Submitted Abstract

ID IMC22-FSAbstr- 383

First Author First Name / Last Name	Perry A (1) Bartelt
Submitting Author First Name / Last Name	Perry A Bartelt
Correspondence	bartelt@slf.ch
Co-Authors >> E-Mails will be not listed	Ivanova, Kseniya (2)
Organisations	1: WSL Institute for Snow and Avalanche Research, SLF 2: Climate Change, Extremes and Natural Hazards in Alpine Regions Research Center CERC, Switzerland
Country	Switzerland
Region	Western Europe

Title	A Longwave Reynolds-Averaging Model (Lw-Rans) To Simulate Turbulence In Powder Snow Avalanches.
Keywords	Powder Snow Avalanches, Turbulence, Impact Pressures, Dynamic Magnification
Type	List Of Focus Session
Focus Session ID	25

Abstract

Reynolds numbers for powder avalanches are clearly in the turbulent range, Re > 106. Nonetheless, the effects of the turbulent fluctuations are seldom considered in powder snow avalanche modelling and engineering. Accelerometer measurements on the mast at the Vallée de la Sionne test site indicate transverse and longitudinal pressure fluctuations in the range of the natural vibration frequencies of tall cantilever-type structures. Impulsive turbulent fluctuations can therefore excite the inertial forces within a structure, producing a dynamic load that leads to collapse and failure. Dynamic magnification of pressure loads contributes to tree-blow down by powder avalanches. Since forest destruction is often used to calibrate the spatial extent of the avalanche air-blast, an understanding of turbulence is an important part of avalanche hazard mitigation.

In this paper we present a RANS type turbulence model in the framework of long-wave approximation. The model splits the kinetic energy k associated with the turbulent fluctuations into two parts. The first part kF describes the mean initial turbulent energy in the air-ice-dust mixture that is transported from the core to the cloud during the formation phase. This initial energy is concentrated at the avalanche front and is calculated directly from the random kinetic energy produced in the avalanche core. The second part kP describes the turbulent energy in the cloud as it dissipates to the viscous subrange. A single equation tracks the total energy of the cloud, accounting for the additional production by shearing and air-entrainment, and likewise the dissipation of turbulent energy. The model therefore contains only one parameter describing the turbulent energy dissipation. We demonstrate the applicability of the long-wave approximation by calculating several powder avalanches that occurred near the SLF Davos between 2017-2021. These events have been documented with high-precision aerial drone scans and field surveys of forest damage. We find that turbulent fluctuations are created during the interaction with the core, but are rapidly transported outwards to the lateral edges of the cloud as they dissipate. We show how cloud velocity, height and impact pressures change with different decay assumptions and the practical significance for hazard engineering.