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RUSSIAN EARTH OBSERVATION SYSTEM

THE RUSSIAN EARTH OBSERVATION SATELLITE CONSTELLATION

Russian orbital group of remote sensing provides information support for a widerange of applications in various areas of economic activity.

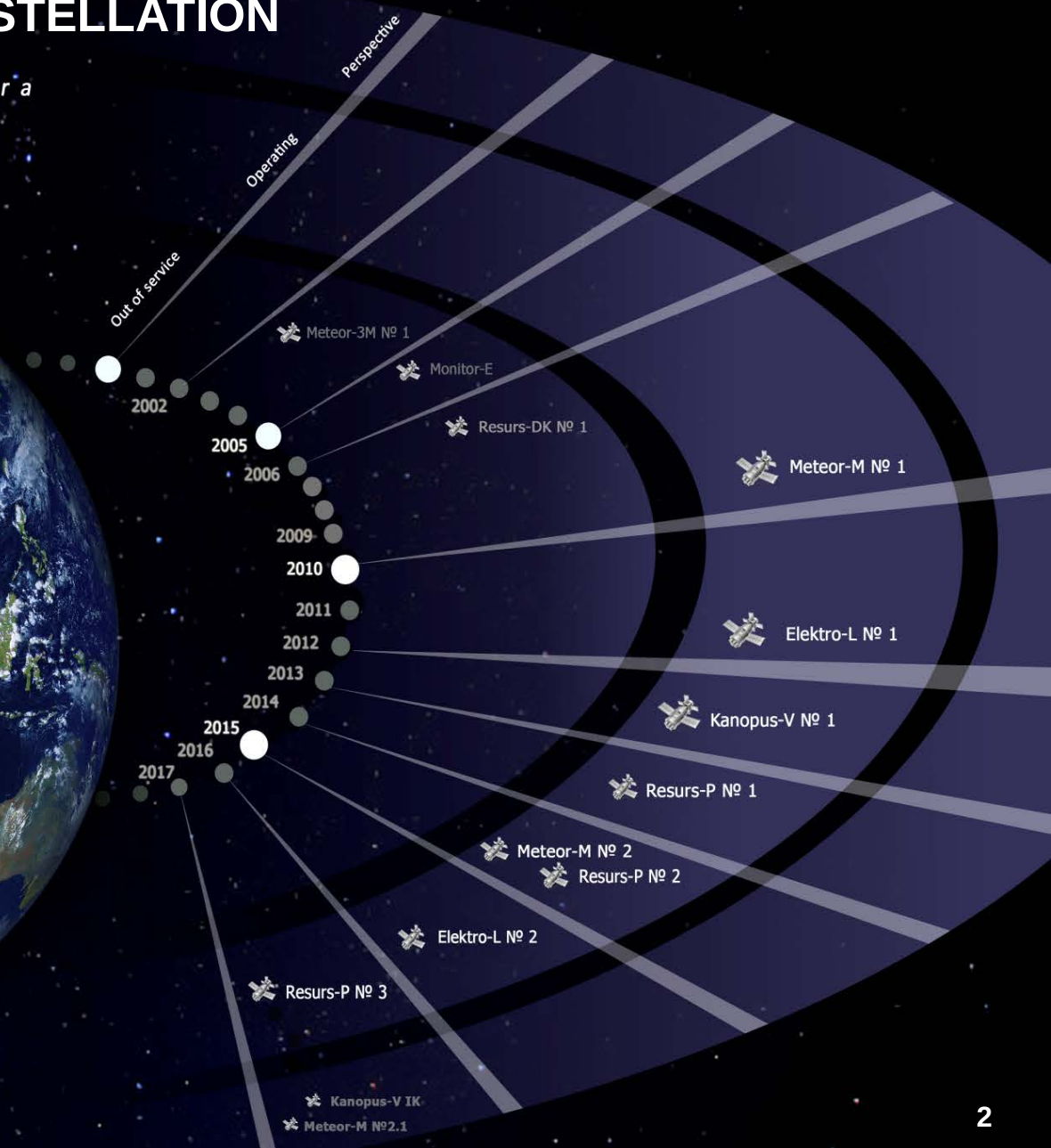
Russian orbital group includes 8 satellites:

Resurs-P 1
Resurs-P 2
Resurs-P 3

Kanopus-V 1

Meteor-M 1
Meteor-M 2

Elektro-L 1
Elektro-L 2



INFORMATION CAPABILITIES OF RUSSIAN EARTH OBSERVATION SATELLITE CONSTELLATION

Satellite / Characteristics	Resurs-DK	Resurs-P				Kanopus-V		Meteor-M			Electro-L
Launch Date (dd-mm-yyyy)	15.06.2006 (archive only)	25.06.2013 (Resurs-P1) 26.12.2014 (Resurs-P2) 13.03.2016 (Resurs-P3)				22.07.2012		17.09.2009 (Meteor-M1) 08.07.2014 (Meteor-M2)			20.01.2011 (1) 11.12.2015 (2)
Active Lifetime (years)	3	5				5…7		5			10
Instrument	Geoton	Geoton	GSA	ShMSA		PSS	MSS	KMSS*		MSU-MR*	MSU-GS*
				VR	SR*			MSU-50*	MSU-100*		
Swath Width (km)	28 / 16**	38	25	97	441	23	20	900	900	2800	Entire disk of the Earth
Spatial Resolution (m): • Panchromatic (PAN) • Multispectral (MS)	1 / 3** 2–3 / 3–5**	1 3	– 30	12 23.8	60 120	2.1 –	– 12	– 60	– 120	– 1000	VIS – 1000, IR – 4000
Spectral Bands	4	6	96-255	6	6	1	4	3	3	6	10
Revisit Period (days)	6–10	3–4						1–3			15–30 minutes

* Open access data; ** Before / after September 2011

Satellite / Thematic Tasks	Cartography	Ecological Monitoring	Infrastructure Object Monitoring	Environmental Management	Natural Resources Monitoring	Monitoring of Man-Made and Natural Disasters
Resurs-DK	1:10,000 and smaller	+	+	+	+	+
Resurs-P	1:10,000 and smaller	+	+	+	+	+
Kanopus-V	1:25,000 and smaller	+	+	+	+	+
Meteor-M	1:500,000 and smaller	+	–	+	–	+
Electro-L	–	–	–	+	–	Large-scale +

RESURS-DK

MISSION PURPOSE

Near real-time acquiring of highly informative data in visible and near-IR spectral range for ecological monitoring, natural resources inventory, mineral exploration, and mapping

Launch date – June 15, 2006

ONBOARD INSTRUMENT

Highly Detailed-Resolution Optical Camera [Geoton]

Resolution PAN (0.58-0.80μm)	– 1m / 3m*
Resolution MS (3 bands, 0.5-0.8μm)	– 2-3m / 3-5m*
Swath width	– 28km / 16km*

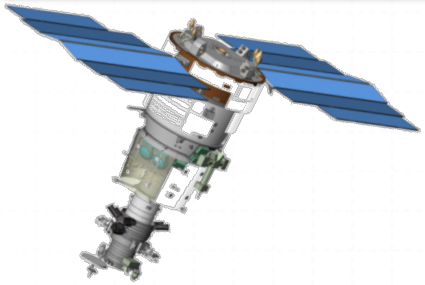
CURRENT TASKS

- Inventory of natural resources, topographic and thematic mapping
- Monitoring of the biosphere pollution sources;
- Monitoring of emergencies
- Research activities

RESURS-P

MISSION PURPOSE

Near real-time acquiring of highly informative data in visible and near-IR spectral range for ecological monitoring, natural resources inventory, mineral exploration, and mapping



Launch date – 25 June, 2013 (Resurs-P1)
26 December, 2014 (Resurs-P2)
13 March 2016 (Resurs-P3)

CURRENT TASKS

- Maps creation and update (scale 1:10,000 and smaller)
- Environmental ecological monitoring
- Operational emergencies monitoring
- Respond to agriculture and forestry challenges
- Socio-economic infrastructure monitoring

ONBOARD INSTRUMENTS

Highly Detailed-Resolution Optical Camera [Geoton]

Resolution PAN (0.58-0.80μm)	– 0.9m
Resolution MS (5 bands, 0.45-0.90μm)	– 3m
Swath width	– 38km

2 Wide-Swath Optical Cameras [ShMSA]

High Resolution Camera [ShMSA-VR]

