GOES-R and GPM

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http://www.goes-r.gov

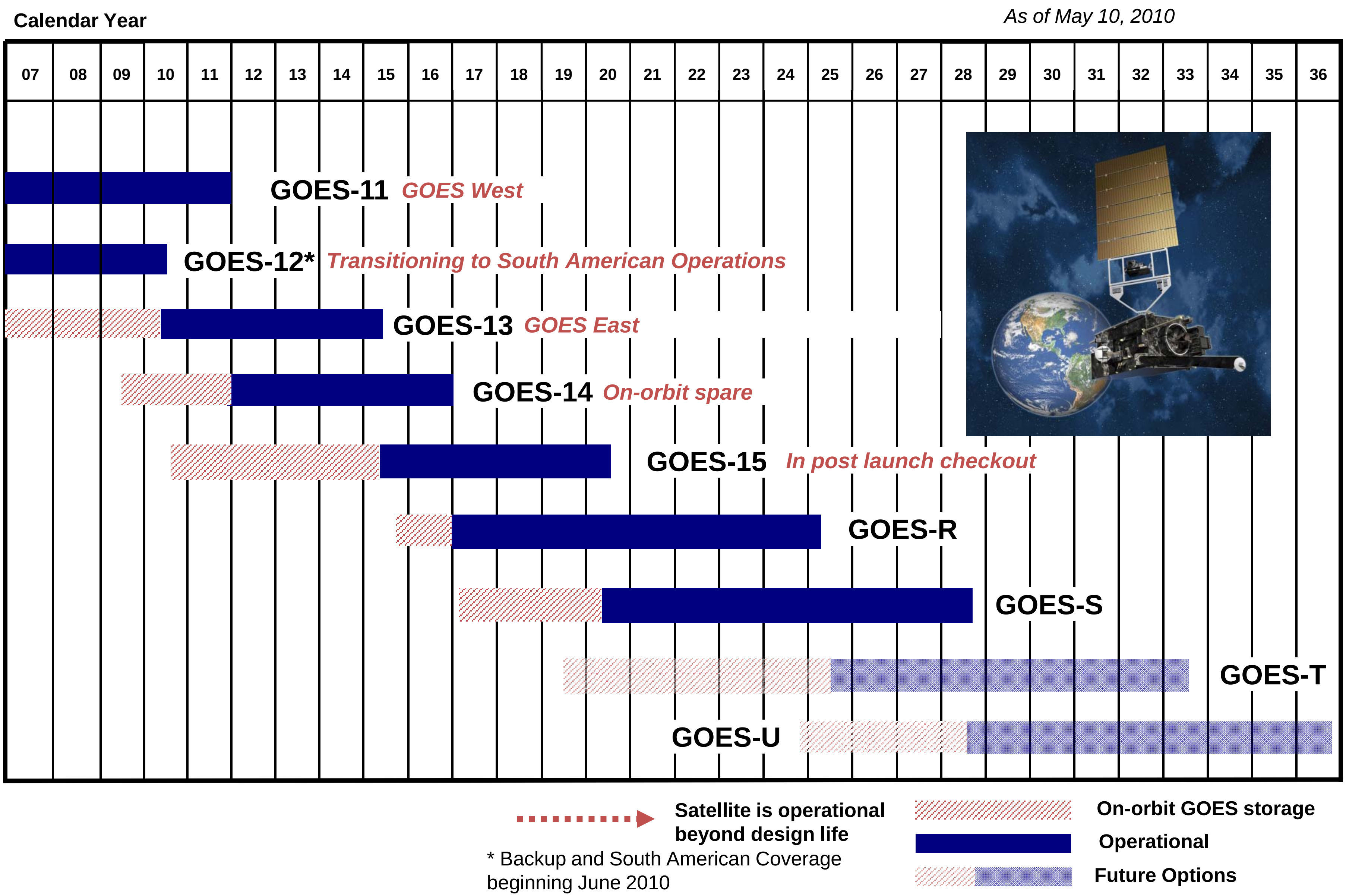
1st NOAA GPM User's Workshop

University of Maryland, ESSIC

College Park, MD

August 18-19, 2010

Continuity of GOES Operational Satellite Program



GOES-R Spacecraft

Specifications

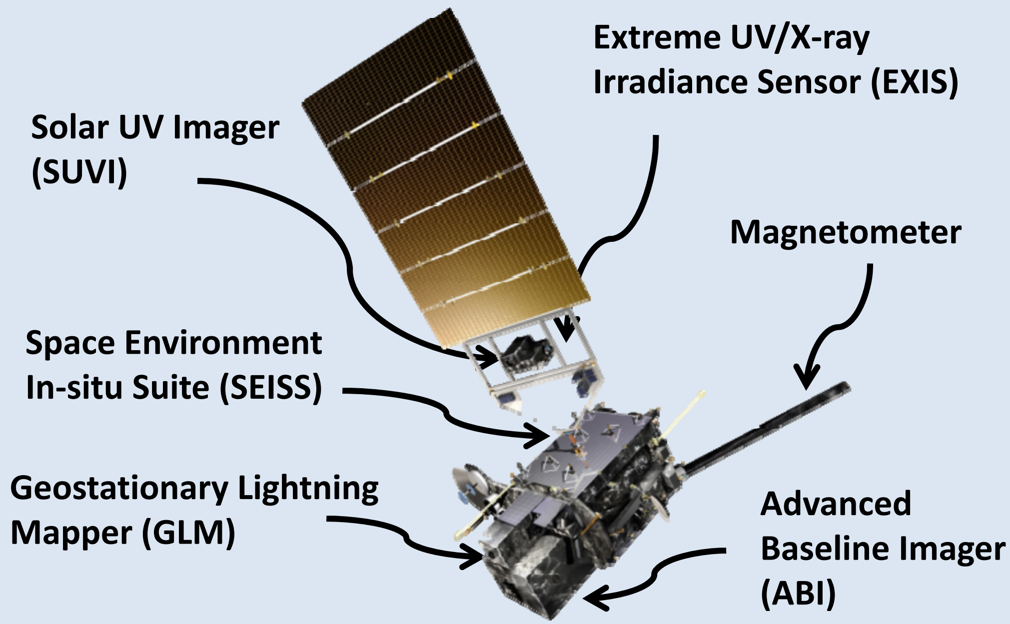
Size: ~5.5 meters (from launch vehicle interface to top of ABI)

Mass: Satellite (spacecraft and payloads) dry mass <2800kg

Power Capacity: >4000W at end-of-life (includes accounting for limited array degradation)

Current Status

- Lockheed-Martin Space Systems Co (LMSSC) began work on July 22, 2009
- Spacecraft System Definition Review (SDR) completed March 9-10, 2010
- Conducted Integrated Baseline Review (IBR) Apr 27, 2010



Unique Payload Services:

- High Rate Information Transmission/Emergency Managers Weather Information Network (HRIT/EMWIN)
- Data Collection System (DCS)
- Search and Rescue Satellite Aided Tracking (SARSAT) Repeater
- GOES-R Re-Broadcast (GRB)

Why GOES-R?

- Continuation of the U.S. capability required to observe, protect and manage the earth's resources to promote environmental stewardship.
