EUMETSAT

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The Meteosat Archive

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FORMAT GUIDE No. 4

Climate Data Set (CDS)

OpenMTP Format

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Meteorological Archive and Retrieval Facility
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1. INTRODUCTION

1.1. Overview

The Climate Data Set (CDS) contains a condensed form of the information contained in the raw image segments processed by EUMETSAT to produce the other meteorological products. The mean count, standard deviation, and number of pixels in each pixel count cluster, corresponding to radiation providing scenes of the Earth's surface and of clouds, are given. The CDS product also includes the Infra-Red mean pixel count of each cluster corrected for atmospheric absorption effects and, in case of high clouds that do not appear opaque to the IR sensor, also corrected for semi-transparency.

The CDS product is currently archived for every image slot (i.e. half-hourly) throughout the day. This has not always been the case, however. In the past the product was archived only three-hourly or hourly.

This document describes the OpenMTP format for CDS product retrieval. This is a new format developed for the MTP programme, and represents an enhancement and evolution from the previous IBMMOP format used by the MOP programme up to mid-November 1995.

1.2. Contact Point

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2. OVERVIEW

2.1. Introduction

This section provides brief details of the background to the OpenMTP format for CDS products.

The OpenMTP format is a new format developed for the Meteosat Transition Programme (MTP). It represents a progression from the IBM-compatible 'IBMMOP' format used by ESOC during the preceding Meteosat Operational Programme (MOP) which ran until mid-November 1995.

The main differences between the OpenMTP and IBMMOP formats are as follows:

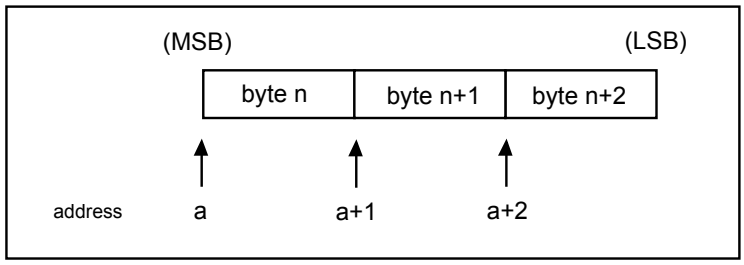
- The machine level representation of bits and bytes used in the OpenMTP format follows the standard used by UNIX / open systems architecture (SUN, HP, SGI ...) machines, whereas the IBMMOP format follows the standard used by IBM machines. The open systems representation uses the IEEE standard for real number representation, and ASCII rather than EBCDIC encoding for character data. It is anticipated that support for this open system representation will provide increased convenience for users.

  The OpenMTP data representation is discussed in section 2.2.
- The OpenMTP format includes an additional ASCII format header which can be easily examined by a user to check the content of a product file.
- The OpenMTP format provides significant extra information for products generated in the MTP era (i.e. since November 1995). This information is stored in fields which are not present in the IBMMOP format.

2.2. Representation

This section describes the open system machine representation of the basic data types character, logical, short integer (two byte), integer (four byte), and single-precision floating-point.

The representation is 'big endian' which implies the following layout:



Where byte n is more significant than byte n+1. That is, the most significant byte is located at the lowest address, the least significant byte is located at the highest address. This is in contrast to little endian format (employed by for instance DEC VAXes and IBM PCs) where the least significant byte is located at the smallest address and the most significant bytes are located at the highest address.

In the following, bytes will be numbered from left to right starting with 0. Also bits are numbered from left to right starting with 0. Thus in a two byte integer, for example, the left-most byte will be given the number 0, the right-most byte will be given the number 1, the left-most bit will be given the number 0 and the right-most bit will be given the number 15.

Character type

Character fields are coded in ASCII and occupy 1 byte of storage.

Logical type

Logical fields are coded in single bytes. A byte value of 0 corresponds to 'FALSE' and any other value to 'TRUE', although in line with convention a value of 1 is normally used for 'TRUE' within the OpenMTP format.

