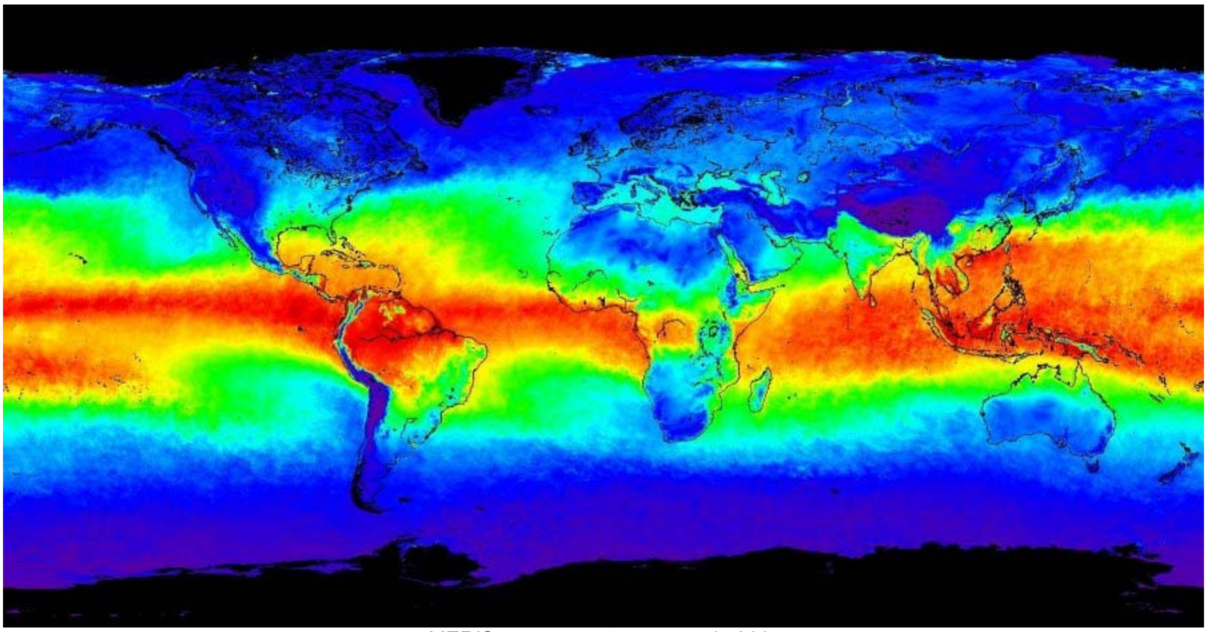
Mécanique Appliquée et Sciences de l'Environnement	MERIS level3	Product Handbook

MERIS

Medium Resolution Imaging Spectrometer

ENVISAT-1 Ground Segment

MERIS Level 3 Product Handbook



MERIS average water vapour in 2005

Title: MERIS Level-3 Product Handbook
Doc. no: P0-RS-ACR-GS-2002
Issue: 1
Revision: 0
Date: November 24, 2006

This page is intentionally left blank

Change Record

Issue	Date	Description	Changes	Approval
1.0	24/11/06	Initial version	N/A	Yes

Table of Contents

1 OVERVIEW 4

2 REFERENCE DOCUMENTS 5

2.1 LIST OF ABBREVIATIONS AND ACRONYMS 5

3 LIST OF AVAILABLE PRODUCTS 6

3.1 CHLOROPHYLL-*A*, CASE-1 WATER (CHL1) 6
3.2 TOTAL WATER VAPOUR COLUMN, CLEAR SKY (WVCS) 6
3.3 ABSOA_DUST FLAG STATISTICS (ABSD) 7
3.4 AEROSOLS OPTICAL THICKNESS OVER LAND AND WATER (T443/T865/T550) 8
3.5 ANGSTROM ALPHA COEFFICIENT OVER LAND AND WATER (A443/A865/A550) 9
3.6 NORMALISED WATER LEAVING RADIANCES (N412/N443/N490/N510/N560) 11

4 BINNING DEFINITION 15

4.1 SINUSOIDAL GRID DEFINITION 15
4.2 SPATIAL AGGREGATION 16
4.3 TEMPORAL AGGREGATION 16
4.4 PIXEL SELECTION CRITERIA 17
4.5 DATA-DAY ALGORITHM 19

5 PRODUCT FORMAT 22

5.1 OUTPUT PARAMETERS 22
5.2 OUTPUT FILES FORMAT 22
5.3 PRODUCT FILENAME CONVENTION 27

List of tables

Table 4.1: Global ISIN grid definition 15
Table 4.4-1 - Pixel selection criteria 18
Table 4.4-2 - MERIS level-2 flags description 19
Table 5.1-1 - List of processed parameters 22
Table 5.2-1 - External MKL3 netCDF file format 23
Table 5.2-2 - netCDF variable attributes description 23

List of figures

Figure 3.1-1 - Chlorophyll-a concentration - Monthly average - April 2005 6
Figure 3.2-1 - Total water vapour column - Monthly average - April 2005 7
Figure 3.3-1 - ABSOA_DUST flag statistics - Monthly average - February 2005 7
Figure 3.4-1 - Aerosols optical thickness over land - Monthly average - April 2005 8
Figure 3.4-2 - Aerosols optical thickness over water - Monthly average - April 2005 8
Figure 3.4-3 - Aerosols optical thickness over land & water - Monthly average - April 2005 9
Figure 3.5-1 - Angstrom alpha coefficient over land - Monthly average - April 2005 9
Figure 3.5-2 - Angstrom alpha coefficient over water - Monthly average - April 2005 10
Figure 3.5-3 -Angstrom alpha coefficient over land & water - Monthly average - April 2005 10
Figure 3.6-1 - Normalised water leaving radiance at 412 nm - Monthly average - April 2005 12
Figure 3.6-2 - Normalised water leaving radiance at 443 nm - Monthly average - April 2005 12
Figure 3.6-3 - Normalised water leaving radiance at 490 nm - Monthly average - April 2005 13
Figure 3.6-4 - Normalised water leaving radiance at 510 nm - Monthly average - April 2005 13
Figure 3.6-5 - Normalised water leaving radiance at 560 nm - Monthly average - April 2005 14
Figure 4.5-1 - Data-day definition 20

1 Overview

Taking advantage of the level 2 MERIS data re-processing, a number of demonstration MERIS Level 3 products have been generated for the complete mission. They have been processed using the standard L2 products processed with the last processor version.

The MERIS level-3 binned data products consist of the accumulation of MERIS level-2 data (MER_RR_2P) corresponding to a specific period. The MERIS level-2 product is fully described in [RD6].

The MERIS level-3 binned data are specified on a global sinusoidal grid (ISIN), with a spatial resolution of 1/12° (roughly 9.277 km) i.e. 4320 bins at the equator.

The first set of products are **marine products**:

- Chlorophyll Concentration for the open ocean (case I): Chlorophyll concentration is a very convenient measure of abundance of phytoplankton biomass, which has an important role in fixing CO2 through photosynthesis.
- Water leaving radiances at 412, 443, 490, 510 and 560 nm.
- Aerosol optical thickness at 865 nm and the angstrom coefficient. The aerosol retrieval is an important step in the atmospheric correction, but it also gives an indication on the status of the atmosphere (pollution, dust storm...etc).

The second set of products are **land products**:

- The aerosol optical thickness at 443 nm and the angstrom coefficient. The aerosol properties give information on the air quality and aerosol types over land. It can be used as well to correct the land reflectance from the atmospheric effect.

The third set of products are **atmosphere products**:

- The water vapour over clear sky: the water vapour is the most effective greenhouse gas in the atmosphere. It influences weather and climate and is responsible for cloud development, precipitation, and modulates the atmospheric radiative energy transfer.

  It effects weather and climate and is responsible for cloud development, precipitation, and modulates the atmospheric radiative energy transfer. Therefore it influences the energy balance of the earth and, in turn, also effects the temperature and circulation of the earth-atmosphere system.

In addition, two other quality products have been processed:

- The aerosol optical thickness at 550 nm both over land and sea.
- The repartition of the ABSO_DUST flag: the ABSO_DUST flag represents the Dust-like absorbing aerosol selected for atmosphere correction.

MERIS level-3 products are available at http://www.enviport.org/meris.

The MERIS level-3 products described in this document have been generated using the MKL3 toolbox v4.0 developed by ACRI-ST.

