Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2021-266

Anonymous Referee #1

Referee comment on "CycloneDetector (v1.0) – Algorithm for detecting cyclone and anticyclone centers from mean sea level pressure layer" by Martin Prantl et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-266-RC1, 2021

General comments:

In this manuscript the authors present an algorithm for detecting both cyclone and anticyclone centres on a Sea Level Pressure chart. This constitutes an interesting subject but unfortunately, as a climatologist, I cannot say that I would trust the method presented, at least in its current version. The method is based on:

- Computing the isobars.
- I assume (not completely clear from the text) that in a second step, "closed" isobars are searched for and selected as "system candidates".
- What (accordingly to the text) are "clearly not supposed to be pressure system centres" (the technical meaning of such a claim should be clarified) are eliminated based on the area enclosed by the contour, which is approximated by the axis-aligned bounding box (AABB). The authors do not offer any convincing clue on the precision of this approximation or the influence of the latitude or projection on the relative error. Could this approximation introduce a latitude-dependent bias in the algorithm?
- The remaining "systems" are classified as local maxima or minima based on the application of a mask of variable radius. The size of the radius can be set manually or automatically estimated. The authors recommend a value between 5 and 50 "pixels" (do the authors mean grid-points?) (line 156) but the only clue they offer to support such affirmation is that it is based on "their experiments". These "experiments" should be detailed, and specific sensibility test included, otherwise it is not clear to the user the effect of this variable on the results.

As a test of the performance, the authors show a global map for a specific day (Figure 5) which seems reasonable (but with several caveats, see below) and then a comparison of their results with two Met Office analysis for the North Atlantic. Again, with reasonable results. The three cases shown are at least suggestive. But the practical utility of an algorithm aimed to track pressure systems relies on the confidence a researcher can put

on it, and at the current state, the algorithm presented by Prantl et al leaves many questions open as:

- It is difficult to believe that the performance of the algorithm is not affected by the projection used (as it is claimed by the authors). At least, the relation between the area of a centre and the area of its corresponding AABB could be projection-dependent and the latter area is part of the rejection procedure. The authors should provide a sensitivity test on this issue. In my opinion, the algorithm should be optimized for a fixed projection and resolution and then convert any input array to meet the optimal algorithm requirements. Otherwise for the same meteorological situation, the user could obtain different outputs depending on the projection or the resolution.
- Apparently, the results depend on the isobar spacing (in fact it is one of the user selectable parameters). In my opinion, an automated method for detecting pressure systems should not be dependent upon the step at which the isolines are drawn. The area "T" enclosed by a "valid" system is again user-selectable. I assume this area also depends on the isobar step. The authors recommend using between 10.000 and 20.000 km^2, but this seems rather arbitrary, and it is difficult to believe (in absence of a specific test) that this area can be considered the same for low- and high-pressure centres. Figure 4 clearly shows that the number of systems detected heavily depends on the area threshold "T" and the isobar step chosen (see their Figure 4).
- It is not completely clear (the contours are not labelled nor coloured) but from Figure 5, apparently some important centres are not detected (as one in the middle of the equatorial Pacific or a very clear intense cyclone next to the Kamchatka Peninsula) while other, probably less meteorologically relevant (along Central America, for example) are classified as pressure centres by the algorithm. The list given here is not exhaustive.
- Apart of the three case-studies of Figures 5, 6 and 7, the authors evaluate the performance of their results by comparing them with a sample of 385 Met Office Analysis. They obtain a reasonable match (92% of the detected systems are also found in Met Office maps and conversely, 83% of the Met Office systems are found by the algorithm). Although these figures are reasonable, in my opinion the analysis is somewhat simplistic. First because the performance test is only done over the relatively organised North Atlantic (there are areas of the world much more complex as Africa or sub-tropical latitudes over land) and second, because the authors only use the number of detected systems to check the method.

Summarising, the authors' idea is interesting, but the algorithm given here is too simple and the performance tests are not convincing. The problem of localising by means of automatic algorithms meteorologically meaningful low- or high-pressure centres is, believe it or not, one of the most difficult in meteorological analysis. This is the reason because previous research on this topic usually considers not only the pressure field, but vorticity, local gradients, several levels, etc… because one needs more than a "large enough" local maxima or minima in a gridded SLP dataset to deal with the complexities of the synoptic scale meteorology.

Specific comments:

The quality of Figures 1 to 3 is not suitable for publication in an EGU journal. Figure 4 is clearly “over engineered”.