EUMETSAT

MTG-FCI: Meteorological Product Requirements

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Table of Contents

1 INTRODUCTION

1.1 Purpose of this Document

This document describes the processing requirements for the meteorological products, to be extracted centrally at EUMETSAT HQ from the future Meteosat Third Generation Flexible Combined Imager instrument (MTG-FCI). This document should be seen in conjunction with the respective product Algorithm Theoretical Baseline Documents (ATBDs), as outlined in section 1.2 below.

1.2 Applicable Documents

Doc ID	*Title*	*Reference*
[AD-1]	MTG-FCI: ATBD for Radiative Transfer Model	EUM/MTG/DOC/10/0382
[AD-2]	MTG-FCI: ATBD for Cloud Mask and Cloud Analysis Product	EUM/MTG/DOC/10/0542
[AD-3]	MTG-FCI: ATBD for Optimal Cloud Analysis Product	EUM/MTG/DOC/11/0654
[AD-4]	MTG-FCI: ATBD for Atmospheric Motion Vector Product	EUM/MTG/DOC/10/0532
[AD-5]	MTG-FCI: ATBD for Volcanic Ash Product	EUM/MTG/DOC/10/0560
[AD-6]	MTG-FCI: ATBD for Active Fire Monitoring Product	EUM/MTG/DOC/10/0613
[AD-7]	MTG-FCI: ATBD for Global Instability Indices Product	EUM/MTG/DOC/10/0381
[AD-8]	MTG-FCI: ATBD for Outgoing Longwave Radiation Product	EUM/MTG/DOC/10/0527
[AD-9]	MTG-FCI: ATBD for Clear Sky Reflectance Map Product	EUM/MTG/DOC/10/0559
[AD-10]	MTG-FCI: ATBD for All Sky Radiance Product	EUM/MTG/DOC/10/0612
[AD-11]	MTG-FCI: ATBD for GSICS Corrections	EUM/MTG/DOC/11/0034
AD-12	MTG Conventions & Terms Document	EUM/MTG/DEV/08/0034

1.3 Acronyms and Definitions

The following table lists definitions for all acronyms used in this document.

Acronym	*Full Name*
AMV	Atmospheric Motion Vectors
ASR	All Sky Radiance
ATBD	Algorithm Theoretical Basis Document
CRM	Clear Sky Reflectance Map
FCI	Flexible Combined Imager
GII	Global Instability Indices
GSICS	Global Space Based Inter-calibration System
IASI	Infrared Atmospheric Sounding Interferometer
IR	Infrared (channel)
MSG	Meteosat Second Generation
MTG	Meteosat Third Generation
NIR	Near Infrared (channel)
NWP	Numerical Weather Prediction
OCA	Cloud Product (Optimal Cloud Analysis)
OLR	Outgoing Longwave Radiation
RMS	Root mean square difference
SCE	Scene Identification
SEVIRI	Spinning Enhanced Visible and Infrared Imager
TOZ	Total Column Ozone
TPW	Total Precipitable Water
VIS	Visible (channel)
WV	Water Vapour

2 PRODUCT REQUIREMENTS

This section will provide a detailed list of the product requirements in terms of

- Geographical coverage
- Vertical resolution
- Horizontal resolution
- Measurement range
- Accuracy
- Precision
- Update frequency
- Latency
- Qualifiers describing e.g. day/night availability, dependence on cloud conditions etc.

for the following meteorological products:

SCE:	Scenes Analysis (cloud mask)
CLA:	Cloud Analysis
OCA:	Optimal Cloud Analysis
AMV:	Atmospheric Motion Vectors
GII:	Global Instability Indices
TOZ:	Total Ozone
VOL:	Volcanic Ash
FIR:	Active Fire Monitoring
OLR:	Outgoing Longwave Radiation
ASR:	All Sky Radiance
CRM:	Clear Sky Reflectance Map
GSICS:	Inter-satellite Calibration

All these products were developed for Meteosat Second Generation (MSG) observations, where many products have been operationally available for MSG for many years. The product requirements thus have a strong heritage to MSG, i.e. users will expect the same product quality as for MSG.

