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## ***Interactive comment on “Developing an index for heavy convective rainfall over a Mediterranean coastal area” by M. Korologou et al.***

**M. Korologou et al.**

marina.korologou@gmail.com

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Dear editor,

in our final response we replied to the referees comments point-by-point. We finalize a revised version that includes alterations and corrections that referees suggested. We uploaded the new revised version along with our final response as a supplement.

Below we are reporting analytically the alterations and corrections that corresponds to referee comments.

### First Referee ( Dr. Sioutas) Comments - 1/4/2014

**Dr. Sioutas general comment:** The paper is dealing with the development of an index for predicting heavy convective rainfall over a Mediterranean coastal area. Since severe convection forecasting remains a challenging research and operational issue, this work is highly important and welcome.

The paper is generally well written, in appropriate length and with clear conclusions. I would recommend acceptance of the paper for publication to NHESS, with the following minor specific comments and technical corrections.

*Author Reply:* I would like to thank Dr. Sioutas for his comments and for his time.

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Regarding specific comments, all of them are accepted and the manuscript revised accordingly.

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1. In the Title, some word like “forecasting” should be added to define the index operation and role.

*Author Reply:* The Title has been changed accordingly.

2. In Section 2 (Data), lines 37-105: A too long and rather confusing phrase that should be rewritten in order to give a more clear meaning. A similar small change should be considered for lines 106-109.

*Author Reply:* Lines 95-112 from the initial manuscript were substituted with lines 93-119 of the last version that including requested explanation on the data which were used.

3. In Section 3 (Data) after line 134: An improvement of Figure 1 is recommended, i.e. including in a small box the whole Greece and highlighting the area in question.

*Author Reply:* Done.

4. In Section 2 (Data), lines 205-106 and 111-112: Concerning data accuracies, as they estimated at 88% and 90% levels, respectively, some more explanation is needed about what those accuracies are expressing, i.e. an average estimate for all the parameters examined?

*Author Reply:* Requested information is inserted in the lines 111, 118, 119 of the last version.

5. In Section 2 (Data), line 151: Some information should be added, about how these 143 cases were identified as flash flood events.

*Author Reply:* Lines 149-151 from the initial manuscript were substituted with lines 156-161 of the last version that including requested information.

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6. In Section 3 (Methodology), lines 188-190: the statement “... their performance found to be poor (Dimitrova et al., 2009) and thus of no practical value” is not acceptable as it is expressed. There are many references supporting a good performance of the instability indices examined, depending on a variety of meteorological conditions and other factors, thus some revision in the text is needed here.

*Author Reply:* Lines 188-190 from the initial manuscript were revised (lines 196-201 of the last version).

7. In Section 3 (Methodology), line 246: For the “Combined Hypothesis Development” tool, some more description of the concept and some reference is needed.

*Author Reply:* Lines 209-211 from the initial manuscript were rewritten to introduce the term “Combined Hypothesis Development” (lines 222-225 of the last version).

8. In Section 4 (Developing the New Local Instability Index), lines 318-320: Some reference is needed here, about the tools and methods used.

*Author Reply:* The requested reference added (lines 344-345 of the last version).

9. In Paragraph 4.1 (ACAPE Term), lines 343-352: Some explanations should be given in the text about the various threshold values set, i.e. what criteria have been used.

*Author Reply:* The requested explanation is given and also the related reference on how the specific thresholds were estimated is added (see comment A8).

10. In Paragraph 4.2 (Moisture Term), 377-380: This phrase should be a little revised, since cooling at lower levels generally results to a more stable airmass.

*Author Reply:* Lines 377-380 from the initial manuscript were revised (lines 398-401 of the last version).

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11. In Section 5 (Calculations, Evaluation and Discussion): Some comment is needed about the size of the data sample and its representativeness in relation to the extracted results. Except September and October, all the remaining months exhibit a small number of thunderstorm cases. Future work may consider a larger number of cases, possibly including severe summertime thunderstorm cases.

*Author Reply:* It will be considered in our future work.

12. In Section 6 (Conclusions): Future research as it mentioned in the last paragraph, is also recommended, to implement a more representative severe thunderstorm data sample, including hail, windy conditions and possibly other areas, i.e. northern Greece that is usually affected by severe thunderstorms mainly in May and June. The use of weather radar data for a more accurate specification of thunderstorm intensity is also highly recommended, to a further improvement and strength of the proposed LII index, towards a more widely research and operational forecasting use.

