Assessment of eutrophication status of Amurskiy Bay (Japan/East Sea)

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Acknowledgment

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Objective:

To assess eutrophication status of the Amurskiy Bay with aim to improve management and sustainability of health of coastal environment.

Outline

I. Introduction

II. Assessment of eutrophication status of the Bay

III. Consequences of eutrophication of the Bay

IV. Summary

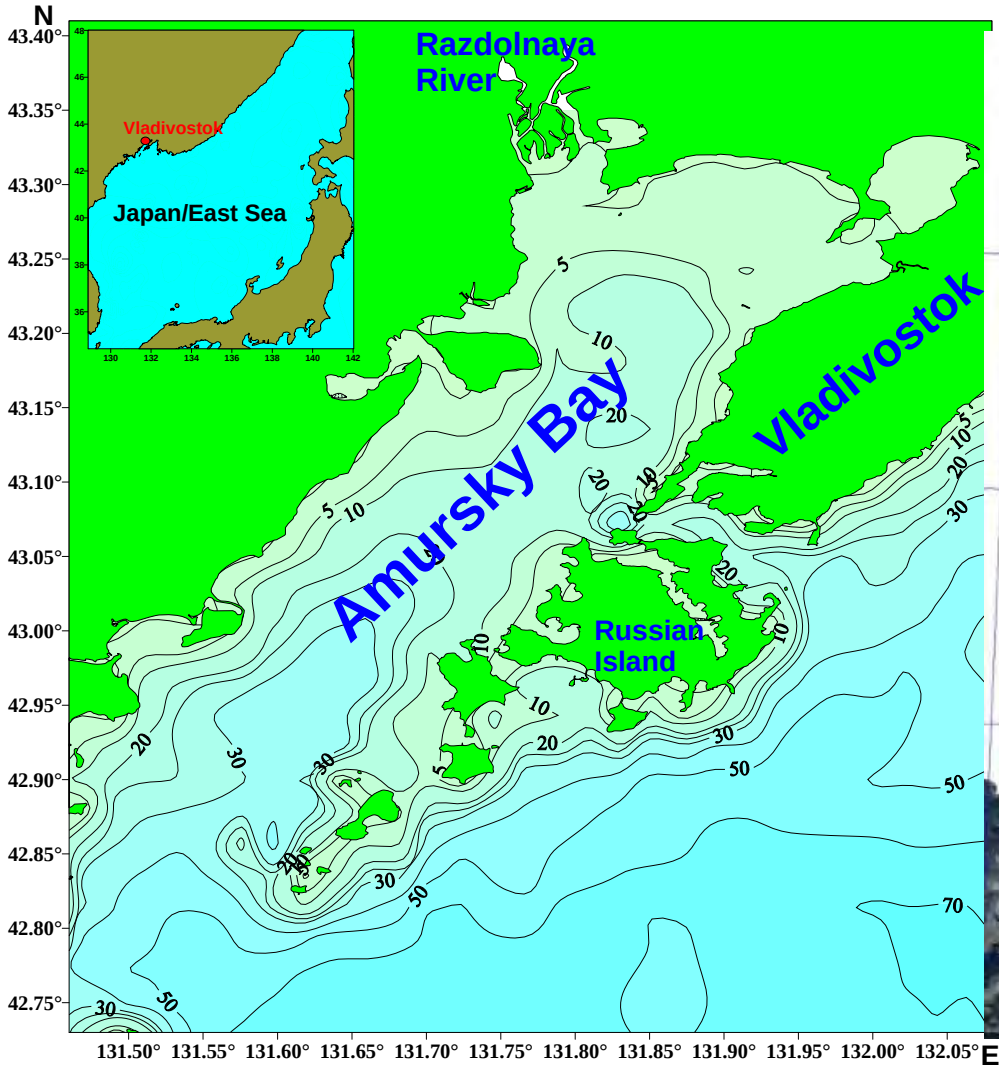
I. Introduction

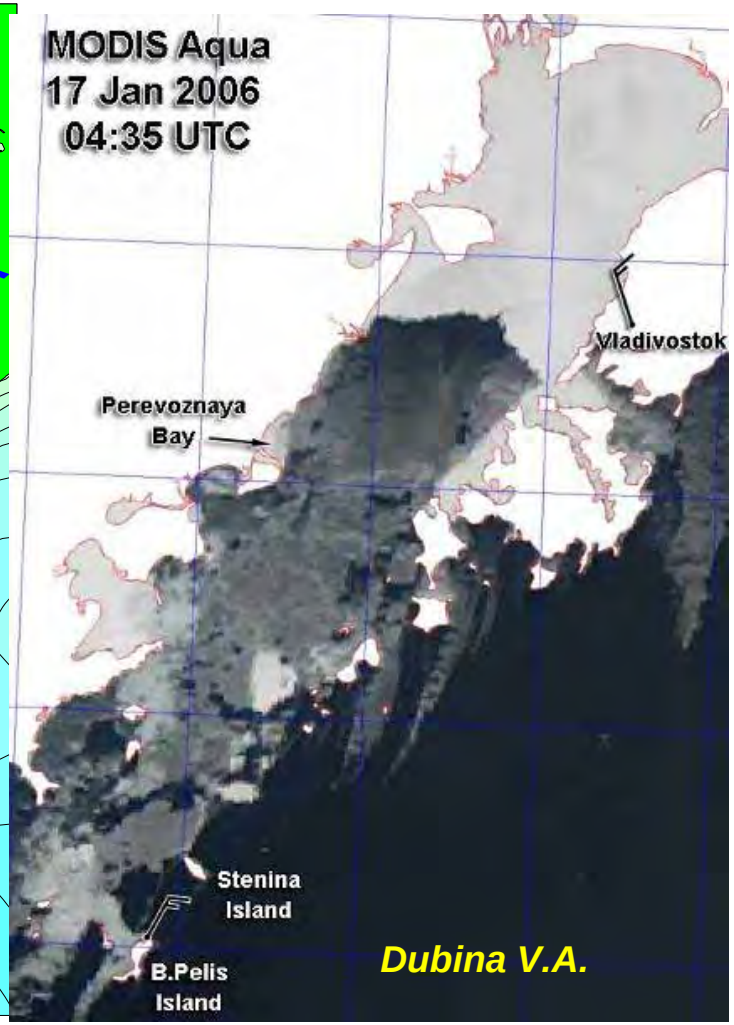
Definition of eutrophication:

‘the enrichment of water by nutrients, especially nitrogen and/or phosphorus and organic matter, causing an increased growth of algae and higher forms of plant life to produce an unacceptable deviation in structure, function and stability of organisms present in the water and to the quality of water concerned, compared to reference conditions’
(J.H. Anderson et al., 2006, J. Plankton Res., V.28, P.621-628.)

Before to demonstrate assessment of eutrophication status we describe pecularities of the Amurskiy Bay.

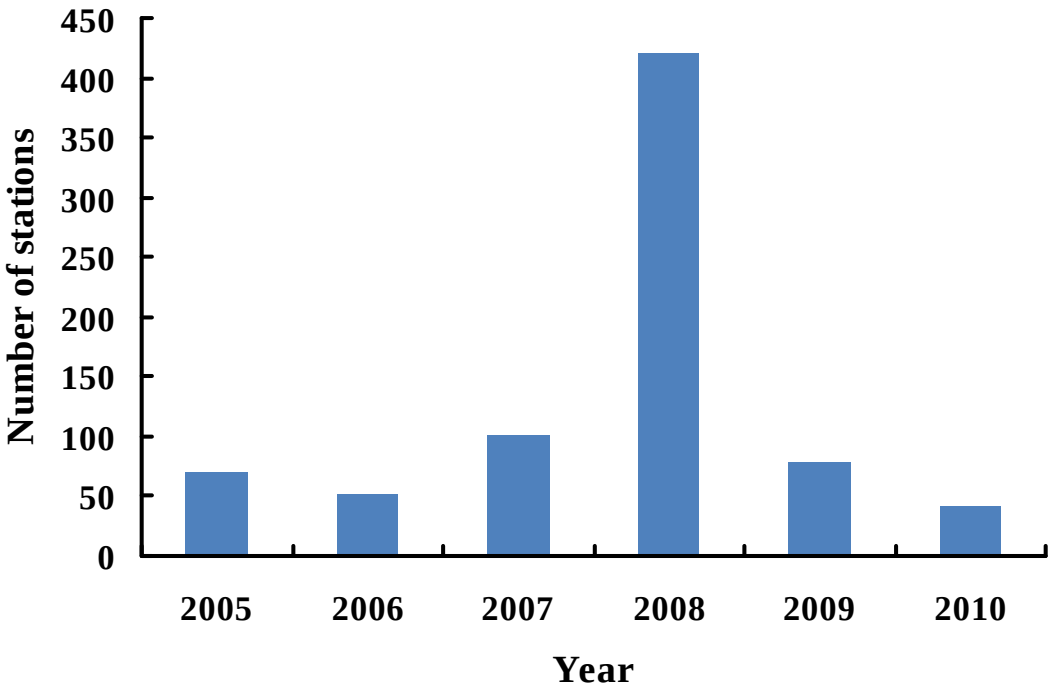
Peculiarities of the Amurskiy Bay





<u>Amurskiy Bay</u> is semiclosed basin. It is located in the northwestern part of Peter the Great Bay. Its length is about 70 km and depth varies from 0 up to 53 m (average depth is about 15 m). Square of the bay is about 1000 km^2. Annual river-runoff is 2.5 km^3. Population around Amurskiy Bay is 400,000. Northern part of the Bay is covered by ice in winter time.

