雷観測静止観測衛星
Geo-Lightning Sensor (GLS)

牛尾知雄，佐藤光輝（北海道大），鈴木睦（JAXA）
H. J. Christian(UAH), S. J. Goodman(NOAA)
R. J. Blakeslee(NASA/MSFC)

Outline

- Background
- Geo Lightning sensor over the US
- Japanese status

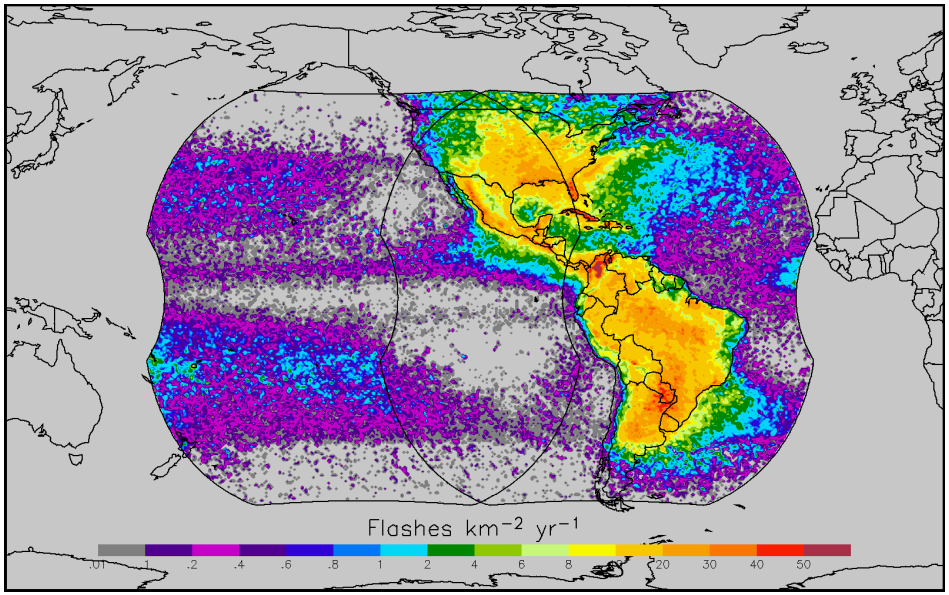
WHY DO WE NEED TO OBSERVE LIGHTNING FROM SPACE?

Natural Hazards and Lightning

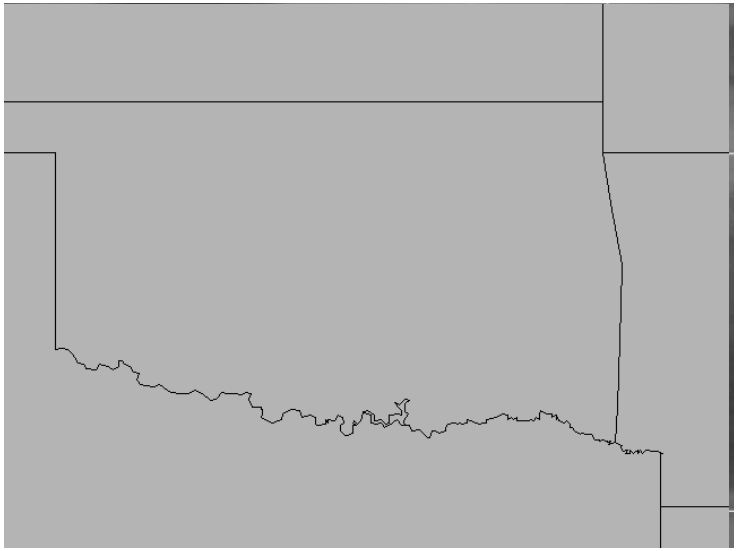
- Tornadoes
- Hailstorms
- Wind
- Thunderstorms
- Floods
- Hurricanes
- Volcanoes
- Forest Fires
- Air Quality/NOx

GOES-R Geostationary Lightning Mapper (GLM)

