Аномальные цветения фитопланктона в Черном море

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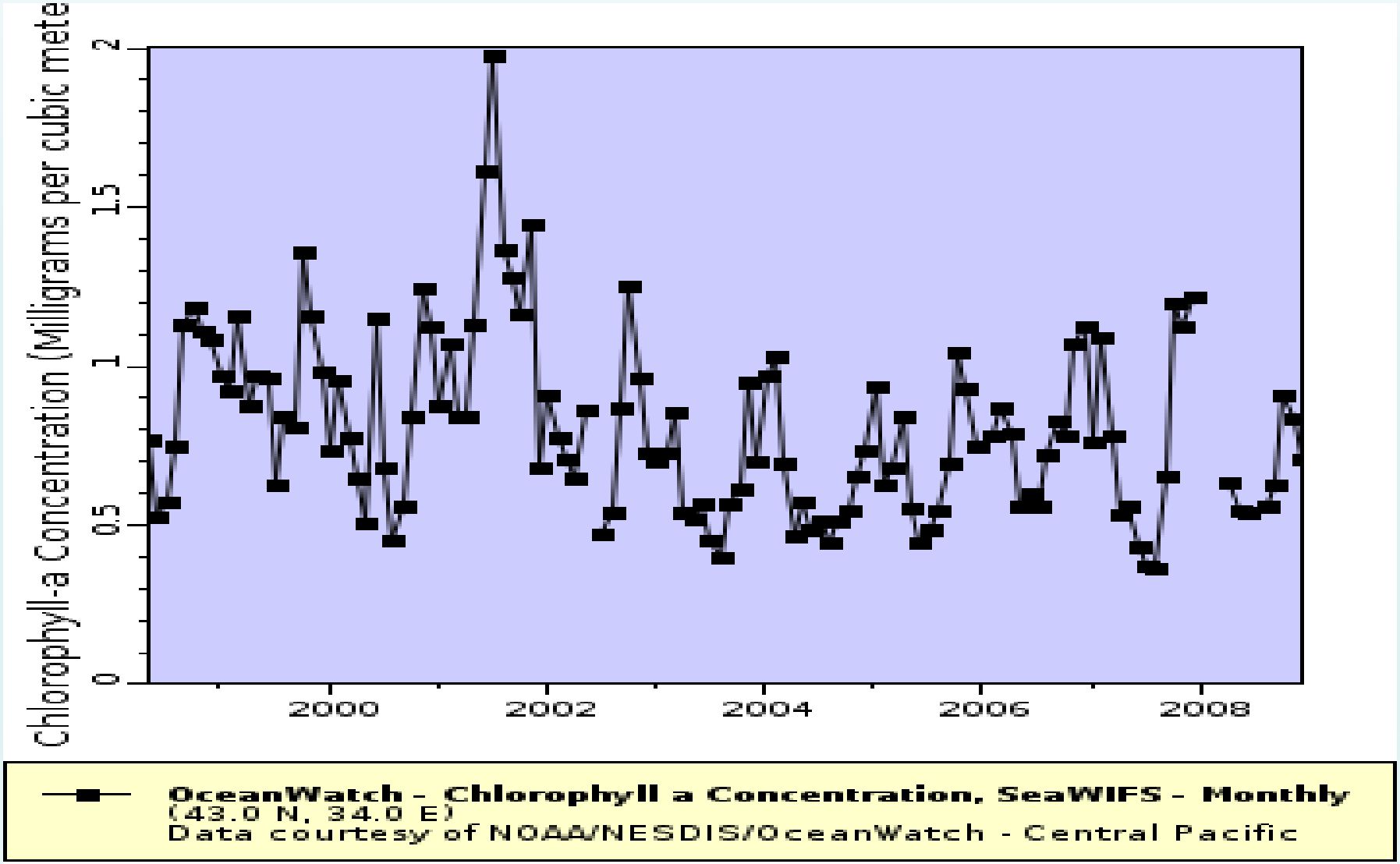
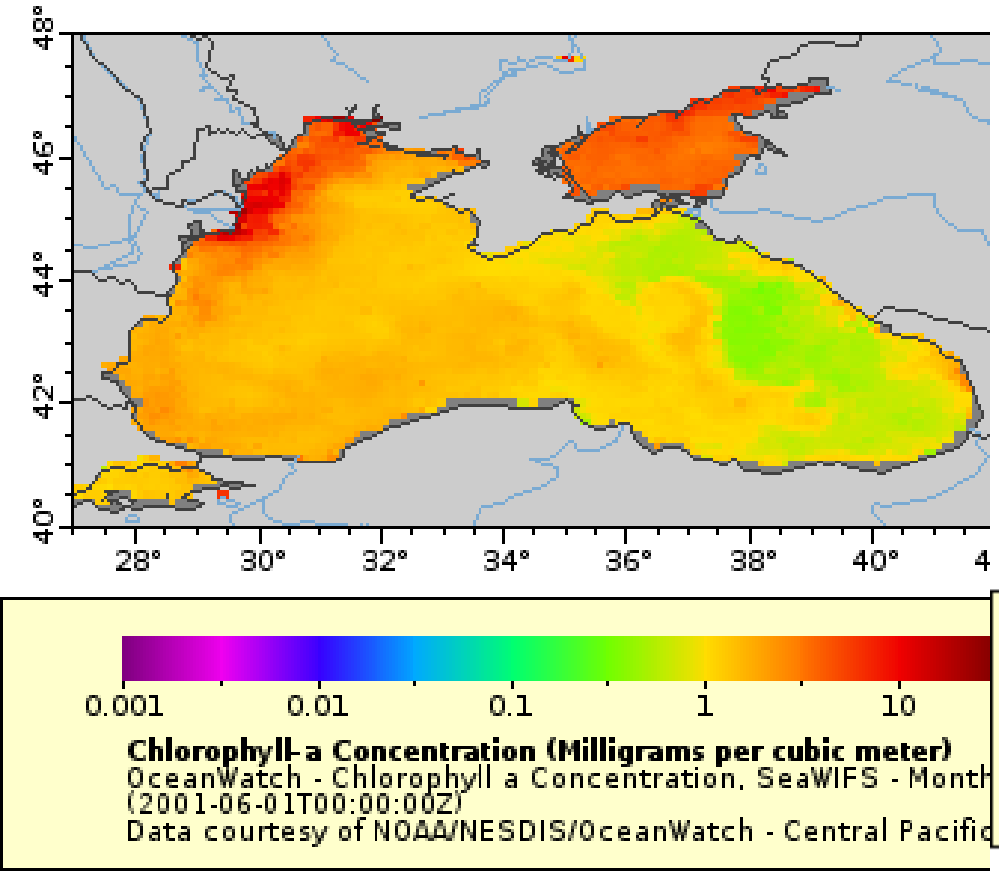
Морской гидрофизический институт РАН

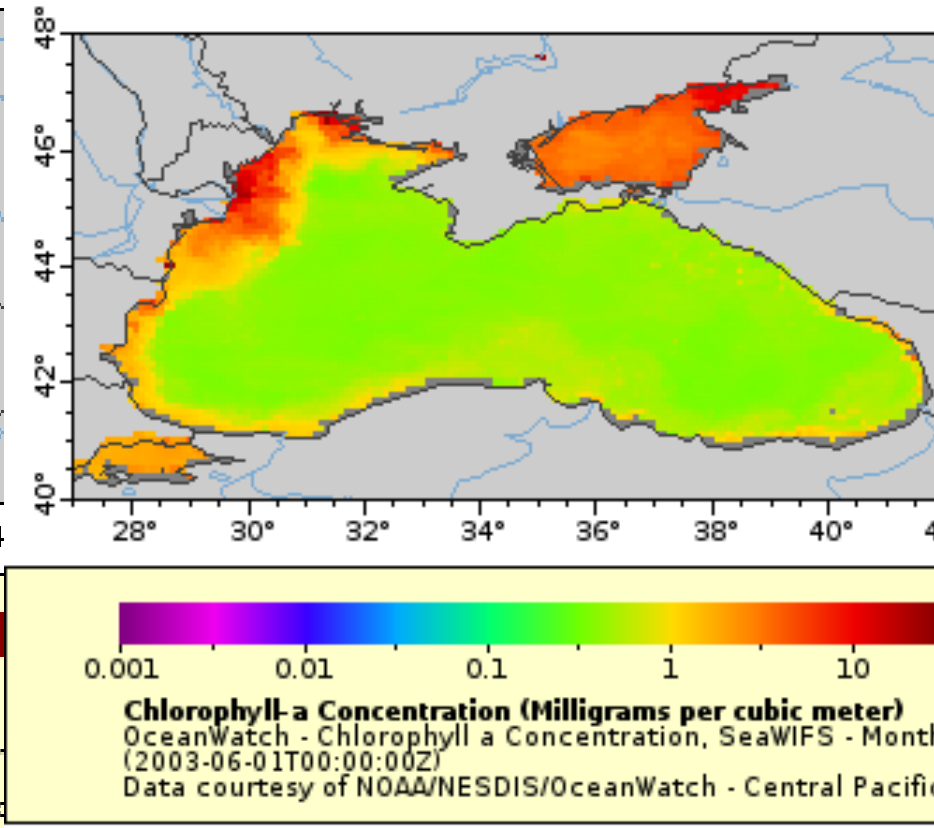
2017

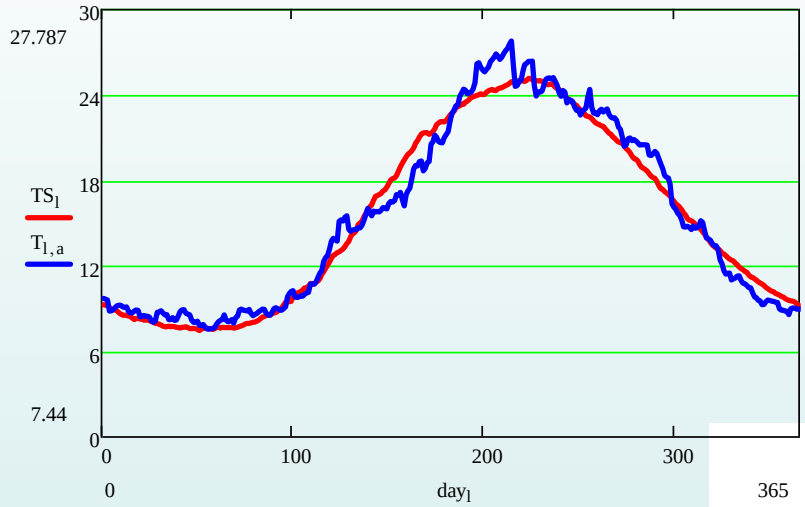
- Что такое цветение фитопланктона?
  Фиксируемое в оптическом диапазоне изменение оптических свойств?
- Что мы видим на спутниковых изображениях?
- Адвекция? Перемешивание?

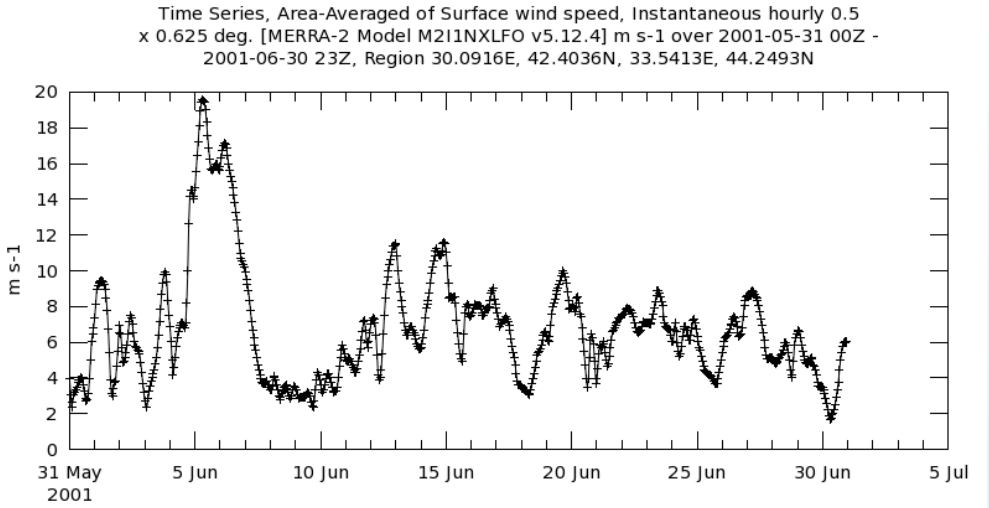

Chlorophyll-a Concentration (Milligrams per cubic mete
0
0.5
1
1.5
2
2000
2002
2004
2006
2008
OceanWatch - Chlorophyll a Concentration, SeaWIFS - Monthly
(43.0 N, 34.0 E)
Data courtesy of NOAA/NESDIS/OceanWatch - Central Pacific

