VAISALA / APPLICATION NOTE

TLS200 Enables Breakthrough in Lightning Safety at Airports

Over a decade of lightning research conducted at universities, meteorological services/institutes, and Vaisala has shown that all areas where cloud lightning is overhead are at risk for cloud-to-ground (CG) lightning. The only effective way to capture the full CG lightning threat is with VHF (very high frequency) total lightning mapping provided by Vaisala TLS200 technology.

Advantages of Cloud Lightning Detection with VHF Technology

CG lightning emits the highest amplitude pulses in the LF (low frequency) to VLF (very low frequency) range due to a large amount of current traveling over long distances. In contrast, cloud lightning results in short-range discharges with weaker current, producing small VLF/LF/HF pulses near the origination of the cloud flash but larger VHF pulses throughout all of the branches of the cloud flash. Since the overall electrification and lightning discharge process involves many electrical events, single origination points detected in the VLF/LF/HF range are not at all representative of the true spatial extent of the lightning threat.

Figure 1 shows a typical example of cloud flash detection at VHF and VLF/LF/HF frequencies. The blue dots show VHF cloud lightning mapping and the red dots show VLF/LF/HF cloud lightning detection. The VLF/LF/HF cloud flash representation is missing >90% of the branching areas shown at VHF. In addition, since the VLF/LF/HF cloud pulses are small in amplitude, VLF/LF/HF cloud lightning detection networks produced by all commercial lightning vendors typically only detect ≤50% of all cloud lightning flashes. In contrast, the larger VHF pulses allow >90% cloud flash detection efficiency for VHF lightning detection networks with little-to-no fluctuations in detection efficiency.

Lightning Mapping Enables Improved Storm Detection and Protection

TLS200 cloud lightning mapping provides a much more comprehensive picture of the lightning threat through all phases of thunderstorm activity, from growth and development through to maturity and decay. This feature includes a clear picture of the full electrification of the thunderstorm cloud, including the potentially dangerous anvil and stratiform areas later in the storm life cycle. Anvil and stratiform cloud flashes routinely travel distances of 25 to 100+ km as only observed using VHF detection technology **(Fig. 2)**.

Consider the most frequent situation of a thunderstorm approaching an airport (occurs ~70-90% of the time). VHF cloud lightning mapping provides 10s of minutes of lead time before the first cloud-to-ground strokes approach the fixed asset. During the 2007/2008 North American Monsoon seasons, Vaisala analyzed the arrival times of (1) VHF total lightning mapping, (2) VLF/LF cloud lightning detection, and (3) CG lightning for 29 thunderstorms directly affecting Tucson International Airport. VHF cloud lightning mapping data arrived at the airport with a mean (median) lead time of 25 (19) minutes before the first CG stroke arrived at the airport. VLF/LF cloud lightning data provided no lead time with a mean (median) lead time of 2.1 (0) minutes late. The VHF cloud lightning lead time was provided by anvil and stratiform mapping. By comparison, the cloud flash origination points detected at VLF/LF are located in the same convective core areas as the CG strokes and therefore provide little-to-no advanced warning.

At times, there also may be a situation where a thunderstorm develops directly over the airport. For this infrequent situation (occurs ~10-30% of the time), better than 90% cloud flash detection efficiency at VHF maximizes the lead time during the growth phase of a thunderstorm because cloud flashes usually precede CG lightning strokes. VLF/LF/HF cloud lightning detection networks only detect ≤50% of all cloud lightning flashes, at best, and therefore miss cloud flashes that could maximize lead time before the first CG stroke in a thunderstorm.

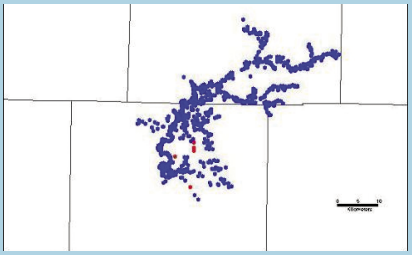

Figure 1. *Cloud lightning flash detected in the Dallas-Fort Worth area of Texas, USA. The blue dots show VHF cloud lightning mapping and the red dots show VLF/LF cloud lightning detection. The total length of this cloud flash as shown by VHF cloud lightning mapping is ~50 km*

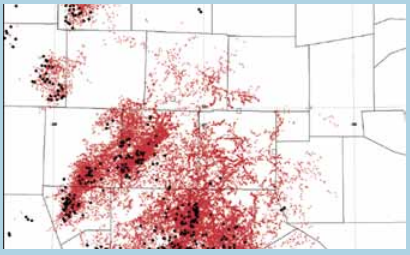

Figure 2*. Map of VHF total lightning mapping in red and VLF/LF cloud pulses in black in north Texas for a 15-minute period. Note the large area of anvil lightning reaching northward from the center of the storm on the south side of the map.*