MERIS Cal/Val organization
Towards Sentinel 3

Philippe.Goryl@esa.int

Plan

1. ENVISAT/MERIS – SENTINEL3/OLCI
2. Calibration principles reminder, Vicarious calibration verification
3. Validation organization
4. Mermaid
5. ODESA
6. Conclusion

ENVISAT

ENVISAT launch : March 2002

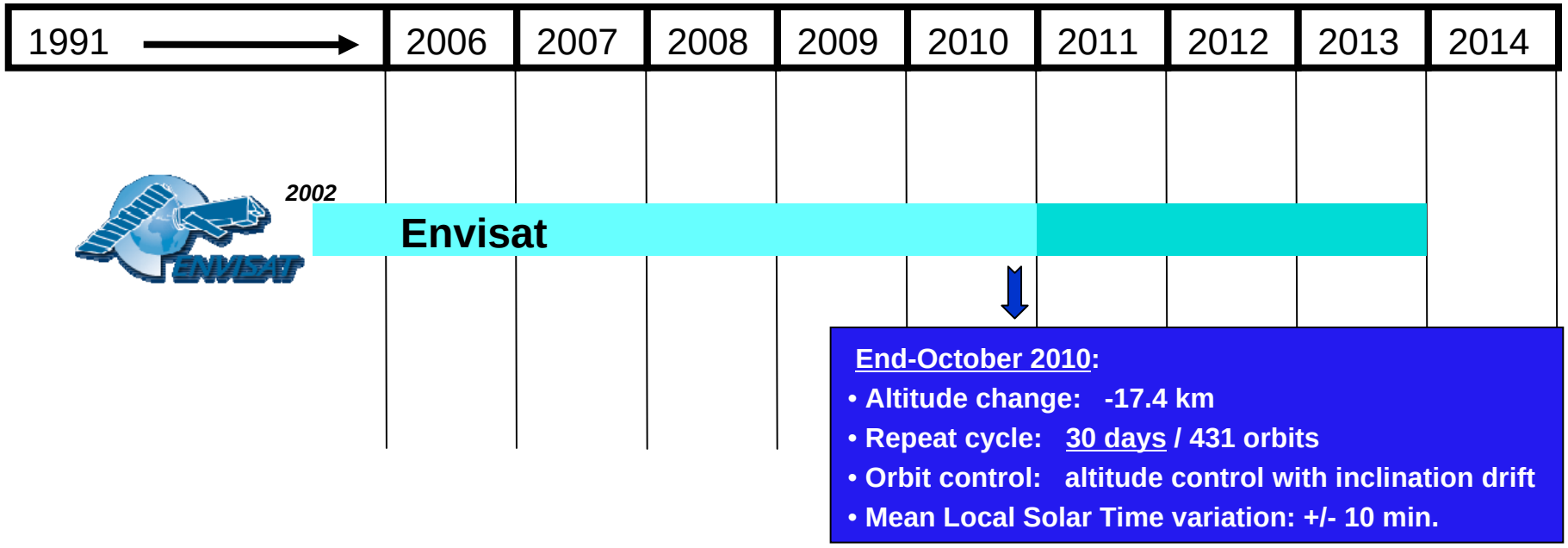
Envisat satellite is in good health
→ MERIS instrument is in excellent shape.

Efficient consumption of on-board hydrazine allow to operate nominally Envisat until 2010. But most of hydrazine will be consumed in 2010.

→ ESA has elaborated a technical solution to further extend mission by 3 years, i.e. until 2013, based on a decrease of orbit altitude.

→ the solution allows to carry on with the current Envisat applications, including MERIS applications.

Envisat Mission Extension (E2010+)

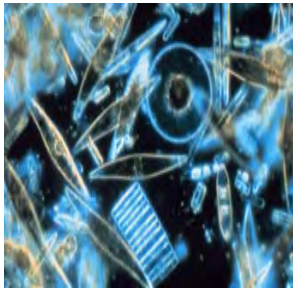


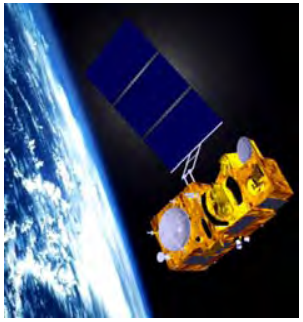
The new orbital parameters allow:

1. **to keep current nominal mission until October 2010,**
2. **to extend the mission until end 2013,**
3. **to allow operations of all instruments with small or no degradation of their measurements, and minor impact on data quality, *except for SAR interferometry***
4. **to commit with the satellite disposal rules.**

Sentinel-3 overview

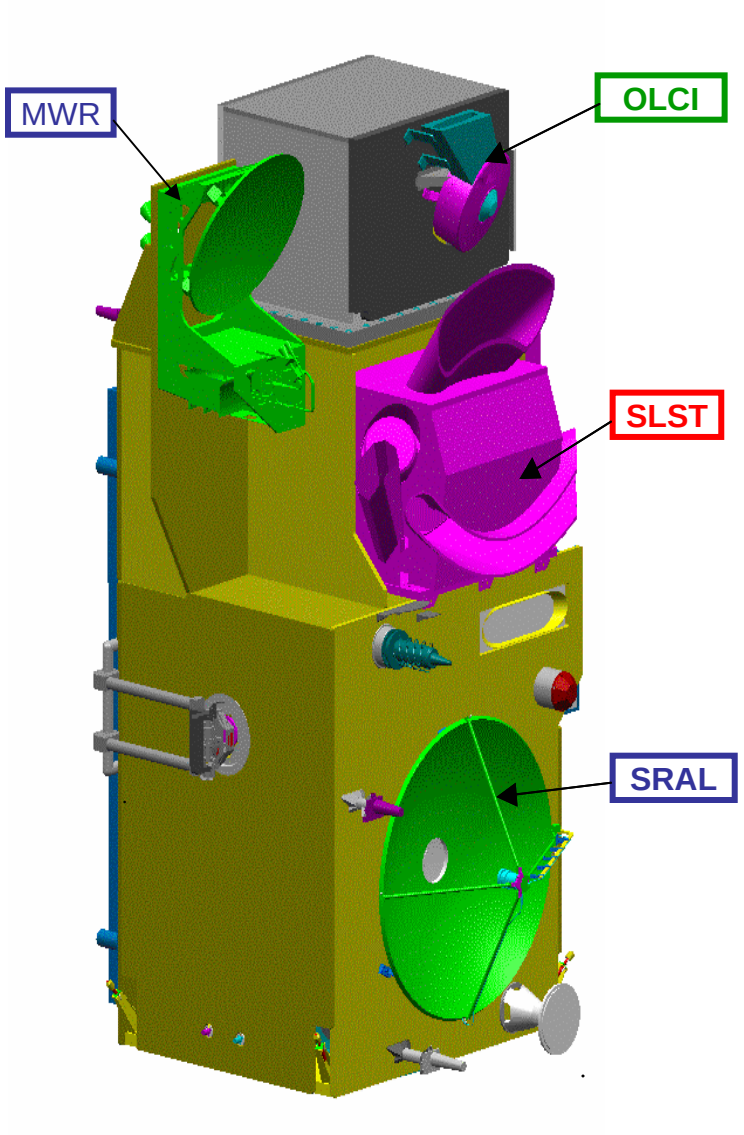
- Sentinel-3 is one element of the GMES system.
- Sentinel-3 is an operational mission for oceanography & global land applications.
- Provides continuity of existing missions, delivering:
  - Sea/Land colour data (at least MERIS quality)
  - Sea/Land surface temperature (at least AATSR quality)
  - Sea surface topography data (at least Envisat RA quality)
- A series of satellites, each designed for a lifetime of 7 years, shall provide an operational service over 15 to 20 years
  - Only 1 satellite is in development at this moment





→ Launch planned for 2013

Sentinel-3 instruments



Instruments:

•Ocean and Land Colour Instrument (OLCI) with 5 cameras, 21 spectral bands

•Spatial sampling: 300m @ SSP

→ *MERIS follow-on*

•Sea and Land Surface Temperature (SLST) with 9 spectral bands, 0.5 (VIS, SWIR) to 1 km res (MWIR, TIR). Swath: 180rpm dual view scan, nadir & backwards

