Развитие информационно-вычислительных технологий мониторинга природно-климатических изменений, литосферных структур и аномальных процессов

Development of information-measuring technologies for monitoring of climatic and natural changes, lithosphere structures and dangerous processes

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Climate doctrine of Russian Federation

Clause19. Enlargement of knowledge on climatic system is a necessary prerequisite for forming and realization of scientifically and socially grounded climate policy.

Monitoring and climate change modeling are not well developed in Russia yet.

Fundamental multidisciplinary studies of climatic changes and their impact on Asian part of Russian territory are of special importance for national safety.

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.

- Since climatic changes observed in Siberia are inhomogeneous, a network for comprehensive monitoring should be spatially distributed and take into account dimensions of the typical Siberian ecosystems (forests, bogs, steppes, mountain regions, Arctic regions, etc.).

- Creation of an information-modeling system intended to monitor, to analyze and to model climatic and natural processes.

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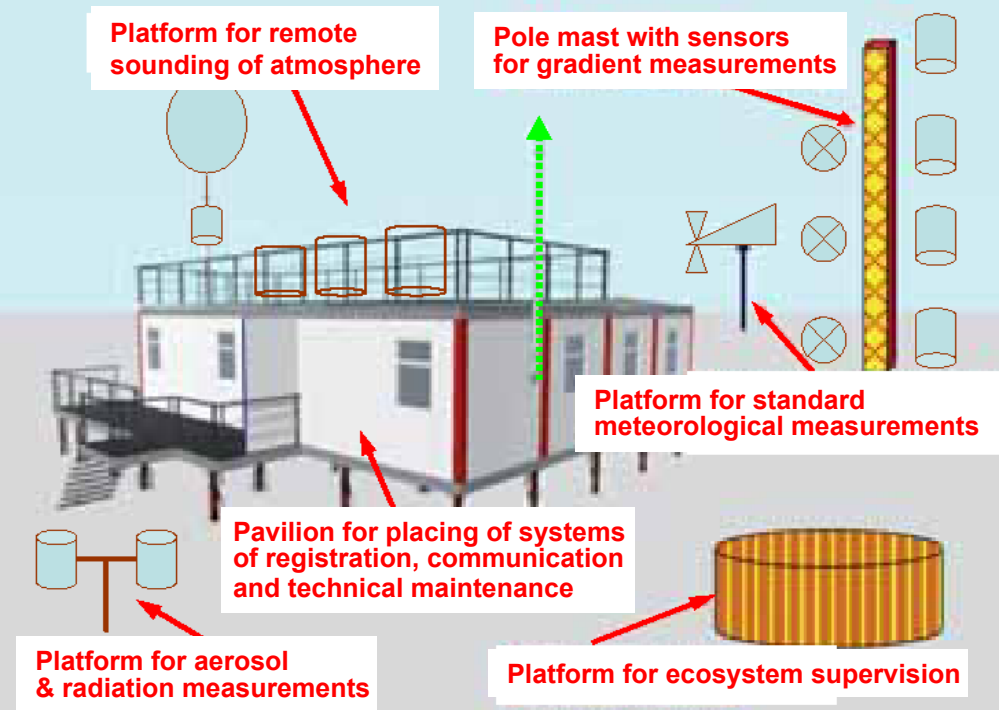
A network planned for monitoring of climatic and natural processes in Siberia

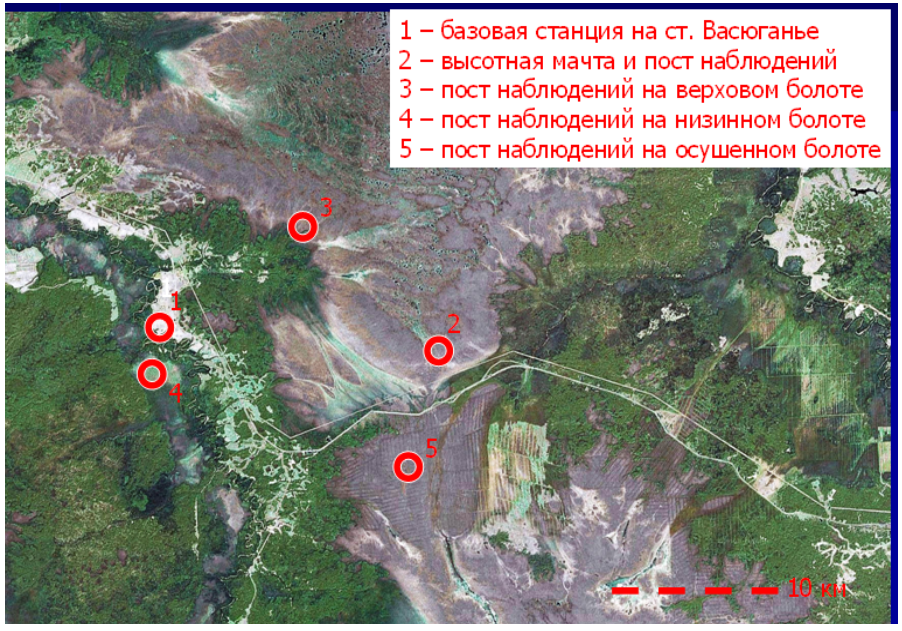
Reference monitoring stations

1. Tomsk (city)
2. Tomsk (Vasyuganie)
3. Ulan-Ude (Istomino)
4. Chita (Arakhley)
5. Krasnoyarsk (Zotino)
6. Barnaul (Aktru)
7. Novosibirsk (Chany)
8. Kyzyl (Dolinnaya)
9. Yakutsk (Spasskaya Pad')
10. Irkutsk (Mondy)
11. Khaty-Mansiisk (Shapsha)
12. Nadym (Polyarnaya)

Regional information-measuring system for monitoring of climatic and natural changes and ecological risks assessment under increasing technogenic impact (Tomsk oblast as an example)

