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## ***Interactive comment on “Variability of summer humidity during the past 800 years on the eastern Tibetan Plateau inferred from $\delta^{18}\text{O}$ of tree-ring cellulose” by J. Wernicke et al.***

### **Anonymous Referee #1**

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This paper presents an 800 year  $\delta^{18}\text{O}$  cellulose record from eastern Tibet. The record is presented as an RH reconstruction. The data is very strong, there are good statistical constraints on the transfer function and the record comes from a place with limited data. For all these reasons, I support the publication of the data so others can take advantage of this important reconstruction. That said, I found much of the discussion on the climate dynamics and proxy processes to be extremely lacking. There is no extensive discussion of the processes that give rise to the RH control on the proxy. For example, there is a slope of -2.3 permille/% RH. What can this slope tell about the processes that transfer a change in RH onto the tree ring cellulose? This needs attention. Further, some of the statistics, namely those devoted to spectral analysis to

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be superficial.

There are a number of weak and confusing discussions about land-surface thermal gradients, ENSO, NAO, solar controls on the monsoon. These discussions are often confusing and occasionally lack logic. Ultimately, a lot of the space that is devoted to large scale climate modes turns out to be unimportant. Therefore, the discussion of climate dynamics can be simplified and focused.

I suggest starting the discussion start from the simple question of what controls RH on the eastern Tibetan Plateau. RH can be controlled by 1) air mass trajectory, 2) whether air is principally subsiding or rising, 3) local land surface processes such as soil moisture, 4) boundary layer dynamics for example, the stable nighttime boundary layer tends to have 100% RH whereas daytime turbulence and mixing of free tropospheric air tends to lower RH. Once a clear understanding of controls of RH at the proxy site are established than the significance of this in terms of large scale climate can be explored. Ultimately, the observation of a century long decline in RH is fascinating but understanding the processes that actually led to this decline would make this study really breakthrough.

I recommend this paper be published but only after a major rewrite of the Discussion is conducted.

Pg 3328 4: “This is the first chronology for eastern Tibet...” 8: “variations...More moist conditions prevailed during the termination...” 10: Simply state that there is no systematic shift in the mean state during the LIA, which is contrary to Indian Summer Monsoon reconstructions. 10: Your record does not show a consistent decline through the 20th century. It appear to flatten off by the 1950’s. 19-20: It is never clear what records share the same spectra. Cross spectral analysis is needed. 24: Vuille is a good reference for d18O of monsoon but not a good reference for the socio-economic impacts of the monsoon.

Pg 3329 1: Do these references actually discuss changes in humidity or a decline in

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precipitation. The two are not identical, related-yes, but not identical. 1: "...explained by a reduction in the thermal gradient..." 11: "...increases and can be used to facilitate targeted decision making regarding water and resource management." 12: "dislocation" is the wrong word. Northerly movement... 15: Intraseasonal oscillations such as the madden Julian Oscillation have strong controls on monsoon precip and particularly in generating the complex spatial patterns. 29: "stronger rainfalls..."

Pg 3330 11: erase "sensitive" 14: "Therefore," 15: "...unclear to what extent..."

Pg 3331 6: "The oldest tree is 804 years old"

Pg 3332 5: "During periods of the chronology with extremely narrow rings, we used shifted block pooling to obtain sufficient material." 11: Spectrometer misspelled

Pg 3333 22: fix "the the"

Pg 3334 9-11: More information on the met data is needed. Sunshine hours and vapor pressure are not common met products. Is the sunshine hours, photosynthetic active radiation or net radiation? Is vapor pressure obtained with a hygrometer or inferred through the RH sensor? What equation is used to calculate vapor pressure? Vapor Pressure Deficit would be useful to correlate against d18O cellulose, following the work of Ansgar Kahmen. 12: Evapotranspiration is used here but actually it is only transpiration that influences the leaf water fractionation. Unless you are referring to the secondary effects that evaporation had on soil water and consequently on the d18O of the plant source water. 13: "has demonstrated" 14: "temperatures on tree ring growth." 14-16: Why would May temperatures influence d18O of cellulose. I understand that growth is limited by temperature at high altitude sites but why would temperatures have an effect on the isotope ratio? Could this be tied to the temperature controls on RH? Please explain. 16-18: Sunshine has a negative impact on d18O of cellulose, which seems odd to me. Later on in the paper you discuss that less sunshine=more cloudiness=higher relative humidity which would lead to lower d18O cellulose. What is the mechanism by which more sunshine actually decreases d18O of cellulose? Perhaps,

