

Weather Clim. Dynam. Discuss., referee comment RC2  
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## Comment on wcd-2022-36

Anonymous Referee #2

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Referee comment on "The three-dimensional structure of fronts in mid-latitude weather systems as represented by numerical weather prediction models" by Andreas Alexander Beckert et al., Weather Clim. Dynam. Discuss.,  
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### Summary:

The paper by Beckert et al. documents the method, capabilities and calibration of a frontal identification algorithm that can be used to then produce 3D plots of those frontal structures. I found the paper to be written well with many interesting plots presented. Nonetheless, the paper does not provide significant advancement of an already existing method. Furthermore, while the case studies described in the paper are interesting and certainly do have the potential to be published in WCD (and I strongly encourage the authors to do this), their brief descriptions in this paper are not sufficient for WCD. I feel this paper would be better suited to GMD, for example, given the brief analyses of the case studies. I therefore do not recommend publication in WCD and that the paper should be passed on to GMD for consideration instead. I would happily re-review this paper from a GMD context if it were submitted there. I have provided some more major considerations for the authors below along with a list of minor points.

### Major points:

The paper feels disjointed in its current setup. I feel that Section 3 should be re-distributed into Section 5 so that 3.1 gets mixed in with the introductory paragraph of section 5, 3.2 goes at the start of section 5.1 (5.1.1 and 5.1.2?) and section 3.3 does likewise in section 5.2 (5.2.1 and 5.2.2). There would then be a nice flow from introducing the case study and the plots would flow logically from "concept" to "analysis". Currently there are methods in section 2, an introduction of the case studies in section 3, another methods section is given in section 4 and we then return to the case studies in section 5. As you can see, the paper "jumps" around a bit. Putting section 3 into section 5 and re-ordering the figures will make it flow much better instead of having to refer-back to section 3 from section 5. Furthermore, section 5 jumps around too – better to stick with the one case cyclone and focus in on several features associated with it i.e. make 5.3 part of 5.1 e.g. 5.1.1, 5.1.2 and 5.1.3 then push section 5.4 into 5.2 (5.2.1, 5.2.2 and 5.2.3).

Section 2.3 and Figure 2: The wording in the numbered list should match the plots and the plots should then be referred to in each of the points of the numbered list e.g. point 1 goes with Fig 2a, point 2 with Fig 2b etc. It seems that this Figure-numbered list relation does not hold true in all cases so the authors should either adjust the list or adjust the figure to make the two complimentary. There are also no descriptions of the panels in the Figure 2 caption so you should say "see Section 2.3 for a description of the panels a-h" in the figure caption.

Figure 3b: This is difficult to interpret and would probably be better if the fronts were colour coded to show the difference between warm, cold and occluded (red, blue and purple?). I just find the figure to have a lot of "green swirls" that really need to be separated visually to make the features stand out. Furthermore, the scale is too smooth to really show the location of the fronts in the vertical. Using different colours for the type of front or markedly different colours at each pressure level might make these (and all the other figures that use the green-white colour scaling for the pressure heights) clearer.

Figure 9 and Lines 475 – 490: This whole description is very difficult to see as both the paper and online plots are far too "busy". Surely you can distinguish between the "fast ascending" and "slow ascending" trajectories and plot them separately. I would discard figures 9e and 9f and replace them with figures showing "fast" and "slow" ascending trajectories. You would then only need to slightly re-word lines 475-490 to account for this change. I feel that the whole paragraph would then read much better with the adjusted figure.

Figure 10: I'm not convinced this figure shows anything a 2D figure wouldn't show. It is trying to do too much by overlaying everything on the same plot and so the details are lost. I would like to see this separated out into ~6 panels that show the 3D structure clearly from the best angle. I would also suggest removing the land and just focussing on the cyclone itself (maybe adding in isobars for cyclone-centric orientation). In its current format, it shows less than what a 2D plot shows – but has clear potential to be excellent if it were better focussed (I can see why you would want to see all of this in 3D, it just does not show up well). Figure A3 for cyclone Egon is actually clearer; however, A3 would also benefit from having a slightly more upright angle, removing the land and adding isobars.

