

Expansion of Vaisala's Long Range Lightning Detection Network (LLDN) for the T-PARC/TCS-08 field campaign

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VAISALA

Types of lightning discharge

Cloud-to-ground (CG) flash

- Negative CG flashes usually produce 3-4 “return strokes”, high-current impulses accompanied by a strong light emission.
- In the center flash, 3 strokes were resolved in time by moving the camera rapidly back and forth.



Photo © Ronald Holle 2005 with permission

Types of lightning discharge

Cloud flash (intracloud, cloud-to-cloud: anything that does not have return strokes)

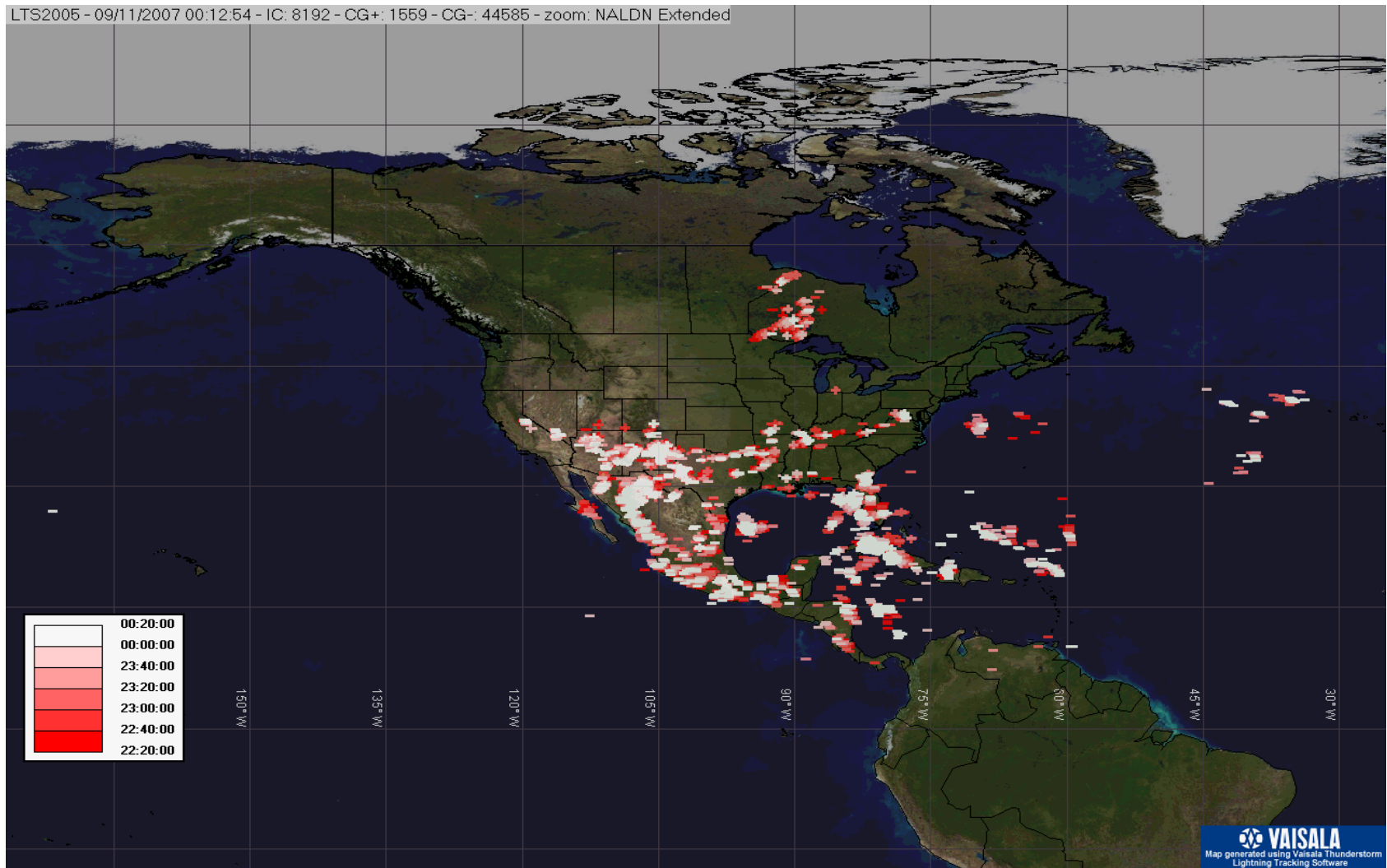
- These are the majority of discharges, comprising 60-80% typically in non severe storms and up to 99-100% in some severe storms



*Photo: NOAA Photo Library, NOAA Central Library;
OAR/ERL/National Severe Storms Laboratory (NSSL)*

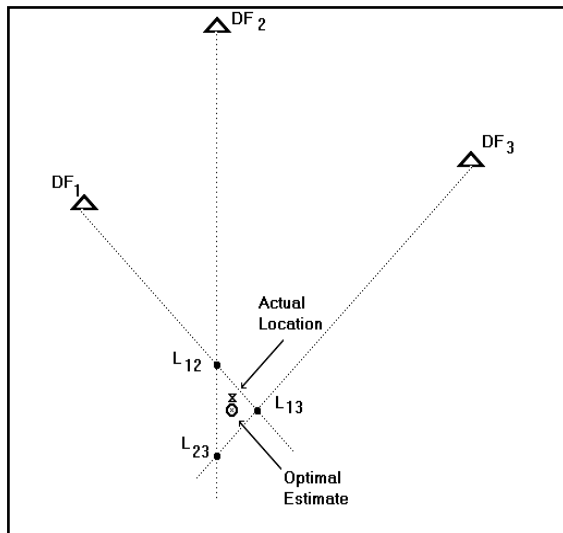
Overview of lightning detection technology

