Climate of the Past Discussions

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Comment on cp-2021-135

Anonymous Referee #1

Referee comment on "Climate signals in stable carbon and hydrogen isotopes of lignin methoxy groups from southern German beech trees" by Anna Wieland et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-135-RC1, 2022

Wieland et al. present an interesting new annually resolved series of lignin methoxy d13C tree ring series . These are highly novel methodologies and promising for paleoclimate reconstructions.

While the records themselves are interesting – and should be published - I do have several concerns regarding the methods used to correct for the plant physiological effects and the interpretation of the long-term trends. I will first describe my main concern and then point out several smaller comments on the manuscript.

Main concerns

d13C in plant material is strongly influenced by various environmental and ecophysiological factors. These include

i) changes in atmospheric d13C and atmospheric CO2 concentration

ii) changes in atmospheric deposition in nitrogen

iii) change in tree light environment

iv) change in tree height

I will first focus on the effect of atmospheric d13C and atmospheric CO_2 concentration changes. The authors correct for the d13C atmosphere effect or the Suess effect. That is all fine. However, the authors then move on to correct for the effect of plant physiological responses to atmospheric CO_2 (eg. change in discrimination or iWUE) using several correction factors that have been proposed by various authors (Kurschner, Feng, Treydte) and which differ almost 3 fold in magnitude. The authors also use a correction factor developed by a previous study for higher altitude Larch trees (Riechelman et al. 2016). As shown in fig. 3 these corrections result in very different upward curves since ca. 1950 with some showing very strong increases in the "corrected" d13C.

I do not disagree with the need to correct for the effect of CO_2 on these series, but we do not know enough about tree responses to CO2 to know which one of these "corrections" represents the "real" tree response. None of the corrections in the literature seem to argue in a particular convincing way how trees respond to CO2 and some just fit curves that results in the highest correlations with the targeted climate variable. In addition, tree ring d13C studies show that trees respond differently between sites and species.

In short, I cannot see how one can choose from these relative arbitrary correction curves which one is the best. The authors are favouring the correction from Riechelman as that results in the highest correlation with observed temperature (fig. 4, 5 and 6), but this is somewhat circular in my opinion. You add several artificial increasing trends to the d13C and then relate it to a climatic record of which we know that is has a positive trend and find a good match. But what do we really learn from this, and secondly can you use such a record for reliable climate reconstructions?

Several of the conclusions are entirely due to this methodological choice of adding trends to the d13C curve. For example, the increase in strength of the correlation with temperature for the upward corrected curve (fig. 4,5) is simply due to the addition of a trend to the series. It is also not surprising that the series with the strongest trends added, results in the strongest inter-series correlation (lines 207 etc). And again the d13C corrected according to Riechelman, results in a good correlation with d2H as you have two series with strong upward trends (fig. 10), but the correlations vary in reality between negative (with the raw data) to slightly positive when correcting for the Suess effect. In my view, we are not learning much from this, and I do not believe one can use these records put recent temperature increases in a longer term context. It seems to violate the stationarity principle and the correction for that is artificial. But do please correct me if i see this wrong.

One needs to know in much greater detail how CO_2 truly affects plant isotope discrimination. In perspective of this and the poor correlations pre-1965, I wonder if the

conclusion that "this is a suitable proxy for reconstructing high to low frequency summer temperatures" (lines 317) . This is perhaps true for the high-frequency variation since 1966, but not for the low-frequency variation and not for the full period.

My other main concern is that other factors that affect d13C are poorly discussed. This includes above mentioned effects of eg. Nitrogen deposition (see Leonardi et al. 2012), and effects of tree height and light (Brienen et al 2017, Vadeboncoeur et al. 2020). For these beech trees these may be very important factors that control tree isotope discrimination, but it depends on the size and age of trees. Such information needs to be added to this article and discussed.

In fact, changes of climate responses with tree height could also well explain the poor relationship between d13C and temperature before 1966. For example, Trouiller et al. 2019 find that large and small tree differ in their growth response and one could thus also expect that the response of d13C will differ.

Minor comments.

- In the introduction in lines 51-61 … Can you expand the section on d2H a bit more and say where the signal comes from (source water, leaf enrichment or both), if this is known.

- Section 71-79: Some of the statements are a bit over assertive: Do we really know that much about mesophyll conductance and the effects fo Ca on photorespiration to make these statements? Be more careful here as there are large uncertainties with the variables in eq. 1.

- Line 82: better to say .. "stomatal control limits photosynthesis" (cannot say gs is higher than the rates of photosynthesis),

- lines 80-86: perhaps also mention post-fractionation processes?

- Fig, 1 : add proper units to the precipitation axis that can be understood… eg. mm per

day or mm per month.

-lines 183: Bravais Person ?? Pearson correlation coefficient

- Lines 211: What is the low frequency series? The LM_R as in figure 5? Why is the LM_RL a low frequency series?

- Equations 3 and 4 are not clear. They are the same but for different periods or is this for different series? Please explain.

- Line 341: Higher compared to what? To other species ? Ara you talking about higher mean discrimination, or higher changes in discrimination over time (i.e. a steeper increase in discrimination)?

- Line 343: strange statement … "It has been shown .. "

- Line 351: why is this not due to a decrease in gs due to increase in RH or VPD with increasing T? Are we also seeing a positive T response in the tree ring widths? Please discuss this.

- Lines 357-363: Explain this a bit more. Trees were supposedly younger, smaller in pre 1966, Could that explain the change? Trees were perhaps below the canopy and limited by other factors? PLease discuss further.

- lines 368-369 : drought stress i only mentioned here for the furst time. Why? include this possible mechanism also in earlier sections. It is not just Assimilation that affects d13C. And you might be able to check if d13C is controlled by A or gs when you also include analysis of ring width. If ring width increases in line with d13C then it must be assimilation controlled, if it is the opposite then it must be controlled by g_s.

-line 370 : you mean overcorrect the original (raw d13C)?

- line 371: indeed a lot of uncertainties that can move your recent trends in d13c any direction depending on the uncertainties.

-line 375: inter-series inconsistencies in the early part of the record again indicate that other factors than climate affect d13C.

- line 379-380 “additionally .. “ explain a bit more. What is soil sealing?

- line 397 .. intensified anthropogenic warming .. this is not clear. What do you mean why do you say intensified? Is that in comparison with the temp increase? The trends in temp and in d2H look pretty similar to me, and no need perhaps for other factors to be involved than simply temperature.