How to Access and Use Modern Geostationary Satellite Data for Flight Planning and Operations
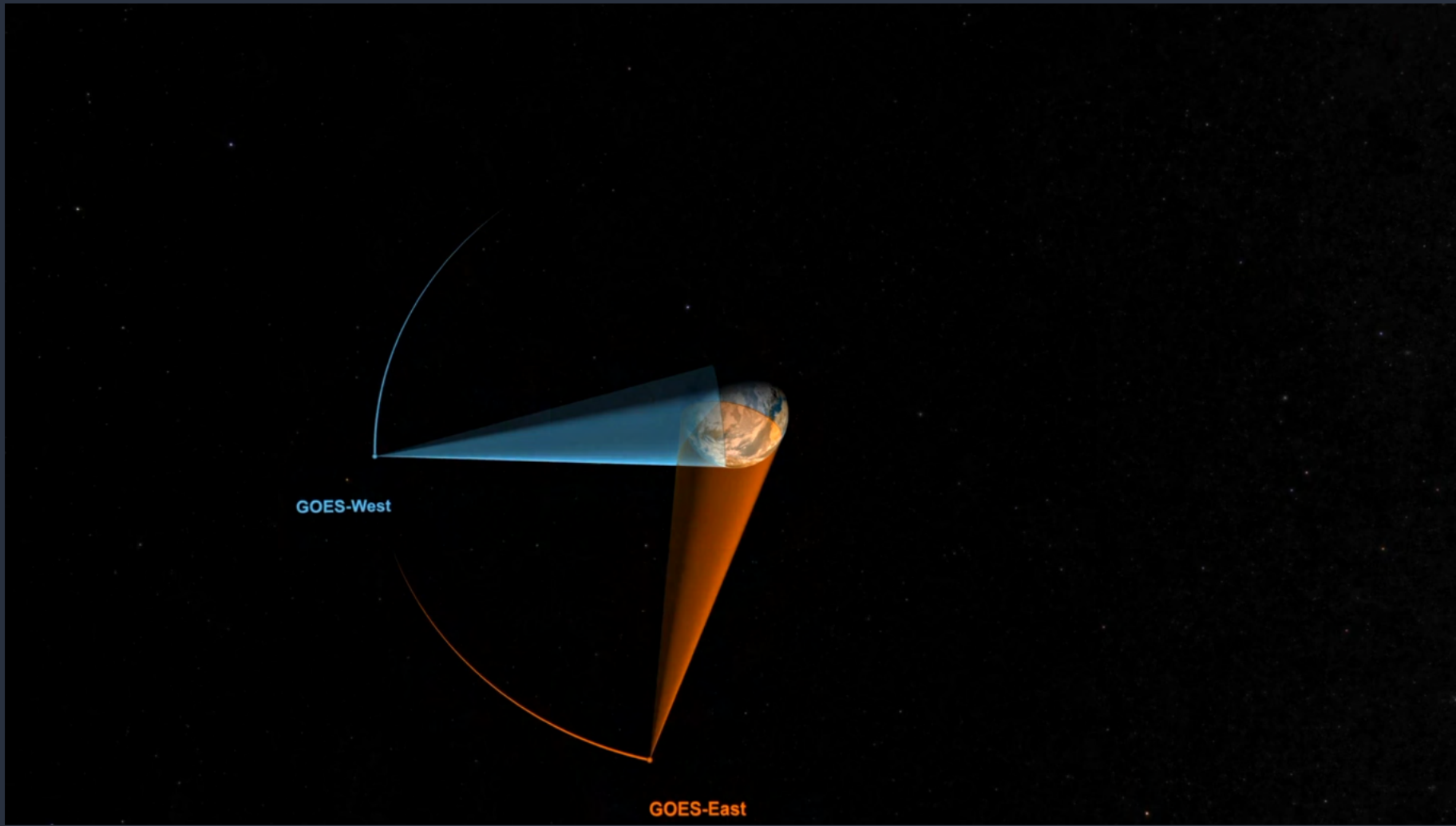
Dan Lindsey
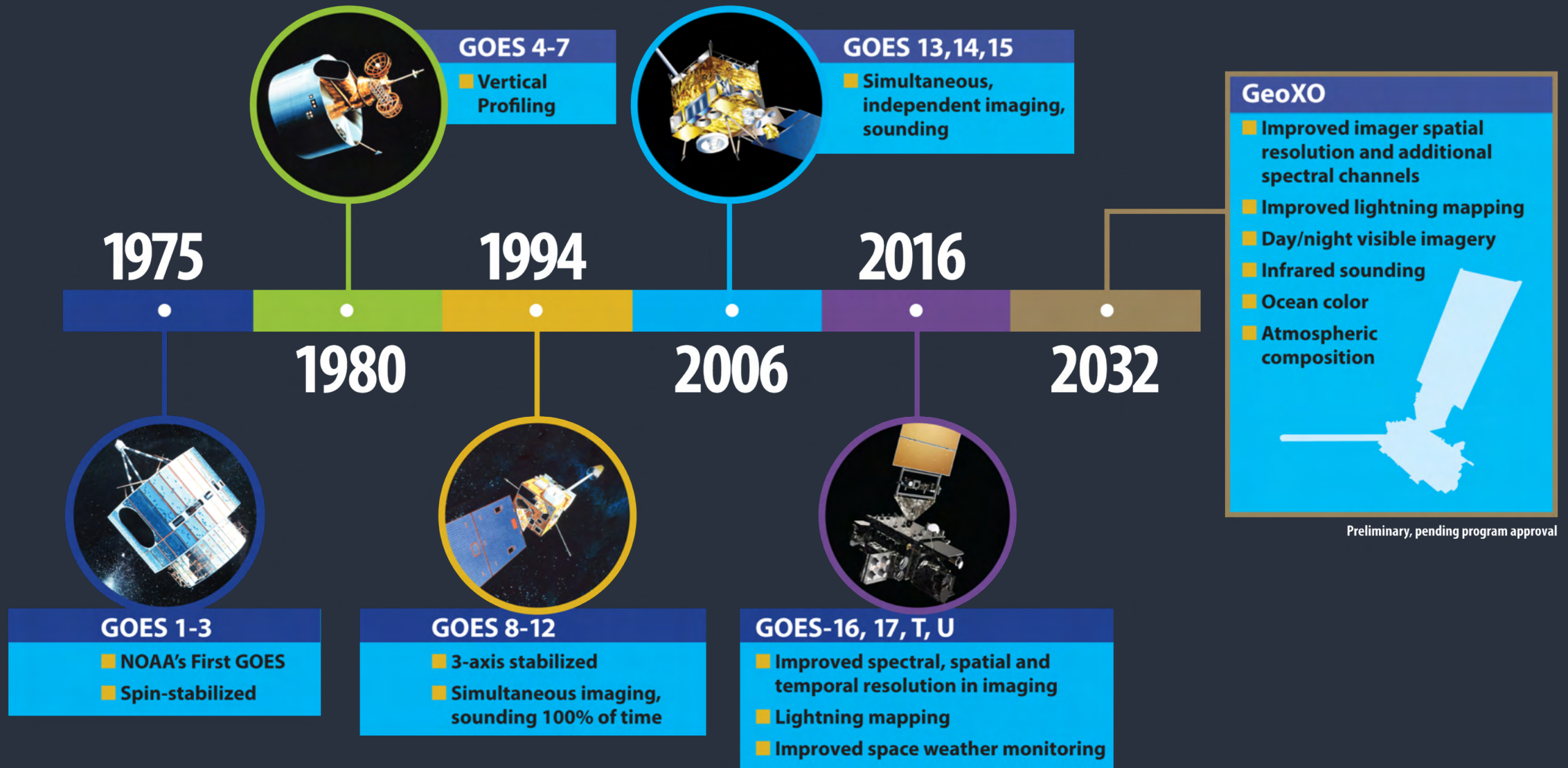**NOAA/NESDIS GOES-R Program Scientist**

Contributions from Tony Wimmers (CIMSS), Mike Pavolonis (NESDIS/STAR), and Yoo-Jeong Noh (CIRA)

