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Modeling nutrient filtering capacities and export fluxes in macrotidal estuaries

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A fully transient model of a macrotidal estuary (The Scheldt) has been used to quantify silica and nitrogen filtering capacities and export fluxes to the coastal zone over a period of one year. Results show that in macrotidal estuaries, the seasonally-resolved nutrient fluxes are not only affected by in-situ biogeochemical transformations, but also by nutrient flux imbalances, which result from the time-lagged response of the scalar fields to hydrological perturbations. The estuarine nutrient retention reveals also a strong temporal variability, which is driven by the complex interplay between reaction and transport. As a result, the estuarine filtering capacities cannot be constrained by the freshwater residence alone and, thus, by empirical relationships that have been established between these two parameters. Furthermore, at the seasonal scale, the nutrient export fluxes to the coastal zone cannot be quantified from the riverine loads and the estuarine filtering capacities. More sophisticated approaches to estimate the functioning and response of macrotidal estuaries are thus needed and an alternative methodology, established on the premise that physical forcing mechanisms are the dominant controls on estuarine biogeochemistry at a series of hierarchically related system levels, is briefly outlined.