

***Interactive comment on “Spatial and vertical structure of precipitating clouds and the role of background dynamics during extreme precipitation event as observed by C-band Polarimetric Doppler Weather Radar at Thumba (8.50° N, 77.00° E)” by Kandula V. Subrahmanyam and K. Kishore Kumar***

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Received and published: 4 August 2020

We are very much thankful to the referee for reviewing our manuscript and providing valuable suggestions. We have exactly followed the referee's instructions and revised the manuscript. We are herewith providing point-by-point response to the referee's

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comments. The replies are typed in 'bold' letters.

Dear author, your research represents a very significant point in the improvement of the knowledge of Indian Monsoon dynamics, from many points of view. However, your manuscript needs a lot of changes, which are strictly necessary to be done before its acceptance. General comments The author presents the capabilities of a C-band Doppler radar with dual polarimetric capabilities for analyzing the precipitating structures in a heavy rain event. It is not necessary including the radar coordinates in the title neither in the abstract. Besides, I suggest indicating the country where the radar is placed (not all the readers are familiarized with the Indian places and it allows understanding better what you will find in the manuscript) English needs a huge reviewing. I suggest only some changes to the abstract, but there are a lot of errors in all the sections. Please, you should review the grammar. We are very much thankful to the referee for providing the positive comments to further improve the manuscript. We removed the radar coordinates in title and abstract in the revised manuscript. We considered the referee's valuable suggestions and utmost care is taken for correcting the English grammar in the revised manuscript.

Abstract "the cynosure" (besides, cynosure is not usual in atmospheric papers. I suggest "a focus of interest") Modified in the revised manuscript

Please, remove "as well as for common men" Removed in the revised manuscript

"This catastrophic event occurred from 12th to 17th August 2018 in which" Modified in the revised manuscript

"and the time evolution of the radar reflectivity structure is examined" Modified in the revised manuscript

"upper-level" and "lower-level" (hyphen) Modified in the revised manuscript

"It is well-known that these extreme events have been increasing over the Indian region during the past few years." Corrected in the revised manuscript

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I suggest rewrite as "The state of Kerala (India) experienced extreme rainfall events during August 2018. These heavy rains led to major flooding, regarded as one of the worst natural disasters experienced by the area in the last hundred years." This is an example, but you should reduce your sentences. They are extremely long and difficult to follow. Modified in the revised manuscript

About the structure: Please, consider removing the lines 10-14. This is introductory and is not referring to your own work. The abstract is a trailer of your work, and you have to create interest in the readers using few sentences. All those not related to your analysis does not result interesting at this point. Following referee suggestion, we have removed those lines in the revised manuscript.

I suggest starting with the L18, and later you can present the event. Modified in the revised manuscript

In my opinion, what is the most interesting point of your research is that is the first time that Dual-Pol has been used in an event like this in your country. At least, I was not able of finding anything similar in the bibliography. Then, this is the key of your work and, besides the obtained results, shows that future research can improve notably the knowledge of the analyzed event type in India. Yes, this is the first study using the Dual-Pol observations used in our country. We are thankful to the referee for appreciating the scientific results presented in manuscript. We are now highlighted this point in the revised manuscript.

Finally, "abbreviations should not be included without explanations" ([https://www.natural-hazards-and-earth-system-sciences.net/for\\_authors/manuscript\\_preparation.html](https://www.natural-hazards-and-earth-system-sciences.net/for_authors/manuscript_preparation.html)) and your abstract has 345 words (an abstract of 100–200 words. [https://www.natural-hazards-and-earth-system-sciences.net/about/manuscript\\_types.html](https://www.natural-hazards-and-earth-system-sciences.net/about/manuscript_types.html)) We apologize for this and the abstract is limited to 200 words in the revised manuscript.

Keywords The keywords are those words that summarize your work. Do you think that

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the chosen ones are the correct? For instance, Monsoon or Dual-Pol provide more information. We have modified keywords as "Extreme precipitation, Monsoon, C-band DWR, Reflectivity, Dual-Pol" in the revised manuscript.

Introduction L69: How deep are the convective systems? Are you referring to mesoscale convective systems (MCS) or to mesoscale convective complexes (MCC) or to other type of convective mode? Can you explain this point? Convective systems as tall as 14 km are observed during this events. But their frequency of occurrence relatively small as compared to stratiform systems. The observed deep convective systems are mainly associated with Mesoscale Convective Complexes (MCC). These systems consist of large stratiform precipitating regions as well as anvil clouds.

L71: what IPCC means? Intergovernmental Panel on Climate Change (IPCC) and this is now included in the revised manuscript.

L96: what ISM means? Indian Summer Monsoon (ISM) and this is now included in the revised manuscript.

L141-144: I suggest rewriting these lines. You should introduce here the objectives (main and secondaries) of your research. However, you are explaining the analysis in general. Description of C-band polarimetric DWR and base products. We have introduced main objective of the present study and then explained the analysis in the revised manuscript as suggested by the referee.

L155-156: is the radar operative for weather surveillance or is used only for research purposes? The radar is operative for weather surveillance. However, the radar operation is limited to day time on most of the days except during meteorological events of interest such as cyclones, monsoon onset and extreme weather events.

L160-161: it looks to me that the degrees of the elevation seem "0" (zero) super index. Please, change by the correct symbol (o). Besides, if you include them in table 1, you do not need to write here. Corrected in the revised manuscript

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158-180: Which is the range of the radar? Is the same for all elevations? The Range of the radar 240 km for pulse width of 1 micro second and it is not the same for all elevations.

Table 1: the caption is not well placed Corrected in the revised manuscript

L175: san? Or scan? It is 'scan'. We apologize for the mistake and now corrected in the revised manuscript.

