# *MTG End-User Requirements Document [EURD]*

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## *Document Change Record*

| *Issue* | *Remarks* |
|---|---|
| v1 Drafts | For internal review |
| v2 Draft of 13 November 2008 | First published version for System PRR |
| v3 Draft of 13 February 2009 | •Updates following PRR RIDs having an impact only on the [EURD]:<br>PRR-EURD-EUM-SB-002, NGA reference removed, § 8.2,<br>PRR-EURD-EUM-SB-004, new requirement FCI-02050,<br>PRR-EURD-EUM-SB-005, Note removed, new requirement IRS-04070,<br>PRR-EURD-EUM-SB-014 Column Headings updated.<br>PRR-EURD-EUM-JE-034, Requirements included, § 4.2.3,<br>PRR-EURD-Univ-UF-111, N/A - Table 12 deleted , § 4.3,<br>PRR-EURD-DWD-WB-150, Clarification provided, § 7.5,<br>PRR-EURD-DWD-WB-151, Table updated, § 8.2,<br><br>•Updates following PRR RIDs having an impact on the [SRD] and [EURD]:<br>PRR-EURD-EUM-SB-001, Updated as per new text, § 1.1,<br>PRR-EURD-EUM-SB-003, Text removed,<br>PRR-EURD-EUM-SB-006, Replaced as recommended,<br>PRR-EURD-EUM-SB-007, Paragraph reworded, § 4.1,<br>PRR-EURD-EUM-SB-008, Paragraph reworded, § 4.1,<br>PRR-EURD-EUM-SB-011, note added in RET 16040 allowing deletion of RET 16060,<br>PRR-EURD-EUM-SB-013, Clarification note added under the table of § 5.1,<br>PRR-EURD-EUM-SB-014 annex updated,<br>PRR-EURD-EUM-SB-015, Recommendation included,<br>PRR-EURD-EUM-SB-016, Recommendation included,<br>URD-EUM-SB-017, Recommendation included,<br>PRR-EURD-EUM-SB-018, New requirement added,<br>PRR-EURD-EUM-SB-019 annex updated,<br>PRR-SRD-EUM-SB-020, tables numbering,<br>PRR-SRD-EUM-SB-023 requirements of §3 updated.<br>PRR-EURD-EUM-JE-035, self standing annex created,<br>PRR-EURD-Univ-UF-098, Whole Lightning chapter updated (§4.3)<br>PRR-EURD-Univ-UF-099, Requirement reworded,<br>PRR-EURD-Univ-UF-100, Description improved, § 4.5.2,<br>PRR-EURD-Univ-UF-102, §5.1 updated<br>PRR-EURD-Univ-UF-103, Correction done, § 4.1,<br>PRR-EURD-Univ-UF-104, Consistency improved, § 5.1, |

| | |
|---|---|
| | PRR-EURD-DWD-WB-147, New chapters added, § 4.5.3 & § 4.5.4,<br>PRR-EURD-DWD-WB-148, Graphical illustration added, FCI-05060,<br>PRR-EURD-DWD-WB-149, IODC service removed,<br>PRR-EURD-DWD-WB-152 annex updated<br>PRR-SRD-DWD-WB-154 text updated in §4.1<br>PRR-SRD-DWD-WB-156 requirements SYS-00020, SYS-00040, SYS-00060<br>PRR-SRD-DWD-WB-158 Diagrams added<br>PRR-SRD-FMI-PYP-199 GMES as per ESA/EUM agreement rather than Kopernikus/GMES.<br><br>•other new requirements:<br>USR-18090<br>SYS-00080<br><br>•Outcome of phase B1 related discussions with ESA.<br>•Harmonisation between [CONV], [SRD] and [EURD].<br>•Harmonisation of terminology.<br>•added explanation of operational availability within timeliness.<br>•Miscellaneous internal comments received.<br>•Miscellaneous corrections and wording improvement<br>•The list of meteorological products and SAF products previously in an annex are now handled in a self standing document. |
| v3A Draft of 12 August 2009 | Published version for SRR Part 1<br>Updates for<br>1) Editorial and grammatical corrections<br>2) Extension of FCI / IRS LAC zones to cover Canary Islands<br>FCI-02050, FCI-02055, IRS-04075<br>3) Removal or modification of requirements on instrument / technical level not relevant for End-Users<br>FCI-02260, DIS-14020, FCI-02060, IRS-04080,<br>4) Requirement relaxations / modifications for risk reduction and to avoid over-specification<br>ARC-12060, ARC-12080, ARC-12100, FCI-02020, FCI-02140, IRS-04140, LI-06100, LI-06140, RET-16080<br>5) Requirement modifications for additional functionality<br>ARC-12020, ARC-12040<br>6) Error corrections<br>FCI-02300<br>7) LI Detection Efficiency requirement added<br>LI-06060, LI-06090<br>8) Appendix B: DCP messages and bulletins archiving not planned |
| v3B Draft of 18 January 2010 | Published version after SRR Part 1<br>Updates for |

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|---|---|
| | 1) Editorial and grammatical corrections<br>2) §3: SYS-00040:<br>a. RIDs #008 & #186: Editorial correction<br>b. RID # 187: Clarification note added on continuity of Imager services<br>3) §3: SYS-00060: RID # 188: Clarification note added on continuity of Imager services<br>4) §3: SYS-00130: Reworded to remove ambiguity<br>5) §4.1.1: Table 1: TBCs removed from FCI channel definitions<br>6) §4.1.1: Figure 3: Modification of drawing title and caption clarifying that the interleaved scanning is not an operational service<br>7) §4.1.1: FCI-02055: editorial clarification and correction<br>8) §4.1.4: Table 3: RID #012: Extended fire range removed for IR 8.7<br>9) §4.1.6: FCI-02320: Correction: removed 'of differing SSD' from the requirement text<br>10) §4.3.2: LI-06060: RID #144: Respective duration for calculation of statistical requirements specified; editorial clarification in note<br>11) §4.3.2: LI-06080: New clarification note<br>12) §4.3.3: LI-06090: Editorial correction<br>13) §4.5.1 and §4.5.2: Product list and descriptions moved to 'EUMETSAT HQ Level 2 Products Generation and Dissemination Baseline for MTG' [L2HQ]; following subsections renumbered<br>14) § 4.7: ARC-12060<br>a. RID #250: Requirement reworded to address completeness instead of availability<br>b. Requirement reworded to cover all datasets<br>15) § 4.7: ARC-12080 and ARC-12100: Requirements deleted, as covered by ARC-12060<br>16) §5.1: Table 14<br>a. Table headers and note 1 reworded to clarify timeliness<br>b. RID #251: Availability now specified with spec and goal; clarification note added<br>c. LI events timeliness requirement set to 2 mn, old value of 30 s now specified as goal<br>d. Added goal (2.5mn) to FCI-RSS high rate dissemination timeliness<br>e. New note clarifying timeliness for dissemination of SAF products<br>17) § 5.2: Table 15<br>a. Added goal values to availability<br>b. Added level 1 requirements<br>18) §5.2.1: DIS-14250 and DIS-14270: New requirements for Level 1 data for consistency with Annex B<br>19) §6: RET-16040: Added 'archived datasets' for clarification in requirement text and note |
| V3C of 30 March 2010 | First version approved by Council as per Council minutes EUM/C/69/10/MIN with the modifications described below:<br>Lifetime requirements SYS-00020, 00040 and 00060 modified to clarify that the specified lifetime is a minimum lifetime. |

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# 1 INTRODUCTION

## 1.1 Purpose and Scope

The purpose of this document [EURD] is to define the End-User Requirements applicable to the Meteosat Third Generation (MTG) Programme.

Service requirements expressed in this EURD apply at the interface between EUMETSAT and the End Users (excluding networks and service components that are outside the EUMETSAT control).

Requirements in the EURD are used for the end-to-end *verification* and *validation* of system functionalities, services, interfaces and operational performance till *commissioning*. Actual performances of the services of the system will be described in the Operational Services Specification after the system has been commissioned.

The essential and In-orbit verifiable End-Users requirements on content, *operational availability*, *timeliness*, etc. are presented for each services provided by the EUMETSAT facilities at its Headquarters as well as in general terms for the EUMETSAT Satellite Application Facilities (SAF) network. The detailed requirements addressing the SAF services are covered separately in SAF-dedicated user and product requirements documentation to be established for each SAF project.

Service delivered by the MTG System will be provided through a cost-effective combination of dedicated and specific new developments and acquisitions and generic, enterprise-like multi-mission infrastructure maintained, sustained, and upgraded by EUMETSAT. Provisions, functions and capabilities made available by the latter will not be detailed in this document.

## 1.2 Applicable and Reference Documents

### 1.2.1 Instructions, Plans and Arrangements

The following documents have been used to establish this document.

| Doc ID | Title | Reference |
|---|---|---|
| [CONVENTION] | EUMETSAT Convention | |
| [STRATEGY] | EUMETSAT Strategy: 2030 | EUM/C/59/06/DOC/28 |
| [DATAPO] | EUMETSAT principles on Data Policy | EUM/C/98/rec IV<br>Date: 3 July 1998 |
| [PPP] | MTG Preparatory Programme Proposal | EUM/C/62/07/DOC/04 REV 1 |
| [SAF_STRAT] | Current SAF Strategy | EUM/C/52/02/DOC/51 |
| [EUM_CS] | EUMETSAT - COSPAS-SARSAT Cooperation Arrangement | TBD |

### 1.2.2 Reference Documents

The following documents provide useful information but are not cross-referenced in a requirement.

| Doc ID | Title | Reference |
|---|---|---|
| [AEG] | Post-MSG User Consultation: Application Expert Groups<br>Position Papers for Nowcasting and NWP Application Users | EUM/C/01/DOC/16 - Annex II |
| [RSE] | Response of Remote Sensing Experts (RSE) to User Requirements Formulated by Post-MSG Application Expert Groups | EUM/C/01/DOC/16 - Annex III |
| [SYSCON] | MTG System Concept | EUM/MTG/TEN/07/0042 |
| [L2HQ] | EUMETSAT HQ Level 2 Products Generation and Dissemination baseline for MTG | EUM/MTG/DOC/09/002 6 |
| [L2SAF] | SAF Level 2 Products Generation and Dissemination Baseline for MTG | EUM/PPS/DOC/09/0032 |
| | WMO -Manual on the Global Observing System | WMO - 544 |
| [CGMS02] | CGMS IDCS Users' Guide | CGMS02 |
| [WMO_GTS] | WMO Manual on GTS -Volume I Global Aspects<br>- Volume II: Regional Aspects | 306-E |
| [TD15] | Data Collection and Retransmission Service | EUM TD-15 to be issued to replace EUM TD-04 and EUM TD-09 |
| [WMOcode] | WMO Manual on Codes:<br>Manual on Codes I.1 - A: Alphanumeric Codes<br>Manual on Codes I.2 - Part B/C: Binary Codes | 306.I.1.A-6<br>306.I.2.B.C |
| [CGMS_GS] | Future replacement of "CGMS LRIT/HRIT Global Specification - CGMS.03" | TBW |
| [CGMS_35] | CGMS position<br>Report of the 35th Meeting of the Coordination Group for Meteorological Satellites | CGM 35 |
| [KOP_S4-5] | GMES Sentinel 4 and 5 Mission Requirements | EOP-SMA/1507/JL-dr<br>Issue 1 Rev. 3 |
| [KOP_S4] | GMES Sentinel 4 Phase A - System Requirements Document | EOP-PI/2008-05-79<br>Issue 1 11 July 2008 |
| [UG04] | EUMETSAT Archive User Guide | UG04 |
| [MOSS] | MSG Operations Service Specification (MOSS) | EUM/OPS-MSG/SPE/00/0011<br>V 4A July 2007 |
| [TD10] | MSG - Meteorological Data Dissemination Service | EUM TD-10 |

Notes:

**CGMS_GS**: The AD reference points to a yet to be written document, which will be the successor to CGMS.03 "CGMS LRIT/HRIT Global Specification"

**CGMS_GS:** The current CGMS.03 "CGMS LRIT/HRIT Global Specification" does not cover *Level 1B* data. For MTG this is expected to be the product level for IRS and LI data. Therefore, if the TBW document does not cover this level, an additional separate document may need to be generated (MTG Specific Implementation).

## 1.3 Acronyms and Definitions

A complete list of acronyms is provided in Appendix G.

Words appearing in *italics* have special meaning defined in Appendix F.

## 1.4 Identification of Requirements

All requirements in this EURD are uniquely identified according to the following convention: XXX-nnnn

Where:

- 'XXX' represents for information the requirements group identifier (i.e. the service type),

- 'nnnnn' represents the requirement number. This number is unique within this document.

The following requirement groups (i.e. service type) are defined:

SYS = System Level

FCI = FCI data acquisition and generation

IRS = IRS data acquisition and generation

LI = LI data acquisition and generation

MET = Meteorological/*Level 2* products generation

DCP = DCP data acquisition and generation

ARC = Archiving and cataloguing

DIS = Near real time dissemination services

RET = Archive retrieval services

USR = User support services

# 2 METEOSAT THIRD GENERATION MISSION NEED

The mission of the Meteosat Third Generation (MTG) System is to provide continuous high spatial, spectral and temporal resolution observations and geophysical parameters of the Earth / Atmopshere System derived from direct measurements of its emitted and reflected radiation using *satellite* based sensors from the geo-stationary orbit. To fulfil its mission it is required to deploy sustained capabilities to acquire, process and distribute to down stream application users and second tier processing centres environmental data on a broad *spectral range* (from UV to LWIR), covering extensive areas (global and regional), and within a variety of different time scales to continue and enhance the services offered by the Second Generation of the Meteosat System (MSG).

The MTG mission encompasses the following observation missions:

- Flexible Combined Imager (FCI) mission, allowing to scan either the full disc in 16 channels every 10 minutes with a spatial sampling distance in the range 1-2km (**F**ull **D**isc **H**igh **S**pectral resolution **I**magery (**FDHSI)** in support of the Full Disc Scanning Service (FCI-FDSS)) or a quarter of the earth in 4 channels every 2.5 minutes with a resolution twice better **(H**igh spatial **R**esolution **F**ast **I**magery (**HRFI**) in support of the Rapid Scanning Service (FCI-RSS)).
- **I**nfra**R**ed **S**ounding (**IRS**) mission, covering the full disc in 60 minutes, providing hyperspectral sounding information in two bands, a **L**ong **W**ave **I**nfra**R**ed (**LWIR**: 700 - 1210 $cm^{-1}$) and **M**id **W**ave **I**nfra**R**ed (**MWIR**: 1600 -2175 $cm^{-1}$) band with a spatial sampling distance around 4km.
- **L**ightning **I**magery (**LI**) mission, detecting continuously over almost the full disc, the lightning discharges taking place in clouds or between cloud and ground with a spatial sampling distance around 10km.
- **U**ltraviolet, **V**isible & **N**ear-infrared (**UVN**) sounding mission, covering Europe every hour taking measurements in three *spectral bands* (UV: 290 - 400 nm; VIS: 400 - 500 nm, NIR: 755 - 775 nm) with a spatial sampling distance around 10km. The UVN mission is implemented with the GMES Sentinel-4 instrument accommodated in the MTG-S *satellites*.

The Space Segment of the MTG System consists of a *satellites* constellation. Three in-orbit *satellites* are needed to support the complete and total set of missions and functions listed above, the full operational capability (FOC). To span the operational life time of the programme over at least 20 years, there will be in total 4 *satellites* dedicated to support the Imagery missions (MTG-I), and 2 *satellites* to support the sounding missions (MTG-S).

Each *satellite* is specified for a nominal lifetime (including *commissioning*) of ca. 8.5 years, carrying the payload complements or meteorological sensors according to the following split which have been confirmed in the definition and feasibility phase -Phase A- for its detailed design and implementation:

- MTG-I: FCI, LI, DCS and SAR
- MTG-S: IRS + UVN (GMES S-4)

This distribution of the *payload* complement and redundancies gives regard to the novelty nature of the sounding missions (IRS and UVN) and their respective downstream applications using data from geo-stationary systems, balancing the *payload* mass distribution, power, *consumables* such as fuel, and data rates making effective use of the same *platform*.

Complementary to the direct observation missions summarised above and yet essential to satisfy key user needs, the following objectives have also to be fulfilled by MTG:

- *Level 2* product extraction;
- Data Collection System (DCS), for collecting and transmitting observations and data from surface, buoy, ship, balloon or airborne Data Collection Platforms (DCP);
- Long term archiving in the *EUMETSAT Data Centre* including reprocessing;
- Near Real Time Data Dissemination & Relay services to users, including Foreign Satellite Data (FSD) collection and distribution (data from other EUMETSAT and Third Party satellite systems for calibration and global applications):
    - EUMETCast & High Rate dissemination services (including relay of Foreign Satellite Data (FSD));
    - RMDCN dissemination service;
    - Search And Rescue (SAR) relay service. Similarly to MSG, the MTG System has the capability to accommodate a GEOSAR transponder, enabling the operations of the mission under the aegis of the COSPAS-SARSAT System.
    - Internet dissemination services;
- *Archived dataset* retrieval services continue to be provided as part of the multi-mission *EUMETSAT Data Centre* services.
- User support services are enhanced to address MTG as well.

# 3 SYSTEM-WIDE REQUIREMENTS

Using the data received from the *satellites*, the following data services are provided within the MTG system:

- FCI data acquisition and generation,
- IR Sounding data acquisition and generation**,**
- Lightning data acquisition and generation,
- UVN data acquisition and generation,
- *Level 2* Products generation,
- DCP message acquisition, bulletin generation and statistics generation,
- Data Archival in *EUMETSAT Data Centre*.

SYS-00020

The following set of services shall be nominally provided during the operational lifetime of the MTG Programme (at least 20 years), once these services become operational for the first time (i.e. after *commissioning* of *MTG-I1*):

1) FCI Full disc data acquisition and generation (in support of the FDSS)

2) Lightning data acquisition and generation

3) *Level 2* Products generation

4) DCP message acquisition, bulletin generation and statistics generation

5) Data Archival in the *EUMETSAT Data Centre*

6) Near Real Time data dissemination and Relay;

7) *archived dataset* retrieval services (from the *EUMETSAT Data Centre*)

8) User support

SYS-00040

The following set of services shall be nominally provided during at least 15.5 years once these services become operational for the first time (i.e. after *commissioning* of *MTG-S1*):

1) IR Sounding data acquisition and generation

2) UVN data acquisition and generation

3) Related *Level 2* Products generation

Note: These services are on top of the ones specified to be available after the *commissioning* of MTG-I1.

SYS-00060

The following set of services shall be nominally provided during at least 12.5 years once these services become operational for the first time (after *commissioning* of the *MTG-I2*):

1) FCI *Local Area Coverage* data acquisition and generation (in support of the RSS)

2) Related *Level 2* Products generation

Note 1: MTG Rapid Scanning nominally starts after commissioning of *MTG-I2*. Until that time, the Rapid Scanning Service (RSS) is provided by MSG-4.

Note 2: These services are on top of the ones specified to be available after the *commissioning* of MTG- I1.

SYS-00080

The *satellite specified lifetime* shall be 8.5 years.

Note 1: This applies to the MTG-I and MTG-S and includes *commissioning* duration.

Note 2: The *system commissioning* of *MTG-I1* and *MTG-S1* is expected to last 12 months. Any follow-on MTG *satellite* is expected to be commissioned within 6 months.

SYS-00100

The MTG System shall include 4 *satellites* (MTG-I) embarking the Flexible Combined Imager (FCI), the Lightning Imager (LI) , the Data Collection Platform (DCP) receiver and the Search And Rescue (SAR) repeater.

SYS-00120

The MTG System shall include 2 *satellites* (MTG-S) embarking the Infra-Red Sounder (IRS) and the UVN-GMES sounder.

SYS-00130

The system shall provide the operational MTG missions (and the related services) when the supporting *satellites* are located within the *nominal longitude range* between 10°W and 10°E.

# 4 DATA ACQUISITION, GENERATION AND ARCHIVING SERVICES

## 4.1 FCI Data Acquisition and Generation Services

The MTG Flexible Combined Imager (FCI) generates simultaneously *images* at various spatial resolutions for 16 *spectral channels*, including 4 at high spatial resolution (extension of SEVIRI HRV to 4 channels). A local area scanning is possible with a higher repetition rate (further called rapid scan for consistency with Meteosat first and second Generation). Normal (full disc) and local area scanning can be interleaved on a single *satellite* (e.g. when only one imaging *satellite* is operational in orbit) or conducted in parallel when 2 *satellites* are available in-orbit. These two scanning modes correspond respectively to the Full Disc Scanning Service (FDSS) and Rapid Scanning Service (RSS).

The operational practices for the Full Disc Scanning Service (FDSS) and the Rapid Scanning Service (RSS) are all defined, however the possible usage of the interleaved scanning pattern is currently TBD. In this respect, the approval by Delegate Bodies will be sought in due time.

The FCI acquires the *spectral channels* simultaneously by scanning a *detector array* per *spectral channel* in an east/west direction to form a *swath*. The *swaths* are collected moving from south to north to form an *image* per *spectral channel* covering either the *full disc coverage* or the *local area coverage* within the respective *repeat cycle* duration. *Radiance samples* are created from the *detector elements* at specific *spatial sample* locations and are then rectified to a *reference grid*, before dissemination to the End Users as *level 1 datasets*. *Spectral channels* may be sampled at more than one *spatial sampling distance* or *radiometric resolution*, where the *spectral channel* has to fulfil FDHSI and HRFI missions or present data over an extended *radiometric measurement range* for fire detection applications.

### 4.1.1 FCI Image Acquisition Requirements

FCI-02020

The Flexible Combined Imager (FCI) shall generate simultaneously *images* for the *spectral channels* given in Table 1:

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

| Spectral Channel | Central Wavelength, $\lambda 0$ | Spectral Width, $\Delta\lambda 0$ | Spatial Sampling Distance *(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<br>0.5 km #1 |
| VIS 0.8 | 0.865 µm | 0.050 µm | 1.0 km |

| **Spectral Channel** | **Central Wavelength,** $\lambda 0$ | **Spectral Width,** $\Delta\lambda 0$ | **Spatial Sampling Distance** *(SSD)* |
|---|---|---|---|
| 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<br>0.5 km #1 |
| IR 3.8 (TIR) | 3.800 µm | 0.400 µm | 2.0 km<br>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<br>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 |

Note 1: The *spectral channels* VIS 0.6, NIR 2.2, IR 3.8 and IR 10.5 are delivered in both FDHSI sampling and a HRFI sampling configurations, the latter is indicated by #1 in the table.

FCI-02040

The FCI shall be able to generate *images* covering the full Earth disc (called *full disc coverage* (FDC)) and a subset (called *local area coverage* (LAC)) with the *repeat cycle* duration and *coverage* as specified in Table 2.

***Table 2: Flexible Combined Imager (FCI)* coverage *versus* repeat cycle *duration***

| **Coverage** | **Repeat cycle** *duration* | *Comment* |
|---|---|---|
| FDC =<br>17.70° diameter circle centred at SSP | 10 minutes | Corresponds to Full Disc Scanning Service (FCI-FDSS) |
| LAC = FDC / 4 | 2.5 minutes | Corresponds to the Rapid Scanning Service (FCI-RSS) |

Note 1: The operational practice for the FDSS (based on the FDC alone) is that the acquisition start times are around HH:00, HH:10, HH:20 etc where HH represents the hours in UTC, as shown in Figure 1.

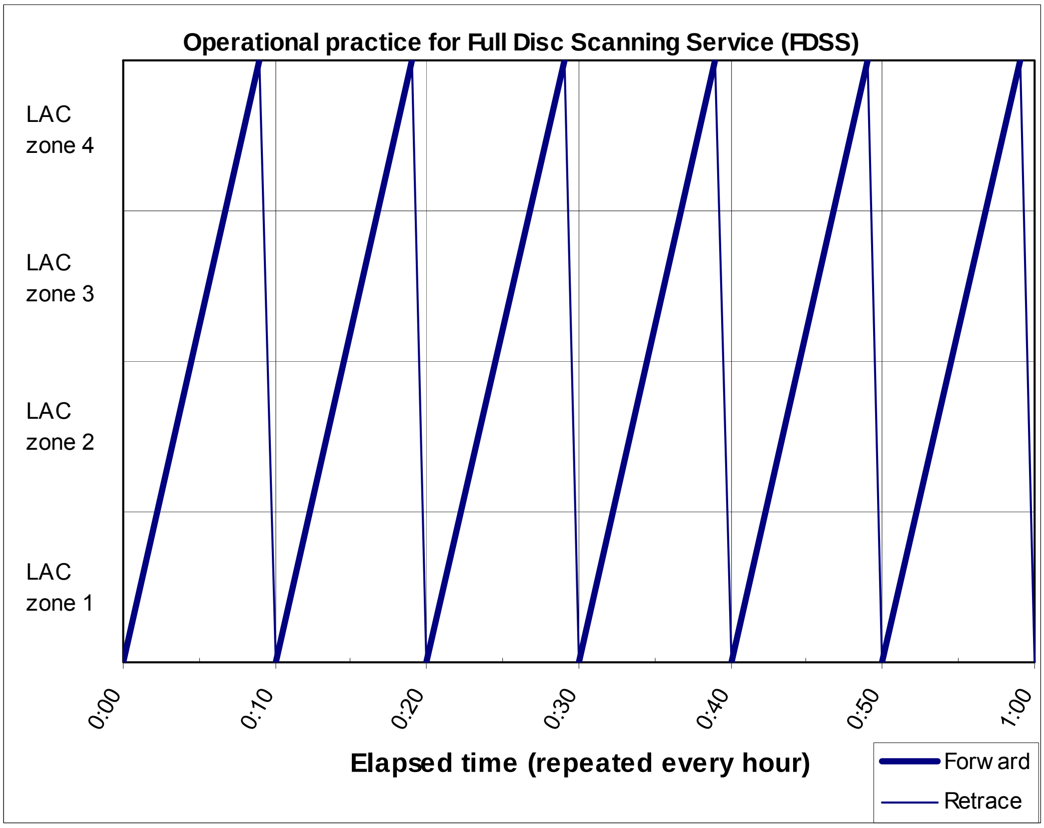



***Figure 1: Operational practice for Full Disc Scanning Service (FDSS)***

Note 2: The operational practice for the RSS (based on the LAC alone) is to scan Europe, as shown in Figure 2.

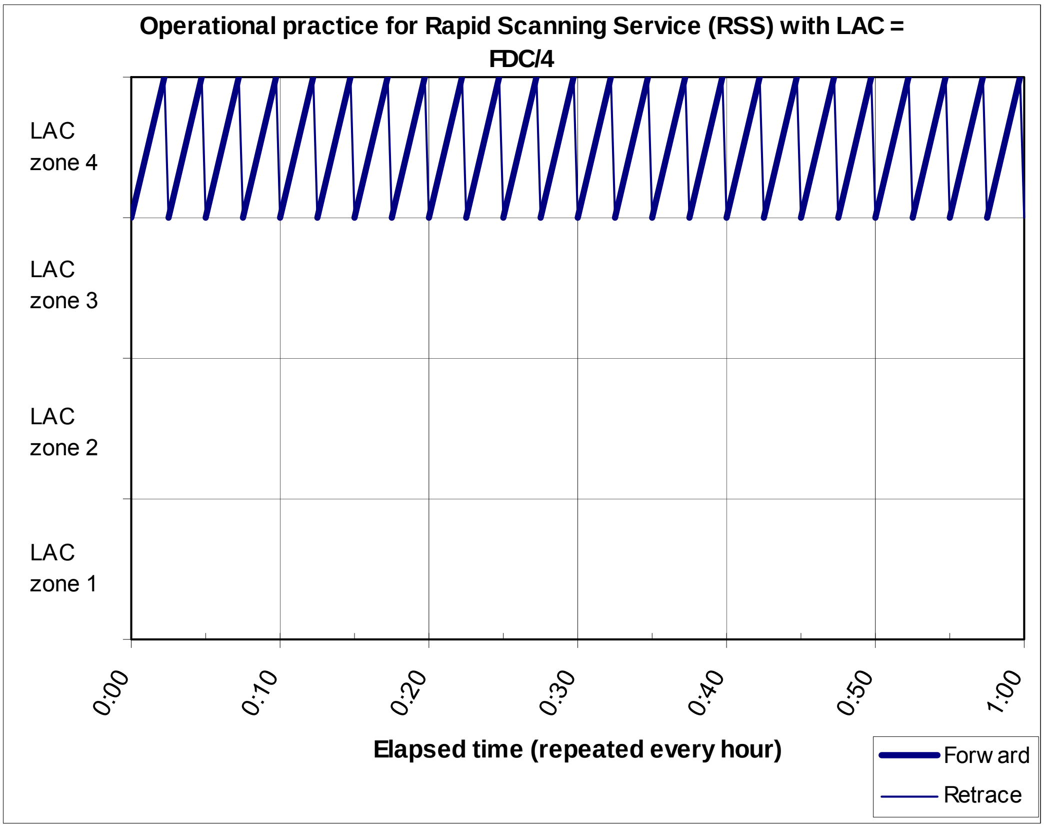



*Figure 2: Operational practice for Rapid Scanning Service (RSS)*

Note 3: The operational practice for FDSS and RSS supported by a single *satellite* (based on FDC interleaved with LAC) is that the acquisition start times for FDC are around HH:00, HH:15, HH:30, HH:45 and the acquisition start times for LAC are around HH:10, HH:12.5, HH:25, HH:27.5, HH:40, HH:42.5, HH:55, HH:57.5, etc where HH represents the hours in UTC, as shown in Figure 3.

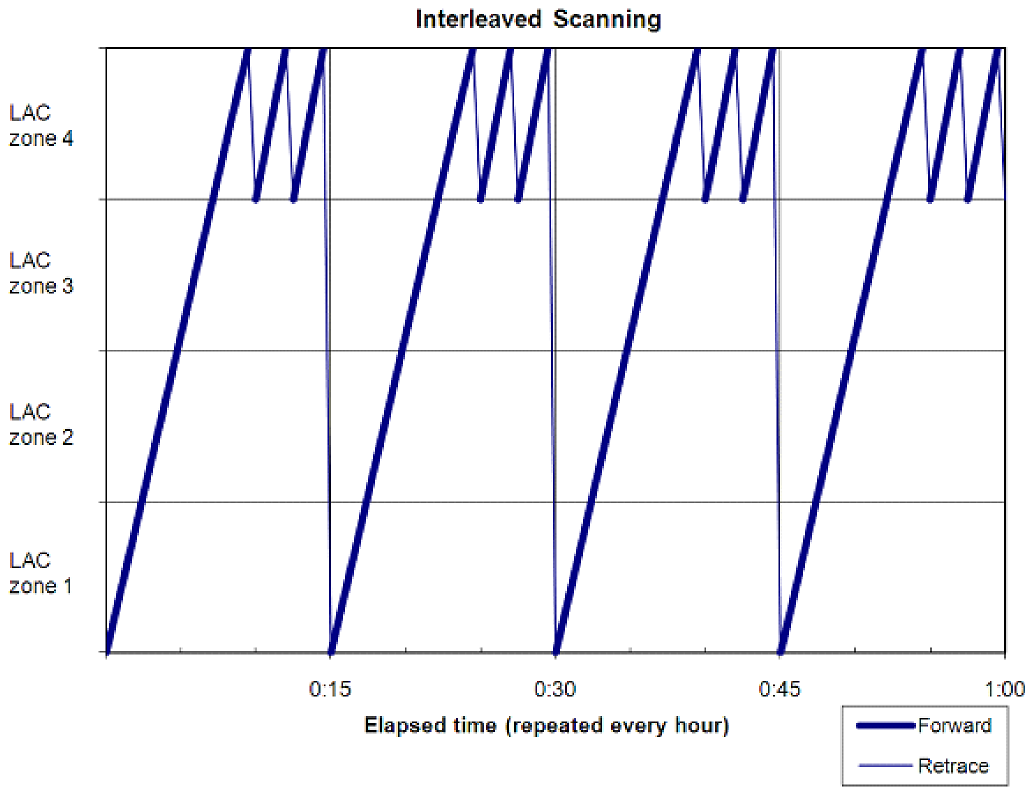



***Figure 3: Interleaved Scanning***

FCI-02050

The start of the FCI LAC shall be configurable, by ground telecommand, to any position within the FDC, provided that the LAC is fully contained in the FDC.

Note 1:The *LAC zones* are labelled consecutively 1 to 4 starting at the southernmost and ending at northernmost (European) *LAC zone*.

