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On the effects of the cloud vertical structure on lightning production

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This work aims to study the role of the ice phase in the mechanism of cloud electrification and lightning formation. Despite thundercloud charge structure has been known since 1920, when C.T.R. Wilson measured Earth's electric field, the mechanisms responsible for the separation of charge regions and then for lightning are still uncertain. Over the various assumptions, the non inductive ice-ice interaction is one of the most accepted. This process requires the presence of large ice hydrometeors (i.e. graupel or hail pellets) that collide with ice crystals in a suspension of supercooled water droplets.
We used data from LINET, a VLF/LF lightning detection network, in relation to reflectivity, IWC and ice effective radius from Cloud Profiling Radar (CPR), a 94 GHz radar on Cloudsat, a polar satellite of the NASA Earth System Science Pathfinder (ESSP) program. LINET has been developed at the University of Munich in 2006 and consists of more than 90 sensors over 17 countries. The good sensitivity of the antenna, which detects signals smaller than 5kA, attributes a total lightning quality to the network, while the Time Of Arrival (TOA) method allows the network to distinguish between IC and CG. The Cloudsat unique capability is to measure, for the first time, the cloud vertical structure in order to improve the microphysical characterization. In particular, it makes possible to individuate different cloud regions depending on the different values of IWC and effective radius.
Lightning data from one year and a half have been superimposed on the images of the corresponding cloud reflectivity data. A severe storm over Padua (eastern Po Valley) has been selected out of convective cases for detailed case study. The relationship between the higher flash rate areas and cloud microphysics has showed two different regions inside the cloud: one of them localized at altitudes around 10 km, characterized by high IWC values therefore a large number of ice crystals, and the other 7 km high, in which we found the higher effective radius values, that indicate the presence of large hydrometeors (hail and graupel), then confirming the hypothesis of the dipole cloud structure and the effectiveness of the non inductive mechanism.