

Clim. Past Discuss., referee comment RC2
<https://doi.org/10.5194/cp-2021-80-RC2>, 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on cp-2021-80

Kevin Anchukaitis (Referee)

Referee comment on "Climate change detection and attribution using observed and simulated tree-ring width" by Jörg Franke et al., Clim. Past Discuss.,
<https://doi.org/10.5194/cp-2021-80-RC2>, 2022

This is a thorough and very interesting study combining proxy systems modeling with the detection and attribution framework applied directly to tree-ring width proxy chronologies. I especially appreciate all the work that authors have invested in dealing with the many challenges of the data, model(s), and simulation output (these are considerable). In particular, the attention to evaluating VSL in the 'real world' before moving into the simulation and D&A framework, observations about the nature of parameter sets (e.g. information around Line 195 is really interesting to think about the implications and potential interpretations of this), attention to temperature and precipitation bias issues, and various other aspects. This will be a useful touchstone paper and I suspect also motivate further work, since tree-ring proxy systems models are both valuable but then again challenging to use in frameworks such as the one here because of model bias, parameter uncertainty, and often mixed or weak climate signals in large tree-ring datasets (particularly for temperature) compared to the deterministic climate signals that emerge from VSL. My major comments below are primarily around the ability of VSL to simulate the chronology set here and how this propagates into the differences between observed and simulated series and how this then impacts particularly the moisture-sensitive D&A:

1. Patterns of successful simulations (Line 194 and elsewhere): I think it would be desirable to get a better idea of where and for what chronologies the VSL simulations are successful - I get the sense from the manuscript and the Tolwinski-Ward papers show that (in general and not surprisingly), VSL will do better when the chronology in question has a strong climate signal itself (because VSL is driven by climate filtered through some possibly nonlinear simulated processes). In any case, it would be helpful to visualize the success of VSL here - where (which chronologies, that is) can VSL successfully simulate and how many of these are moisture vs. temperature - my guess would be that the majority or plurality of the Breitenmoser chronologies are moisture-sensitive or mixed sensitivity based on e.g. St. George 2014 and the original a quick look at the Breitenmoser paper - so, does VSL do really well with more (% wise) T or M limited sites? Are mixed sites generally not as well simulated? Some of this is likely already part of the original Breitenmoser paper, but this is useful information when evaluating where the observations and simulation (e.g. Figure 4) agree or disagree and what might be the

potential reasons behind this.

Particularly for moisture, there is the question of the seasonality of the climate response vs. the seasonality of tree growth. For instance, in western North America and the Mediterranean, winter/spring moisture will be important for growth, while in Northern Europe and other parts of North America, annual or summer moisture will control moisture-sensitive tree growth. The extent to which VSL can do this adequately would seem to be key to making the connection from climate forcing (e.g. volcanism) to local climate to tree growth with as much confidence as possible. I was also surprised (e.g. Figure 4) by the lack of chronologies further to the west (the Great Basin, Sierra, California, etc) - these are some of the most moisture sensitive sites in the world - why are they not represented here? Is this a VSL problem? A model simulation data/bias limitation?

2. Regarding Figure 4 and results shown there: Are all the locations shown in these maps really places where (1) VSL successfully simulates the chronology/ies at the location and, (2) where there is a true T or M limited site? I ask because I find myself surprised, for instance, to see apparently T sensitive sites in mid-latitude or arid North America and parts of the Mediterranean, and note in particular that several of these T-sensitive sites show increased growth post eruption, suggesting perhaps these are not simple temperature sensitive sites in the real world (observations)? Whereas the simulation shows (as expected) a growth reduction everywhere. I wonder if the difference in observations and simulations for T sensitive locations can be explained by the strength of the confidence that some of these are really temperature sensitive? Again, I look at North America and find myself wondering if many of those mid-continent sites are sufficiently temperature sensitive to be confident they can be compared to VSL limited by temperature alone. Or, put another way, VSL (driven by climate) will have a strong temperature-mediated growth response if the parameters and local climate make the simulation at that location temperature sensitive (and, this also leaving aside landscape-scale changes in sensitivity, e.g. differential tree growth response in the same grid point - Bunn et al. (2018). Spatiotemporal variability in the climate growth response of high elevation bristlecone pine in the White Mountains of California. *Geophysical Research Letters*, 45(24), 13-312.).

As well in Figure 4, there seems to be several important and interesting mismatches for moisture sensitive sites as well - for instance, for Crowley et al. eruptions (left and right columns) in North America the simulations show drying/reduced growth in the northeastern United States and a negligible response on the central and western part of the continent, while the observations show the opposite - e.g. a negligible signal in the eastern/northeastern part of the country, and a wet anomaly in the central/west. The authors do note some of these features (Lines 280 to 286), but what stands out to me for the purpose of this manuscript is the differences between simulations and observations even when the same forcing dataset is used in North America in particular. Perhaps though the most consistent signal is indeed the European dipole (wet/more growth in the Mediterranean, drier/reduced growth in Northern Europe) - this latter feature somewhat consistent with Fischer et al. 2007 (10.1029/2006GL027992) and more so I think with Rao et al. 2017 (10.1002/2017GL073057) who look at PDSI.

3. Figure 5 - given the inconsistencies in simulated vs. observed patterns particularly for moisture in North America, how much of the detection for moisture is being driven by the largely successful observed vs. simulation Mediterranean vs. northern European pattern? The caption says that the moisture D&A refers to 'aggregate mean response grouped by the two regions of homogenous response indicated in Fig 4', but nothing is indicated (should there be a box or the region otherwise outlined?), and it isn't clear from the text alone (e.g. around Line 280) - given the mismatch in North America I note above and evident in Figure 4, I think the statement about detection and attribution in Line 310 and onward should probably be caveated - I suspect (and would ask the authors to establish if this is the case with some regional tests) the signal and successful Moisture D&A is being drive by the Mediterranean/European pattern - the authors can also consult Fischer et al. 2007 and Rao et al. 2017.

Minor comments:

Line 113: Just to verify: these are all tree-ring width data, and no density data correct, in Breitenmoser?

Line 119: suggest changing to 'As input to VSL we use the ...'

Line 159: suggest also citing the first paper on this, Cook, E. R., Briffa, K. R., Meko, D. M., Graybill, D. A., & Funkhouser, G. (1995). The 'segment length curse' in long tree-ring chronology development for palaeoclimatic studies. *The Holocene*, 5(2), 229-237.

Line 340: should probable add a citation near here to Stevenson, S., Fasullo, J. T., Otto-Bliesner, B. L., Tomas, R. A., & Gao, C. (2017). Role of eruption season in reconciling model and proxy responses to tropical volcanism. *Proceedings of the National Academy of Sciences*, 114(8), 1822-1826.