

Vaisala Blitzdetektion

Michael Kalkum
12.11.2013

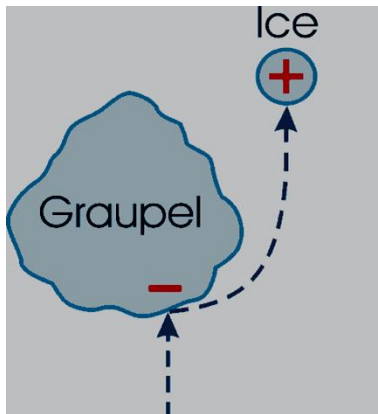
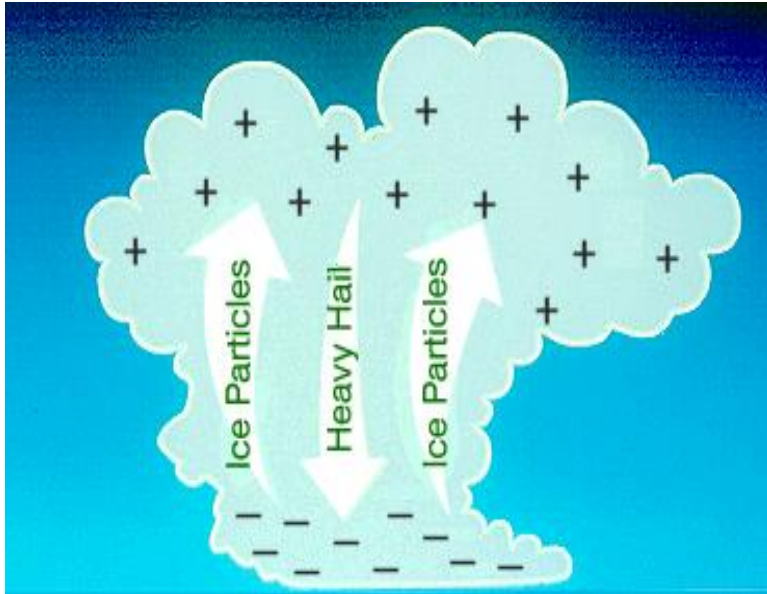
VAISALA

What Is Lightning?

- Lightning is a transient, high-current electrical discharge
 - Lightning stroke is typically 30.000°C
 - Lightning takes the path of least resistance (electrical flow)
- There are three main types of lightning: cloud-to-ground, intracloud, and intercloud discharges
- Lightning primarily occurs in thunderstorms (cumulonimbus clouds)
- Lightning also occurs in snowstorms, sandstorms, and volcanic plumes



The Conditions that Produce Lightning



- At the neg. 10-20 °C level (~5-6 km AGL in summer), you need:
 - Vertical wind velocity of at least 4-8 m/sec (15-30 km/h)
 - Mixed-phase “water”
 - Super-cooled water
 - Ice particles
 - “wet hail” (graupel)
 - This leads to charge separation, through collisions and gravity

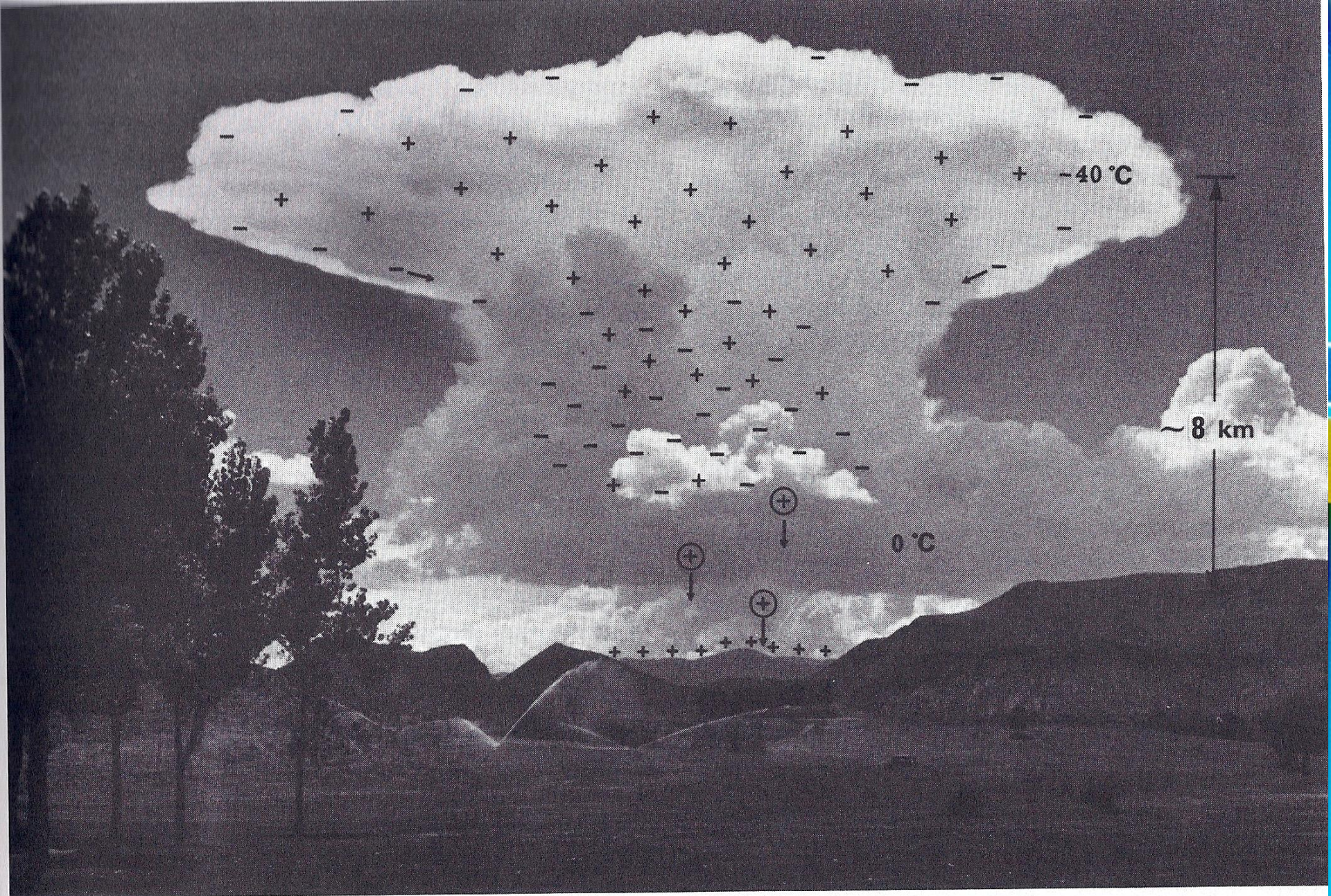
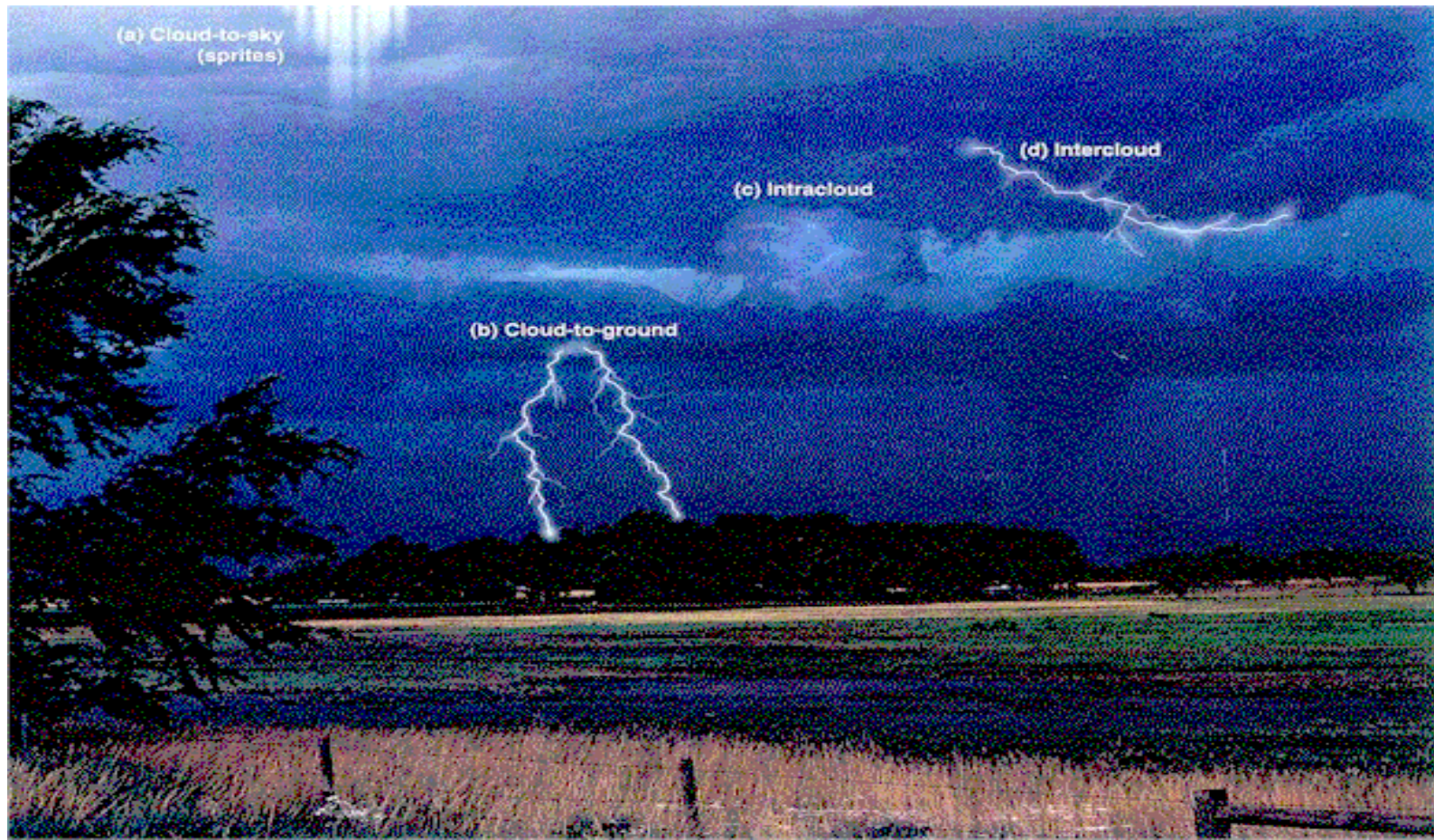


