

# Notes for WCD-0001, “How an uncertain short-wave perturbation on the North Atlantic wave guide affects the forecast of an intense Mediterranean cyclone (Medicane Zorbas)” by R. Portmann et al.

## Background

This is a massively improved manuscript. The authors have clearly taken the time that they needed to revise their approach to the study and present the material in a clear and logical way. The result is a document that is fun to read and easy to draw conclusions from.

I have one general concern regarding the robustness of the storyline for different (primarily earlier) initialization times, and a few specific questions that may require some adjustments to the analysis or text to address (notably Specific Comments # 28, 36, 37 and 59). However, once the authors have completed a set of relatively minor revisions in response to these remaining issues, I look forward to seeing this article in print. I truly appreciate the efforts that the authors have made to bring this manuscript up to a very worthy standard.

Reviewer: Ron McTaggart-Cowan

Recommendation: Minor Revisions

## General Comments

1. This detailed analysis is presented for a single initialization time. Do you know if these results are robust for other (primarily earlier) initializations? Does the previous set of ensemble forecasts show a similar range of solutions for the PV streamer that map onto difference cyclone developments? I understand that repeating this analysis for other initializations would be a huge undertaking and make the work much longer than it is. However, can a subjective evaluation of the robustness of the result be made relatively easily and the results noted in the conclusions?

## Specific Comments

1. [L10] Suggest “... amplified **on** the stratospheric side ...”.
2. [L24] Suggest the more direct “... investigates the impact of PV streamer position uncertainty on medicane development”.
3. [L27] Would everyone agree that medicanes are **the** main meteorological threat in the Mediterranean region? There are other local wind hazards and there’s the flooding on the Alpine south-side that can be pretty intense. I don’t mind if you want to stick with the current wording, but perhaps consider adjusting this to something like, “... are therefore a leading meteorological threat ...”.

4. [L34] Add "... a range of modelling case studies ..." to make it clear that the errors are in a numerical model, not the real atmosphere.
5. [L40] Replace "far equatorward reaching" with "high amplitude" or "meridionally extended".
6. [L48] Suggest citing Clark et al. (2017) and Keller et al. (2019) when mentioning ET here.
7. [L55 and L57] Wikipedia is an unstable reference, so ideally primary material should be cited here instead. If Wikipedia absolutely needs to be cited, then an access date should be provided.
8. [L57] Suggest simplifying to "This cyclone belonged to a special class ...".
9. [L62] Suggest "significant damage" as more common.
10. [L62] The note that "sometimes they acquire the typical appearance of a hurricane" suggests that sometimes medicanes don't acquire hurricane-like characteristics. Given that medicanes are typically identified by morphology, this seems unlikely and therefore the statement should be strengthened.
11. [L73] Remove comma after "during ET".
12. [L97-107] This paragraph is too general to be particularly useful, and contains a defense of the experimental design that would be better placed in a data/methods section. It also disrupts the flow between the "study objectives" paragraph and the "outline" paragraph at the end of the introduction. I think that this paragraph should be removed.
13. [L131-L133] The TRMM mission ended in 2015, replaced by the GPM. Are the 2018 data used here processed by the legacy TRMM algorithm or the newer IMERG algorithm? The text here may be completely correct, but please confirm.
14. [L138-L139] The idea of intersection points between a trajectory and a layer is a bit strange. I would ordinarily have thought of a trajectory line intersecting a 2D plane (e.g. the 325 K surface). Doesn't the use of the 322.5 K lower boundary for the layer simply imply that the points are defined as the locations at which the ascending WCB trajectories cross the 322.5 K surface? The Fig. 1 caption suggests that the simpler 325 K surface definition is used, at odds with the description here. The Fig. 2 caption suggests that the 322.5 K surface is used instead. I realize that the difference between these is relatively small, but consistency is desirable.
15. [L140] Suggest "around **the** cyclogenesis position".
16. [L148] This use of the CPS does not seem to distinguish between convection- and seclusion-induced warm cores. Is there any risk that some of the members classified as medicanes by the CPS are the result of frontal seclusion, a process that is not associated with tropical transition? Might B be useful to distinguish between storms at the early stages of seclusion and those whose warm cores are diabatically generated?
17. [L172-L182] This is an excellent description of your testing technique: very well done.
18. [L184] Suggest reversing "provides first".
19. [Fig. 1] The PV streamer has already formed in (d), so the phrase "before the formation of the PV streamer over the Mediterranean" should be removed or replaced with something like, "during the development of the PV streamer".
20. [Fig. 2] The contour interval for SLP should be noted in the caption (it looks like 4 hPa). The fact that 500 hPa height is shown in yellow contours should be noted, as should the contour interval used for this field.

