NOAA/NESDIS

NESDIS-PLN-1003.3

NESDIS Five-Year Product Plan

December 2023

Prepared by:
U.S. Department of Commerce
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)

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Approval Page

Document Number: NESDIS-PLN-1003.3

Document Title: NESDIS Five-Year Product Plan

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Document Release Date: December 15, 2023

Expiration Date: December 14, 2028

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Document Change Record

Version	Description	CCR#	Revised Sections	Date
1	Initial Version, Fiscal Year (FY22-26)	CCR-2021-009	All	September 30, 2021
2	FY22 Revisions (FY23-27)	CCR-2022-016	• Alphabetized all sections. • Deleted Budget Appendix, and added In-Situ and Utilization Information appendices. • Added in situ sources. • Refined Space Weather section. • Added Analytical products.	September 20, 2022
3	FY23 Revisions (FY24-28)	CCR-2023-040	• Reconstructed to have the algorithms and data source flyout charts to Appendix-A; removed user impacts-driven prioritization for individual baseline product to a stand-alone document; updated the Front Matter to be more comprehensive	January 12, 2023

Version	Description	CCR#	Revised Sections	Date
			• Added the focus areas aligned with User Engagement outcomes and NOAA strategic goals • Added FY23 newly funded algorithms and products, including upcoming R2O • Added new satellites data sources, and removed retired ones • Documented the planned retirements for both algorithms and data sources	

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1. NESDIS Five-Year Product Plan

1.1 Motivation

NESDIS products and services enable earth observations to be accessible, understandable, and useful for the people, systems and applications that need the information to make decisions and take actions that save lives and property and create societal benefits. By bridging the gap between raw data and their practical application, NESDIS products and services empower stakeholders to leverage earth observation information to its fullest extent, making tangible differences in addressing societal needs and environmental challenges.

The NESDIS Five-Year Product Plan (FYPP) provides a pivotal resource in enterprise product management. It encompasses activities responding to evolving user needs, aiming to ensure continuity of their highest priority products given changes in available data sources, infrastructure, and resources. It provides a resource for proactive planning for upcoming developments while fostering innovation. The FYPP informs NOAA Line Offices and internal NESDIS offices who are planning for new data, services and capabilities associated with NESDIS-obtained and/or NESDIS-distributed earth observations.

The FYPP is subject to annual updates, maintaining a rolling five-year forward-looking window for changes, and adjusting priorities based on latest strategic and tactical insights.

1.2 Product Goals FY24-FY28

The NESDIS Product Baseline includes numerous critical products and services that NESDIS is sustaining (see Appendix A). There is also a subset of thematic areas where NESDIS intends to make significant improvements in the near-term and significant coordination is ongoing and required for success. The primary emphasis areas for FY24-FY28 are in the following areas (also visualized in Figure 1).

1. **Focus Areas Recommended from NESDIS User Engagement:** These are areas where enhancement in NESDIS products can contribute significantly per NESDIS User Engagement efforts.

    a. *Air Quality and Atmospheric Composition*– Air Quality and Atmospheric Composition products that rely on satellite and in situ observations are used by NOAA (Office of Oceanic and Atmospheric Research (OAR), National Weather Service (NWS)) and non-NOAA users (city, county, state, Environmental Protection Agency (EPA), general public) with significant impact now and

significant potential for even greater impact if improved. NESDIS flight programs are planning improved air quality sensors (e.g. Geo-XO Atmospheric Composition sensor) that will further increase beneficial impacts. In consultation with NESDIS, OAR and NWS have identified near-real-time emissions, air quality forecasting and monitoring, fire weather forecasting, fire emission monitoring, ozone monitoring, hazards forecasting and greenhouse gas monitoring as areas where NESDIS data play most important roles for success and areas where OAR and NWS will contribute expertise to achieve beneficial outcomes.

b. *Fires*- Fire weather detection products are critical in saving lives and monitoring the environment for potential disasters as well as significant air quality events. To address the need for fire weather data NESDIS is developing the Next Generation Fire System. that will lead to significant upgrades in the NESDIS Fire Product Portfolio, with both legacy product retirements and on-ramping of improved capabilities into operations working closely with agencies and departments in charge of wildfire management.

c. *Floods*- NESDIS' emerging flood product suite focuses on flood detection baseline products with a focus on accurate spatial information of inundated areas, especially in remote or sparsely populated regions, provides forecasters with valuable data to adjust river models in real time, and improving forecast and warnings accuracy and decision support services for flood mitigation efforts. NESDIS' flood detection baseline products also contribute to integrated water forecasting and environmental modeling. Primary users for NESDIS' flood products are the NWS National Weather Center (NWC), River Forecast Centers, Weather Forecast Offices (WFOs), National Ocean Service (NOS), Federal Emergency Management Agency (FEMA), United States Geological Survey (USGS), National Aeronautics and Space Administration (NASA), World Meteorological Organization (WMO), and some international countries. The recently established NOAA CoastWatch Water Prediction Node serves as a conduit between NESDIS data and users in and outside of NOAA. NESDIS flood products currently include Low Earth Orbit (LEO) optical and are improving to include low-latency data from geostationary satellites and updated algorithms. Developmental and innovative flood products (extent and 3-D Flood depth) from all-weather Synthetic Aperture Radar (SAR), downscaled optical flood products, and Blended products that combine the strengths of each satellite source complement critical in situ observations of water level, water quality, and speed/volume of water flow.

d. *Space Weather* - NESDIS' space weather programs are growing rapidly in scope and positive impacts. Improving the accuracy of forecast and early warnings of space weather events is crucial for mitigating impacts to key national infrastructure activities, such as satellite operations, navigation and keeping our nation's power grid at optimal performance. Several product generation activities are anticipated to move from the National Weather Service's Space Weather Prediction Center to NESDIS during the FYPP period. There are numerous orbits of interest for space weather products. Specifically, the Sun-Earth Lagrange 1 (L1) point and Geostationary Orbit (GEO) have the highest priority for products. The Space Weather Follow-On-L1 satellite mission will use a suite of instruments to make in situ measurements of the solar wind thermal plasma and magnetic field, as well as a Compact Coronagraph (CCOR) instrument to detect Coronal Mass Ejections (CMEs). There will also be a CCOR on GOES-U. The SW Next Program (with a first launch of the L1 series SOL-A in the 2028/29 timeframe) is developing collaborations to implement observational objectives from the Lagrange 5 (L5) point.

2. **Blue economy**: Improved NESDIS products in the Oceans, Freshwater and Coasts are needed as part of NOAA efforts to support the development of the New Blue Economy. The New Blue Economy, founded on capabilities for acquiring data and developing information, will enable the nation to spur responsible, long-term economic growth while protecting ocean health, human health, and ensuring social equity. Critical ocean products from NESDIS used for blue economy applications and services are sea surface temperatures, sea surface altimetry, and ocean color (near real-time as well as routine, consistently processed long term time series). Cryospheric data and services need enhancements, particularly given the increasing accessibility and use of the Arctic Ocean. NESDIS is actively engaging with users to further understand specific product-related improvements and additions needed, including through NOAA CoastWatch, with its helpdesk, training, forum, learning portal and connections to NOAA Line Offices.

3. **Climate**: Improving quality and usefulness of foundational climate products such as NESDIS Climate Data Records (CDRs) and radiation budget products in coordination with OAR Climate Program Office and NWS Climate Prediction Center contribute to our understanding, monitoring and prediction of climate change, and the NOAA Strategic Goal for a climate ready nation. NESDIS is actively engaging with users to further understand specific product-related improvements and additions needed.

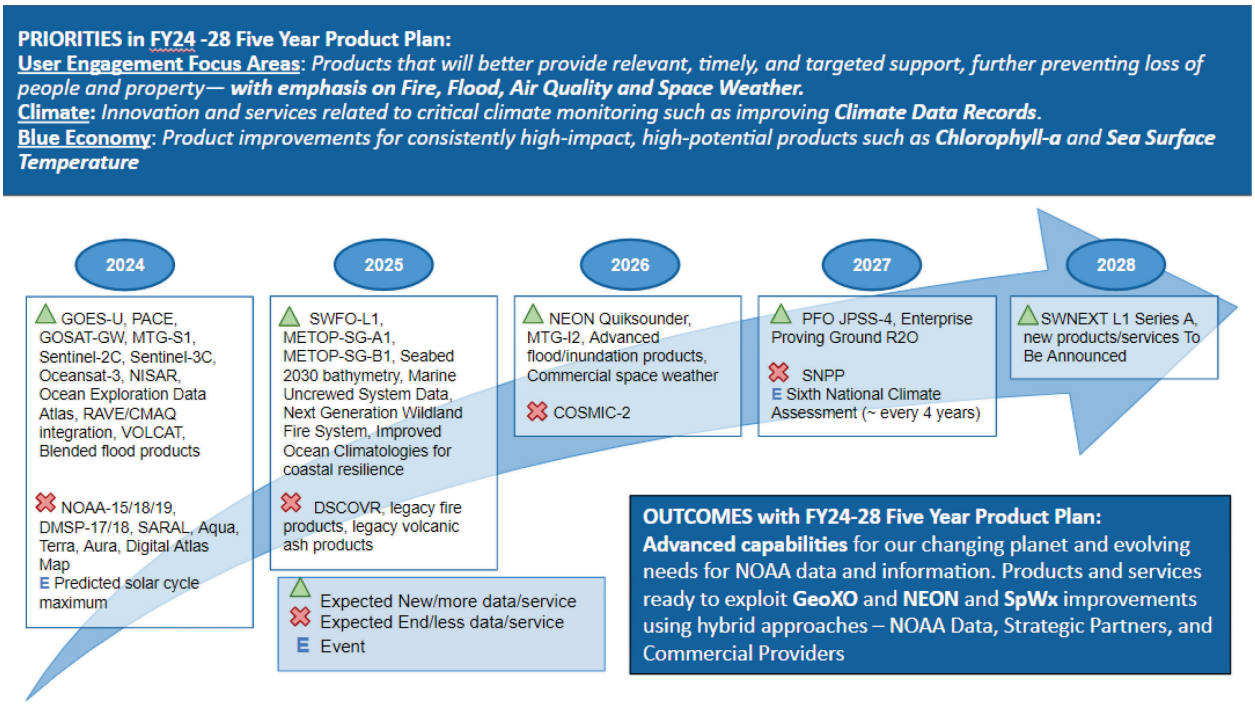

Figure 1: Summary of Five-Year Product Plan Priorities (Top) and Outcomes (Bottom)

1.3 Data Sources for Products FY24-FY28

NESDIS Product Portfolio Managers identify the NESDIS continuity products that require new data sources to meet user needs.

- Major new data sources becoming available for use in NESDIS products in the near term include Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) for systematic ocean color, aerosol, and cloud data, Tropospheric Emissions: Monitoring of Pollution (TEMPO) launched in April 2023, Surface Water and Ocean Topography (SWOT) launched in December 2022 to assess water resources on land and monitor coastal processes and impacts, Global Observing Satellite for Greenhouse gases and Water cycle (GOSAT-GW) for greenhouse gas and water cycle measurements (also continuity with Global Change Observation Mission -Water (GCOM-W), Advanced Microwave Scanning Radiometer 2 (AMSR2), Meteosat Third Generation – Sounding 1 (MTG-S1) for geostationary soundings over Europe (potential risk reduction preparations for Geostationary Extended Observations (Geo-XO) soundings), Meteorological Operational Satellite (MetOp) Second Generation A and B for mid-morning polar-orbiting operational satellite coverage (continuity with Meteorological Operational Satellite C Series (MetOp-C), Near Earth Orbit Network

(NEON) QuickSounder mission (additional microwave soundings for numerical weather prediction models), and Geostationary Operational Environmental Satellite U Series (GOES-U) and Space Weather Follow On L1 mission (SWFO-L1) for space weather (continuity with Deep Space Climate Observatory (DSCOVR). More in situ and remote sensing data and improved services are expected over the next five-years (examples include Ocean Exploration Data Atlas, Seabed 2030 advancements, new Marine uncrewed system observations) to support hurricane intensity forecasting, fishery surveys, ocean exploration, bathymetry and hydrographic surveys.

- Appendix A in the FYPP summarizes the algorithm-specific flyout charts anticipated (but not guaranteed) at the time of FYPP publication. See NESDIS Product Portfolio Managers for more detailed information about the latest status of new product data sources.

Table 1 describes the flyout chart indicators and their associated colors throughout the document. The known data sources at the time of FYPP publication, many being coordinated by the Non-NOAA Data Access Coordination Board (DACB), are included in Table 2. Start-years for data sources are based upon the launch dates and funding for product generation from the best information available when writing the Five-Year Product Plan. The start-years are re-evaluated annually when the plan is updated to use the latest information. Data sources desired for products not in Table 2 require submission to the DACB before use for continuity and sustainment of NESDIS products or new/improved products.

Table 1: Legend for Satellite Flyout Charts

Flyout Chart Indicator	Key
Satellite is not available (pre-launch or has reached the end of life)	N/A
Satellite launched but not yet planned for NOAA Products	X
Satellite launched and planned for NOAA Product Sustainment	Y
Satellite launched and planned or likely to be planned for innovation	E
Satellite beyond the end of life - cost benefit regularly reviewed	Z

Table 2: NESDIS Data Sources - Satellites

NOAA-Managed	Non-NOAA/Used or Planned for NESDIS Operations	Exploitation
• Commercial RO • DSCOVR (through 2025) • GOES-14 (Standby through 2028/29) • GOES-16 (East) (through 2030/31) • GOES-17 (Standby through 2029/30) • GOES-18 (West) (through 2033) • GOES-U (backup starting 2024/2025) • Jason-3 (through 2025) • JPSS-3 (starting 2032) • JPSS-4 (starting 2027) • NEON QuickSounder (starting 2026) • NOAA-15 (Winds Products only through 2024) • NOAA-18 (AMV-only through 2024) • NOAA-19 (retiring on 2024) • NOAA-20 (through 2028) • NOAA-21 (through 2032) • S-NPP (through 2025) • SWFO-L1 (starting 2025) • SOL-A (starting 2028)	• ACE (through 2026) • AQUA (through 2024) • CAPELLA# • Carbonmapper# • CIMR (starting 2029) • COSMIC-2 (through 2026) • CRISTAL-A (starting 2028) • Cryosat-2 (through 2028) • DESIS (ISS)# • DMSP-F17 (through 2024) • DMSP-F18 (through 2024) • EnMAP#* • Formosat-5# • GCOM-W (through 2024) • GHGSat#*(through2024) • GOSAT-GW (starting 2024) • GPM (through 2027) • Himawari-9 (through 2030) • Himawari-10 (starting 2028) • ICEye# • Landsat-9# (through 2026) • MAXAR# • Meteosat-9 (IODC) (through 2025) • Meteosat-10 (through 2030) • Meteosat-11 (through 2033) • MetOp-B (through 2024) • MetOp-C (through 2027) • MetOp-SG-A1 (starting 2025) • MetOp-SG-B1 (starting 2025) • MethaneSat# • MTG-I1 (through 2030) • MTG-I2 (starting 2026) • NISAR (starting 2024)	• ACCP (starting 2027) • Arctic Weather Satellite PFM (starting 2024)** • CO2M (staring 2026) • CHORUS (starting 2025) • Earthcare#* • EOIR (staring 2024) • EPS SG-A1 Sentinel 5 UVNS (staring 2025) • EWS*(Department of Defense (DoD)) • GeoCARB (starting 2025) • Geo-Kompsat-2A (starting 2023) • GEO-KOMPSAT-2B GEMS (starting 2023)* • GEO-KOMPSAT-2B GOCI-II (starting 2023) • GLIMR instrument (starting 2026) • GOSAT-GW TANSO-3# • HRWS-SAR (starting 2029) • ICESat-2 (through 2023) • ISS-TEMPEST-1 (through 2025) • IMAP (starting 2025) • INSAT-3D (through 2023) • ISS COWVR (through 2024) • ISS-TEMPEST-1 (through 2025) • MicroCarb (starting 2024) • MTG-S1 (starting 2024) • PACE Polarimeters (starting 2024) • SAOCOM-1B (through 2025)

NOAA-Managed	Non-NOAA/Used or Planned for NESDIS Operations	Exploitation
	• Oceansat-3 (starting 2024) • PACE OCI (starting 2024) • Pixxel# • PlanetScope# • PredaSAR# • PRISMA# • PUNCH (starting 2025) • Radarsat-2 (through 2024) • RCM-1-2-3-4 (through 2026) • Satellogic# • Sentinel-1C (through 2029) • Sentinel-1D (starting 2024) • Sentinel-2B (through 2024) • Sentinel-2C (starting 2024) • Sentinel-2D (starting 2025) • Sentinel-3A (through 2024) • Sentinel-3B (through 2026) • Sentinel-3C (starting 2024) • Sentinel-3D (starting 2028) • Sentinel 5-P Tropomi (through 2025) • Sentinel-6A MF (Jason-CS) (through 2028) • Sentinel-6B (starting 2026)* • SOHO (through 2025) • SMAP (through 2026) • SMOS (through 2025)	• STEREO (through 2024) • SWOT (through 2025) • TROPICS (through 2025) • TWICC (starting 2024) • TEMPO (through 2027) • WSF-M1* (starting 2024)
# Satellite Analysis Branch (SAB Use Only * Pending Agreements ** Agreement required		

Table 3: NESDIS Data Sources - In situ/Non-Satellite

NOAA-Managed	Non-NOAA and/or Exploitation
• Airborne Gamma Radiation Snow Water Equivalent and Soil Moisture Survey Program • Antarctic UV Network • Atmospheric Baseline Observatories (OAR) • Atmospheric Integrated Research and Monitoring Network • Argo Profiling Floats • Buoy Data (includes Chesapeake Bay Interpretive Buoy System, Coastal Weather Buoys, Global Drifter Program, Global Tropical Moored Buoy Array) • Coastal-Marine Automated Network • Commercial Fisheries-Dependent Data Surveys • Continuously Operating Reference Stations • CPC Global Unified Gauge-Based Analysis of Daily Interpretation • Deep-ocean Assessment and Reporting of Tsunamis • Economic and Socio-cultural Data Surveys (NMFS) • Ecosystems and Fisheries-Oceanography Coordinated Investigations (OAR) • Fishery Independent Surveys • Generic Satellite Messages • Global Energy and Water Cycle Experiment • Global Greenhouse Gas Reference Network • Global Sea Level Observing System • Global Summary of the Month • Global Surface Summary of the Day • Global Ocean Carbon Network • Global Ocean Heat and Salt Content • Global Oscillation Network Group • Global Positioning System Integrated Precipitable Water Sensor • Global Stratospheric/Tropospheric Ozone Network	• Advanced National Seismic System • Commercial Meteorological Aircraft-Based Observations • GCOS Reference Upper Air Network • GHCN-Daily • GHCN-Monthly • Global Argo Data Repository • Global Oscillation Network Group • Global Precipitation Climatology Project (GPCP) • Global Surface Summary of the Day • Global Seismographic Network • GOS Upper Air Network • Ground-Based Lightning Observations • International Arctic Buoy Programme • International Arctic System for Observing the Atmosphere • National Mesonets • SNOwpack TELemetry Network (SNOTEL) • USAF Hurricane Hunters • Uncrewed Systems Datasets • WMO-Regional Basic Surface Synoptic Network

NOAA-Managed	Non-NOAA and/or Exploitation
• Global Surface Radiation Baseline Network • American Vertical Datum (GRAV-D) • Habitat Assessment (NMFS) • Halocarbons and other Atmospheric Trace Species (OAR/HATS) • Historical Observing Metadata Repository (HOMR) • Historical and Monthly Palmer Drought Indices • Hurricane Hunters • Hydrographic Surveying (NOS) • Hydrometeorology Testbed - West Legacy Observing Network • In situ Aerosol System (OAR) • International Best Track Archive for Climate Stewardship • International Comprehensive Ocean Atmosphere Data Set • Integrated Global Radiosonde Archive • IOOS High-Frequency Radars • IOOS Regional Ocean Observing System • Marine Recreational Information Program (NMFS) • Mixed Layer Depth • National Coral Reef Monitoring Program • National Current Observation Program • National Estuarine Research Reserve System System-Wide Monitoring Program • National Observer Program • NCEI Climate Reference Network • NCEI Forts data • NClimDiv • NClimGrid • Next Generation Weather Radar • NCEI Normals • NOAAGlobalTemp • NWS Automated Surface Observing Network • NWS Cooperative Observer Network • NWS Radiosondes	

NOAA-Managed	Non-NOAA and/or Exploitation
• National Program Radiosonde Replacement System • National Status and Trends Program • National Water Level Observation Network • Next Generation Weather Radar • NOAA Profiler Network • NOAA Aircraft • Ocean Noise Reference Station Network • Ocean Reference Stations (OAR/GOOS) • Pacific Tsunami Warning Center Sea Level Network • Physical Oceanographic Real-Time System • Protected Resources Surveys • Real-time Coastal Observation Network (OAR) • Ships (includes Voluntary Observing Ships, Ships of Opportunity-XBT Network, NOAA Ships) • Shoreline Mapping • Standardized Precipitation Index • Steric Sea Level • Surface Observations • Spotter/Skywarn Volunteer Program • Stratospheric Aerosols Network • Stratospheric Water Vapor Profiles • Surface Radiation Budget Network • Surface Underway Marine Database (SUMD) • US Climate Reference Network Surface Ozone (OAR) • Tropical Atmosphere Ocean Array • Upper-air Rawinsonde Network • World Ocean Database (WOD)	

2. Context and Background

2.1 Scope

The FYPP includes algorithm/product families that have a five-year outlook that support the NESDIS Product Baseline. The scope is outlined in Table 4.

Table 4: Scope of Five-Year Product Plan

Content Description	**In the FYPP?**
Algorithms/Products with known five-year outlook	Y - Geophysical section of Appendix A
Sensor Data	Y - Foundational section of Appendix A
In situ data	Y - Foundational section of Appendix A
Imagery	Y - Foundational section of Appendix A
Climate Data Records	Y - Analytical section of Appendix A
Near Real Time Products (<24 hours latency)	Y - Geophysical section of Appendix A
Delayed-mode Products (24+ hours latency)	Y - Geophysical section of Appendix A
Time series Products	Y - Analytical section of Appendix A
Reports (data summarized/expert review)	Y - Analytical section of Appendix A
Services	N
Models	N
Aspirational Products not yet funded for development	N

2.2 Assumptions

The FYPP plan must make assumptions in order to project five years out. Appendix C documents those assumptions. If/when actual events deviate from the assumptions then the FYPP is reassessed and assumptions adjusted accordingly during the annual update process.

2.3 Trade space

Requirements for products may change quickly depending upon changes in the larger value chain (user needs, service delivery, data source availability, etc.). NESDIS has

implemented Product Portfolio Management (PPM) to incorporate trade space and allow for rapid response to user needs. NESDIS products and services not specified or specified but performing beyond minimum specifications in the NESDIS Product Baseline can be divested to invest in higher priority areas. These divestment/investment possibilities are the “trade space” available to the portfolio managers. The FYPP provides the expected size and use of that trade space based upon the best available information at the update time about capacity (including budget, personnel, infrastructure), legislative constraints and user-impact driven priorities. Illustrated in Figure 2 is a brief summary that explains how the PPM managers can effectively utilize trade space when faced with changes in budget constraints or shifting priorities, deviating from the assumptions initially made in the FYPP.

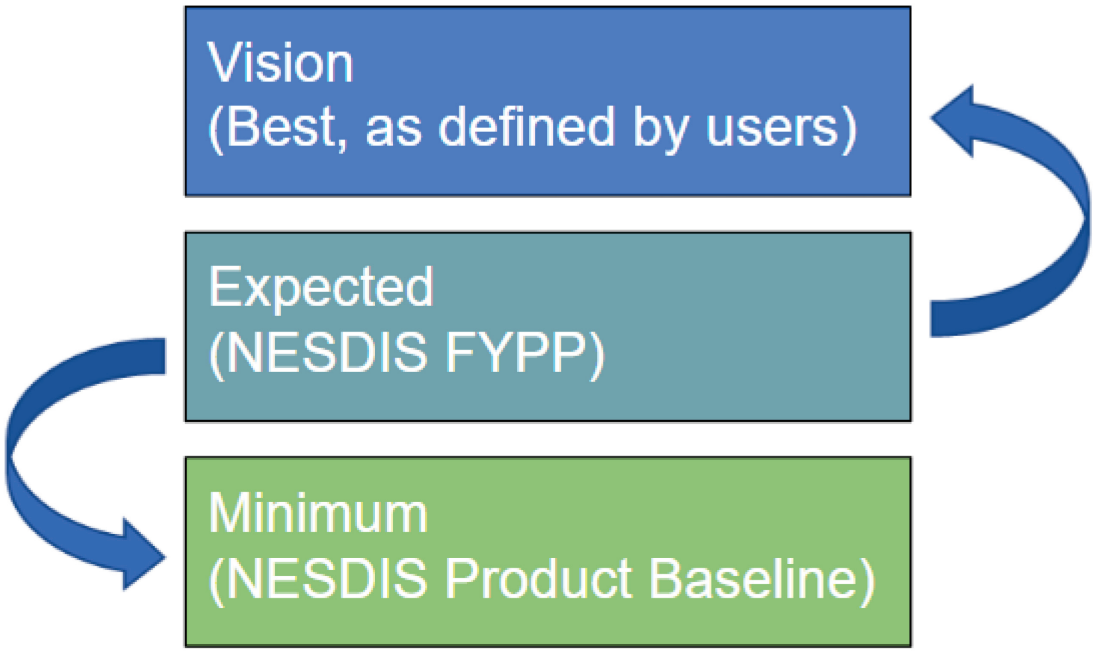

Figure 2: Allowable tactical trades by NESDIS Product Portfolio Managers (PPMs) between expected (outlined in NESDIS FYPP, center box), vision and minimum product performance in response to changes (resources, user readiness, infrastructure, etc.).

2.4 NESDIS Complementary Efforts

The **NESDIS Enterprise Proving Ground** and related plans for innovation and development include aspirational capabilities and potentially game-changing improvements that extend well beyond providing continuity of satellite and in situ

products. As new information is gained the product-related advances ready for implementation will be incorporated into the FYPP.

The **Earth Observation Requirements Evaluation System** (EORES) is the database backbone used for the FYPP and provides satellite Flyout charts, in situ observation information, algorithm descriptions, NESDIS Product Baseline information, NOAA users and impacts, and traceability information to the NOAA Consolidated Observation User Requirement List (COURL). This is managed by the NESDIS Systems Architecture and Engineering (SAE) Office.

The **NESDIS Level Requirements and NESDIS Product Baseline** set the foundation for the FYPP. The NESDIS Level Requirements (NLR) codify NESDIS' mission and includes the NESDIS Product Baseline that defines the types of products and minimum level of service NESDIS commits to sustain and maintain over a long period of time. The FYPP documents how NESDIS satisfies these commitments through a combination of internally developed enterprise algorithms, legacy algorithms and leveraged external products ("pass- throughs") meeting and in most cases exceeding the minimum requirements specified in the Product Baseline.

2.5 Legislation and Agreements

In addition to user-driven priorities, the FYPP strategically plans for operational baseline products within the context of legislation and agreements. Legislation that defines NESDIS's role in support of the larger NOAA mission and informs the FYPP include (but are not limited to):

- Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act
- Disaster Relief Supplemental Appropriations Act
- Bipartisan Infrastructure Law
- Weather Research and Forecasting Innovation Act, as amended
- Coral Reef Conservation Act, as amended
- Flood Level Observation, Operations, and Decision Support Act
- Providing Research and Estimates of Changes in Precipitation Act
- National Integrated Drought Information System, as amended
- Harmful Algal Bloom and Hypoxia Research and Control Amendments Act (HABHRCA), as amended
- Magnuson–Stevens Fishery Conservation and Management Act
- Clean Air Act
- Clean Water Act

- Maritime navigation safety (several)

3. NESDIS Office and Program Coordination

The NESDIS Five-Year Product Plan is owned by SAE and the Office of Common Services (OCS). Proposed changes shall be directed to the NESDIS Enterprise Products and Services Governance Team (nesdisenterpriseproductsteam@noaa.gov). Regular communication with associated NESDIS offices, programs, and stakeholders are coordinated through the NESDIS Level Requirements Working Group and NESDIS Action Item Management System (AIMS) tasks to review, identify, assess, and integrate updates and adjustments into the product plan.

At the beginning of each fiscal year, the product plan for the period beginning that same fiscal year formally goes through the NESDIS Configuration Control Board to obtain the NESDIS AA Signature. Comments/concerns are summarized as part of the NESDIS CCB process (NESDIS-PLN-1314.1, NESDIS Configuration Management Plan). Items that need more analysis prior to inclusion in the product plan are placed as draft entries for the next annual update of the plan. The signed Five-Year Product Plan is placed into the NESDIS Document Repository. There are two key performance indicators (below) to evaluate the progress and success of the plan and inform updates.

- The Five-Year Product Plan **provides foundational information** that is used for the enterprise management of products, including:
    a. **Efficient product sustainability** with best available data sources, including partner data sources for product quality and capability;
    b. **Proactive planning for data sources, infrastructure and associated budgets;**
    c. **Systematic assessment of new data sources** for their value to existing products and potential to support new products;
    d. **Targeting appropriate percentages of** innovation, development, maintenance, and sustainment across each portfolio.
- The Five-Year Product Plan **informs NOAA Line Offices** in planning for use of data and products from new observing systems.

Appendix A: Algorithms/Processing Systems Planned for Sustainment and Improvement (R2O)

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Algorithms/Processing Systems Planned for Sustainment and Improvement (R2O)

(N.B. The following table provides a reference for reading the subsequent flyout charts. Text in the key section is not visible but supports 508 compliant screen readers.)

Flyout Chart Indicator	Key
Satellite is not available (pre-launch or has reached the end of life)	N/A
Satellite launched but not yet planned for NOAA Products	X
Satellite launched and planned for NOAA Product Sustainment	Y
Satellite launched and planned or likely to be planned for innovation	E
Satellite beyond the end of life - cost benefit regularly reviewed	Z

1. Foundational

1.1 Sensor Data

1.1.1 IR Sounder Instrument Data

The IR Sounder instruments gather IR energy emitted from the Earth's surface and atmosphere. Their data provides 3D measurements of temperature and WV through the atmospheric column, along with a host of trace gasses and surface and cloud properties. This helps improve our understanding of severe weather patterns and how they relate to global climate change. Hyperspectral IR radiances are particularly impactful for Numerical Weather Prediction (NWP). In the five years ahead, this will include US and international partner (e.g., EUMETSAT) IR hyperspectral radiances (LEO) and from the Meteosat Third Generation (MTG) IR Sounder IRSR (GEO hyperspectral IR principal components).

Users: NWS/National Center for Environmental Prediction (NCEP) and other NWP Centers, Integrated Calibration/Validation System (ICVS)

Impacts: IR Sounders provide observations that are some of the most impactful observations for NWP 3-5 day forecasts. Hyperspectral IR instruments also benefit

nowcasting, environmental monitoring, and situational awareness, including severe weather.

Table 1.1.1a: IR Sounder Instrument Data Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Infrared Sounder Radiances
Sensor Data	Infrared Sounder Raw Data Records
Sensor Data	Infrared Sounder Sensor Data Records

Table 1.1.1b: IR Sounder Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 CrIS	PM									
MTG-S1 IRS	0									
MetOp-B HIRS/4	Mid AM									
MetOp-B IASI	Mid AM									
MetOp-C IASI	Mid AM									
MetOp-SG-A1 IASI-NG	Mid AM									
NOAA-18 HIRS/4	Early AM									
NOAA-20 CrIS	PM									
NOAA-21 CrIS	PM									
S-NPP CrIS	PM									

1.1.2 Lightning Imager Instrument Data

The lightning imager acts as a high-frame-rate camera that detects light pulses at cloud tops, which continuously observes lightning throughout a near hemispheric Field of View (FOV), capturing large-scale spatiotemporal variability.

Users: NWS

Impacts: Geostationary Lighting Mapper (GLM) continuously detects all forms of lightning day and night, with a high spatial resolution and detection efficiency. It improves severe storm warning lead time, an earlier indication of impending lightning

strikes to the ground, and total lightning detection with nearly uniform spatial coverage of approximately 10 km. Disseminating lightning information in near real-time, continuously with other observable data, such as radar returns, cloud images, and other meteorological variables, provides invaluable data to aid weather forecasters in detecting severe storms in time to give warning to the public.

Table 1.1.2a: Lightning Imager Instrument Data Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Lightning Imager

Table 1.1.2b: Lightning Imager Instrument Data Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 GLM	75.2W									
GOES-17 GLM	104.6W									
GOES-18 GLM	137W									
GOES-U GLM	75.2W			X	X					

1.1.3 Microwave Radiometer Instrument Data

Microwave Radiometer Instrument Data contains Sensor Data Records (SDRs) and temperature data records, including both cross-track microwave sounder radiances critical for temperature and moisture characterizations in weather forecast models as well as conical-scanning microwave imagers used for surface and precipitation applications.

Users: NWS, NWP Community, ICVS

Impacts: The data conveys the accuracy of general and severe weather predictions, such as hurricanes and winter storms. MW data can also be used in Environmental Data Product (EDR) generation, such as flooding and heavy precipitation. Both NWP and EDR products can assist decision-makers to better manage the short-term disaster reduction and long-term climate change issues.

Table 1.1.3a: Microwave Radiometer Instrument Data Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Microwave Radiometer Brightness Temperatures
Sensor Data	Microwave Radiometer Raw Data Records
Sensor Data	Microwave Radiometer Sensor Data Records
Sensor Data	Microwave Radiometer Temperature Data Records

Table 1.1.3b: Microwave Radiometer Instrument Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
Aqua AMSU-A	PM									
DMSP-F16 SSMIS	Early AM									
DMSP-F17 SSMIS	Early AM									
DMSP-F18 SSMIS	Early AM									
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
JPSS-4 ATMS	PM									
MetOp-B AMSU-A	Mid AM									
MetOp-B MHS	Mid AM									
MetOp-C AMSU-A	Mid AM									
MetOp-C MHS	Mid AM									
MetOp-SG-A1 MWS	Mid AM									
MetOp-SG-B1 MWI	Mid AM									
NOAA-15 AMSU-A	Early AM									
NOAA-18 AMSU-A	Early AM									
NOAA-18 MHS	Early AM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									
SMAP SMAP	Early AM									
SMOS MIRAS	Early AM									

1.1.4 Optical Imager Instrument Data

Optical Imagers simultaneously measure data in multiple regions of the electromagnetic spectrum, often including visible light, near and shortwave IR. Funding for pass-through products from Landsat 8/9 and Sentinel-2A/B/C/D is being confirmed.

Users: NWS, General Public/Broadcasters, ICVS, NESDIS, NOAA CoastWatch

Impacts: Optical imagers provide “camera-like” imagery for a broad range of users interested in visible imagery. The counts can be used directly, and calibration input

parameters can be applied or appended for SDR/L1b data; OSPO uses ICVS to monitor satellite instrument health/safety and performance.

Table 1.1.4a: Optical Imager Instrument Data Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Optical Imager Reflectance
Sensor Data	Optical Imager Radiance
Sensor Data	Optical Imager Brightness Temperature

Table 1.1.4b: Optical Imager Instrument Data Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GLIMR GLIMR	TBD									
GOES-14 (Standby) IMAGER	108.2W									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
ISS DESIS DESIS	Drifting									
JPSS-4 VIIRS	PM									
Landsat-8 OLI	Early AM									

Landsat-9 OLI	Early AM									
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 3MI	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-15 AVHRR/3	Early AM									
NOAA-18 AVHRR/3	Early AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
PACE OCI	Noon									
PACE SPEXone	Noon									
S-NPP VIIRS	PM									
Sentinel-2A MSI	Mid-AM									
Sentinel-2B MSI	Mid-AM									
Sentinel-2C MSI	Mid-AM									
Sentinel-2D MSI	Mid-AM									
Sentinel-3A OLCI	Early AM									

Sentinel-3B OLCI	Early AM									
Sentinel-3C OLCI	Early AM									
Sentinel-3D OLCI	Early AM									

1.1.5 Radar and LIDAR Data

Satellite radar altimeters measure the ocean surface height (sea level) sea ice surface height by measuring the time it takes a radar pulse to make a round-trip from the satellite to the sea/ice surface and back. Imaging Radars produce 2-dimensional imagery (range and azimuth) for ice characterization, deforestation, and other applications. Profiling radars can be used for clouds and aerosols. Lidar sensors use lasers and measure the return time and wavelength from the reflection of the light on various surfaces/targets that can be used for wind, cloud, ice, and land characterization.

Users: STAR FTP/HTTP: provided to NWS/OPC, NOAA CoastWatch, NMFS, and Oregon State University.

Impacts: Allows for data assimilation and enables forecasters.

Table 1.1.5a: Radar and LIDAR Instrument Data Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Radar and LIDAR Altimeter

Table 1.1.5b: Radar and LIDAR Instrument Data Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
CRISTAL AMR-C	Drifting 92deg									
CRISTAL GNSS-POD	Drifting 92deg									
CRISTAL IRIS	Drifting 92deg									
CRISTAL LRR	Drifting 92deg									
ICESat-2 ATLAS	Drifting									
JASON-3 LRA	10-day repeat									
JASON-3 Poseidon-3B	10-day repeat									
SWOT Altimeter	21-day repeat									
SWOT KaRIN	21-day repeat									
Sentinel-3A SRAL	Early AM									
Sentinel-3B SRAL	Early AM									
Sentinel-3C SRAL	Early AM									
Sentinel-3D SRAL	Early AM									
Sentinel-6A MF LRA	10-day repeat									
Sentinel-6A MF Poseidon-4	10-day repeat									
Sentinel-6B LRA	10-day repeat									
Sentinel-6B Poseidon-4	10-day repeat									
CryoSat-2	High-Latitude									

1.1.6 Radio Occultation (RO) Data

Satellite RO involves a low-Earth orbit satellite receiving a signal from a Global Positioning System (GPS) or similar satellite. The signal passes through the atmosphere and gets refracted along the way. The magnitude of the refraction depends on the temperature and water vapor concentration in the atmosphere and the electron density profile in the ionosphere. Radio occultation sensors measure only the density instead of the entire distribution and typically only for electrons (compared with Plasma Sensors).

Users: NWS and climate community.

Impacts: RO Instrument Data primarily are assimilated into NWP models, which support weather forecasts and space weather analysis/prediction at NOAA.

Table 1.1.6a: RO Instrument Data Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data / Space Weather	Radio Occultation Data

Table 1.1.6b: RO Instrument Data Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
COSMIC-2 TGRS	Drifting									
KOMPSAT-5 AOPOD	Early AM									
MetOp-B GRAS	Mid AM									
MetOp-C GRAS	Mid AM									
MetOp-SG-A1 RO	Mid AM									
MetOp-SG-B1 RO	Mid AM									
SEOSAR/Paz ROHPP	Early AM									
Sentinel-6A MF GNSS-RO	10-day repeat									

1.1.7 Scatterometers data

Scatterometers are microwave radar sensors that measure the Normalized Radar Cross-Section (NRCS) of the surface, scanned from an airplane or a satellite. Scatterometers are active microwave sensors: they send a signal and measure how much of that signal returns after interacting with the target. Scatterometers are unique among satellite remote sensors in their ability to determine the wind direction over water. Scatterometers can provide a wealth of wind velocity observations over the earth's bodies of water.

Users: NCEP/OPC, NCEP/TPC, NWS/WF.

Impacts: The data support wind/wave forecasts and warnings and are routinely assimilated into the global NWP models. Satellite ocean surface vector winds data provide essential boundary conditions at the air-sea interface.

Table 1.1.7a: Scatterometer Instrument Data Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Scatterometer

Table 1.1.7b: Scatterometer Instrument Data Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
MetOp-B ASCAT	Mid AM									
MetOp-C ASCAT	Mid AM									
MetOp-SG-B1 SCA	Mid AM									
OceanSat-3 OSCAT	Noon									

1.1.8 Shortwave (UV/Vis) Sounder Instrument Data

The Shortwave (UV/Vis) Sounder instrument tracks the health of the ozone layer and measures the ozone concentration in the Earth's atmosphere. It provides total column and vertical profile ozone data and can also measure atmospheric particles such as sulfur dioxide and ash resulting from volcanic eruptions. Other trace gasses are measured in the UV/Vis region of the spectrum, including nitrogen dioxide and formaldehyde. Tropospheric column products for these gasses are currently retrieved with the Ozone Mapping and Profiler Suite (OMPS) instrument (as well as partner instruments like the Ozone Monitoring Instrument and TROPOspheric Monitoring Instrument). The Tropospheric Emissions will produce them: Monitoring of Pollution instruments starting in 2023. The above data will likely be used for air quality forecasting applications shortly. Tools such as OMPS also have mappers to provide total ozone imagery.

Users: 557 WW, Fleet Numerical Metrology and Oceanography Center (FNMOC), Ozone Studies, NWP, ICVS.

Impacts: The STAR OMPS EDR and other ozone retrieval systems use the data. Environmental Data Record (EDR) products, such as total column ozone, vertical ozone, aerosol index, and SO_2, have been operationally produced using SNPP and NOAA-20 OMPS NM/NP SDR data. Other applications of OMPS SDR data include trend monitoring of ozone, studies of the Antarctic ozone hole, retrieval of HCHO total columns, SO_2 and NO_2 retrievals, and H_2CO retrieval.

Table 1.1.8a: Shortwave (UV/VIS) Sounder Instrument Data Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Shortwave (UV/VIS) Imager/Sounder Raw Data Records
Sensor Data	Shortwave (UV/VIS) Imager/Sounder Sensor Data Records
Sensor Data	Shortwave (UV/VIS) Imager/Sounder Solar Irradiance
Sensor Data	Shortwave (UV/VIS) Imager/Sounder Reflectance
Sensor Data	*Shortwave (UV/VIS) Imager/Sounder Dark SDR*

Italics = Not currently in the NESDIS Product Baseline

Table 1.1.8b: Shortwave (UV/VIS) Flyout chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
MetOp-B GOME-2	Mid AM									
MetOp-C GOME-2	Mid AM									
MetOp-SG-A1 Sentinel 5	Mid AM									
NOAA-18_MIRS_PRECIP_AMV_ONLY_SBUV-2	PM									
S-NPP OMPS-L	PM									
S-NPP OMPS-NP	PM									
S-NPP OMPS-NM	PM									
NOAA-20 OMPS-NP	PM									
NOAA-20 OMPS-NM	PM									
NOAA-21 OMPS-L	PM									
NOAA-21OMPS-NP	PM									
NOAA-21 OMPS-NM	PM									
JPSS-4 OMPS-L	PM									
JPSS-4 OMPS-NP	PM									
JPSS-4 OMPS-NM	PM									

1.1.9 Infrared Sounder Cloud-Cleared Radiances

Reference 2.6.3 HEAP for Infrared Sounder Cloud-Cleared Radiances.

1.1.10 Infrared Sounder Principal Components/Thinned Radiances

Reference 2.6.3 HEAP for Infrared Sounder Principal Components/Thinned Radiances.

1.1.11 Optical Imager Clear-Sky Radiance

The ASR Level 2 (L2) Advanced Baseline Imager (ABI) product algorithm provides radiance data as well as metadata for use in operational data assimilation applications. The 2 km IR pixels from the ABI are subset into 15x15 pixel processing boxes and combined with ABI L2 cloud products to allow assessment of the quality of the Level 1b (L1b) data to calculate an optimal radiance value as well as useful quality control metrics. Each field in the All Sky Radiance (ASR) data is reduced by a factor of 225 from the original L1b data volume. The ASR product includes information about all pixels in the processing box as well as the subset of cloudy pixels. The Clear Sky Radiance (CSR) product only reports values in clear sky conditions.

Users: Modelers, Reanalysis, dataset production (used in other NCEI products whose users include drought, severe weather, etc.), and famine early warning.

Impacts: The product of this algorithm provides the Geostationary IR Radiance Information for NWP Assimilation.

