

Modern information technologies for environmental monitoring and modeling

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Content

Introduction

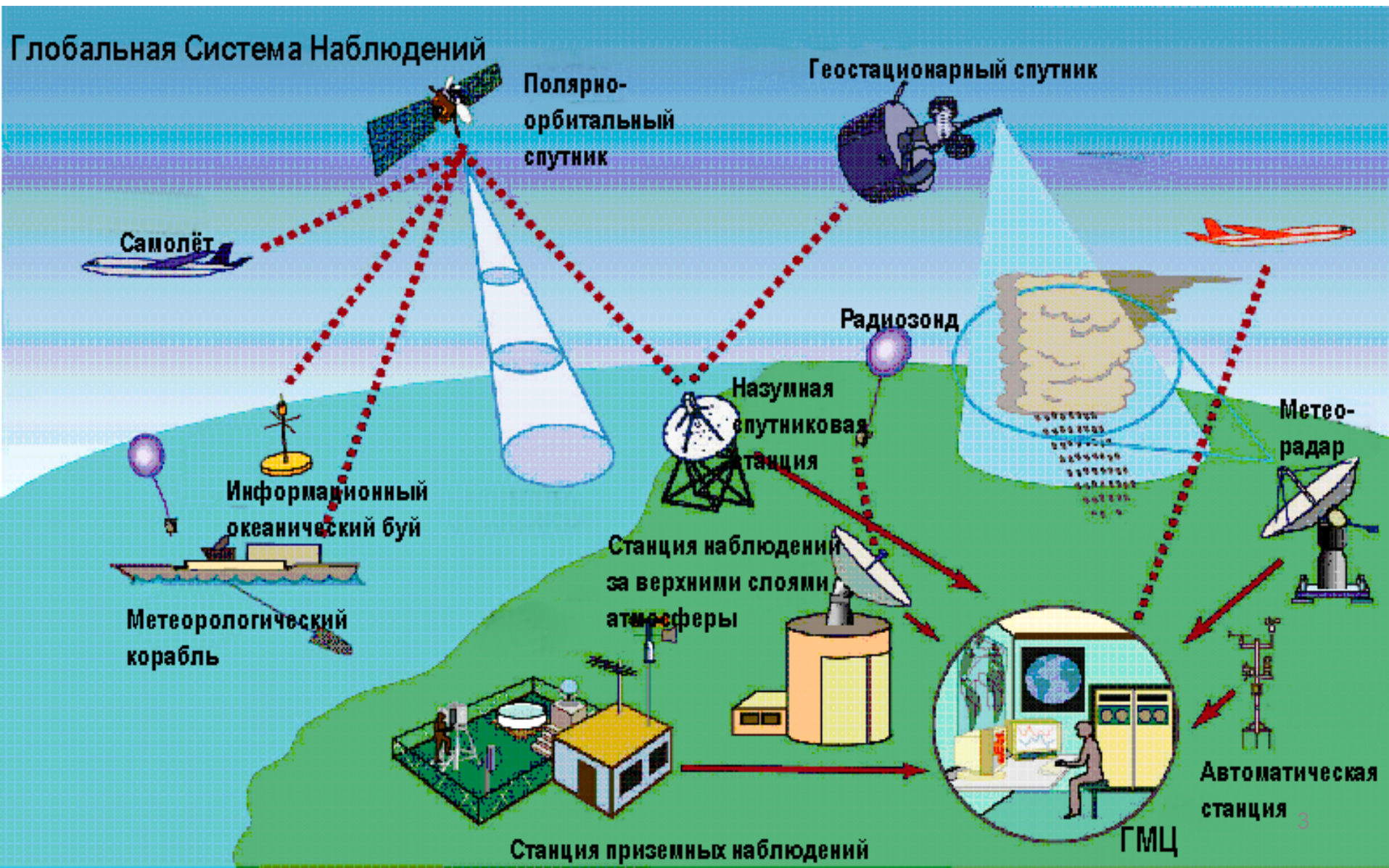
Information-computational technologies

Information-measuring technologies:

- To monitor geosphere-biosphere interactions;
- To monitor lithosphere processes;

