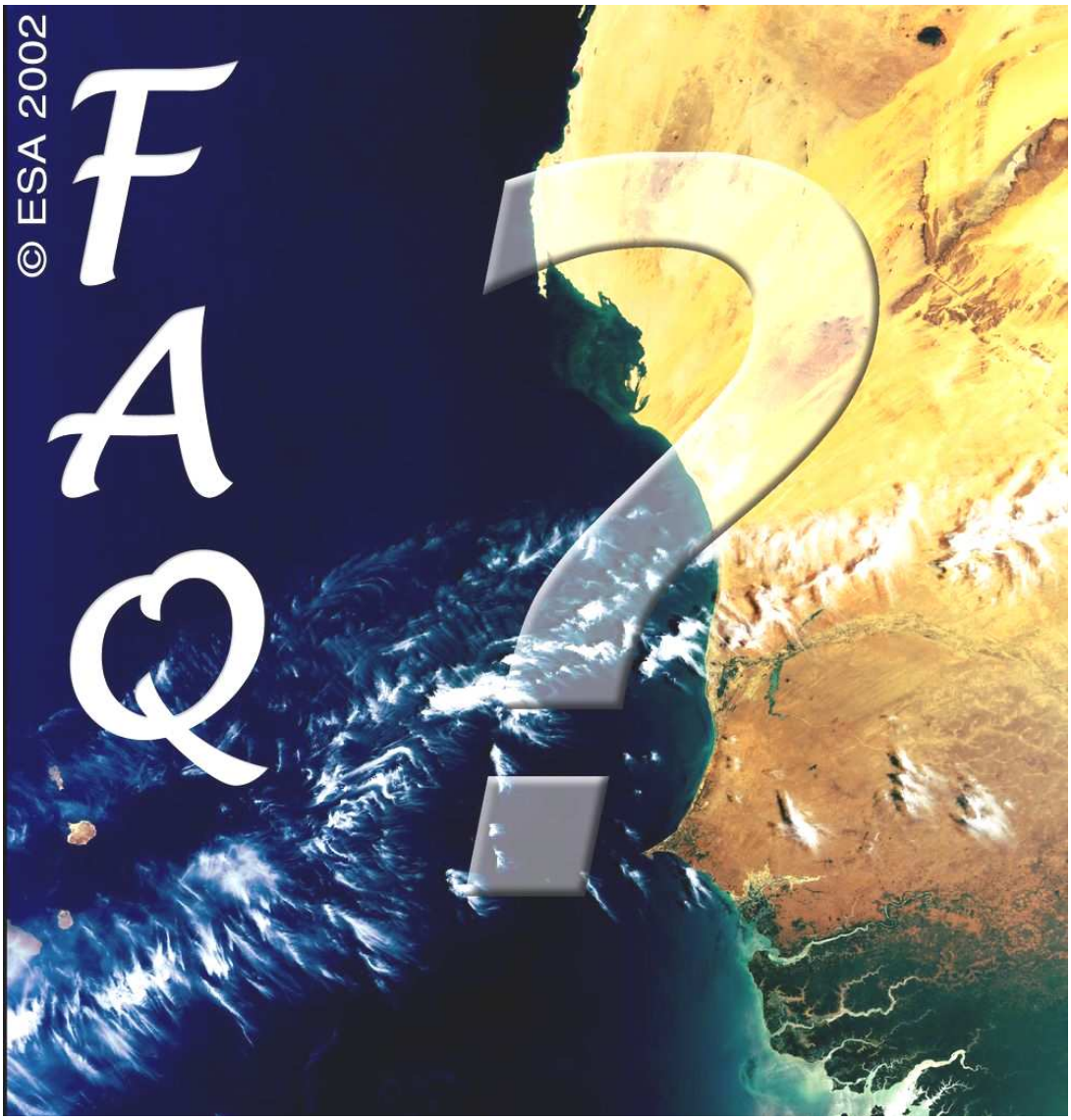
MERIS Frequently Asked Questions



European Space Agency –MERIS Frequently Asked Questions
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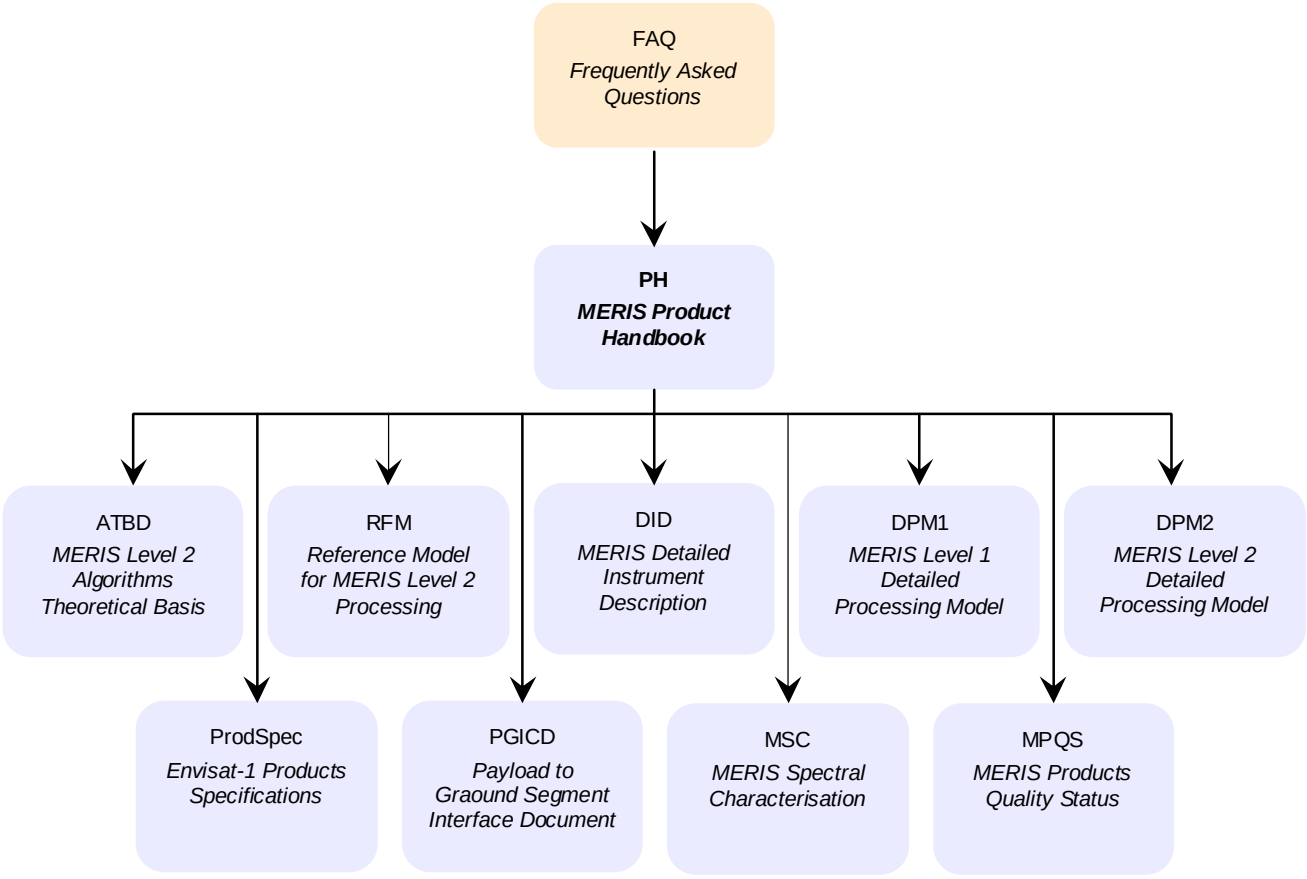
Abstract

This *Frequently Asked Questions* document enables users to get a fast answer about MERIS instrument, products and data processing.

A more detailed description is provided in the *MERIS Product Handbook* which guides users to choose and use MERIS data and explains the way these data are processed and organised.

Scientists may also get a deeper and more detailed level of information in the documents pointed as reference in the *MERIS Product Handbook*.



Chapter 1

Frequently Asked Questions

1.1 Introduction

The purpose of this FAQ is to act as a repository for common questions raised concerning the MERIS mission It includes questions raised with the Quality Working Group and questions of particular interest to new users.

The information contained within this document is supplementary to that contained within the MERIS Handbook, available from http://envisat.esa.int/dataproducts/meris/.

