

# COMPARISON OF MERIS (ALGAL\_1 AND ALGAL\_2) AND MODIS (OC3M) CHLOROPHYLL PRODUCTS AND VALIDATION WITH HPLC *IN SITU* DATA COLLECTED OFF THE WESTERN IBERIAN PENINSULA.

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## ABSTRACT

Ocean colour algorithms that are designed for use at global scales may be less accurate at local and regional scales and therefore it is important to understand the limitations of the different products in reference to specific areas. It is essential to validate the ocean-colour standard products with *in-situ* data in order to provide the quality requirements needed for monitoring purposes. Chlorophyll a (Chl) is used as the main biomass proxy for phytoplankton and ocean colour sensors allow a synoptic and quasi-permanent following of this pigment concentration in surface waters. Water samples collected on board 6 cruises off the Portuguese coast during the period 2005 – 2007 were processed by reversed phase HPLC for pigment determination, and the Chl concentration compared with coincident MERIS and MODIS data. The performance of MERIS (algal1 and algal2) and OC3M MODIS products was evaluated using match-up data sets, constructed with different time and space windows. The results for correlation, bias and rms are presented and discussed.

## 1. OVERVIEW OF MEASUREMENTS

Water samples were collected on board six opportunity cruises off the Portuguese coast, covering only spring and summer periods from 2005 – 2007 (Fig.1).

A total of 420 samples were analysed for pigments concentration with Chl ranging from 0.013 and 5.09 mg.m<sup>-3</sup> (Tab. 1).

Water collection at 5 m depth was performed using a rosette equipped with Niskin bottles for all cruises, except for RV Pelagia 2005 where an “Aquaflow” pumping system was used.

A volume of 5 L was filtered onto Whatman GF/F 47 mm filters and immediately deep frozen. In laboratory, samples were analysed for Chl with reversed phase HPLC using a monomeric ODS C18 column with a high ion strength solvent gradient (for methodological procedures see Mendes *et al.* 2007 [1]).

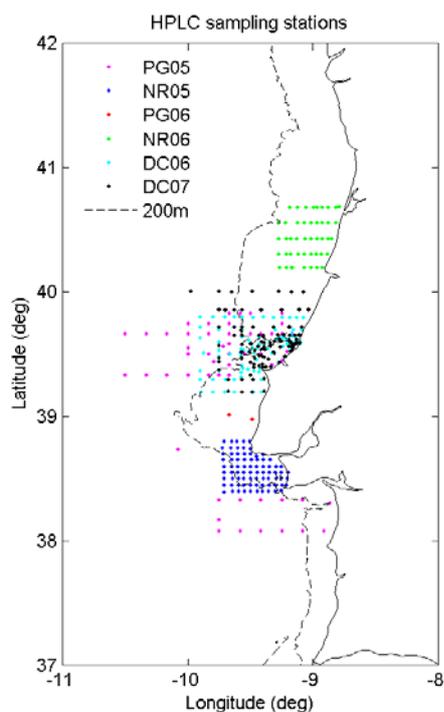


Figure 1. Location of samples taken on board RV Pelagia in 2005 (PG05) and 2006 (PG06), NI Noruega 2005 (NR05) and 2006 (NR06) and NRP D.Carlos I in 2006 (DC06) and 2007 (DC07).

Table 1. List of the oceanographic cruises with respective period of sampling, number of surface samples collected and Chl range.

Cruise	Period	#	Chl (Min.-Max.)
PG05	27/04-17/05	66	0.013 – 2.72
NR05	29/08-06/09	78	0.076 – 2.77
DC06	23/06-06/07	93	0.03 – 4.25
PG06	30/08-21/09	9	0.149 – 2.67
NR06	14/09-17/09	45	0.158 – 2.82
DC07	11/06-07/07	129	0.061 – 5.09
	<b>2005-2007</b>	<b>420</b>	<b>0.013 – 5.09</b>

The retrieved values were then compared with coincident satellite ocean colour data. MODIS (OC3M) and MERIS (algal 1 and algal 2) products were used for this purpose.

## 2. MATCH-UPS

For the match-ups all satellite products were masked. MODIS with L2\_flags and MERIS algal1 and algal2 products with confidence flag PCD\_15 and PCD\_17, respectively. Images of same sampling day were used and mean satellite Chl was calculated for space windows of 300 m (MERIS only), 1, 2 and 4 km away from station location. Time differences between satellite passage and sampling were then calculated and match-ups organized per distance and time intervals (less than 3h, 3-6h and 6-12h). The valid match-ups found are presented in Tab. 2.

Table 2. Number of valid match-ups with satellite masked images using different time and space windows.

Time and space window	Number of valid pixels		
	MODIS Aqua (OC3m)	MERIS (algal1)	MERIS (algal2)
<b>&lt;= 3 h</b>			
300 m	-	6	7
< 1 km	5	8	8
< 2 km	6	9	9
< 4 km	7	10	10
<b>3 – 6 h</b>			
300 m	-	4	7
< 1 km	9	6	7
< 2 km	9	7	7
< 4 km	9	8	9
<b>6 – 12 h</b>			
300 m	-	26	28
< 1 km	14	30	31
< 2 km	16	31	31
< 4 km	21	35	35

## 3. CHL COMPARISON

For all match-ups considered the statistics parameters: correlation coefficient ( $r^2$ ), root mean square (RMS) and mean error (BIAS) were calculated.

