



Introduction

As lightning detection and application becomes more accessible to aviation operations, it is important to present the data in a way that easily allows its integration into operations. At the National Weather Service's Aviation Weather Center (AWC), many of our convective products (i.e. Convective SIGMET) rely on lightning information not only for situational awareness but on forecast production and verification. The Aviation Weather Testbed (AWT) at AWC has been exploring the use of lightning information for internal applications supporting the AWC mission for providing weather information in support of optimal aviation safety and efficiency since 2012. Experimental sets include the use of gridded total lightning datasets such as gridded stroke density in an operational context for the production and evaluation of convective forecast products. Other experimental sets include a statistical correlation between radar echo top information and lightning density to provide a pseudo-echo top data display at a higher temporal density than radar for better situational awareness.

Situational Awareness

The primary use of total lightning data at the AWC is to provide timely and accurate observation data for situational awareness and decision support to the aviation community. In addition to forecast and warning responsibilities over and adjacent to the lower 48 United States, the AWC provides forecasts and warning aids globally in conjunction with international centers in Exeter U.K. The AWC and the AWT have been producing both domestic (Figure 1a) and global (Figure 1b) lightning gridded densities using total lightning data.



Figure 1. a) Display of gridded total lightning density at a 13-km resolution with composite reflectivity and valid Convective SIGMETs (red polygons) and convective outlooks (green polygons) b) Display of gridded total lightning density at 1.25° resolution with IR satellite mosaic and international Convective SIGMETs (red polygons).



Figure 2. Sample products issued during the AWC Testbed Summer Experiment 2013. a) An official long range planning forecast for the FAA Command Center issued by the an AWC National Aviation Meteorologist participating in the experiment. Overlaid is gridded lightning density showing how well the forecast turned out. b) Experimental 2-h Outlook from the Convective SIGMET desk with grayscaled composite reflectivity and gridded total lightning data. c) Sample global convective forecast with global gridded total lightning density.

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The use of total lightning at the AWC was first demonstrated at the AWT summer experiment in 2013 for use in situational awareness and evaluation of convective forecasts produced during the experiment (Figure 2). AWC forecasters found the total lightning displays useful for

The gridded lightning density was used in both subjective and objective evaluations of convective forecasts. An overlay of gridded lightning density with human-drawn convective forecasts were used for subjective

Figure 5. Lightning derived echotops a) on 5-km grid showing isolated convective cells over MO and IL at 1620 UTC 22 July 2014 and b) over the Gulf of Mexico and Caribbean region at 1532 UTC 25 July 2014.

Forecast Evaluation (cont'd)

Subjective evaluations were extended to a seasonal perspective showing model performance for a summer over the CONUS using MRMS echo top information and lightning observations for the same summer season (Figure 3). This provides a subjective means of evaluating model biases during the summer of 2013.



Figure 3. Qualitative verification of high resolution forecast products valid 1900 UTC June-July 2013. a) MRMS echo tops greater than 30kft. Forecast echo tops from b) Hight Resolution Rapid Refresh (HRRR) model, c) WRF-NMM model, and d) WRF-ARW model. In the bottom row are gridded lightning climatologies valid for the same time in strokes/grid point/hour. e) Earth Networks Total Lightning Network and f) Vaisala's GLD360 total lightning.

Objective evaluations have been performed using total lightning data as the truth data for such forecasts as the Extended Convective Forecast Product (ECFP) planning tool available and operational at the AWC (Figure 4). The ECFP uses Short Range Ensemble Forecast (SREF) system data to create probabilistic polygons of convection for flight planning at time ranges beyond the valid times of other aviation-specific convective products. For this, all lightning data is collected during the entire valid window of the ECFP forecast and assessed.



Figure 4. Quantitative verification of the extended convective forecast product (ECFP). The reliability plot of the ECFP product is valid for all leads and valid times for October and November 2014. The ECFP reliability was created using the Vaisala GLD360 lightning data as opposed to usual echo top data. A six-hour smear of lightning data was used to assess each valid forecast period.

Derived Products

Additionally, the AWC/AWT created aviation specific derived products for situational awareness. One such product is lightning derived echo top display providing a field of echo top information every two minutes for aviation specific forecast products. For this, lightning data was collected over a year and then a seasonally-adjusted relationship was derived from MRMS echo top information for the CONUS and then extended over the Caribbean.



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