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

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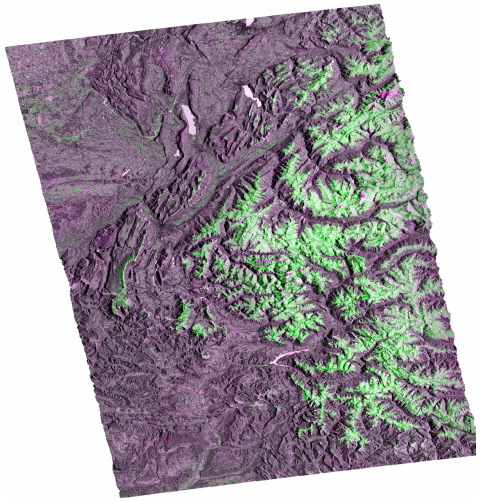


supports:

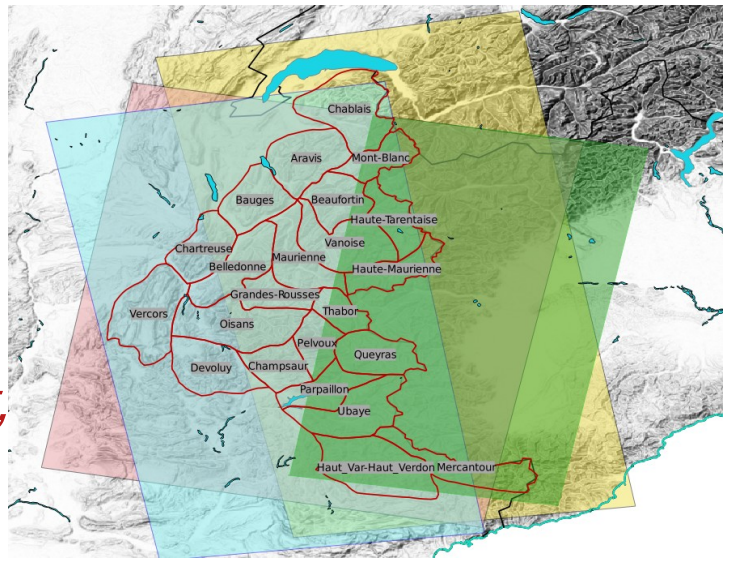
Outline

NOTE :
because I cannot present, in red you will find some comments as if I could explain the slides with simple words...

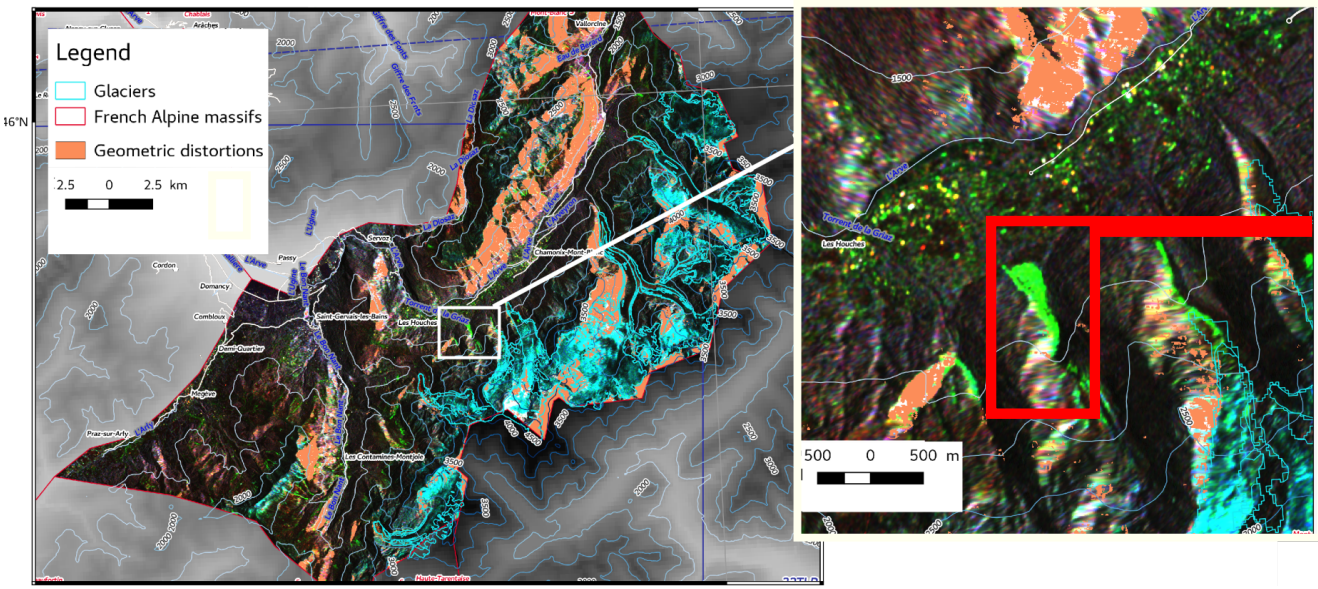
Avalanche detection from SAR satellite imaging