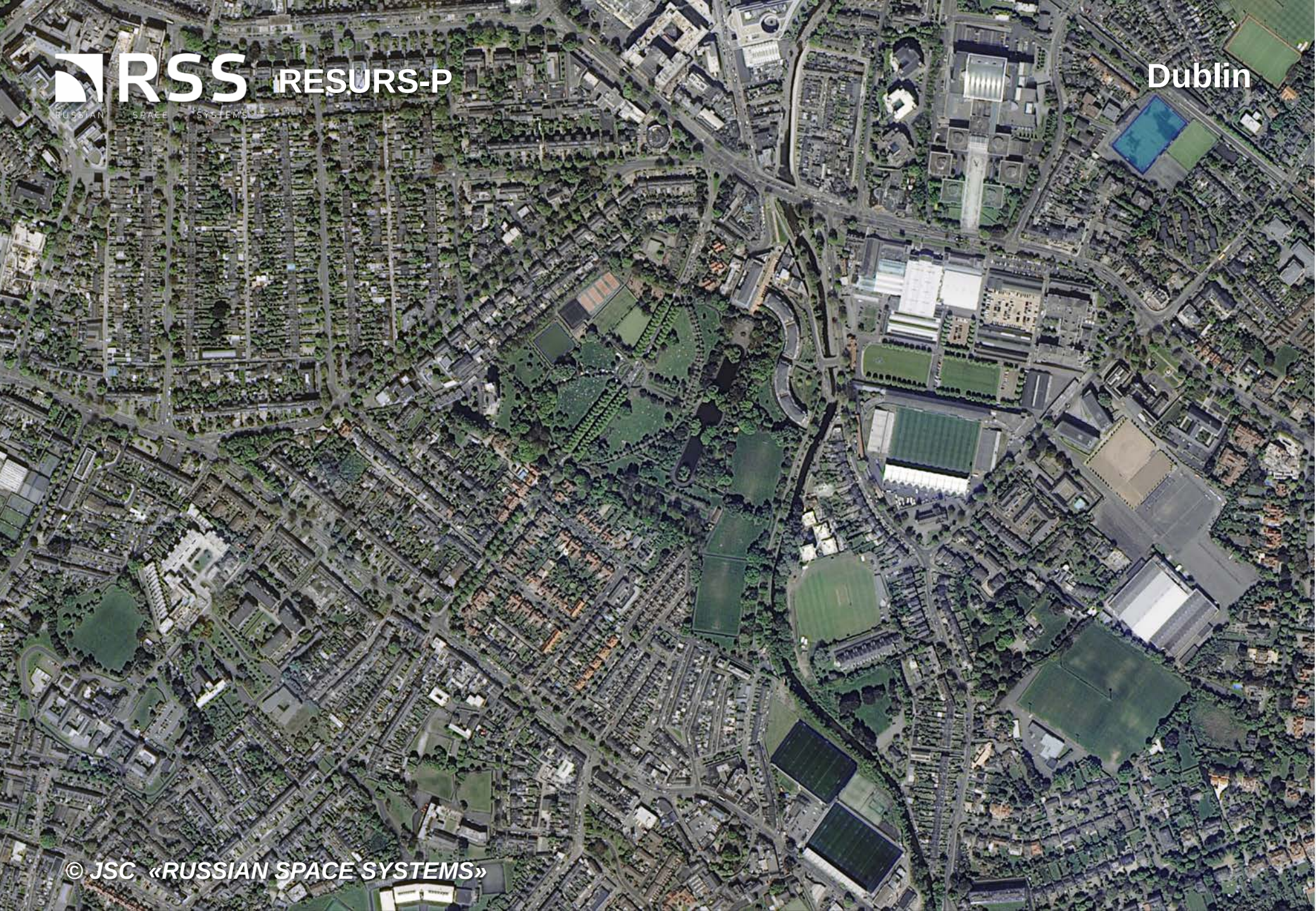
Resolution PAN (0.58-0.80μm)	– 12m
Resolution MS (5 bands, 0.43-0.90μm)	– 23.8m
Swath width	– 97km

Medium Resolution Camera [ShMSA-SR]

Resolution PAN (0.58-0.80μm)	– 60m
Resolution MS (5 bands, 0.43-0.90μm)	– 120m
Swath width	– 441km

Hyperspectral Camera [GSA]

Resolution (96-255 bands, 0.4-1.1μm)	– 30m
Swath width	– 25km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RESURS-P
Dublin
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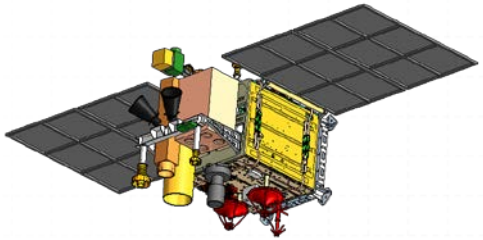
KANOPUS-V

MISSION PURPOSE

Near real-time acquiring of highly informative data in visible and near-IR spectral range for ecological monitoring, natural resources inventory, mineral exploration, and topographic mapping



Launch date – July 22, 2012 (Kanopus-V1)

Next launch – the end of 2015 (Kanopus-V-IK)

ONBOARD INSTRUMENTS

PAN Optical System [PSS]

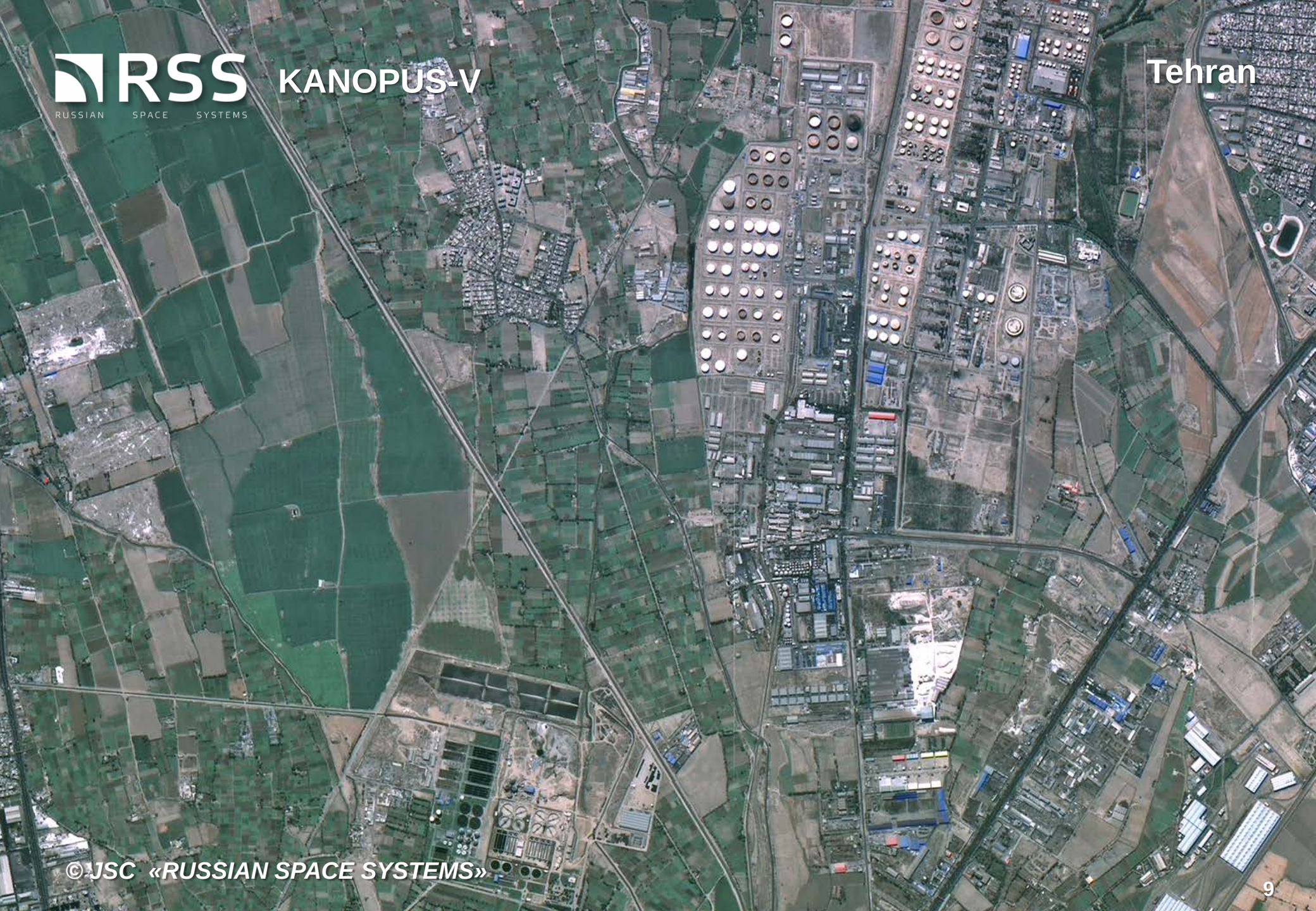
Resolution (0.54-0.86μm)	– 2.1m
Swath width	– 23km

MS Optical System [MSS]

Resolution (4 bands, 0.46-0.84μm)	– 12m
Swath width	– 20km

CURRENT TASKS

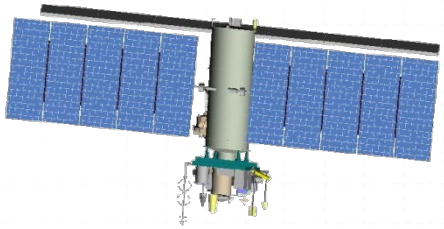
- Maps creation and update (scale 1:25,000 and smaller)
- Environmental ecological monitoring
- Operational emergencies monitoring
- Respond to agriculture and forestry challenges
- Socio-economic infrastructure monitoring



METEOR-M

MISSION PURPOSE

Operational acquiring of cloudiness and the Earth's underlying surface data, hydrometeorological data acquisition, heliogeophysical measurements, Earth's resources study, and ecological monitoring



Launch date – 17 September, 2009 (Meteor-M1)
Launch date – 8 July, 2014 (Meteor-M2)

Next launch – the beginning of 2016 (Meteor-M2.1)

CURRENT TASKS

- Environmental monitoring
- Ice conditions monitoring
- Operational emergency monitoring
- Monitoring of radiation and heliogeophysical conditions in near-Earth space

ONBOARD INSTRUMENTS

2 Medium-Resolution Optical Camera [KMSS]

Land-Using Camera [MSU-100]

Resolution MS (3 bands, 0.53-0.90μm)	– 60m
Swath width	– 900km

Marine-Using Camera [MSU-50]

Resolution MS (3 bands, 0.37-0.69μm)	– 120m
Swath width	– 900km

Low-Resolution Optical Camera [MSU-MR]