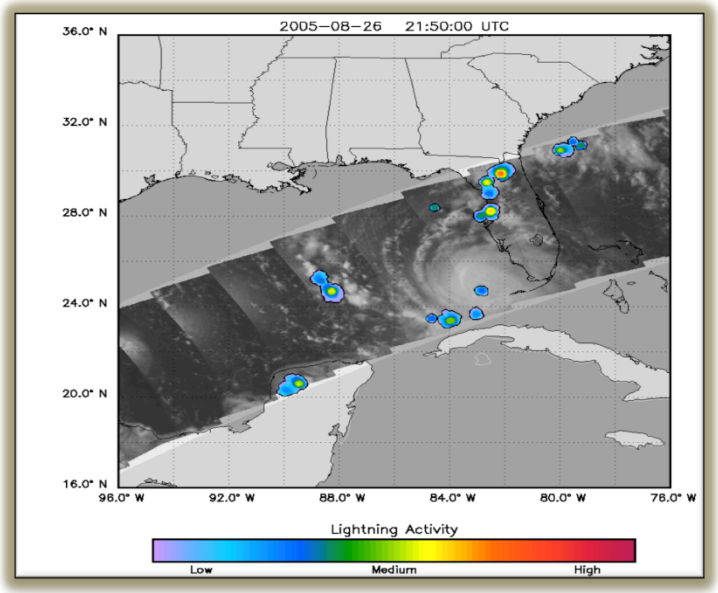
GLM Combined E-W Coverage

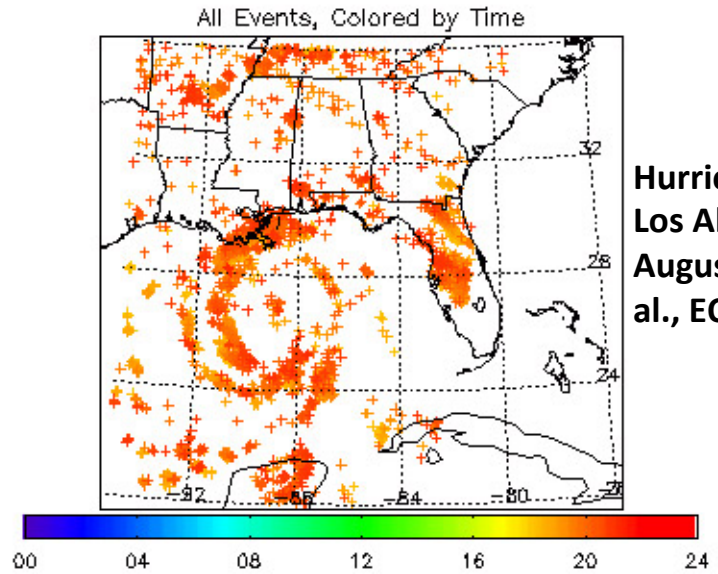


May 3 1999 Oklahoma Tornado Outbreak



1-minute of observations from TRMM/LIS



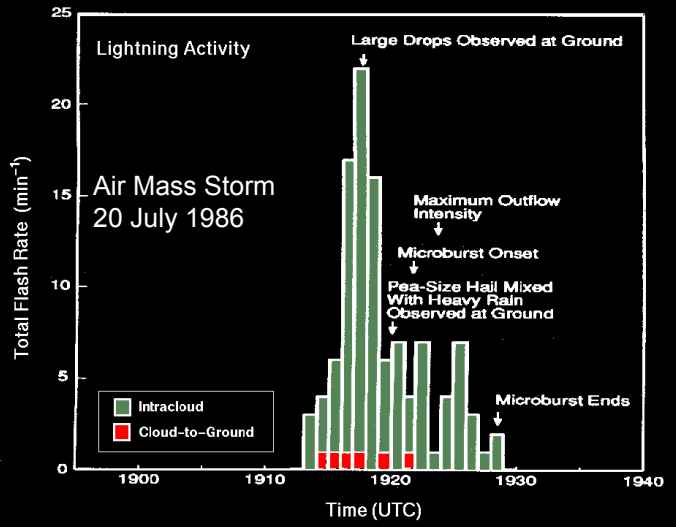


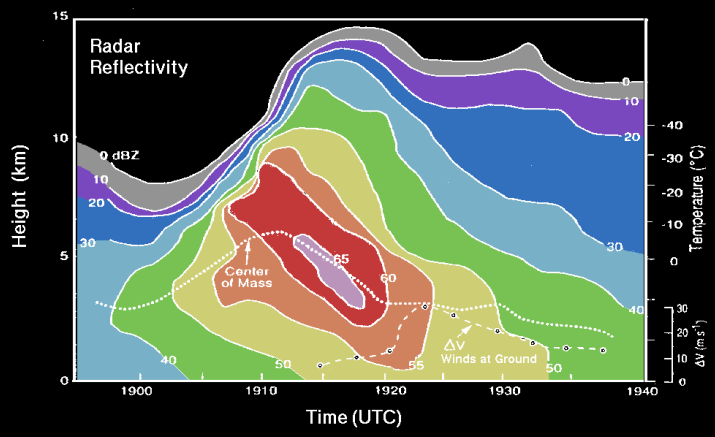
Hurricane Katrina
Los Alamos Sferics Array, August 28, 2005, Shao et al., EOS Trans., 86

Physical Basis:

Lightning Connection to Thunderstorm Updraft, Storm Growth and Decay

- Total Lightning —responds to updraft velocity and concentration, phase, type of hydrometeors, integrated flux of particles
- WX Radar — responds to concentration, size, phase, and type of hydrometeors- integrated over small volumes
- Microwave Radiometer — responds to concentration, size, phase, and type of hydrometeors — integrated over depth of storm (85 GHz ice scattering)
- VIS / IR — cloud top height/temperature, texture, optical depth