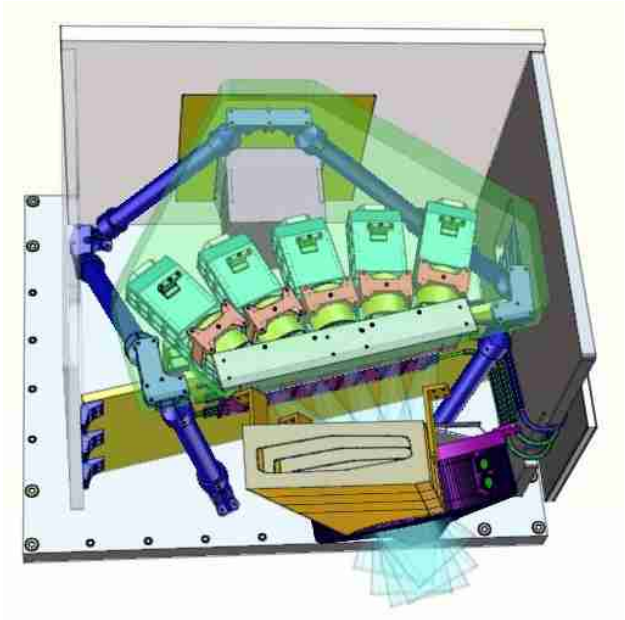
→ *ATSR follow-on*

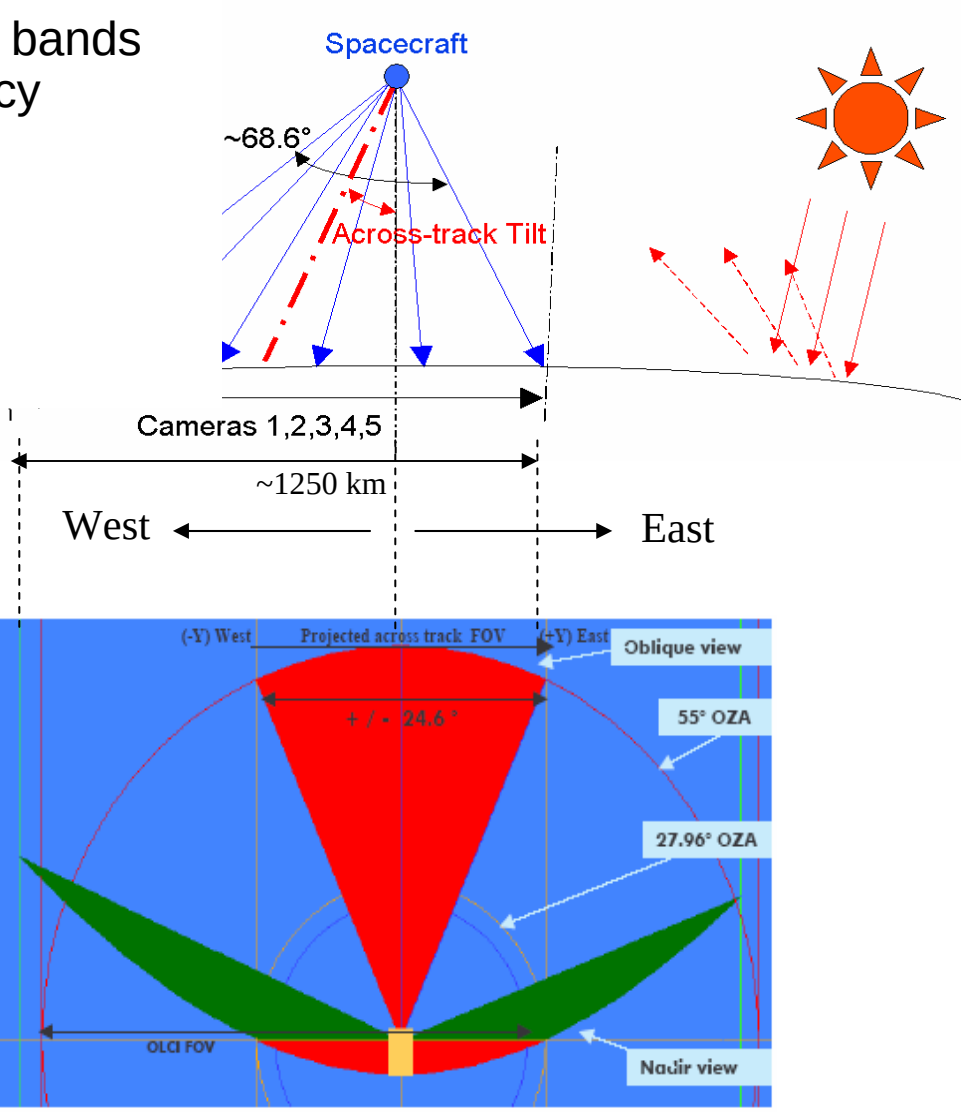
•Radar Altimeter package

SRAL Ku-C altimeter (LRM and SAR measurement modes), MWR, POD (with Laser Retro Reflector and DORIS)

OLCI instrument

- Heritage from MERIS
- 5 cameras, 21 programmable spectral bands (incl. channels for MERIS & VGT legacy products)
- Sun Glint free configuration by design
- Across-track tilt = 12.20°
- Low polarisation < 1%
- Swath covered by SLST for atmospheric correction





Sentinel-3 mission orbit

Type: Sun-synchronous low earth orbit

Repeat cycle: 27 days (14 + 7/27 orbits per day)

Average altitude: 814.5 km over geoid

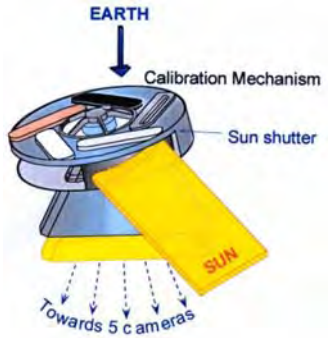
Mean solar time: 10:00 at descending node

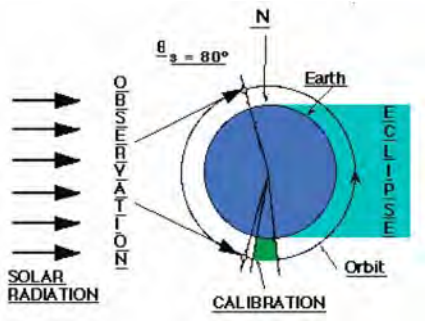
Inclination: 98.65°

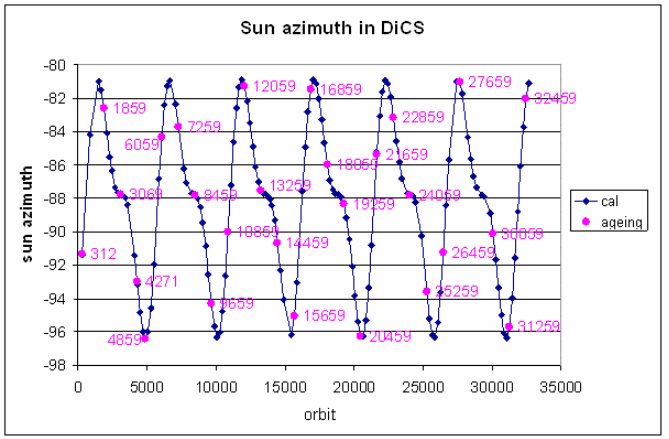
		Revisit at Equator	Revisit for latitude >30°	Specification
Ocean Colour (Sun-glint free)	1 Satellite	< 3.8 days	< 2.8 days	< 2 days
	2 Satellite	< 1.9 days	< 1.4 days	
Land Colour	1 Satellite	< 2.2 days	< 1.8 days	< 2 days
	2 Satellite	< 1.1 day	< 0.9 day	
SLST dual view	1 Satellite	< 1.8 days	< 1.5 days	< 4 days
	2 Satellite	< 0.9 day	< 0.8 day	

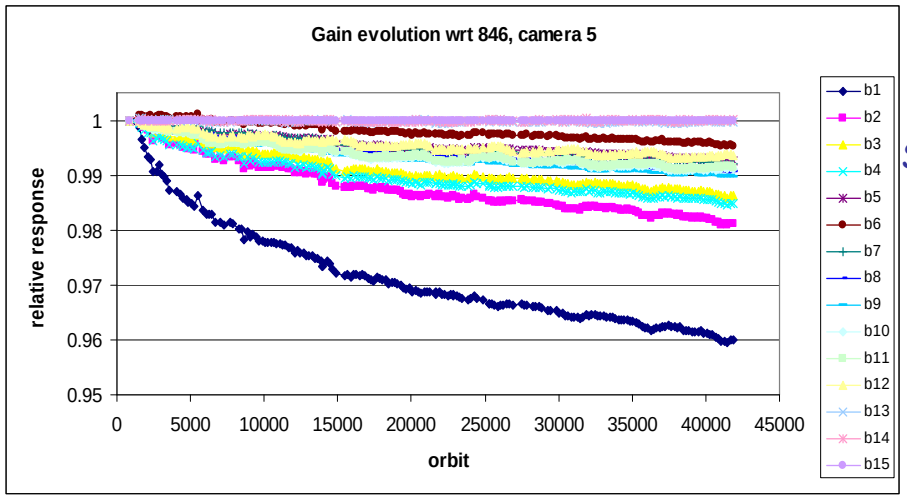
Level 1 radiometric *calibration*

Like MERIS, OLCI performs on board radiometric calibration :
- **Every 2 weeks routine with 1st diffuser**
- **Every 3 months with 2nd diffuser for ageing**









Maximum degradation of 4 %
after more than 8 years in space

Space environment implies **ageing** of Diffuser and Optics
2nd diffuser to monitor diffuser-1 BRDF ageing
=> Diffuser Aging model
frequent calibration to monitor Instrument degradation
=> instrument degradation model

$$G(t) = G(t_0) \cdot \left(1 - \beta \cdot \left(1 - \gamma \cdot e^{-\delta t}\right)\right)$$

Degradation Model based
on the SeaWifs model (Barnes et al.)