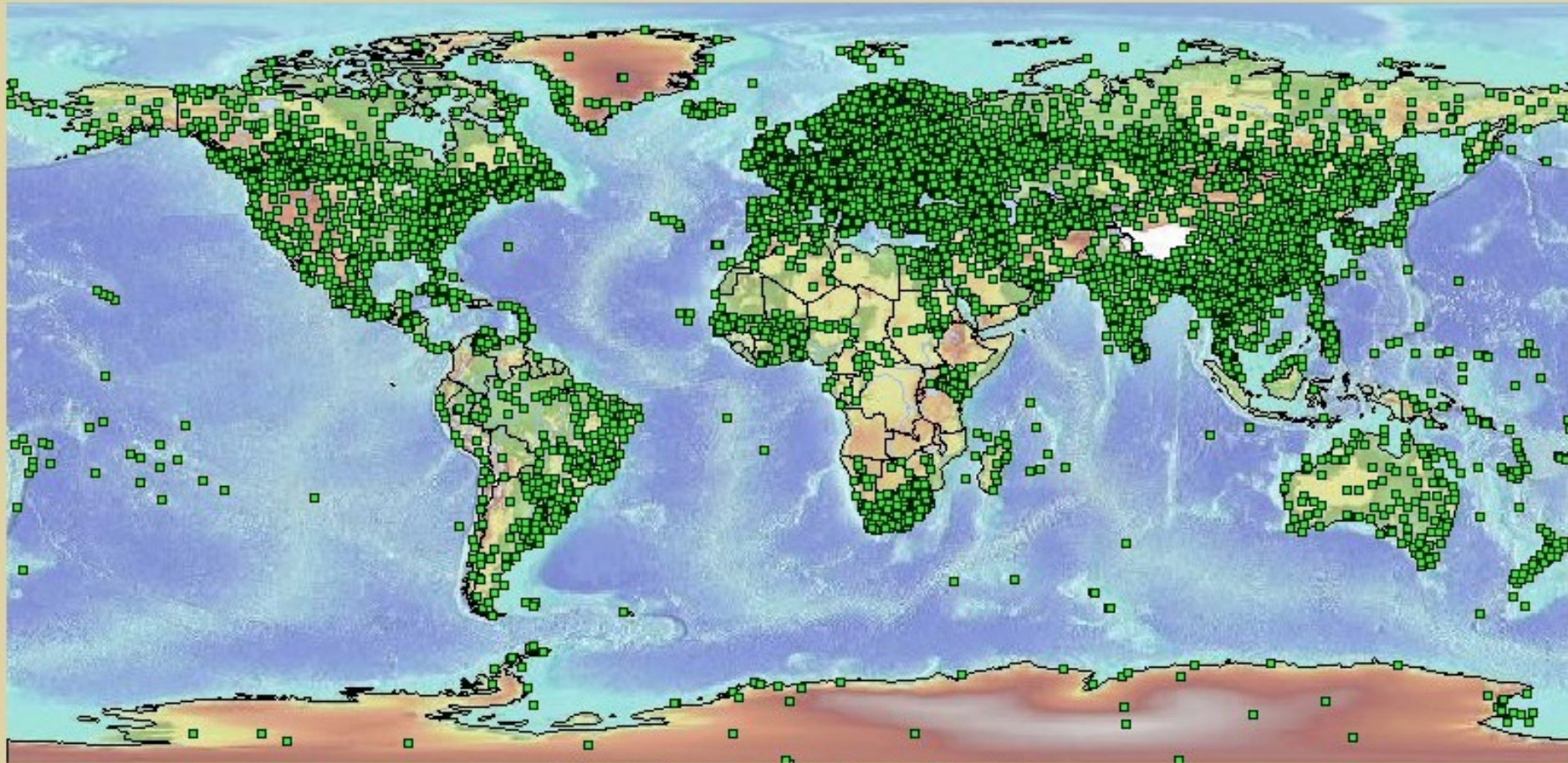
Conclusion

Complex system for hydrometeorological observations



World hydrometeorological observation network

Количество синоптических сообщений: 6060



2011 ▾ Июнь ▾ 28 ▾ 00 ▾

Обновить

☐ Автоматическое обновление (5 мин.)

Introduction

Peculiarities of environmental sciences:

- Wide range of spatiotemporal scales of the processes and phenomena studied;
- Intense acquisition of time series of georeferenced geophysical data;
- Strict requirements to spatiotemporal distribution and accuracy of observational data;
- Permanent increase of number of measured values and parameters;
- Application of mathematical methods for data processing and modeling;
- Necessity to develop distributed information systems in order to access to environmental information.

Information-computational technologies

Russian hydrometeorological portal

Российский гидрометеорологический портал - Windows Internet Explorer

http://www.meteo.ru/

Файл Правка Вид Избранное Сервис Справка

Российский гидрометеорологический портал

METEO.RU

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Москва, 05 октября.

 **+12.1 °C** пасмурно
Ветер: **3; 1 м/с**
Давление: **мм.рт.ст.** Влажность: **91.8%**
Особые явления: **дымка**
По данным [clivare](#) на 08:00(GMT). Местное время: +3ч

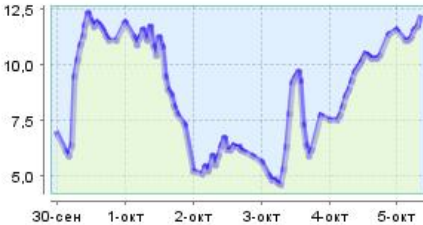
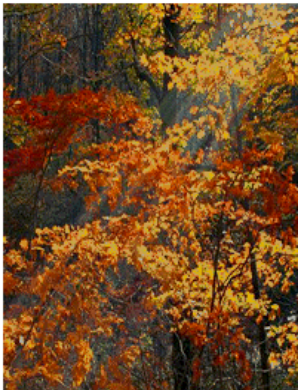
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Дата	Температура, °C	Давление, мм. рт. ст.
05.10	11.1 12.1	737.5 739.5
04.10	7.5 11.4	740.5 741.5
03.10	4.6 9.7	742.8 746.3
02.10	5.1 6.7	744.2 746.8
01.10	7.3 11.9	737.9 743.8
	мин. макс.	

Ученый Совет ФГБУ «ВНИИГМИ-МЦД»

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[Заседания Ученого Совета](#)
[Положение о порядке замещения должностей научных работников в ФГБУ «ВНИИГМИ-МЦД»](#)

Information-computational technologies

NCEP Climate Forecast System Reanalysis

CISL RDA: NCEP Climate Forecast System Reanalysis (CFSR) - Windows Internet Explorer

http://dss.ucar.edu/pub/cfsr.html

Файл Правка Вид Избранное Сервис Справка

CISL RDA: NCEP Climate Forecast System Reanalysis ...

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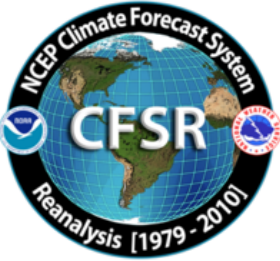
CISL RESEARCH DATA ARCHIVE
MANAGED BY NCAR'S DATA SUPPORT SECTION
DATA FOR ATMOSPHERIC AND GEOSCIENCES RESEARCH

UCAR > NCAR > CISL

GO TO DATASET: nnn . n Dataset History

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NCEP CLIMATE FORECAST SYSTEM REANALYSIS (CFSR)



The National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR) was completed over the 31-year period of 1979 to 2009 in January 2010. The CFSR was designed and executed as a global, high resolution, coupled atmosphere-ocean-land surface-sea ice system to provide the best estimate of the state of these coupled domains over this period. The current CFSR will be extended as an operational, real time product into the future.

The CFSR relative to most, if not all, previous reanalyses include (1) coupling of atmosphere and ocean during the generation of the 6 hour guess field, (2) an interactive sea-ice model, and (3) assimilation of satellite radiances by the Grid-point Statistical Interpolation scheme over the entire period. The CFSR global atmosphere resolution is ~38 km (T382) with 64 levels extending from the surface to 0.26 hPa. The global ocean is 0.25° at the equator, extending to a global 0.5° beyond the tropics, with 40 levels to a depth of 4737m. The global land surface model has 4 soil levels and the global sea ice model has 3 levels. The CFSR atmospheric model contains observed variations in carbon dioxide (CO₂) over the 1979-2009 period, together with changes in aerosols and other trace gases and solar variations. With these variable parameters, the analyzed state will include estimates of changes in the Earth system climate due to these factors.

All available conventional and satellite observations were included in the CFSR. Satellite observations were used in radiance form and were bias corrected with "spin up" runs at full resolution, taking into account variable CO₂ concentrations. This procedure enabled smooth transitions of the climate record due to evolutionary changes in the satellite observing system.

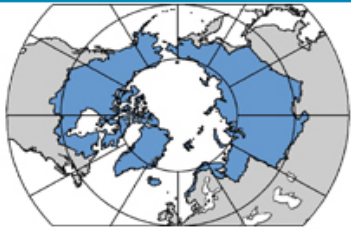
CFSR atmospheric, oceanic and land surface output products are available at an hourly time resolution and 0.5° horizontal resolution. This reanalysis will serve many purposes, including providing the basis for most of NCEP Climate Prediction Center's operational climate products by defining the mean states of the atmosphere, ocean, land surface and sea ice over the next 30-year climate normal (1981-2010); provide initial conditions for historical forecasts required to calibrate operational NCEP climate forecasts (from week 2 to 9 months); and provide estimates and diagnoses of the earth's climate state, over the satellite data period, for community climate research.

