

Title: Can we predict next frost quake?

Abstract:

Fractures in frozen soils (frost quakes) can cause damage to buildings and other infrastructure, but their formation mechanisms remain poorly understood. A methodology is proposed to predict frost quakes. Thermal stress on soil due to changes in weather conditions is calculated and connection between thermal stress and frost quakes in central Finland due to brittle fracturing in uppermost soil is estimated. A hydrological model was used to simulate snow accumulation and melt, and a soil temperature model was used to simulate soil temperature at different depths beneath the snow pack. The results of modelling, together with measurements of air temperature, snow-cover thickness, and soil temperature, were used to calculate temporal variations in thermal stress in soil. It is showed that frost quakes occur when thermal stress caused by a rapid decrease in temperature exceeds fracture toughness and strength of the soil-ice mixture. Results suggest that this methodology can be used to predict thermal stresses on soil and identify stress values that may lead to fractures of frozen soils, i.e., frost quakes.

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Jarkko Okkonen is Senior Researcher at the Geological Survey of Finland. At GSF, his research focus on applied distributed hydrological modeling, with emphasis on groundwater flow. He is also interested in applied geophysics and quantitative hydrogeology and gives lectures at the University of Oulu and University of Helsinki in Finland, and supervise MSc and PhD-student on these fields. Climate variability and climate change impacts on critical zone of earth will be on his menu in the future as well as looking for new tools on impact assessment such as machine and deep learning.