The Lindenberg Upper-Air method intercomparison (LUAMI)

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LUAMI radiosonde intercomparison

- Comparison of ground based and airborne remote sensing with in-situ observations
- Parallel ascents of research type radiosonde with commercial ones
  - Goals:
    - ✓ Identifying systematic errors
    - ✓ Test suitability of Radiosondes for operational networks including GRUAN

Ground based remote sensing

- DWD
  - Raman water vapor LIDAR (RAMSES)
  - CHM 12 Ceilometer (Jenoptik)
  - RASS Windprofiler
  - 36 Ghz Cloud radar
  - Microwave radiometer (total column water vapor)
  - Microwave profiler
  - Tethered balloon
- External
  - Small scale GPS receiver network (run by GFZ)
  - Leosphere Aerosol and Doppler Lidar
  - HALO cloud radar

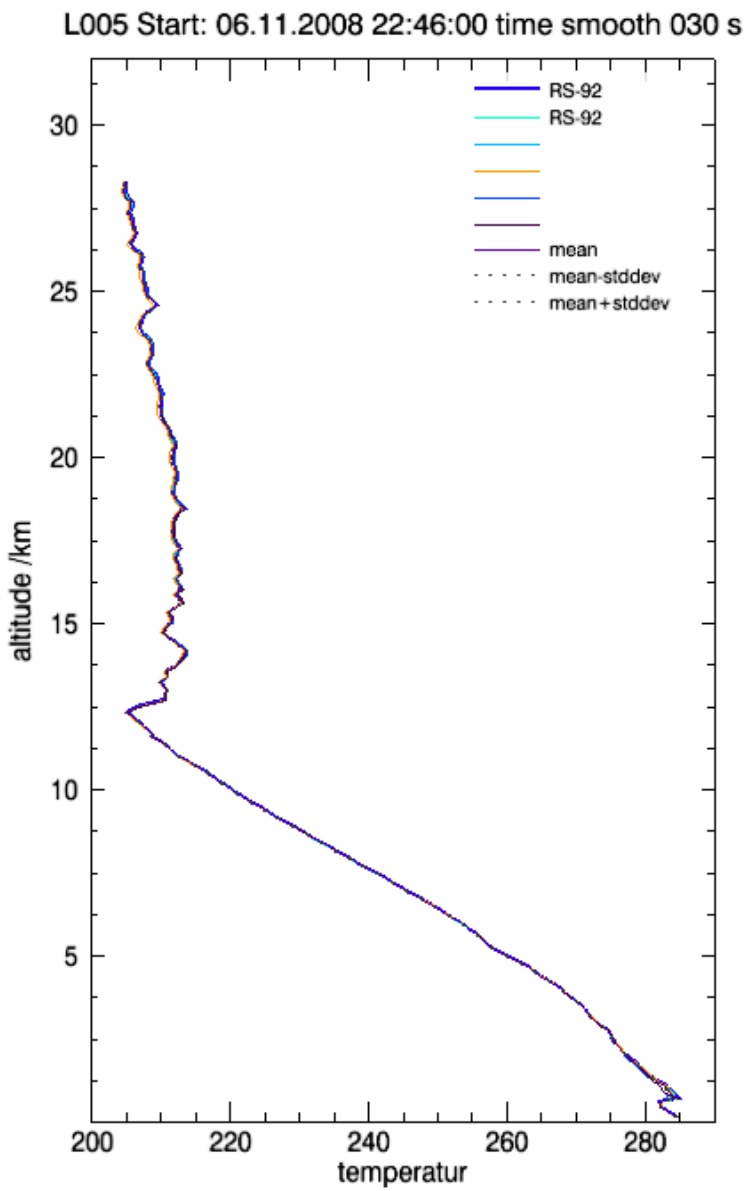
Reference type radiosondes (BQRSS)

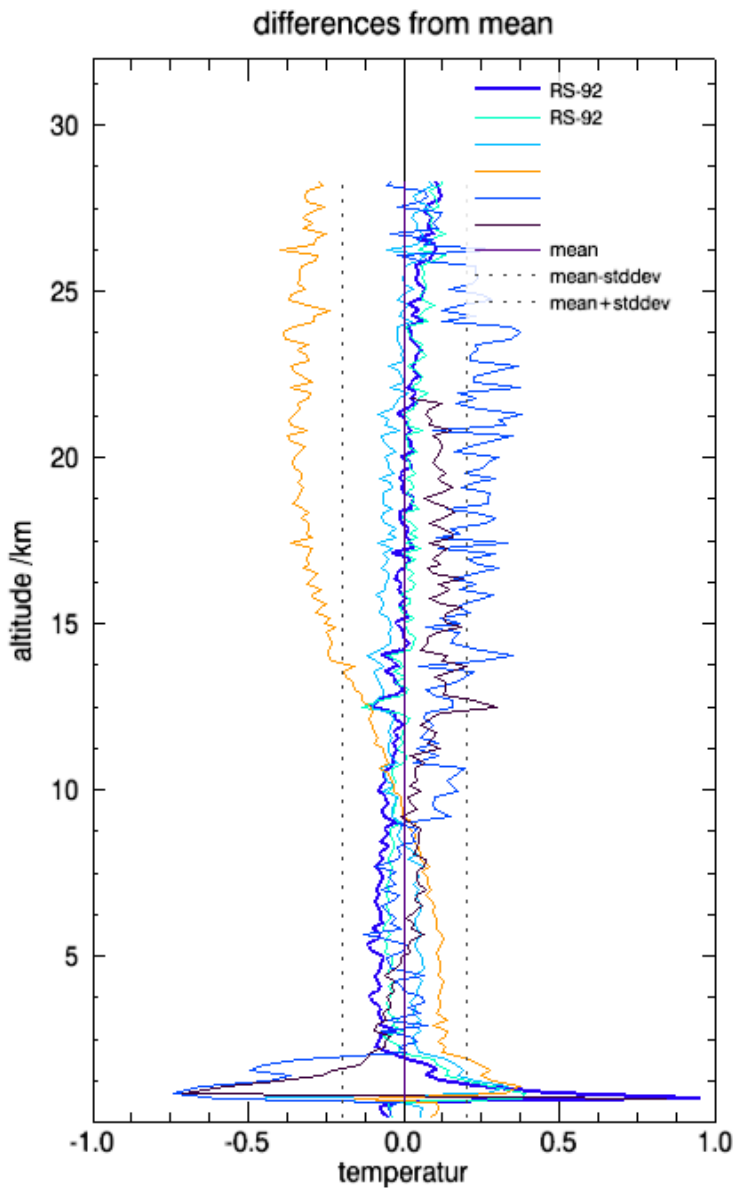
Abbreviation	*Type / Method*	*Organization / Company*
RS-90 FN RS-92 FN	FN Reference method	RAO/DWD, Lindenberg, Germany
SW	Frostpoint mirror	Meteolabor AG Wetzikon, Switzerland
FLASH	Lyman-Alpha-Hygrometer	CAO Moscow, Russia
CFH	Frost-point mirror	RAO/DWD, Lindenberg , Germany, University Colorado, Boulder/USA
APS	Advanced Polymere sensor	Vaisala, Finland
COBALD	Backscatter sonde	ETH Zurich

