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Air-sea coupling aspects in ECMWF Earth System model

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The global analyses and medium range forecasts from the European Centre for Medium range Weather Forecasts rely on a state of the art atmospheric model. In order to best represent the momentum exchange at the surface of the oceans, it is tightly coupled to an ocean wave model. Recently, an ocean model has been included as part of the operational medium range forecasting system.
In this context, a first set of sea state effects on Upper Ocean mixing and dynamics was successfully added to the system. Impact of sea-state dependent momentum forcing, the Stokes-Coriolis force and the enhanced mixing by breaking ocean waves have been added. The first operational implementation of this system was with the ensemble prediction system where the impact of the ocean is known to be beneficial at longer forecast lead times. Work is ongoing to implement the same system into the operational high resolution suite. Tropical cyclone prediction with increased resolution has generally become quite reliable. Nevertheless, systematic intensity biases still exist. The benefit of adding the active coupling with the ocean will serve as an example of how coupling to the ocean can be quite beneficial even at short forecast lead times.
Because the feedback from the ocean can be significant, it is only in the fully coupled system that parametrisation for air-sea processes should be revisited. For instance, experimental evidences point to a sea state/wind dependency of the heat and moisture fluxes. Following an extension of the wind wave generation theory, a sea state dependent parametrisation for the roughness length scales for heat and humidity was introduced. Furthermore, under very strong wind forcing, there are evidences that the present parametrisation of the sea state dependent momentum flux should be modified to respect physical constrains on the wave spectral steepness.