

# Chlorophyll-a concentration at wind-induced upwelling regions in Peter the Great Bay in 2003-2007

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Scientific background. It is known that high biological productivity is observed in the areas of upwelling. Chlorophyll-a concentration is one of the basic parameters of water bioproductivity. Autumn is favorable season for development of upwelling in Peter the Great Bay. It is why we decided to investigate the chlorophyll-a distribution in Peter the Great Bay in autumn.

Objective of our investigation is to show the features of chlorophyll-a distribution, caused by influence of wind-induced upwelling in Peter the Great Bay.

# Data

## Satellite data

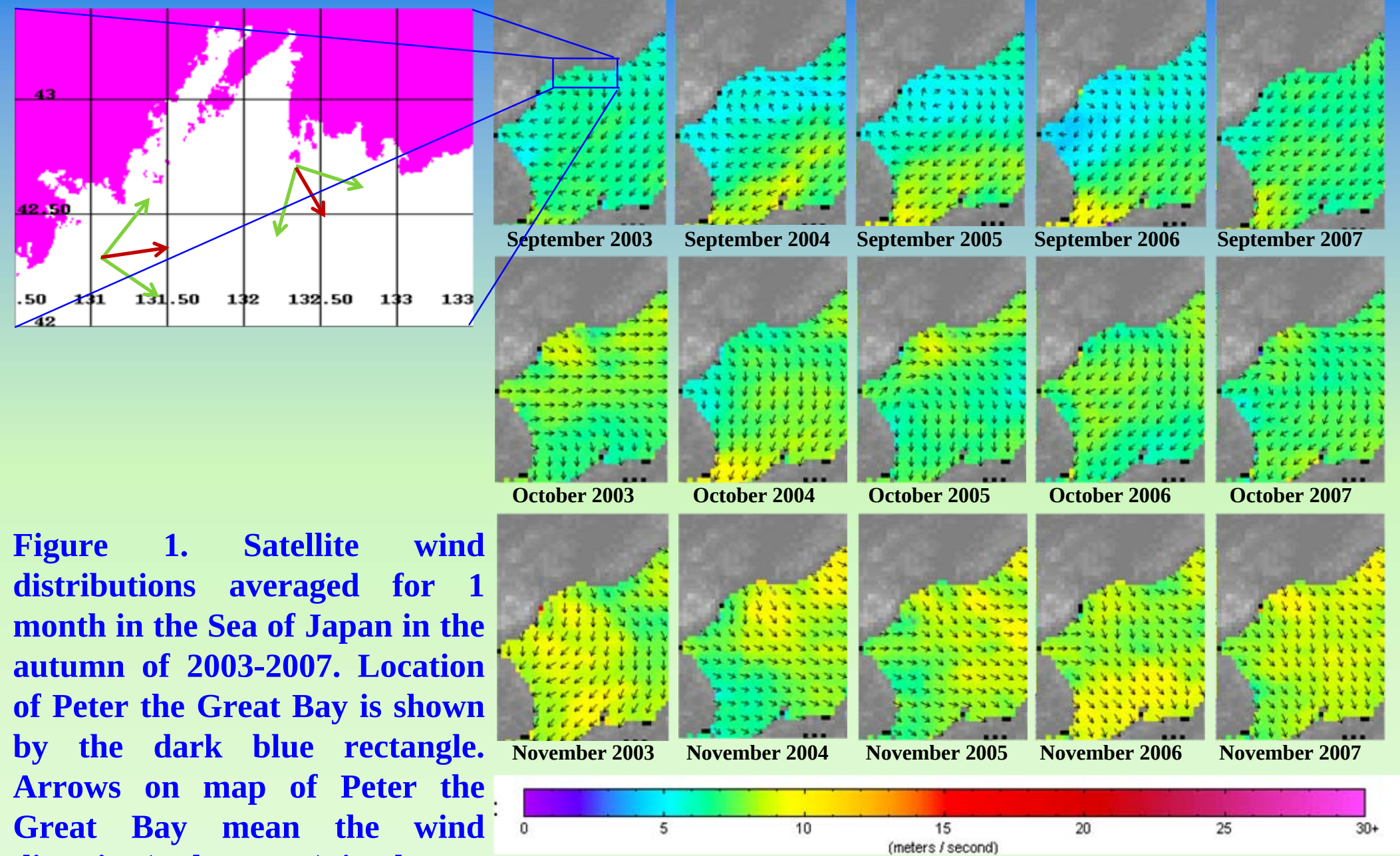
1. Chlorophyll-a concentration for 2003-2007 from SeaWiFS (OrbView-2) color scanner and MODIS(Aqua ) spectroradiometer.
2. Sea Surface Temperature from NOAA and Aqua satellites.
3. Near-surface wind from QuikScat satellite.

## Meteorological data

Near-surface wind from WMO (World Meteorological Organization)

## Acknowledgements

We thank NASA/DAAC, CEARAC, Remote Sensing Systems Group for satellite data and distributions.



**Figure 1.** Satellite wind distributions averaged for 1 month in the Sea of Japan in the autumn of 2003-2007. Location of Peter the Great Bay is shown by the dark blue rectangle. Arrows on map of Peter the Great Bay mean the wind direction (red arrows) in the coordinates system (green arrows).

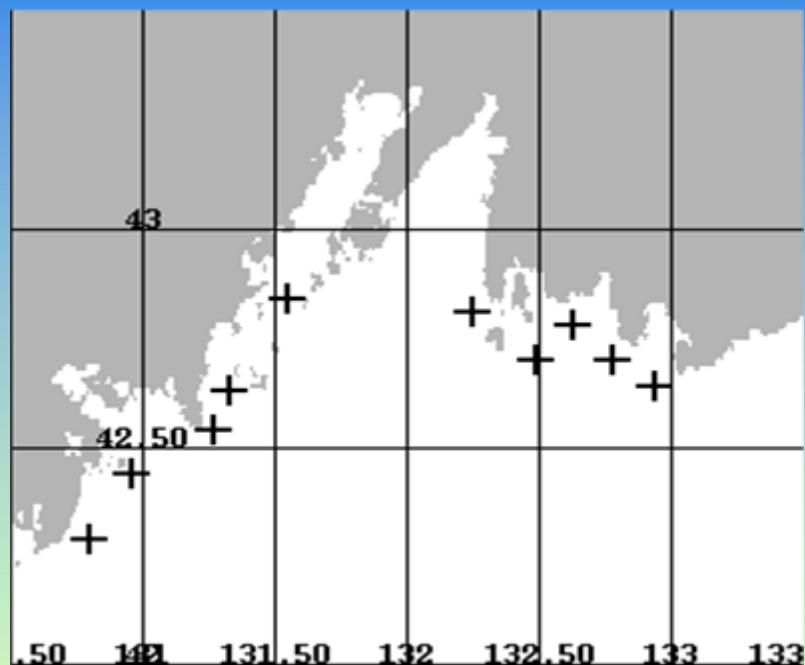


Figure 2. Location of points, where analysis of wind influence on phytoplankton growth was fulfilled.

