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Interactive comment on "Analysis and evaluation of WRF microphysical schemes for deep moist convection over Southeastern South America (SESA) using microwave satellite observations and radiative transfer simulations" *by* Victoria Sol Galligani et al.

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We would like to thank the reviewer for his/her comments. Below we address each of the comments made.

Major comments:

1. Line 181-190: Is there any specific reason to select these three microphysics

schemes? Or just randomly? Why are both the WSM6 and WDM6 schemes selected? This study targets on frozen particles. However, WSM6 and WDM6 use the same parameterization of frozen particles. The performance of WSM6 and WDM6 are consistent for most of the results shown in the manuscript. Is it necessary to include both of them?

The WSM6 was selected because it is being used locally for various meteorological applications and for assimilation studies. The WDM6 was selected to evaluate how different simulations were for the double-moment version of the scheme. Additionally, the THOM scheme was selected given its more realistic PSD and snow density parameters. Despite the fact that the cold-rain processes in the WSM6 and WDM6 schemes are the same, the impact of the double moment scheme in the rain number concentration is large and past studies have indicated (Morrison et al., 2009, Li et al., 2009a,b, Lim and Hong 2010) that the rain number concentration plays an important role in determining the precipitation rate and storm morphology because it modules the related microphysics terms, in particular, the evaporation rate. The WDM6 scheme has been shown to improve skill statistics in precipitation forecasts (e.g., Hong and Lim 2009). Recurring evaluation of these schemes is still necessary and for this reason we consider interesting to show the results for both.

2. Figure 7 and 8: As mentioned in Line 414-415, there are differences in the location of the observed and modelled cloud system. Is it representative to discuss the differences among simulations and observations? For example, the difference of IWP (graupel) between WSM6 and WDM6 are large for the transect in Fig. 7. However, the difference of graupel is small between WSM6 and WDM6 in Fig. 5. It will be more representative to use zonal/meridional means for comparison. And it will be interesting to see the relative contribution (sensitivity) of snow/graupel to the simulated brightness temperature in different microphysics schemes.

We thank the reviewer for these comments. The main point of Figures 7 and 8 is to show the sensitivity of the transect to the different Liu (2008) DDA habits analyzed. The real observations are shown for a reference, as the main analysis of representativity is made from Figures 9-14 with the histograms and the Chi-square test, with an analysis of the distribution of observed and simulated brightness temperatures. With regards to the last comment of the relative contribution of the frozen phase in the simulations, this has been added in Lines 513-516 and Lines 551-556 (shown in red in new manuscript version).

3. As one of the goals of this study is to evaluate the microphysics parameterizations, could the authors have more discussions about how to interpret/use these results in terms of evaluation? As shown in the manuscript, there are large uncertainties in distribution, mass, and scattering properties of frozen particles in different microphysics schemes. However, all the simulations produce comparable bright temperature to the observations. Can we conclude from this study which scheme produces more realistic frozen particles?

Thank you. The THOM scheme parameterizations in terms of snow density are more realistic than constant density WSM6/WDM6 constant density parameterizations. This discussion in the focus of ongoing work that includes ground and satellite radars. Which scheme is producing the most realistic frozen particles is an interesting question which is being addressed.

Minor comments: 1. Line 173 “the five hydrometeor categories”: It depends on the selected microphysics scheme, for example, WSM3 does not provide five hydrometeor categories.

This is true. It has been corrected to: ÂÍIt provides a full description of atmospheric parameters (i.e., pressure, temperature, and prognostic water substance variables).ÂÍ

2. Line 204-207: It is not easy to follow. It will be helpful for reader to understand by providing the following information shown in Thompson et al. (2008): “the spherical and constant-density snow assumption is applied in models through the assumed mass-diameter relation, usually with the power law.” “The new scheme considers snow to be

primarily composed of fractal-like aggregated crystals, which likely captures the vast majority of the actual snow mass reaching the earth's surface."

Thank you for the suggestion. The text has been modified to make this more clear: "The WSM6 and WDM6 schemes, like most models, use a spherical and constant-density snow assumption through the application of a mass-diameter relation, usually with a power law m(D)=(ðİIJŃ/6)sD3, where s is the assumed fixed density of snow (for WSM6/WDM6 s=0.1kg/m3) and D is the particle diameter. Unlike most schemes, snow density in the THOM scheme is not fixed, but varies with size through the mass-size relation m(D)=0.069D2. This is an important difference since observational studies rarely support fixed density snow habits. Magono [1965] and many later studies recognize that a size-independent density is not a physically sound assumption for snowflakes because of the rigidity of ice and the nature of the snow formation processes (Leinonen et al.[2012]). In this sense, the THOM scheme considers snow to be primarily composed of fractal-like aggregated crystals (Thompson et al. [2008]), rather than spherical constant snow crystals, which is a much more realistic approach than the WSM6/WDM6 schemes."

3. Line 237-238: THOM has more frozen particles than WSM6 and WDM6.

We consider that the domain average vertical content is comparable. Yes, the THOM scheme has more frozen particles.

4. Line 244-246: Is there any reference?

Yes. It has been added: Otkin et al., 2003. A comparison of microphysical schemes in the wrf model during a severe weather event.

5. Figure 6C: Please add legend

This figure has been modified, and the legend carefully updated.

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