Comparing satellite data/images with in-situ data.

Case study:

The influence of Wind-Driven Circulation on the Biological Productivity along the Western Black Sea

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OBJECTIVES and IMPORTANCE

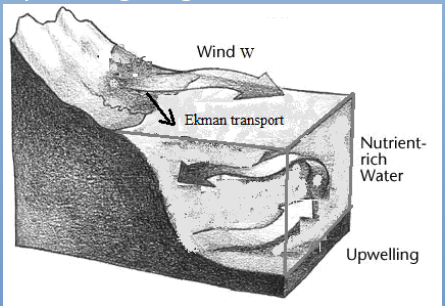
DATA AND METHODS

Frequency of occurrence in the Romanian Coast

Characteristics of the upwelling observed during 2010 - 2012

CONCLUSIONS

Upwelling diagram for NW coast of the Black Sea



Aim: study the general features of the coastal upwelling phenomena on the Romanian Black Sea waters, the extent of the event and the influence on the biological productivity

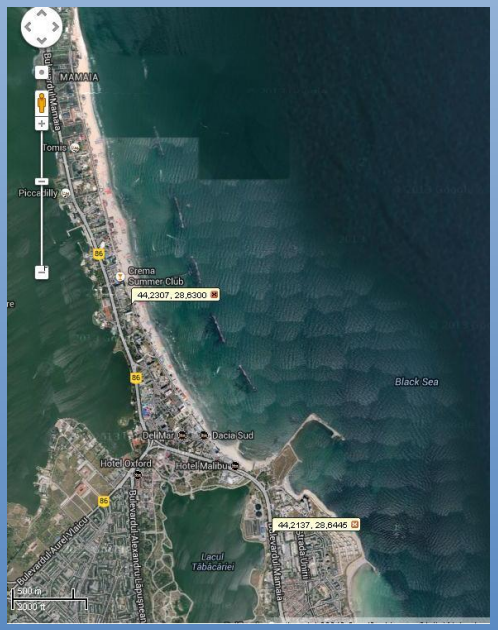
Data extracted from ocean colour images allows to examine ***the temporal and spatial variability of the sea surface layer*** (e.g., Chl-a is an index of phytoplankton biomass, so a time series of Chl-a concentrations can be used in modelling studies that require phytoplankton biomass as an entry variable, such as primary productivity models). In addition, ocean colour images can provide ***information about oceanographic surface structures at the mesoscale*** and ***allow tracking their space-time variations***.

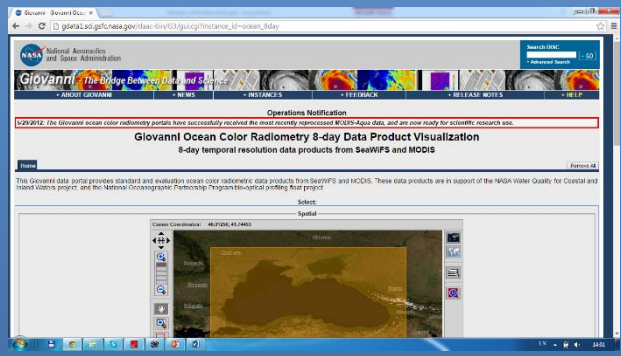
Importance of the upwelling:

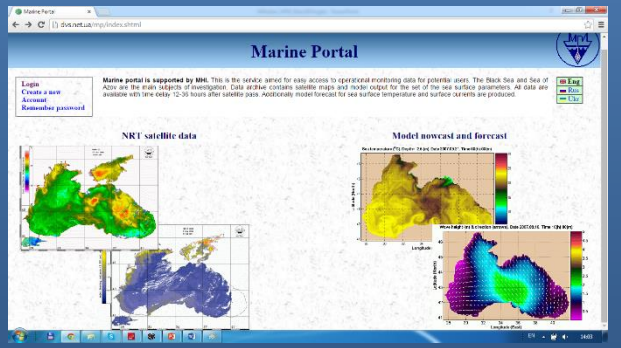
- In the near shore zone, the flow divergence produced by prolonged action of the winds with an offshore component results in an upwelling of the cold intermediate waters, leading to a considerable decrease of the temperature.
- the surface waters are characterized by high contents of nutrients which creates favorable conditions for the development of phyto- and zooplankton.
- In meteorology the convergent and divergent phenomena's are important due to their effects, on: difficulties in the SST prognosis, sea fog appearance near shore, as well as breeze intensification due to the strong horizontal thermal gradient.

DATA AND METHODS

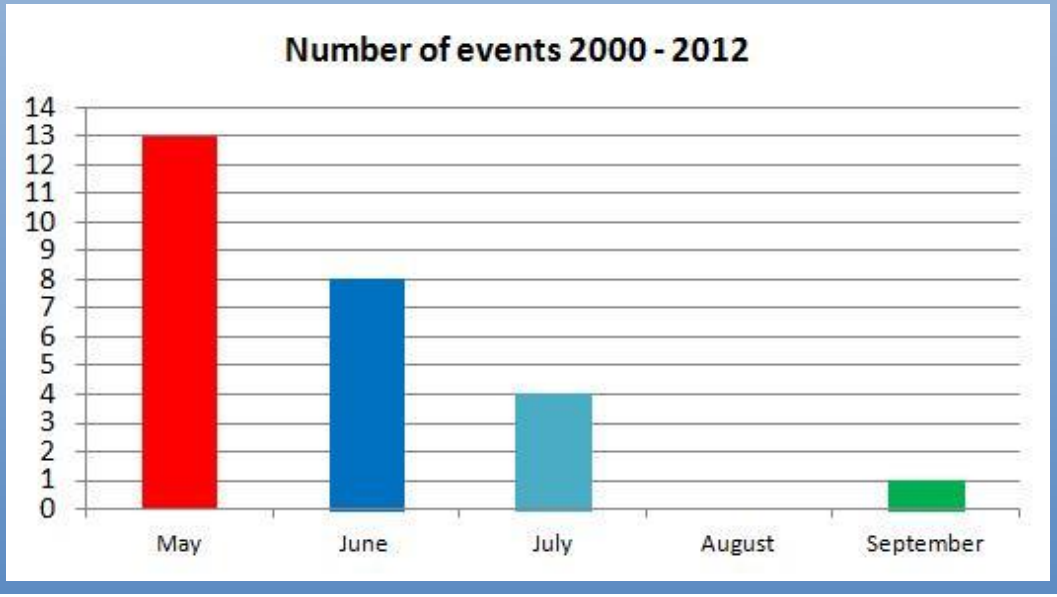
- The SST and SSS is used as a proxy for upwelling, low temperature and high salinity indicating strong upwelling conditions. The highest correlation is between sea surface temperature and the wind component normal to the coast, sea surface temperature is lowest when the wind blows from land to sea.
- Samples of marine water have been collected daily in one station located midway, at the Mamaia Casino (44°14’ N and 28°38’ E) since 1959 by NIMRD “Grigore Antipa” Constanta Romania.
- **TEMPERATURE** is measured with reversible thermometers, one hundred degree accuracy (the values are corrected using standard formula).
- The seawater **SALINITY** is determined in laboratory after the Mohr – Knudsen method with 0.02PSU accuracy.
- **Meteorological data** (on air temperature, wind speed and direction) from the meteorological portal NASA GIOVANNI (***http://daac.gsfc.nasa.gov/giovanni***/): for Constanta station (44°13’ N, 28°38’ E).
- For **chlorophyll *a*** measurements, variable volumes (0.5 – 2 l) of seawater were filtered through Whatman glass-fiber filters GF/F (nominal pore size 0.7 µm), immediately after sampling, concentrations being calculated using the SCORE - UNESCO equations (UNESCO, 1966)
- The analyzed data are for the summer period (May – September), 2010, and **algae bloom informations from the SeaWIFS and MODIS *satellite data*** *(**http://daac.gsfc.nasa.gov/giovanni**/) and images from Marine Hydrophysical Institute of Ukraine – Marine Portal* (***dvs.net.ru***) for the in-situ data validation.

