RUSSIAN FEDERATION

RUSSIAN FEDERAL SPACE AGENCY

EMERGENCIES PREVENTION AND RESPONSE WITH APPLICATION OF SPACE OBSERVATION SYSTEMS

RUSSIAN REMOTE SENSING ORBITAL CONSTELLATION FOR DISASTERS

Spacecraft / Characters	Resurs-DK	Meteor-M №1, 2			Elektro-L	Kanopus-V		Resurs-P № 1, 2			
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		MSU-MR	the visible part of the Earth	PSS	MSS	OEA	GSA	SMSA-VR	SMSA-SR
		MSU-100	MSS U-50								
		900	900	2800		23	20	38	22	97	441
Spatial resolution, m: •panchromatic band	1 / up to 3	-	-	-	in the visible range – 1000	2.5	-	better than 1	-	12	60
•multispectral band	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

ROSCOSMOS'S OPERATOR IN INTERNATIONAL CHARTER ON SPACE AND MAJOR DISASTERS

On August 28, 2013

the procedure of ROSCOSMOS joining to the International Charter on Space and Major Disasters was completed.

Research Center for Earth Operative Monitoring was assigned as the ROSCOSMOS' Operator in the Charter.

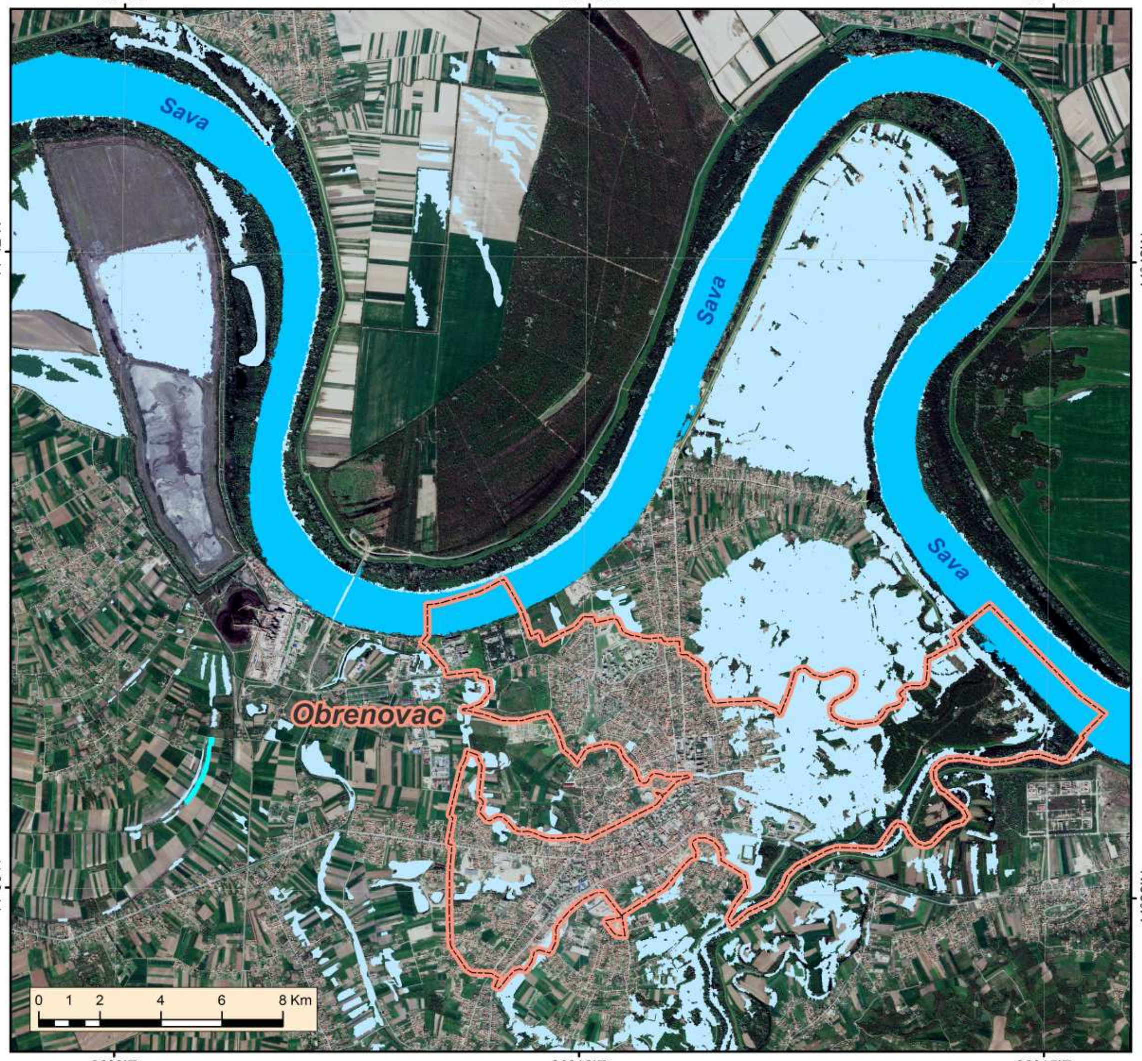
A specialized hard- and software complex was deployed and a division responsible for the Charter activity support in Russia was established at the basis of Research Center for Earth Operative Monitoring

The activation of the International Charter on Space and Major Disaster mechanism enables the implementation of international resources of multi-purpose space facilities (more than 40 spacecraft) in crisis and emergency situations including usage for the benefit of friendly nations.

INTERNATIONAL CHARTER 'SPACE AND MAJOR DISASTERS'

Flooding situation in Serbia on 22 of May 2014

Flooded area extension near Obrenovac city at the Sava river



Data processed by Research Center for Earth Operative Monitoring (NTs OMZ)
JSC "Russian Space Systems"

Area location

TerraSAR-X

Legend

- Obrenovac city boundary
- River mask (as of 20/04/2013)
- Flooded area mask (as of 22/05/2014)

N W E S

Description

Torrential rain in the Balkans caused the worst flooding that the area had experienced in over a century. The rain caused rise of water level which resulted in inundatoin of all nearby inhabited areas. In Serbia it was estimated that 51 people died and more than 36 000 people were evacuated.

Data source

TerraSAR-X image acquired on 22.05.2014, resolution - 3 m
© 2014 German Aerospace Center (DLR), 2014 Airbus Defence and Space / Infoterra GmbH.
Resurs-P image acquired on 22.05.2014, resolution - 1 m
©ROSCOSMOS.
Pleiades image acquired on 20.04.2013, resolution - 2 m
includes material © CNES 2014, Distribution Astrium Services /Spot Image SA, all rights reserved. Commercial Use Prohibited.

