Response to the comments of the Reviewer 2:

Specific Comments:

1. I agree with the first reviewer that perhaps the *Sefton-Nash et al.* [2013] paper is not useful to discuss the results for the second half of the year as that study was not able to distinguish the aerosol type and in fact, found that nearby temperatures tended to be warmer than the CO2 ice threshold. As summarized in *González-Galindo et al.* [2011], some mid-latitude clouds were seen between L_s $200-300°$ by THEMIS-VIS, but again, the composition could not be determined.
   We modified the text to explicitly admit that the composition of the majority of clouds observed in the second half of the year is not established, and that they are likely not CO_2. However, we report on what our simulations have produced. Namely, that gravity wave-induced temperature fluctuations can create conditions favorable for ice condensation throughout the second half of the year as well.
2. The lack of full diurnal coverage of observations makes this kind of comparison difficult. It might be useful to look at daytime and nighttime averages of the shown model quantities (as was done in *Yiğit et al.* [2015] to better understand the high probabilities in the second half of the year and at the higher altitudes.
   The main reason is the increased gravity wave activity in middle-to-high latitudes of the winter hemispheres at both aphelion and perihelion seasons (see the first row in Figure 5). It is also seen that GW-induced temperature fluctuations are larger during the second half of the year. However, given the lack of observational constraints for CO_2 clouds in the second half of the year, we felt it would be rather senseless and speculative to go into detailed discussions of the diurnal structure of the simulated cloud probabilities.
3. In terms of the discussion, the possible reasons for discrepancies were well presented, for example, the uncertainty in sources and the degree of supersaturation. Two other possible uncertainties perhaps could also be mentioned, one is the radiative impact of water ice clouds in the first half of the year and the other is the vertical distribution of dust in the second half of the year. Both are lower atmosphere phenomenon but do affect the strength of the global circulation patterns. It might be useful to discuss how sensitive the parameterization is to these effects. This may also help to explain discrepancies seen in the comparison of temperatures at 80 km to MCS (figure 4a with Sefton-Nash 2013 figure 10).
   The uncertainties mentioned in the manuscript relate primarily to the physics phenomena, which are the main focus here: gravity waves and CO_2 condensation. However, we do agree that other factors affect the simulated circulation and thus contribute to the discrepancies as well. We added the corresponding wording into the text. Exploring the sensitivity of the simulated circulation to the missing in the model mechanisms is beyond the scope of this paper, and requires a separate dedicated study.
4. In section 2.2 (page 4), it is mentioned that “This formulation requires also a prescription of the characteristic horizontal scale λ_h of GWs for calculating τ_i”, it might be useful to state what is used for this study. Is this value a source of uncertainty as well?
   We added the information on the characteristic wavelength $\lambda_h = 300$ km utilized in the gravity wave

parameterization. This value is also a source of uncertainties, like with any parameterization. However, in this particular case, the uncertainty is small, as the appropriate characteristic wavelegths are limited by the 100-500 km range. The reason for that and consequences were discussed in detail in many of our referenced papers on the gravity wave parameterization.

Technical Comments:

1. Page 1 line 13: May I suggest: "Thus, Mars has seasons similar to those one is familiar with on Earth."
   Done.
2. Page 2 line 1: "on average," and yes, warmer than what? "...warmer than the condensation threshold". Now added.
3. Page 2 line 10: suggestion: "with the exception of harmonics with zero horizontal phase velocities with respect to the surface generated by the flow over topography"
   Suggestion implemented
4. Page 5 line 18: "P must be treated as a certain metric introduced".
   Done
5. Figures: Agree with reviewer 1, figures 4 and 5 x-axis label in Ls would be more useful than day number.
   Done
6. Figures 3c,d and 5a,b,c some contour lines to help distinguish?
   Figure redone
7. Figure 4a very difficult (almost impossible) to compare with Sefton-Nash et al., 2013 figure 10. A change in color scale to match would be useful.
   Now it can be better compared

References

González-Galindo, F., A. Määtänen, F. Forget, and A. Spiga (2011), The martian mesosphere as revealed by CO_2 cloud observations and general circulation modeling, *Icarus*, *216*, 10–22, doi:10.1016/j.icarus.2011.08.006.

Sefton-Nash, E., N. A. Teanby, L. Montabone, P. G. J. Irwin, J. Hurley, and S. B. Calcutt (2013), Climatology and first-order composition estimates of mesospheric clouds from mars climate sounder limb spectra, *Icarus*, *222*, 342–356, doi:10.1016/j.icarus.2012.11.012.

Yiğit, E., A. S. Medvedev, and P. Hartogh (2015), Gravity waves and high-altitude CO_2 ice cloud formation in the martian atmosphere, *Geophys. Res. Lett.*, *42*, doi: 10.1002/2015GL064275.