CGMS-WMO Task Force on Metadata Implementation

Guidance Documentation on WMO Core Profile Metadata Creation For Satellite Products

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# Introduction

The CGMS Task Force on Metadata Implementation (CGMS-WMO TFMI) has been created in 2015 and tasked to define guidance documentation for creating WMO Core Profile 1.3 metadata records regarding Satellite Data Products and helping Meteorological Satellite Data Organisation defining and maintaining WIS discovery metadata records.

This documentation is intended for metadata authors or product/infrastructure specialist that would like to create WMO Core Profile 1.3 metadata records for making datasets available via the WMO Information System infrastructure.

The following guide is not intended to create metadata records for datasets that are being distributed on the WMO Global Telecommunication System (GTS) as bulletins. For creating such metadata records, please consult [tbd].

The guidance documentation is composed of the present document and associated WMO Core Profile Templates (see 2 References) that can be used to create individual metadata records or automate the creation of several records. The documentation regroup and define a set of recommendations to be followed in order to provide the right level of satellite product information in the defined WMO Core Profile metadata records. The information included in the metadata record and their respective XML mapping is based on a study involving Satellite data specialists of CGMS member organizations and the WMO IPET-SUP.

# References

WMO Core Profile 1.3 Template:

To view the template use that link:

<https://github.com/CGMS-TFMI/CGMSTFMI-Teleconferences/blob/master/CGMS-TF-MI-Publications/CGMSTFMI-WMOCoreProfile-Guidance-Documentation/WMO-Core-Profile-Templates/WMOCoreProfile1.3-Template.xml>

to download the template use that link:

<https://raw.githubusercontent.com/CGMS-TFMI/CGMSTFMI-Teleconferences/master/CGMS-TF-MI-Publications/CGMSTFMI-WMOCoreProfile-Guidance-Documentation/WMO-Core-Profile-Templates/WMOCoreProfile1.3-Template.xml>

WMOCore Profile 1.3 Raw Template:

To view the template use that link:

<https://github.com/CGMS-TFMI/CGMSTFMI-Teleconferences/blob/master/CGMS-TF-MI-Publications/CGMSTFMI-WMOCoreProfile-Guidance-Documentation/WMO-Core-Profile-Templates/WMOCoreProfile1.3-RawTemplate.xml>

to download the template use that link:

<https://raw.githubusercontent.com/CGMS-TFMI/CGMSTFMI-Teleconferences/master/CGMS-TF-MI-Publications/CGMSTFMI-WMOCoreProfile-Guidance-Documentation/WMO-Core-Profile-Templates/WMOCoreProfile1.3-RawTemplate.xml>

CGMS TFMI Information Model:

<http://www.cgms-info.org/documents/CGMS-TF-MI-SatelliteDataEssentialInformationForDiscoveryMetadata.pdf>

WIS Guidance for creating GTS bulletin metadata:

<http://www.wmo.int/pages/prog/www/WIS/wiswiki/tiki-index.php?page=WmoCoreMetadata>

WMO Core Profile documentation:

Part 1 : <http://wis.wmo.int/2012/metadata/WMO_Core_Metadata_Profile_v1.3_Part_1.pdf>

Part 2 : <http://wis.wmo.int/2012/metadata/WMO_Core_Metadata_Profile_v1.3_Part_2.pdf>

OSCAR Space-based capabilities: <https://www.wmo-sat.info/oscar/spacecapabilities>

# WIS DIscovery Metadata

## WMO Core Profile Presentation

The WMO Core Profile 1.3 is qualified as discovery metadata and used to provide information regarding a particular product. The information contained in the metadata record is used to create the discovery services provided by the WIS Product catalogues called Global Information System Centres (GISC). In the WIS, users need to go to one of the GISCs for discovering and accessing products. Typically a discovery metadata record has to contain the following categories of information regarding a product to help users understanding that product:

1. **Product Information: This part regroup all topic categories regarding the product information**
   * **What**: This is the information regarding the product content and it is mainly defined by the Product Title and the Product Abstract. That information is very important to provide the best possible user’s discovery experience as the Product Title and Abstract are going to be indexed by the Product catalogue (GISC) for creating the discovery services but also in addition to present products in the search result page and the product description page of each WIS Catalogue.
   * **When**: This is the temporal extent described in the metadata record defining the time period under which the product has been produced. It is possible to describe on-going or finite datasets.
   * **Where**: This is the geospatial extent describing which geographical area the product covers over the earth or atmosphere. It can be the full earth, a region or a specific place. It is usually defined as a bounding box with lat-lon coordinate but it can also be built on geographical identifiers such as station names, geographical regions.
   * **Who**: This set of information regroups contact details of the product responsible organization and the contact details of the metadata responsible organization. It can be the same responsible party for both metadata and data.
   * **How to access the product**: This part provides information on how to access the product. It is composed of the distribution information but contains also the data policies or terms and conditions for accessing the product. Most of the time, it is a URL link towards a data access service allowing to sub-select/sub-sample part of the product with a potential required registration if the data policy is restricting the access.
2. **WIS necessary technical information**: This part defines the required set of information to have a functioning-distributed WIS infrastructure. This regroups for instance the WIS unique identifier for each metadata records.

## WMO Core Profile and ISO standard

The WMO Core Profile 1.3 is a customization also called a profile of the more generic ISO 19115 discovery metadata standard allowing the meteorological community to define accurately meteorological products (terrestrial, earth observations, numerical weather predictions model outputs). The ISO 19115 structure is following an information model which is very extensive and requires a deep knowledge and investment for understanding all its intricacies.

By using the current guide for creating metadata records, it is not necessary to be a ISO 19115 metadata expert to start creating WMO Core Profile 1.3 metadata records.

## WMO Core Profile Metadata Scope

One difficulty when creating a metadata record is to understand what should be described in the record for a particular product. Indeed, products of the same type during the life time of a satellite or for forecast outputs are continuously produced and creating a new metadata record for each individual satellite instrument measurement granule produced every three minutes or forecast run produced three times a day would make the WIS catalogues continuously growing and would damage the search experience. In that case, there would be for instance thousands of metadata records returned, with all of them having almost the same information apart from the measurement time when looking for instance, for Infrared radiances from the NOAA GEOS satellite. This would dramatically damage the search experience and would make it difficult to find products.

For this reason, the CGMS TFMI recommends creating one metadata record for an entire “collection” of products where in the collection, the satellite product will only vary within one or multiple dimensions (time, geographical position) while still coming from the same instrument. For instance, EUMETSAT Meteosat Second Generation (MSG) Seviri Level 1.5 which describes all the level 1.5 radiances over the entire MSG mission is described by one unique metadata record. The user discovering this product collection via the WIS portals is re-directed to a EUMETSAT service offering sub-sampling capacities for selecting the interesting time period and geographic region. It is up to the product provider to decide what is a valid collection.

# WIS product Categories

The WIS comprises two different families of products and associated metadata records: The GTS and the DCPC/NC products. The first category is regrouping all datasets intended for global exchange to be distributed via GTS and subject to follow and respect the GTS standards and regulations such as having a bulletin header and providing information allowing WIS portals to directly re-distribute those datasets. Defining metadata records for the GTS bulletin datasets need to follow a set of additional rules and requires an understanding of the GTS. The second category is regrouping datasets described and searchable from the WIS catalogues but served from the different responsible organizations via their own infrastructure and data access services. These products also called DCPC products are the typical datasets to be distributed by satellite providers and shared within the meteorological community. The WMO Core Profile (WMCP) 1.3 metadata records for DCPC datasets have to follow a minimum set of rules to stay compliant with the standard.

The present guide is a solely focusing on describing how to create metadata records for the second category (DCPC datasets) as it is most useful for the meteorological satellite data providers. Please read the WIS Guidance for creating bulletin metadata (See 2 References) in case you would like to define metadata records intended for the GTS.

# COMPLIANCE to additional metadata standards

The current guide is allowing metadata author to create WMO Core Profile 1.3 metadata records that can become compliant with additional metadata recommendations/standards such as for instance the European INSPIRE regulation (see REF technical guidelines recommendations). In that case the metadata author will have to insert in the metadata record the necessary information for being compliant with an additional given standard.

# Generating WMO Core Profile METADATA

This guide is intended to help product specialists creating WIS metadata records describing satellite products. It describes how and where to insert the necessary product information but also WIS specific information in the XML metadata record while abstracting as much as possible the WMO Core Profile standard, ISO 19115 standard and its XML mapping (ISO 19139). The current guide is defining from [. ] a set of recommendations when adding each individual pieces of information regarding a product (title, abstract, data responsible party, data access, etc).