- How to **automatically detect** avalanches?
- SAR (synthetic aperture radar) satellite imaging
- **Snow surface** is very different after an avalanche

Only the bottom part, the deposit, is visible in SAR images



Avalanche detection from SAR satellite imaging



We see the avalanches in green (but many false positives too)

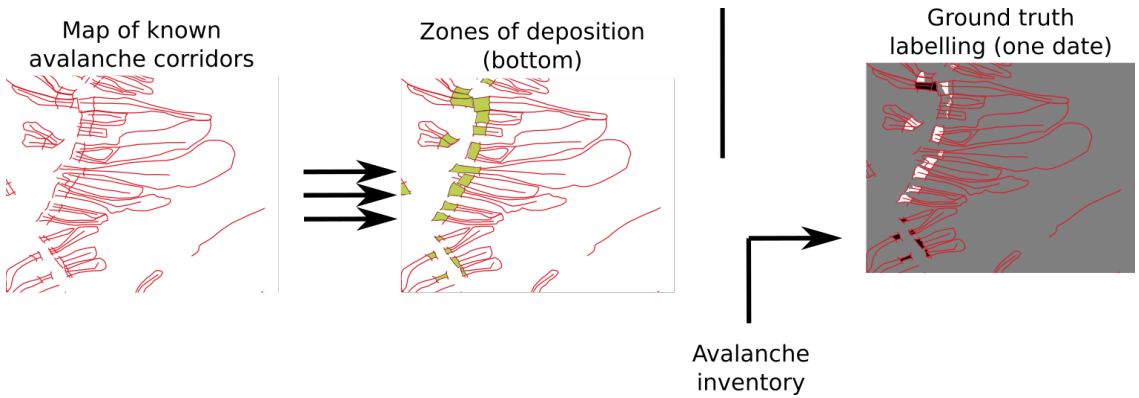
RGB composition SAR image over the Mont Blanc chain using 3 sentinel-1 VH images (R: 2017/08/24, G: 2018/01/15, B: 2018/01/09) highlighting avalanche debris in light green for events between 09th and 15th Jan. 2018.

