



SATELLITE OPERATIONS

2021 Tropical Cyclone Operations and Research Forum

75th Interdepartmental Hurricane Conference

NESDIS Update

Wednesday, March 3, 2021

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Division Chief

Satellite Products and Services Division

NOAA / NESDIS / OSPO

Slide support and creation:

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Outline

- GOES Constellation Status
- GOES Product Status
- GOES-T/U Plans & Schedule
- GOES MDS In Operations
- SAB Status
- GeoXO Preliminary Architecture & Schedule



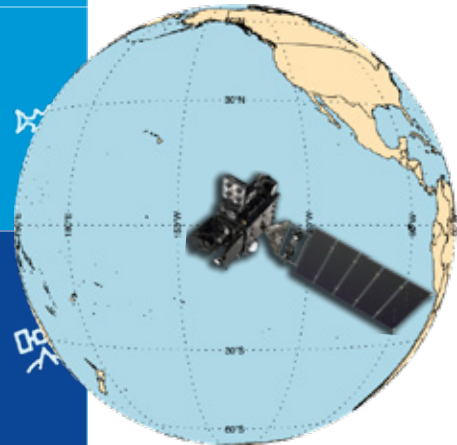
GOES Constellation Status



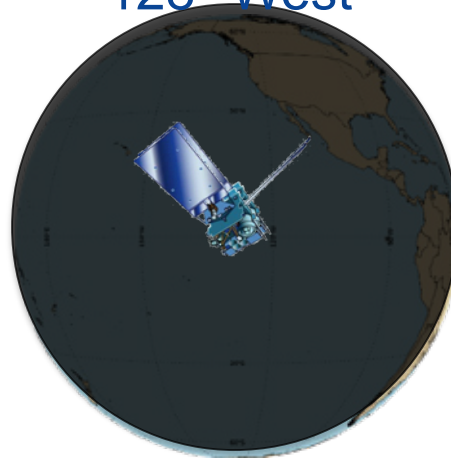


Current GOES Constellation

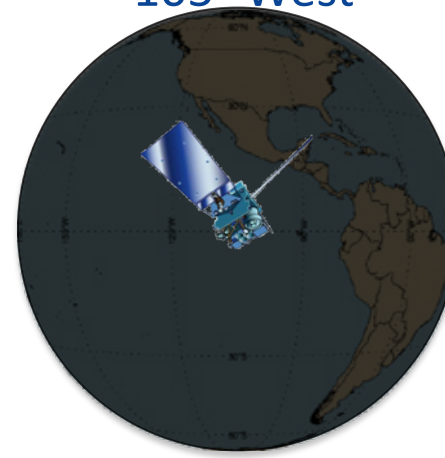
GOES-West
GOES-17
137.2° West



On-Orbit Storage
GOES-15
128° West



Standby
GOES-14
105° West



GOES-East
GOES-16
75.2° West



Prior Supplemental Operations of GOES-15 to support GOES-17 ABI image saturation during loop heat pipe anomaly periods may be considered for August, 2021

GOES-T (GOES-18) is scheduled for launch on December 2021 and after post-launch checkout will be evaluated for transition to on-orbit storage or operations

Operational GOES users should always be prepared for GOES constellation transitions which would include minor antenna repointing for direct readout (GRB) customers and metadata handling (e.g., satellite ID, temperature data quality flags) for all customers. Finally, note GOES-R series ABI do not image when the spacecraft is drifting.



Background LHP (Loop Heat Pipe) Anomaly on GOES-17



- GOES-17 suffered an on-orbit anomaly with the one of the two loop heat pipes that is used to pass heat from the cryocooler to the radiator for rejection
- This anomaly causes the two of the three focal planes to rise to temperatures observable by the infrared imaging sensors causing saturation in certain bands
- This is most pronounced around the two eclipse seasons annually and during those days most severe at local spacecraft midnight, this is when the instrument is most directly pointing toward the sun



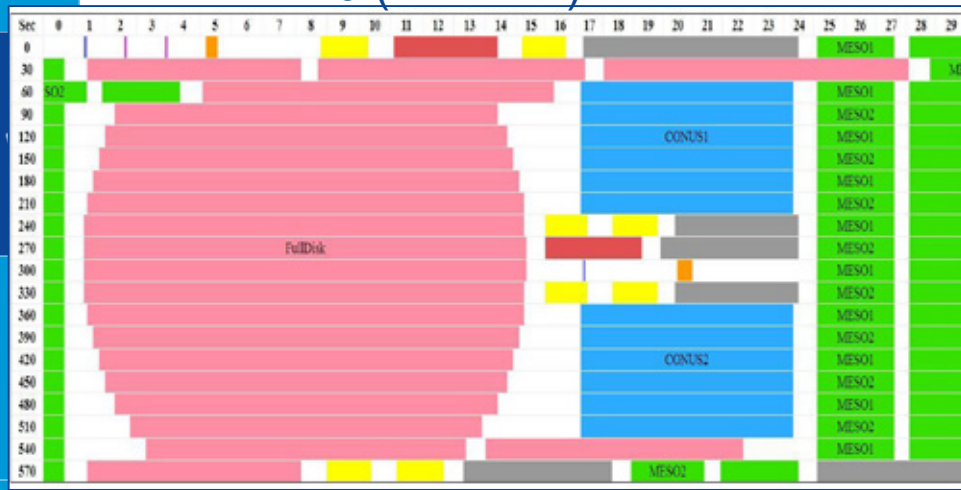
Mode 3 Cooling Timeline

Domain	Mode 6	Mode 3*
Full Disk	10 min	15 min
CONUS	5 min	None
MESO	2x1 min or 1x30 sec	1x1 min alternating

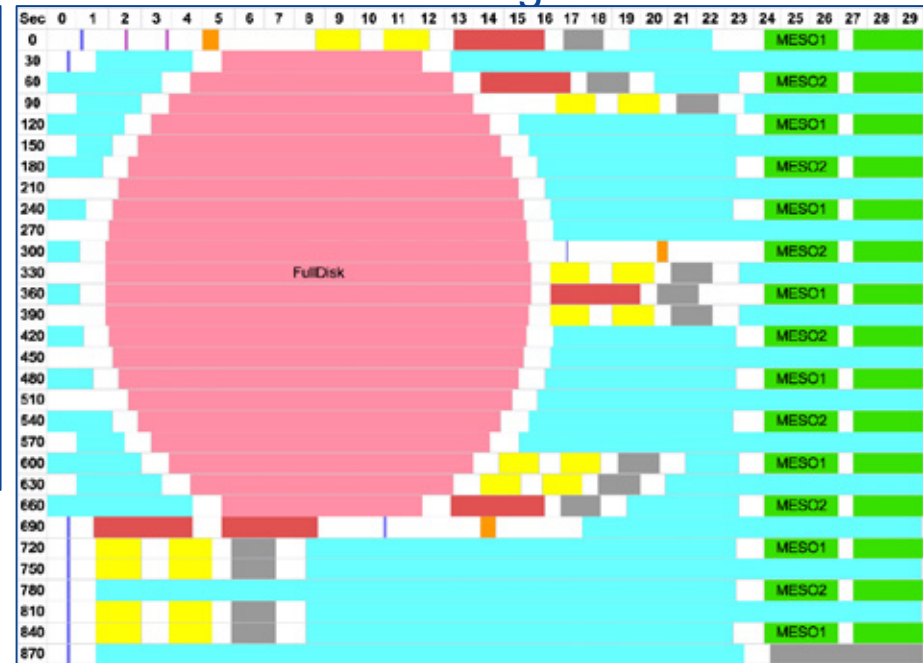
Legend:

- FullDisk Swath
- MESO Swath
- VIS StarLook
- IR StarLook
- SpaceLook
- ScanOps
- IR Calibration
- NadirStare
- CoolStare

