



NOAA: Copernicus Data in Support of the NOAA mission and the Value of International Partnerships

National Environmental Satellite,
Data, and Information Service

May 26, 2021

Dr. Mitch Goldberg, Chief Scientist

Abstract

Copernicus Data in Support of the NOAA Mission and the Value of International Partnerships:

Copernicus data across all Sentinel missions has become an integral part of NOAA products and services.

Cooperation has expanded beyond just data exchange into joint satellite mission cooperation.

As NOAA continues to leverage Copernicus data, it looks towards future Copernicus missions as opportunities for further cooperation that would directly benefit the NOAA mission.





NOAA Operates 16 Satellites



- USA
- JAPAN
- SOUTH KOREA
- INDIA
- CHINA
- FRANCE
- RUSSIA
- SPAIN



- NOAA
- EUMETSAT
- EUROPEAN COMMISSION
- NATIONAL SPACE ORGANIZATION (NSPO)
- EUROPEAN SPACE AGENCY
- NASA
- DEPARTMENT OF DEFENSE

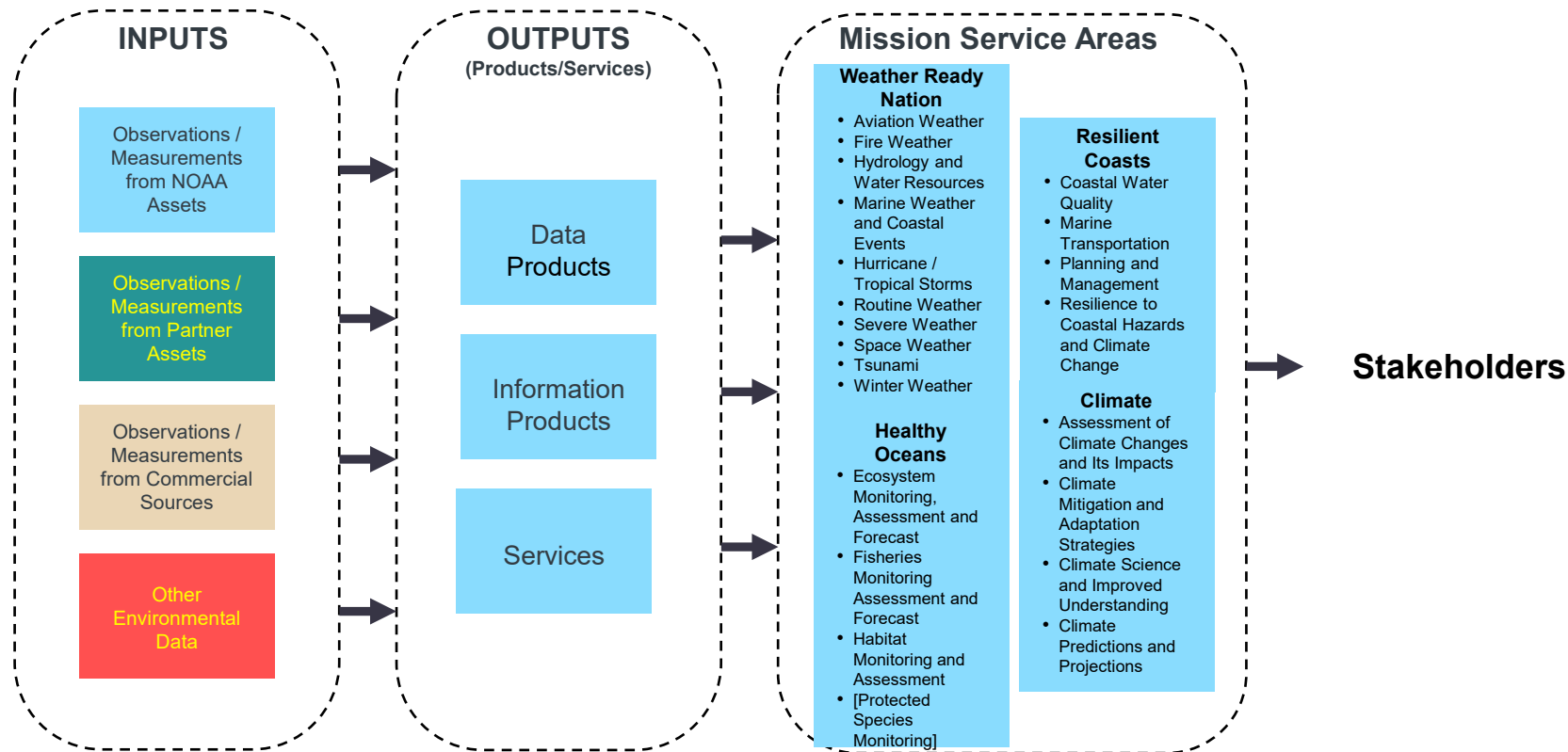


- GEOSTATIONARY ORBIT
- NEAR-POLAR ORBIT
- LAGRANGE POINT 1





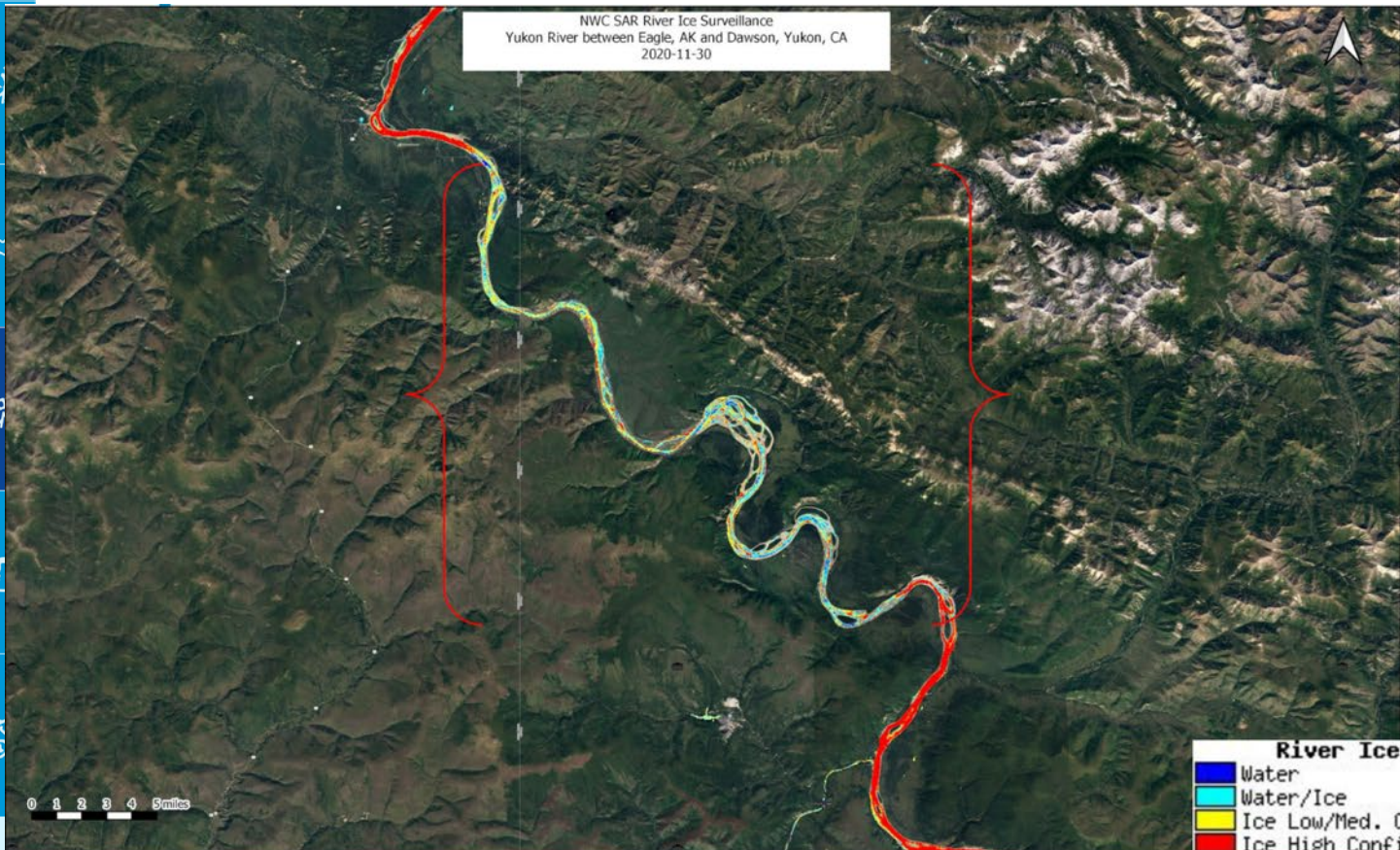
The NESDIS Portfolio Supports NOAA and Partner Missions