Commercial radiosondes (HQOR)

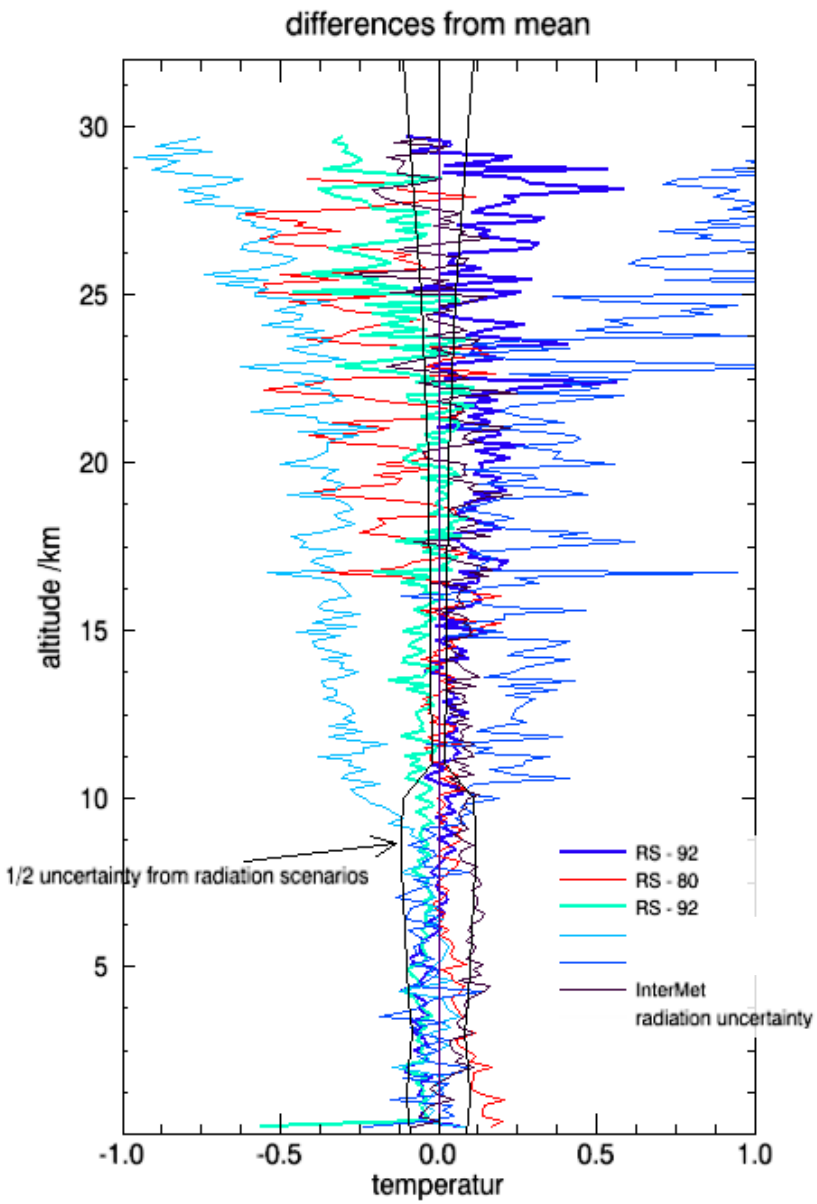
Abbreviation	*Type / method*	*Organization / Company*
RS-92 SGP	PTU - GPS	Vaisala Oyj, Finland
DFM-06	PTU - GPS	GRAW Radiosondes GmbH, Germany
BAT-4G	PTU - GPS	Int. Met. Systems, USA /SZA
SRS-C34	PTU - GPS	Meteolabor

