VAISALA GLOBAL LIGHTNING DATASET GLD360

Technology, operations, and applications overview

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Overview

Vaisala Global Lightning Dataset GLD360 is the highest performing worldwide lightning dataset in existence today. GLD360 is designed for those who are interested in providing warnings to people, ships, or planes, improving weather forecasts, or simply getting a more complete picture of weather; anywhere in the world. Applications for this type of data are known to exist in the areas of meteorology, defense, and aviation.

Technology, operations and performance

Vaisala has a long standing commitment to investigate and support research for applications of long range lightning detection through the establishment and operation of the Long Range Lightning Detection Network (LLDN), PacNet, CaribNet, and a hurricane monitoring product. However, high quality lightning detection has never been available on a global scale.

High quality lightning detection is now available on a global scale

During 2008, Vaisala began building and deploying a new world wide lightning detection network. Data from this network, Vaisala Global Lightning Detection Network (GLDN), is expected to provide significant improvements in mesoscale detection and tracking of convective activity on a global basis. We believe GLD360 is the largest breakthrough in lightning detection since the first regional lightning detection networks were established in the late 1970s. Regional lightning detection networks using Vaisala technology now exist in over 40 countries around the world.

The GLDN consists of sensors strategically placed around the world for optimal detection of cloud-to-ground (CG) lightning strokes. These wideband sensors detect CG lightning using magnetic direction finding and time-of-arrival methodologies combined with proprietary lightning recognition algorithms in the VLF (Very Low Frequency) band. Signals captured by this technology are then transmitted to Vaisala's Network Control Center (NCC) in Tucson, Arizona via a wide variety of communications methods. The NCC combines and correlates each of the raw sensor data to optimize the location estimate of the CG stroke. Data is made available or transferred to customers through standard TCP/IP communications protocols. The GLDN is owned, operated, and maintained by Vaisala.

The GLDN is newly established, and long-term performance uptime statistics are not yet available. However, in order to maintain the highest standards of reliability and quality of the data possible, Vaisala has leveraged the 20+ years of experience gained from owning and operating the National Lightning Detection Network (NLDN). The NLDN exhibits reliability through it's impressive record of 99.97% or better uptime for each of the last 10 years. GLD360 is operated and monitored using similar quality control and uptime procedures by the same NCC personnel who manage the NLDN.

The culmination of technology and operations expertise allow Vaisala to be confident that the following performance criteria will be met.

- 60-70% Cloud-to-Ground Flash Detection Efficiency (Figure 1)
- Median location accuracy between 5 and 10 km

Additionally, GLD360 is the only long range dataset that has the capability of providing polarity and peak amplitude for each stroke detected. Vaisala has conducted preliminary validation of these claims through comparison to the NLDN. Validation work is continuing both by Vaisala and independent third party collaborators. Results will be shared in a separate white paper.

