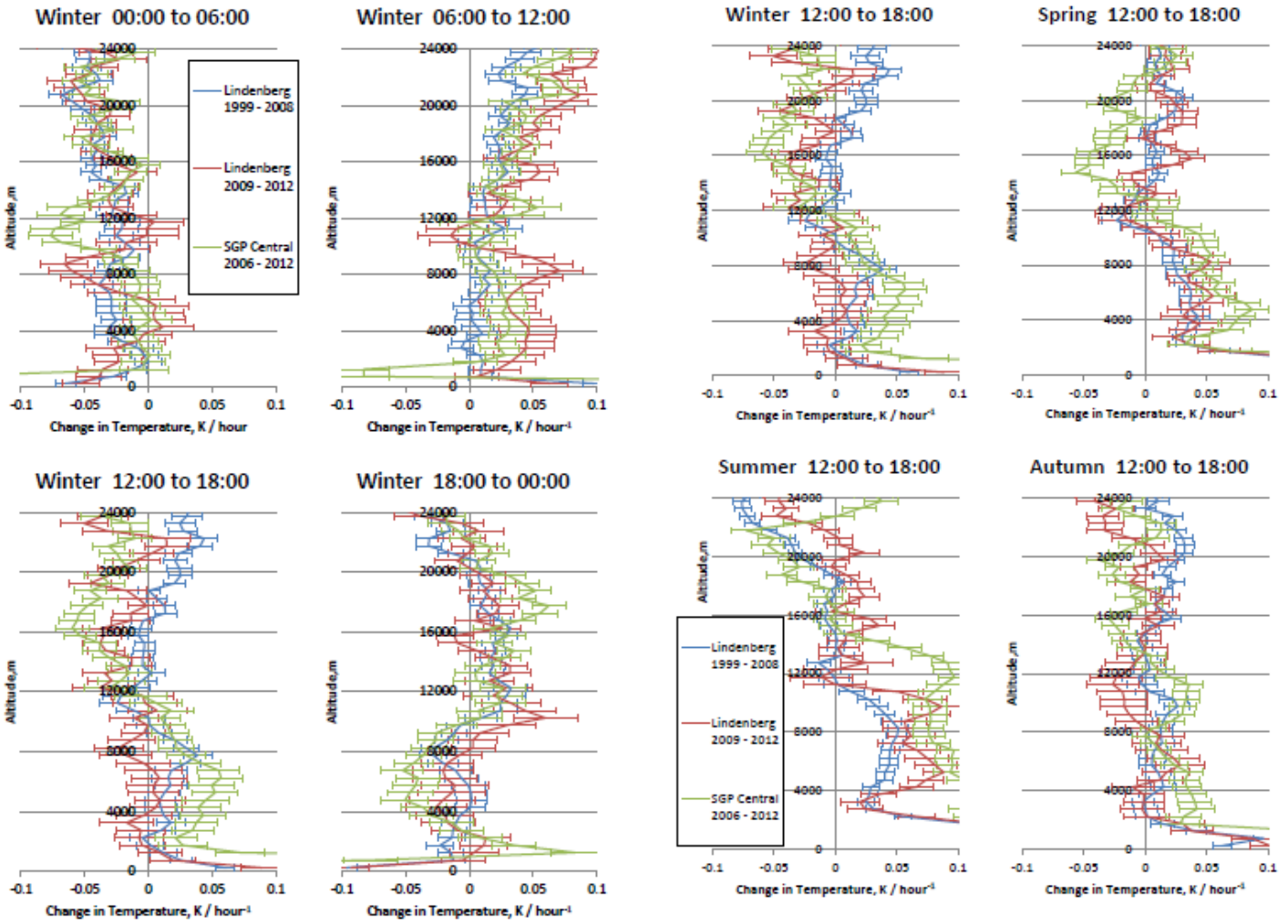
Example Temperature Difference Profiles