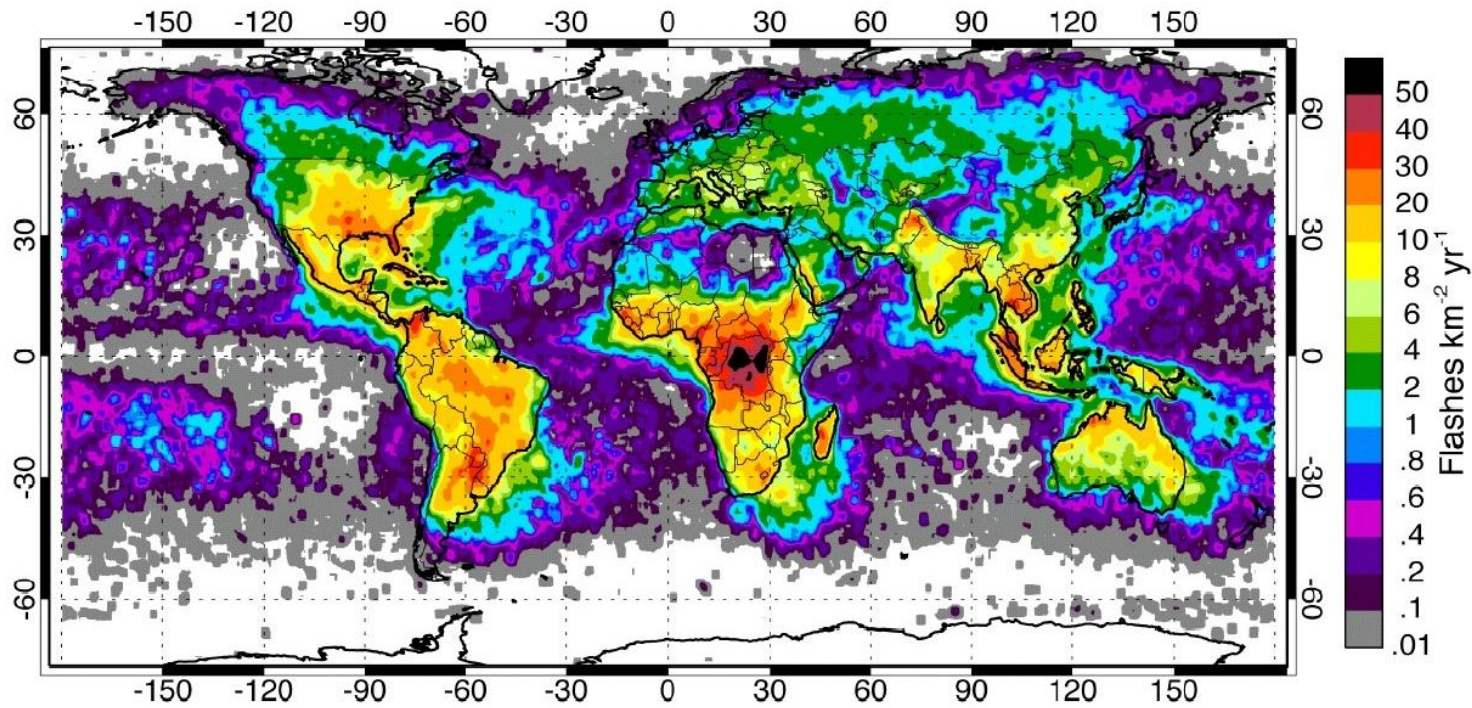
FIGURE 8.1 An isolated thundercloud over Langmuir Laboratory in central New Mexico and a rudimentary picture of how electric charge appears to be distributed inside and around the thundercloud, as inferred from in-cloud and remote observations.

What is Lightning? - Types of Lightning



What Is Lightning? – How Much and Where?

- An estimated 2000 thunderstorms are in progress in the world at any given moment.



