Model sensitivity and nonlinear interactions during extreme sea level events in a wide and fast-flowing estuary: the case of the Río de la Plata

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Abstract

The mighty Río de la Plata (RdP) estuary is affected by extreme storm surges generated by persistent and strong south-easterly winds called "Sudestadas", which produce strong floods in densely populated areas of Argentina. Atmospheric models show deficiencies in the forecast of winds during those events what rises up the question of how sensitive model solutions are to wind uncertainties. Here a sensitivity analysis (SA) for a 2-D barotropic application of ROMS_AGRIF ocean model for the forecast of sea surface height (SSH) at the South-Western South Atlantic Continental Shelf with emphasis on the RdP estuary is presented. The SA was performed taking account the linear and quadratic bottom friction coefficients, the wind speed and direction, and the continental discharge. Results indicate that the estuary response is very sensitive and nonlinear to even small changes in wind speed, and moderately sensitive to changes in the runoff. A study of nonlinear interactions between the surge, the tide and the continental discharge shows that those interactions are strong, producing reductions of around 10% in the total SSH. 90% of that interaction is explained by the tide-surge interaction. The main effect of large increments in the runoff is an increment in the setup, but also the associated augment of the mean outflow currents produces notorious deformations in the storm surge and tides. It is concluded that the inclusion of both the tide and the runoff are indispensable for an appropriate prediction of the SSH in the upper and intermediate RdP.