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Hydrology and Earth System Sciences
Discussions

Interactive comment on "The effect of northern forest expansion on evapotranspiration overrides that of a possible physiological water saving response to rising CO_2: Interpretations of movement in Budyko Space" *by* Fernando Jaramillo et al.

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Response to Reviewer Nr.4

We thank Reviewer Nr. 4 for highlighting that our results should be communicated and for proposing valuable suggestions to improve the manuscript. We have addressed below the Reviewers remarks, questions and suggestions.

Anonymous Referee #4

The manuscript by Jaramillo et al., 2017 analyses long term changes in ET/P and PET/P of Swedish catchments. The topic is of general interest and well suited for the journal. Many catchments show increasing ET/P even though the aridity index is decreasing due to slightly higher precipitation rates. The data is compared with forest inventory data which shows a significant increase in forest biomass. The data suggests that the overall increase in biomass is the dominant driver in increasing ET and thus ET/P. The authors argue that this "overrides physiological water saving responses". I do agree, however, the improved water use efficiency due to higher CO2 levels might still be an important effect and could decrease ET, but clearly only for the same amount of biomass. For biomass aggregated results are presented, but there is no estimate of the physiological water saving response. Furthermore, the time series data does not provide statistical correlations between biomass and ET/P. Thus the study can not provide quantitative links between biomass or physiological water saving response and ET/P. However, both topics are suggested by the title and hypotheses. Therefore I recommend to adapt the red line of the manuscript or improve the analysis. Nevertheless, the observation that increases in forest biomass are potentially linked with increasing ET/P is important and should be communicated.

Response 1: We thank the reviewer for the suggestion of adjusting the red line of the manuscript in order to tone down statements of the role of the water saving response on evapotranspiration. This suggestion also agrees with that of Reviewer Nr. 1 that we also address in the Response 2 to that reviewer. Indeed, we have not quantified the stomatal water saving response, so the title, abstract and structure of the manuscript should be adjusted accordingly. We will do as such by removing the mention of the water saving response from the title and mentioning along the manuscript that our results of a consistent increase in the residual component of the evaporative ratio point to a dominating effect from an increase in forest biomass. Furthermore, we will mention in the Discussion that from such result we infer that a water saving response is either

weak or inexistent.

Concerning the suggestion to add a quantitative assessment, we have now included statistical correlations between the forest attributes of area, biomass, and composition (i.e., the ratio of leaf area index of deciduous forest to total leaf area index) and the residual component of the evaporative ratio $\Psi r = \Psi - \Psi c$ (See new Table 1 below). We have now added the calculation of the coefficient of determination (R2) of the linear regression between all obtained annual values of the residual component of the evaporative ratio ($\Psi r = \Psi - \Psi c$) and the three mentioned attributes of forest structure for the temperate and boreal basin groups (forest cover, biomass and composition). The results agree with our previous results. We found that the R2 for relationship between forest biomass and Ψr is significantly different from zero ($p<0.05$) for both the boreal and temperate groups and that forest biomass explains more of the variance of Ψr than the other forest attributes. In turn, R2 for the relationship between forest cover and Ψr was only significantly different from zero ($p<0.05$) in the temperate group. Forest composition does not have any significant relationship with Ψr in any of the two basin groups, judging the low R2 values and the high p-values. We are grateful to the reviewer for the suggestion to improve the analysis on this issue, since the addition of this new table will be a significant improvement of the study. We will include this new analysis, table and discussion in a revised manuscript.

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New Table 1-

BOREAL

	biomass	forest cover	forest composition	fraction falling as snow
	V	A	Q_{LAI}	f_s
intercept	-0.09	0.44	-0.10	0.11
slope	0.00	-0.78	0.89	-0.15
Adjusted R^2	0.07	0.02	-0.02	0.02
p-value	0.028*	0.168	0.629	0.187

TEMPERATE

	biomass	forest cover	forest composition	fraction falling as snow
	V	A	Q_{LAI}	f_s
intercept	-0.06	-0.25	-0.16	0.02
slope	0.00	0.41	1.09	-0.05
Adjusted R^2	0.08	0.06	0.03	-0.01
p-value	0.026*	0.048*	0.168	0.612

Fig. 1.