Outline

Avalanche detection from SAR satellite imaging

- Method 1: Learn function pixel-wise *(random forests, SVM, k-NN...)*

$$f(VV, VH, slope, orientation, ..) = yes/no$$



yes = white
= avalanche

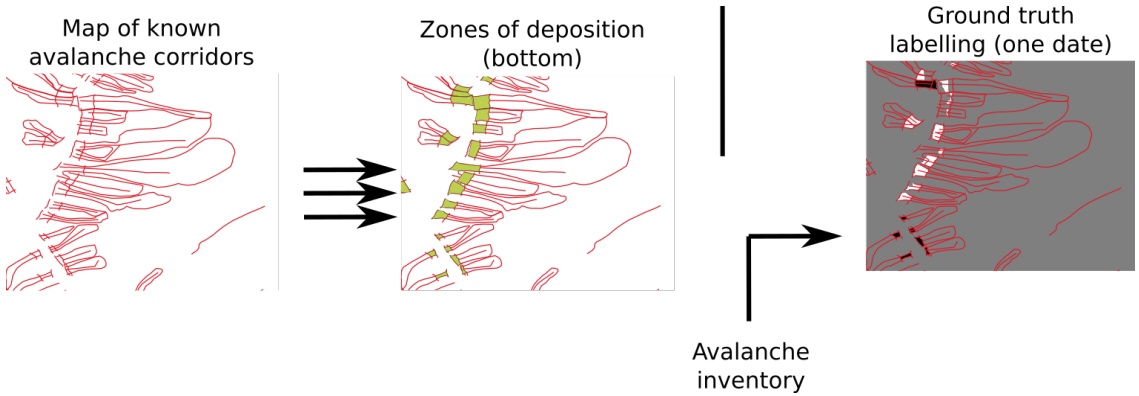
no = black
= no aval.

= list of avalanches (events) recorded by mountain rangers, i.e.:
- in corridor A, an avalanche occurred between Feb. 1 and Feb 4.
- in corridor B, ..

Avalanche detection from SAR satellite imaging

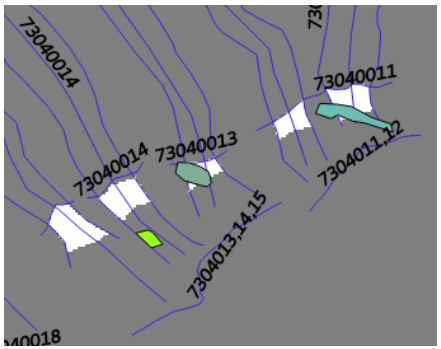
- Method 1: Learn function pixel-wise *(random forests, SVM, k-NN...)*

$$f(VV, VH, slope, orientation, ..) = yes/no$$



Problem: avalanche debris only roughly localized.

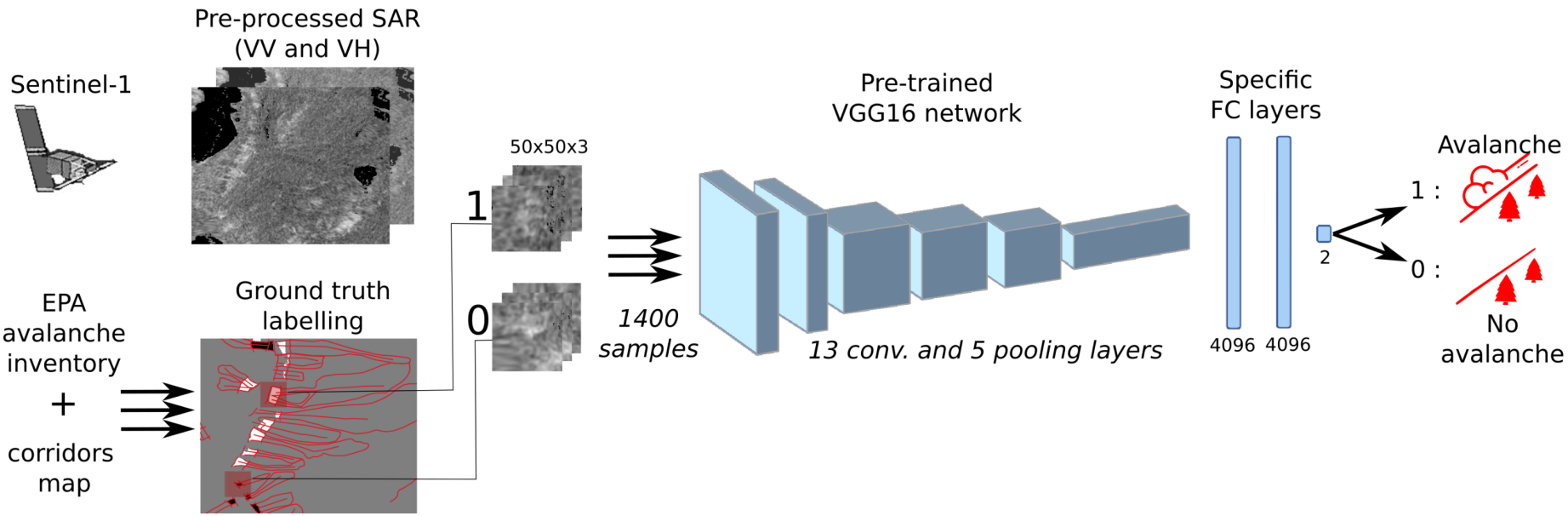
Each avalanche = specific shape.



