

**ITSC-16**

**Angra dos Reis, Brazil, May 07 –13, 2008**

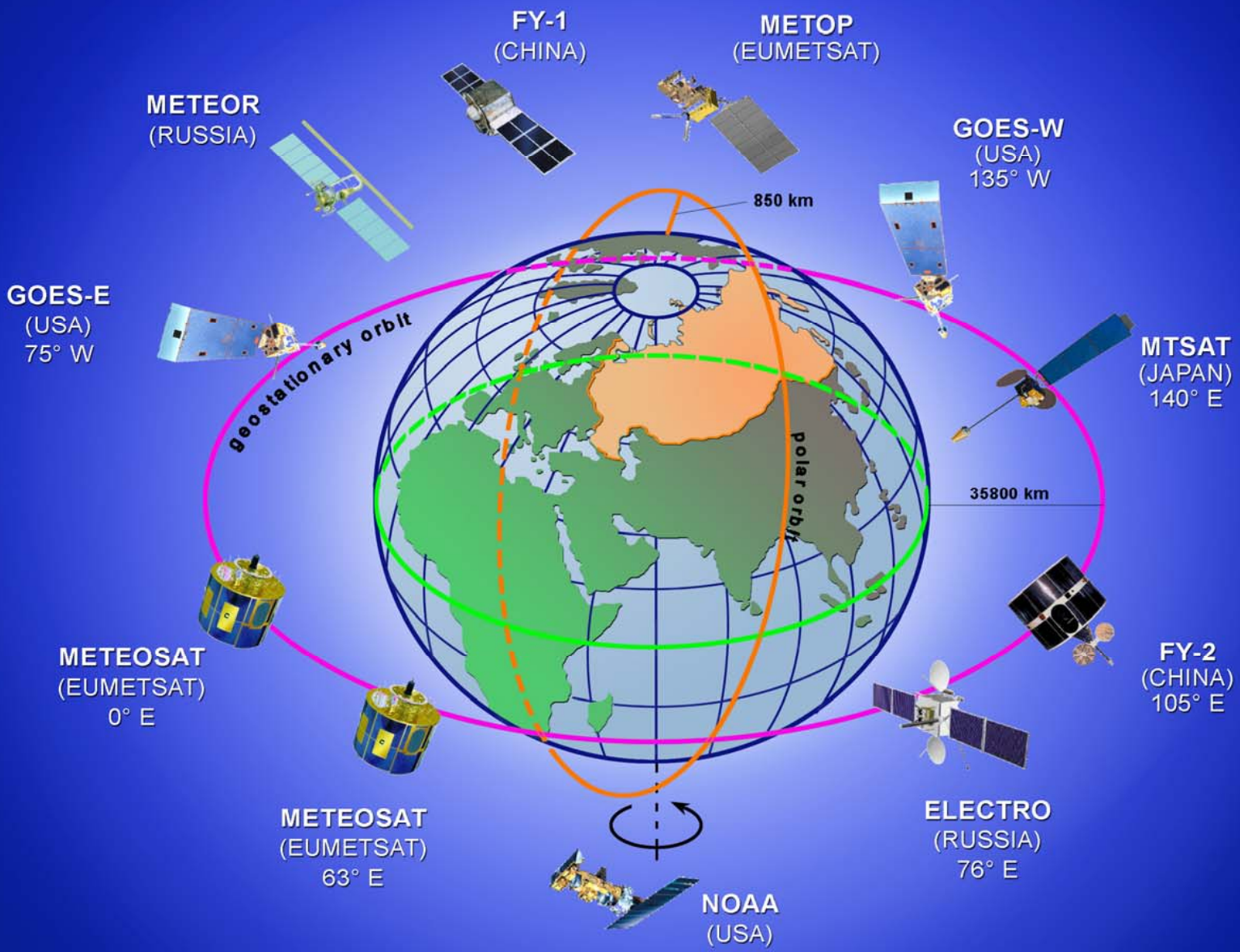
**Status of current and future  
Roshydromet satellite  
programmes**

**Uspensky A.B.**

**State Research Center on Space Hydrometeorology PLANETA, Moscow, Russia**

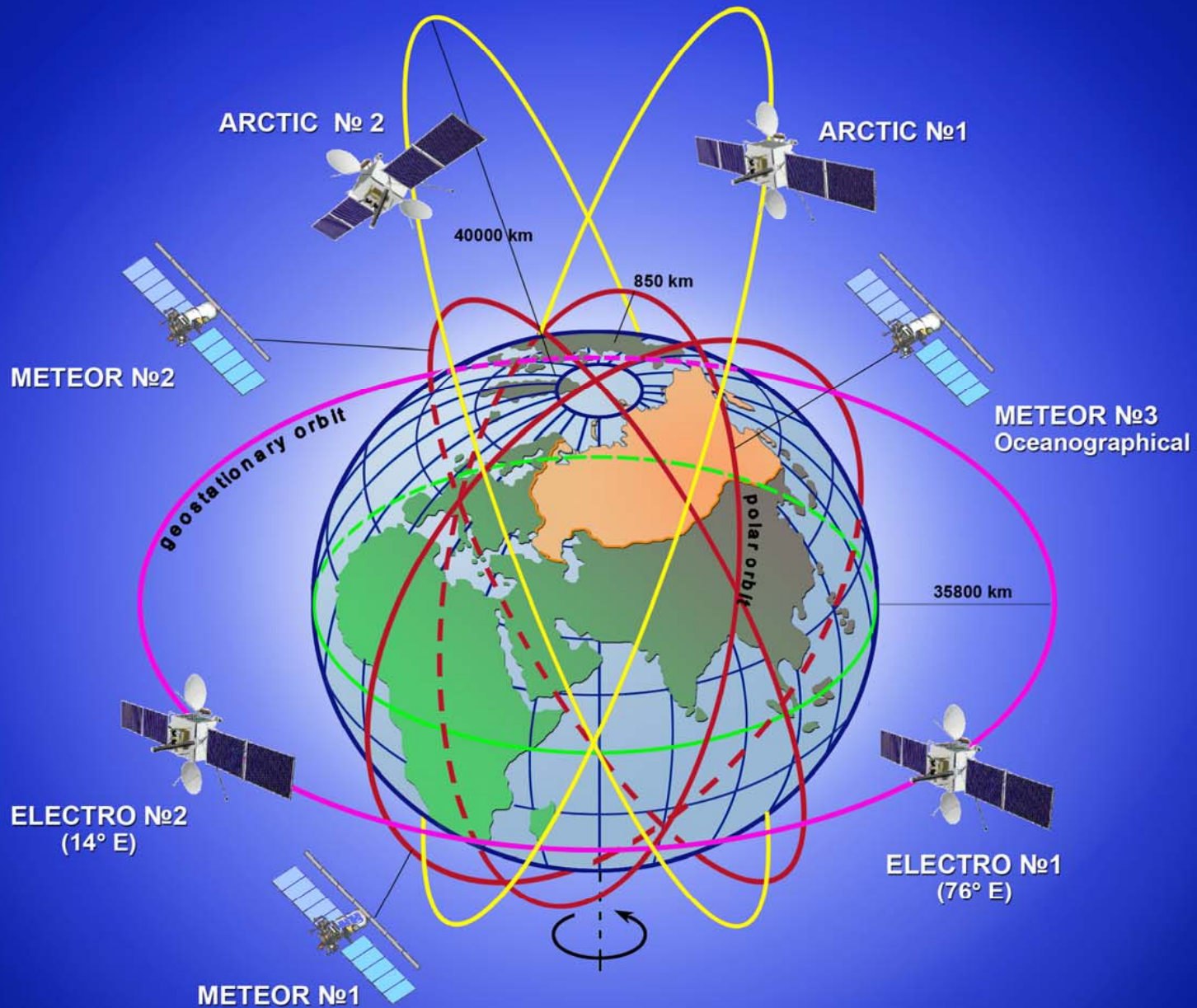


# EARTH OBSERVATION SATELLITE SYSTEM

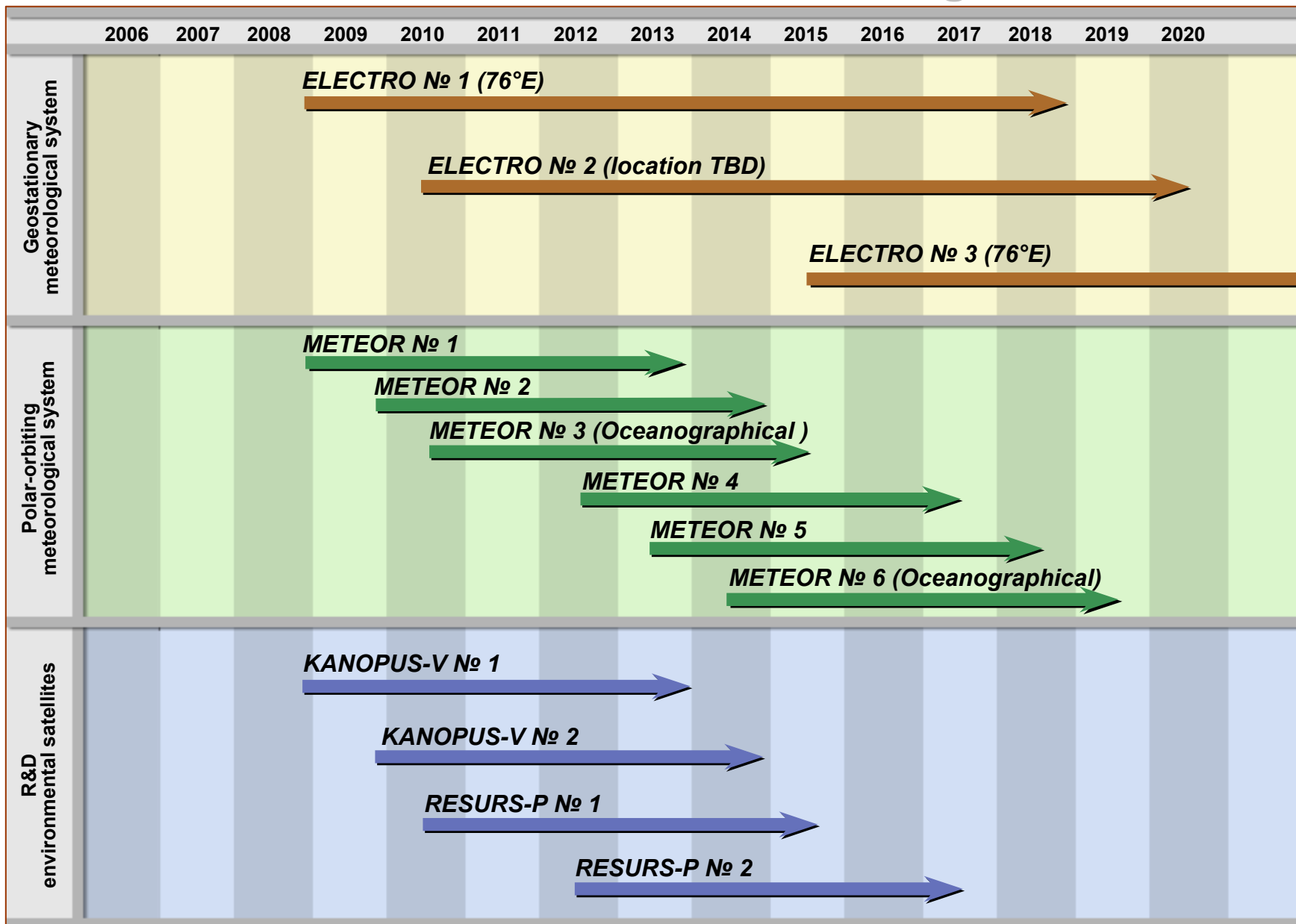




# RUSSIAN HYDROMETEOROLOGICAL SATELLITE SYSTEM

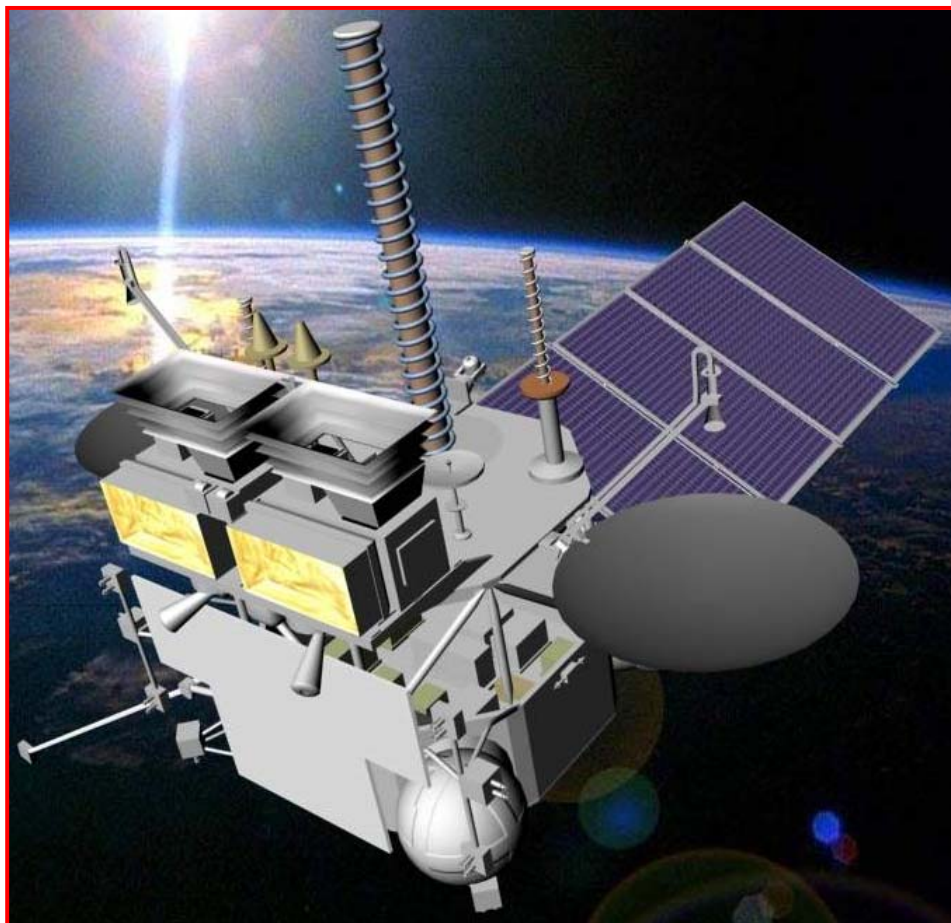


# Russian Earth Observation Satellites Program 2006-2015





# ELECTRO-L General Design



- Three-axis high-precision stabilization
- In-orbit mass - 1500 kg
- Payload mass - 370 kg
- Lifetime - 10 years
- Longitude - 76E
- Data dissemination format - HRIT/LRIT
- Image repeat cycle – 30/15 min

