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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Mediterranean depression characteristics related to precipitation occurrence in Crete, Greece" *by* V. Iordanidou et al.

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Anonymous Referee #1

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General comments:

This manuscript analyses some characteristics of the cyclonic systems in the Eastern

Mediterranean over a 30-year period (1979–2011), but focusing on those triggering precipitation in Crete (Greece). For this purpose, the MS cyclone tracking scheme is applied to the 6-hourly mean sea level pressure fields from ERA-Interim reanalysis. Precipitation amounts are keyed to three severity categories of precipitation (mild, strong and heavy). The topic of the manuscript is pertinent and suitable for NHESS. Although some conclusions can be drawn regarding the cyclone characteristics as a function of both seasonality and severity, which are generally supported by previous studies, the paper still presents some important weaknesses (outlined below). As such, from my viewpoint, this manuscript may be accepted for publication, but only after carrying out major revisions.

1. My major concern about this study is that it merely investigates statistical associations between cyclone parameters and precipitation categories/seasonality, not providing any dynamical analysis. The results are too descriptive, without an analysis or discussion of the underlying processes and mechanisms. For example, a spatial analysis of the cyclone tracks/densities would be particularly helpful, e.g. in explaining preferred directions/origins of the cyclone tracks. A synoptic overview and discussion of the different dynamical regimes/flow types could also significantly improve the manuscript, including its applicability to weather forecasting.

RE: The goal of this study is to investigate statistical associations between rain events of different intensity in Crete Island and cyclones. To do this, the variation of cyclone characteristics and cyclones' topology are compared for different intensity rain events and also for different seasons. Cyclone densities/frequencies as well as the forecasting potentials of cyclones for rain detection are explored in a further analysis, recently published (Iordanidou et al., 2014).

2. The potential applicability of the study in regional hydrological modelling or weather forecasting is barely discussed by the authors. In fact, the 'Conclusions' section is essentially a mere summary of the main results. This section needs a significant improvement to comprise a comprehensive discussion of the outcomes and of their

implications/potential applicability. The novelty of the results should also be clearly demonstrated against previous studies.

RE: The following has been added to the last paragraph of the conclusions according to the reviewers comment: “Although cyclones have been extensively studied for their climatology, topology, frequency (Flocas et al., 2010; Neu et al., 2013) and also their relation to physical phenomena like rain and wind (Catto et al., 2012; Hawcroft et al., 2012), this is the first time the relationship of their characteristics to the intensity of the rain events is investigated. This methodology was recently applied for the construction of a rain prediction model (Iordanidou et al., 2014) providing information that can be valuable and supplementary for forecasting purposes.”

3. Overall, the methodology and datasets are adequate. The MS (Melbourne University) tracking algorithm has been widely applied and successfully tested under different dynamical regimes and for different geographical sectors, including the Eastern Mediterranean. Nonetheless, a more in depth comparison to other existing tracking schemes should be undertaken in section 2. Furthermore, the traceability of the results might be difficult, as some parts of the methodology are not clearly presented (see specific comments below).

RE: MS tracking algorithm is discussed more explicitly as well as compared to other schemes in the introduction section. In the methodology section it is not our intention to compare the different tracking algorithms but to briefly present the main characteristics of the scheme affecting our results. The part of methodology the reviewer refers to below are clarified.

4. The readability of the paper is low. A careful editing is needed. For instance, many sentences are too long, without commas. Many others are also unclear (see specific comments below).

RE: The paper is revised according to the reviewer’s comments resulting in a paper that is clearer, more compelling and more consistent.

5. The number of figures and panels is a bit large and their captions need a significant improvement.

RE: Figures are changed according to the reviewer’s comments.

Specific comments:

Title: Please replace ‘depression’ by ‘cyclone’

RE: The title is changed according to the reviewer’s indication.

Abstract: The abstract should be without paragraphs. Please use ‘0.5o’ in the grid resolution here and throughout the other instances text. The entire abstract need editing and rephrasing so as to become clear and concise.

RE: The paragraphs were removed and the superscript for degrees was added according to the reviewer’s suggestion. The entire abstract was thoroughly revised as the reviewer suggested.

Section 1 (Introduction): 1st sentence: the outlined studies are only for the Mediterranean region. Please either include other references covering other regions worldwide or refer the ‘Mediterranean region’ in the statement.

RE: The sentence is changed according to the reviewer’s comment.

Page 6109, Line 9: please replace ‘effecting’ by ‘controlling’ or ‘governing’

RE: ‘Controlling’ is replaced with ‘governing’.

