

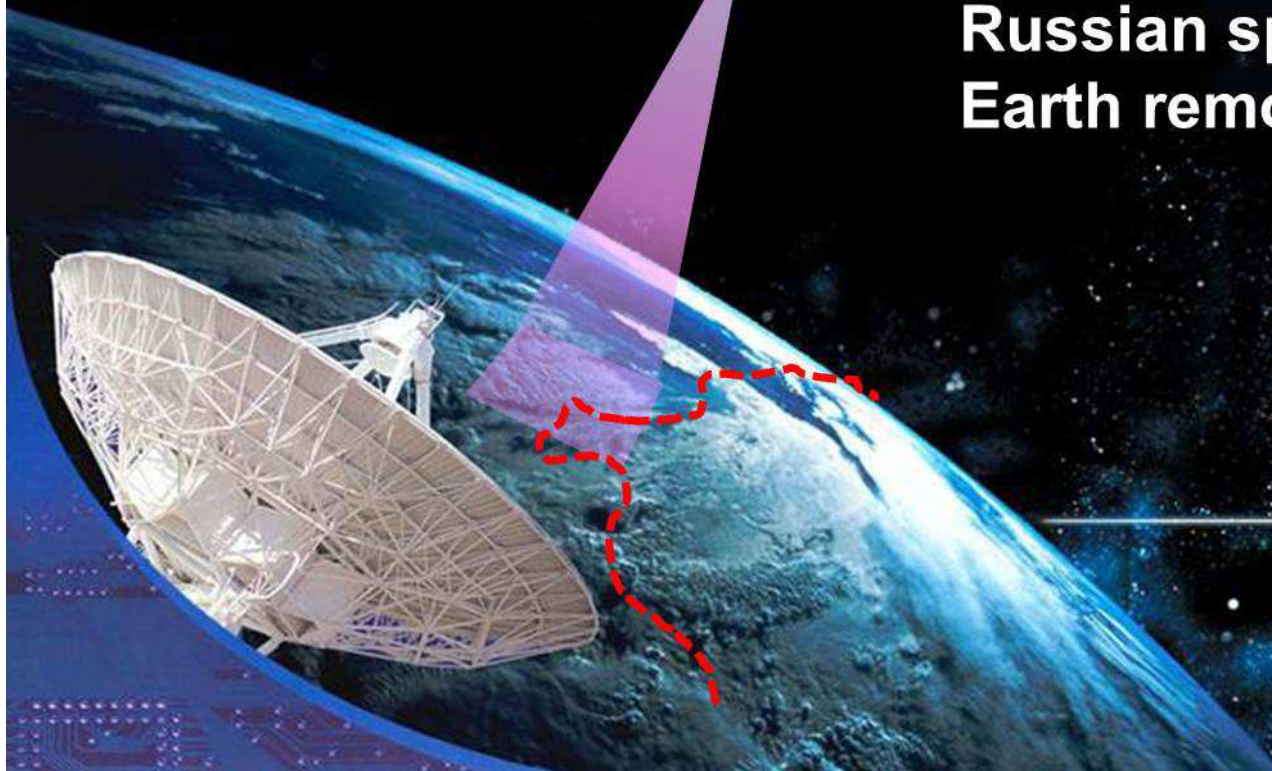


United nation, Vienna, 9-13 February 2015

State of the art and plans for the development of Russian space system for Earth remote sensing

Valery Zaichko

*Head Adviser
Russian Federal Space Agency*





RUSSIAN FEDERAL SPACE AGENCY

- ☐ In the Russian Federation, the federal agency in charge of space activities is the Russian Federal Space Agency (Roscosmos)
- ☐ Earth remote sensing is one of the most important directions of Roscosmos's activities
- ☐ The main document defining the development, and how to create space funding is the Federal Space Program of Russia
- ☐ In the current Russian Federal Space Program for 2006-2015 identified key issues for the creation and development of tools and technologies of remote sensing
- ☐ Now we are working on a new draft Russian Federal Space Program for 2016-2025 which will take a new way of remote sensing developing



KEY DIRECTIONS OF ROSCOSMOS ACTIVITY TO DEVELOP RUSSIAN SPACE SYSTEM FOR EARTH REMOTE SENSING

- ☐ **Enlarging and improvement of Russian orbital group of satellites for Earth Remote Sensing (ERS)**
- ☐ **Development of ERS ground infrastructure, including complexes for acquisition and processing of space data and data distribution system**
- ☐ **Creation of scientific and technical background for the development of prospective ERS onboard equipment**
- ☐ **Improvement of legislation, rules and regulations in the field of Earth Remote Sensing Data**
- ☐ **Coordination with Government bodies, leading public and commercial organizations in the field of Earth Remote Sensing**
- ☐ **Enhancement of international cooperation**



RUSSIAN REMOTE SENSING ORBITAL CONSTELLATION IN 2014:

- ❑ "Resurs-P" № 1 and № 2 with high resolution (better than 1 meter) optical sensor, wide capture multispectral optical sensors (with high – 12 meters and medium – 60 meters resolution) and hyperspectral optical sensor (with 30 meters resolution)
- ❑ "Kanopus-V" with panchromatic optical system (with 2.5 meters resolution) and a multispectral optical system (with 12 meters resolution/
- ❑ Hydro-meteorological satellite "Meteor-M" № 1 and № 2 (with 50-70 meters resolution and 1000 kilometers swath width). It's also used for global monitoring of the Russia territory for 2 or 3 days
- ❑ Hydro-meteorological geostationary space complex "Elektro-L" № 1 with the every 30 minutes global observation of the Earth
- ❑ "Resurs-DK" with 2-5 meters resolution equipment



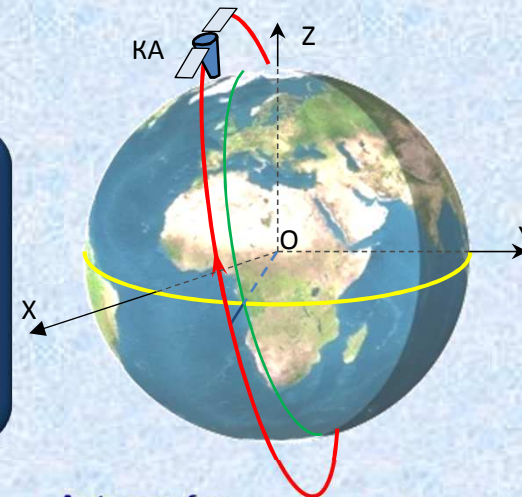
RUSSIAN REMOTE SENSING ORBITAL CONSTELLATION

Spacecraft	Resurs-DK	Meteor-M №1, 2			Elektro-L	Kanopus-V		Resurs-P № 1, 2			
Characters											
Launch date	15.06.2006	18.09.2009			20.01.2011	22.07.2012		25.06.2013, 26.12.2014			
Life time	3 years	5...7 years			10 years	5...7 years		5 years			
Swath width, km	28.3 / 16	KMSS			the visible part of the Earth	PSS	MSS	OEA	GSA	SMSA-VR	SMSA-SR
		MSU-100	MSS U-50	MSU-MR							
		900	900	2800		23	20	38	22	97	441
Spatial resolution, m: • panchromatic band • multispectral band	1 / up to 3	-	-	-	in the visible range – 1000	2.5	-	better than 1	-	12	60
	2 - 3 / 3 - 5	60	120	1000	in IR range – 4000	-	12	3 - 4	30	23	120
Number of sensors	3 / 1	3	3	6	10	1	4	7	up to 256	6	6
Revisit time, day	up to 6	2			30 min.	4		3 - 4			