Table 1.1.11a: ASR/CSR Product Category and Products Generated

Product Category	Product Generated
Sensor	Clear-Sky Radiances
Clouds	Cloud Fraction
Clouds	Cloud Layers

Table 1.1.11b: ASR/CSR Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

1.1.12 GNSS RO Physical Retrieval

GNSS RO bending angle and refractivity products are used to generate atmospheric density profiles (which are functions of bending angle, refractivity, pressure, temperature, and water vapor profiles) derived from multiple RO missions. This algorithm family includes RO inversion packages for L1a (time delay) to L1b (excess phase) processing, L1b- L2 (bending angle and refractivity profile) processing and refractivity to temperature and moisture profile processing.

1.2 Imagery

1.2.1 Microwave Imager/Sounder Imagery

1.2.1.1 GAASP Preprocessor & Microwave Imagery Capability

Description: Preprocessed L1 data, and Imagery products from two microwave conical scanner satellite families are (or will be) generated by a proven algorithm base. The preprocessing capability is an upstream requirement for all other GAASP capabilities. The GAASP Preprocessor & Microwave Imagery products algorithm base is currently operational at NDE. The preprocessed L1b microwave data is reformatted to BUFR for NWS NWP users. The NESDIS Common Cloud Framework (NCCF) migration of all GAASP products is scheduled for late 2024.

Users: NWS, NHC, NAVOCEANO, NCEP, NESDIS/OSPO/SAB, and SMOPS use this as its downstream applications.

Impacts: The GAASP Preprocessor & Microwave Imagery product improves tropical cyclone center position and intensity forecasting, numerical weather prediction, and climate prediction.

Table 1.2.1.1a: GAASP Preprocessor & Microwave Imagery Products Produced and NPB Connections

Product Category	Product Generated
Imagery	Microwave Imager Imagery

Table 1.2.1.1b: GAASP Preprocessor & Microwave Imagery Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
MetOp-SG-B1 MWI	Mid AM									

1.2.1.2 Limb Corrected ATMS Imagery

The Advanced Technology Microwave Sounder (ATMS) image is a limb-corrected nadir view of the ATMS brightness temperatures. The nadir view images enable weather forecasters to obtain the information content about severe weather such as the central position or eye and warm core of hurricanes. To better utilize the image, visualization tools are important to display the integral of vertical structures and heavy precipitations.

Users: NESDIS, ICVS, Hurricane visualizations.

Impacts: Used as an input to NESDIS ICVS and provides vertical structures of hurricanes/heavy precipitation.

Table 1.2.1.2a: Limb Corrected ATMS Imagery Products Produced and NPB Connection

Product Category	Product Generated
Imagery	Microwave Sounder Imagery
Tropical Cyclones Characteristics	Hurricane Imagery

Table 1.2.1.2b: ATMS Limb-correct Imagery Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 ATMS	PM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									

1.2.1.3 MIRS

Reference 2.6.4 for Microwave Sounder Imagery.

1.2.2 Near Constant Contrast Imagery

Reference 1.2.3.3 LEO Imagery for Near Constant Contrast.

1.2.3 Visible and IR Imagery

1.2.3.1 Arctic Composite

Algorithm Description: Hourly NOAA GOES/POES composite imagery products are generated by using polar and geostationary visible, IR and water vapor (WV) satellite imagery as inputs. The products cover five wavelengths, e.g., Infrared (~11.0 μm), Shortwave Infrared (~3.8 μm), Longwave Infrared (~12.0 μm), Water Vapor (WV) (~6.7 μm), and Visible (~0.6 μm), over the Arctic polar region of the globe. Arctic composite image products are delivered to NWS Advanced Weather Interactive Processing System (AWIPS) and NCEP users.

Users: OPC, NIC, WPC, NWS AWIPS, ASIP, and NCEP

Impacts: The product of this algorithm improves real-time assessment of ice conditions for marine navigation and security. Additionally, it also improves the automation of ice product development.

Table 1.2.3.1a: ACI Products Produced and NPB Connections

Product Category	Product Generated
Imagery	Visible and Infrared Imagery

Table 1.2.3.1b: ACI Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 VIIRS	PM									
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

1.2.3.2 GeoColor

Product Description: GeoColor is a multispectral product composed of True Color (using a simulated green component) during the daytime, and an Infrared product that uses ABI bands 7 and 13 at night. During the day, the imagery looks approximately as it would appear when viewed with human eyes from space. It is particularly useful for qualitative aerosol detection (such as smoke and blowing dust) and general situational awareness. At night, the blue colors represent liquid water clouds such as fog and stratus, while gray to white indicate higher ice clouds, and the city lights come from a static database that was derived from the VIIRS Day Night Band.

Users: LDM to AWIPS for NWS, STAR webpage, and NOAA CoastWatch.

Impacts: The product of this algorithm is the identification of smoke, blowing dust, smog, and anything that has a unique color property that distinguishes it from meteorological clouds. Additionally, it supports nighttime cloud detection, because it can differentiate between low liquid water clouds and higher ice clouds at night, and rapid nighttime geo-referencing of weather hazards.

Table 1.2.3.2a: GeoColor Products Produced and NPB Connections

Product Category	Product Generated
Imagery	Visible and Infrared Imagery

Table 1.2.3.2b: GeoColor Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								

1.2.3.3 LEO Imagery

Algorithm Description: Visible Infrared Imaging Radiometer Suite (VIIRS) Environmental Data Records (EDR) Imagery (I-band, M-band, and Near Constant Contrast (NCC)) are generated for situational awareness, current analysis, and as forecast/decision aids. Morning orbit imagery from METOP and EUMETSAT Polar System-Second Generation (EPS-SG) A1 are pass-through products from the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) (Visible Infrared (Vis/IR) only, no NCC imagery). NOAA-15, 18, and 19 Advanced Very High-Resolution Radiometer (AVHRR) imagery are available (Vis/IR) only, no NCC imagery) but low priority and scheduled to retire in 2022. Note that the FY22 funding request includes the continuation of the (Polar Operational Environmental Satellites) POES legacy satellites.

Users: NWS Forecast Offices, AWIPS

Impacts: The product of this algorithm enables weather forecasters to discern environmental phenomena (by either manual analysis or automated algorithms) within the visible, near-infrared, infrared, and microwave portions of the spectrum.

Table 1.2.3.3a: LEO Imagery Products Produced and NPB Connections

Product Category	Product Generated
Imagery	Visible and Infrared Imagery
Imagery	Near Constant Contrast Imagery

Table 1.2.3.3b: LEO Imagery Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-15 AVHRR/3	Early AM									
NOAA-18 AVHRR/3	Early AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

1.2.3.4 GEO Imagery

Algorithm Description: The GEO imagery algorithm uses all spectral bands of advanced imagers to monitor the Earth, atmosphere, and ocean system. The measured reflectance (radiance) within the visible (infrared) bands are converted into Brightness Values (BVs) and Brightness Temperatures (BTs), respectively to generate an array of products aiding forecasters in monitoring and predicting weather, oceanographic, and climate-related phenomena. NESDIS has one standby satellite which has legacy software if it needs to be activated. One Geostationary Operational Environmental Satellites (GOES) satellite has been provided to the United States (US) Space Force, but is not planned for use by NOAA (EWS-G). In addition to US imagery, NESDIS also provides pass-through products/services from various international geostationary satellites.

Users: NWS, OAR/ESRL, United States Air Force Weather Agency (AFWA), FNMOC, Private sector companies (airlines, etc.), broadcast companies, general public, international partners, Federal Aviation Administration (FAA), NASA, Space Flight Met Group, NESDIS/OSPO/SAB, etc.

Impacts: The product of this algorithm supports search and rescue of people in distress and contributes to accurate/timely weather forecasts and better understanding of long-term climate conditions.

Table 1.2.3.4a: GOES Products Produced and NPB Connections

Product Category	Product Generated
Imagery	Visible and Infrared Imagery

Table 1.2.3.4b: GOES Imagery Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-14 (Standby) IMAGER	108.2W									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									

1.2.3.5 Global Mosaic of Satellite Imagery

Algorithm Description: The Global Mosaic algorithm generates an hourly mosaic product from global geostationary satellite longwave IR, shortwave IR, mid-wave Water Vapor (WV), and visible images at 8 km spatial resolution. Coverage is from 60S to 60N. These products are delivered to NWS NCEP and NWS AWIPS.

Users: NWS AWIPS, NCEP EMC, NHC, NOAA nowCAST

Impacts: The product of this algorithm enables users to examine visible imagery (cloud, ice, and snow cover), shortwave/mid-infrared (cloud cover and fog at night), and longwave/thermal infrared (cloud cover and land/sea temperature patterns). Additionally, one can examine the amount of water vapor in the troposphere's mid to upper levels.

Table 1.2.3.5a: GMGSI Products Produced and NPB Connections

Product Category	Product Generated
Imagery	Visible and Infrared Imagery

Table 1.2.3.5b: GMGSI Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									

1.2.3.6 CoastWatch/OceanWatch Imagery, Biology and Biogeochemistry

The CoastWatch/OceanWatch Imagery, Biology and Biogeochemistry product family is the subset of the CoastWatch/OceanWatch program that provides pass-through products from non-NESDIS LEO sources. The sources are chosen if they are at higher resolution than the NESDIS LEO sources and CoastWatch/OceanWatch users (Fisheries, Marine Sanctuaries, etc.) have priority needs for the higher resolution. This product family also provides selected Ocean Color products from Japan Aerospace Exploration Agency Global Change Observation Mission - Climate Second generation

Global Imager (GCOM-C SGLI), NASA PACE Hyperspectral water leaving radiances and passthrough products (e.g., phytoplankton functional types), ESA Sentinel-2 MSI data, EUMETSAT Pass-through data from OLCI Sentinel 3 series ocean color (chlorophyll, water diffuse attenuation, water leaving radiance (reflectances)), and NASA GLIMR coastal, regional geostationary ocean color.

Table 1.2.3.6a: CoastWatch/Ocean Watch Imagery Products Produced and NPB Connections

Product Category	Product Generated
Imagery	Visible and Infrared Imagery

Table 1.2.3.6b: CoastWatch/OceanWatch Imagery Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
Dove Dove Classic	Sunsynch									
GCOM-C SGLI	Mid-AM									
GLIMR GLIMR	TBD									
Landsat-8 OLI	Early AM									
Landsat-9 OLI	Early AM									
PACE OCI	Noon									
Sentinel-2A MSI	Mid-AM									
Sentinel-2B MSI	Mid-AM									
Sentinel-2C MSI	Mid-AM									
Sentinel-2D MSI	Mid-AM									
Sentinel-3A OLCI	Early AM									
Sentinel-3B OLCI	Early AM									
Sentinel-3C OLCI	Early AM									
Sentinel-3D OLCI	Early AM									

1.2.4 SAR Imagery

1.2.4.1 SAROPS

Reference 2.6.5 SAROPS for SAR Imagery.

1.3 Core NCEI Datasets

1.3.1 Global Historical Climatology Network (GHCN)

The Global Historical Climatology Network daily (GHCNd) is an integrated database of daily climate summaries from land surface stations across the globe. GHCNd is made up of daily climate records from numerous sources that have been integrated and subjected to a common suite of quality assurance reviews.

GHCNd contains records from more than 100,000 stations in 180 countries and territories. NCEI provides numerous daily variables, including maximum and minimum temperature, total daily precipitation, snowfall, and snow depth. About half the stations only report precipitation. Both record length and period of record vary by station and cover intervals ranging from less than a year to more than 175 years.

There is also a GHCN monthly (GHCNm).

1.3.2 GridSat-B1

Gridded Satellite (GridSat-B1) data was created to make it easier to use geostationary data. GridSat-B1 data are gridded International Satellite Cloud Climatology Project (ISCCP) B1 data on a 0.07 degree latitude equal-angle grid. Satellites are merged by selecting the nadir-most observations for each grid point.

1.3.3 HURSAT

HURSAT provides Tropical Cyclone-centric satellite data in gridded netCDF format to create a database of small, portable, and easy to work with storm data. The project began with HURSAT-B1, but has expanded to include data from other satellite sources with different temporal and spatial resolution.

1.3.4 Integrated Surface Dataset

The Integrated Surface Database (ISD) is a global database that consists of hourly and synoptic surface observations compiled from numerous sources into a single common ASCII format and common data model. ISD integrates data from more than 100 original data sources, including numerous data formats that were key-entered from paper forms during the 1950s–1970s time frame. ISD includes numerous parameters such as wind speed and direction, wind gust, temperature, dew point, cloud data, sea level pressure, altimeter setting, station pressure, present weather, visibility, precipitation amounts for various time periods, snow depth, and various other elements as observed by each station.

1.3.5 NClimDiv

This dataset replaces the previous Time Bias Corrected Divisional Temperature-Precipitation Drought Index. The new divisional data set (NClimDiv) is based on the Global Historical Climatological Network-Daily (GHCN-D) and makes use of several improvements to the previous data set. For the input data, improvements include additional station networks, quality assurance reviews and temperature bias adjustments. Perhaps the most extensive improvement is to the computational approach, which now employs climatologically aided interpolation. This 5km grid based calculation nCLIMGRID helps to address topographic and network variability. This data set is primarily used by the NOAA National Climatic Data Center (NCDC) to issue State of the Climate Reports on a monthly basis. These reports summarize recent temperature and precipitation conditions and long-term trends at a variety of spatial scales, the smallest being the climate division level. Data at the climate division level are aggregated to compute statewide, regional and national snapshots of climate conditions. For CONUS, the period of record is from 1895-present. Derived quantities such as Standardized precipitation Index (SPI), Palmer Drought Indices (PDSI, PHDI, PMDI, and ZNDX) and degree days are also available for the CONUS sites.

1.3.6 NOAA Global Surface Temperature (NOAAGlobalTemp)

The NOAA Merged Land Ocean Global Surface Temperature Analysis (NOAAGlobalTemp, formerly known as MLOST) combines long-term sea surface (water) temperature (SST) and land surface (air) temperature datasets to create a complete, accurate depiction of global temperature trends. The dataset is used to support climate monitoring activities such as the Monthly Global Climate Assessment, and also provides input data for a number of climate models.

1.3.7 International Comprehensive Ocean Atmosphere Data Set (ICOADS)*[1]

The International Comprehensive Ocean–Atmosphere Data Set (ICOADS) is the world's largest collection of surface marine observations spanning from 1662 to the present, through international partnership and coordinated by NOAA NCEI. The ICOADS is an integrated source of environmental observations such as Sea Surface Temperature (SST), Air Temperature (AT), Sea Level Pressure (SLP), and wind speed and direction.

[1] * Denotes those products that are not included in the NESDIS Product Baseline (NPB). To be included in the NPB, products must undergo the Product Requirement Change Process. The NPB is signed at the NOSC level, and any changes shall adhere to the established change process (NESDIS-PLN-1316.1), which involves a significant amount of time.

These observations are gathered from a variety of observing platforms including ships, moored and drifting buoys, fixed platforms like oil rigs and coastal offshore structures, and more recent surface autonomous/uncrewed systems (SAVs) such as Saildrones. ICOADS provides access to a range of observation types, globally, and through the entire marine instrumental record. As a foundational dataset, ICOADS has been widely used in various climate-related data and assessment products, such as the NOAAGlobalTemp, the NOAA Extended Reconstructed Sea Surface Temperature (ERSST), the NOAA Optimum Interpolation Sea Surface Temperature (OISST), the Met Office (UKMO) Hadley Centre Sea Ice/Sea Surface Temperature/global surface temperature datasets HadISST, HadSST4 and HadCRUT5, Nighttime Marine Air Temperature datasets HadNMAT2, CLASSnmat and UAHNMATv1, the Intergovernmental Panel on Climate Change Climate Assessment Report, the Japan Meteorological Agency centennial-scale SST analysis, the NOAA–CIRES–DOE Twentieth Century Reanalysis, and the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis ERA 5, and the European Copernicus Climate Change initiative, among many others.

1.3.8 NOAA Extended Reconstructed Sea Surface Temperature (ERSST)*

The Extended Reconstructed Sea Surface Temperature (ERSST) is a core NOAA climate product that has been used by NOAA Climate Prediction Center to define and monitor El Nino index using sea surface temperature and other climate monitoring and assessment. It is practically a Climate Data Record even though not officially so. ERSST is constructed from in situ observations from ships, buoys, Argo floats, and some SAVs. ERSST is a monthly product, covering the period from 1850 - present. It is a globally gridded product with a 0.25-degree resolution. ERSST is a core data set in many follow-on products and applications throughout NCEI and NOAA and notably serves as the primary dataset used in the monthly NWS NCEP El Nino indices calculations

1.3.9 NOAA Daily Optimum Interpolation Sea Surface Temperature (DOISST)*

The NOAA Optimum Interpolation Sea Surface Temperature (DOISST) is a core NOAA product that has been widely used by both scientific communities as well as the public media. It is a foundational dataset used by the international community to monitor Marine Heat Waves, including the Marine Heat Wave Indices for the US Large Marine Ecosystems. OISST is an official Climate Data Record (CDR), covering the satellite era, from 1981-present. OISST takes integrated use of satellite and in situ observations, blending them together. OISST is a global 0.25-degree product with daily resolution.

1.3.10 NOAA Blended Seawinds (NBS) Product*

The NOAA NBS Product has been called out in NOAA's Blue Economy Strategy. It supports offshore renewable energy, marine transportation, marine ecosystem and fisheries, among others. NBS is a Level 4 Gap-Free globally gridded product with a

0.25-degree grid and multiple time resolutions: 6-hourly, daily and monthly. NBS is blended from multiple satellite observations.

1.3.11 NOAA Pathfinder Sea Surface Temperature CDR*

The NOAA Pathfinder SST CDR is a collection of global, twice-daily (Day and Night), 4km SST data produced by NCEI. Level 3C processed data (L3C) is generated with measurements combined from a single instrument into a space-time grid. The dataset was computed with data from the Advanced Very High-Resolution Radiometer (AVHRR) instruments on board NOAA's polar orbiting satellite series using a modern system based on SeaDAS Version 6.4 and spans from 1981 to present.

1.3.12 Surface Marine Underway Database (SUMD)*

The NCEI Surface Underway Marine Database (SUMD) provides a comprehensive set of uniformly, quality-controlled *in situ* sea surface measurements from Thermosalinographs, meteorological sensors and others (such as Saildrones) from 1980 to the present. The dataset is a collection from more than 450 ships and unmanned surface vehicles. They are stored in the NCEI NetCDF format with the trajectory feature type. This data access portal allows you to search the SUMD by data parameter, data source, observation date and spatial range.

1.3.13 World Ocean Database*

The World Ocean Database (WOD) is world's largest collection of uniformly formatted, quality controlled, publicly available ocean profile data. It is a powerful tool for oceanographic, climatic, and environmental research, and the end result of more than 20 years of coordinated efforts to incorporate data from institutions, agencies, individual researchers, and data recovery initiatives into a single database. WOD data spans from Captain Cook's 1772 voyage to the contemporary Argo period, making it a valuable resource for long term and historical ocean climate analysis. Original versions of the 20,000+ datasets in the WOD are available through the NCEI archives.
The WOD consists of periodic major releases and quarterly updates to those releases Data sources for WOD were recently indexed by TPIO as part of the Earth Observation Assessment.

Table 1.3.13 World Ocean Database Data Sources

In Situ Data Source	NOSIA Model Data Source ID Column
Fixed In situ Coastal/Ocean Surface (Grp)	Fixed In situ Coastal/Ocean Surface (Grp)
Global Ocean Carbon Network	GOOS_Carbon_Ntwk
IOOS Regional Ocean Observing System	IOOS-Regionals

In situ Ocean Profile (Grp)	In situ Ocean Profile (Grp)
Global Argo Profiling Floats	ARGO
Global Ships of Opportunity for the XBT Network	Ships_of_Opportunity
Air-Launched Autonomous Micro Observer	ALAMO
Animal Borne Tagging and Barcoding system	Animal_Borne_Sensors
National Glider Network	IOOS-National_Glider_Ntwk
NOAA Ships Ocean Profiles MOC	NOAA_Ships_Ocn_Profile MOC
Prediction and Research Moored Array in the Atlantic Ocean Profile	PIRATA(Ocn_Profile)
Research Moored Array for African-Asian-Australian Monsoon Analysis Ocean Profile	RAMA(Ocn_Profile)
Tropical Atmospheric Ocean Buoy Array Ocean Profile	TAO(Ocn_Profile)
University-National Oceanographic Laboratory System Ocean Profile	UNOLS(Ocn_Profile)
Global Ocean Ship-based Hydrographic Investigations Program Ocean Profile	GO-SHIP(Ocn_Profile)
Climate Variability and Predictability	CLIVAR
Global Temperature Salinity Profile Program: International Partners, Canada, Australia, Japan	DBR_TempSalProfileGbl_GTSPP OGSSD
Investigator Data (Grp)	Mobile In situ Coastal/Ocean Surface (Grp)
University-National Oceanographic Laboratory System Research	UNOLS(Rsrch)
Chartered Vessels Research	Chartered_Vessels_Rsrch
Fairweather Research	NOAA_Ship_Fairweather(Rsrch)
Gordon Gunter Research	NOAA_Ship_Gordon_Gunter(Rsrch)
Okeanos Explorer Research	NOAA_Ship_Okeanos_Explorer(Rsrch)
Ronald H. Brown Research	NOAA_Ship_Ronald_Brown(Rsrch)

1.3.14 Marine Geology and Geophysics*

NCEI is responsible for stewardship, archival, and dissemination of geological and geophysical data from the global sea floor and lakebeds. Data are compiled from both national and international sources through cooperative programs and exchange agreements, including through the NCEI led World Data Service for Geophysics. NCEI provides archive services for much of the data collected by NOAA scientists, observing systems, and research initiatives and synthesizes this data into core data sets such as the Index to Marine and Lacustrine Geological Samples (IMLGS). NCEI manages a comprehensive collection of data and environmental information from a broad range of time periods, observing systems, scientific disciplines, and geographic locations.

2. Geophysical

2.1. Atmosphere

2.1.1 Atmospheric Composition and Air Quality

2.1.1.1 Blended Global Biomass Burning Emissions Product (GBBEPx V3)

Reference 2.6.2 GBBEPx for Biomass Burning Emissions and Trace Gases Produce Suite.

2.1.1.2 Aerosol Detection and Optical Depth Algorithm

Algorithm Description: The Aerosol Detection and Optical Depth Algorithm includes several visible-channel, optical sensor-based algorithms to derive aerosols. This algorithm family produces aerosols that are important to understand Air Quality (input to PM2.5 models), Sea Surface Temperature (atmospheric temperature correction) and Climate (direct and indirect aerosol effects). The air quality data is used by NOAA as well as by the EPA, NASA and DoD. EPS-SG A1 3MI and TEMPO are being explored for potential innovation.

Users: OAR/ARL, NRL, NWS, AFWA, FNMOC, CSPP Geo with GRB

Impacts: The products of this algorithm support tracking of aerosols which are useful for climate studies, the aviation sector, and examining atmospheric circulation patterns. Forecasters use aerosol data to monitor smoke and dust to determine visibility and air quality.

Table 2.1.1.2a: Aerosol Detection and Optical Depth Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Aerosol Optical Depth/Thickness
Atmospheric Composition and Air Quality	Aerosol Detection

Table 2.1.1.2b: Aerosol Detection and Optical Depth Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
MetOp-SG-A1 3MI	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
MetOp-SG-A1 Sentinel 5	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
PACE SPEXone/HARP2	Noon									
S-NPP VIIRS	PM									
Sentinel-5P TROPOMI	PM									
TEMPO TEMPO	100W									

2.1.1.3 Enterprise Aerosol Detection Products (ADP)

Algorithm Description: The EPS for Aerosol Detection uses Input Reflectance: 412, 440, 2250 µm; and, several Internal Tests: Spatial Variability Test: 412 µm (land); 865 µm (water), Turbid Water Test: 488 µm, 1.24 µm, 1.61 µm, 2.25 µm, Bright Pixel Test:1.24 µm, 2.25 µm, Normalized Difference Vegetation Index (NDVI) Test: 640 µm, 865 µm, Snow Test: 865 µm, 1.24 µm + IR, Absorbing Aerosol Index; and Dust Smoke Discrimination Index. The output is dust, smoke and ash detection information.

Users: OAR, NWS, NRL, AFWA, FNMOC, CSPP GEO (with GRB).

Impacts: The products of this algorithm support tracking of aerosols which are useful for climate studies, the aviation sector, and examining atmospheric circulation patterns. Forecasters use aerosol data to monitor smoke and dust to determine visibility and air quality.

Table 2.1.1.3a: ADP Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Aerosol Detection
Atmospheric Composition and Air Quality	Dust, Ash, Smoke

Table 2.1.1.3b: ADP Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
TEMPO TEMPO	100W									

2.1.1.4 Enterprise Aerosol Optical Depth (AOD) Products

Algorithm Description: *Enterprise Processing System (EPS) for Aerosol Optical Depth (AOD) and Aerosol Particle Size Parameter (APSP).* The EPS AOD/APSP algorithm is designed to work with VIIRS (Visible Infrared Imaging Radiometer Suite) and ABI (Advanced Baseline Imager) observations. For aerosols over water, the AOD algorithm is based on the Moderate-resolution Imaging Spectroradiometer (MODIS) heritage but aerosols are also retrieved over large inland water bodies. For dark surfaces on land, a "dark-target" approach is applied, while for bright (snow-free) surfaces it uses regional ratios of surface reflectances. The algorithm uses shortwave information for AOD, shortwave and IR information for internal tests, as well as masks (cloud, snow/ice, etc.) and ancillary data (P, Total Precipitable Water (TPW), ozone, wind).

Users: NWS/WFOs, NCEP (NCO and EMC), NCAR, EPA, JCSDA, National Institute of Environmental Health Sciences, DOD (Army, AFWA, NRL, and FNMOC), Air Resources Laboratory, OAR, Academia (CIMSS).

Impacts: These products are used to improve aerosol optical depth and aerosol particle size parameters useful for climate studies, aviation forecasting, environmental monitoring, and numerical weather prediction with forecasting smoke and dust aerosols that affect visibility and air quality.

Table 2.1.1.4a: AOD Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Aerosol Optical Depth (AOD)/Thickness
Atmospheric Composition and Air Quality	Aerosol Particle Size Properties (APS)

Table 2.1.1.4b: AOD Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
MetOp-SG-A1 3MI	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
TEMPO TEMPO	100W									

2.1.1. 5 NESDIS Total Ozone from Analysis of Stratospheric and Tropospheric Components (NTOAST)

Algorithm Description: NTOAST is a Total Ozone Analysis using OMPS and Cross-track Infrared Sounder. A full troposphere and lower stratosphere ozone has been accurately derived based on the fine height resolution profile retrieved from CrIS hyper-spectral observation. The mid-to-upper stratosphere ozone has been analyzed using the new generation ozone profiler OMPS Nadir Profiler.

Users: National Weather Service (NCEP/CPC, NCEP/EMC, NWS Air Quality), International NWP users, Climate User, NOAA Data Visualization Laboratory

ECMWF, WMO, NASA, Downstream NESDIS Algorithms (NOAA Reformatting Toolkit). Impacts: The product of this algorithm represents a new generation of the current operational TOAST. It replaces data from the sensors used to compose the TOAST (SBUV/2 and HIRS) with the most newly developed sensors: OMPS NP and CrIS. This leads to improved product accuracy and provides continuity of TOAST contributions to ozone researchers and other users.

Table 2.1.1.5a: TOAST Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Total Ozone
Atmospheric Composition and Air Quality	Ozone Profile

Table 2.1.1.5b: TOAST Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 CrIS	PM									
JPSS-4 OMPS-NM	PM									
JPSS-4 OMPS-NP	PM									
NOAA-20 CrIS	PM									
NOAA-20 OMPS-NP	PM									
NOAA-20 OMPS-NM	PM									
NOAA-21 CrIS	PM									
NOAA-21 OMPS-L	PM									
NOAA-21 OMPS-NP	PM									
NOAA-21 OMPS-NM	PM									
S-NPP CrIS	PM									
S-NPP OMPS-L	PM									
S-NPP OMPS-NM	PM									
S-NPP OMPS-NP	PM									

2.1.1.6 Hyperspectral Enterprise Algorithm Package (HEAP)

Ref 2.6.3 HEAP for Ozone Profiles and Trace Gas Product Suite.

2.1.1.7 V8 Ozone Profile (V8Pro)

Algorithm Description: V8Pro and V8Toz generate ozone information using OMPS, Global Ozone Monitoring Experiment, Solar Backscatter Ultraviolet Radiometer 2 for NCEP and climate users. In addition, the OMPS Limb Profiler is used to generate a V2Limb Ozone Profile product. There are two intermediate files in the GOME-2 level-2 processing system which are the namelist file and MgII file. These files are updated when current GOME-2 level 1b granule data is processed and a new granule data file arrives. The MGII algorithm writes out the MgII index calculated by current solar irradiance and irradiance measurements at corresponding wavelengths. There is also V8TOS, where there is an LFSO2 algorithm that recalculates the total column ozone from V8Toz correcting for the estimated SO_2 column.

Users: NCEP/CPC, NCEP/EMC, International NWP users, NWP FOs, Climate User NOAA Data Visualization Laboratory, and downstream NESDIS Algorithms (TOAST and NOAA Reformatting Toolkit).

Impacts: The global daily product of this algorithm provides estimates of layer ozone amounts, UV reflectivity, and absorbing aerosol index values at a spatial resolution of 50 km at nadir. The EDR also contains quality information including quality flags, measurement sensitivities, and retrieval efficiency factors.

Table 2.1.1.7a: V8Pro Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Total Ozone
Atmospheric Composition and Air Quality	Ozone Profile

Table 2.1.1.7b: V8Pro Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 OMPS-L	PM									
JPSS-4 OMPS-NM	PM									
JPSS-4 OMPS-NP	PM									
MetOp-B GOME-2	Mid AM									
MetOp-C GOME-2	Mid AM									
MetOp-SG-A1 Sentinel 5	Mid AM									
NOAA-20 OMPS-N	PM									

NOAA-21 OMPS-L	PM									
S-NPP OMPS-L	PM									
S-NPP OMPS-NM	PM									
S-NPP OMPS-NP	PM									

2.1.1.8 TEMPO Trace Gases and Aerosols (Potential R2O over 5 years)

Algorithm Description: TEMPO trace gas and aerosol products include NO_2, SO_2, H_2CO, $H_2C_2O_2$, O_3, UV AOD, UV AI, aerosol layer height, aerosol single scattering albedo, and aerosol particle size. NOAA intends to participate in the Geostationary Environment Monitoring Spectrometer (GEMS) validation team and generate algorithms that will work with TEMPO and a GEO-XO atmospheric composition instrument. Users are OAR, EPA and NWS.

Table 2.1.1.8a: TEMPO Trace Gases and Aerosols Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Aerosol Detection
Atmospheric Composition and Air Quality	Trace Gases Product Suite

Table 2.1.1.8b: TEMPO Trace Gases and Aerosols Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
TEMPO TEMPO	100W									

2.1.1.9 JPSS OMPS Trace Gases (Potential R2O over 5 years)

Algorithm Description: JPSS OMPS trace gas products include NO_2 and H_2CO. Users are OAR, EPA and NWS.

Table 2.1.1.9a: JPSS OMPS Trace Gases Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Trace Gases Product Suite

Table 2.1.1.9b: JPSS OMPS Trace Gases Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 OMPS-L	PM									
JPSS-4 OMPS-NM	PM									
JPSS-4 OMPS-NP	PM									
NOAA-20 OMPS-N	PM									
NOAA-21 OMPS-L	PM									
S-NPP OMPS-L	PM									
S-NPP OMPS-NM	PM									
S-NPP OMPS-NP	PM									

2.1.1.10 MetOp-SG pass-through Trace Gases and Aerosols (Potential R2O)

MetOp-SG Pass-Through trace gas and aerosol products include NO_2, SO_2, H_2CO, $H_2C_2O_2$, O_3, UV AOD, UV AI, aerosol layer height, aerosol single scattering albedo, and aerosol particle size.

Users: OAR, EPA and NWS.

Table 2.1.1.10a MetOp-SG pass-through Trace Gases and aerosols (Potential R2O) Products Produced and NPB Connections.

Product Category	Product Generated
Atmospheric Composition and Air Quality	Trace Gasses

Table 2.1.1.10b MetOp-SG pass-through Trace Gases and aerosols (Potential R2O) Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
MetOp-SG-A1 3MI	Mid AM									
MetOp-SG-A1 METimage	Mid AM									

2.1.1.11 RAVE

Reference to 2.3.1.5 for Trace Gasses and other Air Quality products.

2.1.2 Atmosphere Water Vapor

2.1.2.1 GNSS and GNSS Radio Occultation (GNSSRO) Algorithm Family

Algorithm Description: GPSRO temperature profiles are provided as pass-through products for a variety of satellites. Satellite RO involves a low-Earth orbit satellite receiving a signal from a GPS or similar satellite. The signal has to pass through the atmosphere and gets refracted along the way. The magnitude of the refraction depends on the temperature and water vapor concentration in the atmosphere and the electron density profile in the ionosphere. Bending angles and refractivity profiles are also produced and provided to NWS/NCEP/EMC.

Users: NCEP

Impacts: Water vapor information assists in hurricane forecasting.

Table 2.1.2.1a: GNSS and GNSS Radio Occultation Algorithm Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Water Vapor	Atmospheric Water Vapor Profiles
Atmospheric Temperature	Atmospheric Temperature Profiles

Table 2.1.2.1b: GNSS and GNSS Radio Occultation Algorithm Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
COSMIC-2 TGRS	Drifting									
KOMPSAT-5 AOPOD	Early AM									
MetOp-B GRAS	Mid AM									
MetOp-C GRAS	Mid AM									
MetOp-SG-A1 RO	Mid AM									
MetOp-SG-B1 RO	Mid AM									
SEOSAR/Paz ROHPP	Early AM									
Sentinel-6A MF GNSS-RO	10-day repeat									
PACE SPEXone/HARP2	Noon									

2.1.2.2 GAASP TPW/CLW Algorithm

Algorithm Description: The GAASP TPW algorithm makes use of Tb measurements from 4 AMSR2 channels (23 GHz, and 36 GHz channels, horizontally and vertically polarized [H- & V-pol]). The CLW algorithm makes use of Tb measurements from 9 AMSR2 channels (6 GHz, 7 GHz, and 10 GHz H-pol only, and 18 GHz, 23 GHz, and 36 GHz channels H- and V-pol).Both are statistically based.

Users: NWS/NCEP, OAR/ESRL, AFWA, FNMOC

Impacts: The product of this algorithm, AMSR2, provides numerous products (all weather SST, ocean wind speeds, sea ice, soil moisture, total precipitable water, cloud liquid water) that are used directly by human forecasters and also assimilated into models.

Table 2.1.2.2a: GAASP TPW/CLW Products Produced and NPB Connections

Product Category	Product Generated
Imagery	Microwave Imager Imagery
Atmospheric Water Vapor	Total Precipitable Water (TPW)
Clouds	Cloud Liquid/Ice Water

Table 2.1.2.2b: GAASP TPW/CLW Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									

2.1.2.3 HEAP

Reference 2.6.3 for NOAA global temp

2.1.2.4 Legacy Atmospheric Profiles

Reference 2.1.3.4 for Atmospheric Water Vapor Profiles.

2.1.2.5 MIRS

Reference 2.6.4 for Atmospheric Water Vapor Profiles and Total Precipitable Water.

2.1.2.6 Blended Hydrometeorological Package

Algorithm Description: The Blended-Hydro merges TPW and Rainfall Rate (RR) retrievals derived from multi-satellites/sensors/algorithms and provides unified global TPW and RR maps. With the upcoming R2O, the Blended-Hydro will also provide the blended precipitable water within condensed depth in specified pressure layers (surface-850mb, 850-700mb, 700-500mb, 500-300mb). The Advected Layered-PW (ALPW) allows analysts and forecasters to better pinpoint the location of heavy precipitation and potential flooding, and locate boundaries or concentrations of high moisture in areas with very little data and higher terrain. In addition to satellite data this algorithm also uses in situ GPS-Met data when available.

Users: NWS NCEP (WR, SPC, NHC, WPC, WFO, AWIPS), NESDIS/OSPO/SAB, GeoNetCast - Americas, OAR, WorldWinds, NIC.

Impacts: The blended-hydrometeorological products enable the forecaster to use one improved product in lieu of many products derived from multiple platforms. Blending, advected polar and GOES-16/18 and beyond mitigates the biases from each individual sensor to produce a more accurate, all-inclusive product, therefore, provide better anticipation and forecast of heavy rain and flooding events. The blended TPW product provides a more complete observation of the movement of moisture in the atmosphere, which forecasters in tracking monsoon surges out of the Pacific Ocean during the summer and fall, return moisture surges from Gulf of Mexico after frontal passages, and moisture plumes out of the tropics during the winter. The TPW anomaly product helps forecasters quickly identify areas that are abnormally wet or dry.

Table 2.1.2.6a: Blended Hydrometeorological Package Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Water Vapor	Total Precipitable Water (TPW)
Atmospheric Water Vapor	Percentage of TPW Normal
Atmospheric Water Vapor	Advected Layered Precipitable Water (ALPW)
Precipitation	Rain Rate (RR)

Table 2.1.2.6b: Blended Hydrometeorological Package Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
DMSP-F17 SSMIS	Early AM									
DMSP-F18 SSMIS	Early AM									
GCOM-W AMSR2	PM									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
JPSS-4 ATMS	PM									
MetOp-B AMSU-A	Mid AM									
MetOp-B MHS	Mid AM									
MetOp-C AMSU-A	Mid AM									
MetOp-C MHS	Mid AM									
MetOp-SG-A1 MWS	Mid AM									
MetOp-SG-B1 MWI	Mid AM									
NOAA-19 AMSU-A	Early AM									
NOAA-19 MHS	Early AM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									

2.1.3 Atmospheric Temperature

2.1.3.1 MIRS

Reference 2.6.4 MIRS for Atmospheric Temperature Profile.

2.1.3.2 HEAP

Reference 2.6.3 HEAP for Surface Pressure, Atmospheric Temperature Profile, Stability Indices, and Lifted IndexOzone.

2.1.3.3 NOAA Global Temp

Reference 1.3.6 NOAAGlobalTemp for Surface Air Temperature (In situ).

2.1.3.4 Legacy Atmospheric Profiles (Soundings)

Algorithm Description: The GOES Legacy Sounder algorithm retrieves temperature and moisture profiles and derived products including TPW, layer LPW, lifted index, convective available potential energy, total totals index, Showalter index, and K-index from clear sky radiances within M by M ABI FOV box area. It emulates product families from the legacy GOES Sounder.

Users: NWS (NCEP, AWC, EMC, NHC, OPC, SPC), NESDIS Office of Satellite Data Processing and Distribution (OSDPD) including the NESDIS/OSPO/SAB and the Product Implementation Branch (PIB), OAR and Center for Satellite Applications and Research (STAR), DOD, NCEI, International Partners (South American collaborators and EUMETSAT), and GOES-R.

Impacts: Atmospheric Profiles Soundings products are used to improve NWP and forecasting applications.

Table 2.1.3.4a: Legacy Atmospheric Profiles (Soundings) Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Water Vapor	Atmospheric Water Vapor Profiles
Atmospheric Water Vapor	Total Precipitable Water (TPW)
Atmospheric Temperature	Atmospheric Temperature Profile
Atmospheric Temperature	Lifted Index
Atmospheric Temperature	Stability Indices

Table 2.1.3.4b: Legacy Atmospheric Profiles (Soundings) Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

2.1.3.5 Regional Climate

Algorithm Description: The Regional Climate product family generates climate and weather information tailored to specific interests in various geographic regions and includes regional climate extremes. This includes Climate and Forecast Perspectives - Climate Perspectives ranks a period of observations at a station against the normals and historical observations for the same period. Forecast Perspectives places recent conditions and short-term forecasted conditions in both a historical and geographical perspective. This family also includes Sporting Events Climatologies, a series of climatologies for major sporting events such as the Super Bowl, PGA Tournaments, the Kentucky Derby, NASCAR Races, and major festivals.

Table 2.1.3.5a: Regional Climate - Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Temperature	Maximum/Minimum Temperatures
Climate	Climate and Health
Weather	Regional Winter Weather
Weather	Freeze/Thaw
Climate	Climate and Forecast Perspectives
Climate	Sporting Events Climatology
Weather	Tropical Weather and Impacts

Table 2.1.3.5b: Regional Climate Current/Historical Sources, Types of Data Required, and Inputs

Category	Description
Current/Historical Sources	NCA [Climate and Health]; GHCN-Daily, NWS Forecasts [Freeze/Thaw]; GHCN-Daily, Normals, NWS National Digital Forecast Database [Climate and Forecast Perspectives, Sporting Event Climatologies]; STAR, NWS National Hurricane Center [Tropical Weather and Impacts]

Category	Description
	In situ: GHCN-Daily
Types of data required	Sporting Events [Climatology]; Surface Weather Observations and Weather Forecasts [Freeze/Thaw]; GOES Image Viewer, Hurricane Forecasts [Tropical Weather and Impacts] In situ sources: Surface observations from weather and climate networks around the world including rain, hail, snow, and information from buoys to obtain measurements in oceanic areas
Used as inputs for	Enable services for national, regional, and local planners and officials

2.1.3.6 Monitoring Products

Monitoring products include: Apparent Temperature, Heat Stress Index, Global Regional Values, National Temperature Index, Residential Energy Demand Temperature Index, Global Temperature and Precipitation Maps, GHCN Gridded Products, and Automated Surface Observing System (ASOS) Temperature Departure, Stagnation Index and Degree Day Maps.

Table 2.1.3.6: Monitoring Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Temperature	Maximum/Minimum Temperatures
Atmospheric Temperature	Stagnation Index

In situ Sources:

- GHCN-Monthly
- NOAAGlobalTemp
- nClimDiv
- nClimGrid
- CRN
- ISD

2.1.3.7 Normals and Extremes

Climate Normals and extremes are a large suite of data products that provide information about typical climate conditions for thousands of locations across the United States. Normals act both as a ruler to compare today's weather and tomorrow's forecast, and as a predictor of conditions in the near future. The official normals are calculated for a uniform 30-year period, and consist of annual/seasonal, monthly, daily, and hourly averages and statistics of temperature, precipitation, and other climatological variables from almost 15,000 U.S. weather stations. NCEI generates the official U.S. normals every 10 years in keeping with the needs of our user community and the requirements of the WMO and NWS. The 1991–2020 U.S. Climate Normals are the latest in a series of decadal normals first produced in the 1950s. These data allow travelers to pack the right clothes, farmers to plant the best crop varieties, and utilities to plan for seasonal energy usage. Many other important economic decisions that are made beyond the predictive range of standard weather forecasts are either based on or influenced by climate normals.

Normals and Extremes products include: National Climate Extremes Committee data, State Climate Extremes Committee data, Climate Extremes Index, Extremes In U.S. Climate, Conventional 30 Year U.S. Climate Normals, GHCN-Daily-derived Extremes Indices (GHCNDEX), Supplemental Global Climate Normals, and Operational Auxiliary Normals.

Table 2.1.3.7: Normals and Extremes Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Temperature	Maximum/Minimum Temperatures

In situ Sources:

- GHCN-Hourly
- GHCN-Daily
- GHCN-Monthly
- U.S. Climate Normals
- nClimDiv
- nClimGrid
- CRN
- ISD

2.1.3.8 Radiosonde Products

The Radiosonde Product Family includes upper air products beginning at three meters above the Earth's surface. These data are obtained from radiosondes, which are instrument packages tethered to balloons that are launched from the ground, ascend through the troposphere into the stratosphere, and transmit back to a receiving station on the ground. These observations include vertical profiles of temperature, humidity, wind speed and direction, atmospheric pressure, and geopotential height.

Upper Air Temperature products include NWS Upper Air Soundings, Radiosonde Atmospheric Temperature Products for Assessing Climate (RATPAC), Integrated Global Radiosonde Archive (IGRA), and upper air observations from the U.S. and its territories.