A template based approach has been also chosen to abstract the ISO 19115 standards and a metadata author consulting this guide should make a copy of WMOCoreProfile1.3-Template.xml or WMOCoreProfile1.3-RawTemplate.xml and open that template and fill the information regarding the product he intends to make available via the WIS following the recommendations from [. ]. The template-based approach allows a non-knowledgeable person in ISO 19115 to create an XML metadata record with the most important set of information to make them easily searchable and accessible from a WIS portal.

This approach can also be used as the foundation for building a web-based editing tool where the user will fill a web form that will be used to populate the template to create the final metadata record.

## Template-based principle

A Template is a file containing placeholders or variables that should be replaced with dedicated product information to create a WIS discovery metadata record. The placeholders in the template are in all in capital letters in the form of for instance WMCP-CREATION-DATE or PRODUCT-TITLE.

WMOCoreProfile1.3-Template.xml (see 2 References) is a template for human beings containing in addition to the placeholders, examples in parentheses, ie. ORGANISATION-NAME (e.g NOAA). With a minimum set of effort, a metadata author can by following the examples in WMOCoreProfile1.3-Template.xml and the guidance recommendations from [. ] replace the different placeholders and create a WMO Core Profile 1.3 compliant record.

WMOCoreProfile1.3-RawTemplate.xml is a template with only the placeholders, which can be used as a starting template record for automating the generation of metadata records.

# WMO Core Profile CGMS TFMI recommendations

The following paragraph describes the list of information to provide to build a meaningful metadata record and for each individual information, the template placeholder(s) to replace, what information is expected from the metadata creator, its location within the ISO metadata records and some examples. The metadata creator should while reading the documentation, open the metadata template WMOCoreProfile1.3-Template.xml and find the corresponding placeholder(s) to add the product information.

Information sets below are described in the given order: Product Information, WIS Technical Information, Addiitonal Satellite information. For each element it will be indicated if it is a mandatory attribute to be compliant with the WMO Core Profile 1.3.

## Product Information

|  |  |
| --- | --- |
| **Metadata Responsible Party** | |
| ***TEMPLATE Value:*** | ADD-ORGANISATION-NAME, ADD-ADDRESS-STREET, etc |
| ***Information:*** | Responsible party for the created metadata record |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 |
| ***Category:*** | Administrative information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:contact/gmd:CI\_ResponsibleParty* |
|  |  |

This element describes the metadata responsible party contact details (address, telephone, email). For example:

<gmd:contact>

<gmd:CI\_ResponsibleParty>

<gmd:organisationName>

<gco:CharacterString>EUMETSAT</gco:CharacterString>

</gmd:organisationName>

<gmd:contactInfo>

<gmd:CI\_Contact>

<gmd:address>

<gmd:CI\_Address>

<gmd:deliveryPoint>

<gco:CharacterString>EUMETSAT Allee 1</gco:CharacterString>

</gmd:deliveryPoint>

<gmd:city>

<gco:CharacterString>Darmstadt</gco:CharacterString>

</gmd:city>

<gmd:administrativeArea>

<gco:CharacterString>Hessen</gco:CharacterString>

</gmd:administrativeArea>

<gmd:postalCode>

<gco:CharacterString>64295</gco:CharacterString>

</gmd:postalCode>

<gmd:country>

<gco:CharacterString>Germany</gco:CharacterString>

</gmd:country>

<gmd:electronicMailAddress>

<gco:CharacterString>ops@eumetsat.int</gco:CharacterString>

</gmd:electronicMailAddress>

</gmd:CI\_Address>

</gmd:address>

<gmd:onlineResource>

<gmd:CI\_OnlineResource>

<gmd:linkage>

<gmd:URL>http://www.eumetsat.int</gmd:URL>

</gmd:linkage>

</gmd:CI\_OnlineResource>

</gmd:onlineResource>

</gmd:CI\_Contact>

</gmd:contactInfo>

<gmd:role>

<gmd:CI\_RoleCode codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO\_19139\_Schemas/resources/Codelist/ML\_gmxCodelists.xml#MD\_ScopeCode" codeListValue="pointOfContact">pointOfContact</gmd:CI\_RoleCode>

</gmd:role>

</gmd:CI\_ResponsibleParty>

</gmd:contact>

|  |  |
| --- | --- |
| **Product Level** | |
| TEMPLATE Value: | ADD-PRODUCT-LEVEL |
| Information: | Product Processing Level |
| Necessity: | Optional. Recommend by the CGMS TFMI |
| Category: | Product Information |
| XPath: | */gmd:MD\_Metadata/gmd:contentInfo/gmd:MD\_ImageDescription/gmd:processingLevelCode/ /gmd:code/gco:CharacterString* |

This element describes the product level. Within the earth observation community the level indicates the type of processing that has been applied to original product.

* Level 0 is the original products at full resolution, with all communications artifacts (synchronization frames, ...) removed.
* Level 1 contains the instrument data at full resolution time-referenced with or without radiometric and geometric calibration coefficients and georeferencing parameters applied, depending on the level 1 type. The CGMS TFMI recommends to use the level definition from 8.1 for the different level 1 types.
* Level 2 regroups all derived geophysical variables at the same resolution and location as the Level 1 products.

|  |  |
| --- | --- |
| **Product Responsilbe Party** | |
| TEMPLATE Value: | ADD-PRODUCT-RESPONSIBLE-PARTY |
| Information: | Organisation responsible for the product described in the metadata record |
| Necessity: | Mandatory for WMO Core Profile 1.3 |
| Category: | Product Information |
| XPath: | */gmd:MD\_Metadata/gmd:identificationInfo//gmd:pointOfContact* |

This element contains the contact details regarding the data provider responsible for the product. For an example please refer to the example of “**Metadata Responsible Party”** as it is using the XML element to provide the contact details.

|  |  |
| --- | --- |
| **Product Title** | |
| ***TEMPLATE Value:*** | ADD-PRODUCT-TITLE |
| ***Information:*** | Product Name |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 |
| ***Category:*** | Product information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:identificationInfo//gmd:citation/ /gmd:alternateTitle/gco:CharacterString* |

The Product Title and the Product Abstract are the two most relevant elements in the WCMP metadata record in the context of the WIS Product catalogues as those two elements are presented to the users in the search results and product description page to highlight the product characteristics. They therefore need to focus on presenting the product to the users.

For level 1 products that are calibrated and georeferenced measurements, the CGMS TFMI recommends to define the origin instrument name and type (Imager, Sounder, Altimeter), the product level, the measurement type, the satellite name if well know by the user community. In case of a geostationary satellite, the satellite position (0 degrees) is recommended in the title when it can be shortly described using a geographic identifier.

For instance for products created from geostationary satellites: “AMSR-2 Level 1 Brightness Temperature - GCOM-W1”, “High Rate SEVIRI L1.5 Image Data – MSG – 0 degree”. For products created from LEO satellites: “SLSTR L1B radiances and brightness temperatures in NTC”, “HIRS GDS Level 1B – NOAA”,

For level 2 products that are measurements derived products, the CGMS TFMI recommends to qualify the product type and indicate from which instrument the product originates when relevant. A list of typical product types is provided in annex 1 of this document.

For instance typical titles could be: “AMSR-2 Sea Surface Temperature - GCOM-W1”, “Operational Geophysical Data Record - Sea Surface Height Anomaly - Jason-2”, “Effective Snow Cover by VIS/IR Radiometry”. Below is an example:

<gmd:identificationInfo>

<gmd:MD\_DataIdentification>

<gmd:citation>

<gmd:CI\_Citation>

<gmd:title>

<gco:CharacterString/>

</gmd:title>

<gmd:alternateTitle>

<gco:CharacterString>

AMSR-2 Level 1 Brightness Temperature - GCOM-W1

</gco:CharacterString>

</gmd:alternateTitle>

<gmd:CI\_Citation>

<gmd:citation>

<gmd:MD\_DataIdentification>

<gmd:identificationInfo>

|  |  |
| --- | --- |
| **Product Abstract** | |
| ***TEMPLATE Value:*** | ADD-PRODUCT-ABSTRACT |
| ***Information:*** | Abstract describing the product |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 |
| ***Category:*** | Product information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:identificationInfo//gmd:abstract* |
|  |  |

The product abstract is important in the context of the WIS catalogues, as it is the product information that is presented in the search results page. It should describe what is judged important by the data producer for informing and attracting users to use his product. The CGMS TFMI is recommending to structure the product description in the way described below in order to create a more coherent and homogenous set of satellite data products on the WIS. Having product abstracts structured similarly will help users comparing and related different satellite data products.

The product abstract should focus on describing the satellite product and in particular the origin instrument name and type, the product level, geometry and production frequency (hourly, every 3 minutes, etc). Information related to the product processing can also be provided when relevant. Additionally information related to the format in which the product is made available and the way of getting access to the product is relevant (name the type of service from which the product is available).