Элементы на этой странице не были блокированы

Information-computational technologies

RIMS Rapid Integrated Mapping System

Hydrology, meteorology: data, models, analysis



ArcticRIMS

A Regional, Integrated Hydrological
Monitoring System for the
Pan -Arctic Land Mass

<http://rims.unh.edu/>

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Site Map



<http://earthatlas.sr.unh.edu/maps>

<http://neespi.sr.unh.edu/maps>

<http://nh-rims.sr.unh.edu/maps>

<http://www.riverthreat.net/maps>

<http://riceghg.sr.unh.edu/maps>

Information-computational technologies

SIRS – Information-computational structure for Siberian Integrated Regional Studies

Web portals for complex analysis of datasets of georeferenced geophysical data aimed at monitoring and forecasting climatic and ecosystem changes (meteorological observations, models, reanalyses, remote sensing data) that provide an interactive access to the data, models and tools :

- **ATMOS** (<http://atmos.iao.ru/> and <http://atmos.scert.ru/>)
- **RISKS** (<http://climate.risks.scert.ru/>)
- **ENVIROMIS CLIMATE** (<http://enviromis.scert.ru/en/>)

Information-measuring technologies – application fields:

- Available networks for specialized monitoring (hydrometeorological, aerosol-radiation, greenhouse gases, etc.) are necessary but not enough for complex monitoring of environmental processes.
- Delayed response (phase shifts) of regional systems on global impact factors points to necessity of development of general terms for regional and global monitoring.
- Taking into account mesoscale inhomogeneity of observed climatic changes in Siberia, complex monitoring network should be geographically distributed and consider scales of characteristic Siberian ecosystems (forests, bogs, steep, mountain, Arctic zone, etc.).

Information-measuring systems for atmosphere monitoring.

Devices designed at IMCES SB RAS

AMK-03 Automated meteorological complex

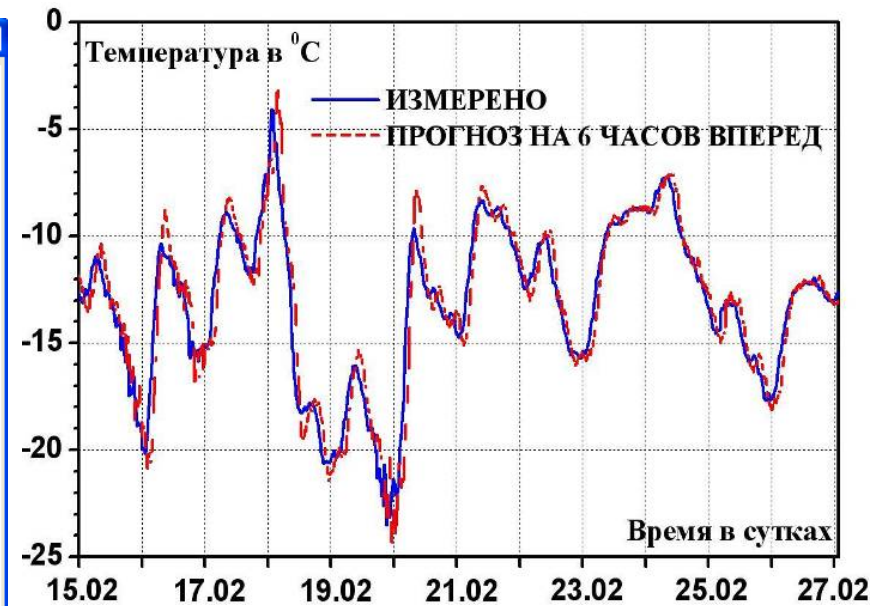
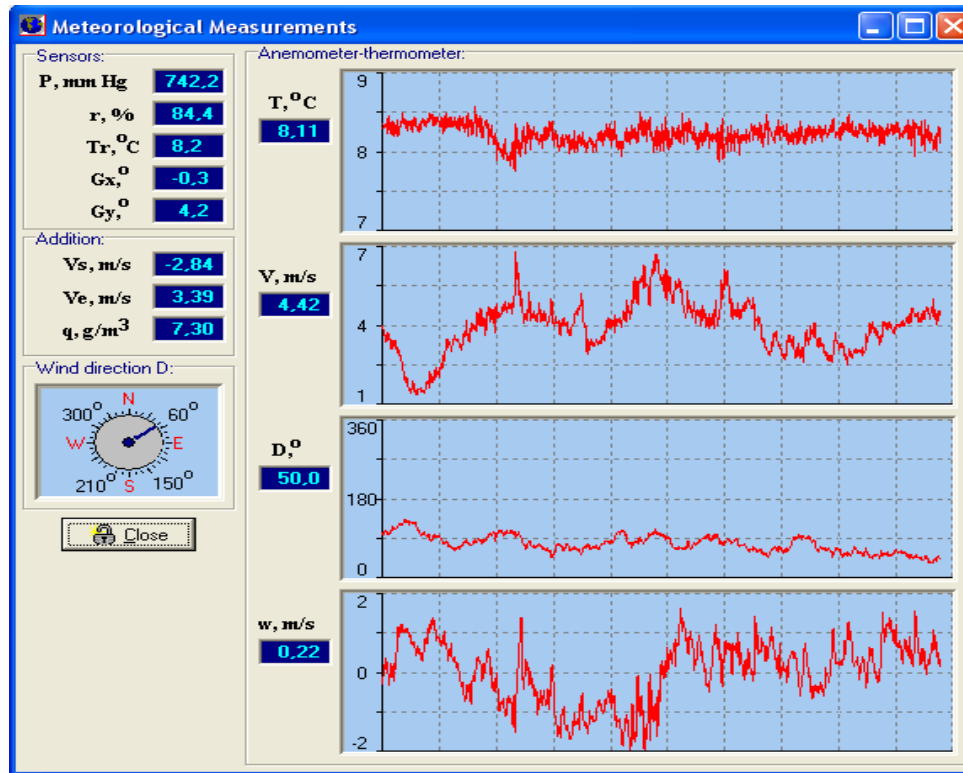


1B65 Mobile automated meteorological set



Measurable parameter	Measurement range	Accuracy
Horizontal wind velocity	0.1 ÷ 30 m/s	< 0.37 m/s
Vertical wind velocity	-15 to +15 m/s	< 0.37m/s
Horizontal wind direction	0 ÷ 360°	± 2°
Air temperature	-50 to +55 °C	< 0.37 °C
Relative air humidity	15 ÷ 100 %	± 2.5% at $T > 0\text{ °C}$; ± 5% at $T \leq 0\text{ °C}$
Atmospheric pressure	520 ÷ 800 mm Hg	1 mm Hg

