Federal Lightning Capability Requirements

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1
INTRODUCTION

This document outlines the lightning capability requirements from a large cross section of United States federal government agencies. The National Oceanic and Atmospheric Administration (NOAA) requested that the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) collect the capability requirements in anticipation of the expiration of the current National Lightning Detection Network (NLDN) contract. The final option year for the current NLDN contract ends in January 2010. The OFCM formed the Joint Action Group for Lightning Detection Systems (JAG/LDS) and charged the JAG/LDS with collecting a description of required lightning capability. The departments and agencies that submitted requirements for this document include: the Department of Defense (DOD), the Department of Commerce (DOC), the Department of Transportation (DOT), the Department of the Interior (DOI) and the National Aeronautics and Space Administration (NASA). Although not all federal offices were included in this requirements study, the broad spectrum of lightning requirements captured in this document sufficiently represent the needs of the federal government.

The requirements in this document are the lightning capabilities required by each participating agency/organization without regard to funding or the capability provided by the current NLDN contract or the capability that may or may not be included in the future NLDN contract. To help standardize the terminology used in this paper, the JAG/LDS adopted a standard lexicon contained in Appendix A. To help standardize the geographic extent and description of the requirements the JAG/LDS adopted a standard geographic zone description at Appendix B.

This document is organized by agency and the original capability requirements submitted by each agency are included at Appendix C.

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2
LIGHTNING REQUIREMENTS BY AGENCY

All agencies provided lightning data capability requirements which are located at Appendix C. The text below describes some of the broad capability contained in the appendix.

2.1 Department of Defense

2.1.1 US Army

The US Army requires cloud-to-ground (CG) and cloud flash (CF) lightning data with complete coverage over zones 1-3 and 5-14. They require horizontal location accuracy (LA) of 0.5 km and detection efficiency (DE) of 95 percent. In addition, all Army ranges require fine horizontal location accuracy of 0.3 km. The data will be used for resource protection at the ranges and worldwide protection of Army equipment and personnel.

2.1.2 US Navy & Marine Corps

The US Navy and Marine Corps need both CF and CG lightning to completely cover all zones, with a horizontal LA of 0.5 km for both CF and CG and a vertical location accuracy of 0.3 km for CF. Horizontal LA over ocean zones is relaxed to 5 km. The DE for all should be greater than or equal to 90 percent. In addition, the Marine Corps requires peak current in addition to the above capability.

For all areas within 15 nm of a Navy or Marine Corps installation, they require CF and CG data with a LA of 0.1 km and a DE of 100 percent. Between 15 nm and 30 nm from all Navy and Marine Corps installations in the above zones they relax the requirement to an LA of 0.3 km and a DE of 99 percent. Again, the Marine Corps requires peak current at these locations.

2.1.3 US Air Force

Most US Air Force (USAF) units in zone 1 require total lightning (TL) coverage over the entire zone with LA of 0.5 km and DE of 100 percent. In addition, the 1st Weather Group requires both CF and CG data over the entire zone to improve aircraft protection. The stated DE of 100 percent is an objective; however a DE capability of 90 percent or greater is still of value to USAF missions.

The 30th Weather Squadron (30WS) and 45th Weather Squadron (45WS), due to their space launch mission, have demanding detection requirements. The 45WS requires point-radius data, out to 15 nm from any point on Cape Canaveral Air Force Station (CCAFS) and Kennedy Space Center (KSC), for both CF and CG, with a LA of 0.1 km and a flash DE of 100 percent as well as a stepped leader DE of 95 percent. The requirements are less stringent with larger distances from CCAFS and KSC. The 30WS requires identical coverage but from any point on Vandenberg Air Force Base. The 30WS and 45WS will use the data to evaluate Lightning Launch Commit Criteria; issue lightning and other severe weather warnings; prepare local and overseas aviation forecasts; assist mishap and other operational anomaly investigations; forecast

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for long distance land and sea transport of expensive, weather sensitive hardware; help customers determine whether to retest sensitive electronic components on launch vehicles, payloads, and ground support equipment after a nearby lightning strike; and conduct technical improvement and design studies using historical lightning data.

The impacts if 30WS and 45WS lightning requirements not satisfied are: decrease in productivity; increase in costs of workforce performing expensive and extensive ground processing of launch vehicles, payloads, and ground support equipment; increase in danger to hundreds or personnel working outdoors; increased likelihood of damage to unprotected systems with sensitive electronics at KSC, Vandenberg, and along local and national transportation routes.

In zones 2-26, select Air Force units require TL with LA of not less than 0.5 km with one exception: the Tanker Air Control Center at Scott AFB needs TL for all zones down to 0.15 km. Detection efficiency for zones 2-26 are 100 percent. The stated DE of 100 percent is an objective; however, a DE capability of 90 percent is still of value to USAF missions.

The 14th Weather Squadron requires the national lightning detection network data for archive purposes. The lightning data is one of hundreds of types of environmental data that are used to create climatology studies to help commanders understand conditions they may encounter worldwide during the planning phases of contingencies and operations. In addition the climatology is used to help build DOD systems that are capable of operating in harsh environments.

14WS currently receives the data monthly from Vaisala by CD in a format agreed to previously. The data includes date-time (to thousands of a second), lat, lon (to thousandths), # sensors, strength, polarity and # flashes. They receive the data monthly but are currently negotiating with NCDC to get a direct feed, at which time they will discontinue receiving the CD. After they receive the lightning data it is loaded into a relational database (Oracle) and can support customers with all or selected fields, summarizations, in space delimited, comma delimited, XML, ASCII or most common formats.

The Air Force uses lightning data for protection of personnel and equipment, cargo airlift, combat delivery, passenger airlift, aeromedical evacuation, special operations airlift, air refueling tankers, strategic brigade airdrop, and air refueling support. The data are necessary for avoiding ground and airborne hazards, issuing weather warnings, watches, and advisories, improving the success of tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Polarity of CG lightning is useful in identifying severe storms, while the polarity of the cloud flashes indicates storm evolution. In addition, recent literature points to the presence of positively charged cloud flashes as being areas of increased likelihood of aircraft-triggered electrostatic discharges, particularly affecting composite-skinned aircraft and unmanned aerial systems. Having the ability to differentiate between CG and CF lightning enhances Operational Weather Squadron support to installation resource protection and aviation operations.

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2.2 Department of Commerce/National Oceanic and Atmospheric Administration

2.2.1 National Weather Service

The National Weather Service requires CG and CF data for all zones. The required LA is 0.5 km with a DE of 100 percent. The required vertical location accuracy for the CF data is 0.1 km. The stated DE of 100 percent is an objective however a DE capability of 90 percent or greater is still of value for NWS operations. The data will be used for watches, warnings, aviation forecasts, technical improvement studies, numerical weather prediction, and climate sciences applications.

National Centers for Environmental Prediction

National Hurricane Center

Lightning data over the Gulf of Mexico, Caribbean Sea and out over the North Atlantic Ocean, as well as the tropical regions of the North Pacific Ocean to the date line will contribute to better analyses of many weather phenomena. The data help to distinguish between convective and cirrus clouds, which helps improve wave and wind estimates for maritime safety. In addition, the oceanic lightning data are being used to study the intensity phases of tropical cyclones and may contribute to better short-term intensity forecasts in the future.

Aviation Weather Center

The Aviation weather center requires TL data 2000 km off of the Atlantic and Pacific coasts to build hazards charts for long haul flights.

Storm Prediction Center

The Storm Prediction Center requires CG data with horizontal LA of 0.5 km and DE of 90 percent over zones 1 through 3.

2.2.2 Office of Oceanic and Atmospheric Research

Working in partnership with other organizational units of NOAA, Office of Oceanic and Atmospheric Research (OAR) provides the research foundation for better forecasts, earlier warnings for natural disasters, and the unbiased science needed to better understand and manage the environment, nationally and globally. For its research, OAR requires the same lightning detection data being used by the NWS (including data for Canada and Alaska, if available, as well as the long-range oceanic data), to improve present applications to warnings and forecasts of hazardous weather and to develop and test techniques for assimilating lightning data into numerical mesoscale and cloud-scale models. Both real-time data and archived data are needed. OAR also uses a collection of research systems capable of mapping all types of lightning within their storm context, to develop applications of the new capabilities of emerging lightning detection technologies.

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2.3 Department of Interior

2.3.1 Bureau of Land Management

The Bureau of Land Management (BLM) requires CG data for zone 1 with a LA of 0.5 km and a DE of 90 percent or greater. Lightning data is used to aid in locating potential wildland fires, to aid in suppressing those fires, and to support research into wildland fires and wildland fire suppression. In addition, the BLM requires the direct electronic transfer of monthly sets of lightning data for archiving. The archive data should contain the same information that the BLM receives in near real time and it should be in the same format that they receive it in today.

Bureau of Land Management, Alaska

The Bureau of Land Management, Alaska (BLM/A) requires the ability to identify 90 percent of cloud-to-ground lightning strike locations in zone 2 including polarity with a LA of 0.5 km from April 1 through October 1. The data is used to enable effective detection of lightning-started wildland fires and to aid in planning for the pre-positioning of suppression resources. It is critical that this data be made available along with other pertinent weather and fire prediction data. It is critical to the Alaska Fire Service (AFS) mission that they receive strike locations along the Canadian border (200 mile corridor) including data from Canadian sensors. The BLM/A also requires confidence data (error ellipse) to monitor and validate lightning data.

The BLM/A also needs to receive the data in real-time 1-minute intervals with the ability to replay data by an alternative communications method, i.e. Internet, to eliminate disruption of real-time transmissions. They require reprocessed archived data monthly for reference.

BLM/A works closely with the following organizations: State of Alaska Department of Natural Resources, National Park Service, Bureau of Land Management (BLM) District Offices, Fish and Wildlife Service, National Weather Service, and Forest Service.

The BLM/A currently accomplishes the above referenced requirements and tasks through the management of a BLM/A owned lightning detection system. This system consists of eleven impact sensors placed across Alaska. The strike string data is transmitted to the Alaska Fire Service at Ft. Wainwright, Alaska via land line or WAN where it is processed along with data from ten Canadian sensors, received via Internet from Vaisala and displayed to the interagency cooperators and public at large via the AFS internal and external websites. These displays also include other pertinent weather and fire prediction data.

2.4 Department of Transportation

2.4.1 Federal Aviation Administration

The Federal Aviation Administration requires CG and CF data for zones 1-5 including off shore by 250 km. The required horizontal LA is 1 km for both CG and CF and the required vertical location accuracy is 0.6 km (+/- 2000 feet). Detection efficiency should be at least 90 percent. At the present time, the FAA does not receive CF information (CC, CA, IC) but is now requesting CF along with current CG data as it will be incorporated into future Next Generation

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Air Transportation System (NextGen) systems. CF information will be used to enhance flight safety products & data and will be incorporated into automated decision support tools (DSTs). A total lightning package, (CF data along with CG data) will provide a greater understanding of the severity of convective activity and will improve overall flight safety and forecasting.

2.5 National Aeronautics and Space Administration

2.5.1 Johnson Space Center

Johnson Space Center (JSC) requires CF and CG data for the area around Houston Texas, zone 1 and the waters off of the California coast with a LA of 0.1 km and a DE of 90 percent. Vertical location accuracy for CF needs to be 100 m. This data will be used for short-term lightning and thunderstorm watch (forecast) and warning (occurrence) for protection of life and property at Johnson Space Center (Houston, Texas) as well as for Orion Vehicle nominal landing in the California coastal waters.

Additionally, JSC has a unique need for CF and CG data worldwide from 51 S to 51 N with a LA of 1 km and a DE of 90 percent. This data will be used for short-term lightning and thunderstorm forecasts for Orion Vehicle Abort Landing Areas: East Coast USA (ISS and Lunar Mission); Newfoundland (ISS Mission); Ireland (ISS Mission); Mid-Atlantic (Lunar Mission); Australian Coastal Waters (ISS and Lunar Mission); Eastern Pacific Mexico (ISS and Lunar Mission); "Anytime" resulting in emergency landing around world (ISS and Lunar Mission).

JSC requires unique archive capabilities outlined at Appendix C.

2.5.2 Kennedy Space Center

Kennedy Space Center (KSC) receives its weather support for ground processing and launch operations from 45WS, thus KSC's requirements are the same as 45WS requirements. KSC launches manned missions from KSC and unmanned science payloads from CCAFS. Due to KSC's space launch mission and because it is in an area that experiences a very large quantity of lightning, it has some of the most demanding detection requirements. KSC requires point-radius data, out to 15 nm from KSC and CCAFS, for both CF and CG, with a LA of 0.1 km and a flash DE of 100 percent as well as a stepped leader DE of 95 percent. The requirements are less stringent with larger distances from the launch facilities. KSC will use the data to evaluate Lightning Launch Commit Criteria; issue lightning and other severe weather warnings; prepare local and overseas aviation forecasts; assist mishap and other operational anomaly investigations; forecast for long distance land and sea transport of expensive, weather sensitive hardware; help customers determine whether to retest sensitive electronic components on launch vehicles, payloads, and ground support equipment after a nearby lightning strike; and conduct technical improvement and design studies using historical lightning data.

The following are impacts if KSC lightning requirements not satisfied: decrease in productivity of and increase in costs of workforce performing expensive and extensive ground processing of launch vehicles, payloads, and ground support equipment; increase in danger to hundreds or personnel working outdoors; increased likelihood of damage to unprotected systems with sensitive electronics both at KSC, and along local and national transportation routes.

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KSC's requirements also include the need for capability that is not technically feasible at this time. Research needs are described in the research section of this document.

2.5.3 Marshall Space Flight Center

Marshall Space Flight Center (MSFC) requires CF (when available) and CG (both stroke and flash) data in zone 1 (primary) and zones 2-6, 16-18, and 20-23 (secondary). The required horizontal location accuracy for both CF and CG is 0.5 km and the DE (CG) is 90 percent. However, it is acknowledged and accepted that in regions of sparse network coverage (e.g., over the oceans and some land-based locations in zones 5-6) the location accuracy and DE may be lower. It is also accepted that CF data will often have low DE (~10-30 percent) except in small geographical regions covered by VHF mapping systems.

The data will support algorithm development and validation activities associated with space-based lightning mapping satellites, such as the Geostationary Lightning Mapper (GLM) for GOES-R. The data will also contribute to NASA science and applications research, including precipitation and storm investigations and applications, climate studies, decadal survey, atmospheric chemistry, and other research (e.g., lightning physics, upper atmospheric interactions). In addition, the data will be used in NASA operations support (e.g., Lightning Launch Commit Criteria Evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies).

The MSFC lightning requirements are not satisfied, NASA's support to the science and applications research discussed above will be reduced in value. In addition, NASA operations support using lightning data could be compromised.

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3
DATA FORMAT REQUIREMENTS

3.1 Department of Defense

3.1.1 US Army

The Army would prefer any data lightning feeds to be in XML format in order to be compatible with the Battle Command/Distributed Common Ground Segment – Army system.

3.1.2 US Navy and Marine Corps

The Navy lightning data flow can be described in three components, the Forecast Center Component, the Navy FDO Component, and the Marine Corps EFM Component. The Navy and Marine Corps would prefer to continue to receive lightning data in the current formats to prevent having to change the software or hardware. For an understanding of the general flow of lightning data for the Navy and Marine Corps, refer to the three component diagrams below.

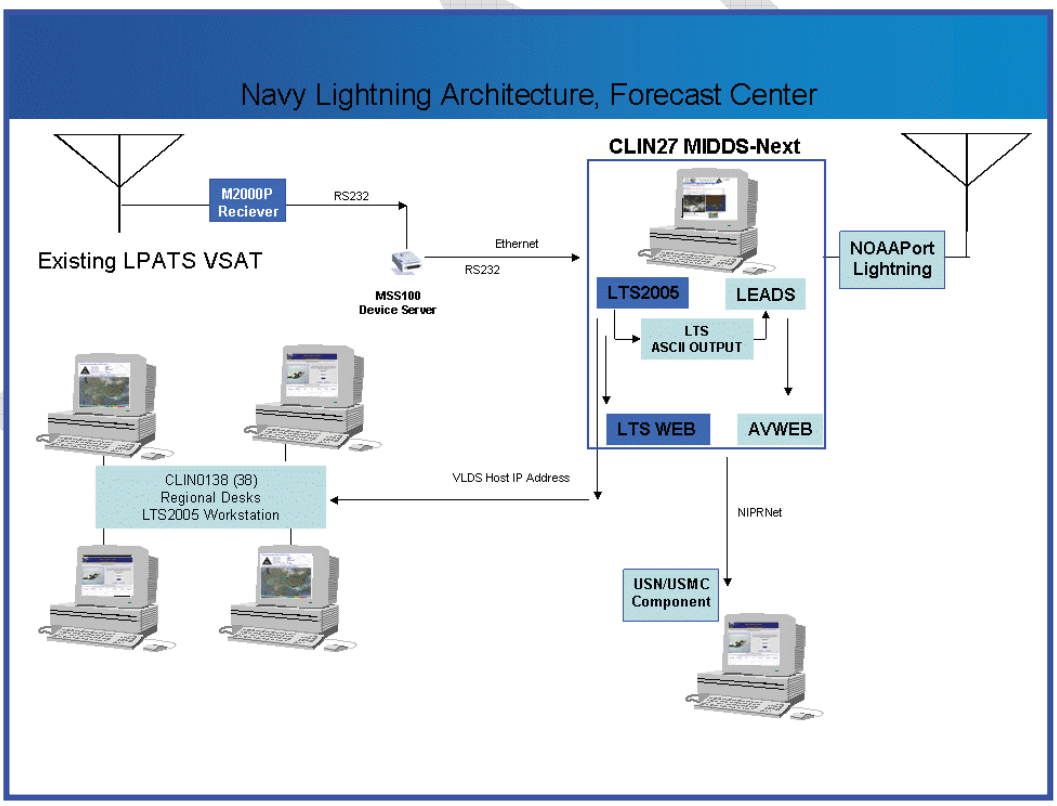

Figure 3-1. Navy Forecast Center Lightning Data Flow Diagram.

