Комплексный мониторинг современных климатических и экосистемных изменений в Сибири

Integrated monitoring of contemporary climatic and ecosystem changes in Siberia

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Monitoring of climatic and natural processes:

- Creation of a reference network for monitoring of dynamic state of atmosphere, hydrosphere, soil and vegetation.
- Creation of a distributed network consisting of self-contained and field information-measuring systems to provide landscape analysis of processes.
- Development of physical, geochemical, hydrological and bioindication methods for landscape analysis of climatic and natural processes now and in the past.
- Delay in response (phase shift) of regional system to global impacts denote a necessity to match monitoring of regional and global processes.
- Creation of an **information-modeling system** intended to monitor, to analyze and to model climatic and natural processes.

Structural features of the integrated regional studies:

- It is unprecedented difficult object of researches: natural and climatic systems with continuously changing parameters of a condition and interaction processes under simultaneous influence of terrestrial and extraterrestrial factors, including anthropogenous influences.
- Special wide integration of scientific disciplines (physical and mathematical, technical, biological, geographical, etc.) as are necessary:

- New methods and devices for monitoring of a condition and processes;

- New information technologies for multifactorial monitoring and modeling;

- A new paradigm for the description and forecasting of dynamics of natural and climatic systems.

The program on integrated monitoring of contemporary climatic and ecosystem changes in Siberia formulated at IMCES SB RAS has the following main goals:

- To get new knowledge on climates and environment in past and at present days including naturally stipulated variability;

- To study roots of climate variability observed analyzing not only mean values of climatic parameters but also their higher-order moments.

Feature:

- Atmosphere-hydrosphere interaction is one of the main factors determining regularities of environmental changes observed in West Siberia because this region is heavily swamped and hydromorphic.

- Therefore within the above program investigations of IMCES SB RAS on climatic and ecosystem changes are integrated with investigations of IWEP SB RAS on water regime variability.

- To study processes of runoff formation at swamped territory catchments, this in-stitute successfully develops landscape-hydrological approach based on combined using of ground-based monitoring, remote sensing, GIS-technologies and landscape approach to hydrological processes description.

IM program the following tasks are solved:

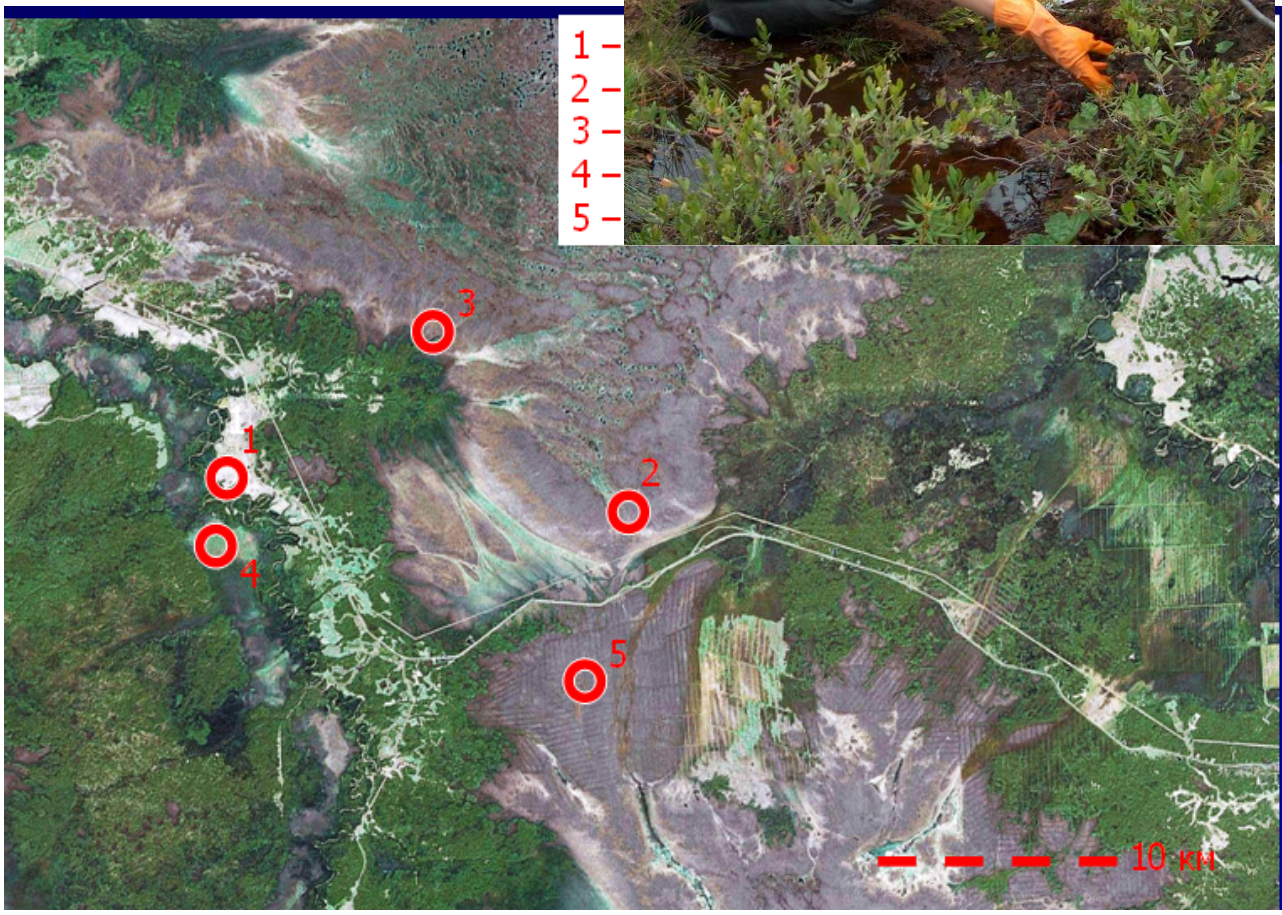
- Integrated study of geosystem and climate changes in Siberia based on multicomponent monitoring using instrumented measurements of characteristics of atmosphere, biosphere and hydrosphere;

