EUMETSAT

Clear Sky Reflectance Map: Product Guide

Doc.No. : EUM/OPS/DOC/09/5165
Issue : v2D
Date : 29 May 2015
WBS :

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Document Change Record

Issue / Revision	Date	DCN. No	Summary of Changes
v1	06/10/2010		Initial issue of document.
v2	20/06/2011		Contents totally replaced by CRM section in "Central Facility MSG Meteorological Product Manual
v2A	22/06/2011		Add confirmation in 4th paragraph that all products have same parameters as 12:00 UTC product
v2B	21/07/2011		Title amendment: 'SEVIRI' prefixed.
v2C	11/11/2014		Format of document changed from Factsheet format to Product Guide format.
v2D	29/05/2015		Editorial changes requested by staff scientist.

Table of Contents

1 PRODUCT DESCRIPTION

The main goal of the Clear Sky Reflectance Map (CRM) generation is to accumulate clear-sky reflectance values over a set period of time during which most areas will have encountered a cloud-free condition. This time period has to be defined in a way that the chances to find clear pixels are maximized, but reflectance changes due to changes in solar illumination and vegetation conditions are minimized. The Clear Sky Reflectance Map product describes the reflection that would be seen from the satellite in the visible and near-infrared MSG channels over a cloud-free Earth. No atmospheric correction and no surface reflection correction according to the viewing angle is applied. Therefore, the CRM corresponds to the so-called remote sensing reflectance.

The CRM product is a composite of seven days' reflectance observations for clear sky scenes for each of these three channels: VIS0.6, VIS0.8 and NIR1.6. The reflectance for each pixel in those channels is collected and averaged over the period. If a pixel does not have a clear sky scene during this period then the value of the previous seven-day period is used. When that value is also not available, then a default value is used.

The product can be used as part of a cloud detection scheme. Furthermore, it can be used to analyse geographical and seasonal variations in surface reflectance. Each of the individual products is constructed out of two images, for example, the 12:00 UTC product uses both the 11:45 UTC and the 12:00 UTC images.

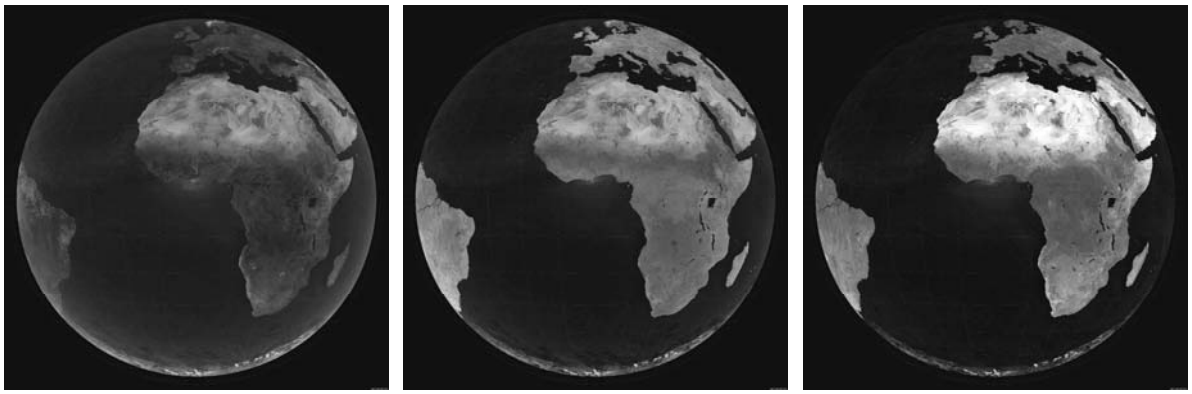

Figure 1: The Clear Sky Reflectance (%) maps for the 12:00 UTC products are shown for the VIS 0.6 µm (left), VIS 0.8 µm (centre) and NIR 1.6 µm channels (right) on 18 May 2011.

