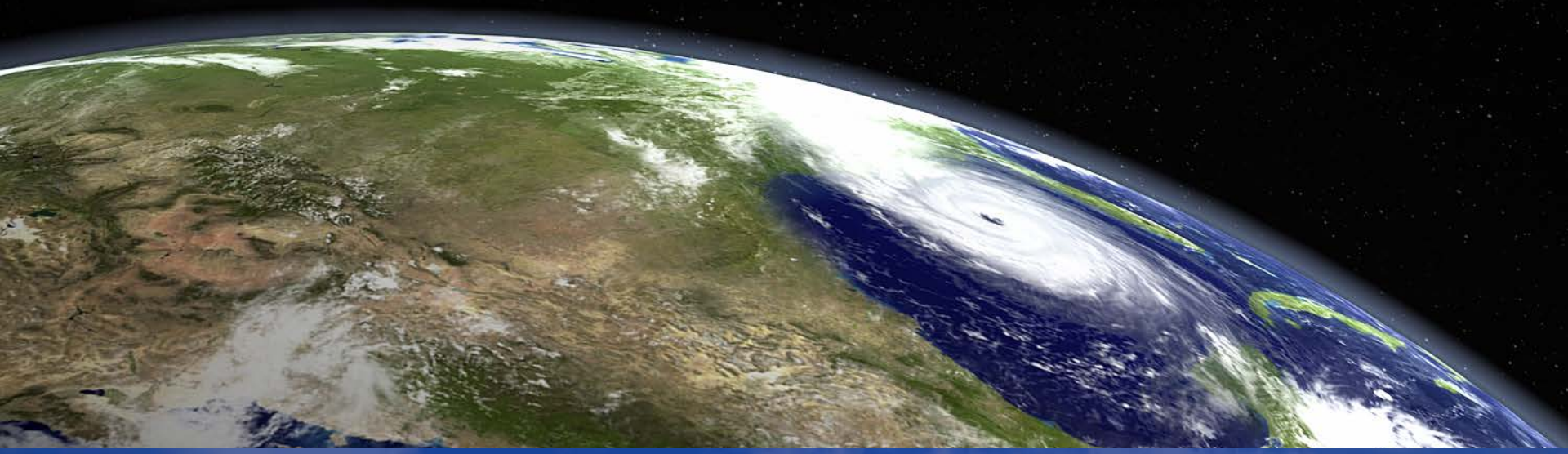
Earth Networks℠

Taking the Pulse of the Planet℠

Improving Aviation Safety with Severe Weather Nowcasting Solutions



Jim Anderson – VP, International
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Our Sensor Network Platforms