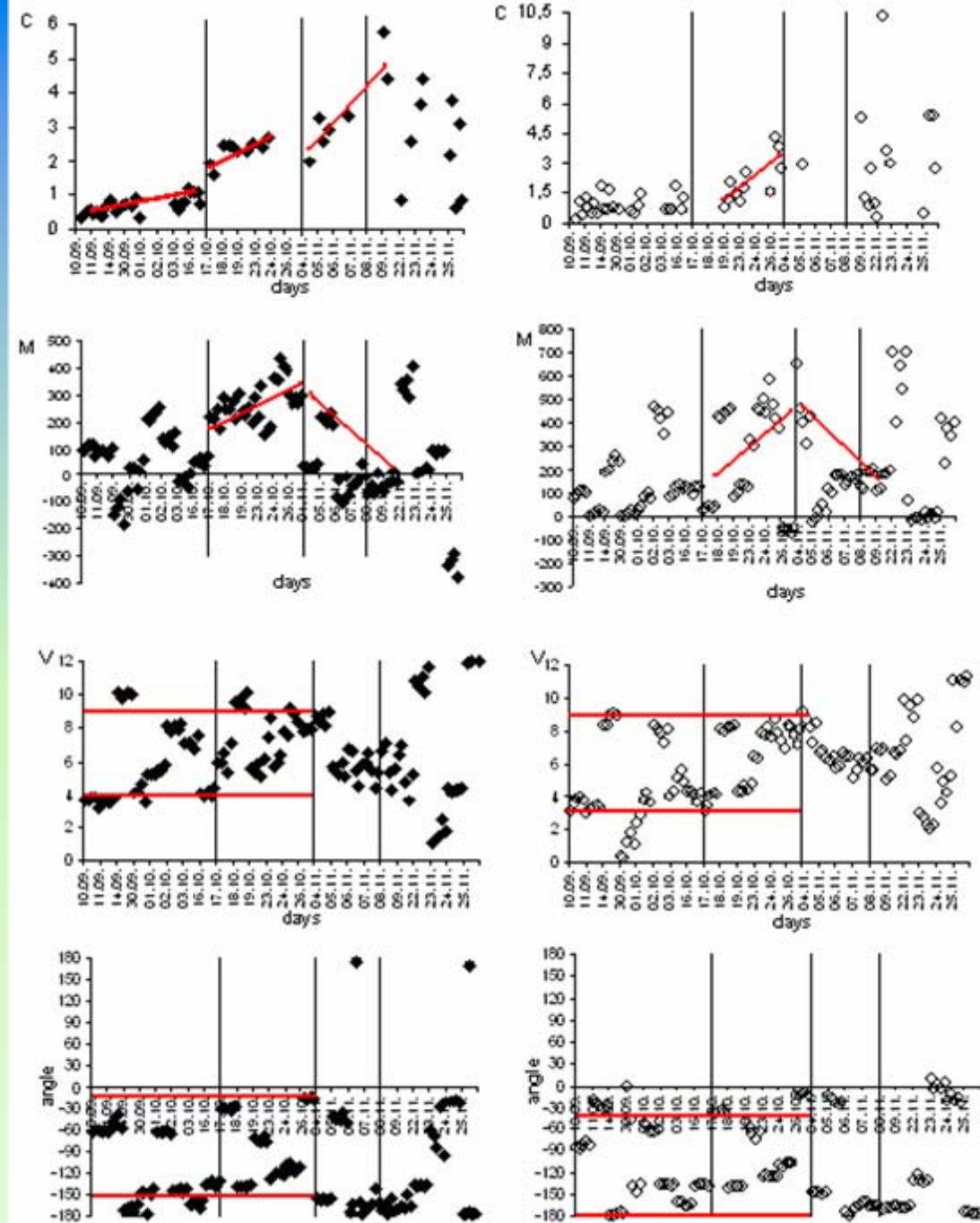
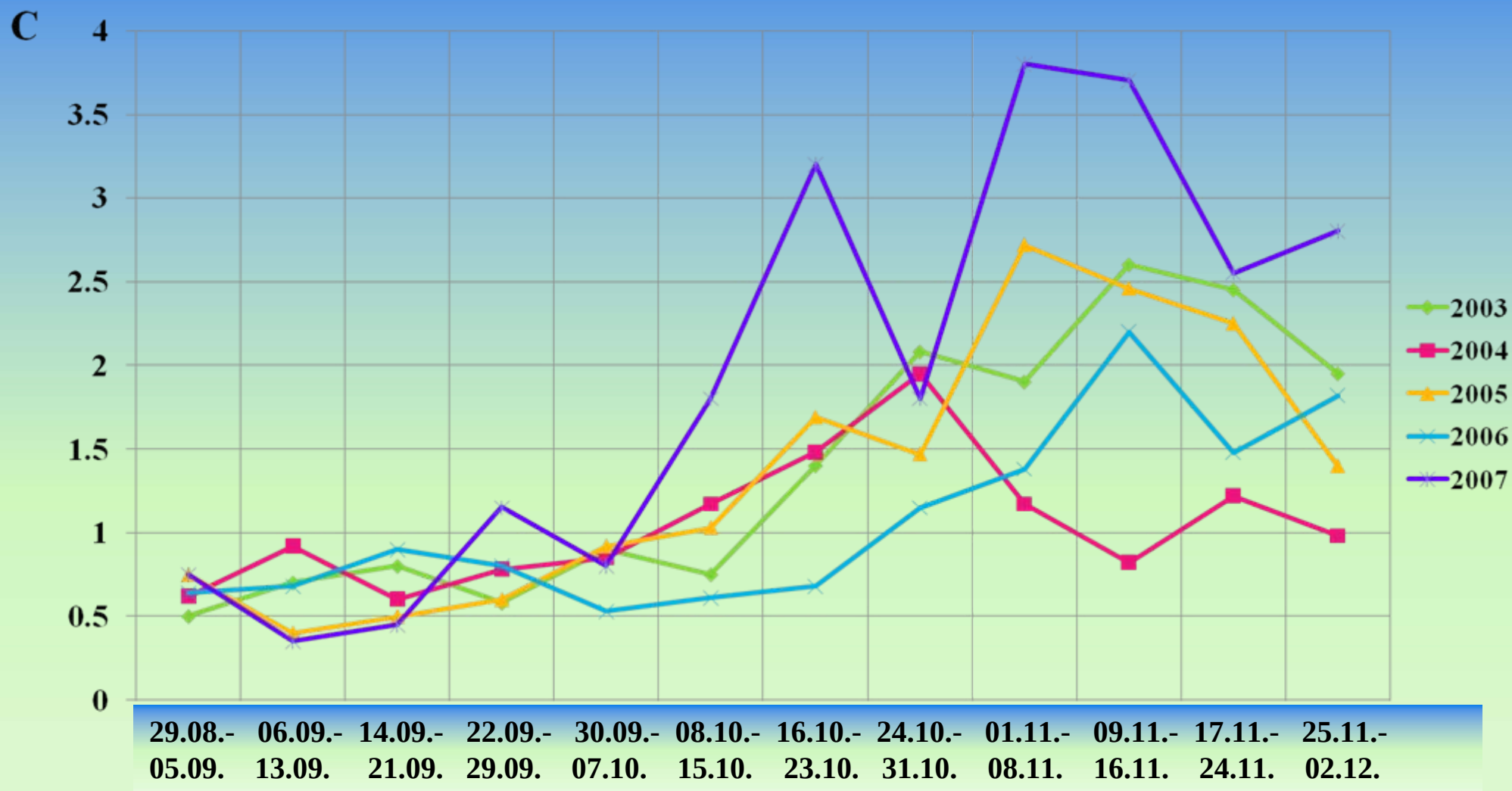
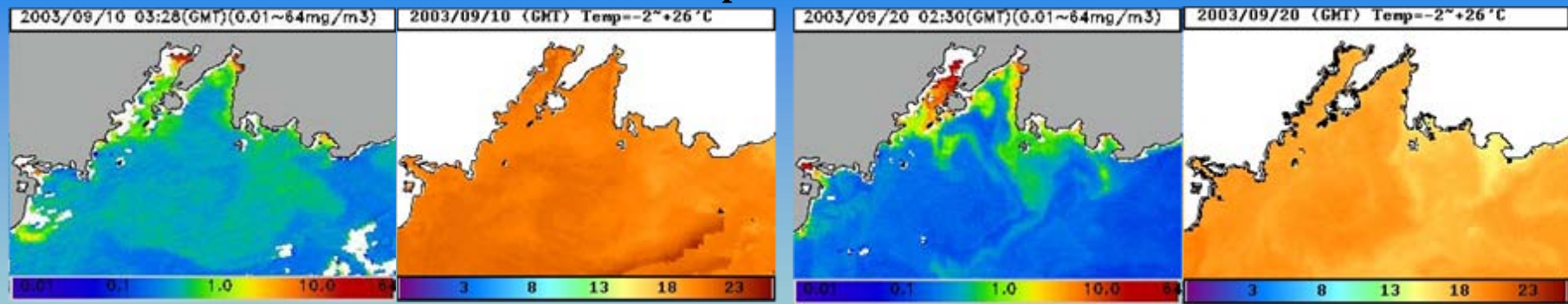


Figure 3. Variation of chlorophyll-a concentration ( $C$ ,  $\text{mg/m}^3$ ), upwelling index ( $M$ ,  $\text{kg/m sec}$ ), velocity ( $V$ ,  $\text{m/sec}$ ) and direction of wind in 2003 at chosen points in definite days (at 5 points – near north-eastern bay coast ( $\diamond$ ) and at 5 -- near western coast of Peter the Great Bay ( $\circ$ )).



