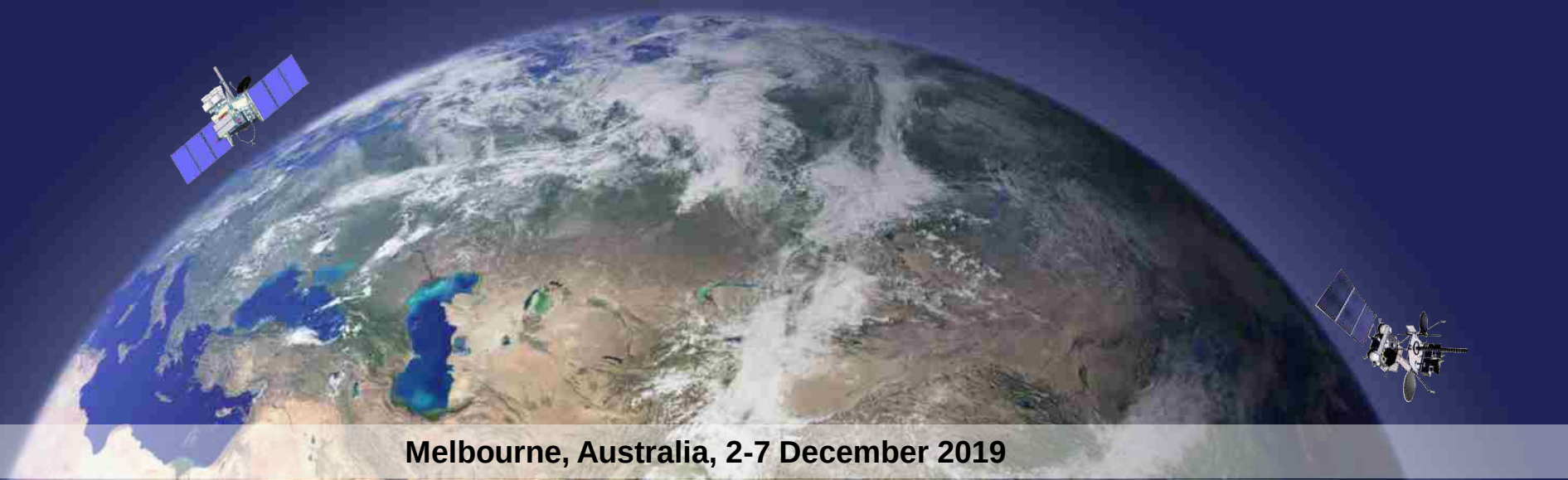
The 10th Asia-Oceania Meteorological Satellite Users Conference (Melbourne, Australia, 2-7 December 2019)

Current State and Prospects of Russian Earth Observation Satellite Systems

Prof. Vasily ASMUS

Director of State Research Center for Space Hydrometeorology PLANETA

ROSHYDROMET



Melbourne, Australia, 2-7 December 2019

Roshydromet Satellite Observation System Objectives

HYDROMETEOROLOGY AND GEOPHYSICAL MONITORING

- atmosphere/ocean monitoring and forecasting;
- ice cover monitoring for navigation in Arctic and Antarctic regions, freezing seas of Russia;
- space weather information service;
- data collection (via satellites) from Roshydromet' observation sites.

DISASTER MONITORING AND EMERGENCY SITUATION CONTROL

- disaster occurrence assessment;
- monitoring of emergency situations;
- evaluation of the damage caused by disaster event.

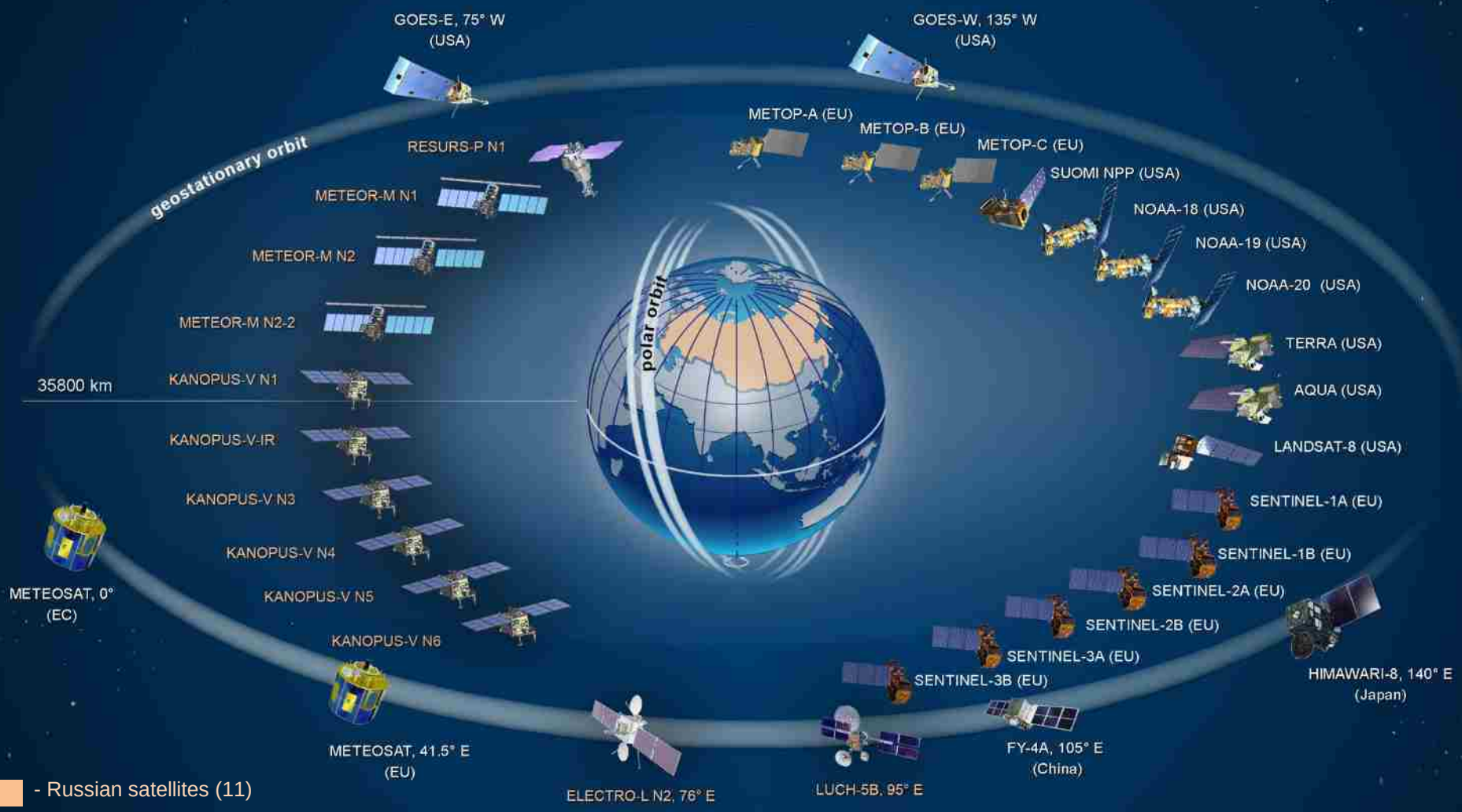
GLOBAL CLIMATE CHANGE MONITORING

- studying of climate, ocean and landscape changes based on observations of earth-radiation budget, cloud cover, ozone, snow and ice cover, water temperature and color, vegetation cover, and etc.

ENVIRONMENTAL POLLUTION MONITORING

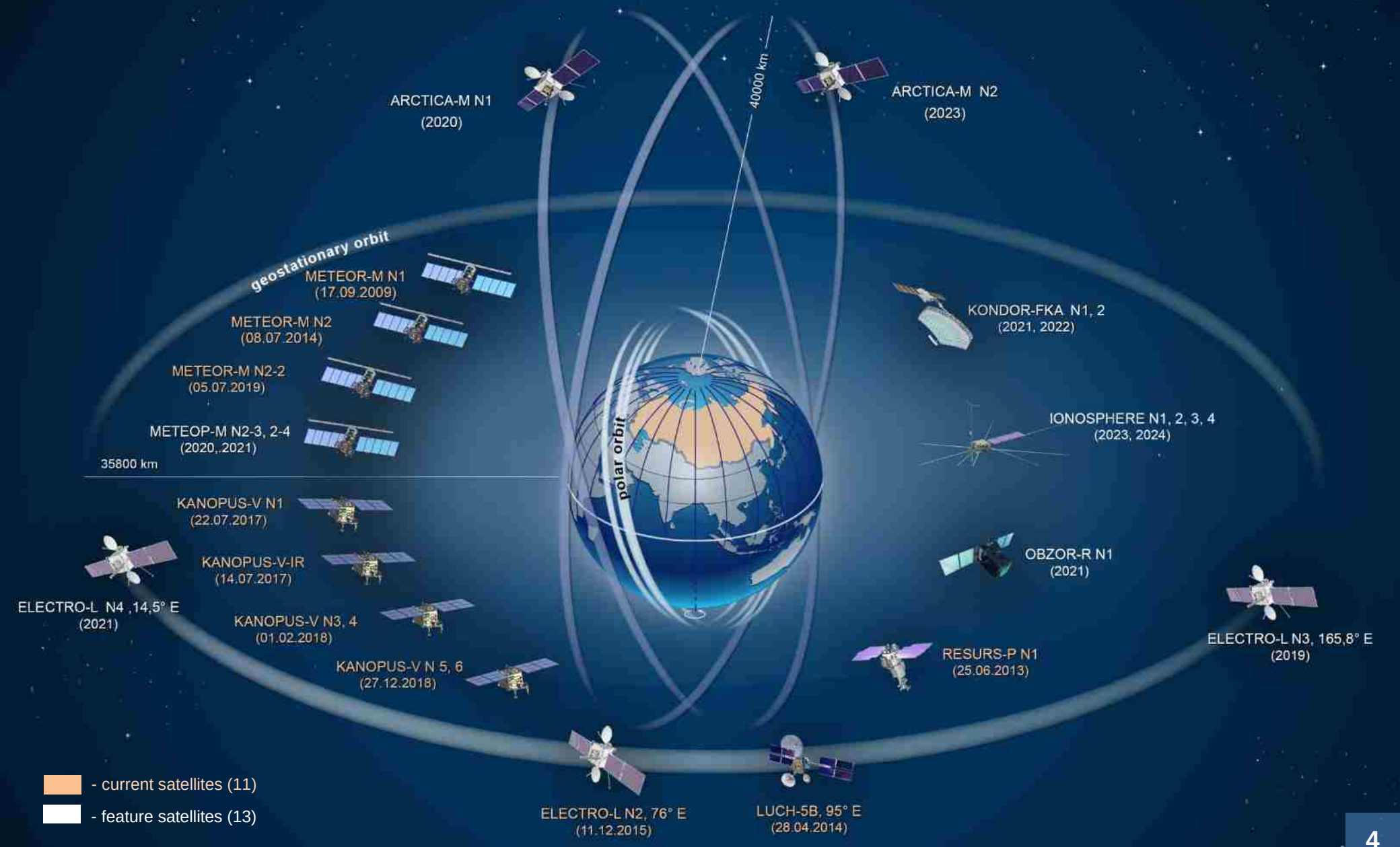
- environmental pollution monitoring of land, atmosphere, and ocean;
- evaluation of probable pollution spread, including radioactive pollution.

GLOBAL EARTH OBSERVATION SATELLITE SYSTEM



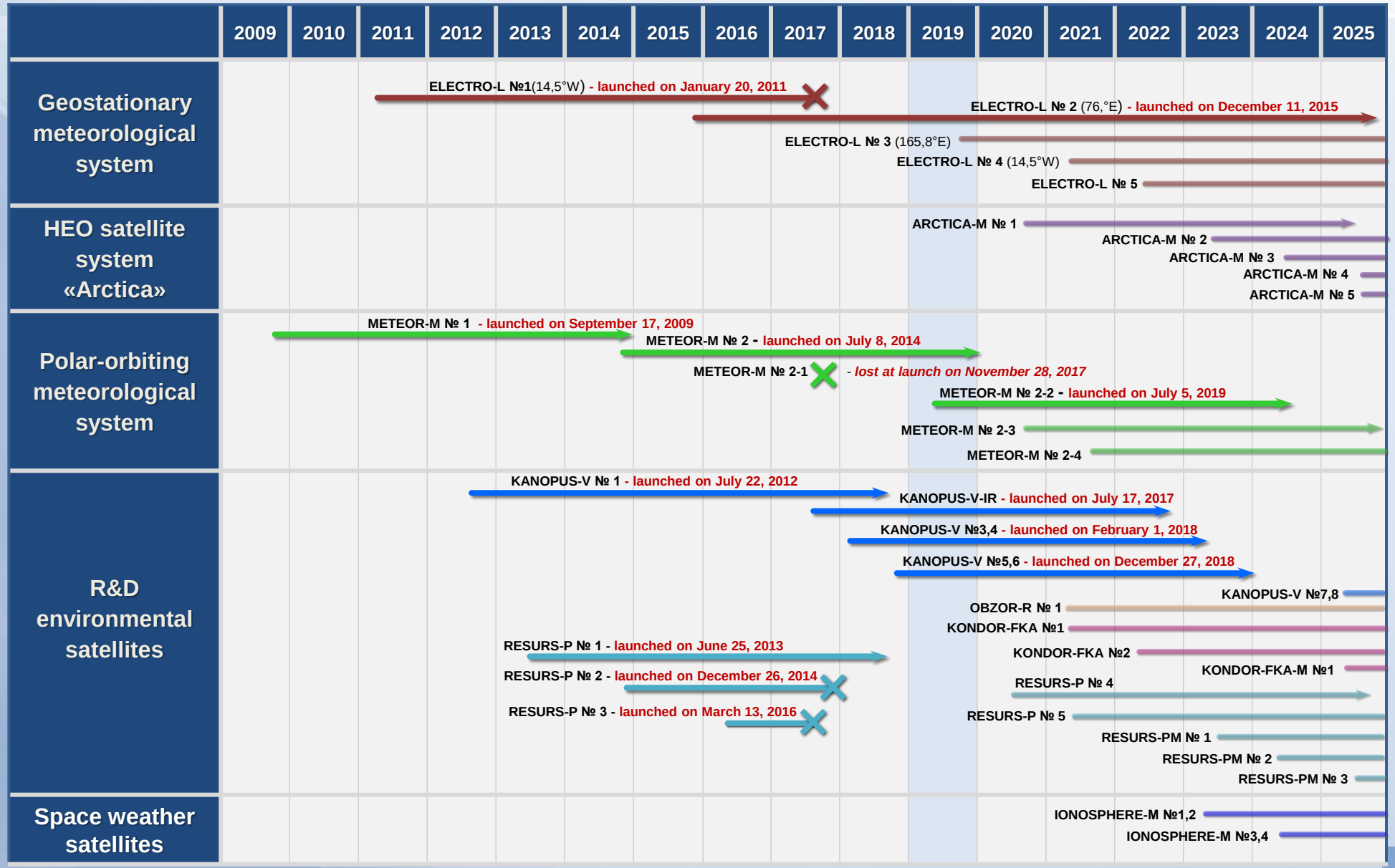
- Russian satellites (11)
- foreign satellites (22)

RUSSIAN EARTH OBSERVATION SATELLITE SYSTEM

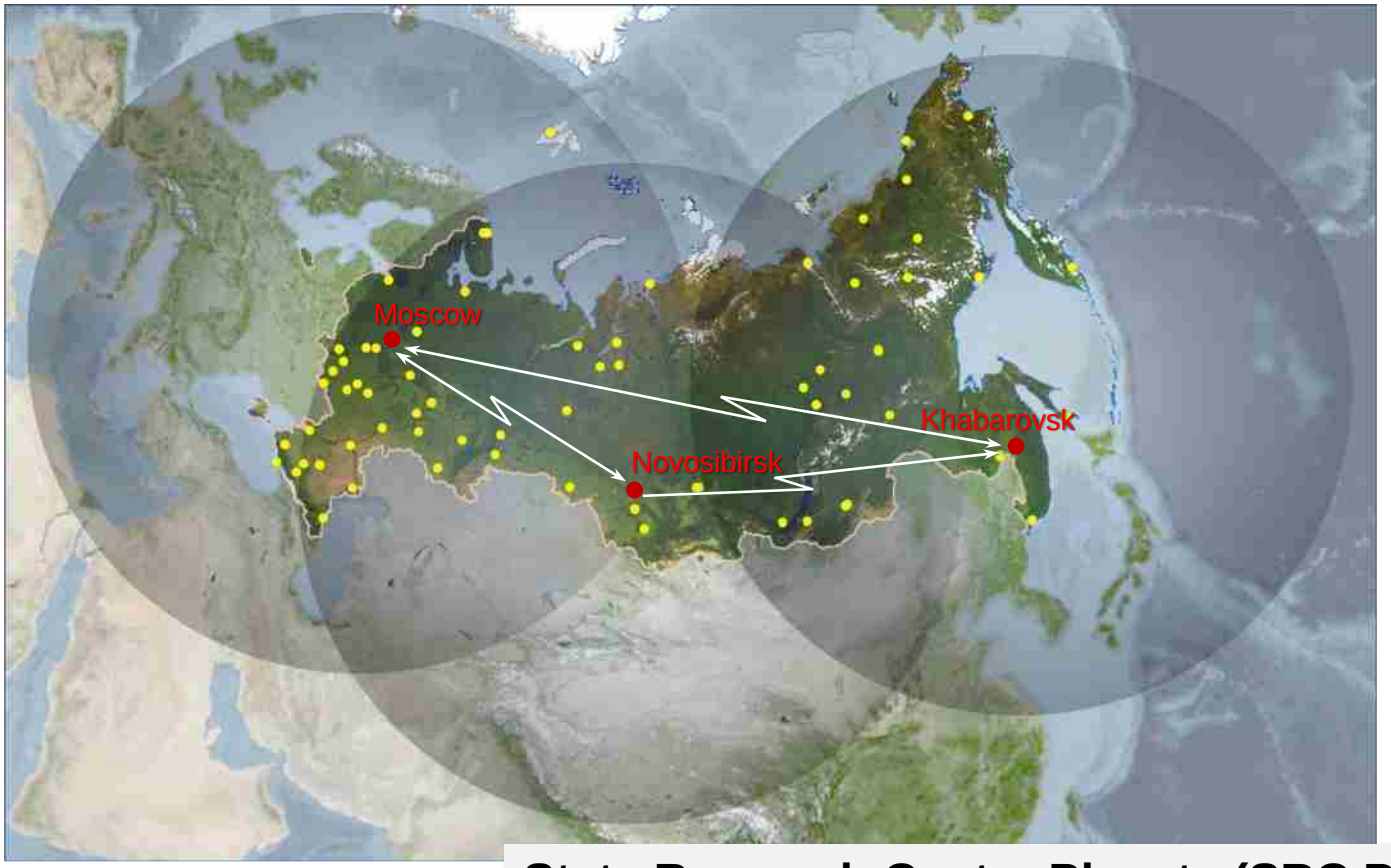


Russian Earth Observation Satellites Program

(Federal Space Program for 2005-2015 and 2016-2025)



Roshydromet Ground Segment of Earth Observation Satellite System



Satellite Centers:

European
(SRC Planeta, Moscow-Obninsk-Dolgoprudny)

Siberian
(SRC Planeta, Novosibirsk)

Far Eastern
(SRC Planeta, Khabarovsk)

● - more than **70** local reception sites

State Research Center Planeta (SRC Planeta) daily activities:

- receives more than **1.4 TB** satellite data;
- produces more than **530 types** of satellite-based products;
- provides data for more than **560** federal and regional users.

