

Evaluation of infrasound avalanche detection systems

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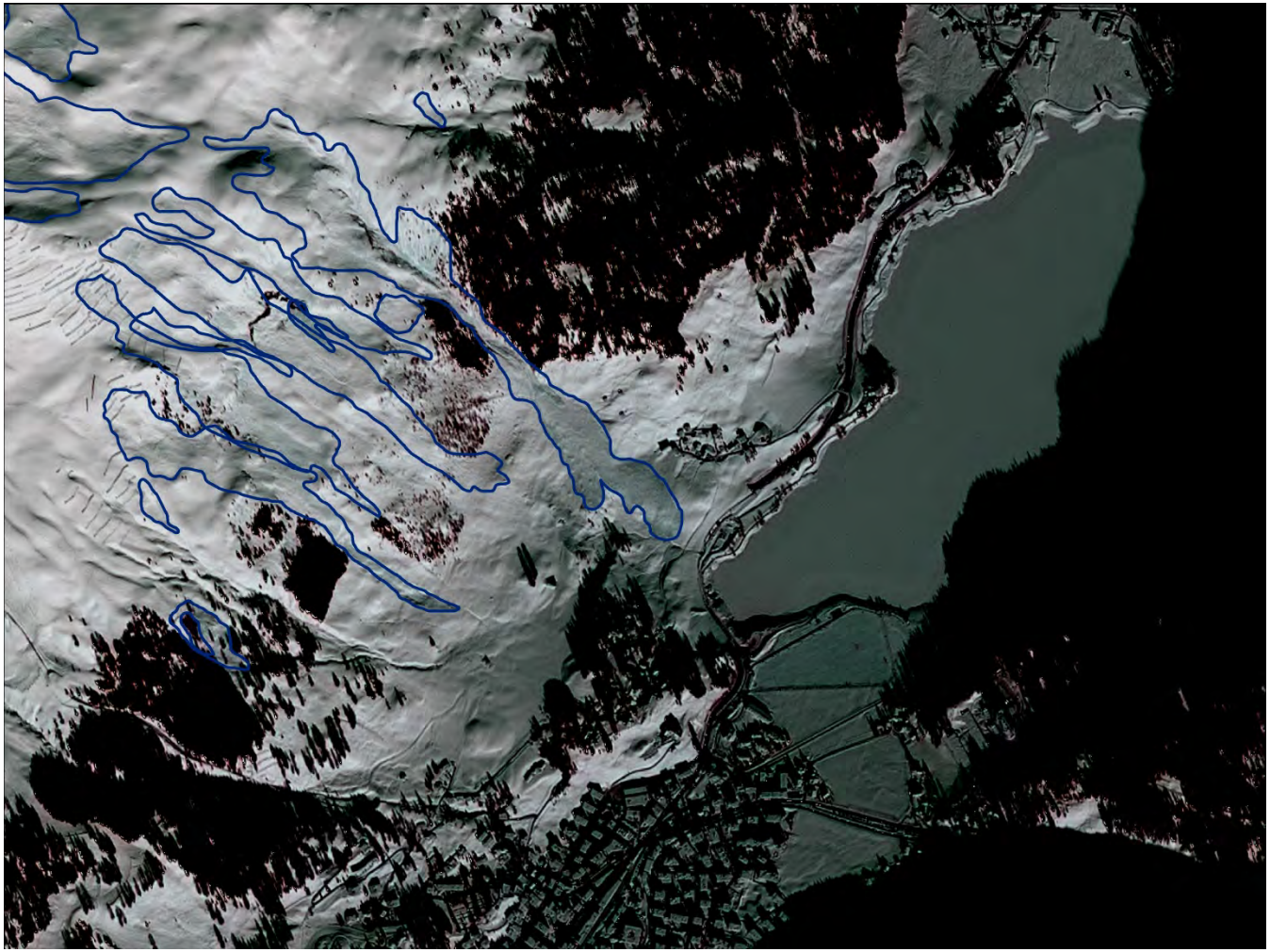
Motivation


SPFW ZERM
Strasse gesperrt
Lawinengefahr
Route barrée
danger d' avalanche
Road closed

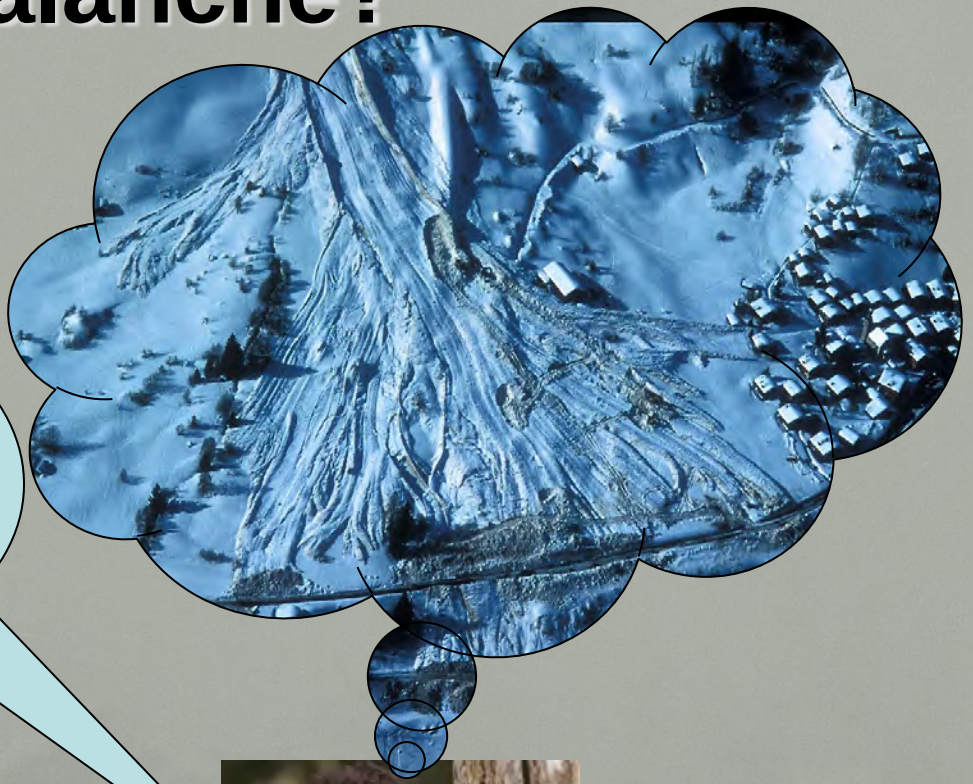
An avalanche rarely comes alone



Can you see an avalanche?