NOAA
National Environmental Satellite, Data, and Information Service

GOES-East and GOES-West

History of Geostationary Operational Environmental Satellites

GOES 4-7
- Vertical Profiling

GOES 13,14,15
- Simultaneous, independent imaging, sounding

GeoXO
- Improved imager spatial resolution and additional spectral channels
- Improved lightning mapping
- Day/night visible imagery
- Infrared sounding
- Ocean color
- Atmospheric composition

1975 1980 1994 2006 2016 2032

GOES 1-3
- NOAA's First GOES
- Spin-stabilized

GOES 8-12
- 3-axis stabilized
- Simultaneous imaging, sounding 100% of time

GOES-16, 17, T, U
- Improved spectral, spatial and temporal resolution in imaging
- Lightning mapping
- Improved space weather monitoring

Preliminary, pending program approval

GOES-East (currently GOES-16)

- Launched in late 2016, operational as GOES-East since 18 December 2017

- Provides coverage of North and South America, the tropical and north Atlantic, and the east Pacific

- Its Advanced Baseline Imager (ABI) and Geostationary Lightning Mapper (GLM) provide guidance to forecasters

GOES-West (currently GOES-17)

- Launched in March 2018, operational as GOES-West since 12 February 2019

- Provides coverage of North America, Alaska, Hawaii, and much of the Pacific Ocean

- Its ABI has a problem with the cooling system, resulting in degraded and missing IR channels are certain times of the night; varies seasonally

- Will be replaced next year with GOES-18
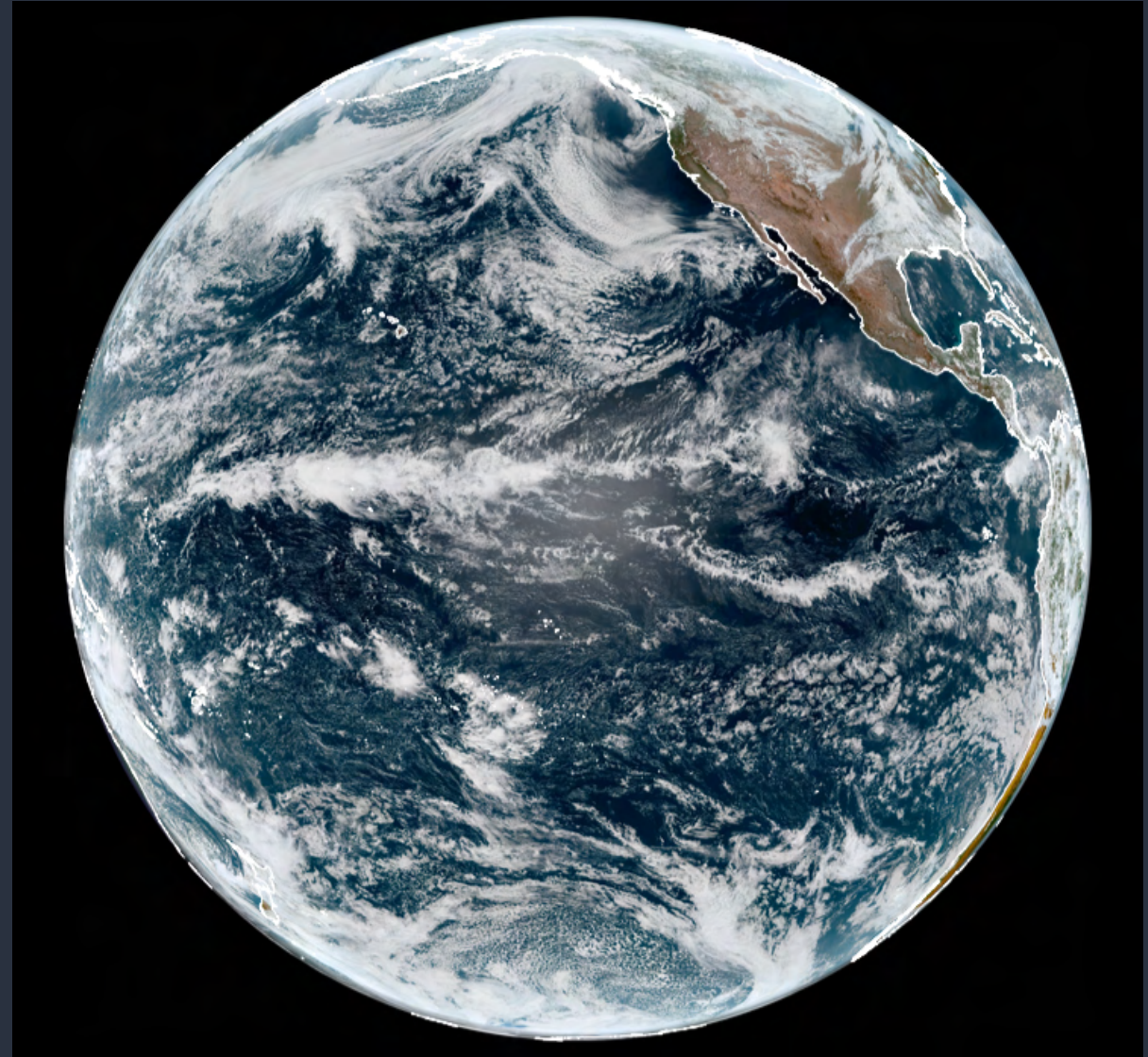
Most Useful Satellite Tools

Visible Imagery

- Satellite measures reflected light from the sun, so it's available in the *daytime only*

- Use GOES-16/17 Band/Channel 2, sometimes called the "red" channel, or 0.64 µm

- Spatial resolution is 500 m

- Ideal for analyzing clouds and their evolution
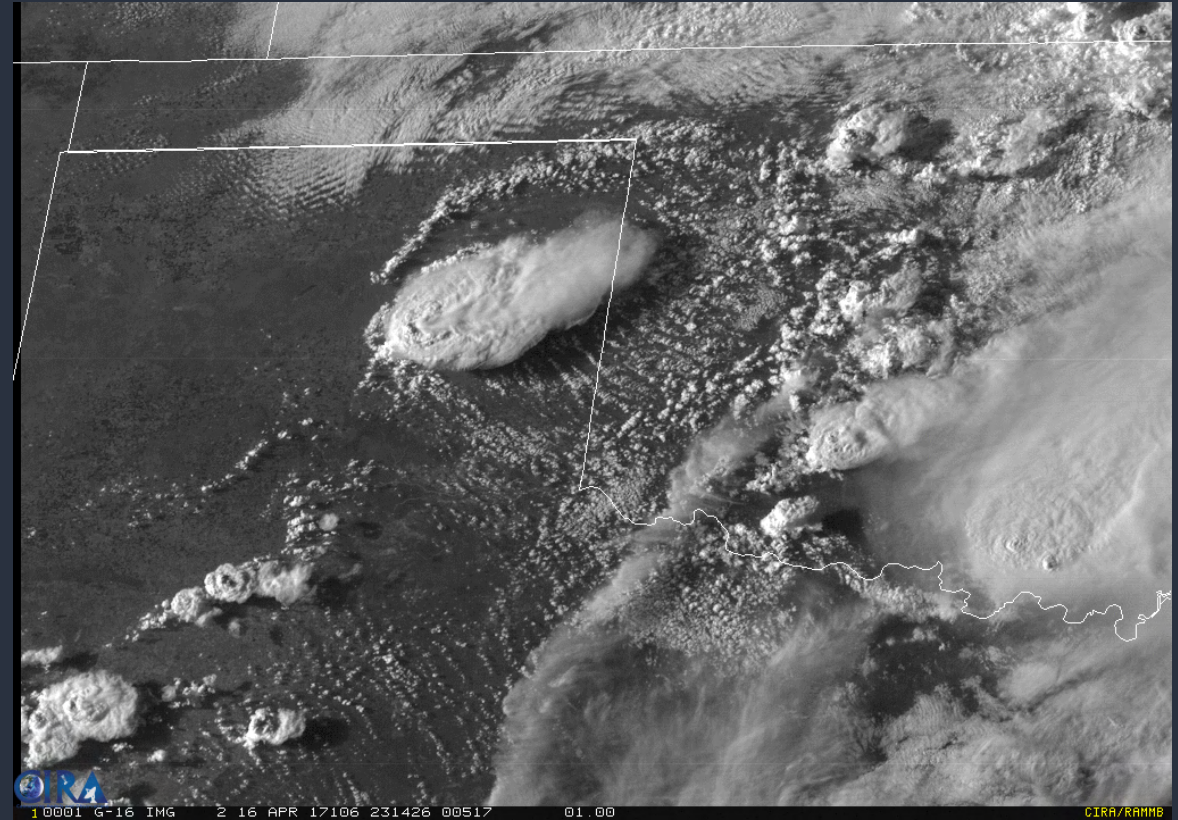
GOES-16 ABI visible imagery in a 1-min Mesoscale sector over north Texas from 16 April 2017

