

Variability of Rivers Nutrient Discharge in the Arctic Basin



E.Vinogradova

P.P.Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russia

Problem

River discharge is

- ✓ a main source of chemical substances including nutrients for the World ocean. It appreciably exerts on a forming of hydrological and hydrochemical conditions of coastal seas and nutrients carried by rivers influence the productivity of a shelf.
- ✓ a sensible indicators of changing climatic conditions in watersheds.
- ✓ only 1-2% of total river nutrients are carried out to open ocean.

Detailed studies of spatial-temporary variability in downstreams of carrying rivers are especially significant for high-latitude Arctic seas where the drain module exceeds its magnitude for the World ocean about 3 times

It is assumed that the main changes of water chemical composition occur at the geochemical river-sea barriers, but the processes in the downstream of the rivers before the influence of sea water are usually neglected.

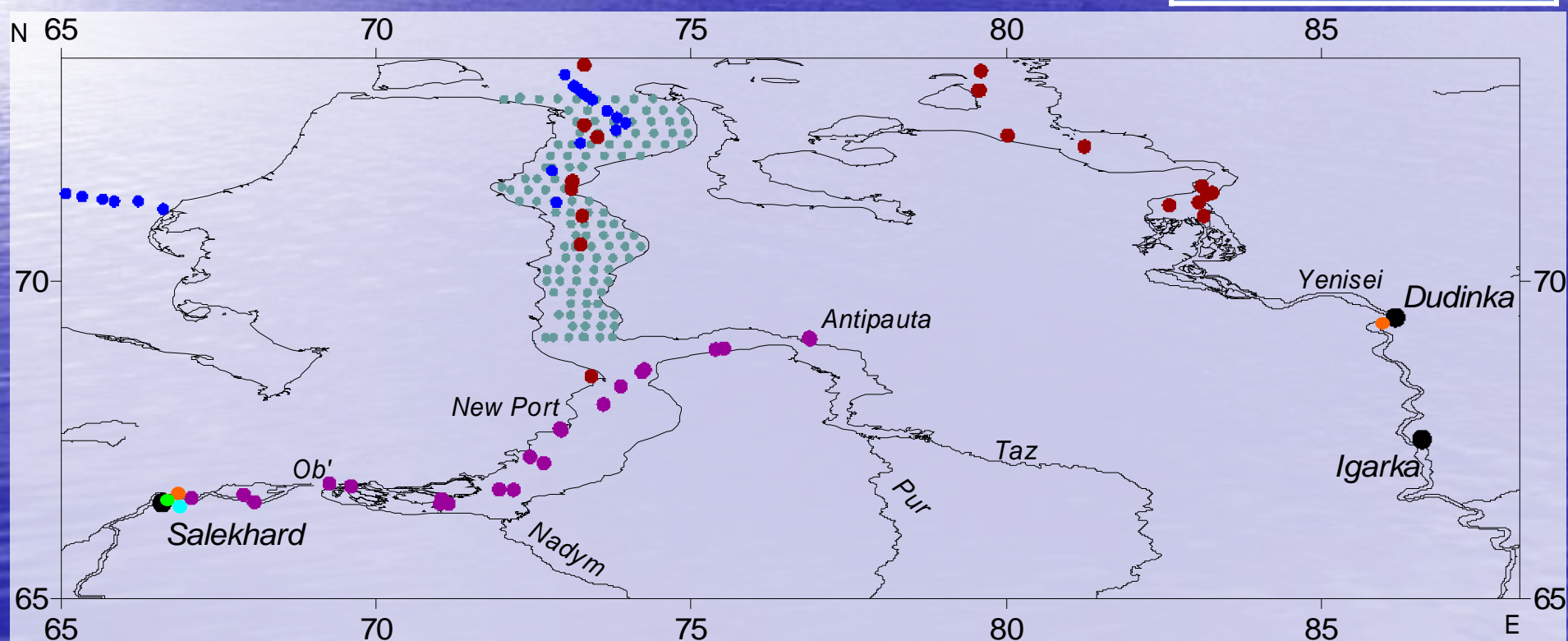
Goal

To estimate the relative role of the water chemical composition changes in the downstreams of the Arctic rivers just before their estuaries.

Position of the sampling points in the Ob' and Yenisei mouths

- September, 1993, 49 cruise R/V “Dmitri Mendeleev”;
- June, 2000, coastal expedition;
- December, 2001, coastal expedition;
- September, 2002, M/V “Mechanic Kalashnikov”;
- December, 2003, coastal expedition;
- September, 2005, H/V “Ivan Kireev”;
- September, 2007, 54 cruise R/V “Academician Mstislav Keldysh”.
- Hidrometeorological stations

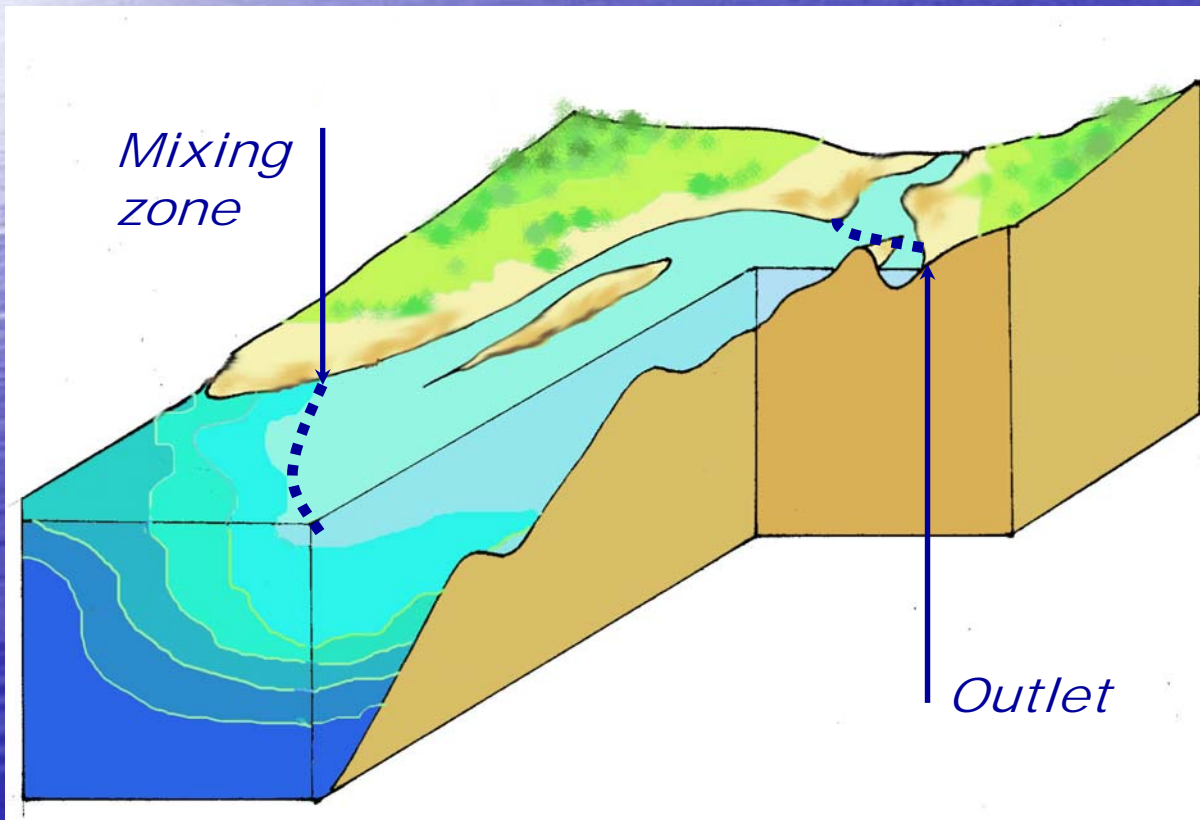
<i>Hydrochemical Parameter</i>
pH
Dissolved inorganic phosphorous
Dissolved inorganic silicon
Nitrates
Nitrites
Ammonium
Total organic phosphorous
Total organic nitrogen
Alkalinity
Methane
T
S