Resolution MS (6 bands, 0.5-12.5μm)	– 1000m
Swath width	– 2800km

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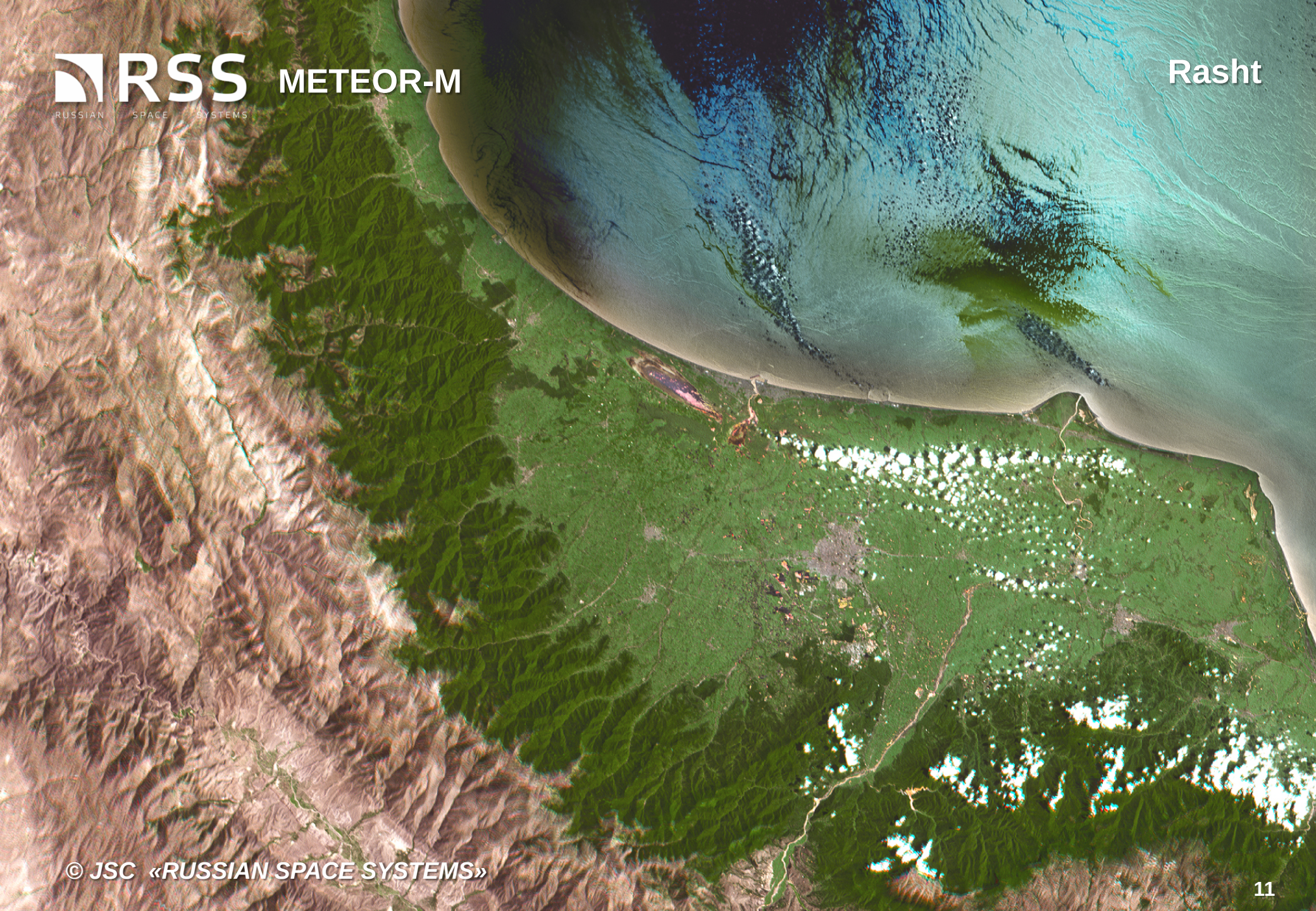
METEOR-M

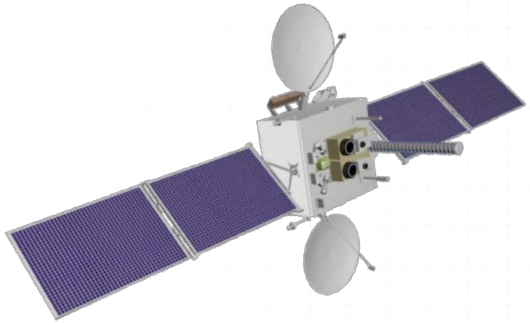
Rasht



ELECTRO-L

MISSION PURPOSE

Operational acquiring of cloudiness and the Earth's underlying surface data, hydrometeorological data acquisition, heliogeophysical measurements



Launch date – January 20, 2011 (Electro-L1)
December 11, 2015 (Electro-L2)

ONBOARD INSTRUMENT

Geostationary MS Optical Camera [MSU-GS]

Coverage area	– the entire disk of the Earth
Resolution VIS (3 bands, 0.5-0.9μm)	– 1000m
Resolution IR (7 bands, 3.5-12.5μm)	– 4000m
Swath width	– 900km
Revisit period in 24h	– 30min (as scheduled) / – 15min (on ground commands)

CURRENT TASKS

- Operational imaging of the Earth's underlying surface
- The World Ocean state monitoring
- Global monitoring of emergencies

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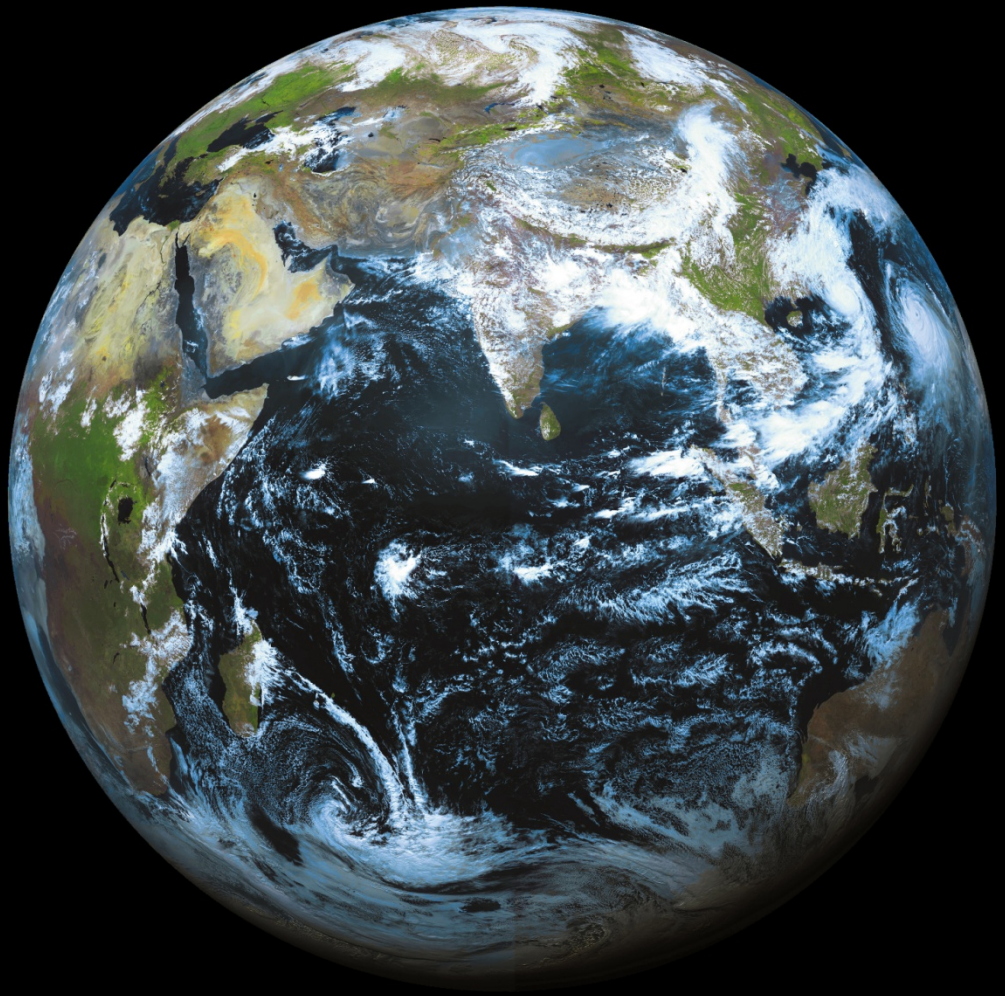
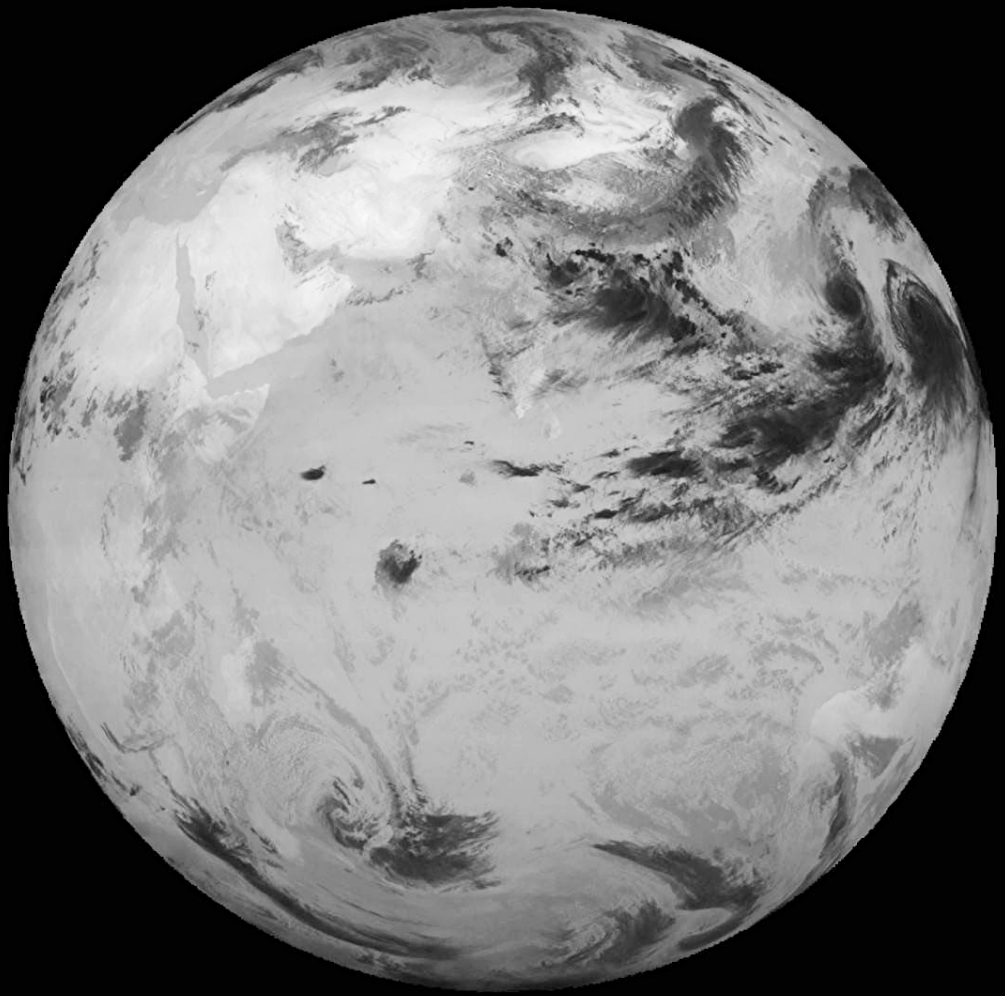
ELECTRO-L