FCI-02055

The FCI *image* shall be such that:

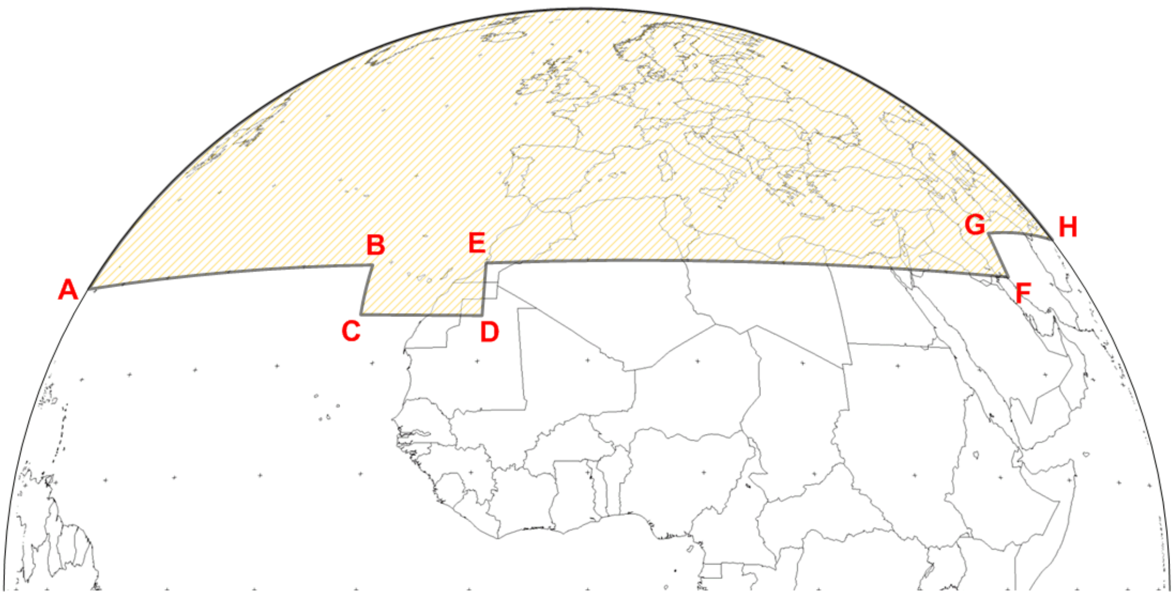
When delivering FDSS:

The complete FDC area of *coverage* is available in the acquired *image*;

When delivering RSS:

the complete Earth surface visible from *geostationary altitude* at 0° inclination and North of latitude 30°N (OR with a goal of the *LAC zone* 4 boundary described in Figure 4) is available.

Note: The implementation of the goal LAC zone 4 coverage might have technical implications making it impossible to scan the LAC zone 4 area in 2.5 minutes. With a reduction to 3.3 minutes, the LAC area could be enlarged to cover 1/3 of the FDC, i.e. north of 20°N.




| | |
|---|---|
| AB | 30°N |
| BC | 22°W |
| CD | 25°N |
| DE | 10°W |
| EF | 30°N |
| FG | 50°E |
| GH | 35°N |

Note: The diagram indicates the goal LAC zone 4 *coverage* in terms of latitude and longitude on the earth.

***Figure 4: Goal LAC zone 4* coverage *for FCI***

### 4.1.2 FCI Image Quality Threshold

As defined in [CONV], the *quality threshold* is met when the requirements on *completeness*, *accuracy* and *timeliness* are fulfilled. The percentages of the *images* that meet the *quality threshold* requirements (within *timeliness*) are addressed in the dissemination sections.

FCI-02060

An FCI *image* shall be considered complete if all of the conditions below are met:

a) FCI *image* acquisition requirements are met,

b) Less than 5% of the *radiance samples* in the *image* are declared *missing samples*

FCI-02080

An FCI *image* shall be considered accurate if all of the conditions below are met:

a) FCI *image level 1* spectral requirements are met,

b) FCI *image level 1* radiometric requirements are met,

c) FCI *image level 1* spatial & temporal requirements are met**,**

d) FCI *image level 1* geometric requirements are met.

### 4.1.3 FCI Image Level 1 Spectral Requirements

Unless otherwise stated the requirements in this section apply:

- to all *spectral channels*
- to all *spatial samples* in a *repeat cycle*
- to all *repeat cycles* over each MTG-I *satellite specified lifetime*.

FCI-02100

The FCI *spectral response function difference* between any two *spatial samples* of the same *image* shall be less than 0.05 for VIS and NIR *spectral channels* and less than 0.10 for IR *spectral channels* when integrated over three times the *spectral width* and centred on the *central wavelength*.

FCI-02120

The FCI *spectral response function difference* between the actual *spectral response function* and that characterised on-ground shall be less than 0.10 for VIS and NIR *spectral channels* and 0.20 for IR *spectral channels* when integrated over three times the *spectral width* and centred on the *central wavelength*.

### 4.1.4 FCI Image Level 1 Radiometric Requirements

Unless otherwise stated the requirements in this section apply:

- to all *spectral channels*
- to all signal levels between the minimum and maximum signal
- to all *repeat cycles* over each MTG-I *satellite specified lifetime*.

***Table 3: Radiometric requirements of the FCI*** **Images**

| Spectral Channel | *Min. Signal,* $\alpha_{min}$ | *Max. Signal,* $\alpha_{max}$ | *Ref. Signal,* $\alpha_{ref}$ | Radiometric Noise *(SNR)* | Medium Term Radiometric Stability | Long Term Radiometric Stability | Radiometric Accuracy |
|---|---|---|---|---|---|---|---|
| VIS 0.4 | 0.01 | 1.20 | 0.01 | >25 | <0.1% | <2% | <5% |
| VIS 0.5 | 0.01 | 1.20 | 0.01 | >25 | <0.1% | <2% | <5% |
| VIS 0.6 | 0.01 | 1.20 | 0.01 | >30<br>>12#1 | <0.1% | <2% | <5%<br><10%#1 |
| VIS 0.8 | 0.01 | 1.20 | 0.01 | >21 | <0.1% | <2% | <5% |
| VIS 0.9 | 0.01 | 0.80 | 0.01 | >12 | <0.1% | <2% | <5% |
| NIR 1.3 | 0.01 | 0.80 | 0.01 | >40 | <0.1% | <2% | <5% |
| NIR 1.6 | 0.01 | 1.00 | 0.01 | >30 | <0.1% | <2% | <5% |
| NIR 2.2 | 0.01 | 1.00 | 0.01 | >25<br>>12#1 | <0.1% | <2% | <5%<br><10%#1 |
| ***Spectral Channel*** | **Min. Signal, Tmin** | **Max. Signal, Tmax** | **Ref. Signal, Tref** | ***Radiometric Noise* (NEdT)** | ***Medium Term Radiometric Stability*** | ***Long Term Radiometric Stability*** | ***Radiometric Accuracy*** |
| IR 3.8 (TIR) | 200K<br>350K | 350K<br>450K | 300K<br>350-450K#2 | <0.1K, <0.2K#1<br><1K#2 | <0.1K<br><0.2K#1 | <0.3K | <0.7K<br>< 1K#1 |
| WV 6.3 | 165K | 270K | 250K | <0.3K | <0.1K | <0.3K | <0.7K |
| WV 7.3 | 165K | 285K | 250K | <0.3K | <0.1K | <0.3K | <0.7K |
| IR 8.7 (TIR) | 165K | 330K | 300K | <0.1K | <0.1K | <0.3K | <0.7K |
| IR 9.7 ($O_3$) | 165K | 310K | 250K | <0.3K | <0.1K | <0.3K | <0.7K |
| IR 10.5 (TIR) | 165K | 340K | 300K | <0.1K<br><0.2K#1 | <0.1K<br><0.2K#1 | <0.3K | <0.7K<br><1K#1 |
| IR 12.3 (TIR) | 165K | 340K | 300K | <0.2K | <0.1K | <0.3K | <0.7K |
| IR 13.3 ($CO_2$) | 165K | 300K | 270K | <0.2K | <0.1K | <0.3K | <0.7K |

Note 1: The channels VIS 0.6, NIR 2.2, IR 3.8 and IR 10.5 are delivered in FDHSI sampling and HRFI sampling configurations. The radiometric requirements for the HRFI sampling configuration are indicated by #1 in the table.

Note 2: For the IR 3.8 channel the dynamic range has been extended with a reduced *radiometric noise* specification for active fire monitoring and are indicated by #2 in the table.

FCI-02140

The FCI *radiometric noise* shall be as given in Table 3 with the SNR (or NEdT) requirement scaled, at signal levels $\alpha$ (or T) between the minimum and maximum signal, different from $\alpha_{ref}$ (or $T_{ref}$), according to the *radiometric scaling function*.

FCI-02160

The FCI *medium term radiometric stability* in the *image* data shall be as per Table 3.

FCI-02180

The FCI *long term radiometric stability* in the *image* data shall be as per Table 3.

FCI-02200

The FCI calibration system shall ensure that the *radiometric accuracy* over *satellite specified lifetime* does not exceed the values provided in Table 3.

### 4.1.5 FCI Image Level 1 Spatial & Temporal Requirements

Unless otherwise stated the requirements in this section apply:

- to all *spectral channels*
- to all areas in the *coverage* of the *repeat cycle*,
- to all *repeat cycles* over each MTG-I *satellite specified lifetime*,
- separately in N/S and E/W directions.

FCI-02220

The FCI *spatial sampling distance* (SSD) shall be as per Table 1.

### 4.1.6 FCI Image Level 1 Geometric Requirements

Unless otherwise stated the requirements in this section apply:

- to all *spectral channels*
- to all areas in the *coverage* of the *repeat cycle*,
- to all *repeat cycles* over each MTG-I *satellite specified lifetime*,
- separately in N/S and E/W directions.

***Table 4: 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 |

FCI-02240

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 4.

FCI-02280

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 4.

FCI-02300

The absolute value of the FCI *relative pixel position knowledge error* (RPPKE) shall be as given in Table 4, when evaluated over all *pixels* common between two consecutive FDC or LAC *images* of the same *spectral channel*.

FCI-02320

The absolute value of the FCI *relative pixel position knowledge error* (RPPKE) between two *spectral channels* when evaluated over all *pixels* between two FDC or LAC *images* taken in the same *repeat cycle* shall be:

a) For the *spectral channels* as specified in Table 5 at a 68.26% confidence level, when delivered in the HRFI sampling configuration.

b) For the *spectral channels* as specified in Table 6 at a 68.26% confidence level, when delivered in the FDHSI sampling configuration.

***Table 5: FCI HRFI* Relative Pixel Position Knowledge Error *between* Spectral channels *(at SSP)***

| | ***VIS*** | ***NIR*** | ***TIR*** |
|---|---|---|---|
| **VIS** | | <0.25 km **[TBC 1]** | <1.00 km |
| **NIR** | | | <1.00 km |
| **TIR** | | | <0.5 km **[TBC 2]** |

**Table 6: *FCI FDHSI* Relative Pixel Position Knowledge Error *between* Spectral channels *(at SSP)***

| | *VIS* | *NIR* | *TIR* | *WV* | $O_3$ | $CO_2$ |
|---|---|---|---|---|---|---|
| **VIS** | <0.20 km **[TBC 3]** | <0.20 km **[TBC 4]** | <1.00 km | | | |
| **NIR** | | <0.20 km **[TBC 5]** | <1.00 km | | | |
| **TIR** | | | <0.15 km **[TBC 6]** | <0.60 km**[TBC 7]** | <0.30 km**[TBC 8]** | <0.30 km**[TBC 9]** |
| **WV** | | | | <0.75 km**[TBC 10]** | | |
| $O_3$ | | | | | | <0.40 km**[TBC 11]** |
| $CO_2$ | | | | | | |

FCI-02340

It shall be possible to rectify FCI *images* from a *satellite* to any longitude within +/- 10° **[TBC 12]** from the *sub-satellite point* of that *satellite* according to a *reference grid* and projection defined according to [CGMS_GS]

Note: The operational practice is to rectify at 0° if the *satellite* is located close to 0°.

## 4.2 IRS Data Acquisition and Generation Services

The MTG Infra-Red Sounder (IRS) has no direct MSG heritage but is related to the EPS IASI mission (from the user point of view) and, from a more general point of view, to the GIFTS mission considered in the USA. The emphasis is on high horizontal resolution, high vertical/spectral resolution and observations of a quarter of the Earth disc every 15 minutes.

The IRS acquires a number of *spectral soundings* simultaneously over a *dwell* using a two dimensional *detector array*. The *dwell coverage* is stepped in an east/west direction to form a line of *dwell spectral soundings*, before moving northward to form the next line, covering the *local area coverage* (LAC) within the *repeat cycle* duration. Up to 4 separate *LAC zones* can be defined and the *LAC zones* scanned in any order with maximum sequence length of 96 LACs before repetition of the sequence. The *spectral soundings* are transmitted to the ground as interferograms and transformed to *spectral channels* as part of the ground processing, before dissemination to the End Users as *level 1 datasets*.

### 4.2.1 IRS Dataset Acquisition Requirements

IRS-04020

The IRS shall cover the spectral domain from 680 - 2250 $cm^{-1}$ in two *spectral bands*; a long wave infrared (LWIR) and a medium wave infrared (MWIR) *spectral band* with the characteristics provided in Table 7.

***Table 7: Infra-Red Sounder (IRS)* Spectral Bands**

| Spectral Band | *Status* | Wavenumber *range* | Spectral Channel Interval | Spatial Sampling Distance*(SSD)* |
|---|---|---|---|---|
| LWIR | Extended | 680-700 $cm^{-1}$ | 0.625 $cm^{-1}$ | 4.0 km |
| | Specified | 700-1210 $cm^{-1}$ | | |
| MWIR | Specified | 1600-2175 $cm^{-1}$ | 0.625 $cm^{-1}$ | 4.0 km |
| | Extended | 2175-2250 $cm^{-1}$ | | |

Note: The LWIR and MWIR *spectral bands* contain specified and extended *wavenumber* ranges. For *spectral channels* lying inside the specified portion of the *spectral band* full compliance is required. No requirements apply to the extended range, except data delivery.

IRS-04040

The IRS shall generate a *dataset* covering a subset of the full earth disc (called *local area coverage* (LAC)) with the *repeat cycle* duration and *coverage* as specified in Table 8**.**

***Table 8: IRS* coverage *versus* repeat cycle *duration***

| Coverage | Repeat cycle *duration* | *Comment* |
|---|---|---|
| FDC = 17.70° diameter circle centred at SSP | N/A | Indicates the maximum *coverage* achievable by combining 4 LACs |
| LAC = FDC/4 | 15 minutes | |

Note 1: The operational practice is to have only sequences of quarter of disc scanning, with the complete sequence repeated every 6 hours according to the following patterns: 5 times (zone3 + zone4) followed by 4 times (zone2 + zone4) followed by 3 times (zone1 + zone4) as shown in Figure 5.

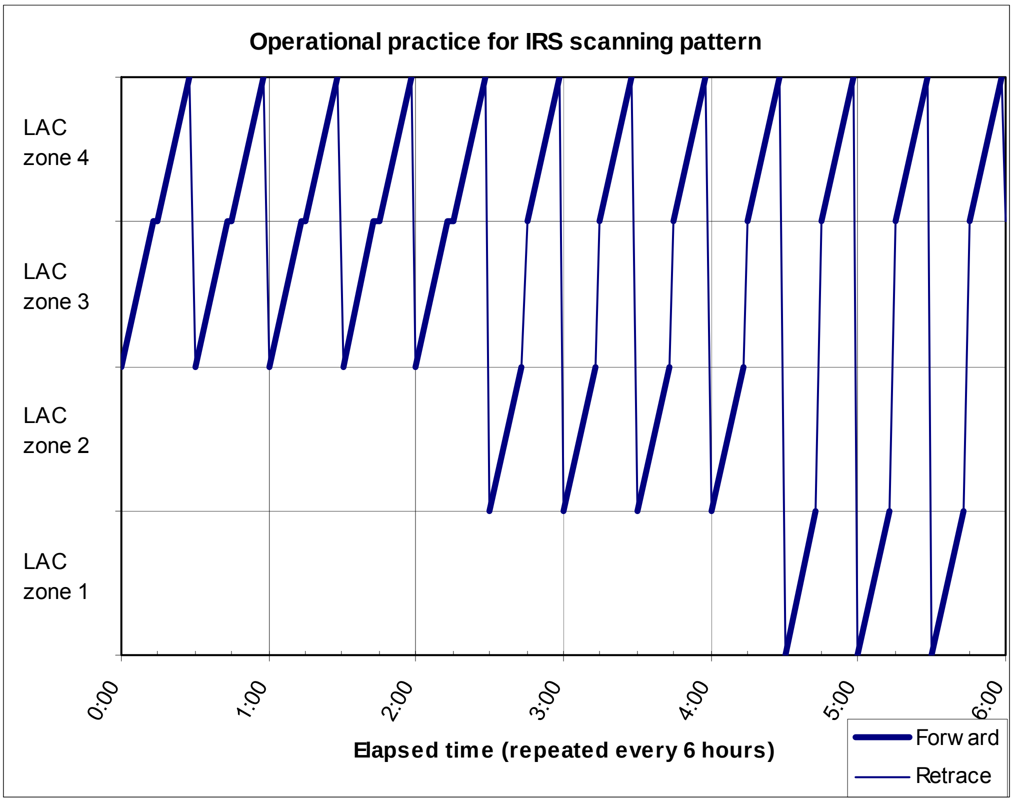



***Figure 5: Operational practice for IRS scanning pattern***

IRS-04060

The IRS LAC shall be scanned using a regular *dwell* sequence with respect to the *target grid*, with a slow step from geographic south to geographic north and a fast step in the geographic east/west direction.

Note: A *dwell* sequence moving form east to west then from west to east for alternate lines of *dwells* is permitted.

IRS-04070

The IRS shall allow the configuration of 4 *LAC zones*, by ground telecommand, each LAC starting at any position within the FDC , provided that the LAC is fully contained in the FDC.

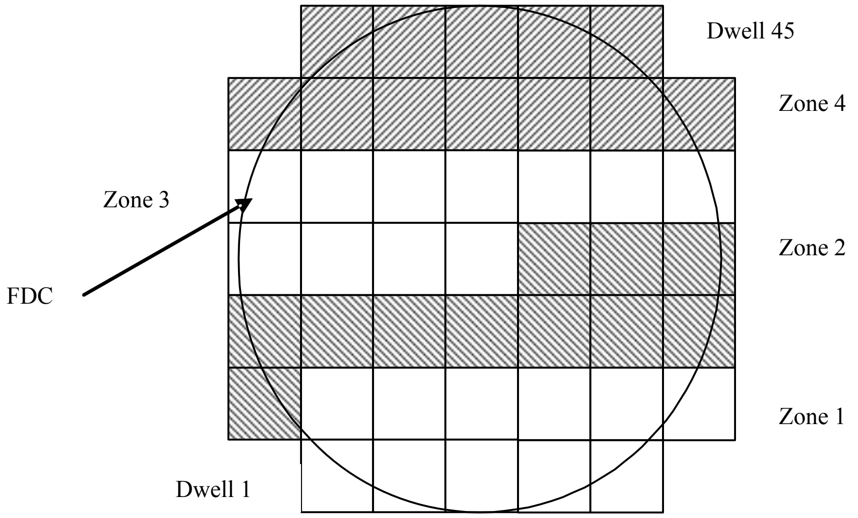
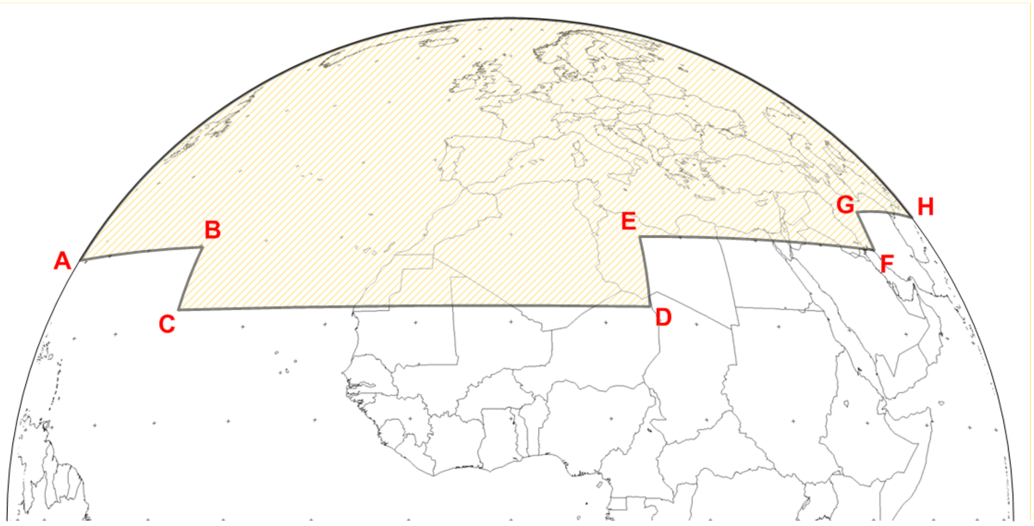



***Figure 6: Example of* LAC zone *definition for a FDC divided by 45* dwells**

IRS-04075

The IRS *image* shall be such that:

- For the *LAC zone* 4 in the IRS operational scenario the complete Earth surface visible from *geostationary altitude* at 0° inclination and North of the LAC boundary described in Figure 7 is available.




Note: The diagram indicates the mandatory LAC zone 4 *coverage* in terms of latitude and longitude on the earth.

| | |
|---|---|
| AB | 30°N |
| BC | 40°W |
| CD | 22°N |
| DE | 15°E |
| EF | 30°N |
| FG | 50°E |
| GH | 35°N |

***Figure 7: Mandatory LAC zone 4* coverage *for IRS Operational Scenario***

### 4.2.2 IRS Dataset Quality Threshold

As defined in [CONV], the *quality threshold* is met when the requirements on *completeness*, *accuracy* and *timeliness* are fulfilled. The percentages of the *datasets* that meet the *quality threshold* requirements (within *timeliness*) are addressed in the dissemination sections.

IRS-04080

An IRS LAC *dataset* shall be considered complete if all of the conditions below are met:

a) The IRS *dataset* acquisition requirements are met,

b) Less than 5% of the MWIR *spectral soundings* in the LAC are declared *missing soundings*,

c) Less than 15% of the LWIR *spectral soundings* in the LAC are declared *missing soundings*.

IRS-04100

An IRS LAC *dataset* shall be considered accurate if all of the conditions below are met:

a) IRS *dataset level 1* spectral requirements are met,

b) IRS *dataset level 1* radiometric requirements are met,

c) IRS *dataset level 1* spatial and temporal requirements are met,

d) IRS *dataset level 1* geometric requirements are met.

### 4.2.3 IRS Dataset Level 1 Spectral Requirements

Unless otherwise stated the requirements in this section apply:

- to all *spectral channels*
- to all *spatial samples* in a *repeat cycle*
- to all *repeat cycles* over each MTG-S *satellite specified lifetime*.

IRS-04120

The IRS instrument shall be based on an interferometer concept (*Fourier Transform Spectrometer* or FTS type) that converts input spectral *radiances* into interferograms.

IRS-04130

The IRS *spectral sample* SRF *centroid wavenumber* shall be determined by the *spectral calibration* algorithm such that the *radiometric error* associated to the shift determination does not exceed 50 mK (NEdT@280K) when considering a spatially homogeneous scene and the spectra given by Figure 8.

Note: The requirement applies at a 68.26% confidence level calculated over all *spectral samples* within a *spectral band*, considering the LWIR and MWIR *spectral bands* separately.

IRS-04135

The IRS *spectral sample spectral response function difference* between the actual *spectral response function* and that characterised during *spectral calibration* averaged over the *spectral calibration* period shall not exceed a value corresponding to a *radiometric error* of 50 mK (NEdT@280K) when considering a spatially homogeneous scene and the spectra given by Figure 8.

Note: The requirement applies at a 68.26% confidence level calculated over all *spectral samples* within a *spectral band*, considering the LWIR and MWIR *spectral bands* separately.

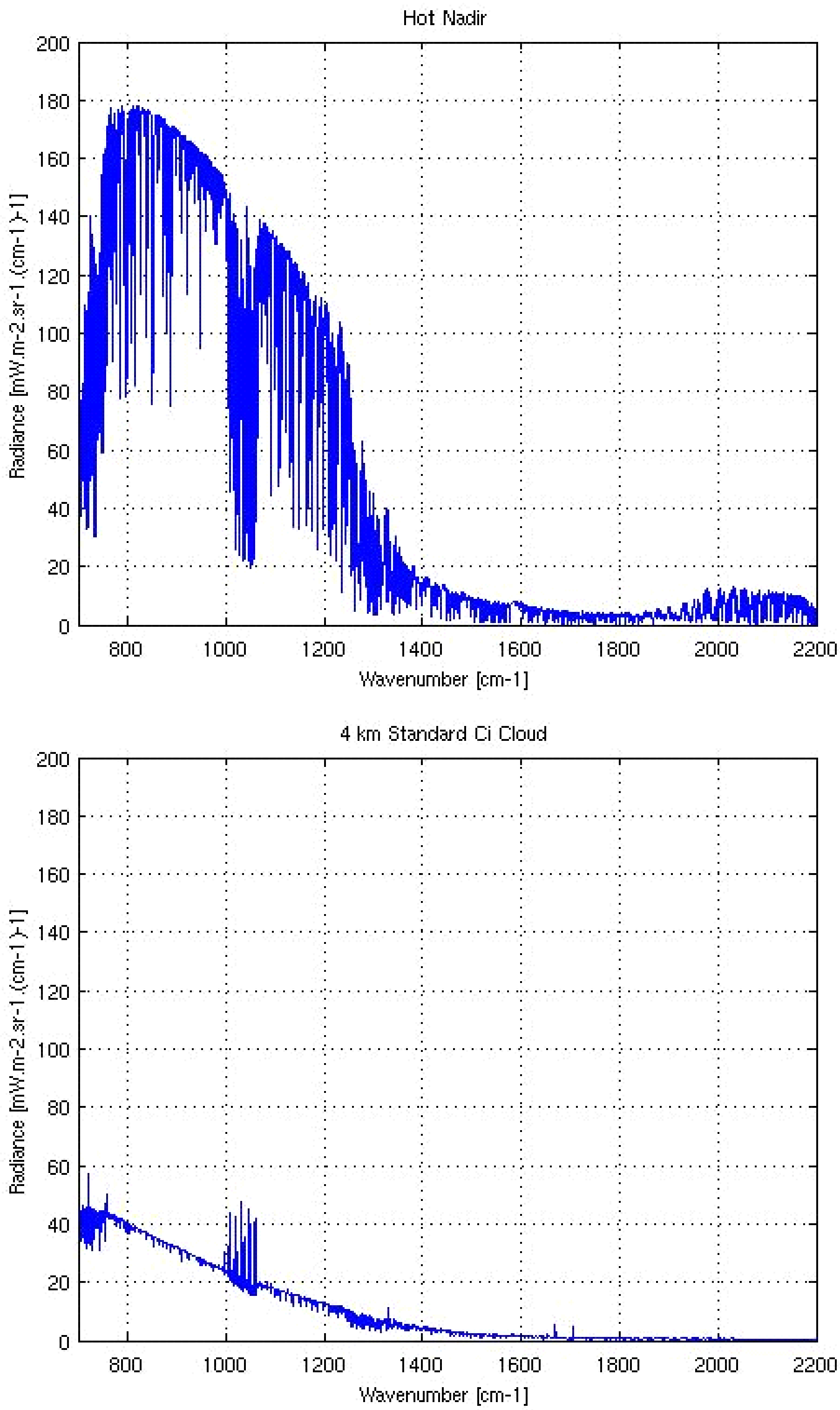



***Figure 8: Spectral* radiances *for a hot desert and cold thick cirrus scene***

### 4.2.4 IRS Dataset Level 1 Radiometric Requirements

*Table 9: Radiometric requirements of the IRS Images*

| *LWIR* Wavenumber *(cm$^{-1}$)* | *Ref. Signal, Tref* | Radiometric Noise *(NEdT)* | Medium Term Radiometric Stability | Long Term Radiometric Stability | Radiometric Accuracy |
|---|---|---|---|---|---|
| 700 | 280K | <0.5K | <0.1K | <0.3K | <0.5K |
| 714 | 280K | <0.5K | <0.1K | <0.3K | <0.5K |
| 715 | 280K | <0.4K | <0.1K | <0.3K | <0.5K |
| 729 | 280K | <0.4K | <0.1K | <0.3K | <0.5K |
| 730 | 280K | <0.3K | <0.1K | <0.3K | <0.5K |
| 769 | 280K | <0.3K | <0.1K | <0.3K | <0.5K |
| 770 | 280K | <0.2K | <0.1K | <0.3K | <0.5K |
| 1100 | 280K | <0.2K | <0.1K | <0.3K | <0.5K |
| 1210 | 280K | <0.35K | <0.1K | <0.3K | <0.5K |
| **MWIR *Wavenumber* (cm$^{-1}$)** | **Ref. Signal, Tref** | ***Radiometric Noise*(NEdT)** | ***Medium Term Radiometric Stability*** | ***Long Term Radiometric Stability*** | ***Radiometric Accuracy*** |
| 1600 | 280K | <0.2K | <0.1K | <0.3K | <0.5K |
| 1810 | 280K | <0.2K | <0.1K | <0.3K | <0.5K |
| 1980 | 280K | <0.4K | <0.1K | <0.3K | <0.5K |
| 2175 | 280K | <0.85K | <0.1K | <0.3K | <0.5K |

IRS-04140

The IRS *radiometric noise* shall be as given in Table 9 with the NEdT scaled at signal levels between black body temperatures 200K and 280K according to the *radiometric scaling function* and between black body temperatures 280K to 313K with a scaling factor of 1.

IRS-04160

The IRS *medium term radiometric stability* for a *spectral channel* shall be as per Table 9.

IRS-04180

The IRS *long term radiometric stability* for a *spectral channel* shall be as per Table 9.

IRS-04200

The IRS calibration system shall ensure that the *radiometric accuracy* is as per Table 9.

### 4.2.5 IRS Dataset Level 1 Spatial and Temporal Requirements

IRS-04220

The IRS *spatial sampling distance* (SSD) shall be as per Table 7.

IRS-04240

The absolute value of the IRS *relative sample position error* (RSPE) between any two *spectral channels* shall meet the requirements in Table 10 when evaluated over a LAC.

Note: In the definition of RSPE r1=r2 for this requirement

***Table 10: IRS* Spectral Channel Relative Sample Position Error**

| *Channel Group* | *Confidence Level* | *RSPE* |
|---|---|---|
| Channel to channel (within a *spectral band*) | 68.26% | < 0.4 km |
| Channel to channel (between *spectral bands*) | 68.26% | < 0.8 km |

### 4.2.6 IRS Dataset Level 1 Geometric Requirements

IRS-04260

The absolute value of the IRS *relative sample position knowledge error* (RSPKE) shall be as given in Table 11, when evaluated over all *spatial samples* common between two *images* of the same *LAC zone* separated in time by twice the *repeat cycle*.

Note: In the definition of RSPKE k1=k2 for this requirement

***Table 11: Geometric Quality Criteria***

| | *Confidence Level* | *Value* |
|---|---|---|
| RSPKE (between two LAC *images*) | 99.73 % | <3.15 km |

## 4.3 Lightning Data Acquisition and Generation Services

The Lightning Imager acquisition and generation has no MSG heritage. It provides a real time lightning location and detection (cloud-to-cloud and cloud-to-ground strokes, with no discrimination between the two types).

The LI is using *detector elements* arranged in a *detector array* covering the earth (no scanning mechanism). The power received by each *detector element* is integrated over the integration period and then compared with the *LI Trigger Threshold*. If the energy exceeds this threshold, it is identified as an *LI Triggered Event*.

The integration period is optimised to meet the Detection Efficiency (DE) and the False Alarm Rate (FAR) requirements, taking into consideration a typical stroke of 0.6 ms duration when observed from above.

During the ground *Level 0* to *Level 1* processing, the *LI triggered events* are filtered to minimise false alarms. In parallel the *LI background radiance images* are processed to improve the geolocation of the flashes.

### 4.3.1 LI Dataset Acquisition Requirements

LI-06020

The Lightning Imager (LI) *full disc coverage* shall include the Earth within a circle of 16º in diameter, shifted northward to cover high latitude regions.

Note: If for design optimisation the *coverage* is not circular then it must cover at least 84% of the visible earth disc (a circle of 17.54° in diameter centred at SSP) and the European territories of all the EUMETSAT member states when the *satellite* is within the *nominal longitude range*.

LI-06040

The *LI triggered events* shall consist in the measurements of the strongest lightning emission features within the cloud top optical spectra produced by the neutral oxygen lines in the near infrared.

Note: The OI(1) line at 777.4 nm made of three lines of nearly equal intensity with a total separation of 0.34 nm.

### 4.3.2 LI Dataset Quality Threshold

As defined in [CONV], the *quality threshold* is met when the requirements on *completeness*, *accuracy* and *timeliness* are fulfilled. The percentages of the *datasets* that meet the criteria threshold requirements (within *timeliness*) are addressed in the dissemination sections.

LI-06060

The LI *datasets* collected over 10 minutes shall be considered complete if all of the following requirements are fulfilled:

a) LI *dataset* acquisition requirements,

b) LI detection efficiency requirements.

Note: Detection efficiency requirements are identified in LI-06090.

LI-06080

An LI *dataset* shall be considered accurate if all of the following requirements are fulfilled:

a) LI *dataset Level 1* radiometric requirements,

b) LI *dataset Level 1* spatial & temporal requirements,

c) LI *dataset Level 1* geometric requirements.

Note: Radiometric requirements are identified in LI-06100

### 4.3.3 LI Dataset Level 1 Radiometric Requirements

Unless otherwise stated the requirements in this section apply:

- for all illumination conditions,
- over each MTG-I *satellite specified lifetime*,
- for a 50% cloud cover of the earth,
- for an average cloud *albedo* of 80%.

