

Lightning Strike Density Product Product Description Document (PDD)

Part 1 – Mission Connection

1. Product Description:

The NWS is responsible for making weather, water and climate information widely available to the public using commonly accepted standards and technologies. Over the Continental U.S. and adjacent coastal waters the WSR-88D Doppler Radar network is used to observe thunderstorms and is the basis for short-term warning decisions. Thunderstorm activity at sea can have significant impacts to the safety of mariners and impact operations. Presently, only satellite imagery gives mariners at sea an indication of thunderstorm activity beyond the U.S. WSR-88D Weather radar Network coverage. Satellite imagery provides the large scale view but does not provide definitive information concerning whether a particular cloud system is producing lightning.

The Lightning Strike Density product is in gridded form (GRIB2). The base data is the Vaisala GLD360 land based detection system. The gridded product is considered a derived product and is therefore acceptable for distribution to the public. The product contains the number of lightning strikes per square meter per second. A lightning flash may comprise of several to many cloud to ground strikes. Graphical images of the gridded product with GOES satellite visible and IR satellite imagery will be available on the Atlantic and Pacific pages of the Ocean Prediction Center web page at www.opc.ncep.noaa.gov.

2. Purpose/Intended Use:

The purpose of this product is to enhance awareness of developing and transitory thunderstorm activity, to give users the ability to determine whether a cloud system is producing lightning and if that activity is increasing or decreasing, and to emulate the future GOES-R Global Lightning Mapper (GLM) data. Hazards from thunderstorms include reduced visibility, saturation of collision avoidance radar due to attenuation from heavy rain, rapidly increasing and shifting winds, building waves, and lightning. Sailing vessels and small fishing vessels are particularly vulnerable to rapidly degrading conditions associated with thunderstorms, especially those operating beyond the WSR-88D detection volume and cell coverage over the open ocean. Over the past thirty years three large sail training vessels capsized and sank due to high winds from thunderstorms; the Baltimore Clipper *Pride of Baltimore* 1986, the Barque *Marques* 1984, and most recently *Concordia* 2010 off of Brazil. The "*Pride*" and *Marques* sank with 4 and 19 fatalities, respectively. All students and crew survived the *Concordia* sinking.

3. Audience:

These products are intended for mariners operating beyond the WSR-88D radar coverage but can be used by anyone with an interest in lightning activity. Mariners are using broadband capabilities as a means of communication and to obtain the latest weather information. Commercial and open source software that are able to request, subset, download, and display meteorological and oceanographic fields in Gridded Binary (GRIB) form have been used by mariners for over twenty years. GRIB files are used across the full range of vessels and operations.

4. Presentation:

Graphical displays of zoomed in areas of the Atlantic and Pacific Offshore waters will be available on the Ocean Prediction Center (OPC) web page under the Atlantic and Pacific tabs. Lightning strike density will be shown as an overlay with GOES visible and infrared imagery. Gridded fields in GRIB2 format will be available on the OPC web page. Once downloaded a software program that can decode and display

GRIB2 data will be needed to display the product. The proposed areas for graphical display of lightning strike density are shown below for the Pacific NW, Northeast, Southeast and CA Offshore waters. These displays will be available on the OPC web page at http://www.opc.ncep.noaa.gov/Atl_tab.shtml and http://www.opc.ncep.noaa.gov/Pac_tab.shtml

