



Improving avalanche forecasting: requirements and challenges

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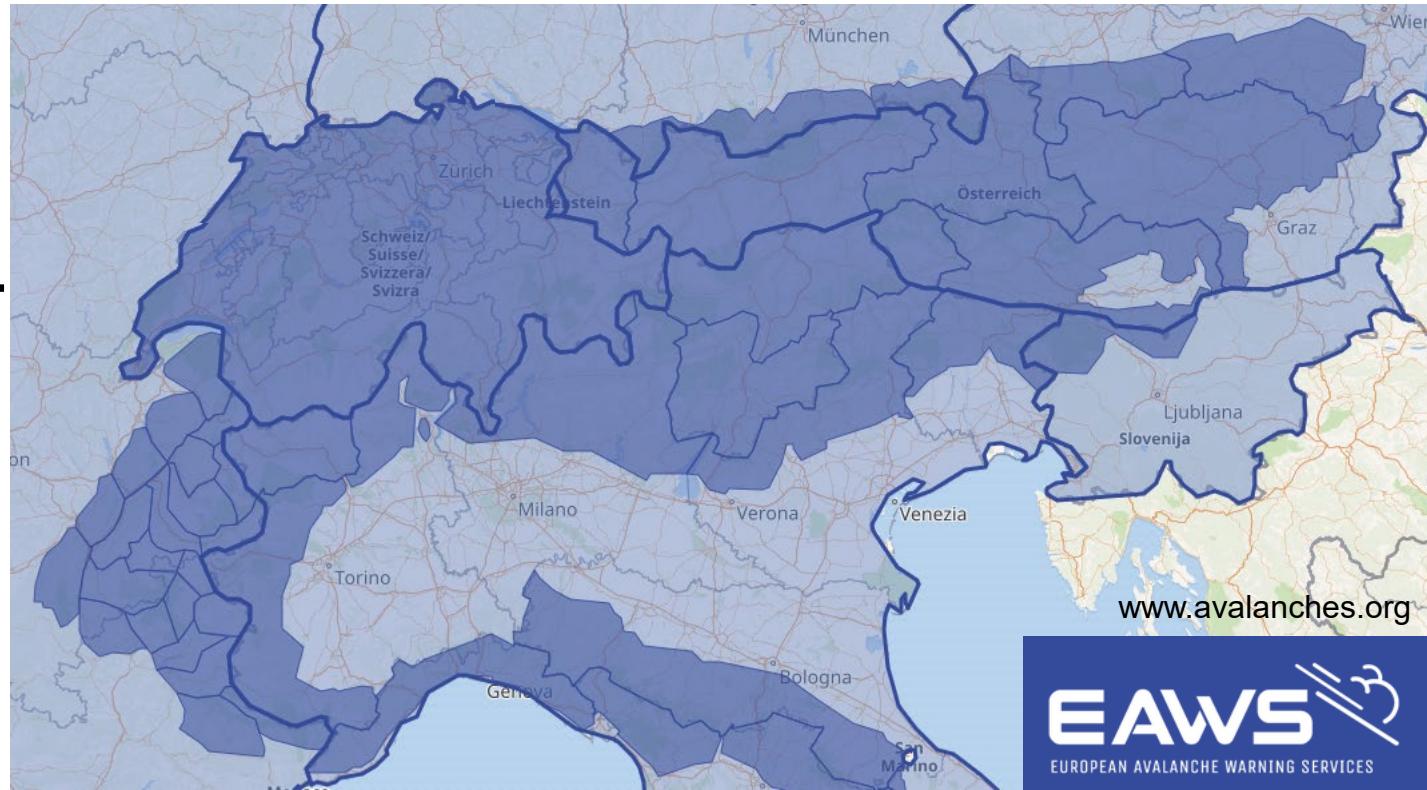
TEAMx Meeting, 6 May 2020

... in complex terrain ...



