DOCUMENT

document title/ titre du document

EVOLUTION

OF THE

MERIS INSTRUMENT

PROCESSING FACILITY

prepared by/*préparé par*	MERIS SPPA Team
reference/*réference*	
issue/*édition*	4
revision/*révision*	0
date of issue/*date d'édition*	February 2012
status/*état*	
Document type/*type de document*	Technical Note
Distribution/*distribution*	

A P P R O V A L

Title *titre*	issue *issue*	revision *revision*

author *auteur*	L. Bourg, J. Jackson, C. Kent	date *date*	February 2012

approved by *approuvé par*	P. Goryl	date *date*

C H A N G E L O G

reason for change /*raison du changement*	issue/*issue*	revision/*revision*	date/*date*
IPF release 5.05	2	1	November 2008
IPF release 5.06	3	0	June 2010
IPF release 6.04 & 3rd Reprocessing	4	0	February 2012

C H A N G E R E C O R D

Issue: 4 Revision: 0

reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*
IPF release 5.06	4, 5, 10, 11 & 14	Sections 2, 3, 4 & 6
IPF release 6.04 & 3rd Reprocessing information	4, 5, 10, 11 & 14	Sections 2, 3, 4 & 6

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Purpose

This document describes the evolution of the MERIS Instrument Processing Facility (IPF) since the beginning of the ENVISAT project. MERIS (Medium Resolution Imaging Spectrometer) is an instrument on board of the ENVISAT satellite put in orbit by the European Space Agency on 1st March 2002 and dedicated to the Earth's environment observations. For more details about MERIS refer to the MERIS web page: http://envisat.esa.int/instruments/meris/.

1.2 Scope

This document is intended to provide a detailed overview of the MERIS IPF releases further installed at ESA processing centres. The description of the different processor upgrades is given, in terms of both data format changes and algorithm modifications, with the aim to help the user community in understanding the impact of IPF modifications on MERIS data quality.

1.3 Definition, Acronyms and Abbreviations

ANX	Ascending Node Crossing
DPM	Detailed Processing Model
FR	Full Resolution
EOHELP	Earth Observation Help Desk
EPAC	Spanish PAC
ESA	European Space Agency
FR	Full Resolution
IODD	Input/Output Data Definition
IPAC	Italian PAC
IPF	Instrument Processing Facilities (PDS)
LRAC	Low Resolution Archiving Centre
LUT	Look Up Table
MAVT	MERIS AATSR Validation Team
MEGS	MERIS Ground Segment data processing prototype
MERIS	Medium Resolution Image Spectrometer
MPH	Main Product Header
NDVI	Normalised Difference Vegetation Index
Par.	Paragraph
PAC	Processing and Archiving Centre (PDS)
PCF	Product Control Facility
PDCC	Payload Data Control Centre (PDS)
PDHS	Payload Data Handling Station (PDS)
PDHSE	Esrin-Payload Data Handling Station
PDHSK	Kiruna-Payload Data Handling Station
PDS	Payload Data Segment

Ref.	Reference
RR	Reduced Resolution
TOA	Top Of Atmosphere
TOAVI	Top Of Atmosphere Vegetation Index
TSM	Total Suspended Matter
QWG	Quality Control Working Group
UKPAC	English PAC

1.4 Reference documents

The following set of Reference Documents fully specifies the MERIS IPF in terms of processing and product format.

Reference	Identifier	Title	Acronym
RD1	PO-TN-MEL-GS-0002	MERIS Level 1 Detailed Processing Model, Parameters Data List	DPM1
RD2	PO-TN-MEL-GS-0006	MERIS Level 2 Detailed Processing Model	DPM2
RD3	PO-TN-MEL-GS-0003	MERIS Input / Output Data Definition	IODD
RD4	PO-RS-MDA-GS-2009	Envisat-1 Product Specifications – Volume 11 MERIS Products Specifications	PROD_SPEC

Any algorithm and/or product format update is fully described in corresponding updates of DPM1, DPM2 and/or in IODD, MERIS Products Specifications. Issues pertaining to each IPF release are listed in Section 4.