Set of hydrochemical data



Hydrochemical observations of the Bay were carried out during 2005-2010

Measured parameters:

Profiles: CTD, Oxygen, Fluorescence, Turbidity – RBR XR-620 Probe

Discreet samples from surface and from near-bottom horizons on: Dissolved Oxygen, Nutrients (Silicate, Nitrite, Nitrate, Ammonium, Phosphate), pH, Total Alkalinity, Chlorophyll, Humic Substances, Transparency by disc Secci.

II. Assessment of eutrophication status of the Bay

It includes:

a. **Choice of reference conditions**

b. **Quantification of nutrients sources**

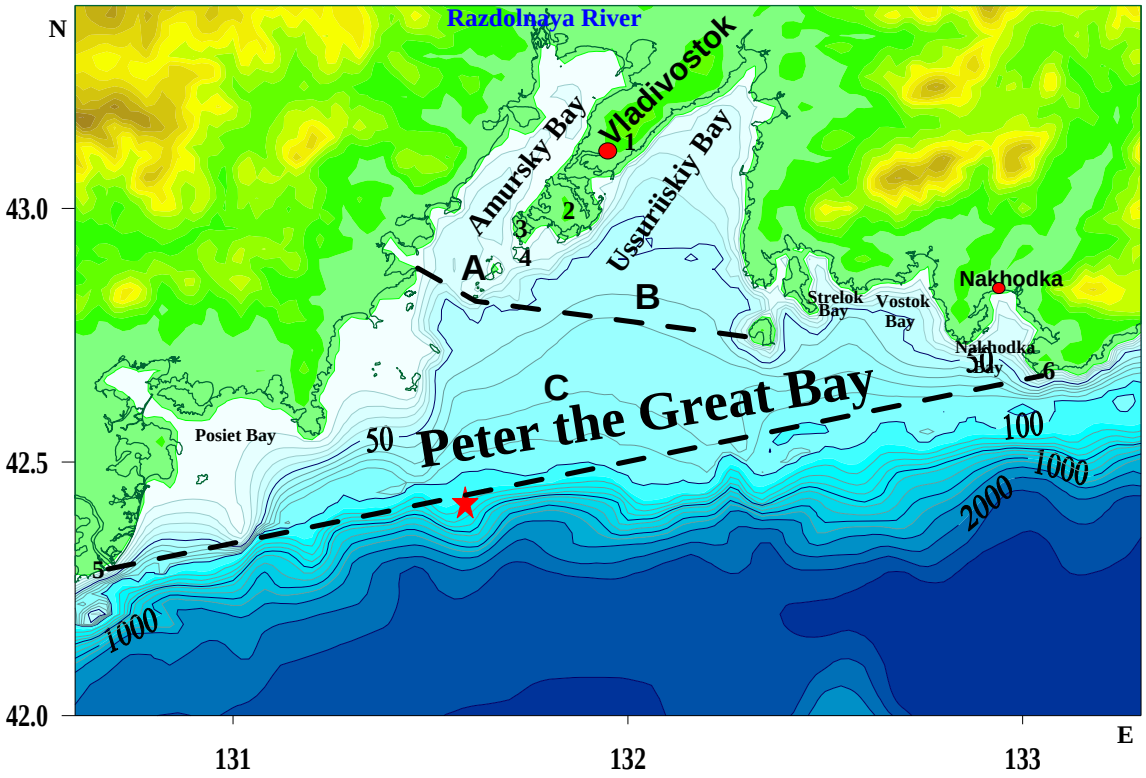
c. **Choice of assessment parameters**

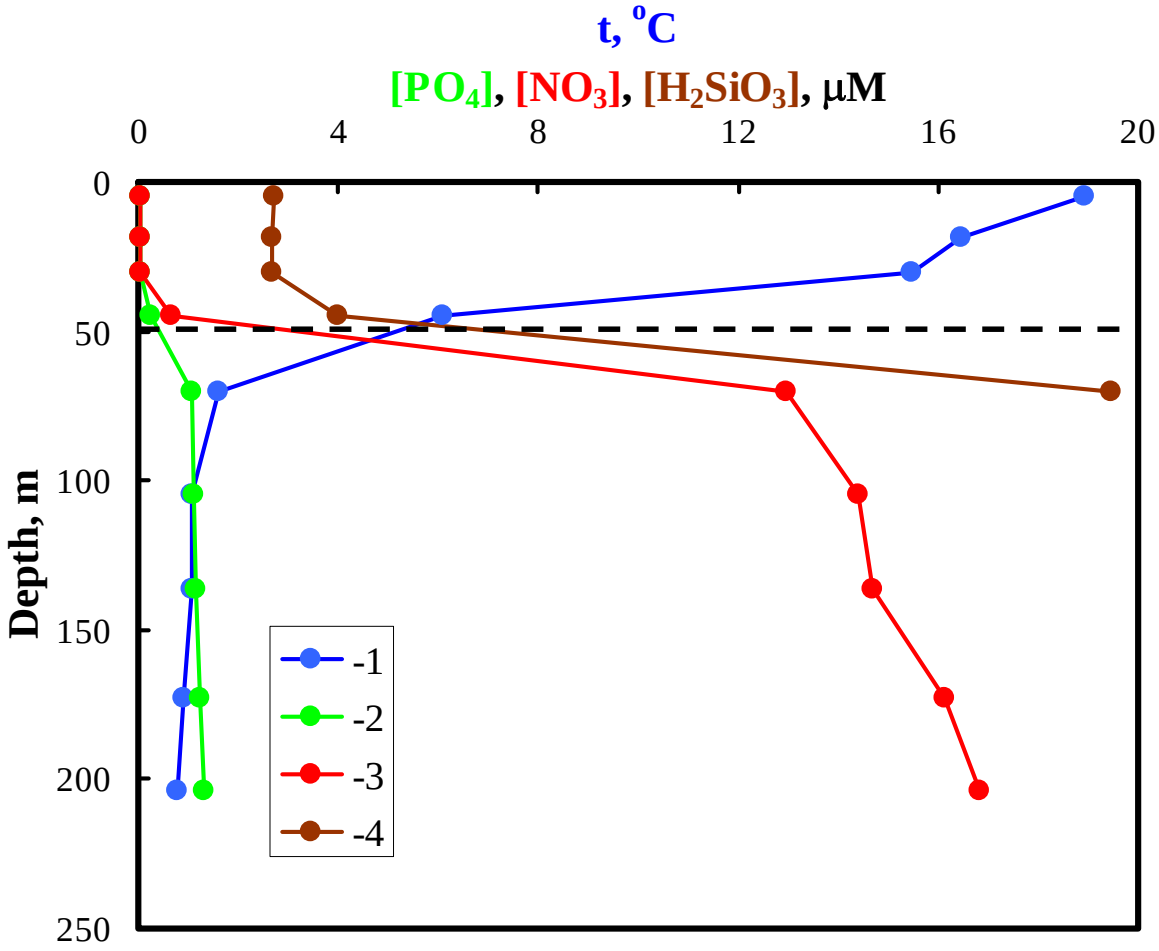
d. **Choice of criteria for threshold values of assessment parameters**

