Verifying the BR-DTS method for partitioning of fluxes

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Introduction

The conventional Bowen ratio surface energy balance method for partitioning of fluxes needs multiple independent sensors, resulting in measuring errors.

BR-DTS method (*Euser et al., 2014*) uses a fibre optic cable to measure the dry and wet bulb temperature profile over the height at a high resolution.

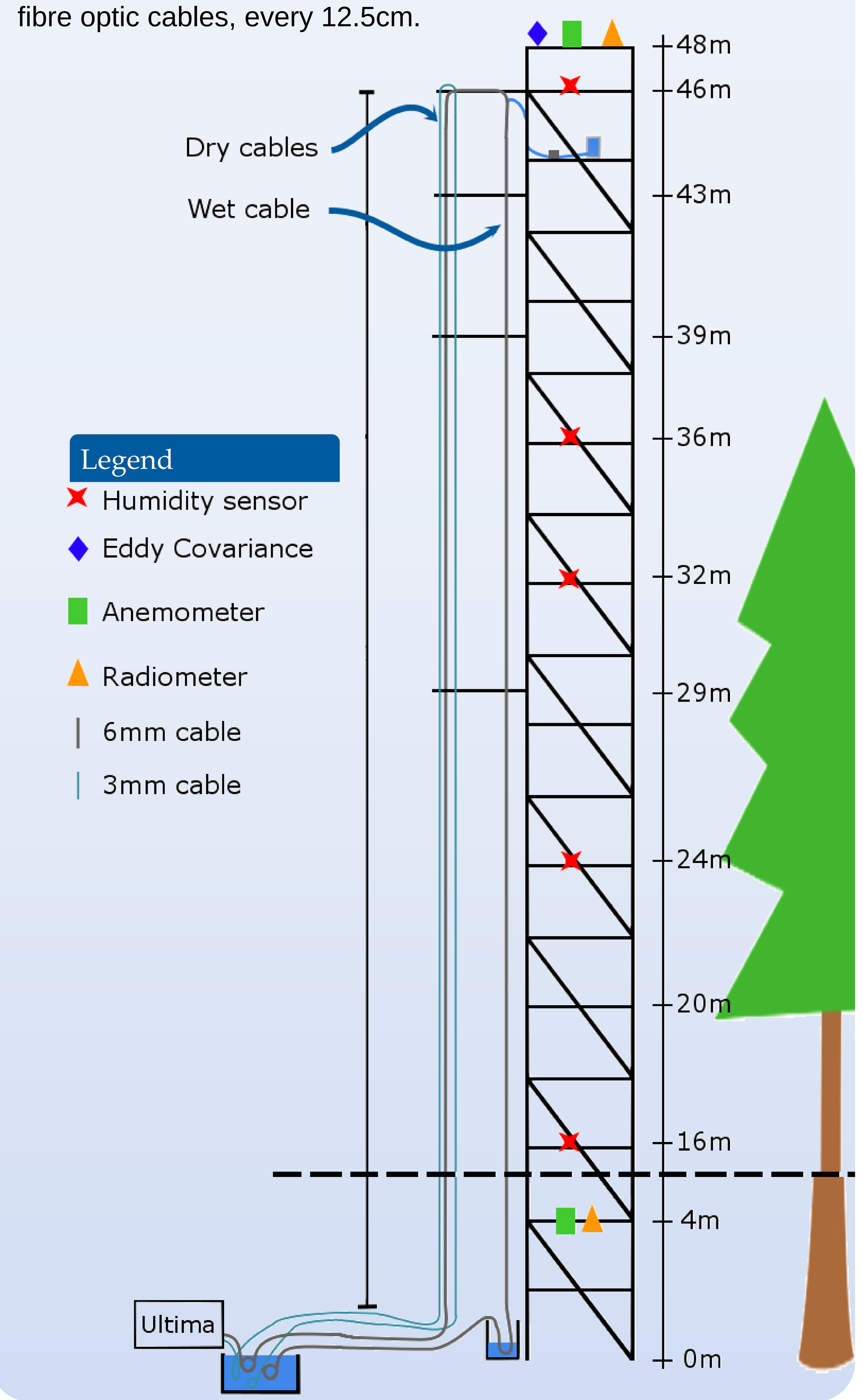
For verification of the method, the cable temperatures are compared to air temperature sensors, and the fluxes resulting from the method are compared to Eddy covariance measurements.

