PERSPECTIVES
in application of remote sensing and ecosystem models for ecosystem state assessment in line with MSFD

Churilova T.[1], Finenko Z.[1], Kryvenko O.[1] ,
Korotaev G.[2], Suslin V.[2], Dorofeev V.[2], Kubryakov A.[2]

1 - Institute of Biology of the Southern Seas of National Academy of Sciences of Ukraine, Nakhimov Ave. 2, Sevastopol, 99011 Ukraine;

2 - Marine Hydrophysical Institute of National Academy of Sciences of Ukraine, Kapitanskaya Str. 2 , Sevastopol, Ukraine, 99011;

European marine policy (MSFD 2008)

Goal - Good Environmental Status (GES) should be achieved by 2020

Satellite optical sensors information gives **new opportunities** in assessment of GES because provide relevant information at spatial and temporal scales, which could not be realized by traditional

in situ monitoring system.

Regional models:

- IOPs model (Suslin et al., 2008);
- Chl/CDM model (Suslin et al., 2008);
- model of downwelling radiance (Churilova et al 2009; Suslin, Churilova 2010);
- Phytoplankton biomass model (Finenko et al., 20011)
- PP models (Churilova et al., 2012; Finenko et al 2009,);
- New and regenerated PP model (Kryvenko et al, 2014?)
- PSD (PSC) model (Suslin et al., in press);
- coupled dynamics and biogeochemical model (developed by Oguz et al., 1996 and modified by Dorofeev et al., 2012)

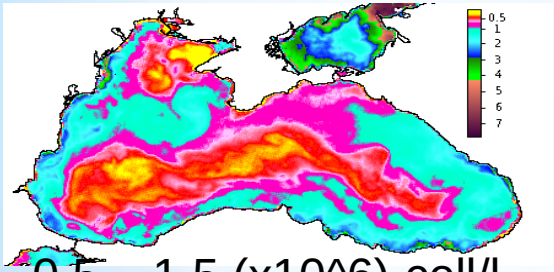
Descriptor: *D1 Biodiversity indicators:*

- Species distribution/population size;
- Habitat condition (*hydrological and chemical conditions)*
- Community condition (for phytoplankton - PSC and its distribution);

