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River silicon concentrations and exports are highly dynamic over time and across seasons

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Riverine exports of silicon (Si) influence global carbon cycling by supporting marine diatom growth, which account for ~25% of global primary production. Climate change will likely alter river Si exports in biome-specific ways due to interacting shifts in chemical weathering rates, hydrologic connectivity, and metabolic processes in aquatic and terrestrial systems, yet factors driving long-term changes in Si exports remain unexplored at local, regional, and global scales. We synthesized data from >200 rivers across the globe to evaluate 1) changes in the magnitude and timing of concentrations and total exports of Si over the last several decades – and how those patterns vary across biome type, and 2) riverine Si regimes, and how they shifted over time and across climate gradients. We show that there have been widespread changes in river Si concentration and yield over the past two decades, with the most substantial shifts occurring in high latitude and high elevation regions (Arctic, boreal, Antarctic, and alpine). The magnitude and direction of trends were highly variable within and among biomes, independent of river discharge, and often stronger in months outside of the growing season. Finally, we classified five common seasonal Si regimes across sites, but found that individual rivers often had variable seasonal regimes over time, demonstrating the importance of understanding shifting phenology to constrain Si export to the ocean. Using these results, we develop a conceptual framework describing controls on river Si exports, which highlight the need to improve our understanding of the sensitivity of river Si to a changing climate.