LI-06090

For any *lightning pulse* characterised by:

a duration longer than 0.6ms, and

a size larger than a circle of 10km diameter, and

an energy density higher than 16.7 $mWm^{-2}sr^{-1}$ (day) or 6.7 $mWm^{-2}sr^{-1}$ (night),

the LI shall transmit to the ground:

all the *LI triggered events* with a Detection Efficiency (DE) better than

a) 90% at 45°N latitude, SSP longitude

b) 70% in average over the whole instrument *coverage* area

LI-06100

The LI shall provide the *lightning event* radiance measured in the spectral interval centred at 777.4 nm and having a width of 0.34 nm, over the full range from 6.7 to 670 $mWm^{-2}sr^{-1}$, with an error (at 1σ) less than:

a) 10% relative accuracy for *radiances* higher than 70 $mWm^{-2}sr^{-1}$

b) 7 $mWm^{-2}sr^{-1}$ absolute accuracy for *radiances* lower than 70 $mWm^{-2}sr^{-1}$

### 4.3.4 LI Dataset Level 1 Spatial and Temporal Requirements

LI-06120

The LI shall provide a *spatial sampling distance* less than or equal to 10km at 45°N for the sub-satellite longitude.

### 4.3.5 LI Dataset Level 1 Geometric Requirements

LI-06140

The absolute value of the LI *absolute sample position knowledge error* (ASPKE) evaluated over the complete *Full Disc Coverage* (FDC) shall be less than 4 km (112 µrad) at SSP, at a 99.73% confidence level.

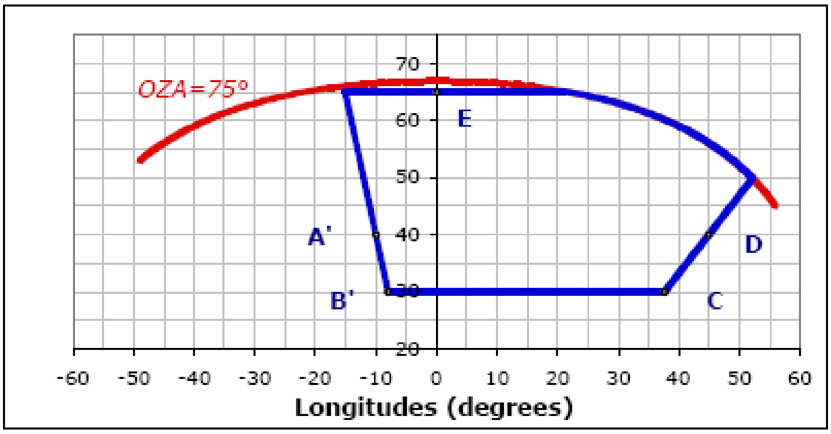
## 4.4 UVN-GMES Data Acquisition and Generation Services

Observation of ultraviolet and visible and near-infrared radiation will be provided by MTG through measurement made with a dedicated instrument (UVN *payload*), that will be the GEO part of the Sentinel 4/5 System provided by EC and ESA. The UVN observations are used to measure several trace gas species, and gain information on aerosols and clouds.

The UVN is specified and developed in context of an ESA programme. This section can therefore not contain EUMETSAT requirements on the instrument, but rather reflects the current understanding of expected UVN performance.

### 4.4.1 UVN Sounding performances

In its nominal mode, the UVN data acquisition service will provide systematically data over a sub-area of the Geographical *Coverage* Area specified in Figure 9, with a *repeat cycle* period shorter than or equal to 1 hour.



| | | A' | B' | C | D | E |
|---|---|---|---|---|---|---|
| Lon | Deg | -10 | -8 | 37.7 | 45 | 0 |
| Lat | deg | 40 | 30 | 30 | 40 | 65 |

***Figure 9: Geographical Coverage Area (blue curve); OZA=75º (red curve)***

### 4.4.2 UVN Spatial resolution and geometric quality performances

The spatial sampling distance at 45N latitude, 0E longitude of UVN measurements, in both N-S and E-W directions, will be smaller than or equal to 8 km.

### 4.4.3 UVN Spectral measurements and quality performances

***Table 12: Spectral bands and performances for GEO-UVN.***

| Band<br>ID | Spectral range<br>[nm] | Spectral resolution<br>[nm] | Spectral sampling ratio |
|---|---|---|---|
| UV | 305-400 | 0.5 | 3 |
| VIS | 400-500 | 0.5 | 3 |
| GEO-NIR | 750-775 | 0.5 (Threshold),<br>0.2 (Breakthrough)<br>0.06 (Goal) | 3 |

Note: Spectral resolution in the GEO-NIR between the Breakthrough and Goal values is highly desirable

The UVN sounder will cover the spectral bands according to the ranges as specified in Table 12.

The spectral resolution will be smaller than or equal to the values specified in Table 12.

The spectral sampling ratio will be larger than or equal to the values specified in Table 12.

The stability of the *spectral channels* between two consecutive solar measurements will be better than 5% of spectral sampling interval (SSI).

### 4.4.4 UVN Radiometric performances

The SNR of the spectral channels for (Earth) radiance and reflectance measurements will be larger than or equal to the values specified in Table 13.

Note: this performance estimate applies per spectral resolution element.

***Table 13: Radiometric performances (per spectral resolution element) for GEO-UVN.***

| ***Wavelength [nm]*** | ***SNR*** | | |
|---|---|---|---|
| | **Spectral Resolution [nm]** | | |
| | **0.5 (Threshold)** | **0.2 (Breakthrough)** | **0.06 (Goal)** |
| 305 (2) | 200 | | |
| 310 | 400 | | |
| 315 | 700 | | |
| 320 | 900 | | |
| 350 | 1040 | | |
| 450 | 1440 | | |
| 500 | 1440 | | |
| 750 | 1200 | 700 | 400 |
| 759 | 1200 | 700 | 400 |
| 759+SSI | 250 | 130 | 60 |
| 770-SSI | 250 | 130 | 60 |
| 770 | 1200 | 700 | 400 |
| 775 | 1200 | 700 | 400 |

(1) Performance values between the specified spectral points are obtained by linear interpolation

(2) The SNR performance is evaluated over the complete instrument dynamic range

(3) Around the lines located at 393.5 nm, 397 nm, 431 nm and 486.3 nm the SNR specification applies to the radiance interpolated from both sides of the lines (“continuum”).

The absolute radiometric accuracy of the Earth reflectance and the radiance will be better than 2-3 % (1$\sigma$).

The relative spatial radiometric accuracy of the (Earth) radiance and reflectance measurements will be smaller than 0.25% (1$\sigma$).

### 4.4.5 Data navigation and registration performances

The knowledge of the navigation information will be better than 20% of SSD over land and 1 SSD over ocean.

Interband spatial co-registration knowledge between band will be better than 5% of SSD.

The inter-channel spatial co-registration within each band will be better than 10% of SSD.

## 4.5 *Level 2* Product Generation Services

In order to provide continuity to the present Meteosat Second Generation (MSG) programme and its set of derived products, the extraction of *Level 2* products is also foreseen as a key service for MTG.

The final list of products to be generated from the MTG missions, the respective generation philosophies, and the decision where each product is generated (at the EUMETSAT Headquarter or within the SAF network) are not fixed yet. These decisions have to be taken by Council following the established process as described below.

For the *Level 2* products generated at the Headquarter, the process for preparing these decisions will be the annual revision by the STG-SWG and OPS-WG eventually presented to STG and approved by Council. For the SAF network, the decision will be taken in the context of the approval by Council of the SAF proposals for the next continuous development and operation phases (CDOP 2 / CDOP 3) but also by subsequent decisions of SAF SGs, as SAF plans evolve in response to user requirements.

### 4.5.1 *Level 2* Product Generation at EUMETSAT HQ

MET-08020

The *Level 2* products generation service at EUMETSAT Headquarters shall provide a continuity of service between MSG and MTG concerning the *Level 2* Products generated, albeit with improved quality, resolution, *timeliness*.

MET-08040

The *Level 2* products generation service at EUMETSAT Headquarters shall provide new *Level 2* Products specific to MTG as agreed by Delegate Bodies.

For the list of products generated at EUMETSAT Headquarters, refer to [L2HQ].

### 4.5.2 *Level 2* Product Generation by the SAFs

The Satellite Application Facilities (SAFs) use specialised expertise in Member States, to complement the production of *Level 2* products at EUMETSAT's HQ.

The SAFs also supply software packages for generating products at the end-users' own sites or generate additional products which may be fed or not into EUMETSAT's dissemination infrastructure.

As is the case for the centrally generated *Level 2* Products, the SAFs ensure a continuity of service between MSG and MTG while new MTG specific products are developed.

The *operational availability* requirements that apply to product generation at the SAF are to be agreed between EUMETSAT and the SAFs.

MET-08060

The *Level 2* products generation service by the SAF shall provide a continuity of service between MSG and MTG concerning the *Level 2* Products generated, albeit with improved quality, resolution, *timeliness*.

MET-08080

The *Level 2* products generation service by the SAF shall provide new SAF *Level 2* Products specific to MTG as agreed by Delegate Bodies.

For the list of products generated by the SAFs, refer to [L2SAF].

## 4.6 DCP Message Acquisition, Bulletin and Statistics Generation Services

The MTG DCS mission involves, as a continuity of MSG mission, the relay of Data Collection Platform (DCP) messages by the *satellite*, on-ground processing of the messages, and dissemination of the resulting DCP messages, statistics and bulletins to end-users. The DCP platforms can be fixed on land or embarked on a buoy, ship, balloon or airborne.

Two types of DCP messages exist:

- self-timed messages: messages transmitted periodically within the allocated time-slots,

- alert messages: special messages transmitted when the values of one or more measured parameters exceed predefined thresholds**.**

The capability to relay ARGOS/GEO channels, is part of the MTG design. However, the implementation of this capability during the development and operation phases of MTG can only be finally confirmed with the MTG programme approval by EUMETSAT Council.

This implementation should be in line with the following understanding:

- The application areas will be associated to activities aimed at an improved knowledge of the earth natural phenomena and the protection of its natural resources, thereby contributing to oceanographic, hydrologic and meteorological modelling & forecasting , as well as climate monitoring,
- The EUMETSAT End Users will benefit from this service and from the low cost/small size of the ARGOS transmitters compatible with MTG DCP.
- A redirection of the ongoing space segment studies will not be required. In this respect a sub-band of about 100kHz will be reserved in the MTG DCP band for ARGOS/GEO, subject to frequency coordination with other operators in this band.
- A more detailed analysis for the implementation mechanisms, sharing of responsibility and ground processing interfaces will be conducted during the phase B.

The performance monitoring of the DCP mission includes monitoring of the reception of DCP reference platforms and the quality and *timeliness* of DCP messages.

DCP-10020

In continuity of MSG, the system shall provide the following functionality for handling Data Collection Platform (DCP) messages:

a) Acquire data, via MTG-I *satellite* relay from registered DCPs for further distribution.

b) Monitor and derive statistics for each individual DCP (e.g. deviations from the nominal time slot and frequency channel allocation) and provide notification to the relevant DCP operator within 2 working days of any anomaly detected.

c) Provide real time indication on the quality of the signal.

d) Process DCP alert messages without waiting, for further distribution via EUMETCast and internet.

e) Create DCP bulletins from acquired DCP messages for further distribution.

Note: ARGOS/GEO signals are relayed as any DCP uplink/downlink. ARGOS data are also extracted from DCP downlink, but further on-ground processing for the ARGOS data is currently **[TBD 1]**.

## 4.7 Archiving Services

The *EUMETSAT Data Centre* (previously UMARF) provides long-term archiving and catalogue functions for all EUMETSAT programmes and projects. This section provides the requirements for the archiving. The retrieval requirements are provided in §6.

It is expected that the EUMETSAT existing multi-mission *EUMETSAT Data Centre* evolves to cope with the MTG needs.

The SAFs are each expected to have their own local archive for the SAF-generated products. However, some SAF-generated products may be transferred for archiving in the *EUMETSAT Data Centre*. In any case, each SAF makes available the catalogue of its own archive on the EUMETSAT Earth Observation Portal. In this way, it is possible for end-users to browse the catalogue of SAF-generated products, as well as all of the centrally stored mission data.

ARC-12020

The following *datasets* shall be archived and catalogued in the *EUMETSAT Data Centre* to allow later retrieval:

a) The *Level 0 datasets* received from EUMETSAT *satellites* including all *auxiliary data* necessary for reprocessing.

b) The *Level 1b* and *Level 1c disseminated dataset* which have been centrally generated.

c) The *Level 2 disseminated dataset* which have been centrally generated.

d) Selected SAF *Level 2* products.

e) Reprocessed *datasets* from *Level 1*, *Level 2* and selected SAF *Level 2* products.

f) *Verification / validation* data and products, including external data used for *verification* and *validation* purposes;

Note 1: Appendix B lists the archived *Level 1 datasets* at the time of publication of this document. They are identified in the column "*EUMETSAT Data Centre*".

ARC-12040

The MTG System shall include, for each SAF either:

a) the catalogue of products generated and archived by that SAF;

b) an interoperability mechanisms which allows the access to the SAF product catalogue.

Note: Assuming that the catalogue is maintained by the SAF archiving centre and provided to EUMETSAT.

ARC-12060

The MTG System shall ensure that mission related *datasets* shall be available in the *EUMETSAT Data Centre*, for later retrieval, with a *completeness* of 99% **[TBC 13]**

Note 1: DELETED

ARC-12080

DELETED

ARC-12100

DELETED

ARC-12120

The *EUMETSAT Data Centre* archive and catalogue of all *archived dataset* elaborated from Meteosat First Generation (MOP/MTP), Meteosat Second Generation (MSG) *satellites*, and MTG shall be maintained over the lifetime of the MTG programme.

Note: The continuity of EPS archive has to be addressed by Post-EPS programme and the continuity of Jason archive has to be addressed by Jason follow-on programme.

ARC-12140

The MTG System shall allow reprocessing of any *archived dataset* to derive and archive new *datasets* or new versions of any *dataset* without impact on the nominal operational missions.

# 5 NEAR REAL TIME DATA DISSEMINATION AND RELAY SERVICES

The following near-real time dissemination and relay services are covered in the following sections:

- EUMETCast & High Rate Dissemination Services,
- RMDCN Dissemination Service (GTS),
- Internet Dissemination Service,
- EUMETSAT Earth Observation Portal,
- Search & Rescue (SAR) Relay Service.

## 5.1 EUMETCast & High Rate Dissemination Services

The EUMETCast & High Rate dissemination services are available for registered Users equipped with dedicated reception software licensed by EUMETSAT. This service offers two alternatives:

- The ‘High Rate Service’ (or full scale), for a restricted set of Users, who have a right to access the data, on the basis of the EUMETSAT Data Policy. This service may be part of EUMETCast (as for MSG), or a separate service. This depends on the number of Users and of the volume to be disseminated.
- EUMETCast for any Users allowing receiving with a simple terminal, the 'essential data' as defined in the EUMETSAT Data Policy.

Note: The need of two dissemination systems is **[TBC 14]** and the split between them depends mostly on the amount of *datasets* to be delivered to users, with associated *timeliness* requirements taking into account their affordability to the users/member states (main reason why there were two different dissemination methods in MTP and MSG). With the information at hand today, delivery of the full set of MTG *datasets* to all potential users at all potential locations might not be possible within the financial envelope of MTG (at least at the beginning of the programme).

Therefore, two separate methods (one for a limited set of users but with all data at full resolution) and the second for a majority of users (across Europe and Africa) but with a more limited set of data.

The following main *disseminated dataset* are expected to be delivered by the <u>High Rate dissemination service:</u>

- the full set of geometrically and radiometrically rectified FCI *images* at full resolution
- a subset or a compressed representation of calibrated and geolocated IR sounder spectra
- calibrated and geolocated UVN sounder *datasets* (**[TBC 15]** if required & financed in context of GMES).

The following main *disseminated dataset* are expected to be delivered by EUMETCast:

- A subset of geometrically and radiometrically rectified FCI *images* at reduced spatial and temporal resolution
- the full set of geometrically and radiometrically rectified Lightning *dataset*
- A subset of *Level 2* Products generated at EUMETSAT Head Quarters
- Foreign Satellite Data (FSD)
- Meteorological Data Dissemination (MDD)
- Data Collection Platforms (DCP) Messages and Bulletins
- Selected SAF Products

In addition, the following data are expected to be delivered by both high and EUMETCast services:

- Service messages
- Encryption Control Information

The dissemination coverage is split in several zones (e.g. Europe, Africa…) and the exact content depends on the zone.

A detailed description of MDD can be found in (TD10). Data from the MDD partners are routed to EUMETSAT via Deutscher WetterDienst (DWD) at Offenbach. The responsibility for the provision of data lies with DWD Offenbach.

***Table 14:* Operational Availability *within* timeliness *for EUMETCast & high rate dissemination***

| **disseminated dataset** | **operational availability** | ***End to end* timeliness *via EUMETCast (see Note 1)*** | ***End to end* Timeliness *via high rate dissemination (see note 1)*** |
|---|---|---|---|
| FCI Rectified *images* | 95% with a goal of 98% | | |
| Full Disc Scanning Service (FCI-FDSS) | | 15mn | 10mn with a goal of 5mn |
| Rapid Scanning Service (FCI-RSS) | | N/A | 5mn with a goal of 2.5mn |
| *Level 2* Products | 95% with a goal of 98% | | N/A |
| >=Daily products | | 60mn | |
| >=3-hourly products | | 60mn | |
| >=Hourly products | | 30mn | |
| <= hourly | | 20mn | |
| Retransmission of Foreign Satellite Data (FSD) | 95% with a goal of 98% | 60mn | N/A |

| | | | |
|---|---|---|---|
| DCPs messages and bulletins | 95% with a goal of 98% | | N/A |
| Alert messages | | 3mn with a goal of 2mn | |
| Bulletins | | 10mn with a goal of 5mn | |
| Retransmission of MDD data received from RMDCN | 95% with a goal of 98% | 60mn | N/A |
| IR Sounder *dataset* | 95% with a goal of 98% | N/A | 30 mn |
| UVN sounding *dataset* | 95% with a goal of 98% | N/A | 60mn **[TBC 16]**<br>See Note 2 |
| Lightning *dataset* | 95% with a goal of 98% | | N/A |
| Events | | 2mn with a goal of 30s | |
| Background Images | | N/A | |
| Products | | 2mn | |
| Retransmission of SAF Products (see note 4) | 95% with a goal of 98% | | N/A |
| 3 hourly or more | | 60mn | |
| Hourly products | | 20mn | |
| Less than hourly | | 10mn | |
| Not disseminated via EUMETCast | N/A | N/A | |
| Service Messages | 95% with a goal of 98% | 60mn | |

Note 1: Operational availability, *timeliness* and the calculation method are defined in [CONV]. A *dataset* arriving after the mentioned *timeliness* is not considered as available for the end-user. Delays outside EUMETSAT control have to be added (e.g. for FSD, MDD, SAF).

Note 2: TBD if required & financed in context of GMES.

Note 3: The objective is to achieve the goal during routine operations. This implies that the initial MTG System and its operation are designed to achieve the goal. The difference between the spec and the goal being a margin allowing some design optimisation and shared between system, ground segment and facilities. At system level the formal verification will consist in the assessment of the margin against the specified values. The operational system validation will be against the goal.

Note 4: The specified timeliness only refers to the EUMETCast contribution, i.e. the dissemination of SAF products and does not include the time required to generate the products at the SAFs. The latter is specified in the respective SAF Product Requirements Documents.

### 5.1.1 Data Delivered and Coverage

DIS-14020

The EUMETCast & High Rate Dissemination services shall provide data to the following geographic regions with the following characteristics:

a) High rate service over Europe;

b) EUMETCast service over Europe.

c) EUMETCast service over Africa.

d) EUMETCast service over South America (TBC).

Note 1: Coverage details regarding current implementation for MSG are provided in [TD15].

DIS-14040

The list and periodicity of disseminated *Level 1 datasets* transmitted by EUMETCast & High Rate dissemination, for each of the geographic regions, shall be as defined in Appendix B.

Note 1: Appendix B lists the contents of the dissemination service for each of the geographic regions at the time of publication of this document.

Note 2: This implies that the services are configurable, during operations.

DIS-14045

EUMETCast shall support the dissemination of centrally generated *Level 2 datasets*.

Note: The list and characteristics of centrally generated *Level 2 datasets* and the dissemination periodicity are continuously reviewed through STG-SWG and STG OPS-WG before approval by Council.

DIS-14047

EUMETCast shall support the dissemination of a subset of SAF *datasets*.

Note 1: The list and characteristics of SAF *datasets* is subject to the approval of Council and is documented and specified in the Product Requirement Documents (PRD)s of each individual SAF.

Note 2: The list of SAF *datasets* disseminated by EUMETCast and the associated periodicity are continuously reviewed through STG OPS-WG before approval by Council.

DIS-14050

The IRS *disseminated dataset* shall consist of either 300 **[TBC 17]** selected *spectral channels* or 300 **[TBC 18]** principal component (PC) scores derived from the full set of *spectral channels*.

Note: To be based on the experience derived from IASI data distribution.

### 5.1.2 Dataset Operational Availability

DIS-14060

The *operational availability* of rectified images of the Full disc scanning service (FCI-FDSS) shall be as per Table 14.

DIS-14080

The *operational availability* of *Level 2* Products shall be as per Table 14.

DIS-14100

The contribution of the EUM ground segment to the *operational availability* of Foreign Satellite Data shall be as per Table 14.

DIS-14120

The *operational availability* of DCP messages & bulletins shall be as per Table 14.

DIS-14140

The contribution of the EUM ground segment to the *operational availability* of MDD shall be as per Table 14.

DIS-14160

The *operational availability* of rectified images of the Rapid scanning service (FCI-RSS) shall be as per Table 14.

DIS-14180

The *operational availability* of IR sounder *dataset* shall be as per Table 14.

DIS-14200

The *operational availability* of UVN sounder *dataset* shall be as per Table 14.

DIS-14220

The *operational availability* of Lightning *dataset* shall be as per Table 14.

DIS-14240

The contribution of the EUM ground segment to the *operational availability* of SAF Products shall be as per Table 14.

Note: The *operational availability* of the SAF product generation for SAF Products that are not disseminated by EUMETSAT is not specified in this document but is specified in each SAF specification.

## 5.2 RMDCN Dissemination Service

The Regional Meteorological Data Communication Network (RMDCN) is used by WMO Region VI to carry the following GTS traffic (within Europe):

- A subset of *Level 1* datasets,
- A subset of *Level 2* Products,
- Data Collection Platforms (DCP) Bulletins,
- Service messages.

The Global Telecommunication System (GTS) of the WMO (World Meteorological Organisation) may further distribute these data to users which are not connected to the RMDCN.

An evolution of the GTS into the WMO Information System (WIS) is foreseen.

***Table 15: Characteristics and* operational availability *within* timeliness *for RMDCN Dissemination***

| disseminated dataset | Operational Availability | Timeliness |
|---|---|---|
| *Level 1 dataset* | 95% with a goal of 98% | 1 hour |
| *Level 2* Products | 95% with a goal of 98% | 1 hour |
| DCPs bulletins | 95% with a goal of 98% | 1 hour |
| Service Messages | 95% with a goal of 98% | 1 hour |

Note: *Operational availability*, *timeliness* and the calculation method are defined in [CONV]. A *dataset* arriving after the mentioned *timeliness* is not considered as available for the end-user.

### 5.2.1 Data Delivered (RMDCN)

DIS-14250

The list, characteristics and periodicity of disseminated *Level 1 datasets* transmitted by RMDCN shall be as defined in Appendix B.

Note 1: Appendix B lists the contents of the dissemination service at the time of publication of this document.

Note 2: This implies that the services are configurable, during operations.

DIS-14260

The RMDCN Dissemination service shall support the dissemination of *Level 2 datasets*.

Note: The list, characteristics and periodicity of disseminated *Level 2 datasets* will be agreed by Delegate Bodies.

### 5.2.2 Dataset Operational Availability (RMDCN)

DIS-14270

The *operational availability* of *Level 1 datasets* shall be as per Table 15.

DIS-14280

The *operational availability* of *Level 2* products shall be as per Table 15.

DIS-14300

The *operational availability* of DCP bulletins shall be as per Table 15.

## 5.3 Search and Rescue (SAR) Relay Service

Since MSG-1, every METEOSAT *satellite* carries a Search and Rescue (SAR) transponder for relay of 406 MHz beacons activated anywhere in its *field of view*. This secondary mission means that the *satellite* is part of the constellation of *satellite*s that constitutes the space segment of the Cospas-Sarsat international system, whose aim is to provide distress alert and location information to appropriate rescue authorities for maritime, aviation and land users in distress.

A detailed description of the SAR system can be found at [www.cospas-sarsat.org]

DIS-14340

The MTG System shall support the SAR mission by accommodating a *satellite* repeater, on each MTG-I, between the SAR distress beacons and the SAR receive ground stations, as long as this is not to the detriment of the other missions.

DIS-14360

The *operational availability* of the *satellite* SAR repeater shall be better than 99% .

## 5.4 Internet Dissemination Services

EUMETSAT is providing an Internet Dissemination Service, which allows general public to receive *dataset* (e.g. Satellite Images) upon registration via the Internet. DCP operators can also receive their own DCP messages and information about the operational status of their DCP platforms. DCP operators have to register with EUMETSAT for admission to this service. Statistics on the performance of the DCP system are also available via this service.

The Internet dissemination service freely distributing MTG data contains:

- all “essential" *image datasets* stipulated in the EUMETSAT Data Policy [DATAPO]
- low spatial and resolution *radiance* products
- image loops
- images in suitable graphic format to support qualitative applications.

The Internet Dissemination Service is implemented using the EUMETSAT multi-programme infrastructure which provides end-user services.

### 5.4.1 Data Delivered (Internet)

DIS-14380

The list, characteristics and periodicity of disseminated *Level 1 datasets* transmitted by Internet shall be as defined in Appendix B.

Note 1: Appendix B lists the contents of the dissemination service at the time of publication of this document.

Note 2: This implies that the services are configurable, during operations.

DIS-14390

The Internet Dissemination Service shall support the dissemination of *Level 2 datasets*.

DIS-14400

The internet dissemination service user guide shall be made available, and kept up to date, to describe the formats and other characteristics of the *disseminated dataset*.

DIS-14420

The Internet Dissemination Service shall only deliver to the registered DCP Operator its own *dataset*.

### 5.4.2 Data-set Operational Availability (Internet)

DIS-14440

The *operational availability* of the *datasets* via the Internet Dissemination Service shall be as defined in Table 14 for EUMETCast.

# 6 DATA RETRIEVAL SERVICES

MTG Data Retrieval services are provided as part of the multi-mission *EUMETSAT Data Centre* services and/or as part of the internet downloading service.

The *EUMETSAT Data Centre* provides long-term archiving and cataloguing functions for data-sets of all EUMETSAT programmes (Meteosat, EPS...). The central catalogue contains reference to all data-sets archived in *EUMETSAT Data Centre*.

The MTG user retrieval services provide users with means and mechanisms to ease and gain access to the MTG mission data, products and information that have been stored in the archive. The user retrieval services enable authorised users of all groups (including those who have no near real time needs or no on-line capability) to retrieve and obtain MTG data, products and information .

The service allow the users to register, navigate through the catalogue of MTG data, retrieve historical scientific mission data, browse low to moderate resolution data/products, and request data. The *dataset* retrieval for off-line users is addressed in §7.4 Helpdesk service.

RET-16020

The *EUMETSAT Data Centre archived dataset* and catalogue of all Meteosat programmes shall be available for retrieval by users over the lifetime of the MTG programme.

Note: For MTG, the *archived dataset* are defined in §4.7.

RET-16040

The *EUMETSAT Data Centre* archive user guide (EUMETSAT Archive User Guide (see [UG04]) shall be maintained, to describe the ordering mechanism and options including the available media, the delivery formats and other characteristics of the MTG *archived datasets* which can be retrieved.

Note 1: For *EUMETSAT Data Centre* supported service and performances, refer to publication in http://www.eumetsat.int..

Note 2: One of the supported format for *archived datasets* retrieval is the one currently used for dissemination.

RET-16080

The *operational availability*, with a *timeliness* of 1 hour, of *disseminated dataset* for retrieval by End-Users shall be better than 99%.

# 7 USER SUPPORT SERVICES

The User Support Services are indispensable for enhancing the usage and reach of EUMETSAT *Datasets* and Services both within the EUMETSAT Member States as well as within the WMO Member States by:

- The distribution of information about the operational status of the systems and services**.**
- The provision of a centralised data access point (the Earth Observation Portal).
- The provision of Operational Programmes data content on EUMETSAT corporative web pages.
- The provision of a helpdesk function.
- The provision of training.

The User support services are capable of providing general, descriptive and expert information about the MTG and its mission data, products and services, both routinely and in response to requests.

## 7.1 Operational information dissemination service

Depending on the context and urgency, the following Service Messages concerning the operational services are provided to the users:

- Administrative - Summarising the service interruptions during the whole of the previous calendar day.
- News - Announcement of an interruption to services in real-time
- Weekly schedule - Announcement of scheduled service interruptions in the forthcoming week

USR-18020

Service messages shall provide information on the status and planning of the MTG operational services, including regular administrative messages (historical information), news messages (on event occurrence) and scheduled service *outages* (one week in advance), via:

a) EUMETCast dissemination**.**

b) High-Rate dissemination**.**

c) RMDCN/GTS dissemination**.**

d) User Notification e-mails**.**

Note: The service messages and their release conditions are described in Appendix A.

## 7.2 EUMETSAT EO Portal service

The EUMETSAT Earth Observation Portal is a multi-mission infrastructure which provides to the users a single online access point to all data and dissemination services including the supporting user administration functions. It allows users to:

- Discover the collection of *datasets* (e.g. image, *Level 2* products, SAF) and relating services for EUMETSAT data and partners;
- Search for and order of specific instances of EUMETSAT *archived datasets* (see §6) and of external partners (WMO, NOAA, ESA, CNES...);
- Subscribe to EUMETSAT or external partners dissemination services;
- Subscribe to User Notification Services (UNS).
- Access to service-related documentation, and appropriate links to information available on EUMETSAT internet.

It also allows partner agencies to discover, search, order and subscribe to EUMETSAT data and dissemination services through their own portal.

It federates with a common interface the following operational services:

- Subscription to the real-time dissemination services:
- Satellite Direct Dissemination services (for MSG only);
- Satellite broadcast services (i.e. EUMETCast / GEONETCast);
- Network dissemination services **[TBC 19]**: via RMDCN, GTS and WIS,
- Internet dissemination services (e.g. *images*, DCP downloading);
- *EUMETSAT Data Centre* Retrieval services including catalogue searching and ordering services;
- Archive Direct services (for MTP only);
- User Notification Services (UNS).

USR-18040

MTG Mission *archived dataset* and services shall be discoverable by users through the EUMETSAT Earth Observation Portal.

USR-18060

User shall be able to search, order, and retrieve MTG *archived dataset* through the EUMETSAT Earth Observation Portal.

USR-18080

Users shall be able to register to MTG services through the EUMETSAT Earth Observation Portal.

Note: For description of EO portal functions and performances refer to http://www.eumetsat.int .

USR-18090

Users shall be able to retrieve all the information necessary to read and display *archived datasets* and *disseminated dataset*.

Note: This includes pseudo code where appropriate, documentation, user guides...

## 7.3 Web Information

USR-18100

Through EUMETSAT Corporative web interface, using a browser, any anonymous user shall be able to retrieve:

a) Information about the MTG programme, data, documentation, services and status;

b) A subset of MTG sub sampled images.

## 7.4 Helpdesk Services

A significant part of theses services are available on-line (through the EO portal (see §7.2) and the internet web pages (§7.3)). However some users may not have a proper internet access and thus an alternative way is provided here.

A helpdesk service is provided to:

- respond to user requests for the provision of user documentation to assist in the full exploitation of the operational services (as an alternative to the on-line access);
- respond to general queries or complaints about the operational services;
- respond to off-line user requests for *archived dataset* retrieval or dissemination subscription (as an alternative to the on-line access);
- respond to user requests for licenses and decryption units for nonessential services (as an alternative to the on-line access);
- respond to requests for admission to the Data Collection Service (as an alternative to the on-line access);
- respond to requests for the certification of Data Collection Platforms;
- maintain a register of users of the operational services (as an alternative to the on-line access);

The response time of the Helpdesk Function depends on whether the user request involves a bespoke response or an off-the-shelf response (e.g. one which can be found on the EO portal).

USR-18120

Multiprogramme and Corporative wide Help desk capabilities shall be upgraded to extend its service and coverage to MTG .

## 7.5 User Training

The scope of user training provided covers the following:

- provision of classroom workshops to National Meteorological Services (NMS'), to assist them in the optimisation of satellite-data usage for current operational services and transition to future ones
- provision of information to NMS' and other user groups, to assist in the development of EPS, MSG and MTG applications
- facilitation in the generation of further Computer Aided Learning modules (CAL - e.g. ASMET, EUMeTRAIN etc.)
- co-operation in international training activities on satellite meteorology and remote sensing for the GEO societal benefit areas, in the framework of EUMETCAL and the WMO Virtual Laboratory for education and training
- support of training courses in Africa and other WMO regions, with the aim of establishing discussions/cooperation (between users of EUMETSAT data), using the WMO Virtual Laboratory focus group mechanism.
- organisation of Graduate Trainee Fellowships
- organisation of Training Placements (in accordance with Council decision)

EUMETSAT commitments concerning training will be extended to cover MTG data use and will be defined for agreement with Council.

