Dear Authors,

This study examines the effect of Black Carbon (BC) on daytime valley and slope winds using high-resolution idealised WRF-Chem simulations. The research is highly relevant not only to the mountain meteorology community but also contributes the air-quality by addressing this important gap in the literature from the side of process understanding. The manuscript presents innovative ideas, and the results offer valuable insights that could benefit the literature. I believe the manuscript is well designed, with an appropriate literature survey, a well-structured methodology and sound results. The manuscript has strong potential for publication in **ACP**. However, I believe the manuscript still have open questions to be discussed.

1. I wonder if the selected grid spacing is enough to properly resolve the valley flow system (more precisely the slope flows), especially given the fact that this work aims for process understanding. As the authors probably know, many works have addressed this topic in the literature in the last few years (see, for instance, Wurps et al., 2020), and a common agreement in the community is that an appropriate horizontal grid resolution to resolve convective flows in complex terrain would range between 20 m and 100 m. Considering the recent improvements in computing power and recent publications addressing similar questions (see Basic et al., 2025) using high-resolution simulations, I think the work would benefit from the introduction of an inner domain using a grid spacing below 100 m.

2. I don't understand why the authors used a south–north orientation for the valley. The consequence is having asymmetrical incoming radiation in the simulation, which to me only adds unnecessary complexity to the problem. The fact that the slope flows develop unevenly in the domain is not really discussed in the manuscript and does not contribute in any way to the main question. Indeed, the authors include only the east slope in the analysis (when showing cross-sections). Wouldn't it be easy to avoid this issue by rotating the valley 90 degrees?

3. Section 3.1, line 233: In this portion of the text, you discuss the accumulation of BC near the surface during the spin-up (in a way, the initial condition for BC). I wonder if you can really explain the accumulation near the surface as you do. It is true that the combination of the stable near-surface atmosphere and the downslope flows can lead to accumulation near the surface (inside the valley), but the down-valley flow helps to "clean" the valley during the night. I guess a proof of this can be seen in the fact that, after the spin-up, concentrations both inside and outside the valley are mostly equal. The question is, then, how much of the surface accumulation is due to the BC transported by the slope flows? or whether such surface accumulation is simply the result of the strong inversion near the surface preventing any mixing. My second point here is: how can you explain that during the first six hours of daylight (and I assume turbulent mixing, at least in SGS) there is hardly any change in the concentration inside the valley?

4. Section 3.4, Here, you mentioned less along-valley momentum is transported out of the valley volume in AER simulation. However, I do not see that difference. Indeed, there are differences in the momentum in the along valley direction, but I'm not sure how significant would be the difference when computing the total transported momentum.

5. Coming back to the grid resolution, I think the need to decrease the grid spacing becomes appreciable in the momentum and heat budgets, where you show that the SGS seems to be very important, when compared with the other terms, specially in the heat budget. I think the manuscript would be way more robust if you solve the small turbulent eddies (adding to the resolved turbulent term), which at the end drive the mixing during the daytime in the boundary layer.

Minor comments:

- Line 188: I guess that the parallel valley is located at x>10 km and x<30 km, isn't?

- Line 366: Are you sure that you meant along-valley momentum there? I think you are referring to cross-valley in the text.

- I've found a few typos in the text, but I'm sure that would be corrected once the manuscript achieves its final form.