**Response to referee #1**

The authors offer a well-presented manuscript examining the ability of a convection-permitting (CP) model (ERA-Interim-driven COSMO-crCLM) to represent the reverse orographic effect at the northeastern Italian Alps area. The manuscript is well-written, and concise, with a good flow and sufficient discussion. The contribution of the manuscript is significant since it gives answers to an issue which may arise for many researchers dealing with CP models.

Every query or suggestion I had during the first part of the manuscript was explained or applied in the next sections, therefore I only have a few minor suggestions, mainly grammatical-syntax comments and typos.

Authors' response: We thank the reviewer for the positive feedback and the provided comments/corrections. We address them in the following. We numbered each comment as R1Cx (Referee 1, Comment x), and our response is indicated in with "R" and blue color. In the proposed modifications to the original text, we indicate the new text in *Italics*.

Some minor/discussion comments:

R1C1. It would be helpful to see a short literature review on existing CPM permitting models (probably in the Introduction), and comments on their performance. This would help you justify better the selection of the ERA-Interim-driven COSMO-crCLM.

R: Thanks for the suggestion, we will add a short review on CPMs in the introduction. It could be something like: "*Thanks to their ability to resolve convective systems and to better represent local processes, CPMs provide more realistic representations of sub-daily precipitation statistics, including the diurnal cycle, spatial structure of precipitation, intensity distribution and extremes (Prein et al. 2015, Berthou et al. 2020, Lind et al., 2016). These added-values have been found using different CPMs over several domains. In additions, CPMs have been proven to better represents temperature especially over mountain regions (e.g. Ban et al., 2014), clouds (e.g. Hentgen et al, 2019), small-scale wind systems (e.g. Belušic et al., 2019), land–atmosphere feedbacks (e.g. Taylor et al, 2013), besides tropical cyclones (e.g. Gentry & Lackmann, 2010) and monsoons (e.g. Marsham et al., 2013). This leads to a greater confidence, especially for short-duration precipitation extremes, in CPM-based projections compared to coarser resolution models, (Kendon et al. 2017, Fosser et al. 2020).*"

In addition, in the description of the convection-permitting model rainfall data (section 2.2) we will also add the following clarification: "*Reanalysis datasets blend in observations and thus provide the best possible lateral boundary conditions to drive a regional model and allow to evaluate the systematic (i.e. not linked to the boundary condition) bias of the model. Ban et al. (2021) evaluated the CPM simulation used here against several observational datasets and found that the bias is limited and comparable within the other CPMs from the Flagship Pilot Study on Convective Phenomena over Europe and the Mediterranean (FPS-Convection; Coppola et al. 2020) run under the Coordinated Regional Climate Downscaling Experiment (CORDEX).*"

R1C2. Lines 17-19: "We introduce the use of a non-asymptotic statistical approach (Simplified Metastatistical Extreme Value, SMEV) for the analysis of extremes from short time slices such as the ones of CPM simulations" The word "introduce" is a bit misleading,

since SMEV has already been introduced; maybe rephrase it to “We propose” or something like this?

R: Thanks for this comment. We will rephrase accordingly: “Here, we *use* a non-asymptotic statistical approach [...]”.

R1C3. Lines 55-57: “Over the Alps, but also elsewhere, CPMs tend to generate more precipitation at higher elevations than in reality, thus reducing the bias with respect to observations compared to RCMs (Lind et al. 2016, Reder et al. 2020).” This sentence is confusing to me, it sounds like CPMs overestimate precipitation at higher elevations than in reality, but at the same time, they reduce the bias compared to RCMs. Could you rewrite this?

R: Thank you for pointing this out. The sentence will be rephrased to: “Over the Alps, CPMs tend to generate more precipitation at higher elevations *compared to RCMs, thus reducing the bias with observations*”.

R1C4. Lines 143-144: “We considered only rain gauges with at least 9 valid years during the period 2000-2009,” Could you explain here why you chose this period?

R: This period corresponds to the CPM one. We will add this information in the new version: “*To match the available period in the CPM,* we considered only rain gauges with at least 9 valid years during the period 2000-2009, where a year is defined [...]”

R1C5. Lines 153-154: “More details on the used physical parameterisations can be found in Leutwyler et al. (2016).” Give two-three sentences on the basics of the process.

R: We will include the following description: “*The model solves numerically the fully compressible governing equations using finite difference methods (Steppeler et al., 2003) on a three-dimensional Arakawa-C grid (Arakawa and Lamb 1977) based on rotated geographical coordinates and a generalized, terrain following height coordinate (Doms and Baldauf 2015). A fifth-order upwind scheme is used for horizontal advection and an implicit Crank-Nicholson scheme in the vertical discretized in 60 stretched model levels ranging from 20 m to 23.5 km (Baldauf et al., 2011). The model employs a third-order Runge-Kutta time-stepping scheme (Wicker and Skamarock, 2002) and a delta-two-stream radiative transfer scheme according to Ritter and Geleyn (1992).The parameterization of precipitation is based on a single-moment bulk cloud microphysics scheme using five categories of hydrometeors, i.e. cloud water, cloud ice, rain, snow, and graupel (Reinhardt and Seifert, 2006). A modified version of the Tiedtke mass flux scheme with moisture convergence closure (Tiedtke, 1989) is used to parameterised shallow convection, while deep convection is resolved explicitly. In the planetary boundary layer and for the surface transfer a turbulent kinetic energy-based parameterization is applied (Mellor and Yamada, 1982; Raschendorfer, 2001) , while in the lower boundary COSMO-crCLIM uses the soil-vegetation-atmosphere-transfer model TERRA-ML with 10-layer soil and a maximum soil depth of 15.24 m (Heise et al., 2006).*”

R1C6. Some suggested syntax changes:

R: Thank you for the following suggestions, we will handle them in the revised manuscript.