Materials & Methods

Measurements were done in a Douglas fir forest in the 'Speuldersbos', in the Netherlands, at a 48m tall measurement tower.

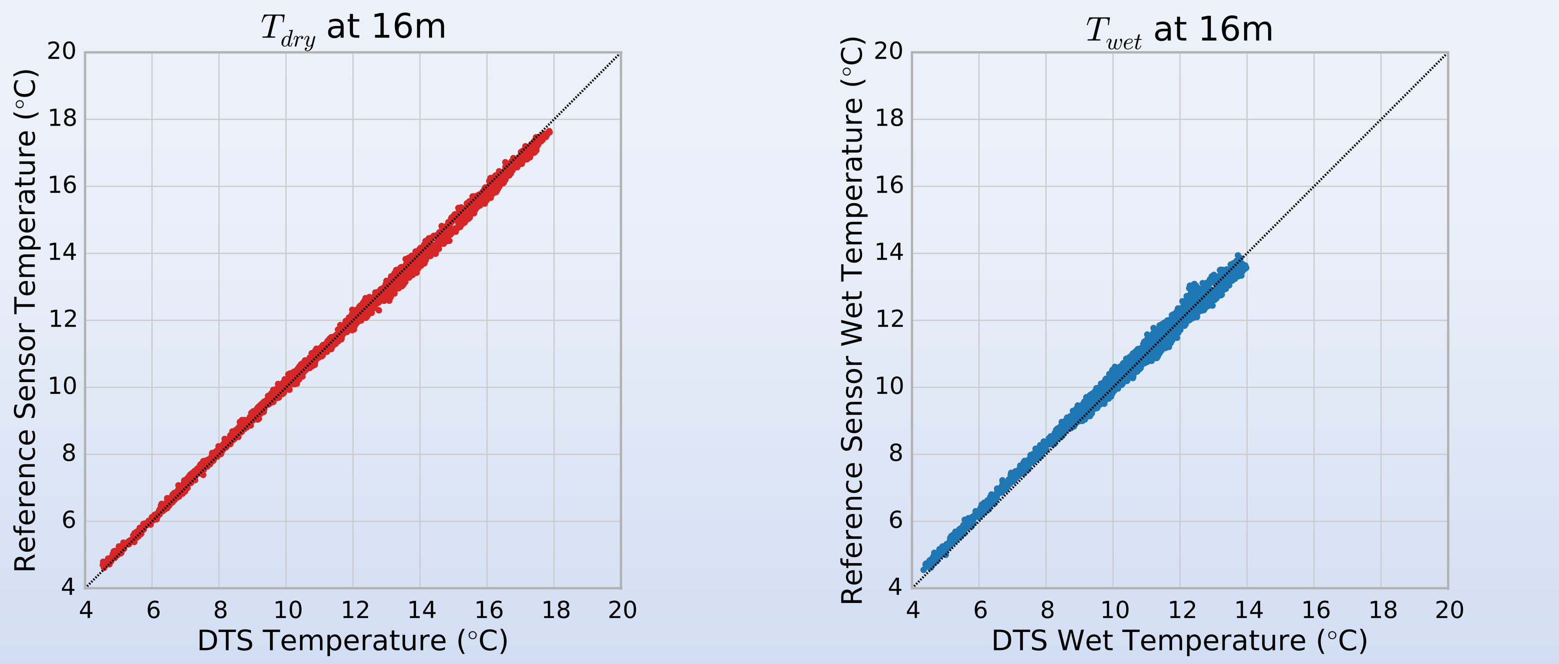
From the dry and wet cable temperatures, the vapour pressure is calculated. Using the gradients of the dry temperature and vapour pressure over height, the Bowen ratio can be determined. Using the Bowen ratio and the energy balance, the latent heat and sensible heat fluxes are determined.

The 'Ultima' DTS system measures the temperature along the fibre optic cables, every 12.5cm.