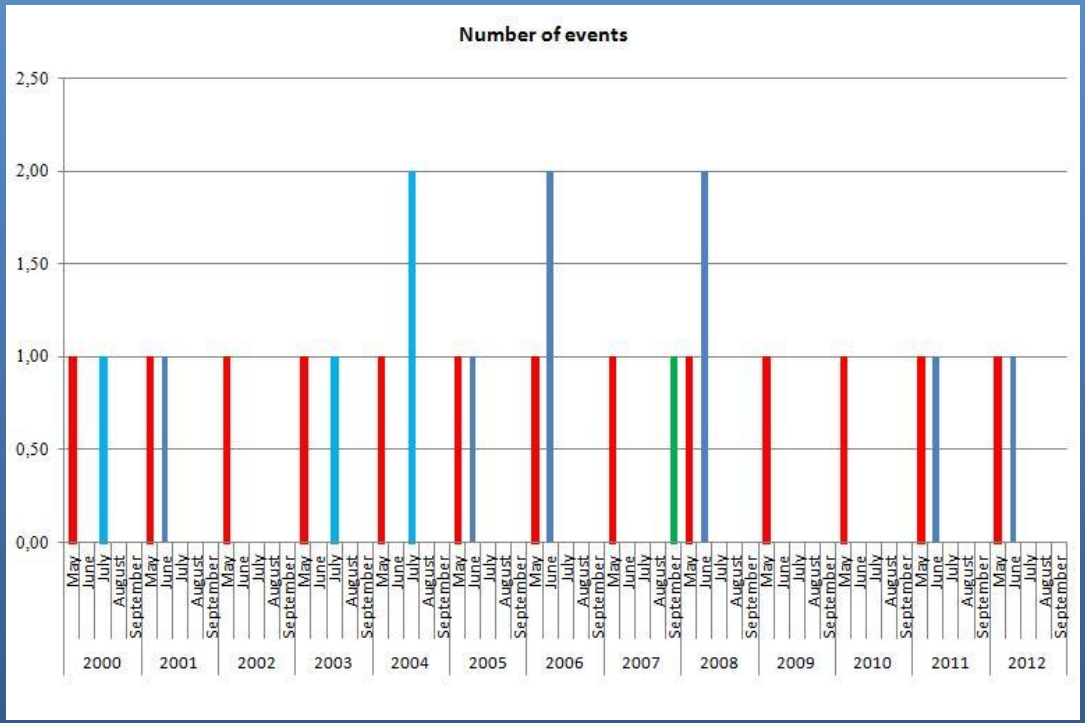




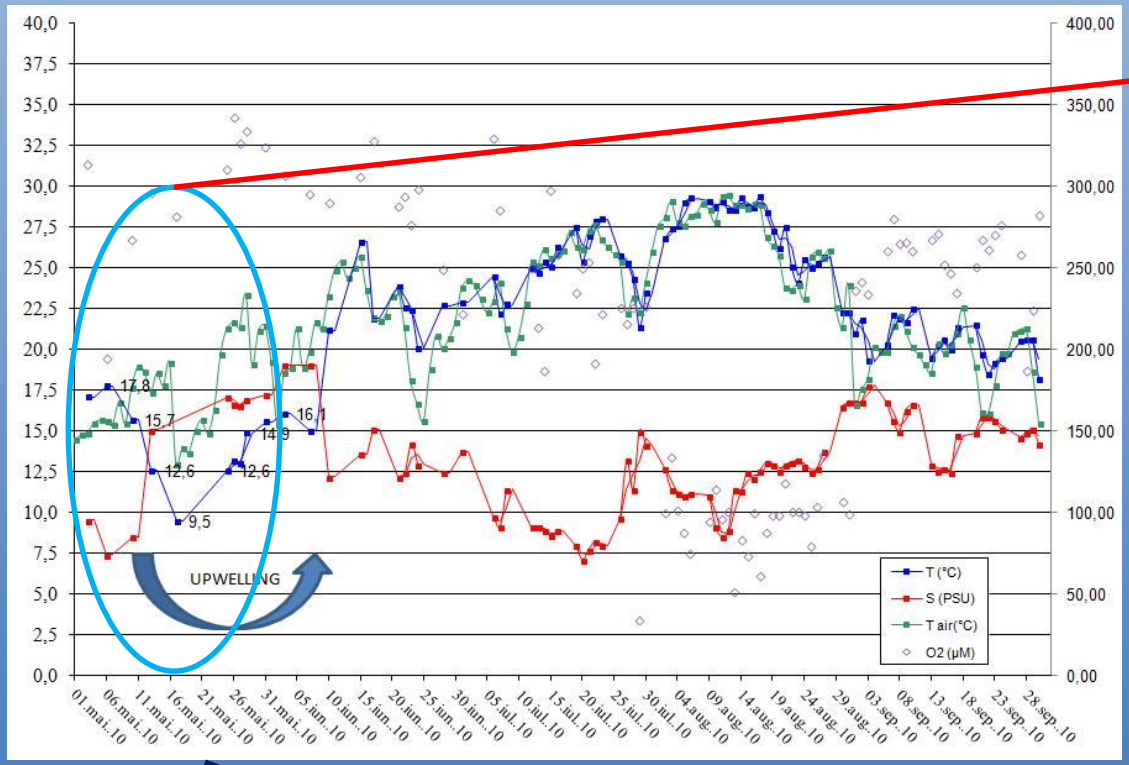


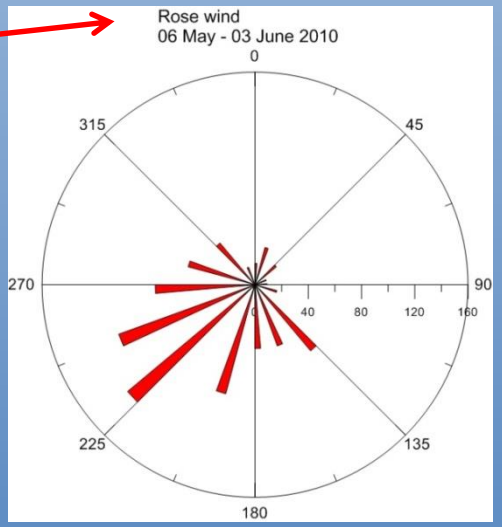
- During the summer of 1970 to 1979, on the southern Romanian littoral, the well-developed coastal upwelling was signalized for 7 from 10 studied years. The phenomena were recorded when the winds from the SSE – SW – WNW sectors were maintained constant more days. The maximum effect was made by the southwestern and western winds.
- A scientific study from 1990, shows that from a total of 33 days, almost 36% from duration of the summer season is dominated by the divergence process. During these 