Coccolithophores Emiliania huxleyi blooms

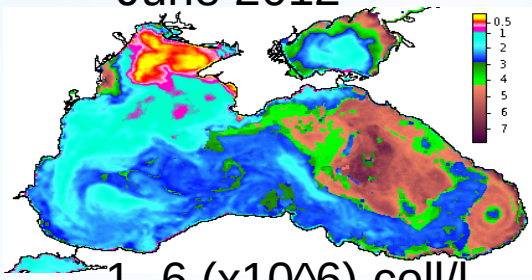
Distribution/abundance

June 2005



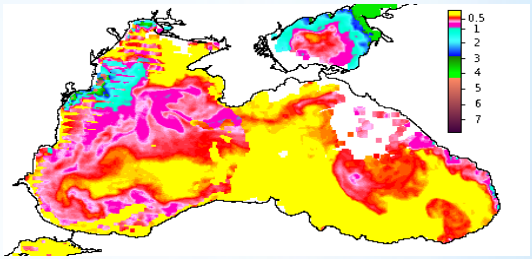
0,5 – 1,5 (x10^6) cell/l

June 2012

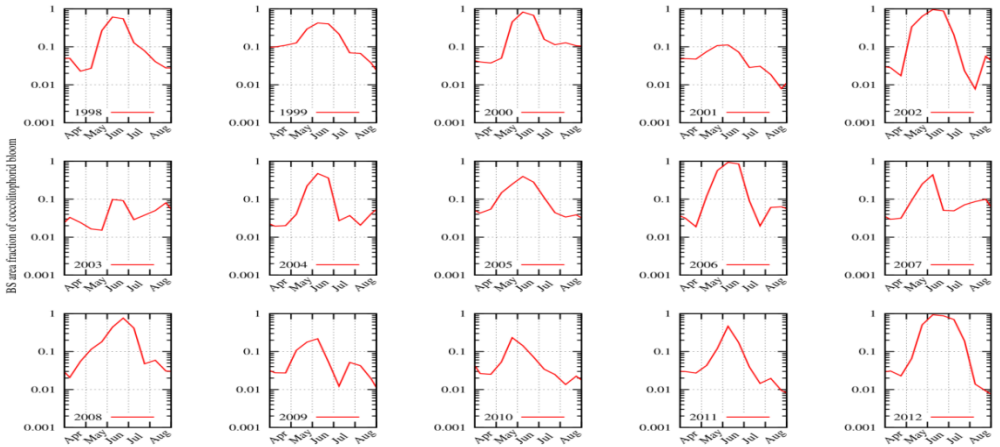


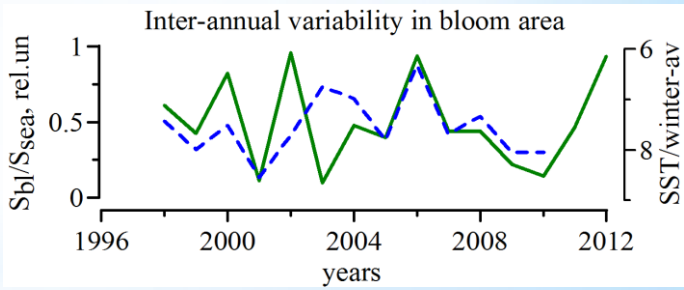
1- 6 (x10^6) cell/l

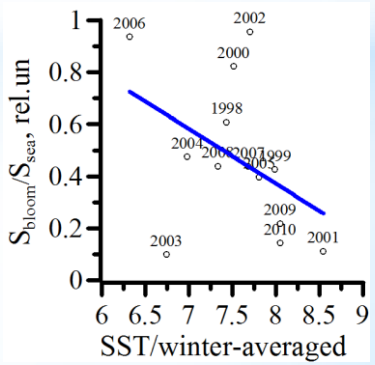
June 2013

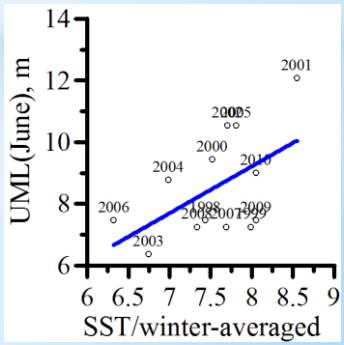


Bloom area









Descriptors: *D1: Biodiversity*

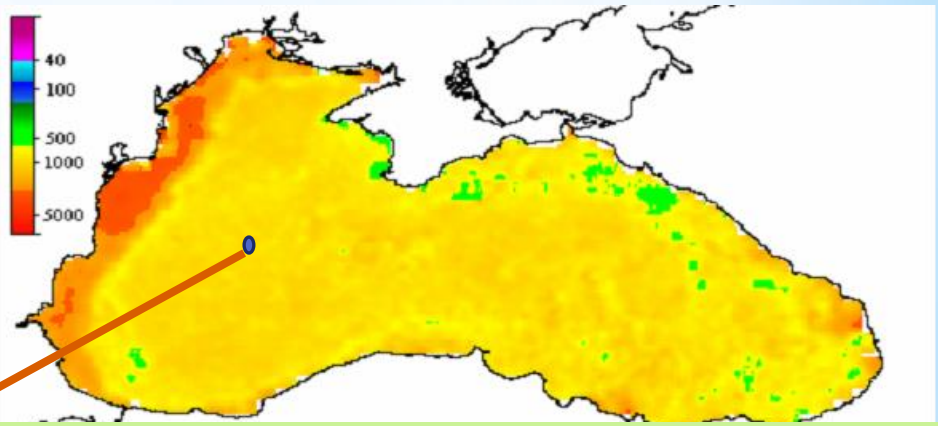
indicator (community condition):

Phytoplankton biomass (PBM)

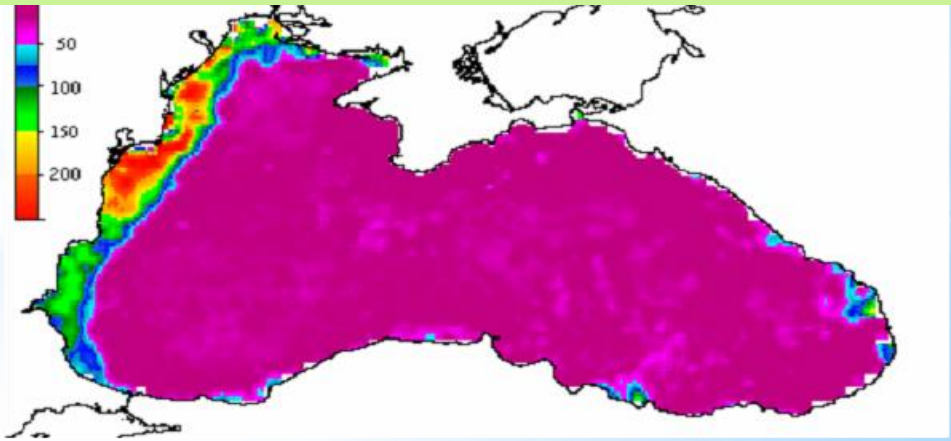
PBM includes:

- Chl regional models, :
- Downwelling radiance model;
- C/Chl ratio – PAR dependent , Finenko et al, 2005

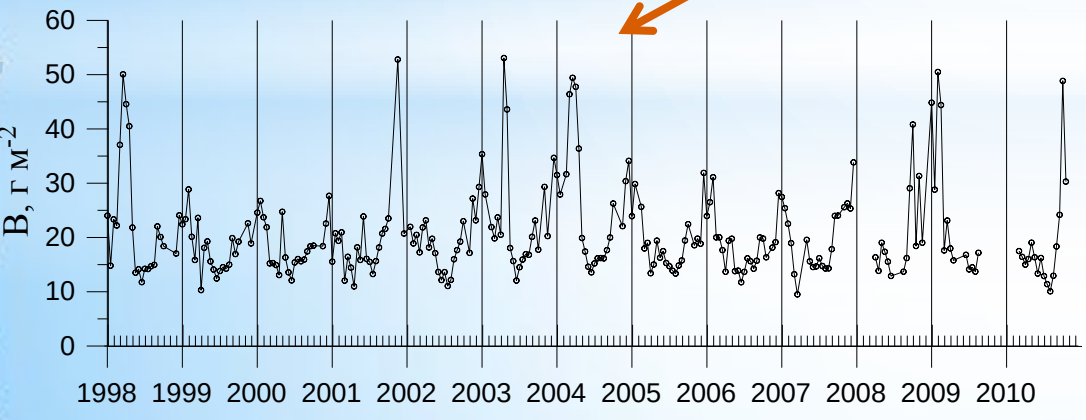
Phytoplankton Biomass within euphotic layer, mg C m-2



Phytoplankton Biomass at surface, mg C m-3



Dynamics of Phytoplankton biomass within euphotic zone in central deep-waters regiont



Descriptors: ***D1: Biodiversity***

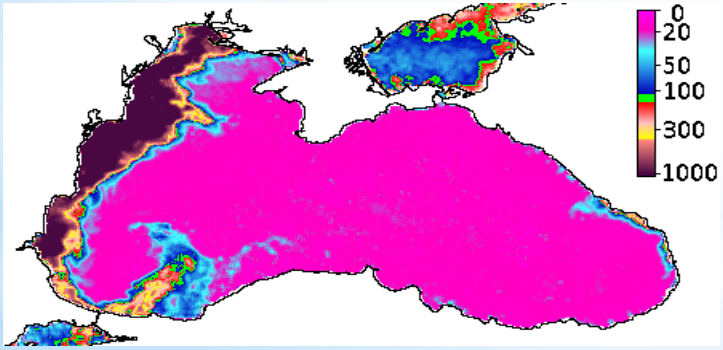
indicator (community condition):

