

Interactive comment on “Precipitation response to Aerosol-Radiation and Aerosol-Cloud Interactions in Regional Climate Simulations over Europe” by José María López-Romero et al.

Anonymous Referee #2

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General Comments

This paper shows results from 20 year run with regional climate model WRF-chem. Experiment setup includes simulations with different aerosol interaction. One clear conclusion of this paper is that both ACI and ARI lead to decrease of precipitation in Europe. Aerosols regional climate effects are still very uncertain and authors have carried out valuable simulations to increase our knowledge of aerosols regions effect on precipitation. Main question of this papper is what is the role of ACI and ARI in regional precipitation observations. However, i find some major comments on authods study. This paper is in scope of ACP and i recomend i to be publics after major revisions.

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Major comments

1. Author clearly list list their findings on how ARI and ACI affects on rainy days, overall precipitation and low clouds. In figures term CLL is not opened, however in text this is indicated as low clouds. Text should mention what aerosol-cloud processes are included in the simulations, direct,indirect,semi-indirect, how these depend on aerosol type. How the aerosols it self formed in these experiments?
2. It's unclear was there simulation where both ACI and ARI were included. Author mention that there are areas where ACI and ARI effects cancel each other out. However due to non-linearities of aerosol-cloud effects, this conclusion would benefit from additional simulation where both ACI and ARI are included.
3. Also basic aerosols effect information should be shown, radiative forcing, direct and indirect. This helps reader to better understand the real effect of aerosols.
4. Only uncertainty regarding the model here is the aerosol setup. What is the role of model uncertainty? Example how much base case precipitation changes differs if you have slightly different initial condition in the model?
5. ARI simulations are not discussed except in figure 6. Similar analysis should be made also for ARI as done for ACI. I highly recomend also showing the results for ARI simulations.
6. In conclusion paper says that aerosol both decrease or increase precipitation , here it should also be stated why and where, what are the mechanisms causing these changes based on these simulations. Example in line 313 author says that decrease of precipitation is due to decrease of rainy days. What causes the decrease of rainy days?
7. Model aerosol configuration should be explained clearly, what natural and athrogenic aerosols are included.

Minor comments

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Figure text in figure 2. I suggest changes letters to be beginning of each sentence. (Top row) (a) Relative differences for precipitation between ACI and BASE experiments; (b) number of days of precipitation $>0.1\text{mm}$; (c) and low clouds. Squares indicate points whose differences are significant for a p-value of 0.05.

In abstract line 9 spatially averaged should also mention the spatial region of the simulations which is the averages.

In method section I would recommend to include model section to describe the model itself

In line 91. Author states "In the BASE experiment aerosols are not treated interactively. . . ." Is this meaning that aerosol itself develops from vapors or aerosols are interaction with clouds?

In line 131. "). The simulations were run splitting the full period into sub-periods of 5 years with a spin-up period of 4 months," this is unclear what has been done?

in line 134, "The evolution of greenhouse gases CO₂, CH₄ and N₂O were considered in accordance with the recommendation of Jerez et al. (2018)." This should be opened and explained the Jerez et al paper

in line 150, "the relative differences.." relative to what?

in line 151 they refer term "criteria" is unclear what criteria.

in line 160, clustering method used should be mentioned.

Titles in figure 5 should be changes to clusters. Also results in figure 4 and 5 should be discussed more. Figure 5 is somewhat puzzling.

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