Lightning: An Essential Climate Variable

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TGA/CISESS/UAH

2019 CISESS Science Meeting

College Park, MD

November 13, 2019

Location: Batesville, Texas, USA; photographer: Marko Korosec; credits: World Meteorological Organization

GCOS

KEEPING WATCH OVER OUR CLIMATE

WMO IOC International Science Council UN environment

Lightning for Climate

A Study by the Task Team on Lightning Observation For Climate Applications (TT-LOCA) Of the Atmospheric Observation Panel for Climate (AOPC)

TTLOCA

GCOS-227

Kick-off meeting held at CICS. College Park, MD February 2018

WMO GCOS Task Team Study

Explore potential climate applications for lightning observations and identify related challenges

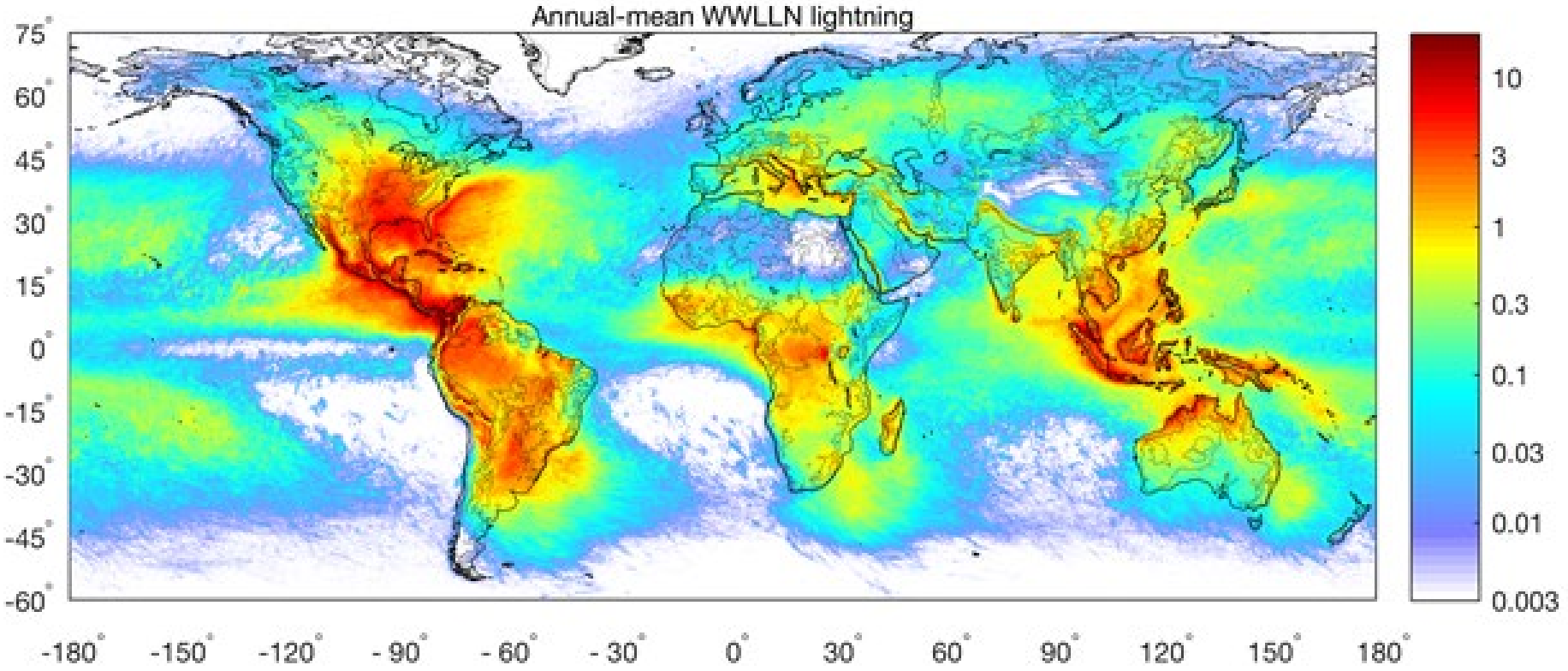
Review current requirements for lightning observations in the GCOS implementation plan in the light of potential climate applications

Define data management and metadata standards that ensure that lightning data can be reprocessed in the future and ensure that changes in observation or processing techniques are fully documented