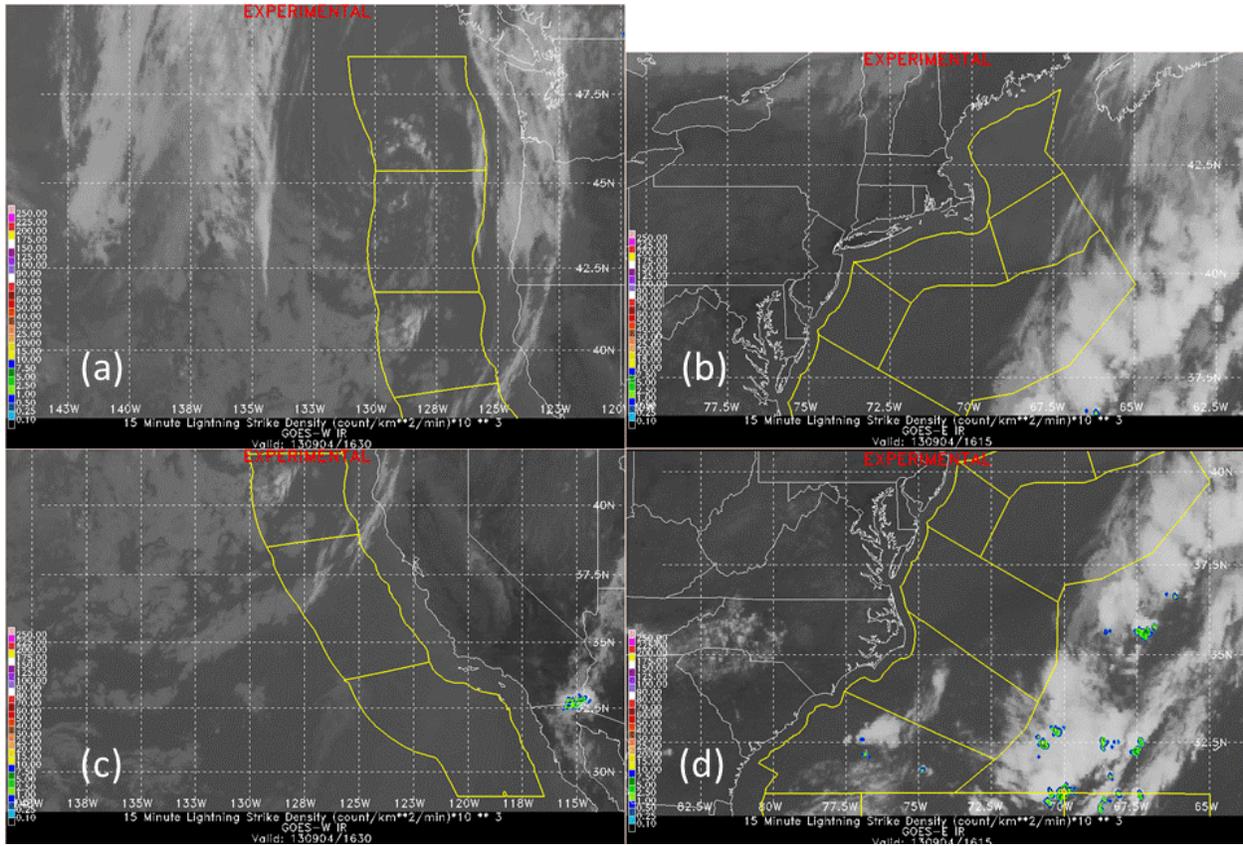


Figure 1. Four panel showing (a) Pacific Northwest, (b) Northeast US, (c) Central and Southern California, (d) Mid-Atlantic and Southeast waters to Bermuda with IR GOES satellite image and 15 minute Lightning Strike Density.