Total Lightning

Weather

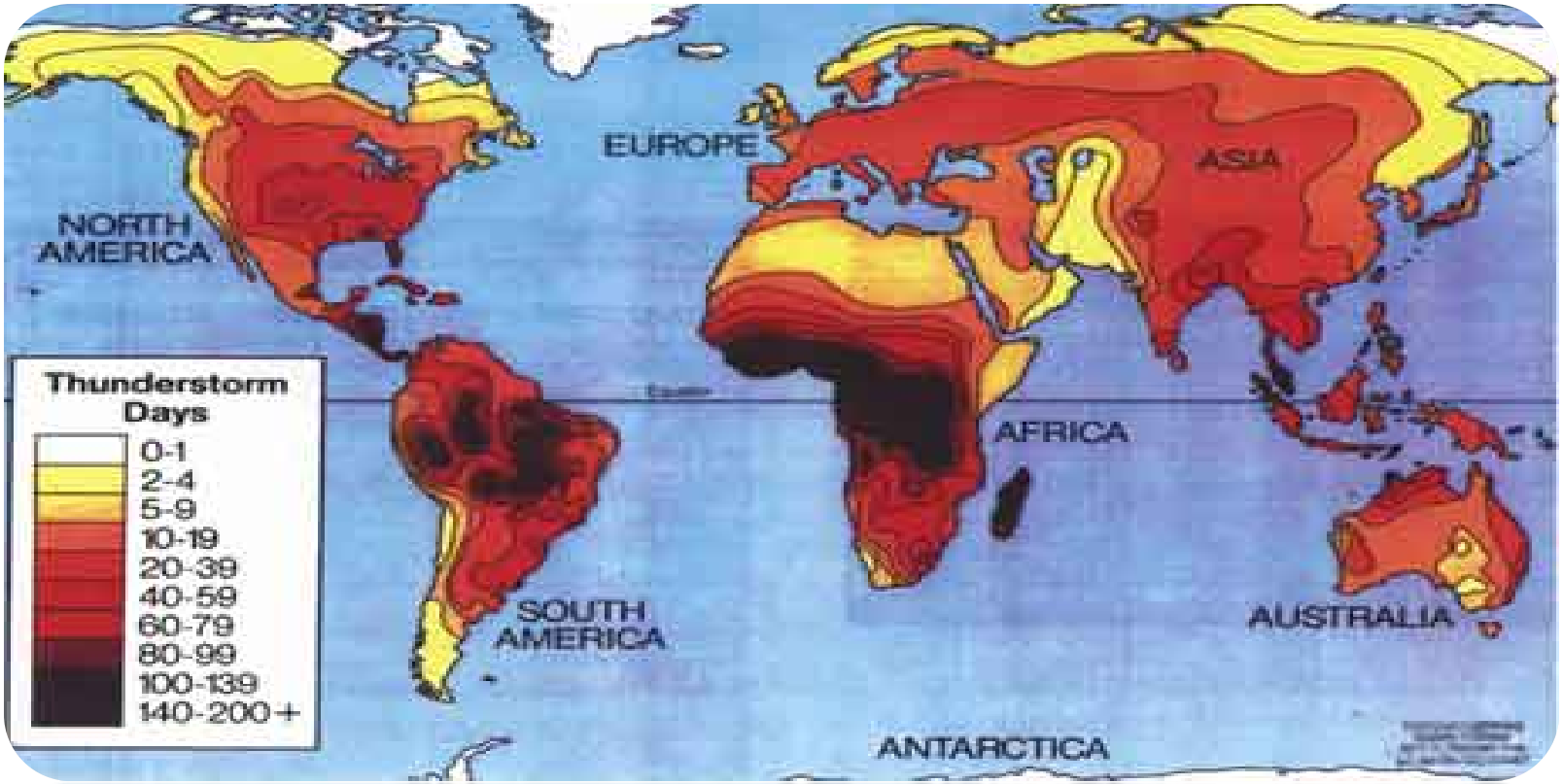
Greenhouse Gas

Boundary Layer

Camera

Earth Networks
Taking the Pulse of the Planet

Thunderstorms – A frequent type of severe weather around the world



- Thunderstorm Days/Year, Courtesy of NLSI

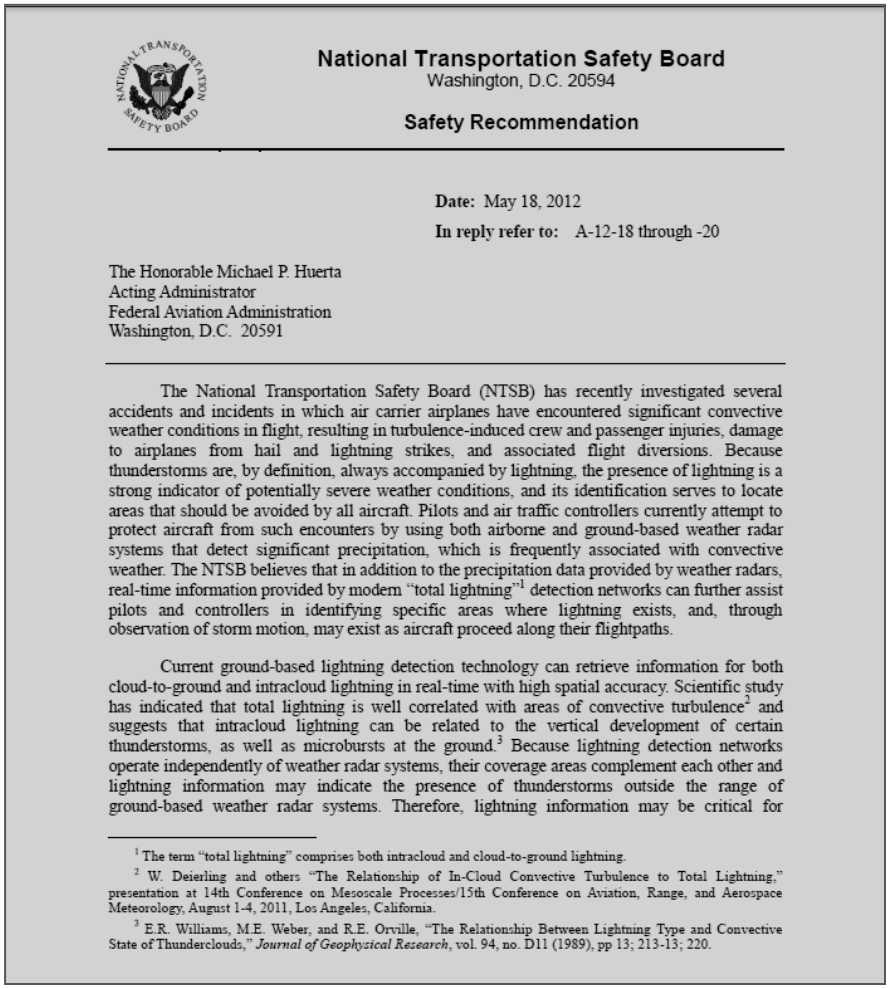
Weather Risks in the Aviation Industry

- Turbulence-induced crew and passenger injuries
- Damage to aircraft resultant from hail and lightning strikes
- Associated flight diversions
- Ground operation safety

