How Analytics Will Inform Future Weather Satellite Capabilities to Best Serve the NWS

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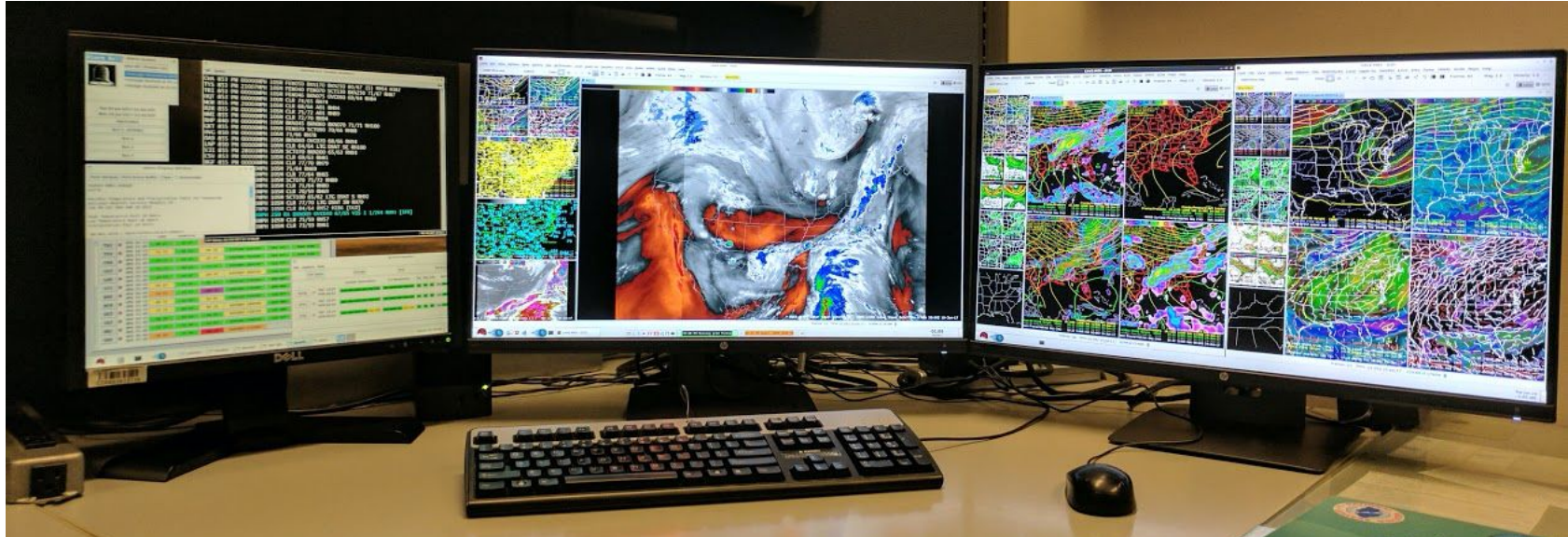*Aerospace Corp., Silver Spring, MD*

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Presentation for
AMS Collective Madison Meeting and
NOAA Satellite Conference, August 2022

Following the Observations

What is the most popular type of satellite imagery?

New analytics are providing the National Weather Service with a complete quantitative assessment of which observational data is reaching the eyes of meteorologists.

Above: An ever-increasing amount of observational data is reaching meteorologists in native form, derived science products, or through assimilation into numerical models.

Advanced Weather Interactive Processing System (AWIPS)

- Users can open multiple instances of AWIPS and each AWIPS has multiple panes
- Products loaded may be in the background (behind other products) or toggled off

Methodology: Single Forecast Office Analysis

Selected two weather forecast offices (WFOs) at random

- Central Region (Mississippi Valley) – Shown again here
- Western Region (Intermountain West) – Shown in previous presentation

Data anonymized and aggregated to not identify individual users (no time series)

Examined logs for at least one request every preceding ten minutes to determine

- Whether AWIPS was running
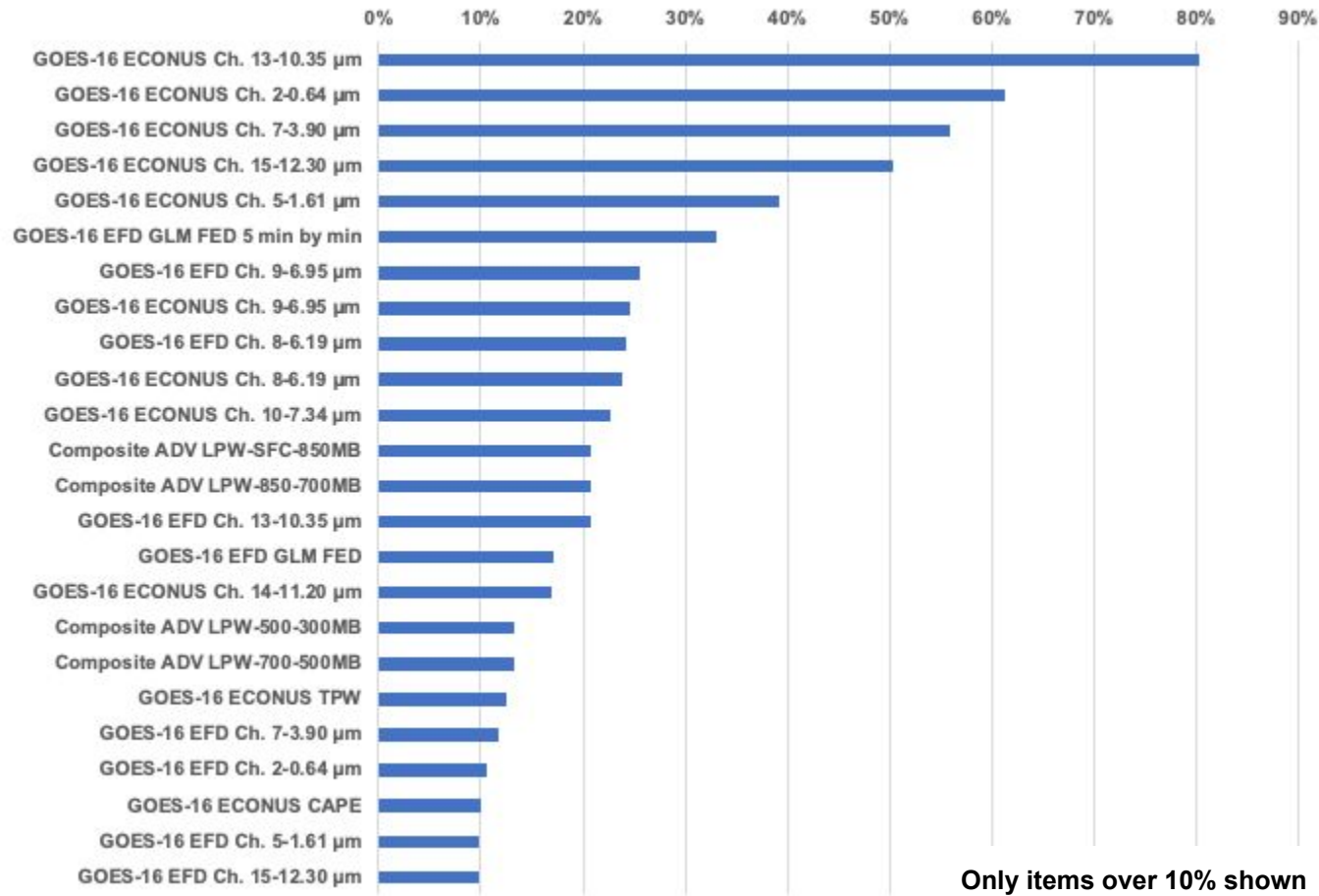- Satellite imagery / products loaded (initial user requests and automated updates)