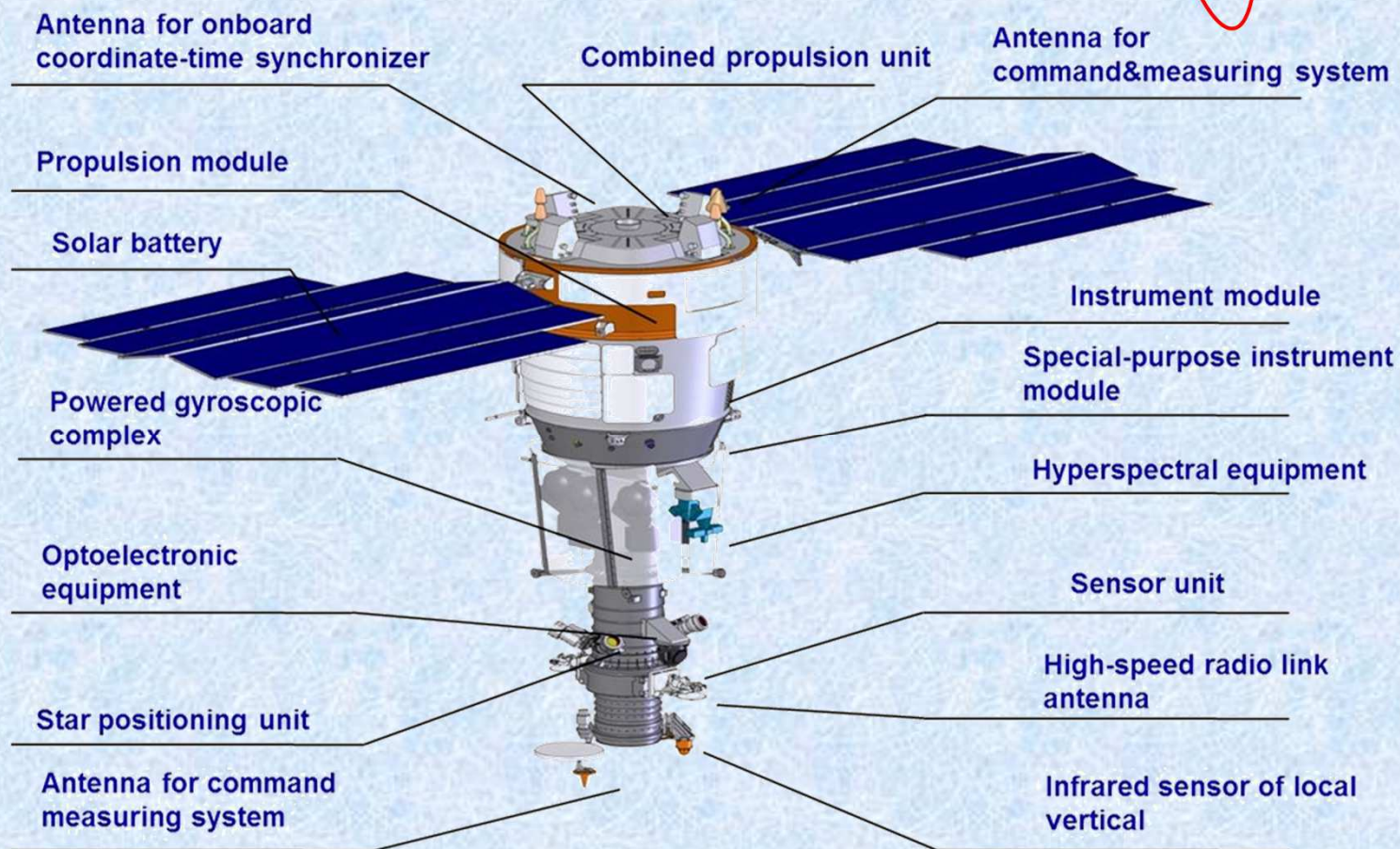
Russian orbital group provides all types and modes of imagery in the optical range

“RESURS-P”

Mission purpose: the RESURS-P satellite is designed to observe the Earth's surface and to radio link the data acquired to ground complexes of data receiving, processing and dissemination for addressing a wide range of tasks to the benefit of various consumers as well as to use for developing an international cooperation of Russia in the environmental control and other actual problems relevant to the Earth remote sensing



General View





"RESURS-P"

Applications Areas:

✓ creation and update of maps
(scale 1 : 10 000 and smaller);

✓ water
area

✓ environment
monitoring

✓ natural
resources
monitoring

✓ natural

✓ oil, gas
resources
development

✓ roads, railroads, oil and gas
pipelines and communication
lines info support and control;

✓ ice condition survey

Main Characteristics

Launch date	25 June 2013		
Designed by	Progress State Research and Production Rocket Space Center TsSKB-Progress		
Orbit	Circular sun-synchronous		
	Inclination	97 deg	
	Height average	475 km	

"Resurs-P" No 2 was launched
on 26 of December 2014.

			Sensor)
			3 - 0.80 μ m
			5 - 0.52 μ m
			2 - 0.60 μ m
			1 - 0.68 μ m
			2 - 0.80 μ m
			0 - 0.90 μ m
			0.9 m
			3 - 4 m
			Sensor)
			Sensors:
			43 - 0.70 μ m
			43 - 0.51 μ m
			0.51 - 0.58 μ m
			0.60 - 0.70 μ m
			0.70 - 0.80 μ m
			0.80 - 0.90 μ m
Spatial resolution	ShMSA-VR	ShMSA-SR	
Panchromatic band	12 m	60 m	
Multispectral band	23 m	120 m	
Swath width	97 km	441 km	7



“RESURS-P” DATA

High Resolution – 1 m



Федеральное космическое агентство



Информация принята и обработана Оператором КС ДЗЗ
(НЦ ОМЗ ОАО “Российские космические системы”)

Italy, Rome, Vatican

August 6, 2013

Panchromatic Image



“RESURS-P” DATA

Medium Resolution – 120 m



Федеральное космическое агентство



Информация принята и обработана Оператором КС ДЗЗ
(НЦ ОМЗ ОАО “Российские космические системы”)

Italy, Sicily
August 14, 2013
Multispectral Image



“RESURS-P” DATA

Pansharpened Image



Федеральное космическое агентство



Информация принята и обработана Оператором КС ДЗЗ
(НЦ ОМЗ ОАО “Российские космические системы”)

Russia Federation, Zhukovsky
International Aviation and Space Salon
(MAKS) - 2013
August 28, 2013



