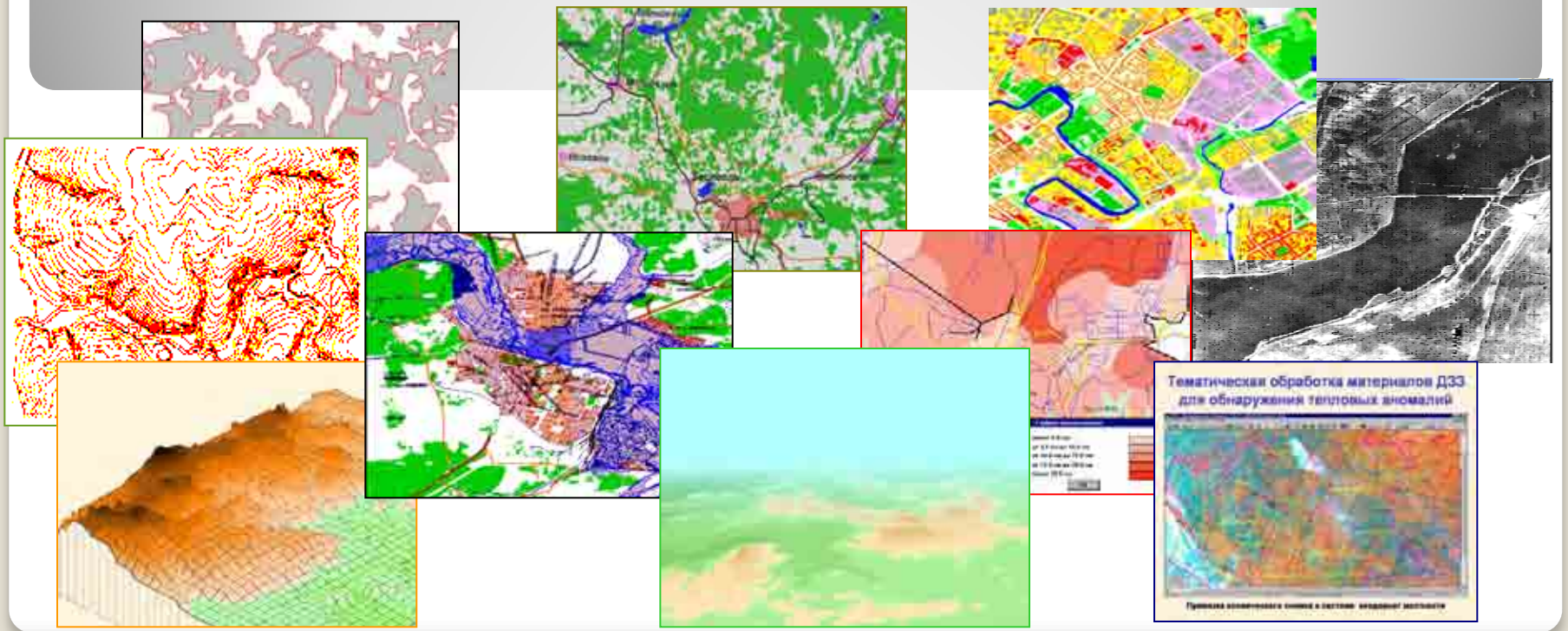
NATIONAL ACADEMY OF SCIENCES OF BELARUS
BELARUSIAN STATE UNIVERSITY

REMOTE SENSING DATA PROCESSING FOR ECOLOGY AND CLIMATE MONITORING AT THE TERRITORY OF THE REPUBLIC OF BELARUS



Belarusian Earth Remote Sensing Space System

БКА (Беларусь) (перспектива)

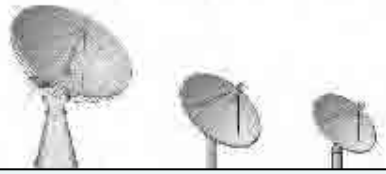
Ресурс-ДК (Россия) (перспектива)

Монитор-Э (Россия)

NOAA (США)

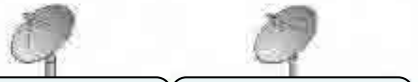
EOS-Terra (США)

Ground Control Segment



NASB Receiving Station

Remote sensing data receiving segment



MAF receiving station

eteorology Center receiving station

RCEOM (Russia)

BERSSS Corporative Network

BERSSS Planning and control segment

Regional space data receiving point

Subject processing segment

Archives and databases of remote sensing data

Remote sensing data consumers

Ministry of Extreme Situations

Ministry of Nature

Ministry of Forestry

Ministry of Agricul-ture and Food

Ministry of Property

Internet (consumers)

Belarusian Earth Remote Sensing Space System

Satellite data receiving station

Antenna control system

Antenna sytemTHA-9PB

Receiving station control system

Time receiving, demodulation and generation equipment

Station energy-supply system

Data space recording system

Earth remote sensing data

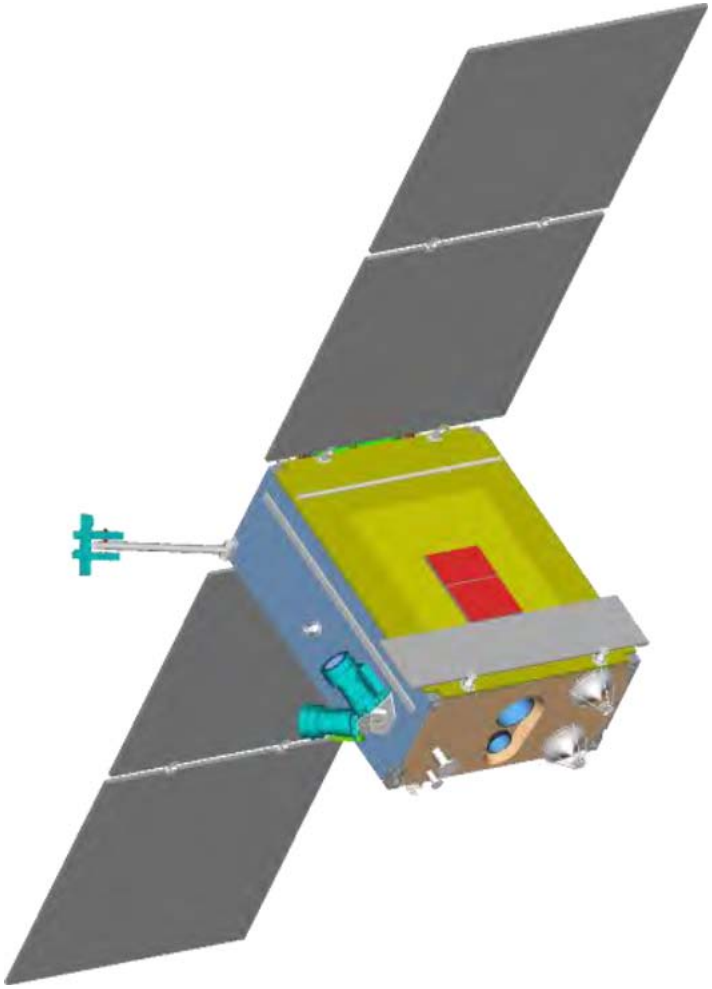
SOLVING TASKS

1. Satellite antenna pointing and monitoring
2. Receiving, multiplication and transformation of radio signal from satellite
3. Demodulation, digital code transformation and registration of space data
4. Received space data preliminary processing and transfer to the BERSSS database

MAIN TECHNICAL CHARACTERISTICS

Parabolic mirror antenna system diameter – 9, m
antenna system total weight – 14,0 t
Operating frequency range – 8,0-8,4 GHz
Satellite data receiving rate –
up to 245 megabyte/s
Receiving data validity (error probability) – 10
Control and antenna pointing methods –
program automaintenance, manual

Belarusian Earth Remote Sensing Space System

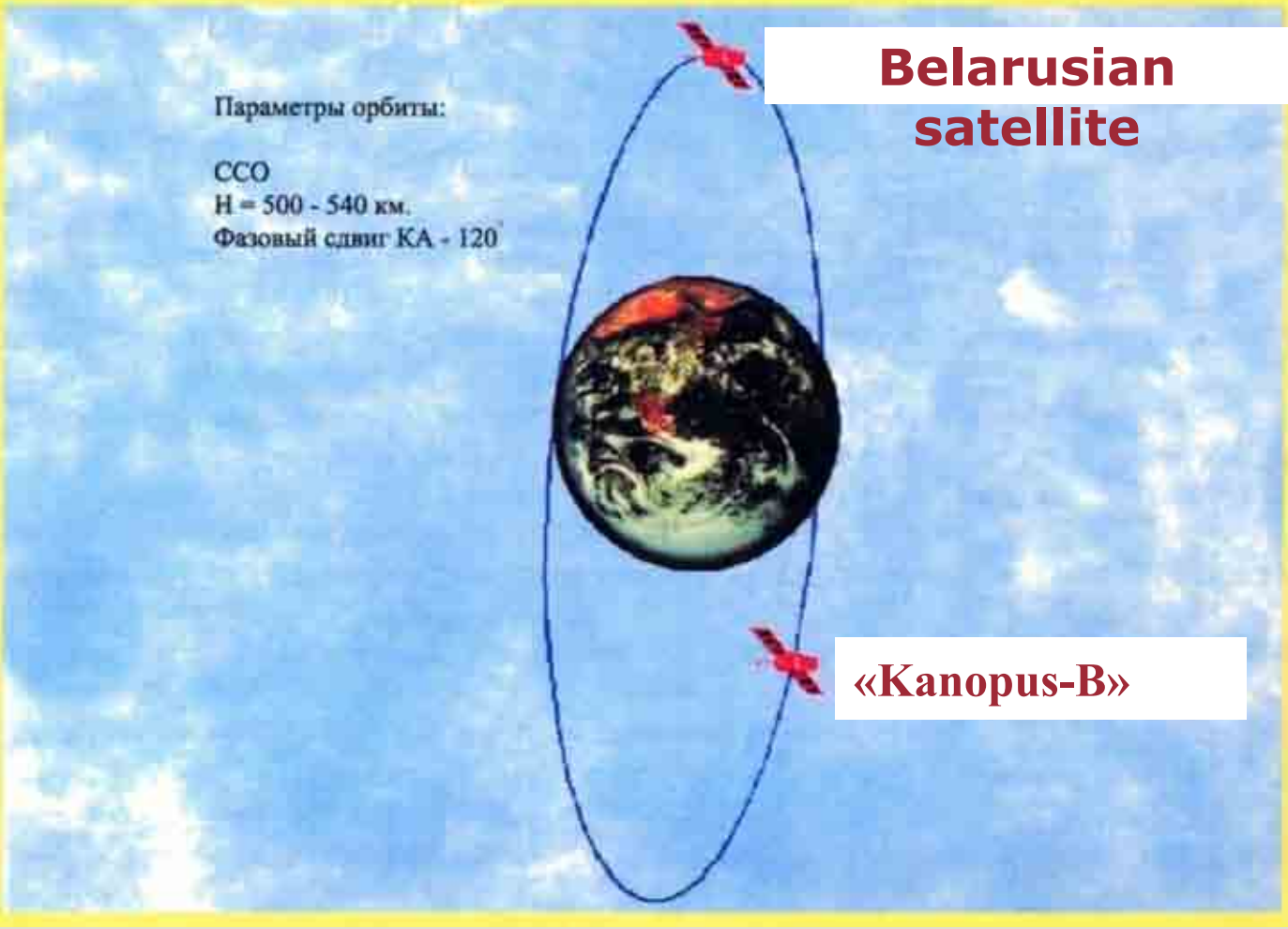


Belarusian satellite main characteristics

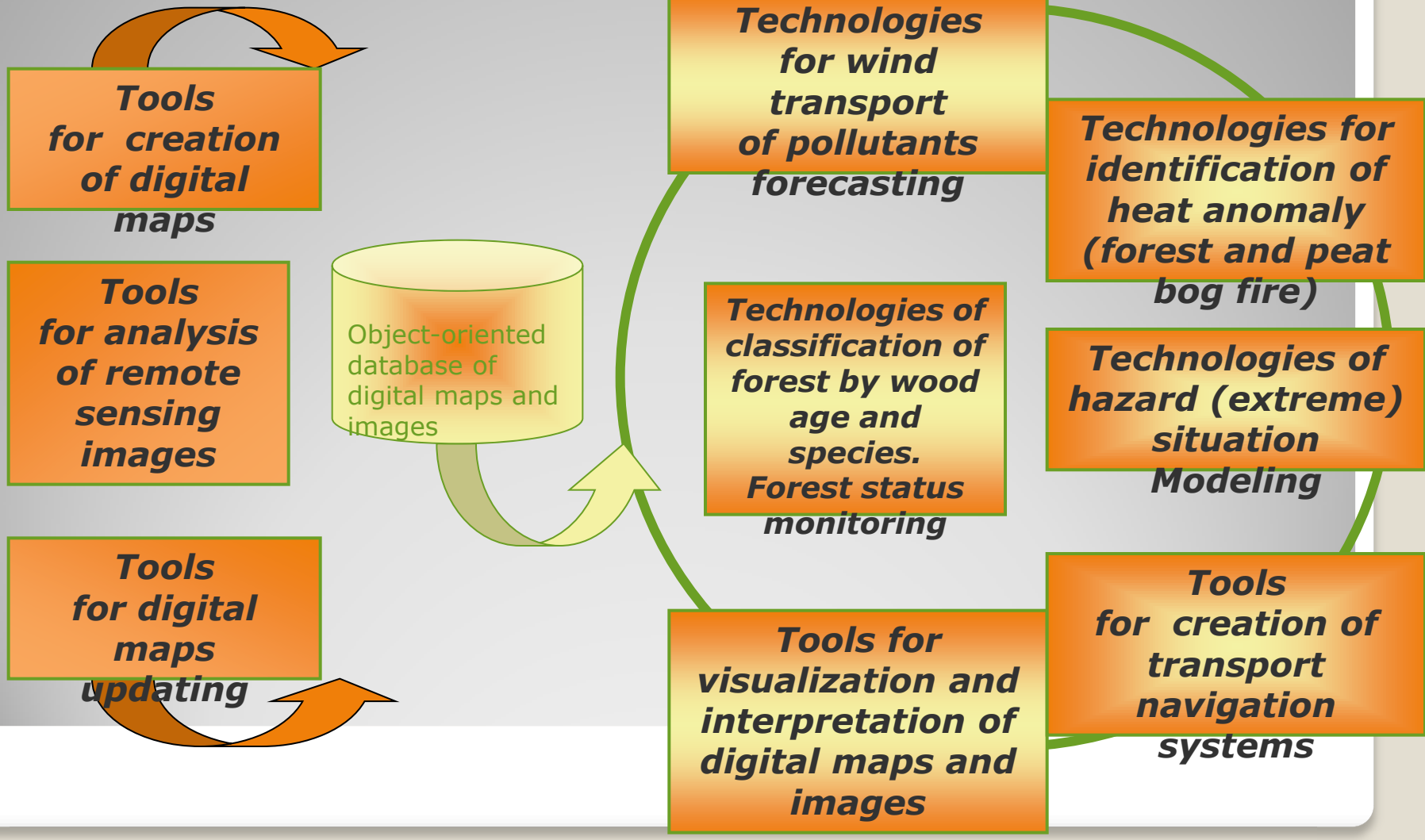
- Solar-synchronous orbit raising,km 510 ± 10
- Field of view, km ± 440
- Swath , km 20
- Resolution:
  - panchromatic subsystem, m 2,1
  - Multispectral subsystem, m 10,5
- In-orbit life, years ≥ 5
- Data transfer rate, mbyte/s up to 245,76
- Orientation accuracy, angl. min 5
- Orbital position definition accuracy, m 15