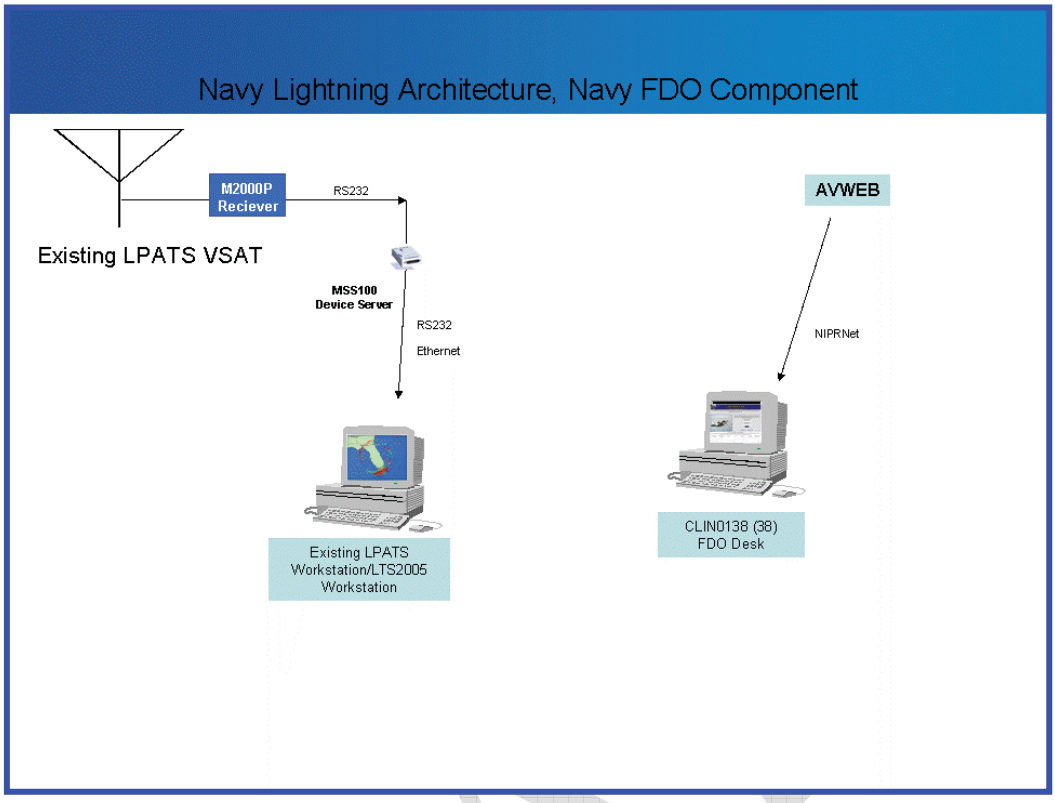

Figure 3-2. Navy Forecast Duty Officer Lightning Data Flow Diagram.

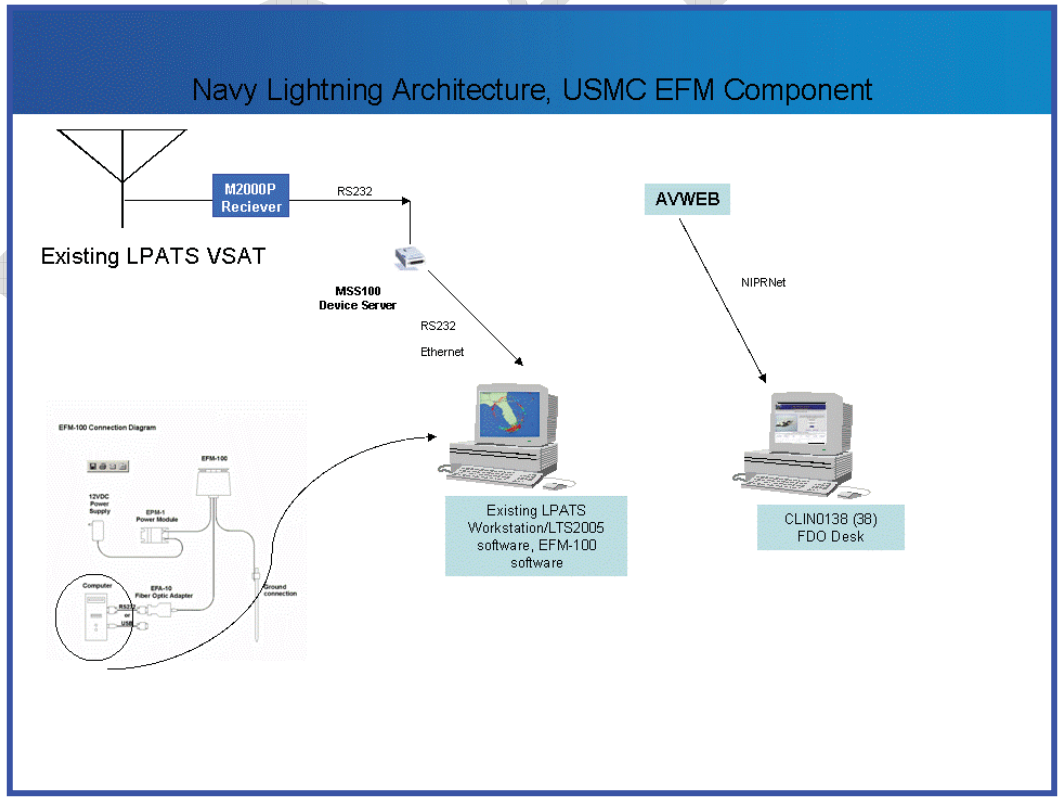

Figure 3-3. Navy Marine Corps EFM Lightning Data Flow Diagram.

3.1.3 US Air Force

The Air Force would prefer to continue to receive lightning data in the format that they currently receive it in.

Air Force Weather Agency

AFWA prefers to receive the lightning data in a streaming ASCII text or XML format if possible. The data stream should include date, time (UTC), latitude (deg), longitude (deg), signal strength (ka), and multiplicity (#strokes/flash). For CF data the vertical location in meters should also be included. The data should be encrypted as it is transmitted to prevent unauthorized receivers from using the data. The data should also be delivered to AFWA through the internet as an alternate source for a backup if the primary transmission method fails. AFWA would prefer a "heartbeat" packet be sent with the data whenever no data has been sent for more than 60 seconds. (See Figure 3-4)

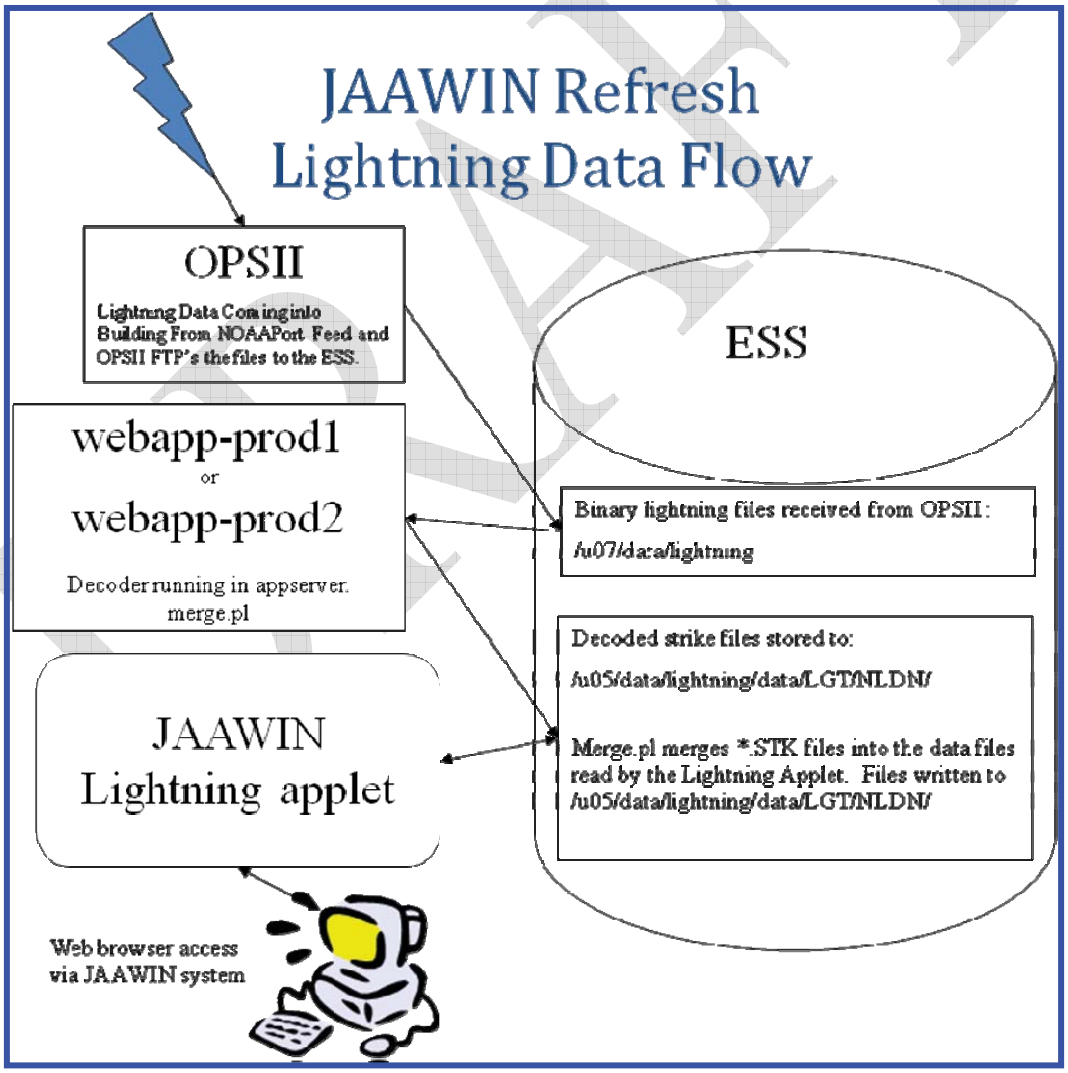

Figure 3-4. AFWA Lightning Data Flow Diagram.

14th Weather Squadron

14 WS receives the data monthly from Vaisala by CD in a format agreed to a number of years ago. The data includes date-time (to thousands of a second), lat, lon (to thousandths), # sensors, strength, polarity and # flashes. They receive the data monthly on a CD but are currently negotiating with NCDC to receive a direct feed at which time they will discontinue receiving the CD. In addition, NCDC and the 14WS developed a joint lightning database for use in climate research and for military and civilian climate applications. After the 14WS receives the lightning data it is loaded into a relational database (Oracle) which can be used to provide customers with all or selected fields as well as summarizations, and can be delivered to the customers in space delimited, comma delimited, XML, ASCII or most common formats. (See Figure 3-5)

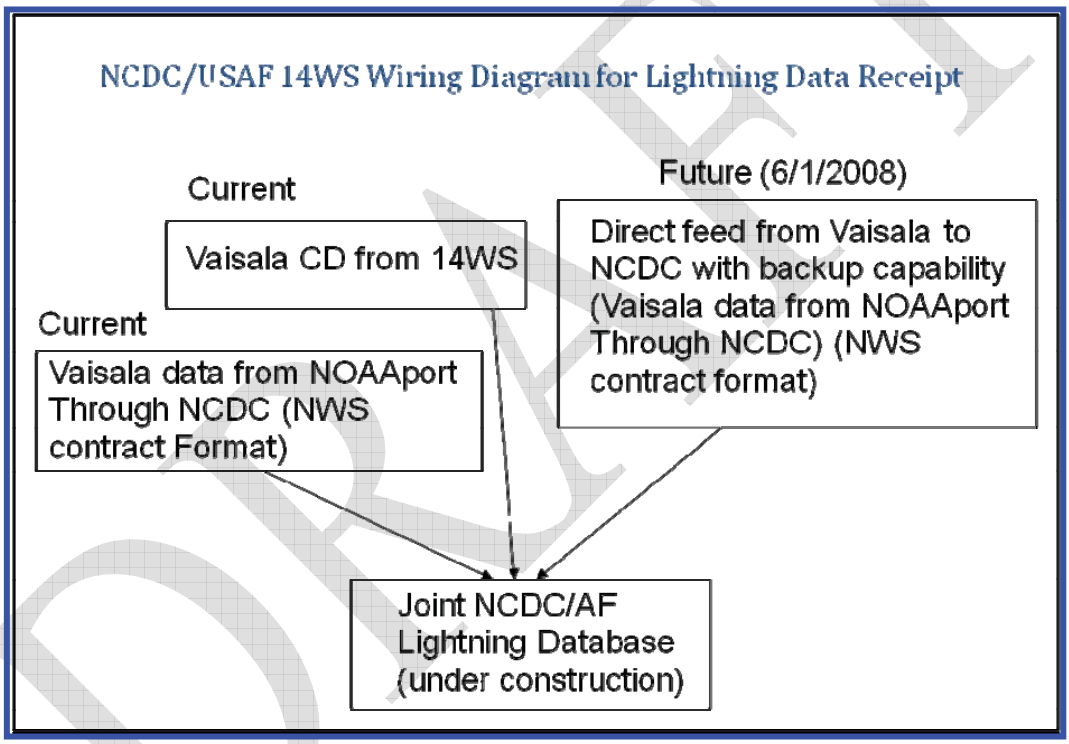

Figure 3-5. NCDC/USAF 14 WS Lightning Data Flow Diagram.

30th Weather Squadron

The 30th Weather Squadron receives the NLDN data through the NOAA Port feed and interacts with the data on AWIPS. The local lightning detection system is currently not functioning but the data is fed in to proprietary software to a workstation on the operations floor. Any change to the current formats would require contracts to bring the same functionality.

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3.2 Department of Commerce/National Oceanic and Atmospheric Administration

3.2.1 National Weather Service

NOAA receives lightning data from Vaisala in a binary Vaisala-proprietary format in one-minute packages of data (each can be a different length, depending on the strokes per package). Data flows through ingestion by the Gateway into the system, it then passes thru the LAN into NCF (NWS Network Control Facility Server), and it is then disseminated from the NCF to AWIPS field nodes via the SBN/NOAA Port. The Aviation Weather Center & the Storm Prediction Center receive lightning data through the NCF/AWIPS, but also directly from Vaisala. See Figure 3-6.

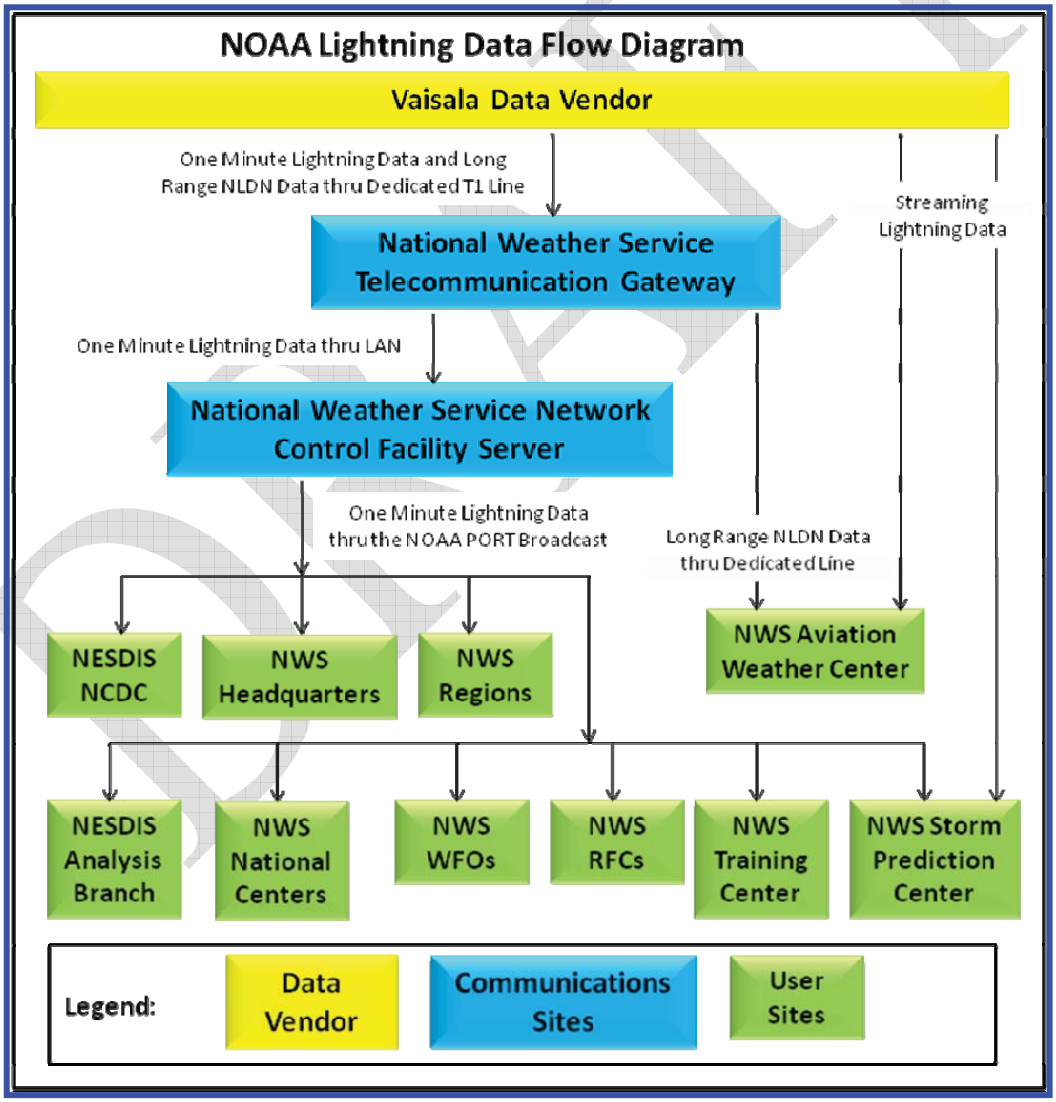

Figure 3-6. NOAA Lightning Data Flow Diagram.

Changes to lightning data formats in the future can have an impact to the ingest of AWIPS II. Through at least September 2011, lightning products must continue to be provided to the NWS in the present format (i.e., the Vaisala-proprietary format). It may be possible to provide the present format via a translation mechanism from another format, if necessary, for some interim period. However, such a translation mechanism, if used, must be provided and accepted for operations on an NWS system in such a way that the AWIPS NCF continues to be provided with lightning products in today's Vaisala-proprietary format.