21. [Fig. 2] Suggest adding “322.5 K **isentropic** level” to avoid confusion with the equivalent potential temperature that serves as the departure threshold.
22. [L206] Suggest inverting to read, “The PV streamer broke up at the time of cyclogenesis, resulting in the ...”.
23. [L207] Suggest replacing “following” with “subsequent”.
24. [L209] Suggest referring to Fig. 3a for locations to help with this discussion.
25. [L245] “Landfall” is usually written as a single word.
26. [L248] The phrase “about one-day period” is approximate and slightly strange. Was this an 18-h period? The exact length doesn’t matter very much here, so the phrase could simply read “... prior to cyclogenesis, the initial cyclone intensification, and the formation ...”.
27. [Fig. 4] A greyscale bar should be included for the brightness temperatures.
28. [L267] To be “substantial” this spread would need to be larger than typical ensemble spread at these lead times. If such a typical spread is known, it would be useful to add this line to Fig. 5 for reference. If it is not (and is not readily computed), then this sentence could be restructured to focus on the decrease in spread in the medium range.
29. [L287] Suggest removing “a” before “substantial”.
30. [L288-290] Suggest simplifying to, “To establish the dynamical link between uncertainties in the position (thus thermal structure) of the cyclone and upstream uncertainties ...”.
31. [L290] Suggest “classifies” instead of “allows separating the”.
32. [L292] Suggest “(clusters)” rather than the current subordination.
33. [L297] Suggest a full stop rather than a colon.
34. [L321] Suggest “... and amplification of these uncertainties along the ...”.
35. [L324] This section title would be more complete as “Uncertainty propagation from the North Atlantic jet streak to the Mediterranean PV streamer”.
36. [L336-L338] I agree that there are no WCB trajectories ending in this region. However, this does not mean that moist diabatic processes are not relevant to the uncertainty. I’ve included a satellite retrieval (Fig. 1 below) that shows extensive high-topped cloud cover in the region. In addition to potential latent heating effects, these clouds will affect the radiative heating profile. If the clouds are handled differently by the members in the different composite groups, they could explain the differences in the solutions rather than “dry upper-tropospheric dynamics” (L338). Imagine, for example, that members in which the local SPPT coefficients suppress the radiative heating tendencies do not amplify the ridge while those in which the coefficients amplify the heating signal create a much more robust ridge. If this is truly the sensitive region for the Mediterranean streamer, this difference in heating could cause the eventual separation of the solutions that is observed. I haven’t demonstrated that any of this is true, but the analysis in the manuscript does not rule out this possibility despite the assertions in the text.
37. [L346 and L362-367] This is a very 2D way of describing the tropopause evolution. What if you considered the “approach” of the high-PV contours as a steepening of the tropopause or development of a tropopause fold. This is of course necessarily related to the jet streak, but might give the readers a useful way to conceptualize the process that’s promoting wave amplification in some members. For example, the approach of a northern stream PV

perturbation towards the jet seems dynamically similar to the events discussed by Winters and Martin (2017).

38. [L351] Please avoid parenthetical negation (Robock 2010).
39. [L357] This trough is referred to as S2 in Fig. 1d. I think that's good because it's definitely a PV streamer rather than a trough at this time; however, the reference needs to be corrected here. Also, there is no S2 in Fig. 1c. Is it possible that the panel references are inverted here?
40. [L368-370] As in Comment #28, it would be useful to have a spread climatology in Fig. 5 for reference so that it is clear that this spread reduction is larger than would be expected by the decreasing lead time.
41. [L376-L379] There is also a notable difference in streamer tilt, with W more positively tilted and E notably more meridional (note the westward shift of the high-PV region over Eastern Europe in the E cluster). This suggests that the streamer may be in a slightly different stage of its life cycle in the different groups.
42. [Fig. 11] If it doesn't take too much effort, you could consider masking out significance regions that are too small to be meaningful. This would help to clean up the otherwise-beautiful plots a bit without any loss of important information.
43. [L411] Remove comma before "because".
44. [L413] Remove dash after "upper-" (this is not a compound adjective).
45. [Fig. 12] I really like Fig. 12 and the associated discussion, but the precipitation panel should appear as its own figure (Fig. 13). There is no association of either axis between panels a and b with panel c, so placing them in a single figure is not beneficial.
46. [L427] This sentence could/should be moved to the figure caption.
47. [L436] Suggest replacing "following" with "subsequent".
48. [L439] Consider replacing "crucial role" (which doesn't really fit with the remainder of the sentence) with "necessity".
49. [L439] Replace "... heating and cross-isentropic ..." with "heating, cross-isentropic".
50. [L444] Change "much lower" to "much reduced" to avoid ambiguity with precipitation fluxes in the vertical.
51. [L445] Change "indicating much lower latent heating" to "indicative of a reduction in column-integrated latent heating".
52. [L445-L446] Without more context or an analysis of why this precipitation bias exists, this does not seem like an "interesting side remark". I think that this sentence should be removed to maintain the focus of this discussion.
53. [L447] Suggest changing "pathway" to "evolution".
54. [L447] Unless WCD uses the APA style, I do not think that the word following a colon should be capitalized.
55. [L451] Consider replacing "... this storyline and they are mostly ..." with "... this archetype, mostly ...".
56. [L459] Suggest "... were used to assess how uncertainties originating in a short-wave perturbation on the North Atlantic wave guide influenced a downstream PV stream and, as a result, ...".
57. [L461] Suggest inverting "appeared first" and changing "at" to "on".

