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Interactive comment on "Evaluation of convection-permitting extreme precipitation simulations for the south of France" *by* Linh N. Luu et al.

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Anonymous Referee #1

General comments: The authors use four indices to evaluate the skills of convection-permitting models and EURO-CORDEX in reproducing daily and sub-daily heavy precipitation over the Mediterranean region. As expected, the models with higher resolution which are able to resolve deep convection show better performance. The results are meaningful, and the paper is well written.

Response: We thank the reviewer for the appreciation of our work.

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Discussion paper

Major comments:

1. The evaluation between the simulation and the observation do not cover the same period. On Line 85-90, the authors mentioned ”Each convection- permitting simulation (hereafter mentioned as CPS) is conducted for two different periods including 1951-1980 and 2001-2030 with the RCP8.5 scenario for the year after 2005. These two periods are chosen with a gap period (1981-2000) rather than a seamless one in order to perform a climate change impact study which will be pre- sented in another article.” Since the climate change impact is not studied in this paper, why do the authors select 2000-2030 simulation to compare with the observation in 1997-2007 (Figure 2,6)? If the period is not the same, are the quantitative results in the paper robust? And why RCP8.5? How much difference between the RCP8.5 and RCP4.5?

Response: 1) As we stated in Table 1 of the preprint, we had two separated periods for in situ observations. First, for the daily timescale dataset, most stations started in 1961 and spanned to 2014. This dataset was adopted from Vautard et al. 2015. Second, the daily maximum of 3-hourly rainfall dataset (daily value of maximum 3-hour time window of rainfall), which was collected lately, started almost in 1998 to 2018. Therefore, we evaluated the daily indices of historical simulations (1951-1980) against observations of 1961-1990 and evaluated the 3-hourly indices of current period simulations against observations of 1998-2018. Because those simulations were forced by CMIP5 models and then evaluated by the mean state of the periods, the slight difference (5 to 10 years) in periods among models and observations does not hinder comparison. Thus, the quantitative results in this study are robust. 2) Chapter 12 in IPCC-AR5 (Collins et al., 2013) showed that anthropogenic radiative forcing started to diverge only after 2030 that also led to the divergence of global mean surface temperature after this year. Therefore, the discrepancy of using the CMIP5 simulations under different RCPs to force regional climate models for the period before 2030 is trivial. We then can consider them as different realizations of weather for a specific climate state.

2. Besides quantitative evaluation, could the authors add more discussion that could

explain the results, tie the results into the scientific literature and emphasize the importance of the results?

Response: We will add further discussion to section 3 in our revised manuscript.

Minor comments:

1. Line 55. Could the authors give more specific introduction about the region? Why do the authors select this region to study?

Response: We would replace a sentence starting in line 55 by 3 sentences providing the motivation why the Mediterraen region has been receiving more interest and specific scientific questions are being addressed by research communities.

"The coastal regions along the Mediterranean frequently undergo heavy precipitation events in the autumn which subsequently lead to flash floods and landslides causing massive losses and damages (Delrieu et al., 2005; Fresnay et al., 2012; Llasat et al., 2013; Nuissier et al., 2008; Ricard et al., 2012). In addition, this area is considered as a hotspot of climate change that strongly responds to warming at global scale (Giorgi, 2006; Tuel and Eltahir, 2020). As a result, the Mediterranean has received an increasing scientific interest in understanding of mechanisms leading to flood-inducing heavy precipitation as well as in improving the model ability to predict and project those events in a complex changing climate that provides substantial support to adaptation and mitigation for society (Drobinski et al., 2014; Ducrocq et al., 2014)."

2. Line 92, What does the "Mediterranean events" mean?

Response: The "Mediterranean events" here denote extreme precipitation events in the Mediterranean coastal areas. We have clarified this in the main text of the article.

3. Line 183, could the authors mark the French Alps in Figure 2? "The EUR-11-HadGem2-ES or CPS-HadGEM2-ES show the best agreement with observations." Did the authors mean the results of French Alps? Could the authors provide quantitative evidence? Like spatial correlation?