Belarusian Earth Remote Sensing Space System

Orbital structure of intergovernmental integrated space system



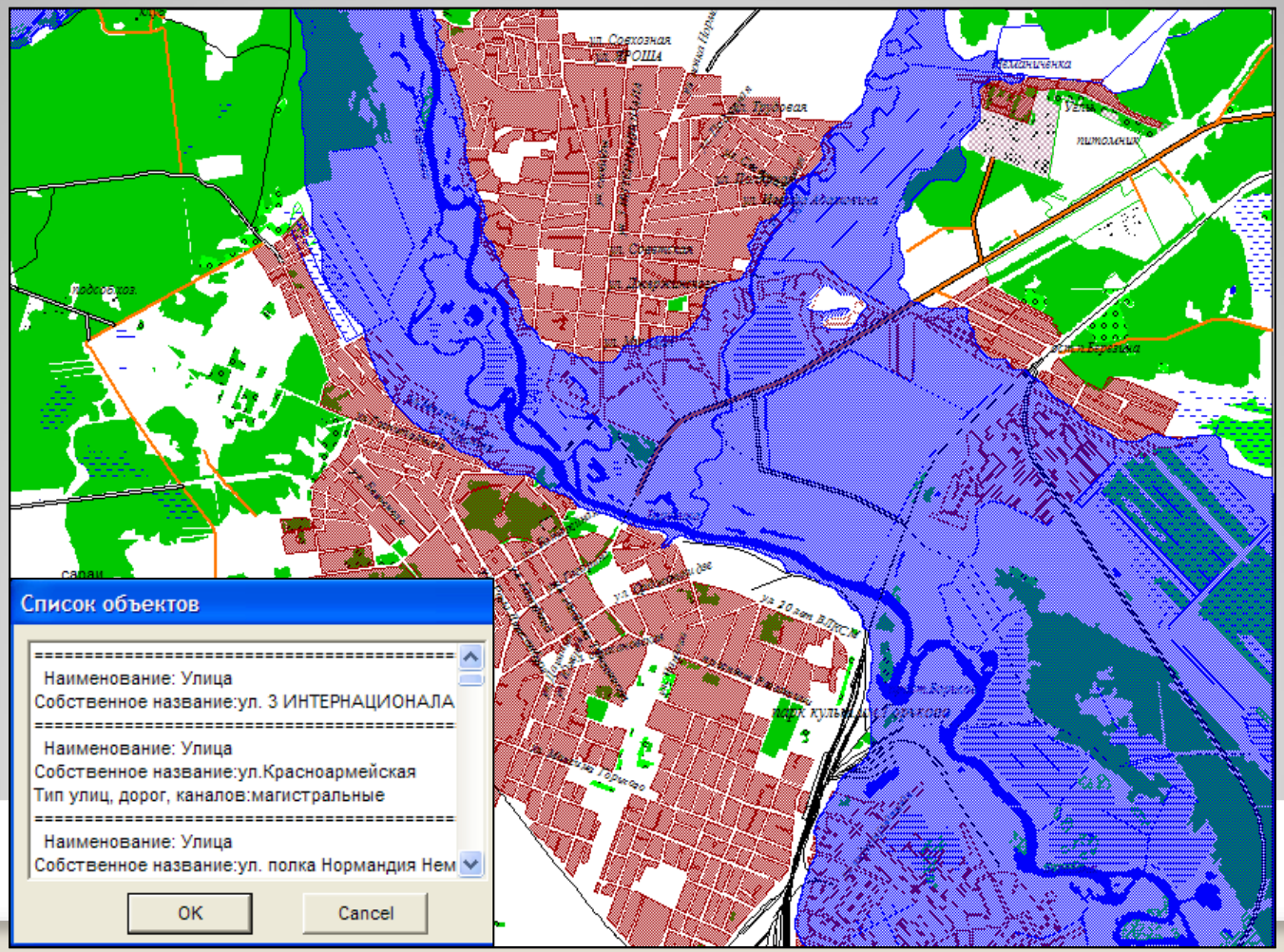
Interpretation of remote sensing images and digital maps and their applications



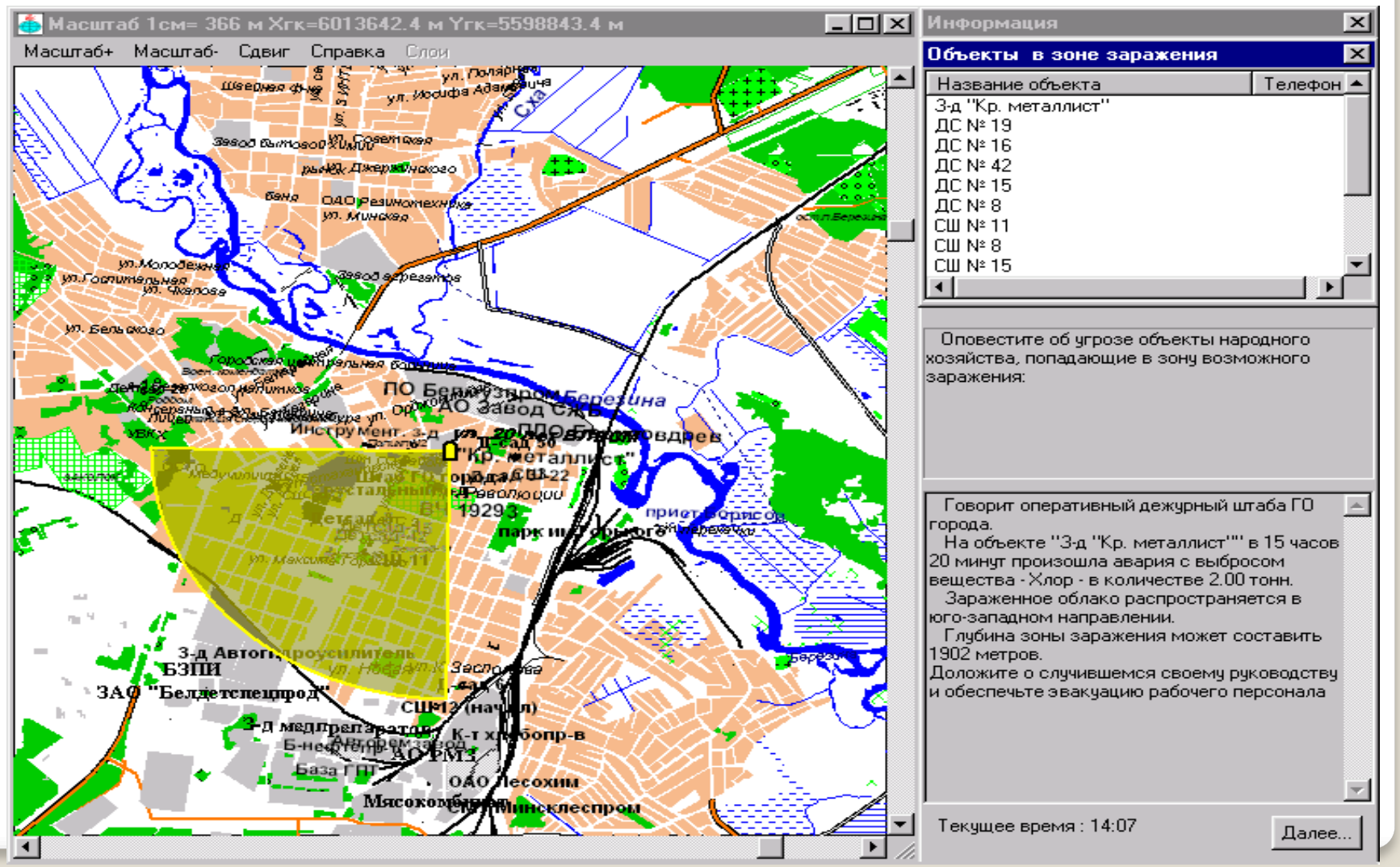
Technologies of hazard (extreme) situation modeling

- ***forecasting and modeling of the disaster on the enterprises and vehicles with chemically dangerous stuff;***
- ***modeling and forecasting of forest fires dynamic;***
- ***modeling of the flooding zones;***
- ***output of maps with information of hazard.***

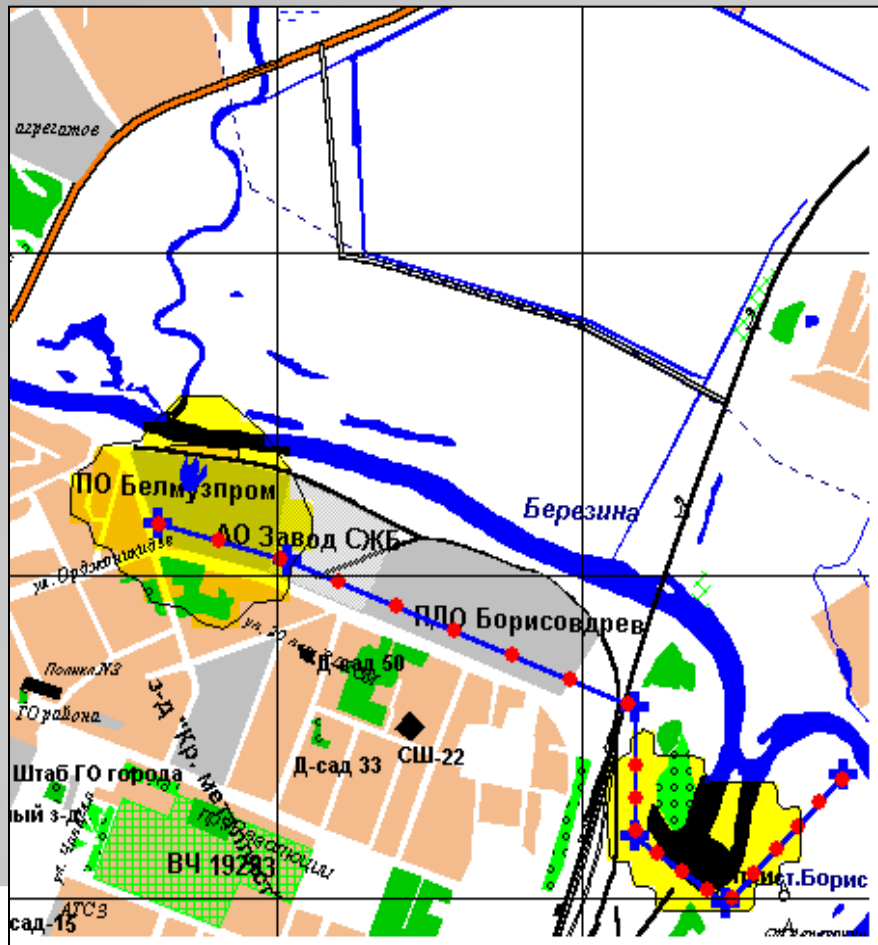
Modeling the flooding zones



Forecasting and modeling of the disaster on the enterprises and vehicles with chemically dangerous stuff



Modeling the fire on matches factory



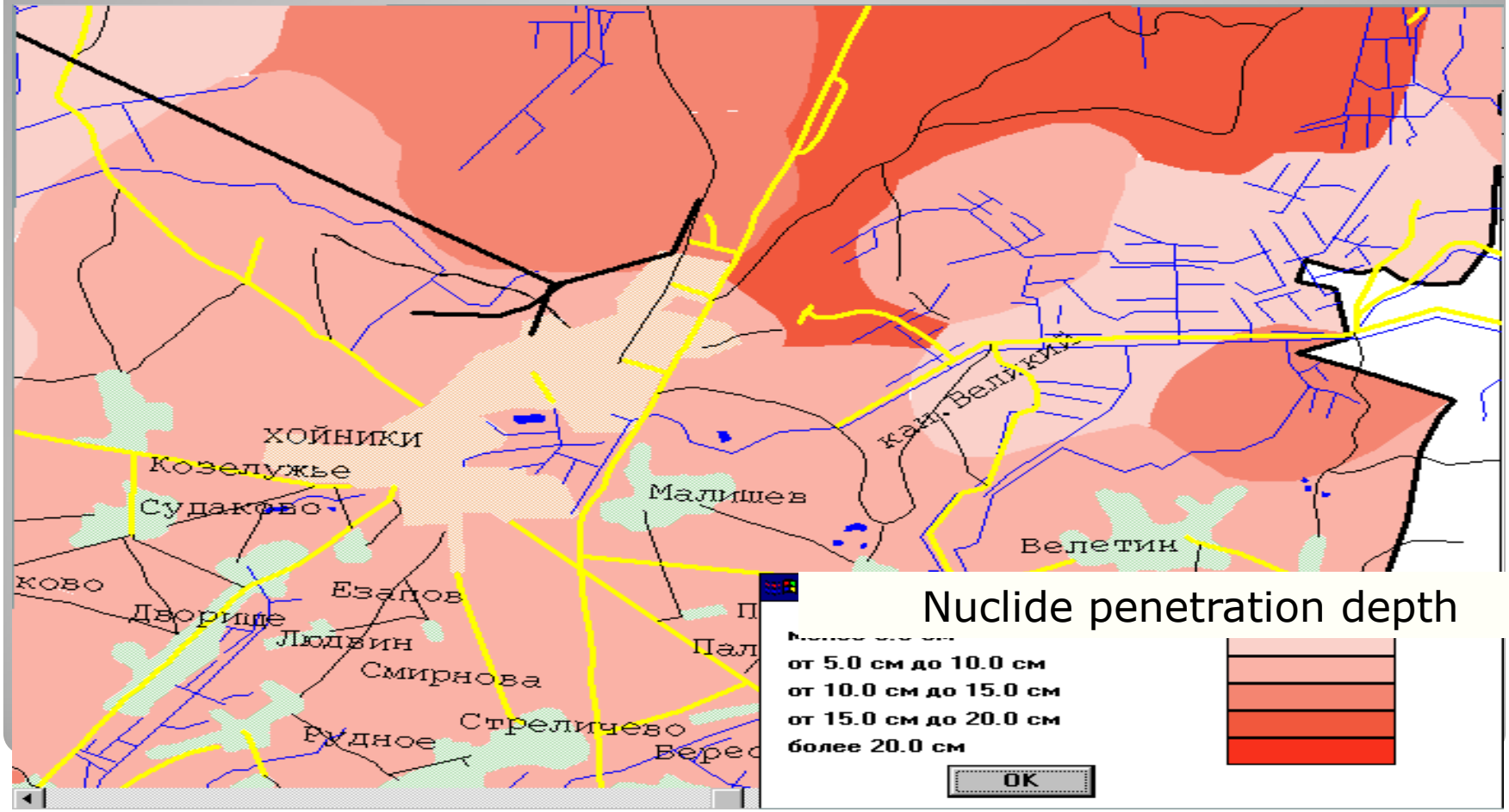
Pollution g/m2	%%	sq.km
<1.00		
1.00-1.50	3.4	0.4
1.50-2.00	0.5	0.1
2.00-2.50	0.0	0.0
>2.50	0.0	0.0
Polluted:	3.9	0.4
Clean:	96.1	10.3

VALUE	DIMENSION	PARAMETER
23.11.1998	dd.mm.yyyy	Data of emergency
15:40	hh:mm	Time of emergency
00:01:30	dd:hh:mm	Period of emergency
303	m	Height of calc. layer
10-14	m/s	Wind velocity
East		Wind direction
90	degree	Wind azimuth
0	m	Height of view
0.0	m/s	Wind velocity
1		Number of stat. points
65	m	Grid step
10.7	sq. km	All area
1.94	q/m2	Max. pollution
13.00	t	Emitted
2.76	t	Sedimented
5	km/h	Vehicle velocity
6		Number of trace nodes
2.4	km	Passed way