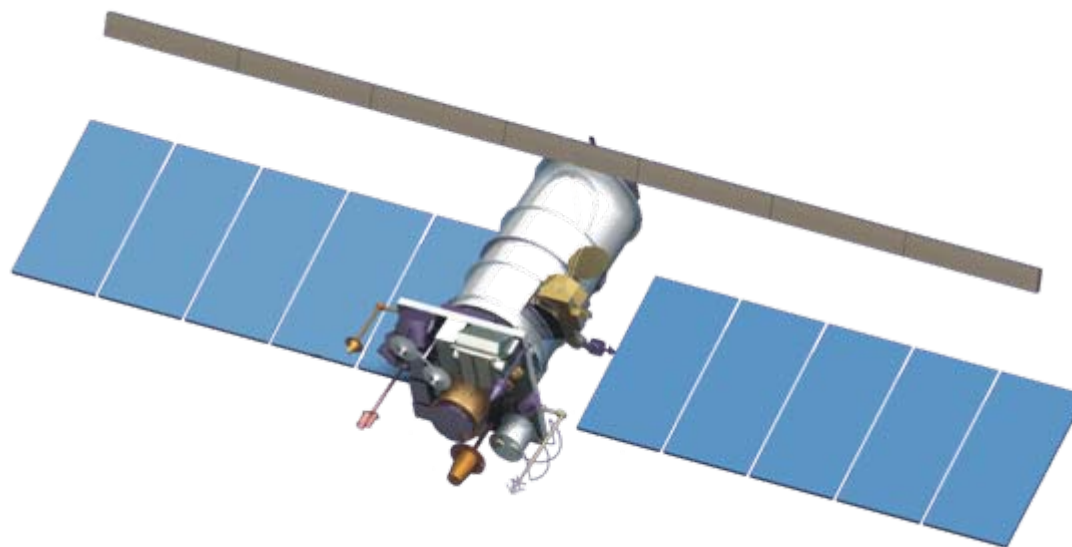
## Mission objectives

- Operational observation of the atmosphere and the Earth surface (MSU-GS)
- Heliogeophysical measurements
- Maintaining Data Collection System and COSPAS/SARSAT Service

# MSU-GS Basic Performance Characteristics

1.	Number of channels • VIS • IR	10 3 7
2.	Spectral range at half maximum of spectral response function ( $\mu\text{m}$ )	0.5-0.65; 0.65-0.80; 0.8-0.9; 3.5-4.0; 5.7-7.0; 7.5-8.5; 8.2-9.2; 9.2-10.2; 10.2-11.2; 11.2-12.5
3.	Image frame (deg x deg)	$20 \pm 0.5 \times 20 \pm 0.5$
4.	HRIT ground resolution in subsatellite point (km)	1.0 (VIS); 4.0 (IR)
5.	S/N ratio for VIS channels	$\geq 200$
6.	NE $\Delta$ T at 300K (K) • in the band 3.5-4.0 $\mu\text{m}$ • in the band 5.7-7.0 $\mu\text{m}$ • in the band 7.5-12.5 $\mu\text{m}$	0.8 0.4 0.1-0.2
7.	Power (W)	$\leq 150$
8.	Weight (kg)	$\leq 88$
9.	Lifetime of basic and reserve units (years)	10

# METEOR-M General Design



- **In-orbit mass – 2700 kg**
- **Payload mass – 1200 kg**
- **Lifetime – 5 years**
- **Orbit – Sunsynchronous**
- **Altitude – 830 km**
- **Data dissemination format – HRPT/LRPT**



# METEOR-M Mission Objectives and Basic Instruments

<b>Instrument</b>	<b>Application</b>	<b>Spectral Band</b>	<b>Swath-width (km)</b>	<b>Resolution (km)</b>	<b>Instruments for intercalibration</b>
<b>MSU-MR</b>	Global and regional cloud cover mapping, SST, LST, ...	0.5 – 12.5 $\mu\text{m}$ (6 channels)	3000	1 x 1	AVHRR/NOAA
<b>KMSS multichannel scanning unit</b>	Earth surface monitoring	0.4-0.9 $\mu\text{m}$ (3 channels)	100	0.06/0.1	
<b>MTVZA imager/sounder</b>	Atmospheric temperature and humidity profiles, sea surface wind	10.6-183.3 GHz (26 channels)	2600	12 – 75	SSMIS/DMSP AMSR/EOS-AQUA AMSU/NOAA
<b>IRFS-2 advanced IR sounder *</b>	Atmospheric temperature and humidity profiles	5-15 $\mu\text{m}$	2000	35	
<b>Severjanin (SAR)</b>	Ice monitoring	9500-9700 MHz	600	0.4 x 0.5	
<b>Radiomet* (radio occultation unit)</b>	Atmospheric temperature and pressure profiles.				

\* - to be launched on board METEOR-M №2

# MTVZA-GJa instrument (Meteor-M N 1)



## Basic performance characteristics of MTVZA-GJa

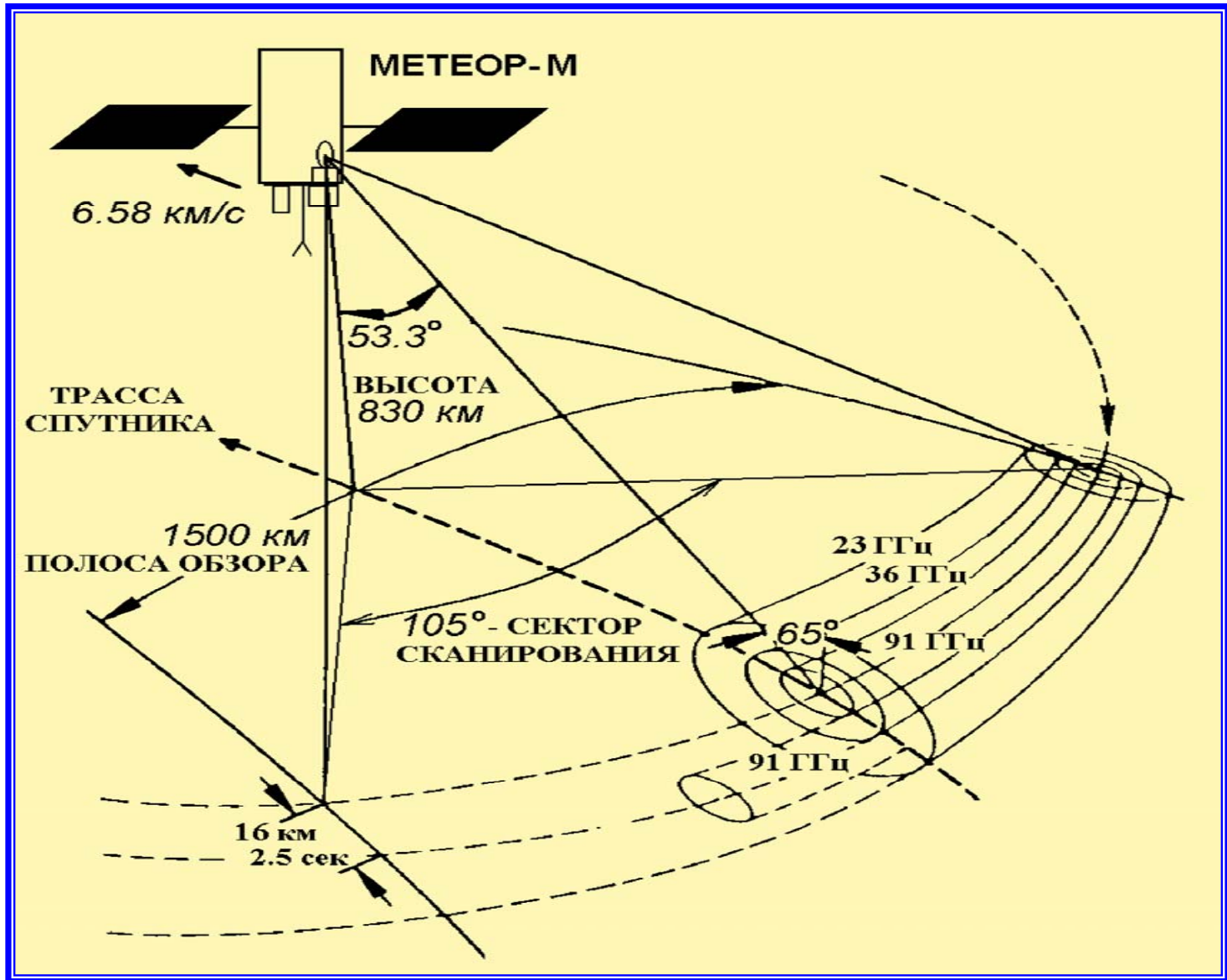
Instrument	MTVZA-GJa
Spectral range	10.6, 18.7, 23.8 31.5, 36.7, 42, 48, <u>52-57</u> , 91, <u>183.31</u> , GHz
Spatial resolution: - horizontal - vertical	16-198 km 1.5-7 km
Swath width	1500 km
Scanning regime	conical
Regime	continious
Scanning duration	2.55 sec
Data flow	35 kbit/sec
Weight	90 kg
Power	80 W



# MTVZA-GJa channel characteristics

Frequency (GHz)	Spatial resolution (km x km)	Pixel within imagery (km x km)	Sensitivity (K/pixel)	Altitude of Weighting function maximum (km)
10.6	89x198	32x32	0.5	-
18.7	52x116	32x32	0.4	-
23.8	42x94	32x32	0.3	-
31.5	35x76	32x32	0.3	-
36.7	30x67	32x32	0.3	-
42	26x60	32x32	0.4	-
48	24x43	32x32	0.4	-
52.80	21x48	48x48	0.4	2
53.30	21x48	48x48	0.4	4
53.80	21x48	48x48	0.4	6
54.64	21x48	48x48	0.4	10
55.63	21x48	48x48	0.4	14
57.290344±0.3222±0.1	21x48	48x48	0.4	20
57.290344±0.3222±0.05	21x48	48x48	0.7	25
57.290344±0.3222±0.025	21x48	48x48	0.9	29
57.290344±0.3222±0.01	21x48	48x48	1.3	35
57.290344±0.3222±0.005	21x48	48x48	1.7	42
91	14x30	16x16	0.6	Surface
183.31 ± 1.0	9x21	32x32	0.8	5.3
183.31 ± 3.0	9x21	32x32	0.6	2.9
183.31 ± 7.0	9x21	32x32	0.5	1.5

# Scanning geometry of MTVZA-GJa (Meteor-M №1)



## Basic performance characteristics of IRFS-2

№	Parameter	Units	Value
1	Spectral range: wavelength wave number	$\mu\text{m}$ $\text{cm}^{-1}$	5-15 2000-665
2	Reference channel wavelength	$\mu\text{m}$	1.06
3	Maximum optical path difference (OPD)	mm	17
4	Angular size of FOV	mrad	40 x 40
5	Spatial resolution (at subsatellite point)	km	35
6	Swath Width and spatial sampling	km	2500, 110 2000, 100
7	Aperture angle of beams reaching the detector	degree	63
8	Duration of the interferogram measurement	s	0.5
9	Dynamic range		$2^{16}$
10	Number of reference points in two-sided interferogram		$2^{15}$
11	Frequency band of measuring channel	kHz	4.5-13.5
12	Reference signal frequency	kHz	65.5
13	Frequency band of reference channel	kHz	61-70
14	Weight	kg	45-50
15	Power	W	50