Most Useful Satellite Tools

Infrared Imagery

- Satellite measures emitted energy from clouds and the Earth's surface, so is available 24 hours a day

- Use GOES-16/17 Band/Channel 13 Infrared (IR), sometimes called the "clean window" channel

- Spatial resolution is 2 km

- Ideal for monitoring clouds, especially at night
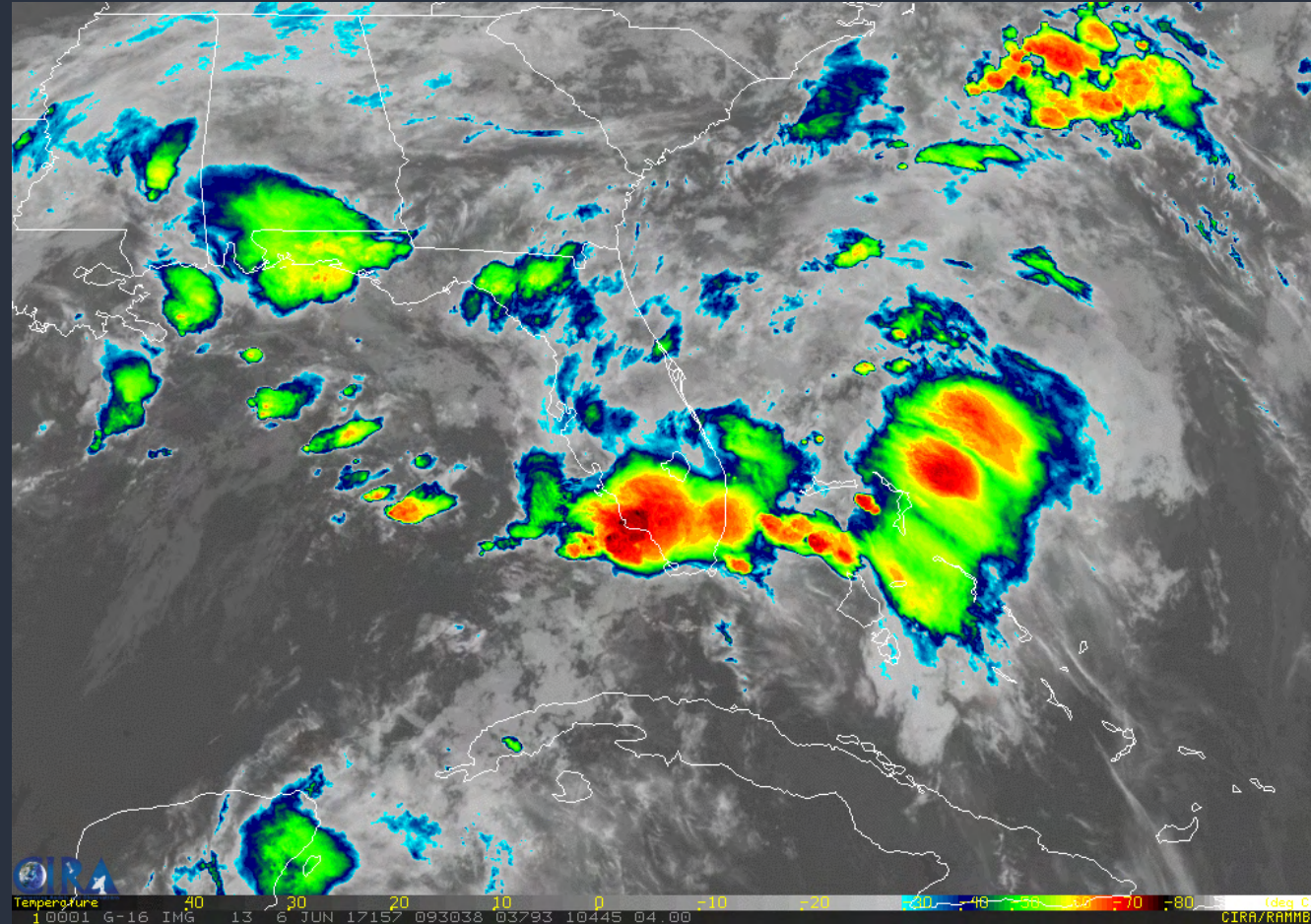
GOES-16 ABI Band 13 IR imagery from 6 June 2017

Most Useful Satellite Tools

GeoColor

- Approximates true color, or what the eye would see from space, during the daytime

- Also has a nighttime IR component where low clouds are colored blue

- Spatial resolution is 1 km (day), 2 km (night)

- Ideal for monitoring smoke and blowing dust in the day, and clouds at night
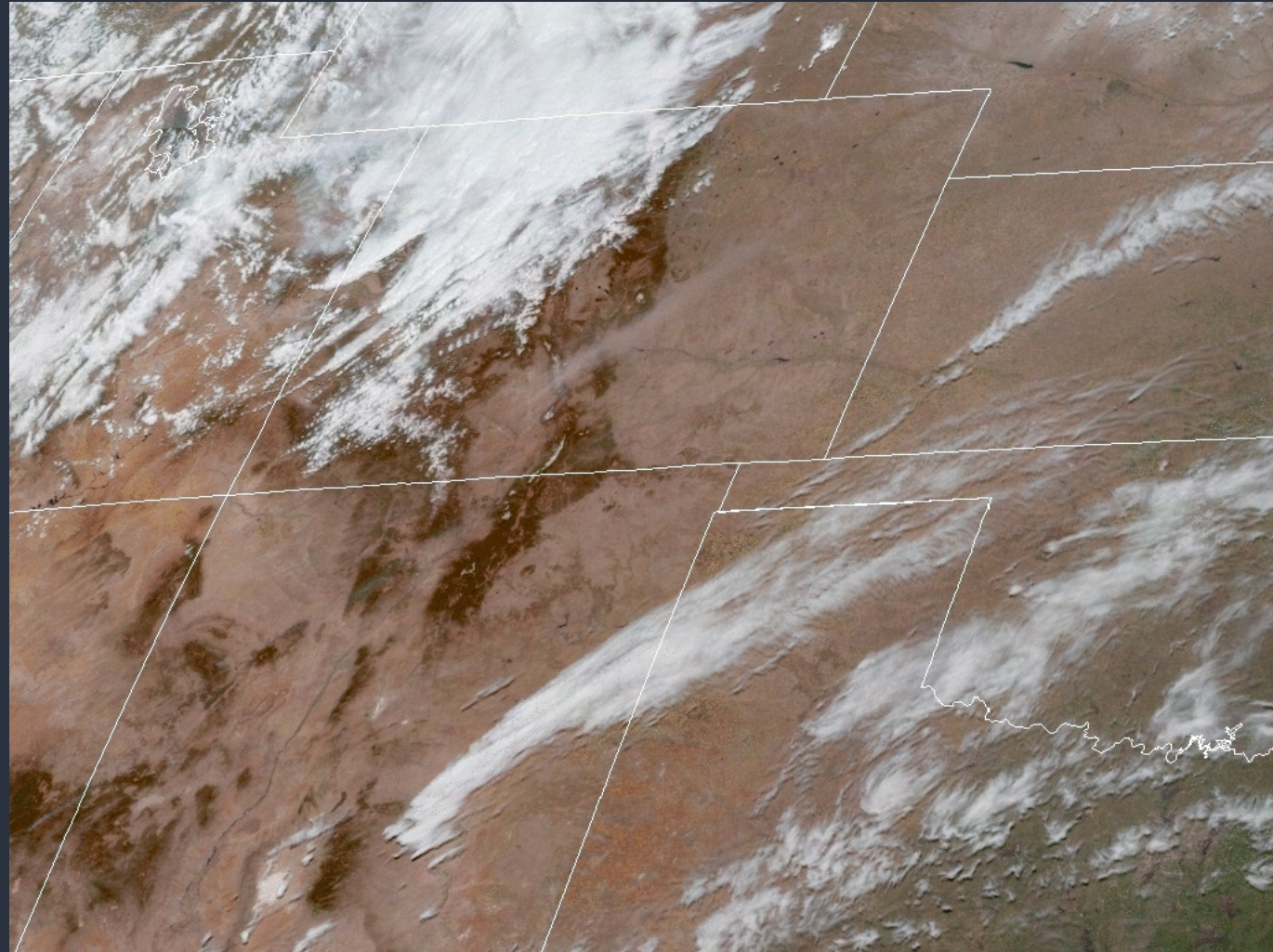
GOES-16 GeoColor imagery from 17 April 2018