**Figure 4. Variation of satellite 8-days chlorophyll-a concentration (C, mg/m<sup>3</sup>), averaged for Peter the Great Bay, from August 29 to December 2, 2003-2007.**

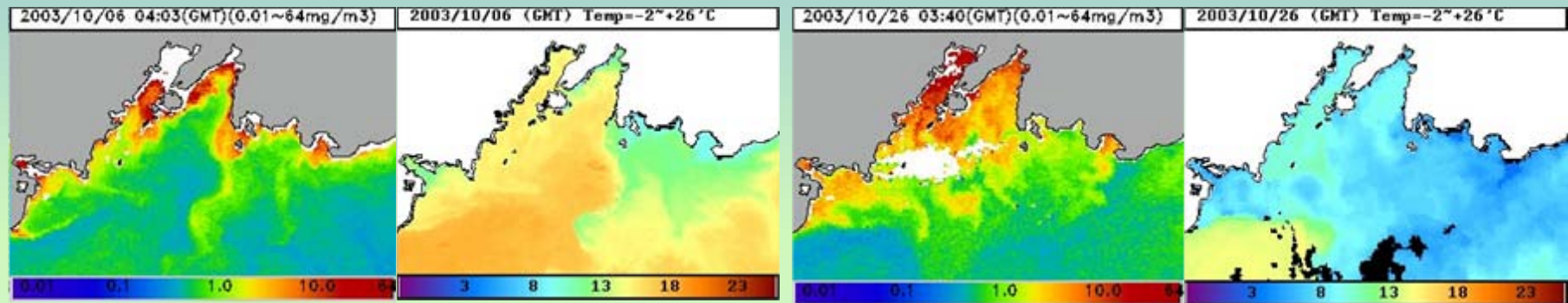
## September



10.09.2003

20.09.2003

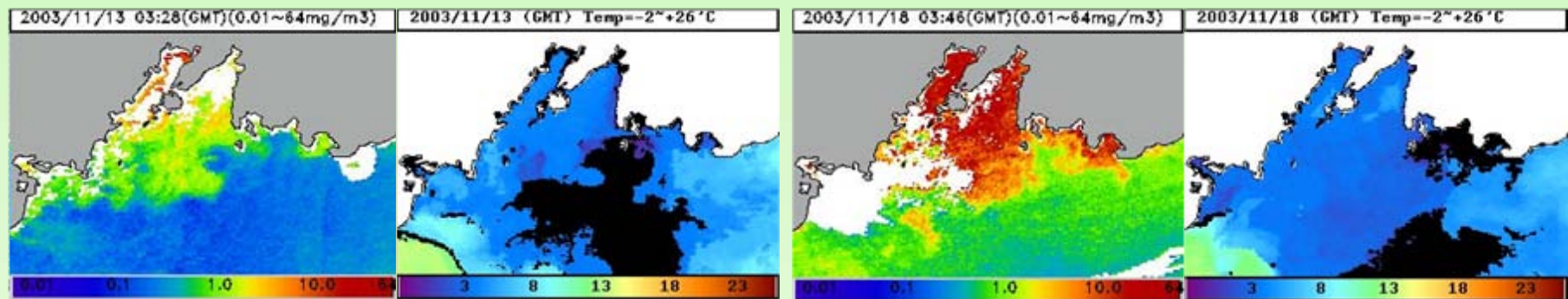
## October



06.10.2003

26.10.2003

## November

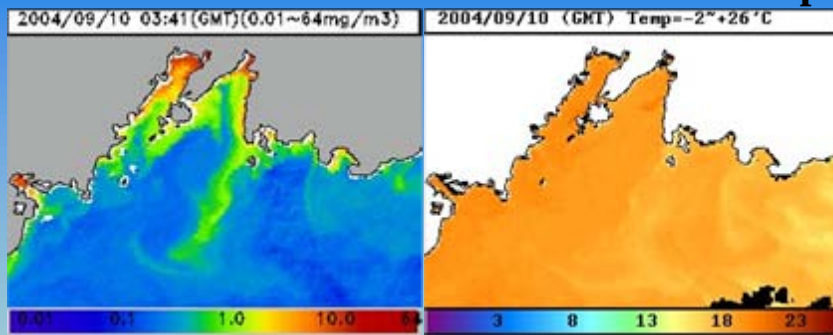


13.11.2003

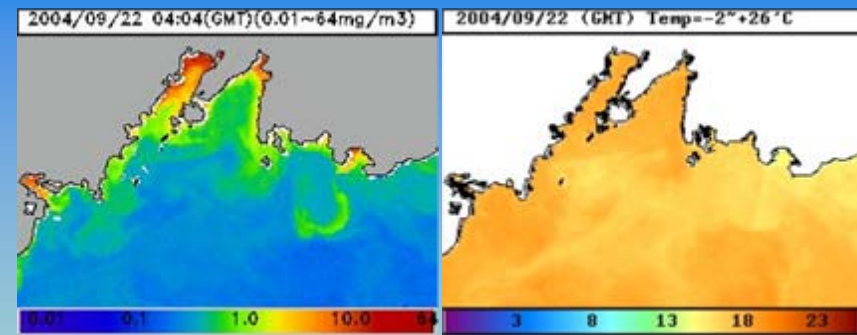
18.11.2003

**Figure 5 . Variability of chlorophyll-a and SST distributions in Peter the Great Bay in autumn 2003.**

## September

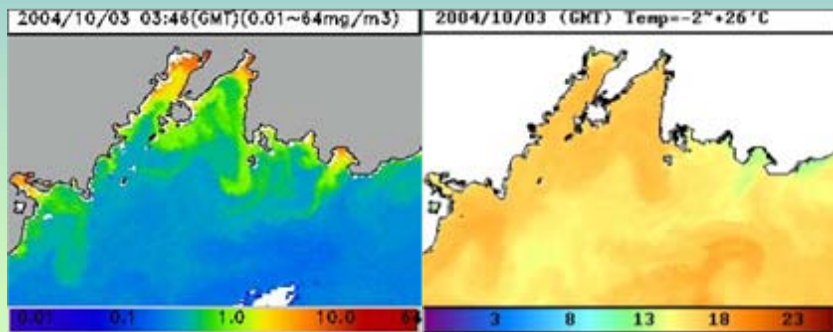


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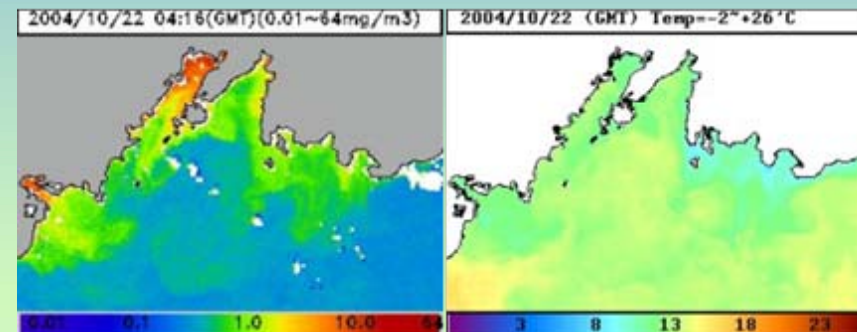


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## October

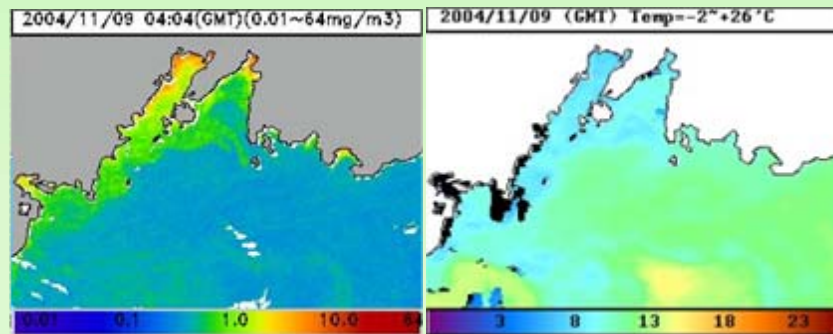


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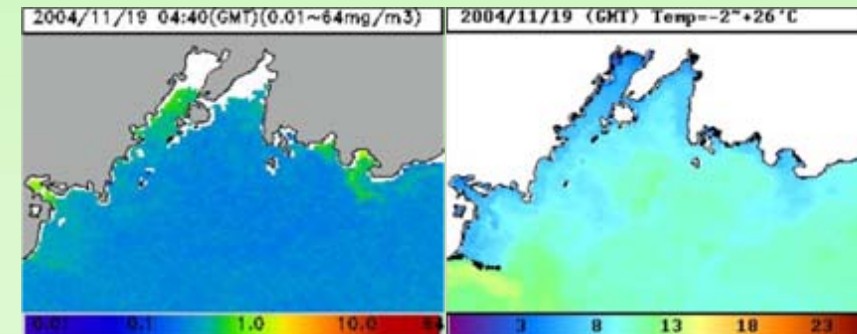