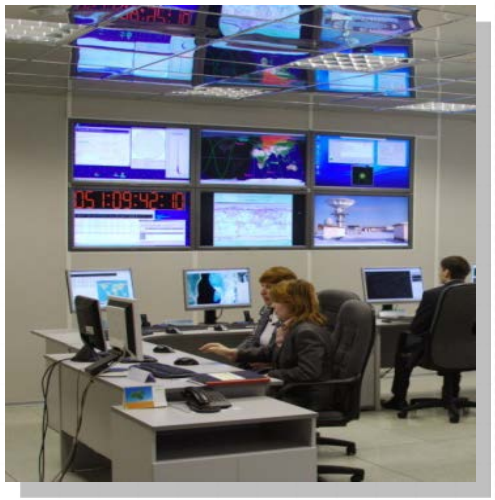


Visible bands (RGB)



IR band (10,2-11,2μm)

RUSSIAN AND FOREIGN EARTH OBSERVATION DATA RECEIVING AND RECORDING FACILITIES



EO Data Receiving and Recording Complex

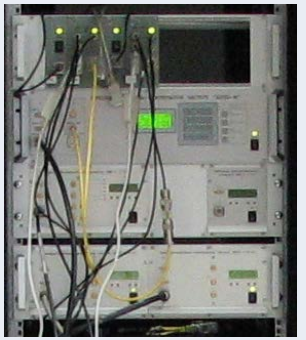
Space Communication Station

The antenna complexes provide data receiving at the rate between 5 and 320 Mbps of X-band with left and right polarization, for 24 hours – up to 30 satellites

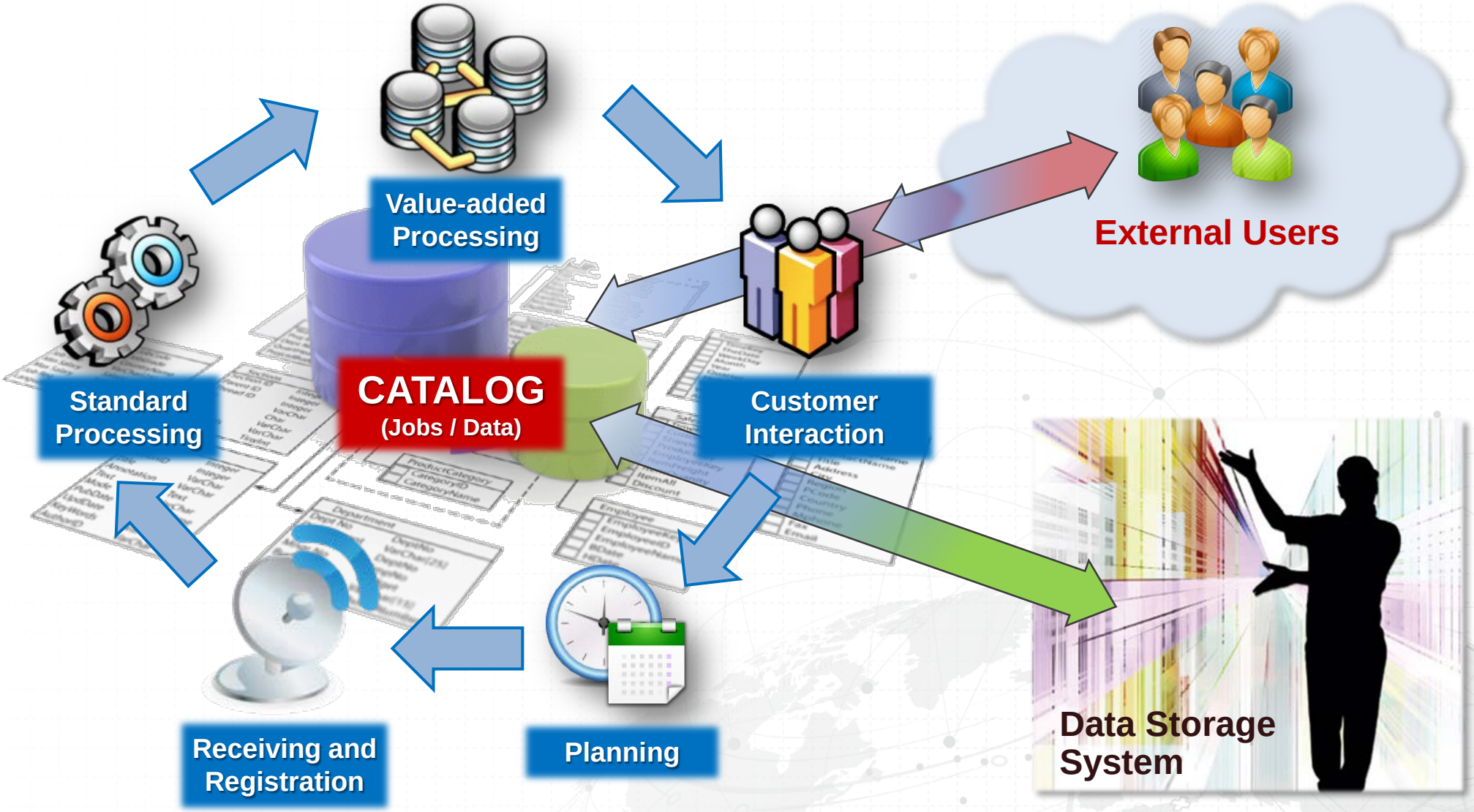
RECEIVING COMPLEXES BEING DEVELOPED BY NTS OMZ OF JSC “RUSSIAN SPACE SYSTEMS”

Complex	PK 2.4	PK 3.1	PK 3.6
Antenna type	*Axial-symmetric parabola c f/d=0,4*		
Antenna size, m	*2.4*	*3.1*	*3.6*
Rotary support	*Double-elevation*		
Polarization	*Right-hand (Lband), right- ad left-hand (Xband)*		
Operating frequencies MHz	*1690-1710; 7450-7550; 8000-8400*		
Receive rate, Mbps	*Up to 310Mbps in Xband (155Mbps in each channel), up to 3.0 Mbps in Lband*		
Quality factor, dB/K	*20*	*22*	*24*
Antenna complex/Rotary support weight no more than, kg	*60/260*	*80/350*	*110/350*
Rotary support power consumption, no more than, W	*100*	*100*	*100*
Reception area	*Entire upper hemisphere including zenith area*		
Primary power supply	*220W, 50Hz*		
Antenna complex operating temperature range, C	*40... +50*		
Antenna complex deployment conditions	*Under radar dome*		