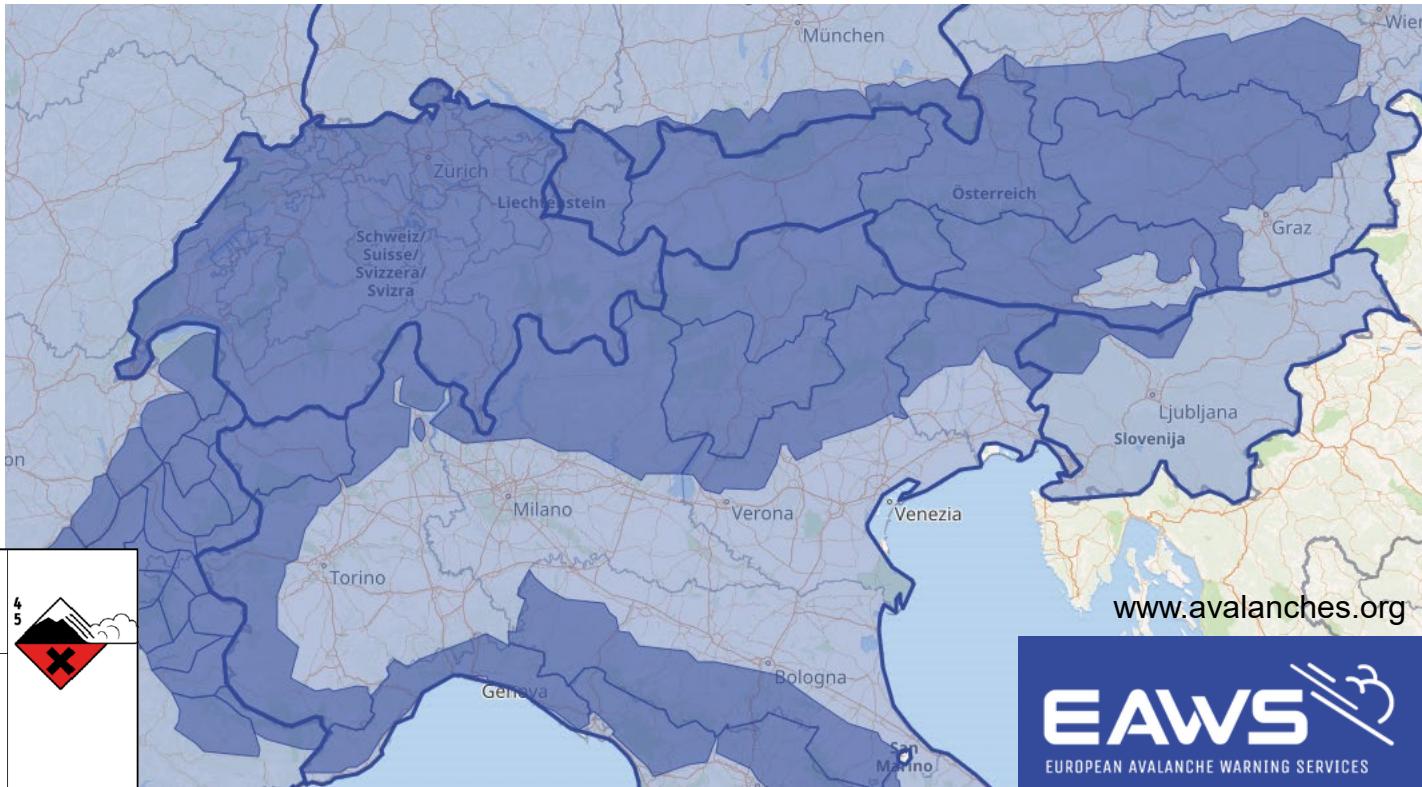
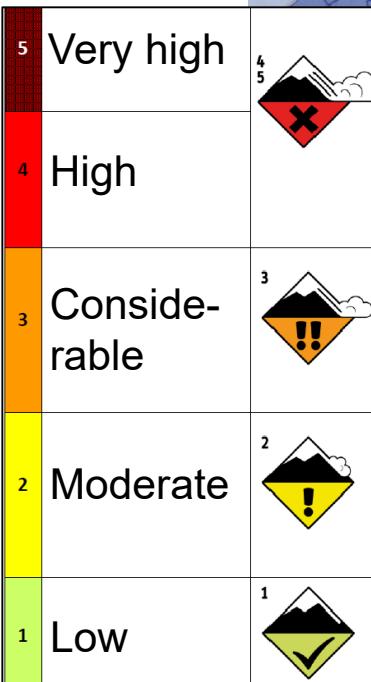
Avalanche forecasting

- Alpine countries + ...
- Many different approaches
- Met offices, civil protection...