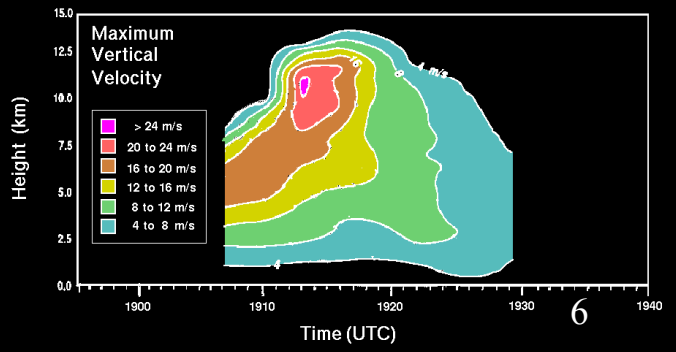


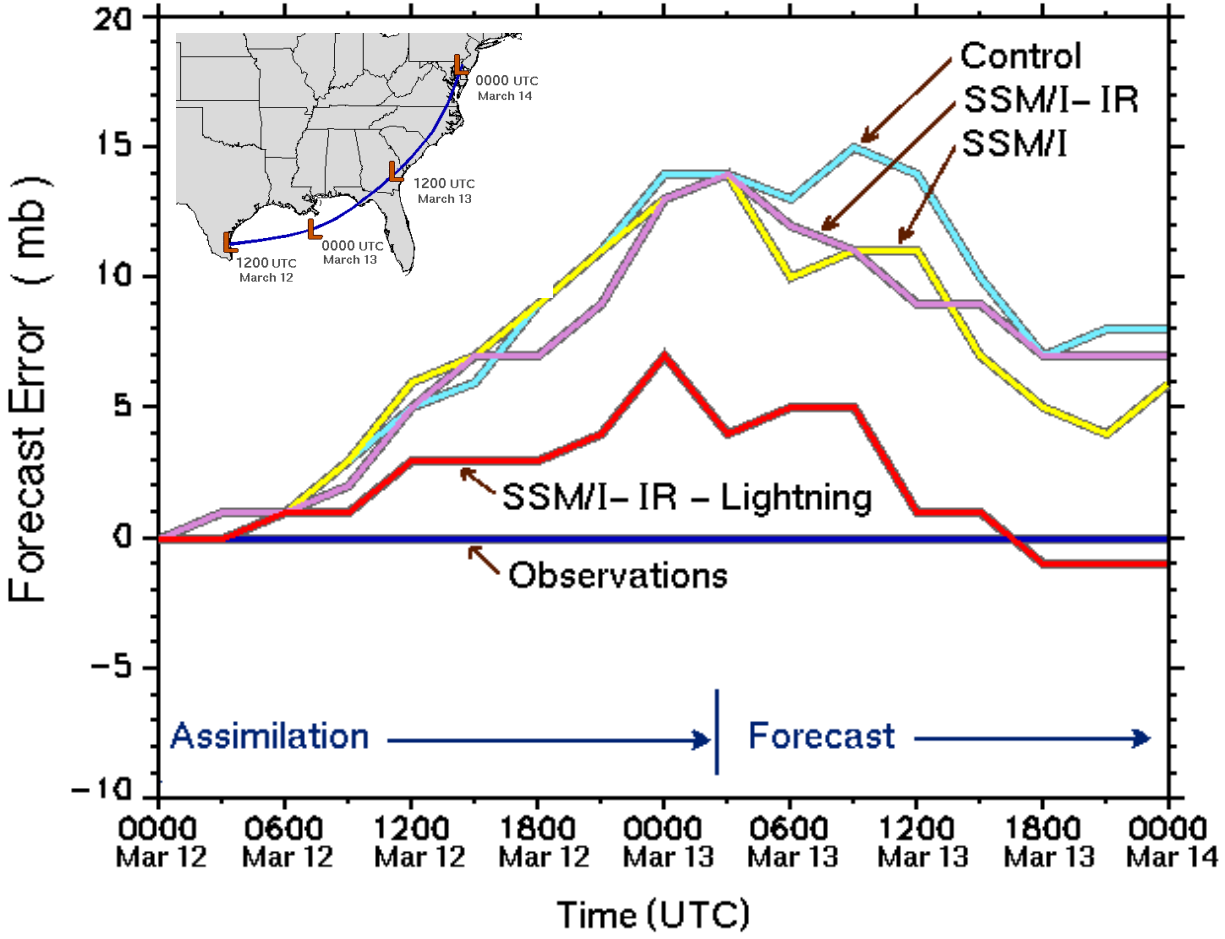
Figure from Gatlin and Goodman, JTECH, Jan. 2010- adapted from Goodman et al, 1988; Kingsmill and Wakimoto, 1991

Lightning Data Assimilation into NWP Models

- Previous lightning data assimilation work:
  - Alexander et al., 1999; Chang et al. 2001 (latent heating)
  - Papadopoulos et al., 2005 (moisture profiles)
  - Mansell et al., 2006, 2007 (BL moisture and updraft speed; NLDN/ LMA convective trigger switch for Kain-Fritsch)
  - Weygandt et al., 2006, 2008 (cloud and moisture fields-lightning-reflectivity relationship to create a latent heating-based temperature tendency field, applied to RUC /HRRR during a pre-forecast diabatic digital filter initialization)
  - Pessi and Businger, 2009 (Vaisala Pacnet long-range lightning data over the open ocean- tropical cyclones, oceanic storms)
- Workshop on Lightning Modeling and Data Assimilation (2010)
  - http://www.nssl.noaa.gov/research/forewarn/lt_workshop/

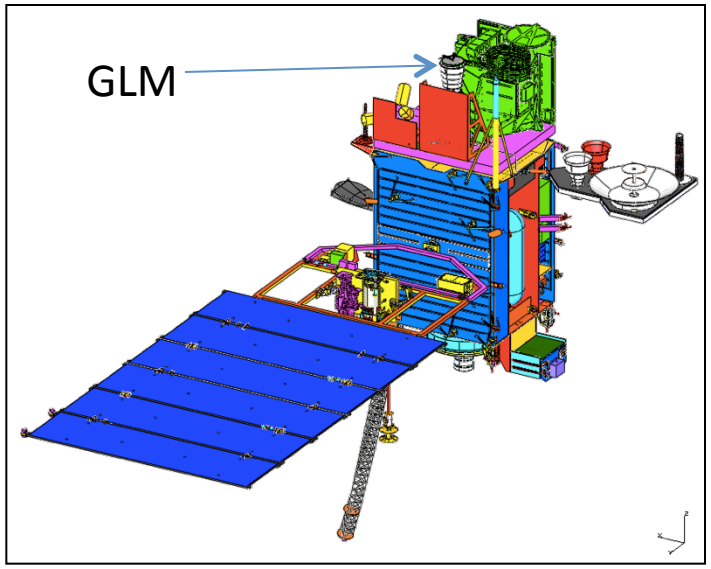
Lightning Data Assimilation: Reduces Forecast Error

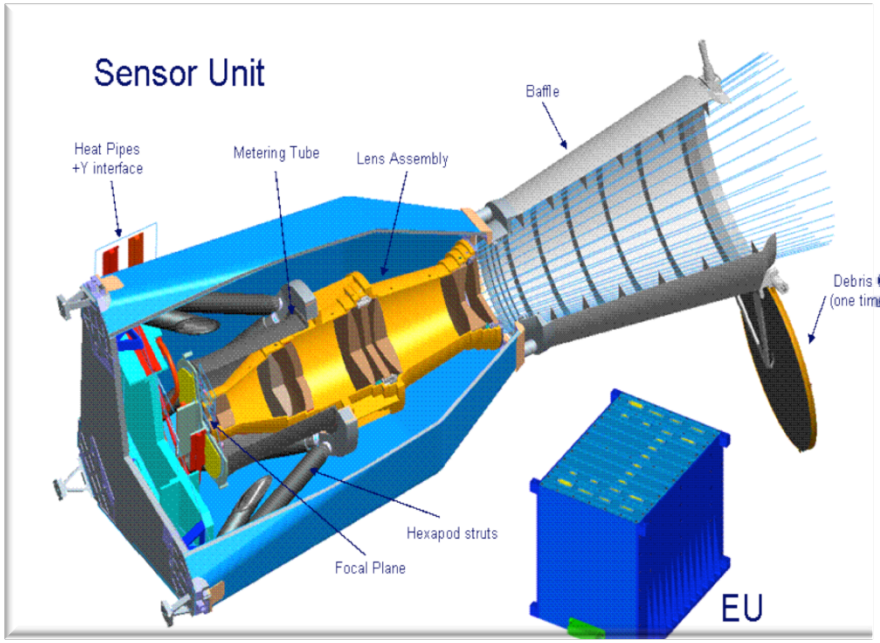
March 13. 1993 Superstorm (Alexander et al.. 1999 MWR)