- Enhance ability to predict and track storms; plan routes for airlines and ship traffic, identify demands for natural resources such as gas and water, and assess space weather impacts on sensitive electronics such as satellites and terrestrial communications.

GOES-R Instruments

✓ Improve hurricane track & intensity forecast
✓ Improve thunderstorm & tornado warning lead time
✓ Improve aviation flight route planning

Advanced Baseline Imager (ABI) and Geostationary Lightning Mapper (GLM)

✓ Improve solar flare warnings for communications and navigation

Extreme Ultra Violet Sensor/X-Ray Sensor Irradiace Sensor (EXIS)

✓ Improve power blackout forecasts due to solar flares

Solar Ultra Violet Imager (SUVI)

✓ Improve energetic particle forecasts

Space Environmental In-Situ Suite (SEISS)

GOES-R OPERATIONAL PRODUCTS

Advanced Baseline Imager (ABI)

BASELINE (25)

- Clouds and Moisture Imagery
- Clear Sky Mask
- Temperature and Moisture Profiles
- Total Precipitable Water
- Stability Parameters (Lifted Index)
- Cloud Top Pressure and Height
- Cloud Top Phase
- Cloud Particle Size Distribution
- Cloud Optical Path
- Rainfall Rate
- Aerosols Optical Depth
- Derived Motion Winds
- Hurricane Intensity
- Volcanic Ash
- Fire/Hot Spot Characterization
- Land and Sea Surface Temperature
- Snow Cover
- Downward Surface Insolation

