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Modulation of wave fields by current and wind intensifications off the Catalan coast

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The coupling between waves, ocean and atmospheric models has been one of the main topics in the physical oceanography community for the last decade. The resulting challenge is more difficult and relevant in coastal areas, where the interaction between wind, waves and currents fields is far from negligible, and therefore some sort of model coupling is required. However, it is important to remark that it is only during energetic "enough" events that the coupling becomes quantitatively significant.
The Western Mediterranean sea is an area characterised by calm periods most of the year. However, coastal areas often present highly variable and heterogeneous wind, wave and current conditions, which make the numerical prediction of meteo-oceanographic processes difficult and with large associated local errors. Specifically, the Catalan coast is frequently affected by offshore wind intensifications channel by river valleys and by local current intensifications associated to coastal "bulges" (e.g. deltaic forms) that can reach up to 1 m/s in the surface.
In this study we present different coupling strategies applied to both calm periods and energetic events, represented by the wind jets or current intensifications mentioned before, with the objective to quantify the effect of model coupling on the resulting wave fields off the Catalan coast.
The SWAN wave model is used to model the wave fields, together with the ROMS oceanic model and the WRF atmospheric model. Two different types of coupling are considered: the first is a one-way coupling consisting in introducing the current field as an input for the SWAN wave model; the second one, consists in running in parallel the ROMS circulation model, the WRF atmospheric model and the SWAN wave model. The second methodology is more complex and should better reproduce the physics involved in the interactions, but requires an important computational capacity, not always available, so a critical comparison between the two methodologies, balancing costs and benefits will be presented and analysed.
From the results obtained from a set of typical synoptic situations, it can be concluded that during most of the time, with the calm conditions typical of the Mediterranean coast, it is not necessary to consider the coupling in any of its forms to provide accurate wave simulations. However, when a wind or current intensification occurs, the results improve considerably with the coupled model and the robustness of predictions greatly improves. Because of that an "intelligent" modelling sequence that activates the coupling in terms of the expected meteo-oceanography is proposed for operational applications.