The questions fall into 4 basic categories:

- General Questions, covering background to the MERIS mission;
- Common Questions From New Users;
- Questions Concerning the Instrument;
- Questions on Data Processing,
- Questions on MERIS Products.

Each of these categories is addressed in the following sections.

1.2 General questions

1.2.1 What does MERIS stand for ?

MERIS stands for "**ME**dium **R**esolution **I**maging **S**pectrometer".

1.2.2 What is MERIS and what does it do ?

MERIS is one of the instruments on board the European Space Agency (ESA) satellite ENVISAT. Objectives of MERIS are to monitor changes of oceans (phytoplankton, yellow substance, suspended matter), atmosphere (water vapour, CO_2, clouds, aerosols), and lands (vegetation index, global coverage, moisture...).

1.2.3 What are the spectral bands of MERIS instrument ?

MERIS instrument observes the Earth in 15 spectral bands in the visible and near infrared.

Table 1.1 - MERIS spectral bands and applications.

Band index	Band centre (nm)	Band width (nm)	Application(s)
1	412.5	10	Yellow substance and detrital pigments
2	442.5	10	Chlorophyll absorption maximum
3	490	10	Chlorophyll and other pigments
4	510	10	Suspended sediment, red tides
5	560	10	Chlorophyll absorption minimum
6	620	10	Suspended sediment
7	665	10	Chlorophyll absorption & fluo. reference
8	681.25	7.5	Chlorophyll fluorescence peak
9	708.75	10	Fluo. reference, atmosphere corrections
10	753.75	7.5	Vegetation, cloud
11	760.625	3.75	O_2 R- branch absorption band
12	778.75	15	Atmosphere corrections
13	865	20	Vegetation, water vapour reference
14	885	10	Atmosphere corrections
15	900	10	Water vapour, land

1.2.4 What is ENVISAT ?

ENVISAT is an advanced polar-orbiting Earth observation satellite providing measurements of the atmosphere, ocean, land, and ice (see http://envisat.esa.int/). It was launched on 1st March 2002 by ESA.

Envisat continues the work of the ERS satellites, and its data supports Earth science research and allows monitoring of the evolution of environmental and climatic changes.

1.2.5 What orbit does ENVISAT use ?

Envisat flies in a sun-synchronous polar orbit of about 800-km altitude. The repeat cycle of the reference orbit is 35 days, although most sensors, being wide swath, provide complete coverage of the globe within one to three days.

1.2.6 What can MERIS data be used for ?

The MERIS Level 1 products provide the radiance as measured by the instrument. The can be used to construct colour composite images, either giving a photographic impression or highlighting certain thematic features of the Earth, and they are input to processing algorithms to derive Level 2 products.

The MERIS level 2 products provide geophysical information ready to be used for various applications.

The primary mission of MERIS is to monitor the ocean colour including chlorophyll concentrations for open oceans and coastal areas, yellow total suspended matter. In addition, MERIS provides with land parameter measurements like vegetation indices and atmospheric parameters like water vapour, cloud top pressure, cloud types, aerosol optical thickness, and Angström coefficients.

1.2.7 If this FAQ does not answer my question, what should I do ?

More detailed information may be found in the "*MERIS Product Hanbdbook*" or in the "*MERIS Detailed Instrument Description*".

All queries regarding ENVISAT and MERIS should be directed to the ESA Earth Observation Help Desk Team (EOHelp@esa.int) in the first instance.

1.3 Common questions from new users

1.3.1 Where can I find a 'user guide' to receiving and utilising MERIS data ?

The MERIS Product Handbook can be downloaded from http://envisat.esa.int/dataproducts/. It contains a Product User Guide designed to help users familiarise themselves with MERIS and "get started" with using MERIS data. This is supported by later sections containing information on the instrument, the products and the algorithms used to generate them.

1.3.2 Where can I get MERIS samples ?

MERIS sample data are freely available at http://envisat.esa.int/services/sample_products/meris/.

1.3.3 How can I be kept up to date with events that might affect my use of MERIS data ?

MERIS Cyclic Reports are distributed by the ESA Data Product Quality Control (DPQC) to keep the MERIS community informed of any modifications to the processor, updates of auxiliary products, instrument anomalies, the status of data acquisition and processing, and the status of the calibration, validation, and quality control activities.