Color polygons = 'expert' SAR labelling. Does not correspond to white zones.

Avalanche detection from SAR satellite imaging

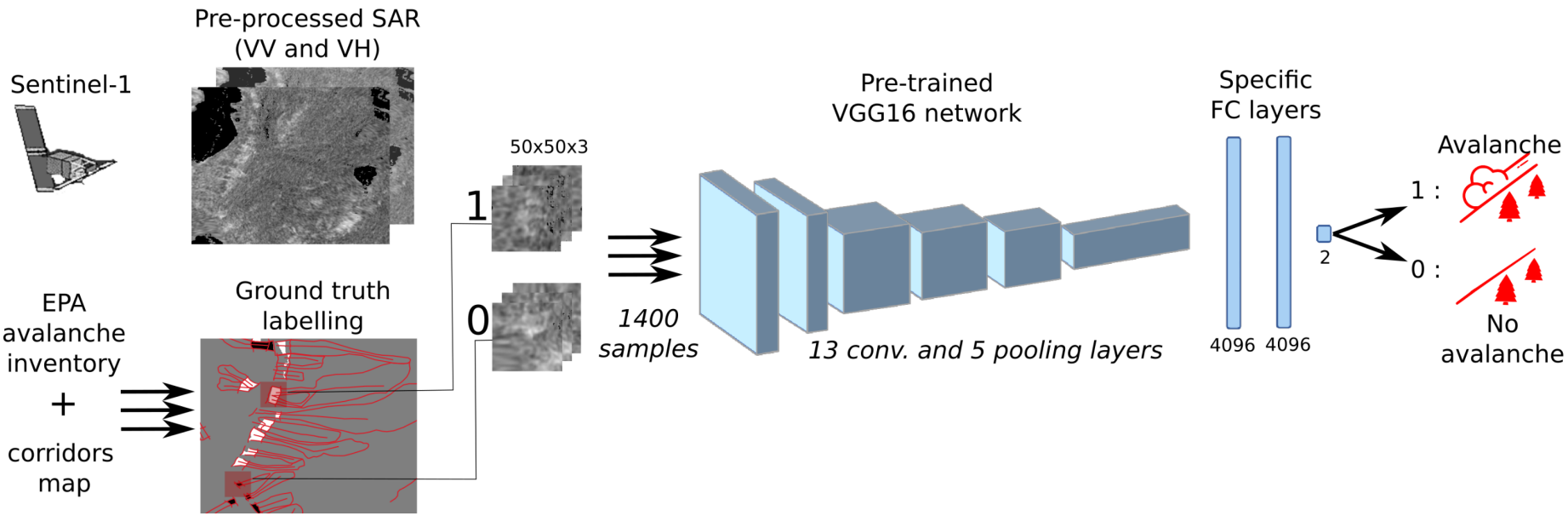
- Method 2: Learn function from patches:



We are more confident that the avalanche will be in a patch centered on the bottom part of the corridor, even if we don't know exactly where..