Lightning is a root cause and contributing factor to most severe weather events

National Transportation Safety Board Recommendations

- NTSB investigated lightning and its effects on air travel
- Reaffirmed that lightning can be extremely hazardous for aircraft
- Total lightning (in-cloud and cloud-to-ground lightning) = areas of developing and existing thunderstorms
- Total lightning = areas of convective turbulence and icing



National Transportation Safety Board
Washington, D.C. 20594

Safety Recommendation

Date: May 18, 2012
In reply refer to: A-12-18 through -20

The Honorable Michael P. Huerta
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

The National Transportation Safety Board (NTSB) has recently investigated several accidents and incidents in which air carrier airplanes have encountered significant convective weather conditions in flight, resulting in turbulence-induced crew and passenger injuries, damage to airplanes from hail and lightning strikes, and associated flight diversions. Because thunderstorms are, by definition, always accompanied by lightning, the presence of lightning is a strong indicator of potentially severe weather conditions, and its identification serves to locate areas that should be avoided by all aircraft. Pilots and air traffic controllers currently attempt to protect aircraft from such encounters by using both airborne and ground-based weather radar systems that detect significant precipitation, which is frequently associated with convective weather. The NTSB believes that in addition to the precipitation data provided by weather radars, real-time information provided by modern "total lightning"[1] detection networks can further assist pilots and controllers in identifying specific areas where lightning exists, and, through observation of storm motion, may exist as aircraft proceed along their flightpaths.

Current ground-based lightning detection technology can retrieve information for both cloud-to-ground and intracloud lightning in real-time with high spatial accuracy. Scientific study has indicated that total lightning is well correlated with areas of convective turbulence[2] and suggests that intracloud lightning can be related to the vertical development of certain thunderstorms, as well as microbursts at the ground.[3] Because lightning detection networks operate independently of weather radar systems, their coverage areas complement each other and lightning information may indicate the presence of thunderstorms outside the range of ground-based weather radar systems. Therefore, lightning information may be critical for

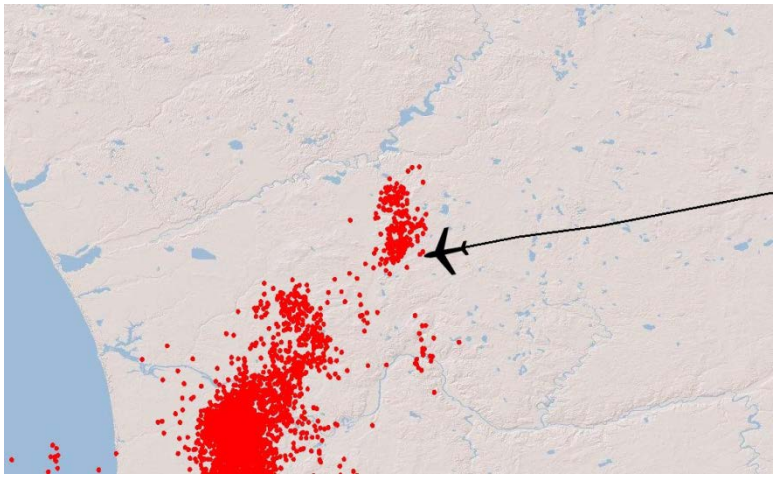
[1] The term "total lightning" comprises both intracloud and cloud-to-ground lightning.

[2] W. Deierling and others "The Relationship of In-Cloud Convective Turbulence to Total Lightning," presentation at 14th Conference on Mesoscale Processes/15th Conference on Aviation, Range, and Aerospace Meteorology, August 1-4, 2011, Los Angeles, California.

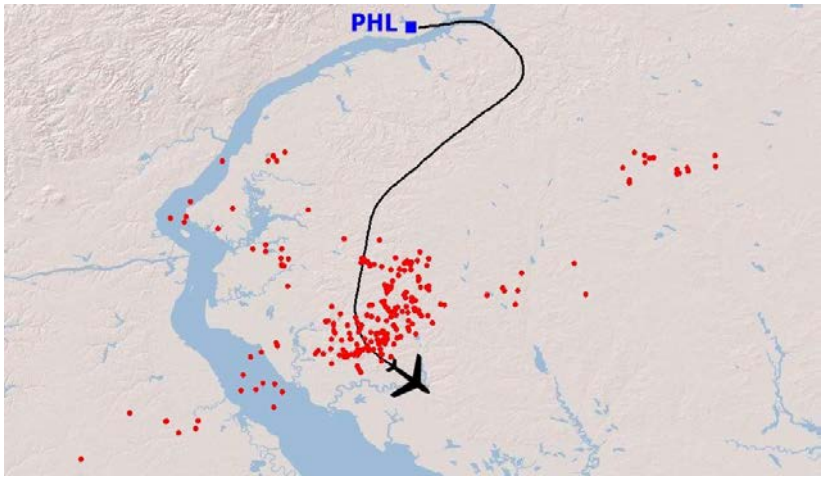
[3] E.R. Williams, M.E. Weber, and R.E. Orville, "The Relationship Between Lightning Type and Convective State of Thunderclouds," *Journal of Geophysical Research*, vol. 94, no. D11 (1989), pp 13; 213-13; 220.