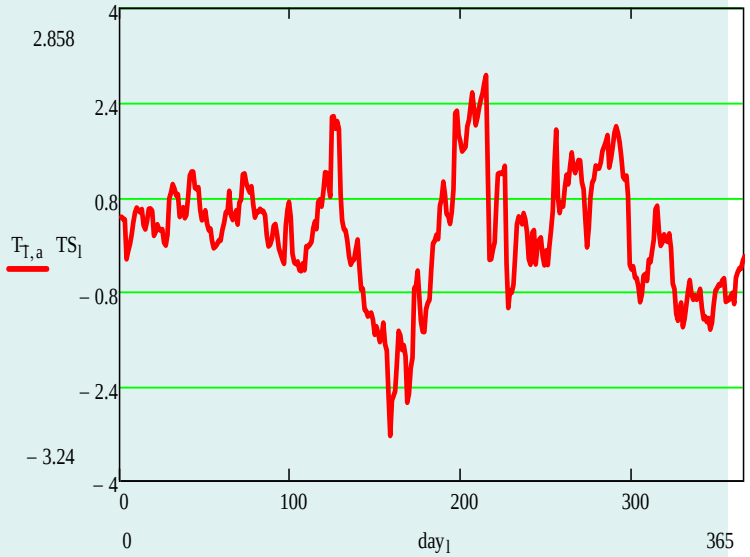
Июнь 2001

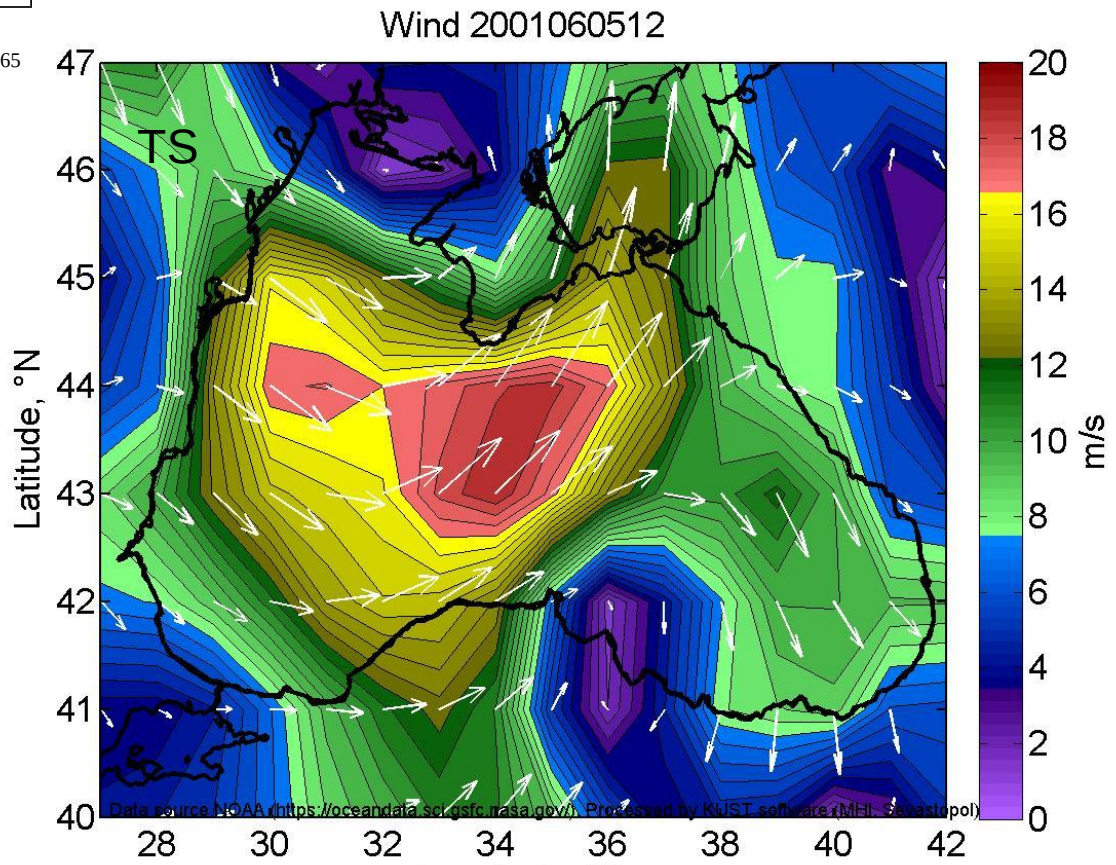

48°
46°
44°
42°
40°
28°
30°
32°
34°
36°
38°
40°
0.001
0.01
0.1
1
10
Chlorophyll-a Concentration (Milligrams per cubic meter)
OceanWatch - Chlorophyll a Concentration, SeaWIFS - Month
(2001-06-01T00:00:00Z)
Data courtesy of NOAA/NESDIS/OceanWatch - Central Pacific

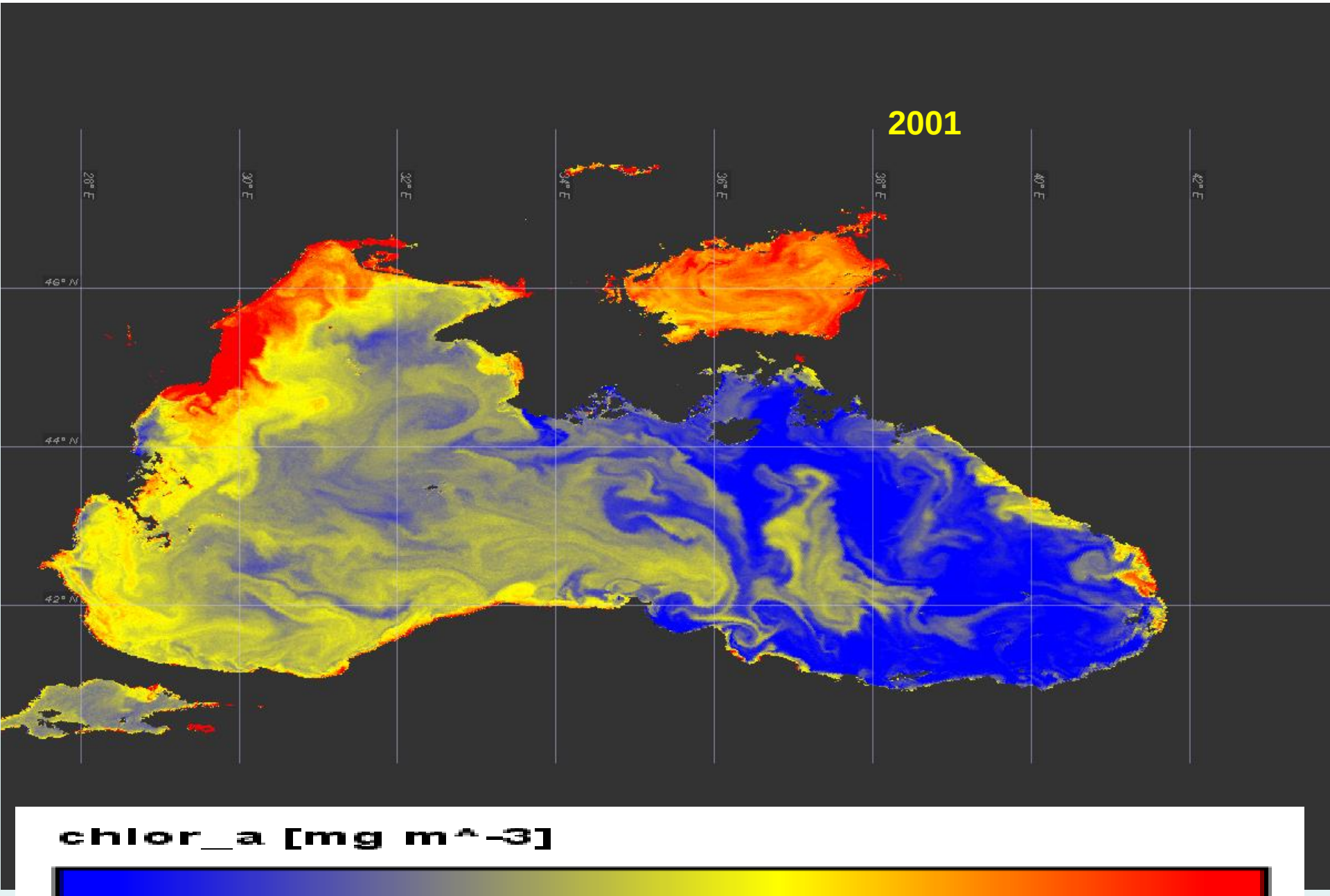

48°
46°
44°
42°
40°
28°
30°
32°
34°
36°
38°
40°
0.001
0.01
0.1
1
10
Chlorophyll-a Concentration (Milligrams per cubic meter)
OceanWatch - Chlorophyll a Concentration, SeaWIFS - Month
(2003-06-01T00:00:00Z)
Data courtesy of NOAA/NESDIS/OceanWatch - Central Pacific

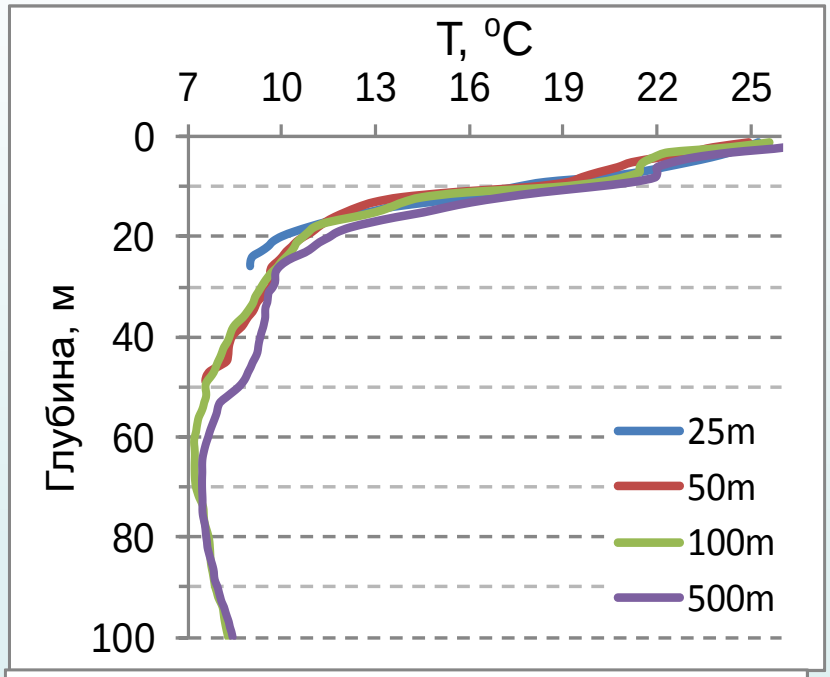

30
27.787
24
18
TS_l
T_l,a
12
6
7.44
0
0
100
200
300
0
day_l
365

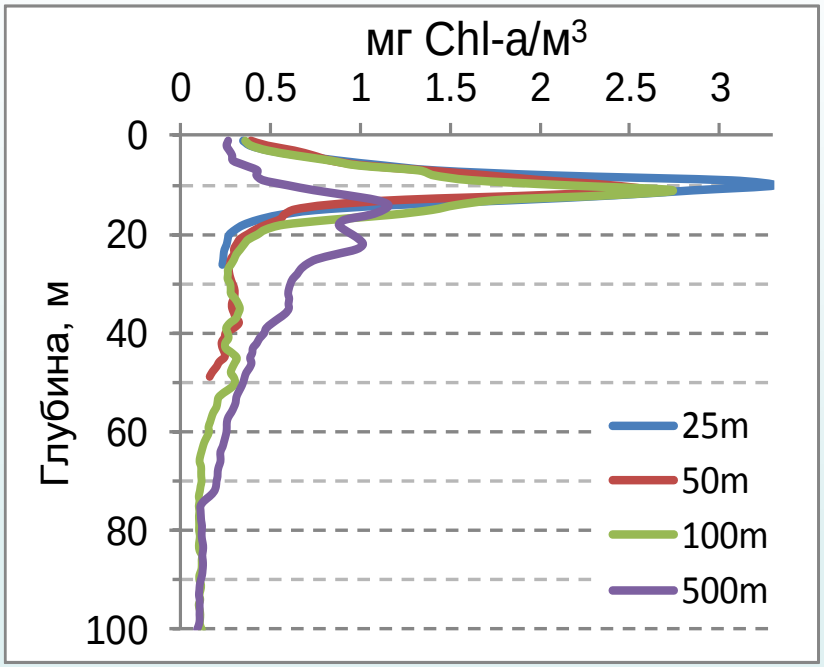

Time Series, Area-Averaged of Surface wind speed, Instantaneous hourly 0.5 x 0.625 deg. [MERRA-2 Model M2I1NXLFO v5.12.4] m s-1 over 2001-05-31 00Z - 2001-06-30 23Z, Region 30.0916E, 42.4036N, 33.5413E, 44.2493N
m s-1
20
18
16
14
12
10
8
6
4
2
0
31 May 2001
5 Jun
10 Jun
15 Jun
20 Jun
25 Jun
30 Jun
5 Jul

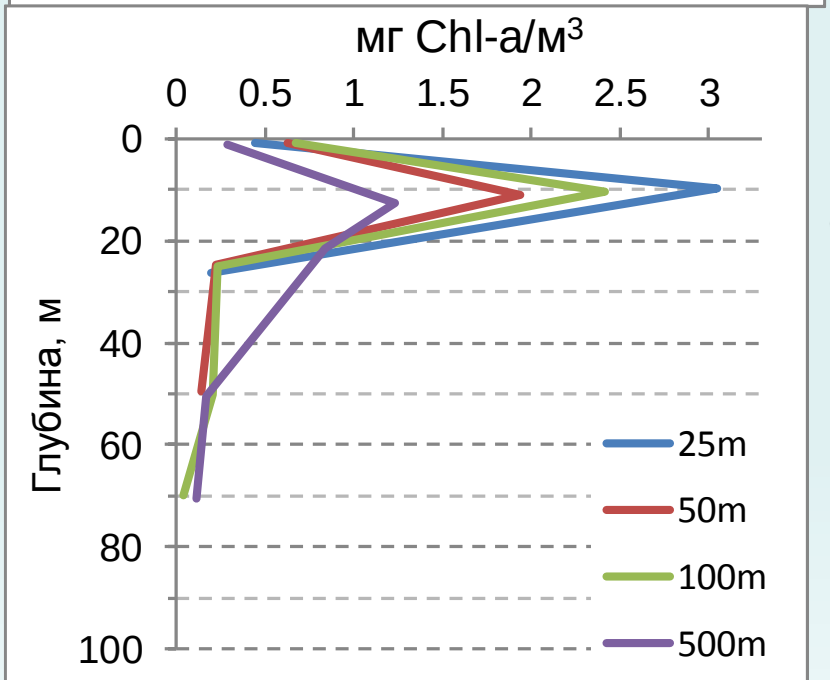

4
2.858
2.4
0.8
T_T,a
TS_l
– 0.8
– 2.4
– 3.24
– 4
0
100
200
300
0
day_l
365


Wind 2001060512
TS
Latitude, °N
47
46
45
44
43
42
41
40
28
30
32
34
36
38
40
42
20
18
16
14
12
10
8
6
4
2
0
m/s
Data source NOAA (https://oceandata.sci.gsfc.nasa.gov). Processed by KUST software (MIII, Sevastopol)