Level 1 radiometric vicarious verification

We have gained confidence in the absolute accuracy of the MERIS L1b radiometric calibration
But Radiometric vicarious calibration is used to verify that:

1. the absolute radiometric level of L1b data is within the error bars of the methodologies.
2. no ten

Methodol
Rayleigh,
Snow, Da

Instrume
Campaign

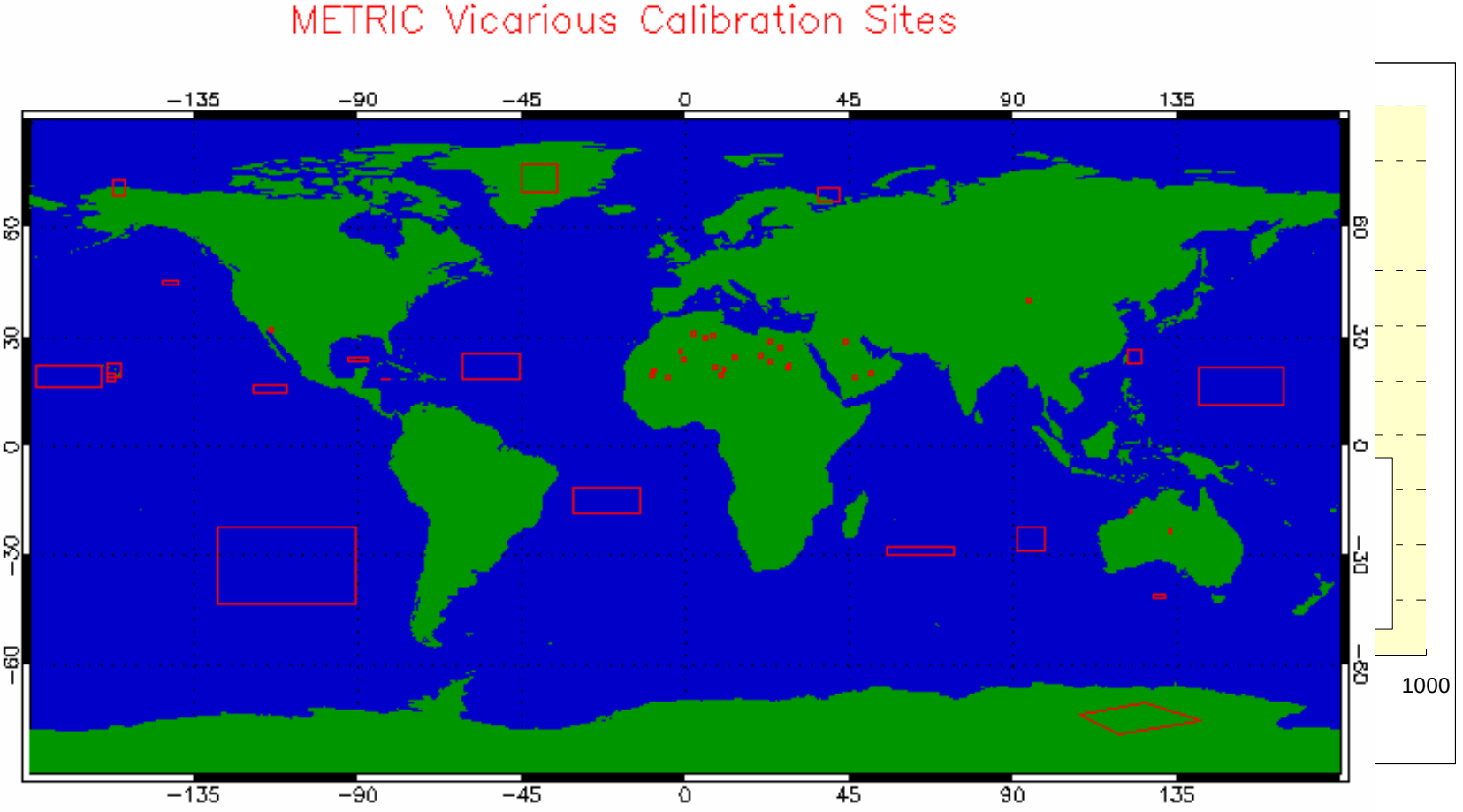
CEOS/IV

CNES : SA
Rayleigh, G

Dave Smit
Desert and

DIMITRI:
Intercomp

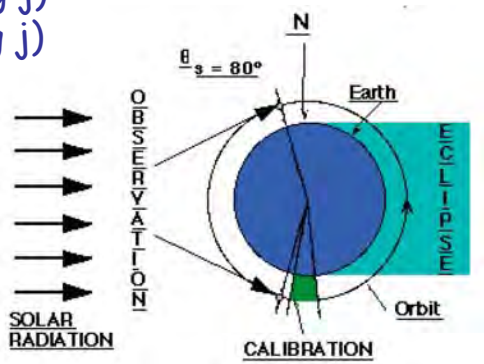
Dark targe
LISE



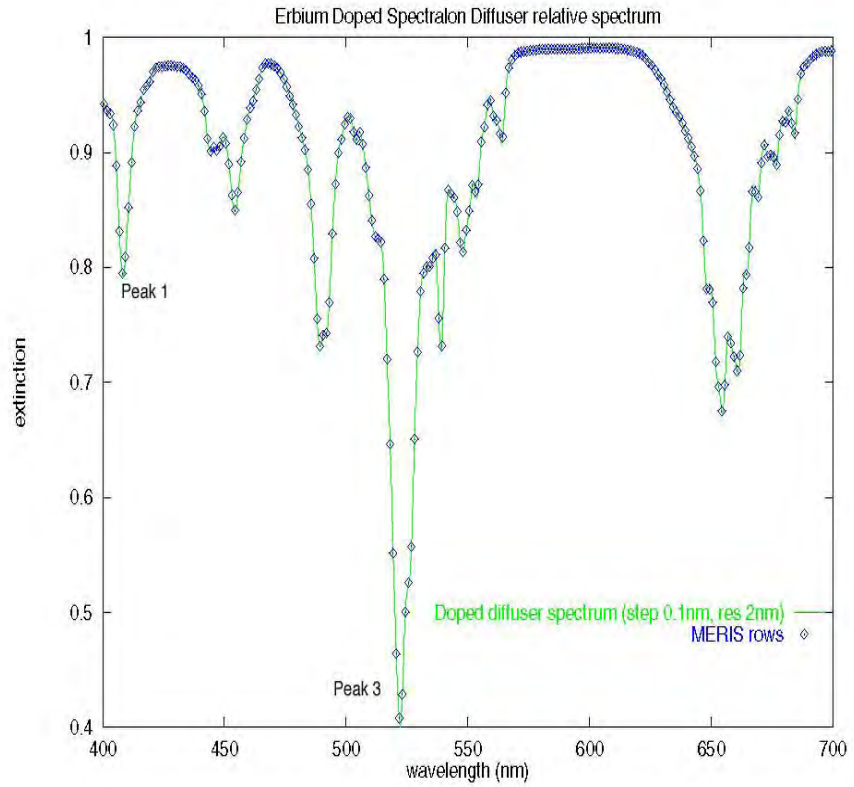
ibration
7

Spectral calibration: Erbium Doped Diffuser

Acquisitions scenario:
Orbit n = Diffuser-1 Cal (Band setting j)
Orbit n+1 = Diffuser-Er (Band setting j)



"Pink" Diffuser Measurements

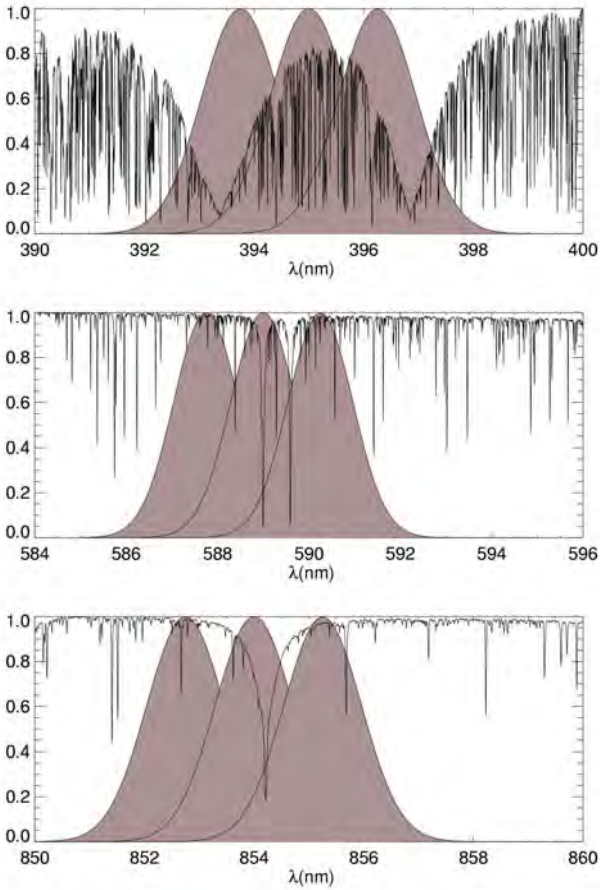


Erbium absorption spectrum

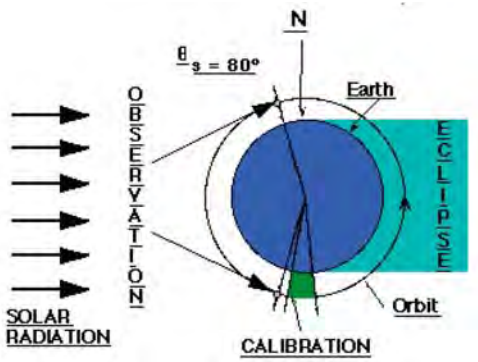
centre	width (nm)	centre	width (nm)
400.625	1.25	514.375	1.25
401.875	1.25	515.625	1.25
403.125	1.25	516.875	1.25
404.375	1.25	518.125	1.25
405.625	1.25	519.375	1.25
406.875	1.25	520.625	1.25
408.125	1.25	521.875	1.25
409.375	1.25	523.125	1.25
410.625	1.25	524.375	1.25
411.875	1.25	525.625	1.25
413.125	1.25	526.875	1.25
414.375	1.25	528.125	1.25
415.625	1.25	529.375	1.25
416.875	1.25	530.625	1.25
418.125	1.25	531.875	1.25