e. **Comparison of raw data with threshold values**

f. **Temporal trends of assessment parameters**

a. Choice of reference conditions

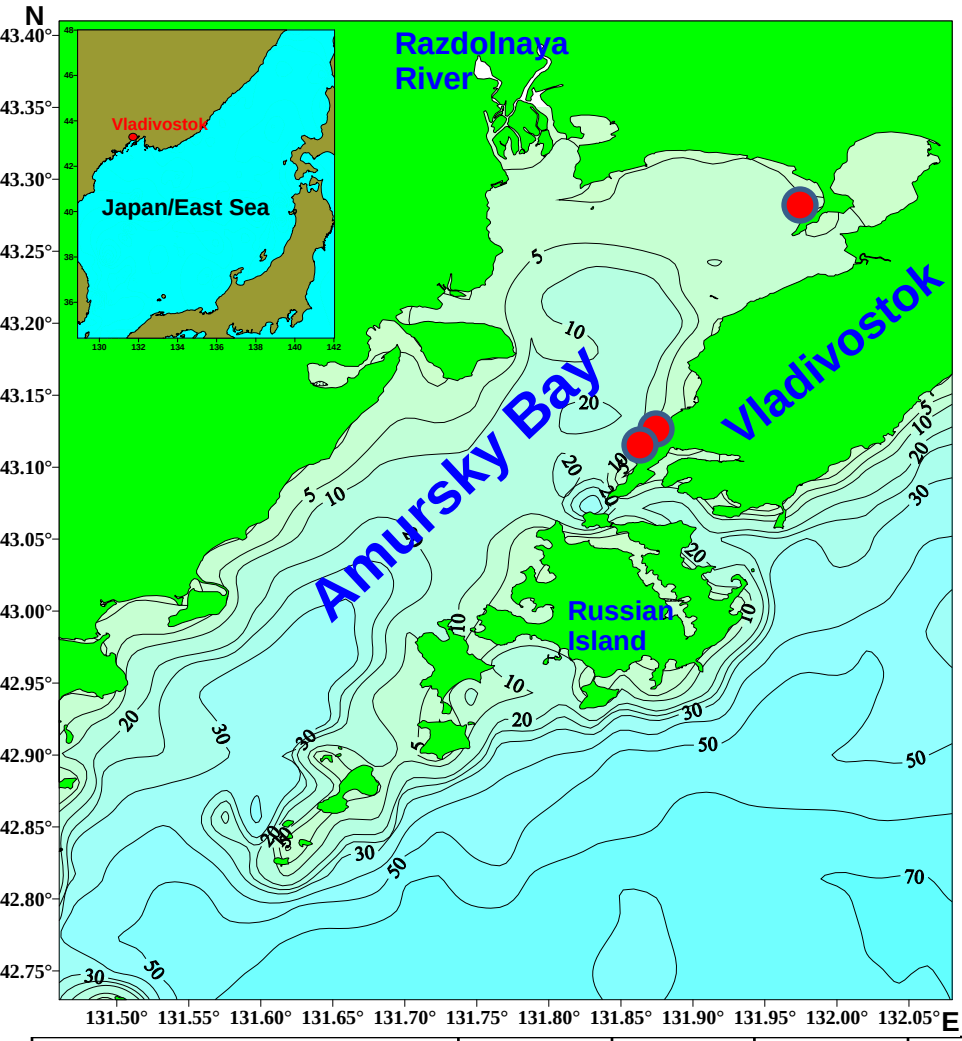




Thick of euphotic layer on "Reference" station was accepted 50 m.

Vertical distribution of PO_4 (µM) - 1, NO_3 (µM) - 2, temperature (°C) - 3 and H_2SiO_3 (µM) - 4 on station which is accepted as "standard" (42.417° N; 131.588° E).

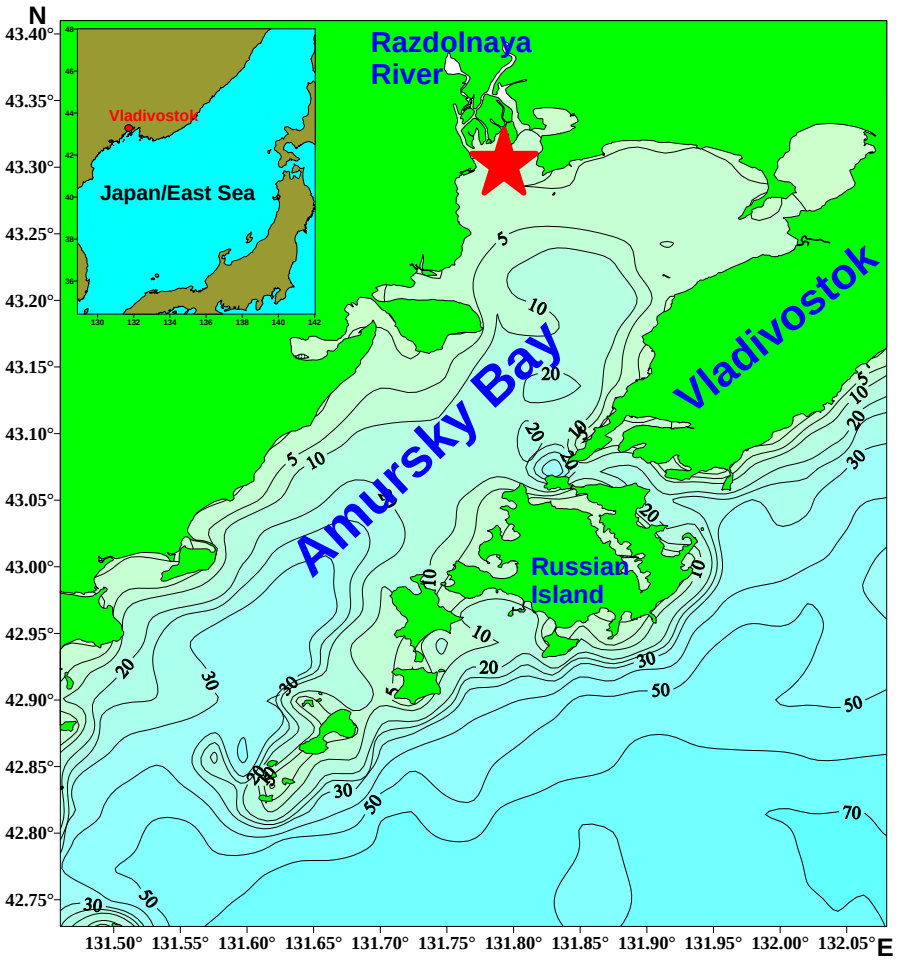
b. Quantification of nutrients sources into the Bay



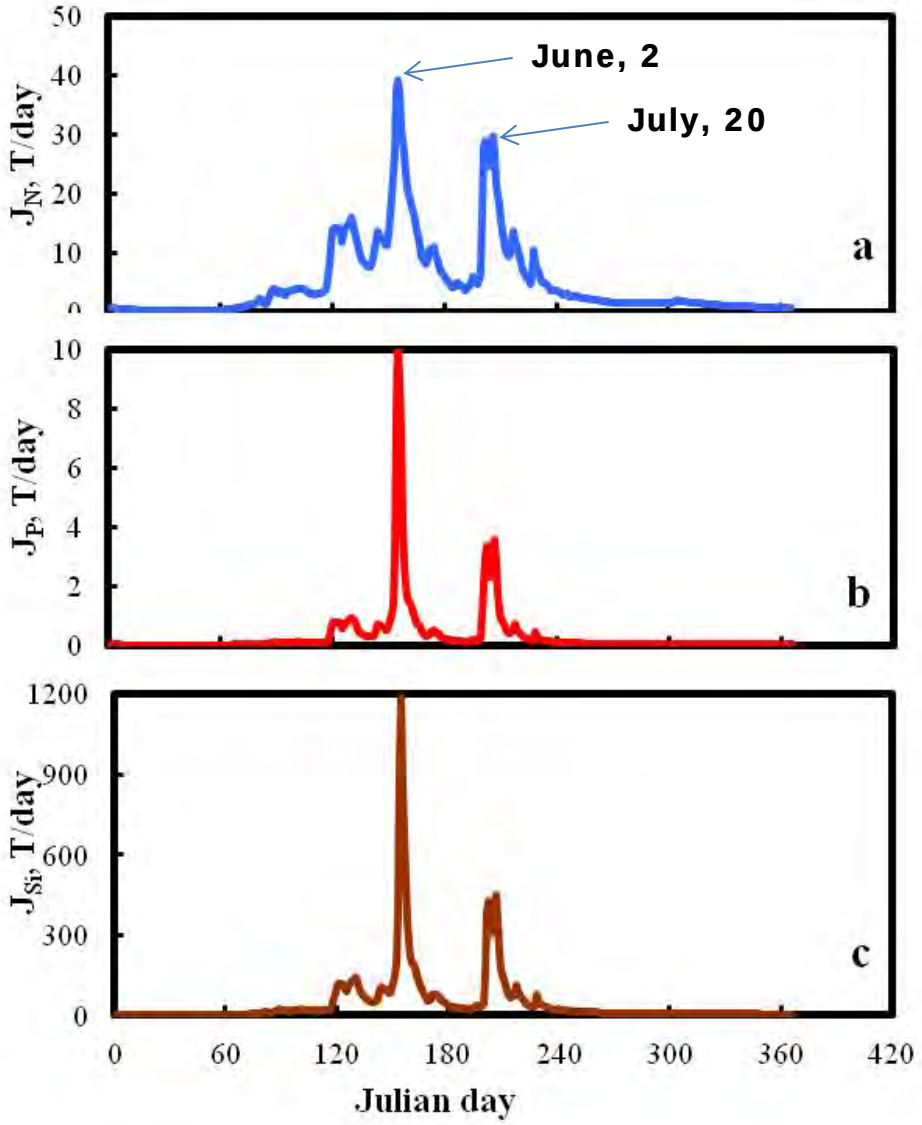
Inputs of untreated waste waters into Vtoraya Rechka which inflow into Amurskiy Bay.