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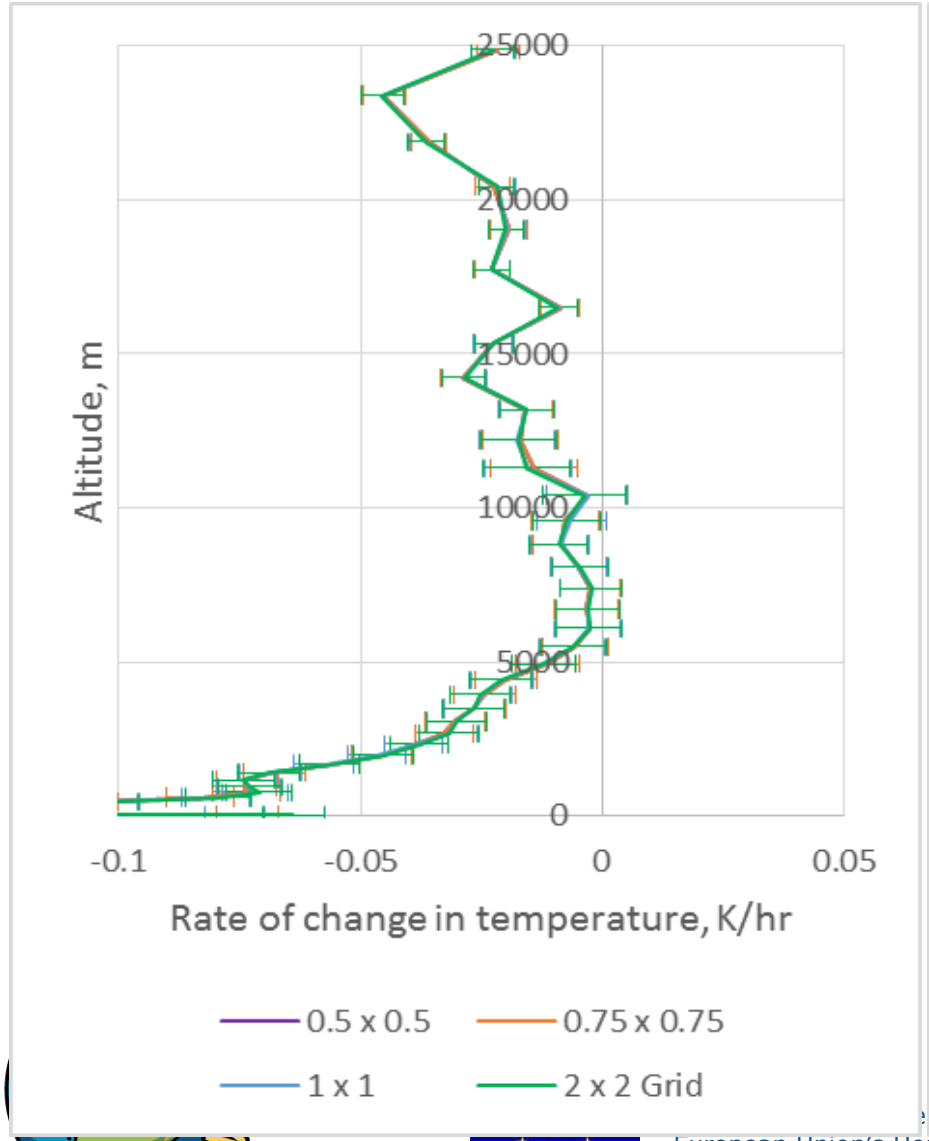