* NESDIS Products/Services also support the DoD tactical, NASA science and Emergency Management missions



Sentinel 1 SAR



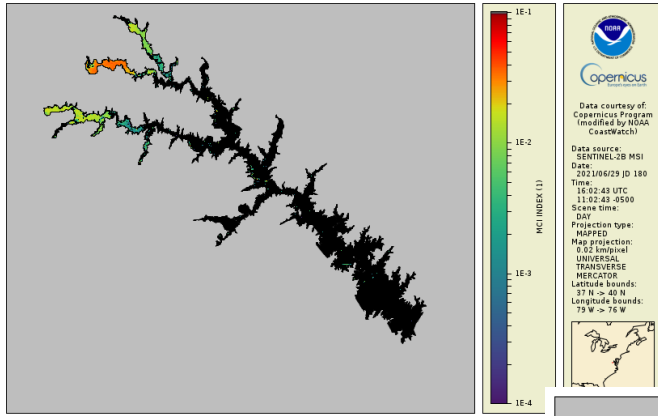
Chinook Winds opened a portion of the Yukon River between Eagle, AK and Dawson, Yukon.



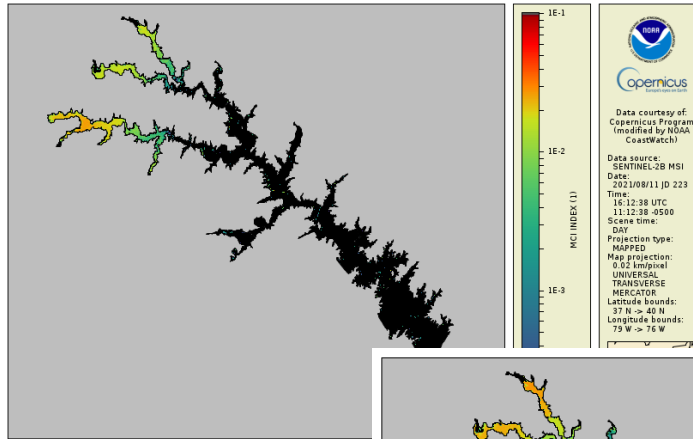
2021 Virginia Lake Anna *Microcystis* bloom



Jun 29



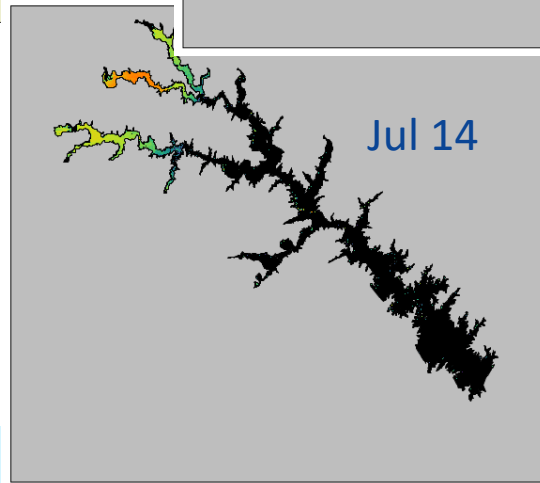
Aug 11



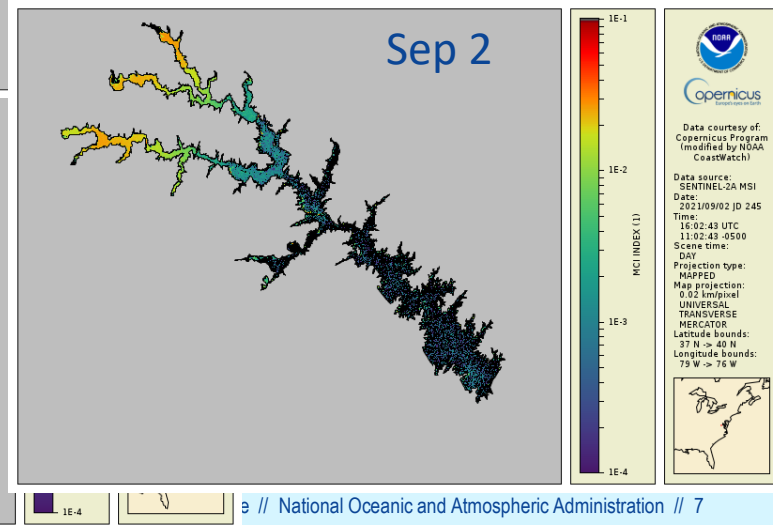
“We actively used the Sentinel-2 MCI images to inform our water sampling activities this year...”

ACA is developing a Cyanobacteria Mitigation, Remediation, & Prevention Plan...and the Sentinel-2 data is being used to inform this plan”

