

Space-time probability density of Mediterranean hurricane genesis in the present and future climate

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Tropical-like storms occasionally develop over the Mediterranean Sea, and sometimes attain hurricane intensity. These storms, often called “Medicanes”, operate on the thermodynamic disequilibrium between the sea and the atmosphere and in this respect, as well as in their visual appearance in satellite images, are much like tropical cyclones. According to the air-sea interaction theory of tropical cyclones, the steady-state maintenance of these storms can be idealized as a Carnot engine with the provision that the heat input is largely in the form of the latent heat of vaporization acquired from the sea surface by the inwards airflow. The mechanical energy available from this thermodynamic cycle balances frictional dissipation, and the theory allows one to determine the potential intensity of the storm from the environmental conditions. Real events from the tropical oceans demonstrate that the idealized model correctly predicts the maximum wind speed -or minimum central pressure- achievable in tropical cyclones. On the other hand, an empirical genesis index that combines the previous potential wind speed value with the low-tropospheric vorticity, mid-tropospheric relative humidity and deep-layer wind shear has been formulated and successfully tested against the true space-time probability of tropical cyclone genesis.

In this work, the above ideas are applied to the Mediterranean region where the record of Medicanes is too sparse to allow any kind of robust statistical analysis of real data. A few well known cases are first used to illustrate the precursor role of a deep, cut-off, cold-core cyclone in the upper and middle troposphere, which acts to increase the local thermodynamic potential for tropical-like cyclones and the relative humidity through a deep layer, thereby inhibiting the formation of convective downdrafts that often prevent the cyclogenesis. High values of the empirical genesis index are invariably obtained for the available cases, indicating that such an index can be a good candidate to estimate -or forecast- the likelihood of Medicanes genesis. Finally, geographical and monthly distributions of potential intensity and genesis index are examined for the whole of the Mediterranean Sea under the present climate conditions and future regional scenarios imposed by global warming. In the first case, the ERA-40 reanalysis dataset for the period 1958-2001 is used. In the second case, recent GCM simulations for the late 21st century are considered. Results are available at <http://medicanes.uib.es>