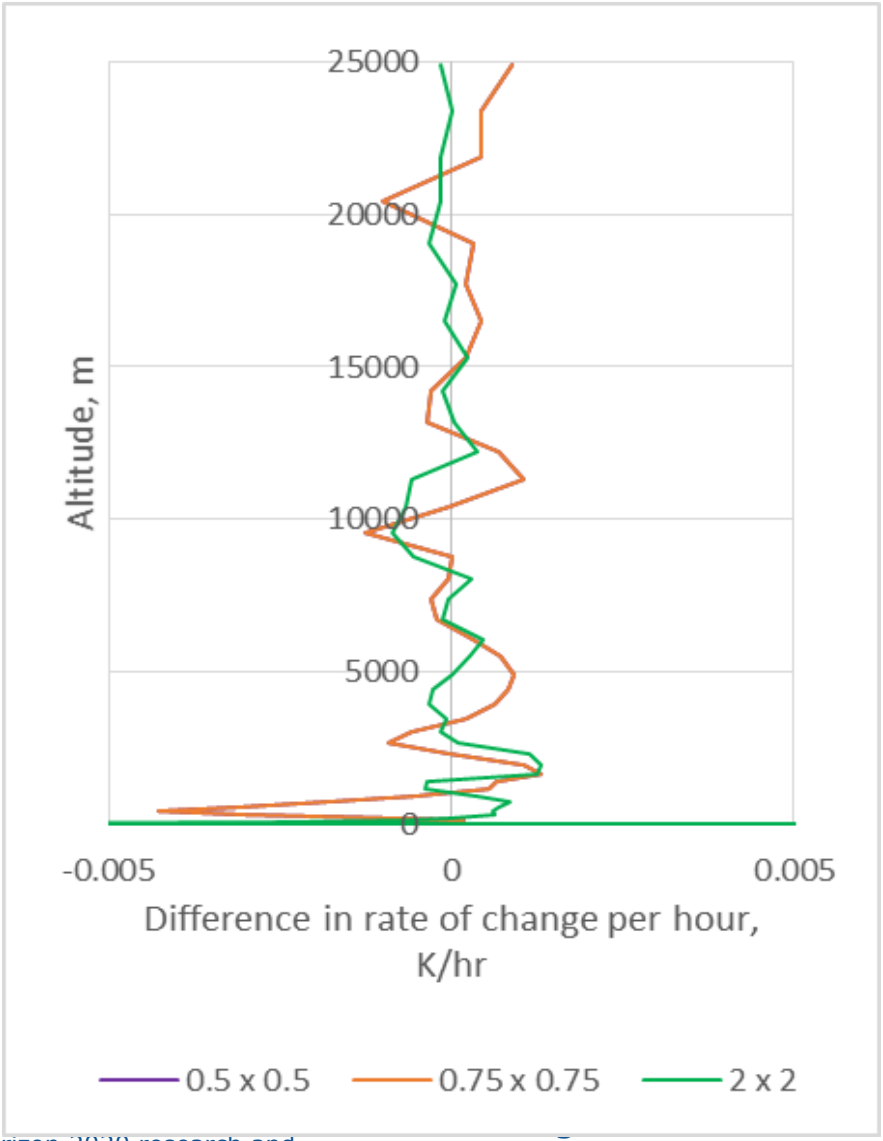
ERA-Interim Data – Grid size