Lightning assimilated via latent heat transfer functional relationship

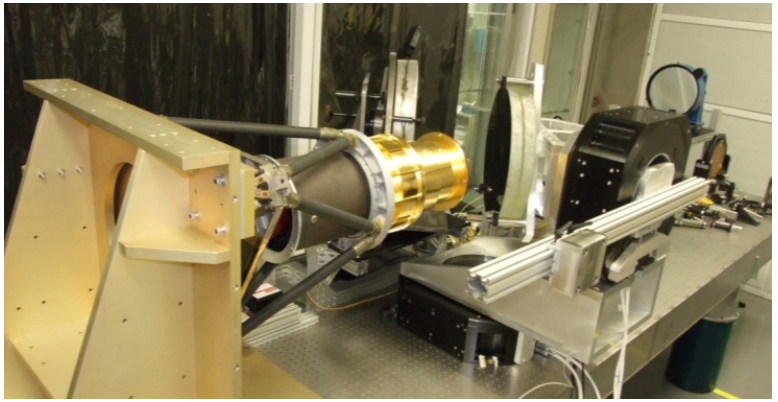
GOES-R Geostationary Lightning Mapper (GLM)





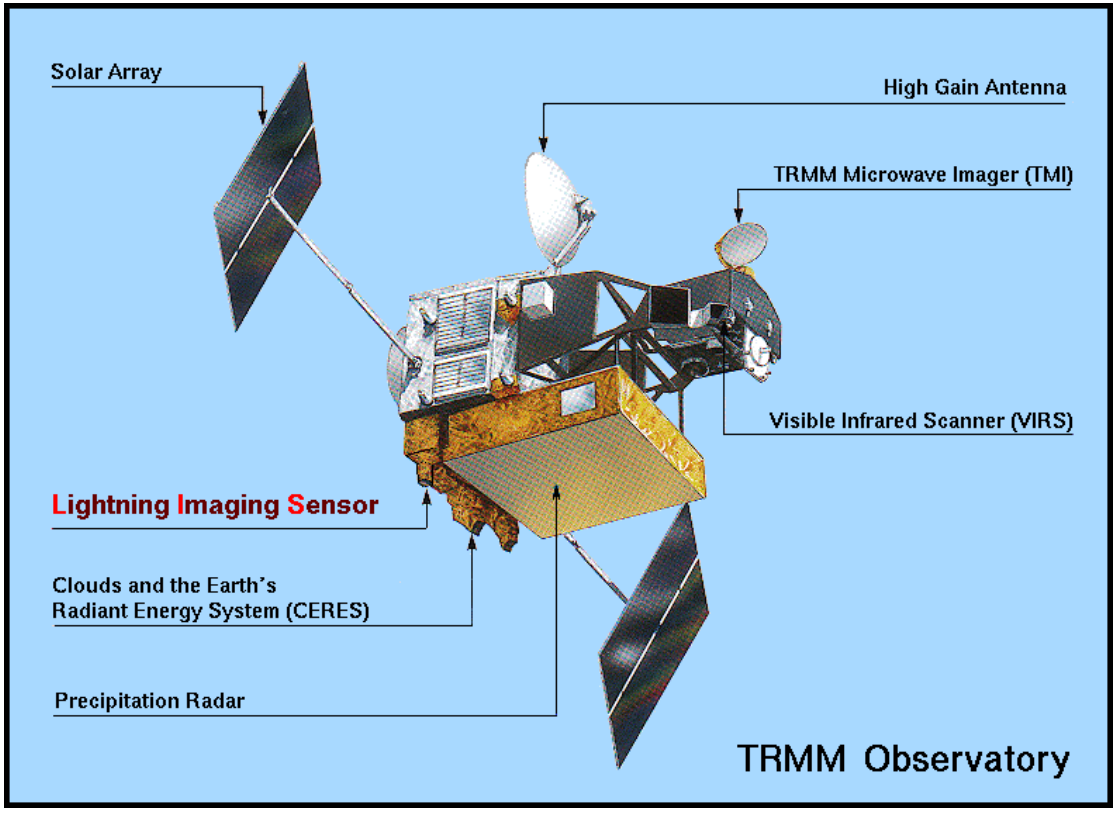
GLM Characteristics

- Staring CCD imager (1372x1300 pixels)
  - Single band 777.4 nm
  - 2 ms frame rate
  - 7.7 Mbps downlink data rate
  - Mass: 114 kg- SU (66 kg), EU (48 kg)
  - Avg. Operational Power: 290 W
  - Volume w/ baffle (cm^3): 81x66x150
- Near uniform spatial resolution/ coverage of total lightning (IC, CG) up to 52 deg lat
  - 8 km nadir to 14 km at edge
  - 70-90% flash detection
- L1 and L2+ products produced at Wallops for GOES-R Re-Broadcast (GRB)
- < 20 sec product total latency



HOW IS THE LIGHTNING OBSERVED FROM SPACE?

