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Comparison of satellite-, lightning- and radar observations in some severe thunderstorm cases

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Various types of severe storms (supercell- as well as multicell types; tornado, large hail or flashflood producing convective events) were examined in a relative coordinate system, moving with the propagating storm. We studied the spatial and temporal distribution of lightnings and compared them with time-averaged radar reflectivity data (CAPPI and column maximum reflectivity) and with radial Doppler velocity measurements. We also used parameters to identify the position of Weak Echo Regions (WER), possibly related to strong updrafts. These products were superimposed with information from satellite data (showing the position of overshooting tops, cold-rings, ice plumes).

One of the most notable cases was the supercell storm, which occurred on 9 June 2012 over southern Hungary, causing large hail. Shortly after its formation, there was a significant increase of flash rate, which correlated with the course of the estimated mean relative vorticity and intensification of the mesocyclonic rotation. At the same time, the brightness temperature of the overshooting tops reached its minimum. The temporal evolution of other parameters, like maximum brightness temperature of the cold ring, or column maximum reflectivity showed less correlation with lightning characteristics. Most of the recorded lightnings were situated in area of high radar reflectivity at low- and mid-tropospheric levels. We found that the ice plume also started to propagate above this region.

We also studied the environment of the storms using stability parameters calculated from both NWP and satellite data (Global Instability Indices, GII). We focused on parameters that could eventually relate to evolution of hail, ice (graupel) in the storms and could characterize the potential for intense lightning activity. Such parameters were the Total Precipitable Water (TPW), CAPE, heights of certain significant isotherms, etc. The parameters were calculated upon data from both SEVIRI and IASI instruments.

It was concluded that the sudden increase in the total lighting number can be a feature, which is related to storm's severity, presence of a mesocyclone or of strong updrafts. It could eventually help to distinguish the severe weather producing storms from the ones with ordinary structure and intensity. In the future, the methods tested during this study might be applied on bigger sample of various remote-sensing data, related to both severe- and ordinary thunderstorms.