“RESURS-P” DATA

Hyperspectral Image



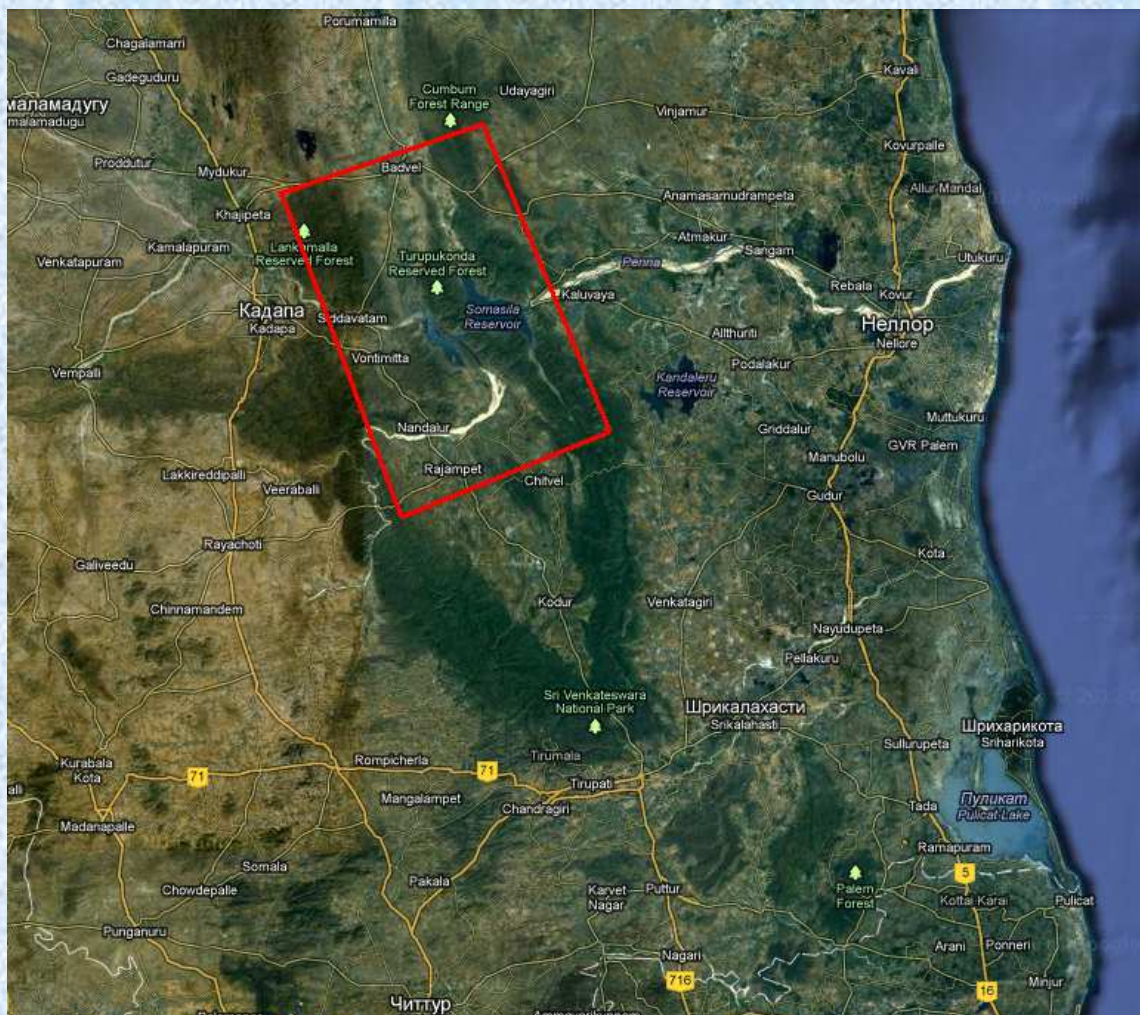
Федеральное космическое агентство



Информация принята и обработана Оператором КС ДЗЗ
(НЦ ОМЗ ОАО “Российские космические системы”)

Dublin, Ireland
July 19, 2013
Hyperspectral image

EXPERIMENTAL THEMATIC PROCESSING OF HYPERSPECTRAL IMAGES USING THE MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY SOFTWARE



The reservoir Somasila (river Penna), Eastern India



Natural colors RGB-
composite



“KANOPUS-V”



Mission purpose: panchromatic and multi-spectral imaging of the Earth

“Kanopus-V” was launched with Belarusian spacecraft (BKA) with similar characteristics.

Today they work together as one unified group and BKA data are also used by Russian consumers

response to agriculture and forestry challenges;

socio-economic infrastructure monitoring

Spectral bands	Blue:	0.46 - 0.51 μm
	Green:	0.51 - 0.60 μm
	Red:	0.63 - 0.69 μm
	Near Infrared:	0.75 - 0.84 μm
Spatial resolution	12 m	
Swath width	20 km	



“KANOPUS-V” DATA



Федеральное космическое агентство



Информация принята и обработана Оператором КС ДЗЗ
(НЦ ОМЗ ОАО “Российские космические системы”)

Italy, Vesuvius
August 2, 2013
Pansharpened Image



“KANOPUS-V” DATA



Федеральное космическое агентство



Информация принята и обработана Оператором КС ДЗЗ
(НЦ ОМЗ ОАО “Российские космические системы”)

Italy, Genoa
August 1, 2013
Pansharpened Image



“RESURS-DK”



Mission objective: multi-spectral remote sensing of the Earth's surface aimed at acquiring high-quality visible images in near real-time as well as on-line data delivery via radio link and providing a wide

Currently, the satellite has been in operation for more than 9 years, with initial expected lifetime of 3 years. It has been raised to a higher orbit to continue its operation.

In this regard, resolution went down to 3-5 m., but it continues to function

✓ supplying home and foreign consumers on a commercial basis;

✓ research activities (measurement of particles and antiparticles' streams)

Swath width*	28.3 km / 16 km
Radiometric resolution	10 bits per pixel
Temporal resolution	6 days
Geophysical scientific instruments	ARINA (Russia) PAMELA (Italy)