The scientific aspects of how these products are derived are detailed in the respective ATBDs [AD-1] to [AD-11], which also describe the general scientific limitations of the adopted product retrieval schemes and some performed validation work through comparison with other types of observations. Accuracies and precisions listed in this document reflect this validation work.

2.1 SCE Product: Scene Analysis

The SCE product performs the initial scene identification on a pixel basis, i.e. discriminated between cloudy and cloud free conditions. It is an important pre-requisite for many other Level 2 products. The algorithm is described in [AD-2].

SCE-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

SCE-002: Vertical Resolution
Not applicable

SCE-003: Horizontal Resolution
IR pixel

SCE-004: Measurement Range
SCE result can be “cloudy”, “cloud free”, “fractional cloud”, “unknown”

SCE-005: Accuracy
95% correct detections

SCE-006: Precision
Not applicable

SCE-007: Update Frequency
Every MTG-FCI image

SCE-008: Latency
1 minute after end of image acquisition

SCE-009: Qualifiers
SCE is a day and night product

SCE-Remarks:
None

2.2 CLA Product: Cloud Analysis

The CLA product describes the cloud phase, the cloud top pressure and the effective cloud amount on a pixel basis, for the pixels identified as "cloudy" or "fractional cloud" in the SCE product. The algorithm is described in [AD-2].

CLA-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

CLA-002: Vertical Resolution
Cloud top

CLA-003: Horizontal Resolution
IR pixel

CLA-004: Measurement Range
For cloud phase: "ice", "water", "mixed", "unknown"
For cloud top pressure: 100 – 1050 hPa
For effective cloud amount: 0-100%

CLA-005: Accuracy
For cloud phase: 80%
For cloud top pressure (expressed as height): 100 m for opaque clouds, 1000 m for semi-transparent clouds (possibly more if cloud is very thin)
Effective cloud amount: 10%

CLA-006: Precision
For cloud phase: 90% classification repeatability
For cloud top pressure: 50hPa for cloud emissivity > 0.8, much higher uncertainties can be expected for very thin clouds
For effective cloud amount: 5% for cloud emissivity > 0.8, again much higher uncertainties can be expected for very thin clouds

CLA-007: Update Frequency
Every MTG-FCI image

CLA-008: Latency
1 minute after end of SCE processing

CLA-009: Qualifiers
CLA is a day and night product

CLA-Remarks:
The accuracy of the retrieved cloud information highly depends on the actual cloud conditions: good accuracies can be achieved for optically thick clouds, while accuracies will be much lower for optically thin clouds.

2.3 OCA Product: Optimal Cloud Analysis

The OCA product applies an optimal estimation method, applied to all MTG-FCI channels, in order to derive a number of bulk and microphysical cloud properties, similar to CLA. OCA provides estimates of the cloud phase, the cloud top pressure, and in addition to CLA, effective particle size, cloud optical depth and fraction cloud amount. A special benefit of OCA lies in the provision of a physically meaningful error of each retrieved parameter. The algorithm is described in [AD-3].

OCA-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

OCA-002: Vertical Resolution
Cloud top of up to two cloud layers

OCA-003: Horizontal Resolution
IR pixel

OCA-004: Measurement Range
For cloud (layer) phase: “ice”, “water”, “unknown”
For cloud top pressure: ~40 – 1050 hPa
For cloud effective particle radius: 2 – 100 µm
For cloud optical depth: 0.1 - 256
For fractional cloud amount: 0 – 100%

OCA-005: Accuracy
(Lower values represent are typical for ‘good’ cloud conditions (e.g. high optical thickness; higher values for ‘poor’ cloud conditions)
For cloud phase: 80% correctly classified
For cloud top pressure (expressed as height): 1 – 10 km
For cloud effective particle radius: 1 – 10 µm
For cloud optical depth: 10 – 100%,
For fractional cloud amount: 10 – 50%

