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Atmospheric Measurement Techniques Discussions

Interactive comment on "Using sonic anemometer temperature to measure sensible heat flux in strong winds" *by* S. P. Burns et al.

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Dear authors,

you are presenting some interesting findings about the performance of sonic anemometers at high wind speeds. Please allow me a few questions and remarks.

1) You state that your site is at 3050 m altitude and a "windy place in winter". Could you please clarify: Were all the data presented here collected at below-freezing temperatures? Were latent heat fluxes then practically negligible? Were some of the data collected while the sonic was surrounded by cloud/fog (on a mountain ridge this is possible even in high wind conditions), and if yes, do they show differences to dry/clear periods? I think such information would be necessary context for specifying the condi-

tions when the observed spurious w-T-correlations occur.

2) You show (Figs 3,4) power spectra of w and T with high-frequency noise (rather extreme for T), and I agree with the conclusion that some of this noise must be correlated to produce the spurious heat flux. Perhaps showing a w-T phase spectrum can elucidate this further.

3) High-frequency noise can show up in the original time series as "spikes", and spikes in the wind and temperature signals of a sonic anemometer can be correlated (if they have a physical cause in the underlying speed-of-sound measurement). Was any algorithm to detect and remove spikes used? If so, was its effectiveness tested?

4) It is well-known that high-frequency noise can be corrected for by filtering. In order to obtain valid covariances, it suffices to filter one component only, either w or T. Why is this not attempted, and then checked if filtered data lead to plausible surface energy budgets?

5) In p455, L20, you state "the problem appears to be with Ts' not w' because w'Ttc' ... produces reasonable heat fluxes". This is logically flawed. Mean w'Ttc' is OK because there is no correlation between the noise of w' and of Ttc', but w' may still be noisy, and in fact your Figs 3 and 4 show that it is. The u-w and v-w correlations, not investigated here, may also be affected, and hence sonic-based u* estimates, too.

6) I can offer a couple of hypotheses on the physical cause. Sound is detected as a pressure oscillation. As wind speed increases, firstly, the ratio of transducer-created sound amplitude ("signal") to turbulent pressure fluctuations ("noise") may decrease. Secondly, the shape of the sound signal may be distorted more than in calmer conditions. Both the reduced signal-to-noise ratio and the distorted shape would make it harder for the sonic anemometer's detection algorithm to identify the exact arrival time of the sound signal at the receiving transducer. Errors in the arrival time detection would manifest themselves as spikes.

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7) Both these hypotheses are based on observations that I made during my PhD work in 1994, using a different sonic type (Biral Solent 1012 R2, name later changed to "Gill"). Back then I observed that the probability of spike occurrence in the w time series was about constant for wind speed u < 5 m/s, at 2 spikes per 10ˆ6 data points, while for 7 m/s < u < 14 m/s the frequency of spikes increased with uˆ3. (For u > 14 m/s I had no observations.) As the number of spikes increases, it becomes difficult to replace them in a meaningful way, and one should define a data validity limit for that.

8) In my view, the manuscript puts too much emphasis on the non-closure of the surface energy budget, which is really only the consequence of a measurement problem. Instead, there should be more emphasis on characterising at which conditions noticeable high-frequency noise occurs in the spectra. Ideally that might lead to identification of the physical causes of this noise; at the least, it should allow to pose a hypothesis what the cause might be, as suggested above.

To the audience rather than the authors: I do not have a lot of sonic anemometer data at wind speeds above 10 m/s, but someone in Fluxnet is bound to have another "windy" site, where it could be investigated if the same noise problems occur at higher temperatures and/or with a different sonic anemometer type.

Best regards Johannes Laubach. Landcare Research, P.O.Box 40, Lincoln 7640, New Zealand laubachj@landcareresearch.co.nz

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Interactive Comment