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Implications of Hydrological Extreme Events on Freshwater Carbon Cycling – Recent Advances from Subalpine Lakes and Streams

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Freshwater ecosystems are a dynamic component of the global carbon (C) cycle. They receive organic matter from the terrestrial ecosystem which is stored, transformed and respired, or delivered downstream. Here we present work from subalpine lakes and streams that aims to answer the question of how hydrological extreme events affect freshwater C-cycling in the subalpine biome. From multi-year, high-frequency data from a subalpine lake we show that the role of the lake shifts from acting predominantly as a transporter of dissolved organic matter (DOM) during a regular precipitation regime to a transformer of DOM during an exceptional drought in summer 2015. Further, we investigated drought impacts on stream C-cycling by mimicking drought conditions in a replicated flume experiment. The results demonstrated that flumes were transient sinks of atmospheric CO_2 during the first two weeks of drought. After that, net ecosystem production turned heterotrophic, suggesting a nutrient limitation for primary production, while respiration remained high. We propose that the duration of a drought period combined with inorganic nutrient availability are key variables that determine if more carbon is respired in-situ or exported downstream in subalpine streams. Overall our results evidence that subalpine freshwater ecosystems rapidly respond to seasonal, inter-annual and extreme climate variability, suggesting that C-cycling in these systems may be highly sensitive to climate change.