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Revisiting Cyclone Detection and Tracking Methods using ECMWF ERA5

dataset for climatological purposes in the Mediterranean Region

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CYCLONES IN MEDITERRANEAN

Main detection and tracking methods

INTRODUCTION

Several studies based on ECMWF analysis and reanalysis (ERA40 and ERA Interim) datasets indicate a large divergence related to the average number of cyclones passing through the Mediterranean region by year. However, the majority agrees on the most important cyclogenesis areas, seasonality variation of the number of cyclones, and trends of cyclone track.

In general, the differences between those methodologies concerns to the meteorological variable used to detect cyclones and the metric used to define its intensity. Nevertheless, spatial and temporal resolutions were fundamental to achieve the results, since the most advanced dataset used in the literature presented relatively low values such as 1.125°x1.125° and 6h, respectively. Past studies reported that these values were already high enough to produce numerical noises.

FIG 1 Study region defined by the area within 9°W to 42°E and 27°N to 48°N.

Cyclones in Mediterranean

Main detection and tracking methods

Data and Methods

Here, the geopotential height at 1000 hPa (Z1000) was used, with horizontal spatial resolution of 0.25°x0.25° and time resolution of 1h, to identify the local minima for each time step (hereafter, candidates), and filtering those with negative gradients of Z1000 within a radius of 1000 km to exclude candidates associated with thermal lows or geopotential troughs.

Following the literature, the domain for Mediterranean region was defined by the area within 9°W to 42°E, and 27°N to 48°N, where were considered only cyclones with at least one tracking point inside the domain. Also, the results were produced for the period 1979-2008 using two types of input data: (Model I) ERA5 data with resolutions reduced to 1.5°x1.5° and 6h, as well as the main previous studies; and (Model II) full-resolution ERA5 data.

Model I

Similar to literature, this method uses a dataset with 1.5°x1.5° and 6h of spatial and temporal resolutions, respectively.

Local minimums (candidates) defined within an area of radius 1.5° (matrix 3x3).

Tracking defined by the closest candidate within an area of radius 1.5° (matrix 3x3).

Model II

This method uses the same dimensions from Model I, but using a dataset with 0.25°x 0.25° and 1h of spatial and temporal resolutions, respectively.

Local minimums (candidates) defined within an area of radius 1.5° (matrix 13x13).

Tracking defined by the closest candidate within an area of radius 1.5° (matrix 13x13).