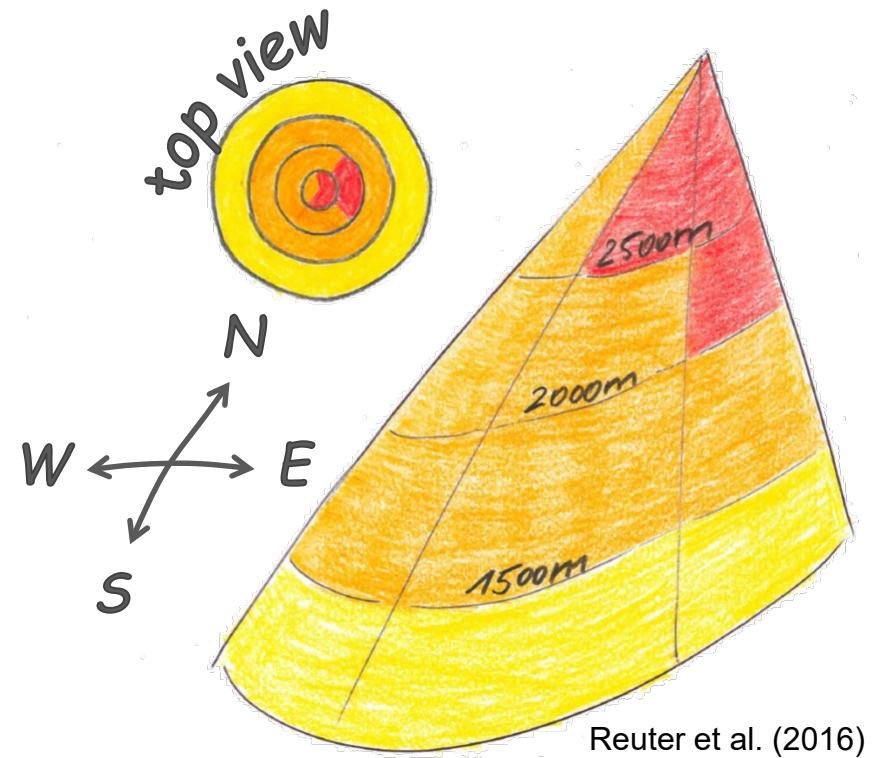
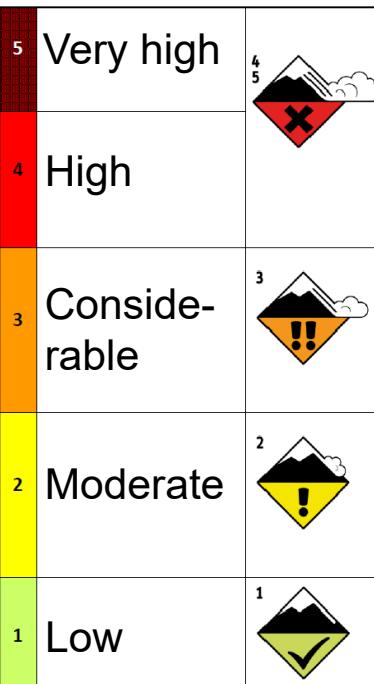
Avalanche forecasting

- Alpine countries + ...
- Many different approaches
- Met offices, civil protection...
- Some coordination:
 - 5-degree danger scale
 - Daily bulletins
 - Regional “probabilistic” forecasts



Avalanche forecasting

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 - **Regional “probabilistic” forecasts**



Avalanche bulletin through Tuesday, 5 May 2020

Moderate danger of dry and wet avalanches will prevail

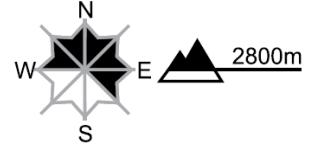
Edition: 4.5.2020, 17:00 / Next update: In the event of heavy snowfall

Avalanche danger

updated on 4.5.2020, 17:00

Wind slabs

Avalanche prone locations



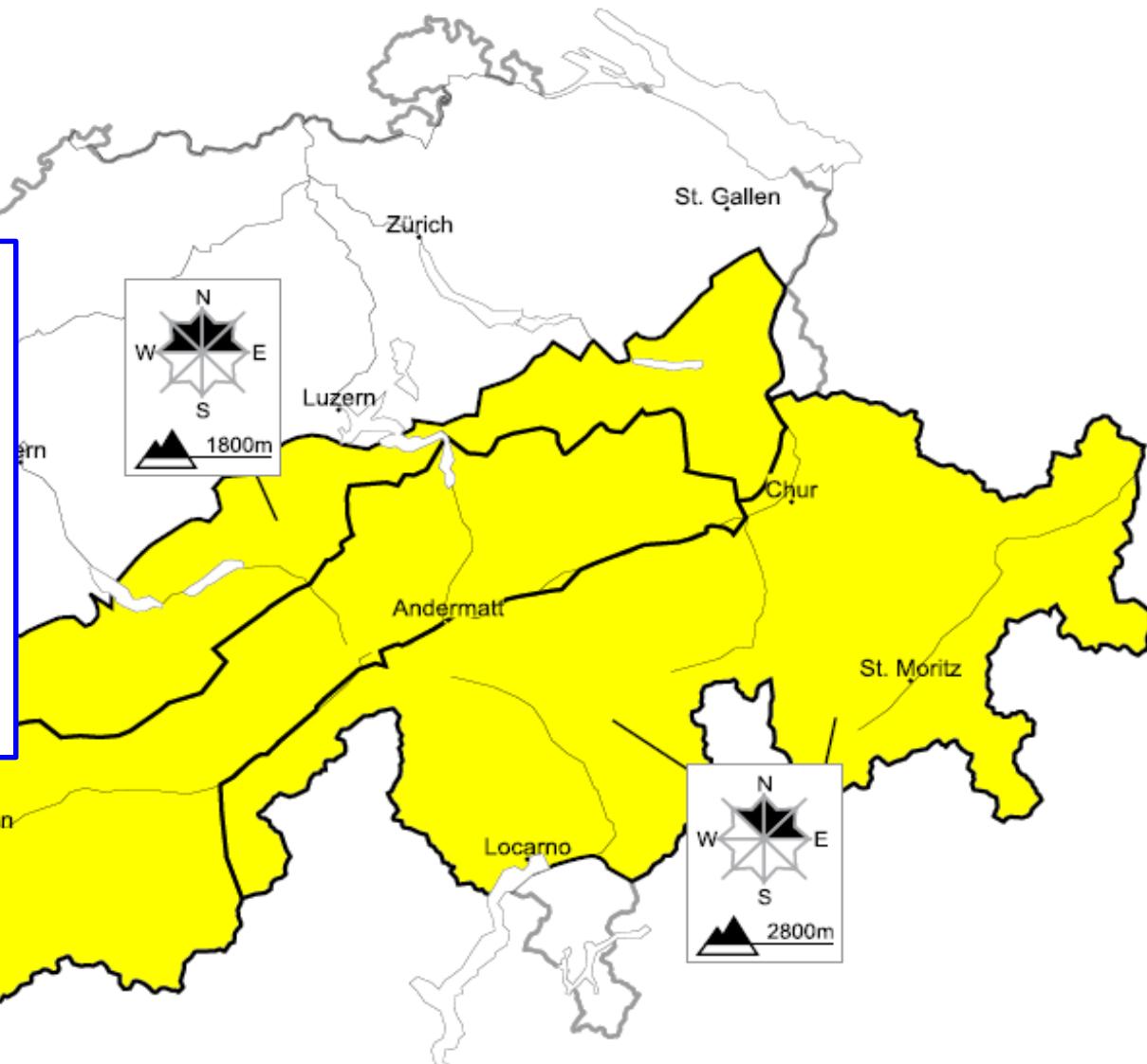
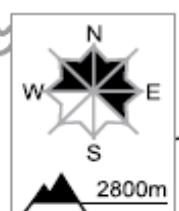
Danger description

