Author reply to RC3 (wcd-2022-11)

The manuscript investigates extreme precipitation events in two sets of regional climate simulations, as well as observational datasets. The focus of the study is on extreme precipitation that was continuously larger than the 80th percentile for at least two days for a given grid point.

The RCM simulation was executed at 25 km grid spacing, while the CPM set of simulations was performed at 3 km grid spacing, without parametrization for deep convection.

First, the synoptic weather type leading to the extreme precipitation events is determined separately for summer and for winter, then the simulated extreme precipitation is evaluated, followed by an investigation of events, and an investigation of the thermodynamic processes leading to extreme precipitation generation in the two different model configurations.

The subject of the manuscript is interesting, the study is performed with adequate techniques, and the presentation and language are of high quality. I thus recommend the publication of the manuscript after minor corrections.

We thank the reviewer for the valuable comments and suggestions to improve the manuscript.

General remarks

Title: the word "scale-dependency" suggest that the processes are investigated over a continuous range of resolutions, in search for discontinuities. Yet, only two different set ups are presented. Thus, I suggest a renaming of the title to e.g. something like "extreme precipitation processes in regional climate simulations of the greater Alpine Region in convection-permitting and convection-parametrizing simulations".

We agree with the reviewer. We will change the title considering these comments, also including suggestions from the other reviewers.

Section 6: scale dependency of thermodynamic processes: a regional weather/climate model forced by boundary data is quite constrained in its way to react, as much of the forcing is provided by the boundary data (as the authors also mention). Thus, part of the analysis in section 6 reveals different strategies of the model configurations to deal with this forcing containing different compensating errors. One forcing mechanism that is not mentioned but that can be of importance, at least for summertime precipitation, is radiative cooling. The radiative cooling leads to a destabilization of the atmosphere, that will enhance convective activity. I suggest to also check the outgoing longwave radiation in the two different sets of simulations for its significance in the extreme precipitation cases.

We will follow the suggestion and check the long wave radiation. We agree that understanding the differences in longwave radiation between RCM and CPM can complement the finding of the other model variables, especially the surface heat fluxes.

Specific comments

Line 65: numerics and physics-dynamics coupling should also be mentioned.

We have included this remark.

Line 293: I disagree with the statement "this does not imply a worse performance by CPM …". The overestimation of grid point extreme precipitation is one of the well-known deficits of convection-permitting models, as you state, despite many advantages. Please reformulate, admitting the issue.

We have revised the statement and mention this known issue. Now it reads:

"The comparison against HYRAS-5km (black), shows a good agreement by RCM and CPM for values between 1 mm d^{-1} and 10 mm d^{-1}. However, CPM (red) overestimates extreme precipitation for grid point maxima. This is a well-known deficit of CPM (Kendon et al., 2012) in spite of its many advantages e.g., improvements in the representation of the diurnal cycle (Kendon et al., 2012; Lin et al., 2018), or better event-scale representation (Chan et al., 2012; Ban et al., 2018)."

Section 5.2: the difference in temperature lapse-rate should be discussed in more detail. The lapse-rate will be the driver for further convective activity. Or formulated differently, the interior of the model domain may take on a different lapse rate in CPM vs CRM to cope with the different representation of convection (compensation model errors again).

We will consider your suggestion and investigate the lapse-rate differences in more detail.

Figure 10: some of the effects illustrated are very closely linked together, e.g. the effects seen in near-surface specific humidity and surface latent heat flux.

We agree that the connection between variables that show relevant resolution effects must be better explained. Some connections are mentioned between lines 459 and 476 but we will extend this information as the reviewer suggests.

For instance, for the relationship between surface specific humidity and latent heat flux emission it is pointed out that:

"e) the surface specific humidity differences can be 470 explained through differences latent heat fluxes between RCM and CPM, where RCM evaporates more moisture over the Sea and CPM over land."

Technical comments

Line 59: see also Vergara-Temprado et al., 2020

We will include a reference to the paper

Line 140/141: include "of" before "these data sets".

Corrected.

Line 156: replace "it" by "they"

In this case we are referring to just one area, the SGer area.

Line 221: include "of" between "range" and "values"

Corrected.

Line 241: should "flowing" be "following" ?

Corrected.

Line 282: OSMO → COSMO

Corrected.

Line 305: remove “is”

Corrected.

Line 316. al → all

Corrected.

Legend Figure 6: insert space before “HYRAS”

Corrected.