GLM

- Lightning Detection

Advanced Baseline Imager (ABI)

OPTION 2 (34)

- Cloud Layer/Heights
- Cloud Ice Water Path
- Cloud Liquid Water
- Cloud Type
- Convective Initiation
- Turbulence
- Low Cloud and Fog
- Visibility
- Surface Albedo
- Upward and Downward Longwave Radiation
- Reflected and Absorbed Shortwave Radiation
- Total Ozone
- SO2 Detections (Volcanoes)
- Surface Emissivity
- Aerosol Particle Size
- Vegetation Index
- Vegetation Fraction
- Snow Depth
- Flood Standing Water
- Rainfall probability and potential
- Enhanced "V"/Overshooting Top
- Aircraft Icing Threat
- Ice Cover
- Sea & Lake Ice Concentration, Age, Extent, Motion
- Ocean Currents.

GPM can offer high quality calibrated data sets for algorithm validation, refinement, and development of new blended GEO-LEO products

ABI Visible/Near-IR Bands

Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (km)	Sample use
1	0.45–0.49	0.47	1	Daytime aerosol over land, coastal water mapping
2	0.59–0.69	0.64	0.5	Daytime clouds fog, insolation, winds
3	0.846–0.885	0.865	1	Daytime vegetation/burn scar and aerosol over water, winds
4	1.371–1.386	1.378	2	Daytime cirrus cloud
5	1.58–1.64	1.61	1	Daytime cloud-top phase and particle size, snow
6	2.225–2.275	2.25	2	Daytime land/cloud properties, particle size, vegetation, snow

ABI IR Bands

7	3.80–4.00	3.90	2	Surface and cloud, fog at night, fire, winds
8	5.77–6.6	6.19	2	High-level atmospheric water vapor, winds, rainfall
9	6.75–7.15	6.95	2	Midlevel atmospheric water vapor, winds, rainfall
10	7.24–7.44	7.34	2	Lower-level water vapor, winds, and SO_2
11	8.3–8.7	8.5	2	Total water for stability, cloud phase, dust, SO_2 rainfall
12	9.42–9.8	9.61	2	Total ozone, turbulence, and winds
13	10.1–10.6	10.35	2	Surface and cloud
14	10.8–11.6	11.2	2	Imagery, SST, clouds, rainfall
15	11.8–12.8	12.3	2	Total water, ash, and SST
16	13.0–13.6	13.3	2	Air temperature, cloud heights and amounts

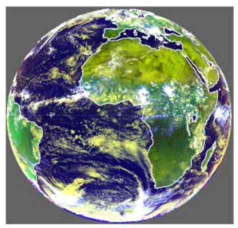
Algorithm Testing and Validation

A wide variety of instrument proxy and simulated datasets are being used

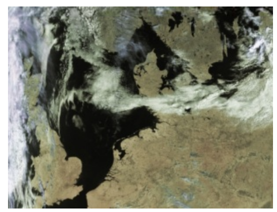
PROXY Data Sources

Current GOES

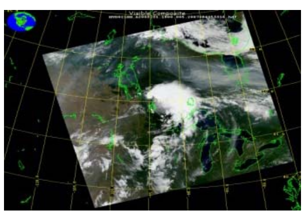
Meteosat/
SEVERI



AVHRR



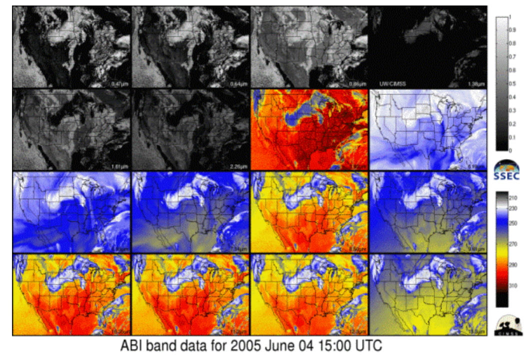
MODIS



TRMM/LIS

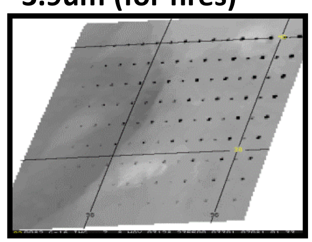
Simulated Data Sources

Simulated GOES-R ABI

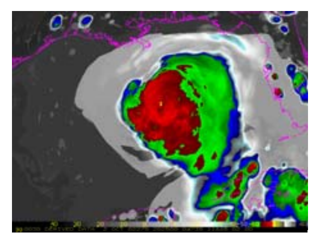


Simulated GOES-R ABI Imagery (Case Studies)

