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информационные технологии

Experience of interferometric monitoring in the Arctic region

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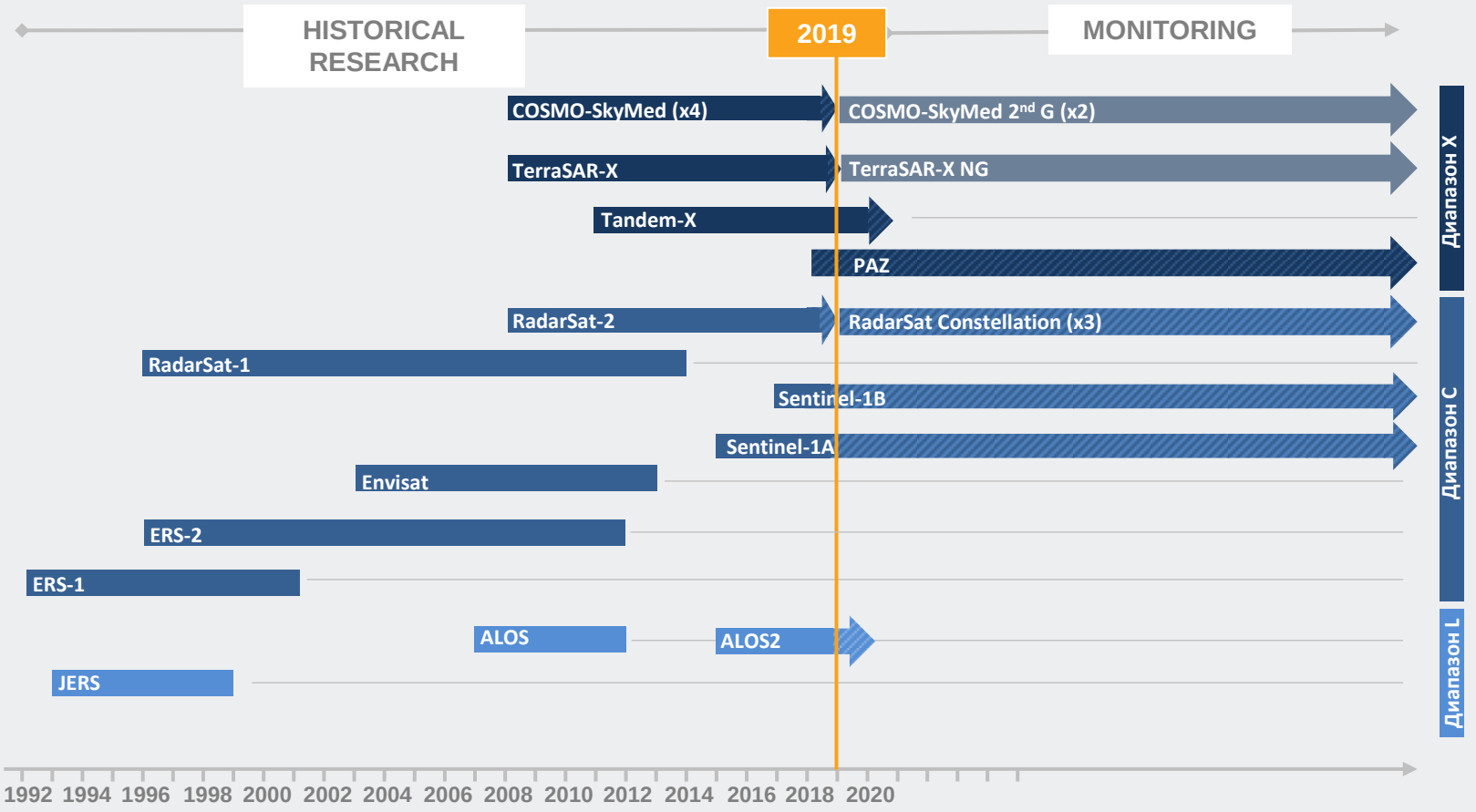
Radar satellite systems



