Aqua Product Details for SR2026

AIRS/AMSU/HSB Products

The data record for AIRS products spans the period from August 30, 2002, to the present. For L2 and L3 AIRS V7 products, three collections are maintained: (1) an AIRS-Only collection, with neither HSB nor AMSU inputs, from August 30, 2002 to the present; (2) an AIRS+AMSU collection for the period during which AMSU-A2 was operational (i.e., from August 30, 2002 through September 23, 2016); and (3) a combined AIRS+AMSU+HSB collection for the period during which HSB was operational (i.e., from August 30, 2002 through February 5, 2003). All AIRS L2 products can be produced without HSB and/or AMSU with only a small loss in yield. In addition, AIRS NRT products (L1B and L2) are produced using combined AIRS and AMSU data along with predicted attitude and ephemeris data shortly after data acquisition and are available for the subsequent 7 days. Since the failure of AMSU-A2, L2 NRT products are produced using the AIRS-Only retrieval.

AIRS data products include L1, L2, and L3 standard and support products. The L1 algorithm maturity is very high. L1B products have been validated and exceed stability and accuracy requirements. L2 products are derived with physical retrieval algorithms using the L1B products. The L2 algorithm maturity and validation status vary depending on the product. L3 products are composed of L2 products that have been spatially and temporally binned and QC filtered to provide compact statistical summaries. The L3 algorithm maturity varies, depending on product. Refer to specific product descriptions for details.

L2 geophysical retrieval products are available from different algorithms. AIRS V6/V7 products are the standard operational AIRS data products, CLIMCAPS-Aqua provides continuity retrieval products, and JoSFRA provides infrared single footprint (13.5 km spatial resolution) retrieval products.

The AIRS products have the following hierarchy of validation levels:

Validation Level	***Description***
Provisional	Product quality is sufficient for use by the general research community, but users are urged to contact the AIRS science team before using the data in publications.
Stage 1 Validation	Product accuracy has been estimated using a small number of independent measurements obtained from selected locations and time periods and ground-truth/field program efforts.
Stage 2 Validation	Product accuracy has been assessed over a widely distributed set of locations and time periods via several ground-truth and validation efforts.
Stage 3 Validation	Product accuracy has been assessed and the uncertainties in the product well established via independent measurements in a systematic and statistically robust way representing global conditions.
Stage 4 Validation	Validation results for Stage 3 are systematically updated when new product versions are released and as the time-series expands.

Validation status for listed products is for the current public versions of all products: Version 5 or 8 for L1B, Version 6.7 for L1C, Version 5 for CO_2, Version 2 for CLIMCAPS, Version 1.16 for TROPESS, Version 2 for data fusion products, Version 2 for Obs4MIPS, and Version 6 or Version 7 for all others.

The primary AIRS data users are the weather forecast and applications communities, and the scientific analysis and modeling communities. National and international global weather prediction centers (e.g., NOAA NWS, U.S. Navy, ECMWF, United Kingdom Meteorological Office) and NASA's GMAO, receive NRT feeds of AIRS data products through the services of NASA and NOAA NESDIS using processing software developed by the AIRS Project. Some of these organizations (e.g., ECMWF, GMAO) also produce reanalysis data sets that incorporate AIRS data. The scientific analysis and modeling communities obtain AIRS data from the GES DISC. These data products are produced using software developed by the AIRS Project. AIRS L1B and L2 data products are additionally available through direct broadcast receiving stations on a real-time basis using executable versions of the same software.

AIRS Infrared Radiance Product (Level 1B)

The AIRS infrared radiance product is a core-mission product consisting of the calibrated and geolocated observed TOA radiance spectra at AIRS IR instrument spatial resolution (13.5 km diameter instantaneous field of view [IFOV] at nadir expanding to 41 km x 21.4 km at the 49.5° scan limit). The spectrum contains 2378 IR channels (frequencies) at a resolution of $\Delta\nu/\nu = 1/1200$ spanning from 3.74 μm to 15.4 μm, with some gaps. The radiometric accuracy is 0.2 K and its stability is better than 2 mK/yr. Absolute spectral accuracy is $\delta\nu/\nu = 10^{-6}$ with a stability better than 10^{-7} per year. The product includes an SO_2 flag and an aerosol/dust flag. The AIRS L1B product is currently read by all AIRS L2 retrieval systems.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 - present	AIRS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NOAA NWS, NOAA NESDIS, NWP centers worldwide, NASA (incl. GMAO), WMO, science and applications community	GES DISC, NOAA/NESDIS, and by direct broadcast	

AIRS Infrared Quality Assurance Product (Level 1)

The AIRS IR quality assurance product is a core-mission product designed to facilitate ordering and selection of AIRS IR data. This product is much smaller than the AIRS IR radiance product, as it only contains quality assurance, geolocation, and other metadata. Data users can review the quality assurance product to determine which subset of the AIRS IR radiance product to use.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 - present	AIRS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

AIRS Visible/Near-IR Radiance Product (Level 1B)

The AIRS visible/NIR radiance product is a core-mission product consisting of calibrated and geolocated observed TOA radiance spectra at AIRS visible/NIR instrument spatial resolution (2.3 km at nadir). The spectrum contains 4 channels in the 0.4 μm to 1.0 μm region. The primary purpose of the visible/NIR channels is the detection and flagging of significant inhomogeneities in the AIRS infrared field-of-view. The absolute radiometric accuracy is 10%-15%.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 - present	AIRS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	

NASA (including for diagnostics), science and applications community	GES DISC and by direct broadcast*

**AIRS Visible/NIR radiance products are only available at the GES DISC for daytime observations; granules composed entirely of nighttime observations are not archived.*

AIRS Visible/Near-Infrared Quality Assurance Product (Level 1)

The AIRS visible/NIR quality assurance product is a core-mission product designed to facilitate data ordering and selection of AIRS visible/NIR data. This product is much smaller than the AIRS visible/NIR radiance product, as it only contains quality assurance, geolocation, and other metadata. Data users can review the quality assurance product to determine which subset of the AIRS visible/NIR radiance product to use.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 - present	AIRS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

AMSU Radiance Product (Level 1B)

The AMSU radiance product is a core-mission product that consists of the calibrated and geolocated observed TOA radiance spectra at AMSU instrument spatial resolution (40.5 km diameter IFOV at nadir), converted to T_b. The radiometric accuracy is 1-2 K. The product contains 13 MW channels in the 50-90 GHz frequency range (AMSU-A1), providing temperature sounding and moisture data, and two channels in the 23-32 GHz range (AMSU-A2), providing surface and moisture information (total precipitable water and cloud liquid water). AMSU is primarily a coarse vertical resolution temperature sounder providing atmospheric information within and below clouds.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
5/21/2002 – present *	AMSU	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NOAA NWS, NOAA NESDIS, NASA GMAO, NWP centers, NASA, science/applications community	GES DISC, NOAA/NESDIS, and by direct broadcast	

**note that the AMSU-A Channel 4 data since April 2008 are considered too noisy for use and that AMSU-A Channel 5 noise level progressively degraded throughout 2012 and is now considered too noisy for use in L2 processing as well; AMSU-A Channel 7 noise exceeded noise specifications at launch and has never been used; AMSU-A2 (AMSU-A Channels 1 and 2) failed on September 23, 2016.*

HSB Radiance Product (Level 1B)

The HSB radiance product is a core-mission product that consists of the calibrated and geolocated observed TOA radiance spectra at HSB instrument spatial resolution (13.5 km diameter IFOV at nadir), converted to T_b. The radiometric accuracy is 1.5 K. The product contains 4 MW channels in the 150-190 GHz range. HSB is primarily a coarse vertical resolution tropospheric moisture sounder (183 GHz) providing information on snow and ice cover and precipitation (150 GHz).

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
5/24/2002 – 2/5/2003	HSB	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	

NASA, science and applications community; no longer used operationally	GES DISC

AIRS L1B and L1C Calibration Subset Product (Level 1B)

The AIRS calibration data subset (ACDS or CalSub) product is a core-mission, specialized matchup data product that contains full-spectrum attributes from collocated footprints of AIRS IR, AIRS visible/NIR, and AMSU radiance products, as well as geolocation and other metadata. The CalSub has been designed to facilitate study of calibration and stability of AIRS data products over time. Together with analogous products for IASI and CrIS from the Sounder SIPS, it is used for intercomparisons. The CalSub itself consists of two collections of radiance products: (1) summary L1B, and (2) full random L1C. While a complete day's coverage of AIRS radiance files consists of nearly 750 data files, a single CalSub file that covers a 24-hour period from midnight to midnight in UTC can be used to characterize a day of data.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30-2002 - present	AIRS and AMSU-A	Validated Stage 3
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, science and applications community		GES DISC

AIRS L1C Infrared Radiance Spectra Product (Level 1C)

The AIRS IR radiance spectra product (L1C) consists of the calibrated and geolocated observed TOA radiance spectra at AIRS IR instrument spatial resolution. The spectrum is resampled to a fixed grid with a spectral stability of better than $\delta\nu/\nu = 10^{-7}$. The spectrum is expanded from the 2378 instrument IR channels (frequencies) to 2645. Gaps are filled and noisy detectors are replaced by a principal component reconstructed value. All synthesized values are flagged. The expanded spectrum enhances the usefulness of the data for climate studies and radiometric comparisons with broadband instruments like MODIS or GOES. Adjustments are also made to compensate for small shifts in the instrument's frequency calibration.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30-2002 - present	AIRS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

CHIRP (Level 1)

The Climate Hyperspectral Infrared Radiance Product (CHIRP) is a Level 1 radiance product derived from AIRS on EOS-AQUA and the Cross-Track Infrared Sounders (CrIS) on the SNPP and JPSS-1+ platforms. CHIRP provides daily calibrated IR radiance spectra with a consistent spectral response function (SRF) across all instruments. CHIRP provides a full radiance record from 2002 onwards starting with AIRS from 2002 to 2016, switching to the SNPP CrIS instrument on September 1, 2016 and to JPSS-1 CrIS radiances starting September 1, 2018. Inter-instrument radiometric offsets are removed with SNPP-CrIS chosen as the "standard". CHIRP contains all information needed for retrievals.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
9/1/2002 – present (AIRS up to 8/30/2016, CrIS thereafter)	AIRS, CrIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

AIRS Atmospheric Temperature Product (Level 2)