Page 6109, Line 12: please replace ‘researchers’ by ‘researches’

RE: ‘Researchers’ is replaced with ‘researches’.

Page 6109, Line 17: the first time you mention the MS scheme, a reference to the paper of Murray and Simmonds should be included.

RE: The reference is added according to the reviewer’s comment.

Page 6110, Line 27: please be more precise about the results of Catto et al. (2012)

RE: The sentence is modified as follows: “Similarly, Catto et al. (2012) quantified the association of precipitation to the different categories of frontal systems and found that up to 90% of rainfall is due to cold and warm fronts using information of global precipitation and reanalysis data.”

Page 6111, 1st sentence: confusing sentence. Please rephrase.

RE: The sentence is rephrased according to the reviewer’s comment as follows: “The majority of extreme rain events in Mediterranean region are associated with cyclones and rarely develop under different circumstances such as small convective cells (Lionello et al., 2006).”

Page 6111, Line 6: “sense of safety”

RE: ‘Safely’ is replaced with ‘safety’.

Page 6111, Line 16: “location” instead of ‘local”

RE: ‘local’ is replaced with ‘location’.

Page 6111, Line 19: you have not investigated “atmospheric circulation patterns”. Only statistical associations between cyclonic characteristics and precipitation events are assessed. Please rephrase for accuracy. Please also replace “rainfall” by “precipitation”.

RE: The sentence is corrected the way the reviewer suggested.

Page 6112, Line 4-12: the method for identifying the precipitation categories should be better explained. Is it applied for each weather station separately? Can we then have different severity categories in the same day? How you estimate the percentiles? Empirically or by adjusting a theoretical distribution? Please also discuss the robustness and sensitivity of your results for precipitation values above the 99.5 percentile.

Q: Is it applied for each weather station separately? RE: Each percentile is estimated for every station and then the average of the corresponding percentiles on all the stations is used as boundary for each rain category.

Q: Can we then have different severity categories in the same day? RE: We consider having a rain event occurrence if at least one of the stations has records of rain within the intervals of the rain categories. It follows that on daily basis rain of different severity categories can be gauged on different stations.

Q: How you estimate the percentiles? Empirically or by adjusting a theoretical distribution? RE: Events are classified into three intensity intervals (rain categories) with respect to the 50th, 95th and 99.5th percentiles of cumulative daily precipitation according to the empirical data distribution.

Q: Please also discuss the robustness and sensitivity of your results for precipitation values above the 99.5 percentile. RE: The concept of choosing the specific percentiles is the statistical analysis of cyclones associated with precipitation besides the average pattern. In particular the 99.5th percentile concerns extreme rain events over 100mm/day which in average affects Crete gauging stations every once in every 3.5 years (there is a different return period for every station).

The corresponding paragraph has been modified according to the reviewer’s comments as follows: “Here we consider that event intensity can be assessed according to the amount of rainfall accumulated at a gauging station over an arbitrary amount of time. Events are classified into three intensity intervals (rain categories) with respect to the 50th, 95th and 99.5th percentiles of cumulative daily precipitation according to the empirical data distribution. Each percentile is estimated for every station and then the average of the corresponding percentiles on all the stations is used as boundary for each rain category. The concept of choosing the specific percentiles is the statistical analysis of cyclones associated with precipitation besides the average pattern. In particular the 99.5th percentile concerns extreme rain events over 100mm/day which in

average affects a gauging station in Crete once in every 3.5 years (there is a different return period for every station). The percentiles for every gauging station are estimated after "dry days" exclusion (lower than 1mm/day). We consider having a rain event occurrence if at least one of the stations has records of rain within the intervals of the rain categories, resulting that on daily basis rain of different severity categories can be recorded."

Page 6112, equation 1: please remove the comma within the mathematical expression.

RE: Equation is fixed.

Page 6113, Line 17: ". . .station can convey. . ."

RE: The sentence is fixed.

Page 6114, Lines 8-10: I am a bit puzzled about this sentence, since you consider a minimum cyclone lifetime of 24 h. Can you have more than one cyclone a day?

RE: You can actually have more than one cyclone in a day. The MS scheme may recognize more than one systems on each (6-hour) time step.

Page 6114, Line 26: please refer to Fig. 2 for the geographical location of the weather stations.

RE: The sentence is modified as follows: "In the present study, precipitation characteristics are analyzed based on a dataset of 69 daily gauging stations which are illustrated in Fig. 2."

