

Ancillary Data at OB.DAAC

What is Ancillary Data and Why Do We Use It?

When NASA retrieves ocean color radiometry and sea surface temperature (SST) from satellite sensors, the satellite's raw measurements alone aren't enough to produce accurate science products. To improve the quality and accuracy of these retrievals, we incorporate **ancillary data** — supplementary information from external sources that helps us better characterize the conditions at the time of observation.

Ancillary data includes a wide variety of environmental information, such as:

- **Meteorological data** — wind speed, surface pressure, and relative humidity
- **Atmospheric gas concentrations** — water vapor, ozone, and nitrogen dioxide
- **Sea surface and land surface properties** — temperature, salinity, ice cover, and land/water masks

These inputs allow our processing algorithms to account for the effects of the atmosphere and ocean surface conditions on the satellite signal, ultimately yielding more accurate and reliable science products.

How Does OB.DAAC Use Ancillary Data?

Because satellites continuously acquire new data, there is often a timing challenge: the **best (optimal) ancillary data** for a given observation may not yet be available at the time of processing. To address this, NASA OBPG uses a two-step approach:

1. **Near Real-Time Processing** — When satellite data is first acquired, we process it using the best ancillary data available at that moment. This allows products to reach users quickly.
2. **Reprocessing (~1 week later)** — About one week after the initial processing, we reprocess the data using the optimal ancillary data. This refines the products and ensures the highest possible accuracy.

A Tiered System for Data Availability

Not all ancillary data sources are available all the time. To ensure continuity, OB.DAAC uses a tiered fallback system:

Priority	Description
Primary	The preferred, highest-quality data source
Backup	Used when the primary source is unavailable
Secondary	Used when neither the primary nor backup is available
Climatology (Static)	Long-term averages used as a last resort when no dynamic data is available

Types of Ancillary Data

Ancillary data at OB.DAAC falls into two broad categories: **Dynamic Sources** (data that changes over time) and **Static Sources** (fixed climatological datasets used as fallbacks).

Dynamic Sources

Dynamic sources are regularly updated datasets that reflect real-world conditions at or near the time of satellite observation. These are the preferred data sources for processing.

Meteorological Data

Meteorological conditions — particularly wind speed, surface pressure, and humidity — directly affect how light interacts with the ocean surface and atmosphere. Accurate meteorological inputs are essential for atmospheric correction of ocean color data.

Primary: GMAO MERRA-2 Meteorological Data

Our primary meteorological source is the **Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2)**, produced by NASA/Goddard's Global Modeling and Assimilation Office (GMAO). MERRA-2 is a high-quality, globally consistent reanalysis product that combines satellite and ground-based observations with model output to provide a detailed picture of atmospheric conditions over time.

- **Source:** GES DISC
- **Spatial Resolution:** 0.5° x 0.625°
- **Temporal Resolution:** 1-hourly
- **Filename Format:** GMAO_MERRA2.YYYYMMDDTHHMMSS.{MET|AER|PROFILE}.nc
- **Processing Notes:** Various GEOS 2-D datasets are aggregated to generate the OBPG product.

GMAO Forward Processing for Instrument Teams (FP-IT) Meteorological Data

When MERRA-2 data is unavailable, we turn to the **GMAO Forward Processing for Instrument Teams (FP-IT)** stream. Unlike MERRA-2, which is a retrospective reanalysis, FP-IT is a forward-processing system that uses a "semi-frozen" version of the GEOS model. This ensures long-term stability and reproducibility, making it especially useful for NASA EOS Instrument Teams who need consistent products over extended time periods.

- **Source:** GES DISC
- **Spatial Resolution:** 0.5° (lat) x 0.625° (lon)
- **Temporal Resolution:** 3-hourly
- **Filename Format:** N201919000_GMAOFP_3h.nc
- **Processing Notes:** Various GEOS 2-D datasets are aggregated to generate the OBPG product.

GMAO Forward Processing Instrument Team Profile Data

Vertical atmospheric profile data from the FP-IT system, providing information on atmospheric conditions at multiple levels of the atmosphere.

- **Source:** GES DISC
- **Spatial Resolution:** 0.5° (lat) x 0.625° (lon)
- **Temporal Resolution:** 3-hourly
- **Filename Format:** e.g., N201919000_PROFILE_GMAOFP_3h.nc

Atmospheric Composition

The composition of the atmosphere — including aerosols and trace gases — affects how sunlight passes through the atmosphere before and after reflecting off the ocean surface. Accurately characterizing these components is critical for atmospheric correction.

Primary: GMAO MERRA-2 Aerosol Data

Our primary aerosol dataset comes from **MERRA-2**, based on the off-line "MERRAero" product, which was integrated using meteorological fields from MERRA. This dataset provides detailed information on aerosol types and concentrations globally.