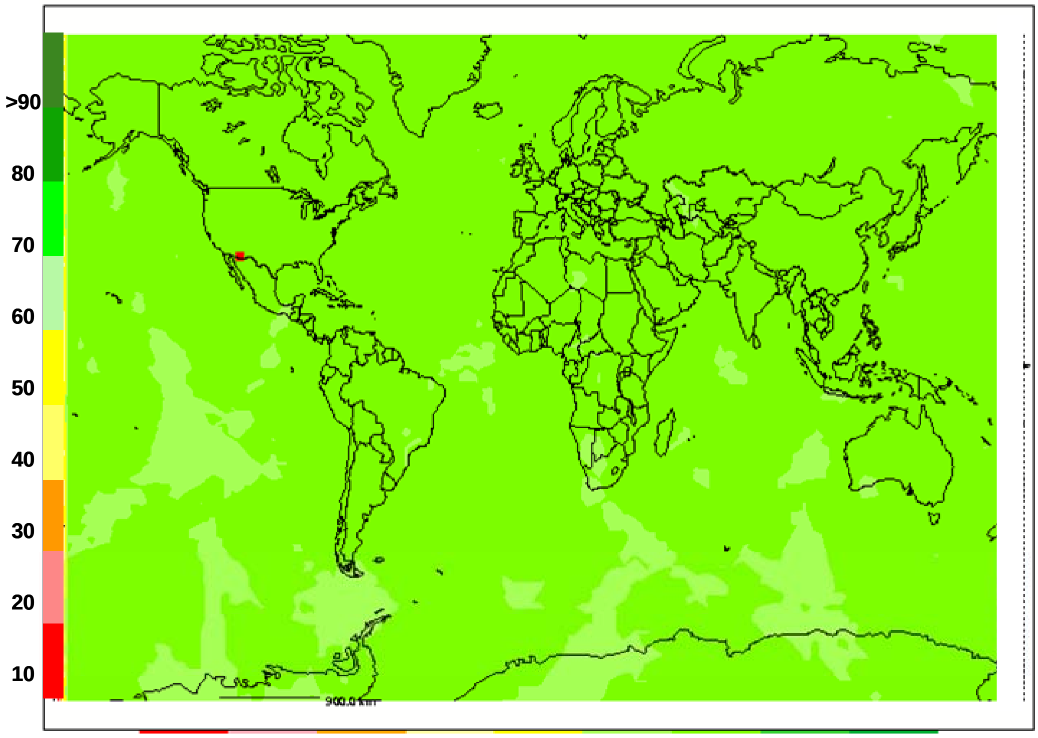

Figure 1: CG flash detection efficiency for Vaisala's GLDN at completion. (Red square is Vaisala's NCC in Tucson, Arizona)

Applications

Long-range or global lightning datasets, such as GLD360, are complementary to visible and infrared satellite, weather radar, and short base line precision lightning networks. They could prove to be even more beneficial in regions that are void of any one of these datasets.

Nowcasting and forecasting

GLD360 will provide the operational meteorology community with an extremely valuable dataset to improve analysis, nowcasts, and forecasts around the world. Continuous thunderstorm identification and tracking around the world will not only improve global thunderstorm nowcasts, but also nowcasts of precipitation, severe weather, turbulence, high seas and tropical cyclone intensity (Knabb et al., 2008, presentation only; Squires and Businger, 2008; Pessi and Businger, 2009a; Demetriades and Holle, 2009). Through collaborations with the scientific community, Vaisala has the applications knowledge to take advantage of lightning relationships to the aforementioned variables, such as precipitation. In some regions of the world, this dataset may provide the only cost-effective way to produce high quality convective precipitation and severe weather nowcasts.

Regional lightning data from Vaisala's NLDN is already being assimilated into numerical weather prediction models to improve forecasts in the United States (Pessi and Businger, 2009b; Weygandt et al., 2008). GLD360 can provide numerical weather prediction centers around the world with a valuable dataset to improve forecasts of (1) synoptic and mesoscale storm track and intensity, (2) precipitation location and intensity, and (3) convection.

Safety and operational efficiency

Lightning is the second leading weather-related killer in the United States. On average, 50 people are killed (500 injured) by lightning each year in the United States alone. Global estimates are staggering at a rate of 24,000 killed (240,000 injured) by lightning each year (Holle, 2007).

GLD360 will provide lightning-sensitive facilities around the world, such as airports, military bases, and mining facilities, with an effective way to produce CG lightning warnings. Vaisala can tailor CG lightning warning solutions powered by GLD360 to meet the appropriate balance of safety and operational efficiency necessary for a lightning-sensitive facility. Vaisala has over a decade of experience in this area (Holle et al., 2003).

The impact of these applications will result in savings of man, money, and machines.

Regional lightning data from Vaisala produced networks around the world are already being used to generate CG lightning warnings for Wind Energy and outdoor recreation. Both of these customer groups primarily care about lightning safety and are not as concerned about impacts on operational efficiency due to CG lightning. Wind Energy workers typically only need appropriate warnings and can be productive on other tasks while the CG lightning hazard exists. Outdoor recreation customers will be able to set up CG lightning alerts on their cell phones to provide them with adequate safety during their outdoor activities. GLD360 will provide these customer groups with CG lightning warning capability anywhere in the world.