it is difficult to exact estimate value of nutrients river discharge

- analytical problems become a work connected with high turbid water samples from transition downstreams.
- problems, connected with sampling: as a rule the balance estimate of flow is based on data of hydrometeorological stations, which are situated far from really estuaries, meanwhile many characteristic features of downstreams waters are lost or distorted due-to high degree of spatial-temporary variability of hydrochemical and hydrological parameters.

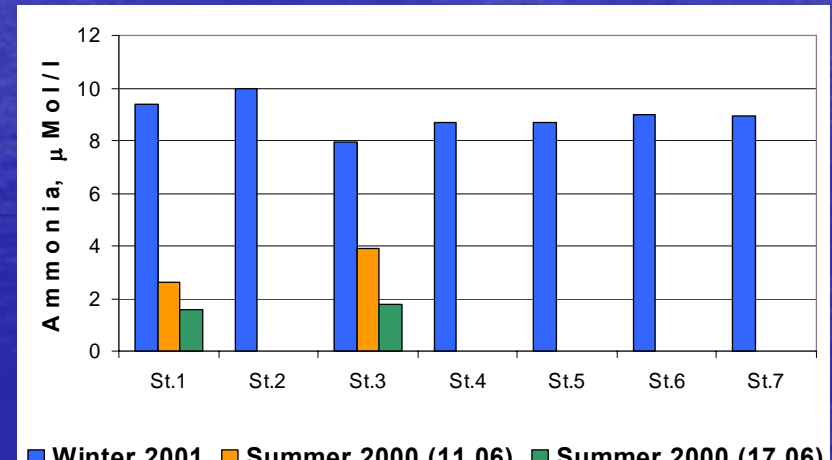
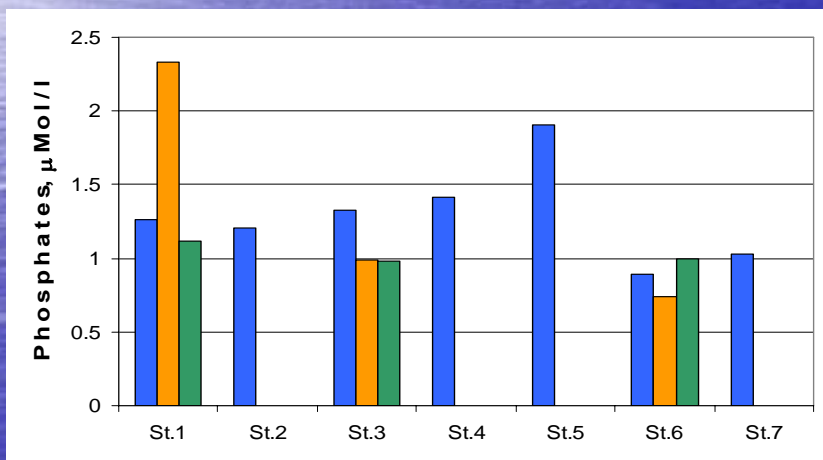
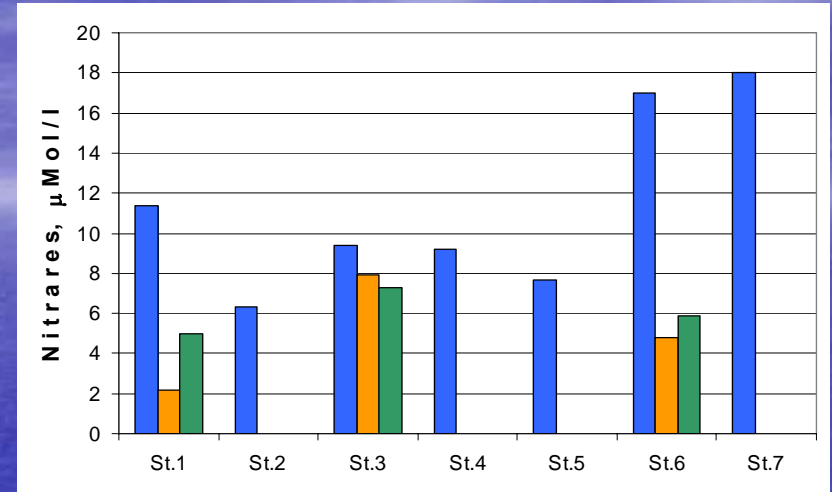
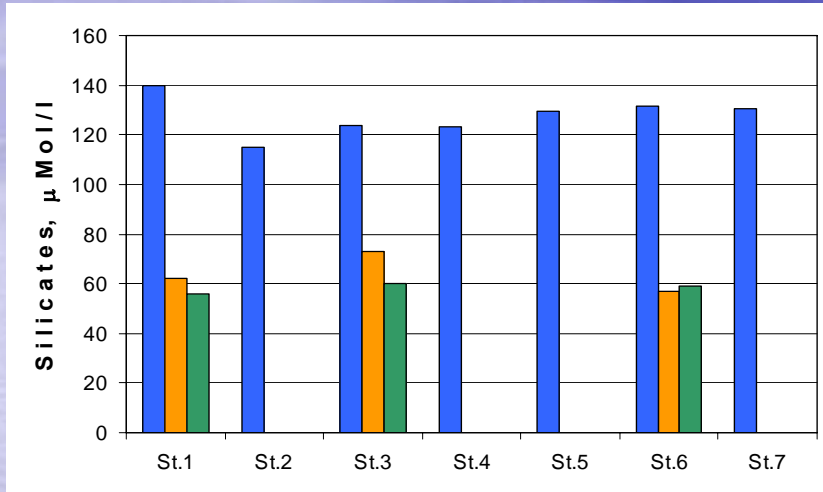
River downstream



We can exact some areas in the river downstream just before mixing zone till really outlet