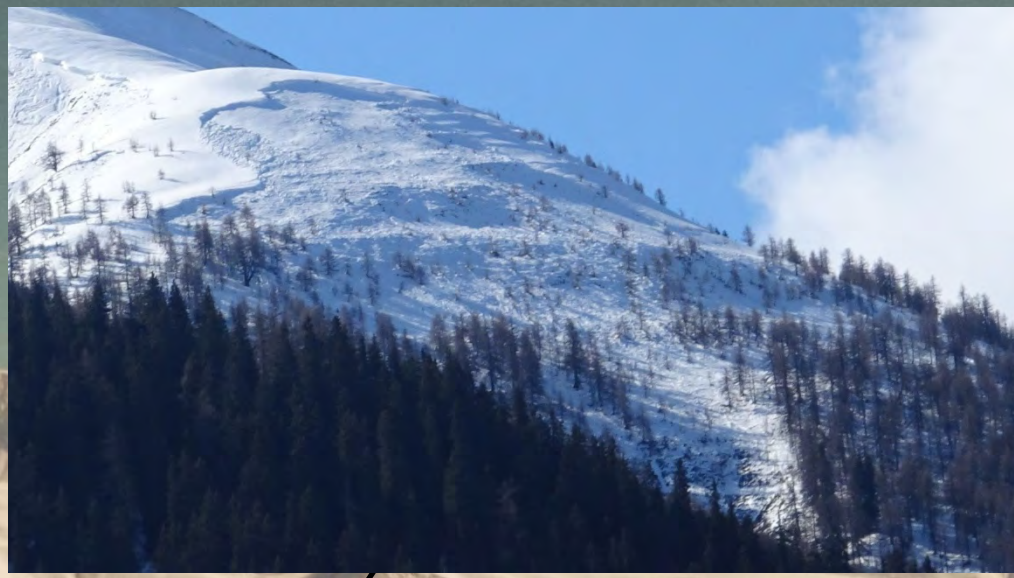
09.03.2017, view from ski area Bellwald

Can you see an avalanche?



Willy Werlen,
Avalanche safety service, Goms

One day later…



Avalanche activity data is needed to forecast avalanche danger

PAST PRESENT FUTURE

Field observations

forecast

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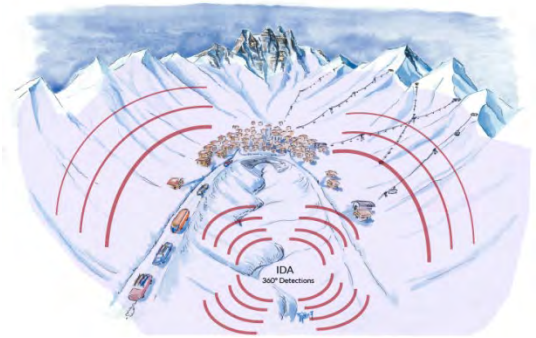


detections systems

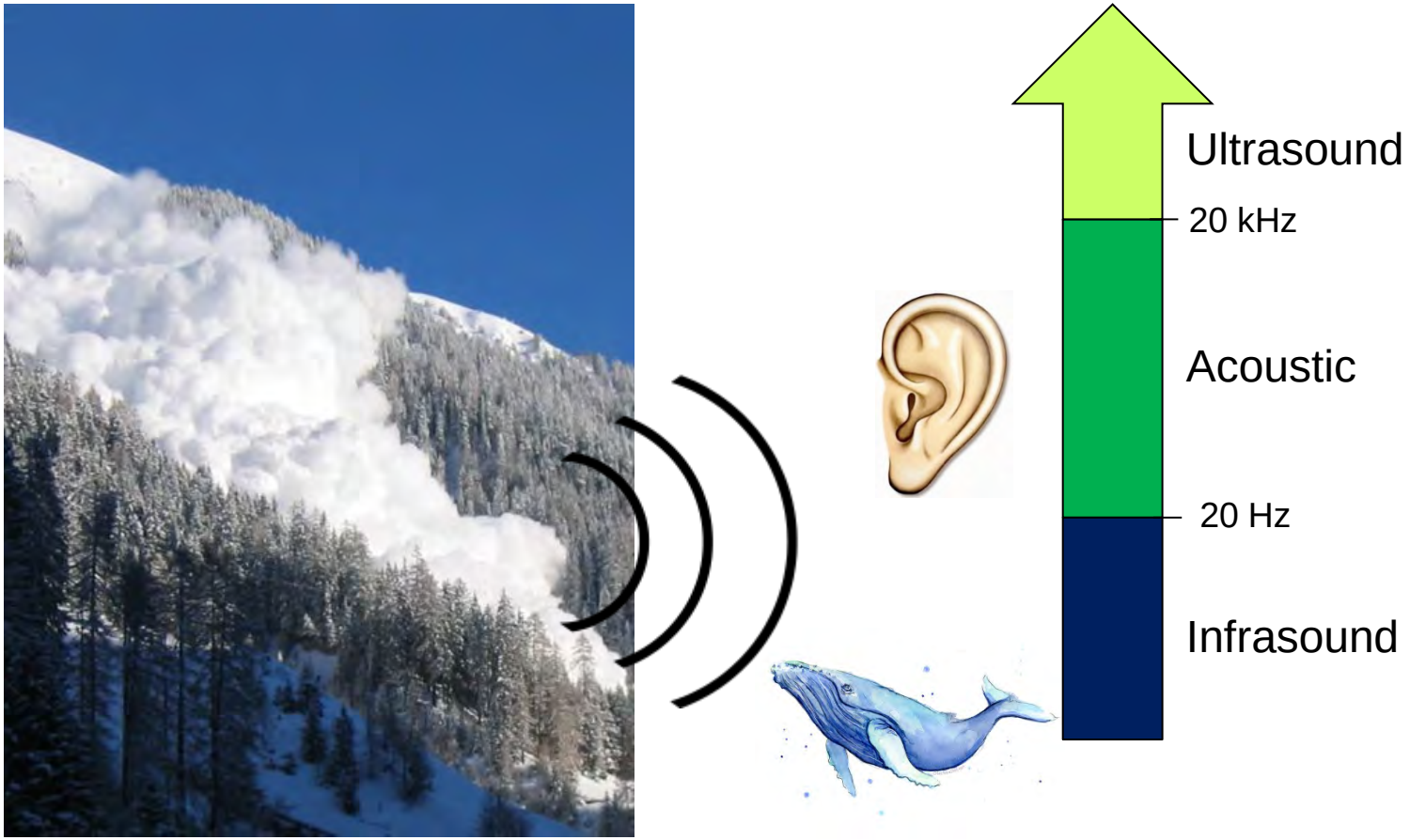
?