1.1 Product history and gaps in coverage:

Initial development and baseline:	25 July 2005	CRM coverage limited to only noon.
Substantial Revision	2 December 2008	CRM coverage expanded to every two hours between 0600 and 2000 UTC.
Substantial gaps in coverage		

2 PRODUCT SPECIFICATIONS

Category	*Specification*
Type	Meteorological product
Applications and users	Perform cloud masking with visible channels. It also supplies information for climate and land surface applications.
Input satellite data	• The reflectances of the required MSG SEVIRI channels from the 11:45 and 12:00 UTC images • Results of the pixel-based Scenes Analysis giving the scenes type. Scenes analysis is an internal product. • Additional data required by the algorithm are the solar zenith angle, satellite observing angle, and the relative azimuth angle between the sun and the spacecraft
Product Distribution	• EUMETCast • EUMETSAT Data Centre
Product Area	Full-earth scanning area (FES)
Product Resolution	pixel
Product Distribution Frequency	• EUMETCast: Daily at 13:15 UTC for the 12:00 UTC product • EUMETSAT Data Centre: ➢ Daily for the 12:00 UTC product ➢ Every Wednesday for the 06:00, 08:00, 10:00, 14:00, 16:00 and 18:00 UTC products
Product Format	GRIB2 format
Product Size	About 20 MB (variable)

3 PRODUCT ILLUSTRATION

Figure 2 and Figure 3 show the variation of the CRM product during day time. The series of images begins with the image at 0600 UTC and continues on the next pages to 18:00 UTC. In Figure 7 are shown as derived from the VIS 0.8 µm channel. These maps are available on a two-per-hour basis.

Notice that the impact of the sunglint area can be seen during the second half of the day. The sunglint area is intentionally not masked, as it may support the user community with respect to cloud detection. Furthermore, it is evident in the 14:00 UTC product that there are some cloud misclassifications in the sunglint area.

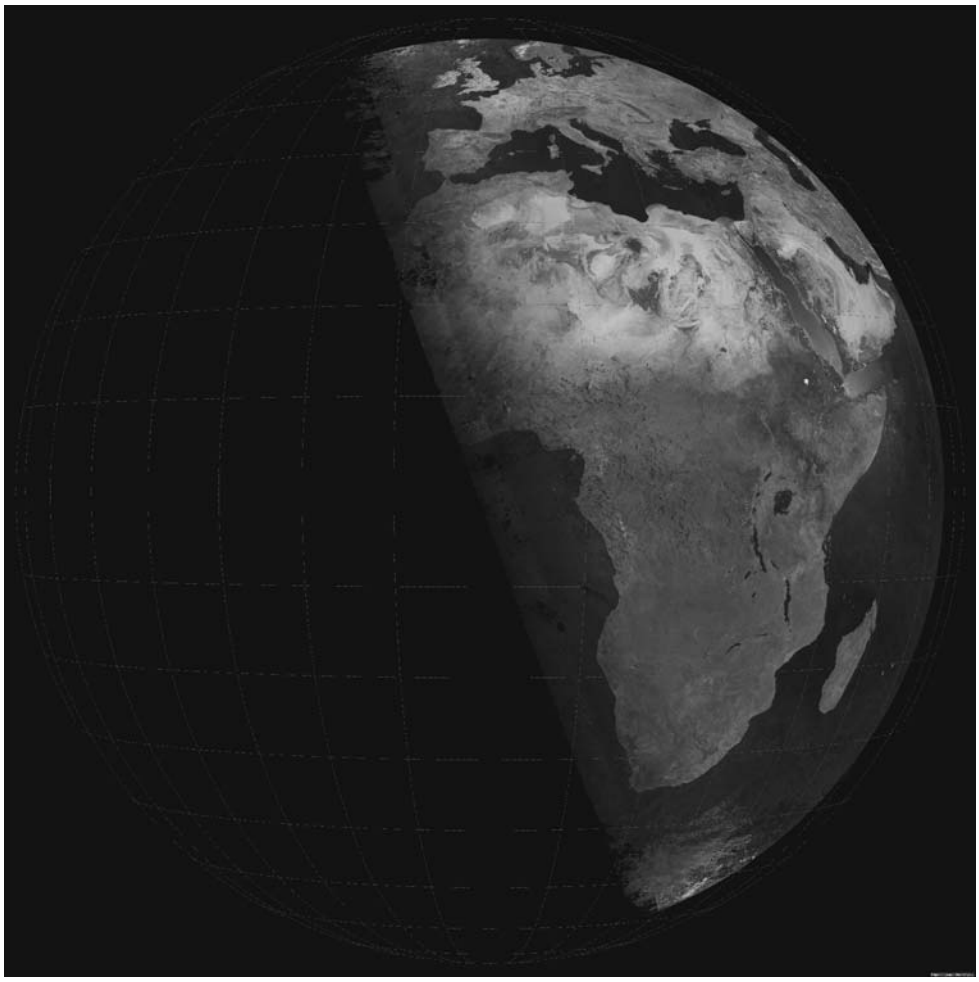

Figure 4: CRM Product 18 May 2011 at 06:00 UTC.