The following considerations are provided concerning the future format (or formats) for lightning products:

- Lightning products should be provided in some open format. The term "open format," as used here, means having a publicly-available, royalty-free specification.
- The lightning product format should be consistent to the greatest practical extent, with respect to commonly-used information technology standards as well as standards for the exchange of hydrometeorological information. The main standards bodies for hydrometeorological information formats include the WMO and ICAO.
- Compression should also be investigated, in particular if a more-verbose format (such as XML) is under consideration. Compression schemes, if any are considered, should be open source and non-proprietary.
- It is anticipated that encryption methods (should they be necessary e.g. for the protection of proprietary data on public networks) will be separated from the basic application-layer data format.
- Examples for data formats that might be considered: XML, GML, netCDF, HDF, and BUFR.

Regardless of the particular format chosen for any future lightning data contracts, a transition plan should be developed which includes an extended multi-year period wherein lightning products are provided in both the legacy and future formats. This dual support of both data formats will facilitate a systematic transition of numerous legacy systems to the new format.

3.2.2 National Environmental Satellite, Data, and Information Service

National Climatic Data Center

NCDC has a requirement to archive lightning data for NWS forensic meteorological purposes and must provide access (up to 5 years) to any data that the NWS forecasters have when making forecasts. These data must be available for NWS litigation.

In addition, NCDC and the Air Force Weather Agency's 14th Weather Squadron developed a joint lightning database for use in climate research and for military and civilian climate applications. NCDC would prefer to continue to receive the lightning data in the same format that it receives it in today to avoid software changes. See Figure 3-5.

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3.3 Department of Interior

3.3.1 Bureau of Land Management

The DOI currently receives the NLDN data in Vaisala's "NLDN Real Time Binary Data Stream" a highly compressed data stream delivered from satellite that includes date, time, latitude, longitude, polarity, and signal strength. In addition, the DOI requires the direct electronic transfer of monthly sets of lightning data for archiving. The archive data should contain the same information that the DOI receives in near real time and it should be in the same format that they receive it in today.

Bureau of Land Management, Alaska

The BLM/A currently manages the BLM/Alaska Fire Service (AFS)-owned lightning detection system. This system consists of eleven impact sensors placed across Alaska. The strike string data is transmitted to the Alaska Fire Service at Ft. Wainwright, Alaska, via land line or WAN where it is processed along with data from ten Canadian sensors, received via Internet from Vaisala and displayed to the interagency cooperators and public at large via the AFS internal and external websites. These displays also include other pertinent weather and fire prediction data. The BLM/A also needs to receive the data in real-time 1-minute intervals with the ability to replay data by an alternative communications method, i.e. Internet, to eliminate disruption of real-time transmissions. They require reprocessed archived data monthly for reference.

3.4 Department of Transportation

3.4.1 Federal Aviation Administration

The FAA would prefer to continue to receive lightning data in the same formats it currently receives it in to prevent having to modify their software.

FAA currently receives CG lightning data only but will be requesting all lightning types in the future. Major sources of lightning data today for the FAA are from Vaisala's NLDN and WSI's USPLN lightning networks. Data is received from Vaisala's NLDN through a satellite direct serial feed, sent in binary data format, and received at an Automated Weather Observation System Data Acquisition System (ADAS) located at each of 20 Continental U.S. (CONUS) Air Route Traffic Control Centers (ARTCC) and 2 Center Radar Approach facilities (CERAP) (San Juan and Honolulu). ADAS sends data in latitude/longitude pairs with a time stamp, intensity, polarity, and quality factor in binary format. An ADAS module, Automated Lightning Detection and Reporting System (ALDARS), takes Vaisala data and sends correlated CG lightning position data to 569 Automated Surface Observing Systems (ASOS) and 19 Automated Weather Sensor Systems (AWSS) sites. They in turn send their observations (METAR, SPECI, One Minute Observations (OMO) with a lightning report in the remarks section back through ADAS. However ADAS also does appending for 180 Federal Automated Weather Observation Systems (AWOS) and forwards reports from all 3 systems throughout the National Airspace System via WMSCR. ASOS/AWOS/AWSS Observations with lightning reports are displayed locally.

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ADAS also provides lightning data in 1-minute updates to the Integrated Terminal Weather System (ITWS). See Figure 3-7.

In addition, FAA lightning data is received from the following Weather Vendors:

- Harris Corp. takes Vaisala data & sends it in binary format to CONUS Weather and Radar Processors (WARP) located at the ARTCCs.

- WSI obtains lightning from USPLN (U.S. Precision Lightning Network) and provides it to the Traffic Flow Management System (TFMS) via the FAA's William J Hughes Technical Center (WJHTC).

- The Alaskan ARTCC WARP receives lightning data from Bureau of Land Management (BLM) sensors in Alaska via NWS' Alaskan Aviation WFO in an Alpha-Numeric format.

- MIT/Lincoln Labs currently relays lightning data received from ADAS to the Corridor Integrated Weather System (CIWS) prototype used in selected ARTCCs.

NOTE: The FAA is currently seeking approval of a CIWS implementation Strategy that would move the operational CIWS to the FAA Technical Center in FY2011. The operational CIWS approach for lightning data is dependent upon the ADAS re-host schedule. The current plan is to use the FAA Tech Center's Weather Data Gateway (WDG) as a subsystem of CIWS to connect 21 ADAS to CIWS using LAPB/X.25/TP4 via NADIN II. Once the re-hosted ADAS installation is complete, the WDG would no longer be necessary since ADAS will support TCP/IP connections.

Lastly, ADAS also provides lightning data to the FAA Regional offices, the FAA Academy (training) & the FAA Tech Center (maintains ADAS network, etc).

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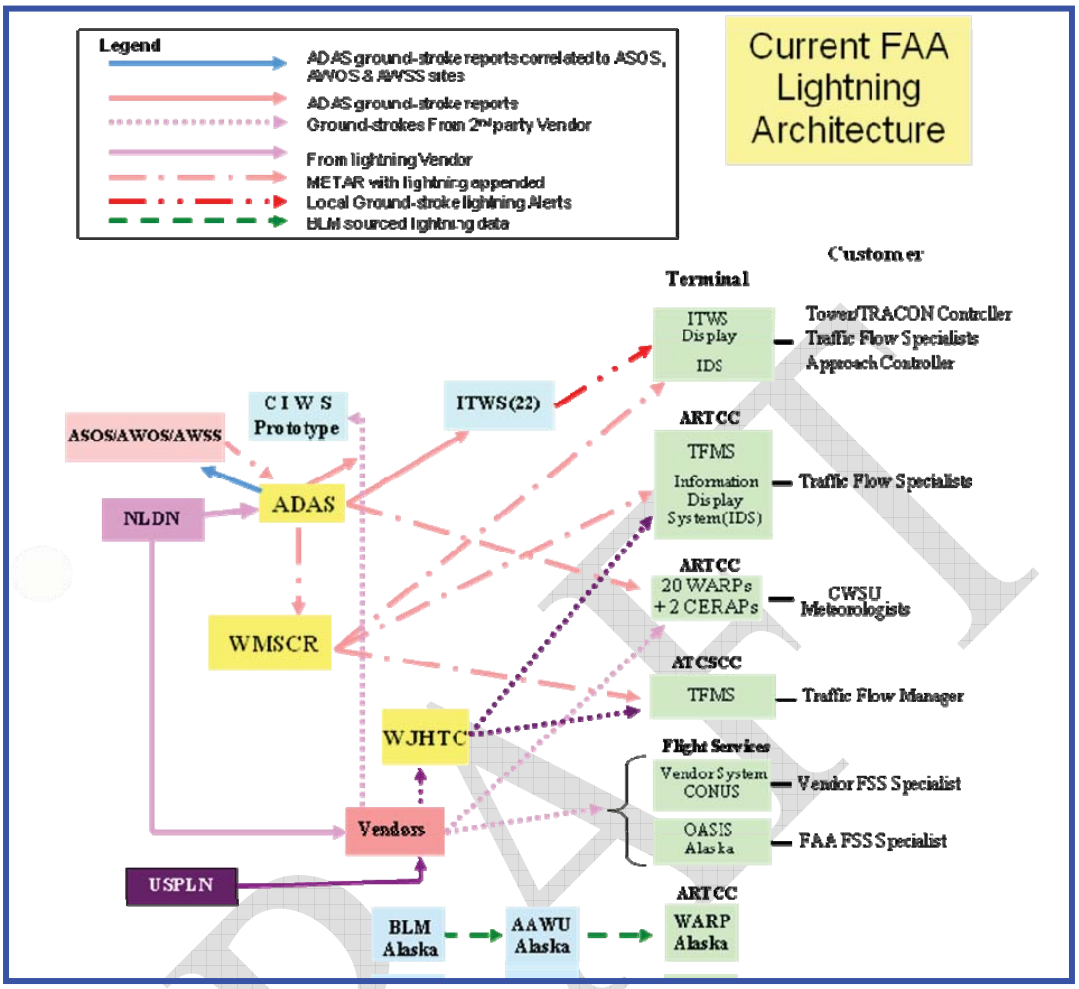

Figure 3-7. FAA Lightning Data Flow Diagram.

Figure 3-7 Acronyms

ALDARS = Automated Lightning Detection and Reporting System
ASOS = Automated Surface Observing System
ATCSCC = Air Traffic Control System Command Center
ARTCC = Air Route Traffic Control Center
AWOS = Automated Weather Observing System
AWSS = Automated Weather Sensors System
BLM = Bureau of Land Management
CERAP = Center RAPCON (Radar Approach Control)
CIWS = Corridor Integrated Weather System
ETMS = Enhanced Traffic Management System
IDS = Information Display System
ITWS = Integrated Terminal Weather System
OASIS = Operational and Suitability Implementation System
OMO = One Minute Observations
TFMS = Traffic Flow Management System
USPLN = United States Precision Lightning Network
WARP = Weather and Radar Processor
WMSCR = Weather Message Switching Center Replacement

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3.5 National Aeronautics and Space Administration

3.5.1 Johnson Space Center

The Johnson Space Center / NWS Spaceflight Meteorology Group receives lightning data from a variety of sources to include: NLDN data via two separate channels, KSC LDAR (VHF), 45th Space Wing Cloud-to-Ground Lightning Sensor System (CGLSS), Texas A&M's LDAR II network over Houston, Spanish Cloud-to-Ground data, and UK Met Office Sferics bulletins. See Figure 3-8.

MIDDS and AWIPS are the two display systems used at JSC. MIDDS is a McIDAS system with local software additions to decode JSC unique data. JSC sends a variety of data from MIDDS to AWIPS through the standard AWIPS interface for local data (LDAD).

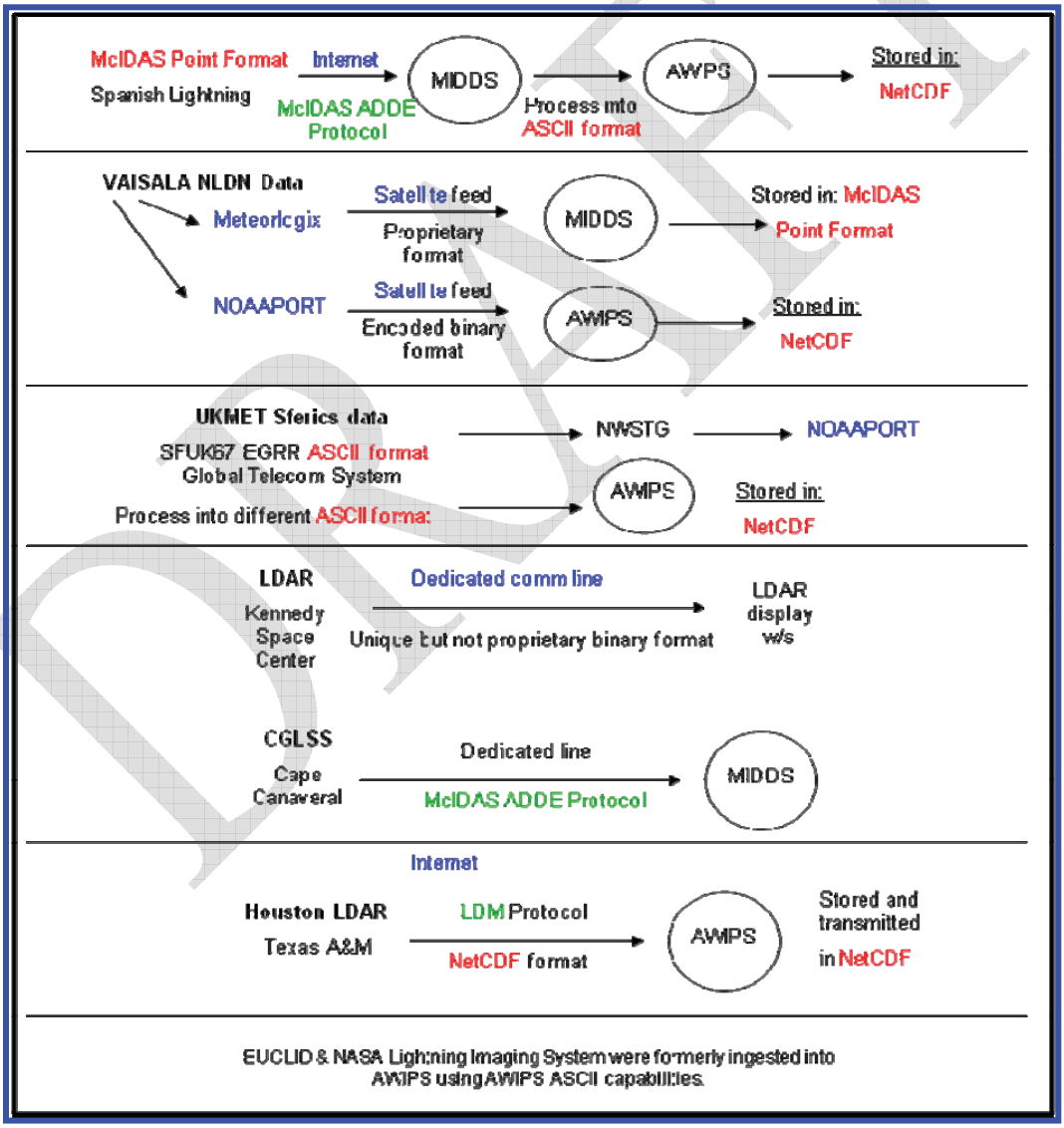

Figure 3-8. NASA/JSC Lightning Data Flow Diagram.

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NASA/JSC would prefer to receive future lightning in ASCII, Comma-Separated Variable (CSV) files to be easy to handle in spreadsheets and most scripting languages (such as TCL and Perl). The scripting languages can then be used to format the data into the required display format. The only downside would be the potential large file size for VHF lightning systems.

3.5.2 Kennedy Space Center

The NASA KSC will accept lightning data in any format but would prefer to continue to receive it in the same format as received today to avoid having to change the software.

3.5.3 Marshall Space Flight Center

The MSFC prefers the data be sent to them in plain text ASCII format. Other formats considered optimal include XML (which can be read as text), Sensor ML (advantages in emerging Sensor webs – however, MSFC can produce XML or SensorML from the data). See Figure 3-9.

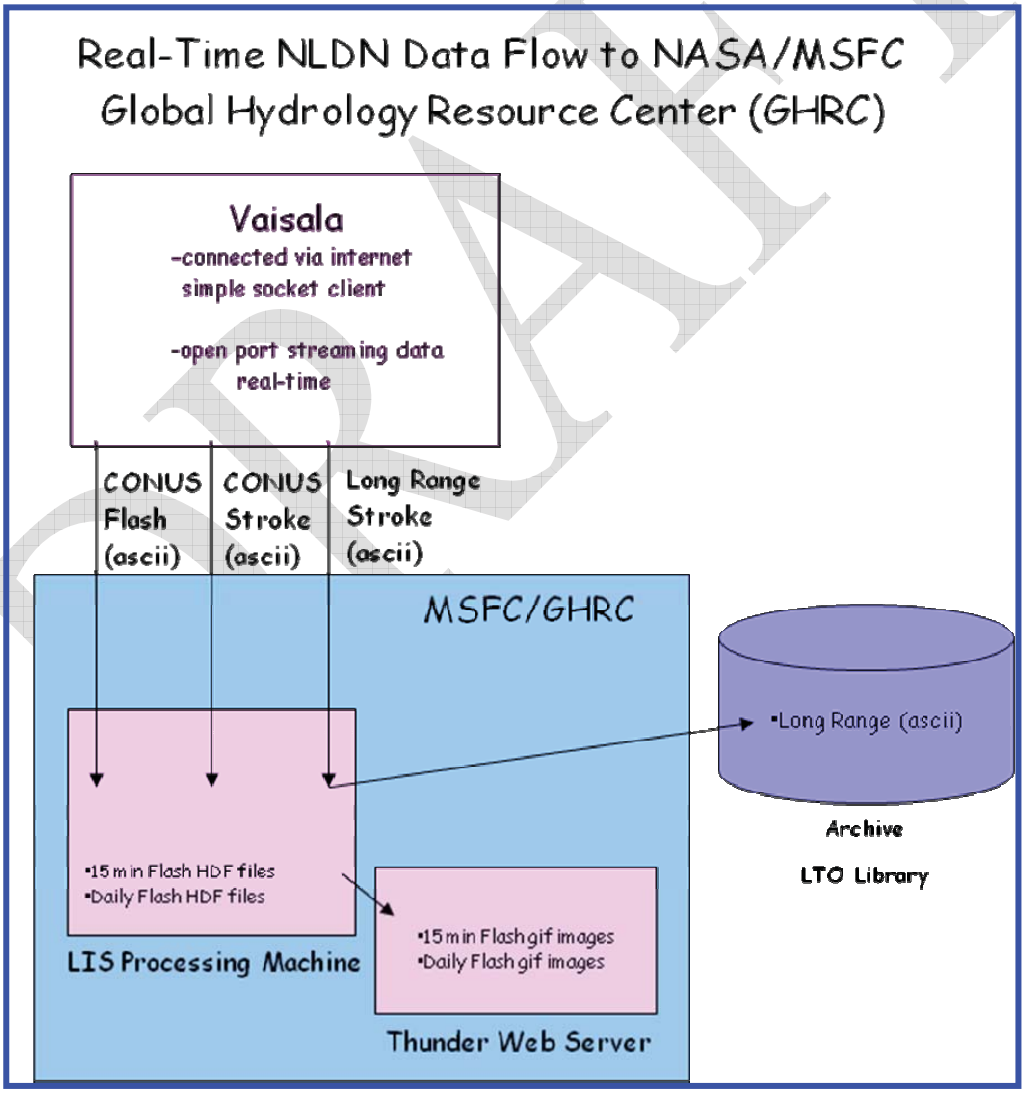

Figure 3-9. MSFC Lightning Data Flow Diagram.