forecast

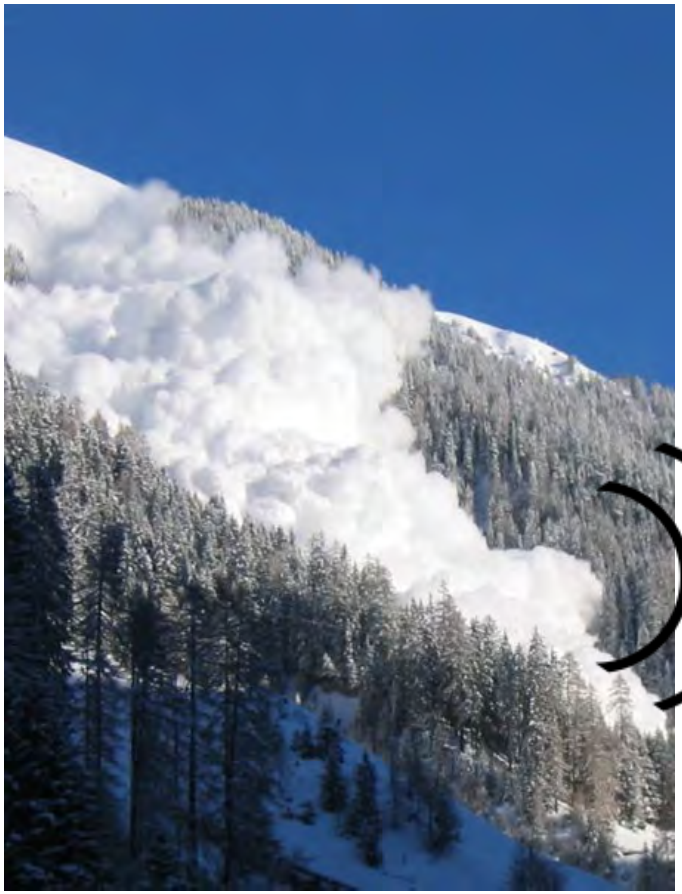
Can infrasound detection systems reliably detect avalanches?

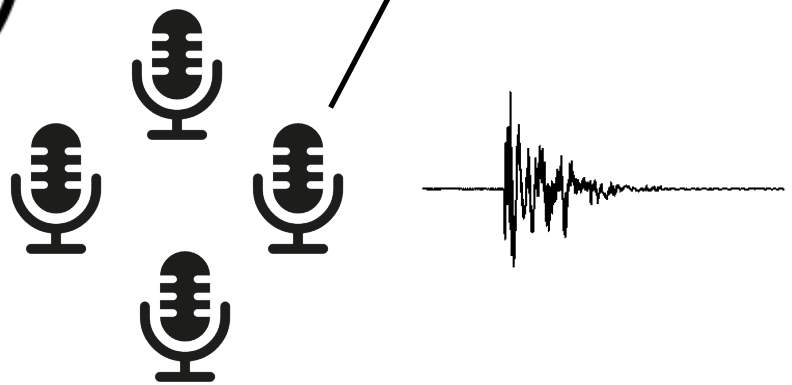
Swiss Federal Office of the Environment (FOEN)