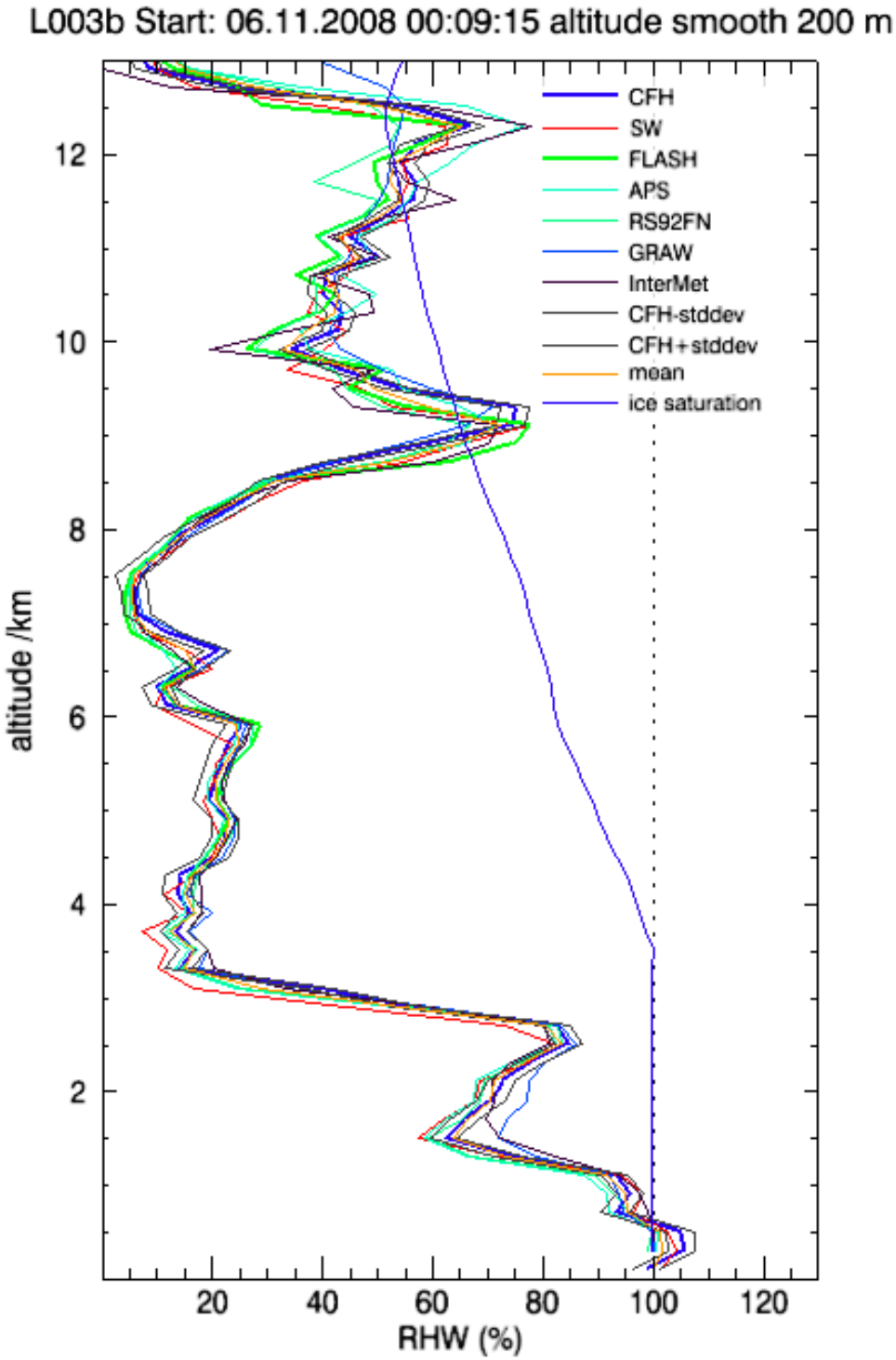
Temperature



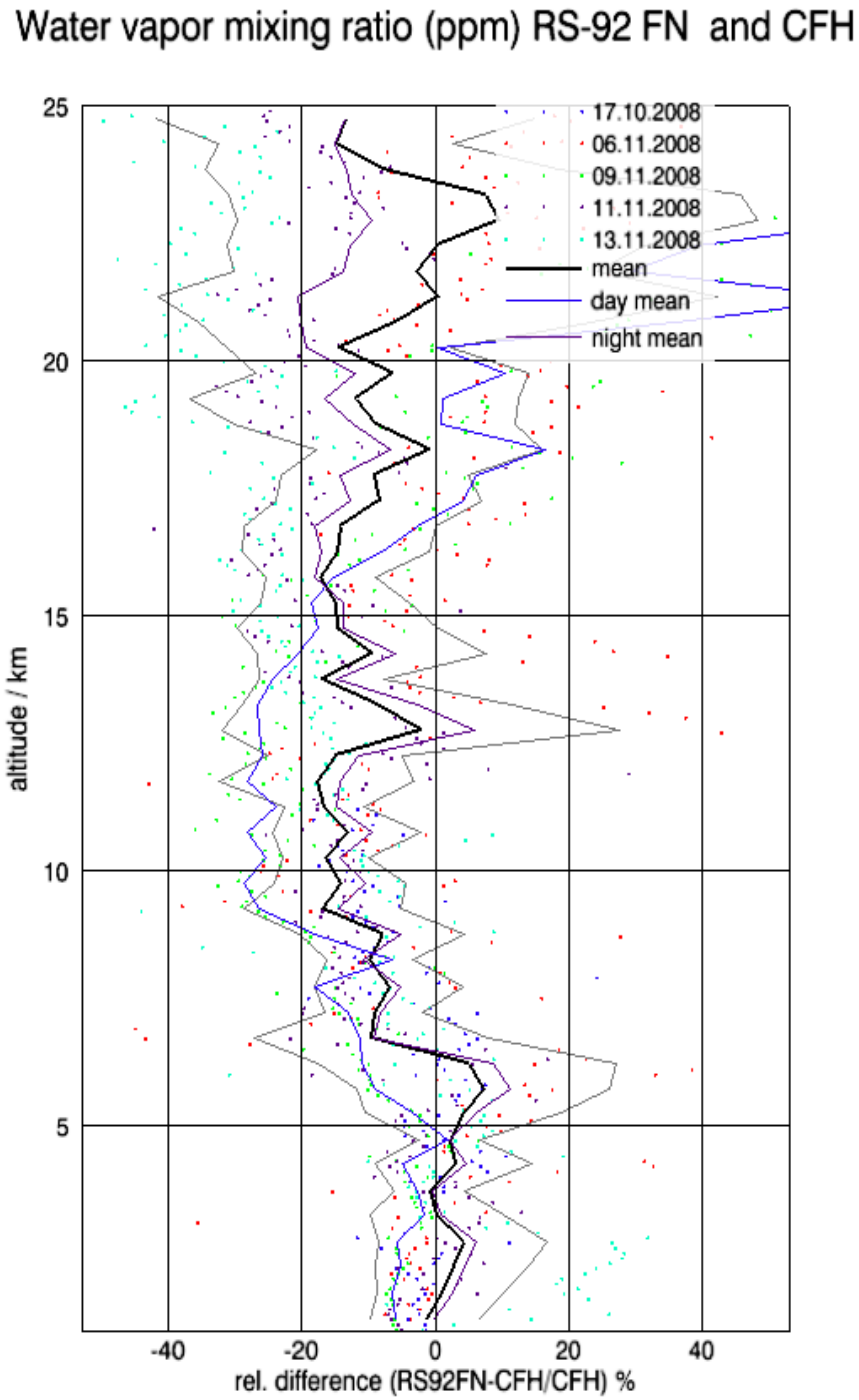


Temperature and radiation



