Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-120-AC1, 2018

Biogeosciences Discussions

Interactive comment on "Environmental and taxonomic controls of carbon and oxygen stable isotope composition in *Sphagnum* across broad climatic and geographic ranges" *by* Gustaf Granath et al.

Gustaf Granath et al.

gustaf.granath@gmail.com

Received and published: 26 June 2018

This response is also posted under SC1.

General comments: The manuscript by Granath et al presents a large northern dataset of d13C and d18O from Sphagnum magellanicum and Sphagnum fuscum tissues. Results show promise for d18O from plant tissue as a proxy for d18O from precipitation; the relationship between tissue and source water could be used broadly to reconstruct

changes in precipitation from peat core records. The relationship between d13C from plant tissue and environmental conditions was shown to be a little more complicated to interpret because of species-specific differences and confounding factors (water table and NPP primarily). The dataset presented here is coherent and spans a broad range of climatic conditions. To my knowledge, the statistical tests performed are adequate and provide honest/reliable results. In general, this is a much needed review of what is known (and what remains unclear) about the relationships between environmental conditions and the stable isotope signature of Sphagnum tissues. This synthesis might help us better understand Sphagnum physiology and its adaptation to local conditions. Also, the text reads well and should be well received by the BG audience and particularly by the terrestrial ecosystem ecology and paleoclimatology communities. I recommend publication of this manuscript pending that the following specific and technical comments be considered in the final article:

Specific comments:

(1) the use of Sphagnum CAPITULUM for the analysis – we know that many other authors have used stems OR leaves in the past and that these 2 types of tissues have different d13C values (see work by Loader for a discussion on the offset); also, there might be translocation from the apex down to the stems and leaves (see work by Bragazza) – I wonder what a difference it makes to analyze the capitulum vs. the top part of the stem. Could this partly explain the relatively wide spread of data you obtained with d13C?

RESPONSE: We used branches in the capitula for our comparisons because we were interested in matching isotope values with environmental conditions in the present growing season. Given our broad sampling including sites that could experience slow growth due to cold temperatures or water stress, we opted to measure tissue that most likely would reflect recent conditions. Loader et al. (2016; J Quat Res 31:426) also used capitula in a study comparing microclimates and Sphagnum isotope values, presumably for the same reason although not explicitly stated.We prepared samples from

10 capitula from each plot. Loader et al. (2016; above) found a 1.7 per mil range in d13C among 102 Sphagnum capitula growing within a 20 cm2 area. We believe our sampling reflects this naturally occurring variation and contributed to the spread of d13C values.

Loader et al. (2007; The Holocene 17:403) show that the carbon isotopic values in branch types (hanging vs pendant branches) differ consistently, but that the difference is small (0.26 per mil). However, there is a much greater difference between these and stems (>1 per mil). Moschen et al. (2009; Chemical Geology 259:262) found a similar offset.

In summary, for absolute isotopic values and its variation it matters what part of the plant that is analysed. However, relationships should remain the same. We will add some text to inform the reader that they should be aware of this when interpreting/applying these relationships.

(2) water table measurements at the END of the growing season: I wonder if part of the somewhat weak relationship between d13C and HWT could be caused by a contracted spread of HWT? Assuming that the dry end of the microhabitat remains dry throughout the growing season, but that the wetter microhabitats tend to dry out over time, it is possible that measuring HWT at the end of summer does not provide an accurate picture. If photosynthesis was to preferentially occur early during the growing season (i.e., under wetter conditions) and then stop, the pattern you observe could be in part explained by a sampling bias.

RESPONSE: Our measurements of HWT is a snapshot and the d13C-HWT relationship and may indeed have been tighter if we had measured continuous HWT. This shortcoming is highlighted in the manuscript (second sentence section 4.1). Unfortunately, collection of continuous HWT data was not logistically possible but we argue that HWT in the end of the season is a good proxy for relative HWT differences among locations. Growth mainly occurs in late summer/fall in temperate and boreal regions and therefore HWT at the the end of the season is assumed to be a better proxy of

relative HWT during growth than spring HWT. We did measure HWT in the spring as well and found spring HWT and fall HWT to be strongly correlated (r=0.74, this number is not in the current manuscript but will be added).

(3) I'd like a precision on the bulk density measurements: it is said that the top 30mm of the stem were used to calculate BD; how was volume determined?

RESPONSE: Also requested by reviewer 3. A known area was cut out carefully to avoid compaction (diameter=10cm). Stems within this area were then trimmed to 30 mm by cutting off the capitula and the lower part. This has now been clarified in the method section.

(4) Figure 2: A discussion on regional differences that you found across your dataset would be useful. For example, are there areas where d13C and HWT was more strongly correlated then others? what about d13C and NPP? Or was NPP more strongly correlated for wetter samples? Same goes with d18O and P, as well as d18O and Evaporation: is there anything else that could be learned from within your dataset?

RESPONSE: These are all good suggestions for further exploratory analyses and also put forward by reviewer 3. The NPP x HWT interaction was actually tested but we missed to give this result (in the text it says "we removed negligible interactions"). This will be fixed. We will look further at some of these details and data are available for other researchers to explore their own ideas. In the revised version we aim to discuss if there are areas/data points that do not fit the overall patterns. It is, however, important to point out that such analyses are of exploratory character as we may find spurious relationships when we perform subset analyses with small sample sizes.

(5) Figure 3: i'm curious to know more about the d18O values between -20 and -15 permille; they are almost all poorly predicted by your linear model. Where do they come from? what might explain their 'unusual' signature?

RESPONSE: Samples with these values occur in continental interiors both in Canada

(Northwest Territories,NWT) and in West Siberia. As the d18O model suggests, these sites are expected to experience precipitation with low d18O values. In fact, the linear relationship looks pretty robust along the d18O values. One value, from NWT, does have a much lower value than predicted but we have no idea why except that the 18Oprecip model is less accurate in this region. We will add some of these details in the revised version.

Technical corrections:

line 204: add a space between and$_{are}$

line 251: we first builT (change the builD for builT) ... and WERE identified (change ARE for WERE). Everything else in here uses past tense

line 286-287: "S. magellanicum..." should follow the previous sentence; there is currently a 'line jump'.

RESPONSE: Thank you for pointing out these correction.

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-120, 2018.