22.10.2004

## November



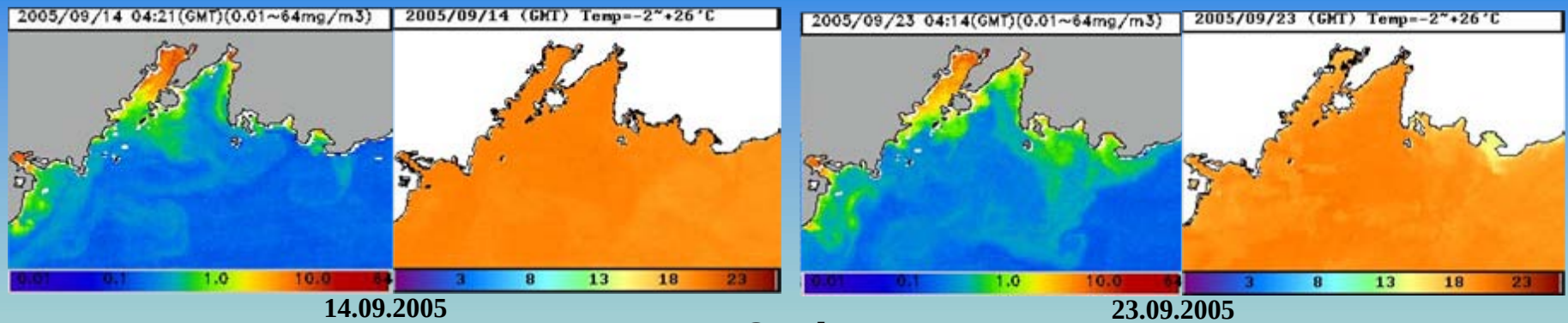
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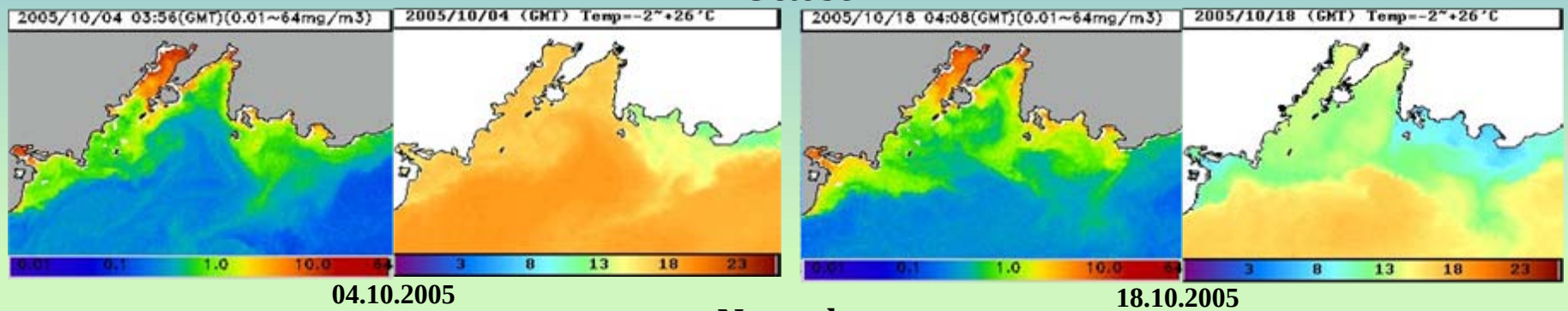
19.11.2004