Mostly small wind slabs will form. These are in some cases prone to triggering. The number and size of avalanche prone locations will increase with altitude. The new snow of the last few days can be released in isolated cases, but mostly only by large additional loads.

The Avalanche Warning Service currently has only a small amount of information that has been collected in the field.

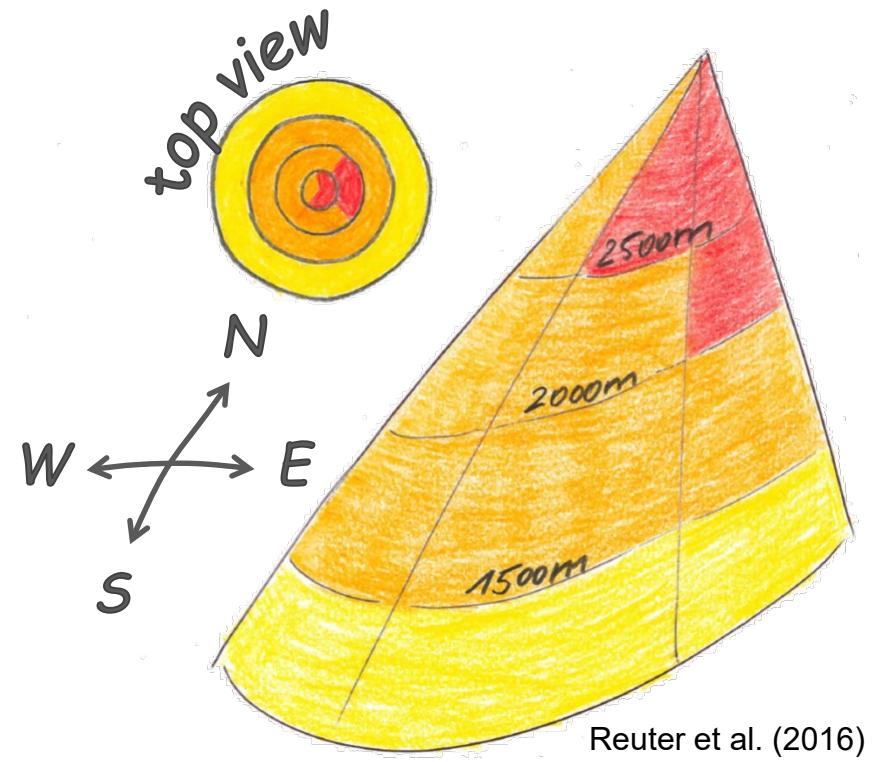
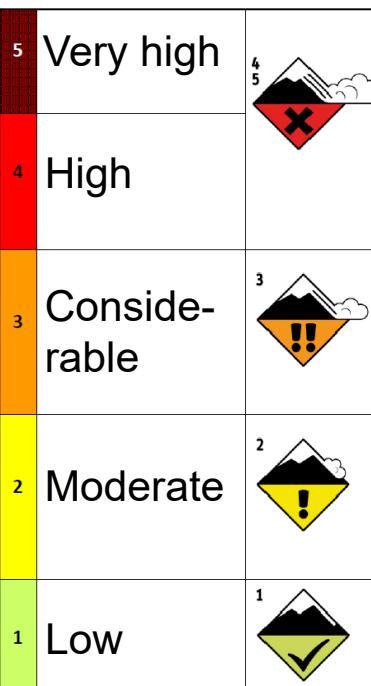
Wet avalanches

Wet and gliding avalanches are possible.