# 8 DELIVERY OF SERVICE AND END USER GROUPS

## 8.1 Data Policy perspective: User Groups

The user community for METEOSAT data and products can be categorised in the following groups, in accordance with the EUMETSAT Principles on Data Policy [DATAPO]:

1) NMS: National Meteorological Services of the EUMETSAT Member States and Cooperating States for their Official Duty.

2) ECMWF: The European Centre for Medium-Range Weather Forecasts for its own use in support of its mission as defined in the ECMWF Convention.

3) WMO: Other National Meteorological Services of WMO Member States.

4) EDU: Educational users and researchers, and by extension private individuals.

5) GMES Service Entities **[TBC 20]**.

Note: This is not a user identified in [DATAPO], but has been added here following discussion at delegate bodies level.

6) OTHERS: All other operators, organisations, users (e.g. Group on Earth Observations (GEO), commercial, industrial, broadcasters, service providers...) with right to access data as per Data Policy or specific cooperation agreements.

## 8.2 Delivery of Services to User groups

Should EUMETSAT decide to deny access to MTG real time data and products to selectable users, this would not apply to groups NMS and ECMWF.

In case of a major contingency situation, the services to the User groups NMS and ECMWF will have priority over the services to the other End User groups.

Pending the Council decision regarding the Data Policy Implementing Rules for MTG Data and Products, the following services availability per end user groups are foreseen. This simplified table is provided for convenience to the reader, in case of conflict, [DATAPO] and other Councils decision prevails. In general a user has to be registered to benefit of the EUMETSAT services.

***Table 16: Services delivery per User groups***

| Service | NMS | ECMWF | WMO | EDU | GMES(TBC) | OTHERS |
|---|---|---|---|---|---|---|
| **1. NEAR-REAL-TIME DATA DISSEMINATION AND RELAY SERVICES** | | | | | | |
| 1.1 EUMETCast and HIGH RATE DISSEMINATION SERVICE | | | fee may apply | | yes | fee may apply |
| 1.1.1 HIGH RATE DISSEMINATION | | | | | | |
| a. FCI-FDSS, FCI-RSS and IR sounders *datasets* | yes | yes | TBD | TBD | yes | TBD |
| b. UVN *datasets* TBC | yes | yes | TBD | TBD | yes | TBD |
| 1.1.2 EUMETCast | | | | | | |
| a. FCI-FDSS images | yes | yes | yes | yes | yes | yes |
| b. *Level 2* | yes | yes | free | yes | yes | free |
| c. FSD | yes | yes | TBD | TBD | yes | TBD |
| d. DCP | yes | yes | yes, free | no | yes | no |
| e. MDD | yes | yes | free | no | Yes | no |
| f. LI | yes | yes | yes | yes | yes | yes |
| g. SAF | yes | yes | yes | yes | yes | yes |
| 1.2 RMDCN DISSEMINATION SERVICE | yes | yes | yes | no | no | no |
| 1.3 SEARCH AND RESCUE (SAR) RELAY SERVICE | no | no | no | no | no | Cospas-Sarsat only |
| 1.4 INTERNET DISSEMINATION SERVICES | yes | yes | fee may apply | yes | yes | fee may apply |
| | | | | | | |
| **2 - ARCHIVED DATA RETRIEVAL SERVICES (***EUMETSAT Data Centre***)** | yes | yes | fee may apply | data older than 24 hours | yes | fee may apply |
| | | | | | | |

| **3 - USER SUPPORT SERVICE** | | | | | | |
|---|---|---|---|---|---|---|
| 3.1 DISSEMINATION OF OPERATIONAL INFORMATION | yes | yes | yes | yes | yes | yes |
| 3.2 EARTH OBSERVATION PORTAL SERVICE | yes | yes | yes | yes | yes | yes |
| 3.3 WEB INFORMATION | yes | yes | yes | yes | yes | Yes |
| 3.4 PROVISION OF A HELPDESK FUNCTION | yes | yes | yes | yes | yes | yes |
| 3.5 USER TRAINING | yes | yes | yes | TBD | yes | TBD |

# APPENDIX A SERVICE MESSAGE BASELINE

Service message types and their schedule of dissemination are as follows:

| *Type* | *Schedule* | | | *Description* |
|---|---|---|---|---|
| | **EUMETCast** | **RMDCN** | **MTG specific service message** | |
| ADMIN | - Updated every day in the morning,<br>- Closed, every 15 minutes<br>- Open, every 30 minutes | N/A | TBD | Service details for the previous calendar day (24 hours). This message contains:<br>- Sections for open and closed related information.<br>- *datasets*<br>- Non available *repeat cycles* |
| NEWS | Once, at the time of problem detection | | | The news message is used to inform users in real time of problems that have occurred, issuing further messages when problems are resolved. |
| REG-RPT | Updated weekly every Thursday, disseminated once per day | | | This report contains scheduled announcements for the following week. |

# APPENDIX B MTG LEVEL 1 DATASETS GENERATION AND DISSEMINATION BASELINE

| Dataset | Format (1) | Coverage (2) | Resolution (3) | Generation periodicity (4) | EUMETCast periodicity | EUMETCast Africa periodicity | EUMETCast South America periodicity | high rate dissemination periodicity | RMDCN (5) | EUMETSAT Data Centre | Internet (SDDI) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FCI-FULL DISC SCAN SERVICE (FCI-FDSS)** | | | | | | | | | | | |
| Image Radiance (16 Channels ( + 1 fire channel TBC)) | L1c | Full disc | Pixel | 10mn | n/a | n/a | n/a | 10mn | n/a | YES | n/a |
| Low resolution radiance of all channels or only VIS 0.6, NIR 1.6, IR 3.8, WV6.3, IR 10.5 (TBC) | L1c in JPEG **[TBC 21]** | Full disc TBC | > pixel resolution & lossy compression | 30mn **[TBC 22]** | 30mn **[TBC 23]** | | | n/a | TBC | YES | YES |
| **FCI-RAPID SCANNING SERVICE (FCI-RSS)** | | | | | | | | | | | |
| HRFI channels (VIS0.6, NIR2.2, IR3.8, IR10.5) at high resolution | L1c | 1/4 disc North | Pixel | 2.5mn | n/a | n/a | n/a | 2.5mn | n/a | YES | n/a |
| Low resolution radiance of all channels or only VIS 0.6, NIR 1.6, IR 3.8, WV6.3, IR 10.5 (TBC) | L1c in JPEG TBC | Full disc TBC | > pixel resolution & lossy compression | 30mn **[TBC 24]** | 30mn **[TBC 25]** | | | n/a | TBC | YES | YES |
| **INFRA RED** | | | | | | | | | | | |

| Dataset | Format (1) | Coverage (2) | Resolution (3) | Generation periodicity (4) | EUMETCast periodicity | EUMETCast Africa periodicity | EUMETCast South America periodicity | high rate dissemination periodicity | RMDCN (5) | EUMETSAT Data Centre | Internet (SDDI) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SOUNDER LOCAL AREA SCANNING SERVICES (IRS-LASS)** | | | | | | | | | | | |
| sounding radiances (IRS-LASS4) | L1b | 1/4 disc North | Pixel | 30mn | n/a | n/a | n/a | n/a | n/a | YES | n/a |
| sounding radiances (IRS-LASS3) | L1b | 1/4 disc middle/North | Pixel | 5 times per 6 hours | n/a | n/a | n/a | n/a | n/a | YES | n/a |
| sounding radiances (IRS-LASS2) | L1b | 1/4 disc middle/South | Pixel | 4 times per 6 hours | n/a | n/a | n/a | n/a | n/a | YES | n/a |
| sounding radiances (IRS-LASS1) | L1b | 1/4 disc South | Pixel | 3 times per 6 hours | n/a | n/a | n/a | n/a | n/a | YES | n/a |
| reduced sub-set of 300 **[TBC 26]** channels or an equivalent number of Principal Components **[TBC 27]** - Zone 4 | L1b | 1/4 disc North | Pixel | 30mn | n/a | n/a | n/a | **[TBD 2]** | **[TBD 3]** | YES | **[TBD 4]** |
| reduced sub-set of 300 **[TBC 28]** channels or an equivalent number of Principal Components **[TBC 29]** - Zone 3 | L1b | 1/4 disc middle/North | Pixel | 5 times per 6 hours | n/a | n/a | n/a | **[TBD 5]** | **[TBD 6]** | YES | **[TBD 7]** |
| reduced sub-set of 300 **[TBC 30]** channels or an equivalent number of Principal Components **[TBC 31]** - Zone 2 | L1b | 1/4 disc middle/South | Pixel | 4 times per 6 hours | n/a | n/a | n/a | **[TBD 8]** | **[TBD 9]** | YES | **[TBD 10]** |
| reduced sub-set of 300 **[TBC 32]** channels or an | L1b | 1/4 disc South | Pixel | 3 times per 6 hours | n/a | n/a | n/a | **[TBD 11]** | **[TBD 12]** | YES | **[TBD 13]** |

| Dataset | Format (1) | Coverage (2) | Resolution (3) | Generation periodicity (4) | EUMETCast periodicity | EUMETCast Africa periodicity | EUMETCast South America periodicity | high rate dissemination periodicity | RMDCN (5) | EUMETSAT Data Centre | Internet (SDDI) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| equivalent number of Principal Components **[TBC 33]** - Zone 1 | | | | | | | | | | | |
| **LIGHTNING SERVICE** | | | | | | | | | | | |
| Lightning event (LE) | L1b | IFOV | Pixel | on event | 10s **[TBC 34]** | | | n/a | **[TBD 14]** | YES | **[TBD 15]** |
| **UVN SOUNDER SCANNING SERVICES** | | | | | | | | | | | |
| sounding radiances (UVN) | L1b **[TBC 35]** | Europe | Pixel | 60mn | n/a | n/a | n/a | n/a | n/a | YES | n/a |
| low resolution sounding radiances (UVN) | L1b **[TBC 36]** | Europe | Pixel | **[TBD 16]** | **[TBD 17]** | | | **[TBD 18]** | **[TBD 19]** | YES | **[TBD 20]** |
| **RETRANSMISSION OF FOREIGN SATELLITE DATA (FSD)** | | | | | | | | | | | |
| As defined in [DISSEMIN] plus growth potential for FSD improved performances. Overall 10 Mbps. | as received | as received | as received | n/a | YES | | | n/a | n/a | n/a **[TBC 37]** | n/a |
| **DCP SERVICE** | | | | | | | | | | | |
| Messages | | Earth disc (5° elevation) | n/a | ad hoc | ad hoc | | | n/a | n/a | NO **[TBC 38]** | YES |
| Bulletins | | Earth disc (5° elevation) | n/a | ad hoc | ad hoc | | | n/a | ad hoc | NO **[TBC 39]** | YES |
| Derived statistical | | n/a | n/a | ? | n/a | n/a | n/a | n/a | n/a | X | X |

| Dataset | Format (1) | Coverage (2) | Resolution (3) | Generation periodicity (4) | EUMETCast periodicity | EUMETCast Africa periodicity | EUMETCast South America periodicity | high rate dissemination periodicity | RMDCN (5) | EUMETSAT Data Centre | Internet (SDDI) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| results | | | | | | | | | | | |
| **Services Messages** | | | | | | | | | | | |
| ADMIN | Ascii | n/a | n/a | 24h | 30mn | 30mn | 30mn | 15mn | n/a | ? | ? |
| NEWS | Ascii | n/a | n/a | ad hoc | once | once | once | once | 24h | ? | ? |
| REG-RPT | Ascii | n/a | n/a | week | 24h | 24h | 24h | 24h | 24h | ? | ? |

**Notes:** (1) BUFR and GRIB2 formats are defined in [WMOcode]. Further information concerning EUMETSAT’s implementation thereof can be found on the EUMETSAT website, navigating thus: ‘Access to Data’ / ‘Meteosat Meteorological Products’ / ‘BUFR & GRIB2’. Both formats include encoded quality control indicators.
**Notes:** (2a) Disc coverage for meteorological products means <65° around SSP .
**Notes:** (2b) Full disc for raw images includes deep space around the earth.
**Notes:** (3) When expressed in km the resolution applies at SSP.
**Notes:** (4) Generation means as available in the EUMETSAT Data Centre. The real-time dissemination frequency of the products may be different from their generation frequency.
**Notes:** (5) The operational practice is that data sets are disseminated hourly at (00:00, 01:00, 02:00, …).

# APPENDIX C DELETED

# APPENDIX D LIST OF TBC

# APPENDIX E LIST OF TBD

# APPENDIX F CONVENTIONS AND TERMS

The following text lists definitions for all *reserved terms* used in this document. It is a subset of the "MTG Conventions and Terms" document. The section numbers below are the original section numbers from this document.

## Annex F.2 MTG Naming Conventions

The MTG space segment elements (MTG *satellites*) are named according to their type and launch sequence

as:

***MTG-I1***

- The first MTG-I *satellite* launched.

***MTG-I2***

- The second MTG-I *satellite* launched.

***MTG-I3***

- The third MTG-I *satellite* launched.

***MTG-I4***

- The fourth MTG-I *satellite* launched.

***MTG-S1***

- The first MTG-S *satellite* launched.

***MTG-S2***

- The second MTG-S *satellite* launched.

***MTG-I***

Any imaging *satellite* of the series (*MTG-I1*, *MTG-I2*, *MTG-I3* or *MTG-I4*).

***MTG-S***

Any sounding *satellite* of the series (*MTG-S1*, *MTG-S2*).

***reserved terms***

It designates the terms defined in the Conventions and Terms document.

## Annex F.3 System Wide Conventions

### Annex F.3.1 Data Definition

***Dataset***

A dataset can be a packet, a subset of *image* (group of related *spatial samples* or lines, *swath*, segment...), *spectral sounding* information, meteorological products, DCP messages or bulletins...

***Housekeeping Telemetry***

Housekeeping telemetry (HKTM) is all the telemetry transmitted through the S-band telemetry link. It corresponds to all the telemetry necessary to monitor the health and status of the satellite.

Note: Data going exclusively via the *payload* telemetry link does not qualify as *housekeeping telemetry*, but may be classed as *instrument auxiliary data* or *platform auxiliary data* or more generally as satellite auxiliary data

***Payload Data***

All the data transmitted via the payload telemetry link. After decryption and extraction of the packets from the frames the payload data is presented as:

- *instrument data*,
- *digitised DCP spectrum*,
- *platform auxiliary data*,
- a copy of the *housekeeping telemetry* (HKTM).

***Instrument data***

For each instrument, the instrument data is composed of:

- *science data* at *level 0*,
- *instrument auxiliary data*.

Note: Compression may apply according to the instrument design.

***Science Data***

The science data is the observation data originating from the instrument(s)/sensors, it applies at any *data level*.

Note: Earth location information is part of associated *auxiliary data*.

***Instrument Auxiliary Data***

Instrument auxiliary data is auxiliary data recording the internal parameters of an instrument as necessary for instrument data processing.

***Digitised DCP Spectrum***

The RF spectrum corresponding to the DCP *satellite* reception bandwidth is digitised on board before being transmitted as packet to the ground.

***Platform Auxiliary Data***

Platform auxiliary data is any *auxiliary data* derived from *platform* equipments that is not transmitted as part of the *housekeeping telemetry*.

Note: Raw data coming from the AOCS is classed as platform auxiliary data, since it cannot be transmitted as part of the HKTM on the S-band telemetry link due to its volume.

***Auxiliary Data***

Auxiliary data is any data that is neither *science data*, *Digitised DCP spectrum* nor *housekeeping telemetry*, used in or generated by *instrument data processing* or *application ground processing*.

Note: See also *instrument auxiliary data*, *platform auxiliary data*, *IDP auxiliary data*, *IQT auxiliary data*, *AGP auxiliary data*...

***IDP Auxiliary Data***

IDP auxiliary data is *auxiliary data* resulting from the Instrument Data Processing.

Note: for example: radiometric and *spectral calibration* information, Earth location information, data derived from external sources and data quality metrics.

***AGP Auxiliary Data***

AGP Auxiliary Data is *auxiliary data* resulting from the application ground processing.

Note: for example: radiometric and *spectral calibration* information, earth location information, data derived from external sources and data quality metrics.

***Disseminated Dataset***

Disseminated Dataset is a grouping of *science data* and *auxiliary data* distributed to the users.

Note: The *disseminated dataset* contains all the information necessary for the user to:

- interpret the *science data* temporally, spatially, spectrally and radiometrically;
- be informed of the quality of the *science data*;
- be informed of the configuration of the processing chain (*satellite*, IDP, AGP).

***Archived Dataset***

As stored in the UMARF archive (e.g. *science data*, *auxiliary data* and *housekeeping telemetry*)

### Annex F.3.2 Operational availability

***Availability***

The availability is ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided. See also *operational availability* and *satellite availability*.

***Outage***

Outages are defined as "the state of an item of being unable to perform its required function or performances". Outages can be *scheduled outage*, *unscheduled outage* or *external outage*.

***satellite availability***

Satellite availability is defined as the percentage of the time during which the *Satellite* provides all the required *payload data*, with the *Quality threshold* being met. All sources of *outages* have to be considered. It has to include the allowance for response from the ground as defined in [OIRD].

***Operational availability***

The ratio of the *datasets* “received” and that meet the *Quality threshold*, with that scheduled to have been “sent” or ”made available", for a given period (removing the part of the period corresponding to the *scheduled outages* and the *external outages*).

Note 1: Implicitly *availability* is a measurement of unscheduled outages due to either space or ground segment problems.

Note 2: By removing the "seasonal effect" (the scheduled outage), the obtained performance can be compared over time to detect any degradation of the service.

Note 3: For the End-users, it is calculated across a complete chain, for example for images, from data acquisition by the Meteosat *satellite* until reception by the User.

Note 4: A *dataset* is "received" if at least one representative user stations / receiver terminals has received it.

Note 5: Unless otherwise specified, the *operational availability* is calculated over a calendar month.

Note 6: The *Scheduled outages* have to be announced to the end-user through the weekly schedule message.

### Annex F.3.2.1 Quality Threshold (Completeness, Accuracy, Timeliness)

***Quality threshold***

The Quality threshold is met when the requirements on *Completeness*, *Accuracy* and *Timeliness* are fulfilled.

Note: This implies that a short *outage* preventing a *repeat cycle* to be completed on time has to be considered as an *outage* of the whole *repeat cycle*.

***Completeness***

A *dataset* is complete if no data has been lost since its generation, unless a requirement in the product specification or service specification allows some losses (e.g. *missing samples*).

Note: service specification only applies at system and ground segment level, not at satellite level. Product is used in the sense of the ECSS.

***Accuracy***

The requirements on accuracy are *dataset* specific and provided in the product specification or service specification.

***Timeliness***

The timeliness is the time difference between the foreseen end of acquisition of the last contributing data (e.g. from a sample, a *dwell*, a *swath*, a segment, an *image*, a file) by EUMETSAT (at *satellite* level for Meteosat, Metop or at Ground Segment level for external data like FSD and SAF), and the end of reception of the corresponding data (possibly processed) by the users (i.e. before decryption and decompression).

Note: It excludes delay introduced by transmission lines and networks outside EUMETSAT control (e.g. internet, RMDCN, GTS, WIS). It excludes also the processing time outside EUMETSAT control (e.g. SAF processing time).

### Annex F.3.2.2 Scheduled Outages

***Scheduled Outage***

The scheduled outages are due to planned operations or predictable events. At satellite level the specification limits these outages to 3% per year. Other scheduled outages are mainly due to planned ground segment maintenance and should be less than 0.5%.

The quality of around 5% of the acquired <datasets> per year maybe degraded for some channels during eclipse seasons.

The tentative list hereafter identifies the events leading to the outage or quality degradation and attempts to estimate their individual duration.

Planned operations or predictable events:

- Satellite orbit manoeuvres (e.g. Station Keeping) leading to a disturbance of the satellite attitude. The frequency of the outages depends on several parameters such as orbital position, satellite collocation strategy, satellite design, manoeuvre strategy. There can be up to a few tens of manoeuvres per year with the outage lasting up to three hours each time.
- Satellite *yaw-flip* leading to re-orientation of the satellite attitude and consequently to an interruption of the mission. This occurs twice a year and with the outage lasting up to half a day each time.
- Instrument decontamination requires that the Infrared sensors are switched off, thus interrupting the imaging in these channels. The decontamination may also require interrupting/degrading the other channels (due to distortions introduced by the IR decontamination). Outage is typically one day once or twice per year, influence on other channels will be re-assessed once the satellite supplier / design is known.
- Outage due to preventive maintenance (e.g. wheel off-loading manoeuvres). Frequency and duration will be refined once the platform supplier / design is known.
- Sun, *satellite*, ground station co-linearity effect. When the Sun enters the main lobe of the ground station antenna, this may prevent the proper reception of the Ka-Band link. The co-linearity occurs twice a year around the Equinox seasons for around 10 days, impacting a few *repeat cycles* per day. The extend of the co-linearity effect will be re-assessed once the MDA sites and characteristics are known.
- The swap of a mission from one *satellite* to another (e.g. after the completion of *satellite commissioning* when the operational missions are transferred to a new *satellite*) will result in an *outage* of a few hours.
- The temporary swap of the full disc scanning service (FDSS) from the prime to the secondary imaging *satellite* and vice versa would result in an outage of a few hours on the FCI-FDSS at each swap and an *outage* of the Rapid Scanning Service (FCI-RSS) for the whole duration of the swap (e.g. during prime *satellite* decontamination, yaw flip manoeuvre).
- Some ground segment maintenance may not be achievable without service interruption (e.g. to swap between a prime and redundant service). These interruptions are sporadic over the year and there exact duration depends on the *dataset* disseminated and maintenance activity performed.

Other images quality degradation:

- During the *eclipse* season the *dataset* quality will be degraded for some channels and/or a part of the coverage, however no interruption of the *dataset* acquisition and dissemination is foreseen. The quality degradation around the *eclipse* is primarily due to *stray light* and thermal effects. The degradation occurs typically for a few hours around midnight. There are 2 eclipse seasons per year, each lasting 42 days. The exact influence of the *stray light* on the *dataset* will be characterised in orbit, although the period of affected data will be predicted from on-ground analysis.

#### Annex F.3.2.3 Unscheduled Outages

***Unscheduled Outage***

This gathers all the unscheduled outages, thus a precise list cannot be made. The most common causes for the unscheduled outages are:

- Ground segment reconfiguration may cause outages, however such maintenance activities are normally scheduled in advance.
- Loss of communication links (e.g. between ground stations and headquarters).
- *Satellite* single event upset (SEU)
- *satellite* safe mode
- random failures
- any disasters or major events outside EUMETSAT's control.

#### Annex F.3.2.4 Outages outside EUMETSAT control

***External outage***

This term groups all the outages outside EUMETSAT control, thus a precise list cannot be made. The most common causes for the outages outside the control of EUMETSAT are:

- Networks outside EUMETSAT responsibility (e.g. RMDCN, GTS and Internet).
- External data unavailability (e.g. Meteorological Data Dissemination (MDD), Foreign Satellite Data (FSD), incoming forecast data...).
- Effect of lack of redundancy of the space segment (i.e. only one *satellite* in orbit).
- Unavailability of DCP beacons and SAR beacons, or those working outside specification.

### Annex F.3.3 System wide relevant

***Reliability***

The reliability of a system or function is defined as the probability that this system or function can perform as required for its specified mission duration. The figures are independent of *availability* figures (see definitions below). The figures assume that the subsystem or function is operating nominally at the beginning of the mission.

### Annex F.3.4 Space Segment related

***Satellite***

The word Satellite is used within MTG system to define a complete self standing subset of the MTG space segment, including *Platform* and *Payload* (observational instruments), all *Platform* and *Payload* supporting functionalities, and the interfaces to the external environment. Two types of *'satellite'* are foreseen in the MTG system, the MTQ-I and the MTG-S.

***Platform***

The part of the *satellite* excluding the *payload*. The '*platform*' provides all the resources, functionalities and performances necessary to support the nominal and contingency operation of the *payload*.

***Payload***

The parts of the *satellite* used to acquire the data that will generate the mission products.

Note: For MTG the payload comprises FCI, IRS, LI, UVN, DCP and SAR when embarked on their respective *satellites*.

***Yaw-flip***

Satellite manoeuvre around the yaw direction for allowing better thermal environment of the satellite. For an Earth Observation geostationary satellite, the yaw flip consists of rotating the satellite by $180^0$ around the yaw axis.

Note: It occurs twice a year around the solar equinoxes to ensure that there is no sun illumination on the spacecraft side where the *payload* radiators are accommodated.

***Ranging***

Orbit determination of a spacecraft requires as input measurements that are related to the *satellite*'s position and velocity.

The classical two-way radar ranging employs a ranging signal that is radiated from the ground station to the *satellite*. A *satellite* transponder is required to receive the signal and to transmit it back to the ground station. The ground station receives the transponder ranging signal from the *satellite* and determines the signal travel time T. This is expressed as an equivalent range value R= 1/2 cT, which is equal to the average of the uplink and downlink distance.

There are basically two different techniques, see Figure 1, to generate ranging signals:

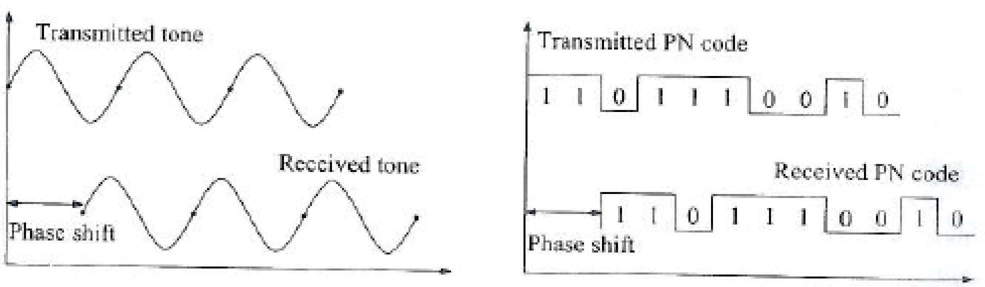


***Figure 1: Principle of distance measurements using tone ranging (left) and code ranging (right)***

***Nominal longitude range***

On the geostationary arc, with a longitude anywhere between 10°W and 10°E.

Note: This value is defined in the SRD requirement SYS-00630

### Annex F.3.5 Lifetime

***satellite specified lifetime***

Each *satellite* is specified for an in-orbit lifetime (including *commissioning*) with a given calculated *reliability*.

***Satellite nominal operational lifetime***

The satellite nominal operational lifetime is defined as the time in orbit over which the performances have to be met with a given *satellite availability* and excluding the time necessary for the execution of LEOP and *satellite commissioning* (see Figure 2).

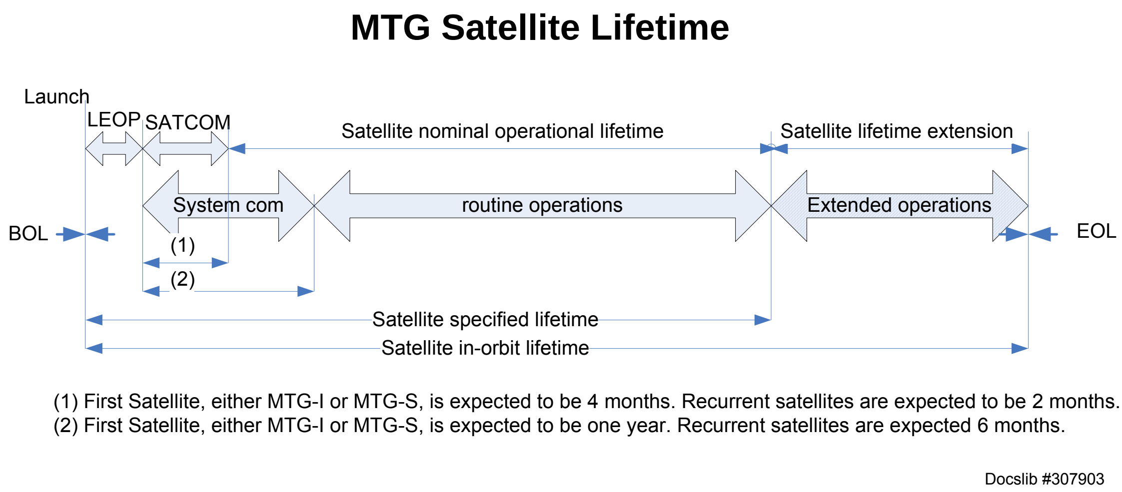



***Figure 2: Definitions of on-ground and in-orbit lifetime are defined for MTG***

### Annex F.3.6 Ground Segment related

***Application Ground Processing***

Relates to the process to transform *Level 1 science data* into *Level 2 science data* using *auxiliary data*; the output includes the *AGP auxiliary data*. It can be centralised (MPEF-**[TBC 40]**) or decentralised (SAF).

***Data Centre***

Multi-Programme facility used for repository of *archived dataset*. Previously called UMARF

***EUMETSAT Data Centre***

see *Data Centre*

### Annex F.3.7 Process relevant

***Commissioning***

Verification and validation activities conducted after the launch and before the entry in operational service either on the space elements only or on the overall system (including the ground elements).

***System commissioning***

*Commissioning* of the overall system terminating with the closure of the System Commissioning Results Review (SCRR).

***Validation***

Confirmation, through the provision of objective evidence that the requirements for a specific intended use or application have been fulfilled.

Note: See also ECSS-P-001.

***Verification***

Confirmation through the provision of objective evidence that specified requirements have been fulfilled.

Note: See also ECSS-P-001.

## Annex F.4 Observation Missions Conventions

### Annex F.4.1 General

***Centroid***

The centroid is the generalized mathematical expression for quantities used in science and engineering such as centre of gravity, centre of mass and barycentre. The *centroid* of a function of N independent variables is the intersection of all hyperplanes that divide the function into two parts of equal moment. The co-ordinates of the centroid in terms of the independent variables is given by the equation:

$$\bar{x}_i = \frac{\int ... \int x_i . f(x_1,...,x_N) dx_1 ... dx_N}{\int ... \int f(x_1,...,x_N) dx_1 ... dx_N}$$

where

$\bar{x}_i$ is the centroid co-coordinate for independent variable $x_i$

$x_i$ is the independent variable, with $1 \le i \le N$

$f(x_1,\ldots,x_N)$ is the dependent function

For example the *centroid* of a function with two independent variables is given by the equation:

$$\bar{x} = \frac{\iint x.f(x,y)dxdy}{\iint f(x,y)dxdy}$$

$$\bar{y} = \frac{\iint y.f(x,y)dxdy}{\iint f(x,y)dxdy}$$

where

$\bar{x}$ , $\bar{y}$ are the centroid co-ordinates

*x, y* are the independent variables

*f(x,y)* is the dependent function

***Data Level***

Data levels are used to describe the condition of the *science data* at various points in the ground processing cycle. The WMO lists the following data levels on their web site:

*Level 0 - Raw data.*

*Level 1 - Data extracted by instrument, at full instrument pixel resolution, with Earth-location and calibration information.*

*Level 2 - Geophysical value (temperature, humidity, radiative flux…) at instrument pixel resolution.*

*Level 3 - Remapped (gridded) product based on geophysical value derived at instrument pixel resolution.*

*Level 4 - Composite product (multisource) or result of model analysis of lower level data.*

For MTG the basic sense of WMO data levels is maintained, without the concept that the *science data* has to be at instrument *pixel* resolution. However, the WMO data sub-levels are not used. Enhancements of the data level definitions are given in the definitions of *level 0*, *level 1* data.

***Level 0***

Level 0 data is the *science data* at packet level, after restoration of the packet-wise chronological data sequence for a given instrument.

***Level 1***

Level 1 describes, for a given instrument, a variety of different data sub-levels that are related to instrument data processing, refer also *level 1a*, *level 1b*, *level 1c*.

Note 1: Not all of the sub-levels will appear as an externally available *dataset* for each instrument and may remain internal to the instrument data processing process or not be generated.

Note 2: Earth-location and calibration information are treated as part of the *IDP auxiliary data* that will be disseminated and archived with the *level 1* data.

Note 3: A *radiance sample* appearing at *level 1b* can represent a measurement taken from an individual *detector element* or a combination of measurements derived from a group of *detector elements*. At *level 1b radiance samples* are associated with a particular *spatial sample*. The *spatial samples* may then be rectified to form *pixels* located at fixed positions in the *reference grid* giving the *level 1c* data.

***Level 1a***

Level 1a data is *level 0 science data* in counts after removal from the packets, whilst maintaining the spatio-temporal sequencing of the data.

***Level 1b***

Level 1b data is *level 1a science data* radiometrically and spectrally calibrated.

***Level 1c***

Level 1c data is *level 1b science data* rectified to a *reference grid*.

***Level 2***

Level 2 relates to *level 1b* or *level 1c science data* converted to geophysical values (temperature, humidity, radiative flux…) during *application ground processing*.

***Level 3***

Remapped (gridded) *Level 2* based on geophysical value derived at *pixel* resolution.

***Level 4***

Composite *Level 2* product (multi-source) or result of model analysis of lower level data.

