Effects of Regional Groundwater on Tropical Rainforest Streams: Carbon Degassing and Particulate Organic Matter.

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Ecosystem carbon (C) budgets are fundamental for understanding global C cycling, including the role that connections to deep Earth C reservoirs play in C budgets. Our study addresses these topics by examining how inputs of deep regional groundwater affect C budgets and fluxes in a tropical rainforest. Our research has focused on two adjacent watersheds at La Selva Biological Station in Costa Rica, the Arboleda and Taconazo. Both streams are similar in most aspects except that the Arboleda stream receives a significant contribution of old (~3000 years) regional groundwater (~34% of the total discharge), and the Taconazo does not. Recent results focus on two surface water pools/fluxes: particulate organic matter (POM) and C degassing.

Routine sampling of POM during 2012-2013 showed that particulate organic C (POC) was somewhat lower in the Arboleda (0.6 ±0.3 mg/L) than in the Taconazo (1.0 ±0.5 mg/L), likely as a result of the Arboleda being diluted by regional groundwater. Also, we found differences in C stable isotope abundance (Arboleda δ13C-POC: -23 ±8‰; Taconazo δ13C-POC: -30 ±4‰) and C:N ratios (Arboleda: 22 ±13; Taconazo: 15 ±2) between streams. We hypothesize that these differences may be due to the regional groundwater inflow at the Arboleda, or a larger contribution of C4 plants to the POC pool from swamps in the Arboleda watershed, two hypotheses to be addressed with other observations. Through high-frequency sampling of storms events, we found that the differences in POM between streams became diminished at high-flow conditions, suggesting a shift in POM sources during high discharge events toward C3 vegetation and soils. POC fluxes from the Arboleda watershed seem to be partially regulated by the connection to regional groundwater and local hydrologic conditions.

Early 2014 data indicate that regional groundwater inputs to the Arboleda cause a major increase (~4x) in stream water dissolved CO₂ concentrations. As a result, CO₂ degassing fluxes across the stream-air interface in the Arboleda were ~4x larger than those in the Taconazo. In contrast, stream methane (CH4) concentrations in the Arboleda and Taconazo were similar (1.9 ±0.3 and 1.3 ±0.1 μM, respectively), as were CH4 degassing fluxes normalized by watershed area (0.123 and 0.097 g C/m²y, respectively). Connections to deep C-rich groundwater are a common feature in many regions around the world, and results from our research highlight that these links have the potential to influence watershed-based C budgets.