* Note: before September 2011 / after September 2011



"RESURS-DK" DATA

South Africa Republic, Durban

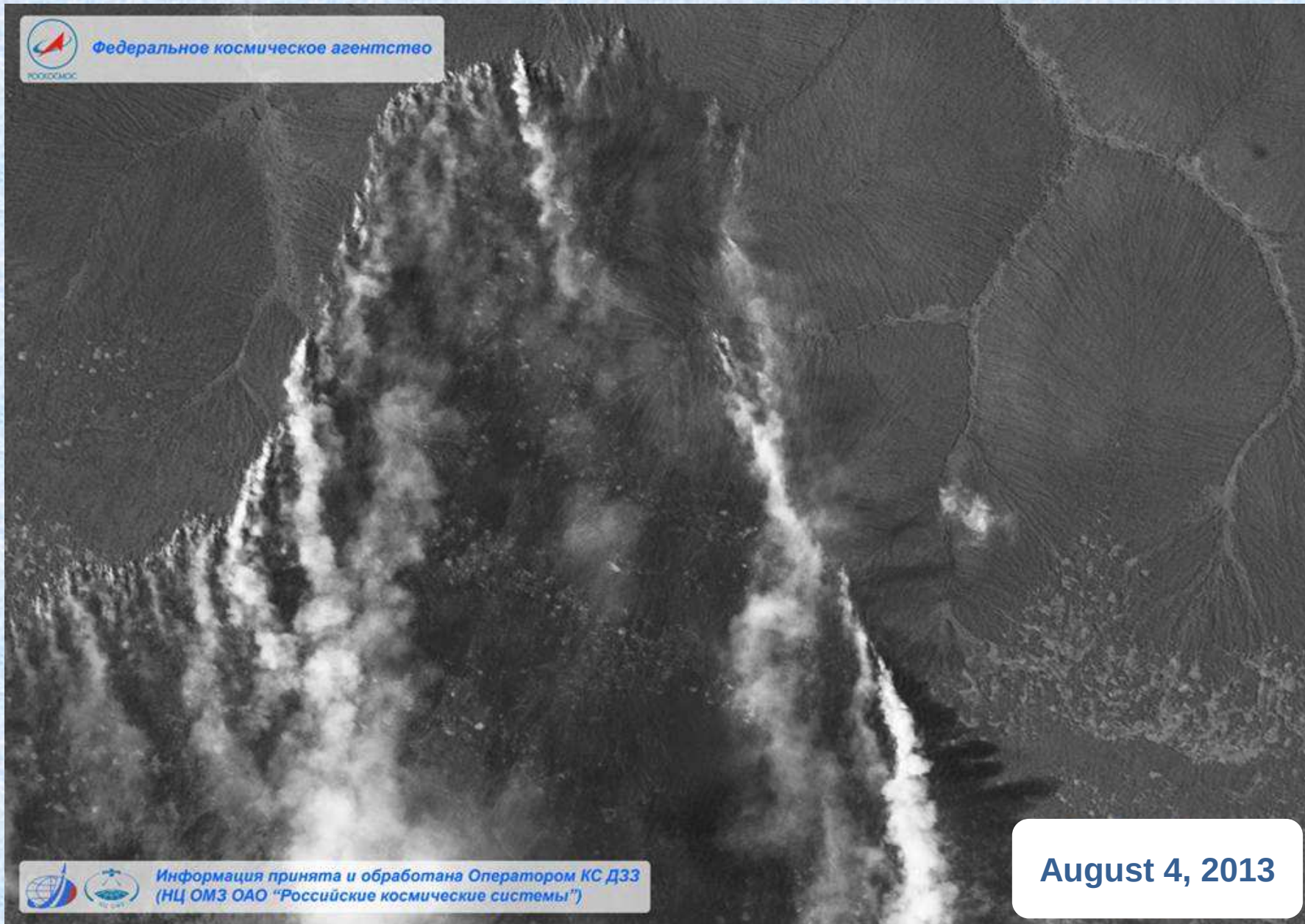


June 15, 2013



"RESURS-DK" DATA

Russia Federation, Yakutiya

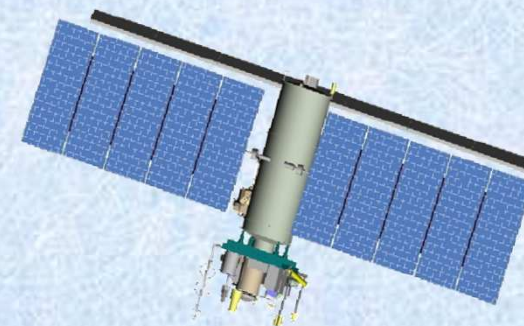


August 4, 2013



“METEOR-M” / KMSS

Mission objective: hydrometeorological supervision, research of natural resources of the Earth and ecological monitoring



Main Characteristics

Solved problems:

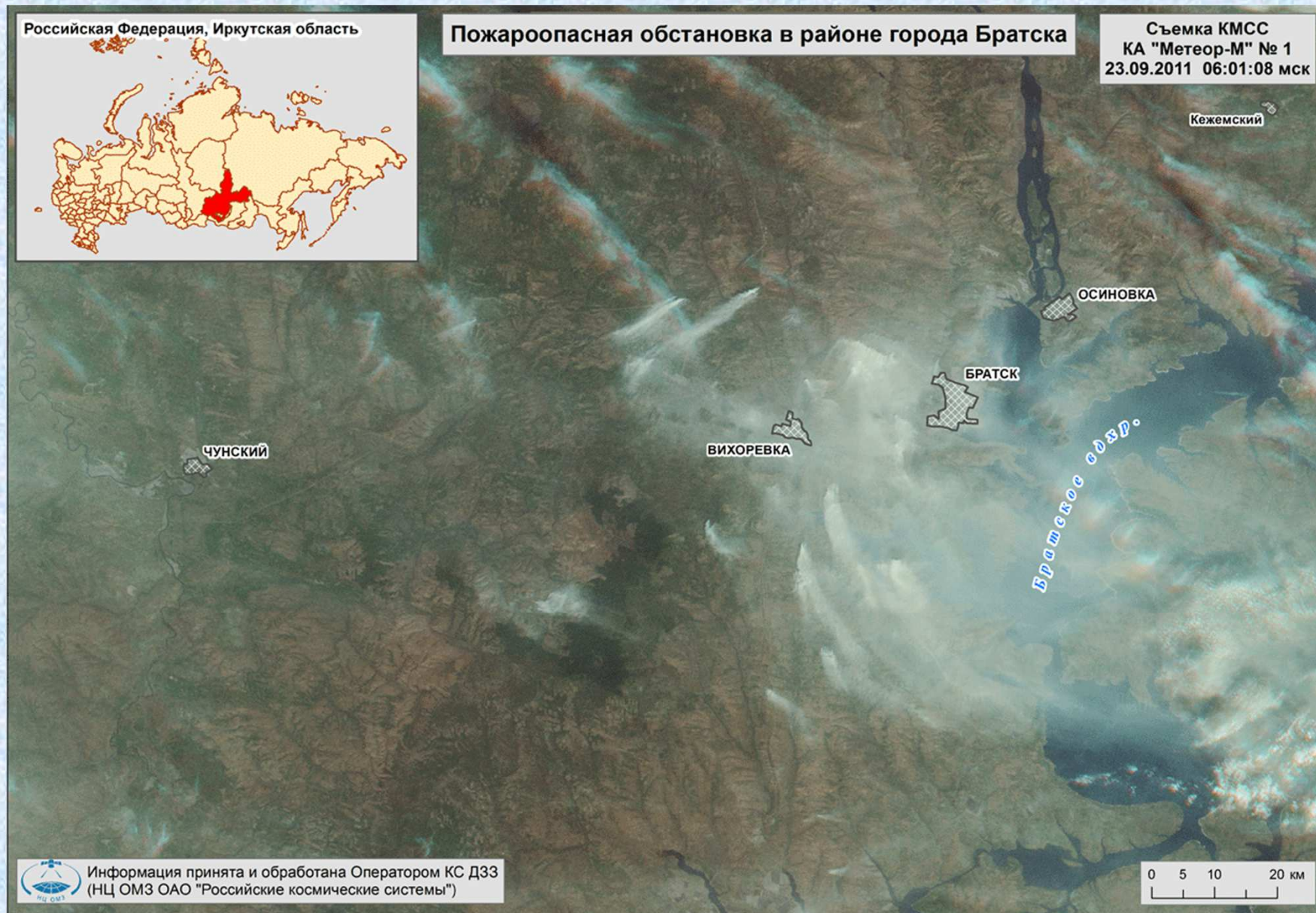
- ✓ reception of the initial hydrometeorological data on a global scale for weather forecasting;
- ✓ control of the dangerous weather phenomena and the prevention of their approach;
- ✓ climate forcing control and the Earth global changing monitoring;
- ✓ radiation and heligeophysical conditions control in near-Earth space in interests of flights' safety, steady radio communication, men health