NTSB - Case Studies

- **Pinnacle Airlines Flight 4018, 7/1/11 Grand Rapids, MI**
- Experienced hail, damage to wings and radome
- *Radar flight crew saw no precipitation*
- Lightning detection noted an area of dense IC lightning activity ahead



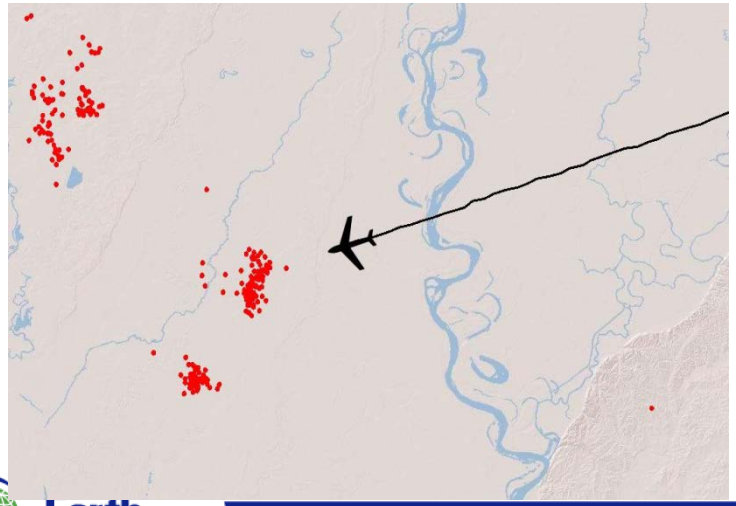
- **US Airways flight 1209, 8/14/11 Philadelphia, PA**
- Struck by lightning at 16,000ft, emergency landing
- *Radar 'moderate rain and turbulence'*
- Actually moderate to severe w/ multiple IC lightning strokes



NTSB - Case Studies

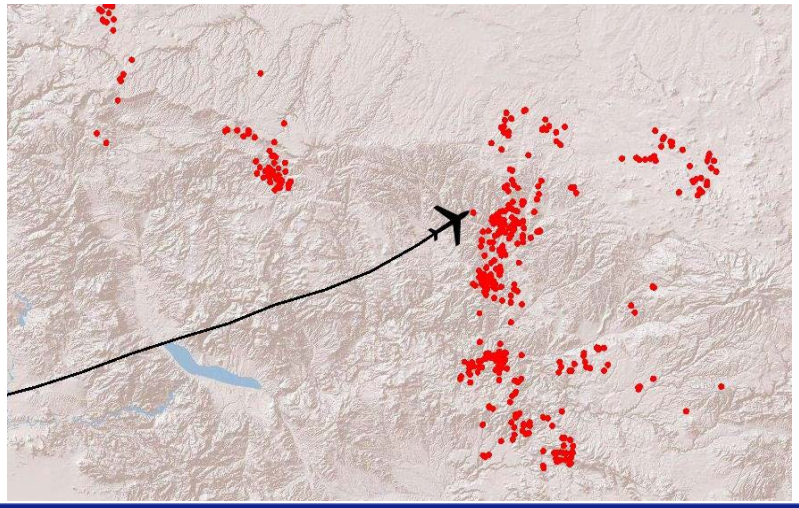
American Eagle Flight 3224, 6/28/10 Pioneer, LA

- Underwent Emergency Landing
- *Radar missed area of turbulence*
- ENTLN detected significant IC lightning strokes 20 minutes prior to the encounter



American Airlines Flight 1894, 8/18/12 Show Low, AZ

- Emergency landing after severe icing conditions at 33,000ft
- *Radar only saw moderate precipitation*
- ENTLN detected significant IC lightning strokes 20 minutes prior to encounter



Earth Networks Total Lightning Network

More than 700 sensors providing long range detection of In-cloud and Cloud-to-Ground Lightning