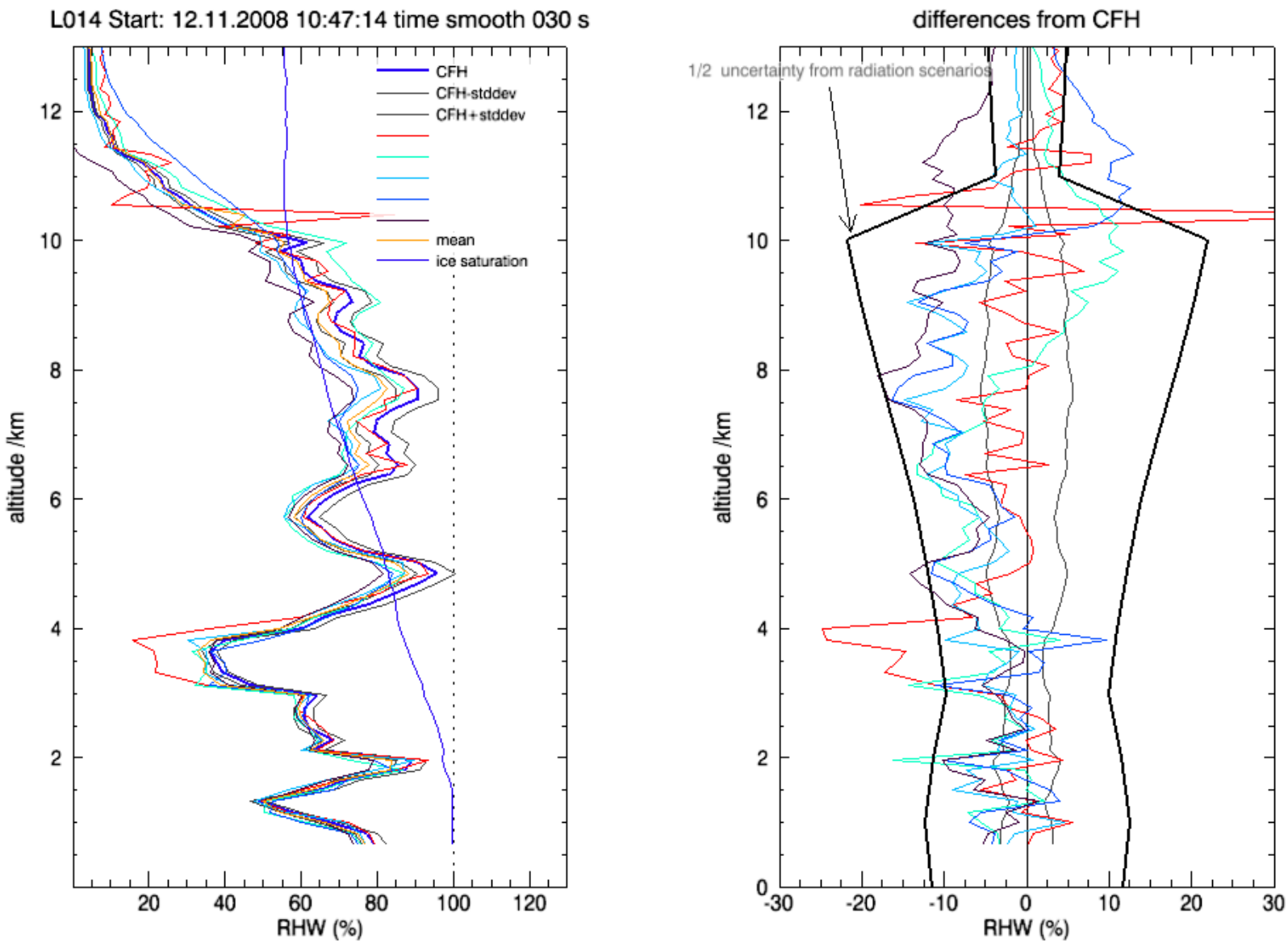


Radiosonde intercomparison: Relative humidity

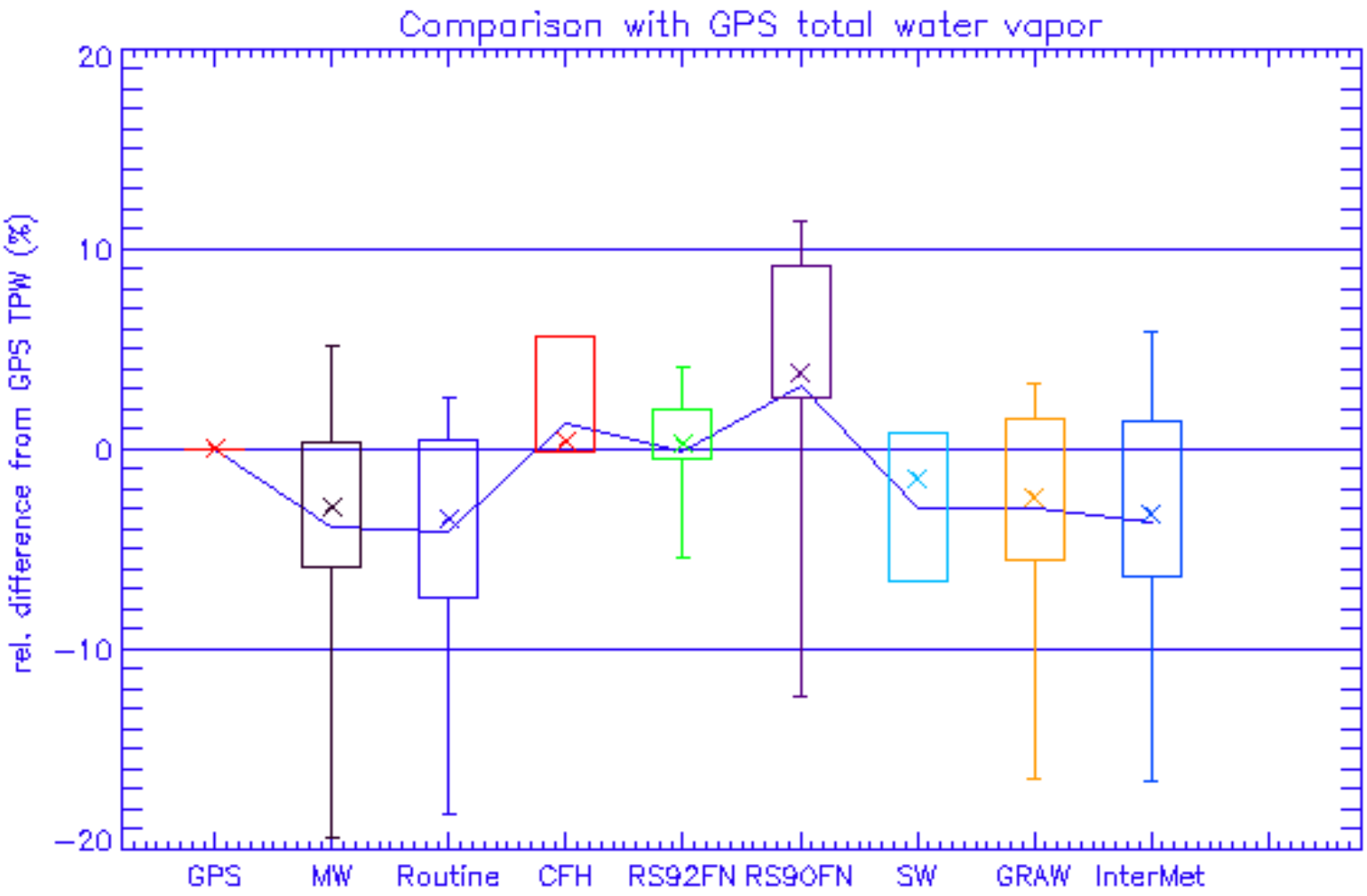


