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Processes forcing the suspended sediments distribution in a wide, shallow and microtidal estuary: a numerical case study for the Río de la Plata

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The impact of the diverse mechanisms driving the suspended sediments distribution in the wide, shallow and microtidal Río de la Plata (RdP) estuary and the adjacent shelf is studied by means of a set of process-oriented numerical simulations. With that aim, a regional application of the hydro-sedimentological Model for Applications at Regional Scale (MARS) is implemented, tested and run under diverse conditions. Even the simulations are idealized, they reproduce both qualitatively and quantitatively well the main features of the suspended sediments observed distribution, particularly the mean values of concentration and its gradients: perpendicular to the estuary axis at the upper and intermediate RdP and parallel to the estuary axis at its outer part. Even though naturally the diameter of the sediments that deposit decays with the distance to the sources (with sands and silts dominating in the upper estuary and fine silts and clays over the Barra del Indio), model results show that the large width and the geometry of the estuary play an important role in the sedimentation process. The widening and deepening, and the associated significant reduction of the currents speed that occurs after (i) the confluence of the tributaries and (ii) downstream the Barra del Indio Shoal, favors sediments deposition downstream those areas. Even though tides are of small amplitude in the study area, they have a significant impact on the lateral mixing and the re-suspension of bottom sediments; this last augments the concentration of fine sediments in the layers close to the bottom but their energy is not enough to rise them up to the surface. The model reproduces the increment in the concentration of fine sediments observed in the areas where tidal dissipation energy by bottom friction maximizes (over the southern coast of the RdP and around Punta Piedras and Punta Rasa), but shows that tides alone cannot account for the observed maxima. Winds (which can be quite large over this area) enhance horizontal mixing, smoothing the pattern produced by the tides. Wind waves are the most important forcing for the vertical mixing of the sediments. Their effect is most evident along the southern coast of the RdP and the Barra del Indio Shoal, where wind waves rise to the surface the sediments resuspended by tides. The bottom salinity front acts retaining the sediments upstream the Barra del Indio shoal; there, estuarine currents and flocculation play an important role in sediments deposition.