Develop a strategy for open data access for lightning data in climate applications, including providing access to data from the private sector

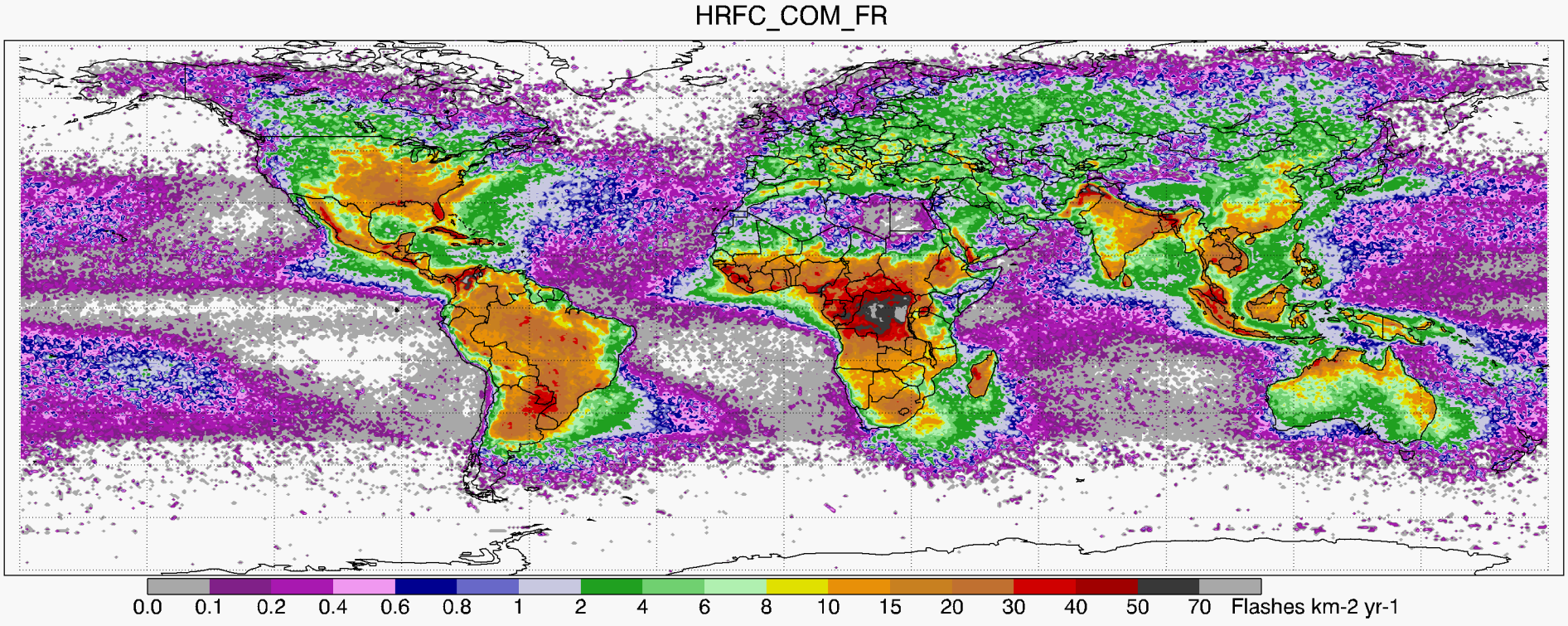
Encourage space agencies and operators of ground-based systems to provide global coverage and reprocessing of existing data sets

Review current data storage facilities and explore the options of a global data center for lightning data for climate applications



Number of lightning strokes accumulated for the years 2008–2017, presented as strokes per year per square kilometer on a 0.1° × 0.1° global grid. Data are from the World Wide Lightning Location Network, and the map is an upgrade of the 0.25° × 0.25° global climatology published by *Virts et al.* [2013].

Aich, V., R. Holzworth, S. J. Goodman, Y. Kuleshov, C. Price, and E. Williams (2018), Lightning: A new essential climate variable, *Eos, 99,* https://doi.org/10.1029/2018EO104583. Published on 07 September 2018.

