Characteristics of Downburst Occurrences Derived from Ground-based Lightning and Meteorological Observations

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A prediction of the downburst occurrence using the existing meteorological observation networks is very difficult because the typical spatial and temporal scale size of downbursts are ~1.8 km and a few minutes, respectively. Once a downburst occurs in a metropolis, various infrastructures suffer huge damage. For this reason, a prediction of the downburst occurrence based on other observation methods is desired. At the convection cell accompanied by a downburst, active lightning activities are confirmed in many cases. In addition to this, we expect that not only the lightning occurrence number but also the charge amount neutralized by lightning discharges may be related to the vertical convection intensities in thunderclouds. So, the purpose of this study is (1) to develop a new method to estimate charge amounts neutralized by lightning discharges, (2) to clarify the relation between lightning activities and downburst occurrences, and (3) to identify the characteristics of downburst occurrences that can be used for the prediction of the downburst occurrence. As a first step, we have analyzed ELF data obtained at Onagawa and Kuju stations and compared ELF waveforms with the lightning current waveforms measured by the Rogowski coil at Mt. Ogami, Niigata. It is found that the cross correlation coefficient between these two waveforms became 0.80, which implies that the dominant component of the observed ELF waves is not the radiative but induction magnetic fields. We further estimated an empirical equation to calculate the charge amounts neutralized by lightning discharges (Q) from the time-integrated ELF magnetic field amplitude (ΣB). Using this empirical equation, it is first possible to estimate charge amounts of any lightning discharges occurred within ~1000 km distance from the observation site. As a next step, we analyzed 8 downburst events occurred in 2015 in Japan using ELF data, JLDN (Japan Lightning Detection Network) data, meteorological (C-band radar, AMEDAS) data provided by JMA, and POTEKA data provided by Meisei Electric Co., Ltd. It is found that the occurrence number of −CG discharges and the lightning charge amounts reached their peak just before/after the occurrence of the downburst in many cases and that the temporal variation of the lightning charge amounts is comparable to that of rain volumes. Thus, we can deduce that these characteristics of lightning activities are the good proxy for the prediction of the downburst occurrence. At the presentation, we will show the relation between ELF waveforms and lightning current waveforms and the results of lightning and meteorological data analyses in the downburst events in detail.

Keywords: lightning, downburst, prediction

