

Interactive comment on “Evaluation of coastal Antarctic precipitation in MAR3.9 regional and LMDz6 global atmospheric model with ground-based radar observations” by Florentin Lemonnier et al.

Anonymous Referee #2

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General Comments

This manuscript examines the vertical profile of precipitation over Dumont d’Urville research station in Antarctica, comparing surface based radar observations to two models: the meso-scale MAR model, and the general circulation LMDz model. Sensitivity tests are conducted with the MAR and LMDz models to explore the changes to snowfall representation that result from modified domain size, resolution, and various parameterizations.

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The introduction talks broadly about precipitation over Antarctica in models and observations, but the focus of the analysis is on a particular coastal location. It would be helpful for the introduction to more clearly set up the importance of the coastal analysis. The methods section needs to be more precise regarding the experimental setup. Because the methods are slightly vague, it is difficult to interpret some of the results (see specific comments below). The detailed sensitivity experiments will likely be of great interest to cryosphere researchers within the LMDz and MAR modeling communities, and perhaps of general interest to the larger precipitation modeling community. The conclusions are nicely presented, highlighting the interesting result that dissipation plays a relatively more important role than microphysical parameterizations in LMDz precipitation over Dumont d'Urville. Overall, this manuscript would benefit from a detailed edit of the text for clarity and flow. I have pointed out some specific instances where the text should be improved, however there are too many to call out each individually. The wording/language issues detract from the analysis and make it hard to follow the narrative.

Specific Comments

[P2L6] The first sentence requires a citation.

[P2L10] While precipitation is the largest positive contribution to the surface mass balance, perhaps it would be worth acknowledging water vapor deposition here as well.

[P3L1] "And even though the simulated surface precipitation is compared to an observation level at an altitude of 1200 meters above the local surface, the discrepancy between data and models is large, and questionable for the future prediction of precipitation." This sentence implies that the satellite rate is not appropriate to compare to the surface. The CloudSat data product used in Palerme et al., 2017, 2C-SNOW-PROFILE, provides a surface snowfall rate estimate based on the reflectivities aloft. Consider rephrasing.

[P3L3] "In addition, the agreement between data and models is even worse for the

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simulation of precipitation on the plateau than over the peripheral regions (Palerme et al., 2017; Roussel et al., 2019).” Since the manuscript analysis is focused on a coastal location, this does not seem relevant for the introduction.

[P4L4-10] This part of the methods section is a bit unclear. Are the “surface schemes” that provide forcing of the atmosphere from below based on climatology? Perhaps it would be helpful to include a map showing the location of the station as well as the region that has been stretched. At a minimum it is important to include the latitude and longitude of the study area, giving an indication of how far away the “nudging” is occurring.

[P4L12] “The vertical precipitation profile studied at Dumont d’Urville in the LMDz model is selected over continental surface.” A map would be helpful to understand what you say here. How large is the region used for the vertical precipitation profile? Do you mask out information over the ocean?

[Figure 1] I am not familiar with looking at vertical profiles of accumulation. Since snow does not actually accumulate above the surface, perhaps a vertical profile of rates would make more sense?

[P6L11] “allows these simulations to be run as “critical” cases of MAR use” For a non-MAR specialist, it is unclear what this means. This sentence does not seem necessary for understanding the modifications you’ve made.

[P7L9] “The different imposed values are summarized in table 1” Why were these particular values chosen?

[P8L3 and Figure 3] Are these vertical profiles only the values over the continental surface (as mentioned in the methods), and if so, which grid boxes are averaged within the BIG and SMALL domains to produce the profiles. Perhaps the grid boxes used could be drawn in Figure 2?

[P8L30] “We therefore made a comparison. . .” I am unclear of the connection between

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the preceding sentence and the comparison this statement goes on to describe. Consider revising to make the connection clearer.

[Figure 4] An x-axis label is needed. The location of Dumont d'Urville is referenced in the text, but it is unclear where the research station is in the figure.

[P9L7] "3.2 Horizontal resolution in LMDz" In the text of this section, you are clear that the horizontal resolution is the same inside the zoom, so perhaps a section heading like "Horizontal configuration in LMDz" would be more appropriate?

[P12L3] "This means that outside the red frame, the BIG simulation is closely following ERA-Interim reanalysis." Looking at your Figure 7, it seems that the area outside the frame is showing differences in all four panels. It would be helpful to have context as to what difference values would be considered large for the variables.

[Figure 7] What is the reasoning for presenting the differences at these two particular levels (950 and 500 hPa)? In the text, I do not see a discussion of one level vs the other, so it is unclear why both are included.

[P16L5] "when a precipitation event occurs (e.g., February 1, 10, 14, and 21)" Perhaps highlight precipitation time periods in Figure 9 so they are more clear to the reader? Do the control and D09 simulations always precipitate at the same time intervals?

[P16L6] "triggered by higher temperature gradients and moister atmospheric masses" It is not clear from Figure 9 that there are stronger temperature gradients or moister air masses. Perhaps reference supporting figures/references/analysis that can support this statement?

[Figure 11] This figure highlights how strong the gradient in precipitation is near Dumont d'Urville. With such a sharp gradient, it seems very important to document what region (location and size) is averaged to get your model vertical precipitation profiles. For example, in Figure 12, where the MAR 5km resolution and LMDz 25km resolution vertical profiles are compared, how many/which grid boxes are averaged? Are multiple

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MAR grid boxes averaged to cover the same spatial region as LMDz? Recommend clarifying this in the methods section.

[P18L18-20] “When a correct general circulation is forced by configuring a small zoomed region where the centre of the zoom remains influenced by the ERA-Interim reanalysis and by improving the GCM dissipation adjustment in a less dissipative way, the model generates a precipitation profile at Dumont d’Urville that is in excellent agreement with the observed profile.” Is the suggestion here that the dissipation adjustment could/should be made to the standard setup of LMDz for more accurate snowfall representation in coastal Antarctica? Is it likely that precipitation characteristics in other regions would be improved/changed by such an adjustment?

Technical Corrections

[P1L6] MAR isn’t defined

[P2L8] remove period in “mm.yr-1”

[P2L24] “The calculation time is crucial”, crucial to what? Consider rephrasing this sentence for clarity.

[P4L1] “water vapor” instead of “vapor water”

[P4L20] “according to (Lin et al., 1983)” remove the parentheses.

[Figure 8] Recommend changing the line color for better contrast. Particularly for D07, since it so closely resembles D01.

[Figure 9] Remove the hard return between the end of the first sentence and the start of the second in the figure caption.

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