Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2022-322-RC2, 2022

Comment on acp-2022-322

Anonymous Referee #2

Referee comment on "Impacts of combined microphysical and land-surface uncertainties on convective clouds and precipitation in different weather regimes" by Christian Barthlott et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-322-RC2, 2022

This study investigated the model uncertainties associated with three factors: soil moisture, CCN concentration, and the shape factor of cloud drop size distribution. Quite a few similar studies have been conducted recently, but none applied such a three-parameter combination. The results showed significant spreads caused by the two microphysical parameters, and the soil moisture factor also enhances the spread. But the significance of these factors compared to many others in the model is unclear. The manuscript can be enriched if the suggestions in the major comments below can be considered.

Note: I have posted a preliminary version of the review, and sorry for double-posting some of the comments.

Major comments

Introduction and methodology:

1. As the authors stated, model uncertainties exist in many physical schemes and dynamics, including initial/boundary conditions (IC/BCs). There can be numerous combinations of such uncertainty sources. Can the authors explain why it is essential to consider the combination of soil moisture and cloud microphysics compared to other possible combinations?
2. Similarly, there are many uncertainties in cloud microphysical parameterizations. How are these factors considered in this study? Can the authors justify why they focused only on uncertainties in N_{CN} and CDSD parameters? Also, the authors mentioned many uncertainties related to aerosol-cloud interactions (lines 45-76). Can these uncertainties be represented by perturbing the N_{CN}?
3. Line 122-123: There is a difference between N_{CN} and N_{CCN} (CN stands for condensation nuclei and CCN for cloud condensation nuclei). For polluted continental conditions, the value of 3200 cm^{-3} seems to be too low for N_{CN} (should be tens of thousands or more) but fine for NCCN. The values used for other conditions should also be justified or, at least, provide a reference.
4. The shape parameter v is also important for other hydrometeors. In fact, the variation in v may be even more prominent for precipitation particles according to some triple-moment schemes. What is the reason for perturbing only v of cloud drops?

Results:

1. The model "spread" is one of the key foci of this study. Yet, the discussion on the

normalized standard deviation (indicating the spread) is too brief and does not provide much scientific insight.
2. I would like to see a more quantitative comparison of spreads from the three sensitivity factors (i.e., soil moisture, CCN, and shape factor. This allows the reader to judge which factors are more important for the consideration of ensemble members.
3. Line 249-250: "The higher the CCN concentration, the lower are the rain intensities." This seems to be a warm-rain characteristic. But, apparently, the studied systems are mostly cold-rain dominant (lines 443-444). For mixed-phase convective systems, higher aerosol concentrations often lead to stronger rain intensity (cf. Tao et al. 2012, etc.). It will be nice to compare the results here with other relevant studies.
4. Figure 7.
The tendency of TQG change with v is different for maritime CN compared to other CN types for cases 2018 and 2020. Some inconsistencies also exist in the 2016 case. Is there any explanation?

Conclusion:
1. It is dangerous to make a conclusion based on only four cases. Large differences can be observed between the two weak cases or between the strong cases, which may suggest that other cases may behave distinctively differently and even produce results that disagree with the conclusions stated here. Furthermore, the uncertainties in the studied parameters may vary if you choose different initial/boundary conditions, physics schemes, or grid resolutions. The authors should at least try to tone down a bit on the certainty of their findings.
2. Perhaps the authors can make a quantitative comparison of the spread caused by each factor by preparing a table summarizing the relative spreads (standard deviation).
3. There are quite a few similar studies with multiple-factors analyses. Because of the numerous possible combinations of uncertainty factors, it will be nice to see some comparisons on the spread/uncertainty with previous studies.

Minor comments
1. Line 5: 60 member ensemble ☐ 60-member ensemble (same in other places of the text)
2. Line 12-13: rain water ☐ rainwater
3. Line 14: strong, but ☐ strong but
4. Line 14: non systematic ☐ non-systematic
5. Line 15: which ☐ , which
6. Equation (1): Since the microphysics scheme used is double moments with A and λ as varying coefficients, v and μ must be specified. The value for μ was never mentioned. If μ was set to 1, then just omit it in the equation.
7. Figures 5, 7-9: These figures are quite complicated. More details (e.g., what is NU) are needed in the caption to assist the readers in understanding the arrangements.
8. Line 215: applies for ☐ applies to