Geophysical Research Abstracts
Vol. 21, EGU2019-17536-1, 2019
EGU General Assembly 2019

Effects of extreme drought in northern boreal headwaters

Ryan Sponseller (1), Lluis Gomez Gener (1), Anna Lupon (2), and Hjalmar Laudon (3)

(1) Umeå University, Department of Ecology and Enviromental Science, Umeå, Sweden (ryan.sponseller@umu.se), (2) CEAB — Centre d'Estudis Avançats de Blanes, Blanes, Spain (anna.lupon@gmail.com), (3) Swedish University of Agricultural Sciences, Department of Forest Ecology and Management, Umeå, Sweden (Hjalmar.Laudon@slu.se)

Climate and land use changes are anticipated to increase the occurrence and severity of drought across the globe. Prolonged drought in streams and rivers has widespread implications for ecosystem processes, including the processing and transformation of terrestrial organic carbon. While these effects are well documented in regions where such events are common, we know little about how protracted drying influences the biogeochemistry and water quality of streams in high latitude regions. Here we take advantage of an ecosystem-scale experiment, an extreme natural drought, and historical water chemistry data to explore how drying shapes patterns of stream metabolic activity, redox conditions, and greenhouse gas dynamics in the Krycklan Catchment Study (KCS) of northern Sweden. An experimentally induced gradient of drought conditions along a 1.4 km stream resulted in rapid reductions in aerobic metabolism, as well as increased concentrations of reduced solutes (e.g., NH4) and greenhouse gases (CO_2 and CH4) in surface waters and hyporheic sediments. These responses increased non-linearly with greater water residence time and were nearly identical to patterns observed along this same stream reach during a severe natural drought the following year (summer 2018). In addition, stream monitoring and oxygen sensor data prior to and during the 2018 drought show widespread hypoxic and anoxic conditions, as well as increases in the CH4/CO_2 ratio across KCS headwaters in response to extreme low flow conditions. Finally, long-term data from the KCS confirm that past transitions to extreme low flows have led to non-linear increases the CH4/CO_2 ratio during summer, consistent with elevated rates of methanogenesis in headwater environments. Our results highlight the sensitivity of streams to drought in northern boreal landscapes, where low flow periods can promote rapid changes in the redox state and biogeochemical cycles in surface and subsurface environments. Given predicted trends toward more extreme and unpredictable hydrological events in this region, the consequences of these responses for greenhouse gas emissions and water quality warrant further attention.