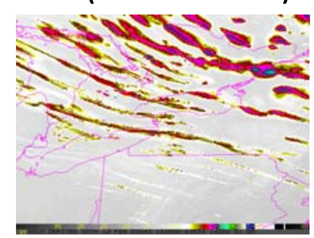
3.9um (for fires)



10.35um (Hurricane Lili)

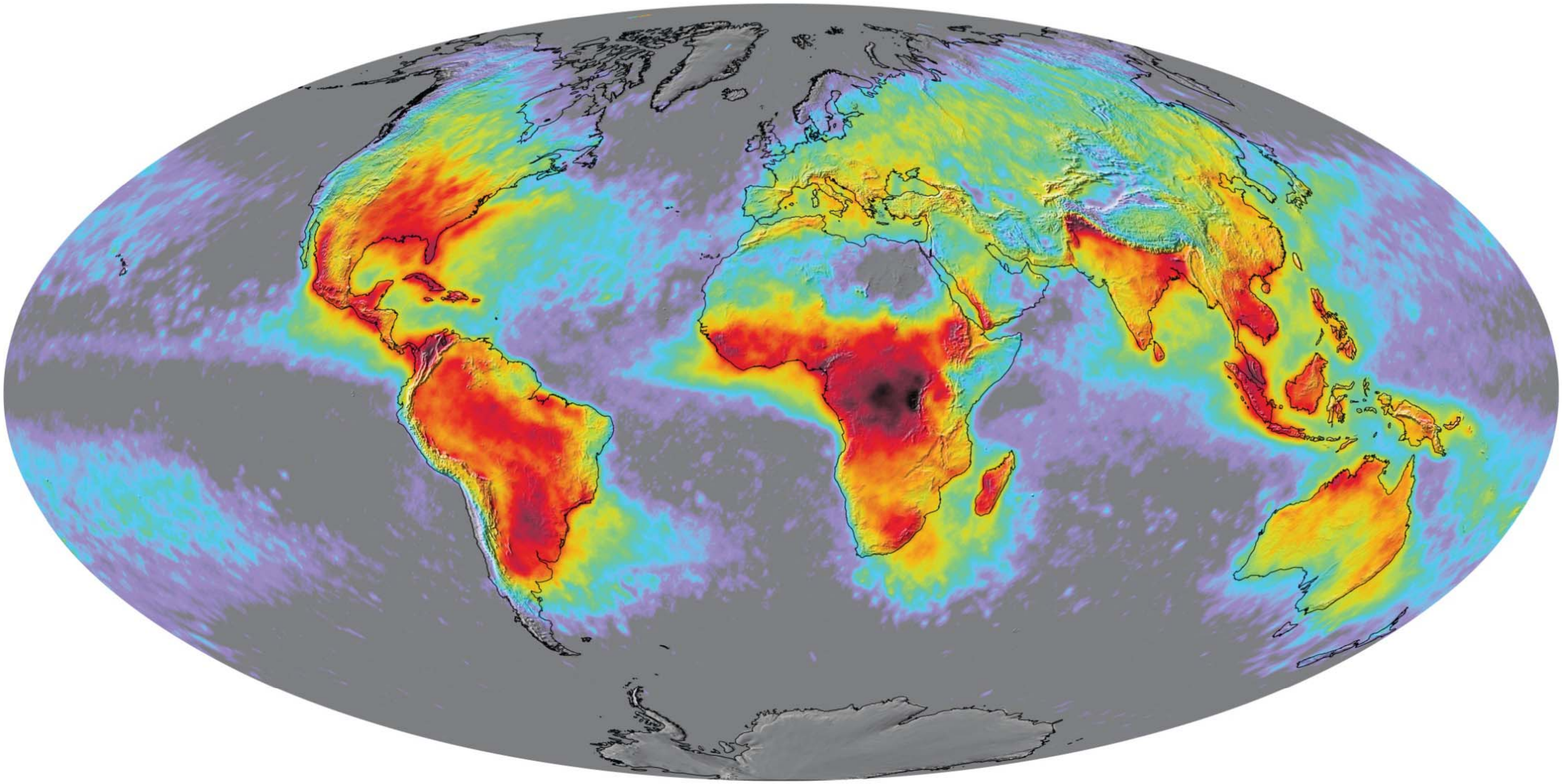


10.35um (Lake Effect Snow)



