This manuscript examines the utility of a variety of biogeochemical measurements to develop an understanding of how peat profiles may have developed over the past millennia, based on a series of peat cores collected from a 'bog' in Minnesota. The site was selected because of a large experimental field manipulation being undertaken; a nearby site had been analyzed for its history and suggested that the site underwent changes from a rich fen-sedge to poor fen and finally a bog over 9000 years, the final sequence to a forested bog being in the past 200-600 years. This is probably characteristic of continental peatlands, where the peat is now removed from the groundwater influences giving rise to the fens (and there have been large variations in water table depth, compared to more 'maritime' peatlands, which may confuse the issue of an 'orderly' progression of redox conditions within the profile). I read the manuscript 'fresh', avoiding looking at the comments of reviewers 1 and 2 until the end. They can judge whether the suggested changes are adequate.

The Introduction discusses the complex nature of processes which lead to variations in C and N within peat profiles, and suggest ways in which these variations can be explained by biogeochemical and ecological processes associated with the development of the peatland. The authors use data collected from 16 peat profiles (sampled to a depth of up to 3 m), foliar vegetation and fungal hyphae and analyzed for C and N concentration and $\delta^{13}C$ and $\delta^{15}N$. The authors propose a conceptual model of C and N dynamics, applicable to the range of peatland types which may have been part of the trajectory at this site, which is inferred from an adjacent peatland, forming a basis for the interpretation of the patterns observed. The manuscript Introduction concludes with four, and a bit, questions derived from the conceptual model and applicable to these peat cores.

Beyond the reporting of results for C, N, $\delta^{13}C$ and $\delta^{15}N$, the manuscript seems heavily dependent on statistical analyses of the relationships among these variables and the location and depth of the peat profiles. However, the authors are careful to identify the patterns observed may be a result of the combination of several processes leading to variations in C and N content and their isotopes. In the Conclusions, their first statement ('Although the multiple potential interactions among climate, vegetation, and soil processes made definitive conclusions difficult……') captures the caution in the interpretation of results through time in peatlands, where external drivers as well as internal processes combine to produce the observed pattern. Thus, I think this manuscript is a useful contribution to the literature, without being 'definitive' and suggested further analyses (deuterium) or combination into models (though HPM is very rudimentary about biogeochemical processes).

Specific comments by page and line number (unfortunate that it is not continuous lineage)
1, 14 'peat depth profiles' – I think 'depth' is redundant.
2, 15 I think Loisel et al. (2014) is probably the best citation to support the role of peatlands being an important long-term C sink (rather than Kuhry and Vitt 1996, which is rather specific) and it contains a wealth of information on C and N (but not isotopes).
2 29 I think aerobic decomposition has a larger effect over a shorter time scale (e.g. 80% of C input lost over a few hundred years, whereas catotelmic decomposition may lose

only another 10% over millennia); thus the changes may occur in those first few centuries, and be 'stored' in the catotelm.
2, 30 'biogeochemical processes' perhaps rather than just 'biochemical'?
3, 16 I suspect sedges are the main plant applicable to your system, but the data in Table 2 suggest that they play a minor role at the present time; in fact it is now a treed site, with 75% of photosynthesis derived from larch and spruce…..
4, 28 I think there are studies which have identified the effect of wetness (water table) on vegetation $\delta^{13}C$ (you mention Loader et al. for Sphagnum), thus data on water table position when plants are growing for the year of sample and preceding years for evergreen foliar materials would be useful. My understanding for these continental peatlands is that water table is very variable within and among years. I would think the USFS gang have data on this.
9, 6 There is considerable interest and excitement (see Larmola et al. 2014 and others) about the opportunities for methanotrophic N_2 fixation in peat profiles (given that many traditional N_2 fixation studies cannot get enough N into the peat profile to account for the large rates of N storage), which would occur just above and below the water table and once fixed, the anaerobic conditions of the peat, as the water table effectively rises as the peat accumulates, may mean that this signature is retained. In the case of the hollows, this would be close to the surface, whereas in the hummocks, it may be 30-40 cm beneath the surface. Depending on the $\delta^{15}N$ changes based on 'normal' decomposition as litter turns into decomposing peat, an increase in $\delta^{15}N$, the addition of relatively $\delta^{15}N$-enriched N might speed this transformation. Comparing hummocks and hollows (merged in Figure 3 b) is there any differentiation in $\delta^{15}N$ which may be related to N_2 fixation (input of -1 $\delta^{15}N$)? The average $\delta^{15}N$ value does seem to 'bounce around' where the water table might be located.
10, 38 The role of ectomycorrhizal fungi will be dependent not only on changes in vegetation (such as from fen to bog) but also the rooting depth of the various plants – how far do spruce and larch roots penetrate at the present time, relative to water table depth?

Tim Moore

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