3 months, there was observed more of upwelling phenomena, with different intensity and continuance.

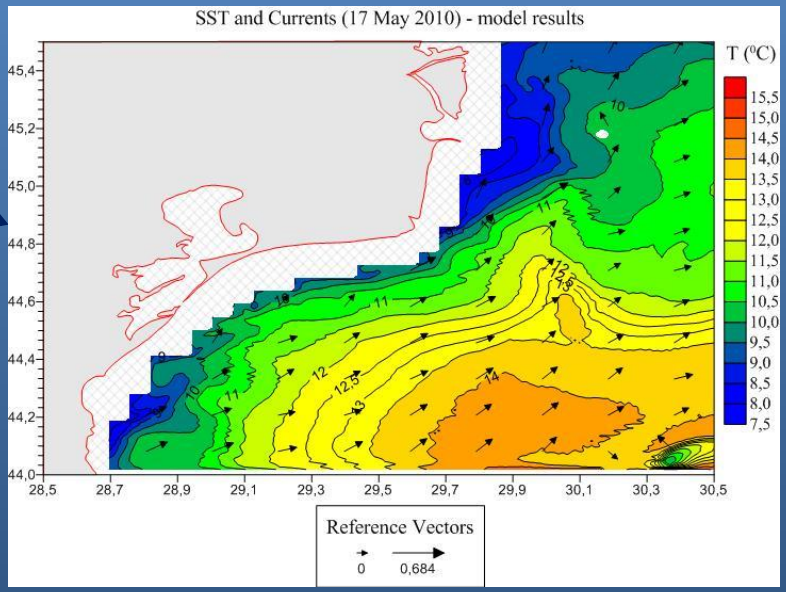




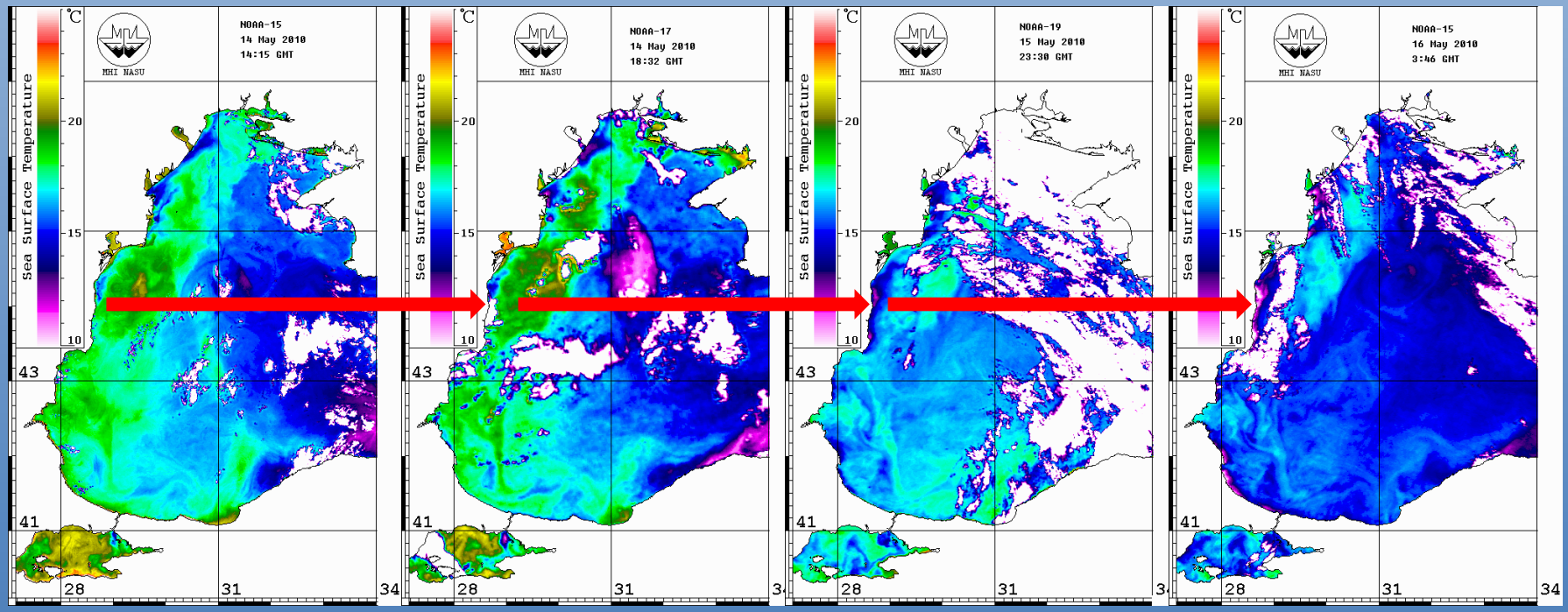
Period	Persistence	Twater (°C) min	Day/Month	Twater (°C) max	Day/Month	Wind direction
01.05-31.09.2010	> 10 days	9.5°C	17th May	17.8 °C 16.1 °C	06 May 03 June	SV
01.05-31.09.2011	> 10 days	12.4 °C	10 May	13.3 °C 18.5 °C	04 May 20 May	V
	> 10 days	15.0 °C	28 June	22.1 °C 20.4 °C	21 June 04 July	SE, S
01.05-31.09.2012	> 10 days	14.0 °C	08 May	15.2 °C 19.0 °C	07 May 15 May	V
	> 10 days	14.0 °C	14 June	18.5 °C 22.4 °C	01 June 18 June	SV