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4
LIGHTNING RESEARCH REQUIREMENTS

This chapter summarizes lightning capability needs that cannot be met with current technology and require research.

4.1 Department of Defense

4.1.2 US Army

Research is required to provide better prognostic warning capability to describe where and when lightning will strike. The warnings will be used for range operations and ground personnel and equipment protection.

4.1.1 US Air Force

30th Weather Squadron and 45th Weather Squadron (includes NASA KSC)

Both the 30WS and 45WS as well as NASA KSC require the following research to help improve launch availability and increase safety:

- Information on lightning cessation – identify the last lightning strike within 5 minutes of its occurrence. This tool should be simple enough to allow manual use in a forecast setting. We also desire it be automatable, i.e. based entirely on range sensors, with no subjective inputs from the forecaster.
- Information on the ambient electric field aloft — identify when and where the atmospheric electric field exceeds 3KV/meter.
- Integrate lightning data with data available from other weather sensors to provide probability of severe weather.
- Develop methodology to integrate, and the product to display, all lightning from the many sources now available and planned, including national, international, and local networks; satellite; etc.
- Analysis of Lightning Launch Commit Criteria climatology, and an analysis of the conditions under which aircraft have experienced natural and triggered lightning strikes.
- Development of an optimized Lightning Detection and Ranging (LDAR) flash algorithm and LDAR flash database based on all available LDAR saved data. The flash algorithm would take LDAR stepped leaders (4-D data: x, y, z, t) and reduce it to 4-D data of the lightning flashes start point, end point, major intervening branches between the origin and terminus, and from which thunderstorm cell the lightning originated.

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4.2 Department of Commerce/National Oceanic and Atmospheric Administration

4.2.1 Office of Oceanic and Atmospheric Research

The research needed by NOAA's Office of Oceanic and Atmospheric Research (OAR) to improve lightning detection capabilities for the NOAA mission includes several topics:

Research is needed to extend the considerable encouraging research on the relationship of lightning to updraft trends, ice production, and severe weather in individual storms, by quantifying the relationships for significant numbers of storms in each of the climatologically different regions of the United States.

The lightning mapper planned for GOES-R will detect lightning over the majority of the American hemisphere, but will have less spatial resolution (roughly 10 km) than ground-based research systems for mapping all types of lightning (50 m - 1 km) and will detect the light that escapes from cloud tops. Research is needed to examine how the GOES-R mapper's limitations will influence what characteristics of lightning it detects and, in particular, how this will affect inferences of a storm's severe weather potential, updraft trends, and ice mass production.

Because lightning must have continuing current to ignite forest or range fires, research is needed to develop techniques for detecting continuing current from ground or satellite based lightning mapping systems. This will improve applications for fire weather operations.

Some relatively simple techniques have been developed for assimilating lightning mapping data into mesoscale forecast models, to improve initialization of the model for the subsequent forecast period. Because lightning is now mapped over regions having little or no radar coverage (e.g., mountainous regions, much of Canada and Alaska, and oceanic regions within 600 km of the contiguous United States) and coverage over the eastern and central Pacific, central Atlantic, and Carribean regions is increasing due to expanding ground-based systems and the planned GOES-R lightning mapper, these data have considerable potential for improving forecasts within and downstream of data-sparse regions, such as the west coast of the United States and oceanic regions. Therefore, an effort is needed to test and transfer existing lightning assimilation techniques into operational forecast models and to develop new techniques that take advantage of the additional storm information that can be inferred from technologies, such as satellite lightning mappers, that map all types of lightning, not just cloud-to-ground lightning.

Predicting when lightning is going to begin and knowing when lightning activity has ended are significant safety concerns for those outdoors for any reason, and this has considerable economic impact on rocket launch operations and for agencies and businesses whose personnel work outside, as well as for munitions handling, electric power distribution systems, and other commercial, medical, and military equipment highly susceptible to lightning damage. Research is needed into the microphysical and kinematic properties of storms that give rise to lightning, so that the beginning and cessation of lightning activity can be diagnosed more reliably. Research is also needed into the electrical characteristics of large storm anvils and of the stratiform precipitation regions of squall lines, because these regions produce considerable lightning in

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regions often considered relatively safe and little is known about what causes enough electrification to produce lightning there.

The information provided by aggregate lightning activity from systems that map the lightning within clouds complements the information about precipitation characteristics that can be provided by polarimetric radars. Research is needed to learn how to merge total lightning mapper data with polarimetric radar data to better characterize internal storm structures. This research also should be combined with further research using numerical cloud models that include electrification processes, to improve capabilities to predict lightning activity, beyond the present practices of extrapolating lightning activity forward in time or using criteria based solely on radar reflectivity structure. Forecasting lightning activity will become increasingly feasible as computational capacity increases and the resolution of forecast models reaches down to cloud scales. Research will be required to develop techniques for assimilating the merged polarimetric and lightning mapping data into cloud-scale models.

Laboratory results suggest that precipitation formation can be affected by the electrical properties of storms. Research to estimate reliably the magnitude of this effect in storms has been almost impossible, but with the development of new research capabilities, such as polarimetric radar, detailed lightning mapping systems, *in situ* microphysical sensors, and sophisticated numerical cloud models that include electrical processes, it is now feasible and should be pursued.

4.3 National Aeronautics and Space Administration

4.3.1 Marshall Space Flight Center

Presently, estimates of ground flash charge deposition and total flash energy are not provided by the NLDN. However, such estimates would be of significant value to NASA MSFC researchers involved with studies of lightning nitrogen oxides (NOx) production. Lightning NOx affects the concentration of tropospheric ozone (a greenhouse gas) and the concentration of atmospheric OH (which in turn affects the concentration of additional greenhouse gases). Therefore, lightning NOx studies are directly related to NASA Earth Science research related to global chemistry/climate modeling and regional air quality modeling.

4.4 Department of Interior

4.4.1 Bureau of Land Management

Research is required to validate practical correlation of continuing current and fire event ignition.

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5
PRIORITIZATION OF REQUIREMENTS

The requirements are listed below in order of importance with #1 being the highest priority capability. There are several capabilities that received six requests that are all identified as having a priority of number 4. There are similar grouping of capabilities for priority numbers 6, and 7. As agencies approach the contracting process, these requirements can be further prioritized taking cost, schedule, and operations into consideration.

Dozens of launch and test ranges in the United States as well as dozens of military bases overseas represented by the DOD, and NASA requested point-radius coverage of CF and CG systems with high LA and DE. There is enough interest in these systems to mention this localized capability as a high priority and both the DOD and NASA are interested in system cost and availability.

#1 Priority (Reasoning: Nine of ten agencies require this capability.)

- Cloud-to-ground lightning detection covering zone 1 (CONUS, VI, PR) with a detection efficiency of 90 percent or better and a location accuracy of half a kilometer or better.

#2 Priority (Reasoning: Eight of ten agencies require this capability.)

- Cloud-to-ground lightning detection covering zone 2 (Alaska).

#3 Priority (Reasoning: Seven of ten agencies require this capability.)

- Cloud flash lightning detection covering zone 1 (CONUS, VI, PR) with horizontal location accuracy of 0.5 km or better, vertical location accuracy of 0.3 km or better, and a detection efficiency of 90 percent or greater.

#4 Priority (Reasoning: Six of ten agencies require this capability.)

- Cloud-to-ground lightning detection covering zone 3 (Hawaii).
- Cloud-to-ground lightning detection covering zone 4 (Canada).
- Cloud-to-ground lightning detection covering zone 5 (Mexico).
- Cloud flash lightning detection covering zone 2 (Alaska).
- Cloud flash lightning detection covering zone 3 (Hawaii).

#5 Priority (Reasoning: Five of ten agencies require this capability.)

- Cloud-to-ground lightning detection covering zone 6 (Central and South America).

#6 Priority (Reasoning: Four of ten agencies require this capability.)

- Cloud-to-ground lightning detection covering zone 10 (Middle East).

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- Cloud-to-ground lightning detection covering zone 7 (Europe).
- Cloud flash lightning detection covering zone 4 (Canada).
- Cloud-to-ground lightning detection covering zone 20, 21, 22, 23 (NE, NW, SE, SW Pacific Oceans).
- Cloud-to-ground lightning detection covering zone 16 (Gulf of Mexico, Caribbean Sea and West Indies).
- Cloud-to-ground lightning detection covering zone 17 (North Atlantic).
- Cloud-to-ground lightning detection covering zone 8 (Northern Asia).
- Cloud-to-ground lightning detection covering zone 18 (South Atlantic).
- Cloud-to-ground lightning detection covering zone 9 (Southern Asia).
- Cloud-to-ground lightning detection covering zone 11 (Africa).
- Cloud-to-ground lightning detection covering zone 12 (East Indies and Philippines).
- Cloud-to-ground lightning detection covering zone 13 (Australia and New Zealand).
- Cloud-to-ground lightning detection covering zone 14 (Greenland and Iceland).
- Cloud flash lightning detection covering zone 5 (Mexico).
- Cloud flash lightning detection covering zone 16 (Gulf of Mexico).

#7 Priority (Reasoning: Three of ten agencies require this capability.)

- Cloud-to-ground lightning detection covering zone 19 (Mediterranean and Black Seas).
- Cloud-to-ground lightning detection covering zone 25 (Arctic Ocean).
- Cloud-to-ground lightning detection covering zone 24 (Indian Ocean).
- Cloud-to-ground lightning detection covering zone 26 (Southern Ocean).
- Cloud-to-ground lightning detection covering zone 15 (Antarctica).
- Cloud to flash lightning detection covering zones 6 through 15.
- Cloud to flash lightning detection covering zones 17 through 26.

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APPENDIX A: LIGHTNING LEXICON

This section contains a description of the terminology used in this document and was designed to aid each agency as they populated the requirements spreadsheets in Appendix C.

Archive: is the permanent archive of the lightning data collected by the vendor under the contract. Under this column indicate whether you need archive data (yes or no), whether you want to be able to maintain your own copy of the archive or are willing to rely on the vendor's archive, and what level of archive data you need (e.g., products made by the user from the vendor's data essentially in real time, products made by the vendor, or the time and location and other parameters for each mapped point.)

Parameters needed in the archive: is self explanatory. What parameters will you need in the archive: mapped lightning location, time, measures of error, peak current, multiplicity, polarity, etc. or just images of mapped locations or something else?

Cloud-to-ground lightning: is lightning having a channel spanning from a cloud to the earth. A cloud-to-ground flash can also be called a ground flash.

Cloud flash: is any lightning flash that does not strike ground. In the scientific literature, this is often called an intracloud flash, which, strictly defined, is a flash that stays within a single cloud. Other types of cloud flash include a cloud-to-cloud flash and a cloud-to-air flash. (Note: Determining the subcategory of a cloud flash requires knowledge of cloud boundaries, which no lightning mapping system can provide. Therefore, I suggest that we do not deal with the subcategories of cloud flashes in our requirements and specifications. In terms of impact on assets and personnel, what I think we care most about is where lightning is, not whether it is inside or outside clouds.)

Continuing current: is the reduced current flowing in a channel to ground for at least a few tens of milliseconds following a return stroke. It can last a few hundred milliseconds, with roughly 100 ms being typical. Current magnitudes vary from a few tens of amperes to more than 200 A, with 100-200 A being typical. Continuing current maintains ionization and visible, but reduced, luminosity in the channel to ground. It may occur in half to somewhat less than half of flashes. Because it takes a few tens of milliseconds to heat vegetative fuels to ignition temperature, it is continuing current that is responsible for igniting naturally occurring forest fires and range fires, not the return stroke, which has a much larger, but much briefer, current.

Data latency: is the maximum elapsed time from the occurrence of an event until it is reported to the user.

Detection efficiency: is the fraction of flashes detected by a lightning mapping system. It can apply specifically to cloud flashes (cloud flash detection efficiency), to cloud-to-ground strokes (stroke detection efficiency), to cloud-to-ground flashes (cloud-to-ground flash detection efficiency), or to all flashes (total flash detection efficiency or flash detection efficiency).

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Dart or continuous leader: is a leader of a cloud-to-ground flash that propagates smoothly toward ground some period after a return stroke. If too long an interval has occurred, the conductivity of the lower part of the channel can decrease too much to support a dart leader over the remainder of the distance to ground, and further progress to ground occurs by stepped leaders, usually deviating from the previous stroke's path to ground. A leader that has a transition to a stepped leader mode is sometimes called a dart-stepped leader. A dart leader's brightest luminosity is at its tip, which propagates at roughly 10^7 m/s.

Flash duration: is normally considered to be the period during which electric current flows through at least some channels in a flash. Once a current no longer flows through it, a channel quickly cools and loses its luminosity and ionization.

Flash multiplicity: is the number of strokes in a cloud-to-ground flash. Under this column, please enter "yes," if you want an estimate of the number of strokes in a flash, or "no," if you do not need an estimate of the number of strokes. It would be difficult to specify a level of performance for multiplicity, because many subsequent strokes produce very weak signals and accurate multiplicity also is affected by how accurately strokes are grouped into flashes. If detecting as many strokes as possible is important for your application, I suggest that you include specifications for strokes, instead of or in addition to specifications for cloud-to-ground flashes. Keep in mind that stroke detection efficiency is generally lower than flash detection efficiency. For systems such as the NLDN or USPLN, stroke detection efficiency is very sensitive to the spacing between stations, and a high stroke detection efficiency will require closely spaced stations (which are more expensive).

Flash polarity: usually (and for our purposes always) refers to the polarity of charge lowered to ground by a cloud-to-ground return stroke. Usually, all strokes in a flash lower the same polarity of charge to ground, but there are exceptions. A positive cloud-to-ground flash has positive polarity and a negative cloud-to-ground flash has negative polarity.

Flash type: is the category of a flash. For our use of flash type, the categories are cloud flash and cloud-to-ground flash.

Geographical coverage: is the region in which data are needed. Indicate first the zone in which the coverage is needed and then whether the whole zone or some part of the zone is needed. Subsets of the zone can be given as range from specified points, states, or latitude and longitude boundaries.

Ground strike point: is the point at which a cloud-to-ground flash strikes ground.

Horizontal resolution: is the spatial resolution your application requires. This applies to pixilated data, not to point data, and so would apply mainly to an imaging sensor such as the geosynchronous lightning mapper planned for GOES-R.

Initiation point or region: is the point or region at which a lightning flash begins. Initiation occurs when the build up of regions of net charge in a storm creates electric forces (typically

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between the charges) larger than the threshold at which the insulating properties of air break down. The flash then propagates bi-directionally, one end propagating toward and into positive charge, the other propagating toward and into positive charge. The currents flowing in the lightning channel redistribute charge in the storm to make the electric force smaller than the breakdown threshold. Locating lightning initiation is possible only with systems that map lightning channels that are inside clouds. There is uncertainty in all attempts to determine where a lightning flash originates, because one is never sure whether the mapping system one uses can map a flash's initial leaders. However, most systems that map lightning within clouds can estimate at least the region in which a flash originated.

Leader: the faintly luminous channel which seeks out a path of least resistance into the surrounding air or between a channel and a nearby object during the growth of a lightning channel. Typical leader progression speeds are 10^5 – 10^7 m/s. The channel subsequently becomes bright when a return stroke or another type of current surge travels through it.

Lightning channel: The tortuous path of luminous hot ionized air through which the electric current of a lightning flash flows. Near ground, lightning channels typically are a few centimeters in diameter, though a broader sheath of radial current may flow toward or away from the channel. (Note: The processes by which the insulating properties of air break down ionize the air and heat it.)

Lightning flash: is a total lightning discharge, which usually is composed of many distinct luminous events that often occur in such rapid succession the human eye cannot resolve them. The duration of a flash is typically less than 1 second, but can be several seconds. (Note: In theory, a flash consists of all lightning channels that are physically connected together, though older channels in a flash may have dissipated while newer ones are developing. In practice, delineating flashes with data from a particular type of lightning mapping system can sometimes be ambiguous and may depend on the lightning properties the system detects.)

Location accuracy: is the standard error (normally expressed in meters or kilometers) in the horizontal location at which a lightning mapping system indicates that a lightning channel segment occurred. Depending on what the mapping system is supposed to report, the reported location may be either the ground strike point of a cloud-to-ground flash or the location of any lightning channel segment above ground. The standard error is the standard deviation in the distance of the mapped location from the actual location. Because the error may be greater in some directions about the actual location than in other directions, the standard error is sometimes expressed as an error ellipse. For our specifications, however, we need to specify only the maximum standard deviation which will be acceptable for our applications.

Location precision: is the least significant digit in the reported location. For example, locations could be reported to the nearest kilometer or nearest 10 meters. Because the required precision should be appropriate to the required location accuracy, a separate column for precision was not included.

Negative cloud-to-ground lightning: is cloud-to-ground lightning that lowers negative charge to the ground. A negative cloud-to-ground flash is sometimes called a negative ground flash.

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Peak current accuracy: is the standard error in the reported peak current of a return stroke. This parameter, along with multiplicity, does not apply to cloud flashes. Note that peak current is not measured directly, but is estimated from the received signal by a theoretical model which uses some typical values of lightning return stroke parameters that will not be measured (it would take high speed, stereo video recordings of every return stroke to measure one of the required parameters). Thus, errors in peak current estimates will be relatively large by necessity, and the accuracy will be almost impossible to verify, except in a few cases of lightning triggered to instrumented towers.