- Quantitative estimations of spatial and dynamic characteristics of natural and climatic systems in Siberia, reveal of regularities and relations between spatial and temporal changes of climate and climate-forming factors observed;

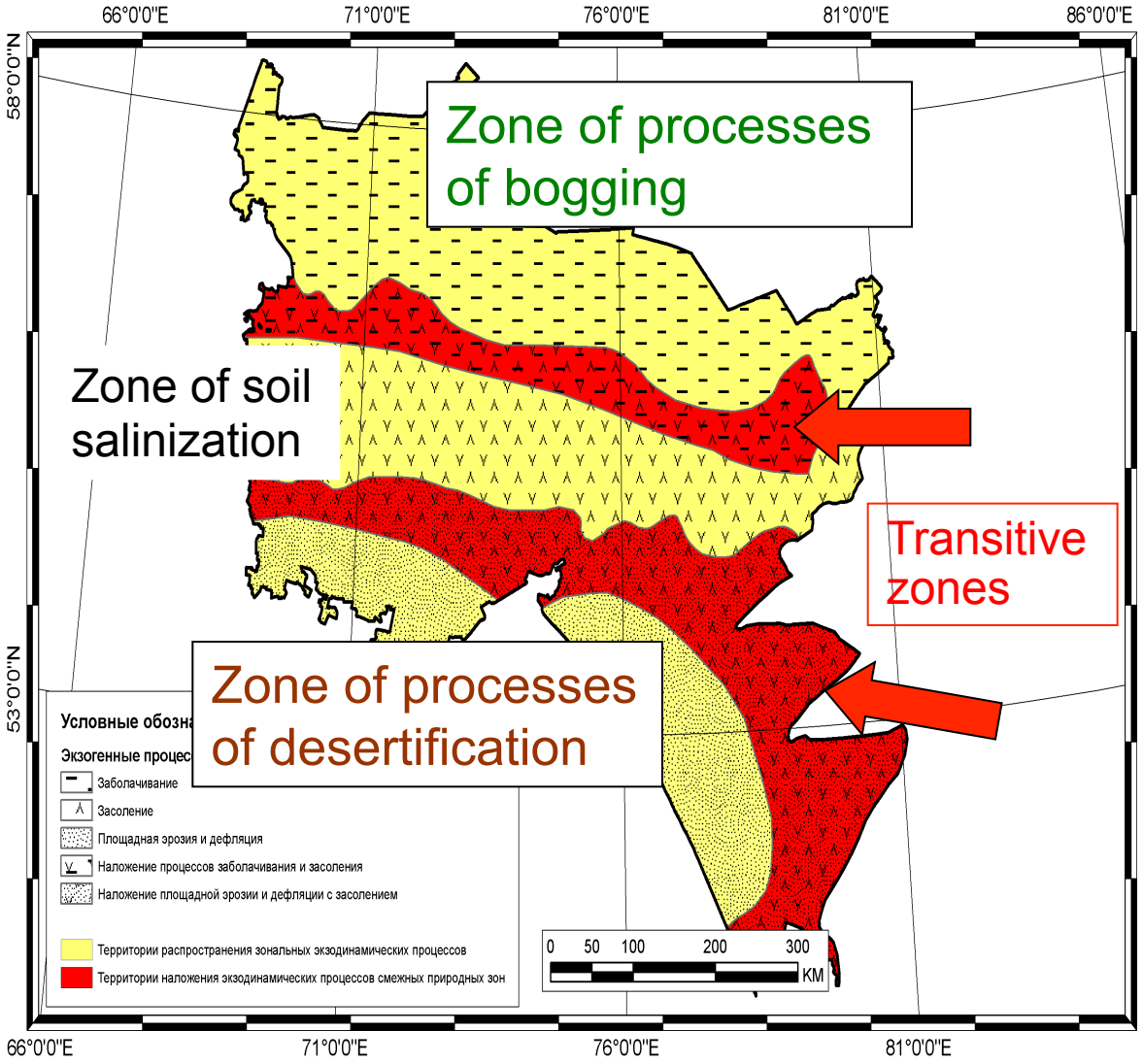
- Determination of significant correlations and peculiarities of climate forming cycles transformation based on system-evolution analysis of estimation ensemble obtained from instrumented monitoring, paleoreconstruction and modeling of geosphere-biosphere changes;

- Substantiation of spatiotemporal regimes of monitoring, development of methodical and technological provision for system intended for monitoring of natural and climatic processes in Siberia.

