Guide to Instruments and Methods of Observation

Volume IV – Space-based Observations

EXCERPT: Paragraphs on Lightning

2.2.4.4 ***Lightning***

Lightning: a very narrow (~1 nm wide) near-infrared wavelength band is used to observe the neutral atomic oxygen emission line triplet near 0.774 μm. This part of the lightning spectrum represents about 10% of the total lightning optical energy. Strong absorption from oxygen obscures the Earth's surface and enables flashes to be detected at cloud top even in daylight. The intensity (total optical energy), areal extent, and number of flashes in a given period and trend over a given area are representative diagnostic attributes of convection, including cloud electrical energy, microphysics, kinematics and precipitation. In developing storms lightning extent is compact, and as convective storms grow upscale or merge the lightning may extend over several hundreds of kilometres. In addition, lightning is a response to the build-up of thundercloud charge and is a natural source of NO_x in the atmosphere.

3.2.10 **Lightning imagers**

These instruments have the following main characteristics:

(a) Detector matrix (CCD): continuous Earth observation in a very narrow O_2 band at 777.4 nm;

(b) Measurement of flash occurrence, spatial extent (area) and intensity in the IFOV;

(c) Spatial resolution of 5–10 km;

(d) Continuous and contiguous horizontal sampling; full disk from GEO and swath of several hundred kilometres from LEO;

(e) Applicable in LEO and GEO.

Lightning imagery and flash rate tendency is useful as a proxy for updraft intensification/convective vigor, convective precipitation, continuing current, and NOx generation. Different sampling is applicable from LEO and GEO:

(a) From LEO, the measurement is available for the interval during satellite motion in which one Earth's spot is visible within the FOV of the CCD matrix (about 90 seconds);

(b) From GEO, monitoring is continuous.

Tables 3.27 and 3.28 set out an example of a lightning imager in LEO (LIS) and one in GEO (GLM).

Table 3.27. Example of lightning imager in LEO: LIS on TRMM

LIS	*Lightning Imaging Sensor*
Satellite	Tropical Rainfall Measuring Mission (TRMM)
Mission	Proxy for convective intensification and severe storm development, proxy for convective precipitation, proxy for NOx generation
Main features	CCD camera operating at 777.4 nm (O_2) to count flashes and measure their spatial extent and intensity
More information	https://www.wmo-sat.info/oscar/instruments/view/250

Table 3.28. Example of lightning imager in GEO: GLM on GOES

GLM	*Geostationary Lightning Mapper*
Satellites	GOES-R (GOES-16), GOES-S (GOES-17), GOES-T, GOES-U
Mission	Proxy for convective precipitation and turbulence, proxy for NOx generation, study of the Earth electric field.
Main features	CCD camera operating at 777.4 nm (O_2) to count flashes and measure their intensity
More information	https://www.wmo-sat.info/oscar/instruments/view/157

5.3.17 Lightning detection

Definition: Mapping of lightning events as number of flashes in a given time interval over a given area – Physical unit: counts – Uncertainty expressed as hit rate (HR) and false-alarm rate (FAR).

Method 1: Lightning mapping – Principle: Detection of flashes by a charge-coupled device camera in a very narrow channel in a NIR oxygen absorption band (generally at 777.4 nm) for operability also in daylight. The number of flashes in a given time over a given area, and their intensity, are related to the maturity of the convective process in cloud. Applicable in both LEO and GEO.