## Spectral regions used by the IRFS-2 instrument

<b>№</b>	<b>Spectral region</b>	<b>Absorption band</b>	<b>Application</b>
1	665 to 780 $\text{cm}^{-1}$	$\text{CO}_2$	Temperature profile
2	790 to 980 $\text{cm}^{-1}$	Atmospheric window	Surface parameters ( $T_s, \epsilon_v$ ) Cloud properties
3	1000 to 1070 $\text{cm}^{-1}$	$\text{O}_3$	Ozone sounding
4	1080 to 1150 $\text{cm}^{-1}$	Atmospheric window	$T_s, \epsilon_v$ , Cloud properties
5	1210 to 1650 $\text{cm}^{-1}$	$\text{H}_2\text{O}, \text{N}_2\text{O}, \text{CH}_4$	Moisture profile, $\text{CH}_4, \text{N}_2\text{O}$ column amounts

# Roshydromet Satellite Ground Segment

## 3 Main centers:

### Europe

(Moscow-Obninsk-Dolgoprudny)

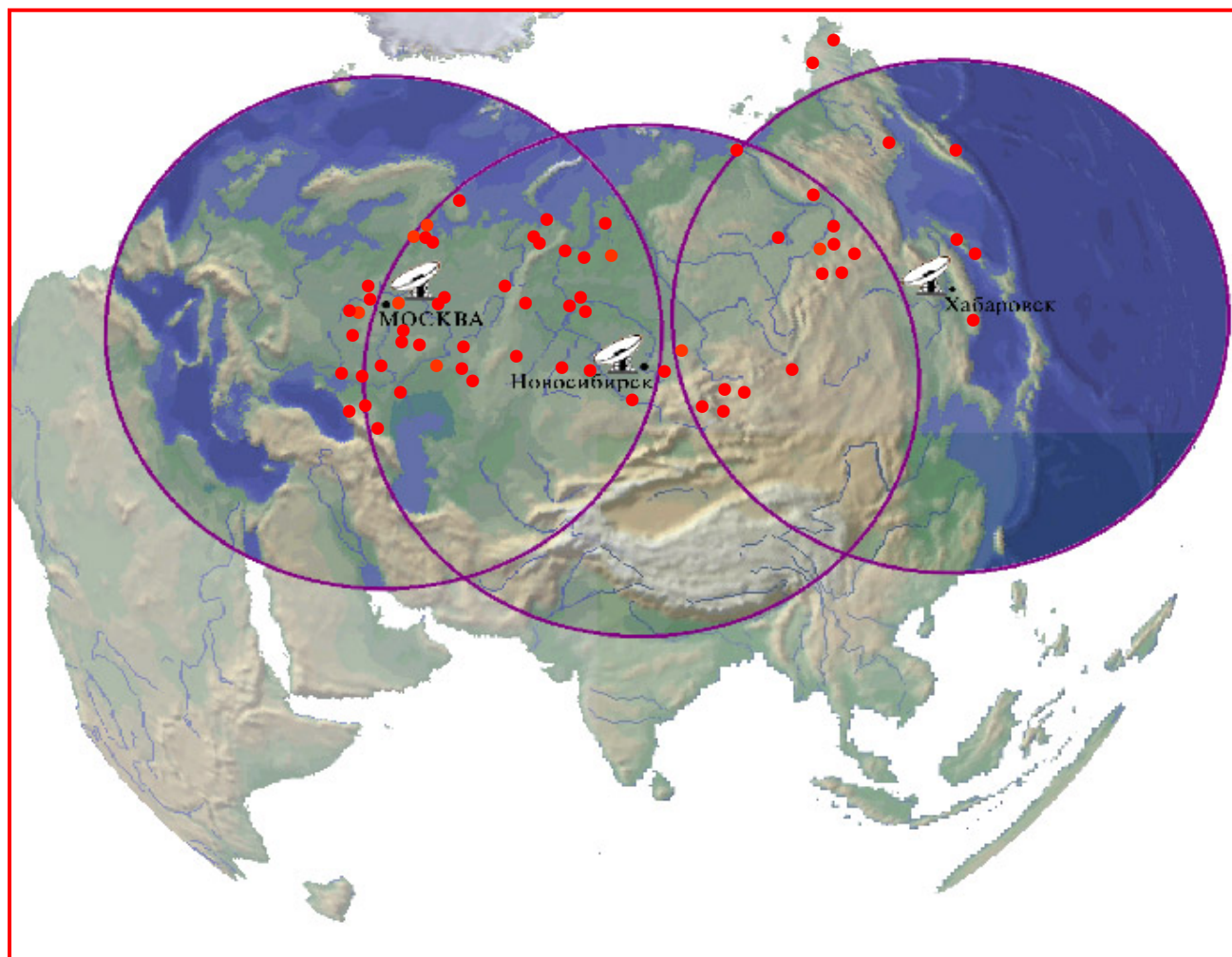
### Siberia

(Novosibirsk)

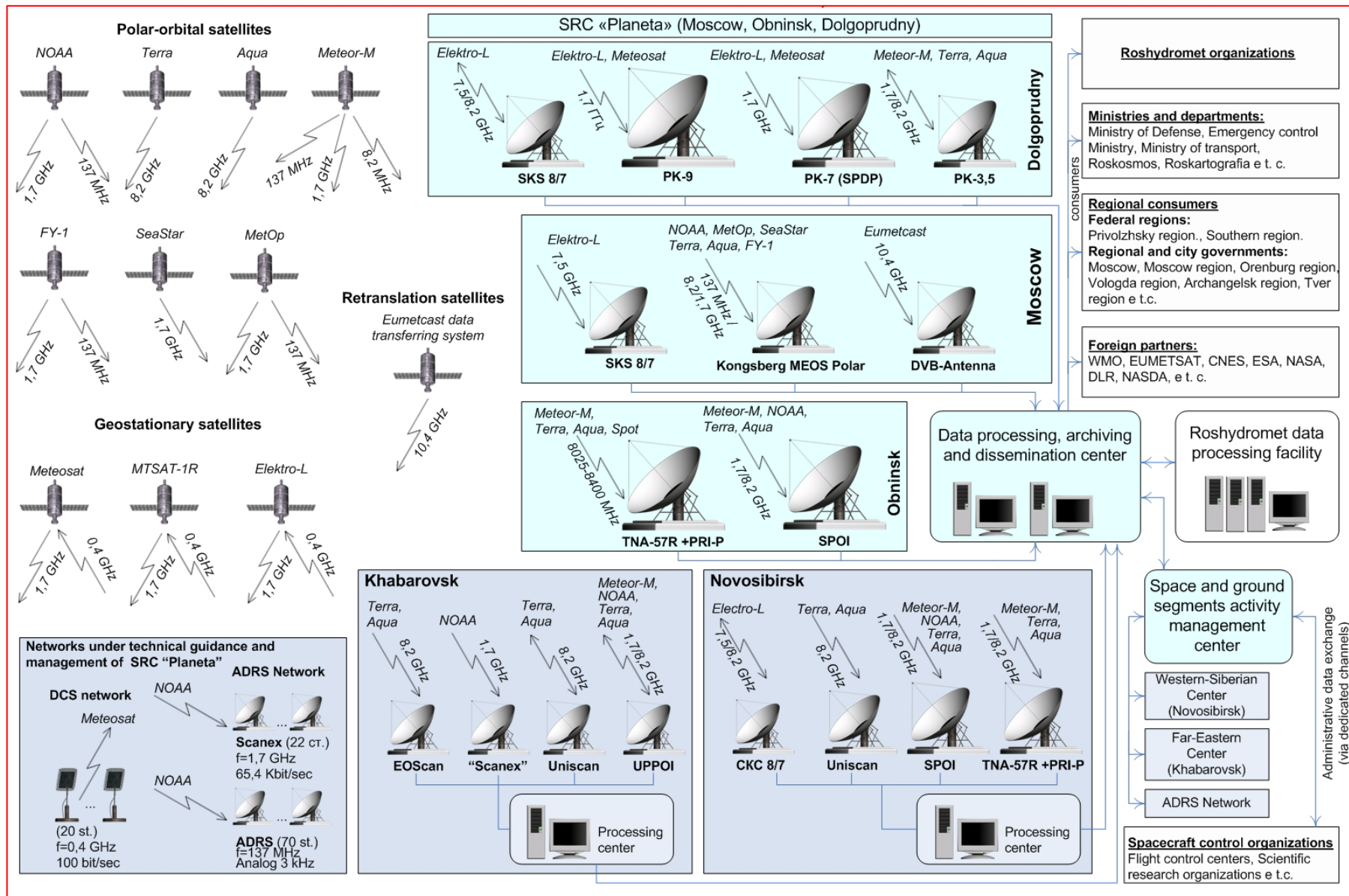
### Far-East

(Khabarovsk)

● - 68 Local centers



# Status of Roshydromet Ground Segment







Federal Service for Hydrometeorology  
and Environmental Monitoring



Russian Federal Space Agency

# High-elliptical Orbits Satellite System "Arctica"



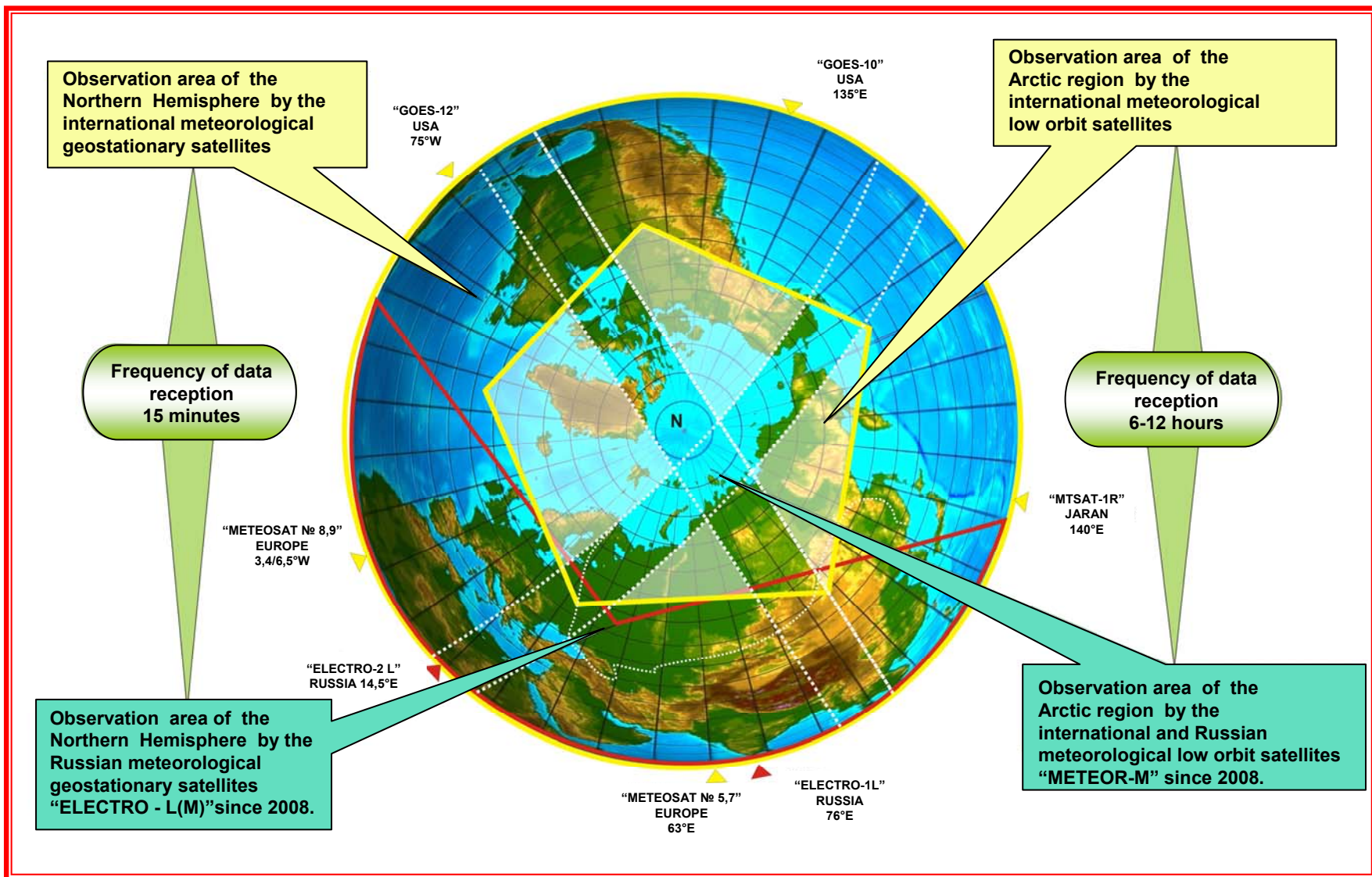
State Centre on Space Hydrometeorology  
"Planeta"



Lavochkin Association



# Earth observation by the international meteorological satellite system





# Mission objectives

**Monitoring of the Earth atmosphere and surface in Arctic region (inaccessible for observation from geostationary orbit) on the base of multispectral imaging with high temporal resolution (15 – 30 min).**

**Providing heliogeophysical information in polar areas.**

**Maintaining data collection system, telecommunication service for data exchange and retransmission.**

**Search & Rescue service ( COSPAS-SARSAT ).**

# Main Tasks and Applications

## Utilization for analysis and forecasting :

- weather in the regional (Arctic) and global scales
- ice cover in Arctic
- flight conditions for aviation (cloudiness, wind, jet-streams etc.)
- snow cover
- heliogeophysical conditions in the near Earth Space