LIS on TRMM


Solar Array
High Gain Antenna
TRMM Microwave Imager (TMI)
Visible Infrared Scanner (VIRS)
Lightning Imaging Sensor
Clouds and the Earth's
Radiant Energy System (CERES)
Precipitation Radar
TRMM Observatory

雷観測センサー　LIS･OTD

■LIS（Lightning Imaging Sensor）

観測波長：0.77765μm

高度：350km

軌道傾斜角：35°

視野角：70°

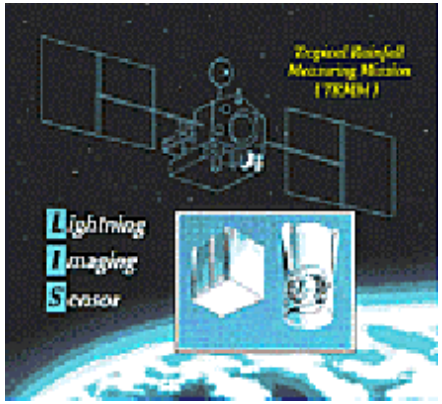
（600km×600km）

打上年月：1997年11月

解像度：4km

観測範囲：-35～35度

◎検知効率：0.8以上



•OTD（Optical Transient Detector）

観測波長：0.77765μm

高度：740km

軌道傾斜角：70°

視野角：100°

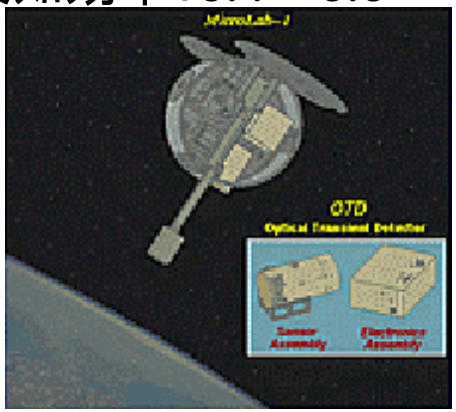