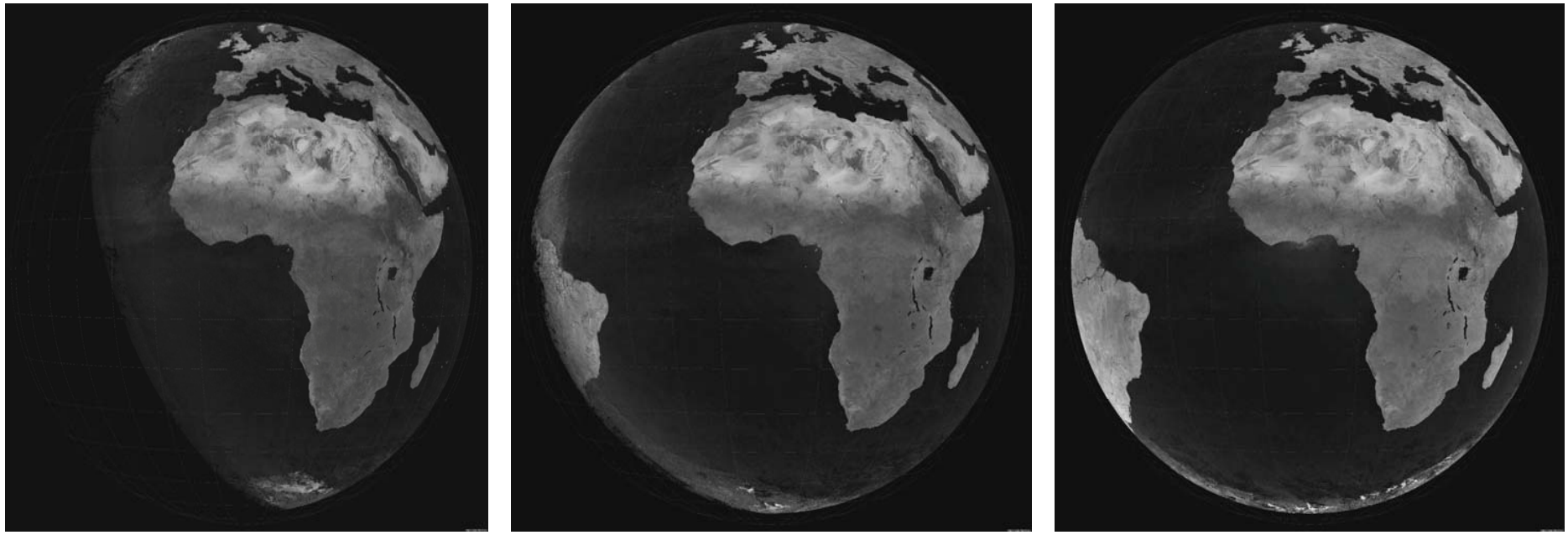

Figure 5: CRM Product 18 May 2011 at 08:00 UTC (left), 10:00 UTC (middle), and 12:00 UTC (right).