Local observation network on the territory of Great Vasyugan Bog

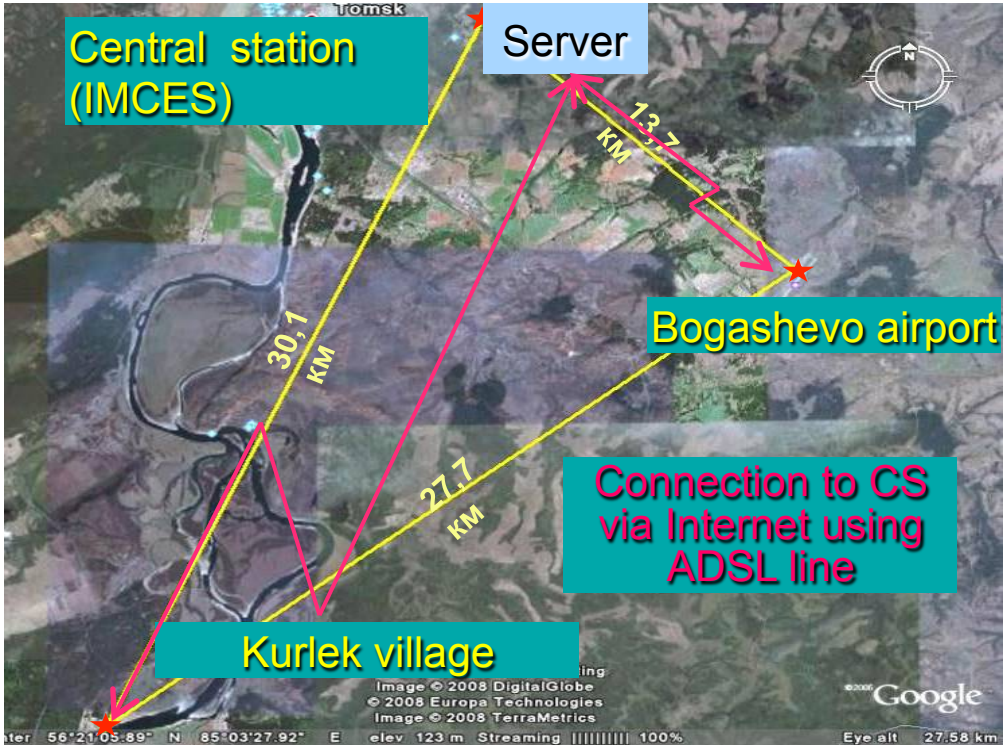




Block diagram of a standard observation site incorporated into regional monitoring network

Regional information-measuring system for monitoring of climatic and natural changes and ecological risks assessment under increasing technogenic impact (Tomsk oblast as an example)

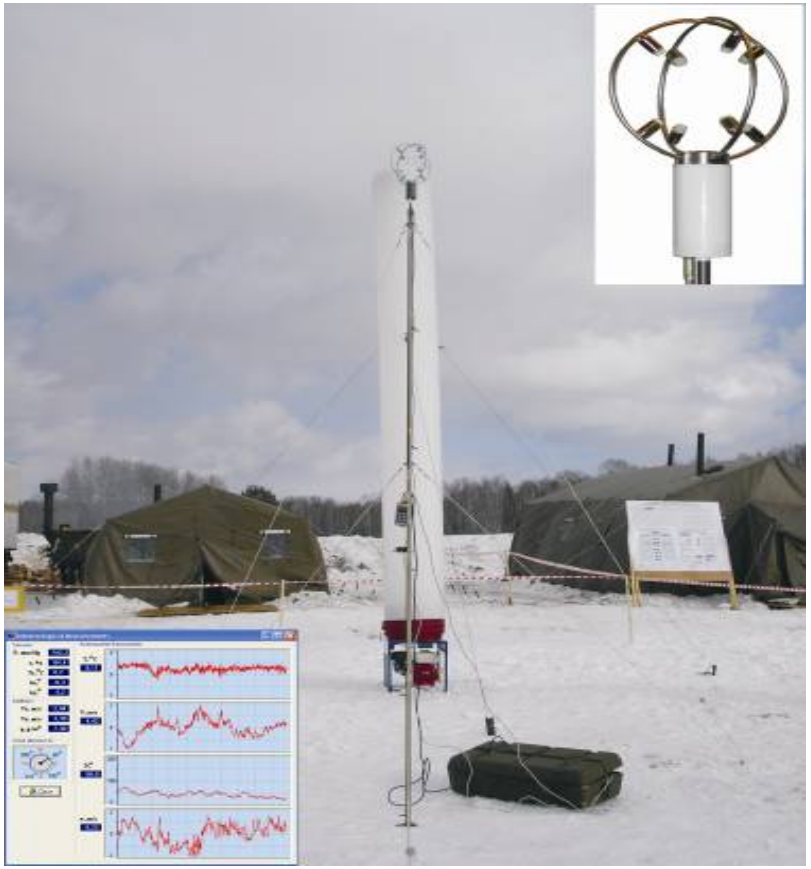
Site of the geophysical observatory of IMCES SB RAS in Akademgorodok