**Figure 6. Variability of chlorophyll-a and SST distributions in Peter the Great Bay in autumn 2004.**

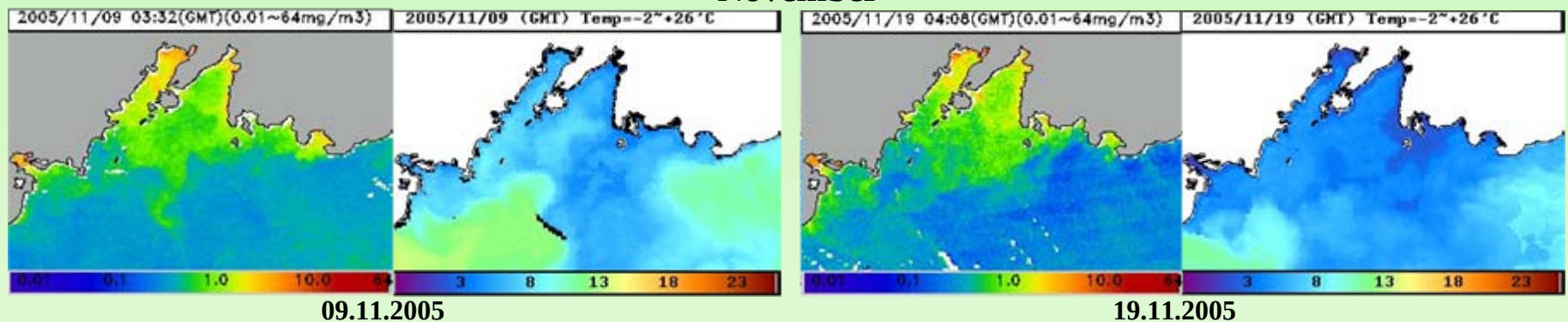
## September



## October

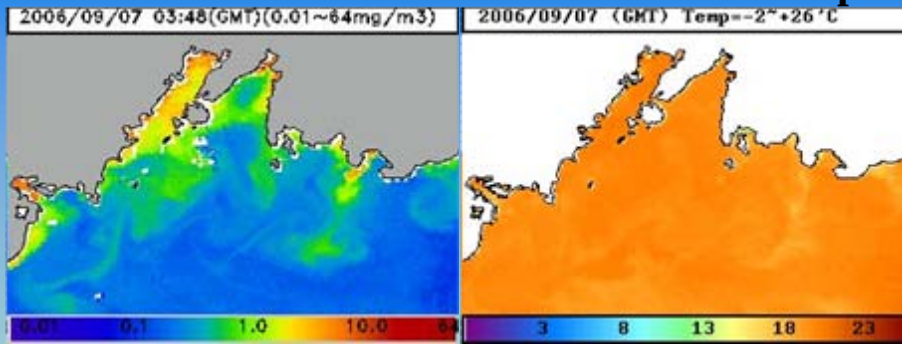


## November

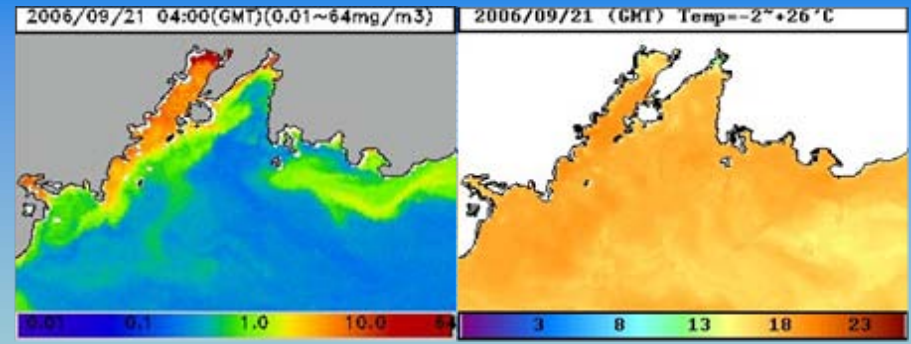


**Figure 7 . Variability of chlorophyll-a and SST distributions in Peter the Great Bay in autumn 2005.**

## September

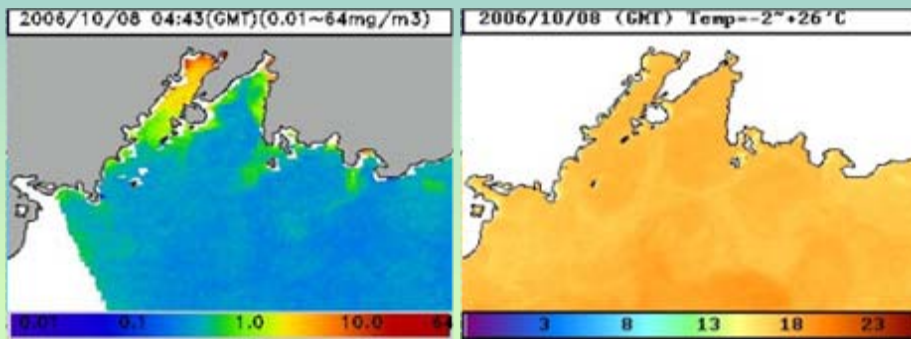


07.09.2006

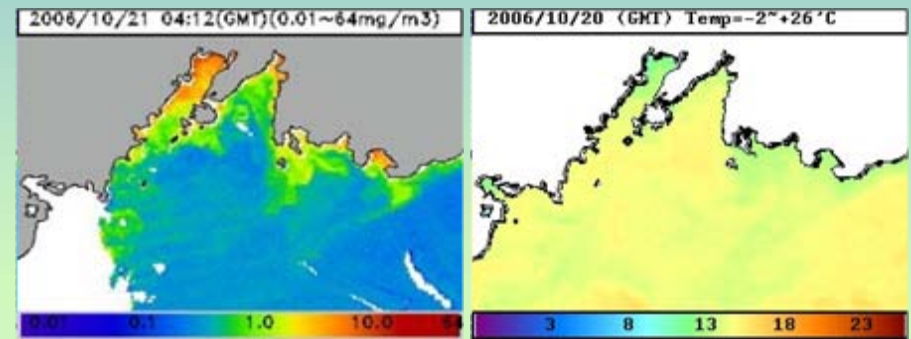


21.09.2006

## October

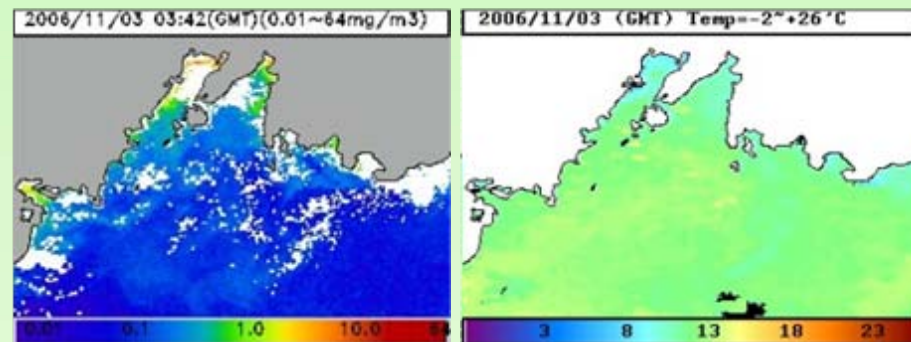


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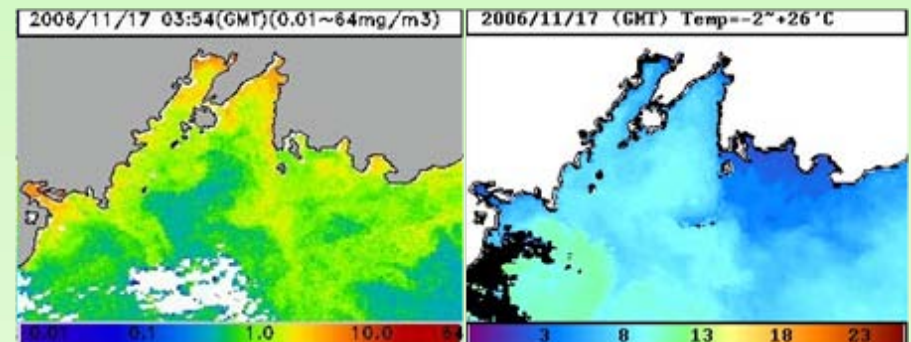


21.10.2006

## November



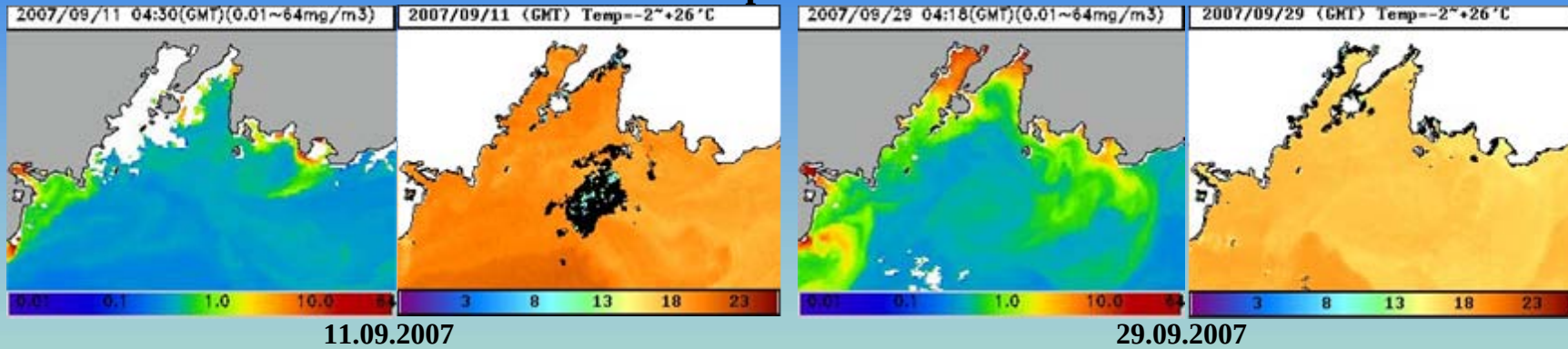
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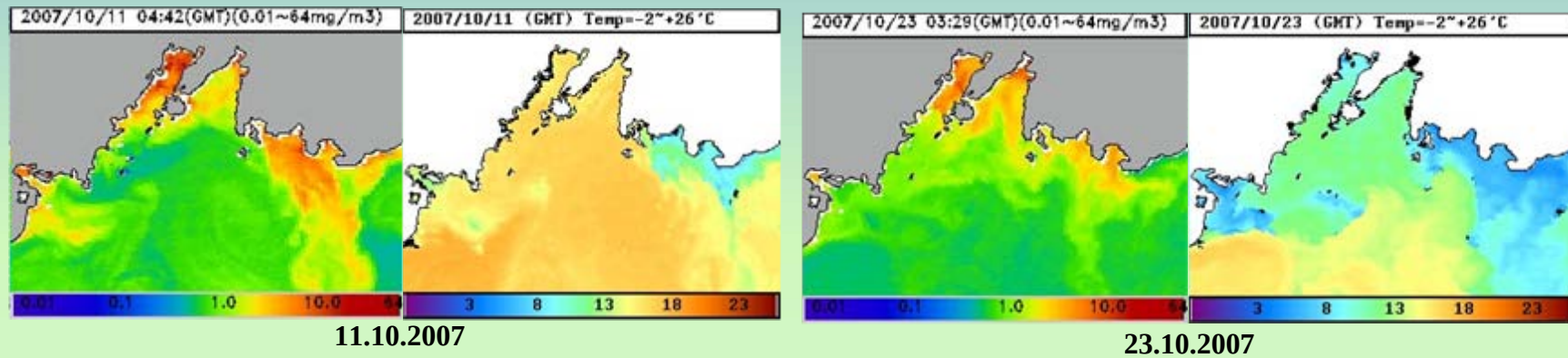
17.11.2006