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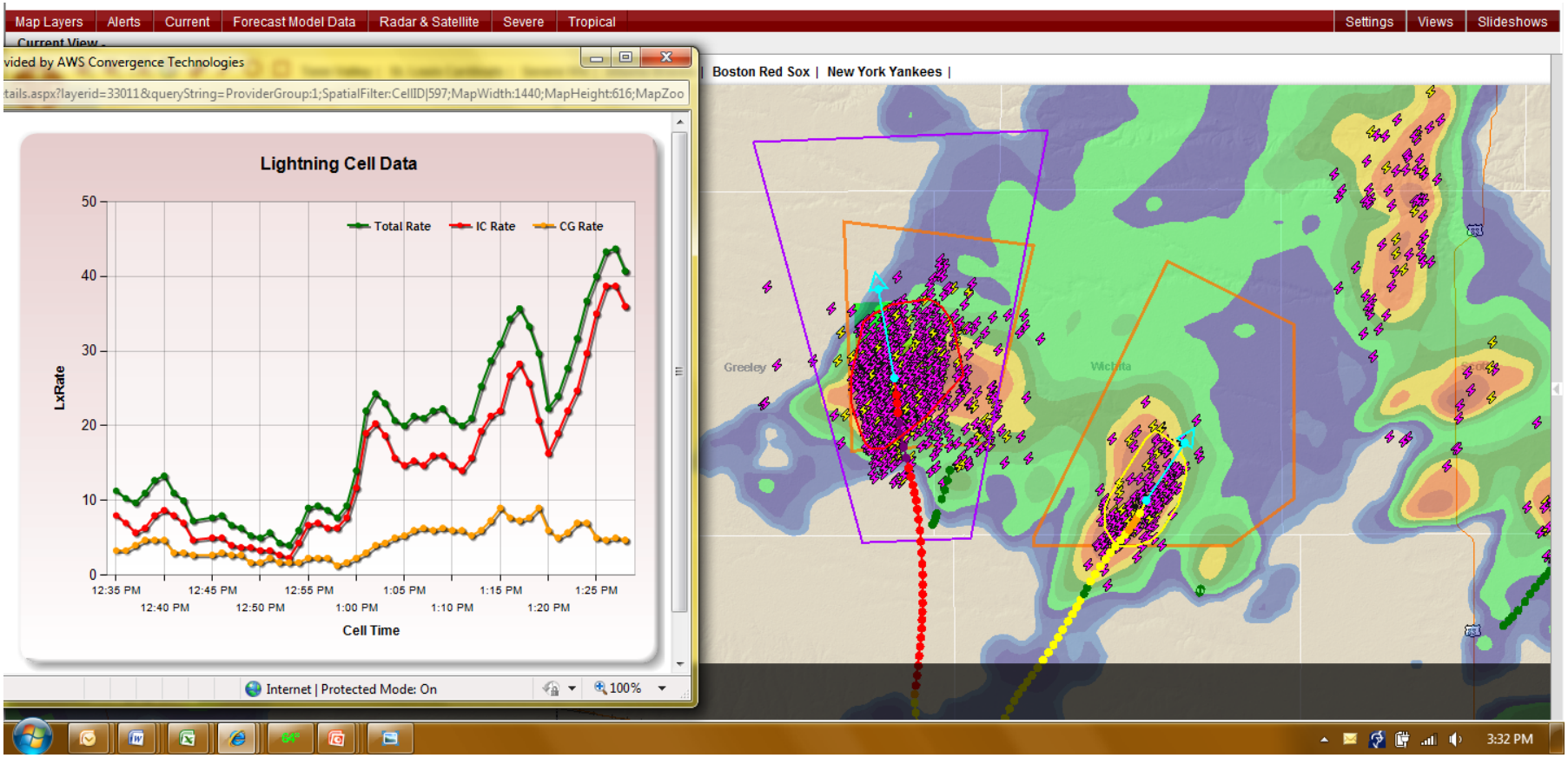
Dangerous Thunderstorm Alerts