For a full list of the reports, see http://earth.esa.int/pcs/envisat/meris/reports/cyclic.

For more information regarding AATSR products, please refer to "AATSR Product Handbook" at http://envisat.esa.int/dataproducts/ .

1.3.4 How can I order MERIS data ?

A number of interactive catalogues are available for browsing ESA earth observation data. These can be found at http://envisat.esa.int/services/ .

The ESA Data Distribution Policy governs the distribution of MERIS data. The Data policy can be found at: http://eopi.esa.int/esa/esa/ .

Meris users can receive ENVISAT data on media, via FTP or via the web, depending on the nature of the order. The ESA Earth Observation Help Desk Team (EOHelp@esa.int) can also advise on data access issues.

More information can be found in the How to get MERIS Data from ESA catalogues and ftp servers dedicated to the users - Access_to_MERIS_data document (see http://earth.esa.int/pcs/envisat/meris/documentation/Access_to_MERIS_data.pdf) or directly contacting the EOHelp@esa.int.

1.3.5 Where can I find articles/papers on the exploitation of MERIS data ?

MERIS – (A)ATSR Workshop (26-30 September 2005)
http://envisat.esa.int/workshops/meris_aatsr2005/

ENVISAT/ERS Symposium (6-10 September 2004)
http://earth.esa.int/salzburg04/

ENVISAT MERIS and AATSR Validation Team Workshop - MAVT-2003 (20 - 24 October 2003)
http://envisat.esa.int/workshops/mavt_2003/

Envisat Validation Workshop (9-13 December 2002)
http://envisat.esa.int/pub/ESA_DOC/envisat_val_1202/proceedings/

Envisat Calibration Review (9-13 September 2002)
http://envisat.esa.int/calval/proceedings/

ERS-Envisat Symposium "Looking down to Earth in the New Millennium" (16-20 October 2000)
http://earth.esa.int/pub/ESA_DOC/gothenburg/start.pdf

ESA Data User Element (DUE) Projects
http://dup.esrin.esa.it/index.asp

ESA EO PI Projects
http://eopi.esa.int/esa/esa

International Journal of Remote Sensing Vol.20 N°9 June 1999: Special Issue: ESA Medium Resolution Imaging Spectrometer (MERIS).

MERIS Scientific Advisory Group (1995). MERIS: The Medium Resolution Imaging Spectrometer. *European Space Agency Technical Report* **SP-1184.**

Rast, M. and J.-L. Bézy (1995). The ESA medium resolution imaging spectrometer (MERIS): requirements to its mission and performance of its system. *Remote Sensing in Action, Proc. 21st Annual Conf. Remote Sensing Soc.* **1995**:125-132.

Rast, M. and J.-L. Bézy (1997). The MERIS instrument. *International Journal of Remote Sensing 18***.**

Schüller, L., J. Fischer, W. Armbruster, and B. Bartsch (1997). Calibration of high resolution remote sensing instruments in the visible and near infrared. *Adv. Space Res.* **19**:1325-1334.

1.3.6 What tools are available for reading MERIS products ?

Most users write their own routines in C, IDL or other languages to read and process MERIS data. The detailed MERIS product specifications will assist with this task. See the documents describing the format at http://envisat.esa.int/support-docs/productspecs/index.htm. However some tolls provide with the capacity of reading and processing MERIS data:

- The Basic ERS & Envisat (A)ATSR and Meris Toolbox (**BEAM**) is a collection of executable tools and an application programming interface (API) which has been developed to facilitate the utilisation, viewing and processing of ESA MERIS, (A)ATSR and ASAR data. See http://www.brockmann-consult.de/beam/ and in particular the BEAM FAQ at address http://www.brockmann-consult.de/BEAMWiki/Wiki.jsp?page=FAQ .
- The **EnviView** tool provided by ESA (see http://earth.esa.int/services/tools/enviview/) can also be used to convert ENVISAT data into hdf file format. This allows the data to be automatically read by any third-party software supporting this format.

  EnviView is a free application that allows Envisat data users to open any Envisat data file and examine its contents. It provides simple visualisation capabilities, and allows data to be exported to HDF for use in other software packages

All the Envisat tools are available from: http://www.envisat.esa.int/services/tools_table.html.

