SEVIRI SEV_06-CLD Cloud Product Technical Document

Revision History

Revision 0 (7/16/2014): Initial technical document release.

Overview

This document serves as a general announcement of the availability of the SEVIRI SEV_06-CLD *beta* product for evaluation purposes. SEV_06-CLD uses MODIS-like algorithms for cloud optical and microphysical property retrievals, and a modified GOES-R Algorithm Working Group (AWG) algorithm for cloud-top temperature and pressure. Cloud masking is obtained from the Météo France Satellite Application Facility for supporting NoWCasting (SAFNWC) software package.

The SEV_06-CLD datasets share a common retrieval core with the Collection 6 MODIS Level-2 cloud product (product names MOD06_L2 and MYD06_L2 for MODIS Terra and Aqua, respectively). The core cloud optical property code is equivalent to that used in the MODIS Adaptive Processing System (MODAPS) PGE06 v6.0.78 production version. Optical properties, pixel-level uncertainties and QA assignments are provided in the same exact fashion and via the same code base as the archived MODIS product. Existing user MOD06 optical property visualization and analysis codes are largely expected to work with SEV_06-CLD files.

As discussed more extensively below, this beta product has not been extensively validated and is being provided for evaluation purposes only.

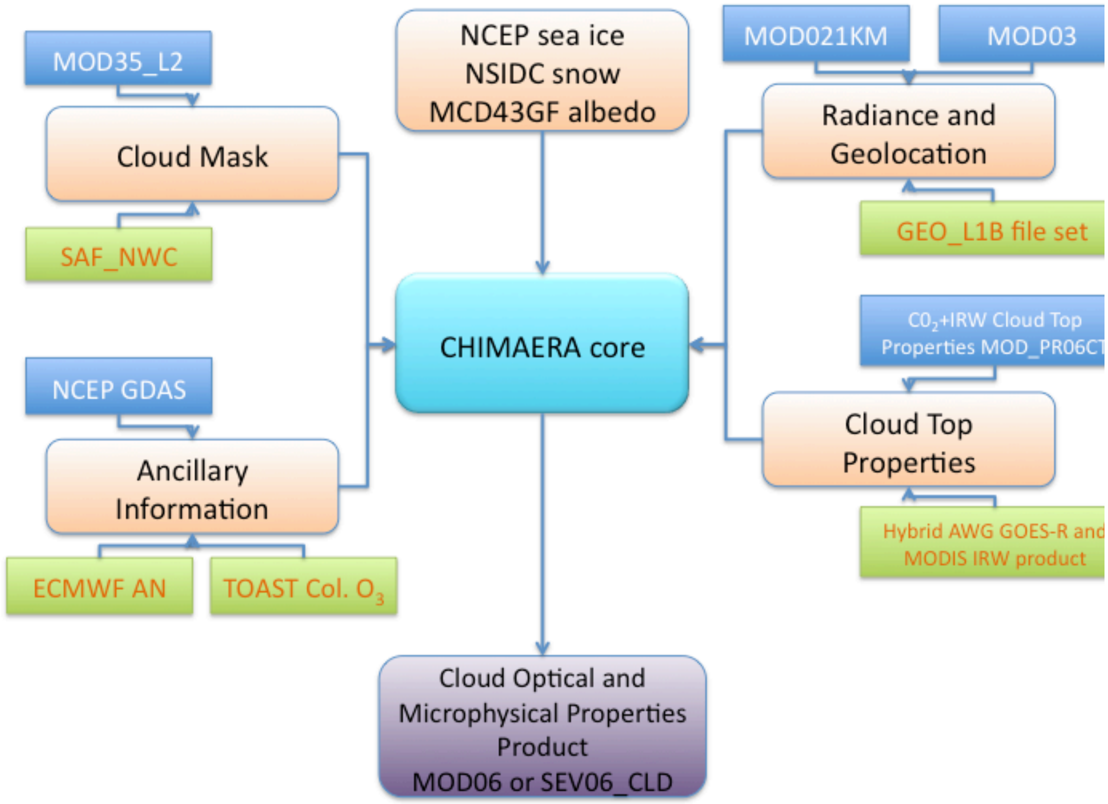

Figure 1: Internal processing chain for the CHIMAERA MODIS (blue boxes) and SEVIRI (green boxes) cloud optical and cloud-top properties products.

