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Air-sea coupling at the oceanic mesoscale in high-resolution coupled models

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Models and observations show that the ocean drives the atmosphere at the mesoscale: warm (anticyclonic) eddies are associated with increased latent and sensible heat fluxes, increased vertical mixing in the atmospheric boundary layer and increased surface wind speed (and vice versa for cyclonic eddies). Modelling studies further suggest that this oceanic influence at the mesoscale propagates into the free troposphere and affects large-scale modes of variability.

Few studies have explored the strength of the air-sea coupling on the ocean mesoscale in coupled models and in particular how this coupling depends on the resolution of the atmospheric and ocean components. Here, we exploit three high-resolution configurations of the coupled climate model HadGEM3-GC3.1 with different combinations of atmospheric/oceanic resolutions, namely 60 km-1/4^o, 60 km-1/12^o, and 20 km-1/12^o. Using an eddy-tracking algorithm and a composite analysis, we estimate the patterns of air-sea fluxes, sea surface temperature, and surface air-temperature associated with mesoscale eddies.

To quantify the air-sea coupling and compare resolution, we compute the heat flux feedback which relates the air-sea flux anomalies to the SST anomalies. This feedback parameter is thought to increase toward smaller spatial scales. We show that the heat flux feedback is very sensitive to resolution, being the highest ($\sim$35 W/m^2/K) at 20 km-1/12^o. We further demonstrate that the low heat flux feedbacks seen at other resolutions (down to 5-10 W/m^2/K in some cases) is due the re-gridding of the SST from the oceanic to the atmospheric grid which significantly damps mesoscale SST anomalies. Although the true heat flux feedback is not well known, our results suggests that the 20 km-1/12^o combination is closer to reality and that other resolutions significantly underestimates the strength of the air-sea coupling at mesoscale.