The flooded area mask was obtained on the basis of TerraSar-X data with usage of Resurs-P data. The flooded area water mask was overlaped by the river mask created on the basis of Pleiades data.

DLR cnes ROSCOSMOS

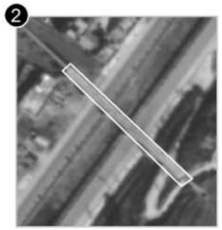
Monitoring of Chinese territories affected by earthquake, based on Resurs-P1 data.

Imagery fragments before and after the earthquake

1

06.02.2014


05.08.2014

2

06.02.2014


05.08.2014

3

06.02.2014


05.08.2014

4

06.02.2014


05.08.2014

City district of Wenping, based on Resurs-P1 data acquired on 05.08.2014

Location

Legend

Roads

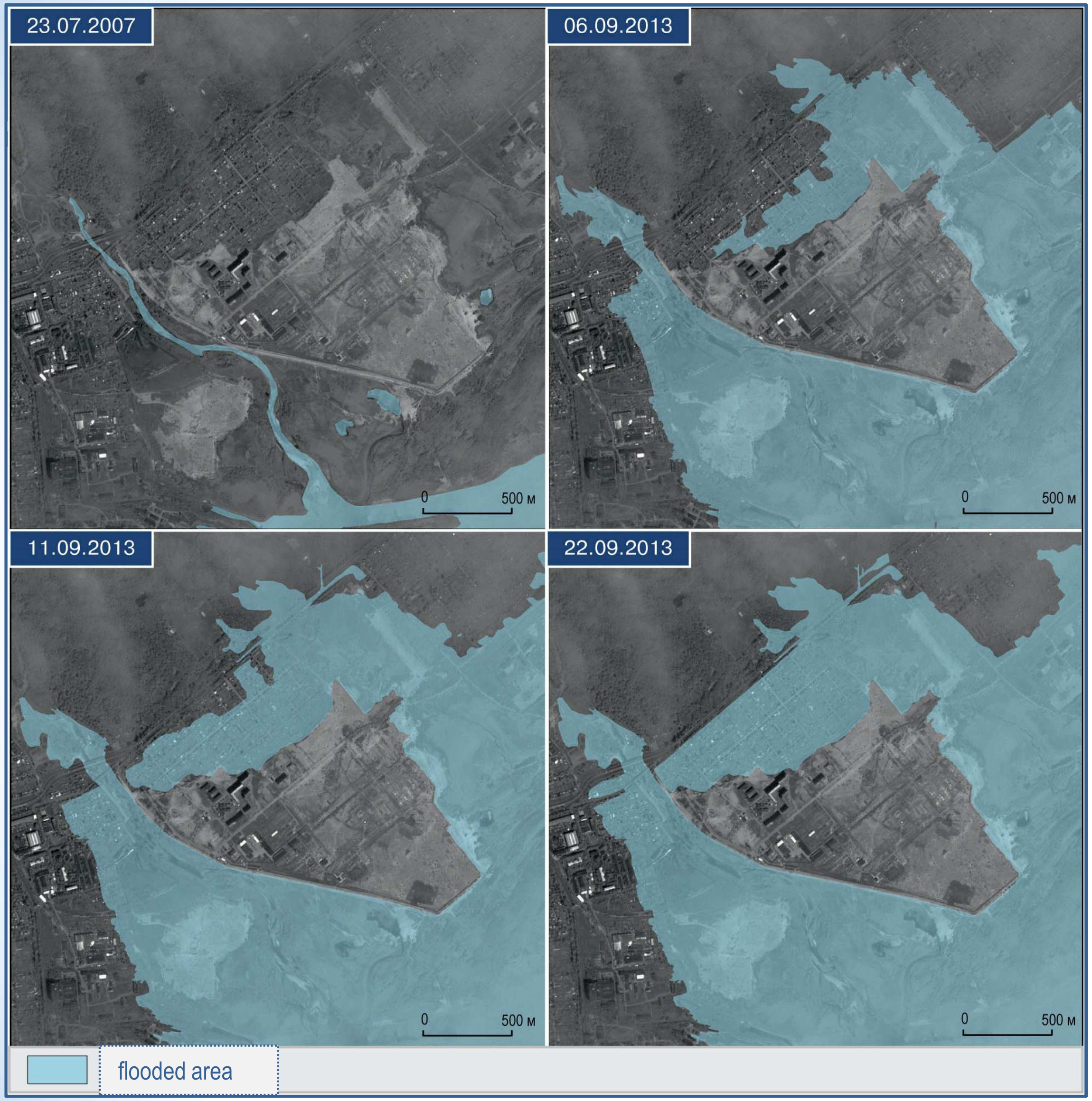
Highways

Territories potentially affected by earthquake

N
W E
S

Description

A 6.5 magnitude earthquake struck the South-Western China (Yunnan province) on August 3, 2014. The hypocenter was located at the distance of 11 km from Wenping and 29 km from Zhaotong, The earthquake source was located at the depth of 10 km. According to massmedia, some buildings were destroyed to the ground, overally more than 12 000 structures were destroyed and 30 000 were damaged.