2001
28° E
30° E
32° E
34° E
36° E
38° E
40° E
42° E
46° N
44° N
42° N
chlor_a [mg m^-3]
0.66
2.69
6.65

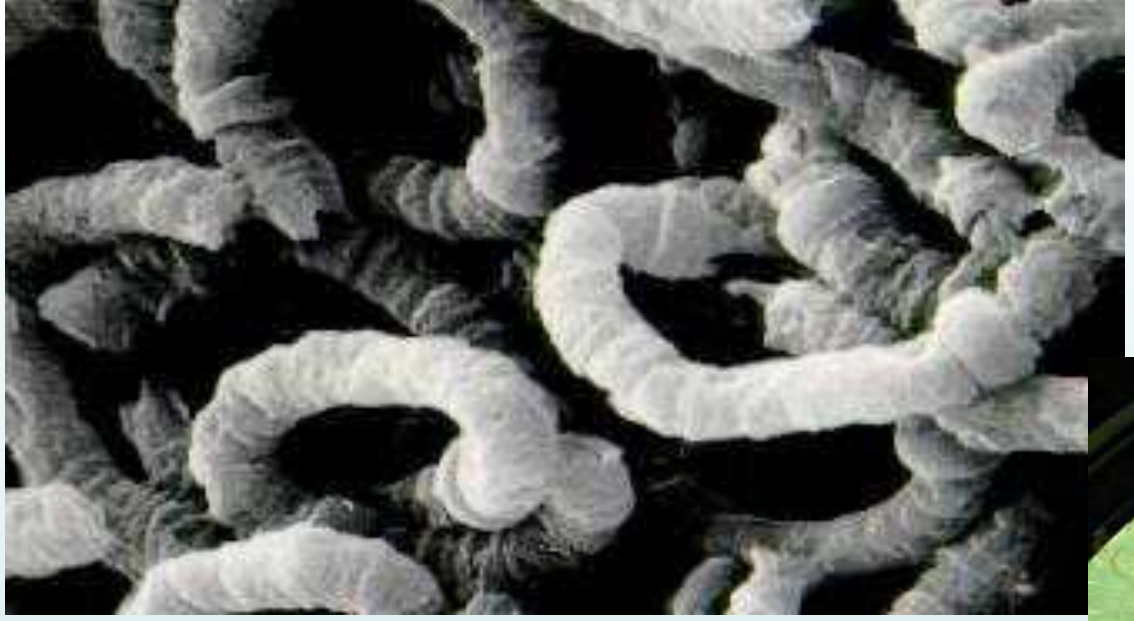






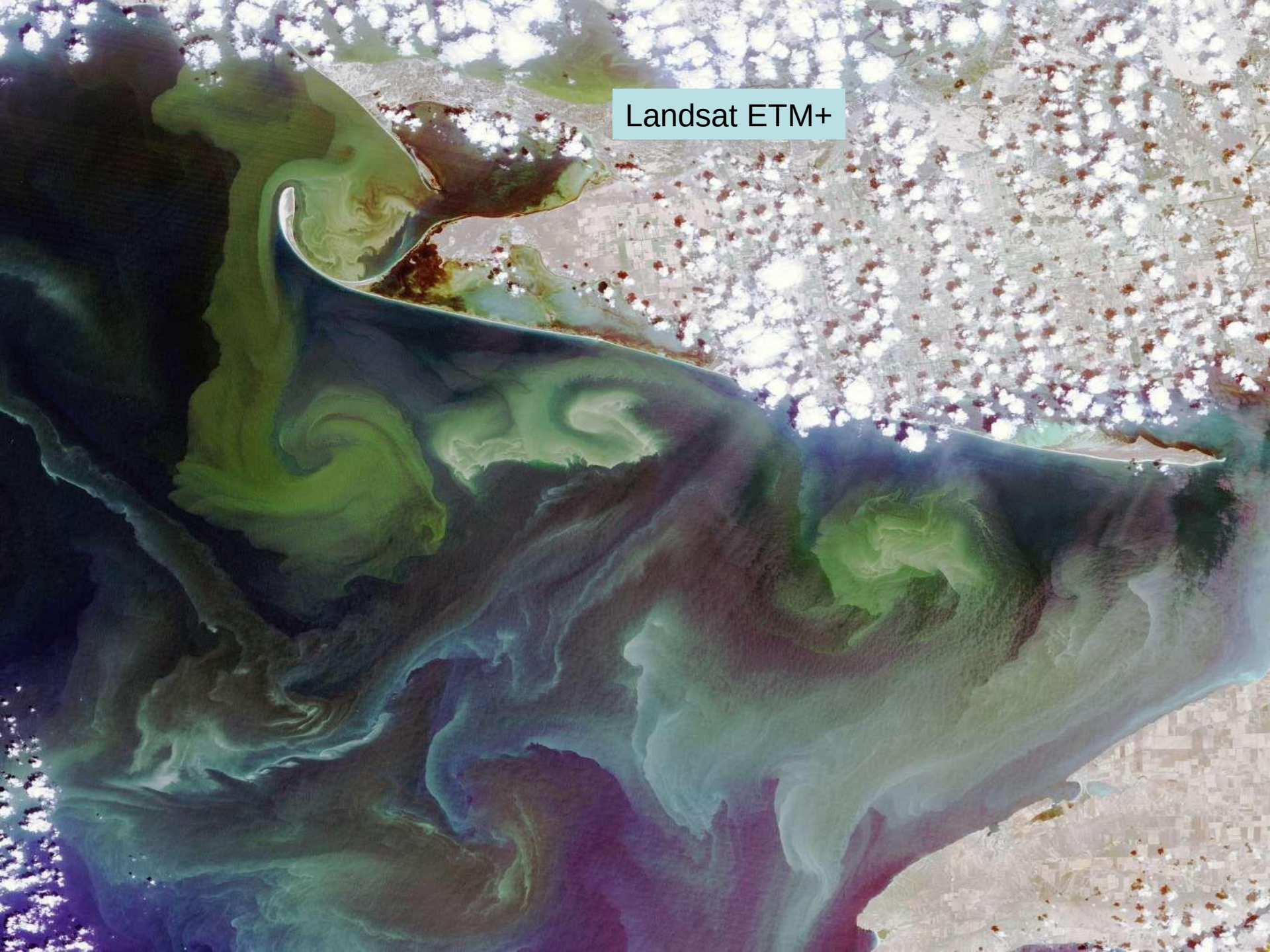
Вертикальные распределения температуры, Флюоресценции и концентрации Хл_а

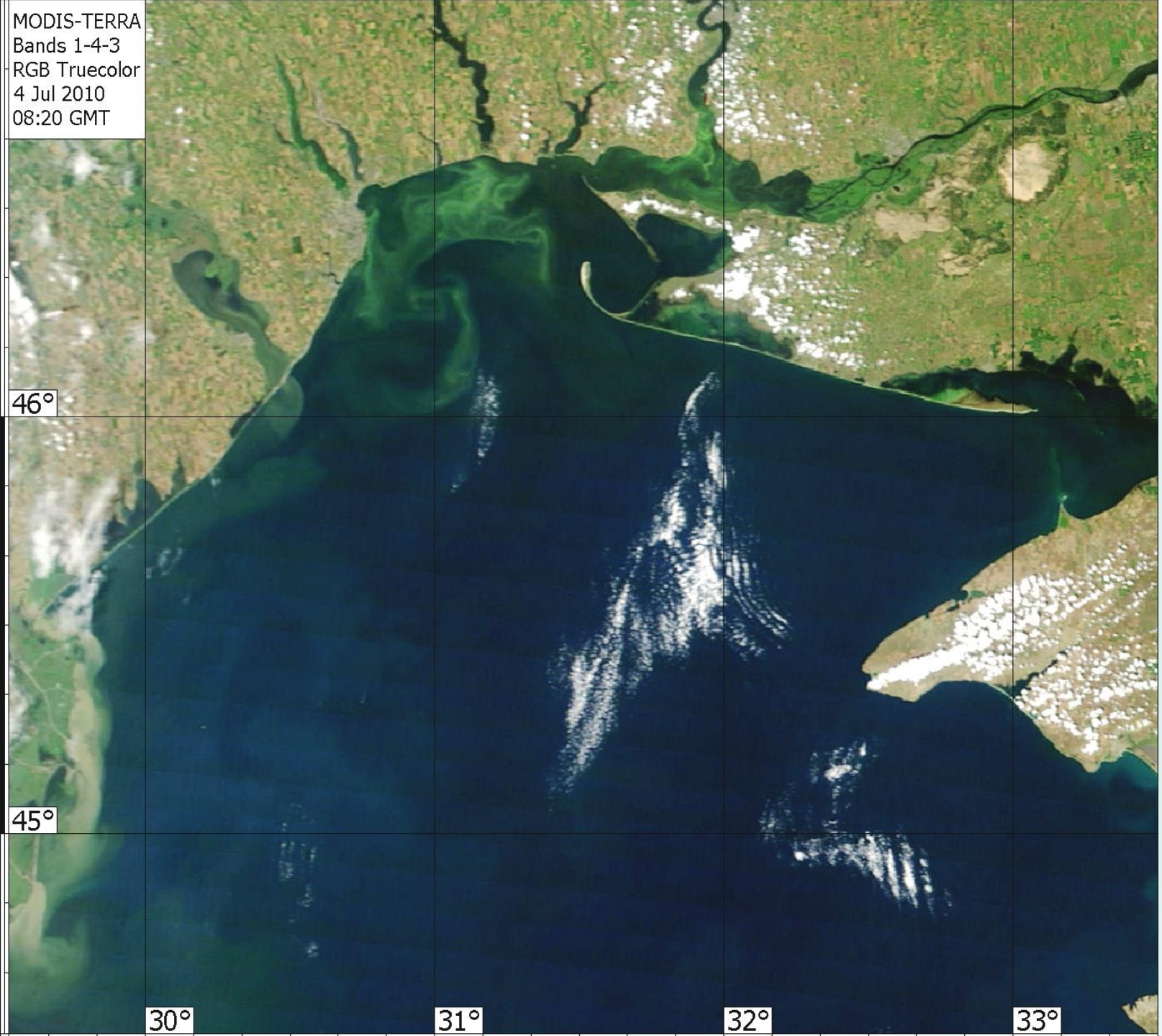
Спасибо АЛЁНЕ АРАШКЕВИЧ!

