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Frost free season in Central Europe and its relationship with atmospheric circulation

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The length of frost free season is a very important factor in natural ecosystems as well as for human activities. The shifts in last spring and first fall freezes leading to increasing length of frost free period have already been detected in many European and non-European regions.

The aim of the study was to investigate the temporal and spatial variability of last spring and first autumn frost events as well as the length of the frost-free season in Central Europe in relation to atmospheric circulation. Studies were conducted for the period 1951–2015 using gridded, daily minimum air temperature data obtained from the E-OBS dataset at 0.25° spatial resolution. Late spring frost events and severe frost events were also examined with respect to the beginning of the thermal growing season. The role of atmospheric circulation was described using Grosswetterlagen circulation types and NAO index, and finally estimated using empirical orthogonal function analysis (EOF).

The results of this study confirm the warming of the climate in Central Europe via a statistically significant increase in minimum air temperature and a decreasing number of days with frost in most of the studied area as well as a clear trend towards an extension in the frost free season up to 10 days per decade in the western parts of Europe. The occurrence of first autumn frost shows no significant trend in most of the studied regions. Detailed analysis of circulation types favoring the occurrence of frost in Central Europe indicates that anti-cyclonic situations are mainly responsible. EOF analyses for the springtime confirm that the first mode, which accounts for 56% of total variance, is related to an extensive high pressure system over eastern Ukraine and Belarus, which brings an inflow of cold, continental air masses to Central Europe.

The relationship between atmospheric circulation and frost occurrence potentially provides an alternative approach to investigate past and future trends in frost risk under the assumption that only a small number of airflow patterns are associated with severe frost events and that changes in the frequency of these airflow patterns will result in changes in the risk of frost damage.