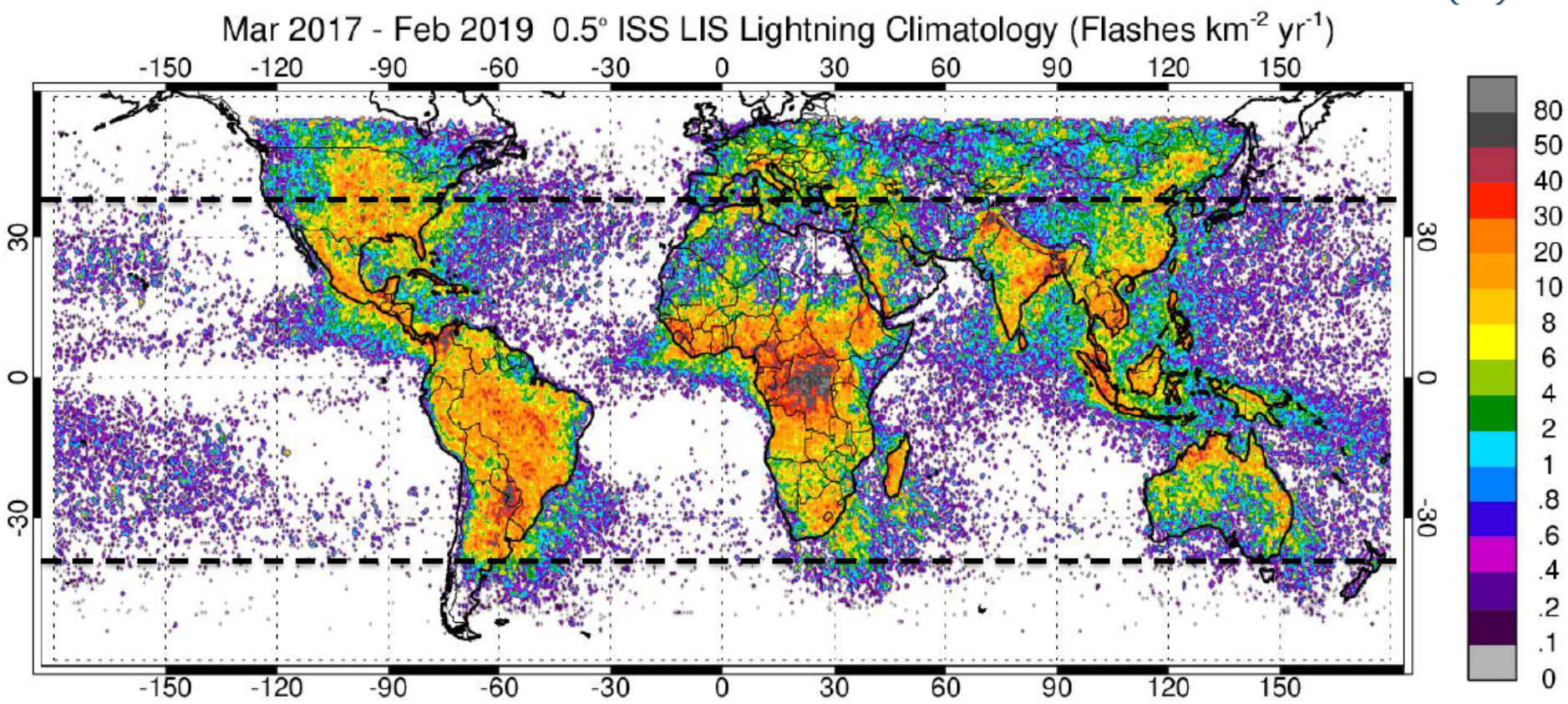


Combined 0.5 deg grid OTD-LIS May 1995-Dec 2014

Cecil et al., Atmospheric Research 2014, https://doi.org/10.1016/j.atmosres.2012.06.028

Annual Global Flash Rate Density

LIS Working Great



- Annual global lightning flash rate density (*Flashes km^{-2} yr^{-1}*) from LIS on ISS during two years on orbit with view time and detection efficiency corrections applied. Climatology agrees closely with results from the prior two missions. Dash lines represent TRMM limit.
- For the first time since the OTD mission ended in 2000, ISS LIS now observes mid-latitude storms from space, and provides coverage of full CONUS and Middle & Southern Europe.