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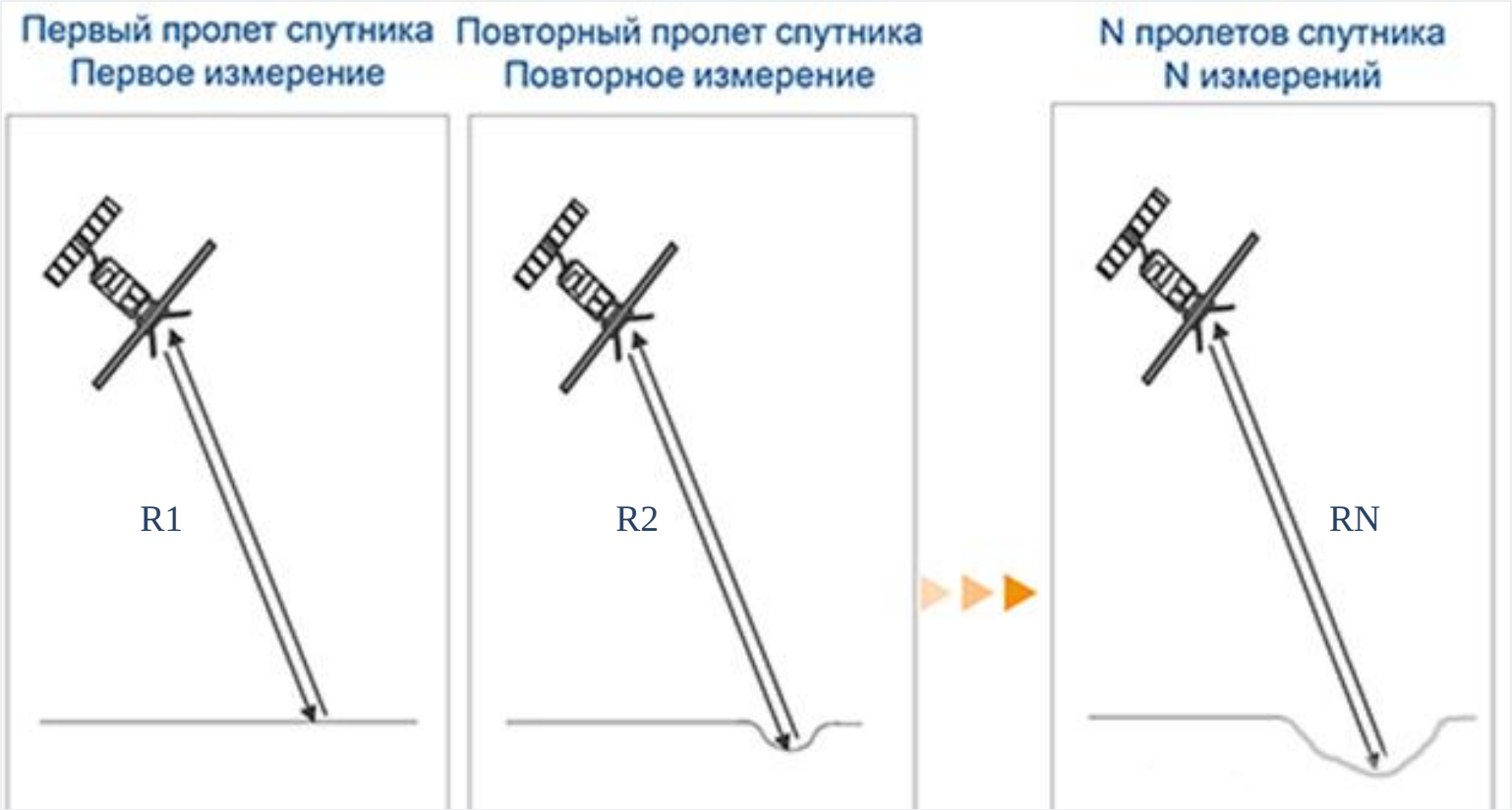
InSAR technology