2 Reference documents

RD1. *IOCCG Report Number 4, 2004 - Guide to the Creation and Use of Ocean-Colour, Level-3, Binned Data Products*

RD2. *Level-3 SeaWiFS Data Products: Spatial and Temporal Binning Algorithms (Appendix A), SeaWiFS Technical Report Series, Vol. 32*

RD3. *MERIS Input / Ouput Data Definition, PO-TN-MEL-GS-0003*

RD4. *MERIS level 2 Detailed Processing Model, PO-TN-MEL-GS-0006*

RD5. *Level-3 SeaWiFS Data Products: Case Studies for SeaWiFS Calibration and Validation, part 3 (Chapter 5 - SeaWiFS global fields: What's in a day), SeaWiFS Technical Report Series, Vol. 27*

RD6. *MERIS Product Handbook (http://envisat.esa.int/dataproducts/meris/)*

RD7. *netCDF format description (http://www.unidata.ucar.edu/software/netcdf/)*

RD8. *XML format description (http://www.w3.org/XML/)*

2.1 List of abbreviations and acronyms

AAC	Aerosol Angstrom Coefficient
AOT	Aerosol Optical Thickness
BRDF	Bi-directional Reflectance Distribution Function
CHL	Chlorophyll
DTD	Document Type Definition
IOCCG	International Ocean Colour Coordinating Group
ISIN	Integerised Sinusoidal Grid
L2	Level 2 product
L3	Level 3 product
MERIS	Medium Resolution Imaging Spectrometer
MODIS	Moderate Resolution Imaging Spectro-radiometer
MGVI	MERIS Global Vegetation Index
NIR	Near Infrared
QL	Quicklook
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
XML	Extensible Markup Language

3 List of available products

3.1 Chlorophyll-*a*, case-1 water (chl1)

CHL_1 is the chlorophyll-a concentration (mg/m^3) for case 1 water.

Case 1 waters are defined as waters for which phytoplankton and their associated materials (such as debris, heterotrophic organisms and bacteria, excreted organic matter) control the optical properties (Morel and Prieur, 1977 ; Gordon and Morel 1983).

To the extent that the quantification of these materials (living and inanimate) is operationally made through the determination of a single pigment, i.e. chl *a*, it can be said that the optical properties of such case 1 waters depend only on the chl *a* concentration.

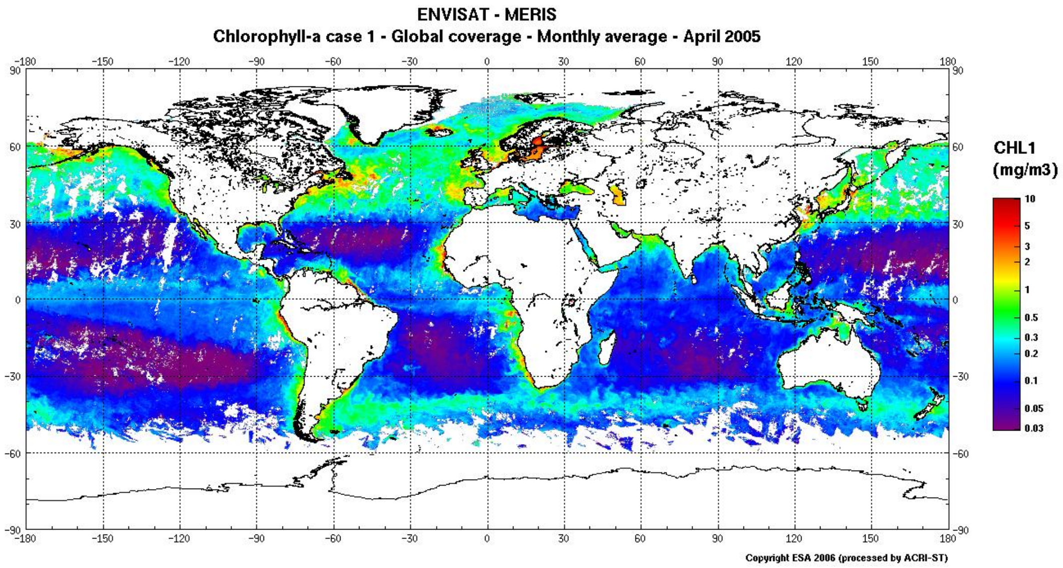


Figure 3.1-1 - Chlorophyll-a concentration - Monthly average - April 2005

3.2 Total water vapour column, clear sky (wvcs)

Water vapour (g/cm^2) is the most effective greenhouse gas in the atmosphere.

It influences weather and climate and is responsible for clouds developement, precipitation, and modulates the atmospheric radiative energy transfer (Ramanathan *et al.*, 1989).

Therefore it influences the energy balance of the earth and thus also temperature and circulation of the earth atmosphere system (Starr and Melfi, 1991).

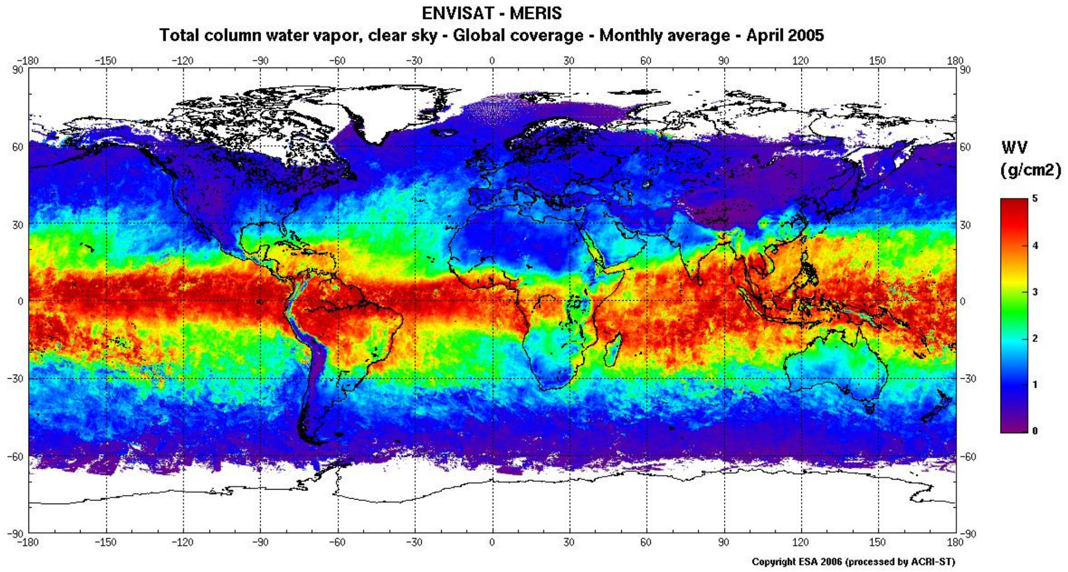


Figure 3.2-1 - Total water vapour column - Monthly average - April 2005

3.3 ABSOA_DUST flag statistics (absd)

ABSOA_DUST flag is raised to indicate the presence of dust-like absorbing aerosols.

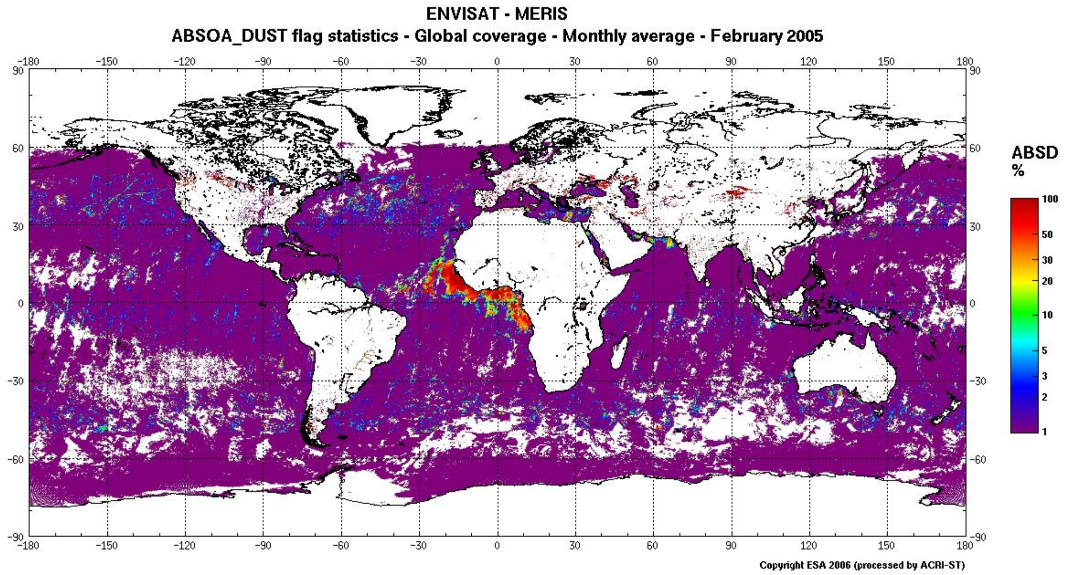


Figure 3.3-1 - ABSOA_DUST flag statistics - Monthly average - February 2005

3.4 Aerosols optical thickness over land and water (t443/t865/t550)

Optical thickness, or optical depth, is a dimensionless quantity that indicates the amount of depletion that a beam of radiation undergoes as it passes through a layer of the atmosphere.

