First comparison of measurements of Ka-band cloud radar with lightning at the Milešovka Mt. (Central Europe)

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1/ Motivation

The Milešovka observatory is a unique meteorological observatory situated on the highest top of Central Bohemian Uplands in Central Europe (Figure 1) with continuous measurements since 1905. The observatory is suitable for atmospheric research due to a 360° view and an absence of high obstacles in the surroundings.

Besides standard meteorological instruments, the observatory is newly equipped with a Ka-band vertically pointing cloud Doppler radar (MIRA35c), disdrometer (Thies Laser Precipitation Monitor), ceilometer (Vaisala CL51), and atmospheric electric field monitor (Boltek Electric Field Monitor EFM-100).

In this contribution, we compare measurements of the above-given instruments with lightning data from Siemens lightning database (BLIDS) during 11 convective events in summer 2018 that occurred in the vicinity of the Milešovka Mt.

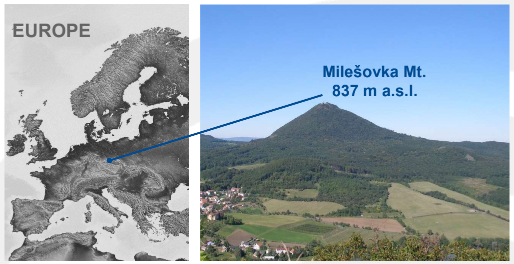


Fig. 1 Geographical location of the Milešovka observatory at the Milešovka Mountain (Central Europe)

2/ Summer events in 2018

We studied 11 convective precipitation events that are prone to lightning and were observed in summer (June-August) 2018 at the Milešovka observatory by our cloud radar. Only few precipitation cases occurred in summer 2018 in the vicinity of Milešovka Mt. due to an unusually dry and sunny summer in Central Europe. The majority of the events was associated with lightning activity, which was detected by our electric field monitor as well as the BLIDS lightning network of ground-based measurements.

Sokol Z, Minářová J, Novák P. 2018. Classification of Hydrometeors Using Measurements of the Ka-Band Cloud Radar Installed at the Milešovka Mountain (Central Europe). *Remote Sensing* **10**(11): 1674. DOI: 10.3390/rs10111674.

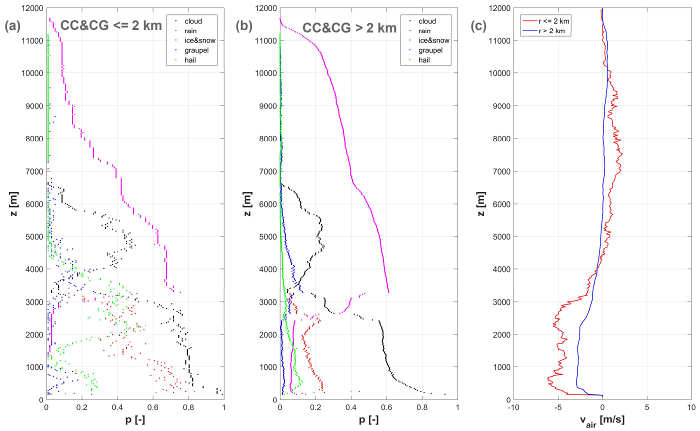
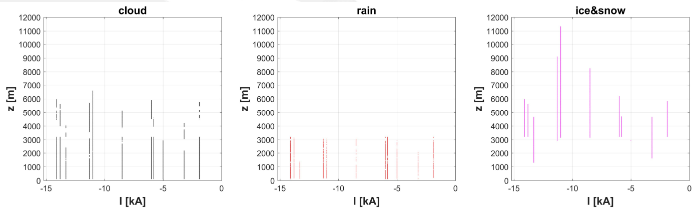


Fig. 2 Vertical profile [m] of (a, b) occurrence probability of hydrometeors and (c) mean vertical air velocity [m/s] during 11 convective events, when BLIDS recorded CC & CG flashes (a; red curve in c) up to 2 km and (b; blue curve in c) 2-20 km from the Milešovka Mt. in summer 2018.



