Silicon isotopes in Patagonian rivers: Investigating how variable glacial cover affects the biogeochemical cycling of silicon

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Silicon (Si) is intricately linked to the global carbon cycle via consumption of CO_2 during silicate weathering reactions and as an essential nutrient for diatoms, which account for a large proportion of global primary productivity. Rivers deliver the vast majority of Si to the oceans, connecting terrestrial and oceanic sub-cycles. Therefore, understanding the controls on riverine Si concentrations is a key requirement in quantifying the variability of Si fluxes and the links between silicate weathering and climate in the past. Patagonia represents a unique natural laboratory to investigate Si cycling, with diverse and near-pristine terrestrial and marine ecosystems, a spectrum of glacial cover and rapid rates of deglaciation and environmental change. Here, we present novel geochemical and geospatial data from 40 river catchments between 41-48°S, to elucidate the key controls on riverine Si isotopic compositions and the magnitude of Si fluxes to the fjords. Both dissolved (DSi) and amorphous Si concentrations are highly variable between catchments, ranging from 15-280µM and 0.5-53µM respectively, giving inference of weathering processes and the primary sources of Si in this region. Increasing glacial cover exerts a key control, systematically driving DSi isotopic compositions significantly lighter than non-glacial river-systems, which we infer to be due to increased weathering and dissolution of secondary mineral phases. We also observed large seasonal differences in the DSi isotopic signature in key rivers discharging into the fjords, with values becoming significantly heavier in winter due to reduced meltwater inputs. These findings indicate that Si isotopes could be developed as a proxy for variability of glacial meltwater inputs in this region. Overall, our dataset provides novel insights into the controls on riverine Si isotope compositions and the magnitude of Si fluxes to the fjords, allowing for evaluations of how this system is likely to change with continued retreat of the Patagonian Icefields.