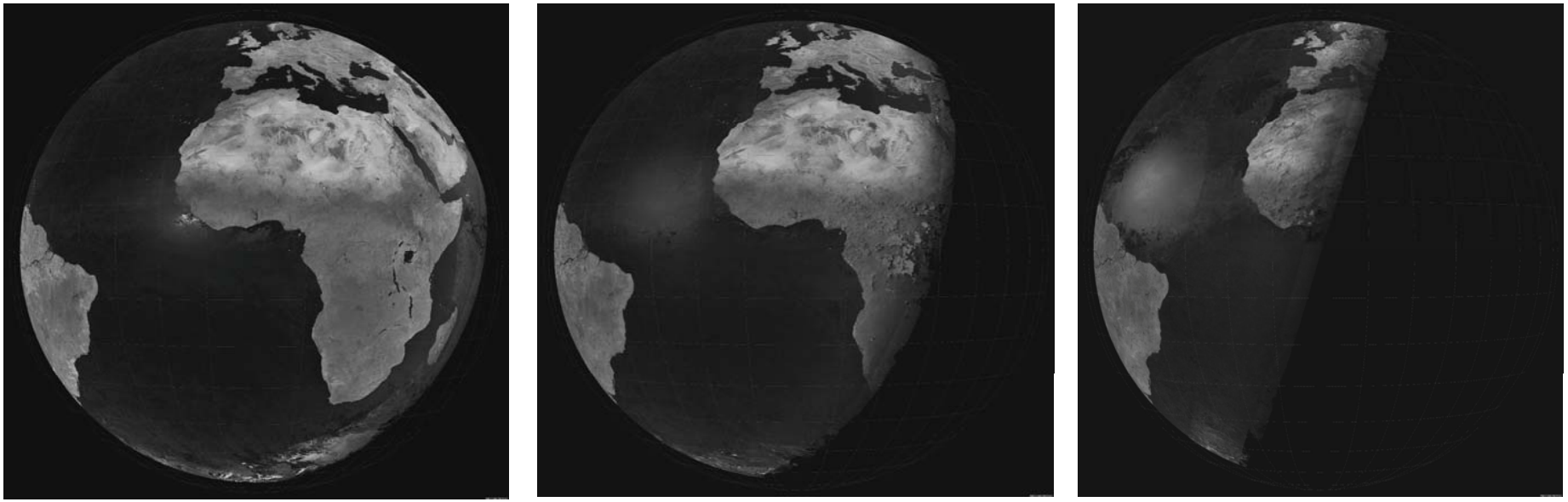

Figure 6: CRM Product 18 May 2011 at 14:00 UTC (left), 16:00 UTC (middle), and 18:00 UTC (right).

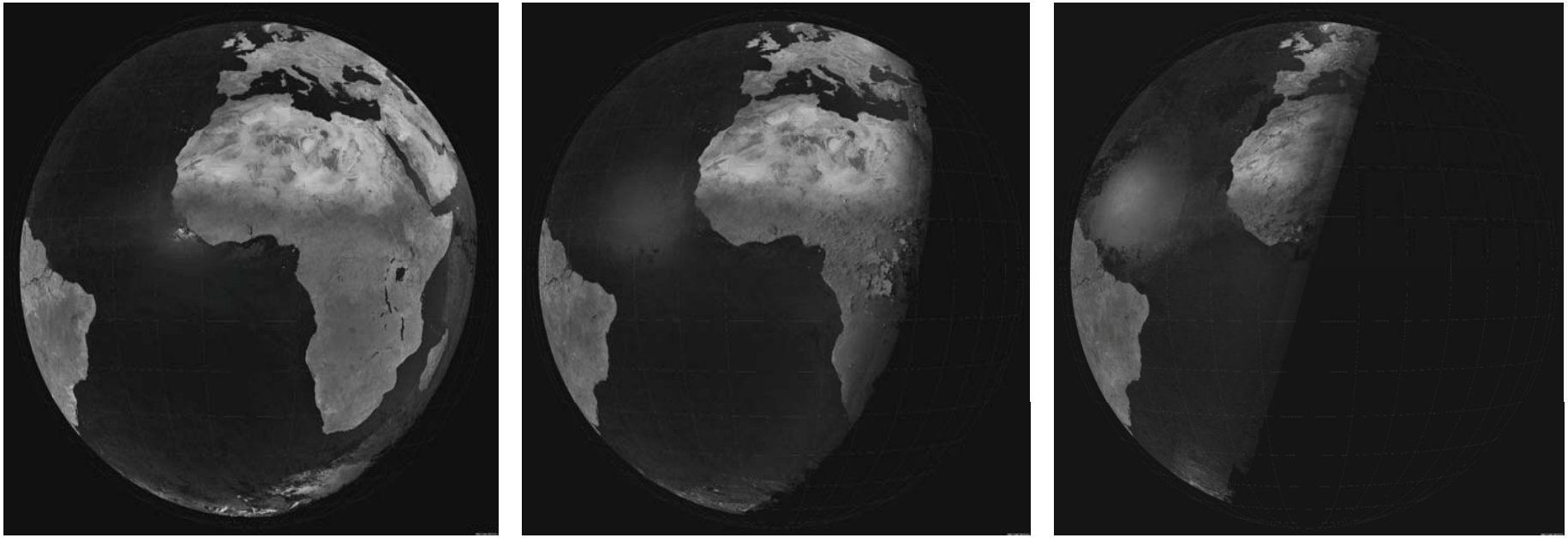

Figure 7: The two-per hour Clear Sky Reflectance (%) maps are shown as derived from the VIS 0.8 µm channel on 18 May 2011. From left: 14:00 UTC, 16:00 UTC, and 18:00 UTC.