Lightning Terminology

- A complete lightning discharge is called a *flash (ein Blitzereignis)*
- A flash is composed of individual *strokes (Teilblitze)* which is each discrete charge transfer
- The number of strokes in a flash is called the *multiplicity*
- Lightning has *polarity*. A stroke that lowers negative charge from the cloud is a *negative stroke* (Negativblitze) while one that lowers positive charge from the cloud is a *positive stroke*
- The maximum magnitude of the stroke is called it's *peak current* value (Ø 20.000 A f. Neg.blitz, 300.000 A Pos.blitz)
- The bright visible part of lightning is called the *return stroke*
- The actual path of the lightning is called the *channel*
- An *event* is a detected point of electrification
- Blitzdichte = Flashes pro km²

Detecting a flash: Optical (8000 images/sec)

1) Downward negative leader



2) Leader near ground



3) Return stroke



4) Composite of all images



Vaisala and Thunderstorm Detection

- The **world leader** in lightning detection
- **37 years** (since 1976) of manufacturing reliable lightning detection systems
- No other company in the world has as much **research and field experience** as Vaisala in the area of lightning detection
- Vaisala's networks use the **best combination of methodology** for lightning detection
- **15 generations** of lightning equipment design improvements



TSS928 Product Introduction

- Classifies CG lightning by range and by directional octant. The ranges include:
 - Overhead, 0-5 nautical miles (0-9 km)
 - Near, 5-10 nautical miles (9-19 km)
 - Distant, 10-30 nautical miles (19-56 km)
- Sensor gives detection efficiency (>90% typical) for flash discharges within 10 nautical miles (19 km)

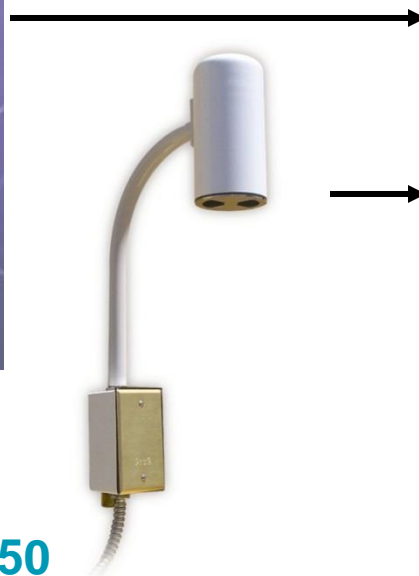
TSS928 and ALARM Software with EFM550

Stand alone or with display

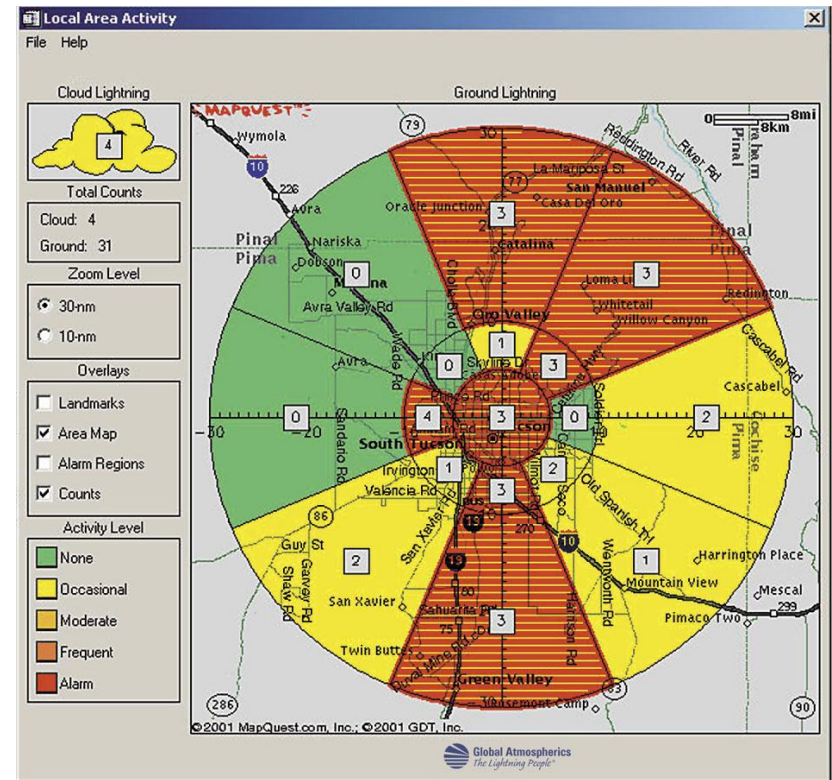


TSS928

TCP/IP or
RS-232, RS422
Serial

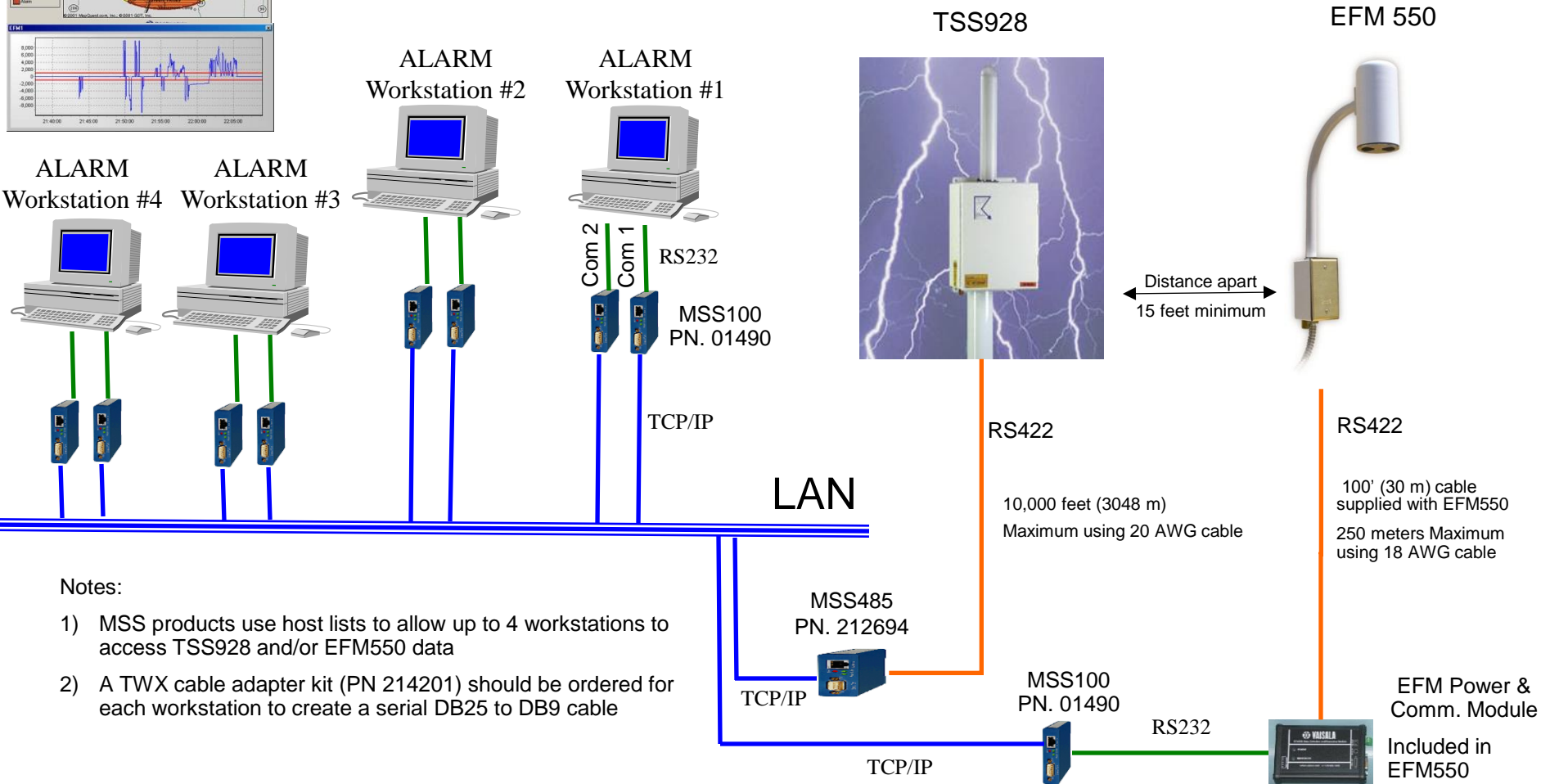
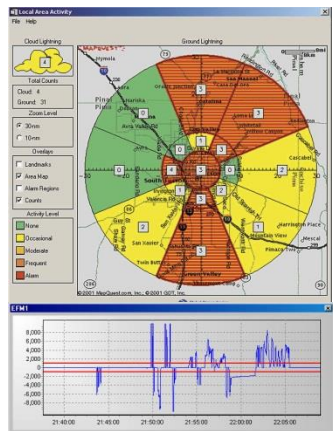


