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

Reply to Heping Liu

S. P. Burns et al.

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The thoughtful comments by Heping Liu are greatly appreciated. Our replies to Heping's comments are below.

Comment 1: *The Burns et al. (2012) paper presents an important issue about using sonic anemometry to obtain sensible heat fluxes. The results indicated that the sonic derived sensible heat flux after buoyancy flux correction is larger than thermocouple-derived sensible heat flux when wind speeds are high. Here we propose another perspective view, aiming to explain part of this difference.*

We rewrite the equation that describes sonic-derived sensible heat fluxes:

$$H_{\text{sc}} \;=\; \rho \, C_p \, \overline{w't'_{\text{sc}}} \;=\; \rho \, C_p \, \left(\overline{w't_{\text{s}}'} \;-\; 0.51 \, \overline{T} \, \overline{w'q'} \;+\; 2 \, \frac{\overline{T}\,\overline{u}}{\overline{c^2}} \, \overline{u'w'} \right), \qquad (1)$$

where H_sc is sensible heat flux obtained by sonic anemometer. Equation (1) is the same as Eq. (3) in Burns et al. (2012).

As indicated in previous studies, the measured turbulent fluxes of sensible and latent heat only account for approximately 80% of available energy (Wilson et al. 2002; Foken et al., 2011). Even though the thermocouples were used (instead of sonic temperature), EBEX was unable to close the surface energy balance (Oncley et al. 2007). These facts have indicated that current hygrometers and gas analyzers may underestimate latent heat fluxes, same as sensible heat fluxes. Underestimation of latent heat fluxes may be even worse, as indicated by cospectral analysis. Under this circumstance, underestimation of w'q' in Eq. (1) leads to the overestimation of sonic-derived sensible heat flux (i.e., HTc) through applying Eq. (1) to convert buoyancy flux into sensible heat flux, even if $w't_{\text{s}}'$ would be perfectly measured.

Reply to Comment 1: This is an important point. In our revised manuscript we have shown an empirical correction to the CSAT Ts error that (we believe) explains the primary cause for the H_sc error. However, we agree that other (smaller) errors such as the under-measurement of latent heat flux will also contribute to the differences between the CSAT and thermocouple heat fluxes.