Users of the Satellite Data and Products

State Research Center Planeta

European Center
(Moscow, Obninsk, Dolgoprudny)

Siberian Center
(Novosibirsk)

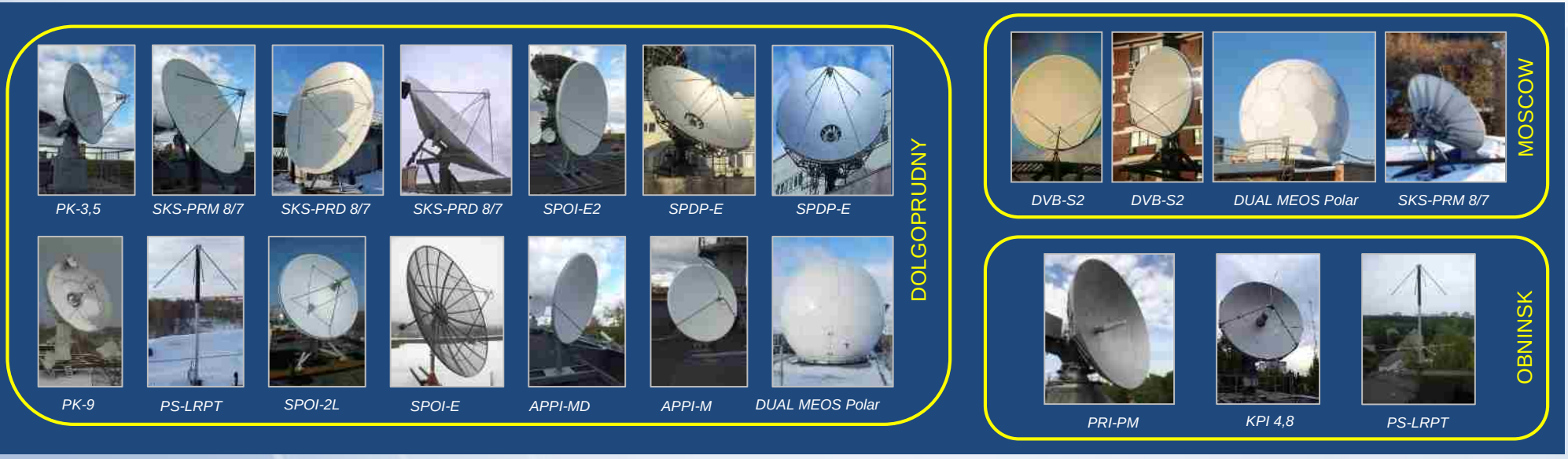
Far Eastern Center
(Khabarovsk)

USERS

- ROSHYDROMET
- NATIONAL METEOROLOGICAL SERVICES OF THE CIS COUNTRIES
- MINISTRY OF DEFENSE
- EMERCOM
- MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
- FEDERAL AGENCY FOR FORESTRY
- FOREST FIRES AVIATION SERVICE
- FEDERAL AGENCY FOR WATER RESOURCES
- MINISTRY OF AGRICULTURE
- ROSCOSMOS
- MINISTRY OF TRANSPORT
- AIR TRAFFIC CONTROL CENTERS
- MINISTRY OF SCIENCE AND HIGHER EDUCATION
- RUSSIAN ACADEMY OF SCIENCES
- RUSSIAN FEDERAL AND LOCAL AUTHORITIES
- MASS MEDIA

SRC Planeta Receiving Stations

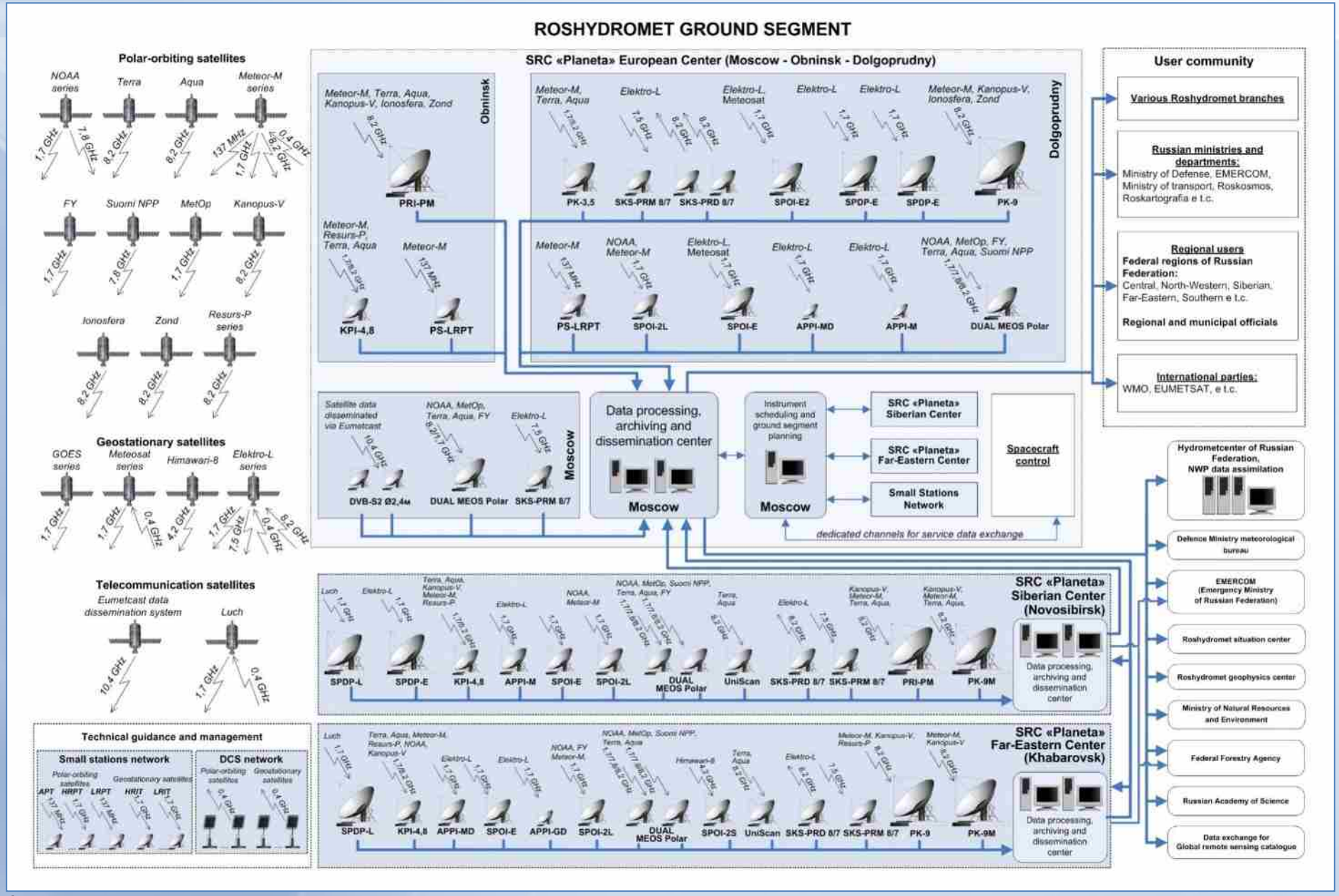
EUROPEAN CENTER



SIBERIAN CENTER

FAR EASTERN CENTER

Roshydromet Ground Segment of Earth Observation Satellite System



ELECTRO-L
Geostationary Meteorological Satellite

ELECTRO-L N2 (76°E) launched on 11 December 2015

ELECTRO-L N3 (165.8°E) — planned for 24 December 2019

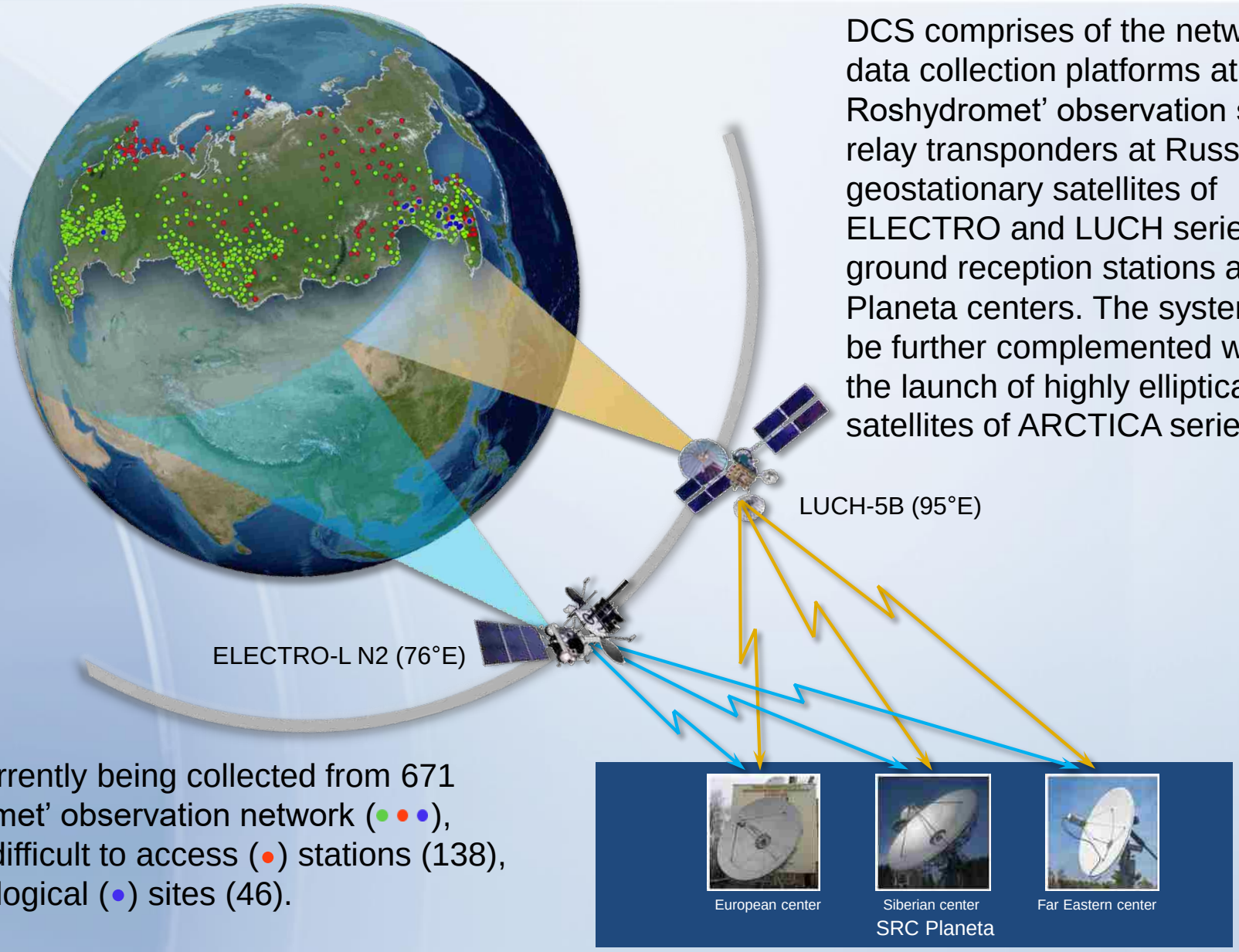
Parameter	Value
Three-axis high-precision stabilization	
In-orbit mass	~ 1500 kg
Payload mass	~ 370 kg
Lifetime	10 years
Longitude	76°E,14.5°W, 165.8°E
Altitude	830 km
Data dissemination format	HRIT/LRIT
Coverage/Cycle	Full disk every 30/15 min

Mission objectives

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

Data collection system (DCS) at Roshydromet' Observation Network

DCS comprises of the network of data collection platforms at Roshydromet' observation sites, relay transponders at Russian geostationary satellites of ELECTRO and LUCH series, and ground reception stations at SRC Planeta centers. The system will be further complemented with the launch of highly elliptical orbit satellites of ARCTICA series.



Data is currently being collected from 671 Roshydromet' observation network (• • •), including difficult to access (•) stations (138), and hydrological (•) sites (46).

METEOR-M
Polar-orbiting Meteorological Satellite

Parameter	Value
In-orbit mass	~ 2700 kg
Payload mass	~1200 kg
Lifetime	5 years
Orbit	Sun-synchronous
Altitude	830 km
Data dissemination format	HRPT/LRPT

METEOR-M N2 (ECT 09:30) launched on 8 July 2014

METEOR-M N2-2 (ECT 15:00) launched on 5 July 2019

Mission objectives

- Weather analysis and forecasting on global and regional scales
- Global climate change monitoring
- Sea surface observations
- Space weather analysis and prediction

METEOR-M N2, 2-2 Basic Instruments Specifications

Instrument	*Application*	*Spectral band*	*Swath width (km)*	*Resolution (km)*
MSU-MR Low-resolution multi-channel scanning radiometer	Global and regional cloud cover mapping, ice and snow cover observation, forest fire monitoring	0.5 – 12.5 μm (6 channels)	2900	1 x 1
KMSS Visible spectrum scanning imager	Earth surface monitoring for various applications (floods, soil and vegetation cover, ice cover)	0.4-0.9 μm (3+3 channels)	450/900	0.05/0.1
MTVZA-GY Imager-sounder (module for temperature and humidity sounding of the atmosphere)	Atmospheric temperature and humidity profiles, SST, sea level wind, etc.	10.6-183.3 GHz (26 channels)	1500	16 – 90
IKFS-2 Advanced IR sounder (IR Fourier-spectrometer)	Atmospheric temperature and humidity profiles	5-15 μm	2000	35
Severjanin-M * X-band synthetic aperture radar	All-weather Ice coverage monitoring	9500-9700 MHz	600	0.5/1
GGAK-M Heliogeophysical measurements suite	Heliogeophysical data			
BRK SSPD Data collection system (DCS)	Data retransmission from DCPs			

* - onboard Meteor-M N2

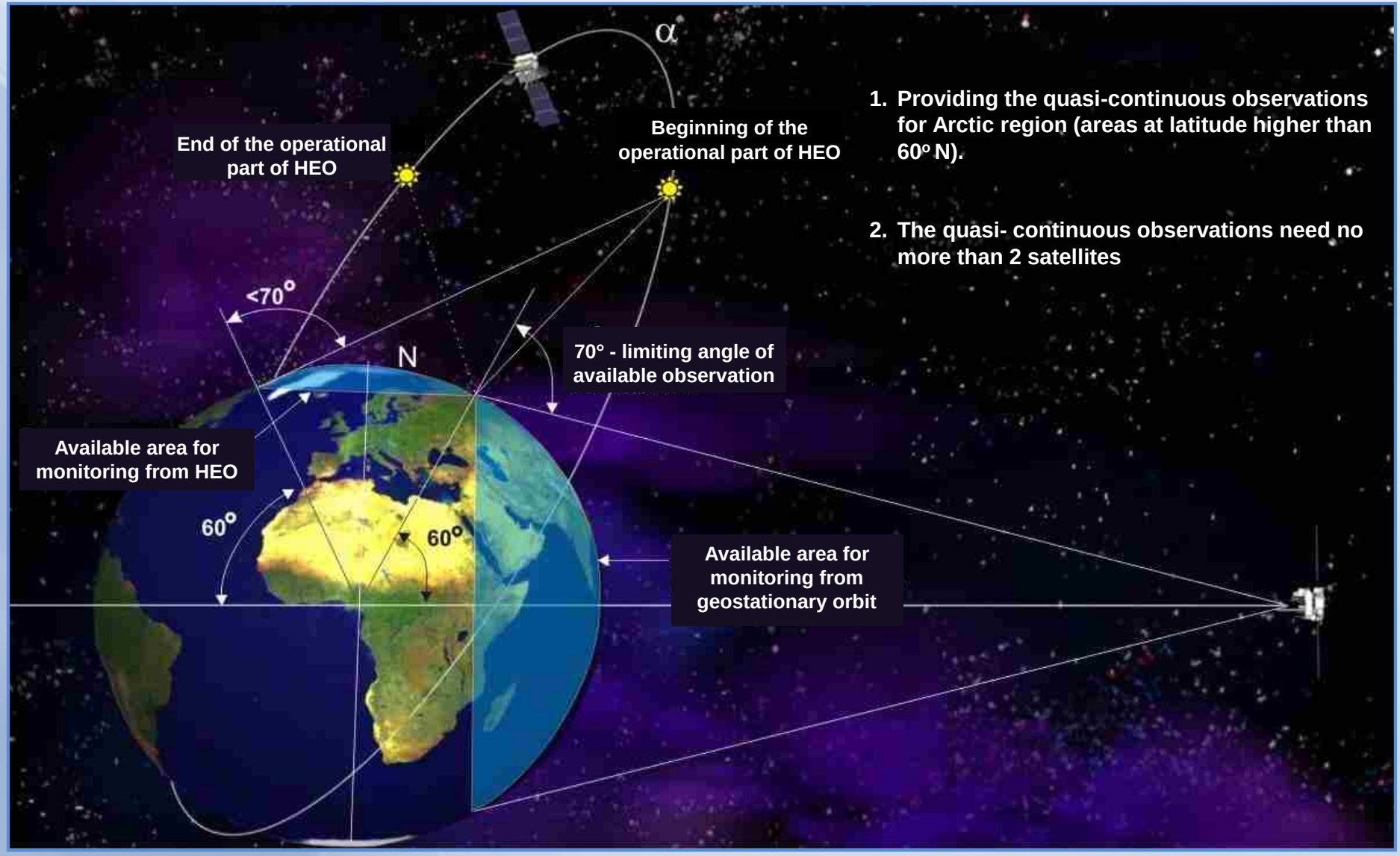
ARCTICA-M
Highly Elliptical Orbit Meteorological Satellite

