NOAA Level 2 Geophysical Products from JPSS VIIRS, OMPS, CrIS, and ATMS: Overview and status of releases via CSPP

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Abstract

The Joint Polar Satellite System (JPSS) Suomi National Polar-orbiting Partnership (S-NPP) and NOAA-20 satellites provide global coverage of level-2 geophysical products from the Visible Infrared Imager Radiometer Suite (VIIRS), Ozone Mapping and Profiler Suite (OMPS), Cross-track Infrared Sounder (CrIS), and Advanced Technology Microwave Sounder (ATMS) instruments as well as the Advanced Microwave Scanning Radiometer-2 (AMSR-2) from the Global Change Observation Mission - Water (GCOM-W1). These imagery, cloud, aerosol, land, ocean, ozone, and atmospheric products are available to users via the NOAA Product Distribution and Access (PDA) and the Comprehensive Large Array-data Stewardship System (CLASS). In addition to these dissemination systems, the JPSS program has been working with the Center for Satellite Applications and Research (STAR) and the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin (UW) to provide the JPSS algorithms to the Community Satellite Processing Package (CSPP) which supports the Direct Broadcast (DB) meteorological and environmental satellite community through the packaging and distribution of free open source science software.

CSPP Low Earth Orbit (LEO)

The CSPP is a collection of freely available software for processing data from Low Earth Orbit (LEO) meteorological satellites including:

- NOAA-20 and Suomi NPP VIIRS, CrIS ATMS
- Metop-A/B/C IASI, ASMU-A, MHS, HIRS
- NOAA-18/19 AMSU-A, MHS, HIRS
- Terra and Aqua MODIS, AIRS
- GCOM-W1 AMSR-2
- FY-3B/C/D VIIR, MERSI-2

CSPP supports the creation of calibrated observational data, geophysical derived products, and mapped images from visible, infrared, and microwave sensors.

The CSPP project is based at the Space Science and Engineering Center at the University of Wisconsin-Madison and is funded by the NOAA JPSS Program Office.

Project Website: http://cimss.ssec.wisc.edu/cspp/

CSPP Software Features

- The CSPP software is freely available
- Includes up-to-date algorithms
- Is pre-compiled for 64-bit Intel Linux (CentOS)
- Is easy to install and operate
- Includes test data for verification
- Runs efficiently on modest hardware
- Has prompt expert user support
- Provides software to reproject imagery in GeoTIFF and AWIPS formats

JPSS-2 Algorithm Cal/Val Timeline (Launch + Months)

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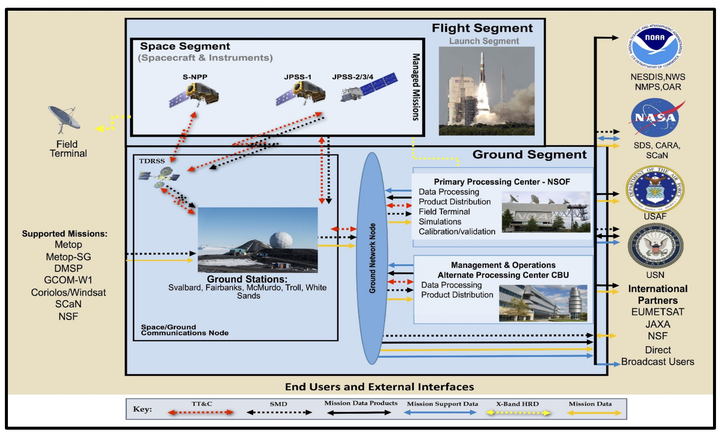
Team	Product	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
SDR	ATMS TDR/SDR		B	P				V																											
	CrIS SDR				B/P						V																								
	VIIRS SDR			B	P			V																											
	OMPS SDR (NP & TC)				B/P						V																								
Imagery	KPP Imagery EDRs			B	P			V																											
	non-KPP Imagery EDRs				B	P				V																									
Clouds	Cloud Mask						B				P						V																		
	Cloud Phase/Type									B	P						V																		
	Cloud Top Property and Cloud Cover Layer									B	P						V																		
	Cloud Base Height									B	P						V																		
	DCOMP and NCOMP									B	P						V																		
Aerosol	Aerosol Optical Depth and Aerosol Particle Size						B				P										V														
	Aerosol Detection						B				P									V															
Volcanic Ash	Volcanic Ash									B	P						V																		
Cryosphere	Ice Surface Temperature and Ice Concentration							B			P			V																					
	Sea Ice Thickness/Age							B			P			V																					
	Binary Snow Cover							B			P									V															
	Fractional Snow Cover							B						P						V															
Land	Active Fires							B			P									V															
	Land Surface Temperature							B						P												V									
	Surface Albedo							B						P						V															
	Global Surface Type																	B		P		V													
	Surface Reflectance							B						P												V									
	Green Vegetation Fraction								B					P												V									
	Vegetation Index								B						P												V								
	Vegetation Health										B						P											V							
OCC	Ocean Color												B				P																	V	
SST	Sea Surface Temperature						B			P											V														
VPW	Polar Winds											B		P		V																			
NUCAPS	AVTP, AVMP, Ozone, OLR							B						P			V																		
	CO, CO2, CH4							B									P			V															
MiRS	MiRS Products						B				P											V													
SFR	Snow Fall Rate (SFR)							B					P																					V	
OMPS EDR	OMPS Ozone EDRs (VBPro & VBTO3)					B/P					V																								
	OMPS LP (SDR & EDR)					B					P					V																			