VLF long range CG lightning detection



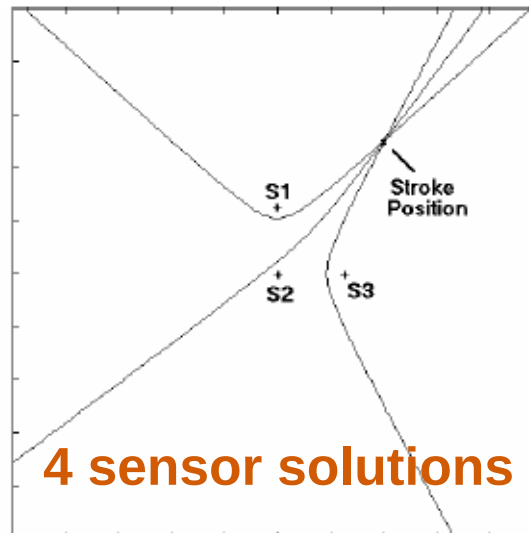
Lightning location methods

DIRECTION FINDING



Individual locations L12, L13, and L23 are triangulated locations for pairs of sensors. The optimal estimate is produced by using the direction information from all reporting sensors.

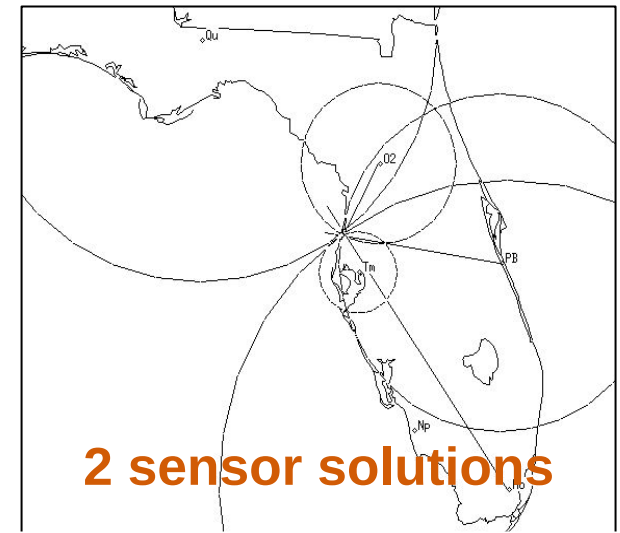
TIME OF ARRIVAL



4 sensor solutions

The location is based on the intersection of hyperbolas produced by arrival-time-differences between pairs of sensors.