Short integer

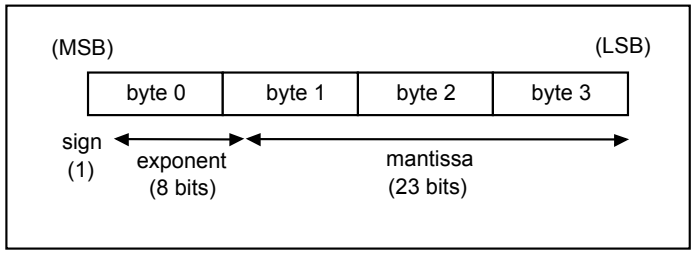
A short integer is two bytes in length. The short integer is represented in two's complement which means that bit 0 of byte 0 has negative weight (-bit0 * 2**15). Unless otherwise stated, short integer fields should therefore be interpreted as signed values with a range of -32768 ... 32767.

Integer type

A full integer is four bytes in length. It is represented in two's complement which means that bit 0 of byte 0 has negative weight (-bit0 * 2**31).

Single-precision floating point

A single-precision (four byte) floating point number has the following representation:



The following three fields describe the single-precision floating-point:

S: The sign of the number. Values 0 or 1 represent positive and negative respectively. One bit (bit 0) is devoted to this field.

E: The exponent of the number, base 2. 8 bits are devoted to this field. The exponent is biased by 127. Thus the range of the exponent is -127 to 128.

M: The fractional part of the number's mantissa, base 2. 23 bits are devoted to this field. The integer part of the mantissa is always a binary 1 for which reason it is implicit in the representation.

3. PRODUCT STRUCTURE

The overall product structure is shown in figure 2. The product consists of a variable number of records of variable length.

The structure contains three distinct components:

- Record 1, ASCII header. This fixed length (542 byte) record contains general information about the file in ASCII format. It enables a user to quickly check the content of the product using a basic editor or print function.
- Record 2, product header. This fixed length (3200 byte) record contains binary format information relating to the overall content of the file along with calibration tables for each image channel.
- Records 3 onwards, CDS segment data. Contains radiance and other information for each segment along with quality and other control information.

  The segment records are hierarchically structured. One record is included for each of the 'M' segments for which there is a CDS result (typically the majority of the 3500 segments covered by the product processing mask). Segments with no results are not included in the product. The number of segments present is recorded in record 2 to assist automatic parsing of the product structure.

  Each segment record in turn contains a 36 byte segment header, followed by one or more results for that segment. Each result corresponds to one cluster of pixels which have comparable radiometric characteristics and are therefore attributed to the same radiometric scene with the segment. The number of clusters per segment varies but is typically in the range 1-3. The format has been designed to accommodate changes to this range. Again, the number of results is recorded in the segment header to assist automatic parsing of the product structure. Each result block occupies 88 bytes.

  Assuming that a typical segment contains 2.3 clusters, the size of a typical CDS product is approximately 820 Kilobytes. The exact size may be defined as:

$$SIZE \quad = \quad 542 + 3200 + \sum_{S=1}^{S=M} \left(36 + C_S \times 88\right) \qquad \text{bytes}$$

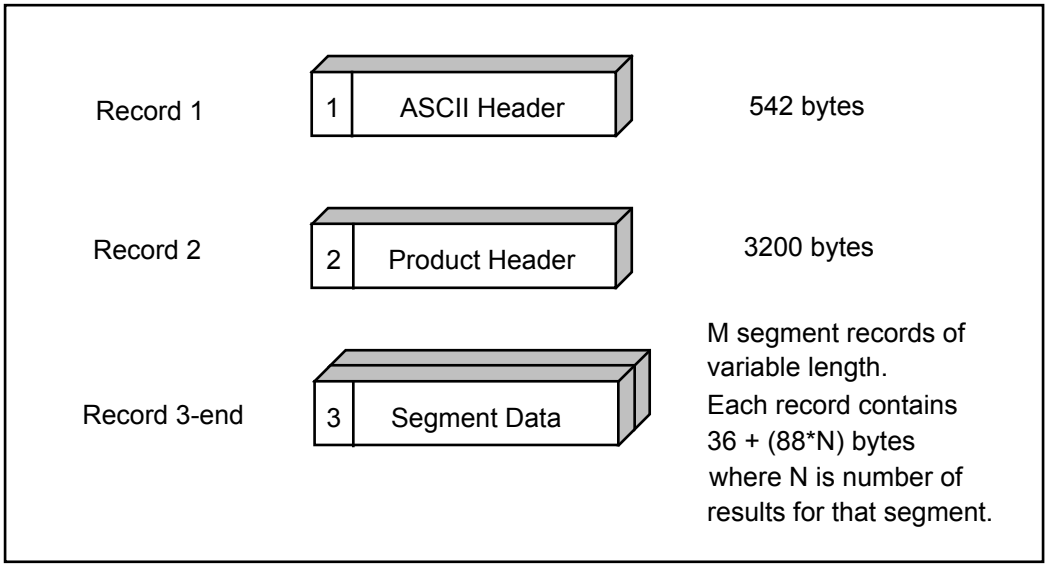
  where S is the segment number, C_S the number of clusters for segment number S, and M the total number of segments with results in the product. This equation can be reduced to the expression:

$$SIZE \quad = \quad 3742 + 36 \times M + 88 \times C \qquad \text{bytes}$$

  where M is the number of segments with results and C is the number of results blocks (ie the total number of clusters summed over all segments) in the product.

The three types of record have structures of type 1 to 3 respectively. Detailed descriptions of each structure are provided in section 4 of this document.

Figure 2 CDS Product Structure



It should be noted that the 'records' in this product format are purely logical. The file should in practice be seen as a single structure consisting of a sequence of bytes.

4. FORMAT AND FIELD DEFINITIONS

This section provides detailed format definitions for each of the four structures introduced in the previous section.

The following information is provided for each field:

- Offset from start of structure. (To get the overall offset from the start of the file, this number must be added to the sum of the sizes of the preceding physical records). The offsets are quoted in zero-relative terms.
- Name of the field. An arbitrary but convenient field identifier.
- Description. Describes the field and any special features of its population.
- Type. The data type of the field, i.e. how it is encoded. The valid types are:

  A<n> - An ASCII string of <n> characters.

  B<n> - A string of <n> values to be treated as simple bytes.

  I2 - A 2-byte integer in binary format.

  I4 - A 4-byte integer in binary format.

  L1 - A one-byte logical value (TRUE or FALSE).

  R4 - A single-precision floating-point (4-byte real) number in binary format.

  See section 2.2 for detailed descriptions of the encoding of each type in the file.
- Dimension. The number of entries in the field, e.g. 1 for a single value, 10 for an array of 10 values, (10, 10) for a two-dimensional matrix of 10 rows of 10 values, etc. The first index quoted is that which cycles fastest, i.e. the first index cycles once for each step in the second index, etc.

Footnotes to each table provide additional information where necessary.

4.1. ASCII Header

As mentioned in section 3, header record 1 is a fixed length ASCII text block of 542 bytes. The record is divided into a series of text lines each of which has the same format, vis:

FIELD_NAME FIELD_VALUE <newline>

Every field starts with a field name, which describes the content of the field. The field name is padded out to 15 characters total width with spaces, and is left justified. The maximum length of the text is 14 characters, so that character 15 (dividing the field name from the field value) is always a blank.

The field value starts at character 16 of the field and continues until character N-1, where N is the total length of the field. If the value text does not extend to this character, the field will be padded with spaces.

A newline character is inserted at character position N of every field, so that a sensible line-by-line format is displayed when a user lists out the opening bytes of the product file using an editor or print command.

The fields of the ASCII header record are given in the table below. The indicated field lengths are the total lengths and therefore include the 15 characters used for the field name and the terminating newline character. The field names that appear in each field are noted as part of the description of the field.