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

Komsomolsk-on-Amur, Khabarovsk Territory

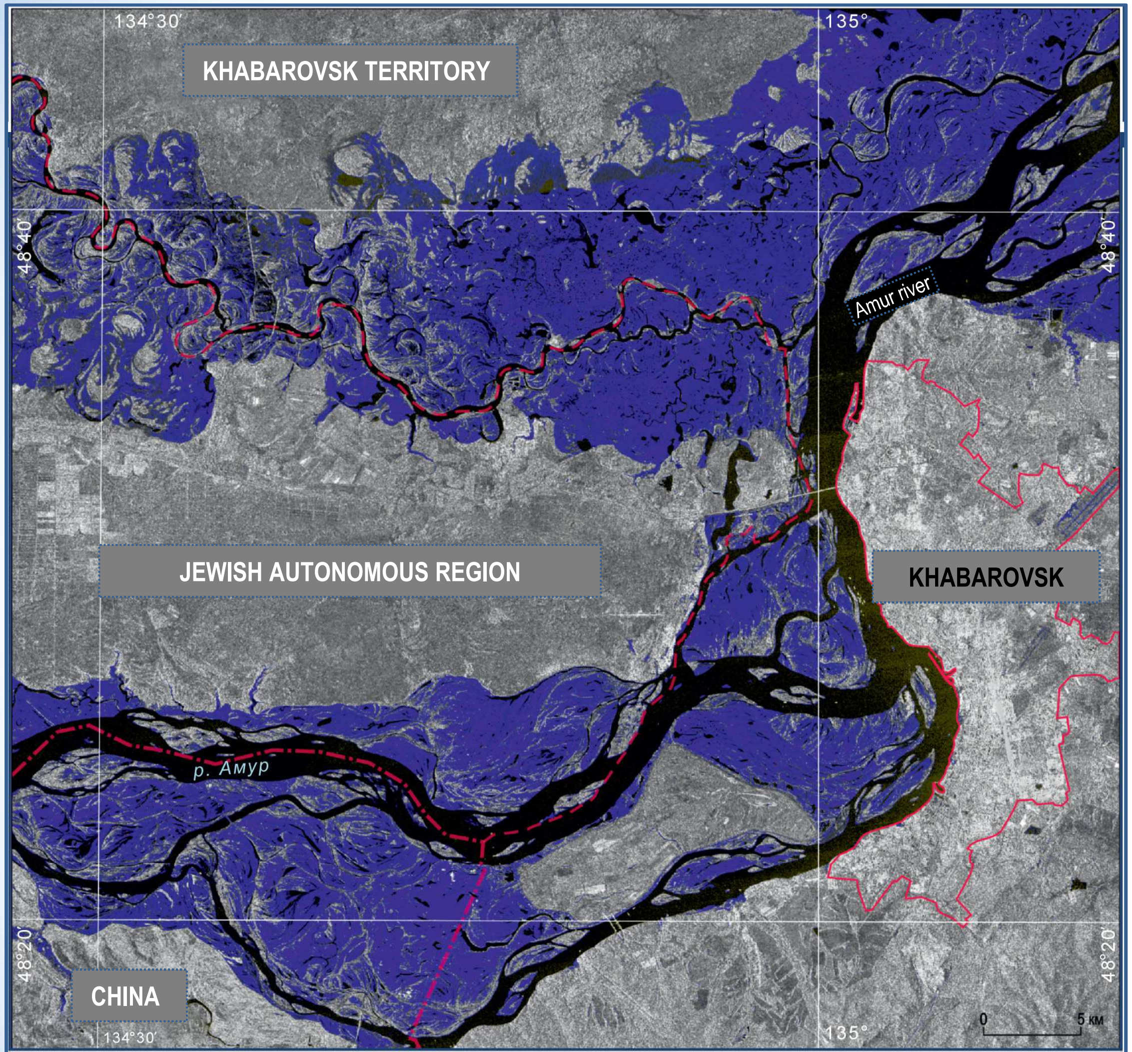
In July, 2013, extreme rainfall in the Far East of Russia caused floods known to be the most disastrous in the history of weather monitoring. In September, 2013, the Amur river level exceeded 8m in Komsomolsk-on-Amur area.

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-DK1 high resolution data.



- flooded area at the moment of data acquisition
- river channel and other hydrographic objects before flooding
- state boundaries
- subjects of the Russian Federation boundaries
- centers of population boundaries

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

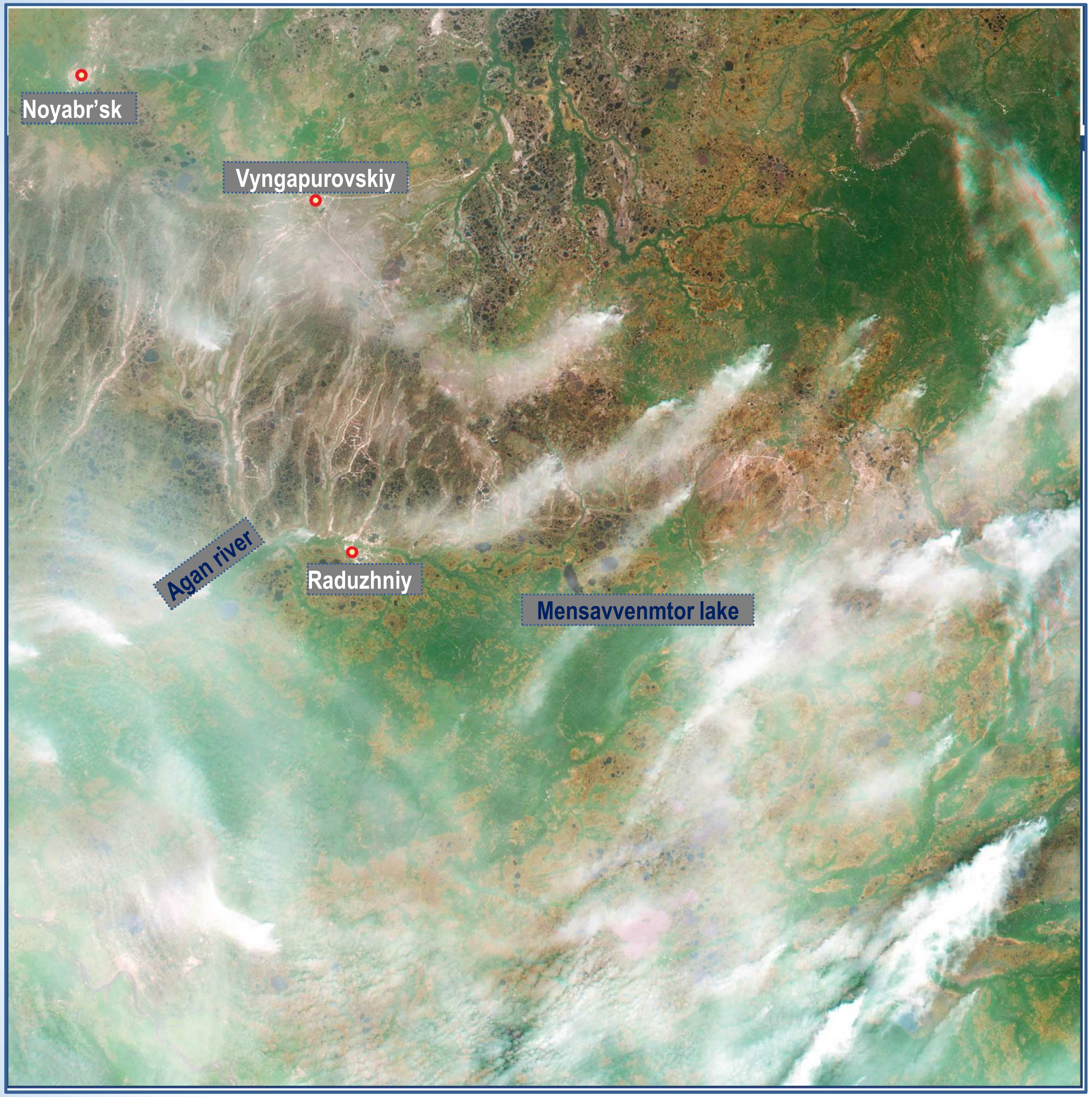
Khabarovsk Territory, Jewish Autonomous Region

Since the end of July, 2013, southern parts of the Far East in Russia and north-eastern areas of China faced disastrous flooding caused by unusually heavy rainfalls that led to the increase of the Amur River level.

