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CO2 consumption and bicarbonate fluxes by chemical weathering in North America.

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Cations released by chemical weathering are mainly counterbalanced by atmospheric/soil CO_2 dissolved in water. Existing approaches to quantify CO_2 consumption by chemical weathering are mostly based on the parameters runoff and lithology. Land cover is not implemented as predictor in existing regional or global scale models for atmospheric/soil CO_2 consumption.

Here, bicarbonate fluxes in North American rivers are quantified by an empirical forward model using the predictors runoff, lithology and land cover. The model was calibrated on chemical data from 338 river monitoring stations throughout North America. It was extrapolated to the entire North American continent by applying the model equation spatially explicitly to the geodata used for model calibration. Because silicate mineral weathering derived bicarbonate in rivers originates entirely from atmospheric/soil CO_2, but carbonate mineral weathering additionally releases lithogenic bicarbonate, those source minerals are distinguished to quantify the CO_2 consumption by chemical weathering.

Extrapolation of the model results in a total bicarbonate flux of 51 Mt C a^{-1} in North America; 70% of which originate from atmospheric/soil CO_2. On average, chemical weathering consumes 2.64 t atmospheric/soil C km^{-2} a^{-1} ($\sim$ 30%-40% above published world average values). For a given runoff and land cover, carbonate-rich sedimentary rocks export the most bicarbonate. However, half of this is assumed to be of lithogenic origin. Thus, the most atmospheric/soil CO_2 per runoff is modeled to be consumed by basic plutonics. The least bicarbonate is exported and the least CO_2 is consumed per runoff by weathering of metamorphic rocks. Of the distinguished different land cover classes of which urban areas export the most bicarbonate for a given lithology and runoff, followed by shrubs, grasslands and managed lands. For a given runoff and lithology, the least bicarbonate is exported from areas with forested land cover.

The model shows 1) that chemical weathering induced CO_2 consumption in North America is above world average, and 2) that some regions (e.g. the Rocky Mountains) show extraordinary high CO_2 consumption. 8% of the area of North America are responsible for 50% of the total bicarbonate flux and associated CO_2 consumption by chemical weathering. The successful implementation of land cover as predictor in the bicarbonate flux model of North America allows the representation of biological factors which may be relevant for processes in the critical zone.