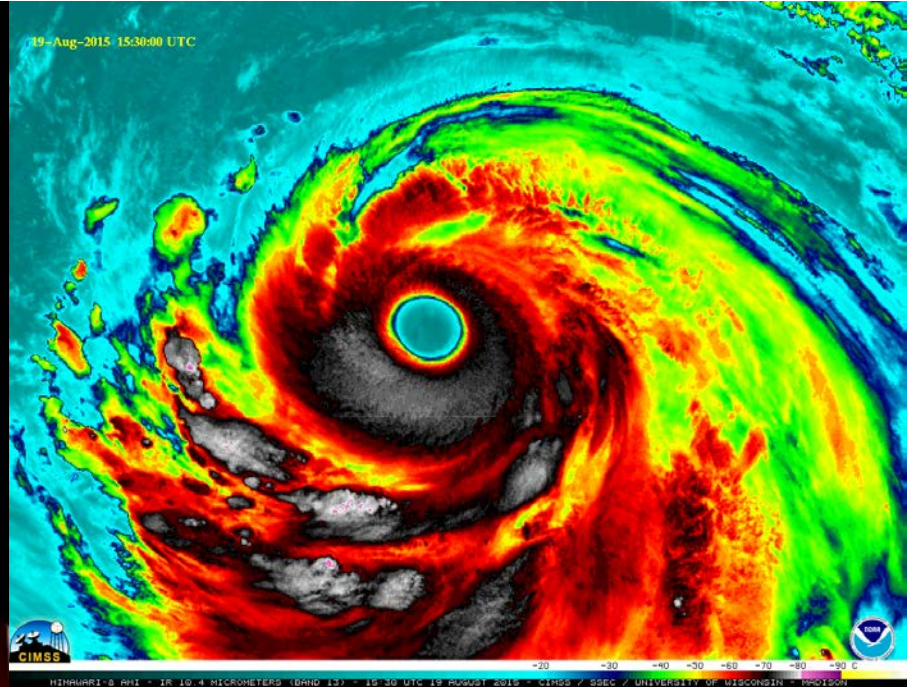
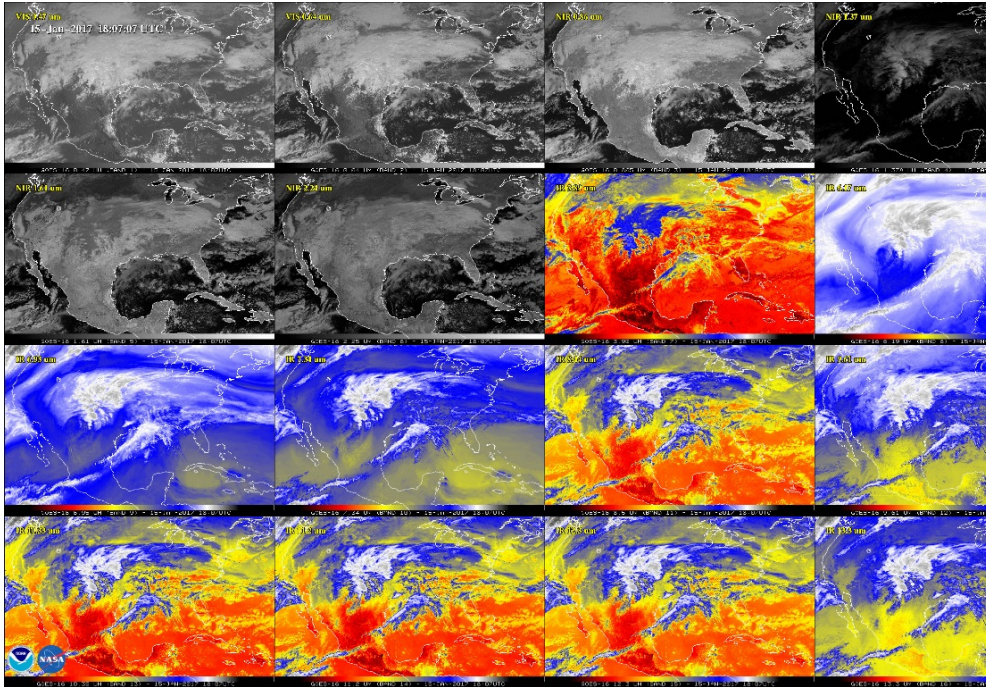




# GOES-16 and Hurricane Forecasting



Meteorology Workshop 2 - New Technology and Products

Michael Brennan

National Hurricane Center

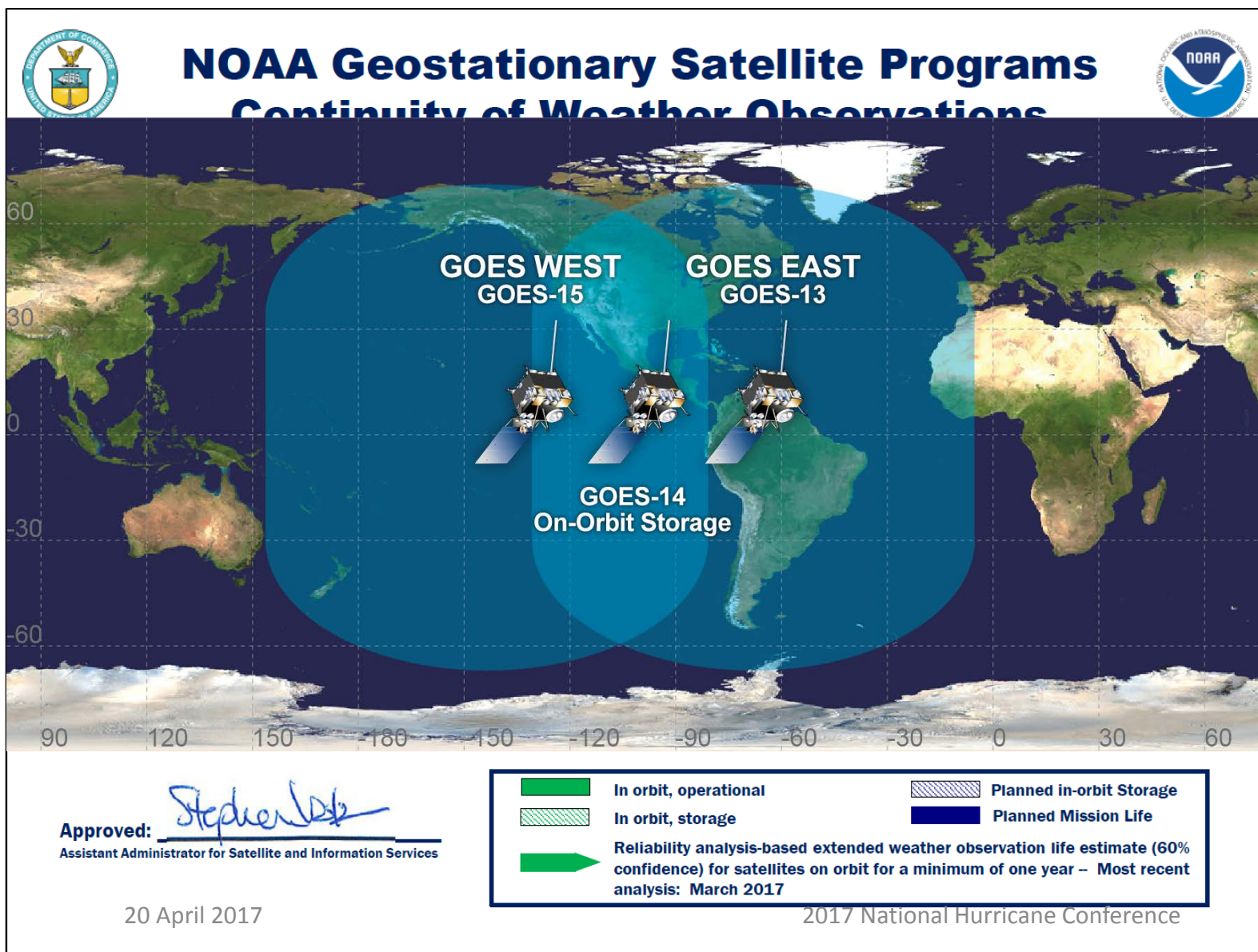
20 April 2017

# Outline

- Current status of NOAA geostationary satellites
- GOES-16 overview
- Capabilities compared to current GOES
- Uses for tropical cyclone analysis and forecasting