EFM550



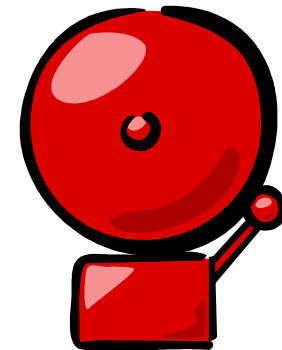
ALARM Software

Multiple ALARM Displays with TSS928+EFM Layout



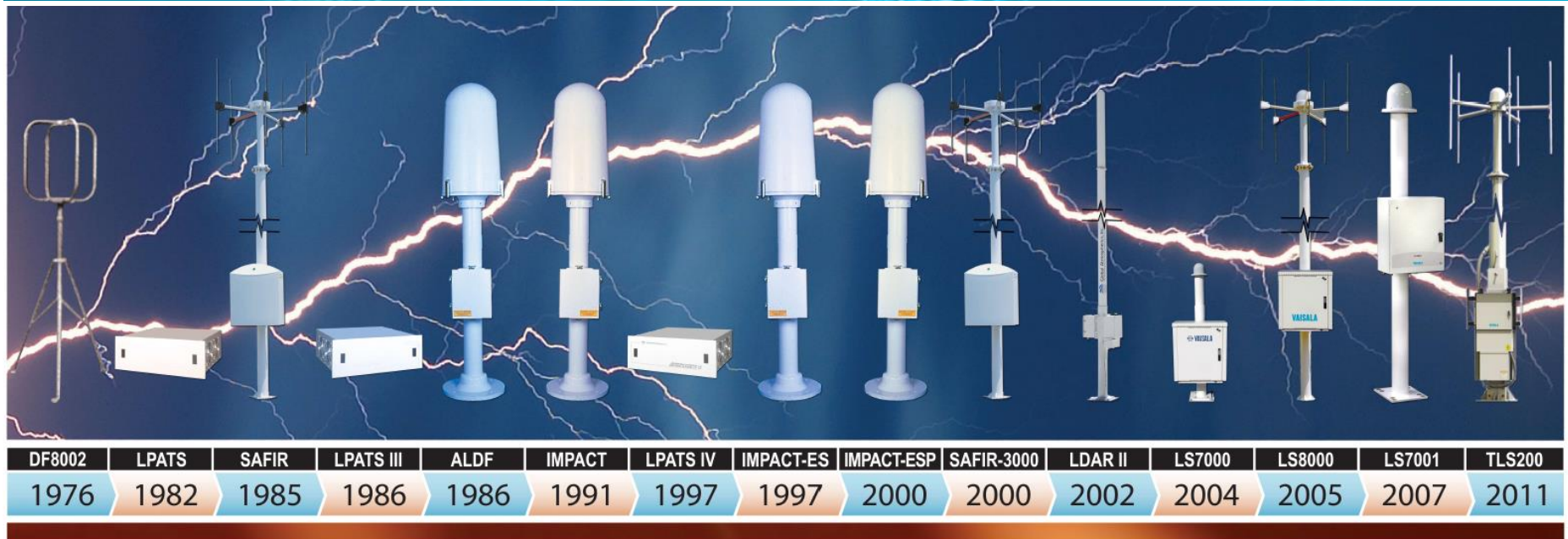
Avoiding False Alarms

- Three-tier warning system recommended
 - **Green** represents a safe condition
 - **Yellow** represents a threatening condition
 - **Red** represents an unsafe condition
- Thresholds and Durations:
 - Threatening Conditions from **Green** to **Yellow**:
 - 1500 V/m for 5 minutes
 - 1700 V/m for 3 minutes
 - 2000 V/m
 - Unsafe conditions from **Green** or **Yellow** to **Red**:
 - 2000 V/m for 3 minutes
 - 2500 V/m for 20 seconds
 - 2700 V/m for any duration
 - Safe Conditions from **Red** or **Yellow** to **Green**:
 - 1500 V/m for 5 minutes
 - 1000 V/m for 5 minutes