Avalanche forecasting

- Alpine countries + ...
- Many different approaches
- Met offices, civil protection...
- Some coordination:
 - 5-degree danger scale
 - Daily bulletins
 - **Regional “probabilistic” forecasts**
- Limited use of models



Weather
+
Snow cover

Avalanche forecasting

- Weather forecasts, numerical model output
- Measurements:
 - automatic weather stations
 - manual observations
- Snow cover data: snow profiles
- (Avalanche) observations, estimates

Observers

Data-driven, experience-based
«manual» decision-making process

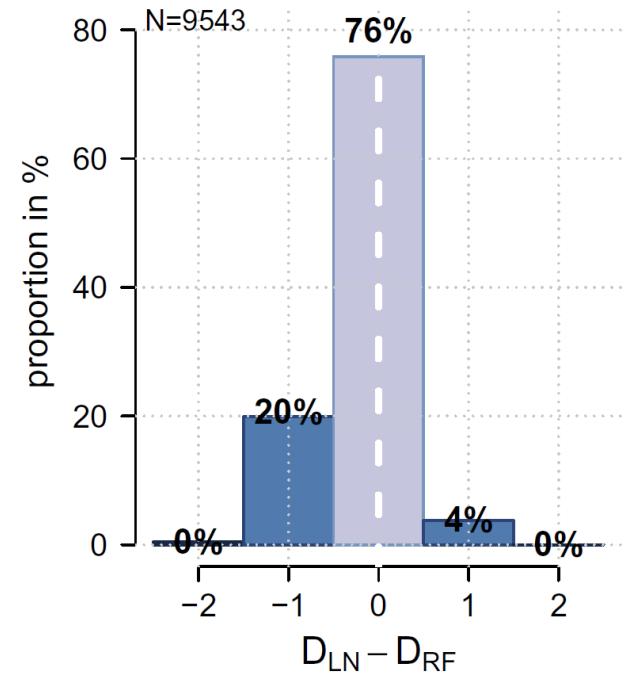
→ Patterns + Experience → Forecast: danger

Uncertainty ! → Verification ?



Avalanche forecasting

- Primary target variable: avalanche danger cannot easily be verified.
- Avalanche danger:
 - Snowpack stability
 - (Spatial) distribution of snowpack stability
 - Avalanche size

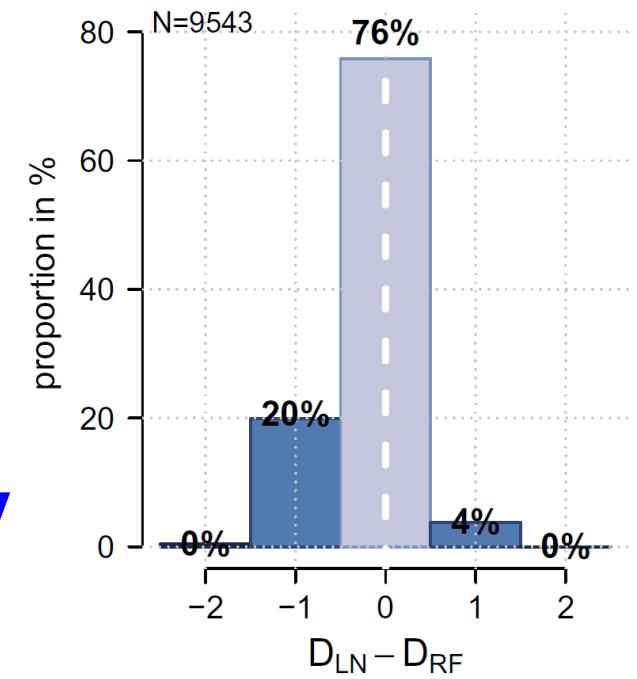
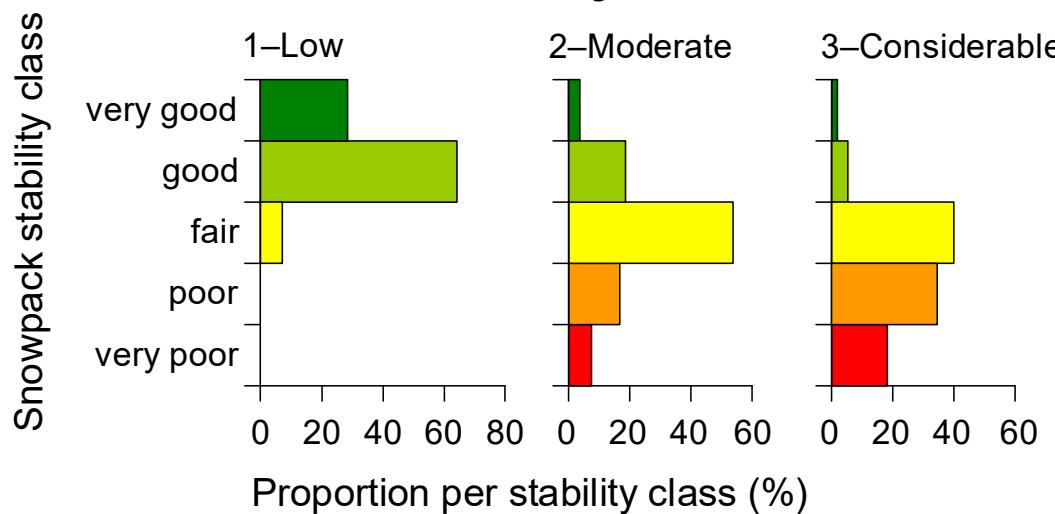