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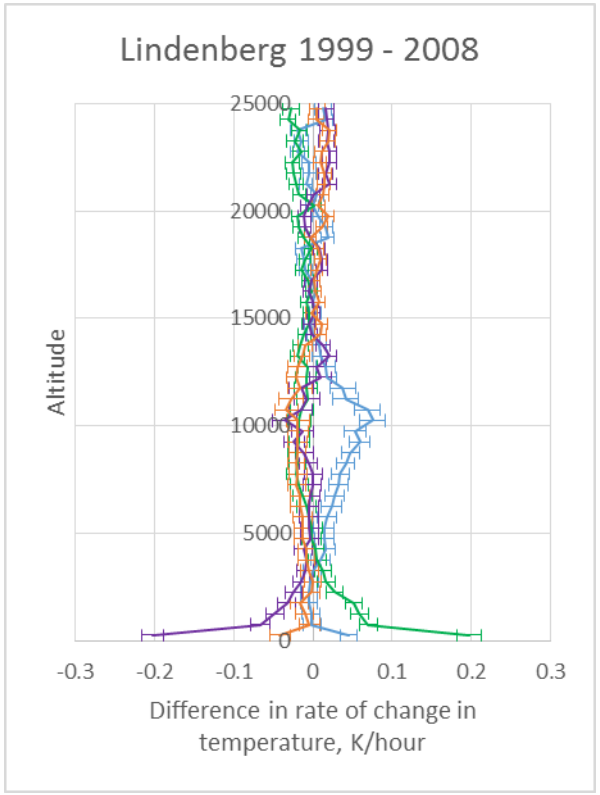
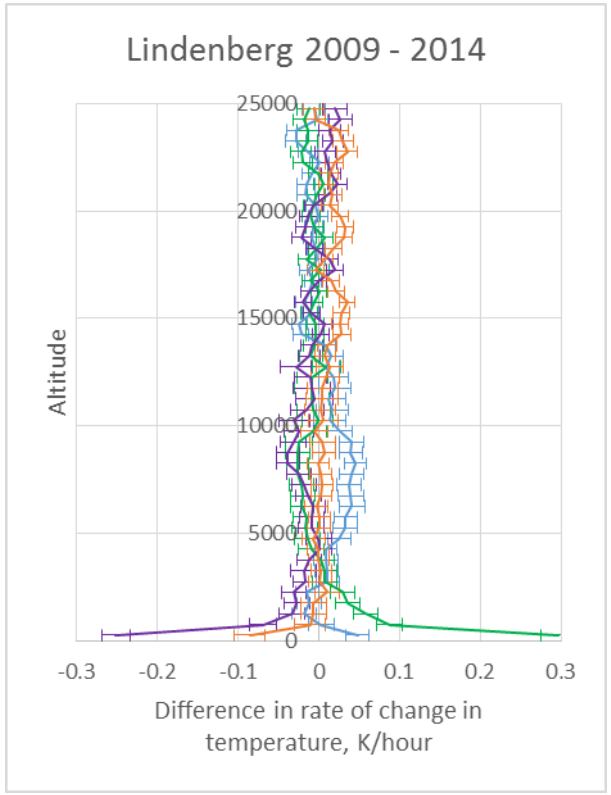
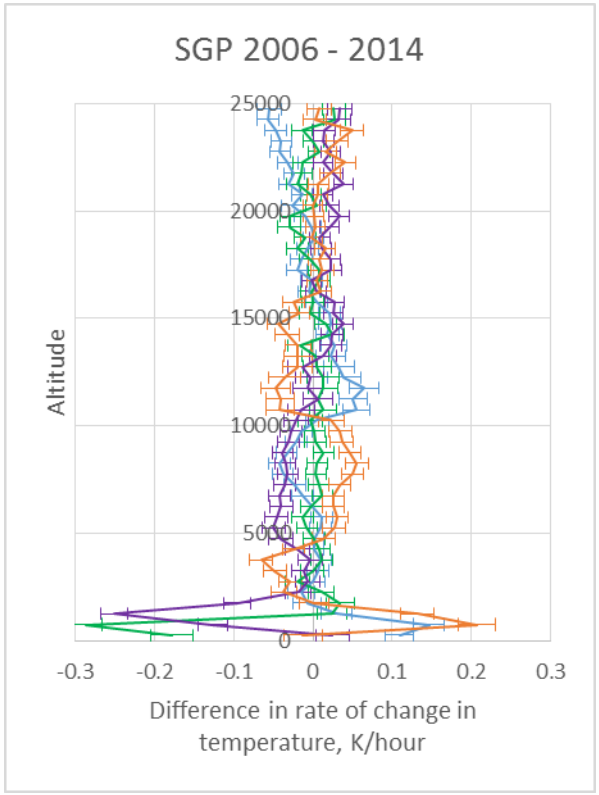
1 x 1grid taken as reference

