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Interactive comment on "Technical note: using Distributed Temperature Sensing for Bowen ratio evaporation measurements" *by* Bart Schilperoort et al.

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Dear referee,

Thank you for your detailed look at our manuscript. With your comments we can hopefully solve the present inconsistencies and ambiguities and improve the quality of this submission.

The paper validated temperature measurements in BR-DTS method and introduced the use of screens in reducing the impact of solar radiation on temperature mea-

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surements in an experiment over a forest. Sensible and latent storage are also considered in energy balance in this paper. The aim to better represent sensible and latent heat flux is within the scope of HESS and the usage of screens is new. However, there are some inconsistencies and ambiguous demonstrations in this paper.

Page 1 Line 2, "now allows its use in hydrological", should be "allow" rather than "allows".

We will change this in the revised manuscript.

Page 2 Line 1, "distributed temperature sensing technology (DTS)", DTS is the abbreviation for "distributed temperature sensing" rather than "distributed temperature sensing technology".

We will change this in the revised manuscript to "distributed temperature sensing (DTS) technology".

Line 1-2, "The precision and spatial resolution now allows its. . ." should be "allow" rather than "allows".

We will change this in the revised manuscript.

Line 11-12, "It also has a resolution of 0.014 K for 15 minute averages, allowing for very small temperature gradients to be measured", please give reference for this sentence.

This is based on the Silixa provided machine calibration sheet. The calibration gives the resolution as 0.06 K for 1 minute averages at a measurement range of 500 m. This value was extrapolated to the 15 minute averages, based on personal communication

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with Silixa about the sources of noise [1].As these numbers are not further investigated in this manuscript, adding the whole analysis would distract from the rest of the manuscript and would have a negative effect on the readability, we will change this to "It also has a resolution of 0.06 K for 1 minute averages (Silixa machine calibration), and will be more accurate when measuring over a longer time period, allowing for very small temperature gradients to be measured" in the revised manuscript.

Page 5 Line 23-24, "second cable with a diameter of 3 mm was used to study the effects of solar radiation", however, the 3 mm diameter fiber temperature is not shown in this paper. What is the temperature difference between the thicker and thinner fiber?

Without the radiation shield, the difference between the cables was in the order of 1 K. The original goal of the installation of the 3 mm cable was to use the solar radiation correction from de Jong, Slingerland, and van de Giesen (2015). However, this method added additional uncertainties due to the required extrapolation. While comparison with reference sensors improved, the uncertainty of extrapolation caused a lot of noise in the Bowen ratio calculations. We will add this explanation to the revised manuscript to explain the lack of the use of the 3 mm diameter cable.

Page 7 Line 5, "The cables were shielded from direct solar radiation using screen gauze secured onto PVC rings", please describe more about screens, e.g. materials, size and manufacturers. These are quite important as different screen gauzes may lead to different shielding effects.

We should indeed have included more information about the screens, and will do so

[1]The main sources of noise in the measurements are Johnson-Nyquist thermal electronic noise and optical shot noise (which are both white noise). As the noise is white noise, every doubling of data points (in space and in time) will lead to a reduction in the uncertainty by a factor $\sqrt{2}$. Of course this will have a limit as other types of noise/errors will become dominant over longer time periods. The exact temperature resolution also depends on the device used, different ULTIMA-S devices can be set to different acquisition distances which will influence accuracy.

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in the revised manuscript. The attached Fig. 1 shows a schematic drawing of one section of screen. The screen gauze we used has coated fibreglass as material, with square holes with a width of 1.5 mm and a gauze material width of 0.3 mm. We used two layers on top of each other to achieve a higher reduction in solar radiation.

Line 23, "The biomass heat storage change and the photosynthesis energy flux were not measured", so GP in equation (1) and dQB/dt in equation (14) should be removed as they are not considered here.

Good point. We will change this in the revised manuscript.

Page 8 Equation (18) is inconsistent with equation (4), which one has been used? In equation (18) and (19), how many vertical points have been used in calculating Bowen ratio? In Euser et al (2014), it was shown that multiple measurements will lead to better results than two data points.