Mode 6 (Nominal) Timeline



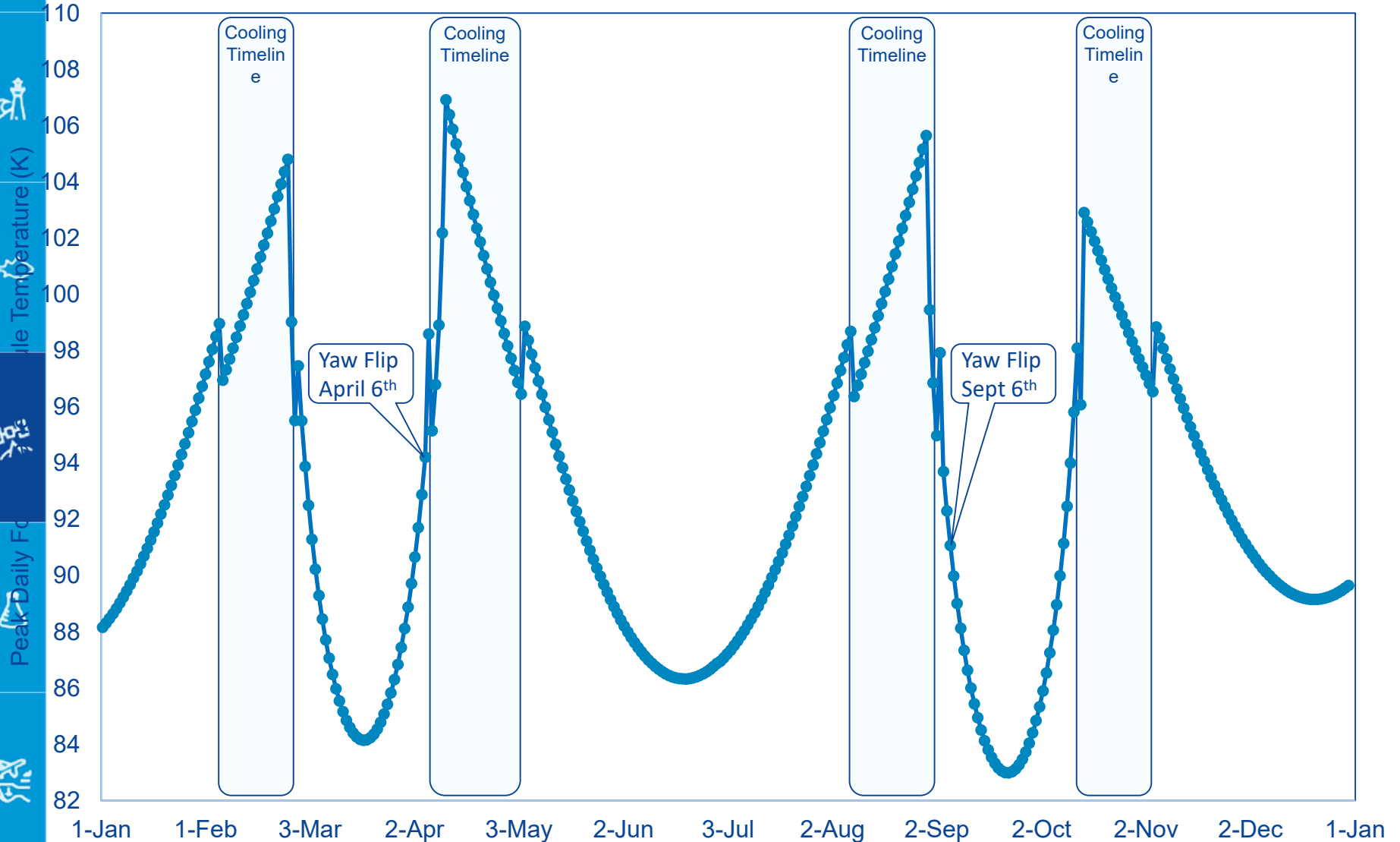
Mode 3 Cooling Timeline



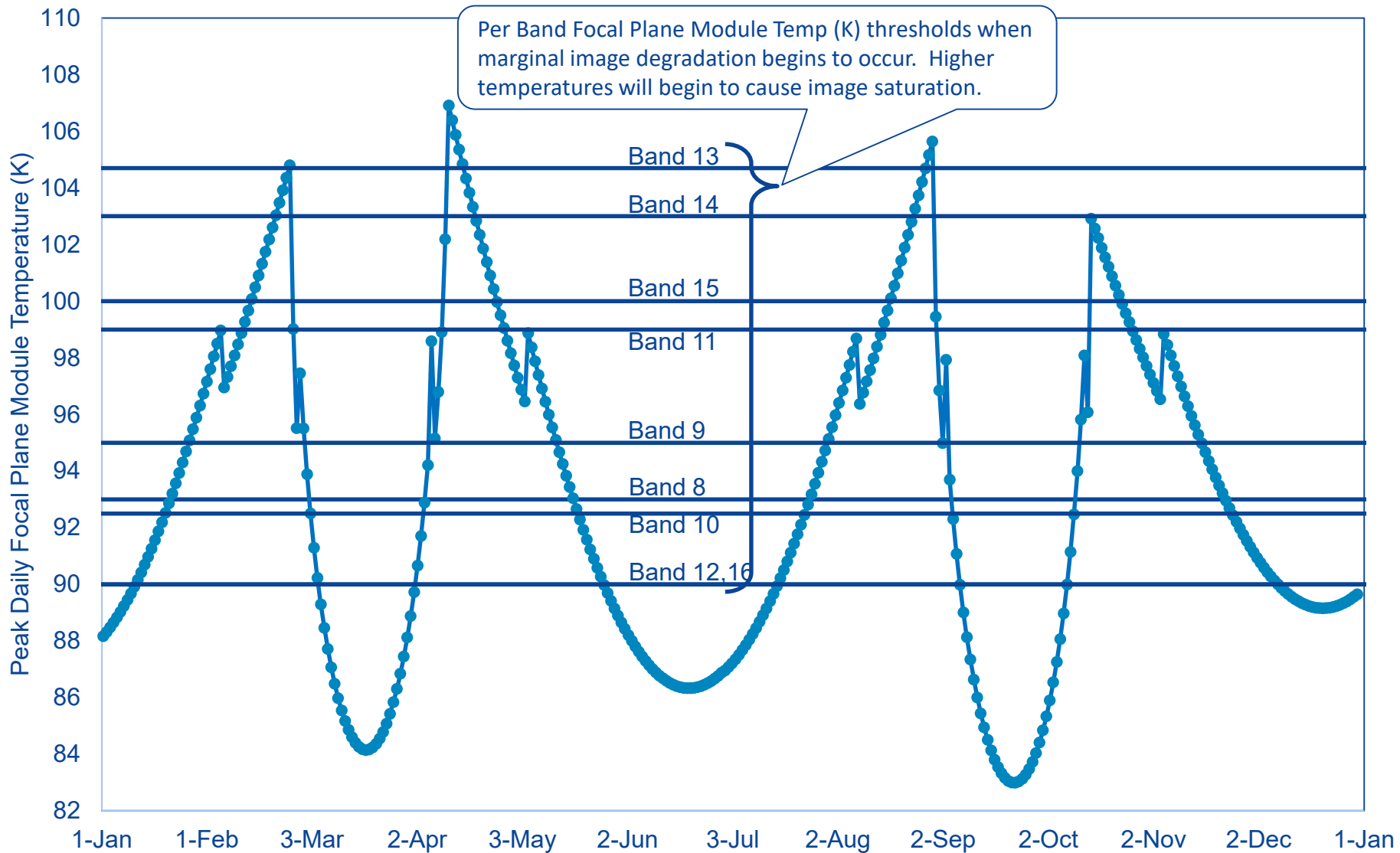
*There was an original Mode 3 (15 min FD, 5 min CONUS, 2x1min MDS) utilized by GOES-16/17, which was effectively replaced by Mode 6 (10 min FD, 5 min CONUS, 2x1min MDS) in April 2019. Ever since the first tests of the Mode 3 cooling timeline (15 min FD, no CONUS, 1x1min alternating MDS) in October, 2019, it is the one and only "Mode 3".



2021 Schedule for GOES-17 ABI Cooling Timeline

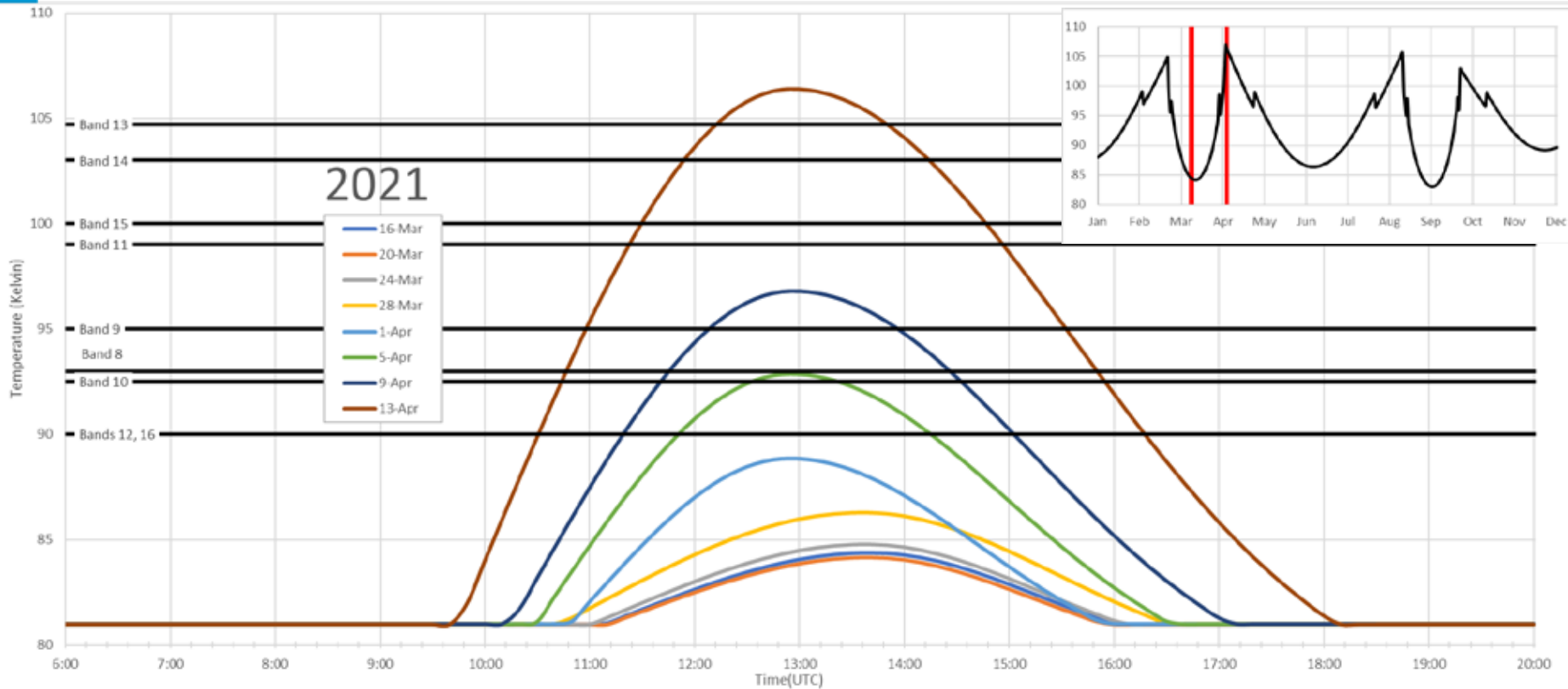


2021 Predicted GOES-17 ABI LW IR Temperatures





2021 GOES-17 ABI Reference Materials



This plot shows hourly maximum temperature of the ABI focal plane module. The higher the temperature, the more saturated imagery becomes. Where the temperature rises to approach a black line for each band, marginal saturation may be observed in imagery. Where the temperature curve exceeds a black line for each band, the imagery may begin to saturate so much that it becomes unusable. The hour of peak temperature varies from day to day.