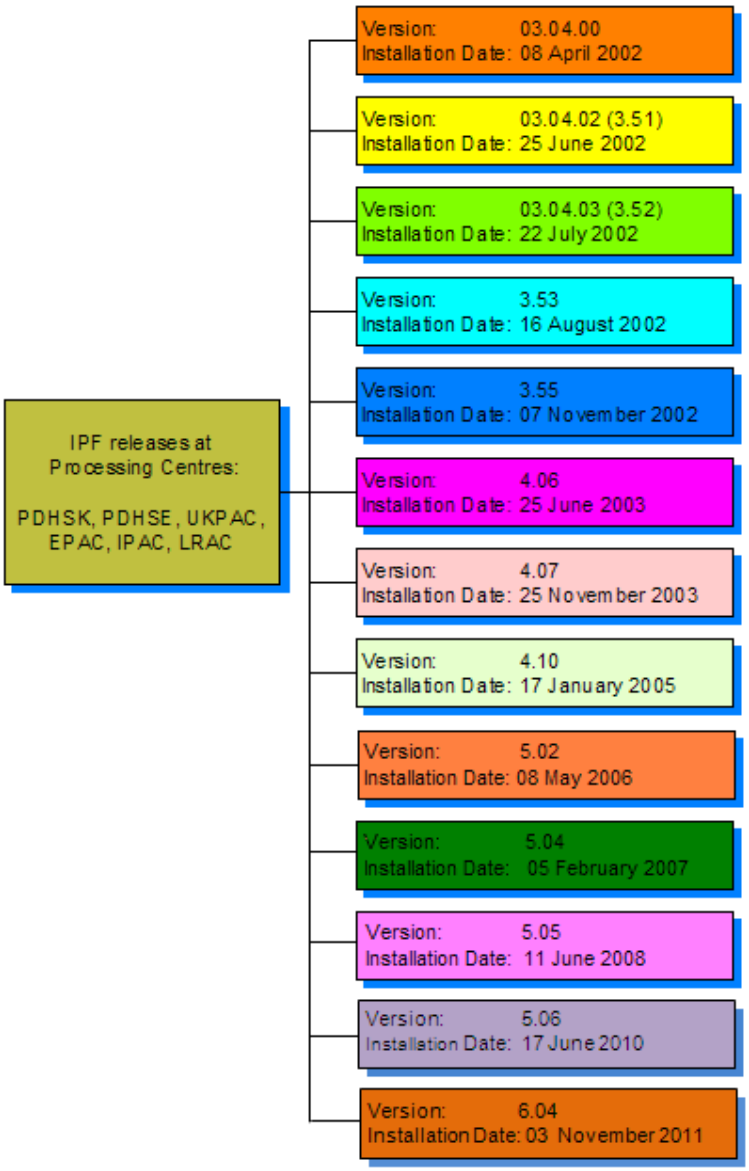
2 SUMMARY OF MERIS IPF RELEASES

The MERIS Instrument Processing Facility (IPF) is installed at different ESA processing centres where the acquired MERIS data are processed and archived. The MERIS acquisition stations are located at Kiruna and ESRIN; the processing and archiving centres (PACs) for specific user's requests are UKPAC, EPAC, IPAC and LRAC.

The IPF on-going evolution is due to the necessity to provide the user community with good quality data for scientific purposes. The data quality improvement implies the necessity to properly tune the auxiliary parameters used in the processing and/or to modify the algorithms for the retrieval of the geophysical products. Indeed, any IPF upgrade results from:

- Suggestions coming from the scientific teams involved in MERIS data exploitation and validation;
- Indications coming from the MERIS QWG which has the objective to assure data quality;
- Anomalies detection identified through user complains (collected by EOHELP)
- Anomalies detection identified through the routine quality control performed by the MERIS PCF team at ESRIN;
- Operational and software bugs identified in the processing chain at centres.

All the MERIS IPF releases installed at ESA processing centres since March 2002 are presented, in chronological order, in the plot below.