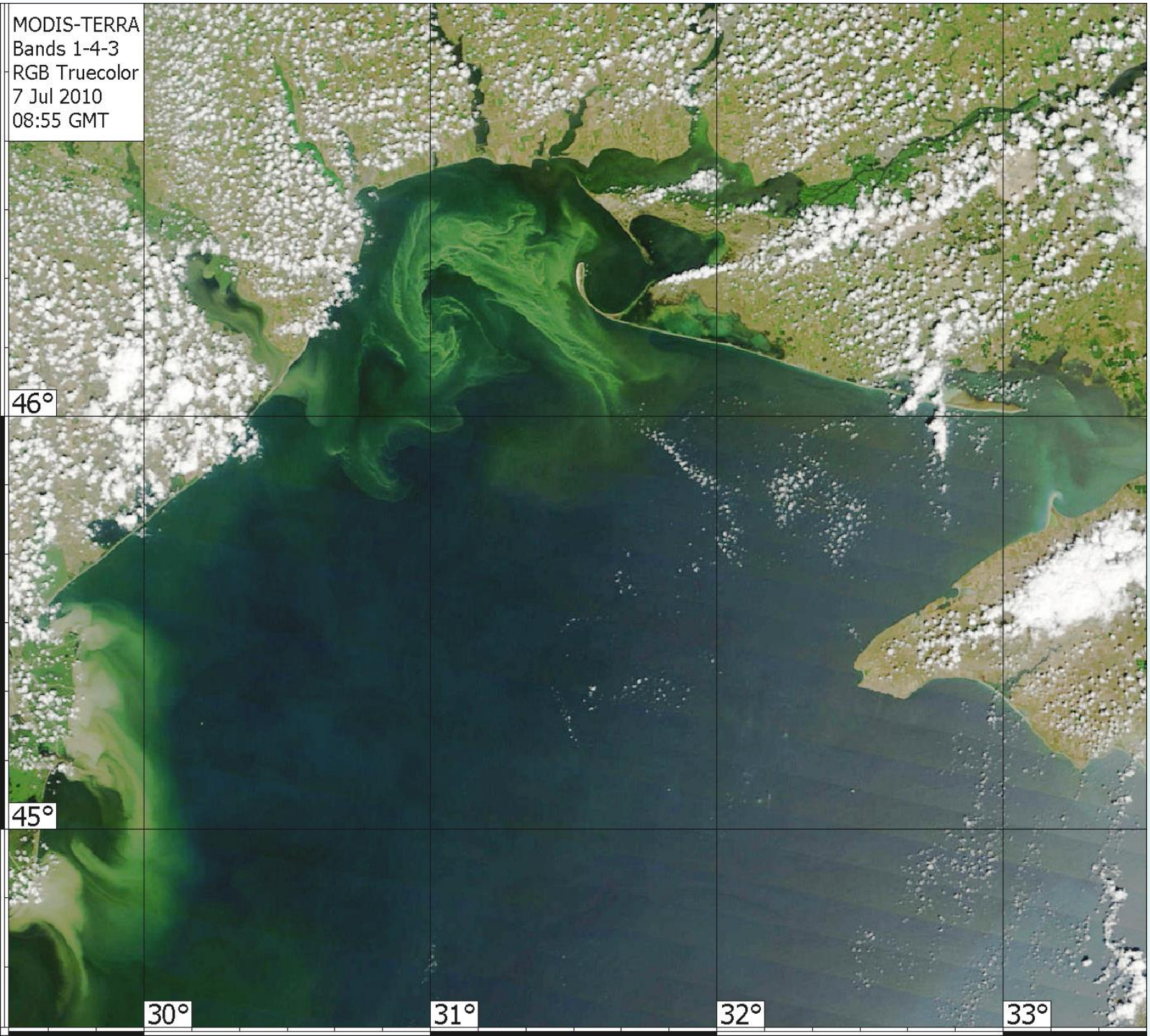


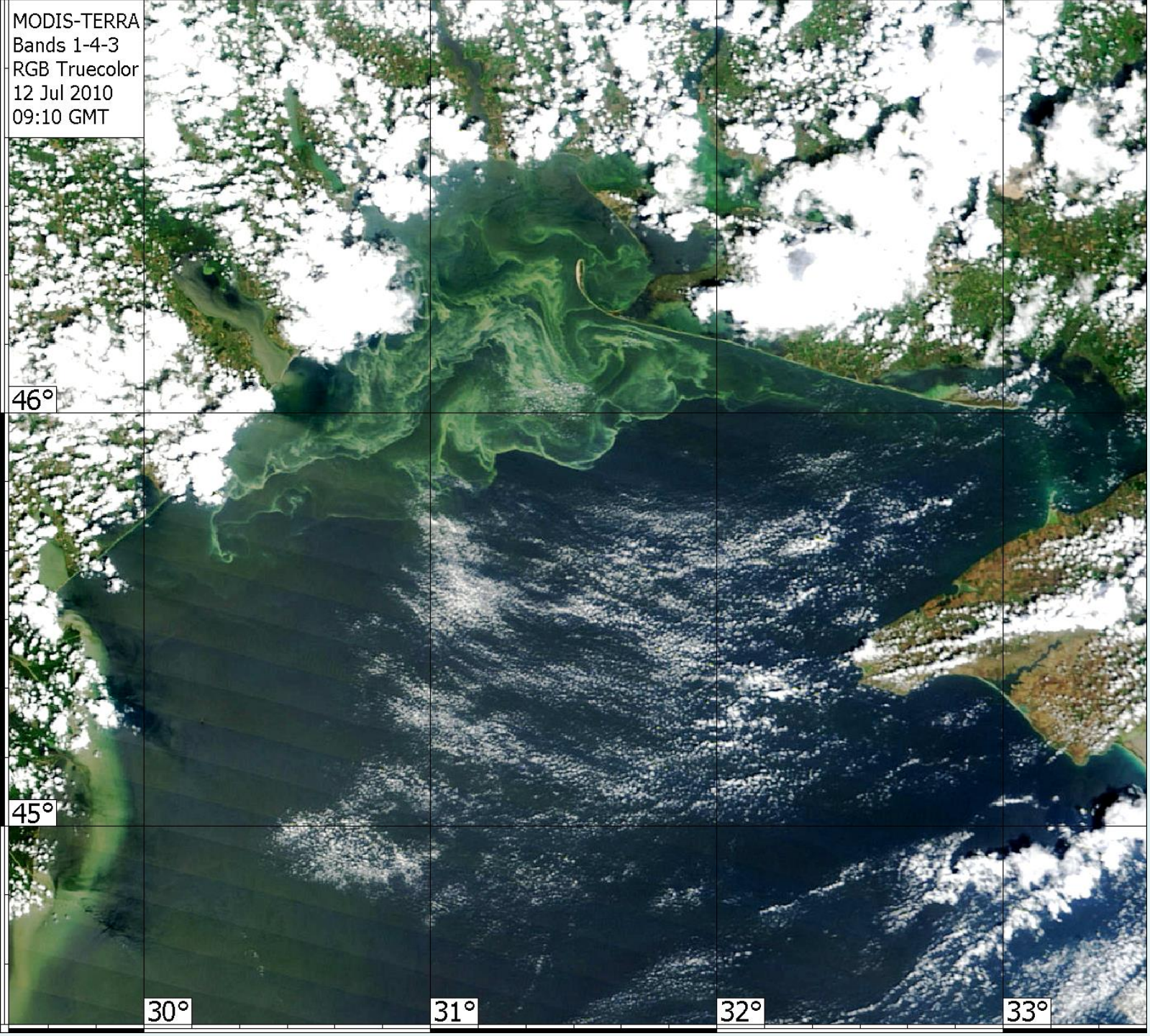
Nodularia spumigena

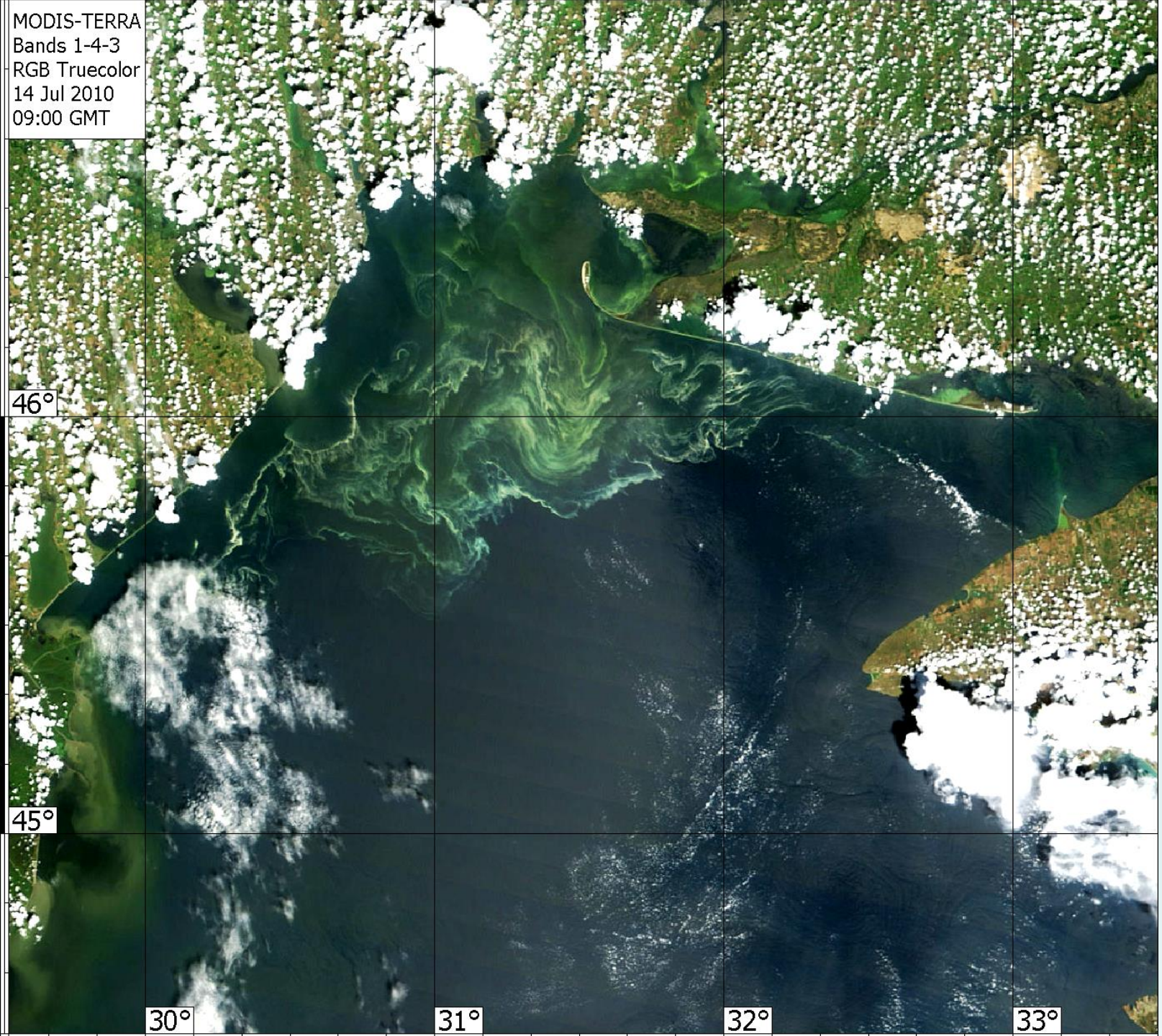
Jul 25 2009 Blue – green algae bloom

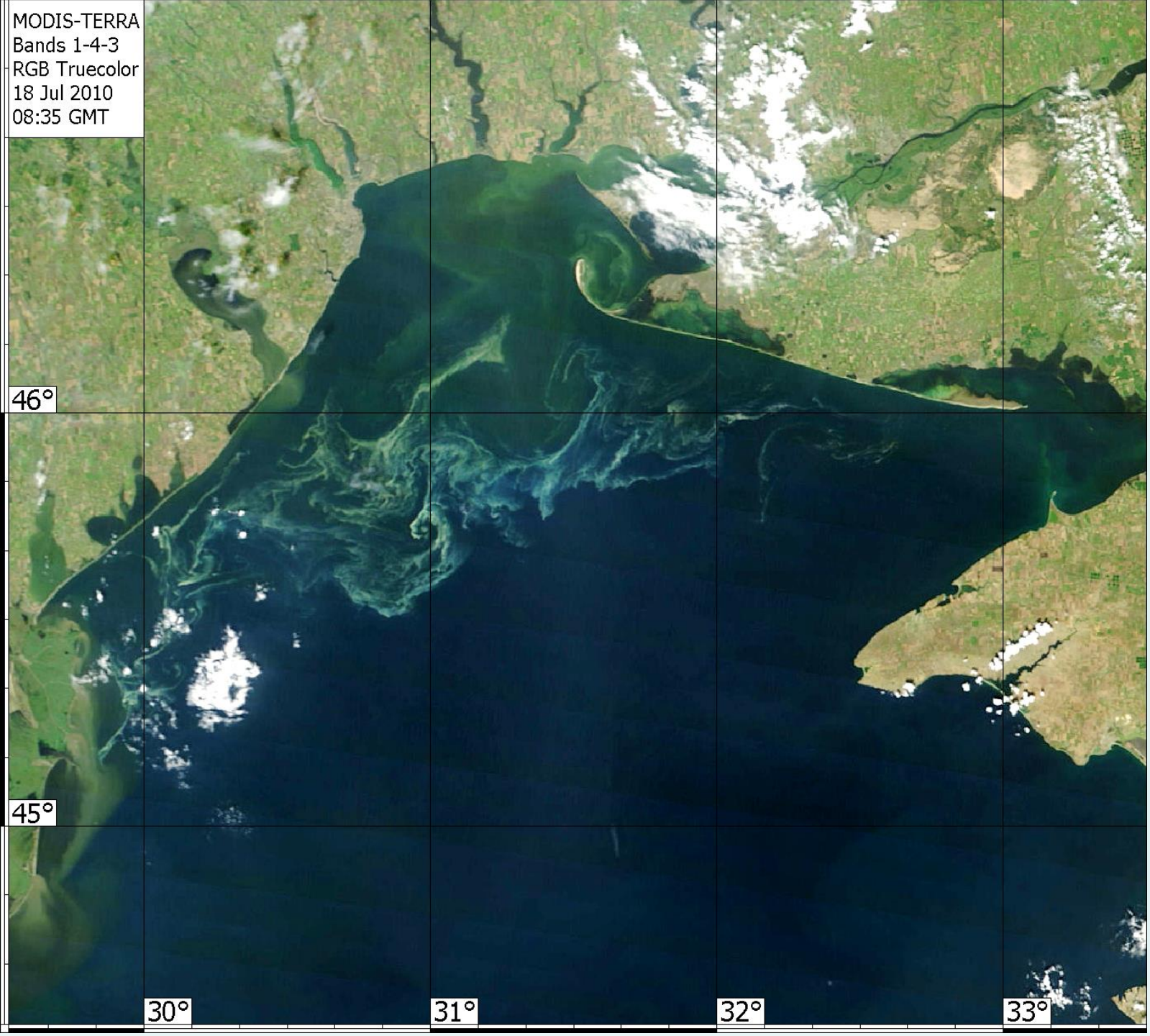

Landsat ETM+

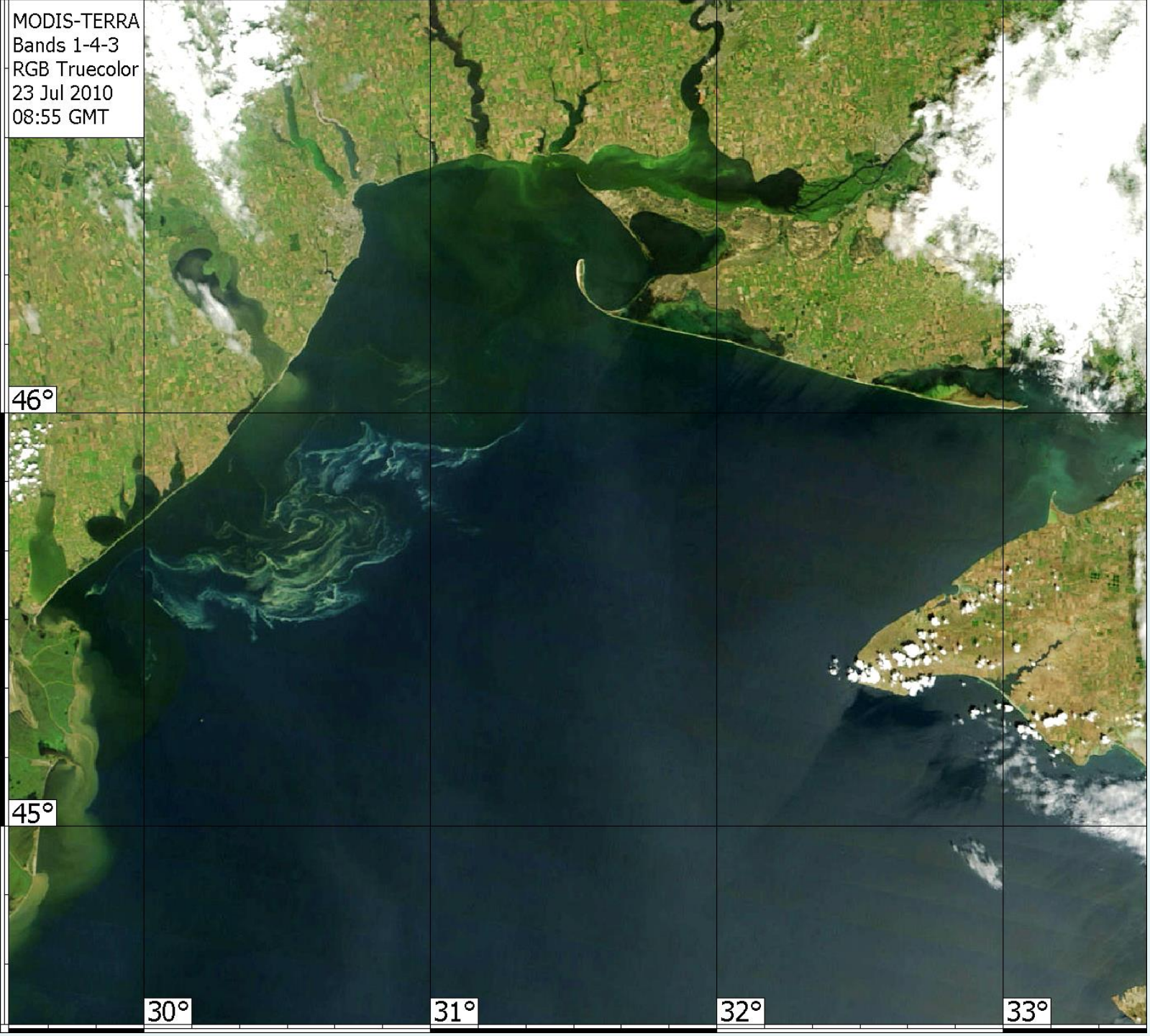

MODIS-TERRA
Bands 1-4-3
RGB Truecolor
4 Jul 2010
08:20 GMT
46°
45°
30°
31°
32°
33°

