

Authors' response to Anonymous Referee #1

on review of "Modeling organic aerosol over Central Europe: uncertainties linked to different chemical mechanisms, parameterizations, and boundary conditions"

by Lukáš Bartík et al. (ecusphere-2025-167)

Dear Anonymous Referee #1,

We sincerely thank you for the time and effort you dedicated to reviewing our manuscript, and for your constructive and insightful comments. Please find below our detailed, point-by-point responses (in black) to the comments you provided (in blue).

The authors have addressed my comments and revised the manuscript sufficiently. I can recommend publication of the manuscript, but I have one further suggestion. In response to one of my comments, the authors have added the paragraph L364-639 discussing the CBCs and their effect. I find that this paragraph would benefit from further clarification of explicitly stating that the gas phase CBCs were also different in these sensitivity simulations compared to the basecase simulations CSwl and CVb.

The paragraph has been revised to clarify that the CBCs differed for both gas-phase and aerosol species in the sensitivity simulations compared to the reference simulations. The revised text (lines 637–642) now reads:

"Since the CBCs were the only factor varied between the simulations used to quantify these impacts (i.e., Sp100s0 vs. CSwl and Vp100s0 vs. CVb), the resulting differences in SOA concentrations can be directly attributed to modifications to the CBCs for both gas-phase and aerosol species. These modifications may affect both the oxidative environment, through species such as ozone, nitrogen oxides, carbon monoxide, and the hydroxyl radical, and the availability of direct SOA precursors such as toluene, xylene, and isoprene, helping to explain the spatial and seasonal variation observed. As mentioned earlier, the detailed composition of the two CBC sets is provided in Sect. \ref{inputs} and Tables S1–S2."

It would be also helpful for the reader if this would be made more clear both when describing the sensitivity study and when starting to discuss these results (e.g. at the beginning of section 3.3 where the text is currently not stating what kind of sensitivity analyses these are). As it is currently described and discussed, the reader may easily get the wrong impression that the only difference here is the boundary condition for the aerosol phase. If there were also simulations with just the different gas phase CBC compared to the basecase, i.e. "Vp0s0" and "Sp0s0", it might be more clear. But as such simulations are missing, bit more clarification would be helpful.

Clarifications have been added in two locations in the manuscript to address this comment: in Sect. 2.4.2, where the sensitivity simulations are described, and at the beginning of Sect. 3.3, where the corresponding results are introduced. These revisions specify that both gas-phase and aerosol-phase CBCs differ from those in the reference simulations.

Section 2.4.2:

The text describing the second sensitivity analysis was revised to make clear that the chemical boundary conditions (CBCs) differed from those in the reference experiments not only for aerosol species but also for gas-phase species.

Specifically, the sentence:

"Each of these sensitivity experiments was performed using the same model setup and IVOC and POM_{SV} parameterizations as in its corresponding reference experiment, except for the chemical boundary conditions."

was replaced by:

“Each of these sensitivity experiments was performed using the same model setup and IVOC and POM_{SV} parameterizations as its corresponding reference experiment, but with CBCs that differed from those prescribed in the reference experiments (i.e., the default CBCs) in both gas-phase and aerosol species.”

Additionally, in the next paragraph, the phrase:

“We then added the same boundary conditions for the remaining remapped aerosol species to each pair of these boundary conditions...”

was revised to:

“We then added the same EAC4-derived boundary conditions for all gas-phase species and for the remaining remapped aerosol species to each pair of these boundary conditions...”

Section 3.3:

The introductory paragraph of Sect. 3.3 was rewritten to clarify the nature of the sensitivity simulations and to explicitly state that both gas-phase and aerosol-phase CBCs were modified relative to the reference simulations.

The former text read:

“To present and discuss the results of this sensitivity analysis, we adopt a similar approach to that employed for the previous sensitivity study. Thus, we first investigate the spatial distributions of the mean seasonal impacts on the near-surface concentrations of POA and SOA in the experiments of this sensitivity analysis during both seasons, using the same definition of these impacts as in the first sensitivity study. Subsequently, we evaluate the OC concentrations obtained from the individual experiments of this sensitivity analysis.”

The paragraph was revised as follows:

“This section presents the results of the second sensitivity analysis, in which the sensitivity experiments employed CBCs that differed from those prescribed in the reference experiments by modified gas-phase and additional aerosol species, as described in Sect. 2.4.2. To present and discuss these results, we follow a similar approach to that used in the previous sensitivity study. We first examine the spatial distributions of the mean seasonal impacts on the near-surface concentrations of POA and SOA in the experiments of this sensitivity analysis during both seasons, applying the same definition of these impacts as in the first sensitivity study. Finally, we evaluate the OC concentrations obtained from the individual experiments of this sensitivity analysis.”

Authors' response to Anonymous Referee #2

on review of *“Modeling organic aerosol over Central Europe: uncertainties linked to different chemical mechanisms, parameterizations, and boundary conditions”*

by Lukáš Bartík et al. (ecusphere-2025-167)

Dear Anonymous Referee #2,

We sincerely thank you for your time and positive assessment recommending acceptance of our manuscript.