<https://www.goes-r.gov/downloads/users/abiPerformance/GOES-17ABISaturationPredictionReferenceTools.pdf>
<https://www.goes-r.gov/users/GOES-17-ABI-Performance.html#channelSaturationPredictions>





GOES Products Status



Complete
In Progress
Not Started

Recent & Future GOES-R Products

Product	Critical Design Review (CDR)	Initial DAP Delivery	Software Code Review (SCR)	Algorithm Readiness Review (ARR)	DAP Delivery	Operations Readiness Review (ORR)	Operational Declaration (SPSRB)
Low Cloud / Fog (GOES-17)	Complete	Complete	Complete	2/19/2021	3/12/2021	5/30/2021	6/28/2021
MTCSWA Upgrades	Complete	Complete	Complete	Complete	Complete	Complete	Complete
ADT Upgrades	Complete	Complete	Complete	Complete	Complete	06/30/21	07/30/21
Blended SST Inclusion of GOES-West (GOES-17)	Complete	Complete	Complete	Complete	Complete	Complete	Complete
High Resolution Geo-Polar Blended Regional SST Analyses	Complete	10/21	11/21	1/22	2/22	5/22	6/22

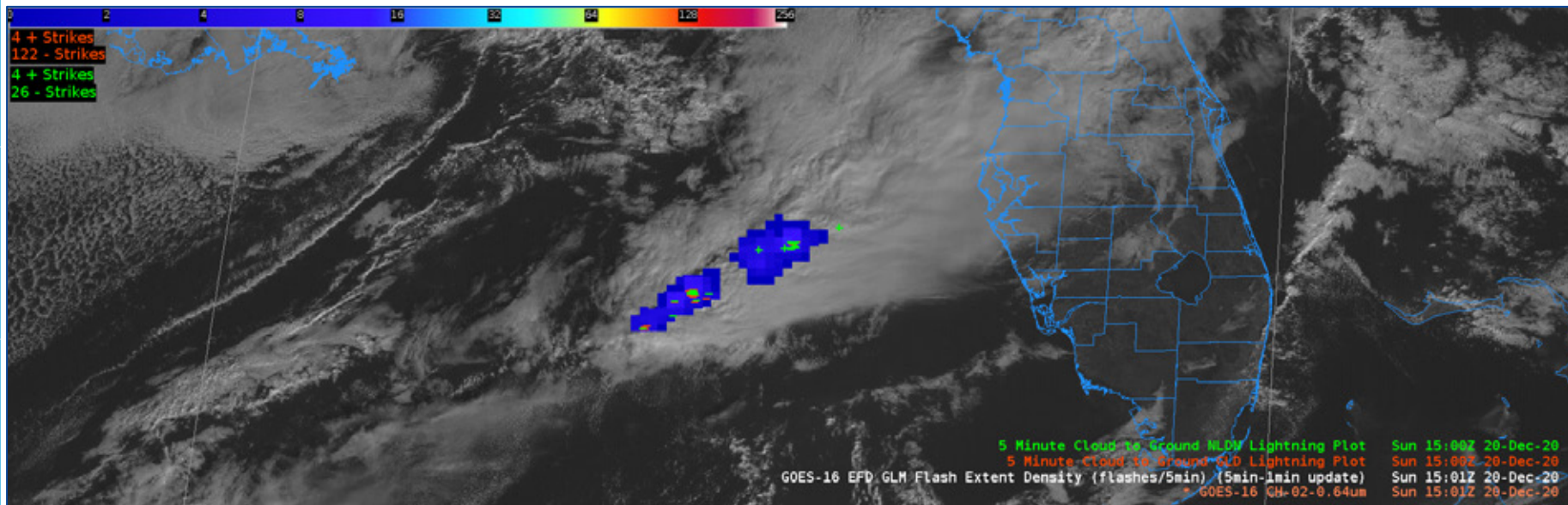


- Initial FY21 product prioritization complete and 12 algorithms identified
 - Includes GOES-16 and GOES-17 Total Precipitable Water
 - No additional funding requests for GOES-R
 - SPSRB Principals briefed at Feb SPSRB meeting
- Potential Follow-On FY21 product consideration
 - ABI Flood Product
 - Held planning call with PPMs Jan 26th
 - User request sent to OSAAP for prioritization (6-8 weeks)
 - OSGS to provide ROM costs (6-8 weeks)
 - SPSRB user requests recently provided to PPMs and now under OSAAP prioritization, but not yet under cost assessment
 - GOES: Sky Cover, Stereo AMVs
 - Blended: Global 2 km DSR and RSR, Global Gridded GOES Surface and Insolation, GOES-17 ACSPO SST

GLM FED Status

Complete
In Progress
Not Started/ECD
Not Started/ECD Changed

- Held TIM with L3Harris Jan 27th
- Initial plan and schedule expected Feb 24th
- Targeting OE deployment in April/May 2021, prior to DOE-2
- Stop-Gap currently in place: ISatSS generation of GLM FED in GEO Cloud with distribution to AWC and onwards to WFOs via NWS LDM (Unidata Local Data Manager)



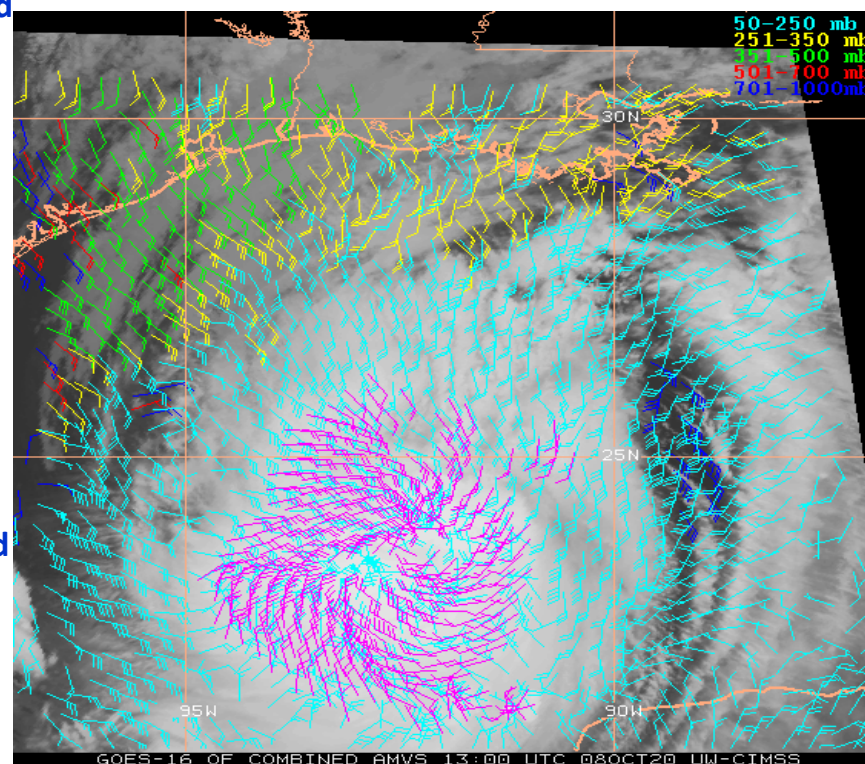
GOES-16 TC-Targeted Observations: Enhanced, Vortex-scale Meso-sector-scan AMVs



During last year's record Atlantic hurricane season, GOES-16 meso scanning sectors targeted TCs with 1-min. refresh multispectral imagery. From automated processing algorithms tailored to hurricane scales, UW-CIMSS produced and demonstrated experimental very high spatiotemporal atmospheric motion vector (AMV) datasets in real time at 15-min. intervals during GOES-16 TC-targeted observing periods.

Several published studies show assimilating these vortex-scale AMVs into hurricane models yield positive forecast impacts. Efforts now are focusing on transitioning this product to NOAA/NESDIS and NCEP operations.

The example AMV plot animation (Hurricane Delta) is thinned for viewing; there are many more vectors than shown. Magenta vectors over the TC core region are derived from an experimental optical flow technique designed to enhance the AMV coverage over the very cold (high-level) CDO regions which are normally difficult to retrieve with conventional correlation tracking methods.



C. Velden (CIMSS), J. Daniels (STAR), J. Sippel (HRD)





MDS in Operations



Operational MDS (and Mode) Request Process



Requesting Entities

14 different offices including all NCEP National Centers, NWS WFO regional focal point offices, and the Satellite Analysis Branch. Submit request to the NCEP Senior Duty Meteorologist (SDM). **Requests for MDS and mode changes must be placed to the SDM at least 30 minutes prior to the desired start time.**

NCEP SDM

Prioritizes and deconflicts multiple requests based on the Priority List in the procedure. Sends request to the Environmental Satellite Processing Center (ESPC) Help Desk.

ESPC Help Desk

Relays request to the Satellite Operations Control Center (SOCC). Sends an email notification with details of the approved request.

SOCC

Approves/denies request based on health/safety of satellite. Executes commands.



Included with Each Request:

- Which satellite (East/West) and change (either MDS or mode change request)

- Center Point in decimal degrees

- Start date/time of location change

- End date/time of coverage

- Requesting organization

- Reason, or phenomenon

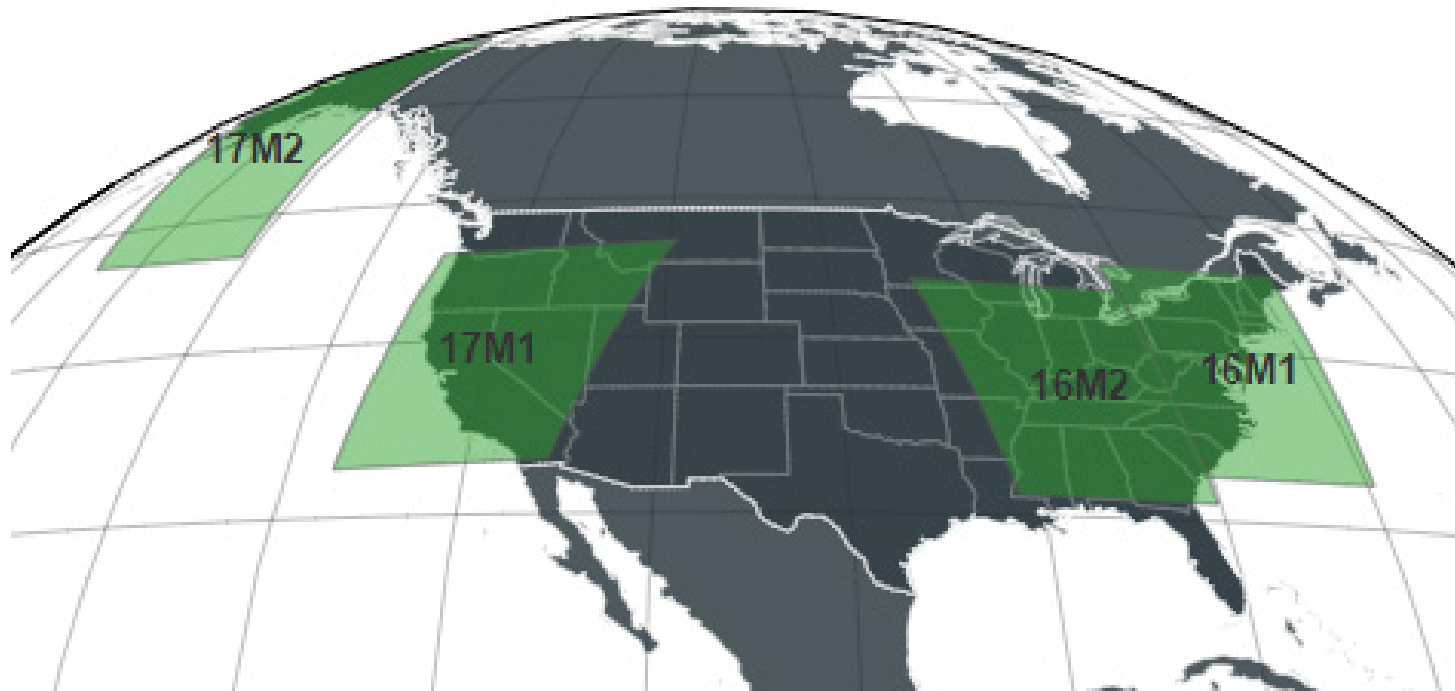
Prioritization of Competing Requests:

NWS generated a list of priorities for all environmental hazards.