Avalanche forecasting

- Primary target variable: avalanche danger cannot easily be verified.
- Avalanche danger:
 - Snowpack stability
 - (Spatial) **distribution of snowpack stability**
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Photo: J. Schweizer



Teschel and Schweizer (2017)

Schweizer et al. (2003)

Distribution of snowpack stability

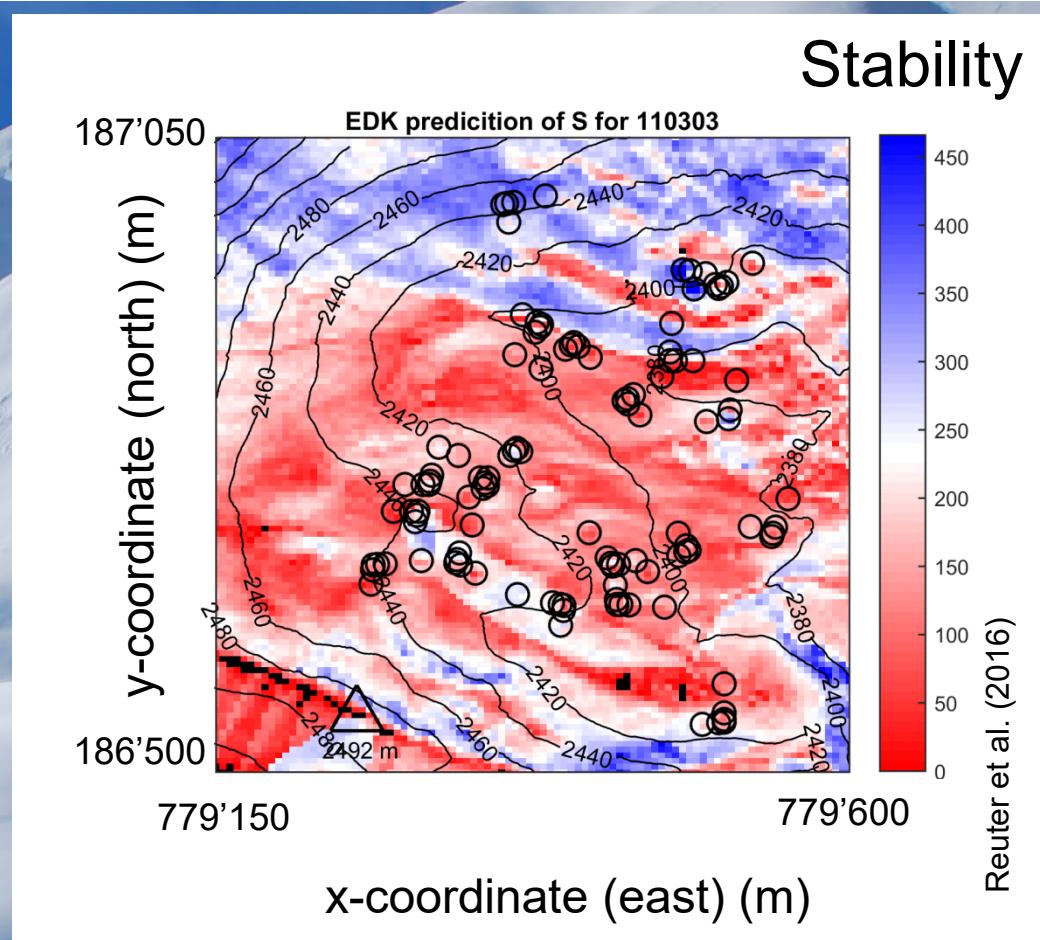
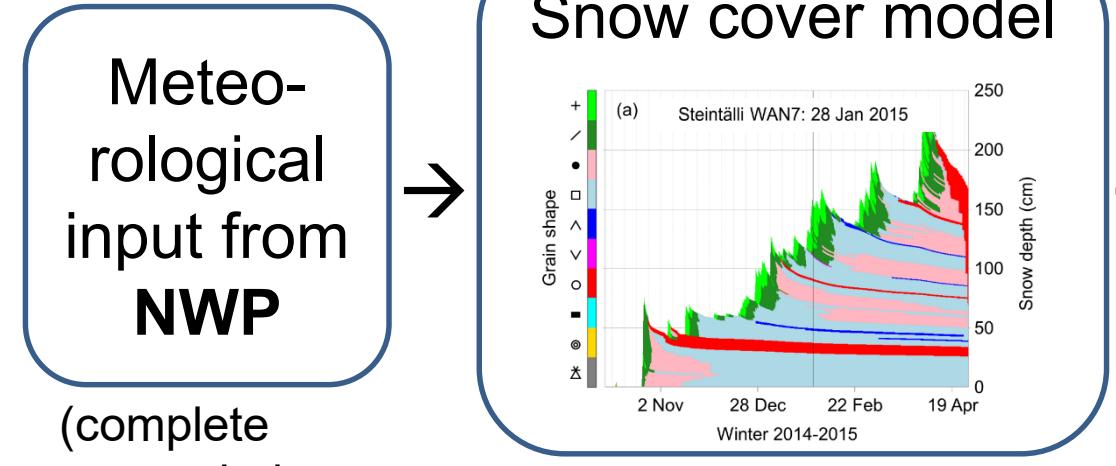


