Project: **1398**

Project title: **OceanWeather**

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Maximum of 2 pages including figures. 9 pt minimum font size.

Report

WP 1

Technical Setup (configurations, experiments)

In the past 12 months, a new high-resolution ICON XPP configuration with a 13km atmosphere and a 5km ocean resolution (R3B7, R2B9) called DRAGON (Development/Dynamics of gRey-zone Atmosphere and eddy-resolvinG Ocean eNsembles) has been introduced and developed at MPI. DRAGON has been added to the two existing coupled ICON-XPP model configurations of R2B4/B6 and R2B5/B7. Since the R3B7 atmosphere is already in operational use at the German Weather Service (DWD), DRAGON builds upon the efforts on this atmospheric component. Therefore, the development of a configuration consisting of a 40km atmosphere and a 10km ocean (R2B6/B8) has been replaced by the support of DRAGON in order to create synergies on the development and tuning of DRAGON as part of the three ICON XPP configurations.

Strategy and scientific background

By using DRAGON, we can more effectively investigate the scientific question of the eddy-mediated feedback onto the atmospheric circulation. Using a 5 km (R2B9) ocean resolution in DRAGON allows the model to resolve even finer structures towards sub-mesoscale oceanic processes. The simulated sea surface temperature (SST) field at 5km resolution captures these (sub-)mesoscale eddy features more clearly than at 20 km (R2B7) (Fig. 1). Along the Gulf Stream and extension region, the SST field exhibits not only a more realistic mean state, but also an enhanced SST variability, compared to the ICON XPP configuration with a 20km ocean resolution.

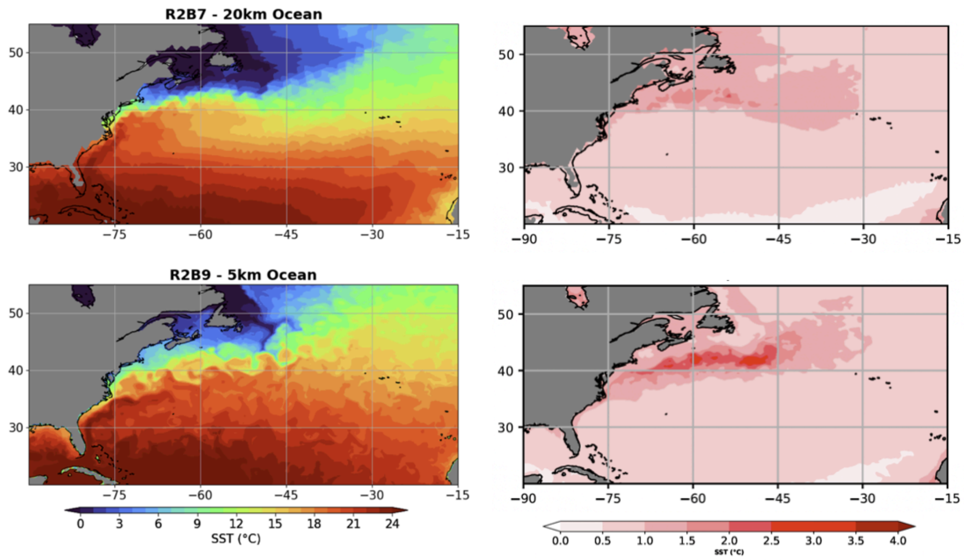

Fig. 1: Snapshots of the SST state using a 20km ocean (R2B7) (upper left) and a 5km ocean (R2B9) (bottom left) and SST variability with seasonal cycle removed for both ocean resolutions (right).

Such enhanced SST variability modifies air-sea heat fluxes and influences storm track activity. One approach to detect the storm track activity is the measure of Warm Conveyor Belt (WCB) activity. WCB activity has been found to be a precursor for past heat waves over the U.S. and Europe. Therefore, the detection of WCB activity is of important relevance and a novel diagnostic using neural network models has been introduced for an improved and more straightforward detection of WCB activity. For the WCB analysis, high-frequency output is required. This high-frequency output has been generated in several ICON-XPP experiments carried out in the past year in order to assess the capability of ICON XPP in representing the WCB activity. First, a coupled ICON XPP run with the R2B5/B7 configuration was conducted over the historical period from 1979 to 2014 (juk0010). In addition, two atmosphere-only experiments with a 40km (R2B6) (juk0011) and a 80km resolution (R2B5) (juk0012) over the same historical period were conducted to assess how the atmospheric model component represents the WCB activity intrinsically. These simulations incorporating high-frequency output for the WCB analyses required more computing time and storage than the standard model output.