Difference in mean rate of change in temperature between ERA-Interim and radiosonde in Spring







Midnight – Early morning
Early morning – Midday
Midday – Late afternoon
Late afternoon - Midnight

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Uncertainty assessment

- Two elements to the uncertainty – the random (uncorrelated) component that reduces with the number of measurements made, and a systematic (correlated) component that effects the underlying rate of change in temperature.
- Dirksen et al, 2014 separate the sonde measurement uncertainty sources into correlated and uncorrelated contributions. However, in their work correlated refers to correlation within one sonde ascent.
- Only those uncertainty sources that remain correlated in the difference between sequential launches would contribute to the systematic element in this study.

Parameter	Correlated during ascent ?	Sequential systematic difference ?
T-sensor calibration	Y	N – random and constant comp.
Spike removal	Y	N - random
Sensor time lag	Y	N - constant
Random variability	N	N - random
Radiation correction		
- rotating radiosonde	N	N - random
- albedo	Y	N – random and constant comp.
- ventilation velocity	N	N - random
- correction parameters	Y	Possible in day-night transitions

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Uncertainty assessment

- The majority of the sonde uncertainty contributes to the random component in this analysis.
- The differences between measured and modelled random uncertainties are of the order of the uncertainty expected for the sonde measurement.
- The residual systematic components of the uncertainties typically agree to within 0.01 K/hr at all altitudes.

Random components of uncertainty	Mid Trop	UTLS
Sonde differences	0.283 K/hr	0.202 K/hr
ERA-Interim differences	0.252 K/hr	0.148 K/hr
Typical sonde measurement uncertainty	0.035 K/hr	0.058 K/hr

Systematic components of uncertainty	Mid Trop & UTLS
Sonde	0.021 K/hr
ERA-Interim	0.014 K/hr
Difference (sonde-model)	<0.01 K/hr

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GRUAN sites selected for ERA-Interim analysis

Location	Latitude	Longitude	Elevation, m above sea level	Period
Ny Alesund	78.92 N	11.92 E	5	01/01/11 to 31/12/14
Barrow	71.32 N	156.61 W	8	01/01/09 to 31/12/14
Sodankyla	67.37 N	26.63 E	179	10/09/10 to 31/12/14
Lindenberg	52.21 N	14.12 E	98	01/01/09 to 31/12/14
Lauder	45.05 S	169.68 E	370	11/12/12 to 31/12/14
Potenza	40.60 N	15.72 E	720	22/02/11 to 31/12/14
Boulder	39.95 N	105.20 W	1743	15/06/11 to 31/12/14
SGP	36.60 N	97.49 W	320	01/01/06 to 31/12/14
Tateno	36.06 N	140.13 E	31	01/01/10 to 31/12/14
La Reunion	21.00 S	55.00 E	2200	01/01/10 to 31/12/14
Darwin	12.43 S	130.89 E	35	01/01/10 to 31/12/14
Manus	2.06 S	147.42 E	6	01/01/11 to 31/12/14

