

NPP Atmosphere products produced at Land PEATE

The atmosphere products produced at Land PEATE are Level 2 products that are required as input for production of land and sea ice products. These products include cloud mask (NPP_CMIP_L2), aerosol model information (NPP_VAMIIP_L2), aerosol optical thickness (NPP_VAOTIP_L2 and NPP_VAOT_L2), and cloud optical properties (NPP_VCOPIP_L2).

VIRS Cloud Mask (NPP_CMIP_L2)

- In IDPS (AS3000), LPEATE (AS3001), and LPA (AS3002) archive sets
- 750m resolution Level 2 swath data
- All pixels
- Day and night

The information in the VIIRS cloud mask is used frequently in the production of swath- level land products. The Cloud Mask consists of six bytes of bitwise quality flags. One set of quality flags is generated for each moderate- resolution (750 m) pixel. The flags indicate the presence of cloud and other conditions such as heavy aerosol and cloud shadow that affect the retrieval of land products. The cloud mask data set also includes flags for day/ night and land/ water for each pixel.

Cloud cover flags are generated from both the reflective and emissive bands through a series of threshold tests. Different sets of thresholds are used under different conditions (day vs. night, land vs. water). Individual threshold test results are stored in the cloud mask along with the overall cloud cover result. Several ancillary data sets are also used to generate the cloud mask, including both NCEP reanalysis and intermediate products generated earlier in VIIRS processing.

Table 1: Cloud mask flag scheme

Byte	Bit	Flag description	Flag values
0	0-1	Cloud Mask Quality	00=Poor 01=Low 10=Medium 11=High
	2-3	Cloud Detection Results & Confidence Indicator	11=Confident Cloudy 10=Probably Cloudy 00=Confident Clear 01=Probably Clear
	4	Day / Night	0=Night 1=Day
	5	Snow / Ice Surface	1=Snow/Ice 0=No Snow or Ice

Byte	Bit	Flag description	Flag values
0	6-7	Sun Glint	00=None 01=Geometry Based 10=Wind Speed Based 11=Geometry and Wind
1	0-2	Land / Water Background	000=Land & Desert 001=Land no Desert 010=Inland Water 011=Sea Water 101=Coastal
	3	Shadow Detected	1=Yes 0=No
	4	Non Cloud Obstruction (Heavy Aerosol)	1=Yes 0=No
	5	Fire Detected	1=Yes 0=No
	6	Cirrus Detection (Solar) (RM9)	1=Cloud 0=No Cloud
	7	Cirrus Detection (IR) (BTM15-BTM16) 1	1=Cloud 0=No Cloud
	2	0	IR Threshold Cloud Test (BTM15)
1		High Cloud (BTM12-BTM16) Test	1=Cloud 0=No Cloud
2		IR Temperature Difference Test (BTM14 – BTM15 & BTM15 – BTM16)	1=Cloud 0=No Cloud
3		Temperature Difference Test (BTM15 – BTM12)	1=Cloud 0=No Cloud
4		Temperature Difference Test (BTM12 – BTM13)	1=Cloud 0=No Cloud
5		Visible Reflectance Test (RM5)	1=Cloud 0=No Cloud
6		Visible Reflectance Test (RM7), also Visible Reflectance Test (RM1)	1=Cloud 0=No Cloud
7		Visible Ratio Test (RM7 / RM5)	1=Cloud

Byte	Bit	Flag description	Flag values
3	0-1	Adjacent Pixel Cloud Confident Value	0=No Cloud 11=Confident Cloudy 10=Probably Cloudy 00=Confident Clear 01=Probably Clear
4	2	Conifer Boreal Forest	1=Yes 0=No
	3	Spatial Uniformity	1=Yes 0=No
	4	Dust candidate	1=Yes 0=No
	5	Smoke candidate	1=Yes 0=No
	6	Dust / Volcanic Ash	1=Yes 0=No
	7	Spare	
	0-7	Spare	
5	0-2	Cloud Phase	000 = Not Executed 001 = Clear 010 = Partly Cloudy 011 = Water Cloud 100 = Supercooled Water/Mixed 101 = Opaque Ice Cloud 110 = Cirrus Cloud 111 = Cloud Overlap
	3	Thin Cirrus Flag	1=Yes 0=No
	4	Ephemeral Water Flag	1=Yes 0=No
	5	Degraded TOC NDVI Flag	1=Yes 0=No
	6	Degraded Sun Glint Flag	1=Yes 0=No
	7	Degraded Polar Night Flag	1=Yes 0=No

Aerosol products summary

There are two categories of aerosol products produced at the Land PEATE, Intermediate Products (IPs) and Environmental Data Records (EDRs). The aerosol IPs and EDRs are both Level 2 swath- based products. The IPs are at 750m resolution, with a separate value for each moderate- resolution pixel. The EDRs are produced at a lower resolution, with each data value aggregated from an 8 x 8 region of moderate- resolution pixels.

