



## MERIS Frequently Asked Questions



European Space Agency –MERIS Frequently Asked Questions  
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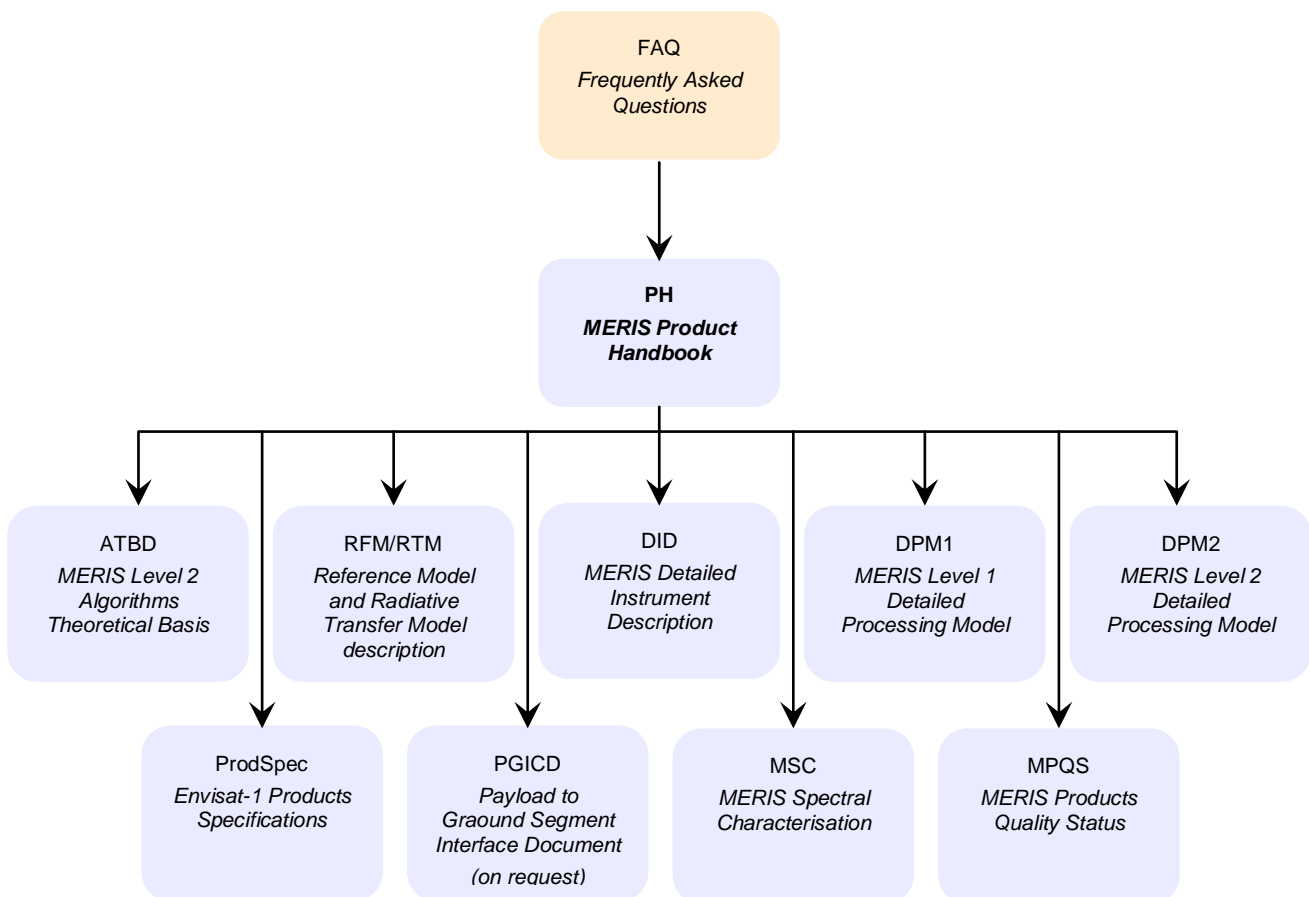
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# Abstract

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](#).



**Figure 1: The FAQ in relation to MERIS Documentation**

# Chapter 1

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## 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 5 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<sub>2</sub>, clouds, aerosols), and lands (vegetation index, global coverage, moisture...).

### 1.2.3 What are the spectral bands of MERIS instrument ?

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



**Table 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 <sub>2</sub> 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 1<sup>st</sup> 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 ?

During the period from launch to October 2010, the Envisat platform was in a sun-synchronous polar orbit of about 800-km altitude. The repeat cycle of the reference orbit was 35 days, although most sensors, being wide swath, provide complete coverage of the globe within one to three days.

During October 2010, in order to extend the lifetime of the mission, ENVISAT underwent an orbital lowering manoeuvre of approximately 18 km; this is known as ENVISAT\_2010+.