Background

SEVIRI is the main imager on the EUMETSAT Meteosat Second Generation platform. As part of our participation in the international CREW (Cloud Retrieval Evaluation Workshop) product intercomparison and assessment effort (www.icare.univlille1.fr/crew/index.php/Welcome), we have adapted portions of the operational Collection 6 MODIS (MOD06/MYD06) cloud optical and microphysical algorithm and the GOES-R cloud top properties algorithm to run on SEVIRI. The overall retrieval package is referred to as CHIMAERA (Cross-platform HIgh resolution Multi-instrument AtmosphEric Retrieval Algorithms); it was designed for flexibility in ingesting data from a variety of satellite and airborne imaging instruments (MODIS, VIIRS, SEVIRI, eMAS, etc.). The CHIMAERA package utilizes a shared-core concept where the same core code and algorithm-specific ancillary data sources are used for all instrument retrievals. Lookup tables (LUTs) such as cloud reflectance/emissivity and absorbing gas transmittances for atmospheric corrections are developed on an instrument-specific basis. Figure 1 illustrates the processing chain for both MOD06_L2 and SEV_06-CLD products.

SEVIRI-specific Algorithm Details

There are some important differences between the implementation of the MODIS and SEVIRI optical property retrieval products (optical thickness, effective particle radius, and derived water path). SEVIRI lacks the MODIS 1.2 µm and 2.1µm channels, which compromises SEVIRI's ability to retrieve clouds over snow/ice surfaces (*Platnick et al.*, 2003). Similarly, the optional 1.6 and 2.1µm MODIS retrieval over snow/ice surfaces (*Platnick et al.*, 2001) is not available. However SEVIRI's spatial coverage is such that snow/ice surfaces typically cover a very small fraction of the observable area and thus are unlikely to be an issue except for users interested in wintertime northern hemisphere scenes and/or mountain regions.

The CO_2 emissive band coverage on SEVIRI consists of a single broadband CO_2 channel instead of the four narrow-band CO_2 channels on MODIS. Therefore the MODIS CO_2 slicing algorithm cannot be used in SEVIRI processing to obtain cloud top properties of high clouds. In lieu of being able to implement a full MODIS cloud-top properties algorithm, the SEVIRI algorithm utilizes a hybrid algorithm. A GOES-R Algorithm Working Group (AWG) style optimal estimation cloud-top properties retrieval, described in *Heidinger and Pavolonis* (2009) and *Heidinger et al.* (2010), is used for retrievals of low emissivity high clouds with good success (*Hamann et al.,* 2014). For low clouds, a MODIS-heritage IR Window retrieval is used. An IR cloud thermodynamic phase algorithm is implemented using the same method utilized in MODIS Collection 6 (*Baum et al.*, 2012).

The cloud algorithms ingest the well-established and documented SAFNWC cloud mask product developed by the Météo France Nowcasting and Weather Prediction Satellite Application Facility. This cloud mask algorithm is described in detail in *Derrien and Le Gleau* (2005) and *Derrien and Le Gleau* (2010). We also rely on the SAFNWC cloud mask to identify broken clouds/partly cloudy pixels for PCL (Partly CLoudy, see Table 3) discrimination. We do not perform a MODIS-like multilayer cloud retrieval as SEVIRI does not have the requisite spectral channels. However, unlike the MODIS cloud mask, the SAFNWC cloud mask does provide a multilayer mask. We also do not perform separate visible/near-infrared/shortwave-infrared cloud thermodynamic phase tests to supplement the IR phase algorithm; only the IR cloud thermodynamic phase algorithm (mentioned above) is used.

The impact of cloud mask and phase differences relative to MODIS can be important for ambiguous scenes (broken clouds, heavy aerosol/dust, supercooled cloud temperatures). For example, any difference in the phase decision will result in potentially strong differences in the retrieved optical thickness and effective radius due simply to the different microphysical assumptions. Regardless, the cloud optical thickness and effective radius retrieval algorithms that are implemented for both the visible/near-infrared (VNIR) -1.6µm and VNIR-3.8µm SEVIRI channel combinations are identical to MODIS Collection 6 as are the QA bit assignments (see modis-atmos.gsfc.nasa.gov/products_C006update.html).

The SEVIRI nadir resolution is 3 km and degrades away from nadir as the view angle becomes more oblique. Like MODIS, retrievals are limited to where the solar zenith angle is less than 81.36° (μ_0>0.15). In consideration of the SEVIRI wide field of view, a limit of the same 81.36 degrees is also applied to the sensor zenith angle. Note that baseline retrieval uncertainties are provided in the data file (see Table 3) and can increase substantially at the extreme solar and view zenith angles. Further, the impact of SEVIRI's coarser spatial resolution (3km vs. 1km) is expected to impact retrievals in heterogeneous cloud scenes (*Zhang and Platnick*, 2011; *Zhang et al.,* 2012).

IMPORTANT NOTICE: Use of SEV_06-CLD Beta Products

At this stage, the SEV_06-CLD product has undergone low-level validation consisting mostly of checks for internal consistency. The product also benefits from the longer-term validation and evaluation of its MODIS counterpart. However, no further investigation has been performed in terms of validity regarding spurious biases or trends that could be caused by the wider range of solar zenith and view zenith angles, coarser spatial resolution and the typically wider spectral channels (especially in the shortwave-infrared). Also, slight contamination by sunglint appears as a potential source of spurious diurnal trend for the retrieved optical properties over the main region of potential interest that constitutes the southern Atlantic ocean.