Band settings j

Spectral calibration: Fraunhofer Lines



Examples of Fraunhofer absorption spectrum
With MERIS spectral response overlay



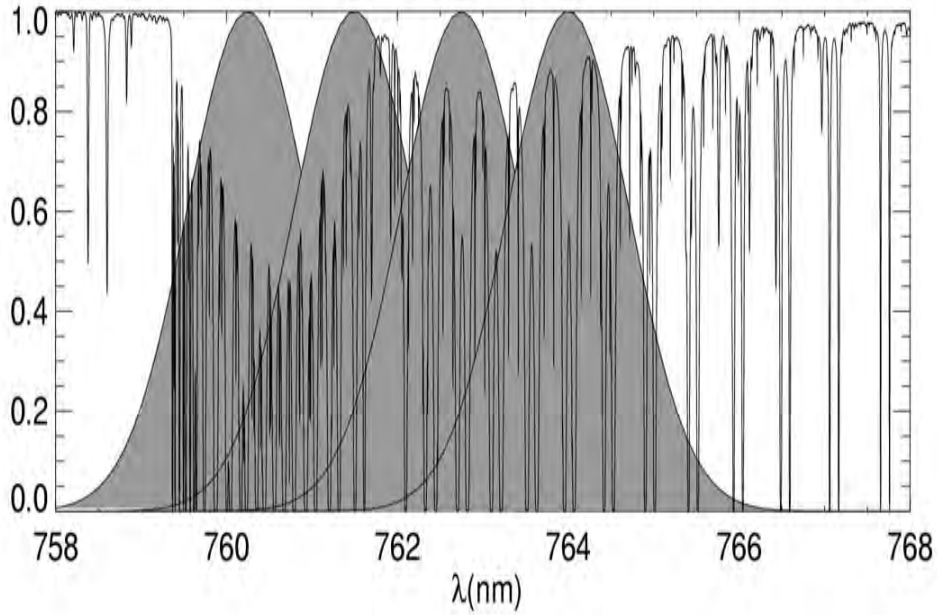
White diffuser-1 measurement

line 1 (393nm)	line 2 (485nm)	line 3 (588nm)	line 4 (655nm)	line 5 (855nm)	line 6 (867nm)
393.125	480.625	584.375	653.125	850.625	863.125
394.375	481.875	585.625	654.375	851.875	864.375
395.625	483.125	586.875	655.625	853.125	865.625
396.875	484.375	588.125	656.875	854.375	866.875
398.125	485.625	589.375	658.125	855.625	868.125
399.375	486.875	590.625	659.375	856.875	869.375
400.625	488.125	591.875	660.625	858.125	870.625
	489.375	593.125			

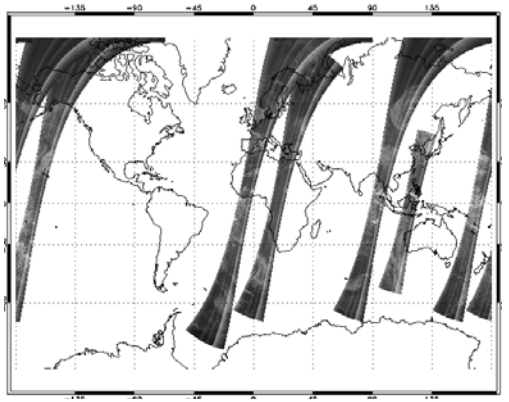
Band settings (3 configurations)

Spectral calibration: Oxygen O2A

For three orbits every six months, MERIS is configured to observe in detail the O2A absorption features



Oxygen O2A absorption spectrum MERIS spectral response overlay



Measurements over Natural target

name	centre	width (nm)
blue-2	442.5	10
red-1	665	10
ref-1	753.125	6.25
O2-0	758.125	1.25
O2-1	759.375	1.25
O2-2	760.625	1.25
O2-3	761.875	1.25
O2-4	763.125	1.25
O2-5	764.375	1.25
O2-6	765.625	1.25
O2-7	766.875	1.25
O2-8	768.125	1.25
O2-9	769.375	1.25
ref-2	778.75	7.5
IR-1	865	10

O2A Campaign Band setting

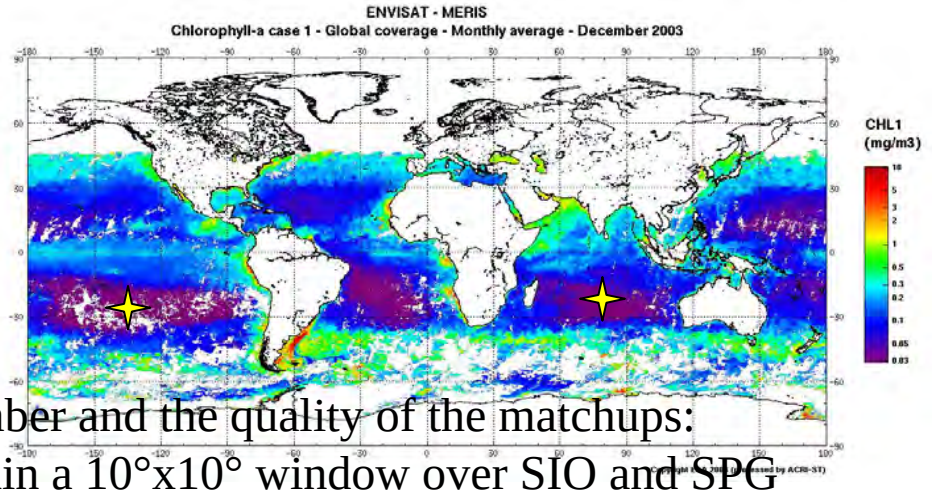
The NIR pre-adjustment

Database for NIR gain computation

NIR investigation carried out on two oligotrophic areas of the world ocean:

South Pacific Gyre

South Indian Ocean.



Database generated from 2003 to 2009

Procedure allow us to both improve the number and the quality of the matchups: data are extracted on the clearest pixels within a 10°x10° window over SIO and SPG

1794 matchups for SIO

1679 matchups for SPG (about 2 days out of 3)

Selection criteria: 5x5 macro-pixel are selected if the surrounding 15x15 macro pixel present none of the following flags cloud, ice haze or glint.

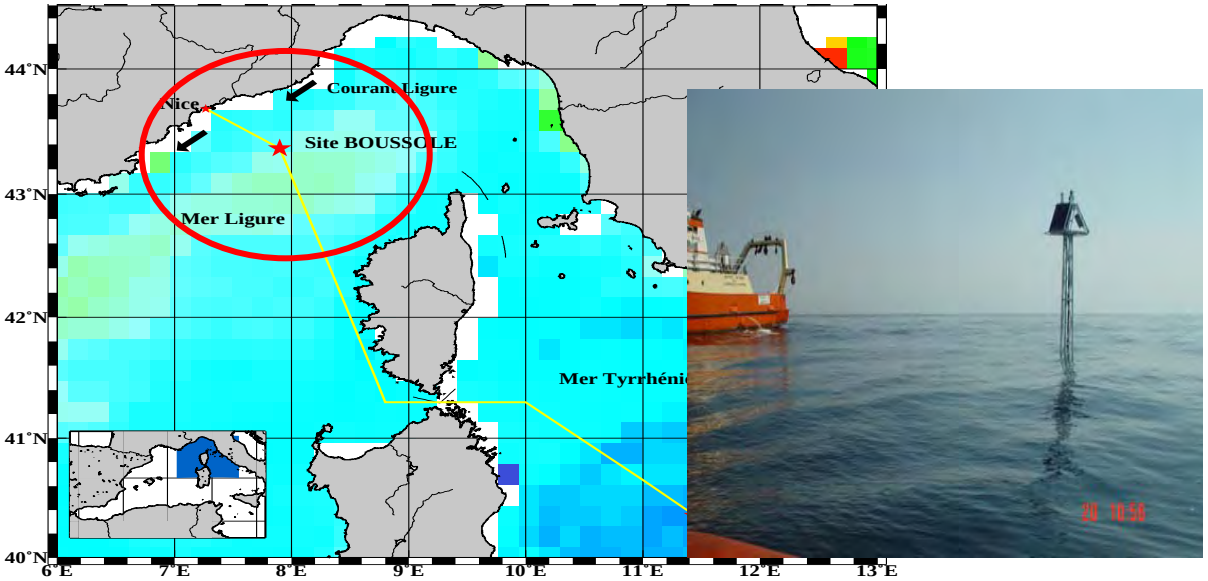
solar zenith angle <60°

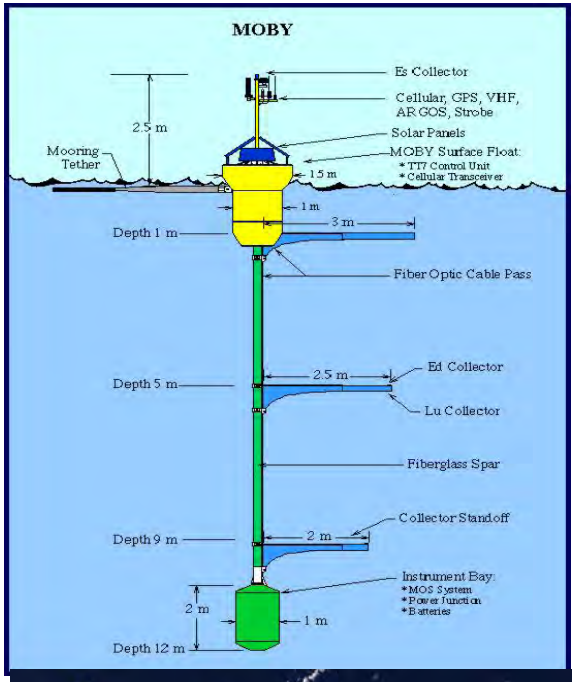
wind speed <9m/s.