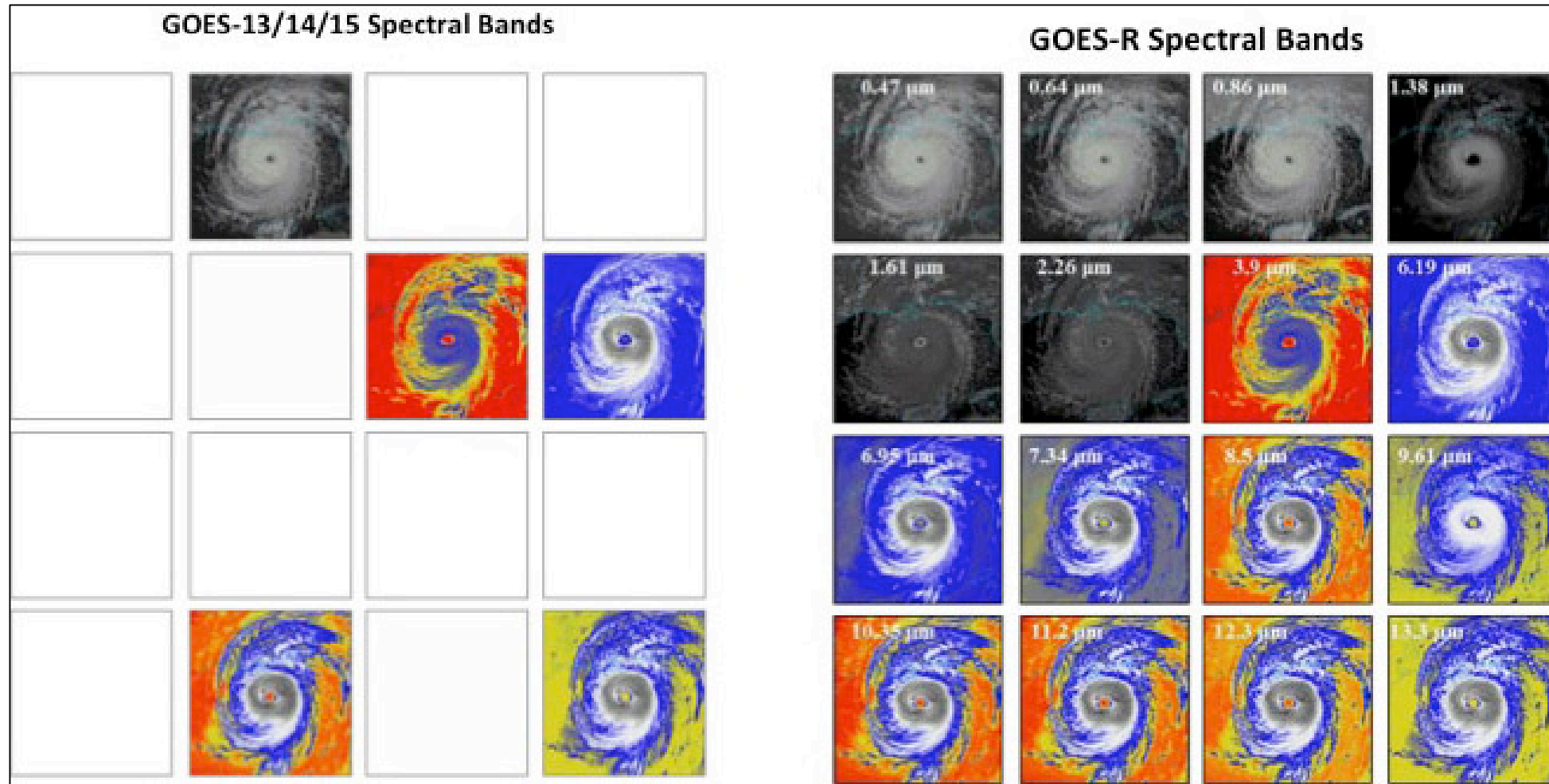


# Status of GOES Constellation



- NOAA currently has four geostationary satellites on orbit:
  - GOES-13 (GOES East 75°W)
  - GOES-15 (GOES West 137°W)
  - GOES-14 (On-orbit spare)
  - GOES-16
- GOES-16 currently at 89.5°W undergoing calibration/validation
  - Will become operational GOES East or West by November 2017
  - Planned location will be announced in May 2017

