The Evolution of a Long-Lived Mesoscale Convective System Observed by GLM

Michael J Peterson[1], Scott Rudlosky[2], Larissa Antunes da Silva[3]

[1] University of Maryland, [2] NOAA/NESDIS/STAR, [3] INPE National Institute for Space Research, Brazil

LEGEND

GPM CONSTELLATION ELECTRIFIED CLOUD

ACCUMULATED GLM FLASHES

< 5 minutes prior

> 60 minutes prior

T+15 9/4/17 15:00 UTC

T+18 9/4/17 18:00 UTC

T+21 9/4/17 21:00 UTC

T+24 9/5/17 0:00 UTC

T+42 9/5/17 18:00 UTC

T+45 9/5/17 21:00 UTC

T+48 9/6/17 0:00 UTC

T+63 9/6/17 15:00 UTC

GLM STORM MATURITY INDEX

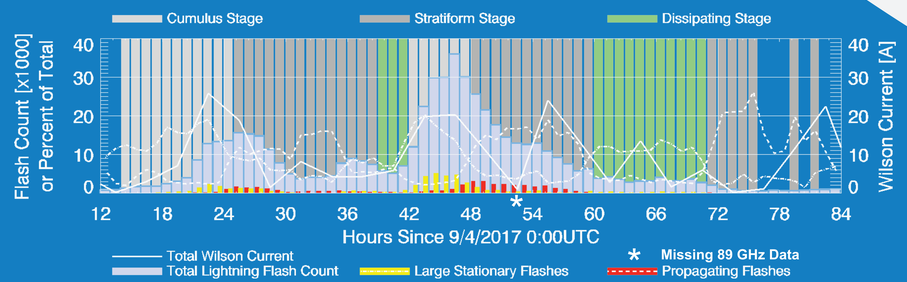
GLM flash characteristics change as isolated convection organizes, matures, and then dissipates. Quantifying and trending these changes can reveal the predominant convective mode and maturity of an electrified storm system observed from orbit.

An initial GLM maturity index distinguishes between storms that initiate many large stationary flashes – associated with new or dissipating convection – and storms that produce many long propagating flashes – common in mature systems with an extensive electrified stratiform region.

Given the total flash rate (TFR), large stationary flash rate (LSFR), and propagating flash rate (PFR) of a storm system:

IF ΔTFR / Δt > 0, LSFR > PFR	CUMULUS STAGE
IF PFR > LSFR	STRATIFORM STAGE
IF ΔTFR / Δt < 0, LSFR > PFR	DISSIPATING STAGE

LIGHTNING / RETRIEVED WILSON CURRENT TIMESERIES



INTRODUCTION

Mesoscale Convective Systems (MCSs) account for ~1% of all thunderstorms, but the high flash rates and Wilson currents produced over many hours make them particularly important for global electricity. A squall line is tracked from initiation over the Great Lakes until it moves over the Atlantic Ocean. The evolutions of Wilson current, flash rate, and flash characteristics are documented from satellite observations.

THE GPM CONSTELLATION

The Global Precipitation Measurement (GPM) mission gathers radiometer observations from domestic and international partners to provide rain and snow data every ~3 hours. Passive microwave data can also be used to approximate the Wilson current supplied by electrified weather to the Global Electric Circuit (GEC) (Peterson et al., 2015; 2017). Intercalibrated GPM constellation 89 GHz measurements are used to trend the total Wilson current generated by the system.

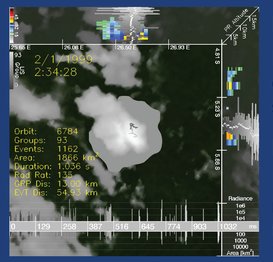
THE GEOSTATIONARY LIGHTNING MAPPER (GLM)

The GLM on GOES-16 is the first lightning sensor in geostationary orbit. It detects Cloud-to-Ground (CG) and intercloud (IC) flashes by recording the optical energy that escapes the cloud. GLM produces 500 frames / second recordings of individual flashes that can be used to characterize the optical evolution, energetics, and morphology of lightning.

GOES-16

FLASH CHARACTERISTICS AND STORM TYPE

The spatial and temporal evolution of a lightning flash varies with storm type based on the discharge structure and radiative transfer in the cloud.

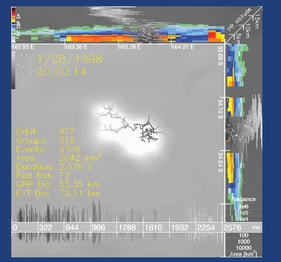


LARGE STATIONARY FLASHES

Large stationary flashes often occur when optical depths are small or radiant energy can escape the side of the thundercloud to illuminate lower clouds.

PROPAGATING FLASHES

Propagating flashes move from one part of the storm to another. They are often found in electrified stratiform regions with expansive horizontal charge layers that promote lateral development. Propagating flashes have been observed that initiate in the convective core and then extend hundreds of kilometers into the stratiform region.



STORM SUMMARY

The total flash rate (TFR) peaks at 01, 12, and 22 UTC on 9/5, reaching a maximum of 600 flashes / minute.

The large stationary flash rate peaks at 23 UTC on 9/4 and 21 UTC on 9/5 as the system grows and intensifies.

The propagating flash rate peaks at 02 UTC on 9/5 and 01 UTC on 9/6 as the system matures and the TFR declines.

CONCLUSIONS

This case suggests that comparing flash types can help identify organizing, maturing, and dissipating convection, which can aid thunderstorm forecasts and rainfall retrievals.

The total Wilson current follows the TFR trend over land with peaks exceeding 20 A on 9/4 and 9/5, while over ocean the total Wilson current reaches 20 A with low flash rates (9/7).

RELATED REFERENCES

Peterson, M., et al., 2015. *J. Atmos. Oceanic Technol.*, doi: 10.1175/JTECH-D-14-00119.1

Peterson, M. J., et al., 2017. *J. Geophys. Res.*, doi: 10.1002/2016JD026336