In (interferometry) - Superposition of waves to identify differences

SAR (synthesis aperture radar) - High resolution radar system



The distance from the satellite to the earth's surface

Change detection

Shift measurement

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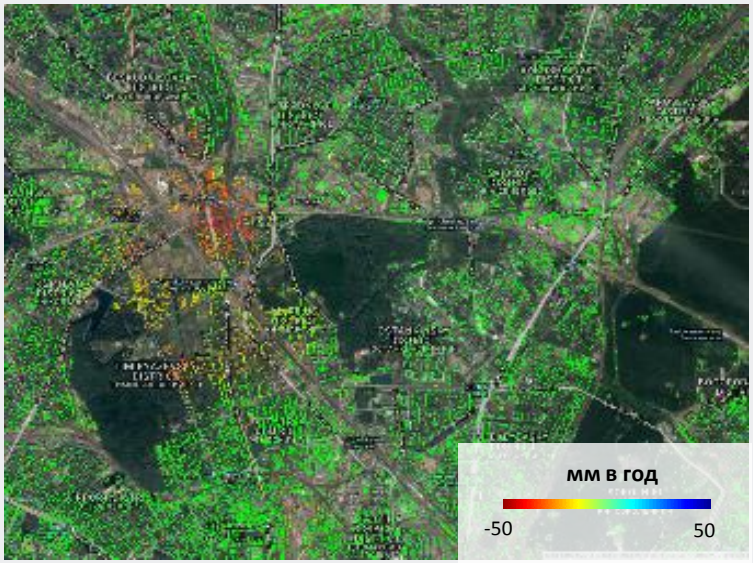
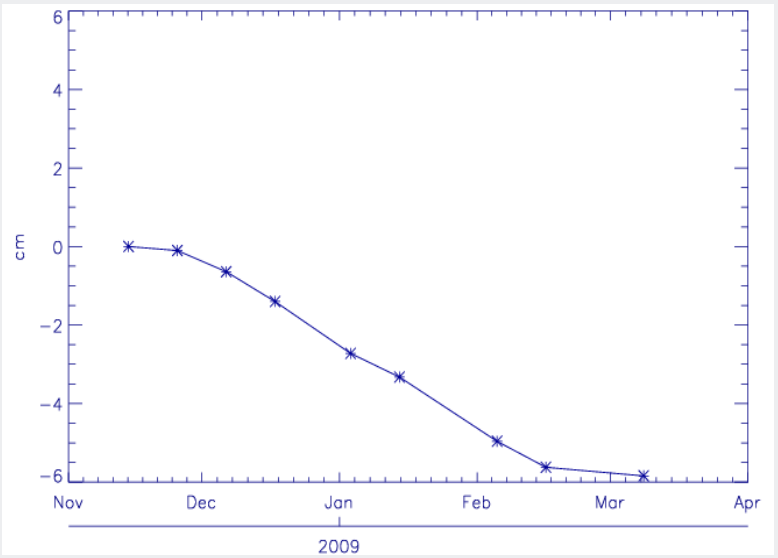


Map of shifts of the earth's surface



Shift graph for each point

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Advantages of InSAR technology

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Historical research

- Archive data allow to implement retrospective studies of the earth's surface displacements for the period from 1992 to the present.
- The condition of the territory is estimated before the beginning of construction works.

Additional means surveillance

- Satellite technology can detect and measure gradients of deformation processes on the earth's surface. Monitoring the evolution of deformations over time in addition to ground measurements.

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Advantages of InSAR technology

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High measurement density

– Urban infrastructure and large engineering structures guarantee a very high quality reflection of the radar signal. Measurements are made at hundreds of thousands points.

High precision measurements

– The average accuracy of shift measurement is 1 mm per year.

– The accuracy of each measurement is 3mm.

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Advantages of InSAR technology

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Regular measurement updates

- COSMO-Skymed system: the survey can be performed every 4 days if all four satellites are used.
- TerraSAR/TanDEM/Paz system: the survey can be performed every 7 days.

Global coverage

- Worldwide coverage allows you to perform research anywhere in the world.
- Each image covers thousands of square kilometers: 100x100 km (Envisat), 30x50 km (TerraSAR-X), etc.

Advantages of InSAR technology

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Economic efficiency

- The technology does not require installation and maintenance of equipment on the ground, measurements is done remotely.
- The technology provides measurements over a wide area.

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Stages of work

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Preliminary

– Analysis of physical and geographical conditions of the territory and characteristics of the object. Study of technical requirements to the results of works.

Survey execution

– Analysis and comparison of capabilities of radar survey systems. Data selection. Order for a new tasking.

Data processing

– Interferometric processing and obtaining information about vertical displacements of the earth's surface and objects of oil/gasfield development.

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Physical and geographical conditions

- Active geocryological processes.
- Snow cover from October to June.
- A large number of rivers and lakes.
- Atmospheric phenomena.

