Overall impression and rating

The manuscript describes three model simulations of supercooled liquid clouds with different aerosol schemes as input. The results are compared with each other and with aircraft observations. Overall, the manuscript is very easy to understand, well structured, and clearly written. Although the actual results do not necessarily provide novel scientific findings, they nevertheless show a robust comparison of three aerosol schemes and their effects on the results with regard to supercooled liquid clouds. This comparison may be particularly useful for the modeling community in terms of further optimizing models. I therefore recommend the manuscript for publication in ACP after my more technical comments have been taken into account.

We sincerely thank the reviewer for the valuable comments and suggestions, which have significantly improved the manuscript. We have revised the manuscript accordingly and believe that the revised version is now more complete. Please refer to our point-by-point responses in blue text; revisions in the manuscript are indicated in italic text.

Specific comments/questions:

• Title: I suggest changing the title of the manuscript so that it better reflects the actual comparisons of a model with three different aerosol input datasets.

Thank you for your suggestion. We have revised the title to "***Quantitative Assessment of Supercooled Liquid Water Sensitivity to Different Aerosol Field Inputs over the Sichuan Basin***", which we believe effectively captures the focus of the study.

• line 39: I would recommend pointing out the major differences between INPs and CCNs here. In particular, INPs are always solid, insoluble particles, while CCNs are always water-containing liquid aerosols (e.g., Belosi et al. 2017 or Krämer et al. 2016). Therefore, I would recommend writing the following in line 39: ...insoluble aerosol act as...

Thank you for your suggestion. We have rewritten it as follows:

"*On one hand, solid, insoluble aerosol particles act as ice nuclei (IN, Belosi et al. 2017)..., On the other hand, hygroscopic aerosols particles act as cloud condensation nuclei (CCN)…*"

Belosi, F., Rinaldi, M., DeCesari, S., Tarozzi, A., Nicosia, A. & Santachiara, G.: Ground Level Ice Nuclei Particle Measurements Including Saharan Dust Events at a Po Valley Rural Site (San Pietro Capofiume, Italy), Atmos. Res., 186, 116-126, https://doi.org/10.1016/j.atmosres.2016.11.012, 2017.

• Section 2.5: How were the in situ measurements compared exactly with the model output? Section 2.2 states that only out-cloud sections of the measurements were used. Was this (only out cloud) also done with the model results? Otherwise, the concentrations (inside and outside clouds) are not necessarily comparable. This is particularly important with regard to the section in lines 387-391 and should also be taken into account in the discussion.

Thanks for the insightful comments. We note that out-of-cloud aerosol data are used only to construct a realistic background aerosol concentration field, whereas the CDP measurements used for model evaluation are obtained under in-cloud conditions. The reviewer's comment highlighted that the model data previously used for comparison (12:00–12:30 UTC, 3500–3700 m, and a 50-km radius centered at 29°N, 105°E, encompassing the orange flight path in Fig. 1b) may have included out-of-cloud grid points.

In the revised analysis, we therefore applied in-cloud filtering criteria consistent with the aircraft in situ observations (CDNC > 10 cm^{-3} and LWC > 10^{-3} g m^{-3}, Zhang et al., 2011) and excluded simulated data that did not satisfy these thresholds. This ensures that the model–observation comparison is restricted to in-cloud conditions. The corresponding text in Sect. 3.3 has been revised as follows:

"*In addition, in-cloud criteria consistent with the aircraft in situ measurements (CDNC > 10 cm^{-3} and LWC > 10^{-3} g m^{-3}; Zhang et al., 2011) are applied, and simulated data not satisfying these thresholds are excluded. This procedure ensures that the model-observation comparison is restricted to in-cloud conditions only.*"

The updated statistics (values that differ from the previous version are highlighted in red) indicate that only the Default experiment shows minor changes, which do not alter the conclusions of this study. The revised results are summarized in the table below.

SLW	Experiments or observation	Percentiles					
		1th	25th	50th	75th	99th	Mean
Content (g m^{-3})	Default	0.040	0.098	0.121	0.149	0.190	0.121
	Climatology	0.063	0.117	0.147	0.175	0.215	0.145
	CAMS	0.066	0.116	0.145	0.173	0.216	0.144
	CDP	0.011	0.057	0.103	0.167	0.320	0.120
Number concentration (cm^{-3})	Default	10.12	11.60	13.53	15.26	19.64	13.68
	Climatology	90.11	136.58	160.30	191.98	340.64	172.11
	CAMS	87.74	121.09	139.73	162.95	236.67	144.37
	CDP	0.08	12.27	460.11	608.37	1254.11	401.92
MVD (μm)	Default	16.58	24.52	26.71	29.11	33.03	26.59
	Climatology	9.34	11.41	12.74	13.89	16.20	12.65
	CAMS	9.61	12.18	13.28	14.46	16.24	13.24
	CDP	2.50	4.61	12.24	15.16	20.50	10.51

Zhang, Q., Quan, J., Tie, X., Huang, M., & Ma, X.: Impact of aerosol particles on cloud formation: Aircraft measurements in China, Atmos. Environ., 45(3), 665-672, https://doi.org/10.1016/j.atmosenv.2010.10.025, 2011.

