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Correction of radiation-induced warm-biased air temperature measured by radiosondes using dual thermistors

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The measurement of essential climate variables (ECVs) in the upper air mostly relies on radiosondes equipped with a group of sensors flying up to about 35 km in altitude. Among ECVs, the measurement of air temperature is warm-biased by solar irradiation during daytime. However, the correction of warm-biased temperature is still challenging since it is affected by other environmental characteristics in upper air such as low-temperature, low-pressure, and ventilation.

Here, the combined effect of low-temperature and low-pressure as well as the ventilation on the air temperature measurement under irradiation is studied for the correction of warm-biased temperature. Dual thermistors with different emissivity is used as temperature sensors and tested in a vacuum chamber-based system and a wind tunnel. The temperature difference of dual thermistors is utilized in order to calculate the irradiance through the establishment of the relationship among the temperature difference and other environmental parameters at varied irradiance, ventilation speed, temperature, and pressure that range from 0 W•m^{-2}to 1500 W•m^{-2}, from 0 m•s^{-1} to 10 m•s^{-1}, from -80 ^{o}C to 25 ^{o}C, and from 10 hPa to 1000 hPa, respectively.It is found that the temperature difference between dual thermistors is increased as the irradiance is increased, ventilation speed is decreased, temperature is lowered, or pressure is lowered. The observed behaviour is explained using heat transfer equations and organized into a single formula. After the combined relationship among parameters is established, the temperature difference between thermistors is solely used to calculate the irradiance with no pyranometer. The calculated irradiance is then used for the correction of the warm-biased temperature of thermistors. The corrected value is also increased as the irradiance is increased, ventilation speed is decreased, temperature is lowered, or pressure is lowered. Finally, the unifying correction formula is obtained using the ground-based facility and applied to radiosonde field tests. The result will be discussed. The dual thermistor-based technique with ground-based calibration facilities can provide the traceability to the International System of Units (SI) in the measurement of irradiance and temperature in upper air.