Harry Looney, LACA Water Quality Project Officer

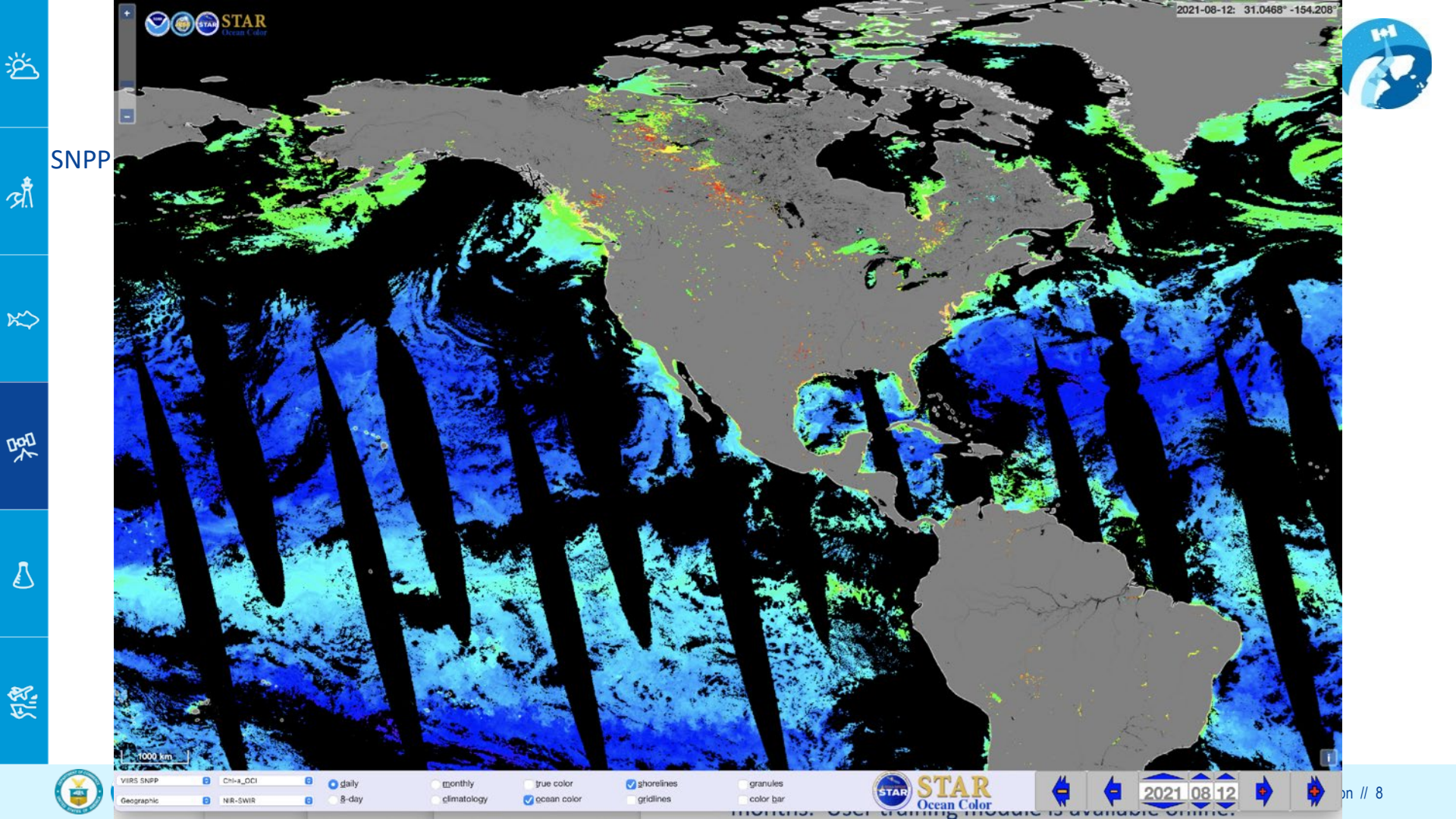


Jul 14



Sep 2





2021-08-12: 31.0468° -154.208°

NOAA NASA STAR Ocean Color

SNPP

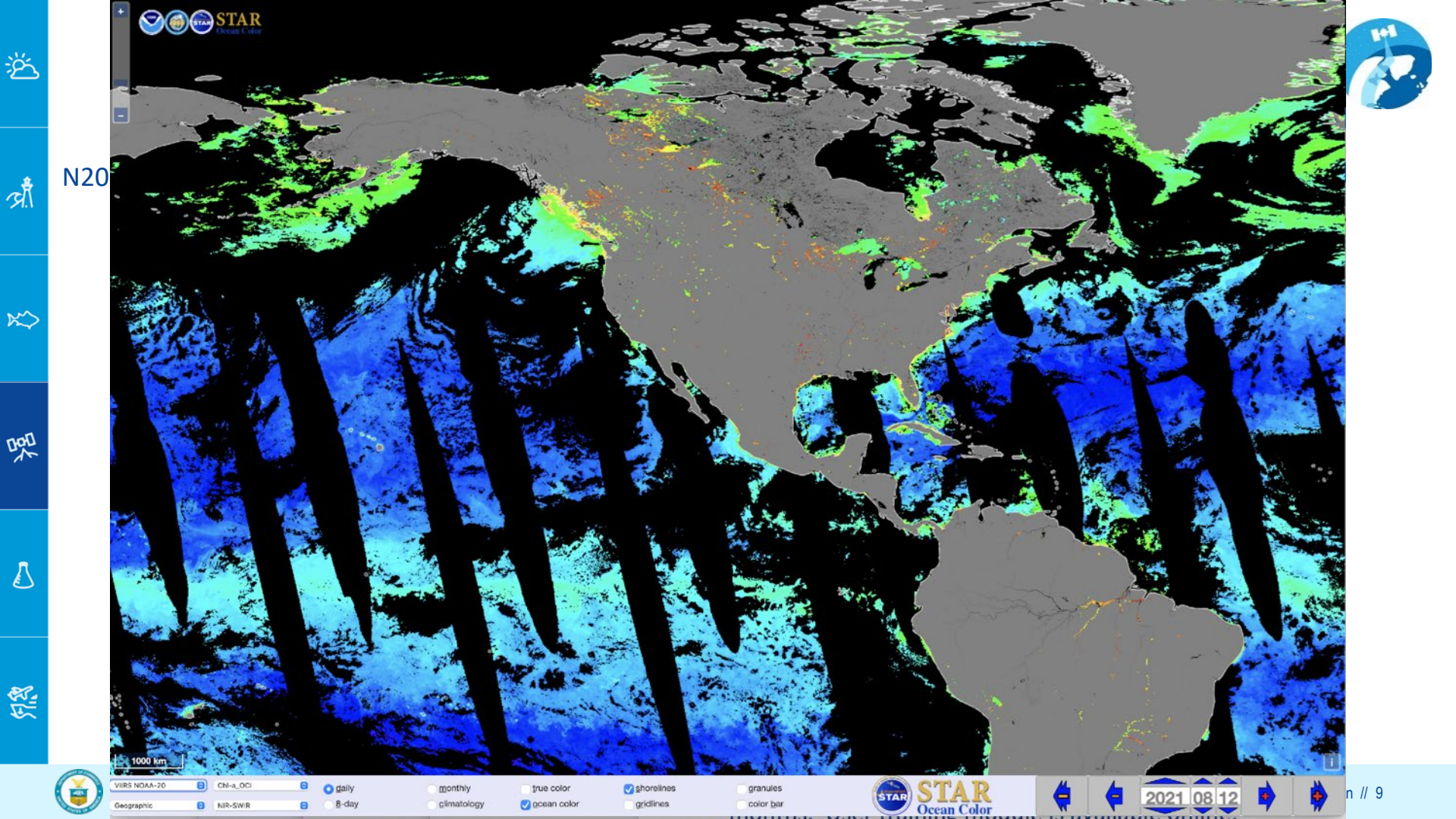
1000 km

VIIRS SNPP Chl-a_OCI daily monthly true color shorelines granules
Geographic NIR-SWIR 8-day climatology ocean color gridlines color bar