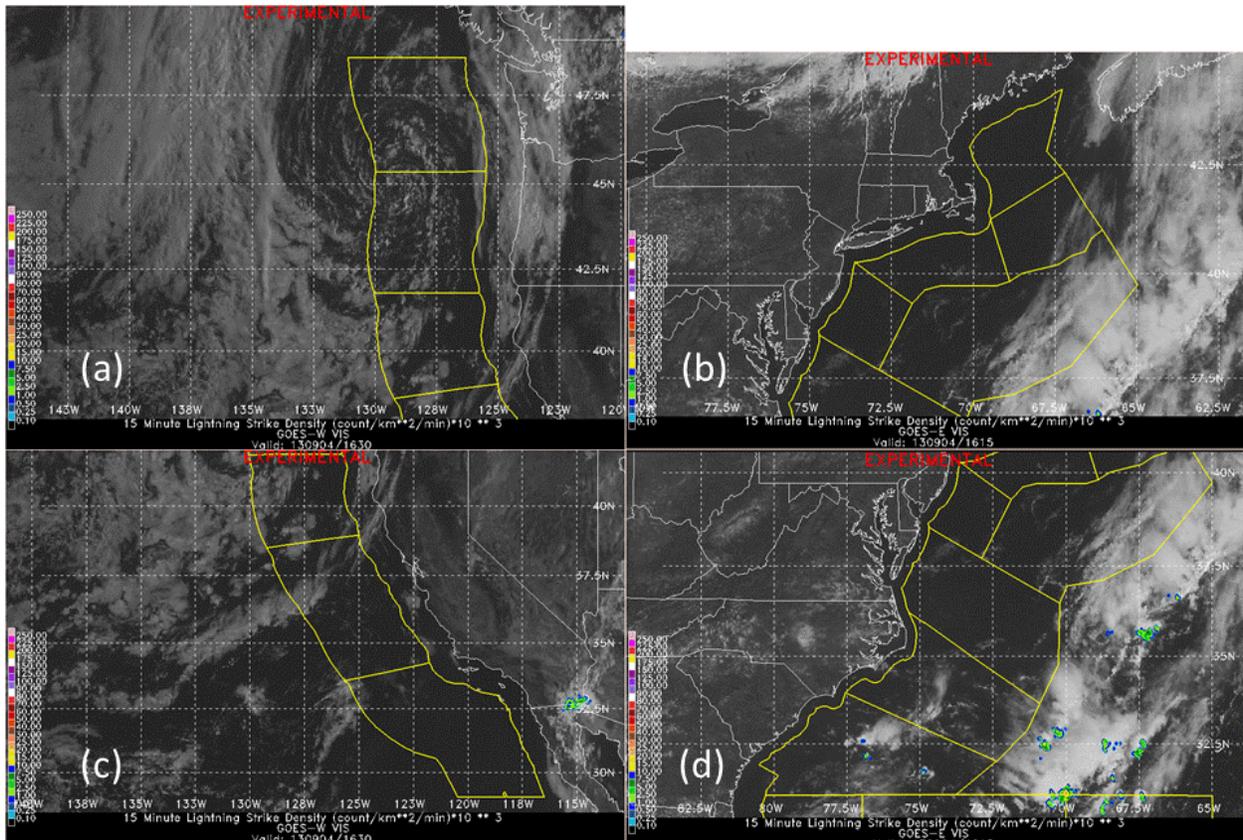


Figure 2. As for Fig. 1 but with GOES visible satellite imagery.

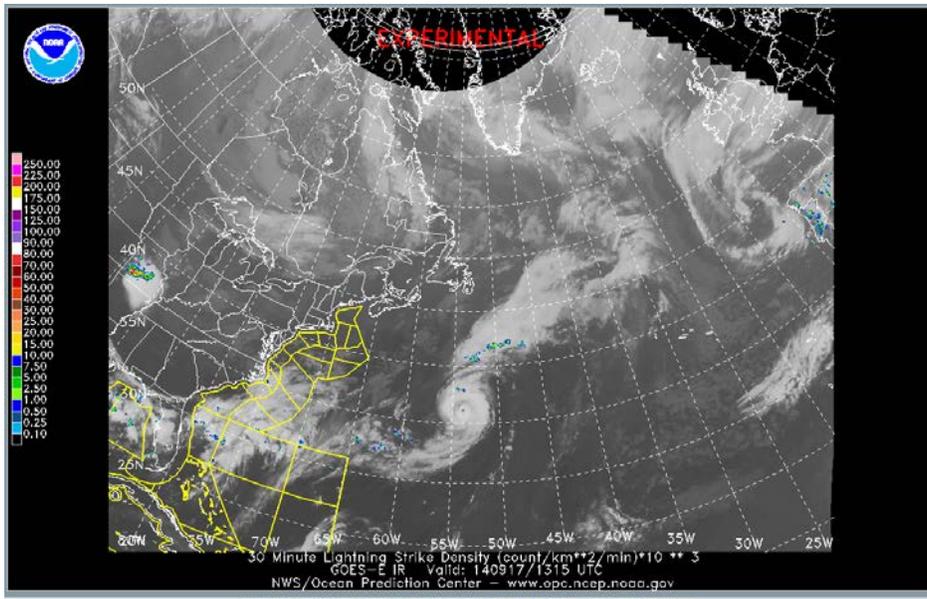


Figure 3. North Atlantic GOES-E IR image with Lightning Strike Density Product from OPC webpage.