Launch date	17 September 2009		
Designed by	Joint Stock Company “Research and Production Corporation Space Monitoring Systems, Information & Control and Electromechanical Complexes” named after A.G. Iosifian”		
Orbit	Circular sun-synchronous Inclination 98.85 deg Height average 835 km		
Sensor	KMSS (Multispectral Medium resolution System) MSU-100 MSU-50		
Spectral bands, μm	MSU-100 Green: 0.535 - 0.575 Red: 0.630 - 0.680 Near Infrared: 0.760 - 0.900	MSU-50 Blue: 0.370 - 0.450 Green: 0.450 - 0.510 Red: 0.580 - 0.690	
Spatial resolution	60 m	120 m	
Swath angle	39 deg		
Swath width	900 km		
Radiometric resolution	10 bits per pixel		
Temporal resolution (at 60 deg latitude)	3 days		
Scientific instruments	MTVZA-GYa, GGAk-M, BIS, BRK SSPD		



“METEOR-M” №1 / KMSS DATA

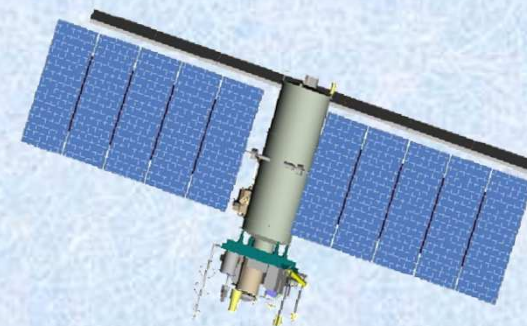
Fires monitoring, Russia Federation, Irkutskaya oblast, 2011





“METEOR-M” / MSU-MR

Mission objective: hydrometeorological supervision, research of natural resources of the Earth and ecological monitoring



Main Characteristics

Solved problems:

✓ reception of the initial hydrometeorological data on a global scale for weather forecasting;

✓ control of the dangerous weather phenomena and the prevention of their approach;

✓ climate forcing control and the Earth global changing monitoring;

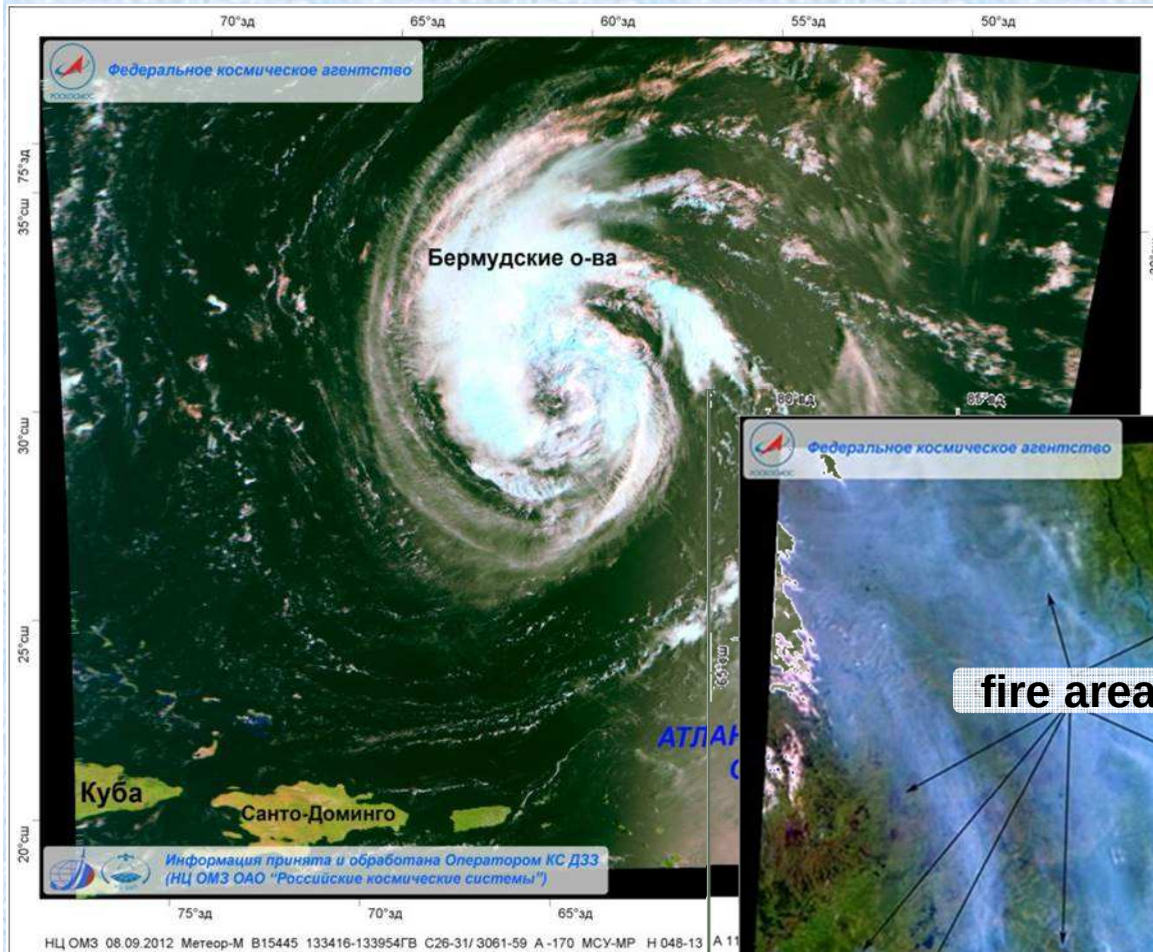
✓ radiation and heligeophysical conditions control in near-Earth space in interests of flights' safety, steady radio communication, men health

Launch date	17 September 2009
Designed by	Joint Stock Company 'Research and Production Corporation Space Monitoring Systems, Information & Control and Electromechanical Complexes' named after A.G. Iosifian'
Orbit	Circular sun-synchronous Inclination 98.85 deg Height average 835 km
Sensor	MSU-MR (Multispectral Low Resolution Optical Instrument)
Spectral bands	Red: 0.50 - 0.70 μm Near Infrared: 0.70 - 1.10 μm Short-wavelength Infrared: 1.60 - 1.80 μm Mid-wavelength Infrared: 3.50 - 4.10 μm Thermal Infrared: 10.50 - 11.50 μm Thermal Infrared: 11.50 - 12.50 μm
Spatial resolution	1 000 m
Swath width	2 800 km
Radiometric resolution	10 bits per pixel
Temporal resolution	1 day
Scientific instruments	MTVZA-GYa, GGAk-M, BIS, BRK SSPD



“METEOR-M” №1 / MSU-MR DATA

Atlantic Ocean,
Bermuda
September 6, 2013



Russia Federation,
Yakutiya
July 22, 2013





“ELEKTRO-L” № 1

Mission purpose: ELEKTRO-L geostationary hydrometeorological spacecraft is designed for operational imaging of cloud cover and the Earth's underlying surface, heliogeophysical measurements, hydrometeorological and housekeeping data collection and relaying



Application Areas:

✓ operative (15-30 min) reception of cloud and Earth underlying surface images;

✓ weather analysis and forecast in regional and Global scale;

✓ aircraft safety flight requirements analysis and forecast;

✓ sea and ocean conditions analysis and forecast;

✓ climate and global changes monitoring;

