**Soil Organic Matter Chemistry Controls on Carbon Dioxide Production**

**in Global Peatlands**

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**Introduction**

 Peatlands play a critical role in the global carbon (C) cycle because they contain approximately 30% of the 1500 Pg of C stored in soils worldwide. However, this C is under threat from drainage and land-use change, with important consequences for global climate. Ecosystem models predict the impact of peatland perturbation on C fluxes based on total soil C pools, yet responses could vary markedly depending on soil organic matter chemistry. Here we combine experimental and observational studies to quantify the chemical nature and response to perturbation of soil organic matter in peatlands worldwide.

**Experimental**

 We quantified the molecular composition and stability of soil organic matter carbon in a global sample of 125 freshwater peatlands using solid-state 13C nuclear magnetic resonance (NMR) spectroscopy. CPTOSS 13C Solid State NMR sprectra of dried, ground samples were obtained using a Bruker Avance II 500 MHz Spectrometer with a 3.2 mm H/C/N MAS probe at the AMRIS Facility. Spectra peaks were integrated to determine percent of C functional groups: carboxyl, aromatic, O-alkyl, methoxyl, and alkyl C. We then incubated a representative subset of the soils under drained (aerobic) soil conditions to determine how organic matter composition influences carbon dioxide (CO2) emissions.

Fig.1 Redundancy analysis axis 1 explained 29% of variance in global variation in soil C composition with *O*-alkyl C affected by most environmental drivers.

**Results and Discussion**

 We find that peat chemistry differs markedly at the global scale (Fig.1) due to variation in mean annual temperature (8.1%), land use (5.8%), peat forming vegetation (5.2%), and nutrient status (3.2%). Despite this variation, greenhouse gas production following drainage can be predicted from soil carbon chemistry (Fig.2; R2=0.88), with greater CO2 fluxes from soils high in *O*-alkyl C (i.e. carbohydrates).

Fig.2 Drainage results in increased CO2 production from peat with greater proportion of *O*-alkyl C. increased.

**Conclusion**

 Linking the global peatland survey and complimentary laboratory study, we propose that soil C chemistry, specifically *O*-alkyl C, can be used to predict risk of C gas fluxes from peatlands in response to perturbation. Global soil C models currently focus on pools using lignin/N ratios, but our study identifies *O*-alkyl C as the primary indicator of organic matter stability (28). Focusing on this class of C compounds provides a straightforward way to improve models and management decisions of peatlands.

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