Base station and supervision posts on the Great Vasyugan Mire

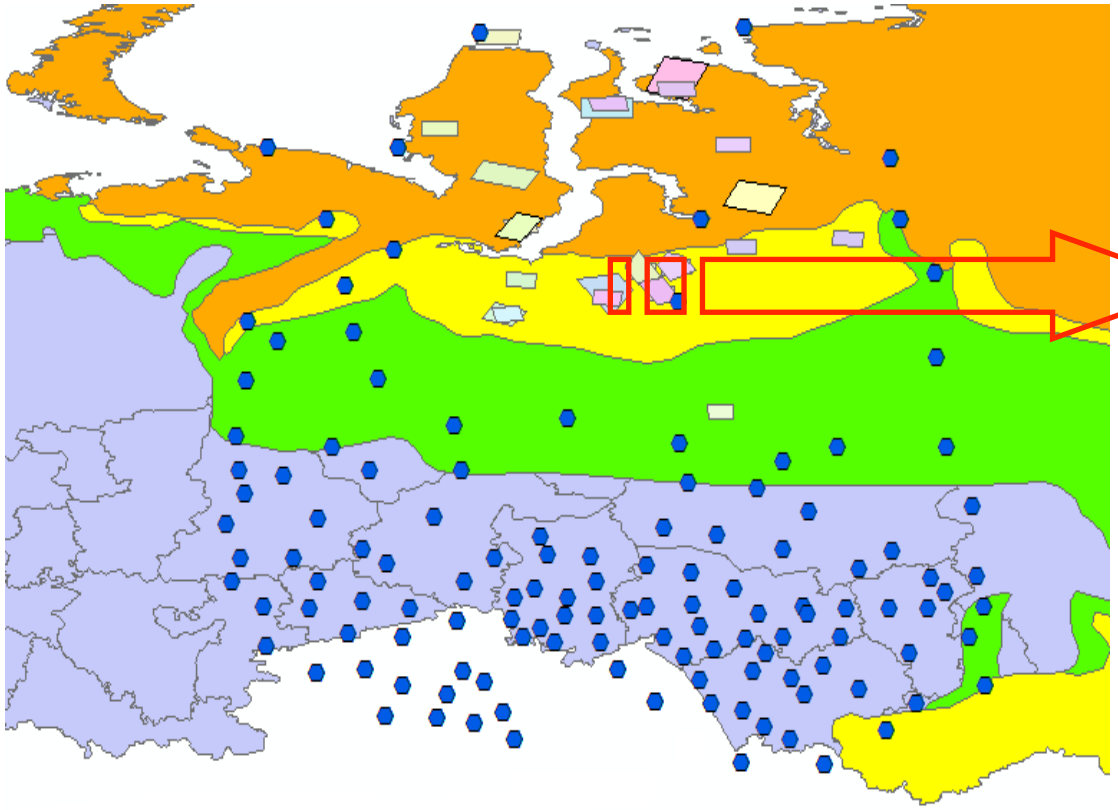


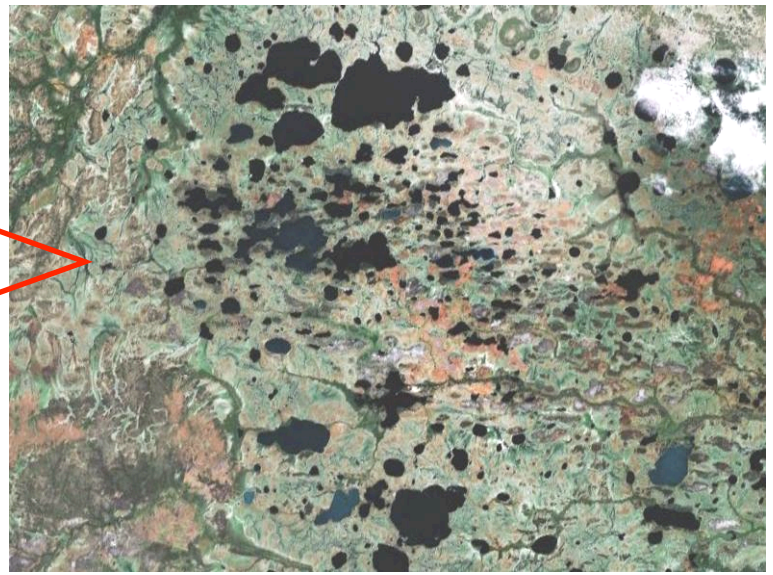
Scheme of exodynamic processes in territory of South of Western Siberia



Zones exodynamic processes is indicators of climatic changes for **3 ÷ 5** and **40 ÷ 50** years' cycles (IWEP SB RAS)

Scheme of an arrangement of ranges and meteorological stations in different zones of permafrost in territory of Western Siberia

