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Assessment of current effect on waves in a semi-enclosed basin

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The wave-current interaction process in the semi-enclosed Adriatic Sea is studied using the Coupled Ocean–Atmosphere–Wave–Sediment Transport (COAWST) modeling system, which is used to exchange data fields between the ocean model ROMS (Regional Ocean Modeling System) and the wave model SWAN (Simulating WAves Nearshore). The 2-way data transfer between circulation and wave models is synchronous with ROMS providing current fields, free surface elevation, and bathymetry to SWAN. In particular, the 3-D current profiles are averaged using a formulation that integrates the near-surface velocity over a depth controlled by the spectral mean wave number. This coupling procedure is carried out up to coastal areas by means of an offline grid nesting. The parent grid covers the whole Adriatic Sea and has a horizontal resolution of 2.0 km, whereas the child grid resolution increases to 0.5 km but it is limited to the northern Adriatic Sea (Gulf of Venice), where the current effect on waves is investigated.
The most frequent winds blowing on the Adriatic Sea are the so-called Bora and Sirocco which cause high waves in the Adriatic Sea, although Bora waves are generally fetch-limited. In fact, Bora winds blow orthogonal to the main basin axis (approximately aligned with the NW-SE direction), while Sirocco has large spatial scale being a southeasterly wind. For the numerical simulations, the meteorological forcings are provided by the operational meteorological model COSMO-I7, which is the Italian version of the COSMO Model, a mesoscale model developed in the framework of the COSMO Consortium.
During the analysis period, the simulated wind, current and wave are compared with observations at the ISMAR oceanographic tower located off the Venice littoral. Wave heights and sea surface winds are also compared with satellite-derived data. To account for the variability of sea states during a storm, the expected maximum individual wave height in a sea storm with a given history is also considered. During intense storms, the effect of coupling on wave heights is resulting in variations of the wave heights up to 15%, with some areas experiencing increase or decrease of wave spectral energy for opposite and following currents respectively.
The study is part of the activities developed in the European Union (EU) funded FIELD_AC project (Fluxes, Interactions and Environment at the Land-ocean boundary. Downscaling, Assimilation and Coupling), which is conceived with the goal to better identify the most significant natural processes in coastal areas, and to address their impact on the coastal and nearshore dynamics by including them in a complete numerical prediction suite.