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Learning to automatically detect avalanche deposition from SAR satellite imagery

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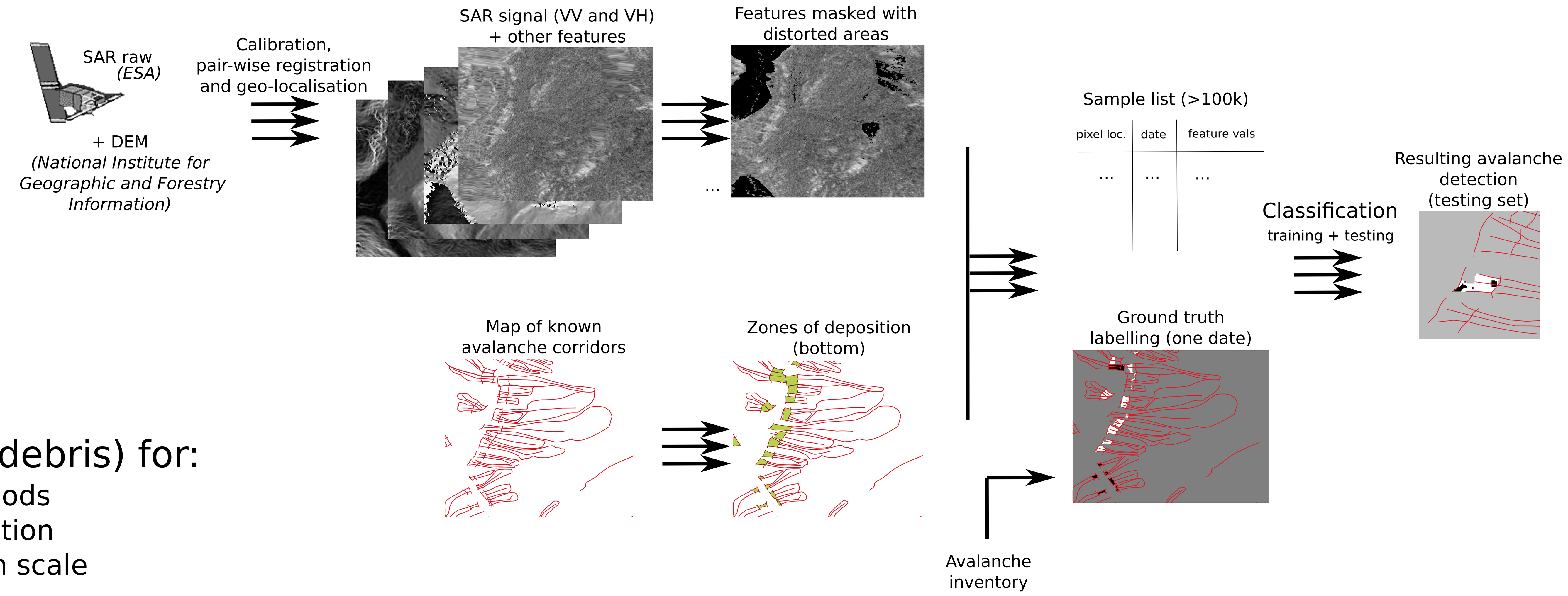


Detect avalanche deposition (debris) for:

* identifing avalanche risk zones/ periods
* improving physical models of prediction
* studying the variability on long-term scale

Recent studies [1,2] showed the potential of learning from Sentinel-1 SAR data, but **no external ground truth** was used to validate.

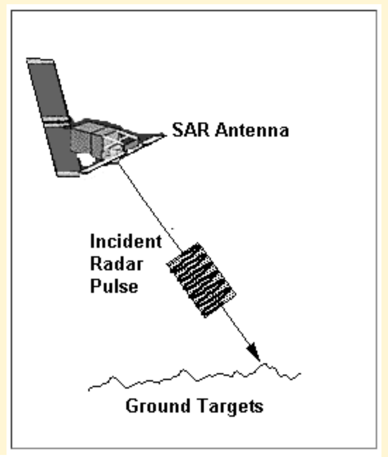
Can we learn avalanche deposition from SAR with an independent event invertory?