Phytoplankton Size Classes

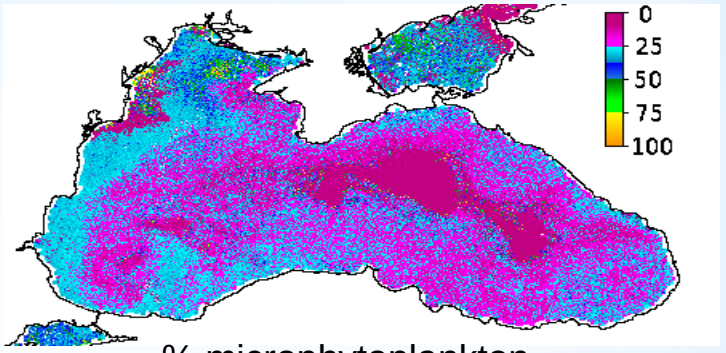
Approach for **pelagic** community (PSC)
Outcomes of *PSD* regional algorithm (adaptation of Kostadinov 2009)):

- biomass, mg C m^{-3}
- % microphytoplankton
- % nanophytoplankton
- % picophytoplankton

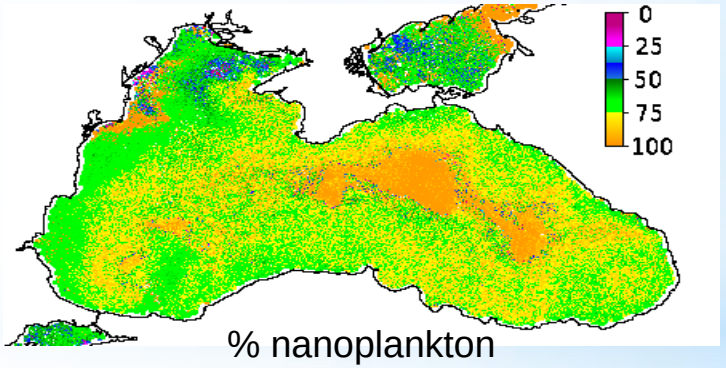
Example of maps for 1st half of June, 2006



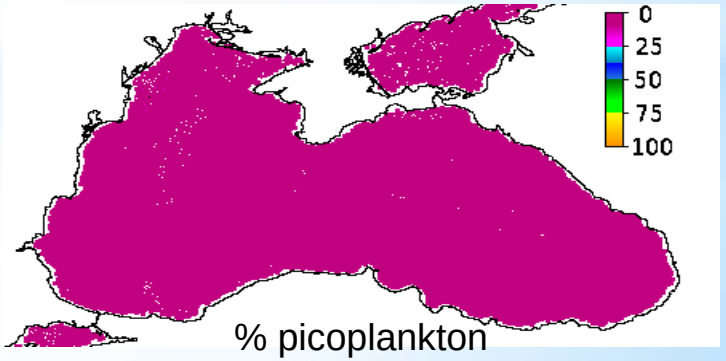
Biomass phytoplankton in surface layer, mg C m^{-3}



% microphytoplankton



% nanoplankton



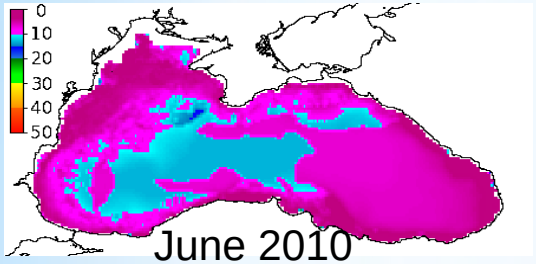
% picoplankton

Descriptor: *D1: Biodiversity*

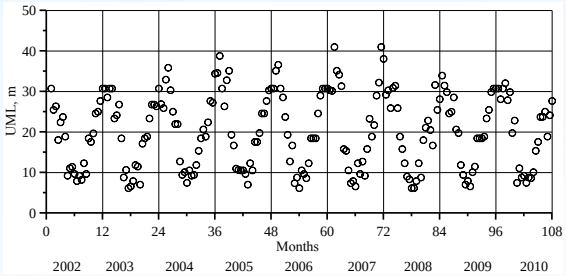
indicators: Habitat condition

- Hydrological (UML depth);

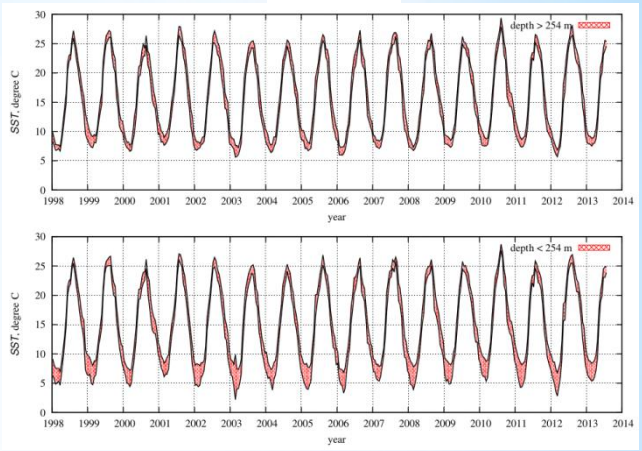
UML depth



June 2010



SST



- Water transparency (Kd)

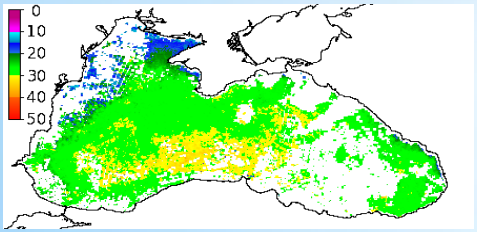
For phytoplankton:

–1% PAR depth and
- light condition in UML

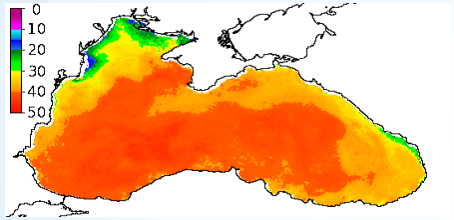
For benthic flora :