Nutrients	DIN	N-tot	DIP	P-tot	DISi
Waste water of Vladivostok	700	1150	100	140	-

Estimated Annual fluxes (T/year) of nutrients into Amurskiy Bay from waste waters of Vladivostok



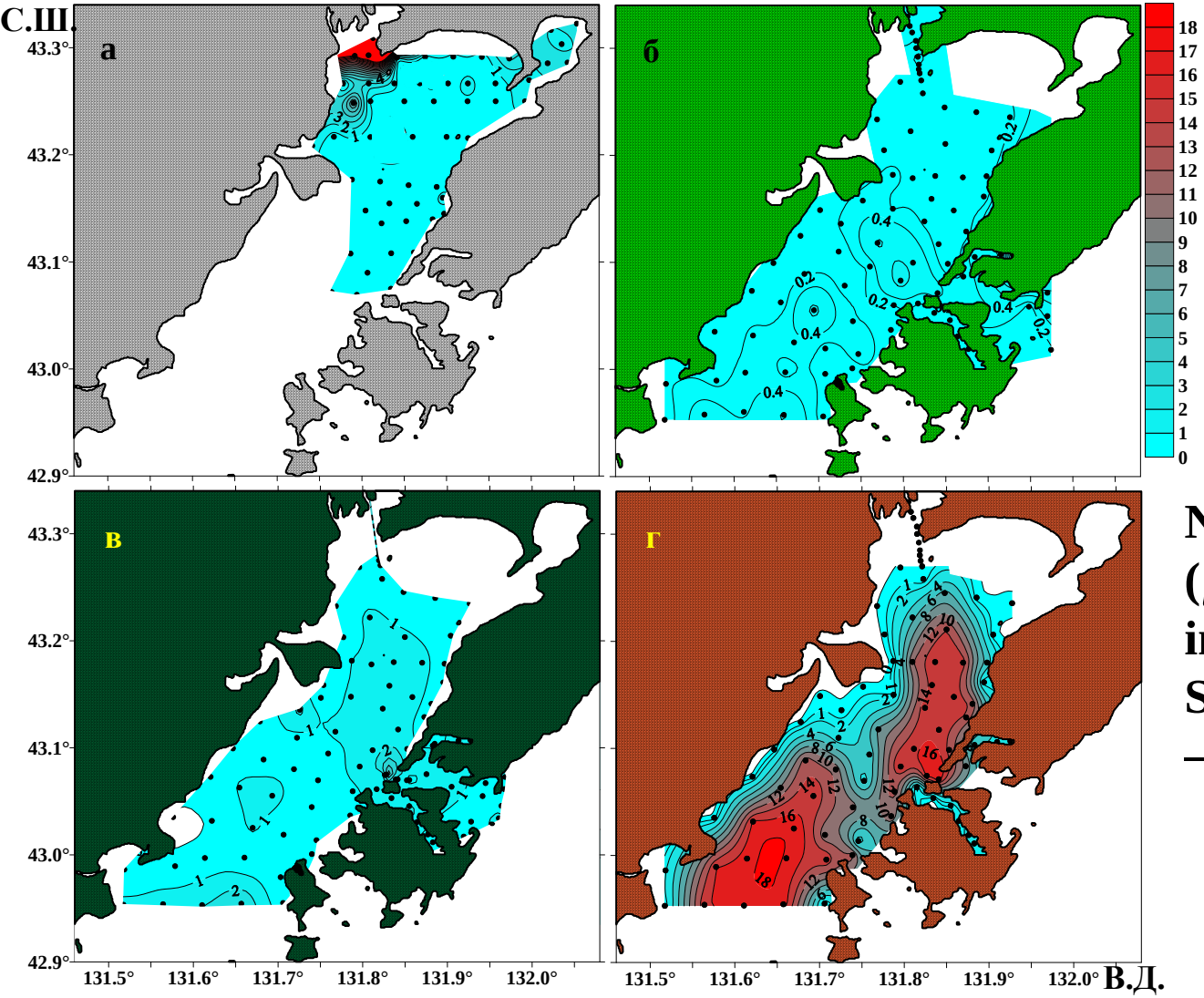
Agriculture fields in valley of the Razdolnaya River are considered as main diffusive source of nutrients loaded into Amurskiy Bay.



Nutrients fluxes into Amurskiy Bay by Razdolnaya River in 2008. a – DIN flux; b – DIP fluxes; c – DISi fluxes.

Nutrients	DIN	N-tot	DIP	P-tot	DISi
River runoff	1800	4200	120	450	17040

Annual fluxes (T/year) of nutrients into Amurskiy Bay by river runoff



Nitrate concentrations (μM) near bottom layer in 2008. а – Winter; б - Sprting; в – Summer; г – Autumn.

Annual fluxes (T/year) of nutrients into Amurskiy Bay by upwelling

Nutrients	DIN	N-tot	DIP	P-tot	DISi
Upwelling	530	-	82	-	1700

Annual fluxes (T/year) of nutrients into Amurskiy Bay

Nutrients	DIN	N-tot	DIP	P-tot	DISi
River runoff	1800	4200	120	450	17040
Waste water of Vladivostok	700	1150	100	140	-
Upwelling	530	-	82	-	1700
Total	**3030**	**5350**	**302**	**590**	**18740**

c. Choice of assessment parameters

According to Anderson definition of eutrophication, the chosen parameters are concentrations of nutrients: DIN, DIP, DISi, and Chl *a*.

d. Choice of criteria for threshold values of assessment parameters

According to OECD-working group (Paris, 1982) we accepted threshold value for chlorophyll concentration as follows: $\mathrm{Chl}\,a_{\mathrm{th}} = 8\,\mu\mathrm{g/L}$

Definition hypoxia as $\mathrm{DO}_{\mathrm{th}}\,(\mu\mathrm{M}) = 76$
and Redfeald stoichiometric ratios in organic matter were criteria for calculations of threshold values of nutrient concentrations.

Threshold values of assessment parameters are following:

1) $$DIN_{th}\,(\mu M) = \frac{(DO_{sat} - 76)\cdot 16}{138}$$

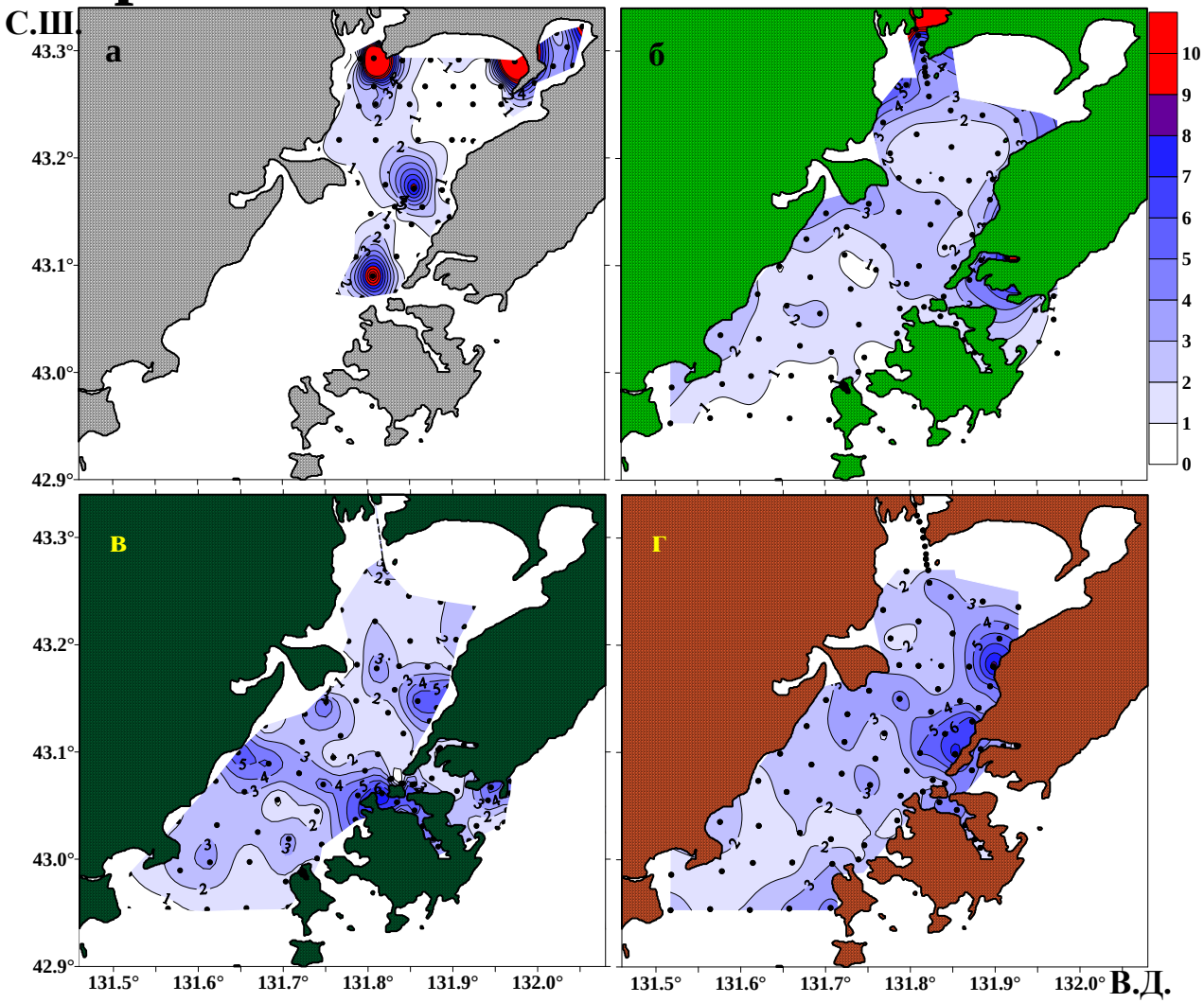
2) $$DIP_{th}\,(\mu M) = \frac{(DO_{sat} - 76)}{138}$$