Timeline of Products

15 generations of lightning detection equipment



Vaisala Lightning Detection Technology

Cloud-to-ground Networks

LS7001



Total Lightning Networks

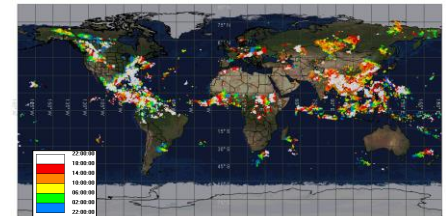
TLS200



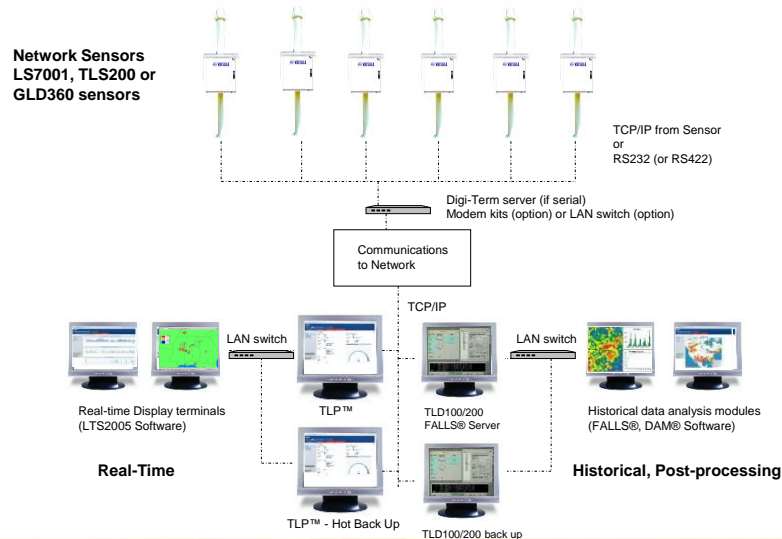
Global Lightning
Detection Network,

GLD360

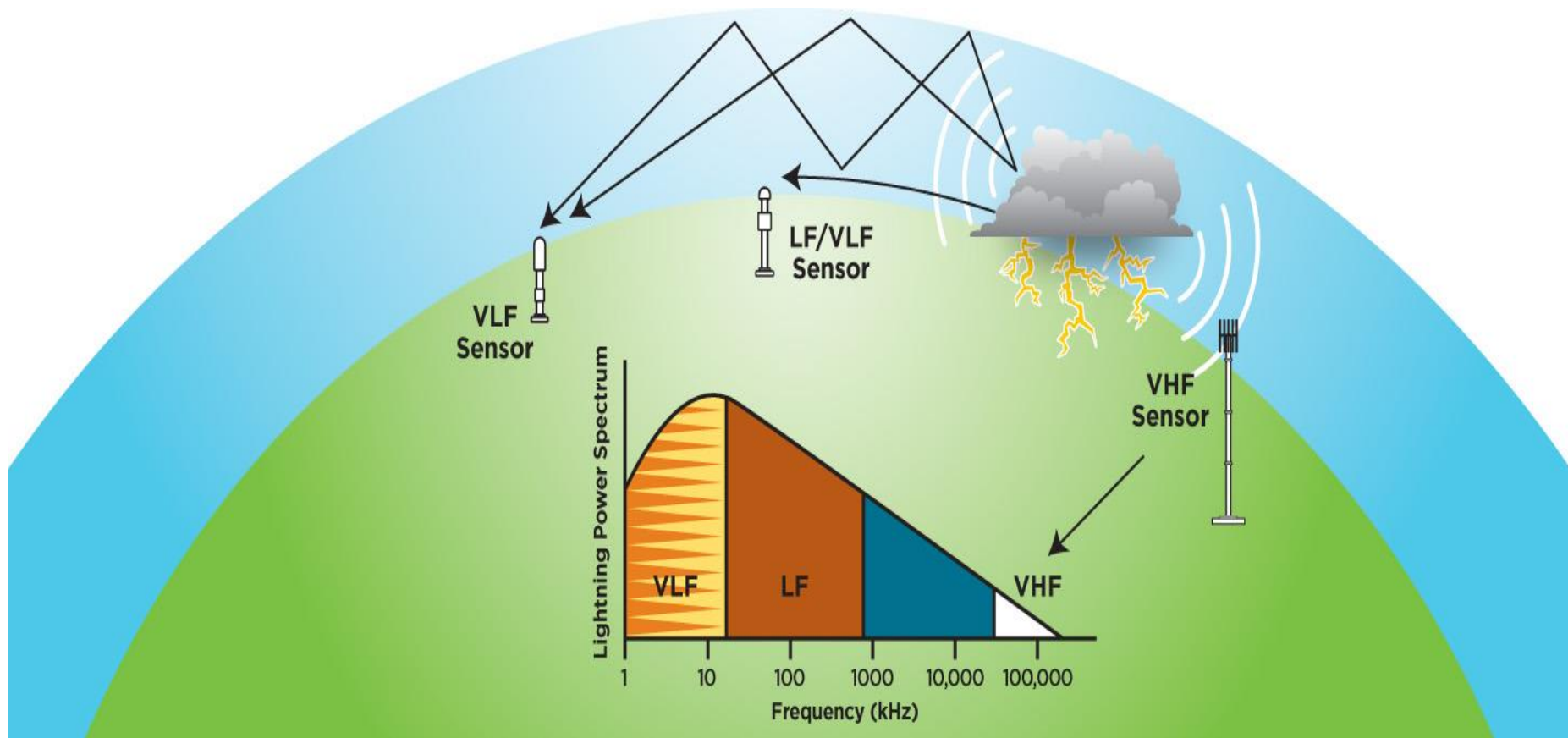
24 hours of GLD360 data on 23 June 2011
2,399,593 lightning locations



Lightning detection network

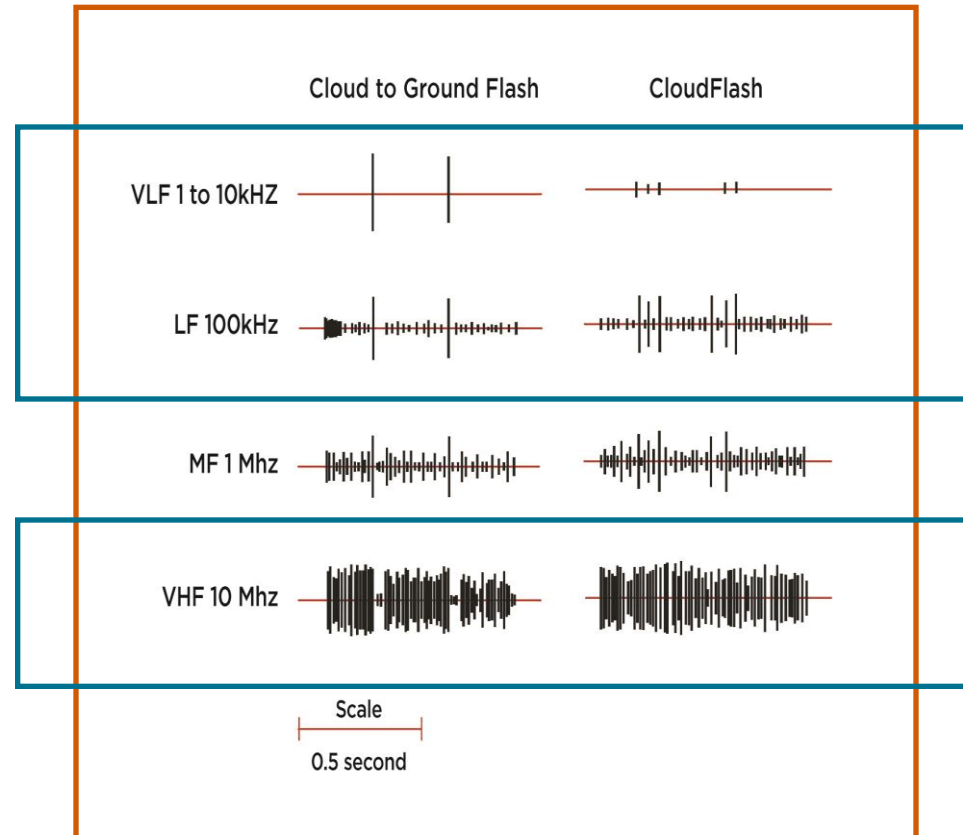


Lightning power spectrum and detection techniques



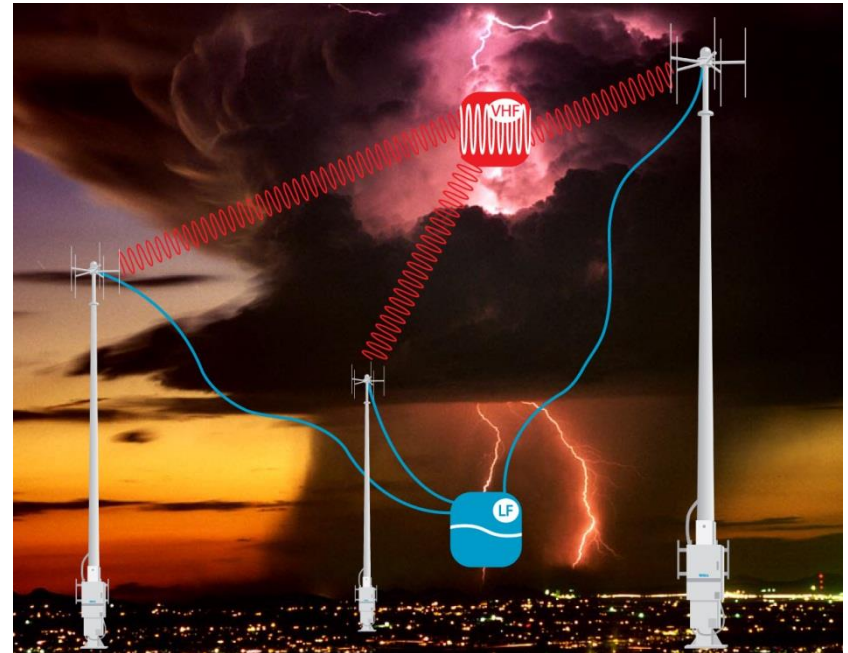
Differences in LF and VHF Signals

- Cloud to ground lightning emits the **highest amplitude pulses in the LF to VLF range** due to a large amount of current moving over large distances.
- Cloud lightning involves short range discharges with very little current: **larger very high frequency (VHF) pulses**.