Since October 2010, and as a consequence of the lower orbital altitude, the repeat Cycle of the ENVISAT orbit is 30 days and comprises of 431 orbits.

In order to further extend the remaining fuel budget, a new control strategy was also introduced. This strategy means a reduction in the number of Orbital Control Manoeuvres (OCMs), and a concomitant increase in drift. The inclination of the ENVISAT Orbit will now be allowed to drift over time; please see [here](#) for more details.

## 1.2.6 What can MERIS data be used for ?

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.

The MERIS Level 1 products provide the radiance as measured by the instrument. They 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.

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

More detailed information may be found in the following documents:

- [MERIS Product Handbook](#)
- [MERIS Detailed Instrument Description](#)
- [MERIS Product Specification](#)
- [MERIS Algorithmic Theoretical Basis Documents \(ATBD\)s](#)
- [MERIS Reference Model Document \(RMD\)](#)
- [MERIS Level 1 Detailed Processing Model \(L1 DPM\)](#)
- [MERIS Level 2 Detailed Processing Model \(L2 DPM\)](#)

All queries regarding ENVISAT and MERIS should be directed to the ESA Earth Observation Help Desk Team ([EOHelp@esa.int](mailto: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 [here](#). 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/](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>.

### 1.3.4 How can I order MERIS data ?

Any user having an accepted Category-1 Project can have access to MERIS data; more information on the ESA Data Distribution Policy and the submission of a Category-1 Proposal can be found at <http://eopi.esa.int/esa/esa/>.

If the data are not available on-line or are subject to a new acquisition, they data can be ordered using the EOLI-SA catalogue (to be downloaded from <http://www.envisat.esa.int/services/catalogues.html>), they are then delivered on media, or soon via FTP for authorised projects.

More information can be found in the [Access\\_to\\_MERIS\\_data](#) document available at [http://earth.esa.int/pcs/envisat/meris/documentation/Access\\_to\\_MERIS\\_data.pdf](http://earth.esa.int/pcs/envisat/meris/documentation/Access_to_MERIS_data.pdf) or by contacting the ESA Earth Observation Help and Order Desk Team ([EOHelp@esa.int](mailto:EOHelp@esa.int)).

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

The ODESA forum – [here](#).

MERIS Validation Team Meeting presentations – [here](#).

2<sup>nd</sup> MERIS – (A)ATSR Workshop (22-26 September 2008) – [here](#).

MERIS – (A)ATSR Workshop (26-30 September 2005) – [here](#).

ENVISAT/ERS Symposium (6-10 September 2004) – [here](#).

MERIS and AATSR Validation Team Workshop – MAVT 2003 (20 - 24 October 2003) – [here](#).

Envisat Validation Workshop (9-13 December 2002) – [here](#).

Envisat Calibration Review (9-13 September 2002) – [here](#).

ERS-Envisat Symposium "Looking down to Earth in the New Millennium" (October 2000) – [here](#).

ESA Data User Element (DUE) Projects – [here](#).

ESA EO PI Projects – [here](#).

*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 document](#) will assist with this task. Additional information on parameters affection all instruments on ENVISAT can be found [here](#). Some tools capable of of reading and processing MERIS data are:

- The open source [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 in particular the [BEAM FAQ](#) and [BEAM Forum](#).
- 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. The last release available is version 2.8.1, dated 5<sup>th</sup> March 2010.

All the Envisat tools are available from [here](#).

The providers of a number of COTS image processing packages such as ERDAS, ENVI and Geomatica also 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). The swath of each camera overlaps with its neighbour. 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.

All acquired Full and Reduced Resolution data products are systematically processed.

### 1.4.2 What are the viewing angles and swath ?

The instrument's **68.5°** field of view (FOV) 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 from the Level 1B products, with pixel values having been processed to get geophysical measurements.
- **Level 3** – are a synthesis of more than one MERIS product (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 MERIS ATBDs ([Algorithm Theoretical Basis Documents](#)). Iterations of the MERIS ATBDs are necessary from time to time in order to reflect algorithm and other improvements.

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” document [here](#).

### 1.5.3 Which version of the MERIS IPF was used to produce my Near Real Time (NRT) 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 in [Volume 5 of the ENVISAT Product Specifications](#).

## 1.5.4 What differences will there be between data processed in Near Real Time (NRT) and OffLine (OFL) ?

About two weeks after acquisition, OFL products are consolidated using improved auxiliary files (containing analysed orbit and meteo parameters rather than forecast). For MERIS, the difference between NRT and OFL products are expected to be small, but depend on the differences in parameter values between the predicted and analysed auxiliary datasets.

## 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 on the '[Status of Envisat Products](#)' webpage.

## 1.5.6 Is there a repository of Reprocessed MERIS Products?

Reprocessing of MERIS data is carried out in order to improve the quality of the entire MERIS archive. Reprocessings are planned by the MERIS Quality Working Group (QWG) to address known issues in the archived products, and to improve the archive following improvements to algorithms and auxiliary tables (such as Look Up Tables (LUT) that are used in processing of MERIS products.

