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Interactive comment on "TITAM (v1.0): Time Independent Tracking Algorithm for Medicanes" *by* Enrique Pravia-Sarabia et al.

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Discussion paper

TITAM (v1.0): Time Independent Tracking Algorithm for Medicanes. Reply to RC1.

September 15, 2020

Referee comments: in blue.

Author responses: in black.

We welcome the feedback and appreciate all the referee suggestions and comments. The majority of them have been included in the final manuscript version.

Related to the general comments, thanks for your kind words.

Now we proceed with the responses to the specific comments. Please note that the changes associated to these comments can be found in the changes version generated with the latexdiff tool.

While the proposed algorithm has been well designed, and takes into account all the properties of this category of cyclones, I was wondering if it allows to track the whole cyclone lifetime as a unique track (not different tracks for different stages of the cyclone lifetime, as in Fig. 10). This is an important point, also considering that the most intense convection is often observed in this earlier stage (Dafis et al., 2018; Miglietta et al., 2013).

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Discussion paper

The algorithm is indeed designed to produce a single medicane track. If a cyclone tracking is expected to be the product of the algorithm execution, then the namelist parameters should be changed accordingly. Figure 10 is an example of a specific situation that could be problematic for a tracking procedure. On it, a large cyclone encompasses a SLP minimum and a distant zone where a medicane is formed. Our intention with the inclusion of Figure 10 was to show that if namelist options are properly adapted, a complete cyclone track can be found. In the same Figure 10, red track shows the path of the medicane, while the blue line represents the cyclone track. Disconnection between both blue paths only means that the algorithm is able to 'jump' from the SLP minimum of the large low pressure air mass, seen as a normal cyclone before the appearance of the medicane, to the medicane (please see Figure 9 for the evolution of the synoptic situation), while the SLP cyclone below loses the structure and is not followed by the algorithm anymore. Please note that in case the cyclone in the North coast of Libya did not lose its structure, both the medicane and the cyclone would be tracked simultaneously. Their tracks would also be disconnected, since they are not part of the same cyclone, even when they are formed from the same low pressure air mass. Thus, though in this particular case the medicane appears disconnected from the cyclone in the early stage, the different lengths of the blue and red tracks of the medicane show that the algorithm is able to track a cyclone as a unique track during its entire lifetime, regardless of whether it fulfills the conditions to be a medicane or not. It seems also important to mention that if Hart conditions are not checked in order to find the complete cyclone track, it will be necessary a second and independent algorithm execution to know the points in which the cyclone is a medicane, provided that the algorithm is not prepared to simultaneously provide a complete track and the points of the complete track where the cyclone shows a medicane structure.

However, for the sake of clarity, we have modified the explanation on Figure 10.

The description of the mechanisms of development of Medicanes is poor and confusing. I recommend the Authors to completely re-write this section, starting from the

explanation in Miglietta and Rotunno (2019) and related bibliography.

As suggested, we have completely re-written this section. Thanks for the constructive comments. For simplicity, we skip the comments in which we have directly considered the suggestions, and will only reply to the ones that could be subject of discussion.

L57-58: "the existence of two different low pressure areas is equivalent to the existence of two medicanes": do you mean that identifying two cyclones is a similar problem as the identification of two medicanes?

Yes. Provided that our algorithm searches the areas with high cyclonic potential and closed circulation, and isolates the points fulfilling the conditions to be a medicane center, it is technically the same thing searching for medicanes structures and searching for different cyclonic areas.

L244: is there a motivation for imposing - | VTL | > - | VTU |?

Yes, since the algorithm has a namelist-oriented conception, and it is prepared to track different types of cyclones, the inclusion of the 4th Hart condition enables the usage of the algorithm for tropical cyclones tracking. Although in medicanes literature this condition is usually not considered, the possibility to use it has been included for completeness and coherence. Since its checking can be deactivated in the namelist, its inclusion does not conflict with the physical argument that, for a medicane, the rate at which the geopotential height perturbation diminishes is not necessarily greater in the lower atmospheric layer than in the upper one.

L273: conversely, if the condition is valid, do you connect the positions at different i?

Let us explain this mathematical condition in detail. Given a medicane center at a certain position M_t^c at a time step t, and if DT_{max} equals one time step, we connect the found center with another one if in the previous or next time steps there exist a center at a distance lower than D_{max} from M_t^c. In case of DT_{max} higher than one time step, then we first check if there is a center separated one time step and at a distance lower

than D_{max}. If so, both are connected, and centers separated by more than one time step are not checked. If no center is found to be at a distance shorter than D_{max} at one time step, then the centers at a distance of two time steps from t are checked to be at a spatial distance under D_{max} from M_t^c, and so on until the number of time steps at which we check the centers meet the maximum DT_{max}. Please note that, by definition, when a center is found at a temporal distance of t-t' timesteps, the center is linked with that center and only that one. This ensures that each point is linked only once (if this is the case), and that we do not link centers too far in space and/or time.

Appendix A: "ZeroVortRadiusLowerLimit": occasionally Medicanes can be smaller than 80 km (see Miglietta et al., 2013)

This is precisely why ZeroVortRadiusLowerLimit is a namelist parameter. The possibility to adapt it to each type of structure and, even for a given structure like medicanes, to use the parameter value that each author considers appropriate is one of the main advantages of the conceived model. However, alghough most medicanes do shrink prior to its landfall, the zero vorticity radius is the mean distance to the line of zero vorticity, which usually exceeds the mark of 100 kilometers. Neither Miglietta et al. (2013) nor Tous and Romero (2013) (which Miglietta et al. (2013) cite for the medicanes radius) seem to provide a clear definition of how the measure the medicane radius. Thus, it is certainly difficult to know whether the medicane sizes they provide are comparable with the ones calculated with our proposed methodology (which also provides an inner radius, being the distance from the center to the point of maximum wind speed). In any case, thanks to the referee for pointing that out.

Figure E1: "Additionally, the green box covers the spatial area selected to run the algorithm on ERA5 data": is this for all Medicanes?

No. ERA5 reanalysis has only been used to provide a track of the Rolf medicane from a reanalysis global database, as presented in Figure 8. IC and BC for the WRF model run come from ERA-interim reanalysis data. Green box is the only one that does not

represent a domain for a model run, but a cropped window for using raw ECMWF reanalysis data as algorithm input, instead of using WRF output data.

References

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