Page 6115, Lines 28-29: please remove this sentence.

RE: The sentence is removed according to the reviewer's comment.

Page 6116, 2nd paragraph: The two referred flood events are not integrated in the analysis. Although this kind of synoptic analysis might be useful, also in agreement with my major comment 1 above, as it is currently, this section is very vague and seems

to be an add-on, without a clear connection to the following analyses.

RE: In the context of the case study (Crete Island) two characteristic flash flood events triggered from cyclones are presented. Synoptic analysis is not the focus of the study though in this case some form synoptic analysis was included to illustrate the area of study and we believe that is useful for the reader in order to understand the relative magnitudes of the parameters analyzed. Moreover, the daily accumulated precipitation that was gauged by these two events are also included in the analysis but results were not solitary presented, rather collectively in a statistical sense.

Page 6116, Line 23: please revise the citation format here and in other instances throughout the manuscript (e.g. page 6117, Line 16).

RE: Citations formatting is now corrected throughout the revised manuscript.

Page 6117, Line 7: Please move this second part of the paragraph "Most of the. . ." to its beginning.

RE: The second part of the paragraph is removed to its beginning according to the reviewer's comment.

Page 6117, Line 6: Please explain the meaning of ". . .in sufficient close distance from. . .". The method of the Euclidean distances is not clearly explained neither here nor in the methods section.

RE: The following is added to the methodology section for clarification: "So, a cyclone is considered to be sufficiently close to Crete when its radius is greater than the cyclones center Euclidian distance to the rectangle boundary surrounding the area of interest."

Page 6117, Line 17: "30oN"

RE: It is changed according to the reviewer's comment.

Page 6117, Line 19: up to 80% for strong or heavy rain? RE: The reviewer's comment is correct. Strong is replaced with heavy. Page 6117, Lines 20-23: the occurrence

of these precipitation events need to be better discussed. Maybe you can add here some references to studies dealing with orographic effects and meso-to-micro climatic processes in Crete.

RE: The appropriate references were added in the text according to the reviewer's comment.

Page 6118, Lines 14-16 and Lines 20-22: there is a repetition.

RE: The repetition is removed.

Page 6119, section 4.3: an adjustment of theoretical probability distributions or a kernel smoothing would be useful to assess the normality or non-normality of the distributions.

RE: The goal here is to discuss the general characteristics of the cyclones effecting Crete with no intention to find the exact fit of a distribution. For this reason, the distributions are empirically assessed from the corresponding histograms.

Page 6120, Lines 4-5: the propagation velocities from your study and from Flocas et al (2010) are indeed different. Can you explain that?

RE: In this study we focus in the cyclones associated with precipitation occurrence over the island of Crete while the study by Floca et al. (2010) examines on all cyclonic tracks over East Med. The difference is also justified as the dataset of cyclones is different in the two studies, here we use ERA-Interim and the study of Flocas et al. (2010) uses ERA-40. Nevertheless, the velocities found by Flocas et al (2010) are included in the range of values the velocities of our study finds.

Page 6120, section 4.4: this section is very descriptive and boring for the reader. Further, in many statements there are no references to figures and to their corresponding panels. Please also consider a different arrangement of the figures/panels, as their readability is not straightforward.

RE: References to figures are added where needed. There is no easy way to differently

arrange the figures/panels. If the reviewer has any specific suggestions on the figure or text rearrangement in section 4.4 we would be happy to implement.

Page 6122, Line 3: "lowest"

RE: "lowest" is replaced with "lowest".

Page 6122, Line 10: replace "relative" by "similar"

RE: "relative" is replaced with "similar".

Tables 3 & 4: maybe you can use p-levels instead of "0" and "1".

RE: We used 0-1 so that the reader can distinguish statistical significance at a glance.

Fig. 3: caption very incomplete.

RE: The caption was enriched giving additional information. Moreover, it is explicitly explained in the manuscript in the last paragraph of the study site section otherwise the caption would be too long.

Figs. 4 and 5: are you sure that you have relative frequencies in all charts? The horizontal bars are not in %... This leads me to another question about the interpretation of the results taking into account that the areas of each sector are very different. To what extent are the differences found between sectors area-weighted?

RE: The sectors present significant differences in extent and this is due to the fact that, geographically, the west-east dimension of Crete is much longer that its north-south one. This is why we specifically mention about this issue when we compare frequencies among the sectors in section 5.2. We did not use area weights because our investigation concerns the actual number of events.

Please improve all figure captions. RE: All figure captions were revised according to reviewers' indication.

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