Calculated percent of time displayed (dividing products loaded by run time)

Removed workstations that seemed static (e.g., 24 hours of same imagery)

Central Region WFO Satellite Imagery / Product Use by Time Displayed (%)

Only items over 10% shown

Most Popular Geo Imagery / Products

Satellite / Sector	Band / Product	% of Time Displayed
G16 ECONUS	**10.35 µm**	**81%** (1870 hrs)
G16 ECONUS	**0.64 µm**	**61%** (1430 hrs)
G16 ECONUS	**3.9 µm**	**56%** (1300 hrs)
G16 ECONUS	**12.3 µm**	**50%** (1170 hrs)
G16 ECONUS	**1.61 µm**	**39%** (910 hrs)
G16 GLM	**Flash Extent Density (FED)**	**33%** (770 hrs)

Analysis Details

Central Region WFO (Mississippi Valley)

12/14/2021 to 1/17/2022

35 days: Over 2,300 hours of forecaster screen time

Includes RGB components

What about **water vapor and full disk imagery**?

Satellite / Sector	Band	% of Time Displayed
G16 EFD	6.95 μm (6 km)	26% (600 hrs)
G16 ECONUS	6.95 μm	25% (570 hrs)
G16 EFD	6.19 μm (6 km)	24% (560 hrs)
G16 ECONUS	6.19 μm	24% (550 hrs)
G16 ECONUS	7.34 μm	23% (530 hrs)
G16 EFD	10.35 μm (6 km)	21% (480 hrs)

Analysis Details

Central Region WFO (Mississippi Valley)

12/14/2021 to 1/17/2022

35 days: Over 2,300 hours of forecaster screen time

Includes RGB components

Most Popular Geo Products

Satellite / Sector	Product	% of Time Displayed
G16 GLM	**Flash Extent Density (FED)**	**33%** (770 hrs)
G16 ECONUS	**TPW**	**13%** (290 hrs)
G16 ECONUS	**CAPE**	**10%** (230 hrs)
G16 GLM	**Total Optical Energy (TOE)**	**6%** (140 hrs)
G16 ECONUS	**Lifted Index (LI)**	**5%** (110 hrs)
G16 ECONUS	**Cloud Top Phase**	**4%** (100 hrs)

Analysis Details

Central Region WFO (Mississippi Valley)

12/14/2021 to 1/17/2022

35 days: Over 2,300 hours of forecaster screen time

Excludes PW composites

Summary: Central Region WFO

- Infrared window, shortwave infrared, and visible imagery are overwhelming favorites
  - Office seems to use single band imagery and composites

- Almost exclusively reliant on GOES-East

- Most popular full disk bands are water vapor and infrared window bands

- GOES-East mesoscale sector of IR window displayed around 6% of time

- Surprisingly high use of the lightning mapper and stability indices during the winter
  - One major, atypical severe thunderstorm event on December 15th

Methodology: Multiple Forecast Office Analysis

- 15 WFOs: 6 Central Region (CR), 4 Eastern Region (ER), 3 Southern Region (SR), 2 Western Region (WR)

- At those WFOs: 225 NWS meteorologists produced 1152 AWIPS CAVE sessions that were included in analysis
  - Included sessions lasted between 1 and 12 hours in duration (all others excluded)

- Most sites collected from 3/14 through 3/22/22, some sites to 3/30

- GOES-East and GOES-West aggregated (counted either/or)

Most Popular By Shift (Multiple Offices)

Single ABI Band	Workstations Loading Per Shift
Band 2 (0.64 µm)	80.2%
Band 7 (3.9 µm)	78.9%
Band 9 (6.95 µm)	71.4%
Band 15 (12.3 µm)	62.6%
Band 13 (10.35 µm)	61.4%
Band 10 (7.34 µm)	54.4%
Band 8 (6.19 µm)	52.5%

Other ABI RGBs / Products	Workstations Loading Per Shift
Nighttime Microphysics RGB	48.6%
GLM FED 5 min	43.3%
CIRA GeoColor	33.0%
Fog Difference	18.1%

Single ABI bands may include ABI bands that contribute to an RGB; working to distinguish

Comparison of imagery / product usage for adjacent WFOs (Central Region)