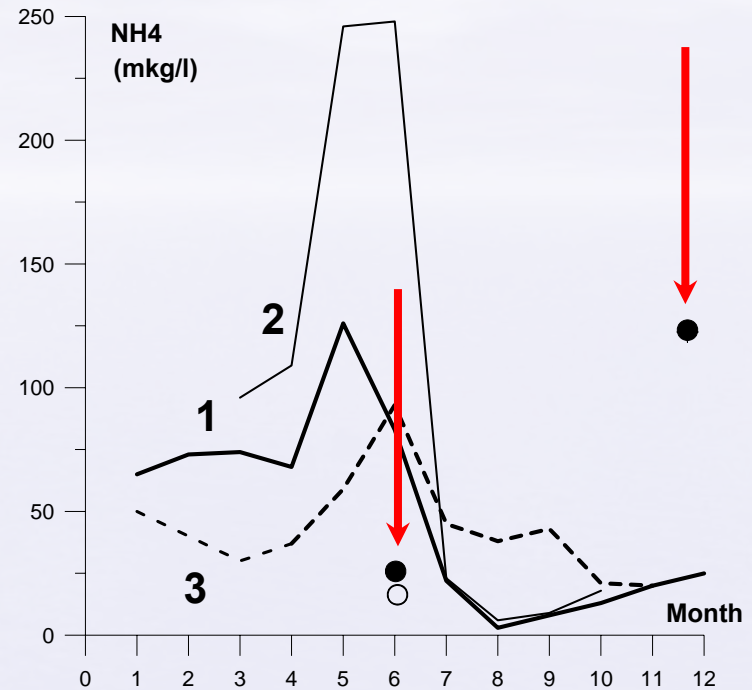
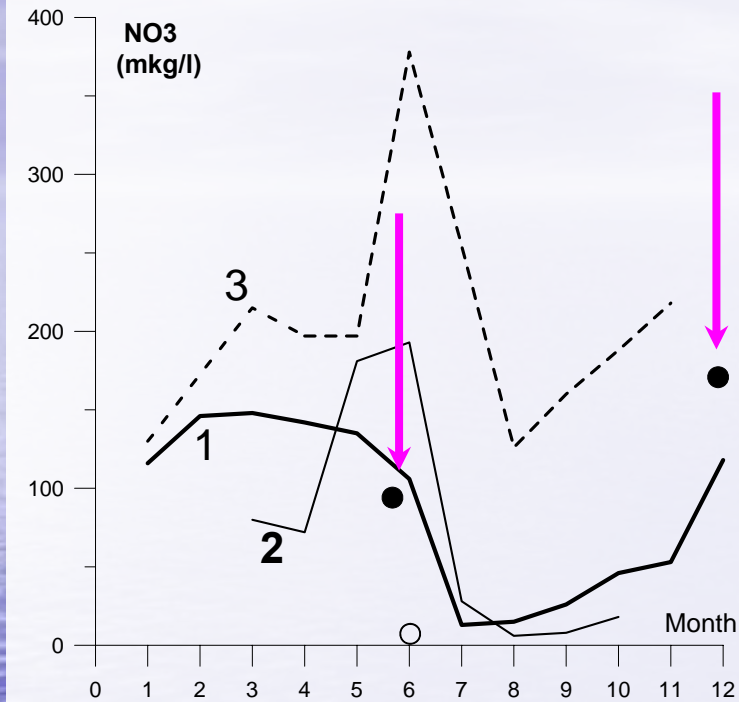
Temporary variability of nutrient discharge by Ob' river

- seasonal variability



Concentration of nutrients in surface water of the Ob' river

In winter underground sources play the main role and could be considered as a steady component of river chemical discharge.



Averaged seasonal variability of ammonia and nitrates in rivers: 1 – Ob', 2 - Yenisei, 3 - Lena dots mark the data of expeditions in 2000 and 2001 years: black – Ob', white – Yenisei. (Makkaveev et al., 2002)

Sharp increase of ammonium (more than 4 times) with moderate growth of nitrates probably connected with change of water composition inflowing into the river

Predesign of nutrients discharge by Ob' and Yenisei rivers shows that in spite of useful increase of water discharge in summer nutrients discharge is increased only about 10%.

-interannual variability

River run-off and estimates of current of dissolved inorganic compounds of nitrogen and phosphorous for some rivers flowing into the Arctic basin

River	Mean annual Q km ³ /yr	Annual Q 10 ³ τ	
		Dissolved inorganic nitrogen	Dissolved inorganic phosphorous
Yenisei	577.3 ¹ 513.0-689.0 ²	74.0-135.0 ¹	6.2 ¹
Lena	532.5 ¹ 401.0-729.0 ²	34.0-170.0 ¹	3.5 ¹
Ob'	404.1 ¹ 269.0-577.0 ²	45.0-160.0 ¹	23.5 ¹
Kolyma	70.8 ¹ 41.0-137.0 ²	4.0-6.0 ¹	0.8 ¹
Indigirka	50.4 ¹ 31.0-80.0 ²	2.0-3.0 ¹	0.4 ¹
Yana	32.2 ¹ 20.0-56.0 ¹	1.0-2.0 ¹	0.4 ¹
Olenek	31.5 ¹ 17.0-58.0 ³	1.3-1.7 ¹	0.2 ¹

¹Holms et al., 2000;
²Savel'eva et al., 2000

Changes of water discharge in the main Siberian rivers under same periods can exceed 50% from its annual value.

- Global tendency towards warming is reflected on a value of total discharge and on a chemical flow of high latitude rivers.

