CGMS

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ASSESSMENT OF THE SPECIFICATION OF RELEVANT MTG CHANNELS FOR FIRE MONITORING

In response to CGMS action 36.03:
CGMS agencies with current and/or future geostationary programmes to review CGMS-36 NOAA-WP-21, and to complete an assessment on the level of compliance to the recommendations in the Working Paper.

This document provides an analysis of the imager end-user requirements onboard Meteosat Third Generation (MTG) satellite in response to CGMS action 36.03. The compliance of these requirements with working paper CGMS-36 NOAA-WP-21 recommendations are analysed.

User requirements concerning wild fire detection and characterisation have been explicitly taken into account for FCI onboard MTG. The dynamic range of the 3.8 µm channel has been expanded to support user requirements on fire detection and characterisation. This translates into a 450K saturation value of the FDHSI mission for a sampling distance of 2km at the sub-satellite point.

Assessment of the specification of relevant MTG channels for fire monitoring

1 INTRODUCTION

This document provides an analysis of the imager end-user requirements onboard Meteosat Third Generation (MTG) satellite in response to CGMS action 36.03. The compliance of these requirements with working paper CGMS-36 NOAA-WP-21 recommendations are analysed.

The paper first presents briefly the MTG programme and the Flexible Combined Imager (FCI) that will fly on that platform. The assessment of the level of compliance to the recommendations in the Working Paper CGMS-36 NOAA-WP-21is analysed next.

2 METEOSAT THIRD GENERATION (MTG) PROGRAMME

The Meteosat Second Generation (MSG) system has become the primary European source of geostationary observations over Europe and Africa with the start of nominal operations in January 2004. It is one of the key EUMETSAT contributions to the Global Observing System (GOS) of the World Meteorological Organisation (WMO). The series of four MSG satellites will deliver observations and services at least until 2020 with the high level of availability expected from an operational system. Meteosat Third Generation (MTG) system, the replacement of MSG, needs to be available around 2017, before the end of the nominal lifetime of MSG.

A single imager optical instrument shall be able to fulfil the performances established for the full disc and the high resolution imagery missions, the MTG Flexible Combined Imager. FCI generates images at various spatial resolutions on 16 optical spectral channels including 4 at higher resolution, providing for the Full Disc High Spectral resolution Imagery mission (FDHSI) and High Resolution Fast Imagery mission (HRFI) mission respectively and supporting two modes of operation to cover the imaging of the full disk within 10 minutes and smaller –local area- regions in a commensurate shorter time. The Full Disk High Spectral resolution Imagery (FDHSI) mission, covering the full disk with a Basic Repeat Cycle (BRC) of 10 minutes with a spatial resolution of 1 km (eight channels at 0.444 µm, 0.51 µm, 0.640 µm, 0.865 µm, 0.914 µm, 1.380 µm, 1.61 µm, and 2.25 µm) and 2 km (eight channels at 3.8 µm, 6.3 µm, 7.35 µm, 8.7 µm, 9.66 µm, 10.5 µm, 12.3 µm, and 13.3 µm). This mission includes fire detection in its objectives, more specifically:

Monitoring of Land Surface Temperatures, to identify locations of smoke development;

Monitoring of vegetation stress, to model initiation and spread of fires;

Quantitative estimates of Fire Radiative Energy.

The High spatial Resolution Fast Imagery (HRFI) mission, looking at local scales (e.g. about 1/4th of the full disk seen from the geostationary position) with a BRC of 2.5 minutes and a spatial resolution of 0.5 km (two channels at 0.640 µm and 2.25 µm)

and 1.0 km (two channels at 3.8 µm and 10.5 µm). There is no specific fire user requirements related to fire monitoring for that mission.

During the MTG user consultation process, requirements for products and services in the time frame between 2015 – 2025 were prepared by the user community. FCI shall generate simultaneously images at the same time for the spectral channels given in Table 1. In that Table, the Spatial Sampling Distance (SSD) is defined at the Sub-Satellite Point and defines the Spatial Sampling Angle (SSA) used to define the Data level 1c equiangular reference fixed grid. The channels VIS 0.6, NIR 2.2, IR 3.8 and IR 10.5 are delivered in lower spatial resolution in the Full Disk Coverage (FDC) and higher resolution in the Local Area Coverage (LAC) configurations. The SSD for the LAC is indicated by [#1] in the table.