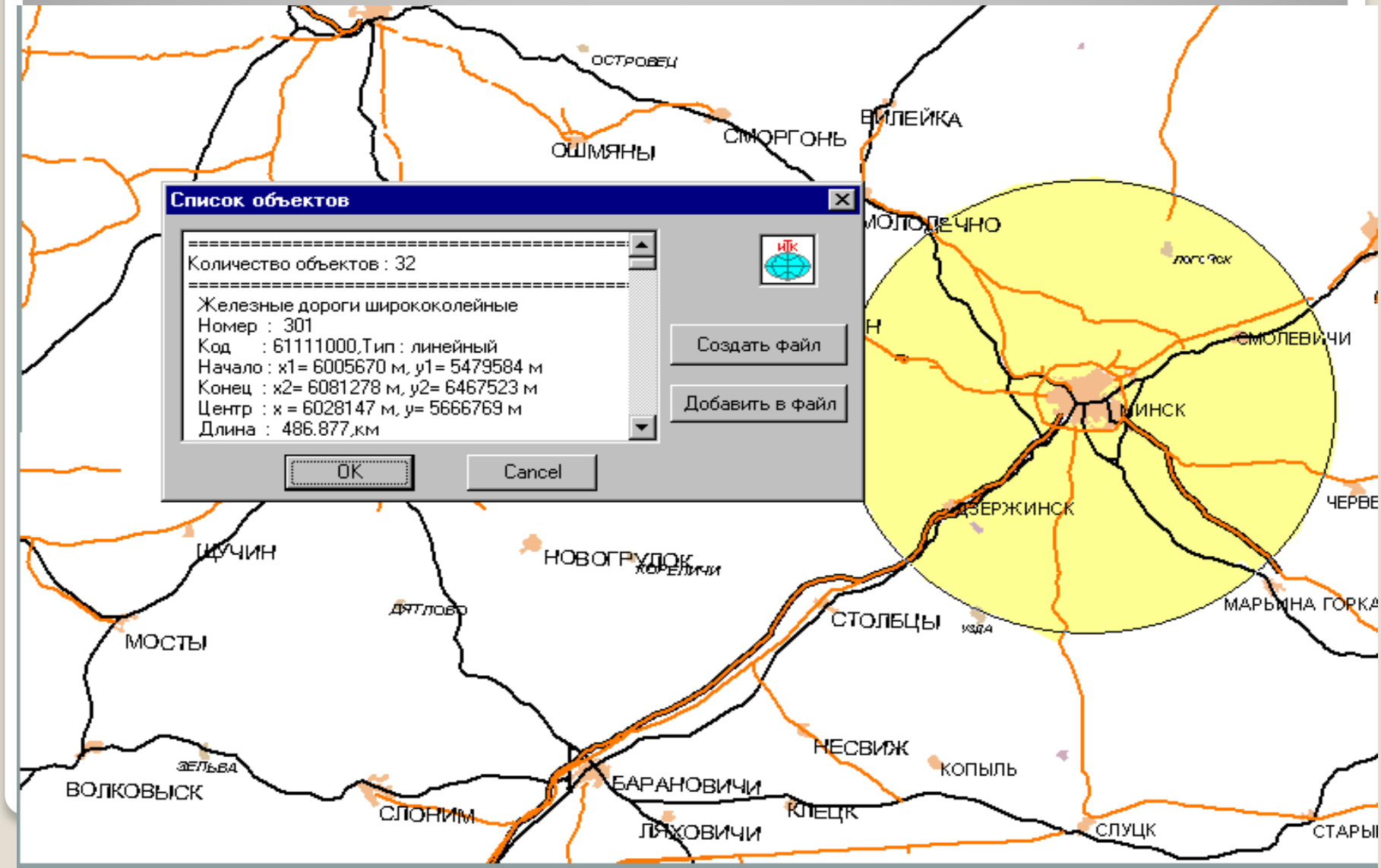
Scale
0 500 m

Date: 27.10.2000
Time: 14:50

Soil nuclide migration forecasting



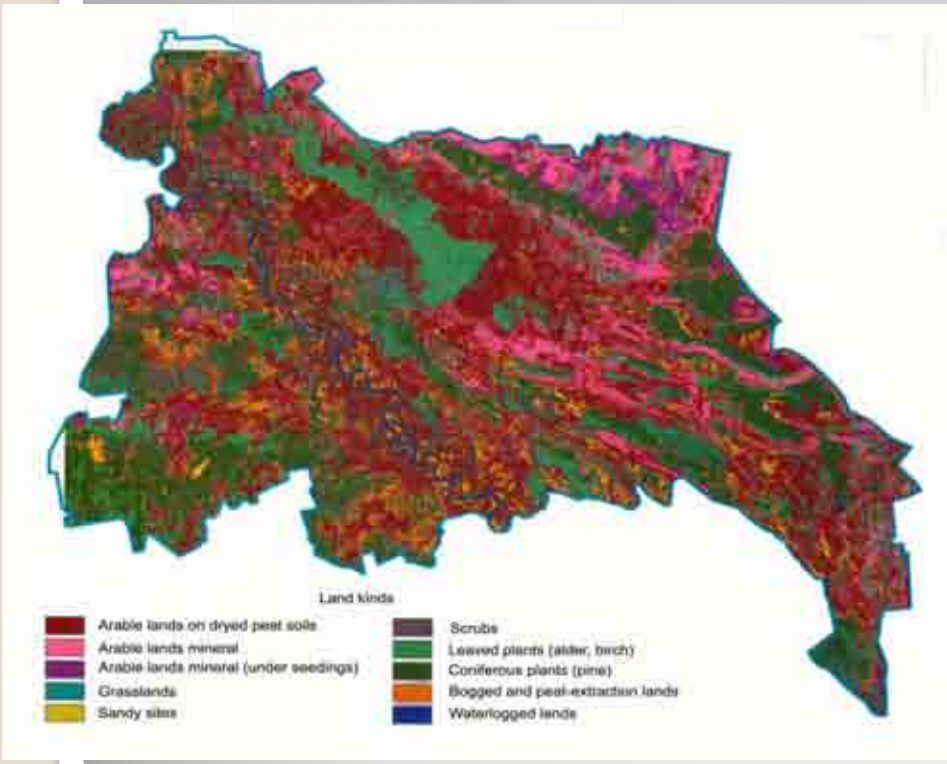
Polluted zones determination and identification of the objects located in these zones



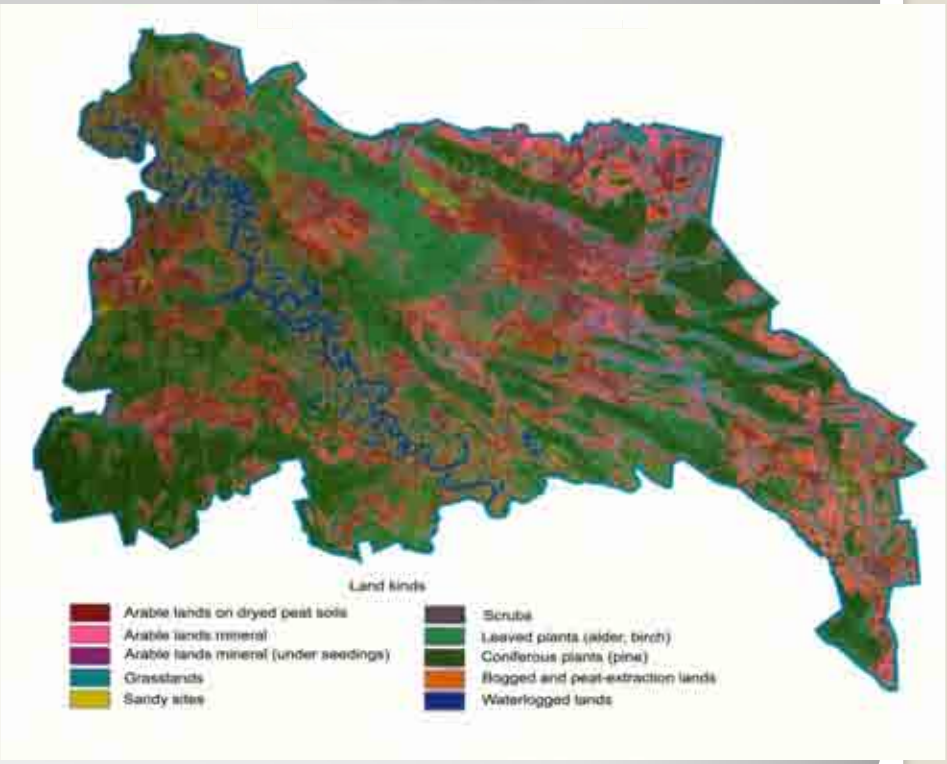
Technologies of land monitoring by using remote sensing images

Transformation of land structure of Polesky radioecological rezerve

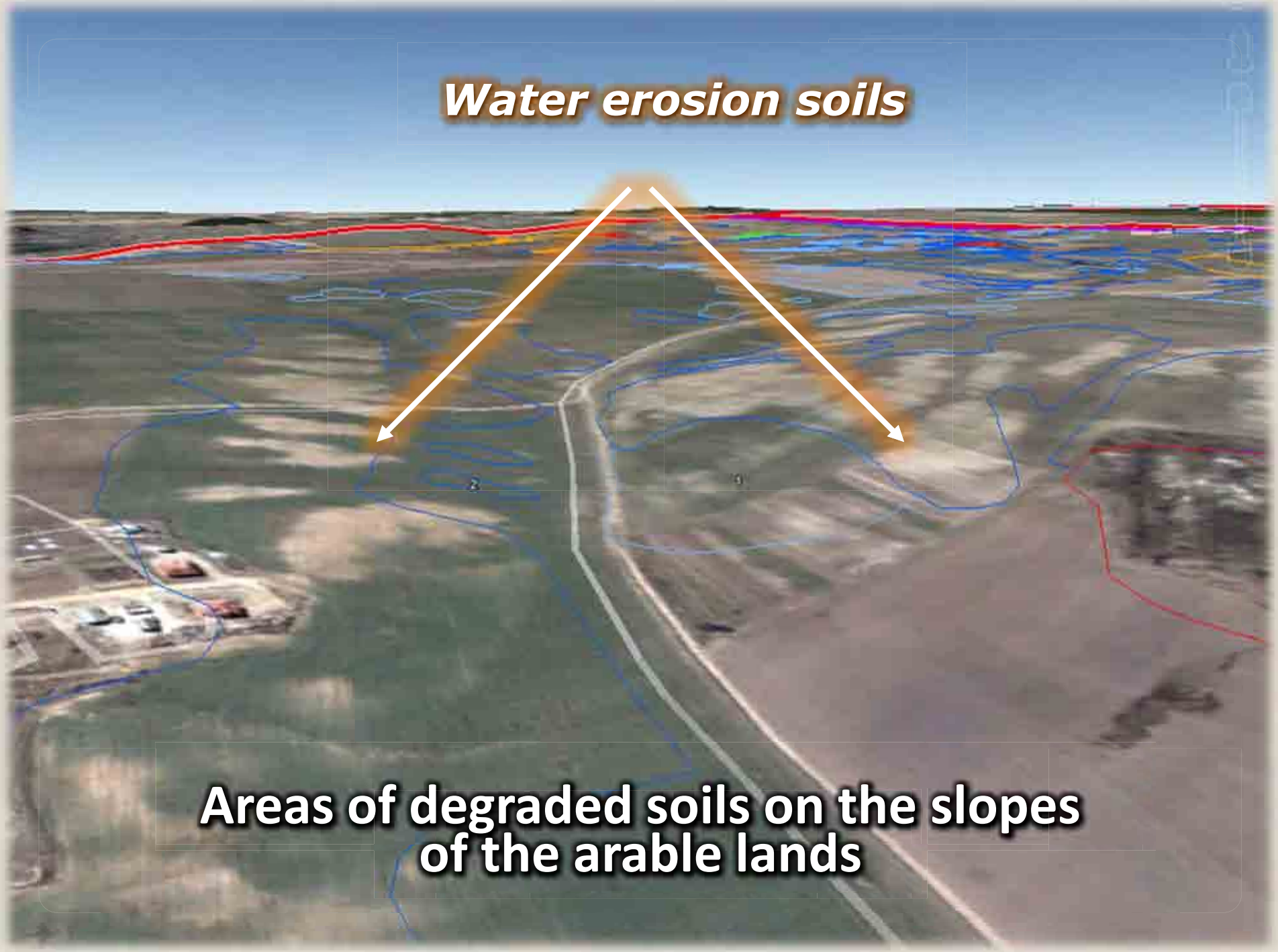
1988

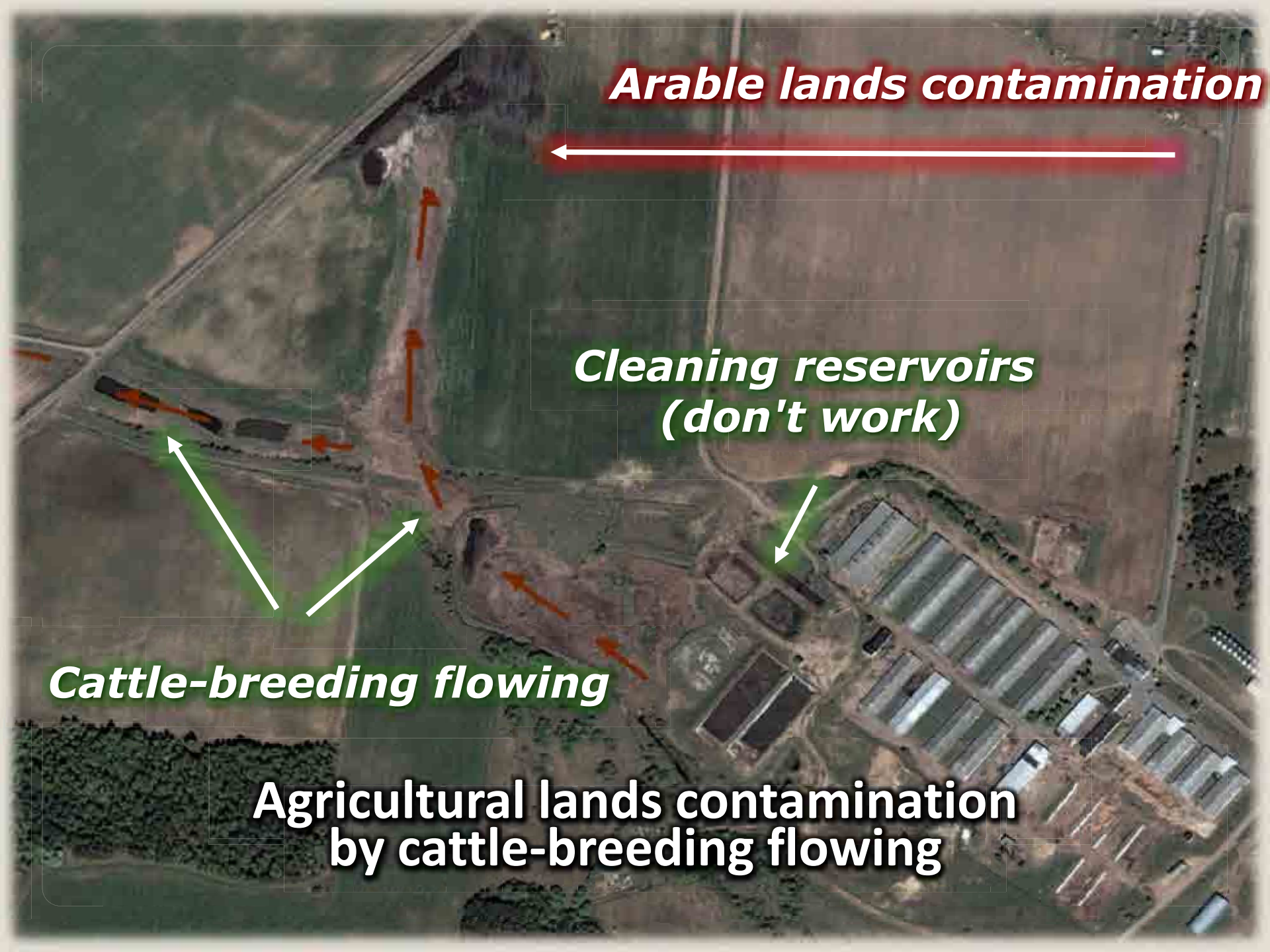


2011

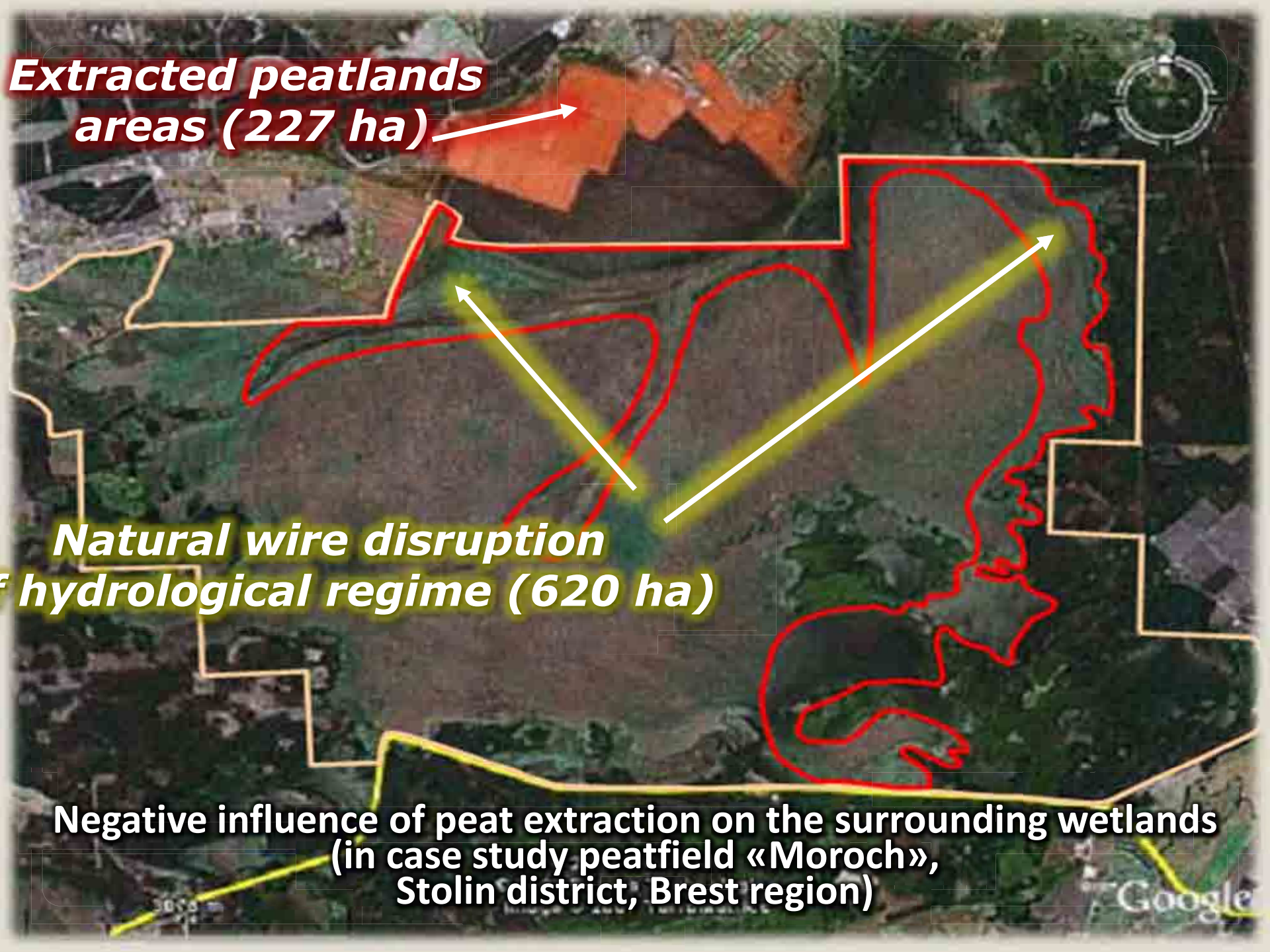


Source: KC Landsat 3 Mss, 5 tm, 7 etm+


Water erosion soils
Areas of degraded soils on the slopes
of the arable lands


Arable lands contamination
Cleaning reservoirs
(don't work)
Cattle-breeding flowing
Agricultural lands contamination
by cattle-breeding flowing


