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Grass Phytolith ^{17}O-excess from Northern American Grasslands Record Relative Humidity of the Growing Season

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Increasing interest in the greenhouse effect and global water cycle has heightened the need for accurate determination of past concentrations of atmospheric water vapor, which can be estimated from atmospheric temperatures (T) and relative humidity (RH). Global climate models struggle to reconstruct past continental RH, which shows the need for a proxy that can directly record past continental RH. The ^{17}O-excess of phytoliths formed in equilibrium with partially evaporated plant water has a high potential for this purpose because this parameter is measurable in these biominerals preserved in sediments and is temperature insensitive. A set of calibration study has shown a clear relationship between the ^{17}O-excess of leaf phytoliths and controlled RH in growing chambers [1-2].

Here, we tested the relationship between ^{17}O-excess of phytoliths and RH in 16 grasslands across North American. We observed a strong correlation between the ^{17}O-excess of naturally grown grass leaf phytoliths and daily average RH during the late growing season from July to August (Fig. 1). These results demonstrating that grass leaf phytolith ^{17}O-excess is a good proxy for RH of the grass growing season in North American grasslands. We also analyzed monthly ^{17}O-excess of leaf and stem phytoliths, soil water and precipitation at one location to assess how fluctuating seasonal RH is imprinted on the ^{17}O-excess of grass phytoliths. The negligible differences between ^{17}O-excess of stem water calculated from stem phytoliths and monthly precipitation indicate that soil water evaporation does not impact the ^{17}O-excess of grass leaf water at the studied sites. The ^{17}O-excess of phytoliths from green leaves generally followed the monthly RH variation (especially in 2021) (Fig. 2). This result suggests that the ^{17}O-excess of leaf phytoliths largely varies with RH, although the temporally relationship at one site with a more limited range in RH is not as strong as the spatially relationship at other sites where the range of RH is larger.

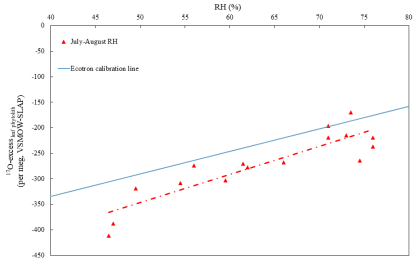

Figure 1. The relationship between ^{17}O-excess$_{leaf\ phytolith}$ of *Calamovilfa longifolia* and daily average RH for July to August [^{17}O-excess$_{leaf\ phytolith}$ = 5.5 RH - 621, R^2 = 0.79] in 16 locations across North America and the Ecotron calibration line from the 2018 growth chamber experiment [^{17}O-excess$_{phytolith}$ = 4.4 RH - 510] [1].

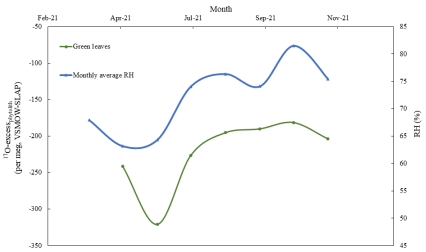

Figure 2. Monthly average RH and ^{17}O-excess of phytoliths from green leaves of *Bromus japonicus Thunb. ex Murr* collected in Strathroy, ON. in 2021.

References

[1] Alexandre, A. et al. Biogeosciences, 15(10), (2018)

[2] Outrequin et al. Climate of the Past, 17(5), (2021)