Information-measuring technologies for *in-situ* atmosphere monitoring



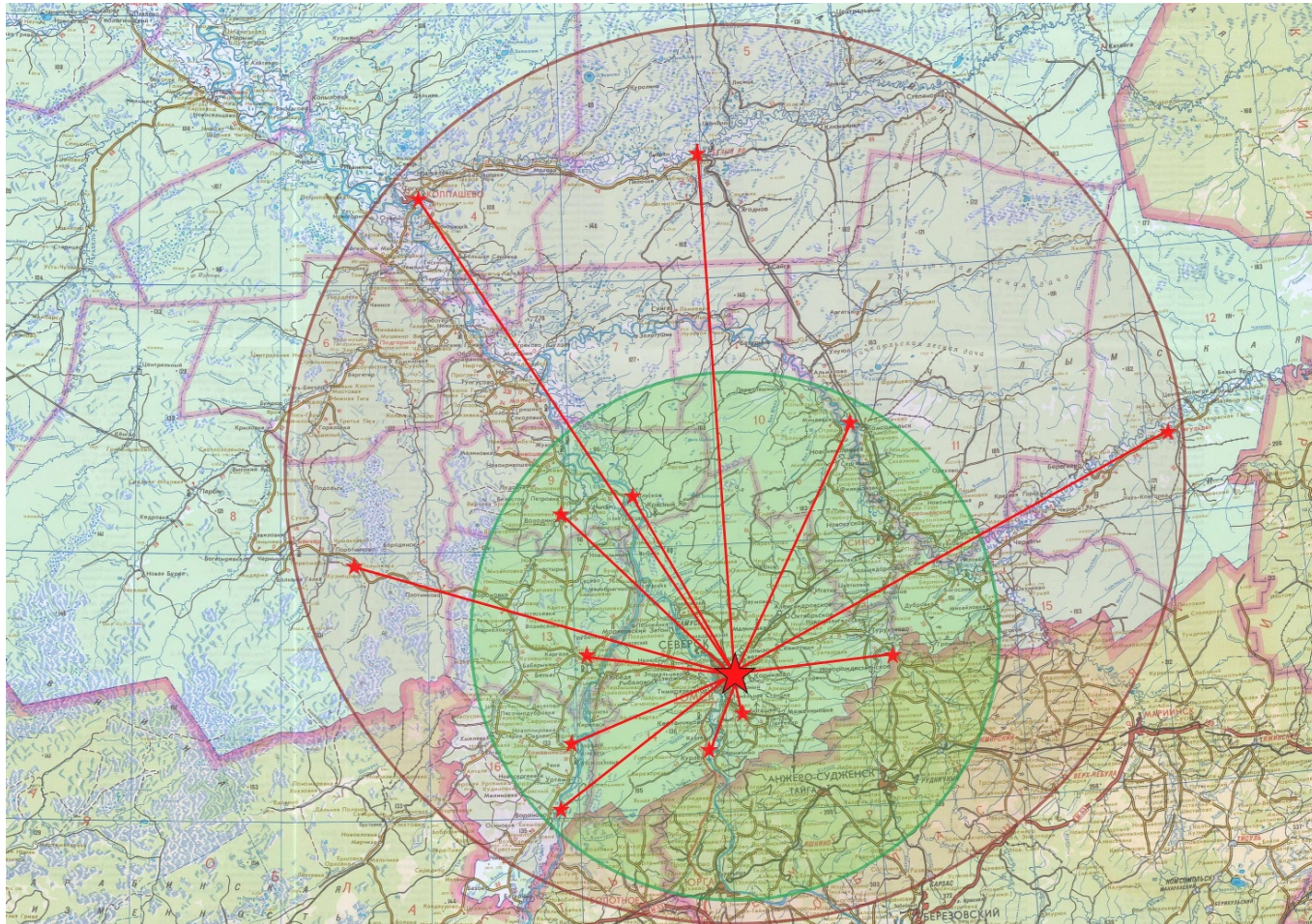
AMK-03:

- measurement of 6 instant values of meteorological quantities;
- computation and storage of more than 60 characteristics of atmosphere state.