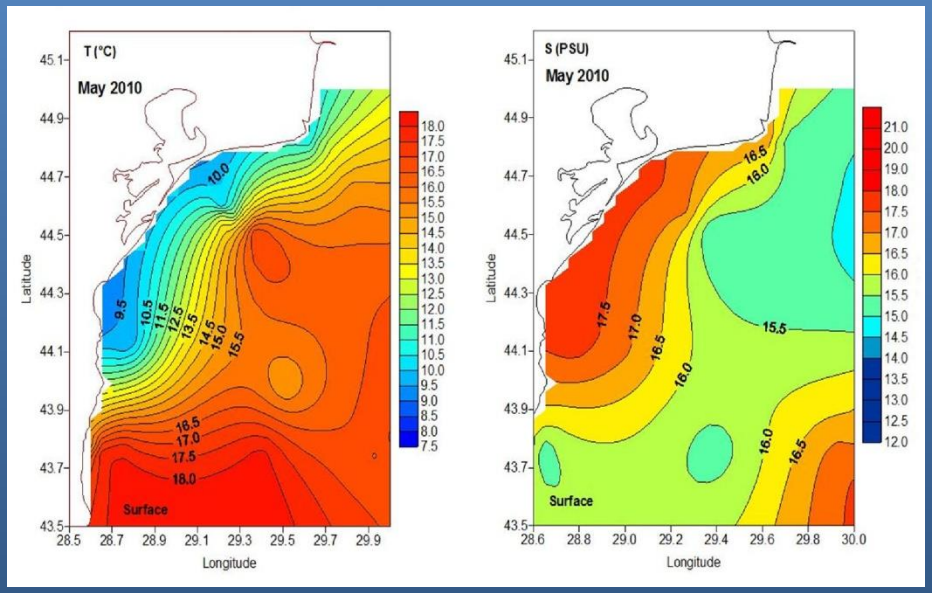

17,8
15,7
12,6
9,5
14,9
16,1
12,6
UPWELLING
T (°C)
S (PSU)
T air(°C)
O2 (µM)


Rose wind
06 May - 03 June 2010
0
45
90
135
180
225
270
315
40
80
120
160


SST and Currents (17 May 2010) - model results
T (°C)
Reference Vectors
0
0,684

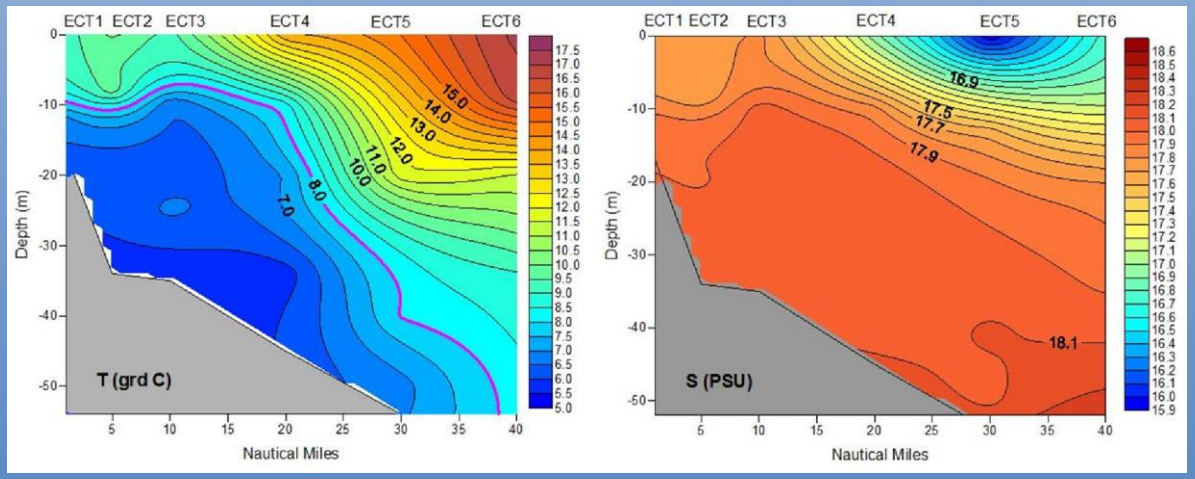
SST evolution– 14-20 May 2010





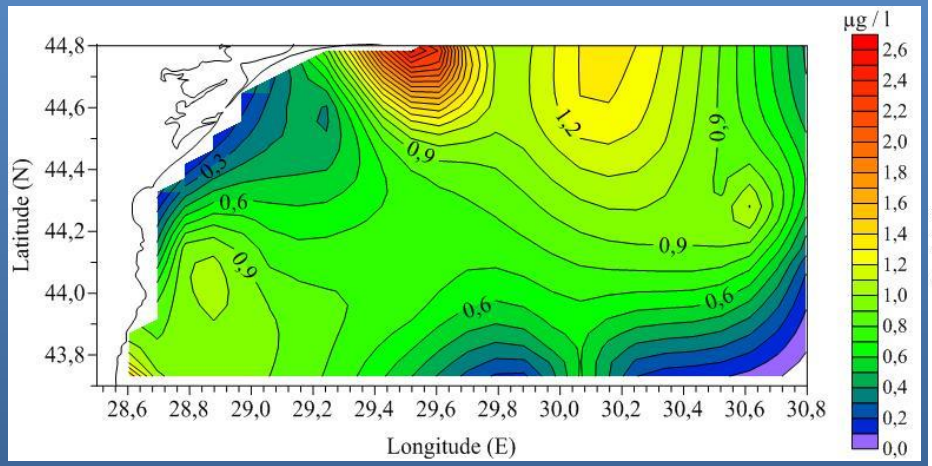
Twater and Salinity Data gathered during the cruise: 14 – 21 May 2010

What satellite data cannot do!