1. **Abstract for Level 1 Products:**

The CGMS TFMI recommends using the list of instrument types from Annex [8.4 Instrument types, and associated characteristics of L1 products], the level 1 types from Annex [8.1 Level 1 type] and the geometry types [8.2 Level 1 product geometry] to create the product abstract.

For instance below is a typical Level 1 product abstract:

*This is the rectified High Rate Meteosat SEVIRI image data product. It is a High Rate, every 15 mins transmission products in 12 spectral channels from SEVIRI, a moderate-resolution optical imager with a fixed disc like field of view centered at 0 degree latitude and 0 degree longitude. Level 1.5 (commonly denominated as Level 1c) image data corresponds to the geolocated and radiometrically pre-processed image data, ready for further processing, e.g. the extraction of meteorological products. Any spacecraft specific effects have been removed, and in particular, linearisation and equalisation of the image radiometry has been performed for all SEVIRI channels. The on-board blackbody data has been processed. Both radiometric and geometric quality control information is included. The product is available in HRIT on EUMETCAST the EUMETSAT NRT dissemination system and in a variety of format (native, netcdf, JPG, PNG, Tiff, etc, see distribution part for more information). There are 96 products generated over a complete day (every 15 mins).*

1. **Abstract Level 2 Products:**

Level 2 Products are products derived from the orginal measurements and as the scope is wider it is more difficult to establish a comprehensive list of the different product type. Therefore the CGMS TFMI recommends using the Level 2 products type defined in Annex 8.3 Level 2 Product types.

Here is a typical Level 2 product abstract:

***Title****: IASI Atmospheric Temperature Water Vapour and Surface Skin Temperature - Metop*

*The Atmospheric Temperature, Water Vapour and Surface Skin Temperature (TWT) product contains the vertical profiles of atmospheric temperature and humidity, with a vertical sampling at 101 pressure levels, and surface skin temperature. The vertical profiles are retrieved from the IASI sounder measurements (of IASI L1C product) together with collocated microwave measurements (AMSU & MHS 1B) when available. The main objective of the Infrared Atmospheric Sounding Interferometer (IASI) is to provide high resolution atmospheric emission spectra to derive temperature and humidity profiles with high spectral and vertical resolution and accuracy. Additionally it is used for the determination of trace gases, as well as land and sea surface temperature, emissivity and cloud properties. The products are provided at the single IASI footprint resolution (which is about 12 km with a spatial sampling of about 25 km at Nadir). The quality and yield of the vertical profiles retrieved in cloudy IFOVs is strongly related to the cloud properties available in the IASI CLP product and the availability of collocated microwave measurements.*

|  |  |  |
| --- | --- | --- |
| **Temporal Extent** | | |
| ***TEMPLATE Value:*** | ADD-TEMPORAL-INFORMATION | |
| ***Information:*** | Time period for which the product is available | |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 | |
| ***Category:*** | Product information | |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:identificationInfo///gmd:extent[3]//gmd:temporalElement/gmd:EX\_TemporalExtent/gmd:extent* | |
|  | |  |

This element describes the starting and ending date or date and time information for the data product. The date information is constructed as YYYY-MM-DD, The date and time information is constructed as YYYY-MM-DDTHH:MM:SSZ. For example: 2016-04-17T13:42:54Z.

The following example shows a dataset with a starting date and an ending date

<gmd:temporalElement>

<gmd:EX\_TemporalExtent id="boundingTemporalExtent">

<gmd:extent>

<gml:TimePeriod gml:id="boundingTemporalExtentPeriod">

<gml:beginPosition>1878-06-27</gml:beginPosition>

<gml:endPosition>2012-12-31</gml:endPosition>

</gml:TimePeriod>

</gmd:extent>

</gmd:EX\_TemporalExtent>

</gmd:temporalElement>

Reference metadata: <http://data.nodc.noaa.gov/geoportal/rest/document?id=%7BBFF658F0-66A1-45E5-B107-446DAF02695F%7D>

It is also possible to describe on-going datasets with a starting date but no ending dates. In that case the attribute indeterminatePosition=”now” should be used.

<gmd:temporalElement>

<gmd:EX\_TemporalExtent id="temporalExtent">

<gmd:extent>

<gml:TimePeriod gml:id="boundingTemporalExtentPeriod">

<gml:beginPosition>2006-10-01</gml:beginPosition>

<gml:endPosition indeterminatePosition="now"/>

</gml:TimePeriod>

</gmd:extent>

</gmd:EX\_TemporalExtent>

</gmd:temporalElement>

Reference metadata: <http://data.nodc.noaa.gov/geoportal/rest/document?id=%7B129EE48B-D70E-4129-BBC0-338BF1622D62%7D>

|  |  |
| --- | --- |
| **Geographical Information** | |
| ***TEMPLATE Value:*** | ADD-GEOSPATIAL-INFORMATION |
| ***Information:*** | Geographic coverage of the product as a bounding box in Latitude/Longitude |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 |
| ***Category:*** | Product Information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:identificationInfo//gmd:extent//gmd:geographicElement/*  *gmd:EX\_GeographicBoundingBox* |

Geographical area covered by the data product. The geographical area is described as a bounding box with latitude and longitude in decimal degrees.

The following example shows the XML element for a dataset with a bounding box information.

<gmd:geographicElement>

<gmd:EX\_GeographicBoundingBox id="boundingGeographicBoundingBox">

<gmd:westBoundLongitude>

<gco:Decimal>-180</gco:Decimal>

</gmd:westBoundLongitude>

<gmd:eastBoundLongitude>

<gco:Decimal>180</gco:Decimal>

</gmd:eastBoundLongitude>

<gmd:southBoundLatitude>

<gco:Decimal>-90</gco:Decimal>

</gmd:southBoundLatitude>

<gmd:northBoundLatitude>

<gco:Decimal>90</gco:Decimal>

</gmd:northBoundLatitude>

</gmd:EX\_GeographicBoundingBox>

</gmd:geographicElement>

|  |  |
| --- | --- |
| **Geographic Identifier** | |
| ***TEMPLATE Value:*** | ADD-GEOGRAPHIC-IDENTIFIER |
| ***Information:*** | Geographic Identifier indicating the zone covered on earth by the product |
| ***Necessity:*** | Optional |
| ***Category:*** | Product Information |
| ***XPath:*** | /gmd:MD\_Metadata/gmd:identificationInfo//gmd:extent//gmd:geographicIdentifier//gmd:code/gco:CharacterString |

Optional geographic identifier indicating the zone covered on earth by the product when it is a well know acronym in the targeted user community.

<gmd:extent>

<gmd:EX\_Extent>

<gmd:geographicElement>

<gmd:EX\_GeographicDescription>

<gmd:geographicIdentifier>

<gmd:MD\_Identifier>

<gmd:code>

<gco:CharacterString>ADD-GEOGRAPHIC-IDENTIFIER (eg. Full Disk 0 degrees)</gco:CharacterString>

</gmd:code>

</gmd:MD\_Identifier>

</gmd:geographicIdentifier>

</gmd:EX\_GeographicDescription>

</gmd:geographicElement>

</gmd:EX\_Extent>

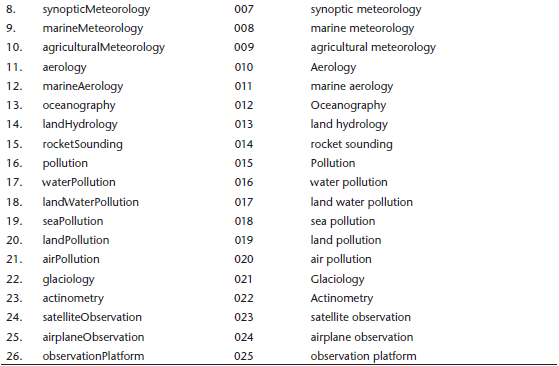
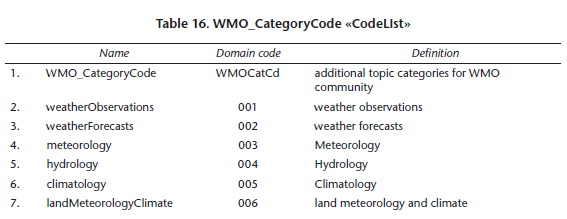
</gmd:extent>

### Descriptive keywords

Descriptive keywords are used to add additional information for classifying the products

|  |  |
| --- | --- |
| **WMO Keyword Category** | |
| ***TEMPLATE Value:*** | WCMP-WMO-CATEGORY-CODE |
| ***Information:*** | One of the WMO Category keywrods for classifiying the product. |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 |
| ***Category:*** | Product Information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:identificationInfo/gmd:MD\_Identification/gmd:descriptiveKeywords* |

Any WIS referenced product shall have a least one WMO Category keyword. The chosen keyword shall be one of the following available values:



The CGMS TFMI recommends to use for satellite products the keyword “satelliteObservation” (024). An additional keyword can also be added if necessary to define the scientific field. For instance below is an example to qualify the product as satelliteObservation and meteorology.