Legend: WFO B, WFO A
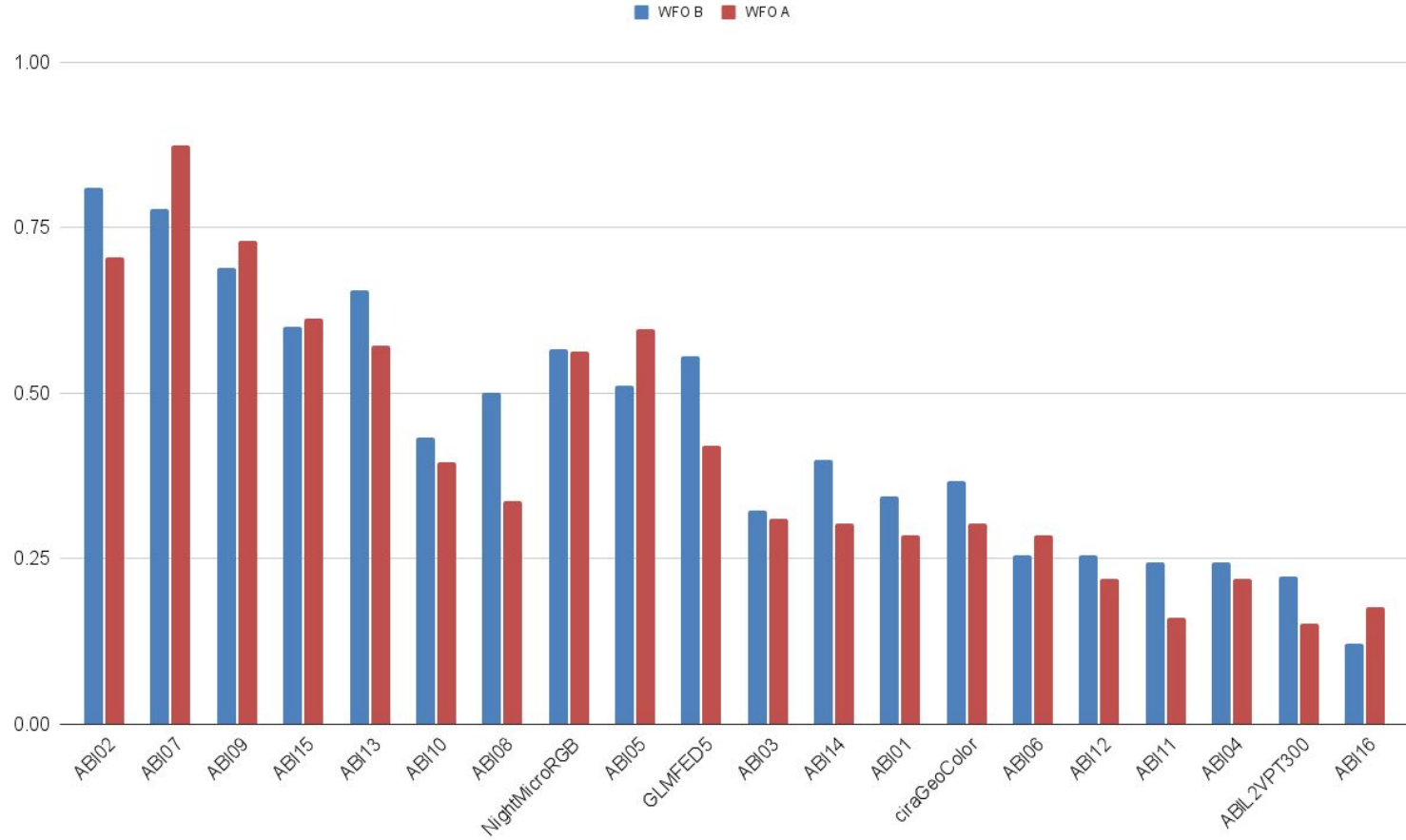
ABI Band 2 (0.64 μm) Usage: Total and By WFO
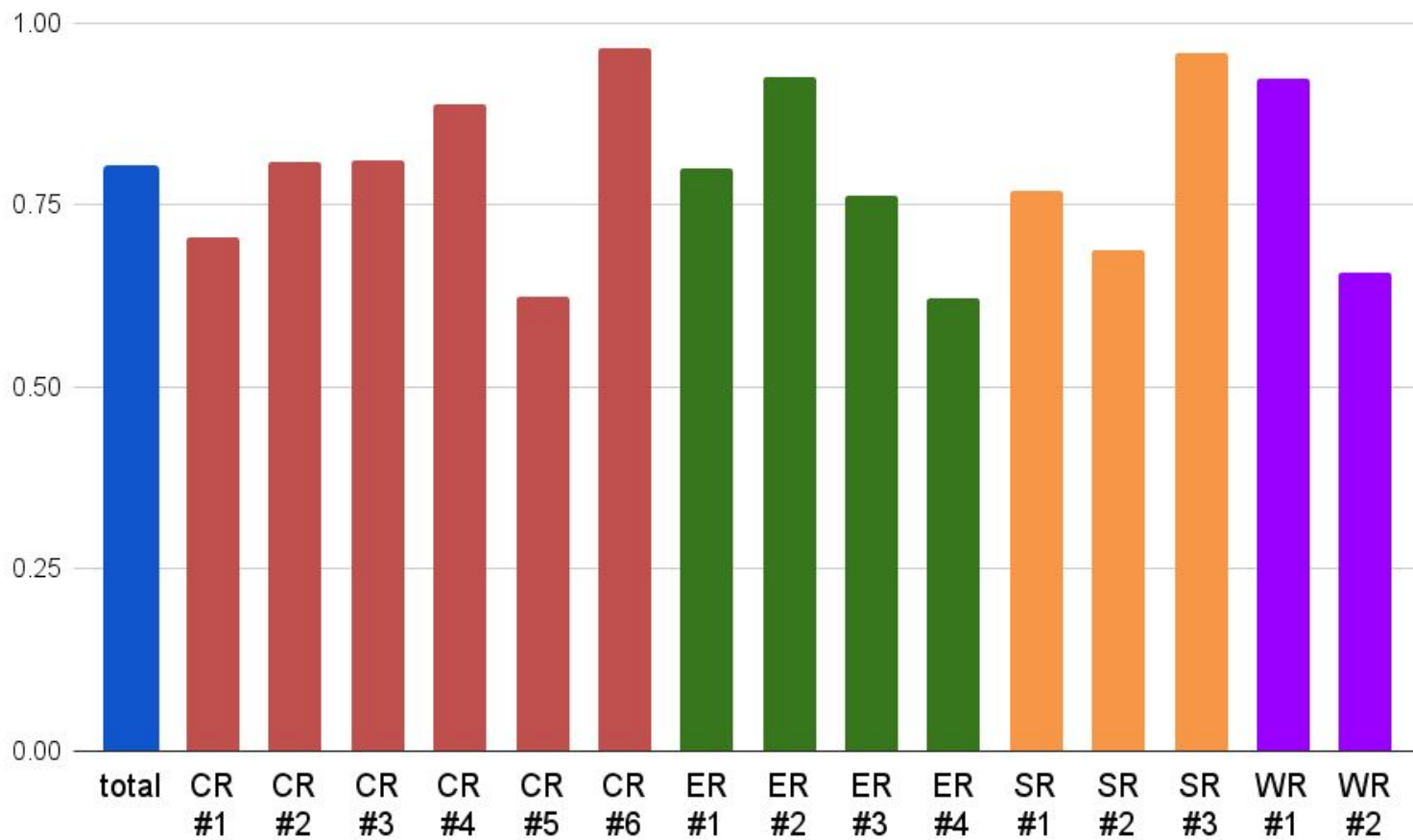