We emphasize that this public beta release shall only serve as a test-bed for users who might be interested in conducting research studies using the SEV_06-CLD products once these have undergone a more complete evaluation and validation process. This release shall not be used for research purposes at this stage and no scientific publication should be attempted from this early release dataset. For these reasons, only a limited half-hour temporal resolution (instead of the native 15 min resolution) is being made available publicly. Finer time resolutions could be processed and made available on request for targeted studies and evaluations aimed at providing feedback regarding the quality of the current products.

It is therefore requested that any issues with this product be promptly reported as it will help diagnose undetected problems and eventually result in a faster release of science quality products.

Data Archive and Availability

Users can obtain the product for analysis and evaluation from the ICARE data center by registering at www.icare.univ-lille1.fr, in the menu "Data Access" at "User Registration". It is strongly suggested that users specify "access to MODIS-like beta SEVIRI cloud products" in the "*Short description of your project*" field of registration form in order for access permissions to be set optimally. The account will be activated promptly. After that, users can access the data via:

- *ICARE web site*: in the menu "Data access", choose Data Archive => GEO => MSG+0000 => SEV_06-CLD-L2.v1.02

- *ICARE ftp site*: with their registered login/password, users can connect to the server ftp://ftp.icare.univ-lille1.fr. The SEVIRI cloud products are stored in the directory "/SPACEBORNE/GEO/MSG+0000/SEV_06-CLD-L2.v1.02".

SEV_06-CLD data for June, July, August and September 2009 is currently available in the ICARE archive. Production for June through September 2006–2008 is planned. A more systematic processing of the longer archive will be made once sufficient evaluation has been performed and feedback from users has been obtained. Again, prompt feedback on any issues or concerns related to the use, interpretation or identification of spurious product biases or trends is highly encouraged and will result in a faster release of a scientifically usable first version of the SEV_06-CLD product.

Global File Attributes

SEV_PGE06 version = " 6.0.78"

Equivalent Operational MODIS Product = " NASA MODIS Science Team Operational Cloud Product MOD06_L2 / MYD06_L2 v6.0.78"

Equivalent Operational PEATE-Atmosphere VIIRS Product = " NASA S-NPP Science Team Operational Cloud Product VIIRS06 v6.0.78"

Provided and Supported By = " NASA GSFC Cloud Retrieval Group"

In Collaboration With 1 = " Steven A. Ackerman and Bryan Baum, University of Wisconsin-Madison, Madison, WI, USA"

In Collaboration With 2 = " Jerome Riedi and ICARE team, University of Lille, Lille, France"

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Table 1. Legend of values stored in SEVIRI cloud mask product and their definitions as per Satellite Meteorology Centre of Meteo-France (SATMOS) website. www.satmos.meteo.fr/html_en/Diffusion_CT_MSG.html

Result Value	**Description**
0	No retrieval
1	Clear sky, land surface
2	Clear sky, ocean surface
3	Snow / ice on land, no cloud
4	Snow / ice on ocean, no cloud
5	Cloud, very low, cumuliform
6	Cloud, very low, other
7	Cloud, low, cumuliform
8	Cloud, low, other
9	Cloud, medium, cumuliform
10	Cloud, medium, other
11	Cloud, high, cumuliform
12	Cloud, high, other
13	Cloud, very high, cumuliform
14	Cloud, very high, other
15	Cloud, semi-transparent, thin
16	Cloud, semi-transparent, meanly thick
17	Cloud, semi-transparent, thick
18	Cloud, semi-transparent, above medium cloud
19	Cloud, broken
20	Undetermined

Table 2: SEVIRI channels and their MODIS equivalents

SEVIRI channel number and central wl (µm)	**SEVIRI band-pass (µm)**	**MODIS channel number and central wl (µm)**	**MODIS band-pass (µm)**
1: 0.635	0.590-0.698	1: 0.658	0.620-0.670
2: 0.810	0.768-0.854	2: 0.863	0.841-0.876
3: 1.640	1.539-1.729	6: 1.625	1.628-1.652
4: 3.920	3.550-4.360	20: 3.851	3.660-3.840
5: 6.250	5.746-6.862	27: 6.766	6.535-6.895
6: 7.350	7.010-7.730	28: 7.282	7.175-7.475
7: 8.700	8.444-8.972	29: 8.642	8.400-8.700
8: 9.660	9.500-9.839	30: 9.673	9.580-9.880
9: 10.800	10.080-11.600	31: 10.984	10.780-11.280
10: 12.000	11.360-12.560	32: 11.897	11.770-12.270
11: 13.400	12.48-14.320	33-36: N/A	13.185-14.385

