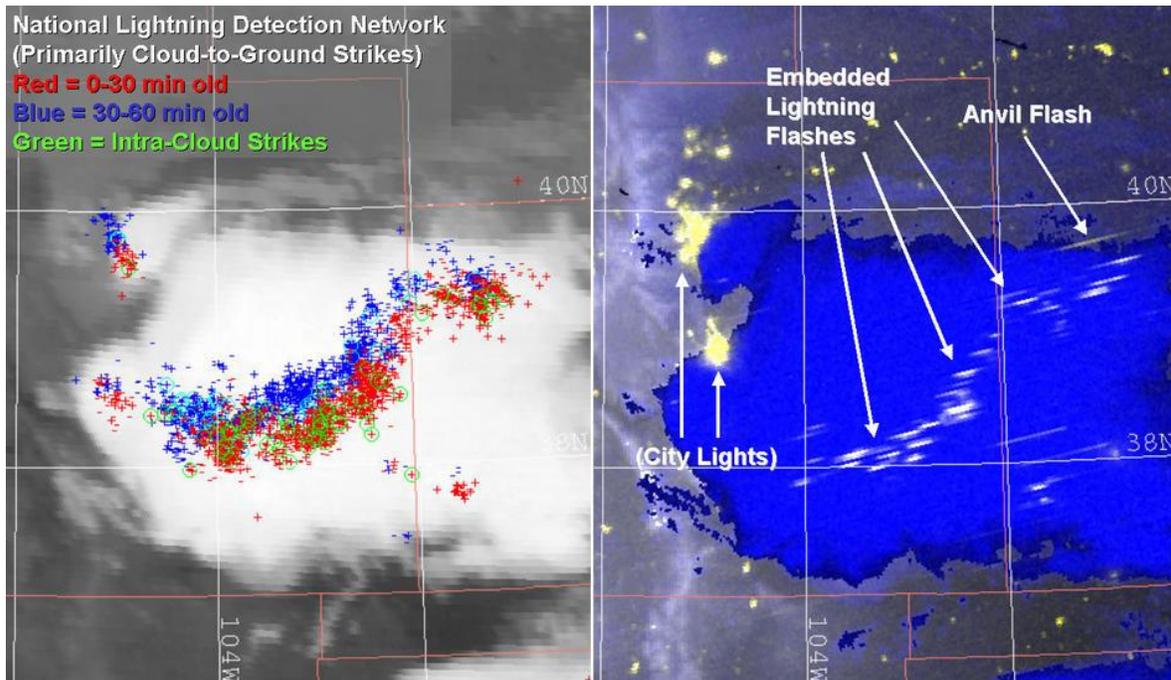




Satellite Product Tutorials:

Lightning Detection Overlays



Above: Real-time streaming data from the National Lightning Detection Network (NLDN) adds a valuable new dimension of information on the current intensity and ongoing development of thunderstorms as observed from satellite. Most lightning strikes recorded by the NLDN are cloud-to-ground variety, but a small subset of the intra-cloud strikes is also detected. Red symbols represent cloud-to-ground strikes within 30 minutes of the satellite image time, and blue symbols correspond to strikes between 30-60 minutes old.

Why We're Interested...

Despite their small size in comparison to tropical systems like hurricanes and typhoons, thunderstorms and their associated lightning pack a powerful and

destructive punch—accounting for 100's of millions in property damage each year. Sudden and deadly, lightning strikes account for over 500 injuries and claim nearly 100 lives every year (that's more than hurricanes or tornadoes). While lightning occurs with all thunderstorms, and roughly 100,000 such storms occur each year in the U.S., 10% of these storms are categorized as severe (capable of producing strong winds, large hail, and tornadoes).

To forecasters and the research community alike, understanding cloud electrification processes is key to providing improved forecasts of severe weather, shaving minutes off severe weather warning times, and ultimately saving lives. Here, we use the information to complement and put into context other value-added satellite products available upon *NexSat*. For example, deep convective cloud top heights typically correlate well with the high-density flash rates, while the cirrus product assists in the classification of thunderstorm "anvil" strikes (often responsible for the fabled "bolt from the blue").