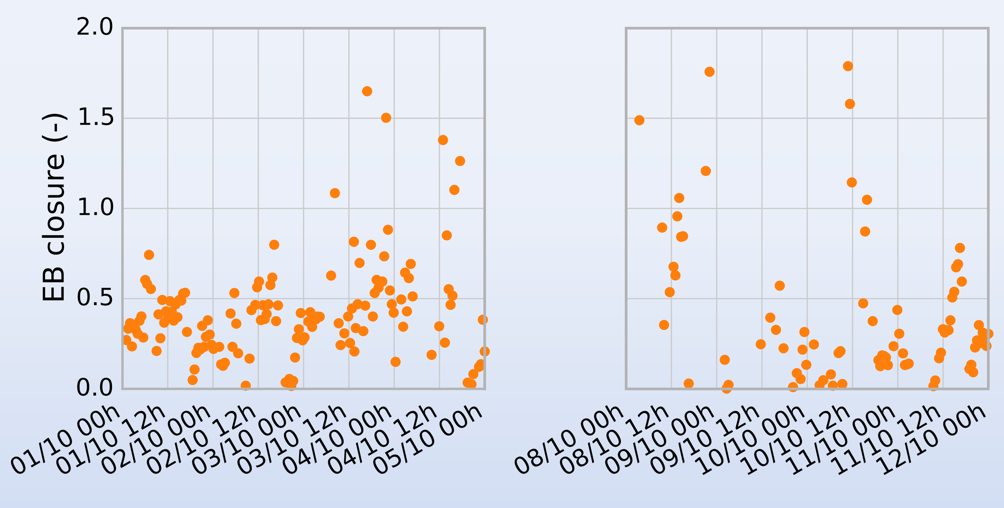
Temperature verification: Below canopy

Below the canopy the temperatures of the DTS and verification sensors were nearly the same. The wet bulb temperature was well represented by the wet cable.



Eddy covariance energy balance closure

The eddy covariance fluxes were checked for energy balance closure, comparing the energy available for the latent and sensible heat fluxes to the fluxes given by the EC system.
An extremely large gap was found. The eddy covariance EB closure rate depends on the wind direction, and is around 0.4 in case of north-eastern winds.



