Impacts of cyclones on the phytoplankton chlorophyll and sea surface temperature spatial and temporal dynamics in the Barents Sea as revealed from space

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Introduction

Knowledge about concentration of phytoplankton chlorophill (chl) as a measure of primary productivity variations in the Arctic Seas is important for organization of sustainable development of this area.

The impact of cyclone passing is well studied in tropical latitudes. This research is performed for the first time across the polar region.

Objectives

(1) to reveal the prime features of the impact of cyclone passage on chl concentration spatio-temporal distribution
(2) to perform numerical estimations of this impact
(3) to detect physical mechanisms, driving the studied phenomenon.

Materials & Methods

- concentration of chl was retrieved with the NASA algorithms OC4 for SeaWiFS and OC3 for MODIS (Aqua&Terra)
- SST from MODIS
- cyclones trajectory from reanalysis data on the geopotencial of the 1000 mbar isobaric surface from NCEP/NCAR as a 200km width strip centered in the cyclone's "eye"
- wind speed from QuickSCAT

93 cyclones were identified, but only **22** of them were used according to the following criteria:

Vegetation period (April-August)

More than 5-6 days with at least 7% clouds - free area for each day after cyclone passage

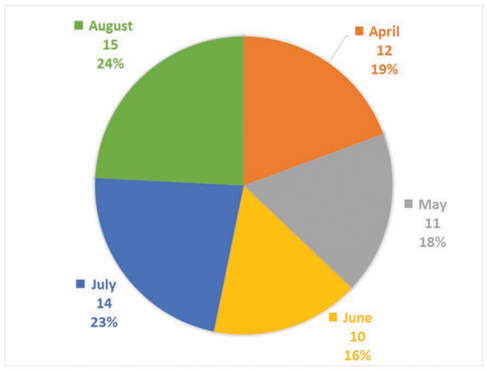
Time of cyclone stay over the Barents Sea no more than 3 days

Free of cloudiness area within the cyclone trajectory not less than 20%

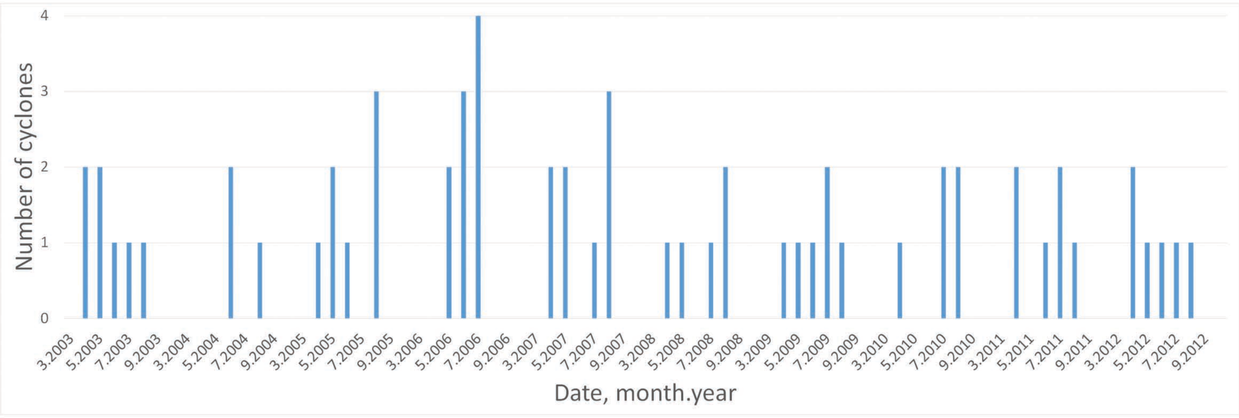
Results

Statistics of cyclone passing

The amount of all cyclone incidences per month was maximum(3-4) in 2005-2007, but mainly there were 1-2 in each month only and this number didn't increase during studied period. The biggest number of cyclones was seen in July and August, but generally their month distribution is equal.

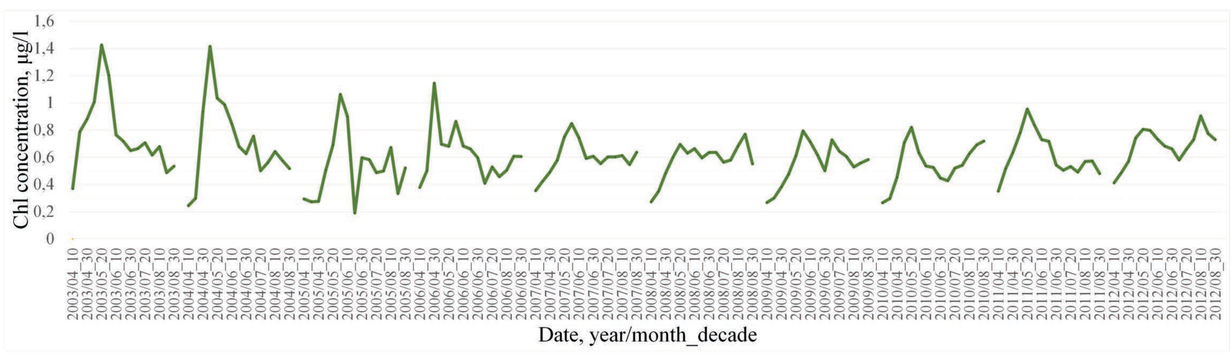


month, number of cyclones,part (%%)