The north-eastern provinces of China were hit the hardest. In the Russian Federation, among the most impacted were the Amur and Jewish Autonomous Regions as well as the Khabarovsk Territory.

Modern satellite radar data enables operative all-weather flood monitoring.

*Data used:
- Landsat-5 © 2010 USGS (19.09.2010);
- TanDEM-X © 2013 German Aerospace Center (DLR), © 2013 Astrium Services / Infoterra GmbH (21.08.2013)



Fire Hazards Monitoring

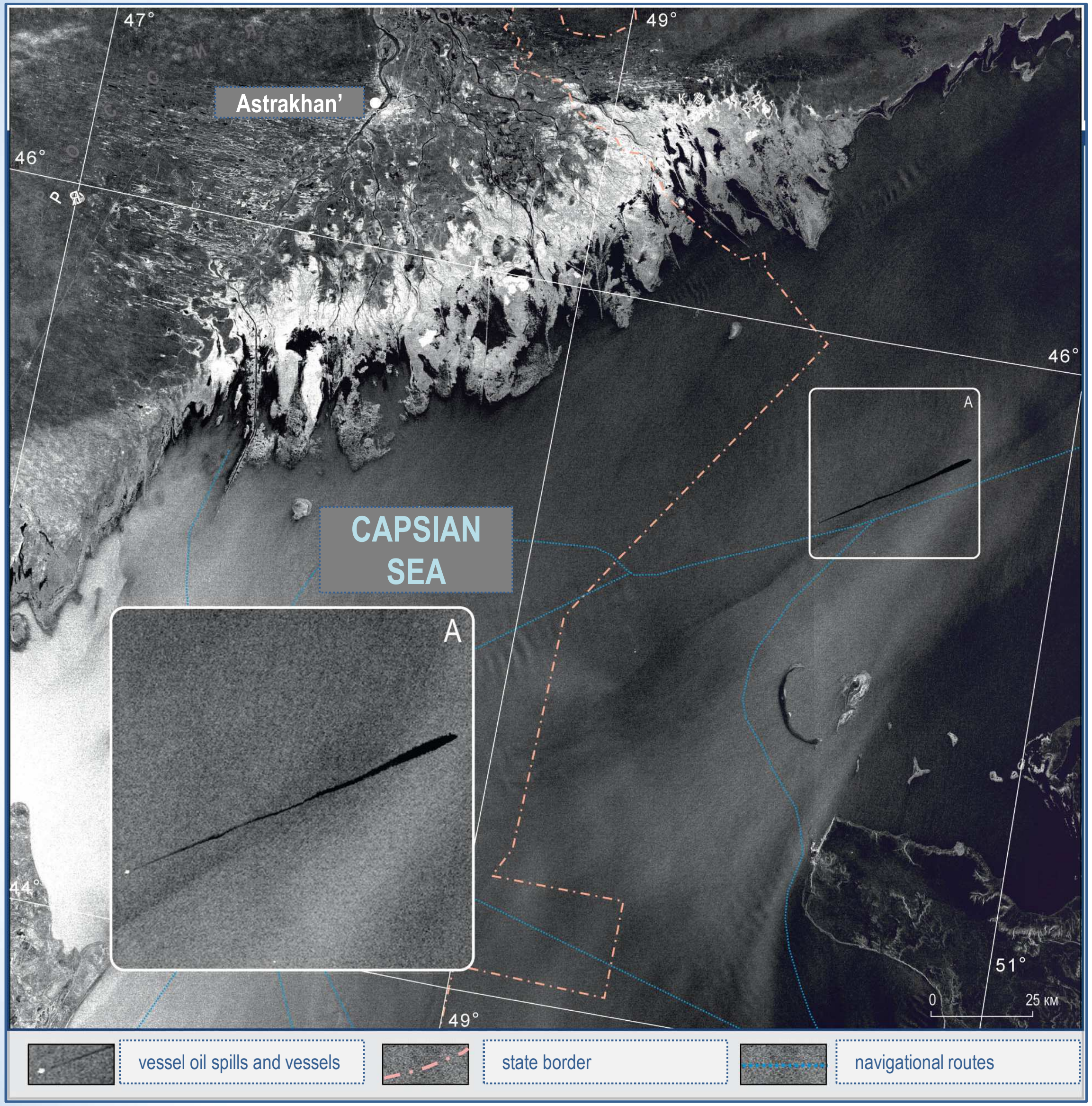
Using Russian Remote Sensing Data*

Khanty-Mansiysk Autonomous District

Since 2009, the Research Center for Earth Operative Monitoring has carried out operative monitoring of forest fires using Meteor-M1 /KMSS medium-resolution data.

The imagery data is used by the EMERCOM of Russia and federal authorities to detect fires, to monitor smoke plume spread, to forecast the condition development and to estimate the fire-affected areas.