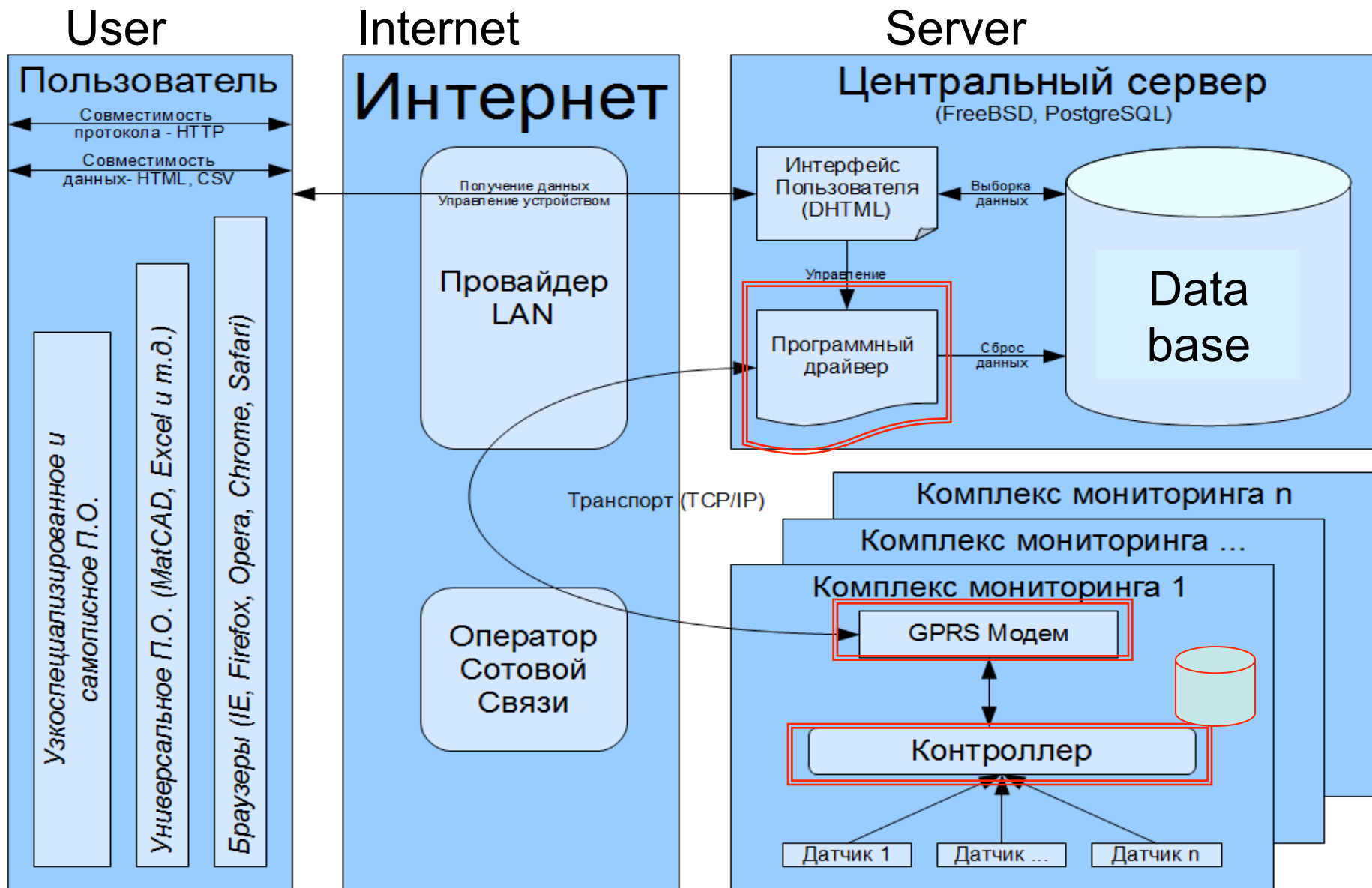


Comparison of measured air temperature values with a 6-hour forecast, which is based on application of Kalman filtering algorithm to mathematical model calculating meteorological quantities' evolution with time.

STORM RING – a regional information-measuring system for monitoring of dangerous meteorological events – joint project of IMCES SB RAS and SibrHRI (Novosibirsk)



Information-measuring system structure

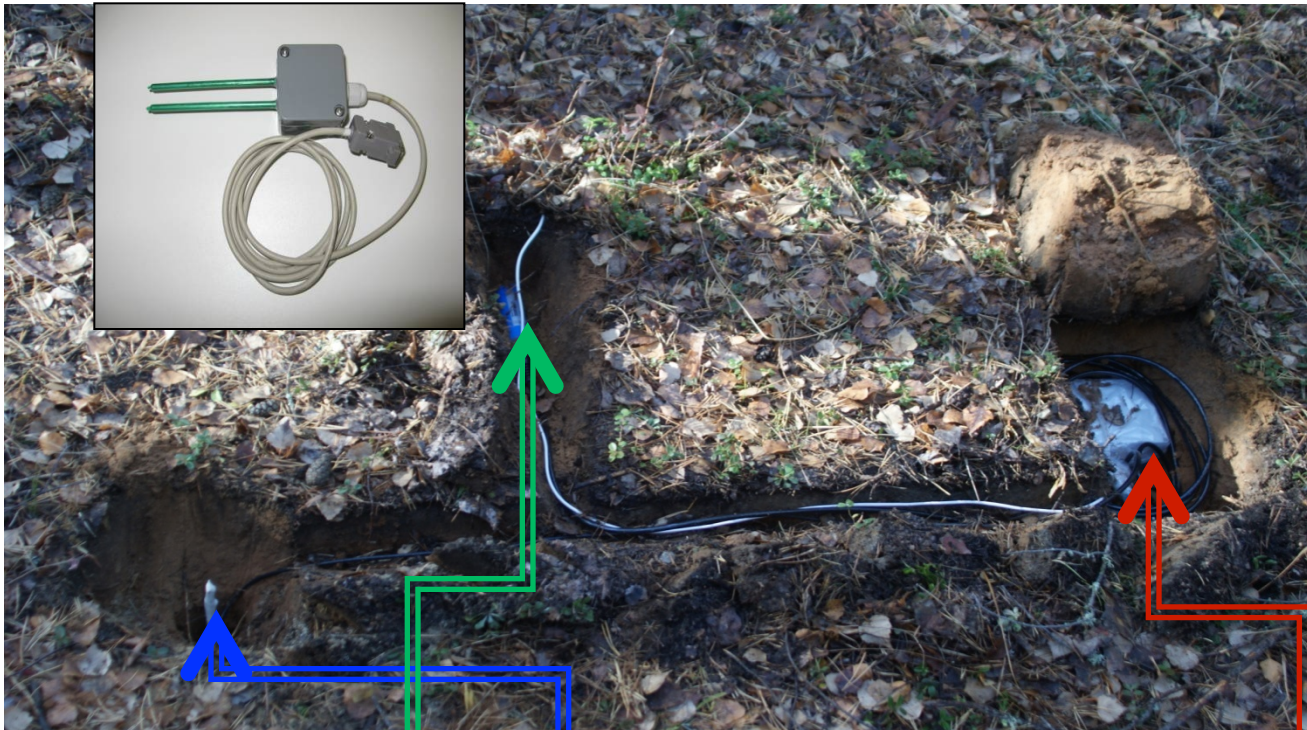


New information-measuring technologies – software-controlled self-maintained monitoring stations:

Requirements to equipment:

- Low power consumption, providing autonomous operation during long time period (more than one year);
- Interfaces for sensors' connection;
- Provision of sufficient measurement accuracy and service life in various exploitation conditions;
- Mobile or satellite interface for immediate data transfer, control, change of operation protocol, alarm;
- Low cost and simple maintenance.

IMCES SB RAS developed a basic system of networked software-controlled meters of environmental parameters, as well as technology for monitoring database formation realizing remote Web-access.



Installation of **soil temperature** probe, IMCO TRIME-PICO32 **soil moisture detector** and **AIPT2 controller**.