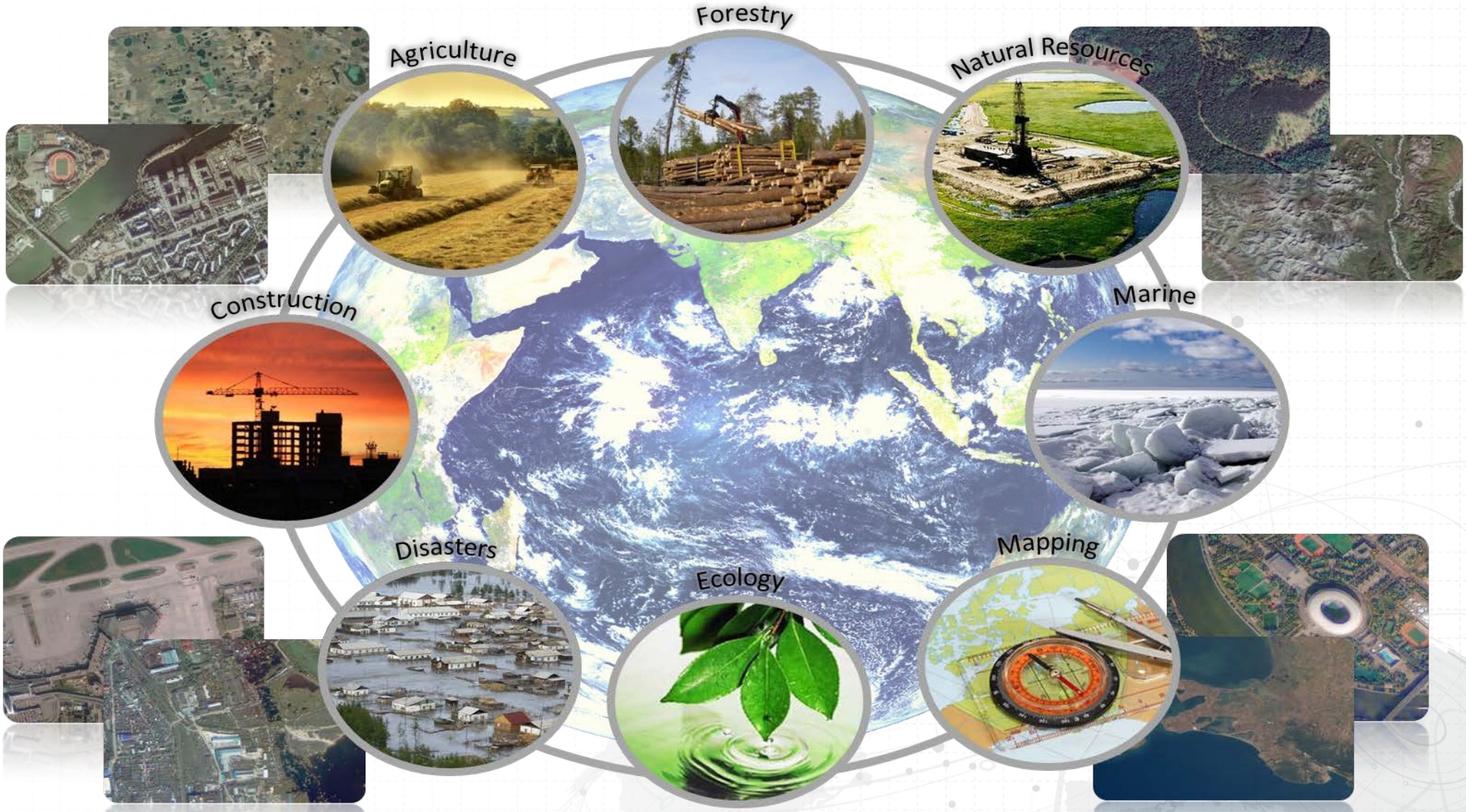
BASIC ENGINEERING SOLUTIONS CHOSEN IN DEVELOPING RECEIVING COMPLEXES

Double-elevation scheme of rotary support construction		Antenna complex feed is dual-band (X- and L-band)	
New types of cycloidal speed reducers used in rotary support		Use of radio receiver	
Receiving complex is automatic		Radio paths have the capabilities of controlling and adjusting: - Given receive frequencies - Modulations - Data receive rate	

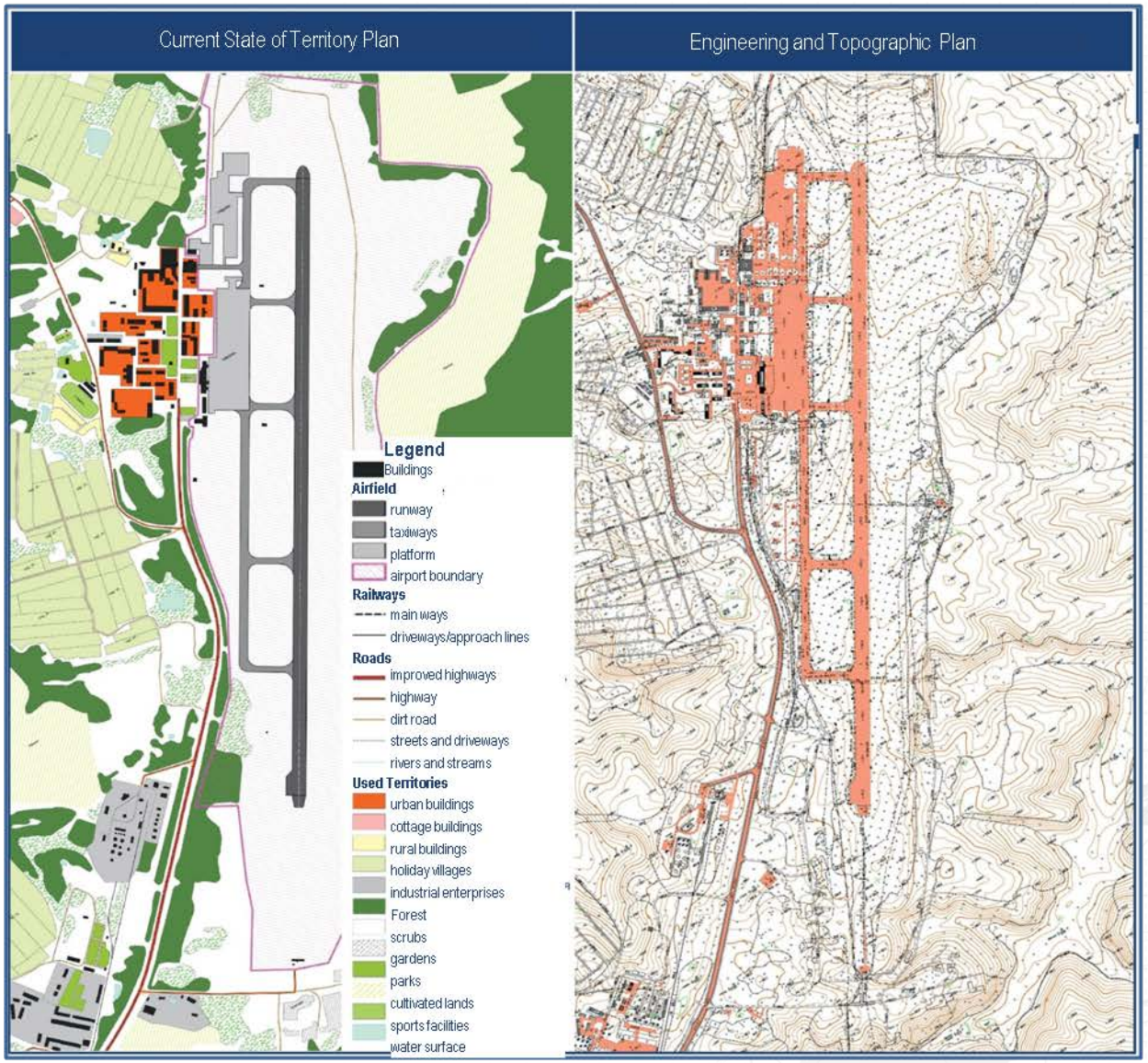
TECHNOLOGICAL SCHEME OF RUSSIAN OPERATOR'S CYCLE



EARTH OBSERVATION DATA APPLICATIONS



MAPPING



Creating a Topographic Plan of Bogashevo Airport, Tomsk
Using Remote Sensing Data*

In 2011, the Research Center for Earth Operative Monitoring mapped the area of Bogashevo Airport (Tomsk, Russia) at a scale of 1:5000

The outcomes of the mapping include:

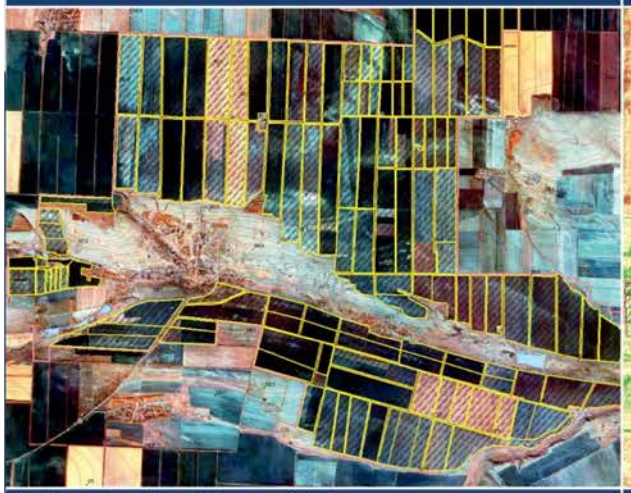
- Digital layout of the airport and its current condition;
- Digital engineering and topographic plan of the airport;
- Digital elevation model

*Data used:

- Resurs-DK of 1 m resolution (10.05.2010);
- Stereo pair of WorldView-1 of 0.5 m resolution (11.09.2011);
- Ground control points with the GPS measurements-based coordinates in the local coordinate system (given by the customer)

