Answer to referee comment by Marie Lothon:

General comment:

To relate mean flow angles to upstream step changes in vegetation height, as done in this study, has rarely (if ever) been attempted neither with sonic nor lidar anemometry. The cited studies for sonic anemometry for direct estimation of the vertical mean wind speed have all used the assumption that the mean flow angles during neutral atmospheric stratification are zero.

A major problem with using sonic anemometry is distortion of the flow by the instrument itself. A second problem with mast-mounted instruments is that of vertical mis-alignment. The flow disortion problem does not exist for the lidar and the vertical misalignment is easily assessed with lidar measurements at greater heights, and therefore we would like to strengthen the lidar anemomtry part of the paper, by moving it to a separate paper.

Specific comments:

Sketch of the flow in Figure 1: For W, which is so hard to assess, a dependence on wind speed is too uncertain to determine although it can not be ruled out. However, if W is caused by the forest edge as sketched out here, other properties of the flow field at the edge should also be dependent on the wind speed. In a different field experiment, we have studied the speedup of the flow over a dense forest edge which is very similar to the edge at Sorø. This dataset is still being processed, but there does not seem to be any dependence on the wind speed for the speed-up.

The integral scale: We will improve our method and use the method in Lenschow et al. (1994). Please, see also answers to specific comments by referee Larry Mahrt.

Lidar conical scanning mode: We will include the suggested reference Browning and Wexler (1968). Some of the issues mentioned in Browning and Wexler (1968) regarding horizontal inhomogeneity of the flow are discussed in Bingöl et al (2009) for lidar measurements.

Page 8177, lines 13-17: We will explain how we fit the measurements to the trigonometric series. It is a least-square fit and in the simplified description in section 2.3, it is a linear least square fit. We have as stated in lines 13-14 on page 8176, that we ignore the fact that the QinetiQ lidar only measures the magnitude and not the sign of the radial wind speed. This simplification is done in order to obtain Eq (8) in a simple way. The real data from the lidar are fitted to the absolute value of a trigonometric series using a non-linear least square fit. We allow ourselves to simplify the fit in the paper since it has no consequences for the estimate of the systematic error caused by a possible inhomogeneity of the flow. We will include a VAD plot to illustrate the procedure.

Method to estimate vertical velocity: We agree with and share the ML's concern. On the top line of Eq (8), the influence from the inhomogeneous flow is stated. We use the continuity equation to explain the inhomogeneity part in terms of W and then arrive at the two terms in Eq 11 to explain the measured W signal. For the second term, which is the inhomogeneity term, we use the common assumptions (1) that W = 0 at the surface and (2) that dW/dz can be approximated by W/z. We further assume that h ≈ z, h being the measurement height. This last assumption leads to an overestimation of the error due to inhomogeneity (because the lidar is on a platform and therefore z > h), but allows for a simple expression, where the error is not a function of height. We will try to make this procedure clearer in the text and agree that it was not very well described in the present manuscript.

Regarding the hypothesis of linearity and time scales: The hypothesis of linearity is a simplification as rightly pointed out by ML. However, it is only assumed that the mean flow, and not the instantaneous turbulent flow, varies linearly over the scanning circle, as we derive the mean vertical velocity from the 30 minute averages over the circle. For the turbulent field, corresponding to each revolution of the beam, the turbulent length scale would indeed invalidate the hypothesis of linearity. We will – in the revised version of the paper – emphasize that this is only applicable to the mean wind field. We could further derive the uncertainty of the measured W by the lidar in terms of non-linear variation, by including second order terms in the Taylor expansion in Eq 4. However, then we would need to estimate the second order derivate of the mean field and such detailed assessment is difficult.

Page 8176 line 14-15: If we know the mean wind direction during the run, even without great precision, there is no ambiguity of the sign for any mean components of the flow. We used the mean wind direction measured on the mast by a vane. We will clarify this in the text.

Page 8178 line 7: We agree that this is surprising, but nevertheless it is true. An explanation for this can be found in Bingöl et al. (2009), but actually also in Browning and Wexler (1968). These references will be added to the text.

Page 8188 line 8-13: We will expand this section discussing the results from the conical scanning lidar to include the assessment of uncertainties regarding outliers, the use of sectorwise averaging, running mean and the median.

Regarding a vertical lidar beam: This would in principle be a good idea, but it is not possible due to the relative intensity noise (RIN) in the homodyne lidar, which means that it can not measure wind speeds very close to zero. A second problem is that we could not calculate the sign of W, which is crucial in order to get the vertical mean wind speed from the fluctuating signal. New instruments with no RIN and heterodyne detection could be pointed directly vertically, but this was not possible at the time of the campaign. We will add a section to the discussion, where we explain this and give an overview over other possible ways of utilizing lidars for vertical mean wind speed assessment.

Regarding "linear mode" versus "pointing horizontally": We agree with ML, and will change the terminology accordingly.

Page 8188 (par 4.5): This section will be shortened, since the approach of determining the vertical velocity from a horizontal gradient of the mean wind speed clearly does not work. It is not only the neglect of the transverse velocity component that makes this derivation impossible, but also the large statistical uncertainty of the mean wind speed that invalidates the approach. Therefore we want to remove Fig 9. The horizontally lidar setup will be mentioned in the new subsection of the discussion mentioned above.

Page 8187 (lines 1-8): We will move part of the discussion in section 5.5 to the results.

Page 8188 (lines 1-3): We will move part of the discussion in section 5.5 to the results.

Paper outline: We agree with ML, that the current outline can be rationalized and have therefore decided to split the papers into two parts. In the new study which is focused on the lidar methodology for measuring the wind field, the derivation of the mean vertical velocity assessment with the lidar will be put it in a separate section. Further, the tests at Høvsøre will be moved to the results section and the Høvsøre site will therefore be described in the Materials and method section. Further, the scale of Fig 2 will be harmonized with that of Fig. 8, such that the difference between the sites will be clearer for the readers.

Minor comments: We agree with all the minor comments.