Offset	Name	Description	Type	Dimension
000	PROD	Field name = 'Product'. MTP era name of product - set to 'CDS'.	A25	1
025	FORMAT	Field name = 'Format'. Name of data format, always set to 'OpenMTP'.	A55	1
080	FVERS	Field name = 'FormatVersion'. Version number of format for this file, initial value is '1'.	A75	1
155	PLTFRM	Field name = 'Platform'. Satellite name in free text format, e.g. 'Meteosat-5'.	A30	1
185	DATE	Field name = 'Date'. Nominal date of product in YYYY-MM-DD format, e.g. '1996-11-30'.	A26	1
211	TIME	Field name = 'NominalTime'. Nominal time of product in HH24:MI format, e.g. 10:59, 22:30.	A21	1
232	SLOT	Field name = 'SlotNo'. Slot number in day: 1 ... 48.	A19	1
251	ORDER	Field name = 'Ref'. Unique reference number of the file within the EUMETSAT order handling system, in ORDER-DELIVERY-ENTRY-ITEM format, e.g. 1767-1-2-10.	A47	1
298	CUST	Field name = 'Source'. Identifier of customer requesting product.	A35	1
333	PTIME	Field name = 'Time'. Production time in YYYY-MM-DD-HH24:MI format, e.g. 1996-11-30-14:30.	A35	1
368	SWVERS	Field name = 'SWVersion'. Software Version used for production.	A75	1
443	FNAME	Field name = 'FileName'. Identifier of data type in ESOC format, provided for compatibility and continuity. For CDS data this will always be set to ' CLIM3HV'.	A24	1
467	CRIGHT	Field name = 'Copyright'. EUMETSAT Copyright notice.	A75	1

4.2. Product Header

This section defines the content of the 3200 byte binary product header.

Offset	Name	Description	Type	Dimension
000	SLOT	Slot number (1-48).	I4	1
004	TIME	Slot nominal time in HH24MI format, e.g. 1030, 2200 - **see section 5.3 below**	I4	1
008	JDAY	Day of the year (eg 123) – **see section 5.3 below**	I4	1
012	YEAR	Year, e.g. 1996	I4	1
016	PLTFRM	Spacecraft identification, in Mx or METx format, i.e. 'M5' or 'MET5' for Meteosat-5.	A4	1
020	Spares	Spares (8 bytes).	--	--
028	FNAME	Product name, always set to ' CDS' for CDS products.	A4	1
032	PTIME	Product time.	I4	1
036	PALG	Product extraction algorithm.	A32	1
068	PVERS	Version of product (raw, final etc).	I4	1
072	NSEG	M, the number of segments with results in the product (typically approx. 3500)	I4	1
076	IRCAL	Calibration table for IR channel.	R4	256
1100	VISCAL	Calibration table for VIS channel. (For future use; currently empty).	R4	256
2124	WVCAL	Calibration table for WV channel.	R4	256
3148	Spares	Spares (16 bytes).	--	--
3164	QTOTAL	Combined quality indicator for whole product	I4	1
3168	DIST	Distribution authorization, logical flag set if product was authorised for distribution at time of generation.	L1	1
3169	Spares	Spares (31 bytes).	--	--

4.3. CDS Data

The first part of the segment record consists of a 36 byte segment header. Every segment is identified by its row (line) and column number within the overall 80 x 80 segment grid.

Offset	Name	Description	Type	Dimension
000	SEGLIN	Segment line (1-80)	I4	1
004	SEGCOL	Segment column (1-80)	I4	1
008	SELPIX	South East corner line pixel number	I4	1
012	SECPIX	South East corner column pixel number	I4	1
016	SELAT	South East corner latitude in degrees.	R4	1
020	SELON	South East corner longitude in degrees.	R4	1
024	SHEIGHT	Segment height in pixels (currently 32).	I4	1
028	SWIDTH	Segment width in pixels (currently 32).	I4	1
032	NRES	N, the number of CDS results blocks, i.e. radiometric clusters, in segment (typically in range 1 to 3)	I4	1

The following part of the table describes the structure of the 88-byte results block. Offsets are given from the start of the segment structure for the first block; add an appropriate multiple of 88 to obtain the offsets for the second and subsequent blocks.

Offset	Name	Description	Type	Dimension
036	CENLAT	Latitude of segment centre (for possible future use)	R4	1
040	CENLON	Longitude of segment centre (for possible future use)	R4	1
044	CCLASS	Classification of this cluster (see note 1).	I4	1
048	NPIX	Number of pixels in this cluster	I4	1
052	GLINT	Sun glint indicator: 0 = no sunglint 1 = sunglint	I4	1