Considers...

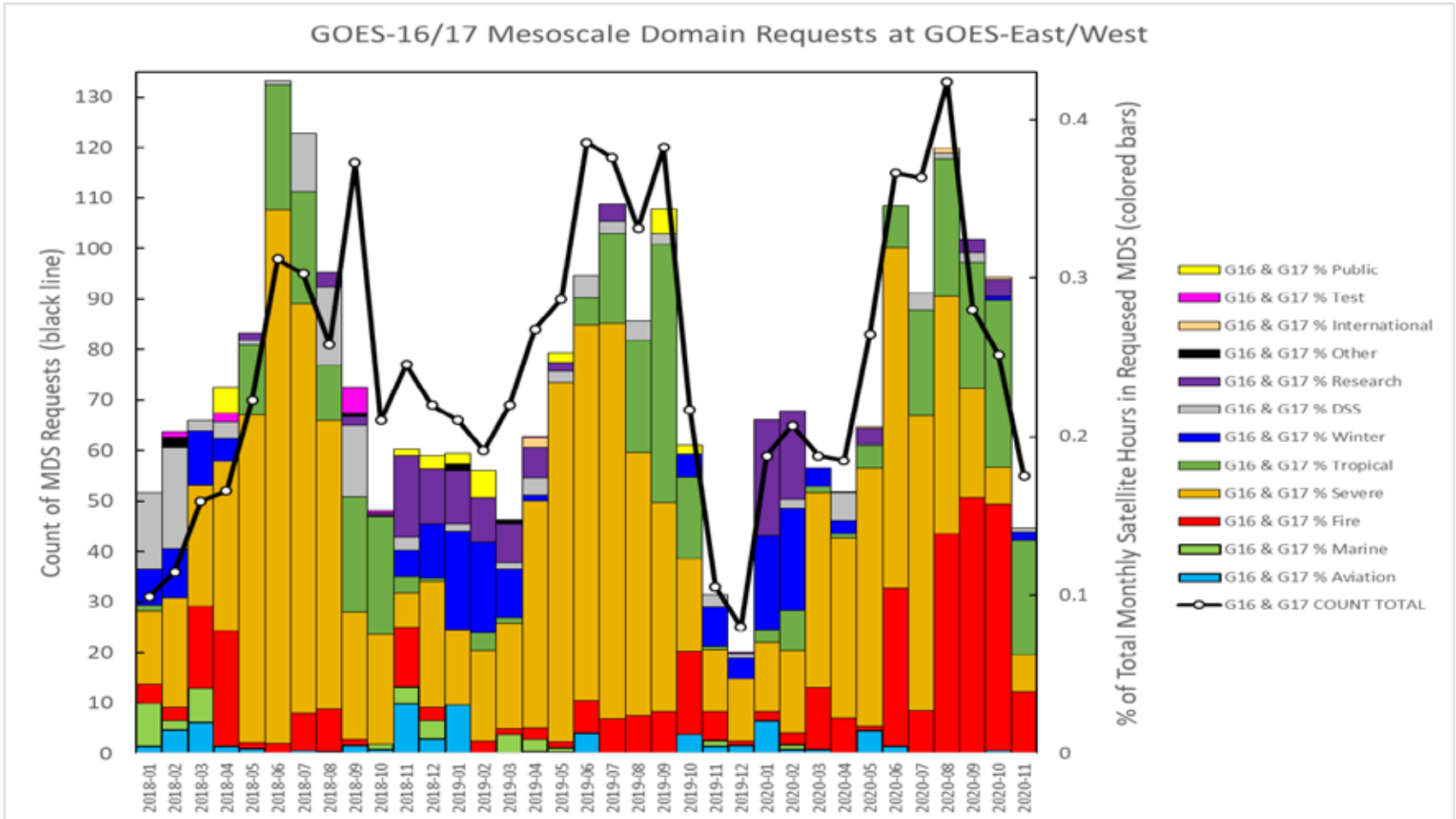
Potential impact of event, temporal evolution/dissipation, known benefits of MDS

Mesoscale Domain Sectors (MDS) Default Locations



Public Tool shows default locations, planned locations, and recent locations:
<https://vlab.ncep.noaa.gov/web/towr-s/mmm/meso-view>

ABI MDS Requests by Month and Category



GOES-16/17 assumed operational GOES-East/West roles in Dec 2016 / Feb 2018.

The months of Jun – Nov have the most requests with a focus on Severe Weather, Tropical Weather, and Fire.

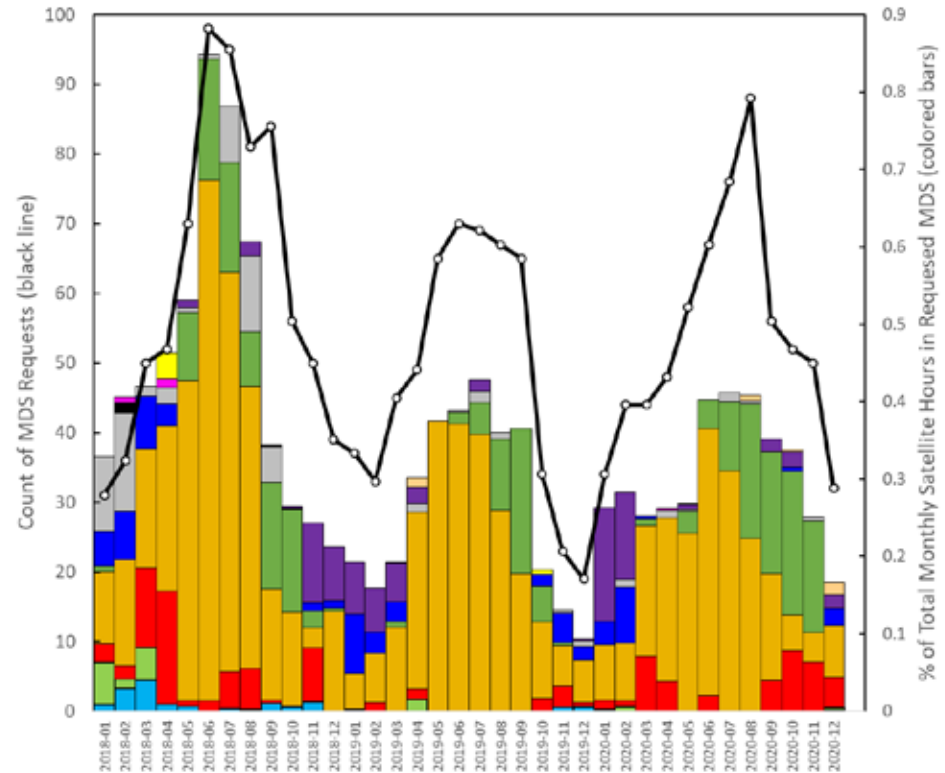
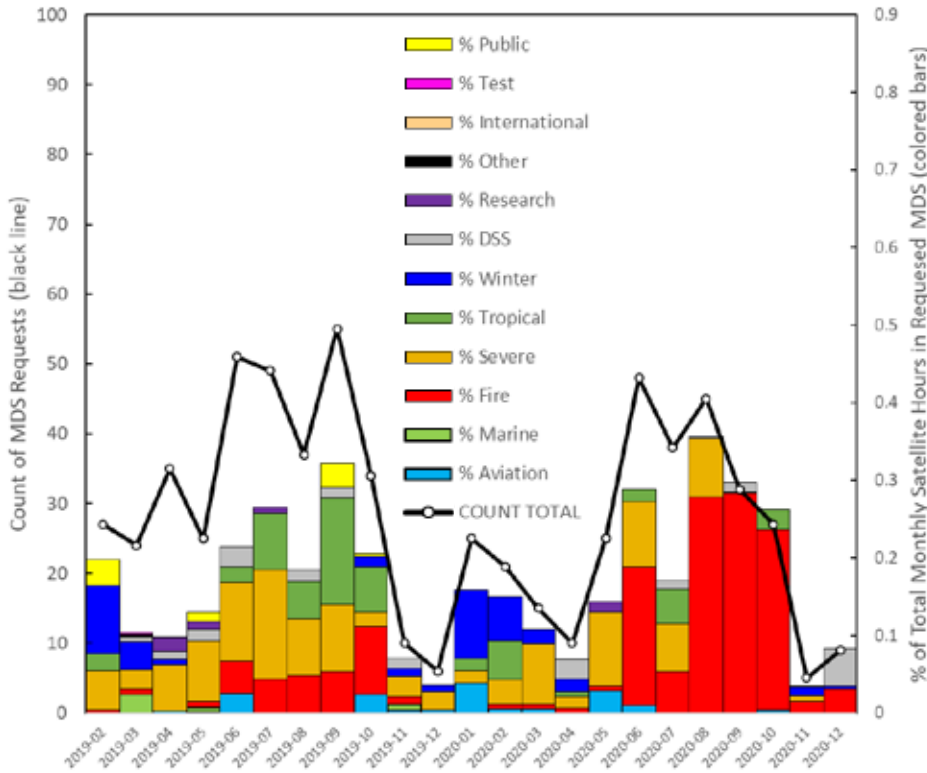




Number & % of ABI Mesoscale Domain Sector (MDS) Requests by Month

GOES-17 MDS Requests at GOES-West

GOES-16 MDS Requests at GOES-East





GOES-T/U Plans & Schedule





GOES-T/U Reviews

Spacecraft	Name	Date
GOES-T (Notional)	Pre-Ship Review	~ Aug 2021
GOES-T (Notional)	ORR	~ Sep 2021
GOES-T (Notional)	MRR	~ Oct 2021
GOES-T (Notional)	FRR & LRR	~ Dec 2021
GOES-T (Notional)	LAUNCH	~ 12/7/2021
GOES-T (Notional)	PLAR	~ Jun 2022
GOES-T (Notional)	HRR	~ Jul 2022
GOES-T (Notional)	OTRR (readiness for drift and storage/ops)	~ Jul 2022

Spacecraft	Name	Date
GOES-U (Notional)	Pre-Ship Review	~ Nov 2023
GOES-U (Notional)	ORR	~ Dec 2023
GOES-U (Notional)	MRR	~ Feb 2024
GOES-U (Notional)	FRR & LRR	~ Apr 2024
GOES-U (Notional)	LAUNCH	~ Apr 2024
GOES-U (Notional)	PLAR	~ Oct 2024
GOES-U (Notional)	HRR	~ Nov 2024
GOES-U (Notional)	OTRR (readiness for drift and storage/ops)	~ Nov/Dec 2024





Satellite Analysis Branch Status / Plans





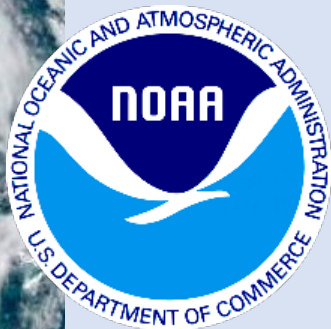
COVID Response

- Prior to April 8, 2020, SAB was doing Dvorak worldwide
- From April 8 through June 7, no estimates at all due to COVID-19. Working on how to do ops remotely.
- Based on emails and requests, restarted Atlantic and Pacific to 130E (north and south) on the morning of June 8, 2020
- Based on additional feedback from NWS, analysis pushed west to 110E on Aug 17.