Parameter	Value
Orbit: Apogee, km Perigee, km Inclination, deg Period, h	 40000 1000 63.4 12
Number of MSU-GS/HE spectral channel	10
Spectral range, μm	from 0.5 to 12.5
Resolution (at nadir): - VIS-channel, km - IR-channel, km	 1 4
Field-of-view from the Molniya orbit, min: - regular mode - frequent mode	 30 15
Spacecraft mass, kg	2000

ARCTICA-M N1 — planned for 2020

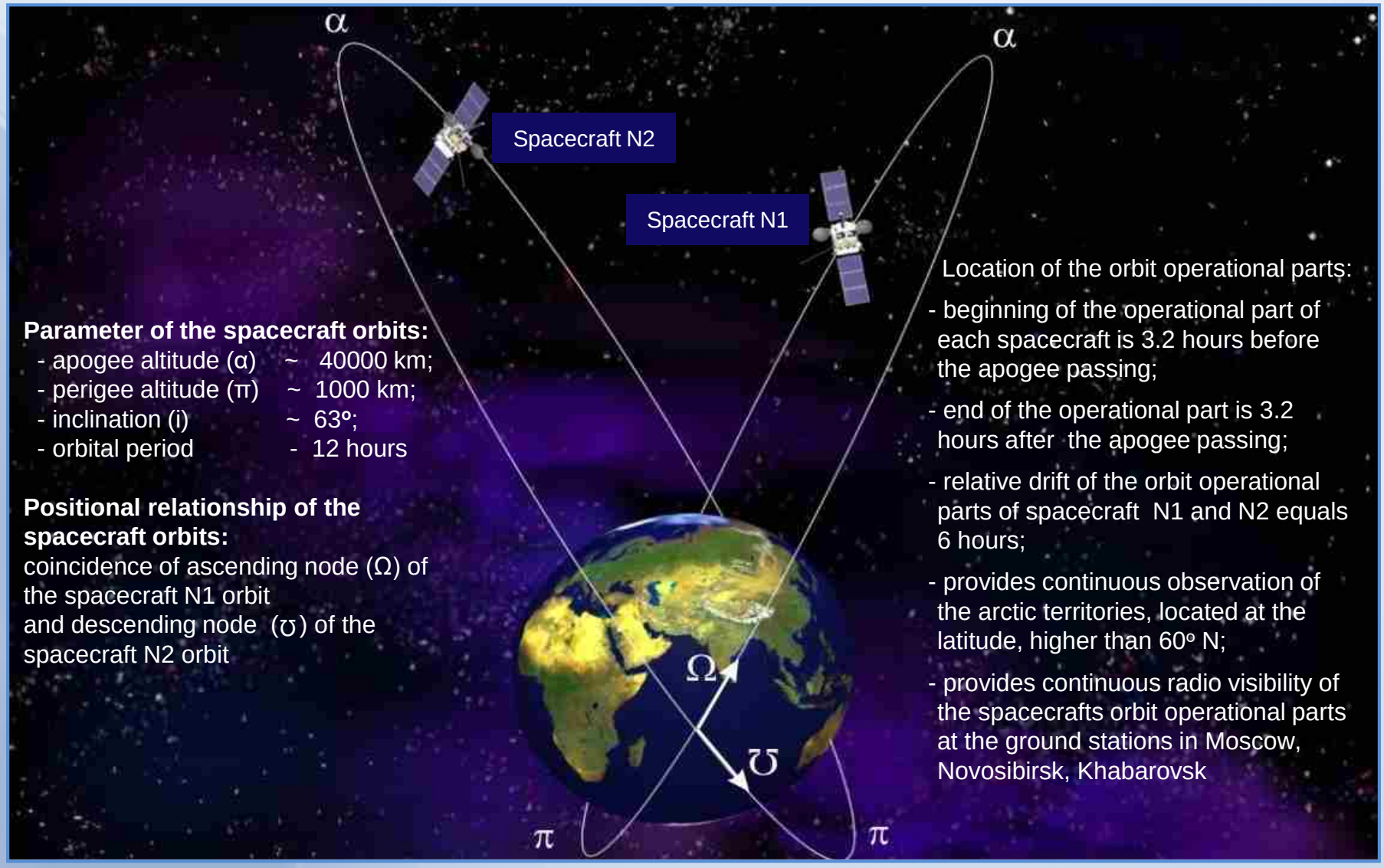
ARCTICA-M N2 — planned for 2023

Highly Elliptical Orbits (HEO) for Arctic Observations



1. Providing the quasi-continuous observations for Arctic region (areas at latitude higher than 60° N).
2. The quasi- continuous observations need no more than 2 satellites

Satellite System Ballistic Configuration



Parameter of the spacecraft orbits:

- apogee altitude (α) ~ 40000 km;
- perigee altitude (π) ~ 1000 km;
- inclination (i) ~ 63º;
- orbital period - 12 hours

Positional relationship of the spacecraft orbits:
coincidence of ascending node (Ω) of the spacecraft N1 orbit
and descending node (ʊ) of the spacecraft N2 orbit

Location of the orbit operational parts:

- beginning of the operational part of each spacecraft is 3.2 hours before the apogee passing;
- end of the operational part is 3.2 hours after the apogee passing;
- relative drift of the orbit operational parts of spacecraft N1 and N2 equals 6 hours;
- provides continuous observation of the arctic territories, located at the latitude, higher than 60º N;
- provides continuous radio visibility of the spacecrafts orbit operational parts at the ground stations in Moscow, Novosibirsk, Khabarovsk

KANOPUS-V Disaster Monitoring Satellite

KANOPUS-V N1
launched on 22.07.2012
KANOPUS-V-IK
launched on 14.07.2017
KANOPUS-V N3, 4
launched on 01.02.2018
KANOPUS-V N5, 6
launched on 27.12.2018

Parameter	Value
In-orbit mass	465 kg (N1,3-6) & 600 kg (IR)
Payload mass	106 kg (N1,3-6) & 191 kg (IR)
Lifetime	5 years
Orbit	Sun-synchronous
Altitude	510 - 540 km
Orbit inclination	97,4 °

KANOPUS-V Basic Characteristics

	Spectral channels *(µm)*	**Resolution *(m)***	**Swath width *(km)***
Panchromatic film-making system (PSS)	0.54-0.86	2.1	23
Multispectral film-making system (MSS)	0.46-0.52 0.51-0.60 0.63-0.69 0.75-0.84	10,5	23
Multi-channel medium and IR range radiometer (MSU-IK-SR)*	3.5-4.1 8.4-9.4	200	2000

* - onboard KANOPUS-V-IK

RESURS-P High Resolution Satellite

RESURS-P N1 launched on 25.06.2013

RESURS-P N2 launched on 26.12.2014 (inactive since 19.12.2017)

RESURS-P N3 launched on 13.03.2016 (inactive since 28.02.2017)

RESURS-P N4 planned for 2020

Parameter	Value
In-orbit mass	- 6275kg
Payload mass	- 2258 kg
Lifetime	5 years
Orbit	elliptical, sun-synchronous
Altitude	475 km
Orbit inclination	97,27 °

Resurs-P Basic Characteristics

	High-resolution instrument GEOTON-L1	Multispectral wide swath suit (high|/medium resolution)	Hyperspectral imaging equipment GSA
Spectral Bands *(μm)*			Not less than 96 spectral channels in the range 0.4-1.1 μm
panchromatic mode	0.58-0.8	0.43-0.9/0.43-0.7	
multispectral mode	0.45-0.52; 0.52-0.6; 0.61-0.68; 0.67÷0.7; 0.7-0.73; 0.72-0.80; 0.80-0.90	0.43-0.51; 0.51-0.58; 0.60-0.70; 0.70-0.90; 0.80-0.90	
Resolution *(m)*			25-30
panchromatic mode	1	12/60	
multispectral mode	3-4	24/120	
Swath width (km)	38	96/480	25

EARS Russian Segment

NOAA-18,19, Metop-A,B, Suomi NPP

8,2 GHz 1,7 GHz

7,8 GHz 1,7 GHz

7,8 GHz 1,7 GHz

7,8 GHz 1,7 GHz

7,8 GHz 1,7 GHz

7,8 GHz 1,7 GHz

DUAL MEOS Polar

DUAL MEOS Polar

DUAL MEOS Polar

European Center
(Moscow-Obninsk-Dolgoprudny)

Siberian Center
(Novosibirsk)

Far Eastern Center
(Khabarovsk)

Users

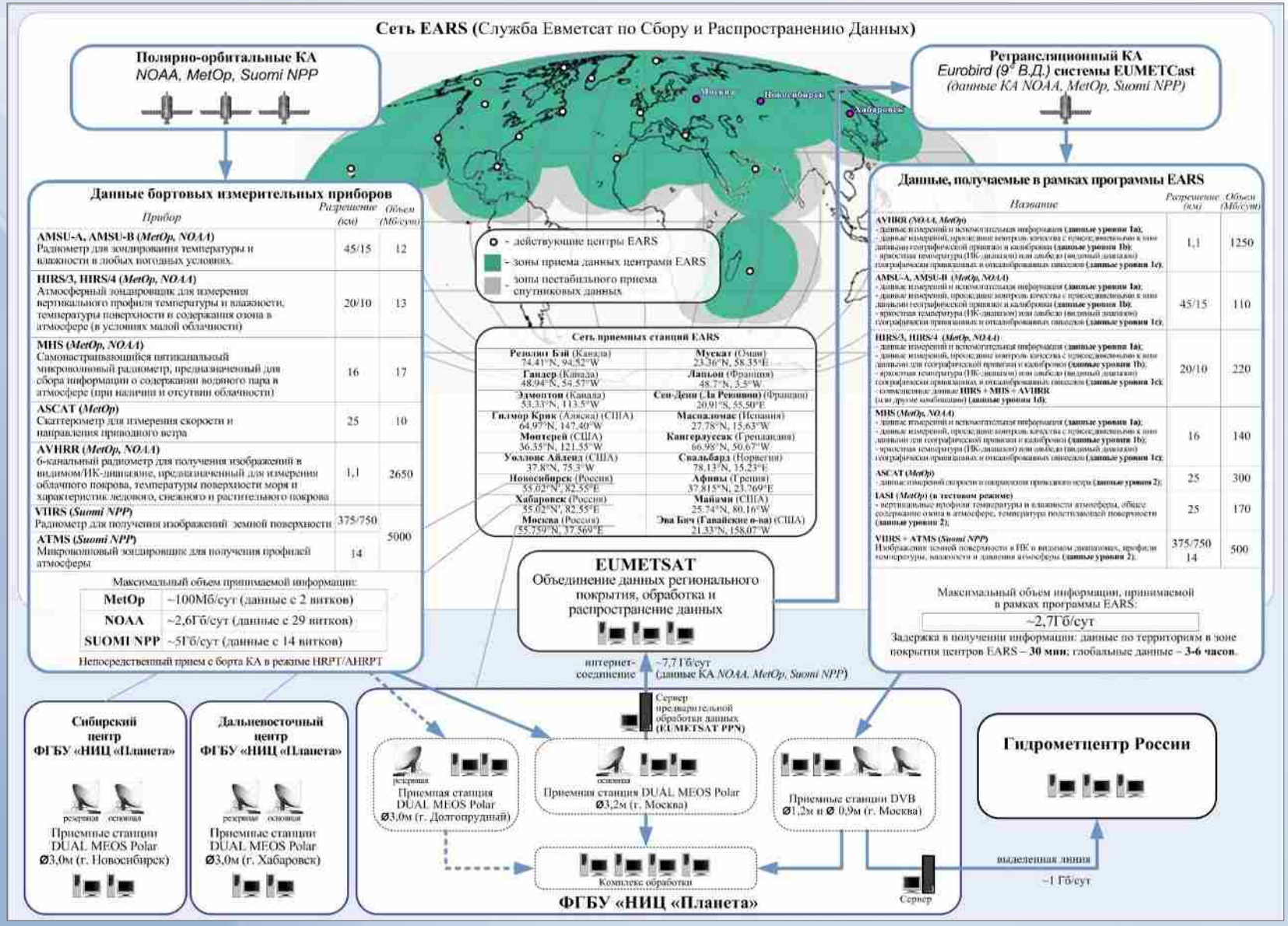
Roshydromet institutions

Russian Ministries and Federal Services organizations

Regional users

EUMETSAT

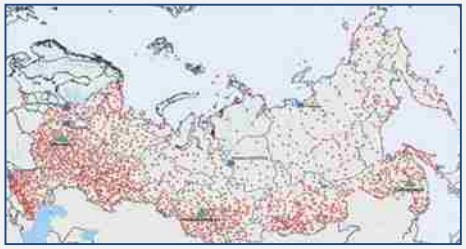
Roshydromet Participation in EARS



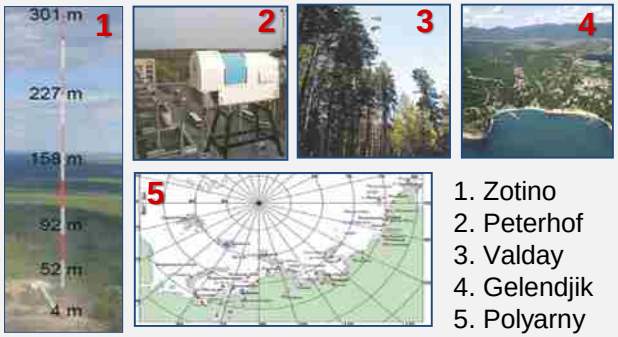
CAL/VAL System for Satellite Data and Products

Standard measurements

Roshydromet' observation sites

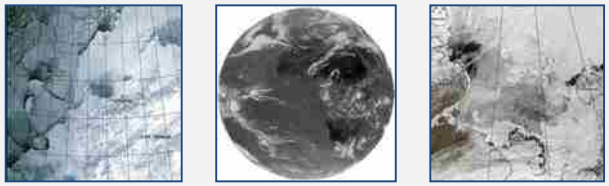


Test sites



1. Zotino
2. Peterhof
3. Valday
4. Gelendjik
5. Polyarny

Foreign satellite data



NOAA/AVHRR METEOSAT/SEVIRI TERRA/MODIS

Russian meteorological satellites of ELECTRO-L and METEOR-M series data

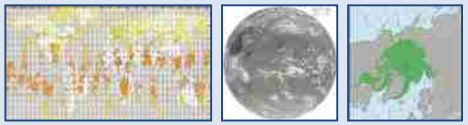
Data calibration

Data inter-calibration

Thematic processing

Validation

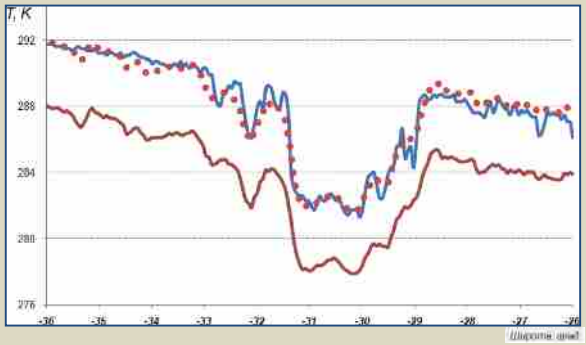
Satellite products



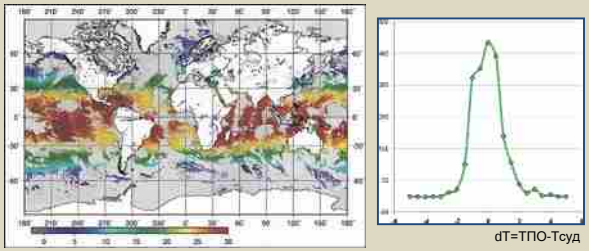
Numerical weather prediction

Cal/Val examples

Data inter-calibration for channel 10.2-11.2 μm over sea surface



Sea surface temperature validation *vs* ship measurements

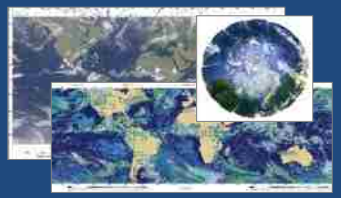


SST derived from METEOR-M/MSU-MR

Bias = -0,01° K
RMSE = 0,9° K

Satellite-based Products

CLOUD COVER



Cloud cover monitoring

Nephanalysis map

Tropical cyclone monitoring

FLOODS AND FIRES

Flooding map

Fires map

SNOW AND ICE COVER

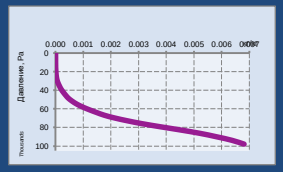
Snow cover map

Sea ice cover map

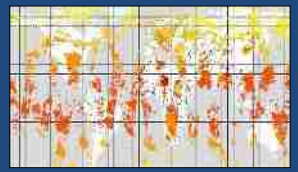
Sea ice drift map

ATMOSPHERIC SOUNDING

Temperature profile

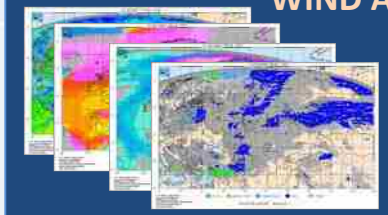


Humidity profile



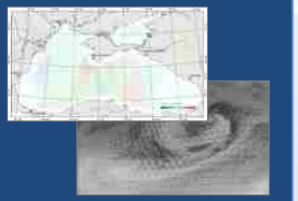
Atmospheric sounding data coverage

WIND AND PRECIPITATION



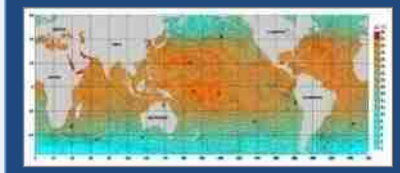
Meteorological phenomena monitoring

Precipitation and cloud cover parameters

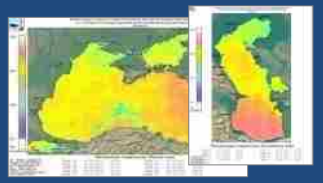


Atmospheric motion winds

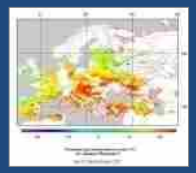
SEA AND LAND SURFACE TEMPERATURE



Ocean surface temperature

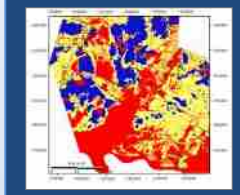


Sea surface temperature



Land surface temperature

ENVIRONMENTAL MONITORING



Risk areas for pollution spread

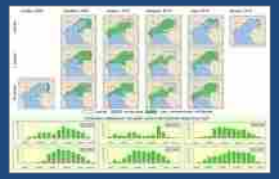
Vegetation index

Water pollution

Volcanic ash spead

CLIMATE CHANGE

Old ice cover monitoring in Russian Arctic



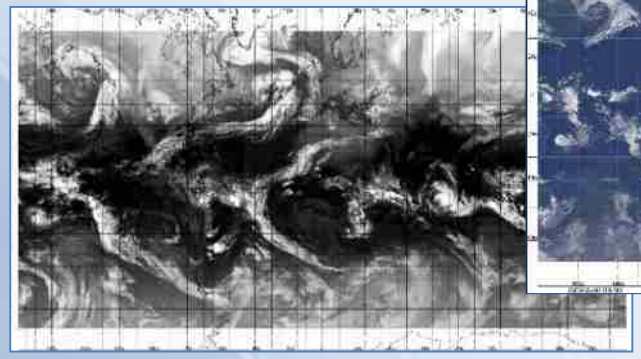
Seasonal changes in Caspian Sea Ice cover

