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The objective of this research was to determine the impacts of climate warming and melting of permafrost on carbon storage in vulnerable high latitude peatlands - a globally important carbon (C) pool. Information on the chemical structure of soil organic matter stored in peat and how organic carbon chemistry relates to the soil respiration rate in a quantitative way is urgently needed in order to understand the fate of the carbon stored in permafrost peatlands.
Solid state 13C NMR in combination with in situ C flux measurements and laboratory incubations was used to quantify the soil organic carbon chemistry and its susceptibility to decomposition in peat samples collected from sub-arctic palsa peatlands (in Northern Sweden and Canada) underlain by permafrost. Measurement of CO2 and CH4 fluxes from eight peatlands at each area indicate that they are currently net sources of CO2 to the atmosphere whilst CH4 fluxes where more variable between peatlands, either being weak sink or weak sources of CH4. Peat samples collected through out the peat profile down to the permafrost table was analysed using DPMAS solid state 13C NMR analysis and showed a depletion of labile material with depth (i.e. the alkyl to O-alkyl ratio increased). Laboratory incubation experiments under C limiting conditions suggest that the temperature response differs between the surface and deeper peat with greater activation energies in the more recalcitrant deeper peat material. Incubating the peat cores under saturated conditions only increased CH4 production marginally and only in the deeper peat layers. The conclusions are that Palsa peatlands are currently net sources of C to the atmosphere during the growing season and that increased temperatures in subsurface peat with increase carbon losses from the more aliphatic carbon at depth providing a positive feedback on climate change.