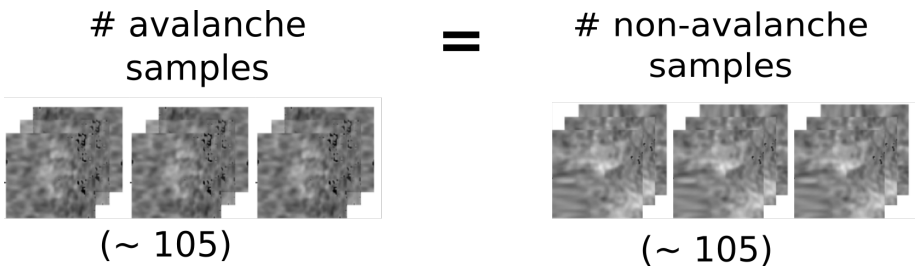
Avalanche detection from SAR satellite imaging

- Method 2: Learn function from patches:



Prelim. results: 70% accuracy on balanced test set

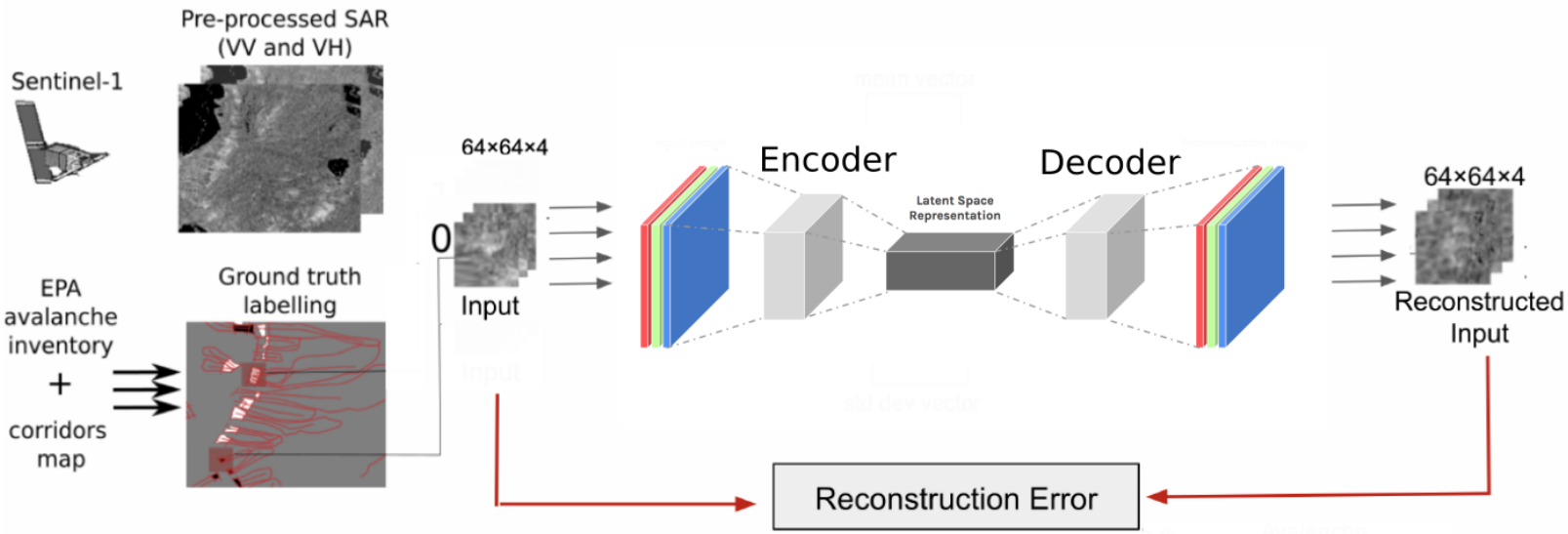
--> Difficult task !