CYCLONES IN MEDITERRANEAN

30 years climatology (1979-2008) based on ERA5 dataset

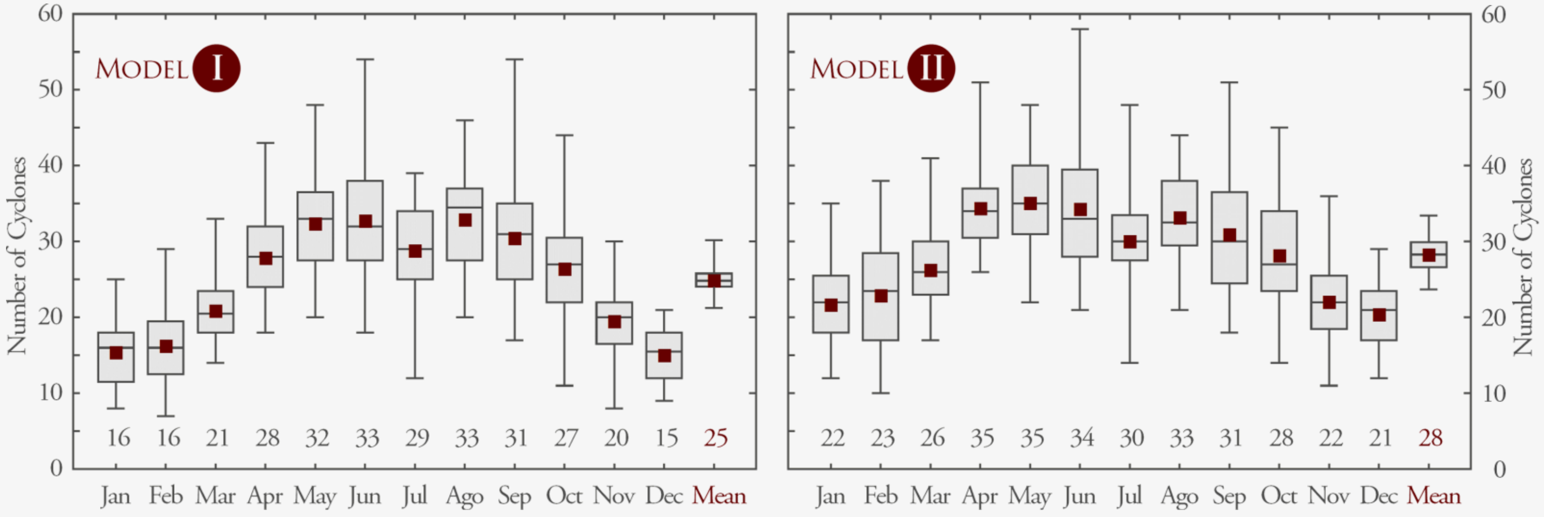

FIGURE 2

Monthly averages of the total number of cyclones in the Mediterranean Region (red squares and bottom numbers) and the respective 1st, 2nd and 3rd quartiles (grey bars) and the absolute minimum and maximum (grey dashes) illustrated as a box plot for Model I (left) and Model II (right) to the period 1979-2018.

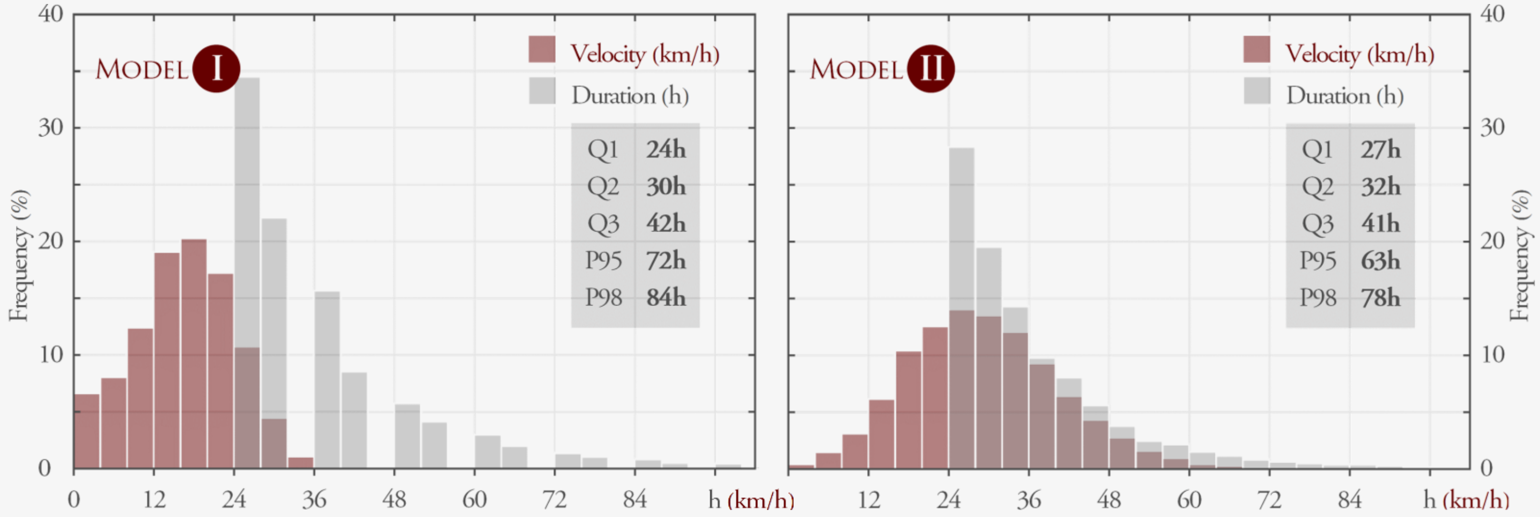

FIGURE 3

Frequency distribution (%) of cyclones mean velocity (red, each 4 km/h) and duration (grey, each 4 h) for Model I (left) and Model II (rght) to the period 1979 -2018. Also, the 1st, 2nd and 3rd quartiles to cyclones duration are presented followed by the extreme percentiles (95 and 98).