**Figure 8 . Variability of chlorophyll-a and SST distributions in Peter the Great Bay in autumn 2006.**

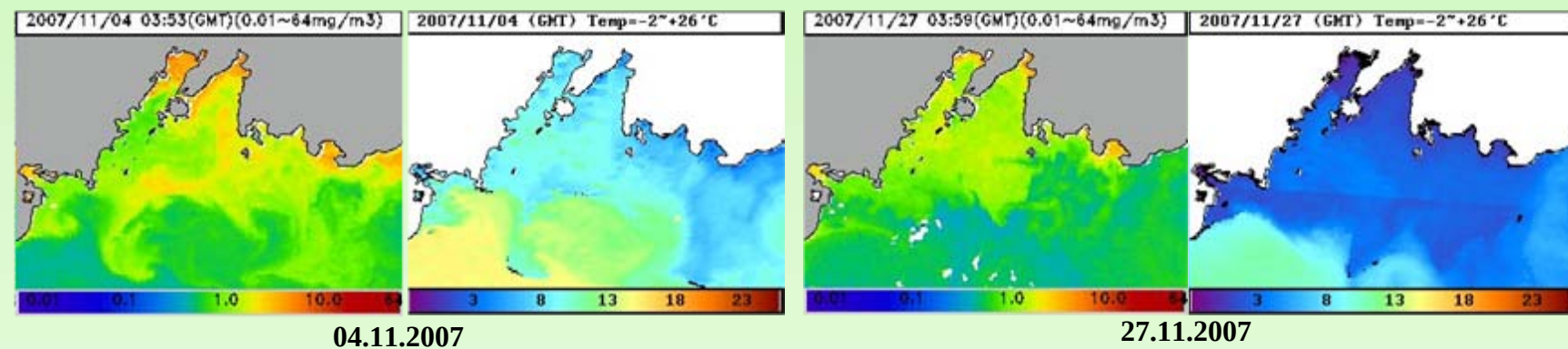
## September



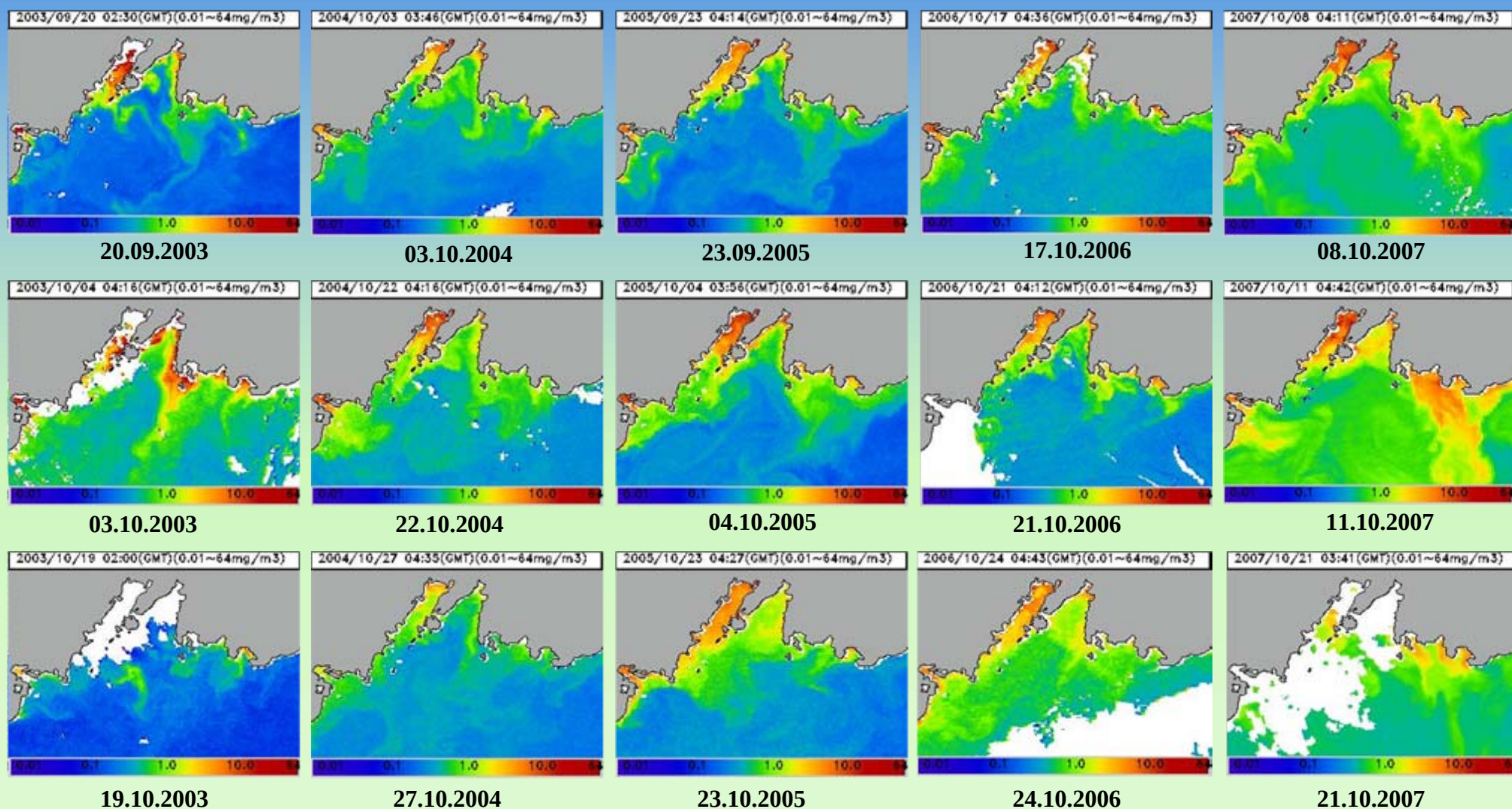
## October



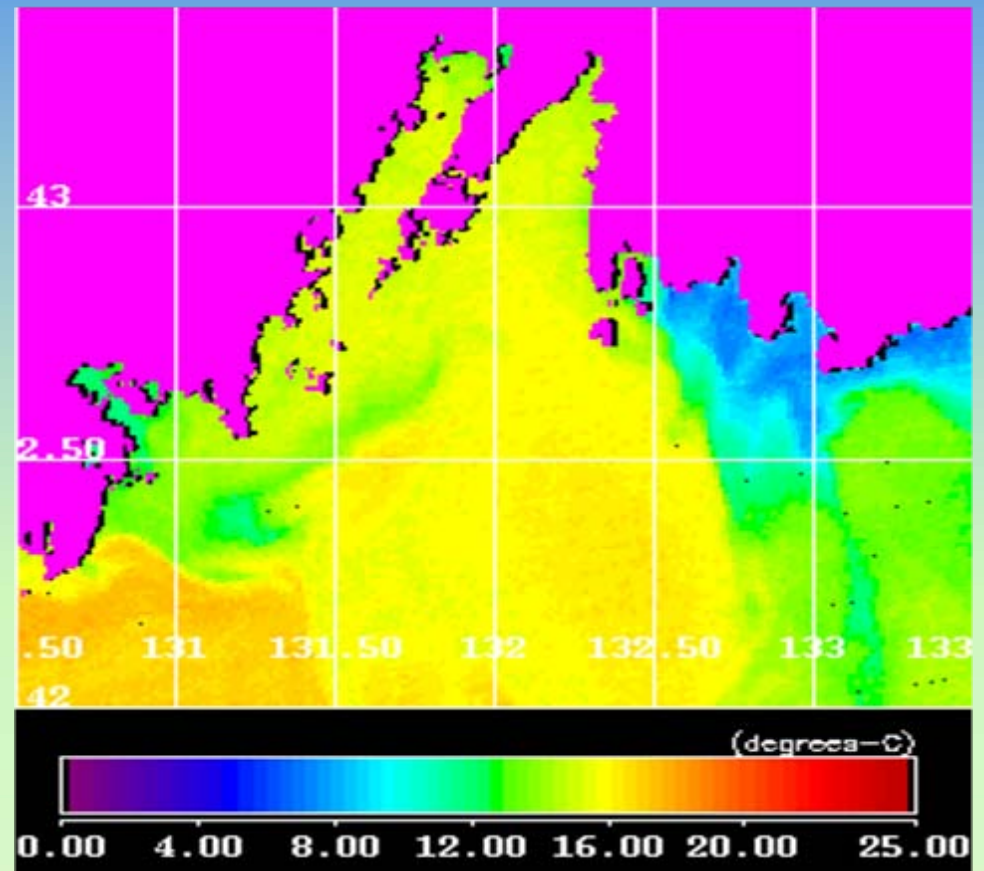
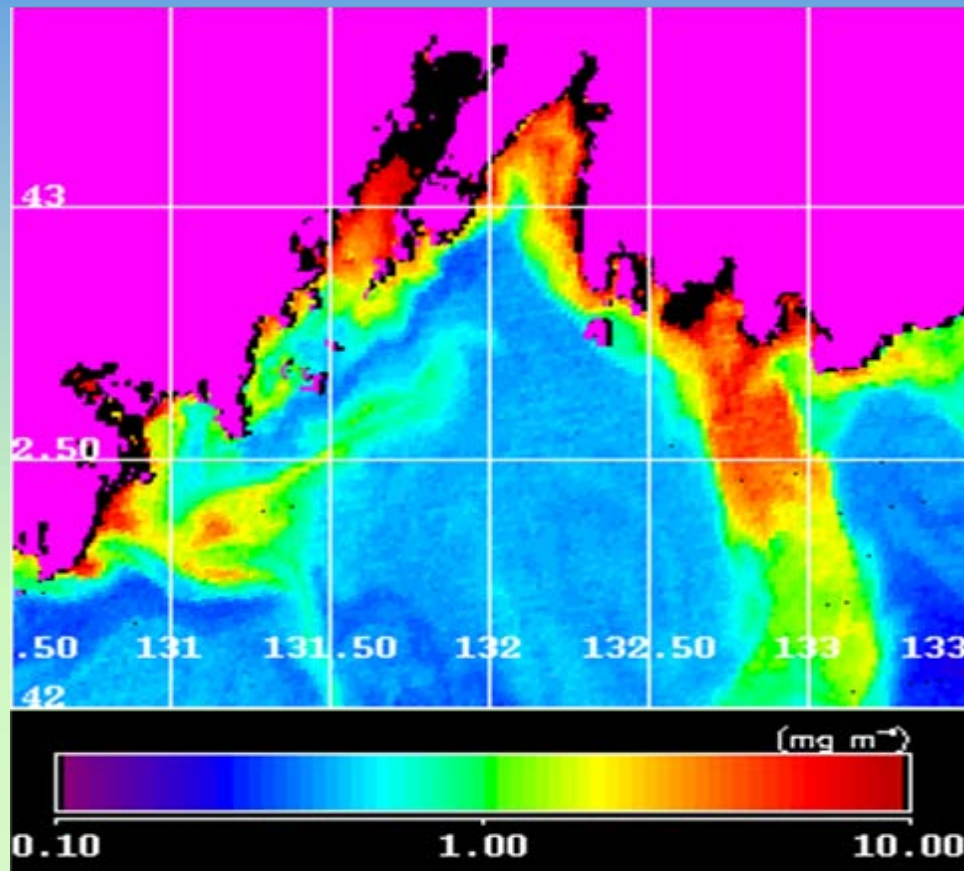
## November



