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Biogeochemical and hydrological constraints on concentration-discharge curves

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The relationship between concentration and discharge (C-Q) can give insight into the location, abundance, rate of production or consumption, and transport dynamics of elements in coupled terrestrial-aquatic ecosystems. Consequently, the investigation of C-Q relationships for multiple elements at multiple spatial and temporal scales can be a powerful tool to address three of ecohydrology's fundamental questions: where does water comes from, how long does it stay, and what happens to the solutes and particulates it carries along the way. We analyzed long-term water quality data from 300 monitoring stations covering nearly half of France to investigate how elemental properties, catchment characteristics, and hydrological parameters influence C-Q. Based on previous work, we segmented the hydrograph, calculating independent C-Q slopes for flows above and below the median discharge. We found that most elements only expressed two of the nine possible C-Q modalities, indicating strong elemental control of C-Q shape. Catchment characteristics including land use and human population had a strong impact on concentration but typically did not influence the C-Q slopes, also suggesting inherent constraints on elemental production and transport. Biological processes appeared to regulate C-Q slope at low flows for biologically-reactive elements, but at high flows, these processes became unimportant, and most parameters expressed chemostatic behavior. This study provides a robust description of possible C-Q shapes for a wide variety of catchments and elements and demonstrates the value of low-frequency, long-term data collected by water quality agencies.