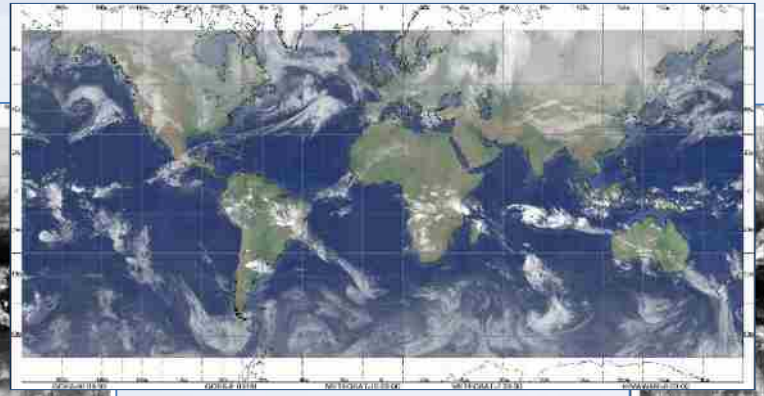
Desertification monitoring at Black Lands of the Kalmyk Republic


CLOUD COVER

Cloud Cover: Global Monitoring

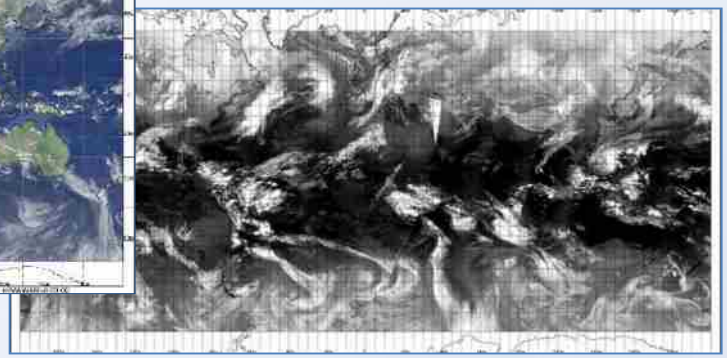
GOES-W, GOES-E, METEOSAT-11, ELECTRO-L N2, HIMAWARI-8



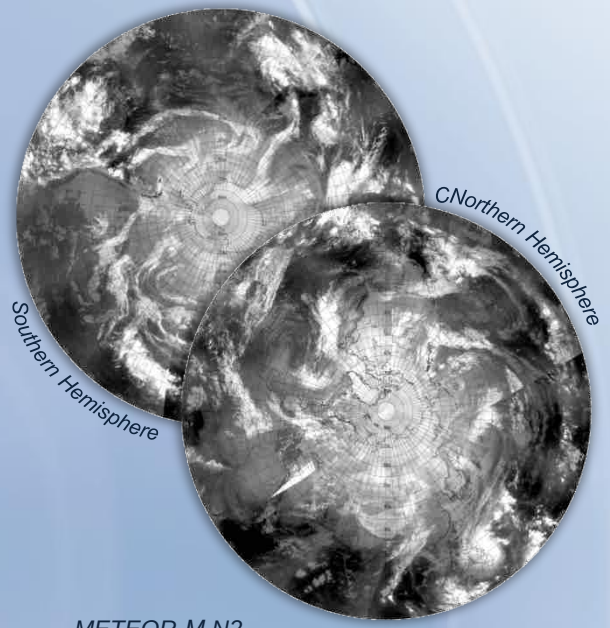


GOES-W, GOES-E, METEOSAT-11, METEOSAT-8, HIMAWARI-8

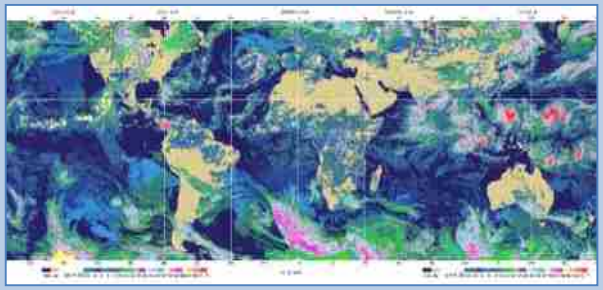
METEOR-M-M N2



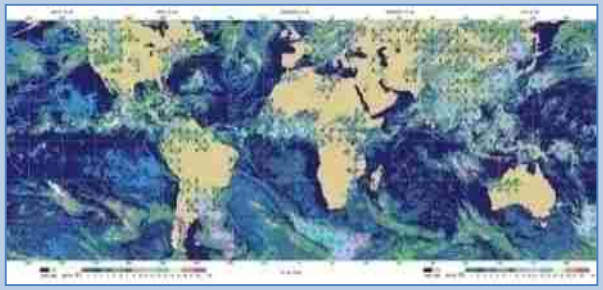
Global Cloud Maps



METEOR-M N2



Cloud Top Height Temperature

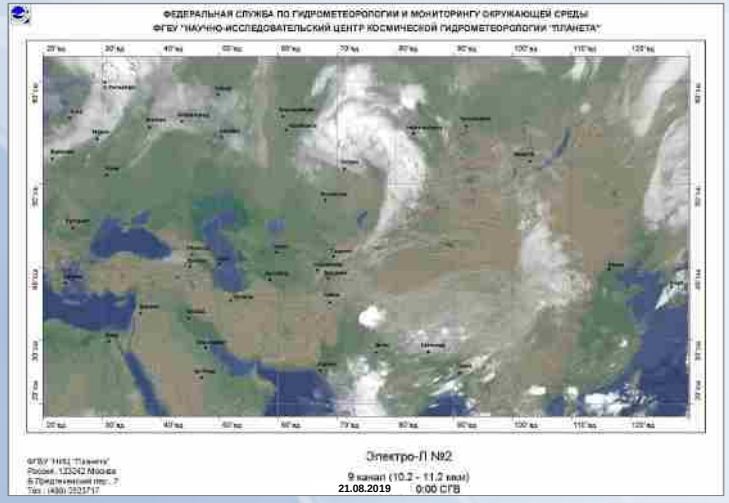


Cloud Cover Fraction and Cloud Top Height

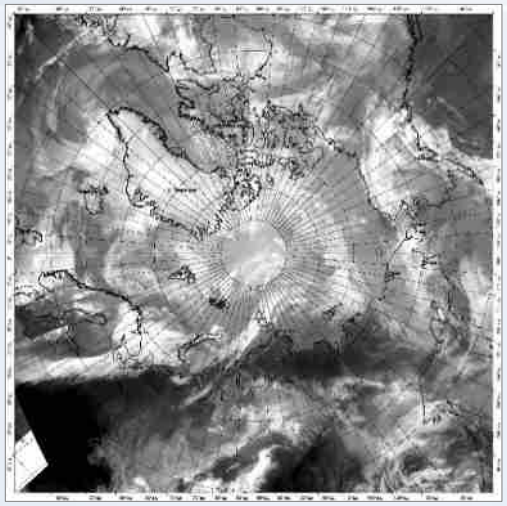
GOES-W, GOES-E, METEOSAT-8, 11, HIMAWARI-8

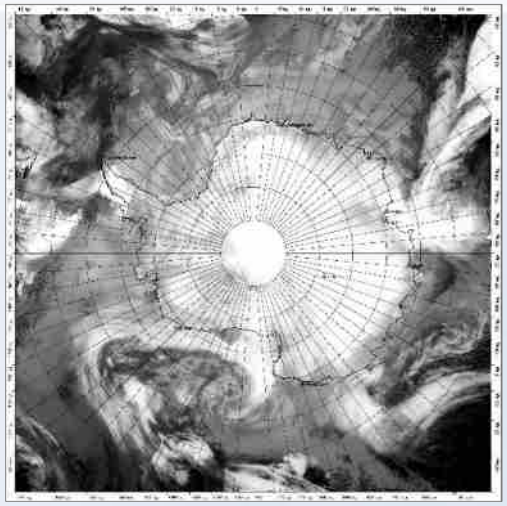
ELECTRO-L N2

Cloud Cover: Regional Monitoring

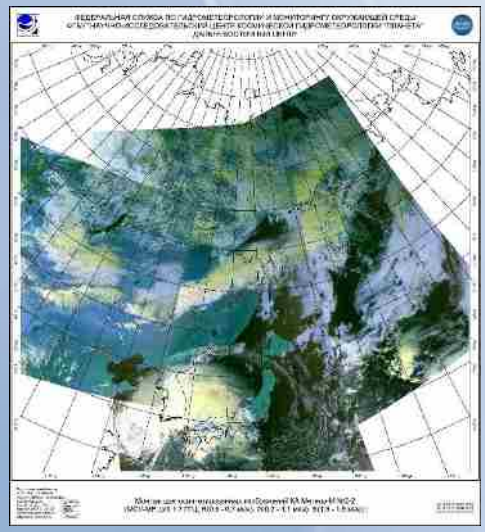


Cloud Cover Animation, Eurasia
(ELECTRO-L N2/MSU-GS)

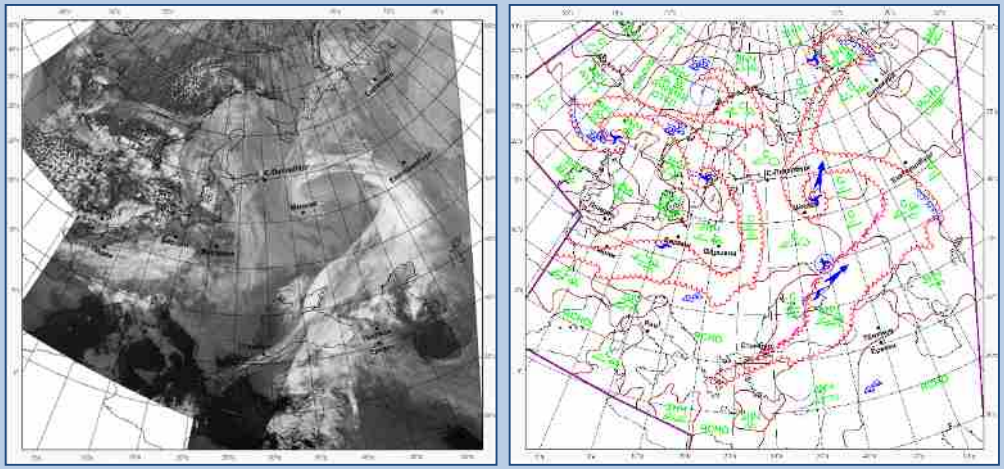




Arctic and Antarctic Mosaics of IR Images
(METEOR-M N2/MSU-MR)

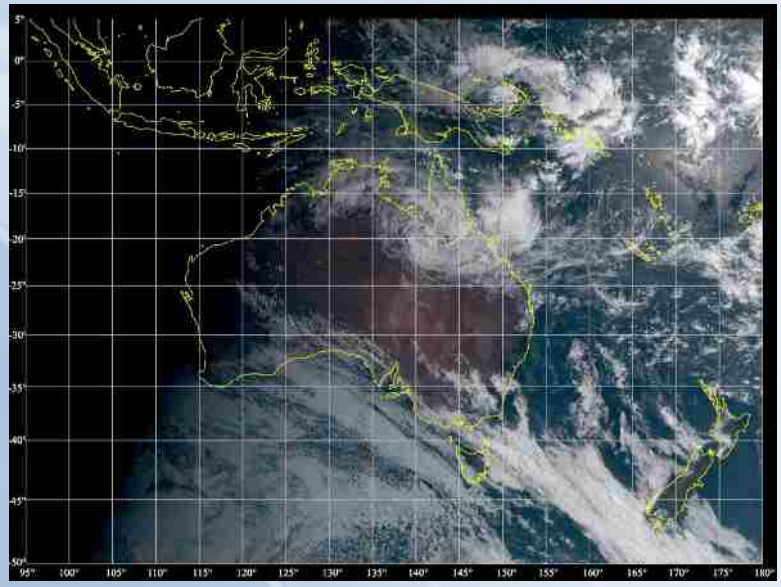


Cloud Cover, Far-Eastern region
(METEOR-M N2-2/MSU-MR)

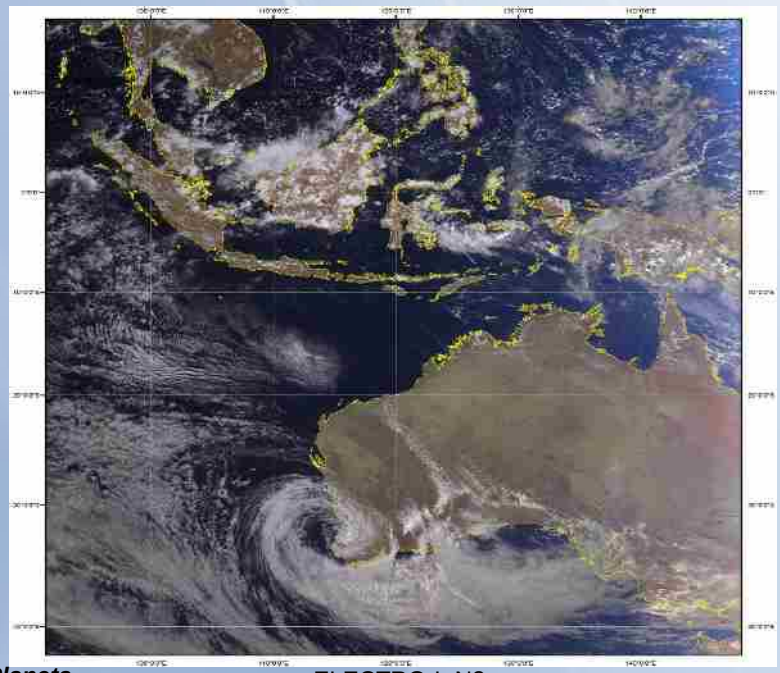


Nephanalysis Map
NOAA/AVHRR (IR-channel: 10.3 -11.3 μm)

Earth Observations: Australia



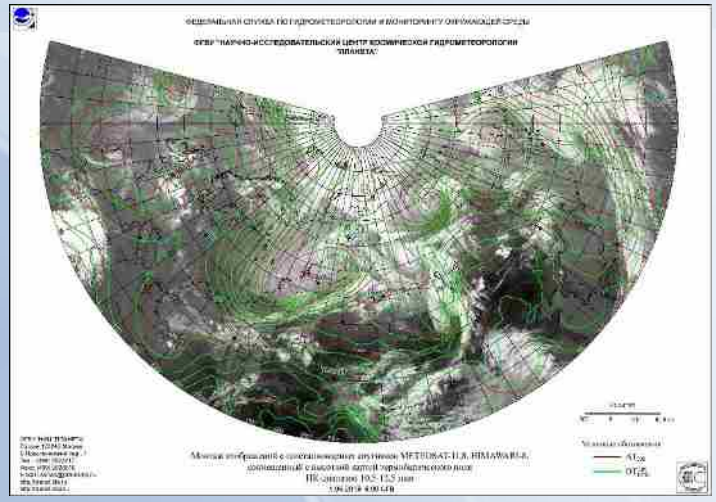
HIMAWARI-8 04.02.2019

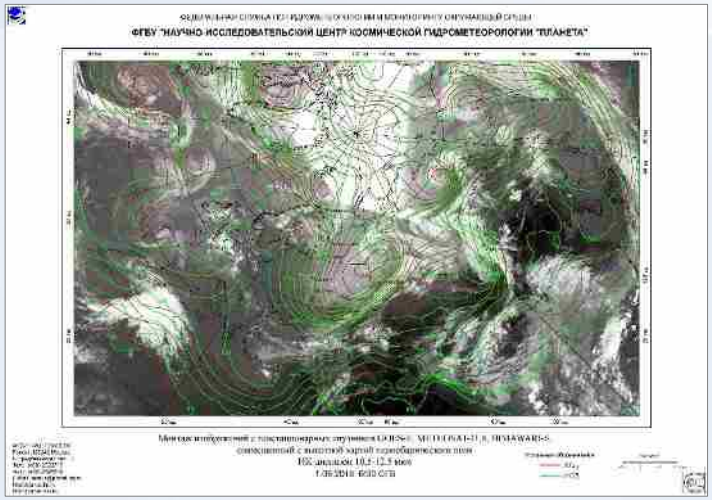


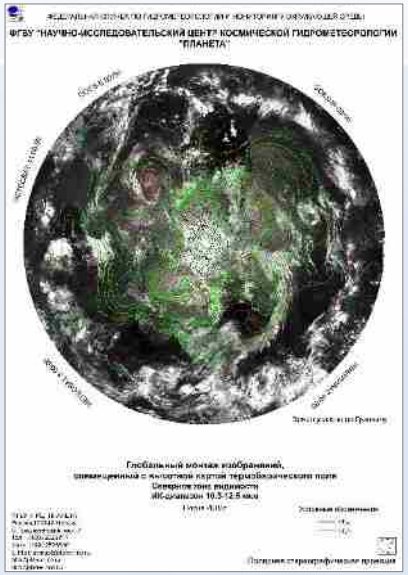
ELECTRO-L N2 04.10.2019

ELECTRO-L N2 04.02.2019

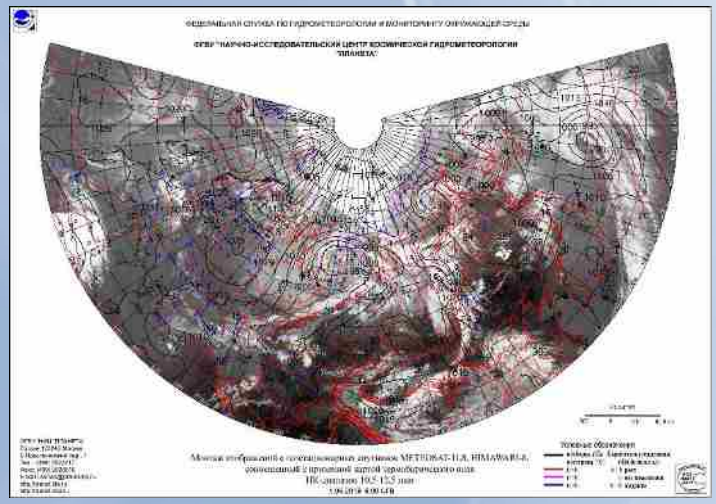
Mosaics of IR Images combined with High-level Thermo-baric Fields

