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Interactive Comment

Interactive comment on "Review Article: Atmospheric conditions inducing extreme precipitation over the Eastern and Western Mediterranean" *by* U. Dayan et al.

U. Dayan et al.

msudayan@mscc.huji.ac.il

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Responses to Referee # 1

1) On the rational to publish this Review: We agree with the Referee and added a paragraph in the Introduction Section giving some arguments on the necessity for such a Review as part of the NHESSD - Special issue on "Climate change, extreme events and hazards in the Mediterranean region", Editor(s): P. Lionello, V. Artale, D. Gomis, and H. Saaroni.

2) On the role of mountain lee cyclogenesis: We agree that its contribution is important,

consequently, a full paragraph discussing this issue was added to Section 2.

3) References concerning the connection to modes of variability were added as suggested. (see last paragraph of Section 5).

4) The text dealing with connection with ENSO was further consolidated by enlarging the relevant paragraph in Section 5 and adding few more references.

5) The technical issues raised by the Referee were solved (i.e., adding line breaks to some long paragraphs and improving the quality of some of the figures). However, we do believe that Figs. 10 and 11 are necessary. Fig. 10 is important in order for the non-middle-eastern reader to be more acquainted with the ARST – an active tropical system incursion affecting the EM and accounting for most of the major floods over the southeastern EM. This system is characterized, often, by the rapid formation of congested convective clouds producing heavy rain. As regarded to Fig. 11, we do think that the good agreement depicted in this figure in the location of the MKI and RDI maxima and rain maxima suggests that these indices are good predictors for torrential rain and flash floods in the Mediterranean region.

Responses to Referee # 2

1) Section 1, page 3688, line 22: Indeed, not every heavy rainfall event causes ïňĆoods; we meant mentioning that some of them might lead to floods. The following references deal with essential atmospheric processes contributing to the development of heavy rain. The words “inducing floods” in line 23 were omitted.

2) Section 1, page 3689, lines 1-4: We fully agree with the Reviewer on the necessity to add some more detail on dynamic and thermodynamic processes and their puzzling relationship. Consequently, we added a paragraph treating this issue after line 4 in page 3689.

3) Section 2, page 3690, lines 14-16: The text was corrected to “summer dryness” as suggested.

4) Section 2, Figure 4: The comment made by the Referee is right. Fig. 4 displays the LTM of the Skin Temperature which includes both, LST (land surface temp.) and SST (sea surface temp.). SST is derived from the NOAA operational global sea surface temperature by analyzing 7 days of in situ (ship and buoy) and satellite SST taken from Reynolds' SST (1994). LST is calculated according to an analytic model (Pan and Mahrt 1987). Both are integrated in NCEP/NCAR Reanalysis Model. Caption of Fig. 4 was corrected for better clarity accordingly.

5) Section 3, page 3691, line 16: The typing error in the word "confined" was corrected.

6) Section 3, page 3691: the references related to the moisture sources in the EM were updated. Two paragraphs were added to this section.

7) Section 4, Figure 5: Since Fig. 5 deals with the Saharan, West-African cloud band, (Kuhnel, 1989), the figure and its description was transferred from its original place to the beginning of this section where it is more appropriate. Further, the associated conditions featuring these TP's group (i.e., position and curvature of the Sub-Tropical Jet, the accompanying upper trough and the moisture transport pathways) were found over the EM (Tubi and Dayan, 2014) as mentioned in the text of this section.

8) Section 5, page 3695, line 27: The original reference of Conte et al. (1989) was added.

9) Section 5, page 3696: We fully agree with the Reviewer. Consequently, a new paragraph was added to this Section so as to include other teleconnection patterns that modulate extreme rainfall variability over the MR.

10) Section 5: On the relationship between variability of mean precipitation and extreme precipitation. We agree with the reviewer that some of the references cited (Dünkeloh and Jacobeit, 2003; Mariotti et al. 2005) were not dealing on the variability of extreme precipitation events. These references were omitted. However, we believe that the reference made to Ziv et al (2006) and Mariotti et al. (2002) are appropriate.

Ziv et al (2006) shows the composite maps of SLP and 500 hPa gph for the ten heaviest rainfall days in Israel. A sentence was added to the text to clarify this point. Mariotti et al. (2002) found that in autumn, anomalous cyclonic circulation brings enhanced moisture from the Atlantic to the western MR leading to positive rainfall anomalies over this region. Heavy western Mediterranean rainfall events were related to moisture advection from the Atlantic (See Section 3 with reference made there to Pinto et al. (2013) who found that moisture advection from the North Atlantic plays a relevant role in the magnitude of the extraordinary rainfall events). Consequently, we though as important to describe the anomalous atmospheric circulation and moisture transport extending from the sub-tropical Atlantic Ocean into the MR for a particular stage of the ENSO cycle as Mariotti et al. (2002) have shown.

11) Section 5, page 3698, lines 5-9, line 22, ïňĄgure 8: We agree with the comment made by the referee and used the term “moderately extreme events” as suggested.

12) Section 6, page 3699, lines 1-10: This paragraph was transferred to the Introduction section as suggested.

13) Section 6, page 3699, lines 23: As regarded to the role of soil moisture in inhibiting deep convection producing heavy rainfall, a paragraph describing these processes has been added in the beginning of this section explaining why they are more frequent over land during summer in the Mediterranean regions.

14) Section7, page 3700, 3701: The information as regarded to the detailed flow directions and seasonality of each of the atmospheric circulation type associated with heavy rain for the EM and WM regions is by far too much to be included in a concise table. However, a table (Table 1) was added to the text summarizing, in a general manner, the main atmospheric circulation patterns producing heavy rainfall over both, eastern and western tips of the MB and their seasonality.

15) Section 7: On the role of a low pressure system forming south of the Atlas Mountain: This low is called “Sharav cyclone”. This cyclone is a thermal low, which is en-

hanced by vigorous boundary level baroclinicity caused by the steep thermal gradient existing between the heated land and the cold Mediterranean Sea (Alpert and Ziv, 1989). Due to their shallow structure, the low moisture content in the Saharan air mass, the shallow vertical extent of these systems and their corresponding low vertical velocities, associated rainfall amounts are usually limited and they do not produce heavy rain. Consequently, this system was not discussed in this section.

16) Section 8: On the possible quantification of heavy rain events as outcome of convective and advective mechanisms. We fully agree with the Reviewer suggestion and added accordingly a paragraph discussing this issue, based on the recent paper of Hertig et al (2014), at the end of Section 8.

17) Section 9, page 3708, line 11, lines 13-14: The comment made by the Reviewer on the seasonal distribution of precipitation over the southern parts of the MR (North African coast) is correct. The dataset produced by the Climatic Research Unit (CRU) of University of East Anglia (UEA) for the period 1960-1990 indicates that the contribution of precipitation amounts for Tunisia during the transitional seasons to the total yearly rainfall is 57.5 percents. The text was corrected accordingly.

18) Further references (Trigo, et al., 1999 and Lionello, (ed), 2012) were added and referred in the text, as suggested.

Refs: (used above in the responses to Referee #2 and not existing in the Review)

Richard W. Reynolds and Thomas M. Smith, 1994: Improved Global Sea Surface Temperature Analyses Using Optimum Interpolation. J. Climate, 7, 929–948.

Pan, H. L., and L. Mahrt, 1987: Interaction between soil hydrology and boundary-layer development, Boundary-Layer Meteorology,38,1-2, 185-202.

Alpert, P., and Ziv, B., 1989: The Sharav cyclone: observations and some theoretical considerations Journal of Geophysical Research, 94,18,495–18,514.

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