- **Source:** GES DISC
- **Spatial Resolution:** 0.5° (lat) x 0.625° (lon)
- **Temporal Resolution:** 1-hourly
- **Filename Format:** NYYYYDDD900_AER_MERRA2_1h.nc (e.g., N2019151900_AER_MERRA2_1h.nc)

GMAO Forward Processing Instrument Team Aerosol Data

When MERRA-2 aerosol data is unavailable, we use aerosol analyses from the **GMAO FP-IT** system, produced using a stable version of the GEOS model.

- **Source:** GES DISC
- **Temporal Resolution:** 3-hourly
- **Filename Format:** e.g., N201919003_AER_GMAOFP_3h.nc

Secondary: Real-Time Ozone Data

Ozone in the atmosphere absorbs ultraviolet light, which can affect satellite ocean color measurements. Our real-time ozone data is derived from **TOMS-like instruments**:

- **2023–present:** Data from the **AURA OMI** instrument
- **Pre-2005:** Data from **Nimbus-7 (N7TOMS)** and **Earth Probe (EPTOMS)** TOMS instruments

All ozone data is normalized based on a de-trended merged SBUV record to ensure consistency across instruments and time periods.

- **Source:** GES DISC
- **Spatial Resolution:** 1.25° x 1° (288 x 180 grid)
- **Temporal Resolution:** Daily
- **Filename Format:** NYYYYDDD00_O3_III_24h.hdf (e.g., N201918800_O3_AURAOMI_24h.hdf)

Surface Properties

Accurate characterization of the sea surface — including temperature and ice cover — is essential for both SST retrievals and ocean color atmospheric correction.

Primary: GHRSSST Level 4 CMC Global Foundation Sea Surface Temperature

Our primary SST source is the **GHRSSST Level 4 CMC** product, which merges data from multiple satellite platforms and in situ observations to produce a high-quality global SST analysis. Data sources include:

- **Infrared radiometers:** (A)TSR series from ERS-1, ERS-2, and Envisat; AVHRR from NOAA-16/17/18/19 and METOP-A
- **Microwave sensors:** TMI, AMSR-E, and Windsat
- **In situ observations:** Drifting buoys and ships from the ICOADS program

The previous day's analysis is used as the background field for statistical interpolation of new observations. This dataset follows the **GHRSSST Data Processing Specification (GDS) version 2** format.

- **Source:** PO.DAAC
- **Spatial Resolution:** 0.2° (lat) x 0.2° (lon)
- **Temporal Resolution:** Daily
- **Filename Format:** YYYMMDDHHMMSS-CMC-L4_GHRSSST-SSTfnd-CMCXdeg-GLOB-vVER-fvVER.nc (e.g., 20170317120000-CMC-L4_GHRSSST-SSTfnd-CMC0.2deg-GLOB-v02.0-fv02.0.nc)

Backup: NOAA Optimal Interpolation (OI) SST Analysis, Version 2

When the CMC GHRSSST product is unavailable, we use the **NOAA OI SST v2** product. This daily SST analysis uses in situ observations from ships and buoys along with AVHRR satellite data, applying optimum interpolation with a satellite bias correction based on 7 days of data.

- **Source:** NCEI
 - **Spatial Resolution:** 720 x 1440 (0.25°)
 - **Temporal Resolution:** Daily
 - **Filename Format:** NYYYYDDD_SST_OIV2AV_24h.nc (e.g., N2019175_SST_OIV2AV_24h.nc)
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Static Sources

Static sources are fixed climatological datasets derived from long-term averages. They serve as a **last resort** when no dynamic data is available, ensuring that processing can continue even during data outages. While not as precise as dynamic sources, these datasets provide reasonable estimates based on historical conditions.

Meteorological

Meteorological Climatology

A monthly climatological dataset used when no dynamic meteorological data or backup sources are available. Provides long-term average atmospheric conditions by month.

- **Temporal Resolution:** Monthly
- **Filename:** `met_climatology_v2014.hdf`

Atmospheric Composition

CAMS Gas Profile Data

Global monthly mean concentrations of well-mixed greenhouse gases — **methane (CH₄)**, **carbon dioxide (CO₂)**, and **nitrous oxide (N₂O)** — from the Copernicus Atmosphere Monitoring Service (CAMS). These gases play a role in radiative transfer through the atmosphere and are included in our processing algorithms.

- **Source:** Copernicus
- **Temporal Resolution:** Monthly
- **Filenames:**
 - `cams73_latest_ch4_conc_surface_satellite_dm_2019.nc`
 - `cams73_latest_co2_conc_surface_inst_2020.nc`
 - `cams73_latest_n2o_conc_surface_inst_2019.nc`
- **Data Download Instructions:** `readme.txt`

NO₂ Climatology

Nitrogen dioxide (NO₂) in the atmosphere can affect ocean color retrievals. We use a **monthly NO₂ climatology** based on data from the **Aura OMI instrument**. Daily OMI NO₂ files are averaged into monthly climatological values to fill the many gaps present in the daily data.