*Author Reply:* It will be considered in our future work.

13. Technical corrections The paper should be checked for corrections of small errors in English expressions.

*Author Reply:* Additional checking and revision in language has been performed.

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## Second Referee (Anonymous) Comments - 9/5/2014

**Anonymous Referee general comment:** The manuscript entitled "Developing an index for heavy convective rainfall over a Mediterranean coastal area" by Korologou et al. is focused on an interesting topic. However, the manuscript is chaotic, lacks of clarity and readability, many details are missing and too many qualitative choices/ techniques have been implemented/ applied. The study could be also improved, for instance,

adding some case studies and associated figures. Finally, I think NHESS is not really the appropriate journal.

*Author Reply:* I would like to thank the Referee for his/her time.

One of the hazards that affect Greece is flash floods caused by thunderstorms associated with heavy rainfall. According to NOAA (<http://www.srh.noaa.gov/mrx/hydro/flooddef.php>) a flash flood depends on heavy and intensive rainfall. Is it a natural hazard? Taken into account the catastrophic consequences of these phenomena, the answer is trivial. Thus, we have a natural hazard that depends mostly on heavy and intensive rainfall, and particularly for the area in question depends on convective thunderstorms which are associated with heavy rainfall. So, investigating the specific natural hazard (flash floods) is equivalent with investigating thunderstorms associated with heavy rainfall. Thus, the referee statement "NHESS (special issue: Advances in meteorological hazards and extreme events) is not really the appropriate journal" is rejected.

In our manuscript we followed a typical research article structure. We consider that the complexity of the manuscript may have been increased as we reported every difficulty encountered throughout this research. Even more, taken into account that we covered a lot of aspects of the examined phenomena, some extra caution may be needed in order the covered topics to be comprehended. However, it is very unfair for such a long term study to be judged, unprovoked, as chaotic e.t.c. We strongly reject the referee general comments as they are not specifically justified.

As an operational hydrometeorologist, I often deal with the challenge of predicting the flash flood events. The main product that the state of the art numerical weather forecasting offers is the EFI (Extreme Forecast Index issued by ECMWF). An indicative case for the specific area is the deadly flash flood manifested on 15th of September 2008. The specific EFI for precipitation issued less than 12 hours before the event, did not include any precipitation warning at all as can be seen in Figure below. The

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proposed index issued just 12 hours before, gave timely warning.

In our attempt to develop the index, it was found that there was a lot of missing observation data and thus, filling of the gaps was required. We chose different methods for temperature and relative humidity. We used qualitative estimation for the humidity because satellite images that are considered to play vital role in humidity estimation were in our disposal (a combination of the SEVIRI IR3.9, IR10.8 and IR12.0 channels). For temperature we used the Acock methodology which may look chaotic but it is appropriate and generally accepted with satisfactory results. We ought to include this session as there were not available data. Besides our research covered different aspects of the specific hazard.

The definition of the flash floods is inherently based on thresholds. Thus, the corresponding modeling has to be based on thresholds as well. The qualitative choices/techniques that have been implemented/ applied are part of our proposed methodology. We argue that is far most rational, scientific and in this case effective when building a hypothesis to be guided from theory, governing laws and experience rather to be arbitrary (reach versus poor explanatory framework). We agree that this increases complexity and reduces readability but simplicity is a *nice to have* and not a *must have*. The aim of this manuscript is to document and share a *best practice* for dealing with the prediction of a deadly natural hazard namely the flash flood.

A rhetoric question can be: what is more appropriate when building a hypothesis? Arbitrary or to be based on justified qualitative "choices/ techniques"? The well-known and widely accepted indices how they have been developed? Do they include thresholds? Of course, they do. How these thresholds were chosen? Were they chosen qualitatively? Of course, they were. Our team also devote a lot of time to pick these thresholds using quantitative techniques with unaccepted results. We rationalized our approach in chapter 3.

Regarding specific comments, most of them are common with the comments of the

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1. p1838, 17: I suggest to add a reference.

*Author Reply:* Requested reference is added.

2. p1839, 8: delete "?"

