EGU24-6300, updated on 27 Jul 2024
https://doi.org/10.5194/egusphere-egu24-6300
EGU General Assembly 2024

Investigating the complexity of Mediterranean Tropical-like cyclones through the use of the vertically integrated Moist Static Energy Budget

Miriam Saraceni[1], Lorenzo Silvestri[2], and Paolina Bongioannini Cerlini[3]
[1]Department of Civil and Environmental Engineering, University of Perugia, Perugia, Italy (miriam.saraceni@unipg.it)
[2]Department of Civil and Environmental Engineering, University of Perugia, Perugia, Italy (lorenzo.silvestri@unipg.it)
[3]Department of Physics and Geology, University of Perugia, Perugia, Italy (paolina.cerlini@unipg.it)

In the literature, Mediterranean hurricanes, i.e., mesoscale cyclones exhibiting tropical characteristics for at least a brief portion of their lifespan, are often labeled as "medicanes". However, the debate on how to classify such cyclones remains open. Initially, a Mediterranean cyclone was designated as a "medicane" if it displayed a central "eye" and spiral cloud bands around the core. Due to their low rate of occurrence, the mechanisms contributing to the formation of medicanes have been investigated in a relatively restricted set of case studies. Generally, the initiation phases of "medicane" life cycles exhibit similarities, with all systems displaying growth through the interaction of an upper-tropospheric potential vorticity (PV) streamer and a low-level baroclinic region, as commonly observed in extratropical cyclones. However, during the mature stages, baroclinic forcing, air–sea interactions, and convection may significantly influence cyclone development. Recently, a general classification has been proposed, based on a limited number of cases, dividing "medicanes" into three groups: Group 1, where baroclinic instability plays a significant role throughout the cyclones' lifetime; Group 2, where baroclinicity is relevant only in the initial stage, and, akin to tropical cyclones, the theory of wind-induced surface heat exchange can explain their intensification; and Group 3, encompassing cyclones developing through a synergy between baroclinic and diabatic processes. The lack of a clear physical definition for medicanes has led to diverse climatologies, necessitating the identification or establishment of criteria for effectively determining which cyclones within this broad category resemble their tropical counterpart. In this study, the investigation of genesis and intensification processes is carried out by analysing the vertically integrated moist static energy (h', with $h = c_p T + L_v q + gt$) budget for a subset of twenty-three among the most studied Mediterranean cyclones labeled as "medicanes" from 1969 to 2023. To cover all chosen cyclones and use a consistent dataset the cyclone tracking, analysis, and budget computation are done employing the ERA5 reanalysis. After tracking the cyclones, the budget is computed within a radius around the cyclone center (from 300 km to 800 km), at least three times the radius of the cyclone, according to each cyclone's size. Within the budget, the increase of h' variance connects radiative, convective, and moisture feedback with the increase in the vertically integrated humidity, temperature, and geopotential variance. The budget, previously employed in studies of convective

organization in the context of the Radiative Convective Equilibrium (RCE) in the tropics has been successfully applied also to tropical cyclones. Here, it is utilized firstly to capture the nature of the former subset of cyclones, understanding objectively through the budget, and specifically with the variance increase of each moist static energy term, which of these cyclones can be assimilated into the tropical-like framework. Additionally, this approach has given insights into the radiative, convective, and moisture feedback mechanisms driving cyclone intensification for these cases. Preliminary findings suggest that the established groups in the literature can be reconciled through the budget, enabling the identification of genuinely tropical-like cyclones using this method.