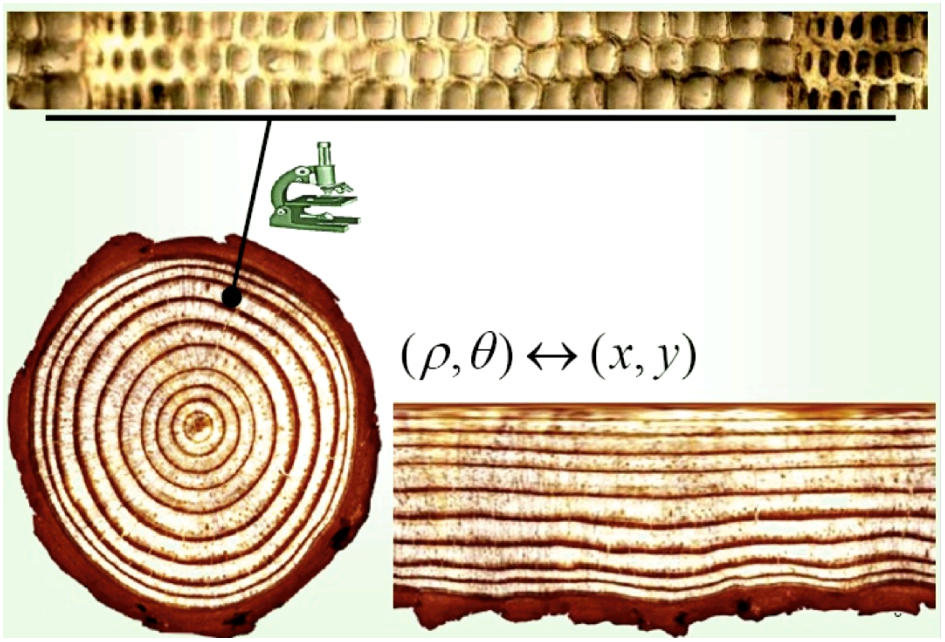


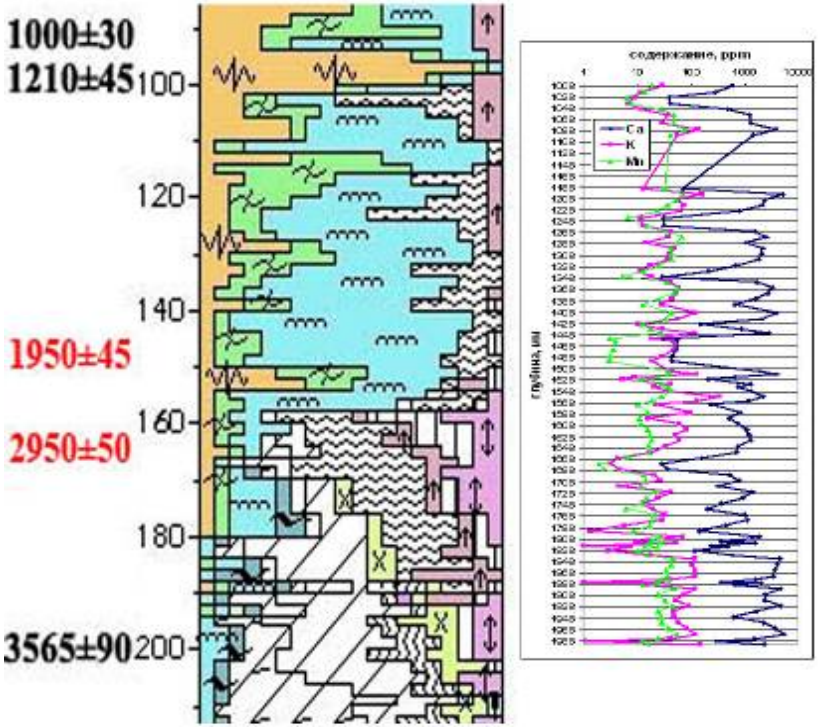


Thermokarstic lakes

Landsat-7 Data (2001)

Bioindication methods for landscape analysis of climatic and natural processes now and in the past

