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Strong connection between chlorophyll-a and suspended sediments at tidal scales in a high-nutrient estuary: Analysis of observations and an idealized model study

Manuel Diez-Minguito (1) and Huib E. de Swart (2)

(1) Andalusian Institute for Earth System Research, University of Granada, Granada, Spain (mdiezm@ugr.es), (2) Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, Netherlands (h.e.deswart@uu.nl)

The Guadalquivir estuary (SW Spain) is a high-nutrient, low-productivity environment. Suspended sediment attenuation of light limits phytoplankton growth at long time scales [Ruiz et al. (2013), Ecol. Model. 265, 194-206]. Recent analysis of high-resolution observations shows also a strong connection between Suspended Sediment Concentration (SSC) and Chlorophyll-a (Chla) concentration at tidal scales. During most of the observation period, SSC and Chla concentrations exhibit in-phase oscillations during the tidal cycle. Both SSC and Chla concentrations peak at maximum ebb and flood. This suggests that intratidal Chla concentrations are related to resuspension by tides of benthic micro-organisms attached to sediment particles and/or flocculation of suspended sediments with Chla-containing biomass. Only when SSC in the water column is very low and the light availability increases, which occurs at some perigean neap tides during low river flows, the positive correlation between SSC and Chla is lost. Chlorophyll-a observations follow then the diel cycle. Similar variability in Chla concentrations was also reported for the southern North Sea [Blauw et al. (2012), PLoS ONE 7(11): e49319]. To gain insight into this correlation between SSC and Chla concentration at tidal scales, a new idealized 1DV model is developed and analyzed. The model accounts for vertical advection of Chla and SSC, resuspension by tidal shear stress, vertical mixing processes, and light-induced growth. Zero-flux boundary conditions are applied at the surface. Results for several spring-neap cycles show that the idealized model is capable of reproducing the observed in-phase fluctuations of SSC and Chla, and their decoupling when a strong decline in SSC occurs.