JPSS Series Mission Architecture



- JPSS Enterprise Algorithms run within the JPSS Ground System and generate environmental data products from Stored Mission Data (SMD) using high quality science and rigor.
- The same JPSS Enterprise Algorithms run within CSPP and generate the same high quality data products from the High Rate Data (HRD) stream.

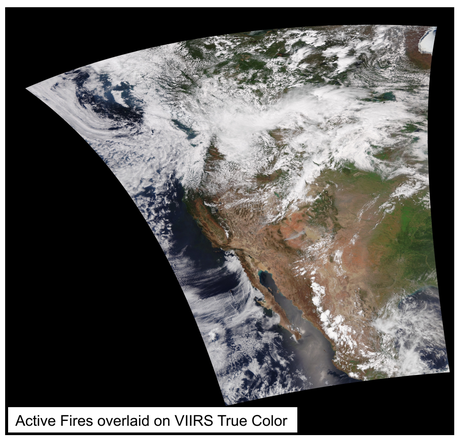
VIIRS Level-2 Environmental Data Records		Latest Release (Date)
Cloud Mask	Describes the area of the Earth's horizontal surface that is masked by the vertical projection of detectable clouds.	Feb 2022 V1.2
Cloud Top Height	Set of heights above mean sea level of the tops of the cloud layers for each cloud-covered Earth location.	Feb 2022 V1.2
Cloud Base Height	Height above sea level where clouds occur.	Feb 2022 V1.2
Cloud Cover Layers	Fraction of a given area of the Earth's horizontal surface that is masked y the vertical projection of clouds.	Feb 2022 V1.2
Cloud Optical Depth	Optical depth of the atmosphere due to cloud droplets, per unit cross section integrated over every distinguishable cloud layer and all distinguishable cloud layers in aggregate, in a vertical column above a horizontal cell on the Earth's surface.	Feb 2022 V1.2
Cloud Particle Size Distribution	Representation of the cloud particle size distribution. The effective radius is defined as the ratio of the third moment of the drop size distribution to the second moment, averaged over a layer of air within a cloud.	Feb 2022 V1.2
Cloud Phase and Type	Provides the primary phase of the cloud (Clear, Liquid, supercooled, Mixed, Ice, and Unknown).	Feb 2022 V1.2
Cloud Top Pressure	Atmospheric pressures at the tops of the cloud layers overlying each cloud-covered Earth location.	Feb 2022 V1.2
Cloud Top Temp	Atmospheric temperature at the tops of the cloud layers overlying each cloud-covered Earth location.	Feb 2022 V1.2
Aerosol Detection	A summary map that indicates the extent of smoke/aerosol coverage and a measure of smoke albedo indicates relative intensity.	Feb 2022 V1.2
Aerosol Optical Depth	A measure of the fine solids suspended in the air including dust, sand, volcanic ash, smoke and urban/industrial aerosols.	Feb 2022 V1.2
Aerosol Particle Size	A measure of the bimodal size distribution of the aerosol population in terms of the effective radius (re) and effective variance (ve) of each mode.	Feb 2022 V1.2
Volcanic Ash – Detection and Height	Maps the location and concentration of volcanic ash after an eruption and dispersion by the wind.	Feb 2022 V1.2
Ice Surface Temp	IST provides the radiating, or "skin", temperature of the sea and fresh water ice surface under clear-sky conditions. It includes the aggregate temperature of objects comprising the ice surface, including snow and melt water on the ice. The VIIRS IST EDR provides surface temperatures retrieved at VIIRS moderate resolution for ice-covered oceans both day and night.	Feb 2022 V1.2
Ice Concentration	Ice concentration provides the fraction of an area covered by ice. It is calculated for every VIIRS moderate resolution band pixel (750 m) over unfrozen ocean and inland water bodies.	Feb 2022 V1.2
Ice Thickness	VIIRS ice thickness provides estimates of sea, lake, and river ice thickness under clear-sky conditions. The ice surface may be covered by snow or, in the summer, melt ponds. The depth of snow is not included in ice thickness product. Calculations are done at VIIRS moderate resolution (750 m) for ice-covered water bodies both day and night. It is not a direct measurement, but rather a model-based approach driven by other satellite products.	Feb 2022 V1.2
Snow Cover	The snow cover product contains two products: a fractional snow cover (FSC) and a binary snow cover (BSC) mask. The fractional snow cover is defined as the fraction of a given area of the earth's horizontal surface that is masked by snow. The binary snow/no-snow mask provides a mapping of snow-covered areas as either containing or not having snow.	Feb 2022 V1.2
Land Surface Temp	Measurement of the skin temperature over global land coverage including coastal and inland water.	Feb 2022 V1.2
Land Surface Albedo	The Ratio between solar radiation reflected by Earth's land surface and solar radiation incident at the surface.	Feb 2022 V1.2
Surface Reflectance	Surface reflectance for three imagery-resolution bands and nine moderate-resolution bands	Feb 2022 V1.1
Vegetation Index	The Vegetation Index includes TOA NDVI, the TOC NDVI, the TOC EVI	Feb 2022 V1.1
Active Fires	A 2-Dimensional array of values representing the fire and other relevant thematic classes of each pixel.	June 2022 V2.0
Flood Detection	High resolution remotely-sensed data identifying flood inundation and extent generated from the 375 m VIIRS Initially designed to capture snowmelt and ice jam flooding and inundation but has expanded applications to levee breaches, post-storm flooding, and more	Nov 2018 V1.1
Sea Surface Temp	Skin temperature of the ocean at depths on the order of 10 microns is retrieved in each cloud-free pixel over water.	Oct 2022 V2.0
Polar Winds	Winds derived by tracking clouds features in the VIIRS longwave infrared channel. Wind speed, direction, and height are measured throughout the troposphere, pole-ward of approximately 65 degrees latitude, in cloudy areas only.	TBD