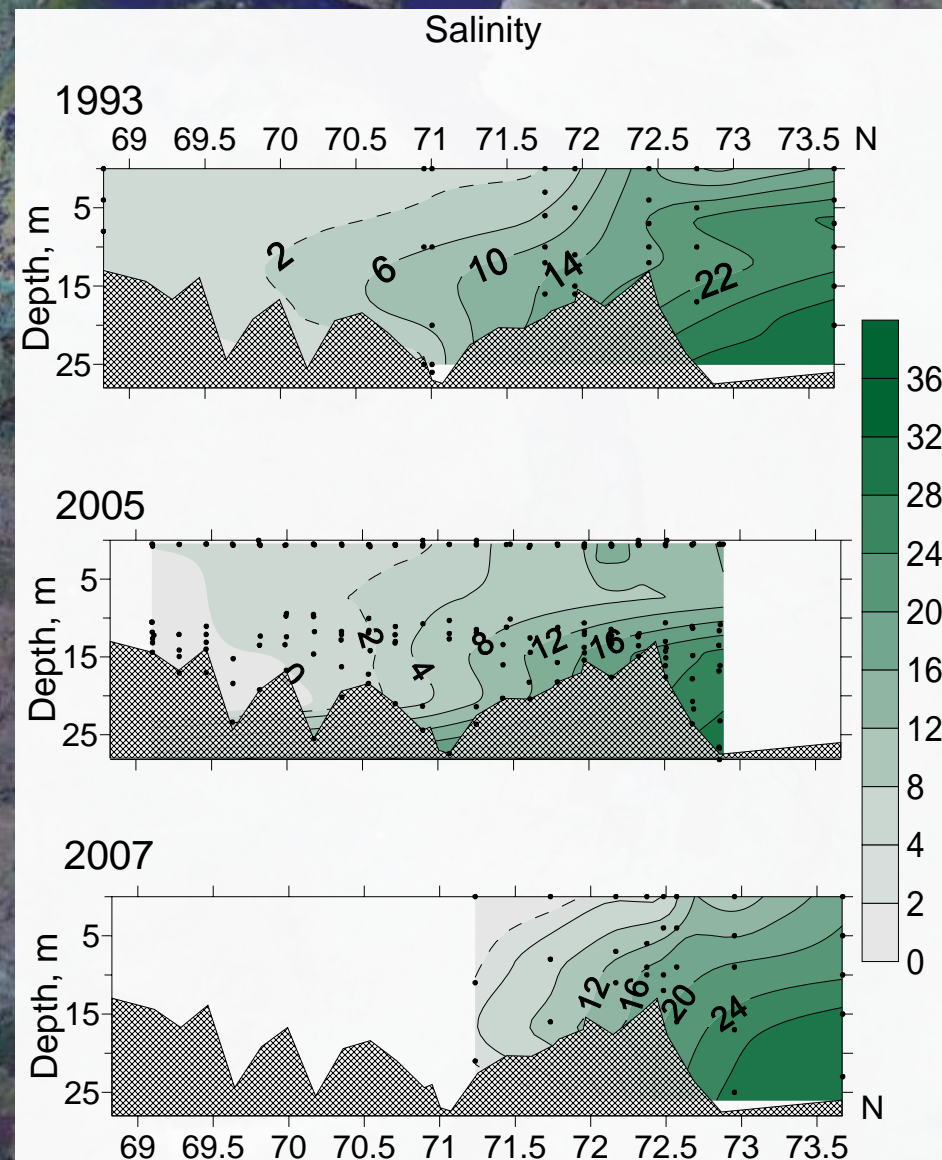
Annual discharge of Siberian rivers has obvious trend towards increase since beginning 30s till beginning 90s years against the background of significant annual fluctuations.

- Analyses of river discharge data since 70s years till end 90s shows, that increasing of winter run-off played the main role at that time. Value of summer runoff grown minor. For some rivers its decrease had been observed. It connected with:
 - increase of winter precipitation,
 - total soil water retention
 - growth of thickness of seasonal melted frozen subsoil layer in catchment areas.
- Value of-run off and climatic changes in high latitudes lead to contraction difference between value of winter and summer run-off with little increase of total annual run-off.

Interannual variability of water discharge has an influence upon nutrients discharge.

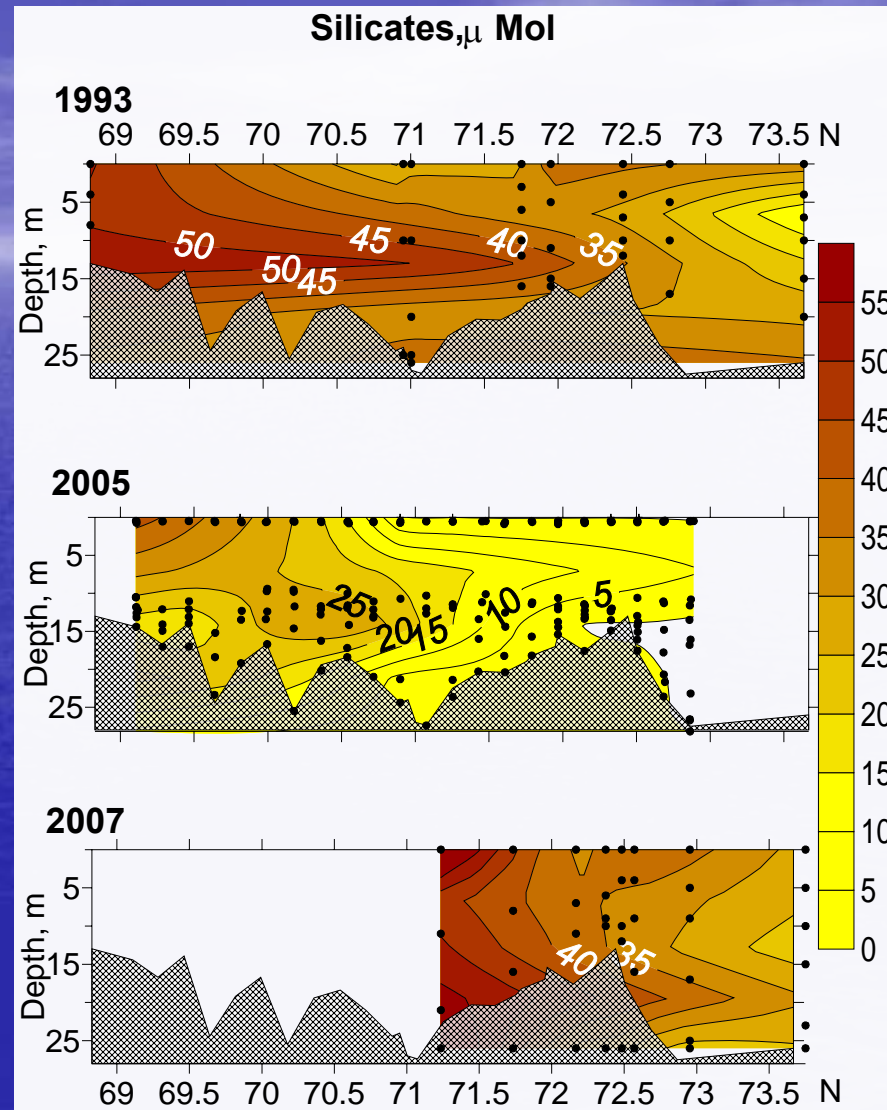
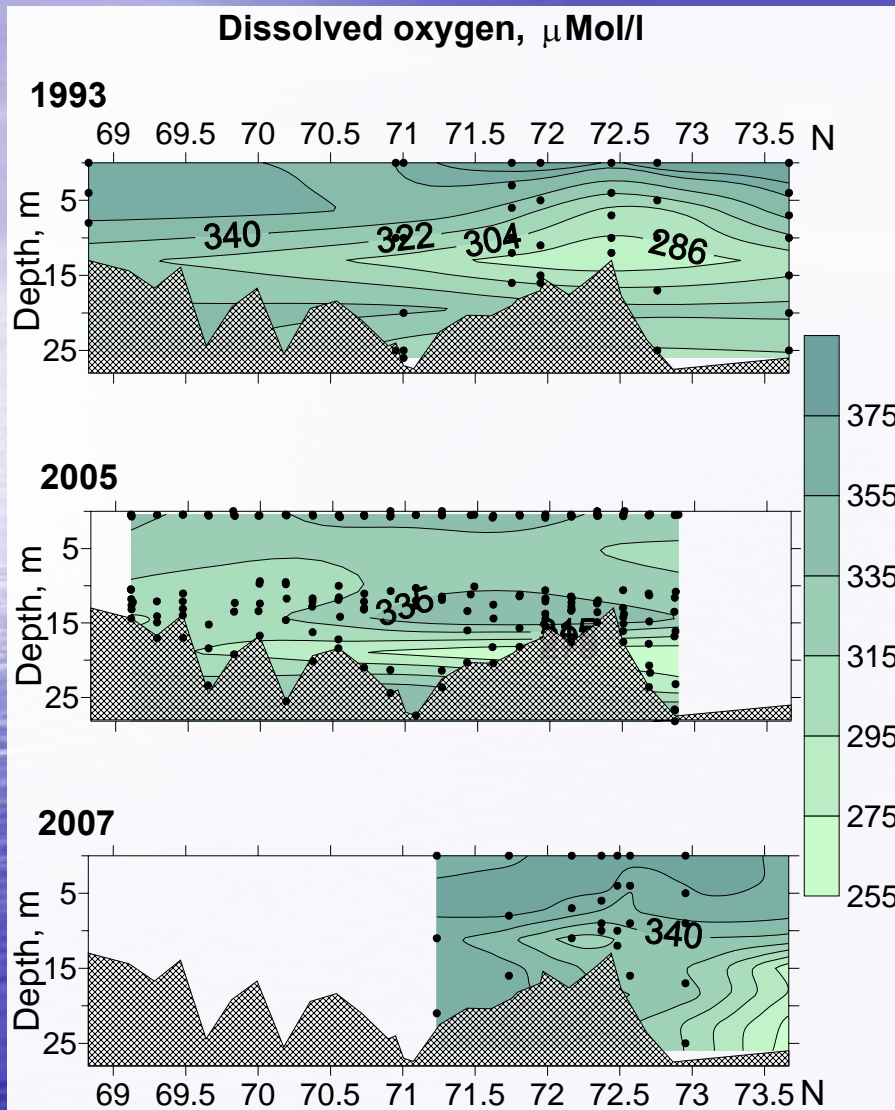
Basing on the data receive in some Seasons but in different years mixing zone of river and sea waters drifted to the North for 1993 – 2005 – 2007.