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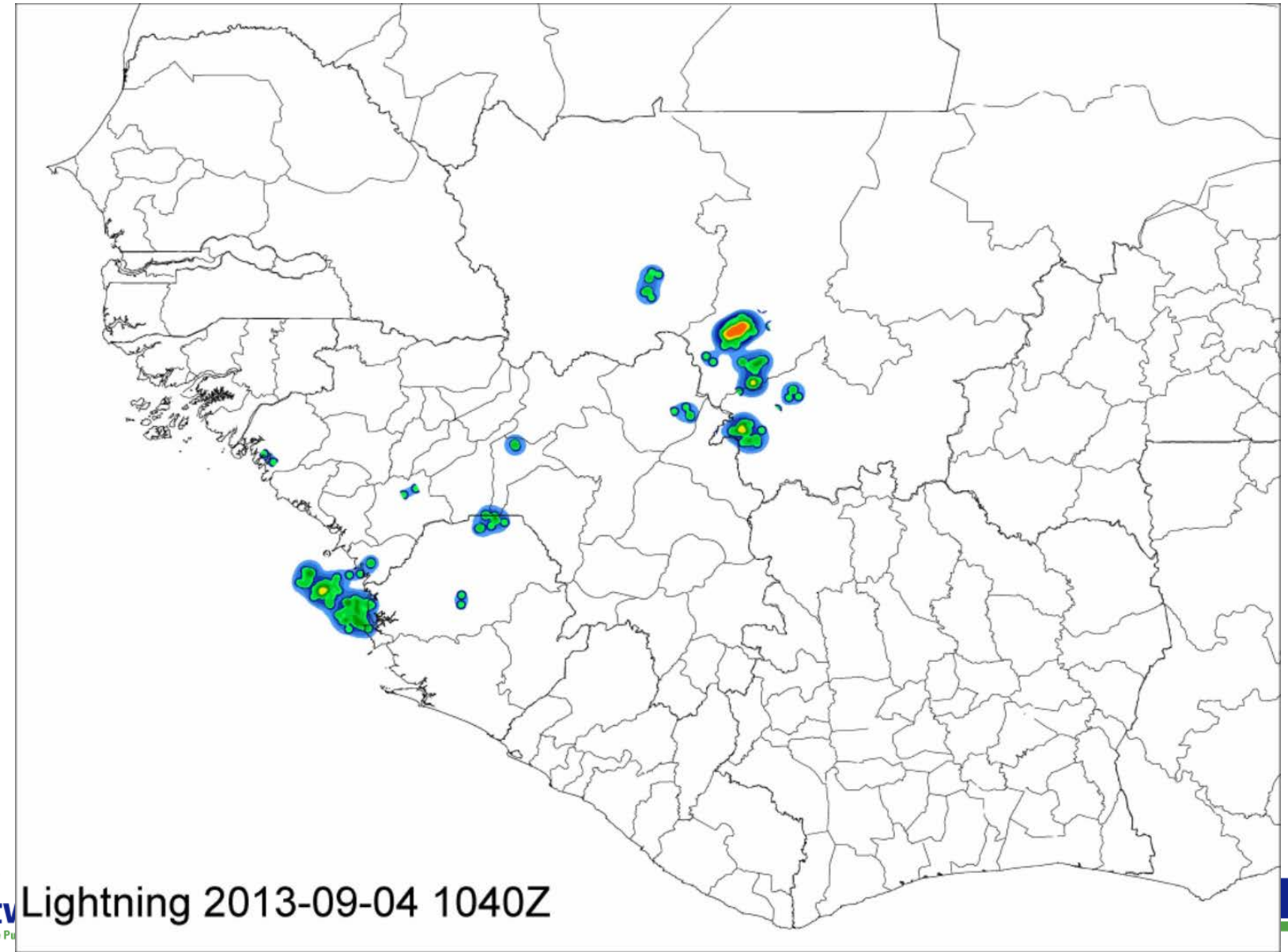
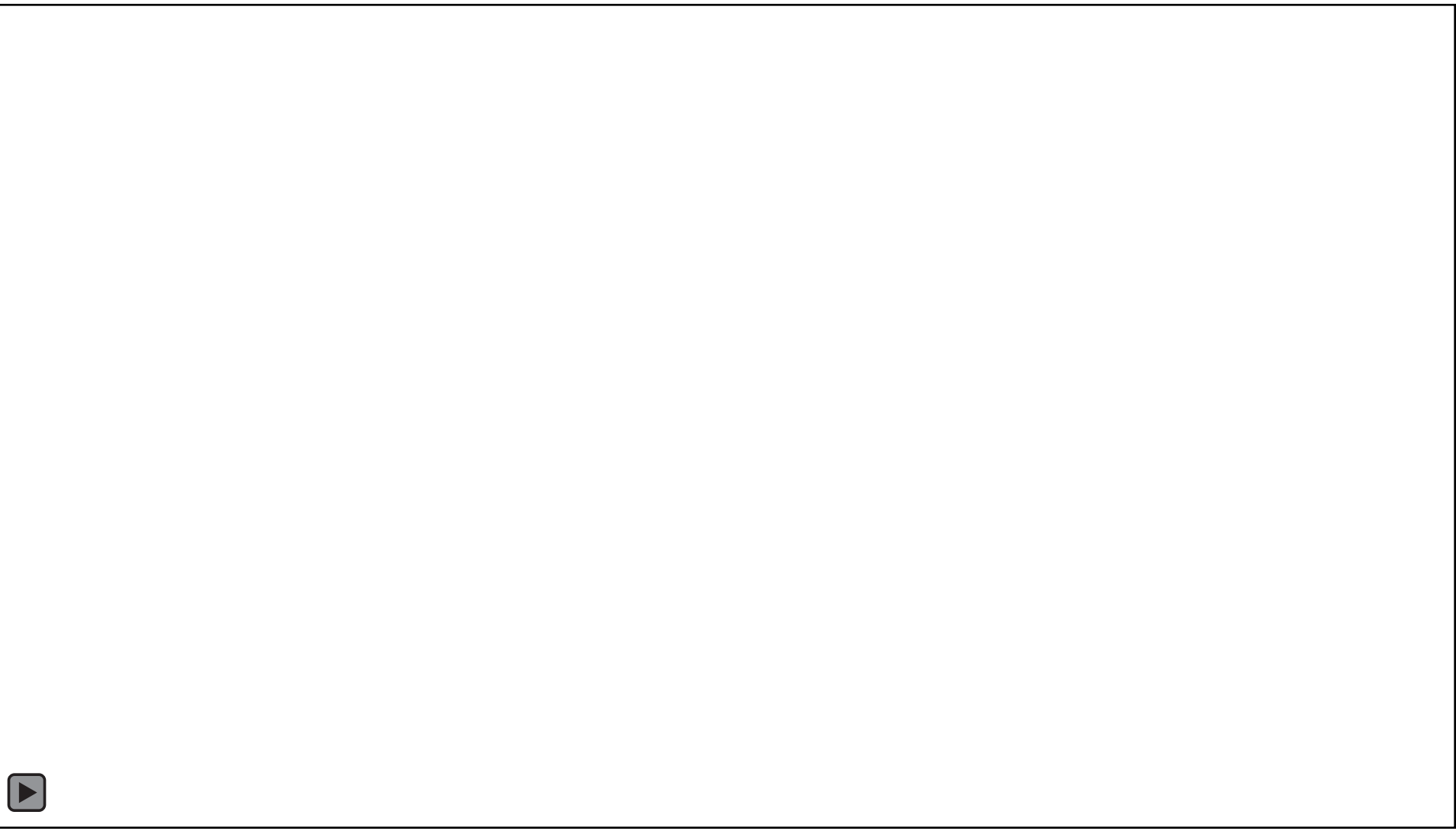
Guinea Example