Local observation network near Tomsk to monitor dangerous weather conditions

Instrumentation for monitoring

Russian and foreign certified devices

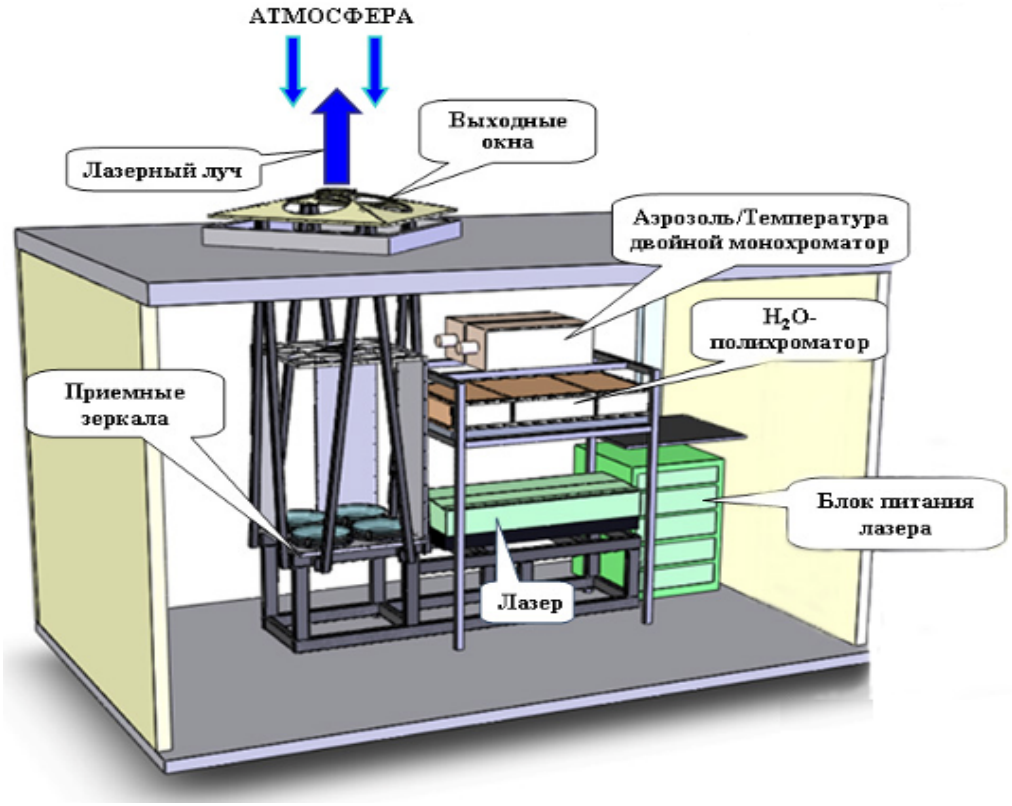


Automated meteorological complex
(IMCES SB RAS)
Monitoring of meteorological quantities fluctuations in surface atmospheric layer

Solar spectrophotometer
(IAO SB RAS)
Monitoring of atmosphere optical thickness

Instrumentation for monitoring

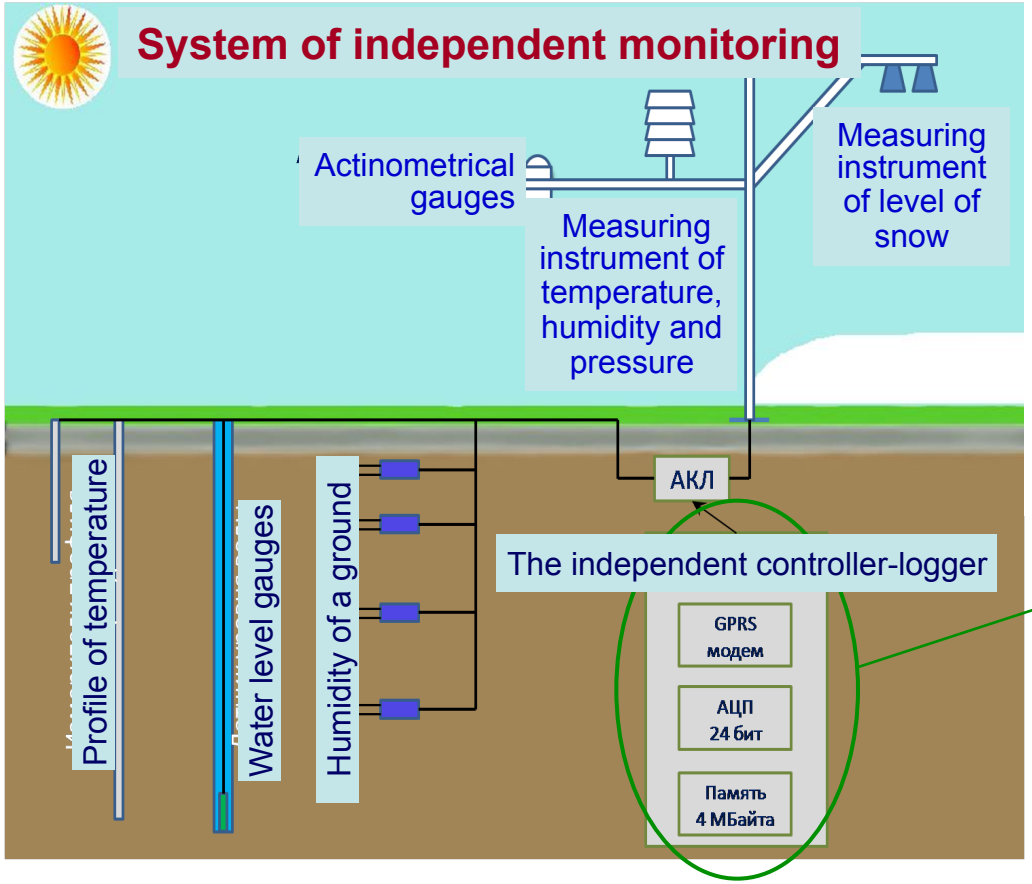
Designing and certification of new devices