Arable land
covered by vegetation
Arable land
(open soil)
Drained peatlands degradation
by intensive agricultural use

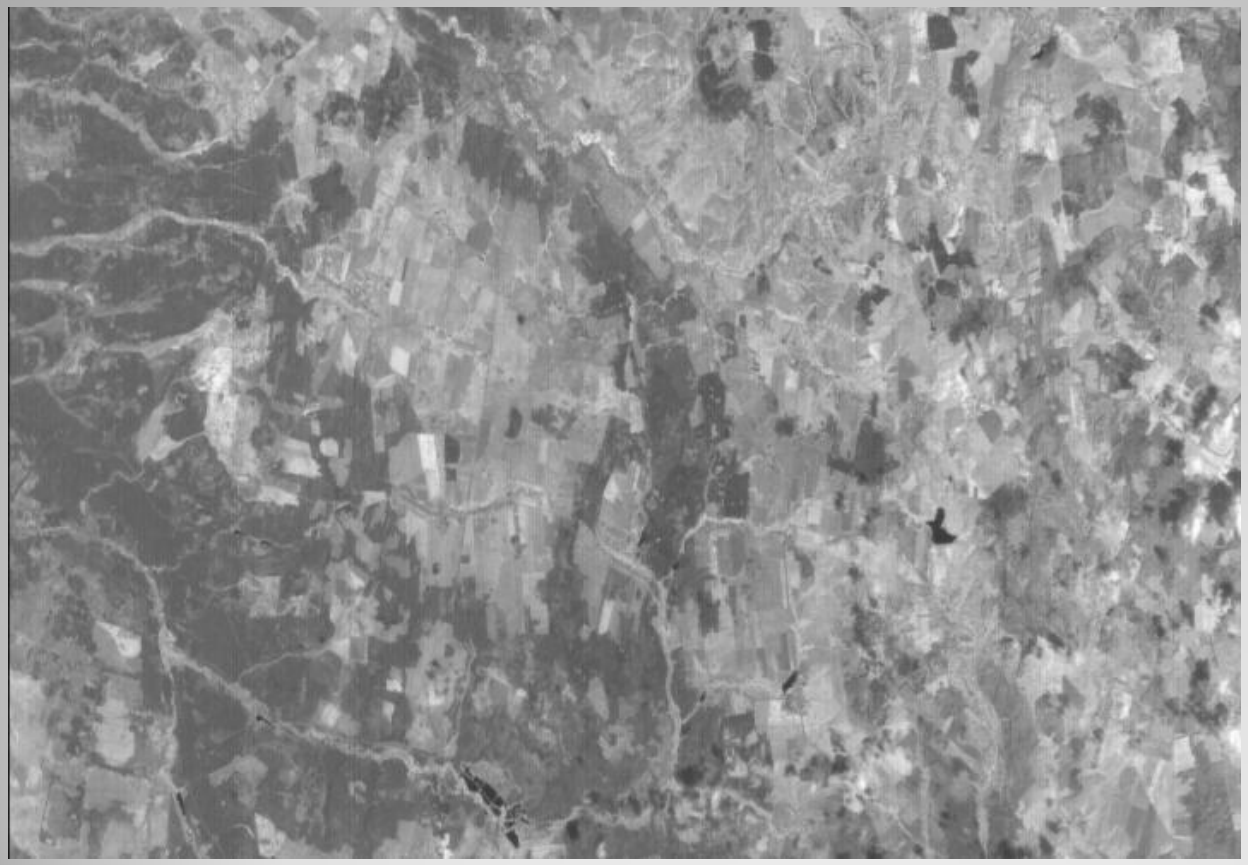


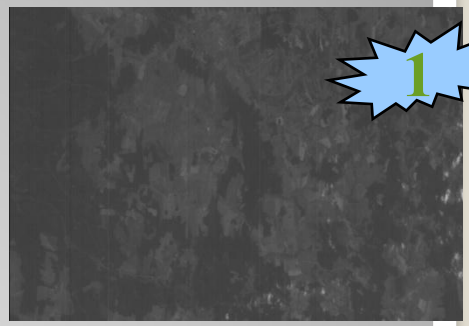
Negative influence of peat extraction on the surrounding wetlands
(in case study peatfield «Moroch»,
Stolin district, Brest region)

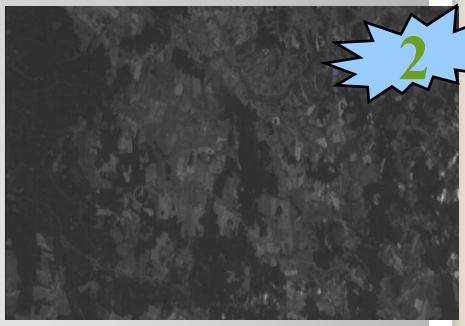
Technologies of classification of forest by wood species and age. Forest status monitoring

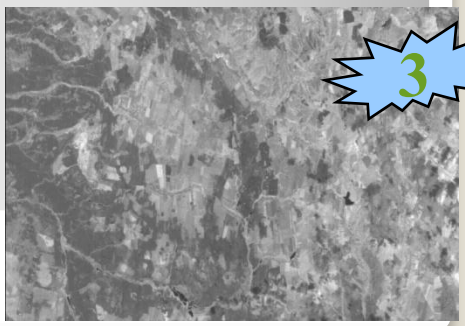
- ***acquisition and pre-processing of spectra-zone space images;***
- ***images to map rectification;***
- ***classification of forest by wood species , its age and drying up ;***
- ***plotting of thematic maps and printing the reports.***

Initial spectral image



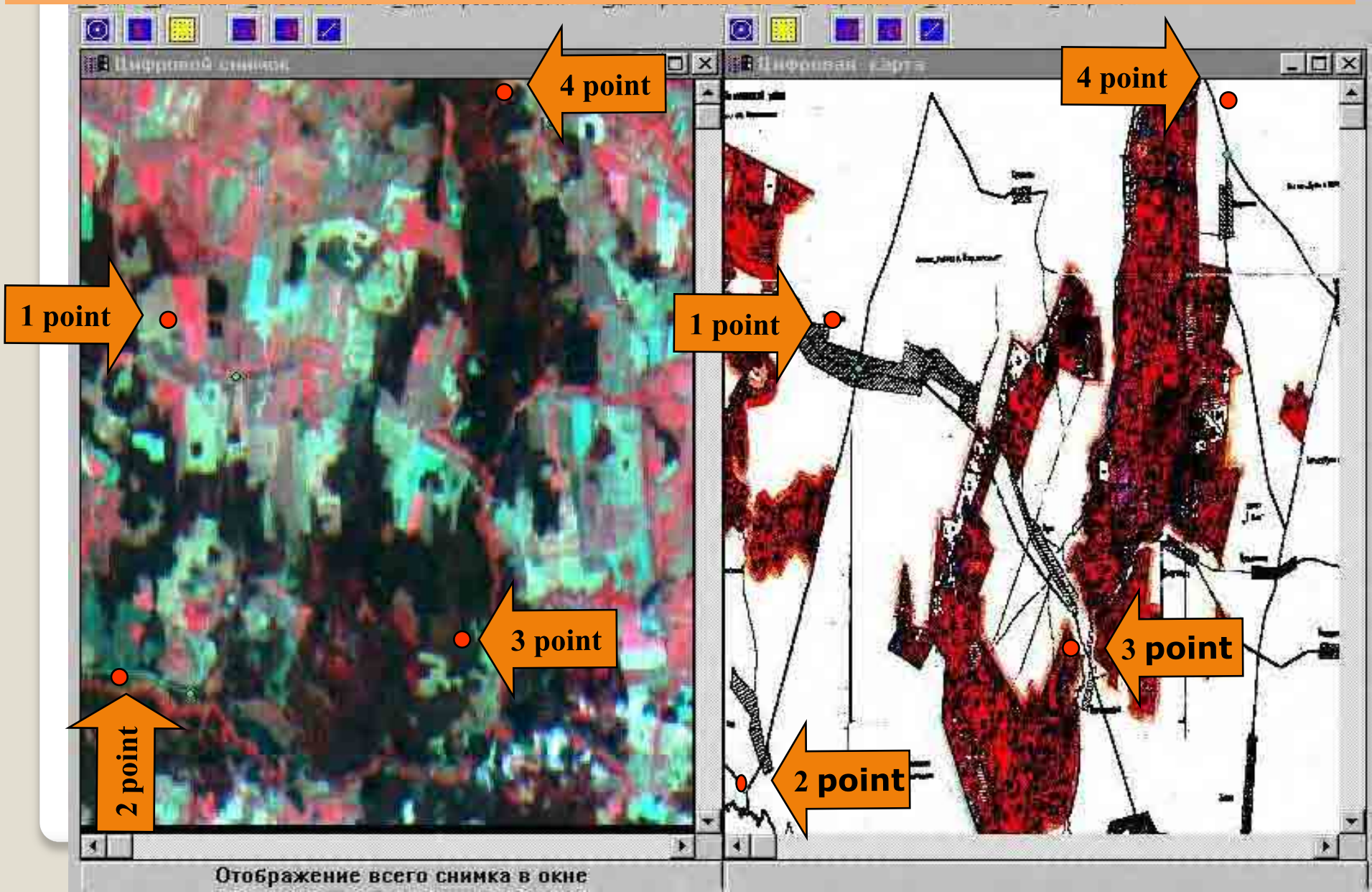






3 spectral channels

Images to map rectification



Monitoring forest resources

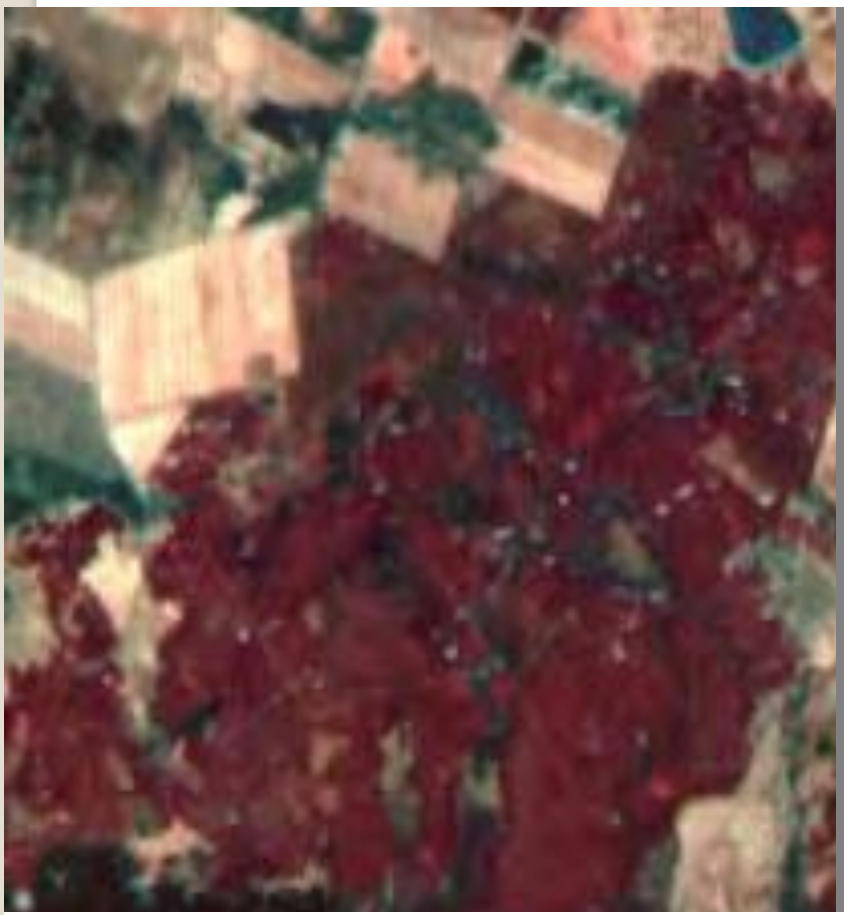
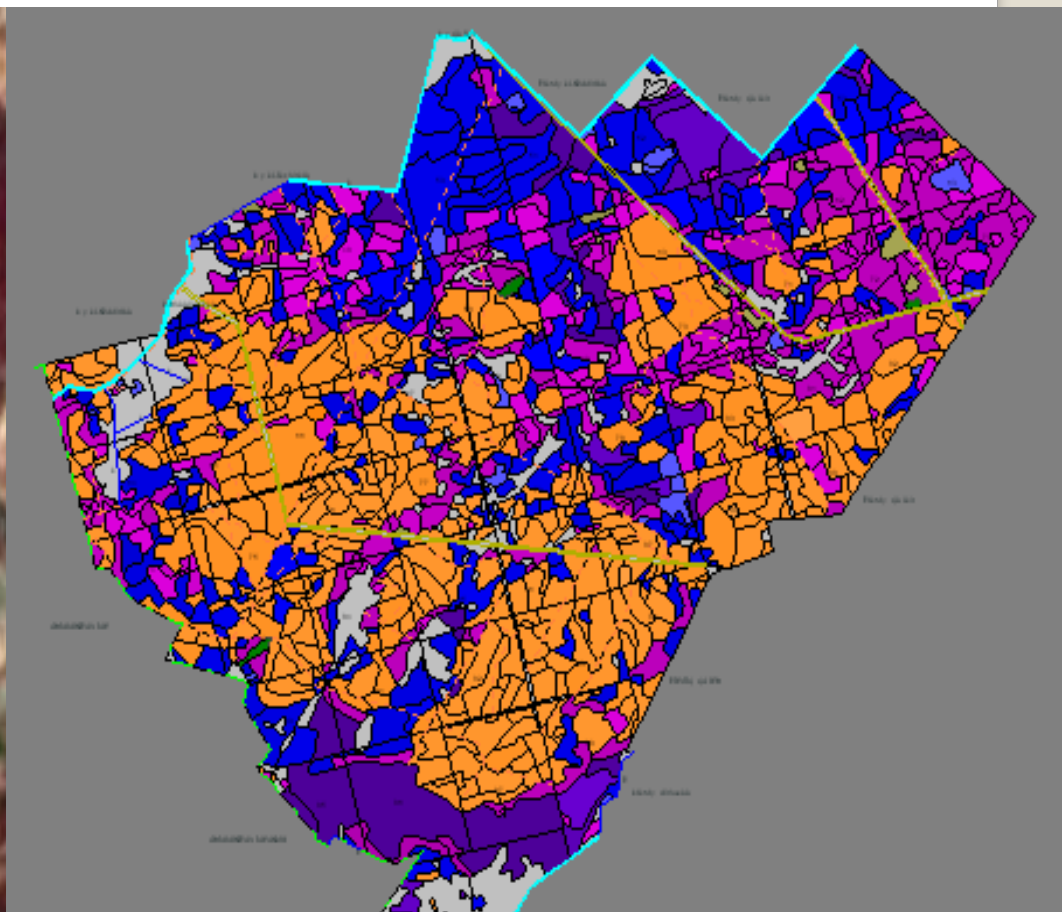
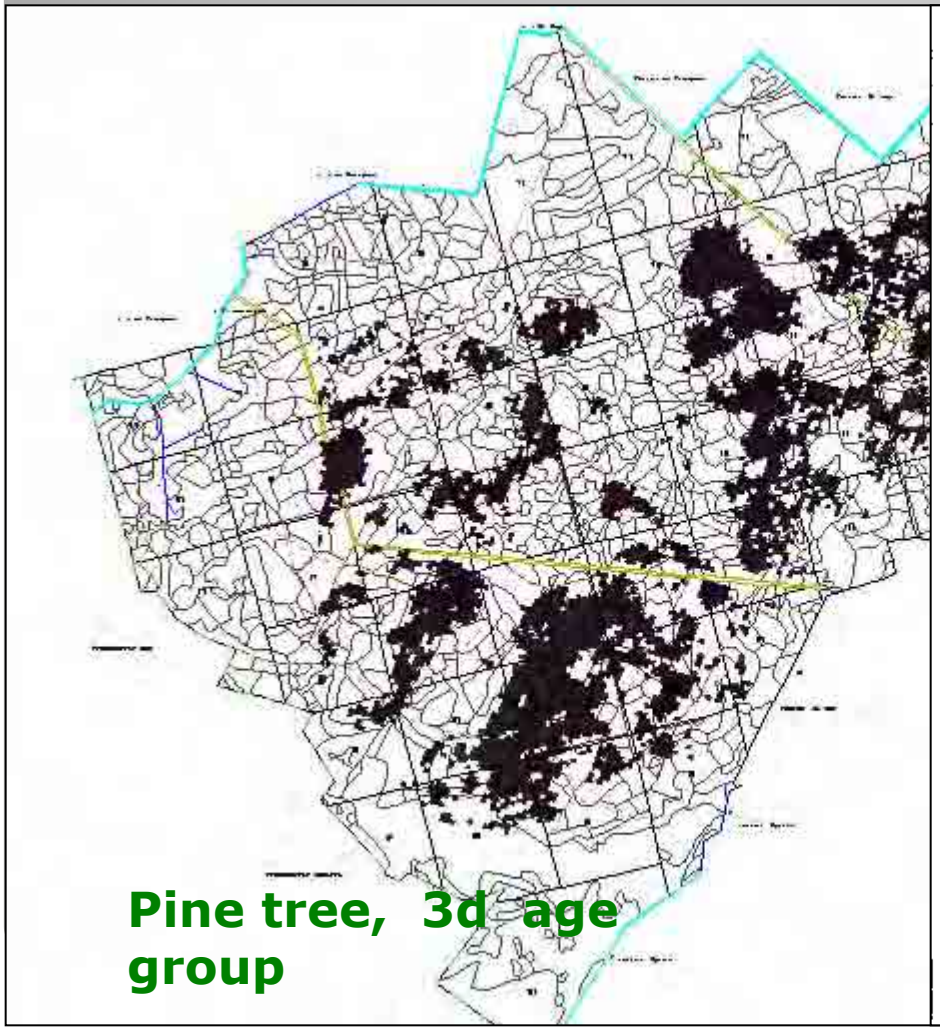