***Spatial Sampling Distance***

The spatial sampling distance is the required *spatial sample* spacing and is used as a base unit against which geometric requirements are assessed. All requirements expressed in spatial sampling distance are taken to apply at the *sub-satellite point* and can be translated to a *spatial sampling angle* used to evaluate the requirement at all other positions in the area of *coverage*.

***Spatial Sampling Angle***

The angle subtended by the *spatial sampling distance* at the *Sub-Satellite Point* as seen from the *satellite*.

***Sub-Satellite Point***

The sub-satellite point (SSP) is the intersection by the line drawn from the satellite to the centre of the Earth with the surface of the Earth's Reference Ellipsoid.

***Geocentric Nadir***

The geocentric nadir is the direction from a point external to Earth's Reference Ellipsoid toward the centre of the Earth. When the point is located at the centre of mass of a *satellite* this direction points toward the *Sub-Satellite Point*.

***Geodetic Nadir***

The geodetic nadir is the direction of a line normal to the Earth's Reference Ellipsoid starting from a point external to the Earth's Reference Ellipsoid.

***Nadir***

This term should not be used, EUMETAT documents should always refer to *geocentric nadir* or *geodetic nadir*.

***Reference Grid***

The reference grid defines the geo-referenced position of the *image pixel centroids* at *level 1c*.

The grid angles are defined, in terms of the *Normalized Geostationary Projection*, as follows:

- Rotation about the axis $S_3$ ($\lambda_S$);

- Rotation about the axis $S_2$' ($\varphi_S$), where $S_2$' lies in the $S_1/S_2$ plane at an angle $\lambda_S$ from $S_2$ about the $S_3$ axis.

The grid steps are equiangular both in $\lambda_S$ and $\varphi_S$ and equal to the *spatial sampling angle* of the considered channel, Figure 3. The corresponding projected distance a the *sub-satellite point* is the *spatial sampling distance*.

For reference grids of differing resolutions the grids are aligned as given in Figure 4 i.e. the fine grid *pixel* centres are offset by half the smaller *spatial sampling angle* from the coarse grid *pixel* centres in both $\lambda_S$ and $\varphi_S$.

See Figure 5.

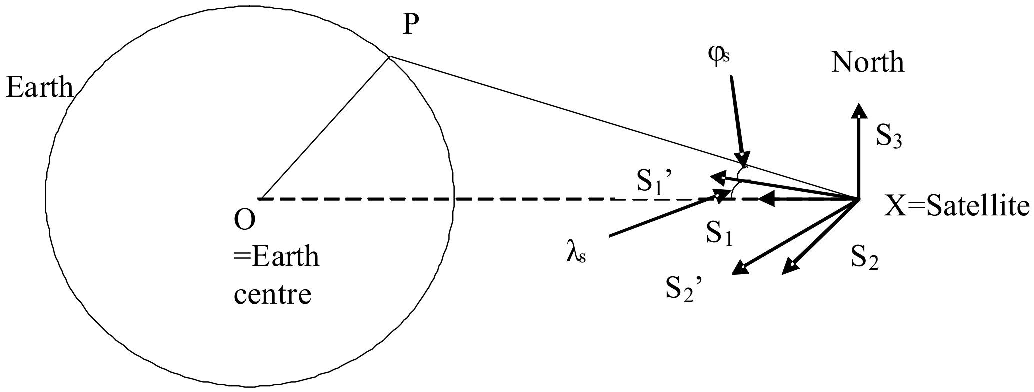



***Figure 3: Angular Definition of the Reference Grid***

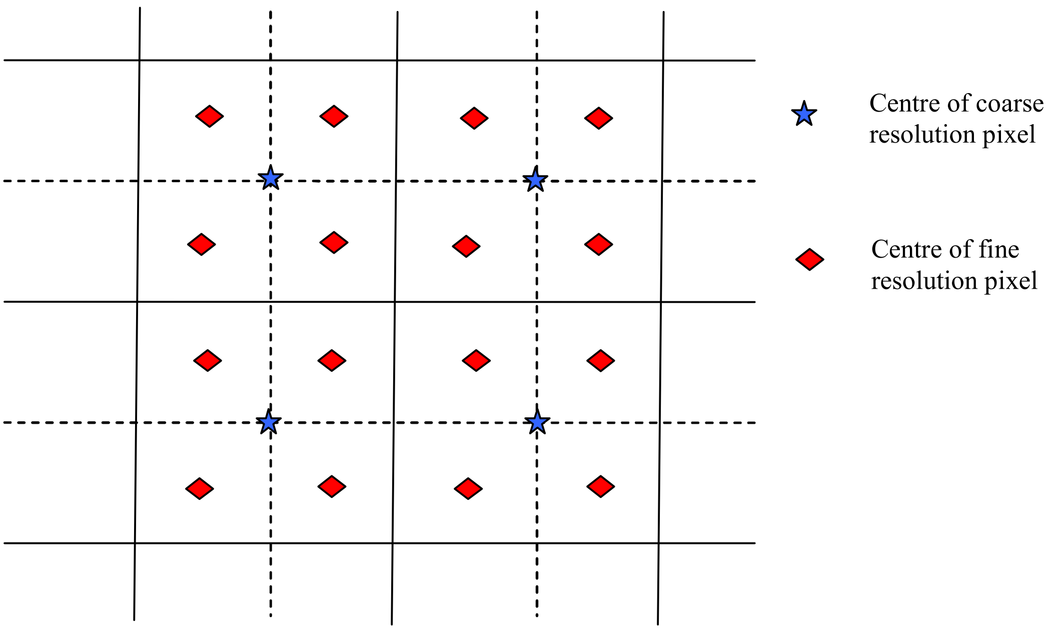



***Figure 4: Alignment of Reference Grids of Differing Resolutions***

### *Target Grid*

The Target Grid is the set of *spatial samples* defined by the scan strategy for an unperturbed spacecraft at a fixed geostationary position. The points are defined using the same projection as the *reference grid*.

Note: See Figure 5.

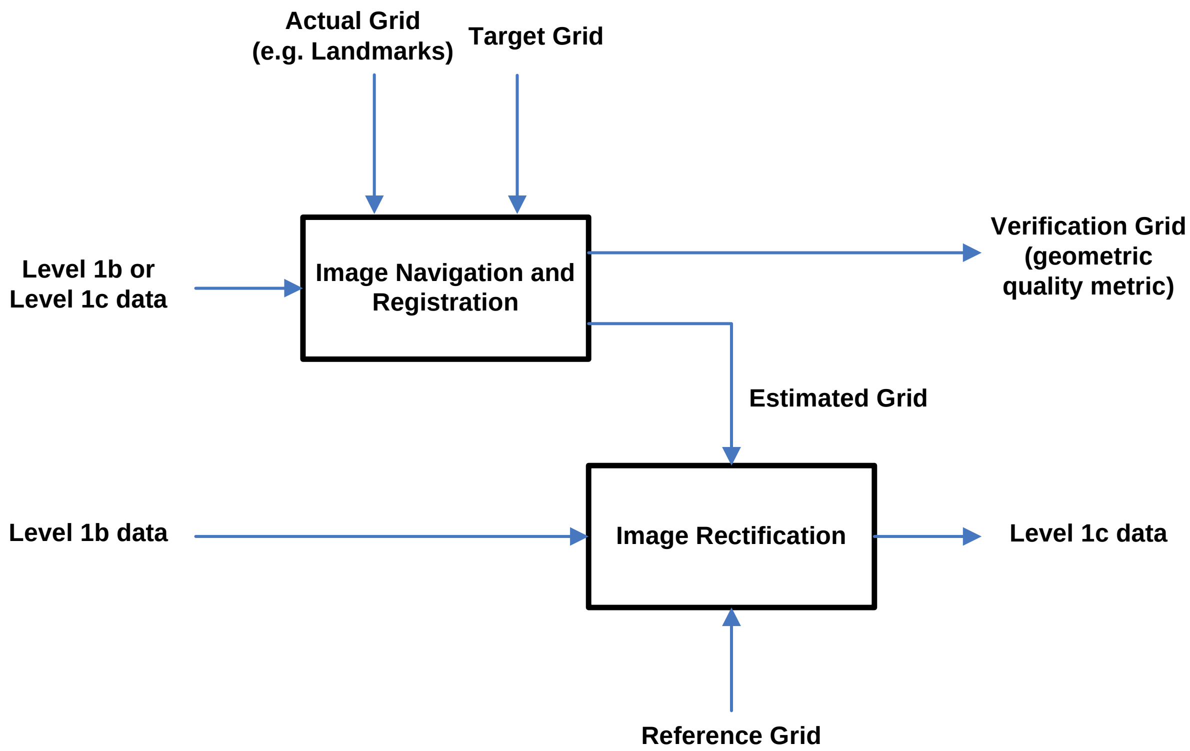



***Figure 5: Relationship between data grids***

### *Estimated Grid*

The estimated grid is the set of *spatial samples* defined as an outcome of the *image navigation* process, i.e. each *spatial sample*'s location in space as a result of the *image navigation* process. The points are defined using the same projection as the *reference grid*.

See Figure 5.

### *Verification Grid*

The verification grid is the set of *spatial samples* used for *image navigation* verification in conjunction with the *estimated grid*. The points are defined using the same projection as the *reference grid*.

See Figure 5.

***Actual Grid***

The actual grid is the set of *spatial samples* given by the actual scan, orbit and attitude. The points are defined using the same projection as the *reference grid*.

See Figure 5.

***Geometric Deformation Grid***

The difference between *estimated grid* and *reference grid*, used for the rectification process

## Annex F.4.2 Data Acquisition and Generation

***Image***

An image is defined as the set of *radiance samples* acquired in a *repeat cycle*, associated with a single *spectral channel* and

- at *level 1c*: with all the points (*pixels*) of the *reference grid* that are included in the area of *coverage*;
- at *level 1a* and 1b: with all the points (*spatial samples*) of the *actual grid* that are included in the area of *coverage*.

***Imagette***

An imagette is defined as a fraction of an *image*.

***Coverage***

Coverage is defined as the region over which *science data* is collected.

***Full Disc Coverage***

Full Disc Coverage (FDC) is defined as the maximum area of *coverage* required from an instrument, particularly if this involves the complete *coverage* of the Earth disc.

***Local Area Coverage***

Local Area Coverage (LAC) is defined as a sub-area of *full disc coverage*.

***LAC Zone***

A LAC zone is defined as an area of *coverage* meeting the LAC requirements. In cases where more than one LAC zone are in use the LAC zones should be numbered from south to north starting from 1; see Figure 6 and Figure 7.

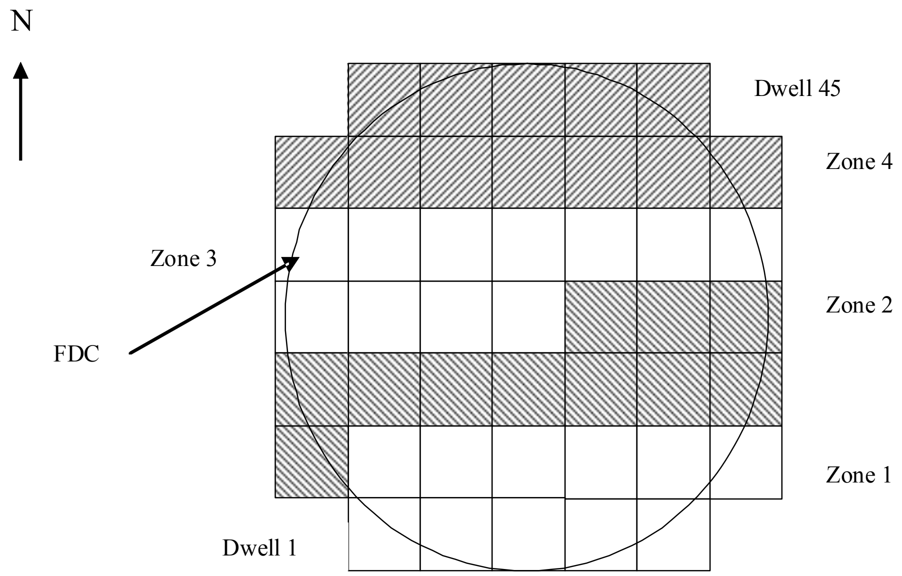



***Figure 6: Illustration of LAC zone numbering for the IRS***

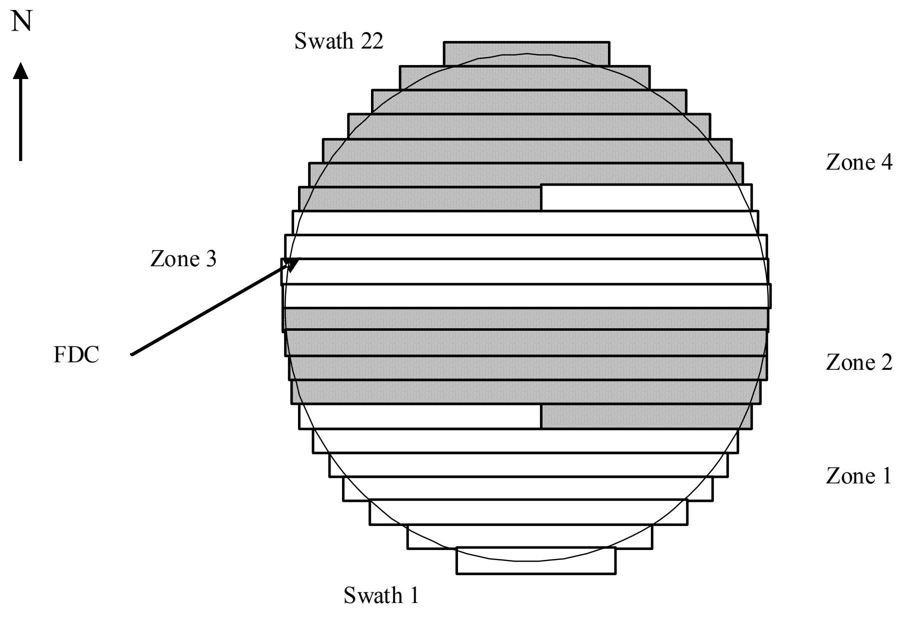



***Figure 7: Illustration of LAC zone numbering for the FCI***

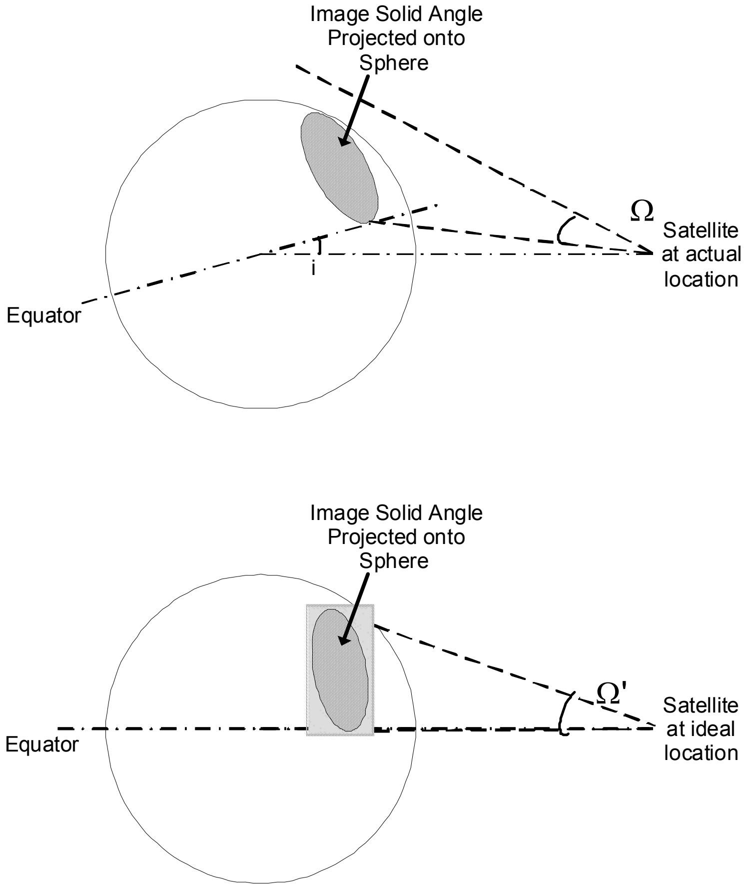



***Figure 8: Illustration of the derivation of the image solid angle for LAC Clipping calculation***

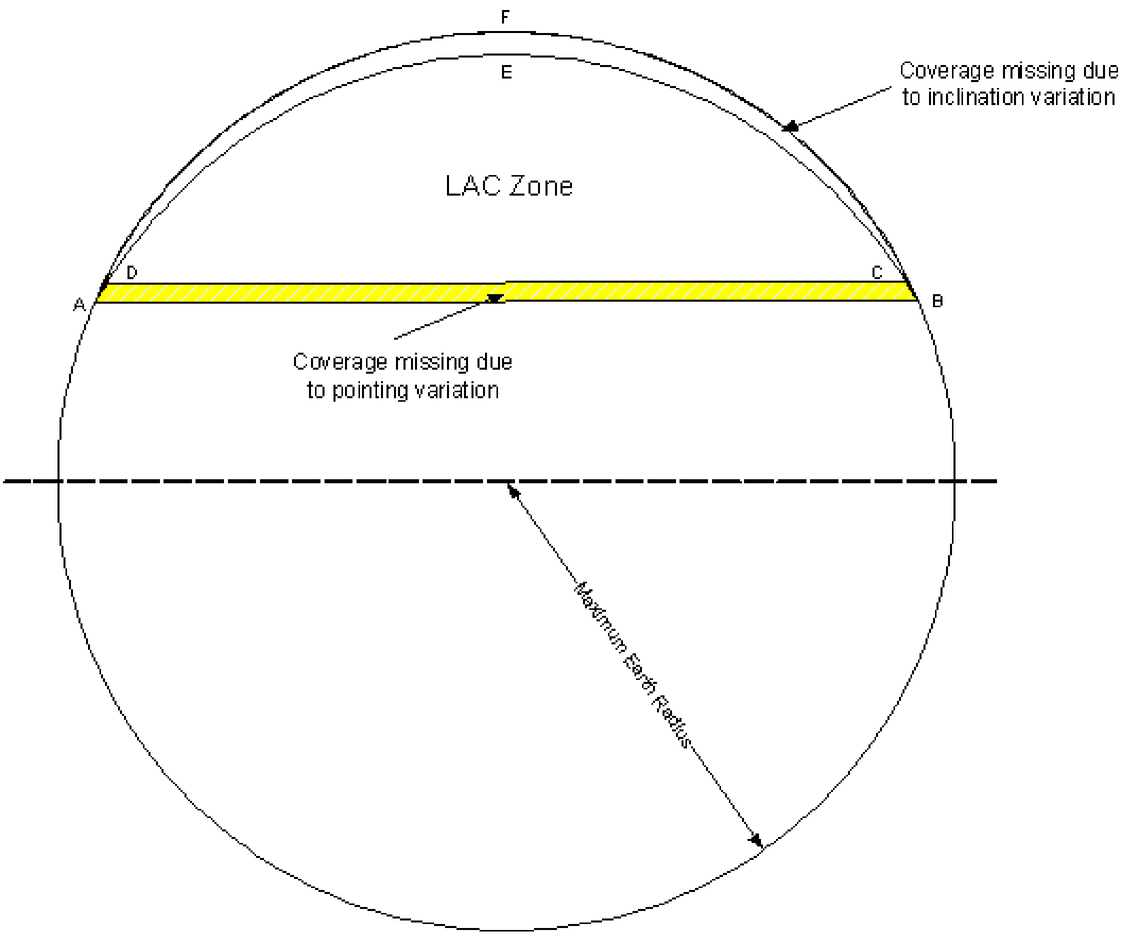



***Figure 9: Illustration of areas of LAC missing due to pointing and inclination variation***

***Dwell***

A dwell is the time period and area over which the sounder gathers simultaneously a group of *spectral soundings* and has properties of *dwell time* and *dwell coverage*. The dwells within a *LAC zone* are numbered in the order of acquisition starting from 1; see Figure 10.

Synonyms: Stare

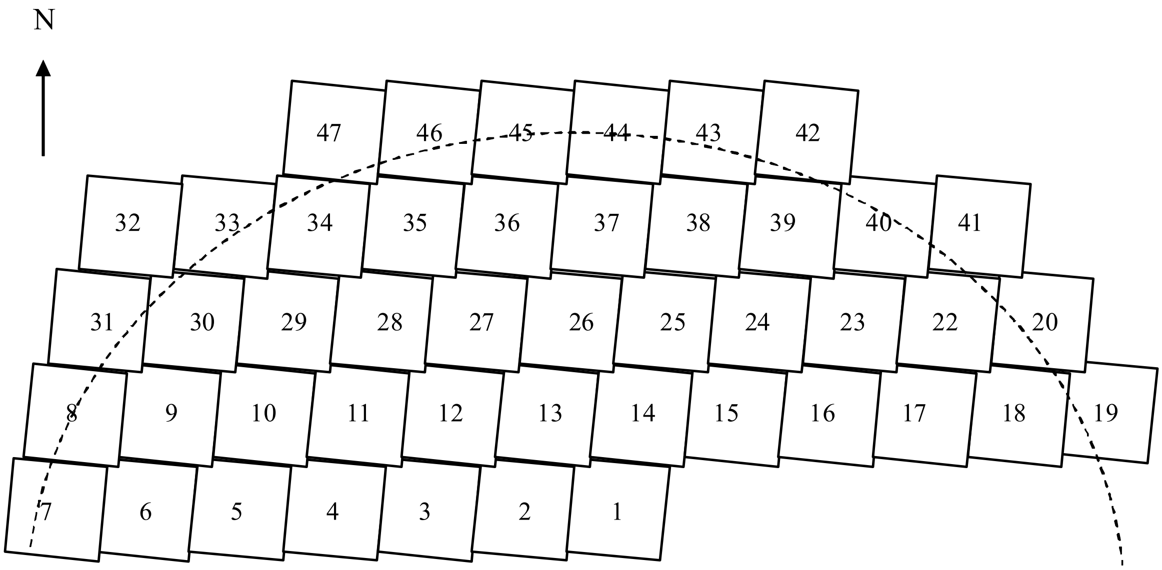



***Figure 10: Illustration of dwell numbering within a* LAC zone**

### *Dwell Coverage*

Dwell coverage is the area covered by all *spatial samples* of the *spectral soundings* collected during the same acquisition time.

### *Dwell Time*

The dwell time is the time period required to collect an interferogramme (from which are deduced all spectral samples).

### *Swath*

A swath is defined as the area covered by the *spatial samples* collected during a single east to west or west to east scan of a scanning instrument.  The swaths are numbered from south to north staring from 1; see Figure 11.

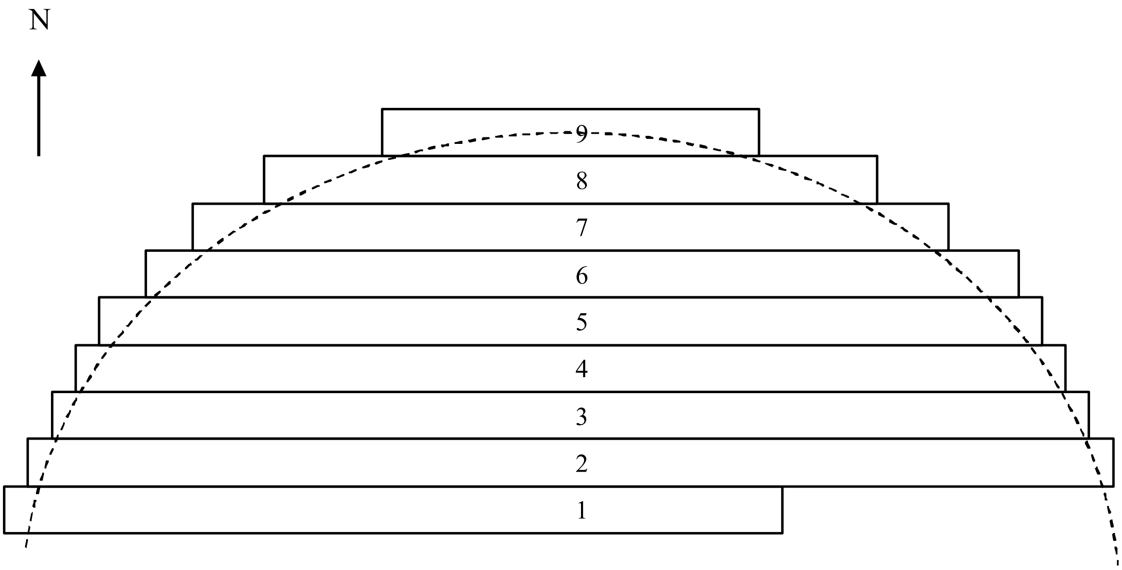



***Figure 11: Illustration of swath numbering***

***Row***

A row is defined as a line of *spatial samples* or *pixels* running in a (nominal) East to West and West to East direction. The rows are numbered from the south to north starting from 1. The term row can be applied to *dwells*, *swaths* or rectified *images*; see Figure 12, Figure 13 and Figure 14.

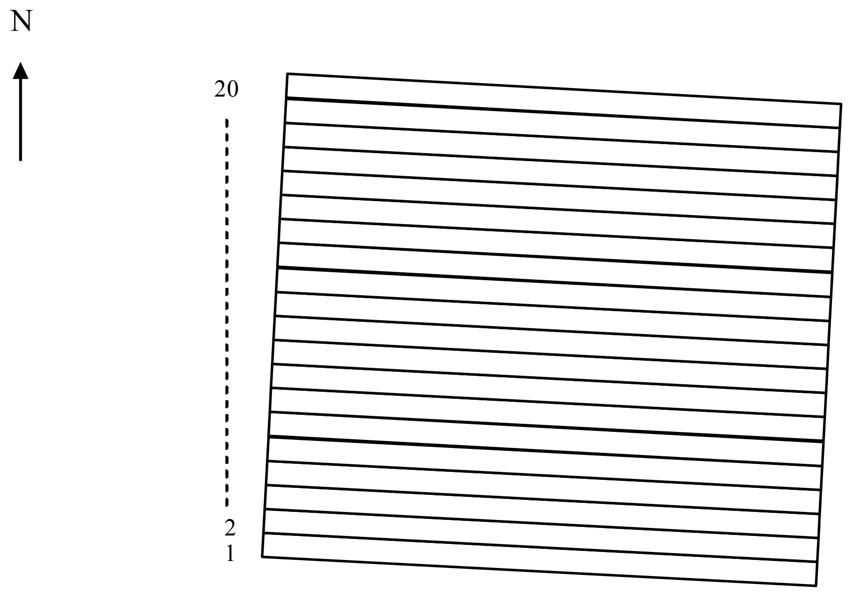



***Figure 12: Illustration of row numbering within a*** **dwell**

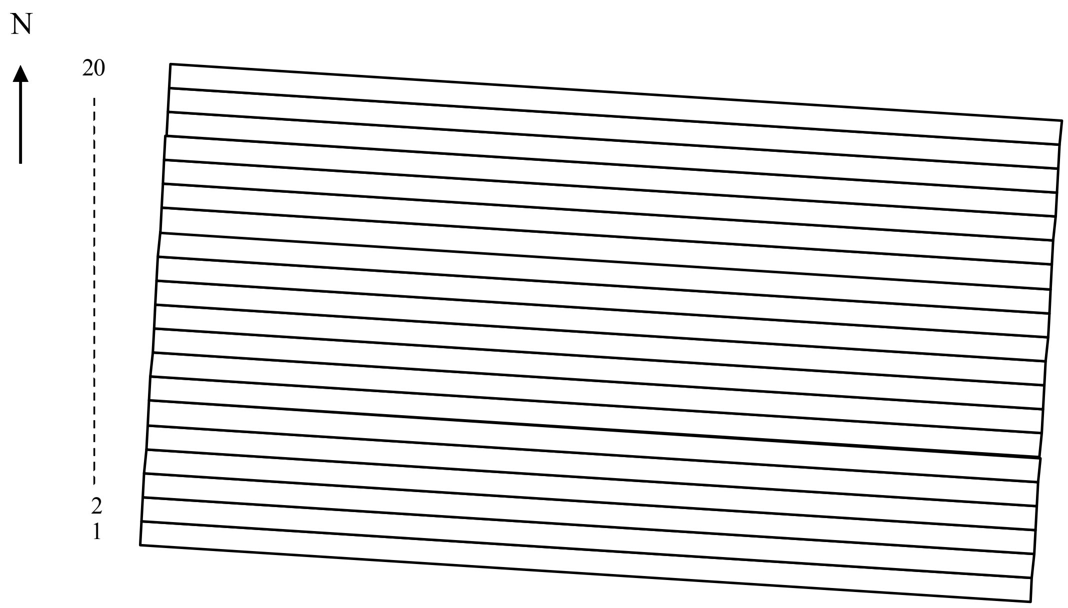



***Figure 13: Illustration of row numbering within a*** **swath**

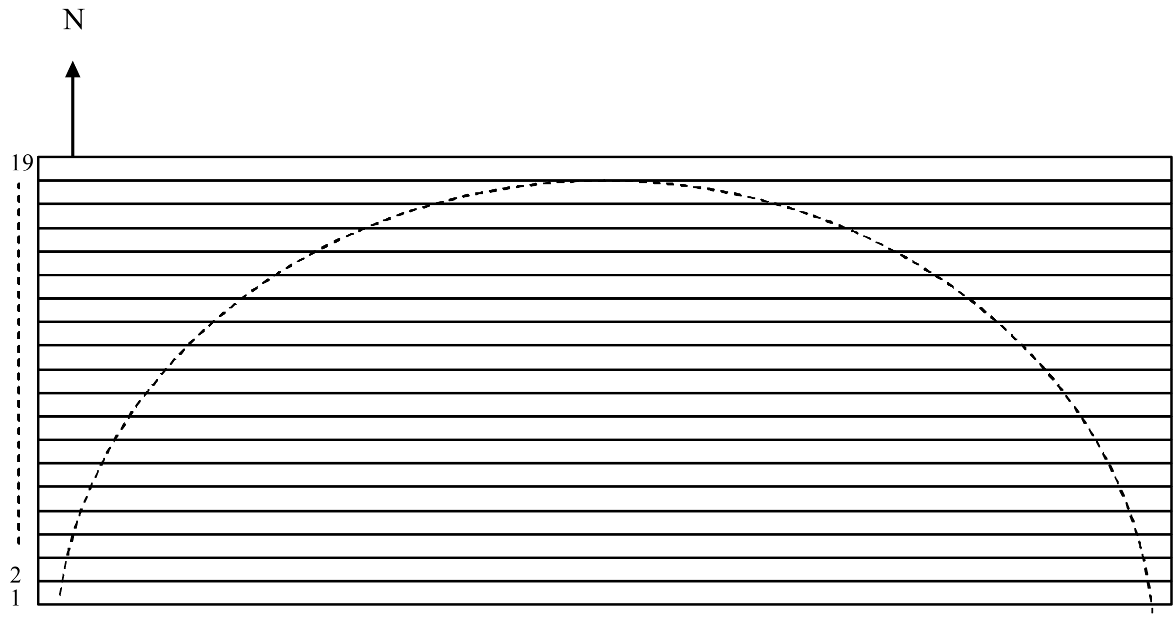



***Figure 14: Illustration of row numbering within a rectified*** **image**

***Column***

A column is defined a line of *spatial samples* or *pixels* running in a (nominal) South to North direction. The columns are numbered from the west to east starting from 1. The term column can be applied to *dwells*, *swaths* or rectified *images*; see Figure 15, Figure 16 and Figure 17.