- light condition near bottom, E/m2/day;
- area covered by macroalgae/seagrass

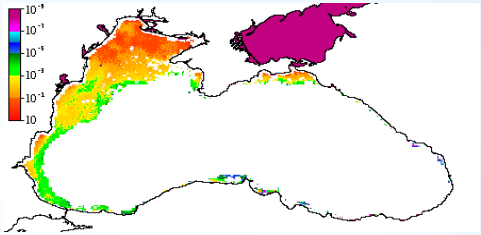
January 2007



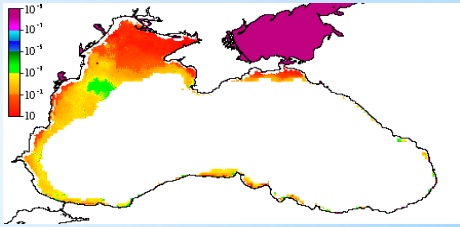
June 2007



January 2003



June 2003

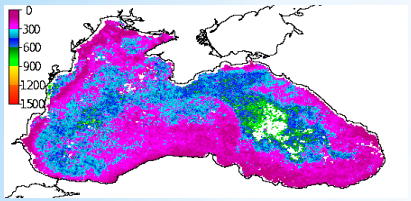


Descriptor: *D 4: Foodwebs*

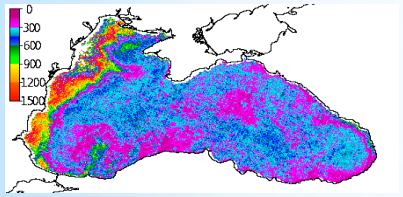
indicators:

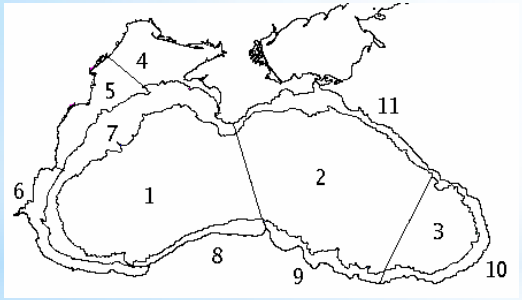
- Productivity: 1) Total Primary Production within the layer (*in* mgC m^{-2} day^{-1})

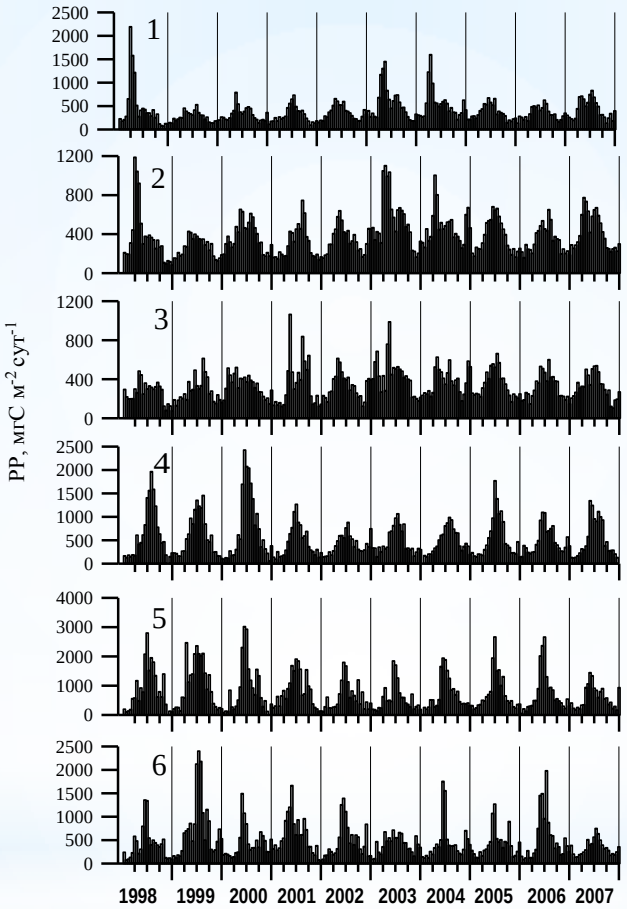
March 2003 (2)

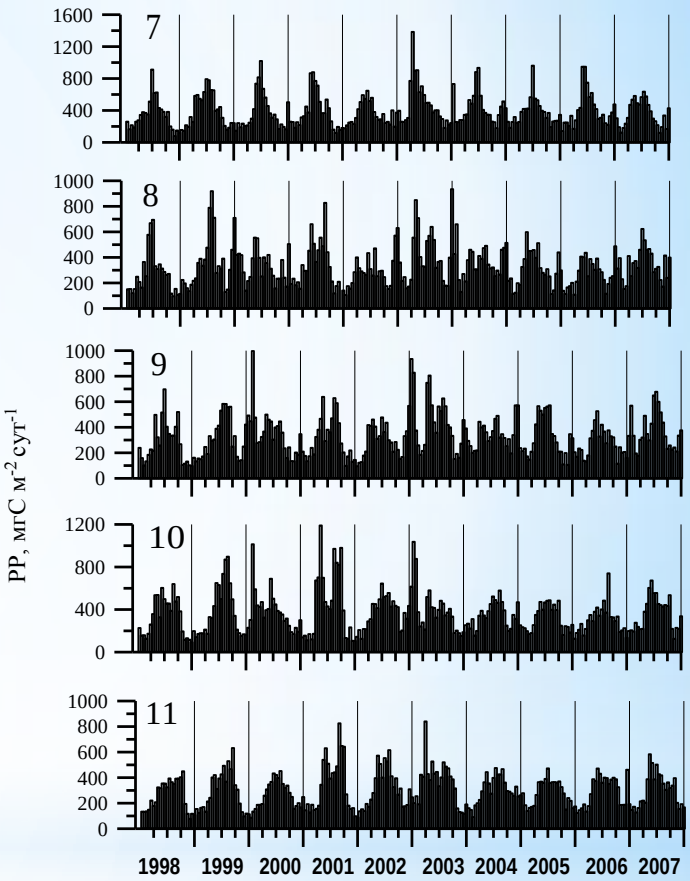


June 2006 (1)









2) New and regenerated PP

Assessment of (1) inorganic N and P assimilation rate by phytoplankton based on remote sensing Chl data; (2) f- ratio

Descriptor: ***D 4: Foodwebs***

indicators:

Community condition :

