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Modeling the Biogeochemical and phytoplankton dynamics of an arid ecosystem: the coastal waters of the Eastern Red Sea (Saudi Arabia)

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Located on the Eastern side of the Red Sea, Jeddah's coastal waters (Saudi Arabia) are characterized in the North, by numerous shallow micro-tidal hyper-saline lagoons and, in the South, by a steep continental slope and waters as deep as 500-600 meters directly off-shore of the city. In contrast to temperate marine ecosystems, the carbon and nutrient dynamics in this dry region are still poorly known and the nature and extend of land-sea interactions remain to be identified. To improve the mechanistic and quantitative understanding of the coastal biogeochemical dynamics in arid environments, a 3-dimensional, finite element model of the Northern Red Sea has been developed. Despite the large domain investigated, the model provides a very detailed representation of the local circulation patterns along the coast and inside the lagoons as well as the main large-scale physical features observed in the Red Sea area.

The hydrodynamic and transport models have been coupled to a biogeochemical and ecological model of the carbon and nutrient cycles including 3 distinct phytoplankton groups (diatoms, cyanophyceaes and flagellates). Year long simulations using climatologic forcings provide an insight on the seasonal dynamics of nutrients and phytoplankton in the region and, in particular, the role of nutrient recycling in the water column to sustain a relatively high primary production ($\sim$300 gC m-2 yr-1). Furthermore, scenarios of nitrogen and phosphorus enrichment in the neighborhood of Jeddah's urban area were run to assess the potential effect of untreated waste water release into the sea. The simulations reveal the influence of the local bathymetry on the ecological response to such perturbations with a contrasted behavior between the Northern part of the model domain, where nutrient enrichment increase primary production 3 fold and the Southern portion, where phytoplankton dynamics is hardly affected by anthropogenic pressure.