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Carbon and oxygen isotope composition of Sphagnum cellulose and their dependence on temperature and precipitation in a Scandinavian mire (Kiruna, northern Sweden)

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The peat profile investigated was retrieved from a site close to the city Kiruna located in Northern Sweden at the northern limit for Picea at 67°59'N and 20°19'E. The site is a mixed mire consisting of bog and fen vegetation with ombrogenic peat formed in the hummocks. A peat monolith was cut from the mire surface in 2003 and sampled continuously at varying depth intervals to provide near-annual resolution in the upper part in accordance with the radiocarbon chronology. Sphagnum tissue was hand picked from the bulk material and separate branch and stem samples were prepared. Cellulose extraction followed a sodium chlorite bleaching protocol and was completed by an additional copper-complex treatment to exclude minerogenic contamination (Wissel et al., 2008). Carbon isotope values were corrected for changes of the atmospheric carbon dioxide isotope composition during the last century. The detailed chronologies of carbon and oxygen isotope composition of cellulose cover the period back to AD 1720 with a time resolution of 1 to 8 years.

The content of extracted cellulose in branches and stems varied from 10 to 20 %. Overall isotope variations amounted to several per mil for both carbon and oxygen. We found the isotope composition of the different morphological units of the Sphagnum moss to be considerably offset. On average, branches were enriched by 2.1 per mil in carbon and by 1.2 per mil in oxygen compared to stems. Explanations for these isotopic differences include plant physiological as well as environmental reasons.

The evaluation of the climatic impact on the cellulose isotope records was based on monthly temperatures from Tornedalen (Klingbjer and Moberg, 2003) and on monthly precipitation from Kiruna. To enable direct correlation analysis, the instrumental records were averaged to match the temporal resolution of the proxy time series. April temperature had the strongest effect on the carbon isotope composition of cellulose and could explain about one third of the total carbon isotope variance ($r = -0.57$). Since April is not part of the growing season, this has to be interpreted as indirect influence e.g. on the length of the vegetation period. The effect of precipitation was visible in cellulose oxygen isotopes. The strongest impact was detected for the seasonally aggregated October, November, December precipitation ($r = -0.4$). This indicates the influence of meteoric water on the isotopic composition of mire water and Sphagnum cellulose. Relative carbon isotope anomalies indicate deteriorated growth conditions for Sphagnum, and thus reduced summer temperatures for the period AD 1840 to AD 1910. To allow for a statistical calibration, several interfering factors need to be further resolved to reduce the uncertainty in the climate isotope relationship.

References

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