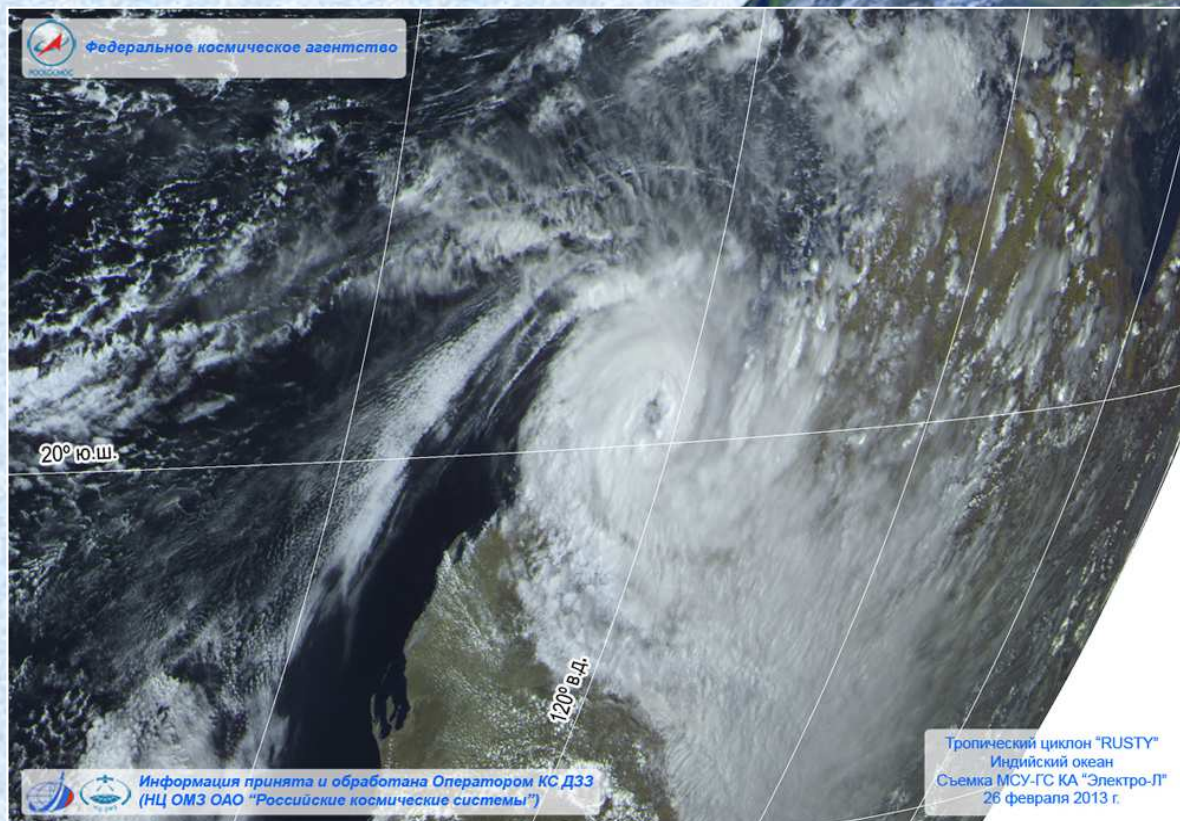
✓ environmental ecological monitoring

Main Characteristics

Launch date	20 January 2011		
Designed by	Lavochkin Research and Production Association		
Orbit	Geostationary sun-synchronous		
	Standing point	76 ged E	
	Inclination	not more than 0.5 deg	
	Height	36 000 km	
Sensor	MSU-GS (Geostationary Multiband Scanning Instrument)		
Spectral bands	Visible:	0.46 - 0.70 μm	
	Mid-wavelength Infrared:	6.0 - 7.0 μm	
	Thermal Infrared:	10.5 - 12.5 μm	
Spatial resolution	Visible band	1 000 m	
	Infrared bands	4 000 m	
Temporal resolution	30 min in case of emergency situations - 15 min		
Swath width	All visible part of globe		
Around the Earth orbital period	24 hours		
Geophysical scientific instrument	GGAK-E		



“ELEKTRO-L” №1 DATA



Indian Ocean,
“Rusty” cyclone
February 26, 2013



THE AMOUNT OF "ELEKTRO-L" DATA PRODUCED IN THE SHOOTING SESSION FOR 5 MINUTES

"Elektro-L" № 1 data is updated every 30 minutes, able to be updated every 15 minutes if necessary.

Satellite position is 76° east longitude
The second and third satellite will be launched to the point of 15° West and 156° East longitude respectively

$\Delta\lambda = 8.2 - 9.2$ min $\Delta\lambda = 9.2 - 10.2$ min $\Delta\lambda = 10.2 - 11.2$ min $\Delta\lambda = 11.2 - 12.5$ min



IN 2015 RUSSIAN FEDERATION WILL BE LAUNCH 4 REMOTE SENSING SATELITES:

- ❑ "Resurs-P" № 3 with high resolution (better than 1 meter) optical sensor, wide capture multispectral optical sensors (with high – 12 meters and medium – 60 meters resolution) and hyperspectral optical sensor (with 30 meters resolution)
- ❑ "Kanopus-V"-IK with panchromatic optical system (with 2.5 meters resolution) and a multispectral optical system (with 12 meters resolution) and infrared camera
- ❑ Hydro-meteorological satellite "Meteor-M" № 2-1 (with 50-70 meters resolution and 1000 kilometers swath width). It's also used for global monitoring of the Russia territory for 2 or 3 days
- ❑ Hydro-meteorological geostationary space complex "Elektro-L" № 2 with the every 30 minutes global observation of the Earth

RUSSIAN EARTH OBSERVATION MISSIONS 2006–2015



Multispectral sensors developed by JSC "Russian Space Systems"

Global and Regional Scale Data VNIR, IR, Microwave
 (1) Meteorology
 (2) Natural Resources Studies
 (3) Disasters
 (4) Geophysics

> 80 mil. sq. km
Medium-Res Images

Global Scale Data Geostationary Orbit VNIR, IR
 (1) Meteorology
 (2) Disasters
 (3) Geophysics

ELECTRO-L1

Global Scale Data Geostationary Orbit VNIR, IR
 (1) Meteorology
 (2) Disasters
 (3) Geophysics

ELECTRO-L2

Global and Regional Scale Data VNIR, IR, Microwave, SAR (X-Band)
 (1) Meteorology
 (2) Natural Resources Studies
 (3) Disasters
 (4) Geophysics

METEOR-M2

METEOR-M2-1

2006

2007

2008

2009

2010

2011

2012

2013

2014

2015



RESURS-DK

Local Scale Data VNIR
 (1) Natural Resources Studies
 (2) Cartography
 (3) Geophysics

STILL IN OPERATION!