Avalanche detection from SAR satellite imaging

- Method 3: Anomaly detection using an auto-encoder

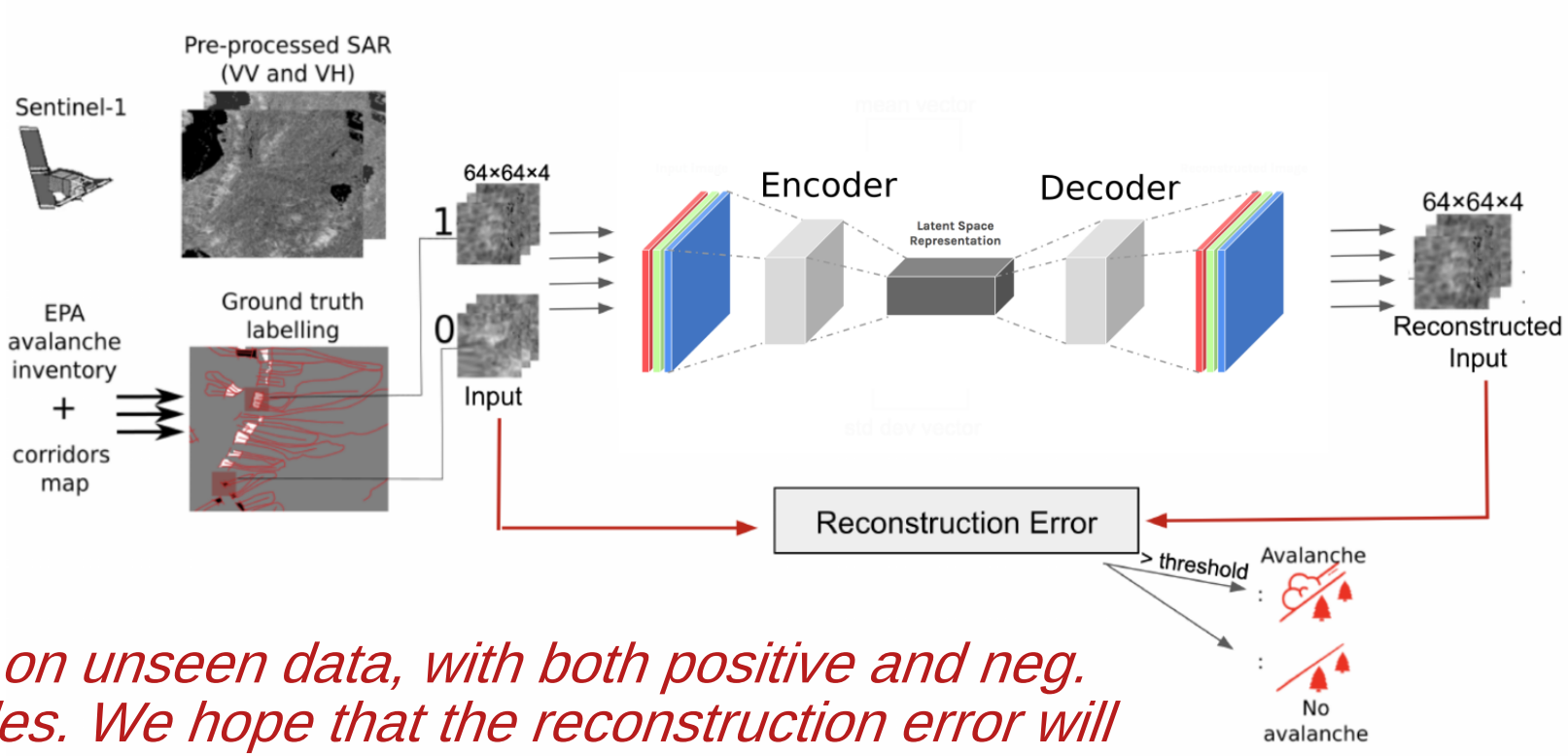
Idea: can we do better by viewing the problem in a different way?
We know that avalanches are SCARCE = use an outlier detection?



1) First, train the model with only 'negative' examples. It will learn a sparse representation of the patch by minimizing the reduction error of the training set.