Most Useful Satellite Tools

GeoColor

- Approximates true color, or what the eye would see from space, during the daytime

- Also has a nighttime IR component where low clouds are colored blue

- Spatial resolution is 1 km (day), 2 km (night)

- Ideal for monitoring smoke and blowing dust in the day, and clouds at night

- City lights a static background to help with geo-referencing

2020/01/14 20:01:16 UTC
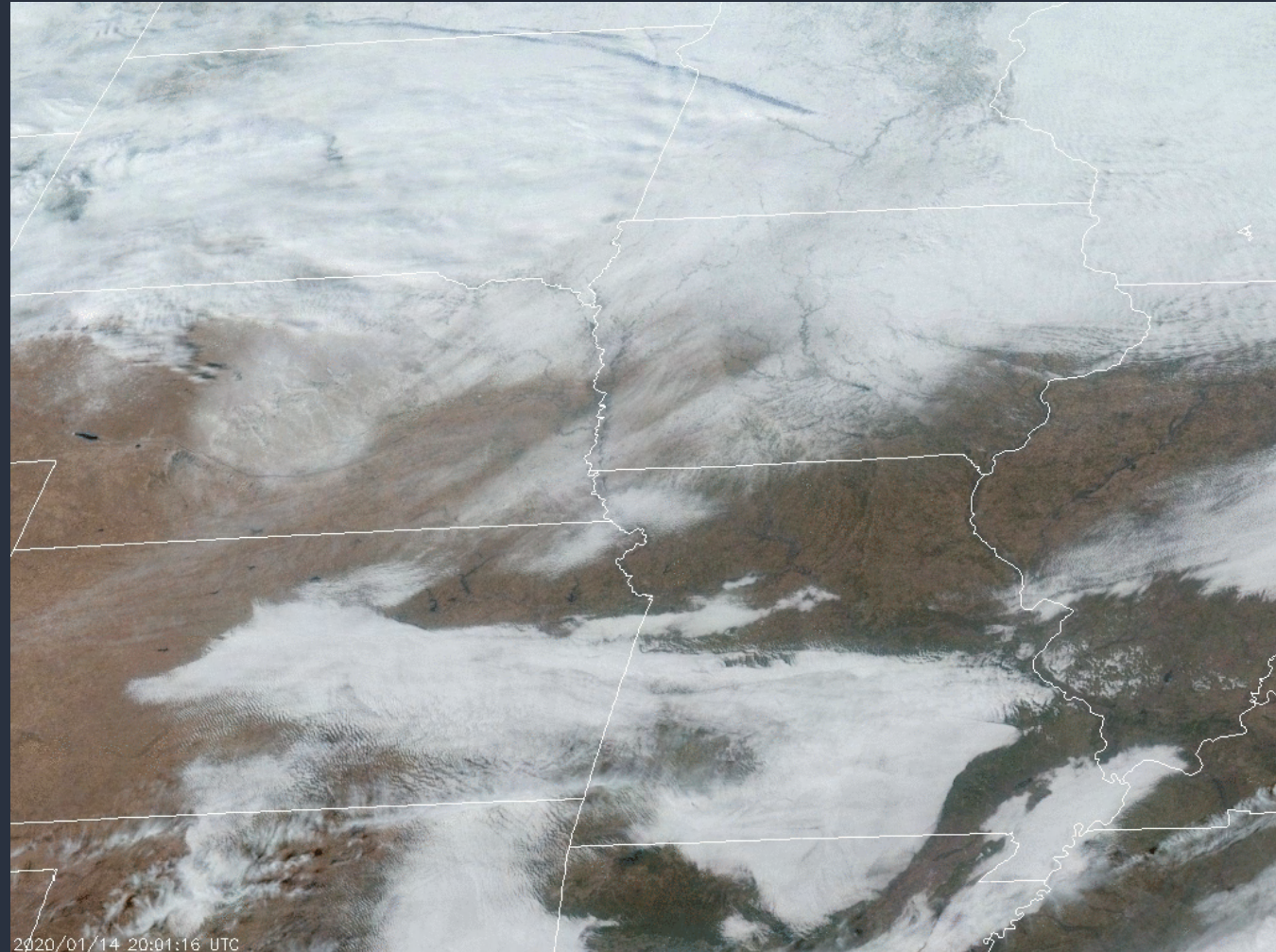
GOES-16 GeoColor imagery from 14 January 2020

Most Useful Satellite Tools

Nighttime Microphysics RGB

- Another good tool for monitoring low clouds at night

- Low clouds (stratus and fog) show appear a yellow'ish color, as in the example on the right

- Only available at night (as its name suggests)
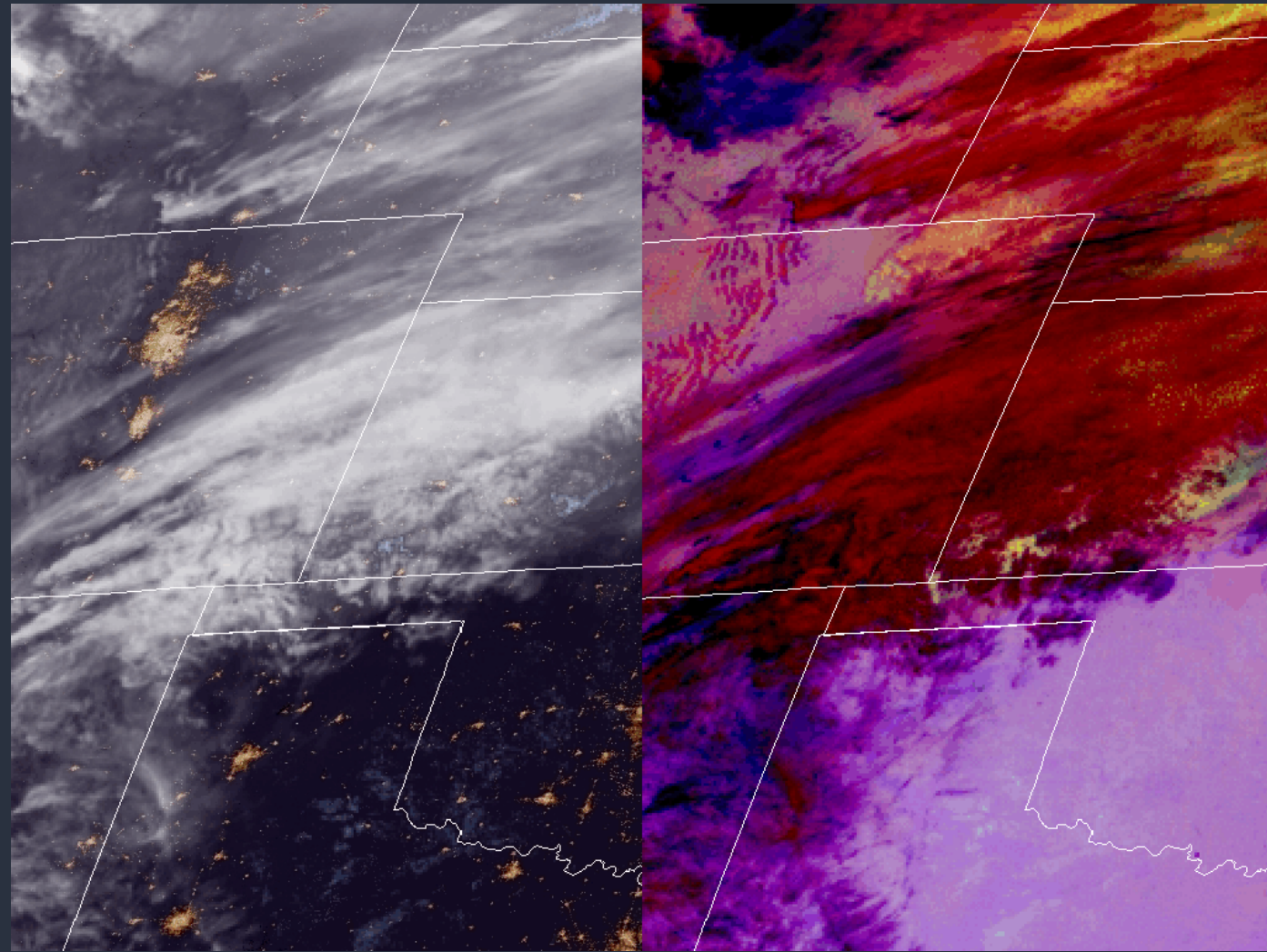
GOES-16 GeoColor + Nighttime Microphysics RGB