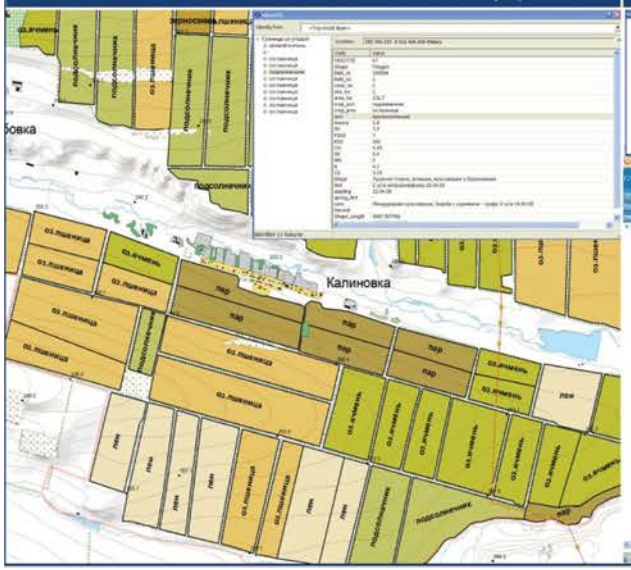
AGRICULTURE

Resurs-DK Data

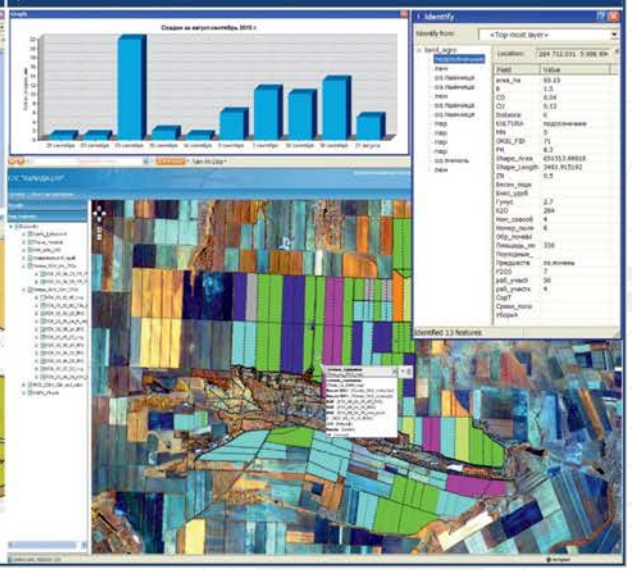


Agricultural Crops Condition According to NDVI (June)

Database Loading with Semantic Data



Access to GIS via Web Browser



Geoinformation System of Agricultural Production Cooperative*

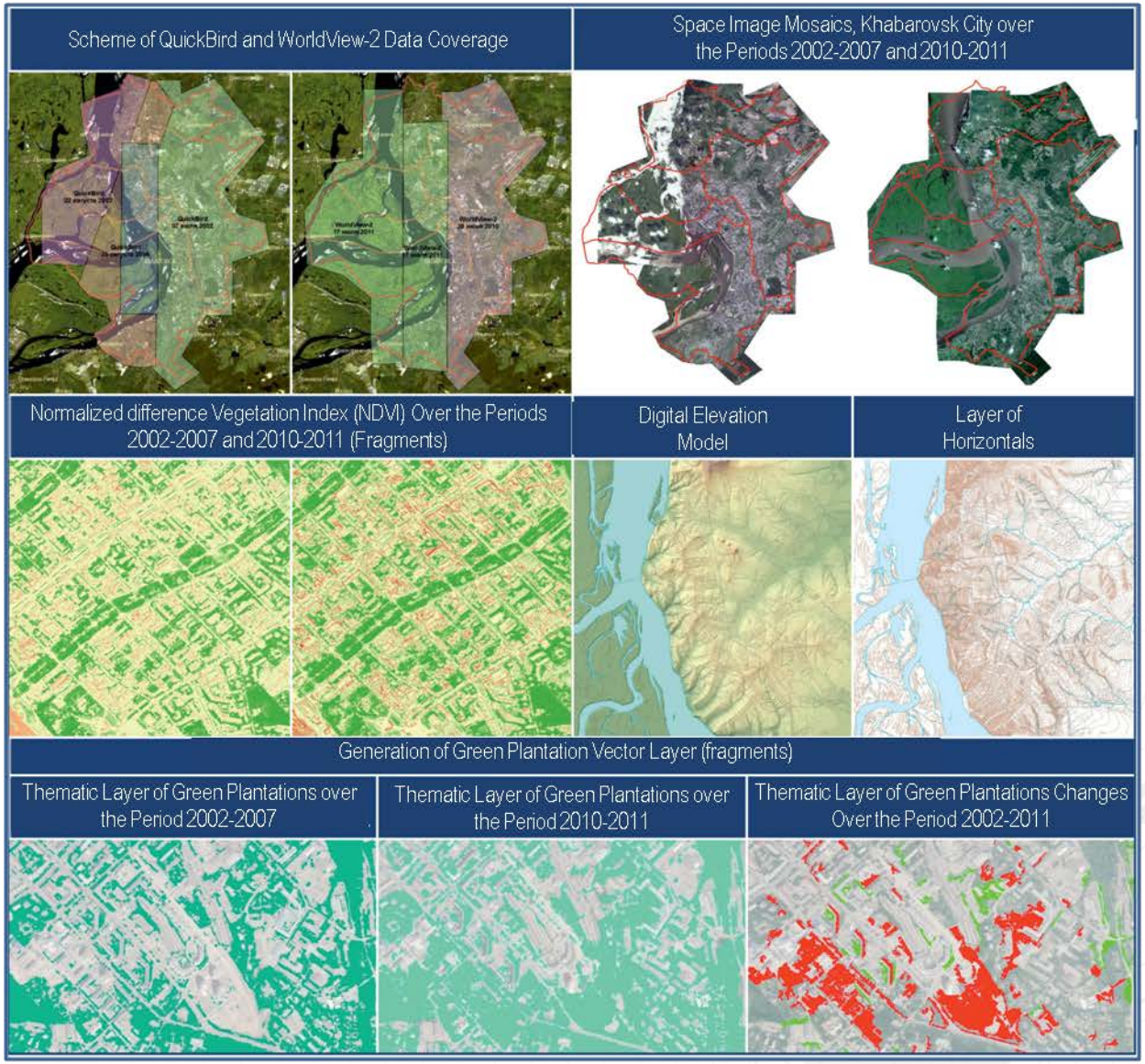
Stavropol Region

In order to estimate the agricultural crop condition, the Normalized Difference Vegetation Index (NDVI) was calculated. The NDVI calculated for different dates of the entire vegetation period is used to study the seasonal dynamics of vegetation and to observe its phenological changes. During the period March-September, the planned observations of agricultural crops comprising the test site were carried out and times and phases of vegetation development were registered. The planned soil and plant sample selection and chemical analysis were performed. The data on condition and characteristics of agricultural crops on the test site were entered into the database and are available now for overview by the Web application developed. The GIS of test site network was developed and brought into pilot operation. The GIS is designed for storage, visualization and remote access to geospatial database and ground-based measurements that describe the test via the Internet using the web applications

*Data used:

- Meteor-M1 of 60 m resolution;
- Resurs-DK of 1 m resolution;
- SPOT of 10 m resolution;
- ALOS of 7/10 m resolution;
- Field observations acquired in cooperation with Federal State Institution Agrochemical Service Center Stavropolskiy

CITY VEGETATION



Green Plantations Assessment, Khabarovsk*

In 2013, the investigations in the environmental control and natural resources assessment of Khabarovsk were pursued for the Khabarovsk Authorities by the Research Center for Earth Operative Monitoring.

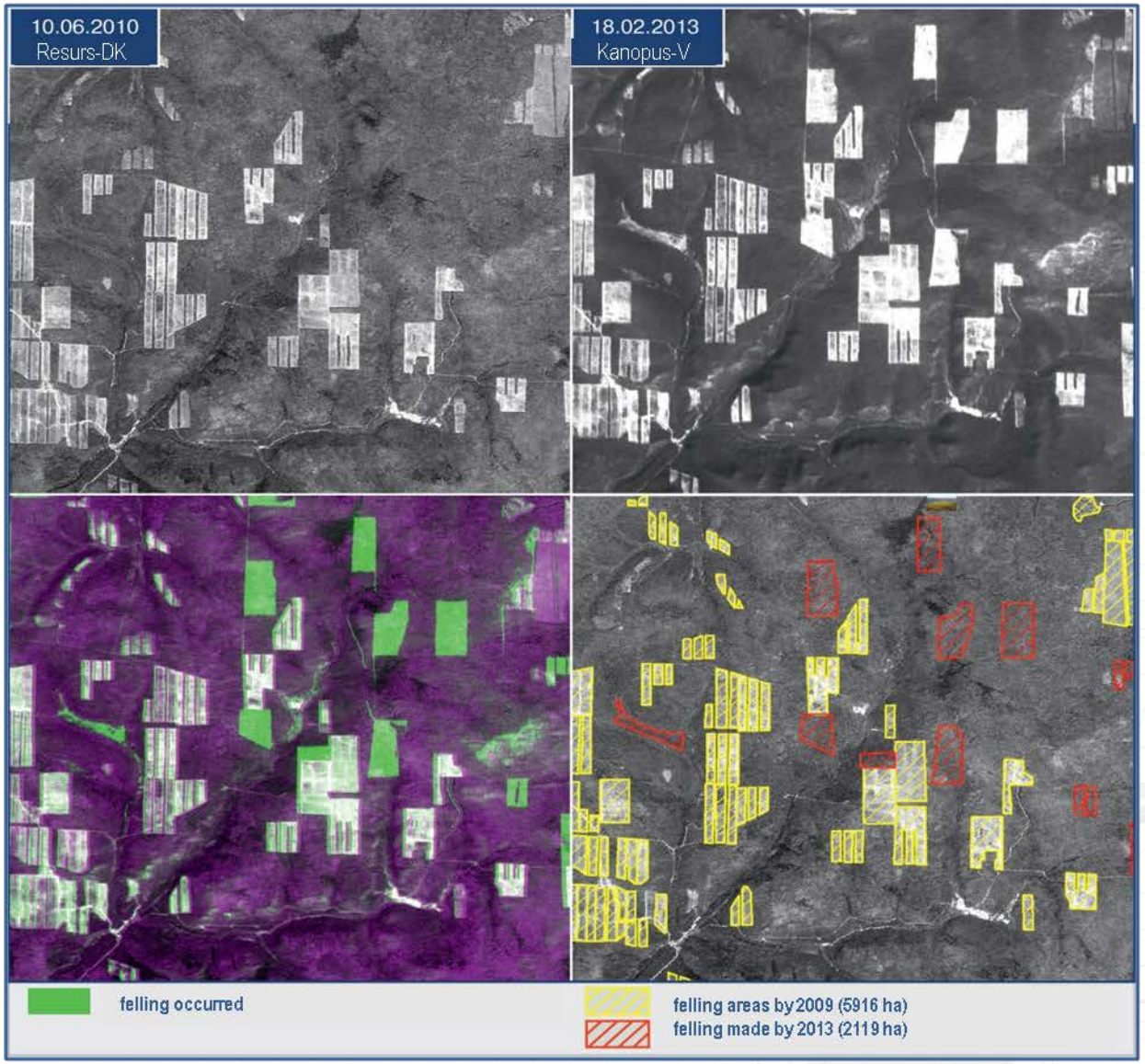
Investigation Results:

- Production of digital schematic map of Khabarovsk city current status;
- Generation of digital elevation model;
- Determination of urban plantation areas for the periods 2002-2007 and 2010-2011;
- Comparative analysis of plant resources for the stated period of time both for the city in whole and for separate administrative districts;
- Acquiring the data on provision of Khabarovsk and administrative districts with green plantations and calculation of provision of inhabitants with green per capita;
- Assessment of green plantation provision of some historic districts and micro-districts of new housing construction

*Data used:

- The main information source of green plantations' assessment – QuickBird (2.44 m resolution) and WorldView-2 (1,84 resolution) data over the periods of active vegetation (June-August) 2002-2007 and 2010-2011;
- ASTER / Terra stereo pair images of 15 m resolution

FORESTRY



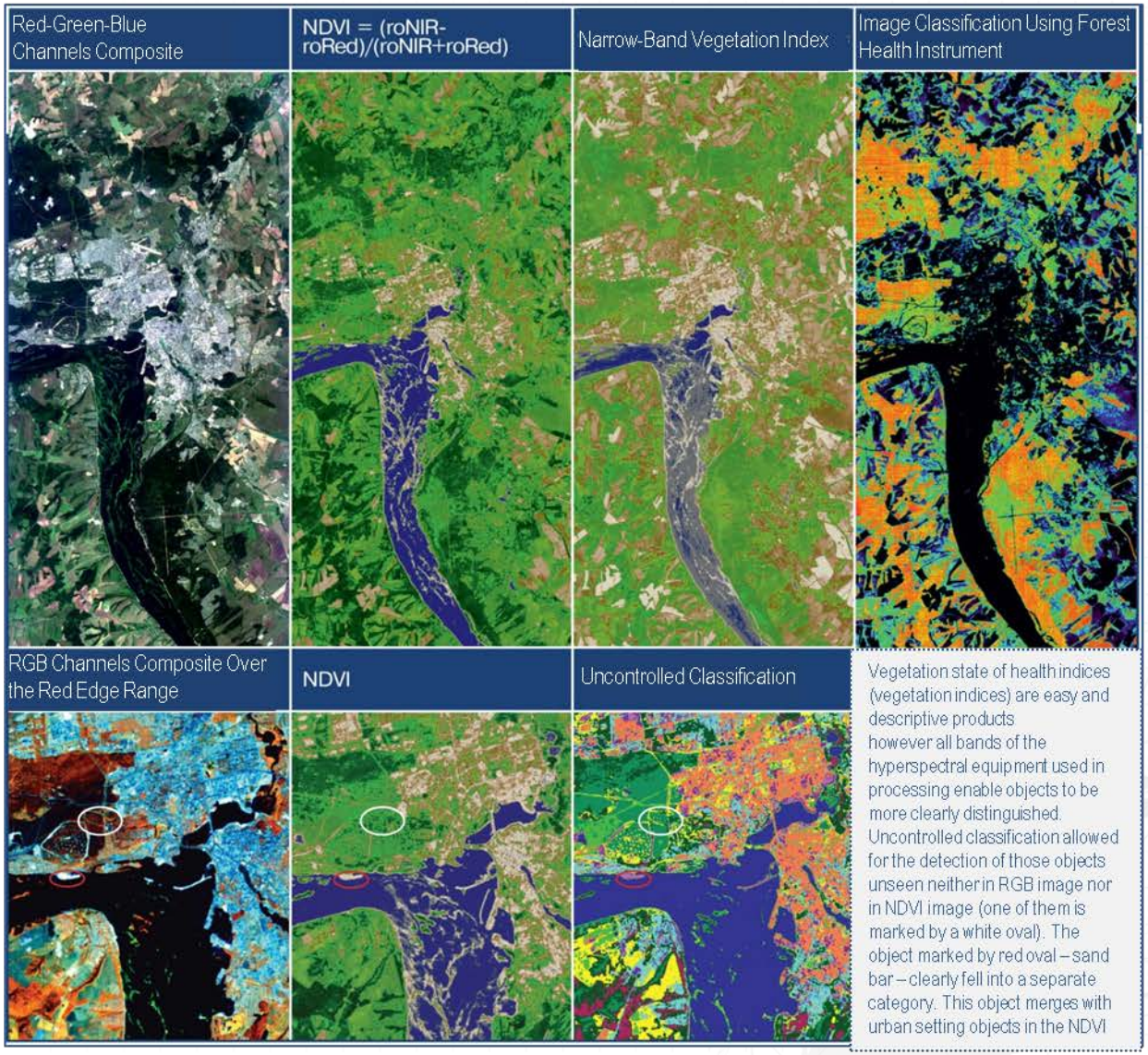
Deforestation Monitoring*

Irkutsk Region

The state-of-the-art remote sensing facilities enable acquiring operative and reliable data on forest condition and economic activity over any territory. Illegal logging causes enormous damage to forest and economy. The monitoring based on remote sensing data enables detecting and specifying the felling made over a specific period of time and determining felling area and coordinates

*Data used:
- Resurs-DK of 1 m resolution;
- Kanopus-V with 2.7 m resolution

NATURAL RESOURCES



Elaborating Tools and Methods for Value-Added Use of Hyperspectral Data*

Kazan City

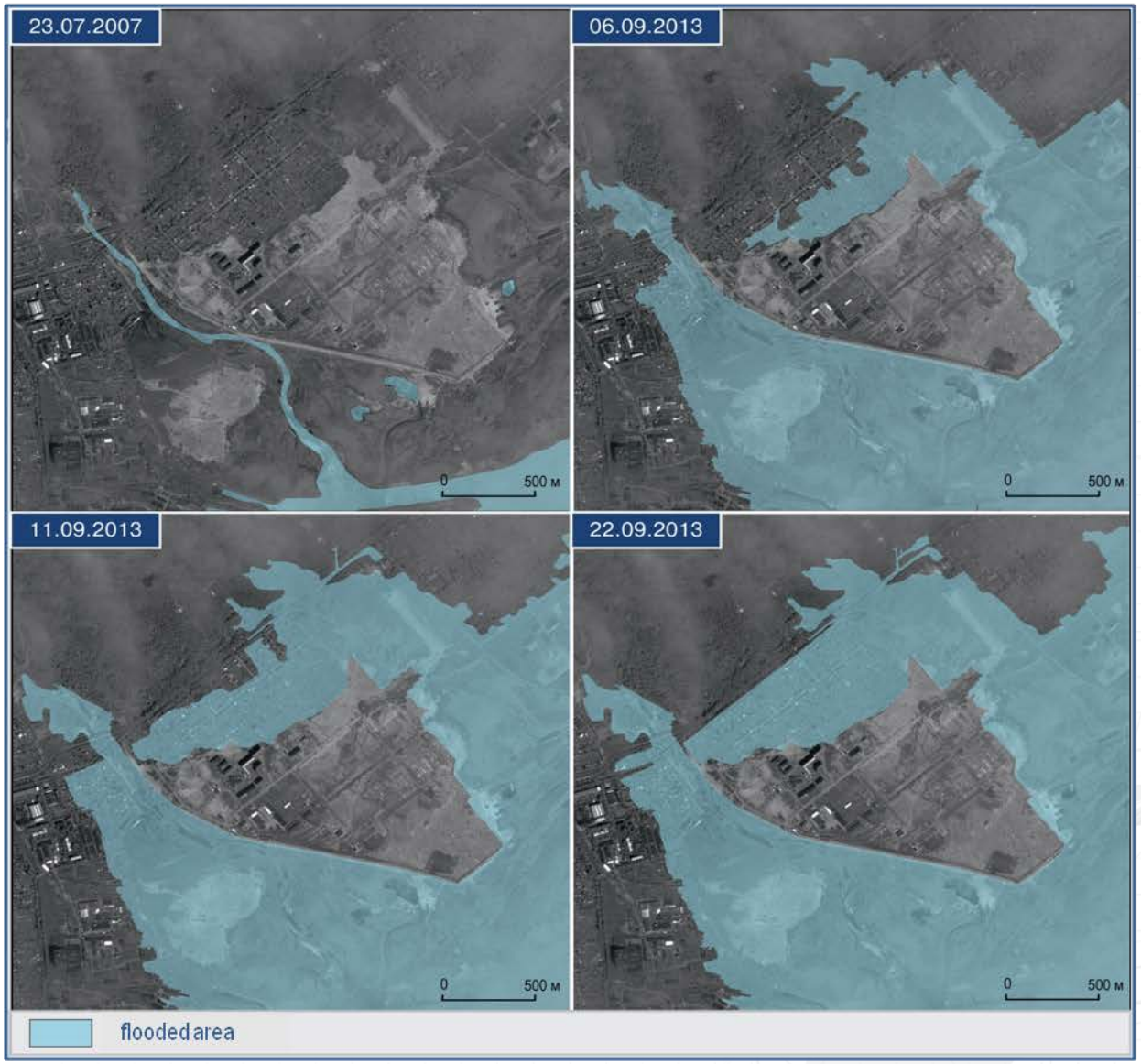
Hyperspectral imaging is the most advanced technique of 'space vision' that makes it possible, using the physicochemical composition of objects observed, to determine vegetation type and condition, water surface pollutant composition, to identify minerals, soils, to detect illicit drug-yielding crops and to determine many other physical parameters of the earth surface.