<gmd:descriptiveKeywords>  
 <gmd:MD\_Keywords>  
 <gmd:keyword>

<gco:CharacterString>satelliteObservation</gco:CharacterString>  
 </gmd:keyword>  
 <gmd:type>  
 <MD\_KeywordTypeCode xmlns="http://www.isotc211.org/2005/gmd" codeListValue="theme" codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO\_19139\_Schemas/resources/Codelist/gmxCodelists.xml#MD\_KeywordTypeCode">

Theme

</MD\_KeywordTypeCode>  
 </gmd:type>  
 <gmd:thesaurusName>  
 <gmd:CI\_Citation>  
 <gmd:title>  
 <gco:CharacterString>WMO\_CategoryCode</gco:CharacterString>  
 </gmd:title>  
 <gmd:date>  
 <gmd:CI\_Date>  
 <gmd:date>  
 <gco:Date>2008-06-01</gco:Date>  
 </gmd:date>  
 <gmd:dateType>  
 <gmd:CI\_DateTypeCode codeListValue="publication" codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO\_19139\_Schemas/resources/Codelist/gmxCodelists.xml#CI\_DateTypeCode"/>  
 </gmd:dateType>  
 </gmd:CI\_Date>  
 </gmd:date>  
 </gmd:CI\_Citation>  
 </gmd:thesaurusName>  
 </gmd:MD\_Keywords>  
</gmd:descriptiveKeywords><gmd:descriptiveKeywords>  
 <gmd:MD\_Keywords>  
 <gmd:keyword>

<gco:CharacterString>meteorology</gco:CharacterString>  
 </gmd:keyword>  
 <gmd:type>  
 <MD\_KeywordTypeCode xmlns="http://www.isotc211.org/2005/gmd" codeListValue="theme" codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO\_19139\_Schemas/resources/Codelist/gmxCodelists.xml#MD\_KeywordTypeCode">

Theme

</MD\_KeywordTypeCode>  
 </gmd:type>  
 <gmd:thesaurusName>  
 <gmd:CI\_Citation>  
 <gmd:title>  
 <gco:CharacterString>WMO\_CategoryCode</gco:CharacterString>  
 </gmd:title>  
 <gmd:date>  
 <gmd:CI\_Date>  
 <gmd:date>  
 <gco:Date>2008-06-01</gco:Date>  
 </gmd:date>  
 <gmd:dateType>  
 <gmd:CI\_DateTypeCode codeListValue="publication" codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO\_19139\_Schemas/resources/Codelist/gmxCodelists.xml#CI\_DateTypeCode"/>  
 </gmd:dateType>  
 </gmd:CI\_Date>  
 </gmd:date>  
 </gmd:CI\_Citation>  
 </gmd:thesaurusName>  
 </gmd:MD\_Keywords>  
</gmd:descriptiveKeywords>

|  |  |
| --- | --- |
| **Product Sample Visualization URL** | |
| TEMPLATE Value: | PRODUCT-IMAGERY-URL |
| Information: | URL to a sample data visualization |
| Necessity: | Optional for WMO Core Profile 1.3 but used by WIS Portal to display products |
| XPath: | */gmd:MD\_Metadata/gmd:identificationInfo//gmd:graphicOverview/gmd:MD\_BrowseGraphic/gmd:fileName/gco:CharacterString* |

The CGMS TFMI recommends to add a link to the product visualization when possible as GISC portals can display the provided linked image to make the products more attractive for end users.

Below is an example based on EUMETSAT Seviri Level 1.5.

<gmd:graphicOverview>  
 <gmd:MD\_BrowseGraphic>  
 <gmd:fileName>

<gco:CharacterString>http://navigator.eumetsat.int:80/smartEditor/preview/msg-level-1-5.jpg</gco:CharacterString>  
 </gmd:fileName>  
 <gmd:fileDescription>  
 <gco:CharacterString>preview</gco:CharacterString>  
 </gmd:fileDescription>  
 <gmd:fileType>  
 <gco:CharacterString>jpg</gco:CharacterString>  
 </gmd:fileType>  
 </gmd:MD\_BrowseGraphic>  
</gmd:graphicOverview>

### Data Policy Information

tbd

### Data Access Information

tbd

## Mandatory WIS Technical Information

|  |  |
| --- | --- |
| **Metadata Record Unique Identifier** | |
| ***TEMPLATE Value:*** | ADD-WMCP-IDENTIFIER |
| ***Information:*** | Unique Identifier for individual WIS Discovery Metadata Records |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 |
| ***Category*** | WIS Technical Information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:fileIdentifier* |
|  |  |

The WCMP UID should be structured as follow:

urn:x-wmo:md:DataProviderInternetDomainName:ProductUID

with

“:” a separator

**urn:x-wmo:md:** being mandatory,

**DataProviderInternetDomainName:** being the Citation authority based on the Internet domain name of the data-provider organization (eg. int.eumetsat, gov.noaa)

**ProductUID** being a unique identifier with a structure defined by the responsible satellite data organisation

Examples:

UID for Roshydromet MTVZA-GY Level 1C data Meteor-M N2:

urn:x-wmo:md:planet.iitp.ru:EO:ROSH:DAT:METEOR-M:MTVZA-GY

EUMETSAT Meteosat Seviri Level 1.5:

urn:x-wmo:md:int.eumetsat:EO:EUM:DAT:MSG:HRSEVIRI

Additional rules apply for metadata records describing a GTS products. Please refer to the WMO Core Profile Version 1.3 Specification for additional information regarding GTS products.

|  |  |
| --- | --- |
| **Metadata Modification DateStamp** | |
| ***TEMPLATE Value:*** | ADD-LAST-MODIFICATION-DATE |
| ***Information:*** | Last modification date of the metadata record |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 |
| ***Category:*** | WIS Technical Information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:dateStamp* |

This is the metadata record last modification date with the following date pattern: YYYY-MM-DD

|  |  |
| --- | --- |
| **Creation Date** | |
| ***TEMPLATE Value:*** | ADD-CREATION-DATE |
| ***Information:*** | Creation date of the product |
| ***Necessity:*** | Mandatory for WMO Core Profile 1.3 |
| ***Category:*** | WIS Technical Information |
| ***XPath:*** | /gmd:MD\_Metadata/gmd:identificationInfo//gmd:citation//gmd:date//  gmd:dateType=”creation” |
|  |  |

This is the product Creation date with the following date pattern: YYYY-MM-DD.

For instance:

<gmd:date>  
 <gmd:CI\_Date>  
 <gmd:date>  
 <gco:Date>2015-03-23</gco:Date>  
 </gmd:date>  
 <gmd:dateType>  
 <gmd:CI\_DateTypeCode codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO\_19139\_Schemas/resources/Codelist/gmxCodelists.xml#CI\_DateTypeCode" codeListValue="creation"/>  
 </gmd:dateType>  
 </gmd:CI\_Date>  
<gmd:date>

### Additional Satellite Product information

Below the CGMS TFMI recommends adding a links to a set of typical information: calibration and product information such as processing information. In addition, it is recommended to add links from the OSCAR space database in order to describe the instrument and platform information from that curated official WMO source of information.

|  |  |
| --- | --- |
| **Calibration URL Information** | |
| ***TEMPLATE Value:*** | URL-TO-CALIBRATION-INFO |
| ***Information:*** | URL links to additional calibration information regarding the product |
| ***Necessity:*** | Optional, recommended when available by the TFMI CGMS Information model |
| ***Category*** | Product Information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:identificationInfo//gmd:citation//gmd:citedResponsibleParty* |

The CGMS TFMI recommends for qualifying the product to provide additional information pointers regarding technical and scientific aspects of the product. It is recommended to provide when available information regarding the product calibration and quality. That information can be provided within the identificationInfo element by replacing the placeholder URL-TO-CALIBRATION-INFO.