056	ZENIT	Solar zenith angle in degrees, 0 = sun below horizon.	R4	1
060	ZENITSC	Spacecraft zenith angle in degrees.	R4	1
064	AZIMSC	Absolute azimuth difference between sun and spacecraft in degrees, 0 = sun below horizon.	R4	1
068	IRMEAN	Mean Infra-Red channel count for this cluster	R4	1
072	VISMEAN	Mean Visible channel count for this cluster	R4	1
076	WVMEAN	Mean Water Vapour channel count for this cluster	R4	1
080	IRSD	Standard Deviation of Infra-Red channel count for this cluster	R4	1
084	VISSD	Standard Deviation of Visible channel count for this cluster	R4	1
088	WVSD	Standard Deviation of Water Vapour channel count for this cluster	R4	1
092	CORIR	Corrected IR mean count for this cluster	R4	1
096	Spares	Spares (8 bytes).	--	--
The following fields contain parameter quality indicators.				
104	LOCQ	Location quality indicator (for possible future use)	I4	1
108	CDSQ	Cluster quality indicator	I4	1
112	Spares	Spares (8 bytes).	--	--
The following fields contain control flags from the Automatic and Manual Quality Control processes.				
120	AQCREJ	AQC deleted flag (‘TRUE’ means that the cluster has been merged).	L1	1
121	MQCREJ	MQC reinstated flag (not used)	L1	1
122	MQCMOD	MQC deleted flag (not used)	L1	1
123	Spares	Spare (1 byte).	--	--

Notes:

1. Each cluster of pixels is classified into one of nine types according to its spectral signature and a database of the underlying surface cover types. The CCLASS field indicates the type assigned, and is encoded as follows.

1	Sea
2	Snow-free mountains
3	Forest (any)
4	Savannah
5	Bright desert
6	Steppe / Other
14	Low cloud
15	Medium cloud
16	High cloud

5. ADDITIONAL NOTES

5.1. Applicability

The format description applies equally to products generated from the Meteosat Operational Programme (1978 – mid-November 1995) and from the Meteosat Transition Programme (November 1995 onwards).

However, the format includes many fields added as an enhancement for MTP, which cannot be fully populated when MOP era data is retrieved as the required underlying data is not available from the archive. See below.

5.2. Format History

The OpenMTP product format is an evolution from the IBMMOP format used for many years by ESOC within the MOP programme. Users who wish to continue with the ESOC format can still retrieve the data in that form. However, the OpenMTP format offers additional data and features which should enhance the value of the product to most users.

5.2.1. Evolution of Algorithms

The algorithms used to generate CDS data for archiving have inevitably evolved over the years. It is not possible to provide a detailed history, but key points will be noted here in a future issue of this document.

5.2.2. Retrieving MOP Data in OpenMTP Format

There are many new fields in the OpenMTP format which cannot be populated for MOP era data from the Meteosat Archive. These fields, and the way they are populated when these older data are requested, are tabulated below. (Note that these limits only affect the binary header record and the segment records; the ASCII header is fully populated for all data).

Binary Header Record

Offset	Name	Value for MOP Era Data
016	PLTFRM	' N/A'. The original satellite from whose data the product was derived is not recorded in the ESOC archive.
036	PALG	'MIEC: Information Not Available'. The algorithm history is not available.
068	PVERS	Always set to 0 for MOP era data. (The version numbers for MTP era data start from 1).
3164	QTOTAL	Set to 0 (arbitrary).
3168	DIST	Set to FALSE (arbitrary).

CDS Segment Data Records

Offset	Name	Value for MOP Era Data
104	LOCQ	Set to FALSE. Information not available for MOP era data.
108	CDSQ	Set to FALSE. Information not available for MOP era data.
120	AQCREJ	Set to FALSE. Information not available for MOP era data.
121	MQCREJ	Set to FALSE. Information not available for MOP era data.
122	MQCMOD	Set to FALSE. Information not available for MOP era data.

5.3. Health Warnings

For **all slot 48 CDS products** there is a possible ambiguity in the time field in the product header. It should be interpreted as in the following example (CDS product for 16th February 1999 2400 UTC) :

SLOT 48

TIME 0000 [to be unambiguous this should be 2400]

JDAY 047

YEAR 1999

In addition, during the period 16th November 1995 until 9th March 1997 a processing error caused the **wrong day number** to be set in the product header **for slot 48 products**. The day number should be decreased by one and so for products generated during this period the product header should be interpreted as in the following example (CDS product for 10th January 1996 2400 UTC) :

SLOT 48

TIME 0000 [to be unambiguous this should be 2400]

JDAY 011 [**this is an error - it should be 010**]

YEAR 1996