COMBINED DF+TOA

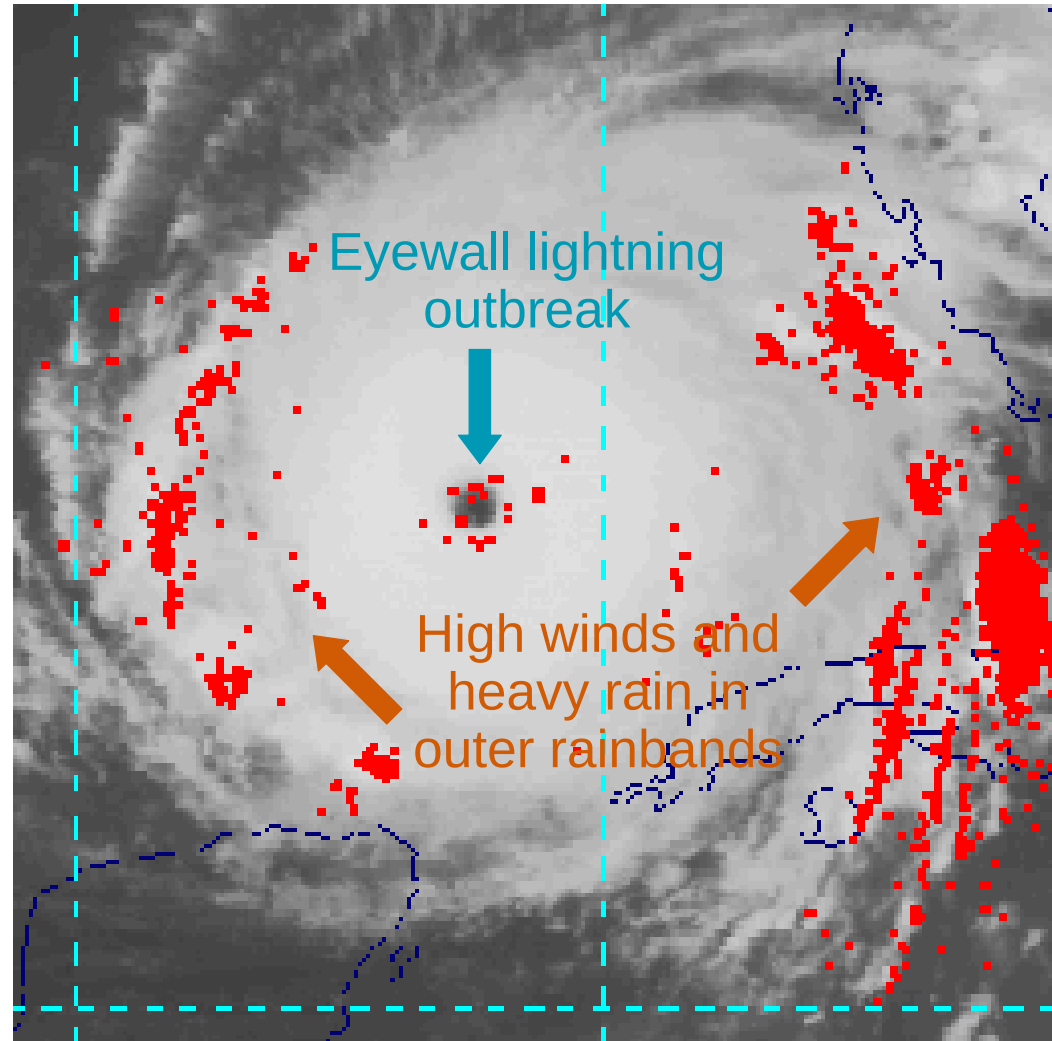


2 sensor solutions

Combined MDF + TOA technology
Location with 5 Sensors
(Least-squared Error Combination of Arrival-time and Angle)

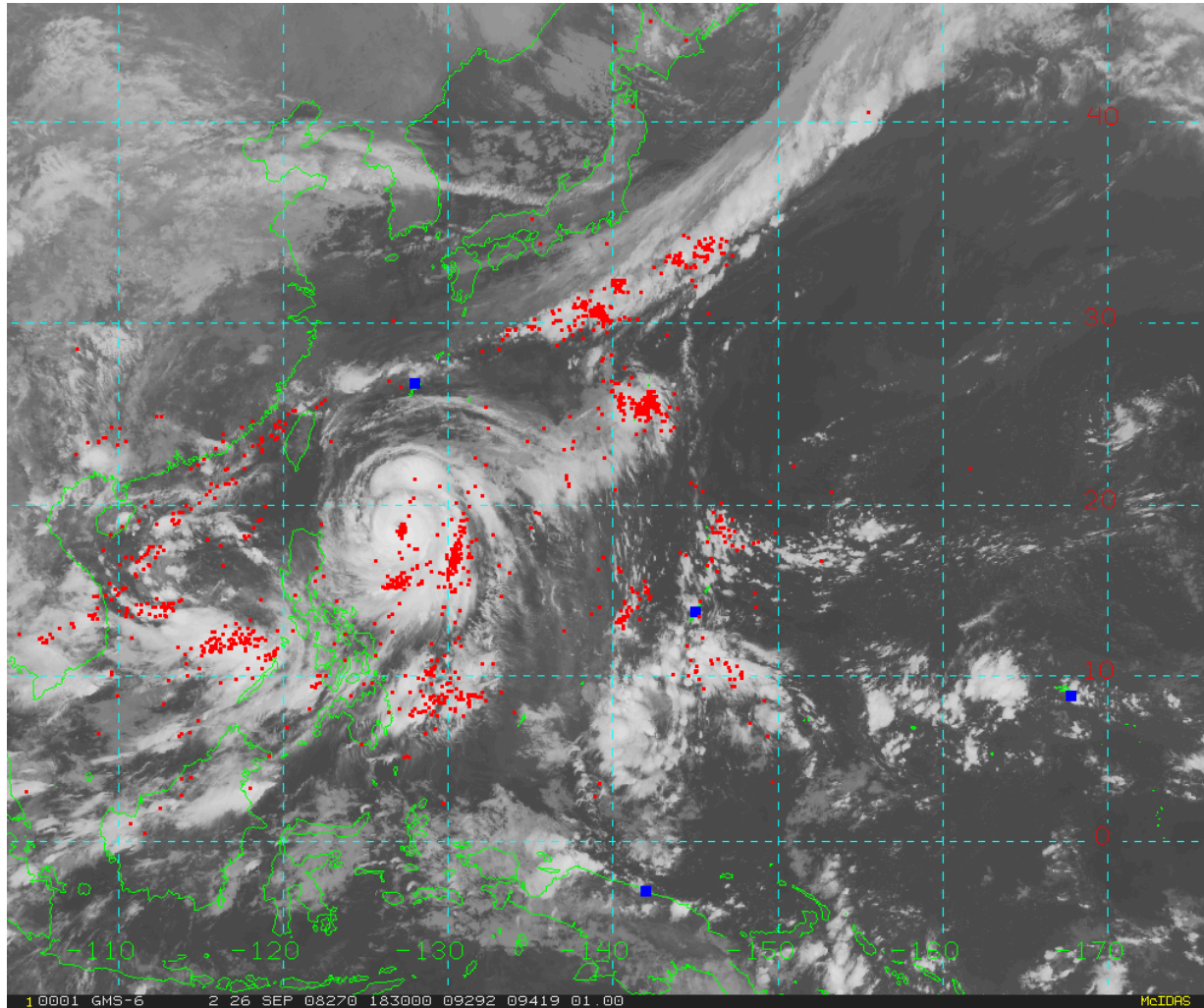
Tropical cyclone intensity diagnosis and forecasting – Hurricane Rita (2005)