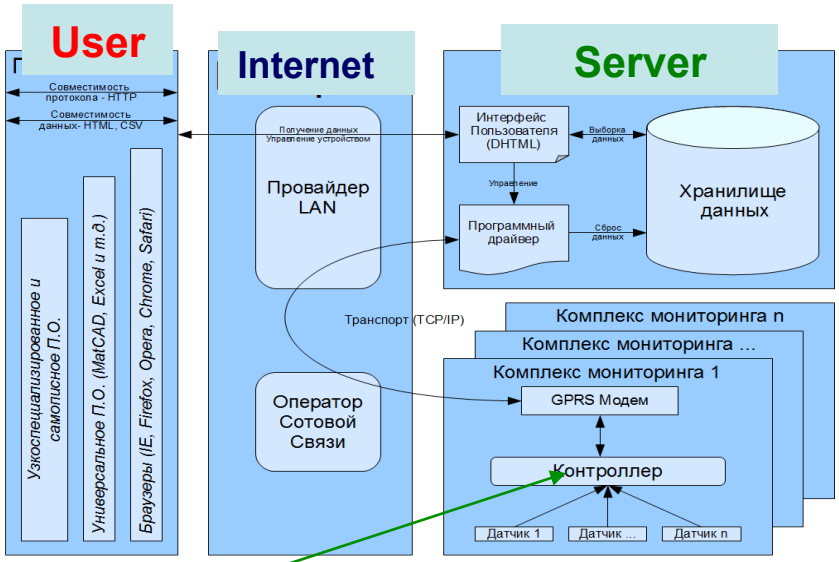


Aerosol lidar *(IAO SB RAS) Monitoring of altitude profile of troposphere aerosol*

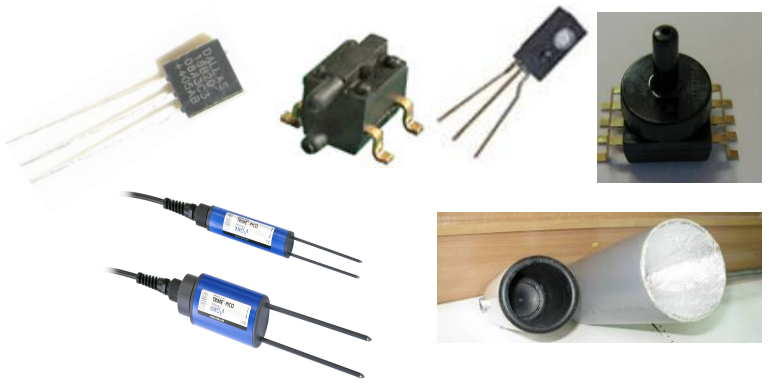
Raman lidar *(IMCES SB RAS, IAO SB RAS) Monitoring of altitude profiles of trace gases in the atmosphere*

Information-measuring technologies for monitoring of climatic and natural changes





Structure of information-measuring system



Set of gauges and sensor controls

Soil thermal hydrometer *(IMSEC SB RAS)*

Monitoring of subsurface temperature and soil humidity profiles

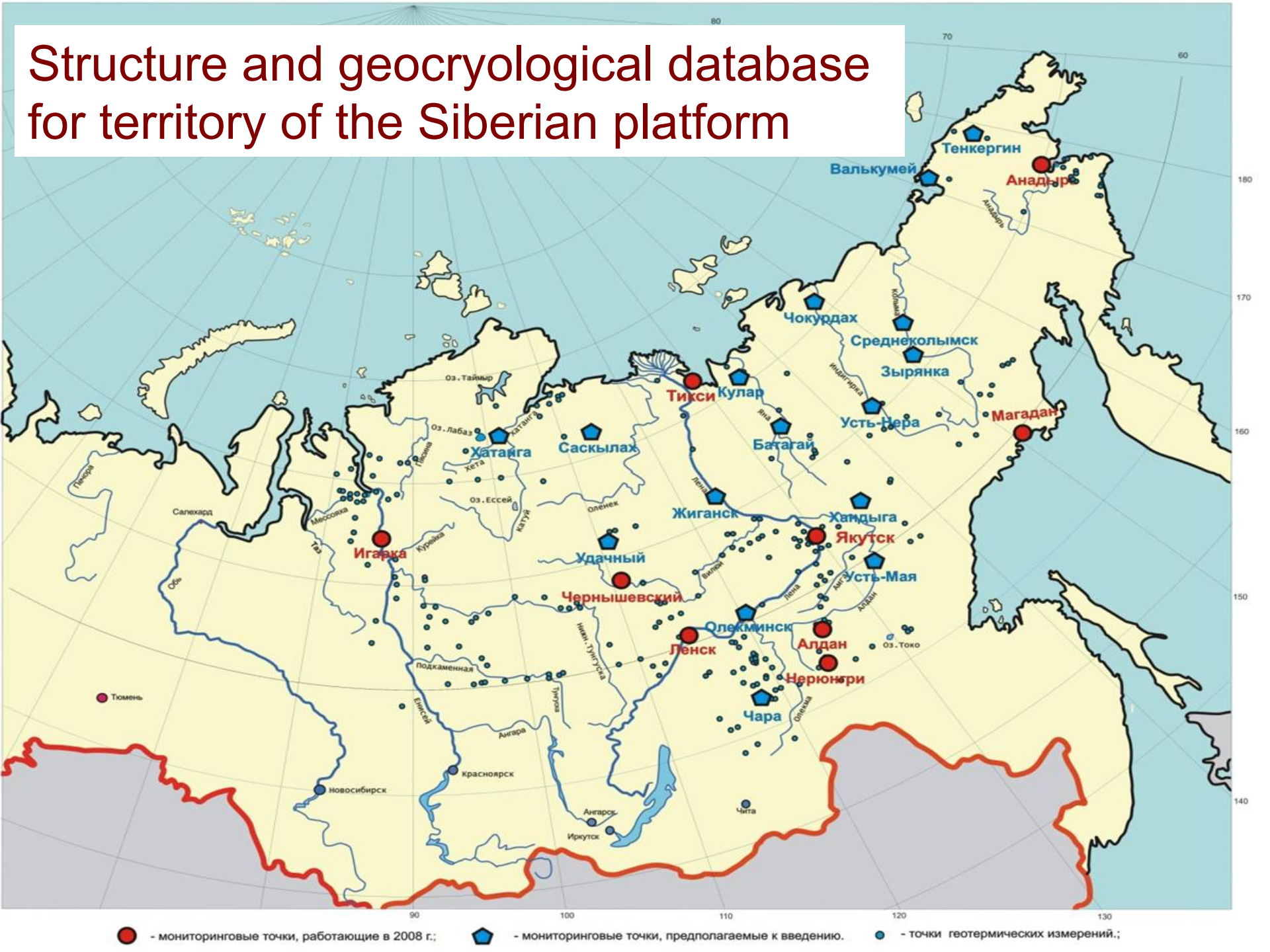
Information-measuring technologies for monitoring of climatic and natural changes