→ around 1500 matchups for gain computatioon

Further pixel constraints for gain computation reject pcd_1_13, pcd_19, case2_s, no maritime aerosols, chl > 0.2mg/m3

Adjustment in the visible



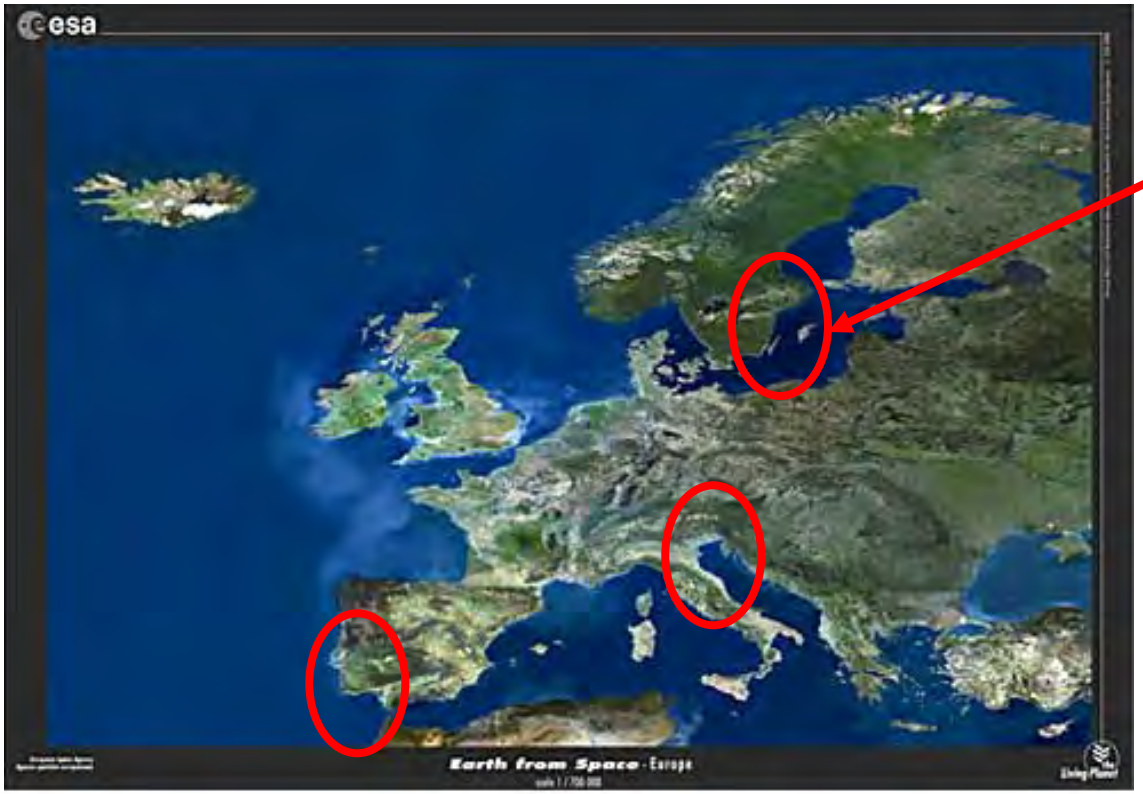


BOUSSOLE / MOBY used for:

→ adjustment in the visible

→ Validation

In-situ Sites



Swedish Aeronet:

SMHI, Norrköping 2007. It is one of the few high latitude AERONET stations.

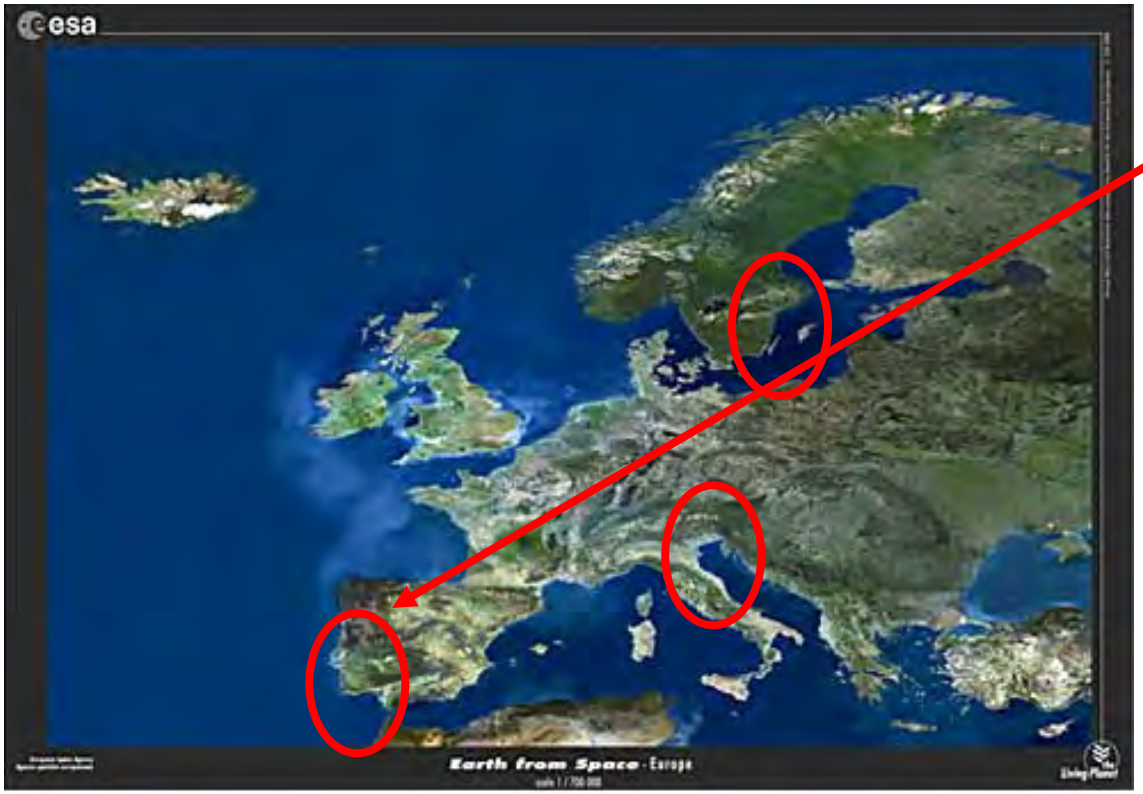
CIMEL is converted into an AERONET-OC and deployed at Lake Vänern (spring 2008).

TriOS- RAMSES hyperspectral spectroradiometers Vänern and in immerfjärden.

PI: Susanne KratzerUniv. Stockolm

Anu Reinart, Tartu Observatory, Estonia

In-situ Sites



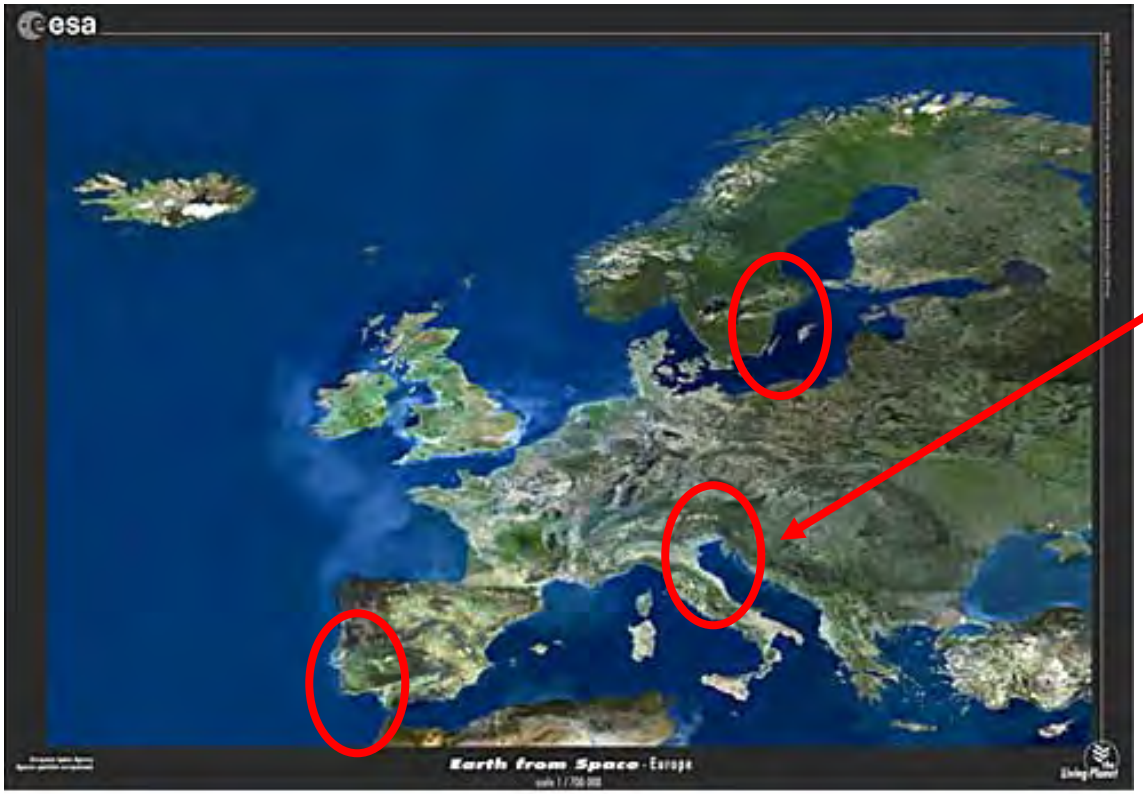
Portugal Water:

hyperspectral radiometer with a pitch and roll sensor and a compass

sun photometer

PI: John Icely – Sagremarisco, Algarve

In-situ Sites

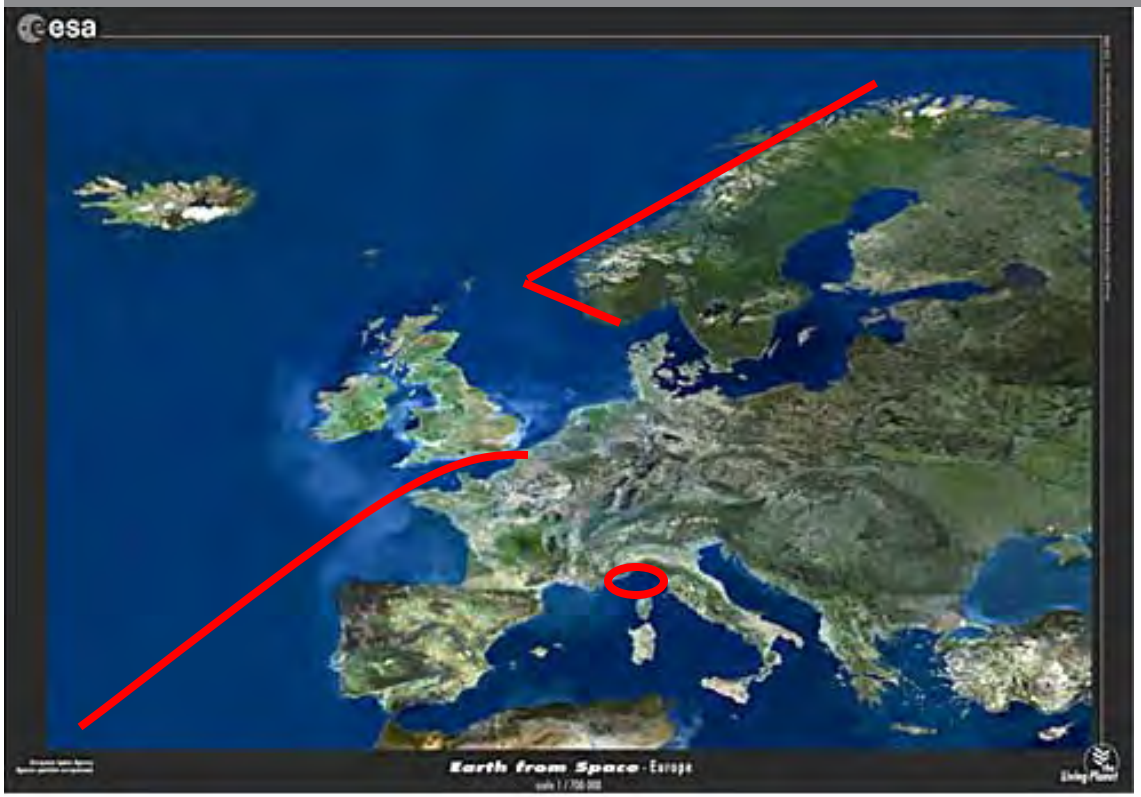


AAOT:
Venice Tower

SeaPrism

PI: Giuseppe Zibordi - JRC

In-situ Sites



Ramses Trios – on ferries – Norway NIVA (Kai Sorensen)

Simbada (D.Ramon, P-Y Deschamps)

+ International cruise

- **NATO – Ligurain Sea**
- **Bencala cruise**
- **BIOSOPE (pacific)**
- **Aopex (west Med.)**

MERIS level 3 products - Quality Control - Microsoft Internet Explorer

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QC

Address http://www.enviport.org/boards/test/meris_lv3_qc.htm

Go Links

MERIS marine level 3 products

Quality Control

Level 3 products

- MERIS level 3 demonstration products
- MODIS & SeaWiFS level 3 products
- GlobColour merged level 3 products

Quality control methodology

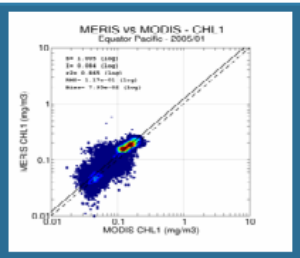
- Rationale
- Input data
- Parameters
- Zones
- Quality control items
  - Visual inspection
  - Time series
  - Histograms
  - Scatter plots
  - Anomalies

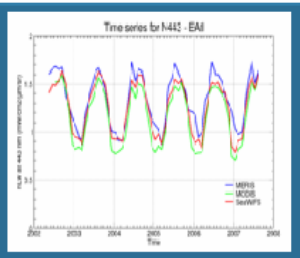
MERIS level 3 products analysis

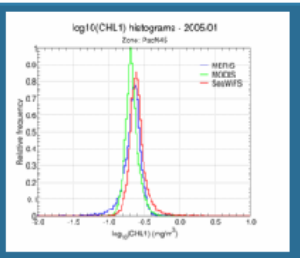
- MERIS time series
- MERIS CHL1 histograms
- MERIS chlorophyll anomaly images
- MERIS Google-Earth images

MERIS versus other sensors

- MERIS/MODIS/SeaWiFS CHL1 scatter plots
- MERIS/MODIS/SeaWiFS time series
- MERIS/MODIS/SeaWiFS CHL1 histograms







Following the MERIS Science Advisory Group recommendation, ESA started the generation of some MERIS level 3 demonstration products, using the MKL3 tool developed by ACRI-ST. The MKL3 tool is implemented on the GRID On Demand Processing chain at ESA and the MERIS level 3 products are generated routinely and are available on the web.

Although the validation of level 3 data cannot replace the validation of level 2 data, it may contribute to the estimation of the measurements quality by providing information where in-situ data does not exist, at a global scale almost every day, at daily, monthly, seasonal and annual temporal scales almost everywhere, on the long-term instrument stability and on instrument ageing.

The statistical analysis of the spatial variations of the level 3 data combined with oceanographic knowledge can lead us to a certain level of validation or invalidation of the products. Of course, the huge number of available points in the level 3 products increase the quality of the statistics.

Comparisons of level 3 products between sensors can be also of great interest to estimate the coherency between the couples instrument + processing as well as to characterise some possible inter-calibration between the products, for example before any merging attempt.

The analysis has been applied to the MERIS monthly level 3 products available on the ESA web site (1/12° sinusoidal grid) and the MODIS and SeaWiFS level 3 products available on the NASA Ocean Colour web site (both at 9 km on an Plate-Carré grid). The MERIS products have been reprojected on the same 9km Plate-Carré grid before any computation (using the Sutherland-Hodgeman area clipping and flux-conserving algorithms).

The following marine parameters are covered by the quality control tasks:

- chlorophyll-a, case 1 water
- normalised water leaving radiances (nLw) at 412, 443, 490, 510 and 560 nm
- aerosol optical thickness over water at 865 nm
- Angstrom coefficient over water at 865 nm

The statistical analysis has been performed at global level and on a set of dedicated zones.

MERIS LV3 QC is performed by ACRI-ST

Last update of the server: 18/jan/2008

MERIS level 3 products - Quality Control - Microsoft Internet Explorer

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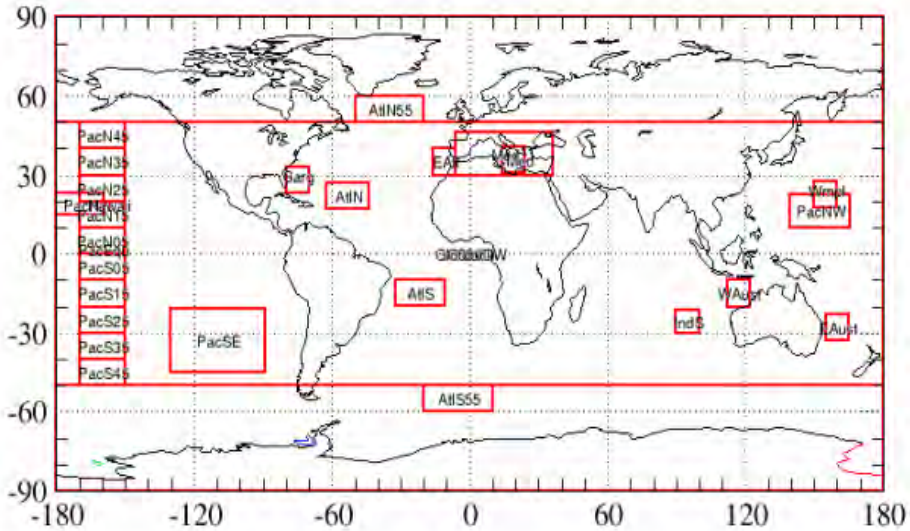
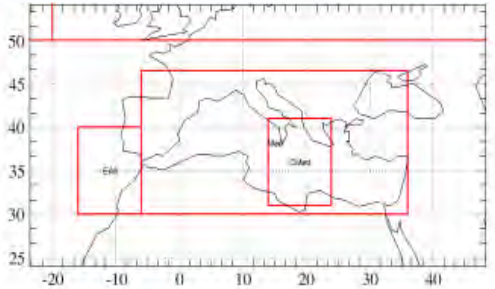
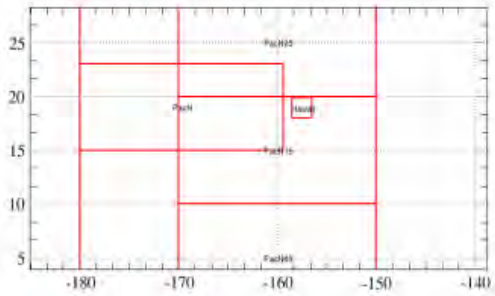
Address http://www.enviport.org/boards/test/proc_Q/meris_time/meris_time.htm Go Links