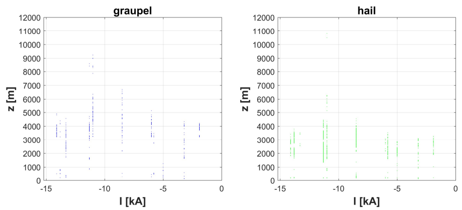


Fig. 3 Vertical profile [m] of hydrometeors during CG flashes of I [kA] peak current recorded up to 2 km from the Milešovka Mt. by the lightning detection network BLIDS. Note that all the CGs were negative.

3/ Methodology

Using cloud radar measurements, we derived spectral moments and applied the algorithms developed by Sokol et al. (2018) to calculate vertical air velocity (v_{air}) and to identify hydrometeors. We distinguish hydrometeors based on their terminal velocity within three temperature ranges. Although we consider cloud, ice, snow, graupel, rain, and hail, we combined ice with snow, as suggested in Sokol et al. (2018).

We reduced the BLIDS dataset of lightning to lightning discharges recorded up to 1, 1.5. 2, 2.5, 3, 5, 7, 10, 15, and 20 km from the Milešovka Mt. during the 11 selected events and we looked for possible relations among occurrence of diverse hydrometeors, v_{air}, distance of lightning from the Milešovka Mt. and lightning peak current, polarity, and type (CG/CC). Moreover, we compared the lightning distance from the Milešovka Mt. with the changes of vertical electric field using the data of the electric field monitor. We also used the disdrometer measurements to compute the intensity of hydrometeors during the events; the disdrometer identifies similar kinds of hydrometeors as in Sokol et al. (2018).

4/ Results

Fig. 2 and 3 show the vertical profile of the five identified hydrometeors from cloud radar data (2 s time step) during the 11 convective events, when the lightning was observed up to 2 km or 2-20 km from the Milešovka Mt. by BLIDS. Fig. 2 shows the results irrespective of the lightning type, while Fig. 3 depicts the results for CG flashes only.

It is obvious from Fig. 2 that the probability of hail is higher for flashes that occurred close to Milešovka Mt.; especially in the altitudes up to 1 km and from 2 to 3.5 km. The occurrence of rain is also much higher for close by lightning. Fig. 3 shows that all the CG flashes were of negative peak current during the events, which agrees with the general knowledge that negative CGs are more frequent than positive CGs.

Fig. 4 displays the derived intensity of hydrometeors on Aug 8, 2018, based on disdrometer measurements that are at 1-min time step, thus we cannot compare it with the cloud radar data directly. Fig. 4 also depicts changes of vertical electric field Ez (based on data of electric field monitor), which indicates lightning, and flashes as recorded by BLIDS up to 10 km from Milešovka Mt. However, we did not identify any strong dependence of lightning distance on changes of Ez.

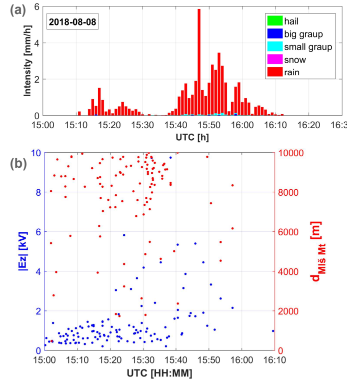


Fig. 4 Event on Aug 8, 2018: (a) Intensity of hydrometeors based on disdrometer data; (b) Changes in electric field based on data of electric field monitor and flashes recorded up to 10 km from the Milešovka Mt. by BLIDS.

We owe great thanks to BLIDS for providing lightning data during the 11 studied events.

5/ Summary & Future plans

Comparison of diverse data sources provides an interesting insight in storm events. However, further investigation is needed.

We plan to study 7 more events from summer 2018 when BLIDS recorded lightning up to 20 km from Milešovka Mt. We will also run the COSMO NWP model during the events to compute Lightning Potential Index and our developed Cloud Electrification and Lightning Model that explicitly describes the processes.

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