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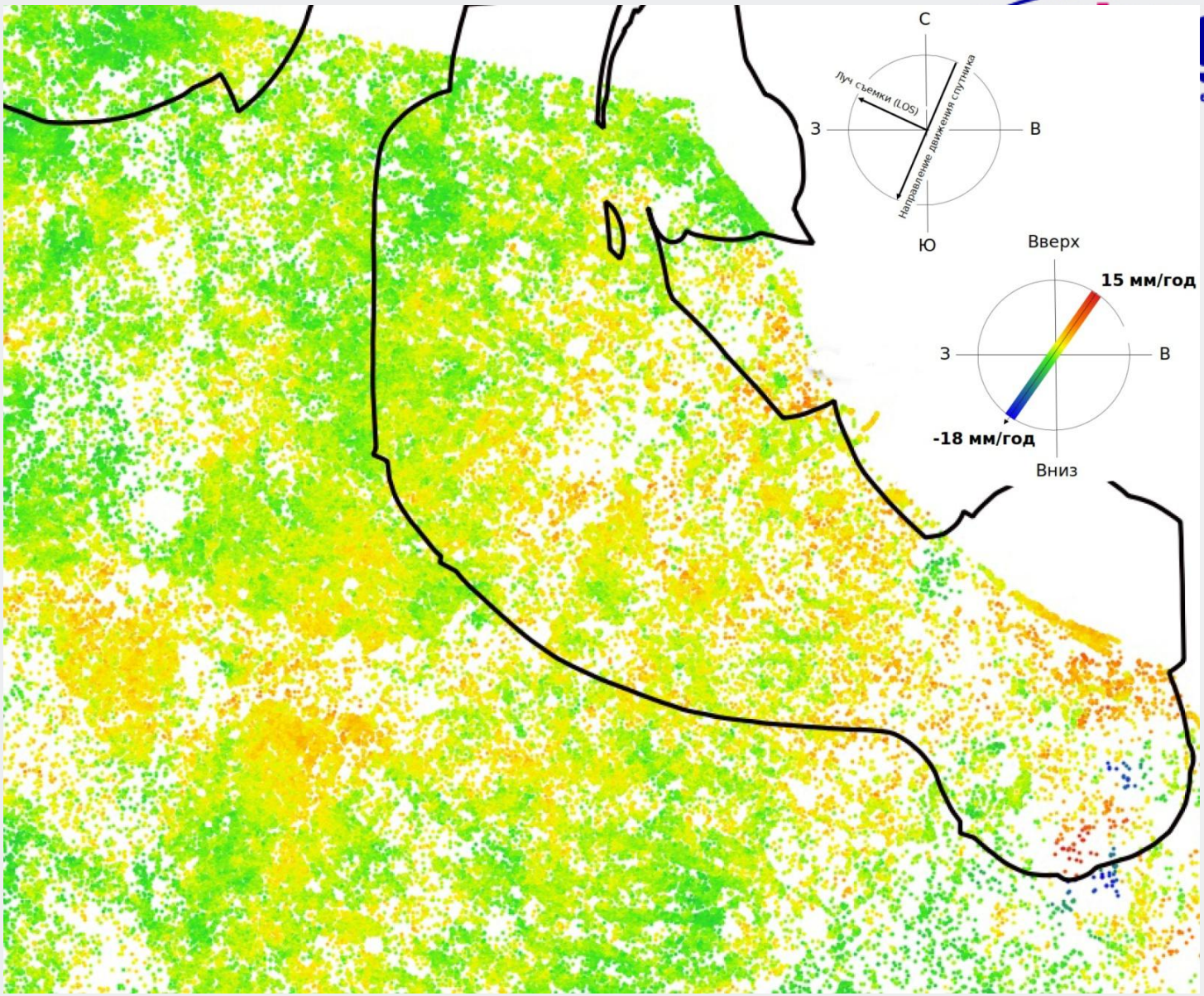
Data selection

№	Name	Units	Values	Notes
1.	Wavelength	centimeters	3 (X) – 24 (L)	As the wavelength increases, the penetrating power increases, but the accuracy of deformation determination decreases
2.	Spatial resolution	meters	1 – 30	For heavily built-up area it is recommended to use: 1-3 m, for other areas: 3-30 m.
3.	Width of the frame	kilometers	10 – 250	Depends on the spatial resolution, the higher the resolution, the smaller the scene width
4.	Repetition period	days	1 – 28	Depends on the orbit and number of satellites

Data selection

№	Name	Units	Values	Notes
5.	Humidity, rainfall	degree	Min-Max.	As rainfall and humidity increase, longer-wave data will be better at maintaining coherence.
6.	Vegetation cover	degree	Min-Max.	With increasing density of vegetation, the coherence of a shorter wavelength data will decrease.
7.	Snow cover	availability	No-Yes	In the presence of snow cover processing is possible for l-band data, for X-and C-bands processing is possible only by the method of permanent reflectors.