ECV Candidate Data Repository

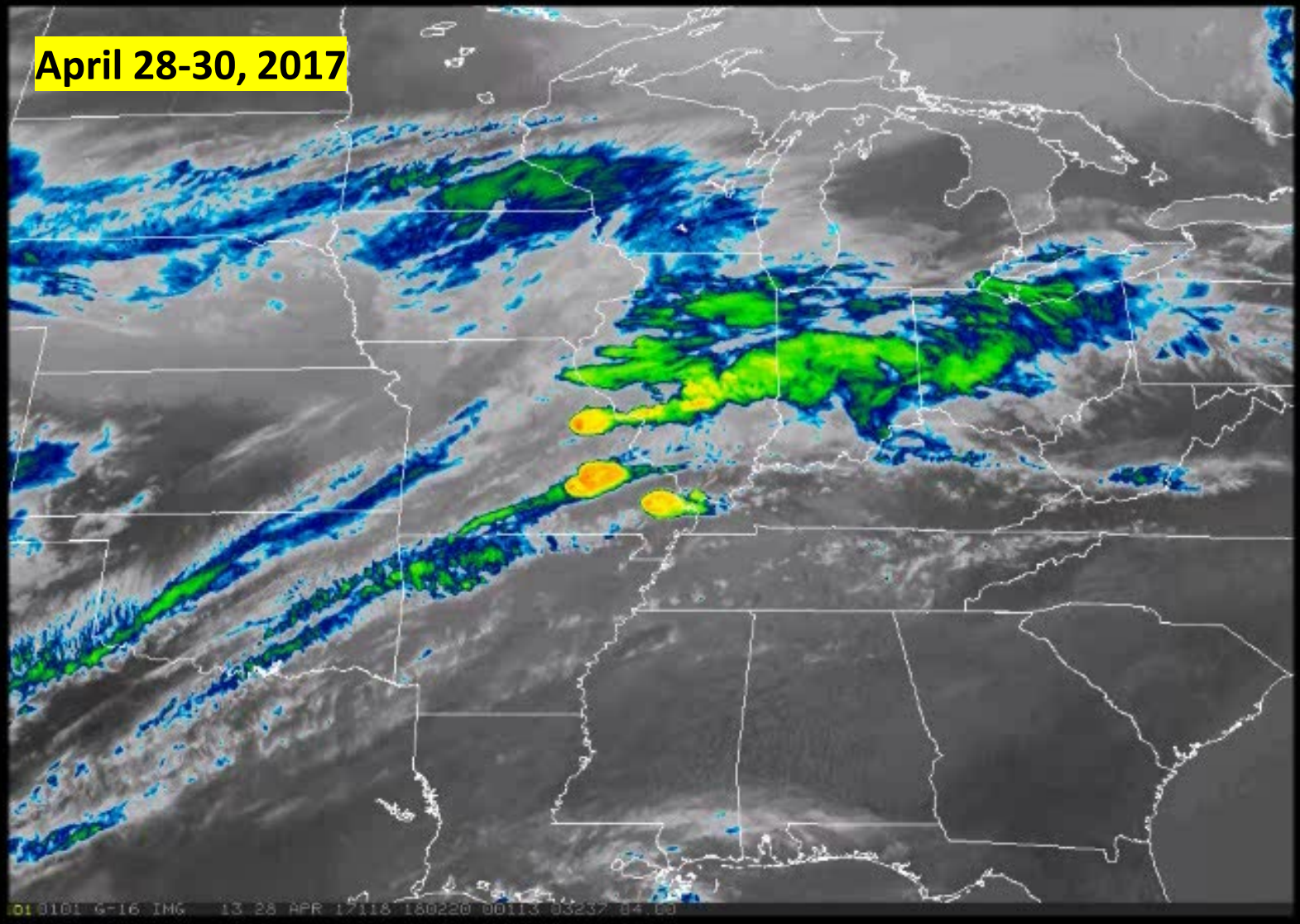
- NCEI (Monica Youngman, Jeff Privette)
  - CLASS
  - GLM L2
- NASA GHRC DAAC (Geoffrey Stano)
  - LIS – OTD, TRMM-LIS, ISS- LIS (1995- 2000, 1997-2015, 2017-)
  - GLM – L0

Combined space-based and ground-based 10-km grid at daily or better temporal resolution, data set lightning attributes TBD

