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Interactive comment on "Low-level jets and above canopy drainage as causes for turbulent exchange in the nocturnal boundary layer" *by* T.-S. El-Madany et al.

Anonymous Referee #1

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Review of " Low-level jets and above canopy drainage as causes for turbulent exchange in the nocturnal boundary layer" by El-Madany et al. bg-2014-49

GENERAL COMMENTS

This paper presents results from a set of micrometeorological measurements performed during 17 consecutive nights in a complex sloping terrain in northern Taiwan. The measurements were used to identify nocturnal drainage flows and analyse their effect on turbulent exchange measured with two eddy covariance (EC) systems. In total 14 drainage flow events were identified and they were divided into two categories (low-level jet (LLJ) and above canopy drainage flow (ACDF)) based on the height of

the wind speed maximum. The manuscript discusses the characteristic features of LLJ and ACDF, such as their temporal and spatial extent and reasons for their termination, in addition to their effect on turbulent fluxes. The paper is well-structured and clearly written and thus is relatively easy to follow and understand.

It is widely known that eddy covariance method does not work optimally in nocturnal stably stratified boundary layer where turbulence is intermittent or almost non-existent and also advection may be important. Periods with low turbulent mixing are often filtered out by removing data with low friction velocity (u*-filtering), whereas periods with non-stationary (i.e. intermittent) turbulence are flagged with the stationarity test (Foken and Wichura, 1996). u*-filtering is applied in many studies and consequently often significant amount of night time data is discarded (Barr et al., 2013) leaving gaps in the data which need to be filled. Thus it is important to investigate different processes that take place in nocturnal stably stratified boundary layer and to this end the manuscript under review has its own contribution.

Therefore I consider that the manuscript is within the scope of Biogeosciences and can be published after a few modifications. The biggest concern that I have with the manuscript is that the measured data is not always utilised as much as it could. For instance the storage change term, which is often estimated in eddy covariance studies, is not calculated at all, even though vertical profile of CO_2 concentration is measured with a relatively good vertical and temporal resolution. Furthermore, a comparison between the two eddy covariance systems (5 m and 10 m above the canopy) during a jet period and outside a jet period would be interesting to see, since this would give some hints on how well the measured EC fluxes represent the fluxes at the biosphere-atmosphere interface.

SPECIFIC COMMENTS

Page 4698 line 18: How dense is the canopy (LAI?)? This is important for understanding how easily turbulence can penetrate through the canopy.

Page 4699 line 11: What was the tube diameter and material?

Section 3.4: The storage change term (Aubinet et al. (2012), chapter 1, first term in Eq. (1.24a)) should be calculated from the measured CO_2 concentration profile and its magnitude and evolution during a jet period should be discussed. Now the effects of changes in CO_2 storage are discussed in several parts of the manuscript, but they are not quantitatively determined. I would add discussion about the storage change term also in section 4.2 and other parts of the manuscript where the accumulation of CO_2 below the EC measurement level is discussed.

Page 4705 line 8: Friction velocity threshold is site specific (see for instance Barr et al., 2013) and thus a threshold estimated for one site cannot be used at another. Please estimate the threshold for your site or express clearly that the value used (0.17 m/s) may not be the right value for this site since it is taken from another study.

Page 4705 lines 16-17: This can be said based on Fig.7 only if the data shown in the bottom part of the figure is normalised with the corresponding variance of w. If the data is not normalised, then the relative contribution of small eddies to the power spectral density is difficult to assess based on Fig. 7 alone.

Section 3.5.3: I would add a paragraph or two showing a comparison between the two EC systems during a jet period and outside a jet period. In an ideal case the CO_2 fluxes from these two systems should be equal, whereas in a case when the two measurement levels are decoupled from each other the turbulent fluxes might not agree.

Page 4709 lines 16-26: Is this significantly different from what Mahrt et al. (2010) described?

Figure 7: Please consider adding a third subplot which shows the power spectral density normalised with the corresponding variance of w. It would help in assessing the relative contribution of each frequency to the total variance of w

TECHNICAL CORRECTIONS

Page 4703 lines 1-2: Mention that these values for the vertical wind are given in a coordinate frame which is perpendicular to gravity, not to ground.

Page 4708 lines 6-7: Please reformulate this sentence. The CO_2 flux is not necessarily small at night. Furthermore, the word “small” is a relative term and it should be mentioned to what the fluxes are compared with. I guess the meaning of this sentence is to say that under these conditions the EC fluxes represent the fluxes at the atmosphere-biosphere interface.

Figures 2 & 3 & 4: Please add in the captions of these figures that the data shown is given in coordinate frame which is perpendicular to gravity, not to the ground.

Figures 2 & 3 & 4 & 5: Would it be possible to remove the grey background from these figures?

REFERENCES

Aubinet, M., Vesala, T., Papale, D., 2012. Eddy Covariance: A Practical Guide to Measurement and Data Analysis. Springer, Dordrecht, Heidelberg, London, New York, 438 pp.

Barr, A.G., Richardson, A.D., Hollinger, D.Y., Papale, D., Arain, M.A., Black, T.A., Bohrer, G., Dragoni, D., Fischer, M.L., Gu, L., Law, B.E., Margolis, H.A., McCaughey, J.H., Munger, J.W., Oechel, W., Schaeffer, K., 2013. Use of change-point detection for friction–velocity threshold evaluation in eddy-covariance studies. Agric. Forest Meteorol. 171–172, 31–45.

Interactive comment on Biogeosciences Discuss., 11, 4695, 2014.