Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Lead centre progress report II

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outline

- Reference quality of observations
- The RS92 GRUAN data product
- Development of GRUAN data product

What is a „Reference“ measurement?

For GRUAN it was defined (Immler et al. AMT 2010) that Reference Quality requires:

- traceability to SI units or a commonly accepted standard
- comprehensively estimated uncertainty
- documentation of instrument, procedures and algorithms
- validation of the data-products

Temperature uncertainty budget for RS92

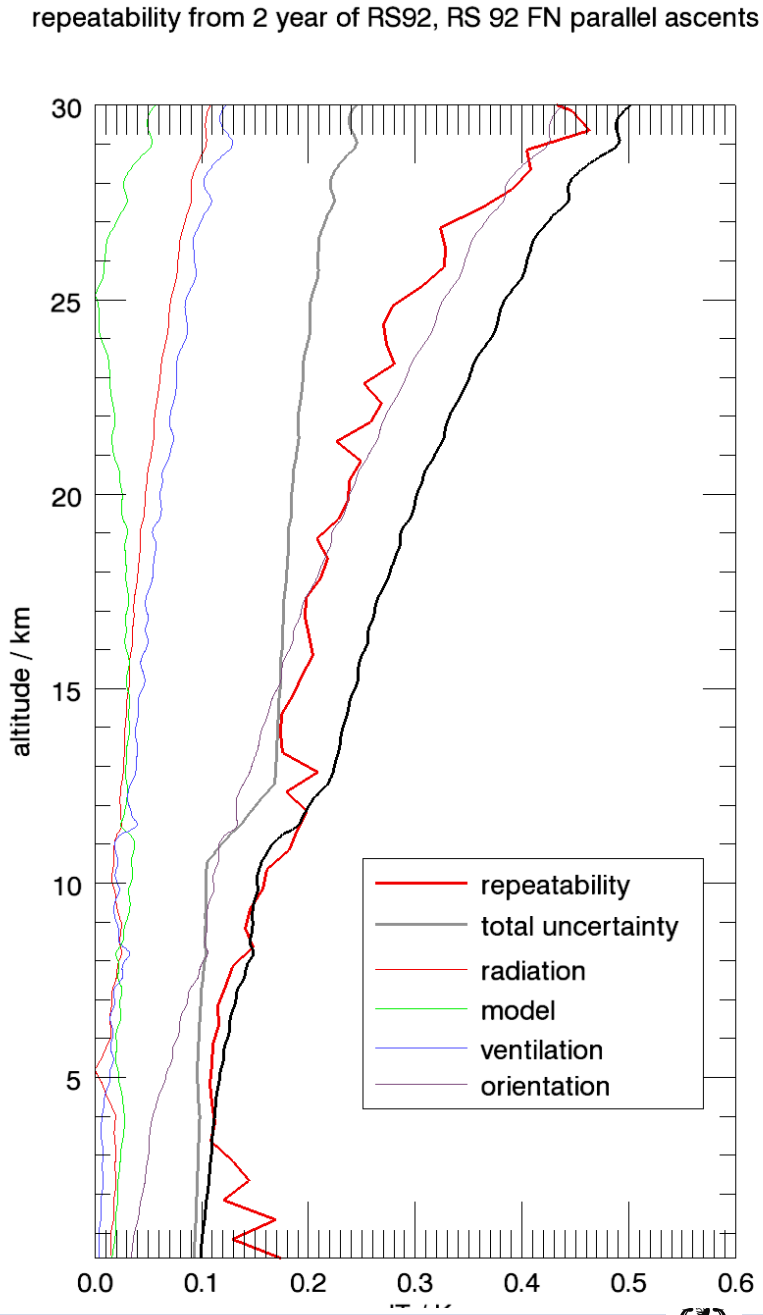
Uncertainties:

Calibration: 0.1 K TS 0.2 SS

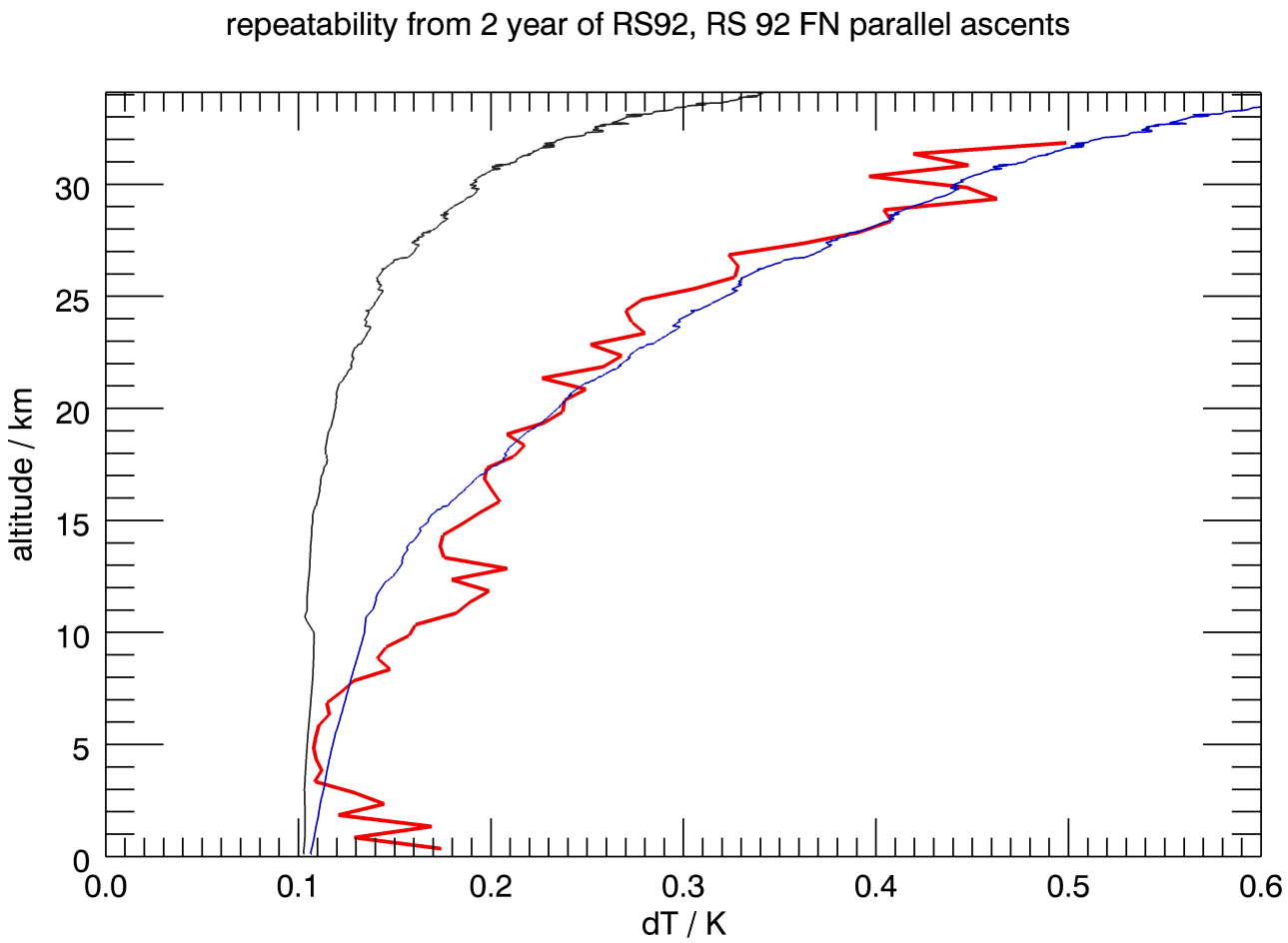
Radiation:

- Radiation field
- Ventilation
- Orientation
- Correction model

(Vaisala - Lindenberg)