3) $$DISi_{th}\,(\mu M) = \frac{(DO_{sat} - 76)\cdot 17}{138}$$

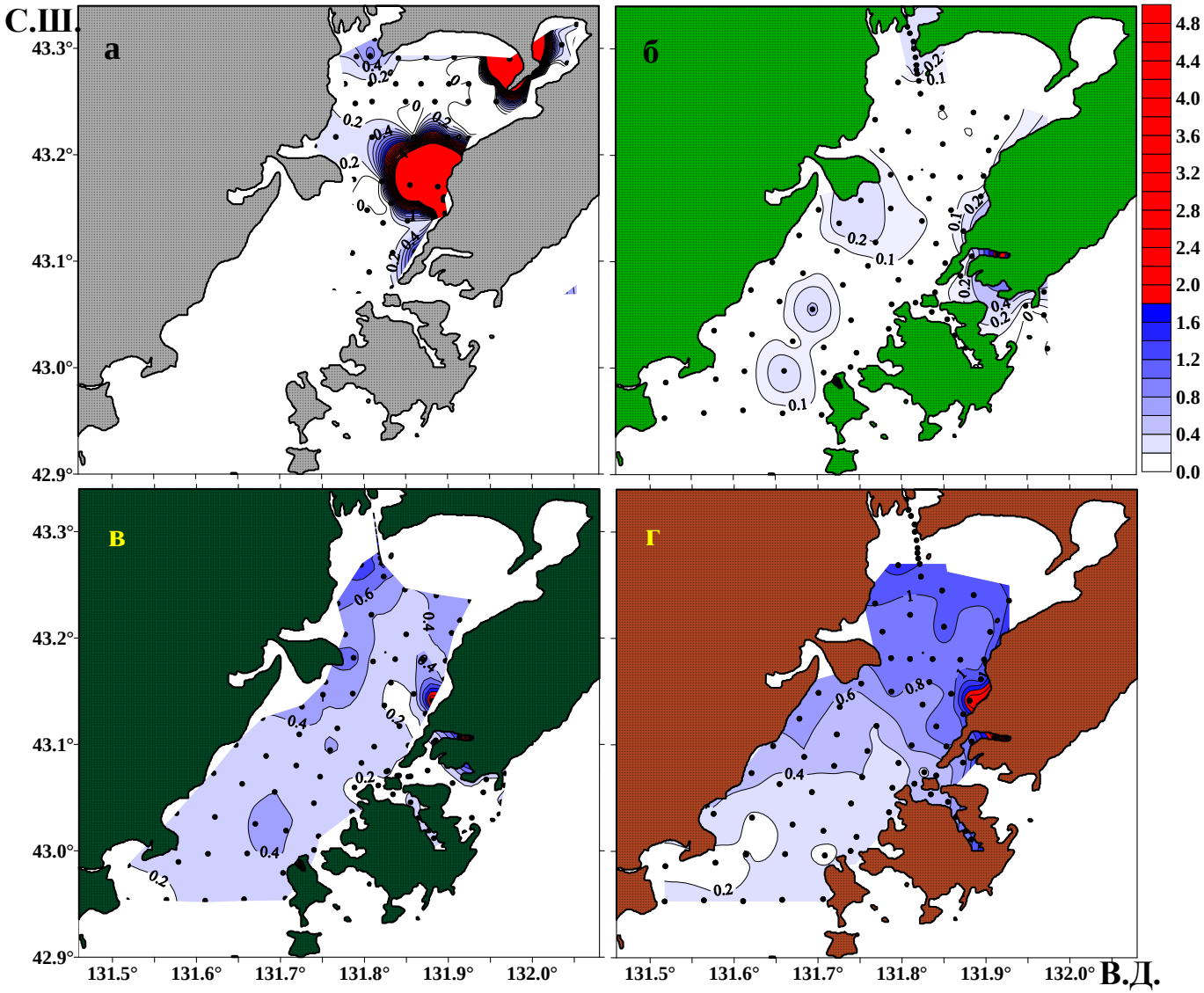
Brzezinski M. **J.Phyc. 1985. V.21.P.347-357.**

Season	Winter	Spring Autumn	Summer
t, °C	0	10	20
S, ‰	33	33	33
DIN_{th}, umol/kg	32	24	18
DIP_{th}, umol/kg	2.0	1.5	1.1
$DISi_{th}$, umol/kg	34.0	25	19

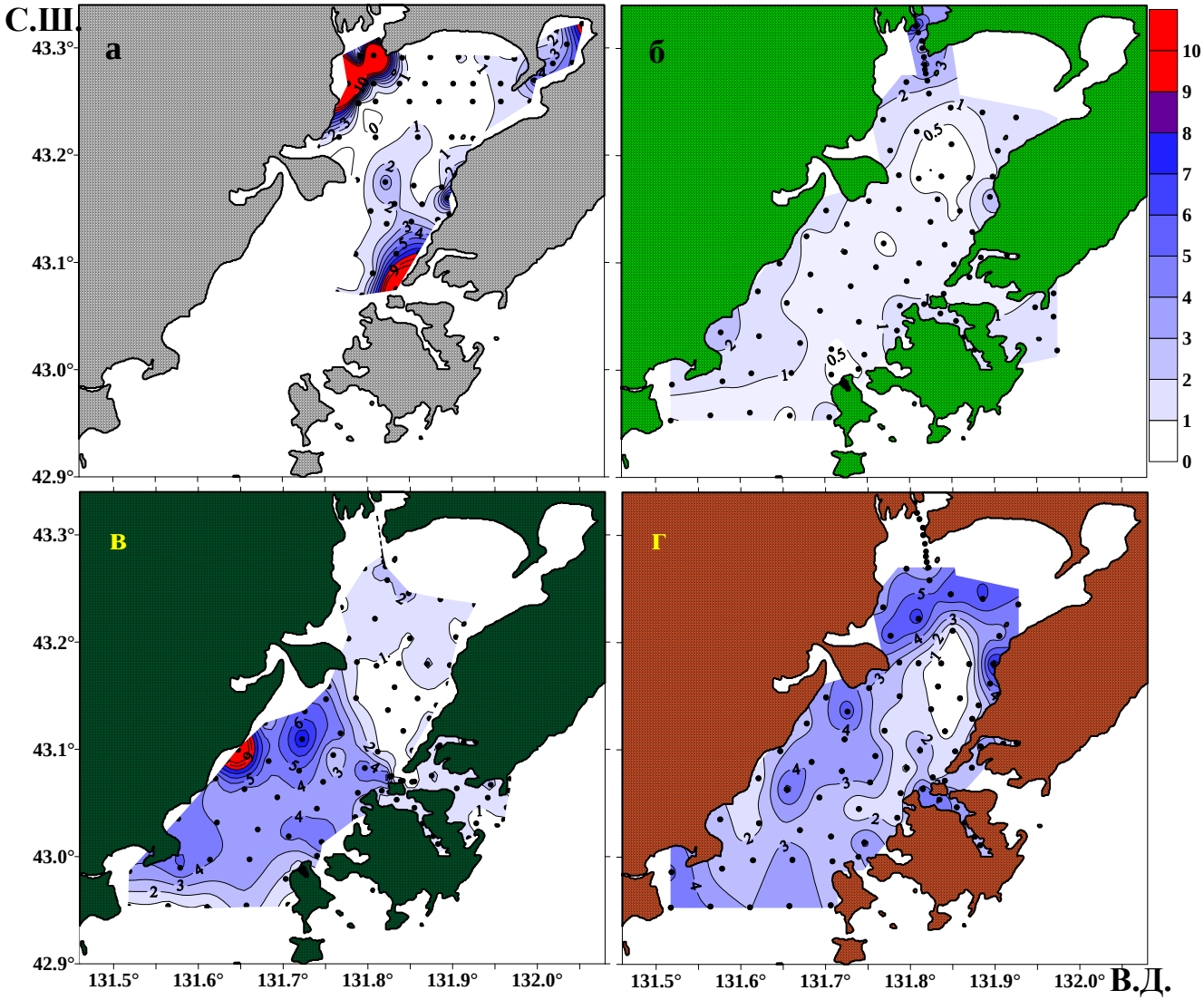
e. Comparison of raw data with threshold values