Avalanches produce soundwaves

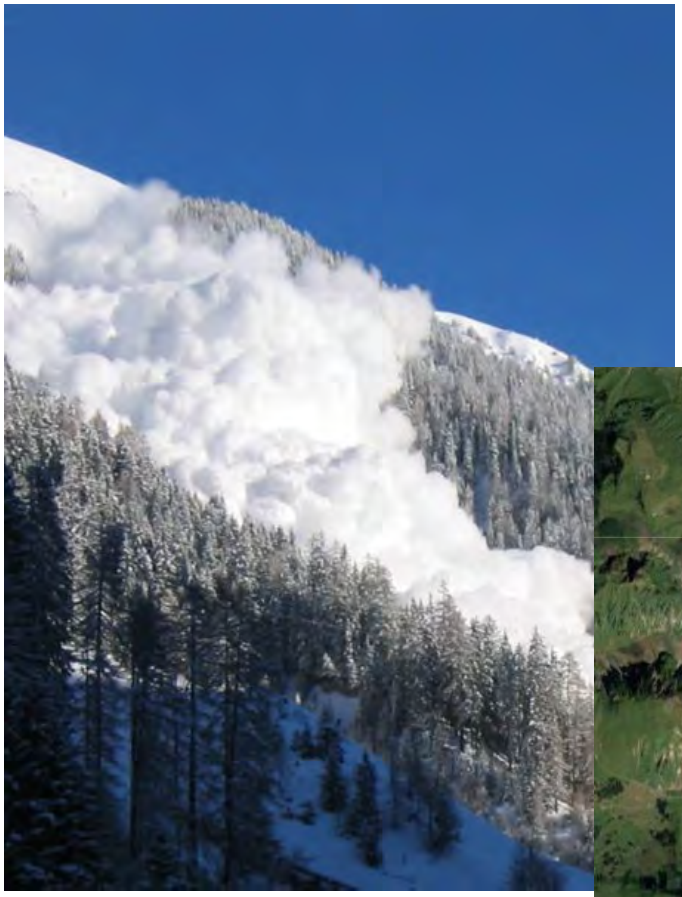


Detection systems record infrasound

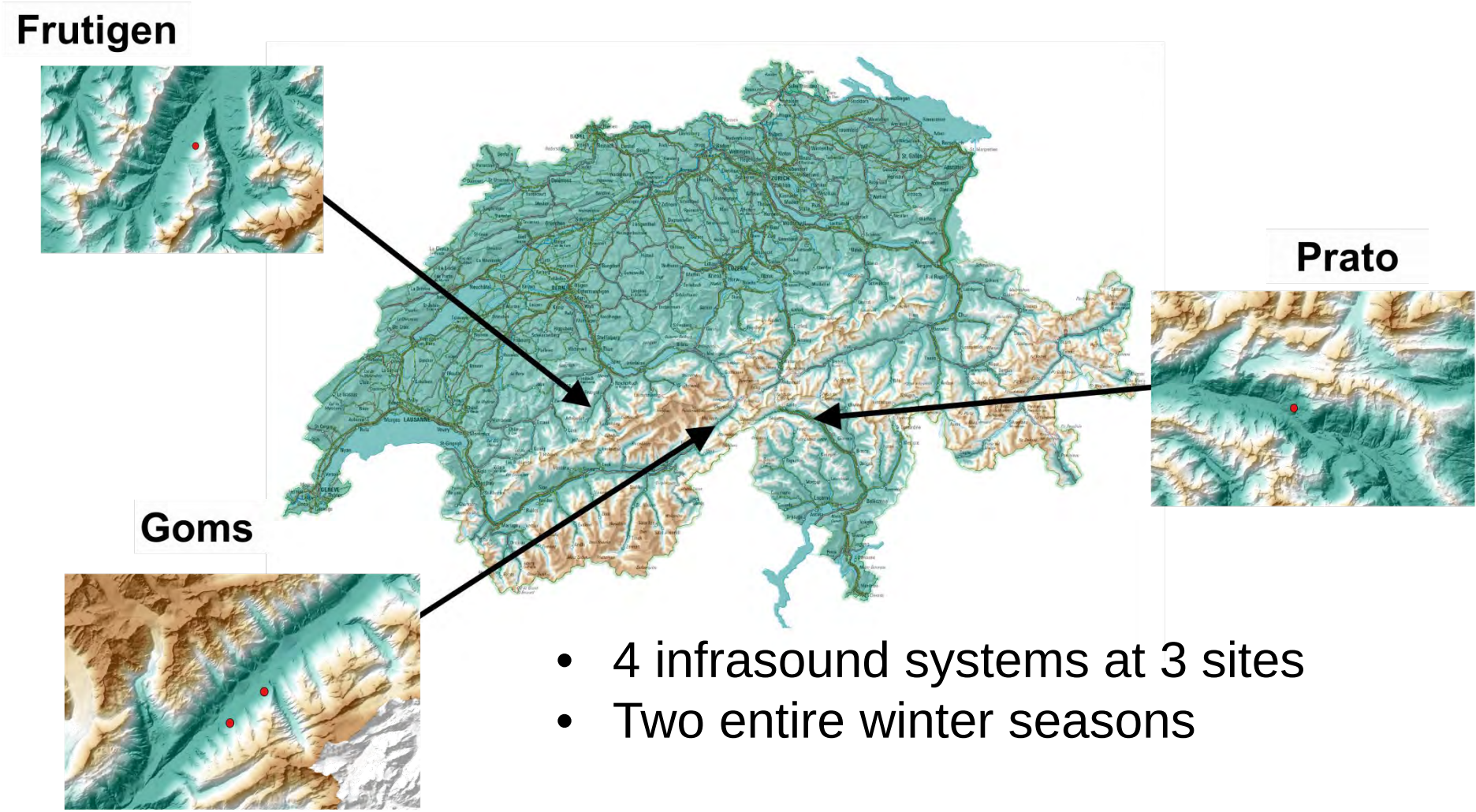




Direction of avalanche is identified



Evaluation of the detection system



- 4 infrasound systems at 3 sites
