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Albedo effect on radiative errors in air temperature measurements

H. Huwald (1), C. W. Higgins (1), M. O. Boldi (1), E. Bou-Zeid (2), M. Lehning (3), and M. B. Parlange (1)

(1) School of Architecture, Civil and Environmental Engineering, EPFL, Lausanne, Switzerland (hendrik.huwald@epfl.ch), (2) Department of Civil and Environmental Engineering, Princeton University, Princeton, USA, (3) Swiss Federal Institute for Forest, Snow and Landscape Research, SLF, Davos, Switzerland

Air temperature measurements are necessary for numerous purposes and applications in environmental and climate research such as time series analyses, model forcing or validation, and the computation of dependent quantities, for instance, the sensible heat flux. Often the considered physical processes, parameterizations, or the scaling involving air temperature are non-linear in nature. The presence of solar radiation and the lack of sufficient sensor ventilation lead to significant errors in air temperature measurements, even when the measurement principle is accurate and precise. We present various air temperature measurements combined with other measurements of meteorological parameters using different sensor systems at a snow-covered and a vegetated site. Measurements from naturally ventilated air temperature sensors in multi-plate shields are compared to temperatures measured using a sonic anemometer which are unaffected by solar radiation. Under certain conditions, e.g. clear sky, low wind speed, and over a snow surface, 30min mean temperature differences can be as large as 10C. Unshielded thermocouples showed smaller temperature errors compared to shielded and naturally ventilated sensors which were most affected by shortwave radiation. Temperature errors decrease with decreasing solar radiation and increasing wind speed but do not completely disappear for effective ventilation at a given radiation. The influence of the surface properties on radiative errors was identified as a key variable since temperature errors grow faster for reflected than for incident solar radiation. We propose an extension of an existing similarity regression model to correct for radiative errors; thus surface-reflected shortwave radiation is identified as a major source of error and the key variable for obtaining a unique non-dimensional scaling of radiative errors.