Responses to reviews of 'Synoptic conditions and atmospheric moisture pathways associated with virga and precipitation over coastal Adélie Land in Antarctic'

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April 2020

Review 2

General Comments

This manuscript investigates, using ground-based measurements (MRR) and reanalysis simulations (back-trajectories and diagnostic tools), the synoptic conditions that produce precipitation, both virga and surface snowfall, over Durmont d'Urville station. The authors found that precipitation and virga (pre- and post-precipitation) are associated to different phases of crossing warm fronts. In the study, they identify the synoptic mechanisms that produce such precipitation, showing the importance of large-scale lifting into the warm conveyor belt. Although some sublimation produced by katabatic winds is almost always present in the three phases, what distinguishes surface precipitation from virga is an enhanced lifting near the station that releases moisture picked up nearby. Since first MRRs (in Dumont D'Urville and Princess Elisabeth) were recently installed in Antarctica, several advances in the field of Antarctic precipitation have been produced. Now, precipitation and sublimation is been better quantified, and we know better the ability of the reanalyzes to reproduce it. This is another piece of work that improves our knowledge about how moisture is released as precipitation over the Eastern Antarctic coast. In this case, the investigation focuses on the conditions that produces such precipitation. Although most of the results are not unexpected (for example that precipitation is associated with a cyclone west to DDU), they are quantified. In my opinion, the most important finding is showing that the areas where moisture is picked up, is in the Southern Ocean near to the station that may have implications for ice core analysis.

Piecemeal The title is clear and clearly define the object of this study. Introduction is well written, and the unifying thread is appropriate. Relevant

literature about previous studies about East Antarctic precipitation are cited. The objectives are clear and concise. The several data sources and methods of this paper are clear and correctly described. Results a reorganized and very well exposed. I like that authors have shown a study case to exemplify the statistical analysis. I think that it enriches the investigation.

Conclusions I think that the subject of this paper fits the target of The Cryosphere journal. It is furthermore very well written and structured. I think this interesting research should be published in The Cryosphere. I only have very few minor reviews.

We gratefully thank Sergi Gonzalez for the thorough review of our article and for supporting its publication in The Cryosphere journal. Please find herebelow our responses to his comments:

Specific Comments

-P14 L1 Please, specify in which height start back-trajectories. The statistics is for the lowest back-trajectories or for all the starting heights from 1000 to 300 hPa? If the later, it would be interesting showing the differences between low-level trajectories, medium-level trajectories and high-level trajectories (maybe in another Appendix), since their pathways may be very different.

The statistics presented here are for precipitating air parcels (see Fig.2 in the paper for the selection of precipitating air parcels). The origin pressure (altitude) of tracked air parcels thus depends on the vertical gradient of the snow water content at DDU, and can be different from one timestep to another during a precipitation event. Note that most precipitating air parcels arrive above DDU in the mid troposphere (pressure generally comprised between 550 and 700 hPa, see Fig. 9 of the paper). Including all the back-trajectories in the statistics would of course modify the maps of back-trajectory occurrences in Fig. 8. In particular, including trajectories arriving in the low-level dry katabatic layer at DDU would lead to an increase of trajectory occurrences over the Plateau because katabatic air parcels originate from the Plateau (not shown). Note however that our point here is not to study the trajectory of air parcels according to their arrival height at DDU but to observe the general pathway and origin of parcels that lead to precipitation generation above DDU during the pre-precipitation virga, surface precipitation and post-precipitation virga periods. To clarify this point, we have modified the introduction of Fig. 8 in the text as follows: 'Maps of 2-day back-trajectory occurrences of precipitating air parcels (see Fig. 2 for their selection) for the three composites are plotted in Fig. 8. It should be noted that trajectories of non-precipitating air parcels - among which those arriving in the low-level dry katabatic layer - are not included in the statistics.'

-Fig 7 Showing Equivalent Potential Temperature at 700 hPa is a good choice to show here because it is high enough to penetrate into the continent but low

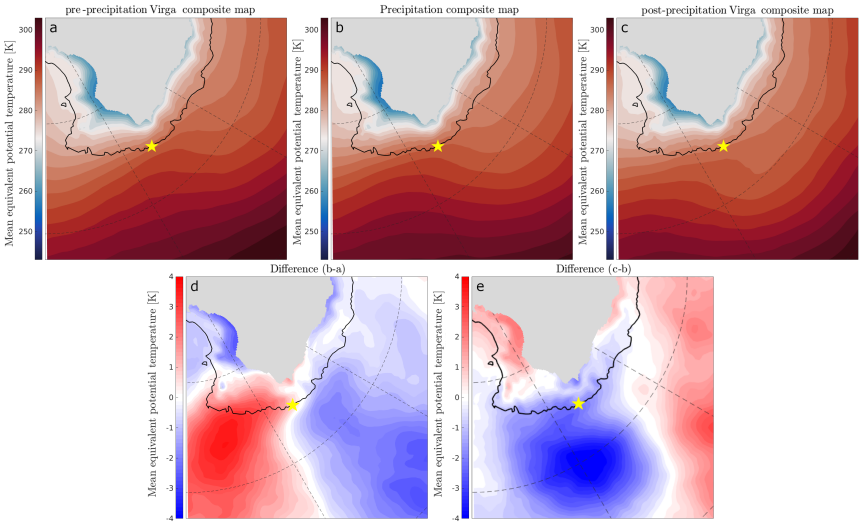

Figure 1: Composite maps of equivalent potential temperature at 700 hPa for the pre-precipitation virga composite (panel a), surface precipitation composite (panel b) and post-precipitation virga composite (panel c). Panel d shows the difference between panel b and panel a, panel e the difference between panel c and panel b. Regions with a topography higher than 2500 m (≈ altitude of the 700 hPa level) have been shaded.

enough to show the low-level front. However, using the 700 hPa field over the plateau has no much sense since it intercept the terrain showing extrapolated values. The authors should shade (in black for example) the area over 2500 or 3000 m to avoid to distract the reader with the values under the terrain.

Following your recommendation, we have shaded the regions with an altitude higher than 2500 m.

-Figure 7d is a good way to visualize the differences between pre-precipitation virga and precipitation stages, since at first glance, maps look similar despite the differences. I suggest also to show the difference between c-b. Following your recommendation, we also show the difference between c-b (Panel e in Fig. 1). We have also modified the end of Sect. 4.2.2 as follows: 'During post-precipitation virga (Fig. 7c), the warm sector has penetrated into the Plateau, while relatively cold air is now present to the north and east of DDU suggesting a further rotation of the cold sector of the cyclone (Fig. 7e). Such a picture overall concurs with our inferences from Fig. 6.'

- P10 L3-9 The paragraph 'Given the almost...' have only one sentence. Usually paragraph have several sentences and describe one idea. So, I suggest including this paragraph and the following together with the previous one (that

starts in the previous page) since the authors are arguing about the same idea
This has been done.