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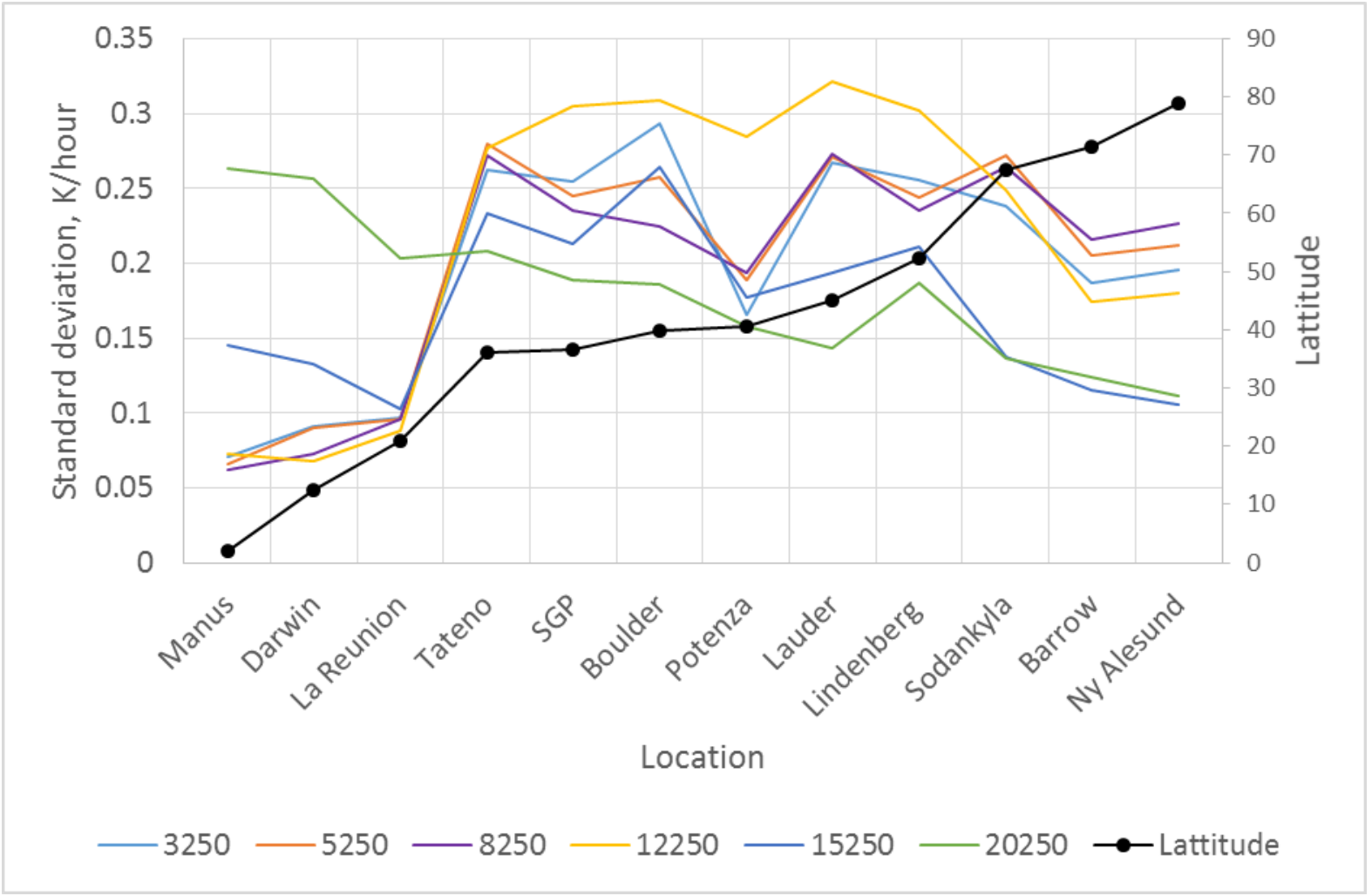
Random component of uncertainty at 12 GRUAN sites



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Extension to humidity

- Extraction of radiosonde and ERA-Interim datasets and conversion to same altitude and humidity scales (non-trivial exercise and potential source of additional uncertainty).
- Assessment of random and systematic behaviour in humidity mismatch uncertainty as a function of altitude, time of day, season and sample size.
- Comparison between radiosonde and ERA-Interim results, for both standard and GRUAN-processed sonde datasets.