OCA-006: Precision
(Lower values represent are typical for ‘good’ cloud conditions (e.g. high optical thickness; higher values for ‘poor’ cloud conditions)
For cloud phase: 90% classification repeatability
For cloud top pressure (expressed as height): 0.1 – 5 km
For cloud effective particle radius: 0.1 – 10 µm
For cloud optical depth: 50% classification repeatability
For fractional cloud amount: 10%

OCA-007: Update Frequency
Every MTG-FCI image

OCA-008: Latency
1 minute after end of CLA processing

OCA-009: Qualifiers

OCA is a day and night product. Due to the lack of VIS and NIR channels at night, the night time results will not meet the above accuracy requirements; particularly: optical thickness for values greater than 3-4; effective radius generally and cloud top pressure for low optical thickness (< 3-4) clouds.

OCA-Remarks:

Retrieved cloud parameters have wide accuracy ranges because the measurement sensitivity varies so much on conditions. Additionally the scene often does not conform to the simple cloud models used. Therefore, the OCA product will be available with quality control information for all pixels and for individual parameters. An overall diagnostic is the solution cost and high cost indicates all products have potentially large errors. Additionally, each parameter will have an error estimate which will reflect the very large range of expected accuracy that results from different cloud conditions. It is essential to take not of these estimates, especially in the case of 2 layer retrievals where the accuracy of the (partially hidden) lower layer will often be poor.

2.4 AMV Product: Atmospheric Motion Vectors

The AMV product derives wind information, expressed as speed, direction and height, from consecutive images. The product tracks the motion of clouds or of clear air structures in the WV absorption channels. The algorithm is described in [AD-4].

AMV-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

AMV-002: Vertical Resolution
For cloud tracked winds: cloud top
For clear sky winds: height of tracked WV structure

AMV-003: Horizontal Resolution
50 km

AMV-004: Measurement Range
For wind direction: 0 – 360 deg
For wind speed: 0 – 150 m/s
For wind height: 100 – 1000 hPa

AMV-005: Accuracy
Accuracy requirements are expressed as normalised root mean square vector differences against collocated radiosondes and the NWP first guess wind field: 0.35 / 0.50 / 0.45 for high (100-400 hPa) / medium (400-700 hPa) / low level (700-1000 hPa) winds; threshold requirement is 0.53 / 0.60 / 0.67 for high / medium / low levels.
AMV-006: Precision
4 m/s on each of the two wind vector components (u- and v-component)

AMV-007: Update Frequency
Every 30 minutes

AMV-008: Latency
10 minutes after acquisition of the last image contributing to the AMV product

AMV-009: Qualifiers
AMV is a day and night product. Actual horizontal coverage depends on the availability of suitable cloud and clear sky tracers.

AMV-Remarks:
None

2.5 GII Product: Global Instability Indices

The GII product holds the K-Index and the Lifted Index, describing the atmospheric (in)-stability. In addition, the product also contains the total column atmospheric humidity (total precipitable water), and the layer precipitable water in three different atmospheric layers (low, midlevel, high). The algorithm is described in [AD-7].

GII-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

GII-002: Vertical Resolution
For K-Index and Lifted Index: not applicable
For Layer Precipitable Water: 3 atmospheric layers, surface to 850 hPa, 850 – 500 hPa, above 500 hPa
For Total Precipitable Water: total column value

GII-003: Horizontal Resolution
3 x 3 IR pixels

GII-004: Measurement Range
For K-Index: -30 - + 70°C
For Lifted Index: -20 to 40 K
For precipitable water values: 0 – 100 kg/m^2

GII-005: Accuracy
For K-Index: 5 K
For Lifted Index: 5 K
For Layer Precipitable Water: 3 / 3 / 0.5 kg/m^2 for low / midlevel / high layer
For Total Precipitable Water: 6 kg/m^2

GII-006: Precision
For Lifted Index: 90% product repeatability within ±1 K
For K-Index: 90% product repeatability within ±1 K
For Precipitable Water Values: 90% product repeatability within ±1kg/m^2

GII-007: Update Frequency
Every MTG-FCI image

GII-008: Latency
5 minutes after end of SCE processing

GII-009: Qualifiers
GII is a day and night product. The product can only be retrieved over clear sky conditions.