For instance for the EUMETSAT Seviri Level 1.5 product the calibration information is inserted as follow in the below element:

<gmd:citedResponsibleParty>  
 <gmd:CI\_ResponsibleParty>  
 <gmd:contactInfo>  
 <gmd:CI\_Contact>  
 <gmd:onlineResource>  
 <gmd:CI\_OnlineResource>  
 <gmd:linkage>

<gmd:URL>

[http://www.eumetsat.int/website/home/Data/Products/Calibration/MSGCalibration/index.html</gmd:URL](http://www.eumetsat.int/website/home/Data/Products/Calibration/MSGCalibration/index.html%3c/gmd:URL)> </gmd:linkage>

<gmd:name>  
 <gco:CharacterString>Seviri Instrument Calibration information</gco:CharacterString>

</gmd:name>  
 <gmd:function>  
 <gmd:CI\_OnLineFunctionCode codeList="http://www.ngdc.noaa.gov/metadata/published/xsd/schema/resources/Codelist/gmxCodelists.xml#CI\_OnLineFunctionCode" codeListValue="calibrationInformation"/>  
 </gmd:function>  
 </gmd:CI\_OnlineResource>  
 </gmd:onlineResource>  
 </gmd:CI\_Contact>  
 </gmd:contactInfo>  
 <gmd:role/>  
 </gmd:CI\_ResponsibleParty>  
</gmd:citedResponsibleParty>

If there is no need to add additional calibration information, the element gmd:citedResponsibleParty containing the placeholder URL-TO-CALIBRATION-INFO has to be removed.

|  |  |
| --- | --- |
| **Product Url Technical and Scientific Information** | |
| ***TEMPLATE Value:*** | URL-TO-PRODUCT-INFO |
| ***Information:*** | URL to additional product information |
| ***Necessity:*** | Optional, recommended when available by the TFMI CGMS Information model |
| ***Category*** | Product Information |
| ***XPath:*** | */gmd:MD\_Metadata/gmd:identificationInfo//gmd:citation//gmd:citedResponsibleParty* |

The CGMS TFMI additionally recommends to add additional technical/scientific URL link information regarding the product if necessary. That information can be provided by replacing the placeholder URL-TO-PRODUCT-INFO with the given URL as described in the following example:

<gmd:citedResponsibleParty>

<gmd:CI\_ResponsibleParty>

<gmd:contactInfo>

<gmd:CI\_Contact> <gmd:onlineResource> <gmd:CI\_OnlineResource>

<gmd:linkage>

<gmd:URL>[http://www.eumetsat.int/website/home/Data/Products/Level1Data/index.html</gmd:URL](http://www.eumetsat.int/website/home/Data/Products/Level1Data/index.html%3c/gmd:URL)>

</gmd:linkage>

<gmd:name> <gco:CharacterString>Meteosat Second Generation product documentation</gco:CharacterString>

</gmd:name>

<gmd:function>

<gmd:CI\_OnLineFunctionCode codeList="http://www.ngdc.noaa.gov/metadata/published/xsd/schema/resources/Codelist/gmxCodelists.xml#CI\_OnLineFunctionCode" codeListValue="productInformation"/>

</gmd:function>

</gmd:CI\_OnlineResource>

</gmd:onlineResource>

</gmd:CI\_Contact>

</gmd:contactInfo>

<gmd:role/>

</gmd:CI\_ResponsibleParty>

</gmd:citedResponsibleParty>

### Referencing OSCAR Space Information

OSCAR Space is a database of information regarding space-based capabilities maintained by WMO and referencing all earth-observation missions. The CGMS TFMI recommends to add links to the instrument and satellite mission information contained in OSCAR in order to create a coherent set of information for earth observation metadata records, creating a consistent description of all satellite based products and allowing users to easily understand the product (its type, origin instrument, …).

|  |  |
| --- | --- |
| **OSCAR Instrument information** | |
| ***TEMPLATE Value:*** | ADD-OSCAR-INSTRUMENT-PAGE, ADD-INSTRUMENT-NAME |
| ***Information:*** | URL to the corresponding OSCAR instrument page |
| ***Necessity:*** | Optional for WMO Core Profile 1.3 but recommended by CGMS TFMI |
| ***Category:*** | Product Information |
| ***XPath:*** | *gmd:MD\_Metadata/gmd:identificationInfo/gmd:MD\_Identification/gmd:descriptiveKeywords* |

The metadata author should replace the ADD-OSCAR-INSTRUMENT-PAGE placeholder with OSCAR instrument page URL and ADD-INSTRUMENT-NAME with the intrument name. The OSCAR database is freely accessible from <https://www.wmo-sat.info/oscar/spacecapabilities>.

For instance the page URL for the GOES IMAGER is <http://www.wmo-sat.info/oscar/instruments/view/879> and the page URL for the SEVIRI IMAGER is <http://www.wmo-sat.info/oscar/instruments/view/503>

<gmd:descriptiveKeywords>

<gmd:MD\_Keywords>

<gmd:keyword>

<gmx:Anchor xlink:href="http://www.wmo-sat.info/oscar/instruments/view/503" xlink:actuate="onRequest" xlink:role="http://www.wmo-sat.info/oscar/instrumenttypes/view/1">SEVIRI</gmx:Anchor>

</gmd:keyword>

<gmd:type>

<gmd:MD\_KeywordTypeCode codeListValue="instrument" codeList="http://www.ngdc.noaa.gov/metadata/published/xsd/schema/resources/Codelist/gmxCodelists.xml#MD\_KeywordTypeCode">instrument</gmd:MD\_KeywordTypeCode>

</gmd:type>

<gmd:thesaurusName>

<gmd:CI\_Citation>

<gmd:title>

<gco:CharacterString>OSCAR (Observing Systems Capability Analysis and Review Tool) List of all Instruments (http://www.wmo-sat.info/oscar/instruments)</gco:CharacterString>

</gmd:title>

<gmd:date>

<gmd:CI\_Date>

<gmd:date>

<gco:Date>2016-02-10</gco:Date>

</gmd:date>

<gmd:dateType>

<gmd:CI\_DateTypeCode codeListValue="revision" codeList="http://www.ngdc.noaa.gov/metadata/published/xsd/schema/resources/Codelist/gmxCodelists.xml#CI\_DateTypeCode">revision</gmd:CI\_DateTypeCode>

</gmd:dateType>

</gmd:CI\_Date>

</gmd:date>

<gmd:citedResponsibleParty>

<gmd:CI\_ResponsibleParty>

<gmd:organisationName>

<gco:CharacterString>WMO Secretariat</gco:CharacterString>

</gmd:organisationName>

<gmd:contactInfo>

<gmd:CI\_Contact>

<gmd:onlineResource>

<gmd:CI\_OnlineResource>

<gmd:linkage>

<gmd:URL>http://www.wmo.int/pages/about/sec/sg\_en.html</gmd:URL>

</gmd:linkage>

<gmd:protocol>

<gco:CharacterString>WWW:LINK-1.0-http-link</gco:CharacterString>

</gmd:protocol>

</gmd:CI\_OnlineResource>

</gmd:onlineResource>

</gmd:CI\_Contact>

</gmd:contactInfo>

<gmd:role>

<gmd:CI\_RoleCode codeListValue="publisher" codeList="http://www.ngdc.noaa.gov/metadata/published/xsd/schema/resources/Codelist/gmxCodelists.xml#CI\_RoleCode">publisher</gmd:CI\_RoleCode>

</gmd:role>

</gmd:CI\_ResponsibleParty>

</gmd:citedResponsibleParty>

</gmd:CI\_Citation>

</gmd:thesaurusName>

</gmd:MD\_Keywords>

</gmd:descriptiveKeywords>

|  |  |  |
| --- | --- | --- |
| **WCMP OSCAR Plateform information** | | |
| ***TEMPLATE Value:*** | | ADD-OSCAR-PLATFORM-PAGE, ADD-OSCAR-PLATFORM-NAME |
| ***Information:*** | | URL to the corresponding OSCAR platform page |
| ***Necessity:*** | | Optional for WMO Core Profile 1.3 but recommended by CGMS TFMI |
| ***XPath:*** | | gmd:MD\_Metadata/gmd:identificationInfo/gmd:MD\_Identification/gmd:descriptiveKeywords |
|  |  | |

The metadata author should replace the ADD-OSCAR-PLATFORM-PAGE placeholder with OSCAR instrument page URL and ADD-PLATEFORM-NAME with the platform name. The OSCAR database is freely accessible from <https://www.wmo-sat.info/oscar/spacecapabilities>.

For instance the page URL for the NOAA GOES-14 Satellite is <https://www.wmo-sat.info/oscar/satellites/view/150>.

