Replies to comments of Reviewer #1

Manuscript Title: Fiber optic distributed temperature sensing for the determination of the nocturnal atmospheric boundary layer height
Manuscript Number: AMTD-3-2723-2010

We thank the reviewer for the constructive comments which helped to improve the quality of the manuscript. The responses below address and consider all of the reviewer's remarks and questions (presented in italic) and corresponding modifications were made in the manuscript (explained below).

R#1: *The objective (measure height of nocturnal ABL) is relatively modest and it would seem that the rich dataset could be used for further analysis. It is not explicitly stated but I assume that the method is used during the night because radiation during the day would disturb the measurements. Although short wave radiation would basically be zero during the night, this clearly does not hold for long wave radiation. So it would be good to clarify what the role of the long wave radiative balance of the fiber has on the measured temperature.*

Reply: We agree that the data set bears much more potential for further analysis. In this work, we wanted to focus on one simple (but useful) application to demonstrate the applicability of the method and introduce DTS measurements for atmospheric boundary layer studies.
Indeed, night time periods were used to measure in absence of solar radiation, which significantly affects the temperature readings. Another reason was to observe the development of a stable boundary layer with a relatively shallow boundary layer height compared to daytime convective conditions.
At night time, incoming long wave radiation is the main source term in the energy balance determining the temperature of the cable. The cable in turn emits infrared radiation as a function of its temperature following the Stefan-Bolzmann law. Although we do not know the exact emissivity of the cable, it is likely larger than the bulk atmospheric emissivity, resulting in a somewhat higher long wave emission at a given temperature compared to the ambient air. Note that for the small diameter of the cable also radial conductive processes are present which compensate for radiative losses. During pre-calibration in laboratory setting, the time response of the fiber cable was observed to be less than 5 minutes, i.e. there is only short time required to readjust to ambient air temperature after a temperature perturbation. Thus we believe that the cable is in equilibrium with the ambient air during stable atmospheric conditions and the different emissivities may cause only a minor temperature error in the measurements. These issues have been added in the paper in section 2.

R#1: *Both ends of the cable were on the ground. It is a pity that the return cable was not inserted into the temperature bath as well. Not sure why this was not done because it would have allowed to correct with a slope and an offset, as is preferable given the differential attenuation of Stokes & anti-Stokes along the cable. Instead, a comparison is made between the up and down parts of the cable. The authors give a high correlation. What would be good to see is if this correlation varies along the cable. If an offset would not have been enough, one would expect a higher correlation between points that are close to each other along the cable (those close to the balloon) than between those that are far from each other along the cable (those close to the ground). A graph of R vs height would show* *that. This would be helpful to see for future experiments, whether the return cable should also go through the temperature bath.*

Reply: We completely agree that placing also the return cable into the water bath would provide valuable information on the calibration settings of the fiber. Due to practical problems (the water bath basin proved to be too small for both fiber cable spools), this desirable setup was not possible for our experiments, wherefore the attenuation slope was determined prior to the campaign in the lab. As shown in Fig. 3 of the manuscript, this procedure resulted in good correlations also for points close to the ground.
Figure 1a shows the correlation between the two measured time series for every height separately. The correlation coefficient R^2 is observed to decrease from 0.99 at a height of 99 m (i.e. where the distance of the measurement points along the fiber is 2 m) to 0.97 1 m above ground (distance of 198 m), which may indicate that the fiber attenuation is not properly accounted for. However, such an effect would also cause a significant trend in the normalized mean bias ($NMB(z) = 100\% \times \Sigma[T_2(z) - T_1(z)] / \Sigma[T_1(z)]$, where $T_1(z)$ and $T_2(z)$ are the time series of the two temperature measurements at height z) along the fiber. As shown in Figure 1b, the NMB exhibits changes of less than 0.1%, wherefore we conclude that the decrease of correlation is not due to an inadequate choice of the attenuation parameter but rather reflects the more pronounced variability in air temperature observed at lower heights (caused by surface heating/cooling and associated turbulence). Nevertheless, we recommend for future experiments of this type to put both ends of the cable into the reference temperature bath, allowing for an in-situ calibration of both the slope and the offset. We added this suggestion into section 2 of the manuscript.

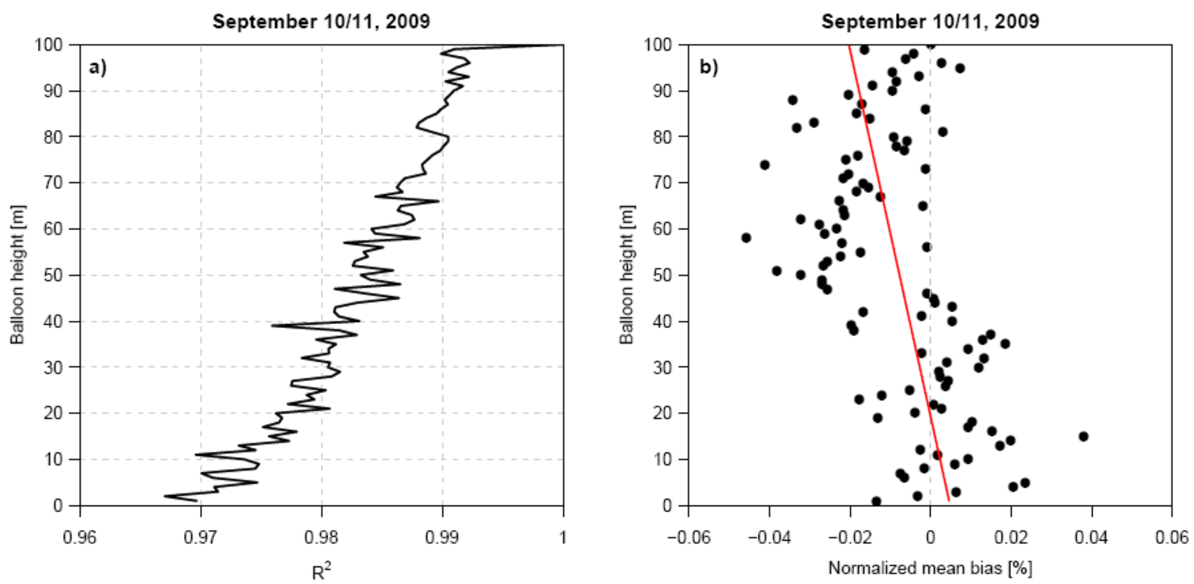

Figure 1: Correlation (a) and normalized mean bias (b) between the two measured time series for every height individually.

R#1: *Finally, a barometer is used to determine height because of the wind drag. Is this wind drag accounted for when the measured temperatures are given their heights? Does this matter at all or is it in the order of less than one meter? (If so, one might in the future as well use the cable to measure height. If not, how does one correct?)*

Reply: Given the low wind speeds during the measurement campaigns, the cable distance can be considered as representative for the height without correcting for the wind drag. For clarification, we added this information into section 3 of the manuscript.