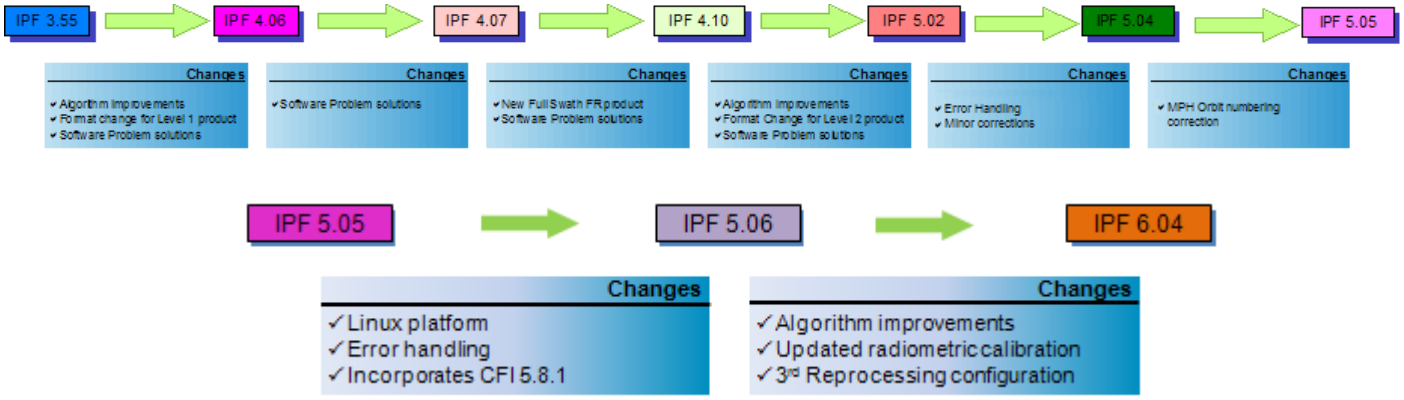
Each processor release has been properly documented in the MERIS Products Specification, IODD, DPM1 and DPM2 (see Par.#4 for details on the reference documents).

Before the delivery of a new IPF, any foreseen change has been early validated and verified using as reference the MERIS prototype. As final step before the installation at Processing Centres, a direct comparison is performed by the MERIS PCF Team at ESRIN between the dataset produced by the test IPF and the dataset generated by the prototype. This test is carried out in order to avoid data anomalies due to implementation errors.

3 DESCRIPTION OF MERIS IPF MODIFICATIONS

In the period March-November 2002, the MERIS processor has been characterized by a very fast evolution (see installation dates in Par.2). Indeed, during the MERIS Commissioning Phase, it has been necessary for very frequent adjustment of auxiliary parameters and algorithms in order to fix or at least improve some anomalous behaviour detected in the early acquired MERIS products.

IPF release 3.55 was the first durable release operational in the ground segment; IPF 3.55 is the operational processor when MERIS begins to acquire in SciHiO2 configuration on December 2002 (with band 11, affected by strong O2 absorption, shifted 1.25 nm toward infrared).
The following plot highlights the type of changes, which have been applied to each new IPF release, starting from IPF version 3.55.



A detailed description of the modifications applied to the processor, with respect to the previous IPF release, is reported in the following paragraphs.

3.1 From IPF 3.55 to IPF 4.06

MERIS IPF 4.06 has been installed on June 25th, 2003. The new processor release includes algorithm modifications and format changes regarding some auxiliary products and the Level 1b product. The relevant changes for each product type are listed below.

MERIS PRODUCT TYPE	MODIFICATIONS LIST
Level 1 product	Changed product format in order to replace the "Spectral Shift Index" with the "Detector Index". This new parameter allows linking each pixel to the instrument detector, giving the per-pixel Sun irradiances. It is used in the TOA (Top of Atmosphere) reflectance computation
	Added an Instrument Response Degradation Model to apply on radiometric gains
Level 2 product	Applied the Smile Correction to TOA reflectance
	Added a dedicated high glint flag for the Water vapour processing
	Applied a new XC interpolation scheme
	Used a weighted interpolation between aerosol couples
	Added new TOAVI science flags

With the new IPF version the following problems have been solved:

- incorrect location of the image centre in FR products for a given latitude and longitude
- incorrect values in Level 2 extracted products due to a bad use of flags as a mask
- incorrect calculation of the number of frames in the case of incomplete granules at the end f products
- degradation coefficients not applied to the FR products
- change in classification process for some pixels when atmospheric corrections are applied

3.2 From IPF 4.06 to IPF 4.07

MERIS IPF 4.07 has been installed on November 25th, 2003. The new processor upgrade fixes an identified anomalous behaviour regarding FR Level 1b products in some specific cases: all the radiometric bands with null values and wrong geo-localisation.