During 2011, the 3<sup>rd</sup> Reprocessing is being carried out using the MERIS Ground Segment (MEGS) Processor Version 8.0. MEGS 8.0 is fully equivalent to IPF v6 that will be used for the NRT production at ESA Ground Stations. More information on the 3<sup>rd</sup> Reprocessing is available [here](#).

Information on Previous Reprocessings can be found at:

**1<sup>st</sup> Reprocessing** – [here](#).

**2<sup>nd</sup> Reprocessing** – [here](#).

## 1.5.7 What is the AMORGOS processing tool?

The purpose of the AMORGOS (Accurate MERIS Ortho-Rectified Geo-location Operational Software) tool is to generate accurate geo-location information - longitude, latitude, altitude - for each MERIS pixel, starting from a MERIS Reduced Resolution product or MERIS Full Resolution product: either a Full Swath or a standard half-swath Scene product. **The Full Resolution quarter-swath product is not managed.**

Ortho-rectified geo-location must be understood as the computation of the intersection of a given sample line of sight with the Earth surface (as represented by the Digital Elevation Model) rather than with the reference ellipsoid as in Level 1b. However, it must be noted that image geometry is either the Instrument one (FSO mode) or the Level 1b one (FSG mode) and thus the output product is not ortho-rectified *stricto sensu*.

The AMORGOS tool is freely available [here](#).

## 1.5.8 What is ODESA?

ODESA is the [Optical Data processor of the European Space Agency](#) and provides users a complete level 2 processing environment for the MERIS instrument as well as for the future ESA optical sensors on board Sentinel 3.

ODESA supplies the user community with the MERIS Ground Segment development platform MEGS®, including source code, embedded in an efficient framework for testing and for validation activities.

Validation facilities include match-up processing & analysis, data set selection & analysis, level 3 products generation & analysis and the possibility to perform remote processing, e.g. for testing purposes and for validation activities requiring large amounts of data.



## 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 ?

<u>Full Resolution</u>	260 m across track	290 m along track
<u>Reduced Resolution</u>	1040 m across track	1160 m along track

### 1.6.3 What are the image sizes of MERIS products ?

**Table 2: MERIS Image Dimensions**

Product	Image Size	Ground Coverage (km)
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 is the image data stored 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 .

The BEAM toolbox (see Section 1.3.6 above) 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  $\text{Log}_{10}(\text{mg}/\text{m}^3)$  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  $\text{mg}/\text{m}^3$  to tens of  $\text{g}/\text{m}^3$ .

**Note:** The Algal Pigment Index I is not applicable in water with significant amounts of suspended matter or yellow substance. In such cases, the 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  $\text{Log}_{10}(\text{mg}/\text{m}^3)$  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 and stored as 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
- *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 pixel atmospheric correction activated
  - High (uncorrected) glint
  - Presense of white scatterer in water
- *Science Flags, land:*
  - Snow or Ice covered 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 can be in order of 1.7nm from between cameras, while they are in the order of 0.1nm within one camera.

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

The smile effect is corrected for Level 2 products.

\*NOTE: The largest impact of the smile effect is in Band 11, which has a very narrow spectral bandwidth (3.75nm).

More information can be found [here](#).

## 1.6.8 What is the Longitude Correction anomaly ?

An anomaly has been discovered in the MEGS processor resulting in faulty annotations for the lon\_corr values within MERIS products; the parameter contains the nominal absolute value, but an incorrect sign. The lon\_corr values are corrective terms which can be added to the Tie Point longitudes in order to account for surface elevation, and are thus only considered over Land surfaces.

This anomaly affects ALL products (Reduced and Full Resolution, Level 1 and Level 2) processed with MEGS 8.0 or lower, and IPF 4.x or lower. Products processed with IPF 5.02 or higher contain nominal annotations.

This anomaly will impact on any processing/analysis in which the lon\_corr value is applied to the longitude tie-point data; and can impact geolocation accuracy by several kilometres over high terrain.

The lon\_corr value is NOT used by either the MERIS Level 2 processor, or the [AMORGOS](#) post-processor, and their computations are therefore not affected. However, both processors copy the Level 1 annotations from the input product to their output, and so the erroneous lon\_corr annotation from the input product will remain in the output product.

**The methodology below can be used to correctly handle the lon\_corr values whatever the product data software code and version:**

- 1) Take the absolute value of lon\_corr
- 2) Assign to it the sign of sin(view\_azimuth)

i.e.

+|lon\_corr| for  $0 \leq \text{view\_azimuth} < 180$   
-|lon\_corr| for  $180 \leq \text{view\_azimuth} < 360$