MERIS level 3 - Quality Control

MERIS time series







Glob	Glob50	Glob50DW	AtlN	AtlN55	AtlS
AtlS55	CMed	EAtl	EAust	Hawaii	IndS
Med	PacEqu	PacN	PacNW	PacN05	PacN15
PacN25	PacN35	PacN45	PacSE	PacS05	PacS15
PacS25	PacS35	PacS45	Sarg	WAust	Wmpl
GlobDW	GlobEW	GlobMW	GlobOW	GlobSW	

Last update of the server: 18/jan/2008

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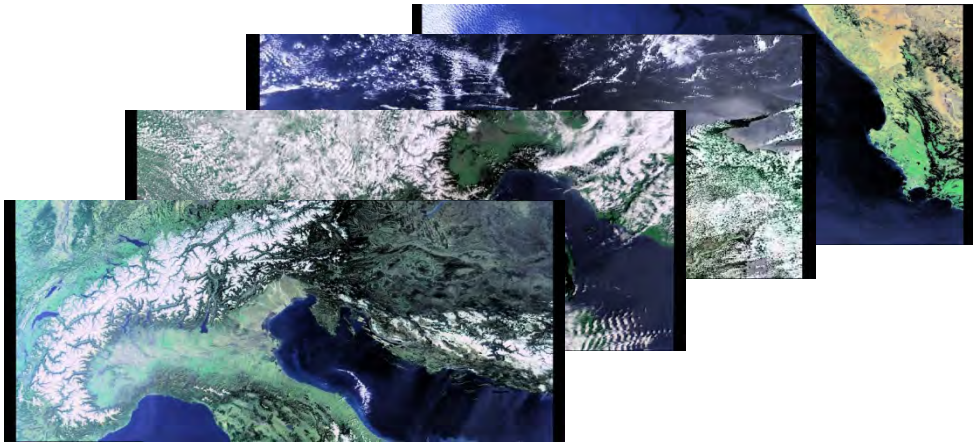
validation DataBase

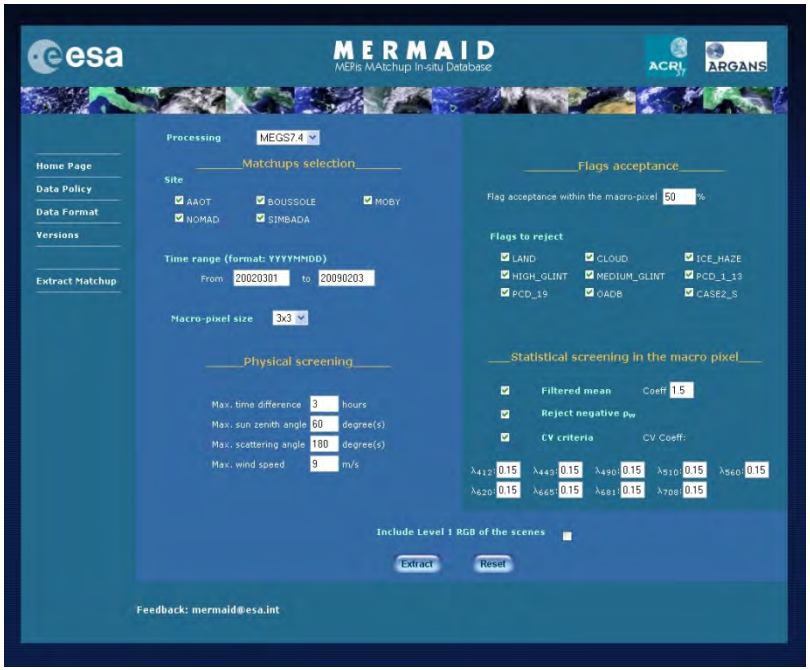
MERMAID

- A centralised database of concurrent MERIS acquisitions and in-situ optical measurements (protected by a standard data policy)

- Available to Ocean Colour researchers working within the MERIS mission: MERIS QWG, MVT and any collaborating PI

- Accessible on the web with a simple interface and standard data format





Validation - MERMAID

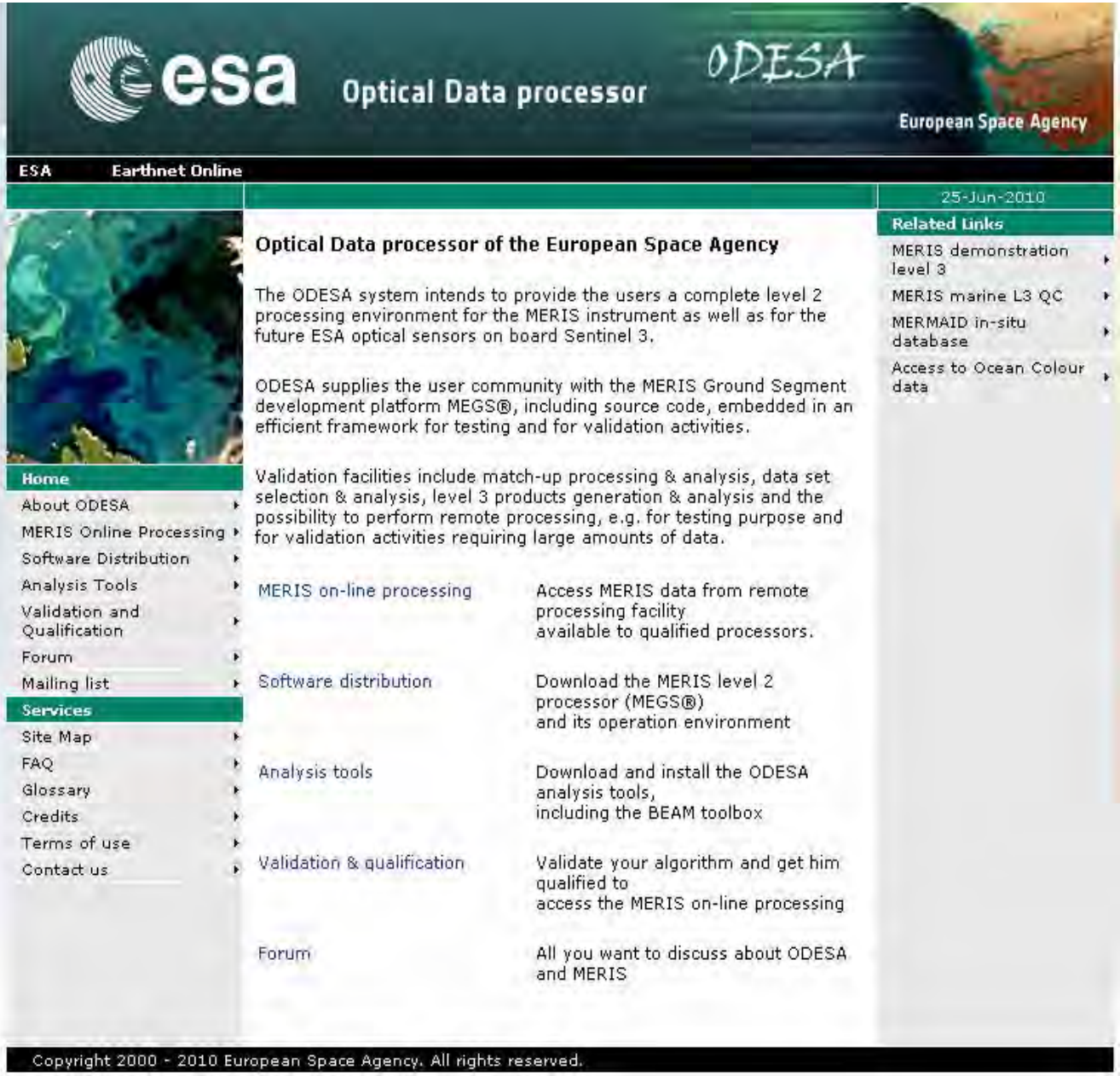
→ MatchUp Database : MERMAID
Mermaid 2010

G. Zibordi: Abu Al Bukhoosh (53), Gustav Dalen Tower (99) , Helsinki Lighthouse (89).
J. Icely: Algarve (16)
M. Ondrusek: Moby updated (472)
S. Kratzer: NW Baltic Sea (39), Palgrunden (28)
A. Hommersom: Wadden Sea (3)
D. MacKee: Bristol-Irish Sea (29)
G. Zibordi: new MERIS band-shifted matchups at AAOT (224 furnished after QC of 5064 potential measurements and less than 2 hours difference)
D. Antoine: new Boussole data recently provided (566)
J. Werdell : NOMADv2 instead of NOMAD (420 instead of 140)
D. Vandemark: MVCO (192)
→ 14 sites/missions with also SIMBADA (327).