Avalanche detection from SAR satellite imaging

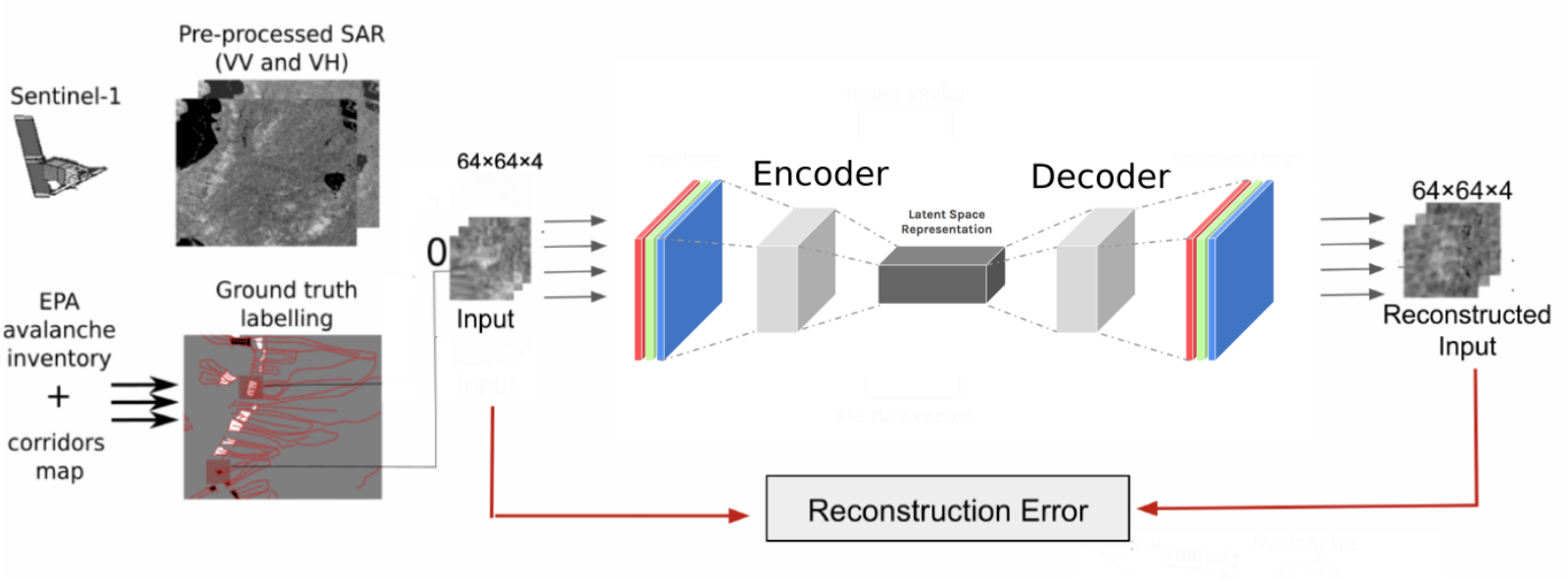
- Method 3: Anomaly detection using an auto-encoder



2) test on unseen data, with both positive and neg. samples. We hope that the reconstruction error will be larger for the avalanches, since it was not used in train.

Avalanche detection from SAR satellite imaging

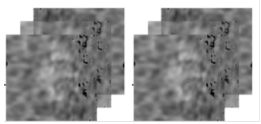
- Method 3: Anomaly detection using an auto-encoder



Prelim. results: 63% balanced accuracy on unbalanced test set

Harder than previous 'balanced' task

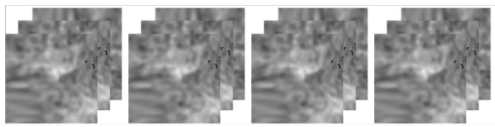
avalanche samples



(~ 100)

<<

non-avalanche samples



(~ 6000)

Thank you

Conclusion : - The definition of what problem we want to solve is fundamental. Here, it is harder to separate the avalanches on an unbalanced dataset, but it is closer to reality (avalanches are a rare event).

- The ground truth data, even if not perfect, can be useful. For ex. here, we only know a rough location and a rough date

- Yet, in this problem we need more information to be able to solve this task. Specifically, there are too few databases with ground truth labels that are independent of the SAR acquisition.

See our papers on the different methods for more details. Look at my webpage for ex. (sophiegif.github.io/)