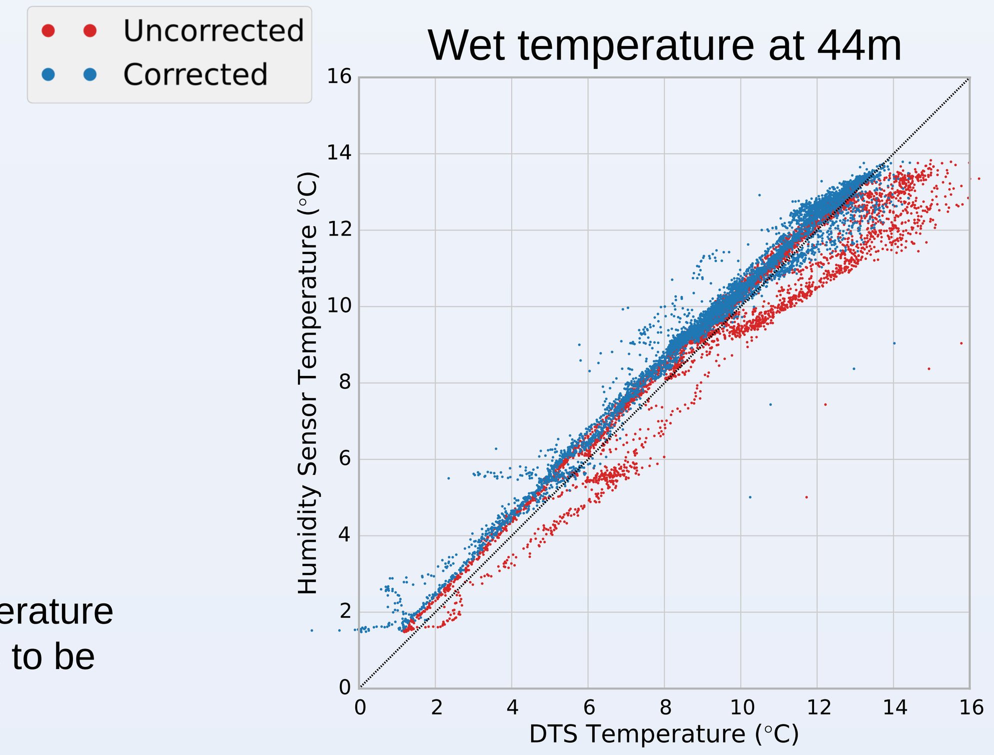
Temperature verification: Above canopy

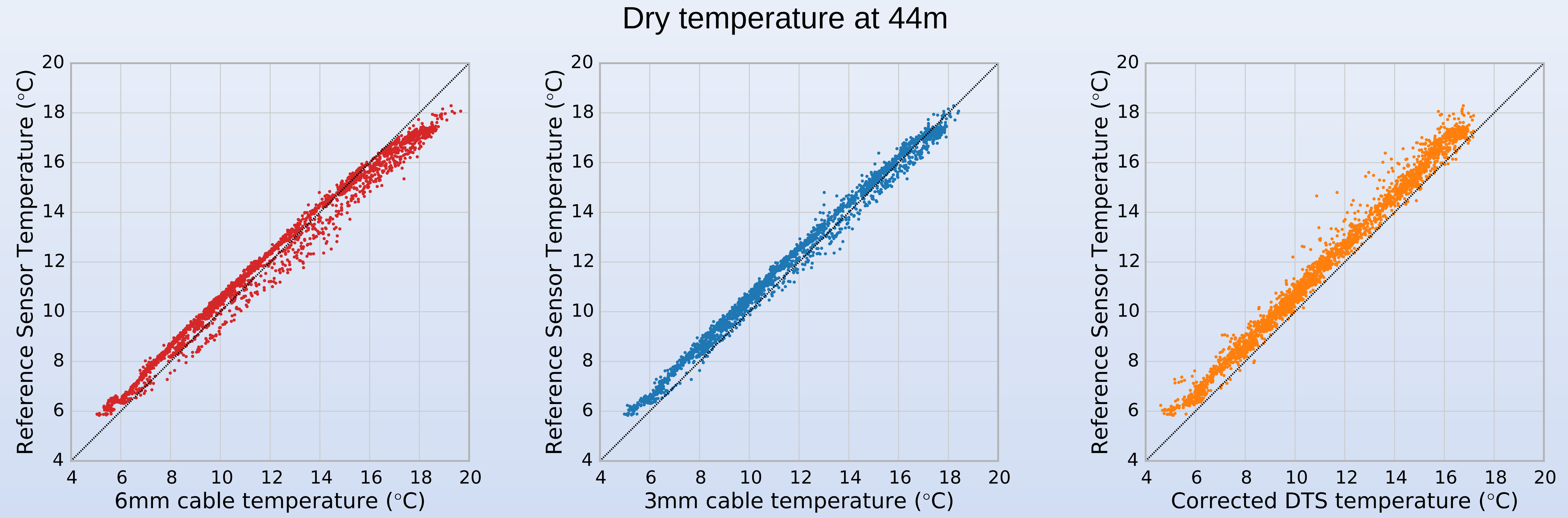
Above the canopy the effects of solar radiation are visible. The correction method using two different diameter cables does work, but adds noise and needs sufficient wind speed.

The correction for the dry cables is described by:
Where *T1* and *T2* are the cable temperatures and *d1* and *d2* their respective diameters.
(*de Jong et al., 2015*)

$$T_a = T_2 - \frac{T_1 - T_2}{\sqrt{\frac{d_1}{d_2}} - 1}$$

The wet temperature can be corrected using the relation between the temperature increase, incident shortwave radiation and wind speed, but this relation has to be empirically derived.