IPF 4.06 has been verified so that an invalid Orbit State Vector source, which can be given at ANX time (ascending node cross) or at product START TIME, would prevent correct computations of the product limits and then constrain all further processing including data extraction. The code has been modified in order to properly manage the Orbit State Vector in all the geo-location algorithms and therefore MERIS DPM Level 1b has been updated.

3.3 From IPF 4.07 to IPF 4.10

IPF 4.10 has been installed on mid January 2005. The new processor release basically corrects some minor bugs and improves the processing time. IPF 4.10 allows the FR Full Swath processing, however, the operations regarding the Full Swath products are not yet decided and no ordering is possible at present. The relevant changes are listed below.

MERIS PRODUCT TYPE	MODIFICATIONS LIST
Level 1 product	Implemented the Full Swath Product (4481 pixels per line)
	Improvement of the product limit calculation for FR scenes
Level 2 product	Implemented the Full Swath Product (4481 pixels per line)
	Improvement of the product limit calculation for FR scenes
	Improvement of the Level 2 performance by optimising the Turbid Water Correction algorithm
Browse product	Implemented the Full Swath Product (4481 Full Resolution pixels per line)

With the new IPF version the following problems have been solved:

- Vertical feature observed in Water Vapour in several RR Level 2 products
- Almost all radiometric bands with null values in some MER_FR__2P products
- Pixels flagged as invalid have high glint or pixel type flag raised inconsistently in some MER_FR__2P products
- Misplaced coastline in RR Browse Product
- Flag ice_haze (ice_highaero_f) never set to true

3.4 From IPF 4.10 to IPF 5.02

IPF 5.02 has been installed on 8 May 2006. The new processor release includes algorithm modifications and format changes regarding some auxiliary products and the Level 2 product. The relevant changes for each product type are listed below.

MERIS PRODUCT TYPE	MODIFICATIONS LIST
Level 1 product	Improvement of the Satellite Navigation in off-line mode
Level 2 product	Improvement of the Pixel Classification
	Improvement of the correction for Gaseous absorption
	Improvement of the Surface Pressure Retrieval over Land
	Improvement of the Water Vapour retrieval over Ocean
	The NDVI has been replaced by the new MERIS Terrestrial Chlorophyll Index (MTCI)
	Improvement of the Aerosol Remote Sensing over Land, Aerosol Optical Thickness over Land now provided at 443 nm (where it is best retrieved)
	Improvement of the Atmosphere Correction over Water through: • better Water Pixels selection for Water Processing • revised implementation of the Turbid Water Correction algorithm (ATBD 2.06) • revision of the Aerosol Database • better detection of dust-like aerosols
	Spectral Dependence of the Aerosol Scattering now described by the aerosol Anström Exponent instead of the former Epsilon parameter (applies to Land and Water pixels).
	Improvement of the Water Processing including: • revised Algal Pigment Index 1 algorithm • new Case II Neural Net • Yellow Substance product coded on a log scale (improves resolution for low values)

MERIS PRODUCT TYPE	MODIFICATIONS LIST
	Improvement of the Product Confidence Data and Science Flags
Browse product	Algorithm and format revised.