The AIRS atmospheric temperature product is a core-mission product that consists of the atmospheric temperature profile, SAT, and heights of the tropopause and top of the boundary layer for the following combinations of L1 data: AIRS+AMSU+HSB, AIRS+AMSU, and AIRS-Only. The L2 standard temperature profile is reported on 28 pressure levels and has a RMS accuracy of 1 K per km and has been validated to meet documented accuracy goals for all regions from the equator through the polar regions. Except for the AIRS-only version of the L2 product, a separate MW-only profile is also provided. The spatial resolution is 45 km at nadir for all L2 temperature products.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB*	Validated Stage 4
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA (incl. SPoRT), NSF NCAR, NOAA, DOD, IPCC/UN, science and applications community		GES DISC and by direct broadcast

AIRS Atmospheric Moisture Product (Level 2)

The AIRS atmospheric moisture product is a core-mission product that consists of the water vapor mass mixing ratio profile, the water vapor saturation mass mixing ratio profile, the RH profile, the total precipitable water vapor, near-surface water vapor and VPD. As with the L2 temperature product, three varieties of Atmospheric Moisture Products are available based on which L1 products were used: AIRS+AMSU+HSB, AIRS+AMSU, or AIRS-Only. The L2 standard moisture profile is accurate to 15% per 2 km in the troposphere, and the total precipitable water vapor is accurate to 5%. Like the L2 temperature product, the moisture product has been validated to meet documented accuracy goals for all regions from the equator through the polar regions. A separate MW-only precipitable water vapor burden is also provided for both the AIRS+AMSU+HSB and AIRS+AMSU product variants. Version 7 reports profiles on 15 pressure levels, both as layer quantities and as level quantities. The spatial resolution is 45 km at nadir.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB*	Validated Stage 4
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA (incl. SPoRT), NSF NCAR, NOAA, DOD, IPCC/UN, science and applications community		GES DISC and by direct broadcast

AIRS Atmospheric Minor Constituents Product (Levels 1 and 2)

The AIRS atmospheric minor constituents product is a core-mission product that consists of the atmospheric volume mixing profile and total burden of O_3, volume mixing ratio profiles of CO and CH_4, a volume mixing ratio of mid-troposphere CO_2, and flags for SO_2 and dust/aerosols. The spatial resolution at nadir of the O_3, CO, and CH_4 products is 45 km. The spatial resolution at nadir of the CO_2 product is 90 km. The spatial resolution at nadir of the dust/aerosol and SO_2 flags is 13.5 km.

Ozone*:* The O_3 profile is reported on the standard 28 pressure levels with an accuracy of 20% (70-250 hPa). The burden is accurate to 5%.

Carbon Monoxide*:* The CO profile is reported on 28 atmospheric levels with an accuracy of 15% over 9 layers. The layers were identified by a study of the retrieval vertical sensitivity to CO.

Methane*:* The CH_4 profile is reported on 28 levels and 10 layers. The layers were identified by a study of the retrieval vertical sensitivity to CH_4. The AIRS Version 6 methane products have been validated against aircraft observations.

Sulfur Dioxide: The AIRS algorithm determines the presence or absence of S_2O. Fields of view (FOVs) in which SO_2 is detected are flagged in the L1B product.

Dust and Aerosols*:* The AIRS algorithm determines the presence or absence of dust and aerosols. FOVs in which dust or aerosols are detected are flagged in the L1B product. The Version 5 dust flag has been validated against in situ observations and compared with similar quantities from other sensors in the A-Train.

AIRS Carbon Dioxide – mid-Troposphere*:* AIRS provides CO_2 volume mixing ratio for the mid-troposphere (300-500 hPa) and averaging kernel. Version 5 data have been validated against in situ aircraft data.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB) CO Mid-Tropo: 8/30/2002–2/28/2017 (AIRS+AMSU, AIRS-Only)	AIRS, AMSU, HSB	O_3, CO: Validated Stage 3 CH_3, CO_2 Mid-Tropo: Validated Stage 2 SO_2, Dust & Aerosols: Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NOAA, NASA, ESA, AWC, IPCC/UN, science and applications community	GES DISC and by direct broadcast	

AIRS Cloud Product (Level 2)

The AIRS cloud product is a core-mission product that consists of fractional cloud cover, cloud-top height, and cloud-top temperature for up to two cloud formations within each AIRS footprint, with a spatial resolution of 15 km at nadir. Their respective requirements are 5%, 0.5 km, and 1 K. Comparisons to CloudSat and MODIS data indicate the cloud product meets mission requirements.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, IPCC/UN, science and applications community	GES DISC	

AIRS Surface Product (Level 2)

The AIRS surface product is a core-mission product that consists of surface skin temperature, IR surface emissivity, and reflectivity at selected frequencies, MW surface classification, and MW emitted radiance surface brightness and surface emissivity at selected frequencies. These products are all at a spatial resolution of 45 km at nadir. The AIRS surface skin temperature is accurate to 1 K over non-

frozen ocean. The AIRS surface skin temperature and emissivity products have been validated against in situ data in several desert regions.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB	Skin Temp (ocean): Validated Stage 3 Skin Temp (land): Validated Stage 2 Emissivity & Brightness Temp: Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC and by direct broadcast	

AIRS Thermodynamic/Ice Cloud Products (Level 2)

The AIRS thermodynamic/ice cloud product consists of four cloud properties: cloud thermodynamic phase, ice COT, ice cloud effective diameter, and effective ice cloud top temperature.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

AIRS Cloud-Cleared Radiance Product (Level 2)

The AIRS cloud-cleared radiance product is a core-mission product that consists of the cloud-cleared IR radiance spectrum at AMSU geospatial resolution, 45 km at nadir. The cloud cleared radiances are accurate to better than 1 K.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

AIRS Cloudy and Clear-sky Outgoing Longwave Radiation Product (Level 2)

The AIRS outgoing longwave radiation product consists of spectrally integrated cloudy OLR and clear-sky OLR at AMSU geospatial resolution, 45 km at nadir. Climatologies of CERES and AIRS Version 5 OLR are in good agreement

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

AIRS Precipitation Estimate Product (Level 2G)

The precipitation estimate from AIRS is intended for merging into the precipitation product of GPCP. It is derived from the AIRS L2 Support product, and the 6-minute swath granules (240 per day) are combined into one daily "L2G" global grid where every hour is a "layer", and the grid cell size is 0.25 degrees, to fit with TRMM products. Since AIRS precipitation is retrieved at about 45 km resolution at nadir, many grid cells in this 0.25-degree grid are "empty".

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
9/1/2002 – present	AIRS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
GPCP data users & science and applications community	GES DISC	

AIRS Near-Real Time Geophysical Products (Level 2)

AIRS NRT products are produced by the same core science algorithms as in the routine science data production but using predicted ephemeris in place of definitive ephemeris and the NRT processing proceeds whether the previous or subsequent Level 1B granules are present or not or whether the forecast surface pressure is present. The advantage of NRT data is its fast turnaround time, generally available within 3 hours of observations globally. They can be utilized in regional weather forecast models as well as in support of field campaigns. The NRT products include temperature, moisture, minor constituents, cloud, surface, cloud-cleared radiances and other L2 variables.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
Near-Real Time data are available on a rolling archive with the approximate 7 most recent days available.	AIRS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NWP centers, NOAA, NASA, AIRS applications (drought/volcano tool), science and applications community	GES DISC	

AIRS Level 3 Averaged Product

The L3 averaged product is a core-mission product composed of selected parameters (based on the associated quality indicator) from all L2 products that have been QC filtered and spatially and temporally averaged into 1° x 1° grid cells over the entire globe, closely matching the scheme utilized by the Television and Infrared Observation Satellite (TIROS) TOVS Pathfinder. Daily and monthly L3 products are produced. The content of the L3 averaged product includes the number of sample values and the mean of sample values. Researchers may therefore combine daily results over any chosen time span to derive the means of the gridded parameters in each cell. There are two sets of L3 products for the standard L2 products: (1) Products that have been independently QC filtered as in Version 5, and (2) products that have been jointly QC filtered for temperature and atmospheric moisture. The latter, referred to as TQ-joint filtered, were designed to support climate studies and climate modeling applications requiring thermodynamically consistent temperature and humidity.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB	L3 products Validated Stage 2-4 based on L2 Validation
Primary NASA and/or operational agency users	*Availability and location of the product*	

NASA, IPCC/UN, science and applications community	GES DISC

AIRS Level 3 Monthly Spectral OLR Product

The L3 monthly spectral OLR product provides spectrally resolved OLR, spatially gridded in 2° x 2° grid cells. This product has been compared against OLR products from CERES and from model reanalyses. Spectrally resolved OLR contains information about trends in narrow bands or opposing trends in different bands. Both types of trends may be undetectable in band-averaged OLR. Spectral OLR products are especially well suited to evaluating climate models, which have comparably coarse spectral resolution and well-recognized opposing trends in different spectral bands.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present	AIRS	Validated Stage 4
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, science and applications community		GES DISC

AIRS Obs4MIPS Atmospheric Temperature and Humidity Products (Level 3)

Obs4MIPs strives to make observational products more accessible for climate model intercomparisons, intended for users who wish to compare satellite derived observations with climate model outputs (from CMIP models in particular). The AIRS Obs4MIPs Version 2 datasets are based on the AIRS Version 6 L3 standard monthly products. Monthly averages of AIRS/AMSU retrieved profiles are provided for temperature, specific and RH, in 1° x 1° latitude and longitude boxes on CMIP6 mandatory pressure levels.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
9/1/2002–8/31/2016 (AIRS+AMSU)	AIRS and AMSU	Based on AIRS/AMSU L3 data: Validated Stage 3
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, science and applications community, Earth System modeling centers		Earth System Grid Federation

CLIMCAPS-Aqua Atmospheric Temperature Product (Level 2)

The CLIMCAPS-Aqua atmospheric temperature product consists of the atmospheric temperature profile, SAT, and tropopause height for the following combinations of L1 data: AIRS+AMSU, and AIRS-Only. The L2 standard temperature profile is reported on 100 pressure levels.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU)	AIRS and AMSU	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

CLIMCAPS-Aqua Atmospheric Moisture Product (Level 2)

The CLIMCAPS-Aqua atmospheric moisture product consists of profiles of water vapor column densities, total precipitable water vapor, and derived relative and specific humidity profiles. As with the L2 temperature product, two varieties of Atmospheric Moisture Products are available based on which L1 products were used: AIRS+AMSU, or AIRS-Only. A separate MW-only precipitable water

vapor burden is also provided for the AIRS+AMSU product variant. V2 reports column densities on 100 pressure layers. The spatial resolution is 45 km at nadir.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU)	AIRS and AMSU	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

CLIMCAPS-Aqua Atmospheric Minor Constituents Product (Level 2)

The CLIMCAPS-Aqua atmospheric minor constituents product consists of atmospheric profiles of O_3, CO and CH_4 layer densities and mixing ratios, CO_2 mixing ratio profiles, and layer density profiles for HNO_3, N_2O, and SO_2. The spatial resolution at nadir of the minor constituent products is 45 km.

