EGU24-6255, updated on 12 Jul 2024
https://doi.org/10.5194/egusphere-egu24-6255
EGU General Assembly 2024

A Synthesis of *Sphagnum* Litterbag Experiments: The Role of Initial Leaching Losses and a Test of the Holocene Peatland Model

Henning Teickner[1], Edzer Pebesma[2], and Klaus-Holger Knorr[1]
[1]University of Münster, Institute of Landscape Ecology, Ecohydrology and Biogeochemistry Group, Münster, Germany
[2]University of Münster, Institute for Geoinformatics, Spatio-temporal Modelling Lab, Münster, Germany

Decomposition is one of the major controls of long-term sequestration of carbon in northern peatlands. Our knowledge of the magnitude and controls of decomposition rates is derived to a large extent from litterbag experiments and estimated decomposition rates and environmental controls inform decomposition modules in dynamic peatland models.

Here, we combine synthesized *Sphagnum* litterbag data from 15 studies with simulation and modeling to address the following questions:

1. How large are initial leaching losses in *Sphagnum* litterbag experiments?

2. How does considering or ignoring initial leaching losses affect decomposition rate estimates?

3. Can the Holocene Peatland Model (HPM) (Frolking et al., 2010) predict decomposition rates from litterbag experiments?

We provide a systematic overview on *Sphagnum* decomposition rates and initial leaching losses. Data from litterbag experiments suggest that the assumption that leaching losses from *Sphagnum* litterbag experiments generally account for only few percent of the initial mass is wrong. Average initial leaching loss estimates range between 2 to as much as 22 percent of the initial mass. Ignoring initial leaching losses when estimating one-pool decomposition rates can bias predicted remaining masses when extrapolated to several decades because decomposition rates are overestimated.

With standard parameters, the HPM had an average root-mean square error (RMSE) of 0.06 yr^{-1} for decomposition rates estimated separately from litterbag data (reference decomposition rate estimates). The HPM and reference decomposition rate estimates could be made compatible with each other (training RMSE = 0.02 yr^{-1}) by constraining the reference decomposition rate estimates and by adjusting HPM parameters with information from the litterbag experiments.

In terms of HPM parameters, the analysis suggests that oxic decomposition rates may be fastest at larger water contents and that anoxic decomposition rates may be less limited with depth below the water table (= larger under anoxic conditions) than assumed by the HPM, indicating either misspecification of the HPM or the influence of varying water table levels on the litterbag data.

Since a previous sensitivity analysis of the HPM has shown that limitation of anoxic decomposition rates is important for peat accumulation (Quillet et al., 2013), the HPM may currently overestimate peat accumulation rates.

References

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