Interactive comment on "Evaluation of uncertainties in mean and extreme precipitation under climate changes for northwestern Mediterranean watersheds from high-resolution Med and Euro-CORDEX ensembles" *by* Antoine Colmet-Daage et al.

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Dear Editor,

We are responding to the comments from Reviewer 1 who has provided a very long list of interesting comments.

The major question about the model ensemble has been justified and the other techni-

cal corrections have been answered.

Thereafter, the comments from Reviewer 1 start with "RC1:" and our responses start with "ACD:"

RC1: The manuscript addresses the issue of changes in precipitation patterns under climate change in three selected Mediterranean regions, using a CORDEX high-resolution ensemble. The topic is dealt using widely accepted methodologies (evaluation metrics) and some newer concepts for quantifying changing of extreme precipitation patterns and error additivities in GCM/RCM simulations. The paper in general is well written and constructed. The abstract and conclusions summarize the basic features and findings of the work presented. Their introduction, despite being a bit lengthy is quite informative, the methodology clearly presented (some issues addressed below) and the description of results clear and concise. My major comment is that the ensemble members used in this study do not cover the existing EURO and MED-cordex simulations, as the title of the manuscript indicates. The criteria for not including existing and most importantly independent EURO/MED CORDEX simulations (eg RegCM4 or WRF331F) is not clear to me. Moreover, the authors decided to include 2 ensemble members from the same family (ALADIN5.2 and ALADIN5.3) i.e. two model versions which I expect they share similar structural errors and therefore expected to share similar behaviour. I don't find this choice methodologically sound. I understand the choice of authors, only if additional independent EUROMED CORDEX ensemble members were not available by the time of manuscript preparation.

ACD: We are very grateful that Reviewer 1 has read our paper very carefully and has left comments very precisely. Indeed, the major question is frequently asked and the response is as follows. The EUROMED CORDEX ensemble establishment has been driven by several reasons. First of all, and as supposed by the reviewers, no more ensemble members could be downloaded after the ESGF website hacking in August 2015. The website crash hasn't been available for more or less one year. After this period, the paper was already being written, and considering the above reasons, we

have decided to maintain the same model ensemble. The final aim of this study is to focus on the hydrological impact of future precipitation issued from the quantile ranked change coefficient function. Thus, we are not really arguing to assess the entire climate model spread as studied in the CMIP5 ensemble by McSweeney et al. (2015). Finally, ALADIN5.2 (Med-CORDEX) and ALADIN5.3 (Euro-CORDEX) are both effective to the same research laboratory, e.g. the CNRM. However, as discussed with Samuel Somot (personal communication), despite they both are issue from the same framework, they have some different physical structures and different parameters âĂć Binary changes (V6.01) because the calculator had changed. âĂć RRTM for the LW âĂć FMR-6 bands for the SW âĂć ECUME for the air-sea fluxes âĂć The mix length like for Lenderink ALADIN5.2 is more precisely described in Colin et al. (2010) and Herrman et al. (2011) and the ALADIN5.3 is slightly described in Tramblay et al. (2017) and Bador et al. (2017). Moreover, these two regional climate models are the most used in France, so it was interesting to propose their evaluation with an assessment of the added value with the most recent one (ALADIN5.3) in terms of mean and extreme precipitation over complex regions.

RC1: Technical corrections

RC1: Page 1, Line 18: "over past period" Over the past period: which is this period?

ACD: The period referred here is 1981-2010. We propose to add into the abstract.

RC1: Page 4, Line 14: there is a submitted paper, if available please provide the full citation

ACD: Unfortunately, the paper is not published at this date. It has been submitted in the Journal of Hydrology.

RC1: Page 5, Line 7. I missed two important ensemble members of EURO/MED CORDEX simulations, namely RegCM, and WRF. Especially RegCM is one of the most traditional regional climate models used for the investigation of European and partic-

ularly Mediterranean climate and I was wondering why authors did not include those ensemble members in their current study.

ACD: The absence of WRF and RegCM models are due to the same reasons explained in the answer of the major comments.

RC1: Page 6, line 4: I don't understand why the RCMs with spatial resolution of 12 Km where regridded to the 8 Km of SAFRAN. Why didn't they regrid from 8 to 12 Km?

ACD: The final aim of this work consists in applying future precipitation on hydrological models to assess their impacts as explained in section 1. Hydrological models generally work at 100m resolution. The spatial scale is different between the precipitation input resolution and the model computing resolution. It is a source of error that has to be minimizing as much as possible. So, to go closer to the hydrological scale, we decided to regrid the precipitation from 12 to 8km. To ensure that this operation will not bring additional biases to the precipitation an analytical test has been done.

RC1: Page 6, line 5. Remapping procedures are known to affect precipitation statistics (e.g. Diaconescu et al., 2015 http://journals.ametsoc.org/doi/pdf/10.1175/JHM-D-15-0025.1). The authors mention that they have tested how interpolation methods affect their results, without providing additional information. Extra care needs to be taken, especially when one attempts a percentile analysis in precipitation.