Validation: RS-92 RS-92 comparison

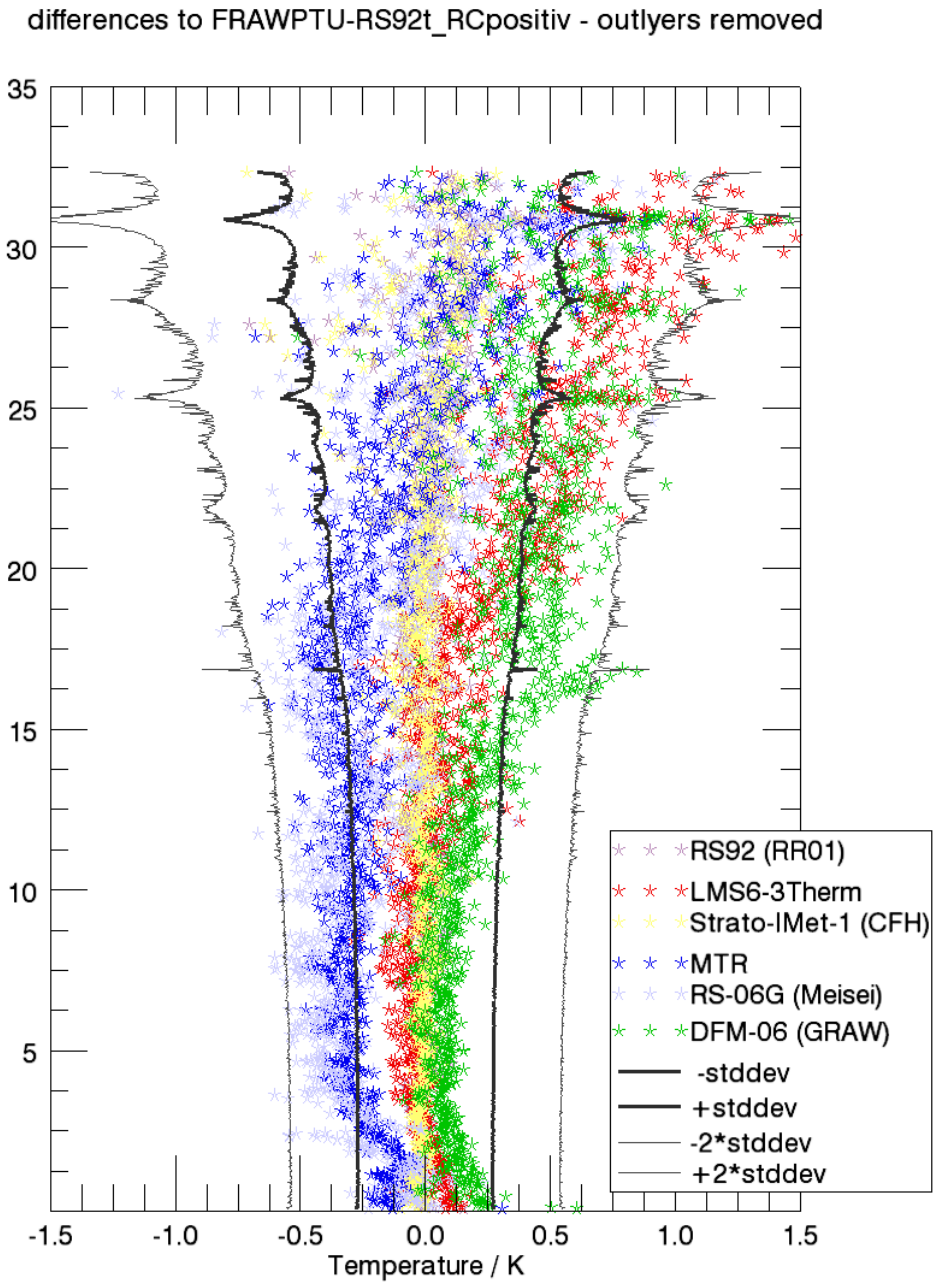


Temperature product validation
CIMO 2010 Yangjiang

- Different techiques -
  same results within uncertainties
  Validation of uncertainty estimates:

$$\left|T_{test} - T_2\right| < 2\,u_{test}^2$$

$$\left|m_1 - m_2\right| < k\sqrt{u_1^2 + u_2^2}$$



RS92 Temperature product: summary

- Product from raw data
- Documentation is currently under review by Task Team on Radiosondes

- At night time uncertainty close to GRUAN specification (0.1K TS, 0.2K SS)
- At day time larger uncertainties above 25km.
  - Same problem for all sensors

RS92 Temperature product: conclusions

- RS92 temperature product is available that complies GRUAN reference quality standards.
- Probably more important than improving accuracy is to ensure long-term stability
  - Ground check to independent reference
  - Regular (weekly) dual soundings with other sensor (e.g. GRAW DFM-09)
  - Managed change!

