EGUsphere, author comment AC3
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Reply on RC2

Yu Zhuang et al.

Author comment on "Dynamic response and breakage of trees subject to a landslide-induced air blast" by Yu Zhuang et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-468-AC3, 2022

The paper tests tree motion equations and breakage conditions under air blasts triggered by large landslides by modeling a tree as a flexible variable cross-section beam hinged at the ground using elastic support. They assess bending and overturning forces.

I like the way the authors approach the problem of impact forces in air blasts. But the question remains unclear-how realistic are the numbers you obtained from your model? A comparison/plot of field observed results vs your model results would potentially benefit the readership of this paper. I saw not only trees but even reinforced concrete pillars being pulled out from the ground by the air blast during field trips in the Langtang avalanche. The pullout forces are very important, probably references from tree pullout tests could be helpful – check with as many cases as you can to know how realistic are those numbers in your model. A case validation on any of the large avalanches would be great!

Response: Many thanks for your valuable comments. I totally agree with your suggestion that a comparison of field tests with our modeling results would benefit the readership. For the eigenfrequency prediction method (Section 2.1), we used parameters provided by Jonsson et al. (2006) and compared the calculated results with their measurements (Lines 207-210). Good consistency checks the validity of our model. As for the tree motion model (Section 2.2), Pivato et al. (2014) and Zhuang et al. (2022a) have validated the model through comparing with test results. We further checked the model through comparing it with analytical solutions performed by Bartelt et al. (2018) in the case of a weak air blast (Line 287-291). Therefore, we suggest that our model could represent the essential characteristics of trees subjected to a powerful wind load.

We also agree with your comments that pullout forces are very important. We have indeed investigated the air blast triggered by Langtang avalanche (Zhuang et al. 2022b). The pullout of trees you mentioned corresponds to the overturning failure mode we defined in section 2.3. Notably, previous research proved that pressures required for uprooting are in the same range or higher than for stem breakage (Bartelt and Stöckli, 2001; Feistl et al. 2015). Therefore, both bending and anchorage resistance are very important, and the occurred failure mode depends heavily on the biometric characteristics of trees (discussed in Lines 252-254, 311-317). In lines 243-251, we performed simulations on the air blast induced-tree breakage. Modeling results were compared with bending strength and anchorage resistance measured by Peltola et al. (2000) and Lundström et al. (2007).

Actually, most research about landslide-air blasts just describes the tree-breakage phenomenon. Very few studies tested the geometric and mechanical properties of damaged trees. Our previous work on the Wenjia valley avalanche-induced air blast indicated that the damaged trees are primarily tall spruces (Zhuang et al. 2019), similar to the tree parameters presented in Table 1. According to your advice, we will perform a brief case validation using the Wenjia valley avalanche.

Bartelt, P. and Stöckli, V.: The influence of tree and branch fracture, overturning and debris on snow avalanche flow, Ann. Glaciol., 32, 209-216, 2001.

Bartelt, P., Bebi, P., Feistl, T., Buser, O., and Caviezel, A.: Dynamic magnification factors for tree blow-down by powder snow avalanche air blasts, Natural Hazards Earth System Sciences, 18, 759-764, 2018.

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Jonsson, M. J., Foetzki, A., Kalberer, M., Lundström, T., Ammann, W., and Stöckli, V.: Root-soil rotation stiffness of norway spruce (Picea abies (L.) Karst) growing on subalpine forested slopes, Plant Soil, 285, 267-277, 2006.

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Zhuang, Y., Xu, Q., Xing, A. G., Bilal, M., Gnyawali, K. R.: Catastrophic air blasts triggered by large ice/rock avalanches. Landslide, 2022b. Doi: 10.1007/s10346-022-01967-8.

L224 -. What do Feistl et al. 2015 say about assuming density=5 kg/m3?

Response: As described in the manuscript (Lines 223-224), the landslide-induced air blast is a multi-medium fluid that contains numerous dusts, leading to a higher density than air (1.225 kg/m^3). Researchers (e.g., Feistl et al. 2015) in WSL Institute for Snow and Avalanche Research SLF (Switzerland) have done great work on air blast dynamics through experiments and numerical modeling, and suggest a density of 5kg/m^3 for the air blast. Therefore, this value is selected in our work.

Feistl, T., Bebi, P., Christen, M., Margreth, S., Diefenbach, L., and Bartelt, P.: Forest damage and snow avalanche flow regime, Natural Hazards and Earth System Sciences, 15, 1275-1288, 2015.

L330 -> short-duration impulses and can intensify the destruction of vegetation and structures far beyond …

Response: Measurements of air-blast duration reported by Russian and Swiss researchers (Grigoryan et al., 1982; Sukhanov, 1982; Caviezel et al., 2021) indicated that the air blast is intermittent and of short duration, lasting only a few seconds. Additionally, the generated air blast has been known to be capable of causing fatalities and destruction far beyond the runout of the movement mass (Zhuang et al. 2022b). Therefore, we made the statement in the manuscript.

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