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Insights and issues with estimating Holocene peatland carbon stocks: a synthesis and review

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Of all terrestrial ecosystems, peatlands are arguably the most efficient at sequestering carbon (C) over long time scales. However, ongoing and projected climate change could shift the balance between peat production and organic matter decomposition, potentially impacting the peat C sink capacity and modifying peat C fluxes to the atmosphere. Yet, the sign and magnitude of the peatland - C - climate feedback remain uncertain and difficult to assess because of large uncertainties in regional peat C stocks and limited understanding of peatland responses to climate change.

Here we present results from the most comprehensive compilation of Holocene peat soil properties with associated carbon (C) and nitrogen (N) accumulation rates for northern peatlands. Our database consists of 268 peat cores from 215 sites located north of 45N. It encompasses regions within which peat C data have only recently become available, such as the West Siberia Lowlands, the Hudson Bay Lowlands, Kamchatka in Far East Russia, and the Tibetan Plateau. The database is publicly available at https://peatlands.lehigh.edu.

Several scaling-up methods for estimating present-day peatland C stocks are presented, and uncertainties associated with each one of them are addressed. Likewise, the assumptions for calculating peat C volumes are discussed in light of conceptual models of spatial heterogeneity in peatland structure and function. We also examine the theoretical basis and underlying assumptions for the models of peatland lateral expansion and peat vertical growth used in estimating paleo peatland C stocks. Finally, we explore the importance of the fen-to-bog transition and of permafrost aggradation on C sequestration.