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Field intercomparison of six different three-dimensional sonic anemometers

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Although sonic anemometers have been used extensively for several decades in micrometeorological and ecological research, there is still some scientific debate about the measurement uncertainty of these instruments. This is due to the fact that an absolute reference for the measurement of turbulent wind fluctuations in the free atmosphere does not exist. In view of this lack we have conducted a field intercomparison experiment of six commonly used sonic anemometers from four major manufacturers. The models included Campbell CSAT3, Gill HS-50 and R3, METEK uSonic-3 Omni, R.M. Young 81000 and 81000RE. The experiment was conducted over a meadow at the TERENO/ICOS site De-Fen in southern Germany over a period of 16 days in June of 2016 in preparation of the ScaleX campaign. The measurement height was 3 m for all sensors, which were separated by 9 m from each other, each on its own tripod, in order to limit contamination of the turbulence measurements by neighbouring structures as much as possible. Moreover, the data were filtered for potentially disturbed wind sectors, and the high-frequency data from all instruments were treated with the same post-processing algorithm. In this presentation, we compare the results for various turbulence statistics from all sensors. These include mean horizontal wind speed, standard deviations of vertical wind velocity and sonic temperature, friction velocity and the covariance between vertical wind velocity and sonic temperature. Quantitative measures of uncertainty were derived from these results. We find that biases and regression intercepts are generally very small for all sensors and all computed variables, except for the temperature measurements of the two Gill sonic anemometers (HS and R3), which are known to suffer from a transducer-temperature dependence of the sonic temperature measurement. The comparability of the instruments is not always as good, which means that there is some scatter but the errors compensate at least partly. The best overall agreement between the different instruments was found for the variables “mean wind speed” and “buoyancy flux”, which reflects that the sensors are optimized for measuring these quantities.