Ozone*:* The O_3 profile is reported as layer densities on 100 pressure layers. A derived mixing ratio profile is also provided on 100 pressure levels.

Carbon Monoxide*:* The CO profile is reported as layer densities on 100 pressure layers. A derived mixing ratio profile is also provided on 100 pressure levels.

Methane*:* The CH_4 profile is reported as layer densities on 100 pressure layers. A derived mixing ratio profile is also provided on 100 pressure levels.

Carbon Dioxide*:* The CO_2 profile is reported on 100 pressure levels.

Nitric Acid: The HNO_3 profile is reported as layer densities on 100 pressure layers.

Nitrous Oxide: The N_2O profile is reported as layer densities on 100 pressure layers.

Sulfur Dioxide: The SO_2 profile is reported as layer densities on 100 pressure layers.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU)	AIRS and AMSU	O_3: Validated Stage 2 CH_4, CO, CO_2, HNO_3, N_2O, SO_2: Provisional
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

CLIMCAPS-Aqua Cloud Product (Level 2)

The CLIMCAPS-Aqua cloud product consists of fractional cloud cover, cloud-top pressure, and cloud-top temperature, reported at a horizontal resolution of 15 km at nadir (AIRS footprint). Cloud top properties in AIRS footprints are constrained to the same temperature profile retrieved over the 45 km AMSU footprint.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU)	AIRS and AMSU	Provisional

Primary NASA and/or operational agency users	*Availability and location of the product*
NASA, science and applications community	GES DISC

CLIMCAPS-Aqua Surface Product (Level 2)

The CLIMCAPS-Aqua surface product consists of surface skin temperature, IR surface emissivity, and reflectivity at selected frequencies. These products are all at a spatial resolution of 45 km at nadir.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU)	AIRS and AMSU	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

CLIMCAPS-Aqua Cloud-Cleared Radiance Product (Level 2)

The CLIMCAPS-Aqua cloud-cleared radiance product consists of the cloud-cleared IR radiance spectrum at AMSU geospatial resolution, 45 km at nadir.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU)	AIRS and AMSU	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

CLIMCAPS-Aqua Level 3 Averaged Product

The L3 averaged product is composed of selected parameters (based on the associated quality indicator) from all L2 products that have been QC filtered and spatially and temporally averaged into 1° x 1° grid cells over the entire globe, closely matching the scheme utilized by TIRO TOVS Pathfinder. Daily and monthly L3 products are produced. The content of the L3 averaged product includes the number of sample values and the mean of sample values. Researchers may therefore combine daily results over any chosen time span to derive the means of the gridded parameters in each cell. There are two sets of L3 products: (1) with specific quality control, dependent on variable and level, and (2) with comprehensive quality control ensuring consistent analysis across variables and levels.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU)	AIRS and AMSU	L3 products: provisional or validated to stage 1 based on L2 validation
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

JoSFRA AIRS-Aqua Atmospheric Temperature Product (Level 2)

The Joint Single Footprint Retrieval Algorithm (JoSFRA) Level-2 geophysical parameters include estimates of atmospheric temperature profiles and surface temperature, retrieved from AIRS infrared spectra. The JoSFRA algorithm uses an optimal-estimation scheme and retrieves geophysical quantities from AIRS thermal infrared spectra at their native horizontal resolution. Cloud observations

from MODIS are used in the forward model without recourse to a cloud-cleared state. JOSFRA retrievals provide improved spatial resolution (13.5 km vs 50 km for cloud-cleared retrievals) and information content quantification, making them well-suited for process studies.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
Selected periods during 2002 – 2019. Additional data requests can be made.	AIRS & MODIS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

JoSFRA AIRS-Aqua Water Vapor Products (Level 2)

The JoSFRA Level-2 water vapor profiles are retrieved from AIRS infrared spectra. The JoSFRA algorithm uses an optimal-estimation scheme and retrieves geophysical quantities from AIRS thermal infrared spectra at their native horizontal resolution. Cloud observations from MODIS are used in the forward model without recourse to a cloud-cleared state. JOSFRA retrievals provide improved spatial resolution (13.5 km vs 50 km for cloud-cleared retrievals) and information content quantification, making them well-suited for process studies.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
Selected periods during 2002 – 2019. Additional data requests can be made.	AIRS & MODIS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

TROPESS AIRS-Aqua Atmospheric Temperature Product (Level 2)

The NASA TRopospheric Ozone and Precursors from Earth System Sounding (TROPESS) project, uses an optimal estimation algorithm, known as the MUlti-SpEctra, MUlti-SpEcies, Multi-SEnsors (MUSES) to produce the TROPESS AIRS-Aqua L2 Atmospheric Temperature product, which contains the vertical distribution of the retrieved atmospheric state of temperature, formal uncertainties, and diagnostic information measured by the AIRS instrument. The forward stream standard product is global for the time period from 2021-02-01 to present. The data have a spatial resolution of 15 km (AIRS nadir FOV), and are reported at 31 vertical levels from the surface to 0.1 hPa.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
2/21/2021 – present	AIRS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

TROPESS AIRS-Aqua Water Vapor Products (Level 2)

The NASA TROPESS project uses the MUSES optimal estimation algorithm to produce the TROPESS AIRS-Aqua L2 Water Vapor products, which contain the vertical distribution of the retrieved atmospheric state of water vapor, formal uncertainties, and diagnostic information measured by the AIRS instrument. The forward stream standard product is global for the time period from 2021-02-01 to present. The data have a spatial resolution of 15 km, and are reported at 17 vertical levels from the surface to 0.1 hPa.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*

2/21/2021 - present	AIRS	Validated Stage 1
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, science and applications community		GES DISC

TROPESS AIRS-Aqua Atmospheric Minor Constituents Products (Level 2)

The NASA TROPESS project uses the MUSES optimal estimation algorithm to produce the TROPESS AIRS-Aqua L2 minor constituents products, which contain the vertical distribution of the retrieved atmospheric state of O_3, CH_4, CO, deuterated water vapor and NH_3, formal uncertainties, and diagnostic information measured by the AIRS instrument. The forward stream standard products are global for the time period from 2021-02-01 to present. The data have a spatial resolution of 15 km (AIRS nadir FOV), and are reported at 26 (O_3 and CH_4), 14 (CO), 17 (HDO) or 15 (NH_3) vertical levels from the surface to 0.1 hPa.

Ozone*:* The O_3 profile is reported on 26 pressure levels. The profiles have been validated against a global set of O_3 sonde measurements over multiple years.
Carbon Monoxide*:* The CO profile is reported on 14 pressure levels. The product has been validated using pole-to-pole profile measurements from the HIPPO and ATom aircraft campaigns as well as NOAA profile measurements over the US for multiple years.

Methane*:* The CH_4 profile is reported on 26 levels. The product has been validated using pole-to-pole profile measurements from the HIPPO and ATom aircraft campaigns as well as NOAA profile measurements over the US for multiple years.

Deuterated Water Vapor*:* The profile of deuterated water vapor is reported on 17 levels. The product has been validated using aircraft campaign measurements.

Ammonia*:* The profile of NH_3 is reported on 14 levels. The product has been validated using aircraft campaign measurements.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
2/21/2021 - present	AIRS	O_3, CO, CH_3: Validated Stage 2 Deuterated Water Vapor, NH_3: Validated Stage 1
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, science and applications community		GES DISC

TROPESS AIRS-Aqua and OMI-Aura Ozone Product (Level 2)

The NASA TROPESS project uses the MUSES optimal estimation algorithm to produce the TROPESS AIRS-Aqua and OMI-Aura L2 O_3 product. The product contains the vertical distribution of the retrieved atmospheric state of O_3, formal uncertainties, and diagnostic information measured by the AIRS instrument on Aqua and the OMI instrument on Aura. The forward stream standard product is global for the time period from 2021-02-01 to present. The data have a spatial resolution of 13 km x 24 km (OMI nadir FOV), and are reported at 26 vertical levels from the surface to 0.1 hPa.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
2/21/2021 – present	AIRS and OMI	Validated Stage 2
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, science and applications community		GES DISC

AIRS and CrIMSS Spatial Statistical Data Fusion Near-Surface Atmospheric Temperature Product (Level 3)

Estimates of SAT are produced with the Spatial Statistical Data Fusion (SSDF) algorithm, fusing data from AIRS with data from CrIMSS instruments on SNPP. These are daily (day/night) products on a ¼ x ¼ degree latitude/longitude grid covering the continental U.S. Performing the data fusion involves filtering input data, matching the remote sensing datasets to an in situ dataset taken as a truth estimate, characterizing bias and variance relative to the truth estimate, and performing the spatial statistical data fusion, inferring a value for each grid point based on nearby and distant values of the input L2 datasets and variance estimates. An additional SAT product is provided by performing the same algorithm using AIRS as the only remote sensing input dataset.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/31/2002 – 12/31/2020 (AIRS-Only) 11/28/2012 - 12/31/2020 (AIRS+CrIMSS)	AIRS and AMSU	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

ClimFISP

The Climate Fingerprinting Sounder Product (ClimFiSP) Version 2 provides Level 3 daily and monthly atmospheric data including temperature profiles, water vapor, ozone, cloud properties, as well as surface properties, including skin temperature and emissivity. Data are available on a ½ by ½ degree grid. These geophysical variables are derived, via the ClimFiSP retrieval algorithm, from the Climate Hyperspectral Infrared Radiance Product (CHIRP), a Level 1 radiance product that harmonizes measurements from three different infrared sounding instruments: the AIRS sensor on EOS-Aqua and the CrIS sensors on the Suomi-NPP and NOAA-20 (JPSS-1) satellites. All three platforms follow similar sun-synchronous orbits, with ClimFiSP daily records including data for both the ascending (1:30 p.m.) and descending (1:30 a.m.) orbit passes. ClimFiSP retrievals derived from each instrument are provided separately to facilitate detection of potential radiance biases between the CHIRP-AIRS and CHIRP-CrIS data records, and to evaluate their impact on the long-term data record formed by merging AIRS and CrIS data.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
9/1/2002 – present	AIRS and CrIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

AIRS Drought Products

Anomalies of near-surface quantities, temperature, RH, and VPD are provided as percentiles relative to a climatology based on the AIRS record from 2002 to the present. The percentiles are binned into 7-day, 14-day, 28-day, and 56-day averages and updated and delivered weekly, on a 1/2-degree latitude-longitude grid, covering the continental US. The products are formatted for use as part of the United States Drought Monitor (USDM).