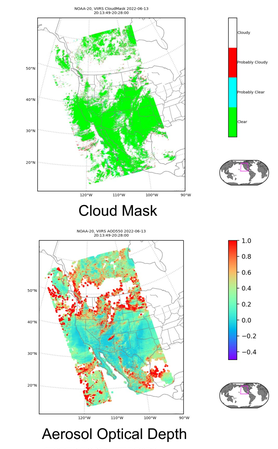
OMPS Level-2 Environmental Data Records		Latest Release (Date)
Nadir Profile	Nadir Profile Spectrometer provides ozone profiles in a single ground pixel of 250x250 km at nadir from SNPP; 5 ground pixel of 50x50 km at nadir.	TBD
Total Colum	Nadir Total Column Spectrometer Provides Total Column ozone data with 50x50 km resolution at nadir.	TBD
Limb Profile	The algorithm retrieves aerosol extinction profiles at 675 nm from OMPS Limb Profile radiance measurements.	TBD

CrIS and ATMS Level-2 Environmental Data Records (Hyper-Spectral Enterprise Algorithm Package (HEAP))		Latest Release (Date)
Atm. Vertical Moisture Profile	Vertical sampling of atmospheric moisture (water vapor) between 1100 hPa and 0.016 hPA – a total of 100 layers.	Jan 2022 V2.0
Atm Vertical Temp Profile	Vertical sampling of atmospheric temperature between 1100 hPa and 0.016 hPA – a total of 100 points.	Jan 2022 V2.0
Carbon Dioxide	Retrievals of column and total carbon dioxide, calibrated by the users with ground-based measurements, of stated precision needed to afford deduction of long-term variations and trends.	Jan 2022 V2.0
Carbon Monoxide	Measure of the carbon monoxide in a specified volume of air.	Jan 2022 V2.0
Methane	Measure of the amount of methane in a specified volume of air.	Jan 2022 V2.0
Infrared Ozone Profile	Measurement or first guess of the ozone in 100 layers.	Jan 2022 V2.0
Outgoing Longwave Radiation	Instantaneous radiative energy emitted by the Earth-atmosphere system at the Top of the Atmosphere (TOA) to space into a hemisphere.	Jan 2022 V2.0