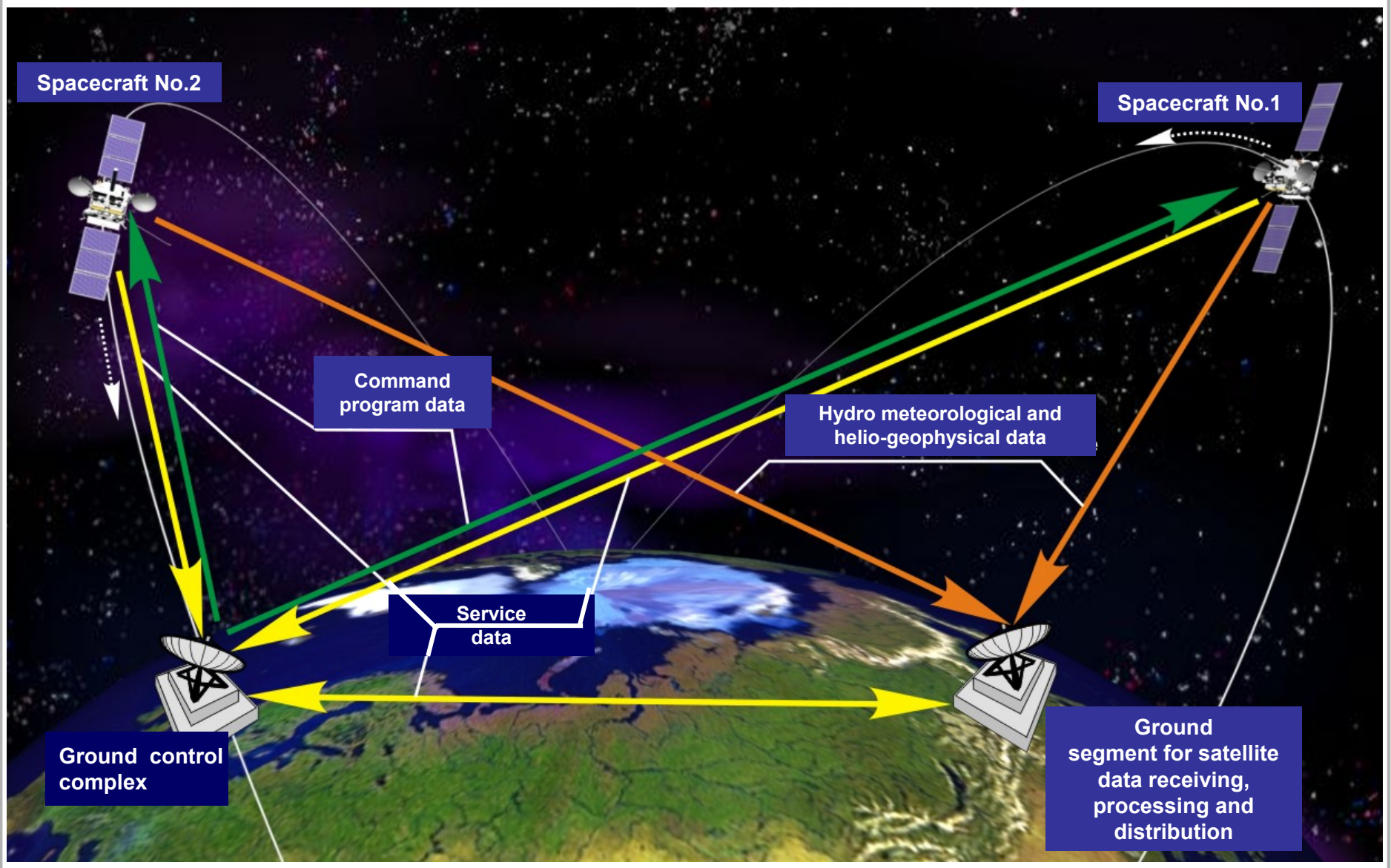
**Monitoring of disasters (fires, floods, volcanic eruptions etc.)**

**Monitoring of climate changes**

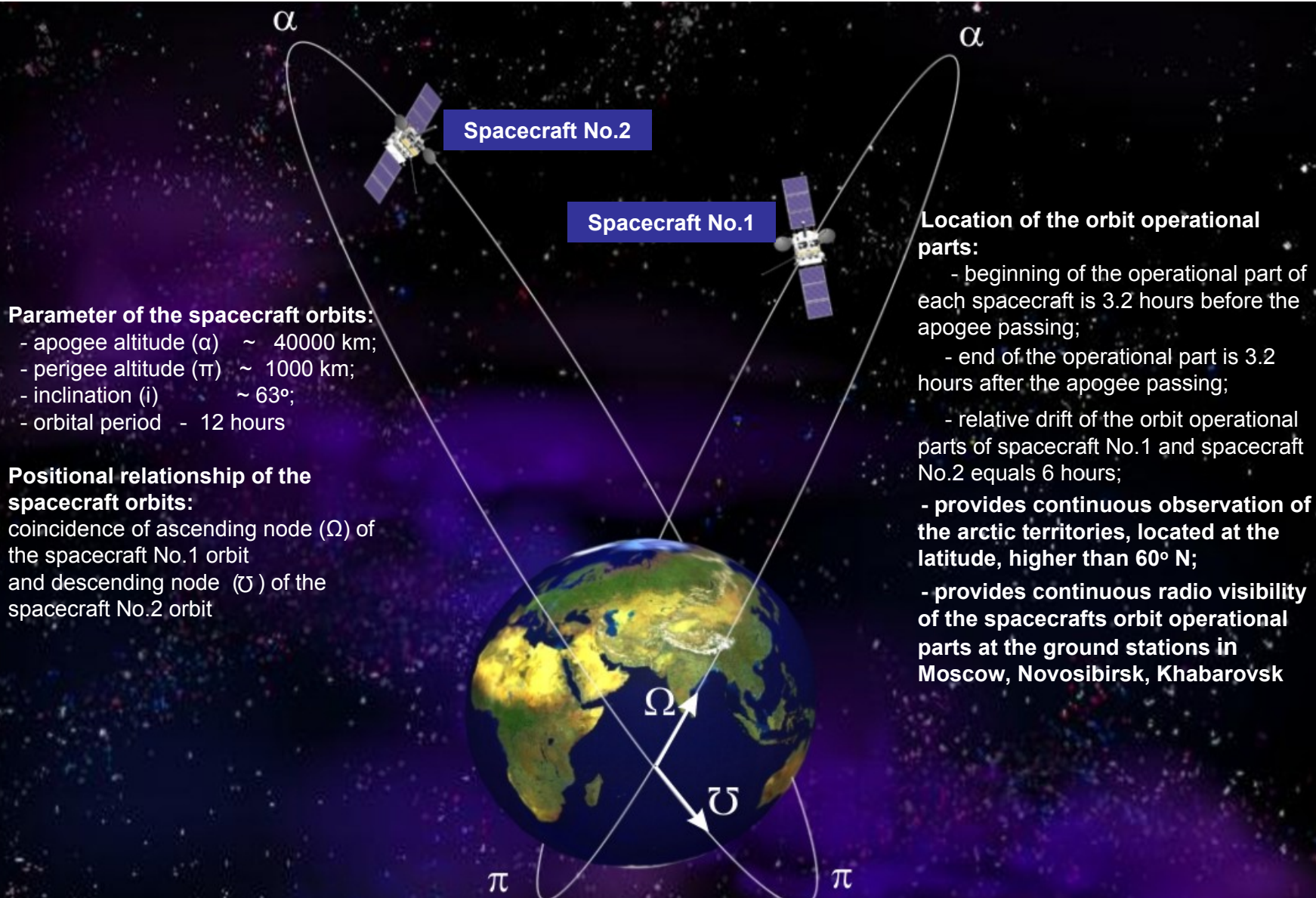
**Data collection and relay from land-, sea- and air-based observing platforms**

**Exchange and dissemination of processed satellite, meteorological and heliogeophysical data**

# "Arctica" System General Design

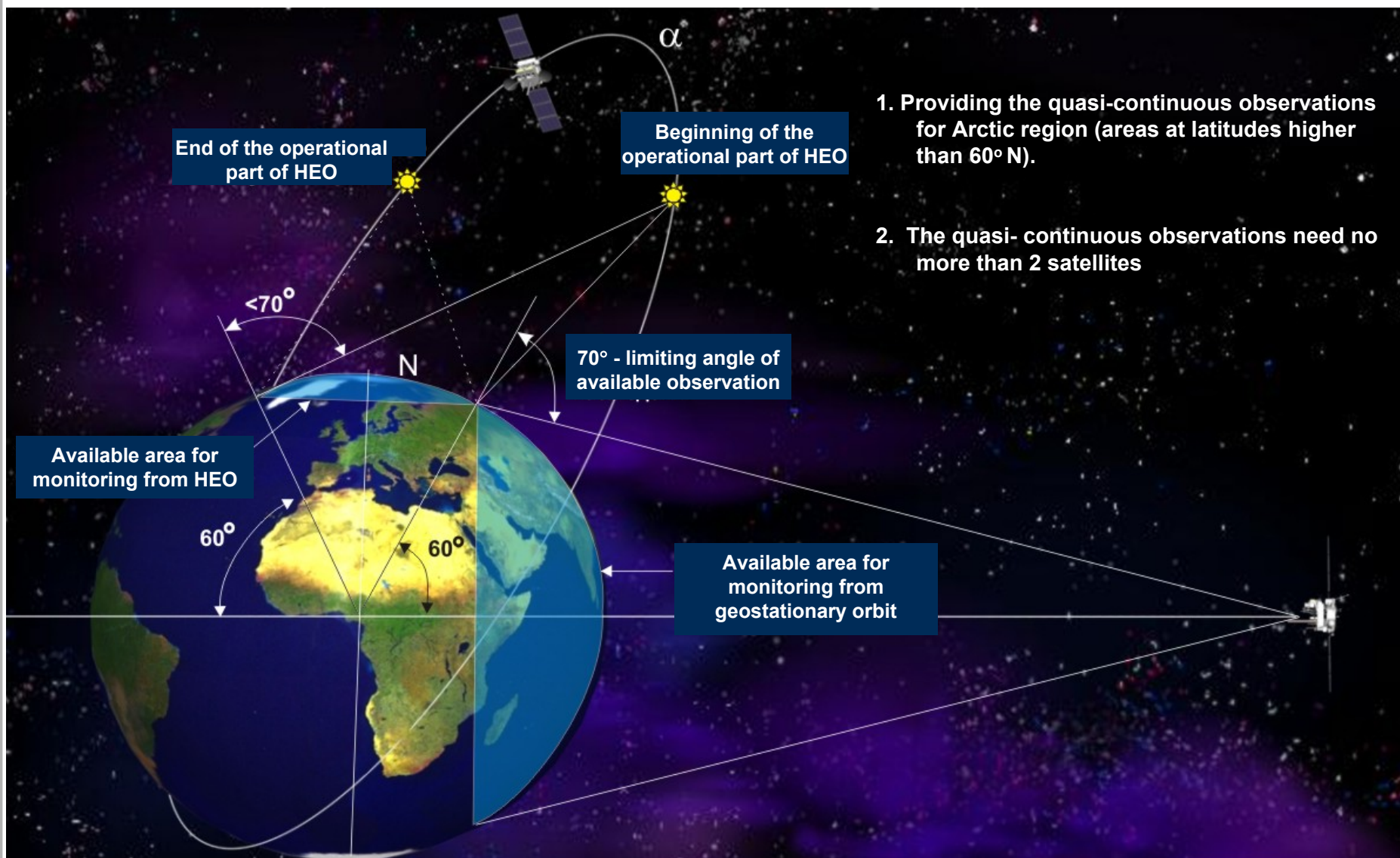


# Ballistic configuration of the space system





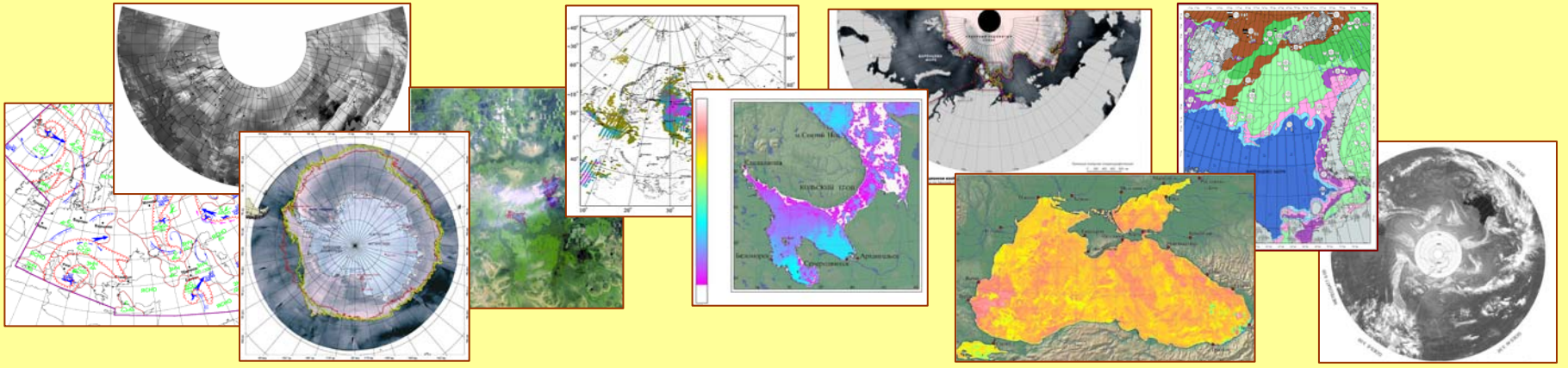
# Advantages of the high-elliptic orbits (HEO) over geostationary orbits for Arctic observations



