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Comment

Interactive comment on “Spatial and temporal patterns of recent and future climate extremes in the Eastern Mediterranean and Middle East region” by E. Kostopoulou et al.

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Anonymous Referee #1

The manuscript “Spatial and temporal patterns of recent and future climate extremes in the Eastern Mediterranean and Middle East region” by Kostopoulou et al. is mainly focused on a standard analysis of temperature and precipitation simulated by a regional climate model. The manuscript lacks of clarity and should be carefully revised. Many sentences/paragraphs should be supported by appropriate references (see the specific comments). The applied methods are not well explained and there are some technical

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Interactive Discussion

Discussion Paper



issues, e.g. on the estimated seasonal cycles and on the model evaluation w.r.t observations. Concerning the latter, there are not enough details to properly evaluate what has been done by the authors. As for the results, the authors should give information for all seasons and provide the significance of all results. Since the analysis is standard and computationally inexpensive, the authors should take care of all details. Finally, the aim of the manuscript is not really clear. What do the authors want to prove with the trend analysis of the two periods? Is a trend analysis of two separate periods able to reveal interesting and interpretable results? What about potential changes in seasonal precipitation/mean temperature?

We thank the anonymous reviewer for the constructive comments, which have assisted in improving our revised manuscript. Following the reviewers general recommendations we have thoroughly revise our manuscript and reorganise its structure. Some parts of the text were removed in other sections, new ones were added when necessary, many sections were rewritten to incorporate new material and all sections were carefully updated to clearly state the aim and the results of the study. For instance, the methodology section was particularly revised to inform the reader in a clear and concise manner about the methods employed in the current study. The seasonal cycles have been recalculated according to Referee-1 recommendation, while a new feature added in the evaluation of the Regional Climate Model. We used the non-parametric Kernel density estimator to construct estimates of the density function for every pair of observed and model climate series (for maximum, minimum temperature and precipitation on a seasonal scale). These distributions provided information about the structure of the data and used to determine similarity between the compared series and evaluate the RCM. In the revised manuscript we present information for all seasons. We have drawn new figures to replace figures 3 and 5 and we now show the present and future trends for maximum, minimum temperature and precipitation for every season. In every case we first discuss all the decadal trends found and then we emphasise on the regions where statistically significant trends have been revealed. The trend analysis is presented for seasonal temperature and precipitation in a present and a future

C2252

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Interactive Discussion

Discussion Paper



period and aims at investigating whether the 21st century changes tend to occur in a more rapid rate than during the 20th century, and further to identify the sub-regions which are projected to undergo the largest changes. Moreover, additional references were included in the revised manuscript. Please see next our responses to each of the reviewer's comments.

Some specific comments 4427, 1-2: Please add a reference. 4427, 5: Please add a reference. Response: Text was modified and the following references were added. Christensen, J. H. and co-authors: Regional climate projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, (eds. A. Solomon, D.Qin, M. Manning, Z. Chen, M. Marquis, and co-editors), Cambridge University Press, Cambridge, UK and New York, NY, USA, 2007a. Meehl, G. A. and co-authors: Global Climate Projections. In 'Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change'. (Eds S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller). pp. 747-845. (Cambridge University Press: Cambridge, United Kingdom and New York, NY, USA), 2007.

4427, 5: I suggest to delete "even local conditions", or at least specify that "local" refers to a spatial scale of _10 km. Response: Sentence has been deleted in the revised manuscript according to the reviewer's comment.

4427, 11: Please add a reference. Response: We have cited: Nakicenovic, N., Swart, R., (Eds.): IPCC Special Report on Emissions Scenarios. Cambridge University Press, UK, 2000.

4427-4428, 23-14: The authors should add and use the following reference (and references therein) to give a proper description of what has been done for the Mediterranean region (especially for the western-central part of the basin): "The Climate of the Mediterranean Region: from the past to the future" Lionello eds. 2012. Response:

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

We thank the reviewer for this recommendation. We have included the book and other related articles in our list of references: Lionello, P. (Eds.): 2012: The Climate of the Mediterranean Region: From the Past to the Future, Amsterdam: Elsevier (NETHERLANDS) 9780124160422, 502pp, 2012. Brunet, M., Jones, P. D., Sigro, J., Saladie, O., Aguilar, E., Moberg, A., Della-Marta, P.M., Lister, D., Walther, A., and Lopez, D.: Temporal and spatial temperature variability and change over Spain during 1850-2005. *Journal of Geophysical Research*, 112, D12117, doi:10.1029/2006JD008249, 2007. Brunetti, M., Lentini, G., Maugeri, M., Nanni, T., Auer, I., Böhm, R., Schöner, W.: Climate variability and change in the Greater Alpine Region over the last two centuries based on multi-variable analysis. *International Journal of Climatology*, 29, DOI: 10.1002/joc.1857, 2197-2225, 2009. Goubanova, K. and Li, L.: Extremes in temperature and precipitation around the Mediterranean basin in an ensemble of future climate scenario simulations. *Global Planet. Change* 57, 27–42, 2007. Kuglitsch, F.G., Toreti, A., Xoplaki, E., Della-Marta, P. M., Zerefos, C. S., Türkes, M. and Luterbacher, J.: Heat wave changes in the eastern Mediterranean since 1960, *Geophysical Research Letters*, 37, L04802, doi:10.1029/2009GL041841, 2010. Ulbrich U. and co-authors: Climate of the Mediterranean: Synoptic Patterns, Temperature, Precipitation, Winds, and Their Extremes. In Lionello P. (Ed.) *The Climate of the Mediterranean Region. From the Past to the Future*, Amsterdam: Elsevier (NETHERLANDS) 9780124160422, 502pp, 2012.