Table 2.1.3.8: Radiosonde Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Temperature	Upper Air Temperature

In situ Sources:

- NWS Radiosondes
- IGRA
- US RRS Soundings
- GTS Messages

2.1.3.9 Automated Surface/Weather Observing System (ASOS/AWOS)

The ASOS program is a joint effort of the NWS, the FAA, and the DOD. There are currently more than 900 ASOS sites in the United States. These automated systems collect observations on a continual basis, 24 hours a day. ASOS data are archived in the Global Surface Hourly database.

Automated Weather Observing System (AWOS) units are operated and controlled by the Federal Aviation Administration. These systems are among the oldest automated weather stations and predate ASOS. They generally report at 20-minute intervals and, unlike ASOS, do not report special observations for rapidly changing weather conditions.

Table 2.1.3.9: ASOS/AWOS Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Temperature	Surface Air Temperature

In situ Sources:

- ASOS Network
- AWOS Network
- NWS SRRS
- ASOS: US CLIMAT
- HOMR
- GHCN-Daily
- ERSST
- NCEP Ice Concentration

2.1.3.10 Climate Products

Climate products include GSOM/GSOY, NOAA Global Temp, nClimGridDaily, In situ/Grids: nClimGrid Monthly, ISTI, and GHCN-Monthly Temperature.

Table 2.1.3.10: Climate Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Temperature	Surface Air Temperature

In situ Sources:

- GHCN-Daily
- ERSST
- NCEP Ice Concentration
- Monthly Climatic Data for the World UK Hadley Centre
- NWS Monthly CLIMAT

2.1.3.11 Regional Climate Center CLIMATE Databases

Each RCC has developed a wide range of station-based summaries that include station normals, records and thresholds for temperature and precipitation. These summaries can be found on the Regional Climate Center (RCC) website

(https://www.ncei.noaa.gov/regional/regional-climate-centers), as a part of their CLIMOD databases, or as a part of ACIS.

Table 2.1.3.11: RCC CLIMOD Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Temperature	Station-based climate summaries

In situ Sources:

- GHCN-Daily

2.1.3.12 ThreadEx

Threaded Stations Extremes (ThreadEx) addresses the fragmentation of station information over time due to station relocations for the express purpose of calculating daily extremes of temperature and precipitation. There are often changes in the siting of instrumentation for any given National Weather Service/Weather Bureau location over the observational history in a given city/region. As a result, obtaining a long time series (i.e., one hundred years or more) for computation of extremes is difficult, unless records from the various locations are "threaded" or put together. In consultation with NCEI and the NWS, the Northeast Regional Climate Center (NRCC) has evaluated station relocations and built "threads" for 270 locations that are published in NCEI's Local Climatological Data using NOAA daily data sets.

Table 2.1.3.12: ThreadEx - Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Temperature	Regional Climate Center: Extremes

In situ Sources:

- GHCN-Daily

2.1.3.13 GNSS and GNSS Radio Occultation (GNSSRO) Algorithm Family

Reference 2.1.2.1 for Atmospheric Temperature Profiles.

2.1.4 Clouds

2.1.4.1 ASOS Satellite Cloud Product (ASOS-SCP)

Algorithm Description: The ASOS-SCP algorithm provides site-specific satellite-derived cloud cover information complementary to the site-specific cloud cover information acquired by ASOS ground-based ceilometer observations. The algorithm uses GOES-derived pixel cloud information (cloud-top pressure, height, average adequate cloud amount) centered over each ground site. A decision tree algorithm is used to statistically segment cloud height and cloud amount information to arrive at a composite satellite cloud report that mimics the ground-based sky cover determinations noted above (OVC, BKN, SCT, and CLR) for three distinct atmospheric layers (high, mid, low). The ASOS SCP product is a post-process of the cloud products and is used by NWS for augmenting the surface-based cloud observations at ASOS sites. These include Categorical Cloud Coverage, Range of Cloud Top Heights, and Average Effective Cloud Amount (ECA).

Users: NWS/WFOs

Impacts: This product compliments the NWS ASOS net of stations. These text products detect the cloud cover conditions over the ASOS stations and list them by state. The product detects the cloud cover conditions at the middle (631-400 MB) and high (above 400 MB) layers of the atmosphere. These products enable improved weather forecasting and understanding of the atmosphere.

Table 2.1.4.1a: ASOS-SCP Products Produced and NPB Connections

Product Category	Product Generated
Clouds	Cloud Heights (Top and Base)

Table 2.1.4.1b: ASOS-SCP Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

2.1.4.2 Enterprise Cloud Base Height

Algorithm Description: Cloud-base height (height above sea level where cloud base occurs), altitude, pressure, and geometrical thickness.

Users: National Weather Services Offices & Specialized Centers (Numerical Weather Prediction purposes - NCEP/EMC, JCSDA, others).

Impacts: This product supports weather forecasting and numerical weather prediction. It is also an intermediate product for the MetOp-C (AVHRR) Cloud Cover Layers (CCL) algorithm.

Table 2.1.4.2a: Enterprise Cloud Base Height - Products Produced and NPB Connections

Product Category	Product Generated
Clouds	Cloud Heights (Top and Base)
Clouds	Cloud Optical Depth/Thickness

Table 2.1.4.2b: Enterprise Cloud Base Height Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-18 AVHRR/3	Early AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.4.3 Enterprise Cloud Layers

Algorithm Description: Cloud Cover is the fraction of a given area of the Earth's surface masked by clouds. Cloud Vertical Structure is based on cloud height and cloud base. Layered convective and supercooled cloud fractions are also calculated as part of the Cloud Cover Layers algorithm.

Users: NOAA Aviation Weather Center, CIRA, CIMSS, NWS.

Impacts: The products of this algorithm support aviation forecasting applications that align with NOAA missions to understand and predict changes in climate, weather, oceans and coasts and to share that knowledge and information with others.

Table 2.1.4.3a: CCL Products Produced and NPB Connections

Product Category	Product Generated
Clouds	Cloud Fraction
Clouds	Cloud Layers

Table 2.1.4.3b: CCL Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
MTG-I1 FCI	0									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.4.4 Cloud-Top Height/Temperature/Pressure (Cloud Height)

Algorithm Description: The enterprise cloud top height algorithm uses many combinations of infrared bands to simultaneously retrieve cloud top height, cloud top temperature, and cloud top pressure for each cloudy pixel. These cloud products are a prerequisite for generating other downstream products, including cloud layers, optical/microphysical products, and derived motion winds. Forecasters can use this information to determine areas of cloud growth and the likelihood of precipitation.

Users: NWS Offices and Specialized Centers (Numerical Weather Prediction purposes (i.e., NCEP/EMC, JCSDA, others)). This product is also an input for cloud products, AVHRR Polar Winds products, NUCAPS System, Cryosphere products, Aerosol products, Land Surface Temperature/Albedo/Reflectance, and Vegetation Index/Green Fraction Index.

Impacts: The products of this algorithm are used to compute wind vectors from cloud drift. Cloud base is an important meteorological variable for aviation safety.

Innovation: PPM is improving GOES Sky Cover products to ensure continuity and is looking to leverage Artificial Intelligence/Machine Learning (AI/ML) techniques to improve cloud products' accuracy and scientific value.

Table 2.1.4.4a: Cloud Height Products Produced and NPB Connections

Product Category	Product Generated
Clouds	Cloud Heights (Top and Base)
Clouds	Particle Size Distribution
Clouds	Cloud Emissivity
Clouds	Cloud Top Temperature
Clouds	Cloud Top Pressures
Clouds	Cloud Top Phase

Table 2.1.4.4b: Cloud Height Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 VIIRS	PM									

MTG-I1 FCI	0									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MeOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.4.5 Enterprise Cloud Mask

Algorithm Description: The Cloud Mask Algorithm provides Cloud Probability, 4-Level Mask, Binary Mask and Various Diagnostic Bits.

Users: NWS Offices and Specialized Centers (Numerical Weather Prediction purposes (i.e., NCEP/EMC, JCSDA, others). This product is also an input for cloud products, AVHRR Polar Winds products, NUCAPS System, Cryosphere products, Aerosol products, Land Surface Temperature/Albedo/Reflectance, and Vegetation Index/Green Fraction Index.

Impacts: The development of this algorithm supports integrated Water Forecasting, Coasts, Estuaries and oceans, Marine Transportation Systems, and Marine Weather.

Table 2.1.4.5a: ECM Products Produced and NPB Connections

Product Category	Product Generated
Clouds	Cloud Mask

Table 2.1.4.5b: ECM Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 VIIRS	PM									
MTG-I1 FCI	0									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.4.6 Enterprise Cloud Phase/Type

Algorithm Description: The Cloud Phase Algorithm calculates Cloud Phase, Cloud Types, and Cloud Phase Probability.

Users: OAR/ESRL, AFWA, FNMOC, NWS Offices, and Specialized Centers (Numerical Weather Prediction purposes (i.e., NCEP/EMC, JCSDA, others)). This product is also an input for cloud products, AVHRR Polar Winds products, NUCAPS System, Cryosphere products, Aerosol products, Land Surface Temperature/Albedo/Reflectance, and Vegetation Index/Green Fraction Index.

Impacts: Cloud top phase enables meteorologists to better monitor and track changes in the water properties of clouds, improve icing forecasts for the aviation community, and aid in enhancing warnings for severe weather.

Table 2.1.4.6a: Cloud Phase/Type - Products Produced and NPB Connections

Product Category	Product Generated
Clouds	Cloud Phase

Table 2.1.4.6b: Cloud Phase/Type Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6 W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 VIIRS	PM									
MTG-I1 FCI	0									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.4.7 Daytime/Nighttime Cloud Optical and Microphysical Properties (DCOMP/NCOMP)

Algorithm Description: DCOMP uses a physical basis for inferring Cloud Optical Depth (COD), Cloud Particle Size (CPS), Liquid Water Path (LWP) and Ice Water Path (IWP) from imagery taken by sensors which make observations in visible and near-IR spectrum. The COD and CPS will be inferred for all pixels identified as containing clouds by a preprocessed cloud mask. We distinguish clouds as either ice phase or water phase. The latter is also included in our definition of supercooled and mixed-phase clouds. The COD and CPS are used subsequently to calculate LWP/IWP, whose values can be compared with those derived from active measurements from space-born instruments such as the Cloud Profiling Radar on CloudSat and passive microwave sensors such as AMSR-E or Special Sensor Microwave Imager (SSMI), as well as ground-based microwave profilers.

NCOMP uses a physical basis to retrieve nighttime water and ice COD, particle size, and liquid or ice water path from imagery taken by IR optical sensors. The algorithm is based primarily on a Solar-IR Technique from NASA Langley Research Center.

Users: Archive- NCDC, FAA, NCEP, and NWS & Specialized Centers (Numerical Weather Prediction purposes (i.e., NCEP/EMC, JCSDA, etc.)). NCOMP and DCOMP are also input products for Cloud Base and Cloud Cover/Layers.

Impacts: The products of this algorithm support cloud characterization and numerical weather prediction.

Table 2.1.4.7a: DCOMP/NCOMP - Products Produced and NPB Connections

Product Category	Product Generated
Clouds	Cloud Optical Depth/Thickness

Table 2.1.4.7b: DCOMP/NCOMP Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 VIIRS	PM									
MTG-I1 FCI	0									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.4.8 GAASP TPW/CLW

Reference 2.1.2.2 for Cloud Liquid/Ice Water.

2.1.4.9 MIRS

Reference 2.6.4 MIRS for Cloud Liquid/Ice.

2.1.4.10 Fog Low Stratus (FLS)

Algorithm Description: Flown on the GOES-R series of NOAA geostationary meteorological satellites. The GOES-R fog/low cloud detection product is designed to quantitatively identify clouds that produce Instrument Flight Rules (IFR) conditions, defined as having a cloud ceiling between 500 ft (152 m) and 1000 ft (305 m) Above Ground Level (AGL), or Low Instrument Flight Rules (LIFR) conditions, defined as having a cloud ceiling below 500 ft (152 m) AGL. The GOES-R fog product does not differentiate between IFR and LIFR conditions but returns a probability that the cloud ceiling is below 1000 ft (305 m) AGL. There are visibility requirements included in the IFR and LIFR definitions; however, surface visibility is not available for the GOES-R algorithm (the GOES-R surface visibility algorithm relies on the fog product described herein) and is therefore not used for the GOES-R fog/low cloud algorithm. The algorithm utilizes the 3.9 and 11 μm channels at night to detect IFR conditions. Fog detection during the day is determined using the 0.65, 3.9, and 11 μm channels. The fog detection algorithm utilizes textural and spectral information and the difference between the cloud radiative temperature and surface temperature. It is likely that the Joint Polar Satellite System (JPSS) will be desired, but have not received formal requests from users.

Users: NWS (LDM, AWIPS, Field Offices), NCEP (AWC, EMC, NCO, WPC), NCEI, FAA, JCSDA, OPC, and Image Cloud-Aerosol Product Oversight Panel (ICAPOP) from the SPSRB.

Impacts: These products improve aviation forecasting, marine forecasting, and fog advisory issuance in numerical weather forecasting applications.

Table 2.1.4.10a: Low Cloud and Fog - Products Produced and NPB Connections

Product Category	Product Generated
Clouds	Fog

Table 2.1.4.10b: Low Cloud and Fog Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

2.1.4.11 Optical Imager Clear-Sky Radiance

Reference 1.1.11 for Cloud Fraction and Cloud Layers.

2.1.4.12 AI/ML Enterprise Cloud Product Algorithms (Potential R2O over 5 years)

Algorithm Description: Placeholder for future enterprise cloud product activities that explore and implement AI/ML techniques to improve accuracy and scientific value of these products.

Table 2.1.4.12a: ML Enterprise Cloud - Products Produced and NPB Connection

Product Category	Product Generated
Clouds	Cloud Mask

Table 2.1.4.12b: AI/ML Enterprise Cloud Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									

2.1.5 Lightning

2.1.5.1 Lightning Detection Products from Lightning Cluster Filter Algorithm (LCFA)

Algorithm Description: The GLM Lightning Cluster-Filter Algorithm (LCFA) generates Level 2 lightning products (flashes, groups, events) from L1b GLM geo-located, time-tagged lightning event data. The LCFA builds a parent-child tree structure that identifies

the clustering of optical events into groups and groups into flashes. One major product the GLM software produces is a lightning dataset. The satellite data stream must be decoded, filtered, clustered, and output to the appropriate file to obtain the lightning dataset. The LCFA only generates the lightning dataset after the L1b code processes the event data. Specifically, the LCFA receives as input the L1b pixel-level optical "event" data and processes this data into more convenient lightning data products easily utilized by scientific research and broader operational user communities. Therefore, the LCFA must take the event data and assemble the higher-level clustered lightning data products (events, groups, and flashes), and in so doing, it generates derived lightning characteristics associated with these higher-level products. It also interrogates individual flashes, groups, and events statistically to determine how likely the events/groups/flashes are associated with lightning or noise.t Criteria) and NASA SMD (Science O2R).

Users: NWS, NCEP including (AWC, SPC, EMC, NHC, and WPC), NESDIS/OSPO/SAB, DoD including (AFWA, FNMOC, JTWC), the Department of Energy (DoE), and the EPA, NASA ESMD, FAA, United States Department of Agriculture (USDA) - Forest Service, Bureau of Land Management (BLM), NSF (Universities), Private Industry, EUMETSAT (GEO WG).

Impacts: Lightning Detection products are used to improve severe weather forecasting applications.

Table 2.1.5.1a: LCFA - Products Produced and NPB Connections

Product Category	Product Generated
Lightning	Lightning Detection: Events, Groups, and Flashes

Table 2.1.5.1b: LCFG Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 GLM	75.2W									
GOES-17 GLM	104.6W									
GOES-18 GLM	137W									
GOES-U GLM	75.2W			X	X					

2.1.5.2 Gridded Lightning Mapper Product Algorithm

Algorithm Description: The Gridded Geostationary Lightning Mapper Product algorithms take GLM Level 2 data (events, groups, and flashes) produced as points and restore and disseminate the spatial footprint information while greatly reducing the file size, involve re-navigating the GLM event latitude / longitude to the 2×2 km ABI fixed grid. Flash extent density, the number of flashes that occur within a grid cell over a given period of time, is the first NWS product.

Users: NWS

Impacts: The products of this algorithm are utilized to detect electrically active storms, observe the areal lightning extent, track embedded convective cells, identify strengthening and weakening storms, monitor convective mode and storm evolution, characterize storms as they transition offshore, and provide insights into TC intensity changes.

Table 2.1.5.2a: Gridded Lightning Mapper Products Produced and NPB Connections

Product Category	Product Generated
Lightning	Lightning Detection Products

Table 2.1.5.2b: Gridded Lightning Mapper Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 GLM	75.2W									
GOES-17 GLM	104.6W									
GOES-18 GLM	137W									

2.1.5.3 ProbSevere LightningCast

Algorithm Description: LightningCast is a machine learning model, and form of artificial intelligence, that transforms visible and/or infrared satellite imagery into 60-minute predictions of where lightning will occur in the future. LightningCast is currently capable of processing GOES-R ABI or Himawari-9 AHI imagery. A U-Net model architecture, which generates lightning predictions at each satellite pixel, is employed. LightningCast was trained to predict where the GLM (or similar sensor) will observe lightning. Although the GLM was used to train LightningCast, it is not used to run the model. Only ABI or AHI L1b are needed. LightningCast, which is written in python, is extremely

computationally efficient, resulting in rapid conversion of satellite imagery into actionable information that helps keep people safe.

Users: NWS, NCEP (e.g., AWC and OPC), DoD, FAA, USDA - Forest Service, BLM, Research community, Commercial users, General public.

Impacts: ProbSevere LightningCast provides prognostic information on lightning, before the threat is realized, thereby allowing for actions that protect life and property. As such, the NWS and other stakeholders routinely utilize LightningCast for decision support services.

Table 2.1.5.3a ProbSevere LightningCast Products Produced and NPB Connections

Product Category	Product Generated
Lightning	*Probability of Lightning in the Next Hour*

Italics = Not currently in the NESDIS Product Baseline

Table 2.1.5.3b ProbSevere LightningCast Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								

2.1.6 Precipitation

2.1.6.1 Blended Hydrometeorological Package (Blended-Hydro) - RR

Algorithm Description: The Blended-Hydro merges TPW and Rainfall Rate (RR) retrievals derived from multi-satellites/sensors/algorithms and provides unified global TPW and RR maps. The blended rain rate (RR) product is produced hourly by blending together recent rain rate retrievals from passive microwave instruments on eight polar-orbiting satellites, including POES, NOAA-19, NOAA-20, MetOp-B, S-NPP, GCOM-W1, GPM, DMSP F17 and F18. The blended RR eliminates the bias between those data sets and provides a unified, meteorologically significant rain rate field for satellite analysts and weather forecasters.

Users: NWS NCEP (WR, SPC, NHC, WPC, WFO, AWIPS), NESDIS/OSPO Satellite Analysis Branch, GeoNetCast - Americas, OAR, WorldWinds, NIC.

Impacts: The blended-hydrometeorological products enable the forecaster to use one improved product in lieu of many products derived from multiple platforms.

Table 2.1.6.1a: Blended-Hydro RR Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Water Vapor	Total Precipitable Water (TPW)
Atmospheric Water Vapor	Percentage of TPW Normal
Atmospheric Water Vapor	Advected Layered Precipitable Water (ALPW)
Precipitation	Rain Rate (RR)

Table 2.1.6.1b: Blended-Hydro RR Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
DMSP-F17 SSMIS	Early AM									
DMSP-F18 SSMIS	Early AM									
GCOM-W AMSR2	PM									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
JPSS-4 ATMS	PM									
MetOp-B AMSU-A	Mid AM									
MetOp-B MHS	Mid AM									
MetOp-C AMSU-A	Mid AM									
MetOp-C MHS	Mid AM									
MetOp-SG-A1 MWS	Mid AM									
MetOp-SG-B1 MWI	Mid AM									
NOAA-18 AMSU-A	Early AM									
NOAA-18 MHS	Early AM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									

2.1.6.2 Enterprise Rain Rate (under R2O transition)

Follow-on to GHE, with the rain rate algorithm set to provide 2-km spatial resolution and 10-min refresh. In addition to infrared radiances, this algorithm also uses Global Forecast System (GFS) 6-12 hour forecast fields and Climate Prediction Center (CPC) combined microwave (MWCOMB) as inputs (the latter as a calibration standard). The Multi-Radar Multi-Sensor (MRMS) gauge-adjusted radar rain rates and the Global Precipitation Mission (GPM) Dual-frequency Precipitation Radar (DPR) data are used for validation.

Users: NWS (AWIPS), NHC, NCEP, West Gulf River Forecast Center, Nadi (Fiji) Regional Specialized Meteorological Center (RSMC - indirect user through eTRaP),

Perth (Australia) Tropical Cyclone Warning Center (TCWC - indirect user through eTRaP), Hydrologic Research Center.

Impact: Rainfall products are used in precipitation and flood forecasting. Rainfall rates are important to the Department of Commerce and the Department of Transportation.

Table 2.1.6.2a: Enterprise Rain Rate Products Produced and NPB Connections

Product Category	Product Generated
Precipitation	Rain Rate
Precipitation	Accumulated Rainfall Total

Table 2.1.6.2b: Enterprise Rain Rate Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									

2.1.6.3 Enterprise Snowfall Rate (SFR)

Algorithm Description: The NESDIS SFR product is retrieved from an enterprise algorithm which applies to both passive microwave sounders and imagers. The algorithm consists of two components: snowfall detection and snowfall rate estimation. The snowfall detection module is a Machine Learning (ML) model while the snowfall rate algorithm is based on a 1DVAR inversion model and further enhanced with ML models. The current product is over global land. A set of ocean (ice-free ocean, sea ice, and coast) algorithms is under development in an ongoing project. Winter precipitation data is often difficult to collect. The satellite retrieved SFR product is an alternative to

traditional snowfall observations. It fills in radar gaps and provides situational awareness to weather forecasters especially in data poor areas such as mountainous and remote regions.

The operational Enterprise SFR product is produced from 5 passive microwave (PMW) sounders (NOAA-20, SNPP, NOAA-19, MetOp-B, and MetOp-C). Adding GMI SFR and SSMIS SFR is potential R2O to extend the Enterprise SFR to include imagers and improve the overall product quality. The Enterprise SFR is an important input to the NCEP/CPC global blended precipitation product CMORPH2. CMORPH2 has wide applications in areas such as hydrology, water resources management, and weather forecasting.

There is also a merged SFR (mSFR) product under consideration for T2O that is distributed to Weather Forecast Offices via NASA/Short-term Prediction Research and Transition Center, supported by the NESDIS Enterprise Proving Ground. The mSFR product combines the broad coverage of satellites (filling in radar spatial gaps) with the frequent observations of radar (filling in satellite temporal gaps) to create a spatiotemporally enhanced snowfall rate product. It has very low latency, and provides looping capabilities with 10-minute resolution that allows effective storm tracking.

Users: NWS WFOs, NCEP, and AFWA.

National Ice Center (NIC), NASA Short-term Prediction Research and Transition Center (SPoRT).

Impacts: The SFR products are used, either directly or as input to blended precipitation products, in weather forecasting, hydrologic modeling, water resource management, cryosphere applications etc. These products can improve precipitation forecasts and especially extreme precipitation nowcasting which is related to flood, water management activities such as reservoir operations, and debris flow, to name a few. They also provide winter precipitation estimates which can be used to predict snowpack runoff and spring flooding.

Table 2.1.6.3a: SFR Products Produced and NPB Connections

Product Category	Product Generated
Precipitation	Snowfall Rate

Table 2.1.6.3b: SFR Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
DMSP-F17 SSMIS	Early AM									
DMSP-F18 SSMIS	Early AM									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
JPSS-4 ATMS	PM									
MetOp-B AMSU-A	Mid AM									
MetOp-B MHS	Mid AM									
MetOp-C AMSU-A	Mid AM									
MetOp-C MHS	Mid AM									
MetOp-SG-A1 MWS	Mid AM									
MetOp-SG-B1 MWI	Mid AM									
NOAA-19 AMSU-A	Early AM									
NOAA-19 MHS	Early AM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									

2.1.6.4 Global Hydro-Estimator (GHE) (will be replaced by Enterprise Rain Rate)

The Hydro-Estimator (HE) is a single-channel (11-μm) RR algorithm whose origins go all the way back to the semi-automated Interactive Flash Flood Analyzer (IFFA; Scofield 1987). The HE algorithm uses IR brightness temperatures to identify regions of rainfall and retrieve RR, while using NCEP Global Forecast System (GFS) model fields to account for the effects of moisture availability, evaporation, orographic modulation, and thermodynamic profile effects. The HE RR estimates are produced routinely every 15 minutes for the continental US using the data from NOAA's GOES, and over the entire globe equator-ward of 65 degrees using available geostationary data over Europe, Africa, and Asia. The operational Global HE (GHE) products available include instantaneous RRs and 1-hour, 3-hour, 6-hour, 24-hour and multi-day precipitation accumulations. Current retirement is scheduled for late 2023, so follow-on satellites are not shown in Flyout.

Table 2.1.6.4a: Global Hydro-Estimator Products Produced and NPB Connections

Product Category	Product Generated
Precipitation	Rain Rate
Precipitation	Accumulated Rainfall Total

Table 2.1.6.4b: Global Hydro-Estimator Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-11 SEVIRI	0									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									

2.1.6.5 GAASP - Precipitation Products

Algorithm Description: GAASP uses the Goddard PROFiling (GPROF) algorithm (version 2017) to deliver a global swath-level RR product. In the standard output, GPROF retrieval provides estimates of the liquid precipitation rates and their convective/stratiform split for snow-free surfaces. Originally developed for TRMM Microwave Imager (Gopalan et al. 2010; Kummerow et al. 2011), over the years, the algorithm has evolved into an enterprise retrieval capable of serving a wide range of passive microwave instruments (Kummerow et al. 2015). To deliver global estimates of precipitation, the current retrieval version employs a Bayesian scheme with an a priori established link between Global Precipitation Measurement - Core Observatory Dual-frequency Precipitation Radar- observed precipitation profiles and corresponding simulated brightness temperatures. To ensure consistent and well-constrained solution, this link is supported with ancillary data on the surface and atmospheric conditions,

reflected through 14 unique surface types and modeled-analyses of 2-m temperature and TPW.

Users: NWS (CPC, WFOs, NESDIS, NHC), NESDIS/OSPO/SAB, NCEP (EMC), and two downstream applications (eTRaP and CMORPH).

Impacts: GAASP Precipitation products are used to obtain more accurate estimates of precipitation type and precipitation rates in numerical weather prediction. Additionally, GAASP Precipitation products are also used to obtain more accurate estimates of Tropical Cyclone (TC) intensity precipitation rates in numerical weather prediction.

Table 2.1.6.5a: GAASP Precipitation Products Produced and NPB Connections

Product Category	Product Generated
Precipitation	Rain Rate

Table 2.1.6.5b: GAASP Precipitation Products Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
MetOp-SG-B1 MWI	Mid AM									

2.1.6.6 MIRS

Reference 2.6.4 MIRS for Rain Rate

2.1.6.7 Accumulated Rainfall Total Products

Product Description: Accumulated rainfall total products included Monitoring, US, Temp, Precip and Drought: Weekly Divisional Products, GHCN-M Precipitation, GPCP Daily and Monthly, NEXRAD QPE, and HADS.

Table 2.1.6.7: Accumulated Rainfall Total Products Produced and NPB Connections

Product Category	Product Generated
Precipitation	Accumulated Rainfall Total

In situ Sources:

- GHCN-Daily
- CLIMAT
- MCDW
- COOP Hourly Precipitation Data (C-HPD)
- Rapid Update Cycle Forecast Model
- Rain Gauge Data
- HADSDATA
- HADSMETA
- NWS Cooperative Observer HPD Network

2.1.6.8 Climate Monitoring Products

Product Description: Climate Monitoring Products include: Monitoring, US, Temp, Precipitation and Drought: National Temperature and Precipitation Maps and U.S. Percentage Areas (Very Warm/Cold, Very Wet/Dry).

Table 2.1.6.8: Climate Monitoring - Products Produced and NPB Connections

Product Category	Product Generated
Precipitation	Maximum/Minimum Precipitation

In situ Sources:

- nClimDiv
- GHCN-Daily
- CLIMAT
- MCDW
- COOP Hourly Precipitation Data (C-HPD)

2.1.7 Radiation Budget

2.1.7.1 HEAP

Reference 2.6.3 HEAP for Outgoing Longwave Radiation.

2.1.7.2 MIRS

Reference 2.6.4 MIRS for Surface Emissivity.

2.1.7.3 Surface Reflectance Retrieval Algorithm

Algorithm Description: The algorithm for surface reflectance retrieval corrects for the effects of gaseous absorption, molecular and aerosol scattering, thin cirrus contamination, glare from surrounding surface pixels (adjacency adjustment), and the coupling of the atmosphere and the surface bidirectional reflectance as a function of the viewing and solar geometries, elevation of the target and spectral band. The output products include surface reflectance by channel, quality flags, and bitmasks in netCDF4 format.

Users: NWS, NCEP, and downstream NESDIS applications that use these products (directly or indirectly): Vegetation Indices (VI), Green Vegetation Fraction (GVF), Surface Type

Land Surface Albedo (L2, L3 Gridded), and Soil Moisture Operational Products System (SMOPS).

Impacts: Through their downstream uses, surface reflectance products impact multiple NOAA mission areas, such as numerical Weather prediction, radiation budget estimates, and climate monitoring. Additionally, the product of this algorithm supports CoastWatch sector imagery.

Table 2.1.7.3a: Surface Reflectance Products Produced and NPB Connections

Product Category	Product Generated
Radiation Budget	Surface Reflectance

Table 2.1.7.3b: Surface Reflectance Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.7.4 Geostationary Shortwave Radiation Budget (SRB) Product Algorithm

Algorithm Description: The Shortwave Radiation Budget (SRB) algorithm is a physical, radiative transfer based, algorithm designed to retrieve radiative fluxes at the Top of Atmosphere (TOA) and the surface from satellite observations and ancillary data. It uses total column amounts of WV and ozone, upstream L2 cloud mask, and when available, additional L2 products that define the atmosphere and the surface (e.g., cloud optical depth, cloud phase, AOD, surface albedo) to determine the amount of shortwave radiation reflected to space at TOA and transmitted to the surface. When the additional L2 products are not available, the SRB algorithm uses the narrowband reflectance observed by the satellite Imagers to estimate the direct and diffuse atmospheric reflectance and transmittance needed to retrieve the downwelling and upwelling radiative fluxes at TOA and at the surface. In both cases, radiative fluxes are calculated in 18 contiguous narrow bands. Integration of these fluxes over wavelength in the SW spectral range (0.2-4.0 μm) provides the final products of Reflected Shortwave Radiation (RSR) at TOA, the Downward Shortwave Radiation (DSR) at the surface and the Upward Shortwave Radiation (USR) at the surface , while integration over the visible wavelengths (0.4-0.7 μm) generates the Photosynthetically Active Radiation (PAR).

Users: NOAA/CLASS, NCEP, GOES Evapotranspiration and Drought Product (NCEI).

Impacts: The product of this algorithm supports verification of model prediction of shortwave radiative flux, provides input needed to improve accuracy of forecasting coral reef health and drought, provides surface energy budget data needed in climate studies, and helps in monitoring changes in available renewable (solar) energy at the surface.

Table 2.1.7.4a: Geostationary SRB - Products Produced and NPB Connections

Product Category	Product Generated
Radiation Budget	Reflected Shortwave Radiation: TOA
Radiation Budget	Downward Shortwave Radiation
Radiation Budget	Photosynthetically Active Radiation

Table 2.1.7.4b: Geostationary RB SW Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

2.1.7.5 Geostationary Shortwave Irradiance Product (GSIP)

Algorithm Description: The GSIP products consist of the RSR, the DSR, the USR, and PAR. These are retrieved from measurements made by the imager instruments onboard NOAA and non-NOAA geostationary satellites using the Enterprise SRB algorithm (see 2.1.7.5 Geostationary Shortwave Radiation Budget (SRB) Product Algorithm).

Users: Coral Reef Watch.

Impacts: The 24-hour product of this algorithm is required to correct most false positives in the current NOAA Coral Reef Watch Light Stress Damage (LSD) product.

Table 2.1.7.5a: GSIP - Products Produced and NPB Connections

Product Category	Product Generated
Radiation Budget	Reflected Shortwave Radiation: TOA
Radiation Budget	Downward Shortwave Radiation
Radiation Budget	Photosynthetically Active Radiation

Table 2.1.7.5b: GSIP Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									

2.1.7.6 Radiation Budget Product Generation Algorithms

Product Description: The Radiation Budget Product Generation Algorithms use AVHRR to generate a suite of longwave radiation budget products.

Table 2.1.7.6a: Radiation Budget - Products and NPB Connections

Product Category	Product Generated
Radiation Budget	Outgoing Longwave Radiation

Table 2.1.7.6b: Radiation Budget Product Generation Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
NOAA-18 AVHRR/3	Early AM									

2.1.7.7 ABI Surface Albedo

Algorithm Description: This albedo algorithm is responsible for land surface albedo estimation for clear sky pixels identified by the ABI cloud mask product. Using the ABI AOD product as the first guess value, this algorithm estimates both AOD and the parameters in the surface directional reflectance function simultaneously. It references

albedo climatology from previous satellite products, including Terra and Aqua MODIS, Multi-angle Imaging SpectroRadiometer, and GOES. Daily and weekly albedos for the solar zenith angle smaller than 70 degrees at five visible and near IR narrow bands and three broadbands are produced.

Users: Scientific Community

Impacts: The product of this algorithm supports Surface energy balance and weather/climatology study; land model verification and improvement.

Table 2.1.7.7a: ABI Surface Albedo - Products Produced and NPB Connections

Product Category	Product Generated
Radiation Budget	Surface Albedo

Table 2.1.7.7b: ABI Surface Albedo Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

2.1.7.8 VIIRS Surface Albedo (SURFALB)

Algorithm Description: The NDE surface albedo EDR product is granule-based and gridded datasets covering land and sea-ice surfaces. It is derived from an enterprise algorithm (for the entire JPSS mission) which regresses TOA visible and shortwave reflectance to a land surface broadband albedo, with one online process and one offline process. The L2 granule albedo product is estimated online from a combination of the directly estimated albedo (i.e. the regression) and a historical temporally filtered gap-free albedo. The directly estimated albedo is computed from a regression relationship of the albedo and the satellite sensed multichannel TOA reflectance, while the historical albedo is accumulated offline using previous granule albedo data. The Level-3 gridded albedo product provides 1-km global daily mean shortwave albedo map in Sinusoidal projection, which is generated based on Level-2 data with two processing steps: anchoring the science data to specific geographic points and composition in temporal dimension to produce daily global SURFALB map that has been gridded into a specific map projection. Read-me file is available for the SURFALB Data Users. The Bidirectional Reflectance Distribution Function (BRDF) product is related and has been

requested by users with the same priority as albedo. The BRDF estimation is based on an inversion algorithm inherited from the MODIS BRDF derivation, using the surface reflectance data as input.

Users: NWS/NCEP Land, OAR/ARL, OAR/ESRL, AFWA, FNMOC

Impacts: The product of this algorithm serves as input for NCEP GDAS and NDAS models.

Table 2.1.7.8a: SURFALB - Products Produced and NPB Connections

Product Category	Product Generated
Radiation Budget	Surface Albedo

Table 2.1.7.8b: SURFALB Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
S-NPP VIIRS	PM									
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									

2.1.8 Tropical Cyclone Characteristics

2.1.8.1 eTRaP

Algorithm Description: eTRaP is an application that combines Tropical Rainfall Potential forecasts from multiple satellite sensors in a "simple ensemble" to produce improved deterministic and probabilistic guidance for heavy rainfall in landfalling tropical cyclones.

Users: NWS (NHC, CPHC, WPC, RFC, GFFG), NESDIS/OSPO/SAB Tropical Team, Other Tropical Cyclone Centers (JTWC, BOM Australia Tropical Cyclone Warning Centers (TCWCs), Nadi Fiji Regional Specialized Meteorological Center (RSMC), WorldWinds Inc.

Impacts: The product of the eTRaP algorithm provides critical information for decision-makers from NWS/WPC and other organizations on the amount of expected rainfall for flood forecasting and emergency management decisions.

Table 2.1.8.1a: eTRaP - Products Produced and NPB Connections

Product Category	Product Generated
Tropical Cyclone Characteristics	Tropical Cyclone Rainfall Potential/Probability

Table 2.1.8.1b: eTRaP Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
DMSP-F17 SSMIS	Early AM									
DMSP-F18 SSMIS	Early AM									
GCOM-W AMSR2	PM									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 ATMS	PM									
MetOp-B AMSU-A	Mid AM									
MetOp-C AMSU-A	Mid AM									
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									
MetOp-B MHS	Mid AM									
MetOp-C MHS	Mid AM									
MetOp-SG-A1 MWS	Mid AM									
MetOp-SG-B1 MWI	Mid AM									
NOAA-19 MHS	Early AM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									

2.1.8.2 Multi-Platform Tropical Cyclone Surface Winds Analysis (MTCSWA)

Algorithm Description: The main MTCSWA product is the estimation of the surface wind field around active tropical cyclones. The product domain is global, and the active storms are determined by areas of interest (invests) and storms that have reached an intensity that triggers warnings in that basin. This information comes from several operational tropical cyclone warning centers. For this product, the Joint Typhoon Warning Center, Honolulu, HI, provides locations/intensities of active systems in the Southern Hemisphere, Indian Ocean, and western North Pacific; the NCEP Central Pacific Hurricane Center, Honolulu, HI, provides locations/intensities for the North Central Pacific, and the NCEP Tropical Prediction Center in Miami, Florida provides location and intensities in the Eastern North Pacific and North Atlantic Basins.

Users: NHC, JTWC, CPHC.

Impacts: The output from HISA supports hurricane intensity estimates and forecasts and allows for the continuity of NOAA products between current and future operational satellites.

Table 2.1.8.2a: MTCSWA - Products Produced and NPB Connections

Product Category	Product Generated
Tropical Cyclone Characteristics	Tropical Cyclone Intensity and Position
Tropical Cyclone Characteristics	Tropical Cyclone Surface Wind

Table 2.1.8.2b: MTCSWA Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 ATMS	PM									

MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
MetOp-B AMSU-A	Mid AM									
MetOp-B ASCAT	Mid AM									
MetOp-B MHS	Mid AM									
MetOp-C AMSU-A	Mid AM									
MetOp-C ASCAT	Mid AM									
MetOp-C MHS	Mid AM									
MetOp-SG-A1 MWS	Mid AM									
NOAA-18 AMSU-A	Early AM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									

2.1.8.3 Tropical Cyclone Formation Probability (TCFP)

Algorithm Description: NCEP global forecasts, weekly sea surface temperature, and geostationary imagery are used as input to an algorithm to estimate the probability of tropical cyclone formation within a certain distance (e.g., 500 km) of each grid point within the next 48 hours 45 S to 45 N and 0 to 360 E. The product domain is divided into several main basins based on satellite coverage and warning agency boundaries.

Users: NWS (NHC), JTWC, DOD.

Impacts: Provide real-time, objective guidance for the 48-hour probability of TC formation, a period more consistent with the needs of NHC/JTWC forecasters.

Table 2.1.8.3a: TCFP - Products Produced and NPB Connections

Product Category	Product Generated
Tropical Cyclone Characteristics	Tropical Cyclone Formation Probability

Table 2.1.8.3b: TCFP Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									

GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									

2.1.8.4 SAROPS

Reference 2.6.5 for Tropical Cyclone Surface Wind.

2.1.8.5 International Best Tracks for Climate Stewardship (IBTrACS) Algorithm

Algorithm Description: IBTrACS is the complete global collection of tropical cyclones available. It merges recent and historical tropical cyclone data from multiple agencies to create a unified, publicly available, best-track dataset that improves inter-agency comparisons. IBTrACS was developed collaboratively with all the WMO Regional Specialized Meteorological Centers and other organizations and individuals worldwide.

Users: WMO, NHC, Academia, JTWC.

Impacts: Improved tropical cyclone track dataset that can be shared with the public to better inform and forecast cyclone tracks.

Table 2.1.8.5: IBTrACS - Products Produced and NPB Connections

Product Category	Product Generated
Tropical Cyclone Characteristics	Hurricane Tracks

2.1.8.6 MIRS

Reference 2.6.4 for Hurricane Imagery.

2.1.8.7 Geostationary-based Proxy Visible (nighttime visible) (Potential R2O over next 5 years)

Algorithm Description: This algorithm provides 10-minute blended visible and proxy visible imagery (in regions without sunlit).

Users: NOAA, International agencies, Public Service, Private Sector, Climate research, Forecast development, Insurance industry.

Impacts: The product of this algorithm provides brightness temperature imagery centered on global tropical cyclones in order to provide a means to analyze storm structure and intensity.

Table 2.1.8.7a: Geostationary-based Proxy Visible (Nighttime visible) Products Produced and NPB Connections

Product Category	Product Generated
Tropical Cyclones Characteristics	Hurricane Imagery

Table 2.1.8.7b: Geostationary-based Proxy Visible (Nighttime visible) Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-8 (IODC) SEVIRI	41.5E									

2.1.8.8 Tropical Cyclone Environmental Monitoring and Tropical Cyclone Intensity short-term forecasts (Potential R2O over five years)

Algorithm Description: These tools are for NHC/JTWC and include rapid intensification indicators, weakening indicators, improved utilization of derived motion vector winds (DMV) for short-term monitoring of vertical wind shear, divergence, and tracking of upper-level tropical lows, moisture in-storm flux (a MIRS + global forecast system tool),

use of SAR, SMAP, SMOS winds, 3D synthetic/Machine Learning based winds for Data Assimilation purposes and for estimation of the radius of maximum wind. This section will be updated beyond the current list of Geostationary satellites in the flyout chart once the project plan for R2O for other satellite inputs is finalized/funded. The project will also generate a synthetic 89 GHz based on GOES, Himawari, and MTC.

Users: NHC, CPHC, JTWC, other RSMCs, public via Internet and Automated Tropical Cyclone Forecast system.

Impacts: The products of this algorithm support one of the consensus looks to help derive the official wind speed and position of tropical cyclones in products issued by JTWC and the RSMCs including NHC and CPHC.

Table 2.1.8.8a: Tropical Cyclone Environmental Monitoring Products Produced and NPP Connections

Product Category	Product Generated
Tropical Cyclones Characteristics	Tropical Cyclone Intensity and Positions

Table 2.1.8.8b: Tropical Cyclone Environmental Monitoring Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									

2.1.8.9 Advanced Dvorak Technique (ADT)

Algorithm Description: The ADT utilizes longwave-IR, temperature measurements from geostationary satellites to estimate Tropical Cyclone (TC) intensity. The ADT is based upon the operational Dvorak Technique developed by Vern Dvorak of NOAA over 30 years ago. This step-by-step technique relies upon the user to determine a primary cloud pattern and measure various TC cloud top parameters in order to derive an initial

intensity estimate. Various rules regarding TC development and intensity change over time are employed to guide the user in the scene selection process and govern the rate of intensity change over a given time period. While primarily Geostationary satellites support the algorithm, there are optional inputs from GPM GMI and GCOMW AMSR2 in the current algorithm, and follow-ons from MetOp_SG MWI and GOSAT GW AMSR3 are being considered.