Information-measuring monitoring system on Great Vasyugan Bog



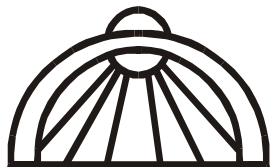
Self-maintained monitoring stations



Great Vasyugan Bog, Tomsk oblast



TUNKA station, Buryatiya



ИМГЭС СО РАН

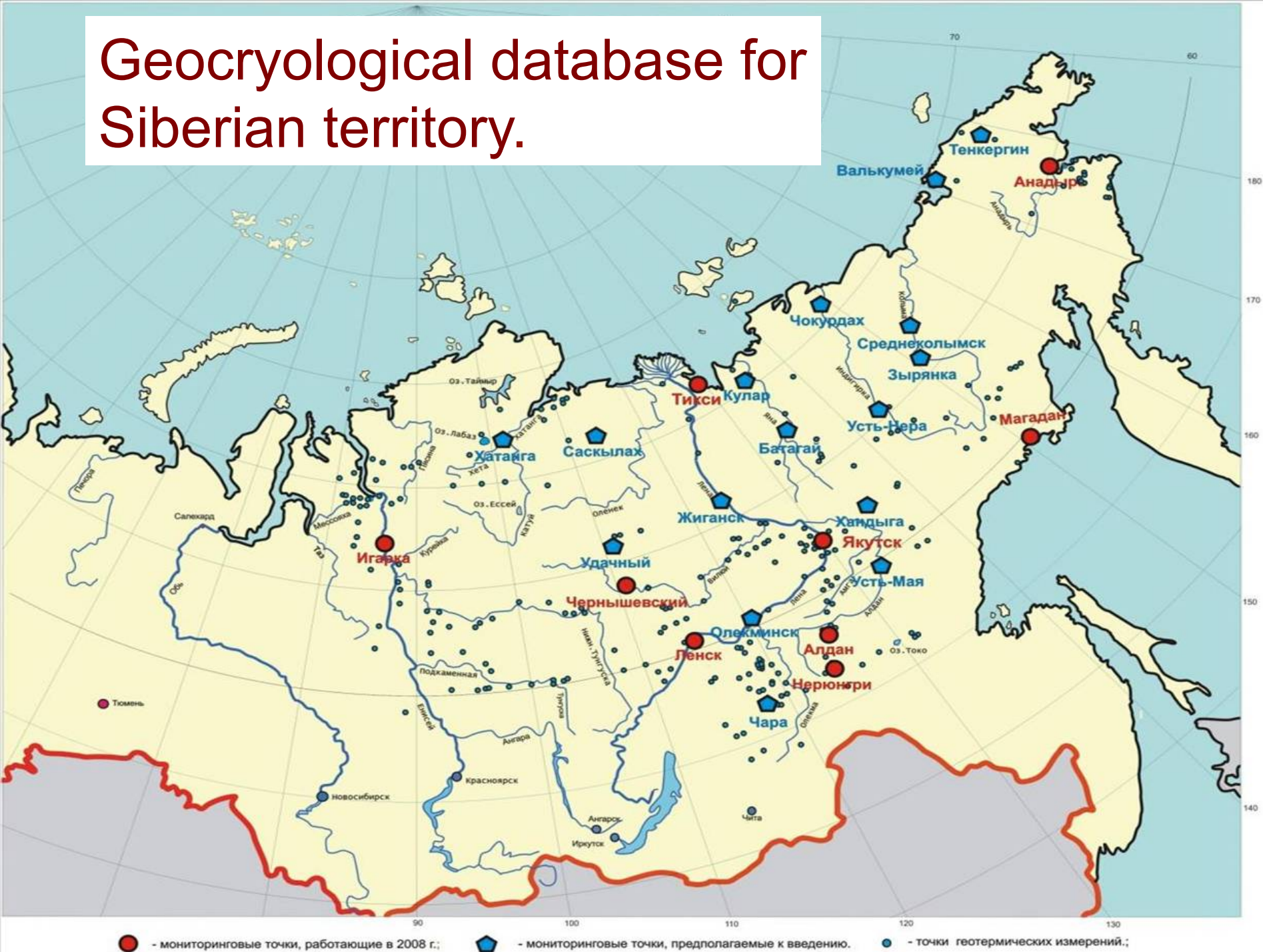
Self-maintained monitoring station

Parameter	Measurement range, accuracy
Atmospheric pressure	500 ... 810 mm Hg, ± 1.5 %
Air temperature and humidity	-55 ... +50°C, ± 0.1 °C; 0 ... 100%, ± 3.5 %.
Horizontal wind velocity and direction	0.9 ... 78 m/s, ± 5 %; 0 ... 360°, ± 7 %
Soil temperature profile	-55 ... +50°C, ± 0.1 °C
Soil moisture	0 ... 100%, 0 ... 40%: ± 1 %; 40 ... 70%: ± 2 %; Temperature range: -15...+50°C
Water table	0 ... 10.5 m, ± 1 %
Liquid precipitation amount	± 0.2 mm
Water conductivity	10^{-8} ... 0.2 Cm/m, ± 5 %
Snow depth (m)	0 ... 1.2 m, ± 0.05 m
Solar radiation	range 0.2 ... 10 μm , ± 5 %, 10 – 2000 W/m ²

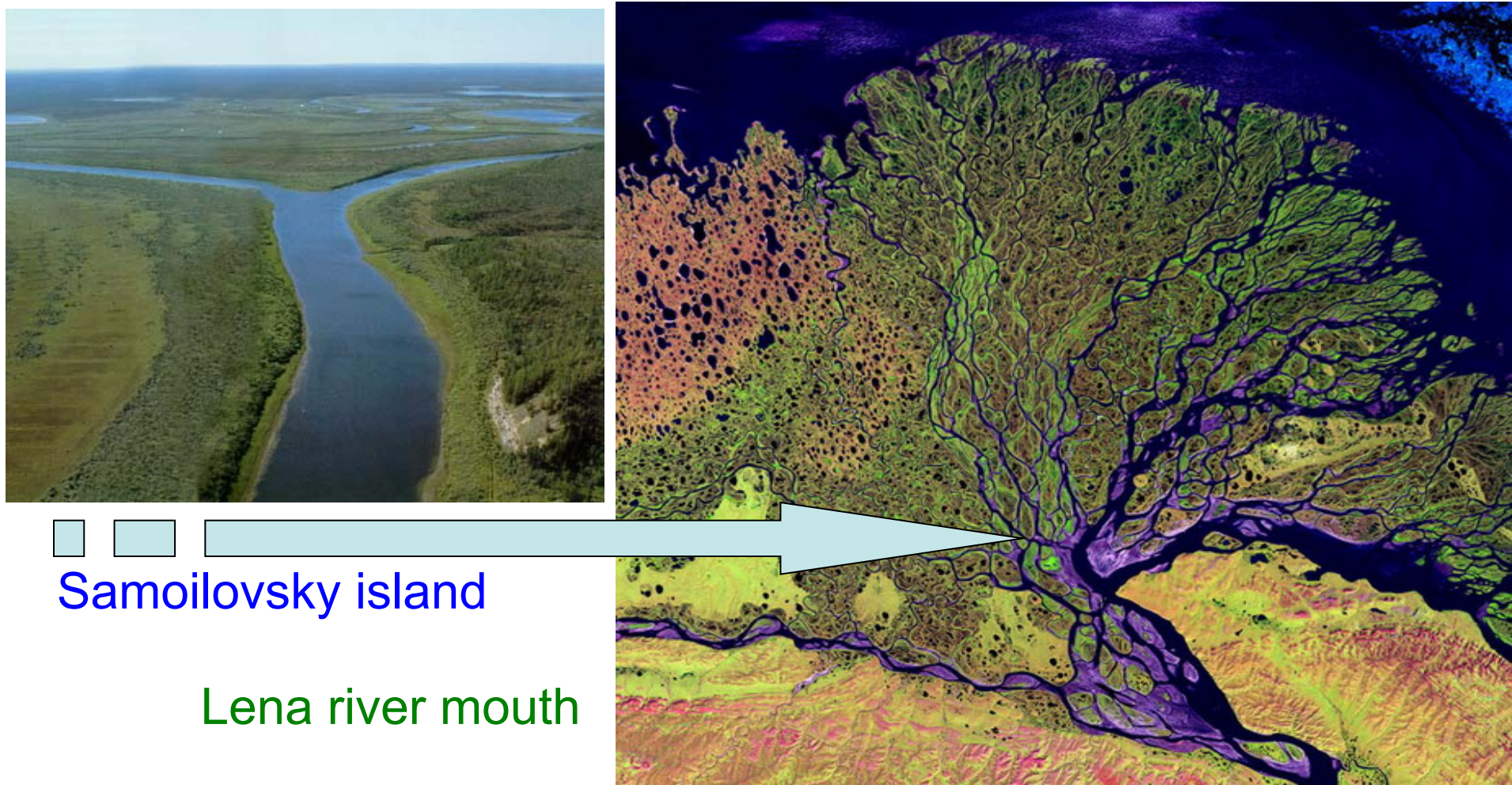
Main application fields for self-maintained measuring systems in Arctic :

