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Investigating the impact of light and water status on the exchange of COS, $13CO_2$, CO18O and H218O from bryophytes

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Terrestrial surfaces are often covered by photoautotrophic communities that play a significant role in the biological fixation of C and N at the global scale. Bryophytes (mosses, liverworts and hornworts) are key members in these communities and are especially adapted to thrive in hostile environments, by growing slowly and surviving repeated dehydration events. Consequently, bryophyte communities can be extremely long-lived (>1500yrs) and can serve as valuable records of historic climate change. In particular the carbon and oxygen isotope compositions of mosses can be used as powerful proxies describing how growing season changes in atmospheric CO_2 and rainfall have changed in the distant past over the land surface.
Interpreting the climate signals of bryophyte biomass requires a robust understanding of how changes in photosynthetic activity and moisture status regulate the growth and isotopic composition of bryophyte biomass. Thus theoretical models predicting how changes in isotopic enrichment and CO_2 discrimination respond to dehydration and rehydration are used to tease apart climatic and isotopic source signals. Testing these models with high resolution datasets obtained from new generation laser spectrometers can provide more information on how these plants that lack stomata cope with water loss. In addition novel tracers such as carbonyl sulfide (COS) can also be measured at high resolution and precision (<5ppt) and used to constrain understanding of diffusional and enzymatic limitations during dehydration and rehydration events in the light and the dark.
Here, we will present for the first time simultaneous high-resolution chamber measurements of COS, $13CO_2$, CO18O and H218O fluxes by a bryophyte species (Marchantia sp.) in the light and during the dark, through complete desiccation cycles. Our measurements consistently reveal a strong enrichment dynamic in the oxygen isotope composition of transpired water over the dessication cycle that caused an increase in the oxygen isotope discrimination of CO_2. These data followed closely values predicted by our process-based model. We also observed a consistent pattern in the fluxes of CO_2 and COS during the desiccation cycle. Initially when the bryophyte was wet and a barrier to diffusion existed, net CO_2 and COS uptake rates were low. As the water film on the bryophyte disappeared the net rates of CO_2 and COS uptake increased to a steady maximum rate whilst relative water content values remained above 100%. Thereafter, the bryophyte turned from a COS sink to a source. In this talk we will further explore how the COS exchange rate of bryophytes varies with light level and whether there is any evidence for differences in the activity of the enzyme carbonic anhydrase with light and moisture status. We also use the data to develop and test a new theoretical model of COS exchange for astomatous plants for the first time.