Master Thesis Description - 2022

Supervisors: Claudia Pasquero (claudia.pasquero@unimib.it) and Fabien Desbiolles (fabien.desbiolles@unimib.it)

Location: Department of Earth and Environmental Sciences, University of Milano-Bicocca, Milan, Italy

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Project: What are the physical characteristics of the surface ocean that influence the intensification of tropical cyclones?

Scientific context:

Tropical cyclones (TC), also known as hurricanes in the North Atlantic or typhoons in the Northwest Pacific, are among the most spectacular and deadly geophysical phenomena. For example, both the most lethal and the most expensive natural disasters in U.S. history were tropical cyclones (i.e.: Galveston Hurricane and Hurricane Andrew). Understanding and being able to predict the trajectory and intensity of TC is therefore a major social and economic issue. The trajectory of TC is largely controlled by large-scale atmospheric flows, and it is relatively well understood and forecast. However, the intensity of TC (measured as the maximum surface wind speed) is determined by more local factors such as air-sea interactions. The links between those small-scale processes and TC intensity are poorly understood, hindering the reliability of forecasts. Improving our understanding of those links could lead to major advances in the prediction of TC intensity and thus to more effective policies to protect populations in coastal areas.

Project aim: The objective of this internship project is to statistically analyze model outputs and observational data in order to investigate what rapid intensification events of tropical cyclones depend upon.

Material and methods:

1) The first stage of this internship will be devoted to the adaptation of a MATLAB computer program initially used to identify Mediterranean tropical-like cyclones, for the detection of tropical cyclones in global atmospheric circulation model outputs. This will require the identification of low-pressure storms, the tracking of storm displacements, and the identification of the energy source for the system to clearly separate tropical cyclones from extratropical ones. This last step will be based on Hart's cyclone phase diagram.
   During the adaptation of the algorithm, it might be decided to convert the MATLAB code into Python.

The algorithm will be applied to atmospheric reanalysis (ERA5), to obtain a tropical cyclone inventory.

2) The second stage consists in performing a statistical analysis of the intensification rate from two datasets: the tropical cyclone inventory obtained from ERA5, and the IBTrACS observational dataset of tropical cyclones, which records position and maximum intensity of storms in tropical areas every 6 hours. The use of the reanalysis will allow the investigation of the links between intensification rate and environmental characteristics.

References:

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