TLS200 key performance specifications

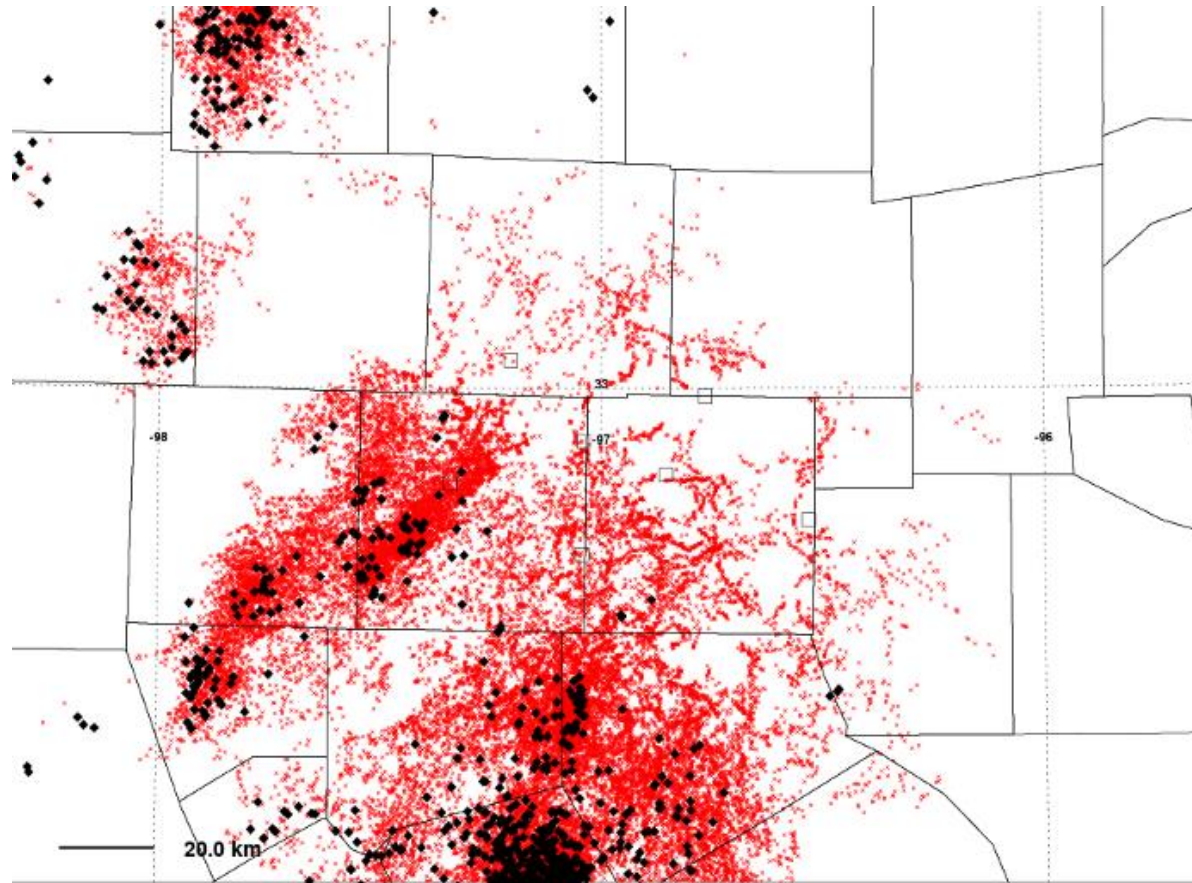
- **Cloud Lightning Detection**
 - >90% Inter-cloud, Intra-cloud with mapping the spatial extent
- **Cloud to Ground Lightning Detection**
 - >90% CG detection capability
- **Cloud Lightning Location Accuracy**
 - 1-2km depending on the network layout
- **Cloud to Ground Lightning Location Accuracy**
 - 250 meters or better with older central processing algorithms
 - 150 meters or better with TLP™ central processing algorithms



What Is The Difference?

VHF (Red) and LF Only Intra-cloud (Black)

VLF/LF/HF cloud
lightning detection
vs.
VHF total
lightning mapping



Arizona Installation (Pepsi Site)

(Version 2 builds)



TLP™ Sensor Map

VAISALA / Total Lightning Processor™ logout

System: Up Processes: 25/25 **Sensors: 137/139** **Transports: 139/142**

System > Sensor Map Help

System

- Status
- Process Status
- Sensor Status
- Transport Status
- Sensor Map**
- Archive Management
- Network Performance
- Performance Mapping
- DE/LA Projections
- Remote Access
- Configuration
- Help/About