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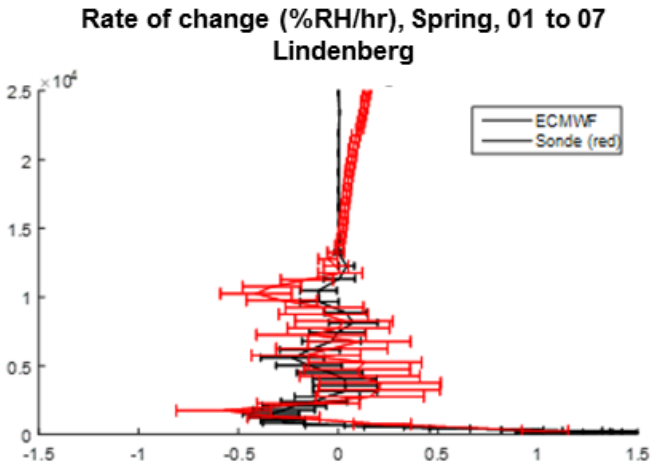
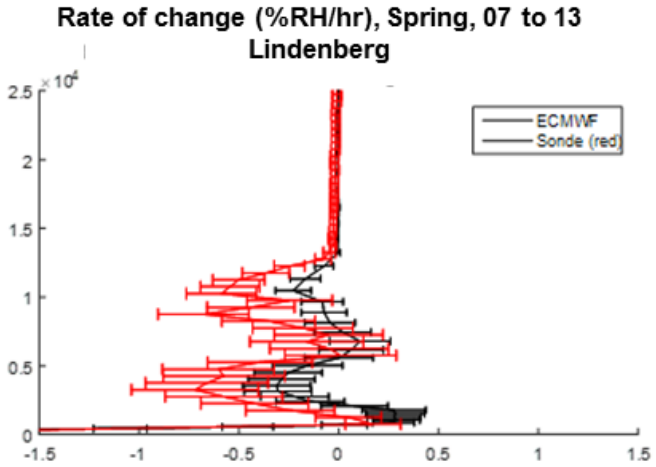
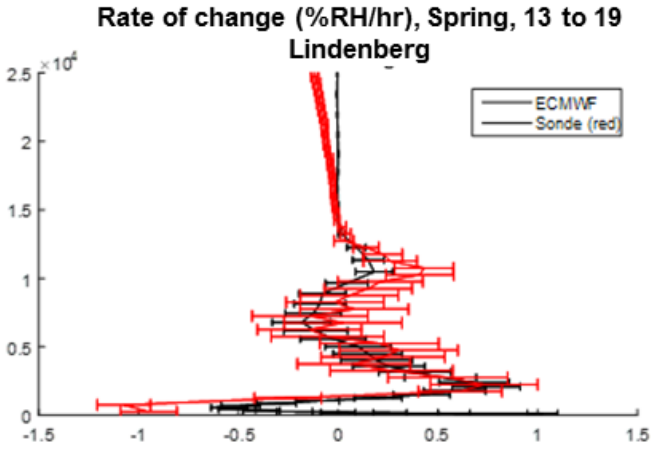
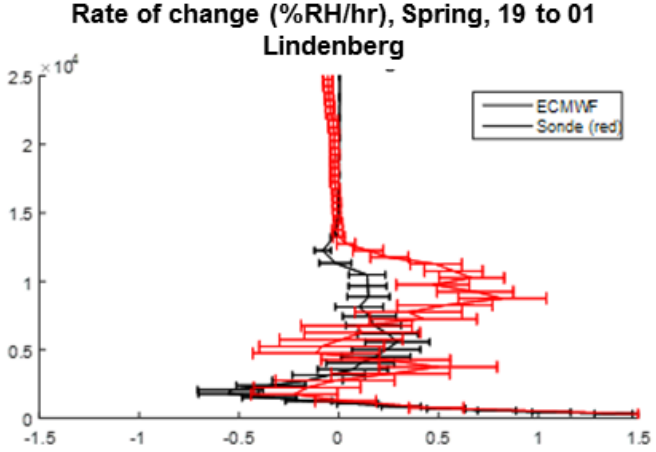
Initial humidity results - Lindenberg









