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Interactive comment on "Rainfall pattern greatly affects water use by Mongolian Scots pine on a sandy soil, in a semi-arid climate" *by* Hongzhong Dang et al.

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Genera comments: The MS by the authors presents data from 3 years of measurements of Mongolian Scots Pine. While such data will be very useful for our understanding of this species plant water use and strategies, as well as ecosystem functioning in which this species is found, the collection of sap flow data and subsequent statistical analyses were poor and do not warrant publication.

Response: We greatly appreciate the critical and very helpful comments raised by the referee. We carefully discussed the comments with co-authors and thoroughly revised the manuscript as in supplement.

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Specific comments: The authors deployed the Granier technique, or thermal dissipation probe (TDP), to measure sap flow in Mongolian Scots Pine. The TDP sensor only has one measurement point that the authors installed at an unknown depth in the sapwood. The width, or depth, of the sapwood is also unknown. From the single measurement point, sap flow data were scaled upwards to tree and then entire forest stand. Such a scaling approach no doubt introduced significant errors as it is known, from a vast amount of research, that sap flow varies across the radial profile of sapwood. Measuring at a single point in the sapwood will then significantly over- or under-estimate true sap flow. Furthermore, the Granier technique is an empirical technique and requires a species specific calibration. The authors chose a generic calibration which may lead to further errors in their estimate of sap flow. Therefore, the sap flow data collected by the authors cannot reliably be used to estimate total tree or stand water use.

Response: In this study, we measured sap flux density (Js) by Granier-type thermal dissipation method (Dynamax Inc., Houston. TX. USA) with 3-cm probe. The sapwood width of the trees in our experiments ranged from 4.38 to 6.98 cm for all years and trees, We added this information in the revised text. The probes were thus installed only in sapwood properly.

We totally agree with the referee on the necessity of the species-specific calibration of TDP where possible. In this paper, we used a generic calibration considering the sensors were all in active xylem (sapwood). Granier and other early users demonstrated that the generic calibration produced total sap flow within an error of 10% and smaller based on many different type of xylem structure including Pinus (Goulden ML, Field CB. 1994; Lu et al, 2004; Do, et al,1998). The validity of the original calibration has also been supported by results from studies showing generally good quantitative agreement between water flux estimates obtained with the Granier method compared with other sap flow methods, water absorption, branch bag measurements, eddy covariance measurements and catchment-scale water balance (Granier et al. 1990, 1994;

Kostner et al. 1996; Saugier et al. 1997; Tournebize and Boistard, 1998; Ewers et al. 2007; Ford et al. 2007; Lu etal, 2004). Considering most of validation for TDP is made on excised stems under very strict laboratory controlling conditions, we use the original Granier generic parameter before a proper one developed in future work.

The calculation of total transpiration by TDP in 0-3 cm radial is limited by how much this data represent the whole tree. Previous studies in similar tree species (Pinus sylvestris) showed that the sap flux within 0-3 cm sapwood width covers 64% of total sap flux in radial direct for a tree (Lu et al., 2004; Nadezhdina et al., 2002). To calibrate the transpiration of TDP measurements, we separated sapwood into outer area (0-3 cm) and inner area (3 cm to the heartwood), a coefficient as the ratio of the sap flux in inner area by that in outer area was used with a value of 0.56 (Lu et al., 2004; Nadezhdina et al., 2002)(Fig.1). Accordingly, the data of sap flux measurements in our study were calibrated by this coefficient in the revised text. We also clarified in the M&M section.

Comment: The statistical approach by the authors is also incorrect. The authors analysed a series of collinear variables across a series of univariate or a multivariate regression analysis. All the environmental variables are related to each other therefore the author's approach will introduce a significant amount of error. Collinearity in regression models is a commonly overlooked statistical error. I recommend the author's read the chapter on collinearity in Quinn and Keough (2002) "Experimental Design and Data Analysis for Biologists". The authors can run their predictor variables through a Principle Components Analysis to reduce their related variables to a series of unrelated variables. The factor scores that come out of the PCA can then be used in a multiple linear regression analysis as the predictor variables.

Response: We totally agree. In the revised text, we use a normalized transpiration, Ts /ET0, the potential transpiration under actual evaporative demand determined by meteorological factors, e.g. solar radiation, air temperature, humidity and wind speed (Yuan et al., 2013). Thus, the relationship between normalized transpiration and soil relative extractable water (REW) is not in collinearity. The parameters of this relationship reflect the plant response (changing in physiological traits) to the water availability. We deleted the multivariate regression between, gw, REW and D.

Comment: The analyses and results have the feeling that the authors are fishing through their data set looking for significant patterns and then presenting those patterns. There is no systematic analytical approach and it is extremely difficult to follow and comprehend. For example, several drought periods are declared based on REW and a regression analysis between Ts and ET0 is presented in Figure 4. But what is the significance of REW <= 0.24? Why is it not 0.25 or 0.23? These REW values may be important but it just seems some random numbers were chosen. The MS would be far stronger, and much easier to read and comprehend, if there was a systematic and biologically realistic designation of drought periods.

