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Investigating The Role of Atmosphere-Wave Interaction in the Mediterranean Sea using coupled climate model (RegESM)

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In this study, a coupled regional atmosphere-wave model has been implemented and tested in the Mediterranean Sea to study the effects of surface roughness length in the simulated wind speed and direction of the atmosphere model over the sea. In general, the standalone atmosphere models tend to overestimate the wind speed especially over the sea due to their poor representation of the surface fluxes and roughness length. The designed modelling system (RegESM; Turuncoglu et al., 2013) mainly aims to improve the modelled surface winds by adding two-way interaction between atmosphere and wave models.

The used version of the RegESM modelling system is configured to have two model components: **(1)** WAM spectra wave model (The WAMDI Group, 1987) and **(2)** ICTP's RegCM4 atmosphere model (Giorgi et al., 2012). The model components are coupled using Earth system Modelling Framework (ESMF; Hill et al., 2004; Collins et al., 2005). In this case, atmosphere model sends surface wind speed components to wave model and retrieves surface roughness length and friction velocity to calculate surface fluxes (Zeng et al., 1998). The current version of the modelling system only represents the interaction between atmosphere and wave components but does not include an ocean component but the ocean component will be included in the future.

The designed modelling system is configured for Mediterranean Sea and a set of sensitivity tests are performed to tune the individual model components. In this case, the horizontal resolution of the atmospheric model is set to 50 km and covers whole Mediterranean Basin. In this case, the atmospheric model is forced by ERA-Interim reanalysis dataset (Dee et al., 2011) for 2008-2012 periods. In this configuration, the wave model has higher horizontal resolution (0.125°) than the atmospheric model and the interpolation between the model components is handled by ESMF. The coupling time step to exchange the fields between the model components is set to one hour. The model results are compared with available observational datasets provided by EMODNET.

The sensitivity tests of the standalone wave model shows that the quality of the simulated wave fields (significant wave height, direction and spectra) are strongly depends on the accuracy of given surface wind input. In this case, the wave model produces very similar results for same wind forcing even the horizontal resolution of the model is increased. The sensitivity tests also show that the model has better agreement with EMODNET observations when it is forced with raw ERA-Interim surface wind. The previous studies also show that the higher resolution (50 km) wind input might produce stronger peaks in the wave model results but this could be improved by atmosphere-wave coupling.

The tuned model components are also used to investigate effects of the atmosphere-wave coupling. The model is integrated between 2008-2012 and the results of the model are compared with the available observations and standalone simulations of the individual components of the modelling system. The preliminary results show that coupled model improves the simulated wave fields and the wind speed over the sea and has better agreement with the in-situ observations along with the increased correlation coefficients and reduced errors (RMSE).

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