- Two entire winter seasons

Visual monitoring

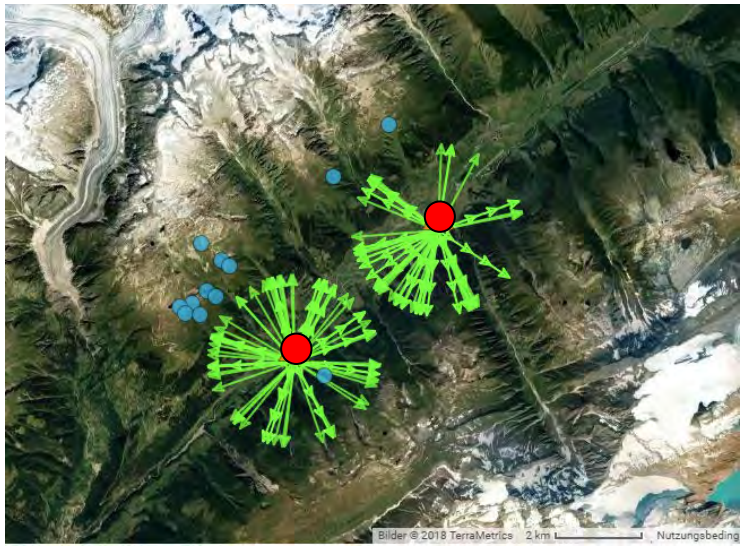
→ In total 840 observed avalanches

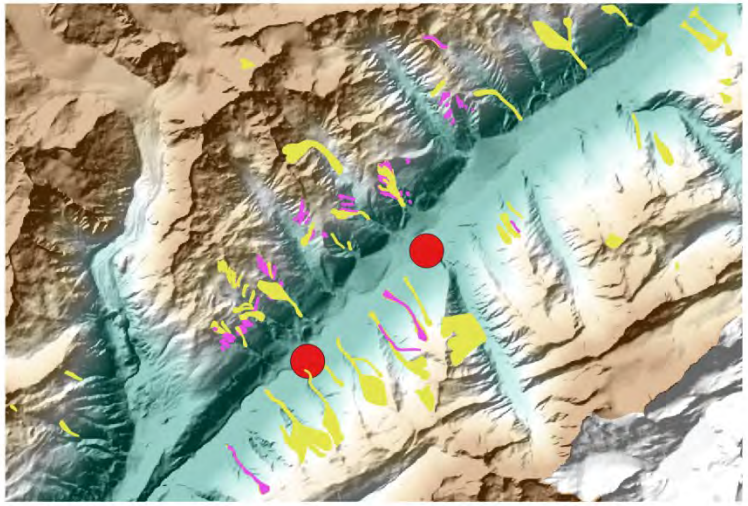
Infrasound vs. visual observation

110 infrasound alarms

vs.

840 observed avalanches





infrasound system