3.1 Known Limitations

3.1.1 CRM values undeliverable

There are some limitations in the product results. One limitation is in the area near the terminator in the South Atlantic. Sunlight disappears fast in the southern hemisphere winter. As explained in the algorithm review in Section 4.3, when CRM value updates are not possible, the value is delivered after a slow transition from the last valid CRM value to a climatology value. This is an advantage. With the return of sunlight to those polar areas, CRM data are already available—otherwise it would take several weeks before there would be sufficient CRM data to be used in cloud detection algorithms. Of course, not all pixels will be clear-sky at the same time, which produces an initial inhomogeneous structure.

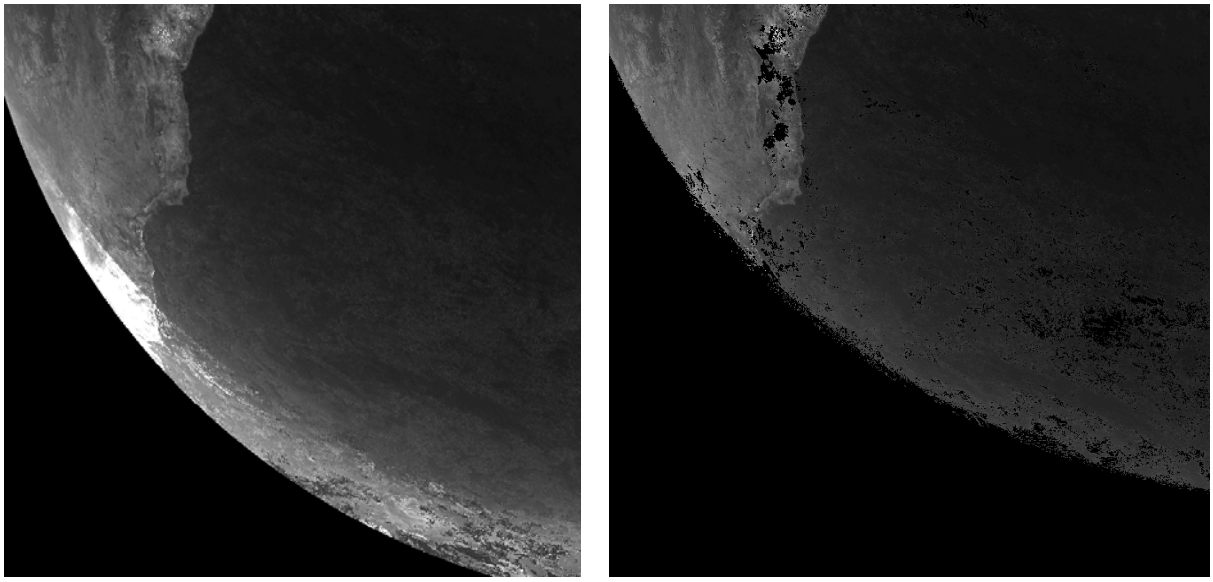

Figure 8: The Clear Sky Reflectance Map for the VIS 0.6 µm channel of 2 July 2008. The left figure shows the original product, while the right figure shows the product with masking applied to the number of accumulations and to the solar zenith angle.

For cloud-detection algorithms, this means that in polar winters the CRM value will reach a climatological value. In principle, this is not a problem as those parts of the cloud detection algorithms using the VIS channel will be inactive due to insufficient illumination. At present, the disseminated product contains the pixels mentioned above. These can be clearly seen in Figure 8. The usefulness of these pixels depends on the application. Interested users can flag pixels with characteristics like *zero number of accumulations*, or *solar zenith angle greater than* 72°:

3.1.2 Solutions that provide user flexibility

Technically, there are two options to eliminate these minor blemishes from the product: apply a filter on the data on the product generation side, or, apply a filter on the data reception, or user side. In the current product configuration, we have chosen a filter on the user side. We feel that the proper solution really depends on how the user will apply the data. If the application will use the product as "first guess" for further cloud detection, the user might prefer to retain the data. At a minimum, the user should be able to select the preferred option. In Figure 8, the filter has been placed on the data reception side—masking the number of accumulations and the solar zenith angle.

4 BASIC STRUCTURE OF THE CRM ALGORITHM

For each pixel, the reflectance value for clear scenes are collected for a period of seven days for each specific daily derivation time for these channels: VIS0.6, VIS0.8, NIR1.6 and IR3.9_sol. Then, these values are averaged: this provides the clear-sky reflectance of channels VIS0.6, VIS0.8, NIR1.6 and IR3.9_sol for that pixel. Also, the mean solar zenith angle and the mean relative azimuth angle (sun/satellite) for each specific daily derivation time at the sub-satellite point for that seven-day period is determined for each pixel. If a pixel has no clear scene in that seven-day period, the value of the previous seven-day period is used. If that value is not available, the value shall be set to a default invalid value.