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3.5 From IPF 5.02 to IPF 5.05

The evolutionary path of the IPF processor from 5.02 to 5.05 was as follows:

- IPF 5.03 was never operational.
- IPF 5.04 was operational from 5 February 2007 to 11 June 2008. The IPF 5.04 switch was successfully executed on Monday 05 February 2007, with the operational version moving from 5.02 to 5.04. This evolution centred on error handling and minor bugs corrections, and did not involve algorithm changes. The new software switch was performed on all Centres/Stations, with new MERIS production at PDHS-K beginning on Orbit 25800, and the first new MERIS production at PDHS-E starting from Orbit 25805.
- IPF 5.05 was operational from 11 June 2008. IPF 5.05 was developed in response to a problem of wrong orbit numbers being included in the MPH of MERIS higher level products. This problem only occurred when the orbit number reached 32768. An excerpt from the SMR document attached to version 5.05 outlines the main changes with regard to version 5.04:
    - MPH parameters of the product model are copied to the L1 header in the packet extraction module. The intermediate variables (relative_orbit and absolute orbit) used in Extract_Packets.h were previously defined as short signed int. As of this Version, they have been changed to long int.
    - The format of the different MPH parameters was implemented in such a way that if it was a number of the form +/-5digits it was automatically interpreted as being short int. As of this Version, this has been changed to use the MPH definition, which gives both the format and type of each parameter. This change was done in the variables MPH_FIELD_SIZES and MPH_FIELD_TYPES of ENVISAT_Header.h, and in the method Set of ENVISAT_Header.C.

For details of known anomalies regarding MERIS products please refer to the disclaimers on the ENVISAT webpage at following address: http://envisat.esa.int/dataproducts/availability/

3.6 From IPF 5.02 to IPF 5.06

The evolutionary path of the IPF processor from 5.05 to 5.06 was as follows:

- IPF 5.05L05 became operational on 28th September 2009 and represented the operational switch of the IPF processor from the AIX to Linux platform. This included no format or algorithm changes.

- IPF 5.05L06 became operational on 21st October 2009. This version of the IPF contained a colouration fix for the MERIS Browse products (MER__BP).

- IPF 5.06 became operational on 17th June 2010. IPF 5.06 was developed for the ENVISAT 2010+ Orbital scenario change and incorporated two main updates:
    - the integration of CFI 5.8.1 which is compliant with the changing Orbital scenario due to ENVISAT 2010+;
    - a correction in the handling of small data gaps (incomplete frames) in MERIS Level 0 products.

3.7 From IPF 5.06 to IPF 6.04

IPF versions 6.00 to 6.03 were internal to ESA and never made operational.
IPF 6.04 became operational at Ground Stations on 3rd November 2011, starting from Orbit #50609 at Kiruna, and #50617 at ESRIN.

IPF 6.04 is equivalent to the MERIS Ground Segment (MEGS) Processor Version 8.0.
MEGS 8.0 was used for the 3rd Reprocessing of the MERIS archive (http://earth.esa.int/object/index.cfm?fobjectid=7744).

The main IPF/MEGS 3rd Reprocessing improvements include:

- Updated radiometric model and coefficients
- Revised pixel classification and flagging
- Vicarious adjustment of Marine Reflectances
- New Bright Pixel Atmospheric Correction (BPAC) algorithm
- Updated Radiative Transfer LUTs and interpolation methodologies
- New Case_2 waters atmospheric correction for Algal_2, TSM and Yellow substance products
- New Water Vapour retrieval over land algorithm
- New Surface Pressure algorithm over Land

Detailed information on all of the changes implemented for IPF 6.04 and MEGS 8.0 can be found online at the MERIS PCS website (http://earth.eo.esa.int/pcs/envisat/meris/documentation/).

4 DOCUMENTS LIST APPLICABLE TO EACH MERIS IPF RELEASE

The reference documents applicable to each processor release are listed below.

MERIS IPF release	DPM1 issue	DPM2 issue	IODD issue	PROD_SPEC issue
3.55	**5.1**	**5.1**	**5.1**	**3H**
4.06	**6.1a**	**6.1a**	**6.1a**	**3J**
4.07	**6.1a**	**6.1a**	**6.1a**	**3J**
4.10	**6.1a**	**6.1a**	**6.1a**	**4A**
5.02	**7.0a**	**7.2a**	**7.3a**	**5A**
5.04	**7.0a**	**7.2a**	**7.3a**	**5A**
5.05	**7.0a**	**7.2a**	**7.3a**	**5A**
5.06	**7.0a**	**7.2a**	**7.3a**	**5B**
6.04	**8.0**	**8.0b**	**8.0a**	**6A**

NOTE: the documents pertaining to IPF version 6.04 are available to the users on the ENVISAT website http://earth.esa.int/pub/ESA_DOC/ENVISAT/MERIS, and the MERIS PCS website http://earth.eo.esa.int/pcs/envisat/meris/documentation/.