GOES-R Satellite Aviation Applications

1) Low cloud/fog monitoring (visibility and icing)

2) Volcanic ash detection and tracking

3) Thunderstorm monitoring

4) Turbulence detection

5) Three-dimensional distribution of clouds

Two types of GOES-R products

- Imagery, requiring qualitative analysis by an expert
- Quantitative products, or algorithms designed to provide value-added information to the user

Low Cloud Monitoring – 13 July 2017 – SF Bay Area

- 500 m visible band provides very good spatial resolution for monitoring low clouds and stratus

- 5 min imagery over CONUS (this example) and 1 min imagery in Meso sectors also means the latency is very low

- Here, forecasters in SFO may be able to use this imagery to anticipate stratus dissipation
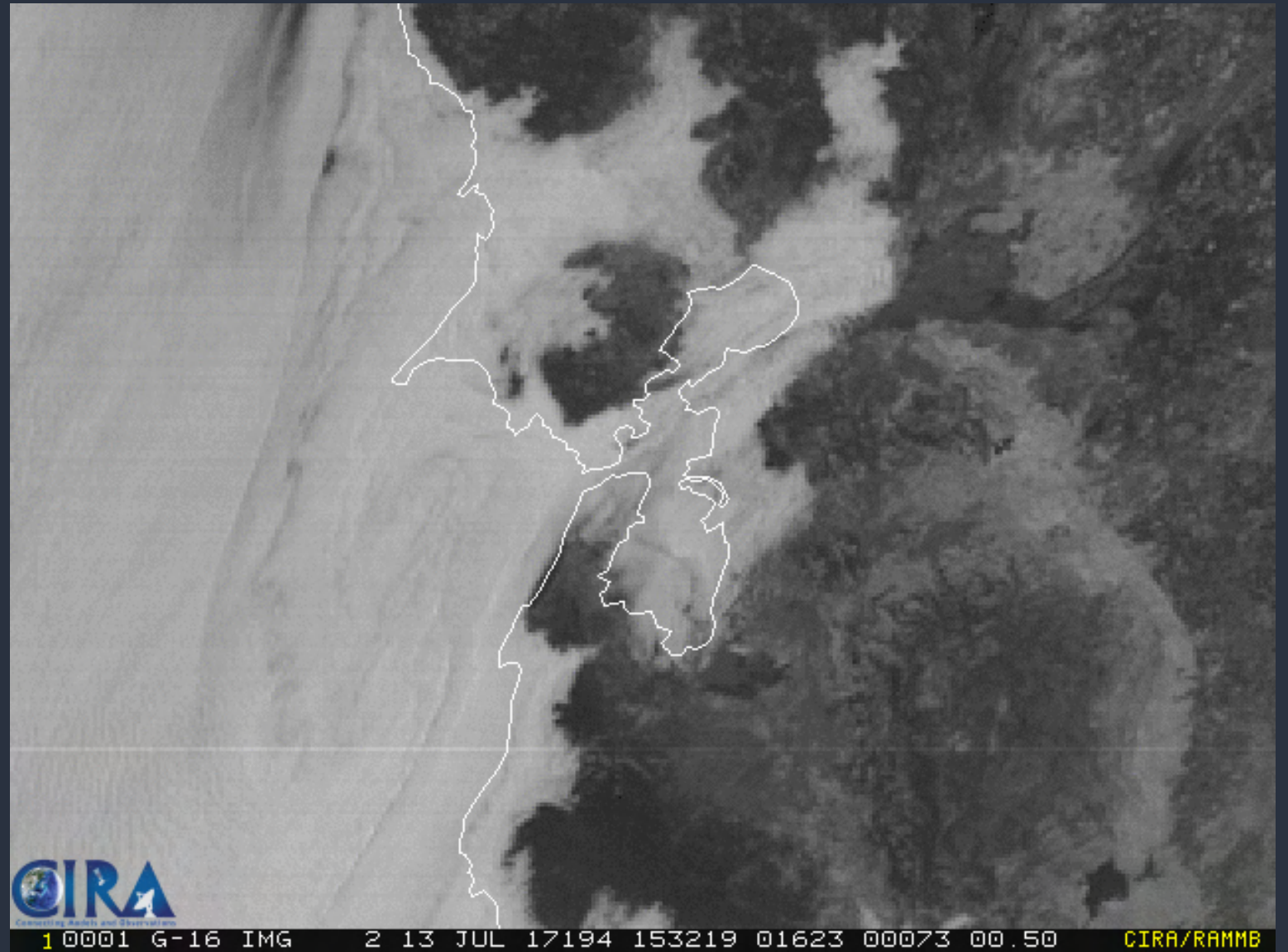
- ABI/AHI provide many tools for monitoring volcanic ash

- This GeoColor example from Himawari shows the brown ash emerging over low clouds during the day

2 0002 HIMAWARI-8 2 21 JUN 19172 190000 01865 12455 01.00

- The Ash RGB uses IR bands, so is available 24/7

- Ash appears red/pink and sulfur dioxide (SO2) has a greenish tint

- This example also picks up on aircraft contrails
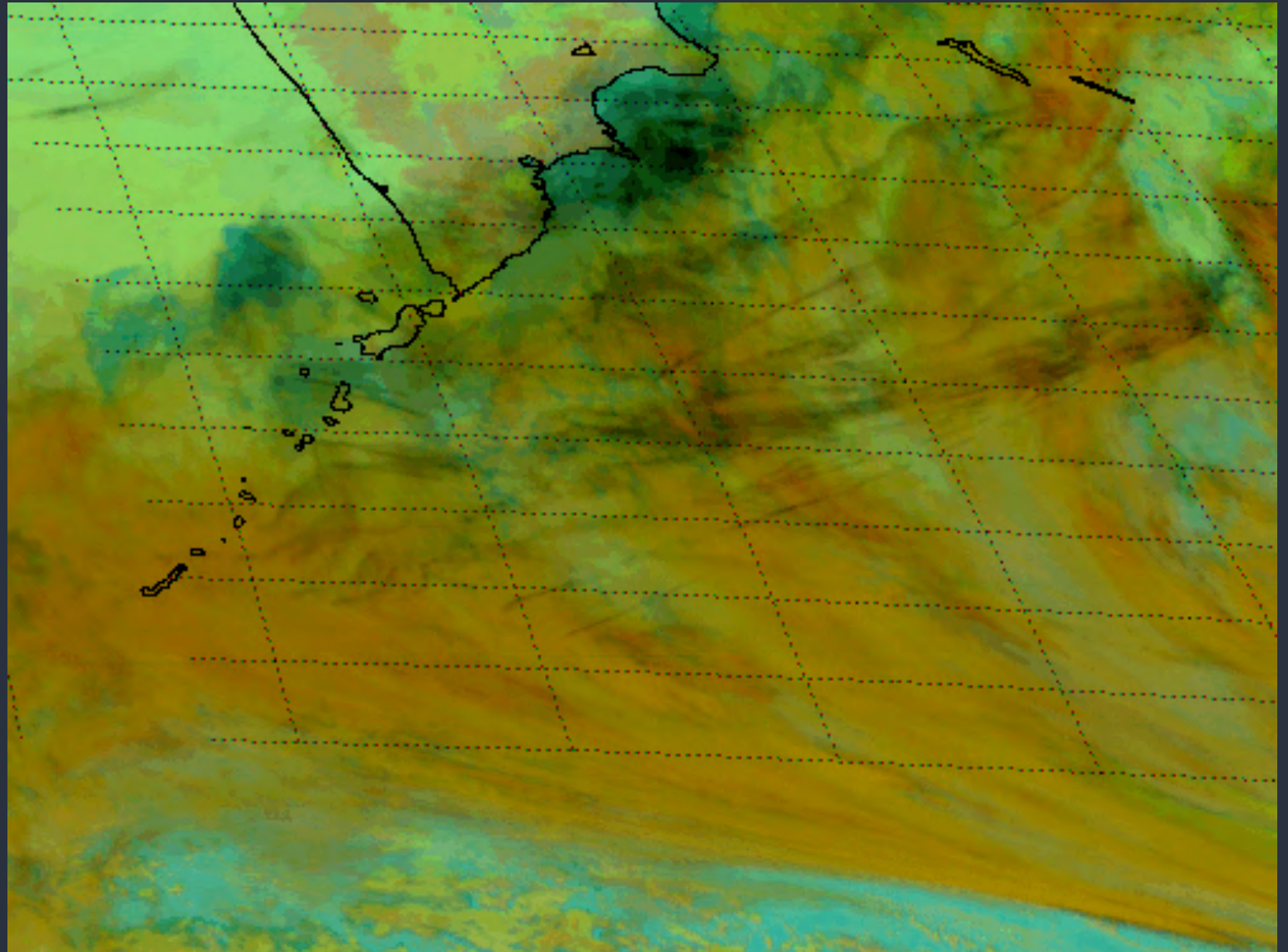
Raikoke Plume over the Aleutians – June 2019 - GOES-17 SO2 RGB