ABI Band 13 (10.35 µm) Usage: Total and By WFO
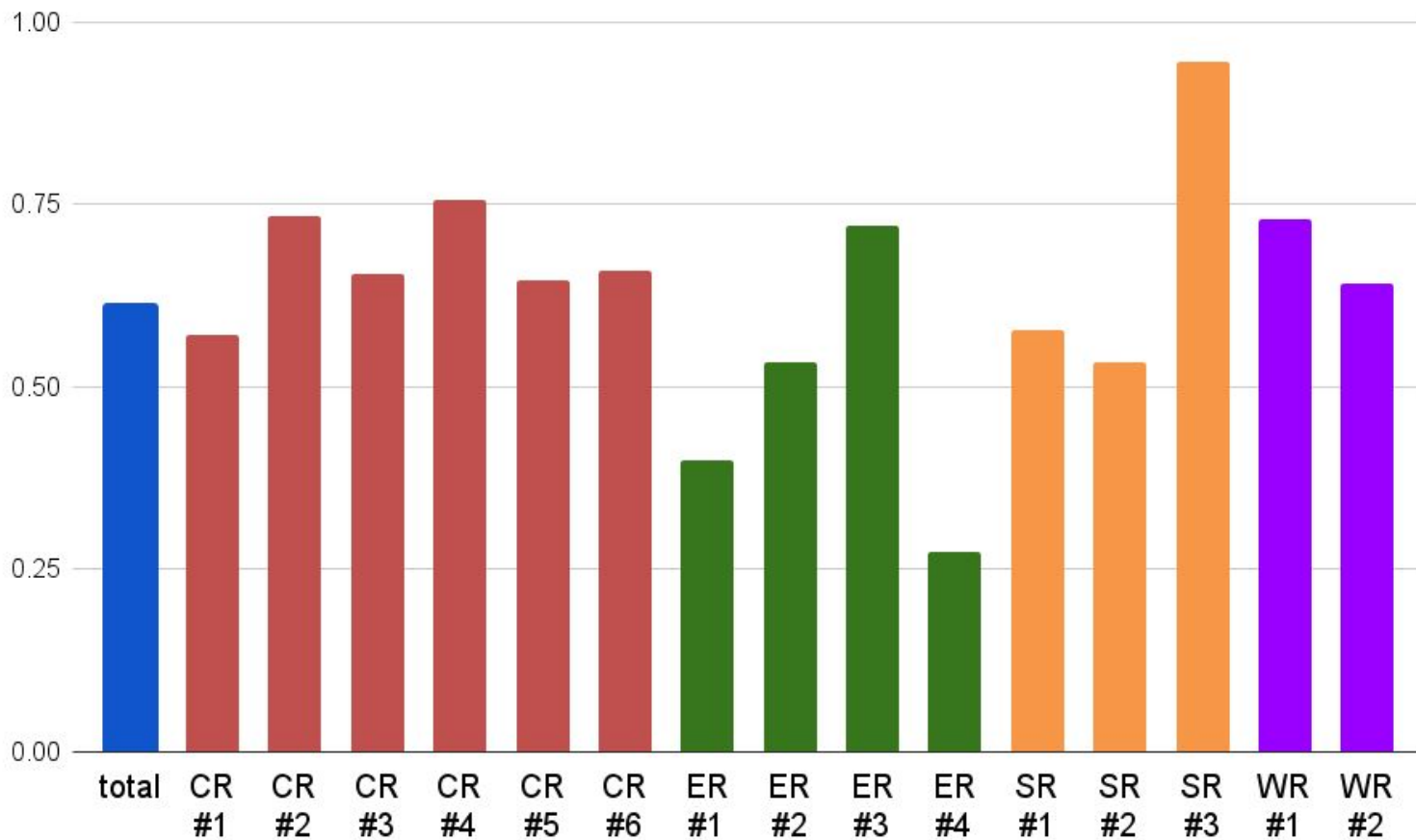
ABI Band 5 (1.61 μm) Usage: Total and By WFO
