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Interactive comment on "Century-scale wood nitrogen isotope trajectories from an oak savanna with variable fire frequencies" *by* Matthew Trumper et al.

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The biogeochemical cycle of nitrogen is complex and influenced by human activities in various ways. Understanding and monitoring the slow impact of human interference on N accumulation and losses is important, but limited by the lack of long-term records. A number of studies have therefore measured N15 signals in tree rings to investigate changes that may be interpreted as N availability or losses. The isotopic effects of various processes in the N cycle are variable and not perfectly understood, but reasonably well to draw some general conclusion from differences in N15 signals, or changes thereof, in soils or plants. That said, interpreting any N15 trends in wood poses ad-

ditional questions and is not as straightforward as with C13. First N concentrations in wood are very low so precise isotopic analysis is more challenging than for C isotopes which means a higher signal-to-noise ratioSecond, at least in sapwood N is somewhat mobile so N isotope in a growth ring do not necessarily reflect the year the wood was formed. From the little that is known it is reasonably assumed that only a small proportion is translocated or not across many years. Third, while N in heartwood is likely limited to cell walls, in sapwood some is in living cells (and presumably more mobile) so concentrations in more recently produced wood tends to be higher (as seen in Fig. 5). Very little is known about related changes in N15 signals of wood. Fourth, changes in N15 might also carry a source signal (N15 trend in deposition). Finally, the discrimination during uptake and transfer in different species can be variable. Trends in N15 in wood are thus open to many interpretations unless some or all of the confounding factors can be controlled and studies such as the one by Tumper et al. that do so at least help to clarify how useful trends in tree ring N15 are.

While the study by Tumper et al. found a clear effect in sapwood on N concentrations, this appears to be unrelated to changes in wood N15, which are all seen in heartwood, so the inter-annual mobility and sapwood/heartwood differences are unlikely to be an issue. Given that the trees are from a small area, changes in N deposition and the N15 signal thereof at least should not affect differences in N15 trends. Also, they used only one species, so at least we should not expect differences in N15 found to be a species effects. That said, the previous documentation of species-specific trajectories (McLauchlan& Craine, 2012 Biogeosciences, 9, 867-874) where N15 can go up in one species while going down in another pours cold water on the use of tree ring N15 as an indicator of changes in the N cycle or availability and questions many interpretation of N15 trends one might suggest. Tumper et al. found significant differences in N15 trends between treatments. Frustratingly, the patterns seen do not offer an easy interpretation and a relationship with fire appears elusive. In the low-fire regime, wood N15 changes approx. with the onset of burns. However, N15 changed at the same time in the no-burn regime, in the medium-fire regime the shift in N15 was much earlier than the burning regime, and in the high-frequency fire there was no change in N15 (Fig. 6). Having to reject their initial hypothesis, they discuss alternative causes of the observed N15 trends, specifically changes in vegetation. Still, if vegetation change has something to do with the fire regime, we would expect an effect to be somehow related to the time or intensity of the burns. Data on the change in vegetation cover might help to support or refute this idea, but are not presented. I am not sure if the aerial photographs available or other records could be analyzed for this.

A rather serious limitation of the study is that there are no replicates of fire treatment. The four trees per treatment were not from different plots, spatially quite close and at a substantial distance from trees sampled for other treatments. Unfortunately, there is a spatial variability in N15 as trees from different location differ substantially in wood N15 before any treatment. If this also affects N15 trends we do not know, but in the end the data do not convincingly show that N15 trends are related with fire regimes at all.

The results are presented in a useful way for readers to understand and make up their minds. For me, the clearest message of the manuscript is pointing to the challenges and perhaps limitations of using tree ring N15 and this as well as technical limitations should be acknowledge in the discussion.

Other than that, I suggest a number of relatively small changes or additions that might help interpret the data.

Table 2: please add the treatment (burn regimes) to the individual trees (this is in Table 1) or mark the groups of 4 in some way so that it is easy to compare groups.

Why is $p>0.05$ considered significant for the MK test for trends but $p<0.01$ for the Student t-test for shifts in mean?

Page 9/ line 12 “Standardizing wood 15N for each tree by subtracting the tree mean 15N from each data point produced similar results: standardized 15N values were different among stands in 1902 ($p = 0.039$).” If you standardize by subtracting the

mean, the standardized mean will be the same for all groups. If the values from 1902 are not the same (as the mean of the time series), this simply says that there were different trends, but this is better shown in the trends rather than some standardized values, so simply drop this.

"Tree age did not have an effect on the mean or trend of 15N.” This is reassuring, but how was this tested and where is this shown? If there is a trend in individual trees, how do you distinguish an age from an environment effect? Looking at the data, age effect is a very implausible explanation for the trends found, which might be stated.

9/22 “Declines in wood 15N were roughly synchronous in these stands, beginning primarily between 1940 and 1965” I would not call events that differ by 20 years or more to be synchronous, not even roughly.

Wood % N was negatively correlated with wood N15 across all trees. This is potentially problematic: if there is a trend in %N that is caused by (recent) sapwood having higher N, and N and N15 are correlated, you might get trends in N15 that are related to changes in %N from heartwood to sapwood and not driven by external changes. Ideally, heartwood (the last 20 yrs or so) should thus be excluded. Given that changes in N15 occurred much earlier than 20 yrs ago, this appears not to be a problem, but should perhaps be mentioned in the discussion. In any case I suggest to test if the N $\sim$ N15 relationship also holds true if you exclude sapwood.

“Higher resolution sampling using annual or sub-annual growth rings may provide greater insights into short-term effects of fire on wood 15N and N availability and is recommended for future study” – I do not see how this would improve the outcome and would rather invest more analyses in sampling more trees and sites. Perhaps even pool wood across several years to dampen noise caused by short-term inter-annual variation, unless this is of specific interest (mostly not).

In the discussion studies that looked at N mineralization and total N at specific (and different) time points in the experiment are mentioned. These are published data, but it would be useful to present them together with (perhaps only recent) wood N15 in a table or figure to see if there is any relationship.

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