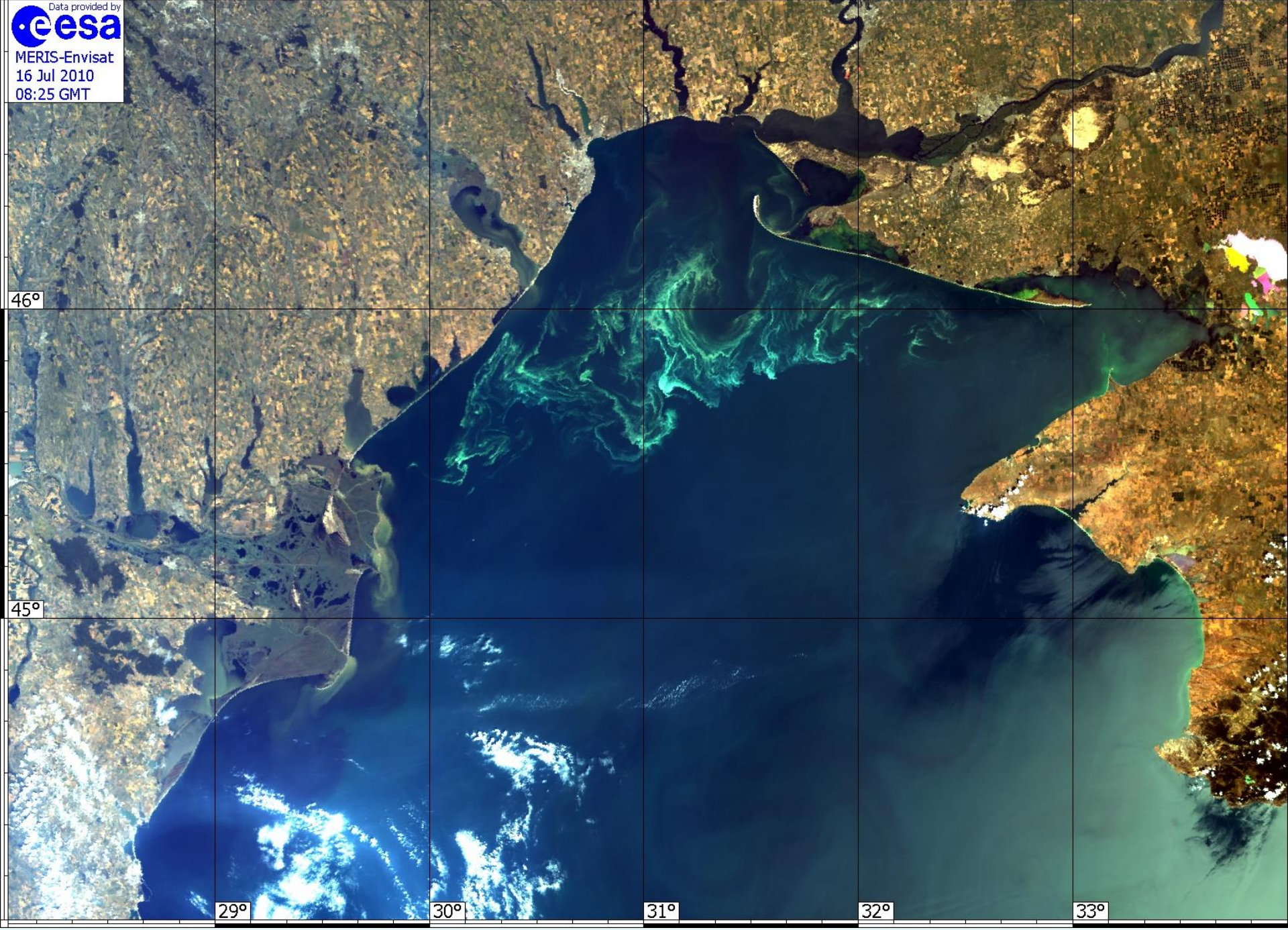

MODIS-TERRA
Bands 1-4-3
RGB Truecolor
7 Jul 2010
08:55 GMT
46°
45°
30°
31°
32°
33°

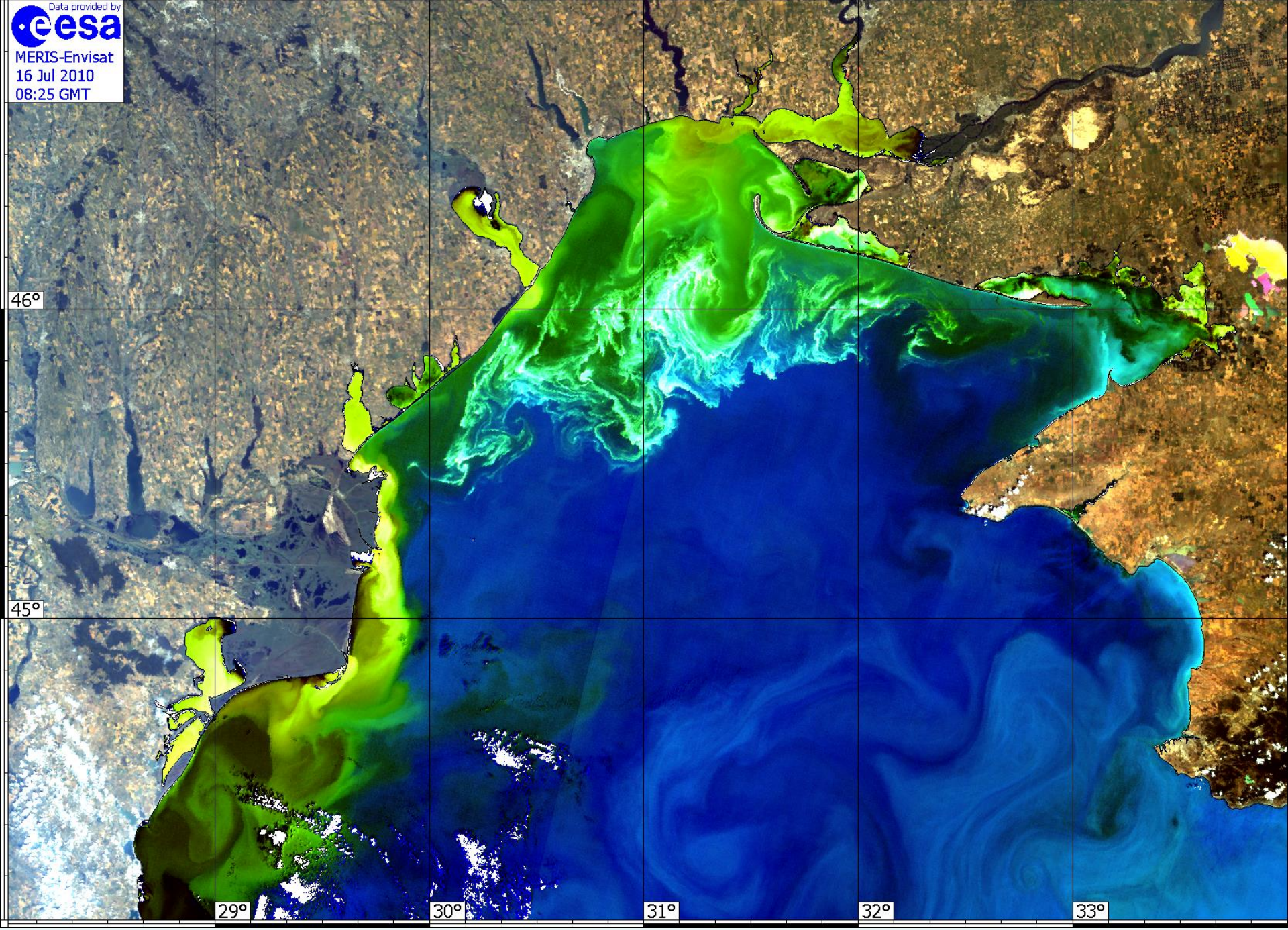

MODIS-TERRA
Bands 1-4-3
RGB Truecolor
12 Jul 2010
09:10 GMT
46°
45°
30°
31°
32°
33°

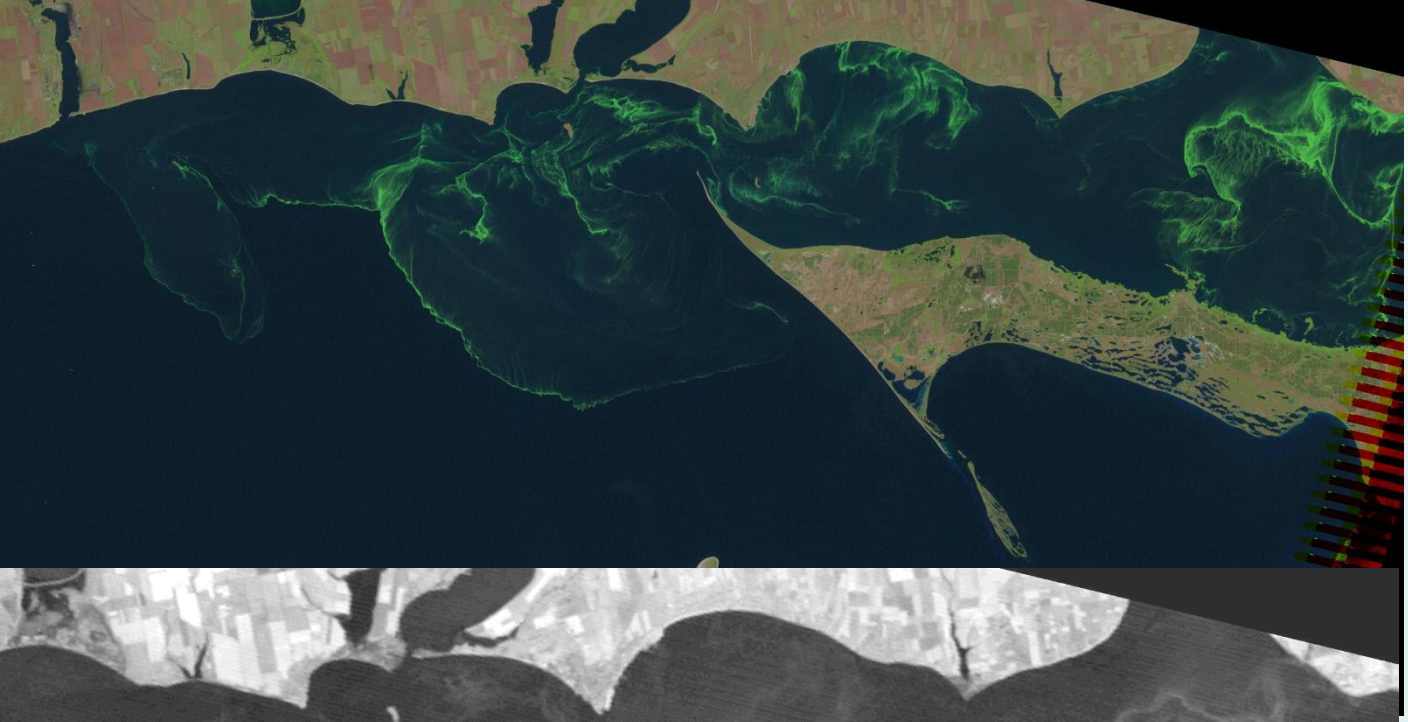

MODIS-TERRA
Bands 1-4-3
RGB Truecolor
14 Jul 2010
09:00 GMT
46°
45°
30°
31°
32°
33°


MODIS-TERRA
Bands 1-4-3
RGB Truecolor
18 Jul 2010
08:35 GMT
46°
45°
30°
31°
32°
33°


MODIS-TERRA
Bands 1-4-3
RGB Truecolor
23 Jul 2010
08:55 GMT
46°
45°
30°
31°
32°
33°


Data provided by
esa
MERIS-Envisat
16 Jul 2010
08:25 GMT
46°
45°
29°
30°
31°
32°
33°


Data provided by
esa
MERIS-Envisat
16 Jul 2010
08:25 GMT
46°
45°
29°
30°
31°
32°
33°