Figure 1: I suggest you to remove the mid and right panels (which not provide any information), and makes the left one larger. Besides, you can improve it, including a general map of India and changing the current one by another considering the topography of the region. The new proposal would orientate the reader about the radar environment. As suggested by the referee, we have removed the mid and right panel in Figure 1 and included topography of the region in the revised manuscript.

Figure 2: Which software have you used for displaying the radar data? Interesting to include in the text. Besides, it results interesting to explain the reason of the discontinuity in the N ray and, also, in the 120o direction (E-SE). You need to add some labels for helping the identification in the text. (L208-256) We have used 'MatLab' software for processing and displaying the DWR data in this paper. We also added proper labels in the figure in the revised manuscript.

L221: I suppose that you are referring to fig. 2 Yes and we apologize for the mistake.

For the para that goes from L208 to 256, I suggest a re-distribution of the text. In my opinion, it is necessary that first you introduce the variable (e.g. reflectivity, radial wind, spectral width...), explaining what you analyze in the imagery, and after, a description of the image of figure 2. Besides, including the labels would help to detect the key signatures and understanding better the imagery from the point of view of the reader. In this point, you can combine with the meteorological explanation. I suggest <https://journals.ametsoc.org/doi/full/10.1175/BAMS-D-17-0317.1> for describ-

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ing dual-pol variables, but there are many other in the bibliography. As suggested by referee, we have described the DWR parameters such as reflectivity, radial wind and spectral width along with polarimetric variables (Zdr, Phidp and Rho) in the revised manuscript. Further, we also included the proper labels for the better understanding of the figures in the revised manuscript as suggested by referee.

Results and Discussions I suggest you to change the title of the section by "Analysis of the event" Changed in the revised manuscript

Figure 3: the text about this figure must explain why you have selected the concrete period. Besides, I suggest indicating in the map what you are you referring in the text (e.g. "deep convection, where it was located over the Arabian Sea"). Why you do not indicate the line at 7.51 UT? Another thing about this time, which is important in the text: "most of places in and around Kerala", please, mark with a star or a similar symbol. We have now included the map in the figure with proper labels. Also mentioned the time period in the revised manuscript

Figure 4: it would be nice to know the transect used for making the cross section (you can display it in figure 3). Besides, I think that these graphs should be accompanied of other products (radial wind or polarimetric products).I don't understand the meaning of the figure 3 if you include after figure 4. What are you trying to explain in both figures that differentiate them? Please, you must explain clearly the intention of each figure. We have now added transects used for cross section. We also included cross section of radial wind along with reflectivity maps in the revised manuscript. Figure 3 represents the temporal evolution of spatial structure of precipitating clouds. It provides the information on rapid development of clouds, while Figure 4 provides range-height intensity at two fixed azimuth (320 and 326 degrees).

Figure 5: I don't understand why are you always considering the same direction of the cross section if the system you follow is moving in time. Question about this figure and the radar functioning: did you notice about attenuation signal caused by heavy rainfall

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over the radome? Figure 5 is removed in the revised manuscript as suggested by other reviewer. We did not see any significant attenuation caused by heavy rainfall over the radome.

Figure 6: title of "y-axis" should be "direction". The description of this figure is vague and it is basic in the present manuscript. In special, the part of the polarimetry should be improved. We have modified figure6 in the revised manuscript. We also added description on polarimetric parameter Zdr(differential radar reflectivity).

I do not understand the link between figure 6 and 7. In the previous cases, figures 3, 4, 5 and 6, the interaction between them was weak and need to increase some sentences explaining why you move from one subject to the other. In the case of the transition between figures 6 and 7, this transition is null. You change from polarimetric analysis of precipitation evolution to daily cumulated rainfall without explaining this move. Please, include some connectors between all the figures, being more concise in the last case. We have now included the connection and modified the text in the revised manuscript as suggested by the referee.

Figure 7: the figure needs a clear improvement. There is no spatial reference (location of the area of analysis). Besides, you should explain many artifacts that appear in the imagery: effect of topography, beam blockage, propagation of the structures... We have improved the figure as well as its description as suggested by the referee.

Figure 8: Please, include in some of the previous figures (referent fig. 1) the location of the radiosonde station. This is important to know the reliability of the thermodynamic analysis on respect the area of analysis. Besides, why do you include all the month period? Why do you not focus on the period of interest, and include the daily cumulated (or better the 12-hour cumulated) rainfall values in the area of analysis? What is Western Ghats? For foreign people, you need to explain (and include in a map) all the geographic elements included in the study. (another example is the Arabian Sea) We have modified the figures with geographic map and provided the labels in the revised

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manuscript. We have also included the location of the radiosonde in the figure. We have now focused on the extreme precipitation period, i.e., 12-18, August 2018 and included the daily cumulated rainfall in the present study.

Sections 3.1 and 3.2 must be better connected: you need to include some sentences explaining how meteorological aspects are related to the radar imagery. Included in the revised manuscript

Summary and discussions The sentence "The maximum reflectivity and width of convective core found to be 45 dBZ and 7km respectively." makes reference to something not explained before. You cannot write here about something not shown previously. Besides, you need to explain each conclusion in a different point. We have now discussed this results in section 3 and the conclusions are presented point-wise.

Acknowledgements: Why are you using "the authors" if only one single person signs the manuscript? I have added an author with the approval of handling editor, before the paper was in open discussion.

References: "These references have to be listed alphabetically at the end of the manuscript under the first author's name." I only attach some examples, but it may exist in more cases. We apologize for this and stand corrected in the revised manuscript.

Please also note the supplement to this comment:

<https://nhess.copernicus.org/preprints/nhess-2020-2/nhess-2020-2-AC1-supplement.pdf>

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2020-2>, 2020.

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