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Quantitative problems estimating net carbon sequestration rates over 1–150 years using radiometric dating tools

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Understanding carbon (C) sequestration rates in peatlands over longer timescales is predicated on the ability to accurately estimate peat mass accumulation rates. Over shorter timescales (1–10 y) C accumulation can be estimated from short-term field studies, such as measurements of plant growth rates (e.g., moss increments) and analyses of C losses from, e.g., plant litterbags. However, over longer timescales (10–104 y) we must rely on radiometric dating tools. Over timescales spanning 102–104 y, 14C dating is effective for estimating apparent accumulation rates, although not without complicating factors; nonetheless estimates of long-term accumulations are fairly robust. Over intermediate timescales (10–102 y) – i.e., the period of time between litter formation and long-term burial in the catotelm – studies of C storage rely mostly on age-depth modeling based on radiometric analyses of Pb-210, Cs-137, Be-7 and more recently also bomb-pulse C.-14 Accurate estimates of C sequestration rates rely on the assumption that these radiometric elements are largely immobile in peat; however, there is substantial evidence to suggest that this is often not the case, which can lead to overestimations of C accumulation rates. Here, we present data on radiometric analyses of several peat cores from Store Mosse, a 10,000 ha raised bog in central Sweden, and the implications these data have for estimating carbon accumulation rates. Of particular interest in this study is Be-7 (half-life = 53.3 d) a short-lived tracer that is useful for studying recent atmospheric deposition and where in the peat profile recent deposition accumulates. In the uppermost peat there is an exponential decay in Be7 activity from the plant layer (0–2 cm) down to a depth of 8 cm. Be-7 reappears in the peat again at 12–16 cm depth, where bulk deposition and nitrogen increase (above the permanently saturated peat layers). These data (including Pb-210) show that these dating tools penetrate into deeper, older layers, which affects the outcome of the age-depth models and thus estimates of C accumulation rates.