Dry bias of polymer sensors still

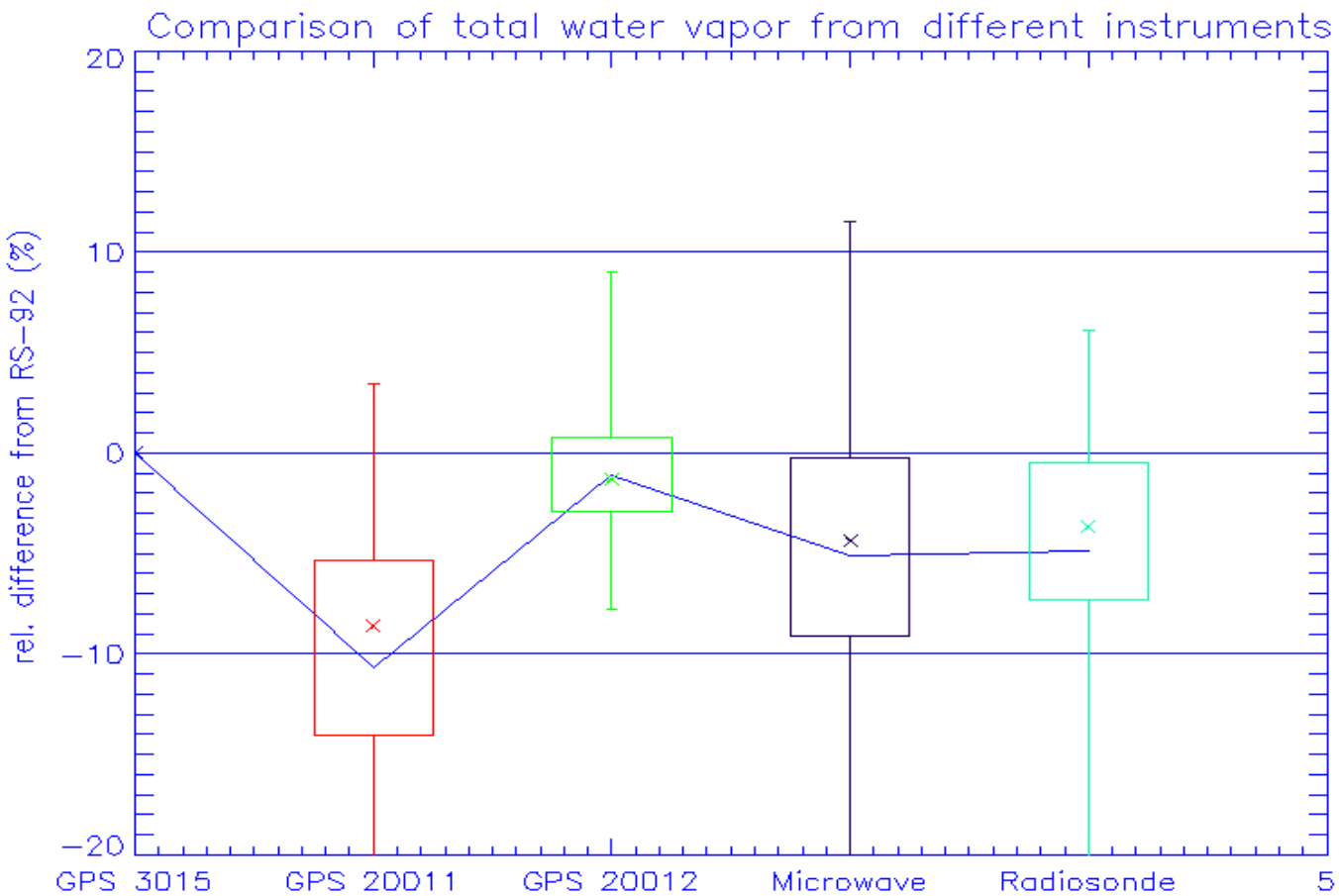
Radiation error on humidity measurements