Blue –Green algae bloom manifestation in optical and thermal data of ETM+

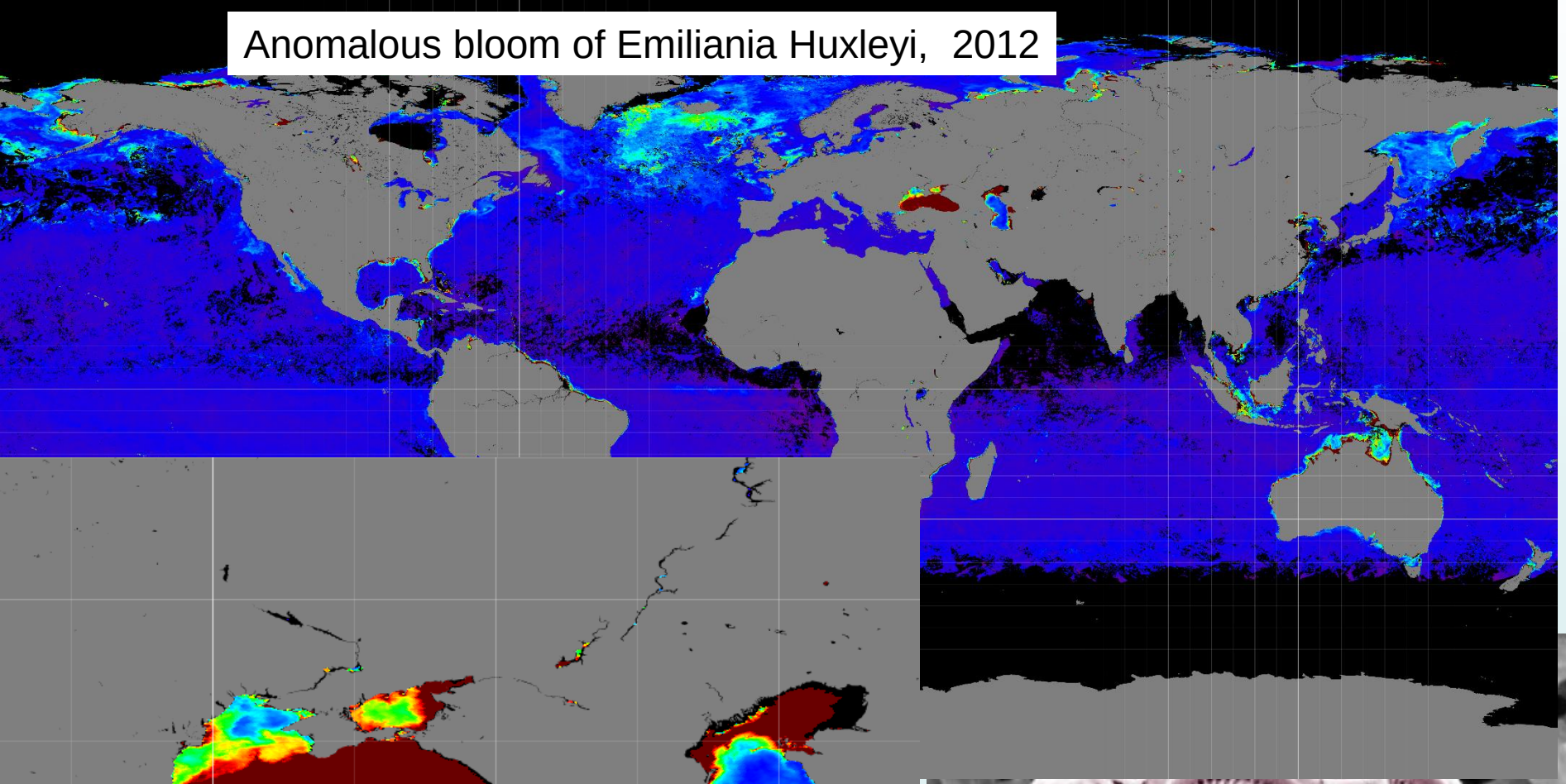
Strong heating of the bloom area due to high absorption of the Sun radiation.

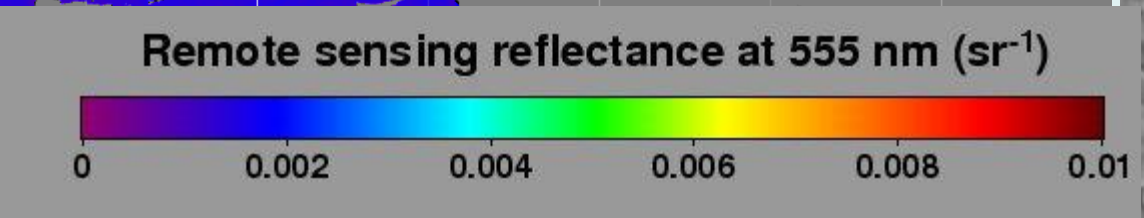
Summary

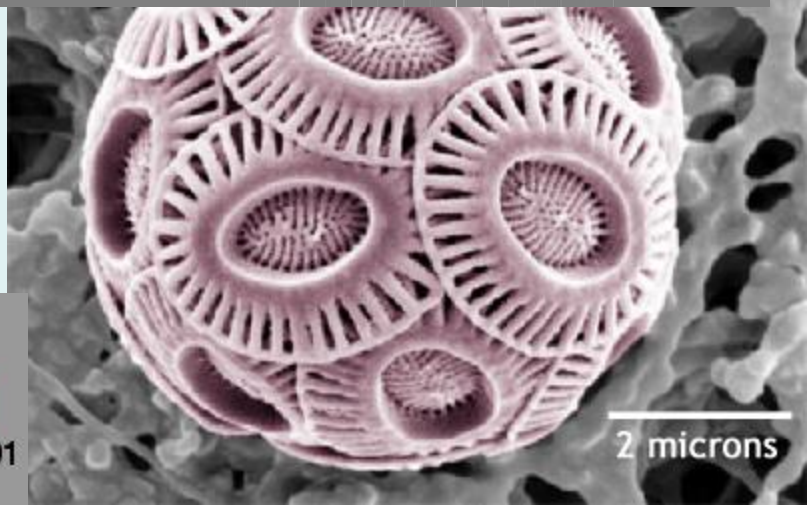
- Initial source – fresh waters (Dniepr, Kuban)
- Preferable conditions – high temperature and low wind
- Propagation related with frontal zone
- Strong impact on the thermal and optical properties of the upper layer
- Blocking of the surface gas transfer
- Shadowing deeper layers

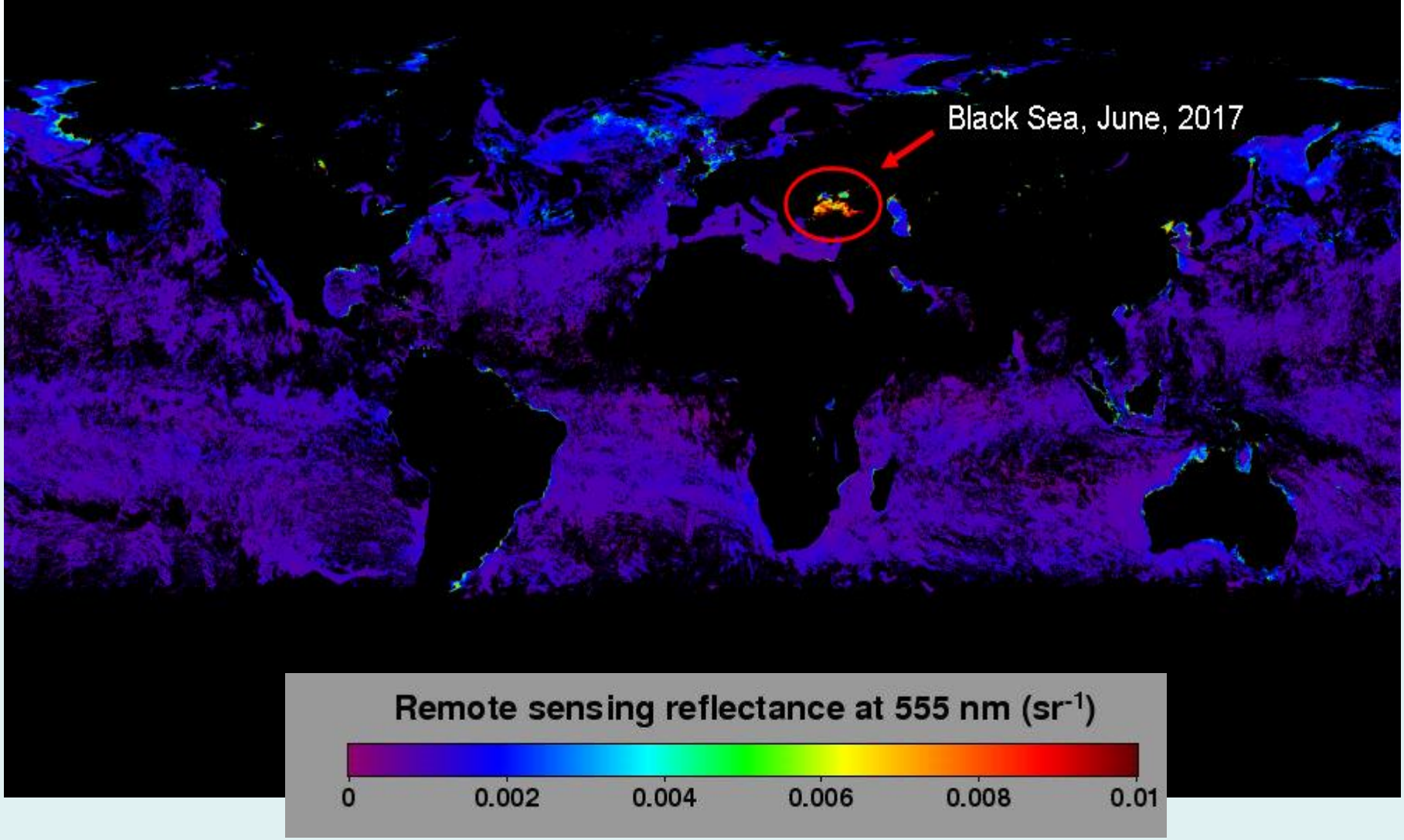
- Coccolithophore bloom

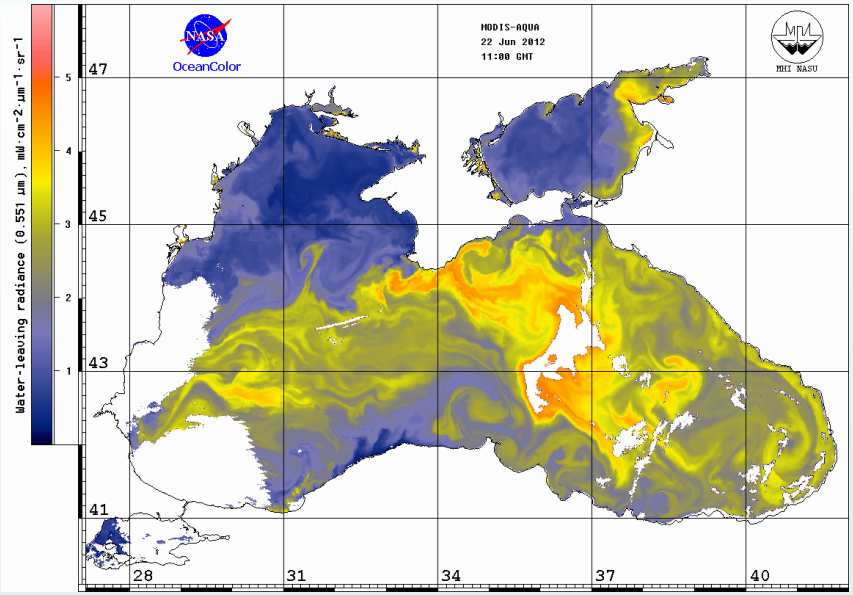
Anomalous bloom of Emiliania Huxleyi, 2012

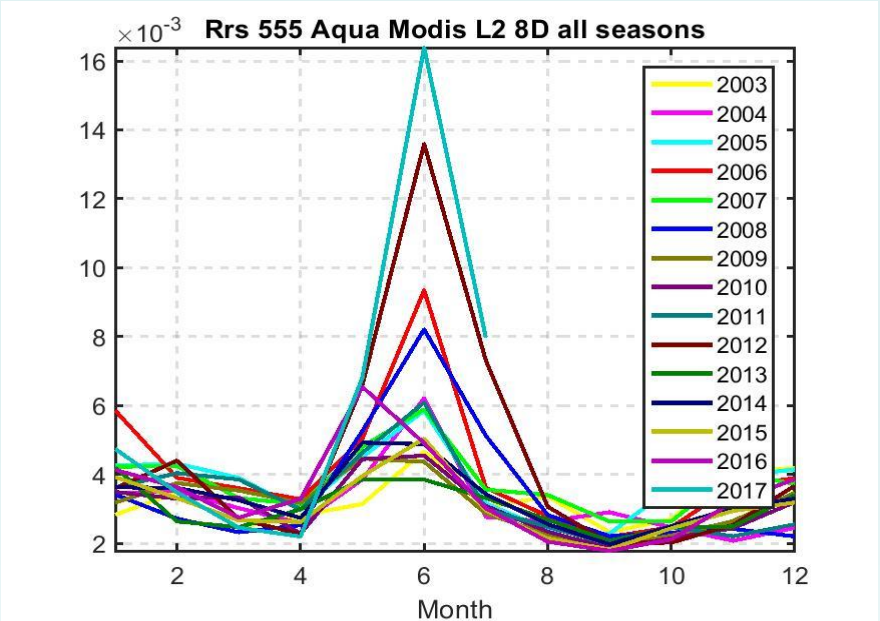


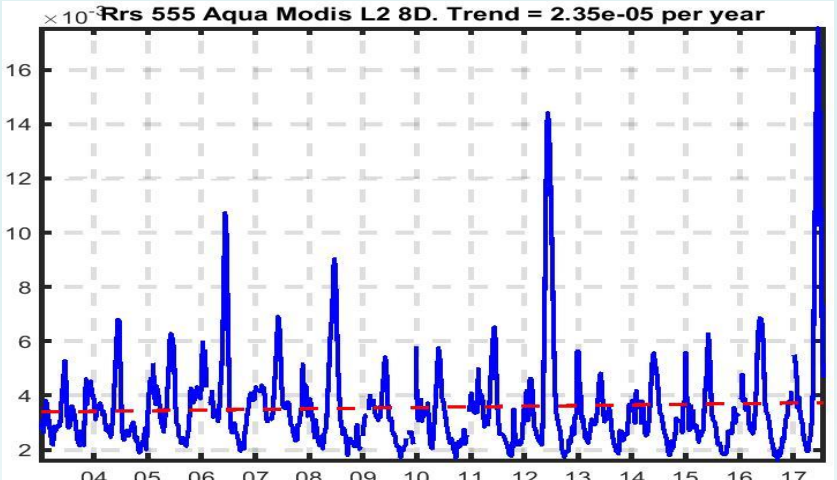





Black Sea, June, 2017
Remote sensing reflectance at 555 nm (sr-1)
0
0.002
0.004
0.006
0.008
0.01