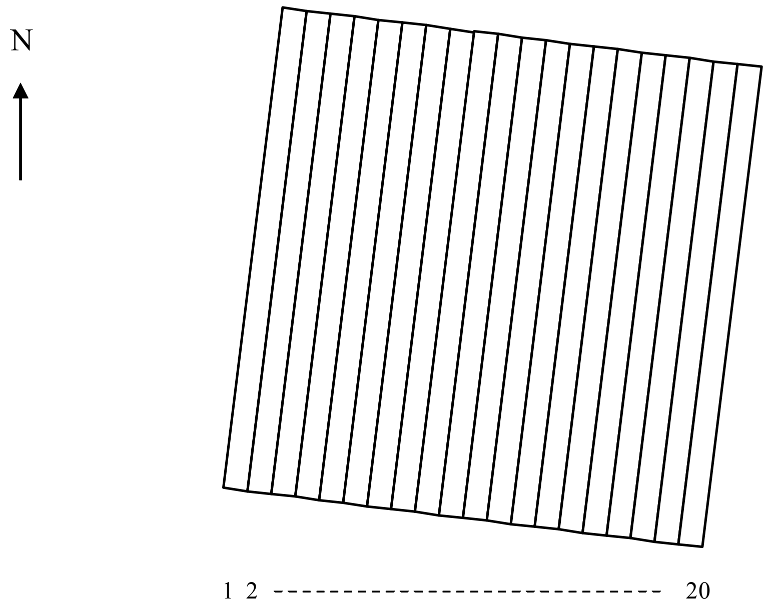



***Figure 15: Illustration of column numbering within a* dwell**

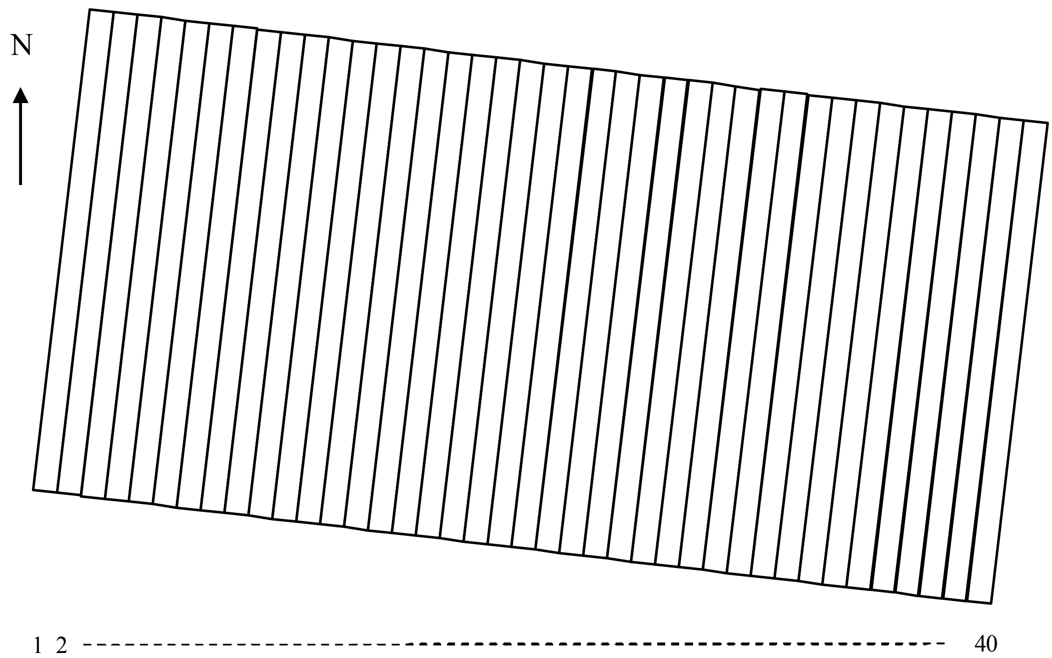



***Figure 16: Illustration of column numbering within a* swath**

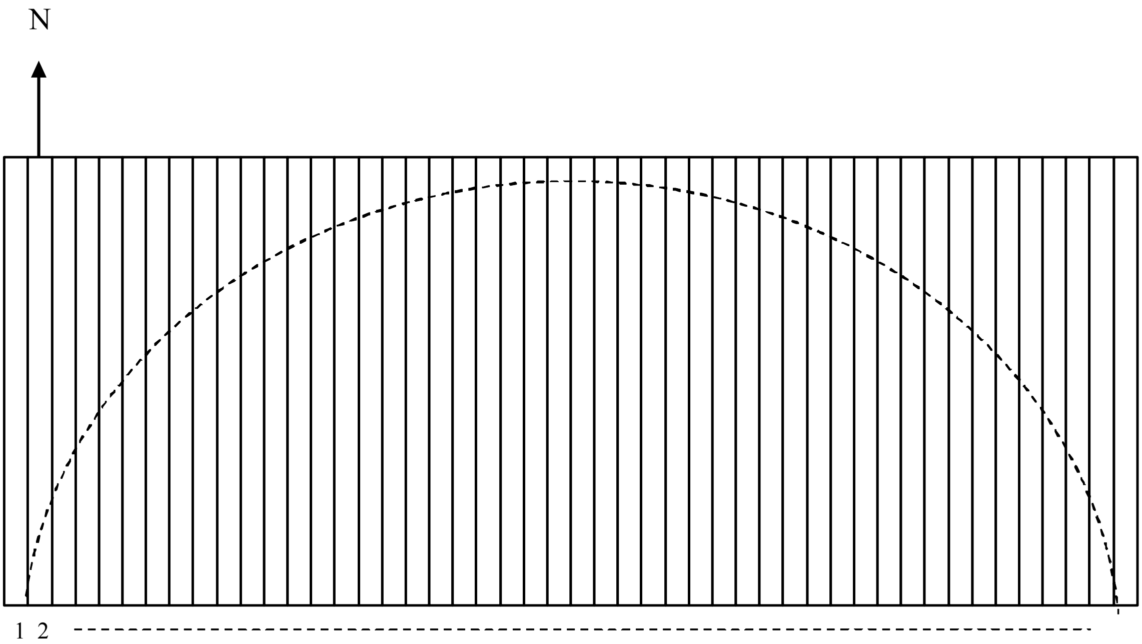



***Figure 17: Illustration of column numbering within a rectified*** **image**

***Repeat Cycle***

For the FCI: The repeat cycle is defined as the time elapsed between the start of two consecutive sets of *images* taken in all *spectral channels* covering the same defined *coverage*.

For the IRS: The repeat cycle is defined as the time elapsed between the start of the data acquisition for two consecutive *LAC zones*.

For the LI: The repeat cycle is defined as the time elapsed between the start of the data acquisition for two consecutive *LI background radiance images*.

***Detector Element***

A detector element is a single measurement device that, together with others with similar characteristics, makes up a *detector array*. The detector element responds to incoming radiation to produce a signal that can be converted from an analogue to a digital format.

***Detector Array***

A detector array is a collection of *detector elements*. It may be linear or two dimensional.

***Lightning Optical Pulse***

A lightning optical pulse is produced by an electric discharge within or below a cloud, where the optical radiation is emitted from the hot lightning channel. The lightning pulse duration is on the order of 50 μs and the released photons are transported to the cloud surfaces by scattering. The resulting lightning optical signal to be observed at the cloud top has a pulse duration delayed and widened in time to about 600 µs, distributed over an enlarged area of a minimum of about 100 $km^2$ up to a maximum area of about 10.000 $km^2$ depending on the number of scattering processes involved. The spectral and temporal characteristics are illustrated in Figure 18.

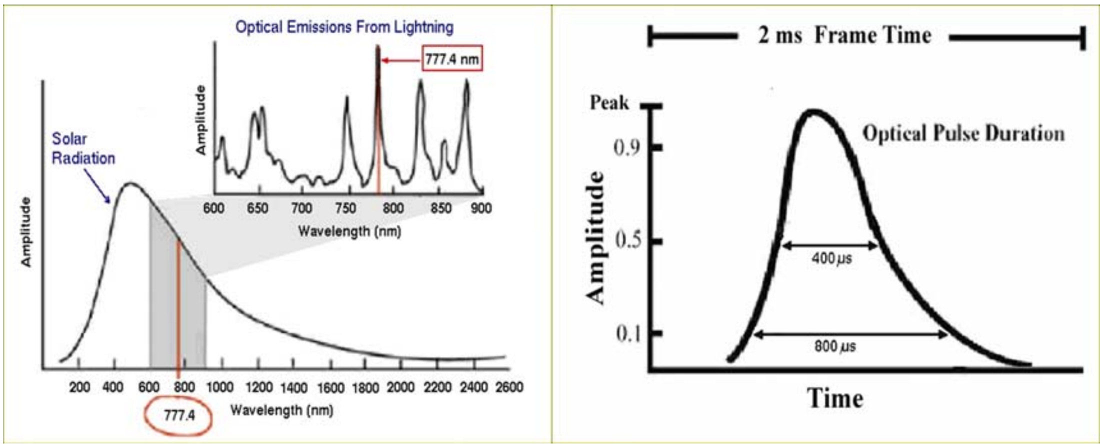



***Figure 18: Optical emission from lightning and lightning pulse duration***

***Lightning Pulse***

Synonym for *Lightning Optical Pulse*

***Lightning Flash***

Lightning flashes are composed of multiples of cloud discharges causing *lightning optical pulses* grouped by proximity in location over a flash duration.

The total flash duration is typically between 1 and 1.5 seconds, where the individual cloud discharges are typically separated by about 50 ms.

## Annex F.4.4 Spectral

***Wavenumber***

Wavenumber, ν, is defined as the reciprocal of the spectral wavelength.

$$\nu = \frac{1}{\lambda}$$

Note: In this definition the symbol ν is used in place of the symbol σ used in ISO 31-6-4:1992(E)

***Spectral Variable***

The spectral variable, ξ, is any quantity used to represent the frequency behaviour of a monochromatic wave. The spectral variable can be a spectral frequency, wavelength or *wavenumber*. The term spectral variable will be used in all the statements that are applicable to any one of the above mentioned quantities.

### *Spectral Range*

The spectral range is defined as the complete spectral domain over which the instrument is able to produce calibrated measurements. The spectral domain may or may not be contiguous (continuous, with its parts in uninterrupted contact).

### *Spectral Band*

A spectral band is a subset of the *spectral range* of an instrument that has associated common properties and is contiguous. For example the IRS has two spectral bands MWIR and LWIR.

### *Spectral Channel*

A spectral channel is the smallest spectral interval measured by an instrument. A *spectral band* is formed by a set of contiguous spectral channels.

For the FCI: A spectral channel is characterised by a set of *spectral response functions* per *spatial sample* that comply with the *spectral response* template for that spectral channel.

For the IRS: A spectral channel is defined after *spectral resampling* of the measured *spectral samples* to a discrete spectral positions separated according to the *spectral channel interval* within the *spectral band*.

The spectral channel, identified by the index k, has an associated *spectral variable*, $\xi_k$, where this location corresponds to the position of its *spectral response function centroid*.

See also *radiance sample*.

### *Radiance Sample*

A radiance sample is an *effective radiance* measured by the instrument at a specific spatial and spectral location, see Figure 19. The radiance sample has spatial properties of spatial location ($x_i$,$y_j$) and shape (*point spread function*). Together the spatial properties are referred to as the *spatial sample* or *pixel* depending on whether the radiance sample has been located on the *estimated grid* or the *reference grid* respectively. Likewise the radiance sample has spectral properties of spectral location ($\xi_k$) and shape (*spectral response function*). Together the spectral properties are referred to as the *spectral sample* or *spectral channel* depending on whether the radiance sample is located according to a reference spectral location and *spectral response function*. The *point spread function* and *spectral response function* are related to the *instrument response function*.

For the FCI: The *spectral channel* is fixed by the optical and *detector element* spectral filtering characteristics. Thus for each *spatial sample* of a *spectral channel* a single radiance sample is measured. The *spatial samples* are rectified to the *reference grid* to form *pixels*, again each with their associated radiance sample.

For the IRS: A *spectral sounding* is taken at a location given by the *spatial sample*. Once the *spectral sounding* interferogram has been Fourier transformed to the spectral domain a series of *spectral samples* are obtained, each with its own radiance sample. The *spectral samples* are then subject to *spectral resampling* to fixed spectral locations and *spectral response functions* to form *spectral channels*, again each with their associated radiance sample.

For the LI: A single *spectral channel* is defined, thus each *spatial sample* has an associated radiance sample.

Note: In the case of the IRS the PSF of the *spatial sample* will vary with the *spectral sample* or *spectral channel*, although the nominal location will be the same across the *spectral variable* range.

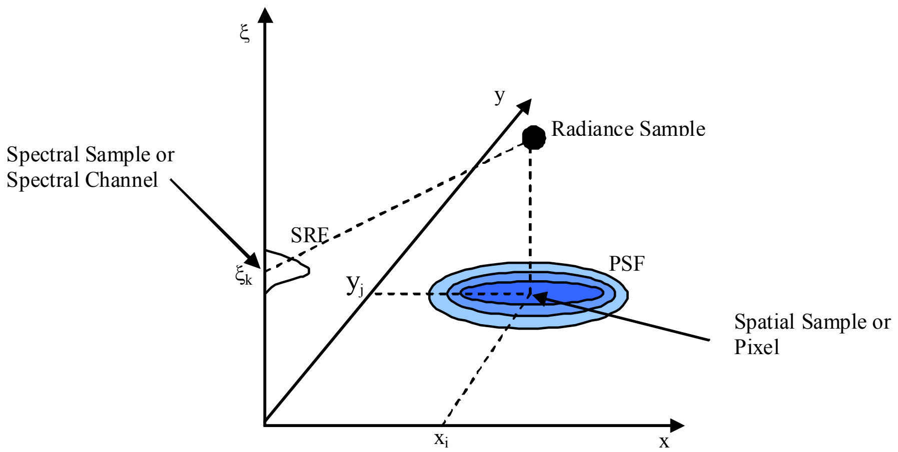



***Figure 19: Radiance Sampling***

### *Spectral Sample*

For the IRS: Spectral samples are obtained by performing a discrete Fourier Transform of the sampled *spectral sounding* interferogram for a *spatial sample*.

The spectral sample, identified by the index k, has an associated *spectral variable*, $\xi_k$, where this location corresponds to the position of its *spectral response function centroid*.

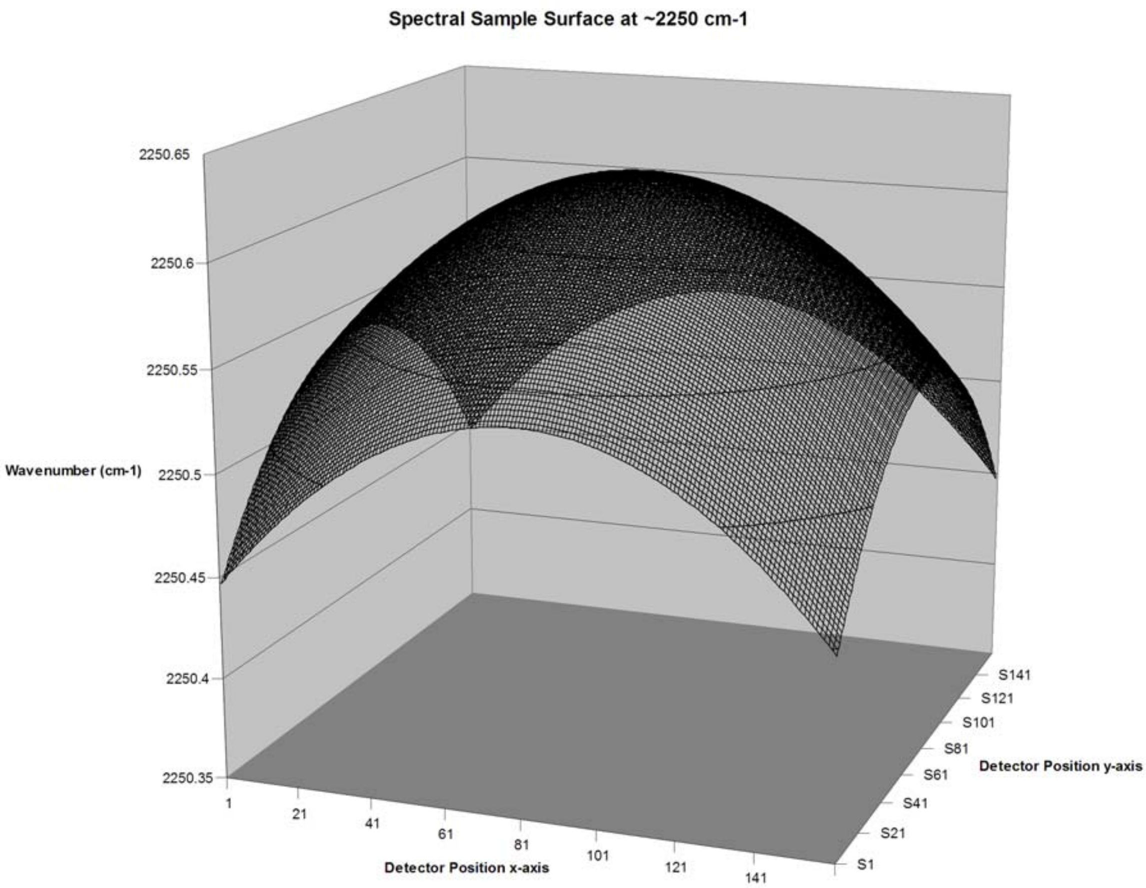
See also *radiance sample*.

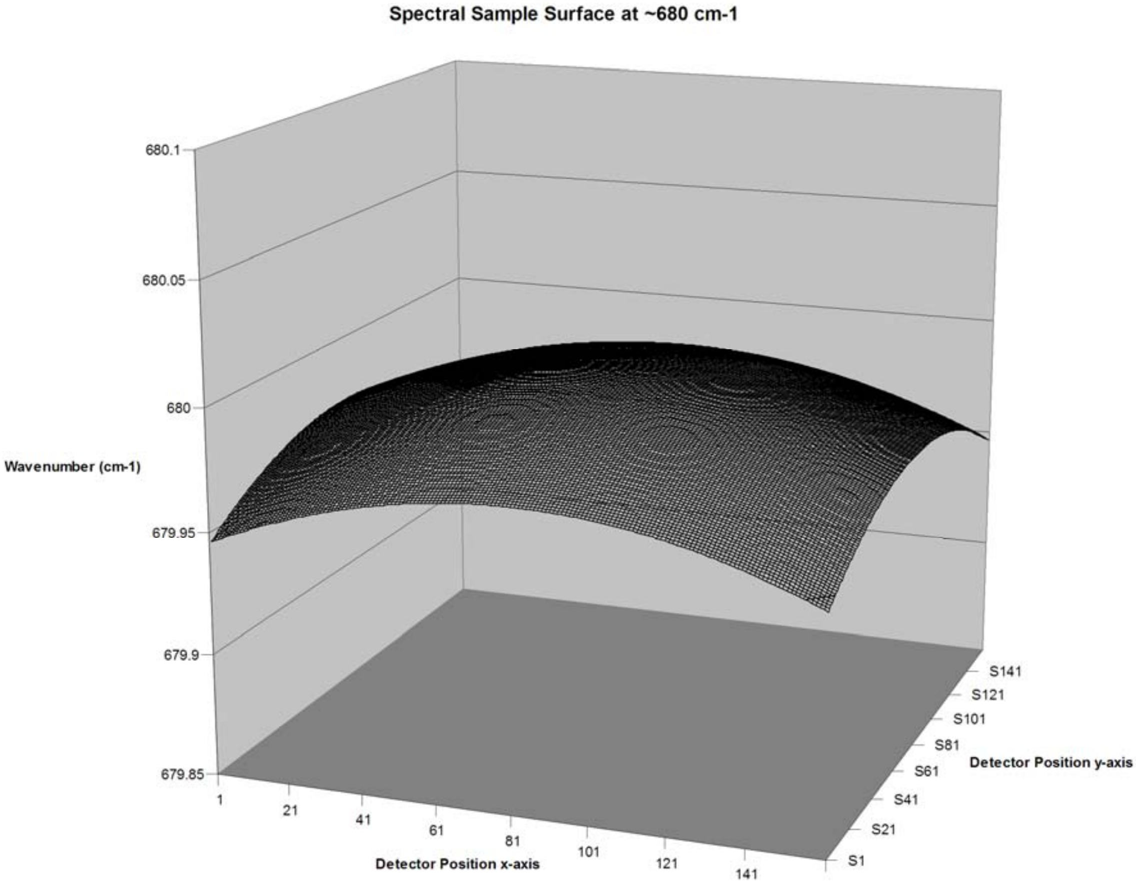
Note: As the IRS will perform a number of *spectral soundings* simultaneously there will be a scale change between the spectral spacing of the *spectral samples* for each *spatial sample*. This is due to the change in *maximum optical path difference* caused by the position of a *spatial sample* in relation to the optical axis. Thus each *spatial sample* will have *spectral samples* taken at a set of *wavenumbers* specific to that *spatial sample*.

***Spectral Sample Surface***

For the IRS: The spectral sample surface is defined as the group of *spectral samples* with the same index number following the discrete Fourier transform of all the *spectral sounding* interferograms in an area of *coverage*. The spectral sample surface has an associated *wavenumber* that is taken as the *wavenumber* corresponding to a *spectral sample* located on the optical axis. The *wavenumbers* of the individual *spectral samples* making up a spectral sample surface is illustrated in Figure 20,

Note: In this definition it is assumed that each *spectral sounding* consists of the same number of interferogram samples. On performing a Fourier transform of the interferogram each *spectral sounding* has the same number of *spectral samples*.


Spectral Sample Surface at ~2250 cm-1
Wavenumber (cm-1)
2250.65
2250.6
2250.55
2250.5
2250.45
2250.4
2250.35
1
21
41
61
81
101
121
141
Detector Position x-axis
S1
S21
S41
S61
S81
S101
S121
S141
Detector Position y-axis




Notes:

1. The plots of the spectral sampling surfaces are generates assuming a 4km *spatial sampling distance*, a 0.625 $cm^{-1}$ *spectral channel interval*, a magnification ratio of one and are plotted for a *dwell coverage* of 640km x 640km.

2. The plots assume that the optical axis lies in the centre of the *dwell coverage* and that the ZOPD for each interferogram within the *dwell* is in the same interferogram sample position.

***Figure 20: Illustration of Spectral Sample Surface***

### *Spectral Channel Interval*

For the IRS: The spectral channel interval is the spectral distance between adjacent *spectral channels* with in a *spectral band*.

Note: The spectral channel interval defines the standard grid to which the *spectral samples* collected for each *spatial sample* are spectrally resampled to form *spectral channels*

***Spectral Width***

For the FCI: The spectral width is used to specify the spectral extent of a *spectral channel* in terms of the *normalised spectral response* envelope.

Note: The specified spectral width, $\Delta\lambda_0$ will be different from the actual spectral width, $\Delta\lambda_s$, of a *spectral channel*, where the actual spectral width has traditionally been defined as the Full Width Half Maximum value of the *spectral response function*, ignoring local oscillations in the passband. However, with the usage of *effective radiance* there is strictly speaking no longer a need to provide the actual spectral width, although in practice the spectral width will still be quoted for historical comparison and conceptual understanding reasons.

***Central Wavelength***

For the FCI: The central wavelength is used to specify the spectral location of a *spectral channel* in terms of the *normalised spectral response* envelope.

Note: The specified central wavelength, $\lambda_0$, will be different from the actual central wavelength, $\lambda_S$, of a *spectral channel*, where the actual central wavelength has traditionally been defined as the *centroid* of the *spectral response function*. However, with the usage of *Effective Radiance* there is strictly speaking no longer a need to provide the actual central wavelength, although in practice the central wavelength will still be quoted for historical comparison and conceptual understanding reasons.

***Spectral Calibration***

For the **IRS**: Spectral calibration is the process of determining the position and shape of the spectral response function (SRF) of a spectral sample or group of *spectral sample*s by the observation of a known, stable spectral scene.

See ECSS-P-001B 3.28 Calibration.

***Spectral Resampling***

For the IRS: Spectral resampling is the process by which the *spectral samples* derived from a sampled interferogram are relocated to pre-determined *wavenumber* locations, thus forming *spectral channels*. The positions of the *spectral channels* are those given by the *spectral channel interval* starting at the first *wavenumber* in the *spectral band*.

***Spectral Response***

Obsolete

***Normalised Spectral Response***

The normalised spectral response is equal to the *spectral response function* normalised by the maximum *spectral response function* over the *spectral variable* range of interest at the time of measurement.

$$S_{[ijksr]}(\xi) = \frac{SRF_{[ijksr]}(\xi)}{\max\left(SRF_{[ijksr]}(\xi)\right)}$$

where

$S_{[ijksr]}(\xi)$ is the normalised spectral response

$SRF_{[ijksr]}(\xi)$ is the *spectral response function*

*i* and *j* identify the *spatial sample* within a *swath*/*dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

*r* is the *repeat cycle*

$\xi$ is the *spectral variable*

***Instrument Response Function***

For the FCI and IRS: The Instrument Response Function (IRF) is defined as the output signal to input radiant intensity ratio, with the output signal being the effective radiance measured by the instrument when observing a monochromatic point source. The IRF is specific to the selected spatial sample or pixel and spectral sample or spectral channel and is a function of the spatial position and the spectral variable of the source. The IRF units are $m^{-2}$. $\mu m^{-1}$.

As a consequence of the above definition, the output of either the FCI or the IRS is given by

$$L^{eff}{}_{[ijksr]} = \int_0^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} IRF_{[ijksr]}(x,y,\xi).L_{\xi}(x,y,\xi)dxdyd\xi$$

where

$L^{eff}{}_{[ijksr]}$ is the *effective radiance*, including all the spectral and spatial filtering actions produced by the combined effect of the optical system, the detector and processing up to point of interest .

$IRF_{[ijksr]}(x,y,\xi)$ is the instrument response function

$L_{\xi}(x,y,\xi)$ is the spectral *radiance* of the scene

*i* and *j* identify the *spatial sample* within a *swath*/*dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

*r* is the *repeat cycle*

*x* and *y* are the spatial variables

$\xi$ is the *spectral variable*

Another consequence of the definition is the fact that the integral of IRF along the spatial variables and *spectral variable* is unity.

$$\int_{0}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} IRF_{[ijksr]}(x,y,\xi)dxdyd\xi = 1$$

Note: In the definition of IRF the instruments are assumed to be linear.

### *Spectral Response Function*

For the FCI and IRS: The Spectral Response Function (SRF) is defined as the output signal to input radiance ratio, with the output signal being the effective radiance measured by the instrument when observing a spatially uniform, monochromatic source. The SRF is specific to the selected spatial sample or pixel and spectral sample or spectral channel and is a function of the spectral variable of the source. The SRF units are $\mu m^{-1}$.

The SRF can be equivalently defined as integral of IRF

$$SRF_{[ijksr]}(\xi) = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} IRF_{[ijksr]}(x,y,\xi)dxdy$$

where

$IRF_{[ijksr]}(x,y,\xi)$ is the *instrument response function*

$SRF_{[ijksr]}(\xi)$ is the spectral response function

*i* and *j* identify the *spatial sample* within a *swath*/*dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

*r* is the *repeat cycle*

*x* and *y* are the spatial variables

$\xi$ is the *spectral variable*

As a consequence of the above definition, in the special case where the scene is spatially uniform, the SRF can be used (in place of the IRF) to evaluate the instrument output by the equation:

$$L^{eff}{}_{[ijksr]} = \int_0^{+\infty} SRF_{[ijksr]}(\xi) L_{\xi}(\xi) d\xi$$

where

$L^{eff}{}_{[ijksr]}$ is the *effective radiance* including all the spectral and spatial filtering actions produced by the combined effect of the optical system, the detector and processing, up to the point of interest.

$L_{\zeta}(\xi)$ is the spectral *radiance* of the scene

Another consequence of the definition is the fact that the integral of SRF along the *spectral variable* is unity.

$$\int_0^{+\infty} SRF_{[ijksr]}(\xi) d\xi = 1$$

Synonyms: *instrument spectral response function*, *instrument line shape*

Note: In the definition of SRF the instruments are assumed to be linear.

***Instrument Spectral Response Function***

Synonym for *Spectral Response Function* (SRF)

***Instrument Line Shape***

Synonym for *Spectral Response Function* (SRF).

***Spectral Response Function Difference***

The spectral response function difference is given for two different conditions.

For the difference between the actual SRF and a characterised SRF

$$\Delta SRF_{[ijksr]} = \int_{\xi 1}^{\xi 2} \left| SRF^{a}_{[ijksr]}(\xi) - SRF^{m}_{[ijksr]}(\xi) \right| d\xi$$

where

$\Delta SRF_{[ijksr]}$ is the spectral response function difference

$SRF^{m}{}_{[ijksr]}$ is the characterised *spectral response function*

$SRF^{a}{}_{[ijksr]}$ is the actual *spectral response function*

*i* and *j* identify the *spatial sample* within a *swath*/*dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

*r* is the *repeat cycle*

$\xi$ is the *spectral variable*

$\xi 1$ and $\xi 2$ are the integration limits

For the difference between two actual SRF separated either in space or in time

$$\Delta SRF_{[(i1-i2)(j1-2)ks(r1-r2)]} = \int_{\xi 1}^{\xi 2} \left| SRF_{[i1\,j1ksr1]}(\xi) - SRF_{[i2\,j2ksr2]}(\xi) \right| d\xi$$

where

$\Delta SRF_{[(i1-i2)(j1-j2)ks(r1-r2)]}$ is the spectral response function difference

$SRF_{[i1\,j1ksr1]}(\xi)$ and $SRF_{[i2\,j2ksr2]}(\xi)$ are the *spectral response functions* for either two different *spatial samples* within the same *repeat cycle* (r1=r2) or the same *spatial sample* belonging to two different *repeat cycles* (i1=i2, j1=j2) for *spectral channel k*

Synonym: *SRF shape error index*

***SRF Shape Error Index***

Synonym for *spectral response function difference*

***Fourier Transform Spectrometer***

A Fourier Transform Spectrometer (FTS) is an interferometer concept that converts input spectral radiances into interferograms that contain spectral information within the bandpass of the interferometer.

***Spectral Sounding***

A spectral sounding is defined as the complete set of *spectral samples* for any fixed *spatial sample* captured during a *dwell* of a sounder.

See also *radiance sample*.

## Annex F.4.5 Radiometric

***Irradiance***

Irradiance is defined as the radiant power incident on a surface element, divided by the area of the element:

$$E = d\Phi / ds$$

where

*ds* is an infinitesimal element of surface

$d\Phi$ is the radiant power incident over ds

*E* is the irradiance evaluated on ds

As all the radiometric quantities, irradiance can be integral or spectral. The above definition is applicable to the integral irradiance (with Φ the radiant power over a generic spectral interval). The spectral irradiance is irradiance per unit spectral interval and is represented by the equation:

$E_\xi = dE/d\xi$

where

$\xi$ is the *spectral variable*

$E_\xi$ is the spectral irradiance per unit *spectral variable*

***Radiance***

Radiance is defined as the radiant power per unit projected area and unit solid angle, leaving a surface in a given direction.

$L = \frac{d^2\Phi}{ds.d\Omega.\cos\theta}$ where

*ds* is an infinitesimal element of surface

$\theta$ is the angle between the direction of observation and the normal to ds

$d\Omega$ is an infinitesimal solid angle around the observation direction

$d^2\Phi$ is the radiant power emitted by ds within the solid angle dΩ

*L* is the radiance from the surface, in the direction given by θ

The spectral radiance is radiance per unit spectral interval and is represented by the equation:

$L_\xi = dL/d\xi$ where

$\xi$ is the *spectral variable*

$L_\xi$ is the spectral radiance per unit *spectral variable*

***Effective Radiance***

The effective radiance is the calibrated output of an instrument with finite spatial and spectral resolution, in units of spectral *radiance*. It equates to spectral *radiance* of a spatially and spectrally flat scene that would produce the same output as that produced by the actual scene.

### *Radiometric Measurement Range*

The radiometric measurement range is defined as the complete radiometric domain over which the instrument is able to produce calibrated measurements.

### *Planck Function Derivative in Temperature*

The Planck function derivative in temperature is given by:

In terms of wavelength (λ) in m

$$\frac{\partial B}{\partial T}(\lambda,T).d\lambda = \frac{2\cdot h^2\cdot c^3}{k.T^2.\lambda^6}\frac{e^{\frac{h\cdot c}{k.\lambda.T}}}{\left(e^{\frac{h\cdot c}{k.\lambda.T}}-1\right)^2}.d\lambda$$

In terms of wavelength (λ') in μm

$$\frac{\partial B}{\partial T}(\lambda',T).d\lambda' = \frac{2\cdot h^2\cdot c^3}{k.T^2.\lambda'^6}\frac{e^{\frac{10^6.h\cdot c}{k\lambda' T}}}{\left(e^{\frac{10^6.h\cdot c}{k\lambda' T}}-1\right)^2}.10^{30}.d\lambda'$$

In terms of *wavenumber* (ν) in $m^{-1}$

$$\frac{\partial B}{\partial T}(\nu,T).d\nu = \frac{2\cdot h^2\cdot c^3\nu^4}{k.T^2}\frac{e^{\frac{h.c.\nu}{k.T}}}{\left(e^{\frac{h.c.\nu}{k.T}}-1\right)^2}.d\nu$$

In terms of *wavenumber* (ν') in $cm^{-1}$

$$\frac{\partial B}{\partial T}(\nu',T).d\nu' = \frac{2\cdot h^2\cdot c^3\nu'^4}{k.T^2}\frac{e^{\frac{100.h.c.\nu'}{k.T}}}{\left(e^{\frac{100.h.c.\nu'}{k.T}}-1\right)^2}.10^{10}.d\nu'$$

### *Reflectance*

For a given spectral value, reflectance is the ratio between the power per unit surface area emitted by a surface and the power per unit surface area (*irradiance*) incident on the surface.

***Albedo***

For a given spectral interval, albedo is the ratio between the power per unit surface area emitted by a surface and the power per unit surface area incident on the surface.