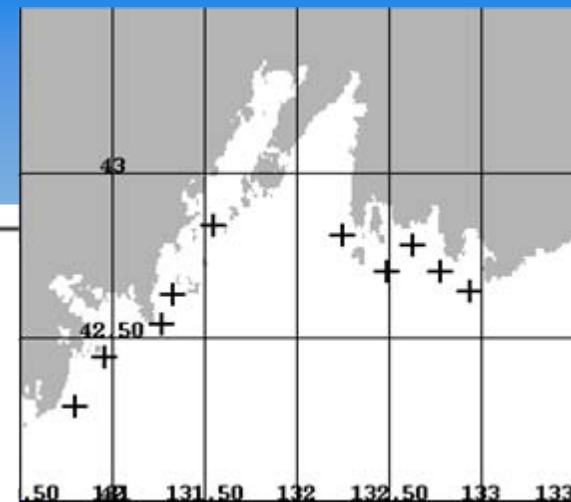
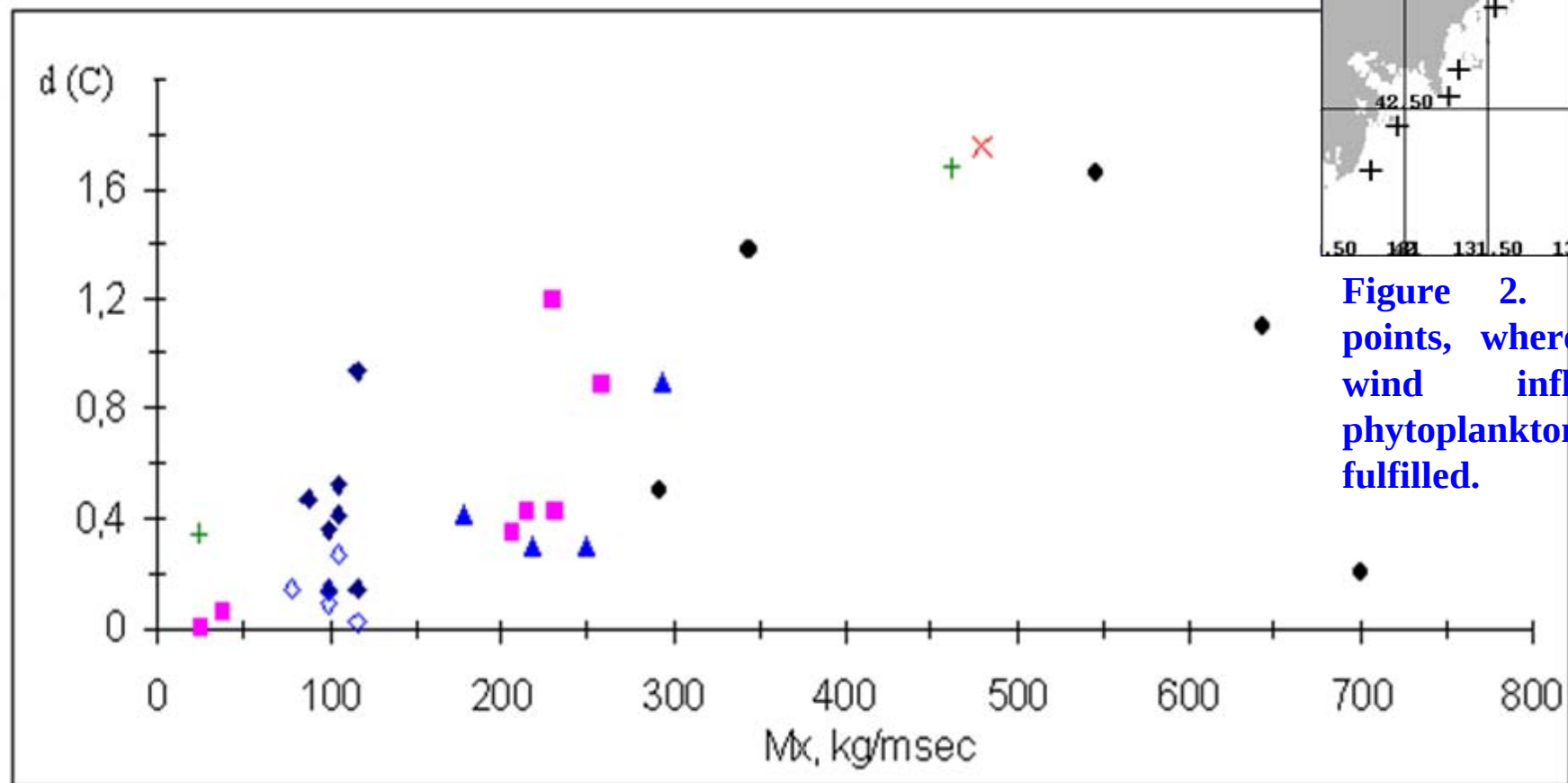
**Figure 9 . Variability of chlorophyll-a and SST distributions in Peter the Great Bay in autumn 2007.**



**Figure 10. Chlorophyll-a distribution in Peter the Great Bay at the beginning of upwelling (top panel), the maximal appearance of upwelling (middle panel) and the disappearances of upwelling (bottom panel) in 2003-2007.**

