Thermal and solar radiation errors on air temperature measured with upper-air radiosondes

R. Philipona[1], A. Kräuchi[2], G. Romanens[1], G. Levrat[1], P. Ruppert[3], E. Brocard[1], P. Jeannet[1], D. Ruffieux[1], B. Calpini[1]

[1]*Federal Office of Meteorology and Climatology MeteoSwiss, Aerological Station, CH-1530 Payerne, Switzerland.*

[2]*Institute for Atmospheric and Climate Science, ETH Zurich, CH-8057-Zurich, Switzerland.*

[3]*Meteolabor AG, CH-8620 Wetzikon, Switzerland.*

Abstract

Atmospheric temperature and humidity profiles are long since important for weather prediction, but climate change now strongly enhanced interest in upper-air observations asking for very high quality reference measurements of air temperature and water vapour particularly in the upper troposphere and lower stratosphere. Here we show an experimental approach to determine the radiation error on radiosonde air temperature measurements. On the one hand we accurately measured solar shortwave and thermal longwave radiation profiles during radiosonde ascents from the surface to 35 km altitude. On the other hand air temperature was measured with several thermocouples on the same flight, simultaneously under sun shaded and unshaded conditions. The experiments reveal that thermal radiation errors on the very thin thermocouple of the Meteolabor SRS-C34 radiosonde are similar during night and day and produce a radiative cooling in the troposphere on the order of -0.1 K, but a radiative heating of about +0.1 K in the stratosphere. Solar radiation however, produces a radiative heating of about +0.1 K near the surface, which more or less linearly increases to about +0.9 K at 32 km (~10 hPa). We then applied the new radiation error to the SRS-C34 data measured during the 8th WMO Intercomparison of radiosonde systems held at Yangjiang, China in 2010, and compared the SRS-C34 to the ten other internationally used radiosonde systems, which were flown during this campaign.

Shaded and unshaded air temperature measurements

The specifically prepared SRS-C34, which has several thermocouples is also equipped with a shading plate in the upper part on the right of the sonde (Fig. 3). All thermocouples are identical and referenced to the same resistance thermometer. The original thermocouple, which measures air temperature T is on the left side and unaffected by the shading plate. On each side of the shading plate a thermocouple is mounted at a distance of 5 cm and more or less in the centre of the shading plate. During the ascent the sonde package is free to rotate, hence the temperature sensors T_S beside the shading plate are at times in the shade and at times exposed to the sun. Due to the large size of the sonde package the rotation is rather slow and the very fast temperature sensors (t_c < 300 ms) can easily track the air temperature changes when T_S is in the shade or in the sun. Hence, these experiments allow measuring the difference of the air temperature measured by the original air temperature sensor, which is continuously exposed to direct solar radiation and the air temperature measured under direct sun shaded conditions.

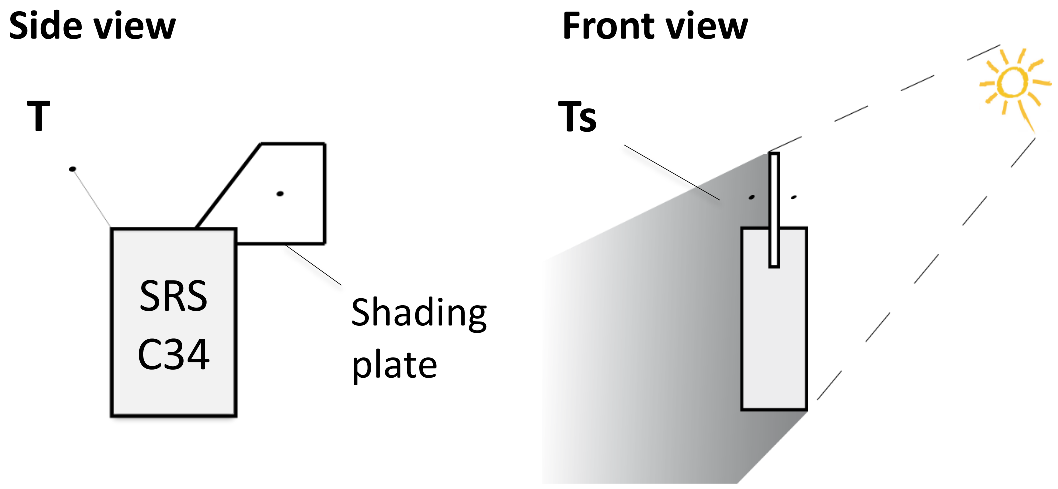

Figure 3: SRS-C34 radiosonde with several temperature sensors and shading plate.

The results of the shading experiments have been summarized in a manuscript that has been submitted for publication in the *Journal of Geophysical Research*.

Solar shortwave and thermal longwave radiation profiles during radiosonde ascents from the surface to 35 km altitude have been published in a paper in *Geophysical Research Letters*, by

R. Philipona, A. Kräuchi and E. Brocard (2012), Solar and thermal radiation profiles and radiative forcing measured through the atmosphere, *Geophys. Res. Letters*, **39**, L13806, doi:10.1029/2012GL052087.