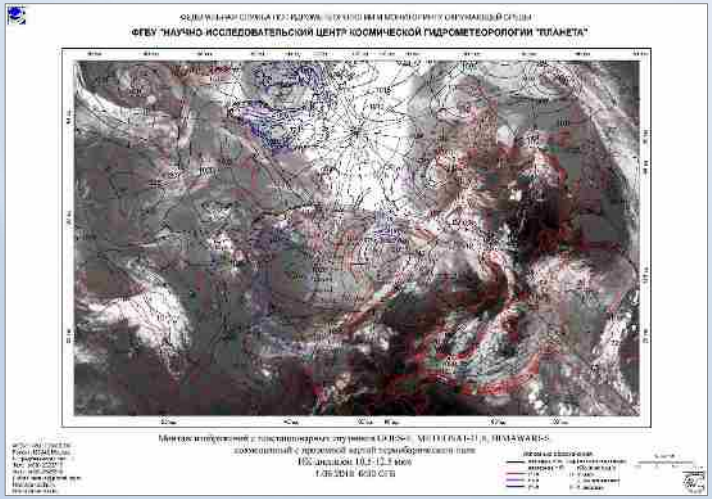


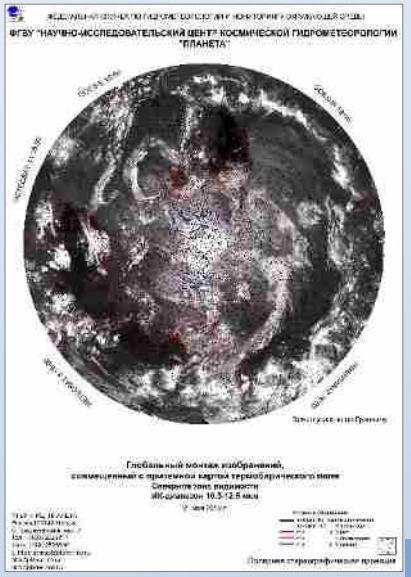




Mosaics of IR Images combined with Low-level Thermo-baric Fields

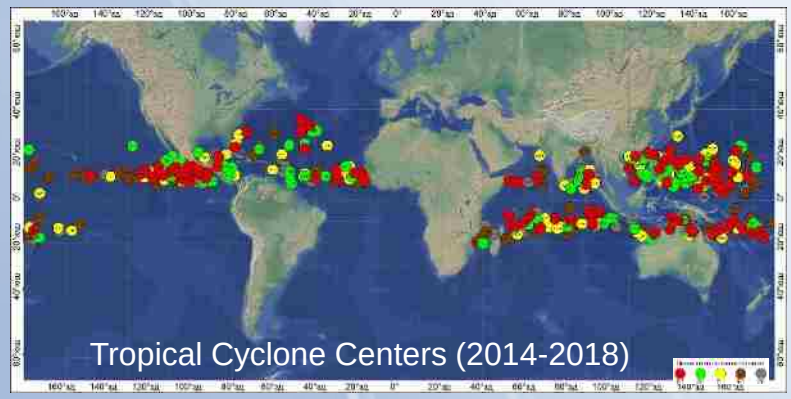


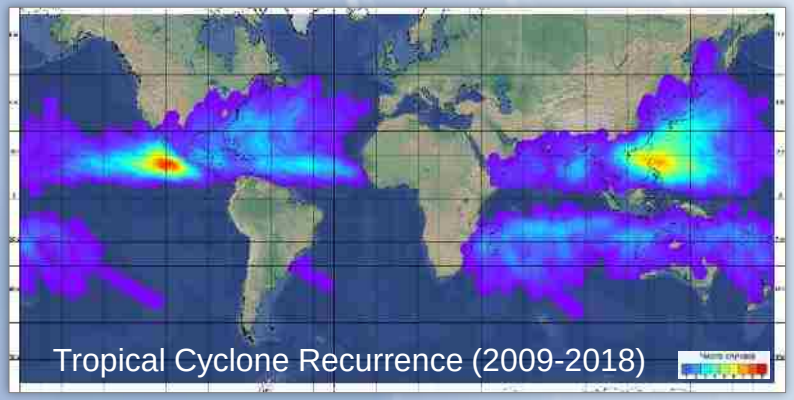


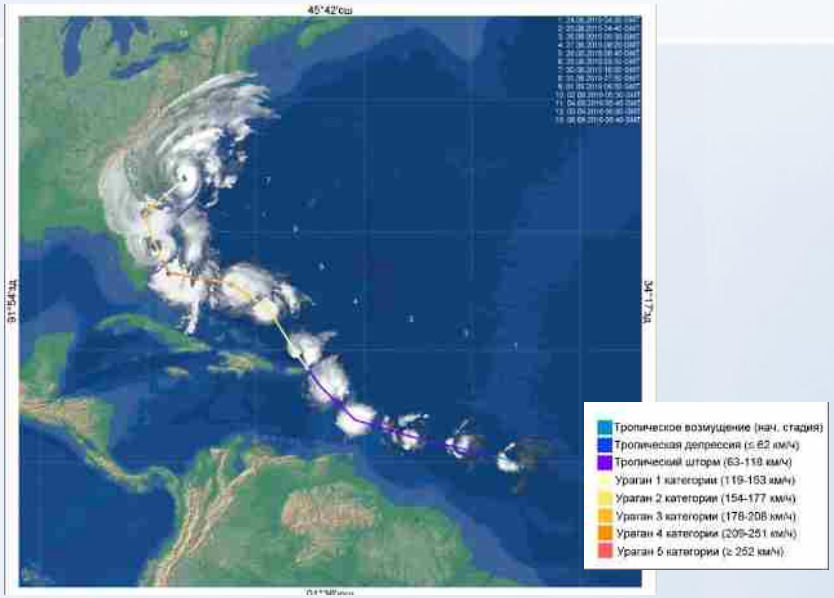


Tropical Cyclone Monitoring

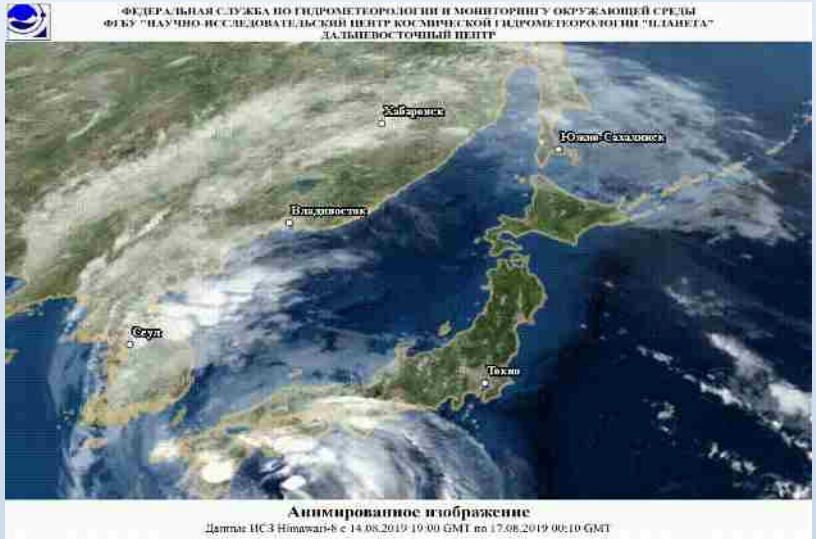
(geostationary satellites)







Tropical Cyclone DORIAN 24.08.2019 - 06.09.2019



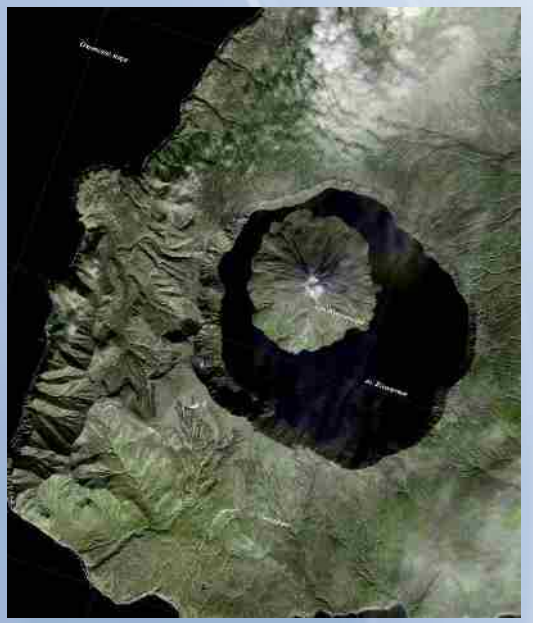
Tropical Cyclone LEKIMA 02-14.08.2019

VOLCANIC ACTIVITY MONITORING

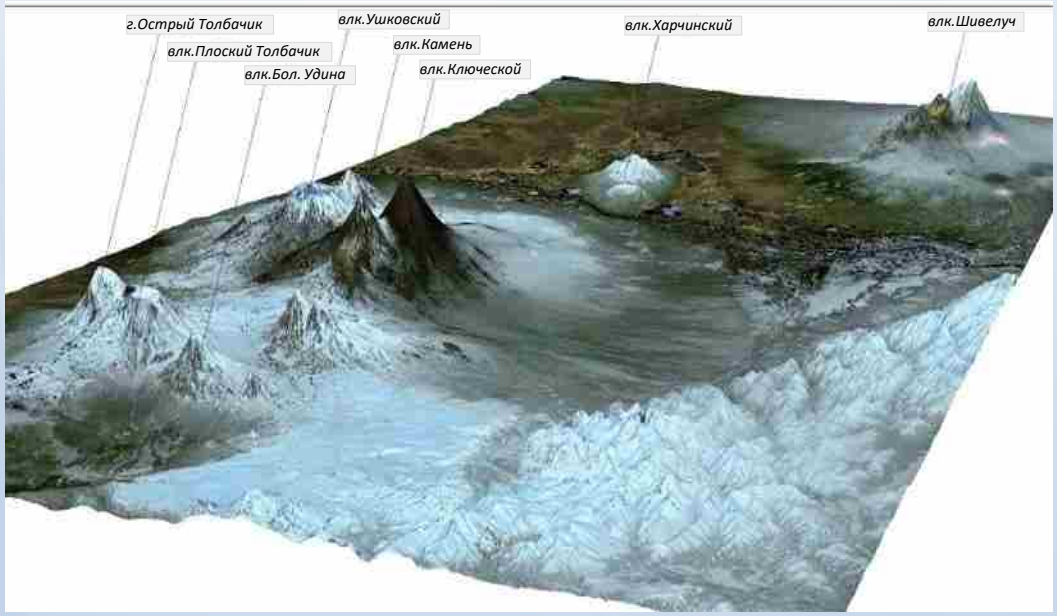
Volcanic Activity Observation: Kamchatka Krai

Resurs-P N1 (Geoton-L1)

Meteor-M N2 (KMSS)



Kanopus-V (MSS)



Satellite imagery of Kamchatka Krai volcanoes (3D-visualization), *Landsat-8 (OLI)*

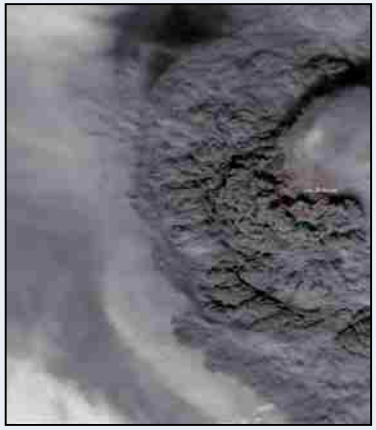
Volcanic Activity Observations

Roshydromet provides operational monitoring of volcanic activity in Kamchatka and Kuril Islands. During the period of eruptions, satellite images of volcanic plumes are produces. The following eruption parameters are detected based on the satellite data: effective particle radius, optical depth and ash content, total sulfur dioxide content.

Raikoke volcano eruption (June, 2019)

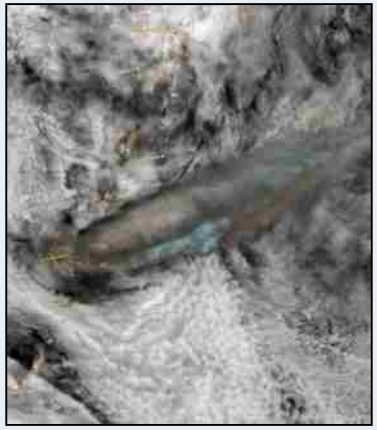
On June 21, 2019 18:05 UTC, an explosive eruption of Raikoke volcano occurred on the Northern Kuril Islands. The ash plume reached a height of 10-13 km and spread over more than 550 km to the east - northeast of the volcano.

Satellite Imagery



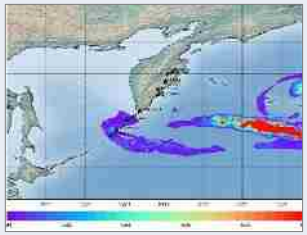
Kanopus-V N 1, 22.06.2019 01:17 UTC

TERRA, 22.06.2019 01:25 UTC

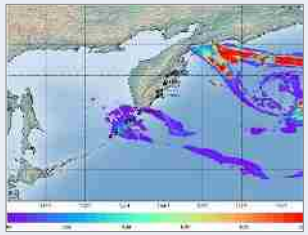


Suomi NPP, 22.06.2019 02:13 UTC

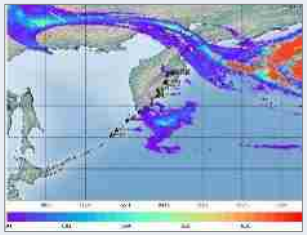
Dynamics of Sulfur Dioxide Level based on Sentinel-5P (ml/sq.m.)



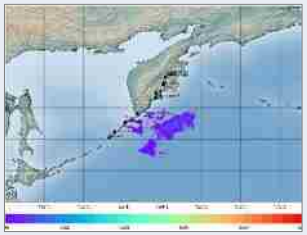
23.06.2019, 02:01 UTC



24.06.2019, 01:41 UTC

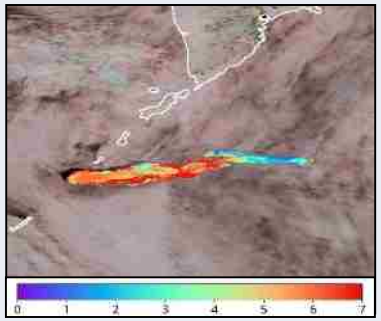


25.06.2019, 01:21 UTC

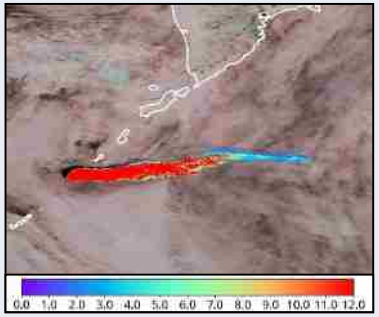


25.06.2019, 03:01 UTC

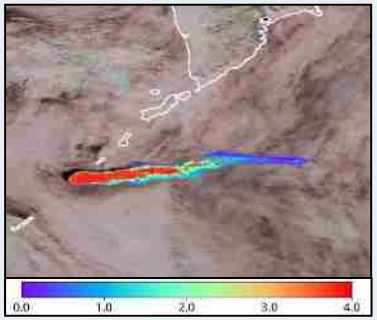
Eruption parameters based on AVHRR/Metop, 21.06.2019 23:55 UTC



Effective radius of ash particles, µm

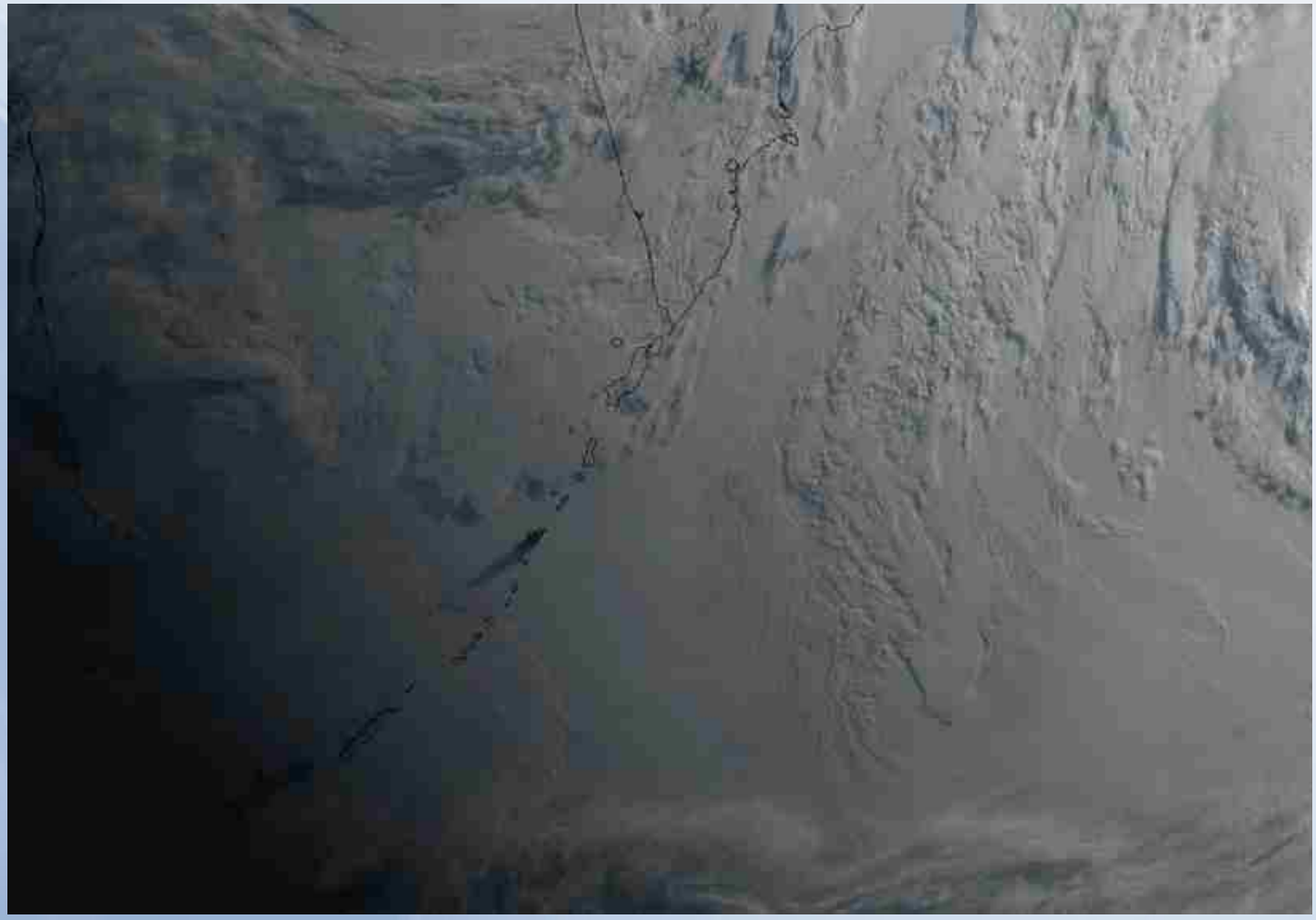


Ash content, g./sq.m.