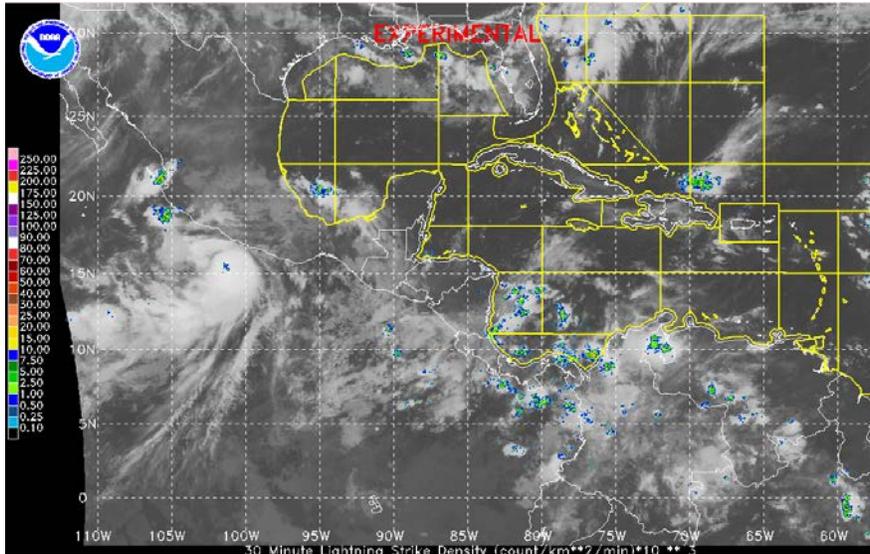


Figure 4. Tropical GOES-E IR image with Lightning Strike Density Product from OPC webpage.

5. Point of Contact:

Point of Contact is Joseph Sienkiewicz of the National Weather Service Ocean Prediction Center, Chief of Ocean Applications at: joseph.sienkiewicz@noaa.gov.

Part 2 - Technical

1. Format and Science Basis:

The Lightning Strike Density Product is derived from the Vaisala GLD360 global cloud to ground detection network. The Vaisala network is capable of detecting cloud-to-ground strokes, cloud-to-ground flash information and survey level cloud lightning information. According to Vaisala, the GLD360 is capable of a detection efficiency greater than 70% over most of the Northern Hemisphere with a median location accuracy of 5 km or better. The real time data can be available from Vaisala within 60 seconds of acquisition.

Files will be generated in GRIB2 format by the Ocean Prediction Center on the NCEP Compute Farm server system and displayed with satellite imagery on the OPC web site. Once generated the experimental product will be transferred to the NCEP RZDM ftp site for availability and then made available via a link from the NWS Ocean Prediction Center website. Graphical images will be generated every 15 minutes using the GEMPAK software and uploaded to the web as soon as generated in gif format.

a. Definition of Lightning Stroke

A lightning stroke is defined as, "Parameter that refers to a specific part of a cloud-to-ground lightning flash. A single stroke consists of a downward propagating leader (either a stepped leader or dart leader) plus an upward propagating return stroke. A single CG flash, especially those with negative polarity, may have multiple (return plus subsequent) strokes (up to 20, but mean is three). The strokes of a flash may be separated by more than 5 km from each other." Source is the Functional Requirements Document For the Lightning Data Program (LDP).