*Data used:
«Meteor-M1» (20.06.2012)



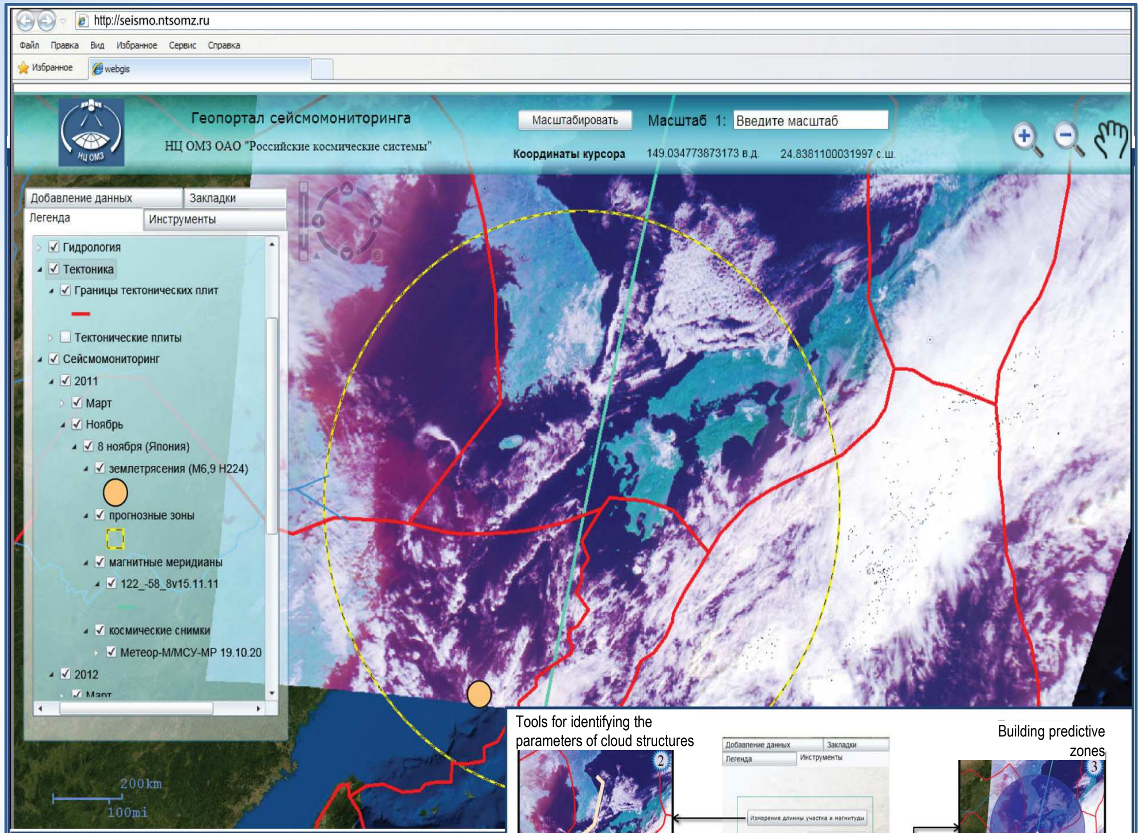
Monitoring of Oil Spills*

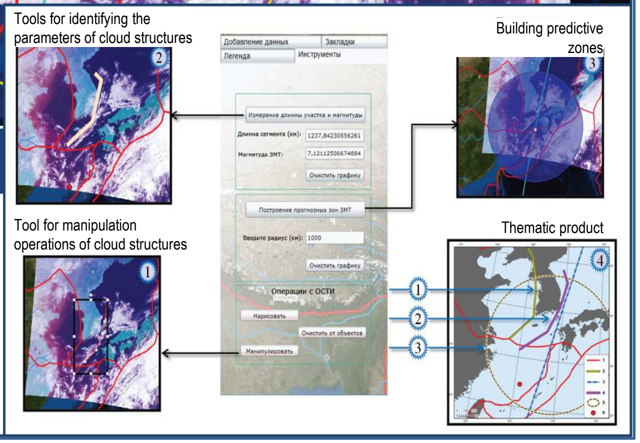
Northern Part of the Caspian Sea

Oil spills have significant negative impacts on the marine environment. Oil leaks at sea are a common occurrence. They are particularly dangerous in cases of oil ships accidents or accidents on oil platforms and in coastal areas as well as along busy navigational routes. Sea contamination caused by marine transport and emergency situations results from intended discharge of pollutants.

Use of recent satellite radar data enables operational all-weather environmental monitoring of marine areas.

*Data used:
ENVISAT ASAR (02.06.2008)





Key Results of Geoinformation Product use:

1. Monitoring experiments were pursued in pilot areas of Japan and Russia. Eight EQ predictions recorded in the Scientific Council of Seismology were confirmed: four for the area of Japan and four for Kamchatka (Russia).
2. Signs of the destructive EQs that occurred in Iran, Salvador, Guatemala and Pakistan were analyzed.
3. Forty products across seven seismically active areas were generated for the period 2012-2013.

Seismic monitoring

Since 2004, the Research Center for Earth Operative Monitoring has accumulated a large amount of remote sensing data with the signs of a impending earthquake (EQ) and geophysical measurements, and has formalized a number of techniques to process them under a research and development project to develop methods and means of seismic monitoring.

User access to the product database is provided via Seismic Monitoring web-portal interface. The developed portal solutions enable users to perform primary analysis of the signs of an impending EQ to predict the date. place and magnitude in any seismically active area as well as to obtain prognostic parameters of forthcoming EQs

Users are provided with the capabilities for resolving their thematic tasks using information layer expansion and new instrument and service implementation on the basis of information and technical interface protocols.