The MERIS aerosol optical thickness available in the level 2 products is a measurement the opacity of the aerosol layers at 865 nm. It is measured by assuming that the ocean is a black surface in the NIR (see Normalized water leaving radiance / reflectance). For more information, see [RD6]

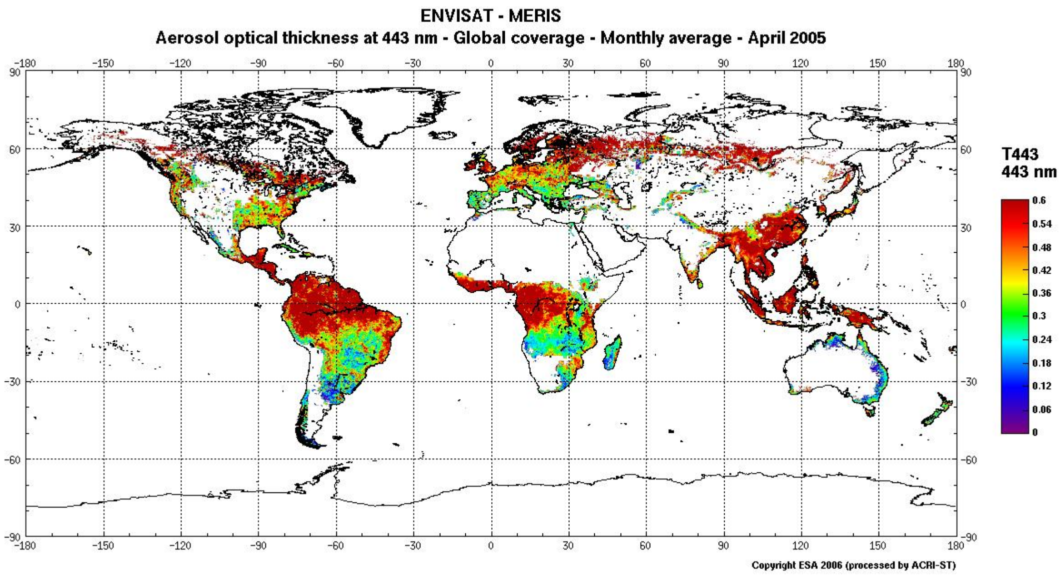


Figure 3.4-1 - Aerosols optical thickness over land - Monthly average - April 2005

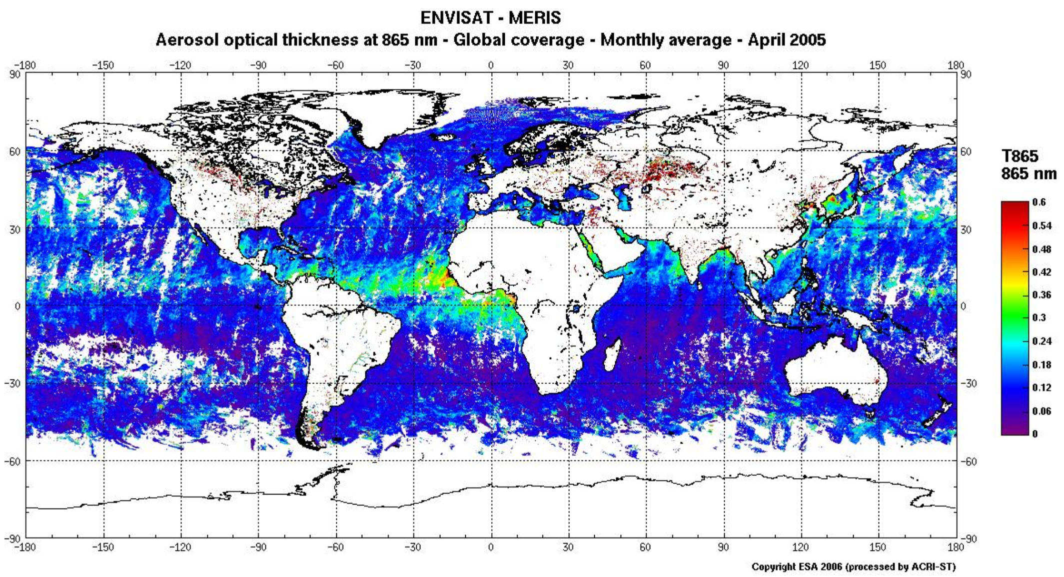


Figure 3.4-2 - Aerosols optical thickness over water - Monthly average - April 2005

Merged AOT (t550) is computed from t443 & t865 using $t550 = txxx \cdot (550/xxx)^{-a}$ with a=1 for land (xxx=443) and a=a865 for water (xxx=865)

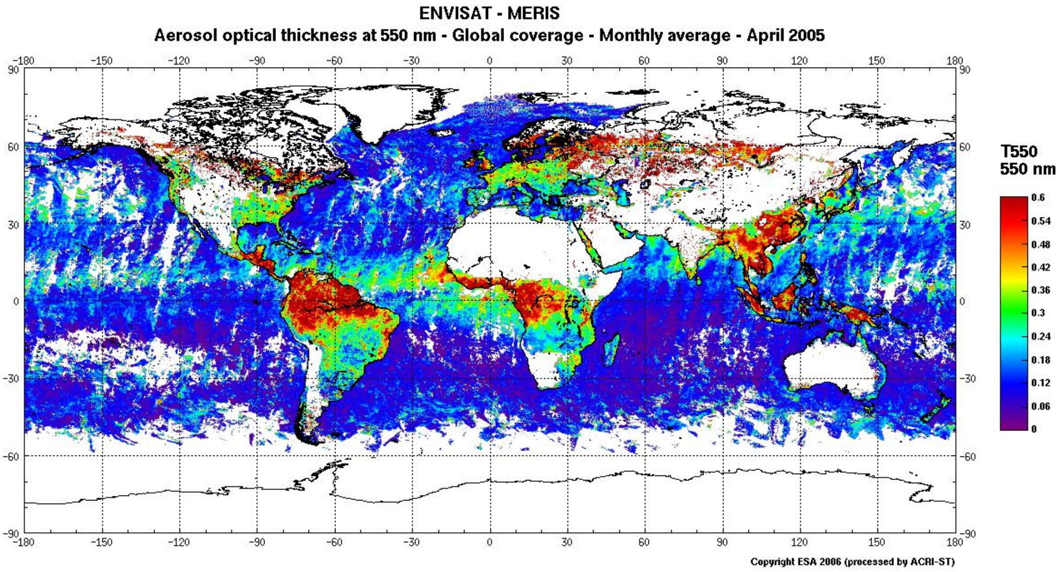


Figure 3.4-3 - Aerosols optical thickness over land & water - Monthly average - April 2005

3.5 Angstrom alpha coefficient over land and water (a443/a865/a550)

The MERIS aerosol Angstrom exponent is a description of the aerosol assemblage detected over water bodies. It is expressed as the spectral slope of the Aerosol optical thickness in the near infrared. For more information, see [RD6]

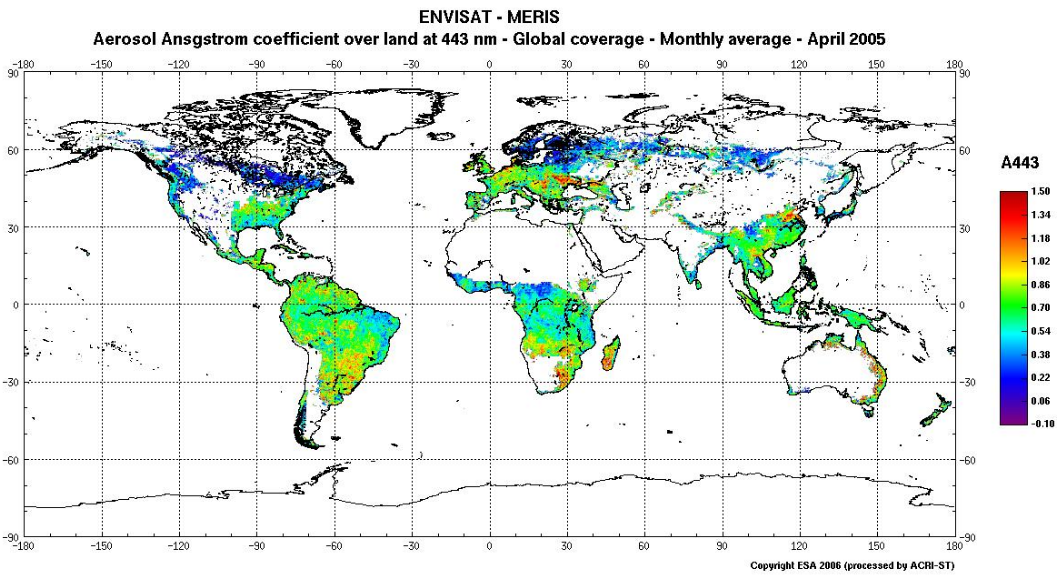


Figure 3.5-1 - Angstrom alpha coefficient over land - Monthly average - April 2005