- In this SO2 RGB, SO2 and sulfate aerosols appear orange or yellow
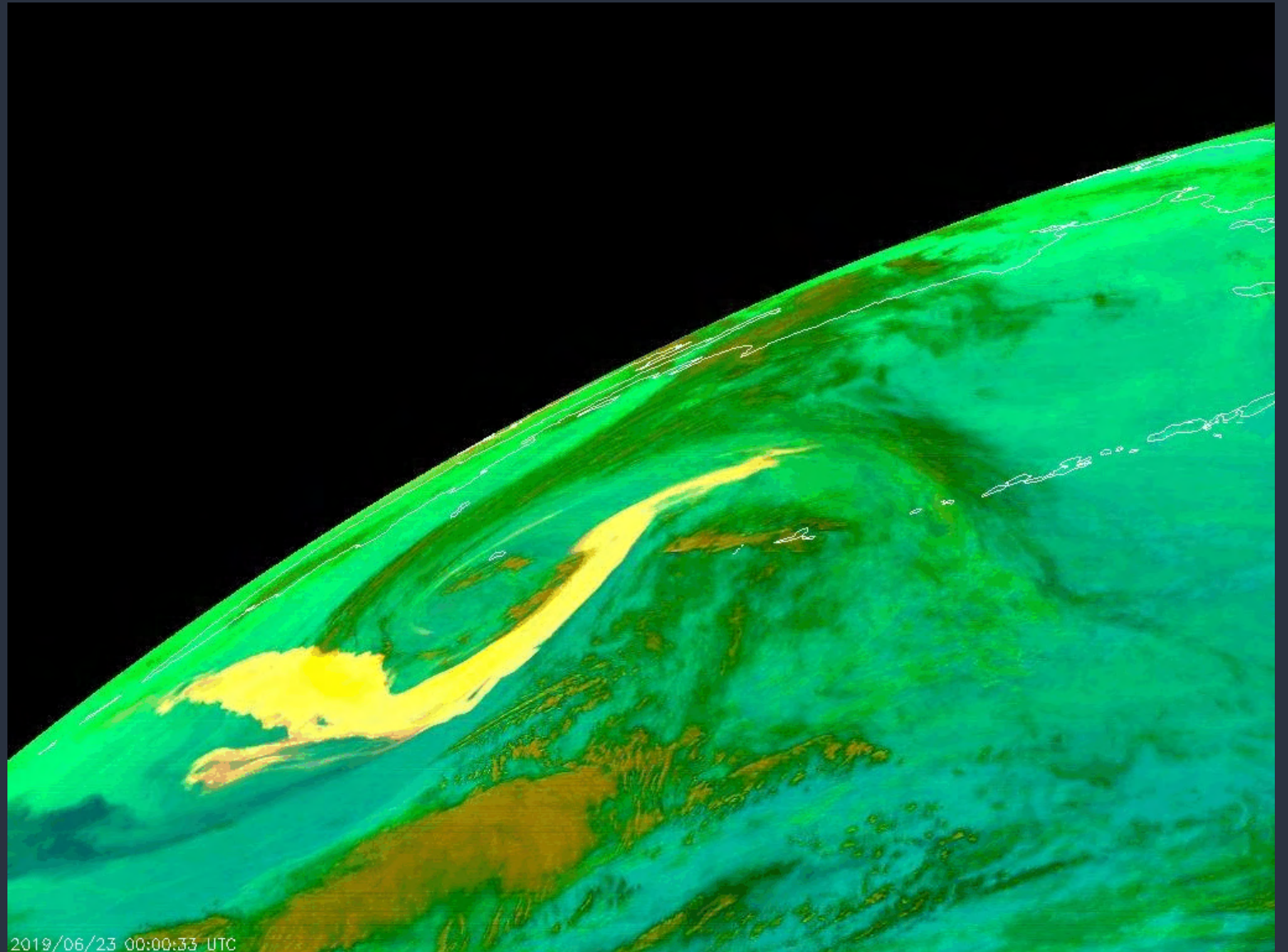
2019/06/23 00:00:33 UTC

The VOLcanic Cloud Analysis Toolkit (VOLCAT)

Thermal Monitoring

Eruption Alerts
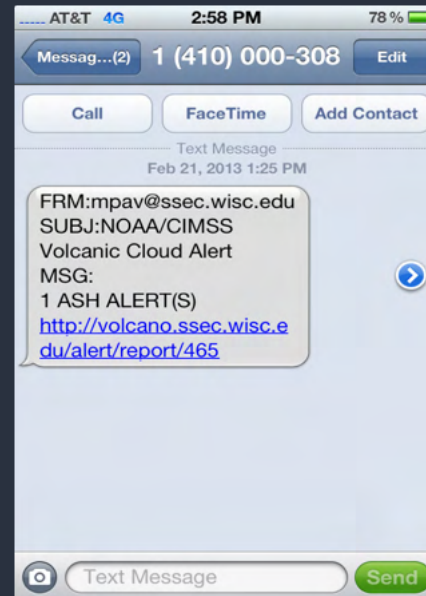
Volcanic Cloud Tracking
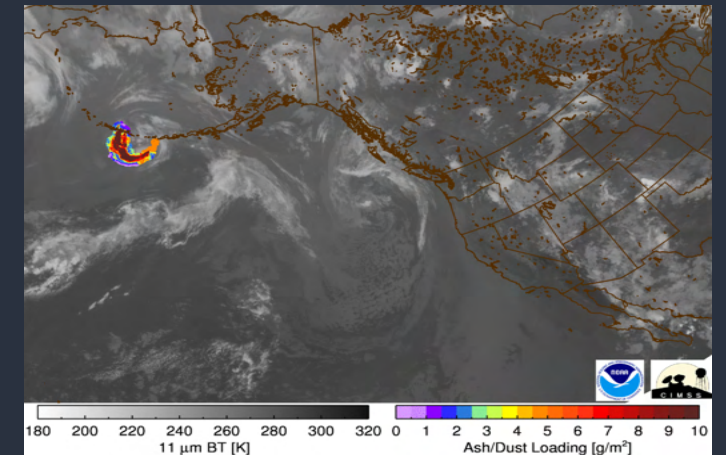
Volcanic Cloud Characterization
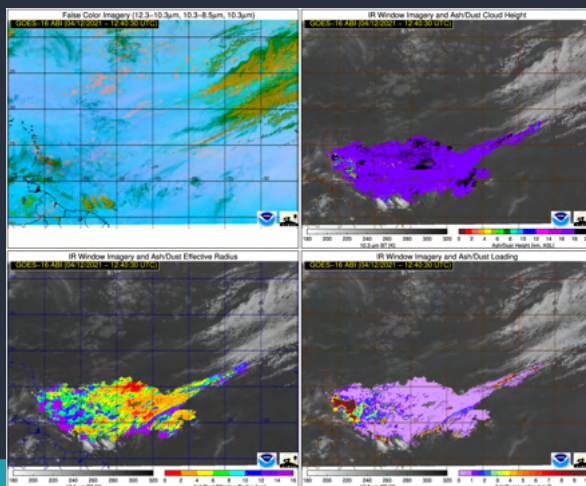
- VOLCAT was developed by Mike Pavolonis (NESDIS/STAR) and operated by UW-CIMSS