Line 25: “SMEV’s capability”

Line 26: “promises further applications”

Line 45: “In CMPs,

Lines 51-53: “In areas with a complex terrain, the possibility of explicitly resolving convection along with a more detailed representation of orography and surface properties are crucial elements for correctly capturing the initiation and development of convection”

Line 269: Do you mean “A spatial pattern” instead of “organization”?

Lines 361-363: I think a verb like “show” is missing from that sentence: “The consistency of the return level estimates obtained from the full record and from the 10 yr record, and the small increase in the associated uncertainty show that, once its assumptions are verified, SMEV is a reliable statistical method for the analysis of extreme precipitation from short time slices.”

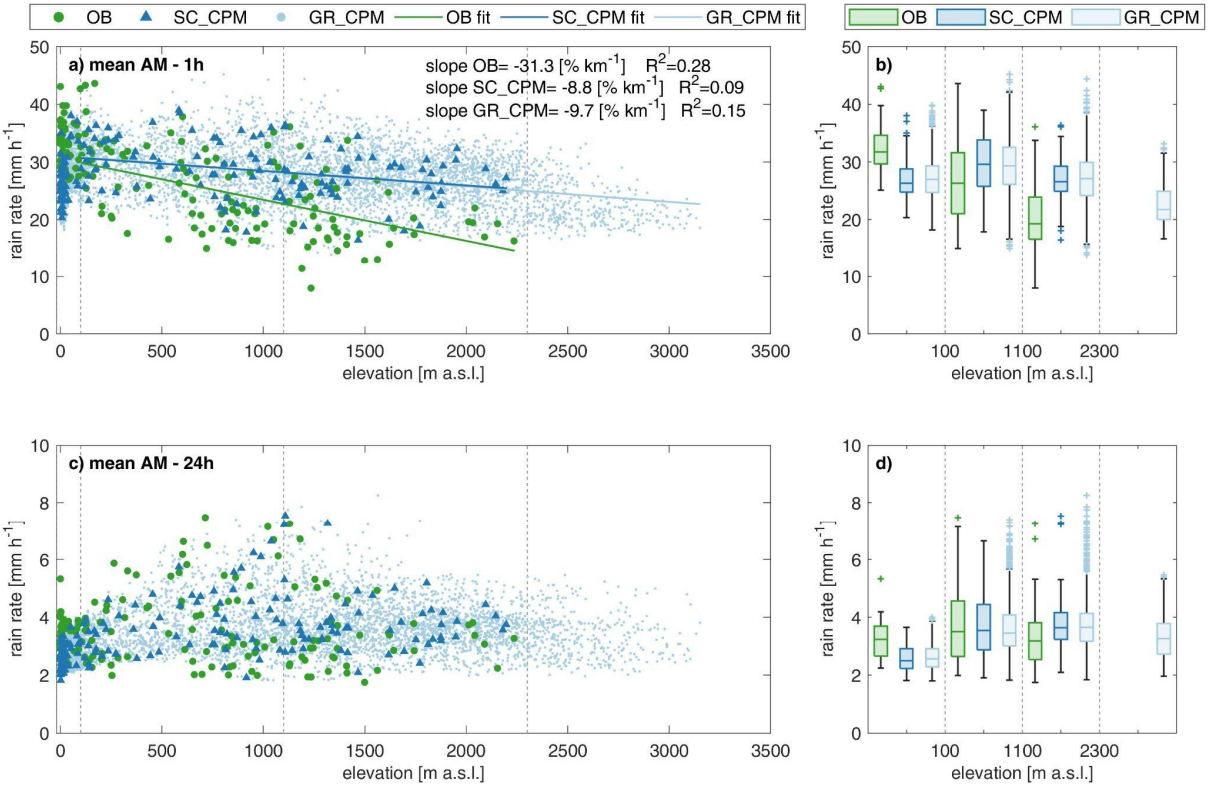
Line 415: “n” in italics

Line 480: “100 yr, and parameters of…”

Figure comments:

R1C7. Figure 2, Figure 4 and rest of the figures showing linear regression: do you want to also show the coefficient of determination R2?

R: We will add the coefficient of determination R^2 in all the figures where a linear regression is shown (see example below for modified Figure 4).




R1C8. Figure 4: “(SC_CPM), and all CPM”

R: We will add “and” in the caption in Figure 4, and also in Figures 6, S4, S5.

R1C9. Figure 4: “the linear regressions lines shown as a solid line, are expressed as..”

R: We will include the suggested version in the caption of Figure 4, and also in Figures 6, S4, S5.

R1C10. Figure 4: Could you change color for the observations, it is the same as CPM

R: Thank you for pointing this out, we will update the legend for the SC_CPM with the correct color (blue) in Figure 4 and also in Figures 6, S3, S4, S5.

R1C11. Figure 4: You do not focus on the orographic effect for daily but still can show the slope for the 24-hour case

R: The orographic effect at daily duration is rather complicated and doesn't have a unique relation with elevation, as described at lines 72-75: "However, a simple precipitation–height relation is difficult to establish, because the topographic signal is also associated with slope and shielding. In addition, the precipitation increase is robust only for low and intermediate topographic heights. In the Alps, maximum annual mean precipitation is typically in the height range of 800–1200 m (Frei and Schär, 1998), and above this altitude precipitation may again decrease with height." We thus prefer to not show these regressions, but just evaluate the agreement between OB and CPM through the boxplot for different elevation classes.

R1C12. Figure 7: remove "," from: "grid, CPM"

R: We will correct it.

R1C13. Figure 7: "are significant" instead of "result significant;"

R: We will modify it.