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Predicting riverine dissolved silica fluxes by chemical weathering: results from a hyperactive region and analysis of first-order controls

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Silicate weathering and resulting transport of dissolved matter influence the global carbon cycle in two ways. First, by the uptake of atmospheric/soil CO_2, and second, by providing the oceanic ecosystems via the fluvial systems with the nutrient dissolved silica (DSi).

Previous work suggests that regions dominated by volcanics are hyperactive or even “hot spots” concerning DSi-mobilization from the critical zone. Here, we present a new approach for predicting riverine DSi-fluxes by chemical weathering, emphasizing “first-order” controlling factors (lithology, runoff, relief, land cover and temperature). This approach is applied to the Japanese Archipelago, a region characterized by a high percentage of volcanics (29.1% of surface area).

The presented DSi-flux model is based on data of 516 catchments, covering approximately 56.7% of the area of the Japanese Archipelago. The spatial distribution of lithology — one of the most important first order controls — is taken from a new, high resolution map of Japan. Results show that the Japanese Archipelago is a hyperactive region with a specific DSi-yield 6.6 times higher than the world average of 3.3 t SiO_2 km^{-2} a^{-1}, but with large regional variations.

Approximately 10% of its area exceeds 10 times the world average specific DSi-yield. Slope constitutes another important controlling factor on the mobilization of DSi-fluxes from the critical zone, besides lithology and runoff, and can exceed the influence of runoff on specific DSi-yields. Even though the monitored area on the Japanese Archipelago stretches from about 31° to 46° N, temperature is not identified as a significant first-order model variable. This may be due to the fact that slope, runoff and lithology are correlated with temperature due to regional settings of the Archipelago, and temperature information is substituted to a certain extent by these factors. Land cover data also do not improve the prediction model. This may partly be attributed to misinterpreted land cover information from satellite images. Implications of results for chemical weathering rates based on lithological information applied are discussed.

Reference:

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