Peak current: can obviously apply to the maximum of any time-varying current. However, in the context of lightning, it usually refers to the peak current during the return stroke of a cloud-to-ground flash. It typically occurs within a few microseconds (sometimes <1 microsecond) of the onset of the return stroke. The mean value has varied over the years as the number and sensitivity of measurements improved. The mean is now usually given as 15-25 kA. The 99th percentile is roughly 100-200 kA. Peak current can be estimated roughly from the peak electromagnetic signal measured by many lightning mapping systems during a return stroke, but to do this, one must make assumptions about the speed at which the return stroke progresses up the channel.

Phenomena: is the specific type of lightning or the specific lightning process for which you need data. If you need all lightning to be detected and do not need flash type discrimination, indicate total lightning. If you need all lightning, but need the flash type (cloud-to-ground flashes and cloud flashes) to be identified, please enter each type on a separate line that lists the specifications applying to mapping that type of flash. If you need cloud-to-ground stroke data instead of or in addition to cloud-to-ground flash data, please list cloud-to-ground stroke on its own line.

Polarity: is the polarity of charge lowered toward ground in a vertical lightning channel during the mapped flash. For most applications, this will apply only to the return stroke of a cloud-to-ground stroke or to the first return stroke of a flash or to the return stroke with the largest peak current in a flash. A positive cloud-to-ground stroke lowers positive charge to ground and a negative cloud-to-ground stroke lowers negative charge to ground. Use this column only on a spreadsheet line for cloud-to-ground strokes or cloud-to-ground flashes, and indicate whether you need to know the polarity (yes or no). If knowing the polarity is important for your application, please also indicate a probability of false detection for polarity in the false detection column.

Positive cloud-to-ground lightning: is cloud-to-ground lightning that lowers positive charge to ground. A positive cloud-to-ground flash is sometimes called a positive ground flash.

Probability of false detection: the fraction (given as a percentage) of mapped events that are not actually produced by the indicated lightning process. Thus, cloud flashes identified as cloud-to-ground flashes would be a false detection of cloud-to-ground flashes. One could also have a false detection of cloud flashes, a false detection of flash polarity (the wrong polarity was indicated), or a false detection of flashes (something other than lightning was identified as a

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lightning flash. False detection of flashes needs to be a very small percentage. For some applications, false detection of polarity or of flash type may be of no concern, but for others, they may be critical. If correct identification of polarity is of concern to you, please specify the probability of false detection for both cloud-to-ground flashes or strokes (depending on what you specified on this line under phenomena) and for polarity.

Reliability: is the fraction of time in which the data provided by the contract meet the specified operational standards. This should be fairly close to 100 percent, though some periods for maintenance and repair should be allowed. We probably also would want a specification of how long the vendor has to correct a problem with the network and perhaps another specification of how long to correct a problem with communication of data to the government points of contact.

Reporting frequency: is the maximum time interval between reports to a user. For example, a user might get the mapped lightning data grouped into one-minute packets of data. If there is no lightning in the region of coverage, a report is still needed at the reporting frequency to indicate no lightning.

Return stroke: refers to part of a cloud-to-ground flash. It is the intense luminosity and electric current pulse that propagates upward from the earth into the cloud after a stepped leader or dart leader connects with earth or with an upward spark from the earth. Typical return stroke ascent speeds are roughly 1 x 10^8 m/s (roughly 1/3 the speed of light).

Stepped leader: is the initial downward leader of a cloud-to-ground lightning flash. It advances intermittently in steps at intervals of approximately 50-100 microseconds. The length of a channel step typically is 50 m to a few hundred meters. An average propagation speed, including the pauses between steps, is typically 5 x 10^5 m/s. It is possible that stepped leaders also occur in cloud flashes, but they have been identified by images on film or video, which have been available almost exclusively beneath clouds.

Stroke or lightning stroke: refers to a specific part of a cloud-to-ground lightning flash. A single stroke consists of a downward propagating leader (either a stepped leader or a dart leader) plus an upward propagating return stroke. A single cloud-to-ground flash may have multiple strokes. The most frequently occurring number of strokes in a cloud-to-ground flash is one, but the mean number of strokes per flash is three. Using "stroke" to refer to part of a cloud flash is incorrect.

Timing accuracy: is the standard error in the reported time at which a mapped lightning process occurred. For example, one might require the reported time of a ground strike to be accurate to within a second or to within a millisecond. The accuracy a user needs will depend on the application. To associate a particular mapped lightning process with other events or other lightning data, millisecond accuracy is needed.

Timing precision: is the least significant digit in the reported time. The needed precision will depend on the application, but millisecond precision should be adequate for most, if not all, government applications of lightning mapping data.

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Total lightning: Indicate total lightning if you need all lightning to be detected but do not need flash type discrimination (i.e. CF or CG).

Triggered lightning: normally refers to lightning that is initiated by an object which enhanced the local electric field (any reasonably good conductor will enhance any electric field in which it is placed, but tall, narrow conducting objects, such as a tall tower, enhance the electric field at the ground the most). Aircraft and rockets in flight may either intercept or trigger a flash. Most, if not all, cloud-to-ground flashes that begin at the ground are thought to be triggered by tall towers or buildings or other tall objects.

Vertical accuracy: is the standard error (expressed in meters or kilometers) in the vertical location at which a lightning mapping system indicates that a lightning channel segment occurred.

Vertical extent: applies only to flashes, not to lightning strikes to ground. If you need to locate lightning channels above ground, how high (in kilometers MSL) do you need to detect them?

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APPENDIX B: GEOGRAPHIC ZONES

Terrestrial Zones: Coverage of terrestrial zones extends 250km off shore and over adjacent land areas except coverage of zone 1 extends 500 km off shore and over adjacent land areas.

Zone 1	48 Contiguous States, Puerto Rico and Virgin Islands
Zone 2	Alaska
Zone 3	Hawaii
Zone 4	Canada
Zone 5	Mexico
Zone 6	Central and South America
Zone 7	Europe
Zone 8	Northern Asia
Zone 9	Southern Asia
Zone 10	Middle East
Zone 11	Africa
Zone 12	East Indies and the Philippines
Zone 13	Australia and New Zealand
Zone 14	Greenland and Iceland
Zone 15	Antarctica

Marine Zones:

Zone 16	Gulf of Mexico, Caribbean Sea and West Indies
Zone 17	North Atlantic Ocean
Zone 18	South Atlantic Ocean
Zone 19	Mediterranean and Black Seas
Zone 20	Northeast Pacific Ocean
Zone 21	Northwest Pacific Ocean
Zone 22	Southeast Pacific Ocean
Zone 23	Southwest Pacific Ocean
Zone 24	Indian Ocean
Zone 25	Arctic Ocean
Zone 26	Southern Ocean

A graphical representation of geographic zones follows.

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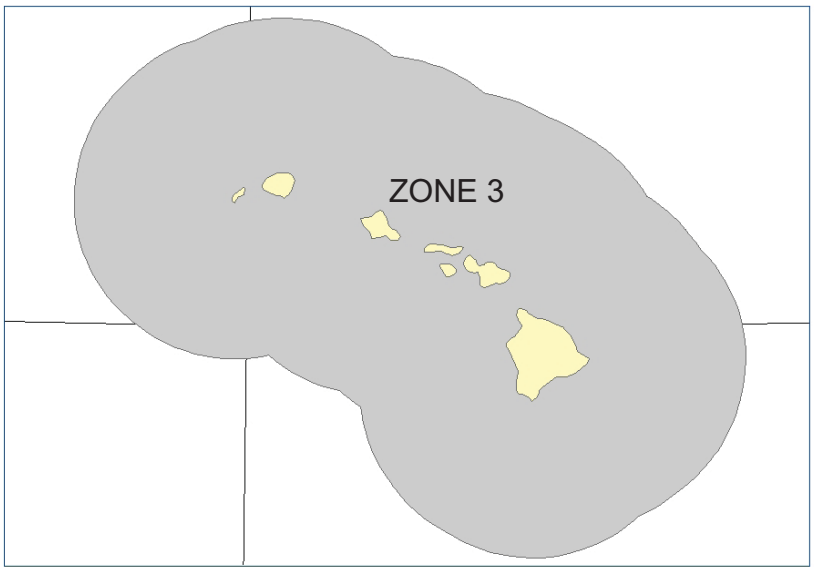
LIGHTNING ZONE 1

FORTY EIGHT CONTIGUOUS STATES AND PUERTO RICO AND THE VIRGIN ISLANDS

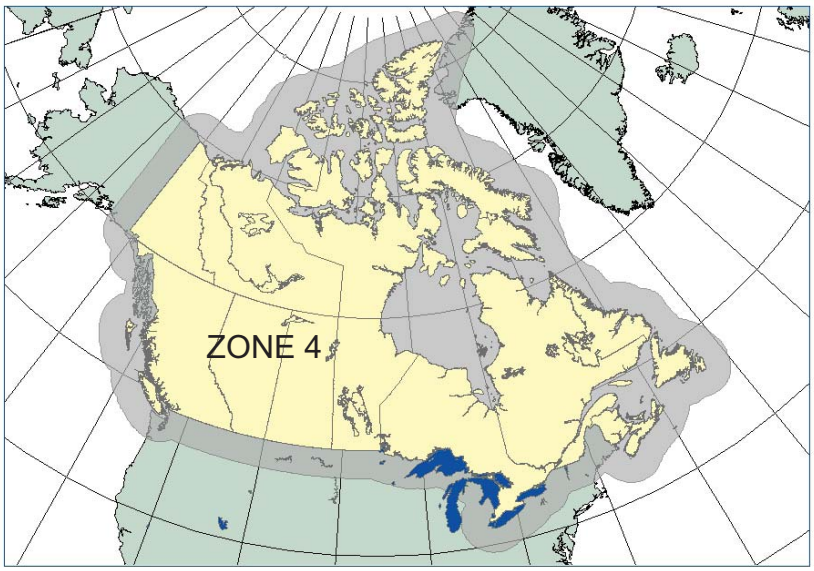
LIGHTNING ZONE 2

ALASKA

LIGHTNING ZONE 3
HAWAII



LIGHTNING ZONE 4
CANADA

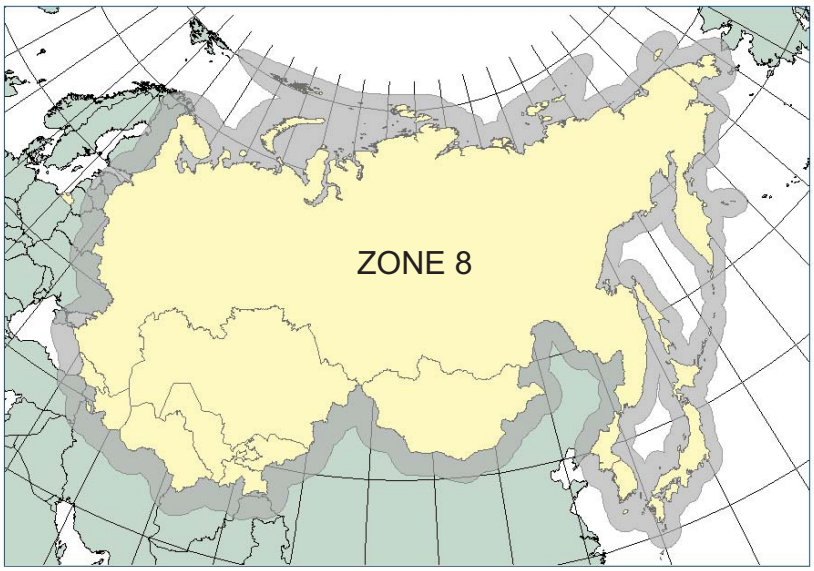


LIGHTNING ZONE 5
MEXICO

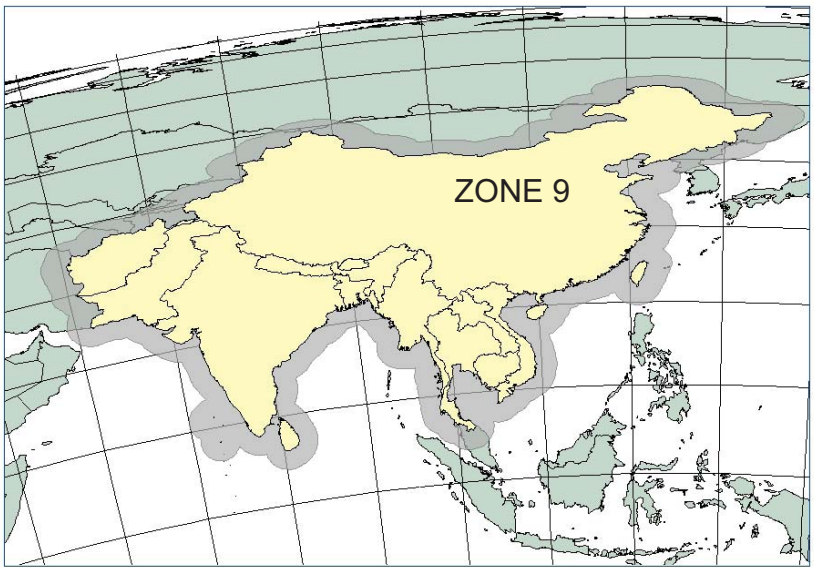
LIGHTNING ZONE 6
CENTRAL AND SOUTH AMERICA

LIGHTNING ZONE 7
EUROPE

LIGHTNING ZONE 8
NORTHERN ASIA

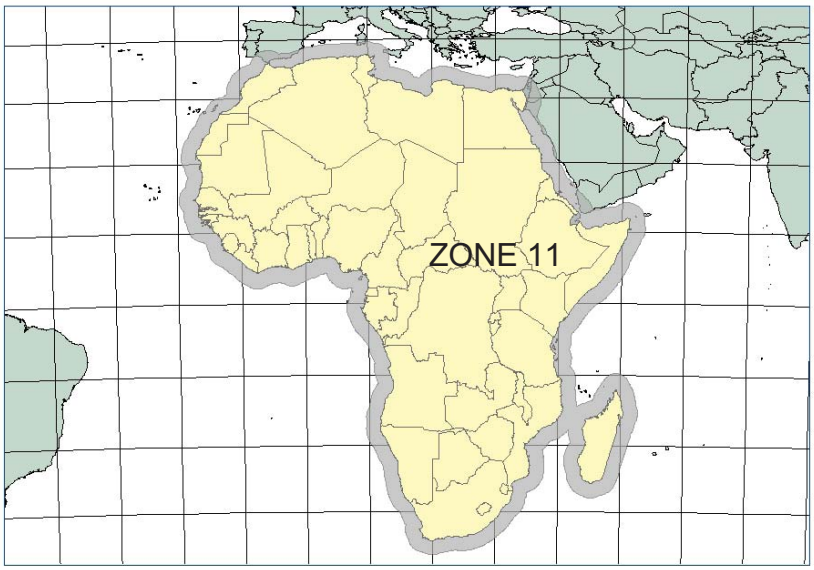


LIGHTNING ZONE 9
SOUTHERN ASIA

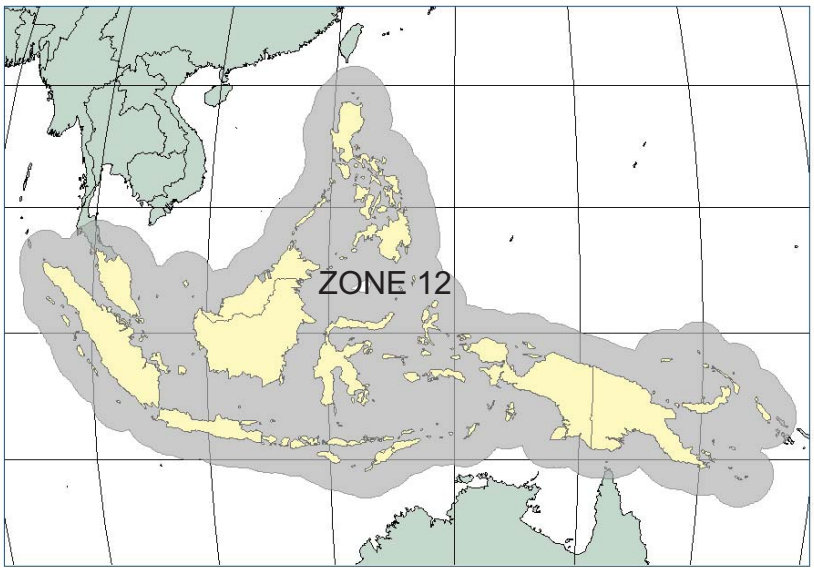


LIGHTNING ZONE 10
MIDDLE EAST

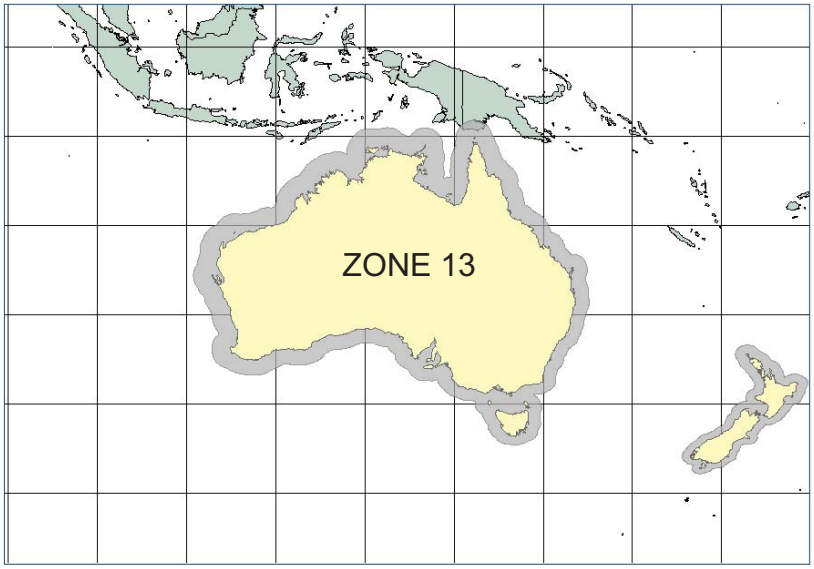
LIGHTNING ZONE 11
AFRICA



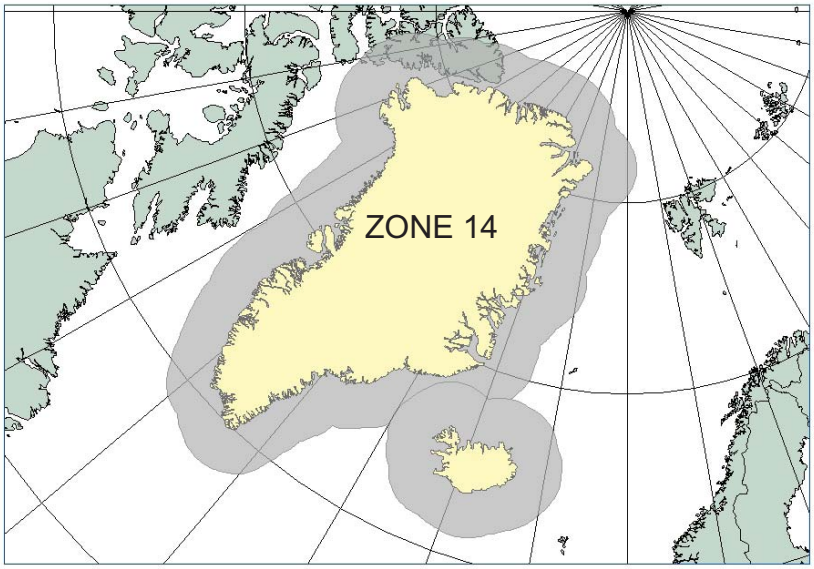
LIGHTNING ZONE 12
EAST INDIES AND THE PHILIPPINES