STAR Ocean Color

2021 08 12

on // 8



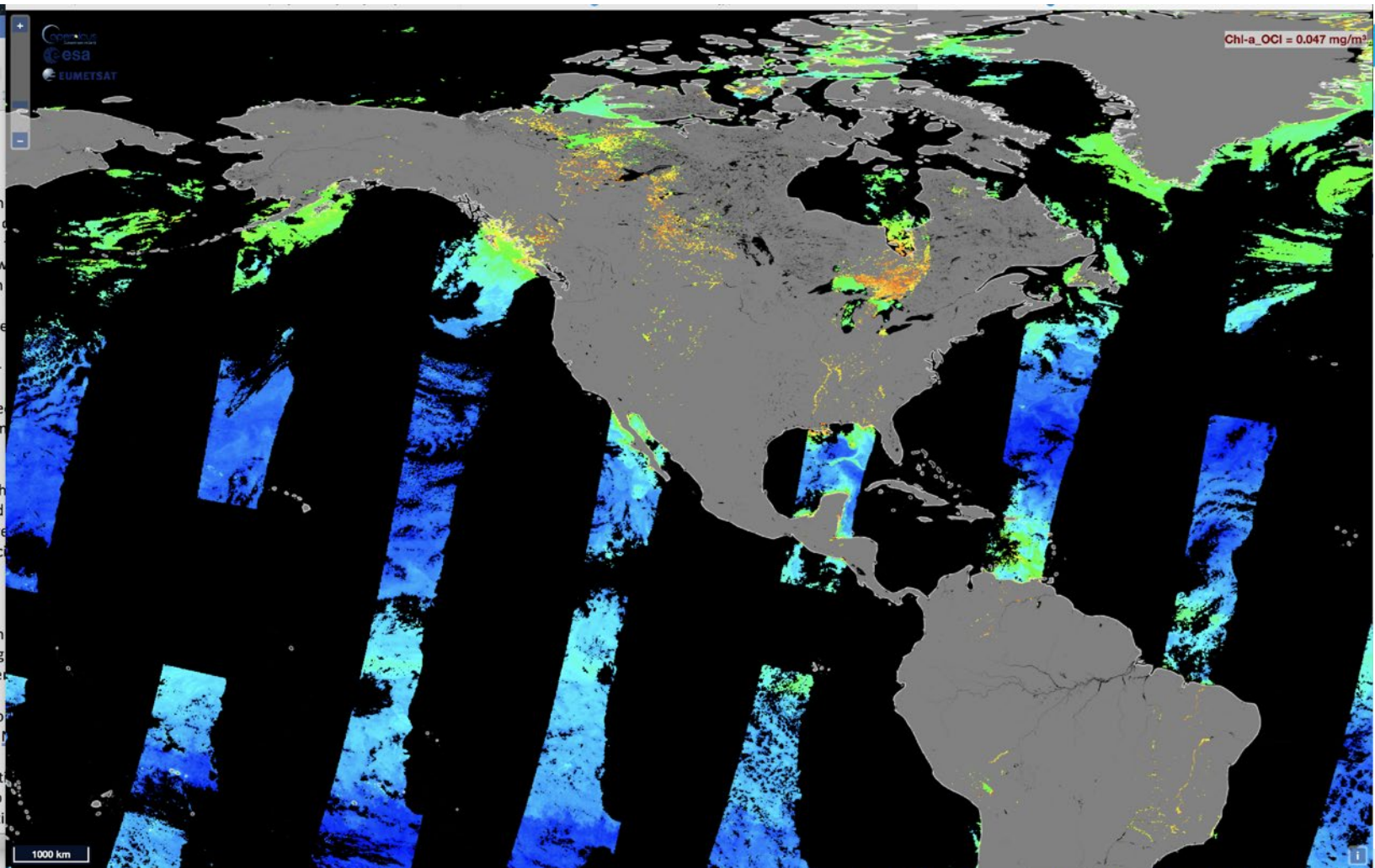
N20

1000 km



S3A

Chl-a_OCI = 0.047 mg/m³



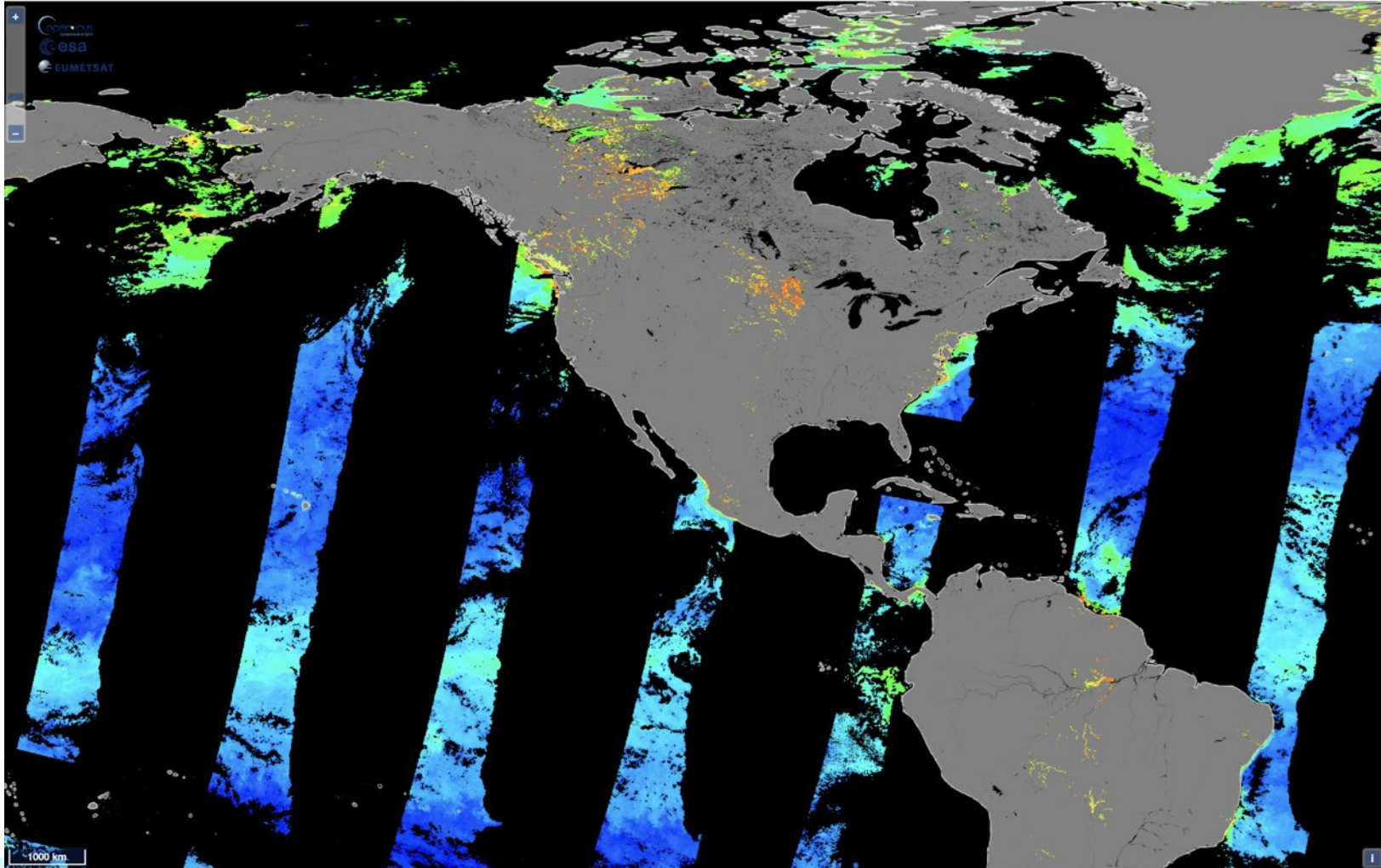
DLCI Sentinel3A Chl-a daily monthly true color shorelines granules
 Geographic DLCL_NRT 8-day climatology goan color gridlines color bar



