Evaluating the capability of a global high resolution coupled model in reproducing tropical cyclones activity

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Tropical Cyclones (TCs) are among the most destructive natural phenomena on Earth and severely impact nearly a billion people. **Coupled models** have become a necessary tool to improve our knowledge on those natural hazards. Improving their ability to **represent accurately the statistics of TCs** is of prior importance. We investigate the capability of a **global high resolution (1/12°) EC-Earth coupled model** to realistically reproduce global TC activity. We focus on four main TC activity indicators: **seasonality**, **position of genesis**, **track** and **intensity**.

1 Global high resolution coupled model

EC-Earth model[1,2]

- **Atmosphere:** Integrated Forecast System (**IFS**), spectral truncation at T1279 (i.e. nominal spatial **resolution ~15km**), 91 vertical levels
- **Ocean:** Nucleus for European Modelling of the Ocean (**NEMO**), spatial **resolution 1/12°**, 75 vertical levels
- **Sea ice**: Louvain la Neuve sea-ice model version 3 (**LIM3**)

Global, 24 years of simulation.

2 Tracking of TCs

Tracking algorithm[3] based on :

1/ Detecting individual events
- Max. SLP threshold (**SLP < 1000hPa**)
- Min. local gradient of SLP threshold (∇**(SLP) > 0.66 hPa/degree**)

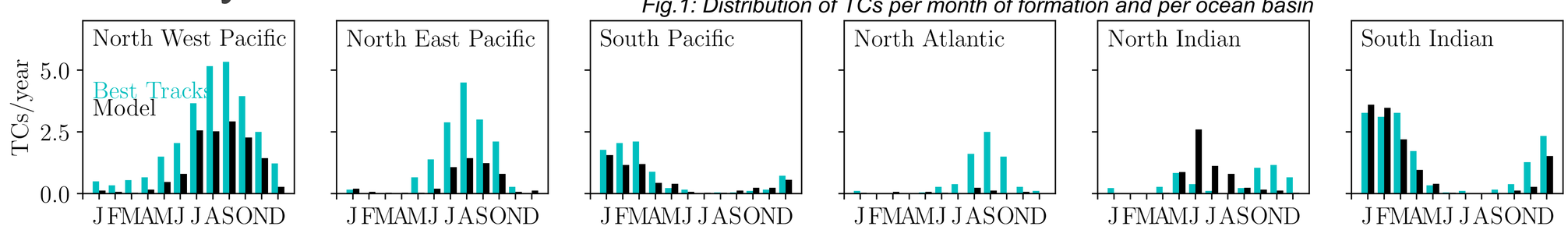
2/ Grouping individual events into one TC
- Min. life duration threshold (**$lifetime_{TC}$ > 18h**)
- Min. strengh threshold (**max $\nabla(SLP)_{TC}$ > 1 hPa/degree**)
- Max. Latitude formation threshold (**$Lat_{genesis}$ < 25°**)

3 Observations

Comparison with observed statistics
- **K. Emanuel Best Tracks** database[4]
- Same SLP (**SLP < 1000hPa**) and latitude (**$Lat_{genesis}$ < 25°**) thresholds to have comparable statistics
- **2002-2019 period** because few SLP observations before

4 Seasonality

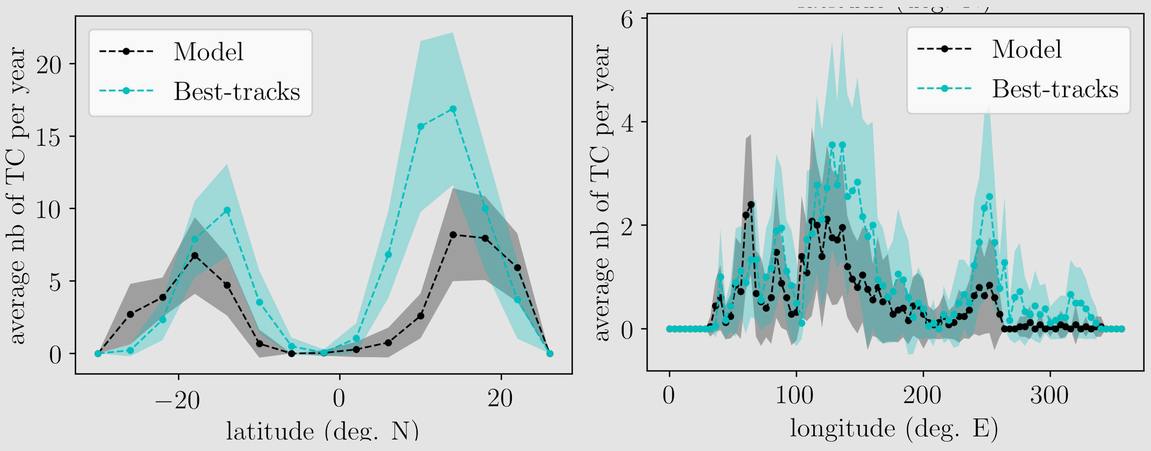
Fig.1: Distribution of TCs per month of formation and per ocean basin



We observe an **overall deficit of TCs** in our model. **Seasonality is well represented** in almost all tropical oceans, **except** for two basins. **North Indian ocean** TC activity in the post-monsoon season is not accurately depicted in our model. **North Atlantic ocean** TCs are almost absent in our model all along the year.

5 Genesis position

Fig.2: Annual average of TCs forming at each (left) latitude and (right) longitude



Our model is **capable of simulating realistically the meridional structure of TCs genesis locations, yet** with a small poleward shift, along with a strong underestimation of TCs forming in the Atlantic.