<gmd:descriptiveKeywords>

<gmd:MD\_Keywords>

<gmd:keyword>

<gmx:Anchor xlink:href="http://www.wmo-sat.info/oscar/satelliteprogrammes/view/102" xlink:actuate="onRequest">Meteosat Second Generation</gmx:Anchor>

</gmd:keyword>

<gmd:type>

<gmd:MD\_KeywordTypeCode codeListValue="instrument" codeList="http://www.ngdc.noaa.gov/metadata/published/xsd/schema/resources/Codelist/gmxCodelists.xml#MD\_KeywordTypeCode">instrument</gmd:MD\_KeywordTypeCode>

</gmd:type>

<gmd:thesaurusName>

<gmd:CI\_Citation>

<gmd:title>

<gco:CharacterString>OSCAR (Observing Systems Capability Analysis and Review Tool) List of all Instruments (http://www.wmo-sat.info/oscar/instruments)</gco:CharacterString>

</gmd:title>

<gmd:date>

<gmd:CI\_Date>

<gmd:date>

<gco:Date>2016-02-10</gco:Date>

</gmd:date>

<gmd:dateType>

<gmd:CI\_DateTypeCode codeListValue="revision" codeList="http://www.ngdc.noaa.gov/metadata/published/xsd/schema/resources/Codelist/gmxCodelists.xml#CI\_DateTypeCode">revision</gmd:CI\_DateTypeCode>

</gmd:dateType>

</gmd:CI\_Date>

</gmd:date>

<gmd:citedResponsibleParty>

<gmd:CI\_ResponsibleParty>

<gmd:organisationName>

<gco:CharacterString>WMO Secretariat</gco:CharacterString>

</gmd:organisationName>

<gmd:contactInfo>

<gmd:CI\_Contact>

<gmd:onlineResource>

<gmd:CI\_OnlineResource>

<gmd:linkage>

<gmd:URL>http://www.wmo.int/pages/about/sec/sg\_en.html</gmd:URL>

</gmd:linkage>

<gmd:protocol>

<gco:CharacterString>WWW:LINK-1.0-http-link</gco:CharacterString>

</gmd:protocol>

</gmd:CI\_OnlineResource>

</gmd:onlineResource>

</gmd:CI\_Contact>

</gmd:contactInfo>

<gmd:role>

<gmd:CI\_RoleCode codeListValue="publisher" codeList="http://www.ngdc.noaa.gov/metadata/published/xsd/schema/resources/Codelist/gmxCodelists.xml#CI\_RoleCode">publisher</gmd:CI\_RoleCode>

</gmd:role>

</gmd:CI\_ResponsibleParty>

</gmd:citedResponsibleParty>

</gmd:CI\_Citation>

</gmd:thesaurusName>

</gmd:MD\_Keywords>

</gmd:descriptiveKeywords>

# Annex

## Glossary

* CGMS: [Coordination Group for Meteorological Satellites](https://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwiC9PHG4InNAhXKOBQKHVzeBJEQFggcMAA&url=http%3A%2F%2Fwww.eumetsat.int%2Fwebsite%2Fhome%2FAboutUs%2FInternationalCooperation%2FCoordinationGroupforMeteorologicalSatellitesCGMS%2F&usg=AFQjCNH18aBm6zouTA-zkV75tNvyyC4wXw&sig2=TAxhG0PvU1KOCG-zvgq5Kw&bvm=bv.123325700,d.bGs)
* CGMS-WMO TFMI: CGMS-WMO Task Force on Metadata Implementation
* GTS: Global Telecommunication Network
* WMO IPET-SUP: WMO Inter-Programme Expert Team on Satellite Utilization and Products
* WIS: WMO Information System
* GISC: Global Intercommunication System Centre
* DCPC: Data Collection and Production Centre
* NC: National Centre
* WMCP: WMO Core Profile
* ISO 19115: <http://www.iso.org/iso/catalogue_detail?csnumber=26020>

## Level 1 types

* ***level 1a***: separated sensor counts for each instrument.
* ***level 1b***: geo-referenced sensor counts with appended calibration coefficients (reversible: calibration coefficients are separated from sensor counts). For radar: back-scatter crosssections.
* ***level 1c***: geo-referenced brightness temperatures (or radiances) and albedo (non-reversible: calibration coefficients have been applied to sensor counts and radiances have been converted to brightness temperatures). In the case of IASI, the spectra are apodized.
* ***level 1d***: re-mapped and filtered brightness temperatures (or radiances) and albedo (e.g. cloud mask applied.

## Level 1 product geometry

* Swath
* Nadir only
* Set of limb observations
* Spectrum

## Level 2 Product types.

|  |
| --- |
| **Atmosphere Types** |
| **Aerosol**  **Cloud**  **Forecasts**  **Humidity**  **Lightning**  **Precipitation**  **Pressure**  **Radiation**  **Temperature**  **Trace Gases**  **Wind** |
| **Land Types** |
| **Fire**  **Land Surface Temperature**  **Snow and Ice**  **Soil Moisture**  **Vegetation**  **Ocean**  **Ocean Colour**  **Ocean Salinity**  **Ocean Surface Wind**  **Sea Ice**  **Sea Surface Height**  **Sea Surface Temperature**  **Wave** |
| **Climate Types** |
| **Fundamental Climate Record**  **Thematic Climate Data Record**  **Operational Climate Monitoring** |