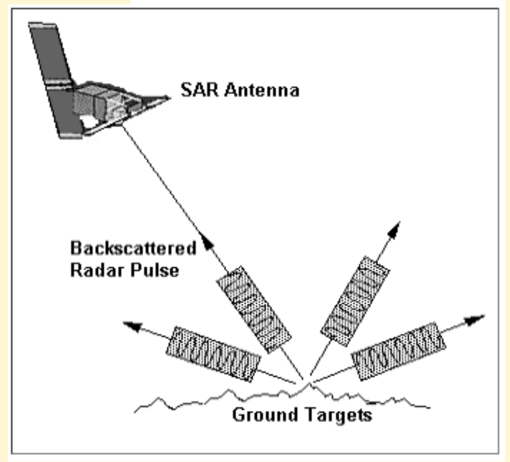
DATA

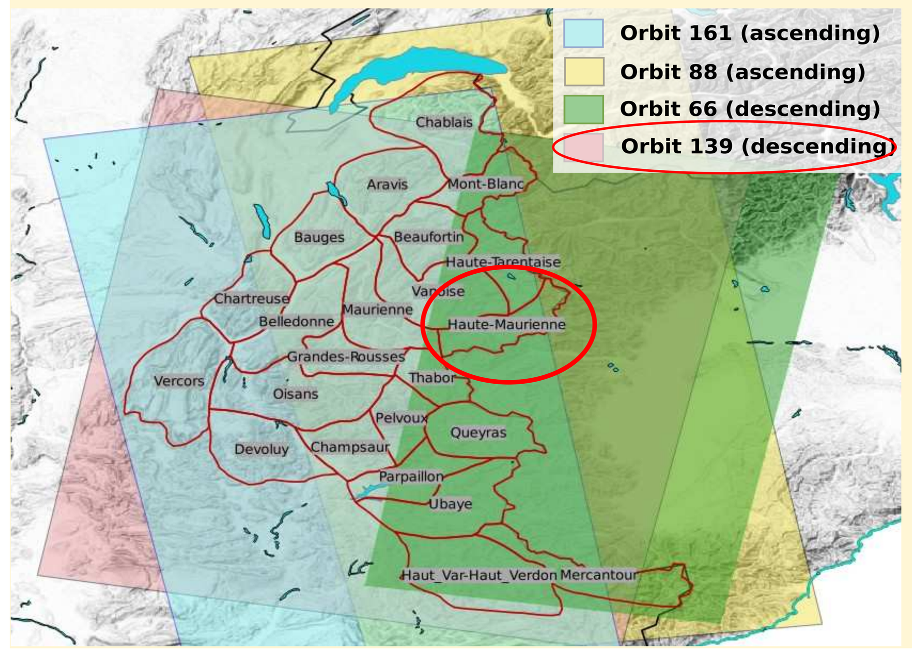
Sentinel-1 satellites SAR (synthetic aperture radar):
- Sensitive to snow properties [1]
- Penetrate through clouds
- 20m resolution, every 6 days

Season 2017-18:
- Backscatter coefficients VV & VH
- maps of orientation, altitude, slope

Validation:
- avalanche event site inventories
- 4000 avalanche corridors







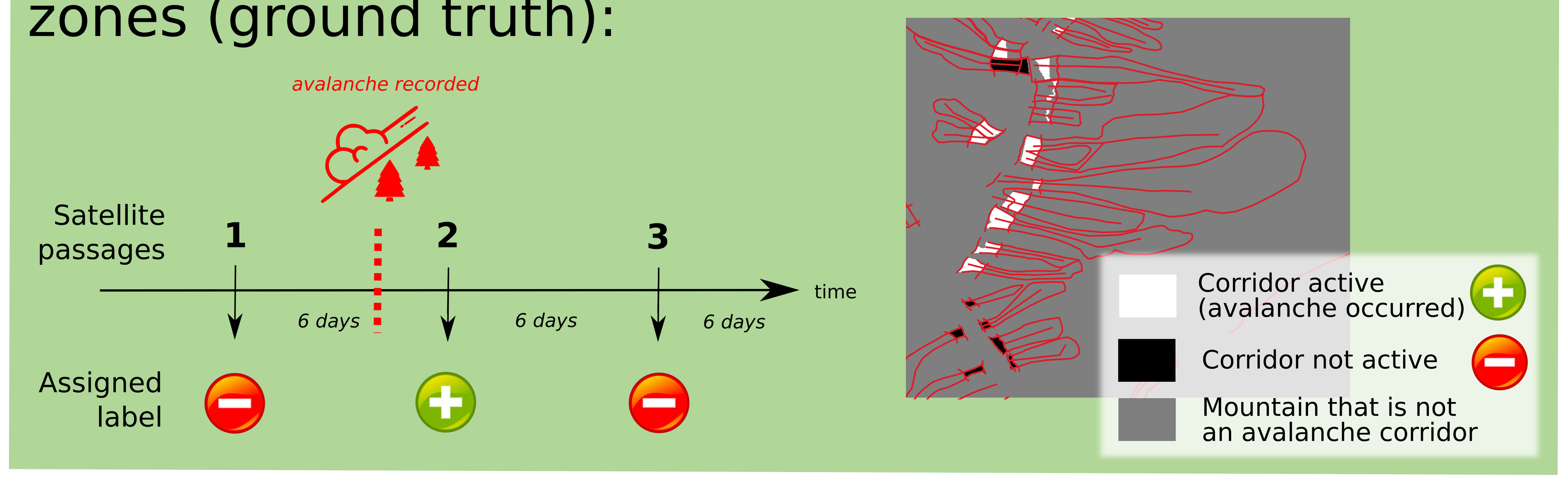
French Alps Sentinel-1 orbits.

Studied region:
Haute Maurienne mountains.