*Author Reply:* The "?" is the reference below which has been corrected after NHESS guidance (line 48 of last version): "Tyagi, B., Krishna, V. N., and Satyanarayana, A. N. V.: Study of thermodynamic indices in forecasting pre-monsoon thunderstorms over Kolkata during STORM pilot phase 2006–2008, Nat. Hazards, 56, 681–698, 2011".

3. p1839, 15-17: Please rephrase.

*Author Reply:* P1839, 15-17 were rephrased (lines 57-61 of last version).

4. p1839, 22-23: "northwestern Peloponnese". It is a repetition.

*Author Reply:* Deleted.

5. p1839, 23: MEEC, 2012 is not in the references.

*Author Reply:* Corrected (line 67 of last version).

6. p1839, 23: "from the 1st of January 2006 to the 30th of . . . "

*Author Reply:* Corrected (lines 67-68 of last version).

7. p1839, 25-27: Please rephrase.

*Author Reply:* P1839, 25-27 were rephrased (lines 68-73 of last version).

8. p1839, 27: mesoscale?

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*Author Reply:* According to the temporal and spatial classification of the meteorological phenomena, severe thunderstorms with heavy rainfall are referred as mesoscale because of their duration and their horizontal length. Below, a relative reference is given: "Fujita, T.T. (1986). "Mesoscale classifications: their history and their application to forecasting". In Ray, P.S. Mesoscale Meteorology and Forecasting. Boston: American Meteorological Society. pp. 18–35."

9. p1840, 12-14: Please rephrase.

*Author Reply:* P1840, 12-14 were rephrased (lines 89-92 of last version).

10. p1840, 15-26: Please try to provide a better explanation and clarify.

*Author Reply:* The specific lines have already been rephrased according to the previous referee comment.

11. p1840, 22-24: please rephrase.

*Author Reply:* The specific lines have already been rephrased according to the previous referee comment.

12. p1840, 29: please clarify.

*Author Reply:* Clarifications were given at our response to Referee General Comments.

13. p1841, 5-9: please provide more details.

*Author Reply:* Clarifications were given at our response to Referee General Comments.

14. p1841, 12-14: Please clarify.

*Author Reply:* P1841, 12-14 were revised giving the appropriate clarification (lines 138-141 of last version).

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15. p1841, 19: Please replace "fuse".

*Author Reply:* Corrected (line 148 of last version).

16. p1841, 26: provide more details on flash flood data.

*Author Reply:* Among the 508 6-hour recorded intervals with thunderstorms events, the 143 cases were considered as severe according to the definitions given in lines 138-141 or/and 146-148 of the last version.

17. p1842, 4: "lack".

*Author Reply:* Corrected (line 170 of last version).

18. p1842, 16: Please describe the indices and add references.

*Author Reply:* Re-checked the relative citations and found to include detailed description of the specific indices.

19. p1842, 24: Please give more details.

*Author Reply:* The specific lines have already been rephrased according to the previous referee comment.

20. p1843, 5-20: Please revise and rephrase.

*Author Reply:* Revised and rephrased including the previous referee comment.

21. p1844, 8-9: Please add references.

*Author Reply:* Requested reference was added (line 254 of last version).

22. p1844, 26: Please delete "(5<sup>th</sup> . . .)".

*Author Reply:* This expression is used also in the schematic diagrams for the convenience of readers so we prefer to keep it as it is.

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23. p1844, 10-11: Please rephrase.

*Author Reply:* Rephrased (lines 258-265 of last version).

24. p1846, 8-9: redundant.

*Author Reply:* Deleted.

25. p1846, 10-14: Please provide more details.

*Author Reply:* P1846, 10-14 were revised, changing also "crucial" with "critical" because the term is more explanatory and representative (line 247 and lines 336-345 of last version).

26. p1848, 13: Please add a reference.

*Author Reply:* The critical values- thresholds were calculated with the linear programming (LP)-based branch-and-bound algorithm of the optimization toolbox of MATLAB (R2010a), bintprog (p1846, 9-12). Reference was inserted (lines 344-345 of last version).

27. p1850, 16: please clarify conjunction.

*Author Reply:* In mathematics, a compound statement ( $p \wedge q$ ) known as conjunction, results in true if both of the statements p and q are true, otherwise the value of false. We revised "conjunction" with *logical conjunction*.

I would like to thank one more time the referees for their time and valuable comments. A new revised version of the manuscript that include all the aforementioned alterations and corrections was uploaded as a supplement.

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