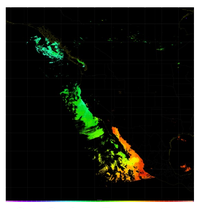
ATMS - Microwave Integrated Retrieval Suite (MIRS) Environmental Data Records		Latest Release (Date)
Cloud Liquid Water	The equivalent amount of water within a cloud in a specified segment of a vertical column of the atmosphere.	March 2022 V3.0
Ice Concentration	The areal extent of sea ice relative to the total at a given location in the ocean. It is empirically derived using the natural variation in the emissivity of ice and water in the microwave frequencies between 23 and 50 GHz.	March 2022 V3.0
Imagery	ATMS image is a limb-corrected nadir view of the ATMS Temperature Data Record.	March 2022 V3.0
Land Surface Emissivity	Relative ability of the land surface to emit energy by radiation.	March 2022 V3.0
Land Surface Temp	The sensor-facing skin temperature of the land surface. It includes the aggregate temperature of objects comprising the land surface, including any open water, in the cell.	March 2022 V3.0
Moisture Profile	A calculation of the mixing ratio at specified points along a local vertical. The mixing ratio of a sample of air is the ratio of the mass of water vapor in the sample to the mass of dry air in the sample.	March 2022 V3.0
Rainfall Rate	The amount of rainfall during a period of time. The required Rainfall Rate products provide the instantaneous rainfall rate during the time of observation in mm/hour.	March 2022 V3.0
Snow Cover	Horizontal extent of snow cover.	March 2022 V3.0
Snowfall Rate	Water equivalent snowfall rate estimate.	March 2022 V3.0
Snow Water Equivalent	The product of snow depth and snow relative density (with respect to the density of liquid water), a measure of the amount of water stored in a snowpack per unit area; it is expressed in units of length (e.g., cm or inches), being a quantity of type surface density, normalized by water density. It is the depth of water in the snowpack, if the snowpack were melted.	March 2022 V3.0
Temp Profile	A calculation of temperatures at stated intervals throughout the atmosphere.	March 2022 V3.0
Total Precipitable Water	The total column amount of water vapor available in a vertical atmospheric profile.	March 2022 V3.0

GCOM-W1 AMSR-2 Level-2 Environmental Data Records		Latest Release (Date)
Cloud Liquid Water	Equivalent amount of water within a cloud in a specified segment of a vertical column of the atmosphere.	Feb 2021 V1.0.1
Imagery	Brightness temperature data from each microwave channel display at the native resolution.	Feb 2021 V1.0.1
Rainfall type/rate	Amount of rainfall during a period of time.	Feb 2021 V1.0.1
Sea Ice Characterization	Sea Ice properties derived from all-weather imagery.	Feb 2021 V1.0.1
Sea Surface Temp	Skin temperature of the ocean at depths on the order of 10 microns is retrieved in each cloud-free pixel over water.	Feb 2021 V1.0.1
Sea Surface Wind Speed	Measure of atmospheric wind speed/direction at the sea/atmosphere interface in clear sky and cloudy conditions.	Feb 2021 V1.0.1
Snow Cover	Horizontal extent of snow cover.	Feb 2021 V1.0.1
Snow Water Equivalent	Snow-Water Equivalent (SWE) is the product of snow depth and snow relative density (with respect to the density of liquid water), a measure of the amount of water stored in a snowpack per unit area; it is expressed in units of length (e.g., cm or inches), being a quantity of type surface density, normalized by water density. It is the depth of water in the snowpack, if the snowpack were melted.	Feb 2021 V1.0.1
Soil Moisture	Moisture within the surface soil layer to the depth where microwave emission or reflection signals can be sensed by satellite sensors.	Feb 2021 V1.0.1
Total Precipitable Water	Total equivalent water of unit cross-sectional area between any two specified levels, including the total atmospheric column.	Feb 2021 V1.0.1