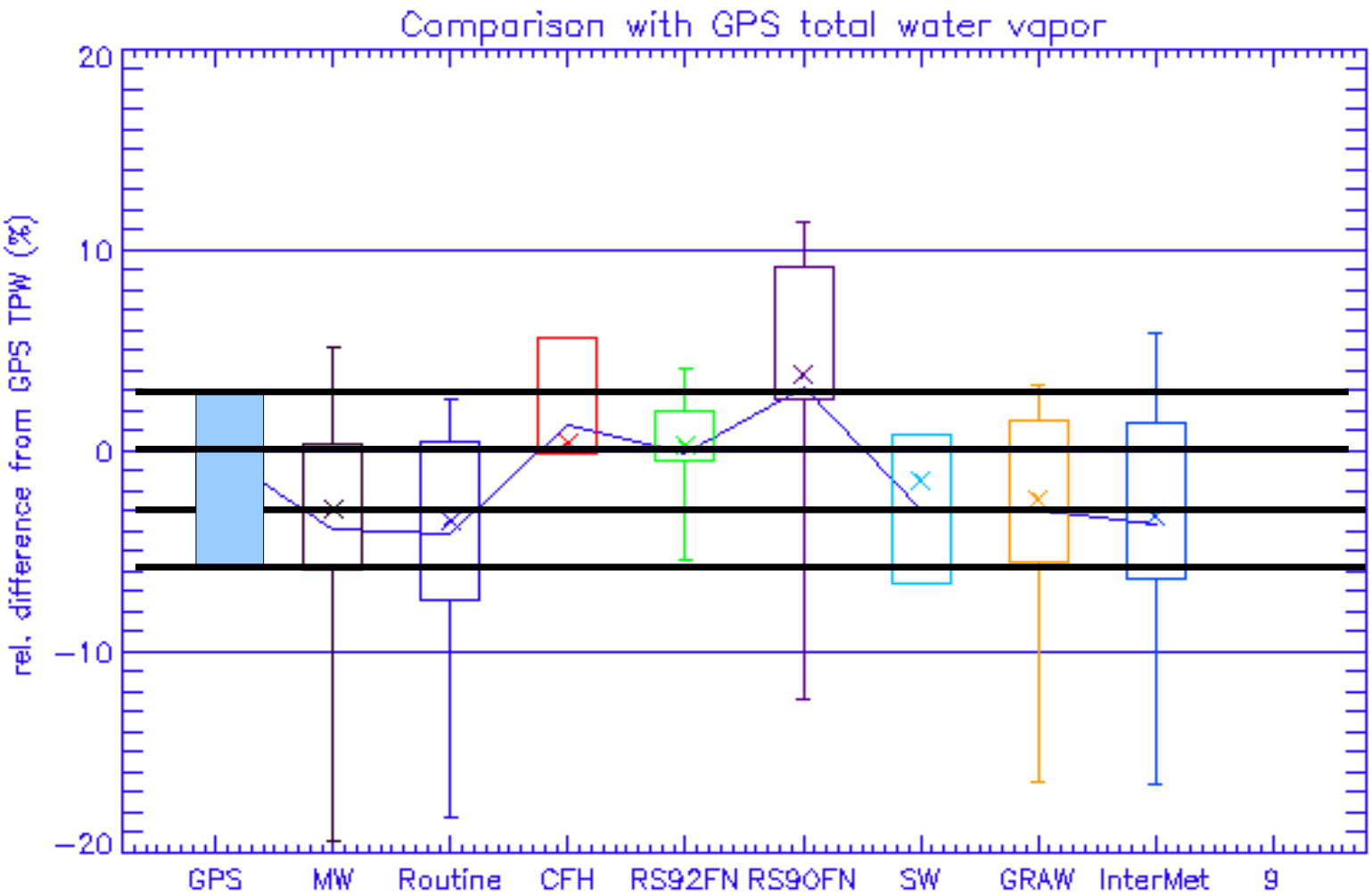
GPS, MW, and Radiosondes



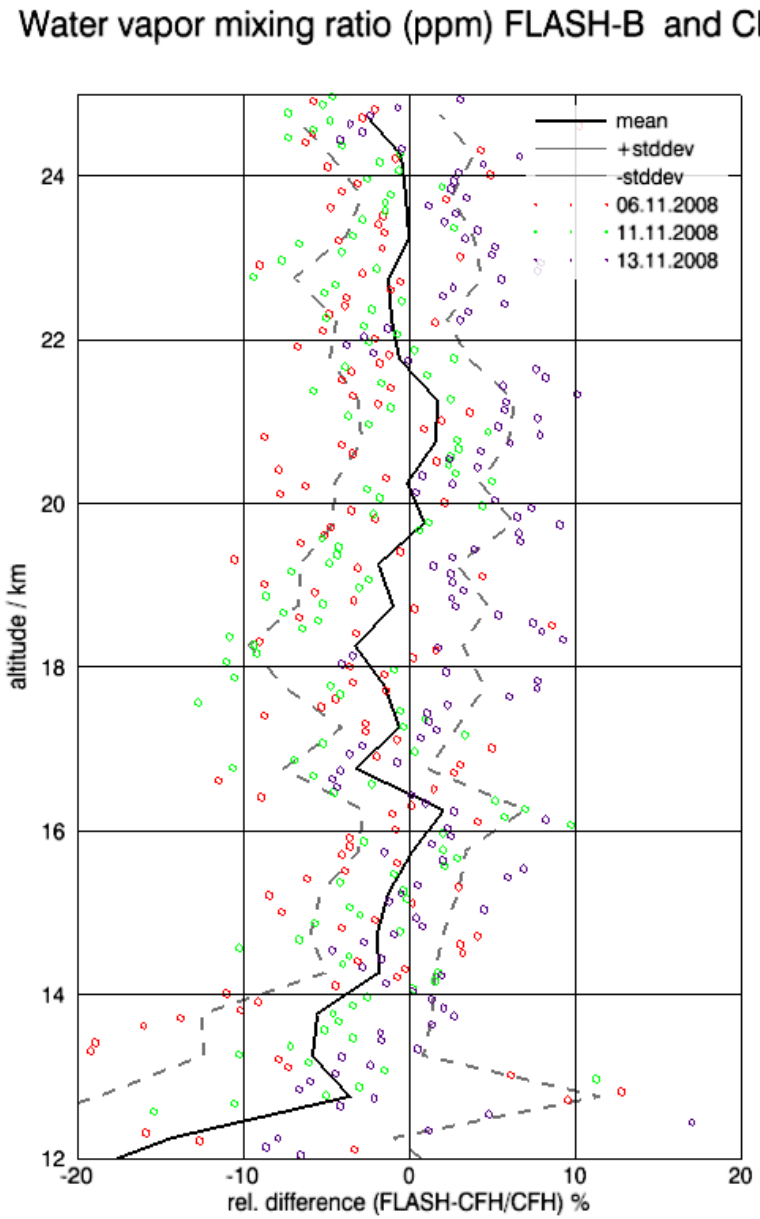
How accurate is the GPS / MW?