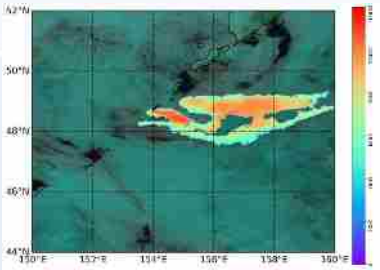
Optical depth at 11 µm

Raikoke Volcano Eruption

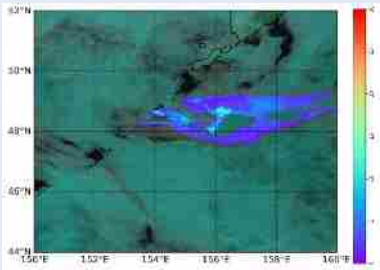


HIMAWARI 8 / AHI

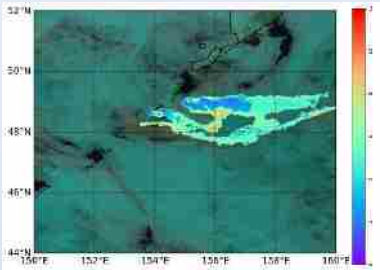
21.06.2019 18:30 UTC – 22.06.2019 08:50 UTC



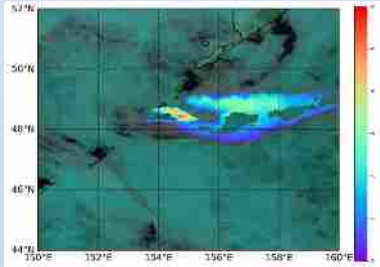
Volcanic cloud top height, m



Ash content, g./sq.m.



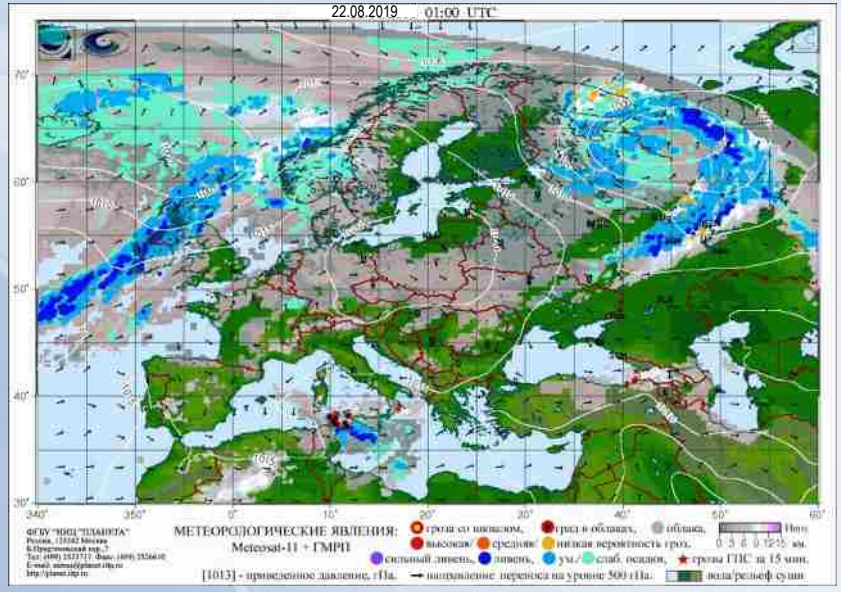
Effective radius of ash particles, µm



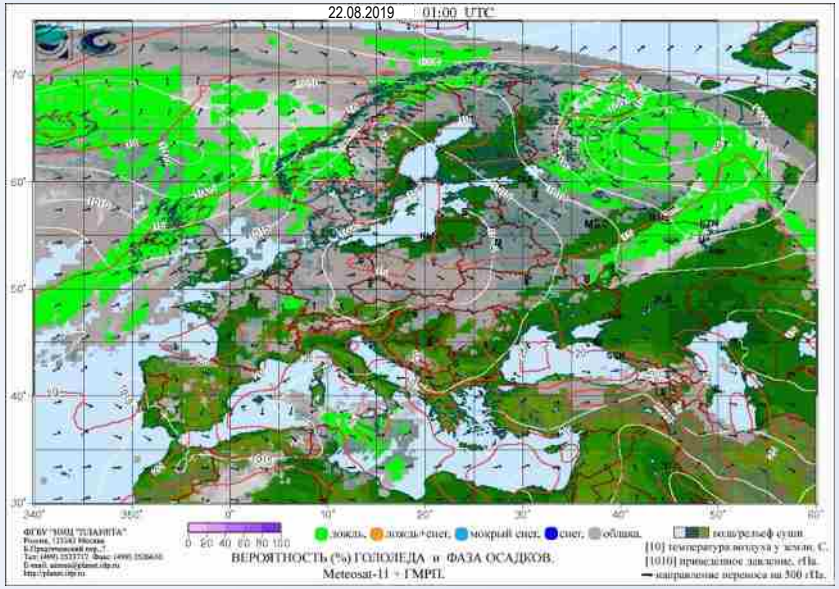
Optical depth at 0,55 µm

METEOROLOGICAL PHENOMENA MONITORING

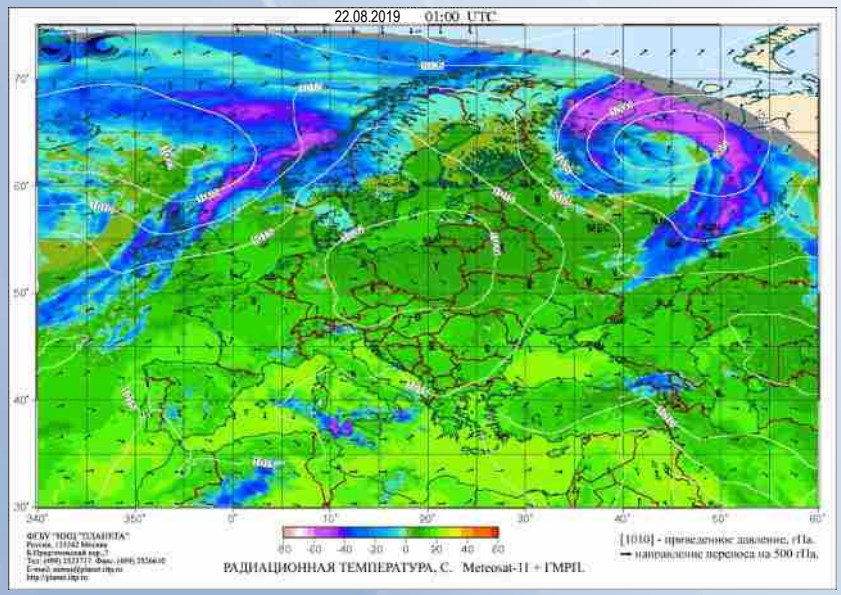
Meteorological Phenomena Monitoring



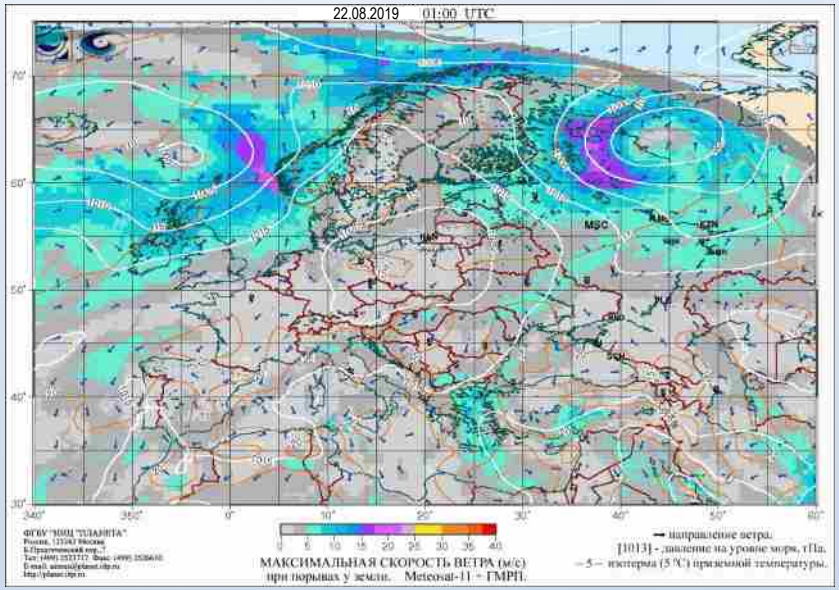
Atmospheric phenomena 22.08.2019



Precipitation phase 22.08.2019



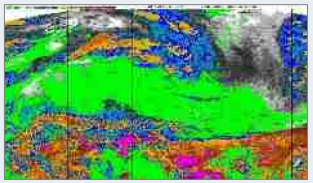
Radiative temperature 22.08.2019

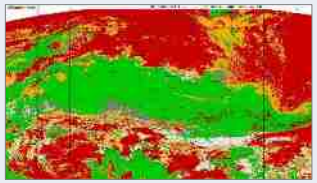


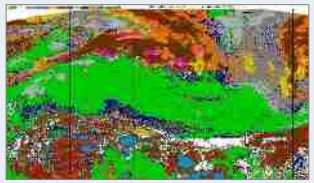
Maximum wind speed (wind gusts) 22.08.2019