1) Biomass of phytoplankton;

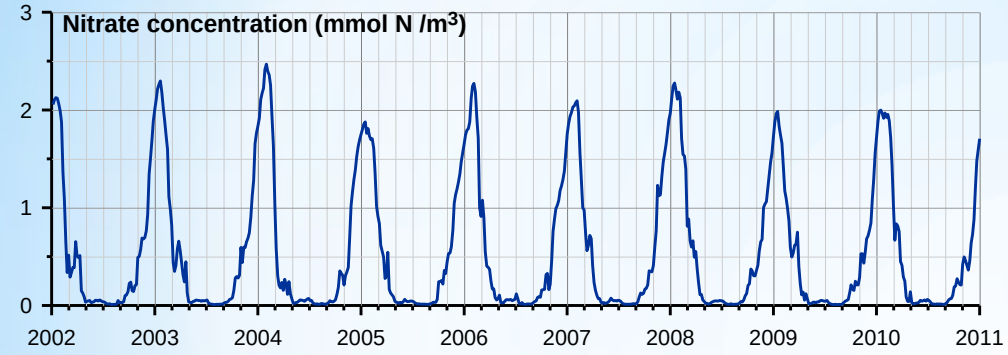
2) PSC (related to taxonomic structure of phytoplankton);

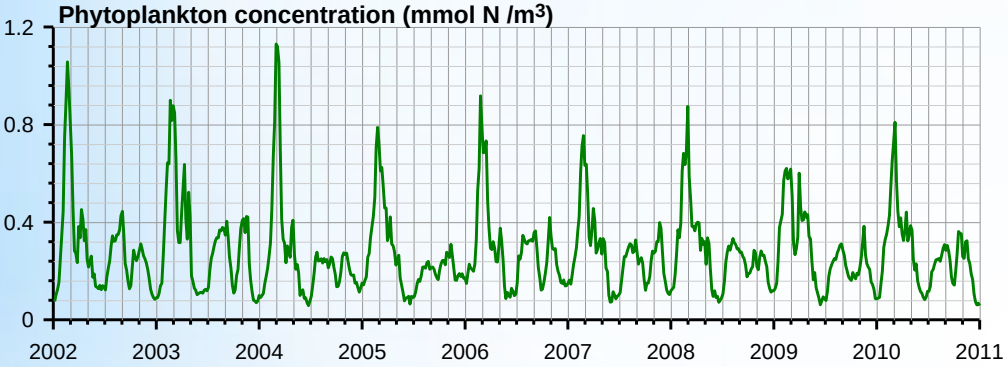
3) Biomass of fodder zooplankton;

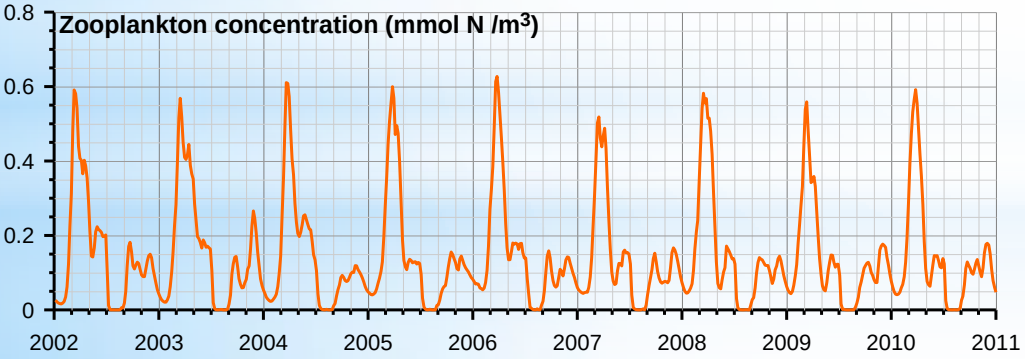
4) jelly/fodder-zooplankton ratio) (*Dorofeev et al.,2012)*;