Leap Day Tornado Outbreak

February 29, 2012



Total Lightning Yields 50% Increase in Lead Time

Earth Networks
Dangerous Thunderstorm Alert (DTA)

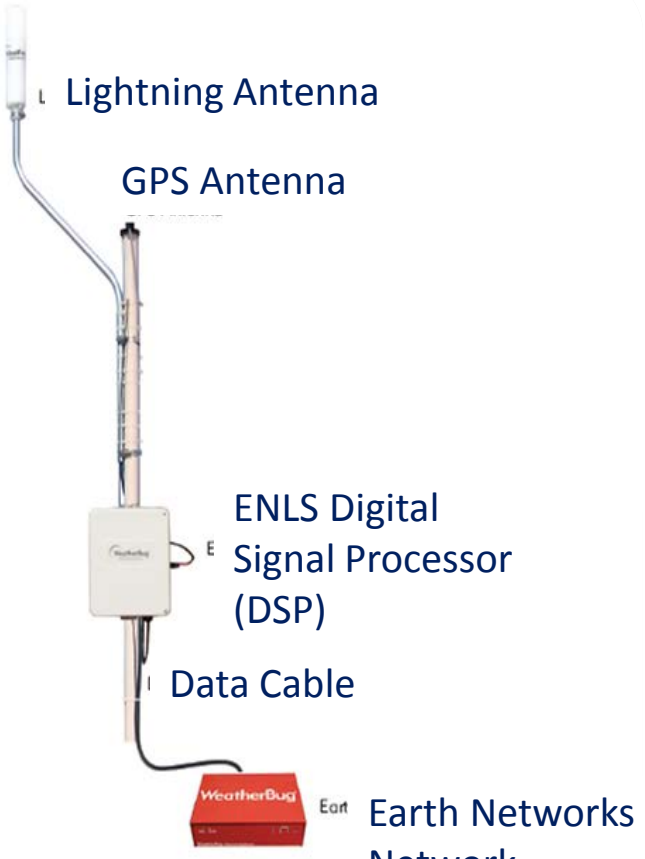
27 Minutes

NWS Severe T'Storm & Tornado Warnings

18 Minutes

Earth Networks Total Lightning System

- ✓ Most Modern System
- ✓ Easily Deployable
- ✓ National Scale Total Lightning Detection
- ✓ Highest Degree of Location Accuracy and Detection Efficiency

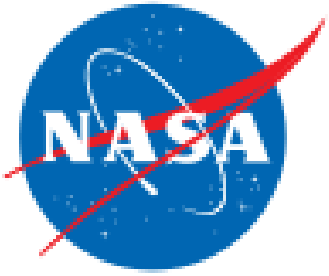


Earth Networks Lightning Sensor

Alerting System

- Omni-directional
- Equipped with 1 or more 110 dBa horn units
- 170,000 peak candela strobe light
- Indoor component includes internal loudspeaker with adjustable volume for indoor alerting
- Web-based interface for configuration of alert distance, hours of operation, alert duration