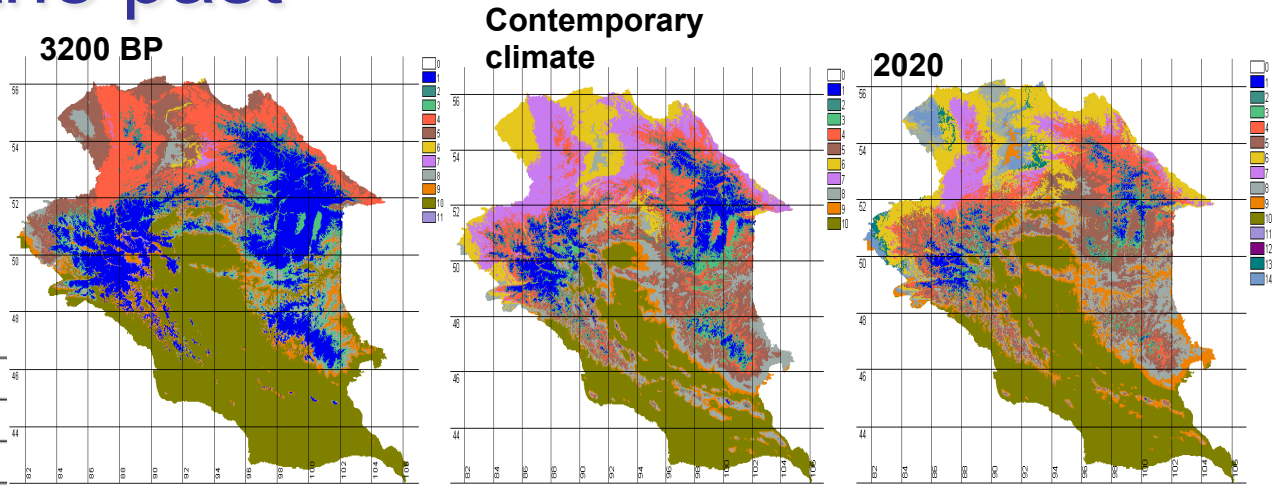


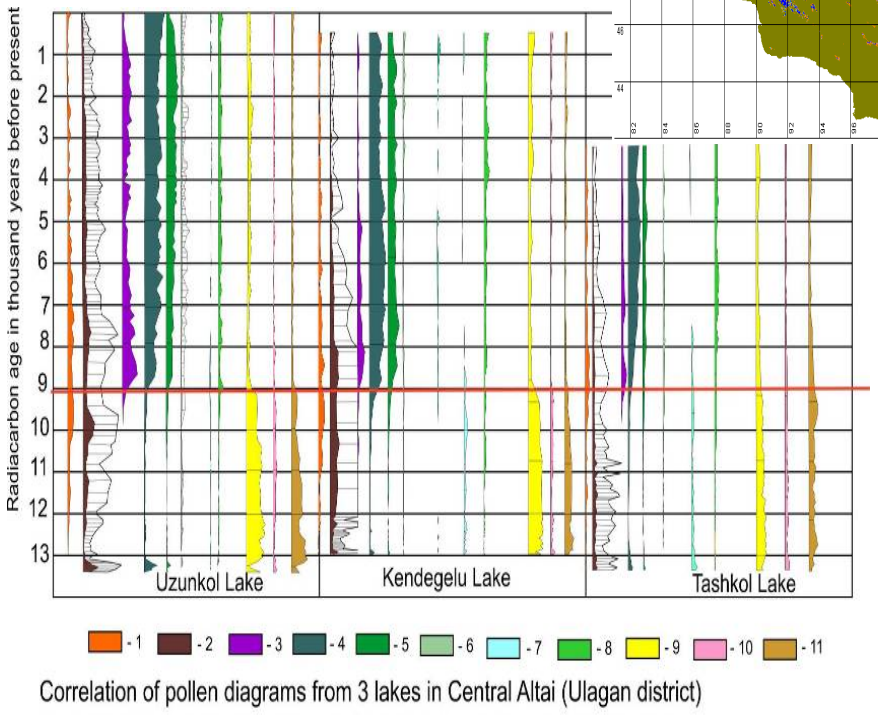


Mathematical model of tracheid and dendrochronologies year rings

The complex analysis of stratigraphic columns of peat adjournment

Bioindication methods for landscape analysis of climatic and natural processes now and in the past