2021 08 12



S3B



OLCI Sentinel3B
 Chl-a
 daily
 monthly
 climatology
 Geographic
 OLCI_NRT
 8-day

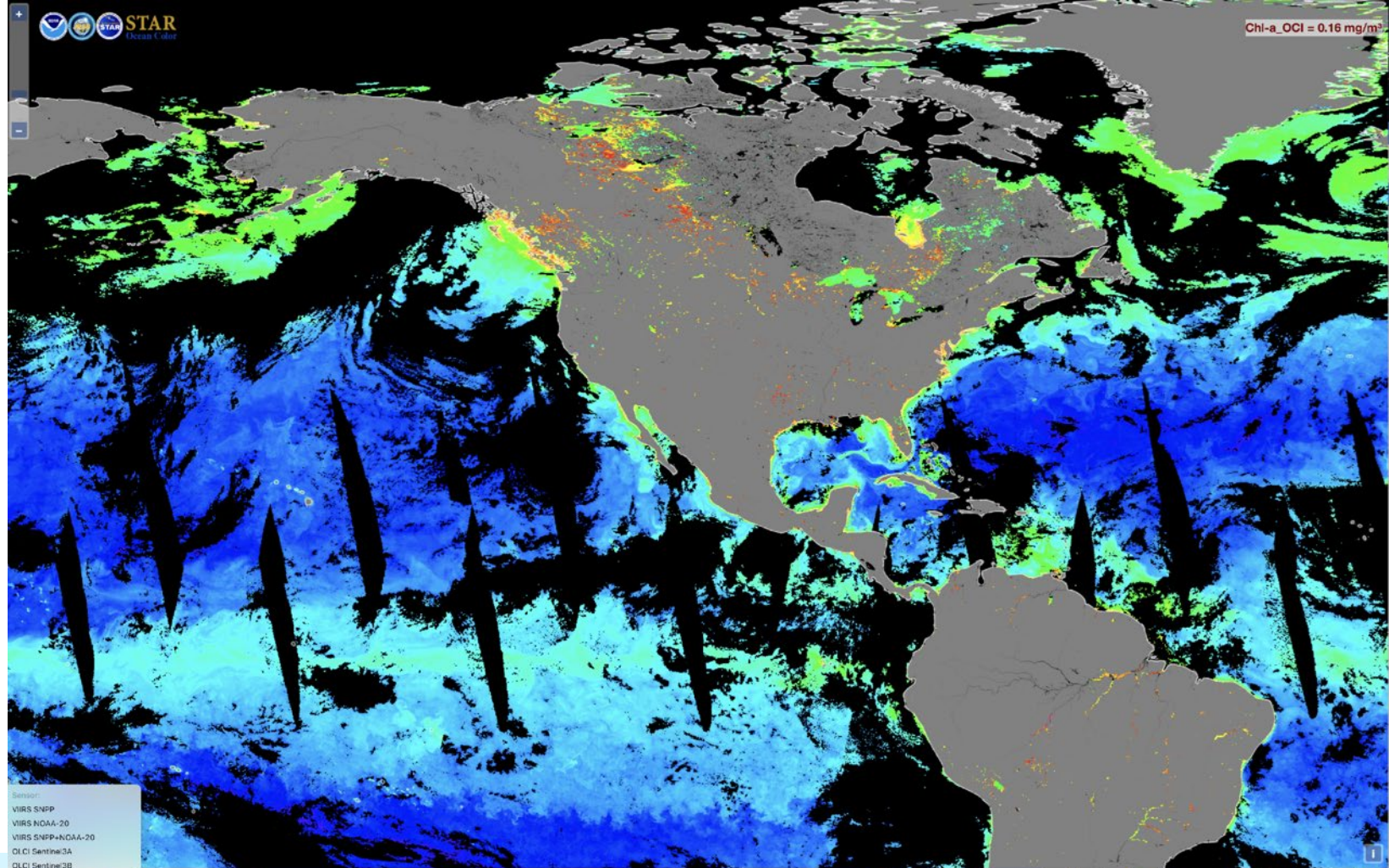
true color
 ocean color
 shorelines
 gridlines
 granules
 color bar



Navigation icons: Home, Back, Forward, Refresh, and a date display showing 2021 08 12.



Merged



Sensor:
VIIRS SNPP
VIIRS NOAA-20
VIIRS SNPP+NOAA-20
DLCI Sentinel3A
DLCI Sentinel3B

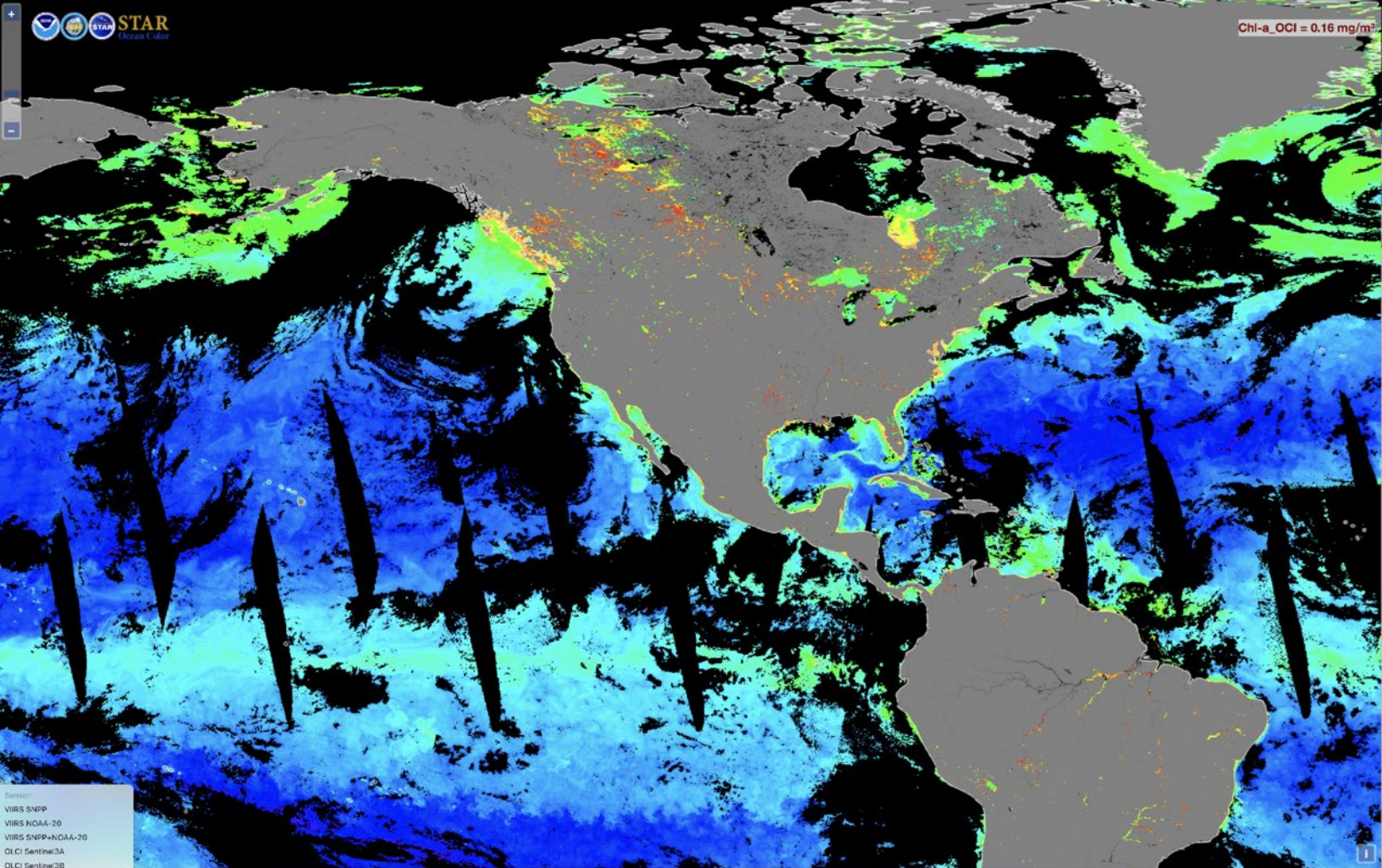
VIIRS SNPP+NOAA-20 + OLCI/A/B
SGLI GCOM-C
OCOCI