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/2018 (some from 2017) – present, using climatology: 9/2022 –present	AIRS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NDMC for USDM, drought community	JPL, available for NDMC	

AIRS Quantization Products

The AIRS/Aqua Level 3 quantization products are distributional summaries derived from the Level-2 standard retrieval products (of swath type) to provide a more comprehensive set of statistical summaries than the traditional means and standard deviation. The products combine the Level 2 standard data parameters over grid cells of 5 x 5 deg spatial extent for temporal periods of five days or one month. They preserve the multivariate distributional features of the original data and so provide a compressed data set that more accurately describes the disparate atmospheric states that are in the original Level 2 swath data set. The geophysical parameters are: Air Temperature and Water Vapor profiles (11 levels/layers), Cloud fraction (vertical distribution).

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
8/30/2002 – present (AIRS-Only) 8/30/2002–9/23/2016 (AIRS+AMSU) 8/30/2002-2/5/2003 (AIRS+AMSU+HSB)	AIRS, AMSU, HSB	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, science and applications community	GES DISC	

AMSR-E Products

The Aqua AMSR-E data record extends from June 20, 2002 to September 2011. All the AMSR-E algorithms have been validated, and all the AMSR-E data products can be obtained from the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado, at nsidc.org (more specifically at https://nsidc.org/data/amsre/data_summaries/index.html). The primary AMSR-E data users include the international scientific community and a wide variety of agencies throughout the world. The product names and descriptions here are those approved by the AMSR-E Science Team in 2017, shortly before the AMSR-E Team was disbanded, following the successful completion of the AMSR-E program. Added is bracketed information after the product names, to indicate the data available at nsidc.org, which additionally archives the AMSR-E brightness temperature data.

Columnar Cloud Water over the Ocean [daily, weekly, and monthly L3 data on 0.25° x 0.25° grid available at nsidc.com]

The AMSR-E columnar cloud water product is a core-mission measure of the total vertically integrated liquid cloud water in the marine atmosphere. The spatial resolution is 12 km, and the RMS accuracy at this resolution is 0.02 mm. The product is produced for individual pixels across the AMSR-E swath (Level 2) and on an Earth grid (0.25º in latitude and longitude), averaged daily, weekly, and monthly (Level 3). The retrieval algorithm is based on a radiative transfer model and on experience with previous microwave radiometers. The performance of the algorithm is assessed through comparisons with computer simulations and clear sky infrared retrievals.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
UoH SOEST, IPRC, CLIVAR, Royal Australian Navy, Directorate of Oceanography & Meteorology	NSIDC	

Columnar Water Vapor over the Ocean [daily, weekly, and monthly L3 data on 0.25° x 0.25° grid available at nsidc.com]

AMSR-E columnar water vapor is a core-mission measure of the total vertically integrated water vapor in the marine atmosphere. The spatial resolution is 24 km, and the RMS accuracy at this resolution is 1.0 mm. This product is produced for individual pixels across the AMSR-E swath (Level 2) and on an Earth-grid (0.25º in latitude and longitude) averaged daily, weekly, and monthly (Level 3). The retrieval algorithm is based on a radiative transfer model. The performance of the algorithm is assessed using computer simulations, radiosonde measurements, and Global Positioning System (GPS) water vapor measurements.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
UoH SOEST, IPRC, CLIVAR, Royal Australian Navy, Directorate of Oceanography & Meteorology	NSIDC	

Sea Surface Temperature (SST) [daily, weekly, and monthly L3 data on 0.25° x 0.25° grid available at nsidc.com]

AMSR-E SST is a core-mission product indicative of the water temperature at a depth of about 1 mm. This product is retrieved at two spatial resolutions, 38 and 56 km, with an RMS accuracy of 0.5 K. The SST product is produced for individual pixels across the AMSR-E swath (Level 2) and on an Earth grid (0.25º in latitude and longitude) averaged daily, weekly, and monthly (Level 3). It is available in all weather conditions except rain. The retrieval algorithm is based on a radiative transfer model; and the performance of the algorithm is assessed by comparison with the Reynolds' Optimum Interpolation (OI) SST product and moored and drifting buoys.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature
Primary NASA and/or operational agency users		*Availability and location of the product*
NOAA NESDIC NCDC, NRL FNMOC, NAVOCEANO, DoD JTWC, NASA EO, Scripps Institution of Oceanography, UoH SOEST, IPRC, CLIVAR, JAMSTEC, UK Met Office, Météo-France/Centre de Météorologie Spatiale, Australian Bureau of Meteorology, Royal Australian Navy, Directorate of Oceanography & Meteorology		NSIDC

Sea Surface Wind Speed [daily, weekly, and monthly L3 data on 0.25° x 0.25° grid available at nsidc.com]

AMSR-E sea surface wind speed is a core-mission product calculated over the ocean and reflecting the neutral stability wind at 10 m above the surface. This product is retrieved at two spatial resolutions, 24 and 38 km, with an RMS accuracy of 1 m/s. Only the scalar wind speed is retrievable, not the wind direction. The product is produced for individual pixels across the AMSR-E swath (Level 2) and on an Earth grid (0.25º in latitude and longitude) averaged daily, weekly, and monthly (Level 3). It is available for both clear and cloudy conditions but not for areas experiencing rain. Retrieval accuracies are determined through comparisons with scatterometer retrievals and moored buoy measurements of wind speed.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature

Primary NASA and/or operational agency users	*Availability and location of the product*
NASA GSFC, NOAA NESDIC NCDC, NOAA NWS, UoH SOEST, IPRC, CLIVAR, JAM NPD, JAFIC, Risø National Laboratory, Denmark, Royal Australian Navy, Directorate of Oceanography & Meteorology	NSIDC

Instantaneous Rainfall [L2B global swath data available at nsidc.com]

AMSR-E instantaneous rainfall is a core-mission product produced by matching the observed brightness temperature to a database of a priori cloud profiles derived from a variety of sources including cloud dynamical models and ground-based radars. Calculation of rainfall over oceans uses all AMSR-E channels, whereas the algorithm for rainfall over land is restricted to high frequency channels that detect brightness temperature depressions due to ice scattering. Despite the differences, the Land and Ocean rainfall algorithms have been combined into a single framework in the Level 2 rainfall product, which is provided at 12 km spatial resolution. The instantaneous rainfall product was validated over oceans by using the TRMM rainfall radar. Over land, ground radars and rain gauge networks are the most common validation tools.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature

Primary NASA and/or operational agency users	*Availability and location of the product*
NASA GSFC, NOAA, NRL FNMOC	NSIDC

Monthly Rainfall [monthly L3 data on 5° x 5° grid available at nsidc.com]

AMSR-E monthly rainfall is a core-mission Level 3 product that consists of mean monthly rainfall amounts in 5° x 5° boxes. The accuracy of the product is estimated at 1 mm/day or 20% (whichever is greater) over the ocean and 2 mm/day or 40% (whichever is greater) over land. Monthly accumulations are produced by simply summing Level 2 rainfall rates multiplied by the average time between satellite visits into the appropriate grid boxes.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature

Primary NASA and/or operational agency users	*Availability and location of the product*
No known users	NSIDC

Sea Ice Concentration [daily L3 data on 12.5 km and 25 km grids available at nsidc.com]

AMSR-E sea ice concentration is a core-mission, Level 3 product calculated with the NASA Team algorithm 2 (NT2), which is based on the use of radiance ratios called the polarization and the spectral gradient ratio. The retrievals are mapped onto a polar stereographic projection, with the results for the gridded product being presented at spatial resolutions of both 12.5 km and 25 km. The retrievals have an estimated accuracy of better than 5% in autumn and winter but can be significantly less accurate in spring and summer in areas affected by melt or meltponding. The calculated difference between the NT2 algorithm results and the sea ice concentrations obtained with a different algorithm, called the Bootstrap algorithm, used as the standard algorithm for the JAXA and ESA Climate Change Initiative (CCI) sea ice data sets, is also an archived AMSR-E product.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
Sea ice and climate research communities, NOAA Environmental Modeling Center, NIC	NSIDC	

Sea Ice Drift [daily L3 data on 6.25 km grid available at nsidc.com]

AMSR-E sea ice drift is a Level 3 daily product mapped as a 5-day velocity vector (U and V components) at a 100 km resolution on a polar stereographic 6.25 km grid. The algorithm makes use of the 89 GHz horizontal-polarization channel for determining sea ice drift and the 18 GHz and 37 GHz vertical-polarization channels for the algorithm ice mask. The estimated accuracies of the ice drift speed and direction are 3 cm/s and 26 degrees, respectively. The product is limited to non-summer months. At the request of the sea ice research community, this new product replaces the former AMSR-E sea ice temperature product. Sea ice drift is expected to be useful to the sea ice modeling community for model validation and to have potential operational applications.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature
Primary NASA and/or operational agency users		*Availability and location of the product*
Sea ice (including sea ice modeling) and climate research communities, NCEP EMC Marine Modeling and Analysis Branch		NSIDC

Snow Depth on Sea Ice [daily L3 data on 12.5 km grid available at nsidc.com]

AMSR-E snow depth on sea ice is a core-mission Level 3 product mapped as a 5-day running mean at a 12.5 km grid resolution. The retrieval algorithm makes use of the spectral gradient ratio involving the 18 GHz and 37 GHz vertically polarized radiances. Snow depth is measured with an RMS uncertainty of 5 cm.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
Sea ice and climate research communities	NSIDC	

Snow Water Equivalent (SWE) and Snow Depth [daily, 5-day, and monthly L3 data available at nsidc.com]

The AMSR-E algorithm for SWE and snow depth, both core-mission products, is based on the Nimbus 7 Scanning Multichannel Microwave Radiometer (SMMR) and Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave Imager (SSMI) algorithms for these variables. However, relevant differences exist between the improved AMSR-E sensor and its predecessors. For example, the low frequency 10 GHz channel is used in the AMSR-E algorithm to examine deep snow. Additionally, the AMSR-E algorithm uses a 'dynamic' approach that aims at accounting for the evolution of grain size, density, stratigraphy, and wetness. This Level 3 product is mapped daily, every 5 days, and monthly at 25 km resolution. The accuracy is 10 mm or 20%.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature

Primary NASA and/or operational agency users	*Availability and location of the product*
NASA GSFC GMAO, DoD/Air Force Weather Service, NCEP	NSIDC

Surface Soil Moisture [L2B and daily L3 data available at nsidc.com]

AMSR-E surface soil moisture is a core-mission product that is defined (for AMSR-E measurements) as the mean volumetric moisture content (m^3/m^3, i.e., dimensionless) in the top few millimeters of soil, or sensing depth, averaged over the footprint's spatial resolution. Soil moisture retrievals are not made in the presence of moderate-to-dense vegetation cover, snow, frozen ground, precipitation, open water, or mountainous terrain. The resolution for both L2 and L3 products is 56 km, at a nominal 25 km Earth-registered grid. The estimated accuracy is 0.06 m^3/m^3 where vegetation is less than 1.5 kg/m^2. The L2 product is provided in ascending and descending swath segments. The Level 3 product is generated by compositing the L2 products into daily global maps.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – 9/2011	AMSR-E	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
Land hydrology and climate science researchers	NSIDC	

CERES Products

All CERES data products are available from ASDC at NASA LaRC. The primary CERES data users are the U.S. and international general scientific communities (universities and government laboratories). The main U.S. federal agencies that use CERES data are NASA, DoE, NSF NCAR, and NOAA. All CERES data products have been substantially validated.

CERES Bidirectional Scans (BDS) (Level 1B)

The BDS product is a core-mission data product containing 24 hours of instantaneous L1B CERES data for a single scanner instrument. The BDS contains instantaneous radiance measurements recorded every 0.01 second for views of space, internal calibration, solar calibration, and Earth footprints. The BDS is primarily used as input to the L2 CERES data products.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002 – 12/2025	CERES	Mature
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, DoE, NSF NCAR, NOAA		LaRC ASDC

CERES Single Scanner Footprint TOA/Surface Fluxes, Clouds, and Aerosols (SSF) (Level 2)

The SSF product is a core-mission data product that contains instantaneous CERES footprint data for a single scanner instrument, produced in hourly files. The SSF merges instantaneous CERES radiances and radiative fluxes with cloud and aerosol information from MODIS on Terra or Aqua and meteorological parameters from the NASA GSFC GMAO GEOS DAS Version 5.4.1 product. Radiative fluxes are inferred from measured radiances using new CERES ADMs developed from RAP scan CERES measurements.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002 – 12/2025	CERES, MODIS	Mature

Primary NASA and/or operational agency users	*Availability and location of the product*
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC

CERES Cloud Radiative Swath (CRS) (Level 2)

The CRS product is a core-mission data product that contains instantaneous CERES footprint data for a single scanner instrument, produced in hourly files. The CRS consists of TOA, within-atmosphere and surface radiative fluxes from RTA calculations initialized using observation-based input data sources. Cloud information is from MODIS and aerosol optical properties are from the Model of Atmospheric Transport and Chemistry (MATCH) product, which assimilates MODIS AOD retrievals. Meteorological parameters are from the GEOS 5.4.1 product.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
1/2018 – 12/2022, 5/2024 - 8/2024	CERES, MODIS	Mature
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, DoE, NSF NCAR, NOAA		LaRC ASDC

CALIPSO Cloudsat CERES and MODIS (CCCM) (Level 2)

The CCCM product is a core-mission data product that integrates measurements from CALIPSO, CloudSat, CERES and MODIS. Aerosol properties from CALIPSO and cloud properties from both CALIPSO and Cloudsat are matched to MODIS pixels and then to CERES Aqua footprints. The product includes observed CERES TOA SW, LW and window fluxes and flux profiles computed by a RTA using MODIS, CALIOP, and CPR derived aerosol, clouds, and surface properties.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2006 – 12/2017	CERES, MODIS, CALIPSO, Cloudsat	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

CERES Gridded Instantaneous TOA/Surface Fluxes, Clouds, and Aerosols (SSF1deg-Hour) (Level 3)

The SSF1deg-Hour product is a core-mission data product that contains spatially averaged flux, cloud, and aerosol parameters in a 1° nested grid, written to daily files for a single platform. The input to the SSF1deg-Hour product is the SSF. Only cross-track data are processed.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002 – 2/2023	CERES, MODIS	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

CERES Regionally Averaged Computed TOA, within the Atmosphere, and Surface Fluxes Hourly (CRS1deg-Hour) (Level 3)

The CRS1deg-Hour product is a core-mission data product that contains spatially averaged computed fluxes in a 1° nested grid, written to daily files for a single platform. The input to the CRS1deg-Hour product is the CRS. Only cross-track data are processed.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*

1/2018 – 12/2022	CERES, MODIS	Mature
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, DoE, NSF NCAR, NOAA		LaRC ASDC

CERES Time-Interpolated TOA Fluxes, Clouds, and Aerosols (SSF1deg–Day and SSF1deg–Month) (Level 3)

The SSF1deg-Day and -Month products are a core-mission products that contains daily and monthly 1° regional, zonal, and global averages of the clear-sky and all-sky TOA LW, SW, and net fluxes together with the associated MODIS-derived cloud and aerosol properties and GMAO meteorological properties. Temporal interpolation completes the diurnal cycle by assuming constant meteorology between satellite observation times.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002 – 2/2023	CERES, MODIS	Mature
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, DoE, NSF NCAR, NOAA		LaRC ASDC

CERES and GEO-Enhanced TOA, Within-Atmosphere and Surface Fluxes, Clouds, and Aerosols (SYN1deg–1Hour, –Day, –Month) (Level 3)

The SYN1deg product is a core-mission product that contains CERES TOA and Fu-Liou RTA surface and within-atmosphere fluxes, together with the associated MODIS-derived cloud properties, MATCH assimilated aerosols, and GMAO meteorological input data. Fluxes are computed hourly, with and without aerosols, along with PAR and UV fluxes. Inputs are from a merged Terra/Aqua-CERES/MODIS and hourly GEO multi-satellite cloud and flux data stream. Temporal averaging relies on GEO observations to fill in the diurnal cycle between Terra and Aqua observation times. These data are provided at 1-hourly, 3-hourly, daily, and monthly intervals at the CERES 1° grid resolution as well as at 1° zonal and global scales.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
3/2000 – 12/2025	Terra/Aqua/NOAA-20 CERES, Terra/Aqua MODIS, NOAA-20 VIIRS, Meteosat-5 & 7-11, GMS-5, GOES-8-18, MTSAT-1R and 2, Himawari-8-9	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

CERES Energy Balanced and Filled TOA/Surface Fluxes (EBAF–TOA and EBAF–Surface) (Level 3B)

The EBAF product is a core-mission product that contains CERES TOA fluxes with consistent Fu-Liou RTA-based surface fluxes. It is derived from the CERES SSF1deg and SYN1deg products. Fluxes are adjusted within uncertainty to ensure a 5-year global average of EEI consistent with that from Argo in-situ ocean measurements and estimates of deep ocean heat storage, ice warming and melt, and atmospheric and lithospheric warming. It also includes CERES and imager-based high-

resolution clear-sky fluxes. These data are provided at monthly intervals and at 1° grid resolution, 1° zonal, and global scales.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
TOA: 3/2000 – 12/2025 Surface: 3/2000 – 11/2025	Terra/Aqua/NOAA-20 CERES, Terra/Aqua MODIS, NOAA-20 VIIRS, Meteosat-5 & 7-11, GMS-5, GOES-8-19 MTSAT-1R 1 & 2, Himawari-8-9	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

CERES Cloud Type Histogram (CldTypHist) (Level 3)

The CldTypHist product is a core-mission product that contains histograms of Terra/Aqua MODIS and hourly GEO imager cloud properties stratified by cloud types that are defined by cloud top pressure, optical depth, and phase. The cloud properties are gridded onto 1°x1° regions and averaged over monthly and monthly hourly (i.e., the monthly mean of each GMT hour) time scales. CldTypHist is produced using the same cloud properties that are input to SYN1deg.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002-7/2024	Terra/Aqua/NOAA-20 CERES, Terra/Aqua MODIS, NOAA-20 VIIRS Meteosat-5 & 7-11, GMS-5, GOES-8-19, MTSAT-1R and 2, Himawari-8-9	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

CERES TOA Flux-by-Cloud-Type (FluxByCldTyp) (Level 3)

The FluxByCloudTyp product is a core-mission product that contains instantaneous gridded CERES TOA fluxes and associated MODIS-derived cloud properties stratified into 42 cloud types according to cloud top pressure and optical depth. Imager-based high-resolution fluxes are derived for the clear-sky and cloud layer portions of each CERES footprint. The product is available in daily files for 1° regions between 60°S and 60°N during daytime.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002 – 12/2025	Terra/Aqua/NOAA-20 CERES, MODIS, VIIRS	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

CERES Near-Real-Time TOA/Surface Fluxes and Clouds (FLASH_SSF) (Level 2)

The FLASH_SSF product is a core-mission product that contains instantaneous footprint CERES TOA fluxes, parameterized surface radiative fluxes, and imager cloud properties in the SSF format, produced within one week of observation and processed prior to official CERES calibration updates.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*

NRT, available only until calibrated products become available	CERES, MODIS, VIIRS	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

CERES Near-Real-Time Time-Interpolated TOA/Surface Fluxes and Clouds (FLASH_TISA) (Level 3)

The FLASH_TISA product is a core-mission product that contains temporally interpolated daily averaged CERES TOA fluxes, parameterized surface radiative fluxes, and imager cloud properties, produced within 1 week of observation and processed prior to official CERES calibration updates. These data are provided in daily files at 1° grid resolution.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
NRT available only until the calibrated products become available	Terra/Aqua/NOAA-20 CERES, Terra/Aqua MODIS, NOAA-20 VIIRS	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

ERBE-like Footprint TOA Fluxes (ES-8) (Level 2)

The ERBE-like Footprint TOA Fluxes (ES-8) product is a core-mission data product that provides a continuation of the ERBE S-8 product record of TOA radiative fluxes, analyzed using the same scene identification algorithm and ADMs that produced the ERBE data. The ES-8 product contains 24 hours of instantaneous unfiltered radiances and radiative fluxes for a single scanner instrument.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002 – 12/2025	CERES	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