***Spectral Radiance at the Top Of Atmosphere***

For the VIS/NIR *spectral channels* the spectral radiance at the Top Of Atmosphere (TOA) is estimated according to the following formula:

$$L^{sun}{}_{\lambda}(\lambda) = \frac{\rho(\lambda).E^{sun}{}_{\lambda}(\lambda).\cos(\theta^{sun})}{\pi}$$

Where

$L^{sun}{}_{\lambda}(\lambda)$ is the spectral radiance at TOA

$\rho(\lambda)$ is the *reflectance* at TOA

$E^{sun}{}_{\lambda}(\lambda)$ is the sun extraterrestrial spectral *irradiance* perpendicular to the direction of propagation given in Figure 21

$\lambda$ is wavelength

$\theta^{sun}$ is the solar zenith angle

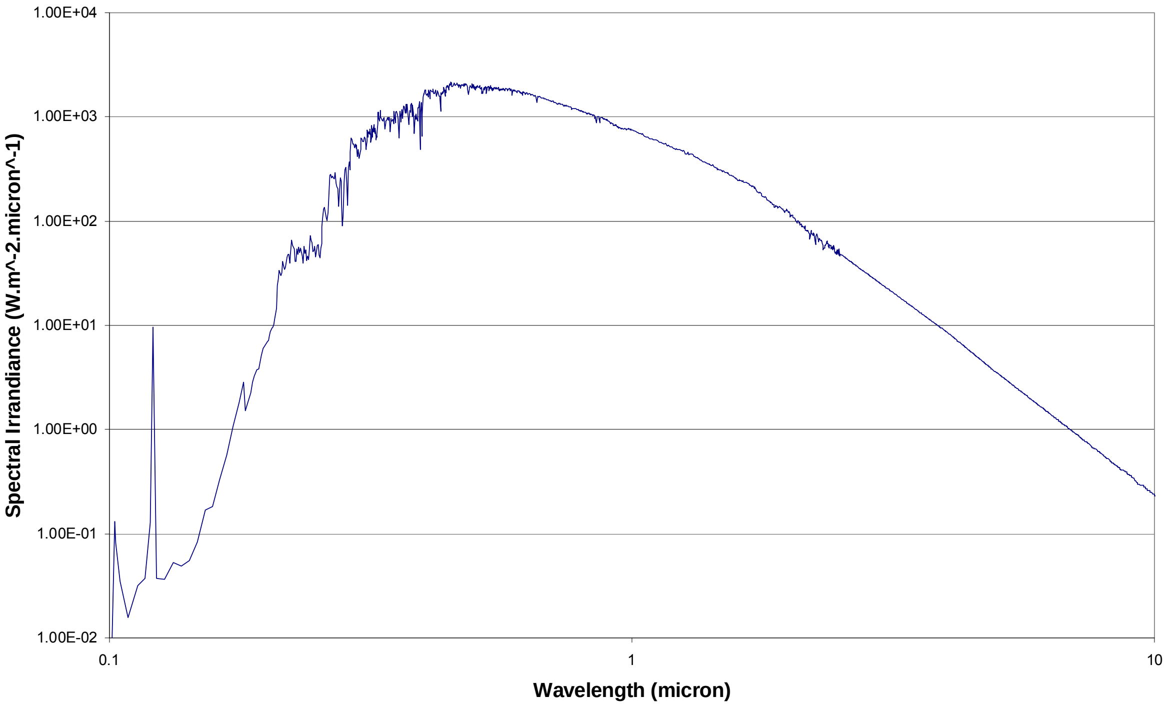



***Figure 21: Reference Solar Spectral* Irradiance**

***Radiometric Error***

The radiometric error is defined as the difference between the measured *effective radiance* for a particular *radiance sample* and the reference *effective radiance*

$$\Delta L^{eff}[ijksr] = L^{eff,m}[ijksr] - L^{eff,r}[ijksr]$$

where

$\Delta L^{eff}[ijksr]$ is the radiometric error

$L^{eff,m}{}_{[ijksr]}$ is the measured *effective radiance*

$L^{eff,r}{}_{[ijksr]}$ is the reference *effective radiance*

*i* and *j* identify the *spatial sample* within a *swath*/*dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

*r* is the *repeat cycle*

Note: In this definition the measured *effective radiance* is assumed to contain calibration related errors and *radiometric noise* contributions, whereas the reference *effective radiance* is derived using a perfectly characterised reference *spectral response function* viewing a scene, traceable to a radiometric standards (e.g. National Physical Laboratory (UK)), with zero *radiometric noise* contribution.

***Radiometric Noise***

The *radiometric noise* is the standard deviation of the *radiometric error* associated with a *spectral sample surface* or a *spectral channel* respectively, collected during one *repeat cycle*. When expressed in this form the *radiometric noise* is given as *noise equivalent delta radiance* (NEdL).

$$NEdL^{eff}[kr] = \sqrt{\frac{\sum_s \sum_i \sum_j \left(\Delta L^{eff}[ijksr]\right)^2}{n} - \overline{\Delta L^{eff}[kr]}^{\,2}}$$

$$n = \sum_s \sum_i \sum_j 1$$

where

$\Delta L^{eff}[ijksr]$ is the *radiometric error*

$\overline{\Delta L^{eff}[kr]}$ is the *radiometric accuracy*

$NEdL^{eff}{}_{[kr]}$ is the *noise equivalent delta radiance*

*i* and *j* identify the *spatial sample* within a *swath*/*dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

*r* is the *repeat cycle*

*n* is the number of *spatial samples* or *pixels* in the *repeat cycle*

For the thermal infrared (TIR) *spectral channels*, the *radiometric noise* can be given in terms of *noise equivalent delta temperature* (NEdT) associated with a blackbody temperature at which the NEdT is computed.

$$NEdT_{[kr]} = \frac{NEdL^{eff}{}_{[kr]}.n}{\sum_s \sum_i \sum_j \int_0^{+\infty} SRF^{r}_{[ijskr]}(\xi).\frac{\partial B(\xi,T)}{\partial T}.d\xi} \approx \frac{NEdL^{eff}{}_{[kr]}}{\partial B(\xi_0,T)/\partial T}$$

where

$NEdT_{[kr]}$ is the *noise equivalent delta temperature*

$\frac{\partial B(\xi,T)}{\partial T}$ is the *Planck function derivative in temperature*

$SRF^{r}_{[ijskr]}(\xi)$ is the reference *spectral response function*

$\xi_0$ is the *spectral channel* reference position; *central wavelength* for the FCI and *wavenumber* of the *spectral channel* for the IRS.

For the VIS/NIR *spectral channels*, the *radiometric noise* can be given in terms of *signal to noise ratio* (SNR) associated with a signal at which the SNR is computed.

$$SNR_{[kr]} = \frac{\overline{L^{eff}{}_{[kr]}}}{NEdL^{eff}{}_{[kr]}}$$

$$\overline{L^{eff}{}_{[kr]}} = \frac{\sum_s \sum_i \sum_j L^{eff}{}_{[ijksr]}}{n}$$

where

$SNR_{[kr]}$ is the *signal to noise ratio*

$L^{eff}{}_{[ijksr]}$ is the measured *effective radiance*

Note: *Radiometric noise* applies to radiometrically calibrated spectra, meaning that the noise induced by *radiometric calibration* is included.

### *1/f Noise*

1/f noise is a non-stationary noise associated with each *pixel*; when present, this noise causes each *pixel* to drift with respect to the other *pixel*s on the array in a spatially uncorrelated manner.

1/f noise is the component of the *noise power spectral density* that falls of according to the formula.

$$NPSD^{1/f}[_{pqksr}] = a.\kappa_p^{m_p}.\kappa_q^{m_q}$$

$$m_p \approx -1$$

$$m_q \approx -1$$

where

$NPSD^{1/f}_{[pqksr]}$ is the *noise power spectral density* 1/f noise component

*a* is a constant of proportionality for the 1/f noise component

$m_p$ and $m_q$ are constants defining the slope of the 1/f noise in a logarithmic plot in the *column* and *row* directions

$\kappa_p$ and $\kappa_q$ are the *normalised spatial frequencies* in the *column* and *row* directions

*p* and *q* identify the sample in the spatial frequency domain in the 'directions' of *column* and *row* respectively

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* {when considering *spatial samples*}

*r* is the *repeat cycle*

See *white noise* for the derivation of the constants from the *noise power spectral density*.

Synonyms: Pink noise

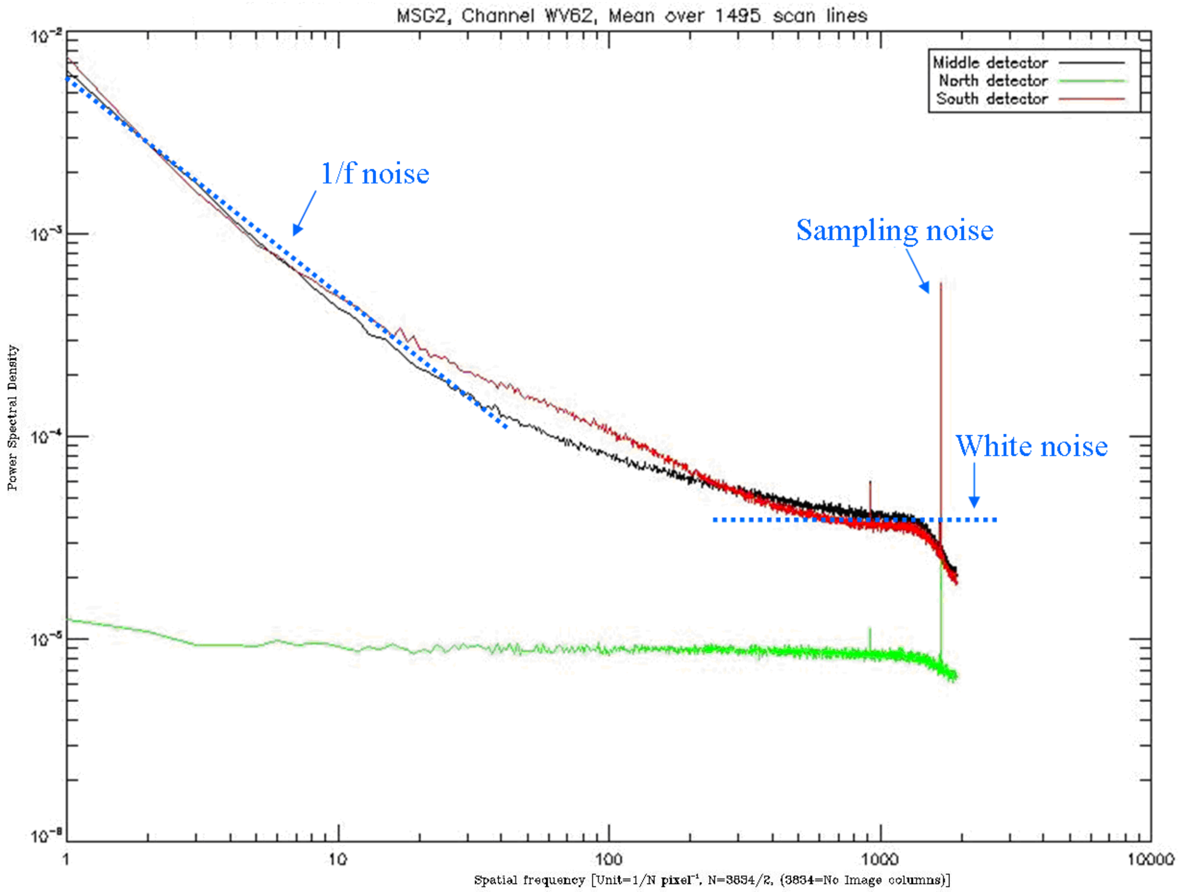



***Figure 22: Example of <1/f noise> and* white noise *characterisation***

***Radiometric Scaling Function***

The radiometric scaling function is used to derive radiometric requirements for measurement conditions different from the reference case.

For the IR *spectral channels*, the radiometric scaling function, applied to radiometric requirements given in equivalent temperature, is given by the equation

$$R(T^m) = R(T^r) \cdot \frac{\partial B(\xi_0, T^r)/\partial T}{\partial B(\xi_0, T^m)/\partial T}$$

Where

$R(T^m)$ and $R(T^r)$ are the radiometric requirements for the measured and reference temperatures respectively

$\partial B(\xi_0, T^m)/\partial T$ and $\partial B(\xi_0, T^r)/\partial T$ are the *Planck function derivative in temperature* for the measured and reference temperatures respectively

$\xi_0$ is the *spectral channel* reference position, being *central wavelength* for the FCI and position given by the wavenumber for the IRS.

$T^m$ and $T^r$ are the measured and reference temperatures respectively

For the solar channels, the radiometric scaling function, applied to radiometric requirements given as *signal to noise ratio*, is given by the equation:

$$SNR^m = SNR^r . \sqrt{\frac{\rho^m(\lambda_0).\cos(\theta^{sun,m})}{\rho^r(\lambda_0).\cos(\theta^{sun,r})}}$$

Where

$SNR^m$ and $SNR^r$ are the *signal to noise ratios* for the measured and reference conditions respectively

$\rho^m(\lambda_0)$ and $\rho^r(\lambda_0)$ are the *reflectance* at the TOA for the measured and reference conditions respectively.

$\theta^{sun,m}$ and $\theta^{sun,r}$ are the solar zenith angles for the measured and reference conditions respectively

$\lambda_0$ is the central wavelength of the *spectral channel*

The radiometric scaling function, applied to radiometric requirements given as a percentage, is given by the equation:

$$R(L^m) = R(L^r).\frac{\rho^r(\lambda_0).\cos(\theta^{sun,r})}{\rho^m(\lambda_0).\cos(\theta^{sun,m})}$$

Where

$R(L^m)$ and $R(L^r)$ are the radiometric requirement in percent for the measured and reference radiances respectively

***Radiometric Resolution***

The radiometric resolution is the minimum radiometric quantization step of an instrument.

***Noise Equivalent delta Temperature***

See *radiometric noise*.

Synonyms: *noise equivalent differential temperature*, *noise equivalent temperature*

***Noise Equivalent differential Temperature***

Synonym for *noise equivalent delta temperature*.

***Noise Equivalent Temperature***

Synonym for *noise equivalent delta temperature*.

***Noise Equivalent delta Radiance***

See *radiometric noise*.

Synonyms: *noise equivalent differential radiance*.

***Noise Equivalent differential Radiance***

Synonym for *noise equivalent delta radiance*.

***Signal to Noise Ratio***

See *radiometric noise*.

***Radiometric Accuracy***

The radiometric accuracy is the mean *radiometric error* associated with a *spectral sample surface* or a *spectral channel*, collected during a *repeat cycle*. In terms of *effective radiance* this is expressed by the equation

$$\overline{\Delta L^{eff}{}_{[kr]}} = \frac{\sum_s \sum_i \sum_j \Delta L^{eff}{}_{[ijksr]}}{n}$$

$$n = \sum_s \sum_i \sum_j 1$$

Where

$\overline{\Delta L^{eff}{}_{[kr]}}$ is the radiometric accuracy expressed as an *effective radiance*

$\Delta L^{eff}{}_{[ijksr]}$ is the *radiometric error*

*i* and *j* identify the *spatial sample* within a *swath/dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* {when considering *spatial samples*}

*r* is the *repeat cycle*

*n* is the number of *spatial samples* or *pixels* in the *image*

For the thermal IR *spectral channels* the radiometric accuracy is measured in terms of a brightness temperature; this can be related to the *effective radiance* expression by the equation

$$\overline{\Delta T_{[kr]}} = \frac{\overline{\Delta L^{eff}{}_{[kr]}}.n}{\sum_s \sum_i \sum_j \int_0^{+\infty} SRF^r_{[ijksr]}(\xi).\frac{\partial B(\xi,T)}{\partial T}.d\xi} \approx \frac{\overline{\Delta L^{eff}{}_{[kr]}}}{\partial B(\xi_0,T)/\partial T}$$

where

$\overline{\Delta T_{[kr]}}$ is the radiometric accuracy expressed as a brightness temperature

$\frac{\partial B(\xi,T)}{\partial T}$ is the *Planck function derivative in temperature*

$SRF^{r}_{[ijksr]}(\xi)$ is the reference *spectral response function*

$\xi_0$ is the *spectral channel* reference position; *central wavelength* for the FCI and *wavenumber* of the *spectral channel* for the IRS.

For the VIS/NIR *spectral channels* the radiometric accuracy is expressed as a percentage of the *effective radiance* when viewing the solar *irradiance* reflected with a *reflectance* of $\rho(\lambda)$ and a solar zenith angle of $\theta_s$; this can be related to the *effective radiance* expression by the equation

$$\overline{\Delta L^{sun}[kr]} = \frac{\overline{\Delta L^{eff}[kr]}.\pi.n}{\sum_s \sum_i \sum_j \int_0^{+\infty} SRF^{r}_{[ijksr]}(\lambda).\rho(\lambda).E^{sun}{}_{\lambda}(\lambda).\cos(\theta^{sun})d\lambda}.100$$

$\overline{\Delta L^{sun}[kr]}$ is the radiometric accuracy expressed as a percentage of the *effective radiance* when viewing the solar *irradiance* reflected with a *reflectance* of $\rho(\lambda)$ and a solar zenith angle of $\theta^{sun}$.

$\rho(\lambda)$ is the *reflectance* at TOA

$E^{sun}{}_{\lambda}(\lambda)$ is the sun extraterrestrial spectral *irradiance* perpendicular to the direction of propagation given in Figure 21

$\lambda$ is wavelength

$\theta^{sun}$ is the solar zenith angle

Note: The above definition deviates from the ISO 5725:1998 usage of the term accuracy.

### *Radiometric Stability*

The radiometric stability is the absolute value of the difference between the *radiometric accuracy* of two different *images*.

$$\overline{\Delta L^{eff}[k(r1-r2)]} = \left|\overline{\Delta L^{eff}[kr1]} - \overline{\Delta L^{eff}[kr2]}\right|$$

where

$\overline{\Delta L^{eff}[k(r1-r2)]}$ is the radiometric stability

$\overline{\Delta L^{eff}[kr]}$ is the *radiometric accuracy*

*k* is the *spectral sample* or *spectral channel*

*r* is the *repeat cycle*

*r1* and *r2* are two different *repeat cycles*

For the TIR *spectral channels* the radiometric stability is measured in terms of a brightness temperature; this can be related to the *effective radiance* expression by the equation

$$\overline{\Delta T_{[k(r1-r2)]}} = \frac{\overline{\Delta L^{eff}{}_{[k(r1-r2)]}}.2.n}{\sum_s \sum_i \sum_j \int_0^{+\infty} \left(SRF^r_{[ijksr1]}(\xi) + SRF^r_{[ijksr2]}(\xi)\right).\frac{\partial B(\xi,T)}{\partial T}.d\xi} \approx \frac{\overline{\Delta L^{eff}{}_{[k(r1-r2)]}}}{\partial B(\xi_0,T)/\partial T}$$

$$n = \sum_s \sum_i \sum_j 1$$

where

$\overline{\Delta T_{[k(r1-r2)]}}$ is the radiometric stability

$\frac{\partial B(\xi,T)}{\partial T}$ is the *Planck function derivative in temperature*

$SRF^r_{[ijksr1]}(\xi)$ is the reference *spectral response function*

*i* and *j* identify the *spatial sample* within a *swath*/*dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

$\xi$ is the *spectral variable*

$\xi_0$ is the *spectral channel* reference position; *central wavelength* for the FCI and *wavenumber* of the *spectral channel* for the IRS.

*n* is the number of *spatial samples* or *pixels* in the *image*

For the VIS/NIR *spectral channels* the radiometric stability is expressed as a percentage of the *effective radiance* when viewing the solar *irradiance* reflected with a *reflectance* of $\rho(\lambda)$ and a solar zenith angle of $\theta^{sun}$; this can be related to the *effective radiance* expression by the equation

$$\overline{\Delta L^{sun}{}_{[k(r1-r2)]}} = \frac{\overline{\Delta L^{eff}{}_{[k(r1-r2)]}}.\pi.2.n}{\sum_s \sum_i \sum_j \int_0^{+\infty} \left(SRF^r_{[ijksr1]}(\lambda) + SRF^r_{[ijksr2]}(\lambda)\right).\rho(\lambda).E^{sun}{}_{\lambda}(\lambda).\cos(\theta^{sun})d\lambda}.100$$

where

$\overline{\Delta L^{sun}_{[k(r1-r2)]}}$ is the radiometric stability expressed as a percentage of the *effective radiance* when viewing the solar *irradiance* reflected with a *reflectance* of $\rho(\lambda)$ and a solar zenith angle of $\theta^{sun}$.

$\rho(\lambda)$ is the *reflectance* at TOA

$E^{sun}{}_{\lambda}(\lambda)$ is the sun extraterrestrial spectral *irradiance* perpendicular to the direction of propagation given in Figure 21

$\lambda$ is wavelength

$\theta^{sun}$ is the solar zenith angle

***Medium Term Radiometric Stability***

For the TIR *spectral channels* the medium term radiometric stability is the *radiometric stability* between any two *images* lying in the interval between two calibration cycles. For the VIS/NIR *spectral channels* the medium term radiometric stability is the *radiometric stability* evaluated between any two *images* separated by less than or equal to 24 hours.

***Long Term Radiometric Stability***

The long term radiometric stability is the *radiometric stability* evaluated between any two *images* separated by less than or equal to the nominal instrument lifetime.

***LI Triggered Event***

A triggered event occurs when the energy registered by a *detector element* exceeds the *LI trigger threshold*.

***LI Trigger Threshold***

The trigger threshold is used, at *detector element* level to discriminate a *lightning optical pulse* from the background radiance.

***LI background radiance images***

The Background Radiance for each LI *detector element* in the LI *detector array* averaged over a given time interval.

***Lightning Event***

A lightning event is defined as a *LI triggered event* caused by a *lightning optical pulse*.

## Annex F.4.6 Spatial and Temporal

### *Field of View*

The field of view (FOV) is the solid angle subtended by some portion of an instrument. The term can be applied to a *detector element*, a *detector array*, a focal plane containing multiple *detector arrays* or the complete instrument

Note: Usage of the term field of view without a specific reference to the item under consideration is often confusing. Care should be exercised when using this term.

### *Spatial Sample*

A spatial sample is a spatial location in the area of *coverage* at which an instrument returns a measurement.

For the FCI: The spatial sample is associated with a single *radiance sample* per *spectral channel*

For the IRS: The spatial sample is associated with a single *radiance sample* per *spectral sample* in the case of a non-resampled spectra, a single *radiance sample* per *spectral channel* in the case of a resampled spectra and the mean *radiance sample* for all *spectral samples* in the case of an *spectral sounding* interferogram.

For the LI: The spatial sample is associated with a single *radiance sample* for the single defined *spectral channel*

The spatial sample, identified by the indices (i,j), is spatially located at $(x_i,y_j)$, where this location corresponds to the position of its *point spread function centroid*.

See also *radiance sample*.

### *Spatial Sampling Error*

The spatial sampling error (SSE) is the difference between the distance of two spatial samples in the *target grid* minus the distance of the corresponding spatial samples in the *actual grid*.

$$SSE_{[(i1-i2)(j1-j2)ksr]} = SD^{t}_{[(i1-i2)(j1-j2)ksr]} - SD^{a}_{[(i1-i2)(j1-j2)ksr]}$$

where

$SSE_{[(i1-i2)(j1-j2)ksr]}$ is the spatial sampling error between *spatial samples (i1,j1)* and *(i2,j2)*

$SD^{t}_{[(i1-i2)(j1-j2)ksr]}$ is the distance between *spatial samples* in the target grid *(i1,j1)* and *(i2,j2)*

$SD^{a}_{[(i1-i2)(j1-j2)ksr]}$ is the distance between *spatial samples* in the actual grid *(i1,j1)* and *(i2,j2)*

*i* and *j* identify the *spatial sample* within a *swath* or *dwell* or the *pixel* within a <repeat cycle. in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

*r* is the *repeat cycle*

The spatial sampling error is evaluated for either i2=i1+1 and j1=j2 or i1=i2 and j2=j1+1

***Point Spread Function***

For the FCI and IRS: The Point Spread Function (PSF) is defined as the output signal to input spectral radiant intensity ratio, with the output signal being the effective radiance measured by the instrument when observing a spectrally uniform point source. The PSF is specific to the selected spatial sample or pixel and spectral sample or spectral channel and is a function of the spatial position. The PSF units are $m^{-2}$.

The PSF can be equivalently defined as integral of IRF

$$PSF_{[ijksr]}(x,y) = \int_0^{+\infty} IRF_{[ijksr]}(x,y,\xi)\,d\xi$$

where

$PSF_{[ijksr]}(x,y)$ is the point spread function

$IRF_{[ijksr]}(x,y,\xi)$ is the *instrument response function*

*i* and *j* identify the *spatial sample* within a *swath/dwell* or the *pixel* within a *repeat cycle* in terms of *column* and *row*

*k* is the *spectral sample* or *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle* when considering *spatial samples*

*r* is the *repeat cycle*

*x* and *y* are the spatial variables

$\xi$ is the *spectral variable*

As a consequence of the above definition, in the special case where the scene is spectrally uniform, the PSF can be used (in place of the IRF) to evaluate the instrument output by the equation:

$$L^{eff}{}_{[ijksr]} = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} PSF_{[ijksr]}(x,y).L_{\xi}(x,y)\,dxdy$$

where

$L^{eff}{}_{[ijksr]}$ is the *effective radiance* including all the spectral and spatial filtering actions produced by the combined effect of the optical system, the detector and processing up to point of interest.

$L_{\xi}(x,y)$ is the spectral *radiance* of the scene

Another consequence of the definition is the fact that the integral of PSF along the spatial variables is unity.

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} PSF_{[ijksr]}(x,y)dxdy = 1$$

Note: In the definition of PSF the instruments are assumed to be linear.

## Annex F.4.7 Geometric

### *Image Rectification*

Image rectification is the process creating a *level 1c image* from a *level 1b image*. The *level 1c image* has the property that there is a well-defined and invariant relationship between *image* coordinates (*rows* and *columns*) and the Earth location (*geodetic latitude* and longitude). In order to achieve this transformation the *radiance samples* associated with the *level 1b spatial samples* are interpolated from the *estimated grid* to the *reference grid* to give *radiance samples* for each *level 1c pixel*.

### *Image Navigation*

Image navigation specifically refers to the knowledge of the relationship between a *spatial sample* in instrument coordinates and the corresponding point on the earth, given by latitude and longitude coordinates. In general, image navigation refers to the methods employed to obtain that knowledge, whereas image navigation accuracy is a measure of how well that relationship is known. Image navigation is used to derive the *verification grid* of past *spatial sample* positions, where means to derive this knowledge are available. When used to derive the position of future *spatial samples* based on past information the *estimated grid* is generated.

### *Image Registration*

Image registration is an indication as to how well *image navigation* knowledge is maintained and controlled between *images* separated over time or between different *spectral channels* or instruments.

### *Pixel*

A pixel is a precise location on the *reference grid* at which an instrument returns a measurement. The pixel is constructed from a number of *spatial samples* that have been interpolated to the given *reference grid* location during the *image rectification* process.

The pixel, identified by the indices (i,j), is spatially located at ($x_i$,$y_j$).

See also *radiance sample*.

Note: Like the *spatial sample* the pixel also possess a *point spread function* that may extend over a number of SSDs in all directions, i.e. it will not be same as a square of sides SSD in length.

***Actual Site***

The actual site (AS) of a *spatial sample* corresponds to the *centroid* of the true projection of the *spatial sample point spread function* on the Earth's surface at the time of measurement.

Note: The combined actual sites of an *image* give the *actual grid*.

***Measured Site***

The measured site (MS) of a *spatial sample* corresponds to the estimate of the *spatial sample actual site* as derived from the *image navigation* process and used in the *image rectification* process or delivered as *IDP auxiliary data* with the *level 1b* data.

Note: The combined measured sites of an *image* give the *estimated grid*.

***Reference Site***

The reference site (RS) is the geographical location of a *pixel* and corresponds to one of the grid points of the *reference grid*.

***Corrected Site***

The corrected site (CS) is the true geographical location of the *centroid* of the PSF associated with a *pixel*. Ideally a corrected site corresponding to each *pixel* is measureable, but in practice only geographic features such as coast lines, mountains and lakes will be available.

Note: In practice the location of the geographic features will be to sub-SSD accuracy.

***Absolute Sample Position Knowledge Error***

The absolute sample position knowledge error (ASPKE) is defined by the equation

$$ASPKE_{[ijksrd]} = AS_{[ijksrd]} - MS_{[ijksrd]}$$

where

*ASPKE* is the absolute sample position knowledge error

*AS* is the *actual site*

*MS* is the *measured site*

*i* and *j* identify the *spatial sample* in terms of *column* and *row* within a *swath* or *dwell*

*k* is the *spectral channel*

*s* is the *swath* or *dwell* of a *repeat cycle*

*r* is the *repeat cycle*

*d* is the direction of evaluation (north/south or east/west)

***Absolute Pixel Position Knowledge Error***

The absolute *pixel* position knowledge error (APPKE) is defined by the equation

$$APPKE_{[ijkrd]} = CS_{[ijkrd]} - RS_{[ijkrd]}$$

where

*APPKE* is the absolute *pixel* position knowledge error

*CS* is the *corrected site*

*RS* is the *reference site*

*i* and *j* identify the *pixel* in terms of *column* and *row* within an *repeat cycle*

*k* is the *spectral channel*

*r* is the *repeat cycle*

*d* is the direction of evaluation (north/south or east/west)

***Misregistration***

Obsolete

***Coregistration***

Coregistration is used to describe the relative position of the *spatial sample*s or *pixel*s between different spectral channels of an instrument or between instruments. The term can be applied to the spatial or the temporal position of *spatial sample*s or *pixel*s.

***Relative Sample Position Error***

The relative sample position error (RSPE) is defined by the equation

$$RSPE_{[ij(k1-k2)s(r1-r2)d]} = AS_{[ijk1sr1d]} - AS_{[ijk2sr2d]}$$

where

*RSPE* is the relative sample position error

*AS* is the *actual site*

*i* ,*j* identify the *spatial sample* in terms of *column* and *row* within a *swath* or *dwell*

*s* is the *swath* or *dwell*

*k1* and *k2* are two *spectral channels*

*r1* and *r2* are two *repeat cycles*

*d* is the direction of evaluation (north/south or east/west)

The RSPE is assessed between *spectral channels* for r1=r2 or *repeat cycles* for k1=k2

***Relative Sample Position Knowledge Error***

The relative sample position knowledge error (RSPKE) is defined by the equation

$$RSPKE_{[ij(k1-k2)s(r1-r2)d]} = \left(AS_{[ijk1sr1d]} - MS_{[ijk1sr1d]}\right) - \left(AS_{[i'j'k2s'r2d]} - MS_{[i'j'k2s'r2d]}\right)$$

where

*RSPKE* is the relative sample position knowledge error

*AS* is the *actual site*

MS is the *measured site*

*i ,j,s* identify the *spatial sample* in terms of *column*, *row* and *swath* or *dwell* for *spectral channel k1* and *repeat cycle r1*

*s* is the *swath* or *dwell* of *spectral channel k1* and *repeat cycle r1*

i', *j', s'* identify the *spatial sample* in terms of *column*, *row* and *swath* or *dwell* for *spectral channel k2* and *repeat cycle r2* that lies closest in terms of the *measured site* position to *spatial sample (i,j,s)* of *spectral channel k1* and *repeat cycle r1*

*k1* and *k2* are two *spectral channels*

*r1* and *r2* are two *repeat cycles*

*d* is the direction of evaluation (north/south or east/west)

The RSPKE is assessed by the process of *image registration* between *spectral channels* for r1=r2 or *repeat cycles* for k1=k2

Synonyms: *misregistration*, *coregistration*

Note: RSPKE is only given for *spectral channels* of identical *spatial sampling distance*.

***Relative Pixel Position Knowledge Error***

The relative *pixel* position knowledge error (RPPKE) is defined by the equation

$$RPPKE_{[ij(k1-k2)(r1-r2)d]} = \left(CS_{[ijk1r1d]} - RS_{[ijk1r1d]}\right) - \left(CS_{[ijk2r2d]} - RS_{[ijk2r2d]}\right)$$

where

*RPPKE* is the relative *pixel* position knowledge error

*CS* is the *corrected site*

*i* and *j* identify the *pixel* or *pixel* group in terms of *column* and *row* within a *repeat cycle*

*k1* and *k1* are two *spectral channels*

*r1* and *r2* are two *repeat cycles*

*d* is the direction of evaluation (north/south or east/west)

The RPPKE is assessed by the process of *image registration* between *spectral channels* for r1=r2 or *repeat cycles* for k1=k2

When the RPPKE between *spectral channels* with differing *spatial sampling distance* is required:

A group of $p^2$ of the finer resolution *spectral channel pixels* centred on a coarse resolution *pixel* is taken as a *pixel* group. Each fine resolution *pixel* group is identified by a the indices (i,j) of the coarse resolution *pixel*.

$$p = \frac{SSD_{coarse}}{SSD_{fine}}$$

where

$SSD_{coarse}$ is the coarse resolution *spatial sampling distance*

$SSD_{fine}$ is the fine resolution *spatial sampling distance*

The *reference site* for the fine resolution *pixel* group is the mean *reference site* of the fine resolution *pixels*. Due to the properties of the *reference grid* this means that the fine resolution *pixel* group and coarse resolution *pixel* are located at the same position. Likewise the *corrected site* for the fine resolution *pixel* group is the mean *corrected site* of the fine resolution *pixels*.

