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Estimations for charge distributions in thunderclouds using the VHF broadband digital interferometer

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Electrifications in thunderclouds are occurred by collisions between graupel particles and ice crystals. Strong electrifications produce lightning discharges. It is also considered that there are causal associations between the leader progressions and the charge distributions in thunderclouds. The typical thundercloud charge structure is approximated by three vertical charge regions which are composed of main positive at the top, main negative in the middle and lower positive at the bottom. Recent in situ measurements suggest that the charge structures in thunderclouds are not so simple. Ground-based electric field measurements and balloon measurements have been conducted traditionally for understanding of charge distributions in thunderclouds. However, the detection efficiency of electric field mesurements is not so good. Meanwhile balloon measurements have small observational range. The wide range observations for charge distributions with high accuracy are required. Recently, VHF-UHF lightning mapping systems have made it possible to obtain images of in-cloud lightning channels. It is known that VHF impulses are mainly radiated from the tip of negative breakdowns like at the negative stepped leader. From this aspect it is noticed that the VHF impulse source location during leader developing phase is equivalent to the imaging of the leader progression. Lightning Research Group of Osaka University (LRG-OU) has been developing the VHF broadband digital interferometer (DITF) that leads us to visualize the lightning channels by localizing the VHF radiation sources since 1995. The ultra-wide detection frequency makes it possible that the images of lightning channels are visualized with a high accuracy. In addition, since negative breakdowns progress toward positive charge region, their source location gives the positive charge distribution. It is also considered that the negative breakdowns initiate from near negative charge regions. In other words, the VHF broadband DITF do not only visualize negative breakdown progressions but also give information on charge distribution inside thunderclouds. We estimate for charge distributions in thunderclouds using the VHF broadband DITFs with a slow antenna. We discuss the time series variation of the charge structures.

Keywords: Lightning, Thundercloud, Charge distribution