

## Review of the manuscript No. NHESS-2022-166

*“Lava flow hazard modelling during the 2021 Fagradalsfjall eruption, Iceland: Applications of MrLavaLoba”* by Pedersen et al.

This manuscript deals with the numerical modelling of lava flow before and during the 2021 Fagradalsfjall volcanic eruption in Iceland. I see that the manuscript was significantly changed based on the reviewer’s comments: it is shortened, many issues have been clarified, references have been added. Meanwhile, I have a few structural issues and a few scientific points to be clarified before the manuscript could be accepted for publication.

Structure of the manuscript.

- Abstract, Introduction and Conclusion contain identical sentences, which should be avoided.
- The abstract must also contain a sentence or two sentences that describes the main findings of the modelling. It should also contain elements describing the context of your work as well as a sentence comparing your work to existing knowledge explaining the importance of your work in the context of disaster management.
- The Introduction section should contain more than it is now presented (2 paras). It should state about the topic of the manuscript and why it is important to the natural hazards’ community, to the advancement of knowledge, and to society. It should introduce the region under the study and present a summary of the state-of-art knowledge about lava flow in the region. The authors should cite the publications that initiated the main debate or posed the main questions, which are intended to be addressed. The authors should not limit themselves to their own papers on the subject or to those of their close collaborators, and to give proper credit to all opinions/ideas published on the subject (e.g., operational lava flow modelling). Such description of the works done earlier will allow the authors to position your finding in the Discussion section (based on the modelling) with respect to what is known/done before this study. The authors should also state the outstanding questions that need to be addressed on the topic of your paper, the essential data or constraints that need to be collected. Partly this is done, but structurally, the paper jumps from one topic to another. Therefore, I would propose to consider the following non-significant rearrangement of the sections.
- Sections order:
  1. Introduction (add more information as it is described above)
    - 1.1. Geological setting and ... (current sect. 2)
    - 1.2. Fagra... and eruption (current sect. 2.1)
    - 1.3. Lava flow ... (current sect. 1.1)
    - 1.4. Lava flow hazard ... (current sect. 1.2.)
  2. Data (current sect. 3.1)
    - 2.1. Pre-erup... (current sect. 3.1.1)
    - 2.2. Syn-erup... (current sect. 3.1.2)
  3. Methods (current section 3.2 but drop the titles “3.2.1. Software” and “3.2.2. Implementation”)
  4. Results to the end of the manuscript (as they are)

Such a small restructuring will allow reading fluently without linking the pieces to each other.

Scientific (and technical) points.

- Line 53. "In a chaotic way" – better "in an unpredictable way"
- Line 54. Codes cannot be stochastic or deterministic, but the methods can. So, before the use the jargon "stochastic codes", the authors should explain what it means.
- Line 82. The authors should discuss that the discharge rate and lava temperature/radiative heat transfer should play an essential role in the lava flow pattern and flow morphology.
- Line 85. How the second part of the sentence starting from "the earlier versions" is linked to the first part of the sentence.
- Lines 170-180. How does the roughness of the computational grid (compared to the fine 2m-size DEM model) influence the results of the modelling? Different smoothing techniques applied to a fine topographic surface (to create a rough computational grid) may result in changes of the lava flow pattern.
- Lines 184-187. How essential is to write the unnecessary detail in the part of the sentence starting from "mainly following ..."? Do readers need the detail, which are not explained at all, just stated? Will the details be used in this study? If not, I would delete this part of the sentence.
- Line 194. "... the lava field had become very complex to simulate." This needs to be clarified. What is the complexity of the lava field compared to pre-eruptive field? A new topographic surface? If so, is it complex? The lava fills surface valleys making the new surface topography smoother and less complex for computational aims.
- Lines 204-205. "... the number of computational flows, and)." What the number of computational flows mean? The number of the streams that the lava flow generates? How it can be pre-defined? Also, is it something missing after "and."
- Line 208. "inertial" factor should be explained.
- Line 209. What does "parent parcel" mean? Is this a branching model generating siblings parcels? Please clarify.
- Line 213. How the "final lava thickness" is determined? Clarify.
- Lines 214 (and 443). "saving masked grids obtained by considering inundated cells". Please explain the meaning of "masked grids". Does it belong to data augmentation? If so, why is it used in the modelling? Also, explain what means "inundated cells" (those cells which is covered by a modelled lava?)
- Line 216. "the probabilistic nature of the code" should be replaced "the probabilistic nature of the model".
- Line 235. "the code was optimized to accelerate runs." The optimization of the code should be briefly described and not only refer to the formal changes in the code, but also to the basic computational idea behind the modifications, e.g., faster computations based on new numerical method, rapid grid change ...
- Line 262 (and elsewhere in the manuscript). Please clarify the definition of the worst-case scenarios. In which sense they are worst. From the point of hazard assessment view, some of them are not worst at all.
- Line 272. Indicate the highways in Figs. 1 and 4 (black curve? or dashed curve?). Provide explanation of the curves in the figure captures.

- Lines 294-95, 356-58, 368 (and elsewhere in the MS). "... during "emergency mode" response" (and similar sentences about meetings with the stakeholders). In Table 2, in column "Disadvantages" of the MrLavaLoba code, the authors write that "results not designed for hazard communication". If so, what do then the results of the numerical modelling mean for "emergency-mode" response? Clarify in the table and/or the text.
- Lines 374-75. "...the locations of critical lava margins were manually selected on the basis of the available knowledge and expert evaluation." Did the authors check the sensitivity of the manual selection on the inundation morphology?
- Lines 512-21. The first two paragraphs should be re-written to avoid "copy-pasted" texts from abstract and the Introduction section.
- Table 1. First column "Vents". I guess that it is the number of vents (No. vents). Correct? If so, replace it. In the current line "Vents", please clarify the sign "/" (e.g., 2/10, Fissure 2/All... 5/Critical

In conclusion, addressing the issues here is crucial for the study to meet the standards of scientific rigour and contribute to the field in a meaningful manner. Once the clarity in organization of the paper and explanation/justification are provided, the result of the study can be considered relevant for publication in NHESS.

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