The basic applied gauges:

- profile of temperature of a ground, air, water: - 55 … + 50 °C, Δ ±0,1°c (individual calibration);
- atmospheric pressure, Δ ±1,5 %;
- humidity of air, 0 … 100 %, Δ ±3,5 %;
- speed and wind direction, Δ ±5 and Δ ±7 %;
- water level, ranges 0,7; 3,5; 10,5 m, Δ ±1,5 %;
- volume water maintenances in a ground;
- conductivity of water;
- level and quantities of snow, 0 … 1,5 m, Δ ±5 %;
- solar radiation, 0,2 … 10 microns, Δ ±5 %;
- quantity of liquid deposits, Δ ±4 %.

Feature: extremely the low price; a wide set of interfaces of connection of gauges; autonomy of work of station for a long time (more than 1 year) from the independent power supply (8.5... 16); the mobile or satellite interface for maintenance of operative data transmission; possibility of direct reading of the saved up data by means of SD-Flash cards.

Structure and geocryological database for territory of the Siberian platform



Technologies for monitoring of lithosphere structures and anomalous processes

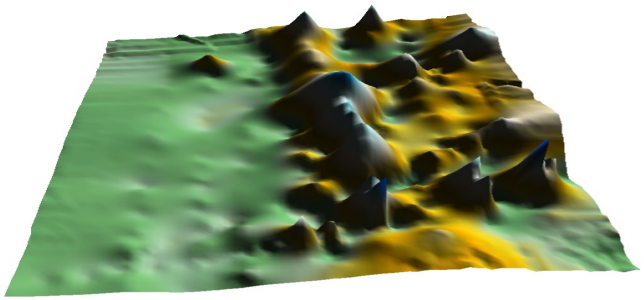
VLF – a range of **V**ery **L**ow **F**requencies of electromagnetic waves:
Frequency $f = 3 \div 30$ kHz --- Length of a wave $\lambda = 10 \div 100$ km

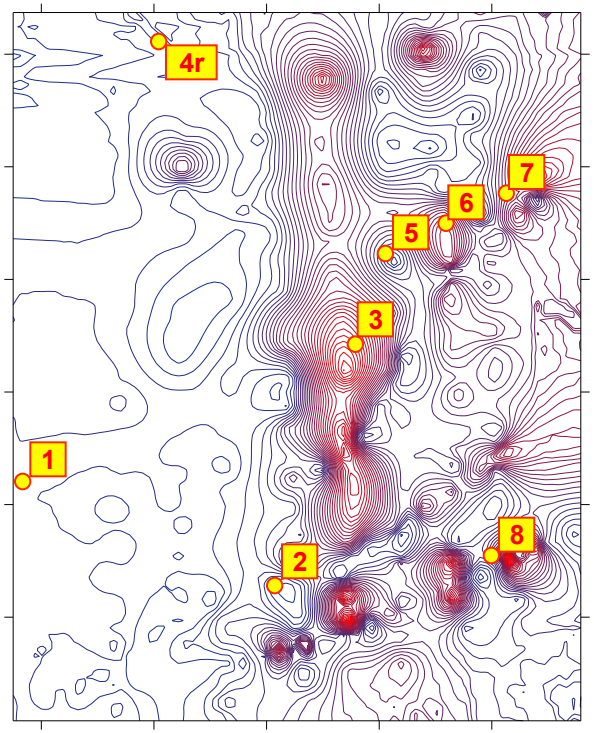
Measuring apparatus - the passive programmed **M**ultichannel **G**eophysical **R**ecorder «**MGR-01**»: variants of use and formation of a network of monitoring

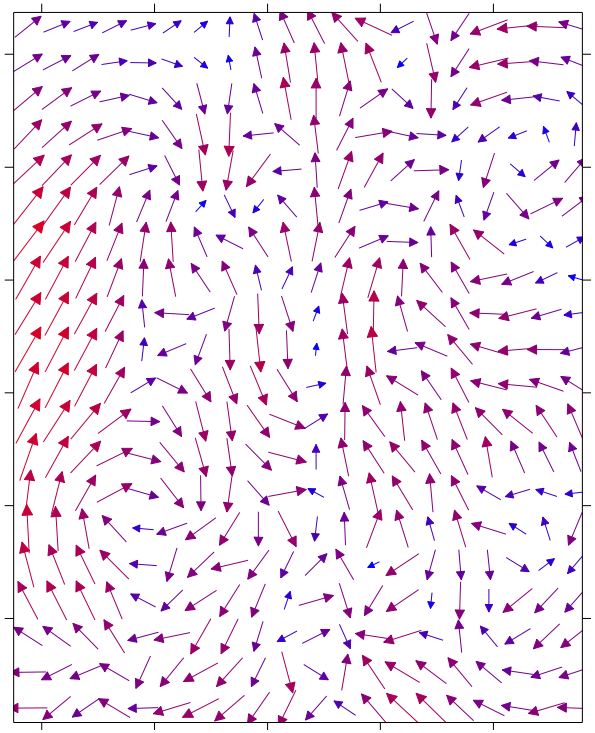
Adjustment of system of VLF-recorders in field conditions

Technologies for monitoring of lithosphere structures and anomalous processes

To monitor and to predict landslide risks, an electromagnetic method was developed, which allows to allocate geophysical structures and to monitor geodynamic processes by VLF radio noise.

