

## ***Interactive comment on “Empirical atmospheric thresholds for debris flows and flash floods in the Southern French Alps” by T. Turkington et al.***

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The paper develops a methodology to determine robust thresholds for flash floods and debris flows utilizing regional atmospheric conditions derived from ECWMF ERA-Interim reanalysis data and compare results with rain gauge derived threshold. The paper addresses technical questions within the scope of NHESS and presents new data and novel concepts for flash flood thresholds. More details about the relevance of the paper are given in the technical comments. The paper conforms to international standards; scientific methods are clearly outlined while assumptions need more comments. Authors achieved some appealing results but, in my opinion, the generalization is far to be real and results are strongly related to the analyzed site. Title is clear, the

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abstract is pertinent, easy to understand and resume well content of the paper. Mathematical formulas, symbols and abbreviations are correctly defined. About CAPE, it should be useful to provides a brief description about the physical meaning and the equation to evaluate it. Formulas and reference are adequate. The overall presentation probably is too long especially in the discussion of results. Due to the lengthy and articulated presentation the reader may be confused. Probably this part should be reduced and synthesized. Technical language is precise and understandable by fellow scientists, English is of good quality.

Technical comments In this part I'll try to give some technical comments, not on procedures, tests and other application used in the paper, but only from a physical point of view. Of course, comments reflect my opinions and should be used to improve and not for reject the paper. The paper compares two very different source of information to evaluate critical threshold for flash flood and debris flow. The first source is derived from a posteriori analysis of different meteorological indexes; those are selected using a criterion based on the best interpretation of flash flood and debris flow. Selection of indexes CAPE and specific humidity look right (?). The first one represents the level of instability, the second one the presence of precipitable water in atmosphere. But, are these two indexes exhaustive to evaluate precipitation intensity? High values of CAPE or tCAPE not always mean rain or intense rainfall, also if associated to high specific humidity. More, while single convective phenomena normally have a duration less than 3 hours, a tCAPE based on dt greater than 3 hours may be not adequate. Precipitation process is normally driven by the Vertically Integrated Vapour Moisture (J) that accounts the integral of vapor moisture and velocity vectors for feeding of rainfall. Instead of a single specific humidity at 700 hPa, the use of J could be more appropriate to evaluate precipitation. Rainfall, especially for frontal events, may be easy evaluated with a simple continuity equation of flux J throughout the cell. A second aspect is related to the cell dimension of ERA-interim which extension is about 6400 kmq. If the cell dimension is adequate to evaluate frontal events, in the case of extreme convective rainfall, where cumulonimbus dimension may be of 100-200 kmq, reduction of stability

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of tCAPE of the cell may be uncorrelated to rainfall intensity. About rainfall results, looking to fig. 1, the position of the rain gauges, compared to the “affected torrents”, is inadequate. Only rain gauges 1 and 5 are close to the “affected torrents” and probability, while they are located at a distance less than 10 km they are strongly correlated. Finally, the affected region is about one half of 512 km<sup>2</sup> with only one significant rain gauge. So far we have about one rain gauge for 256 km<sup>2</sup>. Evaluation of flash flood in this context is very hard if we consider that core of intense cumulonimbus precipitation is few tens of km<sup>2</sup>. While the paper deals with flash flood and debris flow, normally associated to short rainfall, it isn't surprising that meteorological indexes work better than rainfall. Some doubts about the number of analyzed events. In my opinion, 43 events are insufficient for a significant inference, considering that events are categorized in 4 classes. Finally to evaluate past rainfalls for ungauged sites, infrared (MSG) and microwave satellite data probably may give more accurate results.

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