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Convection index as a tool for trend analysis of intense summer storms in Switzerland

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Convective summer thunderstorms are generally responsible for the most devastating floods in urban and small natural catchments. In this study we focus on the identification of the nature and magnitude of changes in the properties of intense summer storms of convective character in Switzerland in the last three decades. The study is based on precipitation records from the SwissMetNet (MeteoSwiss) network at 63 stations that cover altitudes ranging from 200 up to 3300 m a.s.l. over the period 1981-2012 (32 years). Additionally, the same stations also measure the number of lightning strikes within a range of 30 km from each station.

In an accompanying contribution we describe the method how intensive summer storms can be reliably selected out of all storms in long and high resolution precipitation time series. On the basis of the statistical distributions and dependence among key storm characteristics at the event scale (total rainfall depth R, storm duration D, and peak intensity I) and using high resolution lightning data as a surrogate we defined a threshold intensity I^* that differentiates between the events accompanied with lightning with an acceptably small probability of misclassification. This allowed us to identify intense summer events with convective character as those where $I > I^*$ regardless of their duration or total rainfall depth.

The current study makes use of the threshold intensity I^* for the definition of a seasonal convection index at each station (Llasat, 2001). This index gives us a measure of 'convectiveness', i.e. the total precipitation depth coming from convective storms relative to the total precipitation depth of all summer storms. We computed the convection index at all 63 stations and analyzed the series for trends. We found that the seasonal convection index increases at most of the stations in Switzerland and in approximately 20% of the cases this increase is statistically significant. This is likely a consequence of the fact that the number of summer storms exceeding the threshold I^* also shows an increasing tendency with a similar percentage of statistically significant changes.

Although our analysis indicates an increasing tendency in the intensity and frequency of summer storms with convective character in Switzerland, it is not yet clear whether these can be traced to causal factors such as atmospheric warming, etc. This remains an open research question.