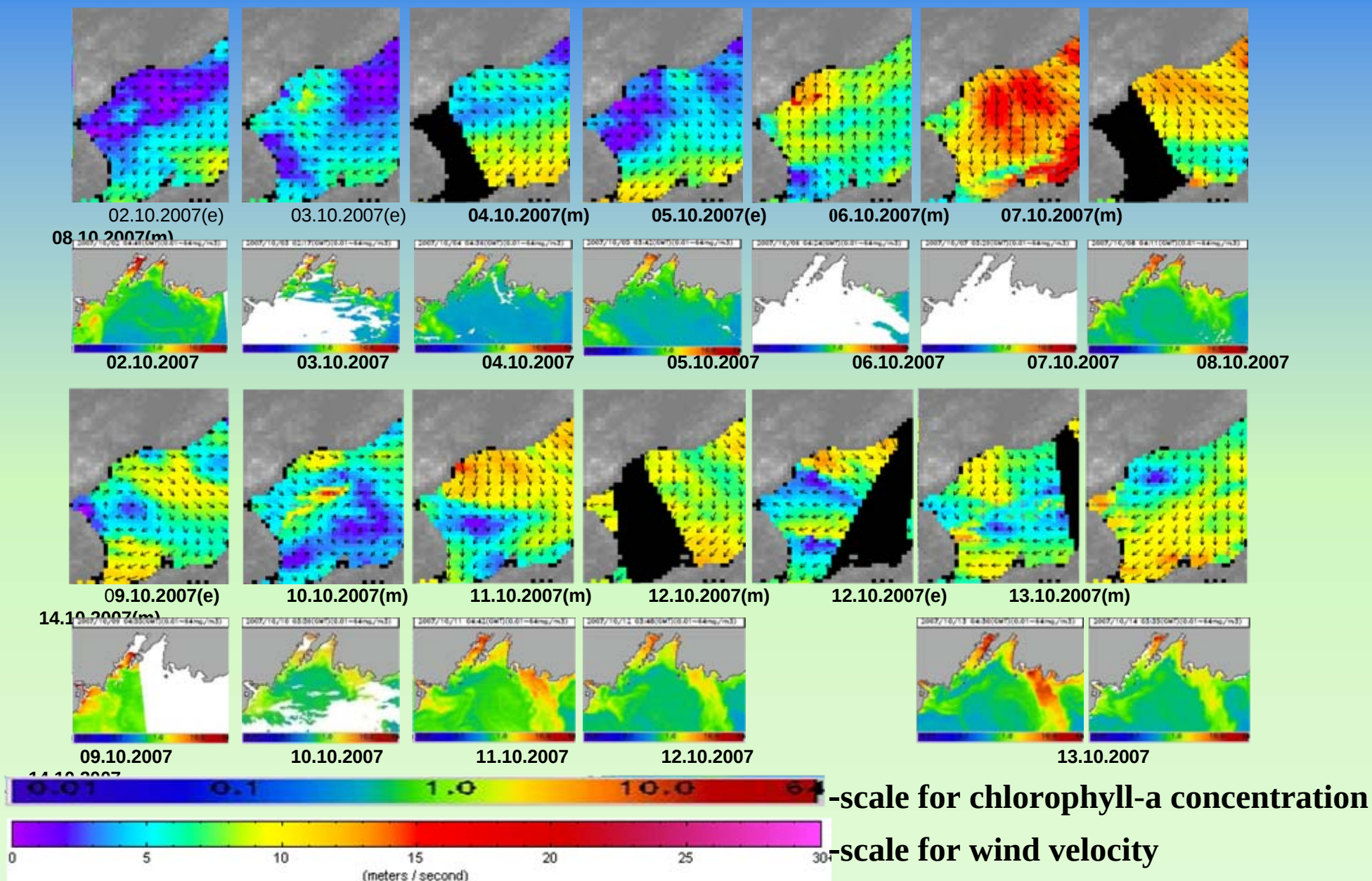


**Figure 11. Chlorophyll-a and SST distribution in Peter the Great Bay at the wind upwelling on November 13, 2007.**

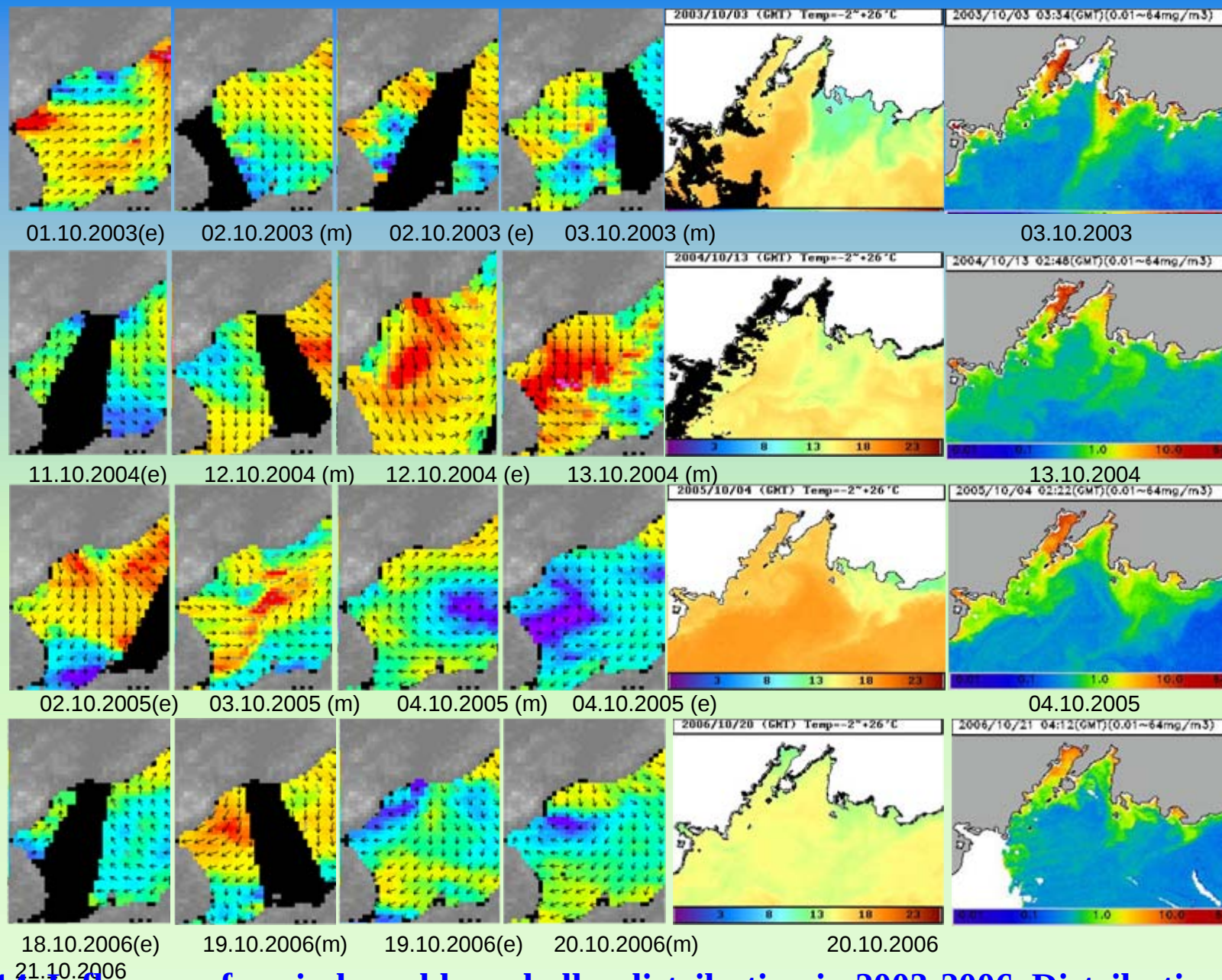


**Figure 2. Location of points, where analysis of wind influence on phytoplankton growth was fulfilled.**

**Figure 12. Increase of chlorophyll-a concentration during the upwelling events in Peter the Great Bay in 2003 between days: 10.09. and 11.09. (◇), 11.09. and 14.09. (◆), 01.10. and 03.10. (■), 17.10. and 18.10. (▲), 24.10. and 26.10. (×), 04.11. and 05.11. (+), 22.11. and 25.11. (●).**



**Figure.13. Influence of a wind on chlorophyll-a distribution in 2007. Distributions of a wind from October to 14, 2007 and below their the corresponding chlorophyll-a distributions. Symbols of m or e in brackets mean the satellite observation of a wind in the morning or in the evening.**



**Figure.14. Influence of a wind on chlorophyll-a distribution in 2003-2006. Distributions of a wind before the beginning of upwelling and on their right the corresponding SST and chlorophyll-a distributions. Symbols of m or e in brackets mean the satellite observation of a wind in the morning or in the evening.**

## CONCLUSIONS

-In the late September - the later October the area of the increased chlorophyll-a concentration develops near the north-east coast of Peter the Great Bay. This area extends from the coast offshore towards the deep sea to 30-40 km. The cause of the increased chlorophyll-a concentration is wind upwelling.

-Upwelling characteristics were more strongly pronounced in the early October 2007.

-Increase of chlorophyll-a concentration (biological response on wind influence) begins in 1-2 days at wind blowing with 3.5-4 m/sec velocity.

**Thank you  
for attention**