Exploring the dynamics of Tropical Cyclones in the Eastern Tropical Atlantic: a Weather Types perspective

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Background and Objectives

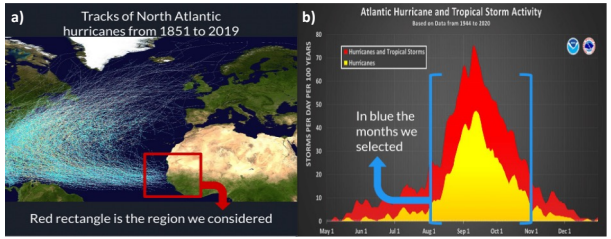

Figure 1: TC climatology (source NOAA-NHC) a) In red ETNA region b) MaTC season.

- Tropical cyclones (TCs) development in the Eastern Tropical (Northern) Atlantic (ETNA) occurs offshore Senegal in the Cape Verde region **(Fig. 1a)**, peaking in September **(Fig. 1b)**.
- TCs develops from depressions travelling westward from West Africa **(Fig. 2)**. However, the mechanisms concurring to the formation of TCs from easterly depressions are still unclear, even though it is known there there is a correlation of African Easterly Waves (AEWs) with the cyclogenesis but not a causation **(Fig. 2)**.

Scientific questions:

1) At what meteorological condition are the TCs more associated, if indeed they are with some?
2) In what condition do TCs and AEWs interact? How do they do it?

Figure 2: Interaction AEW - TC - AEJ (source MIT).

Data and Methods

- Data from ERA5 (geopotential Z, vorticity VO; Q 700 hPa and 850 hPa) and CAMS (AOD 550 nm) reanalysis products are analysed for the period 2003-2022.
- Infos of MaTCs (HUs and TSs) are from HURDAT2 (NHC, USA) and infos of AEWs are from AEWDAt (KIT, Germany).
- We looked for clusters (i.e., basins of attraction) in the phase-space of the climate-weather on the ETNA: these are the weather types (WTs);
- Applying Self-Organizing Maps for initial clustering and Hierarchical Agglomerative Clustering for refinement, we found 8 WTs based on Z and VO at 700 hPa **(Fig. 3)**.

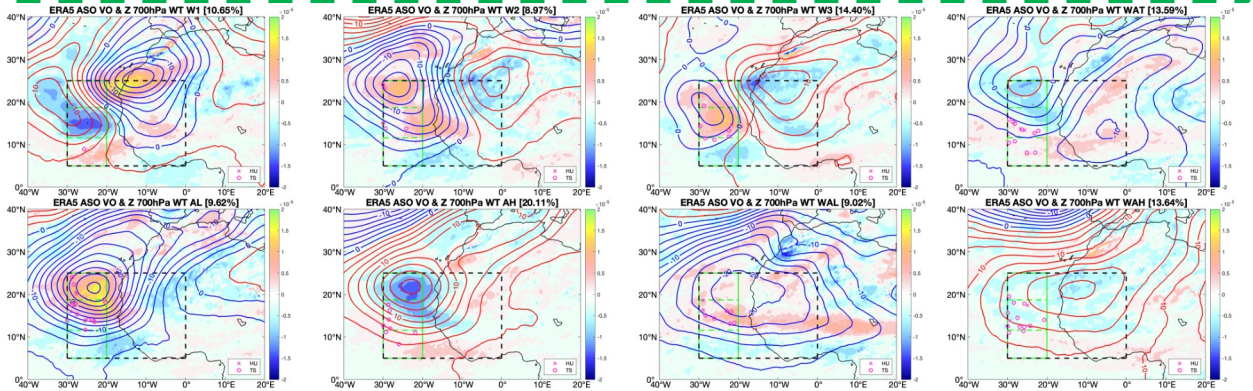

Figure 3: WT classification of Z and VO anomalies 700 hPa MaTCs. Black box is the ETNA region and Green one is the oceanic part used to observe the MaTCs.

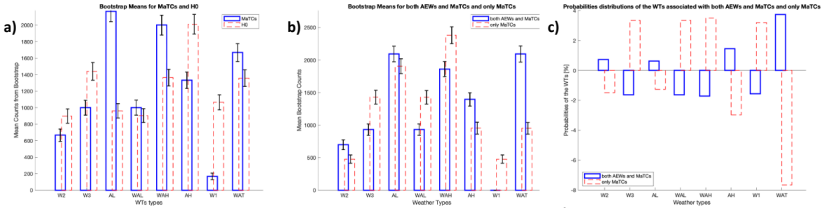

Figure 4: bootstrap results to compare conditional and marginal distributions (if the conditional differ from the marginal the two variables are dependent):
a) climatological distribution of the day associated to each WT (H0) and the same distribution conditioned to the presence of at least one MaTC (MaTCs);
b) Comparison between the frequency distribution of WT associated with the presence of at least one MaTs and none AEWs (only MaTCs) and the one which require the presence of at least one AEWs (both MaTCs and AEWs);
c) Same distributions of fig 4.b but after the MaTC distribution from fig 4.a is subtracted.

Results

- Found a partition of WTs showing dependence with MaTCs **(Fig. 4.a)**: WTs AL, WAH and WAT favourable; WTs W1, W2, W3, and AH suppressive.
- **Figure 4.b** show two distinct MaTCs' families characterized by opposite reactions to WTs. **Figure 4.c** underscores opposite responses for the two families.
- More research is needed (expanding the MaTC sample) To understand those WTs for which explaining the linkage with TCs is not straightforward.

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