（1300km×1300km）

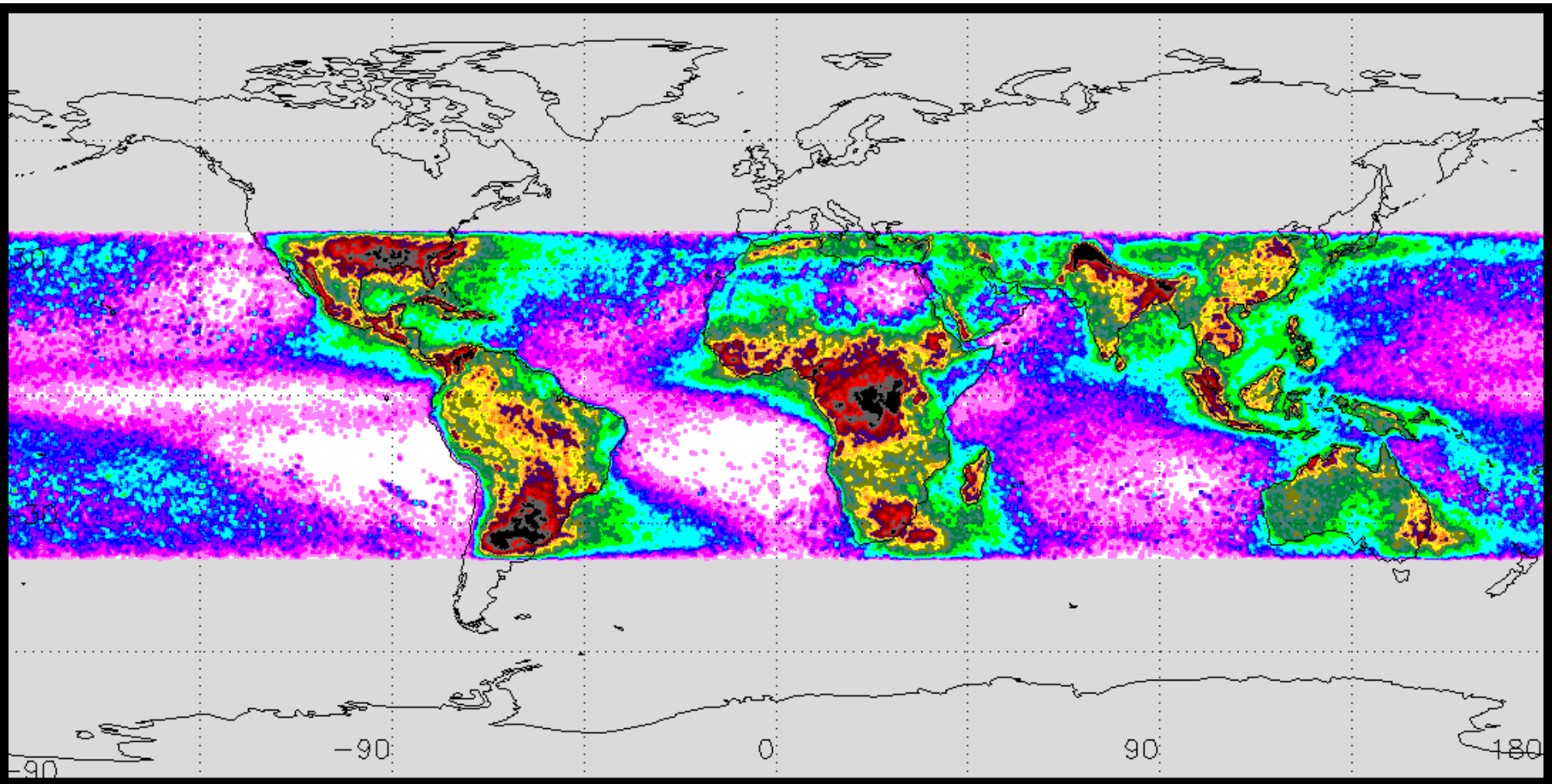
打上年月：1995年4月

解像度：10km

◎観測範囲：約65度以下

検知効率：0.4～0.6





Orbits	54389
Areas	2584015
Flashes	12435841
Groups	146500597
Events	691198532

08/31/2007 Version 04.1

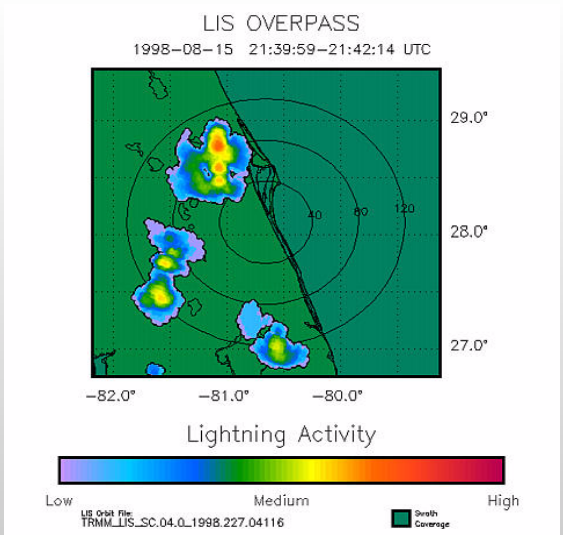
Flash scale

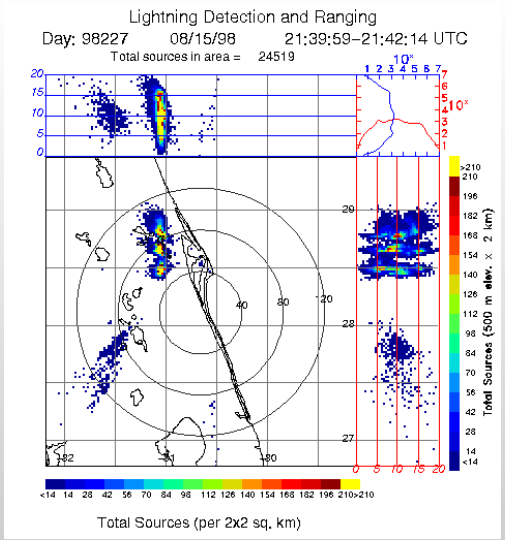
January 1998 - July 2007

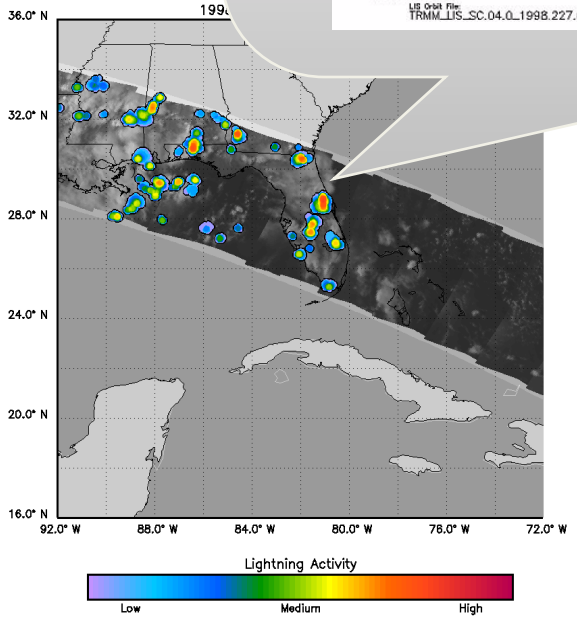
Lightning Imaging Sensor

NASA/MSFC

Ground Validation
8/15 1998 Case Study







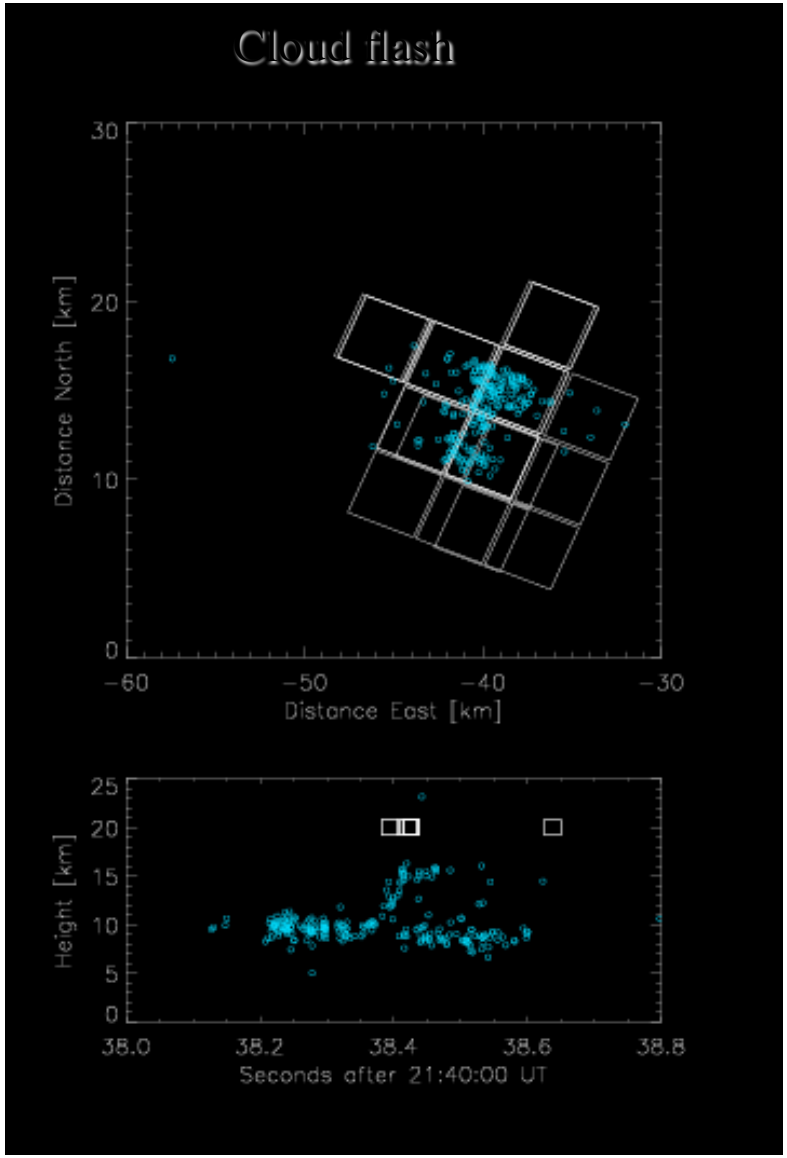
During the LIS overpass of 80 seconds in the daytime

