General comments

This work aims to identify the impact of aerosol-cloud interactions (indirect effect) over the Alpine region on temperature, precipitation and cloud fraction and also explore how this impact varies with elevation. It uses the WRF model to conduct two sensitivity experiments with low and high aerosol concentrations. The scientific question is very interesting. The paper is concise and well structured. Conclusions are substantial and the interpretation of physical properties is well discussed and summarized in a graph.

In general I believe that the methodology is sufficient for the scope of the paper. However I would like to see some more information in the methodology regarding some technical aspects of the experiments and discuss some issues. Also, I think some additional plots regarding some of the physical processes-impacts would be of value (even in the supplement). To summarize, it is a pleasant paper that I would recommend for publishing after some minor additions.

Specific comments

1. The WRF model is driven in the experiments by a GCM (EC-EARTH). Since this is a sensitivity study for a past period, I would expect that the standard would be to use reanalysis data to conduct the experiments. This would safeguard in the case the GCM has some major biases in the region and time chosen and fails to capture the climatology. I would be interested to know whether there is a specific reason for choosing the GCM instead of reanalysis. I understand that we are mainly interested in the differences between the polluted and the pristine experiments and not whether they sufficiently capture the climatology, so this is not a huge deal. However, since we are interested in the Alpine region it would be nice to know whether the experiments do capture the basic features of the climate there. Maybe a quick qualitative validation with some plots of observational/reanalysis in the supplement next to the control run?

2. Is there a specific reason for choosing the specific time period of 1979-1983 for the experiments?

3. I do not have any major issues with the domain setup. However, I would prefer the outer (larger) domain to be bigger. I would extent it more to the west, so that the distance between the outer and inner domains would be larger. In the current setup, any disturbance coming from the west would enter, pass through the relaxation zone and only after a few grid points would reach the inner domain. I don't know whether it has the distance to be sufficiently analyzed. Also, I would probably extend it more to the south to fully capture the Ligurian Sea thus better capture any possible cyclogenesis events. Just a few thoughts for future consideration.

4. I would like to see some more technical information in the methods regarding the WRF setup, like the number of vertical levels and the top pressure level used. Especially, in a highly mountainous regions this could be important.

5. As far as I understand you used the 'use_aero_icbc=false' option in the namelist regarding the Thompson aerosol aware mp. It would be interesting for WRF users to state this in the methodology. It can be in a parenthesis.

6. In the supplement S3 it is stated that some changes have been made in the code (orange highlights) to "better represent the aerosol concentrations in the Great Alpine Region." I would like a further elaboration on that. What is the rationality behind the changes?

7. Also in supplement S3, the aerosol number concentrations used in the experiments of the various variables (naCCN,naIN) are given. I think it would be important to state: Did you also change the numbers for the PRISTINE experiment from the original code? How did you choose the numbers for the POLLUTED run? Any possible references this was based on?

8. One major concern I would have regarding the Thompson aerosol aware mp in the 'use_aero_icbc=false' mode would be the aerosol concentrations over time. As far as I understand there are no aerosol coming from the lateral boundaries only the (fake) ground emissions. I don't know how this would affect aerosol concentrations throughout long term simulations. Have you checked how the aerosol concentrations over the domain for a specific experiment and season change throughout the years? Do they remain stable? Any large differences? If so, this could affect results from year to year. I would be really interested to know.

9. I think it would be interesting to note whether the aerosol concentrations produced in each experiment are plausible. For example, is the POLLUTED experiment something that can actually happen or is it an idealized case of unrealistically high aerosol pollution? Are the aerosol concentrations seen in the PRISTINE experiment a typical example of low pollution over the area? It would help to frame the overall research as being either mainly idealized or having ties with reality.

10. Page 4, lines 83-84. How much did you play with the cloud fraction threshold? If you could back up the cloud fraction threshold (in)sensitivity with a plot in the supplement the better (not necessary though).

11. In the Results section, impacts on shortwave and longwave radiation are mentioned. Since these are key to the interpretation of the impacts on temperature it would be nice to include figures on shortwave and longwave impacts in the supplement.

12. Figures 4 and 5 in the captions. You use the term "station altitude". If I am not mistaken, isn't this supposed to be "grid cell altitude"? Also please comment on what the colors mean in these figures.

13. Page 10.line 177. 'Convective cloud evolution…". Makes sense but I would like to see a reference.

Technical corrections

1. Abstract, line 4. Probably "the highest mountains" should change to "some of the highest mountains". Minuscule issue, however technically the highest mountain peak in Europe (the continent) is in Caucasus.

2. Introduction, page 1, line 18. "precipitations"→"precipitation"

3. Methods, page 2 line 52-53: The term "grid step" is understandable but I would probably change it to "grid resolution".

4. Page 7, line 144: "this aspects" → "this aspect"

5. Discussion. Page 9. line 167: "are reduced"→ "is reduced"

6. Supplement page 6: In the code segment there is the "niCCN3" variable whereas in the text below it is discussed as "naCCN3". I suspect one of the two must change.