CICS Alumni Contributions to Lightning Science

- Dr. Rachel Albrecht – Prof. University of São Paulo
  - TRMM- LIS global frequency and distribution of lightning
- Dr. Eric Bruning – Prof. Texas Tech University
  - GLM lightning grids – FED, AFA, TOE, EUMETSAT LI-MAG
- Dr. Scott Rudlosky – NESDIS/STAR
  - GLM – ground-based lightning comparisons, training
- Dr. Michael Peterson – Los Alamos National Lab
  - GLM visualizations, GLM/LIS optical properties

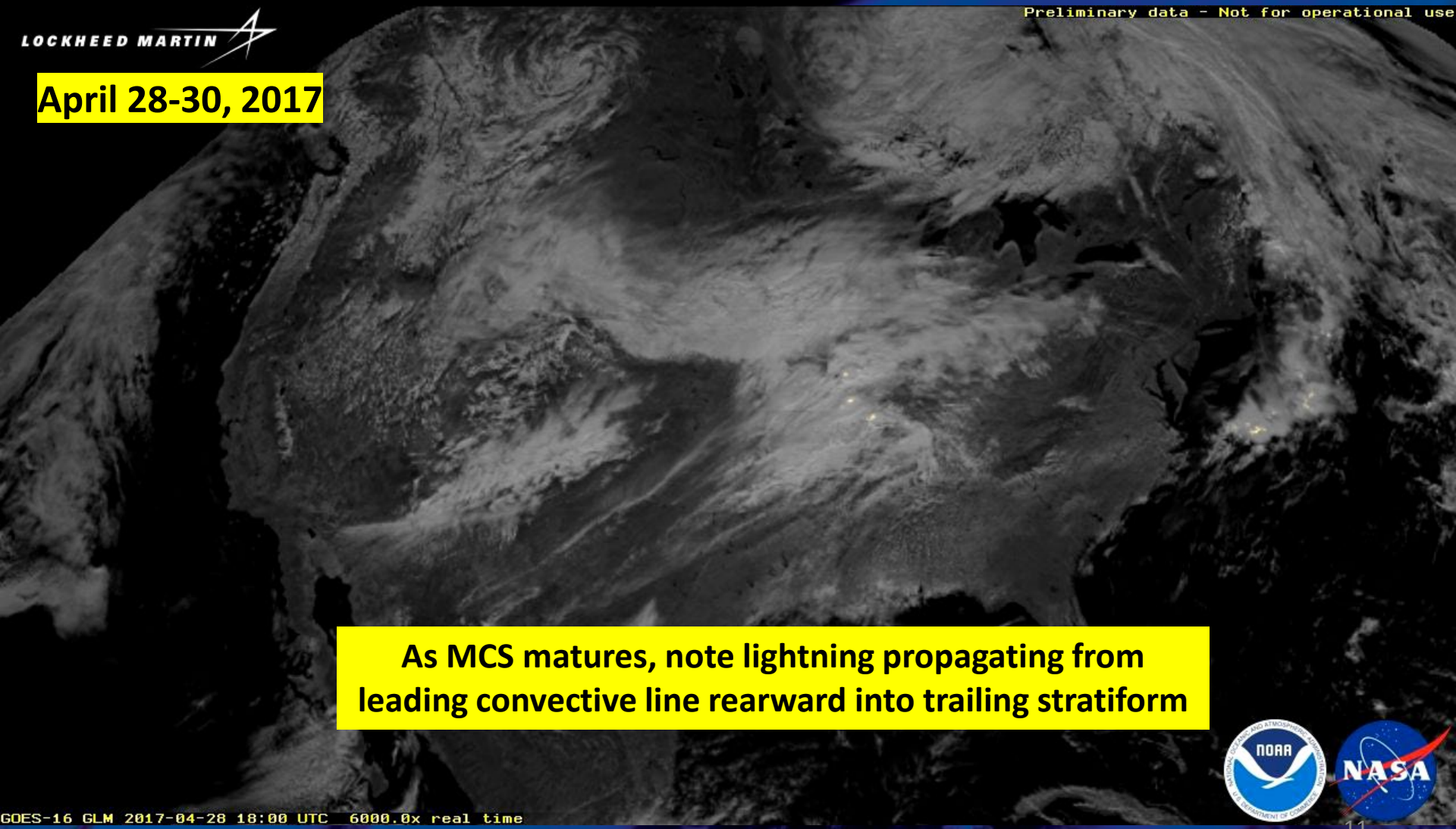
ABI Band 13 Infrared Imagery
Upscale Growth of an MCS



GLM Lightning and Background Imagery
Pre-frontal Severe Weather in Southeast U.S.

