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Identification of thunderstorms in reanalysis data and development of a statistical convective initiation model

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A proxy parameter for the occurrence of electrified convection was developed as a function of several parameters derived from reanalysis data. The objective was to identify relevant factors beyond instability and convective inhibition to increase the understanding of the conditions under which thunderstorms form.
Storms may not occur even though the atmosphere is in an area of CAPE/shear space that would support severe storms once initiated. Hence, convective initiation should be accounted for explicitly. Conceptually, the probability of a severe storm P(severe_storm) can be split into two separate factors, namely the probability that a storm forms and its conditional probability of becoming severe:

$$P(\text{severe\_storm}) = P(\text{storm\_initiation}) \times P(\text{severe\_storm}|\text{storm\_initiation})$$

The main goal of this study is to find an optimized function for P(storm_initiation) in order to improve P(severe_storm). To pursue this aim several parameters related to instability, moisture or shear were calculated in Central Europe in the time period 2008-2013 from the ERA-Interim global atmospheric reanalysis. The relation between these parameters and the lightning occurrence is investigated, using data from the EUropean Cooperation for LIghtning Detection (EUCLID).

For convective initiation it shows that sufficient CAPE is crucial while dry mid-level air severely suppresses CI. In the underlying data CI depends more on relative humidity between 850 hPa and 500 hPa than on CIN given sufficient CAPE. A subtle dependency on wind shear was found in which two regimes favor thunderstorm formation. The frequency of lightning was higher for very weak and for high values than for intermediate values of both deep-layer and low-level shear.

The function for P(storm_initiation) for the above parameters was computed statistically using a generalized additive model for big datasets. Further the same calculation has been carried out for P(severe_storm|storm_initiation) for severe weather phenomena. Eventually both were combined to a statistical convective initiation model P(severe_storm).