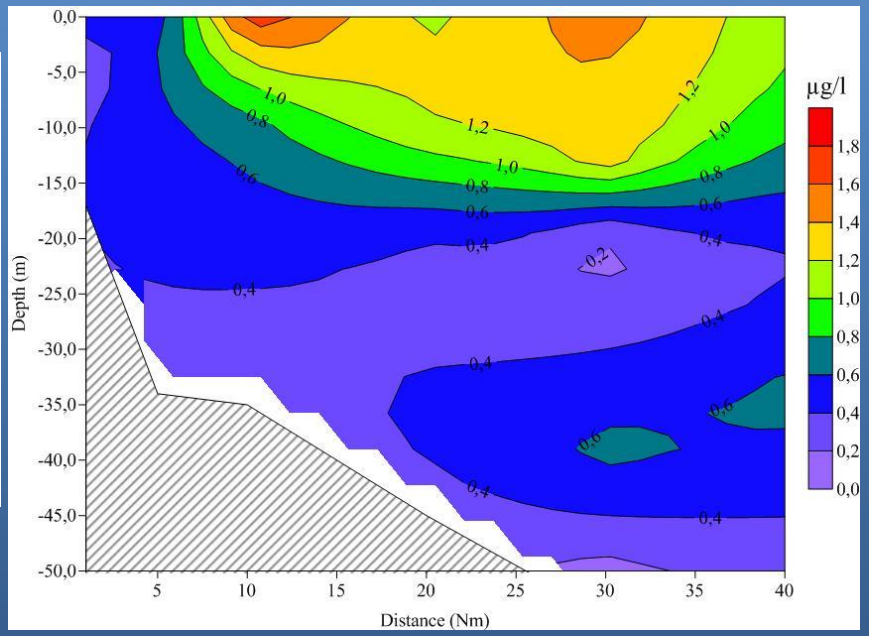


- The Shelf Cold Water, characterized by isotherm of 8ºC, is observed at the depth of 10 m.
- the upwelled waters - till 20 Nautical Miles at the surface.

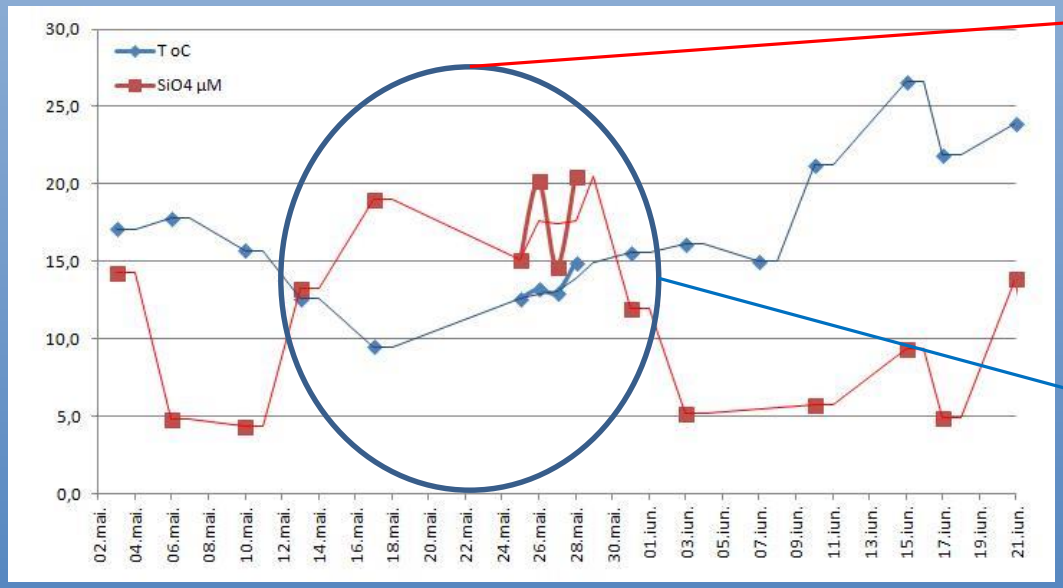
Data gathered during the cruise: 14 – 21 May 2010



Chl-*a*



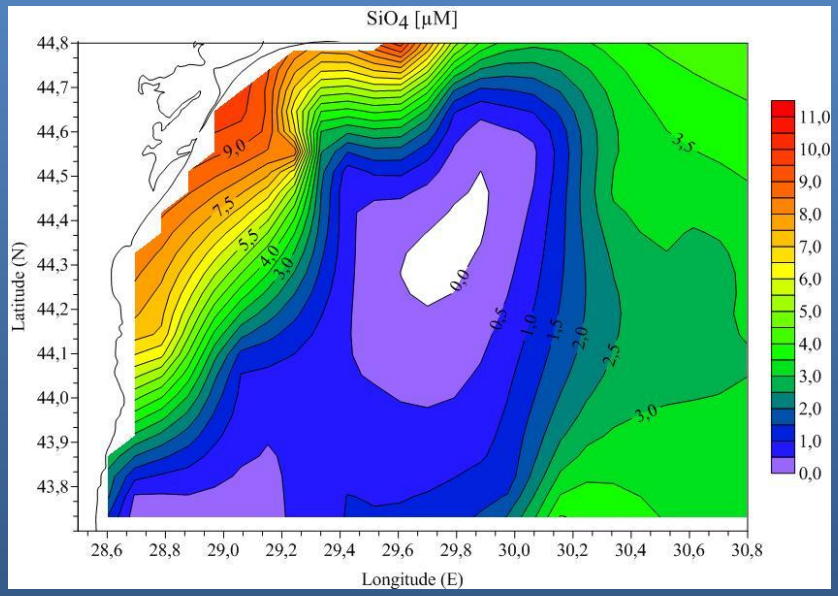
SiO4 and PO4 as indicators:

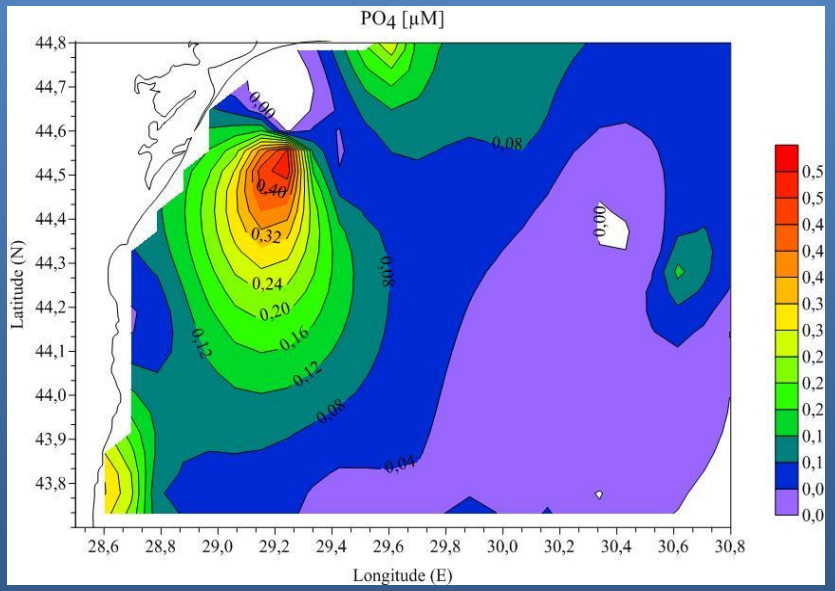


13 May:
T = 12.6 °C
SiO4 = 13.3 µM
PO4 = 0.05 µM

17 May:
T = 9.5 °C
SiO4 = 19.0 µM
PO4 = 0.02 µM

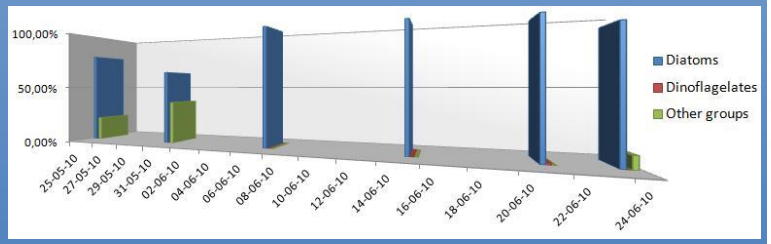
28 May:
T = 14.9 °C
SiO4 = 20.5 µM
PO4 = 0.12 µM

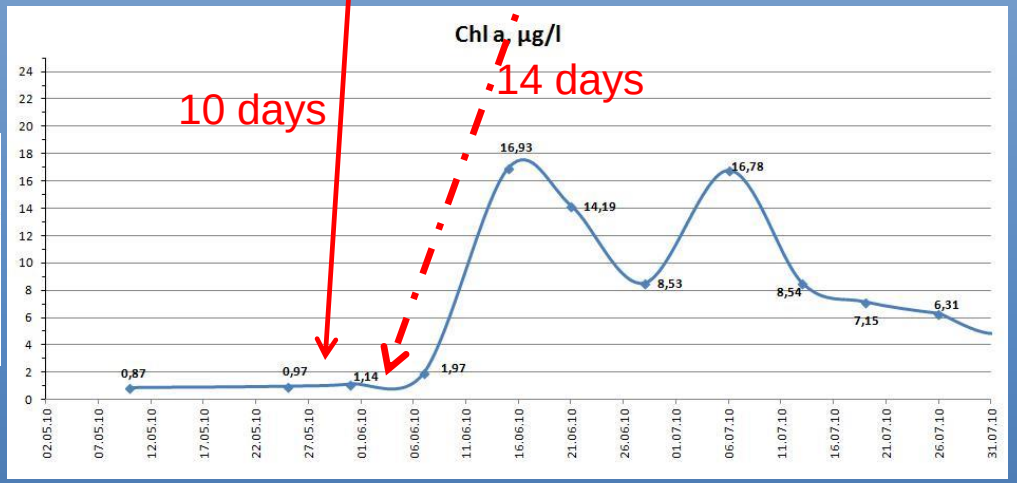




Biological productivity after the upwelling event:

	Max of density (cells/L)	May				Maximum
GROUP	**Taxa**	**17.05.2010**	**25.05.2010**	**27.05.2010**	**31.05.2010**	**Mai**
Chlorophyta	*Carteria* sp.	10000			550000	550000
Bacillariophyta	*Skeletonema costatum*		20000	120000		186000
Bacillariophyta	*Nitzschia tenuirostris*				10000	390000



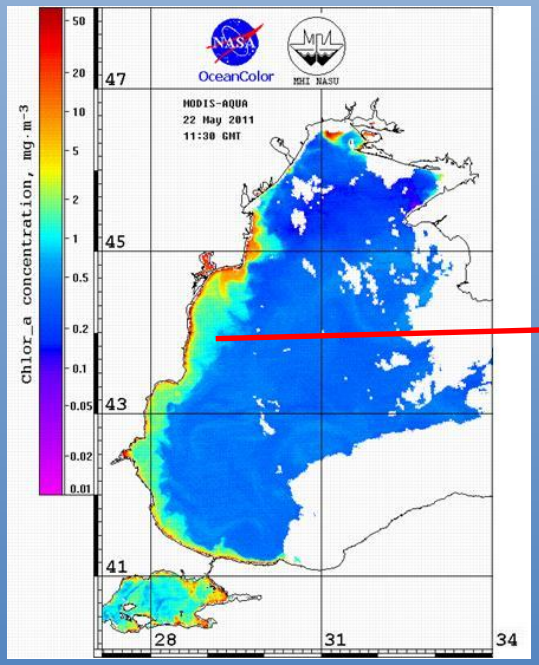


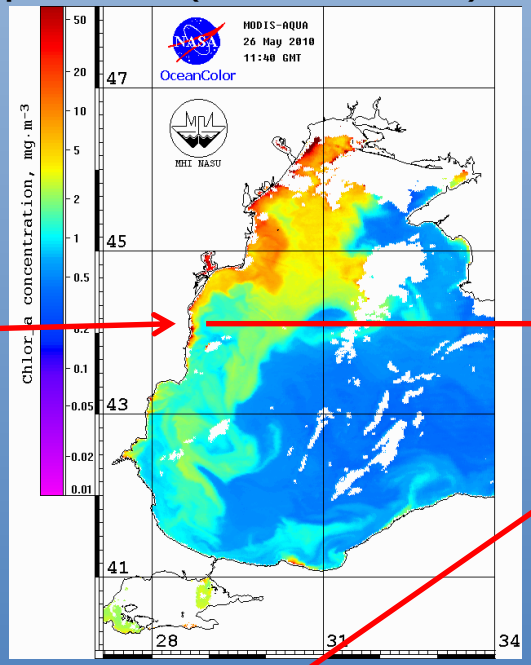
	Max of density (cells/L)	June								Maximum
GROUP	**Taxa**	**03.06.2010**	**07.06.2010**	**08.06.2010**	**10.06.2010**	**15.06.2010**	**17.06.2010**	**21.06.2010**	**24.06.2010**	**June**
Bacillariophyta	*Cerataulina pelagica*				5400000	3680000	1380000			5400000
Cryptophyta	*Cryptomonas* sp.			1760000		20000				1760000
Chlorophyta	*Carteria* sp.		10000		30000	1630000		10000		1630000
Bacillariophyta	*Cyclotella caspia*	10000			1480000	650000	30000	110000		1480000
Bacillariophyta	*Navicula* sp.	1110000	60000	20000				20000	30000	1110000
Bacillariophyta	*Nitzschia delicatissima*	80000	20000	20000	830000	210000	60000			830000
Bacillariophyta	*Chaetoceros curvisetus*	110000			560000	410000	40000			560000
Bacillariophyta	*Chaetoceros socialis*		20000	60000	310000	180000	30000	70000		310000