Humidity correction

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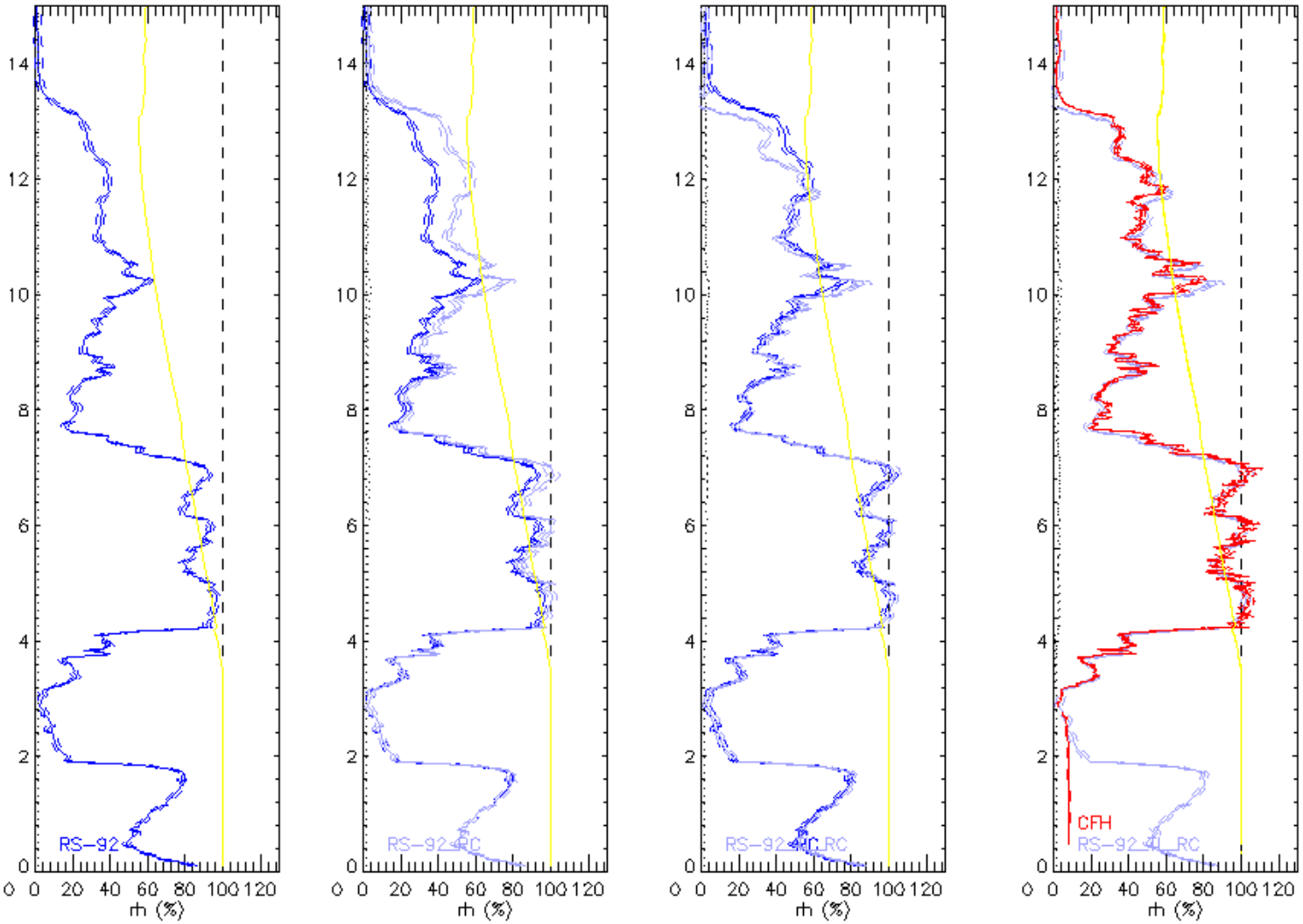
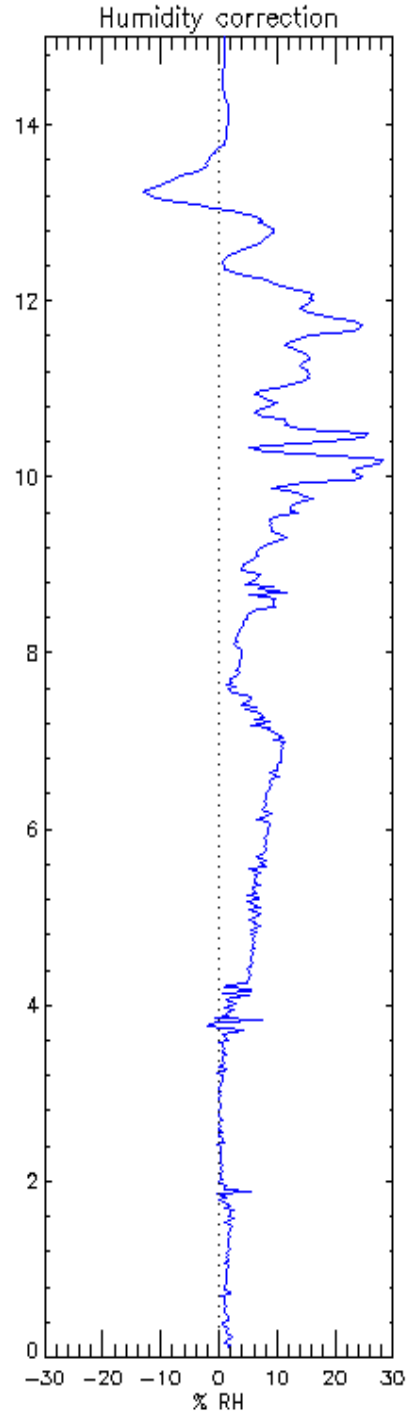
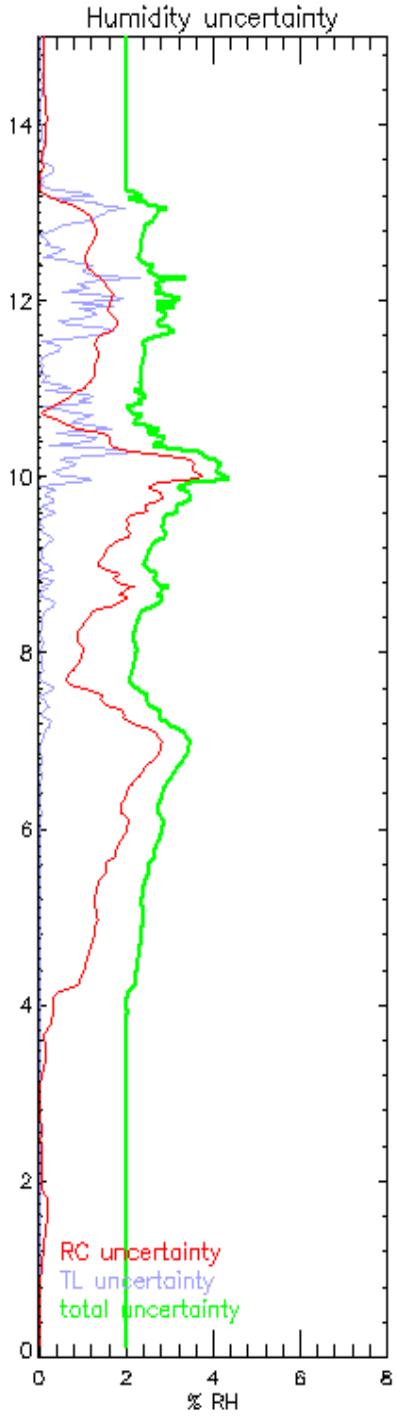
Radiation corr. | Time-lag corr. | Comparison to CFH