ERBE-like Gridded Instantaneous TOA Fluxes (ES-9) (Level 3)

The ES-9 product is a core-mission data product that provides a continuation of the ERBE S-9 product record of TOA radiative fluxes, analyzed using the same algorithms that produced the ERBE data. The ES-9 product contains a month of instantaneous spatially averaged CERES TOA fluxes on a 2.5° grid for cross-track data only.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002 – 12/2025	CERES	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

ERBE-like Time-Interpolated TOA Fluxes (ES-4) (Level 3)

The ES-4 product is a core-mission data product that provides a continuation of the ERBE S-4 product record of TOA radiative fluxes, analyzed using the same algorithms that produced the ERBE data. Daily average, hourly average over the month, as well as monthly average TOA radiative fluxes are given in 2.5°, nested 5°, and nested 10° regions. Zonal and global monthly average fluxes are also included.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
7/2002 – 12/2025	CERES	Mature
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoE, NSF NCAR, NOAA	LaRC ASDC	

MODIS Products (See also https://modis.gsfc.nasa.gov/data/dataprod/index.php)

The MODIS products have the following hierarchy of validation levels:

Validation Level	***Description***
Stage 0 Validation	No validation. Product accuracy has not been assessed. Product considered beta.
Stage 1 Validation	Product accuracy is assessed from a small (typically < 30) set of locations and time periods by comparison with in-situ or other suitable reference data.
Stage 2 Validation	Product accuracy is estimated over a significant set of locations and time periods by comparison with reference in situ or other suitable reference data. Spatial and temporal consistency of the product and consistency with similar products has been evaluated over globally representative locations and time periods. Results are published in the peer-reviewed literature.
Stage 3 Validation	Uncertainties in the product and its associated structure are well quantified from comparison with reference in situ or other suitable reference data. Uncertainties are characterized in a statistically rigorous way over multiple locations and time periods representing global conditions. Spatial and temporal consistency of the product and with similar products has been evaluated over globally representative locations and periods. Results are published in the peer-reviewed literature.
Stage 4 Validation	Validation results for stage 3 are systematically updated when new product versions are released and as the timeseries expands.

Brief descriptions of the suite of Aqua MODIS (or combined Terra+Aqua MODIS) data products are given below. All the products listed except those designated as 'other products' are part of the core-mission and are maintained/refined over the course of the mission by investigators who have been selected by NASA Headquarters as part of the ROSES process. Aqua-MODIS comprises 23 algorithm maintenance investigators, most of whom are funded to deliver algorithm and code for the MODIS data products. The Aqua MODIS data record extends from June 24, 2002 to the present. The core products have all been substantially validated over a widely distributed set of locations, conditions, and time periods via several ground-truth and validation efforts. The primary MODIS data users include the general scientific community, a wide variety of federal, state, and local agencies worldwide and commercial companies. The principal federal users are the DoD, NOAA, USDA, Department of Interior (DoI), and EPA. There are an estimated 240 Direct Broadcast (DB) stations operating worldwide with an estimated 1000 separate entities routinely using the MODIS data from Aqua and Terra. MODIS standard products are available to users from several locations: the MODIS LAADS at NASA GSFC; the Land Processes (LP) DAAC in Sioux Falls, South Dakota; NSIDC in Boulder, Colorado; the Ocean Biology DAAC at GSFC; and the Physical Oceanography DAAC at

JPL. Additionally all data can be accessed through NASA Earthdata search and Worldview. For land and atmosphere products, MYD is the standard designator for Aqua MODIS products and MCD is the standard designator for MODIS combined Aqua/Terra products. The standard designator for Terra MODIS products is MOD.

MODIS Level 1 (radiance and reflectance) products:

MODIS Level 1A Radiance Counts (MYD 01)

The L1A data set contains counts for 36 MODIS channels, along with raw instrument engineering and spacecraft ancillary data. The L1A data are used as input for geolocation, calibration, and processing. Quality indicators are added to the data to indicate missing or bad pixels and instrument modes. Visible, SWIR, and NIR measurements are made during daytime only, while radiances for TIR are measured during both day and night portions of the orbit.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Level 1B Calibrated Geolocation Data Set (MYD 02)

The L1B dataset contains calibrated and geolocated at-aperture radiances for 36 bands generated from MODIS L1A sensor counts (MYD 01). The radiances are in $W/(m^2\ \mu m\ sr)$. In addition, reflectance may be determined for the solar reflective bands (bands 1-19, 26) through knowledge of the solar irradiance (e.g., determined from MODIS solar-diffuser data, and from the target-illumination geometry). Additional data are provided, including quality flags, error estimates, and calibration data.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validate Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Geolocation Data Set (MYD 03)

The MODIS Geolocation product contains geodetic coordinates, ground elevation, solar and satellite zenith, and azimuth angle for each MODIS 1 km sample. These data are provided as a companion data set to the L1B calibrated radiances and the L2 data sets to enable further processing. These geolocation fields are determined using the spacecraft attitude and orbit, instrument telemetry, and a digital elevation model.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Atmosphere Products *(see also https://atmosphere-imager.gsfc.nasa.gov/products.htm)*

MODIS Aerosol Product (MYD 04 L2/L3)

The MODIS Aerosol Product provides column-integrated aerosol information globally over both the continents and oceans for cloud-free scenes. The primary data product is AOT at 550 nm, and it is obtained from three complementary algorithms. The Dark-Target (DT) algorithms provide coverage over "dark" surfaces, including vegetated, dark-soiled, and some urban surfaces over land (DT-land), as well as over large water bodies (oceans and large lakes, DT-ocean). In addition to AOT, the DT-ocean algorithm retrieves fine-mode fraction (FMF) and reports Angstrom Exponent (AE), which both indicate the proportion of 'fine-sized' (e.g., smoke and pollution from combustion) versus 'coarse-sized' (e.g., mineral dust and sea-salt) aerosol particles. The enhanced Deep-Blue (eDB) algorithm retrieves AOT and AE over all snow-free land surfaces (including deserts and urban areas as well as vegetation). Daily L2 (MYD 04) data are produced at a spatial resolution of 10 km at nadir (10 x 10 pixel arrays) for all three algorithms. In addition, MYD 04 provides a 'combined' AOT dataset that draws from all three algorithms and provides more complete spatial coverage. A finer spatial resolution (3 km at nadir; 3 x 3 pixel arrays) is available that contains DT retrievals over both land and ocean.

The L3 product is available at daily (D3) and monthly (M3) aggregations and contains statistics derived from over 180 science parameters from the MODIS L2 Atmosphere Products. A range of statistical summaries (scalar statistics and 1- and 2-dimensional histograms) are computed, depending on the L2 science parameter. Statistics are aggregated to a 1° × 1° equal-angle global grid.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Total Precipitable Water (MYD 05)

The MODIS Precipitable Water product (MYD 05) consists of column water-vapor amounts. During the daytime, a near-IR algorithm is applied over clear land areas of the globe and above clouds over both land and ocean. Over clear ocean areas, water vapor estimates are provided over the extended glint area. An IR algorithm for deriving atmospheric profiles is also applied both day and night for L2. The L2 data are generated at the 1 km spatial resolution of the MODIS instrument using the near-IR algorithm during the day, and at 1 km pixel resolution both day and night using the IR algorithm.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Cloud Product (MYD 06 L2/L3)

The MODIS Cloud Product combines IR and SW techniques to determine physical and radiative cloud properties. Cloud particle phase, effective radius, COT, and cloud integrated water path are derived at 1 km pixel resolution using the MODIS visible, near-IR, and SW IR bands and are available for the sunlit portion of the day. Cloud height, cloud top temperature, cloud top pressure, effective emissivity, and cloud particle phase parameters are derived by IR retrieval methods for both day and night at both 1 km and 5 km resolutions. Finally, the MODIS Cloud

Product includes cirrus reflectance in the visible at 1 km pixel resolution, useful for removing cirrus scattering effects from the land surface reflectance product.

The L3 product is available at daily (D3) and monthly (M3) aggregations and contains statistics derived from over 180 science parameters from the MODIS L2 Atmosphere Products. A range of statistical summaries (scalar statistics and 1- and 2-dimensional histograms) are computed, depending on the L2 science parameter. Statistics are aggregated to a 1° × 1° equal-angle global grid.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Atmospheric Profiles (MYD 07 L2/L3)

The MODIS Atmospheric Profiles product (MYD 07) consists of the following parameters: total-O_3 burden, atmospheric stability, temperature and moisture profiles, and atmospheric water vapor. The MODIS atmospheric profile algorithm is a statistical regression that accounts for surface emissivity. The retrievals are performed using clear sky radiances measured by MODIS within a 5 x 5 field of view (~5 km resolution at nadir) over land and ocean for both day and night.

The L3 product is available at daily (D3) and monthly (M3) aggregations and contains statistics derived from over 180 science parameters from the MODIS L2 Atmosphere Products. A range of statistical summaries (scalar statistics and 1- and 2-dimensional histograms) are computed, depending on the L2 science parameter. Statistics are aggregated to a 1° × 1° equal-angle global grid.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Level 2 Atmosphere Joint Product (MYD ATML2)

The MODIS Atmosphere L2 Joint Product contains 89 key data sets gleaned from the complete set of standard L2 products. These can be grouped into the following categories: Aerosol, Water Vapor, Cloud, Atmospheric Profiles, and Cloud Mask. The Joint Atmosphere product was designed to be small enough to minimize data transfer and storage requirements, yet robust enough to be useful to a significant number of MODIS data users interested in statistical studies. Scientific data sets (SDSs) contained within the Joint Atmosphere product cover a full set of high-interest parameters produced by the MODIS Atmosphere group and are stored at 5 km and 10 km (at nadir) spatial resolutions.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Cloud Mask (MYD 35)

The MODIS cloud mask product indicates whether a pixel is unobstructed between the surface and the satellite. The product provides 48 bits of output per 1 km pixel, and these include information on sets of multispectral test results (from 19 MODIS spectral bands), the decision tree used to arrive at the product, and limited ancillary information such as a land/ocean and snow/no snow flags. The first eight bits provide a summary sufficient for most applications. Additionally, the first two bits offer information in four categories: confident clear, probably clear, uncertain/probably cloudy, and cloudy.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LAADS, Earthdata & Worldview	

MODIS Land Products *(see also modis-land.gsfc.nasa.gov/)*

MODIS Surface Reflectance (MYD 09)