An aerosol model for each pixel is derived via a LUT inversion. First, an atmospheric correction is performed using a Lambertian assumption for the red (672nm) and blue (488nm) bands to obtain an estimate of surface reflectance for each of these bands. Based on a LUT generated from radiative transfer modeling, the AOT at 550nm that would be consistent with this ratio is found for each candidate aerosol model. These AOT values are used to estimate expected surface reflectance values at 412nm, 445nm, and 2.25um. The aerosol model that minimizes the difference between expected and calculated surface reflectances in those bands is selected.

Once an aerosol model is selected, that model is used along with the 550nm AOT value for that model to calculate AOT values in all bands. If the pixel background is too bright for an accurate retrieval of AOT over a small area, interpolation from AOT values calculated for nearby darker pixels is performed. If the bright area is too large for valid interpolation over the entire region, AOT values from the NAAPS analysis or climatological AOT values are used for the central area of the bright region. At the edges of the bright region, NAAPS/ climatology values are combined with valid AOT retrievals from nearby pixels to obtain interpolated AOT.

The AOT and AMI IPs are used as input to the surface reflectance algorithm. The AOT IP is also used in the generation of snow and ice products. The pixel- level results in the AOT IP and AMI IP are aggregated into 8 x 8 pixel cells in order to generate the AOT EDR and Suspended Matter EDR.

Table 1: NPP/ VIIRS atmosphere products produced at the Land PEATE

Product	Type/ format	Resolution	Found in Archive Sets	Notes
NPP_VAMIIP_L2	Level 2 swath	750m	3000/IDPS, 3001/LPEATE, 3002/LPA	All pixels, day and night
NPP_VAOTIP_L2	Level 2 swath	750m	3000/IDPS, 3001/LPEATE, 3002/LPA	All pixels, day and night
NPP_VSUM_L2	Level 2 swath, aggregated	6 km	3000/IDPS, 3001/LPEATE, 3002/LPA	Aggregated to 8x8 pixel cells. Day and night.
NPP_VAOT_L2	Level 2 swath, aggregated	6 km	3000/IDPS, 3001/LPEATE, 3002/LPA	Aggregated to 8x8 pixel cells. Day and night.

VIIRS Aerosol Model Information IP (NPP_VAMIIP_L2)

The VIIRS Aerosol Model Information IP includes four aerosol model indicators. Each is contained in one byte. One is an overall aerosol model, one is for large- mode aerosols, one is for small- mode aerosols, and one is a combination model. The aerosol model determination is made based on the VIIRS SDR and cloud mask along with meteorological data from NCEP.

VIIRS Aerosol Optical Thickness IP (NPP_VAOTIP_L2)

The VIIRS Aerosol Optical Thickness (AOT) IP is generated for each 750m pixel in a swath. The AOT IP contains three two- dimensional data fields: 550nm AOT, 550nm slant AOT, and Angstrom exponent. It also contains five bytes of quality flag data for each 750m pixel. AOT and Angstrom exponent are obtained from visible and near-IR VIIRS Level 1B data and granulated meteorological data from reanalysis products.

VIIRS Aerosol Optical Thickness EDR (NPP_VAOT_L2)

The VIIRS Aerosol Optical Thickness (AOT) EDR is retrieved at 6 km resolution, on an 8 x 8 pixel grid. and contains AOT values at the following wavelengths: 412nm, 445nm, 448nm, 550nm, 555nm, 672nm, 746nm, 865nm, 1240nm, 1610nm, and 2250nm. The EDR also contains an Angstrom exponent, small mode fraction, and 5 bytes of quality flags at each pixel.

VIIRS Suspended Matter EDR (NPP_VSUM_L2)

The VIIRS Suspended Matter EDR contains an integer indicating a suspended matter type and a scaled smoke concentration value for each 8x8 moderate- resolution pixels.

Table 2: MODIS equivalents for VIIRS aerosol products

VIIRS product	MODIS equivalent
NPP_VAMIIP_L2	None
NPP_VAOTIP_L2	None
NPP_VAOT_L2 (6 km resolution)	MOD04_L2 (10 km resolution)
NPP_VSUM_L2 (6 km resolution)	MOD04_L2 (10 km resolution)

Cloud products summary

The only cloud product produced at the Land PEATE is the VIIRS Cloud Optical Properties IP (COP IP). [This product is input to the xxx algorithm.]