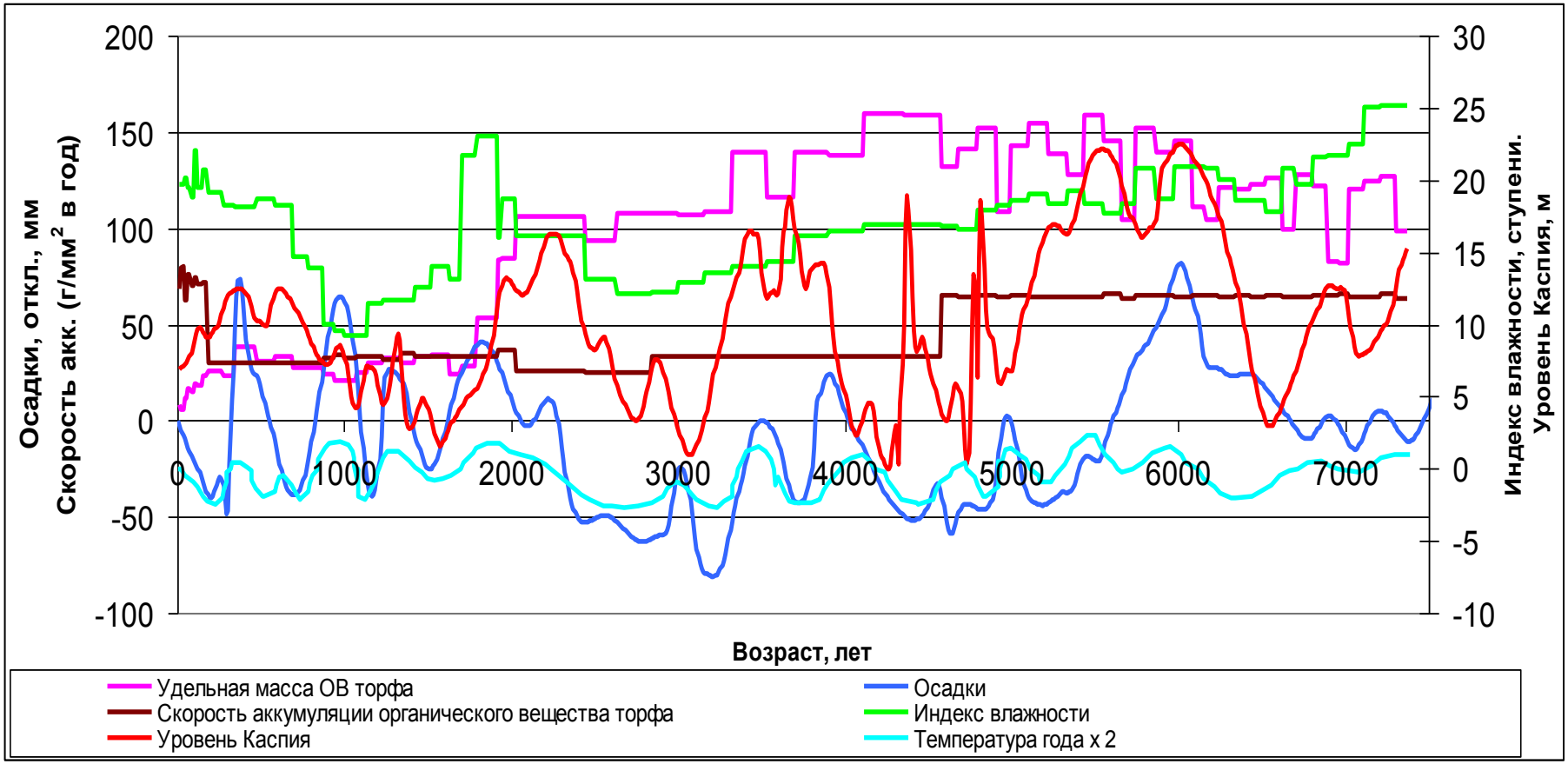


Correlation of pollen diagrams from 3 lakes in Central Altai (Ulagan district)

1 - Larix, 2 - Picea, 3 - Abies, 4 - Pinus sibirica, 5 - Pinus sylvestris, 6 - Betula, 7 - Salix, 8 - Betula nana, 9 -Artemisia, 10 - Chenopodiaceae, 11 - Poaceae.

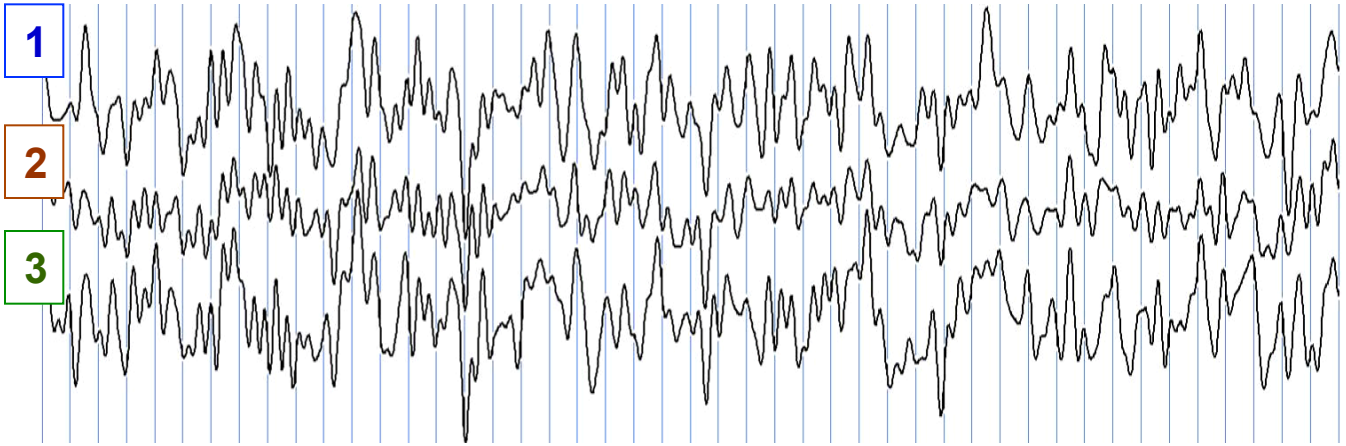
Tahonometrichesky analysis of pollen of plants and diatomis used for restoration of landscapes in the past and their modelling in the future

Multiple factor analysis of climatic and natural processes now and in the past



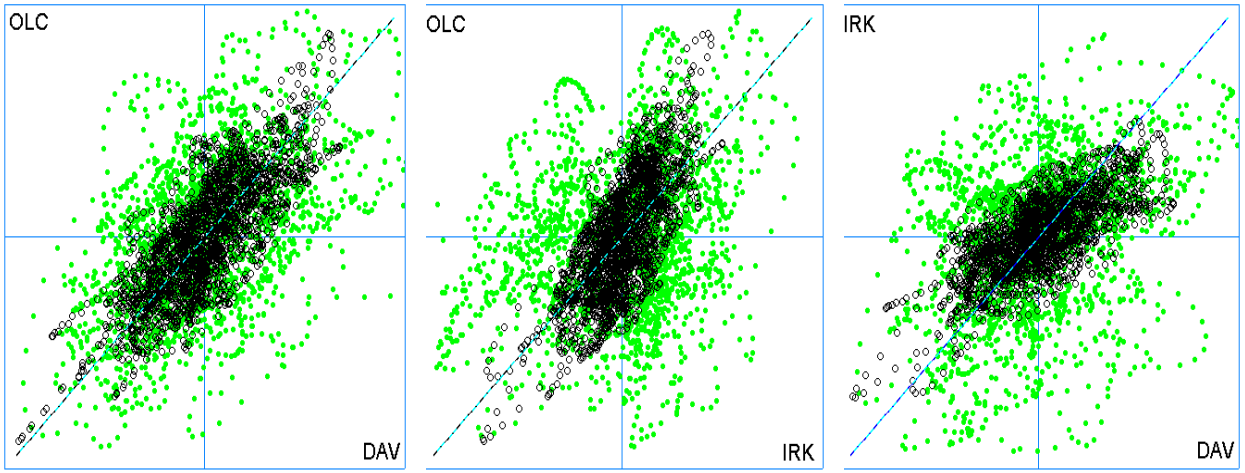
Change of the integrated indicators **of a water mode** of the Iksinsky bog, **climate** (southern taiga of Western Siberia) and **level of Caspian sea** in Holocene