- **Source:** GES DISC
- **Spatial Resolution:** 0.25° x 0.25° (1440 x 720 grid)
- **Temporal Resolution:** Monthly (not year-specific)
- **Filename:** `no2_climatology_v2013.hdf`

Ozone Climatology

A monthly ozone climatology used as a last resort when no dynamic ozone data or backup sources are available.

- **Temporal Resolution:** Monthly
- **Filename:** ozone_climatology_v2014.hdf

Surface Properties

Surface property datasets help define the physical boundaries between land, water, and ice — information that is fundamental to correctly interpreting satellite observations.

Contiguous United States Land/Water Mask

A water mask covering the contiguous United States (latitudes 23°–55°N, longitudes 127°–65°W). Most values were derived from **Shuttle Radar Topography Mission (SRTM)** 1-arcsecond data, aggregated to 2-arcsecond resolution, with missing or erroneous values corrected from other sources.

- **Source:** SRTM
- **Spatial Resolution:** 2 x 2 arcseconds (111601 x 57601 grid)
- **Filename:** lwm_CONUS_SRTM60m_v3.1.nc

ETOPO1 1 Arc-Minute Global Relief Model

A compact global topography and bathymetry dataset based on **ETOPO1 Ice Surface** data, with an additional layer for surface altitude of inland water bodies.

- **Source:** NOAA
- **Spatial Resolution:** 1 x 1 arcminute (21601 x 10801 grid)
- **Filename:** ETOPO1_ocssw.nc

GEBCO 15-arcsec Global Relief Map and Land/Water Mask

A compact global surface topography and bathymetry dataset from the **GEBCO Project**, including surface altitude of inland water bodies and a land/water mask.

- **Source:** GEBCO Project
- **Spatial Resolution:** 15 x 15 arcseconds (86401 x 43201 grid)
- **Filename:** gebco_ocssw_v2020.nc

Global Land/Water Flags

A global land/water flag dataset that classifies water into **7 distinct types**. The original 15-arcsecond files have been aggregated into a single global file, using 30-arcsecond values where higher resolution is unavailable. This dataset is used specifically for **VIIRS geolocation processing**.

- **Source:** LandSeaMask_DEM
- **Spatial Resolution:** 15 x 15 arcseconds (86400 x 43200 grid)
- **Filename:** LandWater15ARC.nc

Global Land/Water Mask

A simple global land/water mask generated using the **Generic Mapping Tools (GMT)**:

```
grdlandmask -Glandmask_GMT15ARC.nc?watermask=nb -I15s -Rd -Df -N1/0
```

- **Source:** GSHHG
- **Spatial Resolution:** 15 x 15 arcseconds (86401 x 43201 grid)
- **Filename:** landmask_GMT15ARC.nc

Land Surface Albedo Climatology

A climatological dataset of land surface reflectance derived from **MODIS/Terra+Aqua** observations (2001–2017). It provides gap-filled, snow-free albedo estimates at an 8-day interval for five spectral bands (0.659, 0.858, 1.24, 1.64, and 2.13 microns). This data helps account for land surface reflectance contributions in satellite retrievals near coastlines.

- **Source:** LP DAAC
- **Spatial Resolution:** 30 arcsec (42300 lon x 21600 lat)
- **Temporal Resolution:** 8-day averages over the 2001–2017 period (46 periods per year)
- **Filename:** N2001_2017_ALBEDO_CLIM.nc

Mixed Layer Depth

The **ocean mixed layer** is the near-surface layer of the ocean where turbulence keeps temperature, salinity, and other properties relatively uniform with depth. Mixed layer depth information is used to help characterize ocean surface conditions.

- **Source:** NOAA-NODC
- **Filename:** mld_climatology_woa1994.hdf

Sea Ice Climatology

A monthly climatological sea ice dataset used when dynamic sea ice data is unavailable. Covers **two polar regions** centered on the North and South Poles.

- **Source:** NSIDC
- **Temporal Resolution:** Monthly
- **Filename:** ice_climatology.hdf

Sea Surface Salinity Climatology

A global sea surface salinity climatology used when dynamic salinity data is unavailable.

- **Source:** NOAA-NODC
- **Temporal Resolution:** 1°
- **Filename:** sss_climatology_woa2009.hdf

Sea Surface Temperature Climatology

A global SST climatology used as a last resort when no dynamic SST data is available.

- **Source:** PODAAC
- **Spatial Resolution:** 2048 (lat) x 4096 (lon)
- **Filename:** sst_climatology.hdf

Shallow Water Mask

A mask used to identify shallow water regions in satellite data processing.

- **Filename:** watermask.dat

Miscellaneous

Water Spectra

This file contains the full range of **electromagnetic wavelengths** related to water absorption and scattering coefficients. It is used in processing algorithms to accurately model how light interacts with water across different wavelengths.

- **Filename:** water_spectra.nc

For questions about ancillary data or OB.DAAC processing, please contact the OB.DAAC support team via the [Earthdata Forum](#).