GII-Remarks:
None

2.6 TOZ Product: Total Ozone

The TOZ product describes the amount of ozone in an atmospheric column. TOZ is described in Dobson Units (DU), where 1 DU = 0.000214 kg/m^2. The TOZ product is retrieved together with the GII product (section 2.5) within the same algorithm framework, i.e. the algorithm description for TOZ is also described in [AD-7].

TOZ-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

TOZ-002: Vertical Resolution
Total column

TOZ-003: Horizontal Resolution
3 x 3 IR pixels

TOZ-004: Measurement Range
0 – 700 DU

TOZ-005: Accuracy
25 DU

TOZ-006: Precision
90 % product repeatability within ±10 DU

TOZ-007: Update Frequency
Every MTG-FCI image

TOZ-008: Latency
5 minutes after end of SCE processing

TOZ-009: Qualifiers
TOZ is a day and night product. The product can only be retrieved over clear sky and low cloud conditions.

TOZ-Remarks:
None

2.7 VOL Product: Volcanic Ash

The VOL product describes whether a given image pixel contains volcanic ash and provides the total ash mass loading in kg/m^2. The algorithm is described in [AD-5].

VOL-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

VOL-002: Vertical Resolution
Total column

VOL-003: Horizontal Resolution
1 IR pixels

VOL-004: Measurement Range
0.1 – 25 g/m^2

VOL-005: Accuracy
0.1 g/m^2

VOL-006: Precision
0.1 g/m^2

VOL-007: Update Frequency
Every MTG-FCI image

VOL-008: Latency
10 minutes after image reception

VOL-009: Qualifiers
VOL is a day and night product.

VOL-Remarks:
Product accuracy will highly depend on the scene conditions: Good accuracy as indicated above can be achieved for single ash layers within an otherwise clear atmosphere; accuracy will be degraded in case of a volcanic ash layer above clouds. Ash detection and retrieval of mass loading is impossible for an ash layer which is totally obscured by higher clouds.

2.8 FIR Product: Active Fire Monitoring

The FIR product identifies pixels containing large (wild) fires, which are observed as "hot spots" in the IR 3.8 channel. The product discriminates between actual and possible fires, where "possible fires" are fires which are not detected with high confidence. The algorithm is described in [AD-6].

FIR-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

FIR-002: Vertical Resolution
Not applicable

FIR-003: Horizontal Resolution
1 IR pixel

FIR-004: Measurement Range
FIR result can be "no fire detected", "fire detected", "possible fire detected"

FIR-005: Accuracy
For both the fires and the possible fires, the detection rate is 95% for fires exceeding 2000 MW of radiative power. Less than 35% of smaller fires (< 400 MW) are detected.

FIR-006: Precision
95% fire detection repeatability

FIR-007: Update Frequency
Every MTG-FCI image

FIR-008: Latency
10 minutes after image reception

FIR-009: Qualifiers
FIR is a day and night product. Fires below thin clouds can be detected, fires remain undetected if below optically thick clouds.

FIR-Remarks:
None

2.9 OLR Product: Outgoing Longwave Radiation

The OLR product describes the outgoing longwave radiation at the top of the atmosphere, i.e. the thermal radiative loss of the earth-atmosphere system to space. It is expressed in W/m^2. The OLR retrieval method (regression) depends on the scene conditions – different regression coefficients exist for clear sky, opaque cloud and semi-transparent cloud conditions. The algorithm is described in [AD-8].

