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Greatness from small beginnings: Impact of oceanic mesoscale on weather extremes and large-scale atmospheric circulation in midlatitudes

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We study how mesoscale air-sea interactions over the North Atlantic can influence weather extremes, e.g. heavy precipitation and wind storms, and the overall atmospheric circulation both locally and downstream in the midlatitudes. We use a global coupled climate model with a high-resolution North Atlantic grid (dx ~ 8 km) and an atmosphere model resolution of either 125 km or 25 km. The high-resolution North Atlantic grid allows the model to resolve the current systems and SST fronts associated with e.g. the Gulf Stream and North Atlantic Current. As air-sea fluxes of momentum, heat and freshwater are calculated on the atmosphere grid, spatial variations in fluxes associated with sharp SST fronts are much better represented when using the high-resolution atmosphere then when using the low-resolution model.

Preliminary results show that coupling to the high-resolution (dx ~ 25 km) rather than low-resolution (dx ~ 125 km) atmosphere model increases the intensity and variance of surface heat and freshwater fluxes over eddy-rich regions such as the Gulf Stream. As a result, the high-resolution model simulates more intense heavy precipitation events over most of the North Atlantic Ocean. We also show that more frequent coupling between the atmosphere and ocean components increases the intensity of the air-sea fluxes, in particular wind stress, which has a large impact on the ocean. More intense air-sea fluxes can provide more energy for cyclogenesis and we will discuss how the oceanic mesoscale, in particular in the eddy-rich regions, can alter the storm tracks and jet stream to influence extreme weather and the climate over Europe.

The coupled model comprises NEMO 3.6/LIM2 ocean and OpenIFS 40r1 atmosphere, and works by allowing the global OpenIFS model to send and receive fields from both a global coarse-resolution ocean grid and a refined grid over the North Atlantic grid via the OASIS3-MCT4 coupler. The ability to run these simulations is a very recent development and we will give a brief overview of the coupled modelling system and benefits of using regional grid refinement in coupled models.