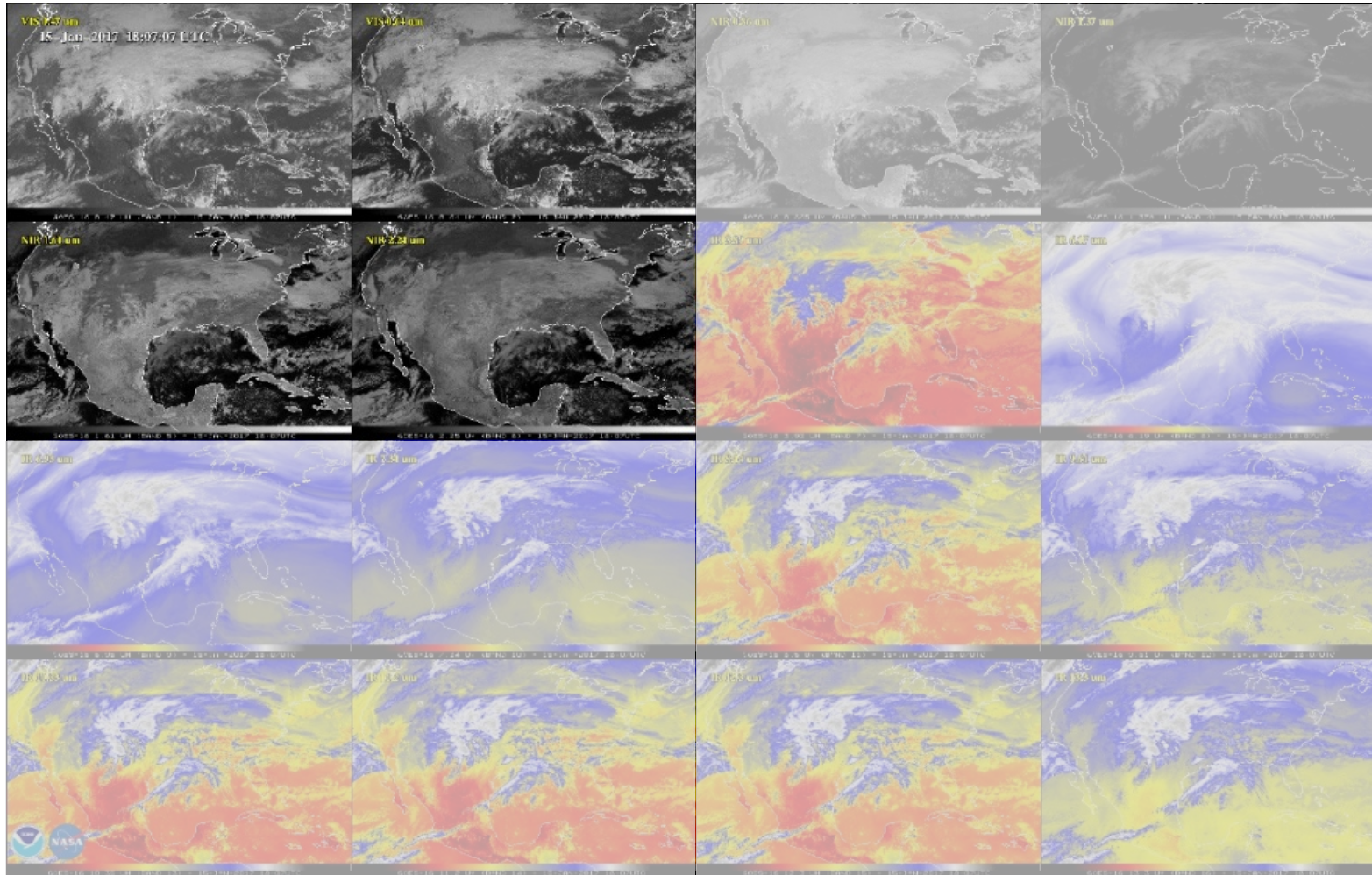
# GOES-16 Spectral Bands



5 channels

16 channels

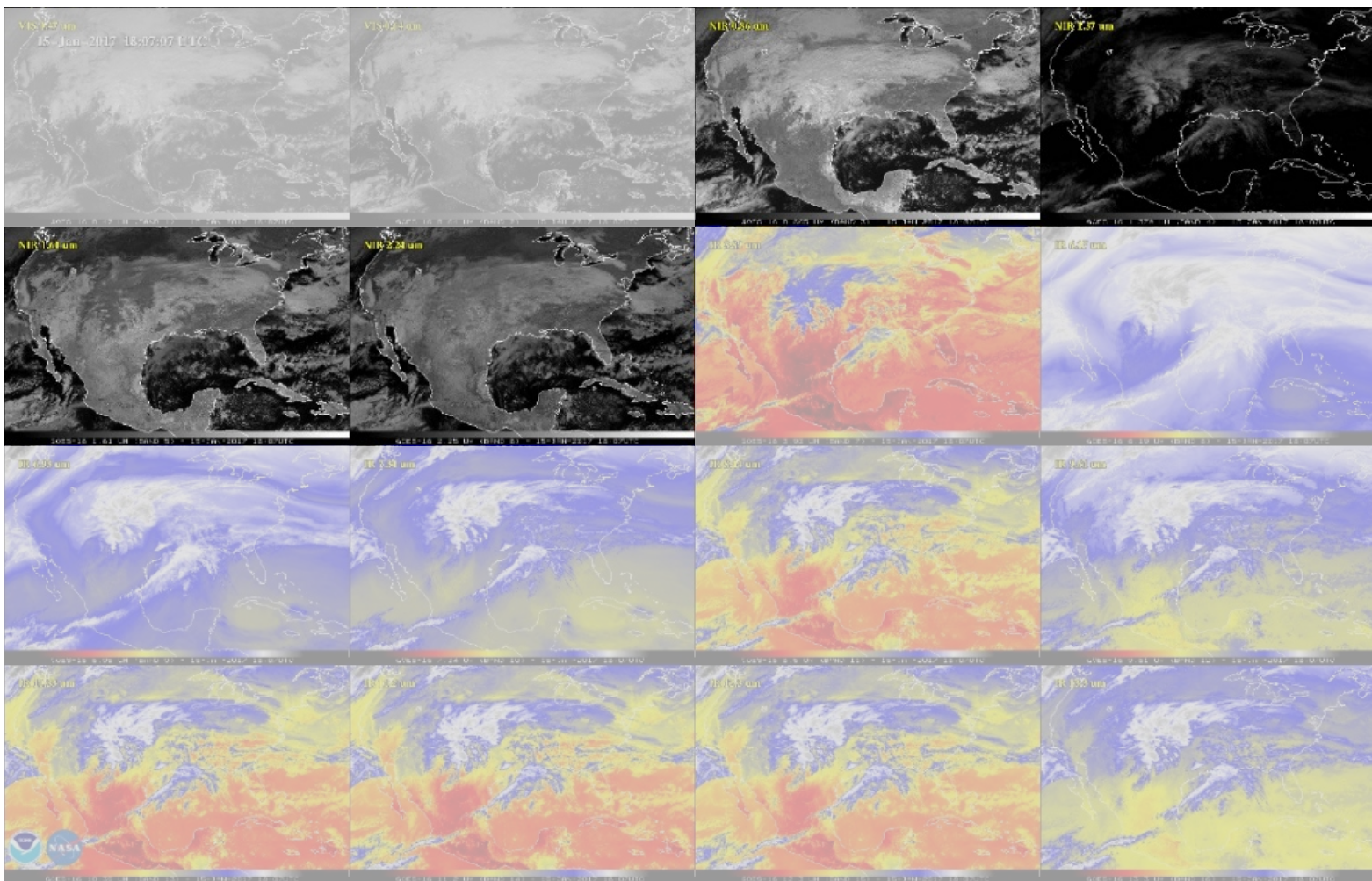
# GOES-16 Spectral Bands



## Visible Channels

- Band 1: Blue ( $0.47 \mu\text{m}$ )
  - Resolution: 1 km
- Band 2: Red ( $0.64 \mu\text{m}$ )\*
  - Resolution: 0.5 km
  - Legacy GOES Resolution: 1 km