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<input type="text" value="SWIR"/>	<input type="radio"/> 8-day	<input type="radio"/> climatology	<input checked="" type="checkbox"/> ocean color	<input type="checkbox"/> gridlines	<input type="checkbox"/> color bar





Merged



Sensor:
VIIRS SNPP
VIIRS NOAA-20
VIIRS SNPP+NOAA-20
DLCI Sentinel3A
DLCI Sentinel3B

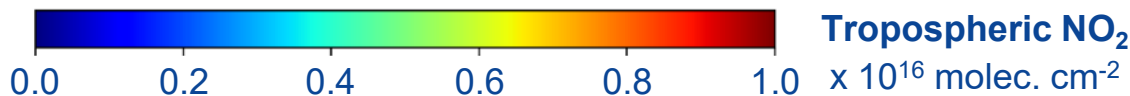
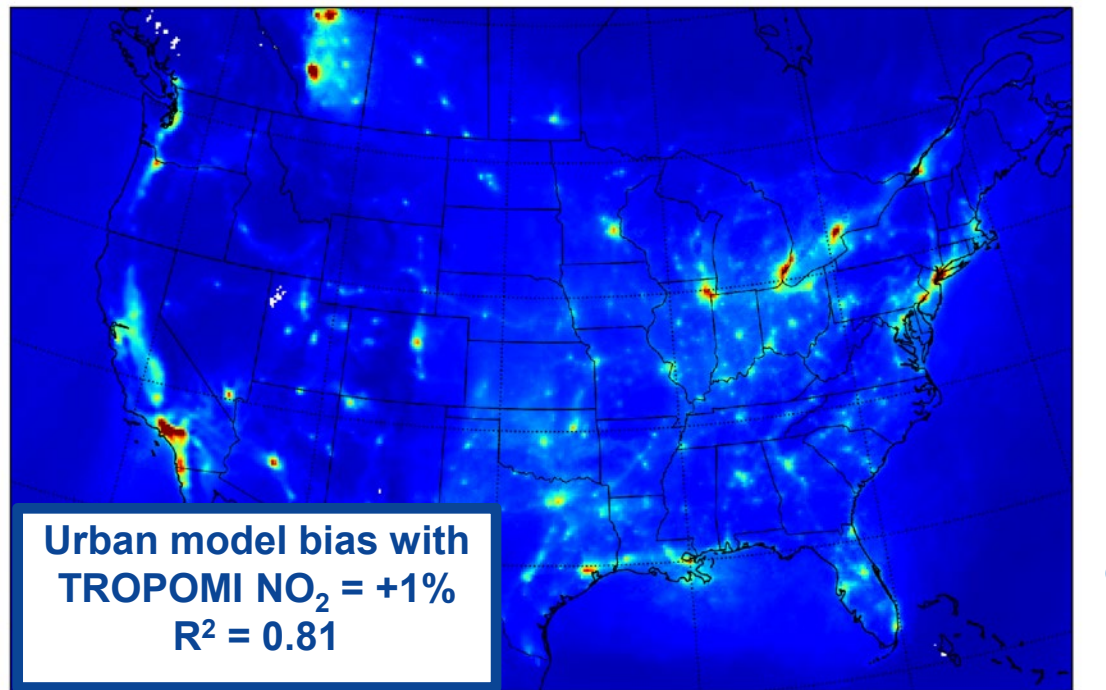
VIIRS SNPP+NOAA-20 + OLCI/A8
SGLI GCOM-C
OCOCI

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<input type="text" value="SWIR"/>	<input type="radio"/> 8-day	<input type="radio"/> climatology	<input checked="" type="checkbox"/> ocean color	<input type="checkbox"/> gridlines	<input type="checkbox"/> color bar



Quantifying Urban Emission Changes with Satellite NO₂ and Formaldehyde

WRF-Chem (12 km x 12 km) – July, 2018



WRF-Chem Modeling
w/ updated NOAA CSL
emissions through 2018

Strong agreement
with TROPOMI NO₂

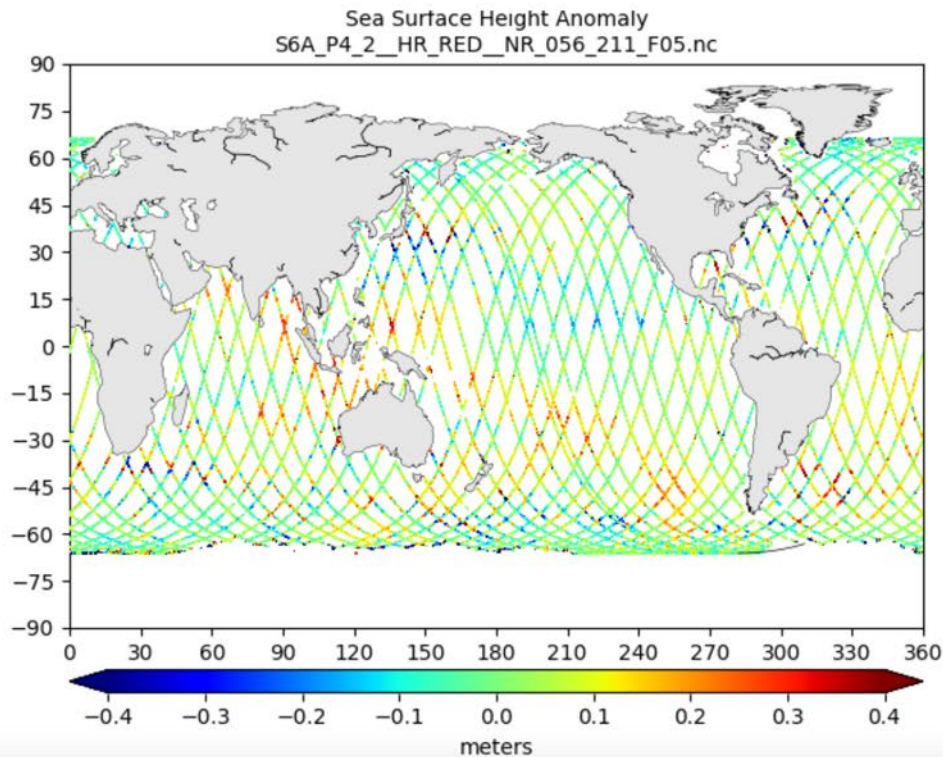
(Li et al., in preparation)

How do urban NO_x and VOC
emissions change during COVID-19?