## Instrument types, and associated characteristics of L1 products

|  |  |  |  |
| --- | --- | --- | --- |
| Instrument | General Instrument Characteristics | L1 Product Type   * level 1a: separated sensor counts for each instrument. * level 1b: geo-referenced sensor counts with appended calibration coefficients (reversible: calibration coefficients are separated from sensor counts). For radar: back-scatter crosssections. * level 1c: geo-referenced brightness temperatures (or radiances) and albedo (non-reversible: calibration coefficients have been applied to sensor counts and radiances have been converted to brightness temperatures). In the case of IASI, the spectra are apodized. * level 1d: re-mapped and filtered brightness temperatures (or radiances) and albedo (e.g. cloud mask applied) | L1 Product Geometry   * Swath * Nadir only * Set of limb observations * Spectrum |
| 01. Moderate-resolution optical imager | Wide range of instruments with the following general characteristics:  Operating in the VIS, NIR, SWIR, MWIR and TIR spectral bands, i.e. from ~ 0.4 to ~15 μm.  Discrete channels, number from a few to a few tens, separated by dichroics, filters or spectrometers, with bandwidths from ~10 nm to ~1 μm.  Imaging capability, i.e. continuous and contiguous sampling, with spatial resolution in the order of 1 km, covering a swath of several 100 km to a few 1000 km.  Scanning law generally cross-track, sometimes multi-angle, sometimes under more polarisations.  Applicable in both LEO and GEO.  Depending on spectral bands, number and bandwidth of channels, and radiometric accuracy, the application fields may include: cloud observation, surface variables, ocean colour, aerosol, and cloud-motion winds. | 1b, 1c, 1d | Swath |
| 02. High resolution optical imager | Spatial resolution in the range of less than 1 m to a few 10 m.  Covered wavelengths in the VIS, NIR and SWIR bands, i.e. 0.4 to 3 μm, with possible extension to supporting MWIR and TIR.  Variable number or channels and bandwidths:  single channel (panchromatic) with around 0.4 μm bandwidth (e.g., 500-900 nm)  3 to 10 (multispectral) channels with around 0.1 μm bandwidth  continuous spectral range (hyperspectral) with typically100 channels of around 10 nm bandwidth;  Imaging capability, i.e. continuous and contiguous sampling, covering a swath ranging from a few 10 km to some 100 km, often addressable within a field-of-regard of several 100 km.  Applicable in LEO (GEO not excluded but not yet exploited).  Depending on the spectral bands, number and bandwidth of channels, and steerable pointing capability, the application fields may include:  panchromatic: recognition, stereoscopy;  multispectral: land use/cover, vegetation classification, disaster monitoring;  hyperspectral: vegetation process study, carbon cycle. | 1b, 1c, 1d | Swath |
| 03. Cross-nadir scanning SW sounder | Covered wavelengths in the UV, VIS, NIR and SWIR bands, i.e. 0.2 to 3 μm.  Spectral resolution ranging from a fraction of nm to a few nm.  Spatial resolution in the order of 10 km.  Horizontal sampling not necessarily continuous and contiguous.  Scanning capability varying from none (nadir-only) to a swath of a few 1000 km.  Applicable both in LEO and in GEO.  Covered application fields depending on spectral bands and resolution:  UV basic for ozone;  extension to VNIR includes some Cl compounds and several NOx;  extension to SWIR includes some green-house species, more accurately measured if supporting MWIR and/or TIR bands are associated. | 1b, 1c, 1d | Swath |
| 04. Cross-nadir scanning IR sounder | Covered wavelengths in the MWIR and TIR bands, i.e. 3 to 15 μm, with possible extension to FIR up to 50 μm, and auxiliary channels in VIS/NIR.  Spectral resolution in the order of 0.1 cm-1 (very high) or 0.5 cm-1 (hyperspectral) or 10 cm-1 (radiometer).  Spatial resolution in the order of 10 km.  Horizontal sampling not necessarily continuous and contiguous.  Scanning capability varying from none (nadir-only) to a swath of a few 1000 km.  Applicable both in LEO and in GEO.  Covered application fields mostly depending on the spectral resolution, as follows:  radiometers: coarse vertical resolution temperature and humidity profiles;  hyperspectral: high vertical resolution temperature and humidity profile, coarse ozone profile and total column or gross profile of few other species, mostly green-house;  very-high resolution spectrometers: profiles of several species of atmospheric chemistry interest, including CFC’s and other aggressive species. | 1b, 1c, 1d | Swath |
| 05. SW and IR sounder | Covered wavelengths in both short-wave (VIS/NIR/SWIR and long-wave (MWIR/TIR).  Spectral resolution in the order of 0.2 cm-1 in both SW and LW bands.  Spatial resolution in the range of less than 1 km to a few 10 km.  Horizontal sampling not necessarily continuous and contiguous.  Scanning capability varying from none (nadir-only) to a swath of a several 100 km.  Applicable in LEO.  The purpose of this type of instrument is to observe greenhouse gases with signatures in both SW and LW to improve the profiling vertical resolution in the PBL. | 1b, 1c, 1d | Swath |
| 06. MW imaging radiometer, conical scanning | Covered frequencies from 1 to 200 GHz (wavelengths 1.5 mm to 30 cm), operating in atmospheric window channels of bandwidths from some 100 MHz to some GHz.  Spatial resolution from a few kilometres to some 100 km, determined by antenna size and frequency.  Horizontal sampling continuous and contiguous, over a swath of some 1500 km.  Conical scanning, providing two or more polarisations.  Applicable only in LEO.  Covered application fields mostly depending on the frequency and the spatial resolution (i.e., the antenna size):  sea-surface salinity and volumetric soil moisture from lowest frequencies;  sea-surface temperature, surface soil moisture, wind speed from low-medium frequencies (wind vector by full polarisation);  precipitation, snow, ice from higher frequencies. | 1b, 1c, 1d | Swath |
| 07. MW sounding radiometer, cross-track scanning | Covered frequencies from 20 to 200 GHz (wavelengths 1.5 to 15 mm), operating in absorption bands split in several channels of bandwidths from a few MHz to some GHz.  Spatial resolution from some 10 to some 100 km, determined by antenna size and frequency.  Horizontal sampling not necessarily continuous and contiguous.  Cross-track scanning, providing single or dual polarisations over a swath of some 2000 km.  Applicable only in LEO (possibilities in GEO being studied).  Covered application fields depending on the exploited frequency bands:  nearly-all-weather temperature profile from oxygen bands (e.g., 54 GHz, 118 GHz);  nearly-all-weather humidity profile from water vapour bands (e.g., 183 GHz);  precipitation also observed. | 1b, 1c, 1d | Swath |
| 08. MW imaging/sounding radiometer, conical scanning | Covered frequencies from 10 to 1000 GHz (wavelengths 0.3 mm to 3 cm), operating in absorption bands split in several channels of bandwidths from a few MHz to several GHz; and a number of window channels of bandwidths from some 100 MHz to some GHz.  Spatial resolution from a few kilometres to some 100 km, determined by antenna size and frequency.  Horizontal sampling continuous and contiguous, over swath of some 1500 km.  Conical scanning, providing dual polarisation for window channels and single or dual polarisation for absorption-band channels.  Applicable only in LEO.  Covered application fields depending on the exploited frequency bands and channels:  nearly-all-weather temperature profile from oxygen bands (e.g., 54 GHz, 118 GHz);  nearly-all weather humidity profile from water vapour bands (e.g., 183 GHz);  sea-surface temperature, surface soil moisture, wind speed from low-medium frequencies (wind vector by full polarisation);  precipitation, snow, ice from higher frequencies. | 1b, 1c, 1d | Swath |
| 09. Special scanning or non-scanning MW radiometer | Imaging, by synthetic aperture or real-aperture multi-beam antenna:  operating in L-band (typically 1.4 GHz);  spatial resolution in the order of 50 km with swath of a few 100 km (multi-beam) or some 1000 km (synthetic aperture);  applicable only in LEO;  for sea-surface salinity and volumetric soil moisture.  Imaging, by cross-track electronic scanning:  operating in K-band (typically 19 GHz);  spatial resolution in the order of 20 km with swath of some 3000 km;  applicable only in LEO;  for sea ice and heavy precipitation over the sea.  Nadir-pointing radiometers:  operating on frequencies from 15 to 40 GHz (wavelengths 7.5 mm to 2 cm), across the water vapour absorption band around 23 GHz by two or three channels with a bandwidth of several 100 MHz;  spatial resolution of some 20 km and near-continuous sampling along the track;  applicable only in LEO;  to provide information on total-column water vapour to correct for the atmospheric path delay induced on the signal of the radar altimeter.  Imaging from GEO by real or synthetic aperture antenna:  operating in absorption bands of oxygen (e.g., 54, 118, 425 GHz) and water vapour (e.g., 183, 380 GHz);  spatial resolution changing with frequency, e.g. 50 at 54 GHz;  to provide sub-hourly sampling of nearly-all-weather temperature and humidity sounding, and liquid and solid precipitation. | 1b, 1c, 1d | Swath or nadir-only |
| 10. Limb-scanning sounder | Covered wavelengths in the ranges of short-wave (UV to SWIR), or infrared (MWIR and TIR) or millimetre-submillimetre (0.1 to 3 mm or 100 to 3000 GHz).  Spectral resolution in the range of 0.2 nm (SW) or 0.05 cm-1 (IR) or 100 MHz (Mm-submm).  Limb scanning, mechanically determining the vertical resolution (in the range of 1-3 km) and the observed atmospheric layer (in the range of 10 to 80 km); and the spatial resolution (about 300 km along-view).  In the SW range, scanning may be provided by solar occultation, as well as moon or stars occultation.  Applicable only in LEO.  Application: high-vertical resolution atmospheric chemistry in the stratosphere and mesosphere, to track species depending on the exploited spectral band. | 1b | Limb scan |
| 11. Broad-band radiometer | Covered wavelengths in the bands of total radiation emerging from Earth and atmosphere (0.2-300 μm) and the fraction represented by reflected solar radiation (0.2-4.0 μm).  One broad-band channel integrating over each of the two bands, and optional narrow-bandwidth channels in VIS and/or TIR to collect information on clouds within the IFOV.  Cross-track scanning with continuous and contiguous sampling, to cover a swath of a few 1000 km with spatial resolution in the order of 10 km; or biaxial scanning or combination of a cross-track scanning and a wide-angle non-scanning unit to enable conversion of radiance into irradiance; or non-scanning, either with 2π view or along-track only.  Applicable both in LEO and in GEO. Observation from the L1 Lagrange libration point also is possible.  Application: observation of upward long-wave and short-wave irradiance at TOA, associated to solar irradiance for the purpose of monitoring Earth radiation budget. | 1b, 1c | Swath |