AWG Proxy and Product Application Teams assembled a wide variety of instrument proxy and simulated datasets to use for algorithm development, testing, and validation activities

Global Distribution of Lightning Activity

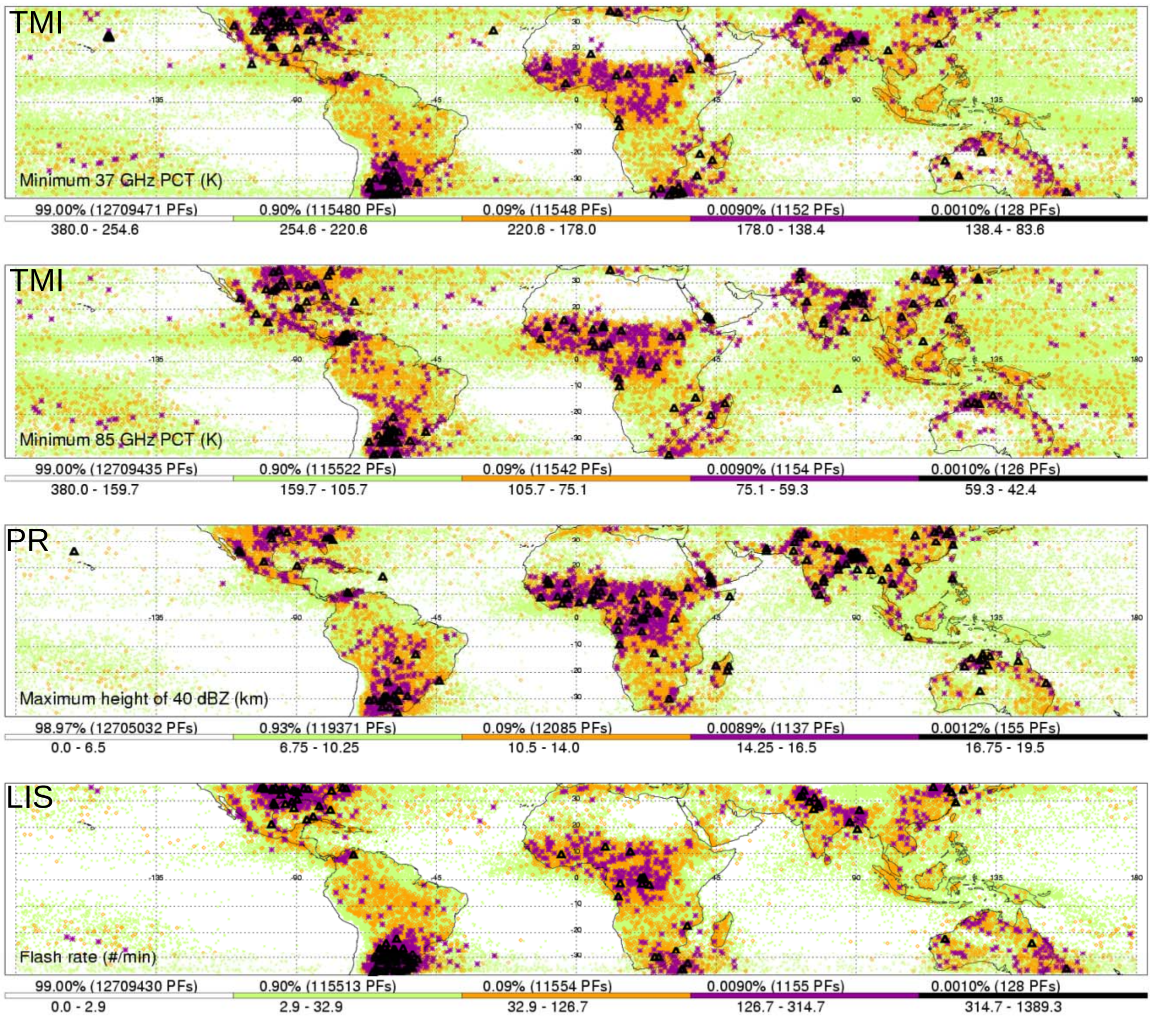


Goodman et al., 2007. Glimpses of a Changing Planet, M. King, ed., Cambridge University Press

Mean annual global lightning flash rate (flashes km^{-2} yr^{-1}) derived from a combined 8 years from April 1995 to February 2003. (Data from the NASA OTD instrument on the OrbView-1 satellite and the LIS instrument on the TRMM satellite.)