Long term divestiture/replacement of SAB tropical and precipitation products

- NESDIS Satellite Analysis Branch (SAB) continues to work with NWS to gradually transition its weather watch functions in a manner that assures NWS and other forecasters' needed information sources will be maintained or enhanced.
- SAB has discontinued precipitation products and briefings in those areas where the NWS user requested termination.
- A team of NWS managers whose Centers and divisions have tropical storm responsibilities is providing oversight and guidance of next steps in SAB's Dvorak divestiture, as each AOI reaches a minimum number of alternate, high quality, Dvorak analyses from other organizations.
- For the western north Pacific basin, NWS requires a minimum of 3 independent Dvorak fixes for consensus (with Tokyo RSMC and JTWC being 2 of these). The NWS Team is looking into other nation's fixes as a possible replacement for SAB in this basin in 2 or 3 years after careful vetting of their Dvorak analyses.



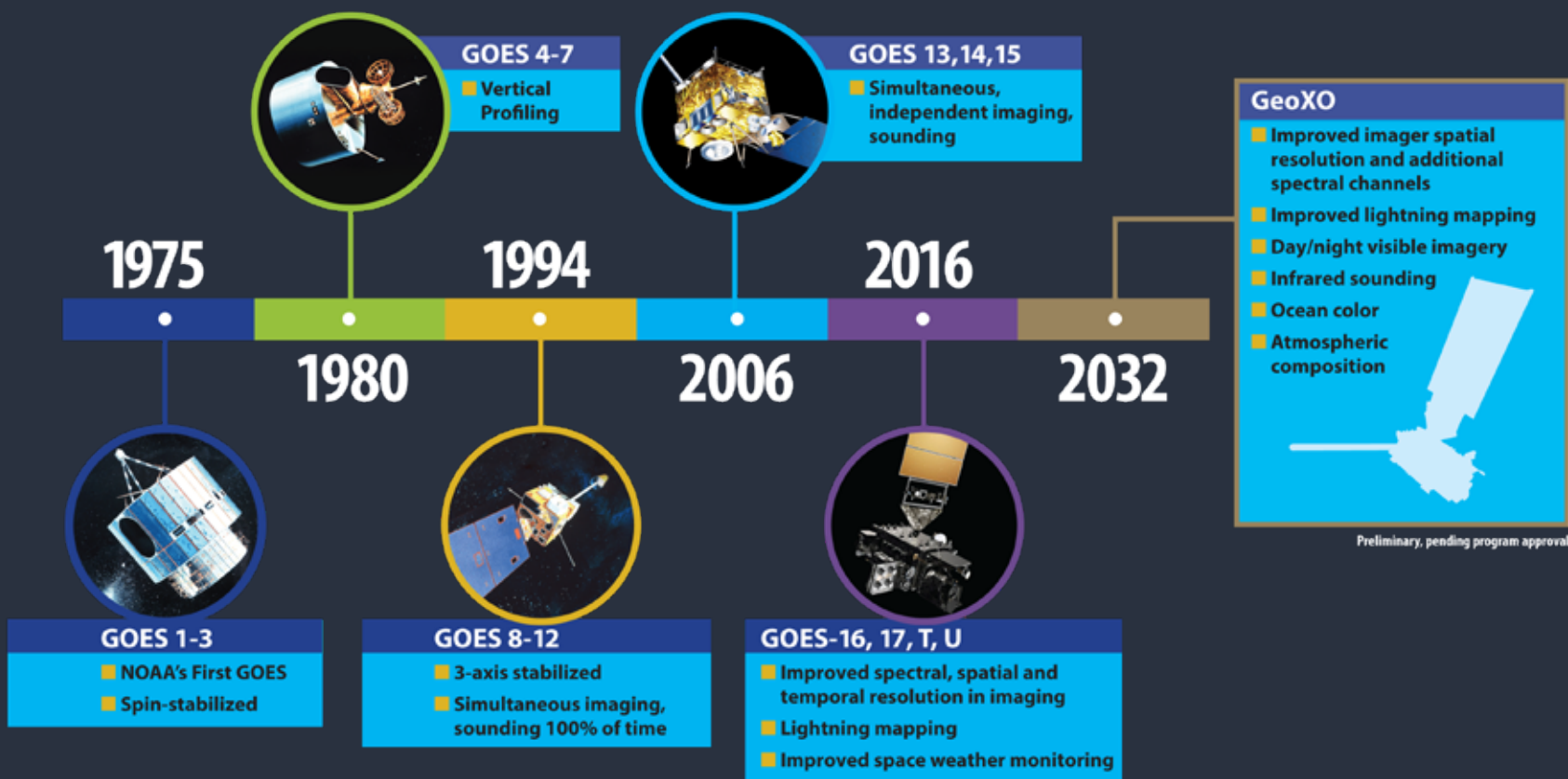
GeoXO: NOAA's Next Gen Geostationary Satellite System

Pam Sullivan, GOES-R/GeoXO Program Director

NOAA
National Environmental Satellite,
Data, and Information Service



History of Geostationary Operational Environmental Satellites

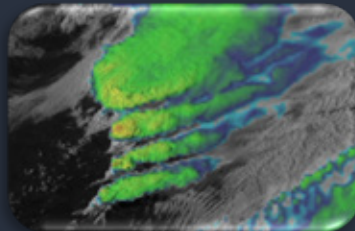


Background: Current GOES-R Capabilities

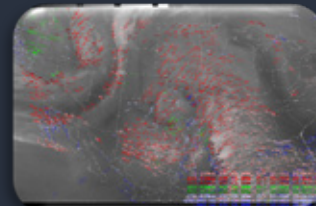
- Imagery and Lightning data provided by GOES satellites are essential for field office operations for mesoscale and short-range forecasting, and for issuing watches and warnings
- Solar and in situ measurements provide data for space weather forecasts and warnings



Tropical Cyclone Tracking and Evolution



Severe Storms



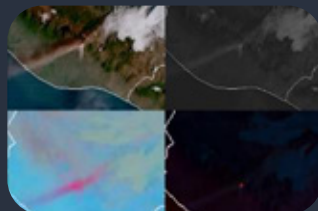
Atmospheric Winds



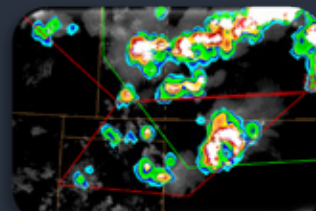
Solar Activity



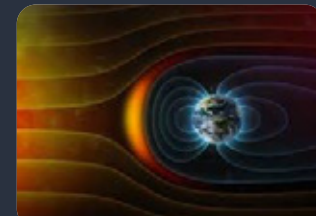
Wildfire Detection and Characterization



Volcanic Ash Tracking



Lightning

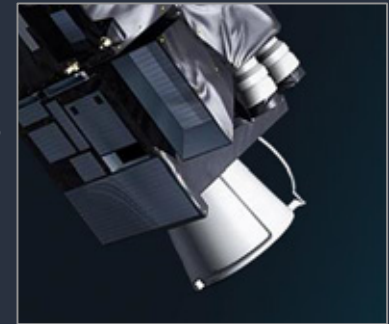


Space Weather In Situ Conditions

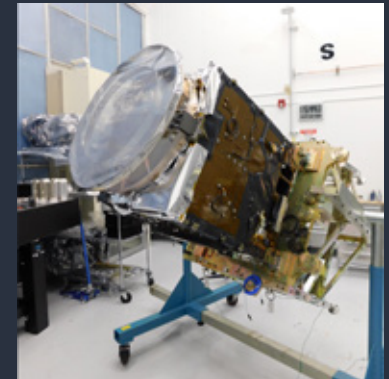
Background: Emerging GEO Applications

- Technology advancements, including NASA and international missions, provide opportunities to:
 - Improve observations for weather forecasting
 - **Day/Night Imager** provides visible imagery at night for:
 - Tropical cyclone analysis
 - Detection of low clouds, fog, and smoke
 - **Hyperspectral IR Sounder** improves:
 - Numerical weather prediction
 - Local severe storm nowcasting
 - Extend observations to ocean and atmospheric monitoring
 - **Ocean Color Instrument** monitors:
 - Dynamic coast/ocean features and ecosystem change
 - Coastal/inland water quality
 - Natural and anthropogenic hazards
 - **Atmospheric Composition Instrument** monitors:
 - Air quality
 - Linkage between air quality, weather, and climate