Response: We provide the revised data about REW levels in Table 2 and listed out the reference. We focused on the biological traits such as growth status and physiological index such as transpiration rate of needles (Tr), stomatal conductance (Cs) and intercellular carbon oxide concentration (Ci) to divide drought periods and give a designation.

Comment: Figure 5 also suffers from this problem. What is EW? Is this something the authors have just created? If it is so important, why is it being introduced deep into the Results section and not in the Introduction section? Why is the power model important? Does it have a slightly better R2 than a linear regression model? But does it carry greater explanatory power in terms of an AIC analysis or other statistical approach?

Response: We agreed. In the revised text, we deleted this.

Comment: Throughout the MS, there are several grammatical and spelling errors. For example, “sapflow” should be “sap flow”.

Response: We thoroughly revised the manuscript and corrected those mistakes.

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Other points: The linear regression in figure 1 is in appropriate and statistically incorrect. Is the purpose of the regression to demonstrate that rainfall decreased and temperature increased over this time period? If yes, probably consult the climate science literature to determine the methods they use to statistically quantify such changes.

Response: We agreed. We use the anomalies of air temperature and precipitation (%) to display the fluctuation of variables and trends during the long period.

Comment: Can you please provide more details about the soil profile – for example, is the texture consistent down the profile or are there distinct horizons? Is the texture described in the text only for the top 40cm of soil where, presumably, most of the MP root activity is?

Response: We added related information about soil profile in Line 82-85 in revised manuscript, that is: The soil is sandy with a sedimentary aeolian sand layer more than 3 m and an ancient alluvial sand layer with the total depth more than 126 m (Jiao, 1989). The mean bulk density of the upper 2 m soil layer is 1.61 g cm-3. The mean soil texture is 83 % of sand (> 0.05 mm), 9 % of silt (0.05–0.002 mm) and 8 % of clay (< 0.002 mm). The organic matter content is 0.3–1.0 g kg-1.

Comment: Where were the soil moisture sensors installed? Next to the weather station outside of the plot? or somewhere inside of the plot?

Response: Three placements in experiment area were measured. Each placement was set between four neighborhood sample trees. Measurements were done at 10 min intervals with hourly means recorded by a SQ2020 data logger (Grant Instruments Ltd, UK). We clarified this in the revised text.

Comment: What was the sapwood width of MP?

Response: We added the data of sapwood width (SW, cm) of MPs in Table 1.

Comment: Why were the TDP sensors installed on the north-face of the trees? Presumably, this is where sap flow would be lowest around the circumference of the trunk.

Response: The reason of the TDP sensors installed on the north-face of the trees is mainly to minimize interference from solar direct radiation in northern hemisphere.

We added four references, see below, to the manuscript in Line 381-382, 396-397, 416-417, 426-427and also into references part.

Nadezhdina, N., Cermak, J. and Ceulemans, R.: Radial patterns of sap flow in woody stems of dominant and understory species: scaling errors associated with positioning of sensors, Tree Physiol., 22, 907-918, 2002. Tang, F.D., Lin, Y. and Li, Y.: Impact of water stress photosynthesis characteristics of Mongolian pine seedlings and Grafting Korean pine seedlings with stocks of Mongolian pine, Journal of Liaoning University, 42, 274-276, 2015 (in Chinese with English abstract). Yuan, M.W., Zhang, L.Z., Gou, F., Su, Z., Spiertz, J.H.J., van der Werf, W.: Assessment of crop water productivity in semi-arid Inner Mongolia. Agr. Water Manage., 122, 28-38, 2013. Zhu, J.J., Kang, H.Z., Li, Z.H., Wang, G.C. and Zhang, R.S.: Impact of water stress on survial and photosynthesis of Mongolian pine seedlings on sandy land, Acta Ecologica Sinica, 25, 2527-2533, 2005 (in Chinese with English abstract).

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/bg-2017-69/bg-2017-69-AC3-supplement.pdf

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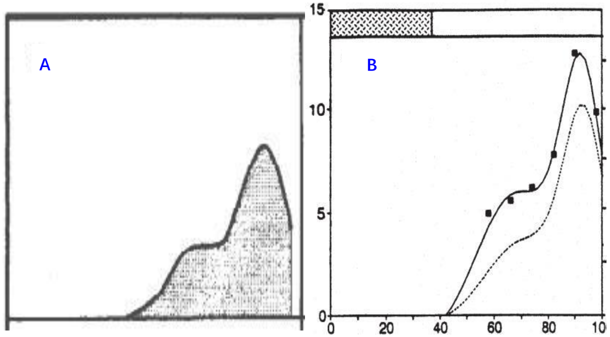

Fig. 1. Radial pattern of sap flux density of Pinus sylvestris. (A): from Lu et al.(2004), (B) :from Nadezhdina et al., (2002).