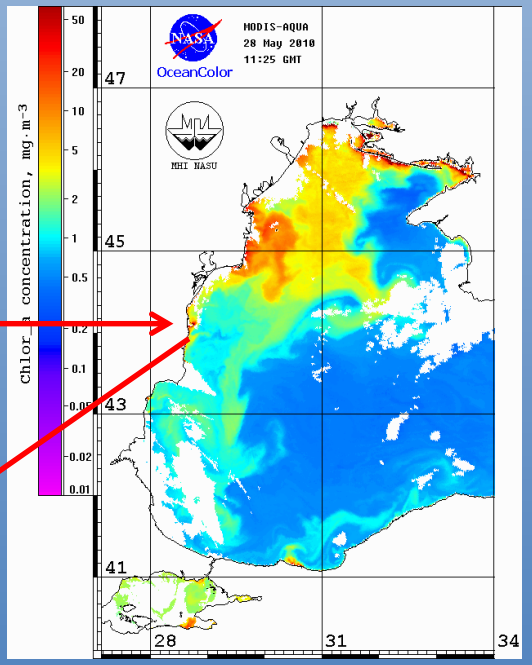
Challenges

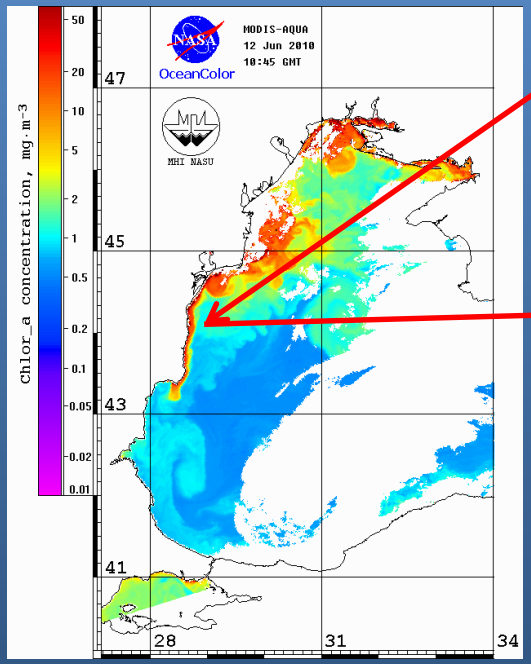
- One of the main challenges in using ocean-colour imagery is to determine the degree of correlation between the in situ measurements and the satellite-derived data.
- NASA uses the 'match-up' technique, which is based on a hypothetical linear relationship between satellite Chl-a concentrations and the in situ values obtained from water samples (ocean). For most data, a 70% correlation (or 30% error) is considered a good fit (Gregg and Casey, 2004; Djavidnia et al., 2006).
- It is also important to consider the data scales e.g., in situ measurements are generally based on ~1 liter of sea water, while remotely-sensed estimations are obtained from an area of ~1 km^2 . It is difficult to obtain an ideal match-up in space and time. Ideally, in situ measurements should be collected at the same time as the radiometric measurements required to validate ocean-colour algorithms.

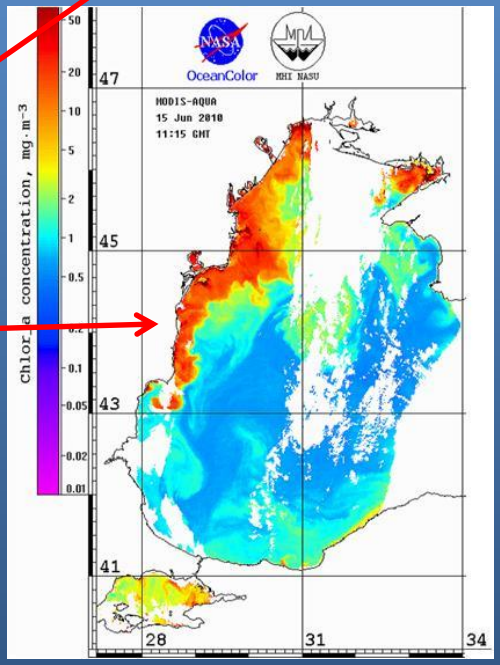
Extent of chorophill – *a* (satellite data):