LOCKHEED MARTIN

April 28-30, 2017



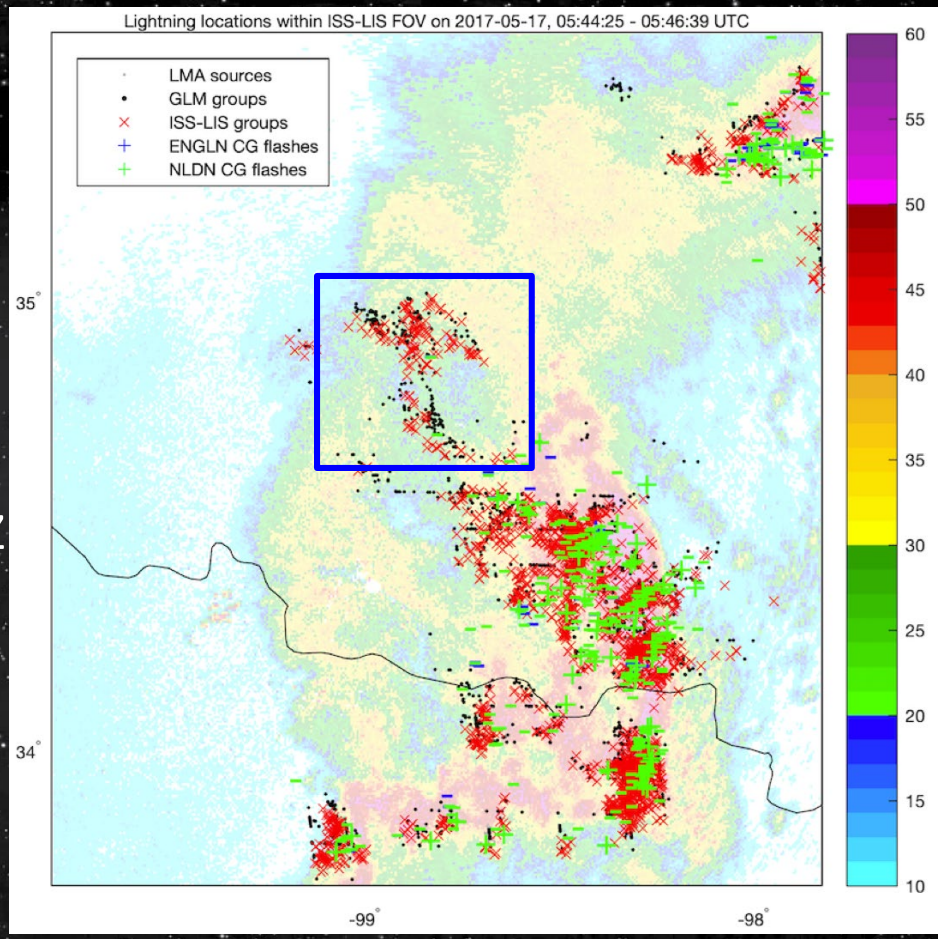
As MCS matures, note lightning propagating from leading convective line rearward into trailing stratiform

Largest GLM lightning flash

(Peterson, 2019, JGR)