Dispersion & Transport Forecasting
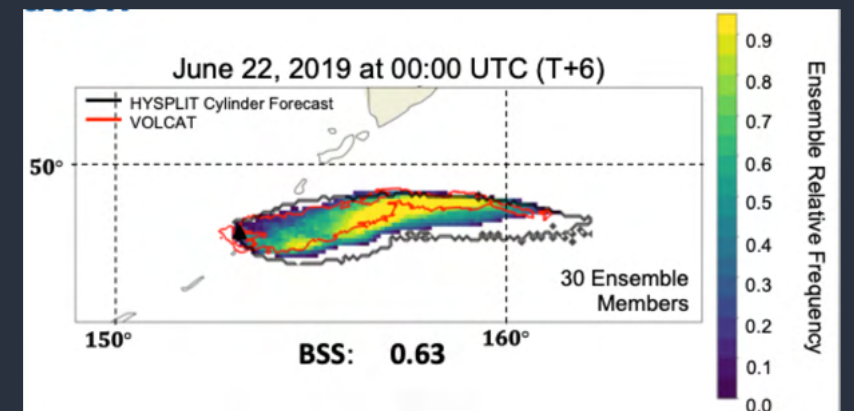
Operational Applications

VOLCAT Event Dashboard

Example Volcanic Ash Advisory from the Washington VAAC

VOLCAT Alert Report

```
FVXX25 KNES 092346
VA ADVISORY
DTG: 20210409/2346Z

VAAC: WASHINGTON

VOLCANO: SOUFRIERE ST VINCENT 360150
PSN: N1319 W06110

AREA: W_INDIES

SUMMIT ELEV: 3865 FT (1178 M)

ADVISORY NR: 2021/007

INFO SOURCE: GOES-16. NWP MODELS. ASH3D. VOLCAT.
RADIOSONDE. SOCIAL MEDIA.

ERUPTION DETAILS: CONT EXPLOSIVE ERUPTION

OBS VA DTG: 09/2320Z

OBS VA CLD: SFC/FL220 N1326 W05820 – N1215 W05842
– N1226 W05946 – N1301 W06100 – N1315 W06104 –
N1314 W06106 – N1304 W06043 – N1326 W05937 –
N1326 W05820 MOV SE 30KT SFC/FL420 N1459 W05807 –
N1329 W05826 – N1329 W05936 – N1323 W05953 –
N1407 W06026 – N1407 W06026 – N1456 W05947 –
N1459 W05807 MOV E 35KT SFC/FL500 N1408 W06026 –
N1323 W05952 – N1307 W06044 – N1316 W06109 –
N1323 W06111 – N1408 W06026 MOV E 40KT
```
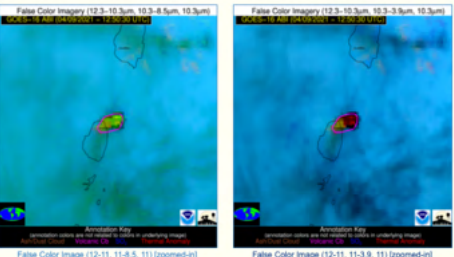
Thunderstorm Monitoring – 10 Oct. 2021 – TX/OK

- There are many ways to monitor convection with GOES-16/17 ABI and GLM

- Overlaying GLM fields provides added value to pinpoint which clouds are producing lightning

- This example is GeoColor with GLM Group Energy Density overlaid

10-10-2021 22:32:55 UTC
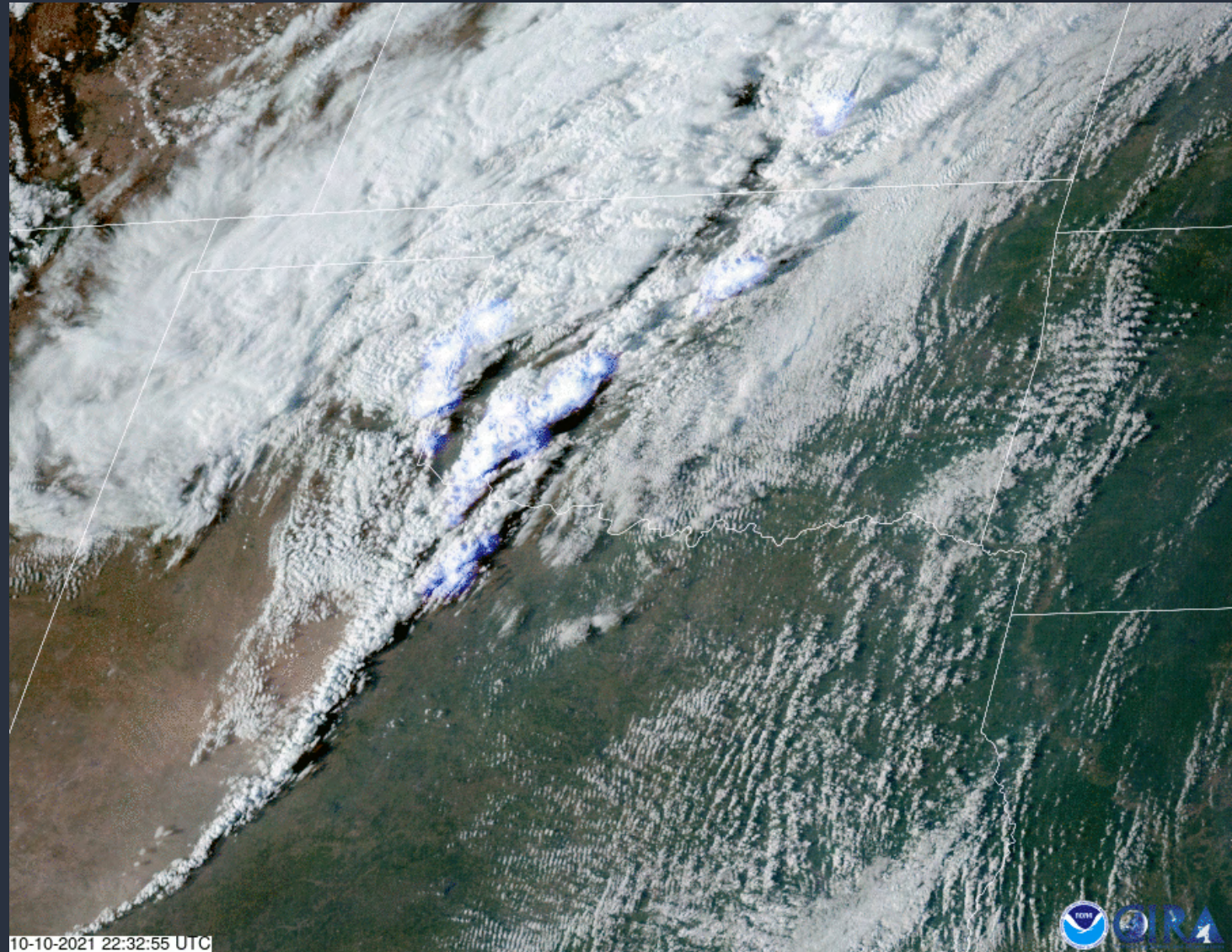
Automated turbulence detection – Tony Wimmers (CIMSS)