- National Weather Service (NWS) National Hurricane Center (NHC) is already using Vaisala's Long Range Lightning Detection Network (LLDN) data today

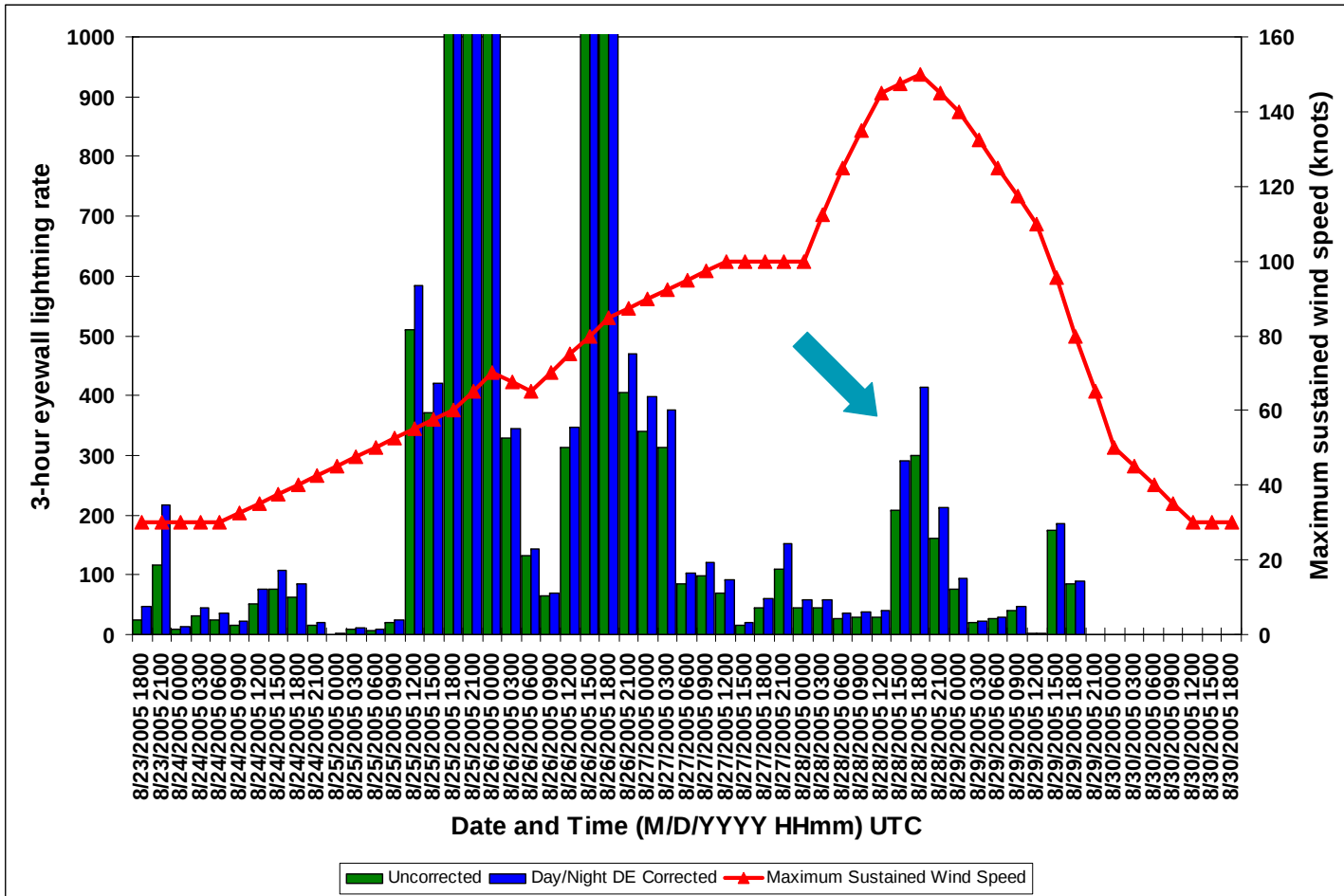


Vaisala LLDN Lightning in Typhoon Jangmi

