Geophysical Research Abstracts
Vol. 19, EGU2017-10577, 2017
EGU General Assembly 2017

Using Distributed Temperature Sensing for evaporation measurements: background, verification, and future applications.

Bart Schilperoort (1), Miriam Coenders-Gerrits (1), Tara van Iersel (1), Cesar Jiménez Rodríguez (1), Willem Luxemburg (1), Cesar Cisneros Vaca (2), and Murat Ucer (2)

(1) Water Resources Section, Delft University of Technology, Delft, The Netherlands, (2) Faculty of Geo-Information Science and Earth Observation, University of Twente, Enschede, The Netherlands

Distributed temperature sensing (DTS) is a relatively new method for measuring latent and sensible heat fluxes. The method has been successfully tested before on multiple sites (Euser, 2014). It uses a glass fibre optic cable of which the temperature can be measured every 12.5cm. By placing the cable vertically along a structure, the air temperature profile can be measured. If the cable is wrapped with cloth and kept wet (akin to a psychrometer), a vertical wet-bulb temperature gradient over height can be calculated. From these dry and wet-bulb temperatures over the height the Bowen ratio is determined and together with the energy balance the latent and sensible heat can be determined.

To verify the measurements of the DTS based Bowen ratio method (BR-DTS) we assessed in detail; the accuracy of the air temperature and wet-bulb temperature measurements, the influence of solar radiation and wind on these temperatures, and a comparison to standard methods of evaporation measurement. We tested the performance of the BR-DTS on a 45m high tower in a tall mixed forest in the centre of the Netherlands in August. The average tree height is 30m, hence we measure temperature gradients above, in, and underneath the canopy.

We found that solar radiation has a significant effect on the temperature measurements due to heating of the cable coating and leads to deviations up to 2°C. By using cables with different coating thickness we could theoretically correct for this effect, but this introduces too much uncertainty for calculating the temperature gradient. By installing screens the effect of direct sunlight on the cable is sufficiently reduced, and the correlation of the cable temperature with reference air temperature sensors is very high (R^2=0.988 to 0.998). Wind speed seems to have a minimal effect on the measured wet-bulb temperature, both below and above the canopy.

The latent heat fluxes of the BR-DTS were compared to an eddy covariance system using data from 10 days, with quality control applied to both methods. When comparing the daytime values, there is a high correlation (R^2=0.75), a low bias (mean difference of $\pm$15W/m^2) and a good accuracy (standard deviation of the difference of 40W/m^2) for both the latent and sensible heat flux. This can lead to a small error. Nonetheless, the results show that when the system is set up with care, and by eliminating sources of errors, the DTS based Bowen ratio is in agreement with an eddy covariance system, even above a tall forest canopy, which is notoriously hard to measure.

Further applications of the DTS data in evaporation measurement studies are the flux-variance method (where the standard deviations of the air temperature and absolute humidity are used to estimate the sensible and latent heat fluxes), the surface-renewal method, and correcting the Bowen ratio for the non-unity of the eddy diffusivity ratios. These can all be used to gather additional data on the evaporation to increase the accuracy.