Table 3: SEV_06-CLD SDS list and equivalent MOD06 SDSs

SEV_06-CLD SDS name	Equivalent MOD06 SDS name	Notes
MSG_Latitude	Latitude	
MSG_Longitude	Longitude	
Relative_Azimuth_Angle		Can be calculated from solar and sensor azimuth angles
Above_Cloud_Water_Vapor		This water vapor amount is from an integrated ancillary profile and is not a direct retrieval
Cloud_Optical_Thickness_16	Cloud_Optical_Thickness_16	Except over snow/ice surfaces where MODIS is able to use 1.2μm channel.
Cloud_Optical_Thickness_16_PCL	Cloud_Optical_Thickness_16_PCL	Except for different PCL definition as stated earlier
Cloud_Optical_Thickness_38	Cloud_Optical_Thickness_37	Except over snow/ice surfaces where MODIS is able to use 1.2μm channel.
Cloud_Optical_Thickness_38_PCL	Cloud_Optical_Thickness_37_PCL	Except for different PCL definition as stated earlier
Cloud_Effective_Radius_16	Cloud_Effective_Radius_16	See COT note
Cloud_Effective_Radius_16_PCL	Cloud_Effective_Radius_16_PCL	See COT PCL note
Cloud_Effective_Radius_38	Cloud_Effective_Radius_37	See COT note
Cloud_Effective_Radius_38_PCL	Cloud_Effective_Radius_37_PCL	See COT PCL note
Cloud_Water_Path_16	Cloud_Water_Path_16	See COT note
Cloud_Water_Path_16_PCL	Cloud_Water_Path_16_PCL	See COT PCL note
Cloud_Water_Path_38	Cloud_Water_Path_37	See COT note
Cloud_Water_Path_38_PCL	Cloud_Water_Path_37_PCL	See COT PCL note
Cloud_Effective_Radius_Uncertainty_16	Cloud_Effective_Radius_Uncertainty_16	Calibration uncertainty of flat 5% used for SEVIRI because there is no L1B uncertainty

		index
Cloud_Effective_Radius_Uncertainty_38	Cloud_Effective_Radius_Uncertainty_38	See CER_Unc16 note
Cloud_Optical_Thickness_Uncertainty_16	Cloud_Optical_Thickness_Uncertainty_16	See CER_Unc16 note
Cloud_Optical_Thickness_Uncertainty_38	Cloud_Optical_Thickness_Uncertainty_38	See CER_Unc16 note
Cloud_Water_Path_Uncertainty_16	Cloud_Water_Path_Uncertainty_16	See CER_Unc16 note
Cloud_Water_Path_Uncertainty_38	Cloud_Water_Path_Uncertainty_38	See CER_Unc16 note
Cloud_Phase_Optical_Properties	Cloud_Phase_Optical_Properties	SEVIRI CPOP SDS at this time is identical to SEVIRI Cloud_Phase_Infrared SDS
Single_Scatter_Albedo_Ice	Single_Scatter_Albedo_Ice	
Asymmetry_Parameter_Ice	Asymmetry_Parameter_Ice	
Extinction_Efficiency_Ice	Extinction_Efficiency_Ice	
Single_Scatter_Albedo_Liq	Single_Scatter_Albedo_Liq	
Asymmetry_Parameter_Liq	Asymmetry_Parameter_Liq	
Extinction_Efficiency_Liq	Extinction_Efficiency_Liq	
Failure_Metric_16	Failure_Metric_16	
Failure_Metric_38	Failure_Metric_37	
Quality_Assurance	Quality_Assurance_1km	Full QA bit description is present in file metadata just like MOD06
Cloud_Mask	Cloud_Mask_1km	SEVIRI Cloud_Mask SDS does not require any bit decoding, values are as listed in Table 1
Cloud_Top_Temperature	cloud_top_temperature_1km	SEVIRI uses the AWG algorithm, but use of data is same as for MOD06
Cloud_Top_Height	cloud_top_height_1km	
Surface_Temperature	surface_temperature_1km	Interpolated model surface temperature
Cloud_Top_Pressure	cloud_top_pressure_1km	See CTT note
Cloud_Top_Method	cloud_top_method_1km	

Cloud_Phase_Infrared	cloud_phase_infrared_1km	SEVIRI uses an identical algorithm to MODIS, but 13.2 µm instead of 7.2 µm for absorbing IR channel.

References and Useful Links

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MODIS Collection 6 User Guide and QA tables: modis-atmos.gsfc.nasa.gov/products_C006update.html

MODIS Data Archive (Level-1 and Atmosphere Archive and Data Distribution System): ladsweb.nascom.nasa.gov

MODIS Atmosphere Team publications and references: modis-atmos.gsfc.nasa.gov/pubs_main.html

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