> 25 mil. sq. km
Hi-Res Images

Local and Regional Scale Data VNIR
 (1) Natural Resources Studies
 (2) Cartography

> 40 mil. sq. km
Hi-Res images



KANOPUS-V

Local and Regional Scale Data VNIR (Hi-Res), IR
 (1) Natural Resources Studies
 (2) Cartography
 (3) Disasters

> 15 mil. sq. km
Hi-Res images

Local and Regional Scale Data VNIR (Hi-Res), IR, Hyperspectral
 (1) Natural Resources Studies
 (2) Cartography
 (3) Disasters



RESURS-P1



RESURS-P2



RESURS-P3



KANOPUS-V-IK

Visible / IR Data

SAR Data

Background: METEOR-M1 / MSU-MR mosaic (2012)



BUILD-UP OF REMOTE SENSING SATELLITE CONSTELLATION

Spacecraft	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hydrometeorological Satellite Constellation												
M												
E												
E												
A												
A												
R												
RE												
KAR												
KANOPUS-V				1	1	1	2	2	4	4	4	4
Total	2	2	3	4	5	7	11	13	17	22	25	26

In such a constellation capacity will increase significantly with the amount of information they received, which must be processed and presented in the form of the most accessible to the consumer



COMMON GEOGRAPHICALLY DISTRIBUTED INFORMATION SYSTEM OF EARTH REMOTE SENSING (ETRIS DZZ)

The creation and deployment of remote sensing orbital impossible without the development and improvement of ground-based infrastructure, the establishment and improvement of technologies and services for the processing of remote sensing data

In order to carry out such work in Russia creates a common geographically distributed information system of Earth remote sensing (ETRIS DZZ), which can be integrated in the international system for the collection, processing and dissemination of remote sensing data

ETRIS DZZ

For an efficient provision of consumers including regional ones with space data, ROSCOSMOS is engaged in deploying the ETRIS DZZ of:

General Bank of Geo
Information Data

Regional centers for space
data receiving, processing,
storage, and distribution

Federal and Regional
Funds of Remote
Sensing Data

ROSCOSMOS'
Geoportal and
regional geoportals

Research and educational
centers of higher educational
institutions

Regional centers of
space services



ETRIS DZZ

ETRIS DZZ constitute the basis of remote sensing centers and points to obtain space information posted throughout the territory of the Russian Federation.

In 2014-2015, planned to develop three large reception center in the north of the country in the areas of Murmansk, Anadyr and Tiksi that will provide complete coverage of the territory of the Russian input areas



ETRIS DZZ

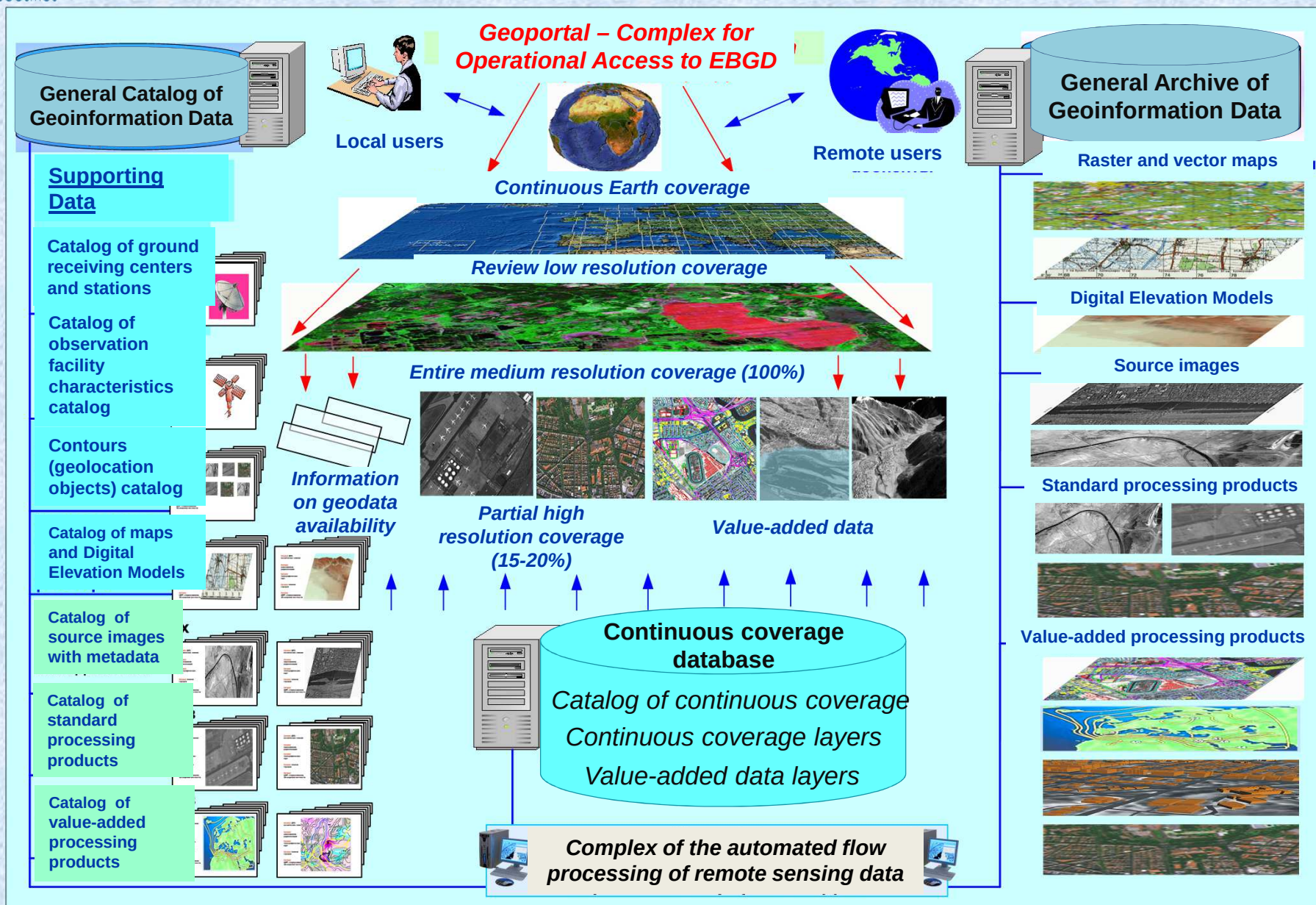
The implementing the Conception of the Russian Remote Sensing System Development for the Period till 2025 as to ETRIS will allow ROSCOSMOS to coordinate in full ground centers for

An important element of ETRIS DZZ is also a single geographically distributed geo-data bank, which is based on the Fund remote sensing data.

Access to and visualization of information provided by the Russian Federal Space Agency Geoportal

- Da
- Da
- Sp
- Sp
- Space Monitoring Centers of other ministries, departments, organizations, and universities...
- Space Monitoring Centers in the Arctic Region