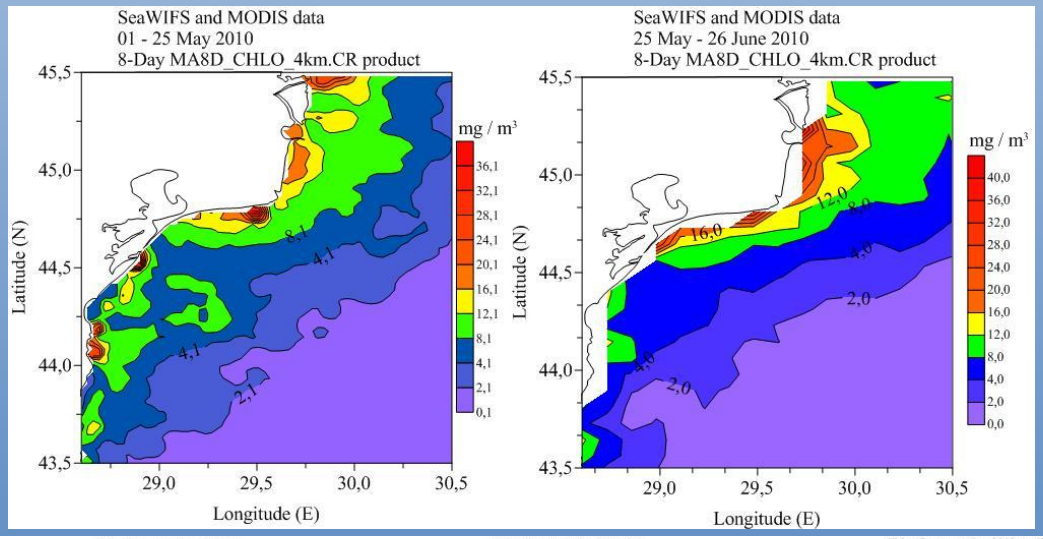




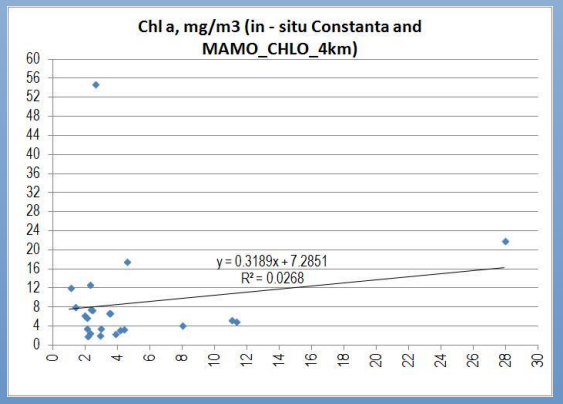




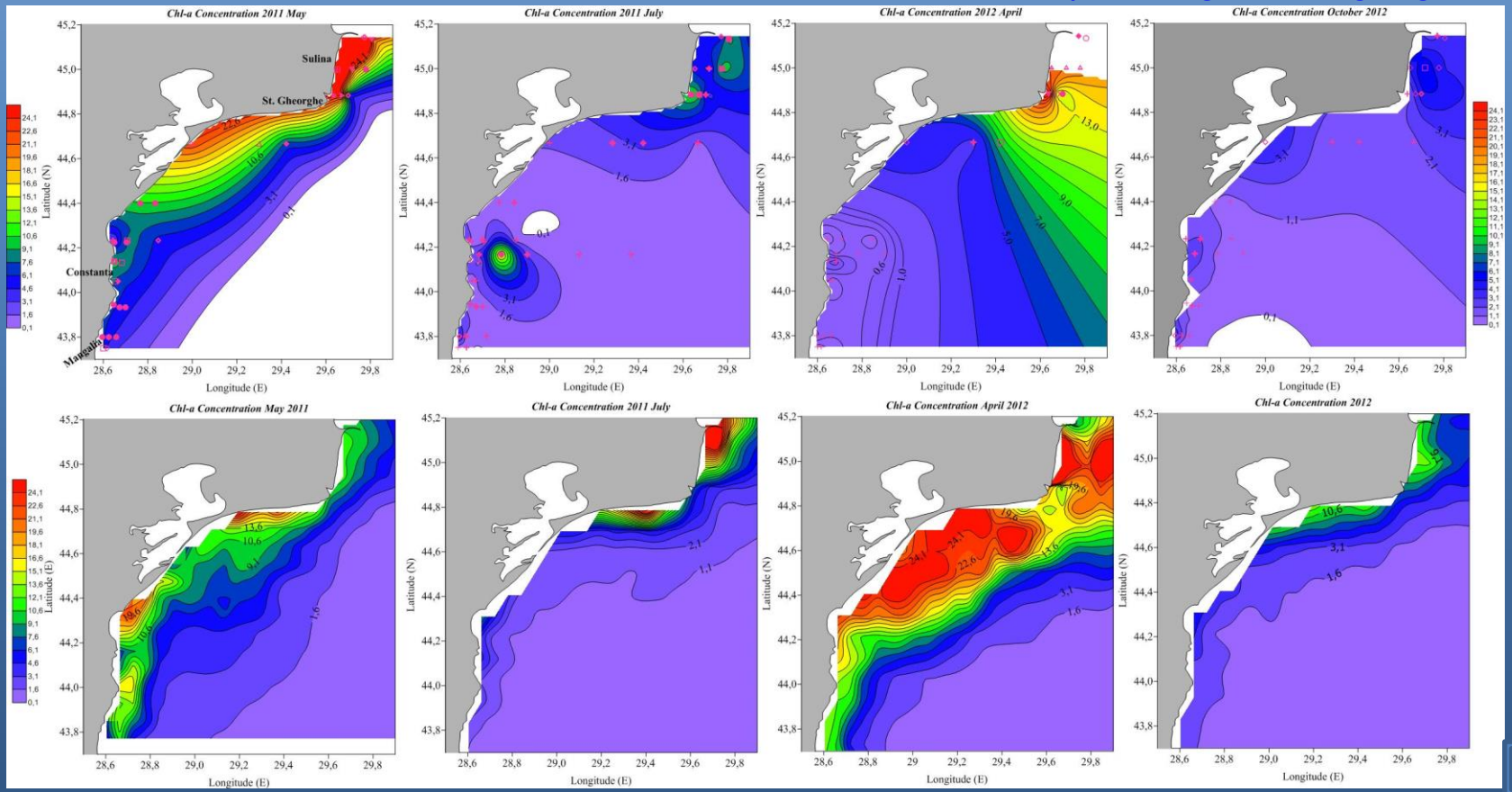
Source:
dvs.net.ru



01.2010 – 12.2012



http://daac.gsfc.nasa.gov/giovanni/



MONITORING SATELLITE

CONCLUSIONS

1. *The in situ and remote sensor measurements* evaluate processes on different space/time scales. Satellite remote sensing allows the study of processes >10 km horizontal scale, encompassing several decades, while in situ measurements study processes over much smaller time and space scales (cm to meters, minutes to days).

- no good correlation were found between the satellite data retrieved from NASA Giovanni
- good correlation of the chl-a extent at horizontal scale from data gathered during NIMRD cruises and the satellite image retrieved from MHI Ukraine

2. *The upwelling phenomena*

- the frequency of the coastal upwelling characterized by the low temperature and high salinity is less then *3 events / year.*
-in shallow waters is observed mainly in MAY, characterized by a decrease of the temperature by ~5-6°C in several days.
- on the Romanian Black Sea Coast the event were recorded when the southern, southwestern winds or moderate to strong western winds maintained constant several days.
- the Silica and phosphorus can be used as indicators of upwelling events and also as indicator for the diatoms bloom.

Thank you for your attention!