Image fragment of separate forest region

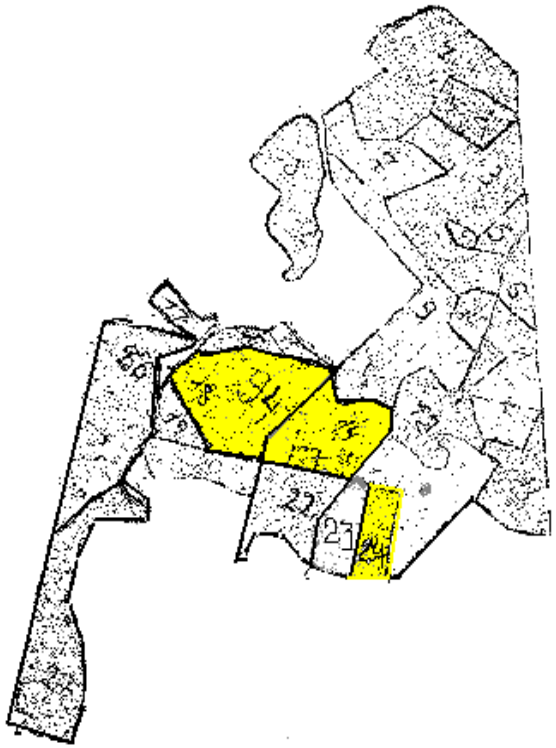


Digital map fragment of the same forest region

Classification of forest by wood species , its age and drying up



Pine tree, 3d age group

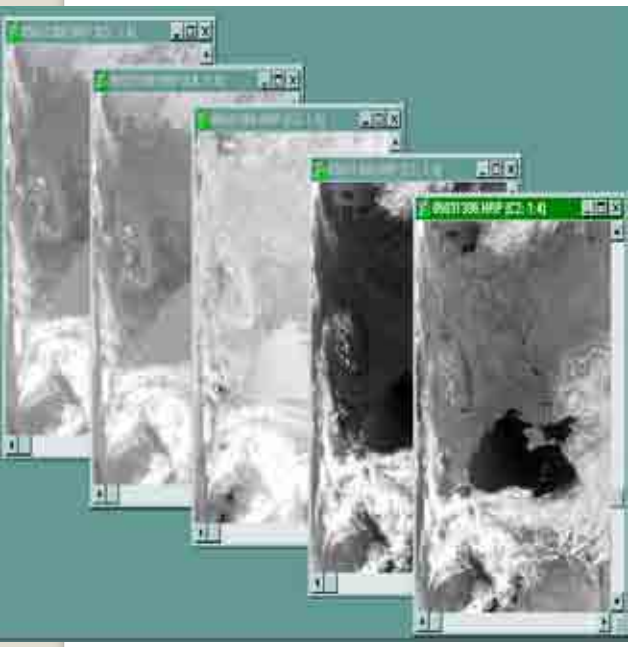


Area with drying fir tree

Technologies for identification of heat anomaly (forest and peat bog fire)

- ***acquisition and pre-processing of spectra-zone space images;***
- ***images to map rectification;***
- ***localization and identification of heat anomaly (like forest or peat fires) on the land surface;***
- ***plotting of thematic maps.***