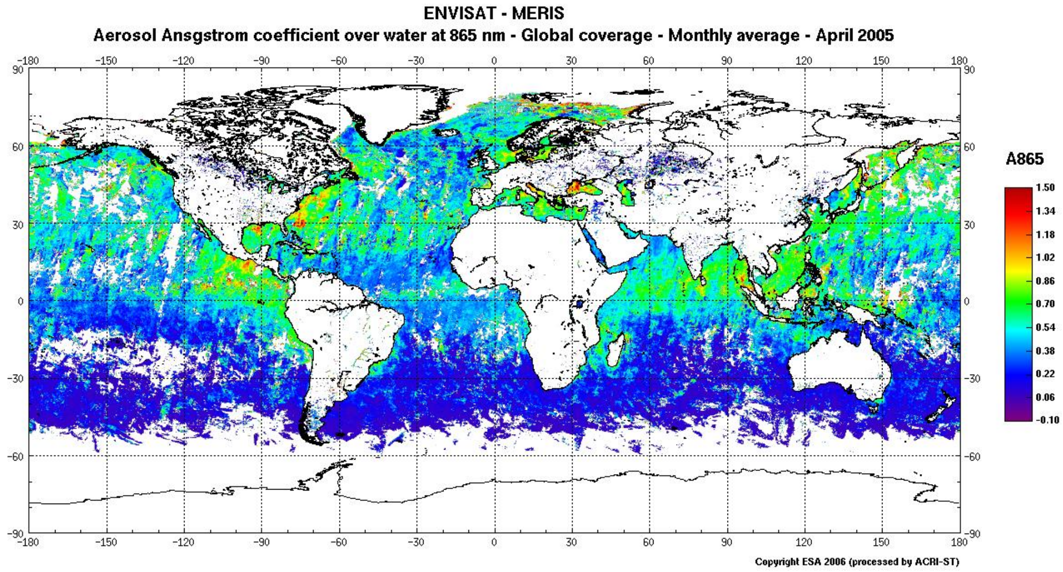


Figure 3.5-2 - Angstrom alpha coefficient over water - Monthly average - April 2005

Merged AAC (a550) is computed from a443 & a865 using a550 = axxx . $(550/xxx)^{-a}$ with a=1 for both land (xxx=443) and water (xxx=865)

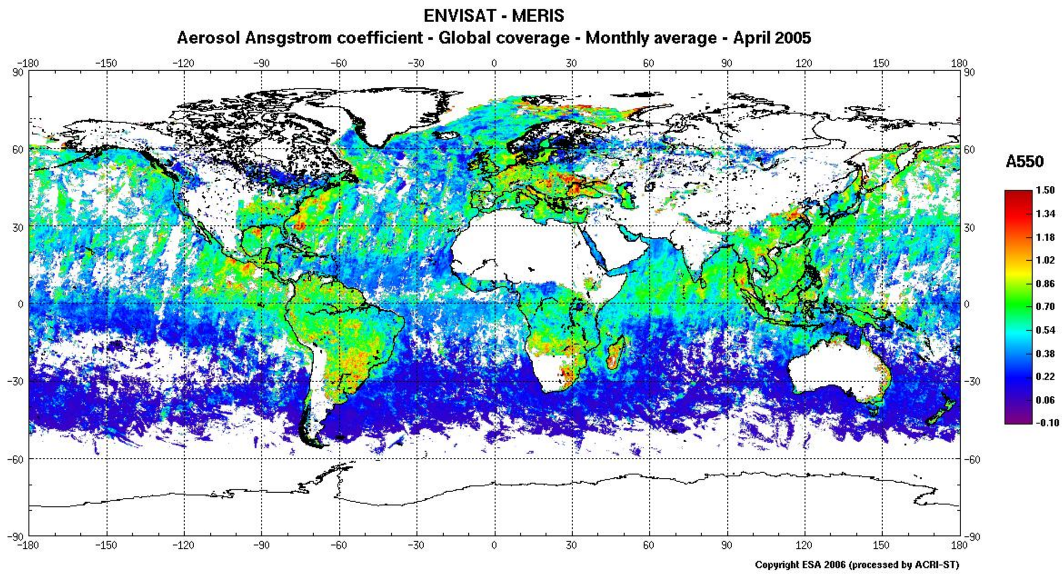


Figure 3.5-3 -Angstrom alpha coefficient over land & water - Monthly average - April 2005

3.6 Normalised water leaving radiances (n412/n443/n490/n510/n560)

The normalized water-leaving radiance, $[Lw]_N$, was defined by Gordon and Clark [1981] through :

$$L_w(\lambda) = [L_w(\lambda)]_N \cdot \cos(\theta_S) \cdot t_d(\theta_S, \lambda)$$

where $L_w(\lambda)$ is the radiance backscattered out of the water at a wavelength λ, and t_d the diffuse transmittance of the atmosphere. θ_S is the solar zenith angle.

It can be easily related to the MERIS water leaving reflectance (available in the level 2 products) by:

$$[\rho_w]_N(\lambda) = \frac{\pi}{F_0}[L_w(\lambda)]_N$$

without ambiguity since all the agencies use to the same reference F_0: Thuillier [2003].

The normalized water-leaving radiance is approximately the radiance that would exit the ocean in the absence of the atmosphere and with the sun at the zenith. This definition was motivated by the desire to remove, as much as possible, the effects of the atmosphere and the solar zenith angle from $L_w(\lambda)$; however, Morel and Gentili [1991, 1993, 1996] have shown that a residual dependence on illumination and observation geometrical conditions (bi-directionality) remains in $[L_w(\lambda)]_N$. This bi-directional effect has been experimentally put in evidence through field experiments, and conforms the theoretical findings (Morel, Voss and Gentili, 1995; Voss and Morel, 2005)

This leads to the definition of the “exact” normalized water leaving radiance, in which the BRDF correction is introduced:

$$[L_w]_N^{ex} = [L_w]_N \frac{\Re_0}{\Re(\theta', w)} \frac{f_0(\tau_a, w, IOP)}{Q_0(\tau_a, w, IOP)} \left(\frac{f(\theta_s, \tau_a, w, IOP)}{Q(\theta_s, \theta', \phi, \tau_a, w, IOP)} \right)^{-1}$$

$$[\rho_w]_N^{ex} = \frac{\pi}{F_0}[L_w]_N^{ex}$$

where :

- the parameter Q (sr), defined as $Q = E_u(0^-) / L_u(0^-, \theta', \phi)$ and is the ratio of upward irradiance (at null depth and just below the surface, denoted 0^-) to the slant (θ', ϕ) upward radiance, also at 0.
- The dimensionless coefficient f appears through $R = E_u(0^-)/ E_d(0^-) = f .(b_b / a)$. It relates the irradiance reflectance, R (the ratio of upward to downward irradiance, beneath the surface), to the ratio (b_b/ a) of two inherent optical properties: b_b, the backscattering coefficient, and a, the absorption coefficient of the water body.
- the dimensionless factor $\Re$, which depends on θ' and on wind speed, merges all the reflection and refraction effects that occur when downward irradiance and upward radiance propagate through the (wavy) interface.

Short-hand notations $\Re_0$, f_0 and Q_0 refer respectively to the particular values of $\Re$ when θ_S = 0 and in absence of wind, the particular f-value when θ_S = 0, and the Q value when θ_S and θ' are both equal to 0.

$\left[L_w\right]_N^{ex}$ is the quantity recommended for spatial and temporal binning for Level 3 products generation by IOCCG report number 4 (Chapter 3). It is described in details in Morel and Mueller [2002].

It corresponds to the current definition of the MODIS and SeaWiFS water leaving radiance products.

$\left[L_w\right]_N^{ex}$ can be derived easily from MERIS $\left[\rho_w\right]_N$ products, at least for Case 1 waters, since all the quantities involved in the transformation are available at MERIS wavelengths within MERIS processing auxiliary data.

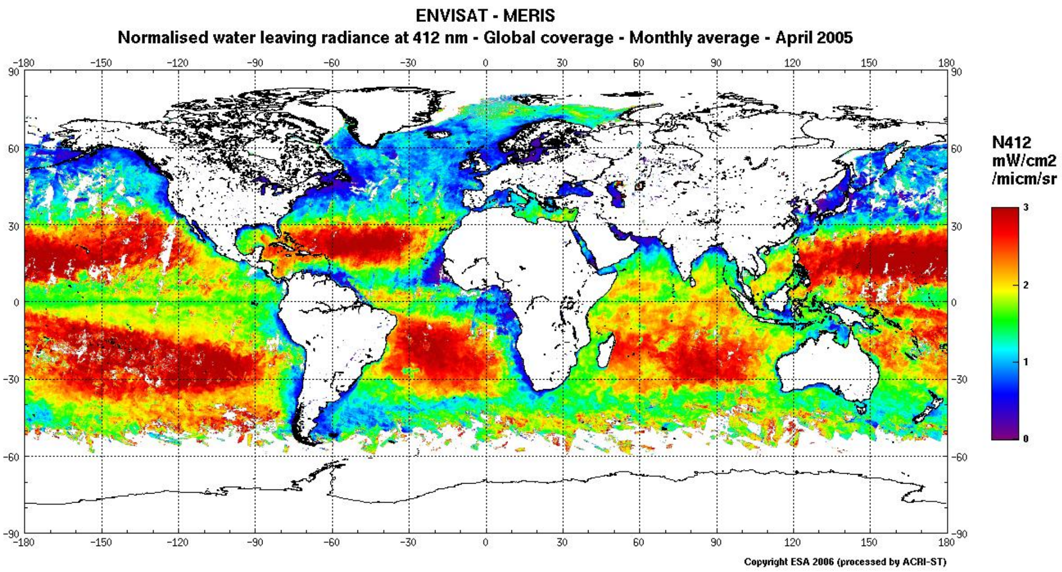


Figure 3.6-1 - Normalised water leaving radiance at 412 nm - Monthly average - April 2005