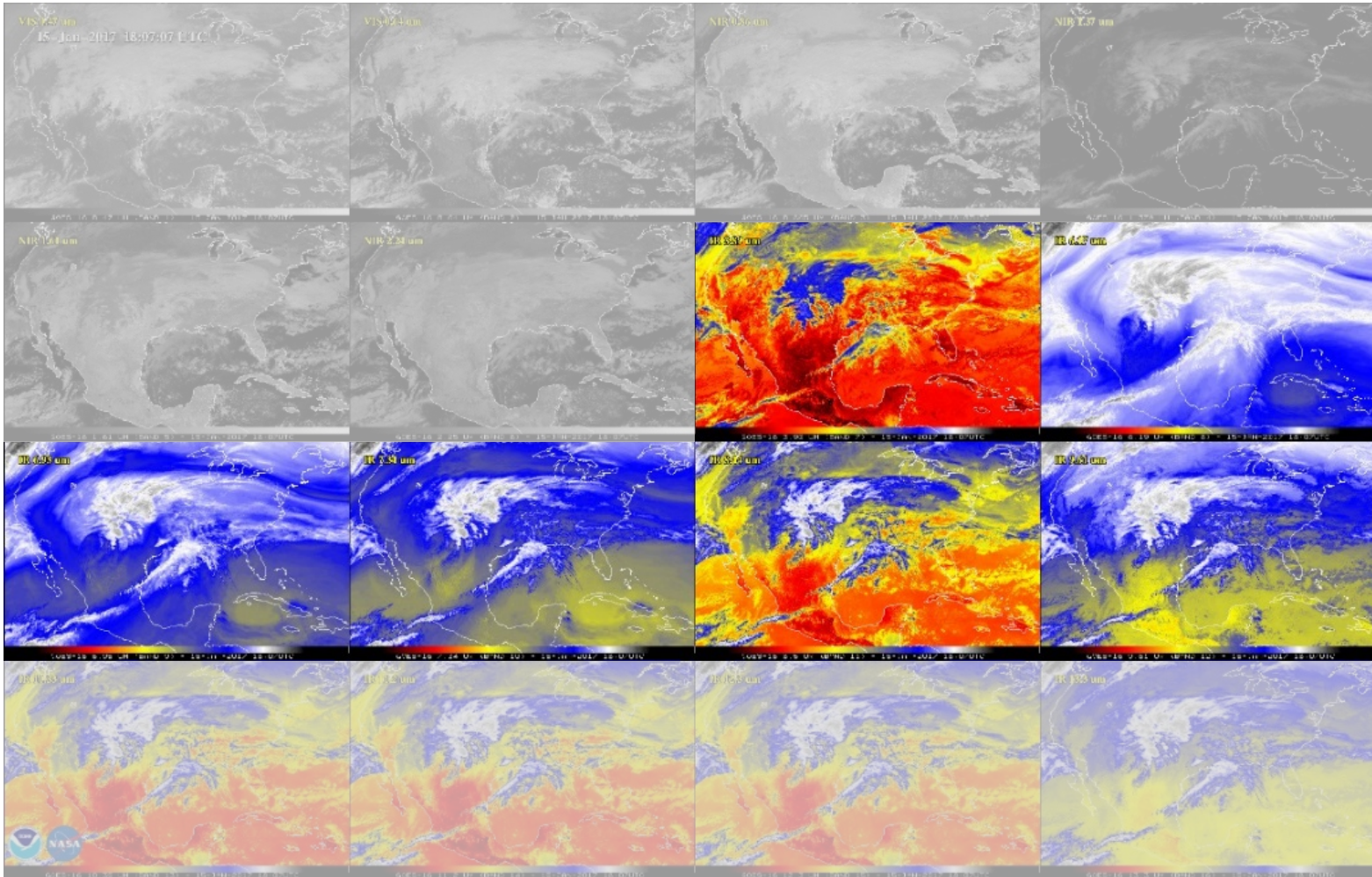
# GOES-16 Spectral Bands



## Near IR Channels

- Band 3: Veggie ( $0.86 \mu\text{m}$ )
  - Resolution: 1 km
- Band 4: Cirrus ( $1.37 \mu\text{m}$ )
  - Resolution: 2 km
- Band 5: Snow/Ice ( $1.6 \mu\text{m}$ )
  - Resolution: 1 km
- Band 6: Cloud Particle Size ( $2.2 \mu\text{m}$ )
  - Resolution: 2 km

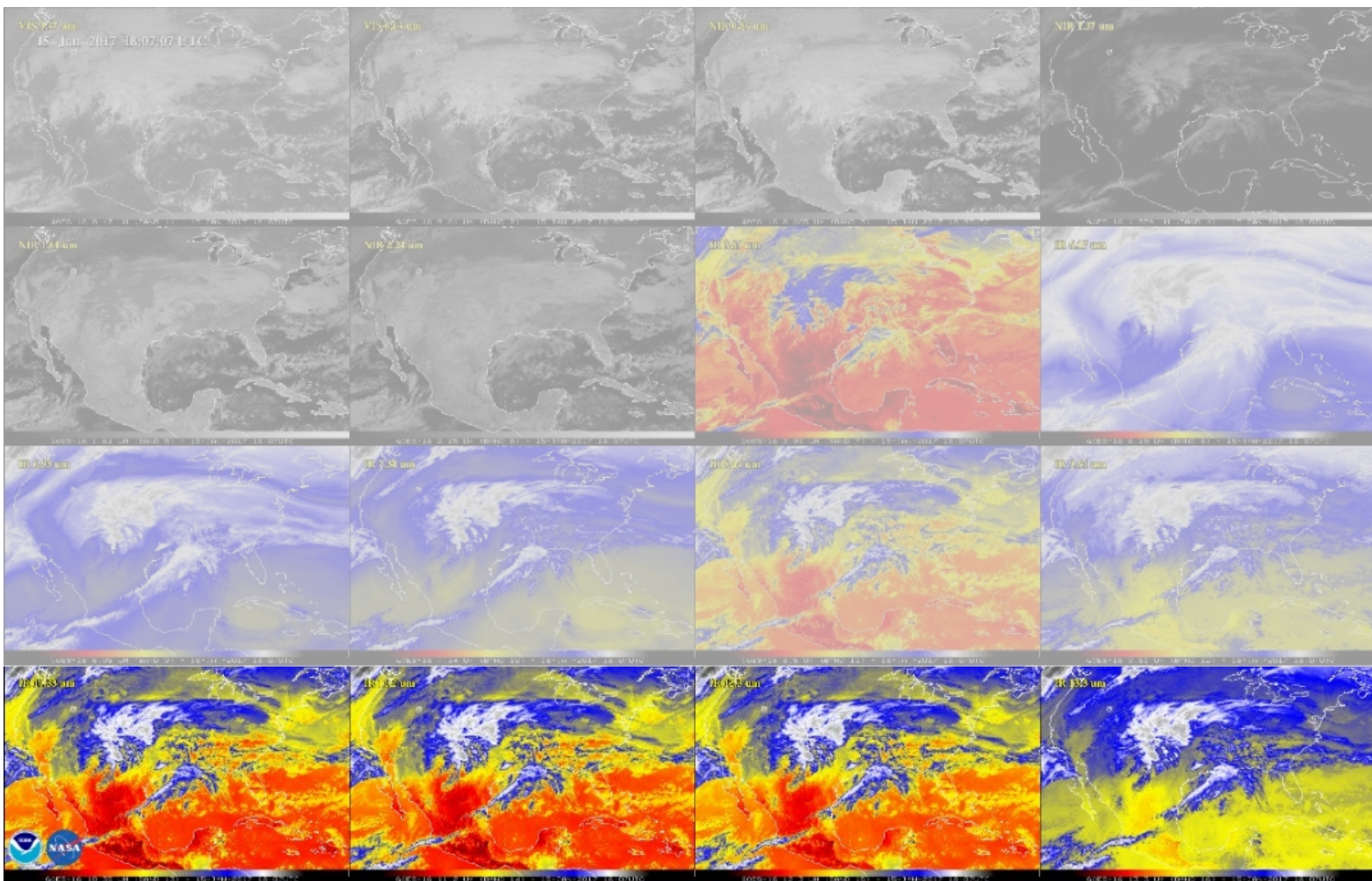
# GOES-16 Spectral Bands



## IR Channels (2-km resolution)

- Band 7: Shortwave Window (3.9  $\mu\text{m}$ )\*
  - Legacy GOES - 4-km resolution
- Band 8: Upper-level Water Vapor (6.2  $\mu\text{m}$ )
- Band 9: Mid-level Water Vapor (6.9  $\mu\text{m}$ )\*
  - Legacy GOES - 4-km resolution
- Band 10: Low-level Water Vapor (7.3  $\mu\text{m}$ )
- Band 11: Cloud Top Phase (8.4  $\mu\text{m}$ )
- Band 12: Ozone (10.3  $\mu\text{m}$ )

# GOES-16 Spectral Bands



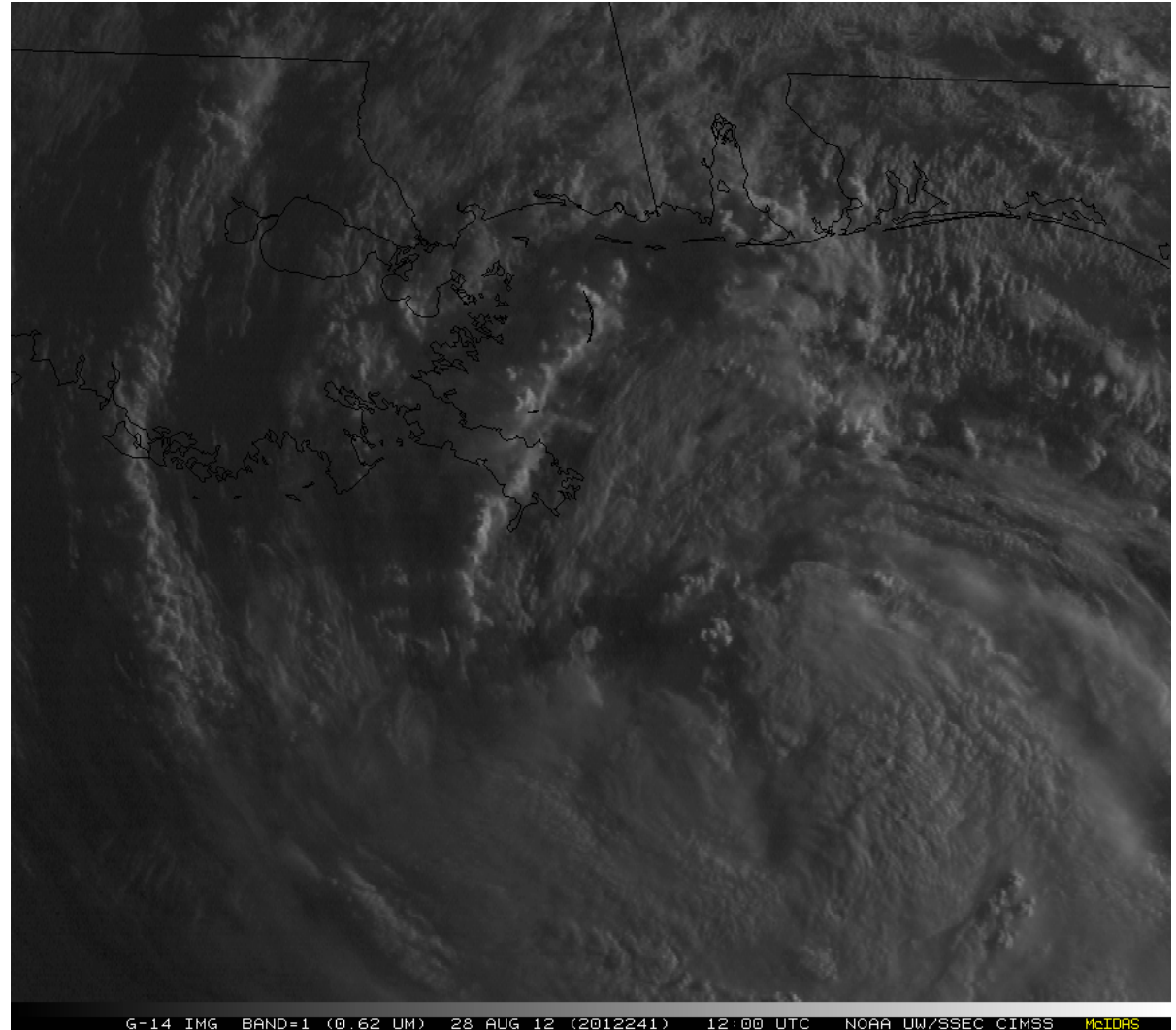
## IR Channels (2-km resolution)

