Evaluating the biogeochemical cycle of selenium in San Francisco Bay through modeling

Meseck, Shannon L., Gregory A. Cutter

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ABSTRACT: A biogeochemical model was developed to simulate salinity, total suspended material, phytoplankton biomass, dissolved selenium concentrations (selenite, selenate, and organic selenide), and particulate selenium concentrations (selenite + selenate, elemental selenium, and organic selenide) in the San Francisco Bay estuary. Model-generated estuarine profiles of total dissolved selenium reproduced observed estuarine profiles at a confidence interval of 91-99% for 8 different years under various environmental conditions. The model accurately reproduced the observed dissolved speciation at confidence intervals of 81-98% for selenite, 72-91% for selenate, and 60-96% for organic selenide. For particulate selenium, model-simulated estuarine profiles duplicated the observed behavior of total particulate selenium (76-93%), elemental selenium (80-97%), selenite + selenate (77-82%), and organic selenide (70-83%). Discrepancies between model simulations and the observed data provided insights into the estuarine biogeochemical cycle of selenium that were largely unknown (e.g., adsorption/desorption). Forecasting simulations investigated how an increase in the discharge from the San Joaquin River and varying refinery inputs affect total dissolved and particulate selenium within the estuary. These model runs indicate that during high river flows the refinery signal is undetectable, but when river flow is low (70- day residence time) total particle-associated selenium concentrations can increase to >2 μg g''. Increasing the San Joaquin River discharge could also increase the total particle-associated selenium concentrations to >1 μg g''. For both forecasting simulations, particle-associated selenium was predicted to be higher than current conditions and reached levels where selenium could accumulate in the estuarine food web.