- Creation of a distributed monitoring network with sufficient covering to form climatic and geocryological database for Siberia
- Validation of numerical mesoscale climatic models
- Investigation of sea temperature fields
- Investigation of underwater permafrost in Arctic

Geocryological database for Siberian territory.



Program on Comprehensive investigations of the state and evolution of Siberian Arctic environment is under formation based on International Research Station “Samoilovsky Island”



International Research Station «Samoilovsky Island»



August 2010



April, 2012

Physical grounds and technologies of very low-frequency (VLF) monitoring

Very Low Frequency range:

$f = 3 \div 30 \text{ kHz}$, $\lambda = 10 \div 100 \text{ km}$

Sources of pulsed VLF fields:

- Solar-terrestrial interactions;
- Atmospheric processes;
- Lithosphere processes;
- Strains in materials and constructions, surfaces, solid dielectrics

Natural **P**ulsed
Electro**M**agnetic
Field of the **E**arth
(NPEMFE)

Physical grounds and technologies of very low-frequency (VLF) monitoring

Very Low Frequency range:

$$f = 3 \div 30 \text{ kHz}, \lambda = 10 \div 100 \text{ km}$$

Peculiarities in VLF NPEMFE propagation :

- can penetrate deeply into the Earth crust and sea water;
- due to diffraction propagate for a long distances in the atmosphere;
- strong attenuation of electromagnetic field components when penetrating in the earth crust.

Physical grounds and technologies of very low-frequency (VLF) monitoring

Very Low Frequency range:

$$f = 3 \div 30 \text{ kHz}, \lambda = 10 \div 100 \text{ km}$$

Electromagnetic field structure (*E and H components*) is studied for spatial objects of various scales L (relative to wavelength λ of the fields recorded):

- $L / \lambda \ll 1$: **microscale** (concrete constructions, bridges, tunnels, roads, etc.);
- $L / \lambda \sim 1$: **mesoscale** (local lithosphere structures and inhomogeneities, landslides, mines, open-pits, etc.);
- $L / \lambda \gg 1$: **macroscale** (seismic monitoring, investigation of internal Earth structure).

Monitoring of lithosphere structure and anomalous processes - mesoscale

$$L / \lambda \sim 1 : \text{mesoscale}$$

Information from:

- emission of pulsed VLF radiation from lithosphere structures and inhomogeneities present in detection zone;
- alteration of a signal coming from remote sources by lithosphere structures and inhomogeneities.

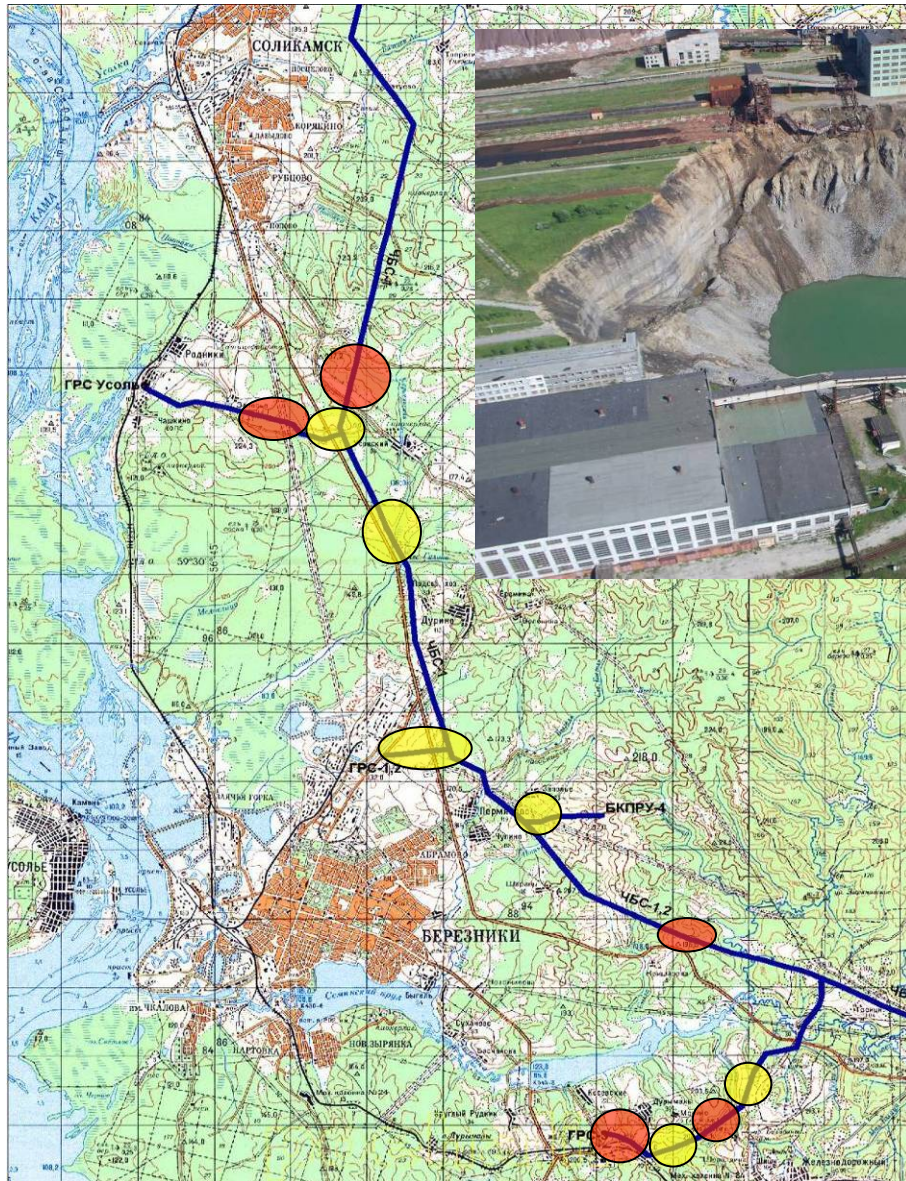
Sources of noise:

- components of natural pulsed electromagnetic field of the Earth from other sources.