Dynamics of surface concentrations

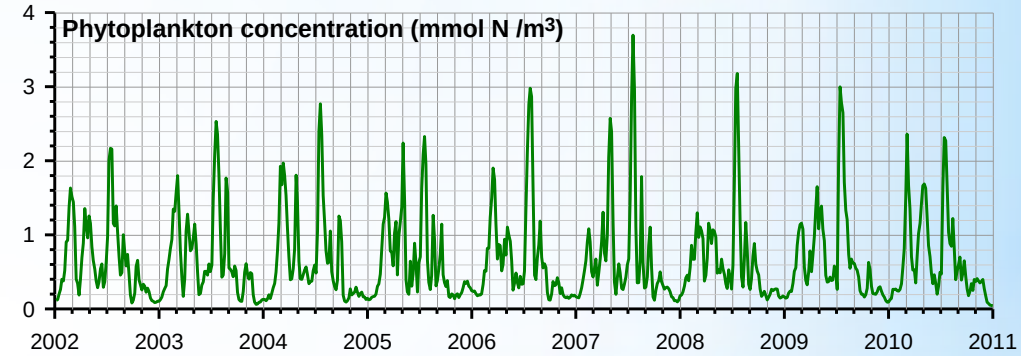
Deep part of the Black Sea

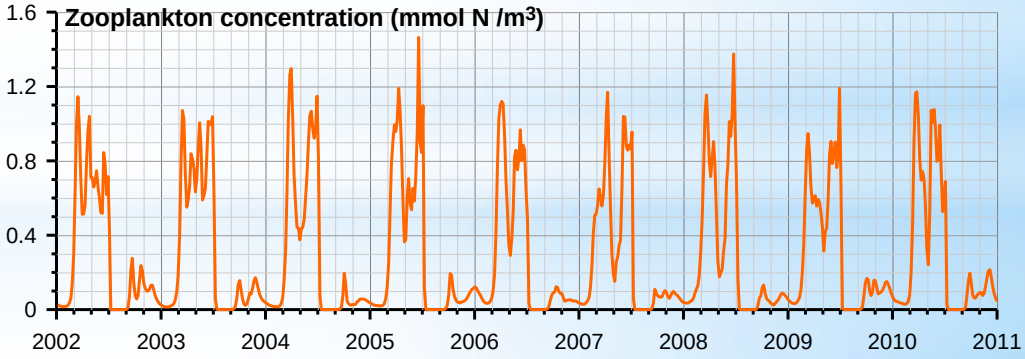






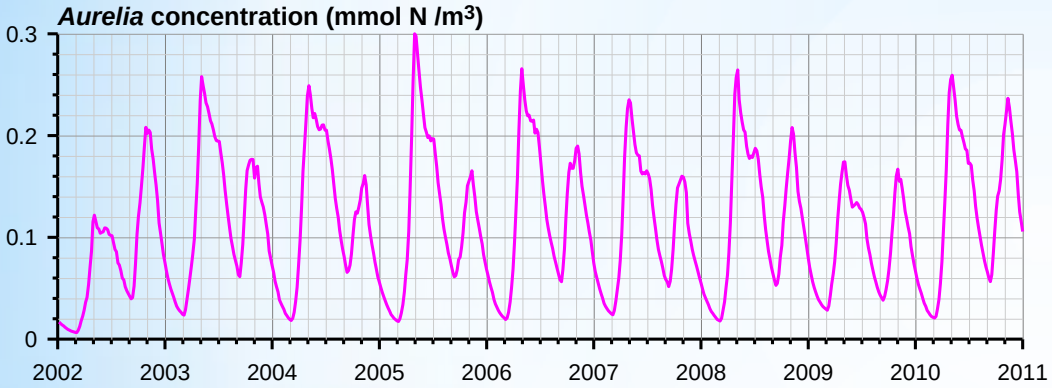
NWS of the Black Sea



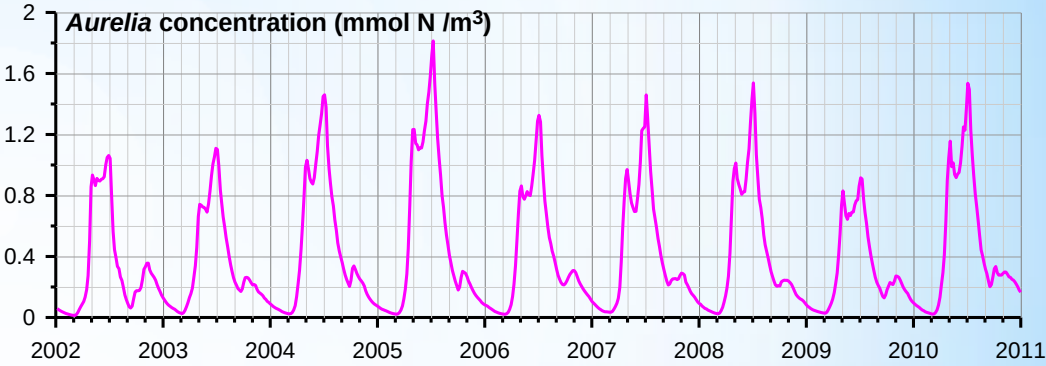


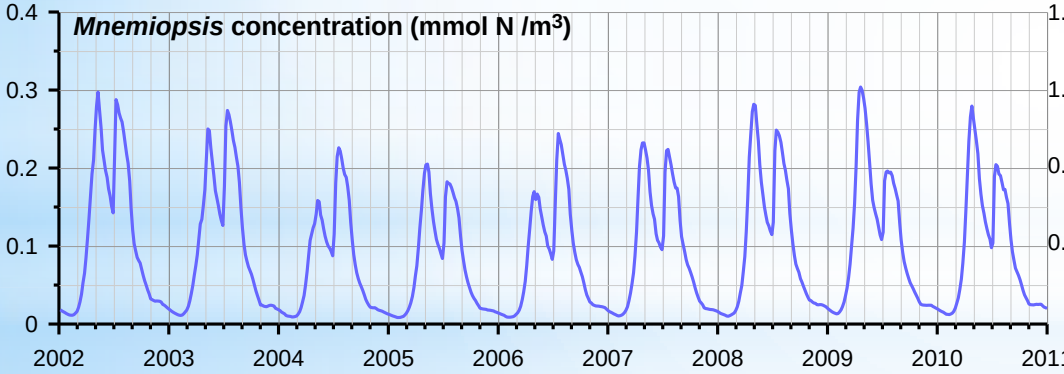
Dynamics of surface concentrations

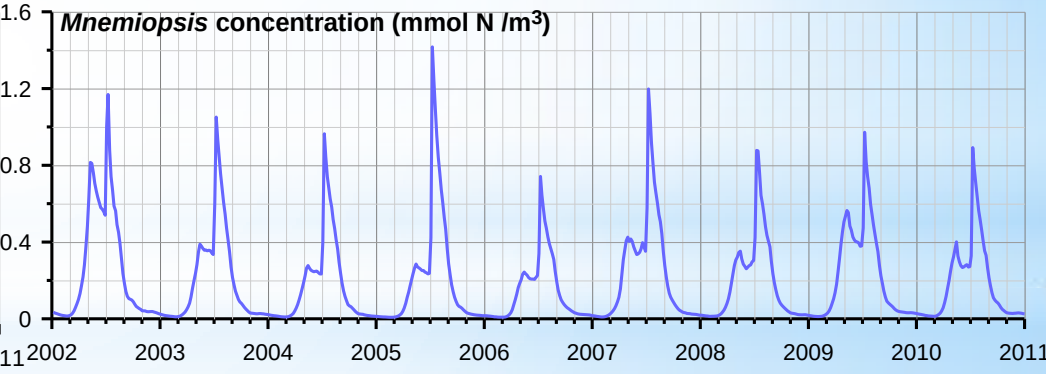
Deep part of the Black Sea



NWS of the Black Sea



