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Dry bias in Vaisala RS90 radiosonde humidity profiles over Antarctica

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Middle to upper tropospheric humidity plays a large role in determining terrestrial outgoing longwave radiation. Much work has gone into improving the accuracy of humidity measurements made by radiosondes. Some radiosonde humidity sensors experience a dry bias caused by solar heating. During the austral summers of 2002/03 and 2003/04, at Dome C, Antarctica, Vaisala RS90 radiosondes were launched to measure tropospheric pressure, temperature, and humidity in clear skies at solar zenith angles (SZAs) near 83 and 62 degrees. As part of this field experiment, the Polar Atmospheric Emitted Radiance Interferometer (PAERI) measured downwelling spectral infrared radiance. The radiosoundings are used to simulate downwelling radiances, which are compared with the PAERI measurements. The dry bias of the radiosonde humidity is then determined by scaling the humidity profile with a height-independent factor to obtain the best agreement between the measured and simulated radiances in microwindows between strong water-vapor lines from 17.8 to 18.8 μm and near line centers from 7.7 to 9.1 μm. The dry biases, as relative errors in RH, are 8% $\pm$ 5% (microwindows; one standard deviation) and 9% $\pm$ 3% (line centers) for SZAs near 83 degrees, and 20% $\pm$ 6% and 24% $\pm$ 5% for SZAs near 62 degrees. Assuming solar heating is minimal at SZAs near 83 degrees, we remove errors that are unrelated to solar heating and find the solar-radiation dry bias of 9 Vaisala RS90 radiosondes at SZAs near 62 degrees to be 12% $\pm$ 6% (microwindows) and 15% $\pm$ 5% (line centers). Systematic errors are estimated to be 3% and 2% for microwindows and line centers.

These corrections apply to atmospheric pressures between 650 and 200 mb.