Where are the Most Intense Thunderstorms on Earth?

(E. J. Zipser, Daniel J. Cecil, Chuntao Liu, Stephen W. Nesbitt and David P. Yorty.
Bulletin of the American Meteorological Society, August 2006



-Most intense convective storms on earth; color code indicating their rarity.

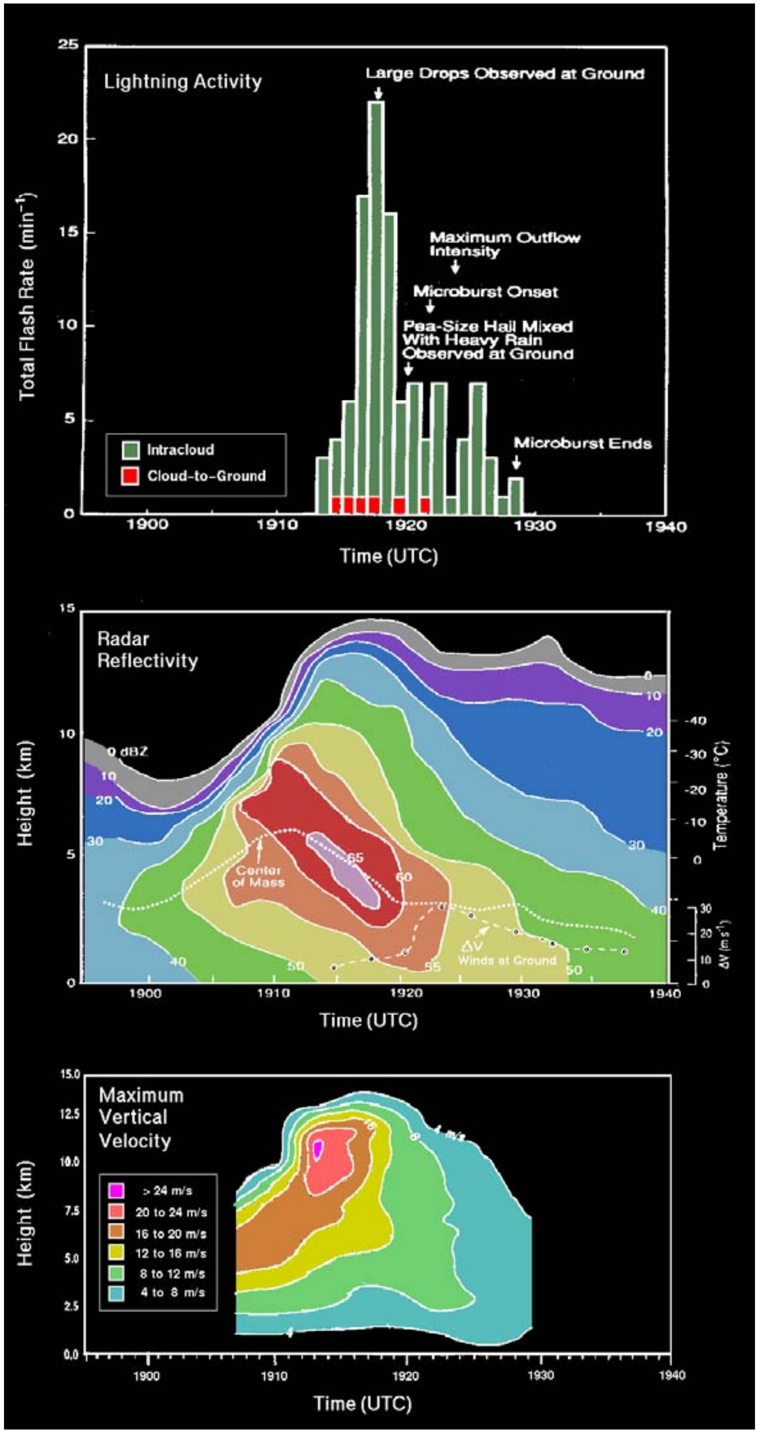
-The deepest and most electrically active storms, indicated by the black triangles, also have large amounts of precipitation-sized ice and hail, as indicated by the very cold microwave brightness temperatures.