• Section: 3.1: Intercomparison to ERA5 data. First, the ERA5 data should be introduced in Section 2 because you used it in the end to compare the other simulations to ERA5. And you can't assume that everyone knows the details of ERA5 relevant for this comparison.

We have added Sect. 2.4 to provide a description of the ERA5 dataset used in this study:

2.4 ERA5 data

In this study, European Centre for Medium-Range Weather Forecasts Reanalysis 5 (ERA5) data from the European Centre for Medium-Range Weather Forecasts (ECMWF) are employed as an independent reference to evaluate the WRF simulations. ERA5 is produced with a coupled data assimilation and forecasting system that combines multiple observational datasets with a global numerical weather prediction model, and can therefore be regarded as a reanalysis that closely

approximates the observed atmospheric state. ERA5 provides globally complete atmospheric fields with hourly temporal resolution and a horizontal grid spacing of 0.25° (Hersbach et al., 2020). The ERA5 variables used in this work include three-dimensional temperature, cloud liquid water content, and geopotential height, from which the SLW path is derived for comparison with the model output.

Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz‐Sabater, J., ... & Thépaut, J. N.: The ERA5 global reanalysis. Q. J. R. Meteorol. Soc., 146(730), 1999-2049, https://doi.org/10.1002/qj.3803, 2020.

• Line 368: I would perhaps simply add that the models lack in reproducing a bimodal SLW distribution.

We have revised this sentence as follows:

"*However, all three experiments fail to reproduce the bimodal distribution of MVD or the first peak near 4 µm, highlighting a common limitation in representing small droplet populations.*"

Technical comments/questions:

• line 62: "simply" to "simple"

Corrected

• line 87: "climatic" to "climatological"

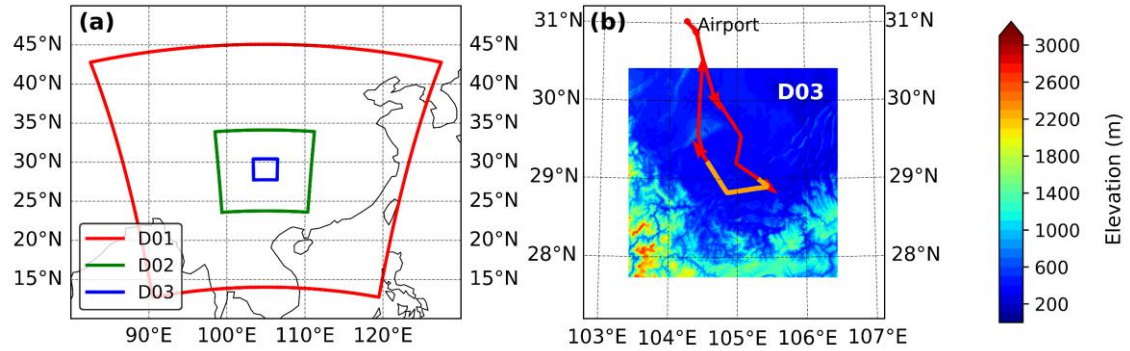
Corrected

• line 108: "is" to "were"

Corrected

• Figure 1: The arrow of the flight path is hardly visible. Maybe place it better directly next to flight path or enlarge it a bit. In addition, it would be nice, if you could also plot the innermost nest in panel b. Then it is easier to compare.

Corrected

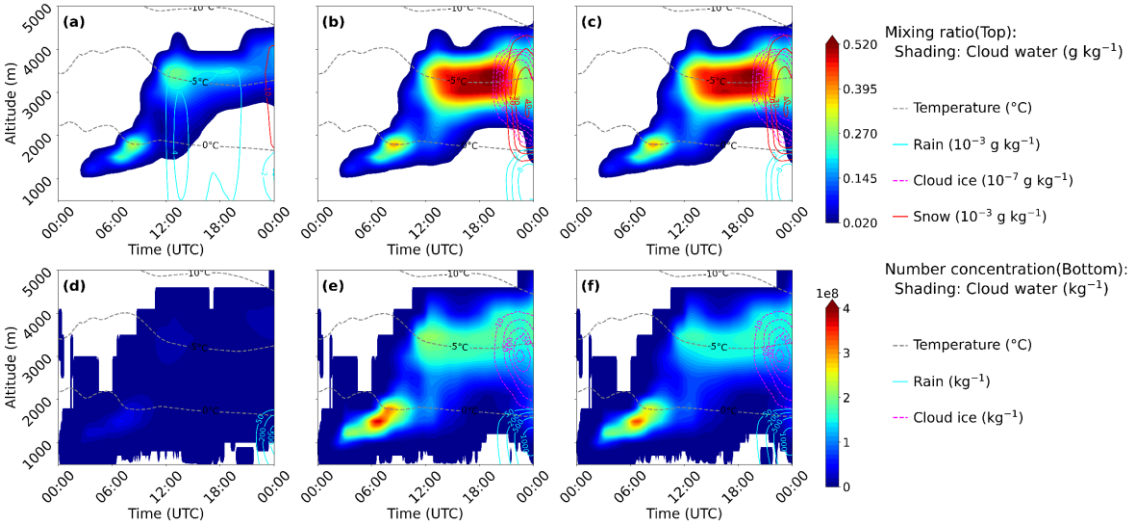


• Figure 2: The orange line looks more reddish. May name it red instead of orange.