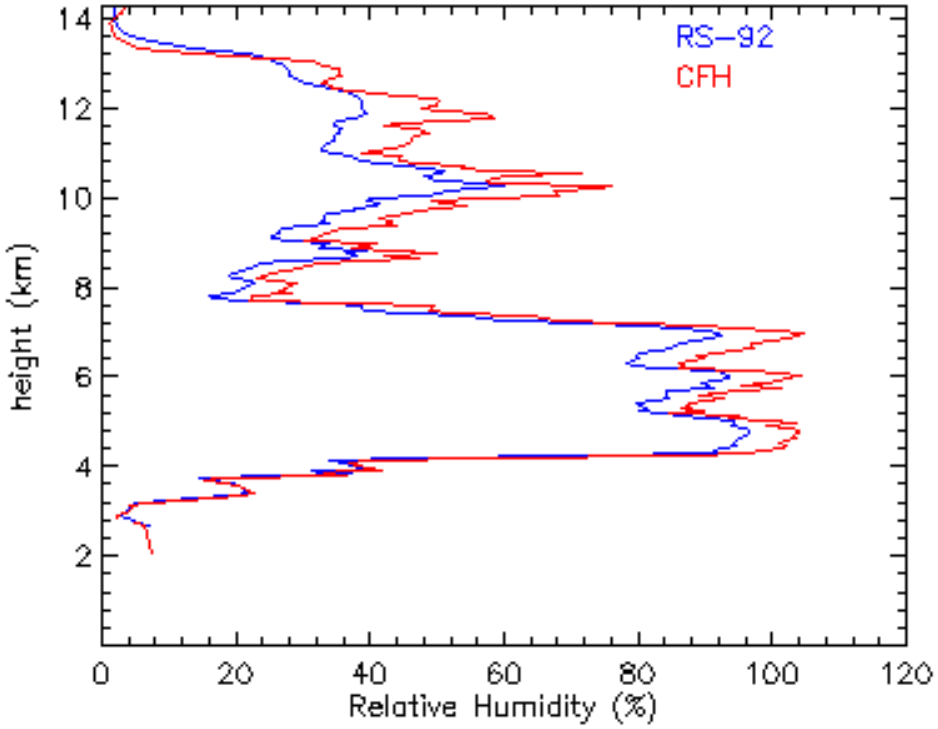


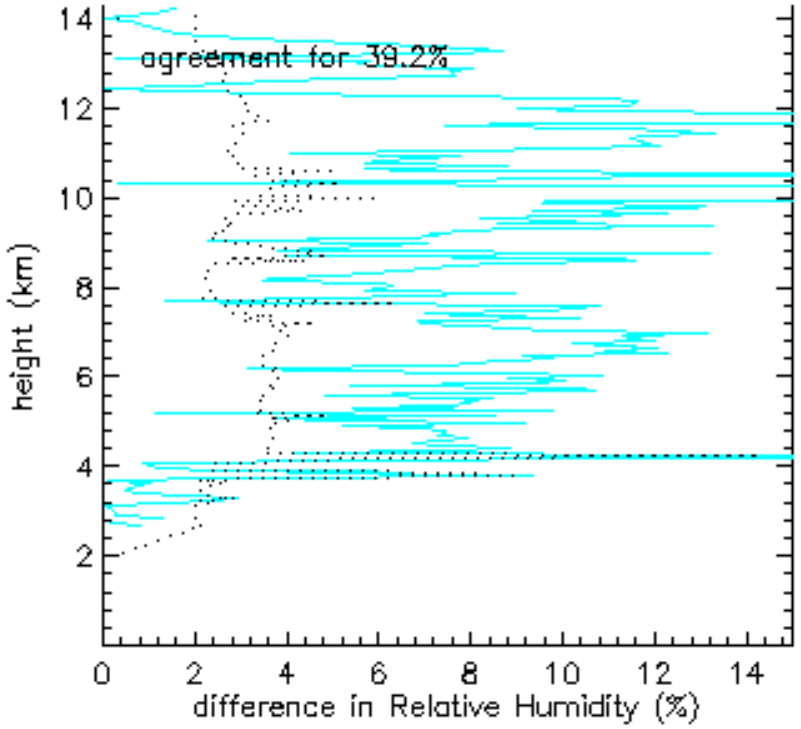




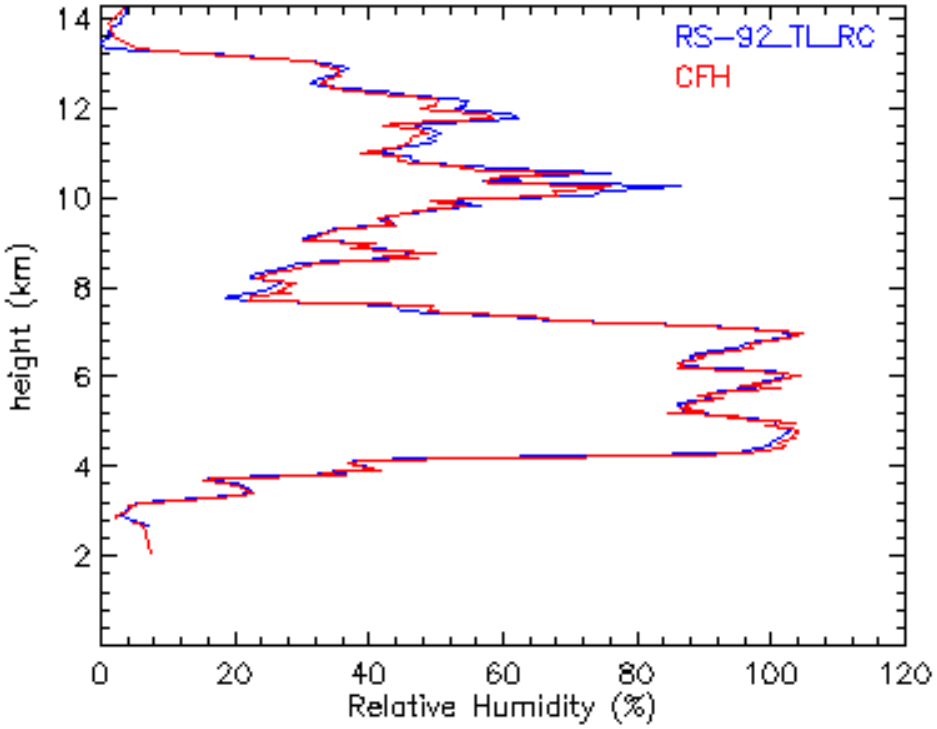
Humidity correction and its uncertainty

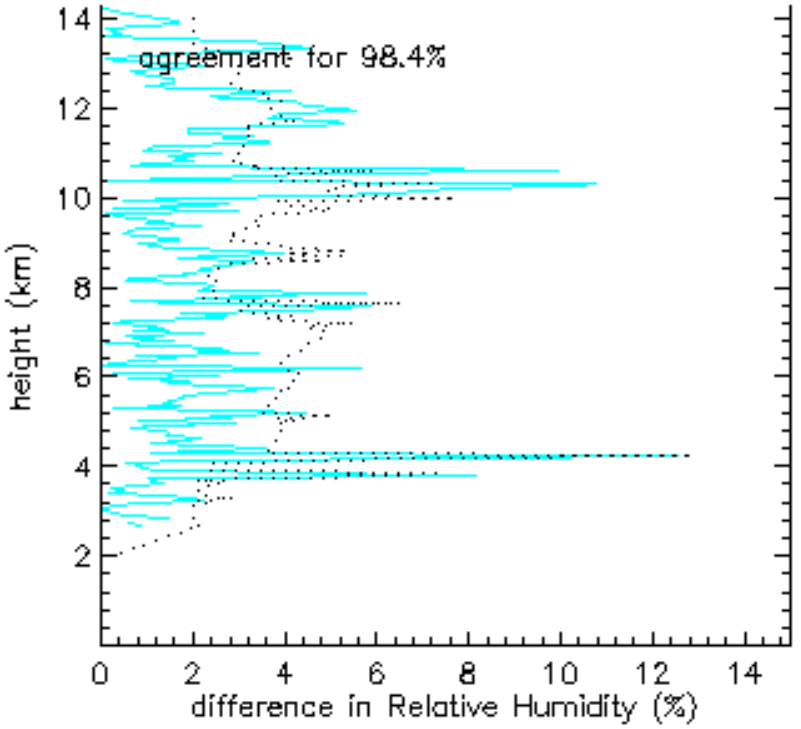
Comparison RS-92 (Routine) with CFH, 16.06.2009





Validation of uncertainty estimates





$$\left|U_{RS92}-U_{CFH}\right|<2\times\sqrt{u_{RS92}^2+u_{CFH}^2}$$

RS92 humidity: Summary

- RS-92 humidity need adjustments on calibration, radiation effect and time-lag
  - uncertainties are
    - 2-3 %RH in lower troposphere,
