Keynote Nigel Roulet (Short abstract)

PEATLANDS IN THE GLOBAL CARBON CYCLE AND THEIR ROLE AS MODIFIERS OF CLIMATE

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ABSTRACT

The role of peatlands in the climate system stems from their influence on the global carbon cycle - specifically the net ecosystem exchanges of CO_2 and CH_4. Estimates vary considerably but northern peatlands store between ~ 20 and 30% of Earth's terrestrial carbon and account for between ~ 5 to 15% of the annual emissions of CH_4 to atmosphere.

The long-term removal of CO_2 and emission of CH_4 from peatlands suggest they could represent a -0.5 W m^{-2} reduction in global radiative forcing in the Holocene climate (equivalent to ~ 10 to 20% of anthropogenic climate forcing since ~ 1700). However, these estimates are based on the highly uncertain because they require reconciling the rate and magnitude of ecosystem biogeochemical cycles with the lifetime and the radiative properties of at least two (CO_2, CH_4) and possibly three (N_2O) greenhouse gases.

Understanding the processes that regulate the exchange of CO_2 and CH_4 well enough to simulate the response of peatlands to environmental change, such as the direct and indirect consequences of climate and/or land cover changes, is a not a trivial problem. Not only do these estimates require good descriptions of the structure and function of ecosystem biogeochemistry, but an equally good description of the physical attributes of the energy exchanges and hydrology. Relatively small changes in the moisture storage (5 – 10%) and temperature (2 – 3^{o}C), could lead to large changes in ecosystem production and respiration. Persistent changes in moisture (e.g. water table changes of ±5 – 10 cm) can alter the structure of the plant community leading to orders of magnitude change in CH_4 exchange. Integrated energy-water-biogeochemical models of peatlands need to take account of not only the changes in ecosystem function but also ecosystem structure - i.e. the dynamics of peatland functional plants types, are required to assess the future role of peatlands in a changing climate.

Many peatlands have some self-regulation. However, the limits of homeostasis may be exceeded if environmental change occurs too quickly and/or is too large. A central question in peatland research is whether climate change will push some peatlands beyond their envelope of self-regulation. Certain changes, such as the melting of permafrost, have the potential to very rapidly send peatland off on a trajectory that might cause transitions to very a different forms of peatlands with a different structures and functions.