- Band 13: Clear IR Longwave Window (10.3  $\mu\text{m}$ )\*
  - Legacy GOES - 4-km resolution
- Band 14: IR Longwave Window (11.2  $\mu\text{m}$ )\*
  - Legacy GOES - 4-km resolution
- Band 15: Dirty Longwave Window (12.3  $\mu\text{m}$ )
- Band 16: CO<sub>2</sub> Longwave Window (13.3  $\mu\text{m}$ )



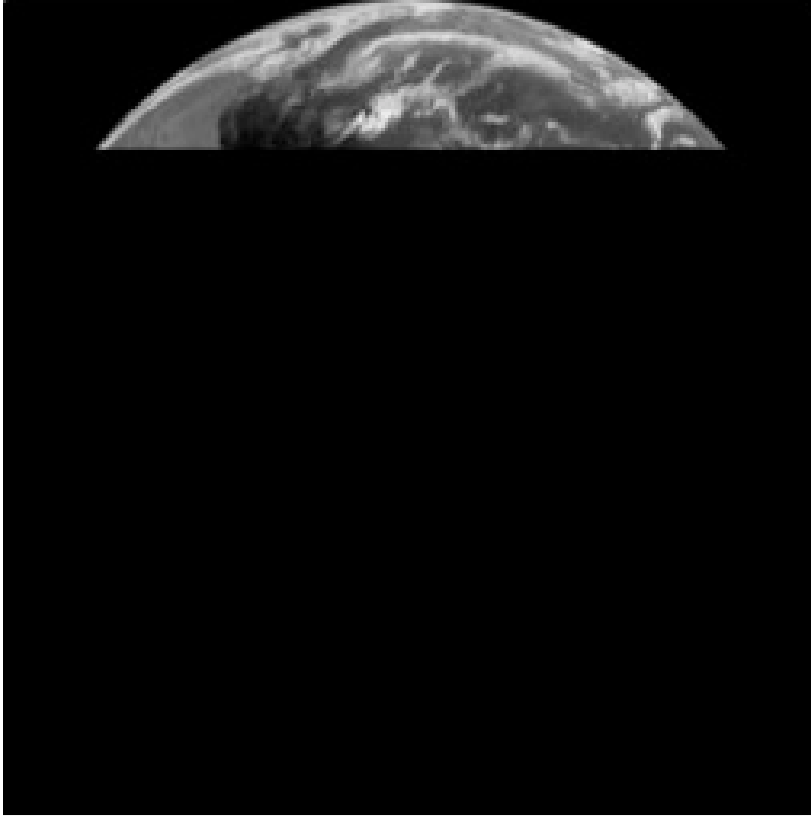
# GOES-16 Scan Strategy

- Full Disk: 5-15 min
- Mesoscale: 30 sec over 1000 x 1000 km box
- CONUS Sector: 5 min
- Flex Mode:
  - Full disk every 15 min
  - CONUS every 5 min
  - 2 Meso sectors every 60 sec or 1 Meso every 30 sec