| 12. Solar irradiance monitor | Covered wavelengths in the range of solar radiation (0.15-50 μm).  Integration over the full range (Total Solar Irradiance) and/or spectroscopy in the 0.15-3 μm range.  Total Solar Irradiance measured by absolute techniques, e.g. active cavity radiometers.  Applicable in LEO, in GEO, and in special high-orbits.  Application: observation of the solar irradiance:  at TOA in association with upward long-wave and short-wave irradiance, for the purpose of monitoring Earth radiation budget;  at the Sun surface, particularly for variability, significant of Sun interior processes. | 1b | Spectrum |
| 13. GNSS radio-occultation sounder | GNSS receiver exploiting at least two L-band frequencies around 1.18, 1.25 and 1.58 GHz.(or 19, 24 and 25.4 cm).  Earth’s limb observation from surface to the satellite altitude during the occultation phase of satellites of the GNSS constellations (GPS, GLONASS, Galileo, Beidou).  Directional antennas looking aft- (for setting GNSS) and/or fore- (for rising GNSS), and toroidal antenna for navigation.  Spatial resolution around 300 km in the direction LEO-satellite to occulting GNSS-satellite, a few 10 km transverse.  Horizontal sampling limited by the daily number of occultation events, from 250 to 1500 depending on the number of tracked GNSS constellations and the aft- and/or fore- tracking capability.  Supported by a complex system of ground stations for clock error correction by double differentiation.  Applicable only in LEO.  Applications: very-high vertical resolution profiling of temperature, water vapour and air density; and electron total content and density in the ionosphere. | 1b | Set of limb observations |
| 14. Lightning imager | Detector matrix (CCD) all-time watching the earth in a very-narrow oxygen band at 777.4 nm.  Measurement: flash rate and intensity in the IFOV.  Spatial resolution 5-10 km; horizontal sampling continuous and contiguous, over a swath of several 100 km from LEO, full disk from GEO.  Applicable both in LEO and in GEO.  Applications: detection of convective cloud systems, thus proxy of precipitation; also proxy of earth’s electric field and of NOx generation. |  |  |
| 15. Cloud and precipitation radar | Operating frequencies in Ku (~14 GHz), or Ka (~35 GHz), or W (~94 GHz) bands. Ku and Ka bands often flown together.  Pulse repetition rate such as to result in a vertical resolution of a few 100 m.  Spatial resolution 2 to 5 km; horizontal sampling continuous and contiguous, swath from only nadir (W-band) to several 100 km (Ku and Ka bands).  Applicable only in LEO.  Applications depending of the exploited frequency:  Ku-band suitable for heavy rain (liquid, with droplets that may exceed 1 cm);  Ka-band: suitable for light rain (from stratiform clouds) and snowfall;  W-band: suitable for non-precipitating clouds (droplets < 0.1 mm). | 1b | Swath or nadir-only |
| 16. Radar scatterometer | Operating frequencies in C (~5 GHz), and/or Ku (~14 GHz) bands.  Very accurate calibration, to measure backscatter coefficients (σ0) from sea capillary waves.  Observation performed from at least 3 distinct directions; spatial resolution 10 to 50 km; horizontal sampling continuous and contiguous, swath some 1000 km.  Two scanning concepts: pushbroom, side-looking with azimuths 45°, 90° and 135\*, on one side or both; and conical, with two beams to provide four distinct σ0 from each IFOV.  Applicable only in LEO.  Applications: sea-surface wind; also surface soil moisture. | 1b | Swath |
| 17. Radar altimeter | Operating frequencies in Ku-band (~14 GHz) or Ka-band (~36 GHz), with supporting C (~5 GHz) or S (~3 GHz) to correct for signal rotation in the ionosphere.  Very accurate ranging measurement, supported by co-flying MW radiometer in the 23 GHz water vapour band for path delay correction.  Observation essentially nadir (large-swath possibly to be performed by interferometry of signals from two parallel antennas); spatial resolution in the order of 20 km, possible to be improved to hundred metres along-track by SAR-like processing.  Applicable only in LEO.  Applications:  sea-surface height (ocean topography), significant wave height, sea-surface wind speed, sea-ice thickness;  geoid (by analysis of measurement series and the support of precise orbitography). | 1b | Nadir |
| 18. Space lidar | Operating wavelengths in the UV (e.g., 355 nm), or VIS (e.g., 532 nm), or NIR (e.g., 1064 nm), or SWIR (e.g., 1600 nm); possible dual-wavelength, two receivers (for Mie and Rayleigh scattering), polarimetry.  Spatial resolution in the range of 100 m, often degraded up to 50 km in order to collect enough de-correlated samples; vertical resolution in the range of 100 m (a few 10 cm for lidar altimeters).  Non-scanning; either nadir-viewing or oblique.  Several designs for different purposes:  Doppler lidar generally operating in UV, for both Mie and Rayleigh scattering, to track aerosol and air molecules; oblique view for radial wind in clear-air and aerosol;  Backscatter lidar operating at one (in UV) or two (VIS and NIR) wavelengths, often with more polarisations; nadir view for aerosol profile, cloud top height and atmospheric discontinuities;  Lidar altimeter operating at two wavelengths, VIS and NIR; nadir view, very high vertical resolution (for sea-ice elevation) and horizontal resolution (for ice boundaries);  Differential absorption lidar (DIAL), operating at one wavelength centred on the absorption peak of one trace gas (e.g., O3, H2O and CO2), and nearby windows; nadir-view. | 1b |  |
| 19. Imaging radar (SAR) | Operating frequencies in P (~0.4 GHz), L (~1.3 GHz), S (~2.7 GHz), C (~5.3 GHz), X (~9.6 GHz), or Ku (~17.2 GHz) band - the mostly used bands being L, C and X.  Several combinations of polarizations in transmission and reception possible to be implemented: HH, VV, VV/HH, HH/HV and VV/VH.  Spatial resolution can be traded-off with swath: from 1-30 m associated to swath of 30-100 km; and 100-1000 m associated to swath of 300-500 km.  Pushbroom, side-looking generally on one side, keeping high resolution within a field-of-regard of several 100 km.  Wide range of applications for every frequency band, with variable effectiveness:  P-band most suited for biomass monitoring and hydrological mapping;  S-band best suited for volumetric soil moisture;  C-band covering the widest range (sea-ice, wave parameters by spectral analysis of image segments, surface soil moisture, snow parameters, glaciers, ground water, etc.);  X-band providing the best spatial resolution, thus best suited for surveillance;  Ka-band specifically suited for snow, that is semi-transparent at lower frequencies;  interferometry of the signals from one SAR at different times or two SARs flying in tandem enables measuring the Digital Elevation Model (DEM) and detecting changes of contours and elevation.  Applicable only in LEO. | 1b |  |
| 20. Positioning system | Laser retroreflector: mirrors (generally cube corners) to reflect laser beams sent to the satellite by ground laser-equipped sites during positioning sessions.  GNSS receiver: exploiting the differential phase of signals from a few satellites of the Global Navigation Satellite System.  Radio positioning system: transponders involving satellite and ground transmitting-receiving stations.  Star tracker: CCD imager that tracks bright stars, recognise the pattern and sends information to the satellite attitude control system.  Applications:  satellite navigation and attitude control;  basic to provide the underlying geoid for the altimetry mission, in turn basic for geoid determination;  space geodesy: crustal plates positioning and motion;  concurring to the observation of the Earth’s gravity field. |  |  |
| 21. Gravity sensing system | Accelerometer: to measure the variation of the gravity field along the satellite trajectory.  Gradiometer: network of accelerometers to measure the gravity-gradient tensor.  Satellite-to-satellite ranging: transmit-receiver systems in K-band (24 GHz) and Ka-band (32 GHz) to accurately measure the distance and its variations between satellites in coordinated orbits. Also implemented by simultaneous reception of signals from tens of GNSS satellites for extremely accurate determination of positioning changes.  Applications closely connected with precise orbitography by positioning sys |  |  |
| 22. Solar processes monitor | Family of instruments for remote observation of solar phenomena, either as spectrally-analysed fluxes from the full sun disk, or by detailed imagery of the layers of the solar atmosphere and the heliosphere. Observations:  Electromagnetic radiation at discrete wavelengths and total spectral irradiance: Gamma-ray, X-ray, EUV, UV, radio, etc.;    Coronal mass ejections and their propagation through interplanetary space;  Additional features of the sun and solar atmosphere, such as: magnetic field and the velocity of surface and sub-surface flows..  Observing positions include LEO, GEO, the L1 Lagrange libration point, but also any orbit around the Sun or Earth with constant viewing of the Sun. |  |  |
| 23. Solar wind and cosmic radiation monitor | System of detectors for in-situ measurements of the plasma, energetic particles, and magnetic field in the heliosphere. Specific observations:  solar wind (electrons, protons, and heavy ions);  energetic electrons, protons, and heavy ions, including galactic cosmic rays;  solar wind magnetic field. |  |  |
| 24. Magnetosphere/ionosphere sounder | Systems providing 3-D sounding of the Magnetosphere and Ionosphere through the use of satellite fleets on particular orbits:  formation fliying across the magnetospheric volume and tail in highly elliptical orbits;  optimized low orbits for ionospheric coverage.  The measurements include plasma and energetic particles, magnetic fields, electric fields, scintillations, and electromagnetic waves and radiation |  |  |
| 25. Aurora imager and other special imagers | Family of instruments to image auroral features:  FUV and UV imagers;  VIS and/or NIR imagers.  This also includes imagers of the plasmasphere. |  |  |
| 26. Magnetosphere/ Ionosphere sensor (platform environment) | System of sensors of the plasma, energetic particles, and magnetic and electric fields in the magnetosphere and ionosphere. These instruments are designed both to detect Space Weather disturbances in the magnetosphere and ionosphere, and for the diagnoses of satellite anomalies. Observations include:  low-energy and high-energy electrons, protons, and heavy ions;  magnetic field;  electric field. |  |  |
| 27. Data collection system | Transponder that relays to ground the data collected in situ by Data Collection Platforms (DCP). Applicable in LEO and GEO. Operating modes:  random access to collect messages transmitted at fixed times (self-timed DCP) or in emergency (alert DCP);  message acquisition only after interrogation of the DCP;  location of the DCP if mobile (only from LEO). |  |  |
| 28. Search & rescue system | Transponder that relays distress signals from ground users in difficulty to local user terminals that, in turn, relay the message to a mission control centre enabled to activate the most appropriate unit of the international search & rescue organisation. Applicable in LEO and GEO. LEO enables location of the transmitting user. For GEO, the information on location must be embedded in the message. |  |  |