Seasonal dynamics 2003-2012

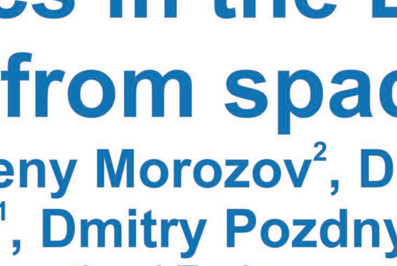
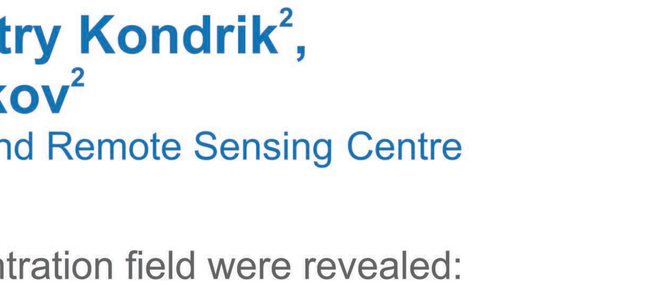
Seasonal dynamics of chl concentration variations was derived to estimate cyclone contribution to it



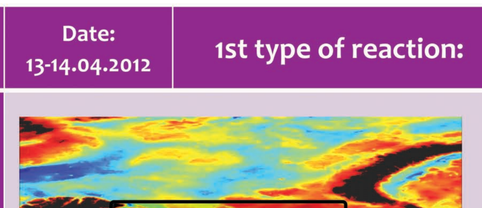
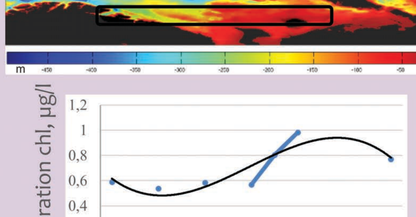
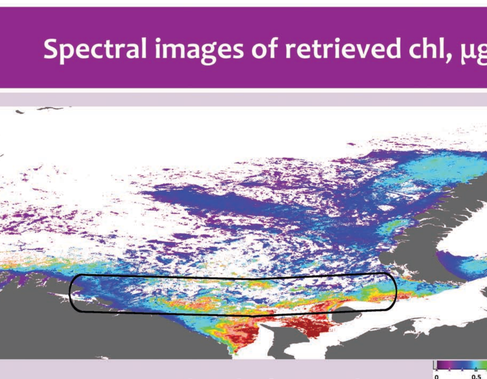
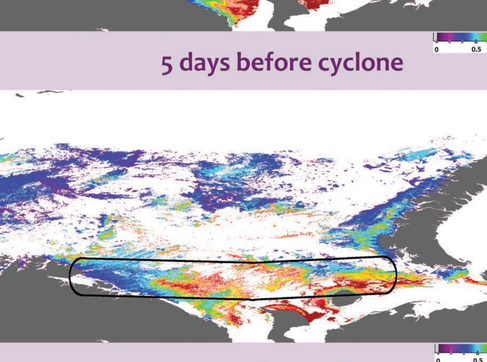
Cyclone impact

3 types of reaction on chl concentration field were revealed:

1st type: mixing->raising nutrients
decrease of chl and SST in the first days after cyclone passage, which than turns to gradual increase of these parameters

Type	Date: 13-14.04.2012	1st type of reaction:	Spectral images of retrieved chl, µg/l
F->G	  		 5 days before cyclone  5 days after cyclone

2nd type: maximum raising->mixing->raising nutrients
A brief increase in chl and SST in the first days after cyclone passage, which turns to gradual decrease in the mentioned parameters, followed by small growth of them

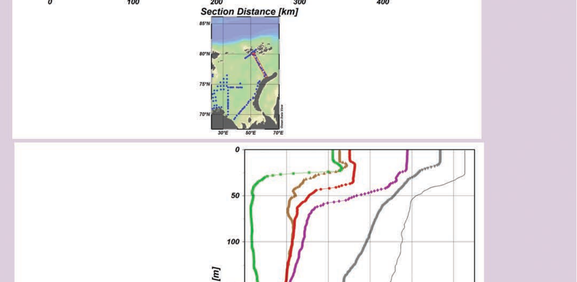
Type	Date 11-12.07.2006	2nd type of reaction:	In situ auxiliary data (WOD 2013, NOAA)
G->F	  		 

3d type: low productive season
practical absence of any reaction of chl concentration field on cyclone passage (chl <0,1 mcg/l)

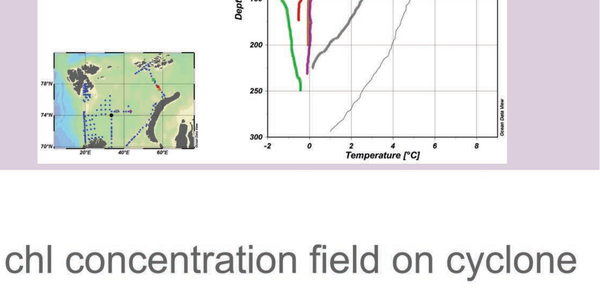
Correlation analysis and multilinear regression

Statistical dependence between chl modulations and cyclone parameters

$$\Delta chl = -0.00516638 * Hcycl + 0.000661515 * Vtr + 0.180391348,$$



where Δchl = excess of chlorophyll concentration growth over its falling,
Hcycl = cyclone baric depth,
Vtr = cyclone passing speed.
Determination coefficient is 0,75.



Conclusions

The cases of the cycle-driven increase in chl proved to be prevalent and is potentially capable of boosting the primary productivity in the Barents Sea, however its increase is not high to add significantly to the annual product.

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