Although it should be noted that subject to hydrometeorological conditions and value of discharge the position of this zone can be changeable within very wide boundaries. Basing on three surveys we can only suppose of existence such trend in position of river-sea interaction zone.



Ямало-Ненецкий

The distribution of salinity in the Ob' mouth



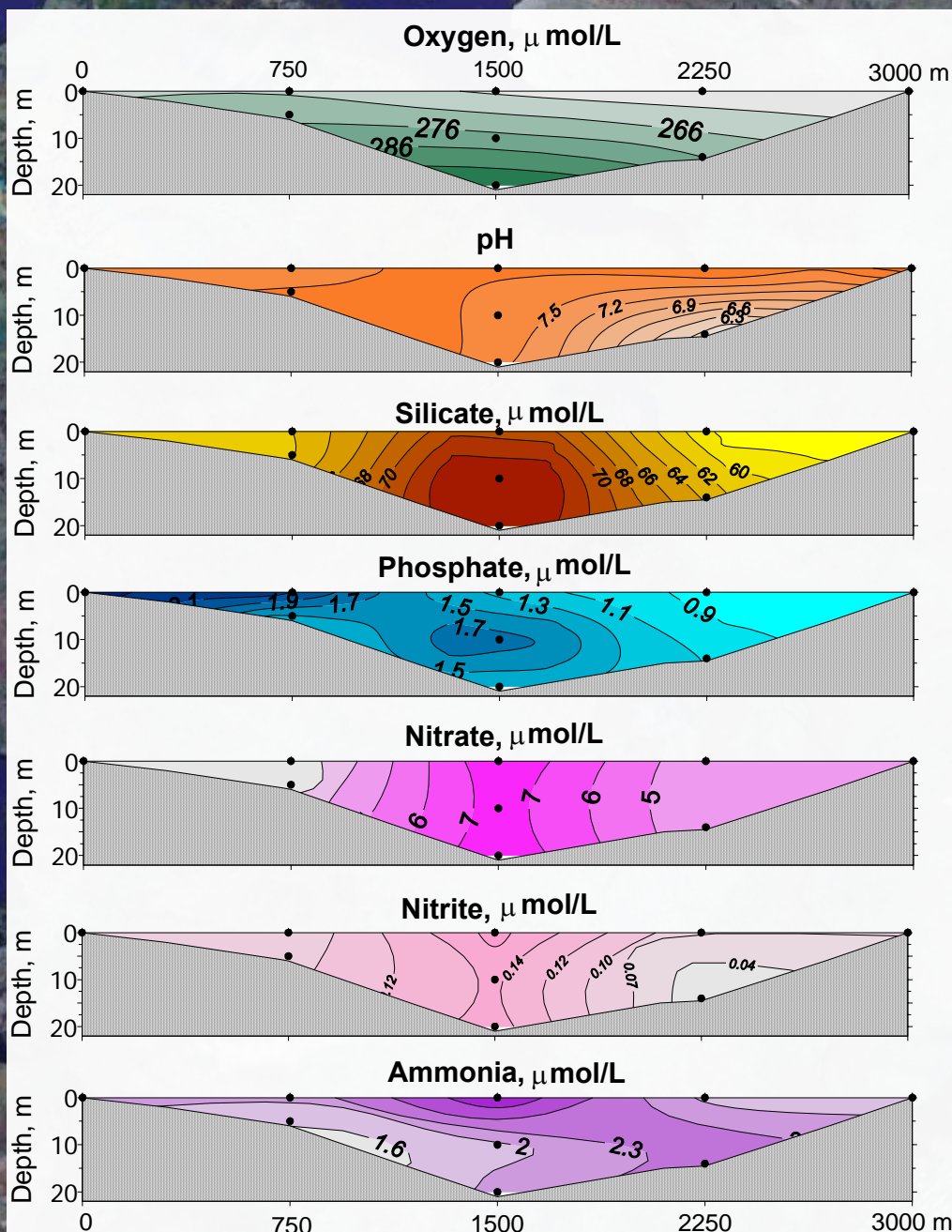
The distribution of dissolved oxygen and silicates in the Ob' mouth

Hydrochemical parameters in the transect across Ob' river at Salekhard

11.06.2000

Chemical composition of river discharge is individual for each river and it is generated by character of a catchment area. So flowing through low Ob's waters consist nitrogen compounds and dissolved carbon dioxide more then Yenisei's waters, which are enriched by silicates and carbonates compare with Ob's waters.

