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Wetting increases respiration loss from the Arctic tundra

Donatella Zona (1), David Lipson (2), Katie Barott (2), Kyaw Tha Paw U (3), Steven Oberbauer (4), Paulo Olivas (4), Steven Hastings (5), Larry Hinzman (6), and Walter Oechel (2)

(1) University of Antwerp, Belgium (donatella.zona@ua.ac.be), (2) Global Change Research Group, Department of Biology, San Diego State University, San Diego, CA, USA, (3) Department of Land, Air, and Water Resources, University of California, Davis, CA, USA , (4) Department of Biological Sciences, Florida International University, Miami, FL, USA, (5) Polar Field Services, Barrow, AK, USA, (6) International Arctic Research Center, University of Alaska, Fairbanks, AK, USA

Numerous studies (Billings et al. 1982; Peterson et al. 1984; Oberbauer et al. 1991; Funk et al., 1994; Oechel et al., 1998) have demonstrated that decreasing soil moisture and increasing soil oxygen increase respiration loss in the Arctic tundra. Warming and drying of tundra soils due to climate change are assumed to increase greenhouse gas emissions and the potential for strong positive feedbacks on the climate of the Arctic.
However, here we show that an increase in the water table can lead to the same result, increasing respiration. In the largest scale water table manipulation experiment ever performed in the Arctic tundra, we showed that increasing the water table to 7.5 cm above the surface caused the ecosystem to more than half its net C uptake (9 gCm-2season-1) compared to the 23 gCm-2season-1 of a control site where water table was about 2 cm below the surface.
Standing water saturated the moss layer, increased the heat conduction into the soil, and lead to higher soil temperature, deeper thaw and, surprisingly, to higher respiration rates in the most anaerobic area of the manipulation experiment. Probably, the increase in thaw depth increased substrate availability and freed sufficient Fe(III) to act as an electron acceptor in place of oxygen for respiration and CO2 production in these anaerobic soils (Zehnder and Stumm 1988, Kappler et al. 2004, Lipson et al. in review). In contrast to the general assumption that aerobic peat soils release more CO2 than soils under anaerobic conditions (Billing et al., 1982; Funk et al., 1994; Bridgham et al., 1998), here we show that this is not always the case. That the increase in the water table can result in increased respiration, even under nearly fully anaerobic conditions, through previously underestimated pathways, highlights yet another unexpected positive feedback on climate change of carbon exchange in the Arctic.
That anaerobic conditions do not necessarily prevent CO2 loss in permafrost areas has major implications on current and future estimates of the carbon balance, especially considering the very large amount of C stored in the Arctic soils as soil organic matter. These finding suggest a significant re-evaluation of possible carbon loss from Arctic ecosystems under warmer and wetter conditions.