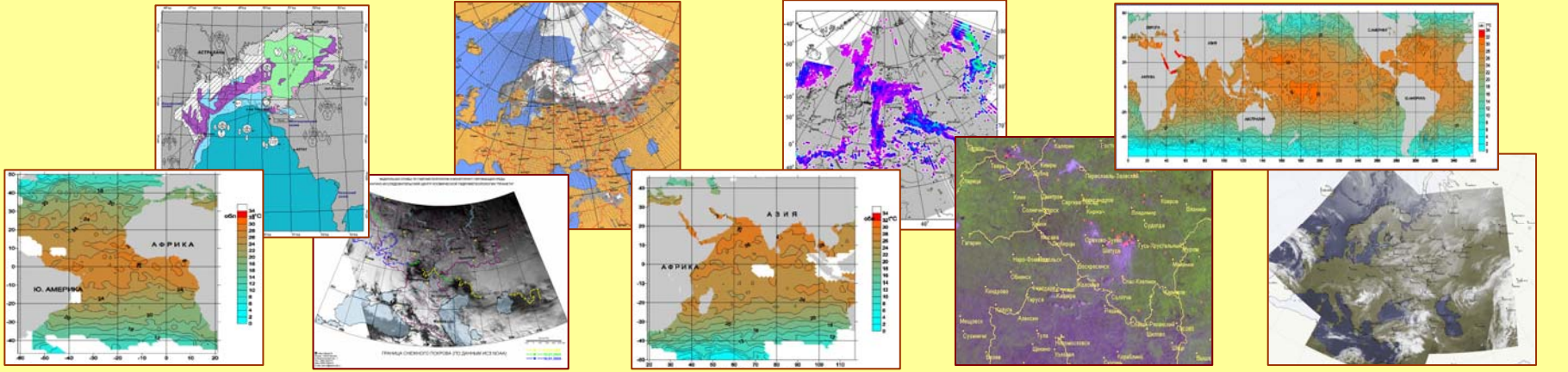


# Conclusions

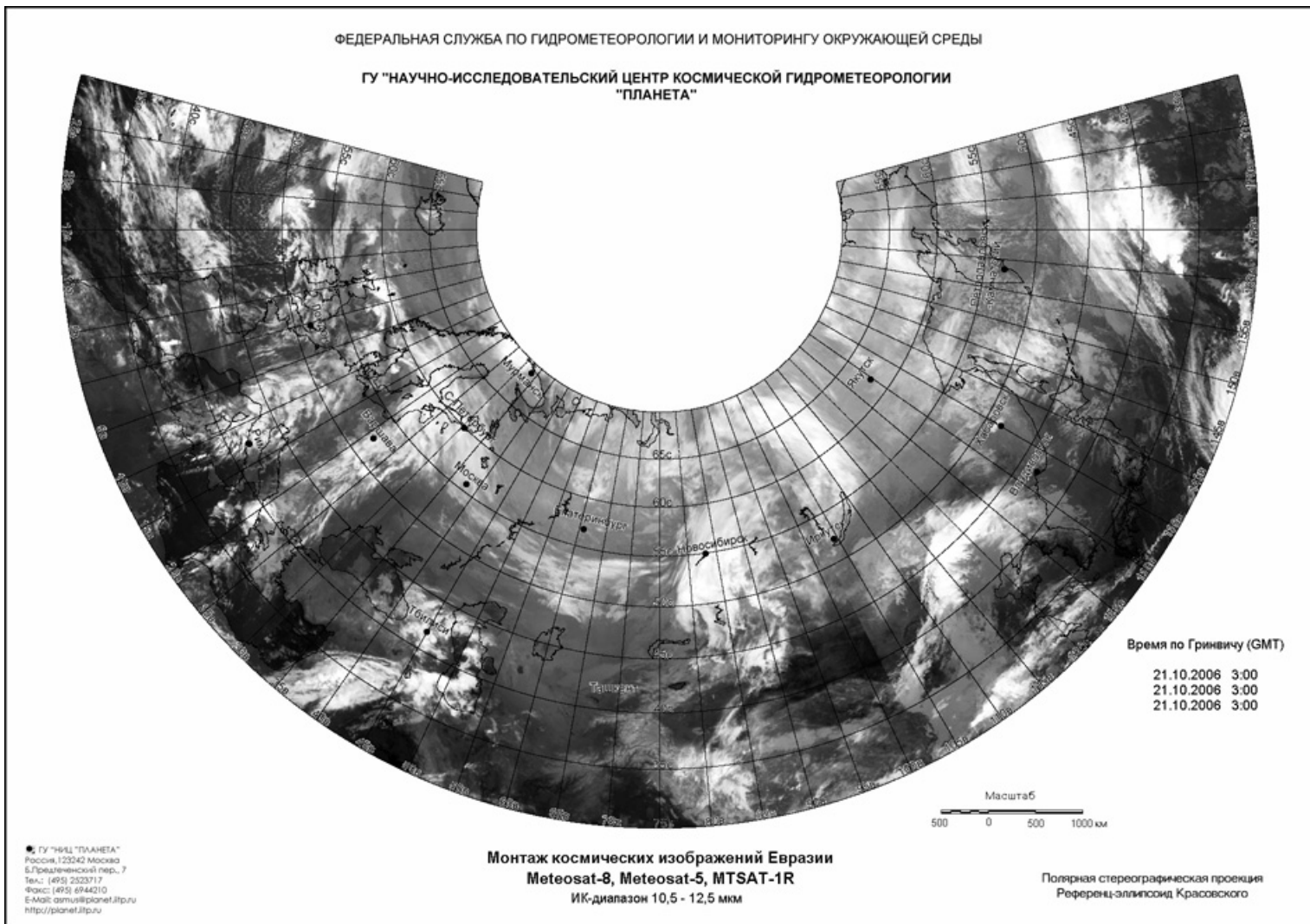
1. To a great extent the progress of global and regional numerical weather forecasting, as well as providing safety navigation along Northern Sea Route together with many other Earth monitoring problems depends on the capabilities to provide hydrometeorological information for the Arctic region (at the latitudes higher than 60 deg. N) in quasi-continuous mode with high temporal resolution.
2. Geostationary meteorological satellites cannot provide such information and therefore the proposed "Arctica" system should supplement existing global satellite observation system.
3. Russia has great experience on design and exploitation HEO satellite systems, as well as the technical stock on the development of "Electro-L" and "Spectr-R" type spacecrafts. Based on this Roscosmos and Roshydromet (as responsible Russian governmental bodies) propose to realize "Arctica" project in the frame of wide international cooperation.



# OPERATIONAL PRODUCTS

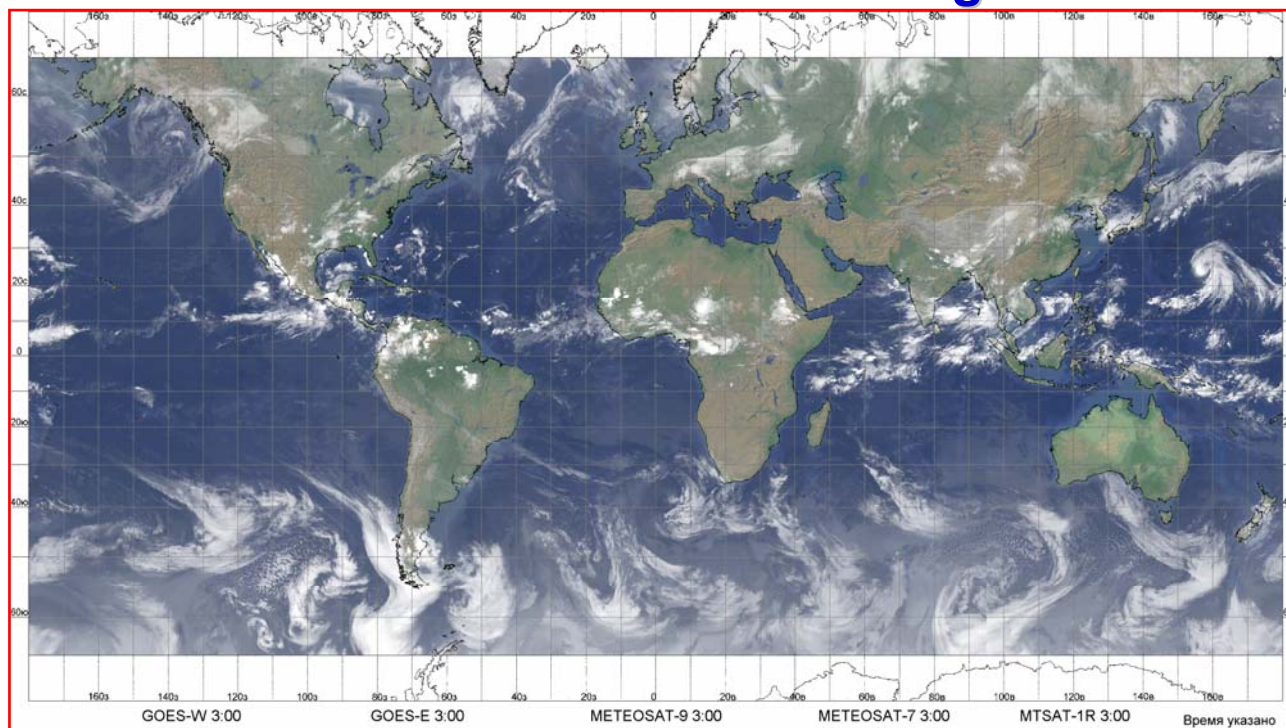


# Cloud cover monitoring: Russia





# Global mosaics of IR images

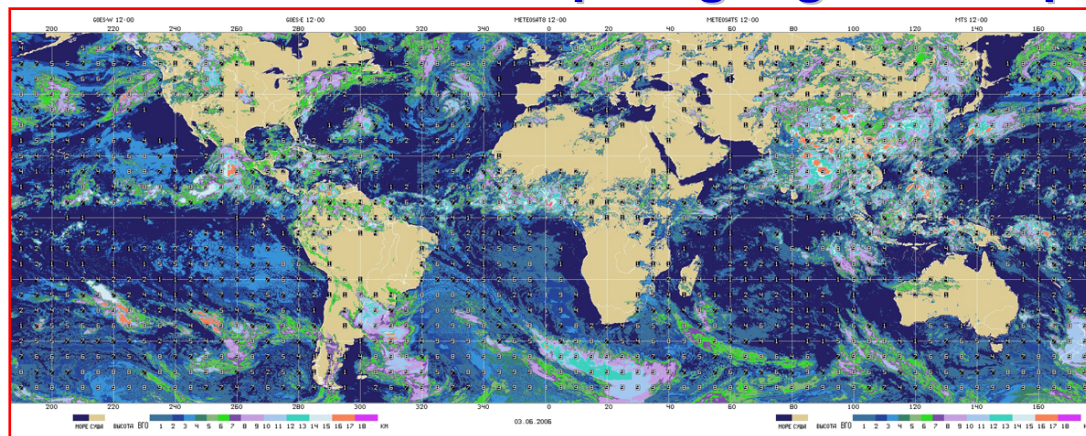


Глобальная карта  
облачности



ИК-диапазон 10.5-12,5 мкм  
28.02.2008 г.