infrasound alarm

avalanches 2015/16

avalanches 2016/17

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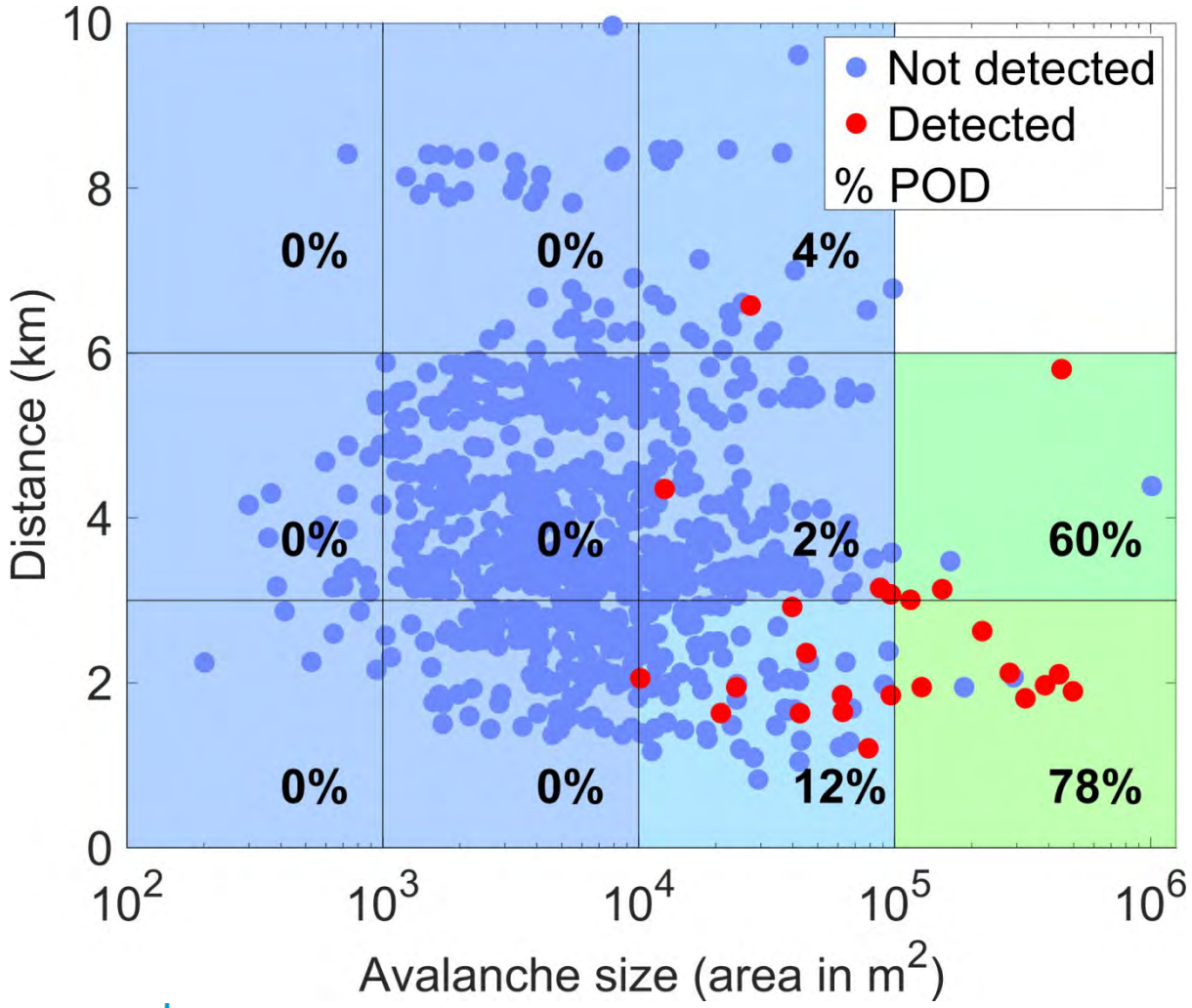
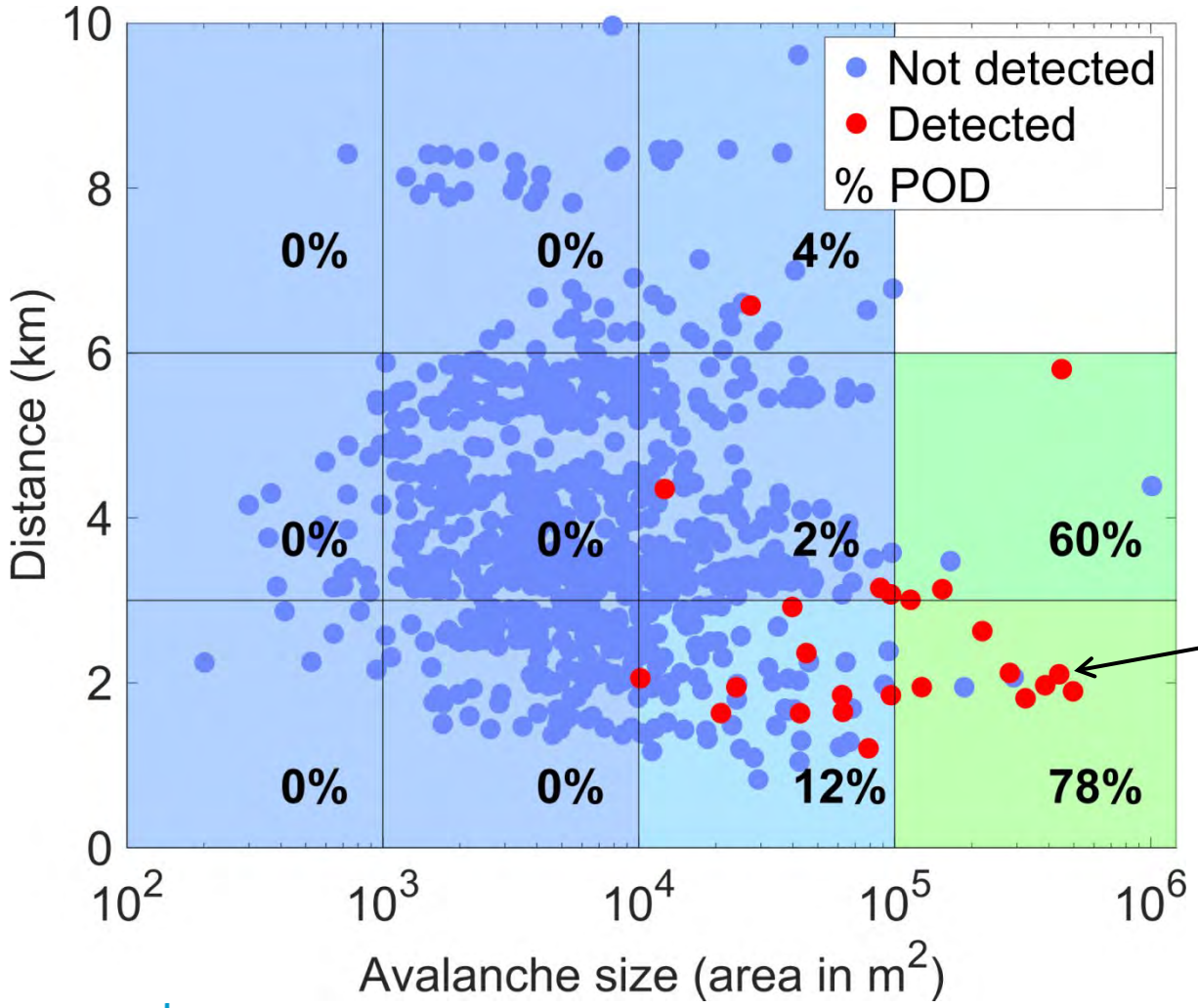
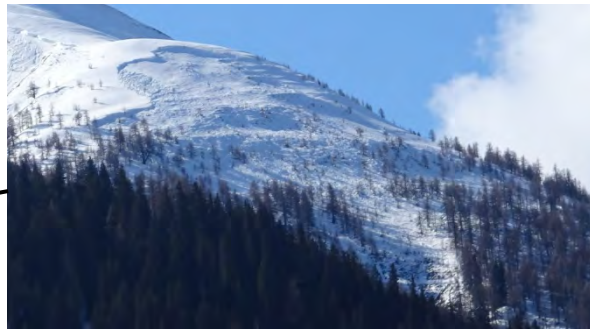
Probability of detection