Acquisition and pre-processing of spectra-zone space images

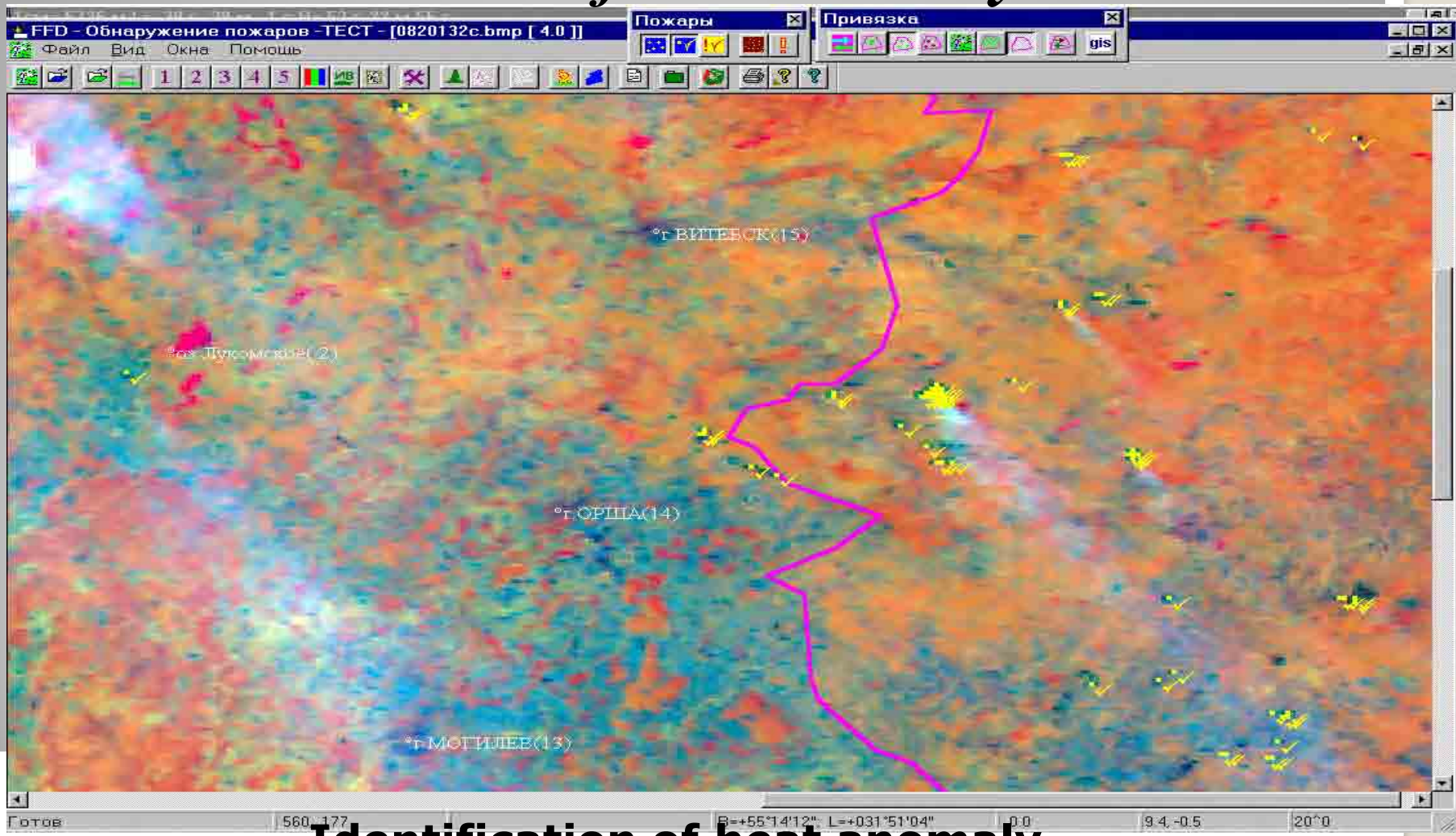


Spectral space image

Second spectral space channel date visualization

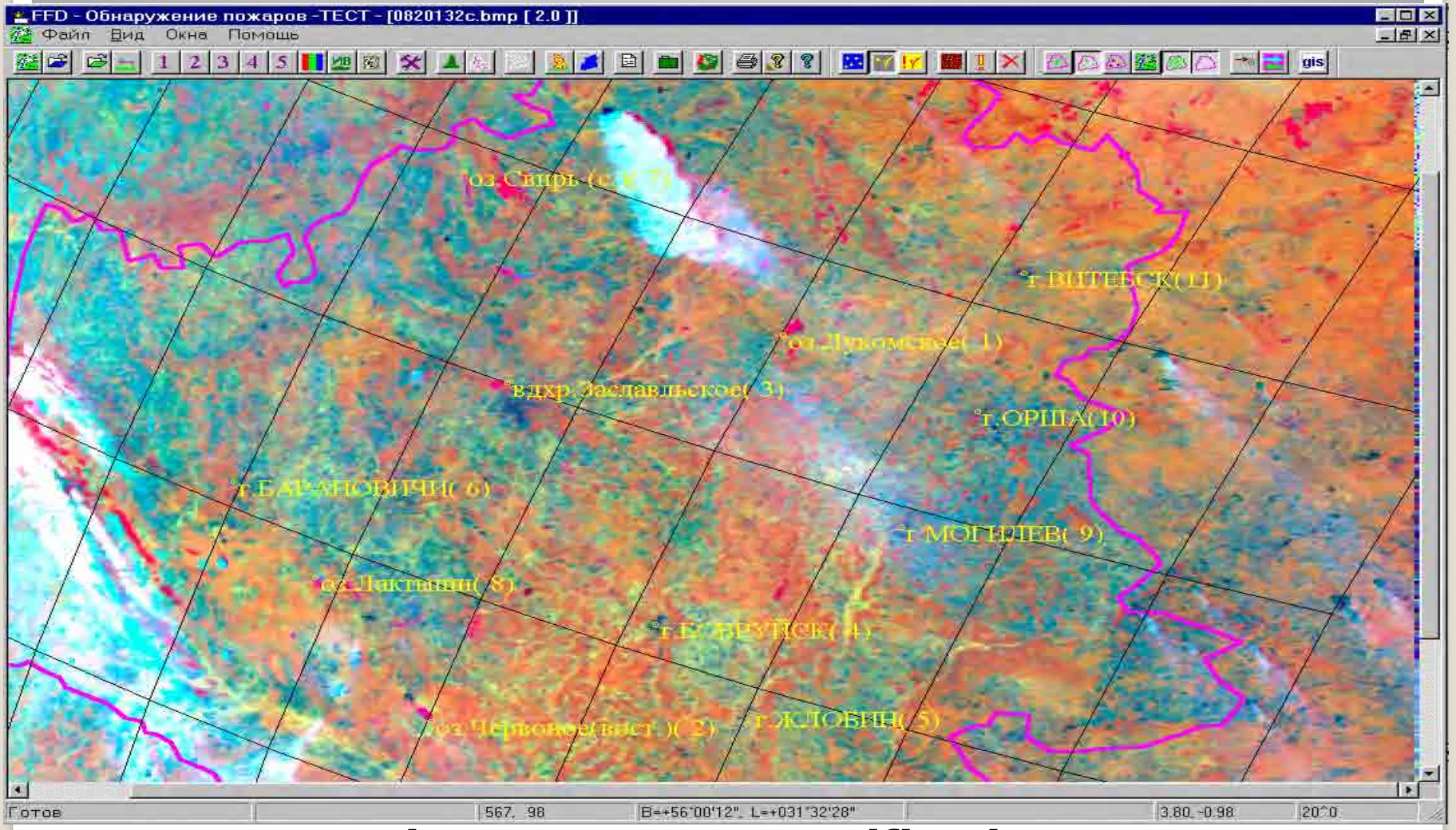
Color synthesized image

Localization and identification of heat anomaly



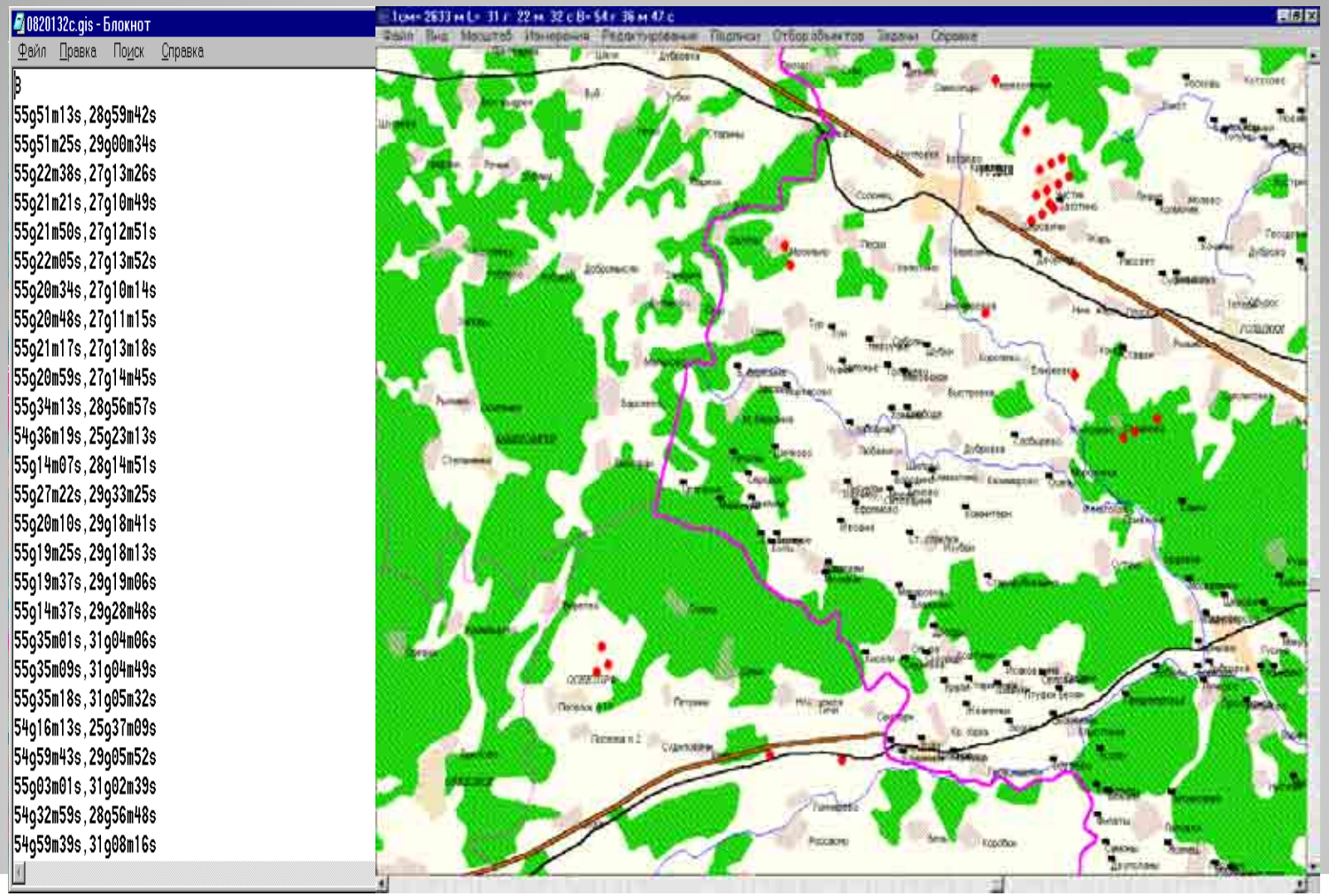
Identification of heat anomaly

Localization and identification of heat anomaly



images to map rectification

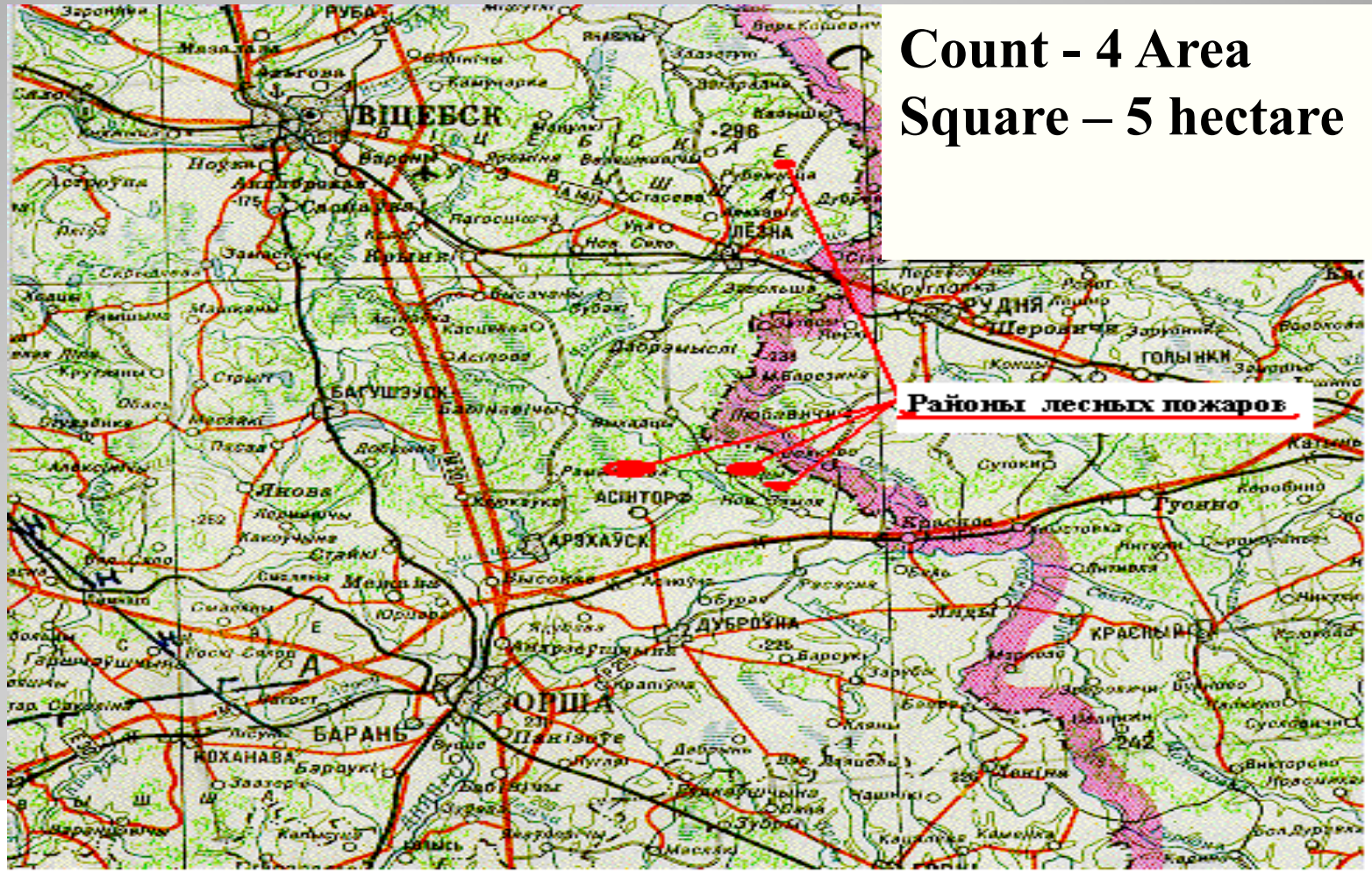
Plotting of thematic maps



Geographic coordinates of heat anomalies

Map fragments with the sources of heat anomalies

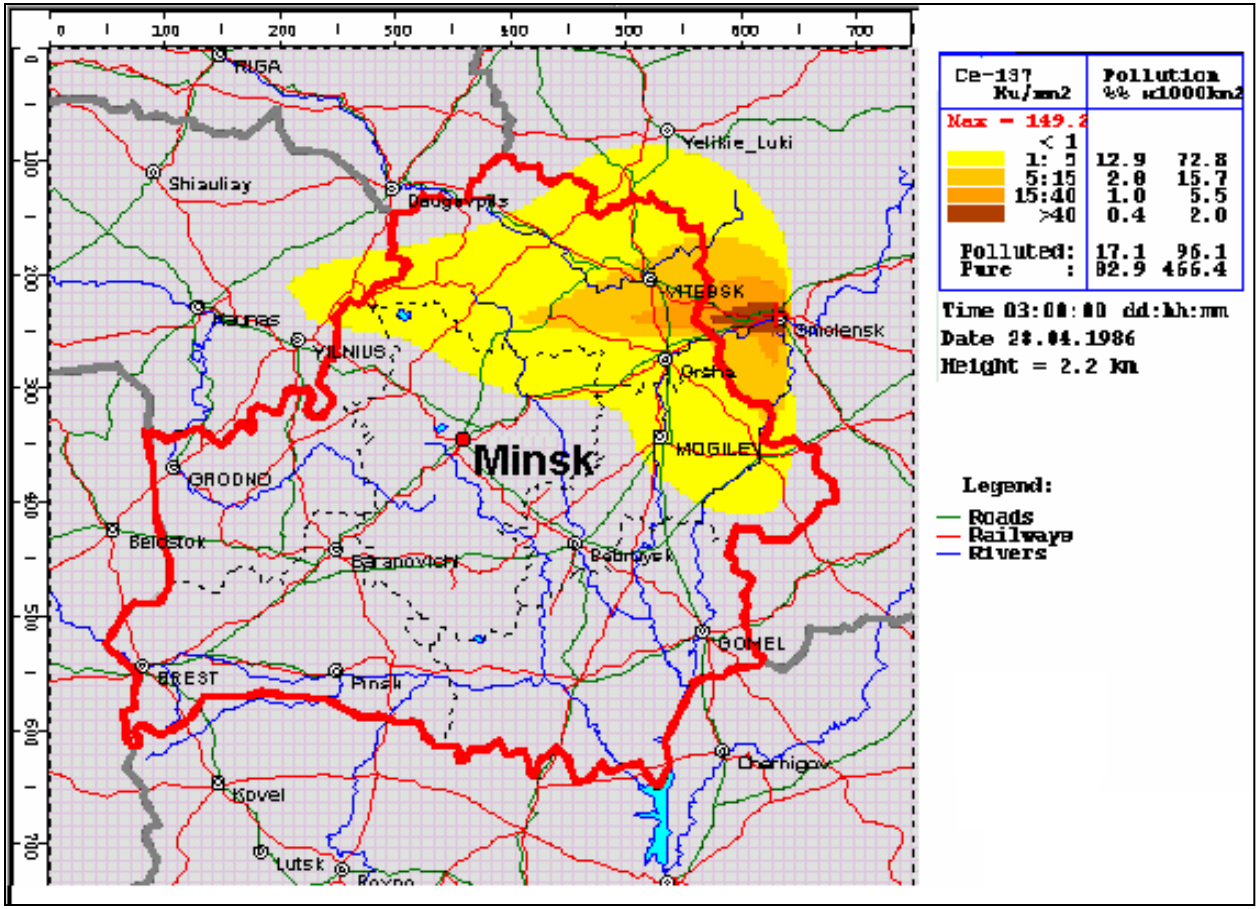
Overlay of heat anomaly into digital maps



Technology for wind transport of pollutants forecasting

The technology calculates the wind transport of pollutants released into the atmosphere as the result of natural or industrial accidents, fires, terror attacks, war actions and others. The species can be gaseous as firm or water aerosols, smokes and ash from the fires on the oil production. It could be chemical or radioactive origin. Forecast for three-five days is produced on local or regional levels as the map of pollution ground surface, pollution species concentration, and also as the tables, diagrams with numerical characteristics of pollution. After users option the "back trajectories" could be calculated to determine those zones the species moved from.

Technology for wind transport of pollutants forecasting



Hypothetic accident on Smolensk NPP (Russia), 28.04.86

A

Active crustal faults for control the seismic processes of the Soligorsk mining region

B

Soligorsk mining region

Impact of the solid salt waste on the Earth surface state

A

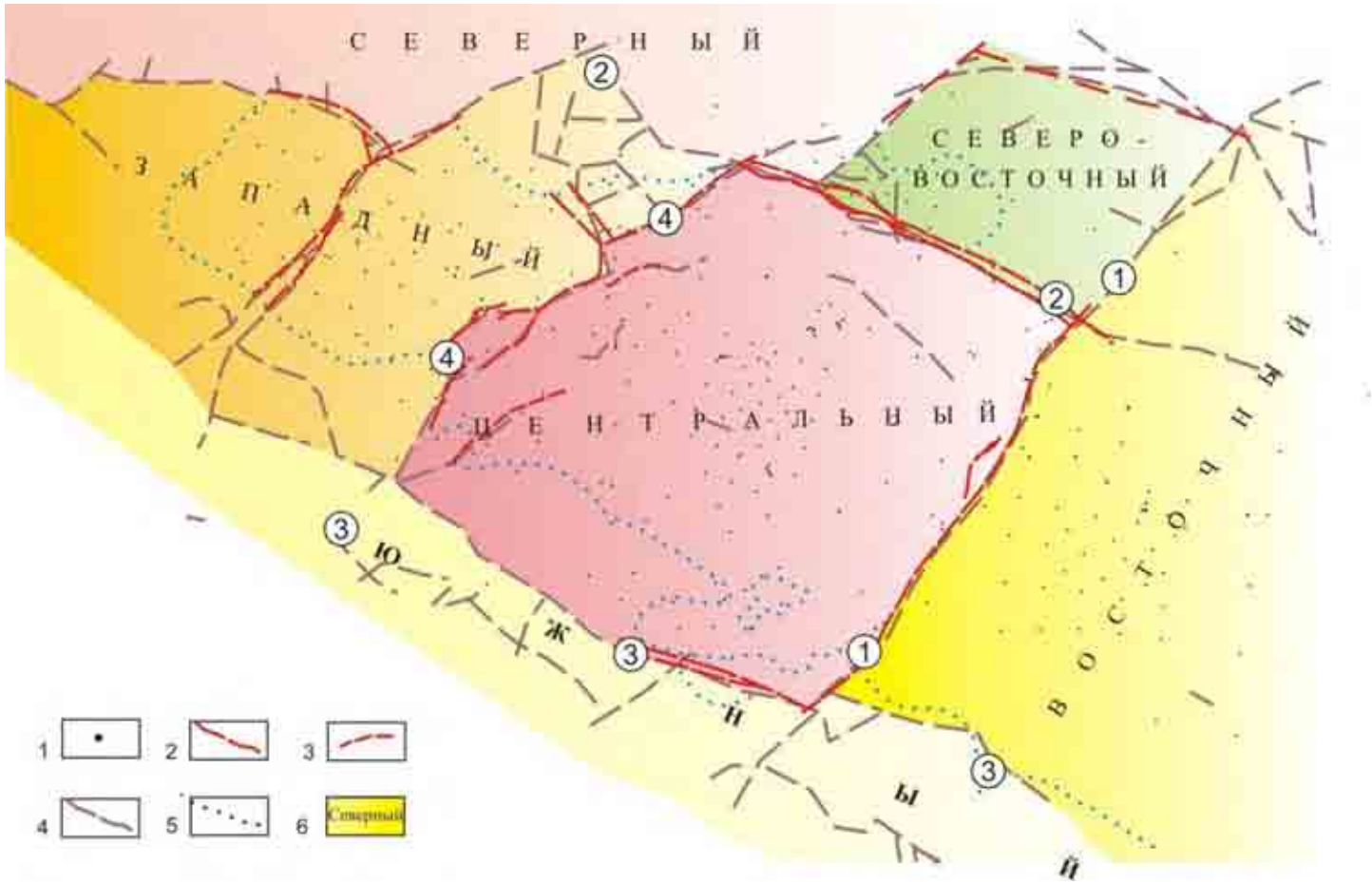
B

System of the active crustal faults that control the seismic processes of the Soligorsk mining region

A - satellite image of Starobin mining region
B - Satellite geodynamical model of Starobin centrocline of Pripyat Trough

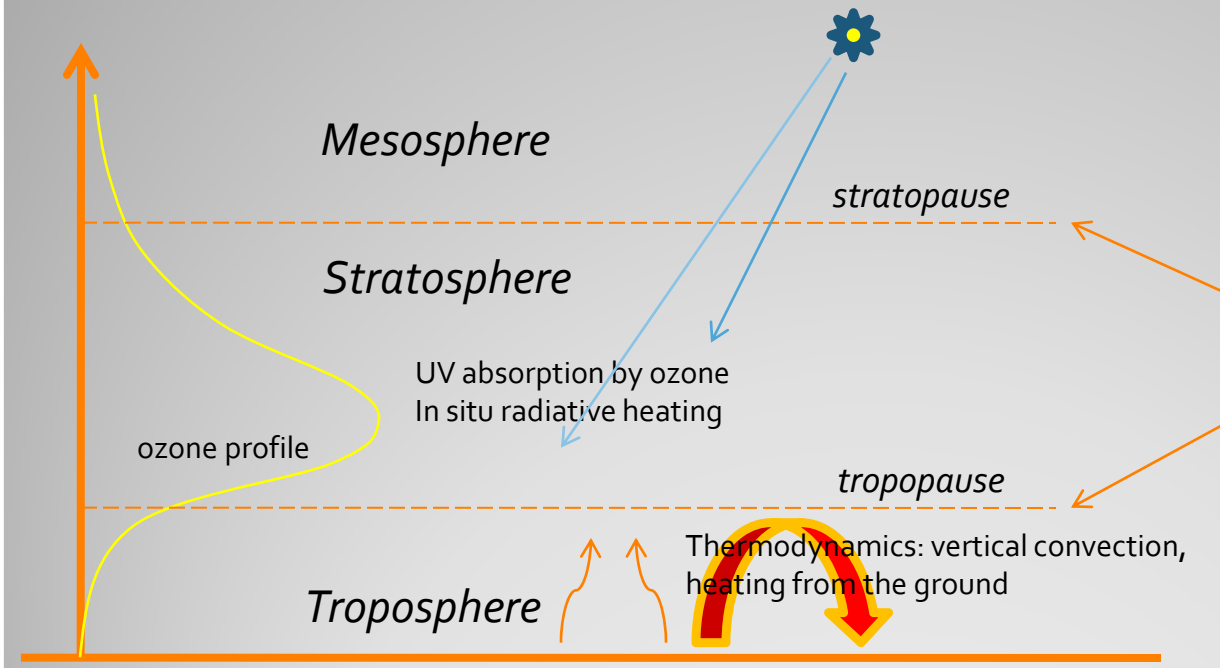
Structural scheme of Soligorsk mining region

Structural scheme of Soligorsk mining region



1 – скважины; 2-3 дизъюнктивные дислокации: 2 – основные по III к ; 3 – малоапмлитудные по III к;
4 – в подсолевых отложениях (ОГ «ПС»); 5 – границы выклинивания III к; 6 – тектонические блоки

Mesosphere-stratosphere-troposphere interactions
Influence of solar activity variations



The boundaries between the layers (stratopause & tropopause) originate from dynamical equilibrium between **in situ ozone radiative heating** in the stratosphere and rival processes in the troposphere and the mesosphere

Areas of our current research relating to satellite systems operation and the weather prediction:

1) Atmosphere influence on orbital dynamics of space-based systems.

