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Convective growth and glaciation with Meteosat in relation to precipitation formation

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The limited understanding of dynamical and microphysical processes in developing deep convective clouds and their observable signatures poses a significant challenge for weather and climate research. Aiming to improve our current knowledge, we present satellite-based growth and glaciation characteristics for a broad collection of convective storms over Central Europe. The changing cloud-top properties are furthermore related to the onset and magnitude of radar-based surface precipitation. Based on this, we analyze the storm composite behavior and discuss implications for satellite-based nowcasting methods and for the evaluation of convective-scale weather simulations. For the majority of developing storms, convective growth spans a period of approximately half an hour. Glaciation rate indicators suggest that freezing 15 min prior to the maximum cooling plays an important role in invigorating convective updrafts through the release of latent heat. Smaller ice particles are found for larger cloud-top cooling, which provides observational evidence that ice particles form later and have less time to grow in stronger convective updrafts. Furthermore, maximum cloud-top height, anvil expansion rate, maximum precipitation intensity and core size are found to be positively correlated. With respect to the onset of precipitation, our analysis shows a high probability that significant precipitation already occurs 30 min prior to maximum cloud-top cooling.