Lightning ECV : Oklahoma MCS

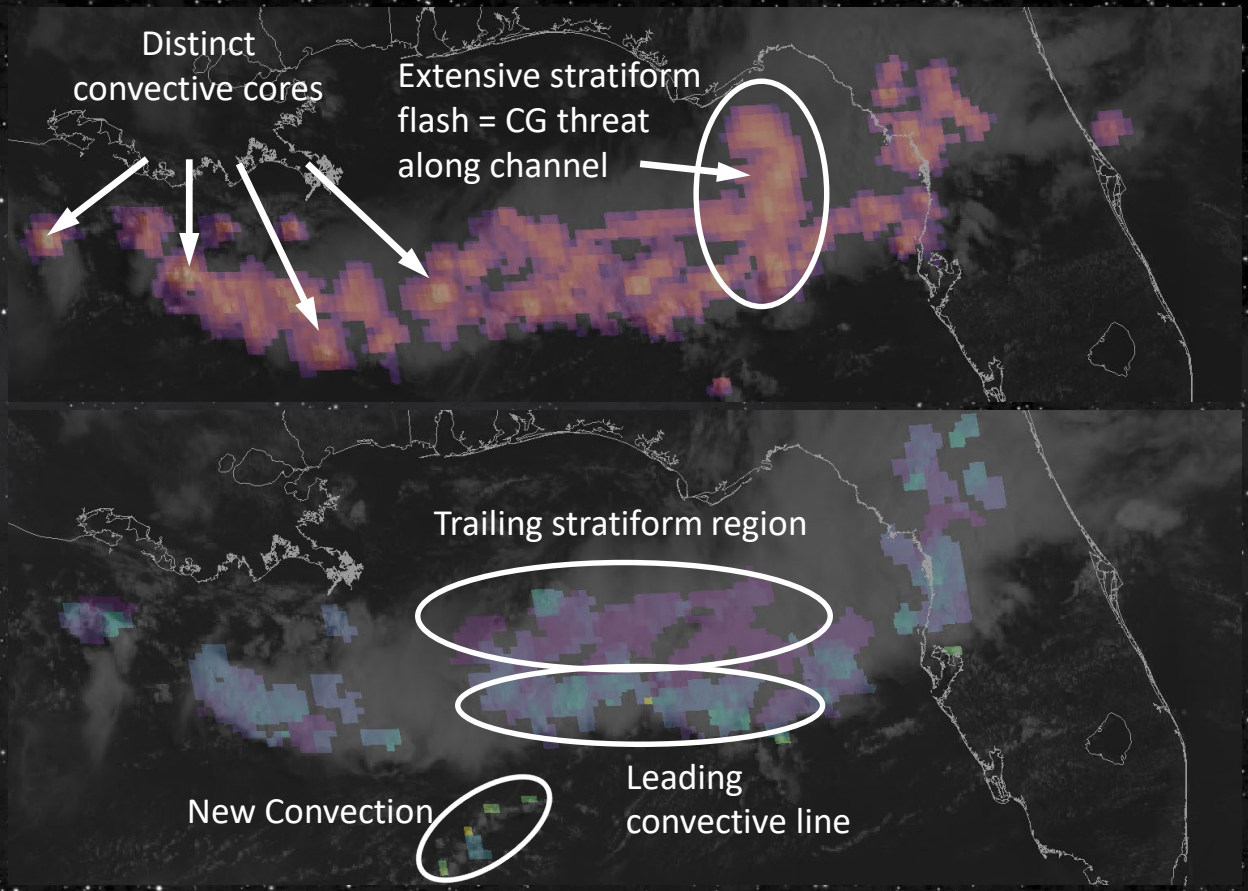
- Flash begins at northern end of convective line and propagates northwest into the trailing stratiform.
- Another, shorter segment propagates south-southwest.



- Date: 2017-05-17
  - 05:46:02.5141Z to 05:46:03.6591Z
- Duration: 1.145 s
- Area: 3,566 km^2, Length: 56 km
- Optical energy: 1.05 x 10^{-11} J
- GLM (2 flashes, 334 groups)
- Ground observations:
  - ENGLN: 6 negative CG
  - Vaisala (NLDN): 1 pos, 2 neg CG

GLM TOE and AFA Applicability

- **Bright regions in the Total Optical Energy (TOE) indicate…**
  - **the most energetic convective cores**
  - **lightning channels within extensive flashes**
- **Average Flash Area (AFA) reveals…**
  - **small flashes in new / intense convection and along the leading line**
  - **larger flashes in the stratiform/anvil regions and decaying storms**



Additional GLM Information

- Websites :
  - https://www.goes-r.gov/
  - https://www.star.nesdis.noaa.gov/GOES/
  - https://rammb-slider.cira.colostate.edu/
  - http://cimss.ssec.wisc.edu/goes/goesdata.html
  - https://lightning.umd.edu/glm/
  - https://weather.msfc.nasa.gov/sport/goes_imager/
  - https://www.ncdc.noaa.gov/data-access/satellite-data/goes-r-series-satellites