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The aerosol and Convective Available Potential Energy (CAPE) effects on lightning activities over Pearl River Delta (PRD), South China

Menghui Wang
Department of Earth System Science, Tsinghua University, Beijing, China (menghuiw@foxmail.com)

Research on lightning activities is mainly based on the aerosol hypothesis and thermal hypothesis. Although Aerosol Optical Depth (AOD) and Convective Available Potential Energy (CAPE) are widely used as the main proxies of aerosol hypothesis and thermal hypothesis respectively, the complex effects, particularly indirect effects on lightning activities from both of them are poorly measured quantitatively.

This study analyses the trend of Flash Rate (FR), AOD, and CAPE over the tropical coastal region-Pearl River Delta (PRD) (22.5°N-25°N; 112.5°E-115°E), South China during 2000-2013. From 168-month total time series, all the three factors have a regular variation by annual cycle. From mean monthly data, FR is a unipolar trend with maximum 0.0695 flashes km-2 day-1 on June, and CAPE also appears a unipolar change with maximum 1014 J kg-1 on August, however, AOD shows a bipolar change on March and October with maximum 0.8850 and 0.5508, respectively. Based on the multi-year trend, three factors (FR, CAPE, AOD) all generally appear a slight increase per year (0.2161 flashes km-2 year-1; 2607 J kg-1; 5.625).

Furthermore, by employing the path analysis method, we get the direct effect from CAPE (AOD) on lightning activities, and the indirect effect from CAPE (AOD) on lightning activities through AOD (CAPE) over different temporal scales. From 168-month total time series, the direct effect from CAPE (AOD) is 0.8641 (0.2088), and the indirect effect from CAPE (AOD) by AOD (CAPE) is -0.0691 (-0.2859). The effects on other temporal scales are also given. Finally, we explain the effects on lightning activities from aerosol and CAPE climatologically.

Our results are highly related to the analysis of lightning activities based on the aerosol hypothesis and thermal hypothesis.