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Trend analysis of convective indices relevant for hail events in Germany

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Severe thunderstorms and associated extreme events such as hail represent a substantial hazard potential for buildings, crops, and critical infrastructure. In the last decades, damage caused by severe hailstorms has significantly increased in Central Europe. In the southwest of Germany, more than 40% of all damage to buildings by natural hazards is associated with large hail (1986-2008). In the light of global warming, the questions arise if the thunderstorm potential of the atmosphere already has changed and which changes will be expected in the future.
The purpose of this work is to investigate the probability of occurrence and the intensity of thunderstorm events by means of trend analysis of different atmospheric parameters that give information about atmospheric stability. At seven sounding stations in Germany (complemented by additional Central European stations) appropriate convective indices were statistically analyzed. By comparing hail loss data from a building insurance company with several convective indices, those parameters with the highest prediction skill for hail were identified. The evaluation with synoptic station data confirmed the temporal homogeneity of the sounding data. Accordingly, changes in the instrumentation of the sondes are not relevant for the trends.
First results show that the convective potential in atmosphere has changed significantly in the last decades. For a time period of 32 years (1978-2009), convective parameters considering near-surface values of temperature and moisture display mainly a trend towards higher convective potential (like CAPE$_{surface}$, LI$_{surface}$). On the other hand, most of the parameters computed from temperature and dew point at higher levels or mixed over the lowest 100 hPa show a decrease in the thunderstorm potential (Showalter-Index, CAPE$_{100hPa}$, LI$_{100hPa}$). The different trend directions can be explained by different trends in temperature and dew point at the various layers. While the temperature at all examined layers in the 12UTC soundings has been increased, the dew point at all stations show an increase only near the surface. At higher levels, only two stations revealed a significant increase in the dew point temperature.
By varying the time series (1957 until 2009) with respect to their start and end date, the stability of the linear trends and their significance was tested. It was found that most of the convective indices show a trend to more intense convection during the last two decades, whereas the change in the trend direction happens later in the north of Germany (mid-1990s) compared to the south (beginning 1990s).
Within the frame of in the project „Haris-CC“ (Hail risk and changing climate) it is planned to describe past hailstorms by a multi-dimensional parameter space of appropriate meteorological indicators (e.g., convective energy, moisture flux convergence, large-scale weather patterns), obtained from reanalysis-data and soundings. The methods will be transferred to an ensemble of high resolution regional climate model simulations. Future changes of the hail hazard will be projected from the current hazard and the climate change signal.