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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Atmospheric Conditions Leading to an Exceptional Fatal Flash Flood in the Negev Desert, Israel" *by* Uri Dayan et al.

Anonymous Referee #1

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1. General comments The study "Atmospheric Conditions Leading to an Exceptional Fatal Flash Flood in the Negev Desert, Israel" by Uri Dayan, Itamar M. Lensky and Baruch Ziv presents a thorough analysis of the synoptic and sub-synoptic patterns which produced a major storm in southern Israel, causing the death of 10 people. To my view, the significance of the paper is clear, given that there seems to be no sufficient knowledge to alert people ahead of such storms. Although analyzing one case study, the study has a substantial contribution to the understanding of flood-bearing rainstorms in Israel and its vicinity, as general conclusions are drawn and using a comparison to another eleven spring storms that caused floods in the area. I find the analysis done along the cyclone track (MCV, speed) especially interesting, as it shows this cyclone intensified over Israel, and was therefore specifically intense over this region,

and as it gives sort of reference values that can help in forecasting of severe storms. Furthermore, I think that the study of the atmospheric conditions during flood-bearing storms is much needed as these are the biggest natural hazard causing fatalities in the region. The scientific and presentation quality is good, although I have quite a few comments on both topics. Overall, I think that this study is interesting and important, and is worth publication in NHESS after addressing the points raised below. Three of my comments worth specific attention and are written under "specific comments". Other comments are smaller in nature (even if some are also conceptual) and most of them are technical in nature.

2. Specific comments - L160-174: These lines present an interesting idea; however, I am not sure the support given to it is enough. It is not clear to me if the slowing of the cyclone occurs every time there is a closed cyclone over the region or only when there is a dipole pattern. If the dipole is needed, I am not sure whether the 500 hPa GPH anomaly can explain the dipole. The way I understand it from your description is that both the southern part of the high and the northern part of low induce easterly flow and slow the propagation of both systems. However, examining the actual synoptic maps (and not the anomaly maps), I cannot see the highs. I can observe two ridges, one from to the west of the low and the other to the east of it (extending in Fig. 2c to the north of the cyclone). Do you account the ridge from the east for the slowing of the systems? I am not sure the pressure gradient is represented well enough by the anomaly maps. - L189-196: What is the timing of the rainfall that produced the flood? Rainfall is observed in the region of "Tzafit" both on 06-12UTC and in 12-18UTC, while significant omega is only seen in 15UTC. Please address this point, as it is crucial to understand whether ERA5 omega values are indeed accurate enough to capture such a small-scale rain spot. - L225-236: I am wondering about the Tropical moisture source. Fig. 8 as well as Fig. 2c (and to some degree 2b) show southwesterly flow to Saudi Arabia, all consistent with your "tropical" source attribution. However, examining Fig 2a (and 2b) I can see convection triggered close to the cyclone's center, with northerly (Mediterranean) flow at low elevations. This makes me think the moisture source could

have been Mediterranean to begin with, and this moisture (combined with the deep convection along the cyclone's track) could be the only moisture source to precipitation from this cyclone. The southwesterly flows in Saudi Arabia (Fig. 8 and Fig. 2c) existed probably at the night of the 25th of Apr, but to reach this region with sufficient moisture, you would probably had to look for southwesterly flows prior to this night, and this does not seems to be the case (Fig. 2a and b). Moreover, 18-24 h before arrival to "Tzafit Creek" the position of the red backtrajecktory is in southern Syria. Going further back in time with the red trajectory gives Iraq (ground level) as the origination of the track. I am not familiar enough with this region, but I would expect it to be rather dry, and anyway, the track does not go all the way back to tropical latitudes. Please add some support for your moisture source determination, or correct this part of the text, as I suspect the Mediterranean could possibly be the only source in this case. One possible solution is to plot moisture content along the backtrajectory, and another one could be plotting a matrix of trajectories arriving to close-by locations.