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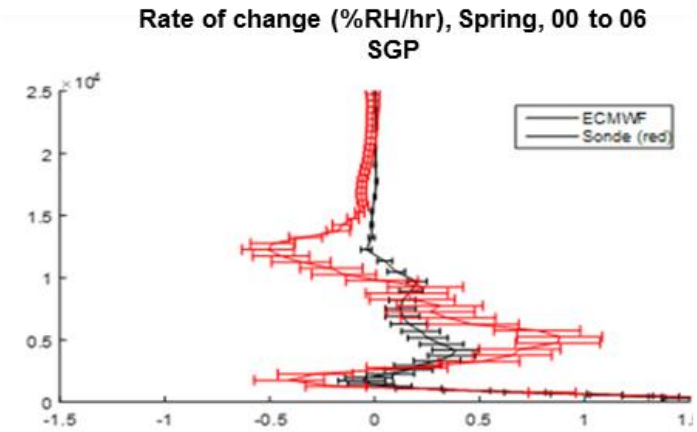
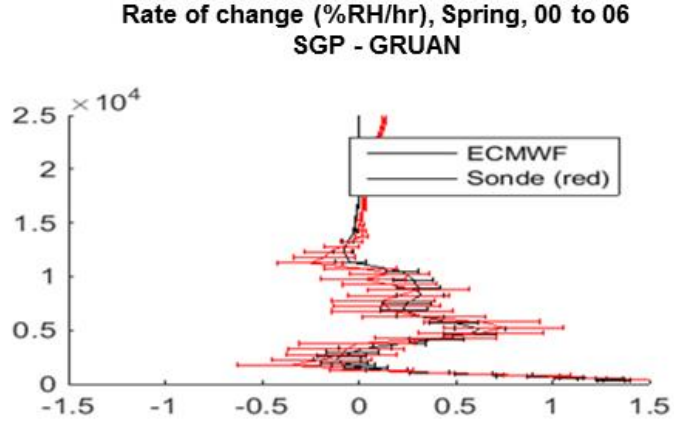
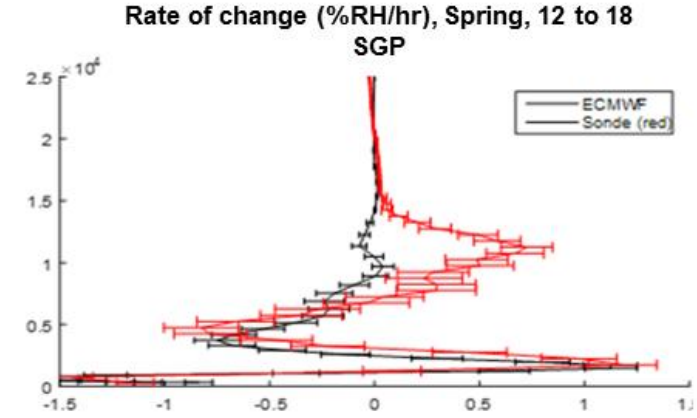
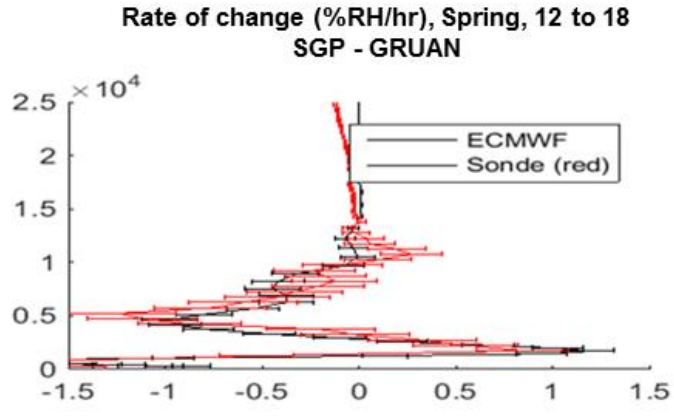
Comparison between ARM and GRUAN humidity sonde data at SGP









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Conclusions

- Method provides a direct means of estimating the temporal mismatch uncertainty in temperature as a function of altitude, season and time of day, for any selected site using ERA-Interim model data.
- Validated by comparing the ERA-Interim results with GRUAN-processed radiosonde data where long-term high frequency data is available.
- Differences between the radiosonde and ERA-Interim temperature data generally consistent with the expected uncertainties.
- Similar studies underway for the humidity data - shown improved agreement between measured and modelled differences with GRUAN-processed data.
- This work has been based on the available reference data with traceable uncertainties: GRUAN RS92 sonde dataset.
- As additional reference datasets and uncertainties become available they can be integrated into this analysis – particularly relevant with higher temporal resolution data.

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