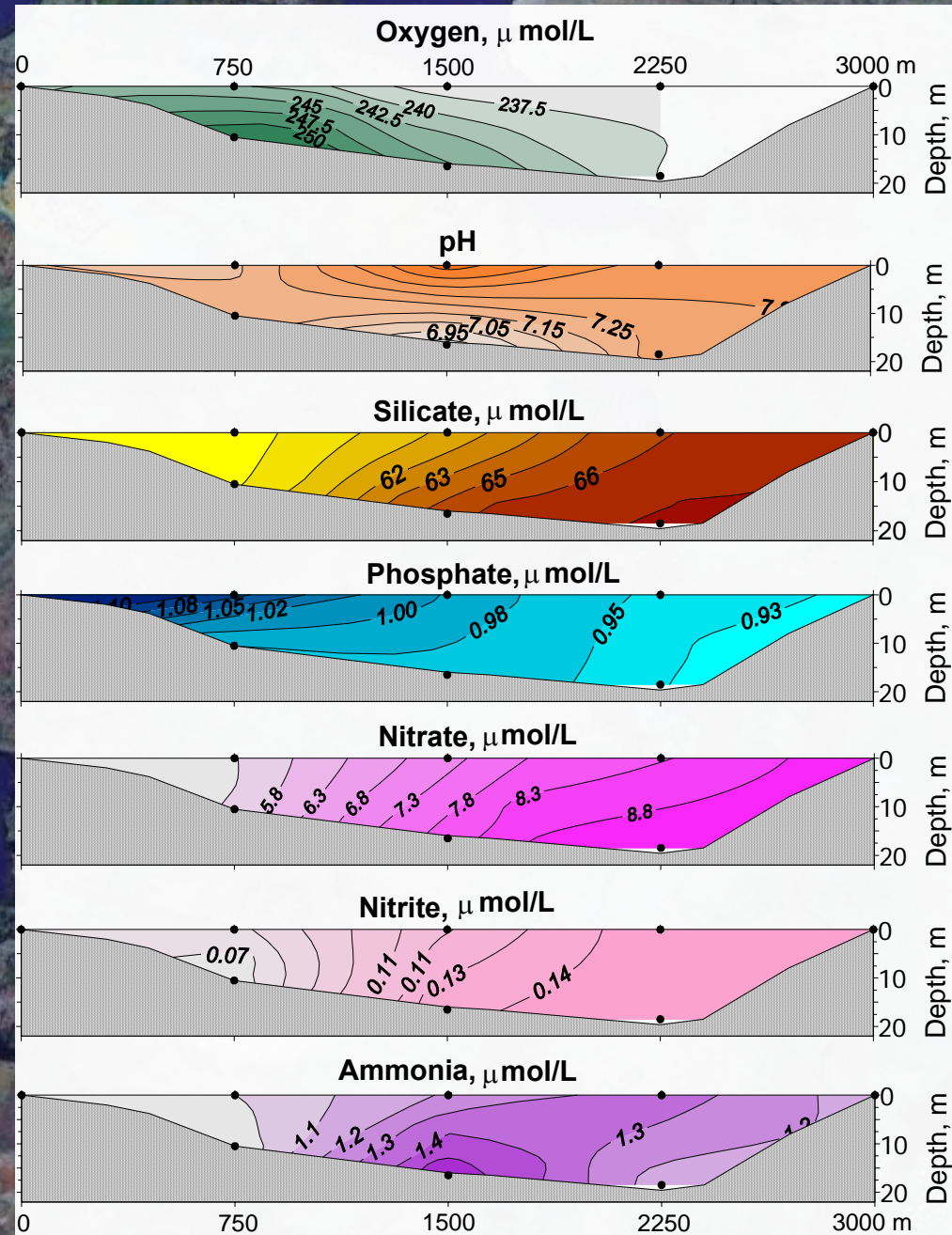
High concentrations of nutrients (except phosphates) are clearly tracked to the deepest stream stations in summer. It is explained by more active development of photosynthetic processes near banks. In winter nutrients concentrations are considerable growth (especially silicates) and its maximums are displaced to bank stations.



Hydrochemical parameters in the transect across Ob' river at island Tatarski 17.06.2000

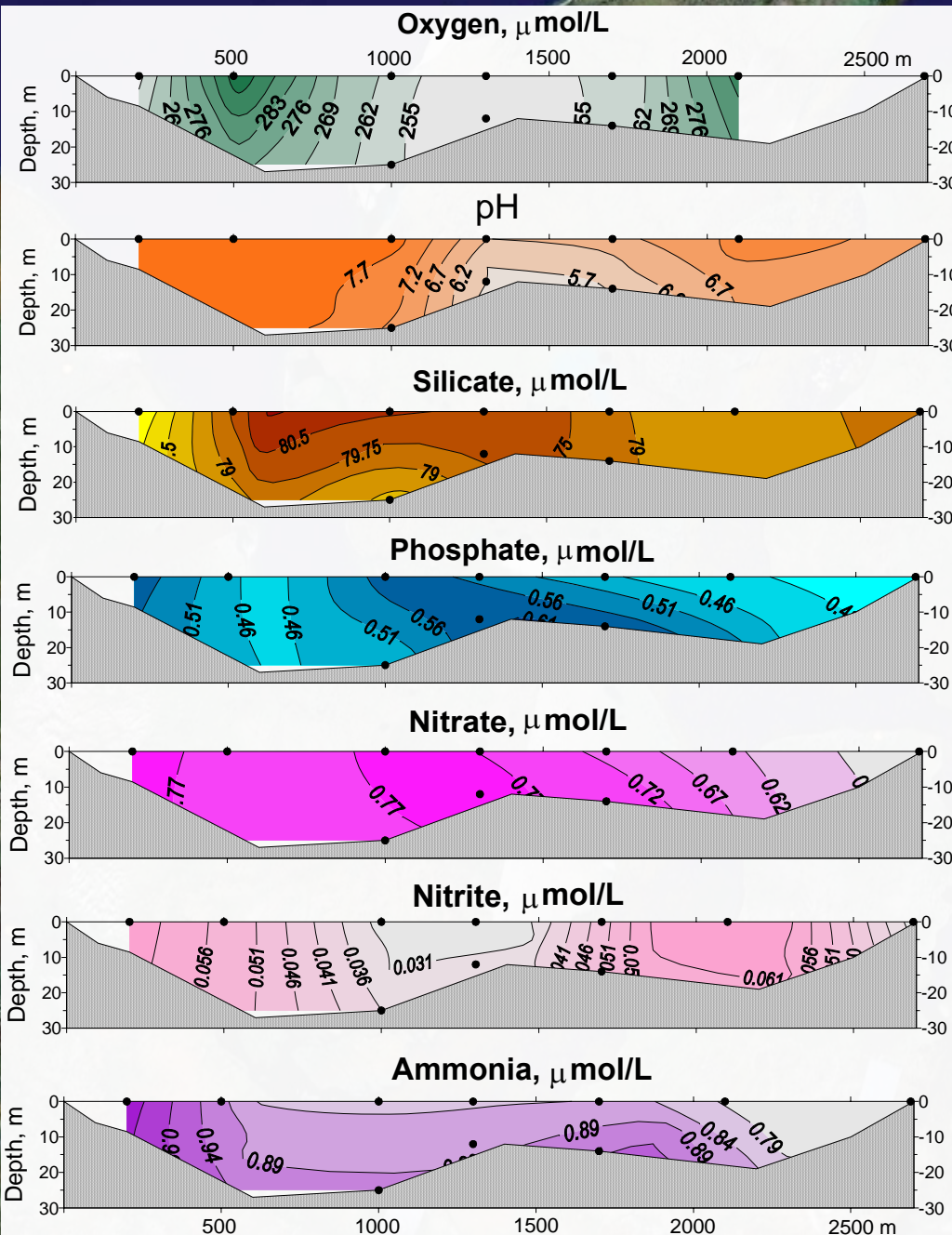
In spite of essential mixing waters entered from other region of a catchment area retain their hydrochemical features in a main channel along some distance. That is stipulating the presence similar nutrients irregularities.