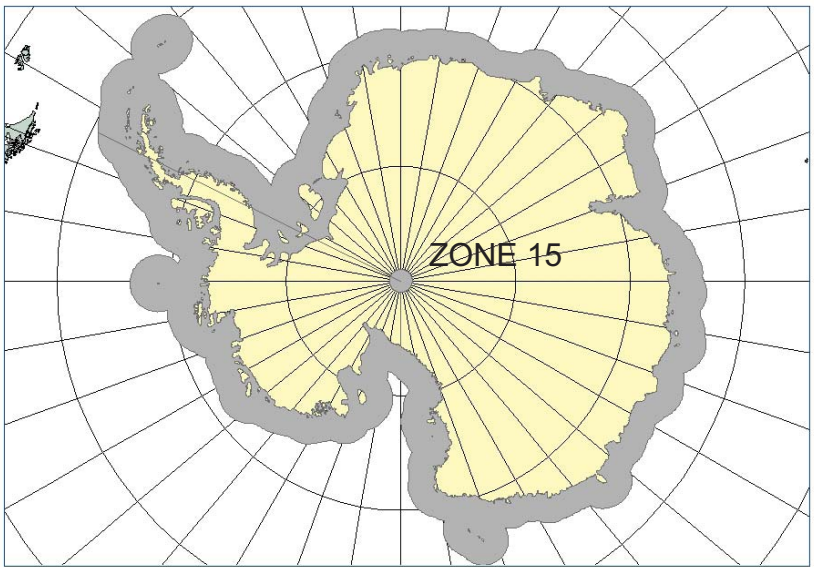
LIGHTNING ZONE 13
AUSTRALIA AND NEW ZEALAND



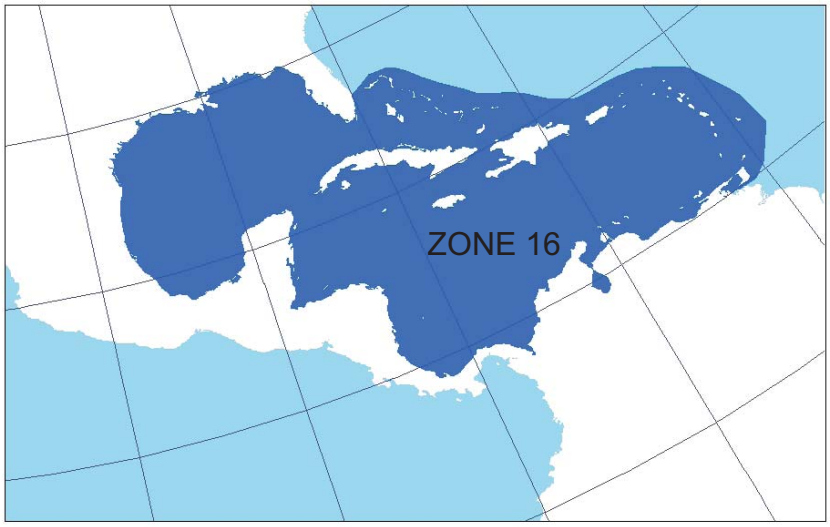
LIGHTNING ZONE 14
GREENLAND AND ICELAND



LIGHTNING ZONE 15
ANTARCTICA

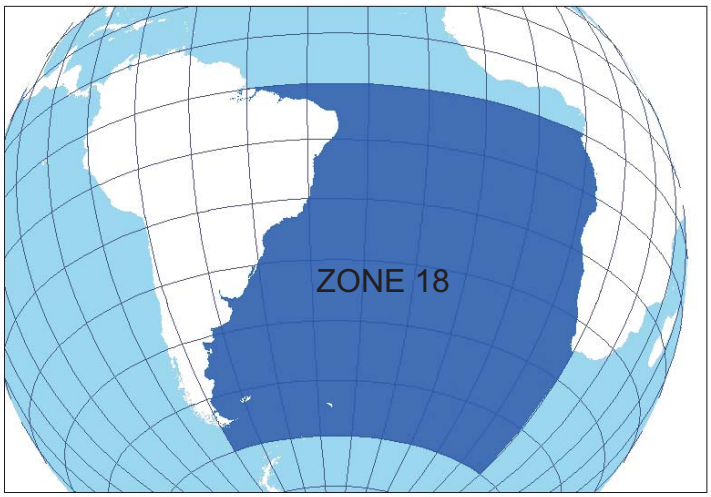


LIGHTNING ZONE 16
GULF OF MEXICO, CARIBBEAN SEA AND WEST INDIES



LIGHTNING ZONE 17
NORTH ATLANTIC OCEAN

LIGHTNING ZONE 18
SOUTH ATLANTIC OCEAN

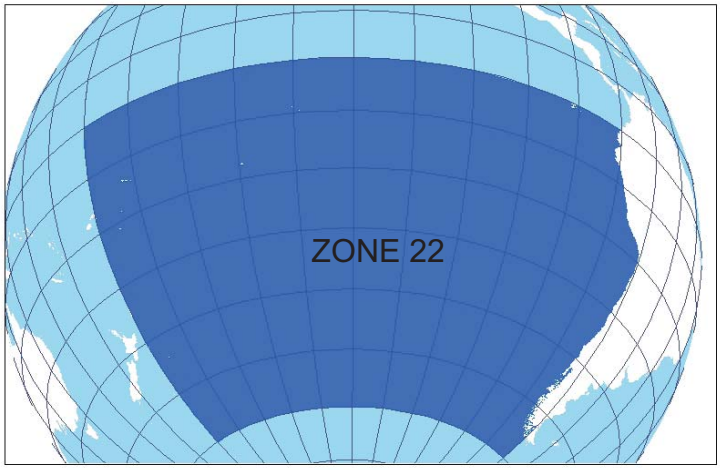


LIGHTNING ZONE 19
MEDITERRANEAN AND BLACK SEAS

LIGHTNING ZONE 20
NORTHEAST PACIFIC OCEAN

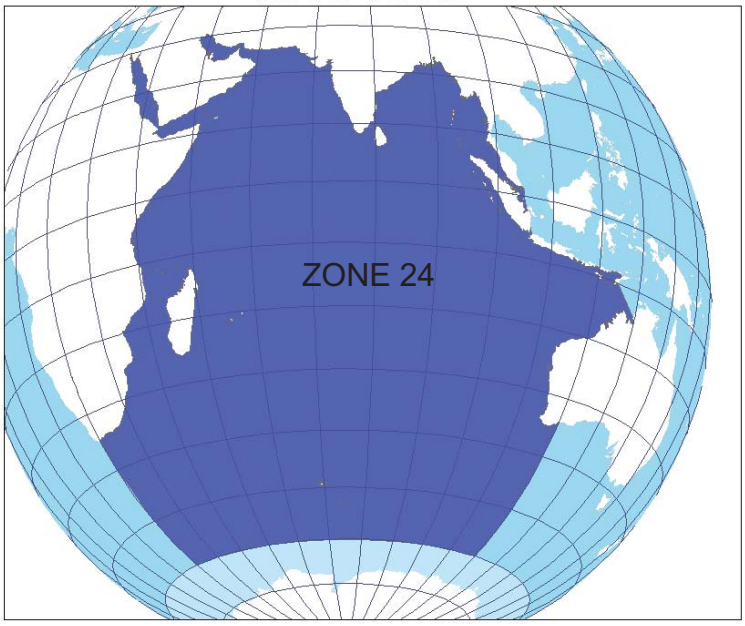
LIGHTNING ZONE 21
NORTHWEST PACIFIC OCEAN

LIGHTNING ZONE 22
SOUTHEAST PACIFIC OCEAN

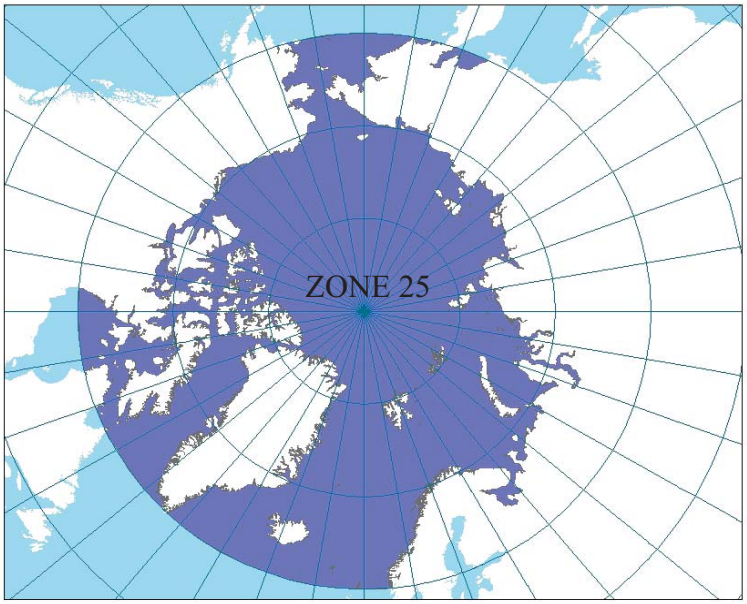


LIGHTNING ZONE 23
SOUTHWEST PACIFIC OCEAN

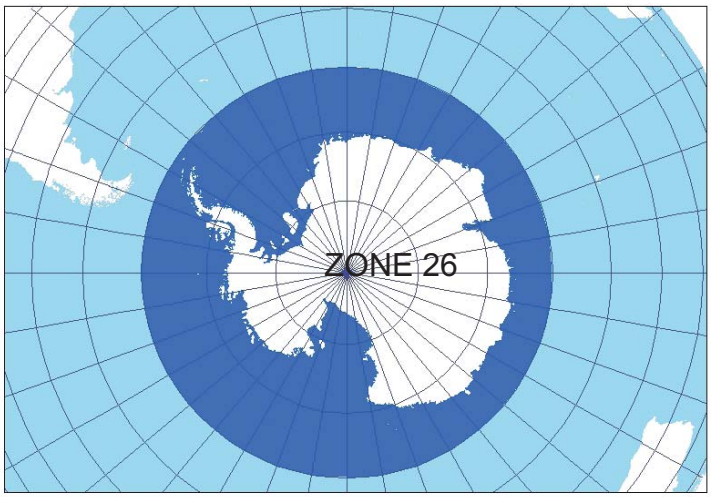
LIGHNING ZONE 24
INDIAN OCEAN



LIGHTNING ZONE 25
ARCTIC OCEAN



LIGHTNING ZONE 26
SOUTHERN OCEAN



APPENDIX C: AGENCY REQUIREMENTS TABLES

The following are lightning requirements submitted by each agency.

DRAFT

Department of Defense
United States Army

USER	GEOGRAPHICAL COVERAGE	Phenomena	Stroke Types	Location ACCURACY	Vertical Extent
U.S. Army Ranges	Zones 1-3	CF & CG	All	0.3 km	Sfc-Cloud top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3 km	5 min	< 5 min.	95%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	False Detection Percentage
99.88%		Required		5%

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Yes	Yes		Resouce protection at Army Ranges	Probable loss of equipment or life due to lightning strike

Department of Defense
United States Army

USER	GEOGRAPHICAL COVERAGE	Phenomena	Stroke Types	Location ACCURACY	Vertical Extent
U.S. Army	Zones 1-3, 5-14	CF & CG	All	0.5 km	Sfc-Cloud top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3 km	5 min	1 min	95%	<1%

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	False Detection Percentage
99.88%	1 sec			

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
No	Yes		Worldwide Army ground operations. Protection of equipment and personnel	Loss of life or equipment

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG, 30 WS, 21 OWS, 623 AOC/STW (30WS needs better coverage, at least 90% DE, than NLDS offers off of West Coast)	Zone 01	TL	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.30 km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative		.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions for Flight Weather Briefing support. Result is negative impact to FWB prep of 175-1 MEFs. Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG	Zone 01	CG & CF	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.30 km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative		.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Polarity of cloud to ground is useful in identifying severe storms while the polarity of the cloud flashes points to where the storm is on its morphology. In addition, recent literature points to the presence of positively charged cloud flashes as being areas requiring greater than normal horizontal and vertical separation due to increased likelihood of aircraft triggered electrostatic discharges to composite skinned aircraft and unmanned aerial systems. Having the ability to differentiate between cloud to ground and cloud flashes will enhance the support the OWSs provide to installation resource protection and aviation operations.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45WS and 30WS	> 50 to <= 100 NM of KSC, Cape Canavaral AFS and Vandenberg AFB	Stepped Leader	2.5km	5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 3.0 (50th percentile) • ≤ 4.5 (90th percentile)	1 min	≤ 1min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	N/A	N	N/A

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Y			Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45WS and 30WS	> 30 to <= 50 NM of KSC, Cape Canavaral AFS and Vandenberg AFB	Stepped Leader	1km	2km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 1.0 (50th percentile) • ≤ 1.5 (90th percentile)	1 min	≤ 1min	• ≥ 95% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	N/A	N	N/A

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Y			Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45WS and 30WS	> 50 to <= 100 NM of KSC, Cape Canavaral AFS and Vandenberg AFB	Return Stroke	0.25km	0.5km	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A	1min	≤ 1 min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	positive and negative	Y	±20%

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Y	Y			Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45WS and 30WS	Zone 01, southern half of CONUS, including adjacent coasts	TL	0.25km	0.5km	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A	5min	≤ 5min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	positive and negative	Y	±20%

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Y	Y			Space Shuttle ferry flights, classified missions, back-up capability for higher performance local capability as listed above

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45WS and 30WS	> 30 to <= 50 NM of KSC, Cape Canavaral AFS and Vandenberg AFB	Return Stroke	0.2km	0.4km	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A	1 min	≤ 1min	≥ 95%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	N/A	Y	±20%

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Y	Y			Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45WS and 30WS	> 15 to <= 30 NM of KSC, Cape Canavaral AFS and Vandenberg AFB	Stepped Leader	0.15k	0.3km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 0.30 (50th percentile) • ≤ 0.50 (90th percentile)	1 min	≤ 1min	• ≥ 99% (flash) • ≥ 90% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	N/A	N	N/A

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Y	Y			Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45 WS and 30WS	> 15 to <= 30 NM of KSC, Cape Canavaral AFS and Vandenberg AFB	Return Stroke	0.12km	0.25km	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A	1 min	≤ 1min	≥ 99%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	N/A	Y	±10%

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Y	Y			Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45 WS and 30WS	<= 15 NM of KSC, Cape Canavaral AFS and Vandenberg AFB	Stepped Leader	0.05km	0.1km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 0.10 (50th percentile) • ≤ 0.15 (90th percentile)	1 min	≤ 1min	• 100% (flash) • ≥ 95% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	N/A	N	N/A

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Y			Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
45 WS and 30WS	<= 15 NM of KSC, Cape Canavaral AFS and Vandenberg AFB	Return Stroke	0.05km	0.1km	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A	1 min	≤ 1min	≥ 99%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	N/A	Y	±5%

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Y	Y			Degraded Lightning Launch Commit Criteria evaluation, lightning warnings, severe weather warnings, aviation forecasts, mishap investigation, and technical improvement studies

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 02	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS, Det 1-2 WS	Zone 03	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following; Potential catastrophic damage to 1 of 4 Radio Solar Telescopes worldwide. Risk to personnel performing maintenance on equipment

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG, 17 OWS, 21 OWS, 623 AOC/STW	Zone 04	TL	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following. Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions for Flight Weather Briefing support. Result is negative impact to FWB prep of 175-1 MEFs