3. Technical (and more specific) comments - L10: Please state either that the ten casualties were among the people that die during the event (to the best of my knowledge, three more people died in other streams in Israel during the same event) or that among the flash floods one was specifically deadly, killing 10 people. - L11-12: "The timing of the storm is also unique, at the end of the rainy season, when rain is relatively rare and spotty". Is it unusual to get extreme storms at the transitional seasons at the Negev desert? If not, please correct. - L13: Please rephrase "one of the latest spring severe events in the region during the last 3 decades" to "one of the most severe latest-spring events in the. . ." or something in that spirit. The same holds for L46-47. - L17: consider rephrasing "latest" to "last". - L36-37: consider rephrasing "most weather-related fatal hazard" to "most fatal weather-related hazard". - L40-44: It is not clear whether most rainfall in the desert areas occurs during Dec-Feb or only over the non-desert parts of Israel. Please clarify this point. - L55: "over which floods took place" during this event? In general? Please explain. - L58: Please explain how "maximum intensity" is defined. - L58: Can you please elaborate on the 11 storms? Are these the only storms during

Apr-May over this period? Are these the highest discharge storms (as suggested in L66)? Are these the same storms listed in Table 1? If these are the same storms, please number the different storms in the list, as it is hard to find 11 storms in it. If they are not the same storms, please list these storms in a table as well. - L61: what is the spatiotemporal resolution of the radar data used? If I am not mistaken, Marra & Morin (2015) data come from another radar in the region. - Figure 1: It is not clear whether this map comes from accumulated IMS radar data ("RADAR" is stated in the figure's caption) or from the "rain measuring network" (L60). The shape of the contours looks as if coming from an interpolation of gauges. Please explain and change the text referring the figure or the figure's caption accordingly. It seems radar data is more appropriate to use since rain gauges in the analyzed region seems scarce. - L66: What do you mean in "the data of floods"? Does this refer to hydrographs? Peak discharge? - L70: please add a reference to this statement. Consider one (or more) of the following for this specific region: (Armon et al., 2018; Dayan & Morin, 2006; Kahana et al., 2002, 2004); and in general: (Bárdossy & Filiz, 2005; Borga & Morin, 2014; Doswell et al., 1996). - L69-74: please explain why you use different datasets (ERA5 and NCEP/NCAR). Do coarse scale ERA5 data the same (or very similar) to NCEP/NCAR data? If not, the use of ERA5 data both in the synoptic scale and in the meso-scale is probably better. - L83: What are the units of the cyclone depth? is it m or hPa? Do you measure the depth at the 500 hPa as well? Does V refer to the 500 hPa? - L90: "usually 500 hPa" – is this the case here or do you consider another pressure level? - L98-103: did you consider using the Beit Dagan sounding data for the MKI index as well? This could help understanding whether there are significant differences in ERA5 data in respect to the sounding data, which is not situated within your study area. - L104-105: Where does PW come from? Is this based on ERA5? Please indicate it in the text. - L107-109: Can you describe what kind of backtrajectories did you used? Which atmospheric model was used (NCEP/NCAR reanalysis / ERA5 / Other data)? What kind of levels did you use (model / pressure / isentropic)? - Fig. 2: Could you please describe the MODIS imagery? Does the image come from

