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Interactive comment on "Tree-, stand- and site-specific controls on landscape-scale patterns of transpiration" *by* Sibylle K. Hassler et al.

Anonymous Referee #2

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This study presents an analysis of the determinants of sap flux at the landscape level, studying hydrometeorological, site-level, stand-level, and tree-level factors. Measurements were carried out in > 60 beech and oak trees, within a ∼ 300 km2 catchment, which varied topographic and bedrock conditions. The main results are that hydrometeorological conditions (evaporative demand and soil water supply) explain little variation in landscape-level sap flux patterns, compared to that explained by site-, stand- and tree-level factors.

The dataset in this manuscript is rich and spans a large variability in natural conditions. However, the overall focus and the data analyses may present some critical limitations, in order to interpret the results in the light of catchment-scale variation in transpiration controls.

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First, the authors present sap velocity (probably better named as sap flux or sap flow density, per unit sapwood area) not tree transpiration. While sapwood area-based sap flow density may be an interesting quantity in itself for more physiologically-oriented studies, where water transport characteristics are compared across species or ecological settings, it may have less interest from the hydrological point of view. A more natural approach would be to scale sap flux to whole-tree sap flow, using tree sapwood area and a reasonable integration of spatial variation of sap flux within the sapwood.

A related point is that, even if sensors measuring sap flux in three points along the tree's xylem depth were installed, so potentially accounting for some of the radial variation in sap flux, the authors chose only the point with the highest sap flux values (pg. 4, L. 33). In my opinion, they should integrate sap flux over the probe length and make some assumption about the variation of sap flux beyond the probe length and up to the sapwood-heartwood boundary.

As for the modelling approach, I think that the contribution to explained variation by the different the predictors, will depend on the order in which these predictors are introduced in the model, something that is not stated in the methods. In other words, do results of the variable importance analysis change if hydrometeorological variables are introduced first, and then the rest of the factors?

Also related to the models, the authors focus on the variance explained by the different predictors but they do not go into much depth in the direction of change in sap flux with the variation in the predictors (which is necessarily complex given the multiple variables involved). The presentation of the results could also be improved. For instance, Fig. 4 could focus only on the most important variables (reduce the number of panels) and use conditioning symbols, shapes or colours to show multivariate relationships; one example, sap flux density vs dbh coded by species, geology or basal area categories.

Overall, the study does not seem to convey a clear message or a novel result. Some of the findings on the structural controls of sap flow across the landscape are not really

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that new (Adelman et al. 2008, Loranty et al., 2008, Angstmann et al. 2013, Tromp-van Meerveld & McDonnell, 2006, the last two studies cited in the manuscript).

Adelman, J.D., Ewers, B.E. & MacKay, D.S. (2008) Use of temporal patterns in vapor pressure deficit to explain spatial autocorrelation dynamics in tree transpiration. Tree physiology, 28, 647. Loranty, M.M., Mackay, D.S., Ewers, B.E., Adelman, J.D. & Kruger, E.L. (2008) Environmental drivers of spatial variation in whole-tree transpiration in an aspen-dominated upland-to-wetland forest gradient. Water Resour. Res., 44.

Specific comments

P. 5., L. 6. What about the role of vapour pressure deficit in driving transpiration? Epot here seems to include a radiative term only. p. 7, L. 16 - 22. Please see my comment above on the possibility of showing bivariate plots with conditioning variables to show interactions between predictors.

P. 9, L. 2 - 18. I don't fully agree with the explanation that soil moisture limitations are not detected because soil water availability is not exhaustively measured (over the entire soil profile or taking into account water in fractures). Transpiration shows a threshold response with declining soil moisture, and even when deeper soil layers may be playing a role in supplying water you could still detect a (highly non-linear) relationship with most soi layers (e.g. Duursma et al 2008). Even if water was taken from deep layers, transpiration would still be related to soil water status in the upper layers (Warren et al., 2004).

Duursma, R., Kolari, P., Perämäki, M., Nikinmaa, E., Hari, P., Delzon, S., Loustau, D., Ilvesniemi, H., Pumpanen, J. & Mäkelä, A. (2008) Predicting the decline in daily maximum transpiration rate of two pine stands during drought based on constant minimum leaf water potential and plant hydraulic conductance. Tree Physiology, 28, 265–276.

Warren, J.M., Meinzer, F.C., Brooks, J.R. & Domec, J.C. (2005) Vertical stratification of soil water storage and release dynamics in Pacific Northwest coniferous forests.

Agricultural and Forest Meteorology, 130, 39–58.

P. 10, L. 31-34. There are indeed some studies on this; see the Adelman et al 2008 study cited above on the spatial patterns of physiological regulation of transpiration.

P. 10, L. 39-40. Could this lack of sensitivity for oak be caused by the inherent limitations of the heat ratio method in measuring high flows (see e.g. Vandegehuchte & Steppe, 2013).

Vandegehuchte, M.W. & Steppe, K. (2013) Sap-flux density measurement methods: working principles and applicability. Functional Plant Biology, 40, 213–223.

P. 11, L. 5-15. The authors should try to upscale sap flow density to sap flow using the three measuring points along the sapwood and using sapwood areas (measured or derived from allometry). Although they would need to make some assumptions on the circumferential variability, but nevertheless, I think it's worth doing the scaling.

P. 11, L. 11-12. Other studies show sap flow well beyond the outermost ring in deciduous oaks (e.g. Poyatos et al., 2007).

Poyatos, R., Čermák, J. & Llorens, P. (2007) Variation in the radial patterns of sap flux density in pubescent oak (Quercus pubescens) and its implications for tree and stand transpiration measurements. Tree Physiology, 27, 537–548.

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