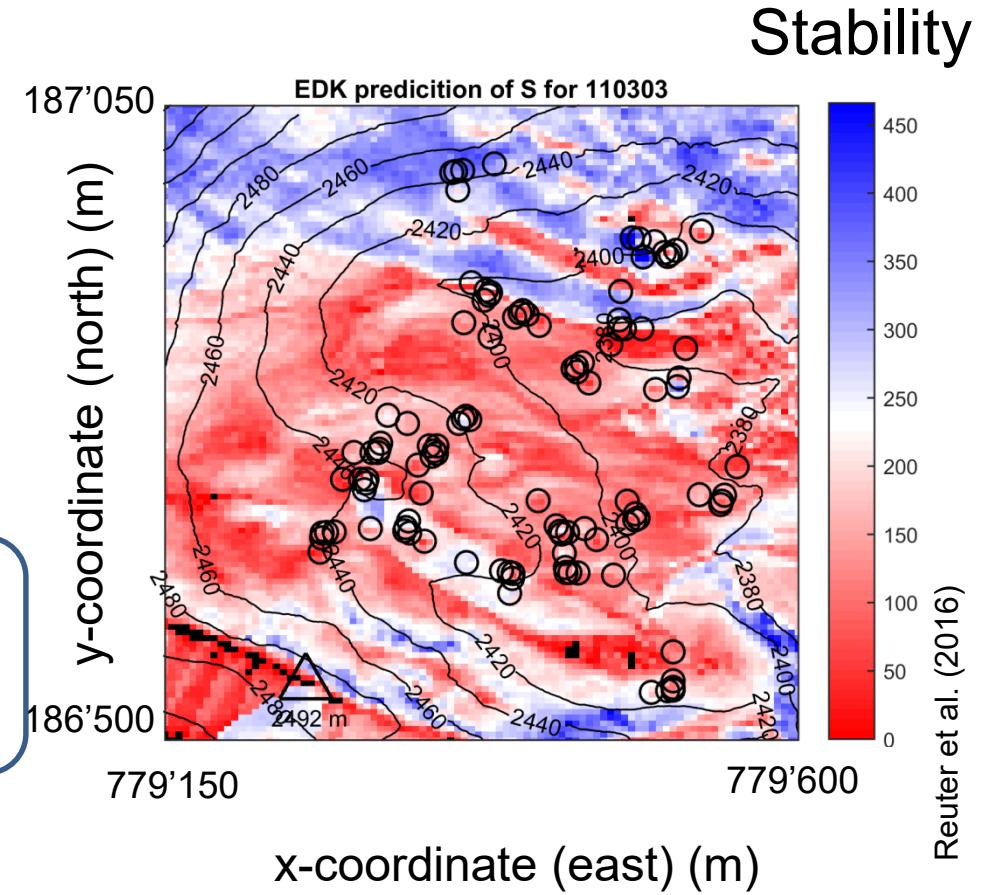
Photo: J. Schweizer

Improving avalanche forecasting

- Forecast of **snowpack stability** (+ spatial distribution) with at least 100 m resolution in complex terrain.