6 Track density

The model simulates realistic track densities in both the North Pacific and the South Indian oceans**.** TCs in the Bay of Bengal are constrained to the northern coast whereas the observed TCs are around 10°N. **The model barely simulates any TCs** in the **North Atlantic oceans.**

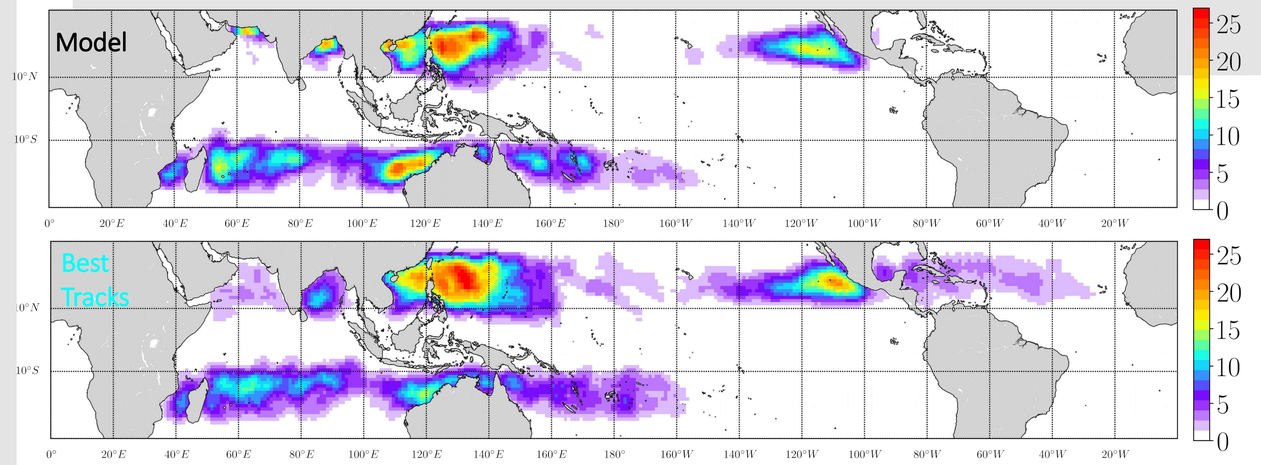
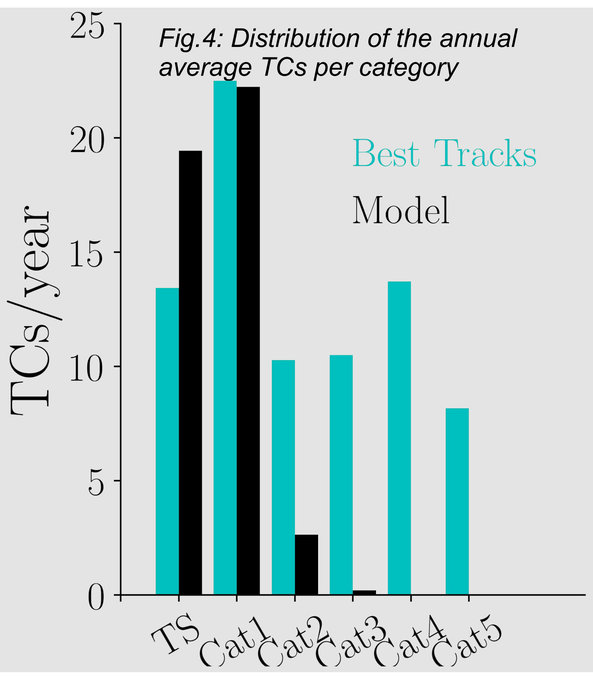


Fig.3: Map of annual average of track density in (up) the model and (down) the observations

7 Intensity

We distinguish TC categories using the Saffir-Simpson classification with SLP thresholds. In spite of its high spatial resolution, our model simulates few TCs reaching categories higher than 1, and is **not capable of simulating TCs of category higher than 3**, i.e. with SLP < 945 hPa.

Fig.4: Distribution of the annual average TCs per category



8 Conclusion and perspectives

Although TCs intensities are much lower than in observations, overall, the EC-Earth model simulates realistically most TCs spatial and seasonal features in most basins, except the North Indian and North Atlantic ocean. This may be due to a poor representation of the monsoon regime for the former, and a too strong climatological vertical wind shear for the latter. Those hypotheses are currently being tested. We also aim at characterizing the sensitivity of these statistics to the presence or absence of the current feedback (CFB) in our model. We expect an improvement of TC activity statistics when the CFB is turned on[5].

References: **1 -** Hazeleger, W., Wang, X., Severijns, C., Ştefănescu, S., Bintanja, R., Sterl, A., Wyser, K., Semmler, T., Yang, S., Van den Hurk, B., et al., 2012. EC-Earth V2. 2: description and validation of a new seamless earth system prediction model. Clim. Dyn. 39 (11), 2611–2629. **2 -** http://www.ec-earth.org/ **3 -** Di Luca, A., J.P. Evans, A. Pepler, L. Alexander, and D. Argüeso, 2015: Resolution Sensitivity of Cyclone Climatology over Eastern Australia Using Six Reanalysis Products. J. Climate, 28**,** 9530–9549 **4 -** ftp://texmex.mit.edu/pub/emanuel/HURR/tracks_netcdf/ **5** - L. Renault, F. Lemarié, T. Arsouze, 2019a:On the implementation and consequences of the oceanic currents feedback in ocean–atmosphere coupled models.Ocean Modelling, 101423 **Pictures**: *Header:* NOAA/CIRA