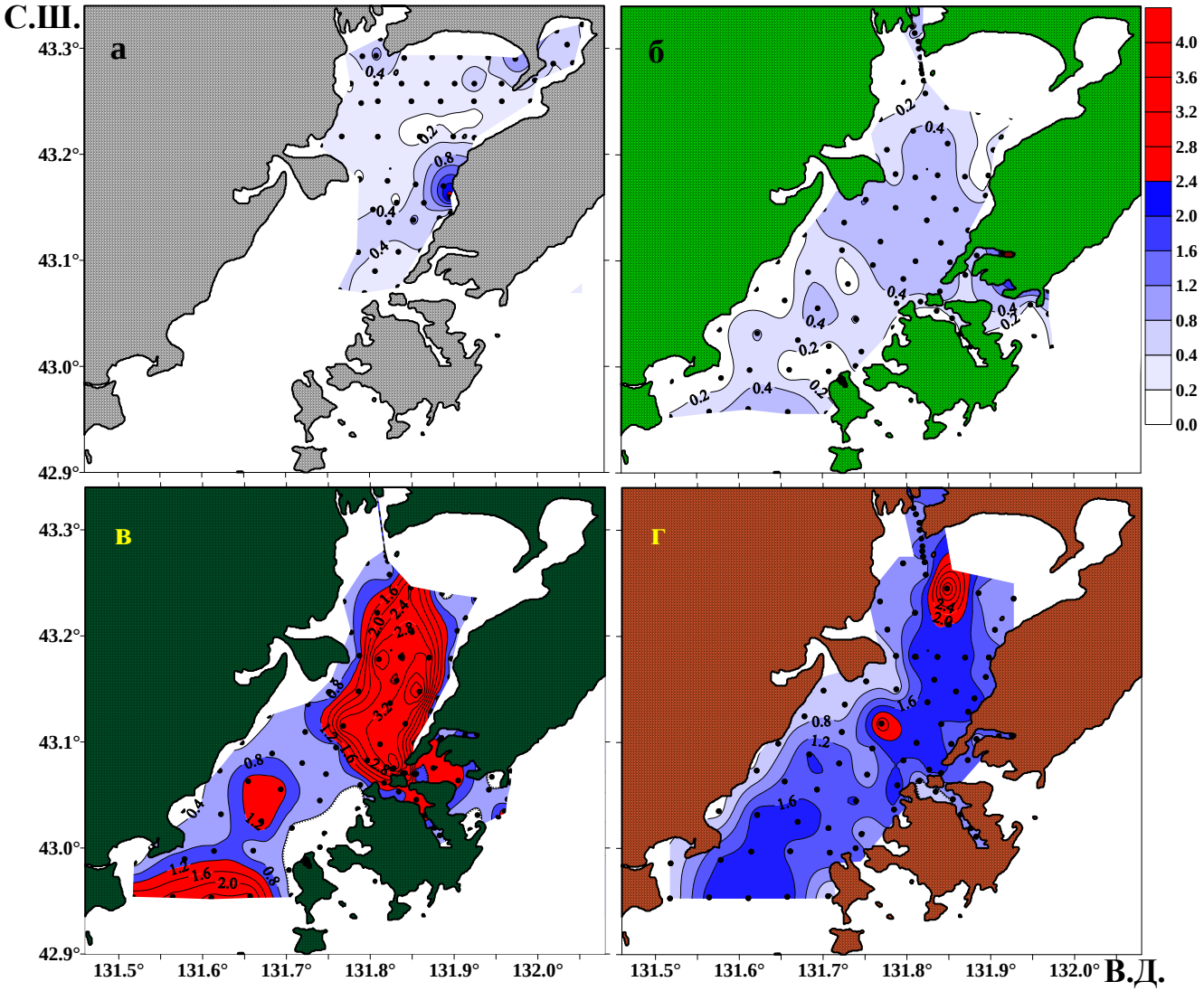
Seasonal distribution of Chl concentration (μg/L) in surface waters of Amurskiy Bay. **а** – Winter, **б** – Spring, **в** – Summer, **г** – Autumn 2008. **Red color** means concentrations of Chl **higher than 8 μg/L**.



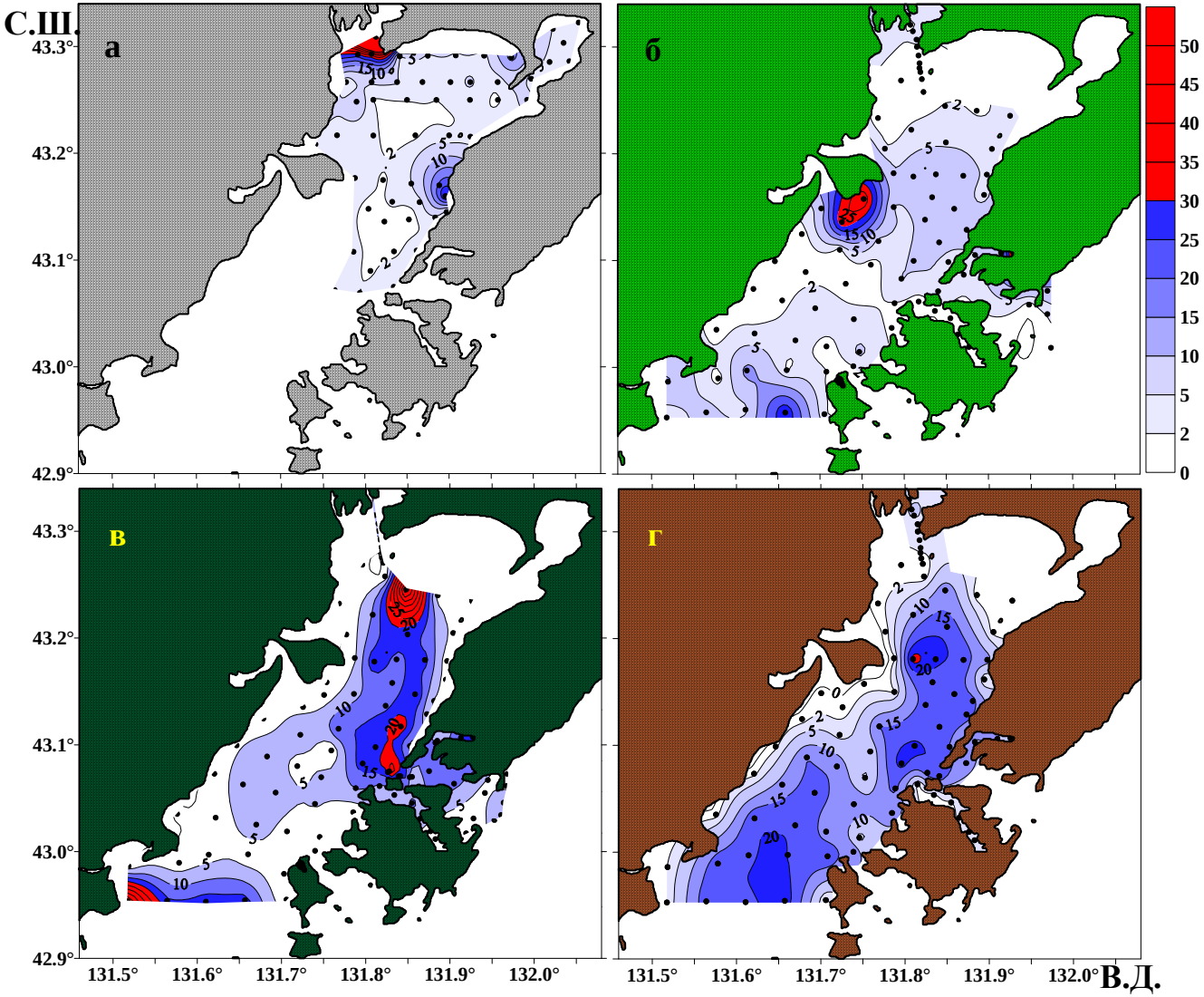
Seasonal distribution of DIP concentration (μM) in surface waters of Amurskiy Bay. **а** – Winter, **б** – Spring, **в** – Summer, **г** – Autumn 2008. **Red color** means concentrations of DIP **higher than threshold values.**



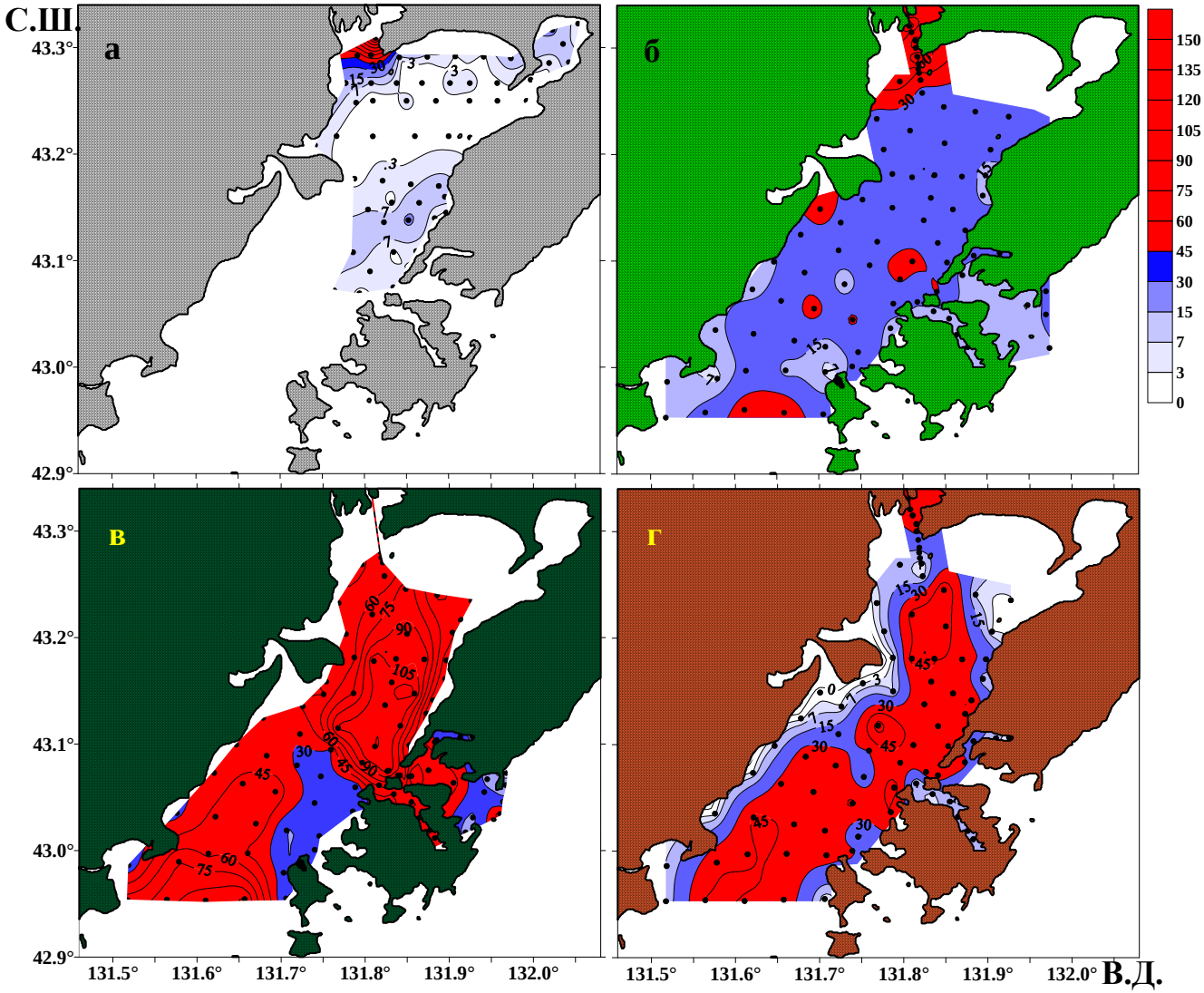
Seasonal distribution of Chl *a* concentration (μg/L) in bottom waters of Amurskiy Bay. **а** – Winter, **б** – Spring, **в** – Summer, **г** – Autumn 2008. **Red color** means concentrations of Chl *a* **higher than 8 μg/L.**