Probability of detection



Width: 300 m
Length: 2.5 km
Distance: ~2 km



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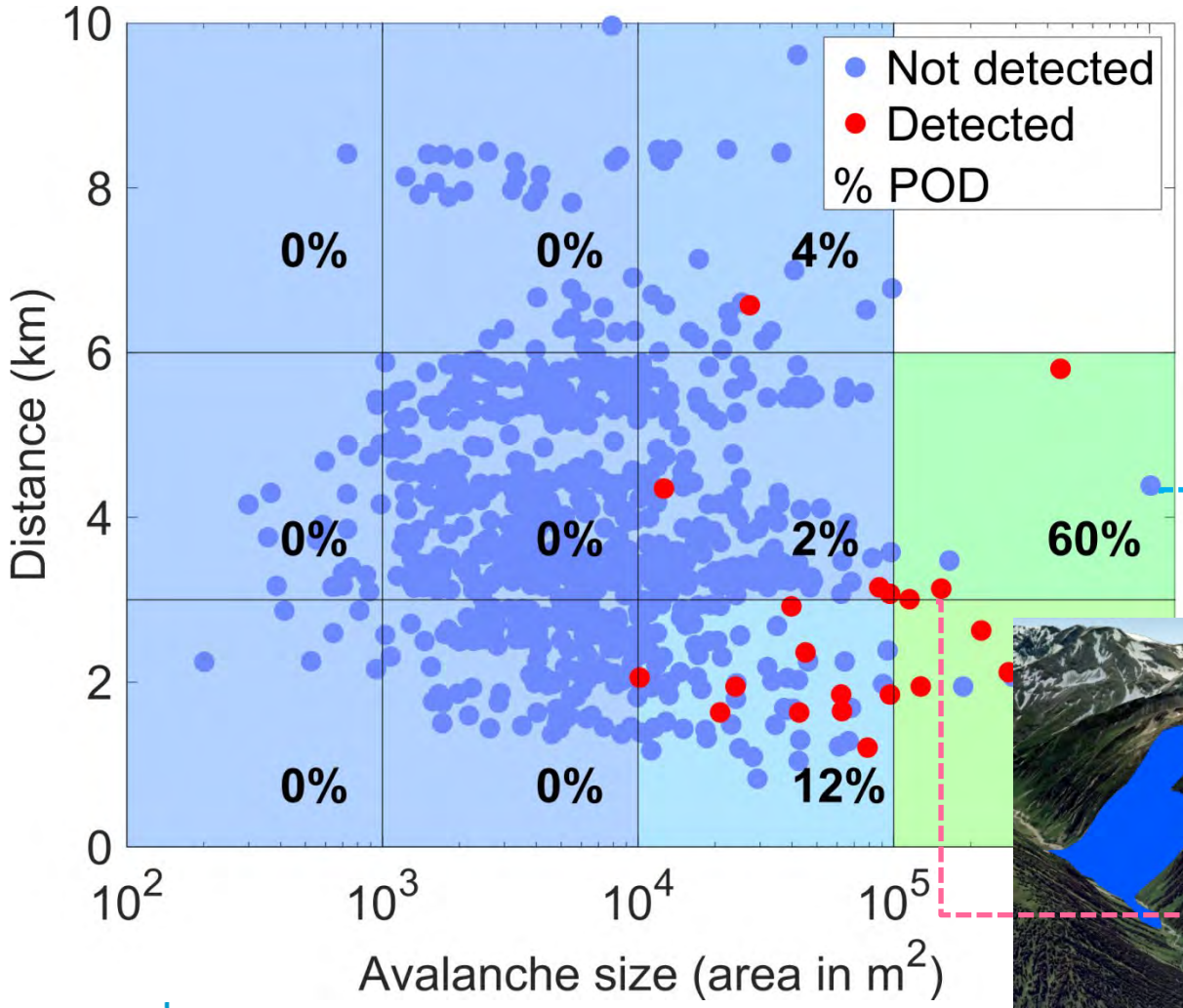
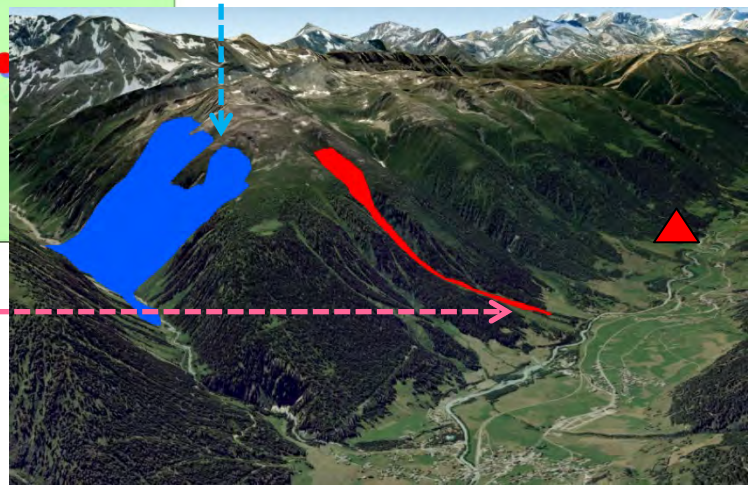
Influence of topography



Avalanche 1:
width: 1 km
length: 1.8 km
distance: 4.1 km

Avalanche 2:
width: 120 m
length: 1.8 km
distance: 3.1 km



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Conclusion

Can infrasound detection systems reliably detect avalanches?

- small avalanches (< 100 x 100 m^2) **X**
- large avalanches (~100 x 1000 m^2) within a distance < 3 km ✓
- topographic barriers have a strong influence

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→ Important additional information for local avalanche safety services

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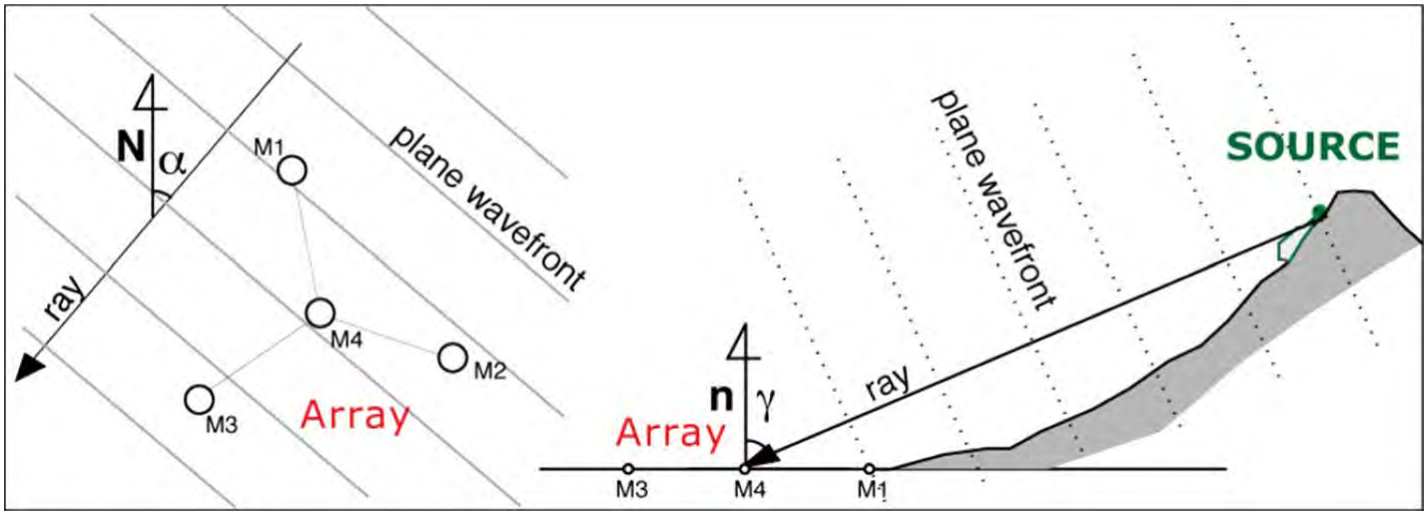
Thank you for your attention!