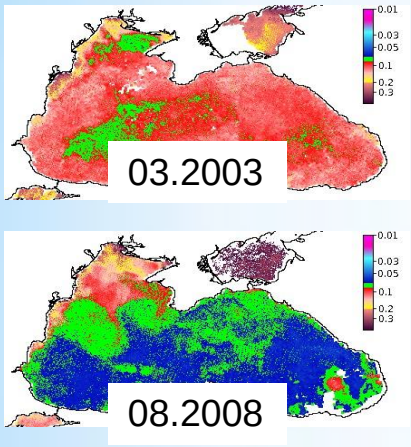




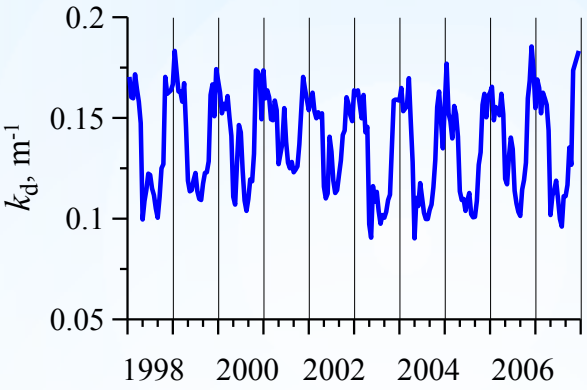
Descriptor: ***D5:Eutrophication:***

Indicators:

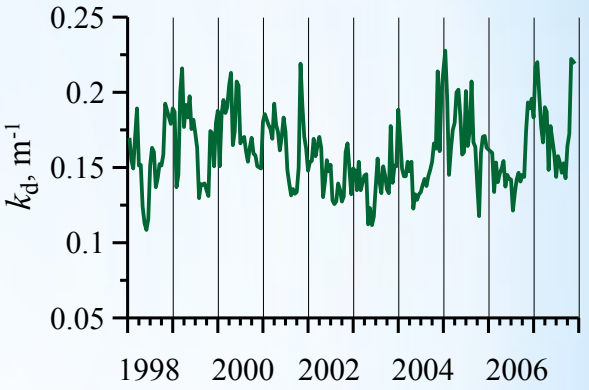
1) Water transparency (kd, m-1);



Deep-waters

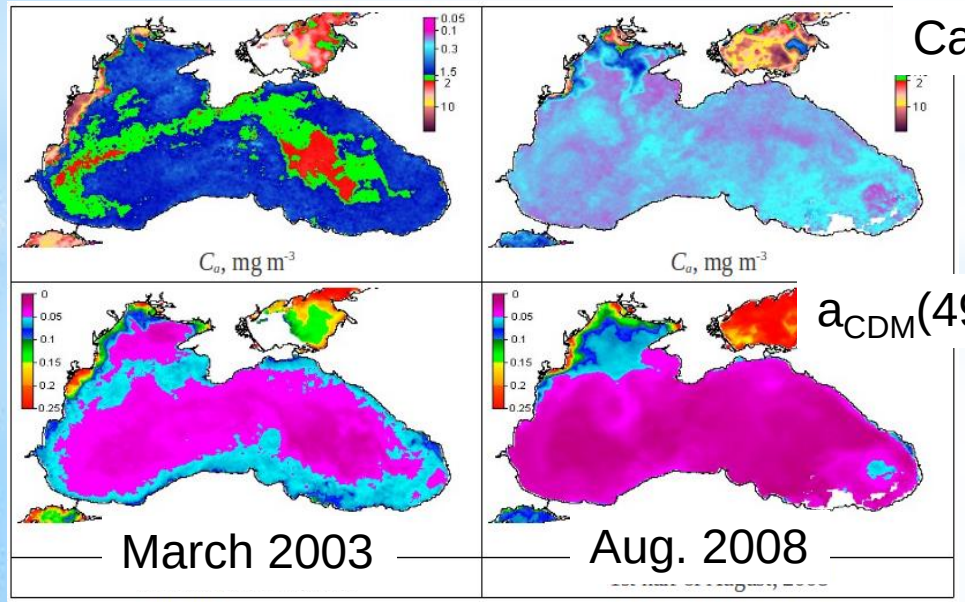


NW shelf



2) Chlorophyll concentration (bloom frequency; intensity and area extent of bloom);

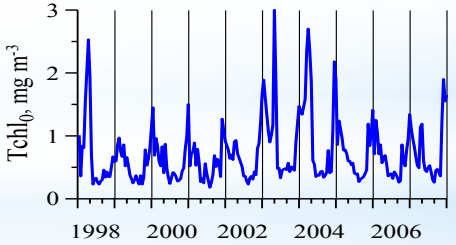
3) CDM absorption (as indicator on organic enrichment of waters)