The providers of a number of COTS image processing packages such as ERDAS, ENVI and Geomatica also planned to extend their products to directly support the MERIS product format. The individual packages/providers should be consulted for details of each tool's capabilities.

1.4 Instrument Characteristics

1.4.1 What are the acquisition modes of MERIS instrument ?

MERIS is a push-broom instrument composed of five cameras (also called modules). Swath of each camera overlaps with the successive one. Each camera is composed of one CCD array for each one of the 15 bands. The ground sampling for one CCD (resolution) represents 260 metres across track by 290 metres along track in a "**full resolution**" mode.

A on-board electronic unit computes a combination of four adjacent samples across-track over four successive lines leading to a "**reduced resolution**" of 1040 metres across track by 1160 metres along track.

The full resolution is processed on-demand while the reduced resolution is processed systematically;

1.4.2 What are the viewing angles and swath ?

The instrument's **68.5°** field of view around nadir covers a swath width of **1150 km**.

1.4.3 Where can I obtain the full set of MERIS channel spectral response functions ?

The detailed spectral response functions of each band for each camera is given in document "*MERIS Spectral Characterisation*" (see the reference documents in "*MERIS Product Handbook*").

1.5 Data Processing

1.5.1 What are the MERIS product levels ?

The ENVISAT nomenclature of the products delivered to the public describes three types of processing levels:

- **level 1B** – are images resampled on a path-oriented grid, with pixel values having been calibrated to match the Top Of Atmosphere (TOA) radiance.
- **level 2** – are images deriving form the level1B products, with pixel values having been processed to get geophysical mesurements.
- **level 3** – are synthesis of more than one MERIS products (and possibly external data) to display geophysical measurements for a time period.

1.5.2 Does MERIS data processing change ?

The definition of the products to be computed and a first version of the algorithms to be used have been defined before the launch of ENVISAT in the ATBD (Algorithm Theoretical Basis Documents).

The way these algorithms are implemented, and their possible refinements, are described in the DPM (Detailed Processing Model) documents. These models are upgraded leading to change the versions of the IPF (Instrument Processing Facility).

History of these changes is to be found in the "MERIS Instrument Processing Facility Evolution" at address http://earth.esa.int/pcs/envisat/meris/documentation/MERIS_IPF_evolution.pdf

1.5.3 Which version of the MERIS IPF was used to produce my data ?

The MERIS IPF (Instrument Processing Facility) version number is given by a field within the Main Product Header (MPH) of the product. MPH description is to be found at http://envisat.esa.int/support-docs/productspecs/index.htm.

1.5.4 What differences will there be between data processed in Near-Real-Time and Off-Line ?

About two weeks after acquisition, Off-Line products are consolidated using better auxiliary files (orbit and meteo parameters). For MERIS, the difference between Near-Real-Time and Off-Line products are negligible.

1.5.5 Is there a repository of known problems with the MERIS data processing/products ?

Disclaimers addressing issues affecting MERIS product quality are published at http://envisat.esa.int/dataproducts/availability/.

1.6 MERIS products

1.6.1 How do I interpret the information in the filename of my MERIS data ?

File naming convention is fully explained in Section 2.2.1 of the" *MERIS Product Handbook*".

1.6.2 What are the spatial resolutions of MERIS products ?

Full Resolution	**260 m** across track	**290 m along** track
Reduced Resolution	1040 m across track	1160 m along track

1.6.3 What are the image sizes of MERIS products ?

Product	image size	ground coverage
Full Resolution Full scene	2241 pixels x 2241 lines	582 km (across-track) by 650 km (along-track)
Full Resolution Quarter scene	1153 pixels x 1153 lines	300 km (across-track) by 334 km (along-track)

Reduced Resolution	1121 pixels x N lines	1165 km (across-track) by 1300 km (along-track)

1.6.4 Where are image data in my MERIS product ?

Image data are stored in the Measurement Data Sets (MDS) records of the product after ASCII headers. These headers are organised in a (tag,value) fashion.

The structure of the MERIS products is summarized in section in Section 2.2.2 (MERIS product data structure) of the "*MERIS Product Handbook*".