2) Spaceborne remote sensing of the Earth atmosphere and surface, including the investigation of its optical characteristics in different spectral ranges (UV, visible, IR)

3) Climate (Global) and Mesoscale (Regional) weather prediction models designing and validation

4) Investigation of the Ozone Layer as an important factor of stratosphere and troposphere dynamics

5) Investigation of atmospheric NO_2 and aerosol components

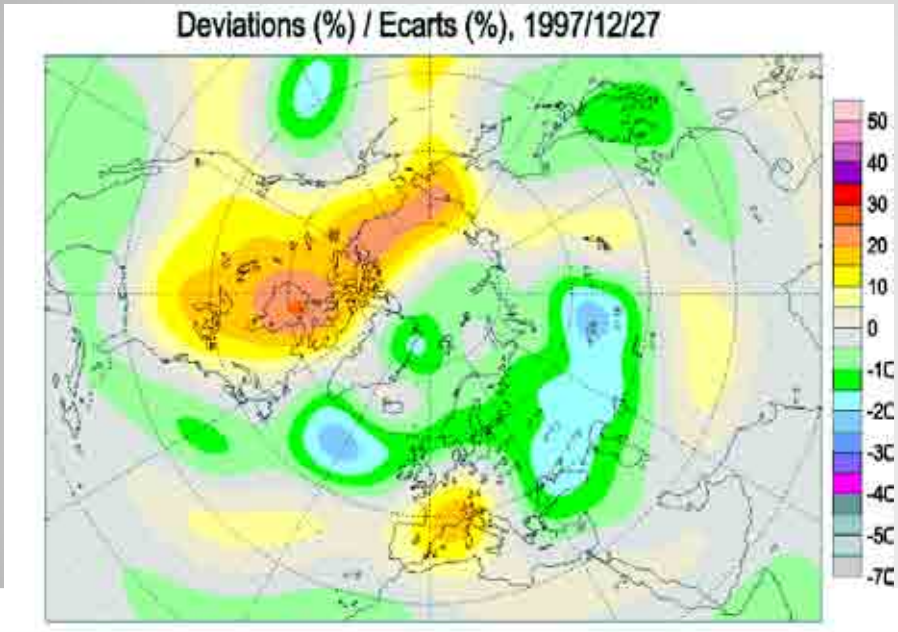
6) Investigation of the Earth UV Climate

I. Stratosphere-Troposphere Interactions: Dynamical anomalies in the stratospheric ozone field

Local anomalies – synoptic-scale deviations in the total ozone content (TOC)

- Local ozone anomalies are of a predominantly dynamical nature
- Their formation, evolution and decay evince subtle dynamical processes, related to stratosphere-troposphere interactions

Example case study:
the deepest "ozone mini-hole" (negative anomaly) over Central and Eastern Europe



Environment Canada, compiled from observational data

Available data:

1. Ozone satellite observations (global coverage)
2. Ground-based ozone observations (points)
3. Model-based reanalysis (assimilation of satellite and/or ground-based observations in a numerical model)

main effort:

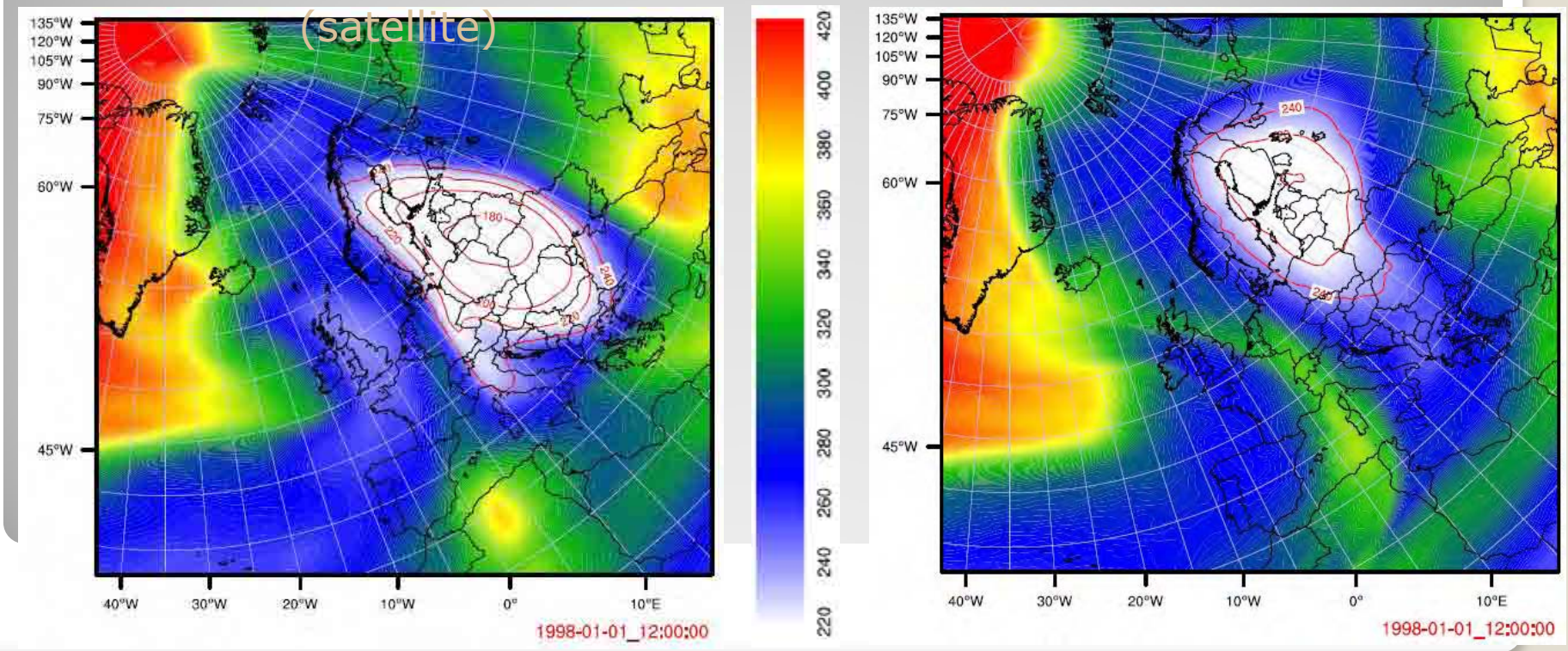
- Modelling of ozone anomalies formation, evolution and decay

Ozone anomalies modelling

- Aim: to simulate with high spatial resolution dynamical and radiative processes in all the troposphere and the stratosphere and lower mesosphere
- For that purpose, a modified WRF-Chem modelling system is used, which is based on the state-of-the-art, fully nonhydrostatic mesoscale atmospheric model Weather Research & Forecasting (WRF)

ERA-Interim reanalysis (satellite)

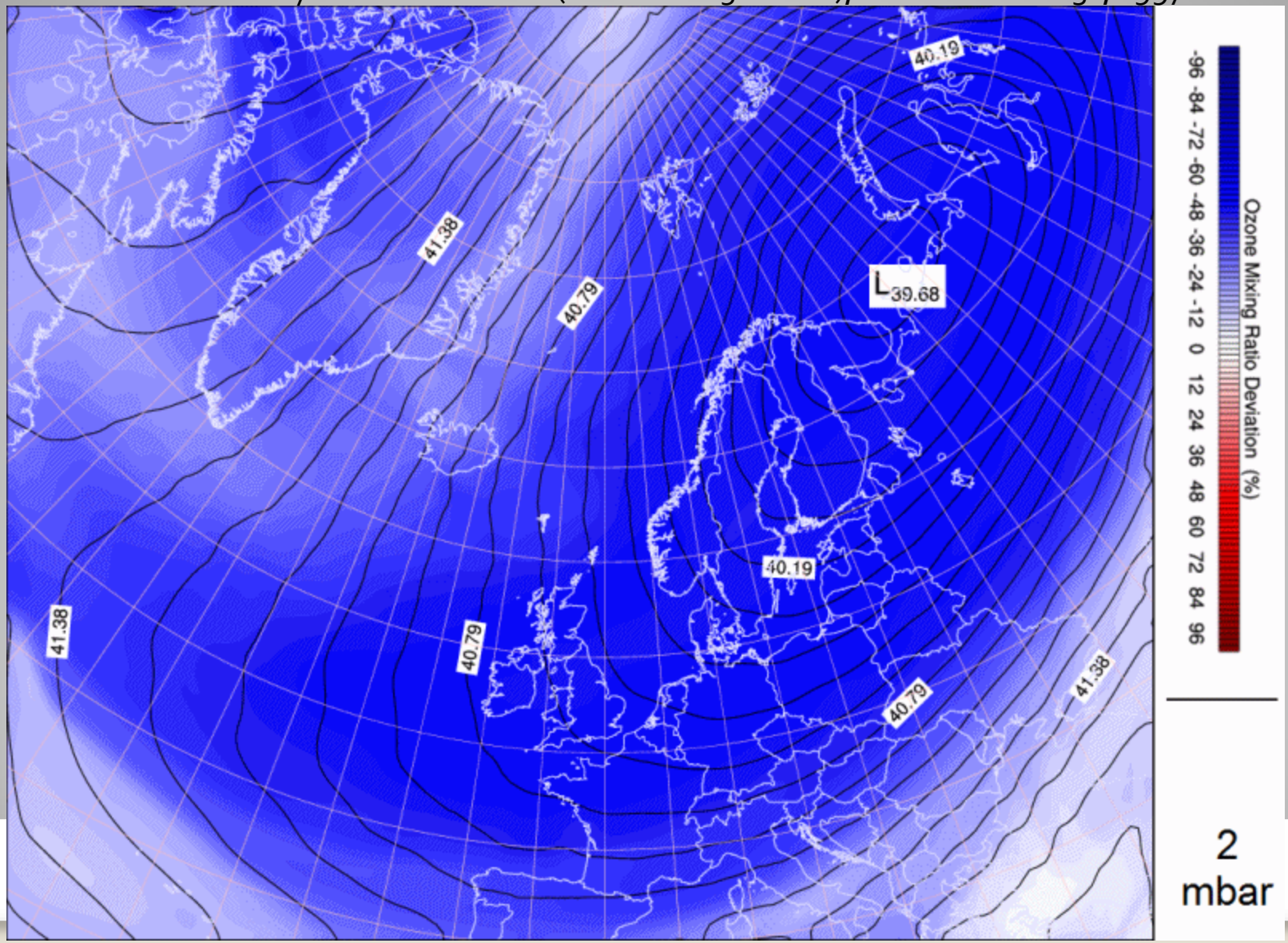
WRF-Chem



TOC field (Dobson units, DU), on 1998-01-01, 12UTC

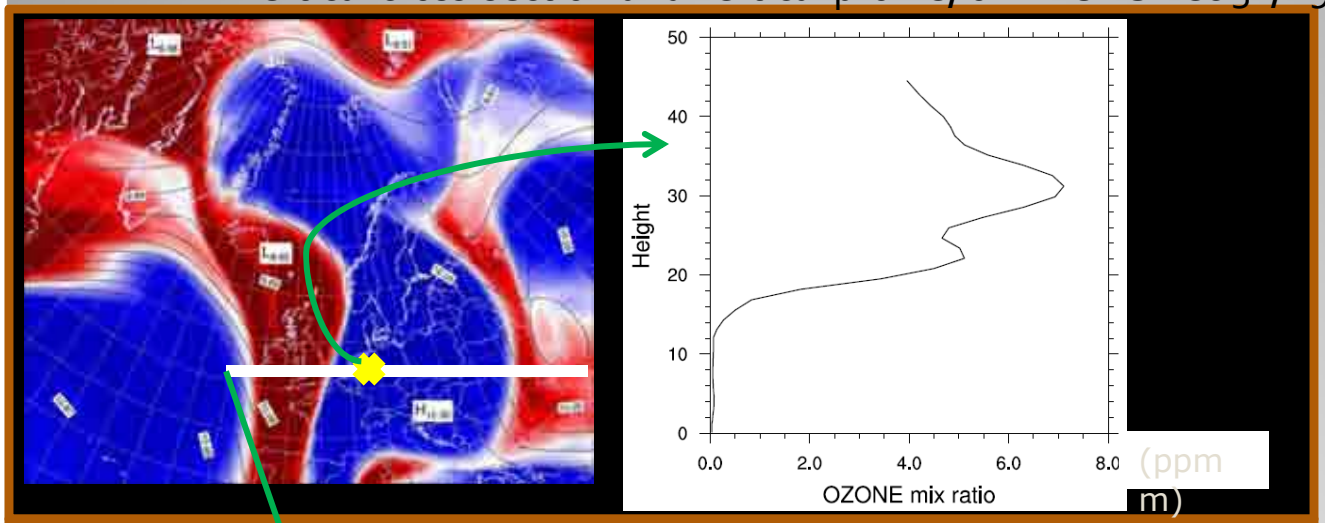
Structure of the 1997-1998 local ozone anomaly (mini-hole)

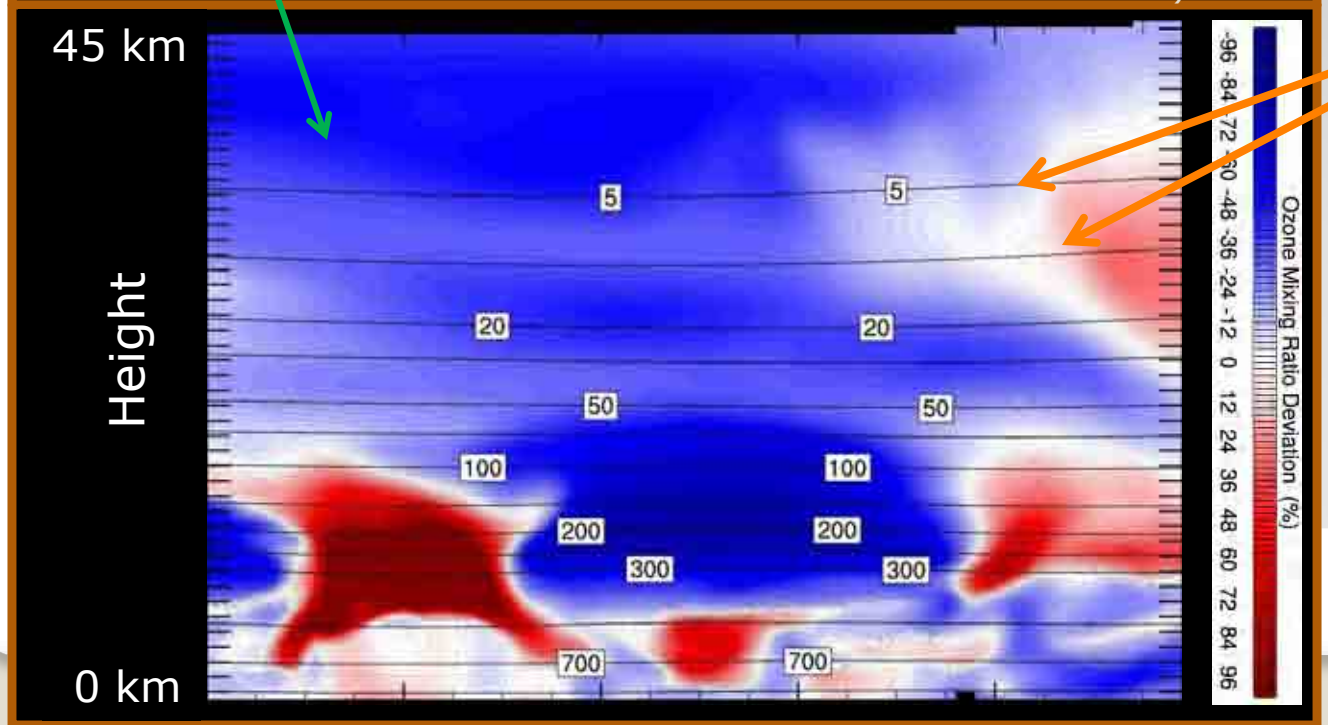
•cross-sections by isobaric surfaces (from 2 to 650 mbar), on 12 UTC Dec 31, 1997



Structure of the 1997-1998 local ozone anomaly (mini-hole)

- vertical cross-section and vertical profile, on 12 UTC Dec 31, 1997





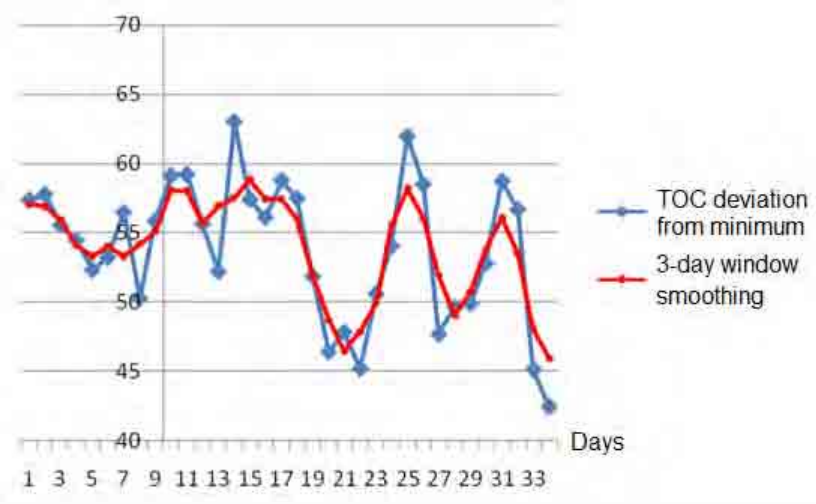
Isobaric surfaces (mbar)

II. Mesosphere-stratosphere interactions
Influence of solar activity

- In the second part of the study, it is planned to use a global modelling system (e.g., CAM-CESM with SD-WACCM physics and chemistry parameterization) to perform simulations with the whole mesosphere, stratosphere and troposphere.
- Modelling will be carried out aiming to investigate in detail the processes of mesosphere-stratosphere interactions, influence of stratospheric ozone distribution on the stratopause height patterns and mesospheric parameters.

- Special attention will also be paid to the influence of solar activity. While it is still a planned work for the second phase of this study, some results from various statistical analysis of the connection between solar proton events and total ozone content fluctuations were already obtained in the NOMREC BSU in the course of a previous project

Solar activity (proton events) influence on stratospheric ozone



• An impact of solar activity (e.g. proton events) on the upper layers of the atmosphere is propagated to mesosphere and lower layers via several different mechanisms, ozone mechanism being one of the most important

•TOC field have been shown to oscillate for several days after a solar proton event occurs

Belarusian State University - the leading educational center in Belarus, founded in October 30, 1921

1 November 1921,1390 students started attending classes in its three faculties: labor, medical and social sciences. Only 14 professors and 25 candidates of sciences (Ph.D) were among first lecturers.