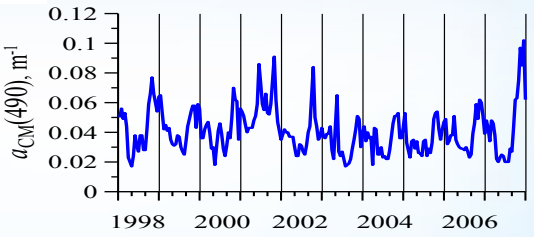


Ca

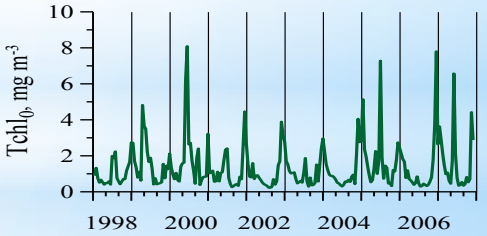
$a_{CDM}(490)$

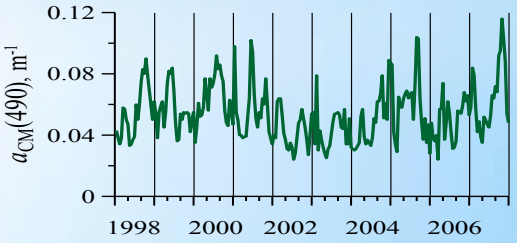
Deep-waters





NW shelf





Descriptors: ***D8: Contaminants (oil pollutions):***

Indicator: Area extent of oil spills (its spreading),

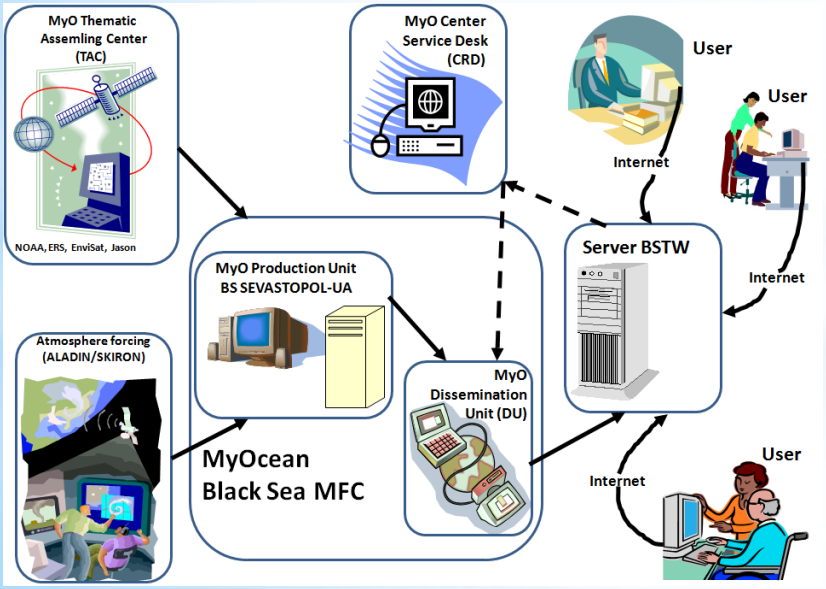
Kubryakov et al, 2011)

Increased oil transportation in the Black Sea - risk of catastrophic oil spill. Oil pollution could produce significant damage to the Black Sea ecosystem

The **BlackSeaTrack Web** (BSTW) system for accidental oil spill forecasts in the Black Sea has been developed on the base of the Seatrack Web (STW) model (Baltic Sea countries).

The BSTW system consists of three parts:

❑ forcing in the form of forecasted stratification, sea currents and wind fields, which is provided by the Black Sea MFC located at MHI in Sevastopol. The Black Sea MFC is the **MyOcean** regional marine forecasting center. It **runs operationally** and produces weather and ocean forecasts;



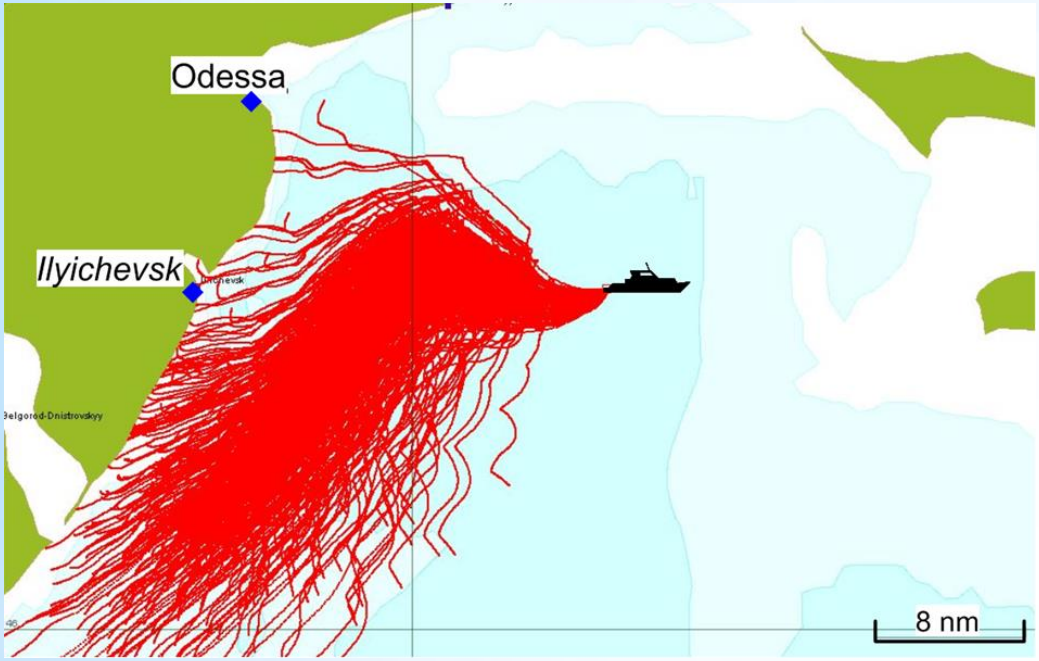
❑an **oil drift model** jointly developed by SMHI and the Royal Danish Administration of Navigation and Hydrography and which takes into account and adequately describes almost all physical and chemical processes affecting an oil spill;

❑ a graphical user interface developed by SMHI and based on open source GIS-server technology.

The BSTW system is available via the Internet, fully operational 24 hours a day and user friendly. It allows immediate access to the latest forecasts that drives the system. In addition, it provides other floating objects and backtracking.

Descriptors: ***D8: Contaminants (oil pollutions):***

Indicator: Area extent of oil spills and their spreading (Kubryakov et al, 2011)



One of the biggest oil spills in recent years occurred in the Ukrainian Black Sea. Oil spilled on the beaches of Odessa and Ilyichevsk (2011)

BSTW was used to prove the /find ship responsible for the accident

The BSTW system demonstrates good results when calculating the actual oil spills.

❑Therefore, the system can be used as a tool for sustained observation to identify oil spills and assess its spreading in the Black Sea.

Regional models could be used for assessment of D1, D4, D5 and D8 indicators (in operative mode)

D1: Biodiversity indicators:

- Species distribution/population size (;
- Habitat condition (*hydrological and chemical conditions)*
- Community condition (PSD/PSC)

D 4: Foodwebs indicators:

- Productivity: Primary Production (Total, New and regenerated);

Community condition :

1) Biomass of phytoplankton;
2) PSC (related to taxonomic structure of phytoplankton);
3) Biomass of fodder zooplankton;
4) jelly/fodder-zooplankton ratio)

D5:Eutrophication indicators :

- Water transparency (Churilova et al., 2008);
- Chlorophyll (Friquency, intensity and area of bloom)

D8: Contaminants indicators (oil pollutions):

- oil spills area extent and spreading

The development of the regional models and its application for ecosystem state assessment - on going work in frame of the FP 7 projects:
MyOcean, DEVOTES; PERSEUS

Thank you for attention