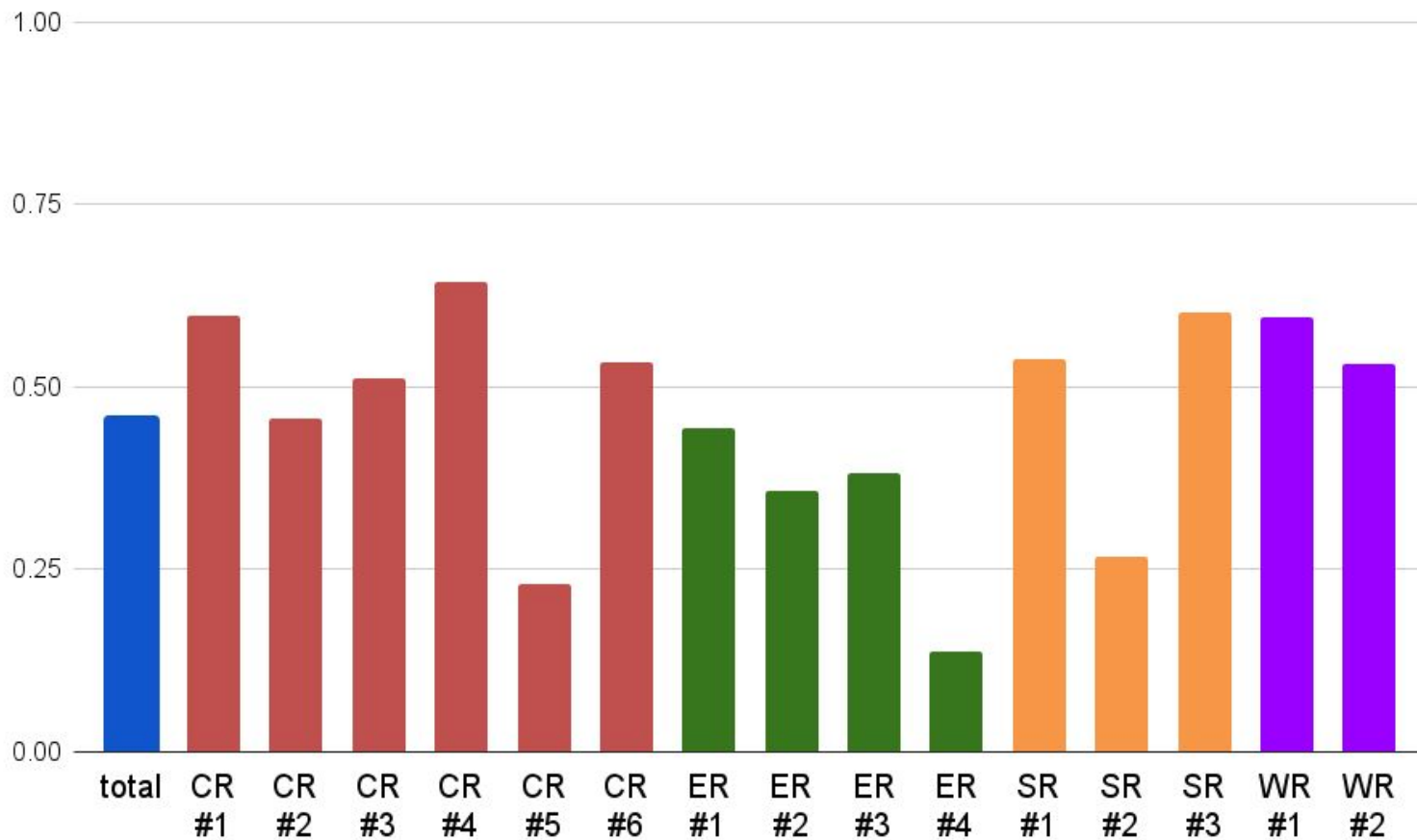
GLM 5-Minute Flash Extent Density Usage: Total and By WFO
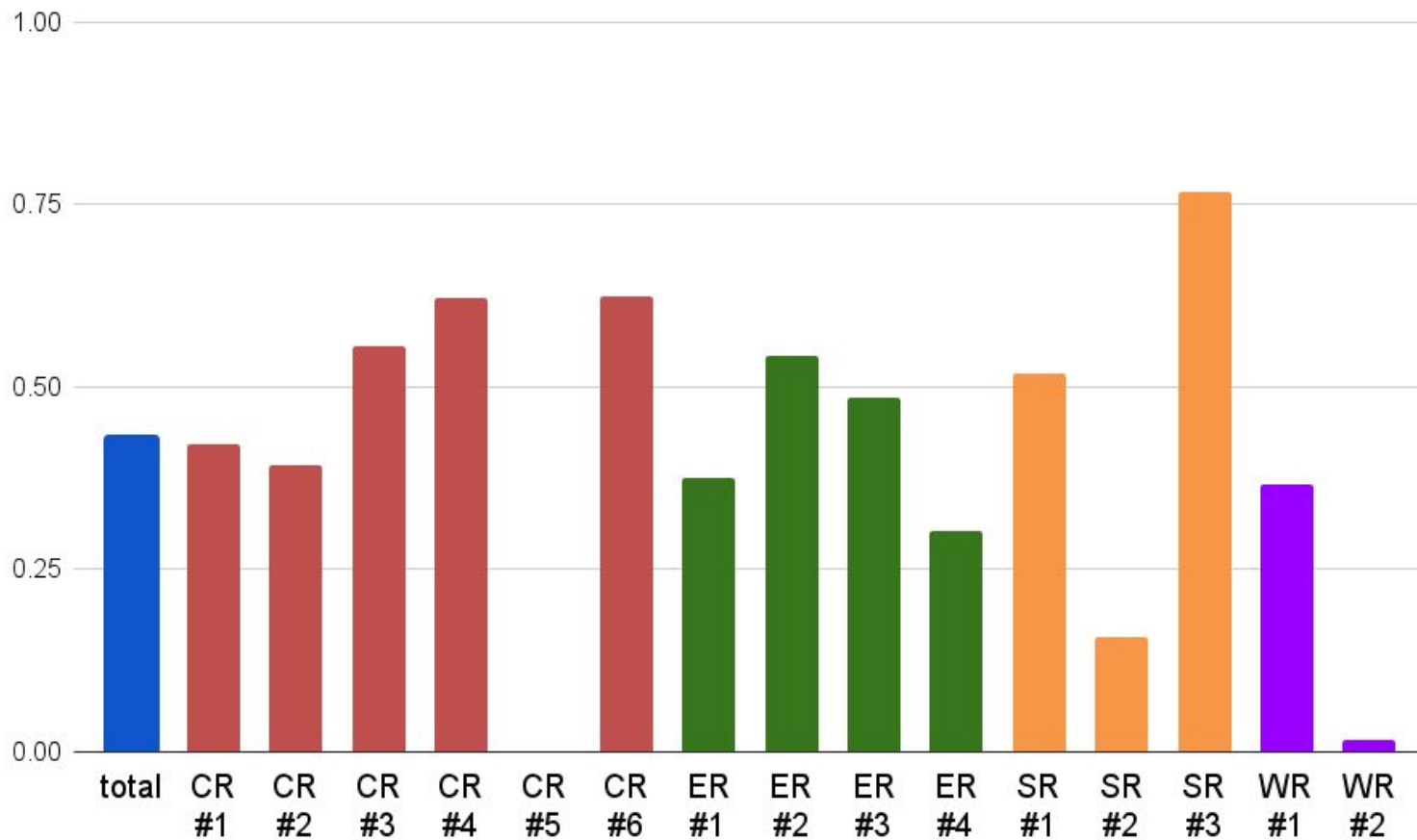