Coupling of a wave model within the ACCESS climate system

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Located at the interface between ocean and atmosphere, wind-waves are part of the climate system and affect processes in and between oceanic and atmospheric boundary layers as well as in the marginal sea ice zone. Coupled general circulation models used for climate projections get more and more complex but do not take into account or simplify certain wave-dependent processes. In the context of climate change, coupled climate models are a precious tool to help assessing our future environment. Including wind-wave physics in those models would be a step towards a better representation of physics, with the aim to reduce model biases and projection uncertainties.

The present study aims (1) to define the wave-dependent processes that can have a significant impact on climate projections, and (2) to implement a wave model in a coupled climate model for long-term simulations.

Wave feedbacks on ice, atmosphere and ocean are numerous and affect, among others, momentum and energy fluxes, turbulence in boundary layers, gas, mass and heat exchanges, albedo and sea ice floe size and concentration. For instance, the momentum transfer between ocean and atmosphere depends on the surface roughness, which itself depends on the local sea state. Present parameterizations of the surface roughness use a wind-dependent Charnock coefficient instead of a wave-dependent one, missing waves generated in remote areas, such as swell. However, little is known about their magnitude at climate scale.

The inclusion of a wave model into a coupled climate model aims at better assessing the magnitude of those wave feedbacks and their effect on climate projections. The wave model WAVEWATCH III (NOAA) is implemented into the Australian Community Climate and Earth System Simulator coupled model ACCESS-CM 1.3 (CAWCR). The OASIS 3 coupler (CERFACS) allows transferring surface wind conditions from the atmospheric model (Unified Model, UKMO) to the wave model and wave-dependent Charnock coefficient from the wave model to the atmospheric model. This is a first step towards a fully coupled wave-atmosphere-ocean-ice model.