

Interactive comment on “Atmospheric circulation patterns, cloud-to-ground lightning, and locally intense convective rainfall associated with debris flow initiation in the Dolomite Alps of northeastern Italy” by S. J. Underwood et al.

Anonymous Referee #2

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This manuscript presents results from research that aims to correlate debris flow initiation with synoptic and local meteorological patterns, including cloud to ground lightning flashes (CGFs). The long term goal of the work would be to use these patterns as part of a debris flow warning system. The manuscript is reasonably well written (with the exception of an abundance of undefined technical jargon) and the research problem and hypotheses are nicely laid out. Unfortunately, the results seem less than convincing (from a debris flow warning standpoint) because the authors don't address the issue of the number (or percentage) of false positive warnings that would occur if either their

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synoptic or CGF results were used for warnings. Below, I list major, minor, and editorial comments that are intended to improve the manuscript.

Major comments

1) The manuscript incorporates a large amount of meteorological jargon that needs to be defined. Meteorologists undoubtedly know these terms, but a substantial part of the NHES audience (particularly landslide and debris flow people), will not. I think each term needs to be defined at first usage. Following this suggestion will help for the manuscript to be understood, used, and cited by landslide and debris flow researchers. As is, the manuscript will quickly bury many readers under a number of terms that they don't understand. Most of the terms are first used without any definition (see specific terms with page and line numbers below). I realize that some of these terms are eventually defined, but they need to be defined at first usage. A possible alternative would be to add them all to some type of glossary section.

Meso- β (p. 3, line 27), Meso- α (p. 6, line 3), solar h convention (p. 7, line 2), geopotential height (p. 8, line 17), Rossby wave patterns (p. 8, line 20), gpm (p. 11, line 9), Omega (p. 13, line 1), lifted index (p. 15, line 5), transitory short wave (p. 32, line 10)

2) In order for anyone to begin to use the results of this research for a warning system, an estimate of the number of false positives would be needed. In other words, for example, how often do either the observed synoptic patterns or Meso- β lightning patterns occur when there is no debris flow activity? It seems to me that there can easily be storms with cloud to ground lightning, but no rainfall. If these types of storms occur frequently, there would be a great deal of false positive debris flow warnings. I think the authors need to address this topic before the results of the manuscript can be considered for use in a debris flow warning system.

3) Figures 7-18 need to have the debris flow time shown on the figures. This is essential. The authors are trying to make the point that there are certain patterns that occur in the 60 minutes before debris flows occur, but they don't show us the debris flow times.

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Also, it would be helpful to see the group type (STH, AL, or HL) shown in each of these figures. The figures are not ordered sequentially by date, is that because of different group types?

4) Sections 6.1 to 6.12. These sections seem very long for the message that they convey. I usually appreciate knowing the details, but I'm afraid that there are so many details in these sections that readers will be buried. I suggest shortening these sections to only include the information that is most important to make your points.

5) It would be very helpful to see the results of the correlation and lead-time analysis (currently imbedded within the text on pages 28-31) summarized in two figures, one figure for each analysis. This would make it easier for readers to digest the results.

Minor comments

p. 6, line 24. Please define "proximal". In other words, within how many kilometers?

p. 7, lines 18-23. Are there any potential adverse impacts to the results due to the fact that some zero times are before the debris flow initiation times, and some are after the debris flow initiation times (see table 1)?

p. 3. lines 8-10. What is the approximate return period for debris flows in the Dolomites, either for single basins or for the region as a whole? A reference here would also be helpful.

p. 8, line 14. You need a reference at the end of this sentence. In other words, who calculated these parameters?

p. 9, lines 5-10. Please state how many groups you defined somewhere in this paragraph.

p. 9, line 27. Which ArcGIS applications did you use?

p. 10, line 4. Which atmospheric variables did you use?

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p. 10, lines 10-15. Was the lead-time analysis used for both synoptic data and Meso- β data? Currently unclear.

p. 10, lines 4-15. Most readers (including me) would appreciate seeing more details about the correlation and lead-time analyses. I realize that you give references for these techniques, but you need to give us a bit more explanation for each. This manuscript should be able to stand by itself and some additional text about these techniques should make that possible.

p. 13, lines 25 and 26. What is a mature phase and why is it important?

p. 14., line 8. Who defined the critical interval? Add reference.

p. 16, lines 6-7. (and sections 6.2 to 6.12). Most readers will not know how to interpret a "lifted index". This needs to be described in the methods section.

p. 28, line 5. mm per minute? I thought the best data that you had were 5 minute data. Needs a bit more explanation.

p. 32, line 4. This seems like a very strong statement given the impression that I get from figures 7-18. At least for the correlation between CGFs and LICR, results seem less than conclusive. I think you should be cautious with your words here.

Table 2. The group type (STH, AL, or HL) needs to be added for each debris flow date (i.e., either in the first row with dates, or as a new second row above all of the other data rows). Also, "for each of the 12 debris flow events" should be added to the end of the caption sentence. Also, please explain why most Peak discharges are negative, and one is positive. What are the implications of this fact?

Figure 2. Each of the boxes and the circle should be labeled in this figure. In other words, add the labels "synoptic", "meso- α ", and "meso- β ".

Figure 3. Same suggestion as figure 2 for "meso- α ", and "meso- β ".

Figure 4. The meaning of the arrows, solid and dashed lines, contours, and shaded

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area needs to be added to either the caption or the figure itself. I realize that you mention these items in the main text, but they need to be added so the figure can stand alone. Also, the Meso- β location (i.e., a dot) should be added this figure. Please spell out the group name (STH) in the caption.

Figures 5 and 6. Same suggestions as for figure 4.

Figure 10. In the caption, please say why no CGF line is shown.

Editorial comments

p. 6, line 1, insert "a" between "have" and "duration".

p. 4, line 9. Insert a space between "is" and "also"

p. 4, line 17, insert "meteorological" between "incorporated" and "stability"

p. 4, line 18, change "authored" to "authors"

p. 14, line 14, insert "to" between "intended" and "further"

p. 14, line 16. Insert "to test" between "intended" and "the"

p. 34, line 2. Insert a comma after "cases".

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 5717, 2015.