Corrected

• Figure 4: I would recommend collecting the explanation of the isolines in one place in the caption. Explain the part: cloud water: g kg^{-1}, rain: 10^{-3} g kg^{-1}, cloud ice: 10^{-7} g kg^{-1}, snow: 10^{-3} g kg^{-1}, temperature: °C together with the shading.

Corrected

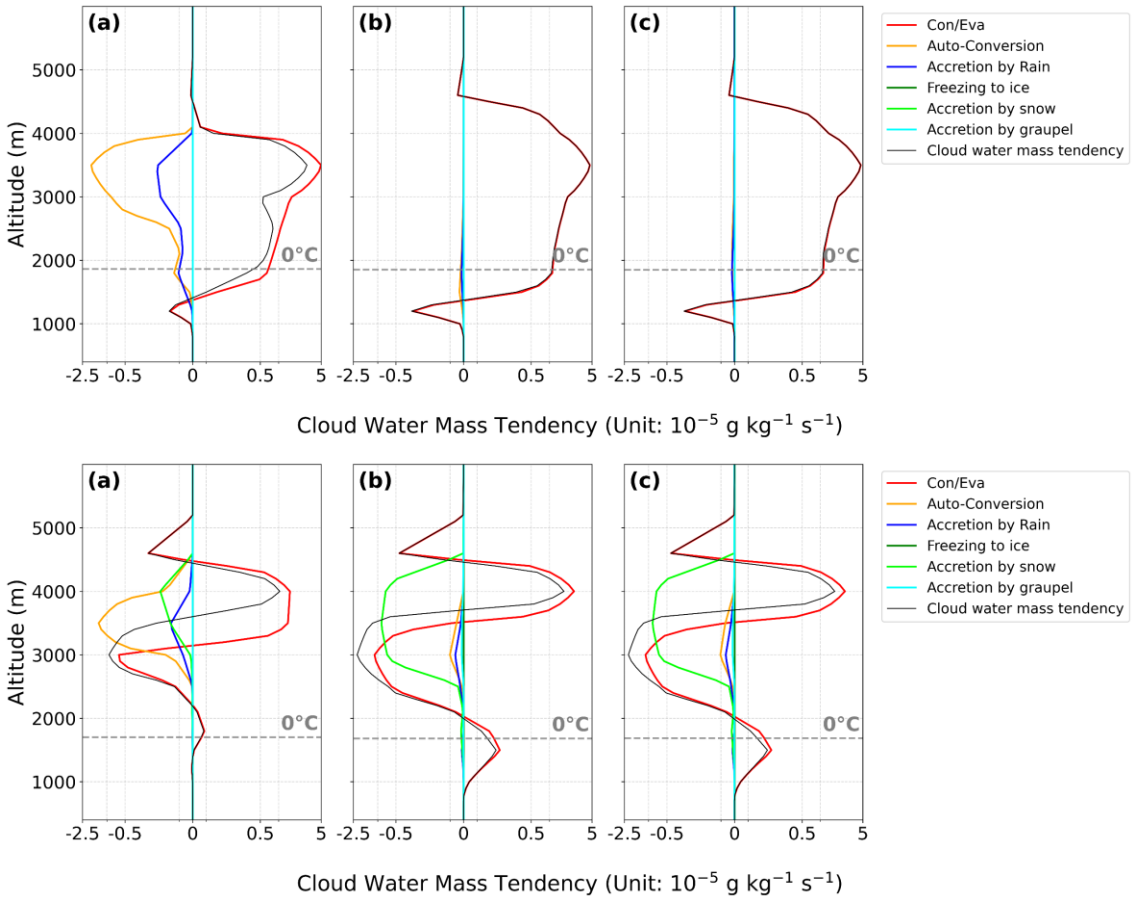


• Table 2: Please avoid line breaks in the units (row 1 and 5).

Corrected

• Figure 5: Please provide information in the caption, what QCten is. All other classes can be inferred by the name itself.

Corrected



• line 361: Please exchange "confirm" with "show" or similar. Because you cannot confirm the same thing with the same data. Both plots show this feature in MVD from the same CDP data.

Corrected

• Line 397: Which blue dot are you referring to in Figure 10c. I just see only multiple blue plots from simulation, but not a specific one.

We have revised this sentence as follows:

"*This suggests that CAMS provides a better simulation for larger droplets, as indicated by the cluster of blue dots in Fig. 10c, which coincide with the observed second peak of MVD.*"