ACD: An analytical equation, containing latitude and longitude parameters, is resolved over the 8 km grid and the 12 km grid. Then the analytical field from the 12 km grid is interpolated to the 8 km grid. The previous analytic field on the 8km grid is then compared to the interpolated analytic field. The analytic equation is: $f(x) = 2 - cos(pi*(acos(cos(lat*x)*cos(lon*x))/alt))$ The attached figure show the function resolved on the top and the spatial interpolation biases on the bottom. The bottom map shows biases from 4.10-6 to 5.10-5 for the interpolation method used (Bilinear) over the whole domain studied. Then we have considered that the interpolation impact was negligible. We can provide additional information in section 2.3

RC1: Page 6, line 25. Could authors add a couple of lines on the behaviour of ÎŠ? What it means when ÎŠ is <0 or >0? Is shortly mentioned in Figure 4 caption, better mention in text.

ACD: The deltaB corresponds to the bias in the annual cycle of precipitation simulated with the RCMs that is strictly related to the influence of the lateral boundary condition imposed by the GCM. A high positive value indicates an overestimation of the total monthly precipitation, and a negative value indicates an underestimation of the total monthly precipitation. We propose to include this additional information in section 2.4.

RC1: Page 8, line 9." Figure 2b displays the normalized annual cycle". The caption of Figure 2b says "Bias of the annual cycle of precipitation".

ACD: We thank the review of this precise notification. We propose to correct this mistake by replacing the term "normalized" with "bias of the" like expressed in the caption.

RC1: Page 9, line 7." The results are coherent with other studies". Please refer to those other studies.

ACD: This sentence has been misunderstood. The role was to outline the following sentences where specific results are compared to other studies. We propose to replace this sentence by "The results are coherent with specific studies as cited thereafter".

RC1: Page 9, line 13: "thus" > eventually mean "those"?

ACD: We thank the reviewer to have noticed that mistake. We propose to correct it as recommended by the reviewer.

RC1: Page 20, Table 1: I miss the Radiation, Microphysics and Land Surface Model selections of each RCM simulation. It is useful information for regional climate modelers.

ACD: This information is not actually available on the website where the data have been downloaded and on the Med and Euro-CORDEX websites.

RC1: Page 9, line 20: Déqué et al., 2011 is missing in the references list.

ACD: We thank the reviewer for this comment is due to a mistake. The corresponding paper has to be cited as Déqué et al., 2012.

RC1: Page 10, line 9. "...Fig 5 is considerably larger". I don't find the differences in spreads between Fig 3 and 5 "considerable larger" for the Muga region.

ACD: We agreed that the adjective used isn't adapted to the reality observed on the plot. To correct it, we propose to replace this formulation with "…Fig5 is larger except for the Muga catchment".

RC1: Page 11, line 3-4: "Future precipitations from RCP…distribution". I don't think I understand this sentence.

ACD: Indeed, the idea that we would like to express here is not clearly stated through this sentence. To correct it, we propose to replace the sentence with: "Precipitation issued from RCP simulations are not bias corrected here. However, since explained in section 1, they are used to estimate to change coefficients between past and future quantile intensities of precipitation."

RC1: Page 12, line 14-15. While some reported that model performance in the past do not necessarily relate with model performance in the future, some report the opposite: Boberg and Christensen, 2012, Nature Climate Change.

ACD: This is an interesting article that we ignore. It will be relevant to add it to the discussion section.

RC1: Comparison of Fig 3 and Fig 5 is a bit confusing. In Figure 5, colors are used for GCMs and markers for RCMs, which is quite nice. In Figure 3, colors are used for RCMS; it would be easier to keep using markers for RCMs, similar to Figure 5.

ACD: We understand that similar markers would make easier the interpretation of the EVAL and HIST quantile-quantile plots. Unfortunately, that change cannot be done

easily during the summer. If the Editor considers that make this change is kind of major importance, we will try to do it as soon as possible, but it should not be done before September 2017.

RC1: Finally, is there a particular need to use SAFRAN in Figure 3 and 5? Isn't it supposed to be the diagonal line?

ACD: As supposed by the reviewer, the SAFRAN quantiles and the diagonal line are superposed in the quantile-quantile plots. However, it's interesting to see the specific dots values for the SAFRAN quantiles. We prefer to maintain that figure like that for this paper as we consider that the proposed modification won't have a significant change in the figure interpretation.

RC1: Figure 7. If this figure refers to autumn, it should be mentioned in the figure caption.

ACD: As recommended by the reviewers, we propose to insert in the figure caption that the change coefficient plots correspond to the autumn season (SON).

Yours sincerely,

Antoine Colmet-Daage

On behalf of all the co-authors.

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RCM_Regrid_Safran_ErreurInterpolation_bilinear_Analytique
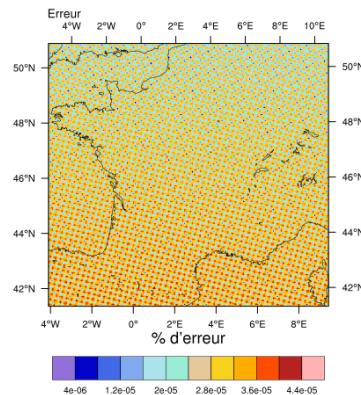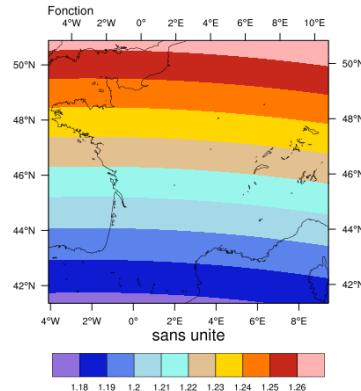

Fig. 1. Error of spatial interpolation through the ESMF Bilinear method