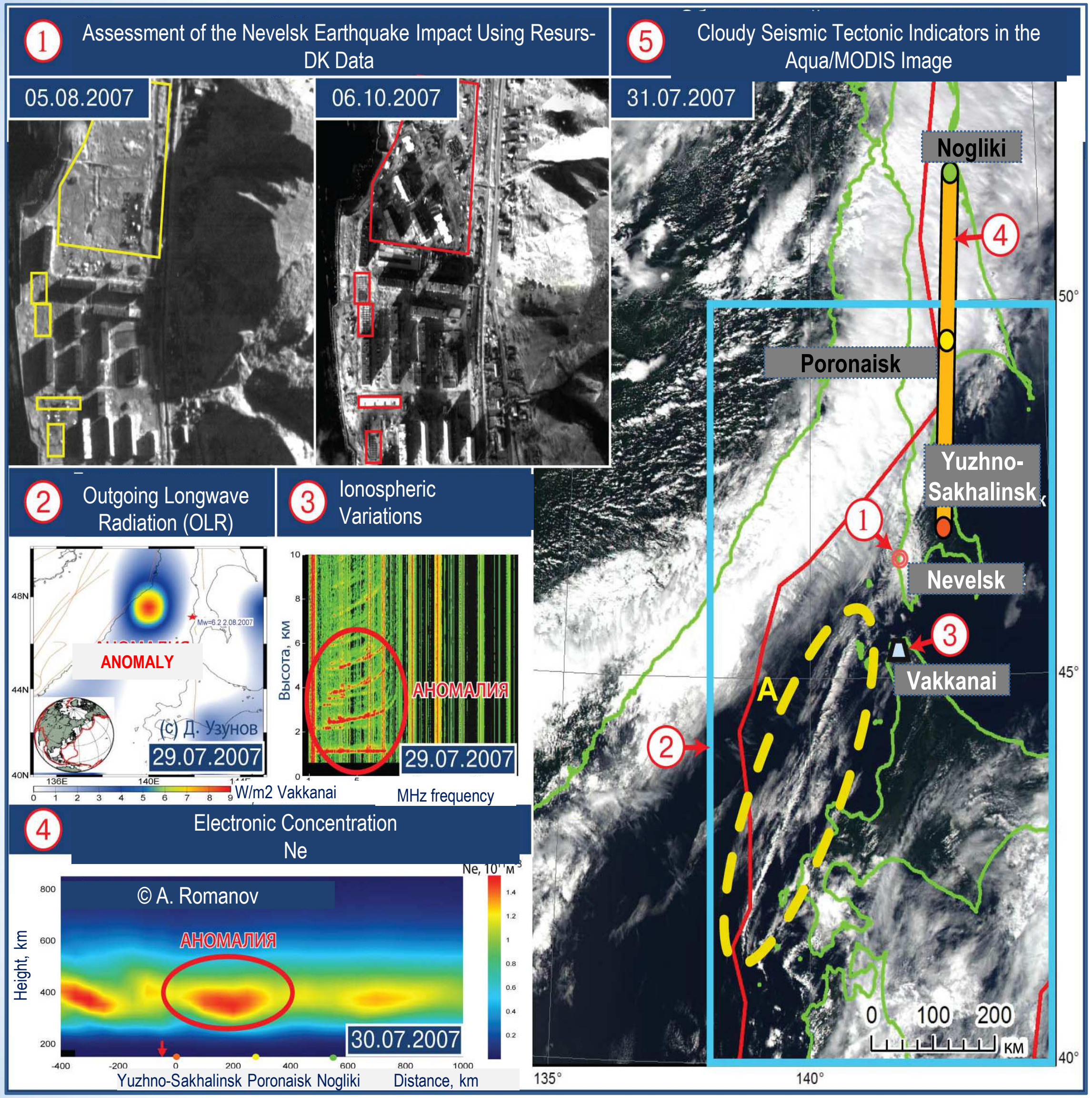
A set of seven types of digital seismic monitoring products and their combinations was developed.

The main products include:

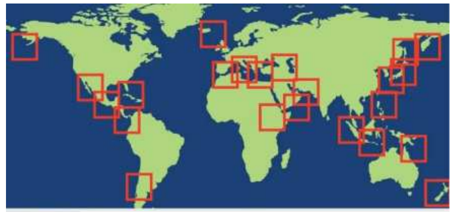
- A composite software that contains maps of tectonic plate boundaries and EQ-triggering seismic-magnetic meridians as well as semantic tables of potential EQ dates.
- A composite software that contains a map of tectonic plate boundaries and a satellite image with marked cloud seismic-tectonic indicators.
- Prognostic EQ map with design variables: intervals of magnitudes and dates as well as the epicenter.

Currently, the geoinformation seismic monitoring database of the Research Center for Earth Operative Monitoring contains over 1000 composite software products based on the most severe EQs that have occurred between 2002 and the present day

www.seismo.ntsomz.ru



Example of Seismic Monitoring Problem Solving



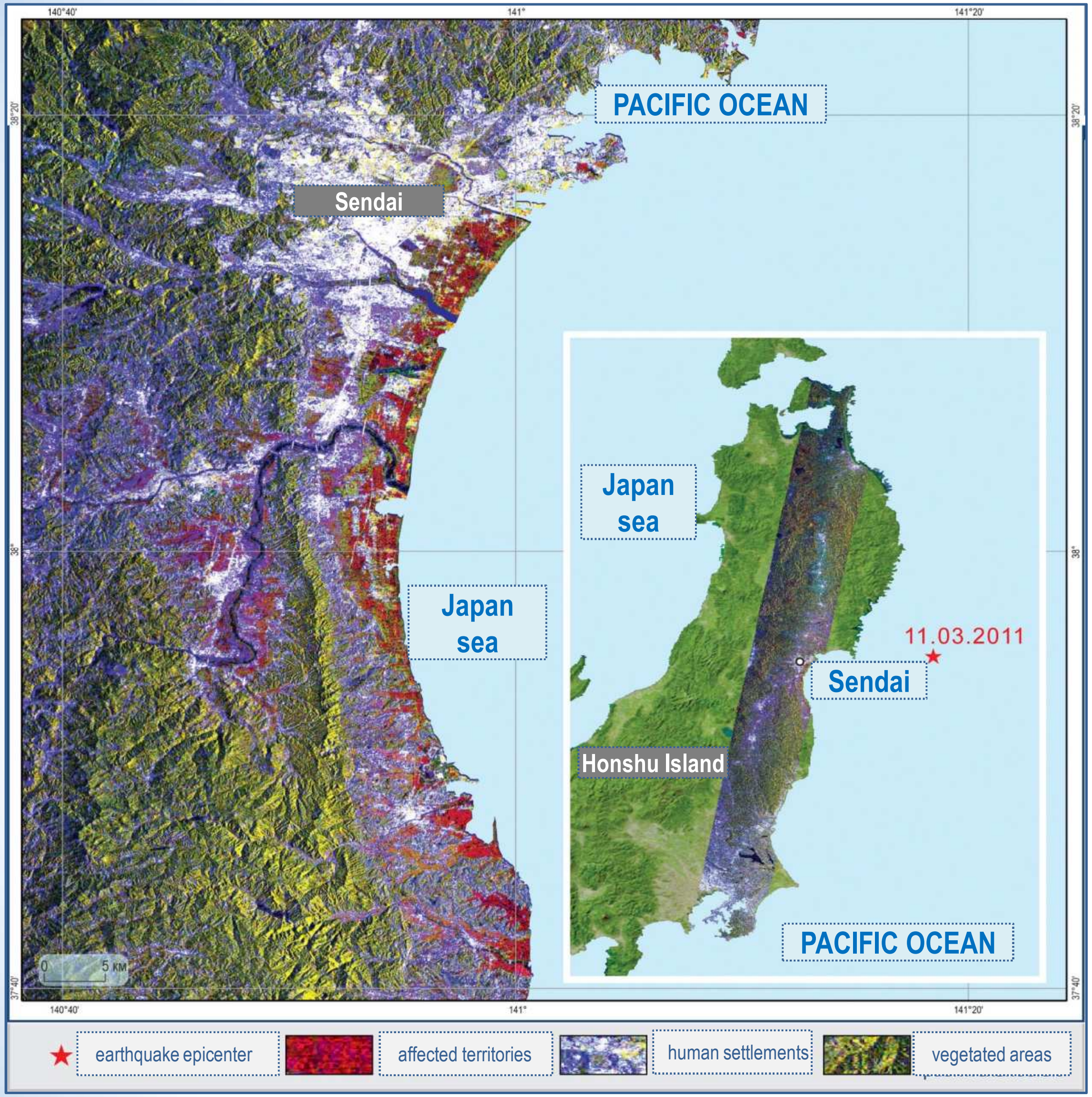
Seismic monitoring experiment zones in 2004-2013

On August, 2007, an EQ of M=6.2 occurred in the Sakhalin Island. Analysis of space monitoring data obtained in the Sakhalin Island area enabled determining the signs of the impending EQ.