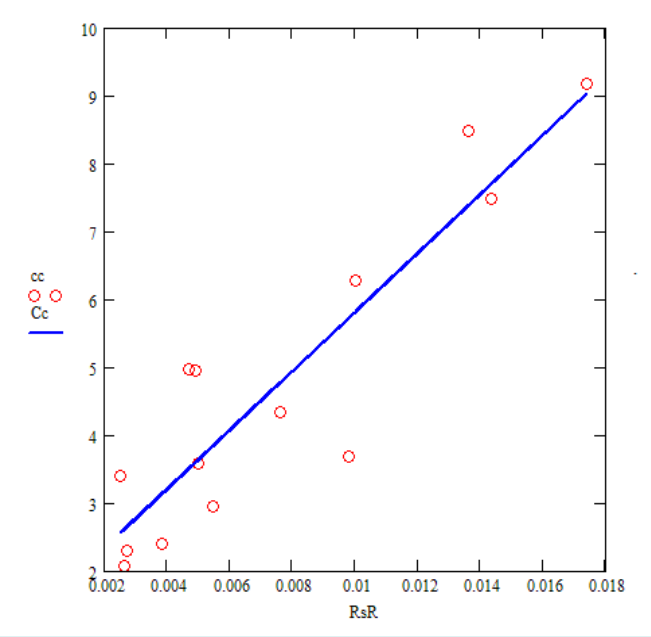

MODIS-AQUA
22 Jun 2012
11:00 GMT
OceanColor
MMI NASU
Water-leaving radiance (0.551 µm), mW cm⁻² µm⁻¹ sr⁻¹
47
45
43
41
28
31
34
37
40


Rrs 555 Aqua Modis L2 8D all seasons
×10⁻³
Month
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017


Rrs 555 Aqua Modis L2 8D. Trend = 2.35e-05 per year
×10⁻³

Comparison with in situ data for 2009 -2012 year near Novorossiisk

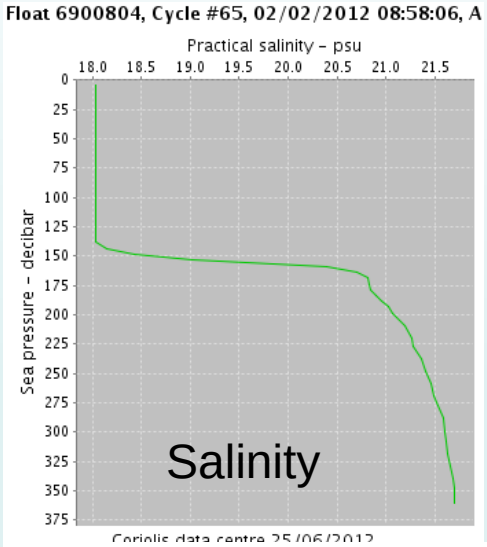
Log(C(cell/liter))as a function of the Reflectance on 0.55мкм

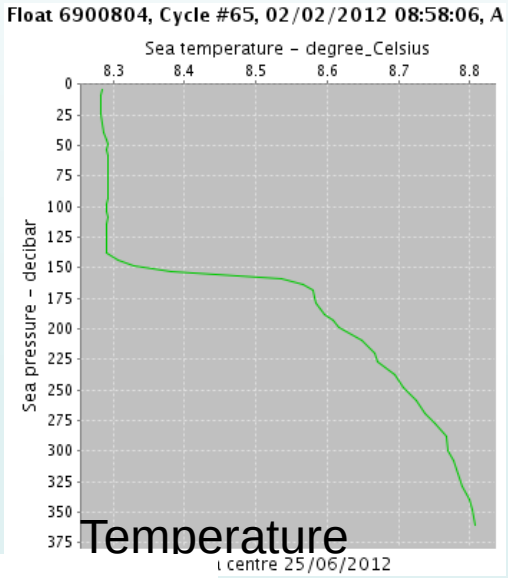


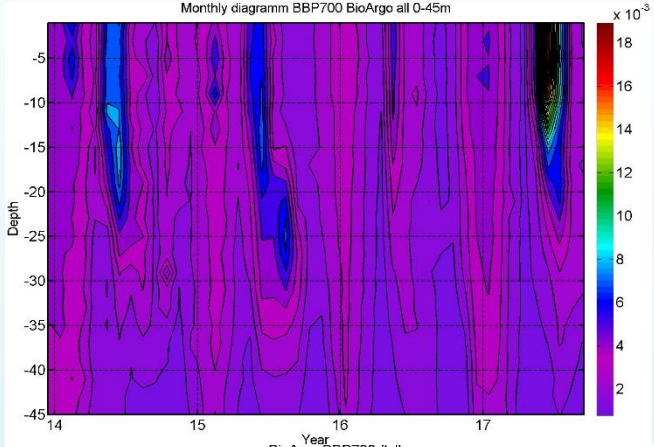
Concentration 2012 > $2*10^7$ cells/liter

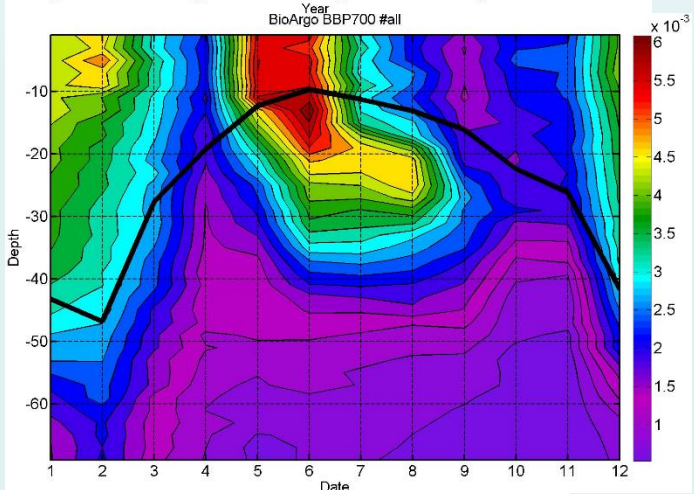
Estimated mass of the coccolith – $4*10^{-3}$ g/liter

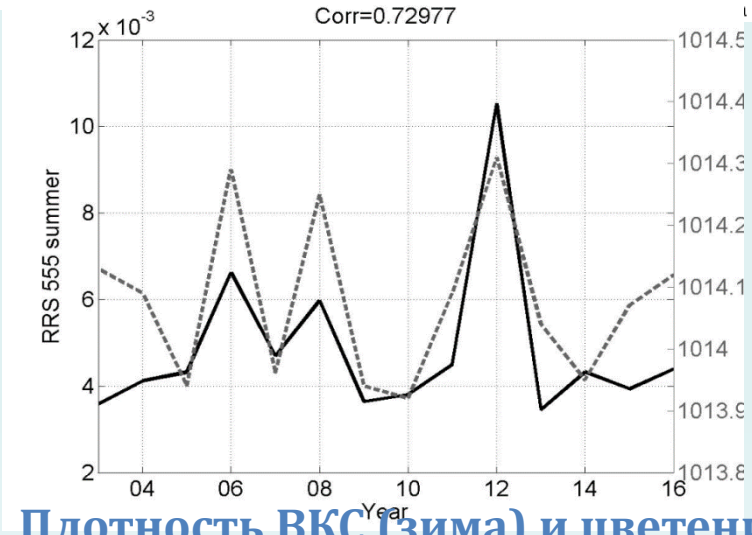
Reason – deep winter convection
ARGO float mixing layer - 150м