4428, 24-26: The sentence is questionable. RCMs cannot replace observations. Response: We thank the reviewer for this comment, and we have omitted the sentence in the revised manuscript.

4428, 26: Please do not use acronym without providing the full name. Please add a reference both for the project and the model. Response: We have revised the manuscript and every abbreviated word, in their first occurrence, is now followed by its full form in parentheses. References for the project and model are added too.

4429, 5-10: Please rephrase. Response: Following the reviewer's comment we have

Full Screen / Esc

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Interactive Discussion

Discussion Paper



re-worded this part of the text.

4429, 23: “This study”. Response: The correction was done according to reviewer’s recommendation.

4430, 3-6: Please move this link at the line where CIMME project has been introduced for the first time. Response: The correction was done according to reviewer’s recommendation.

4430, 10: Please add a reference, and provide complete information. Different CRU datasets exist. Response: We specify the CRU dataset used in this study (TS3.0, <http://badc.nerc.ac.uk/data/cru/>) and add a reference: Mitchell, T. D. and Jones, P. D: An improved method of constructing a database of monthly climate observations and associated high-resolution grids. Int. J. Climatol. 25, 693–712, 2005.

4430, 19: Please provide complete information and add the appropriate references. Linear model is not enough. Response: The complete information is provided later in the paragraph.

4430, 23: Please provide a list of the calculated extremes with detailed information. If the work of the CLIVAR Expert Team on Climate Change Detection and Indices has been used, please cite the associated reference. Response: The manuscript was appropriately modified according to reviewer’s recommendation. The following reference is added: Karl, T. R., Nicholls, N., Ghazi, A.: CLIVAR/GCOS/WMO workshop on indices and indicators for climate extremes: workshop summary. Clim. Change, 42, 3–7, 1999.

4430, 24: Please give a detailed description. Linear regression is not enough. Response: The manuscript was appropriately modified according to reviewer’s recommendation.

4431, 3: Please explain how the bias has been evaluated. Concerning daily precipitation, what do the authors want to show/prove? Please note that modeled precipitation

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Interactive Discussion

Discussion Paper



is an “areal” variable and that daily precipitation has a distribution with right-skewness and exponential/heavy tail. Response: The evaluation section was largely revised. We discuss the difference between station data and RCM output. We are using the control run and calculate the correlation in time. We thank the reviewer for the comment on model precipitation.

4431, 5: The authors cannot conclude that the model has a cold bias based on the evaluation on 14 stations (the details of the evaluation are not provided). Response: We agree with the reviewer. This conclusion, however, was based on our analysis of evaluation using a small number of available station data. The fourteen stations used in this study are only representative from the western part of the EMME region and do not allow robust conclusions to be drawn about the accuracy of the model data. This part of the text was modified.

4431, 6-8: As far as I understood, the RCM has been driven by HadCM3P, so a correlation analysis of daily time series is not informative. Response: We are using the control run and calculate the correlation in time.

4431, 9-10: The seasonal cycle of temperature has to be calculated by using time-window (3-5 days) centered on the calendar day. Then, the output has to be smoothed by using for instance splines. Concerning precipitation, please use a smoothing algorithm. Response: We have followed the reviewer’s recommendation. For the maximum and minimum temperature, we have used a 3-day window centred on the calendar day and then applied a smoothing spline. Similarly, we have applied smoothing to the precipitation annual cycle and the results are presented in a redrawing of figure 1. The associated text has been accordingly modified.

4432, 1: Please clarify the meaning of “diverging”. Response: As the word is ambiguous we have removed it from the manuscript in the revised version.

4432, 8: Please replace “may reach as” with “reach values as” Response: The correction was done according to reviewer’s recommendation.

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Interactive Discussion

Discussion Paper



4432, 16: “Mann- Kendall test”. Please add the associated reference and move this part to the section on the methods. 4432, 17: Which significance level has been used? Response: The manuscript was appropriately modified according to reviewer’s recommendation. The Statistical significance was determined using the Kendall tau test and the significance level of 5% is used to indicate statistically significant trends. This is explained in the section ‘2.2. Methodological approach’. The relative references which are added are the following: Kendall, M. G.: Rank Correlation Methods. 4th ed., London: Griffin, 258 pp., 1970. Helsel, D. R., and Hirsch, R. M.: Statistical Methods in Water Resources, Elsevier, 522 p., 1992.

4432, 18-25: What about the other season? The lack of significant trend for summer TX in many areas is surprising and does not match with the signal identified in many instrumental time series from the station located over the Mediterranean region. I think the authors should discuss this point. Response: We have drawn new figures to show the present and future trends for maximum, minimum temperature and precipitation for every season. In every case we first discuss all the decadal trends found and then we emphasise on the regions where statistically significant trends have been revealed. This part of the manuscript has been largely revised.

4433, 4-9: This paragraph is not in the correct section. Response: The manuscript was appropriately modified according to reviewer’s recommendation. The description of indices and associated references are included in the section ‘2.2. Methodological approach’.

4433, 10: “of the mean of the selected indices”. Response: The correction was done according to reviewer’s recommendation.

4433, 12: Please delete “can”. Response: The correction was done according to reviewer’s recommendation.

4433, 15: This is simply an effect of the absolute threshold. Response: We thank the reviewer for this comment which is included in the revised manuscript.

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Interactive Discussion

Discussion Paper



4434, 20: What about the significance of the identified differences? Figures 1-4-6: Please revise the caption. Response: The confidence in estimated changes is obtained by bootstrapping the differences between the two periods. Figure captions are revised.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 4425, 2013.

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1, C2251–C2258, 2014

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Interactive Discussion

Discussion Paper

C2258