Ionospheric monitoring was performed using Kosmos, Transit, GPS and GLONASS space modules equipment. Data-receiving stations and data-processing facilities were located in Nogliki, Poronaisk and Yuzhno-Sakhalinsk. Cloud cover images were obtained using Terra, Aqua and NOAA satellites as well as open geophysical on-line sources.

The signs of the impending EQ were determined as a result of assessing lithospheric and atmospheric process parameters. In the image, anomalies are circled. Potential M=6.9+0.2 was measured using cloud seismic indicators (Block 5, Structure A) based on the following formula: $M(A)=\ln(D/D_o)$ where M is calculated magnitude, D – cloudy structure extent, Do – reference cloud. The date and location were determined using a set of abnormal signs (Block 2, 3 and 4) 3 days prior to the anticipated EQ.

The EQ impacts were evaluated using Resurs-DK very-high resolution data (Block 1). The ground work and outcomes obtained under the Sakhalin Experiment are now used for other EQ prone areas, primarily for Kamchatka and Japan. Eight EQ predictions with M>6.0 were confirmed in 2012-2013 on the experimental seismic monitoring site of the Research Center for Earth Operative Monitoring.



Earthquake and Tsunami Impacts Monitoring*

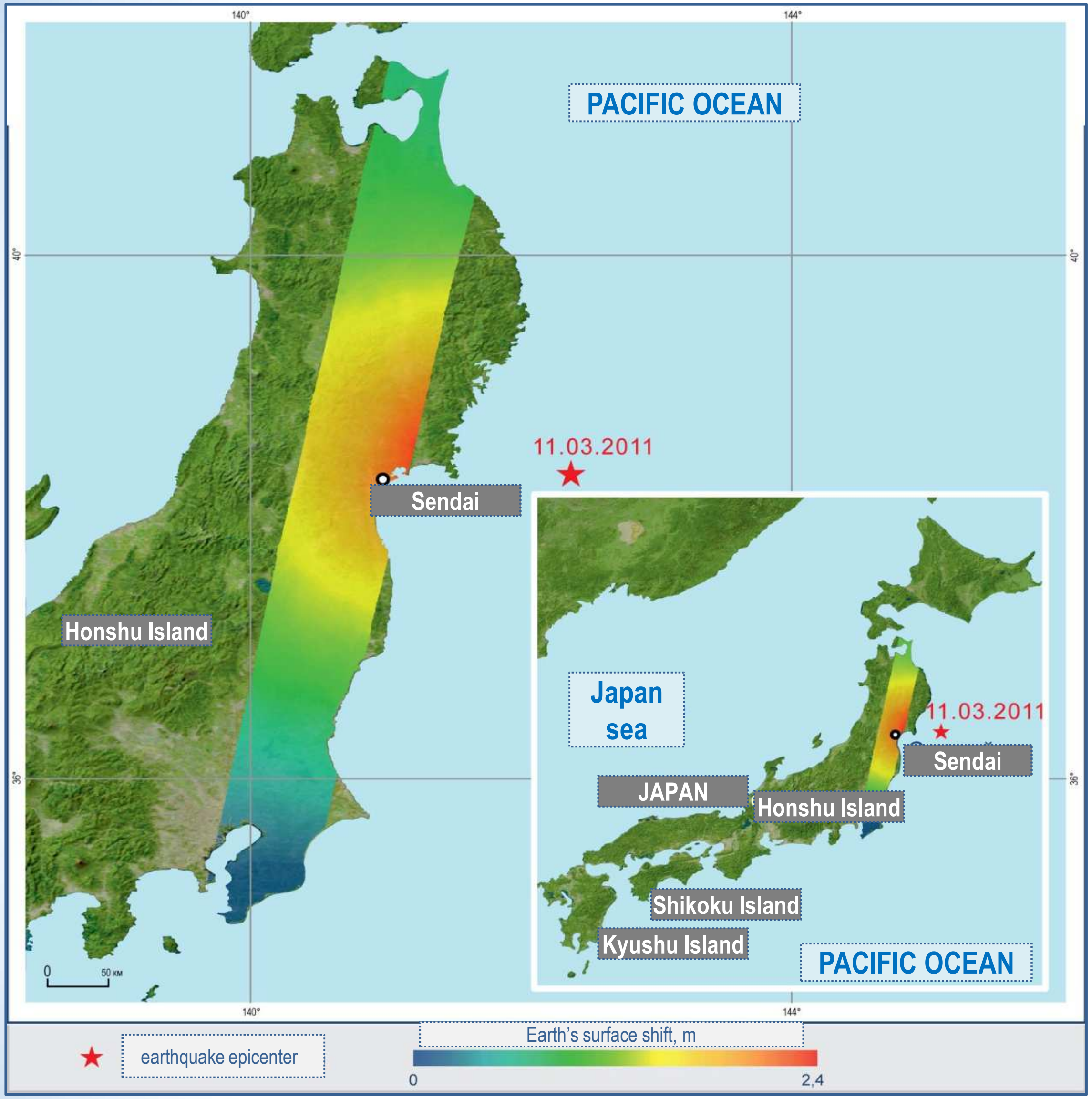
Japan

On March 11, 2011, an EQ of M=9 occurred near the east coast of Honshu Island. Its epicenter was identified 70 km off the shore. The nearest large city of Sendai is 130 km away from the epicenter. Japan's capital, Tokyo, is 373 km away.

The EQ caused a devastating tsunami resulting in significant damage in the northern islands of the Japanese archipelago.

A shift map based on processed satellite radar data enables detecting areas of most significant destruction.