The results of the comparison of MODIS (OC3M) with in situ surface Chl reveal a general overestimation, particularly evident for lower Chl values (Fig.2). For 1km space and 3h time windows, although only 6 match-ups were retrieved, data have good correlation ( $r^2=0.93$ ) and low BIAS and RMS (Fig.2 A). The correlation decreases but is still significant when a time window of 12h is used. The Bias and RMS are similar (Fig.2 B).

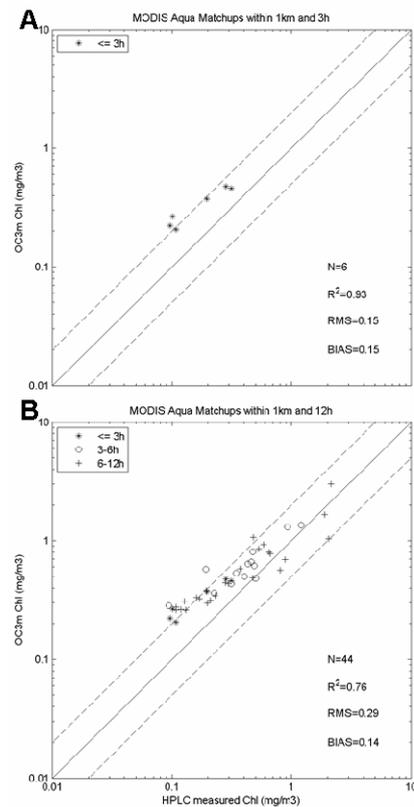


Figure 2 MODIS (OC3M) match-ups for 1km and different time windows: < 3h (A) and 12h (B).

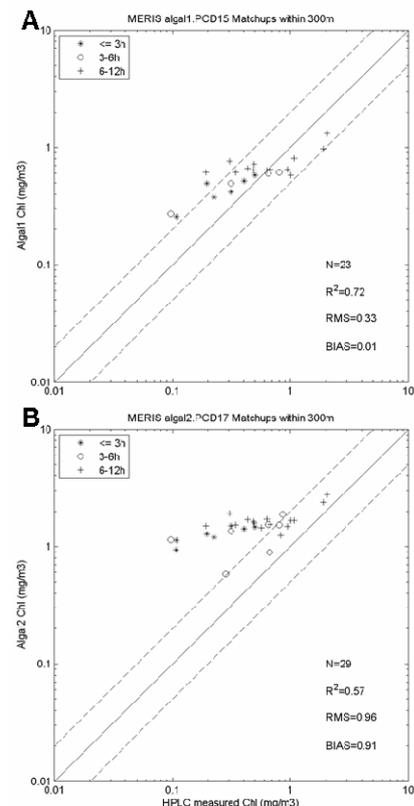


Figure 3 MERIS match-ups for 2005 using 300m and 12h windows: algal1 (A) and algal2 (B).

MERIS data were analyzed separately for 2005 (MEGS 7.0) and 2006/2007 (MEGS 7.4) as 2005 images were not available with MEGS 7.4 processing for this study.

For 2005 (Fig.3 A) Algal 1 product shows good agreement with the in situ data whilst Algal 2 product (Fig.3 B) has high BIAS and RMS. Adjustments were included in the MEGS 7.4 reprocessing and for the 2006/07 data a decrease in BIAS and RMS is verified (Fig.4 B). Algal 1 product, for the same stations, has higher correlation but worst BIAS and RMS (Fig.4 A).

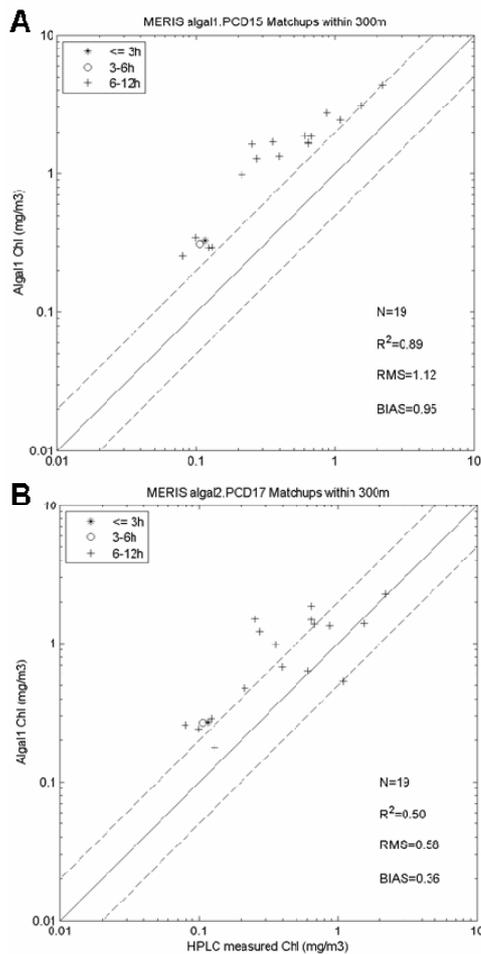


Figure 4 MERIS match-ups for 2006/07 using 300m and 12h windows: algal1 (A) and algal2 (B).