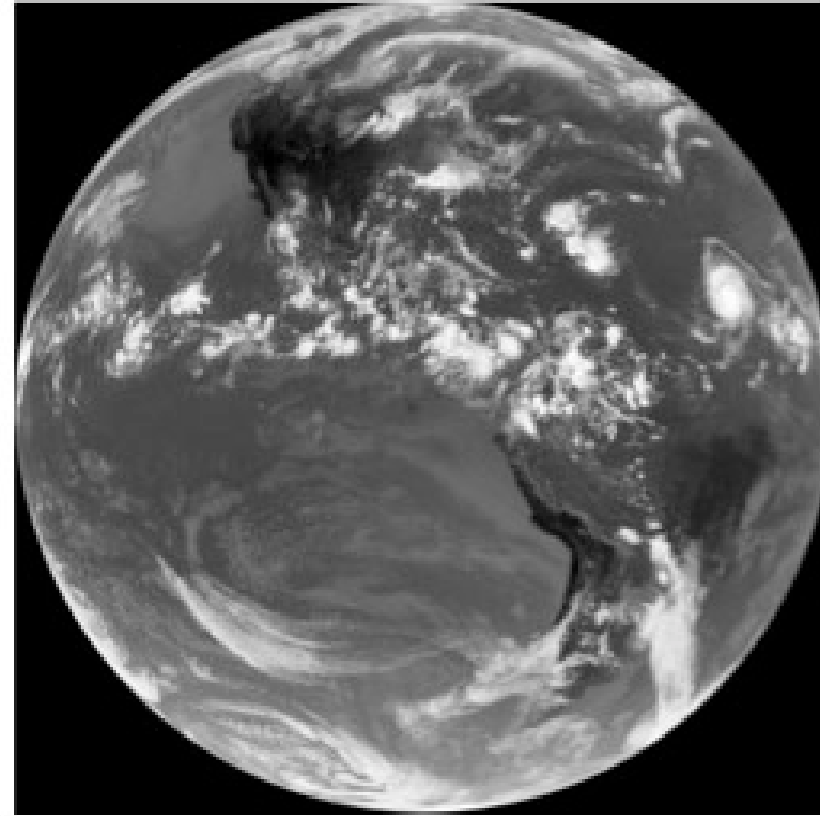


GOES-14 SRSO 1-min visible imagery over Hurricane Isaac

# GOES-16 Scan Strategy



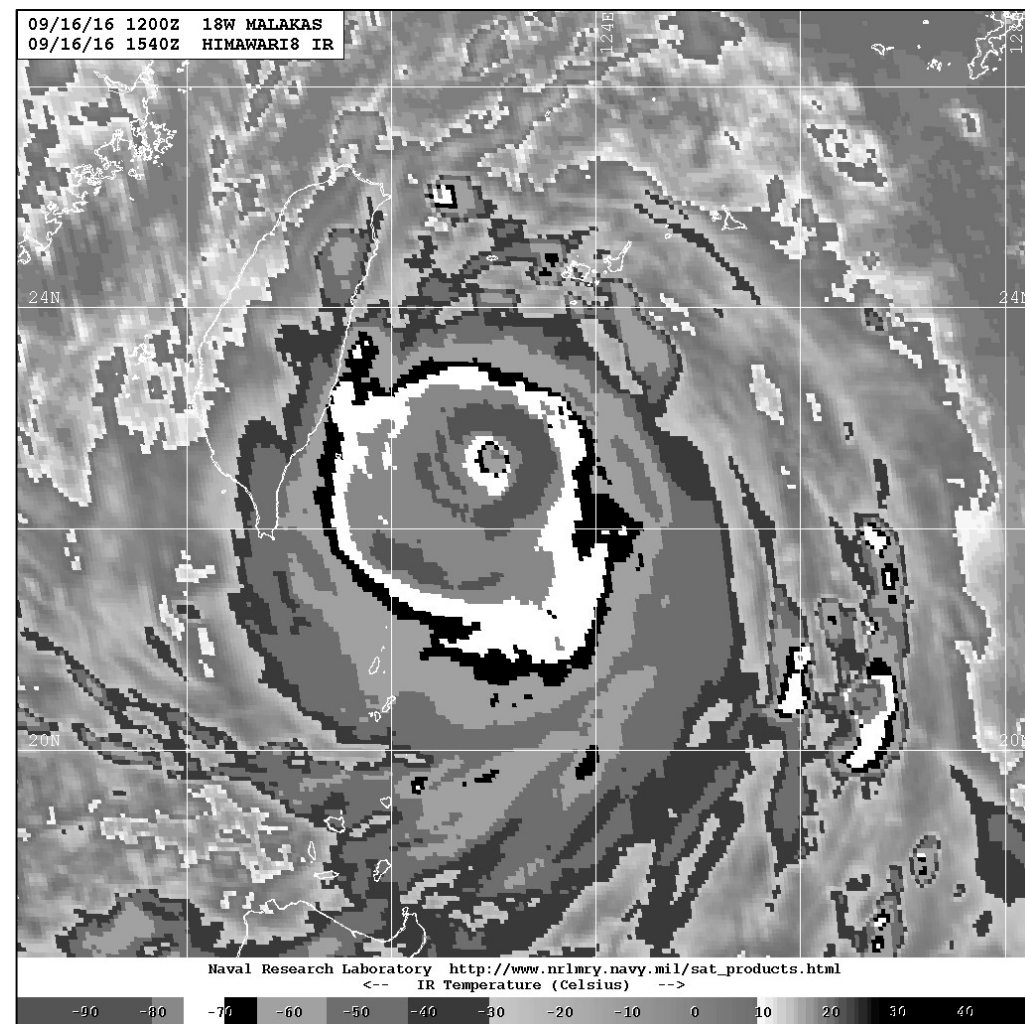
**Current GOES  
5-minute Capability**



**GOES-R  
5-minute Capability**

# GOES-16 Utility in Tropical Cyclone Analysis

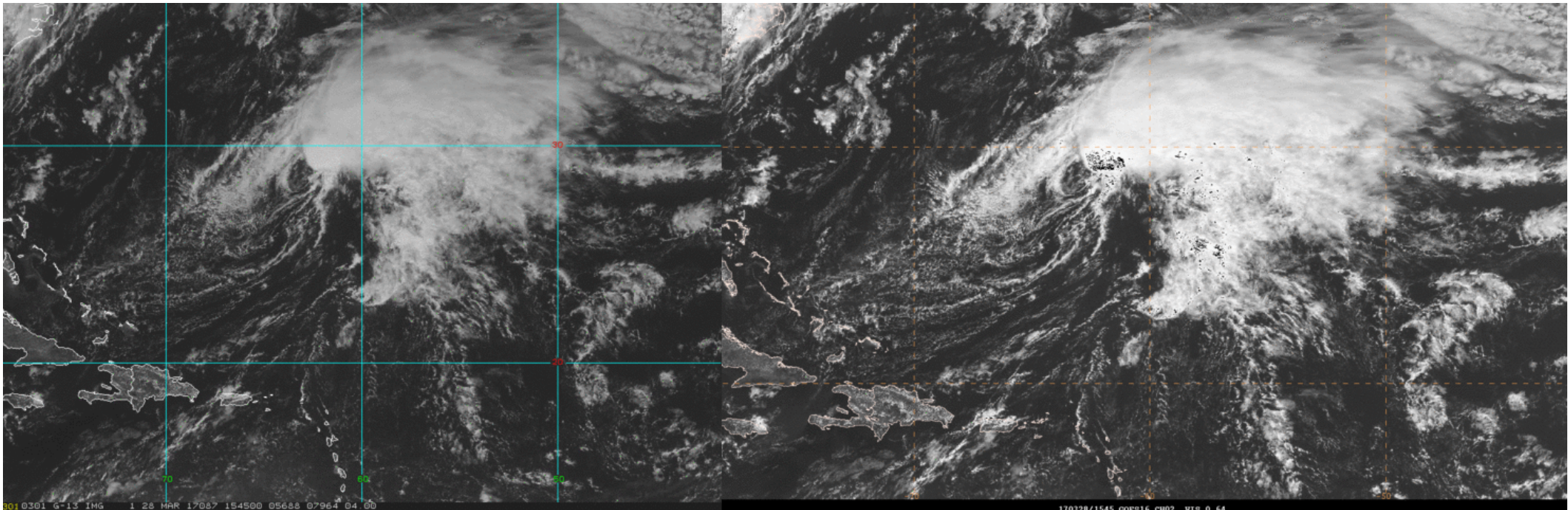
- Forecast process begins with analysis
  - **Cyclone location and initial motion**
  - **Intensity (maximum winds)**
  - Size (34, 50, and 64-kt wind radii)
- Geostationary satellite imagery critical in determining location and intensity through the Dvorak technique
  - Proper analysis critical to initializing model guidance and making a successful forecast
- Geostationary imagery and data also used to analyze the environment and other critical features
  - Imagery, cloud track winds, etc.