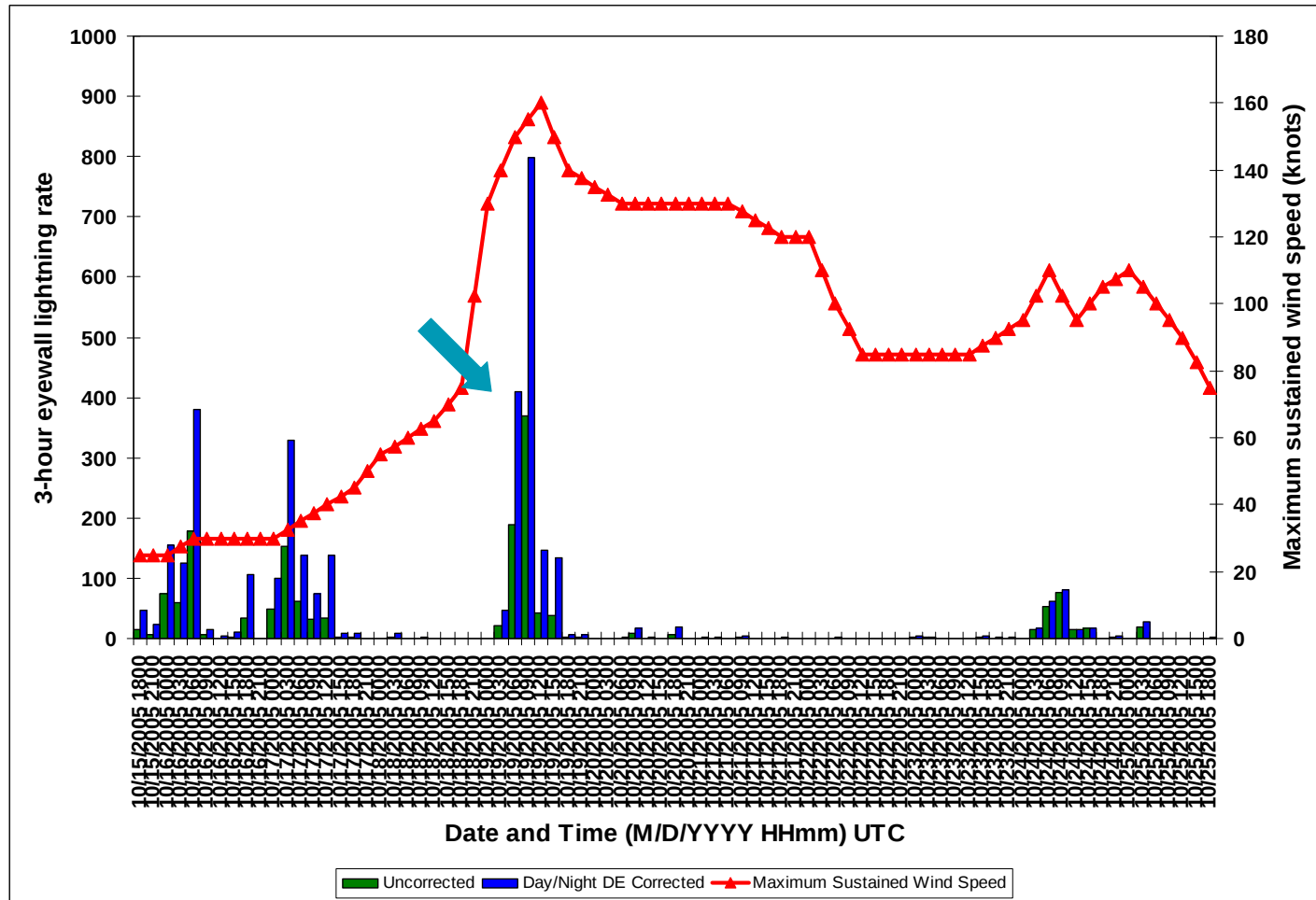
1830 UTC 26 September 2008



Tropical cyclone intensity diagnosis and forecasting – Eyewall lightning outbreak during a Hurricane Katina eyewall replacement cycle