BSU today

- 20 faculties and educational institutes
- lyceum
- college
- 3 scientific-experimental stations
- 3 museums
- 4 scientific-research institutes
- 115 scientific-research laboratories
- 25 scientific centers
- 10 unitary enterprises

BSU today

University staff:
8680 staff members, including:
- 2477 lecturers
- 1900 researchers and research engineers

Lecturers:
- 6 academicians of the National Academy of Science of Belarus
- 7 corresponding member of the National Academy of Science of Belarus
- 291 doctors of science
- 1350 candidates of science

Participation of BSU in USSR, Russia and international space

Mir project (USSR)

Venera project (USSR)

Buran-Energia project (USSR)

International Space Station

Photospectral system «ФСС», 2000 – today (ISS)

Designed to research reflected emission spectrum from underlying terrain and to obtain visible photographic image on board
ISS -1 - ISS -24 (experiment «Ураган»).

ФОТОСПЕКТРАЛЬНАЯ СИСТЕМА ФСС

(создана НИИПФП им. А.Н.Севченко БГУ по контракту с РКК «Энергия»)

предназначена для проведения измерений спектров отраженного излучения подстилающих поверхностей в диапазоне длин волн от 350 до 1050 нм и фотоизображений в видимом диапазоне длин волн на Российском сегменте Международной космической станции в (экспериментальная отработка наземно-космической системы мониторинга и прогноза развития природных и техногенных катастроф)

В июле, августе ОАО РКК «Энергия» были проведены летно-космические испытания ФСС. Целью этих испытаний была проверка работоспособности ФСС и отработка различных режимов съемки космонавтом в рамках космического эксперимента «Ураган».

ЮРЧИХИН
Федор Николаевич

СКВОРЦОВ
Александр Александрович

С борта РС МКС космонавтами А.А. Скворцовым и Ф.Н. Юрчихиным в ходе первых включений научной аппаратуры ФСС получены первые результаты съемок земной поверхности. На основании полученных результатов проведен анализ работы аппаратуры ФСС в различных режимах.

14 июля 2010 г. был проведен трехуровневый подспутниковый эксперимент по съемкам объекта «Кольцевая структура» (обвалованное песчаным кольцом озеро в Гомельской области, РБ).

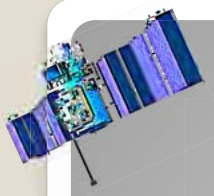
БЛОК ВНЕШНИХ ДАТЧИКОВ БВД

научной аппаратуры "Фотон-Гамма" для эксперимента "Молния-Гамма"

(разработка НИИПФП им. А.Н.Севченко БГУ совместно с ИЗМИРАН)

Транспортным кораблем «Прогресс» БВД в октябре 2010 г. доставлен на борт РС МКС.

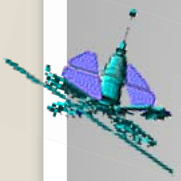
16 февраля 2011 г. российские космонавты Дмитрий Кондратьев и Олег Скрипочка во время выхода в открытый космос установили БВД на внешней поверхности модуля «Звезда» российского сегмента Международной космической станции.



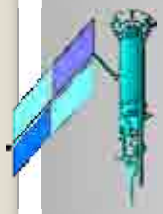
BSU aerospace educational center: structure, research and development

Main aims:

- To develop it into authorized center in the fields of GIS technologies and monitoring (ESRI, ERDAS, Leika products);

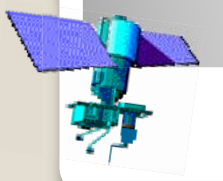


- Providing the process of training specialists in remote sensing data reception and processing with educational programs;

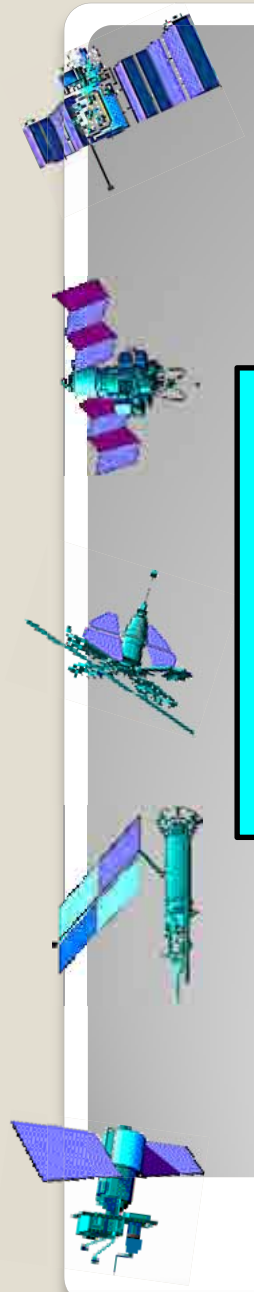


- Receiving and processing of remote sensing data;

- Working within the Belarusian Earth remote sensing space system corporate network;



- Development new scientific experiments and equipments.



REMOTE SENSING

Development Ground station equipments

Development new methods and software

Receiving and processing of remote sensing data

EDUCATION

Educational and methodical support for the Universities

Development Aerospace courses

Aerospace training courses

BSU AEROSPACE EDUCATIONAL CENTER

Development and launching microsatellie

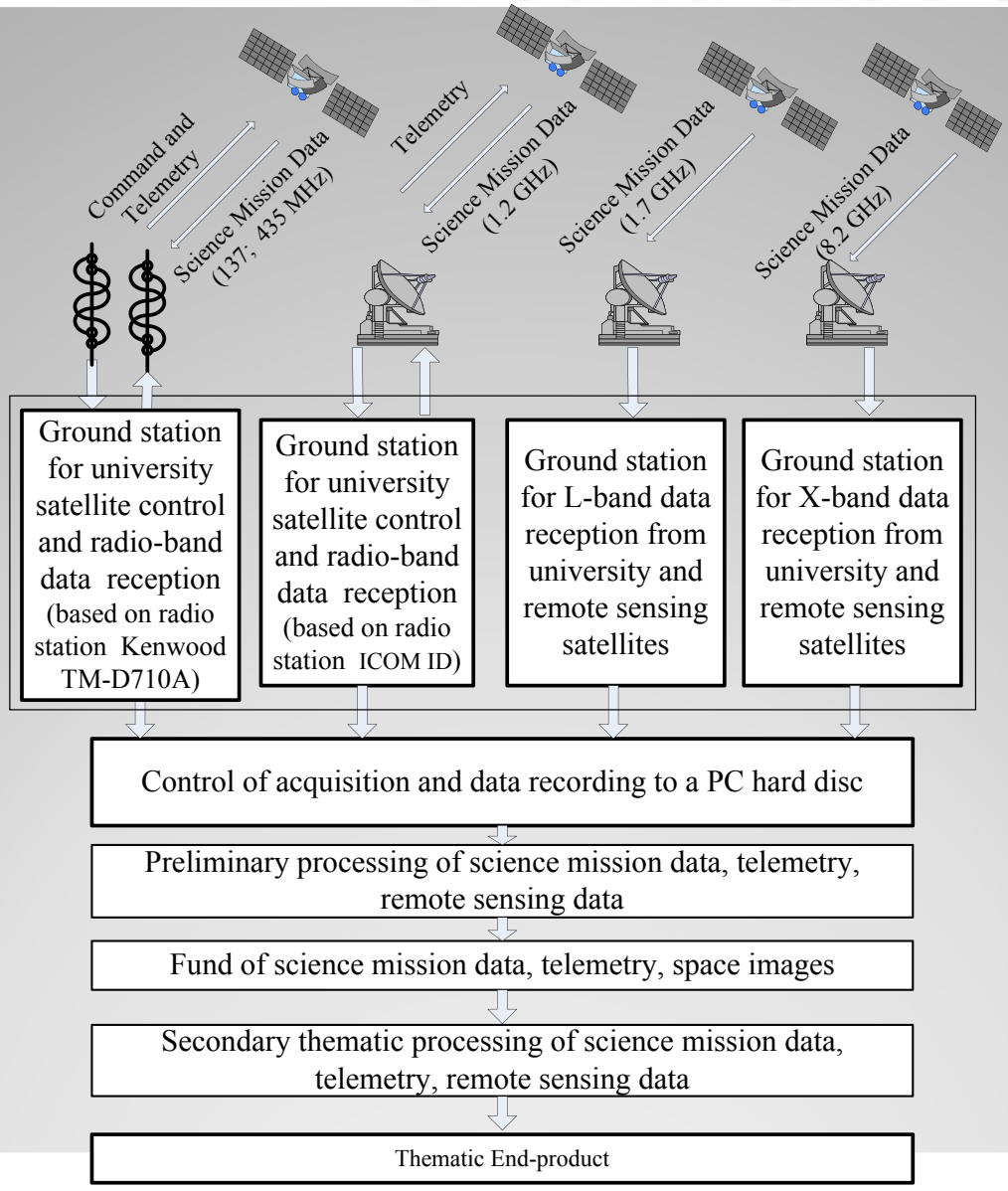
Development new scientific experiments

Development new scientific equipments

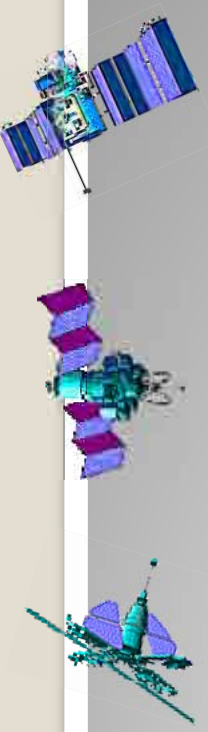
Experimental data and telemetry processing and analyzing

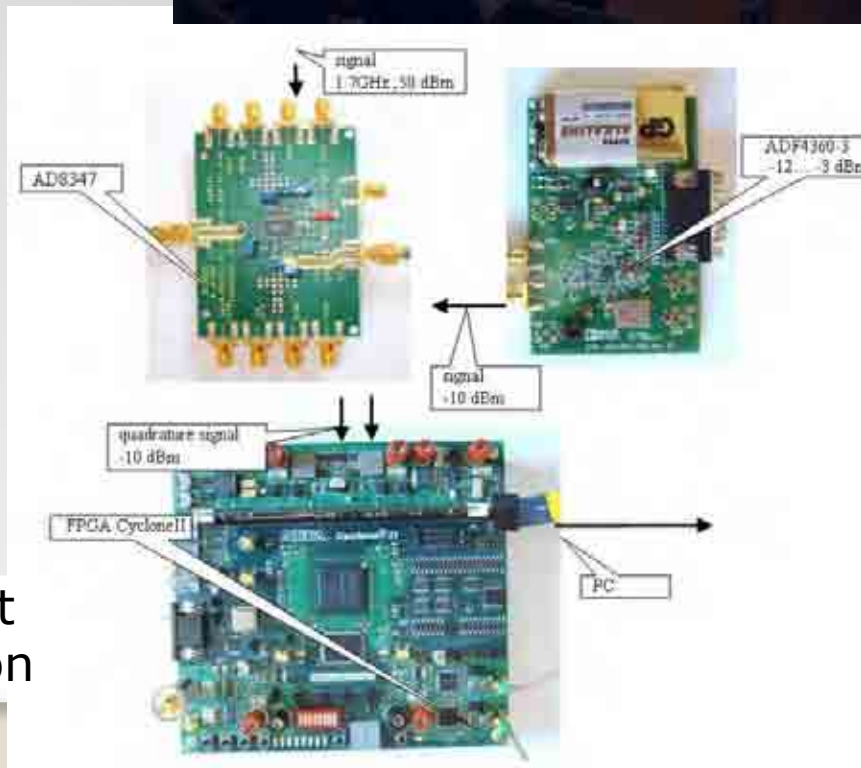
UNIVERSITY MICROSATELLITE

Ground station



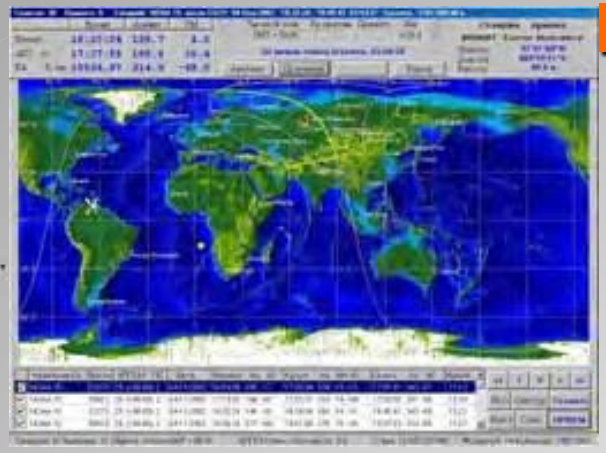
Ground station for L-band data reception from university and remote



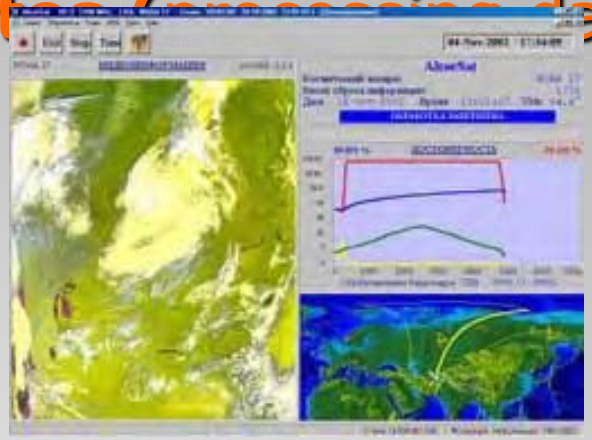


Development
Ground station
equipments

Ground station for L-band data reception from university and remote sensing

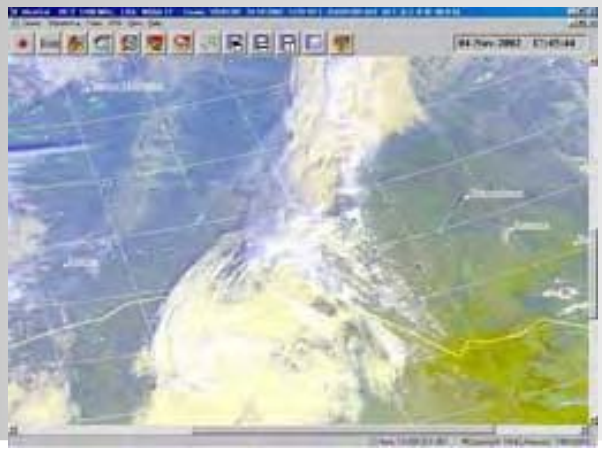


Control of acquisition

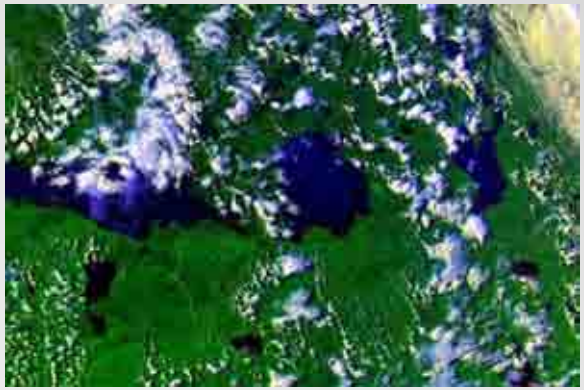


Decoding information

AVHRR image from NOAA-19



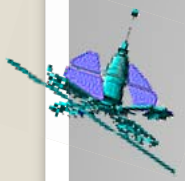
Visualisation and preliminary processing



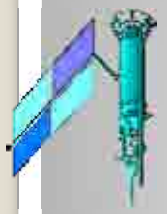
FengYun-1D image, CHRPT format

Aerospace Education in BSU

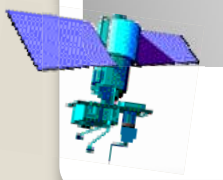
2008 г. – BSU aerospace educational center was opened.

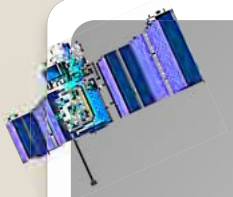


2009 – new specialization **“Satellite information systems and technologies” was opened.**



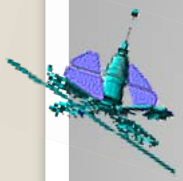
2010 – new speciality **“Aerospace radio electronics and information systems and technologies”.**



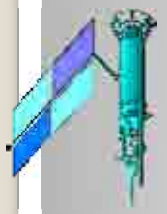


BSU University microsatellite (Project)

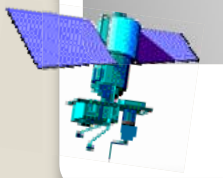
BSU University microsatellite will be intended for solving applied, scientific and educational issues as well as training students of BSU and other universities in control methods of spacecrafts and information processing out of space.



The project will be developed in collaboration with the Universities and the Institutes of Russia, Ukraine and Europe.



The main purpose of the experiment is study of interaction of the atmospere, ionospere and magnetosphere of the Earth by means of the orbital detectors.



Thank you!