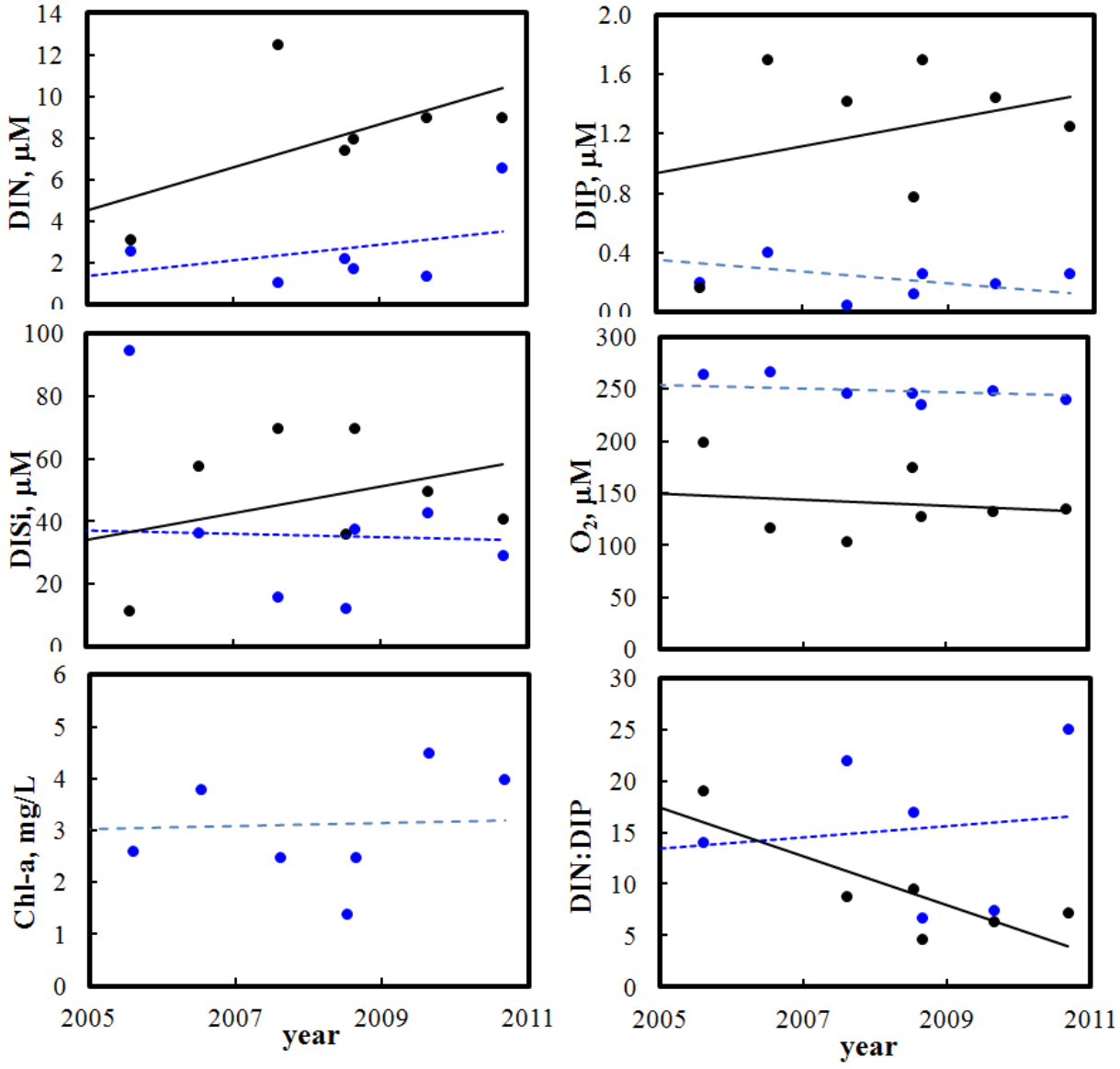
Seasonal distribution of DIP concentration (μM) in bottom waters of Amurskiy Bay. **а** – Winter, **б** – Spring, **в** – Summer, **г** – Autumn 2008. **Red color** means concentrations of DIP **higher than threshold values.**



Seasonal distribution of DIN concentration (μM) in bottom waters of Amurskiy Bay. **a** – Winter, **b** – Spring, **c** – Summer, **d** – Autumn 2008. **Red color** means concentrations of DIN **higher than threshold values**.



Seasonal distribution of DISi concentration (μM) in bottom waters of Amurskiy Bay. **a** – Winter, **b** – Spring, **c** – Summer, **d** – Autumn 2008. **Red color** means concentrations of DISi **higher than threshold values**.



f. Trends of assessment parameters in the Amurskiy Bay in Summer season.

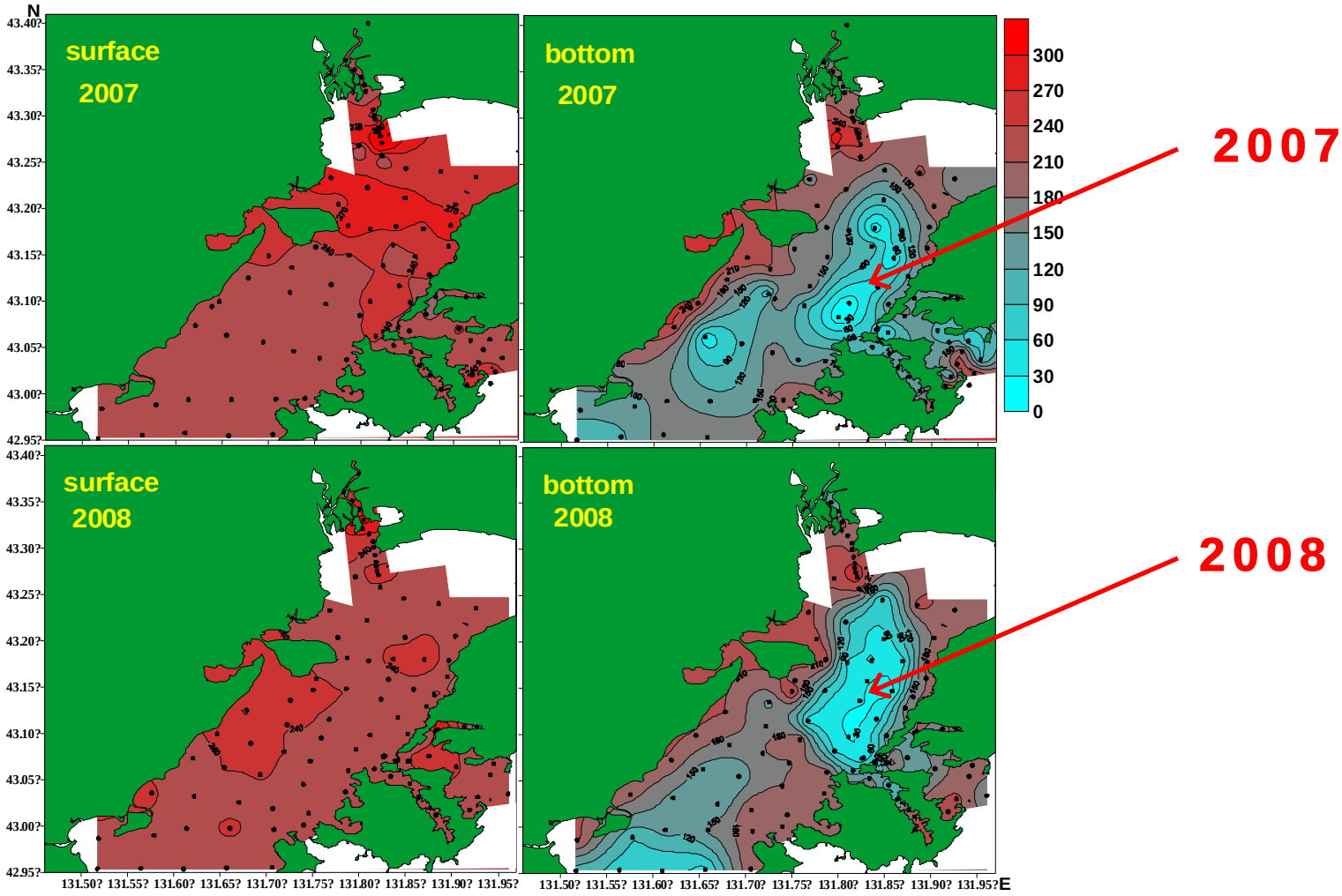
Solid lines and black circles correspond to bottom horizon -15 m. Dash lines and blue circles correspond to surface horizon.