Table 2.1.8.9a: ADT - Products Produced and NPB Connections

Product Category	Product Generated
Tropical Cyclones Characteristics	Tropical Cyclone Intensity and Positions
Tropical Cyclones Characteristics	Hurricane Imagery

Table 2.1.8.9b: ADT Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137.2W									
GOES-U ABI	75.2W			X	X					
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									
MetOp-SG-B1 MWI	Mid AM									

2.1.8.10 Hurricane Intensity and Structure Algorithm (HISA) Family

Algorithm Description: Cooperative Institute for Research in the Atmosphere 's HISA was first developed in 2004 using input from the statistical temperature retrievals from the Advanced Microwave Sounding Units (AMSU) on-board NOAA-15 and -16. Several upgrades have been made to HISA since 2004. Currently, operational versions of HISA are using as input both statistical and MIRS temperature and CLW retrievals from microwave sounders on-board seven polar-orbiting satellites, including NOAA-15, -16, -18, -19, METOP-A and -B, and S-NPP, providing up to 14 intensity estimates per storm per day. HISA is also being adapted to work with JPSS-1 ATMS-MIRS retrievals. In addition to maximum sustained winds, minimum sea-level pressure, and estimates of 34-, 50-, and 64-kt wind radii that are available to operational forecasters at the National Hurricane Center (NHC), Central Pacific Hurricane Center, and Joint Typhoon Warning Center (JTWC) via Automated Tropical Cyclone Forecasting System f-decks, HISA is providing azimuthally averaged gradient winds and 2-D balanced winds at standard pressure levels that are available in NetCDF format. Recently, work has begun on adapting HISA to use as input data obtained from Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS). TROPICS is currently planned to include a constellation of six smallsats, all of which will be carrying ATMS-like instruments. Unlike ATMS that has 22 temperature and moisture channels ranging from 23 GHz to 191 GHz, TROPICS Radiometers (TR) only have 12 channels, ranging from 91 GHz to 205 GHz.

Users: NHC, CPHC, JTWC

Impacts: The products of this algorithm support data visualization.

Table 2.1.8.10a: HISA - Products Produced and NPB Connections

Product Category	Product Generated
Tropical Cyclones Characteristics	Tropical Cyclone Intensity and Positions

Table 2.1.8.10b: HISA Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 ATMS	PM									
MetOp-B AMSU-A	Mid AM									
MetOp-B MHS	Mid AM									
MetOp-C AMSU-A	Mid AM									
MetOp-C MHS	Mid AM									
MetOp-SG-A1 MWS	Mid AM									
NOAA-18 AMSU-A	Early AM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									
TROPICS-01 (Pathfinder) TMS	Drifting									

2.1.8.11 3-D Situationally Aware Tropical Cyclone Vortex (Potential R2O over next 5 Years)

Algorithm Description: This algorithm estimates the 3D winds around tropical cyclones and can be used to better initialize the Unified Forecast System models.

Table 2.1.8.11a: 3-D Situationally Aware TC Vortex Products Produced and NPB Connections

Product Category	Product Generated
Tropical Cyclones Characteristics	Tropical Cyclone Surface Wind

Table 2.1.8.11b: 3-D Situationally Aware TC Vortex Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									

2.1.9 Volcanic Eruption Characteristics

2.1.9.1 Volcanic Cloud Analysis Toolkit (VOLCAT)

Algorithm Description: Volcanic Ash Advisory Centers (VAACs) are responsible for issuing volcanic ash advisories to aviation when airborne volcanic ash is present. VAACs primarily rely on satellite data to detect and track volcanic ash clouds. To help VAACs shift through thousands of new satellite images acquired each day, NESDIS developed the VOLcanic Cloud Analysis Toolkit (VOLCAT). VOLCAT, powered by AI, automatically detects recent volcanic eruptions and tracks volcanic ash clouds. VOLCAT enables VAACs to consistently issue timely volcanic ash advisories through automated identification of subtle eruption indicators in satellite images. VOLCAT alerts have been cited in over 12,000 volcanic ash advisories, which illustrates the value of AI as a force multiplier for hazard detection.

Users: VAACs (Anchorage, Buenos Aires, Darwin, London, Montreal, Tokyo, Toulouse, Washington, and Wellington), NOAA/OAR/ARL, NCEP, USGS, State Volcano Observatories, USAF, Delta Airlines Met Department, Commercial aviation weather providers, and the research community.

Impacts: The VOLCAT product supports aviation Weather, routine weather, climate science, and climate predictions and projections. Additionally, VAACs, volcano observatories (including the USGS), and airlines regularly use the VOLCAT service/products provided.

Table 2.1.9.1a: VOLCAT Products Produced and NPB Connections

Product Category	Product Generated
Volcanic Eruption Characteristics	Volcanic Ash Detection, Tracking, and Characterization
Volcanic Eruption Characteristics	Volcanic SO_2 Detection, Tracking, and Characterization
Volcanic Eruption Characteristics	Volcanic Thermal Anomaly Detection, Tracking and Characterization

Table 2.1.9.1b: VOLCAT Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-16 GLM	75.2W									
GOES-17 ABI	104.6W									
GOES-17 GLM	104.6W									
GOES-18 ABI	137W									
GOES-18 GLM	137W									
GOES-U ABI	75.2W			X	X					
GOES-U GLM	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 CrIS	PM									
JPSS-4 OMPS-NP	PM									
JPSS-4 VIIRS	PM									
MTG-I1 FCI	0									
MTG-I1 LI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									

MetOp-B AVHRR/3	Mid AM									
MetOp-B IASI	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-C IASI	Mid AM									
MetOp-SG-A1 IASI-NG	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-15 AVHRR/3	Early AM									
NOAA-18 AVHRR/3	Early AM									
NOAA-20 CrIS	PM									
NOAA-20 OMPS-N	PM									
NOAA-20 VIIRS	PM									
NOAA-21 CrIS	PM									
NOAA-21 VIIRS	PM									
S-NPP CrIS	PM									
S-NPP OMPS-NP	PM									
S-NPP VIIRS	PM									

2.1.9.2 Multispectral Principle Component Imagery (MPCI)

Algorithm Description: The MPCI algorithm utilizes Brightness Temperature Differences (BTD) between three IR bands on GOES-centered at 3.9, 10.7 and 12.0 mm wavelengths to provide improved detection of airborne volcanic ash using multispectral infrared satellite data. The detailed algorithm can be found at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.890.8396&rep=rep1&type=pdf

Table 2.1.9.2a: MPCI - Products Produced and NPB Connections

Product Category	Product Generated
Volcanic Eruption Characteristics	Volcanic Ash Detection, Tracking, and Characterization

Table 2.1.9.2b: MPCI Flyout

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

2.1.9.3 OMPS SO_2 Alert System

Algorithm Description: The OMPS SO_2 Alert System provides near-real-time information on SO_2 level for 34 selected volcano sites around the globe. The information is extracted from near-real-time satellite remotely sensed global SO_2 measurements, Aerosol Index, and Cloud Reflectivity as observed by the Ozone Monitoring Instrument (OMPS) aboard the SNPP and NOAA20

Table 2.1.9.3a: OMPS SO_2 Alert System - Products Produced and NPB Connections

Product Category	Product Generated
Volcanic Eruption Characteristics	Volcanic SO2 Detection, Tracking, and Characterization

Table 2.1.9.3b: OMPS SO_2 Alert System Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
S-NPP OMPS-NP	PM									
NOAA-20 OMPS-NP	PM									
NOAA-21 OMPS-NP	PM									
JPSS-4 OMPS-NP	PM									

2.1.9.4 Baseline Volcanic Ash

Algorithm Description: The JPSS/GOES-R Baseline Volcanic Ash is a combination tool/algorithm that uses visible and IR optical sensors to identify volcanic ash as well as height and mass loading. The GOES-R portion of the algorithm has retired and the JPSS portion will retire once VOLCAT (see above) becomes operational.

Table 2.1.9.4a: Baseline Volcanic Ash - Products Produced and NPB Connections

Product Category	Product Generated
Volcanic Eruption Characteristics	Volcanic Ash Detection, Tracking, and Characterization

Table 2.1.9.4b: Baseline Volcanic Ash Flyout

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.10 Winds

2.1.10.1 Derived Motion Winds (DMW) Products

Algorithm Description: The Derived Motion Winds algorithms/products involve the use of optical flow methods for deriving winds (for severe storms, tropical cyclones) and assessments (i.e., deep convection cloud-top flow kinematics). Products include cloud drift winds and water vapor winds. The Derived Motion Winds algorithm uses three images to estimate atmospheric motion for a set of targeted tracers viewed in selected spectral bands. The targeted features can be clouds or, in the case of clear-sky conditions, moisture gradients. The choice of spectral band determines the intended target (cloud or clear-sky moisture gradient) and location (low, mid, and upper troposphere) in the atmosphere where the winds will be generated. Some products (Himawari-9) are pass-throughs from agencies running similar algorithms.

Users: NWS NCEP (data assimilation) and global NWP centers (data assimilation), and NWS WFOs

Impacts: Helps to improve NWP forecasts by assimilating this product. Benefits operational forecasting for NWS offices with responsibility over areas with only satellite data (e.g., oceans, arctic region). Additionally, this product supports local forecasts & warnings, integrated water forecasting, and environmental modeling.

Table 2.1.10.1a: DMW - Products Produced and NPB Connections

Product Category	Product Generated
Winds	Atmospheric Winds

Table 2.1.10.1b: DMW Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-14 (Standby) IMAGER	108.2W									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 VIIRS	PM									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.1.10.2 Ocean Surface Winds & Ice (Scatterometer)

Algorithm Description: Wind retrievals from the ASCAT scatterometer are generated based on the KNMI's (Royal Netherlands Meteorological Institute) retrieval system that NOAA modified to meet its requirements. The OceanSat-3 retrieval system was developed by NOAA. The ice products are generated from the enhanced resolution processing system originally developed by BYU for QuikSCAT that NOAA adapted to address its requirements. Ocean Surface Winds & Ice products impact NOAA mission

critical area: Tropical Cyclone (TC) intensity forecasting, Cryosphere monitoring, Climate, and Ocean Prediction. This processing system was migrated to the NCCF in fall 2022, with additional Wind & Ice product processing systems planned to be added in 2024 and beyond (e.g OceanSat-3, MetOp-SG B1).

Users: NWS (NCEP/EMC, NHC, OPC, CPHC, Pacific Region, AK Region, Western Region, Southern Region, Central Region, Pacific Region, Eastern Region), NIC, NOAA CoastWatch.

Impacts: Scatterometers provide global ocean surface vector wind measurements which NWS is required to warn on. Winds also drive waves which NWS is required to warn on. Scatterometer out also supports hurricane intensity and the extent of wind warning thresholds (gale, storm and hurricane). This provides for the continuity of NOAA products between current and future operational satellites

Table 2.1.10.2a: Scatterometer Winds & Ice Products Produced and NPB Connections

Product Category	Product Generated
Winds	Ocean Surface Vector Winds
Lake and Sea Ice	Ice Cover

Table 2.1.10.2b: Scatterometer Winds Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
MetOp-B ASCAT	Mid AM									
MetOp-C ASCAT	Mid AM									
MetOp-SG-B1 SCA	Mid AM									
OceanSat-3 OSCAT	Noon									

2.1.10.3 GAASP Ocean Surface Winds Algorithm

Algorithm Description: The AMSR2 SSW algorithm is statistical based and consists of several steps. The first step is a multivariate regression that uses all 12 AMSR2 channels (6 - 36 GHz, H- and V-pol) in addition to some linear combination of Tbs as independent variables. The second step is to apply a set of corrections to fine tune the regressed values of SSW. We start with a latitude correction, followed by SST correction, TPW correction, Earth Incidence Angle correction, and finally relative wind direction

correction that is a function of wind speed. Finally, a 5 X 5 median filter is applied as a low pass filter to smooth the retrieved wind speed.

Users: NESDIS/OSPO/SAB and NWS.

Impacts: Supports the weather forecasting and warning mission and contributes to goals of healthy oceans and resilient coasts.

Table 2.1.10.3a: GAASP Ocean Surface Winds Products Produced and NPB Connections

Product Category	Product Generated
Winds	Ocean Surface Wind
Imagery	Microwave Imager Imagery

Table 2.1.10.3b: GAASP Ocean Surface Winds Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
MetOp-SG-B1 MWI	Mid AM									

2.1.10.4 SAR-Altimeter Processor for Ocean

Reference 2.6.8, for Ocean Surface Wind

2.1.10.5 SAROPS

Reference 2.6.5 for Ocean Surface Wind

2.1.10.6 Enterprise Stereo Winds

Algorithm Description: The stereo-winds algorithm tracks atmospheric cloud features from multiple viewing perspectives over multiple times, generally involving multiple satellite platforms. Multi-temporal observations provide information about the wind velocity and the observed parallax between viewing perspectives provides information about the height. The stereo-winds method requires no prior assumptions about the thermal profile of the atmosphere to assign a wind height, since the height of the tracked feature is directly determined from the viewing geometry. Stereo winds can currently be generated from visible and Longwave Infrared (LWIR) observations from

numerous GEO-GEO satellite/instrument configurations (e.g., GOES-16 ABI, GOES-18 ABI, and Himawari-9 AHI) and GEO-LEO satellite/instrument configurations (e.g., GOES-16 ABI, GOES-18 ABI, Himawari-9 AHI, NOAA-20/VIIRS, and NOAA-21/VIIRS).

Users: NWS: WFOs, NCEP (EMC, OPC, AWC, TPC, NHC, AWC); DoD: Naval Research Laboratory (NRL), FNMOC, Air Force - 557th Weather Wing); International NWP: ECMWF, MetOffice, CMC, JMA, DwD, Meteo-France, BoM, KMA

Impacts: GEO-GEO and GEO-LEO stereo winds will increase the utilization of NOAA's satellite winds in NOAA and international partner operational NWP forecast systems with the potential for measurable improvements in the accuracy of global and regional weather forecasts. Through its application to increasing combinations of NOAA and International partner GEO and LEO satellites, the future vision is to produce a global stereo wind product that has the potential to bring further improvements to the accuracy of global and regional NWP model forecasts.

Table 2.1.10.6a Stereo Winds Products Produced and NPB Connections

Product Category	Product Generated
Winds	*Atmospheric Wind Vector Speed and Direction*

Italics = Not currently in the NESDIS Product Baseline

Table 2.1.10.6b Stereo Winds Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-18 ABI	137W									
Himawari-9 AHI	140E	X								
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									

2.1.10.7 CoastWatch Tailored Products

Reference 2.7.2 For Ocean Surface Winds and SAR Winds

2.2. Cryosphere

2.2.1 Lake and Sea Ice

2.2.1.1 GMASI

Reference 2.6.1 for Ice Extent

2.2.1.2 MIRS

Reference 2.6.4 for Sea Ice Concentration, Ice Extent

2.2.1.3 Ice Concentration, Ice Cover, and Ice Surface Temperature

Algorithm Description: Ice Concentration L2 products are generated by a proven algorithm that generates the following products: Ice Concentration, Ice Cover, and Ice Surface Temperature. Ice Concentration products run on both LEO and GEO satellite platforms. For LEO (VIIRS), Ice concentration and Ice Surface Temperature are separate products. For GEO (ABI), Ice Surface Temperature is an intermediate product, part of the ice concentration product.

Users: NIC (National Ice Center), OAR , NWS/WFOs (National Weather Service/Weather Forecast Offices), NMFS (National Marine Fisheries Service), NOAA CoastWatch – PolarWatch Node, AFWA , FNMOC , NAVOCEANO (Naval Oceanographic Office).

Impacts: The product of this algorithm supports a suite of blended sea ice products that would provide users with spatial resolution, all-weather capabilities, thus greatly improving real-time assessments of ice conditions for marine navigation and security. The products can also be used as a first guess in the construction of ice charts, thereby sparing the analyst from having to synthesize the multi-sensor data themselves. Furthermore, weather services could use the product for improved lake or ocean effect snow forecasts.

Table 2.2.1.3a: Ice Concentration, Ice Cover, and Ice Surface Temperature Products Produced and NPB Connections

Product Category	Product Generated
Lake and Sea Ice	Ice Concentration/Extent
Lake and Sea Ice	Ice Surface Temperature

Table 2.2.1.3b: Ice Concentration, Ice Cover, and Ice Surface Temperature Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
MetOp-SG-A1 METimage (TBD)	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.2.1.4 Enterprise Ice Age/Thickness

Algorithm Description: Ice Age/Thickness L2 products are generated by a one-dimensional surface energy budget model that solves the energy balance equation for ice thickness based on other satellite-derived quantities and parameterizations.

Users: DoD, FNMOC, AFWA, Naval Oceanographic Office (NAVOCEANO), NWS: National Ice Center (NIC) and WFOs, NWS: Alaska Sea Ice Program Geographical Information Network of Alaska (ASIP GINA), NWS: NCEP, OAR, and National Marine Fisheries Service (NMFS)

Impacts: The products of this algorithm support navigation and numerical weather prediction (NWP), amongst other applications.

Table 2.2.1.4a: Enterprise Ice Age/Thickness Products Produced and NPB Connections

Product Category	Product Generated
Lake and Sea Ice	Ice Age
Lake and Sea Ice	Ice Thickness

Table 2.2.1.4b: Enterprise Ice Age/Thickness Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
MetOp-SG-A1 METimage (TBD)	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.2.1.5 GAASP Sea Ice

Algorithm Description - The primary sea ice concentration algorithm is the NASA Team 2 algorithm (Markus and Cavalieri, 2000). The algorithm is an enhancement to the original NASA Team algorithm (Cavalieri et al., 1984) that adds the high-frequency (89 GHz) channels to reduce sensitivity to surface inhomogeneity. The method is iterative where modeled BTs for different atmospheric conditions are adjusted to minimize a cost function of the difference between the model and observed brightness temperatures. The minimum cost function is the sea ice concentration solution. This approach provides the best atmospheric correction (from 12 standard atmospheres) to account for the greater sensitivity of the 89 GHz to atmospheric emission.

Users: NAVO, NWS, and NESDIS

Impacts: The product of this algorithm supports navigation advisories and NWP.

Table 2.2.1.5a: GAASP Sea Ice Products Produced and NPB Connections

Product Category	Product Generated
Lake and Sea Ice	Sea Ice Concentration/Extent

Table 2.2.1.5b: GAASP Sea Ice Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
MetOp-SG-B1 MWI	Mid AM									

2.2.1.6 SAROPS

Reference 2.6.5 for Ice Thickness, Ice Age, and Sea Ice Motion

2.2.1.7 SAR-Altimeter

Reference 2.6.8 for Ice Thickness

2.2.1.8 CoastWatch Tailored Products

Reference 2.7.2 for Ice Surface Temperature and Ice Thickness

2.2.1.9 Visible/Infrared Ice

Algorithm Description: Ice surface temperature uses a regression approach similar to SST, utilizing 11 and 12 μm brightness temperatures (Tb), polar-specific Raob data, and a radiative transfer model.

Ice concentration uses a tie-point algorithm to locate “pure” ice and water in a small search box, then interpolates to the observed Tb or reflectance to find the subpixel ice fraction.

Ice thickness/age estimation is based on a sophisticated one-dimensional surface energy budget model that solves the energy balance equation for ice thickness based on other satellite-derived quantities and parameterizations.

Users: NIC, OAR, NWS/WFOs, NMFS, AFWA, FNMOC, NAVO

Impacts: The product of this algorithm supports a suite of blended sea ice products that would provide users with spatial resolution, all-weather capabilities, thus greatly improving real-time assessments of ice conditions for marine navigation and security. The products can also be used as a first guess in the construction of ice charts, thereby sparing the analyst from having to synthesize the multi-sensor data themselves. Furthermore, weather services could use the product for improved lake or ocean effect snow forecasts.

Table 2.2.1.9a: Vis/IR Ice Products Produced and NPB Connections

Product Category	Product Generated
Lake and Sea Ice	Ice Surface Temperature
Lake and Sea Ice	Ice Age
Lake and Sea Ice	Sea Ice Concentration/Extent
Lake and Sea Ice	Ice Thickness

Table 2.2.1.9b: Vis/IR Ice Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.2.1.10 Vis/IR Sea Ice Motion

Algorithm Description: The Vis/IR Sea Ice Motion, or ABI Ice Motion algorithm, relies on utilizing the cross correlations between sets of pixels between image pairs to determine

ice motion vectors. This algorithm will be replaced by the upcoming enterprise ice motion algorithm.

Users: NCEI (accesses the data from NSIDC server)

Impacts: The product of this algorithm is ingested into the Global Climate Dashboard. Product is accessed any time a graphical view of ice conditions is needed by researchers and the public.

Table 2.2.1.10a: Vis/IR Sea Ice Motion Products Produced and NPB Connections

Product Category	Product Generated
Lake and Sea Ice	Sea Ice Motion

Table 2.2.1.10b: Vis/IR Sea Ice Motion Flyout

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

2.2.1.11 Enterprise Ice Motion (Planning R2O)

Algorithm Description: The enterprise ice motion algo retrieves ice motion vectors under clear conditions from multiple sensors on multiple satellite platforms, including ABI from GEOS-R, AVHRR from JPSS, METimage from Metop-SG, etc. In this algorithm, a maximum cross-correlation procedure is applied to two images covering the same area but separated in time in order to retrieve the ice motion vectors. The ice motion vector is determined for each pixel observed by the satellites.

User: NWS Alaska Sea Ice Program (ASIP), NIC, NCEP/EMC, NCEI

Impact: The product of this algorithm, daily sea ice motion, is ingested into the Global Climate Dashboard. Product is accessed any time a graphical view of ice conditions is needed by researchers and the public

Table 2.2.1.11a: Enterprise Ice Motion - Products Produced and NPB Connections

Product Category	Product Generated
Lake and Sea Ice	Sea Ice Motion

Table 2.2.1.11b: Enterprise Ice Motion - Lake and Sea Ice Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					

2.2.1.12 Blended Ice Motion (Potential R2O over 5 years)

Algorithm Description: The Blended Sea Ice motion product combines data from a variety of sources and sensors to produce a consistent sea ice motion product.

Users: UW/CIMSS, UW/CIMSS RealEarth, GINA

Impacts: The product of this algorithm supports NWP centers in a number of countries that have expressed interest in these variables, and the proposed system will improve numerical weather forecasts and provide operational ice analysts with new tools.

Table 2.2.1.12a: Blended Sea Ice Motion - Products Produced and NPB Connections

Product Category	Product Generated
Lake and Sea Ice	Sea Ice Motion

Table 2.2.1.12b: Blended Sea Ice Motion Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
ALOS-4 PALSAR-3	Noon									
GCOM-W AMSR2	PM									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
GOSAT-GW AMSR3	PM									

JPSS-4 VIIRS	PM									
MetOp-SG-A1 METimage	Mid AM									
NISAR SAR-L	Early AM									
NISAR SAR-S	Early AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
RADARSAT-2 SAR	Early AM									
RCM-1 SAR RCM	Early AM									
Sentinel-1A SARC	Early AM									
Sentinel-1C SARC	Early AM									
Sentinel-1D SARC	Early AM									

2.2.2 Snow and Glacier

2.2.2.1 GAASP - Snow Cover Area (SCA) Family

Algorithm Description: The SCA algorithm is based on the decision tree classification method of Grody (1991) and Grody and Bassist (1996) (hereafter referred to as Grody's SCA algorithm) with snow climatology tests and wet snow filter as enhancements that are introduced here. The SD algorithm is based on the current NASA AMSR-E SD algorithm described fully in Kelly (2009) (hereafter referred to as Kelly's SD algorithm). Snow Water Equivalent (SWE) is calculated by the multiplication of the SD and the corresponding snow density from the static snow density lookup table for each snow cover class (Brown and Mote, 2009).

Users: DOD and NIC

Impacts: Snow products for the US Government used to improve the daily IMS (Interactive Multisensor Snow) analysis and detection system leading to improvements with NWP snow model forecasts.

Table 2.2.2.1a: GAASP SCA Family - Products Produced and NPB Connections

Product Category	Product Generated
Snow and Glacier	Snow Cover
Snow and Glacier	Snow Depth
Snow and Glacier	Snow Water Equivalent

Table 2.2.2.1b: GAASP SCA Family Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
MetOp-SG-B1 MWI	Mid AM									

2.2.2.2 MIRS

Reference 2.6.4 MIRS for Snow Cover and Snow Water Equivalent

2.2.2.3 GMASI

Reference 2.6.1 GMASI for Snow Cover

2.2.2.4 County Snowfall

Algorithm Description: County-by-county record snowfall events for one-day, two-day and three-day storms. These are used as the baseline to which FEMA compares recent snow storms when determining eligibility for snowstorm disaster relief.

Users: FEMA

Impacts: Supports U.S. Government assessment of snowfall in disaster declarations.

Table 2.2.2.4: County Snowfall - Products Produced and NPB Connections

Product Category	Product Generated
Snow and Glacier	Extreme Snowfall

In situ Sources:

- GHCN-Daily

2.2.2.5 Regional Snowfall Index

Algorithm Description: The RSI combines snowfall amount and snowfall area in juxtaposition with population to estimate the societal impacts of large snowstorms on a regional scale.

Users: Emergency managers, financial sector, news media, and the retail sector.

Impacts: The product of this algorithm quantifies, typically comparatively, major snowstorms with respect to their relative regional impact.

Table 2.2.2.5: RSI - Products Produced and NPB Connections

Product Category	Product Generated
Snow and Glacier	Snow Cover

In situ Sources:

- GHCN-Daily
- U.S. Census

2.2.2.6 Vis/IR Snow Product Family

Algorithm Description: This product family includes Binary Snow Cover (2-step algorithm), a threshold-based decision tree classification algorithm with consistency testing of snow identifications and auxiliary climatic datasets to eliminate/reduce spurious snow identifications as well as Fractional Snow Cover. Fractional Snow Cover is a single-band technique, examining pixels to determine which part is snow, and uses observations in one (visible, I1) spectral band with two endmembers (snow, snow-free land. The endmember values change with viewing/illumination geometry of observation (kernel-driven BRDF model), applied to pixels identified as “snow covered” in the Binary Snow Map.

Users: Meteorologists, climate modelers, scientific assessments

Impacts: This product of this algorithm is a weekly binary representation of snow vs no snow for the Northern Hemisphere and is provided on an Equal Angle Scalable Earth (EASE) grid for the period from 1966 to present. Each grid cell is associated with an area so that the aerial coverage of snow cover extent can be calculated.

Table 2.2.2.6a: Vis/IR Snow - Products Produced and NPB Connections

Product Category	Product Generated
Snow and Glacier	Snow Cover

Table 2.2.2.6b: Vis/IR Snow Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.2.2.7 Snow Monitoring In situ

Algorithm Description: Products include Monitoring, US, Snow and Ice: Daily U.S. Snowfall and Snow Depth and daily snowfall and snow depth maps and data.

Table 2.2.2.7: Snow Monitoring In situ - Products Produced and NPB Connections

Product Category	Product Generated
Snow and Glacier	Snow Depth

In situ Sources:

- GHCN-Daily

2.3. Land and Surface Hydrology

2.3.1 Fires

2.3.1.1 Enterprise Fire Algorithm

Algorithm Description: The Enterprise Fire algorithm provides an enterprise approach for generating active fire products from all the user-requested sensors, including JPSS M-band Active Fire, JPSS I-band Active Fire, GOES-R ABI fire detection and characterization (including Mesoscale) and Meteosat-SG/Spinning Enhanced Visible and InfraRed Imager (SEVIRI) Fire products. The Enterprise Fires System will share the input/output modules, Persistent Anomalies modules, and underlying essential functions to make the software package easier to update and maintain in the future.

Users: NOAA/NESDIS Wildland Fire Program, NESDIS Hazard Mapping System including NESDIS/OSPO/SAB, NWS Fire Weather Program, USDA Forest Service, US agencies through the National Fire Center, NOAA High-Resolution Rapid Refresh (NWS HRRR), and international users.

Impacts: Improved fire detection and monitoring and support to NWS HRRR models and supports other models and algorithms.

Table 2.3.1.1a: Enterprise Fire Algorithm - Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Biomass Burning Emissions
Fires	Fire Detection and Characterization

Table 2.3.1.1b: Enterprise Fires Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
MetOp-SG-A1 METImage (TBD)	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.1.2 Hazard Mapping System

Algorithm Description: NOAA/NESDIS Satellite Analysis Branch's HMS was first implemented in 2003 in response to the high demand for active fire and smoke information over North America. The system combines near real-time polar and geostationary satellite observations into a common framework in which expert image analysts perform quality control of automated fire products and digitize smoke plumes. Historically, the system has used data from multiple satellite instruments as they enter operations and are later replaced with follow-up missions. The HMS uses the 2-km resolution ABI data from GOES-16 (East) and GOES-18 (West) geostationary satellites, along with 375-m resolution VIIRS data from S-NPP, NOAA-20, and NOAA-21 polar satellites, and 1km resolution MODIS data from the Terra polar satellite. Complementary USGS 30 m resolution Landsat-7 Enhanced Thematic Mapper Plus and Landsat-8 Operational Land Imager, and European Space Agency (ESA) 20 m resolution Sentinel-2A/B Multi-Spectral Instrument data are also used in support of the daily fire analyses. These are primarily pass-through data products, not individual algorithms per satellite. Burn scars and burned areas are emerging products from HMS. These use a variety of SAR satellites, including ICEYE, Capella, Sentinel, etc). The HMS leverages satellites in the Satellite Analysis Branch Family of algorithms when possible.

Users: General public and fire management decision makers through a GIS map viewer.

Impact: The products of this algorithm improve understanding of the location of ongoing fire activity in North America.

Table 2.3.1.2a: HMS - Products Produced and NPB Connections

Product Category	Product Generated
Fires	Fire and Smoke Analysis

Table 2.3.1.2b: HMS Flyout chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
Landsat-8 OLI	Early AM									
Landsat-9 OLI	Early AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
Sentinel-2A MSI	Mid-AM									
Sentinel-2B MSI	Mid-AM									
Sentinel-2C MSI	Mid-AM									
Sentinel-2D MSI	Mid-AM									
Terra MODIS	Mid-AM									

2.3.1.3 Next Generation Fire System

Algorithm Description: The Next Generation Fire System (NGFS) is a collection of satellite sensor agnostic algorithms and tools, within the VOLcanic Cloud Analysis Toolkit (VOLCAT), designed to enable delivery of actionable information and analysis-ready data for critical active fire applications. The NGFS exploits spectral satellite measurements from the visible, shortwave infrared, midwave infrared, and longwave infrared portions of the electromagnetic spectrum, along with advanced spatial and temporal metrics, to detect fires in a manner that is consistent with human expert analysis of satellite imagery, which, by definition, is artificial intelligence. The NGFS estimates fire intensity via the fire radiative power product. The NGFS fire detection and intensity products are highly resilient to atmospheric obstructions, such as clouds and smoke. The NGFS employs an event-centric data model, where fire events are automatically tracked, thereby supporting critical use cases and advanced data queries. The NGFS combines satellite-based fire events with independent data layers that provide essential context for decision making and analysis. Independent data layers include: NWS fire weather outlooks, red flag warnings, National Interagency Fire Center (NIFC) wildfire incident perimeters, geopolitical boundaries, government agency

jurisdiction boundaries, persistent anomaly sources, and biomass fuel data. The NGFS generates products, with terrain corrected geolocation, from geostationary and low earth orbit satellites. The event-based data model and accurate geolocation allows results from multiple sensors to be readily combined within downstream applications. In addition to the satellite sensor agnostic fire detection and characterization algorithm, the NGFS has several higher-order capabilities, such as wildfire alerts, fire perimeter generation, time of arrival analysis, and fire incident intensity monitoring tools. To ensure impactful service delivery, the NGFS is closely tied to the NESDIS fire storefront project. The NGFS capabilities and fire storefront will continue to evolve as guided by the NESDIS Wildland Fire Program user engagement activities, the Bipartisan Infrastructure Law, and NOAA-wide priorities. The most critical satellite sensors for NGFS applications are listed below.

Users: NWS WFOs, NWS IMETs, NWS NCEP/EMC (via RAVE), OAR/GSL, USFS, DOI, Alaska Interagency Coordination Center, WIFIRE, FireGuard (National Guard), State Land/Fire Management agencies, First Responders, Utility Companies, Research Community, Public

Impacts: The NGFS, in combination with the fire storefront, is specially designed to: 1. Provide satellite-derived information that helps reduce response time to a new fire incident, 2). Enhance weather and fire monitoring in support of fire incident management, 3). Enable improved fire emissions monitoring, smoke forecasts, and fire behavior/spread forecasts, 4). Improve understanding of long-term fire trends and patterns, and 5). Simply access to fire products and information. Upon being transferred to operations, the NGFS products will be used in the Regional ABI and VIIRS Emissions (RAVE) system to generate particulate and gas emission rates. NGFS capabilities are undergoing evaluation in the NOAA Fire Testbed, with early feedback from the NWS indicating that the reduced response time objective is being met. In addition, the Bipartisan Infrastructure Law (BIL) explicitly requires NOAA to address USFS and DOI fire detection and monitoring needs. The trilateral BIL agreement is impact focused. NOAA fire products are expected to improve the effectiveness and efficiency of wildland operations with the Federal land management agencies.

Table 2.3.1.3a: NGFS - Products Produced and NPB Connections

Product Category	Product Generated
Fires	Fire Detection and Characterization
Fires	*Fire detection and supporting attributes*
Fires	*Fire Radiative Power (FRP)*
Fires	*Pyro cumulonimbus detection and characterization*
Fires	*Wildfire alerts*
Fires	*Fire perimeters*
Fires	*Fire time of arrival*
Fires	*Fire incident intensity monitoring tools*
Fires	*Fire activity summaries*

Italics = Not currently in the NESDIS Product Baseline

Table 2.3.1.3b: NGFS Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
GOES-16 GLM	75.2W									
GOES-17 GLM	104.6W									
GOES-18 GLM	137W									
GOES-U GLM	75.2W			X	X					
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MetOp-SG-A1 METimage	Mid AM									
Meteosat-9 (IODC) SEVIRI	45.5E									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
NOAA-20 VIIRS	PM									
JPSS-4 VIIRS	PM									
Sentinel-3A SLSTR	Early AM									
Sentinel-3B SLSTR	Early AM									
MTG-I1/Meteosat-12 FCI	0									

2.3.1.4 RAVE

Product Description - NOAA is congressionally mandated to provide ozone and particulate matter forecast guidance for the nation. This air quality guidance is produced twice daily for 72 hours for ozone and PM2.5 (particulate mass in µg/m3 for particles smaller than 2.5 µm in median diameter); ozone and PM2.5 are the main components of photochemical smog that leads to poor air quality harmful to human health. A key element for improving predictions has been to develop accurate hourly fire emissions of trace gasses and aerosols to initialize the online Community Multiscale Air Quality (CMAQ) model. NESDIS and its affiliates at the South Dakota State University developed a new fire emissions algorithm based on fire radiative power products from GOES-16, GOES-17, SNPP, and NOAA-20; this new regional Advanced Baseline Imager and Visible Imaging Radiometer Suite Emissions (RAVE) algorithm provides emissions of various precursor trace gasses and aerosols that are used as inputs for the model.

Users - EPA, NWS, NCEP/EMC

Impacts - NCEP anticipates RAVE data will provide an ability to provide more timely and accurate smoke and related gas emissions from fires critical for air quality predictions. The data will aid in fire weather forecast model development, and demonstrate capabilities for chemical data assimilation in these models. NWS anticipates that RAVE data will lead to improved skill in operational air quality and fire weather forecasts, leading in turn to improved guidance to the US EPA and state/local air quality managers responsible for issuing air pollution alerts. These alerts enable the public to take steps to avoid exposure to poor air quality, particularly vulnerable populations such as those with asthma and cardiovascular conditions, children, and the elderly.

Table 2.3.1.4a: RAVE - Products Produced and NPB Connections

Product Category	Product Generated
Fires	Fire Detection and Characterization
Fires	*Fire Radiative Power*
Atmospheric Composition and Air Quality	*Hourly Emission of PM2.5*
Atmospheric Composition and Air Quality	*Trace Gasses*
Atmospheric Composition and Air Quality	*Total Particulate Matter*

Italics = Not currently in the NESDIS Product Baseline

Table 2.3.1.4b: Atmospheric Products from RAVE Trace Gases and Aerosols Flyout

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
Himawari-10 AHI	140E									
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
MetOp-SG-A1 METimage (TBD)	Mid AM									

2.3.1.5 VIIRS Active Fires

Algorithm Description: The VIIRS Active Fire products derived from the VIIRS M-band and I-band measurements are based on hybrid thresholding and contextual approaches that build on the heritage of the MODIS Fire and Thermal Anomalies algorithm, but including modifications and additional processing elements to account for VIIRS sensor characteristics. The VIIRS Active Fires algorithm is planned to be discontinued once the critical downstream products (e. g. RAVE) switch over to using Enterprise Fire (section 2.3.1.1) VIIRS I-band data.

Users: NESDIS Satellite Analysis Branch, NESDIS smoke/aerosol teams and their users, air quality forecasting, NWS Incident Meteorologists, other fire management stakeholders, science community.

Impacts: The product of this algorithm supports the NWS HRRR model, other models; GBBEPx algorithm.

Table 2.3.1.5a: VIIRS Active Fires - Products Produced and NPB Connections

Product Category	Product Generated
Fires	Fire Detection and Characterization

Table 2.3.1.5b: VIIRS Active Fires Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.1.6 GBBEPx V3

Reference 2.6.2 GBBEP for Fire Detection and Characterization

2.3.2 Floods

2.3.2.1 Enterprise Flood Mapping

Algorithm Description: Enterprise Flood Mapping provides seven level one products from VIIRS and ABI instruments that support flood detection efforts with US and Global coverage provided. Accurate spatial information of inundated areas, especially in remote or sparsely populated regions, provides forecasters with valuable data to adjust river models in real-time, improving accuracy and decision support services for flood mitigation efforts.

Users: NWS, National Water Center (NWC), NOAA CoastWatch Water Prediction Node at NWS/Office of Water Prediction, NWS/Alaskan River Forecast Center (AKRFC), NWS/North Central River Forecast Center (NCRFC), FEMA,US Geological Survey (USGS), NASA, United States Army Corps of Engineers (USACE), WMO's International Charter and Food Program, and other public users

Impacts: Accurate spatial information of inundated areas, especially in remote or sparsely populated regions, provides forecasters with valuable data to adjust river models in real time, improving forecast accuracy and decision support services for flood mitigation efforts.

Improvements: PPM is working to address (1) the gap between the steam gauge network to provide actionable intelligence on the location of routed flood requests and (2) a lack of gridded data for spatial flood inundation over large domains.

Table 2.3.2.1a: Flood Mapping Products Produced and NPB Connections

Product Category	Product Generated
Flood	Flood Detection

Table 2.3.2.1b: Flood Mapping Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
S-NPP VIIRS	PM									
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
GOES-16 ABI	75.2W									
GOES-18 ABI	137W									
GOES-17 ABI	104.6W									
GOES-U ABI	75.2W			X	X					

2.3.2.2 Blended VIS/IR/SAR Flood Detection

Algorithm Description: VIIRS Flood Detection includes a series of algorithms: a water detection algorithm based on decision-tree approach, a geometry-based cloud shadow removal algorithm, an object-based terrain shadow removal algorithm, a minor flood detection based on change detection algorithm and a water fraction retrieval algorithm with dynamic nearest neighboring searching method. Floodwater is determined by comparing the detected water against a water reference map derived from MODIS global 250-m water mask (MOD44W) and water layer in the 30-m National Land Cover Dataset.

The current joint VIIRS/ABI Flood Product blends the daily flood detection results from VIIRS and ABI using a nearest interpolation method. It is based on the VIIRS 375-m flood maps, and uses the 1-km ABI clear-sky flood detection results to fill the gaps of clouds and cloud shadows in the VIIRS maps. Thus, it shows the flood extent under the maximal clear-sky coverage derived by the satellites during daytime, and keeps the finer VIIRS 375-m spatial resolution. The product has the same spatial coverage with the ABI flood product in the American mainland and islands between 50.5° S and 50.5°N in latitudes.

Users: NWS (National Water Center (NWC), AKRFC, North Central River Forecast Center (NCRFC)), FEMA, USGS, NASA, USACE, WMO International Charter and Food Program, NOAA CoastWatch Water Prediction Node at NWS/Office of Water Prediction, and other public users

Impacts: Accurate spatial information of inundated areas, especially in remote or sparsely populated regions, provides forecasters with valuable data to adjust river models in real time, improving forecast accuracy and decision support services for flood mitigation efforts.

Table 2.3.2.2a: Vis/IR Flood Detection - Products Produced and NPB Connections

Product Category	Product Generated
Flood	Flood Detection

Table 2.3.2.2b: Vis/IR Flood Detection Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
Himawari-9 AHI	140E	X								
Meteosat-11 SEVIRI	0									

2.3.3 Surface Moisture

2.3.3.1 ASCAT Soil Moisture

Algorithm Description: ASCAT Soil Moisture (SM) is a pass-through product from EUMETSAT under the IJPS agreement. It provides an estimate of the water content of the 0-5 cm topsoil layer, expressed in degree of saturation between 0 and 100 [%]. The algorithm used to derive this parameter is based on a linear relationship of SM and scatterometer backscatter and uses change detection techniques to eliminate the contributions of vegetation, land cover and surface topography, considered invariant

from year to year. Seasonal vegetation effects are modeled by exploiting the multi-angle viewing capabilities of ASCAT. The SM processor has been developed by Vienna University of Technology (TU Wien).

Users: NCEP/EMC, 557th WWW, USGA, NOAA CoastWatch Water Prediction Node at NWS/Office of Water Prediction.

Impacts: The products of this algorithm support volumetric soil moisture observations (and companion soil temperature observations) which are a high-quality national dataset that can be used to verify and validate model and satellite estimates of soil moisture, as an input into weather and climate models, and as data set for monitoring drought and climate trends. Spatially distributed soil moisture observational data products are needed to verify, calibrate and correct these model simulations and forecasts.

Table 2.3.3.1a: ASCAT SM - Products Produced and NPB Connections

Product Category	Product Pass-through
Surface Moisture	Soil Moisture

Table 2.3.3.1b: ASCAT SM Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
MetOp-B ASCAT	Mid AM									
MetOp-C ASCAT	Mid AM									
MetOp-SG-B1 SCA	Mid AM									

2.3.3.2 GAASP - Soil Moisture Products

Algorithm Description: The Single Channel Radiance (SCR) method used in GAASP Soil Moisture EDR is mainly based on an algorithm developed by Jackson (1993). In this approach, brightness temperature from a single channel is converted to emissivity that is further corrected for vegetation and surface roughness effect. The Fresnel equation is then used to determine the dielectric constant and a dielectric mixing model is used to obtain the soil moisture.

Users: NWS/NCEP/EMC and US Air Force (557th Weather Wing) (through the SMOPS products). ASCAT SM serves as one of the inputs to SMOPS.

Impacts: GAASP Soil moisture products are used to improve Numerical Weather Prediction and are used as a tool for information with agricultural, flood, and drought forecasts.

Table 2.3.3.2a: GAASP Soil Moisture - Products Produced and NPB Connections

Product Category	Product Generated
Surface Moisture	Soil Moisture

Table 2.3.3.2b: GAASP Soil Moisture Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									

2.3.3.3 Soil Moisture Operational Products System (SMOPS)

Algorithm Description: SMOPS combines soil moisture retrievals from multi-satellites and sensors to provide a global soil moisture map.

Users: NWS NCEP (GFS model verification, calibration, and data assimilation), US Air Force (557th Weather Wing), NOAA CoastWatch Water Prediction Node at NWS/Office of Water Prediction, NWS National Water Center (National Water Model verification and data assimilation), USDA/FAS, NASA.

Impacts: The products of this algorithm support volumetric soil moisture observations (and companion soil temperature observations), which are a high-quality national dataset that can be used to verify and validate model and satellite estimates of soil moisture as an input into weather and climate models, and as data set for monitoring drought and climate trends. Spatially distributed soil moisture observational data products are needed to verify, calibrate, and correct these model simulations and forecasts. Additionally, SMOPS informs numerical weather and water prediction models, which benefit from assimilating soil moisture data, thereby improving forecasts.

Table 2.3.3.3a: SMOPS - Products Produced and NPB Connections

Product Category	Product Generated
Surface Moisture	Soil Moisture

Table 2.3.3.3b: SMOPS Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
MetOp-B ASCAT	Mid AM									
MetOp-C ASCAT	Mid AM									
MetOp-SG-B1 SCA	Mid AM									
SMAP SMAP	Early AM									
SMOS MIRAS	Early AM									

2.3.3.4 SAR SM and Vegetation - Pass-through

Algorithm Description: NASA is generating SM and vegetation products from SAR data that are being explored as pass-through products for NOAA benefits.