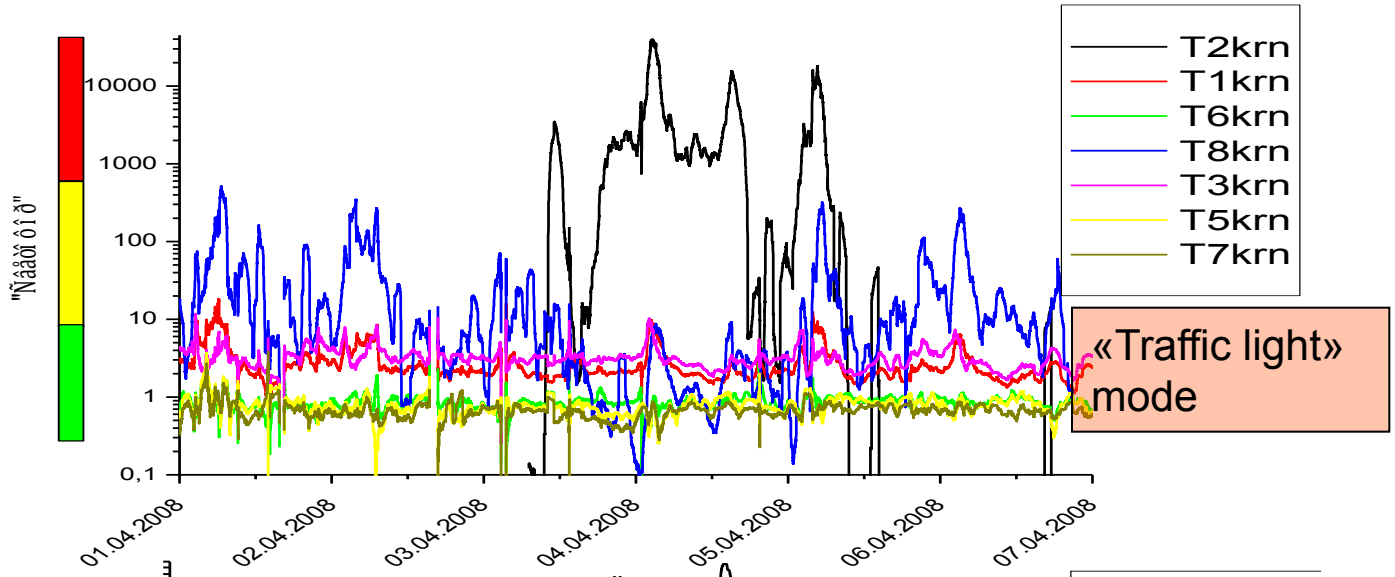




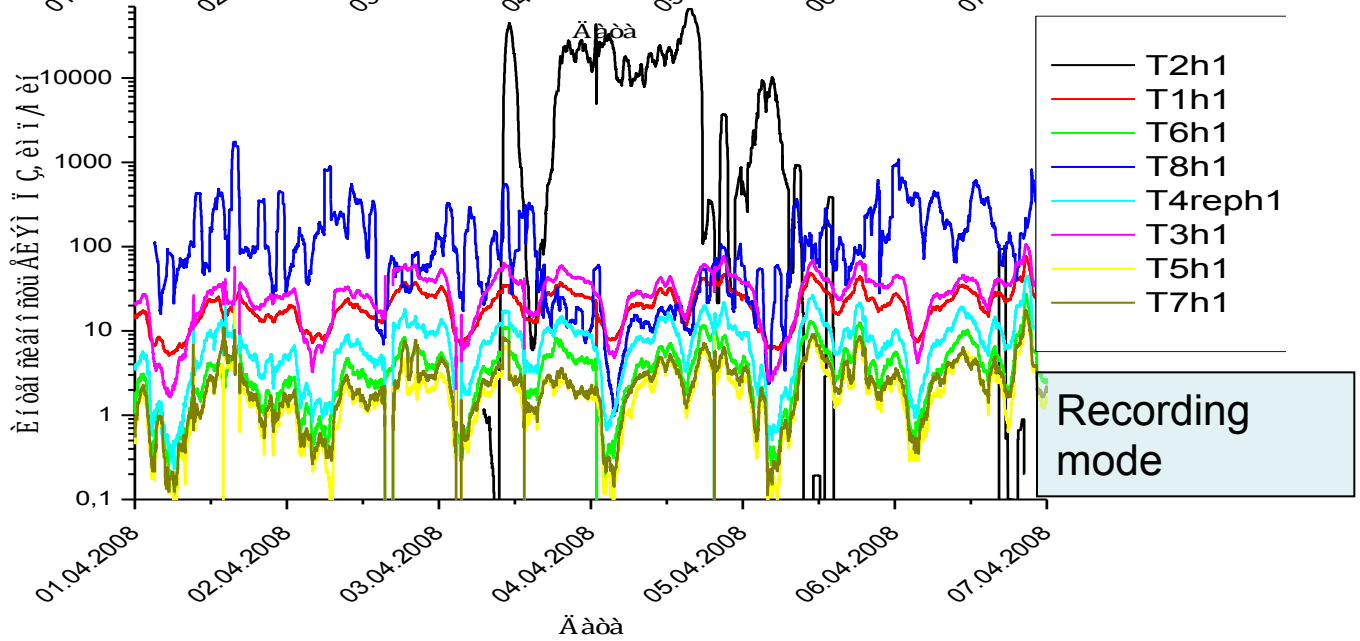


Assessment of landslide processes on the Kama river slope near Siberia – West Europe pipeline (MGR-01 device locations are shown by yellow dots)