Table 1 : Channel specification for the Flexible Combined Imager (FCI)

Channel	Centre Frequency	Spectral Width	SSD
VIS 0.4	0.444 µm	0.060 µm	1.0 km
VIS 0.5	0.510 µm	0.040 µm	1.0 km
VIS 0.6	0.640 µm	0.050 µm	1.0 km/0.5 km[#1]
VIS 0.8	0.865 µm	0.050 µm	1.0 km
VIS 0.9	0.914 µm	0.020 µm	1.0 km
NIR 1.3	1.380 µm	0.030 µm	1.0 km
NIR 1.6	1.610 µm	0.050 µm	1.0 km
NIR 2.2	2.250 µm	0.050 µm	1.0 km/0.5 km[#1]
IR 3.8 (TIR)	3.800 µm	0.400 µm	2.0 km/1.0 km[#1]
WV 6.3	6.300 µm	1.000 µm	2.0 km
WV 7.3	7.350 µm	0.500 µm	2.0 km
IR 8.7 (TIR)	8.700 µm	0.400 µm	2.0 km
IR 9.7 (O_3)	9.660 µm	0.300 µm	2.0 km
IR 10.5 (TIR)	10.500 µm	0.700 µm	2.0 km/1.0 km[#1]
IR 12.3 (TIR)	12.300 µm	0.500 µm	2.0 km
IR 13.3 (CO_2)	13.300 µm	0.600 µm	2.0 km

3 COMPLIANCE TO WORKING PAPER CGMS-36 NOAA-WP-2

3.1 Data access and pre-processing protocols

FCI radiances will be generated in Level 1b first and then and 1c. Level 1b will consist in Level 1a data radiometrically corrected and calibrated in physical units. Earth location is appended for every sample, but data is not resampled. Note that Level 1a data correspond to radiometric, spectral and geometric (i.e. Earth location) correction and calibration computed and appended, but not applied. The Level 1c corresponds to Level 1b data resampled to a specified fixed reference grid). Level 1c mission data

shall be registered to a reference grid and projection defined according to the CGMS HRIT/LRIT Global Specification. Only Level 1c data will be disseminated in NRT.

3.2 Spatial resolution

As can be seen from Table 1, the FCI IR3.8 and IR10.5 channels will be available at the 2km sampling distance at the sub-satellite point in the FDHSI mode and at 1km in the HRFI mode.

3.3 Pixel saturation and characterization of sensor behaviour at high temperatures

The FD-IR 3.8 channel shall have a dynamic range expanded to 450K to support fire detection and quantification. This should prevent pixel saturation for a sampling distance of 2km at the Sub-Satellite Point (SSP). This expanded dynamic range is compliant with CGMS-36 NOAA-WP-21 recommendations.

3.4 Data navigation

The absolute value of the FCI *absolute pixel position knowledge error* (APPKE) within a 500 by 500 *pixel imagette* shall be as given in Table 2. The absolute value of the FCI *absolute pixel position knowledge error* (APPKE) evaluated over the complete FDC or LAC *image* shall be as given in Table 2.

Table 2 : Geometric Quality Criterion

	Confidence Level	SSD=0.5 km	SSD=1.0 km	SSD=2.0 km
APPKE (500x500 *pixels*)	99.73%	<0.90 km	<1.80 km	<3.60 km
APPKE (*image*)	99.73%	<0.75 km	<1.50 km	<3.00 km
RPPKE (between consecutive *images*)	99.73%	<1.05 km	<1.05 km	<1.05 km

These geometric quality criterion are in agreement with the CGMS-36 NOAA-WP-21 recommendations.

3.5 Band-to-band co-registration

The co-registration between the VIS, NIR and IR channels are given in Table 1.

Table 3 : FCI FDHSI Relative Pixel Position Knowledge Error between Spectral channels (at SSP)

	VIS	NIR	TIR	WV	O_3	CO_2
VIS	<0.20 km	<0.20 km	<1.00 km			
NIR		<0.20 km	<1.00 km			
TIR			<0.15 km	<0.60 km	<0.30 km	<0.30 km

3.6 Impact of Point Spread Function on fire detection and characterization

The impact of the PSF on fire detection has not yet been investigated in detail.

3.7 Calibration and Validation Activities

For the Level 1b data, the absolute radiometric accuracy of the IR channels over their full dynamic range shall be better than 0.7K traceable to the National Physical Laboratory (UK) radiometric standards. For the expanded dynamic range of the 3.8 µm channel, this requirement is relaxed to 1K.

No validation activities related to fire detection or Fire Radiative Power estimation have yet been defined.

4 CONCLUSIONS

User requirements concerning wild fire detection and characterisation have been explicitly taken into account for FCI onboard MTG. The dynamic range of the 3.8 µm channel has been expanded to support user requirements on fire detection and characterisation. This translates into a 450K saturation value of the FDHSI mission for a sampling distance of 2km at the sub-satellite point. Level 1b data, which is recommended by CGMS-36 NOAA-WP-21 for fire application will be available but only at the central facility in near real-time (NRT). The data volume associated with the pixel geo-location information prevents a NRT dissemination.