Users: NWS, NCEP

Impacts: The products of this algorithm support volumetric soil moisture observations (and companion soil temperature observations) which are a high-quality national dataset that can be used to verify and validate model and satellite estimates of soil moisture, as an input into weather and climate models, and as data set for monitoring drought and climate trends. Spatially distributed soil moisture observational data products are needed to verify, calibrate and correct these model simulations and forecasts.

Table 2.3.3.4a: SAR SM and Vegetation - Products Produced and NPB Connections

Product Category	Product Generated
Surface Moisture	Soil Moisture
Vegetation	Vegetation Indices (NDVI, EVI, etc)

Table 2.3.3.4b: SAR SM and Vegetation Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
ALOS-4 PALSAR-3	Noon									
NISAR SAR-L	Early AM									
NISAR SAR-S	Early AM									

2.3.3.5 Palmer Variants

Algorithm Description: Calculations of the Palmer variants (PDI, PDSI, PHDI, Z-index) based on monthly information in the US. Output is rolled up from stations and climate division level, to states, to regions to CONUS. Weekly Palmer-type maps beginning in 2005, Year-over-year animations of various Palmer-type drought analyses. The North American Objective Blended Drought Indices are an objective mathematical integration of precipitation, soil moisture, and Palmer Drought Index data across the North American continent. They serve as an additional objective tool to aid North American Drought Monitor (NADM) authors and other stakeholders in analyzing drought across the continent. Linkages to the North American Climate Services Partnership (NACSP).

Table 2.3.3.5: Drought Indices - Products Produced and NPB Connections

Product Category	Product Generated
Surface Moisture	Drought Indices

In situ Sources:

- GHCN-Daily
- GHCN-Monthly
- Climate Prediction Center Soil Moisture Data

2.3.3.6 GET-D Product System (Potential R2O over 5 years)

Algorithm Description: The Geostationary satellite EvapoTranspiration and Drought (GET-D) product system was operational at NESDIS/OSPO for Environmental Modeling Center NWP, National Water Model evapotranspiration simulation evaluation and data assimilation, and the NIDIS drought monitoring before the primary geostationary satellites switched to GOES-16/18. GET-D has been updated for the GOES-R series of satellites and is based on the Atmosphere-Land Exchange Inversion (ALEXI) model which uses thermal band satellite observations.In addition to Geostationary-based

imagers, the JPSS VIIRS has the thermal band for surface temperature observations. Using VIIRS observations could provide ET data products at global scale for global models and drought monitoring. If funded, this entry will be updated to include VIIRS.

Table 2.3.3.6a: GET-D Products Produced and NPB Connections

Product Category	Product Generated
Surface Moisture	Drought Indices

Table 2.3.3.6b: GET-D Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									

2.3.3.7 Analytical Drought

Reference 3.2.5 for Drought Indices

2.3.4 Land Surface Temperature

2.3.4.1 Land Surface Temperature (LST L2)

Algorithm Description: LST, a key indicator of the Earth surface energy budget, is widely required in applications of hydrology, meteorology, and climatology. It is of fundamental importance to the net radiation budget at the Earth's surface and monitoring the state of crops and vegetation, as well as an important indicator of both the greenhouse effect and the energy flux between the atmosphere and ground (Norman & Becker, 1995; Li & Becker, 1993;). LST is one of the land EDRs for the JPSS mission. The LST EDR measures the skin temperature over global land coverage, including coastal and inland-water. The VIIRS LST EDR is derived from a baseline split-window regression algorithm (Yu et al., 2005).

Users: NCEP, OAR, AFWA, FNMOC, STAR soil moisture and evapotranspiration data team.

Impacts: The products of this algorithm are needed for NWP and hydrological modeling, automated cloud analysis, and general operations such as wind chill, temperatures, and heat stress factors. Also used to support rescue operations, extreme weather events, and climate research.

Table 2.3.4.1a: LST L2 - Products Produced and NPB Connections

Product Category	Product Generated
Surface Temperature	Land Surface Temperature

Table 2.3.4.1b: LST L2 Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.4.2 Gridded Land Surface Temperature (LST L3)

Algorithm Description: Level 3 Gridded Land Surface Temperature (LST-L3) products are generated by an algorithm that uses outputs from L2 LST and a Gridding Tool to generate day and night products. A Gridding Tool maps the granule LST-L2 product to the corresponding gridded product for both day and night, which is then converted to Gridded L3 LST by a separate module. NOAA-21 (J2) enhancements planned operational by early 2024, with a potential All-Weather LST product operational in 2025. Land Surface Temperature (LST) products impact NOAA mission areas: Climate Monitoring, Radiation Budget, Weather Forecasting, and Numerical Weather Prediction.

Users: NCEP Land, NOAA OAR, AFWA, and FNMOC.

Impacts: The products of this algorithm are needed for NWP and hydrological modeling, automated cloud analysis, and for general operations such as wind chill, temperatures, heat stress factors. Also used to support rescue operations.

Table 2.3.4.2a: LST L3 - Products Produced and NPB Connections

Product Category	Product Generated
Surface Temperature	Land Surface Temperature

Table 2.3.4.2b: LST L3 Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.4.3 NOAA Global Temp

Algorithm Description: The NOAA Merged Land Ocean Global Surface Temperature Analysis (NOAAGlobalTemp, formerly known as MLOST) combines long-term sea surface (water) temperature (SST) and land surface (air) temperature datasets to create a complete, accurate depiction of global temperature trends. The dataset is used to support climate monitoring activities such as the Monthly Global Climate Assessment, and also provides input data for a number of climate models. To achieve global temperature coverage, NOAAGlobalTemp combines the sea surface temperature (SST) with land surface air temperature (LSAT). Data is available as a series of temperature anomalies relative to a 1971–2000 monthly climatology. To compute anomalies relative to climatologies for other time periods (e.g. 1991–2020), calculate the average of the NOAAGlobalTemp anomalies for that time period (e.g. 1991–2020), and then subtract the average from the original anomalies.

Table 2.3.4.3: NOAA Global Temp Products Produced and NPB Connections

Product Category	Product Generated
Surface Temperature	Land Surface Temperature

Input Datasets:

- ERRST v5
- GHCNm v4
- ICOADS
- IABP

2.3.4.4 MIRS

Reference 2.6.4 for Land Surface Temperature

2.3.5 Vegetation

2.3.5.1 Green Vegetation Fraction (GVF)

Algorithm Description: GVF/NESDIS Vegetation Product System (NVPS) Green Vegetation Fraction The NVPS produces two sets of products, each with their own algorithm: vegetation index data suite (VIs) and the green vegetation fraction (GVF). The weekly GVF data is provided daily. The intermediate product output of the daily VIs processing is used in the GVF generation.

Users: NCEP: Environmental Modeling Center (EMC), NASA SPoRT, NOAA ESRL, NWS WFOs, University of Maryland (UMD), GeoNetCast- Americas (potential, 1km global GVF), USGS, USDA, and GVF is input to NESDIS Algorithm Land Surface Emissivity (LSE)/ Land Surface Temperature (LST).

Impacts: Green Vegetation Fraction (GVF) data are needed for land surface initialization in numerical weather prediction models and land surface monitoring, supporting Numerical Weather Prediction (NWP) and seasonal climate numerical forecasts.

Table 2.3.5.1a: GVF - Products Produced and NPB Connections

Product Category	Product Generated
Vegetation	Green Vegetation Fraction

Table 2.3.5.1b: GVF Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
NOAA-18 AVHRR/3	Early AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.5.2 Vegetation Health Indices (VH)

Algorithm Description: Global and Regional VH is a NOAA/NESDIS system estimating vegetation health, moisture condition, thermal condition, and their products. It contains Vegetation Health Indices derived from the radiance observed by the AVHRR onboard afternoon polar-orbiting satellites: the NOAA-7, 9, 11, 14, 16, 18, and 19 and VIIRS from the Soumi-NPP satellite. The VH products from AVHRR were produced from the NOAA/NESDIS Global Area Coverage (GAC) data set from 1981 to the present. The data and images have 4 km spatial and 7-day composite temporal resolution. VH products from VIIRS were also processed from 2012 to the present (1km resolution, 7-day composite). The VH products can be used as proxy data for monitoring vegetation health, drought, soil saturation, moisture, and thermal conditions, fire risk, greenness of vegetation cover, vegetation fraction, leave area index, start/end of the growing season, crop and pasture productivity, teleconnection with El Niño Southern Oscillation, desertification, mosquito-borne diseases, invasive species, ecological resources, land degradation, etc.

Users: Archive- CLASS, NCEP/CPC, USDA, NWS

Impacts: The products for this algorithm are input for land models and drought monitoring.

Table 2.3.5.2a: VH - Products Produced and NPB Connections

Product Category	Product Generated
Vegetation	Vegetation Health Indices
Vegetation	Leaf Area Index
Vegetation	Green Vegetation Fraction

Table 2.3.5.2b: VH Flyout chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
NOAA-18 AVHRR/3	Early AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.5.3 Vegetation Indices (VI)

Algorithm Description: The NVPS produces two sets of products, each with their algorithm: the vegetation index data suite (VIs) and the green vegetation fraction (GVF). The VIs include the TOA Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and the top-of-canopy NDVI and EVI. Daily VIs, weekly VIs, and bi-weekly (more specifically, 16 days) VIs are produced daily. The intermediate product output of the daily VIs processing is used in the GVF generation.

Users: National Weather Service/ National Centers for Environmental Prediction (NWS/NCEP), United States Geological Survey Earth Resources Observation and Science (USGS EROS), United States Department of Agriculture (USDA), NOAA/NESDIS/STAR (VH), VTT Technical Research Centre of Finland, Japan Manned Space Systems Corporation, input to NESDIS Algorithms (Green Vegetation Fraction and Soil Moisture Operational Products System).

Impacts: Vegetation Indices (VIs) are used to monitor and characterize terrestrial landscapes; VIs are related to the absorption of photosynthetically active radiation by vegetation and correlate with biomass or primary productivity.

Table 2.3.5.3a: VI - Products Produced and NPB Connections

Product Category	Product Generated
Vegetation	Vegetation Indices (NDVI, EVI, etc.)

Table 2.3.5.3b: VI Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
NOAA-18 AVHRR/3	Early AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.5.4 Leaf Area Index (LAI)

Product Description - Substantially improve the prediction accuracy of NCEP global and mesoscale models (GFS and NAM). Substantially enhance the impact of satellite-measured leaf area index in surface-sensitive satellite channels over land in NCEP global and regional data assimilation systems (GDAS and NDAS). High-quality LAI products are also an essential input for many ecological and hydrological models. Allows expansion of high spatial (500m) resolution LAI products covering the Global regions with no gap.

Users - NOAA/NWS/NCEP Environmental Modeling Center (EMC) and USDA

Impacts - Since the leaf area index is the most critical measurable parameter in the Noah-MP model, the land model to be used in upcoming NWM operational systems, this product is expected to improve land surface representation in the modeling system and benefit the forecast accuracy in numerical prediction.

Table 2.3.5.4a: Global 1-km VIIRS leaf area index (LAI) - Products Produced and NPB Connections

Product Category	Product Generated
Vegetation	Leaf Area Index

Table 2.3.5.4b: Global 1-km VIIRS leaf area index (LAI) Products Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.5.5 Vegetation/Surface Type

Algorithm Description: The VIIRS Annual Surface Type (AST) product algorithm uses the 17-class scheme developed by the International Geosphere-Biosphere Program. The VIIRS AST algorithm is based on approaches developed for generating global land cover products from MODIS and AVHRR (Friedl et al. 2010; Friedl et al. 2002; Hansen et al. 2000; Loveland et al. 2000). These approaches require gridded global composites of satellite images as inputs, which are used to produce metrics designed to provide more consistent representation of the spectral-temporal signatures of different surface types across the globe than the original observations or composites. The derived metrics are then classified to produce global land cover maps using classification models derived using machine learning algorithms and globally representative training samples.

Users: NWS (Community Hydrologic Prediction System (CHPS), National Water Center (NWC), NCEP Land Monitoring Team, National Center for Atmospheric Research (NCAR) including Weather Research and Forecasting (WRF) and Community Earth System Model (CESM), Environmental Monitoring Center (EMC)), NASA Goddard Earth Observation Model (GEOS) and NASA VIIRS LAI Team, OAR, Carbon stock, fluxes, and biodiversity studies, AFWA, and FNMOC.

Impacts: The Annual Surface Type (AST) products are used in NOAA’s NWP and NWM models to monitor seasonal variability, which impacts NOAA mission areas of Climate/Environmental land/vegetation monitoring and numerical weather prediction.

Table 2.3.5.5a: AST - Products Produced and NPB Connections

Product Category	Product Generated
Vegetation	Vegetation/Surface Type

Table 2.3.5.5b: AST Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.3.5.6 SAR SM and Vegetation - Pass-through

Reference 2.3.3.4 SAR SM and Vegetation for Vegetation Indices

2.3.5.7 Climate Data Records

Reference 3.4 refer available CDRs

2.4. Oceans, Freshwater and Coasts

2.4.1 Topography and Bathymetry

2.4.1.1 Altimetric Stacking

Algorithm Description: Stacked SSH profiles from repeat ground-track satellite radar altimeters are produced with an algorithm that robustly combines data from repeat cycles to reinforce SSH signal from seafloor topography while reducing measurement noise and SSH attributed to time-varying ocean dynamics. The algorithm has been applied to SSH from the Ka-band altimeter on SARAL/AltiKa and the high-rate SRAL delay-doppler radar altimeter on Sentinel-3A and Sentinel-3B.

Users: STAR FTP: provided to NOAA CoastWatch moderate assurance service to NWS.

Impacts: The products from this algorithm support data assimilation and forecaster efforts and support safe underwater navigation by US Navy vessels through satellite-derived bathymetry. Additionally, there is dependency of ETOPO on this type of data.

Table 2.4.1.1a: Altimetric Stacking - Products Produced and NPB Connections

Product Category	Product Generated
Topography and Bathymetry	Sea Floor Bathymetry

Table 2.4.1.1b: Altimetric Stacking Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
Sentinel-3A DORIS	Early AM									
Sentinel-3A LRR	Early AM									
Sentinel-3A MWR	Early AM									
Sentinel-3A SRAL	Early AM									
Sentinel-3B DORIS	Early AM									
Sentinel-3B LRR	Early AM									
Sentinel-3B MWR	Early AM									
Sentinel-3B SRAL	Early AM									
Sentinel-3C DORIS	Early AM									
Sentinel-3C LRR	Early AM									
Sentinel-3C MWR	Early AM									
Sentinel-3C SRAL	Early AM									
Sentinel-3D DORIS	Early AM									
Sentinel-3D LRR	Early AM									
Sentinel-3D MWR	Early AM									
Sentinel-3D SRAL	Early AM									

2.4.1.2 ETOPO Global Relief Model

ETOPO 2022 is a release of NOAA's "Earth TOPOgraphy" dataset and represents a NCEI core data set to numerous downstream products. As cited by Dr. Volz, "*the updated ETOPO 2022 provides a tool to meet the present and future needs of the scientific global hazard and mapping communities.*" It is a full-coverage, seamless, gridded topographic and bathymetric bare-earth elevation dataset. The ETOPO Global Relief Model integrates topography, bathymetry, and shoreline data from regional and global datasets to enable comprehensive, high resolution renderings of geophysical

characteristics of the earth's surface. The model is designed to support tsunami forecasting, modeling, and warning, as well as ocean circulation modeling and Earth visualization.

ETOPO is released globally as a full-global-coverage earth surface elevation file comprising 288 individual 15 x 15 degrees tiles (latitude/longitude) at 15-arc-second geographic resolution. The tiles are provided in GeoTiff and Network Common Data Form (NetCDF) formats, with identical information provided in each format. An additional 62 tiles have "bed" versions that provide bedrock elevations under the surface of the Greenland and Antarctic ice sheets. Each 15s tile has a Source ID (SID) integer file identifying from which data source each ETOPO grid cell was acquired. All tiles are in horizontal WGS84 geographic coordinates (EPSG1:4326) and referenced in meters relative to the Earth Gravitational Model of 2008 (EGM2008) geoid surface

(EPSG:3855). Each tile comes with an accompanying integer Source ID ("sid") tile specifying from which source dataset each ETOPO elevation was derived (see Section 5). Data Sources and Processing), as well as an accompanying "geoid" tile for converting EGM2008 geoid heights into WGS84 ellipsoid elevation heights (EPSG:4979). Since most other geoid, ellipsoid, and/or tidal vertical datums are defined by grids in reference to the WGS84 ellipsoid, this eases the conversion of ETOPO 2022 tiles into other vertical reference datums of the user's choice. For most purposes, EGM2008 is an adequate approximation of mean sea level. Another major periodic update to ETOPO is planned during the next 5 year product cycle.

Input datasets:

Source Name	Vertical Datum	Layer source ID	Creator	Primary Use
GEBCO 2022	MSL	1	GEBCO Compilation Group (2022)	Sea bathymetry, base layer, large lake bathymetry
GEBCO 2022 Sub-ice	MSL	2	GEBCO Compilation Group (2022)	Sea bathymetry (sub-ice, polar regions)

NOAA Estuarine DEMs	various	3	NOAA/NCEI (archived)	Sea bathymetry
NOA Regional DEMs	various	4	NOAA/NCEI (archived)	Sea bathymetry
GMRT 4.0	MSL	5	GMRT.org, Lamont-Doherty Earth Observatory	Sea bathymetry
BlueTopo	NAVD88	6	NOAA OCS	Sea bathymetry
BOEM Gulf of Mexico Bathymetry	MSL	7	BOEM	Sea bathymetry
ShallowBathy Everywhere	EGM2008	8	Oregon State University	Sea bathymetry
Copernicus DEM 30m	EGM2008	9	European Space Agency	Land topography
FABDEM	EGM2008	10	European Space Agency and Bristol University	Land topography
BedMachine	EIGEN-6C4 geoid	11	NASA	Ice sheet bed topography
GEBCO Lake Depths	MSL	12	GEBCO Hydrolakes outlines and GEBCO elevations	Global surveyed lake depths (for very large lakes)

CUDEM	various	13	NOAA Coastal DEM Team	Land Topography and sea bathymetry (US & Territories)

The following datasets were not directly included in ETOPO, but were instrumental for the development, production, and/or validation of the source data layers.

Source Name	Vertical Datum	Creator	Primary Use
ICESat-2 - ATL03 and ATL08	EGM2008 / WGS84	NASA	Photon elevation data for DEM evaluation
Hydrolakes	n/a	HydroSHEDS	Global vector outlines of inland water bodies
OpenStreetMap	n/a	OpenStreetMap	Building outlines (masked during ICESat-2 validation)
World Settlement Footprint 2015	n/a	(Marconcini, et al., 2020)	Heavy-urban-area footprints (masked during ICESat-2 validation)

2.4.1.3 Subsurface ocean in situ data and products

The World Ocean Database (WOD) is the largest publicly available unrestricted use, uniformly formatted and quality controlled database of historic and recent subsurface ocean profile data where an oceanographic profile is a series of depth (pressure) measurements of an essential ocean variable in the water column between the surface and the ocean bottom. Managed at NOAA/NESDIS/NCEI, the WOD is also a project of the International Oceanographic Data Exchange (IODE) of the Intergovernmental Oceanographic Commission (IOC). The WOD program is a contribution to the U. N. Decade of the Ocean. Over the next five-years this program will be completed, realizing

an international network of contribution and use of the WOD in the cloud, a resource for consolidation of ocean profile data flow globally. Essential ocean variable chlorophyll (and primary productivity) will be curated into a high quality dataset for use in NESDIS primary productivity product from its present state in the WOD by gleaning necessary metadata from the original archived data and augmenting from other available historic and recent data sets. Similarly, transmissivity (light attenuation) will be augmented and curated in the WOD for more reliable use by the satellite community. Additional essential ocean variables will be added to the WOD. Continued collaboration with the International Quality Controlled Oceanographic Database (IQuOD) will enhance the utility of the WOD to the modeling and research community. Collaboration and added discoverability and data delivery directly from the main ocean observing systems which contribute to the WOD (e.g. the Argo profiling float program, NOAA OMAO fleet) will be executed in order to augment and optimize data flow to the WOD. Collaboration with the developing NOAA glider program will ensure optimized data flow from this source. Collaboration with the NCEI/Ocean Acidification Program/Global Ocean Monitoring and Observing program Ocean Carbon and Acidification Data System (OCADS) will augment and enhance data flow for essential ocean carbon variables. The Global Temperature and Salinity Profile Program (GTSPP), maintained at NCEI under the auspices of the IODE will be updated and restored as the main source of near-real time ocean profile data to the WOD.

The WOD is inherent input data for the **Next-Generation Enterprise Ocean Heat Content Product Suite (Section 2.4.5.10**) and the NCEI in situ derived ocean heat content (OHC)) Climate Data Record. Expansion and improvement of the OHC method will be executed over the next five years.

Elevation of other time series of in situ ocean variables to climate data record status will be accomplished over the next five years - these include ocean salt (freshwater) content, steric sea level, ocean dissolved oxygen, ocean mixed layer depth and stability, ocean carbon variables, ocean nutrients. Regionalization of these prospective climate data records will be accomplished by developing the Marine Environmental Buoy Database (MEBD) to bring in coastal and near coastal data which are not part of the WOD. As more data are added to the WOD, a new version of the World Ocean Atlas means climatological fields of essential ocean variables will be calculated.

Other essential ocean variables which are not part of the WOD, but which are essential for an understanding of the ocean will be developed and enhanced in the next five years. Foremost of these is the Global Ocean Currents Database (GOCD) which will bring together diverse sources of surface and subsurface ocean currents in one

database for models and ocean research. The sources of the GOCD include the Joint Archive for Shipboard Acoustic Doppler Profilers (JAS-ADCP), joint with the University of Hawaii, as well as the Integrated Ocean Observing System (IOOS) High-Frequency RADAR data assembly center. These pathways to the GOCD will be developed over the next five years. As mentioned above, the MEBD will be enhanced as a source of regional data and information for global and regional time series and models. The Surface Underway Marine Database (SUMD), a project of the surface marine section will be expanded to include carbon variables and be the main data portal for Sailgliders.

2.4.2 Surface Height

2.4.2.1 NOAA SAR-Altimeter Processor for Ocean

Reference 2.6.8 for Sea Surface Height and Significant Wave Height

2.4.2.2 RADS

Reference 2.6.7 for Sea Surface Height, Significant Wave Height, Absolute Dynamic Topography, and Delayed Mode Mean Sea Level Height (Proposed Baseline)

2.4.2.3 NOAA Jason Ground System

Algorithm Description: The NOAA Jason Ground System produces L1 data and standardized L2 products at operational latencies and distributes interim and delayed mode latencies.

Users: NCEI/CLASS, CNES, EUMETSAT, NASA/JPL, NAVOCEANO, NCEP, NESDIS/OSPO/SAB, NMFS, USN

Impacts: The products of this algorithm support definitions of winds that indicate global and local circulation patterns, force ocean surface circulation (surface currents), determine sea state, influence water levels along the coast, help to determine surface height, produce storm surge, and drive the motion of the lower layers of the atmosphere.

Table 2.4.2.3a: NOAA Jason Ground System - Products Produced and NPB Connections

Product Category	Product Generated
Surface Height	Sea Surface Height
Surface Height	Significant Wave Height
Surface Height	Delayed Mode Sea Surface Height (Proposed Baseline)

Table 2.4.2.3b: NOAA Jason Ground System Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JASON-3 AMR	10-day repeat									
JASON-3 DORIS	10-day repeat									
JASON-3 LRA	10-day repeat									
JASON-3 Poseidon-3B	10-day repeat									
Sentinel-3A GNSS-POD	Early AM									
Sentinel-3B GNSS-POD	Early AM									
Sentinel-3C GNSS-POD	Early AM									
Sentinel-3D GNSS-POD	Early AM									
Sentinel-6A MF AMR-C	10-day repeat									
Sentinel-6A MF DORIS	10-day repeat									
Sentinel-6A MF GNSS-POD	10-day repeat									
Sentinel-6A MF LRA	10-day repeat									
Sentinel-6A MF Poseidon-4	10-day repeat									
Sentinel-6B AMR-C	10-day repeat									
Sentinel-6B DORIS	10-day repeat									
Sentinel-6B GNSS-POD	10-day repeat									
Sentinel-6B LRA	10-day repeat									
Sentinel-6B Poseidon-4	10-day repeat									

2.4.2.4 SAROPS

Reference 2.6.5 for Significant Wave Height

2.4.2.5 Near Real-Time Altimeter Validation System (NRTAVS)

Algorithm Description: NRTAVS is a highly automated service that is triggered by the release of near real time products and produces comprehensive, running web-based summaries of individual correction terms, as well as wind, wave and sea-surface height for satellite radar altimeter missions. The summaries produced by the system include geographic images, statistical profiles of pass parameters and data flags, as well as estimates of the radial orbit error.

NRTAVS was developed jointly by NOAA and the Jet Propulsion Laboratory for the monitoring of the near real time processing of the Jason-1 mission. NOAA has since extended NRTAVS to its successor missions Jason-2 and Jason-3 and have adapted it for AltiKa/Satellite with ARgos and ALtiKa (SARAL), Sentinel-3A, and Sentinel-3B, and Sentinel-6 Michael Freilich.

Upgrades are developed by STAR for EUMETSAT and the NOAA Jason Ground System at OSPO. EUMETSAT and NOAA use the system to quickly respond to any warning generated by NRTAVS. NRTAVS provides an early warning to operators and users of any observed degradation of the product quality, confirm continued quality after software or operational changes, and take rapid action where needed. It is provided as a public service (https://www.star.nesdis.noaa.gov/socd/lsa/NearRealTime/NRT_NRTAVS.php).

Table 2.4.2.5a: NRTAVS - Products Produced and NPB Connections

Product Category	Product Generated
Surface Height	Sea Surface Height
Surface Height	Significant Wave Height

Table 2.4.2.5b: NRTAVS Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
CRISTAL AMR-C	Drifting 92deg									

CRISTAL GNSS-POD	Drifting 92deg									
CRISTAL IRIS	Drifting 92deg									
CRISTAL LRR	Drifting 92deg									
JASON-3 AMR	10-day repeat									
JASON-3 DORIS	10-day repeat									
JASON-3 GPSP	10-day repeat									
JASON-3 LRA	10-day repeat									
JASON-3 Poseidon-3B	10-day repeat									
SWOT GPSP	21-day repeat									
Sentinel-3A DORIS	Early AM									
Sentinel-3A GNSS-POD	Early AM									
Sentinel-3A LRR	Early AM									
Sentinel-3A MWR	Early AM									
Sentinel-3A SRAL	Early AM									
Sentinel-3B DORIS	Early AM									
Sentinel-3B GNSS-POD	Early AM									
Sentinel-3B LRR	Early AM									
Sentinel-3B MWR	Early AM									
Sentinel-3B SRAL	Early AM									
Sentinel-3C DORIS	Early AM									

Sentinel-3C GNSS-POD	Early AM									
Sentinel-3C LRR	Early AM									
Sentinel-3C MWR	Early AM									
Sentinel-3C SRAL	Early AM									
Sentinel-3D DORIS	Early AM									
Sentinel-3D GNSS-POD	Early AM									
Sentinel-3D LRR	Early AM									
Sentinel-3D MWR	Early AM									
Sentinel-3D SRAL	Early AM									
Sentinel-6A MF AMR-C	10-day repeat									
Sentinel-6A MF DORIS	10-day repeat									
Sentinel-6A MF GNSS-POD	10-day repeat									
Sentinel-6A MF LRA	10-day repeat									
Sentinel-6A MF Poseidon-4	10-day repeat									
Sentinel-6B AMR-C	10-day repeat									
Sentinel-6B DORIS	10-day repeat									
Sentinel-6B GNSS-POD	10-day repeat									
Sentinel-6B LRA	10-day repeat									
Sentinel-6B Poseidon-4	10-day repeat									

2.4.3 Biology and Biogeochemistry

2.4.3.1 Multi-Sensor Level1-Level 2 (MSL-12) Processing System

Algorithm Description: The NOAA MSL12 ocean color data processing system was developed to use a consistent and common data processing system to produce global ocean color products from multiple satellite ocean color sensors. Ocean color sensors aboard polar-orbiting satellites (S-NPP with VIIRS and the NOAA-20/NOAA-21 JPSS with VIIRS) measure visible and IR wavelengths of electromagnetic radiation reflected from the ocean surface (remote sensing reflectance) used to calculate normalized water leaving radiances that are used to generate a variety of ocean color products: chlorophyll-a, merged daily chlorophyll, water attenuation coefficients, and Chl-a fronts. Ocean Color products are useful for assessing phytoplankton biomass and suspended sediment/water quality, as well as tracking potentially harmful algal blooms to better understand the health of our oceans. This algorithm produces information used by the Great Lake Color Producing Agents algorithm for the L2 product (Potential R2O) and will be used for proposed multi-year time series since 1997 (SeaWiFS).

Users: NMFS, NWS, NOS, OAR, NOAA CoastWatch/OceanWatch/PolarWatch, Coral Reef Watch, EUMETSAT, Universities (Rhode Island, Southern Mississippi, and dozens of others), and commercial users (“blue economy”).

Impacts: Ocean Color products are useful for phytoplankton biomass, suspended sediment/water quality, as well as tracking potentially harmful algal blooms in order to better understand the health of our oceans.

Table 2.4.3.1a: MSL-12 - Products Produced and NPB Connections

Product Category	Product Generated
Biology and Biochemistry	Chlorophyll-a
Biology and Biochemistry	Chlorophyll-a Anomaly
Biology and Biochemistry	Chlorophyll-a Front
Biology and Biochemistry	True Color
Biology and Biochemistry	Normalized Water-leaving Radiance (Reflectance)
Biology and Biochemistry	Water Diffuse Attenuation

Biology and Biochemistry	Delayed Mode Chlorophyll-a
Biology and Biochemistry	Delayed Mode Water Diffuse Attenuation
Biology and Biochemistry	Delayed Mode Normalized Water Leaving Radiance (Reflectance)
Analytical- Time Series	Multiyear Blended Gap-Free Chlorophyll-a
Analytical- Time Series	Chlorophyll-a Reanalysis (Proposed Baseline)
Analytical- Time Series	Gap-Free Water Diffuse Attenuation (Proposed)
Analytical- Time Series	Multiyear Ocean/water bio-optical, biological, and biogeochemical products, e.g., chlorophyll-a concentration, water diffuse attenuation coefficient at 490 nm, inherent optical properties, suspended particulate matter, etc. (Proposed Baseline)
Analytical- Time Series	Gap-Free Suspended Particulate Matter (Proposed Baseline)

Table 2.4.3.1b: MSL-12 Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GLIMR GLIMR	TBD									
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.4.3.2 PACE Ocean Color products

Reference 2.7 for pass-through and tailored ocean color products planned from PACE.

2.4.3.3 CoastWatch/OceanWatch Tailored Products

Reference 2.7 for pass-through and tailored Ocean Color Products

2.4.3.4 Northeast Shelf Hyperspectral Ocean Color

Algorithm Description: Hyperspectral ocean color data will become operationally available with the launch of NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) satellite and will be continued by futured missions such as GeoXO. The Northeast Shelf is a highly productive and important area for fisheries and migratory species management, among others. A suite of hyperspectral ocean color products, resolved for the optically complex waters of the Northeast Shelf, is needed to better model, manage, and assess change in this large marine ecosystem. These products (e.g. chlorophyll, color dissolved organic matter) will help better optically classify the different water masses in the region (e.g. seascapes), be synergistic with NASA-developed PACE algorithms, and allow seamless coastal to shelf performance.

Users: NMFS

Impacts: The products of this algorithm are needed for the Northeast Fisheries Science Center to better model and manage fisheries and other marine species in the Northeast Shelf. The approach and algorithm can be adapted for other coastal, shelf, pelagic, and/or Great Lake systems as needed.

Table 2.4.3.4a: Northeast Shelf Hyperspectral Ocean Color - Products Produced and NPB Connections

Product Category	Product Generated
Biology and Biochemistry	Chlorophyll-a
Biology and Biochemistry	*Color Dissolved Organic Matter*

Italics = Not currently in the NESIDS Product Baseline

Table 2.4.3.4b: Northeast Shelf Hyperspectral Ocean Color Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
PACE OCI	Noon									
PACE SPEXone	Noon									

2.4.3.5 Coastal and Freshwater Harmful Algal Blooms

Product Description - Toxic algal blooms, such cyanobacteria, are a global problem which affect both inland and coastal areas throughout the United States. The Cyanobacteria Assessment Network (CyAN) project has created specific cyanobacteria products to support efforts to provide safe drinking water, manage recreational beaches and advise state management agencies in approximately 2000 lakes throughout the

US. However, state agencies now seek higher resolution products to monitor smaller lakes and reservoirs for algal blooms. An experimental chlorophyll-a product using Sentinel 2 imagery has been developed as part of a multi-agency effort for select regions but is requested to be provided on a national level to support algal bloom monitoring.

Users NOAA CoastWatch, US EPA, US ACE, USGS, State environmental agencies, and aquaculture activities.

Impacts - By providing higher resolution (~10-20 meters) chlorophyll-a bloom imagery, the ability to resolve potential harmful algal blooms in lakes within the US increases from approximately 2,000 lakes to approximately 150,000 lakes. This is a direct benefit to state agencies grappling with monitoring freshwater lakes and reservoirs for algal toxins which are a public health threat to drinking water and recreational activities. In addition, better resolution water quality and Chlorophyll-a products will provide important information for coastal and nearshore aquaculture activities.

Table 2.4.3.5a: Coastal and Freshwater Harmful Algal Blooms - Products Produced and NPB Connections

Product Category	Product Generated
Biology and Biochemistry	Chlorophyll-a

Table 2.4.3.5b: Coastal and Freshwater Harmful Algal Blooms Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
Sentinel-2A MSI	Mid-AM									
Sentinel-2B MSI	Mid-AM									
Sentinel-2C MSI	Mid-AM									
Sentinel-2D MSI	Mid-AM									

2.4.3.6 Net Primary Productivity (PP)

Product Description - Oceanic Primary productivity (PP) is a measure of the rate of photosynthesis by phytoplankton in marine and freshwater environments. This rate measurement is separate from phytoplankton biomass, which is estimated from chlorophyll concentrations. It is an essential climate variable that is necessary for understanding ocean and freshwater productivity, aquatic food webs, and the impact of climate change on phytoplankton photosynthesis. Because of the need to look at long-term variability (Balch et al, 2022), the PP product requirements extend back to 1997,

using data from multiple ocean color sensors that preceded VIIRS (i.e. SeaWiFS, MERIS and MODIS). While there are long-term sensor agnostic products available (i.e. GlobColour and OC-CCI) for a suite of ocean color products, none of these include PP.

Users - NMFS, OAR

Impacts - Creating a single consistent time series of PP will have high impact and value within and outside of NOAA and allows for accurate regional comparisons of PP. Having this PP product available will increase the value of the VIIRS measurements, and it will also make this data more accessible to the broader public.

2.4.4 Water Pollution

2.4.4.1 SAROPS
Reference 2.6.5 for Oil Spills and Marine Debris Detection

2.4.4.2 CoastWatch Tailored Products

Reference 2.7.2 for Oil Spills and Marine Debris Detection

2.4.4.3 Oil Spill Mapping

Algorithm Description: The oil spill mapping algorithm generates oil spill and marine debris monitoring maps using SAR data. In addition to the satellites listed here, Capella, and Umbra are pending funding agreements and may be used in the future.

Users: BOEMRE and BSEE, NOS, USCG, DOJ, DOI, EPA, state officials, public

Impacts: The products of this algorithm support monitoring and reporting of marine pollutions events mainly within the US economic exclusion zone

Table 2.4.4.3a: Oil Spill Mapping - Products Produced and NPB Connections

Product Category	Product Generated
Oceans, Freshwater and Coasts	Oil spills and marine debris detection

Table 2.4.4.3b: Oil Spill Mapping Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
ALOS-4 PALSAR-3	Noon									
ISS DESIS DESIS	Drifting									
NISAR SAR-L	Early AM									
NISAR SAR-S	Early AM									
RADARSAT-2 SAR	Early AM									
RCM-1 SAR RCM	Early AM									
Sentinel-1A SARC	Early AM									
Sentinel-1C SARC	Early AM									
Sentinel-1D SARC	Early AM									

2.4.5 Water Temperature and Salinity

2.4.5.1 Advanced Clear Sky Processor for Ocean (ACSPO)

Algorithm Description: ACSPO is the NOAA Enterprise SST system. It is currently used to produce consistent SST products from single sensors flown (or soon to be flown) aboard LEO (NOAA and METOP-SG AVHRRs, JPSS VIIRSs, EOS MODIS, and METOP-SG METImage) and GEO (GOES-R ABI, Himawari AHI, and MTG FCI) satellites, in a community consensus Group for High-Resolution SST (GHRSST) Data Specification version 2 NetCDF format Two products are produced from each platform/sensor: L2P (original swath projection) and gridded uncollated (L3U)/Level 3 Collated (L3C) for LEO/GEO, respectively (gridded 0.02deg; U=uncollated; C=Collated). Individual-sensor 0.02deg L3U/L3C products are subsequently fused together into gridded super collated (L3S). Currently, super-collation is done separately for LEO and GEO satellites, resulting in L3S-LEO and super-collated-GEO lines of products. Eventually, the L3S-LEO and L3S-GEO will be super collated together into one global L3S product. All products are generated Operationally (in near-real time, with several hours of latency) and in a reprocessed mode (Re-analysis, with several months of latency). Per multiple user requests, all products are reported with thermal front layers. Following user requests, work is underway to generate corresponding ACSPO Climatology and Anomaly products.

Users: Coast Watch, Coral Reef Watch, NCEP, NOS, NCEI, NMFSC, Canadian Met Center (CMC), UK Met Office, Australian Bureau of Meteorology, Danish Meteorological

Institute, University of Melbourne, Japan Meteorological Agency, University of Maryland, Digital Globe, Inc (supports US Fisheries).

Impacts: SST is needed for many applications, including operational weather and ocean forecasting (including ocean circulation and tropical storm trajectory and intensity forecasts), military and defense operations, validating or forcing ocean and atmospheric models, ecosystem assessment, tourism, coastal zone management, crew safety/ditching at sea, fisheries, climate variability, and seasonal forecasting.

Table 2.4.5.1a: ACSPO - Products Produced and NPB Connections

Product Category	Product Generated
Water Temperature and Salinity	Sea Surface Temperature
Water Temperature and Salinity	Sea Surface Temperature Anomaly
Water Temperature and Salinity	Sea Surface Temperature Front
Analytical- Time Series	Multiyear Reanalysis Sea Surface Temperature
Analytical- Time Series	Reanalysis Sea Surface Temperature

Table 2.4.5.1b: ACSPO Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
Aqua MODIS	PM									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 VIIRS	PM									
MTG-I1 FCI	0									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-18 AVHRR/3	Early AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
Terra MODIS	Mid-AM									

2.4.5.2 Ocean Heat Content (OHC) Products

Algorithm Description: The current operational OHC algorithm is based on a two-layer reduced gravity ocean model uses a blended daily ocean climatology of mean isotherm depths and reduced gravities, objectively analyzed sea surface height anomaly fields (SSHA) from available altimeter missions and satellite sea surface temperatures (SST) from Remote Sensing System's Optimally Interpolated SST and NESDIS GEO-POLAR Blended SST Analysis (Harris and Maturi, 2012) to produce isotherm depths of the 20^{o} and 26^{o} (D20, D26), mixed layer depth (MLD), and OHC. The software is efficient in that additional satellite data such as another set of altimeter-derived SSHA tracks can be easily ingested into the calculation.

Users: NOAA Coral Reef Watch (CRW), NOAA Coast Watch, and NOAA Ocean Watch, NESDIS/OSPO/SAB, NOAA National Marine Fisheries Service (NMFS)/NOAA Fisheries, Tropical Cyclone Centers (TCCs): (including the JTWC and Meteo-France), National Hurricane Center, NWS/NCEP Central Operations (NCO), NWS/NCEP/EMC,

Worldwinds, India NRSC, NESDIS/STAR/MECB, NOAA Environmental Visualization Laboratory, NESDIS Regional and Mesoscale Meteorology Branch, National Taiwan University, City University of Hong Kong.

Impacts: OHC products impact several NOAA mission critical areas, such as Tropical Cyclone Intensity Forecasting, Coral Reef Watch, and Fish Stocks.

Table 2.4.5.2a: OHC - Products Produced and NPB Connections

Product Category	Product Generated
Water Temperature and Salinity	Isotherm Depth (20C and 26C)
Water Temperature and Salinity	Ocean Mixed Layer Depth
Water Temperature and Salinity	Ocean Heat Content
Water Temperature and Salinity	*Objective Analysis Error*

Italics = Not currently in the NESDIS Product Baseline

Table 2.4.5.2b: OHC Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JASON-3 Poseidon-3B	10-day repeat									
Sentinel-3A SRAL	Early AM									
Sentinel-3B SRAL	Early AM									
Sentinel-6A MF/Jason-CS	10-day repeat									
SARAL AltiKa	35-day repeat									
CryoSat-2	High-Latatude									

2.4.5.3 Coral Bleaching Heat Stress

Algorithm Description: The Coral Bleaching Heat Stress algorithms are Level 5 algorithms derived from STAR's Daily Global 5km Geostationary-Polar Blended Night-

Only Sea Surface Temperature (SST) Level 4 Analysis. The Satellite Coral Bleaching Heat Stress Monitoring Products suite includes Coral Reef Watch Daily Global 5km Satellite Sea Surface Temperature (SST, a.k.a. Coral Temp), Sea Surface Temperature Anomaly (SSTA), Coral Bleaching Hot-Spot (HopSpot), Degree Heating Week (DHW), Coral Bleaching Virtual Stations and Bleaching Alert Area (Single-Day and 7-Day Maximum, BAA), 7-Day SST Trend, Year-to-Date Maximum Composites of SST, SSTA, HotSpot, DHW, and BAA, and Minimum and Mean Composites of SST and SSTA, and Coral Reef Watch Satellite Bleaching Alert (SBA) Email System.

Users: All coral reef ecosystem managers (NOAA examples: NOS/ONMS, NOS/OCM/CRCP) worldwide, who have custodial duties (especially protection and restoration) for tropical coral reefs, In-water monitoring networks (incl. citizen science monitoring networks), Scientific researchers (NOAA examples: NMFS/PIFSC, NMFS/SEFSC, NMFS/SERO); and Non-Governmental Organizations (NGOs) / government agencies (incl. those of the U.S. Coral Reef Task Force).

Impacts: Products derived from the Coral Bleaching Heat Stress algorithm support multiple NOAA mission areas, including climate/environmental monitoring with impacts on coral reefs; assist users with in-water coral reef monitoring efforts around the world; are used in analyses of climate change impacts on coral reef ecosystems (e.g., bleaching, disease, mortality); support conservation, restoration, and resilience-based research and management projects that aim to protect and/or restore coral reefs in a rapidly warming world; and help resource managers, decision makers, and other users prepare and prioritize resources for events (e.g., mass coral bleaching or widespread disease outbreak) that have long-term, ecologically-significant impacts on coral reef health and function.