58. [L461-463] This summary makes it sound as though the PV differences and the short-wave perturbation happened (by chance) to occur at the same time. Is there not a dynamical link between them? The subsequent sentence suggests that they were both prompted by the high-PV perturbation in the polar stream, but this all seems like a weaker connection than the earlier analysis implied.
59. [L465 and L491] As noted in Specific Comment #36, I think that the current analysis does not rule out the importance of upper-tropospheric moist processes (cloud formation) and their secondary effects.
60. [L465] The referent of his pronoun (“they”) is unclear.
61. [L471] Suggest “... cyclogenesis that affects cyclone ...”.
62. [L478-480] I like this discussion and the context of systematic errors that you cast it in.
63. [L482] I think that your analysis (including trajectories) was robust enough to let you conclude using the definite article that “The reason for this ...”.
64. [L483-L484] Recommend putting a full stop after “region” and beginning the next sentence as “This prevented ...”.
65. [L484] Replace “... to be strong enough and reach ...” with “... from being strong enough and reaching ...”.
66. [L488] Suggest adding “the” before “medium-range”.
67. [L493-L494] I think that I understand what you’re trying to say here, but the concept of “upstream influence” is strange enough that I think that a reformatting of this sentence would help to clarify your conclusion.
68. [L499] Suggest removing “for example”.
69. [Fig. S4] Please use the full citation method requested at <https://www.lightningmaps.org/about>.

## References

Robock, A. (2010), Parentheses are (are not) for references and clarification (saving Space), *Eos Trans. AGU*, *91*(45), 419–419, doi:10.1029/2010EO450004.

Winters, A. C., and J. E. Martin, 2017: Diagnosis of a North American Polar–Subtropical Jet Superposition Employing Piecewise Potential Vorticity Inversion. *Mon. Wea. Rev.*, **145**, 1853–1873, <https://doi.org/10.1175/MWR-D-16-0262.1>.

## Figures

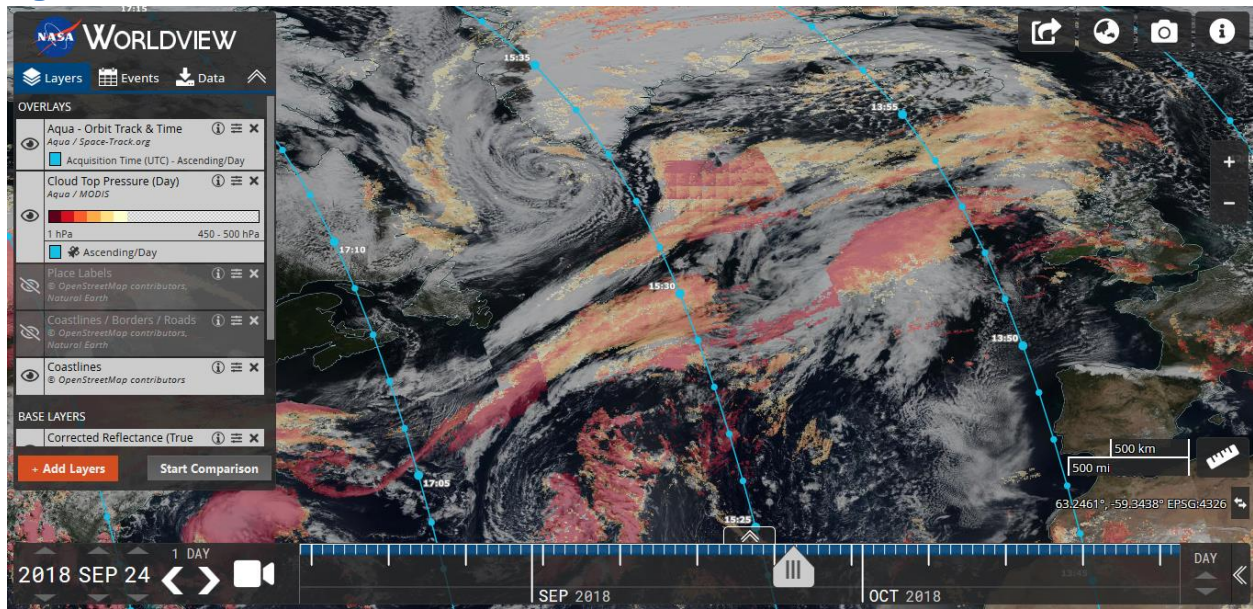


Figure 1: Composite satellite image for 24 September 2018 from NASA Worldview. Aqua/MODIS estimates of cloud top pressure are shown in warm colours for >500 hPa as shown on the colour bar.