-A line of storms in northern Argentina produced more than 1000 discharges per minute, the greatest flash rate observed to date.

-During the eight year period 1998-2005 nearly 13 million storms have been observed by the suite of instruments on the Tropical Rainfall Measuring Mission.

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

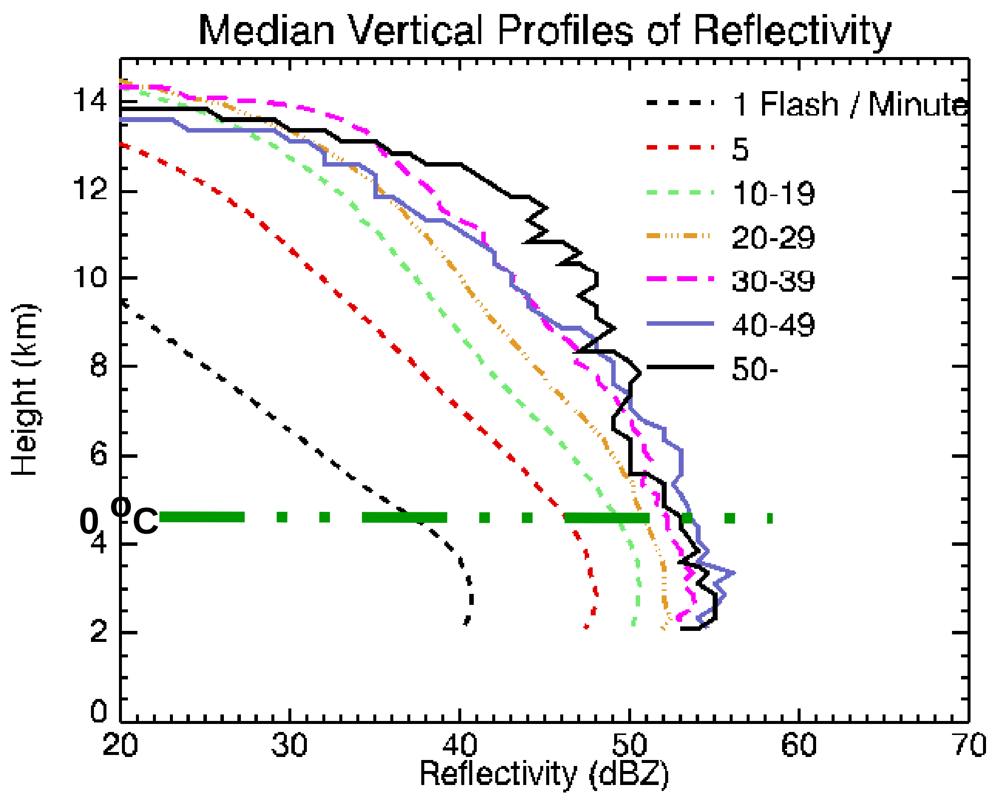


(Gatlin and Goodman, 2010)

Physical Basis: Flash Rate Coupled to Mass in the Mixed Phase Region

TRMM PR and LIS

(Cecil et al., Mon. Wea. Rev. 2005)

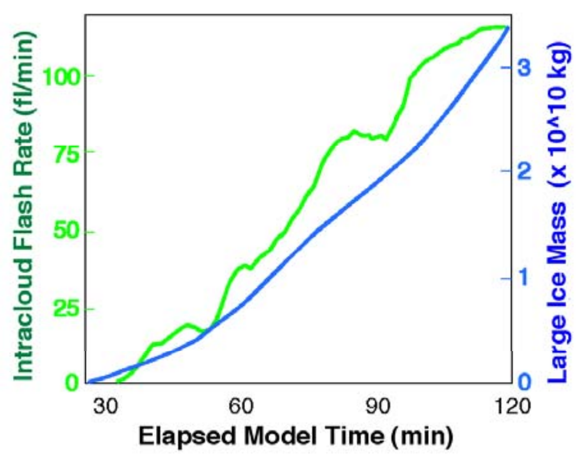


Process physics understood

Storm-scale model with explicit microphysics and electrification (Mansell)

