Atmos. Chem. Phys. Discuss., referee comment RC2
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# Comment on acp-2021-921

Anonymous Referee #2

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Referee comment on "Aerosol indirect effects in complex-orography areas: a numerical study over the Great Alpine Region" by Anna Napoli et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-921-RC2, 2021

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Review of:

"Aerosol indirect effects in complex orography areas: a numerical study over the Great Alpine Region"

Authors: Anna Napoli et al.

Recommend minor revisions.

General comment:

The authors simulate and examine a multi-year scenario regarding the impact of surface-based aerosol on clouds, precipitation and surface meteorology at low and high elevation locations centered around the Great Alpine Region. The paper is well-written, analysis is

robust, and the concluding conceptual model of aerosol effects on the processes driving the differences is quite interesting. I do have several questions below pertaining to some of the interpretation of results and assumptions associated with the simulations.

Specific comments:

1.Line 30: “avere anche” perhaps needs translation?

2.Line 35-36: You should add older references for the CCN suppression of conversion from cloud droplets to raindrops as well as reduced precipitation. This is a well-established effect far predating Thompson and Eidhammer 2014.

3.Line 50: Why 1979-1983? More recent reanalysis products are available for model initialization and nudging.

4.Line 55: Your horizontal grid spacing is 4km, which might barely qualify as convection permitting. Can you cite some studies that justify 4km as convection permitting?

5.Line 75: It would be helpful to show vertical profiles of aerosol number concentration during winter and summer over lowland and at elevation. This would help in interpreting

the differences between pristine and polluted. Your initial differences of CCN number from 10 /cc to 10,000 /cc is a very large difference. 10,000 /cc is perhaps unrealistic for CCN sized aerosols. How does the concentration evolve over time once the CCN flux scheme takes affect? What size aerosols are prescribed and what is their chemistry? Can aerosols from lowland be transported upslope to impact orographic clouds?

6.Line 77: Are aerosols radiatively active at all? You mention that they do not interact with shortwave radiation; but what about longwave radiation?

7.Line 81: The wording in this sentence seems to need some correction starting with, "We define a cloud event….".

8.Figure 3: For this figure and others as well, plotting things relative to local time would be more helpful than UTC when examining diurnal cycles. While the domain is close to UTC, examining things in local time would be more intuitive.

9.Line 129: How might your diurnal cycles change at elevation if you did not vary the emissions so dramatically with elevation? Is the amount of change in emissions with elevation justified?

10.Line 148-149: Why are updraft velocities reduced with aerosol loading? Many recent studies in the literature point to invigoration of updrafts in high aerosol situations unless there is stabilization due to aerosol radiative effects at play (but you are not simulating aerosol radiative effects). Will you provide mean vertical profiles of cloud droplet concentration in the convective clouds? Droplet numbers and size impact autoconversion rates, condensational growth rates, and riming rates; and these can impact latent heating

rates and updraft speeds.

11.Lines 177-179: Here you state that convective cloud evolution is independent of aerosols. While aerosols typically do not control the convection, they can modify it depending on the strength of convection and aerosol concentration. There are complex interactions and feedbacks related to aerosols, precipitation, cold pools, and convective cloud lifetime that do permit aerosols to have impacts on the convection. It would be helpful to place your convection analysis in the context of additional cited literature involving aerosol impacts on convection. You might start with Alex Khain's paper classifying aerosol impacts on precipitation from various cloud types.

Khain, A. P., N. BenMoshe, and A. Pokrovsky, 2008: Factors Determining the Impact of Aerosols on Surface Precipitation from Clouds: An Attempt at Classification. *J. Atmos. Sci.*, **65**, 1721–1748, https://doi.org/10.1175/2007JAS2515.1.

12.Line 187-189: Here you mention aerosol suppression of convection due to stability, but the aerosols in this study cannot directly impose such an effect. Further, van den Heever and Cotton (2007) do not discuss aerosol impacts on atmospheric stability. Please clarify your statement.