# Cloud fraction and top height global map

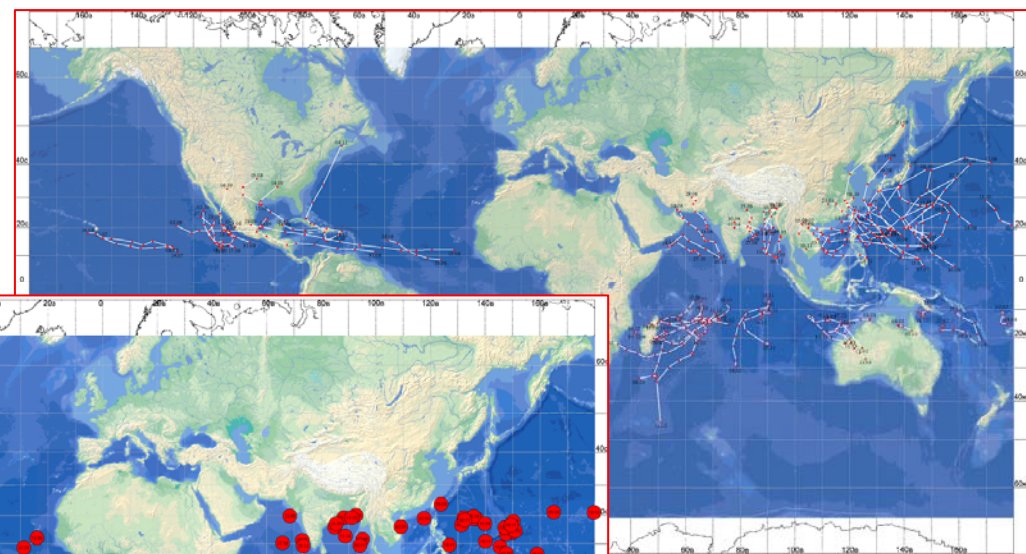



Глобальная карта облачности  
(балльность, высота) по  
данным геостационарных ИСЗ