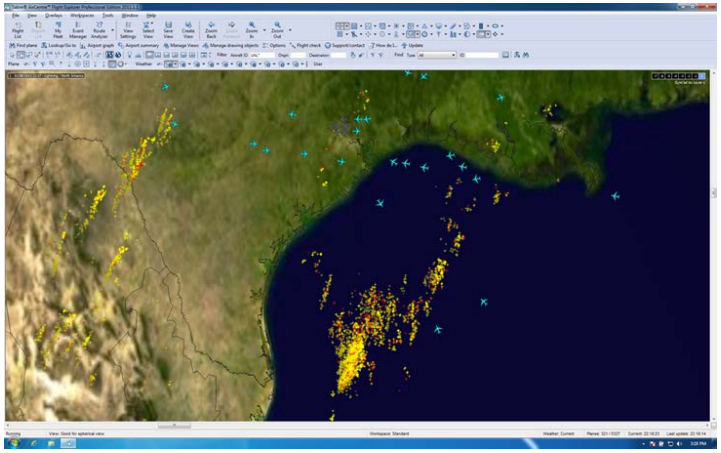
Select Aviation Clients and Partners

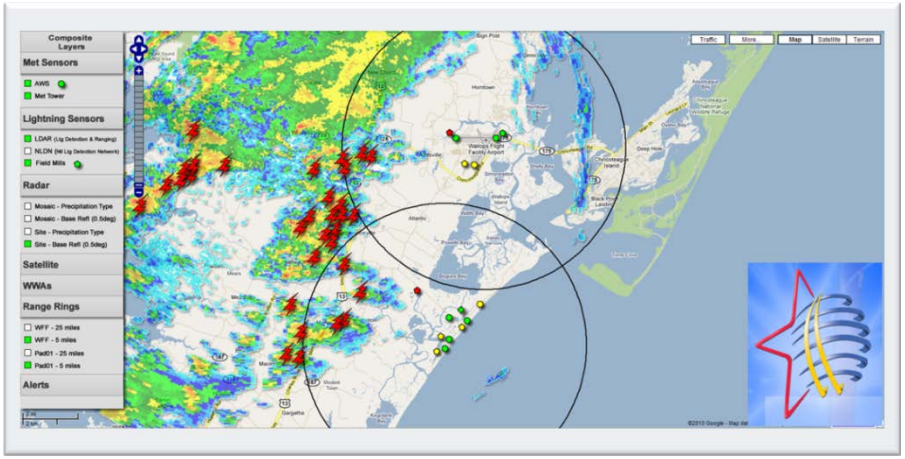


Data Integration: Aviation Support Applications & Products

ENTLN data integration enhancing:

- WDT's Lightning Decision Support System
- MeteoStar's LEADS system
- Sabre's Flight Explorer





Technology Value to the Aviation Industry

Real-time total lightning and weather information provides critical advanced visibility into changing weather conditions for improved severe weather management across all operational segments of aviation.

Stakeholder	Need	Earth Networks Solution
Air traffic controllers	Current weather and lx information for approach, landing and take-off of aircraft	proximity alerts, Dangerous Thunderstorm Alerts (DTAs), PulseRad
In-flight/cockpit/air navigation systems	Improved routing and global situational awareness; crew and passenger safety; asset protection (turbulence/strikes)	proximity alerts and DTAs
Ground operations	Protection for crew, passengers and assets	proximity alerts, DTAs, outdoor alerting
Air carrier operations	In-flight routing and situational awareness; ground operations	proximity alerts, DTAs, outdoor alerting

Discussion

EN Early Warning Systems at Airports

- Improves runway selection in real time on TS+ approach.
- Precise timing of severe weather event start & end
- High spatial resolution: will TS affect airfield?
- Locate turbulent areas for final approach with high resolution
- Vertical lightning distribution in the vicinity of the airport
- Light / sound beacons for ground operations
- Independent visualization tool
- Turn-key solution

Earth Networks Technology Value - Terminal Air Traffic Management

- Increases Safety and Certainty
- Local, reliable, real time storm information
- No advanced training or skills required for use
- Data layers ready for integration into any existing display system
- Save operational costs

Earth Networks Technology Value - Air Navigation Services

- Improve Air Nav Operators capacity to provide real-time severe weather information to cockpits.
- Precise storm cell location and tracking
- In-Cloud Lightning detection
- Indicator of most convective areas of storms

Earth Networks Technology Value - Flight Dispatchers & Handlers

- Improvement of socket management
- Up-to-the-minute Sever Weather Briefings
- Safer routing and choice of alternative airports
- Safety for ground operations
- Safer baggage and cargo management

…and how EN Solutions can help

•**Real Time, Global FOR THE FIRST TIME**: Earth Networks systems can track Severe TS cells over oceans / sea since they're GLOBAL. No typical radar coverage restrictions

•**Storm Tracking**: Real time storm cell tracking over land / seas. Permits corridor selection in real time

•**IC flash rating**: Precise IC flash density for independent areas.

•**PulseRad**: Proxy Rad Imagery estimates moderate and heavy rainfall without radar

Weather Risks in the Aviation Industry

Convective weather is a significant concern for aviation around the world, posing significant risks:

Stakeholder	Need
Air traffic controllers tower operations	Current weather and lx information for approach, landing and take-off of aircraft, on-the-ground asset management and pilot briefings
In-flight/cockpit/air navigation systems	Routing and global situational awareness; crew and passenger safety, and asset protection (turbulence/strikes)
Ground operations	Protection for crew, passengers and assets
Air carrier operations	In-flight routing and situational awareness; ground operations

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