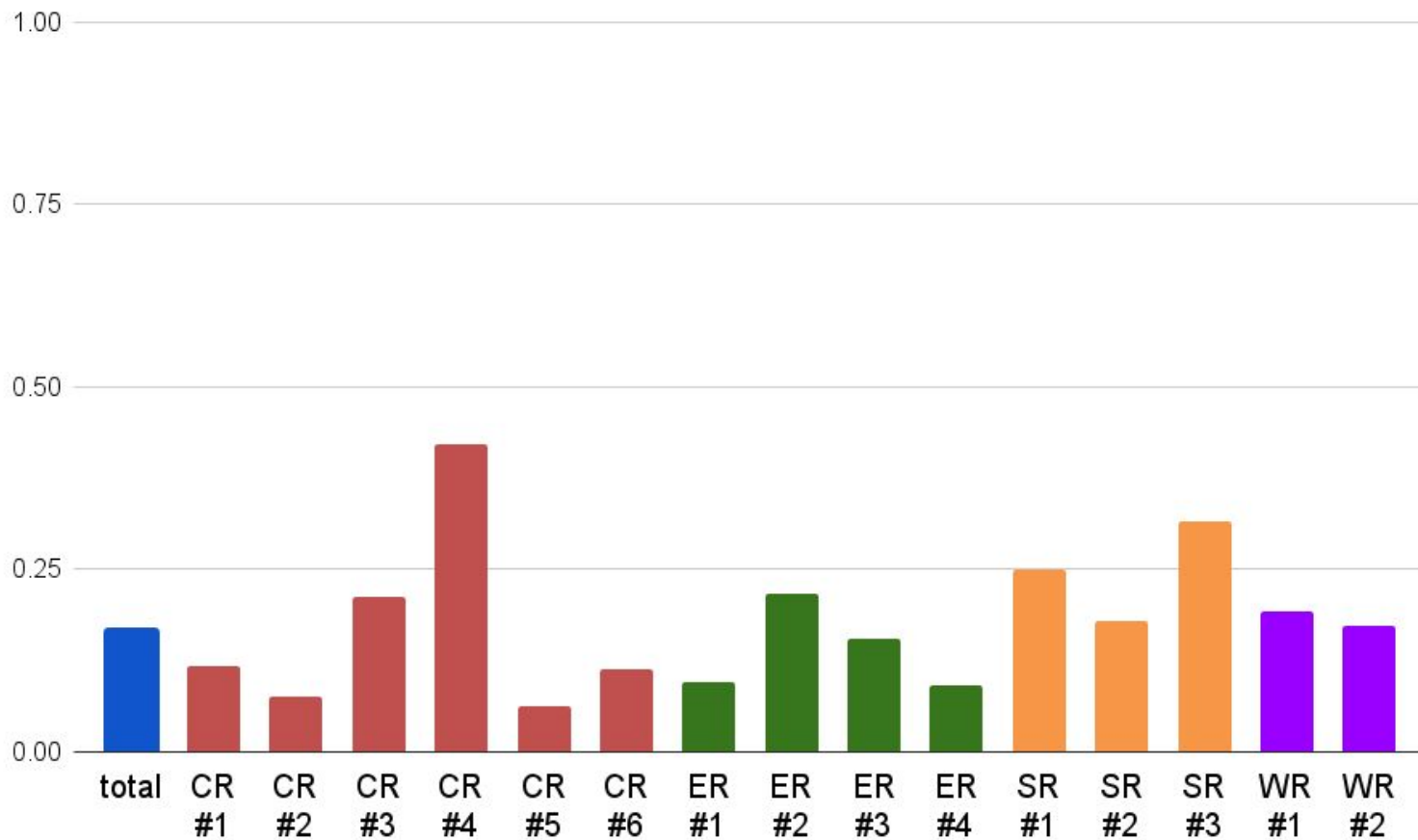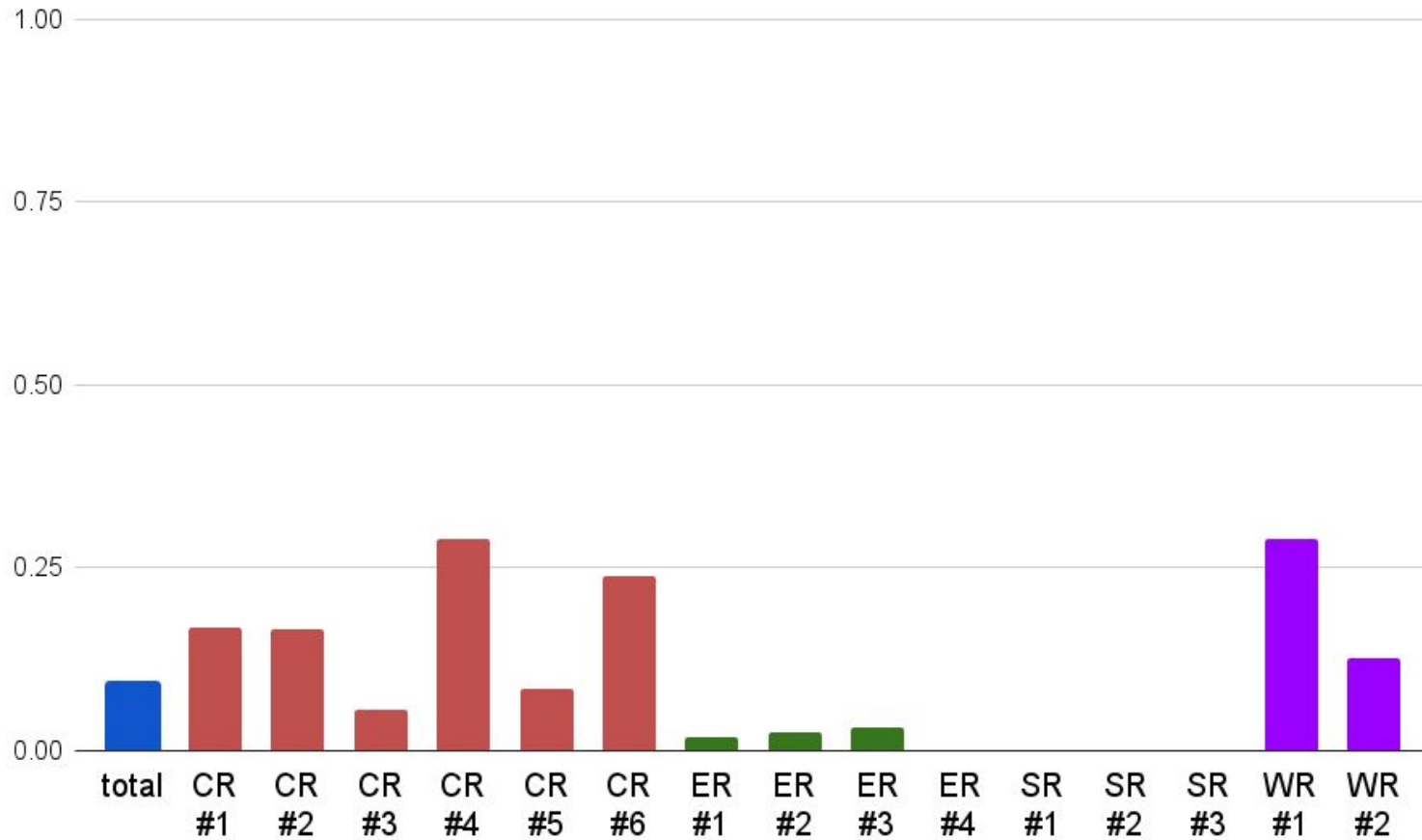
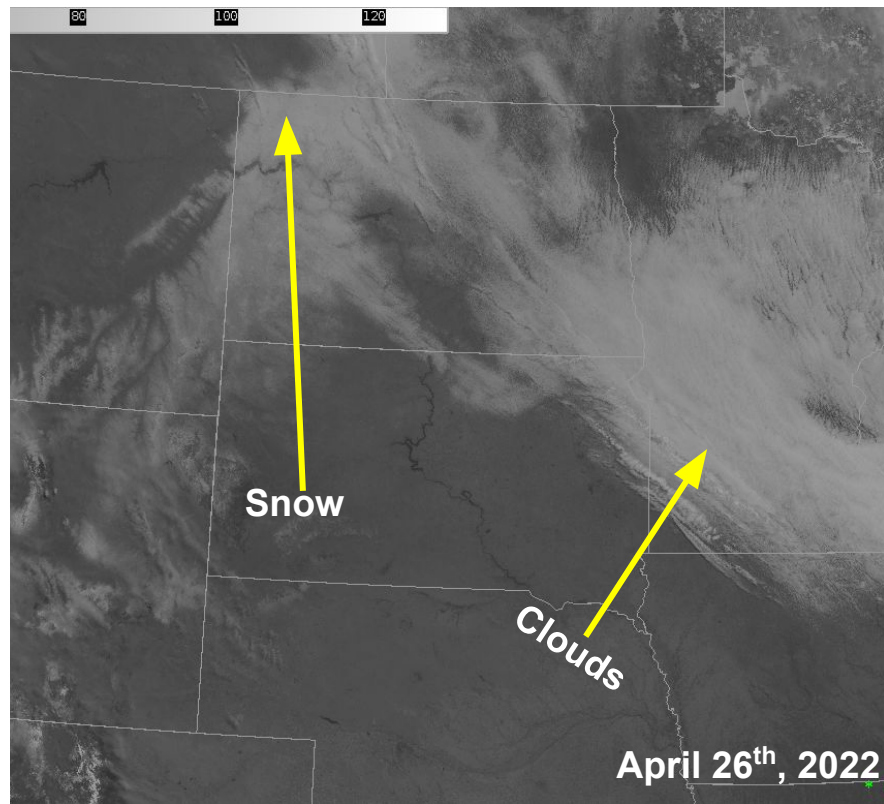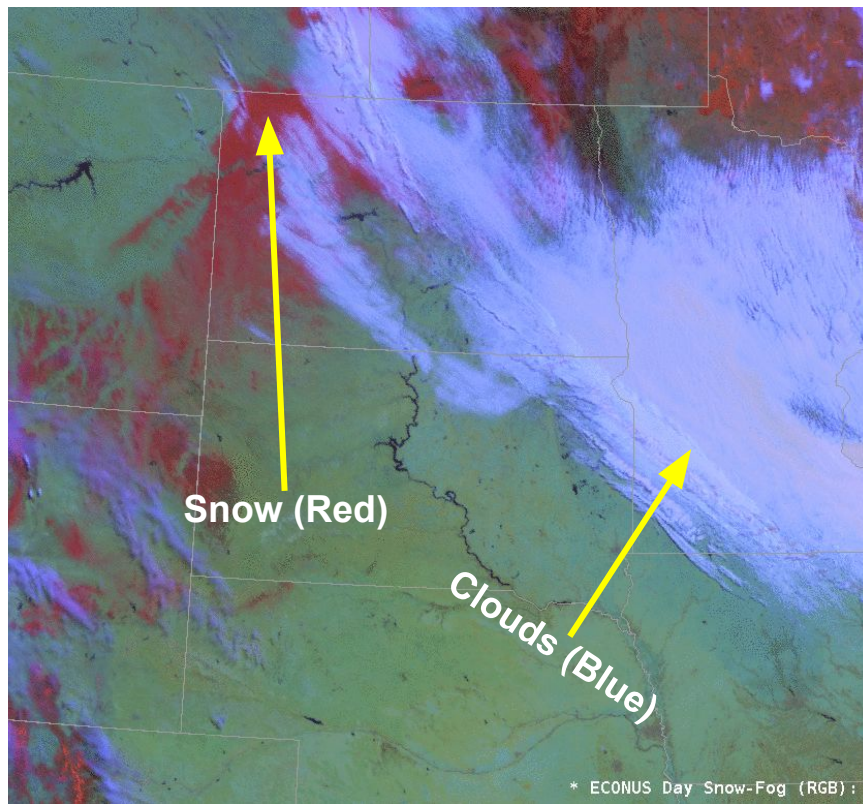# GOES-16 