Significant changes of chemical compound of water are registered with stream.



Ямало-Ненецкий

Hydrochemical parameters in a transect across river Yenisei



Changes of hydrochemical characteristics are from 53 till 97%.

Reasons of spatial variability of hydrochemical parameters of the river discharge

- ✓ **Changes of dynamic characteristics of the flow.**

At widening of a channel the flow velocity sharply falls. It leads to the mass setting the particular substances and to the changes of a chemical compound of waters connected with it.

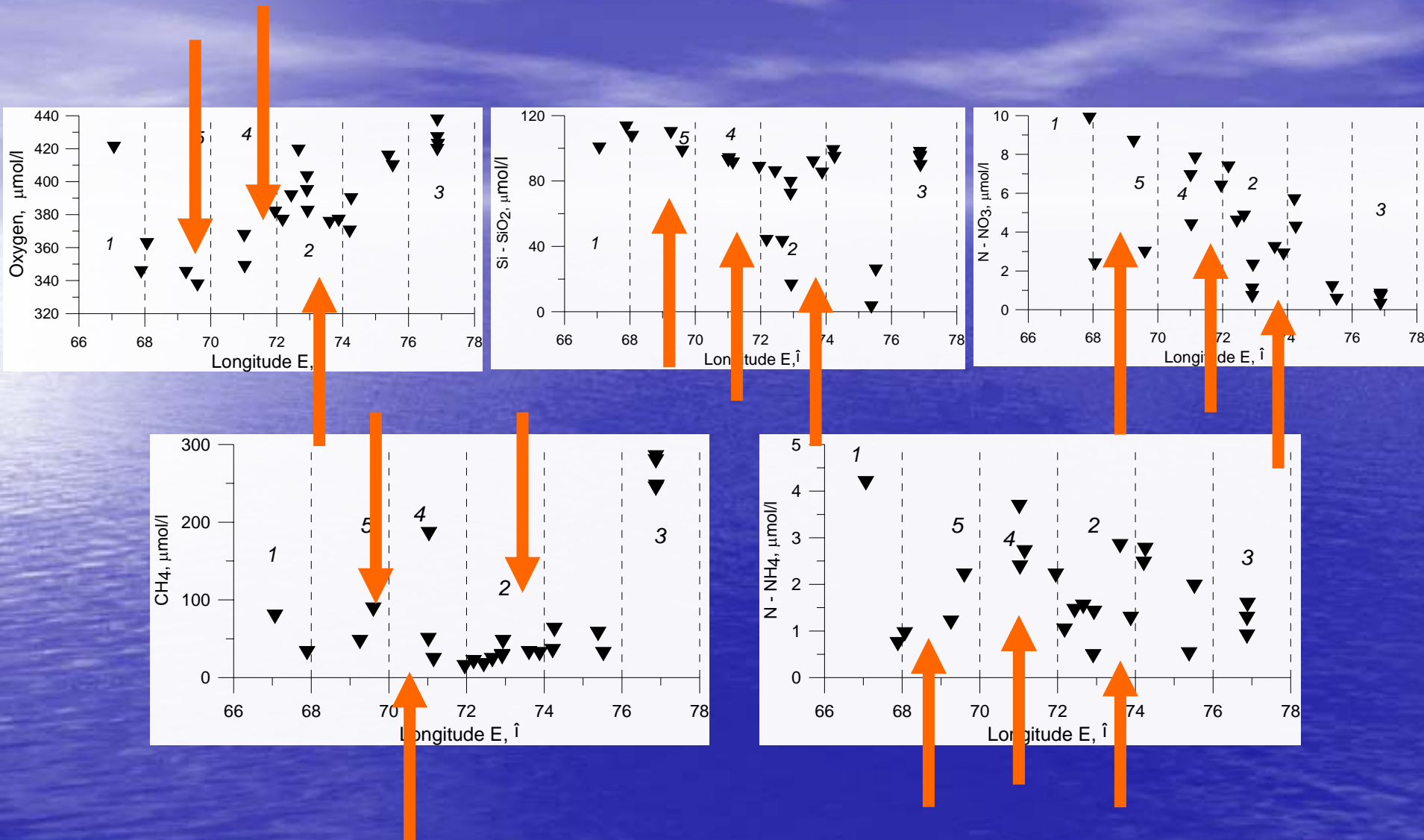
- ✓ **Influence of orography river laying down.**

In the bottom deeps there is a natural accumulation of organic substance

- ✓ **Active development of photosynthetic processes**

- ✓ **Influence of technogenic and household sewage**

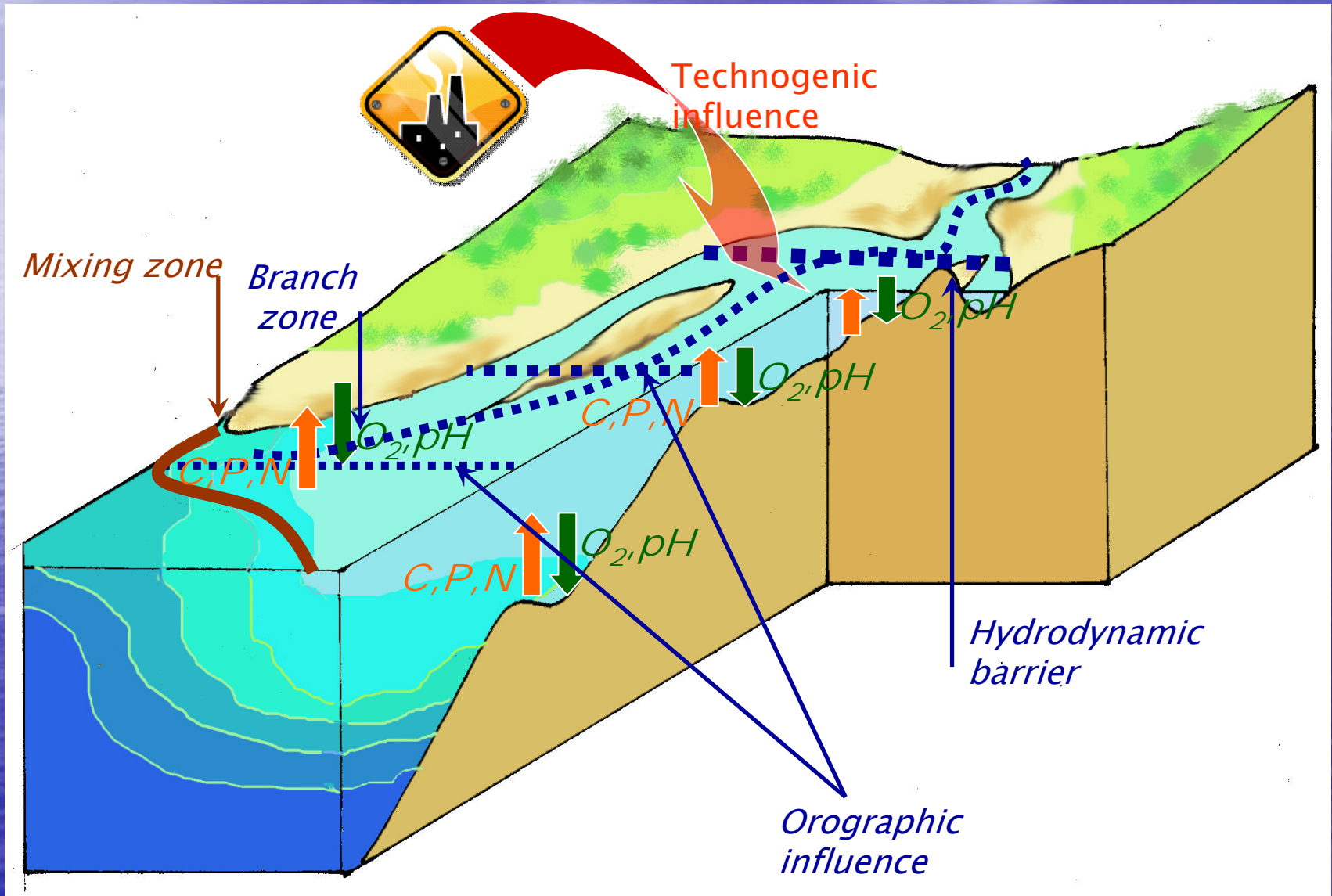
Changes of hydrochemical composition of Ob' river



