Regional groundwater systems convey deep crustal carbon into rainforest water, air, and plants in Costa Rica

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This project focuses on the discharge of high-carbon regional groundwater into streams and wetlands in a Costa Rican rainforest, and resultant impacts on ecosystem carbon pools and fluxes. Streams, springs, and swamps that receive inputs of old, high-DIC regional groundwater function as hot-spots of C flux in the lowland rainforest landscape. The importance of this hot-spot C transfer driven by regional groundwater has been demonstrated by comparing C concentrations, fluxes, chemistry, and isotopes in two adjacent rainforest watersheds at La Selva Biological Station: the Arboleda and Taconazo. Both watersheds have young low-DIC local groundwater, but the lower Arboleda also receives inputs of old high-DIC regional groundwater.

Old high-DIC regional groundwater:

- is responsible for an average DIC flux into the Arboleda watershed "from below" of ~820 g C m^{-2} yr^{-1}, a value 22–30% of the magnitude of whole ecosystem respiration at La Selva
- increases stream export of total DIC by 70x
- increases stream water CO_2 concentration by 4-6x in the dry season and 5-11x in the wet season (average increase is 7x)
- increases CO_2 degassing flux by 7-15x in the dry season and 4-8x in the wet season (average increase is 8.5x)
- has no significant effect on stream methane concentration or degassing flux (regional groundwater at La Selva is oxic despite a long subsurface residence time of ~3000 yr)
- lowers the stream DOC concentration slightly (old regional groundwater is lower in DOC than young groundwater) but increases DOC export by a factor of 3.5 (because of the large additional water throughput)
- causes differences in stream water DOM chemistry (e.g., leads to less aromatic DOM) at baseflow but not during storm flow.

In the Taconazo, where respiration is the only ecosystem source for CO_2, $\delta^{13}C$-CO_2 vs. 1/[CO_2] give a typical straight-line Keeling plot defined by atmospheric CO_2 and CO_2 from ecosystem respiration. However, data from the lower Arboleda plot to the upper left of this line toward higher $\delta^{13}C$ values at higher CO_2 concentration, indicating the contribution of CO_2 from regional groundwater. Also, average ^{14}C-CO_2 in air (n=3) was very low (61% modern) near a stream zone of high gas exchange (weir) in the Arboleda but not in the Taconazo (100%); near the Arboleda stream but far upstream away from the weir, the average was 97%, reflecting a small but non-zero influence of deep crustal C delivered to the Arboleda stream by regional groundwater flow and outgassed there by normal gas exchange processes.

^{14}C data from live understory plant leaves unambiguously show the presence of deep crustal C in modern plants: mean % modern C (n=6) was only 64% for leaves growing near the Arboleda weir, but 102% for leaves growing near the Taconazo weir.