GENERAL BANK OF GEOINFORMATION DATA STRUCTURE



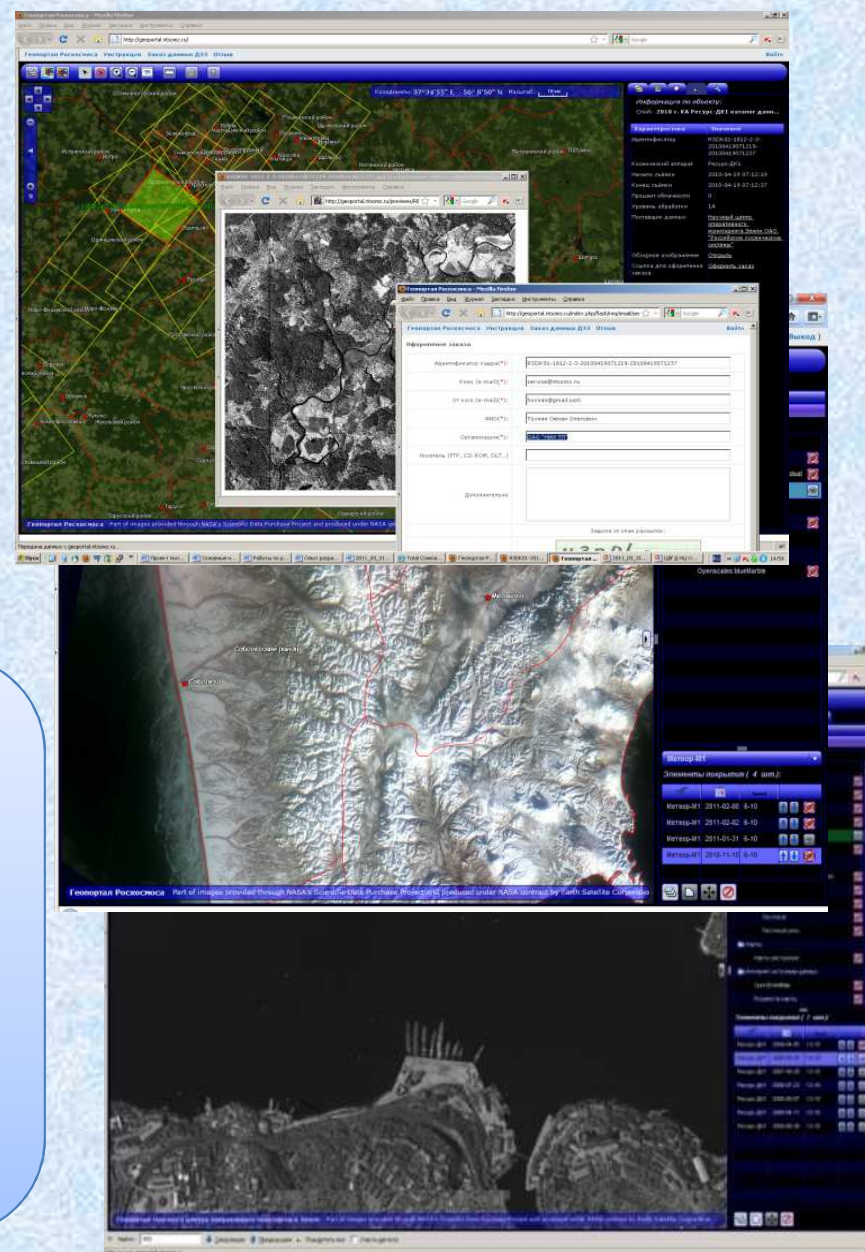
INFORMATION SERVICES. ROSCOSMOS'S GEOPORTAL



Roscosmos Geoportal provides operative access, data search, satellites characteristics, remote sensing data and products of its processing ordering, as well as the ability to monitor ground-based sites and facilities in time.

Every day more than 1000 visitors access the Geoportal via Internet.

A strong consumer segment is established

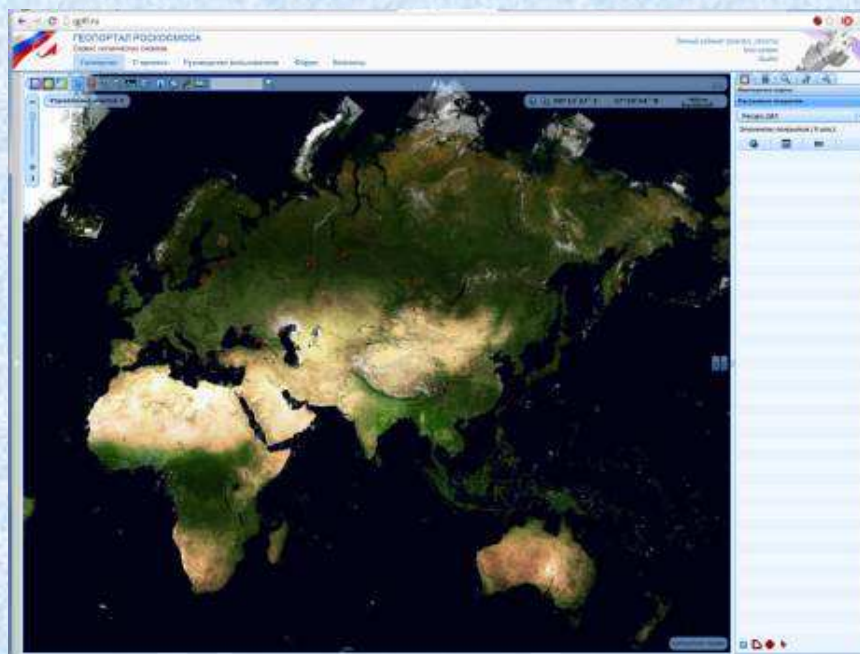


INFORMATION SERVICES. ROSCOSMOS'S GEOPORTAL

Free Access

- Metadata catalogue
- General catalogue of remote sensing data
- Continuous earth surface coating with space imagery data
- Provision of space information and thematic products on customers demands

ROSCOSMOS'S GEOPORTAL



Authorized access

- All features of free access to Geoportal
- Access to thematic data segments and special thematic products
- Very-high resolution data access

Internet



www.gptl.ru



Internet

Launched in December 2010, Roscosmos Geoportal provides online access to information from Russian ERS satellites to a wide range of users and additional opportunities for authorized users

Управление картой

lego

500 м

37°37'48" E 55°44'30" N

Москва

Векторные карты

Непрерывные покрытия

Непрерывные покрытия:

Ресурс-ДК1

Элементы покрытия (10 шт.):

Ресурс-ДК1	2009-09-09	12-16	
Ресурс-ДК1	2006-09-18	12-16	
Ресурс-ДК1	2010-07-14	12-16	
Ресурс-ДК1	2009-04-15	12-16	
Ресурс-ДК1	2007-06-03	12-16	
Ресурс-ДК1	2007-06-23	12-16	
Ресурс-ДК1	2007-08-15	12-16	
Ресурс-ДК1	2007-08-20	12-16	
Ресурс-ДК1	2008-09-05	12-16	
Ресурс-ДК1	2007-04-10	12-16	

Авторские права

Геопортал Роскосмоса



COLLABORATION WITH THE INTERNATIONAL ORGANIZATIONS IN THE FIELD OF EARTH REMOTE SENSING

- ☐ Roscosmos participation in the Group for Earth Observation (GEO)

Russian Federation
is open for collaboration
with the international community
at using and free distribution
of Russian remote sensing data

- ☐ Joining to the international organization "UN-Spider"

- ☐ Participation in the UNO Committee on peaceful utilization of space on ERS matters

Contributions to areas of CEOS activities

Participation in the WGCV and WGISS

**We also are working on integrating
Roscosmos Geoportal to WGISS Integrated
Catalog (CWIC)**

**We are also going to join WGDisasters and
WGCapD**

EO Data Policy in Russia

1. Our government organizations have free access to all EO data from Russian satellites
2. Our research organization have free access to all EO data from Russian satellites with no further commercial use
3. All customers (users) around the world will have free access to all 30-meters and more resolution EO data from Russian satellites
4. All 30-meters and less resolution EO data from Russian satellites will be commercially distribute for customers (users) all around the world

Open remote sensing data Portal of Roscosmos

Data from Hydro-meteorological satellite "Meteor-M" (with 50-70 meters resolution and 1000 kilometers swath width)

Data from "Resurs-P" with wide capture multispectral optical sensors (with medium – 60 meters resolution)

Data from Hydro-meteorological geostationary space complex "Elektro-L" with the every 30 minutes global observation of the Earth equipment

Russian Federation
is open for collaboration
with the international community
at using and free distribution
of Russian remote sensing data



ROSCOSMOS

United nation, Vienna, 9-13 February 2015



Thank you for your attention!

Valery Zaichko

opoi@roscosmos.ru