EGU2020-9487
https://doi.org/10.5194/egusphere-egu2020-9487
EGU General Assembly 2020

Detecting avalanche debris from SAR imaging: a comparison of convolutional neural networks and variational autoencoders

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Achieving reliable observations of avalanche debris is crucial for many applications including avalanche forecasting. The ability to continuously monitor the avalanche activity, in space and time, would provide indicators on the potential instability of the snowpack and would allow a better characterization of avalanche risk periods and zones. In this work, we use Sentinel-1 SAR (synthetic aperture radar) data and an independent in-situ avalanche inventory (as ground truth labels) to automatically detect avalanche debris in the French Alps during the remarkable winter season 2017-18.

Two main challenges are specific to this data: (i) the imbalance of the data with a small number of positive samples — or avalanche — (ii) the uncertainty of the labels coming from a separate in-situ inventory. We propose to compare two different deep learning methods on SAR image patches in order to tackle these issues: a fully supervised convolutional neural networks model and an unsupervised approach able to detect anomalies based on a variational autoencoder. Our preliminary results show that we are able to successfully locate new avalanche deposits with as much as 77% confidence on the most susceptible mountain zone (compared to 53% with a baseline method) on a balanced dataset.

In order to make an efficient use of remote sensing measurements on a complex terrain, we explore the following question: to what extent can deep learning methods improve the detection of avalanche deposits and help us to derive relevant avalanche activity statistics at different scales (in time and space) that could be useful for a large number of users (researchers, forecasters, government operators)?