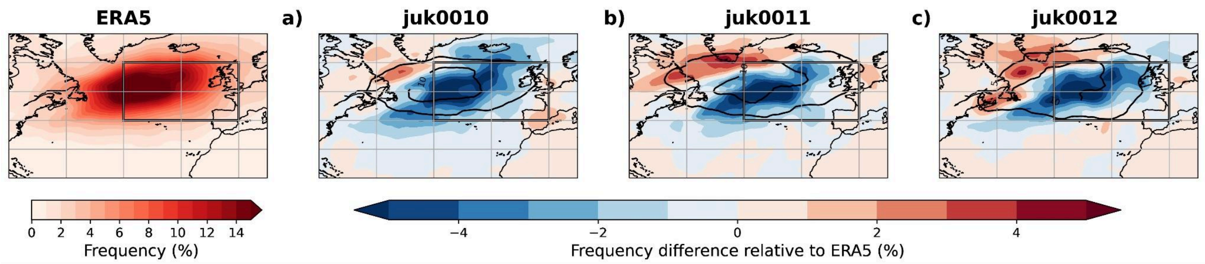

Fig. 2: Occurrence frequency of Warm Conveyor Belt (WCB) outflow for events during summer (JJA) , when the occurrence frequency of any grid point within the highlighted North Atlantic area (0 - 40°W, 40 - 60°N) reaches a probability of higher than 50%.

The atmosphere-only runs indicate an underestimation of WCB activity in ICON XPP compared to ERA5 reanalysis over the North Atlantic. This underestimation is slightly enhanced in the coupled R2B5/B7 configuration, which likely arises from biases in the mean state and variability of the SST field underneath.

<u>Current state (DRAGON, sensitivity experiments, atmosphere-only simulations)</u>

By now adding DRAGON to the WCB analyses, two scientific questions are addressed: (1) we aim to investigate if the reduction of SST biases in DRAGON improves air-sea interaction processes, leading to a better representation of WCB activity, (2) and to quantify the role of the eddy-mediated feedback onto this potential improvement.

In addition, the role of the subdecadal variability in the Gulf Stream and extension region for the WCB activity is examined using sensitivity experiments. Therefore, we performed a historical atmosphere-only simulation from 1870 to 2014 using non-perturbed prescribed SSTs, which serves as a reference. This run is completed. A second atmosphere-only simulation covering the same period utilises the same SST forcing data set, but with an enhanced subdecadal variability (5-10 year time scale) confined to the subtropical North Atlantic. This run will be finished by the end of 2025.

<u>WP 2</u>

In WP2 we successfully completed a coupled preindustrial control simulation with the newly developed, locally refined ocean grid. The local refinement to a resolution of up to 10km leads to a better representation of Western boundary currents and increased SST variability (Fig. 3).

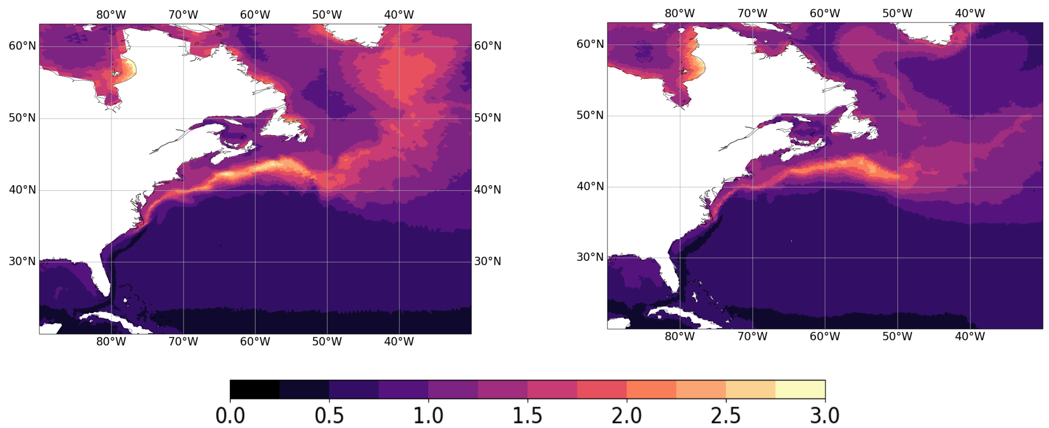

Fig.3 *SST variability defined as standard deviation of 100 years monthly SST (seasonal cycle subtracted), in the PI control simulation with the locally refined (left) and uniform (right) ocean grid. The uniform PI control simulation is the 20km/80km ICON XPP Deck simulation slo1826.*