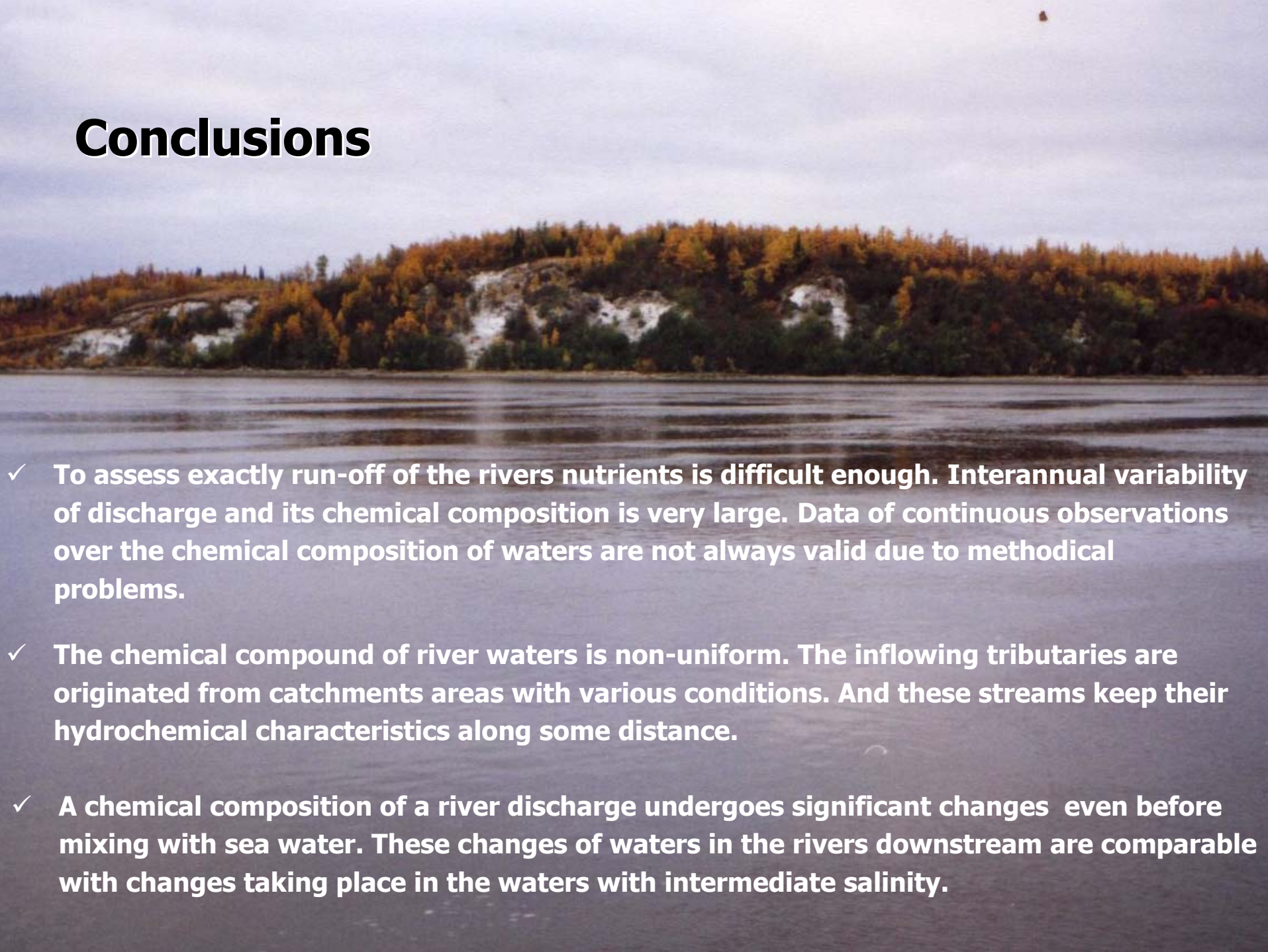
The distribution of hydrochemical parameters in surface water the Ob' river and Ob' mouth on the results of fall-study 2002:

1 - Salekhard; 2 – New Port; 3 - Antipauta; 4 – Nadymski Bar; 5 – outlet of Ob' river

Zonality of the nutrients distribution in river downstream



Conclusions

- 
- ✓ **To assess exactly run-off of the rivers nutrients is difficult enough. Interannual variability of discharge and its chemical composition is very large. Data of continuous observations over the chemical composition of waters are not always valid due to methodical problems.**
 - ✓ **The chemical compound of river waters is non-uniform. The inflowing tributaries are originated from catchments areas with various conditions. And these streams keep their hydrochemical characteristics along some distance.**
 - ✓ **A chemical composition of a river discharge undergoes significant changes even before mixing with sea water. These changes of waters in the rivers downstream are comparable with changes taking place in the waters with intermediate salinity.**



Thank you for your time!

Acknowledgments

I'm grateful to P. Makkaveev; P. Stunhzas and P. Khlebopashev for their constructive comments. I wish to thank A. Egorov for methane GC measurements.

I'm also grateful to L. Skibinski for providing nutrient data from Ob' mouth, 2005.