Lines 554-568 and Figures 11, A4 and A5: I found this passage very difficult to read and follow. The 3D plots make things difficult to reconcile. I would suggest circling exactly where you want the reader to look instead of trying to describe it (lines 554-556). You could then say something simpler like, "There is a gap in the frontal surface between 700-600 hPa in the ECMWF data whereas the frontal surface is present in the COSMO simulation (circled in Figs 12a, b)." It just focuses the reader on the point you want them to look at. I also think it might be worth including Figure A5 in Figure 12 and even plotting the difference between the THETA\_W fields between COSMO and ECMWF (and possibly likewise for THETA). The reason for that is that I'm not convinced by your "convection drives differences in the temperature gradient" argument. It is possible that the opposite is true e.g. the temperature gradient around 700 hPa is stronger in COSMO (i.e. simulated better), which then leads to the development of convection along the frontal zone. The

front may have been going through frontogenesis and the convection is just the result of that. I therefore do not believe your description of this process is convincing enough to be certain of the process you describe. The analysis does not contain enough detail.

**Minor points:**

Figure A1: I cannot find any reference to this figure in the text. Can it be removed?

Figure A2: I think this can be removed if you adjust Figure 9 (you could even include the jet in figure 9).

L221-224: Sentence starting "The method uses..." is very long. Please split this in two.

L287: Change "a decay stages" to "a decay stage".

L300: Change "UTC5.3" to "UTC".

Figure 3 caption: remove the extra ")5.3" near the end of the third line.

Line 321: Add "on" before "17 January 2018".

Line 324: Change "As a result of the cyclone, high wind speeds were registered..." to " The cyclone caused high wind speeds..." to be more concise.

Line 328: Change "... this is a Shapiro..." to "... this was a Shapiro..." as it happened in the past.

Figure 7: Please include the time and date for these plots. It helps for stopping the video in the relevant place (I can see this information is in Figure 2 but should also be here). Also, the caption is unnecessarily detailed as you say most of it in the text. The caption only needs the description of the figures, not the explanation about what each step does (as you explain in the text). Please trim the caption down to make it easier to read.

Figure 7c: Maybe I'm missing something, but it looks like the feature is still in the plot under the blue circle (unlike in 7e where the northern feature disappears). Is this figure correct? Additional – Line 429 (related to Fig 7c comment) – OK I see this more now, but it is very subtle. I would focus that blue circle in to EXACTLY where you want the reader to look.

Figures 7d: it is very hard to work out where this cross section is taken without looking at 6f as there's too much shading. If you put a line on Figure 6c to show the location of the cross-section then that would help make it clearer (then refer to it in the caption).

Line 427: should it be "of the filter" instead of "of filter"?

Figure 9: The plots get very 'busy' with time, especially figure (f). If you could show where the viewpoint 2 and viewpoint 3 cross sections are located in figure (a) for example, then it'd help. If the land masses weren't blocked out so much in / at the very periphery of figure (f) then that would help.

Line 475: "north-easterly direction" should really be "north-eastward direction".

Fig. 11: For clarity, it might be worth making the THETA\_W scale blue-red so that the grey shading shows up better. The grey-blue end could be confused with the horizontal gradient shading.

L585: Change "The most easterly front, ranging from..." to "The most eastward front, extending from...".

L587: Do you mean blue tubes for Fig 13b not green?

Lines 594-595: I do not see the need to describe the feature between 700 hPa and 500 hPa as it has no relevance to what you are focusing on (i.e. the low-level THETA\_W feature). Please remove.

L647-648: "We find that cold frontal...", I disagree with this sentence because you have not shown this. The description of the case study is not detailed enough to be certain of this reasoning (as mentioned in the major points).