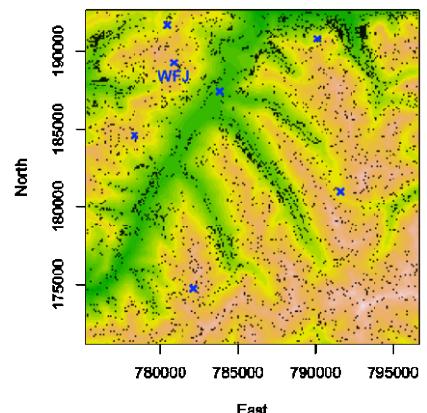


Stability prediction



Snowpack models

- Physically-based snowpack models operate at the point scale:
Crocus, SNOWPACK
- Currently implemented meteorological forcing configurations and associated geometry:
 - Station-based
 - Topographic class-based
 - Grid-based



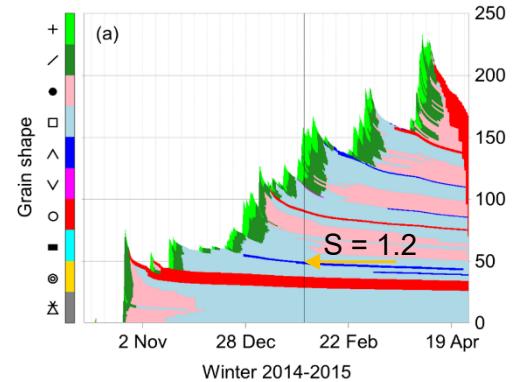
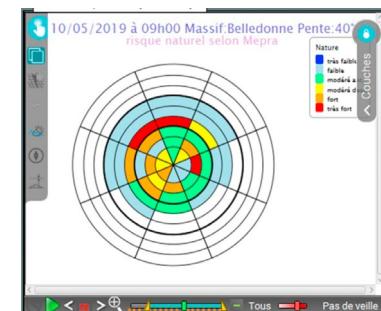
Elevation (m)

3300
3000
2700
2400
2100
1800
1500
1200

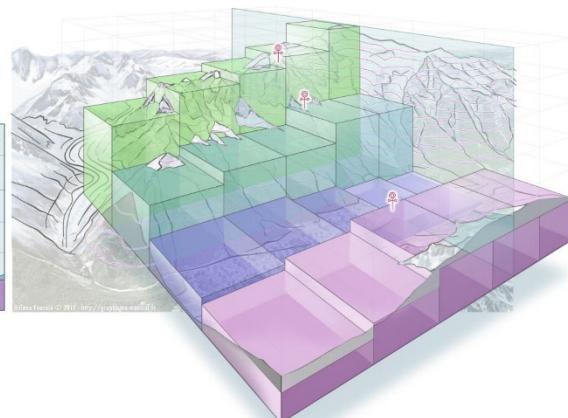
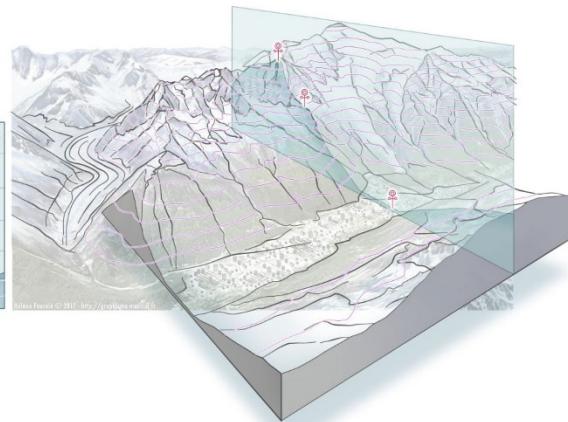
190000
185000
180000
175000

780000 785000 790000 795000

East



Winter 2014-2015



Bellaire et al. (2018)
Morin et al. (2020)
Schweizer et al. (2016)

Improving avalanche forecasting

Requirements and Challenges

Yes, of course, numerical forecasting is the future.

- Sound prediction of instability (and avalanches)
- NWP output downscaling and data assimilation
- Realistic snow distribution: snow transport by wind
- Operationalizing model chains
- Information post-processing and visualization
- Lack of validation possibilities

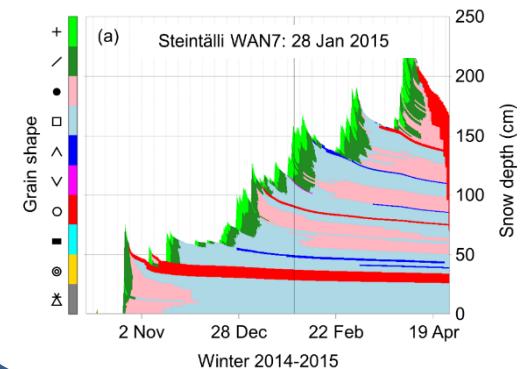
How to improve ?

- Better forecasts or better communication ?

Meteo-
rological
input from
NWP



Snow cover model



Stability
prediction

References

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