The MODIS Surface Reflectance products provide an estimate of the surface spectral reflectance as it would be measured at ground level in the absence of atmospheric scattering or absorption. Low-level data are corrected for atmospheric gases and aerosols, yielding a L2 basis for several higher-order gridded products. In the 8-day product, each surface reflectance pixel contains the best possible observation during an 8-day period as selected based on high observation coverage, low view angle, the absence of clouds or cloud shadow, and aerosol loading.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview	

MODIS Land Surface Temperature and Emissivity (MYD 11)

The LST and Emissivity daily data are presented at 1 km grid spacing by the generalized split-window algorithm and at 6 km grid spacing by the day/night algorithm. In the split-window algorithm, emissivities in bands 31 and 32 are estimated from land cover types, and atmospheric column water vapor and lower boundary air surface temperature are separated into tractable sub-ranges for optimal retrieval. In the day/night algorithm, daytime and nighttime LSTs and surface emissivities are retrieved from pairs of day and night MODIS observations in seven TIR bands. The product is comprised of LSTs, quality assessment, observation time, view angles, and emissivities.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview	

MODIS Land Cover and Dynamics (MCD 12)

The MODIS Combined Terra and Aqua Land Cover product incorporates five land cover classification schemes, derived through a supervised decision-tree classification method. The primary land cover scheme identifies 17 classes defined by the IGBP, including 11 natural vegetation classes, three human-altered classes, and three non-vegetated classes. The Land Cover Dynamics product includes layers on the timing of vegetation growth, maturity, and senescence that mark the seasonal cycles. Estimates of vegetation phenology are provided twice/year from the two 12-month focus periods, July-June and January-December, allowing for hemispheric differences in the growing seasons, and enabling the product to capture two growth cycles if necessary.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	Terra/Aqua MODIS	Land Cover: Validated Stage 4 Land Cover Dynamics: Validated Stage 2
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, DoD, NOAA, USDA, DoI, EPA		LP DAAC, Earthdata & Worldview

MODIS Vegetation Indices (NDVI and EVI) (MYD 13)

Global MODIS vegetation indices, produced at 16-day intervals and at 250, 500, 1000 m, and CMG (0.05°) spatial resolutions, provide consistent spatial and temporal comparisons of vegetation canopy greenness, a composite property of leaf area, chlorophyll, and canopy structure. Two vegetation index products are derived from atmosphere-corrected red, near-IR, and blue surface reflectances: the MODIS NDVI, which provides continuity with NOAA's AVHRR time series record for historical and climate applications, and the EVI, which minimizes canopy-soil variations and improves sensitivity over dense vegetation conditions. The two products more effectively characterize a global range of vegetation states and processes.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview	

MODIS Thermal Anomalies – Fires and Biomass Burning (MYD 14)

MODIS Thermal Anomalies/Fire products are primarily derived from MODIS 4 μm and 11 μm radiances. The fire detection strategy is based on absolute detection of a fire (when the fire strength is sufficient to detect), and on detection relative to its background (to account for variability of the surface temperature and reflection by sunlight). The product includes fire-mask, detection confidence, fire radiative power, and numerous other layers describing fire pixel attributes. MODIS Aqua data and MODIS Terra data are each acquired twice daily at mid-latitudes, allowing for up to four daily MODIS fire observations for locations in those latitudes. These observations serve operational fire management needs and advance global monitoring of the fire process and its effects on ecosystems, the atmosphere, and climate.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview	

MODIS Leaf Area Index (LAI)/Fraction of Photosynthetically Active Radiation (fPAR) (MYD 15/MCD 15)

LAI is defined as the one-sided green leaf area per unit ground area in broadleaf canopies and as half the total needle surface area per unit ground area in coniferous canopies. FPAR is the fraction of photosynthetically active radiation (400-700 nm) absorbed by green vegetation. Both variables are used for calculating surface photosynthesis, ET, and NPP, which in turn are used to calculate terrestrial energy, carbon, water cycle processes, and biogeochemistry of vegetation. Algorithm refinements have improved quality of retrievals and consistency with field measurements over all biomes, with a focus on woody vegetation.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview	

MODIS Evapotranspiration (MYD 16)

Terrestrial Evapotranspiration (ET) is the summation of plant transpiration and soil evaporation. The MYD16 ET algorithm is based on the Penman-Monteith equation. Net solar radiation is partitioned into components of vegetation and soil by vegetation cover fraction estimated using the MODIS fPAR (MYD15) and the MODIS Albedo (MCD 43) products. Air VPD and minimum air temperature are used to constrain leaf conductance, which is up-scaled to canopy conductance with MYD15 LAI. Potential soil evaporation is reduced by air humidity and VPD to estimate soil evaporation. The MYD 16 ET product shows favorable global accuracy and performance against other diverse ET data, including Fluxnet tower eddy-covariance ET measurements, and other model-based products including OpenET. The MYD 16 product also shows long-term consistency and agrees well with measured ET seasonally and interannually.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview	

MODIS Gross Primary Productivity (GPP)/Net Primary Productivity (NPP) (MYD 17)

The GPP product is a cumulative composite of GPP values based on the radiation-use-efficiency concept. The GPP product can be used as input to models that calculate terrestrial energy, carbon, water cycle processes, and biogeochemistry of vegetation. Modifications of parameters in the Biome Property Look-Up Table (BPLUT) have been made to agree with GPP derived from measurements at eddy flux towers and synthesized NPP. Further, they include a spatially non-linear interpolation of coarse-resolution meteorological data at the 1-km MODIS pixel level, instead of nearest neighbor sampling, to increase the accuracy of meteorological data input at the pixel level.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	

NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview

MODIS Land Surface Shortwave Radiation and PAR Product (MCD 18)

Incident solar radiation over land surface, either PAR in the visible spectrum (400-700 nm) or insolation in the SW (300-4000 nm), is a key parameter required by many land surface models. MODIS TOA reflectance and surface reflectance data from both the Terra and Aqua satellites are used as the main input to generate the global all-sky high-resolution (5 km, 3-hour) SW radiation and PAR product over land surfaces. In addition to its total value, this product suite also provides diffuse proportion of SW radiation or PAR as needed by many applications.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	Terra/Aqua MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA	LP DAAC, Earthdata & Worldview	

MODIS Multi-Angle Implementation of Atmospheric Correction (MAIAC) Product (MCD 19)

MAIAC is an advanced algorithm that uses time series analysis and a combination of pixel- and image-based processing to improve accuracy of cloud detection, aerosol retrievals, and atmospheric correction of Terra and Aqua observations. MAIAC provides suites of 1 km atmospheric and surface gridded products. The first suite (MCD19A2) includes cloud/snow mask, column water vapor, aerosol optical depth (AOD) and type (background, biomass burning, or dust) over land, and AOD and fine mode fraction/Angstrom parameter over ocean. The land products include surface reflectance (Bidirectional Reflectance Factor, BRF) in unsaturated bands 1-16 (MCD19A1), parameter of scaled Ross-Thick Li-Sparse (sRTLS) BRDF model in bands 1-8, NDVI, and snow grain size/snow fraction (SGS/SF) for detected snow. The 1km BRDF, SGS/SF and NDVI products (MCD19A3) are naturally gap-filled and reported daily. The MCD19A1 product also includes the 500m BRF for MODIS bands 1-7. The daily atmospheric products are also available at 0.05 degree CMG resolution.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2000 - present	MODIS	Atmosphere products: Validated Stage 4 Land surface products: Validated Stage 2/3
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA		LP DAAC, Earthdata & Worldview

MODIS TES Land Surface Temperature and Emissivity (MYD 21)

The MYD21 daily LST and Emissivity product consists of day and nighttime 1-km LST and TIR emissivity for bands 29, 31, and 32 retrieved using the ASTER Temperature Emissivity Separation (TES) algorithm. The TES algorithm uses radiative transfer models to correct the at-sensor radiance to surface radiance on a pixel-by-pixel basis followed by an emissivity model based on laboratory measurements to separate the surface radiance into temperature and emissivity. The

product includes LST, spectral emissivity for bands 29, 31, and 32, uncertainty estimates, quality assessment, observation time, and view angles.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/ 2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA	LP DAAC, Earthdata & Worldview	

MODIS Global Water Reservoir Product (MYD 28)

The MODIS Water Reservoir product includes time series of surface area, elevation, storage, evaporation rate, and volumetric evaporation for 164 global reservoirs which includes 151 man-made reservoirs and 13 regulated natural lakes. The reservoir surface area algorithm is based on image classifications of NIR reflectance from MODIS Aqua 8-day Surface Reflectance product (MYD09Q1). The storage and elevation values are calculated by applying the area to the pre-established Area-Volume-Elevation (AVE) curves for each reservoir of interest. The reservoir evaporation rate is estimated using the newly developed Lake Temperature and Evaporation Model (LTEM). In the LTEM the MODIS 8-day composite LST data (MYD11A2) is employed to constrain the modified Hostetler Model for calculating lake water temperature profiles. The temperature profiles were then used to calculate lake heat storage change term in the Penman equation. The calculation of the evaporation rate also requires gridded meteorological inputs from GLDAS and bathymetric data. The volumetric evaporation is calculated as the product of the evaporation rate and surface area.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA	LP DAAC, Earthdata & Worldview	

MODIS Bidirectional Reflectance Distribution Function (BRDF)/Albedo (MCD 43)

The daily BRDF/Albedo product provides users with BRDF model parameters that users can use to construct intrinsic surface albedo and compute directional reflectances at any solar and viewing geometry. The models support the spatial relationship and parameter characterization best describing the differences in radiation due to the scattering (anisotropy) of each pixel, relying on multi-date, atmospherically corrected, cloud-cleared reflectance input data measured over rolling 16-day periods, emphasizing the date of interest. Both Aqua and Terra data are used in the generation of this product, providing the highest probability for quality input data. The product suite also contains daily standard spectral and broadband albedos and view angle corrected nadir reflectances (Nadir BRDF-Adjusted Reflectances (NBAR)) along with retrieval quality for the solar angle of the date of interest for those who do not wish to use the BRDF model parameters and calculate their own values. These NBAR retrievals are used for vegetation biophysical and phenology monitoring, as well as land cover/land cover change detection.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 – present	Terra/Aqua MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview	

MODIS Burned Area Product (MCD 64)

