


# EarthCARE Project

## Ground Segment

## EarthCARE Production Model

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## DOCUMENT CHANGE RECORD

ISSUE/REV.	DATE	CHANGE
Issue 1	6 May 2011	Initial issue (diagram only)
Issue 2 PreDP	8 Sep 2011	Issue for ESA GS-PDR Project Pre-Data Pack release (diagram only) Updated to reflect outcome of EarthCARE level 2 stage 1 activities Aligned with EarthCARE Product list EC-ICD-ESA-SYS-0314
Issue 2	1 Nov 2011	Issue for Overall Configuration and Interface Design Review (OCIDR) Added cover pages to diagram
Issue 3 PreDP	5 Jul 2013	Issue for ESA GS-PDR Project Pre-Data Pack release.  <u>Introduction (pages 1-7):</u>  OCIDR RID ALL PDS-31 (GL-PM-01), PROJ-52 (CC_02) and PROJ-88 (GC-28): Provided requested clarifications, see new section 3.2 on granularity and contingency, and comment on “short-loop” use of calibration products, p. 7.  Added a number of further clarifications  <u>Diagram (page 8):</u>  OCIDR RID ALL CPR-1 (TK-01) and CPR-9 (MH-07): Removed “LEDs” indicating tentative information, information is more consolidated now.  Re-aligned with EarthCARE Product list EC-ICD-ESA-SYS-0314. Main changes: <ul style="list-style-type: none"> <li>• Defined CPR L2a products</li> <li>• Removed a number of products (B-FLX, ACM-TCD, ACM-VM)</li> <li>• Combined radiative transfer products ACM-R1D and ACM-R3D into ACM-RT</li> <li>• Added composite “ad-hoc synergy” product ACM-COM</li> <li>• Moved merged observations (now AMB-MO instead of ACM-MO) from level 1d to level 2b (as they are likely to use level 2a data on input)</li> <li>• Combined MSI level 0 products M-NOM and M-ANC into M-L0</li> <li>• Split MSI level 1b calibration product M-CAL into three products M-SD1 (primary solar diffuser), M-SD2 (secondary solar diffuser), and M-BBS (black body/deep space)</li> <li>• Marked GCM products A-GCM and C-GCM as external on-demand</li> <li>• Grouped additional products to be produced by single processor</li> <li>• Reconstructed orbit/attitude files created directly from X-band telemetry, without creating SAT-ANC level 0 product first</li> </ul>
Issue 3	20 Sep 2013	Issue for ESA GS-PDR. Updated issue numbers in section 2.
Issue 4	21 Apr 2015	Issue for PDGS Core Processing Facility ITT. Made diagram consistent with ongoing developments. Main changes: <ul style="list-style-type: none"> <li>• Renamed MSI L1c product from M-NOM to M-RGR (M-NOM is already used for L1b product, so it was a duplicate name)</li> <li>• Removed GCM products A-GCM and C-GCM</li> </ul>

Issue 5	19 Apr 2016	<ul style="list-style-type: none"><li>• Combined MSI cloud products M-CTH and M-CMP into single product M-COP</li><li>• Removed B-RAD product (parameters from B-RAD will be provided in BM-RAD)</li><li>• Removed BBR from merged observations (renamed from AMB-MO to AM-MO)</li><li>• Grouped additional products to be produced by single processor</li><li>• Updated product dependencies (arrows)</li></ul> <p>Issue for EarthCARE System CDR.</p> <ul style="list-style-type: none"><li>• Removed TBC on X-MET generation by ECMWF</li></ul> <p>Made diagram consistent with ongoing L2 developments. Main changes:</p> <ul style="list-style-type: none"><li>• Indicated dependencies on X-JSG and X-MET (symbols)</li><li>• Updated product dependencies (arrows)</li><li>• Added processor names (for processors creating multiple products)</li></ul>
Issue 6	2 Mar 2017	<p>Issue for EarthCARE System CDR.</p> <ul style="list-style-type: none"><li>• Updated document list</li><li>• Removed a number of TBDs</li></ul>

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## 1 Introduction

### 1.1 The EarthCARE mission

Earth Explorer Missions are part of the Earth Observation Envelope Programme (EOEP). They are missions led by the European Space Agency (ESA) to cover primary research objectives.

The EarthCARE Mission has been approved for implementation as the sixth Earth Explorer Mission. The mission is being implemented in collaboration with Japan Aerospace Exploration Agency (JAXA) which provides the Cloud profiling Radar (CPR) in the scope of this cooperation.

The EarthCARE mission has been specifically defined with the basic objective of improving the understanding of cloud-aerosol-radiation interactions so as to include them correctly and reliably in climate and numerical weather prediction models. Specifically, the scientific objectives are:

- The observation of the vertical distributions of atmospheric liquid water and ice on a global scale, their transport by clouds and their radiative impact.
- The observation of cloud distribution ('cloud overlap'), cloud-precipitation interactions and the characteristics of vertical motions within clouds.
- The observation of the vertical profiles of natural and anthropogenic aerosols on a global scale, their radiative properties and interaction with clouds.
- The retrieval of profiles of atmospheric radiative heating and cooling through the combination of the retrieved aerosol and cloud properties.

EarthCARE will meet these objectives by measuring simultaneously the vertical structure and horizontal distribution of cloud and aerosol fields together with outgoing radiation over all climate zones. The EarthCARE observations will be performed in a synergistic manner to make maximum use of the instruments flying on the same satellite.

### 1.2 Purpose and Scope

This document presents the Production Model for EarthCARE science data products. The Production Model shows all data products and the dependencies between them, i.e., it specifies for each data product which other data products are required on input. Furthermore it shows which data products are being produced by a single data processor. It is required in the development phase in order to support a proper definition of data products and test cases combining several data processors in a sequence. Furthermore it is required by the Payload Data Ground Segment (PDGS) to orchestrate the EarthCARE production chain.