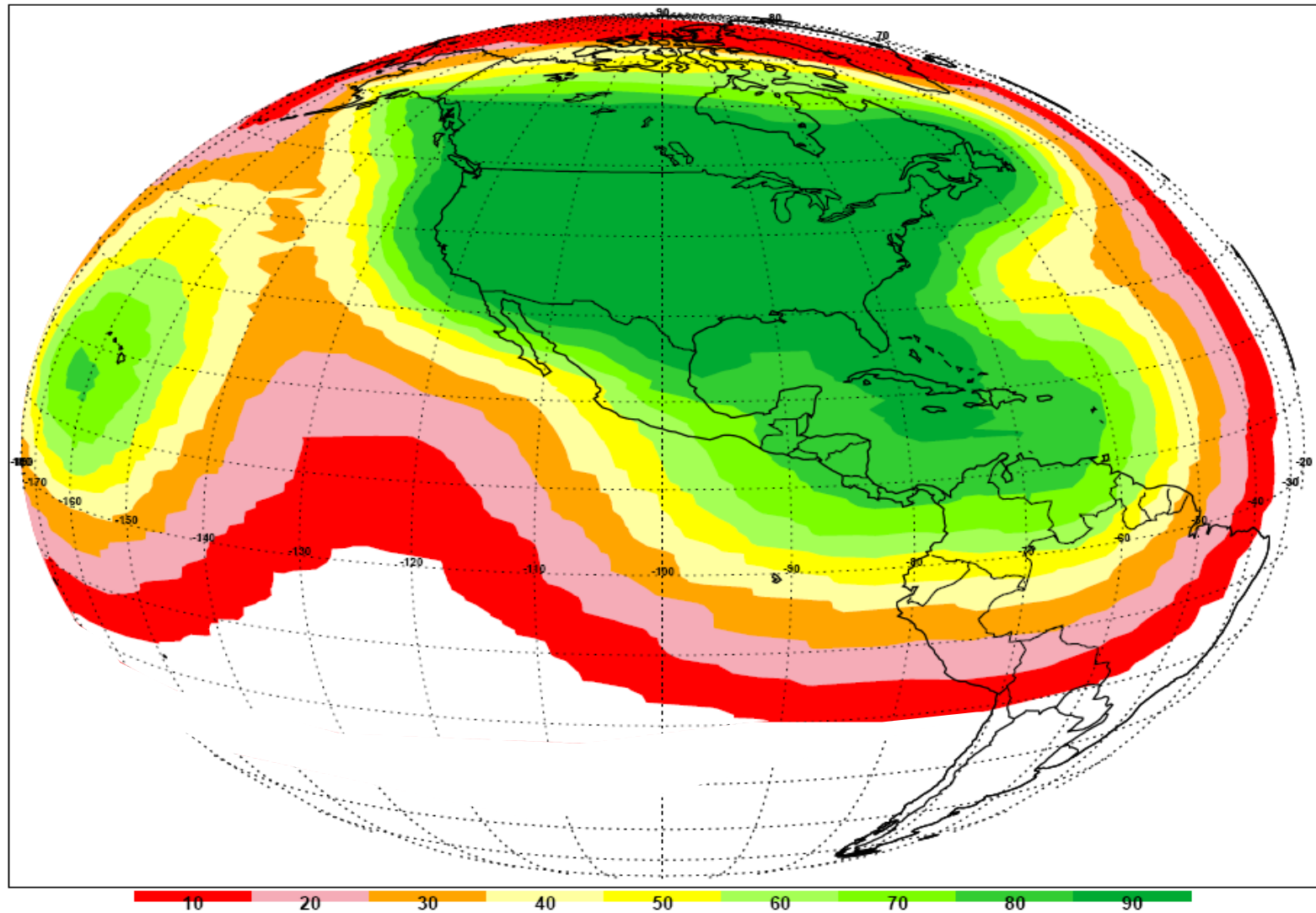


Tropical cyclone intensity diagnosis and forecasting – Eyewall lightning outbreak during a Hurricane Wilma eyewall replacement cycle



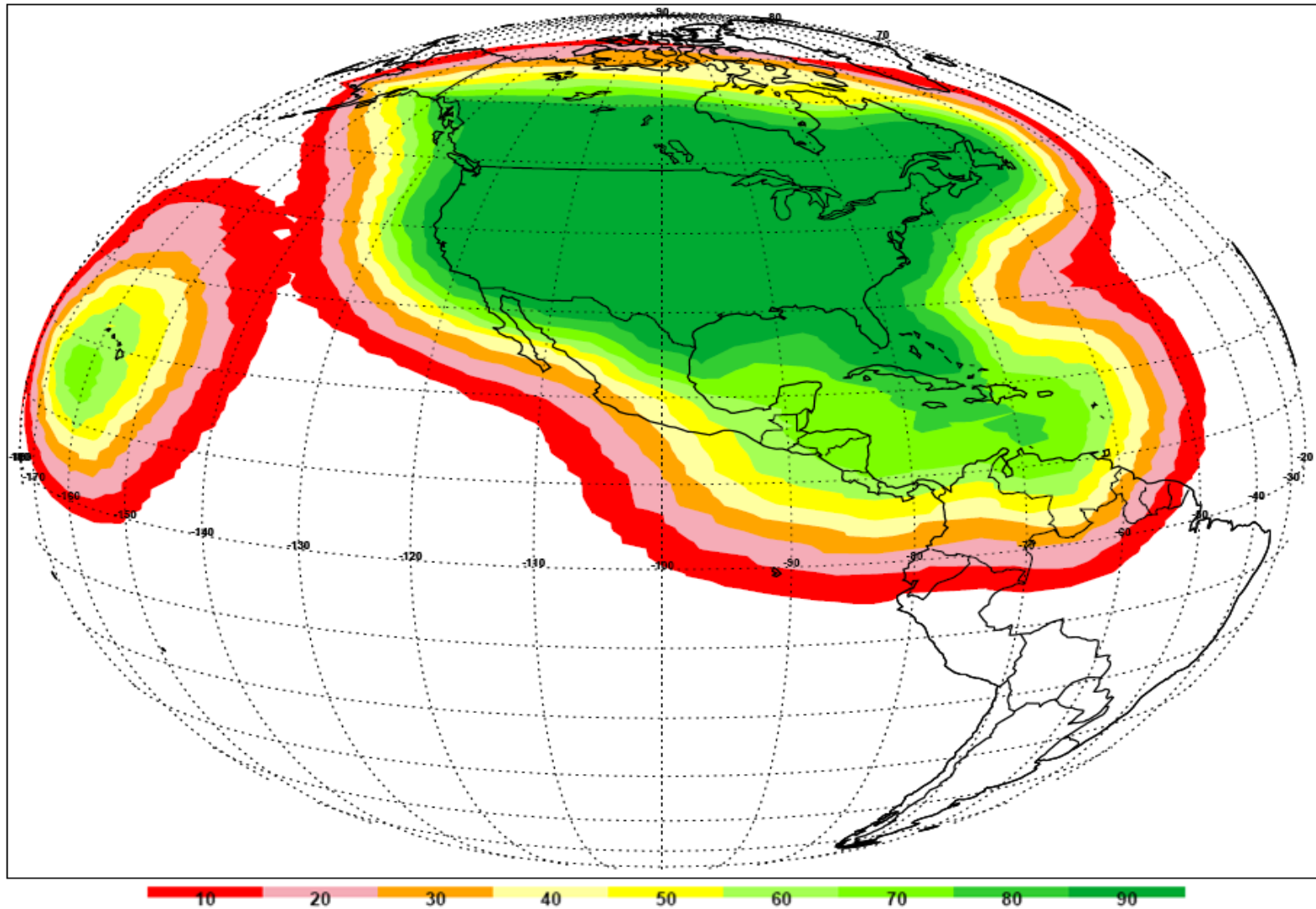
Vaisala LLDN prior to T-PARC/TCS-08 field campaign

