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Comparison of sonic anemometer performance under foggy conditions

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A sonic anemometer comparison was performed at a mountain cloud forest site in Taiwan to evaluate the effect of fog on sonic anemometer performance, with particular emphasis to their employment in eddy-covariance applications. Four sonic anemometers (Campbell CSAT3, Gill R3-50, METEK USA-1, and R.M. Young 81000VRE) were tested for 15 consecutive days with an overall fog duration of 86 hours.
Three aspects were analyzed: (1) spike statistics during foggy and non-foggy conditions, (2) spectral and co-spectral analyses before, during, and after 16 fog events, and (3) correlations between turbulence characteristics of wind and temperature.
All sonic anemometers produce more spikes when the visibility is below 1000 m, compared to conditions with visibilities above 1000 m. However, the overall number of spikes caused by fog is generally low and therefore of no concern for any of the tested sonic anemometers.
Spectral analyses showed that for most anemometers fog mostly affects spectra of the sonic temperature. Here, the high frequency range is either damped or amplified. These effects worsen with increasing duration and density of fog. In case of the 81000VRE and the USA-1, all three wind components, sonic temperature spectra as well as the co-spectra of w'T' and w'u' show noise in the high frequency range in dense fog. The CSAT3 shows noise only in the high frequency range of the sonic temperature and the co-spectra of w'T'. Smallest sensitivity to fog was observed for the R3-50. It seems to be suited best for eddy covariance measurements under dense foggy conditions because also the high frequency part of the transporting turbulence elements can be measured.
Differences between 1) the sonic anemometers and 2) foggy and non-foggy situations are usually not systematically but parametrically dependent. Differences of up to 34 % were found for the variance of vertical wind speed between the sonic anemometers.
When comparing average daytime fluxes (including fog events) the courses of all sonic anemometers are very similar to each other, whereas the absolute values of the sensible heat flux and the friction velocity differ by 17 % to 31 % and by 6 % to 15 %, respectively.