GLM FED 5-Min (by Minute) Applications
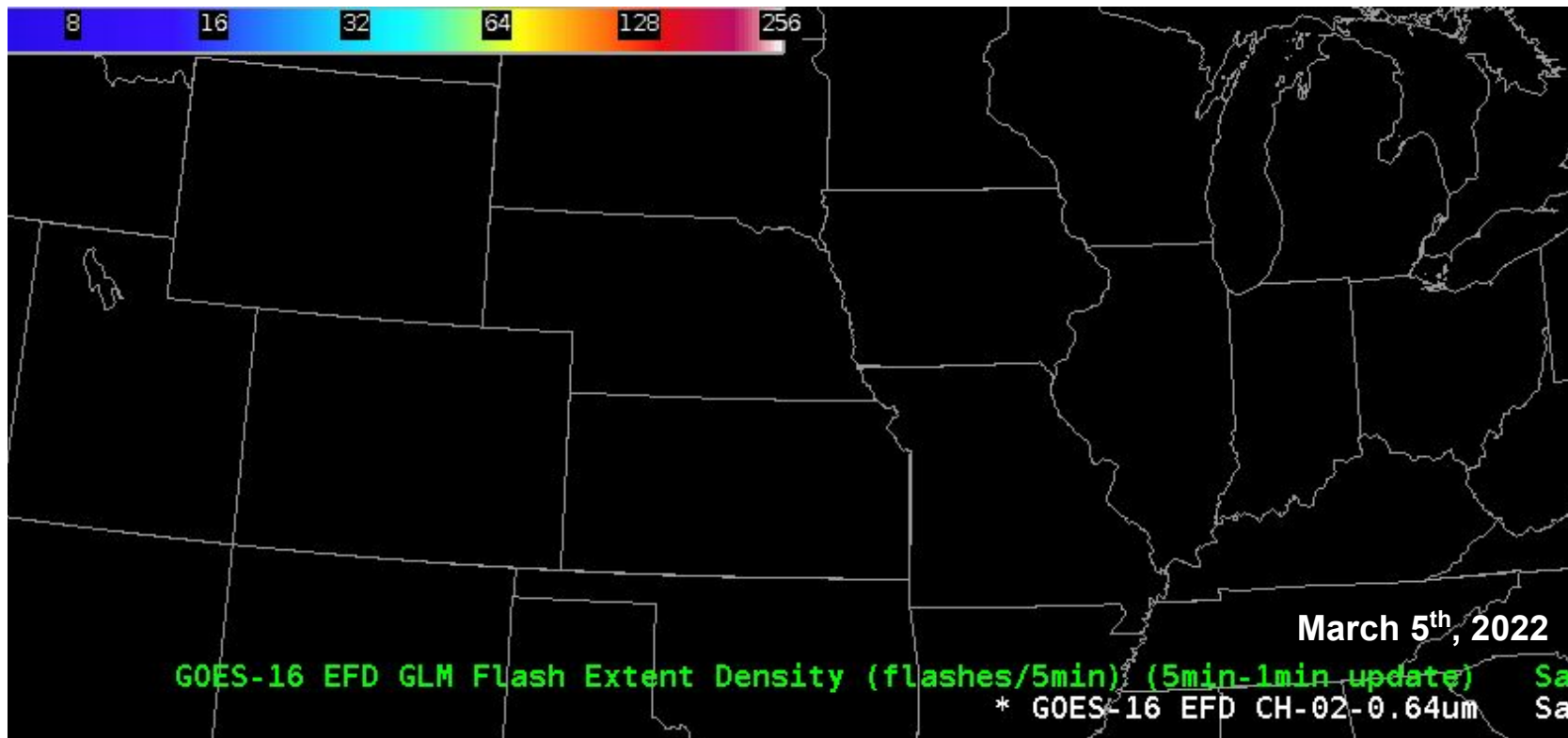
ABI L2 Total Precipitable Water Usage: Total and By WFO