12UTC as well? Is it from a specific MODIS (Terra/Aqua)? If so, please write it. - L131-149 and Fig. 3: It is not clear to me how did you track the cyclone at the 500 hPa. Was it through the large scale NCEP/NCAR data or the ERA5? Or possibly using satellite images? Please explain it either in the materials or specifically when referring to the cyclone's movement. - Fig. 4: Please correct the caption ("with maximum of K. . ."), consider choosing a more appropriate colorscale (centered at zero or starting at zero), a better in-figure-caption units (currently it is "10^1 K m**2 kg**-1 s**-1"), and possibly use PVU units instead. - L141: "This is rather exceptional. . ." – did you compare the value to other values from your reference period? This could be interesting and could also put the results in a broader context. - L185 please replace the square sign with a degree sign. - Figure 7, middle panels: Do these panels represent radar, gauges or a combination of radar and gauges? Panel f seems to be some combination of gauges and radar, but this is not clear from the caption or "materials" section. L181: what do you mean by "integrated"? Does this refers to the combination of sources or to the accumulation of rainfall? Please add units to the MKI legend or caption. - L194: "-10 Pa s-1" do you mean -1 Pa s-1? If not, please correct Fig. 7's legend. - L244: Please see previous comment about the "unique timing" of the storm. - L245: This paragraph seems to me as a summary paragraph, however the term "Syrian low" was only introduced in L245. Could you please either remove this line from the summary or describe this term in the introduction/results sections? - L285: Cape values in Fig. 2 reach to 909 and not to 1000. Please correct or explain this notion. - L286-289: Contribution of tropical moisture was shown in a number of studies; however, I am not sure this is the case here. Please address the previous comments about this subject. If you are certain about the tropical origins, please add more references or add "e.g.". - L290-294: The point raised here is interesting and fits well a discussion section. Since this section of the paper is written in bullets, it looks like a summary or a conclusion. Please give a better distinction between the summary and the discussion. This will help readers to understand which parts in this section should only be treated as a discussion and are therefore introduced firstly in this section, and which are summarizing prior sections.

Perhaps the discussion can remain as one section and the summary can go with the conclusions, and in this way you will reduce redundancy. - L299: Please either add "not shown" after the "-5 K" or show this anomaly. Currently, there is an impression this anomaly is given in Fig 6. - L303-L310 "unique intensity", "exceptionally severe rainstorm", "severity of this rainstorm": what exactly all of these expressions refer to? Do you mean the MCV? The rainfall (is it really that rare)? The casualties (were they influenced by the extreme severity, bad luck, or bad circumstances)? Please explain this point, and better to do it in previous sections of the paper. - L313-314: Is this the case here? Was it written previously? - L315-317: Please see previous comments about tropical moisture origins (although this conclusion seems reasonable anyway). - L318-320: Please also see previous comment regarding L189-196.

4. References Armon, M., Dente, E., Smith, J. A., Enzel, Y., & Morin, E. (2018). Synoptic-scale control over modern rainfall and flood patterns in the Levant drylands with implications for past climates. Journal of Hydrometeorology, 19(6), 1077–1096. https://doi.org/10.1175/JHM-D-18-0013.1 Bárdossy, A., & Filiz, F. (2005). Identification of flood producing atmospheric circulation patterns. Journal of Hydrology, 313(1–2), 48–57. https://doi.org/10.1016/j.jhydrol.2005.02.006 Borga, M., & Morin, E. (2014). Characteristics of Flash Flood Regimes in the Mediterranean Region. In N. Diodato & G. Bellocchi (Eds.), Storminess and Environmental Change Climate Forcing and Responses in the Mediterranean Region (pp. 65–76). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-7948-8_5 Dayan, U., & Morin, E. (2006). Flash flood – producing rainstorms over the Dead Sea: A review. New Frontiers in Dead Sea Paleoenvironmental Research: Geological Society of America Special Paper, 401(04), 53–62. https://doi.org/10.1130/2006.2401(04). Doswell, C. A., Brooks, H. E., & Maddox, R. A. (1996). Flash Flood Forecasting: An Ingredients-Based Methodology. Weather and Forecasting, 11(December 96), 560–581. https://doi.org/10.1175/1520-0434(1996)011<0560:FFFAIB>2.0.CO;2 Kahana, R., Ziv, B., Enzel, Y., & Dayan, U. (2002). Synoptic climatology of major floods in the Negev Desert, Israel. International Journal of Climatology, 22(7), 867–882. https://doi.org/10.1002/joc.766 Kahana,

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