OLR-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

OLR-002: Vertical Resolution
Top of atmosphere

OLR-003: Horizontal Resolution
1 IR pixel

OLR-004: Measurement Range
50 – 750 W/m^2

OLR-005: Accuracy
For cloud free scenes: 98% within ±3 W/m^2 uncertainty
For opaque cloudy scenes: 95% within ±3 W/m^2 uncertainty
For semi-transparent cloudy scenes: 92% within ±3 W/m^2 uncertainty

OLR-006: Precision
95% product repeatability

OLR-007: Update Frequency
Every MTG-FCI image

OLR-008: Latency
10 minutes after image reception

OLR-009: Qualifiers
OLR is a day and night product and can be retrieved for both clear and cloudy scene conditions.

OLR-Remarks:
None

2.10 ASR Product: All Sky Radiance

The ASR product provides averages, together with a number of other statistical parameters, of radiances in each MTG-FCI channel over an area of m by m IR pixels. ASR values are provided for different scene categories (clear sky, cloudy sky, cloud low / medium / high). Errors or uncertainties in the SCE and CLA product are thus directly translated (and averaged into) the ASR product. Details on the product can be found in [AD-10].

ASR-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

ASR-002: Vertical Resolution
Top of atmosphere

ASR-003: Horizontal Resolution
m x m IR pixels (m is TBD, e.g. m=16 for MSG)

ASR-004: Measurement Range
As image radiances for each channel

ASR-005: Accuracy
See sections 2.1 and 2.2 for respective accuracies in the cloud detection and the pixel cloud products. Accuracy for ASR will be better due to averaging process.

ASR-006: Precision
See sections 2.1 and 2.2 for respective precisions in the cloud detection and the pixel cloud products. Accuracy for ASR will be better due to averaging process.

ASR-007: Update Frequency
Every MTG-FCI image

ASR-008: Latency
2 minutes after end of CLA processing

ASR-009: Qualifiers
ASR is a day and night product and can be retrieved over both clear and cloudy scene conditions. The radiance values for the VIS and NIR channels are only meaningful at day.

ASR-Remarks:
None

2.11 CRM Product: Clear Sky Reflectance Map

The CRM product describes the top of atmosphere reflectances that would be registered by the VIS and NIR MTG-FCI channels in cloud free conditions. Measured reflectances over detected clear sky pixels are averaged over a number of days to obtain this product. Details on the product can be found in [AD-9].

CRM-001: Geographical Coverage
Within 65° Great Circle Arc around the subsatellite point

CRM-002: Vertical Resolution
Top of atmosphere

CRM-003: Horizontal Resolution
1 VIS / NIR pixel

CRM-004: Measurement Range
0 – 100% reflectance

CRM-005: Accuracy
3% reflectance

CRM-006: Precision
2% reflectance

CRM-007: Update Frequency
Seven days

CRM-008: Latency
Seven days

CRM-009: Qualifiers
None

CRM-Remarks:
None

2.12 GSICS Product: Calibration Information through Satellite Inter-Calibration

The aim of the GSICS product is to provide a correction to the operational calibration. A proven inter-calibration technique exists for the infrared channels through inter-calibration with a hyper-spectral instrument onboard a polar orbiting satellite, as e.g. IASI. The GSICS correction scheme for solar channels is not specified yet, i.e. the following only applies to infrared channels. The concept is described in [AD-11].

GSICS-001: Geographical Coverage
Between 52° N/S latitude and 52° E/W longitude

GSICS-002: Vertical Resolution
Not applicable

GSICS-003: Horizontal Resolution
Not applicable

GSICS-004: Measurement Range
±10 K correction to IR brightness temperature

GSICS-005: Accuracy
10 mK in clear sky

GSICS-006: Precision
10 mK

GSICS-007: Update Frequency
Daily

GSICS-008: Latency
Daily for the near-real time correction

GSICS-009: Qualifiers
The GSICS calibration correction concept can be applied at day and night, the quoted accuracy and precision is for night time IASI overpasses only, the respective daytime figures would be worse.

GSICS-Remarks:
None