Technology for VLF monitoring and landslide risks forecast



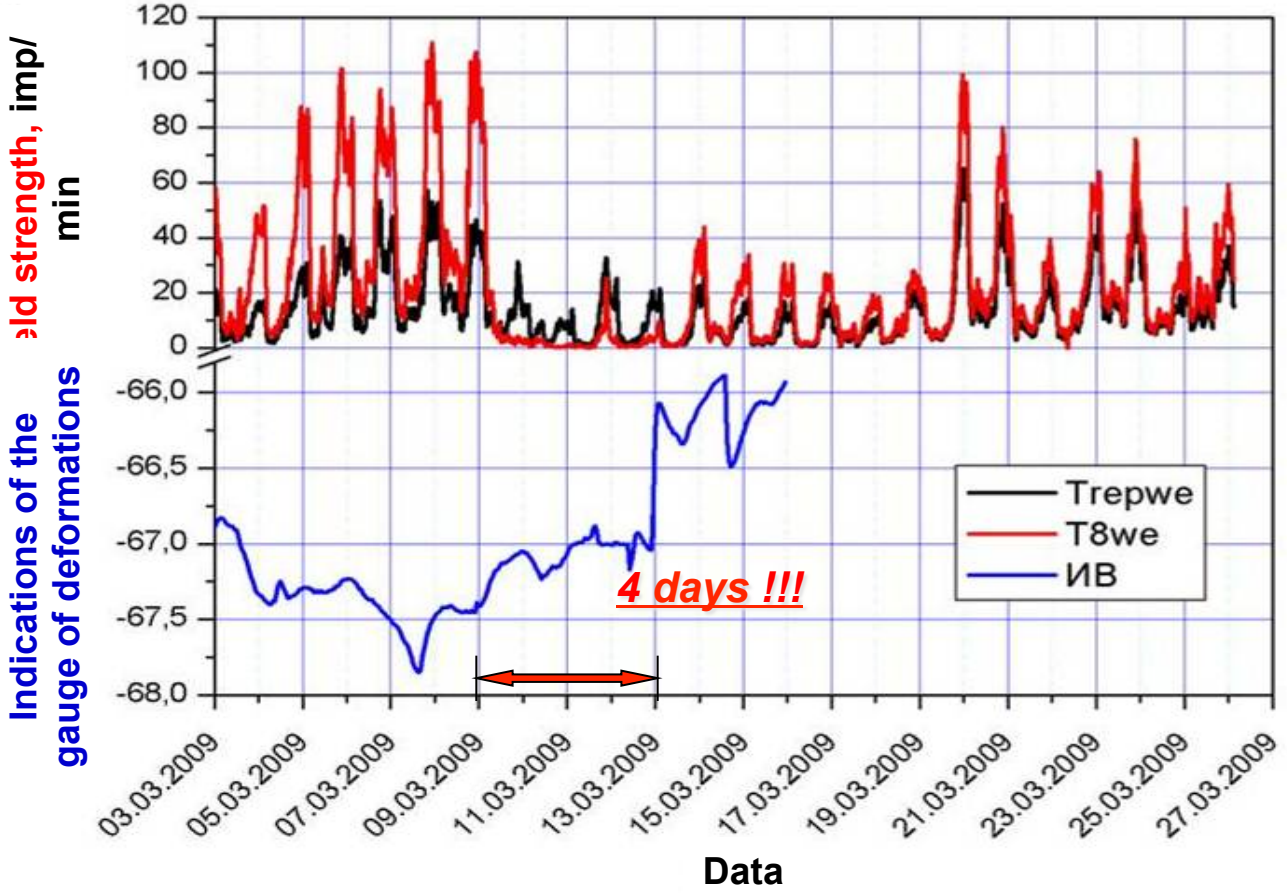
«Traffic light» mode



Recording mode

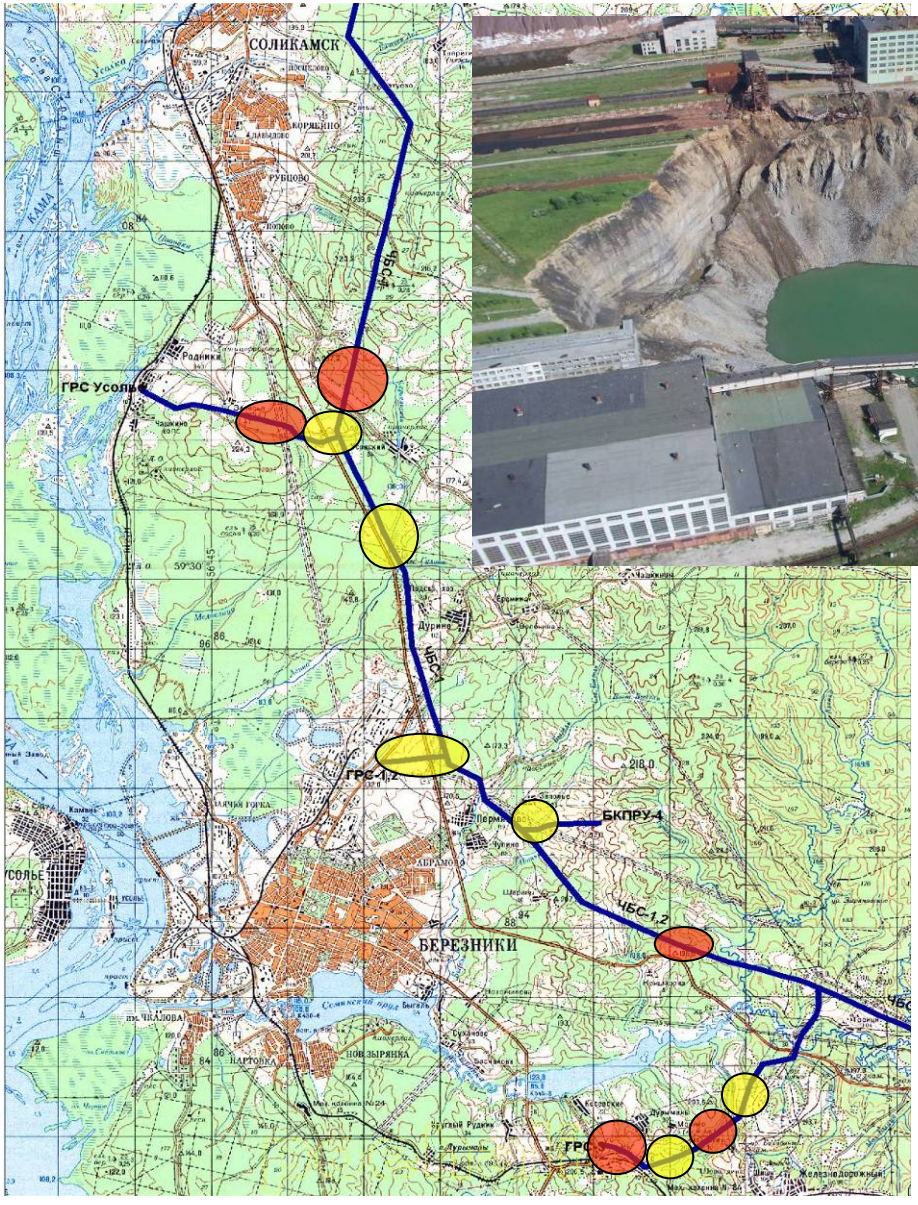
Dynamic characteristics of landslide processes on the river Kama slope near «Siberia-West Europe pipeline» obtained from eight MGR-01 observation stations