Response: The French Alps is located at the boundary of France, Italy and Switzerland, and noticeable in Fig.1 of this response and also the Figure 1 in the preprint. However, We meant that those two simulations show the best agreement with observations over the Cévennes box when comparing them with other simulations with the same resolution (Fig.1). The two downscaling experiments from HadGEM2-ES show dry biases of -5.9% for CPS and -33% for EUR-11 over the Cévennes box whose absolute values are smallest compared to others in the same resolution.

4. Section 3.1, could the authors give some explanation about why the EUR-11 performs better than the CPS which resolve better deep convection in French Alps?

Response: Biases concerned in the french Alps are difficult to interpret due to (1) the large heterogeneity of terrain and presence of high mountains in the area of the trends, and (2) the yet coarse resolution of models (even with CPS configuration) relative to mountains.

5. I think it might be better if the authors exchange the order of 3.3 and 3.4. In the method parts, the second indice is comparing the distribution of wet events.

Response: We will switch the position of section 3.3 and 3.4 in the main text.

6. Line 244. Could the authors give more explanation about "the convection scheme used in EUR-11 over-simplified the cloud process".

Response: The complexity of updraft in mesoscale convective systems was described in Houze (2004). However, the convection schemes usually simplify and formulate these complex processes by statistical distributions. These schemes use information from large-scale variables from model grids to modulate the development of convective cells at a finer scale that cannot be resolved by model resolution (Westra et al., 2014). This also implies assumptions of quasi-equilibrium with large-scale forcing, approximation of moist air entraining in the updraft, and representation of all single cloud elements by sole steady state updraft of the whole cloud ensemble (Houze, 2004; Lenderink and

Attema, 2015; Prein et al., 2013; de Rooy et al., 2013). In addition, convection schemes can respond to instant changes in atmospheric instability through information from grid scale, however, they do not memorize the previous state. This leads to their inability to permit the advection, development or decay of convective storms (Westra et al., 2014). An overview of historical development of assumption/parameterization of convection schemes was presented in de Rooy et al., (2013).

Please find Fig.1 at the end of this document.

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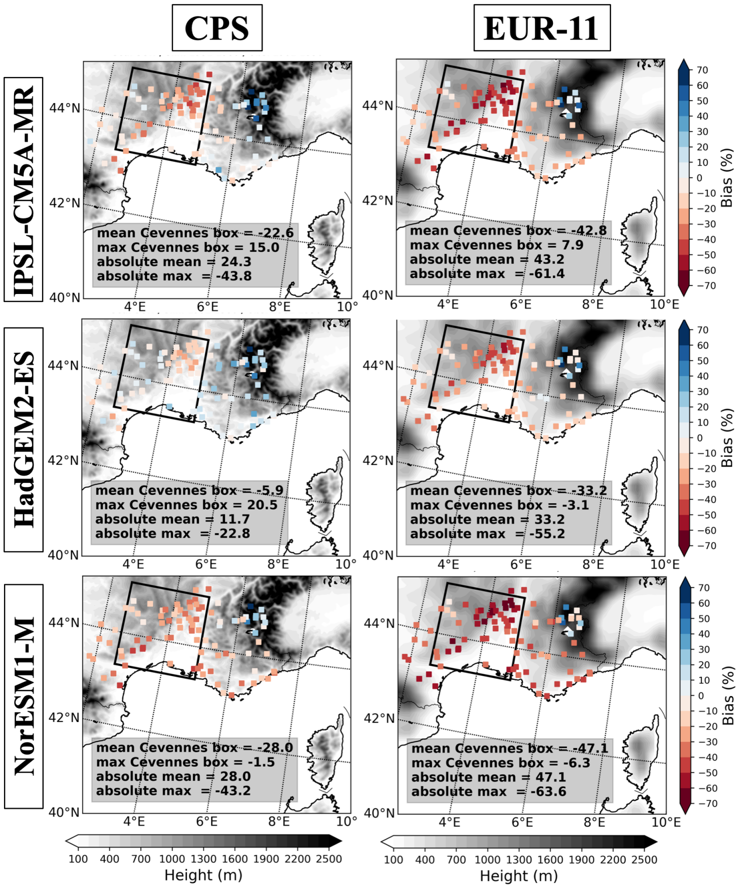

Fig. 1. Bias of Rx1day (%) between simulations and in situ observations. Columns show different ensembles (left for CPS and right for EUR-11), rows show different experiments. The grey shading shows orography