Cyclones in Mediterranean

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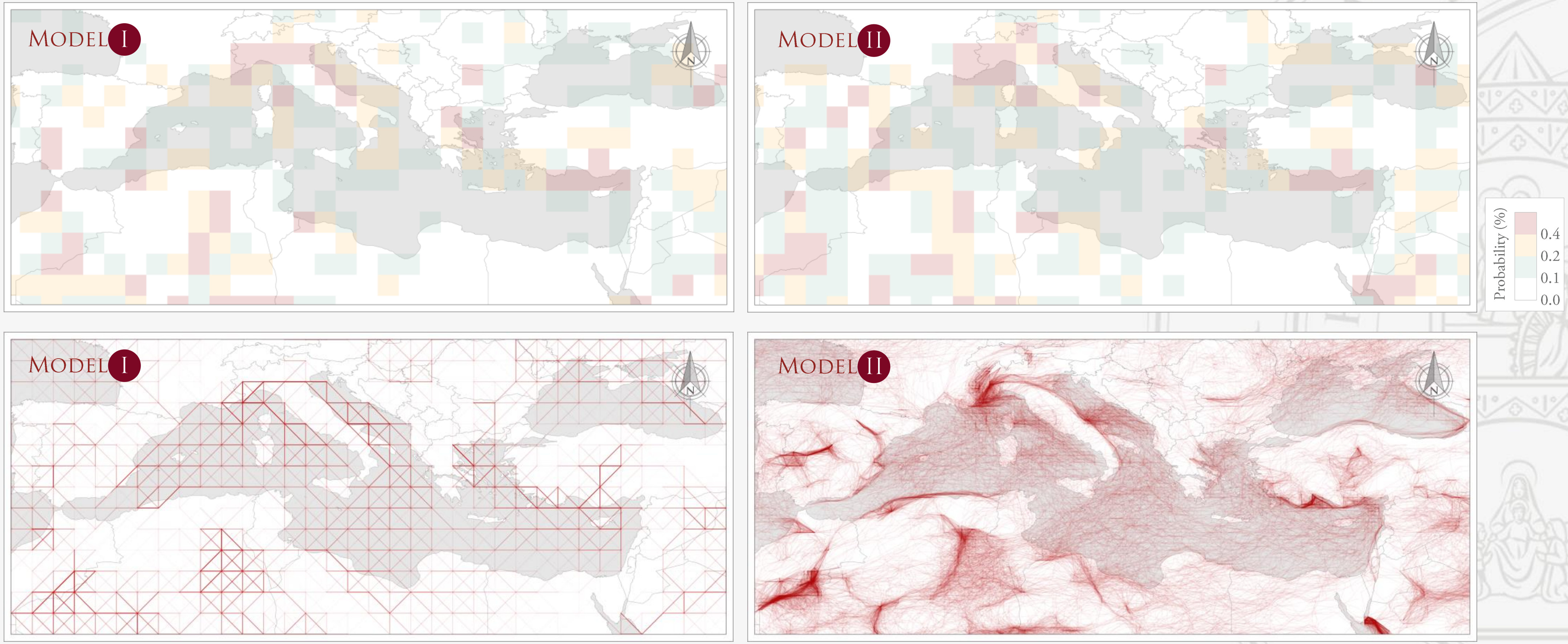

Figure 4 Cyclogenesis probability within 1.5°x1.5° cell area (top) and all cyclone tracks (bottom) during the period 1979-2008 into the Mediterranean Region using Model I (left) and Model II (right). The detail level of cyclone tracking obtained by Model II shows regions with a large number of cyclone passes that are not represented by Model I due to low resolution.

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Final Comments

As expected, Model I results were very similar to those found in the literature in all aspects (number of cyclones, seasonal distribution, areas of cyclogenesis and tracks). On the other hand, since the use of higher resolution data provides greater spatiotemporal detailing of the climatological period, the results of Model II presented a total number of cyclones substantially higher than that of Model I (~25%), but still within the range described in the literature.

The models indicated more frequent cyclones during the spring months with maximums in April (Model I) and May (Model II). An interesting point highlighted in other studies but not observed in their results, is an increase in cyclone frequency between August and October, captured in both Models I and II and more evident in Model II. An explanation is found in the greater number of short-life cyclones, which act in relatively narrow areas intangible to datasets with limited resolution.

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Thank You!

#everythingisgonnabeallright
#andràtuttobene
#vaificartudobem

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