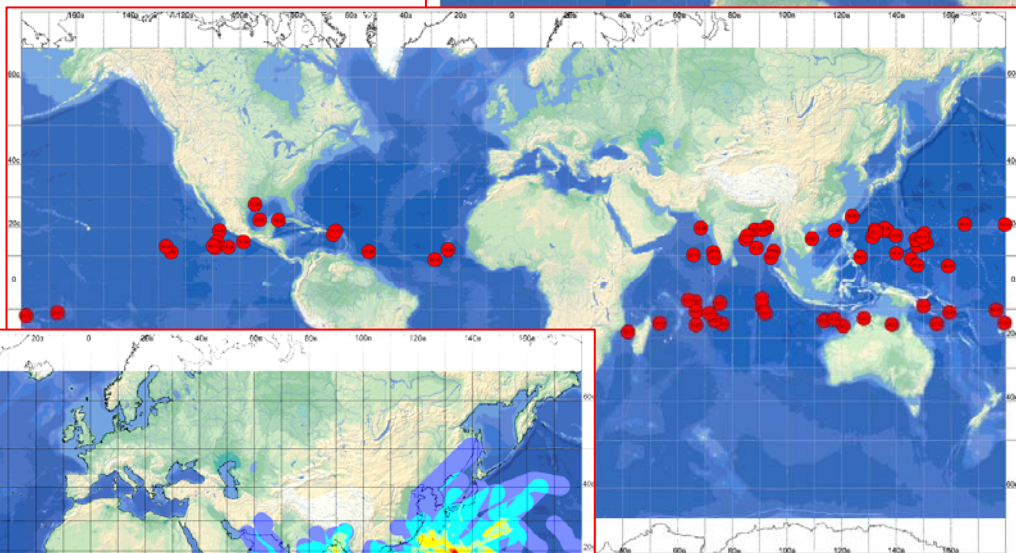



# Tropical Cyclon monitoring

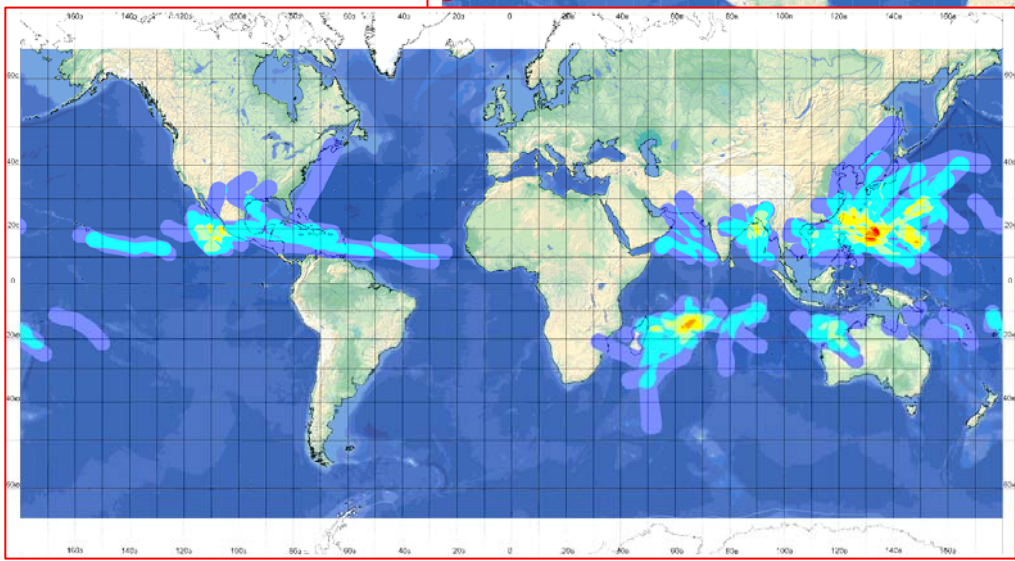
01.01.2007 – 31.12.2007



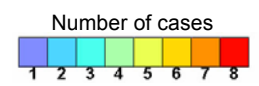
Tropical Cyclon Trajectories Map 



Tropical Cyclon Centers Map 

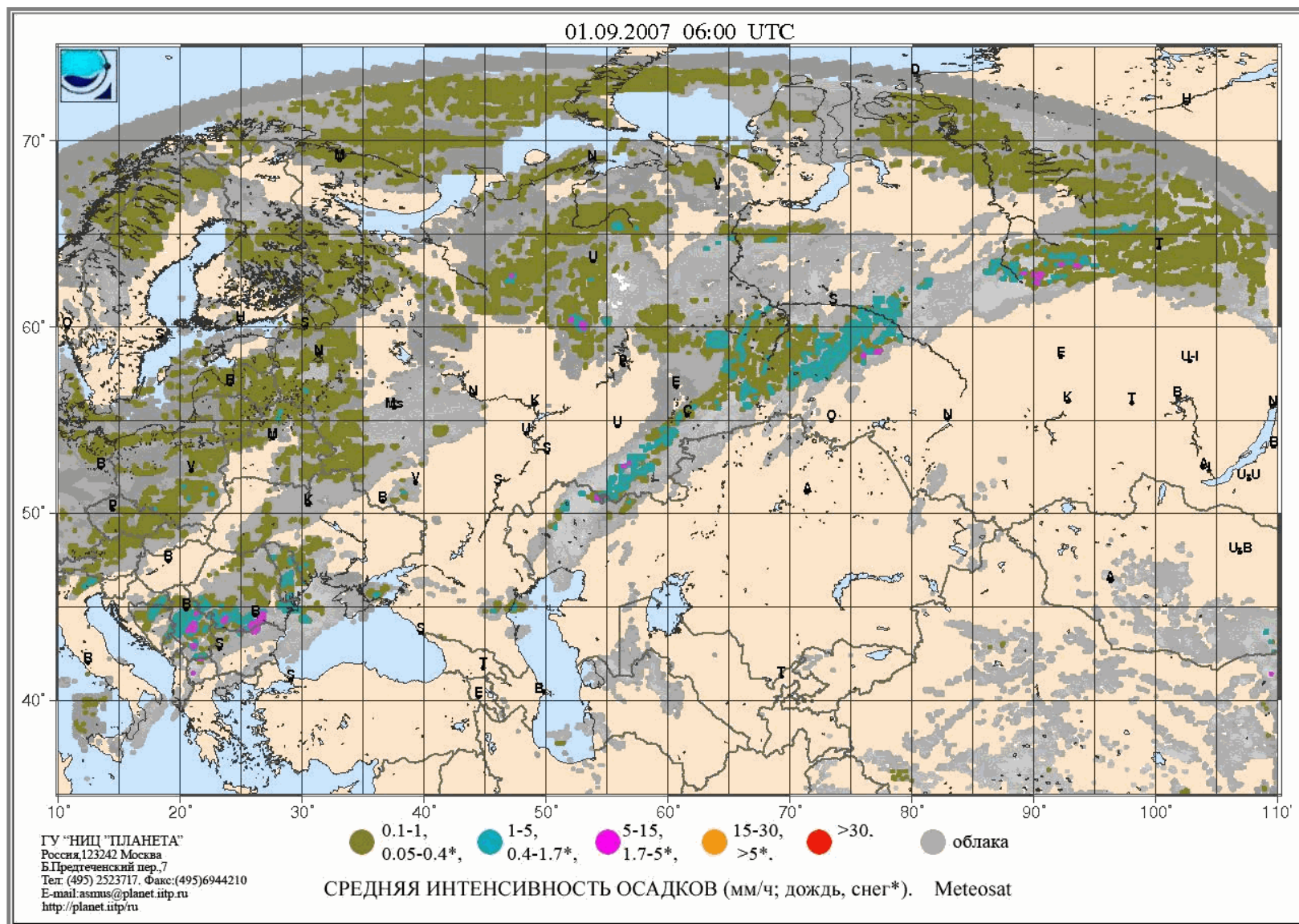


Tropical Cyclon Recurrence Map



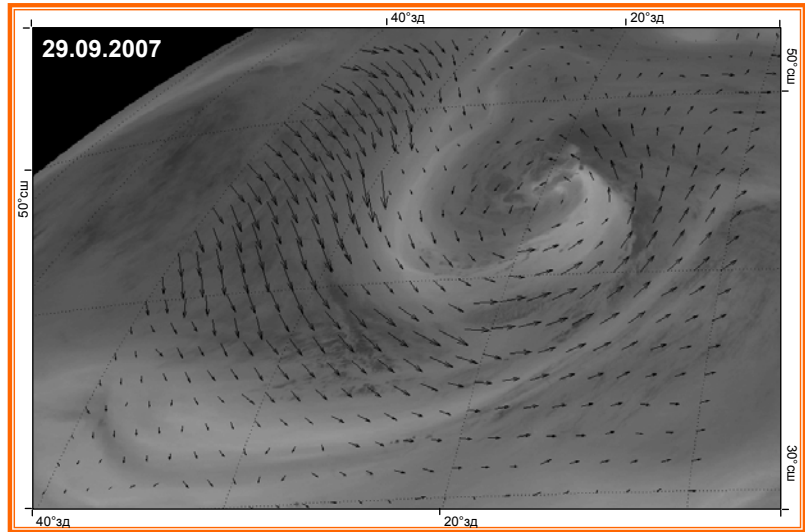


# Precipitation intensity

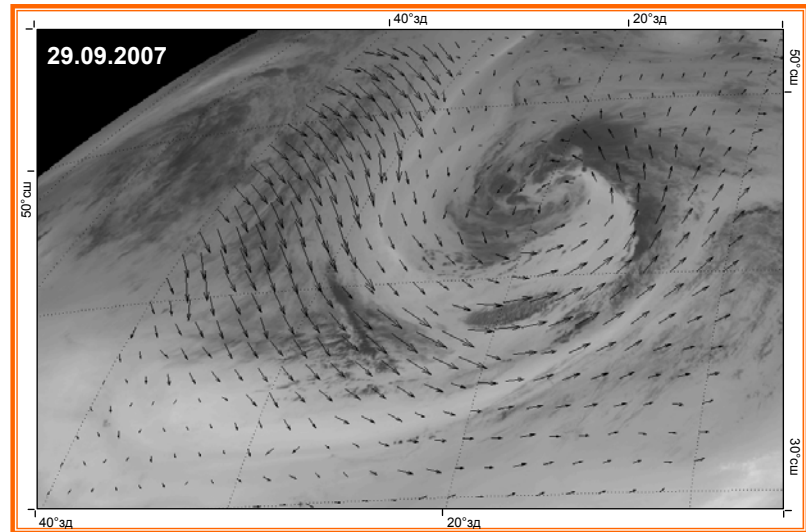


# Atmospheric Motion Winds

## Wind vectors

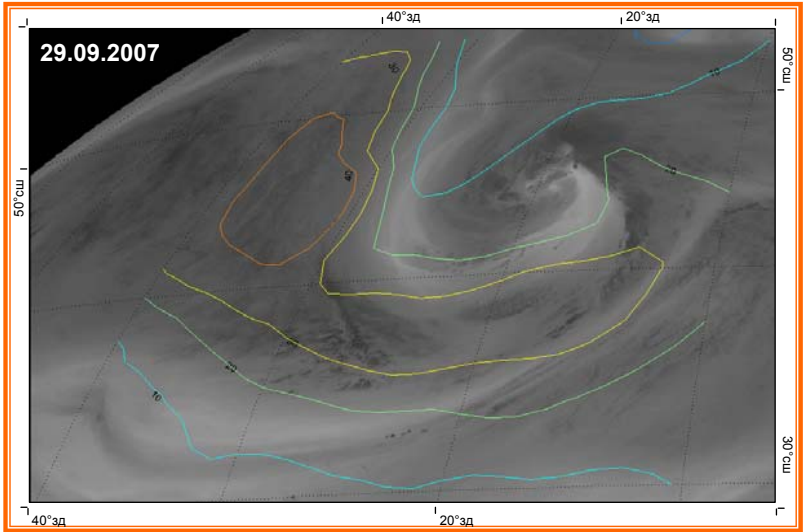


ch 6.2 μm

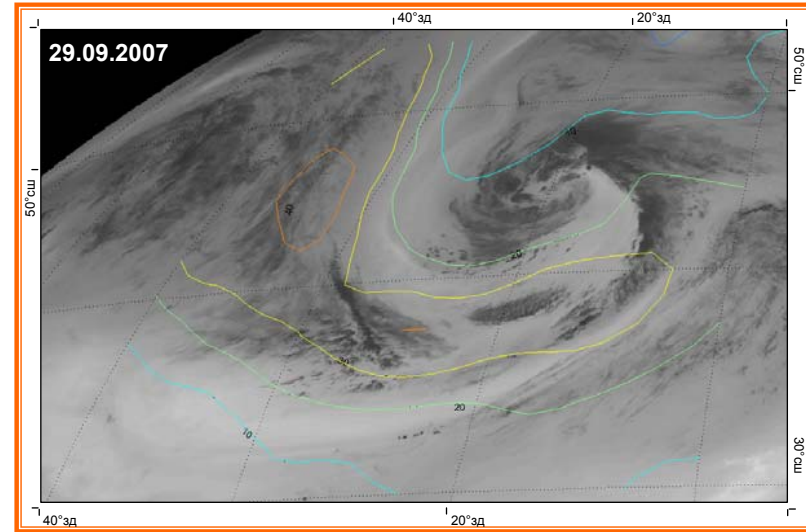


ch 7.3 μm

## Wind vector module, m/sec

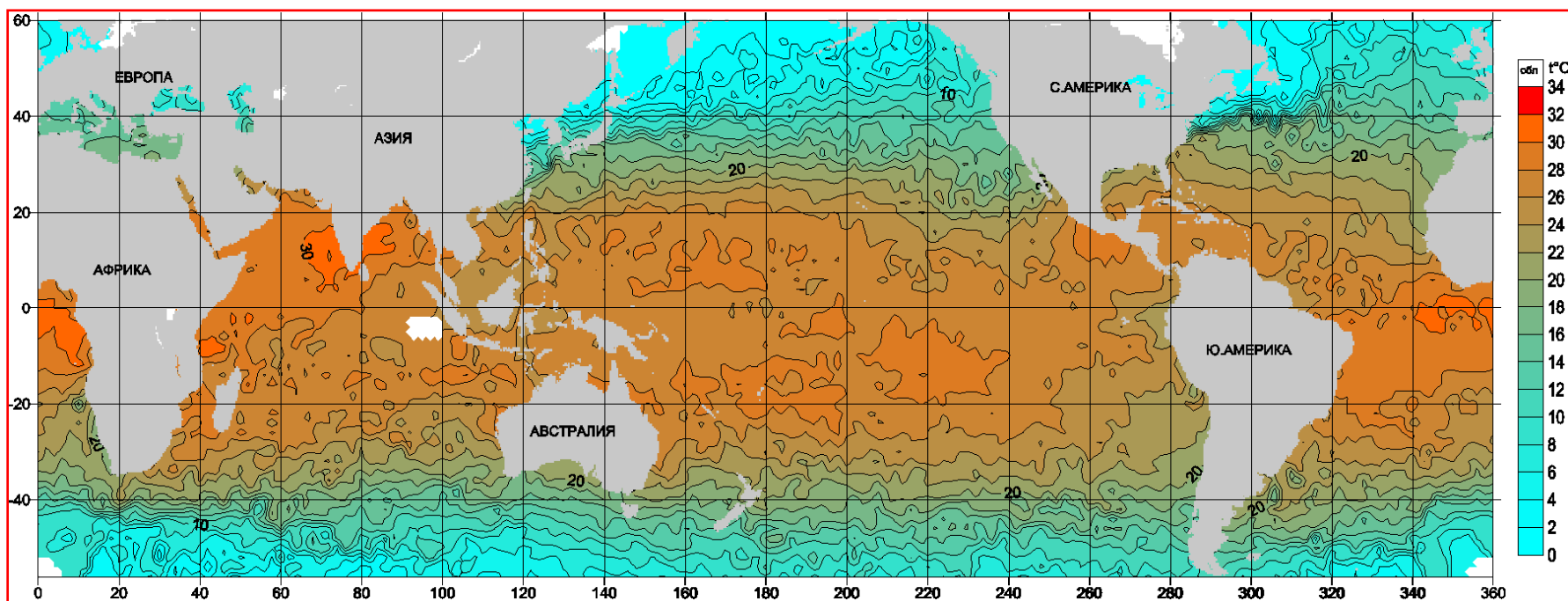


ch 6.2 μm



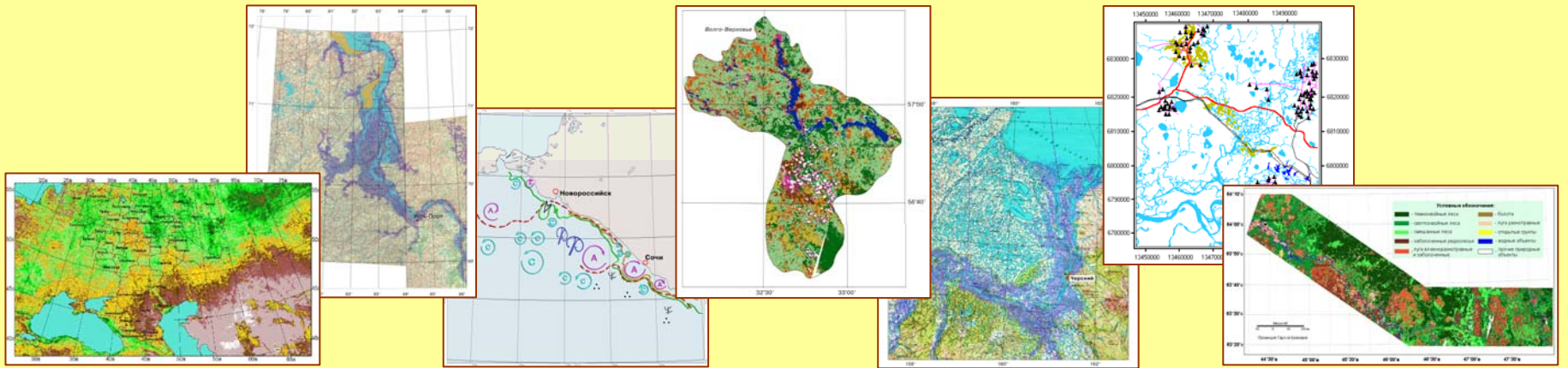
ch 7.3 μm

# Global SST map (5 Geostationary Satellites)

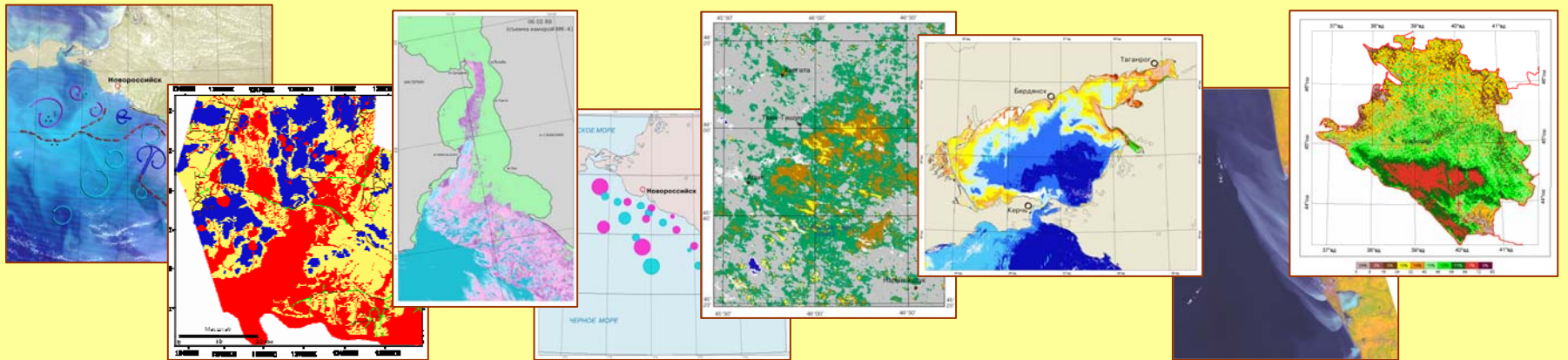


01.09 – 10.09 2007 г.





# REGIONAL MONITORING



# Floods mapping: Russian rivers

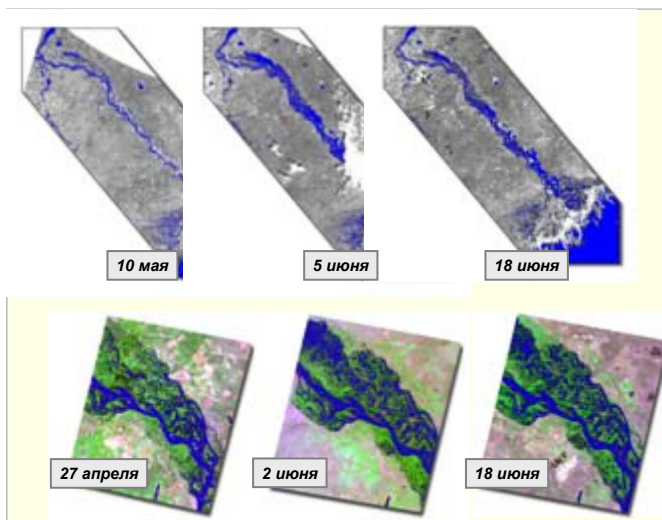
## Пойма реки Оки



Выделение воды на космическом изображении (МСУ-Э)

Карта затопления поймы р. Оки

## Реки Волга и Ахтуба

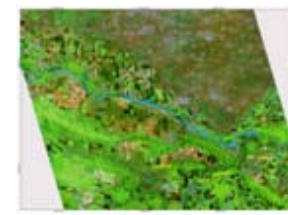


Мониторинг наводнений на основе данных высокого (МСУ-Э) и среднего разрешений (МСУ-СК)

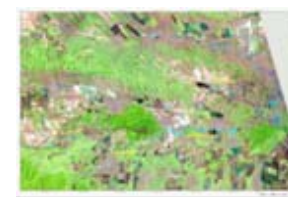
## Чрезвычайная паводковая ситуация на реках Северного Кавказа (ИСЗ «Метеор-3М»)



Река Терек



Реки Терек и Аргун

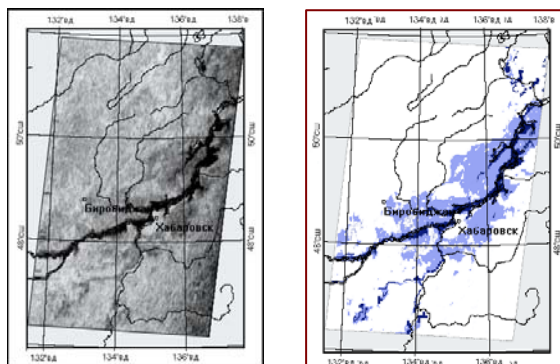


Реки Асса и Фортанга



Река Аргун

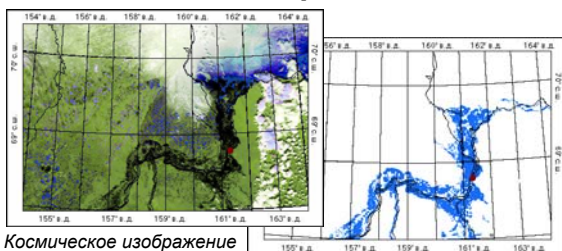
## Среднее течение реки Амур



Космическое изображение (РЛСБО)

Карта-схема затопления

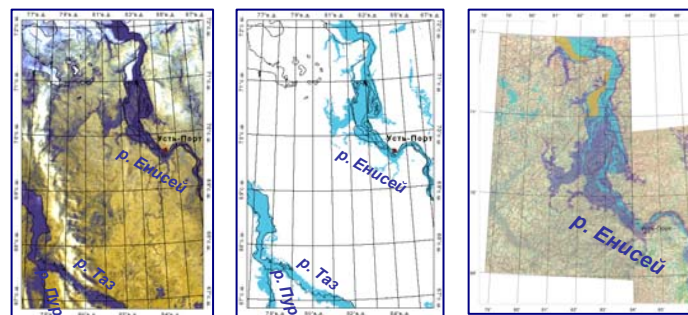
## Нижнее течение реки Колымы



Космическое изображение (NOAA/AVHRR)