Table 2.4.5.3a: Coral Bleaching Heat Stress - Products Produced and NPB Connections

Product Category	Product Generated
Water Temperature and Salinity	Coral Bleaching Hot-Spot (HotSpot)
Water Temperature and Salinity	Degree Heating Weeks (DHW)
Water Temperature and Salinity	Sea Surface Temperature (SST,a.k.a. *CoralTemp*)
Water Temperature and Salinity	Sea Surface Temperature Anomaly (SSTA)
Water Temperature and Salinity	*Bleaching Alert Area (Single-Day and 7-Day Maximum BAA)*
Water Temperature and Salinity	*7-Day SST Trend*
Water Temperature and Salinity	*Year-to-Date Maximum Composites of SST, SSTA, HotSpot, DHW, and BAA, and Minimum and Mean Composites of SST and SSTA*
Water Temperature and Salinity	*Satellite Bleaching Alert (SBA) Email System*

Italics = Not currently in the NESDIS Product Baseline

Table 2.4.5.3b: Coral Bleaching Heat Stress Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30F
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
GOES-16 ABI	75.2W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Meteosat-11 SEVIRI	0									
MTG-I1 FCI	0									
Meteosat-9 (IODC) SEVIRI	45.5E									
Himawari-9 AHI	140E	X								
MetOp-SG-A1 METimage	Mid AM									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									

2.4.5.4 Blended SST

Algorithm Description: The Geo-Polar Blended SST blends SST products from the Physical SST retrieval for Meteosat satellites with ACSPO SST retrievals for other satellites to form a daily global Geo-Polar Blended SST Analysis to serve Coral Reef Watch thermal stress monitoring and Oceanic Heat Content products.

Users: NOAA Coral Reef Watch, NWS, NMFS, NOS, and US Navy.

Impacts: The Geo-Polar SST Analysis is a crucial product used by CRW's Decision Support System for ecosystem-based tropical coral reef management, CoastWatch, the National Marine Fisheries service, and the operational Oceanic Heat Content products used by the National Hurricane Center and NWS Pacific Region Headquarters.

Table 2.4.5.4a: Blended SST - Products Produced and NPB Connections

Product Category	Product Generated
Water Temperature and Salinity	Sea Surface Temperature
Time Series	Reanalysis Sea Surface Temperature

Table 2.4.5.4b: Blended SST Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-10 AHI	140E									
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
JPSS-4 VIIRS	PM									
MTG-I1 FCI	0									
Meteosat-11 SEVIRI	0									
Meteosat-10 SEVIRI	9.5E									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.4.5.5 GEO SST

Algorithm Description: The SST physical retrieval processing system utilizes the Joint Center for Satellite Data Assimilation Community Radiative Transfer Model and NCEP atmospheric profile information to first calculate the Bayesian estimate for probability of clouds and to then perform a deterministic inverse calculation (Modified Total Least Squares) to obtain SST for the clear-sky pixels. This processing system is used to generate SST products in GHRSST Level-2P netCDF format for Meteosat-11 (0 degrees East) and Meteosat-8 (41.5 degrees East). This high temporal resolution SST coverage for the Eastern Atlantic and Indian Ocean is a key input to the daily global Geo-Polar Blended SST Analysis that forms the basis of both Coral Reef Watch thermal stress monitoring and Oceanic Heat Content products. In the near future Meteosat-8 (41.5 degrees East) will be replaced with Meteosat-9 to provide continued coverage of the Indian Ocean domain. The Geo-SST physical retrieval processing system is easily adaptable to accommodate additional satellite platforms.

Users: Archive-CLASS; All coral reef ecosystem managers (NOAA examples: NOS/ONMS, NOS/OCM/CRCP), monitoring networks (including citizen science monitoring networks), and scientific researchers (NOAA examples: NMFS/PIFSC, NMFS/SEFSC, NMFS/SERO), as well as NGOs and government agencies (including the US Coral Reef Task Force) worldwide, who have custodial duties (especially protection and restoration) for tropical coral reefs. NOAA Coral Reef Watch, Ocean Heat Content Users, NWS, NOS, and US Navy. NOS/NCCOS for Harmful Algal Blooms (HAB) and NOS/CO-OPS through the use of Global Real-Time Ocean Forecast System (Global RTOFS); Downstream dependency: Blended SST algorithm. GEO SSTs are vital to the NOAA gapfree real-time SST product suite that includes over a thousand users for Coral Reef Watch, and other users as well.

Impacts: The near real-time products of this algorithm assists users with on-the-ground monitoring of coral reef environmental conditions; is used in analyses of climate change impacts on coral reefs (e.g., bleaching, disease, mortality); supports conservation and resilience efforts; and helps resource managers, decision makers, and other users prepare and prioritize resources for events (e.g., mass coral bleaching or disease) that could have long-term, ecologically-significant impacts on coral reef health and function.

Table 2.4.5.5a: Geo SST - Products Produced and NPB Connections

Product Category	Product Generated
Water Temperature and Salinity	Sea Surface Temperature
Time Series	Reanalysis Sea Surface Temperature

Table 2.4.5.5b: Geo SST Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
Meteosat-10 SEVIRI	9.5E									
Meteosat-11 SEVIRI	0									
Meteosat-8 (IODC) SEVIRI	41.5E									
Meteosat-9 (IODC) SEVIRI	45.5E									

2.4.5.6 ACSPO

Reference 2.4.5.1 for L3 Gridded SST and Multi-Year SST Reanalysis

2.4.5.7 Coral Bleaching Heat Stress

Reference 2.4.5.3 for Multi-Year SST Reanalysis

2.4.5.8 CoastWatch Tailored Products

Reference 2.7.2 for Ocean Surface Salinity

2.4.5.9 Pass-Through Salinity Products

Reference 2.7.1 for Ocean Surface Salinity

2.4.5.10 Next-Generation Enterprise Ocean Heat Content Product Suite (Potential R2O next 5 years)

Algorithm Description: The Next-Generation Upper Ocean Heat Content is an enterprise algorithm under development, which provides vertically resolved, full water column heat content estimates to ~1500 m depth, including resolution of Mixed Layer Depth and Isotherm Depths. It is platform-agnostic and provides high resolution (~7 km) along an orbital path, as well as a higher resolution gridded replacement for the legacy product to meet the needs of current users. The orbital product has been requested by the NWS for AWIPS. The higher resolution gridded capability has been requested by CRW. The full water column depth has been requested by NMFS, via CoastWatch. NMFS Users have requested a multidecadal climatology and anomalies.Users (including users of the legacy OHC product): NOAA Coral Reef Watch (CRW), National Marine Fisheries Service (NMFS), Tropical Cyclone Centers: (NHC, JTWC), NWS - NCEP/EMC, NOAA CoastWatch/OceanWatch, OAR - Hurricane Research Division (HRD).

Table 2.4.5.10a: Next Gen Enterprise Ocean Heat Content - Product Suite Products Produced and NPB Connections

Product Category	Product Generated
Water Temperature and Salinity	Isotherm Depth (20C and 26C)
Water Temperature and Salinity	Ocean Mixed Layer Depth
Water Temperature and Salinity	Ocean Heat Content
Water Temperature and Salinity	*Salinity Stratification*

Table 2.4.5.10b: Next Gen Enterprise Ocean Heat Content Product Suite Flyout Chart[2]

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JASON-3 Poseidon-3B	10-day repeat									
Sentinel-3A SRAL	Early AM									
Sentinel-3B SRAL	Early AM									
SARAL AltiKa	35-day repeat									
CryoSat-2	High-Latitude									
Sentinel-6A MF AMR-C	10-day repeat									
Sentinel-6A MF DORIS	10-day repeat									
Sentinel-6A MF GNSS-POD	10-day repeat									
Sentinel-6A MF LRA	10-day repeat									
Sentinel-6A MF Poseidon-4	10-day repeat									
Sentinel-6B AMR-C	10-day repeat									
Sentinel-6B DORIS	10-day repeat									
Sentinel-6B GNSS-POD	10-day repeat									
Sentinel-6B LRA	10-day repeat									
Sentinel-6B Poseidon-4	10-day repeat									

[2] Current Next Generation Ocean Heat Content (OHC) project plan is under review. Once approved, the flyout chart will be updated with funded satellites. This flyout chart shows current OHC satellites/sensors.

2.5. Space Weather

2.5.1 Solar

2.5.1.1 Partner Coronagraph Data

Algorithm Description: Until a SWFO coronagraph becomes operational (estimated time: late 2024), NOAA relies on non-NOAA satellites and instruments to provide images of the solar corona, from which NOAA forecasters and scientists develop watches and warnings of space weather events, e.g., coronal mass ejections (CMEs) approaching Earth. Algorithms are applied to these images to derive CME speed and direction, and other high-level forecast products. Current coronagraph imagery is provided by the NASA LASCO instrument on the SOHO satellite, which is reaching the end of its useful life.

In the future, NOAA's planned replacement operational coronagraphs are the Compact Coronagraphs (CCORs) on SWFO-L1 (launch date: February 2025) and GOES-U (launch date: April 2024) (See Lagrange 1 Space Weather Algorithm Family).

Regarding partner-based observations, as part of possible observation gap mitigation and to explore how enhanced imagery affects forecast accuracy, the NASA PUNCH mission will provide coronal imagery products to NESDIS on an exploratory basis, which may become an operational product after initial analysis. ESA's Vigil mission (expected launch date: 2029), to be placed at the Sun-Earth Lagrange 5 (L5) point, will host a NOAA-provided CCOR-3 coronagraph nearly identical to the CCOR-2 to be carried on SWFO-L1. Following commissioning, operational coronagraph data are expected to flow in 2030 at the earliest. Solar Energetic Particles can cause Single Effect Upsets (SEU) to spacecraft computer systems.

It is expected that NESDIS will ingest and store partner-provided products instead of producing products within our systems.

Table 2.5.1.1a: Partner Coronagraph Data - Products Produced and NPB Connections

Product Category	Product Generated
Solar	Coronal Imagery

Table 2.5.1.1b: Partner Coronagraph Data Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
PUNCH NFI	Early AM									
SWFO-L1 CCOR	L1									
GOES-U CCOR	75.2W			X	X					

2.5.1.2 *Geostationary Space Weather Algorithm Family*

Reference 2.6.6 for Solar UV Imagery

2.5.1.3 *Geostationary Space Weather Algorithm Family*

Reference 2.6.6 for Solar UV Irradiances

2.5.1.4 *Geostationary Space Weather Algorithm Family*

Reference 2.6.6 for Solar X-ray Irradiances

2.5.2 Heliosphere

2.5.2.1 Lagrange 1 Space Weather Algorithm Family

Algorithm Description: The Lagrange 1 Space Weather Algorithm family includes the algorithms used to compute space weather products from the Deep Space Climate Observatory (DSCOVR) and Space Weather Follow On - Lagrange 1 (SWFO-L1) satellite suite of instruments, as well as NASA's Advanced Composition Explorer (ACE). The important measurements at the Sun-Earth Lagrange 1, approximately one million km upstream (towards the Sun) from Earth include direct, in situ, measurements of the plasma and particles (SWiPS & STIS) and magnetic field (MAG). They also include imaging of the solar corona using the CCOR coronagraphs, as mentioned in *2.5.1.1.*

Users: SWPC and operational receivers of SWPC forecasts/reports/data. Retrospective users include academia and industry.

Impacts: The products of this algorithm support identification of space weather events that can reduce the functionality of power grids. High-energy particle radiation in space can pose health risks to astronauts. Increases in solar X-ray and UV radiation can affect airline routing. Space-based events can produce charging of satellites and reduce their altitude if they are in LEO. Space weather events cause inefficiencies in GPS service, and in some cases may impact search and rescue events. They can cause impacts to

those systems that rely on GPS navigation. Solar Energetic Particles can cause Single Effect Upsets (SEU) to spacecraft computer systems.

Table 2.5.2.1a: Lagrange 1 Space Weather - Products Produced and NPB Connections

Product Category	Product Generated
Heliosphere	Suprathermal Particle Flux
Heliosphere	Heliospheric Vector Magnetic Field
Heliosphere	Solar Wind/Plasma Density
Heliosphere	Solar Wind/Plasma Velocity
Heliosphere	Solar Wind/Plasma Temperature

Table 2.5.2.1b: Lagrange -1 Space Weather Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
DSCOVR FC	L1									
DSCOVR MAG	L1									
SWFO-L1 CCOR	L1									
SWFO-L1 MAG	L1									
SWFO-L1 SWiPS	L1									

2.5.2.2 Partner Heliospheric Algorithm Family

Algorithm Description: The Partner Heliospheric Algorithm Family includes the algorithms used to identify space weather from our international and interagency partner satellite suite of instruments, such as NASA's Interstellar Mapping and Acceleration Probe (IMAP). IMAP will be a sun-tracking spin-stabilized satellite in orbit about the Sun–Earth L1 Lagrange point.

Table 2.5.2.2a: Partner Heliosphere - Products Produced and NPB Connections

Product Category	Product Generated
Heliosphere	Heliospheric Vector Magnetic Field
Heliosphere	Solar Wind/Plasma Density

Product Category	Product Generated
Heliosphere	Solar Wind/Plasma Velocity
Heliosphere	Solar Wind/Plasma Temperature

Table 2.5.2.2b: Partner Heliosphere Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
IMAP IMAP	L1									

2.5.3 Magnetosphere

2.5.3.1 Geomagnetic Model Algorithm Family

Algorithm Description: The Geomagnetic Model Algorithm Family produces several important models, including the World Magnetic Model and the High Definition Geomagnetic Model (HDGM).

The World Magnetic Model (WMM) is a spherical harmonics-based model of the Earth's magnetic field due to the mantle and core. It is jointly developed by the National Centers for Environmental Information (NCEI) and the British Geological Survey (BGS), and is a joint product of the United States National Geospatial-Intelligence Agency (NGA) and the United Kingdom's Defence Geographic Centre (DGC). The WMM is the standard model used by the U.S. and U.K. governments (and international organizations, e.g., the North Atlantic Treaty Organization and the International Hydrographic Organization) for navigation, attitude, and heading referencing systems. It is also used widely outside the government in navigation and heading systems.

The High Definition Geomagnetic Model (HDGM) is a global, high-resolution model of the Earth's geomagnetic main and crustal field, providing magnetic field values (total field, dip, and declination) at any point above or below the Earth's surface. The primary users of HDGM are the DoD and well planners who use HDGM to compute magnetic reference values at any point and easily integrate HDGM into their directional drilling software. HDGM is updated annually to correctly model secular changes in the geomagnetic field. HDGM is funded by and available to users through annual data sales.

Users: DoD, Private Industry, ships, aircraft and submarines, and smartphones for the general public.

Impacts: The products of this algorithm support identification of space weather events that can reduce the functionality of power grids. High-energy particle radiation in space can pose health risks to astronauts. Increases in solar X-ray and UV radiation can affect airline routing. Space-based events can produce charging of satellites and reduce their altitude if they are in LEO. Space weather events cause inefficiencies in GPS service, and in some cases may impact search and rescue events. They can cause impacts to those systems that rely on GPS navigation. Solar Energetic Particles can cause Single Effect Upsets (SEU) to spacecraft computer systems.

Table 2.5.3.1a: Geomagnetic Model Algorithm Family - Products Produced and NPB Connections

Product Category	Product Generated
Magnetosphere	World Magnetic Model
Magnetosphere	High-Definition Magnetic Model

Table 2.5.3.1b: Summary of Past and Current Sources for Geomagnetic Models

Time Frame	Satellites/Instruments
Historical	CHAMP, Oersted, Iridium, DMSP, Cryosat-2
Current	Swarm, Cryosat-2, INTERMAGNET, track line data, pre-compiled crustal field grids archived by NCEI

2.5.3.2 Low Earth Orbit (LEO) Space Weather Algorithm Family

Algorithm Description: NOAA and the MetOp-A, B, C series of satellites carry the Space Environment Monitor-2 (SEM-2) instruments. The LEO Space Weather Algorithm Family is used to produce both directional (nadir and 90° from nadir) and omnidirectional measurements. For directional measurements, protons are measured in 6 bands in the energy range 0.03-6.9 MeV, and electrons in four bands in the range 30-600 keV. For omni-directional measurements, proton energy in the ranges >16 MeV, >35 MeV, >70 MeV, and >140 MeV.

COSMIC-2 also measures ionospheric plasma parameters using its Ion Velocity Meter (IVM) instrument. The legacy Defense Meteorological Satellite Program (DMSP)

satellites are used for energetic plasma similar to NOAA and METOP SEM-2, bulk background plasma, and magnetic field. Similar particle and magnetic field measurements are taken in the heliosphere and the magnetosphere and captured in the Lagrange 1 Space Weather algorithm family.

Users: SWPC and operational receivers of SWPC forecasts/reports/data. Retrospective users include academia and industry.

Impacts: The products of this algorithm support identification of space weather events that can reduce the functionality of power grids. High-energy particle radiation in space can pose health risks to astronauts. Increases in solar X-ray and UV radiation can affect airline routing. Space-based events can produce charging of satellites and reduce their altitude if they are in LEO. Space weather events cause inefficiencies in GPS service, and in some cases may impact search and rescue events. They can cause impacts to those systems that rely on GPS navigation. Solar Energetic Particles can cause Single Effect Upsets (SEU) to spacecraft computer systems.

Table 2.5.3.2a: LEO Space Weather Algorithm Family - Products Produced and NPB Connections

Product Category	Product Generated
Ionosphere	Magnetospheric Vector Magnetic Field
Magnetosphere	Energetic Particle (electron, ion) spectra
Magnetosphere	Vector Magnetic Field Measurements

Table 2.5.3.2b: LEO Space Weather Algorithm Family Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
DMSP-F16 SSI/ES-3	Early AM									
DMSP-F16 SSJ5	Early AM									
DMSP-F16 SSM	Early AM									
DMSP-F17 SSI/ES-3	Early AM									
DMSP-F17 SSM	Early AM									
DMSP-F18 SSJ5	Early AM									
DMSP-F18 SSM	Early AM									
MetOp-B SEM/MEPED	Mid AM									
MetOp-B SEM/TED	Mid AM									
MetOp-C SEM/MEPED	Mid AM									
MetOp-C SEM/TED	Mid AM									
NOAA-18 SEM/MEPED	Early AM									
NOAA-18 SEM/TED	Early AM									
METOP-SG-A1 RO	Mid AM									
METOP-SG-A1 NGRM	Mid AM									
METOP-SG-B1 RO	Mid AM									
METOP-SG-B1 NGRM	Mid AM									

2.5.3.3 Geostationary Space Weather Algorithm Family

Ref 2.6.6 for Energetic Particle (electron, ion) Spectra

2.5.4 Ionosphere

2.5.4.1 Ionosphere Predictions and Models Algorithm Family

Algorithm Description: Solar X-ray flux and SEP events can dramatically impact HF radio communication and low frequency (LF) navigation systems. The one-minute GOES X-ray flux data and five-minute GOES proton flux data are used to drive the ionospheric D Region Absorption Predictions (D-RAP) model, which is used as guidance to understand the HF radio degradation and blackouts . D-RAP depicts the D-region at high latitudes, where it is driven by particles as well as low latitudes, where photons cause the prompt changes. NWS/SWPC operates the D-RAP model, archiving the output in NESDIS.

Users: This product merges all latitudes using appropriate displays and is helpful to customers from a broad base that includes emergency management, aviation, and maritime users.

Impacts: Space weather impacts radio communication in some ways. At frequencies in the 1 to 30 megaHertz range (known as “High Frequency” or HF radio), ionospheric density and structure changes modify the transmission path and even block the transmission of HF radio signals completely. These frequencies are used by amateur (ham) radio operators and many industries, such as commercial airlines. Several government agencies, such as the Federal Emergency Management Agency and the Department of Defense, also use them.

Table 2.5.4.1a: Ionosphere Predictions and Models Algorithm Family - Products Produced and NPB Connections

Product Category	Product Generated
Ionosphere	D Region Absorption Prediction

Table 2.5.4.1b: Ionosphere Predictions and Models Algorithm Family Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 EXIS	75.2W									
GOES-16 SEISS	75.2W									
GOES-17 EXIS	104.6W									
GOES-17 SEISS	104.6W									
GOES-18 EXIS	137W									
GOES-18 SEISS	137W									
GOES-U EXIS	75.2W			X	X					
GOES-U SEISS	75.2W			X	X					

2.5.4.2 GPSRO Space Weather Algorithm Family

Algorithm Description: GPSRO Space Weather instruments provide data arcs of total electron content and, through modeling, vertical profiles of electron density in the ionosphere to support space weather operations and research.

Total electron content can also be measured in other ways, such as ground-based ionosonde remote sensing instruments. NESDIS ingests and archives ionosonde data from external sources.

Users: SWPC and operational receivers of SWPC forecasts/reports/data.

Impacts: The products of this algorithm support identification of space weather events that can cause inefficiencies in GPS service, and in some cases may impact search and rescue events. They can cause impacts to those systems that rely on GPS navigation. These products area also important to understand space weather impacts on radio communications used by many industries, such as commercial airlines and government agencies, such as the Federal Emergency Management Agency and the Department of Defense for critical operations. Solar Energetic Particles can cause Single Effect Upsets (SEU) to spacecraft computer systems

Table 2.5.4.2a: GPSRO Space Weather Algorithm Family - Products Produced and NPB Connections

Product Category	Product Generated
Ionosphere	Total Electron Content
Ionosphere	Ionospheric Plasma Parameters (electron density profiles, scintillation, plasma drift, Rate of change Of TEC Index)

Table 2.5.4.2b: GPSRO Space Weather Algorithm Family Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
COSMIC-2 TGRS	Drifting									
Commercial RO	Drifting									

2.5.4.3 LEO Space Weather Algorithm Family

Ref *2.5.3.2* for Ionospheric Plasma Parameters

2.6. Integrated Algorithms Contributing to Multiple Categories

2.6.1 Enterprise Auto Snow - GMASI

Algorithm Description: The Global Multisensor Automated Snow and Ice mapping system (GMASI) uses the synergy of observations in the visible, infrared, and microwave spectral bands from operational polar-orbiting and geostationary satellites to generate daily global maps of snow and ice cover. The current version of the system incorporates data from the following satellite sensors: METOP-B/C AVHRR, GPM GMI, and GCOM-W1 AMSR2. This 2-km resolution analysis has a full global coverage on a 9000 x 18000 grid. The products are available in NetCDF and GRIB2 formats.

Users: DOD (US Navy - FNMOC), EUMETSAT, CMC, NCOF UK, JAXA, NWS (WFOs, NIC, NWC), NCEP (EMC), NASA (GPM), NESDIS STAR, NCEI CLASS.

Impacts: The blended Auto Snow product of this algorithm is ingested into the NWS data assimilation system, which feeds the global NWP model

Table 2.6.1a: GMASI - Products Produced and NPB Connections

Product Category	Product Generated
Snow and Glacier	Snow Cover
Lake and Sea Ice	Ice Extent

Table 2.6.1b: GMASI Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METImage	Mid AM									

2.6.2 Blended Biomass Burning Emissions Product Version 3 (GBBEPx v3)

Algorithm Description: The GBBEPx V3 system produces global biomass burning emissions (PM2.5, BC, CO, CO_2, OC, and SO_2). The product output also includes a fire

detection record in a Hazard Mapping System (HMS) format, a quality flag in biomass burning emissions, the spatial pattern of PM2.5 emissions, and statistical PM2.5 information at a continental scale. Biomass burning is linearly correlated to the total emitted fire radiative energy (Wooster, 2003). This is due to the fact that the energy content of dry biomass does not vary considerably across different ecosystems and fuel types (Chapin et al., 2002) and that the actual heat yield in a fire event is slightly influenced by environmental factors, including slope, fuel arrangement, and wind speed (Whelan, 1995). The total amount of energy released per unit mass of dry fuel fully burned ranges from 16 to 22 MJ/kg (Lobert and Warnatz, 1993; Whelan, 1995; Trollope et al., 1996; Wooster et al., 2005).

Users: NCEP, NOAA ARL, Universities

Impacts: Data assimilation for numerical weather prediction models that forecast air quality - it helps to define initial conditions, such as fire locations, how high is the aerosol loading being emitted, at what height is the plume injection, and the duration of the fire. Additionally, the products of this algorithm serve as inputs for global aerosol prediction models, such as the NGAC v2 aerosol model at NCEP (NGAC = NEMS [NOAA Environmental Modeling System] GFS Aerosol Component).

Table 2.6.2a: GBBEPx - Products Produced and NPB Connections

Product Category	Product Generated
Atmospheric Composition and Air Quality	Biomass Burning Emissions
Atmospheric Composition and Air Quality	Trace Gases Product Suite
Fires	Fire Detection and Characterization

Table 2.6.2b: GBBEPx Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									

2.6.3 HEAP

Algorithm Description: HEAP uses hyperspectral IR observations from a variety of satellite platforms and includes the NOAA Unique Combined Atmospheric Processing System (NUCAPS) to derive hyper-spectral radiance products, vertical profiles of temperature, WV, ozone, and six trace gas products (CO, CH_4, CO_2, Volcanic SO_2, HNO_3, and N_2O).

Users: NWS (includes AWIPS, NCEP), ECMWF, STAR, NCEP/CPC, DOD (NRL, FNMOC, 557th Airborne Weather Wing, NAVO), Data Acquisition Processing Exchange (DAPE), OSPO, CIRA, University of California Irvine (UCI), ESRL, EUMETSAT,

Japan Met Agency (JMA), Bureau of Meteorology (BOM), NASA GMAO, JCSDA (data assimilation), NESDIS NCEI, NESDIS Vis Lab, SSEC.

Impacts: The products of this algorithm support determining the vertical and horizontal extent of clouds, confirming NWP output, and determining atmospheric stability conditions. Model data assimilation is improved by using IR sounder radiances.

Table 2.6.3a: HEAP - Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Infrared Sounder Cloud Cleared Radiances
Sensor Data	Infrared Sounder Principal Components/Thinned Radiances
Atmospheric Temperature	Atmospheric Temperature Profiles
Atmospheric Temperature	Surface Pressure
Atmospheric Temperature	Stability Indices
Atmospheric Temperature	Lifted Index
Atmospheric Water Vapor	Atmospheric Water Vapor Profiles
Atmospheric Composition and Air Quality	Ozone Profiles
Atmospheric Composition and Air Quality	Trace Gases Product Suite
Radiation Budget	Outgoing Longwave Radiation

Table 2.6.3b: HEAP Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
JPSS-4 CrIS	PM									
MTG-S1 IRS	0									
MetOp-B IASI	Mid AM									
MetOp-C IASI	Mid AM									
MetOp-SG-A1 IASI-NG	Mid AM									
NOAA-20 CrIS	PM									
NOAA-21 CrIS	PM									
S-NPP CrIS	PM									

2.6.4 MIRS

Algorithm Description: MIRS is the retrieval platform for current and future passive microwave instruments on satellites and could be an exploratory algorithm for passive IR sensors on satellites. It is used operationally at NOAA with microwave sensors to produce numerous products. The product priorities vary from Critical (Priority 1) to Supplemental (Priority 4). The current version of MIRS also makes SnowFall Rate (for convenience, not related to the algorithm).

Users: NWS (WFOs, NHC, CPC, EMC), National Ice Center, NESDIS/OSPO/SAB, NCEI (Archive-CLASS), CIRA, JCSDA, JPL, NASA/GSFC, DOD (NRL, FNMOC, 557 WW), TCWC (Australia and New Zealand).

Impacts: The products of the MIRS algorithm are used in the operational HISA TC intensity estimation algorithm. Blended hydro products (TPW and LPW) also use moisture profiles. Precipitation rates are operationally used in the CMORPH algorithm. Products from both NOAA algorithms are widely distributed. For TCs, HISA outputs are used at NHC and in tracking and forecasting TCs in the Pacific Ocean. CMORPH estimates are used for climate applications and by forecasters, for example, the Alaska NWS forecast office. Improvement to MIRS retrievals will lead directly to improvements in these downstream products

Table 2.6.4a: MIRS - Products Produced and NPB Connections

Product Category	Product Generated
Sensor Data	Microwave Radiometer Brightness Temperatures
Imagery	Microwave Sounder Imagery
Atmospheric Water Vapor	Atmospheric Water Vapor Profiles
Atmospheric Water Vapor	Total Precipitable Water (TPW)
Atmospheric Temperature	Atmospheric Temperature Profile
Clouds	Cloud Liquid/Ice Water
Precipitation	Rain Rate
Radiation Budget	Surface Emissivity
Lake and Sea Ice	Sea Ice Concentration
Snow and Glacier	Snow Cover
Snow and Glacier	Snow Water Equivalent
Surface Temperature	Land Surface Temperature

Table 2.6.4b: MIRS Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
DMSP-F17 SSMIS	Early AM									
DMSP-F18 SSMIS	Early AM									
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
GPM Core GMI	Drifting									
JPSS-4 ATMS	PM									
MetOp-B AMSU-A	Mid AM									
MetOp-B MHS	Mid AM									
MetOp-C AMSU-A	Mid AM									
MetOp-C MHS	Mid AM									
MetOp-SG-A1 MWS	Mid AM									
MetOp-SG-B1 MWI	Mid AM									
NOAA-19 AMSU-A	Early AM									
NOAA-19 MHS	Early AM									
NOAA-20 ATMS	PM									
NOAA-21 ATMS	PM									
S-NPP ATMS	PM									
WSF-M	Sunsynchronus									

2.6.5 SAROPS

Algorithm Description: The SAROPS is a set of software programs that generate a variety of products from SAR imagery, such as ocean surface wind speed, ice extent and concentration determination, ice type and age, ice motions, ocean wave spectra, fire monitoring, flooding monitoring, vessel detection, marine debris, tropical cyclone wind speed and characterization, coastal mapping, icebergs tracking, and oil spill detection and classification. SAR Winds was the first product within the SAROPS system and produces images of wind speed over the ocean surface from the NRCS of spaceborne SAR imagery. The baseline wind speed product has led to development of other operational and moderate assurance products for ice extent, wave spectra, ice motion, flooding, marine pollution, and tropical cyclone products. Further development of SAR products will continue and products will be brought forward when ready to transition to operations.

Users: NWS WFOs, NIC, NESDIS/OSPO/SAB, NHC, OPC, JTWC, NWC, and NOAA CoastWatch.

Impacts: SAROPS outputs improve tropical cyclone position and intensity forecasting, coastline wind and waves monitoring, offshore wind monitoring and climatological assessment, integrated weather forecasting, Blue Economy applications, tracking HAB and marine oil events, monitoring active fires, mapping burned area for hydrologic landslides, and ice forecasting.

Table 2.6.5a: SAROPS - Products Produced and NPB Connections

Product Category	Product Generated
Imagery	SAR Imagery
Winds	Ocean Surface Wind
Ocean, Freshwater and Coasts	Oil Spills and Marine Debris Detection
Surface Height	Significant Wave Height
Lake and Sea Ice	Ice Thickness
Lake and Sea Ice	Ice Age
Lake and Sea Ice	Sea Ice Motion
Tropical Cyclone Characteristics	Tropical Cyclone Surface Wind
Fire	*Burned Area*
Marine Oil/Surfactant	*Marine Oil/Surfactant*

Italics = Not currently in the NESDIS Product Baseline

Table 2.6.5b: SAROPS Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
NISAR SAR-L	Early AM									
NISAR SAR-S	Early AM									
RADARSAT-2 SAR	Early AM									
RCM-1/2/3/4	Early AM									
Sentinel-1A SARC	Early AM									
Sentinel-1C SARC	Early AM									
Sentinel-1D SARC	Early AM									

2.6.6 Geostationary Space Weather Algorithm Family

Algorithm Description: The Geostationary Space Weather Algorithm Family comprises the algorithms that use the GOES-R Series suite of instruments to detect approaching space weather hazards. Two Sun-pointing instruments measure solar ultraviolet light and X-rays. The Solar Ultraviolet Imager (SUVI) observes and characterizes complex active regions of the sun, solar flares, and eruptions of solar plasma which give rise to CMEs. The Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS) detect solar flares and monitor solar irradiance that impacts the upper atmosphere. The satellites also carry instruments that measure their space environment. The Space Environment In situ Suite (SEISS) comprises four sensors that monitor proton, electron, and heavy ion fluxes in the magnetosphere. The SEISS instrument suite consists of the Energetic Heavy Ion Sensor, the Magnetospheric Particle Sensors - High and Low, and the Solar and Galactic Proton Sensor. Though located within the magnetosphere, the highest energy particles at this location are nonetheless indicative of the solar and galactic particle populations. The solar energetic particle data from SEISS drive the solar radiation storm portion of NOAA space weather scales and other alerts and warnings and improve energetic particle forecasts. The Magnetometer measures the magnetic field near the equatorial plane of the magnetosphere. In addition, there will be the CCOR instrument on GOES-U to observe the Sun’s corona to detect CMEs. Coronagraph data will help NOAA provide watches and warnings for space weather events that can disrupt the electrical power grid and communications systems as well as navigation and timing systems like the GPS. Similar particle and magnetic field measurements are taken in the heliosphere and the magnetosphere, but have generally different applications and priorities, and are also captured in the Lagrange 1 Space Weather algorithm family.

Users: SWPC and operational receivers of SWPC forecasts/reports/data

Impacts: The products of this algorithm support identification of space weather events can cripple power grids, radiation in space can pose health risks to astronauts, increase in solar radiation can affect airline routing, space-based events can damage satellites and disrupt orbits, cause interruptions in GPS service, impact search and rescue events, alter the Earth's magnetic field and affect non-GPS navigation, and cause impacts to those systems that rely on GPS navigation.

Table 2.6.6a: GOES Space Weather - Products Produced and NPB Connections

Product Category	Product Generated
Heliosphere	Solar Energetic Particle
Heliosphere	Vector Magnetic Field Measurements
Heliosphere	Solar and Galactic Energetic Protons
Magnetosphere	Magnetic Field Measurements
Magnetosphere	Energetic Particle (electron, ion) spectra
Solar	Coronal Imagery
Solar	Solar UV Irradiance
Solar	Solar X-Ray Irradiance
Solar	Solar UV Imagery

Table 2.6.6b: GOES Space Weather Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GOES-16 EXIS	75.2W									
GOES-16 SEISS	75.2W									
GOES-16 SEM MAG	75.2W									
GOES-16 SUVI	75.2W									
GOES-17 EXIS	104.6W									
GOES-17 SEISS	104.6W									
GOES-17 SEM MAG	104.6W									
GOES-17 SUVI	104.6W									
GOES-18 EXIS	137W									
GOES-18 SEISS	137W									
GOES-18 SEM MAG	137W									
GOES-18 SUVI	137W									
GOES-U CCOR	75.2W			X	X					
GOES-U EXIS	75.2W			X	X					
GOES-U SEISS	75.2W			X	X					
GOES-U SEM MAG	75.2W			X	X					
GOES-U SUVI	75.2W			X	X					

2.6.7 RADS

Algorithm Description: LSA RADS is the Enterprise system for the generation of both operational and delayed-mode (climate quality) L2 products jointly developed and maintained by NOAA/STAR and EUMETSAT. It is currently used to produce a consistent line of harmonized SSH, Significant Wave, and Ocean Surface winds products from all altimetry missions ever flown, and is one of the official cal/val platform for NOAA and EUMETSAT in the 4-partner Jason-3 Cal/Val Plan and Sentinel-6/Jason-CS. The RADS suite of products includes: 1) operational along-track Sea Level Anomaly, Absolute Dynamic Topography, Significant Wave Height, and Ocean Surface Wind Speed L2P products and 2) gridded multi-mission (L4) SLA, and geostrophic ocean surface currents distributed through CoastWatch. RADS produces operational (2-5 hour latency), interim (2-3 day latency) and climate quality (1-3 month latency) products. Planned for 2022 are gridded Eddy Kinetic Energy and Absolute Ocean Surface Currents.

RADS analysis tools and the database are provided as a product/service as open-source software from STAR.

Users: OPC, NWS (NCEP, EMC), NOS (WCOFS), NOAA CoastWatch/OceanWatch

Impacts: Order of magnitude increased spatial resolution over the baseline Sentinel-6/Jason-CS operational products. It will allow OPC and other operational users to resolve sub-km significant wave heights for navigation and forecast warnings not available from current altimetry products or forecast models (WaveWatch III), right up to the coastline.

Table 2.6.7a: RADS - Products Produced and NPB Connections

Product Category	Product Generated
Surface Height	Sea Surface Height
Surface Height	Significant Wave Height
Surface Height	Absolute Dynamic Topography
Surface Height	Delayed Mode Mean Sea Level Height (Proposed Baseline)
Winds	Ocean Surface Wind
Time Series	Multiyear Mean Sea Level Height
Time Series	Multiyear Altimetry (sea level anomalies, eddies, wave heights, etc.)

Table 2.6.7b: RADS-Altimeter Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
CRISTAL AMR-C	Drifting 92deg									
CRISTAL GNSS-POD	Drifting 92deg									
CRISTAL IRIS	Drifting 92deg									
CRISTAL LRR	Drifting 92deg									
ICESat-2 ATLAS	Drifting									
ICESat-2 TRSR	Drifting									
JASON-3 AMR	10-day repeat									
JASON-3 DORIS	10-day repeat									
JASON-3 GPSP	10-day repeat									
JASON-3 LRA	10-day repeat									
JASON-3 Poseidon-3B	10-day repeat									
SWOT Altimeter	21-day repeat									
SWOT GPSP	21-day repeat									
SWOT KaRIN	21-day repeat									
SWOT MW Radiometer	21-day repeat									
Sentinel-3A DORIS	Early AM									
Sentinel-3A GNSS-POD	Early AM									
Sentinel-3A LRR	Early AM									
Sentinel-3A MWR	Early AM									
Sentinel-3A SRAL	Early AM									

Sentinel-3B DORIS	Early AM									
Sentinel-3B GNSS-POD	Early AM									
Sentinel-3B LRR	Early AM									
Sentinel-3B MWR	Early AM									
Sentinel-3B SRAL	Early AM									
Sentinel-3C DORIS	Early AM									
Sentinel-3C GNSS-POD	Early AM									
Sentinel-3C LRR	Early AM									
Sentinel-3C MWR	Early AM									
Sentinel-3C SRAL	Early AM									
Sentinel-3D DORIS	Early AM									
Sentinel-3D GNSS-POD	Early AM									
Sentinel-3D LRR	Early AM									
Sentinel-3D MWR	Early AM									
Sentinel-3D SRAL	Early AM									
Sentinel-6A MF AMR-C	10-day repeat									
Sentinel-6A MF DORIS	10-day repeat									
Sentinel-6A MF GNSS-POD	10-day repeat									
Sentinel-6A MF LRA	10-day repeat									

Sentinel-6A MF Poseidon-4	10-day repeat									
Sentinel-6B AMR-C	10-day repeat									
Sentinel-6B DORIS	10-day repeat									
Sentinel-6B GNSS-POD	10-day repeat									
Sentinel-6B LRA	10-day repeat									
Sentinel-6B Poseidon-4	10-day repeat									
CryoSat-2	High-Latitude									

2.6.8 NOAA SAR-Altimetry Processor

Algorithm Description: The SAR-Altimeter Processor Sea Ice Thickness algorithm uses enhanced SAR processing, via the SAR-Altimeter Processor, to produce radar altimeter-based estimates of sea ice thickness. The SAR-Altimeter Processor, developed at STAR, implements focusing SAR algorithms to dramatically increase (~50x) the spatial resolution of sea ice altimetry measurements. A physical-based model helps account for ice properties in radar returns from sea ice surfaces for more accurate estimates of surface elevation. Using these enhanced capabilities, along with ancillary near-real time sea ice concentration, ice-type, and snow depth products, the algorithm has the potential for more reliable and accurate estimates of sea ice thickness enabled through a robust physical model and improved measurement of small sea ice leads, while not being affected by cloud-cover. A sea ice thickness product line is under development with CryoSat-2 data streams. This product line will be sustained as a long-term time series with data from the Sentinel-6/Jason-CS, Sentinel-3, and the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) missions.

Users: NWS/NCEP, WFOs, NIC, ASIP, NMFS, FNMOC, OAR

Impacts: Provides enhanced information for sea ice forecasting, modeling, and ice charting for navigation and safety at sea. Monitoring sea ice thickness is fundamental to polar coastal communities and fisheries that rely on accurate and regular environmental situational awareness. Assimilating sea ice thickness into NWS models has broad-reaching impacts, extending beyond polar regions. Reliable sea ice modeling

has an amplified influence on atmospheric and oceanic modeling and forecasting, with the potential to improve forecasts at latitudes below the Arctic.

Table 2.6.8a: NOAA SAR Altimeter - Products Produced and NPB Connections

Product Category	Product Generated
Surface Height	Sea Surface Height
Surface Height	Significant Wave Height
Winds	Ocean Surface Wind
Lake and Sea Ice	Ice Thickness

Table 2.6.8b: NOAA SAR-Altimeter Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
CRISTAL AMR-C	Drifting 92deg									
CRISTAL GNSS-POD	Drifting 92deg									
CRISTAL IRIS	Drifting 92deg									
CRISTAL LRR	Drifting 92deg									
Sentinel-3A DORIS	Early AM									
Sentinel-3A GNSS-POD	Early AM									
Sentinel-3A LRR	Early AM									
Sentinel-3A MWR	Early AM									
Sentinel-3A SRAL	Early AM									
Sentinel-3B DORIS	Early AM									
Sentinel-3B GNSS-POD	Early AM									
Sentinel-3B LRR	Early AM									
Sentinel-3B MWR	Early AM									
Sentinel-3B SRAL	Early AM									
Sentinel-3C DORIS	Early AM									
Sentinel-3C GNSS-POD	Early AM									
Sentinel-3C LRR	Early AM									
Sentinel-3C MWR	Early AM									

Sentinel-3C SRAL	Early AM									
Sentinel-3D DORIS	Early AM									
Sentinel-3D GNSS-POD	Early AM									
Sentinel-3D LRR	Early AM									
Sentinel-3D MWR	Early AM									
Sentinel-3D SRAL	Early AM									
Sentinel-6A MF AMR-C	10-day repeat									
Sentinel-6A MF DORIS	10-day repeat									
Sentinel-6A MF GNSS-POD	10-day repeat									
Sentinel-6B AMR-C	10-day repeat									
Sentinel-6B DORIS	10-day repeat									
Sentinel-6B GNSS-POD	10-day repeat									
Sentinel-6B LRA	10-day repeat									
CryoSat-2	High-Latitude									

2.7 Pass-through and Tailored Products

2.7.1 Pass-through Products

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Table 2.7.1: Pass-through Products

Product Name	Product Category	Products	Data Source(s)
SAR SM and Vegetation	Surface Moisture	Soil Moisture	NISAR SAR, ALOS-4 PALSAR-3 (SAR Phased Array)
	Vegetation	Vegetation Indices (NDVI, EVI, etc.)	
Pass-through from EUMETSAT	Biology and Biochemistry	Chlorophyll-a	OLCI Sentinel 3 series
		Water Diffuse Attenuation	
		Normalized Water-leaving Radiance (Reflectance)	
	Imagery	VIS/IR Imagery	EPS-SG A1, METOP-B/C
	Atmospheric Composition and Air Quality	Aerosol Optical Depth and Thickness	EPS-SG A1 3MI and Sentinel-5 under exploration
		Aerosol Detection	METOP SG
		Trace Gases Product Suite	
GPSRO Temperature Profiles	Atmospheric Water Vapor	Atmospheric Water Vapor Profiles	KOMPSAT-5 AOPOD SEOSAR/Paz ROHPP TerraSAR-NeXt Gen (DLR) METOP-B GRAS METOP-C GRAS

			METOP-SG-A1 RO METOP-SG-B1 RO COSMIC-2 Tri-GNSS Commercial RO Sentinel-6_MF GNSS-RO
Atmospheric Winds	Winds	Atmospheric Winds	Himawari 9
NGFS	Fires	Fire Detection and Characterization	Sentinel 3 series
Hazard Mapping System	Fires	Fire and Smoke Analysis	METOP SG, Sentinel 2 series
CoastWatch/Ocean Watch	Water Temperature and Salinity	Ocean Surface Salinity	SMOS, SMAP
ASCAT Soil Moisture	Surface Moisture	Soil Moisture	METOP
AOD/ADP	Atmospheric Composition and Air Quality	Aerosol Optical Depth/Aerosol Detection	PACE

2.7.2 CoastWatch Tailored Products

Description: CoastWatch provides tailored products that serve communities based upon data available to meet their needs – This includes products “passed through”CoastWatch services and products that undergo customization to meet user requirements such as L3 composites generated from L2, generated from non-NOAA sources, or products generated by CoastWatch regional nodes and managed at CoastWatch Central (NESDIS/STAR)). Distributed products are included in data.noaa.gov catalog

Passthrough: NOAA CoastWatch relays Level-1/-2 data to various NRT and Science Quality users. Data may come from various sources (OSPO, STAR Science Teams, other Satellite Providers) but are not modified from the original source file. Some of these products are distributed with CoastWatch 'Moderate Assurance' service and

CoastWatch discovery applications to facilitate user subsetting of datasets for specific place and time.