Technology for VLF monitoring and landslide risks forecast



Comparison between records of the reference MGR (black), MGR located on a landslide (red) with the records of the strain gage (blue) located on the pipeline

Technology for VLF monitoring of lithosphere structures and dangerous processes along a gas pipeline

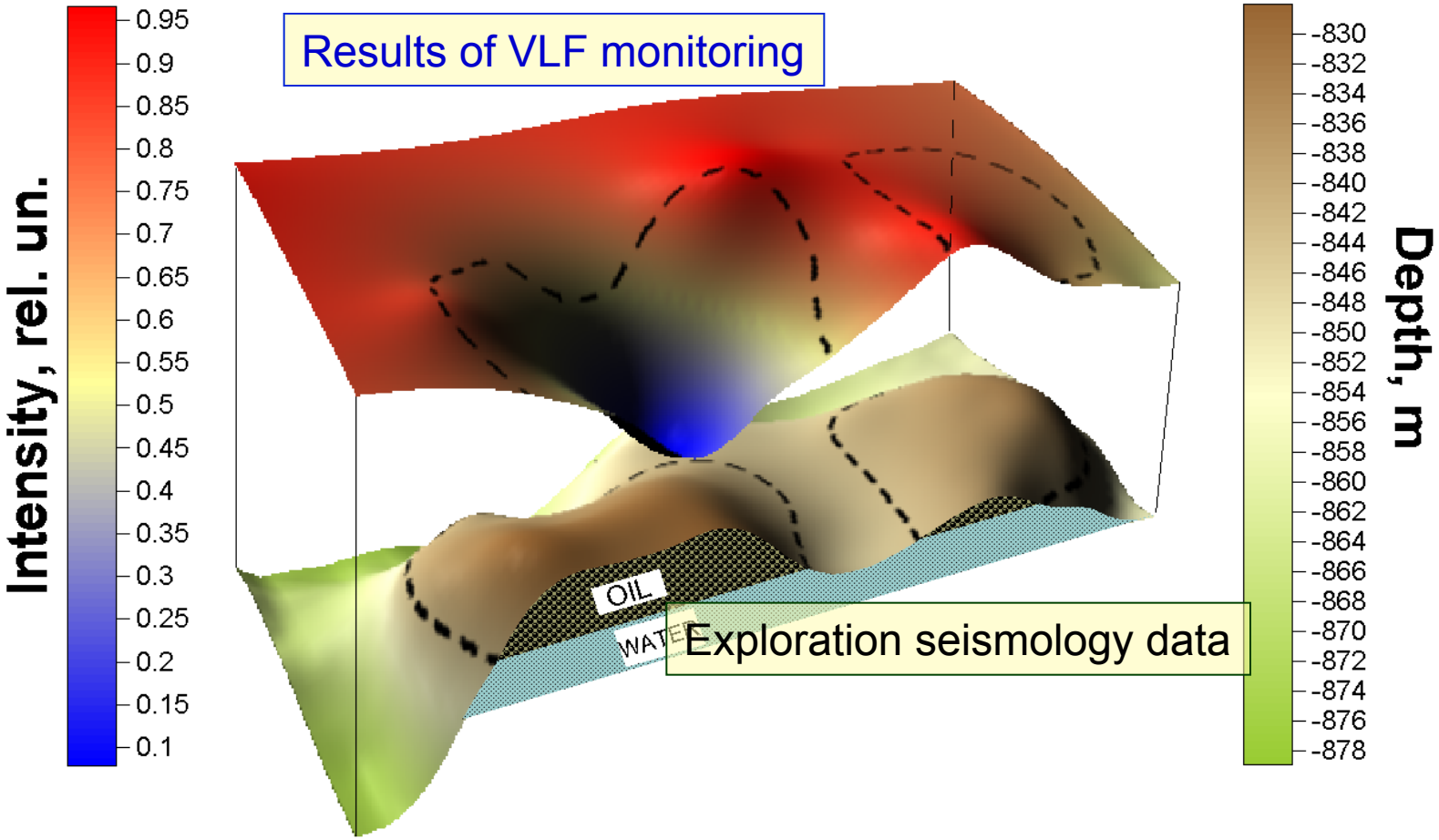


MGR-01 programmable multichannel geophysical VLF recorder

Structural geodynamic mapping of undermined territories along gas-main pipeline

(Gaspromtransgas, JSC, Chaikovsky)

Technology for VLF monitoring of lithosphere structures intended for short-time oil-pool discovery



Comparison between results of short-time monitoring and exploration seismology data on the oil deposit territory

Conclusion

- The project is oriented at comprehensive instrumented studies of natural and climatic changes in order to obtain empirical regularities.

- It fills the gap between standard network meteorological observations, on the one hand, and mathematical modeling of global and regional changes (that needs verification), on the other hand.

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