GOES–16 MOG Probability from 36–37 kft: Imagery from 20211005 at 1430 UTC

https://cimss.ssec.wisc.edu/turbulence/
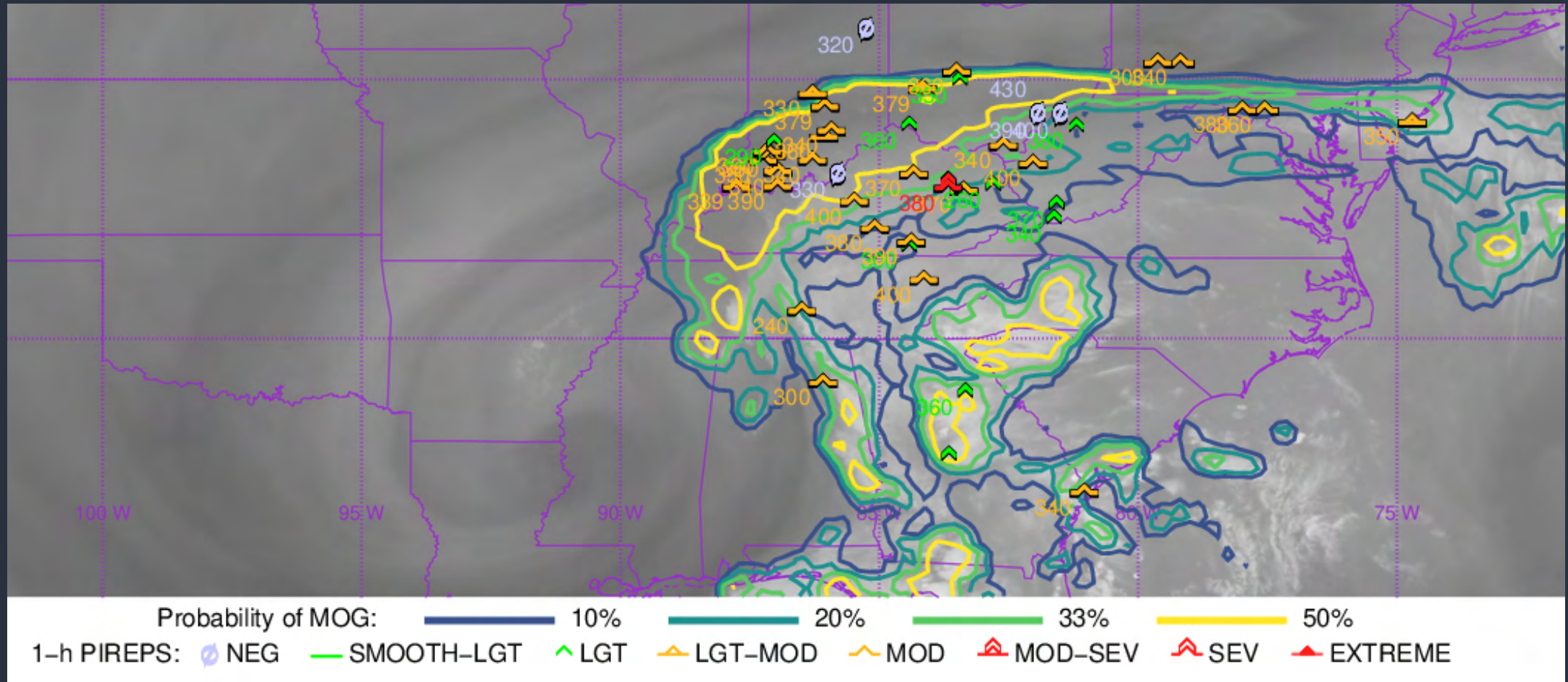
Cloud Vertical Cross Sections – Yoo-Jeong Noh (CIRA)
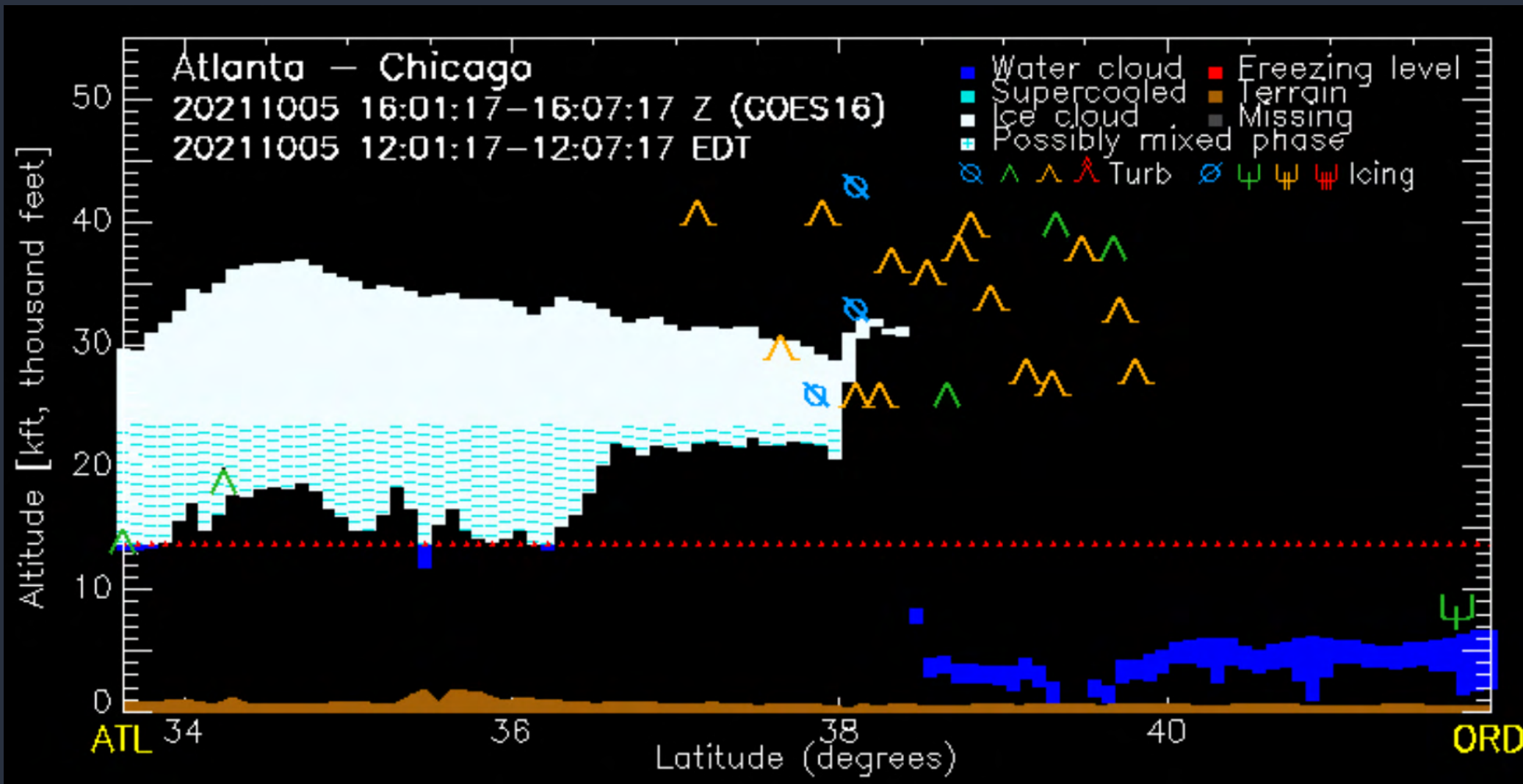
https://rammb.cira.colostate.edu/ramsdis/online/npp_viirs_conus_aviation.asp

Resources on the Web

- GOES-16/17 ABI imagery and products: https://rammb-slider.cira.colostate.edu/

- Another imagery viewer that may load more quickly: https://www.star.nesdis.noaa.gov/goes/index.php

- VOLCAT (Volcano Monitoring) from CIMSS: https://volcano.ssec.wisc.edu/

- CIMSS Automated Turbulence detection page: https://cimss.ssec.wisc.edu/turbulence/

- CIRA Cloud Vertical Cross Section page: https://rammb.cira.colostate.edu/ramsdis/online/npp_viirs_conus_aviation.asp

Real-time Demo

Use web connection to demo some online satellite resources