Users: NOAA NOS (CO-OPS, NCCOS), NOAA NMFS, NOAA OAR (GLERL, AOML), NOAA NWS (NCEP, EMC, OPS, SDM, PBM), NESDIS/OSPO, US Navy (NAVOCEANO, NRL), National Ice Center, USCG, University of Wisconsin (SSEC/CIMMS), NASA JPL, Academia, Commercial, General Public

Tailored Products: Products may be obtained from OSPO, STAR Science teams, or generated within CoastWatch to support NOAA missions by providing access to individual and aggregated datasets. Temporal aggregated datasets allow for monitoring and research to be conducted by NOAA Oceans, Fisheries, and Research. Products may meet user projection or formatting requirements. Typical products include: Ocean Color (full resolution, 4km, 9km, NRT and Science Quality; Global, CONUS), Chlorophyll Anomaly (difference, ratio), VIIRS 'co-gridded' surface reflectance, color producing agents (CPA), Copernicus Sentinel-3 OLCI reflectance/chlorophyll, Copernicus Sentinel-2 MSI chlorophyll/true color, L2 and L3 NOAA CoastWatch Composites for VIIRS Sea Ice Extent and multiyear ocean surface salinity, and OLCI L3 ocean color products tailored using passthrough L2 ocean color products as input.

Managed Products: Seascape time series, Sargassum monitoring and bulletins, Vibrio risk – daily, Vibrio risk weekly cumulative risk (mean and maximum), Vibrio risk daily forecast, C-HARMS, Sardine Potential Habitat, Estuary monitoring for EPA, and TurtleWatch.

Table 2.7.2a: CoastWatch - Tailored Products Produced and NPB Connections

Product Category	Product Generated
Lake and Sea Ice	Ice Thickness
Lake and Sea Ice	Ice Extent
Lake and Sea Ice	Ice Surface Temperature
Lake and Sea Ice	*Sea Ice Concentrate (daily and 4 days composites)*
Water Temperature and Salinity	Ocean Surface Salinity
Winds	*Global Vector Winds*
Winds	*SAR Winds*

Italics = Not currently in the NESDIS Product Baseline

Table 2.7.2b: CoastWatch Tailored Product Flyout

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
GCOM-W AMSR2	PM									
GOSAT-GW AMSR3	PM									
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
SMAP SMAP	Early AM									
SMOS GPS	Early AM									
SMOS MIRAS	Early AM									
SMOS STA	Early AM									
Sentinel-1A	Early AM									
RADARSAT-2	Early AM									
RCM 1/2/3	Early AM									
METOP-B ASCAT	Mid AM									
METOP-C ASCAT	Mid AM									
METOP-SG-B1 SCA	Mid AM									
OceanSat-3 OSCAT	Noon									

3. Analytical Products

3.1 Weather

3.1.1 Automated Severe Weather Analyses and Nowcasts

3.1.1.1 ProbSevere

Current Status: Operational at NWS/NCEP (continuity) with continued innovations to support evolving needs. Accurate and timely severe weather warnings are critical for protecting life and property. In severe weather warning operations, quick decisions must be made, which limits the amount of data that NWS forecasters can manually interrogate, particularly when many storms are present. As outlined in the Science and Technology Plan of the NWS Weather-Ready Nation Roadmap, the development of data fusion techniques is critical for distilling the “fire hose” of data into the timely, actionable, information needed to make quick operational decisions. In an effort to support severe weather warning operations through data fusion, the ProbSevere model was developed. ProbSevere combines data from high-resolution numerical weather prediction models, geostationary satellites, ground-based radar networks, and ground-

based lightning detection arrays to determine which developing thunderstorms are most likely to produce different severe weather hazards (e.g. wind, hail, tornado). The ProbSevere products are designed to directly support decision-making through the provision of human-like insights (e.g. artificial intelligence). ProbSevere v2 is operational at NCEP Central Operations and provided to NWS forecasters via AWIPS. Additional ProbSevere capabilities are under development.

Table 3.1.1.1a: ProbSevere Baseline Products Produced

Product Category	Product Generated
Analytical - Weather	Automated Severe Weather Analyses and Nowcasts

Table 3.1.1.1b: ProbSevere Current/Historical Sources, Types of Data Required, and Inputs

Category	Description
Current/Historical Sources	GOES-16 ABI and GLM, GOES-17 ABI and GLM, GOES-18 ABI and GLM, NEXRAD (via the Multi-Radar Multi-Sensor system) and Earth Networks Total Lightning
Types of Data Required	Geostationary satellites, ground-based radar networks, and ground-based lightning detection arrays, high-resolution model data
Used as inputs for	NCEP Central Operations provides ProbSevere to NWS forecasters via AWIPS.

3.1.2 Freeze/Thaw

Reference Atmospheric Temperature Regional Climate for Freeze/Thaw index.

3.1.3 Global Hazards Monitoring Report

3.1.3.1 Climate Reports and Assessments

NESDIS' climate reports and assessments portfolio encompasses over 13 analytical reports, incorporating over 450 contributors from more than 60 countries. These reports cover a wide range of climate across the globe including the state of sea ice and snow cover extent, climate conditions and impacts across the United States. It emphasizes regional and sub-regional temperature and precipitation patterns, monitoring departure from normal, unusualness, and trends, atmospheric drivers and teleconnections that influence monthly and seasonal climate outcomes in the United States. Additionally, reports in this category include highlighting tornadic behavior across the United States, with a particular focus on regional and sub-regional patterns and monitoring departures from normal and trends and the NOAA U.S. Billion-dollar disaster reports assess the total direct losses from various weather and climate disasters, including tropical cyclones, floods, droughts, heatwaves, severe local storms, wildfires, crop freeze events, and winter storms.

From a national perspective, the NCA report serves as the official U.S. Government's "state of the Union" on climate change. It integrates scientific information from multiple sources, establishes consistent evaluation methods, and informs the nation about observed changes, current climate status, anticipated trends, and impacts. Last but not least, on a global scale, NESDIS contributes to the WMO Annual Report which incorporates data and contributions from national meteorological and hydrological services, research institutions, and other relevant organizations. It provides updates on the state of the climate system, highlighting key climate indicators and their implications. NESDIS also contributes to the Global Analysis Report which is a detailed analysis that describes the global temperature anomalies over land and ocean surfaces and station-based precipitation for the given month.

Table 3.1.3.1a: Weather Climate Reports and Assessments Products Produced

Product Category	Product Generated
Climate	Bulletin of American Meteorological Society State of the Climate
Climate	Monthly State of Climate: Global Snow and Ice Report
Climate	Monthly State of Climate: National Overview
Climate	Monthly State of Climate: National Snow and Ice
Climate	Monthly State of Climate: Synoptic Discussion
Climate	Monthly State of Climate: Tornadoes
Climate	Monthly State of Climate: Tropical Cyclone
Climate	Societal Impacts: Billion Dollar Disasters
Climate	Monthly State of Climate: Upper Air Temperature Report
Climate	National Climate Assessment (NCA)
Climate	U.S. Global Change Research Program Indicators Suite
Climate	WMO Annual Statement
Climate	Monthly State of Climate: Global Analysis Report
Weather	Monitoring, US, Monthly State of Climate: Drought
Weather	Global Hazards Monitoring Report

Table 3.1.3.1b: Weather Climate Reports and Assessments Current/Historical Sources, Types of data Required, and Used as Inputs For

Category	Description
Current/Historical Sources	Expertise and input from hundreds of national and international authors, distilled reports and information from numerous US and foreign data sources, NSIDC, Rutgers University, regional climate center reports, US Drought Monitor, National Weather Service U.S. percent of snow coverage, Rutgers Snow Cover Extent, Great Lakes Environmental Research Lab, Data and graphics prepared by other federal agencies, Storm Prediction Center number of tornadoes and tornado-related fatalities, NWS WFO post event analysis, Climate Monitoring Reports, other environmental data, and other proprietary information from businesses and industry, Mean Layer Temperature - RSS CDR, Mean Layer Temperature - UAH CDR, Mean Layer Temperature - NOAA CDR, NOAA-19, NOAA-20, and Climate Data Records for Essential Climate Variables. **In situ Sources:** ● In situ and satellite data from US and foreign partners ● nclimdiv ● nclimgrid ● USDA Mountain Snowpack totals ● GHCN-Daily ● GHCN-Monthly ● IBTrACS hurricane tracks ● NOAAGlobalTemp

Types of Data Required	Regional Climate Center Reports, US Drought Reports, National Weather Service U.S. percent of snow coverage, Rutgers Snow Cover Extent, Great Lakes Environmental Research Lab, Multiple NCEI datasets, and data and graphics prepared by other federal agencies, Storm Prediction Center reports and National Weather Service WFO post event analysis, Remotely Sensed CDR Data, Remote Sensing Systems (RSS), University of Alabama - Huntsville (UAH), NOAA NESDIS / STAR CDRs, Authorship, Sea Surface Temperature and input from hundreds of authors, Various datasets needed to produce each indicator **In situ Sources:** ● Surface Weather Observations ● USDA Mountain Snowpack totals ● Numerous public and private data sources and in situ data ● Buoy Data
Used as inputs for	NCA, IPCC, and WMO Annual Statement

3.1.4 Land Surface Data Sets/Publication Products, Storm Data

3.1.4.1 Extreme Storms

The Extreme Storms analytical products include tornado climatology reports. These provide statistics ("normals") for tornado activity in the United States, broken down by region, hour and date. It also includes Storm Data, these contain a chronological listing, by states, of storm occurrences and unusual weather phenomena. Reports contain information on storm paths, deaths, injuries, and property damage. This provides an access mechanism for NWS Storm Data.

Table 3.1.4.1a: Extreme Storms Baseline Products Produced

Product Category	Product Generated
Climate	Tornado Climatology
Weather	Land Surface Data Sets / Publication Products, Storm Data

Table 3.1.4.1b: Extreme Storms Current/Historical Sources, Types of Data Required, and Inputs

Category	Description
Current/ Historical Sources	Storm Data, NWS Spotter Reports, Storm Prediction Center number of tornadoes and tornado-related fatalities, National Weather Service WFO post event analysis. NWS Spotter Networks, 911 Call Center, Airplane Pilot, Amateur Radio, ASOS, AWOS, AWSS, Broadcast Media, Buoy, C-MAN Station, Coast Guard, CoCoRaHS, COOP Observer, County Official, Department of Highways, Drought Monitor, Emergency Manager, Fire Department/Rescue, Insurance Company, Law Enforcement, Lifeguard, Local Official, Mariner, Mesonet, Newspaper, NWS Employee, NWS Storm Survey, Official NWS Observations, Other Federal Agency, Park/Forest Service, Post Office, Public, RAWS, River/Stream Gage, SHAVE Project, SNOTEL, Social Media, State Official, Storm Chaser, Trained Spotter, Tribal Official, Utility Company, and WLON. **In situ Sources:** ● NWS Cooperative Observer and Spotter Networks ● NEXRAD ● GHCN-D ● HOMR

Types of Data Required	Storm Events Database, Storm Prediction Center Data; 911 Call Center, Airplane Pilot, Amateur Radio, ASOS, AWOS, AWSS, Broadcast Media, C-MAN Station, Coast Guard, County Official, Department of Highways, Drought Monitor, Emergency Manager, Fire Department/Rescue, Insurance Company, Law Enforcement, Lifeguard, Local Official, Mariner, Mesonet, Newspaper, NWS Employee, NWS Storm Survey, Official NWS Observations, Other Federal Agency, Park/Forest Service, Post Office, Public, RAWS, River/Stream Gage, SHAVE Project, SNOTEL, Social Media, State Official, Storm Chaser, Trained Spotter, Tribal Official, Utility Company, and WLON. **In situ Sources:** ● CoCoRaHS COOP Observer NEXRAD NWS Cooperative Observer and Spotter Networks Buoy Data
Used as inputs for	This climatology provides a historical perspective of tornado activity across the U.S. and can be used for comparison to recent tornadoes by Media, K-12 education, academia, NOAA, Federal Agencies, State Agencies, State Climatologists, Regional Climate Centers. Legal, Insurance, Reinsurance, Agriculture, Media, K-12 education, academia, NOAA, Federal Agencies, Emergency management/disaster preparedness.

3.1.5 Marine Pollution Analysis

3.1.5.1 Satellite Analysis Branch Family

The Satellite Analysis Branch products include the manual (augmented by algorithms) analysis of location of oil spills and marine debris. Outputs include JPG, PDF, KMZ, compressed directory, MPSR text file, shapefiles, ArcGIS layer package files, and ArcGIS layer files. SAB also includes manual analysis of satellite and other data to produce Volcanic Ash Advisory (VAA) in text format and Digital format (XML and Volcanic Ash Graphic (VAG) in PNG, JPG and KML. Methane emissions analysis and imagery is an emerging area, potentially contributing to climate analytical products. A couple of other products, which are not related to marine pollution, e..g., (illegal) vessel

detection and whale detection, are conducted as ad hoc requests from NESDIS and NOAA and non-NOAA government agencies.

Table 3.1.5.1a: Satellite Analysis Branch Family Products Produced

Product Category	Product Generated
Oceans, Freshwater and Coasts	Marine Pollution Analysis
Weather	Volcanic Hazards

Table 3.1.5.1b: Satellite Analysis Branch Family Current/Historical Sources, Types of Data Required, and Inputs

Category	Description
Current/Historical Sources	Planet Labs (PlanetScope SkySat and Tanager), Aqua MODIS Carbonmapper (NGO), DESIS (ISS), EnMAP (DLR) Formosat-5, GHGSat, GOES-East (16), GOES-West (18) GOSAT-GW, Himawari-9 AHI, ICEYE SAR, Landsat-8 (USGS)-OLI +TIRS+", Landsat-9, Meteosat-9, Meteosat-10 Meteosat-11, Methanesat, NOAA-20 VIIRS, NOAA-21 VIIRS Orbital Sidekick, Pixxel, PredaSAR, PRISMA, Satellogic CosmoSkyMed (SAR-2000), Tandem-X, TerraSAR-X, SNPP VIIRS, TERRA MODIS, Sentinel 5P, Sentinel 1A, Sentinel 2A Sentinel 2B, Sentinel 3, UMBRA, MAXAR Worldview-2 MAXAR Worldview-3
Types of Data Required	Broad variety of imagery and ancillary datasets; Visible, Infrared, RGB Imagery (True Color, Ash, SO_2, Dust, Nighttime Microphysics RGBs), PCI imagery, Multi-spectral Imagery, GHGSat, Bluefield, satellites need to have "glint mode" capabilities to circumvent problems with over water SWIR detection. High and fairly high resolution optical satellites for a variety of event-driven satellite analysis functions including marine debris, oil spills, fires, etc., Hyperspectral imagery for a variety of satellite analysis functions including marine debris, oil spills, fires, etc.

Used as inputs for	Monitoring and reporting of marine pollutions events mainly within the US economic exclusion zone, by entities including BOEMRE and BSEE, NOS, USCG, DOJ, DOI, EPA, state officials, public; International Civil Aviation Organization documents reference VAAC's existence and its AOI boundaries, Airlines and FAA and international counterparts of the FAA use to avoid planes flying into volcanic ash; NWS uses as heads up for possible SIGMET issuance. Other users include GTS Users, Internet, ListServ, Social Media for NCEP, NPPU, NWS/Alaska Region, USGS Collaborative effort with Dept of Interior and others to mitigate methane emissions from oil/natural gas infrastructure in GOM (Gulf of Mexico). Users within the Dept of Interior include Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement.

3.1.6 Monitoring, US, Monthly State of Climate: Drought
Reference Climate Reports and Assessments

3.1.7 Regional Winter Weather
Reference Atmospheric Temperature Regional Climate

3.1.8 Tropical Weather and Impacts
Reference Atmospheric Temperature Regional Climate

3.1.9 Volcanic Ash Advisory Database

3.1.9.1 Marine Modeling and Coastal Hazards

Marine Modeling and Coastal Hazards includes the Volcanic Ash Advisory (VAA) Database, which contains VAA messages, VAFTAD model output, and substantiating information from 1983 to 2003, that have been scanned into image format.

Table 3.1.9.1a: Marine Modeling and Coastal Hazards Products Produced

Product Category	Product Generated
Weather	Volcanic Ash Advisory Database

Table 3.1.9.1b: Marine Modeling and Coastal Hazards Current/Historical Sources, Types of Data Required, and Inputs

Category	Description
Current/Historical Sources	Volcanic ash advisory messages, Volcanic Ash Forecast, Transport and Dispersion model outputs and related substantiating information
Types of Data Required	N/A - Static Dataset
Used as inputs for	Researchers and Volcanic Ash Advisory Centers use this product to refine Volcanic Ash Forecast Transport and Dispersion (VAFTAD) models

3.1.10 Volcanic Hazard

Reference Satellite Analysis Branch Family

3.1.11 Wildfire Monitoring

3.1.11.1 Climate Monitoring Products

Climate Monitoring Products provide regularly updated information for wildfires, wind and climate. NCEI maintains a suite of monitoring services that track key climate indicators using objective methods to provide historical context for current environmental conditions. Climate Monitoring services supply detailed information about temperature and precipitation, snow and ice, drought and wildfire, storms and wind, and weather patterns. NCEI Monthly Climate Reports summarize recent conditions and events, with an emphasis on providing historical context. The reports are part of the suite of climate services NOAA provides to government, business, academia, and the public to support informed decision-making.

3.1.11.1a: Climate Monitoring Products Produced

Product Category	Product Generated
Weather	Wildfire Monitoring
Climate	Climate at a Glance
Climate	Wind Climatology and Monitoring
Climate	Monthly State of Climate: Wildfire

Table 3.1.11.1b: Climate Monitoring Products Current/Historical Sources, Types of Data Required, and Inputs

Category	Description
Current/ Historical Sources	National Interagency Fire Coordination Center (NIFC) data; NCEP/CPC Wind Products. **In situ Sources:** ● nClimGrid ● nClimDiv ● GSOM ● GHCN-Daily ● GHCN-Monthly ● ICOADS ● Monthly Palmer Indices
Types of Data Required	NIFC Products, Drought Data, and North American Regional Reanalysis (NARR). **In situ Sources:** ● Surface Weather Observations ● Buoy Data
Used as inputs for	NOAA Objective: Improved scientific understanding of the changing climate system and its impacts - NOAA will continue its world-class observation, monitoring and NESDIS Objective: Produce reference products for targeted sectors, continued retrospective data and information on the planet.

3.1.12 Atmospheric Temperature

3.1.12.1 Atmospheric Temperature Regional Climate

The atmospheric temperature regional climate category includes a variety of climate products covering a gamut of climate topics such as winter, tropical, forecasting, human health, and climates at major public sporting events.

The freeze/thaw index is used in seasonal frost areas, and many states Departments of Transportation take advantage of the information looking for a period of higher road strength in mid-winter by applying winter weight premiums (WWPs), increasing the

allowable weight that trucks can haul. During late winter and early spring when the top road layers begin thawing and can't drain excess water, the road is highly susceptible to damage. To reduce roadway damage, many highway agencies apply spring load restrictions (SLR) during the critical time interval when the pavement is most vulnerable to damage.

The Regional Winter Weather product, through the Accumulated Winter Season Severity Index, provides the character of a winter defined by many of its features, including temperature averages and extremes, snowfall totals, snow depth, and the duration between onset and cessation of winter-weather conditions. The accumulated winter season severity index incorporates these elements into one site-specific value that defines the severity of a particular winter, especially when examined in the context of climatological values for that site.

Tropical Weather and Impacts provide a suite of tropical resources such as tropical outlooks and discussions, storm tracks, satellite imagery, and hurricane preparedness information.

Climate Perspectives ranks a period of observations at a station against the normals and historical observations for the same period. Forecast Perspectives places recent conditions and short-term forecasted conditions in both a historical and geographical perspective.

Climate and Health products include a suite of resources focused on climate change and human health impacts across the Southeast Region and the US. Topics include: increased temperatures and heat stress, water scarcity, air quality, infectious disease, and general information for public health professionals.

Sporting Event Climatologies are a series of climatologies for major sporting events such as the Super Bowl, PGA Tournaments, the Kentucky Derby, NASCAR Races, and major festivals.

Table 3.1.12.1a: Atmospheric Temperature Regional Climate Products Produced

Product Category	Product Generated
Analytical - Weather	Freeze/Thaw
Analytical - Weather	Regional Winter Weather
Analytical - Weather	Tropical Weather and Impacts
Analytical - Climate	Climate and Forecast Perspectives
Analytical - Climate	Climate and Health
Analytical - Climate	Sporting Events Climatology

Table 3.1.12.1b: Atmospheric Temperature Regional Climate Current/Historical Sources, Types of Data Required, and Inputs

Category	Description
Current/Historical Sources	NWS Forecasts, STAR, NWS National Hurricane Center Hurricane Tracks, Normals, NWS National Digital Forecast Database **In situ Sources:** ● GHCN-D
Types of Data Required	Surface Weather Observations and Weather Forecasts, GOES Image Viewer, Hurricane Forecasts, NCA **In situ Sources:** ● NWS Cooperative Observer Network ● NWS Automated Surface Observing Network ● Environment Canada surface observations ● Belarus surface observing network ● European Climate Assessment and Dataset ● NCEI Forts data ● Global Climate Observing System ● High Plains Regional Climate Center real-time surface data

Category	Description
Current/Historical Sources	NWS Forecasts, STAR, NWS National Hurricane Center Hurricane Tracks, Normals, NWS National Digital Forecast Database **In situ Sources:** ● GHCN-D
	● Monthly METAR ● Community Collaborative Rain, Hail, and Snow Network ● NCEI Climate Reference Network ● USDA Snowpack Telemetry data ● USDA Remote Automated Weather Station data ● Ukraine surface observing network ● Uzbekistan surface observing network ● Buoy Data
Used as inputs for	An interface to generate real-time color-contour maps of cumulative freezing and thawing indices to better predict conditions prompting roadway load restrictions across the Northeast, The Accumulated Winter Season Index (AWSSI) was developed to objectively quantify and describe the relative severity of the winter season, resources for the Gulf Coast during tropical events, and event planning for major public events.

3.2 Climate

3.2.1 Bulletin of American Meteorological Society State of the Climate

Reference Weather Climate Reports and Assessments

3.2.2 Climate and Forecast Perspectives

Reference Atmospheric Temperature Regional Climate

3.2.3 Climate at a Glance

Reference Climate Monitoring Products

3.2.4 Climate and Health

Reference Atmospheric Temperature Regional Climate

3.2.5 The Drought Monitor

3.2.5.1 Drought

Drought analytical products include the US and North American Drought Reports. This includes the US Drought Monitor (USDM) which has weekly expert assessment of long-term and short-term drought conditions across the US, its commonwealths, and territories. Multiple sponsoring agencies (NOAA, USDA, NDMC) share production. In addition, it includes the North American Drought Monitor (NADM) which includes maps, narratives, indicators, and data depicting areas of drought and abnormally dry conditions across the North American continent, compiled from national analyses prepared in the U.S., Canada, and Mexico. Monitoring, US, Monthly State of Climate: Drought, USAPI (US-Affiliated Pacific Islands) Support for US Drought Monitor (USDM), and Climatological Rankings are also included, as well as drought amelioration tools - maps of the lower 48 United States precipitation totals needed to end or ameliorate a drought from periods of 1-6 months; includes projected drought maps under certain temperature and precipitation anomaly scenarios.

Table 3.2.5.1a: Drought Monitor Report Products Produced

Product Category	Product Generated
Climate	Drought Monitor
Surface Moisture	Drought Indices

Table 3.2.5.1b: Drought Monitor Report Current/Historical Sources, Types of data Required, and Used As Inputs For

Category	Description
Current/Historical Sources	GHCN-Daily and High Plains Regional Climate Center/Western Regional Climate Center (HPRCC/WRCC) data feeds; GHCN-M, The North American Drought Monitor - Standardized Precipitation Index (NADM SPI) and Palmer drought index.
Types of Data Required	Surface Weather Observations and HPRCC/WRCC data; Surface Weather Observations, NADM SPI, and Palmer Drought Index data. **In situ Sources:** ● GHCN-D ● GHCN-M ● NADM-SPI ● Palmer Drought Index ● nClimDiv
Used as inputs for	Federal and state drought relief funds are based on USDM classifications; USDM is the US input to the NADM. The NADM is used by Government agencies, international commissions, NACSP, and the North American Commission for Environmental Cooperation to understand drought and the need for drought relief.

3.2.6 Global Climate Product Generation for Climate Reports

3.2.6.1 Ocean Climate

The Ocean Climate analytical products include the Global Climate Product Generation for Climate Reports. This includes the assembly and write up of annual ocean variability for important climate variables.

Table 3.2.6.1a: Ocean Climate Products Produced

Product Category	Product Generated
Climate	Global Climate Product Generation for Climate Reports

Table 3.2.6.1b: Summary of Current/Historical Sources, Types of Data Required, and Used as Inputs For Ocean Climate

Category	Description
Current/Historical Sources	Global Ocean Heat Content, Salt Content, Steric Sea Level, Mixed Layer Depth
Types of Data Required	Global Ocean Heat Content, Salt Content, Steric Sea Level, Mixed Layer Depth
Used as inputs for	Bulletin of the American Meteorological Society State of the Climate Report

3.2.7 Monthly State of Climate: Global Analysis Report

Reference Climate Reports and Assessments

3.2.8 Monthly State of Climate: Global Snow and Ice Report

Reference Climate Reports and Assessments

3.2.9 Monthly State of Climate: National Overview

Reference Climate Reports and Assessments

3.2.10 Monthly State of Climate: National Snow and Ice

Reference Climate Reports and Assessments

3.2.11 Monthly State of Climate: Synoptic Discussion

Reference Climate Reports and Assessments

3.2.12 Monthly State of Climate: Tornadoes

Reference Climate Reports and Assessments

3.2.13 Monthly State of Climate: Tropical Cyclones

Reference Climate Reports and Assessments

3.2.14 Monthly State of Climate: Upper Air Temperature Report

Reference Climate Reports and Assessments

3.2.15 Monthly State of Climate: Wildfire

Reference Climate Reports and Assessments

3.2.16 National Climate Assessment

Reference Climate Reports and Assessments

3.2.17 Publication Products, CD Pubs incl. QAR/Extremes reports to NWS

3.2.17.1 Surface Air Properties

Table 3.2.17.1a: Surface Air Properties Products Produced

Product Category	Product Generated
Climate	Publication Products, Monthly Climatic Data for the World (MCDW)
Climate	Publication Products, CD Pubs incl. QAR/Extremes reports to NWS

Table 3.2.17.1b: Summary of current/historical sources, types of data required, and used as inputs for Surface Air Properties

Category	Description
Current/Historical Sources	CLIMAT and TEMP messages from member nations via GTS (Washington DC Hub), Station histories: HOMR [MCDW]; GHCN-Daily, HOMR, IPS Website [QAR/Extremes]

Category	Description
Types of Data Required	Surface Weather Observations [MCDW]; Surface Weather Observations, Station Metadata, Error Reports [QAR/Extremes]
Used as inputs for	World Meteorological Organization data exchange, NOAA Objective: Improved scientific understanding of the changing climate system and its impacts - NOAA will continue its world-class observation, monitoring, ..., NESDIS: Produce reference products for targeted sectors..., continued retrospective data and information on the planet [MCDW]; NWS IAA [QAR/Extremes]

3.2.18 Publication Products, Monthly Climatic Data for the World (MCDW)

Reference Surface Air Properties

3.2.19 Societal Impacts: Billion Dollar Disasters

Reference Climate Reports and Assessments

3.2.20 Sporting Events Climatology

Reference Atmospheric Temperature Regional Climate

3.2.21 Tornado Climatology

Reference Weather Extreme Storms

3.2.22 U.S. Global Change Research Program Indicators Suite

Reference Climate Reports and Assessments

3.2.23 Value of NCEI Information Reports

3.2.23.1 Impact Reports

The Impact Report family of analytical products includes the Value of NCEI Information Reports that are intended to document the uses of NCEI data and the benefits derived by various sectors of the US Economy from that use. These ensure that NESDIS resources are spent on use-inspired, impactful data and products. Each report covers a different sector or a different product. These can be professionally developed or conducted in-house. May include infographics and videos.

Table 3.2.23.1a: Impact Reports Products Produced

Product Category	Product Generated
Climate	Value of NCEI Information Reports

Table 3.2.23.1b: Summary of Current/Historical Sources, Types of Data Required, and Used As Inputs For Services

Category	Description
Current/Historical Sources	All Products in NCEI Center for Weather and Climate holdings
Types of Data Required	Climate Products, In situ & Remotely Sensed **In situ Sources:** · GHCN-Hourly · GHCN-Daily · GHCN-Monthly Temperature and Precipitation · IBTRaCS · Storm Data · Monthly Climate Monitoring Reports - Temperature, Precipitation, Drought, US Drought Monitor, · Regional Ocean Climatologies · Chlorophyll-a · NEXRAD QPE · Pathfinder SST · COOP Hourly Precipitation · Bathymetry · Digital Elevation Models (DEM) · Climate Normals · Regional Snowfall Index · ASOS Low Resolution · HURSAT · Billion Dollar Disasters Report

Category	Description
Used as inputs for	NOAA Objective: Improved scientific understanding of the changing climate system and its impacts - NOAA will continue its world-class observation, monitoring; develop and deliver climate services at global and regional scales, sustained partnerships [to] deliver climate-relevant information for decision making. NESDIS: Produce reference products for targeted sectors, continue retrospective data and information on the planet; enable services for national, regional, and local planners and officials.

3.2.24 Wind Climatology and Monitoring

Reference Weather Climate Reports and Assessments

3.2.25 WMO Annual Statement

Reference Weather Climate Reports and Assessments

3.3 Oceans, Freshwater and Coasts

3.3.1 GPRA Performance Measure Reports

3.3.1.1 Surface Marine In situ

The Surface Marine In situ family of analytical products include quarterly reports on the SST GPRA Performance metric of global ocean SST observations.

Table 3.3.1.1a: Surface Marine In situ Products Produced

Product Category	Product Generated
Oceans, Freshwater and Coasts	GPRA Performance Measure Reports

Table 3.3.1.1b: Summary of current/historical sources, types of data required, and used as inputs for Surface Marine In situ

Category	Description
Current/Historical Sources	Multiple Sources (ships, moored/drifting buoys)
Types of Data Required	Multiple Sources (ships, moored/drifting buoys) In situ Sources: ICOADS
Used as inputs for	SLA with OAR; Public Law 101-606(11/16/90) 104 Stat. 3096-3104, mandated by Congress in the Global Change Research Act (GCRA) of 1990 to “assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.”

3.3.2 Marine Pollution Analysis

Reference Weather Satellite Analysis Branch Products

3.3.3 Oil Spill and Marine Debris Detection

Reference Water Pollution Oil Spill Mapping

3.3.4 Historical Tsunami Events Database

NCEI maintains global observations of tsunami sources and tsunami runup databases. These related databases contain information on both the tsunami source and where the tsunami arrived on land. Worldwide data from 2000 B.C. to the present include instrumental observations, observer comments, site reports, deposits, the date and location, plus a summary of measurements and effects. The runup database includes the date and location of the observation as well as details of the runup measurements and effects at the location. These two databases have been significantly improved over the last few years by careful checking of historical entries, verifying source information, and flagging questionable or meteorological events. In addition to the information about the location and affects, the database contains information on deaths, injuries, dollar damage, buildings destroyed, and photos of the damage. The number of deaths and dollar damages present a simple method of assigning an initial qualitative tsunami hazard. The historical and prehistorical tsunami data are a first tool in decision-making

by the warning centers and are useful for hazard assessment and validating tsunami propagation and inundation models.

Table 3.3.4.1: Extreme Storms Current/Historical Sources, Types of Data Required, and Inputs

Category	Description
Current/Historical Sources	Tsunami warning center messages, on site reports, observer reports, catalogs, peer-reviewed journal articles and historical documents including letters, diaries, and newspaper articles, and more recently instrumental data. **In situ Sources:** ● Tide-gauge stations ● Deep-ocean Buoys (DARTs)
Used as inputs for	This tsunami database provides a historical account of global tsunamis and can is used by Tsunami Warning Centers, tsunami researchers, Emergency managers, education, academia, NOAA, Federal Agencies, State Agencies

3.4 Climate Data Records

Climate Data Records (CDR) are created by merging data from surface, atmosphere, and space-based systems across decades. NOAA's Climate Data Record Program is initially focusing on data from satellites. By applying knowledge gathered over time about instruments' performance and sensor characteristics, the data are reprocessed to create consistent long-term records, allowing insight into changes in the Earth's environmental parameters.

3.4.1 Aerosol Optical Depth/Thickness

3.4.1.1 Aerosol Optical Thickness (AOT) CDR

The Aerosol Optical Thickness (AOT) CDR provides daily and monthly versions of an optical measure of aerosol column loading derived from the global ocean pixel-level Pathfinder Atmosphere Extend (PATMOS-x) AVHRR clear-sky reflectance CDR at 0.63μm channel. This CDR is available in daily and monthly versions. The algorithm

uses imager data from polar orbiter satellites and will make use of the VIIRS GAC when it transitions to new satellites.

The algorithm is produced, archived, and stewarded at NESDIS/NCEI.

Table 3.4.1.1a: AOT Products Produced

Product Category	Product Generated
CDRs	Aerosol Optical Thickness

Table 3.4.1.1b: Summary of Past and Current Satellites for AOT CDR

Time Frame	Instruments/Satellites
Historical	AVHRR; NOAA-7-19 *(via the PATMOS-x CDR)*
Current	AVHRR; MetOp-A *(via the PATMOS-x CDR)*

3.4.2 Cloud CDRs

3.4.2.1 ISCCP

The Cloud Properties CDR from the ISCCP focuses on the distribution and variation of cloud radiative properties to improve understanding and modeling of the way clouds affect climate. This dataset provides an improved understanding of the radiation budget, as well as specific insight on the relationship between clouds and the radiation balance. These data can be used to support many other cloud studies, including efforts to understand the long-term global hydrologic cycle.

This algorithm makes use of Imager data from Polar and GEO satellites.

The algorithm is produced by a non-NOAA entity and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.2.1a: ISCCP CDR Products Produced

Product Category	Product Generated
CDRs	Cloud Fraction
CDRs	Cloud Optical Depth
CDRs	Cloud Top Temperature
CDRs	Cloud Top Pressure
CDRs	Cloud Liquid/Ice Water
CDRs	Cloud Emissivity
CDRs	Cloud Type
CDRs	Cloud Water Path

Table 3.4.2.1b: Summary of Past and Current Satellites for ISCCP CDR

Time Frame	Instruments/Satellites
Historical	AVHRR; NOAA-7-19, MetOp-A, B VISSR/VAS/Imager; GOES 1-15 VISSR/VAS/ABI; Himawari-1-9 MVERI/SEVERI; Meteosat-2-11 SMS1-2 FY2C-2E
Current	AVHRR; NOAA-20 and MetOp-A-B GOES-16-17 Himawari-8 Meteosat-8,-11

3.4.2.2 PATMOS-X

The PATMOS-x CDR provides data for multiple cloud properties and brightness temperatures collected by the AVHRR onboard the NASA POES and European METOP platforms. The AVHRR data record offers a unique, long-term resource for multi-decadal climate studies. PATMOS-x improved the quality of the dataset by recalibrating

and re-navigating the data. The resulting CDR supports climate variability studies over the period of record. The final record has global coverage at a 0.1°x 0.1° equal angle grid and extends from 1979–present. This algorithm uses Imager data (e.g., AVHRR) on polar-orbiting satellites. The algorithm is produced by a non-NOAA entity and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.2.2a: PATMOS-X CDR Products Produced

Product Category	Product Generated
CDRs	Cloud Fraction
CDRs	Cloud Optical Depth
CDRs	Cloud Particle Size
CDRs	Cloud Top Temperature
CDRs	Cloud Emissivity
CDRs	Cloud Top Pressure
CDRs	Total Precipitable Water
CDRs	Optical Imager Brightness Temperatures
CDRs	Optical Imager Radiances
CDRs	Surface Temperature

Table 3.4.2.2b: Summary of Past and Current Satellites for PATMOS-X CDR

Time Frame	Instruments/Satellites
Historical	AVHRR; NOAA-7-17
Current	AVHRR; NOAA-18-19 and MetOp-A-B

3.4.3 LAI FAPAR

3.4.3.1 LAI FAPAR CDR

This CDR combines datasets for LAI and FAPAR, two biophysical variables that can be used to evaluate vegetation stress, forecast agricultural yields, and other modeling and resource management applications. LAI tracks the one-sided green leaf area per unit of ground surface area, while FAPAR quantifies the solar radiation absorbed by plants within the PAR spectral region. The LAI/FAPAR CDR generates a daily product on a .05° by .05° grid using data derived from AVHRR sensors from 1981–present. The

algorithm uses AVHRR from NOAA POES satellites and will be extended to other instruments, such as VIIRS. The algorithm is produced by non-NOAA entities and the product is sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.3.1a: LAI/FAPAR CDR Products Produced

Product Category	Product Generated
CDRs	Leaf Area Index (LAI); Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)

Table 3.4.3.1b: Summary of Past and Current Satellites for LAI/FAPAR CDR

Time Frame	Instruments/Satellites
Historical	AVHRR; NOAA 7, 9, 11,14, 16-18
Current	AVHRR; NOAA-19 VIIRS; NOAA-20

3.4.4 Precipitation

3.4.4.1 PERSIANN CDR

PERSIANN-CDR provides a high-quality CDR of Precipitation. This global precipitation dataset is intended to support Climatologists, Hydrologists, Hydrometeorologists, and Hydroclimatologists in various forms of climate research, including extreme event (flood and drought) analysis.

The algorithm uses IR imager data from GEO satellites.

The algorithm is produced by a non-NOAA entity and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.4.1a: PERSIANN-CDR Algorithm Products Produced

Product Category	Product Generated
CDRs	Rain Rate

Table 3.4.4.1b: Summary of Past and Current Satellites for PERSIANN-CDR

Time Frame	Satellites/Instruments
Historical	GridSat-B1 CDR and GPCP Monthly CDR
Current	ABI; GOES-16 and17 AHI; Himawari-8 SEVIRI; Meteosat-8 and -11 (which are provided by the GridSat-B1 CDR) **In situ Sources:** • GPCP- Monthly CDR

3.4.4.2 CMORPH CDR

This dataset provides scientific researchers a high-quality CDR of satellite precipitation estimates across the globe. These satellite precipitation estimates are reprocessed and bias-corrected to form a high-resolution global precipitation analysis CDR. The bias-corrected CMORPH CDR processing system generates bias-corrected, integrated satellite precipitation estimates globally. Spatial resolution is on an 8km-by-8km grid over the globe (60S–60N) and in a 30-min temporal resolution for 20 years of record, from January 1998 to the present. The production of the output precipitation fields combines three different time-space resolutions to accommodate user requirements of various backgrounds.

The algorithm uses IR imager data on geostationary satellites and passive microwave data.

The algorithm is run at the NOAA Climate Prediction Center, which sends the product to NCEI for ingestion and stewardship.

Table 3.4.4.2a: CMORPH CDR Products Produced

Product Category	Product Generated
CDRs	Rain Rate

Table 3.4.4.2b: Summary of Past and Current Satellites for CMORPH CDR

Time Frame	Instruments/Satellites
Historical	GOES 8-15 Himawari-5-9, and Meteosat-5-9 SSMI/SSMIS; DMSP-F13-16, F18 AMSU; NOAA 15-17 AMSR; Aqua TMI; TRMM MWRI; FY-3B
Current	ABI; GOES-16-17 AHI; Himawari-9 SEVIRI; Meteosat-, 1011, SSMI/SSMIS; DMSP, NOAA 18-19 AMSU; MHS; MetOp-A-B **In situ Sources:** ● CPC Daily Gauge Analysis

3.4.4.3 Global Precipitation Climatology Project (GPCP) CDR

The GPCP Monthly Precipitation CDR consists of monthly satellite-gauge and associated precipitation error estimates taken from January 1979–present. The CDR is created by combining the precipitation information from several satellite and in situ sources into a final merged product that uses the strengths of each data type to create a more accurate record. Passive Microwave estimates are based on Special Sensor SSMI/SSMIS data; IR precipitation estimates are included using GOES data and POES data, as well as other low earth orbit data and in situ observations. Data are provided on a 2.5-degree grid. The GPCP Daily Precipitation Analysis CDR is a companion to the GPCP Monthly analysis and provides complete global precipitation estimates with 1° x 1° spatial resolution and a daily time scale from October 1996–present. The dataset is part of the World Climate Research Program and Global Energy and Water Exchanges (GEWEX) activities and one of an array of datasets describing the water and energy cycles of the planet under the auspices of the GEWEX Data and Assessment Panel. The algorithm uses IR imager data from polar and geostationary satellites and passive microwave data. Non-NOAA entities produce the algorithm, and the product is sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.4.3a: GPCP CDR Products Produced

Product Category	Product Generated
CDRs	Rain Rate

Table 3.4.4.3b: Summary of Past and Current Satellites for GPCP CDR

Time Frame	Instruments/Satellites
Historical	AVHRR; NOAA-7-19 Imager; GOES-8-15 VISSR and AHI;Himawari-5-9 SEVIRI Meteosat-5-9 SSMI/SSMIS; DMSP
Current	ABI; GOES-16-17 AHI; Himawari-8 SEVIRI; Meteosat-8 and -1111, AVHRR; NOAA-19 SSMI/SSMIS; DMSP

3.4.4.4 Hydrological Properties TCDR

Instrumentation utilized is the NOAA AMSU-A, AMSU-B and MHS to create a Thematic Climate Data Record (TCDR) for "window channels." The data period of record begins in 1998 with monthly updates. It contains roughly 48 km (AMSU-A) and 16km (AMSU-B/MHS) resolution over the entire globe, with 30 MHS and 90 AMSU-B/MHS observations per scan. The AMSU-A portion of the Hydrological TCDR covers parameters such as TPW, CLW) Sea-Ice concentration, LST, and Land surface emissivity for 23, 31, and 50 GHz. The AMSU-B/MHS portion of the Hydrological TCDR covers parameters such as IWP, RR, snow cover (SC), and snow water equivalent (SWE). Visual inspections and verification of the various corrections are applied to improve accuracy. The Hydrological TCDR is helpful for water cycle applications, identifying climate extremes, and validating other observations. The algorithm uses brightness temperatures from microwave sounders on polar-orbiting satellites. The algorithm is produced by a non-NOAA entity and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.4.4a: Hydrological Properties TCDR Products Produced

Product Category	Product Generated
CDRs	Rain Rate
CDRs	Cloud Liquid/Ice Water
CDRs	Total Precipitable Water
CDRs	Snow Water Equivalent
CDRs	Snow Cover
CDRs	Sea Ice Concentration
CDRs	Surface Temperature
CDRs	Cloud Emissivity
CDRs	Sea Surface Temperature

Table 3.4.4.4b: Summary of Past and Current Satellites for Hydrological Properties TCDR

Time Frame	Instruments/Satellites
Historical	MHS; POES AMSU A/B; NOAA 15-19, and MetOp-A
Current	AMSU A/B; NOAA-19

3.4.5 Mean Layer Temperatures (MLT)

3.4.5.1 MLT -NOAA

The MLT CDR provides long-term temperature measurements for a thick layer of the upper atmosphere. Input data comes from MLT level-1c swath radiances taken by the MSU, AMSU-A, and ATMS aboard NOAA satellites. The CDR was calibrated using the NOAA STAR Integrated Microwave Inter-Calibration Approach. The final dataset incorporates inter-satellite bias corrections to ensure consistency and adjustments that account for diurnal drift effect, differences between viewing angles, and channel

frequency differences between sensors. The final record is a monthly global gridded dataset with 2.5°x2.5° Latitude/Longitude resolution and extends from 1978–present. This algorithm makes use of microwave sounder instruments on polar-orbiting satellites. The algorithm is produced by NOAA STAR and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.5.1a: MLTs NOAA Products Produced

Product Category	Product Generated
CDRs	Mean Layer Temperatures

Table 3.4.5.1b: Summary of Past and Current Satellites for MLT

Time Frame	Instruments/Satellites
Historical	MSU/AMSU; Aqua, NOAA-7-19, and MetOp-A-B
Current	AMSU; NOAA-1, MetOp-C

3.4.5.2 MLT - UCAR Upper Troposphere and Lower Stratosphere CDR

The Upper Troposphere and Lower Stratosphere MLT CDR provides calibrated MLT data spanning both atmospheric regions. Input comes from the long-term variation of BT measurements from AMSU channel 7 and MSU channel 3 that peak in the upper troposphere and lower stratosphere. These peaks provide the necessary signal to produce the monthly MLT for both atmospheric regions. The AMSU Data (L1b) is calibrated with high-quality radiosonde observations identified by coincident Global Positioning System GPS RO temperature profile measurements. The calibrated MSU/AMSU data in the period of 2001-2014 serve as reference data to calibrate other overlapped MSU/AMSU data from 1980-2001. The final record has global coverage, and extends from 1986–2019.