## **2 Documents**

### **2.1 Applicable Documents**

**[AD1]** EarthCARE Mission Requirements Document, EC-RS-ESA-SY-0012, Issue 5.1

**[AD2]** EarthCARE System Requirements Document for Phases B/C/D/E1, EC-RS-ESA-SY-0001, Issue 1A (20 May 2008)

### **2.2 Reference Documents**

**[RD1]** EarthCARE ESA Product List, EC-TN-ESA-SYS-0314, Issue 4 (2 Mar 2017)

## 3 EarthCARE Production Model

### 3.1 Scope and product levels

This section contains the EarthCARE Production Model for science data products. Dependencies between data products are shown as well as dependencies on dynamic auxiliary input data such as orbit and attitude data and meteorological fields. Static input data such as land/water masks and digital elevation models are not shown. This document focuses on the dependencies between level 2 products (science products). Therefore, and to avoid duplication of information given elsewhere, instrument calibration auxiliary files (which are relevant for level 1 only and some of which are updated regularly) are not considered here either.

EarthCARE product levels are:

Level 0: annotated raw instrument science packets

Level 1b: fully calibrated and geolocated instrument science measurements on the native instrument grid (for the BBR also spatially integrated to a number of groundpixel sizes)

Level 1c (MSI only): MSI level 1b data interpolated to a spatial grid common to all MSI bands. The grid spacing is similar to the one of MSI level 1b.

Level 1d: spatial grid shared by all instruments ("joint standard grid") and ECMWF meteorological fields limited to EarthCARE swath

Level 2a: single-instrument geophysical products

Level 2b: synergistic geophysical products (using data from two or more instruments)

This production model shows data produced by the ESA ground segment, with the exception of externally generated products shown as dashed boxes. These are:

CPR level 1b products C-NOM generated and provided by JAXA

Meteorological analysis and forecast fields X-MET provided by ECMWF

C-NOM and X-MET are used on input by a number of processors in the EarthCARE production chain.

### 3.2 Product granularity and contingency cases

Product granularity is one frame (1/8 orbit between predefined latitudes  $\pm 22.5^\circ$  and  $\pm 67.5^\circ$ ) for all products, including meteorological fields X-MET, joint standard grid X-JSG, as well as orbit and attitude auxiliary files.

It is currently assumed that frames can be processed in random order, i.e., do not have to be processed in the time sequence of the measurements.

Contingency cases: If reconstructed orbit files are not available, they will be replaced by reconstituted or predicted orbit files (in this order) from the Flight Operations Segment (FOS). If reconstructed attitude files are not available, level 1 processors will assume ideal pointing in Yaw Steering Mode. For meteorological data, it is foreseen that a set of X-MET products generated in one production run at ECMWF (there are 4 such runs per day) covers predictions long enough into the future (next 20h) such that data outages in the following run (6h later) would have no effect other than having to use a prediction which is 6h older than usual.

### 3.3 Guide to the diagram

Each of the small boxes represents a single EarthCARE data product. For each product, the product identifier (such as "AM-CTH") and a brief description of the main parameter (such as "cloud top height") are specified. The first part of the product identifier denotes the instrument or combination of instruments from which a product has been derived.

- X product does not contain measurements of any EarthCARE instrument (but is still related to EarthCARE using its ground track)
  - A ATLID
  - C CPR
  - M MSI
  - B BBR
  - AM ATLID + MSI
- etc.

Large boxes containing small boxes indicate that several products are generated by a single data processor (such as all level 1 products per instrument, or level 2a A-AER + A-EBD + A-TC + A-ICE). Otherwise, it is assumed that a given data processor creates a single product.

Arrows indicates products required on input by another product. Processing is strictly from “top” to “bottom”. The vertical position of a product indicates its dependency on products “higher up” the chain. This leads to a division of main processing levels into sub-levels. When counting the number of sub-levels in a processing level (e.g., for latency considerations) products generated by a single processor can be counted as a single sub-level even if they cover several vertical levels in the diagram in order to provide some details on the internal processing sequence in a module. Dependencies between products produced by a single processor are shown by arrows inside the “processor box” only if they are produced strictly in sequence or in parallel (e.g., C-FMR, C-CD, C-TC) but not if a more complex iterative algorithm is used (e.g., A-AER, A-EBD, A-TC).

Level 1 calibration products are generated by the level 1 processors and re-used in subsequent runs (in the case of MSI and BBR, indicated by “circular” arrows) or further evaluated offline. This is a “short-loop” calibration, i.e., the calibration products need to be made available immediately for calibration of the following frames. Meteorological data X-MET are used by almost all level 1 and level 2 processors. Similarly, the Joint Standard Grid X-JSG is used by many level 2 processors. Dependencies on X-MET and X-JSG are indicated by dedicated symbols (cloud and grid, respectively) in order not to clutter the diagram with too many arrows. A word of caution: Level 2 algorithm developments are ongoing. While the total number of products and their main parameters have stabilised, inputs (dependencies on other products) and grouping of products into a single processor are in some cases still tentative.

The production model diagram is shown on the following page.



### Legend

CPR	ATLID
MSI	BBR
Synergy	Other

Produced externally (JAXA, ...)

reuse of calibration product(s) from previous processor runs

	CAL
Calibration Product	

Products produced by single processor

Inputs

Tentative inputs

+H Add XML header file

Products used by other processors as indicated by these symbols:

# X-JSG

☁ X-MET

L0

Aux

L1b

L1c/d

L2a

L2b