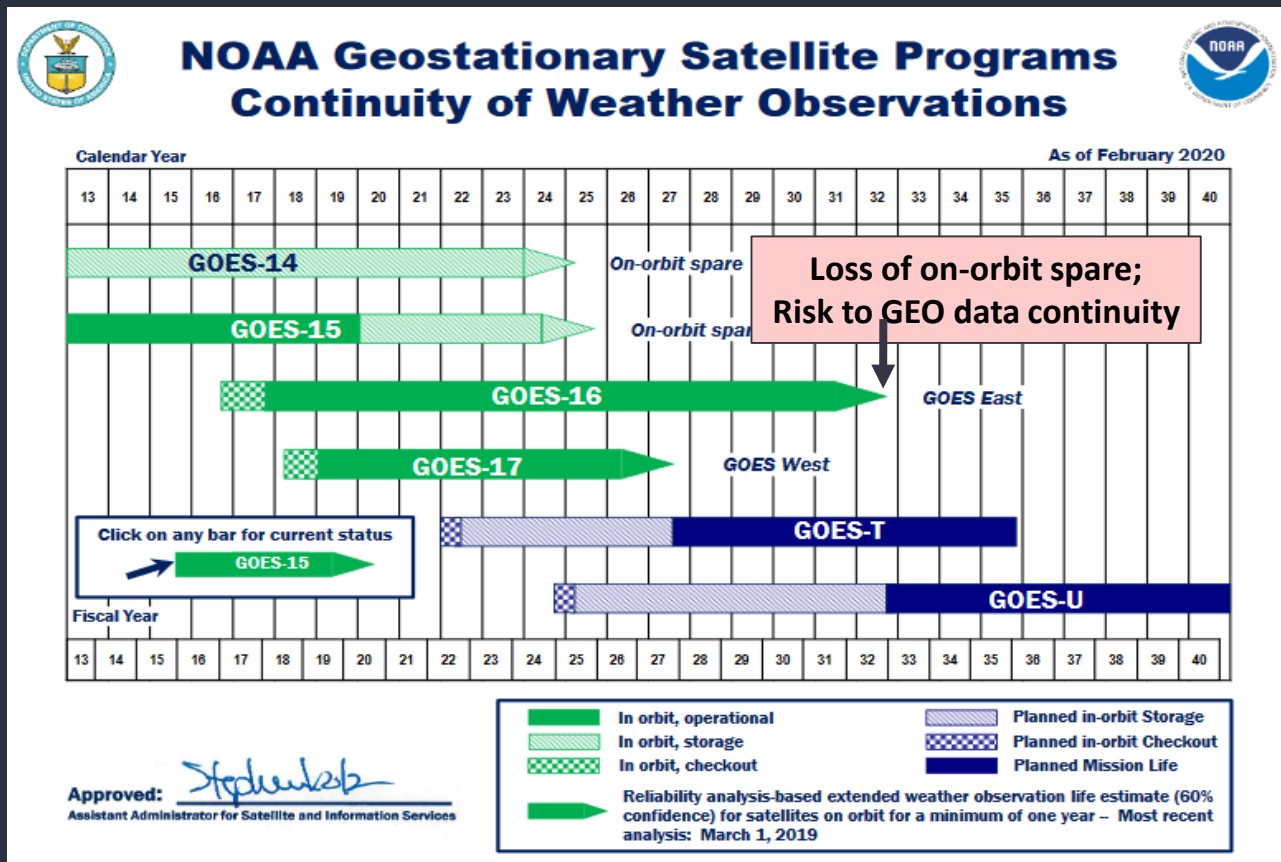
*EUMETSAT
Meteosat 3rd Gen
IR Sounder
Mission,
1st launch 2023*



*NASA TEMPO
Atmospheric
Composition
Instrument,
Launch 2022*



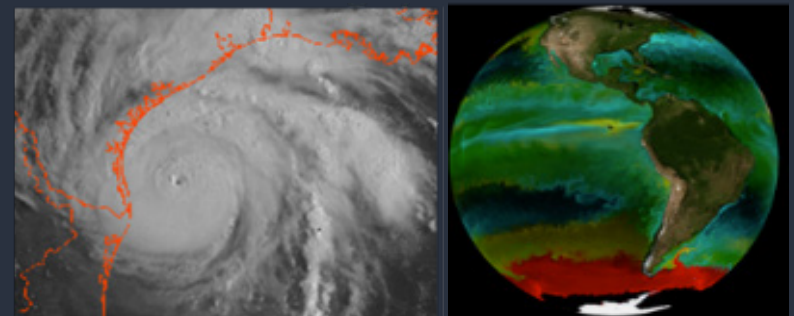
The Next Geo System, GeoXO, is Needed by 2032



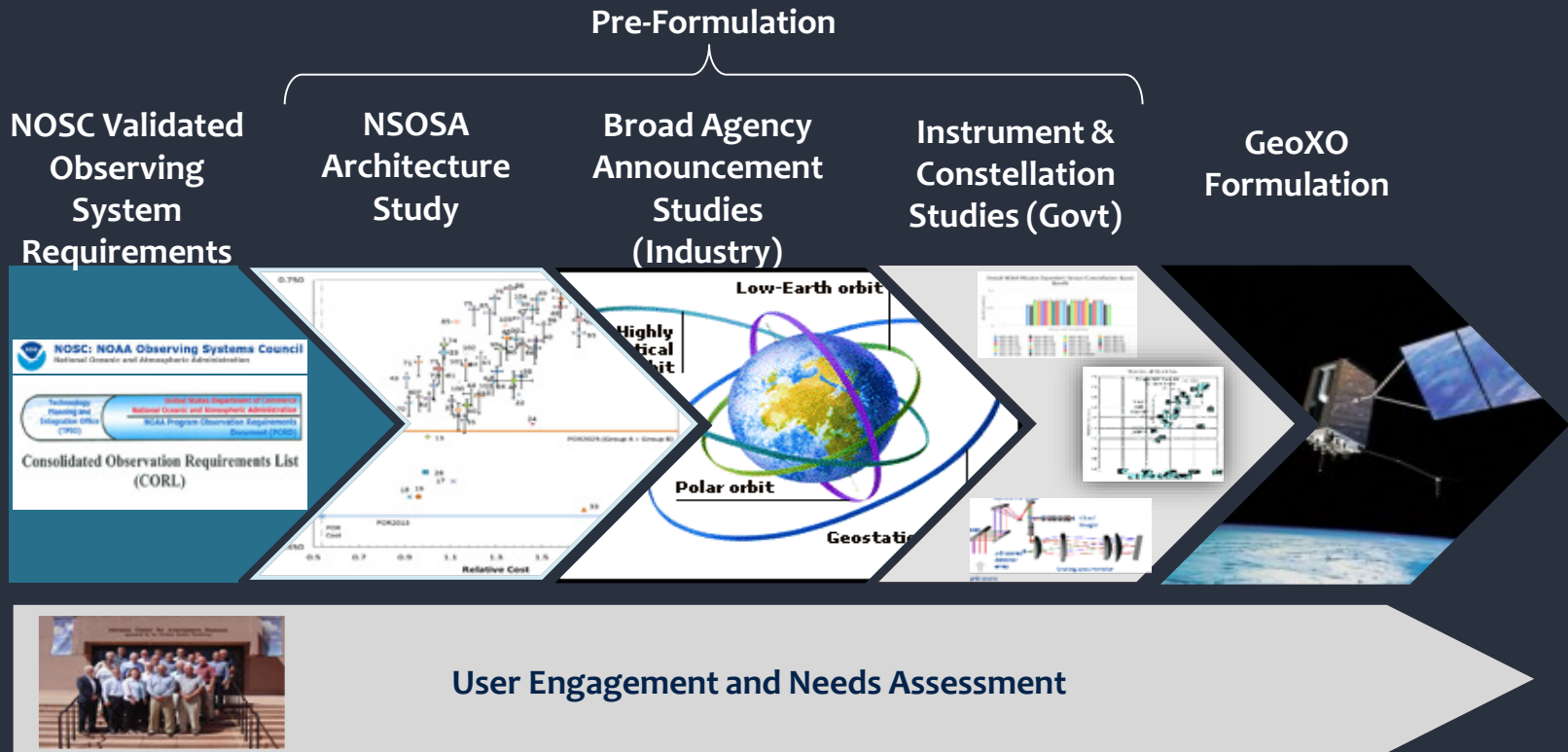
GeoXO Introduction

- ***GeoXO = Geostationary Extended Observations***
 - The mission to follow GOES-R to provide continuity for GEO Earth observations
 - Improves observations for weather forecasting
 - Extends observations to ocean and atmospheric monitoring
 - Anticipate providing accommodations for Space Weather mission instruments
- Program timeline (notional, pending approval)
 - Mission Concept Review, Spring 2021
 - System Requirements Review 2022
 - Program Approval 2022
 - Major Acquisitions Begin 2023
 - System Preliminary Design Review 2025
 - System Critical Design Review 2027
 - 1st Launch 2032
 - Operational timeframe 2032-2050+

Data Continuity, and New Observations

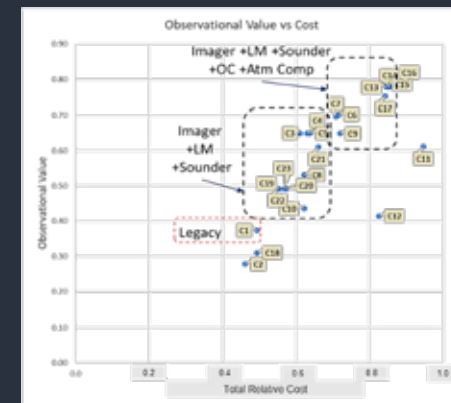


Process to GeoXO Program Definition



GeoXO Pre-Formulation Activities Completed over 2020-2021

- Determination of GeoXO observational priorities, informed by:
 - User needs assessments via workshops, surveys, conferences
 - Value assessments of observational capabilities
- Industry studies of instruments and architecture options
 - Explored designs for Instruments and non-traditional observing options including LEO satellite swarms and commercial data and services
 - Quantified performance, cost, risk, and conops
 - Results used to define program requirements and architecture
- Program instrument and constellation studies
 - Explored performance ranges for Instruments
 - Defined space weather instrument accommodations
 - Assessed options and selected constellation to best meet observing needs
- Generation of program requirements and cost estimate



GeoXO User Engagement in 2020-2021

- User Needs Virtual Workshops
 - Topics of Fire (178 attendees), Weather (233), Agriculture (152), Health (207), Oceans (142)
 - National agencies: CDC, DHS, DoD (USA, USN, USAF, USSF), DOE, DOI, EPA, FAA, FEMA, NASA, NIST, NPS, NSF, USAID, USDA, USFS, USNRC, USGS
 - State/Local: AL, CA, CO, CT, DC, FL, ID, IL, IN, LA, MA, MD, ME, MI, NJ, NY, OK, OR, PA, TX, UT, VI, VT, WA, WI, WV, Fresno, Dallas, Los Angeles, Tulsa, and several counties and tribal areas
 - International: WMO, Canada, Mexico, EUMETSAT, multiple Caribbean/South American orgs
 - Industry: more than 70 companies and advocacy groups from weather, transportation, communications, media, aerospace, natural resource, and energy sectors
 - Academia: more than 60 universities
- Community Meeting on NOAA Satellites
 - 1013 participants representing 33 countries
 - >250 organizations including NOAA, NASA, NSF, DoD (Army, Navy, USAF, USSF), USGS, DOE, NGA, BLM, GAO, plus international meteorological organizations, academia, and industry.
- Listening Sessions, Panels, and Presentations
 - National Weather Association
 - American Meteorological Society
 - American Geophysical Union



