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Comparison of LF and VHF lightning detection methods for thunderstorm warning and nowcasting applications

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One of the primary meteorological uses of information from lightning location systems (LLS) is warning of impending cloud-to-ground (CG) lightning at a point of interest. In this paper we compare and contrast the strengths and weaknesses of LLS systems that operate in the low-frequency (LF) and very-high-frequency (VHF) frequency ranges when used for this warning application.

Cloud lightning information is a key element of a CG warning system, both for storm onset (arrival) and secession (departure). Cloud lightning flashes are detected most efficiently using VHF line-of-sight lightning detection systems that typically cover an area of 10^5-10^6 square km. These networks, employing either time-of-arrival or interferometric techniques, can detect over 90% of all cloud and CG lightning flashes. The total horizontal extent of flashes can be mapped in detail with VHF systems, and some of the vertical channel is also described. However, such VHF systems are limited in areal coverage by the requirement that the source be within line of sight of several sensors.

By contrast, low frequency (LF) systems do not require line-of-sight. However, LF systems detect almost exclusively the vertical channels associated with a cloud flash which are typically located near the initiation point of the flashes, close to the convective cores. Moreover, cloud flash signals are typically much weaker in intensity than return strokes in CG flashes in the LF band, requiring closely-spaced sensors in order to produce high cloud flash detection efficiency.

In this paper we present an overview of the LF and VHF detection methods, and illus-

trate the spatial and temporal representation of flashes and storms provided by each method. We also compare the performance (failure-to-warn, false-alarm, and warning duration) of each system for early warning, secession and warning duration. This study employs data acquired in the south-central U.S. The analysis set includes data obtained by two VHF lightning mapping networks, the U.S. National Lightning Detection Network, and a small short-baseline LF research network.