Peer review report on “Augmentation of WRF-Hydro to Simulate Overland Flow- and Streamflow-Generated Debris Flow Susceptibility in Burn Scars” (nhess-2021-345)

General Comments

This paper presents the hydrologic analysis in post-fire debris flow by employing WRF-Hydro. The research extends an important hydrologic modeling tool to an important topic, post-fire hydrologic hazards. The paper is mainly an application of WRF-Hydro over a large area including burned scars in CA. It integrates multiple techniques and datasets, such as hydrologic simulations, radar data, and debris flow identification using RS, and so on, to improve hydrologic analysis. Also, the revised manuscript has big improvement. It definitely merits publication after consideration of these comments.

One problem with this research is that the debris flow susceptibility (or likelihood) is indicated using water volume. Runoff-generated debris flow occurs when flow strengths exceed the threshold, authors also noticed and mentioned in the manuscript. The key to debris flow occurrence is flow strengths, such peak flow, maximum depth, maximum velocity and so on, rather than volume. Of course, generated volume is closely related to peak flow but also controlled by duration.

A related problem is the spatial resolution of computational cell. The 100m grid is used in the study. It is okay to simulate the overland flow generation and hydrograph at the outlets, but it provides few information about flow dynamics at fine resolution, which is the key to observe the debris flow generation and occurrence.

A highlight of this study is output overland flow by modifying the source code. The overland flow generation is represented by Noah-MP. The related variables are *q_sfcflx_x* and *q_sfcflx_y*. and combined with *qqsfc* and *Noah_distr_routing* to calculate the amount (forgive me if I remember wrong). It is very valuable to point out the modification. I believe the modification of the source code will be published with this work. It will benefit WRF-Hydro community!

Another problem is “atmospheric river” (AR) mentioned many times, and it seems authors emphasize the AR is the major reason of heavy rainstorm of post-fire debris flow. Generally, it is fine. But AR does not the directly produce rainfall and AR is a very large scale atmospheric pattern occurred many places. AR-triggered certain synoptic system, such as NCFR carrying plenty of moisture provides opportunities of heavy rainfall.

The third problem is the performance of MRMS data in the study area. I believe MRMS data is the best option author may have, but its poor quality in mountainous area always unable catch the intensive storms. I’d like to see how authors consider this issue.

A similar problem is only three stream gauges are used to calibrate the model for such a large area. One reason might be lack of natural flow record. You may want to use natural flow data, such as https://rivers.codefornature.org/, https://pubs.er.usgs.gov/publication/70046617

Temporal resolution may be different but still provide valuable information.

Detailed Comments

Line 151. Spatial resolution of 100m is problematic for capturing debris flow behavior. This comment applies to the same issue throughout the text (e.g., lines 273, 332, etc.).

Line 153-154. Other studies did use water-only models but those modeling works were done by using high resolution DEM, such as 1-m lidar data. The flow dynamics at fine resolution describes the initiation of debris flow (e.g., Rengers et al., 2016; Mcguire et al., 2017)

Rengers, F.K., McGuire, L.A., Kean, J.W., Staley, D.M. and Hobley, D.E.J., 2016. Model simulations of flood and debris flow timing in steep catchments after wildfire. Water Resources Research, 52(8), pp.6041-6061.
McGuire, L. A., Rengers, F. K., Kean, J. W., and Staley, D. M. (2017), Debris flow initiation by runoff in a recently burned basin: Is grain-by-grain sediment bulking or en masse failure to blame?, Geophys. Res. Lett., 44, 7310– 7319, doi:10.1002/2017GL074243.

Line 179. Not clear. You may want to point out the time window of rainfall intensity, such as 15-min or 30-min.

Line 192. Add spatial resolution in this section.

Lines 223-225. You may add a figure to compare the RS-based debris flow and field observation.

Line 262. Simplifying the model description? WRF-Hydro has been used extensively.

Line 369. Justify 3 gauges used for calibration is sound. Or you may consider to use natural flow data:

https://rivers.codefornature.org/, https://pubs.er.usgs.gov/publication/70046617, or https://pubs.er.usgs.gov/publication/70046617

Line 376. Justify 1-hour results can represent the flow peaks.

Line 453,455. Change unit of Ks to mm/hr.

Line 505-506. Great metrics you used here in the context of hazards and their impacts.

Line 563-565. I suspect the accumulated volume is a reasonable metrics for runoff-generated debris flow assessment. Initiation of runoff-generated debris flow is a threshold behavior, which means the peak flow or unitless peak flow must be larger than certain threshold, or it is unlikely to happen. You may want to look at this paper and references therein: https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2019GL083623?msclkid=28d5425bbaed11ecaab0029541ed7fcc

Line 669-672. I agree the uniform precip introduce bias of hazards distribution over watersheds. But I highly suspect the assessments based on the data and method in this study, such as the computation grid size, MRMS quality in the study area, parameters on burned scars, and metrics (water volume rather than peak flow) used for debris flow assessment.

Line 730-736. You got the idea but confused why the volume of water is used for debris flow assessment.

Figure 4: change rainrate unit to mm/hr, which is more common for post-fire hydrologic study.

You may tune font size in all figures.