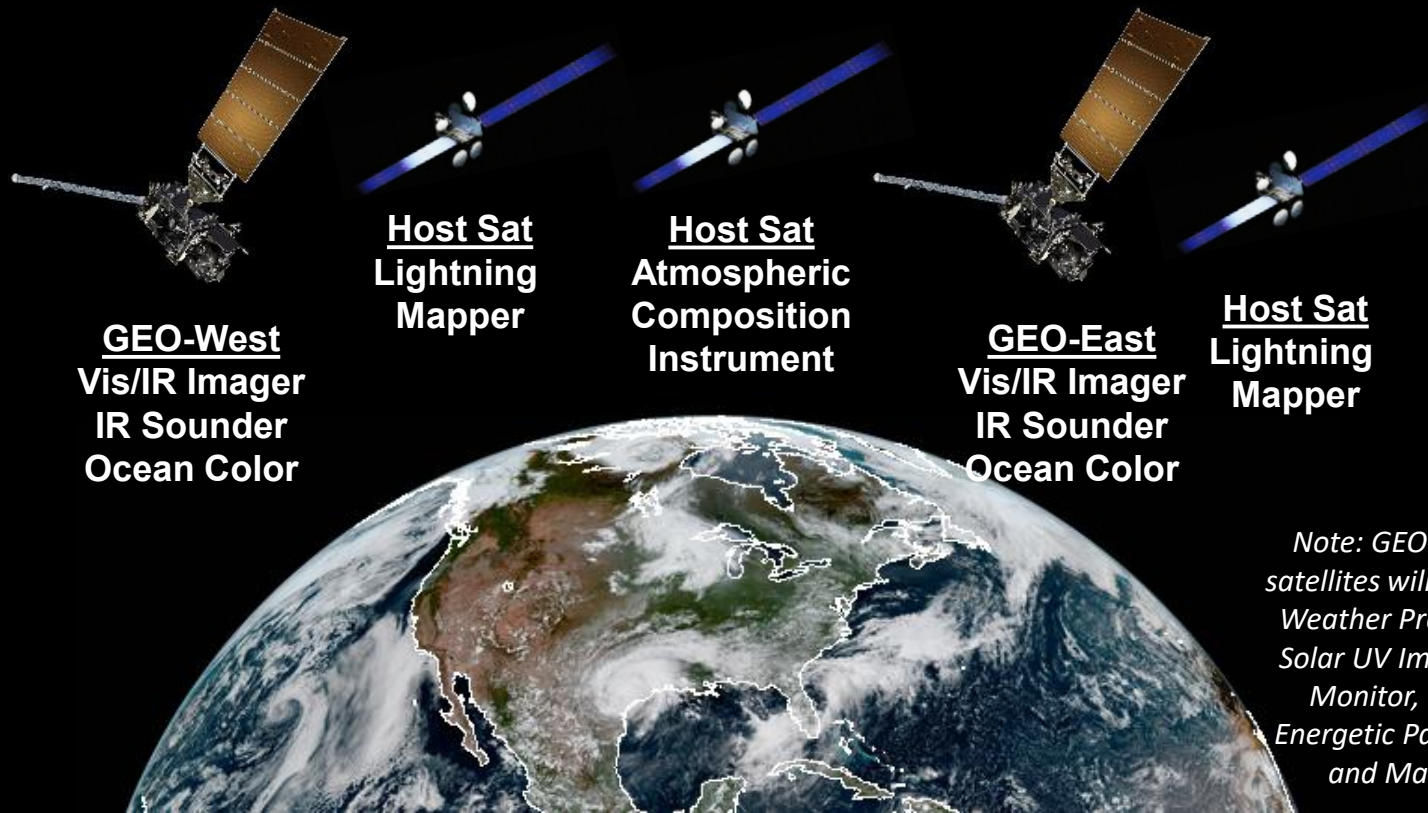
User Needs Translated to Requirements and System Solution

User Need	XORWG Requirement Translation	GeoXO Solution (Pending Program Approval)
Fire ignitions are not available quickly enough through satellite imagery, which forces response agencies to rely on in situ observations.	1 km resolution on a geostationary Imager 3.9 μm band	The GeoXO Imager aims to have a 3.9 μm with 1 km resolution
It is difficult to measure how high or low in the atmosphere (vertical profile) aerosols and other pollutants are.	Lower and Upper tropospheric retrievals of PM2.5 and Ozone	A UV/VIS very high spectral resolution spectrometer in geostationary orbit, designed for Atmospheric Composition retrievals
Real-time data for the full air column would benefit winter weather forecasting.	Retrievals of the vertical profile of temperature and water vapor available at low latency	An IR Hyperspectral Infrared Sounder will be able to provide retrievals of temp and WV profiles in clear sky regions
Forecasting convective weather over the Gulf Stream is needed.	Hemispheric coverage of total lightning occurrence at low latency	A geostationary Lightning Mapper will provide hemispheric coverage of lightning occurrence
Ocean imagery is not captured at a high enough temporal resolution (ideally hourly).	Ocean color retrievals at 1-2-hour daytime temporal cadence	A geostationary Ocean Color instrument will allow for OC retrievals every 1-2 hours during the day in clear sky regions
There is a need for a green visible band so that "True Color" products need not be estimated.	Imager spectral bands centered in the red, green, and blue portions of the spectrum	The GeoXO Imager will include spectral bands in the red, green, and blue portions of the spectrum, allowing for true color imagery
Horizontal winds in the troposphere are not measured in fine enough detail.	Wind vector retrievals throughout the 3-D troposphere	An IR Hyperspectral Sounder in geostationary orbit can be used to retrieve wind vectors in some areas at various vertical levels
Additional data on air pollution levels during heat waves is necessary.	High temporal retrievals of ozone, nitrogen dioxide, and PM2.5	A UV/VIS very high spectral resolution spectrometer in geostationary orbit, designed for Atmospheric Composition retrievals
It is difficult to track and forecast Harmful Algal Bloom movement throughout the day.	Frequent detection of Harmful Algal Blooms	An Ocean Color instrument in geostationary orbit allows for tracking of Harmful Algal Blooms



Recommended GeoXO Constellation

(Preliminary, pending program approval)

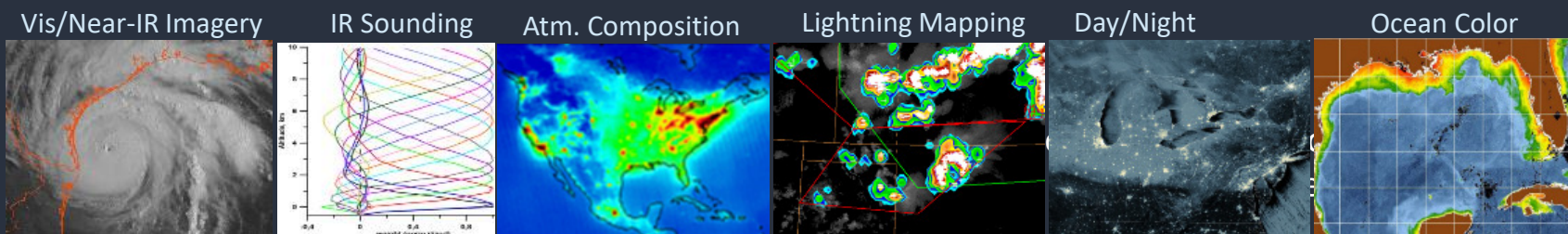


Note: GEO-East and West satellites will also carry Space Weather Program-provided Solar UV Imager, Irradiance Monitor, Coronagraph, Energetic Particle Detectors, and Magnetometer.



An Observing System for the Integrated Earth System

- The recommended GeoXO observations will provide a comprehensive understanding of the atmosphere, oceans, and weather in the U.S. and Western Hemisphere through 2050
 - Imager and Lightning Mapper provide continuity for monitoring severe weather and hazards
 - Day/Night Imager capability improves nighttime monitoring of severe weather and hazards
 - IR Sounder will improve numerical weather prediction and nowcasting for better forecasts
 - Ocean Color Instrument will enhance monitoring of ocean health and productivity
 - Atmospheric Composition Instrument will reduce health impacts due to poor air quality
- The recommended GeoXO constellation supports all observations in a cost efficient configuration
 - Prior NOAA/NASA investments, technology advancement, and use of commercial host services enable meeting these advanced observational needs at a GOES-R-level of investment
- GeoXO advances NOAA's observational capabilities and supports WMO's vision for 2040



Planning has begun for NOAA's next gen GEO system

- Now preparing for formal GeoXO program initiation at Milestone 1 in 2021
- Formulation Phase A/B is planned over 2021-2025 and will include continued user engagement – stay engaged with GeoXO via:
 - Program website: <https://www.nesdis.noaa.gov/GeoXO>
 - NOAA Satellite Conference and industry conferences: AMS, AGU, etc
 - Having GeoXO at your event: contact us at pamela.c.sullivan@noaa.gov
- We look forward to working with the community to develop GeoXO





Questions and Comments



- Additional Information and Backup Slides





NOAA's Himawari-8 Operational Plans

•Current Operations

–NOAA provides Himawari Level 2 products via the NESDIS BDP with 24/7 monitoring capability provided by the Office of Satellite Products and Operations (OSPO) and 24/7 product generation troubleshooting capability provided by STAR.