Geodynamic monitoring (Sentinel)



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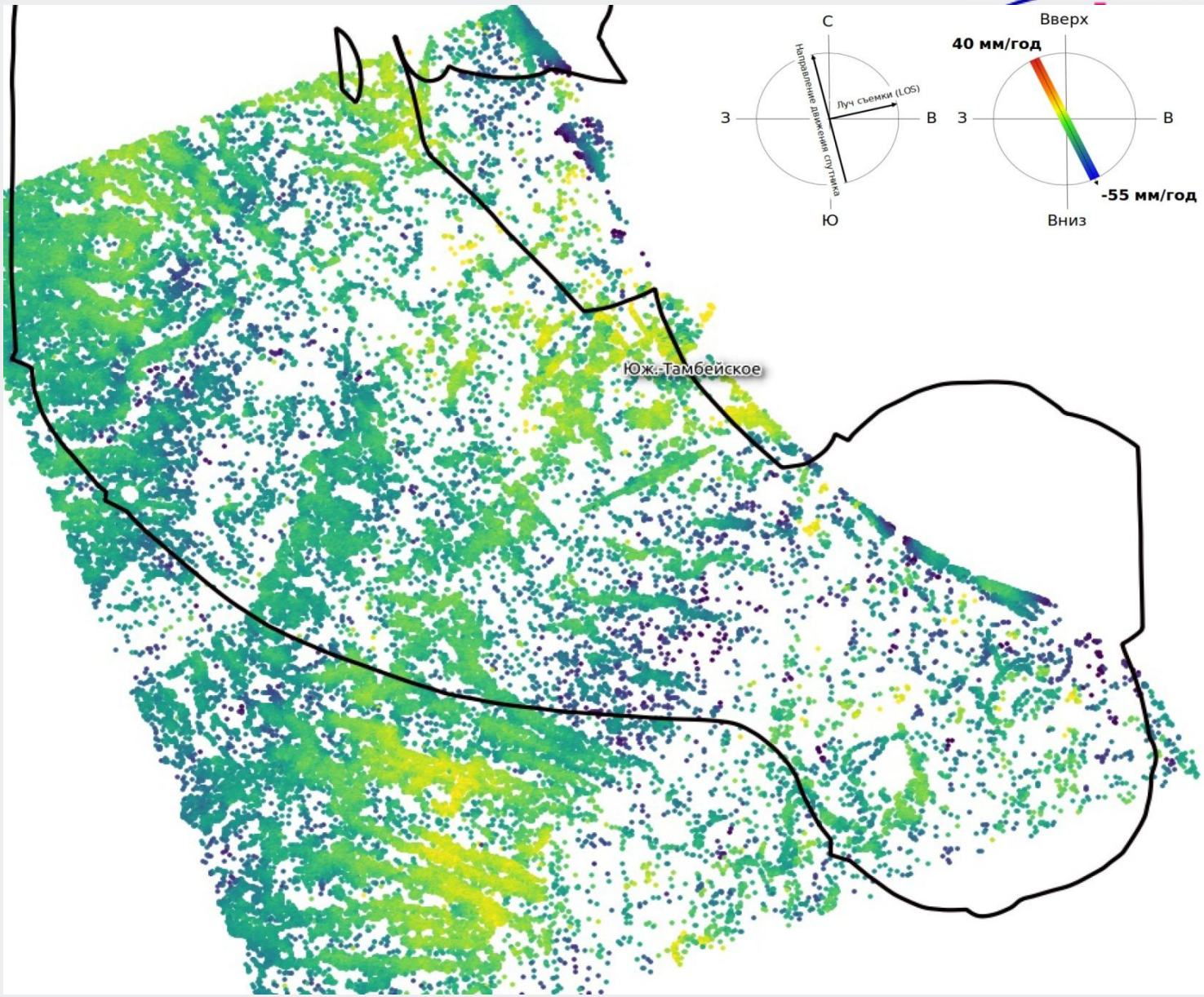
Geotechnical monitoring (CSM)



