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Experiment to quantify the solar radiative temperature error of radiosondes

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One of the main goals of the GCOS Reference Upper Air Network (GRUAN) is to perform reference observations of profiles of atmospheric temperature and humidity for the purpose of monitoring climate change. Two essential criteria for establishing a reference observation are measurement-traceability and the availability of measurement uncertainties. Radiosoundings have proven valuable in providing in-situ profiles of temperature, humidity and pressure at unmatched vertical resolution. Data products from commercial radiosondes often rely on black-box or proprietary algorithms, which are not disclosed to the scientific user. Furthermore, long-term time-series from these products are frequently hampered by changes in the hardware and/or the data processing. GRUAN data products (GDPs) comply with the above-mentioned criteria for a reference product. Correction algorithms are open-source and well-documented and the data include vertically resolved best-estimates of the uncertainties.

This presentation discusses the quantification and the correction for the temperature error due to solar radiation that is applied in the GRUAN data processing for the Vaisala RS41 radiosonde. Heating of the temperature sensor by solar radiation is the dominant source of error for daytime radiosoundings.

At Lindenberg Observatory a dedicated laboratory set-up was built to quantify the solar temperature error of radiosondes. The setup allows to create conditions that are similar to those encountered during an actual radiosounding, with special emphasis on parameters such as pressure, air flow (ventilation), and illumination conditions. The radiosonde is placed inside a quartz tube that is integrated in a wind tunnel-like construction that can be operated between ambient pressure and 3 hPa. During the measurements the radiosonde is rotated along its longitudinal axis to mimic the spinning during ascent, and the large quartz window makes it possible to illuminate the temperature sensor together with a considerable part of the sensor boom, allowing to assess the contribution of the heat transfer from the sensor boom to the sensor. A parameterization of the heating of the sensor in terms of flux, pressure, ventilation and solar elevation is presented. This parameterization is the basis of the GRUAN correction algorithm, which in addition includes a radiation model and altitude information. In conclusion the GRUAN data product is compared to the manufacturer-processed data.