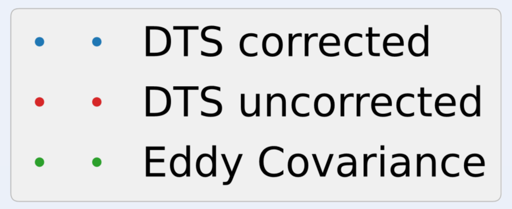


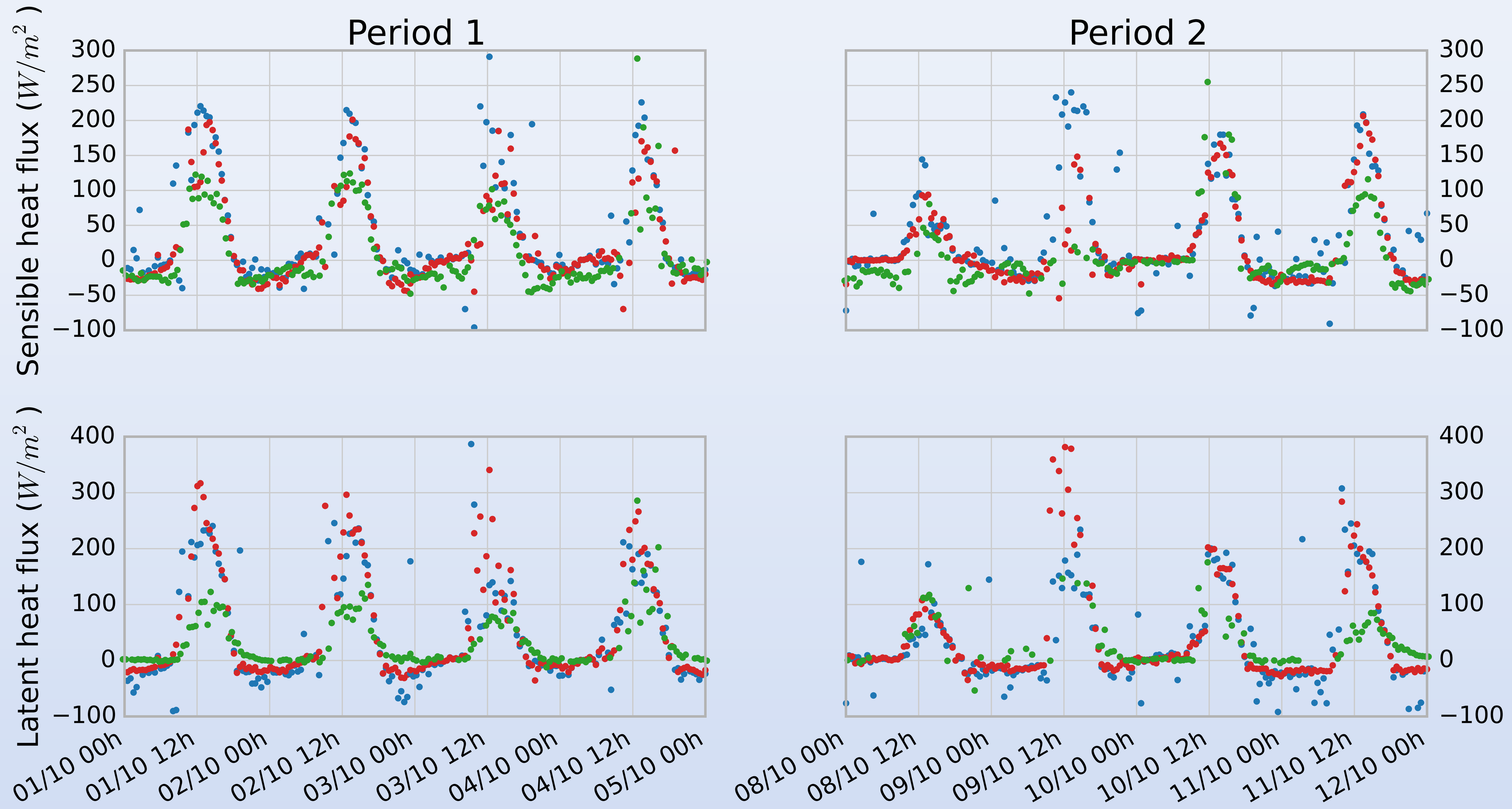
Sensible and latent heat flux comparison

