Ocean-estuary connectivity: fast physics, slow biology

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Résumé:

Long-term observations provide opportunities to learn how coastal ecosystems respond to multi-decadal climate oscillations. We use data from the long-term USGS studies of San Francisco Bay to show strong climate-ocean-estuary connectivity at monthly, annual and decadal scales. Temperature and chlorophyll *a* datasets were used to study physical and biological connectivity. We applied (1) correlation test on monthly and annual timeseries to investigate the propagation of the oceanic signal into the estuary, and (2) changepoint method to detect regime shifts in multi-decadal timeseries. While the propagation of the temperature oceanic signal dampens as moving into the estuary, we observe an increasing correlation with distance between summer chlorophyll *a* and the Spring Transition Index (STI *i.e.* the day of upwelling season onset in the Central California Current System), and even more with 3 and 5-years averaged STI. Regime shifts occur in 1997 for STI, 2001 for summer chlorophyll *a*, and between 1999 and 2001 for predator species in the estuary. Our results highlight fast connectivity associated with physical water exchanges, but slow connectivity mediated by biological migrations of predators into the estuary, in response to multi-decadal climate oscillations. Even slow, biological connectivity leads to drastic changes associated with top-down trophic cascade: the increasing intrusion of predators within the 5 years following the climate shift leads to decreasing benthic grazers, and the decreasing grazing pressure on phytoplankton leads to lagged chlorophyll *a* increase. These results suggest impacts of ocean-estuary connectivity on water quality standards (*e.g.* temperature, chlorophyll *a*, but also oxygen, nitrate, pH, toxic algae). Water quality management plans must consider fast physical and slow biological processes associated with ocean-estuary connectivity, both impacted by multi-decadal climate oscillations.