



## Large-scale atmospheric flow conditions and sea surface temperatures associated with hazardous winter winds in Switzerland

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Strong winter storms are among the most destructive meteorological hazards in Switzerland. Hazardous winter winds in northern Switzerland since the late 19th century, identified in the Twentieth Century Reanalysis (20CR) dataset spanning 1871-present and in independent historic wind speed measurements, exhibited not only pronounced interannual variability but also statistically significant variability at decadal time scales (Welker and Martius 2013). The decadal variability has periods between about 36 and 47 years. The goal of the present study is to further our understanding of the large-scale atmospheric and sea surface temperature (SST) environment in the North Atlantic (NA) and European sectors that has contributed to the occurrence of hazardous winter winds in Switzerland. The analyses cover synoptic, interannual, and decadal time scales and are based on all ensemble members of the 20CR dataset. This work further includes a detailed analysis of the link between the hazardous winter wind variability in Switzerland and important NA and Eurasian teleconnection patterns.

On the synoptic time scale, the ten strongest wind events in Switzerland are examined; on longer time scales, the variability of the winter wind loss potential (WLP) in Switzerland is investigated. The WLP is a simple measure to quantify the local loss potential associated with high wind speeds (see Welker and Martius 2013 for details).

The present study finds that the ten strongest wind events in Switzerland were accompanied by an increased (decreased) surface cyclone frequency to the north (south) of Switzerland, and at upper-tropospheric levels by an eastward extension of the extratropical jet stream. The events were further associated with positive SST anomalies in the eastern NA and the Mediterranean, and positive anomalies of lower-tropospheric temperature and atmospheric moisture over Western/Central Europe.

On interannual time scales, the winter WLP variability in Switzerland was accompanied by a large-scale atmospheric and SST spatial pattern similar to a southeastward displacement of the winter North Atlantic Oscillation (NAO) pattern with a zonally oriented and eastward-extended jet.

The spatial pattern for the decadal-scale winter WLP variability, with periods between 36 and 47 years, is in general closer to the variability pattern of the winter NAO. At periodicities of 36-47 years the winter WLP variability in Switzerland was positively correlated with the winter NAO index variability, even though the strength and statistical significance of their co-variability varied over time. The correlations between the winter WLP in Switzerland and the winter NAO and East Atlantic pattern indices was positive for most of the period since 1950, and increased considerably with time. The distinct eastward shift of the northern node of the NAO during the winters at the end of the 20th century potentially explains the improved correlation between the winter NAO variability and the WLP.

Welker C, Martius O (2013) Decadal-scale variability in hazardous winds in northern Switzerland since end of the 19th century. *Atmos Sci Lett.* doi:10.1002/asl2.467