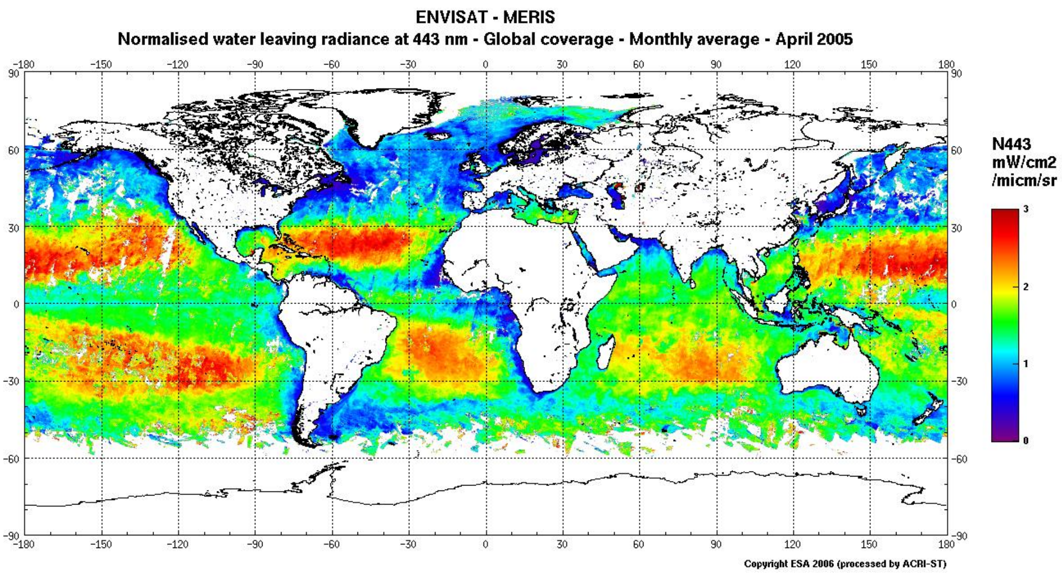


Figure 3.6-2 - Normalised water leaving radiance at 443 nm - Monthly average - April 2005

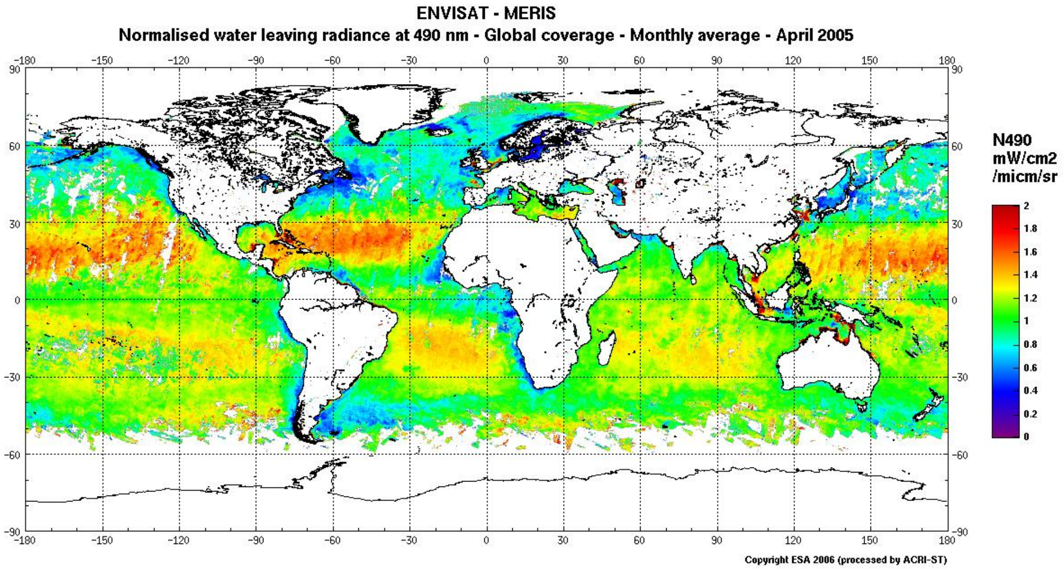


Figure 3.6-3 - Normalised water leaving radiance at 490 nm - Monthly average - April 2005

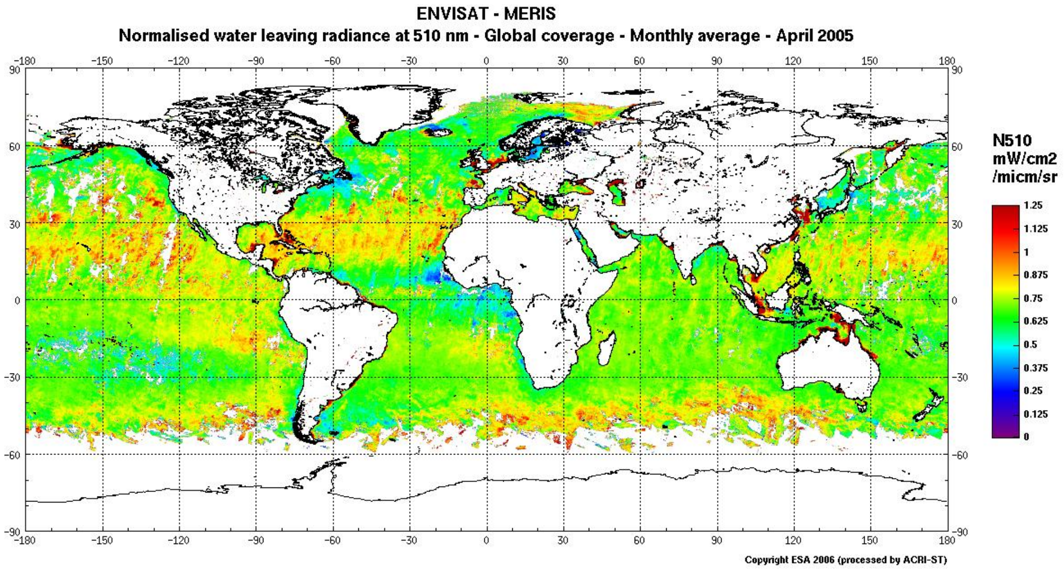


Figure 3.6-4 - Normalised water leaving radiance at 510 nm - Monthly average - April 2005

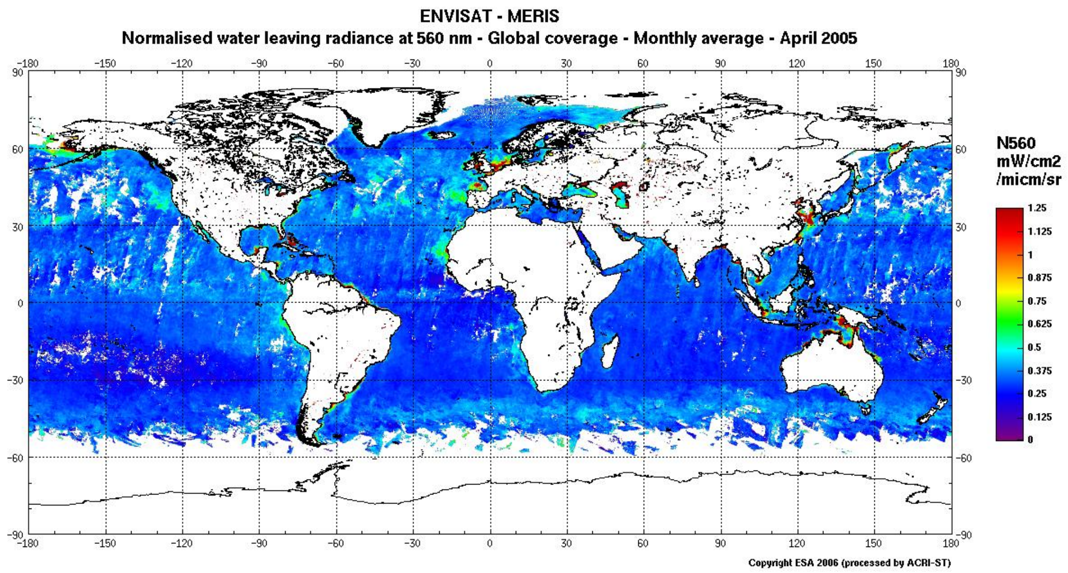


Figure 3.6-5 - Normalised water leaving radiance at 560 nm - Monthly average - April 2005

4 Binning definition

4.1 Sinusoidal grid definition

This chapter describes the sinusoidal equal-area grid on which the MERIS level 2 products are spatially binned (ISIN grid).