    - 5%RH and more in upper troposphere

- Documentation containing detailed description of uncertainty analysis is available and currently under review by Task team on radiosonde

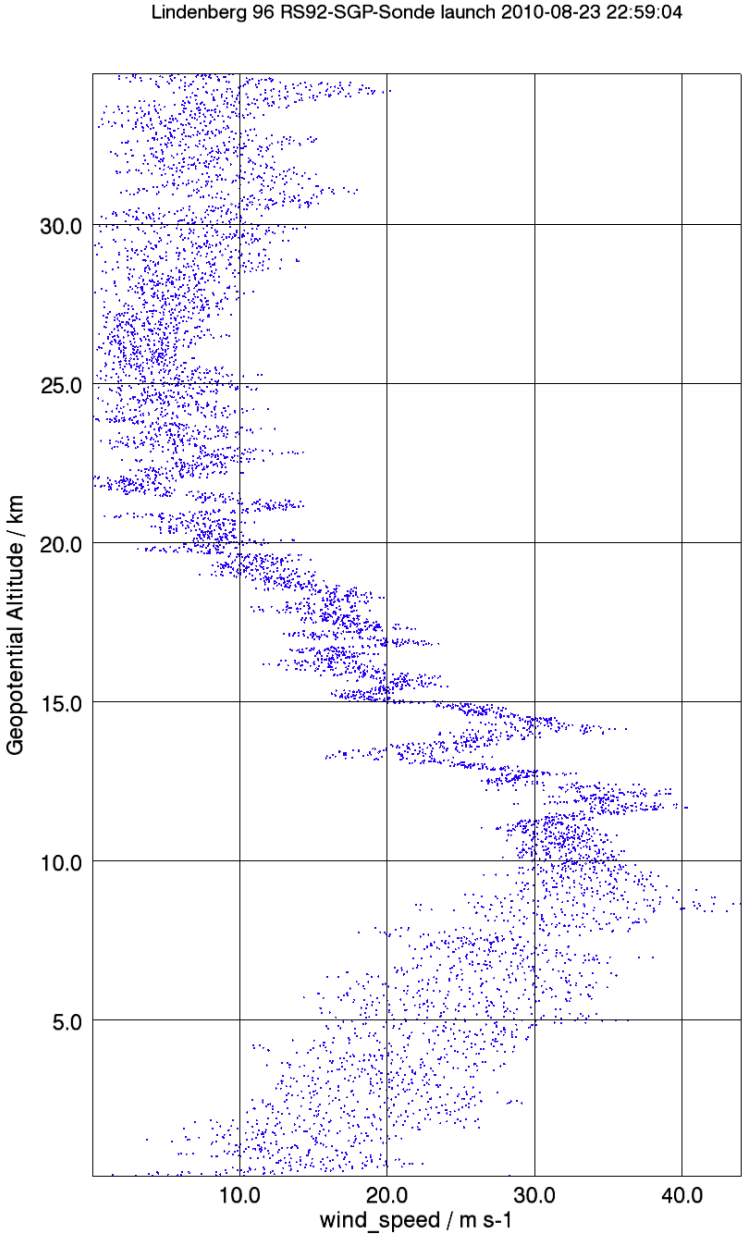
RS92 humidity: Conclusions

- Uncertainty in lower and middle troposphere close to GRUAN spec.
- Product form routine sounding provides high availability
- Accuracy in upper troposphere rather poor
- No data from the stratosphere

- Frostpoint instrument required for these regions
- (Vaisala drycap might also be an option in the future)