Ice flux drives lightning

Physical basis for improved forecasts



IC flash rate controlled by graupel (ice mass) production (and vertical velocity)

GPM-CHUVA Ground Validation IOP Sao Paulo, Brazil Jan. 2011-2012

- CHUVA- ("*C*loud processes of t*H*e main precipitation systems in Brazil: A contrib*U*tion to cloud resol*V*ing modeling and to the GPM (Glob*A*l Precipitation Measurement)")
- Collaboration with GOES-R Geostationary Lightning Mapper (GLM) Science Team, INPE (CPTEC/USP, ELAT), and EUMETSAT MTG Lightning Imager Science Team
- Key scientific measurements include VHF 3-D Lightning Mapping Array, TRMM/LIS, MSG SEVERI (ABI proxy data), high speed digital video, VLF lightning networks, dual-pol radar, electric field-change, ancillary meteorological data

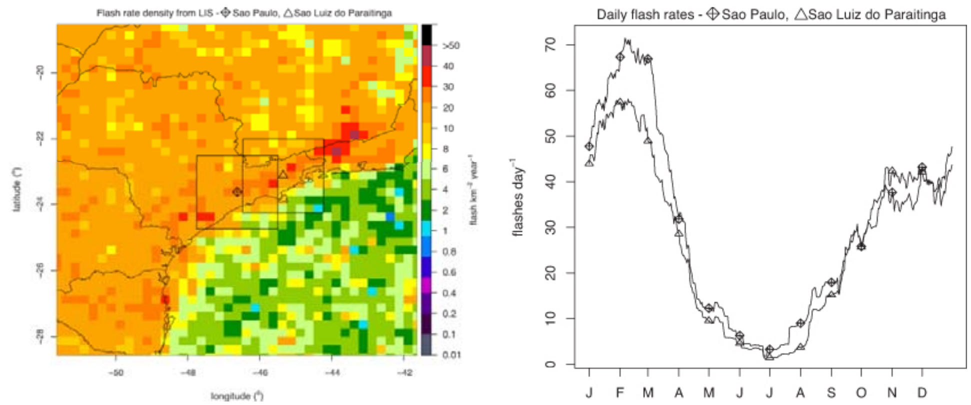


Figure 1 – (a) Lightning flash rate density (fl km^{-2} yr^{-1}) for Southeast Brazil. (b) Daily flash rate (flashes per day) around São Paulo and São Luiz do Paraitinga (flash rate for black squares (2 ¼^{o}) around these cities). Lightning data is from LIS climatology from 1 January 1998 to 31 December 2008 in ¼^{o} resolution.

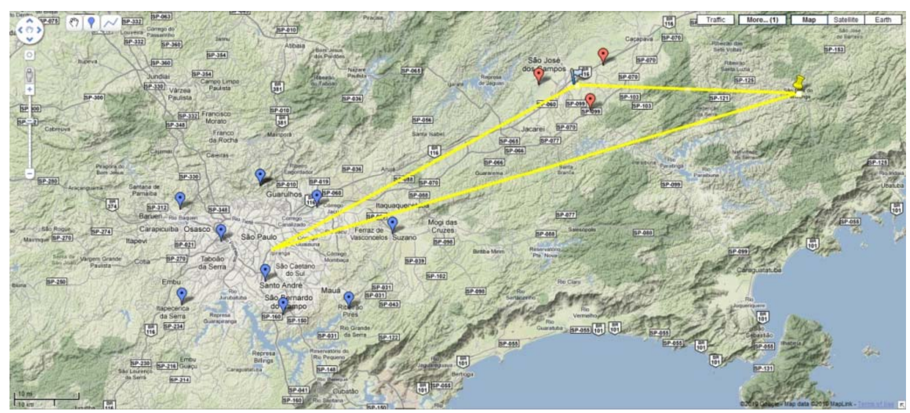


Figure 2 – Blue balloons show preliminary configuration for the SPLMA network for CHUVA. The red balloons show a second network configuration, centered at INPE (Sao Jose dos Campos). Yellow "push pin" is the São Luiz do Paraitinga CHUVA IOP site.