The average size of the grid bins is equal to 1/12°, leading to 2160 rows in latitude, i.e. 1080 latitude rows in each hemisphere (the equatorial line is located between two rows of bins). This discretisation corresponds to roughly 9.277 km. Just below and above the equatorial line, the rows have 4320 bins. This number decreases regularly from the equator to the poles where the last latitude row have only 3 bins.

For each row, the left side of the first bin is always aligned with longitude -180° while the right side of the last bin is aligned with longitude +180°, covering all the latitude row area. The number of bins per row is always an integer number, computed in order to have the bin cell size as close as possible to 9.277 km, so that the effective longitudinal bin size may vary from one row to the next one.

Applying these simple rules from South to North pole leads to a total of 5,940,422 bins.

The following formulas shall clarify the ISIN grid definition.

Earth radius (km)	$R_e = 6378.137$
Total number of latitude rows	$N_{lat} = 2160$ (*)
Latitudinal bin width (km)	$d_r = \frac{\pi \cdot R_e}{N_{lat}}$
Latitudinal angular discretisation (radians)	$\Delta\phi = \frac{\pi}{N_{lat}}$
Centre latitude of each row n (radians)	$\phi_n = -\frac{\pi}{2} + n \cdot \Delta\phi + \frac{\Delta\phi}{2}$ (**)
Longitudinal length of each row n i.e. local perimeter (km)	$p_n = 2 \cdot \pi \cdot R_e \cdot \cos(\phi_n)$
Number of columns in row n	$N_{lon}(n) = \text{nearest}\left(\frac{2 \cdot \pi \cdot p_n}{d_r}\right)$
Effective longitudinal bin width for row n (km)	$d_e^{lon}(n) = \frac{2 \cdot \pi \cdot p_n}{N_{lon}(n)}$
Effective longitudinal angular discretisation for row n (radians)	$\Delta\varphi_n = \frac{2 \cdot \pi}{N_{lon}(n)}$
Total number of bins in the grid	$N_{tot} = \sum_{n=0}^{N_{lat}-1} N_{lon}(n)$

Table 4.1: Global ISIN grid definition

(*) we fix here the number of latitude rows to set the bin size to 1/12° (i.e. a latitudinal dimension close to 9.277 km).

(**) index n varies from 0 to N_{lat}-1

References: [RD1] and [RD2]

4.2 Spatial aggregation

The data binning uses a standard arithmetic mean binning method, as advised by the IOCCG [RD1]. This method is shortly described here.

We assume in this description that we work on a single parameter at a time (i.e. CHL1, N560, ...)

First of all, a global sinusoidal grid is built (see description of the ISIN grid in the appendices). Any MERIS pixel falling inside a bin will contribute to its value if the validity criteria is fulfil (see the pixel selection criteria in the appendices).

The contribution of the MERIS pixels x_i to the bin number n of the ISIN grid for the various variables of the level-3 product is expressed as:

count(n) is the number of contributing MERIS pixels to bin n

$$sum_n = \sum_{i=1}^{count(n)} x_i$$

$$sum\_sq_n = \sum_{i=1}^{count(n)} x_i^2$$

$$min_n = min_{i=1,count(n)}(x_i)$$

$$max_n = max_{i=1,count(n)}(x_i)$$

$$flags_n = OR_{i=1,count(n)}(flags_i)$$

$$npt\_lv2_n = 1$$

4.3 Temporal aggregation

Level-3 products at track level are temporally aggregated into daily products or daily level-3 products to n-days products (monthly, yearly).

For each bin n of the global sinusoidal grid, the following equations are applied:

$$\overline{count}_n = \sum_{f=1}^{nf} count_{i,n}$$, number of contributing MERIS pixels to bin n

$$\overline{sum_n} = \sum_{i=1}^{nf} sum_{i,n}$$

$$\overline{sum\_sq_n} = \sum_{i=1}^{nf} sum\_sq_{i,n}$$

$$\overline{min_n} = min_{i=1,nf}(min_{i,n})$$

$$\overline{max_n} = max_{i=1,nf}(max_{i,n})$$

$$\overline{flags_n} = OR_{i=1,nf}(flags_{i,n})$$

$$\overline{npt\_lv2_n} = \sum_{i=1}^{nf} npt\_lv2_{i,n}$$

where: nf is the number of input products.

4.4 Pixel selection criteria

The following table lists the MERIS level 2 flags taken into account for the generation of the level 3 products. Specific filtering algorithms are also described (e.g. pixels around cloudy pixels are also discarded for the aerosol optical thickness).

A brief description of the various MERIS flags used in this table is given in the next table.

Variable	Name	PCDs / Algorithms
Algal 1	chl1	(WATER=1) + (PCD15=0) + (MEDIUM_GLINT=0) + (LOW_SUN=0) + (ABSOA_DUST=0) + (CASE2S=0) + (WHITE_SCATTERER=0)
Total water vapour columns over clear sky	wvcs	(CLOUD=0) + (PCD14=0) + (ICE_HAZE=0)
Flag ABSOA_DUST	absd	(PCD19=0) + (MEDIUM_GLINT=0) + (LOW_SUN=0) + ((CASE2_S=1) OR ((WHITE_SCATTERER=0) + (CASE2_ANOM=0))
Aerosol optical thickness over Land at 443 nm	t443	(LAND=1) + (PCD19=0) + enlarge CLOUD by 3 track pixels + (CLOUD=0) + conditions listed in the TN by Santer & Vidot * fix MERIS LV2 t443 problem with: t443 = (412/443) * t443
Aerosol optical thickness over Water at 865 nm	t865	(WATER=1) + (PCD19=0) +(MEDIUM_GLINT=0) + (LOW_SUN=0) + ((CASE2_S=1) OR ((WHITE_SCATTERER=0) + (CASE2_ANOM=0))) + enlarge (CLOUD OR ICE_HAZE) by 3 track pixels + (CLOUD=0) + (ICE_HAZE=0)
Merged AOT at 550 nm	t550	from t443 & t865 using t550 = txxx . $(550/xxx)^{-a}$ with a=1 for land (xxx=443) and a=a865 for water (xxx=865) **
Aerosol Angstrom Coefficient over Land	a443	(LAND=1) + (PCD19=0) + enlarge CLOUD by 3 track pixels + (CLOUD=0) + conditions listed in the TN by Santer & Vidot *
Aerosol Angstrom Coefficient over Water at 865 nm	a865	same as t865
Merged AAC	a550	from a443 & a865, no transformation before merging **

Normalised water leaving radiance at 412 nm	n412	(WATER=1) + (MEDIUM_GLINT=0) + (LOW_SUN=0) + (ABSOA_DUST=0) + (rho[412,…,560]>0)	
		+ ((PCD_15=0) OR (PCD_17=0))	because wee need a Chl to normalise
		+ (PCD_19=0)	because wee need a tau to normalise
Normalised water leaving radiance at 443 nm	n443	same as n412	
Normalised water leaving radiance at 490 nm	n490	same as n412	
Normalised water leaving radiance at 510 nm	n510	same as n412	
Normalised water leaving radiance at 560 nm	n560	same as n412	

Table 4.4-1 - Pixel selection criteria

Notes:

1. condition in rightmost column must be satisfied to allow pixel selection
2. it assumes “false” = 0 and “true” = 1

* Santer & Vidot aerosol over land algorithm implementation:

- discard pixel if a865 not in [0, 2.5]
- statistical filtering of t865 on a 9x9 box: filter at +/- 2 standard deviation.

**: for mixed land-water pixels, we select the case with the greater number of observations

Symbol	Description	Level	Relevant to surface type			Bit no.
			water	land	cloud	
LAND	Land product available	class	1	1	1	23
CLOUD	Cloud product available	class	1	1	1	22
WATER	Water product available	class	1	1	1	21
PCD_1_13	Confidence flag for MDS 1 to 13	confidence	1	1	1	20
PCD_14	Confidence flag for MDS 14	confidence	1	1	1	19
PCD_15	Confidence flag for MDS 15	confidence	1	1	1	18
PCD_16	Confidence flag for MDS 16	confidence	1	1	0	17
PCD_17	Confidence flag for MDS 17	confidence	1	1	0	16
PCD_18	Confidence flag for MDS 18	confidence	1	1	1	15
PCD_19	Confidence flag for MDS 19	confidence	1	1	1	14
COASTLINE	Coastline	science	1	1	1	13
COSMETIC	Cosmetic flag (from l1b)	science	1	1	1	12
SUSPECT	Suspect flag (from l1b)	science	1	1	1	11
OADB	Out of Aerosol Data Base (no available aerosol model could fit measurements)	science	1	0	0	10