Himawari IR image of Typhoon Malakas  
1540 UTC 16 Sep 2016

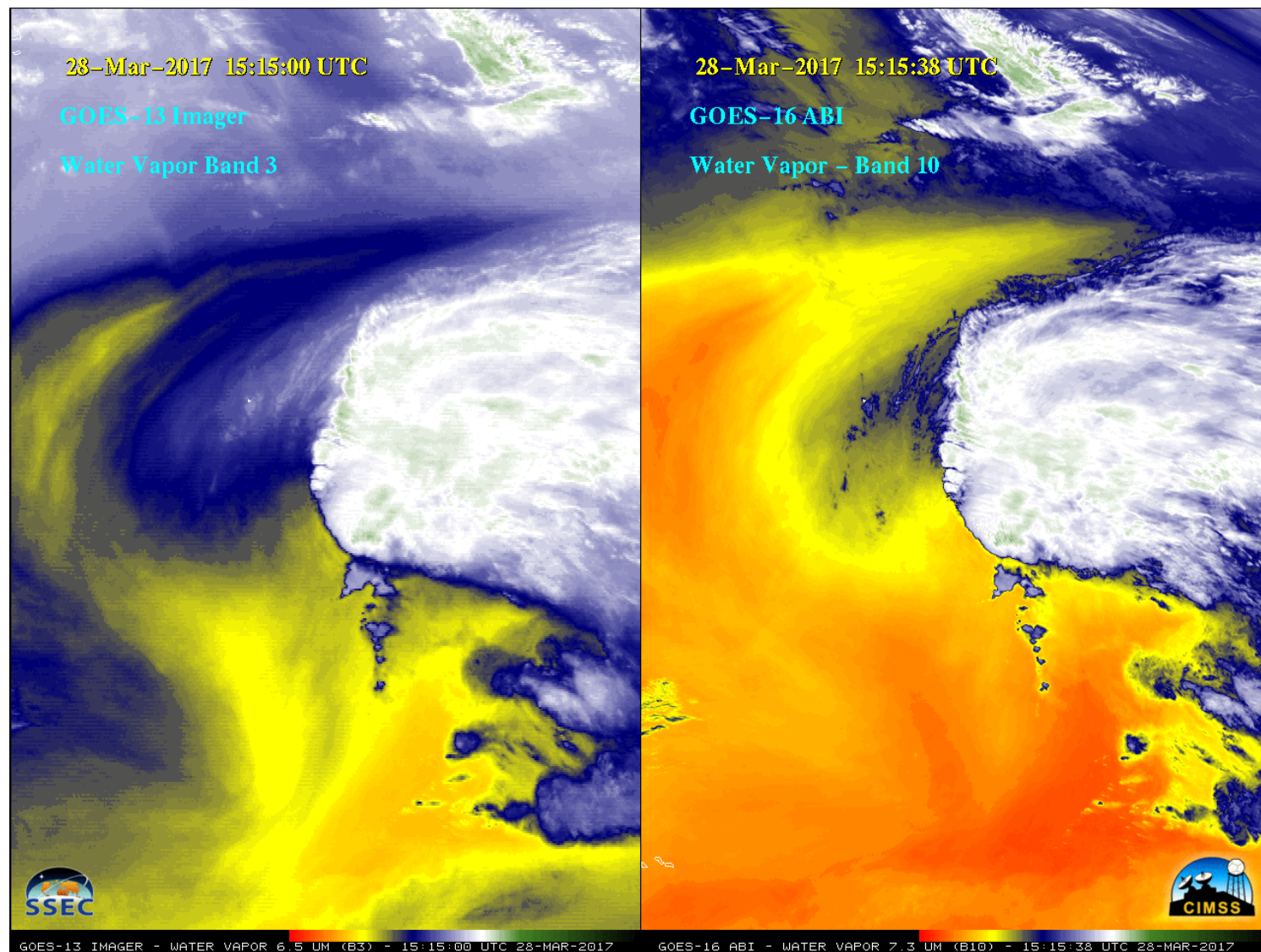
# Improvements over Current GOES

- More frequent imagery will help with analysis of center location and identification
- High frequency visible imagery will make it easier to identify and track the low-level center of developing systems in the low cloud lines
- May be especially useful at sunrise to quickly assess weak/developing systems



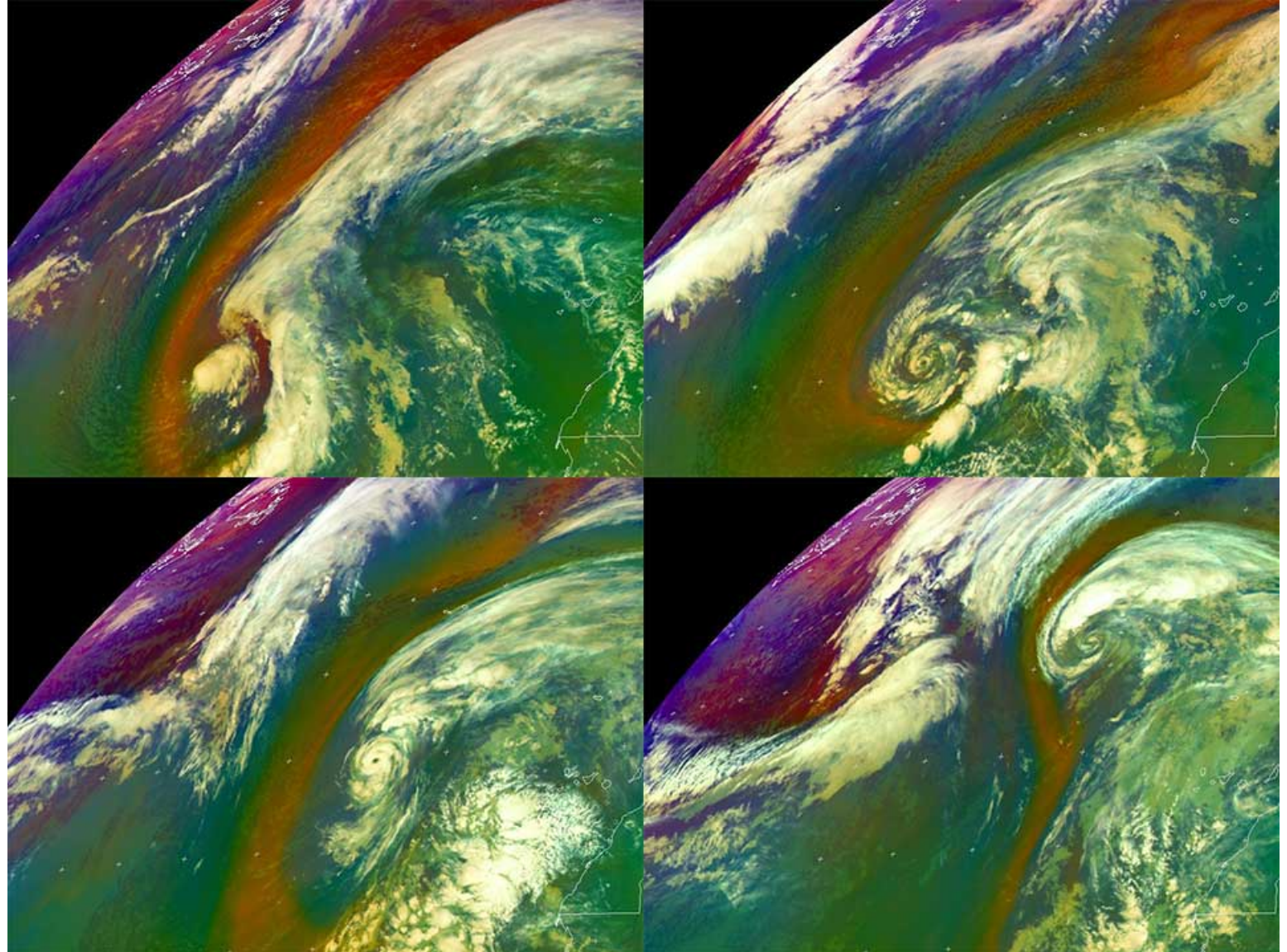
# Improvements over Current GOES

- Multiple water vapor channels with different weighting functions will allow assessment of atmospheric moisture through deeper layers of the troposphere
- GOES-16 7.3- $\mu\text{m}$  imagery on right shows mid-level moisture west of AL90 invest that wasn't seen in GOES-13 6.5- $\mu\text{m}$  imagery that is more sensitive at higher levels