*Data used:
ENVISAT ASAR (19.02.2011– 21.03.2011)
© European Space Agency (2011)



Developing Tools and Methods to Build Shift Maps*

Japan

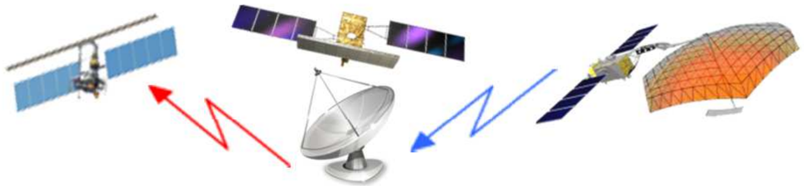
On March 11, 2011, an EQ of M=9 occurred near the east coast of Honshu Island. Its epicenter was identified 70 km off the shore. The nearest large city of Sendai is 130 km away form the epicenter. Japan's capital, Tokyo, is 373 km away.

According to geophysical data, the EQ caused a significant shift of the Northern Japan bringing it 2.4 m closer to the North America. Areas of Japan closest to the epicenter shifted most.

A digital shift map based on processed satellite radar data enables detecting and quantifying such changes.

*Used data:
ENVISAT ASAR (19.02.2011–21.03.2011)
© European Space Agency (2011)

GEOINFORMATION SERVICES OF RUSSIAN SPACE REMOTE SENSING SYSTEMS OPERATOR



Geoinformation services of space remote
(NTs OMZ of JSC “RSS”)

Primary cosmic information

Primary cosmic information

General Bank of Geo Data (EBGD)

since 2010

General catalog and archive of remote sensing data, прошедших

- ✓ *Relative and absolute calibration*
- ✓ *Geometric correction*
- ✓ *Geolocation to main geodetic coordinate systems*
- ✓ *…*

Bank of remote sensing basic products for interagency use (BBP)

since 2016

Catalog and archive of the basic products of remote sensing

Index image:

- ✓ *vegetation cover*
- ✓ *quality of sea water*
- ✓ *distributions of rivers floods*
- ✓ *…*

ROSCOSMOS’s Geoportal

Departmental and regional information systems

Center of the Unified System of Information on the World Ocean Conditions (ESIMO)

International cooperation programs

NEW GEOINFORMATION OPERATOR’S SERVICE

Establishment of space information processing product availability –

proved its efficiency, implemented over the past 20 years the leading space agencies

ESA and NASA

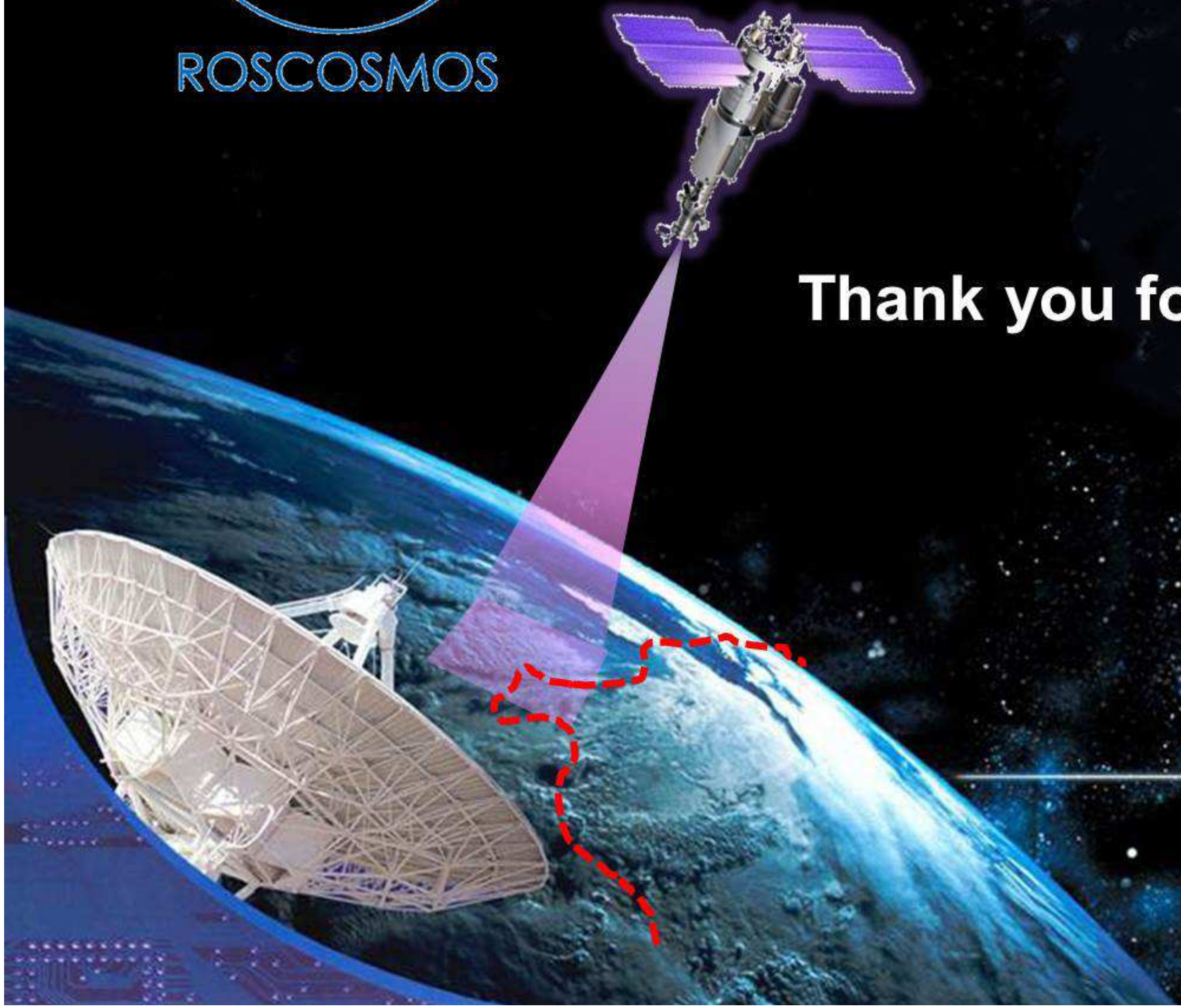
Basic EO products, created on the basis of the Russian information –

an additional resource for existing public services, natural resource assignments

(GMES, EOS DIS)

United nation, Vienna, 9-13 February 2015

ROSCOSMOS



Thank you for your attention!

Valery Zaichko

opoi@roscosmos.ru