Project: **1526**

Project title: **Deciphering OLD ship Records to Understand the Maritime Structure of the Atlantic Intertropical Convergence Zone (DOLDRUMS)**

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Report period: **2025-11-01 to 2026-10-31**

In the reporting period we analysed existing storm resolving model (SRM) simulations (I) worked with already digitized ship log data (II), started a first km scale test simulations (III) and applied machine learning (ML) techniques for gap filling (IV).

Analysis of SRM simulations (I).

During the reporting period, we conducted a model data intercomparison of the present-day Atlantic Intertropical Convergence Zone (ITCZ) in existing storm-resolving model (SRM) simulations with resolutions ranging from 2.5 to 10 km. This was done to figure out the specific model configuration for historic SRM simulations. Looking to the frequency distribution of low wind speed events (Figure 1) we see that the differences between the different km scale simulations are relatively small and vary between summer and winter. While in winter the coupled ICON runs reflect the average values of the ERA5 data, they underestimate them in summer. The difference among the various ICON runs stems more from the model configuration (AMIP vs. fully coupled) than from the horizontal resolution. The IFSC4 run shows significantly greater variability than the ICON runs and the ERA5 data, but its summer mean is much closer to the ERA5 data than to the ICON runs. We also find that a resolution of R2B8 is sufficient for most of our applications.

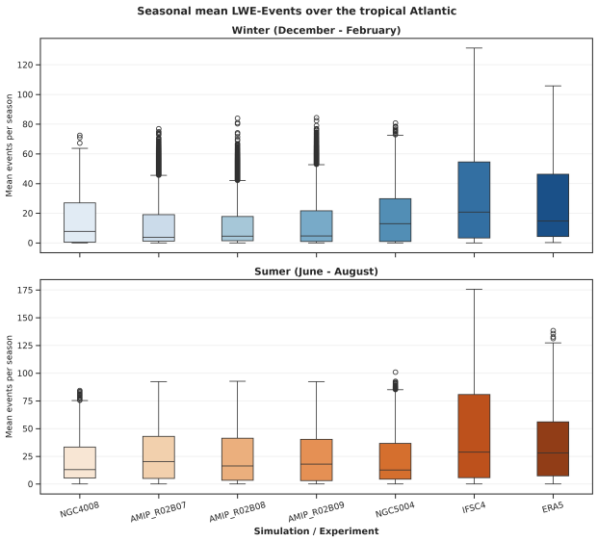


Figure 1: Seasonal mean occurrence of low wind speed (LWSE) events in different storm resolving model (SRM) simulations, see Table 1) in comparison to their occurrence in ERA5 [1]. Please note that the background period is different for the three AMIP runs

Model/Data	Experiment	Resolution	Period
ERA5	-	31 km	2020 to 2022
ICON	ngc4008	R02B8/R2B9 (10 km/ 5 km)	2020 to 2022
	ngc5004	R02B10/R2B10 (2.5km/2.5km))	2020 to 2022
	C5.AMIP_CNTL (AMIP_R0B07)	R2B7 (20km)	1979-1981
	C5.AMIP_CNTL(AMIP_R0B08)	R2B8 (10 km)	1979-1981
	C5.AMIP_CNTL(AMIP_R0B09)	R2B9 (5 km)	1979-1981
IFS/FESOM	IFS_9-FESOM_5-production (IFSC4)	9 km/ 5 km	2020 -2022

Table 1: Overview of the analysed SRM simulations from the NEXTGEMS [2, 3] and DestinE projects (C5 AMIP) in comparison to ERA5 data [1].

Analysis of historic ship log data (II)

Our basic hypothesis is that we can reconstruct the ITCZ from historic ship log data. As a starting point we exploit the Climatological Database for the World's Oceans (CLIWOC) which provides digitized wind and weather observations from historical ship logbook data (1750–1850) [4]. Our analysis of the CLIWOC data already reveals information about the structure and position of the historic Atlantic ITCZ such as the coincidence of regions of low wind speed events (LWSE) with thunderstorms. The seasonal migration of the ITCZ in the East Atlantic is reflected in the ship log data with its northernmost positions in Northern Hemisphere summer and the seasonal distribution of LWSE in the ship log data west of Africa agree well with satellite observations (Figure 2).

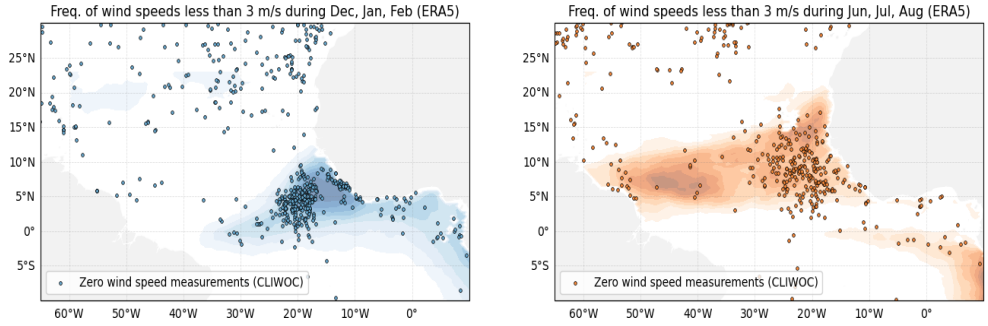


Figure 2: Occurrence of LWSE recorded in ship logs compared with their occurrence in ERA5 [1]. The dots show the ship locations in the CLIWOC data [4], the shaded areas the frequency of hourly wind speeds below 3 m/s in one year of ERA5 data with the frequency increasing from 5% (light color) to 50% (dark color).

SRM simulations. (III)

We started a 1st ICON R2B8 test simulation for 2020, where we write out the data in zarr3 format on a HEALPix grid. At present the simulations are still running.

Artificial Neural Networks (IV)

To map ship logs on ITCZ properties we will deploy supervised learning techniques using artificial neural networks (ANN). As a start we aim to reconstruct a mean surface wind climatology over the tropical Atlantic for 1750 1860, the years covered in the CLIWOC data base. A Deep Learning model is trained on artificial ship logs sampled from ERA5 reanalysis data, so that the training data mimics the spatial and seasonal sampling of the real logbooks. As a first step, the model was trained on the 10 m meridional wind component (v10) over the tropical Atlantic. On ERA5 data it reconstructs the field with a mean absolute error of 0.325 m/s and a Pearson correlation of 0.987.

References:

[1] Hersbach, H. et al, Copernicus Climate Change Service Data Store, doi:10.24381/cds.143582cf, 2017
[2] Segura, H. et al, Geosci. Model Dev.,18, 7735–7761, https://doi.org/10.5194/gmd-18-7735-2025, 2025
[3] Franke, H. et al. under review for publication in J. Atmos. Sci.
[4] García-Herrera, R. CLIWOC Database 2.1 PANGAEA, https://doi.org/10.1594/PANGAEA.743343., 2007.