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG	Zone 04	CG	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Polarity of cloud to ground is useful in identifying severe storms while the polarity of the cloud flashes points to where the storm is on its morphology. In addition, recent literature points to the presence of positively charged cloud flashes as being areas requiring greater than normal horizontal and vertical separation due to increased likelihood of aircraft triggered electrostatic discharges to composite skinned aircraft and unmanned aerial systems. Having the ability to differentiate between cloud to ground and cloud flashes will enhance the support the OWSs provide to installation resource protection and aviation operations.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG	Zone 04	CF	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Polarity of cloud to ground is useful in identifying severe storms while the polarity of the cloud flashes points to where the storm is on its morphology. In addition, recent literature points to the presence of positively charged cloud flashes as being areas requiring greater than normal horizontal and vertical separation due to increased likelihood of aircraft triggered electrostatic discharges to composite skinned aircraft and unmanned aerial systems. Having the ability to differentiate between cloud to ground and cloud flashes will enhance the support the OWSs provide to installation resource protection and aviation operations.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG, 623 AOC/STW	Zone 05	TL	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG	Zone 05	CG	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Polarity of cloud to ground is useful in identifying severe storms while the polarity of the cloud flashes points to where the storm is on its morphology. In addition, recent literature points to the presence of positively charged cloud flashes as being areas requiring greater than normal horizontal and vertical separation due to increased likelihood of aircraft triggered electrostatic discharges to composite skinned aircraft and unmanned aerial systems. Having the ability to differentiate between cloud to ground and cloud flashes will enhance the support the OWSs provide to installation resource protection and aviation operations.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG	Zone 05	CF	0.5 km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.30	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Polarity of cloud to ground is useful in identifying severe storms while the polarity of the cloud flashes points to where the storm is on its morphology. In addition, recent literature points to the presence of positively charged cloud flashes as being areas requiring greater than normal horizontal and vertical separation due to increased likelihood of aircraft triggered electrostatic discharges to composite skinned aircraft and unmanned aerial systems. Having the ability to differentiate between cloud to ground and cloud flashes will enhance the support the OWSs provide to installation resource protection and aviation operations.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
612 SPTS/WX, 2 WS/WXF/I	Zone 06	TL	1.853248km	0.926624km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings. Potentially degraded or missed thunderstorm activity for SCI Customers. Degradation to SOF operational forecasts; watchs/warnings accuracy.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
21 OWS	Zone 07	TL	2.5km	2.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	5min	≤ 5min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions threatening USN, USA and USAF operating areas and locations. Result is Loss of timely and accurate RP support, Negative impact to FWB prep of 175-1 MEFs for European DoD assets currently valued in excess of $300B

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
21 OWS, 2 WS/WXI	Zone 08	TL	20km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions for Flight Weather Briefing support. Result is negative impact to FWB prep of 175-1 MEFs. Potentially degraded or missed thunderstorm activity for SCI Customers

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
623 AOC/STW	Zone 08	TL	5km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Resource Protection effected if within 5nm of Army or AF Airbase or 25nm of projected flight paths (avoidance); thresholds are based on resolution or accuracy of current C2 system displays

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 08, south of 60 deg N, east of 120 deg E	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
28 OWS	Zone 08, Kazakhstan, Kyrgyzstan, Uzbekistan, and Turkmenistan	TL	1.853248km	0.926624km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
21 OWS, 2 WS/WXF/I	Zone 09	TL	20km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions for Flight Weather Briefing support. Result is negative impact to FWB prep of 175-1 MEFs. Potentially degraded or missed thunderstorm activity for SCI Customers. Degradation to SOF operational forecasts; watchs/warnings accuracy.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
623 AOC/STW	Zone 09	TL	5km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Resource Protection effected if within 5nm of Army or AF Airbase or 25nm of projected flight paths (avoidance); thresholds are based on resolution or accuracy of current C2 system displays

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 09, south of 60 deg N, east of 80 deg E	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
28 OWS	Zone 09, Afghanistan, Tajikistan, and Pakistan	TL	1.853248km	0.926624km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
21 OWS, 2 WS/WXF/I	Zone 10	TL	2.5km	2.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	5min	≤ 5min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions threatening USN, USA and USAF operating areas and locations. Result is Loss of timely and accurate RP support, Negative impact to FWB prep of 175-1 MEFs for European DoD assets currently valued in excess of $300B. Potentially degraded or missed thunderstorm activity for SCI Customers. Degradation to SOF operational forecasts; watchs/warnings accuracy

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
28 OWS	Zone 10, excluding Turkey, Syria, Israel, and Lebanon	TL	1.853248km	0.926624km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
21 OWS, 2 WS/WXF/I	Zone 11	TL	20km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions for Flight Weather Briefing support. Result is negative impact to FWB prep of 175-1 MEFs. Potentially degraded or missed thunderstorm activity for SCI Customers. Degradation to SOF operational forecasts; watchs/warnings accuracy.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
623 AOC/STW	Zone 11	TL	5km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Resource Protection effected if within 5nm of Army or AF Airbase or 25nm of projected flight paths (avoidance); thresholds are based on resolution or accuracy of current C2 system displays

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 11, Madagascar/surroun ding waters	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
28 OWS	Zone 11, Egypt, Sudan, Kenya, Somalia, Eritrea, Ethiopia, & Djibouti	TL	1.853248km	0.926624km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS, 2 WS/WXF/I	Zone 12	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	
Reliability	**Timing Accuracy**	**Polarity**	**Peak Current (Y/N)**	**Peak Current Accuracy**
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following; Potentially degraded or missed thunderstorm activity for SCI Customers; Degradation to SOF operational forecasts; watchs/warnings accuracy

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS, Det 5-2 WS	Zone 13	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	
Reliability	**Timing Accuracy**	**Polarity**	**Peak Current (Y/N)**	**Peak Current Accuracy**
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following; Potential catastrophic damage to 1 of 4 Radio Solar Telescopes worldwide. Risk to personnel performing maintenance on equipment

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
21 OWS	Zone 14	TL	20km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions for Flight Weather Briefing support. Result is negative impact to FWB prep of 175-1 MEFs

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
623 AOC/STW	Zone 14	TL	5km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Resource Protection effected if within 5nm of Army or AF Airbase or 25nm of projected flight paths (avoidance); thresholds are based on resolution or accuracy of current C2 system displays

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 15	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG, 45 WS, 623 AOC/STW	Zone 16,	TL	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Y	Y			Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Lightning Launch Commit Criteria evaluation, severe weather warnings, aviation flights

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG	Zone 16,	CG	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Polarity of cloud to ground is useful in identifying severe storms while the polarity of the cloud flashes points to where the storm is on its morphology. In addition, recent literature points to the presence of positively charged cloud flashes as being areas requiring greater than normal horizontal and vertical separation due to increased likelihood of aircraft triggered electrostatic discharges to composite skinned aircraft and unmanned aerial systems. Having the ability to differentiate between cloud to ground and cloud flashes will enhance the support the OWSs provide to installation resource protection and aviation operations.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
1 WXG	Zone 16,	CF	0.5km	0.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF • < 3 Hours MTBR	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Protection of personnel and equipment. Cargo Airlift, Combat Delivery, Passenger Airlift, Aeromedical Evacuation, Special Operations Airlift, Air Refueling Tankers, Strategic Brigade Airdrop Air Refueling Support. Necessary for avoiding ground and airborne hazards, tactics, weapon selection and performance, ground operations, surveillance, reconnaissance and forecasting weather elements. Polarity of cloud to ground is useful in identifying severe storms while the polarity of the cloud flashes points to where the storm is on its morphology. In addition, recent literature points to the presence of positively charged cloud flashes as being areas requiring greater than normal horizontal and vertical separation due to increased likelihood of aircraft triggered electrostatic discharges to composite skinned aircraft and unmanned aerial systems. Having the ability to differentiate between cloud to ground and cloud flashes will enhance the support the OWSs provide to installation resource protection and aviation operations.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
21 OWS	Zone 17	TL	20km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions for Flight Weather Briefing support. Result is negative impact to FWB prep of 175-1 MEFs

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
623 AOC/STW	Zone 17	TL	5km	20km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	15min	≤ 15min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Resource Protection effected if within 5nm of Army or AF Airbase or 25nm of projected flight paths (avoidance); thresholds are based on resolution or accuracy of current C2 system displays

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
612 SPTS/WX	Zone 17, south of 20 deg N, west of 30 deg W	TL	1.853248km	0.926624km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
612 SPTS/WX	Zone 18, west of 30 deg W	TL	1.853248km	0.926624km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
21 OWS	Zone 19	TL	2.5km	2.5km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	5min	≤ 5min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Inability to accurately assess thunderstorm strength and intensity would hamper forecaster capability to accurately assess conditions threatening USN, USA and USAF operating areas and locations. Result is Loss of timely and accurate RP support for European DoD assets currently valued in excess of $300B

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 20	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
612 SPTS/WX	Zone 20, south of 16 deg N, east of 120 deg W.	TL	1.853248km	0.926624km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 21	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 22	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
612 SPTS/WX	Zone 22, east of 120 deg W	TL	1.853248km	0.93km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning strike watches/warnings.

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 23	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 24	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
28 OWS	Zone 24, north of 5 deg N, west of 68 deg E	TL	1.853248km	0.93	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Reliance on grossly inaccurate European lightning detection network, with errors in location of over 80-160km depending on distance from Europe. Increased risk to flight safety and mission accomplishment since aircrews may not be notified of areas of thunderstorms. Increased risk of damage to joint/interagency/multinational assets since weather forces may be unable to issue timely and accurate lightning s Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 25	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
17 OWS	Zone 26	TL	1.853248km	5.559744km	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
0.3km	1min	≤ 1min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
	0.001sec	positive/negative	Y	.01 kamp

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Unable to evacuate Air Field and perform required WWA support, Mission Watch, Flight Following

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
618 TACC/XOW	All Zones	TL	0.402336km	0.152399999768352km	

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
	1min	≤ 1min		

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Potential mission delays/cancellations, safety of flight and ground operations

Department of Defense
United States Air Force

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
623 AOC/STW	All Zones except 1, 4, 5, & 16	TL		0.80	

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
	10min	≤ 10min		

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
				Resource Protection effected if within 5nm of Army or AF Airbase or 25nm of projected flight paths (avoidance); thresholds are based on resolution or accuracy of current C2 system displays

Department of Defense
United States Navy and Marine Corps

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
US Navy & Marine Corps	Zone 1: CONUS; Zone 3: Hawaii ; Guam; Zone 7: Europe; Zone 8: N Asia; Zone 10: Mid East **(<= 15 NM of Navy / Marine Corps Installations)**	Stepped Leaders Return Strokes		• ≤ 0.10 Km (50th percentile) • ≤ 0.15 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
1000ft (0.3km)	Real-time, 24/7/365	≤ 1 min ≤ 2 min	100% < 5NM 95% 5 - 15 NM	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)			Yes - Marine Corps Requirement	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes	- Time and location of strike - Peak Current - Error measurements - polarity	• Resource Protection • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies	Criticial

Department of Defense
United States Navy and Marine Corps

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
US Navy & Marine Corps	Zone 1: CONUS; Zone 3: Hawaii ; Guam; Zone 7: Europe; Zone 8: N Asia; Zone 10: Mid East **(> 15 to <= 30 NM of Navy / Marine Corps Installations)**	Stepped Leaders Return Strokes		• ≤ 0.30 Km (50th percentile) • ≤ 0.50 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
1000ft (0.3km)	Real-time, 24/7/365	≦ 1 min ≤ 2 min	• ≥ 99% • ≥ 90%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)			Yes - Marine Corps Requirement	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes	- Time and location of strike - Peak Current - Error measurements - polarity	• Resource Protection • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies	Significant

Department of Defense
United States Navy and Marine Corps

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
US Navy & Marine Corps	All maritime zones.	Stepped Leaders Return Strokes		• ≤ 5.0 Km (50th percentile) • ≤ 7.5 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
1000ft (0.3km)	Real-time, 24/7/365	≤ 2 min ≤ 5 min	• ≥ 90% • ≥ 80%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)			Yes - Marine Corps Requirement	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes	- Time and location of strike - Peak Current - Error measurements - polarity	• Marine Warnings • Lightning Warnings • Severe Weather Warnings • Optimum Track Ship Routing • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies	Major

Department of Defense
United States Navy and Marine Corps

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
US Navy & Marine Corps	All land zones. (> 30 NM Navy / Marine Corp Installations Regional Coverage)	Stepped Leaders Return Strokes		• ≤ 0.5 Km (CG) • ≤ 5.0 Km (CF)(50th percentile) • ≤ 7.5 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
1000ft (0.3km)	Real-time, 24/7/365	≤ 2 min ≤ 5 min	• ≥ 90% • ≥ 80%	

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)			Yes - Marine Corps Requirement	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes	- Time and location of strike - Peak Current - Error measurements - polarity	• Lightning Warnings • Severe Weather Warnings • Aviation Routing Forecasts • Mishap Investigation • Technical Improvement Studies	Major

Department of Commerce
National Oceanic and Atmospheric Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NWS	All Zones	CG & CF	0.5 km	≤ 0.5 Km	Surface to cloud top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
Threshold: 0.1 Km Goal: 0.01 Km	Continuous	≤ 1 min	100%	TBD (All)

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	Positive/Negative	Y	±10% (All)

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Y		• Watches and Warnings • Aviation Forecasts • Technical Improvement Studies • NWP - Numerical Weather Prediction • Climate	Severely degrades lightning forecasts capabilities, watches and warnings timeliness.

Data Format	Notes
WMO Standard --ascii, BUFR, or binary with complete format documentation. XML, GML, netCDF not desirable, but OK (may make files exceedingly large)	Zones: •**RUC** 1, 2, 4, 5, 6, 14, 16, 17, 20, 25. •**AWC** All •**SMG** All except 14, 15, 25, 26 •**LWF** 1-6, 16, 20-22. •**MOS** 1, 2, 3, 15, 20. •**SPC** 1, 2, 3, 15, 16

NHC Needs: Lightning data over the gulf and out over the Atlantic Ocean to Africa as well as the Pacific Ocean to the date line will allow better tropical forecasts. The data is currently being used to distinguish between convective clouds and thick cirrus to help improve wave and wind estimates for maritime safety. In addition, the oceanic lightning data is being used to study the intensity phases of tropical systems and may provide better intensity forecasts in the future.

Department of Interior

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
Bureau of Land Management	Zone 1	CG		1/2 km for 99% of the area within the zone: the location of a CG flash is the location where it strikes the ground	n/a

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
n/a	continuous (near realtime)	Total time from the time the flash occurs to the time that flash is reported shall be one minute or less for 99% of all flashes.	90% or higher over the 48 contiguous states; 60% or highter over adjacent marine and land areas	see false detection percentage

Reliability	Timing Accuracy	Polarity	False Detection Percentage	Peak Current Accuracy
see detection efficiency	Accuracy of the reported time of flashes shall be 0.001 seconds or better	Polarity shall be reported for all flashes	No more than 1% of all reported lightning flashes shall be due to non-lightning causes	(not currently applicable, will revisit requirment if fire ignition events can be correlated to peak current accuracy)

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Number of strokes per flash shall be reported for all flashes	Y		Lightning data is used to aid in locating potential wildland fires, to aid in suppressing those fires, and to support research into wildland fires and wildland fire suppression.	Critical - wildland fire management efficiency depends on the timeliness of initial attack response, which is in turn heavily reliant on timely and accurate lightning strike data.

Department of Interior

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
Bureau of Land Management Alaska	Alaska, Zone 2	Cloud-to-Ground Flash	Point	1/2km	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A	1 minute	1 minute	90%	<1%

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
99.99	Minute	Yes	Yes	N/A

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Yes	Yes	All	Wildland fire detection and point of ignition as well as predicitive services	Critical

** We also require notification of system/sensor down time and impacts on data accuracy.

Department of Interior

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
Bureau of Land Management Alaska	Alaska, Zone 2	Cloud-to-Ground Stroke	Point	1/2km	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A	1 minute	1 minute	90%	<1%

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
99.99	Minute	Yes	Yes	N/A

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Yes	Yes	All	Wildland fire detection and point of ignition as well as predicitive services	Critical

** We also require notification of system/sensor down time and impacts on data accuracy.

Department of Transportation
Federal Aviation Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
FAA	*CONUS/PR/VI (zone 1) *Alaska (zone 2) *Hawaii (zone 3) *Canada (zone 4) *Mexico (zone 5) (*includes 250 km off shore.)	All lightning types (optimum) CG (minimum)	>= 1 km (5 km max.)	<= 1 km for 99% of area within zone.	Ground to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
plus or minus 2000 ft.	one or more times every 1 min.	<= 1 minute for 99% of all flashes.	>= 90%	No more than 1% of all reported lightning flashes due to non-lightning causes. No more than 1% of all reported CG lightning flashes due to other types of lightning.

Reliability	Timing Accuracy	Polarity	Peak Current (Y/N)	Peak Current Accuracy
99.90% * Mean time between failures 5000 hrs. * Mean time to repair 30 mins.	within 1 second or better of actual flash.	Positive and Negative reported for all flashes	N	N/A

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Yes Number of strokes per flash reported for all flashes.	Yes (Vendor Archive to NCDC for accident investigation purposes.)	mapped lightning location, time	See the Additional Description	* Affects safety of flight * Significant affect on controllers, pilots/aircrews, & ground operations.

Additional Description

TFMS- Lightning Data is entered via vendor supplied data into the Traffic Flow Management System (TFMS) at the William J. Hughes Technical Center (WJHTC). The FAA Air Route Traffic Control Centers (ARTCC), selected Air Traffic Control Towers, selected Terminal Radar Approach Control Facilities (TRACON), and the Air Traffic Control Systems Command Center (ATCSCC), receive lightning data thru TFMS.

ADAS-Lightning data is input into the ASOS/AWOS/AWSS Data Acquisition System (ADAS) via vendor supplied data. The ADAS then enters the data into the Automated Lightning Detection and Reporting System (ALDARS). The ALDARS provides thunderstorm information to the Automated Surface Observing System (ASOS), federal Automated Weather Observing System (AWOS), and Automated Weather Sensor System (AWSS). The ADAS also enters lightning data into the Integrated Terminal Weather System (ITWS) which is used to create terminal weather products for use by air traffic managers.

WARP/ERAM-Lightning data is entered into the Weather and Radar Processor (WARP) Weather Information Network Server (WINS) through a third party contractor for use by ARTCC Center Weather Service Units (CWSU) and by Weather Unit personnel at the ATCSCC. Future enhancements include the addition of lightning data to the controller DSR radar display as part of the En route Automation Modernization (ERAM) program.

CIWS-Lightning data is entered into the Corridor Integrated Weather System (CIWS) through vendor supplied streaming data to improve tactical weather decision support for congested en route airspace to improve safety and efficiency when there is severe en route convective weather. The FAA is currently seeking approval of a CIWS implementation strategy that would move the operational CIWS to the WJHTC in FY2011. The operational CIWS approach for lightning data is dependent upon the ADAS rehost installation schedule. The current plan is to use the FAA Technical Center's Weather Data Gateway (WDG) as a subsystem of CIWS to connect 21 ADAS using LAPB/X.25/TP4 via NADIN II. Once the rehosted ADAS installation is complete, the WDG would no longer be necessary since ADAS will support TCP/IP connections.