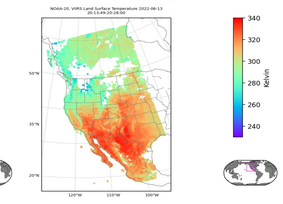

Active Fires overlaid on VIIRS True Color


Cloud Mask

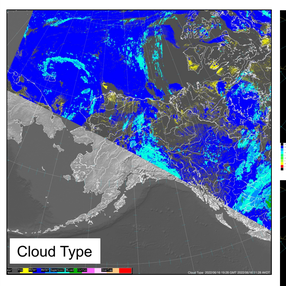
Aerosol Optical Depth

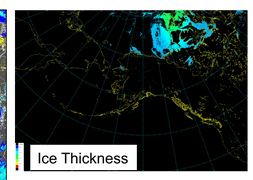

Sea Surface Temperature

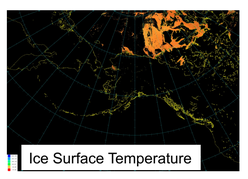

Volcanic Ash

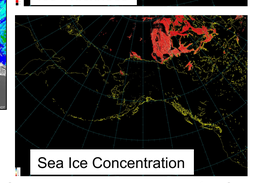

Land Surface Temperature

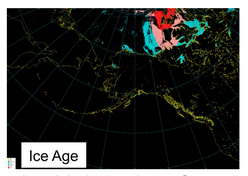
The VIIRS images above were generated at UW-Madison


Cloud Type

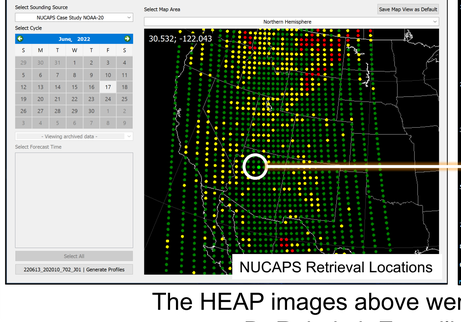

Ice Thickness

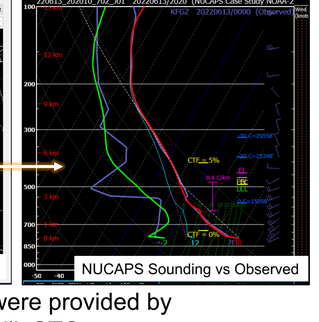

Ice Surface Temperature


Sea Ice Concentration

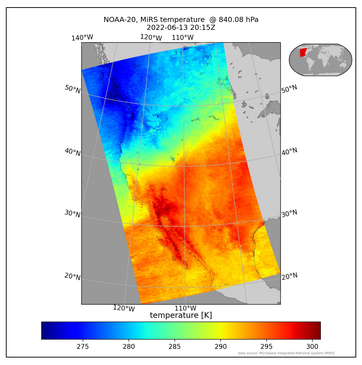

Ice Age

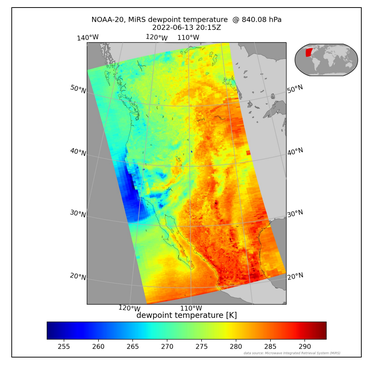
The VIIRS images above were generated at the University of Alaska-Fairbanks Geographic Information Network of Alaska (GINA)


NUCAPS Retrieval Locations

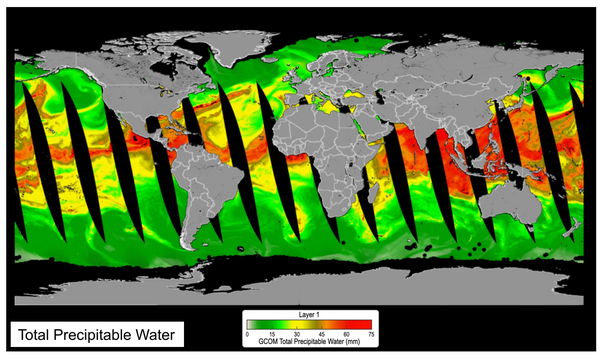

NUCAPS Sounding vs Observed

The HEAP images above were provided by Dr Rebekah Esmaili, STC





The MIRS images above were generated at UW-Madison


Total Precipitable Water

The image above was generated using the NOAA/NESDIS/STAR JSTAR Mapper: https://www.star.nesdis.noaa.gov/jpss/mapper