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more sunshine=more convection=more rainfall=higher humidity=low d18O cellulose. Please elaborate on how sunshine directly influences the isotope ratio in the cellulose. 27: should be “ $r=-0.73$ ”

Pg. 3335 1-2: “more robust than for single months” 13: should that be “binomial” 19: The slope between d18O cellulose and RH is -2.3. How does this compare with previous studies such as Roden 2000. Please consider quantitative comparisons of the slope you found with as many previous studies as possible. For modeling proxies, it is useful to understand how global these slopes are or whether they are species and region-specific 23-25: It really seems that the decline in RH begins in 1871 and ends in the 1950s. The low pass filter suggests the trend continues but this appears to be an artifact of edge effects. I would like the slope of d18O calculate for 1950 through the present and see if it is statistically different than 0.

Pg 3336 4: consider an alternative word to “confuted” 10-13: From the wavelength analysis it appears that the cycles are very intermittent. It would be good to show the global wavelet and also standard FFT to argue that these cycles are statistical and persistent through the record. If these cycles are going to be compared against other records cross-wavelet or cross-spectral analysis is needed. It is not sufficient to say they are commonly forced signals without doing a cross spectral analysis. 26-27: “data sets and the Lamcoka. ...On the contrary, the tree ring width“

Pg 3337 18-22: If the humidity decline is associated with a change in the thermal gradient than show this. Please calculate the thermal gradient using ocean and land temperature datasets such as from Hadley Centre and correlate it to the reconstructed humidity. It is not sufficient to say this, when data is available to test this. 22: “reduction are not sufficiently clear.” 24: replaces “discovered” with “found” 26-28: The solar argument for the humidity decline requires significantly more explanation. If solar forcing is heating the land and ocean evenly, than this would not generate a change in the thermal gradient. If solar is heating up the land more than the ocean than this would increase the monsoon and humidity. If solar is heating up the ocean faster than

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this could theoretically increase the thermal gradient and be a plausible explanation for the change in moisture. There are solar reconstructions and recent observations that could be used to support your argument. In general, this argument needs to be significantly elaborated. Further, I would argue that your record shows flattening off since the 1950's which is consistent with the timing of massive aerosol loading over Asia.

Pg 3338 5: Why would increasing distance from the Bay of Bengal result in an amplified signal. Please explain the logic here. 13-18: The presence of a North South bipolar in Tibetan Plateau humidity is interesting. Is there a modern analog for anti correlation between the north and south TP? This would help to support the proxy observation. 24: "postulated a dominant influence. . ."

Pg 3339: 1-2: Please rewrite this sentence beginning, "However. . ." 4: It is unclear to me, do you argue that cloudiness directly influences RH or that cloudiness is a proxy for precipitation, which directly influences RH? The argument gets obscure in text. 9: "positively associated with the NAO via its impact on Eurasian snow cover and thus invokes. . ." 11: "might induce an el nino. . ." Is this saying the NAO causes ENSO events? Unclear what is meant by this.

Pg 3340 1-3: Many previous studies have noted a recent reduction in ENSO's influence on the monsoon. See the pioneering work by Kumar on this. 4: Should that read "cannot be confirmed"?

There are a number of issues with this section 1) A lot of time is spent laboring through ENSO and NAO influences and then at the end you just reject that idea and invoke a local control argument. Why not just remove all this NAO-ENSO discussion. . .it is confusing, takes up a lot of space and is ultimately irrelevant. 2) The statistical significance of the running correlations is not really properly treated. The df is low for running correlations.

6-15: I found the discussion on the correlation with sensible heat to be rather confusing and missing some key discussion points. It is true, that the correlations are very

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strong but the argument that sensible heat flux is a “direct expression of vertical air motion” is incorrect. Within the ERA Interim model there are directly modeled “vertical velocity” and “convective precipitation rate” terms, which are actually direct indicators of convection as opposed to sensible heat, which is a combined term sensitive to surface temperature, soil moisture etc. . . . Furthermore, the argument that sensible heat is an indicator of evapotranspiration is also odd. Latent heat flux is the better indicator of moisture fluxes. It is also important to discuss that ERA Interim is a model not an observation. I would like to see correlations with latent heat flux, soil moisture, skin temperature, vertical velocity etc. . . all the component that control sensible heat flux to get a sense of the actual process that leads to these strong correlations.

Further, I think it is worth discussing that the spatial correlations with sensible heat appear to be focused along a latitudinal band. I wonder if this is an indicator of westerly controls or on interannual variation in the northern extent of the ASM.

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