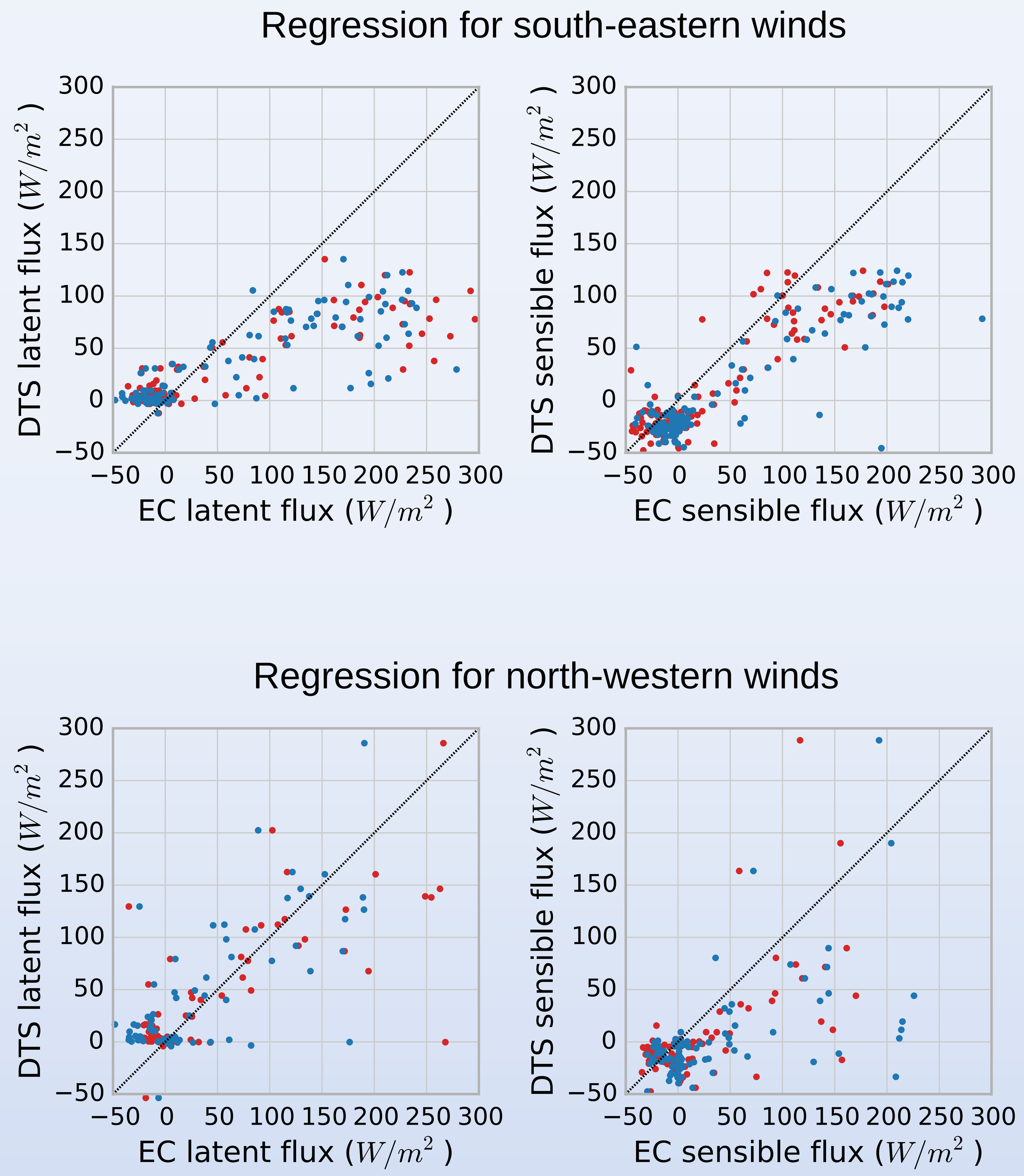
Due to the problems with the eddy covariance fluxes, a good comparison with the BR-DTS method is not possible.

When looking at the days with north-eastern wind, the DTS gives a higher estimate of the sensible and latent fluxes, and correlates reasonably well.

During the days with other wind directions, the correlation was located more around the 1:1 relation, but there was a lot of variance due to the eddy covariance system not responding well to the rainy conditions.







Conclusions

The DTS measured air temperatures are nearly the same as the air temperature sensors, and the performance below the canopy was perfect.

Above the canopy the cable temperatures were influenced by solar radiation, which caused errors in the measured temperature. The dry temperature correction resulted in a higher accuracy.

The wet cable temperature correction did work reasonably well, but is empirical and its usability for Bowen ratio calculations is not known.

The EC system did not work correctly during north-eastern winds, underestimating the fluxes. The location of the system on the measurement tower is probably at fault. During other wind directions the EC system got rained on, and did not give usable results.

The correction methods did make the temperature measurements more accurate, but due to the increased noise and uncertainty the Bowen ratio was not measured more precisely. Accuracy could not be assessed due to lack of reference data.

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