Selection of global and regional a component of chronologies

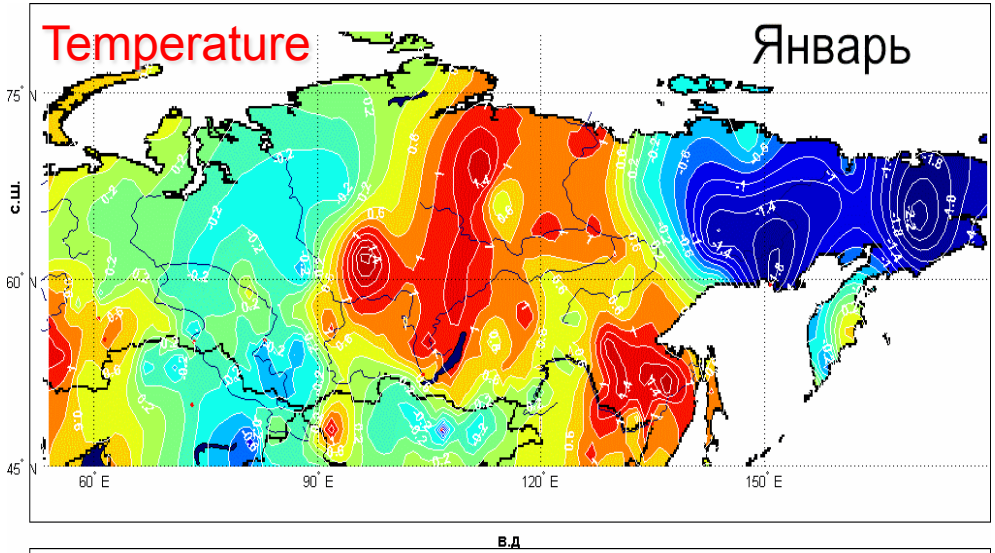


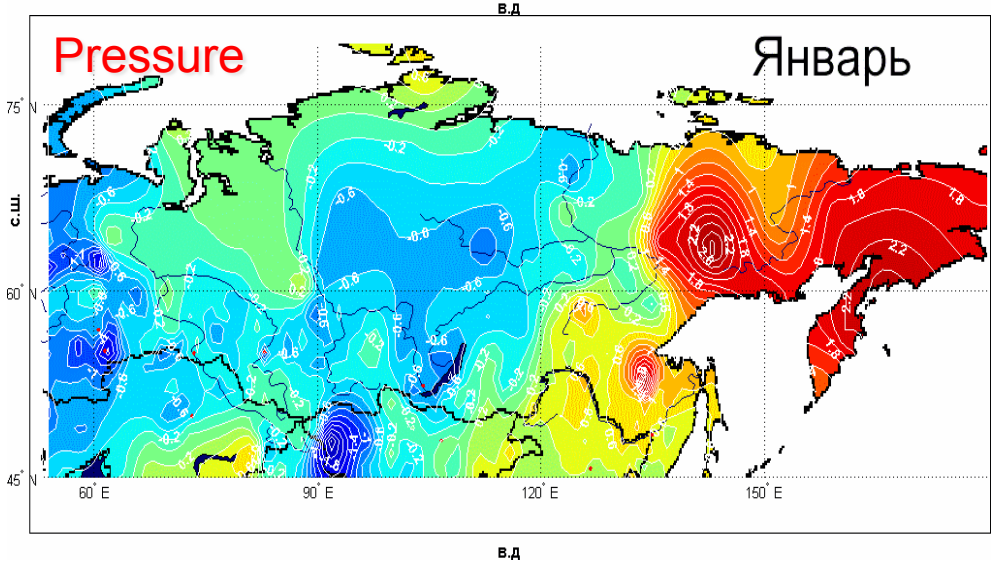
Realizations of global components chronologies ^{18}O: **IRK** (1), **DAV** (2), **OLC** (3) with 1734 to 1998 y.

	DAV	IRK	OLC
DAV		0,36	0,48
IRK	0,66		0,25
OLC	0,79	0,64	
ΔE/E	0,56	0,40	0,62



Results of analysis of instrumented observations over the period of accelerated warming (1975-2005) on Asian part of Russia





Seasonal behavior of linear trends of temperature ^{0}C/10 years and pressure hPa/10 years

Red color	– increase
Blue color	– decrease

Dynamics of the changes observed is complicated and ambiguous: warming in some regions and simultaneous cooling in the others.

The regularity revealed is that atmospheric pressure trends are generally similar to the temperature trends but with the opposite sign.