Synonyms: *misregistration*, *coregistration*

### *Inter-Swath Navigation Error*

The inter-swath navigation error (ISNE) is defined with respect to N adjacent *columns* of *pixels* that have been derived from two adjacent *swaths*, as illustrated in Figure 23, by the equation

$$ISNE_{[ik(s1-s2)rd]} = \left(\overline{CS_{[iks1rd]}} - \overline{CS_{[iks2rd]}}\right) - \left(\overline{RS_{[iks1rd]}} - \overline{RS_{[iks2rd]}}\right)$$

$$\overline{RS_{[iksrd]}} = \frac{\sum_{i-N/2}^{i+N/2}\sum_{j} RS_{[ijksrd]}}{N.\sum_{j} 1}$$

$$\overline{CS_{[iksrd]}} = \frac{\sum_{i-N/2}^{i+N/2}\sum_{j} CS_{[ijksrd]}}{N.\sum_{j} 1}$$

where

*ISNE* is the inter-swath navigation error

*CS* is the *corrected site*

RS is the *reference site*

*i* and *j* identify the *pixel* in terms of *column* and *row* within a *repeat cycle*

*s* is the *swath* of a *repeat cycle*

*s1* and *s2* are two consecutive *swaths* in a *repeat cycle* such that s2=s1+1

*k* is the *spectral channel*

*r* is the *repeat cycle*

*d* is the direction of evaluation (north/south or east/west)

*N* is the number of *columns* over which the average is calculated

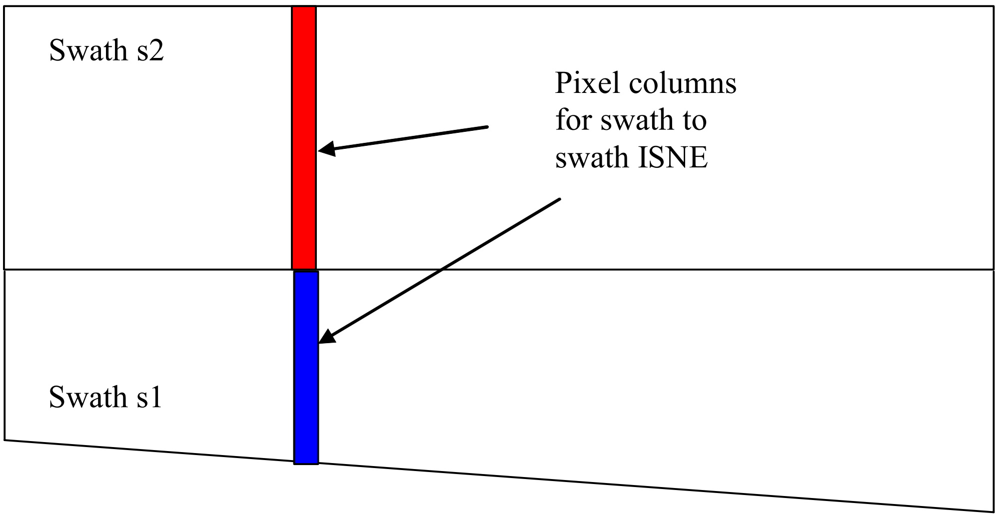



***Figure 23:*** **Columns** ***for ISNE Calculation***

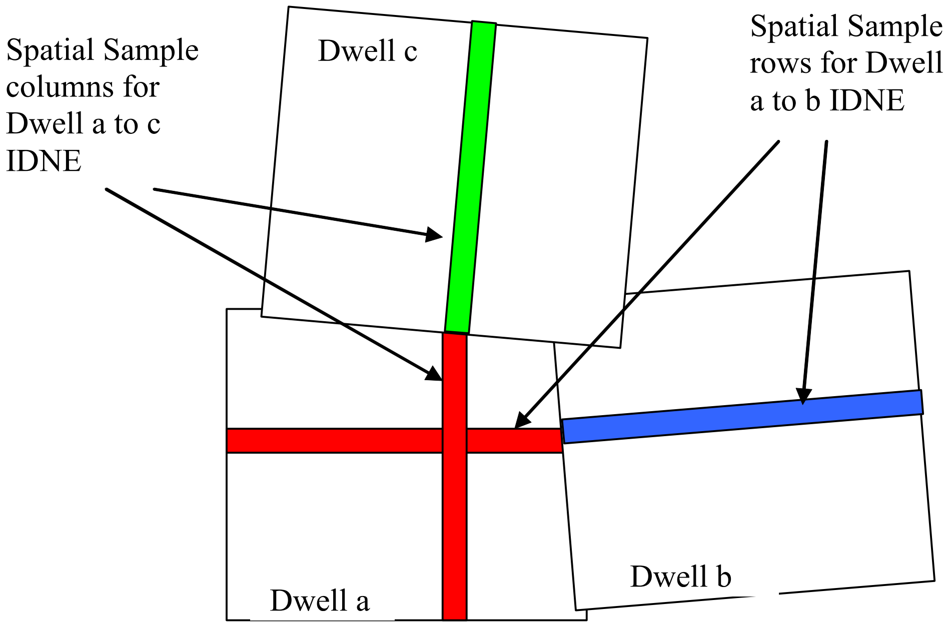



***Figure 24:*** **Columns** ***and*** **Rows** ***for IDNE Calculation***

## Annex F.4.8 Restricted Operations

***Solar Restricted Zone***

The solar restricted zones are described, in terms of the Normalized Geostationary Projection, as illustrated in Figure 25 and the zone defined by the steps

- The T3 axis is the rotation from the GEOS S3 axis by the angle of inclination, i, of the *satellite* toward the satellite-Earth centre, T1, axis.
- The satellite-sun vector, V1, is rotated about the T3 axis by the inner or outer limit radius angle, Θ, to give the vector V2.
- V2 is rotated about V1 to form the restricted zone boundary.

The solar restricted zones are applicable for the uneclipsed and partially eclipsed sun. Inner and outer zones can be defined to allow graded relaxation of requirements for *spatial samples* and *pixels* located close to the sun.

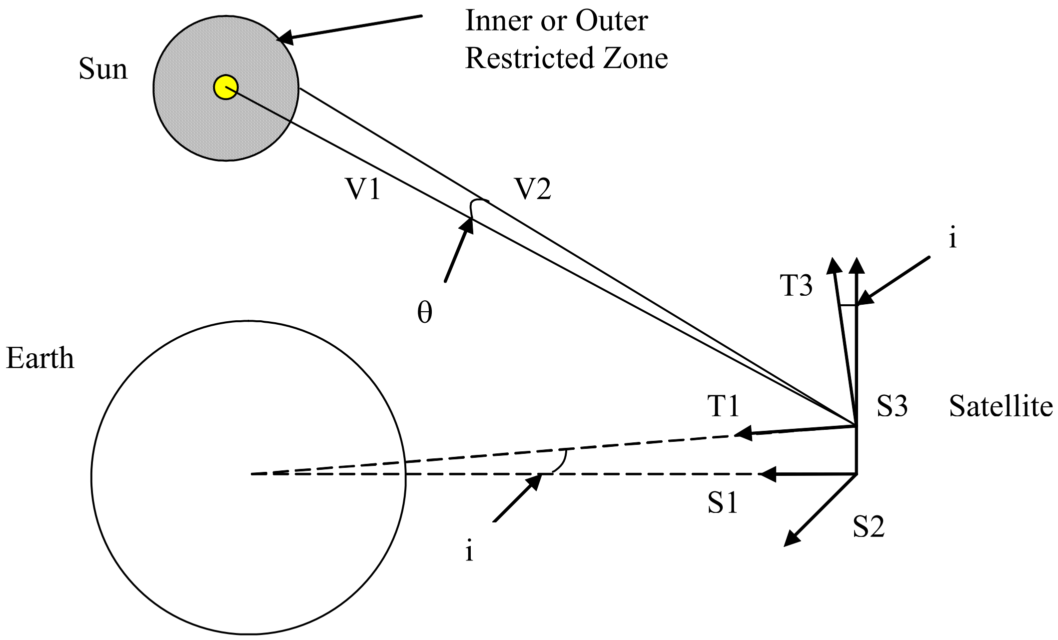



***Figure 25: Illustration of Solar Restricted Zones including orbit inclination***

# Annex F.5 Coordinates Frame Conventions

## Annex F.5.4 Body Frame Specifications

### Annex F.5.4.1 MTG Satellite Coordinate Frames

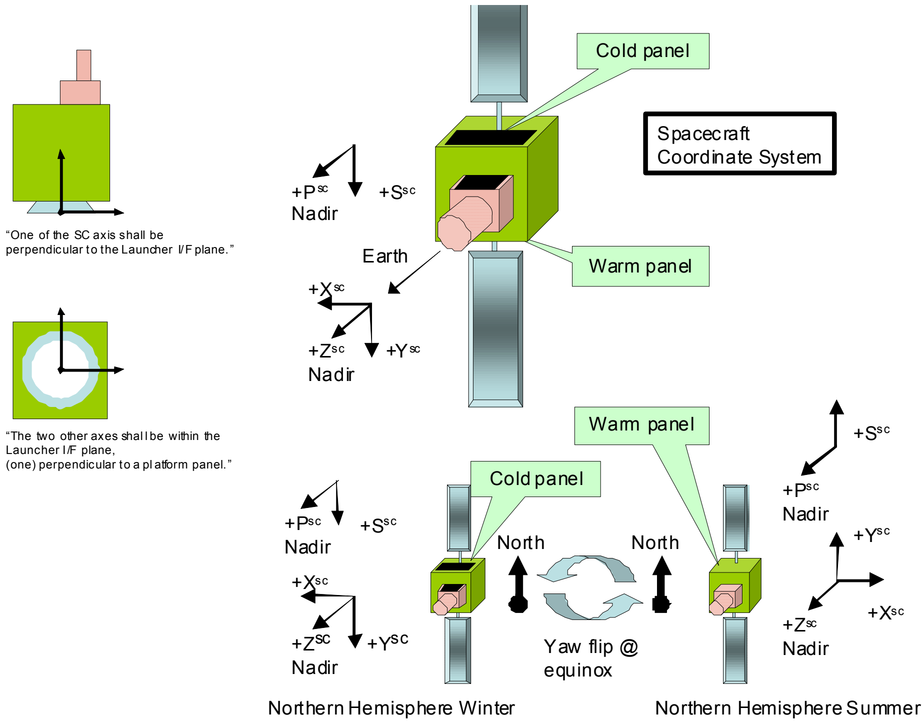



*Figure 26: Schematic S/C Coordinate System*

## Annex F.5.4.2 Local Orbital Frame

### *Local Orbital Frame (LVLH)*

'LVLH' stands for 'Local Vertical Local Horizontal'.

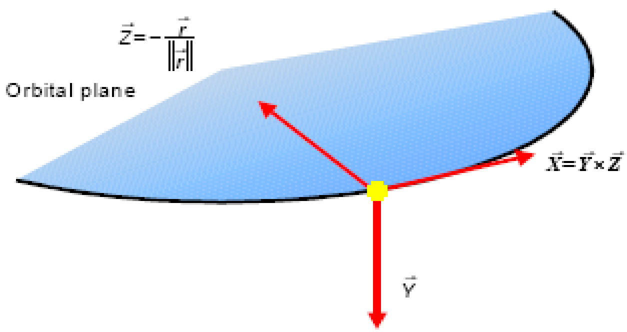



*Figure 27: Local Orbital LVLH frame*

### *Local Orbital Frame (T,N,W)*

In 'TNW', T stands for tangential, N for normal, and W for the Greek omega (ω) denoting the axis of angular momentum.

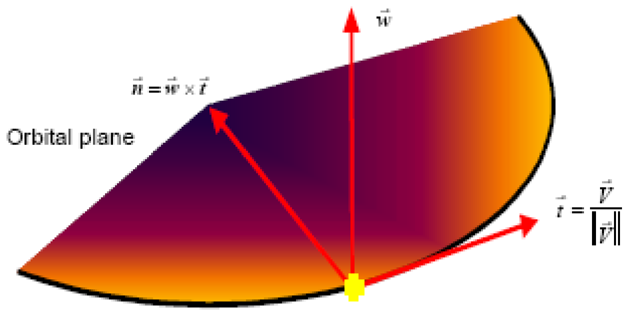



***Figure 28: Local Orbital TNW frame***

### *Local Orbital Frame (Q,S,W)*

Also named RTN (Radial, Transverse, Normal).

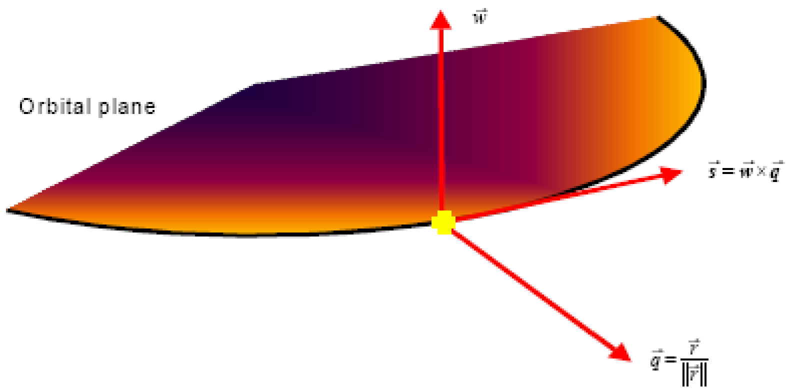



***Figure 29: Local Orbital QSW frame***

## Annex F.5.6 Coordinate System Transformations

### *Normalized Geostationary Projection*

The normalized geostationary projection describes the view from a virtual satellite to an idealized Earth. Herein, the virtual satellite is in a geostationary orbit, perfectly located in the Equator plane at the given longitude, $\lambda_D$. The distance between spacecraft and centre of Earth is given by the geostationary radius and the idealized Earth by the Earth's reference ellipsoid.

In the following a short description of the theoretical background is provided:

Two cartesian coordinate frames are introduced. $(e_1,e_2,e_3)$ has its origin in the centre of the earth. $(e_3)$ points in the northern direction, $(e_1)$ points towards the Greenwich meridian. $(s_1,s_2,s_3)$ has its origin at the satellite position. Again $(s_3)$ points northwards, and $(s_1)$ directs to the centre of the earth. Figure 30 visualizes this situation and identifies several angles and lengths used in the following.

The vector $r_e$ points from the centre of the earth to a point P on the earth's surface. Thus, $\lambda_e$ is the longitude and $\phi_e$ is the geocentric latitude describing the point P. The transformation from geographic coordinates (lon, lat) is as follows:

$$\lambda_e = lon$$

$$\phi_e = \arctan\left(\frac{r_{pol}^2}{r_{eq}^2} \bullet \tan(lat)\right)$$

Where

$r_{pol}$ is the earth's polar radius

$r_{eq}$ is the earth's equatorial radius

The length of $r_e$ is:

$$r_e = \frac{r_{pol}}{\sqrt{1 - \frac{r_{eq}^2 - r_{pol}^2}{r_{eq}^2} \cdot \cos^2(\phi_e)}}$$

The cartesian components of the vector $r_s$ (in the satellite coordinate frame) result as follows:

$$\vec{r}_S = \begin{pmatrix} r_1 \\ r_2 \\ r_3 \end{pmatrix} = \begin{pmatrix} h - r_e \cdot \cos(\phi_e) \cdot \cos(\lambda_e - \lambda_D) \\ - r_e \cdot \cos(\phi_e) \cdot \sin(\lambda_e - \lambda_D) \\ r_e \cdot \sin(\phi_e) \end{pmatrix}$$

From the above equations the satellite scanning angles can be derived:

$$\lambda_s = \arctan\left(\frac{r_2}{r_1}\right)$$

$$\phi_s = \arcsin\left(\frac{r_3}{\sqrt{r_1^2 + r_2^2 + r_3^2}}\right)$$

Note: All trigonometric functions assume angles in degree.

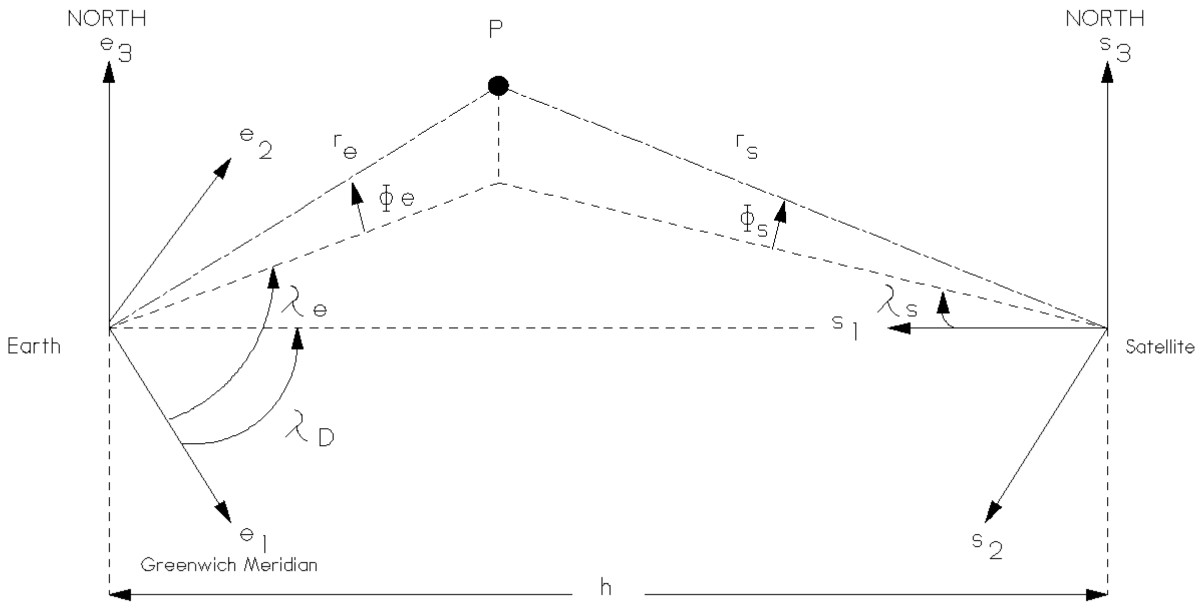



*Figure 30: Coordinate Frames for the Normalized Geostationary Projection*

## Annex F.6 System Parameter and Model Conventions

### Annex F.6.1 Orbit and Attitude Parameters and Models

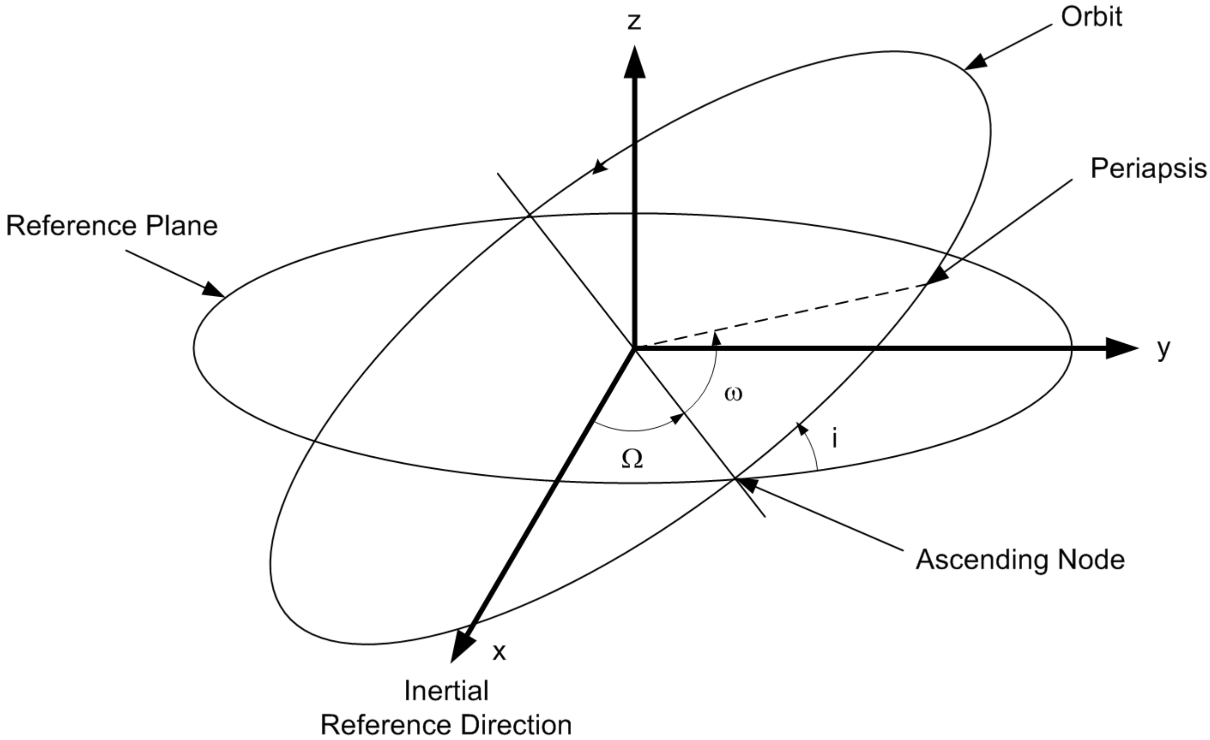



*Figure 31: Classical Keplerian Orbit orientation angles*

***Geostationary Altitude***

The geostationary altitude (35786.4 km) is the distance from the satellite in geostationary orbit to the *sub-satellite point*.

## Annex F.6.2 Earth related Parameters and Models

***Geographical Coordinates***

Geographical co-ordinates give a location on earth as determined by geographical longitude (lon) and geographical latitude (lat). Both co-ordinates are specified in degree.

The geographical longitude is counted eastwards positive, beginning at the Greenwich meridian. The permitted range is -180.0 ... +180.0. The geographical latitude is counted from -90.0 (south pole) through 0.0 (equator) until +90.0 (north pole).

Figure 32 shows the situation for a spherical model of the earth.

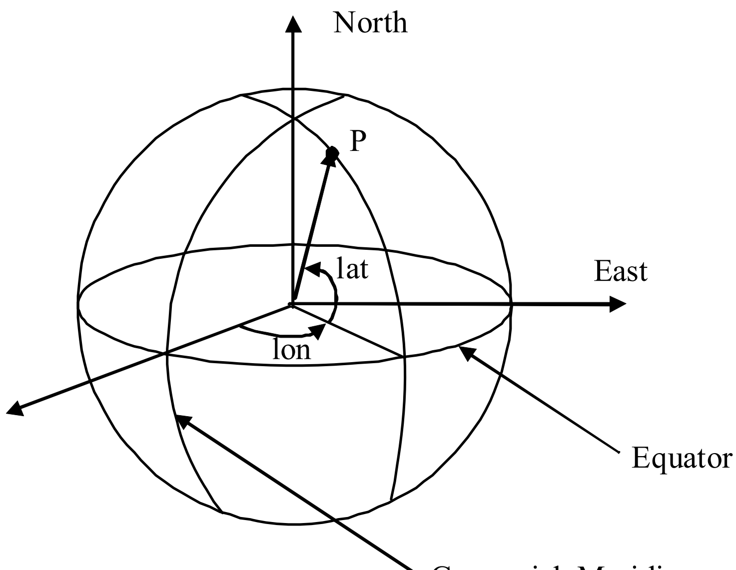



***Figure 32: Geographical Coordinates***

***Geodetic position***

The geodetic coordinates of a point are defined with respect to a given reference surface of the Earth (Earth´s Reference Ellipsoid). The normal projection of a point onto the local horizontal plane defines the *geodetic longitude* $\varphi$, latitude $\lambda$ and the height h (see figure below).

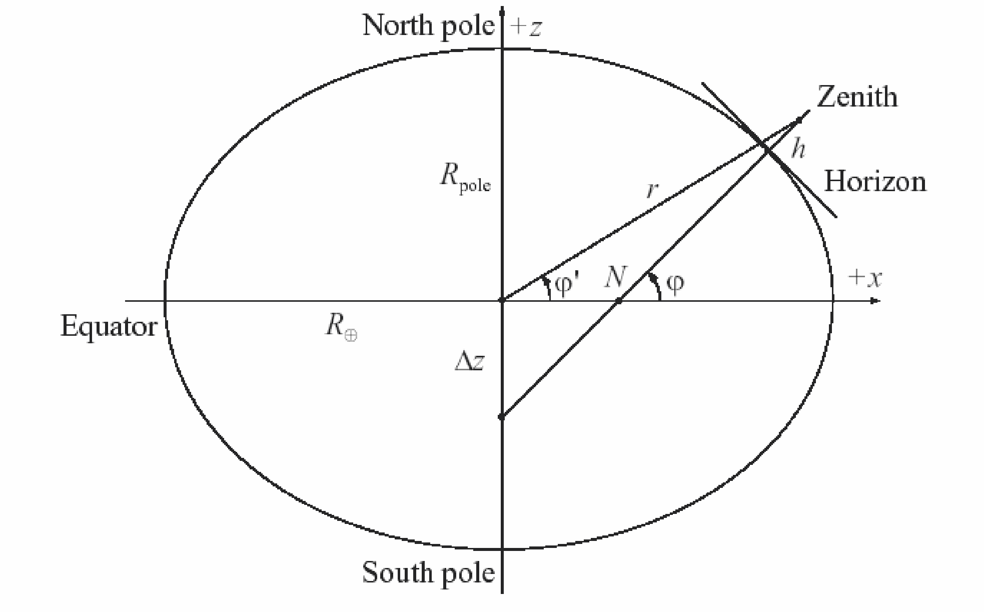



***Figure 33: Geocentric and* geodetic latitude**

***Geodetic latitude***

The geodetic latitude φ differs from the geocentric latitude φ' (see figure above) and are related by the expression:

$$\tan \varphi = \frac{1}{(1-f)^2} \tan \varphi'$$

Note: Geodetic latitude is valid only on the surface of the Earth's reference ellipsoid.

## Annex F.7 Date and Time Conventions

### Annex F.7.1 Time Reference Systems

The following figure provides an overview of the differences between the most relevant time scales described in references [RD2] and [RD5]:

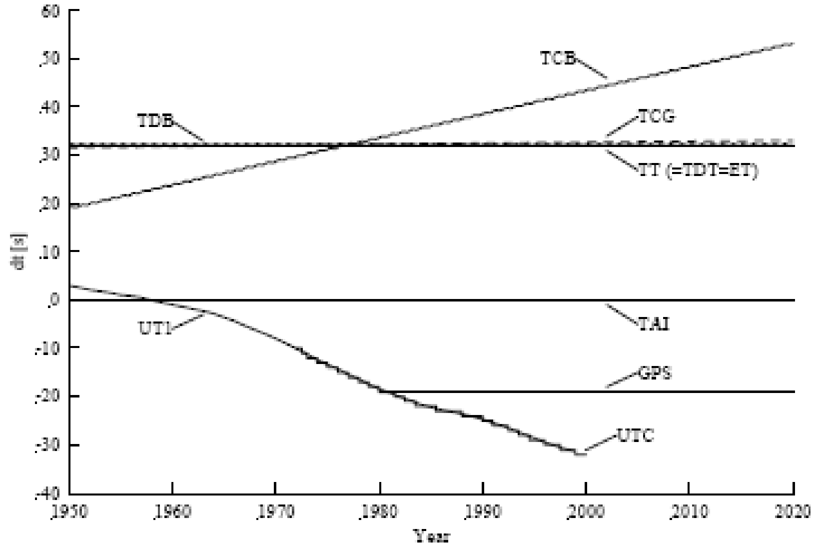



***Figure 34: Differences between Relevant Time Scales between 1950 and 2020***

# APPENDIX G GLOSSARY

The following table lists definitions for all acronyms used in this document. It is a subset of the "MTG Glossary" document.

| Acronym | Full name |
|---|---|
| AD | Applicable Document |
| AEG | Application Expert Group |
| AMV | Atmospheric Motion Vector |
| AND | Alphanumeric Display |
| APP | Aerosol Profile Product |
| APPKE | Absolute Pixel Position Knowledge Error |
| ARGOS | Advanced Research and Global Observation Satellite |
| ASMET | African Satellite Meteorology Education and Training |
| ASPKE | Absolute Sample Position Knowledge Error |
| ASR | All Sky Radiance |
| CAL | Calibration |
| CDS | CCSDS Day segmented Time Code |
| CDOP | Continuous Development and Operational Phase |
| CG | Cloud-to-ground lighning |
| CGMS | Coordination Group for Meteorological Satellites |
| CLA | Cloud Analysis |
| CLM | Cloud Mask |
| CNES | Centre National d'Etudes Spatiales (French Space Agency) |
| CONV | Conventions and Terms document |
| COSPAS | Cosmicheskaya Sistyema Poiska Avariynich Sudov (Space System for the Search of Vessels in Distress) |
| CRM | Clear Sky Reflectance map |
| CSWP | Clear Sky WInd Profile |
| DCP | Data Collection Platforms |
| DCS | Data Collection System |
| DE | Detection Efficiency |
| DIV | Divergence |
| DWD | Deutscher WetterDienst |
| E/W | East/West |
| EC | European Commission |
| ECMWF | European Centre for Medium Range Weather Forecasting |
| EO | Earth Observation |
| EPS | EUMETSAT Polar System |
| ESA | European Space Agency |
| EUMETCAL | The European Virtual Organisation for Meteorological Training |
| EUMETCast | EUMETSAT's Broadcast System for Environmental Data |
| EUMETSAT | European Organisation for the Exploitation of Meteorological Satellites |
| EURD | End Users Requirements Document |

| Acronym | Full name |
|---|---|
| FAR | False Alarm Rate |
| FAR | Flight Acceptance Review |
| FCI | Flexible Combined Imagery Mission |
| FDC | Full Disc Coverage |
| FDHSI | Full Disc High Spectral resolution Imagery mission |
| FDSS | Full Disc Scanning Service |
| FG | Fixed Gain |
| FIR | Active Fire Monitoring |
| FOC | Full Operational Capability |
| FSD | Foreign Satellite Data |
| FTS | Fourier Transform Spectrometer |
| GEO | Geostationary Orbit<br>Group on Earth Observations |
| GEONETCast | global network of satellite based data dissemination systems |
| GEOSAR | Geostationary Search and Rescue mission |
| GIFTS | Geosynchronous Imaging Fourier Transform Spectrometer |
| GII | Global Instability Index |
| GMES | Global Monitoring for Environment and Security |
| GPCP | Global Precipitation Climatology Project |
| GTS | Global Telecommunication System |
| HPI | High Resolution Precipitation Index |
| HQ | Headquarter |
| HRFI | High Resolution Fast Imagery mission |
| HRV | High Resolution Visible |
| IASI | Infrared Atmospheric Sounding Interferometer |
| IC | Intra-cloud lightning |
| IDCS | International Data Collection System |
| IDS | ISCCP data-set |
| IODC | Indian Ocean Data Coverage |
| IR | Infrared |
| IRS | Infrared Sounding Mission |
| ISCCP | International Satellite Cloud Climatology Project |
| LAC | Local Area Coverage<br>Limited Area Coverage |
| LI | Lightning Imagery Mission |
| LTC | Lower Tropospheric Composition |
| LWIR | Long Wave Infra Red |
| MDD | Meteorological Data Distribution |
| MHz | MegaHertz |
| MOSS | Meteosat Operation Service Specification |

| Acronym | Full name |
|---|---|
| MPE | Multi-sensor Precipitation Estimate |
| MPE | Meteorological Products Extraction mission |
| MSG | Meteosat Second Generation |
| MTG | Metosat Third Generation |
| MTP | Meteosat Transistion Program |
| MWIR | Medium Wave Infra Red |
| N/A | Not Applicable |
| N/S | North/South |
| NEdT | Noise Equivalent Differential Temperature |
| NGA | National Geospatial Agency |
| NIR | Near-Infrared |
| NMS | National Meteorological Services |
| NMS | Network Monitoring System |
| NOAA | National Oceanic and Atmospheric Administration |
| NWP | Numerical Weather Prediction |
| OCA | Optimal Cloud Analysis |
| OLR | Outgoing Longwave Radiation |
| OPP | Ozone Profile Product |
| OZA | Observation Zenith angle |
| PBL | Planetary Boundary Layer |
| PC | Principal components |
| PPP | Preparatory Programme Proposal |
| PRR | Preliminary Requirements Review |
| RMDCN | Regional Meteorological Data Communication Network |
| RPPKE | Relative Pixel Position Knowledge Error |
| RSE | Remote Sensing Expert |
| RSPKE | Relative Sample Position Knowledge Error |
| RSS | Rapid Scanning Service |
| SAF | Satellite Application Facilities |

| Acronym | Full name |
|---|---|
| SAR | Search and Rescue |
| SARSAT | Search and Rescue Satellite - Aided Tracking |
| SEVIRI | Spinning Enhanced Visible and Infrared Imager |
| SNR | Signal to Noise Ratio |
| SRD | System Requirements Document |
| SRF | Spectral Response Function |
| SRR | System Requirement Review |
| SSD | Spatial Sampling Distance |
| SSI | Spectral Sampling Interval |
| SSP | Sub-Satellite Point (Nadir) |
| STG | Scientific and Technical Group |
| TBC | To Be Confirmed |
| TBD | To Be Defined/Determined |
| TBW | To Be Written |
| TIR | Thermal Infrared |
| TOZ | Total Ozone |
| UMARF | Unified Meteorological Archive and Retrieval Facility |
| UNS | User Notification Service |
| UTC | Universal Time Coordinated |
| UV | Ultra-violet |
| UVN | Ultraviolet, Visible and Near-infrared<br>UV-VIS and NIR spectrometer/instrument |
| UVNCP | UVN Cloud product |
| VIS | Visible |
| VOL | Volcanic Ash product |
| WIS | WMO Information System |
| WMO | World Meteorological Organisation |
| WRCP | World Climate Research Programme |