- Himawari L2 products available from NOAA BDP for general public access

- Cloud Products: Cloud Mask, Cloud Phase, and Cloud Height
- Derived Motion Winds (DMWs)
- Sea Surface Temperatures (SSTs)
- Rainfall Rate

- L1b data also available in native HSD format from NESDIS BDP and PDA (for operational users)

- Full Disk imagery in 10 min intervals, all channels



NOAA's Himawari-8 Operational Plans

•Future Operations

–NESDIS will move Himawari-8 L2 PG to the NESDIS Common Cloud Framework (NCCF)

- Generated L2 products will flow from NCCF to PDA and from PDA to operational users in netCDF4 format

–Himawari L2 products planned for generation and distribution from PDA for 24/7 operational users:

- Cloud and Moisture Imagery (CMI) in netCDF4 format
- Rainfall Rate
- Sea Surface Temperatures
- Derived Motion Winds
- Cloud Products

–Cloud Top Height, Clear Sky Mask, Cloud Top Phase

–Full operational capability ~ September 2021



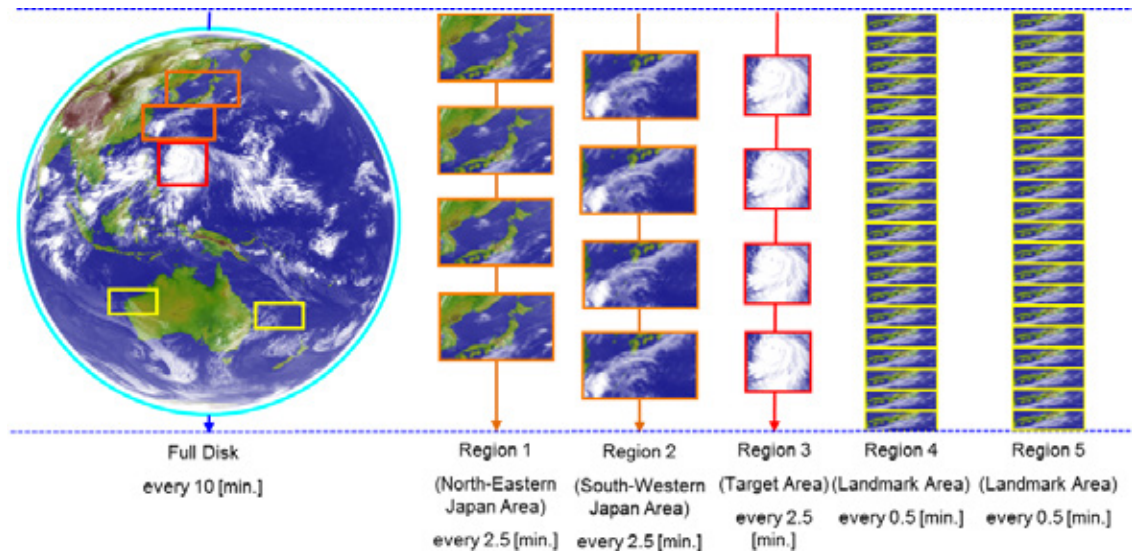
HimawariRequest Established to Support NOAA Operations



- NESDIS in collaboration with NWS established an account with JMA to use HimawariRequest, a service for NOAA operational offices to request relocations of the Himawari-8 (140E) 2.5 min Target Area (floating) sector
 - Enables rapid scanning of hazardous events in the Pacific Region to support NOAA operations
 - Target Area covers 1000 km x 1000 km every 2.5 min in all 16 AHI bands at full spatial resolution
 - NWS/SDM will be the point of contact for NOAA operations
 - All requests will be coordinated with SDM; analogous to NOAA GOES-R MDS coordination procedure
 - JMA website provides real-time location and schedule of Target Area for current operations
 - Requests for Target Area relocation will be sent via email to JMA for review and approval/disapproval
 - Requests limited to a 48 hour period; extensions are considered in extreme events
 - Target Area coverage of typhoons and active volcanoes will have priority



Himawari Scanning Sectors including Floating 2.5 min Target Area (Region 3)

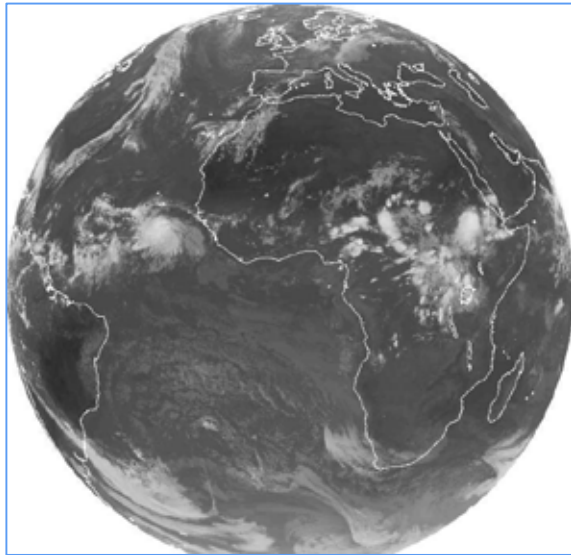


Only Full Disk and Target Area/Region 3 scans will be processed at NOAA/NESDIS



Meteosat Program Update

Current MSG Constellation



Meteosat-11 FD Image

SATELLITE	LIFETIME	POSITION	SERVICES
Meteosat-11	15/07/2015 – Fuel lifetime is until 2033	0°	0° SEVIRI Image Data. Real-time Imagery.
Meteosat-9	22/12/2005–Fuel lifetime is until 2025	3.5° E	Rapid Scan Service gap filling spacecraft and back-up to prime Met-11 spacecraft
Meteosat-10	05/07/2012– Fuel lifetime is until 2030	9.5° E	Rapid Scan Service Real-time Imagery.
Meteosat-8	28/08/2002 – Fuel lifetime is until 2022	41.5° E	Full IODC service

Primary Imaging Operations



Future Meteosat Third Generation (MTG) Satellites

- MTG-I1 (imager mission)
 - Projected launch date Q2/CY2022
 - fully operational by CY2023 at 0 degrees
 - 16 channel imager and lightning mapper
 - Temporal and spatial resolutions similar to GOES-R series
- MTG-S1 (sounder mission)
 - Projected launch date Q4/CY2023
 - fully operational by CY2024 at 0 degrees
 - Two Spectral bands: MWIR (4.44–6.25 μm) and LWIR (8.26–14.70 μm)
 - Spatial resolution of 4 km x 4 km at nadir

EUMETSAT Meteosat Configuration Plans



- Meteosat-9 will replace Meteosat-8 to support IODC mission in Q2/CY2022.

 - New location at 45.5E

- The relocation of Meteosat-10 to 0° and Meteosat-11 to 9.5°E, is currently planned for 2023. The swap duration will be in the order of 30+ days.

 - Meteosat-11 will begin support of Rapid Scanning Service (RSS) at 9.5°E

- MTG-I1 will be assigned to Full Disk Scan Service (FDSS) when starting operations at 0°, taking over the service from Meteosat-10 in 2023.

Metop Program Update



- Metop-A

- Operational EOL - November 2021

- Metop-B

- Operational EOL – August 31, 2023

- Prime Metop satellite since May 2020

- Metop-C

- Operational EOL: December 31, 2027

- Planned to become prime Metop when Metop-B leaves nominal orbit in 2023



- The new Metop-Second Generation (Metop-SG) series will operate in pairs

- Metop-SG A1

- Sounding and Optical Imaging instruments
- Planned launch – CY2023

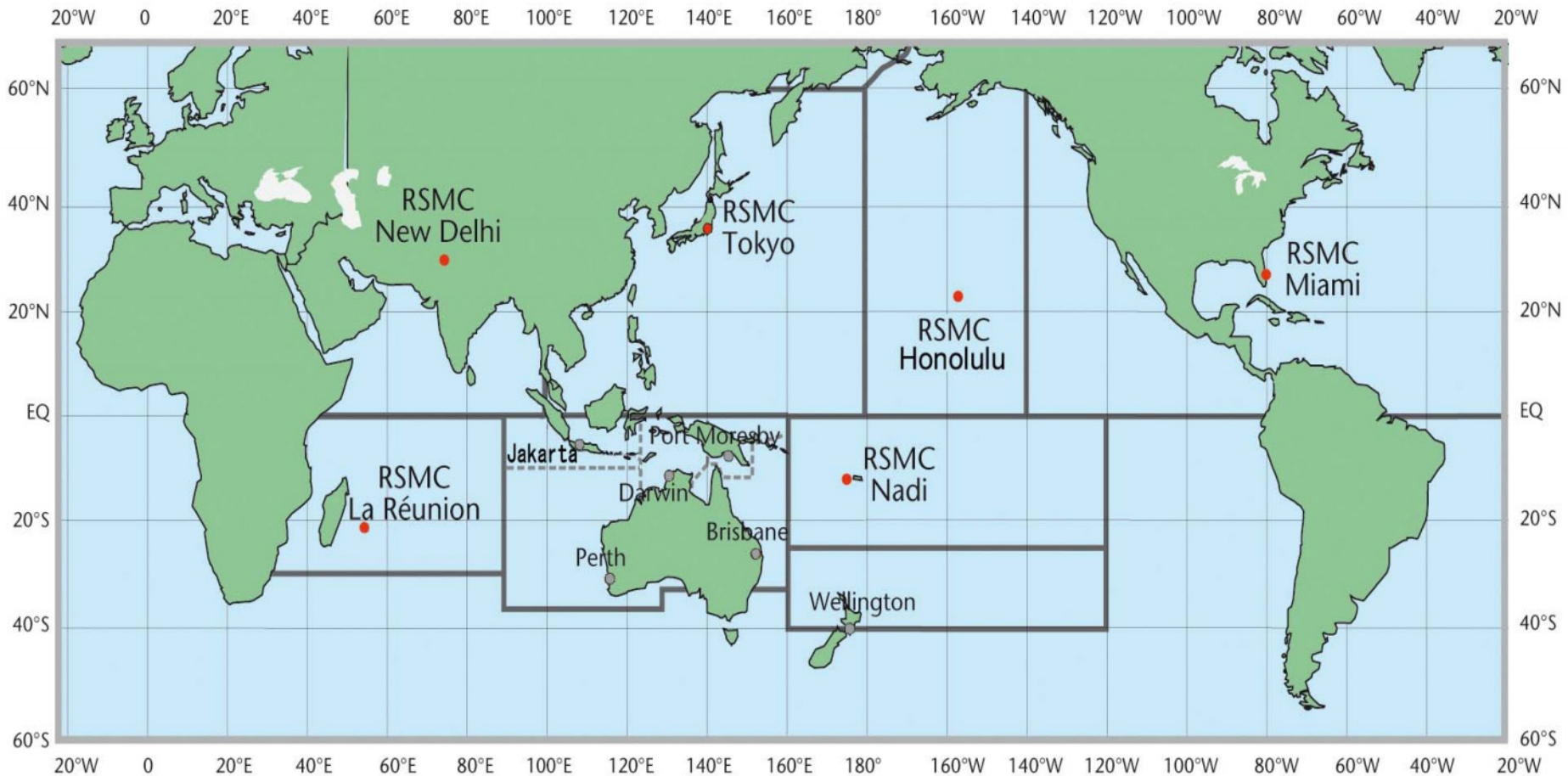
- Metop-SG B1

- Microwave Imaging and Sounding instruments
- Planned launch – CY2024

- Metop-SG A2 and B2

- Planned launches in 2030s

Regional Specialized Meteorological Centers





Tropical Analysis and Forecast Branch Area of Responsibility

