Are we consistent? On assessing and communicating the regional avalanche danger level across forecasting centres in Europe

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Abstract:

Avalanche danger levels are critical piece of information for backcountry recreationists and local authorities in their risk management processes, yet obtaining consistent information across the European Alps has been challenging. Consistency in both assessment and communication of avalanche conditions is crucial, as forecasting quality depends on clear, uniform hazard evaluations. Inconsistencies arise from various factors, including region size, language, and operational methods. Since 2018, the Euregio Avalanche Report, a collaborative effort between Tirol, South Tyrol, and Trentino, has provided a unified avalanche forecast across their administrative borders. This study examines how collaboration in the Euregio region impacts consistency of their assessment and communication products and compares these findings to other neighbouring forecasting centres.

We assessed consistency using Murphy's (1993) framework, focusing on spatial probability of agreement (P_{agree}) of the daily maximum danger level (DL_{max}) between neighbouring regions over several seasons. We compared avalanche danger levels across three data sets from Euregio, expanding the analysis to include Bavaria, Vorarlberg, Salzburg, and Carinthia. To facilitate communication, we also developed PyAvaCore, a Python-based tool that generates CAAMLv6-compliant JSON files for consistent communication of avalanche forecasts.

Data set	Forecasting center	Abbreviation	Seasons	N micro-regions	Size: median (min-max) in km^2
A	Tirol	TIR	2010-2011 until 2014-2015	12	980 (380 – 1920)
	South Tyrol	BOZ		11	650 (180 – 1110)
	Trentino	TRE		21	240 (120 – 540)
B	Tirol	TIR	2018-2019 until 2021-2022	29	350 (100 – 1500)
	South Tyrol	BOZ		20	290 (110 – 1100)
	Trentino	TRE		21	240 (120 – 540)
C	Tirol	TIR	2022-2023	36	330 (100 – 745)
	South Tyrol	BOZ		29	240 (70 – 670)
	Trentino	TRE		21	240 (120 – 540)

Table 1. Overview of the data sets used in this study.

P_{agree} values improved significantly in regions where micro-region sizes were reduced and forecasting methods were harmonized (Figure 1). Increases in consistency were particularly noticeable along the main divides of South Tyrol and Tirol. Regular training sessions and joint assessments also contributed to this improvement. However, differences in snow climate, such as those between western Trentino and the Adige Valley, continued to affect consistency. Additionally, P_{agree} values varied based on avalanche problems, with wind slabs and new snow problems showing better agreement than persistent weak layers or wet snow problems.

The PyAvaCore software enabled consistent communication of avalanche danger levels across 30 forecasting centres in Europe. The system was first implemented in 2022, and by 2023, it covered the entire European Alps. Examples can be seen on the websites of www.avalanches.org or www.avalanche.report. This innovation aligns with EAWS standards while allowing customization by individual centres, enhancing cross-border communication and public safety.

Collaboration among Euregio forecasting centres has improved spatial consistency in avalanche danger level assessments, especially after implementing recommended practices. However, differences due to snow climate and region size persist. The PyAvaCore tool has significantly advanced consistent communication of danger levels across Europe. Further collaboration with neighbouring centres could enhance coordination and communication across the entire Alps.
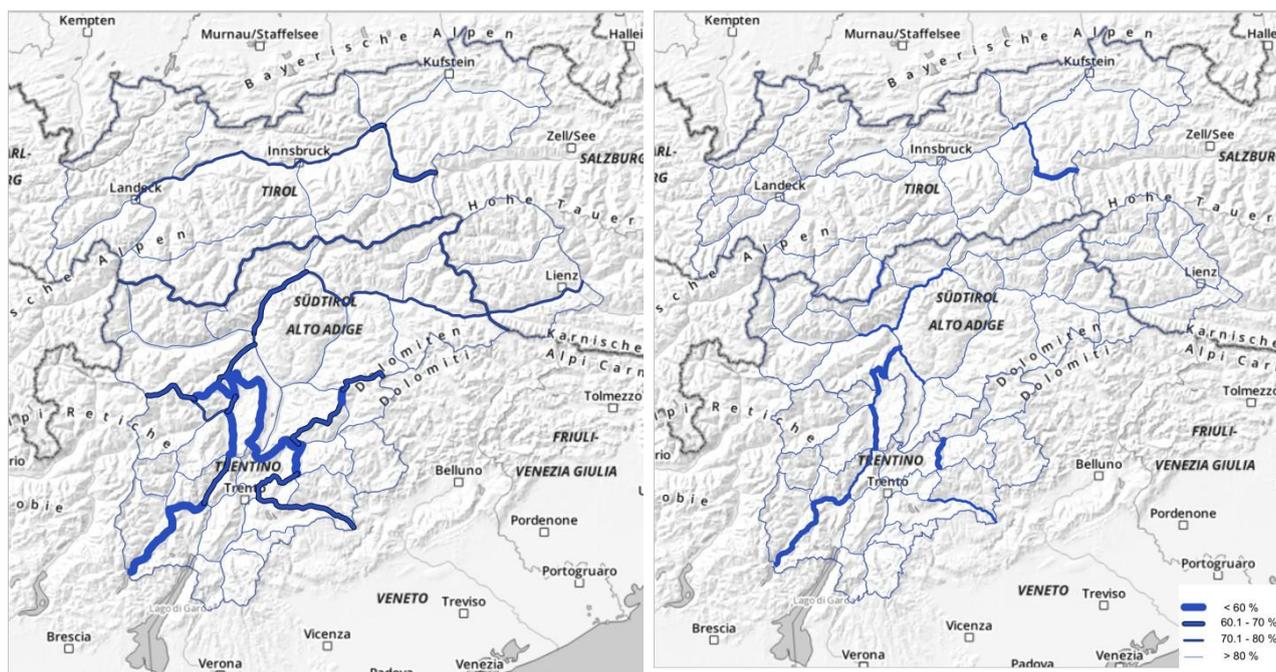

Figure 1. Comparison of P_{agree} for the three forecasting centers Tirol, South Tyrol and Trentino using data set A (cp. Table 1) on the left and data set B on the right. The thicker the blue line, the lower P_{agree} (see legend on lower right for more details).

Acknowledgements

References

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