Nighttime CG flash detection efficiency



Vaisala LLDN prior to T-PARC/TCS-08 field campaign

Daytime CG flash detection efficiency



Vaisala LLDN network expansion in support of T-PARC/TCS-08

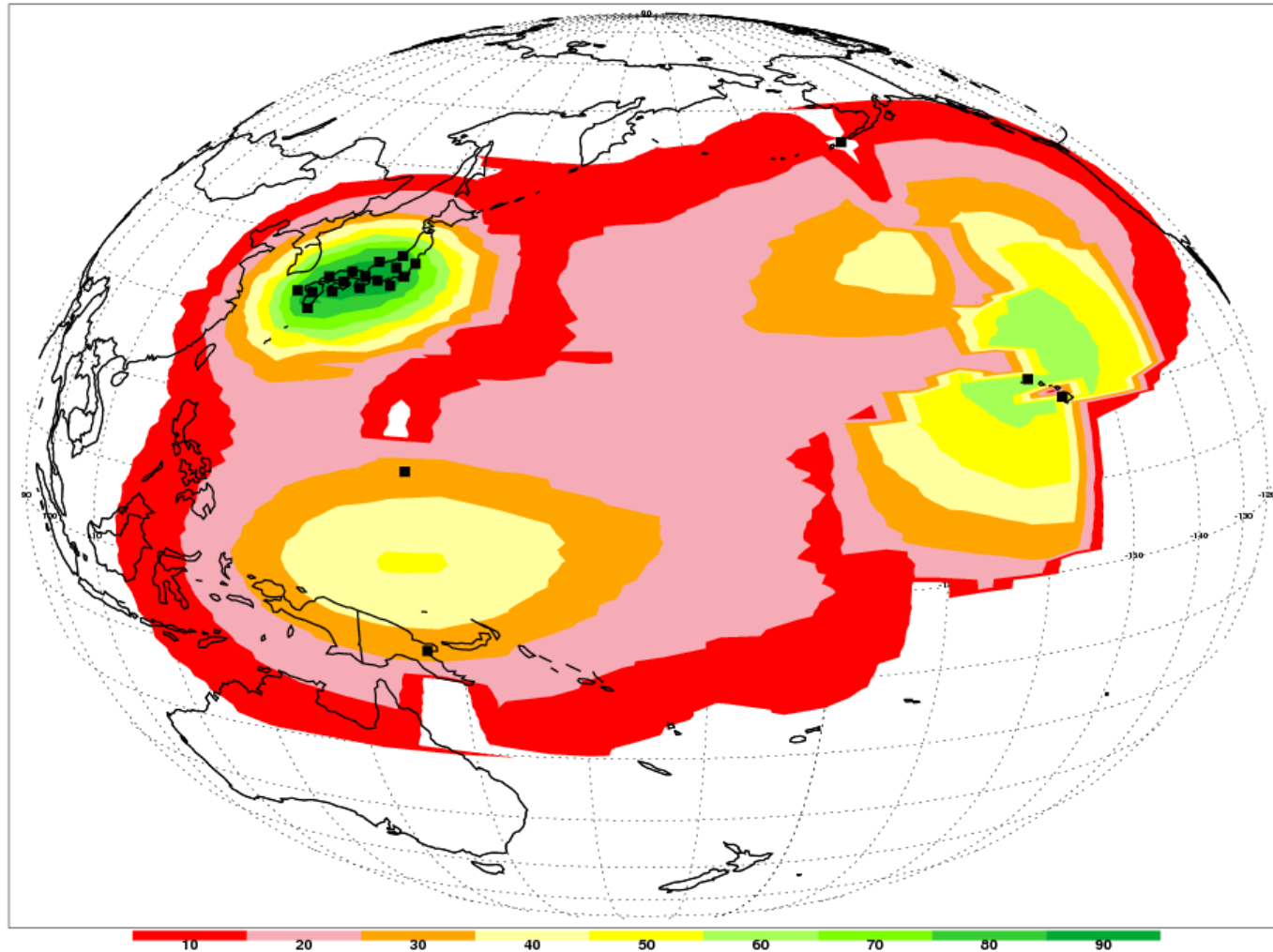
New sites	Survey	Installation	Communicating in time for field program
Guam	✓	✓	✓
Papua New Guinea	✓	✓	✓
Philippines	✓	✓	
Okinawa	✓	✓	

Vaisala LLDN network expansion in support of T-PARC/TCS-08

- In addition, Vaisala acquired limited access to 16 Franklin Japan Corporation lightning detection network sensors in support of the T-PARC/TCS-08 field campaign

