

ESD-2021-55: “ESD Reviews: Extreme Weather and Societal Impacts in the Eastern Mediterranean” by Assaf Hochman, Francesco Marra, Gabriele Messori, Joaquim G. Pinto, Shira Raveh-Rubin, Yizhak Yosef and Georgios Zittis.

Point by point response to Reviewer 1:

- 1. Reviewer 1:** This review-based manuscript overviews the extreme weather events and their associated societal impacts in the eastern Mediterranean region -- by Assaf Hochman et al. The paper is generally well-written. The introduction is well-structured with a good story-line explaining the weather and climate extreme processes. The paper covers major extreme events such as temperature, hydrology (heavy precipitation and drought), wind, and a combination of them. Each of these topics are well described, reviewed and interpreted in terms of the physical understanding, observed trend and future projections, and their societal impacts. I found them informative, simple, and well sustained. An extensive and comprehensive bibliography and references are used and cited also.

Response: We would like to thank the anonymous reviewer for his/her valuable time and useful contributions, which definitely helped to improve our manuscript. We address all of the Reviewer’s comments below and describe how the suggested changes were implemented in the revised version of the manuscript.

- 2. Reviewer 1:** However, the summary seems to be a bit lengthy, I would suggest to make it shorter and concise, as most of them were already discussed in the manuscript.

Response: Thank you for this suggestion. We agree with the reviewer that the text could be shorter and more concise here, with less repetition compared to the points described earlier in the manuscript. Thus, we shortened the summary according to the Reviewer’s suggestion. Specifically, we removed the part focusing on the basic definitions of the synoptic systems as they are extensively discussed elsewhere in the text. The revised Summary and knowledge gaps section is as follows:

‘Extreme weather in the eastern Mediterranean has detrimental effects on society and ecosystems. Here, we provide a review of the state-of-the-art and current research knowledge gaps on this subject. We specifically focus on the physical processes that

drive extreme weather, on the observed trends and future projections of such events, and finally on the societal impacts these events may have.

Extreme weather in the eastern Mediterranean is connected with regional synoptic systems and their interplay with the large-scale atmospheric flow. The region has experienced repeated extreme heat waves in the recent past (Kuglitsch et al., 2010), and their frequency, duration and intensity are projected to increase in the coming decades (Fig. 3 a; e.g., Seneviratne 2012; Lelieveld et al., 2016; Hochman et al., 2018a). On the other hand, the frequency and duration of winter cold spells are projected to decrease in the coming decades (Fig. 3 b; Sillmann et al., 2013). Still, it should be noted that eastern Mediterranean cold spells have received comparatively little consideration in the literature, perhaps due to the naive assumption that they will no longer occur in a warmer climate.

The majority of extreme weather events, including heavy precipitation and intense westerly windstorms, are associated with Cyprus Lows or Active Red Sea Troughs (Fig. 1 c and Fig. 2 a, b; Alpert and Reisin, 1986; Nissen et al., 2010). Similar to other Mediterranean cyclones, Cyprus Lows have been projected to significantly decrease in frequency, persistence and accompanying daily precipitation amounts under increased greenhouse gas concentration pathways (e.g., Hochman et al., 2018a; 2020b). Active Red Sea Troughs have recently received ample attention, since there is an ongoing debate on how an increase in greenhouse gas concentrations will influence their frequency and intensity (Alpert et al., 2004; Peleg et al., 2015a; Saaroni et al., 2020; Hochman et al., 2021b; Marra et al., 2021a). We note here that there is relatively little literature related to the physical understanding, observed trends, and future projections of wind extremes in the southeastern part of the eastern Mediterranean.

Compound extremes in the eastern Mediterranean are often linked either with very hot and humid conditions during summer, especially close to the Mediterranean coast, or cold and wet episodes during winter. Hydrological compound extremes include compound droughts and compound coastal flooding. Hot and humid extremes are projected to increase in frequency and intensity (See Sect. 5.2). There is considerable uncertainty in trends in compound droughts and floods, although some studies point to increasing trends. To the best of our knowledge, studies focusing specifically on future

projections of compound cold and wet events over the eastern Mediterranean are not yet available.

Extreme weather events impose heavy socio-economic tolls (IPCC 2013). These are further aggravated in vulnerable regions, such as the eastern Mediterranean (e.g., Lelieveld et al., 2012). We identify four key means to increase societal resilience to extreme weather: i) Reduce the probability of extreme weather by timely mitigation of hazardous climate change. ii) Improve the ability to forecast extreme weather and its impacts using conventional and/or novel techniques and early warning systems (e.g., Hochman et al., 2020d; 2021a; Merz et al., 2020). iii) Expand the database related to the impacts of extreme weather to support a better mapping of vulnerabilities (e.g., Merz et al., 2020). iv) Develop adaptation strategies to cope with the adverse impacts extreme events may have on society, infrastructure and human-controlled ecosystems. In respect to the latter two points, some specific knowledge gaps have been identified. These mainly relate for example to the impacts extreme weather may have on mortality, morbidity and infrastructure in the eastern Mediterranean. We believe that societal resilience to extreme weather in the region can properly be achieved only by true interdisciplinary cross-border collaborations, in spite of recurring political turmoil (e.g., Hochman et al., 2020a, c; Negev et al., 2021).'

3. **Reviewer 1:** Additionally, I have some minor comments, see below. I hope that these are helpful for the authors. I look forward to reading the revised version.
4. Line 105: can you please define the symbol here, I guess it should be ‘omega’, right?

Response: The reviewer is correct. Instead of using the symbol, we now spell out that we mean omega – shaped anticyclone. This has been implemented in the revised version of the manuscript.

5. **Reviewer 1:** Line 273: you may need to cite an appropriate article(s).

Response: Thank you for this suggestion. We cited Wilhite and Glantz (1985), which discusses the definition of drought, in the revised version of the manuscript.

Reference:

Wilhite, D. A. and Glantz, M. H.: Understanding: The Drought Phenomenon: The Role of Definitions, *Water Int.*, 10(3), 111–120, <https://doi.org/10.1080/02508068508686328>, 1985.

6. **Reviewer 1:** Line 575: it is better to move the pdf to the reference section, and just cite it here.

Response: The reference was moved according to the Reviewer's suggestion and cited accordingly.

7. **Reviewer 1:** Line 656: you may also add "hydrologists"; the extremes events such as peak-discharge and flash flooding, could be addressed by specialists in the field of surface hydrology and water-resources management.

Response: The term 'hydrologists' was added according to the Reviewer's suggestion.

Point by point response to Reviewer 2:

1. **Reviewer 2:** This manuscript aims in providing a review on extreme weather and societal impacts over the region of eastern Mediterranean. The authors achieved that by focusing on the physical understanding, observed trends and future projections of the different kinds of extremes that are studying and identifying the major associated societal impacts. It is very well structured and written study begging with an informative and detailed introduction, followed by different sections on temperature, precipitation, wind and compound extreme events that are all accompanied with proper citation. The authors conclude with a summary where knowledge gaps are also mentioned and a last section where they point out some key questions that are still open and need to be studied. The authors also focus in the need of interdisciplinary cross-border collaborative work in order to achieve better understanding of the extremes in the region and hence achieve societal resilience.

Response: We would like to thank the anonymous Reviewer for his/her valuable time and positive feedback.