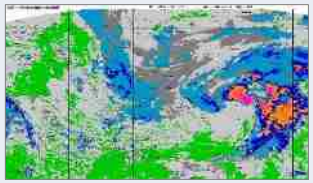
Cloud Cover Parameters

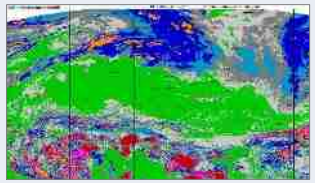
EUROPEAN REGION

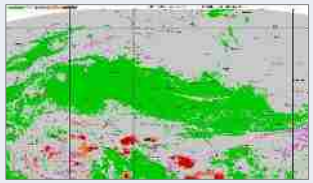

Cloud top height

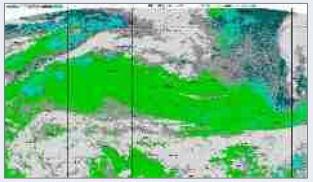

Cloud bottom height

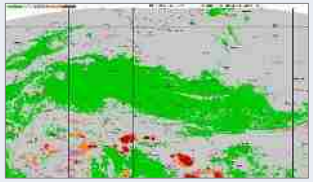

Cloud types

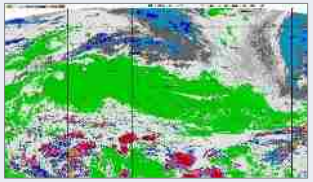

Maximum water content of cloud layer

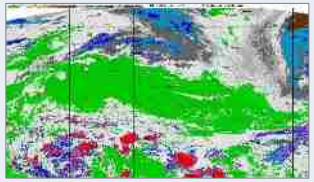

Total liquid water content

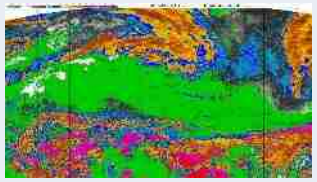

Hail probability and intensity

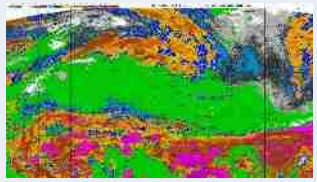

Cloud top water phase


Thunderstorm probability and intensity


Maximum precipitation rate

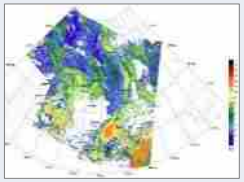

Precipitation type

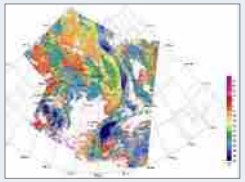

Cloud top height temperature

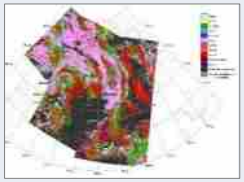

Cloud top height pressure

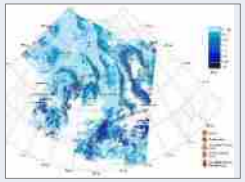
Meteosat-8/SEVIRI

SIBERIAN REGION


Cloud top height

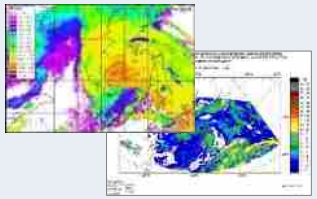

Cloud top height temperature

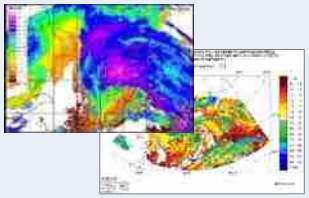

Cloud types

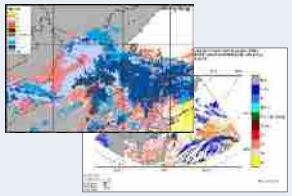

Water content and maximum precipitation rate

Metop, NOAA/AVHRR

FAR EASTERN REGION

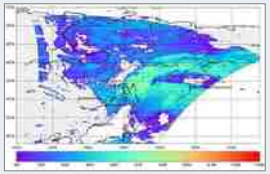

Cloud top height

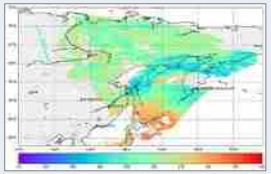

Cloud top height temperature

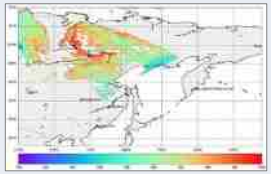

Cloud types

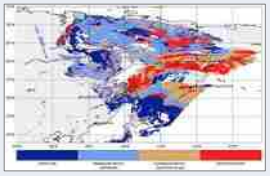
Himawari-8/AHI

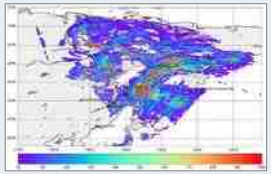
FAR EASTERN REGION

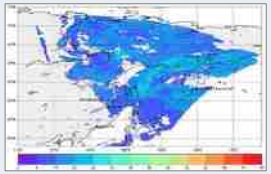

Cloud top height

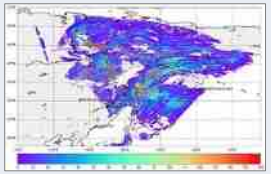

Cloud top height temperature


Cloud top height pressure


Cloud phase

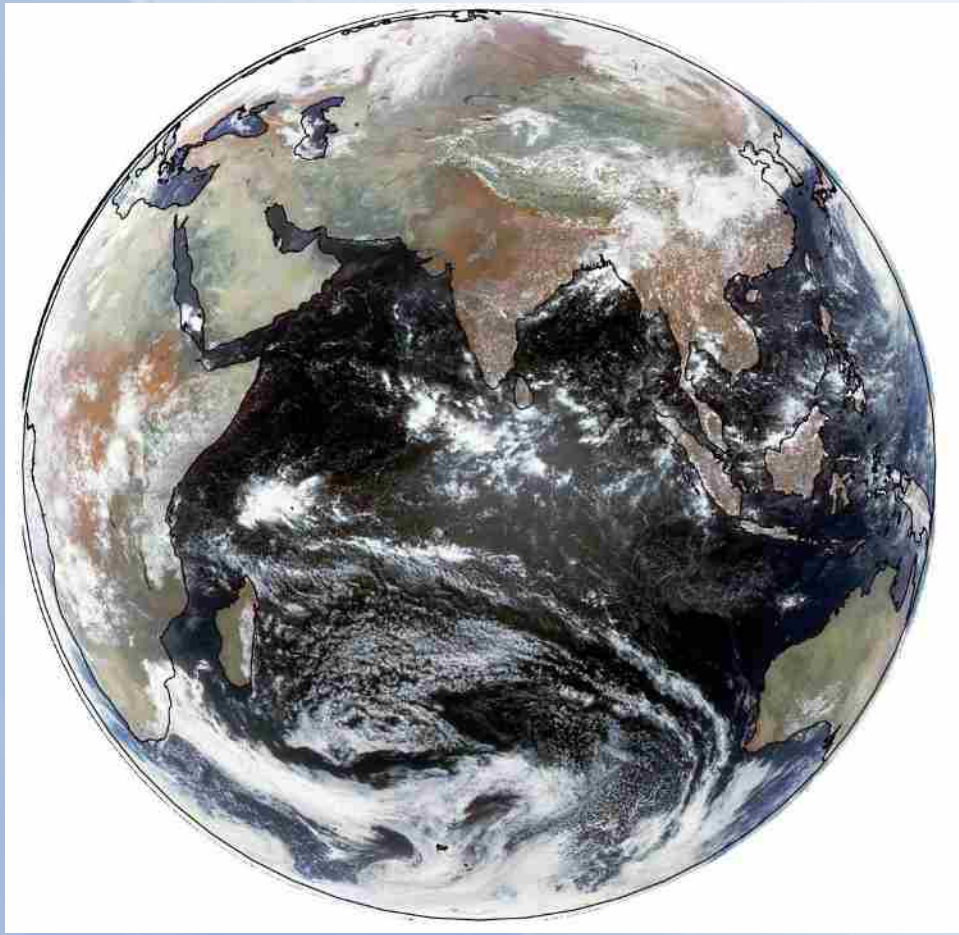

Cloud water content

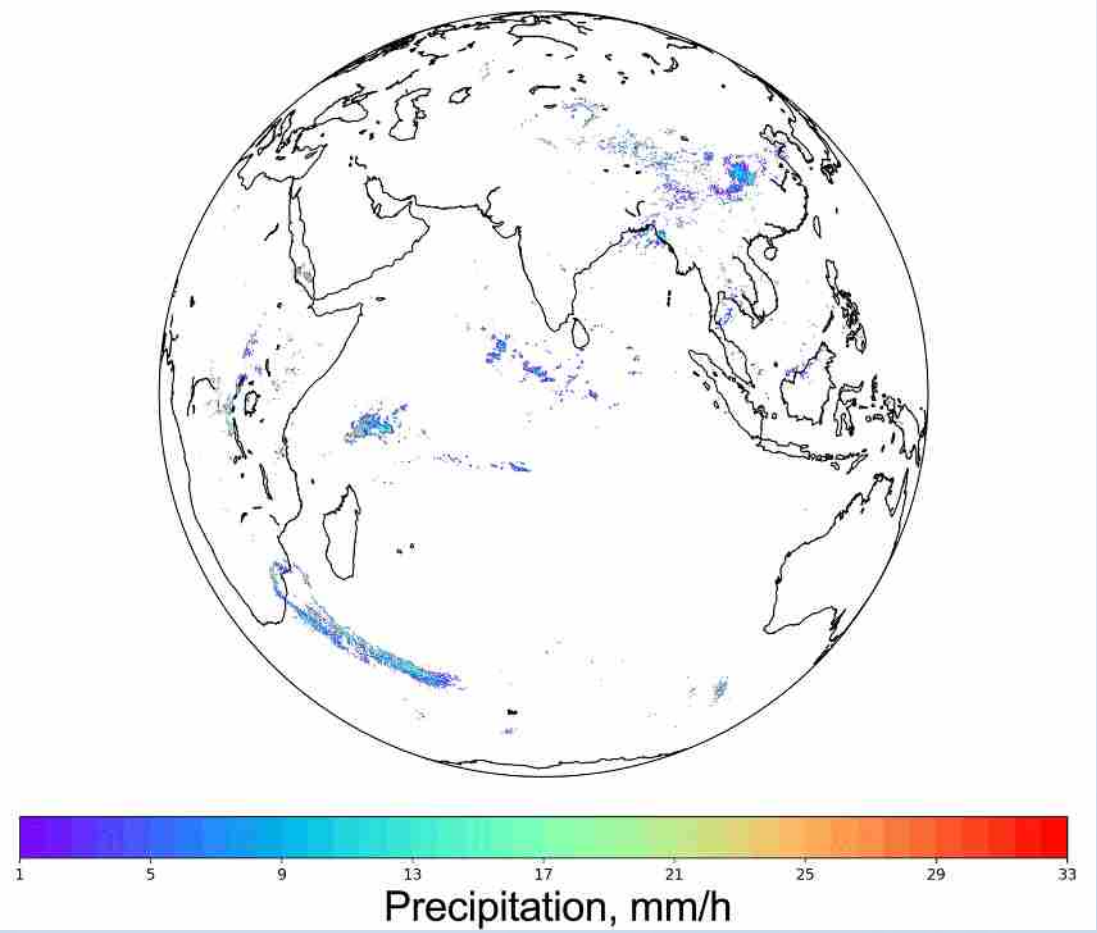

Effective radius of cloud particles


Cloud optical depth

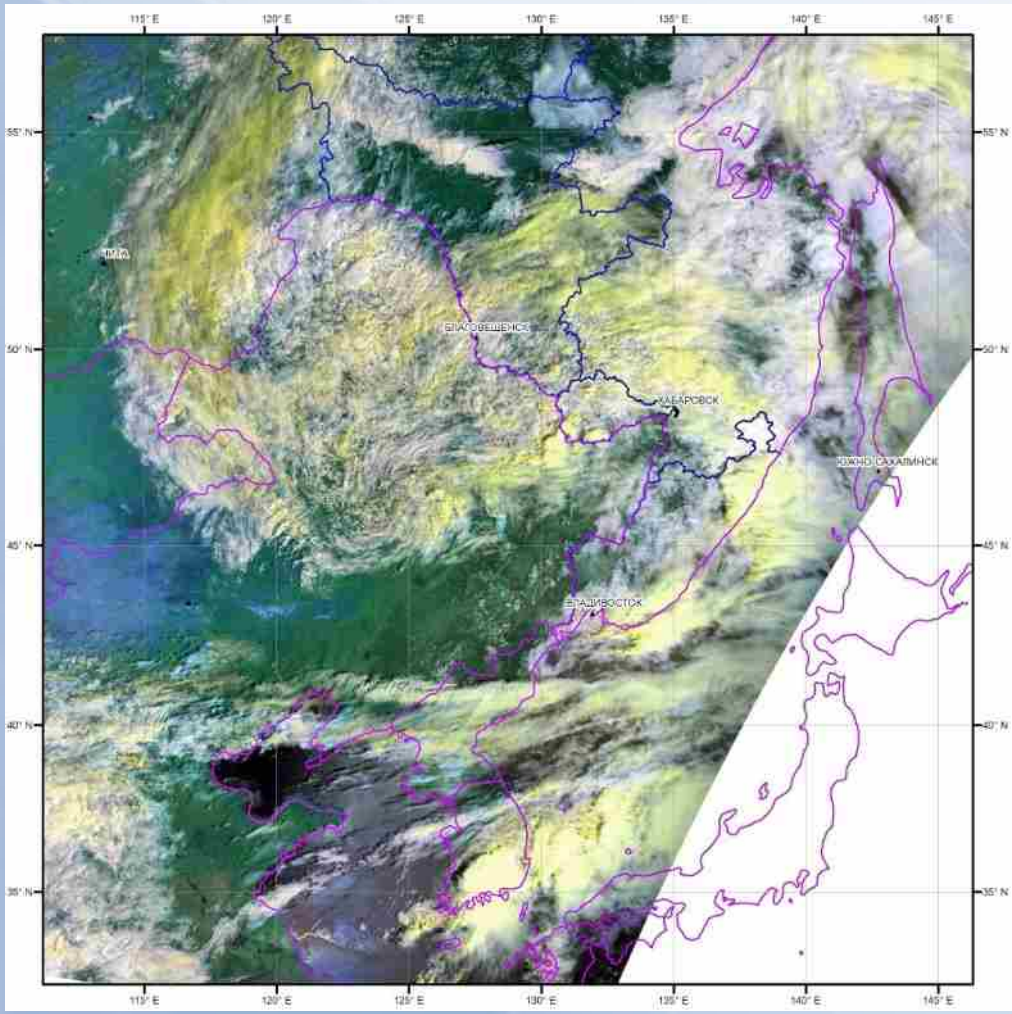
Meteor-M M2/MSU-MR

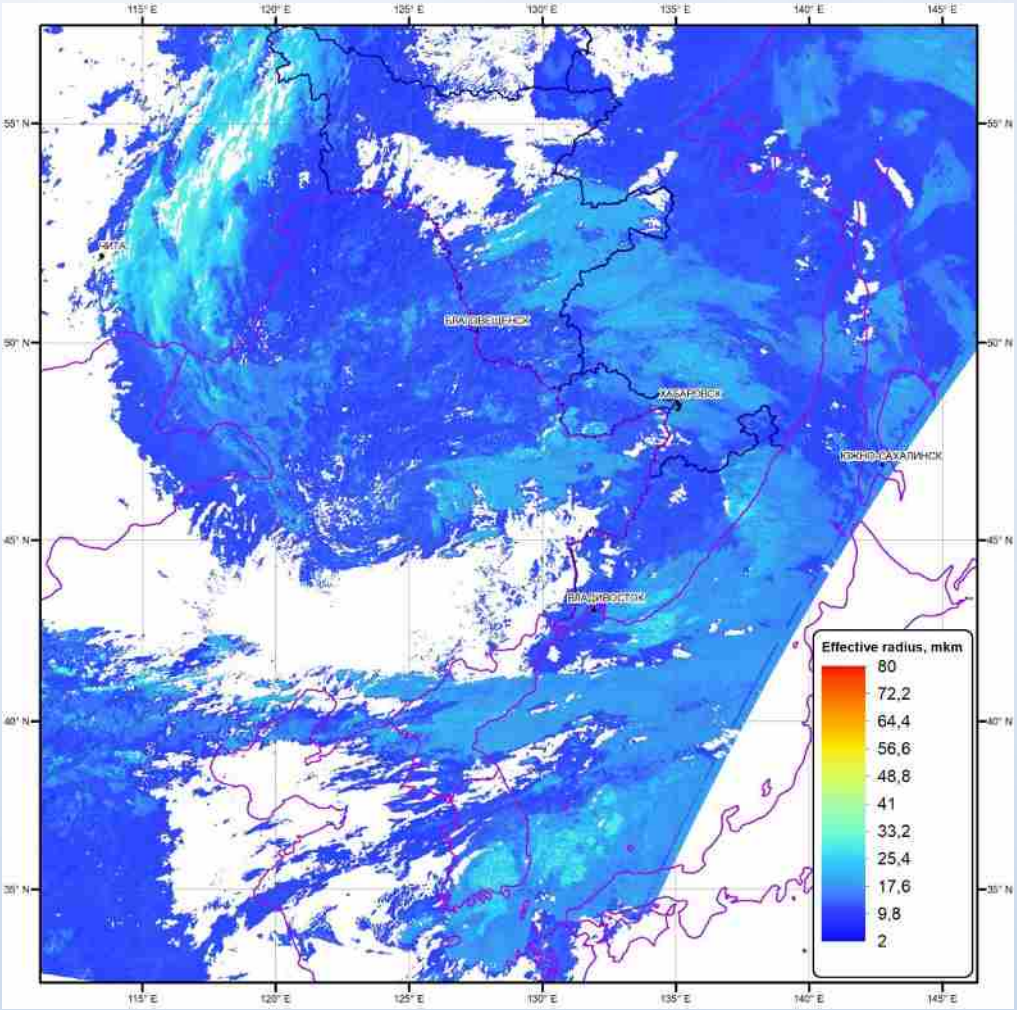
Cloud parameters detection based on MSU-GS / Electro-L N2





Cloud parameters detection based on MSU-MR / Meteor-M N2

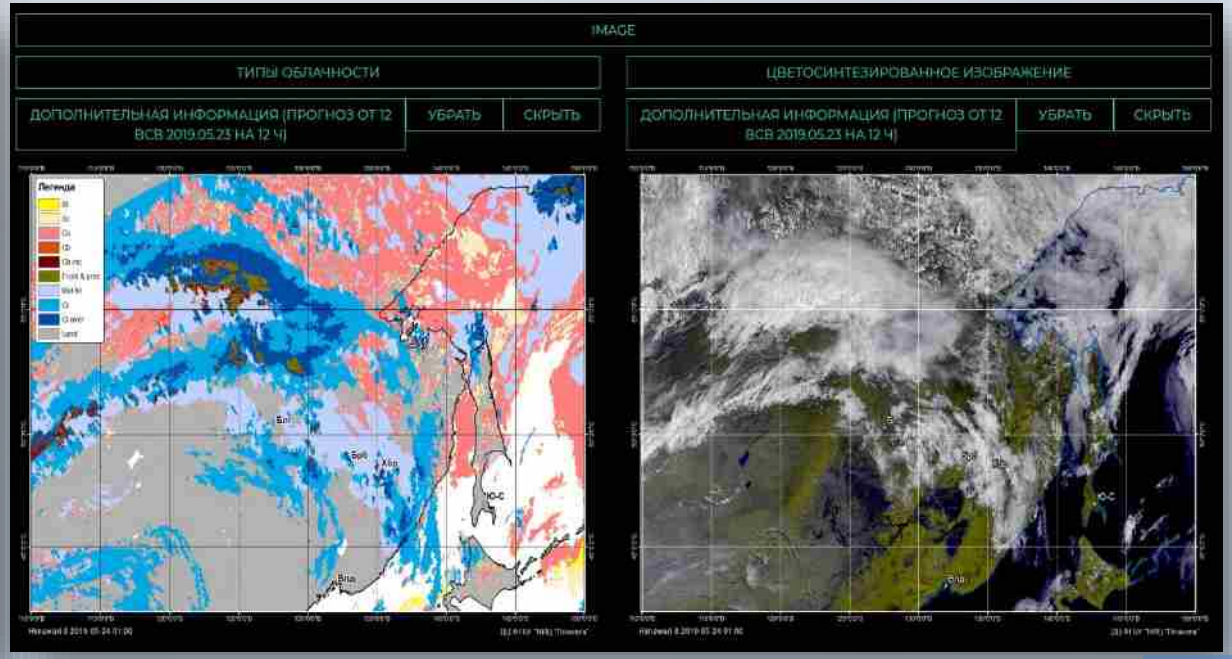




NRT Access to Himawari-8 Data

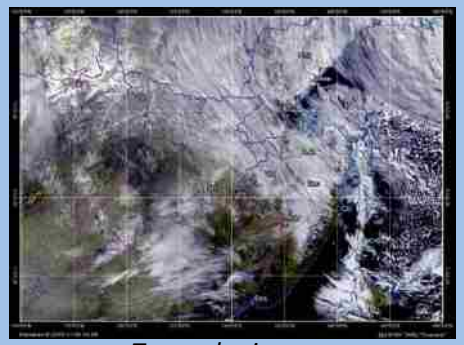
Available products:

- True color images
- IR-channels images
- WV-channels images
- Cloud top height (CTH) and CTH temperature
- Cloud types
- Precipitation intensity
- Fog probability
- NWP data

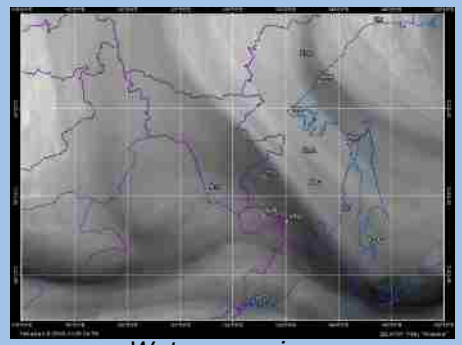


Available products: NRT Himawari-8

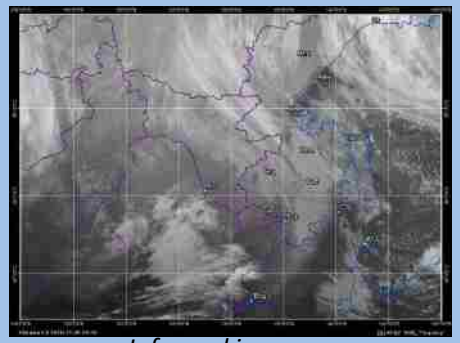
Satellite imagery



True color imagery

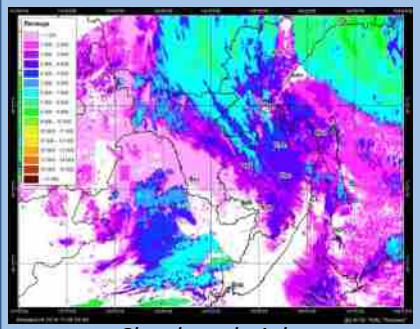


Water vapor imagery

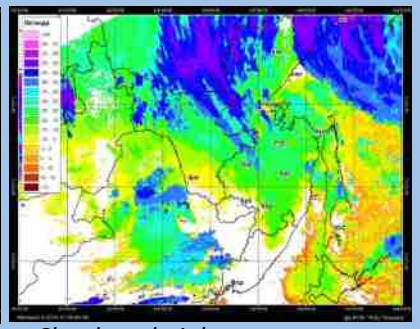


Infra-red imagery

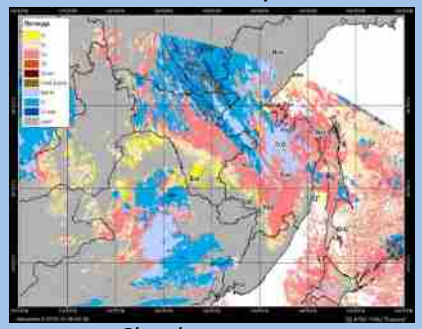
Satellite-based products



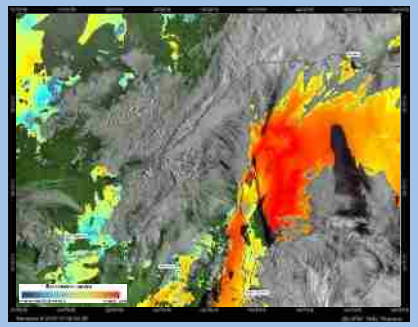
Cloud top height



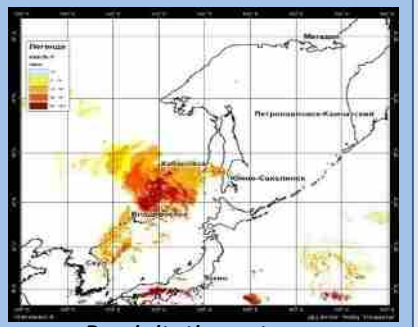
Cloud top height temperature



Cloud types map

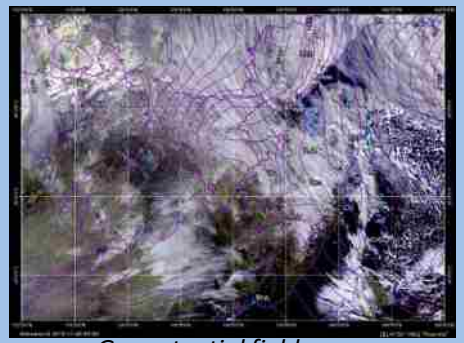


Fog probability map

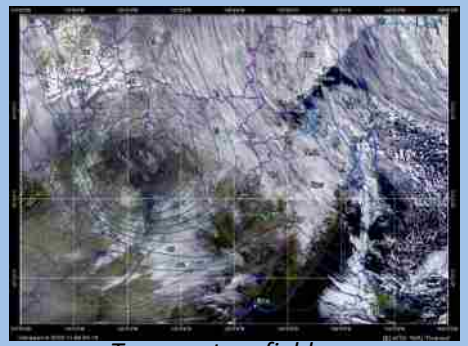


Precipitation rate map

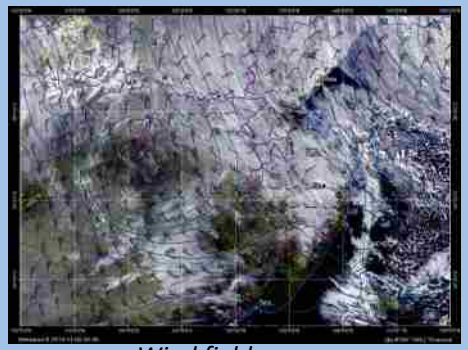
Satellite imagery combined with NWP data