How This Product is Created...

NLDN strike data are based on the NLDN surface network of detectors distributed across the United States. In addition to light and sound, when a lightning strike occurs it emits radio-frequency signals (a point familiar to many who have driven their car through a thunderstorm with their AM radio on—each lightning strike causes an audible static interference in the radio receiver). These lightning-induced radio waves, traveling at the speed of light, reach the individual NLDN detectors at slightly different times. Based on the difference in arrival times for a given strike, its position can be determined through a triangulation process.

For the *NexSat* lightning product, details of the strike record are simply overlaid upon satellite imagery to match lightning activity with the parent thunderstorms. Since lightning is a rapidly evolving phenomenon, we overlay the information upon geostationary satellite observations (*GOES-East* and *West*). For more detailed analyses, the exact satellite scan times can be matched to the known strike times to capture only the subset of flashes corresponding to the instantaneous satellite imagery. This approach is particularly relevant to any satellite sensor having the inherent ability to detect lightning flashes.

How to Interpret...

Lightning data from the NLDN are overlaid upon infrared geostationary satellite imagery (and also the instantaneous [rain rate product](#)) to provide a consistent time series of storm evolution. With the satellite image collection time as a reference, the lightning data are accumulated into two groups—strikes occurring within 30 minute of the image collection and strikes occurring 30-60 minutes prior to the image collection. The former are plotted as red symbols atop the imagery, and the latter as blue symbols, enabling the viewer to gain a temporal reference for storm motion and changes in intensity. Loops of the product using the *NexSat* animation utilities are extremely useful in this context.

Lightning Data Overlay KEY:	
Symbols:	Colors:
* = Strike (Generic)	} Red < 30 min old Blue =30-60 min old
+ = Positive Strike	
- = Negative Strike	
○ = Intra-Cloud Strike	} Green < 30 min old Cyan 30-60 min old

In addition to strike occurrence and location, the NLDN provides many additional detailed parameters useful in characterizing the storms. These include the polarity (positive or negative charge transfer between the cloud and the surface), the amount of electrical current transferred, the duration of the strike and multiplicity (lightning strikes are comprised of many individual strikes), and whether the strike was from cloud to ground (CG) or intra-cloud (IC). For *NexSat*, details on strike location, timing (red vs. blue), polarity, and CG vs IC distinction are shown with increasing detail for smaller sectors. For the largest *NexSat* domains, only location and time of strike are shown as colored asterisks. Medium sized domains include polarity information ("+" for positive strikes and "-" for negative strikes), and small domains additionally include CG vs. IC information (shown as circles). A key

detailing this annotation is shown above. In the rain rate product, only red symbols are used to detail the most current strikes.

Looking Toward the NPOESS Era...

Information from the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Visible/Infrared Imager/Spectrometer (VIIRS) will provide higher resolution depictions of storm tops. The VIIRS "day/night band" will enable nighttime lightning detection (instantaneous over storm top)—and possibilities for validation or supplementation of the NLDN and other lightning detection networks. An example of this capability is shown in the right panel on the first page of this tutorial. [GOES-R](#) (the next-generation geosynchronous operational environmental satellite series) will have a "staring" lightning detection device capable of detecting all (cloud-to-ground and intra-cloud) strikes.

Did You Know...?

- Approximately 1,800 thunderstorms are active at any moment around the world...accounting for nearly 16 million storms annually.
- Lightning kills more people than tornadoes.
- A typical lightning "bolt" is the diameter of a pencil, and five times hotter than the surface of the sun! Thunder is caused by rapid expansion of super-heated air in the vicinity of the bolt.
- A lightning strike is actually comprised of several forward and return strokes as charged particles race between the cloud and surface to neutralize the charge difference (a high-speed video device can capture the "flicker" as this process unfolds).

Want to Learn More?

Visit [Vaisala](#) and learn more about the NLDN

Visit the [National Severe Storms Laboratory \(NSSL\)](#)

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