4.1 Inputs

The Clear Sky Reflectance Map algorithm has the following data inputs. The table lists level 1.5 image data and data derived from the image data:

Parameter	*Units*	*Min*	*Max*	*Prec*	*Acc*	*Resolution*	*Source*
Scenes type		0	255	1	1	pixel	Scene
Reflectances for channels VIS0.6 VIS0.8 NIR1.6 IR3.9_sol HRVIS	%	0	150	0.1	0.1	pixel	Derived from level 1.5 image data
Solar zenith angle	degrees	0	90	10^{-6}	10^{-6}	pixel	Derived from level 1.5 image data
Satellite observing angle	degrees	0	90	10^{-6}	10^{-6}	pixel	Derived from level 1.5 image data
Relative azimuth angle sun/satellite	degrees	0	360	0.1	0.1	pixel	Derived from level 1.5 image data

Table 1: Clear Sky Reflectance Map product inputs.

4.2 Outputs

The following data is produced for the CRM product for every pixel in the form of a GRIB Edition 2-encoded product.

Parameter	*Mnemonic*	*Units*
Reflectances for channels : VIS0.6 VIS0.8 NIR1.6 IR3.9_sol	$REFL_{channel}$	percentage
Solar zenith angle	sol_zenith	degrees
Relative azimuth angle sun/satellite	sol_sat_azimuth	degrees
Number of accumulations	no_accum	-

Table 2: Clear Sky Reflectance Map product outputs

4.2.1 Automatic Quality Control (AQC)

Not required. This is already performed as part of Scenes Analysis.

4.3 Known Data Limitations

One limitation concerns data from the area near the terminator in the south Atlantic where, in the southern hemisphere winter, the sunlight is disappearing. In the area south of the terminator line, old data can be present. See the illustration in Figure 8. This data is not updated for some time because the illumination is not sufficient to obtain a CRM value. The number of accumulations is a good quality indicator. This data is delivered with the product. This number of accumulations should be 0 for all those points. The solution used in this situation is a slow transition from the last valid CRM value to a climatology value. If there is no weekly update for a CRM value for a specific pixel, the CRM value of the previous week is multiplied by a factor of 0.8 and added to the climatological value, which has been multiplied by a factor of 0.2. Hence, when no updates are taking place, the CRM value will be close to the climatological value.

For cloud detection algorithms, this means that in polar winters the CRM value will reach a climatological value. This is in principle not a problem as those parts of the cloud detection algorithms using the VIS channel will be inactive due to insufficient illumination. The advantage will come with the return of sunlight in those areas. Without this climatological value the CRM would contain no data in these polar areas. In consequence it would take several weeks before there would be sufficient CRM data to be used in cloud detection algorithms. Of course not all pixels will be clear sky at the same time, leading to an initial inhomogeneous structure.

Now, the disseminated CRM product contains the above-mentioned pixels, as can be clearly seen in Figure 8. The usefulness of these pixels depends on the application. For example, users can flag pixels, or others, based on their needs:

- zero number of accumulations
- solar zenith angle larger than 72°.

Furthermore, general problems in the cloud detection will impact the CRM product. However, the reliability of the CRM product is equal or higher. Higher because it is unlikely that the same pixel will be cloud-covered for a week in two consecutive images and that at the same time the pixel is always misclassified as clear sky. Hence, the average reflectance will be lower than a typical cloud reflectance. If it is misclassified as clear sky for the whole week, then the reliability is more or less equal to that of the cloud mask (CLM).

4.4 Future Product Improvements

The product relies on the cloud detection scheme for input, hence any product improvement depend completely on improvements to the cloud detection scheme.

5 REFERENCES AND LINKS

Reference Documents

Type	*Document Name*	*Reference*
Validation	MSG-3 System Commissioning Product Validation Test Report	EUM/MSG/REP/12/0190
Detailed Algorithm	MSG Meteorological Products Extraction Facility Algorithm Specification Document	EUM/MSG/SPE/022

Online Resources and Assistance

All of the reference documents listed above are in the EUMETSAT Technical Documents page.

www.eumetsat.int > Satellites > Technical Documents
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