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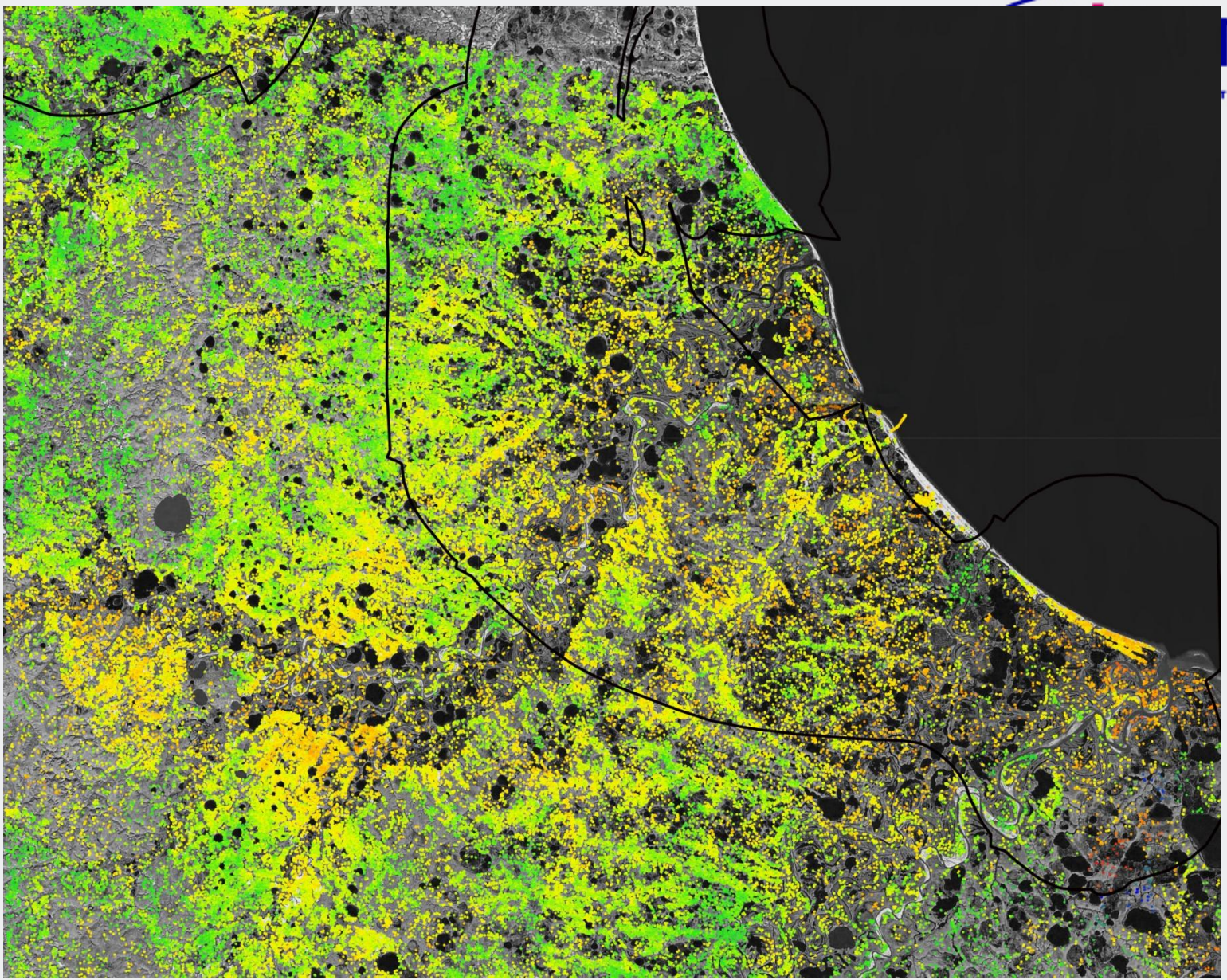
Geodynamic monitoring (Sentinel)