Alignment of a system of VLF recorders in field



Technologies for VLF monitoring of lithosphere structures and anomalous processes

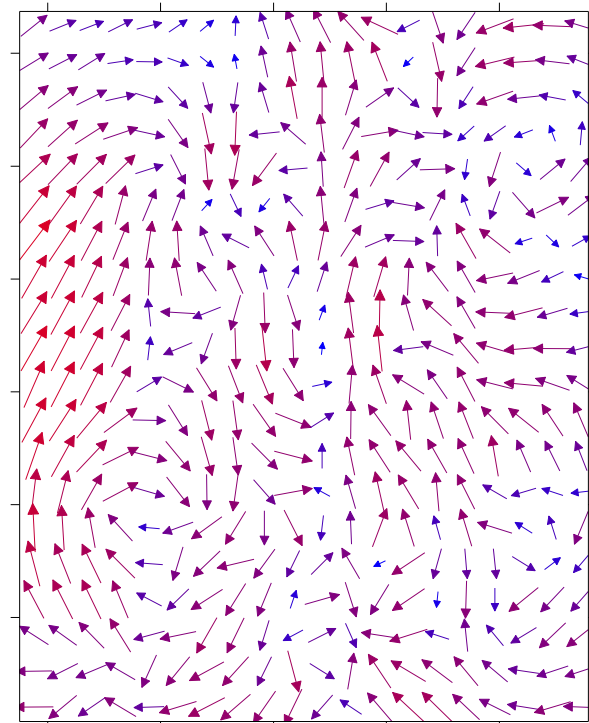
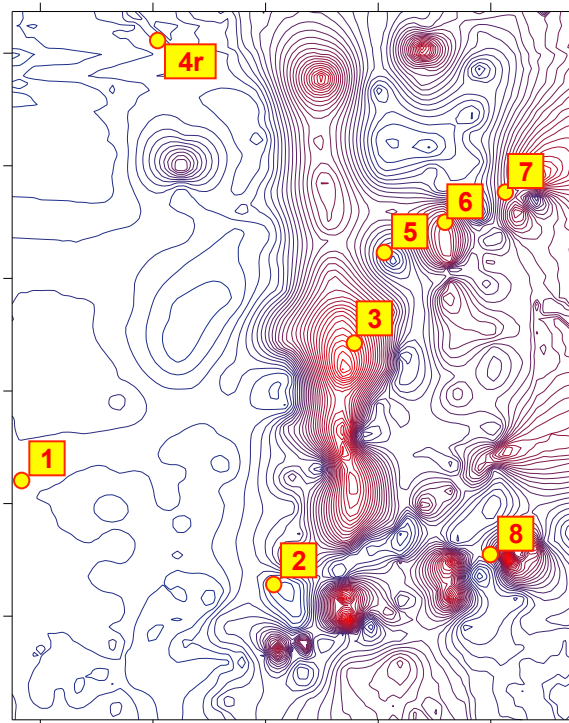
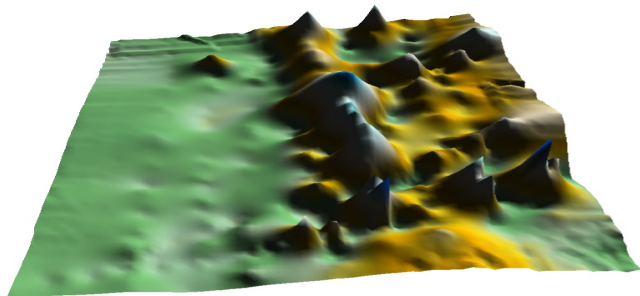


MGR-01 Programmable
multichannel geophysical recorder

Geodynamic mapping at
ChBS-1, 2 pipeline

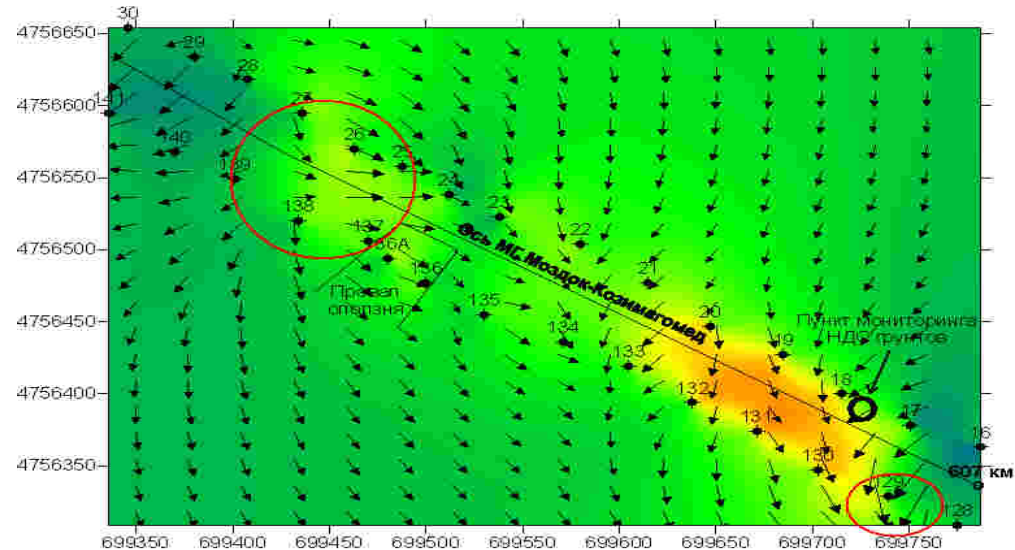
Information-measuring technologies for environmental monitoring

Electromagnetic method is applied to outline geophysical structures and to monitor geodynamic processes from radio noise in VLF range. It makes a basis for information-measuring technology for landslide risks assessment.



Assessment of landslide activity at Kama river near Siberia- West Europe pipeline
(yellow dots are MGR-01 instruments)

Technologies for VLF monitoring of lithosphere structures and anomalous processes



A system is created for monitoring and forecast of geodynamic processes at pipelines:

- Urengoi-Pomary-Uzhgorod
- Mozdok-Kazimagomed
- Dzuarikau -Tskhinval

Since 2010 the system transfers data onto IMCES SB RAS server



Conclusion

Measuring, Information and computational technologies are both instruments and infrastructure for researches

A photograph of a modern, multi-story building with a facade of large, rectangular windows. A wide, outdoor staircase with metal railings leads up to the building's entrance. The scene is surrounded by lush greenery, including a large evergreen tree on the left and various leafy plants in the foreground. The text "Thanks for your attention!" is overlaid in a bold, blue, italicized font across the center of the image.

***Thanks for
your
attention!***