ABSOA_DUST	Dust-like absorbing aerosol selected for atmosphere correction	science	1	0	0	9
CASE2_S	Turbid (sediment dominated Case 2) water	science	1	0	0	8
CASE2_ANOM	Anomalous scattering water	science	1	0	0	7
TOAVI_BRIGHT	bright land pixel according to MGVI processing	science	0	1	0	7
CASE2_Y	Yellow substance loaded water	science	1	0	0	6
TOAVI_BAD	Bad land pixel according to MGVI processing	science	0	1	0	6
ICE_HAZE	Ice or high aerosol load pixel	science	1	0	0	5
TOAVI_CSI	Cloud, Snow or Ice over land acc. to MGVI processing	science	0	1	0	5
MEDIUM_GLINT	Corrected for glint	science	1	0	0	4
TOAVI_WS	Water/Shadow pixel acc. to MGVI processing	science	0	1	0	4
BPAC_ON	Bright Pixels Atm. Correction activated	science	1	0	0	3
DDV	Dense Dark Vegetation (land aerosol retrieval activated)	science	0	1	0	3
HIGH_GLINT	High (uncorrected) glint	science	1	0	0	2
TOAVI_INVAL_REC	Invalid Rectification (MGVI processing)	science	0	1	0	2
LOW_SUN	Sun low above horizon (or conversely high Sun zenith angle).	science	1	1	1	1
WHITE_SCATTERER	Presence of a white scatterer in water	science	1	0	0	0
LOW_PRESSURE	Computed pressure lower than ECMWF one (land, cloud)	science	0	1	1	0

Table 4.4-2 - MERIS level-2 flags description

4.5 Data-day algorithm

The theoretical rules of the definition of the data-day used during the generation of the MERIS daily products are described in [RD5].

The following figure has been extracted from [RD5] and graphically shows the data-day selection logic based on its spatial definition.

These rules have been adapted and simplified in the case of the MERIS instrument.

The simplifications are:

- the useful part of a MERIS track crossing the 180° meridian does not cross the 0° meridian (this is true as there is a constraint on the LOW_SUN flag on each processed parameter).
- the characteristics of the ENVISAT orbits are cyclic, with a period of 501 orbits or 35 days. This is true as far as ENVISAT stays in its Phase 2 configuration. Any modification of the orbit characteristics will imply an update of the "what_data_day" utility.

- we know the properties of the first orbit and first day of the ENVISAT Phase 2 orbit configuration.

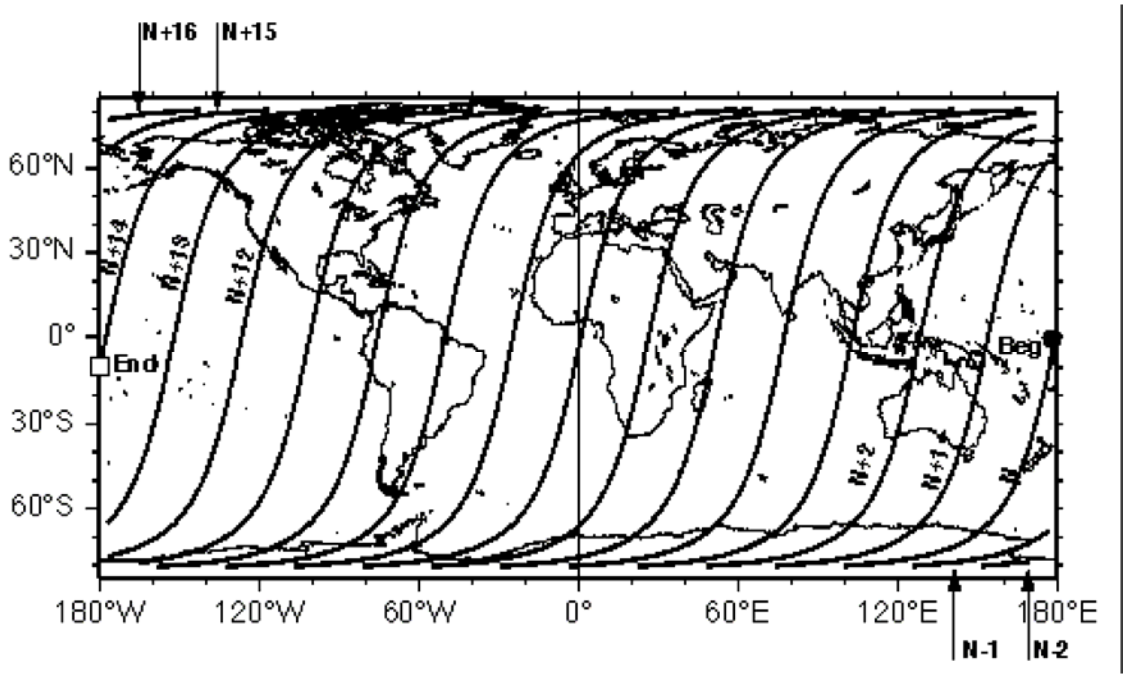


Figure 4.5-1 - Data-day definition

Under these simplifications, the data-day selection is implemented as:

- read the Modified Julian Date 2000 of the beginning of the current orbit
- subtract 828.0 (MJD2000 of the first day of phase 2)
- keep the modulus of this quantity versus 35 (period of one cycle)
- if modulus = 0, use 35 instead - remind it as "iday"
- read the relative orbit number of the MERIS level 2 product - remind it as "iorb"
- if (iday=35) and (iorb<10) increase iorb by 501
- if (iday=1) and (iorb>490) decrease iorb by 501
- setup a LUT ("ista") describing the first orbit crossing the 180° meridian closest to the equator, for each day of the ENVISAT cycle. Define also LUT "iend" as iend(n)=ista(n+1) :

1	15	29	44	58	72	87	101	115	130
144	158	172	187	201	215	230	244	258	273
287	301	316	330	344	359	373	387	401	416
430	444	459	473	487	502				

- compare the actual processed orbit with the ista orbit of the current day iday:

  if $|ista(iday) - iorb| < 3$, the orbit must be splitted in two parts, one for the current day (for which only pixels with positive latitudes are valid) and one for the previous day (for which only pixels with negative latitudes are valid)

  if $|iend(iday) - iorb| < 3$, the orbit must be splitted in two parts, one for the current day (for which only pixels with negative latitudes are valid) and one for the following day (for which only pixels with positive latitudes are valid)

  otherwise, all pixels of the orbit are valid for the current day.

5 Product format

5.1 Output parameters

The following table presents the exhaustive list of processed parameters.

Parameter	Name	Index (var)	Coding mode
Algal 1	chl1	1	log
Total water vapour columns over clear sky	wvcs	3	lin
Flag ABSOA_DUST (Dust-like absorbing aerosol selected for atmosphere correction)	absd	6	lin
Aerosol optical thickness over Land at 443 nm	t443	8	lin
Aerosol optical thickness over Water at 865 nm	t865	9	lin
Merged aerosol optical thickness at 550 nm	t550	10	lin
Aerosol Angstrom Coefficient over Land	a443	11	lin
Aerosol Angstrom Coefficient over Water at 865 nm	a865	12	lin
Merged Aerosol Angstrom Coefficient	a550	13	lin
Normalised water leaving radiance at 412 nm	n412	201	lin
Normalised water leaving radiance at 443 nm	n443	202	lin
Normalised water leaving radiance at 490 nm	n490	203	lin
Normalised water leaving radiance at 510 nm	n510	204	lin
Normalised water leaving radiance at 560 nm	n560	205	lin

Table 5.1-1 - List of processed parameters

A complete description of these variables can be found in [RD6].

Merged AOT (t550) is computed from t443 & t865 using t550 = txxx . $(550/xxx)^{-a}$ with a=1 for land (xxx=443) and a=a865 for water (xxx=865)

Merged AAC (a550) is computed from a443 & a865 using a550 = axxx . $(550/xxx)^{-a}$ with a=1 for both land (xxx=443) and water (xxx=865)

When merging mixed bins (i.e. coastal bins with valid land and water data), the processor keep the input bins with the bigger number of level-2 contributing pixels

5.2 Output files format

The level-3 products are disseminated in netCDF format for the data and in XML format for the metadata. The netCDF format is fully described in [RD7]. The data are scaled when they are written in the netCDF format. The scaling factors are written in the netCDF file as variable attributes.