Lat: 0.0000 Lon: 0.0000

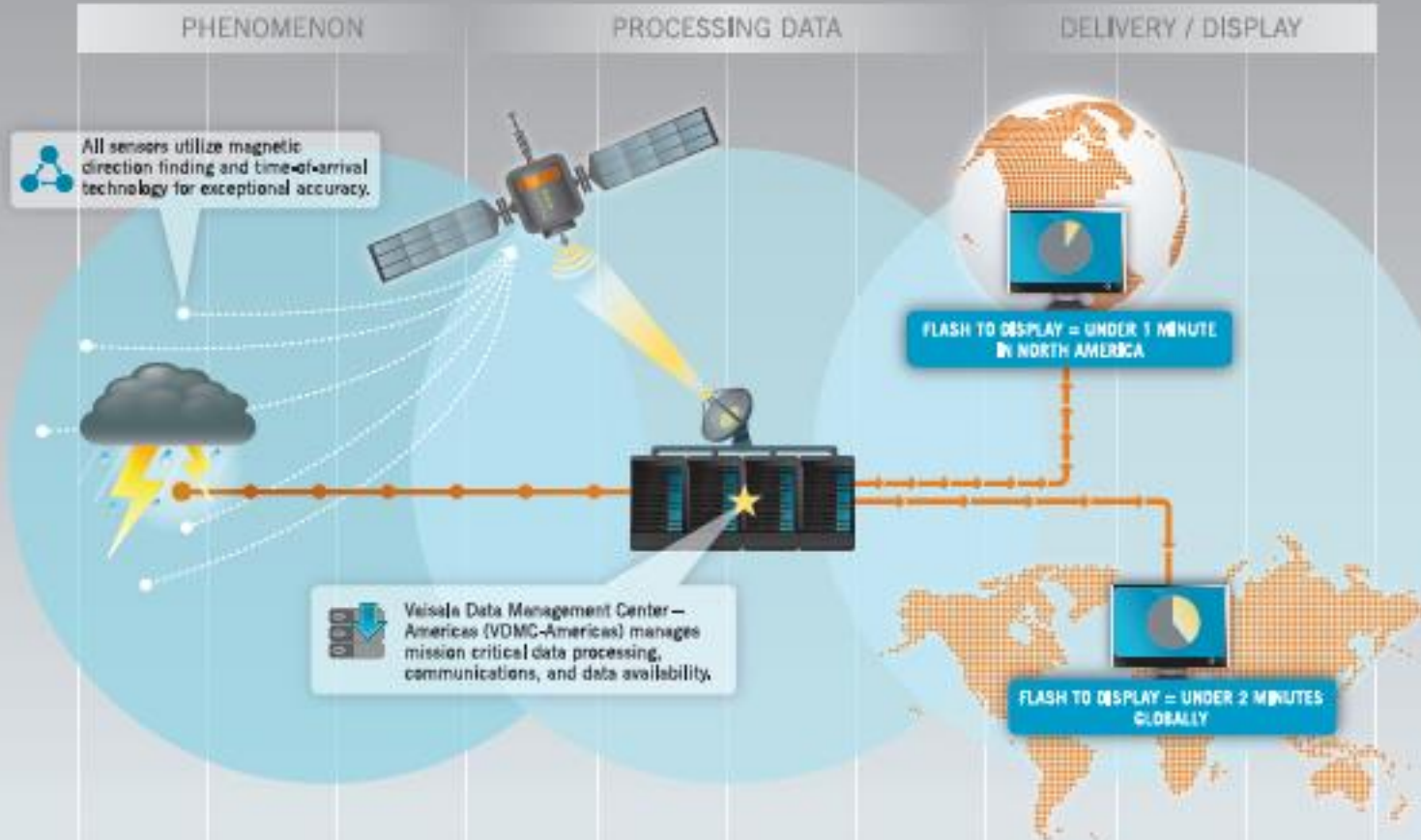
VAISALA

Vaisala Global Lightning Dataset GLD360



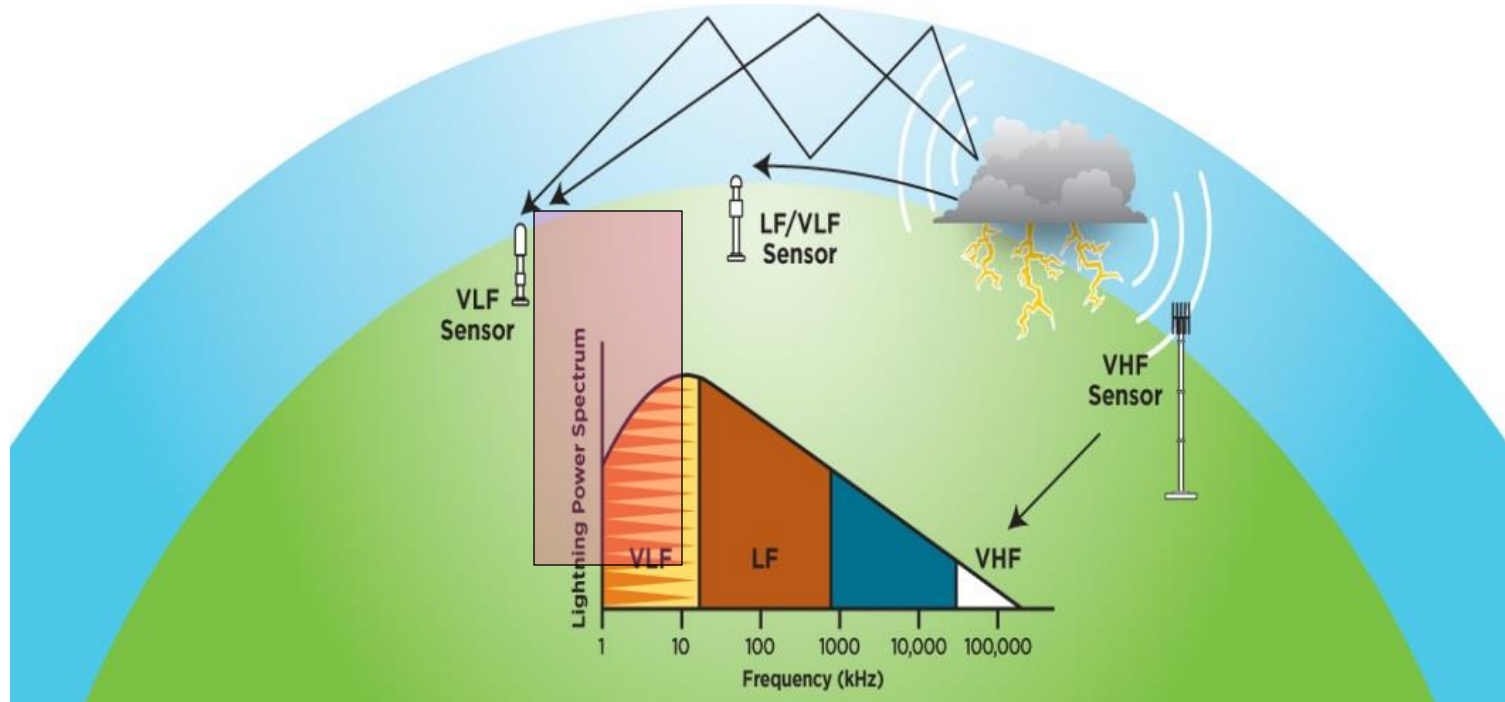
Lightning Data Flow Overview

VAISALA LIGHTNING COMMUNICATIONS PROCESS

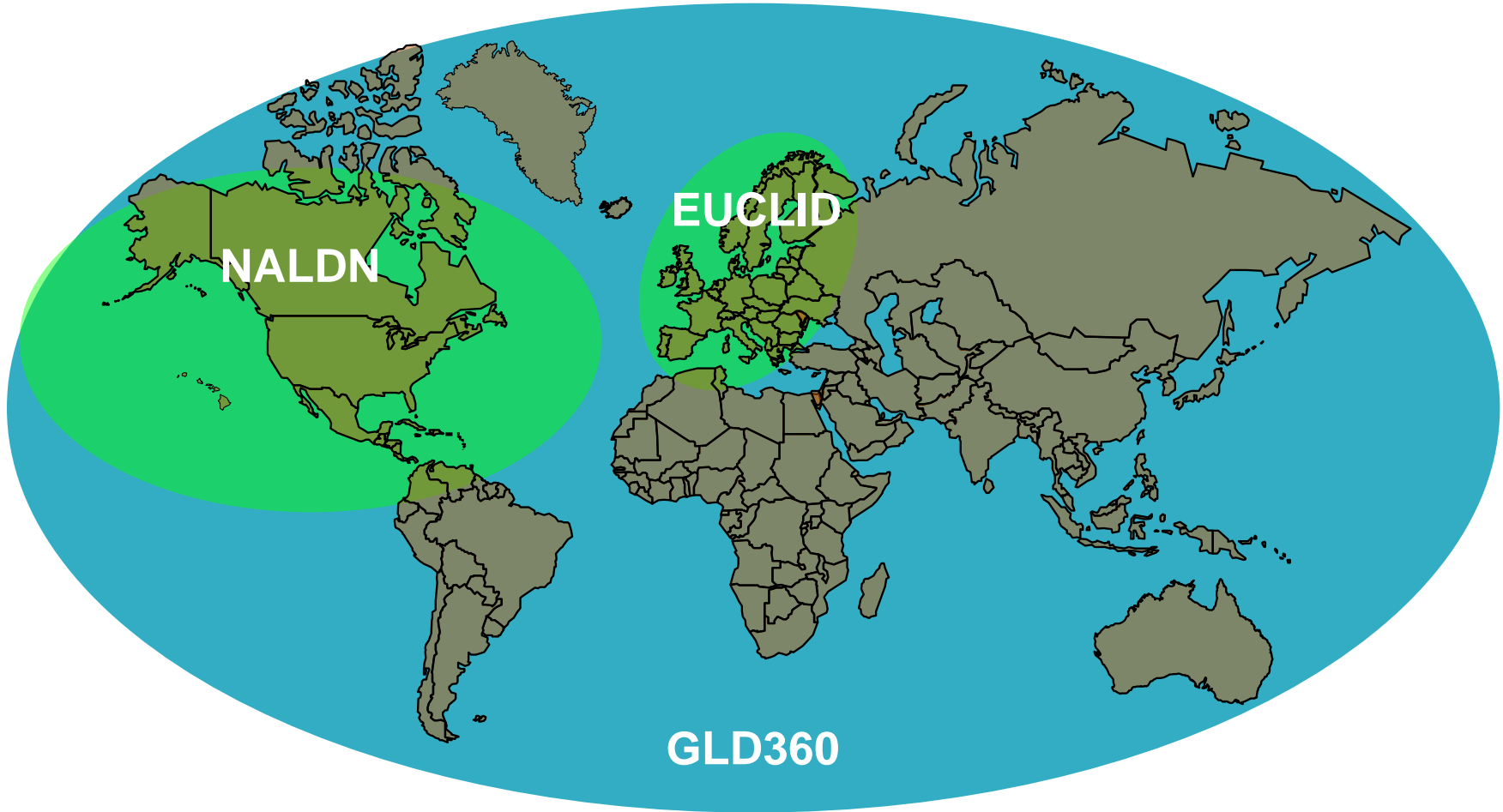


GLD360: VLF “Long-Range” Network

- Technology is based on radio wave reflective propagation between the earth and the ionosphere in Very Low Frequency area, VLF
- Utilizes again a revolutionary combined time-of-arrival (TOA) / magnetic direction finding (NDF) method for detecting and locating cloud-to-ground lightning at extreme distances

