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Abstract

Total Lightning: What It Is and the Operational Impacts

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Operational lightning detection has been most well-known through the National Lightning Detection Network (NLDN). Complementing these observations are the various long-ranged networks, such as the GLD360 and World Wide Lightning Location Network (WWLLN). These networks share two major characteristics; they are ground-based and predominantly observe cloud-to-ground lightning strikes only. These data have been extremely useful in monitoring convection, investigating fire hot spots, and supplementing observations in data sparse regions, particularly with the long-ranged networks. However, cloud-to-ground observations are only a part of the picture as the vast majority of lightning are intra-cloud flashes. Being able to observe both cloud-to-ground and intra-cloud flashes, or total lightning, provides numerous operational benefits.

The operational use of total lightning began in the mid-1990s at the Melbourne, Florida Weather Forecast Office (WFO) with access to the Kennedy Space Center's Lightning Detection and Ranging (LDAR) network. Since then, total lightning has been brought to nearly two dozen operational groups due to collaborative efforts of several ground-based, but short-ranged lightning mapping arrays. These efforts are concurrent with NOAA's purchase of the Earth Networks Total Lightning Network. At its most basic, total lightning provides insight into the strength of active convection. Total lightning production is related (nonlinearly) to the strength of a thunderstorm's updraft. Therefore, as a thunderstorm's updraft strengthens, the total lightning count will increase. This has been used for the most recognized use of total lightning; lightning jumps, which was initially developed at the University of Alabama in Huntsville. While lightning jumps will not indicate the type of severe weather, they serve as a "heads-up" to operational forecasters that a storm is rapidly strengthening and likely to become severe. However, total lightning is capable of providing far more information. With a temporal update less than current Doppler radar volume scans, total lightning is an excellent warning decision support tool to see how storms continue to evolve on a minute-to-minute basis. Additionally, total lightning provides the spatial extent of lightning discharges and the intra-cloud component often precedes the initial cloud-to-ground strike. Each characteristic may greatly enhance lightning safety. Furthermore, the aviation community is investigating these data to help monitor developing convection to aid with flight track status as well as inferring potential turbulence.

Currently, all of this has been done through the short-ranged lightning mapping arrays (LMA). However, GOES-R will bring the Geostationary Lightning Mapper (GLM). While it has a lower spatial resolution (8 km at nadir), the tradeoff is a massive field of view. With nearly a full disc field of view and rapid temporal updates, the GLM will provide total lightning with uniform detection efficiency on a scale not feasible with the current ground-based LMAs. The GLM will leverage all of the accomplishments achieved with the ground-based systems to usher in a robust new data set for CONUS locations as well as expanding the role of satellite observations in data-sparse regions in support of severe weather, tropical forecasting, and aviation applications.