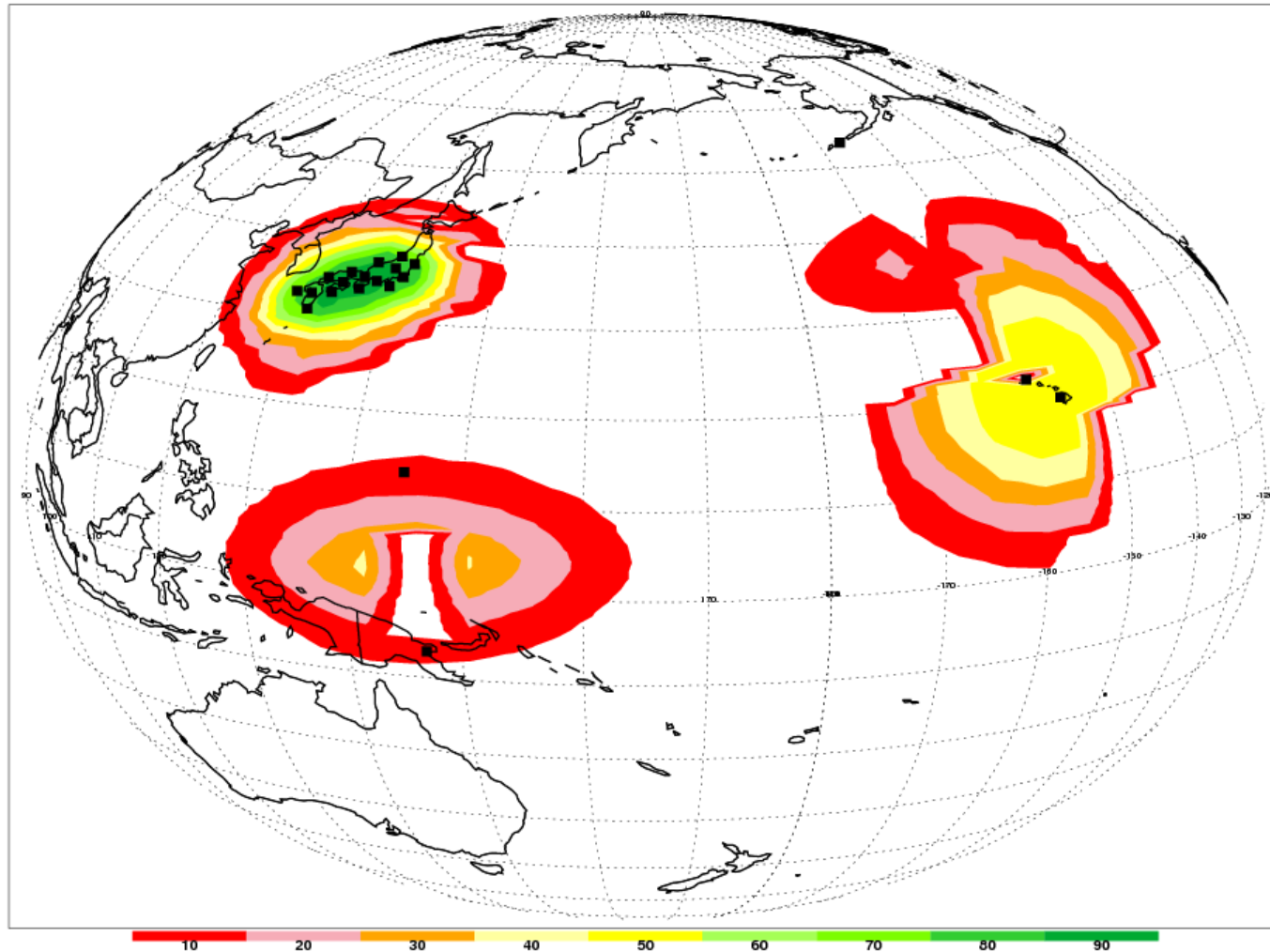
Vaisala Long Range Lightning Detection Network (LLDN)

Nighttime cloud-to-ground (CG) lightning flash detection efficiency during 1 August – 30 September 2009 time period



Vaisala LLDN

Daytime CG lightning flash detection efficiency during
1 August – 30 September 2009 time period



Limitations of Vaisala LLDN network performance in the Western Pacific during the T-PARC/TCS-08 field campaign

- **CG flash detection efficiency**
 - Variable over the T-PARC/TCS-08 domain
 - Performs better at night than during the day
- **CG stroke median location accuracy**
 - Varies between 10-100 km, depending on network geometry
- **Outlier (or grossly mis-located) lightning events**
 - Fraction of outlier lightning events can be high at times
 - Strict QC to remove outlier lightning events substantially reduces CG detection efficiency
 - Please use lightning data in conjunction with satellite data to easily identify outlier lightning events
 - Vaisala will distribute an updated lightning dataset, if it finds a better way to reduce outliers without degrading CG flash detection efficiency

Vaisala LLDN T-PARC/TCS-08 data archive

- University of Hawaii to host Vaisala LLDN T-PARC/TCS-08 data archive
- Time period: 1 August – 30 September 2008
- Region: Western North Pacific Ocean
- Data type: CG lightning stroke data
- T-PARC/TCS-08 participant/collaborator is required to sign a copy of Vaisala's "Policy on Research Requests for Lightning Data" document

Vaisala LLDN data format

- Fixed width text
- Field 1 = date (YYYY-MM-DD)
- Field 2 = time (ms)
- Field 3 = latitude (degrees)
- Field 4 = longitude (degrees)
- Field 5 = length of the semi-major axis of the error ellipse (km)
- Field 6 = chi square (or agreement among sensors)