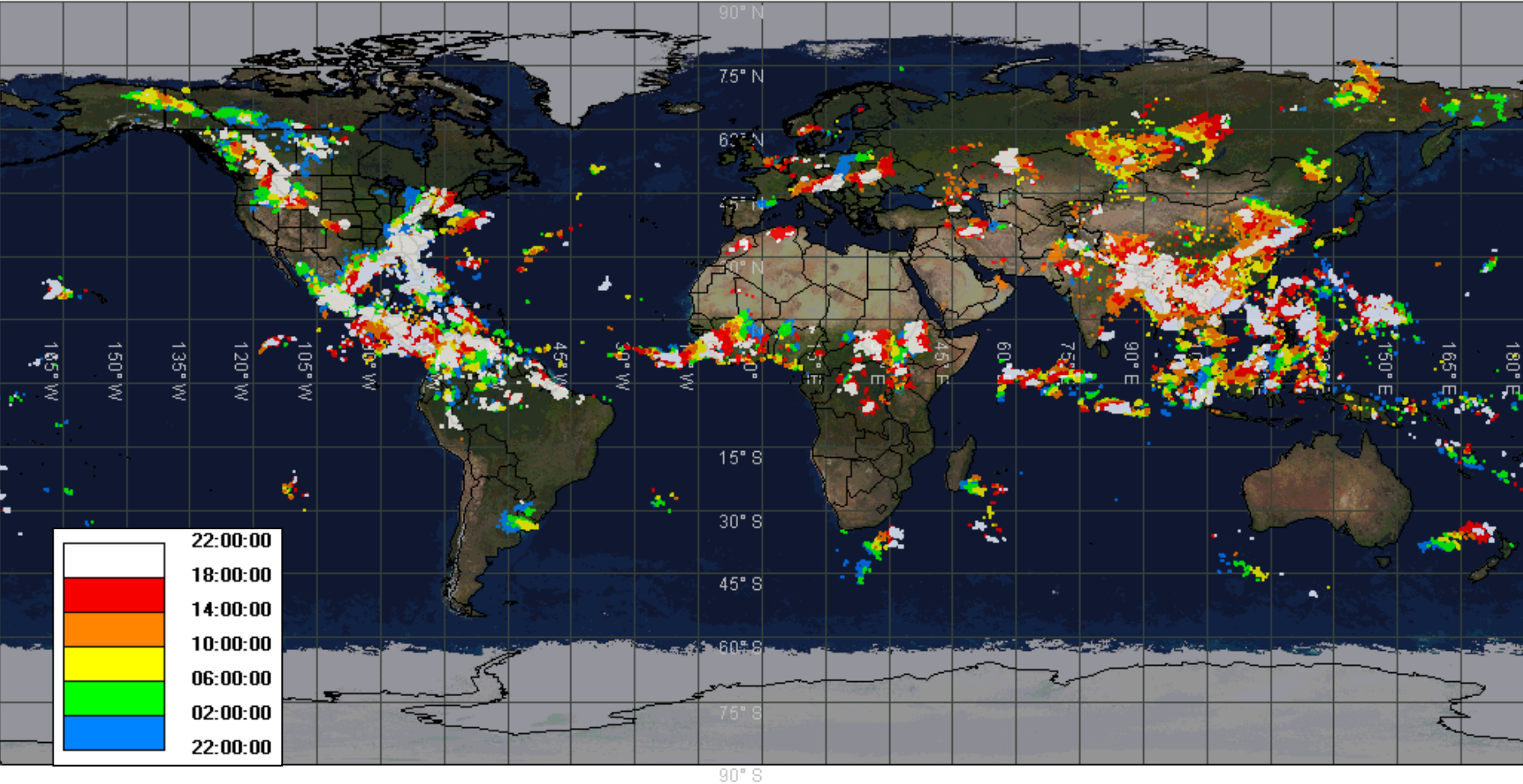


Vaisala Lightning Datasets



24 hours of GLD360 data on 23 June 2011

2,399,593 lightning locations



Vaisala GLD360 performance results

- Detection Efficiency: 70% CG with nearly uniform coverage
- Location Accuracy: 2 - 5 km median stroke location accuracy
- GLD360 also contains polarity and peak amplitude (kA) information



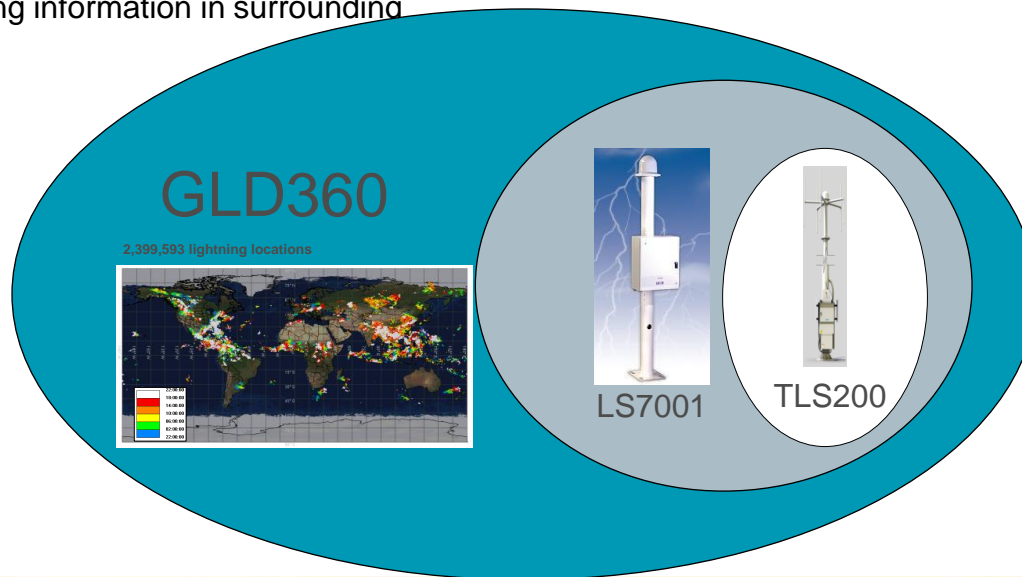
Flexible Combination of Vaisala Lightning Detection Technologies

GLD360 for various applications

- Provides immediate lightning data coverage for every country in the world
- Complimentary data set for a lightning precision network
 - Areas with limited radar coverage
 - For ocean areas
 - For large countries or countries with very challenging geometry
 - To receive lightning information in surrounding countries

Lightning precision networks

- TLS200 or LS7001 networks covering the whole country
- Flexible combinations by hybrid networks
 - TLS200 network covering the critical areas for cloud lightning detection
 - LS7001 network and / or GLD360 covering other areas of the country



Applications of lightning data

VAISALA

Lightning Information Empowers NOWCASTING, SAFETY, ASSET PROTECTION

■ Cloud-to-Ground Lightning Information

- **Electric power utilities:** Track thunderstorm threats to pre-position resources to restore power faster and to improve engineering and design with detailed lightning trends and incident analysis
- **Airports:** Suspend high-risk activities such as fueling during lightning threats
- **Telecommunications:** Prevent service interruptions by switching to alternate distribution paths when towers are threatened
- **Forestry:** Dispatch crews to suspected fire starts for more successful initial attack and investigate ignition cause
- **Insurance:** Validate or disprove insurance claims of property loss due to lightning

Lightning Information Empowers NOWCASTING, SAFETY, ASSET PROTECTION

■ Total Lightning Information

- **Meteorology:** Enables earlier and more accurate identification of severe and non-severe thunderstorm development, intensity, and dissipation. Augment radar and satellite information.
- **Hydrology:** Improve assessment of precipitation potential and flash flood hazard
- **Air traffic management:** Re-route air traffic around hazardous thunderstorms and convective weather
- **Launch facilities:** Monitor for safest weather conditions for satellite and space shuttle launches
- **Defense:** Track thunderstorm development and intensity that can impact air and ground operations
- **Airports:** Identify hazardous convective weather in the airport environment to reduce severe weather risks during take offs and landings, suspend high-risk activities such as fueling during lightning threats

Thank You!