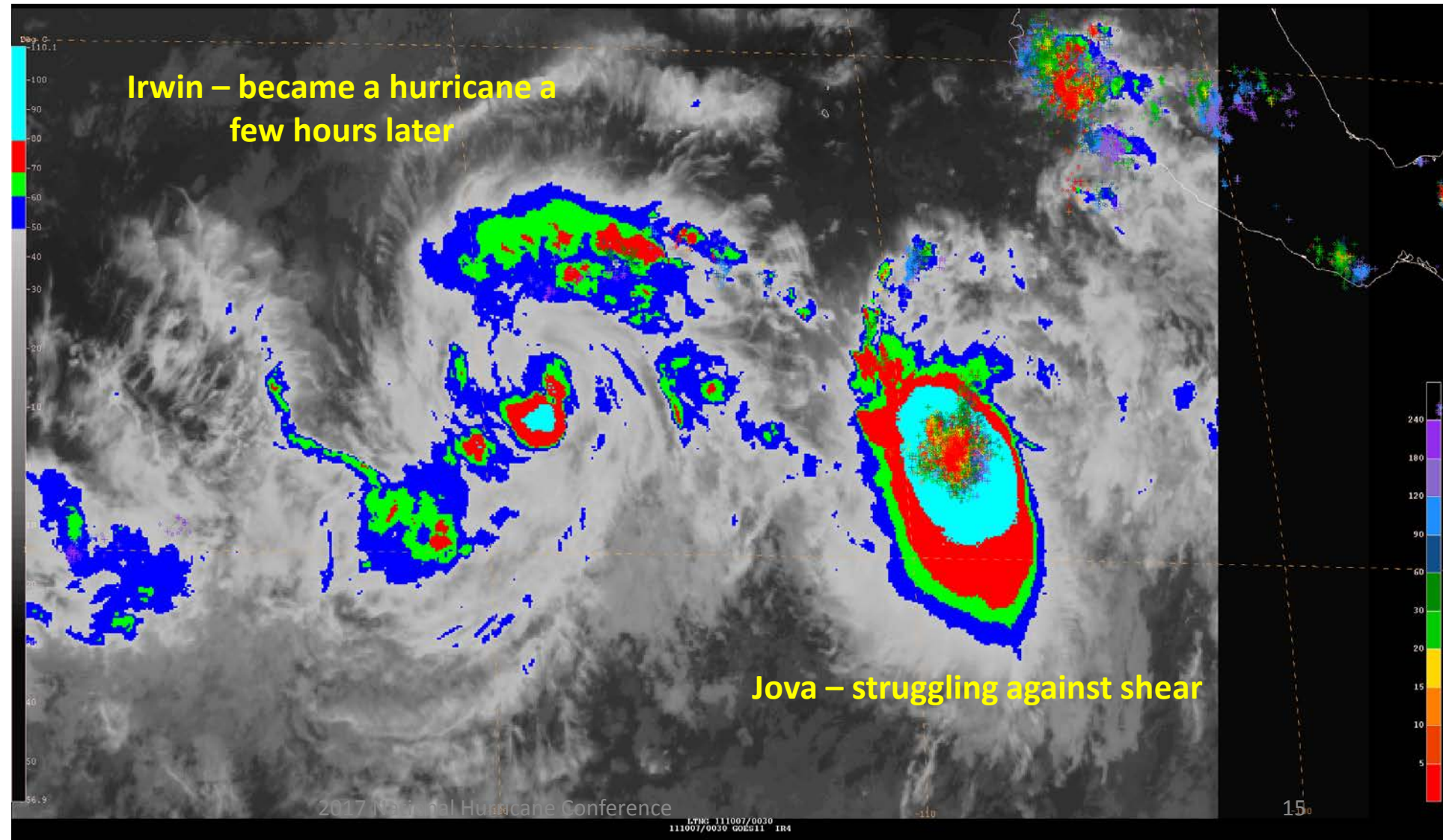
# RGB Airmass Images of Alex (2016)

- RGB Airmass Product combines imagery from 4 different channels (2 WV, 2 IR) to highlight different cloud heights and airmass differences, including tropopause folds
- Useful to monitor extratropical and tropical transition events



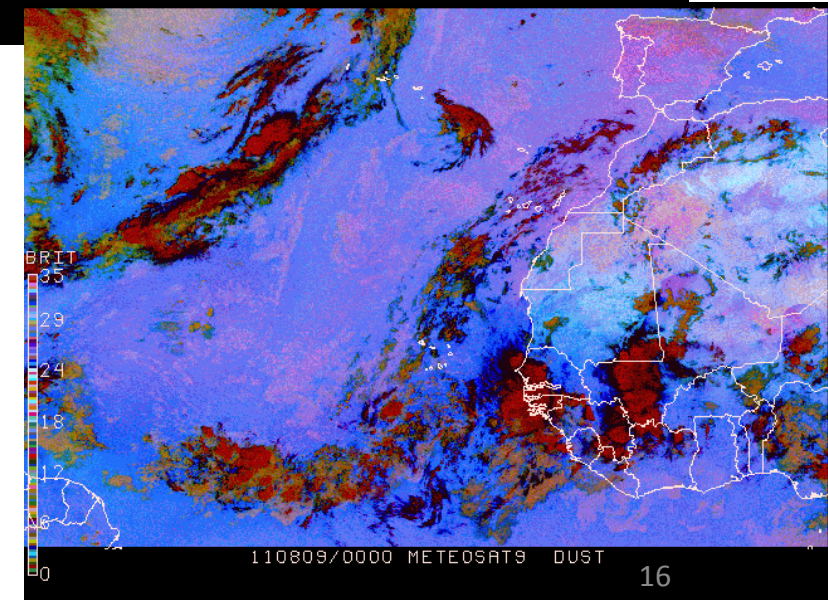
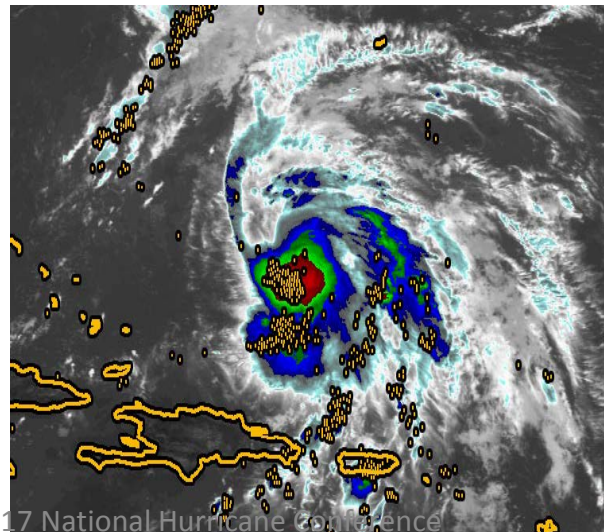
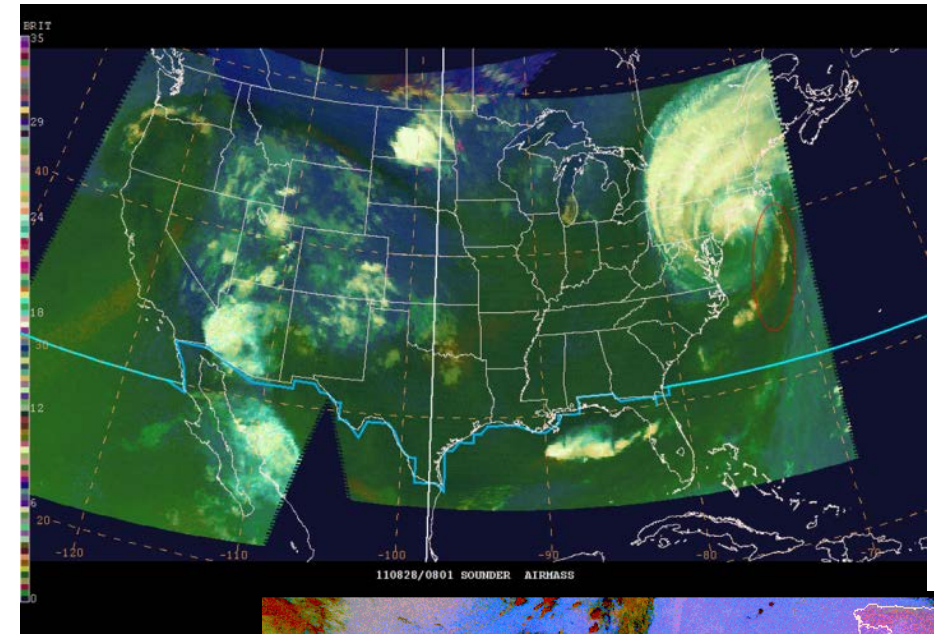
# An Example of Lightning in Eastern Pacific Tropical Cyclones

- GOES-16 lightning mapper will allow investigation of the relationship between lightning trends and TC intensity change
- Current research is mixed on the role that lightning plays in identifying intensity trends



# GOES-R Proving Ground

- NHC had several years of experience using proxy GOES-R products from METEOSAT and other sources
- Allowed forecasters to become familiar with GOES-R capabilities and new products, such as RGBs, and provide feedback to product developers





# Summary

- NHC forecasters will have access to GOES-16 imagery during the 2017 hurricane season
- Initially, GOES-16 will be located at 105°W, providing imagery over the western part of the Atlantic basin and the eastern part of the eastern Pacific basin
  - Will be moved to GOES East or GOES West by November
- NHC and other users will provide feedback to satellite product developers and document utility of new capabilities

