EGU21-6061, updated on 24 Oct 2021
https://doi.org/10.5194/egusphere-egu21-6061
EGU General Assembly 2021

Impact of ocean resolution on storms in the North Atlantic region

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We study the impact of ocean horizontal resolution on storm tracks over the North Atlantic Ocean using the FOCI-OpenIFS climate model and the TRACK storm-tracking algorithm. We find that increasing ocean resolution from 1/2° to 1/10° reduces a cold bias over the North Atlantic which leads to a northward shift of the storm tracks, in particular in winter and spring seasons.

Most climate models with non-eddying oceans, i.e. horizontal resolutions of 100 km or higher, suffer from a cold SST bias in the North Atlantic. Refining the horizontal resolution from 1/2° to 1/10° allows for a distinct Gulf Stream extension and better representation of the major current systems which reduces this cold bias. The associated warming of the ocean surface with increasing resolution also warms the troposphere and leads to a northward shift in the tropospheric eddy-driven jet. Overall, the increased ocean resolution thus improves the ocean circulation as well as the atmospheric circulation.

We use two metrics to evaluate the storm track activity in the simulations. We calculate 2-8 day bandpass-filtered mean sea-level pressure (MSLP) and eddy heat flux (v'T') which is an Eulerian metric that shows variability of low- and high-pressure systems as well as their associated heat flux, but says nothing about the genesis, lysis or life time of individual storms. We also use the TRACK storm-tracking algorithm with 12-hourly MSLP data to produce trajectories of individual storms, which allows us to study individual storms.

The Eulerian approach using MSLP variance and eddy heat fluxes clearly shows a northward shift of the storm tracks as the ocean resolution is increased. Overall, the northward shift leads to reduced biases compared to ERA-Interim reanalysis. Storm-track trajectories show higher storm track and storm genesis densities around 60°N with the higher ocean resolution. Interestingly, a higher ocean resolution also results in longer life time of storms. We speculate that this is due to enhanced air-sea interactions where cyclones are fed more energy from the eddy-resolving ocean than from the non-eddying ocean.