Anonymous Referee #1
Received and published: 20 December 2015

Motivated by paleo-climate/hydrological applications Keel et al. have implemented oxygen isotope diagnostics for tree ring cellulose in a dynamic vegetation model. They show that the model is able to reproduce measured modern-era oxygen isotope ratios of tree ring cellulose with a significant skill, and conclude that the model is a useful tool for paleo-interpretations of tree ring cellulose.

In my view the manuscript would be suitable for publication with moderate revisions taking into account the following questions and comments.

General comments. The paper is well written and the methodology is predominately well described with well-motivated choices for how the isotope diagnostics are imple- mented.

Thank you

Overall I think that structure and order of the figures related to the text could be improved, which would make manuscript easier to follow (see also detailed comments below).

We will change the order of figures and merge some as suggested below.

Fig 1: Soil water and vapor d18O

Fig. 2: Leaf water d18O

Fig. 3a: Leaf water 18O enrichment (now Fig. 5)

Fig. 3b: Stem cellulose d18O map (now Fig. 6)

Fig. 4: Scatter plot of simulated cellulose d18O vs. measurements (now Fig. 7)

Fig. 5a: Simulations for site DVN (now Fig. 8)

Fig. 5b: Simulations for site LAB, LAA… (now Fig. 4)

Fig. 6: Sensitivity analysis (now Fig. 9)

Fig. 7: Test with Tleaf and ewcT (now Fig. 10)

Fig. 8: CRU vs. measured climate (now Fig. 3)

Although I think that the comparison to data and validation of the model is generally well thought out, I miss a more thorough discussion/test of how chances in seasonality could affect the interpretation. E.g. how would the timing of spring melt affect results in high-latitude regions? How would changes in precipitation seasonality affect humidity limited regions? What are the implications of southern versus northern slope proximity of trees? These questions are particularly important for palaeoclimatic interpretation. I am aware that a full study would be beyond the scope of the study, but the authors could provide some more insights regarding these questions from the work with the modern data.

We will add:
„In general, we expect any changes in seasonality that could potentially affect soil water d18O such as e.g. earlier snow melt to be translated to stem cellulose d18O in LPX. To increase the chance of detecting such signals, the monthly output could be used.

In our sensitivity analysis precipitation (amounts) had no influence on stem cellulose d18O. Hence, it seems unlikely that LPX will capture changes in precipitation patterns that are not associated with changes in isotope signals.

Sites LOE and N19 are in close proximity, but on a south- and north-facing slope respectively. The data presented in Fig. 4 show that LPX simulates nearly identical stem cellulose d18O that only differs because the PFTs are not the same.

Detailed comments.

P18465, L2 Other references to millennial-scale tree ring isotope records include Edwards et al. 2008.

Reference will be added

P18465, L18 For comparisons between variability of modelled and ice core d18O see Sjolte et al. 2011 and Masson-Delmotte et al. 2015.

References will be added

P18468, L18 Replace "... carbon (C) and N dynamics..." with "... carbon (C) and nitrogen (N) dynamics..."

Will be changed

P18469, L12 Please clarify the choice of 0.8 for the ratio between the CO2 mole fraction in the stomatal cavity and the ambient air.

Text will be modified to read: " for a fixed ratio, λ, between the
CO2 mole fraction in the stomatal cavity and the ambient air.
λ is set equal to 0.8 following Sitch et al. (2003) to approximate non-water-stressed conditions and as a starting value for the iterative computation of carbon assimilation and transpiration."

P18472, L24 Please clarify that this paragraph is an evaluation of the input data.

The following text will be added to begin the paragraph: "Next, the CRU climate input data are briefly evaluated."

P18473, L7-12 Optimally model output for daytime Rh should be applied. Variations in cloudiness etc. has large impacts on daytime Rh how valid is the 10% correction on longer time scales? E.g. decadal vs. intra-seasonal variations?

For a few summer days we compared average relative humidity for 24h vs. 08:00-18:00 and found that the reduction by 10% was sufficient. We will add:
'This correction was evaluated for a few summer days at the site DVN and found to be sufficient'

P18477, L9 I think that especially the results section, and the paper in general, could benefit from grouping figures differently. I suggest grouping maps that are similar together as figures with several sub-panels with 2-4 panels per figure. At least figure 5 and 6 could easily be merged. Additionally, all sub-panels and sub-plots should be clearly marked with figure indices.

Figure 5 and 6 will be merged and indices will be added to subpanels. Similarly, figure 4 and 8 will be merged.

P18478, L15 For the comparison with the measured data: is there a bias in the model elevation that could explain some of the discrepancy between model and data?

The following text will be added: “We recall that LPX is run with a resolution of 3.75° x 2.5° which implies mismatches between local site conditions (altitude, climate, etc) and grid-cell averages as used to force the model. “

References

Thomas W.D. Edwards, S. Jean Birks, Brian H. Luckman, Glen M. MacDonald,

Climatic and hydrologic variability during the past millennium in the eastern

Rocky Mountains and northern Great Plains of western Canada, Quaternary Research,

Volume 70, Issue 2, September 2008, Pages 188-197, ISSN 0033-5894,

http://dx.doi.org/10.1016/j.yqres.2008.04.013.

Masson-Delmotte,Â˘aV., Steen-Larsen,Â˘aH.Â˘aC., Ortega,Â˘aP., Swingedouw,Â˘aD.,

Popp,Â˘aT., Vinther,Â˘aB.Â˘aM., Oerter,Â˘aH., Sveinbjornsdottir,Â˘aA.Â˘ aE., Gudlaugsdottir,

Â˘aH., Box,Â˘aJ.Â˘ aE., Falourd,Â˘aS., Fettweis,Â˘ aX., Gallée,Â˘aH., Garnier,Â˘ aE., Gkinis,

Â˘aV., Jouzel,Â ˘aJ., Landais,Â˘ aA., Minster,Â˘aB., Paradis,Â˘aN., Orsi,Â˘ aA., Risi,Â ˘aC.,

Werner,Â˘aM., and White,Â˘aJ.Â˘aW.Â˘aC.: Recent changes in north-west Greenland climate

documented by NEEM shallow ice core data and simulations, and implications

for past-temperature reconstructions, The Cryosphere, 9, 1481-1504, doi:10.5194/tc-

9-1481-2015, 2015.

Sjolte, J., G. Hoffmann, S. J. Johnsen, B. M. Vinther, V. Massonâ˘ARˇ Delmotte, and

C. Sturm (2011), Modeling the water isotopes in Greenland precipitation 1959–2001

with the mesoâ˘A ˇ Rscale model REMOâ˘ARˇ iso, J. Geophys. Res., 116, D18105,

doi:10.1029/2010JD015287.