The algorithm uses microwave sounder data from various NOAA satellites.

The algorithm is static. It was produced by NOAA STAR and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.5.2a: MLT - UCAR Upper Troposphere and Lower Stratosphere CDR Products Produced

Product Category	Product Generated
CDRs	Mean Layer Temperatures

Table 3.4.5.2b: Summary of Past and Current Satellites for MLT - UCAR Upper Troposphere and Lower Stratosphere CDR

Time Frame	Instruments/Satellites
Historical	MSU/AMSU; TIROS-N, NOAA-6-18, and MetOp-A-B
Current	AMSU; NOAA-19 and MetOp-B

3.4.6 MLT - Radio Occultation

3.4.6.1 MLT – University Corporation for Atmospheric Research (UCAR) Lower Stratosphere CDR

The Lower Stratosphere MLT CDR shows the long-term variation of AMSU channel 9 brightness and MSU channel 4 brightness measurements that peak in the Lower Stratosphere. These instrument signals are necessary to produce the monthly MLT of the Lower Stratosphere. Data (level-1b) from AMSU/MSU on board multiple satellites were calibrated using coincident GPS RO temperature profile measurements from 2001–present. The calibrated MSU/AMSU data from 2001–2014 serve as reference data to calibrate other overlapped MSU/AMSU data from 1980–2001. The final record has global coverage, and extends from 1986–2019.

This algorithm makes use of microwave sounder instruments on polar orbiting satellites.

The algorithm is static. It was produced by NOAA STAR and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.6.1a: MLT-UCAR Lower Stratosphere CDR Products Produced

Product Category	Product Generated
CDRs	Mean Layer Temperature, Radio Occultation

Table 3.4.6.1b: Summary of Past and Current Satellites for MLT - UCAR Lower Stratosphere CDR

Time Frame	Instruments/Satellites
Historical	MSU/AMSU; TIROS-N, NOAA-6-18, and MetOp-A-B
Current	AMSU; NOAA-19 and MetOp-B

3.4.7 Microwave Imager Radiometer Brightness temperatures

3.4.7.1 AMSU-A CDR

The AMSU-A BT CDR provides calibrated temperature data collected by the AMSU-A sensor. The data are at approximately 48 km global resolution with 30 observations per scan, using the “window” channels covering 23, 31, 50, and 89GHz. Data are subject to visual inspections and calibration correction verification. The final record extends from 1998–present.

The algorithm uses microwave sounder data from polar orbiting satellites.

The algorithm is produced by NESDIS/STAR, archived and stewarded at NESDIS/NCEI.

Table 3.4.7.1a: AMSU-A CDR Products Produced

Product Category	Product Generated
CDRs	Microwave Sounder Radiometer Brightness Temperatures

Table 3.4.7.1b: Summary of Past and Current Satellites for AMSU-A CDR

Time Frame	Instruments/Satellites
Historical	AMSU-A; METOP-A andNOAA-15-18
Current	AMSU-A; NOAA-19

3.4.7.2 AMSU-B/MHS CDR

The AMSU-B and MHS BT CDR provides BT data from the window and WV channel frequencies of each instrument. Channels used are 89, 150, 157, 183 +/- 1, 183 +/- 3, 183 +/- 7, 190GHz. AMSU-B data comes from NOAA-15, -16, and -17 satellites, and MHS is from NOAA-18, -19 and METOP-A.

The data collection period of record spans from 1998–present, with monthly updates and roughly 16km spatial resolution for the entire globe, with 90 observations per scan. Quality control is applied through visual inspections and correction verification. This CDR is useful as input to hydrological products to derive global precipitation, ice water, snow cover, and snow water equivalent.

The algorithm uses microwave sounder data from polar orbiting satellites.

The algorithm is produced by NESDIS/STAR, archived and stewarded at NESDIS/NCEI.

Table 3.4.7.2a: AMSU-B/MHS CDR Products Produced

Product Category	Product Generated
CDRs	Microwave Sounder Radiometer Brightness Temperatures

Table 3.4.7.2b: Summary of Past and Current Satellites for AMSU-B/MHS CDR

Time Frame	Instruments/Satellites
Historical	AMSU-B/MHS; METOP-A and NOAA-15-18
Current	AMSU-B/ MHS; NOAA-19

3.4.7.3 SSMIS BT - Colorado State University Climate Data Record

The SSMI and SSMIS BT CDR uses window-channels from a series of 10 microwave radiometers flown on board the DMSP satellite series. The six SSMI instruments first flown on DMSP F08 in July 1987 provide inter-calibrated data, along with data from four currently operational SSMIS instruments. This fundamental CDR provides data for a number of thematic CDR products including precipitation, sea surface wind speed, sea ice extent, snow cover, CLW, and TPW content. The final record extends from 1987–present.

This algorithm makes use of microwave sounder instruments on polar orbiting satellites.

The algorithm is produced by non-NOAA entities and the product is sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.7.3a: SSMIS BT CSU Products Produced

Product Category	Product Generated
CDRs	Microwave Imager Radiometer Brightness temperatures

Table 3.4.7.3b: Summary of Past and Current Satellites for SSMIS BT CDR

Time Frame	Instruments/Satellites
Historical	SSM/I/SSMIS; DMSP-F8, F10, F11, F13, F14, F15-17
Current	SSM/I/SSMIS; DMSP-F18

3.4.8 Normalized Difference Vegetation Index (NDVI)

3.4.8.1 NDVI Climate Data Record

The NDVI CDR provides a consistent, long-term record of global surface vegetation coverage activity based on remotely sensed observations. NDVI values come from surface reflectance calculations in the red and near IR spectral bands captured by AVHRR. This CDR produces daily output on a 0.05° by 0.05° grid using data from 1981–present.

The algorithm uses AVHRR from NOAA POES satellites and will be extended to other instruments, such as VIIRS. The algorithm is produced by non-NOAA entities and the product is sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.8.1a: NDVI Products Produced

Product Category	Product Generated
CDRs	Normalized Difference Vegetation Index (NDVI)

Table 3.4.8.1b: Summary of Past and Current Satellites for NDVI CDR

Time Frame	Instruments/Satellites
Historical	AVHRR; NOAA-1, 7, 9, 14, 16-18
Current	AVHRR; NOAA-19

3.4.9 Ocean CDRs

3.4.9.1 Ocean Heat Content Climate Data Record

The Ocean Heat Content CDR is a set of ocean heat content anomaly time-series for 1955–present on 3-monthly, yearly, and pentadal (five-yearly) scales. This CDR quantifies ocean heat content change over time, which is an essential metric for understanding climate change and the Earth's energy budget. It provides time-series for multiple depth ranges in the global ocean and each of the major basins (Atlantic, Pacific, and Indian) divided by hemisphere (Northern, Southern).

The algorithm uses data from the World Ocean Database (NCEI) and not satellite data directly.

The algorithm is produced, archived and stewarded at NESDIS/NCEI.

Table 3.4.9.1a: Ocean Heat Content Products Produced

Product Category	Product Generated
CDRs	Ocean Heat Content

Table 3.4.9.1b: Summary of Past and Current Satellites for Ocean Heat Content CDR

Time Frame	Instruments/Satellites
Historical	N/A
Current	N/A

3.4.9.2 Ocean Near Surface Atmospheric Properties - CDR

The Ocean Near-surface Atmospheric Properties CDR is one of three atmospheric CDRs in the NOAA OSB. This product documents air temperature, wind speed, and specific humidity above the ocean surface. It can be used to compare with similar values captured at sea surface level, which provide insight into the essential aspects of the air-sea exchange.

This CDR is made up of data from the SSM/I, a passive microwave sensor, and the equivalent NCEI SST CDR. All input data are put through a combination of statistical techniques using neural networks and diurnal warming parameterizations. These data

provide the near-surface fluxes of evaporation/latent heat and sensible heat calculations that comprise the final record on a 3-hourly 0.25° resolution grid over the global ice-free oceans from January 1988 to present.

The algorithm uses passive microwave imagers.

The algorithm is produced by a non-NOAA entity and is archived and stewarded at NESDIS/NCEI.

Table 3.4.9.2a: Ocean Near Surface Atmospheric Properties Products Produced

Product Category	Product Generated
CDRs	Ocean Surface Wind
CDRs	Near surface Specific Humidity
CDRs	Near Surface Atmospheric Properties

Table 3.4.9.2b: Summary of Past and Current Satellites for Ocean Near Surface Atmospheric Properties CDR

Time Frame	Instruments/Satellites
Historical	SSM/I, SSMIS; DMSP-F8, 10, 11, 13-15
Current	SSM/I, SSMIS; DMSP-F17

3.4.9.3 Ocean Heat Fluxes Climate Data Record

The Ocean Heat fluxes CDR is one of three CDRs that make up the NOAA Ocean Surface Bundle (OSB). They can be used to describe essential aspects of the air-sea exchange. This CDR leverages the parameters of surface atmospheric properties and sea surface temperature to calculate the latent and sensible heat fluxes from a neural-network emulator of the TOGA-COARE Bulk Air-Sea Flux Algorithm (Clayson & Curry, 1996). This algorithm makes use of microwave imagers on DMSP. The final record is a 3-hourly 0.25° resolution grid over the global ice-free oceans from January 1988–2020.

The algorithm is produced by a non-NOAA entity and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.9.3a: Ocean Heat Flux CDR Products Produced

Product Category	Product Generated
CDRs	Surface Heat Flux

Table 3.4.9.3b: Summary of Past and Current Satellites for Ocean Heat Flux CDR

Time Frame	Satellites/Instruments
Historical	SSMI/SSMIS; DMSP-8,10, 13-15
Current	SSMIS; F17 and F18

3.4.10 Outgoing Longwave Radiation CDRs

3.4.10.1 OLR CDR

The daily OLR CDR measures the amount of terrestrial radiation released into space and, by extension, the amount of cloud cover and WV that intercepts that radiation in the atmosphere. Input data for the daily OLR record primarily comes from the High Resolution IR Radiation Sounder (HIRS). The final record is generated through a combination of statistical techniques, including OLR regression, instrument ambient temperature prediction coefficients, and inter-satellite bias corrections.

The monthly OLR CDR measures the amount of terrestrial radiation released into space, as well as the amount of cloud cover and WV that intercepts that radiation in the atmosphere. Input data for the monthly OLR record primarily comes from the HIRS. The final record was developed through a combination of statistical techniques, including OLR regression, instrument ambient temperature prediction coefficients, and inter-satellite bias corrections.

This algorithm makes use of IR sounder data as well as another geostationary-based Fundamental CDR. The algorithm will soon be ready to use hyperspectral IR sounders.

The algorithm is produced by a non-NOAA entity and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.10.1a: OLR CDR Products Produced

Product Category	Product Generated
CDRs	Outgoing Longwave Radiation

Table 3.4.10.1b: Summary of Past and Current Satellites for OLR CDR Family

Time Frame	Instruments/Satellites
Historical	HIRS; TIROS-N, NOAA 6-12, 14-17, and MetOp-A, B
Current	HIRS; NOAA-18-19

3.4.11 Optical Imager BTs

3.4.11.1 Geostationary IR Channel BT- GridSat-B1 CDR

The Geostationary IR Channel BT- GridSat-B1 CDR provides global BT data from geostationary IR satellites. Data comes from the following channels:

- CDR-quality infrared window (IRWIN) channel (near 11 μm)
- Visible channel (near 0.6 μm)
- Infrared water vapor channel (near 6.7 μm)

Input is 3-hourly B1 data from the ISCCP with gridded 0.07°x0.07° spatial resolution that spans from 1980–present. The CDR process merges observations from different satellites by selecting the nadir-most observations for each grid point. This CDR facilitates geostationary data usage that can provide input to precipitation and surface radiations and be applied to a variety of atmospheric monitoring and analysis applications.

The algorithm uses IRWIN observations from meteorological geostationary satellites.

The algorithm is produced, archived and stewarded at NESDIS/NCEI.

Table 3.4.11.1a: GridSat-B1 CDR Products Produced

Product Category	Product Generated
CDRs	Optical Imager Brightness Temperatures

Table 3.4.11.1b: Summary of Past and Current Satellites for GridSat-B1 CDR

Time Frame	Instruments/Satellites
Historical	VIS/VISSR/Imager; GOES 1, 3-13, 15 AHI; Himawari-1 - 8 VIS/VISSR; SMS-1, 2 MVERI/SEVERI; Meteosat-2-10 HIRS; TIROS-N, NOAA-7-18 HIRS; MetOp-A; S-VISSR; FY2-C
Current	ABI; GOES-16-17 AHI; Himawari-9 SEVIRI; Meteosat-11 HIRS; NOAA-19 HIRS; MetOp-B

3.4.11.2 AVHRR Polar Pathfinder (APP) CDR

The APP CDR is a fundamental CDR comprised of:

- Calibrated and navigated reflectances and brightness temperatures from AVHRR channel data
- Viewing and illumination geometry, which includes sensor scan angle, solar zenith angle, and sun-sensor relative azimuth angle
- UTC data acquisition data
- A surface type mask

The data are composites of up to 23 orbits on a 5km EASE-grid generated twice daily over both poles (Arctic and Antarctic) from 1982–present. The daily APP composites are centered on local solar times of 14:00 (high sun, but could be nighttime for some

polar areas in winter) and 04:00 for the Arctic or 02:00 for the Antarctic. The APP covers the north polar region (Arctic) from 48.4 degrees northward, and the south polar region (Antarctic) from -53.2 degrees southward.

The algorithm uses AVHRR from NOAA POES satellites and will be extended to other instruments, such as VIIRS.

The algorithm is produced by NESDIS/STAR, archived and stewarded at NESDIS/NCEI.

Table 3.4.11.2a: APP CDR Products Produced

Product Category	Product Generated
CDRs	Optical Imager Brightness

Table 3.4.11.2b: Summary of Past and Current Satellites for APP CDR

Time Frame	Instruments/Satellites
Historical	AVHRR; NOAA-7,9, 11, 14, 16, 1819, and MetOp-A-B
Current	AVHRR; NOAA-17,18 and MetOp-A-B

3.4.12 Optical Sounder BT

3.4.12.1 HIRS Channel 12 (CH12) CDR

The HIRS CH12 CDR measures upper tropospheric humidity. HIRS level-1b data, in conjunction with cloud-clearing, limb-correction, and inter-satellite calibration, provide the CDR input. The final record has global coverage at a 2.5°x2.5° spatial resolution and provides data from 1978–present.

The algorithm uses IR sounders on polar orbiting satellites. While historically derived from HIRS, work is underway to transition to hyperspectral sounders.

The algorithm is produced, archived and stewarded at NESDIS/NCEI.

Table 3.4.12.1a: HIRS Channel 12 CDR Products Produced

Product Category	Product Generated
CDRs	Optical Sounder Brightness temperature

Table 3.4.12.1b: Summary of Past and Current Satellites for HIRS CH12 CDR

Time Frame	Instruments/Satellites
Historical	HIRS; TIROS-N, NOAA 6-18, and MetOp-A
Current	HIRS; NOAA-19, and MetOp-B

3.4.13 Total Ozone

3.4.13.1 Ozone-Earth System Research Laboratory (ESRL) CDR

The Ozone-ESRL CDR provides a vertically resolved, gap free monthly and zonal mean ozone dataset that spans from 1979– 2007. This dataset incorporates measurements from several different satellite instruments and over 130 ozonesonde stations globally. Ozone-ESRL also encompasses 70 altitude or pressure levels, spanning the atmosphere from the Earth's surface up to 70km or ~0.05hPa, and both ozone volume mixing ratio and ozone number density. This CDR can be used to assess ozone fields from chemistry–climate model simulations, or provide ozone boundary conditions for global climate model simulations that do not treat stratospheric chemistry interactively.

The algorithm is static, archived and stewarded at NESDIS/NCEI.

Table 3.4.13.1a: Ozone-ESRL CDR Products Produced

Product Category	Product Generated
CDRs	Total Ozone

Table 3.4.13.1b: Summary of Past and Current Satellites for Ozone-ESRL CDR

Time Frame	Instruments/Satellites
Historical	ADEOS-1, ADEOS-2, AEM-2, ERBS, Nimbus-7, SPOT-3, SPOT-4, UARS, SAGE I, SAGE II, HALOE, POAM II, POAM III, ILAS, ILAS II, LIMS
Current	TBD

3.4.14 Total Solar Irradiance

3.4.14.1 TSI Climate Data Record

The total, spectrally integrated energy input to the top of the Earth's atmosphere, at a standard distance of one Astronomical Unit from the Sun defines TSI (Wm-2). The data record utilizes solar irradiance models that determine the changes with respect to quiet Sun conditions when facular brightening and sunspot darkening features are present on the solar disk. Where the magnitude of the changes in irradiance are determined from linear regression of the proxy Mg II index and sunspot area indices against the approximately decade-long solar irradiance measurements of the SOlar Radiation and Climate Experiment (SORCE). The algorithm produces the following variables: Daily total solar irradiance, Monthly averaged total solar irradiance and Yearly averaged total solar irradiance.

This algorithm makes use of special solar pointing sensors such as TIM measurements on SORCE and Total Solar Irradiance Calibration Transfer Experiment.

The algorithm is produced by a non-NOAA entity and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.14.1a: TSI CDR Products Produced

Product Category	Product Generated
CDRs	Total Solar Irradiance

Table 3.4.14.1b: Summary of Past and Current Satellites for TSI CDR

Time Frame	Satellites/Instruments
Historical	ISS TSIS-1 TIM; SORCE
Current	ISS TSIS-2 TIM; TSIS-1

3.4.15 Sea Ice Concentration

3.4.15.1 Sea Ice Concentration CDR

The Sea Ice Concentration CDR provides a consistent, daily and monthly time series of sea ice concentrations for both the north and south Polar Regions on a 25 km x 25 km grid. These data can be used to estimate how much of the ocean surface is covered by ice, and monitor changes in sea ice concentration.

The CDR combines concentration estimates using two algorithms developed at the NASA Goddard Space Flight Center. Gridded BTs acquired from a number of DMSP passive microwave radiometers provide the necessary input to produce the dataset.

The algorithm uses conically scanning microwave imagers on polar orbiting satellites.

The algorithm is produced by non-NOAA entities and the product is sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.15.1a: Sea Ice Concentration CDR Products Produced

Product Category	Product Generated
CDRs	Sea Ice Concentration

Table 3.4.15.1b: Summary of Past, Current and Future Satellites for Sea Ice Concentration CDR

Time Frame	Instruments/Satellites
Historical	SMMR; Nimbus-7 SSM/I, SSMIS; DMSP F8, F11, F13
Current	SSM/I, SSMIS; DMSP-F17

3.4.16 Sea Surface Temperature

3.4.16.1 Daily Optimum Interpolation Sea Surface Temperature Dataset (dOISST)

The NOAA 1/4° dOISST provides complete ocean temperature fields constructed by combining bias-adjusted observations from different platforms (satellite, ships, buoys) on a regular global grid, with gaps filled in using interpolation. Satellite data from the AVHRR) provides the main input which permits the high temporal-spatial coverage beginning in late 1981 to the present; this must be adjusted to the buoys due to erroneous cold SSTs following the Mt Pinatubo and El Chichon eruptions. Applications include climate modeling, resource management, ecological studies on annual to daily scales.

The algorithm uses Pathfinder SST (derived from AVHRR observations from NOAA 7-19) and merges them with in situ measurements of SST to derive the OISST.

The algorithm is produced, archived and stewarded at NESDIS/NCEI.

Table 3.4.16.1a: dOISST Products Produced

Product Category	Product Generated
CDRs	Sea Surface Temperature

Table 3.4.16.1b: Summary of Past and Current Satellites for dOISST CDR

Time Frame	Instruments/Satellites
Historical	Pathfinder SST: NOAA-7-18 ASCPO SST
Current	Pathfinder SST: NOAA-19 ACSPO SST In situ Sources: · ICOADS

3.4.16.2 Pathfinder SST CDR

The Pathfinder SST CDR is a collection of global, twice-daily (Day and Night) 4km SST data produced by the NOAA/NCEI. L3C data is generated with measurements combined from a single instrument into a space-time grid. The dataset was computed with data from the AVHRR instruments on board NOAA's polar orbiting satellite series using an entirely modernized system based on SeaDAS (version 6.4).

The algorithm uses AVHRR on NOAA 7-19 and will likely extend to future imagers on polar orbiting satellites.

The algorithm is produced, archived and stewarded at NESDIS/NCEI.

Table 3.4.16.2a: Pathfinder SST CDR Products Produced

Product Category	Product Generated
CDRs	Sea Surface Temperature

Table 3.4.16.2b: Summary of Past and Current Satellites for Pathfinder SST CDR

Time Frame	Instruments/Satellites
Historical	AVHRR; NOAA-7, 9, 11, and 16-18
Current	AVHRR; NOAA-19

3.4.16.3 SST- Woods Hole Oceanographic Institution (WHOI) Climate Data Record

The SST–WHOI CDR is one of three CDRs which combine to form the NOAA OSB CDR. The resultant SST data are produced through modeling the diurnal variability in combination with AVHRR SST observations. The final record is output to a 3-hourly 0.25° resolution grid over the global ice-free oceans from January 1988—present.

The algorithm uses conically scanning microwave imagers on polar orbiting satellites.

The algorithm is produced by non-NOAA entities and the product is sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.16.3a: SST-WHOI CDR Products Produced

Product Category	Product Generated
CDRs	Sea Surface Temperature

Table 3.4.16.3b: Summary of Past and Current Satellites for SST-WHOI CDR

Time Frame	Instruments/Satellites
Historical	SSM/I, SSMIS; DMSP-F8, 10, 11, and 13-15
Current	SSM/I, SSMIS; DMSP F17,19

3.4.17 Solar Spectral Irradiance

3.4.17.1 SSI CDR

SSI is the wavelength-dependent energy input to the top of the Earth's atmosphere, at a standard distance of one Astronomical Unit from the Sun. Its units are Wm-2 nm-1. The data record is constructed from solar irradiance models that determine the changes with respect to quiet Sun conditions when facular brightening and sunspot darkening features are present on the solar disk, where the magnitude of the changes in irradiance are determined from linear regression of the proxy Mg II index and sunspot area indices against the approximately decade-long solar irradiance measurements of the SORCE. This algorithm produces: Daily solar spectral irradiance, Monthly averaged solar spectral irradiance, and Yearly averaged solar spectral irradiance.

This algorithm makes use of special solar pointing sensors.

The algorithm is produced by a non-NOAA entity and sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.17.1a: SSI CDR Products Produced

Product Category	Product Generated
CDRs	Solar Spectral Irradiance

Table 3.4.17.1b: Summary of Past and Current Satellites for SSI CDR

Time Frame	Instruments/Satellites
Historical	ISS; TSIS-1 SIM; SORCE
Current	ISS; TSIS-2 SIM;TSIS-1

3.4.18 Surface Reflectance

3.4.18.1 AVHRR Surface Reflectance CDR

The Surface Reflectance CDR measures the solar radiation reflected from Earth's surface in red (around 640 nm) and near IR (around 860 nm) spectral ranges. Surface

reflectance is a key variable that supplies the primary input for higher-level land surface geophysical parameters. Output is generated daily on .05° by .05° grid using data from 1981–present.

The algorithm uses AVHRR from NOAA POES satellites and will be extended to other instruments, such as VIIRS.

The algorithm is produced by non-NOAA entities and the product is sent to NESDIS/NCEI for ingestion and stewardship.

Table 3.4.18.1a: AVHRR Surface Reflectance CDR Products Produced

Product Category	Product Generated
CDRs	Surface Reflectance

Table 3.4.18.1b: Summary of Past and Current Satellites for AVHRR Surface Reflectance CDR

Time Frame	Satellites/Instruments
Historical	AVHRR; NOAA-7, 9, 11,14, 16-18
Current	AVHRR; NOAA-19

3.5 Time Series

3.5.1 Ozone Profile Time Series

Algorithm Description: NESDIS reprocesses the operational JPSS Ozone Mapping and Profiler Suite (OMNS) Nadir Profiler and Nadir Mapper Sensor Data Records (SDR) with retrospective, improved calibration characterization. The Version 8 Ozone Profile retrieval algorithm (used to make near-real-time operational ozone Environmental Data Records – EDRs) takes these reprocessed SDRs with additional adjustments for instrument degradation and solar activity to create Ozone Profile CDRs). The S-NPP, NOAA-20 and NOAA-21 host the current operational OMPS instruments. Two more JPSS missions (JPSS-4 and JPSS-3) are planned during the next decade.

Users: NOAA NCEP and GML, WMO Ozone Assessment Teams (e.g., SPARC / LOTUS LOTUS – Long-term Ozone Trends and Uncertainties in the Stratosphere | SPARC), Network for the Detection of Atmospheric Composition Change (NDACC).

Impacts: The OMPS V8Pro CDRs provide extensions of the 45-year record of ozone profiles starting with NIMBUS-7 SBUV in 1978 and the follow-on NOAA POES SBUV/2 records. This is one of the key, long-term, satellite-based atmospheric ozone profile records for tracking the recovery of the ozone layer.

3.5.2 Multiyear Ocean Surface Vector Winds

Reference OWDP – OceanSat Scatterometer (OSCAT) Type Instruments Jace Wind

3.5.3 Multiyear Reanalysis Sea Surface Temperature

3.5.3.1 Sea Surface Temperature time series from 1981 (Potential R2O)

This algorithm combines attributes of existing ACSPO L2, L3, and Geo-Polar Blended and OISST analyses based upon NESDIS SST Working Group decisions, with a report titled *Advancing NESDIS Sea Surface Temperature to Fulfill NOAA Requirements and Worldwide Expectations*. Applications of satellite sea surface temperature (SST) include the initialization and evaluation of weather, climate and ocean models, observational quantification of climate change and variability, understanding and parameterization of oceanic process, ocean ecology and recreation, support of defense operations, coastal management, oceanography and geophysics. The SST-WG will produce a world class NOAA/NESDIS SST product suite which will meet NOAA user needs and requirements and exceed current international SST community standards. Support will be needed for the full product suite lifecycle, that is, from science and development through to long-term maintenance, periodic reprocessing, robust product services, and proper stewardship of archived data.

The NOAA/NESDIS SST product suite will:

- Be consistent, routine, products at multiple processing levels: Level 2, Level 3, Level 4, and a formally managed and maintained Climate Data Record (CDR).
- Cover the period 1981 to present, including forward stream near real time
- Be global in coverage
- Be equal to or better than 0.05° spatial grid for Level 4 for resolution

- Have a consistent bias correction scheme that will enable product linkage from near real-time satellite data to historical satellite and pre-satellite era in situ data (i.e., “all the way” back in time).
- Use a “reference prime” approach based on the “best quality” satellite data, adjusted for aerosol and then adjusted on long length scales to in situ data
- Rely on the NOAA International Comprehensive Ocean-Atmosphere Data Set (ICOADS) database for in situ validation
- Rely on existing NOAA Center for Satellite Applications and Research (STAR) monitoring systems
- Be designed with consideration to user survey feedback and be tested with key NOAA stakeholders. (Improvements specifically for Great Lakes and high latitudes will likely require additional development.)
- Conform to Group for High Resolution SST (GHRSST) file format conventions for file formats and be interoperable with NOAA CoastWatch/OceanWatch/PolarWatch (aka NOAA CoastWatch) and NCEI data services.
- Be publicly served initially as best effort and transition to moderate assurance production stages through NOAA CoastWatch
- Transition to high assurance production.
- Be traceable and accessible to users through multiple data portals (assuming Cloud), including NOAA CoastWatch and NCEI.
- Be formally archived at NOAA/NCEI who assumes data stewardship responsibility.
- Undergo periodic reprocessing of the full time series as necessary to maintain product quality and consistency. NOTE: This is a fundamental requirement for maintenance and sustainment, especially as new satellite data become available and older sensors may experience degradation.
- Be described and disseminated through peer-reviewed scientific journals publications and multiple public outreach mechanisms (training course, informational articles, scientific meeting presentations, informational presentations such as workshops, conferences, Town Halls, etc.).

Table 3.5.3.1a: SST Time Series from 1981 Products Produced

Product Category	Product Generated
Water Temperature and Salinity	Sea Surface Temperature

Product Category	Product Generated
Time Series	Multiyear Reanalysis Sea Surface Temperature

Table 3.5.3.1b: Sea Surface Temperature Time Series Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
Terra MODIS	Mid-AM									
Aqua MODIS	Mid-AM									
MetOp-B AVHRR/3	Mid AM									
MetOp-C AVHRR/3	Mid AM									
MetOp-SG-A1 METimage	Mid AM									
NOAA-15_AMV_ONLY AVHRR	PM									
NOAA-18_MIRS PREICP_ONLY AVHRR	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									
S-NPP VIIRS	PM									
JPSS-4 VIIRS	PM									
GOES-16 ABI	75.2W									
GOES-17 ABI	104.6W									
GOES-18 ABI	137W									
GOES-U ABI	75.2W			X	X					
Himawari-8 AHI	140E									
Himawari-9 AHI	140E	X								
MTG-I1 FCI	0									

3.5.3.2 Primary Productivity Algorithm

The Primary Productivity Algorithm is based on ocean color chlorophyll, PAR, temperature and in the future potentially Sea Surface Height. Primary Productivity products have been made available via CoastWatch West Coast Node, daily with 12 h latency beginning in 1997 with SeaWifs and continuing today with MODIS. Funding for VIIRS transition has been initiated.

Table 3.5.3.2a: Primary Productivity Products Produced

Product Category	Product Generated
Delayed Science Time Series	*Primary Productivity*

Italics = Not currently in the NESDIS Product Baseline

Table 3.5.3.2b: Primary Productivity Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
Terra MODIS	Mid-AM									
AQUA MODIS	PM									
S-NPP VIIRS	PM									

3.5.4 Multiyear Great Lakes Color Producing Agents (CPA)

The Great Lakes CPA Algorithm uses MSL12 outputs to generate Chlorophyll, Dissolved Organic Carbon (DOC), Colored Dissolved Organic Matter (CDOM), and Suspended Minerals (SM) for the Great Lakes. Great Lakes CPA Products have been made available via CoastWatch daily with 12 h latency beginning in 2012.

Table 3.5.4a: CPA Products Produced

Product Category	Product Generated
Time Series	*Multiyear Great Lakes Color Producing Agents (NRT with delayed science mode in testing)*

Italics = Not currently in the NESDIS Product Baseline

Table 3.5.4b: CPA Flyout Chart

Satellite / Sensor	Orbit	22	23	24	25	26	27	28	29	30
S-NPP VIIRS	PM									
JPSS-4 VIIRS	PM									
NOAA-20 VIIRS	PM									
NOAA-21 VIIRS	PM									

3.5.5 Sea Ice Index

NCEI in partnership with the National Snow and Ice Data Center (NSDIC) stewards the Sea Ice Index provides a quick look at Arctic- and Antarctic-wide changes in sea ice. It is a source for consistent, up-to-date sea ice extent and concentration images, in PNG format, and data values, in GeoTIFF and ASCII text files, from November 1978 to the present. Sea Ice Index images also depict trends and anomalies in ice cover calculated using a 30-year reference period of 1981 through 2010. The Sea Ice Index is broadly used in many analyses and climate assessments and is a principal component to NOAA's Arctic Report Card.

Appendix B: Acronym Listing

AAI	Absorbing Aerosol Index
ABI	Advanced Baseline Imager
ACSPO	Advanced Clear Sky Processor for Oceans
ADT	Advanced Dvorak Technique
AGL	Above Ground Level
AHI	Advanced Himawari Imager
AIMS	Action Information Management System
AIRS	Atmospheric Infrared Sounder
ALOS	Advanced Land Observation Satellite
AM	Ante meridiem: Before noon
AMSR 2	Advanced Microwave Scanning Radiometer 2
AMSR 3	Advanced Microwave Scanning Radiometer 3
AMSU	Advanced Microwave Sounding Unit
AOD	Aerosol Optical Depth
AOT	Aerosol Optical Thickness
APP	AVHRR Polar Pathfinder
APP-x	AVHRR Polar Pathfinder-X
APSP	Aerosol Particle Size Parameter
ASCAT	Advanced Scatterometer
ASR/CSR	All-Sky Radiances/Clear-Sky Radiances
AST	Annual Surface Type

ATMS	Advanced Technology Microwave Sounder
AVHRR	Advanced Very High Resolution Radiometer
AWIPS	Advanced Weather Interactive Processing System
BAA	Bleaching Alert Area
BRDF	Bidirectional Reflectance Distribution Function
BTs	Brightness Temperatures
CCR	Configuration Change Request
CDRs	Climate Data Records
CLW	Cloud Liquid Water
CMEs	Coronal Mass Ejections
CMORPH	Climate Prediction Center MORPHing Technique
COD	Cloud Optical Depth
COSMIC-2	Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC)-2
COURL	Consolidated Observation User Requirements List
CPS	Cloud Particle Size
CRW	Coral Reef Watch
DCOMP	Daytime Cloud Optical and Microphysical Properties
DMSP	Defense Meteorological Satellite Program
DHW	Degree Heating Week
DLR	German Aerospace Center
DOE/LANL	Department of Energy/Los Alamos National Lab
dOISST	Daily Optimum Interpolation Sea Surface Temperature Dataset

DSR	Downward Shortwave Radiation at the surface
EASE	Equal-Area Scalable Earth
EDR	Environmental Data Records
EPS	Enterprise Processing System
EPS SG	EUMETSAT Polar System- Second Generation
ESA	European Space Agency
ESRL	Earth System Research Laboratory
ETOPO	Earth TOPOgraphy
eTRaP	Ensemble Tropical Rainfall Potential
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EUV	Extreme Ultraviolet
FCI	Flexible Combined Imager
FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
FDC	Fire Detection and Characterization
FOV	Field of View
FY	Fiscal Year
GAASP	GCOM-W AMSR2 Algorithm Software Processor
GAC	Global Area Coverage
GBBEP	Global Biomass Burning Emissions
CCB	Configuration Control Board
GCOM-C SGLI	Global Change Observation Mission - Climate Second generation Global Imager
GEO	Geostationary Earth Orbit

GEWEX	Global Energy and Water Exchanges
GFS	Global Forecast System
GHE	Global Hydro-Estimator
GHRSST	Group for High-Resolution SST
GL	Great Lakes
GLIMR	Geosynchronous Littoral Imaging and Monitoring Radiometer
GLM	Geostationary Lightning Mapper
GMI	GPM Microwave Imager
GOES	Geostationary Operational Environmental Satellites
GOME	Global Ozone Monitoring Experiment
GPCP	Global Precipitation Climatology Project
GPM	Global Precipitation Measurement
GPROF	Goddard PROFiling
GPS	Global Positioning System
GPSRO	GPS Radio Occultation
GSIP	Geostationary Solar Insolation Product
GVF	Green Vegetation Fraction
HEAPS	Hyper-Spectral Enterprise Algorithm Package
HIRS	High Resolution Infrared Radiation Sounder
HISA	Hurricane Intensity and Structure Algorithm
HMS	Hazard Mapping System
IASI	Infrared Atmospheric Sounding Interferometer
ICESAT	Ice, Cloud, and land Elevation Satellite

IFR	Instrument Flight Rules
IGBP	International Geosphere Biosphere
IMS	Interactive MultiSensor Snow and Ice
IODC	Indian Ocean Data Coverage
IPL	Integrated Product List
IR	Infrared
IRWIN	Infrared Window
ISCCP	International Satellite Cloud Climatology Project
IWP	Ice Water Path
JPSS	Joint Polar Satellite System
JTWC	Joint Typhoon Warning Center
km	kilometer
KOMPSAT	Korea Multi-Purpose Satellite
L3C	Level 3 Collated
LAI	Leaf Area Index
LCFA	Lightning Cluster-Filter Algorithm
LEO	Low Earth Orbit
L1b	Level 1b
L2	Level 2
LIDAR	Light Detection and Ranging
LIFR	Low Instrument Flight Rules
LPW	Layered Precipitable Water
LRA	Laser Retro-reflector Array

LST	Land Surface Temperature
MHS	Microwave Humidity Sounder
MIRS	Microwave Integrated Retrieval System
MLT	Mean Layer Temperature
MOD44W	MODIS global 250-m water mask
MODIS	Moderate Resolution Imaging Spectroradiometer
MSL12	Multi-Sensor Level 1-Level 2
MTCSWA	Multi-platform Tropical Cyclone Surface Wind Analysis
MTG	Meteosat Third Generation
MWI	Microwave Imager
MWS	Microwave Sounder
NASA	National Aeronautics and Space Administration
NCC	Near Constant Contrast
NCEI	National Centers for Environmental Information
NCEP	National Centers for Environmental Prediction
NCOMP	Nighttime Cloud Optical and Microphysical Properties
NCRS	Normalized Radar Cross Section
NESDIS	National Environmental Satellite, Data, and Information Service
NESDIS ACIO	NESDIS Chief Information Officer
NESDIS DAA	NESDIS Deputy Assistant Administrator for Satellite and Information Services
NESDIS/OSPO/SAB	NESDIS/Satellite Analysis Branch
NHC	National Hurricane Center

NISAR	NASA-ISRO Synthetic Aperture Radar
NLR	NESDIS Level Requirements
NMFS	NOAA Fisheries
NOAA	National Oceanic and Atmospheric Administration
NOSC	NOAA Observing Systems Council
NRTAVS	Near Real-Time Altimeter Validation System
NTOAST	NESDIS Total Ozone Analysis from Stratospheric and Tropospheric
NUCAPS	NOAA Unique Combined Atmospheric Processing System
NVPS	NESDIS Vegetation Product System
NWC	National Weather Center
NWP	Numerical Weather Prediction
NWS	National Weather Service
OLCI	Ocean and Land Color Instrument
OLW	Outgoing Longwave Radiation
OMPS	Ozone Mapping and Profiler Suite
OSAAP	Office of Systems Architecture and Advanced Planning
OSB	Ocean Surface Bundle
OSCAR	Observing Systems Capability Analysis and Review Tool
OSCAT	OceanSat Scatterometer
OSPO	Office of Satellite and Product Operations
OWDP	Ocean Winds Data Processing
PACE	Plankton, Aerosol, Cloud, Ocean Ecosystem

PALSAR	Phased Array type L-band Synthetic Aperture Radar
PAR	Photosynthetically Active Radiation
PATMOS-x	Pathfinder Atmosphere Extend
PERSIANN	Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks
PM	Post meridiem: After noon
PMEF	Primary Mission Essential Function
POES	Polar Operational Environmental Satellites
R2O	Research to Operations
RADS	Radar Altimeter Database System
RB SW	Geostationary Radiation Budget Shortwave
RCM	The RADARSAT Constellation Mission
RDRs	Raw Data Records
REQ	Requirement
RO	Radio Occultation
RR	Rainfall Rate
RSR	Reflected Shortwave Radiation at TOA
SAR	Synthetic Aperture Radar
SARAL	Satellite with ARgos and ALtiKa
SAROPS	SAR Automated Ocean Products System
SCA	Snow Cover Area
SCE	Snow Cover Extent
SCR	Single Channel Radiance

SD	Snow Depth
SDRs	Sensor Data Records
SEISS	Space Environment In situ Suite
SEM	Space Environment Monitor
SEVIRI	Spinning Enhanced Visible and InfraRed Imager
SFR	Global Snowfall Rate
SIRAL	SAR Interferometric Radar Altimeter
SMAP	Soil Moisture Active Passive
SMOPS	Soil Moisture Operational Product System
S-NPP	Suomi National Polar Orbiting Partnership
SO_2	Sulfur Dioxide
SRB	Shortwave Radiation Budget
SSMI	Special Sensor Microwave/Imager
SSMIS	Special Sensor Microwave Imager/Sounder
SMAP	Soil Moisture Active/Passive
SMOS	Soil Moisture and Ocean Salinity
SORCE	SOlar Radiation and Climate Experiment
SST	Sea Surface Temperature
STAR	The Center for Satellite Applications and Research
SURFALB	VIIRS Surface Albedo
SUVI	GOES Solar Ultraviolet Imager
SWE	Snow Water Equivalent
SWPC	Space Weather Prediction Center

SWO	Office of Space Weather Observations
SWFO	Space Weather Follow On
SWOT	Surface Water and Ocean Topography
Tb	Brightness Temperatures
TBD	To Be Determined
TC	Tropical Cyclone
TCDR	Thematic Climate Data Record
TOA	Top of Atmosphere
TPIO	Technology, Planning and Integration for Observation
TPW	Total Precipitable Water
TR	TROPICS Radiometers
TROPICS	Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats
UCAR	University Corporation for Atmospheric Research
US	United States
USR	Upward Shortwave Radiation at the surface
UTC	Universal Coordinated Time
UV	Ultraviolet
V8Pro	V8 Ozone Profile
V8Toz	V8 Total Ozone
VAAC	Volcanic Ash Advisory Centers
VGAC	VIIRS Global Area Coverage
VH	Vegetation Health

VIIRS	Visible Infrared Imaging Radiometer Suite
VIs	Vegetation Index Data Suite
Vis/IR	Visible Infrared
VOLCAT	Volcanic Ash Detection, Tracking and Characterization
WFABBA	Wildfire Automated Biomass Burning Algorithm
WMO	World Meteorological Organization
WV	Water Vapor

Appendix C: Assumptions

1. NESDIS Line Offices and Programs are successful in their plans for the five-year window such as those related to GEO, LEO, SWO, Enterprise Ground Systems, Product Portfolio Management, Science and Research to Operations.
2. The algorithms listed to support the products during the five-year window may be supported within available NESDIS operations, research, facility, procurement, acquisition and/or construction budgets.
3. The NESDIS Non-NOAA Data Access Policy continues to mature such that all non-NOAA satellites in the FYPP are appropriately planned for use.
4. NESDIS Procedures for changing, retiring, introducing products in response to user needs continues to mature so that product portfolios can be managed with agility.
5. NESDIS and NWS are successful in their attempts to manage Space Weather related products in similar ways to the other geophysical domains, with NWS Space Weather Prediction Center transitioning some production to NESDIS.
6. The FYPP is the primary source for information about continuity products and sustainment. Information about NESDIS services and NESDIS innovation are primarily contained in other plans.
7. Congressional and NOAA strategic priorities do not change significantly with respect to NESDIS products required during the five-year period.
8. The NESDIS Level Requirements and the NESDIS Product Baseline do not change significantly during the five-year period.
9. The NESDIS Integrated Product List accurately reflects the breadth of products generated by NESDIS.

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