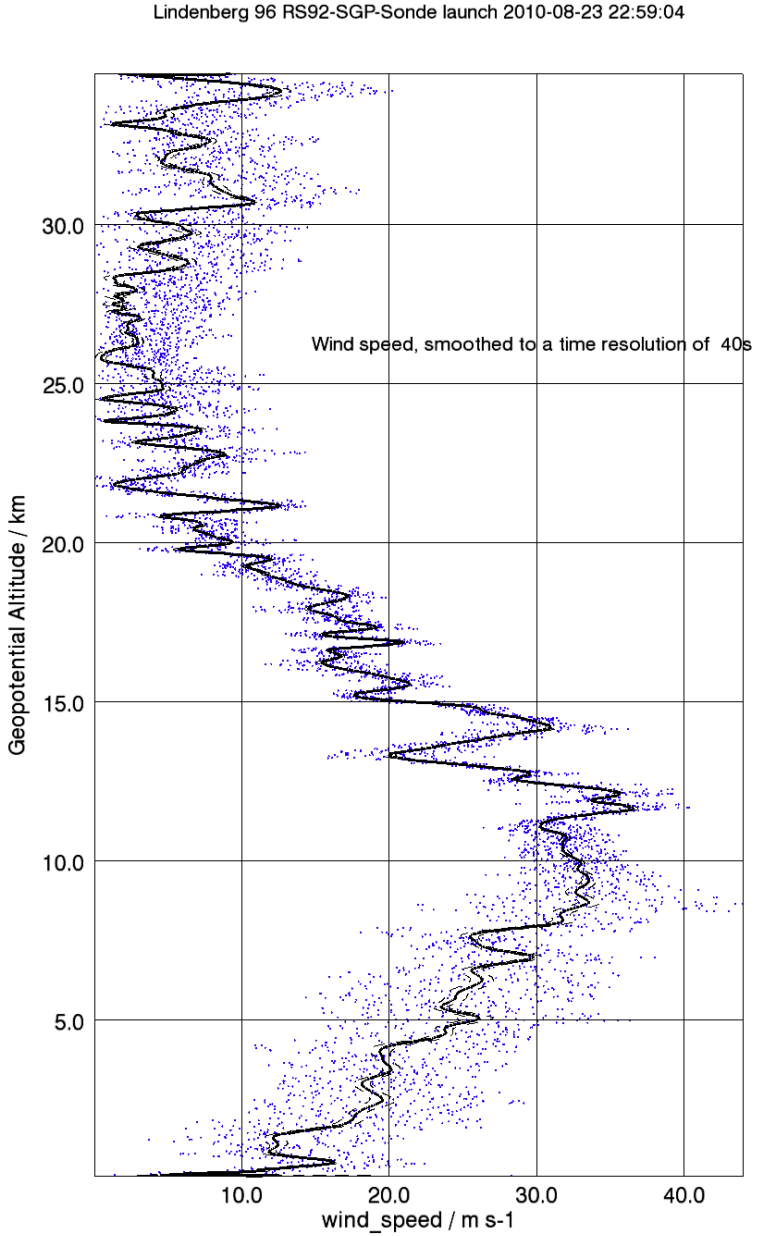
RS92 Wind

Raw data from GPS



RS92 Wind

- Smoothing required
- Typ A evaluation of measurement uncertainty



Uncertainty from "smoothing statistics"

- using any averaging kernel c_i (boxcar, Kaiser window, etc.)

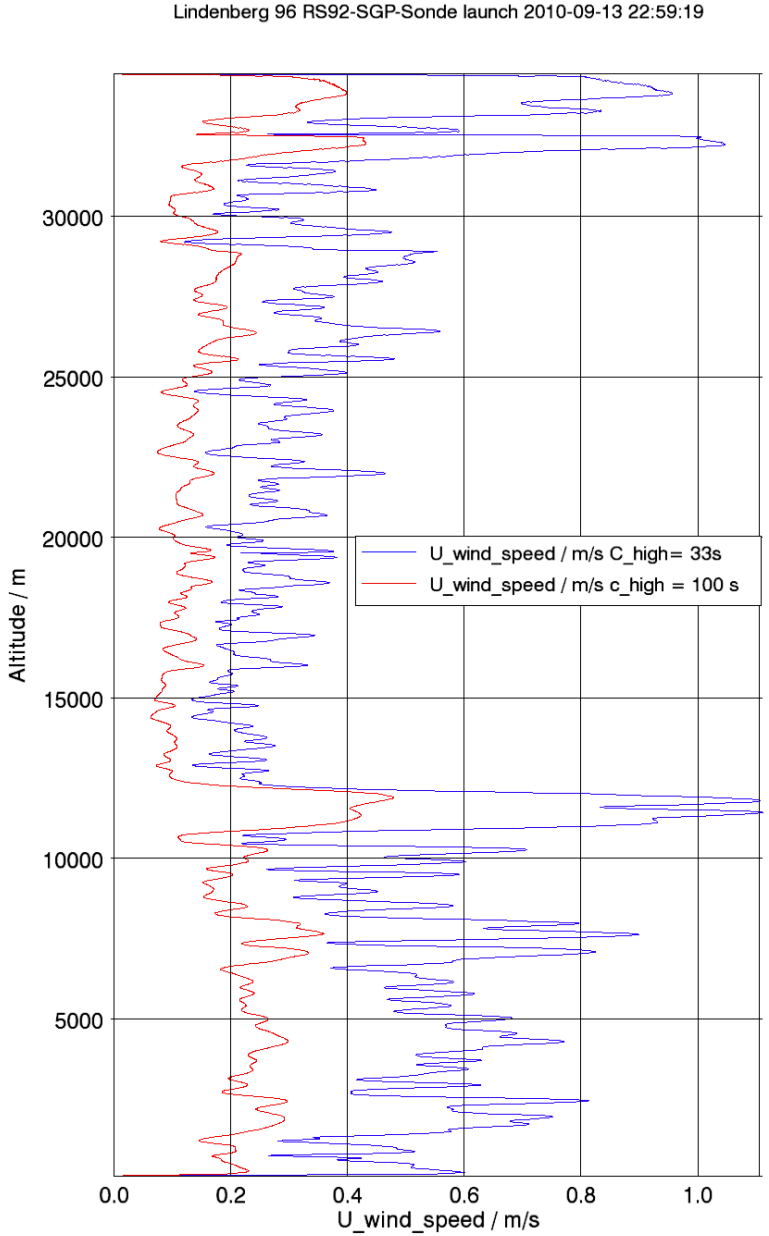
$$d\bar{S}_j = \frac{\sigma_j}{\sqrt{N'}} = \sqrt{\frac{N'}{(N'-1)} \sum_{i=-M}^{M} \left(c_i \left(s_i - \bar{S}_j \right)^2 \right)}$$