The difference between Eq. 4 and Eq. 18 are that in Eq. 4 the partial derivative ($\frac{\partial T}{\partial z}$) was used, which is the average gradient at a point. In Eq. 18 we use the numerical approximation ($\frac{\Delta T}{\Delta z}$). We will clarify this in Eq. 18 by rewriting the first part to;

$$\frac{\partial \Theta}{\partial z} \approx \frac{\partial T_a}{\partial z} - \Gamma \approx \frac{\Delta T_{a,fit}}{\Delta z} - \Gamma(z) \approx ...$$

In the air temperature cable fit, we used all data points from 38.5 to 44 m height. As there are 8 data points per meter this means 44 data points.

Line 14-15, "the DTS measured temperature and vapour pressure is used", "are" rather than "is" should be used.

We will change this in the revised manuscript.

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Page 10 Line 3-4, "the 46 m reference sensor is compared to the cable temperatures at 44 m height", there will be some difference between the temperature at 44 m and 46 m since a log profile used here. One way to address this issue may be extrapolating the 46-meter-high temperature of DTS using the 44-meter-high temperature and log profile.

That could indeed be a way to address the issue, although this would add extra uncertainties. Because of the uncertainties and additional assumptions related to extrapolating the fitted log profile, I believe it is best to make the comparison to the sensor in this way.

Line 6-7, "This error is a deviation of up to 3 K from the reference sensor temperature", what is the time of averaging in calculating this deviation?

The data is for 1 minute averages. This will be included in the text of the revised manuscript.

Page 12 Figure 5. The correlation between Bowen ratios measured by DTS and EC is shown here. It may also help to show the correlation between sensible heat fluxes measured by DTS and EC to compare with figure 8 in Euser (2014).

We chose for Tukey mean-difference plots instead of correlation plots because this will make visual comparisons easier (Altman and Bland, 1983). It is also less sensitive to outliers and high values than correlation plots, as it is focussed around the mean error. The visual comparison is improved by clearly showing around which ranges it deviates from the mean; in our case in Fig. 6 of the manuscript, it is easily visible that the low values are underestimated while the higher values are overestimated.

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Table 1. RMSE of the fluxes

	RMSE 15 min (W m^{-2})	RMSE 15 min (W m^{-2})
B_{DTS}, B_{EC}	76	82
ρ_{DTS}, ρ_{EC}	90	93
H_{DTS}, H_{EC}	82	78

Page 14 The RMSEs in Figure 6 and 7 are large. What would be the RMSEs if the time average is 30 minutes?

The RMSEs of the comparison between the EC and BR-DTS heat fluxes is indeed large, but is for a large part a propagation of the difference in available energy (Page 14 - Fig. 6). The RMSEs are shown in Table 1. There are no large differences between 15 minute and 30 minute time averages.

Page 19 Line 15, journal name should be added to the citation.

Well spotted. We will add it in the revised manuscript.

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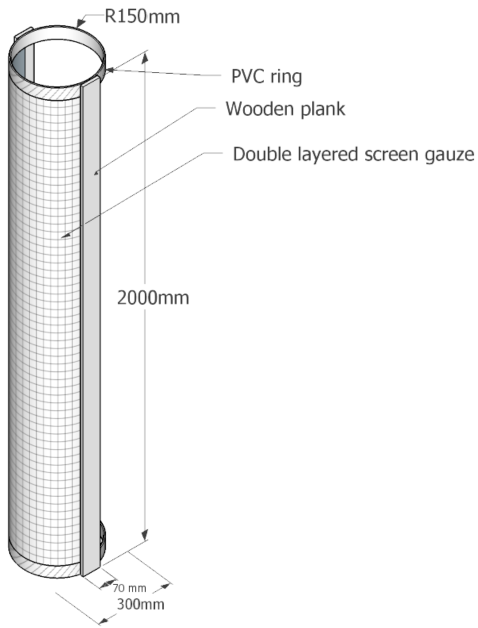

Fig. 1. Schematical drawing of one section of screen

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