ANALYSIS OF THE TLS200 NETWORK DEPLOYED DURING THE CHUVA CAMPAIGN IN BRAZIL

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Abstract: The CHUVA campaign was held in the vicinity of São Luiz do Paraitinga, Brazil from October 2011 to March 2012. One of the objectives of the CHUVA lightning mapping campaign was to perform measurements of total lightning activity, map lightning channels, and characterize in detail the lightning discharges in the region. Vaisala installed a five sensor network consisting of its TLS200 Total Lightning Sensor which combines very high frequency (VHF) interferometry with low frequency (LF) magnetic direction finding and time-of-arrival technologies. The network operated from January through March 2012 and detected total lightning activity over a region with a radius of approximately 100 km around São Paulo. During this period several severe thunderstorms occurred in the region. The TLS200 network detected a total of 294810 cloud-to-ground flashes in January through March, 2012. A larger number of cloud-to-ground flashes occurred during February than in January and March. Various characteristics of the lightning activity, including cloud-to-ground flash density, peak current distribution, and the ratio of cloud and cloud-to-ground discharges, were examined. Our analysis also illustrates the cloud lightning mapping capability of the VHF part of the TLS200 sensor.

Cloud lightning detection performance of a lightning locating system is inherently difficult to quantify. Cloud lightning flashes or ICs may last from several hundred milliseconds to about a second. They may have several vertical and horizontal branches that can extend several kilometers or more spatially. The electromagnetic radiation field signature of an IC flash measured at distances of several tens of kilometers or more typically consists of a few tens to hundreds of electromagnetic field pulses spread over the entire duration of the flash. Typically, pulses in cloud discharges have amplitudes that are smaller than that of first return strokes in cloud-to-ground discharges. Cloud flash detection efficiency is defined as the percentage of the total number of IC flashes occurring in a certain period of time over a certain geographical area that are detected by a network. An IC flash is said to be "detected" if at least one pulse in the flash is detected and reported by the network. Similarly, cloud pulse detection efficiency is defined as the percentage of the total number of pulses in all cloud flashes (again, in a certain period of time over a certain geographical area) that are detected and reported by the network. However, obtaining a ground-truth estimate of the total number of cloud pulses is not practical due to the range of pulse amplitudes, and it is much more error prone than obtaining a ground-truth estimate of the total number of cloud flashes. Hence cloud flash detection efficiency of a lightning detection network is the only practical statistic. To improve cloud flash detection efficiency, an increase in sensor sensitivity (that is, higher gain and/or lower threshold) is required due to the tendency of cloud pulses to have lower amplitudes than return strokes. Cloud lightning detection at LF, where fewer sensors can be used to cover a given area, is considered to have growing importance. Given this, our objective is to quantify the cloud lightning detection capabilities of the TLS200 network deployed in CHUVA, particularly flash detection efficiency and spatial mapping capability at LF and VHF, respectively.