Selection of global and regional a component of climatic processes

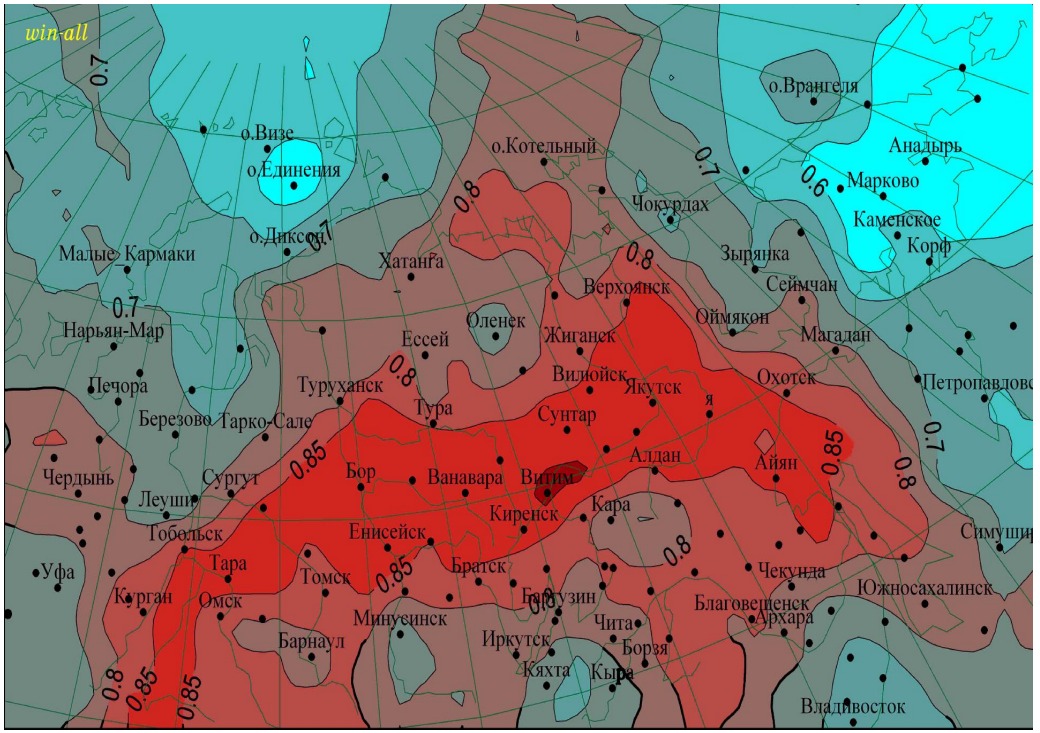
Mathematical model of process

$$\{x_{l,\tau}\} \quad X_{l,\nu} = \frac{1}{N}\sum_{\tau=0}^{N-1} x_{l,\tau}\, e^{-i2\pi\nu\tau/N}$$

Joint filtering

$$Y_{l,\nu} = \begin{cases} X_{l,\nu}, & \operatorname{sign} X_{l,\nu} = \operatorname{sign} X_{j,\nu} \\ 0, & \operatorname{sign} X_{l,\nu} \neq \operatorname{sign} X_{j,\nu} \end{cases}$$

$$y_{l,\tau} = \sum_{\nu=0}^{N-1} Y_{l,\nu}\, e^{i2\pi\nu\tau/N}$$



Coherence criterion

$$C(G,l) = \frac{1}{(b-a)|G|}\sum_{\nu=a}^{b} H\left(\operatorname{sign} X_{l,\nu} \times \sum_{l} \operatorname{sign} X_{l,\nu}\right)$$

Geographical features of climatic changes

Distribution of annual (seasonal) meteo characteristics on territory of Siberia in the allocated area with geographical coordinates 60°-120° E.L. 52°-67° N.L. is described by a matrix in corresponding squares of a geographical grid

Stage 1978 – 1994

60°		80°		100°		120°
M_{11}	-8.5	M_{13}				
M_{21}						
M_{31}		M_{33}	M_{34}		-7	M_{37}
>0	M_{42}	-1	-2.5	M_{45}		
		M_{53}		M_{55}		

Stage 2002 – 2006

60°		80°		100°		120°	E.L.	
M_{11}	-7.5	M_{13}					67° N.L.	M_{11}-Salekhard M_{13}-Turukhansk
M_{21}							65°	M_{21}-Khanty-Mansiysk M_{31}-Tobolsk
M_{31}		M_{33}	M_{34}	-2.8	-7	M_{37}	60°	M_{33}-Kolpashevo M_{34}-Eniseisk
>0	M_{42}	-2		M_{45}			58°	M_{37}-Aldan M_{42}-Omsk
		M_{53}		M_{55}			55	M_{45}-Bratsk M_{53}-Barnaul

M_{jk} - elements of a matrix of integrated characteristics of a climate and types of local cryogenic, hydrological and landscape conditions.

The data obtained and results of their analysis put new priority tasks in studying of climatic changes:

- Investigation of confidence intervals for instrumented data processing (ground and satellite ones), which are used for analysis of contemporary climate changes;
- Development of matched formats for observation data and results of mathematical modeling when analyzing regularities of contemporary climatic changes;
- Further development of a concept of regional climate monitoring aimed at not only at revealing climate change regularities, but also at development of methods for forecast and warning of extreme deviations of climatic regimes.

Final goal of the program is to reveal negative tendencies of accelerated natural complexes transformation and to give scientific grounds for monitoring of natural and climatic processes.

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