Hydrological controls on rate of organic matter mineralization in peats

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The predominant factor that ties together the formation and persistence of peat soils across regions is their dependence on localized hydrology. Hydrology also plays a dominant role in the relative strength of peatlands as sinks for atmospheric carbon dioxide and sources of methane, and thus on peatland net climate impact. Drying of peat soils by climate change and/or drainage is typically followed by reduction in methane emissions. However, this may easily be offset by the increase in carbon dioxide production. Therefore, mechanistic understanding of peatland hydrology and its association with carbon cycling is a prerequisite for assessing vulnerability of peats to disturbances and for incorporating the associated feedbacks in carbon-climate models. We will present physically based model that ties together the structure of peat soils (mainly pore size distribution and mechanical stability) to rates of aerobic and anaerobic decomposition over a wide range of soil water potentials. Peats consist of hierarchical structure with clear separation of the pores into a population of micropores within clumps of organic matter and/or soil aggregates and a group of macropores between clumps and/or aggregates. This essentially partitions the carbon stock in peat soils in to multiple pools that become mineralizable at disparate water potential ranges. While the carbon in macropores can readily be decomposed by aerobic microorganisms when the soil is only slightly drained, the carbon in fine pores remains largely protected from aerobic microbes until the water potential exceeds a threshold that lets in oxygen. In this presentation we will show the mathematical development of the model and illustrative examples that compare projections with data derived from the literature.