5 HOW TO GET MERIS DATA

According to the ESA data policy, satellite data from ENVISAT can be obtained from the Agency at production cost for research and application development upon submission and approval of a Category-1 proposal through the ESA Earth Observation Principal Investigator Portal at **http://eopi.esa.int**.

Further information on the ESA data policy for distribution of ERS and ENVISAT data, including Category-1 prices and the definition of Category-1 and Category-2 use, is available under "ESA data policy" on the above mentioned EOPI portal. The user will find the submission form to be used going to the "AO Submission" area in the left-hand menu.

Please also refer to the "Guidelines for the Submission of proposals for Category-1" on the same page, as well as the FAQ in the "Services" area. Extensive information on the ENVISAT Mission, products and applications is available on the ENVISAT web pages - **http://envisat.esa.int/**, in particular in the sections dedicated to MERIS under "Instruments" and "Product Handbook / User Guide".

A list of currently available ENVISAT products can also be found on the same pages - **http://envisat.esa.int/dataproducts/availability/**

About “how to get” MERIS data please refer to:
http://earth.esa.int/pcs/envisat/meris/documentation/Access_to_MERIS_data.pdf
or contact directly the Earth Observation Help Desk at EOHELP@ESA.INT.

6 MERIS DATA ARCHIVE REPROCESSING

Due to the ongoing work of the QWG and MAVT towards improvement of the algorithms and auxiliary tables involved in the MERIS data processing, reprocessing activities are an expected component throughout the mission's life.

To date, three reprocessing have taken place in 2003, 2005 and 2011. Details regarding each reprocessing are described in the following sections.

6.1 Partial reprocessing of year 2003

During April 2004 the whole 2003 MERIS data archive has been reprocessed and since summer 2004 made available for the users community. The 2003 MERIS reprocessed archive were put available on a dedicated Website. These data are not accessible since the second reprocessing has been started.

The major modifications performed are described in the following document:
http://earth.esa.int/pcs/envisat/meris/documentation/First_2003_MERIS_Reprocessing.pdf

The data quality was assessed by the MERIS QWG and reported in the following document:
http://earth.esa.int/pcs/envisat/meris/documentation/MERISQualityAssessment-MEGS7-QWG-V1.pdf

6.2 The 2005 second reprocessing

In parallel to IPF 5.02 development and testing, MEGS 7.4.1 has been used for a complete re-processing of the MERIS data archive, in order to provide the users with a complete set of homogeneously processed MERIS data.

The major modifications performed are described in the following document:
http://earth.esa.int/pcs/envisat/meris/documentation/MERISRRsecondreprocessing-V2.pdf

The data quality was assessed by the MERIS QWG and reported in the following document:
http://earth.esa.int/pcs/envisat/meris/documentation/MERISQualityAssessment-MEGS74-IPF502-QWG-V1.0.pdf

MEGS version 7.4.1 implements the same processing specification than IPF 5.02, however IPF development, that took place during 2nd reprocessing, allowed to identify a problem in MEGS 7.4.1: the Aerosol Optical thickness over Land is not provided at 443 nm, as it should be, but at 412 nm.

6.3 The 2011 third reprocessing

The third reprocessing of the MERIS Reduced Resolution archive took place during 2011 at ACRI-ST. A number of algorithm, format and LUT updates were implemented into MEGS 8.0 representing a significant improvement in product data quality.

Following release of the reprocessed archive, the IPF was upgraded to version 6.04 and is now equivilent to MEGS 8.0.

Detailed information of the changes implemented for the 3rd reprocessing can be found on the MERIS PCS webpage http://earth.eo.esa.int/pcs/envisat/meris/documentation/.