Карта-схема затопления

## Нижнее течение рек Енисея, Таза и Пура



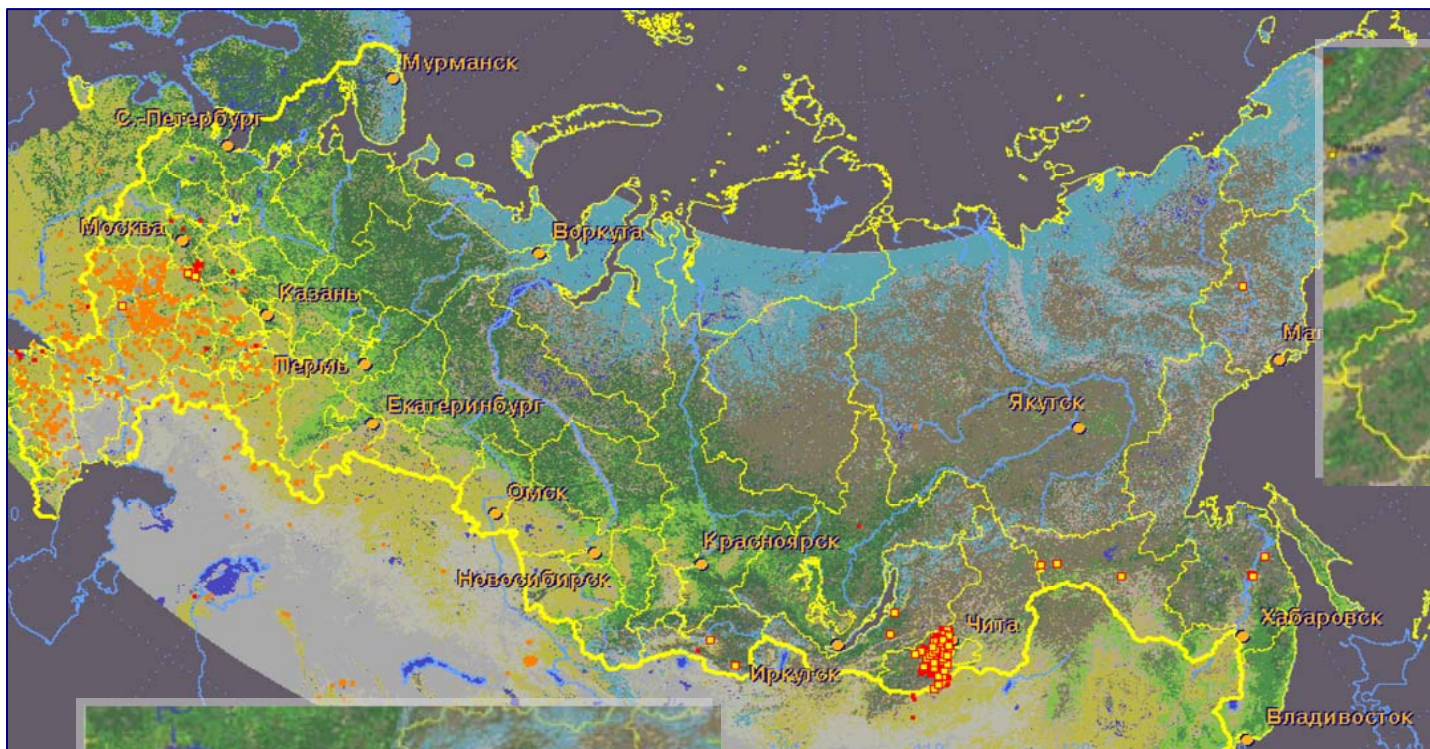
Выделение воды на космическом изображении (NOAA/AVHRR)

Карта-схема затопления

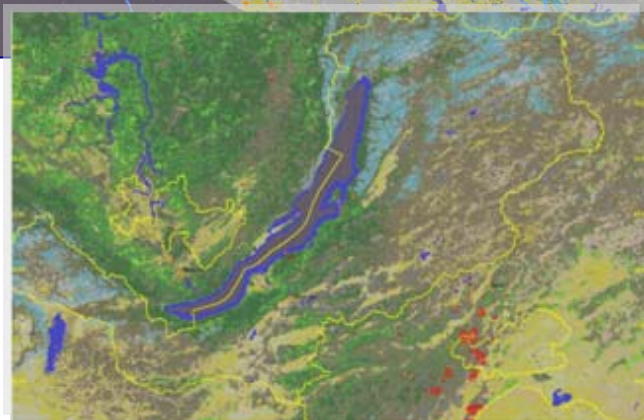
- гидрографическая сеть
- пойменный разлив
- речной лед



# Fire Maps: Russia



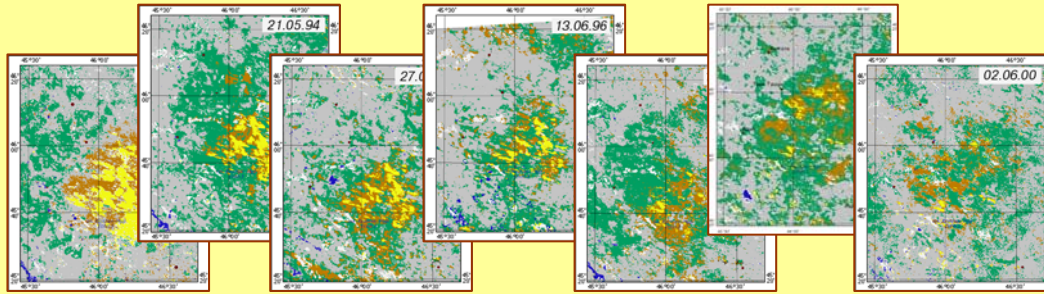
**Buryatia republic**  
(NOAA, 20.08.2007)



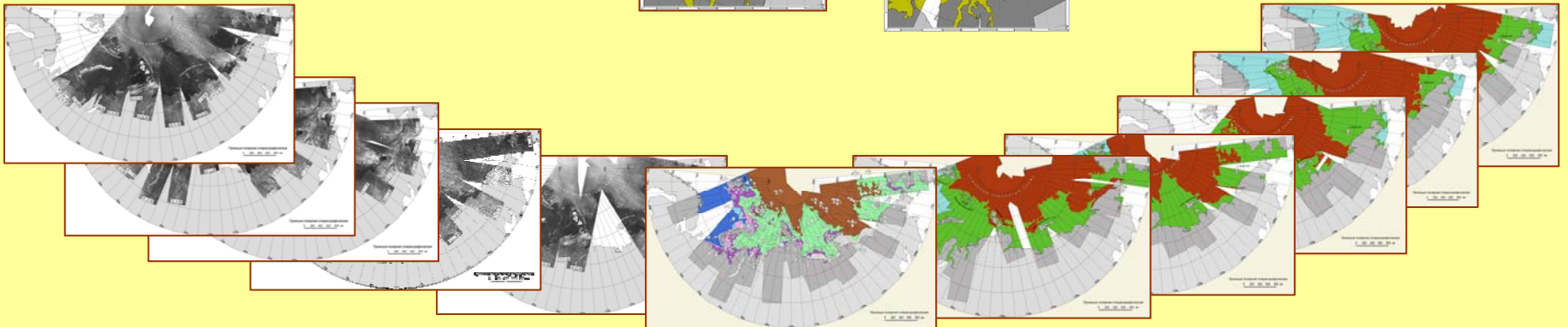
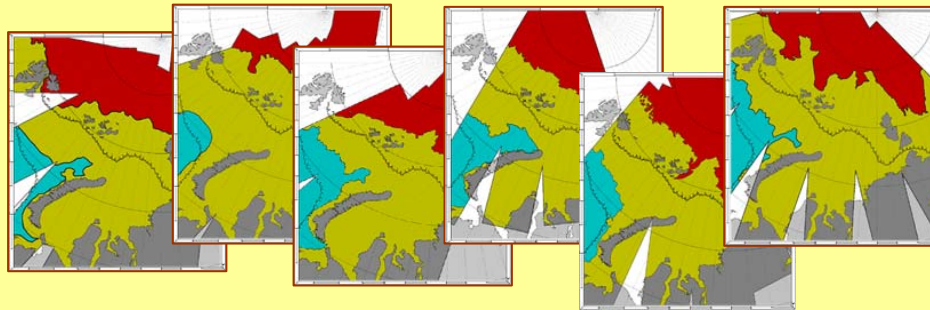
**Chita region** (NOAA, 14.08.2007)

**Eurasia** (NOAA, TERRA, AQUA, 14.08.2007)

- - горячие пятна (лесные территории) по спутниковым данным
- - горячие пятна (нелесные территории) по спутниковым данным
- ⬮ - области горения по спутниковым данным
- - крупные пожары по данным Службы Авиалесохраны
- - границы регионов



# CLIMATOLOGICAL STUDIES

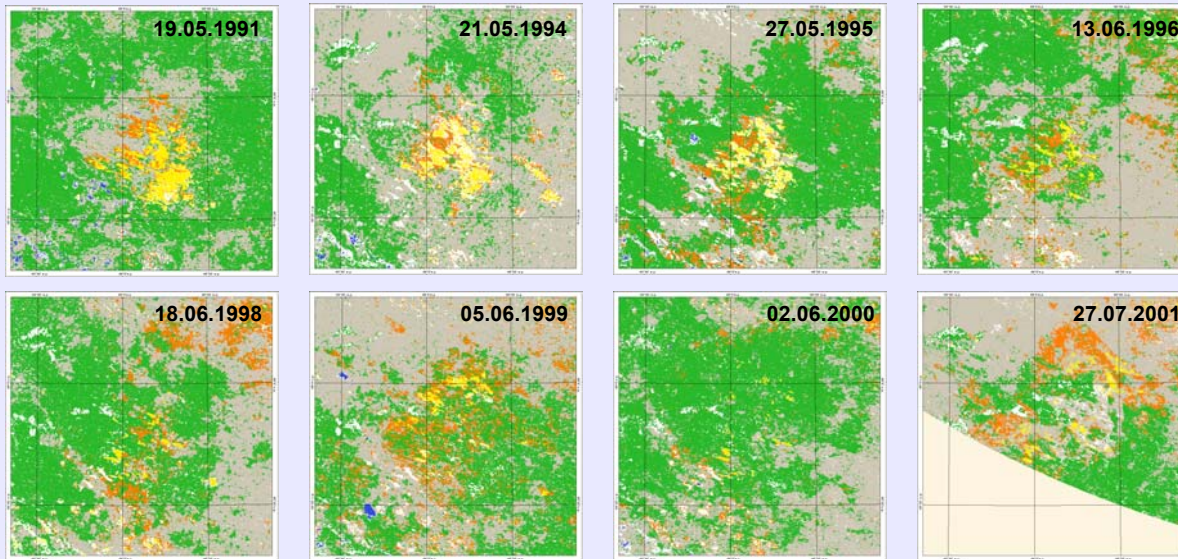




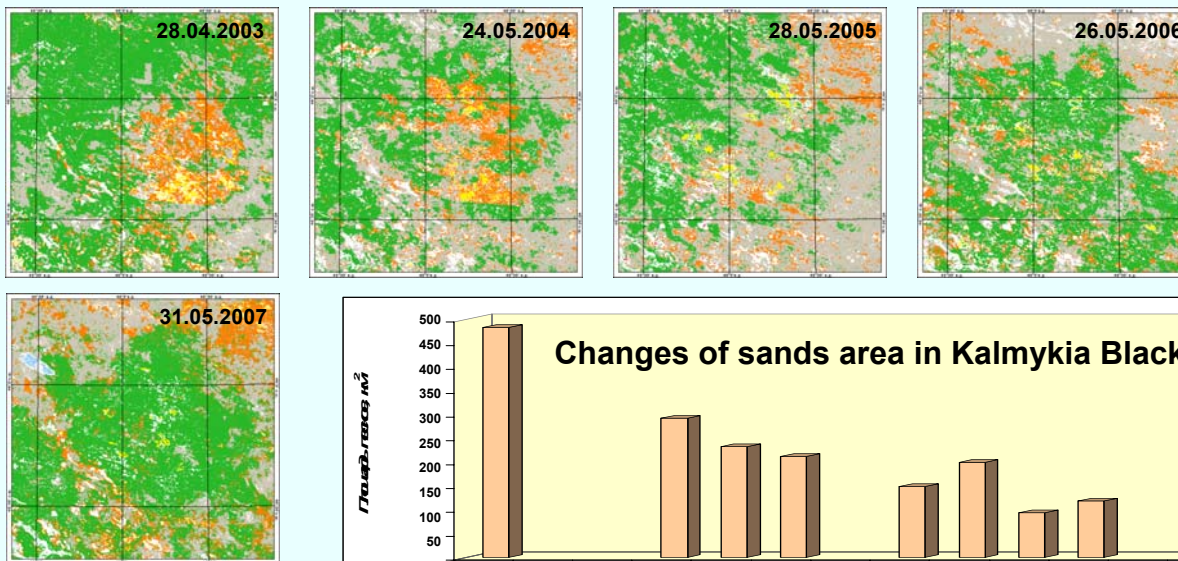
# Drought monitoring: Kalmykia

Changes of soil and vegetation cover in Kalmykia Black Lands

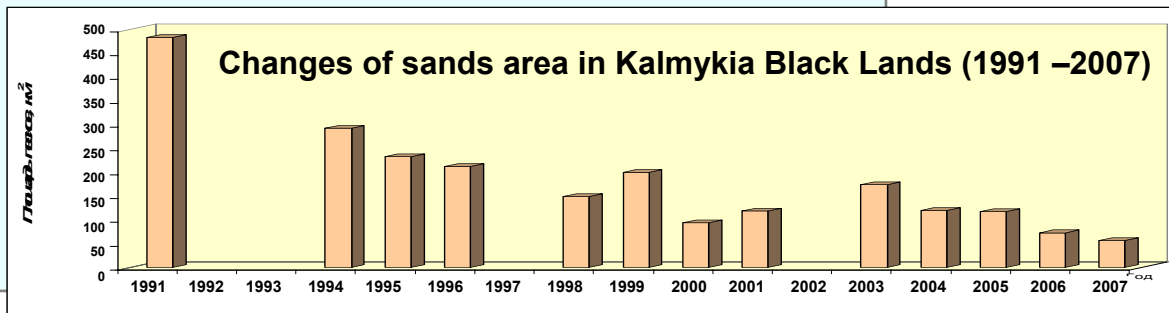
1991 - 2001 гг.  
ИСЗ Ресурс, Океан



2003 - 2007 гг.  
ИСЗ Terra



- пески
- деградированные земли
- открытые почвы
- почвы, покрытые растительностью
- вода
- прочие объекты





*THANK YOU !*



International TOVS Study Conference, 16<sup>th</sup>, ITSC-16, Angra dos Reis, Brazil, 7-13 May 2008.  
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,  
Cooperative Institute for Meteorological Satellite Studies, 2008.