Conclusion

Comparison of raw data nutrient concentrations with threshold values and temporal trend of nutrient concentration in near-bottom layer suggest that Amurskiy Bay has high eutrophication status.

III. Consequences of eutrophication of the Bay

Severe hypoxia of near-bottom layer in the Bay. Lowest oxygen concentration was 4 umol/kg



Distribution of oxygen concentration (umol/kg) in Amurskiy Bay, in surface and bottom layers. August, 2007 (upper panel). August, 2008 (bottom panel).

Hydrochemical anomalies near-bottom water. August, 2008

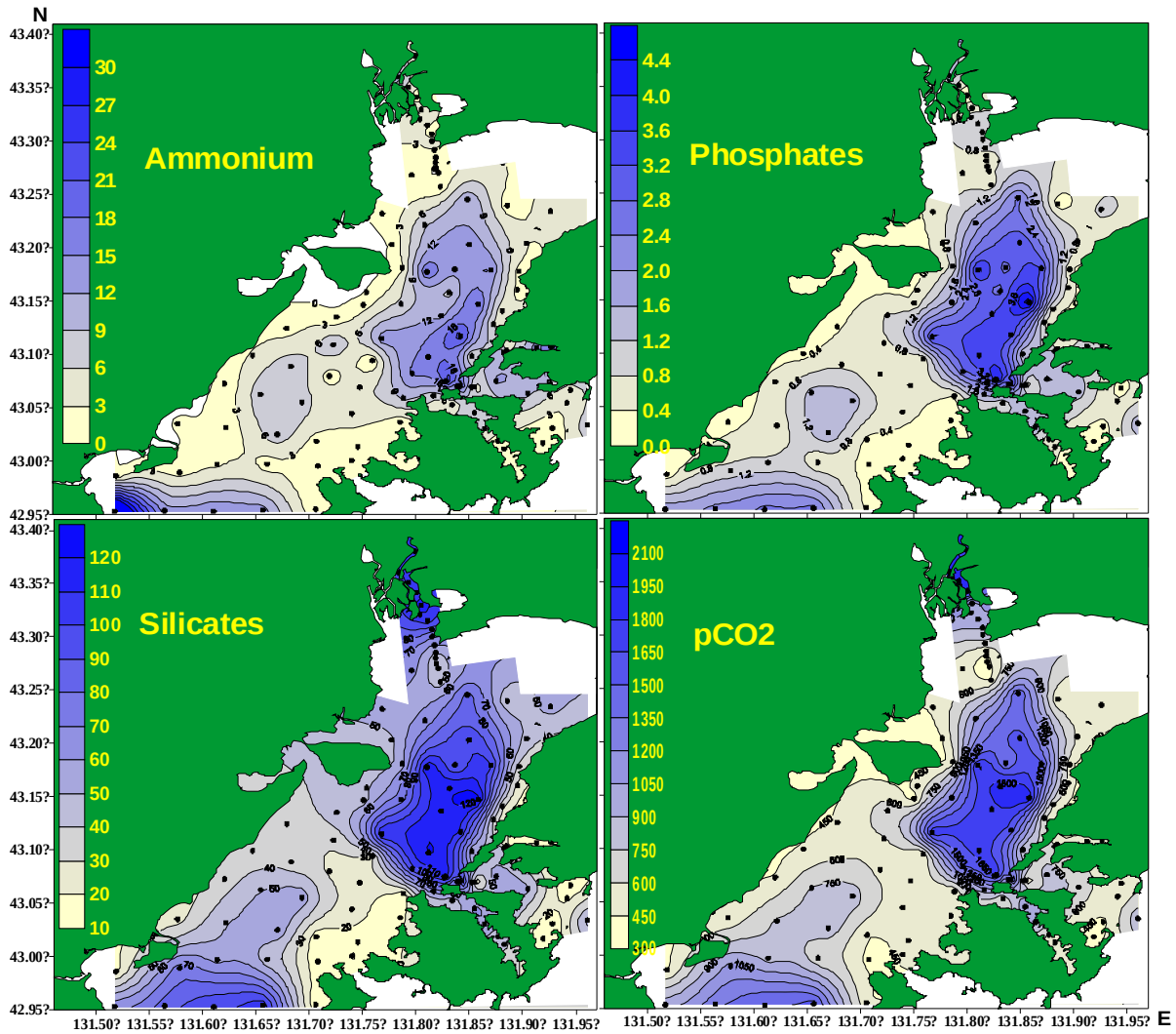
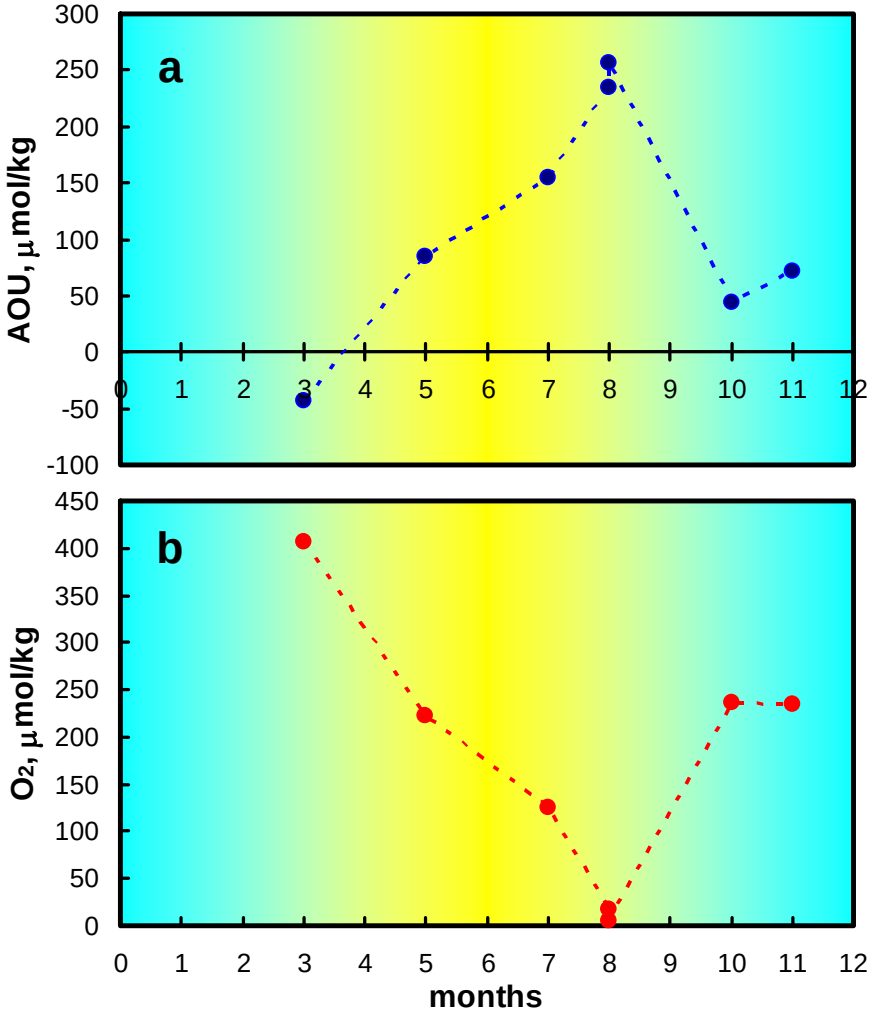


Figure 2. Distributions of Ammonium, Phosphates, Silicates (umol/kg) and CO_2 partial (uatm) in the bottom water of the Amurskiy Bay. August, 2008.



Our data of seasonal oxygen concentration in hypoxia area suggest that hypoxia of Amurkiy Bay has seasonal character.

Seasonal variability Apparent Oxygen Utilization (a) and Oxygen Concentration (b) in near-bottom waters in the anoxic area of the Amursky Bay.

Killed-fish event in Amursky Bay at September 14th , 2008.

Died fishes on 14th September 2008 at the coast of Amurskiy Bay. Most part of the fishes were junior smelt and had a specific smell. *Photo: Vladimir Kolesnikov*

Summary

1. Sources of nutrients into Amurskiy Bay were quantified and most important source of nutrients is Razdolnaya River.

2. Threshold values of nutrient concentrations were derived via definition of hypoxia.

3. Comparison of threshold values of nutrient concentrations with raw data, seasonal hypoxia nea-bottom layer and killed-fish event suggest that Amurskiy Bay has high eutrophication status.