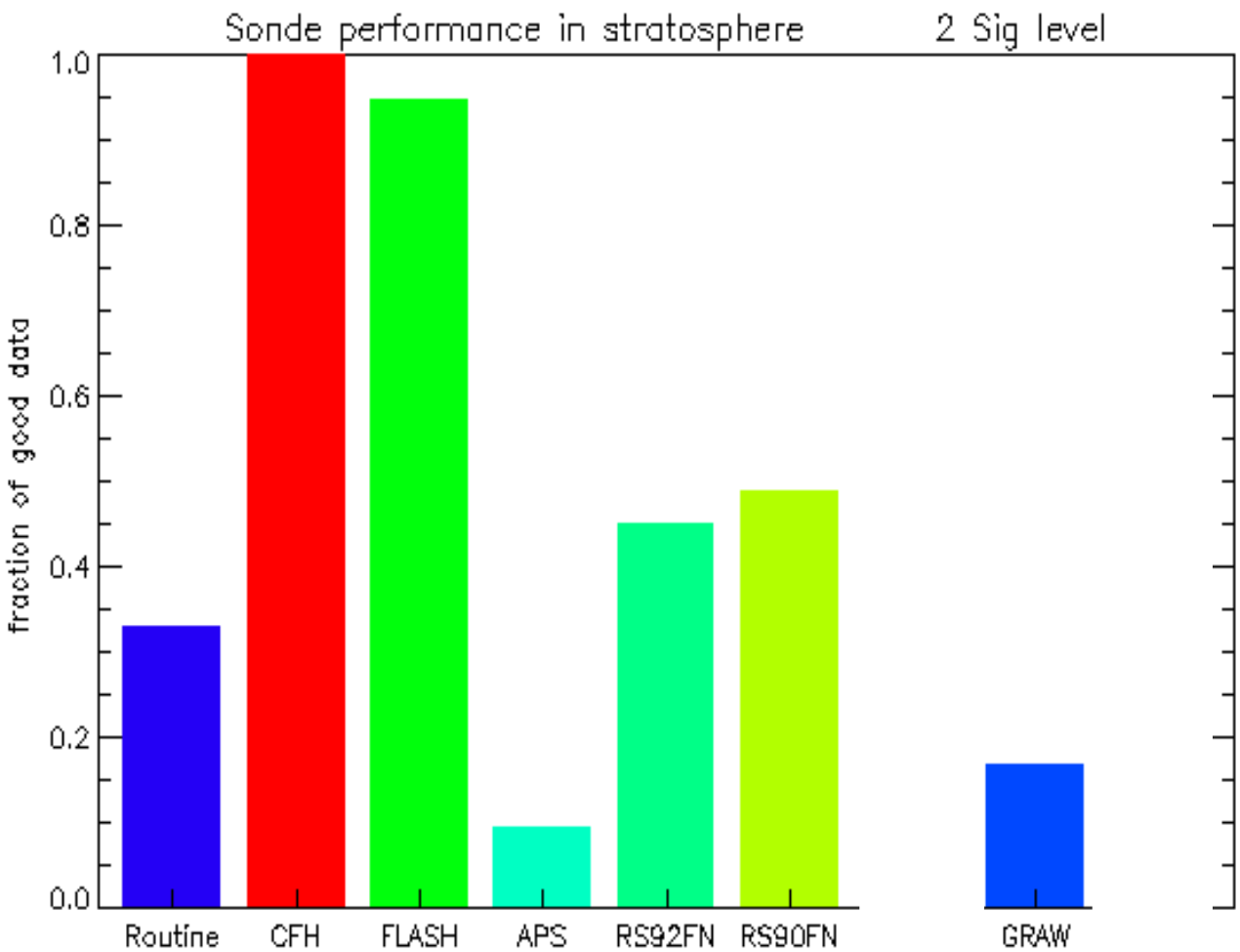
GPS, MW, and Radiosondes



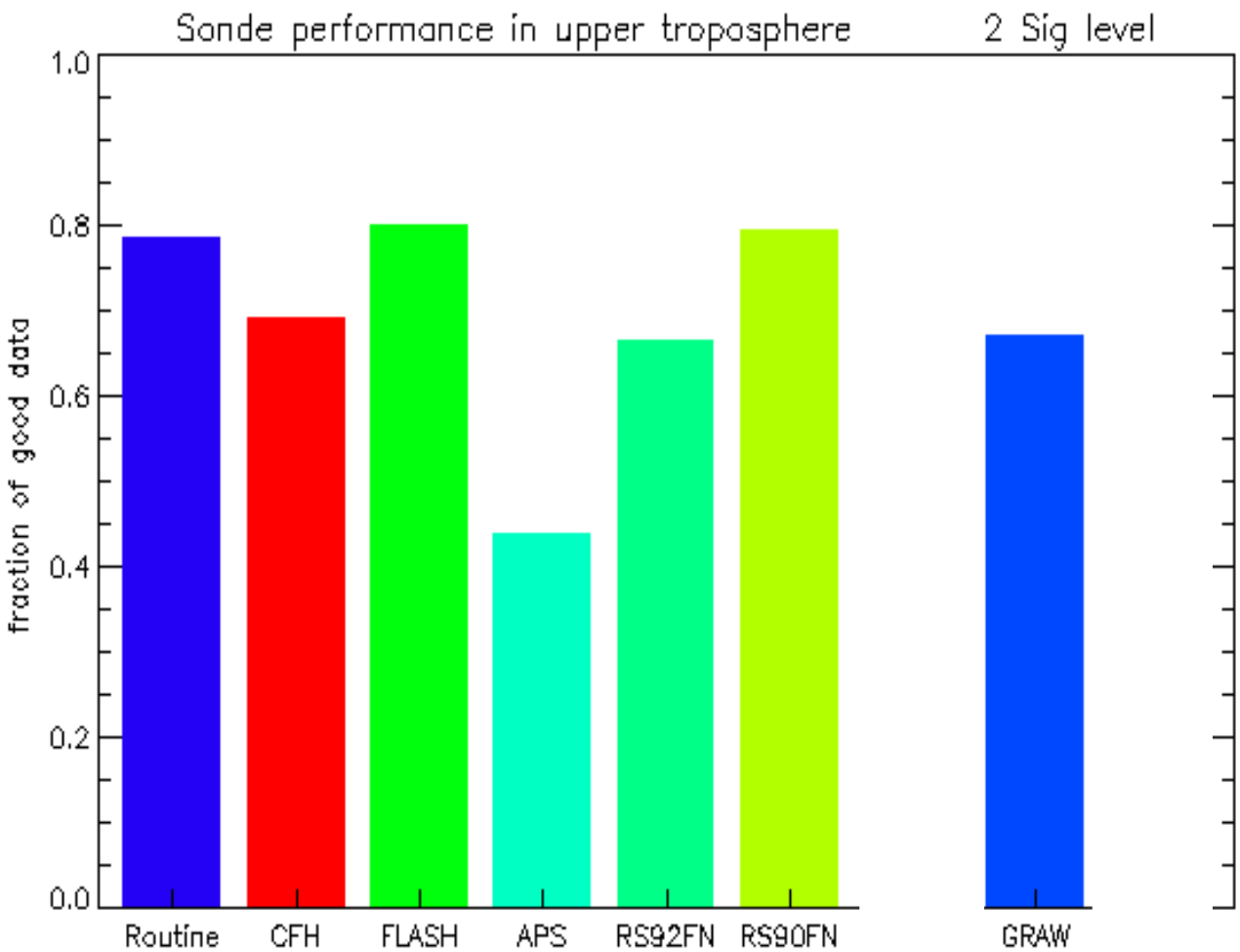
Stratosphere: CFH and FLASH



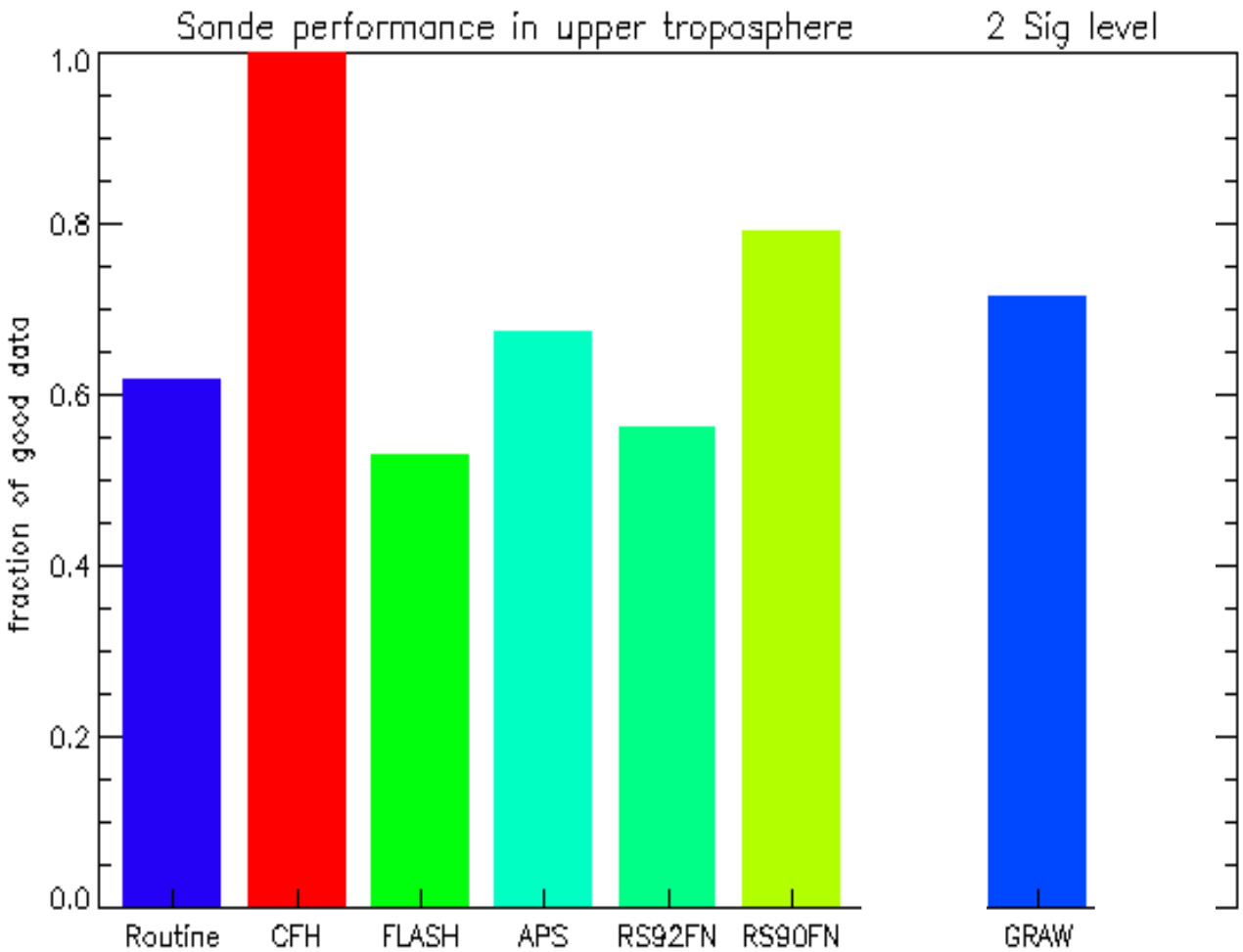
Performance indicator : data within 2x errorbars of CFH



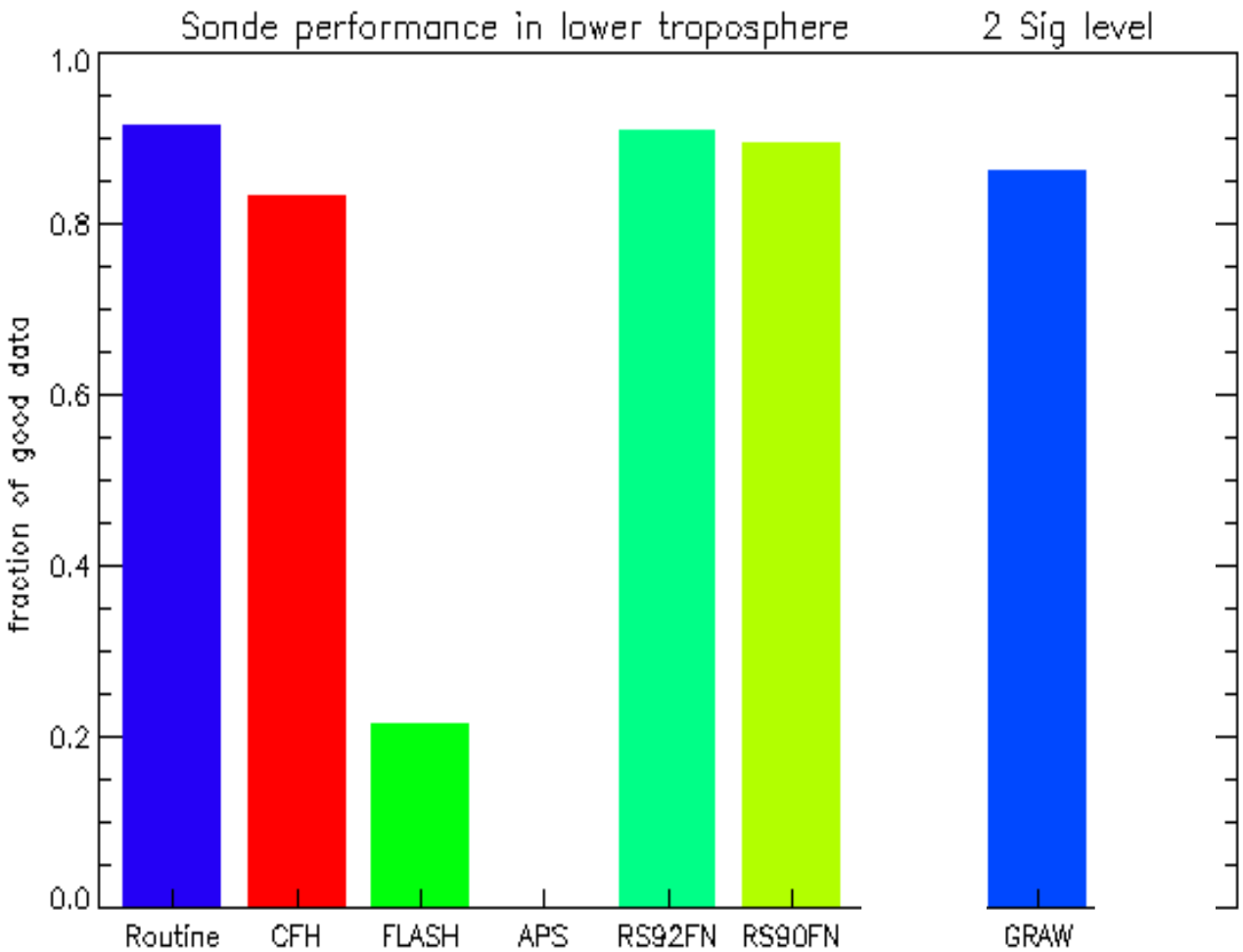
Percentage of data RH within ± 5% rH of mean



Percentage of data RH within ± 2*σ of CFH



Percentage of data RH within 5 % of mean



Conclusion

- ✓ Comprehensive data set for comparisons of Radiosonde and remote-sensing instruments on water vapor
- ✓ Temperature:
  - substantial radiation (0.2 K) error in both, troposphere and stratosphere
  - another error of same magnitude possibly related to calibration
  - issue with clouds
- ✓ Water vapor:
  - GCOS-121 target of 2% accuracy/precision is a tough one!
    - stratosphere: CFH and FLASH (descent) in excellent agreement
    - upper troposphere: All sondes of more or less similar quality
    - lower tropophere: generally good agreement,