According to [NWS Glossary of Meteorological Terms](#) a lightning stroke is defined as, “Any of a series of repeated electrical discharges comprising a single lightning discharge (strike). Specifically, in the case of a cloud-to-ground discharge, a leader plus its subsequent return streamer.”

b. Definition of Lightning Strike Density

Lightning Strike Density is the number of lightning strikes over a given time period within a box of fixed horizontal resolution.

c. Units

Per WMO requirement the density is given in SI units of number of lightning strikes per square meter per second (count $m^{-2} s^{-1}$). The SI Units required by the WMO for such gridded products will require a scaling factor of 10^{11} to display in units of strikes $km^{-2} min^{-1} \times 10^3$. A scaling factor of 10^3 is needed for the units of count $km^{-2} min^{-1}$ to display in integers.

d. Horizontal and Temporal Resolution

The product is written to an 8 x 8 km grid and emulates the resolution of the future Global Lightning Mapper (GLM) instrument to be flown on the GOES-R series of geostationary satellites. The 8 x 8 km grid is coarser than the base data detected by Vaisala. Gridded values will reflect the strike density over 15 and 30 minute collective periods.

e. Domain

The gridded product extends from the western South Pacific to north of Scotland. The corner points for the gridded product are: lower left – 25 degrees South latitude, 110 degrees East longitude; upper right – 80 degrees North latitude, 0 degrees longitude.

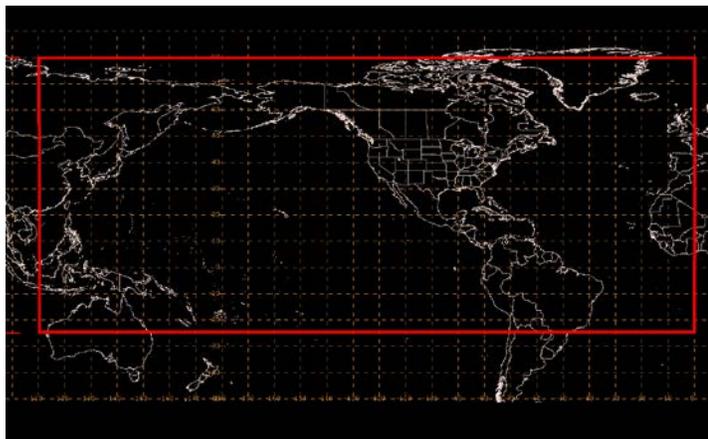


Figure 5. Domain of experimental lightning strike density gridded product in red.

f. Derived data and distribution

The Lightning Strike Density product is based on the Vaisala NLDN and GLD360 data sources. This derived product is a Level 5 product and is appropriate for public distribution. As defined in the Functional Requirements Document For the Lightning Data Program (LDP), Level 5 products are: “NOAA-generated products using lightning data as input but not displaying the contractor transmitted/provided lightning data”.

g. Utility

Lightning Strike Density, as opposed to display of individual strikes, highlights the location of lightning cores, the character of the convective system (multicells or lines), and trends of increasing and decreasing activity. It is also a parameter that is useful to compare cloud to ground capabilities from different sources of lightning data and will be the output of the Global Lightning Mapper on the GOES-R series of satellites.

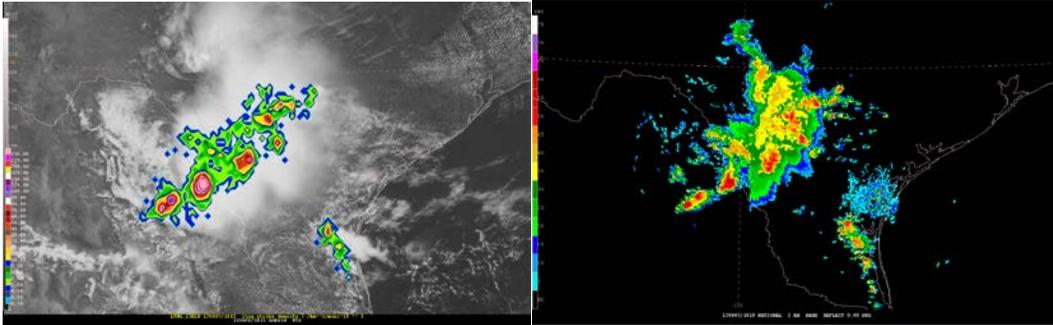


Figure 4. Lightning Strike Density (left) for a cluster of storms over southern Texas with accompanying national radar composite of base reflectivity (right).

2. Availability

These products will be available 24 hours a day and 7 days a week.