Infrasound array



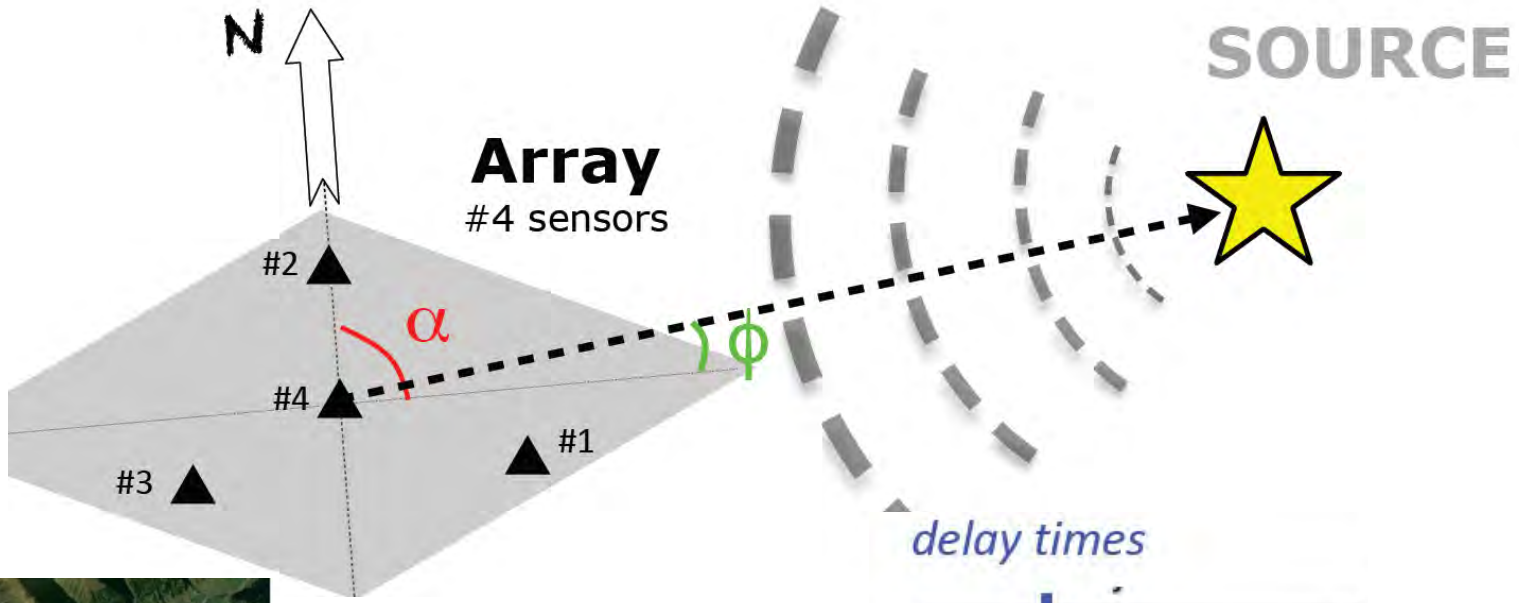
Detection algorithm

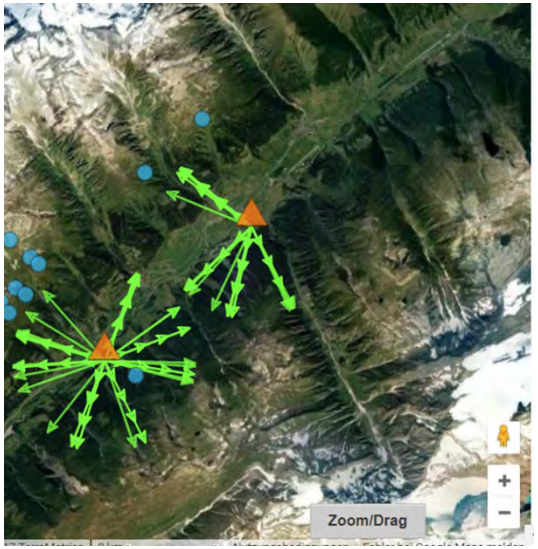
1. Amplitude threshold → reduce amount of data

2. Discriminate from other infrasonic sources, three criteria:
   a) Decrease in angle of height
   b) Azimuth rotation
   c) Minimal signal duration.

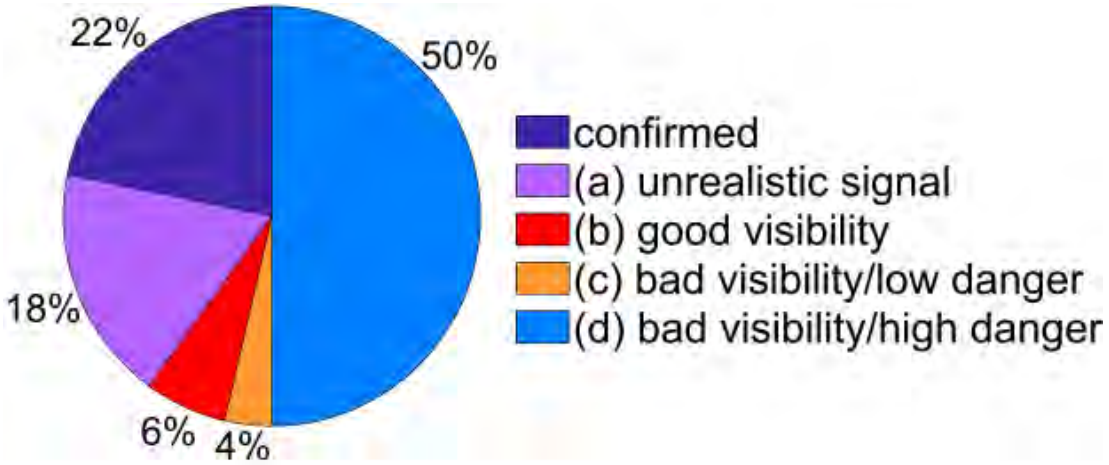
What is infrasound detection?

- Infrasound = sound of frequency < 16 Hz





Characteristic of detection



False alarm rate: 10-28%