Commercial and military aircraft will be able to use GLD360 data to safely and efficiently route aircraft around the world. GLD360 thunderstorm identification and tracking will provide pilots with the information they need to avoid convective turbulence. Global lightning data can also be used to identify high seas areas over the ocean. This information can then be used to optimize ocean shipping routes around the world. The impact of these applications will result in savings of man, money and machines, not to mention fuel savings and increased safety for en-route refueling operations.

Monitoring the climate

Global lightning detection is important for understanding climate change and its impact on society. There are many questions that remain unanswered concerning global climate change and global lightning production. Does a warmer global climate cause an increase in global lightning activity? Could lightning/rainfall relationships be exploited for a better understanding of the relationship between global climate change and global precipitation? These are just two of the many questions that can be answered with a long record of lightning activity on a global scale.

Peterson and Buechler (2008) studied the relationship between global lightning activity and global warming using the Lightning Imaging Sensor (LIS) onboard the Tropical Rainfall Measuring Mission (TRMM) satellite. They found no significant change in lightning activity due to recent global warming. However, regional differences in lightning activity were found. These regional differences included both increased and decreased lightning activity.

The Peterson and Buechler (2008) study had one major limitation. TRMM is a polar orbiting satellite and only detects lightning activity for a couple of minutes a day over any given area on earth. In order to conclusively study the relationships between lightning and global warming a continuous, global lightning record is needed.

With GLD360, Vaisala is building that archive. We anticipate the GLD360 archive will, over time, provide the continuous global lightning data source needed to add to Peterson and Buechler’s work and help everyone better understand relationships between global climate change, lightning activity, and precipitation.

Additional information

If you desire more information on long-range or global lightning detection and it's applications please consider the following reference material.

Demetriades N.W.S., and R.L. Holle, 2009:
Inner core lightning rates in 2004-2007 Atlantic tropical cyclones using Vaisala's long range lightning detection network (LLDN). Preprints, 4th Conference on Meteorological Applications of Lightning Data, January 11-15, Phoenix, Arizona, American Meteorological Society, 8 pp.

Holle, R.L., M.J. Murphy, and R.E. López, 2003:
Distances and times between cloud-to-ground flashes in a storm. Preprints, International Conference on Lightning and Static Electricity, September 16-18, Blackpool, England, Royal Aeronautical Society, paper I03-79 KMI, 8 pp.

Holle, R.L., 2007:
Annual rates of lightning fatalities by country.
International Conference on Lightning and Static Electricity, August 28-31, Paris, France, paper IC07.PPRKM13, 13 pp.

Pessi, A., and S. Businger, 2009a:
Relationships among lightning, precipitation, and hydrometeor characteristics over the North Pacific Ocean.
Journal of Applied Meteorology and Climatology, in press.

_____, and _____, 2009b:
The impact of lightning data assimilation on a winter storm simulation over the North Pacific Ocean.
Monthly Weather Review, in press.

Petersen, W.A., and D. Buechler, 2008:
Global tropical lightning trends: Has tropical lightning frequency responded to global climate change?
Preprints, 3rd Conference on Meteorological Applications of Lightning Data, January 20-24, New Orleans, Louisiana, American Meteorological Society, 1 pp.

Squires, K., and S. Businger, 2008:
The morphology of eyewall lightning outbreaks in two category 5 hurricanes.
Monthly Weather Review, 136, 1706-1726.

Weygandt, S.S., M. Hu, S.G. Benjamin, T.G. Smirnova, K.J. Brundage, and J.M. Brown, 2008:
Assimilation of lightning data using a diabatic digital filter within

the Rapid Update Cycle.
Preprints, International Lightning Meteorology Conference, April 24-25, Tucson, Arizona, Vaisala, 6 pp.

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