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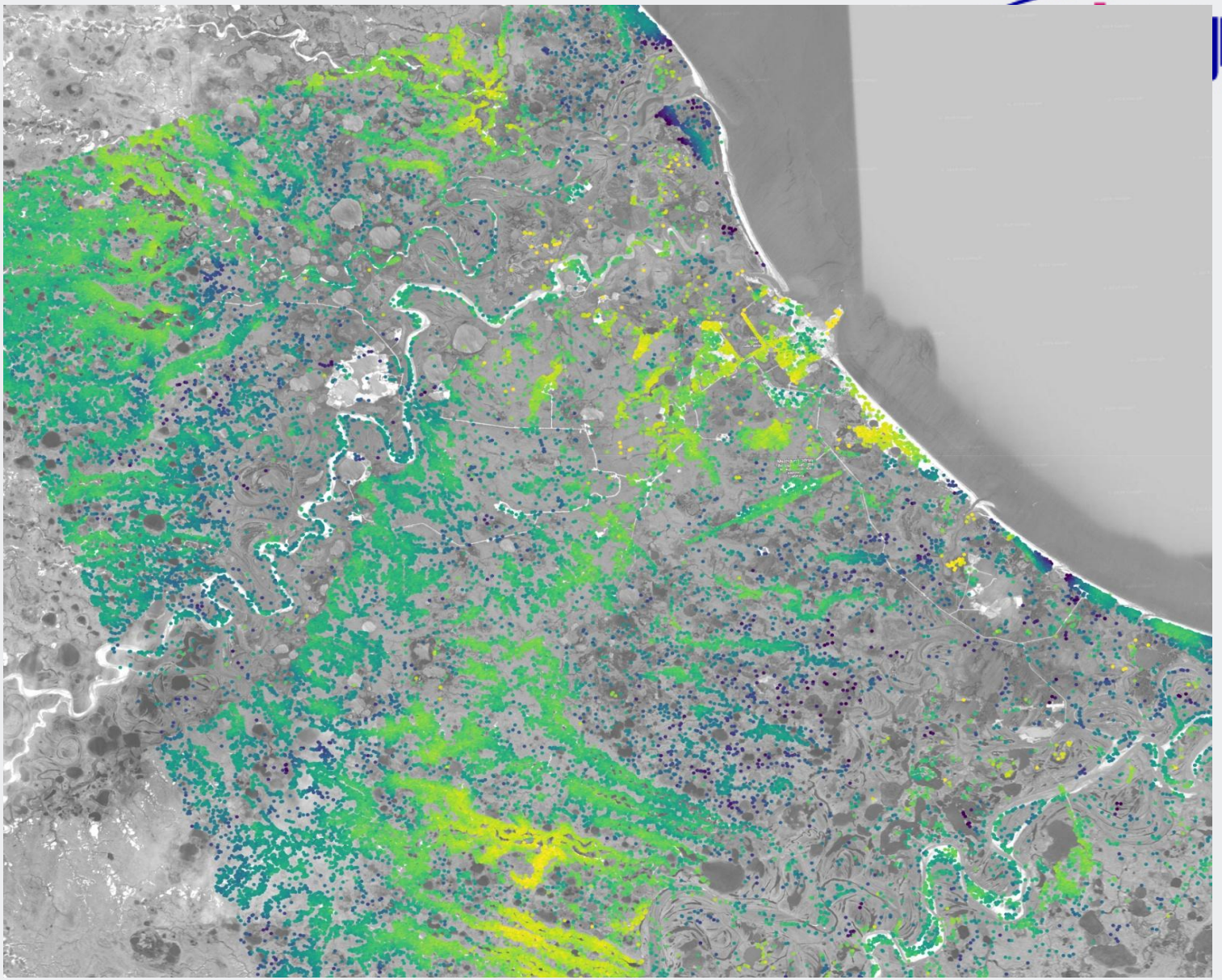

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InSAR in the Arctic

- Using only two radar systems: COSMO-Skymed-1/2/3/4 and TerraSAR/TanDEM/Paz.
- Planning and coordination with the customer tasking plans.
- Receiving interferometric packets of at least 15 images, optimally 20-25 images.
- Using Sentinel data.
- The accuracy of measuring shifts is 4 mm, the shift rate is 1 mm per year.

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Thanks for your attention!

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