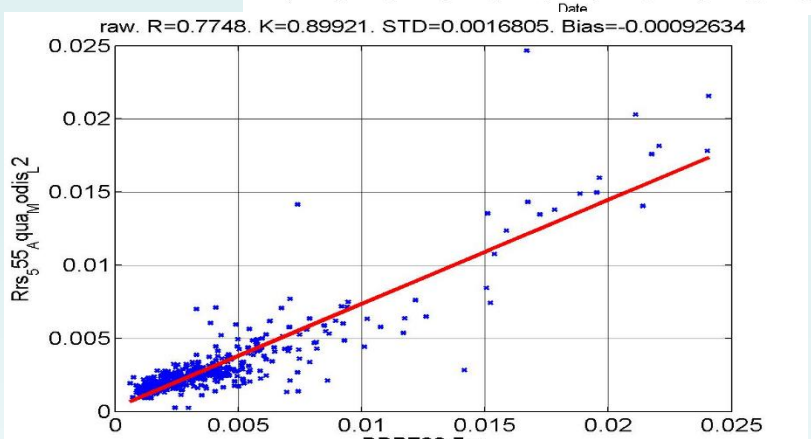




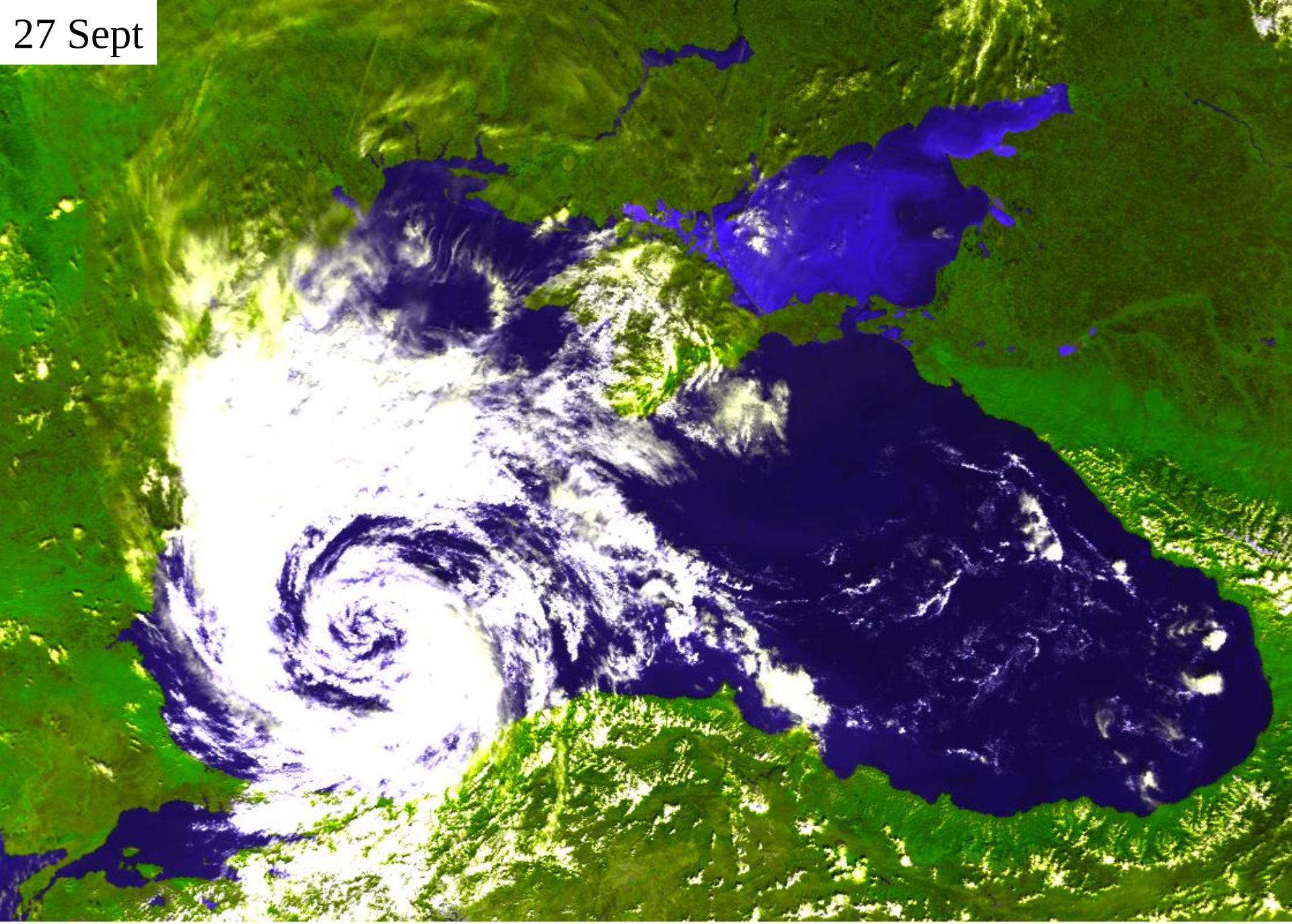


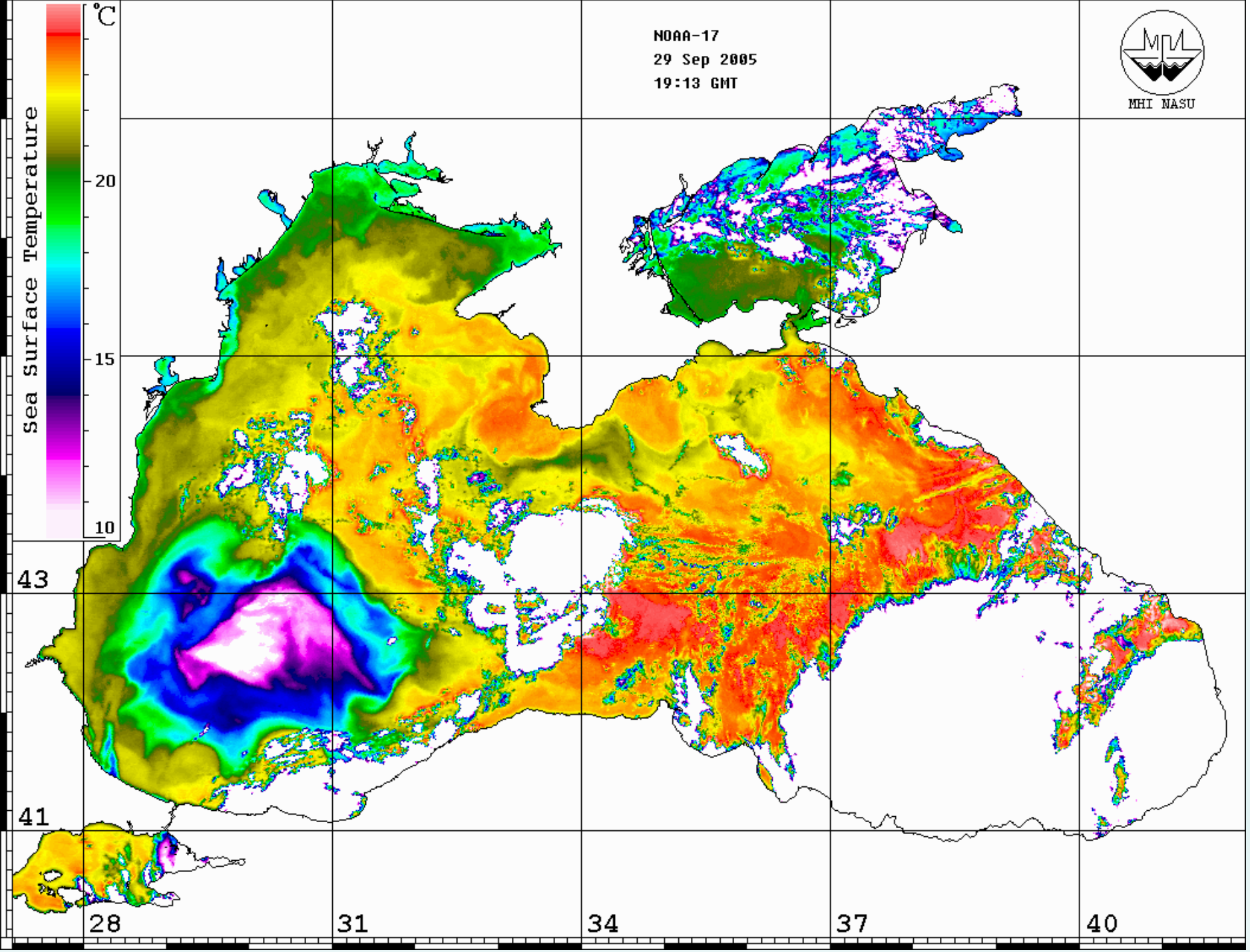


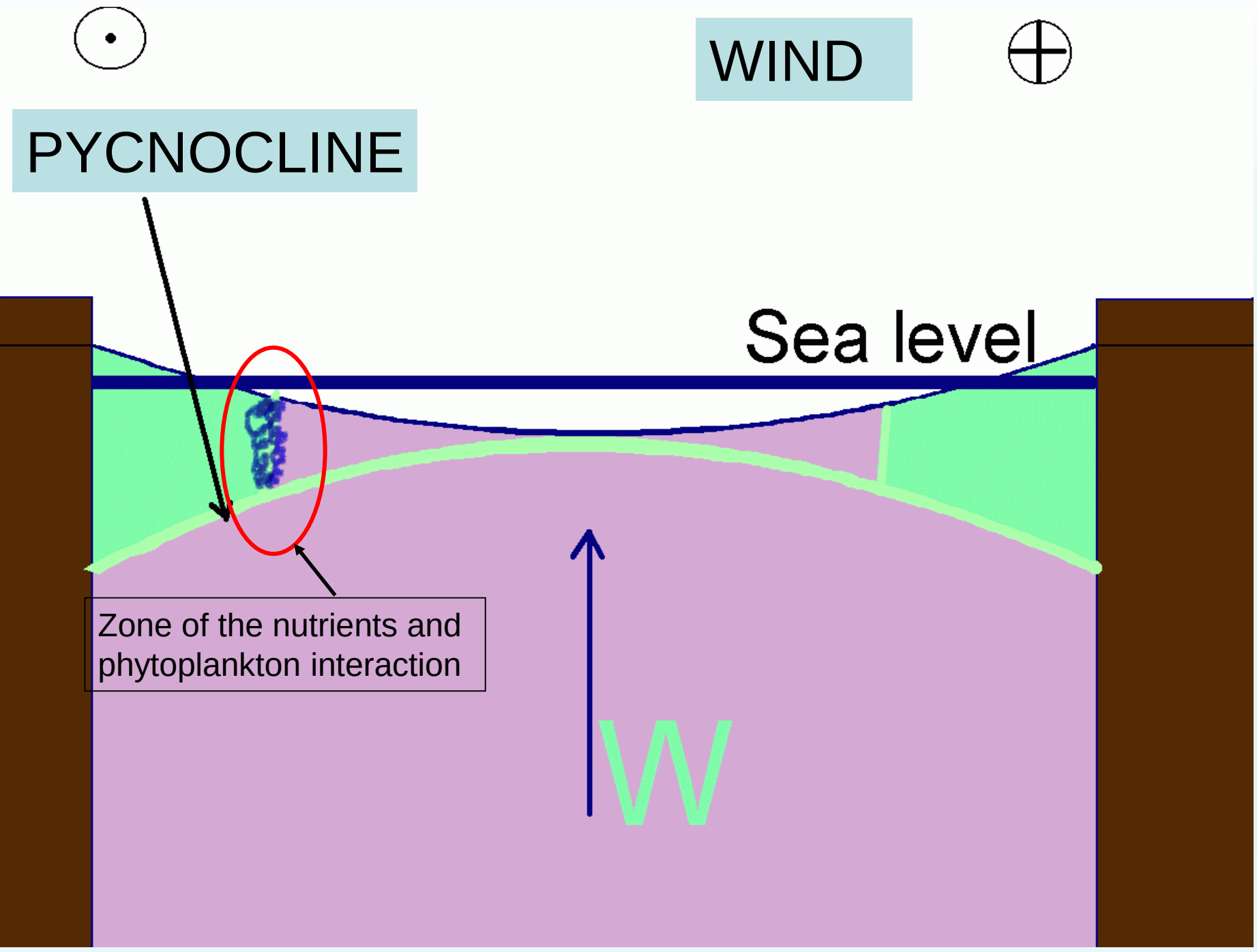


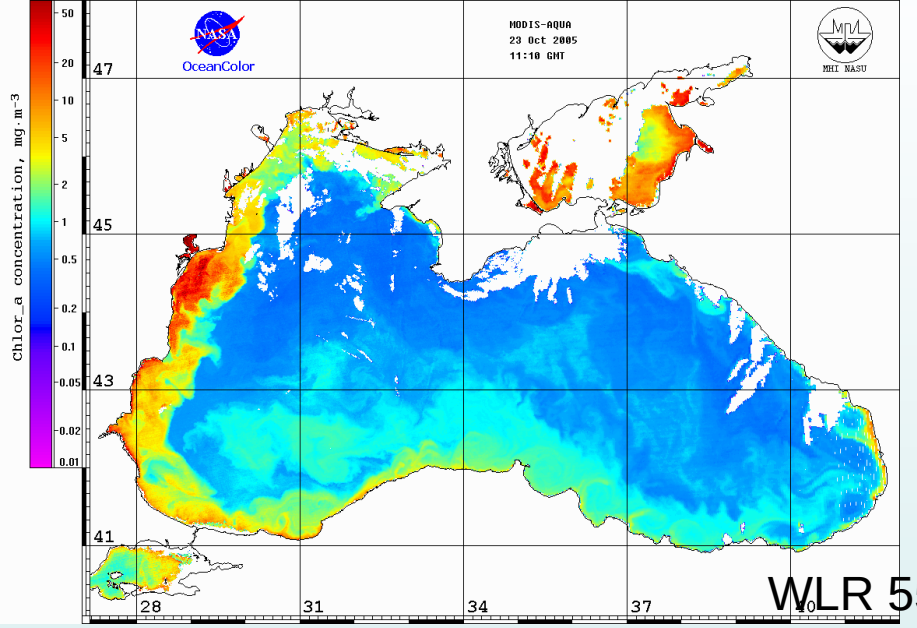


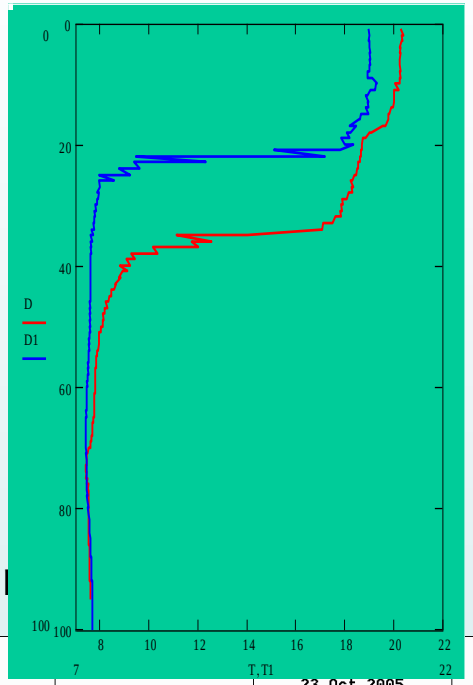
Плотность ВКС (зима) и цветение кокколитофорид (лето)


27 Sept

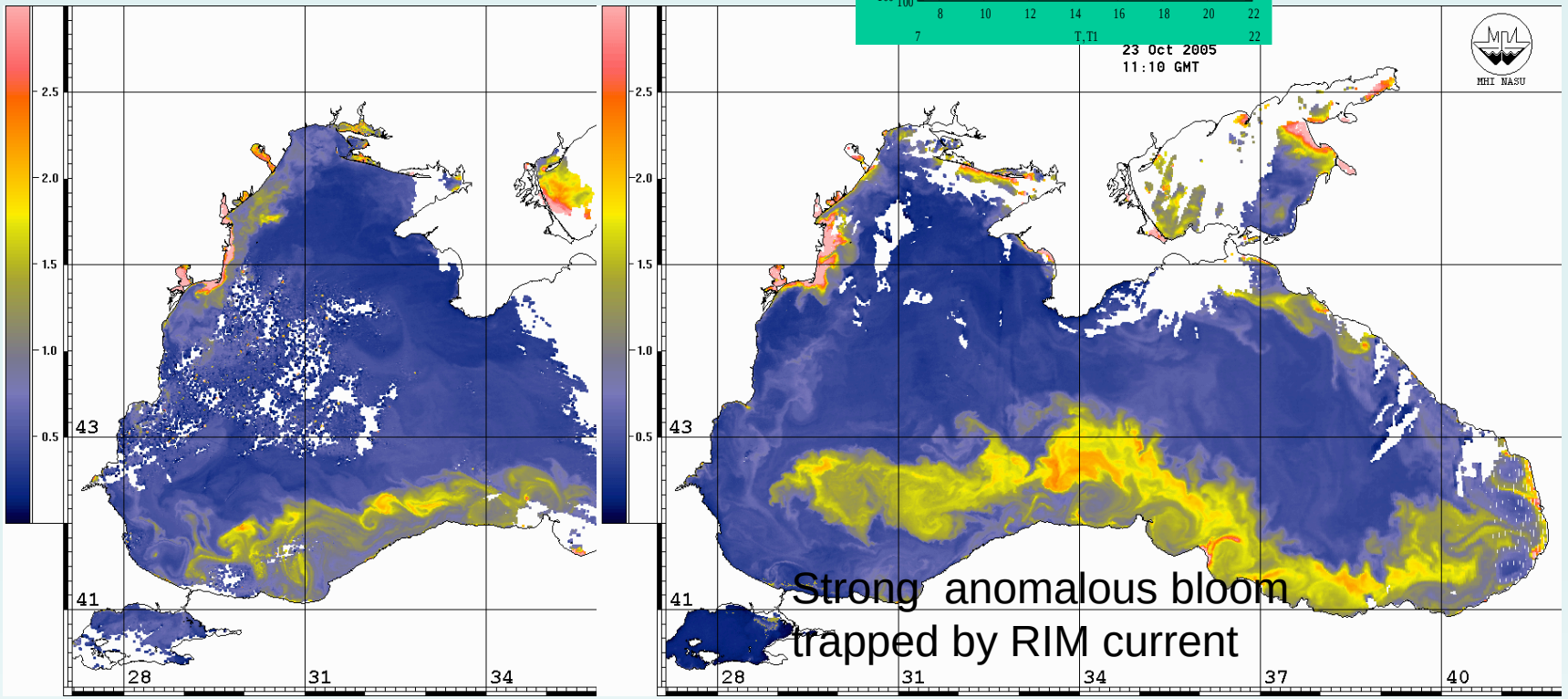

Sea Surface Temperature
°C
20
15
10
NOAA-17
29 Sep 2005
19:13 GMT
MHI NASU
43
41
28
31
34
37
40


WIND
PYCNOCLINE
Sea level
Zone of the nutrients and phytoplankton interaction
W





WLR 555 I



Strong anomalous bloom trapped by RIM current

СПАСИБО

SSTANICHNY@MAIL.RU

Всегда рады сотрудничеству с Вами