The format of the file is described in the following table:

Variable	Type	Description
npt_bin	NC_LONG	Number of bins in the product
count(npt_bin)	NC_SHORT	Number of contributing MERIS pixels
idx(npt_bin)	NC_LONG	Bin index in the global ISIN grid
mean(npt_bin)	NC_SHORT	Arithmetic mean of the parameter
stdev(npt_bin)	NC_SHORT	Standard deviation of the parameter
min(npt_bin)	NC_SHORT	Minimum value of the contributing pixels
max(npt_bin)	NC_SHORT	Maximum value of the contributing pixels

Table 5.2-1 - netCDF file format

Each variable listed in the previous table is described by several attributes:

Attribute	Type	Description
long_name	NC_CHAR	Detailed description of the variable
_FillValue	NC_SHORT	Value identifying missing data (1)
missing_value	NC_SHORT	*Not used*
scaling_equation	NC_CHAR	Description of the scaling equation (2)
scale_factor	NC_FLOAT	Multiplication factor for decoding purpose (3)
add_offset	NC_FLOAT	Offset factor for decoding purpose (3)

Table 5.2-2 - netCDF variable attributes description

(1): as the level-3 product contains only valid data, this field is useless
(2): scaling equation can be linear or exponential depending of the variable
(3): the scaling equation describes how these factors shall be used to decode the variable data

Example: description of the netCDF file for a monthly chl1 product (01/jan/2005):

L3_ENV_MER_CHL1_m__20050101_GLOB_SI_ACR_9277x9277_-90+90+-180+180_0000.nc

```
netcdf L3_ENV_MER_CHL1_m__20050101_GLOB_SI_ACR_9277x9277_-90+90+-180+180_0000 {
dimensions:
   npt_bin = 2934319 ;
variables:
   short count(npt_bin) ;
           count:long_name = "Number of input level 2 data involved in each bin" ;
           count:_FillValue = -999s ;
           count:missing_value = -999s ;
           count:scaling_equation = "value=offset+code*gain" ;
           count:scale_factor = 0.02542169f ;
           count:add_offset = 0.9975921f ;
   int idx(npt_bin) ;
           idx:long_name = "Index number of each bin in the global sinusoidal grid"
;
           idx:scaling_equation = "value=code" ;
   short mean(npt_bin) ;
           mean:long_name = "Arithmetic mean of the geophysical variable" ;
           mean:_FillValue = -999s ;
```

```
                mean:missing_value = -999s ;
                mean:scaling_equation = "value=10**(offset+code*gain)" ;
                mean:scale_factor = 0.000106214f ;
                mean:add_offset = -2.f ;
        short stdev(npt_bin) ;
                stdev:long_name = "Standard deviation of the geophysical variable" ;
                stdev:_FillValue = -999s ;
                stdev:missing_value = -999s ;
                stdev:scaling_equation = "value=10**(offset+code*gain)" ;
                stdev:scale_factor = 0.0002124281f ;
                stdev:add_offset = -4.f ;
        short min(npt_bin) ;
                min:long_name = "Minimum value of the geophysical variable" ;
                min:_FillValue = -999s ;
                min:missing_value = -999s ;
                min:scaling_equation = "value=10**(offset+code*gain)" ;
                min:scale_factor = 0.000106214f ;
                min:add_offset = -2.f ;
        short max(npt_bin) ;
                max:long_name = "Maximum value of the geophysical variable" ;
                max:_FillValue = -999s ;
                max:missing_value = -999s ;
                max:scaling_equation = "value=10**(offset+code*gain)" ;
                max:scale_factor = 0.0001062141f ;
                max:add_offset = -2.f ;
}
```

The level-3 product metadatas are distributed in a XML format file. The XML format is fully described in [RD8]. The XML file is a complete conversion of the internal metadata ASCII file. The building blocks of the XML file is described by the following Document Type Definition (DTD).

```
<!ELEMENT description_file (
    description_filename,
    product,documentation,
    instrument_information,
    processing_information,
    input_files_information,
    time_coverage,
    grid_information,
    variable_information,
    coverage_statistics)>
    <!ELEMENT description_filename (#PCDATA)>
    <!ELEMENT product (
        filename,
        level,
        period)>
        <!ELEMENT filename (#PCDATA)>
        <!ELEMENT level (#PCDATA)>
        <!ELEMENT period (#PCDATA)>
    <!ELEMENT documentation (
        doc_atbd,
        doc_iodd)>
        <!ELEMENT doc_atbd (#PCDATA)>
        <!ELEMENT doc_iodd (#PCDATA)>
```

```
<!ELEMENT instrument_information (
     instrument_short_name,
     instrument_long_name,
     plateform_name)>
     <!ELEMENT instrument_short_name (#PCDATA)>
     <!ELEMENT instrument_long_name (#PCDATA)>
     <!ELEMENT plateform_name (#PCDATA)>
<!ELEMENT processing_information (
     processing_centre,
     processing_software_name,
     processing_software_version,
     processing_utc,
     processing_parameters)>
     <!ELEMENT processing_centre (#PCDATA)>
     <!ELEMENT processing_software_name (#PCDATA)>
     <!ELEMENT processing_software_version (#PCDATA)>
     <!ELEMENT processing_utc (#PCDATA)>
     <!ELEMENT processing_parameters (#PCDATA)>
<!ELEMENT input_files_information (
     nb_input_files,
     input_file+)>
     <!ELEMENT nb_input_files (#PCDATA)>
     <!ELEMENT input_file (#PCDATA)>
<!ELEMENT time_coverage (
     start_utc,
     start_mjdp,
     stop_utc,
     stop_mjdp>
     <!ELEMENT start_utc (#PCDATA)>
     <!ELEMENT start_mjdp (#PCDATA)>
     <!ELEMENT stop_utc (#PCDATA)>
     <!ELEMENT stop_mjdp (#PCDATA)>
<!ELEMENT grid_information (
     aoi_name,
     grid_type,
     grid_name,
     longitude_discretisation,
     latitude_discretisation,
     registration,
     straddle,
     earth_radius,
     nb_bins_equator,
     nb_bins_latitude)>
     <!ELEMENT aoi_name (#PCDATA)>
     <!ELEMENT grid_type (#PCDATA)>
     <!ELEMENT grid_name (#PCDATA)>
     <!ELEMENT longitude_discretisation (
          minimum,
          maximum,
          step_deg,
```

```
            step_km,
            longitude_units)>
        <!ELEMENT latitude_discretisation (
            minimum,
            maximum,
            step_deg,
            step_km,
            longitude_units)>
            <!ELEMENT minimum (#PCDATA)>
            <!ELEMENT maximum (#PCDATA)>
            <!ELEMENT step_deg (#PCDATA)>
            <!ELEMENT step_km (#PCDATA)>
            <!ELEMENT longitude_units (#PCDATA)>
            <!ELEMENT latitude_units (#PCDATA)>
        <!ELEMENT registration (#PCDATA)>
        <!ELEMENT straddle (#PCDATA)>
        <!ELEMENT earth_radius (#PCDATA)>
        <!ELEMENT nb_bins_equator (#PCDATA)>
        <!ELEMENT nb_bins_latitude (#PCDATA)>
    <!ELEMENT variable_information (
        var_code,
        var_short_name,
        var_long_name,
        var_unit,
        nb_data_sets,
        data_set+)>
        <!ELEMENT var_code (#PCDATA)>
        <!ELEMENT var_short_name (#PCDATA)>
        <!ELEMENT var_long_name (#PCDATA)>
        <!ELEMENT var_unit (#PCDATA)>
        <!ELEMENT nb_data_sets (#PCDATA)>
        <!ELEMENT data_set (
            name,
            format,
            coding)>
            <!ELEMENT name (#PCDATA)>
            <!ELEMENT format (#PCDATA)>
            <!ELEMENT coding (
                mode,
                gain,
                offset,
                equation)>
                <!ELEMENT mode (#PCDATA)>
                <!ELEMENT gain (#PCDATA)>
                <!ELEMENT offset (#PCDATA)>
                <!ELEMENT equation (#PCDATA)>
    <!ELEMENT coverage_statistics (
        size_grid,
        nb_bins,
        pct_bins,
        nb_valid_bins,
        pct_valid_bins)>
```

```
ELEMENT size_grid (#PCDATA)>
ELEMENT nb_bins (#PCDATA)>
ELEMENT pct_bins (#PCDATA)>
ELEMENT nb_valid_bins (#PCDATA)>
ELEMENT pct_valid_bins (#PCDATA)>
```

5.3 Product filename convention

This naming convention is shared between all files (netCDF data, XML metadata, QL images). Only the extension identifies the type of file: no extension for internal level-3 binary data products, .nc for netCDF files, .xml for the distributed metadata files and .jpg for the quicklooks.

The file naming convention of the files follows the following rules :

Lz_SAT_INS_PRD_period_date_ROI_G_PC_DLON_DLAT_geom_nnnn[.ext]

where:

- **Lz** is the product level (L3 for level 3 binned ISIN grid)
- **SAT** is the satellite information (ENV for ENVISAT)
- **INS** is the instrument acronym (MER for MERIS)
- **PRD** is the parameter (CHL1 for chlorophyll, WVCS, ...)
- **period** indicates the temporal coverage of the level-3 product (j for daily, d for daily, m for monthly and y for early)
- **date** is specified as yyyymmdd
- **ROI** is the name of the region of interest (GLOB for global coverage)
- **G** indicates the projection grid used (SI for sinusoidal grid)
- **PC** identifies the processing centre
- **DLON** and **DLAT** are the representative discretisation of the sinusoidal grid in km (at the equator in case of an ISIN grid).
- **geom** indicates the spatial coverage of the grid (-90+90+-180+180 in case of a global grid)
- **nnnn** is a counter
- **ext** is the file extension (txt for ASCII metadata, nc for netCDF files, xml for XML files, jpg for JPG files)

The number of fields is constant. Missing information leads to two adjacent underscores.

This page is intentionally left blank