Optical Data processor of ESA

Goal: provide a "run and test" platform to MERIS user community

- ODESA L2/L3 code distribution
- ODESA on-line L2/L3 processing
- ODESA forum
- ODESA validation & qualification
- Integrates BEAM as analysis tool



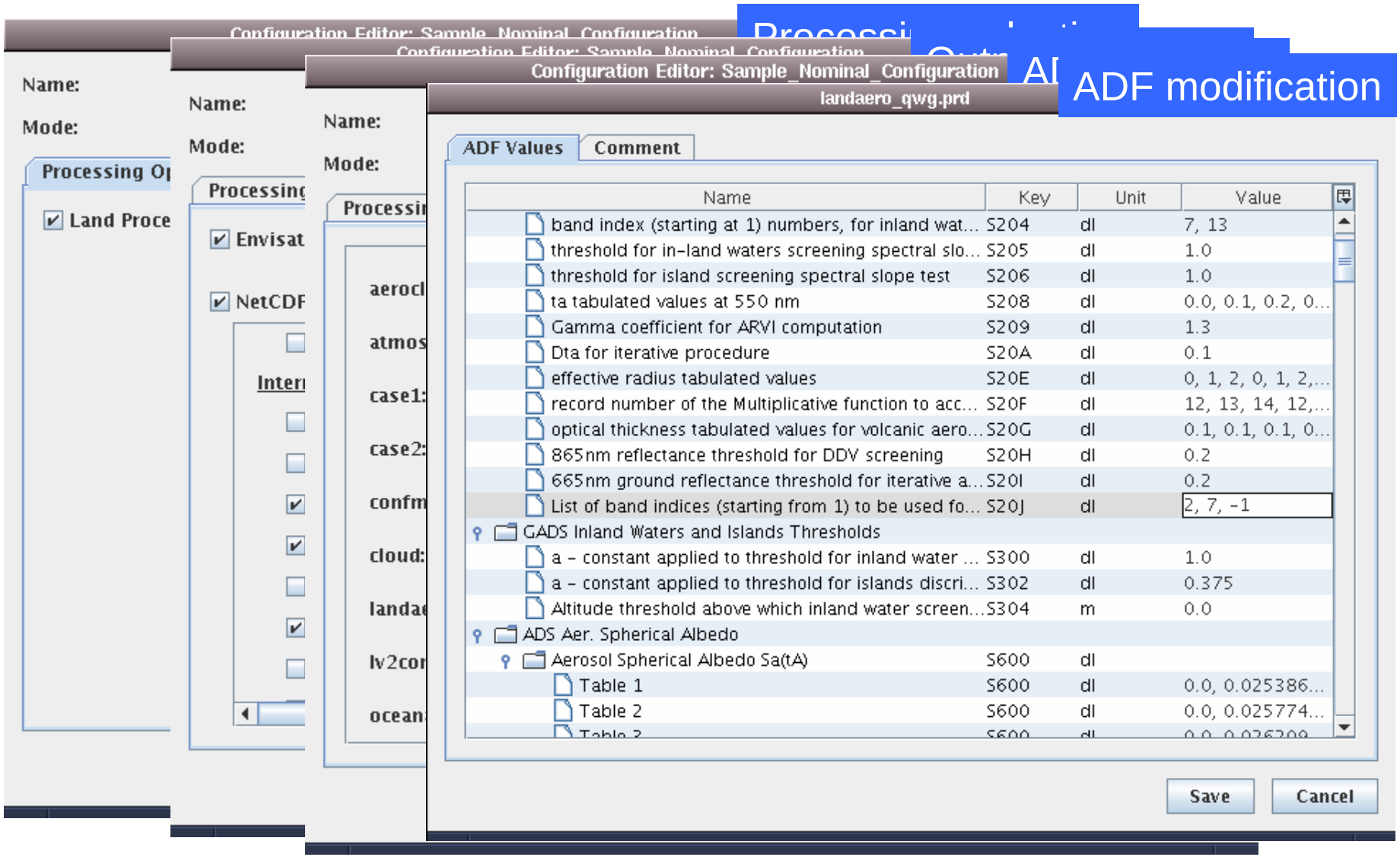
ODESA current web site http://earth.eo.esa.int/odesa/

ODESA L2/L3 code distribution

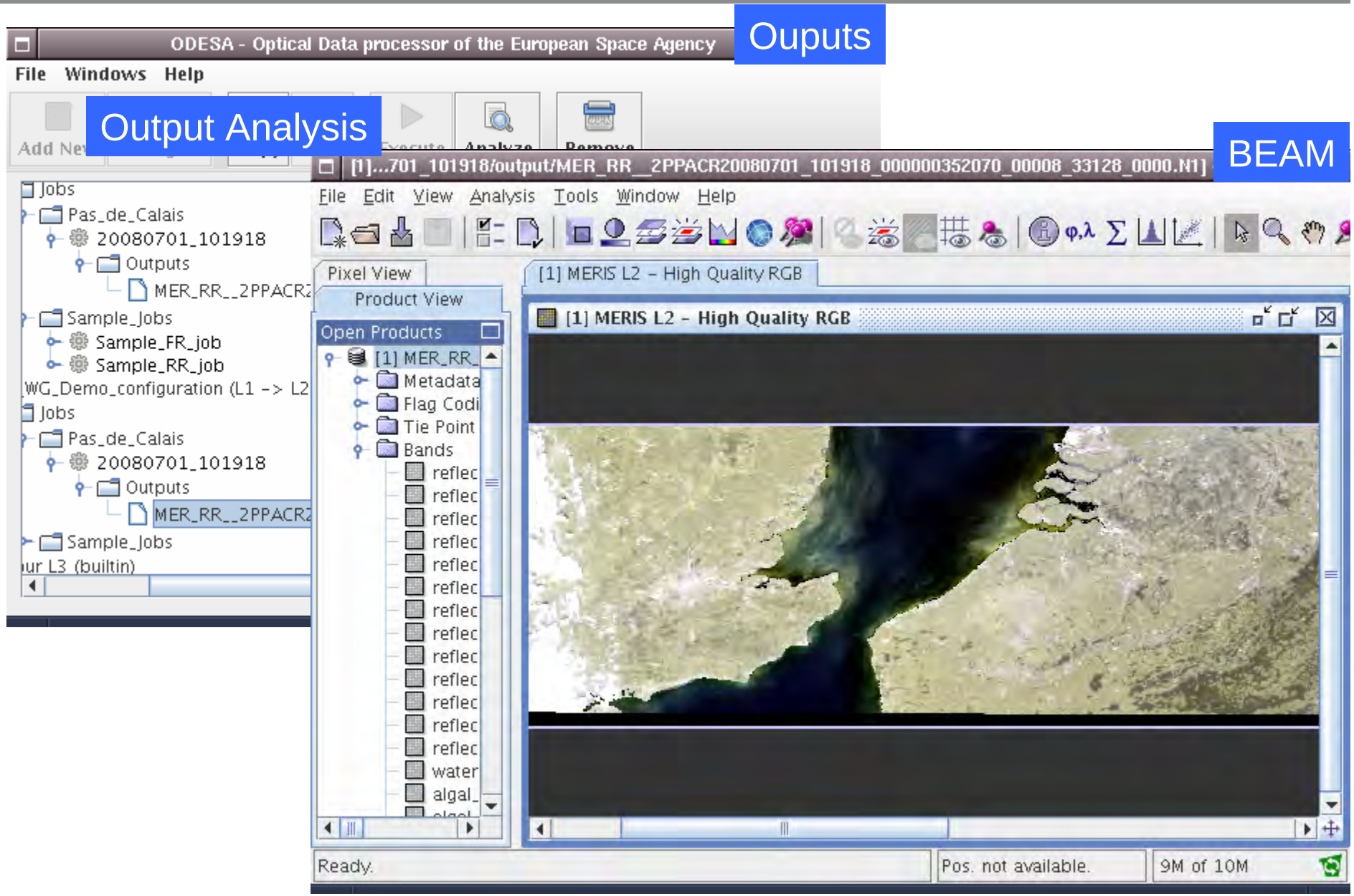
- The source code is delivered within a Graphical User Interface dedicated to the management of configurations of simulations

- Draft version : currently available to QWG members
- 1st version (available to the public when the MERIS reprocessed data set is available):
  - MERIS processor (L1 to L2)
- 2nd version
  - GLOBCOLOUR processor (L2 to L3)
  - Processing of MERMAID matchups

ODESA MEGS Configuration management



ODESA - Results Analysis



ODESA On-line processing & Validation

esa

esa Optical Data processor ODESA European Space Agency

You must log in first

email:

Password:

Submit

Register
Password lost

- **Home**
- About ODESA
- MERIS Online Processing
- Software Distribution
- Analysis Tools
- Validation and Qualification
- Forum
- Mailing list
- **Services**
- Site Map
- FAQ
- Glossary
- Credits
- Terms of use
- Contact us

Registration is very easy. It consists in providing an Email address.
The access is immediately granted with a password supplied by e-mail.

MERIS Online processing

Select an area on map or enter coordinates

North 90°N
West 180°W 180°E East
90°S South

Reset

Level Level1b level 2

Select **a period** From 22/06/2010 to 25/06/2010

an orbit range (*)

Version MEGS_8.0b1

Currently under testing and validation by the MERIS QWG. This version is not available for any other purpose. Known issues are described in the quick start guide.

(*) Date format must be dd/mm/yyyy
Orbit range: the value of the first and last absolute orbit

-Available period: **01/03/2002** to **25/06/2010**
-Available orbits: **1** to **43414**

NB: the total size of generated products is limited to 50 GB

Conclusion

- **Calibration : on board calibration, vicarious technique for monitoring**
- **Validation network for MERIS in place based on:**
  - ✓ **Buoys case 1 – Moby Boussole**
  - ✓ **Aeronet Ocean Colour Network + permanent instrumented sites**
  - ✓ **Cruises**
  - ✓ **Satellite Comparison**
- **MERMAID – Central Tool for validation**
- **ODESA – Environment for validation**

- **Ideally MERIS program, methodologies, tools and infrastructure would need to be continued for OLCI:**

  BUT the set up is different:

  - Sentinel operation is funded by European Commission

  - Funding for the Sentinel exploitation phase is not yet established

  - Eumetsat is in charged of the operation of OLCI marine part

- **Key issue and objective : continuity MERIS / OLCI**