FAA uses lightning data:
* To increase aviation safety both in the en route and terminal areas (WARP, ITWS, CIWS, ERAM)
* To aid in the efficient movement of aircraft. (TFMS, CIWS)
* To determine if thunderstorms are occurring at or in vicinity of ASOS/AWOS/AWSS sites. (ALDARS)
* To aid in short term forecasting of convective weather by CWSUs.* To create weather products that are provided to ATO Technical Operations for planning and action to protect/repair equipment or to determine the need to convert a site to critical power.

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/JSC (Archive)	Zone 1- CONUS (California to Florida and possibly other abort areas)	Cloud-to-Ground	10's of meter	100 meter	sfc - 30 km

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
100 m	As needed - Desire an internet based system to extract relevant archive data. Archive data should cover entire period of system operation, not just contract duration.	~hours to days	● ≥ 99% (CG Flash) ● ≥ 95% (Individual Return Strokes) ● ≥ 50%* (Intra-Cloud) .	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
	ms	Yes	Y	10%

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
Locations of All Return Strokes should be reported	Y	Location, time (ms), peak amplitude of return strokes, uncertainty estimate of location.	Precision detection of lightning for monitoring potential direct and indirect lightning effects on Orion Vehicle during transport from landing location to Kennedy Space Center	Potential for undetected damage to vehicle

Location	Timing Precision	Display	Long-term Stability	Note

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC IC-Ltg	<= 15 NM of any point on KSC and Cape Canaveral	Stepped Leaders In Cloud		• ≤ 0.10 Km (50th percentile) • ≤ 0.15 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 0.10 Km (50th percentile) • ≤ 0.15 Km (90th percentile)		≤ 1 min	• 100% (flash) • ≥ 95% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF(Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	N/A	N/A	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
<= 15 NM of any point on KSC and Cape Canaveral		• Stepped Leader (Lat, Lon, Z of stepped leader) • Flash (Lat, Lon, Z of start-point/end-point of main flash and side branches) • Flash Extent Density • Step Leader Rate • Flash Rate • Timeline of Flash Rate • Automated Alerts of Severe Weather Signatures (Tunable) (Peak in flash rate (perhaps DFRDT and sigma(DFRDT) as developed by SPORT), Peak in flash rate followed by large decrease, IC-Ltg/CG-Ltg Ratio, Positive/ Negative Polarity Ratio, IC-Ltg Holes, etc.) {some of these require integration with CG-Ltg}	Yes	None

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC IC-Ltg	> 15 to <= 30 NM of any point on KSC and Cape Canaveral	Stepped Leaders In Cloud		• ≤ 0.30 Km (50th percentile) • ≤ 0.50 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 0.30 Km (50th percentile) • ≤ 0.50 Km (90th percentile)		≤ 1 min	• ≥ 99% (flash) • ≥ 90% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	N/A	N/A	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
> 15 to <= 30 NM of any point on KSC and Cape Canaveral		• Stepped Leader (Lat, Lon, Z of stepped leader) • Flash (Lat, Lon, Z of start-point/end-point of main flash and side branches) • Flash Extent Density • Step Leader Rate • Flash Rate • Timeline of Flash Rate • Automated Alerts of Severe Weather Signatures (Tunable) (Peak in flash rate (perhaps DFRDT and sigma(DFRDT) as developed by SPORT), Peak in flash rate followed by large decrease, IC-Ltg/CG-Ltg Ratio, Positive/ Negative Polarity Ratio, IC-Ltg Holes, etc.) {some of these require integration with CG-Ltg}	Yes	None

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC IC-Ltg	> 30 to <= 50 NM of any point on KSC and Cape Canaveral	Stepped Leaders In Cloud		• ≤ 2.0 Km (50th percentile) • ≤ 3.0 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 1.0 Km (50th percentile) • ≤ 1.5 Km (90th percentile)		≤ 1 min	• ≥ 95% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	N/A	N/A	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
> 30 to <= 50 NM of any point on KSC and Cape Canaveral		• Stepped Leader (Lat, Lon, Z of stepped leader) • Flash (Lat, Lon, Z of start-point/end-point of main flash and side branches) • Flash Extent Density • Step Leader Rate • Flash Rate • Timeline of Flash Rate • Automated Alerts of Severe Weather Signatures (Tunable) (Peak in flash rate (perhaps DFRDT and sigma(DFRDT) as developed by SPORT), Peak in flash rate followed by large decrease, IC-Ltg/CG-Ltg Ratio, Positive/ Negative Polarity Ratio, IC-Ltg Holes, etc.) {some of these require integration with CG-Ltg}	Yes	None

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC IC-Ltg	> 50 to <= 100 NM of any point on KSC and Cape Canaveral (timing differs from CONUS requirement) (degrades gracefully to CONUS requirement beyond 100 NM)	Stepped Leaders In Cloud		• ≤ 5.0 Km (50th percentile) • ≤ 7.5 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 3.0 Km (50th percentile) • ≤ 4.5 Km (90th percentile)		≤ 1 min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	N/A	N/A	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
> 50 to <= 100 NM of any point on KSC and Cape Canaveral (timing differs from CONUS requirement) (degrades gracefully to CONUS requirement beyond 100 NM)		• Stepped Leader (Lat, Lon, Z of stepped leader) • Flash (Lat, Lon, Z of start-point/end-point of main flash and side branches)	Yes	None

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC IC-Ltg	Zone-1 including adjacent coasts (CONUS and Puerto Rico) (Would be addition to current NLDN capability.)	Stepped Leaders In Cloud		• ≤ 5.0 Km (50th percentile) • ≤ 7.5 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 3.0 Km (50th percentile) • ≤ 4.5 Km (90th percentile)		≤ 5 min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	N/A	N/A	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Space Shuttle Ferry Flights (cross country atop modified 747) (Space Shuttle program may extend beyond currently scheduled ending of 2010) • Classified missions • Back-up Capability for Higher Performance Local Capability -- Lightning Launch Commit Criteria Evaluation -- Lightning Warnings -- Severe Weather Warnings -- Aviation Forecasts -- Mishap Investigation -- Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
Southern half of CONUS, including adjacent coasts		• Stepped Leader (Lat, Lon, Z of stepped leader) • Flash (Lat, Lon, Z of start-point/end-point of main flash and side branches) • The following are not needed by ER/KSC but will likely be needed by other users (Flash Extent Density, Step Leader Rate, Flash Rate, Timeline of Flash Rate, Tunable Automated Alerts of Severe Weather Signatures)	Yes	• If off-shore range of Zone-1 extended slightly, need for Zone-16 data could be deleted.

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC IC-Ltg	Zone-16 Gulf of Mexico, West Indies Carribean Sea	Stepped Leaders In Cloud		• ≤ 5.0 Km (50th percentile) • ≤ 7.5 Km (90th percentile)	Surface to Cloud Top

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
• ≤ 3.0 Km (50th percentile) • ≤ 4.5 Km (90th percentile)		≤ 5 min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	N/A	N/A	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation (long distance anvil clouds from Gulf of Mexico) • Severe Weather Warnings (approaching synoptic storms and squall lines from Gulf of Mexico) • Aviation flights from Patrick AFB to Antigua (West Indies, combined with Zone-1 coverage)

Location	Timing Precision	Display	Long-term Stability	Note
Eastern half of Gulf of Mexico, West Indies		• Stepped Leader (Lat, Lon, Z of stepped leader) • Flash (Lat, Lon, Z of start-point/end-point of main flash and side branches) • The following are not needed by ER/KSC but will likely be needed by other users (Flash Extent Density, Step Leader Rate, Flash Rate, Timeline of Flash Rate, Tunable Automated Alerts of Severe Weather Signatures)	Yes	• Need for Zone-16 data could be deleted, if Zone-1 off-shore distance was extended slightly.

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC CG-Ltg	<= 15 NM of any point on KSC and Cape Canaveral	CG Return Strokes (all strokes per flash)		• ≤ 0.10 Km (50th percentile) • ≤ 0.15 Km (90th percentile)	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A		≤ 1 min	100%	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	positive/negative		±5% (Accuracy)

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
<= 15 NM ofany point on KSC and Cape Canaveral		• All Return Strokes (Lat, Lon) • Flash (Lat, Lon) • Flash Rate • Timeline of Flash Rate • Automated Alerts of Severe Weather Signatures (Tunable) (Peak in flash rate (perhaps DFRDT and sigma(DFRDT) as developed by SPORT), Peak in flash rate followed by large decrease, IC-Ltg/CG-Ltg Ratio, Positive/ Negative Polarity Ratio, IC-Ltg Holes, etc.) {some of these require integration with IC-Ltg}	Yes	None

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC CG-Ltg	> 15 to <= 30 NM of any point on KSC and Cape Canaveral	CG Return Strokes (all strokes per flash)		• ≤ 0.25 Km (50th percentile) • ≤ 0.40 Km (90th percentile)	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A		≤ 1 min	≥ 99%	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	positive/negative		±10% (Accuracy)

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
> 15 to <= 30 NM of any point on KSC and Cape Canaveral		• All Return Strokes (Lat, Lon) • Flash (Lat, Lon) • Flash Rate • Timeline of Flash Rate • Automated Alerts of Severe Weather Signatures (Tunable) (Peak in flash rate (perhaps DFRDT and sigma(DFRDT) as developed by SPORT), Peak in flash rate followed by large decrease, IC-Ltg/CG-Ltg Ratio, Positive/Negative Polarity Ratio, IC-Ltg Holes, etc.) {some of these require integration with IC-Ltg}	Yes	None

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC CG-Ltg	> 30 to <= 50 NM of any point on KSC and Cape Canaveral	CG Return Strokes (all strokes per flash)		● ≤ 0.40 Km (50th percentile) ● ≤ 0.60 Km (90th percentile)	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A		≤ 1 min	≥ 95%	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	positive/negative		±20% (Accuracy)

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			● Lightning Launch Commit Criteria Evaluation ● Lightning Warnings ● Severe Weather Warnings ● Aviation Forecasts ● Mishap Investigation ● Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
> 30 to <= 50 NM of any point on KSC and Cape Canaveral		● All Return Strokes (Lat, Lon) ● Flash (Lat, Lon) ● Flash Rate ● Timeline of Flash Rate ● Automated Alerts of Severe Weather Signatures (Tunable) (Peak in flash rate (perhaps DFRDT and sigma(DFRDT) as developed by SPORT), Peak in flash rate followed by large decrease, IC-Ltg/CG-Ltg Ratio, Positive/Negative Polarity Ratio, IC-Ltg Holes, etc.) {some of these require integration with IC-Ltg}	Yes	None

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC CG-Ltg	> 50 to <= 100 NM of any point on KSC and Cape Canaveral (timing differs from CONUS requirement) (degrades gracefully to CONUS requirement beyond 100 NM)	CG Return Strokes (all strokes per flash)		• ≤ 0.50 Km (50th percentile) • ≤ 0.75 Km (90th percentile)	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A		≤ 1 min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	positive/negative		±20% (Accuracy)

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation • Lightning Warnings • Severe Weather Warnings • Aviation Forecasts • Mishap Investigation • Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
> 50 to <= 100 NM of any point on KSC and Cape Canaveral (timing differs from CONUS requirement) (degrades gracefully to CONUS requirement beyond 100 NM)		• All Return Strokes (Lat, Lon) • Flash (Lat, Lon)	Yes	None

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC	Zone-1 (CONUS and Puerto Rico)	CG Return Strokes (all strokes per flash)		• ≤ 0.50 Km (50th percentile) • ≤ 0.75 Km (90th percentile)	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A		≤ 5 min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	N/A to ER/KSC, but others will likely want 'positive/negative'	N/A to ER/KSC, but others will likely want it to ±20% (Accuracy)	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Space Shuttle Ferry Flights (cross country atop modified 747) (Space Shuttle program may extend beyond currently scheduled ending of 2010) • Classified missions • Back-up Capability for Higher Performance Local Capability -- Lightning Launch Commit Criteria Evaluation -- Lightning Warnings -- Severe Weather Warnings -- Aviation Forecasts -- Mishap Investigation -- Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
CONUS (Southern Half) (Including coasts)		• All Return Strokes (Lat, Lon) • Flash (Lat, Lon) • The following are not needed by ER/KSC but will likely be needed by others (Flash Extent Density, Step Leader Rate, Flash Rate, Timeline of Flash Rate, Tunable Automated Alerts of Severe Weather Signatures (some will require integration with IC-Ltg data))	Yes	• If off-shore range of Zone-1 extended slightly, need for Zone-16 data could be deleted.

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Vertical Extent
NASA/KSC CG-Ltg	Zone-16 (Gulf of Mexico, Carribean Sea, West Indies) (If NLDN could be extended a bit, KSC would not need this zone)	CG Return Strokes (all strokes per flash)		• ≤ 0.50 Km (50th percentile) • ≤ 0.75 Km (90th percentile)	N/A

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
N/A		≤ 5 min	• ≥ 90% (flash) • ≥ 80% (stepped leader)	

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	Real-time, 24/7/365	N/A to ER/KSC, but others will likely want 'positive/negative'	N/A to ER/KSC, but others will likely want it to ±20% (Accuracy)	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes			• Lightning Launch Commit Criteria Evaluation (long distance anvil clouds from Gulf of Mexico) • Severe Weather Warnings (approaching synoptic storms and squall lines from Gulf of Mexico) • Aviation flights from Patrick AFB to Antigua (West Indies, combined with Zone-1 coverage)

Location	Timing Precision	Display	Long-term Stability	Note
Eastern half of Gulf of Mexico, West Indies		• All Return Strokes (Lat, Lon) • Flash (Lat, Lon) • The following are not needed by ER/KSC but will likely be needed by others (Flash Extent Density, Step Leader Rate, Flash Rate, Timeline of Flash Rate, Tunable Automated Alerts of Severe Weather Signatures (some will require integration with IC-Ltg data))	Yes	• Need for Zone-16 data could be deleted, if Zone-1 off-shore distance was extended slightly.

National Aeronautics and Space Administration

USER	GEOGRAPHICAL COVERAGE	Phenomena	HORIZONTAL RESOLUTION	Location ACCURACY	Location PRECISION
NASA/MSFC	Zone-1 (Primary). Other Zones available (Secondary) for specific research and ground validation applications (e.g., Zone3 Hawaii; Zone 2 Alaska; Zone 4 Canada; Zones 5-6 Mexico, Central and South America; Zones 16-18, 20-23 Gulf of Mexico, Atlantic Ocean, Pacific Ocean)	Ground Flash (CG) Return Strokes (RS) Cloud Flash		• ≤ 0.5 Km (CG) • ≤ 0.5 Km (RS) • TBD (Cloud)	• ≤ 0.1 Km (CG) • ≤ 0.1 Km (RS) • TBD (Cloud)

Vertical Accuracy	Reporting FREQUENCY	Data Latency	Detection Efficiency	Probability of False Detection
	Real-time, continuous 24/7/365	≤ 1 min (In Reporting)	• ≥ 90% (CG) • ≥ 60% (RS) • ≥ TBD%* (Cloud) *with existing systems more research needed to correctly characterize cloud detections (nonetheless MSFC interested in all lightning detected)	*TBD (CG) *TBD (RS) *TBD (Cloud) *False detection rate not well known or characterized in extisting systems (includes cloud identified as ground, but also ground identified as cloud)

Reliability	Timing Accuracy	Polarity	Peak Current	Peak Current Accuracy
• > 25,000 Hours MTBCF (Mean Time Between Critical Failure) • < 3 Hours MTBR (Mean Time Between Repair)	• ≤ 1 ms (CG) • ≤ 1 ms (RS) • ≤ 1 ms (Cloud)	pos/neg (CG) pos/neg (RS)	±10% (All)	

Flash Multiplicity	Archive Y/N	Parameters needed in archive	Data Use Description	Impact to Mission if Data Not Available
	Yes		MSFC requires only data in easy to use/access format (prefer compatible with existing ascii format that we presently receive). No Display requirement levied. As a reference point: presently receive Date, Time, Lat (degree), Lon(degrees), Polarity and Signal Strength, Multiplicity (at Flash Level), Semimajor axis, Semiminor axis (both for 50% probability ellipse), ratio Semimajor to Semiminor, Angle of 50% ellipse, Chi-square, number of sensors detecting flashes. Would need to add flash type.	• Validation of space-based lightning mapping satellites • NASA Science Research and Applications -- forecasting and nowcasting applications -- precipitation and storm studies -- climate studies, decadal survey -- other (e.g., atmospheric chemistry) • NASA Operations Support -- Lightning Launch Commit Criteria Evaluation -- Lightning Warnings -- Severe Weather Warnings -- Aviation Forecasts -- Mishap Investigation -- Technical Improvement Studies

Location	Timing Precision	Display	Long-term Stability	Note
CONUS	• ≤ 1 ms (CG) • ≤ 1 ms (RS) • ≤ 1 ms (Cloud)		Yes	Above input represents requirements for long-range lightning detection systems (2-D). No requirements presented for short-range (within 150-200 km) lightning mapping (4-D) (e.g., LMA-type system)

APPENDIX D: ACRONYM LIST

14WS	14th Weather Squadron, Ashville, North Carolina
30WS	30th Weather Squadron, Vandenberg Air Force Base, California
45WS	45th Weather Squadron, Patrick Air Force Base, Florida
AFS	Alaska Fire Service
AFWA	Air Force Weather Agency
AWC	Aviation Weather Center
BLM	Bureau of Land Management
BLM/A	Bureau of Land Management, Alaska
CCAFS	Cape Canaveral Air Force Station
CF	Cloud Flash
CG	Cloud-to-ground
DE	Detection Efficiency
DOC	Department of Commerce
DOI	Department of Interior
FAA	Federal Aviation Administration
ISS	International Space Station
JAAWIN	Joint Army Air Force Weather Information Network
JAG	Joint Action Group
JSC	Johnson Space Center
KSC	Kennedy Space Center
LA	Location Accuracy
LDS	Lightning Data System
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
NIFC	National Interagency Fire Center
OAR	Office of Oceanic and Atmospheric Research
OPSII	Operational Weather Squadron Production System, Phase II
SPC	Storm Prediction Center
TL	Total Lightning

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