The MCD 64A1 burned-area mapping algorithm employs 500-m MODIS imagery coupled with 1-km MODIS active fire observations to map the spatial extent of recent fires only. The hybrid algorithm applies dynamic thresholds to a burn-sensitive vegetation index derived from MODIS 1.2 μm and 2.1 μm atmospherically-corrected surface reflectance observations, and a measure of temporal texture. Cumulative active fire maps are used to guide the selection of burned and unburned training samples and to guide the specification of prior probabilities. The combined use of active-fire and reflectance data enables the algorithm to adapt regionally over a wide range of pre- and post-burn conditions and across multiple ecosystems. The MCD64A1 product ultimately identifies the date of burn, to the nearest day, for each 500-m grid cell within every MODIS land tile.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	Terra/Aqua MODIS	Validated Stage 3
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, USDA, DoI, EPA	LP DAAC, Earthdata & Worldview	

MODIS Cryosphere Products *(see also modis-land.gsfc.nasa.gov/)*

MODIS Snow Cover (MYD 10)

MODIS snow cover data are based on a snow-mapping algorithm that employs a Normalized Difference Snow Index (NDSI) and other test criteria. The MODIS snow product suite is composed of products covering a range of spatial and temporal resolutions, from 500 m to 0.05°, and from swath to daily returns. Additionally, a MYD10A1F gap-filled daily product is available. The overall absolute clear-sky accuracy of the 500 m resolution products is ~93%, varying by land cover and snow condition. The snow products are used by climatologists and by modelers both as input to hydrological models, e.g., to develop snow-cover depletion curves, and to compare with GCM output.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 3
Primary NASA and/or operational agency users		*Availability and location of the product*
NASA, DoD, NOAA, USDA, DoI, EPA		NSIDC, Earthdata & Worldview

MODIS Sea Ice and Ice Surface Temperature (MYD 29)

The MODIS sea ice product contains the SIE and ice surface temperature (IST) measured during daylight and darkness. The sea ice algorithm uses a NDSI modified for sea ice to distinguish sea ice from open ocean based on reflective and thermal characteristics. The sea ice product suite is composed of both swath and gridded products at a range of spatial and temporal resolutions, from 1 km to 0.05° (~4 km), and temporal resolutions ranging from swath to daily, with gridded data in a polar grid (the Equal-Area Scalable Earth Grid, or EASE-grid). IST is accurate to approximately ±1.6 K in clear-sky conditions.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2

Primary NASA and/or operational agency users	*Availability and location of the product*
NASA, DoD, NOAA, EPA	NSIDC, Earthdata & Worldview

MODIS Ocean Products *(see oceancolor.gsfc.nasa.gov for the complete list of community accepted ocean color and SST products; note that the MODIS ocean color products do not follow the MOD/MYD Terra/Aqua convention)*

All MODIS ocean parameters are provided as 1 km (L2), 4.6 km equal-area binned, and 4.6 km and 9.2 km gridded products (L3) over the global ocean. The L2 product is produced within hours of observation. It is used to generate the binned and gridded L3 temporal composites on daily, 8-day 'weekly', monthly, and yearly timescales, as well as monthly and seasonal climatologies.

MODIS Sea Surface Temperature

SST is derived from the TIR channels of MODIS for both the daytime and nighttime global ocean. A second estimate of SST (SST4) is generated from the mid-wave IR channels for the nighttime portion of the orbit only. In addition, a quality assessment parameter is included, as well as estimates of the bias and standard deviation of the retrieval for each pixel for both the SST and SST4 products.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Remote Sensing Reflectance

The principal measurement in ocean color is the spectral distribution of normalized water-leaving radiance NLw(λ), which is defined as the upwelling radiance just above the ocean surface, normalized to represent the idealized case with the Sun directly overhead and no atmosphere. For application in bio-optical algorithms, this quantity is converted to remote sensing reflectance, Rrs, which is simply NLw divided by mean extraterrestrial solar irradiance. From these reflectances, information on a host of ocean optical properties (dissolved substance and particle absorption and scattering coefficients) and constituent concentrations (e.g., chlorophyll-*a*) are derived. Rrs products are generated for each of the nine MODIS visible wavelengths or bands (400-700 nm).

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Apparent Visible Wavelength

Apparent Visible Wavelength (AVW) is an optical water classification index, representing a one-dimensional geophysical metric that is inherently correlated to R_{rs} spectral shape. Since the entire visible-range spectrum is utilized in the calculation of AVW, this product ensures that any diagnostic signals present in the R_{rs} spectrum are considered, and affords the opportunity to describe and analyze spectral trends in R_{rs} in terms of a single variable. Through a process of calibration with field measurements, multispectral sensors with disparate spectral band placement yield comparable

AVW values to hyperspectral instruments, further enabling an effective means of elucidating similarities or differences in spectral signatures within the constraints of two dimensions.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Sub-Surface Chlorophyll-*a* Concentration

Chlorophyll-*a* is the main plant pigment involved in photosynthesis and is a good indicator of phytoplankton biomass. It is required for estimation of primary production and ocean biological sequestration of carbon. It is a core MODIS data product. Records of chlorophyll-*a* started in September 1997 with SeaWiFS, and chlorophyll-*a* concentrations are now also derived from the MODIS sensors on Aqua and Terra. Chlorophyll-*a* algorithms have reached maturity and are very reliable over ~90% of the World Ocean.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Inherent Optical Properties

The inherent optical properties (IOPS) of ocean waters include the total absorbtion and backscattering coefficients, as well as the separation of those properties into components of particle backscattering, absorption due to phytoplankton, and absorption due to disolved organic matter and detritus. The IOPS describe the fundamental optical properties of the ocean, from which a host of bio-optical and bio-geochemical properties can be derived.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Phytoplankton Carbon

Phytoplankton carbon is an important parameter in ocean biogeochemistry, providing insight into the proportion of POC directly associated with primary productivity and the oceanic carbon pump. As such, it is critical input to primary productivity algorithms. This algorithm returns the concentration of phytoplankton carbon (Cphyt) in mg m^{-3}, calculated using an empirical relationship derived from field data between analytical measurements of Cphyt and particulate backscattering coefficient, which is taken from the standard IOP product of MODIS.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Diffuse Attenuation at 490 nm

Diffuse attenuation is related to the exponential decrease in light intensity with water depth, i.e., it is the wavelength-dependent coefficient of depth in the exponent. As such, it is an indicator of water clarity and is used to estimate light penetration and absorption, both of which are important for calculations of primary production and mixed layer heating. The diffuse attenuation at 490 nm (Kd490) is a core product for SeaWiFS and for the Aqua and Terra MODIS sensors. The global time series starts in 1997 with the SeaWiFS data.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Aerosol Optical Thickness (for ocean color atmospheric correction)

AOT at band 869 nm, $\tau_a(869)$ (dimensionless), is defined as the integrated extinction coefficient at 869 nm over a vertical column of unit cross section. It is proportional to the aerosol particle concentration and can be related to atmosphere turbidity (visibility). It is derived over ocean during the MODIS ocean color data processing. The $\tau_a(869)$ values are calculated for every ocean pixel with a clear atmosphere, using the MODIS NIR measurements at 748 and 869 nm. For productive waters, the NIR ocean contributions are estimated using bio-optical models.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Aerosol Angstrom Exponent

The Aerosol Angstrom exponent $\alpha(443)$ (dimensionless) over ocean is the estimated slope at 443 nm of the curve displaying the log of the optical depth versus the log of the wavelength. It is derived from the MODIS bands at 748 nm and 869 nm for every pixel with a clear atmosphere. The $\alpha(443)$ is a measure of the spectral variation of the AOT and is a function of the aerosol particle size (the larger the exponent, the smaller the particle size).

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA	OB.DAAC, Earthdata & Worldview	

MODIS Particulate Organic Carbon

POC is the carbon stored in organic particles (soft tissues) suspended in the water column. Because passive radiometers like MODIS only sense the light that is scattered out of the water column very near the surface, the MODIS POC is essentially the surface concentration in gC/m^3. POC is an important component of the ocean carbon cycle.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	

NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview

MODIS Particulate Inorganic Carbon

PIC is a form of particulate calcium carbonate and constitutes the skeletons of microscopic marine plankton (plants and animals). Coccolithophores are a well-known source of calcite particles because they shed calcite platelets during a phase of their life cycle. The Cliffs of Dover are composed of calcite from such plankton species. Like POC, PIC is another important component of the marine carbon cycle, and carbon in PIC is in concentrations of moles-C/m^3.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 2
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Fluorescence Line Height (FLH)

FLH (units: mW/cm^2 μm sr) is a measure of the chlorophyll fluorescence that peaks at about 685 nm. The MODIS fluorescence band at 678 nm is offset from the peak to avoid an atmospheric oxygen absorption band (O_2 B-band). MODIS FLH is derived by subtracting a baseline radiance computed from the 667 and 748 nm bands, both of which lie outside the fluorescence band. Recent research on FLH has shown that it can be used to study phytoplankton physiology or health (see the next product, the Instantaneous PAR [iPAR]).

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Instantaneous Photosynthetically Available Radiation

iPAR is the total downwelling flux of photons just below the sea surface at the instant MODIS views the pixel, integrated over the wavelength range of 400 – 700 nm. It is derived for all cloud free ocean pixels using the retrieved atmospheric properties to attenuate the extraterrestrial solar irradiance at each MODIS visible wavelength and then integrating over wavelength space. The iPAR can be used in combination with the FLH to estimate chlorophyll fluorescence quantum yield. Variations in fluorescence quantum yield have been interpreted as indicators of phytoplankton physiology (e.g., iron stress).

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 1
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	

MODIS Daily Mean Photosynthetically Available Radiation

Like iPAR, Daily Mean PAR is the total downwelling photon flux integrated over the wavelength range of 400 – 700 nm. However, PAR is derived for all ocean pixels (both clear and cloudy), and it uses a model of 24-hour solar illumination to integrate over a full daily cycle. Thus, PAR represents the daily average energy available for photosynthesis, at each MODIS ocean pixel.

PAR is a critical input to models of NPP, and SeaWiFS PAR has been in widespread use for over a decade. PAR had earlier been produced only from SeaWiFS data, as the MODIS ocean channels saturate over cloudy pixels. It is now being produced with MODIS data using the land channels at 469 nm, 555 nm, and 645 nm.

Duration of Data Record	*Instruments Required*	*Maturity of Algorithms*
6/2002 - present	MODIS	Validated Stage 4
Primary NASA and/or operational agency users	*Availability and location of the product*	
NASA, DoD, NOAA, EPA, USGS	OB.DAAC, Earthdata & Worldview	