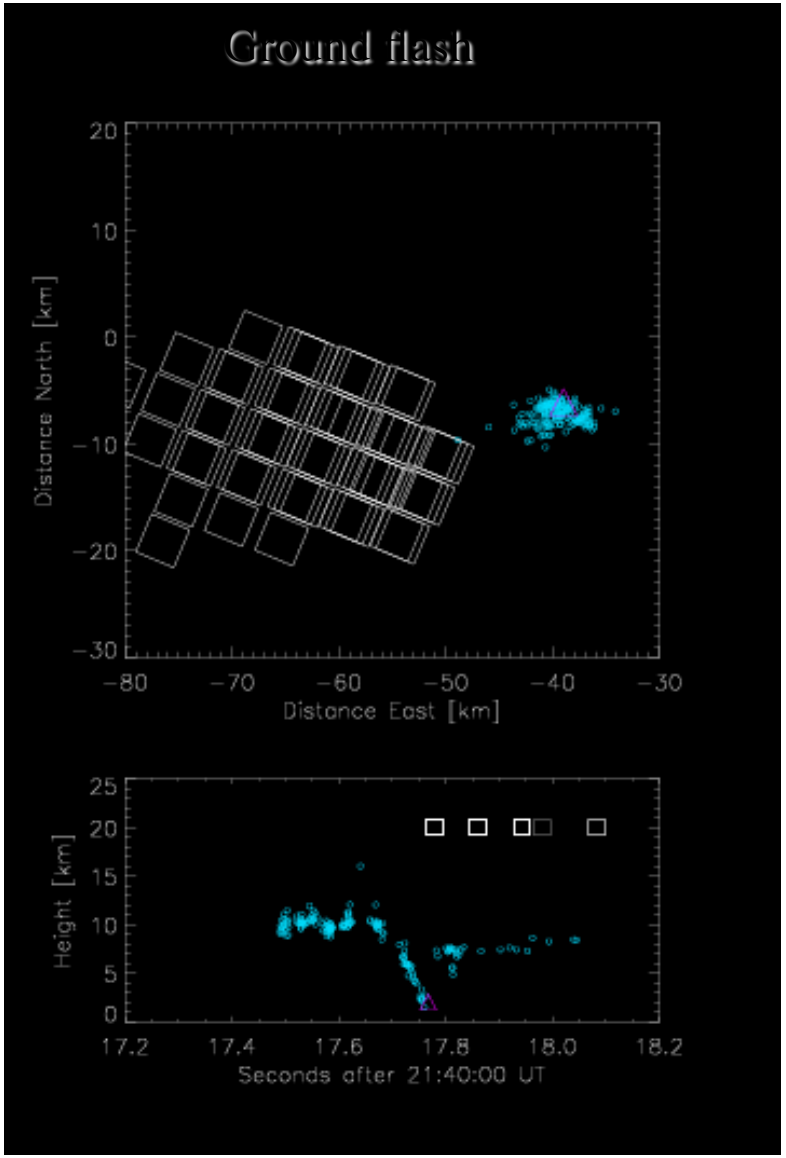
Total 122 LDAR flashes (42 CG, 80 CC)