ABI Day Snow-Fog RGB Usage: Total and By WFO

Day Snow Fog RGB Applications

Snow (Red)

Clouds (Blue)

* ECONUS Day Snow-Fog (RGB):

Snow

Clouds

April 26th, 2022

Summary: Multiple Forecast Office Analysis

- Examining imagery and product usage by shift provides a different perspective than by fraction of shift

- Water vapor: Less likely to be used for situational awareness (always on), but routinely examined at least once per shift (sometimes)

- Certain regional differences not surprising (less use of snow RGBs in southern U.S.) but not always explainable (precipitable water product)

- Office to office variability must be examined more to account for different meteorologists and weather patterns, and must distinguish RGBs from single bands

Future Work

Examine data from more offices

Correlate with seasons, weather events, procedures, and headlines
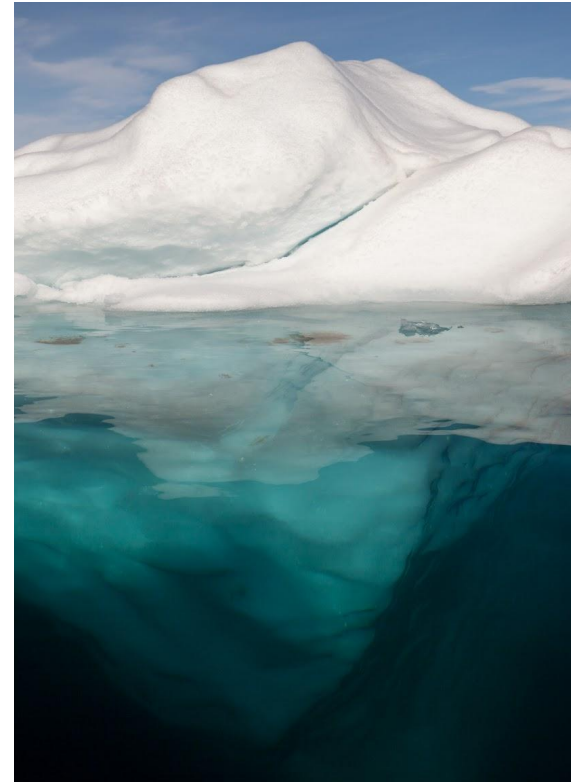
Deploy capability to testbeds / demonstrations

Expand to include LEO missions and possibly non-satellite data

Inform NESDIS product baseline and future efforts for training and product improvements

GXI Spectral Band Specification

	ABI	GXI
Highest spatial resolution (pixel size)	0.5 km	0.25 km
Total number of bands	16	18
Number of water vapor sensing bands	4	6
Number of bands at < 2 km resolution	4	9 (TBR)
Number of IR bands at < 2 km resolution	0	4 (TBR)

Center Wavelength (µm)	Nadir Pixel Size (km)
0.47	0.5 (TBR)
0.64	0.25**
0.865	0.5 (TBR)
0.91	1.0 (TBR)
1.378	2.0
1.61	1.0
2.25	1.0 (TBR)
3.9*	1.0
5.15	1.0
6.185	2.0
6.95	1.0*** (TBR)
7.34	2.0
8.50	2.0
9.61	2.0
10.35	1.0*** (TBR)
11.20	2.0
12.30	2.0
13.30	2.0

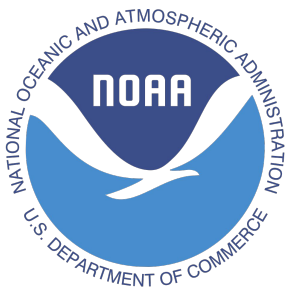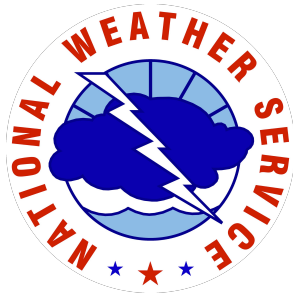*If denoted "TBR": Not finalized and subject to change*

* Seeking saturation temperature as high as possible without negatively impacting the low signal

** MTF equivalent to 0.3 km resolution is acceptable

*** MTF equivalent to 1.5 km pixel size is acceptable

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