The main output product of the hyperspectral equipment data processing is reflectance values of homogenous surface.

Along with the generation of spectral images of the underlying surface objects the hyperspectral data enables the calculation of such indices as NDVI, EVI, ARVI and other characterizing vegetation cover state of health

*Data used:
Resurs-P1 (30.08.2013)

RIVER FLOODS



Situational flood monitoring in the Far East of Russia in 2013 using Russian Remote Sensing Data*

Komsomolsk-on-Amur, Khabarovsk Territory

In July, 2013, extreme rainfall in the Far East of Russia caused floods known to be the most disastrous in the history of weather monitoring. In September, 2013, the Amur river level exceeded 8m in Komsomolsk-on-Amur area.

Russian Ministry of Emergencies (EMERCOM) performed situational monitoring using remote sensing data obtained from Russian and foreign satellites that was made possible after the activation of the International Charter Space and Major Disasters.

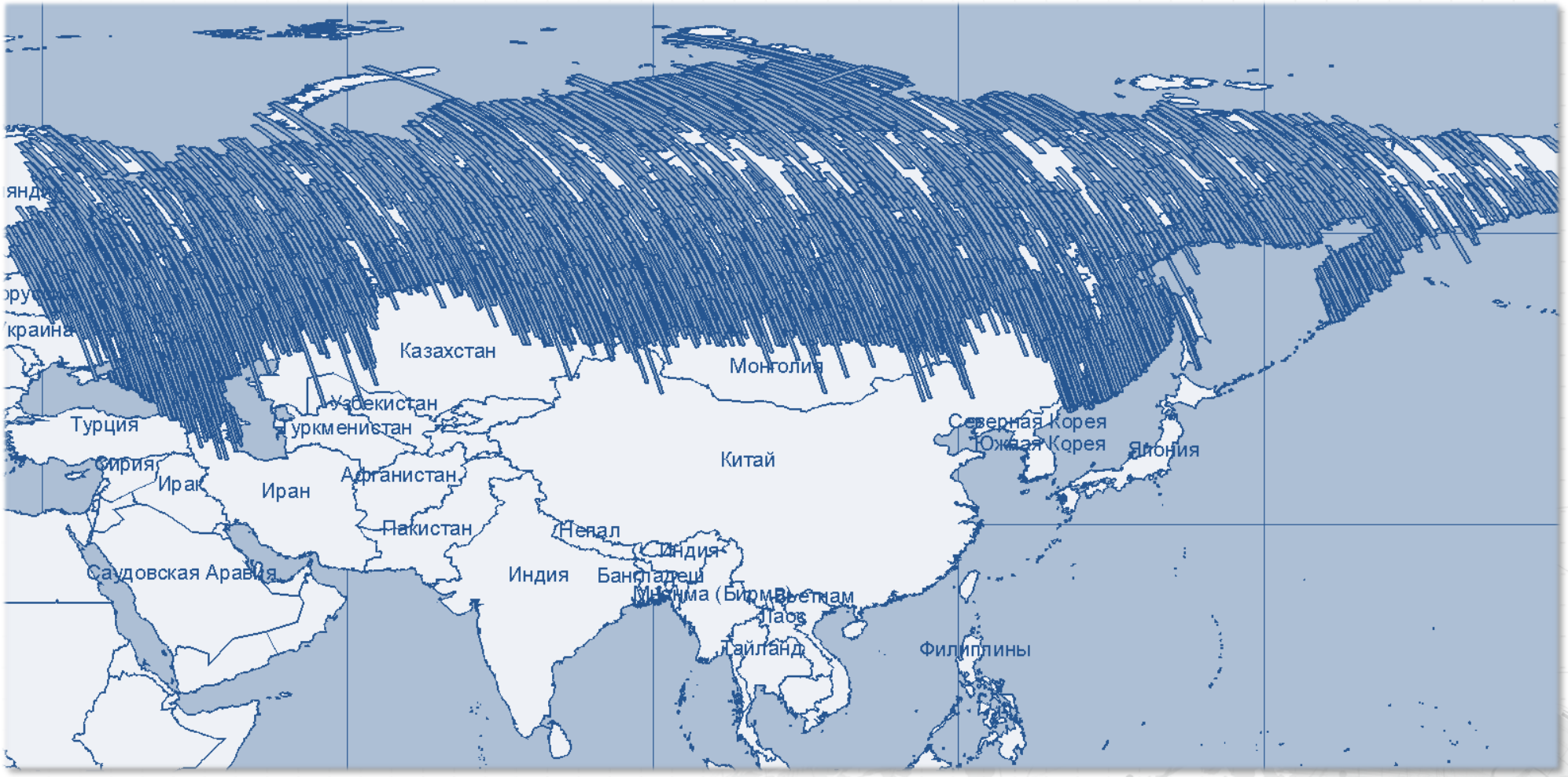
Satellite data was used to detect the flooded areas and to predict further development of the situation

*Data used:
- Water mask – Resurs-P1 and Resurs-DK1 data
- Basis – Resurs-DK high resolution data

RESURS-P DATA COVERING DIAGRAM

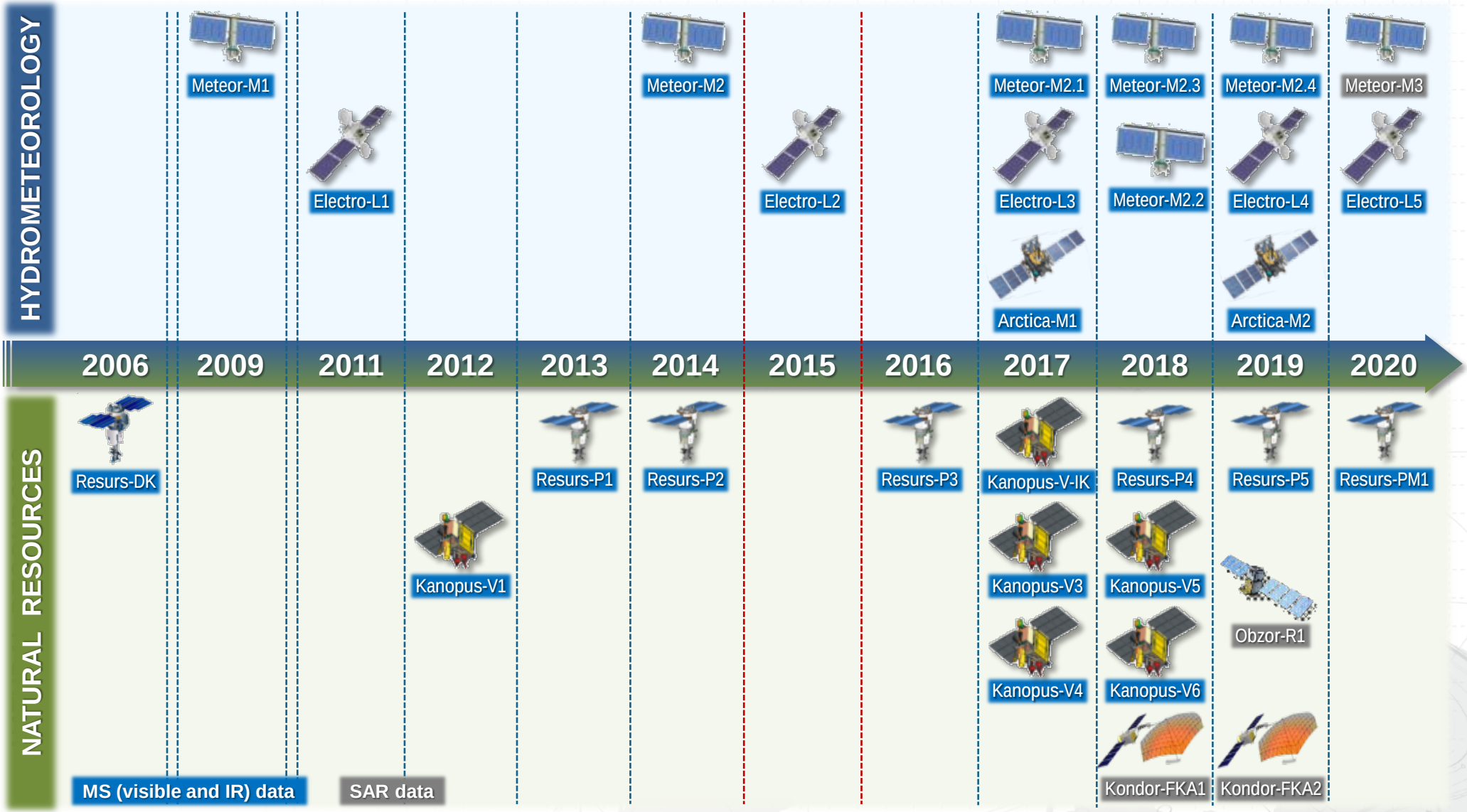
The area of the Russian territory coverage by Resurs-P1 and -P2 (PAN and MS data) is more than 30 million sq. km since 2013

KANOPUS-V DATA COVERING DIAGRAM



The area of the Russian territory coverage by Kanopus-V1 (PAN and MS data) is more than 50 million sq. km since 2013

THE RUSSIAN EARTH OBSERVATION SATELLITE CONSTELLATION 2006–2020



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URSC
United
Rocket and Space Corporation

THANK YOU FOR ATTENTION!