Sentinel-6 High-Rate - Near Real-Time Altimeter Validation System (NRTAVS) - Laboratory for Satellite Altimetry - NOAA / NESDIS / STAR

Map of Values



Feedback approach: We provided a presentation on the future Sentinel Missions along with their Mission Requirements Documents to NOAA services line office representatives and requested initial feedback on how the new Sentinel missions can contribute to NOAA services

Sentinel-7: Anthropogenic CO2 emissions monitoring (CO2M)

Sentinel-8: High Spatio-temporal Land Surface Temperature (LSTM)

Sentinel-9: Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL)

Sentinel-10: Copernicus Hyperspectral Imaging Mission for the Environment (CHIME)

Sentinel-11: Polar Imaging Microwave Radiometer (CIMR)

Sentinel-12: Radar Observing System for Europe - L-band SAR (ROSE-L)



7: Anthropogenic CO2 emissions monitoring (CO2M).

OAR/GML (Global Monitoring Lab)	Sentinel-7 CO2M will provide useful constraints on global carbon flux estimates produced by NOAA's CarbonTracker and other carbon data assimilation systems. Sentinel-7/CO2M will provide global continuous coverage, and thus will fill spatial/temporal gaps in the in-situ sampling. The CO2M data could be assimilated in CarbonTracker, allowing better constraints on both biospheric and anthropogenic carbon fluxes. Satellite observations with well understood uncertainties and stringent QA/QC procedures will be an important complement to NOAA's in-situ observations in verifying greenhouse gas inventories produced by the US EPA and similar regulatory entities around the world.
OAR/GLERL (Great Lakes Environmental Research Lab)	Great Lakes application for carbon monitoring and cycling, with surface-water CO2 monitoring part of Lab activities.



8: High Spatio-temporal Land Surface Temperature (LSTM)

NESDIS	Fires- Map and detect wildfires. The LSTM will have daily coverage of land and coastal areas at 30-50m resolution (in comparison, Landsat has 30m resolution with a 16 day revisit). One potential flag is that the sensor includes fire detection without 3.9 micron channel for fire radiative power, however ET/LST will allow much better monitoring of wet/dry biomass accumulation in forests. Ancillary information is planned to be integrated into the Hazard Mapping System (HMS) to support a higher quality fire analyses, and example parameters include biomass accumulation, and a ground moisture index.
NESDIS	Volcanic Ash- Improved mapping and assessment of volcanic ash activity. High resolution imagery will allow for better visual discernment of ash versus cloud (assuming the eruption penetrates the cloud deck). This, combined with a frequent revisit cycle allows for more continuous monitoring of ash extent. Current daily global coverage is limited to MODIS 250m and VIIRS 375m.
NESDIS	Oil Spills- Increased detection of coastal oil spills, or offshore oil spills that impact coastlines, by using the VNIR bands. Hundreds of well-heads and drilling structures exist within 3mi off of the Gulf Coast, resulting in numerous oil spills on an annual basis. Many times, SAB is the first unit to report a surface sheen, which is then used by the Federal and State response authorities and damage assessment teams. Conversely, SAB is alerted to several oil spills that unfortunately aren't scheduled to be imaged by satellite for several days.
OAR	Coastal water temperatures and updating the current Great Lakes Surface Environmental Analysis blended product. There have also been past projects that monitor coastal thermal plumes from power plants along the Great Lakes coastline
NMFS	High Temperature Events (HTEs.) There are NMFS mission objectives include work in the coastal zone, including the need to support environmental indicators about the heat in these regions.
NWS	Multiple Applications. LSTM mission will support detailed fire and burn scar mapping, improved imaging of urban heat islands during summer heatwaves, and supplemental observations of aerosols and ice, which are also important to quantifying land surface temperature. This mission would provide detailed observations of fronts and downslope winds in clear fields of view. LSTM mission products could contribute to the creation of localized climatologies based on wind regime, season, and coastal water temperature.



9: Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL)

NESDIS	High Latitude	At present, radar altimetry of the oceans and sea ice at high-latitudes is only available from CryoSat-2, launched in 2010. The Copernicus CRISTAL mission is the only planned mission that will provide coverage of polar altimetry for NOAA users and there is an impending gap when CryoSat-2 reaches its end of life. By operating the first dual-band altimeter, CRISTAL will provide high-resolution measurements of sea ice thickness and land ice elevation and their variations, with the capability to determine snow depth on ice. In addition, ocean surface and ocean topography will be enhanced to improve NESDIS products for ocean heat content and provided to the National Weather Service and National Ocean Service for data assimilation. CRISTAL will provide improved near-real-time winds and waves that can be used by the Ocean Prediction Center for marine hazard warnings. The 3D topographic view will offer a unique satellite observation allowing for improvements in sea ice parameterization, river monitoring, ocean surface feature detection, glacial surface deformation, and snow depth and water equivalency estimation. When used in conjunction with other instruments like SAR, altimeters, and optical sensors, CRISTAL will improve the parametrization and accuracy of measurements made with these other instruments.
OAR	Great Lakes Ice	Depending on coverage for the Great Lakes, increase the availability of imagery for ice thickness and detection for the US Coast Guard. This is currently a CoastWatch Central product
NMFS	Arctic	Data on ice thickness, ice sheet elevations, and water height from the altimeter and microwave radiometer would be useful to NMFS in areas such as the Bering Sea and the Arctic. This mission may benefit the Antarctic Ecosystem Research Division at the Southwest Fisheries Science Center.
NWS	Wave height & snow depth	Top-tier priority. CRISTAL altimeter will provide wave height and snow depth, continuing observations the NWS currently uses from Jason. Arctic and southern ocean sea-ice thickness and its snow-depth. Support applications related to snow cover and permafrost



10: Copernicus Hyperspectral Imaging Mission for the Environment (CHIME)

NESDIS	Oil Spills & Marine Debris	Oil Spills and Marine Debris- The ability to detect “see” and characterize marine oil and marine debris will significantly improve with hyperspectral imagery. For oil spills, it is possible to spectrally differentiate thin (non-recoverable) from thick (recoverable) oil, which determines how the response teams decide to most effectively clean up and mitigate the oil. For Marine Debris, high spectral resolution is critical to distinguish plastics from false positives, such as wave caps. Currently, SAB does not have access to hyperspectral data, but even so, the hyperspectral sensors that are currently in orbit have revisits as coarse as 1-2 images over a given point each month. A key observational requirement of Sentinel-10 is high temporal frequency, medium to low latency. Frequent revisit will offset the small imaging swath, and improved latency will allow the satellite-derived information to be used in response efforts. Additionally, CHIME has channels in the SWIR that are critical for the detection of marine plastic.
NOS	HABs	Harmful algal blooms: We have limited high spatial resolution capability, for bays and in support of EPA on small lakes. Sentinel-2 also cannot discriminate blooms. Currently 5-day repeat, but with glint issues in summer limiting monitoring. CHIME will complement to the MSI on Sentinel-2. and provide discrimination. In combination with Landsat-10 we would approach 3 day repeat, which would assure monitoring.
NOS	Bathymetry	Satellite derived bathymetry: Research area. CHIME might provide additional data to help us with satellite derived bathy, although we would have some work figure out how to have it (20 m) inform the Sentinel-22 10 m data.
OAR	HABs	Water quality management of harmful algal blooms (HABs) located within inland waters, i.e. Lake Erie, Saginaw Bay (Lake Huron), Green Bay (Lake Michigan) and Duluth, Apostle Islands (Lake Superior)
OAR	HABs	Phytoplankton community composition for inland and coastal waters, currently in development with airborne hyperspectral data that is collected weekly during the HAB season
NMFS	Various	Multiple critical NMFS applications: Of all the missions, this appears to be the most interesting to NMFS with capabilities to identify oil spills and to deliver water leaving radiances and a series of related optical parameters that mirror our own geophysical parameter needs for JPSS, and GeoXO in the area of optical oceanography, biological oceanography, and fisheries science. This mission appears to have the potential to contribute to the achievement of many NMFS mission objectives over the majority of our operating areas.
NWS	Modeling	Future environmental modeling efforts will focus on forecasting for a fully-coupled earth system. More precise observations of land use, flood extent, and anthropogenic emissions will benefit this work. Currently the National Water Center uses a flood and water mask derived from Sentinel-2, the predecessor mission for CHIME.