$$N' = \left(\sum_{-M}^{M} \left(c_i^2 \right) \right)^{-1}$$

- altitude resolution:

1 / cut off frequency of the filter

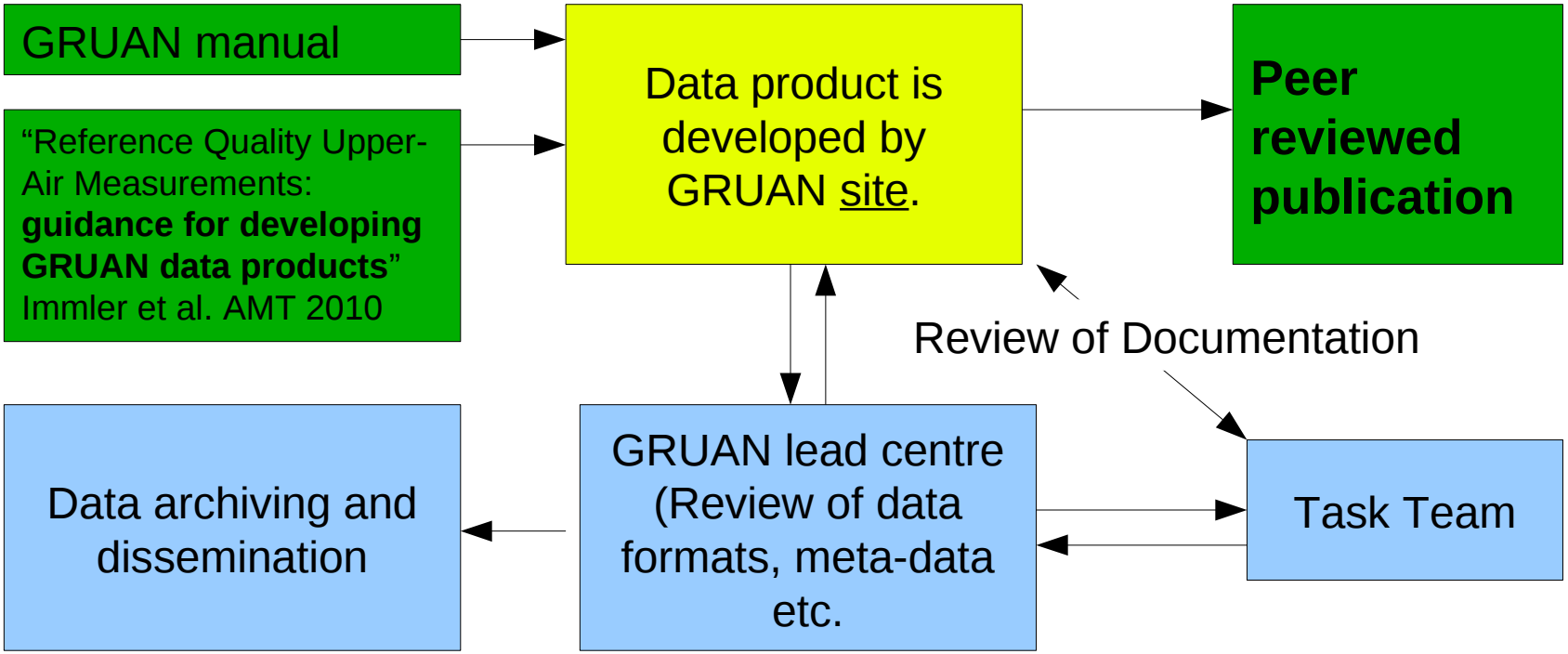
≈ 1 / N'



Some general conclusions on the smoothing of data

- Smoothing can be done using any kind of digital filter or window as long as:
  - Random uncertainties are calculated and propagated
  - Resulting resolution (time or altitude) is reported along with the data.

GRUAN data product development



GRUAN LC achievements

- Definition of a generic and comprehensive framework what „reference observations“ are in GRUAN.
  - Immler et al paper
  - GRUAN Manual
- Set up of a unique data flow infrastructure that ensures collecting, and dissemination of GRUAN data
  - all relevant meta-data are archived in a data-base
  - Raw data are archived

    … see Michaels talk for more information
- First (beta) reference product now available … more should follow soon
  - GRUAN stations must develop such products from their instruments
  - GRUAN station will be precessing centre for that measurement system.