METHODS

Pre-processing

- Calibration, pair-wise registration, geo-localisation
- Create polygons from avalanche deposition corridors
- For each satellite passage, determine active/inactive zones (ground truth):



Learning

- Balanced dataset (over all dates) of > 100k samples
- Train, valid and test splits (60/20/20)

Features:

* VV *as 10*log10(VV/VV$_{summer}$)*
* VV *(previous passage)*
* VH as 10*log10(VH/VH$_{summer}$)
* VH *(previous passage)*
* orientation
* slope
* satellite angle

Classification approaches (with param. grid search):

* Nearest Neighbors
* Linear SVM
* DecisionTree
* Random Forest
* Neural Net (MLP)
* AdaBoost

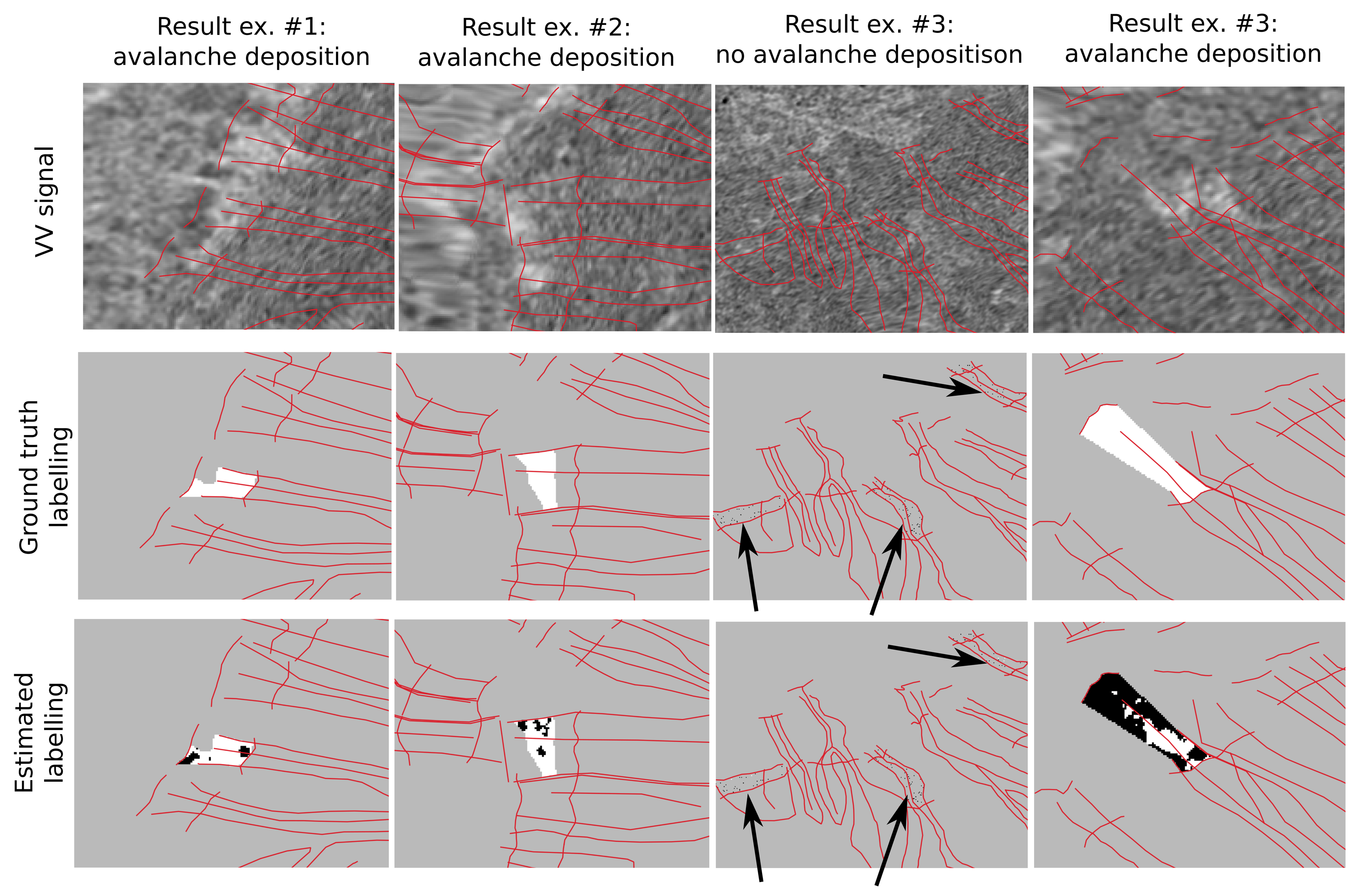
RESULTS

Baseline method [1]: 10*log10(VV/VV$_{summer}$) > 4db * → (+)
< 4db → (−)

accuracy = 50.5%

* if the threshold was not reached previously (6 days before)

Methods / Features (Accuracy score in %)	VV *Valid. set*	VV + VH *Valid. set*	VV + VH + other features *Valid. set*	VV + VH + other features *Test set*
Nearest Neighbors	64.3	66.7	72	72
Linear SVM	65.5	65.5	69.8	68
Decision Tree	67.3	69.4	72.7	67.3
Random Forest	67.4	70	75	71.4
Neural Net (MLP)	67	70	74	72.4
AdaBoost	67.4	69	73.3	69.3



Idea for future work. Use convolutional neural networks for classification from image patches as input (include the context)

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