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Proudman and Chrystal resonances simulated with three numerical models

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The aim of this work was to validate and compare how Proudman and Chrystal resonances are reproduced with different, nowadays widely used, numerical models. The test case was based on simple air pressure disturbances of two commonly used shapes (a boxcar and a sinusoidal), having various wave lengths, and propagating at different speeds. Our test domain was a rectangular basin, 300 km long with a uniform depth of 50 m. For each simulation, we saved water level anomalies and computed the integral of the energy density spectrum for a number of points distributed along the basin. The 341 simulations were performed using three different numerical models: ADCIRC, ROMS and SCHISM. A comparison of the results shows that the models represent the resonant phenomena in different ways.

For the Proudman resonance, the most consistent results, closest to the analytical solution, were obtained with ROMS model, which reproduced the mean resonant speed equal to 21.99 m/s – i.e. close to the theoretical value of 22.14 m/s. ADCIRC model showed small deviations from that value, with the mean speed being slightly lower – 21.79 m/s. SCHISM differed the most from the analytical solution, with the mean speed equalling 21.04 m/s. For the Chrystal resonance, all the models showed similar behaviour, with ADCIRC model providing slightly lower values of the mean resonant period than the other two models.