11: Polar Imaging Microwave Radiometer (CIMR)

NESDIS & NWS	Tropical	Tropical- The 36.5 GHz brightness temperature (Tb) imagery will be used to assess cyclone structure and center location in the low to mid levels, aiding the SAB Dvorak analyst in their assessment.
NESDIS	Precipitation	Precipitation- Improved precipitation rate estimates, total precipitable water (TPW), cloud liquid water (CLW), SST, and ocean wind speed. TPW observations are needed, both as a stand-alone product and as contributions to a series of operational TPW products. Rain rate over the ocean can be done with the CIMR channel compliment (via CLW). It should enhance the retrieval of precipitation over land.
OAR	SST and Arctic	OAR has significant interest in Sentinel-11 CIMR data for SST and Arctic applications. Passive microwave data at these frequencies has been limited and subject to quality issues in the past. CIMR offers a major advance in resolution that would be highly valuable for these applications.
OAR	Great Lakes wind	Wind speed for model validation for the Great Lakes Forecasting System (depending on the resolution)
OAR	Great Lakes ice	Ice thickness, ice-type classification (ICECON – Ice conditions) and updating the current ICECON algorithm for the Great Lakes that is used for ice-breaking each year. The Ice Conditions (ICECON) classifications product is used to aid Coast Guard operational ice breaking activities for winter navigation and also for under-ice ecology research. Once ice begins to form on the lakes, icebreakers find the path of least resistance to create an opening through which ships can travel. This allows safe commercial vessel traffic throughout the Great Lakes. The 4-month ice breaking season assists delivery of critical products supporting power and industrial productivity
OAR	SST	Additional coverage for SST over the Great Lakes, with a need for long-term synoptic monitoring with observed recent increases in lake temperatures
NMFS	SST and salinity	The inclusion of all-sky higher spatial resolution SST will contribute our existing SST products at NOAA. Sea Surface Salinity may be useful, but the specific application of those data at NMFS will need to be reviewed.
NWS	Sea Ice	High spatial resolution all-sky sea ice concentration, ice type/stage of development, snow depth on ice, and snow cover will enhance National Ice Center services.



12: Radar Observing System for Europe - L-band SAR (ROSE-L)

NESDIS	Various	Copernicus ROSE-L mission is high priority. NESDIS operations support all weather, day/night high resolution products and imagery primarily from C-band SAR from Copernicus Sentinel 1, RadarSat 2, and RadarSat Constellation Mission (RCM). The products and services supported by the C-Band SAR data include high resolution ocean winds, waves, tropical cyclone support, ice monitoring, oil and pollution monitoring, illegal fishing, flood monitoring, and ocean morphology. L-Band is superior for vegetation, soil moisture, flood monitoring and offers unique opportunities for improved oil, ice, winds, and illegal fishing applications. ROSE-L would offer improved coverage, lower latency, and improved product support when used in combination with other L-Band missions like NASA/ISRO's NISAR, JAXA's ALOS 2/4 missions, and CONAE's SAOCOM. This is particularly true for Arctic coverage, where none of the other missions take observations.
NESDIS, NOS	Oil Spills	Oil Spills- The Rose-L sensor is highly desired by SAB Oil Spill operations, to close a significant gap in Radar observations over U.S. waters. Radar is advantageous because oil spill detection is not limited by clouds or by daylight hours. When other traditional methods of visual inspection are inhibited, Radar becomes the only source of usable information. Currently, SAB has access to C-Band SAR from Sentinel-1, but the ground track repeat in the Gulf of Mexico, where exists thousand of drilling structures, is 12 days. SAB also has access to a limited amount of Radarsat-2, but only approximately 12-15 scenes per month. The need for additional SAR is extreme.
NESDIS	IUU Fishing	Maritime Awareness- Illegal Unregulated Unreported (IUU) Fishing, and Dark Fleet Detection. Remote sensing is being increasingly used to identify the presence of vessels that turn off their reporting (AIS) beacons to conduct activities including but not limited to illegal fishing, sailing in restricted zones, and drug trafficking. NOAA Ocean Service (NOS) and NOAA Fisheries (NMFS) have requested ad-hoc assistance from the SAB for specific, high priority cases. Support has been limited due to the lack of SAR imagery.
NESDIS	Tropical	Tropical- High resolution wind retrievals. This instrument will produce wind vector retrievals that can be used to aid the SAB Dvorak analyst in determining the intensity of the disturbance, and the definition of the Low Level Center of Circulation (LLCC), to assess whether a bulletin is warranted.
NOS	Geodetic Survey	Geodetic survey adjustments. L-Band interferometry can support monitoring land changes against our geodetic network in areas with subsidence, or after earthquakes.
OAR	Great Lakes ice	Ice thickness and ice-type classification would again be applicable to the Great Lakes, with interest in how this could build upon the ICECON algorithm at CoastWatch Central, which is based on the C-band
NWS	National Ice Center Applications	Enhanced monitoring of the Arctic and Cryosphere through improved sea ice mapping, iceberg detection, extending the monitoring of glaciers and ice caps and addressing the information gaps in Snow Water Content (SWE). Improved monitoring of sea ice motion with L band SAR instrument as compared to C band SAR
NWS	Tropical and Post event damage assessments	Tropical cyclones (winds). The ROSE-L mission is also an opportunity to collect relatively high-resolution imagery for post-storm damage surveys, soil moisture estimates, and ice monitoring in otherwise cloudy scenes. NWS meteorologists have particularly sought observations to serve these specialized needs as the precise locality of this information has become more important to improve impact-based decision-support services.



Collaboration in the Context of Copernicus

- Copernicus Climate Change Service
 - NCEI Climate Archive, Reprocessed Satellite Climate Data Records, State of the Climate, etc.
- Copernicus Emergency Management Service
 - National Water Center & the [NOAA Satellite Flood Monitoring System](#)
 - NWS Climate Prediction Center Accumulated Satellite Precipitation Estimates
 - VIIRS and ABI Fire Detection & Fire Radiative Power and OAR/NWS Smoke Forecasts
- Copernicus Atmosphere Monitoring Service
 - Satellite-based emission inventories (OAR)
 - Satellite-based blended [global biomass burning emissions](#)
 - Air Quality Forecasting (OAR/NWS) and Satellite Data Assimilation (TEMPO)