Total 41 NLDN CG flash

Ushio et al., 2003

地上観測との同期観測例



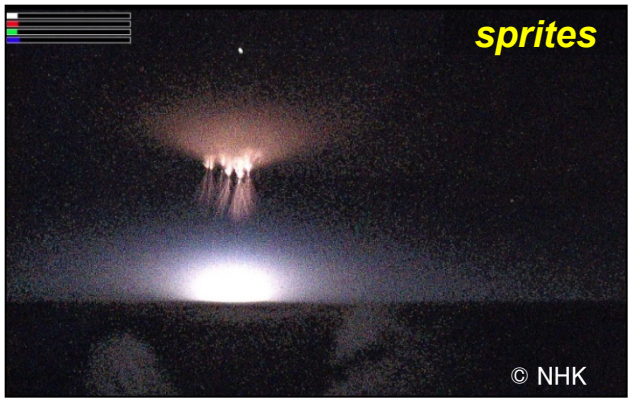


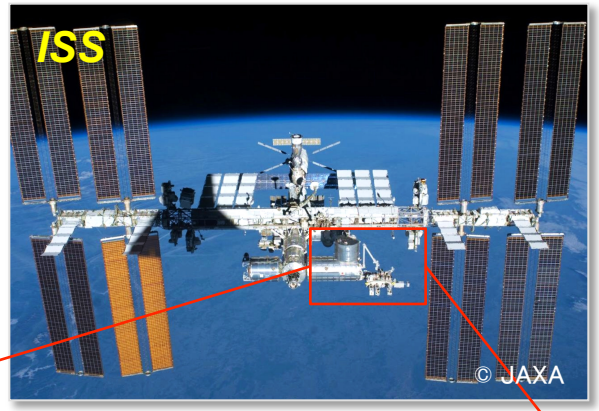
Ushio et al., 2003

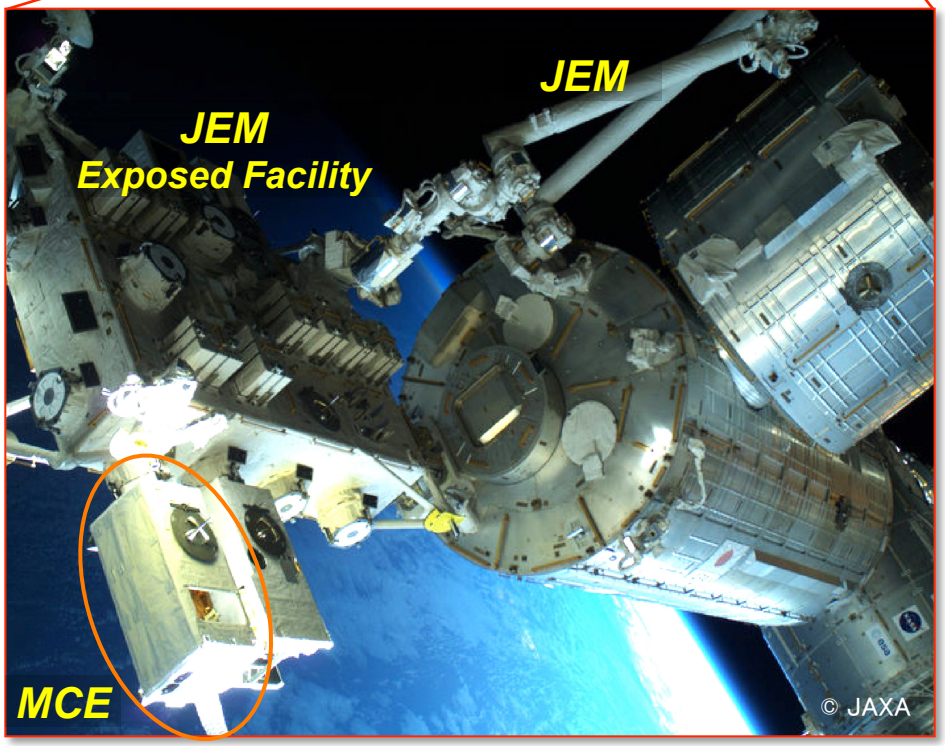
Japanese status

JEM-GLIMS

- **JEM-GLIMS** is a space mission dedicated to observing **lightning & TLEs** with the **nadir view** from the **ISS**.
- JEM-GLIMS started **continuous observations since Nov. 2012**. **Normal operation is still ongoing**.







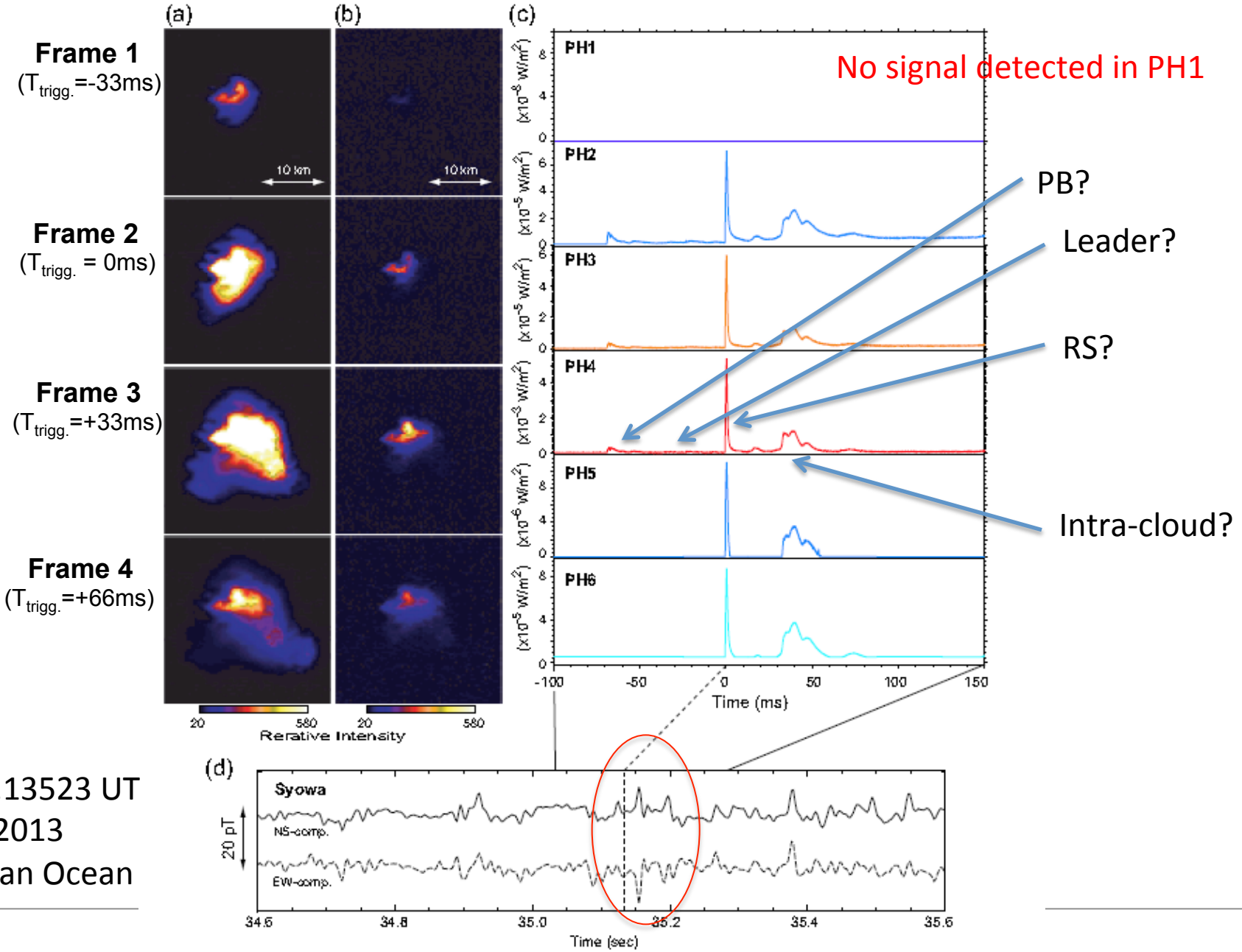
OBJECTIVE

1.Nadir observations of lightning and TLEs from JEM-EF,

*2.Identification of **horizontal distribution** and **occurrence condition** of sprites,*

*3.Identification of **global distributions and occurrence rates of TLEs** and their **seasonal / LT dependences**.*

Lightning flash event 1



20:40:35.13523 UT
Aug. 30, 2013
Over Indian Ocean

Summary

- Physical basis and scientific background were mentioned, and the reason why we need lightning data from geo stationary orbit was described.
- The lightning mapping sensor from geo stationary orbit over the US was introduced.
- On the lightning observation from space, the Japanese status was introduced.