For the stations with both coincident MODIS and MERIS images (only 17) statistics parameters evidence similar performance for same time and space window (1km, 12h). Correlation coefficients of 0.87 were obtained for Algal 1 and 0.78 for OC3M, whereas BIAS was 0.02/ 0.03 and RMS 0.34/0.30, respectively.

In general, all algorithms overestimate in comparison to *in situ* HPLC Chl and this might be due to the fact that comparison is being made with surface *in situ* data and not integrated Chl values. Stramska & Stramki (2005) [2] concluded, using modeling exercises, that the contribution of a non-uniform vertical Chl profile is negligible when surface Chl content is greater than  $0.4 \text{ mg.m}^{-3}$ , at least for deep Chl maximum (DCM) between 20 and 45m, situation verified for the majority of stations. The statistics were then calculated for Chl values lower and higher than  $0.4 \text{ mg.m}^{-3}$  (Tab. 3). A 1km, 12h window was used, and the samples included in the analysis are shown in Fig. 5. For MODIS algorithm correlation decreased for  $\text{Chl} > 0.4 \text{ mg.m}^{-3}$  and RMS increased. Algal 1 product showed similar correlations for both Chl ranges but increased BIAS and RMS for higher Chl concentrations. The lower correlation was verified for Algal 2 product for  $\text{Chl} > 0.4 \text{ mg.m}^{-3}$ .

Table 3. Statistics parameters calculated for different Chl ranges.

Match-ups within 1km and 12h				
	N	$r^2$	RMS	BIAS
OC3m (alldata)	44	0.76	0.29	0.14
algal1 (0607 data)	22	0.89	1.06	0.89
algal2 (0607 data)	23	0.67	0.50	0.35
Chl < 0.4 mg.m/3				
OC3m (alldata)	25	0.73	0.17	0.16
algal1 (0607 data)	12	0.86	0.73	0.57
algal2 (0607 data)	13	0.90	0.33	0.28
Chl > 0.4 mg.m/3				
OC3m (alldata)	19	0.61	0.39	0.12
algal1 (0607 data)	10	0.90	1.36	1.27
algal2 (0607 data)	10	0.34	0.66	0.43

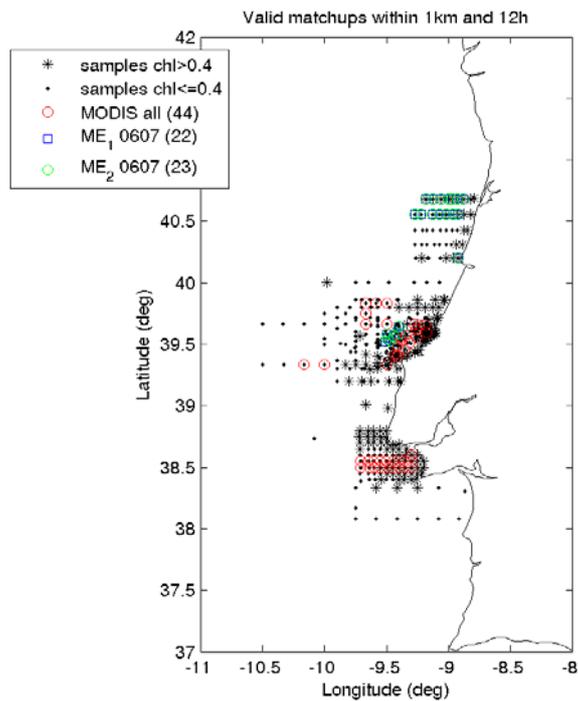


Figure 5. Stations with MODIS (in red) and MERIS algal1 (in blue) and algal2 (in green) valid match-up within 1km and 12h.

#### 4. CONSIDERATIONS AND PERSPECTIVES

The analysis of the present dataset enables only some preliminary conclusions to be drawn. For all products used, a general overestimation was registered; however, the comparison with

integrate values is needed before conclusive results can be put forward.

The statistical parameters gave similar results for OC3M and Algal 1 and the latter correlated better with *in situ* data than Algal 2, although with higher Bias and RMS. The Algal 2 product had low correlation ( $r^2=0.34$ ) with *in situ* Chl concentrations higher than  $0.4 \text{ mg.m}^{-3}$ . These results were obtained for a reduced number of match-ups and will be reevaluated as soon as the 2005 reprocessed MERIS data is available.

#### 5. ACKNOWLEDGEMENTS

The authors wish to thank Henko Stiegter and João Vitorino, for allowing us to participate in RV Pelagia and NRP D. Carlos I, respectively, Rafael Mendes for field and laboratory help and NASA for having MODIS data available through Ocean Color web site.

This study was performed in the framework of “ESA Project AOPT-2423”.

Carolina Sá receives a grant from FCT (Fundação para a Ciência e Tecnologia).

#### 6. REFERENCES

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