The reference description of all the ENVISAT products is provided in the "*Envisat-1 Products Specifications*" documents available at http://envisat.esa.int/support-docs/productspecs/index.htm.

The BEAM toolbox includes readers for C, IDL and Java which decode the measurement data sets (MDS), apply the pixel type flags and the gain and offsets (i.e. providing a rectangular grid of algal pigment index or MGVI floating values). For interactive uses, BEAM/VISAT is doing the same so that the complex MDS structure with multiple use is transparent for the user.

1.6.5 What are the differences between "Algal I" and "Algal II" measurements in the level 2 products ?

Algal Pigment Index I

The MERIS algal pigment index is a measurement of the concentration expressed in Log10(mg/m^3) of phytoplankton (algae) in the water. The concentration is derived by the direct relationship between the ratio of the blue and green signal leaving the water surface and the concentration of algal pigments. The relationship, based on published data, is valid over clear waters and spans a concentration range from mg/m3 to tens of g/m^3 .

Note: The Algal Pigment Index I is not applicable in water with significant amounts of suspended matter or yellow substance. In such cases, corresponding product confidence flag is raised.

For more information, see ATBD 2.9

Algal Pigment Index II

The second MERIS algal pigment index is also a measurement of the concentration expressed in Log10(mg/m^3) of phytoplankton (algae) in the water but, is part of a suite of oceanic products derived by inverting a model of the optical properties of the ocean by the use of a neural network. The other oceanic products are suspended matter and yellow substance.

In clear waters the Algal Pigment Index II product is more noisy than the Algal Pigment Index I.

For more information, see ATBD 2.12

1.6.6 What is the meaning of the MERIS quality flags present in the Level 2 products ?

Flags are provided on a pixel by pixel basis. It is a binary information.

There are different types of flags:

- The classification flags that indicate the types of surface.
- The confidences flags that give an indication on the confidence on the parameter quality retrieval. The pixels where the flag is raised should be discarded or used very carefully. For Level 3 processing it is strongly recommended to systematically exclude values where the PCD is raised.
- The science flags that help in the interpretation of the data. Those flags shall be consulted for a full understanding of the retrieved parameter meaning.

The list of flags is as follows:

- *Surface Classification:*
  - land product available
  - cloud product available
  - water product available
  - Sun low above horizon (or conversely high sun zenith angle)
- Product Confidence:
  - validity for MDS 1 to 13
  - validity for MDS 14
  - validity for MDS 15
  - validity for MDS 16
  - validity for MDS 17
  - validity for MDS 18
  - validity for MDS 19
- *Science Flags, general:*
  - Coastline: From Level 1b
  - Cosmetic: From Level 1b
  - Suspect: From Level 1b
  - Computed pressure is lower than ECMWF one (land, cloud)
- *Science Flags, water:*
  - Aerosol model is out of aerosol model database
  - Dust-like absorbing aerosol selected for atmosphere correction
  - Turbid (sediment dominated Case 2) water
  - Anomalous scattering water
  - Yellow substance loaded water
  - Ice or high aerosol load pixel
  - Reflectance corrected for medium glint
  - Bright pixels atmospheric correction activated
  - High (uncorrected) glint
  - Presense of white scatterer in water
- *Science Flags, land:*
  - Bright pixel flagged by MGVI processing
  - Bad pixel flagged by MGVI processing
  - Cloud, snow or ice over land pixel acc. to MGVI processing

- Water/shadow pixel acc. to MGVI processing
- Land aerosol remote sensing turned on
- Invalid rectification

1.6.7 What is the “smile effect ?

The spectral measurements of each pixel along an image line are made by its own set of CCD sensors: this causes small variations of the spectral wavelength of each pixel along the image that constitute the so-called "smile effect". The variation of the wavelength per pixel is in order of 1nm from one camera to another, while they are in the order of 0.1nm within one camera.

Even though this variation is small compared to the spectral bandwidth of a band, which is typically 10nm, and can hardly be seen in an image, it can cause disturbances in processing algorithms, which require very precise measurements, for example the retrieval of chlorophyll in the ocean. These disturbances could result in a visual artefact, "camera borders.

The smile effect is corrected for level 2 products.

See http://earth.esa.int/pcs/envisat/meris/documentation/MERIS_Smile_Effect.pdf