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Transition of falling snow characteristics causing weak layer formation simulated by a numerical weather model, in avalanche disaster events on March 27, 2017 in Japan

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From March 26 to 28, 2017, a developing cyclone passing the south coast of Japan brought heavy snowfall over mountain areas in the Pacific side of Japan. During this snowfall event, avalanche disasters occurred killing or injuring tens people on March 27. According to the reports from the urgent in-situ snow pit surveys conducted on the next day, these avalanches were classified as a dry snow surface avalanche. The weak layer identified at the vicinity of the avalanche site in Nasu town was composed of weakly rimed planar crystals, in contrast to the upper and lower layers which were composed of more rimed crystals.
In this case, characteristics of falling snow crystals are a strong factor for the occurrence of an avalanche, which is not explicitly incorporated into an avalanche risk evaluation with using a numerical snowpack model. Currently, it is difficult to provide the parameters representing a crystal shape and riming ratio from observation in the same way as the other parameters, such as snowfall amount, air temperature, wind speed and so on. A numerical weather model is an alternative option for this. However, usual weather models are not able to provide the information about the crystal features (Hashimoto et al., 2017). In order to give a solution, the authors have developed new scheme to diagnose the crystal features based on the output data from the Japan Meteorological Agency's Non-Hydrostatic Model (JMA-NHM). The mass ratio of different crystal shapes and accreted droplets to the total mass of snow crystals is obtained by using the scheme.
The authors apply the JMA-NHM with the scheme to the numerical experiment of the snowfall event. As a result, at the avalanche site in Nasu town, riming ratio drastically decreases in the midnight of March 26 as is expected based on the snow pit survey. At the observation site near Mt. Adatara, another avalanche site, the model shows pristine or lightly rimed crystals during the snowfall event, which is qualitatively consistent with the observation. Giving the new snow density that temporally changes depending on the crystal features simulated by the model to a simple snow densification model, the calculated snow hardness decreases as observed in the weak layer. These results show a potential of the weather model for providing the information about crystal features to a snowpack model in the avalanche risk evaluation.

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