Geopotential field map



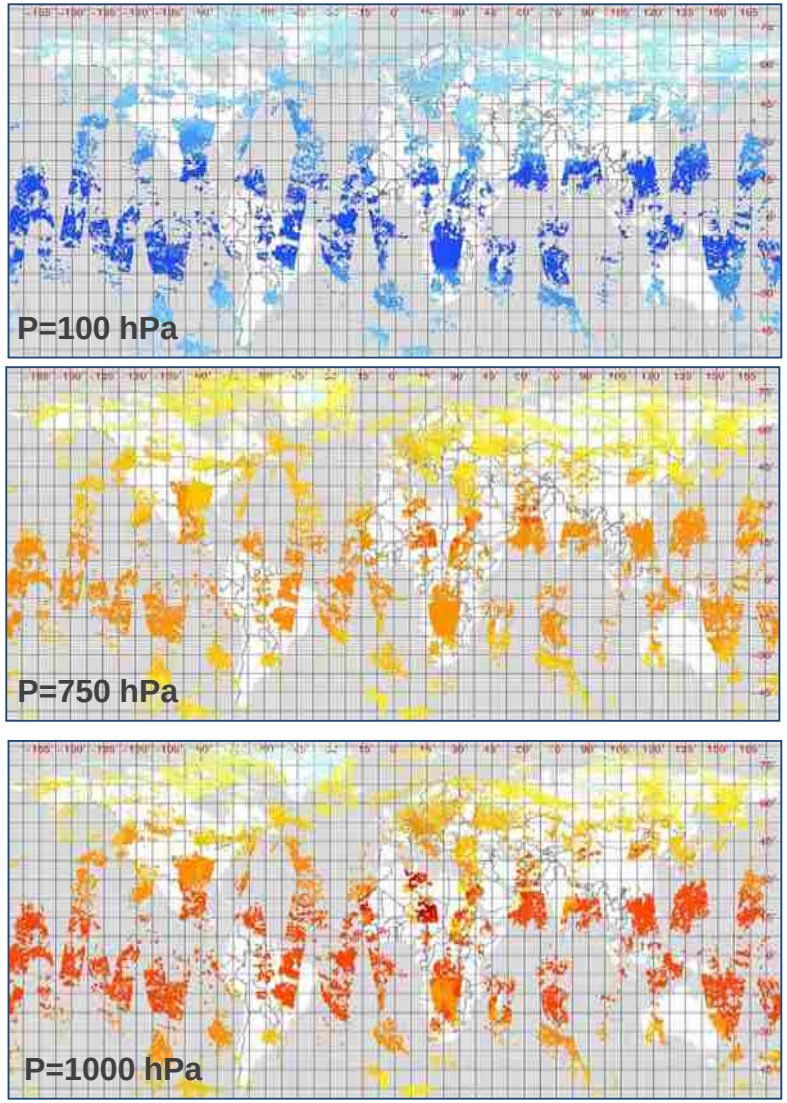
Temperature field map



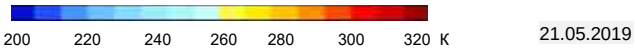
Wind field map

ATMOSPHERIC SOUNDING PRODUCTS

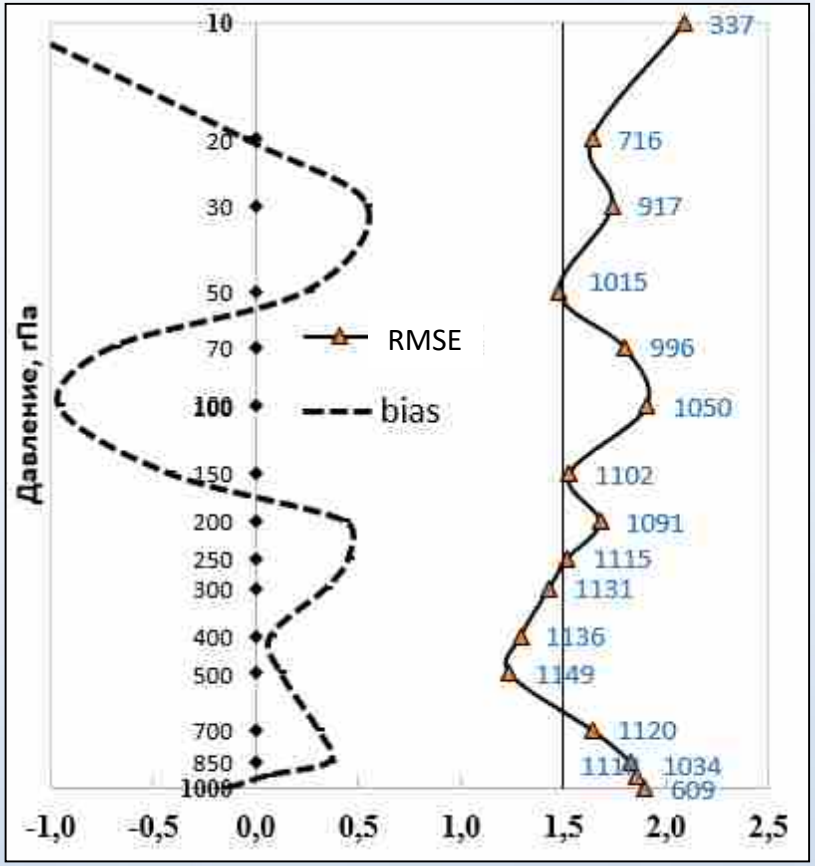
IR Sounder IKFS-2 / METEOR-M N2
Atmospheric Sounding



Temperature fields: IKFS-2 infrared sounder data



April-June 2019

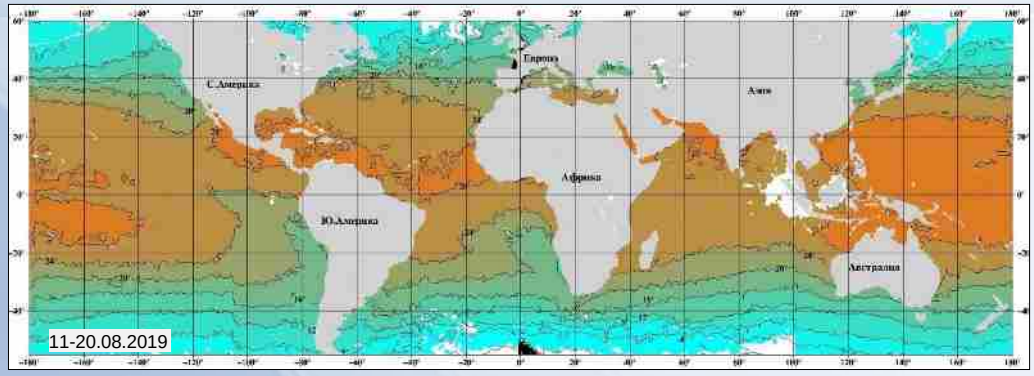


$T_{zond} - T_{ret}$, K

Error statistics for temperature profile retrievals

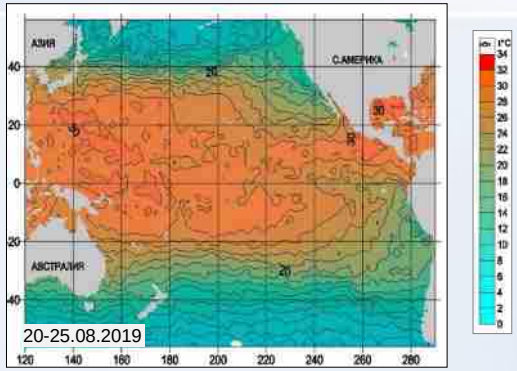
EARTH
SURFACE TEMPERATURE

Global Sea Surface Temperature



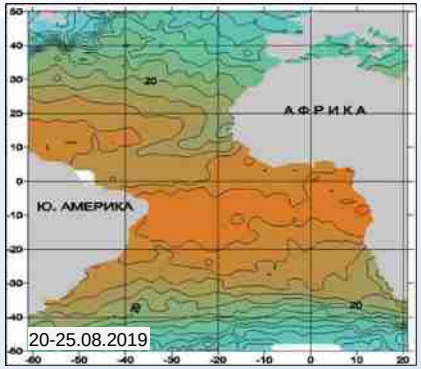
GOES-W, GOES-E, METEOSAT-11, METEOSAT-8, HIMAWARI-8

Global sea surface temperature



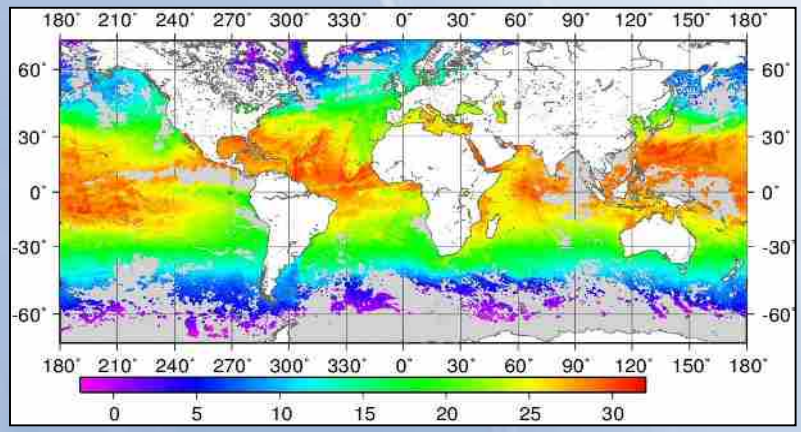
HIMAWARI-8, GOES-W

Pacific Ocean
surface temperature



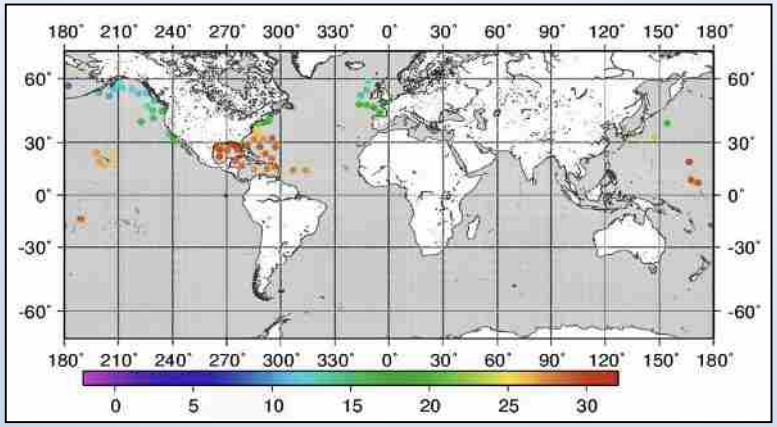
METEOSAT-11

Atlantic Ocean
surface temperature

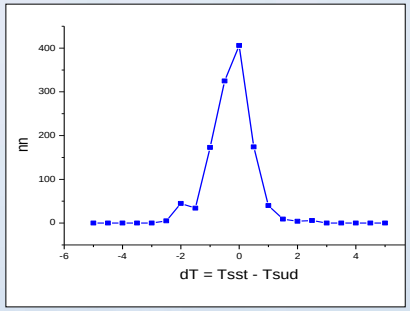


METEOR-M N2/MSU-MR

Global Sea surface temperature
(5-7.07.2019)



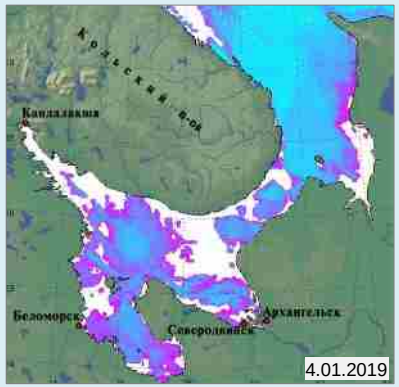
Buoy measurements (6.07.2019, 12:00 UTC)



Bias=-0.26K, RMSE=0.75K, N=1221
(6.07.2019, 12:00 UTC)

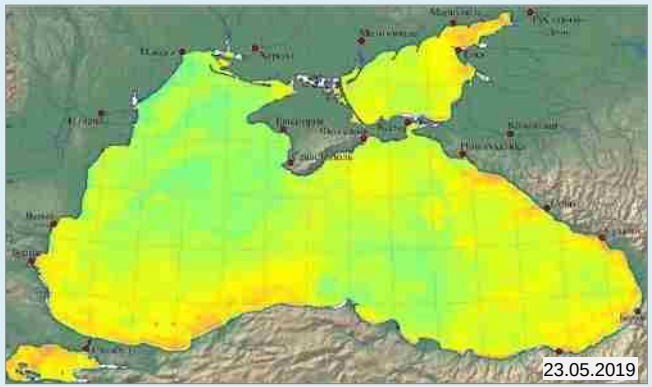
MSU-MR SST estimates vs buoy measurements

Regional Sea and Land Surface Temperature

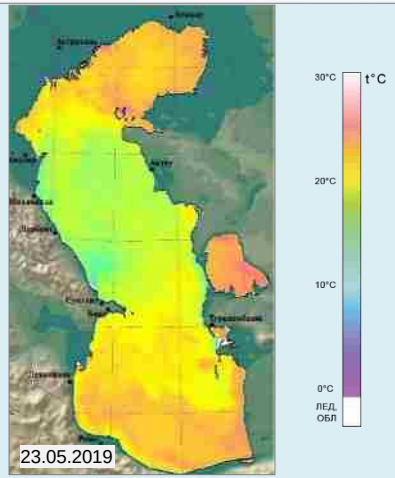


NOAA
White Sea

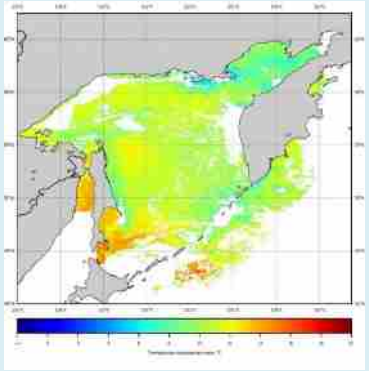
NOAA
Baltic Sea



NOAA
Black Sea

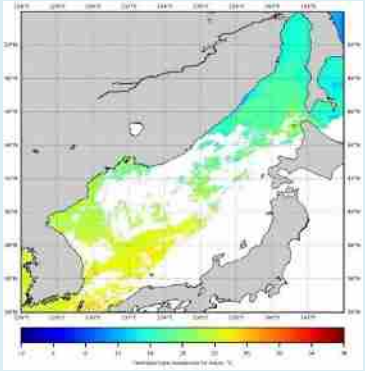


NOAA
Caspian Sea



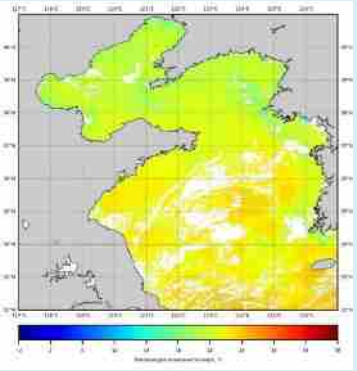
SNPP/VIIRS, 26.09.2019

Sea of Okhotsk



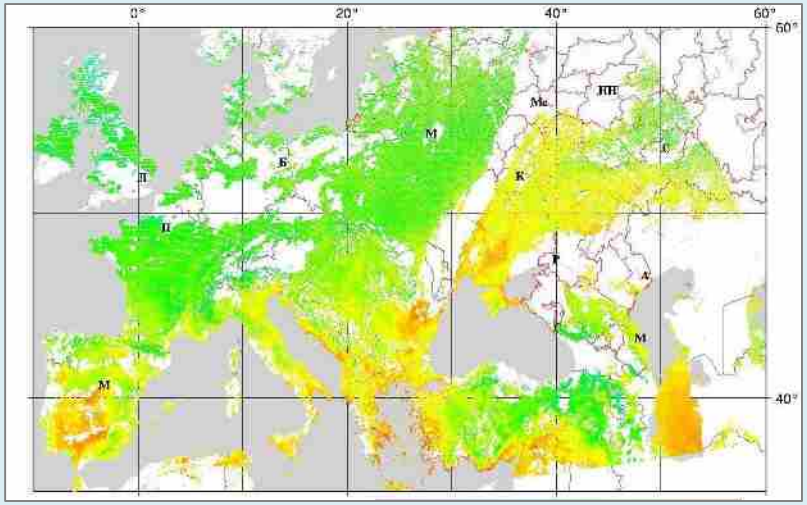
SNPP/VIIRS, 30.09.2019

Sea of Japan



SNPP/VIIRS, 01.10.2019

Yellow Sea



METEOSAT-11

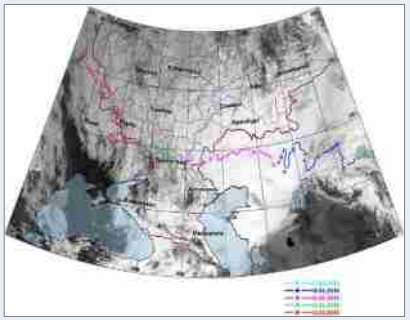
-30 -20 -10 0 10 20 30 t°C

Land surface temperature: Europe

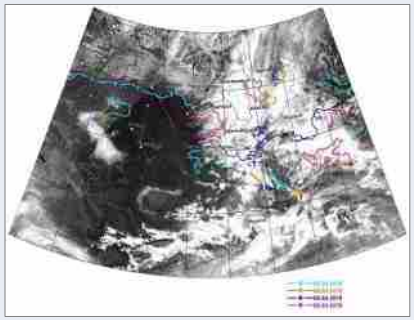
SNOW AND ICE COVER MONITORING

Snow Cover Monitoring

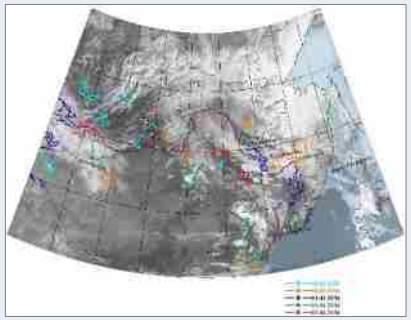
Snow cover boundary maps



European region
(daily product)



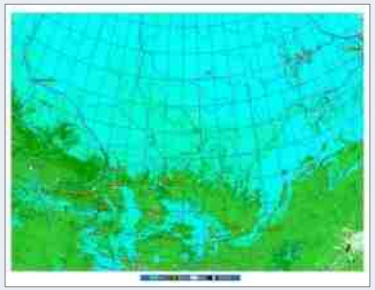
Siberian region
(daily product)



Far Eastern region
(daily product)

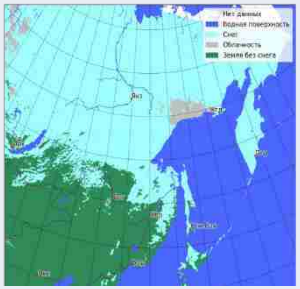
METEOR-M N2/MSU-MR

Snow cover distribution maps



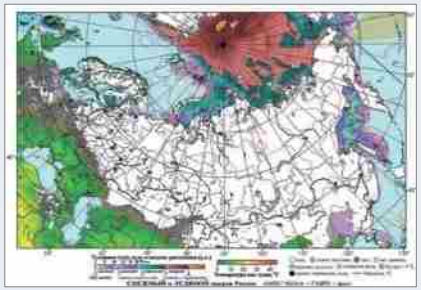
TERRA/MODIS, Suomi NPP/VIIRS

Siberian region
(16-day composite product)



METEOR-M N2/MSU-MR

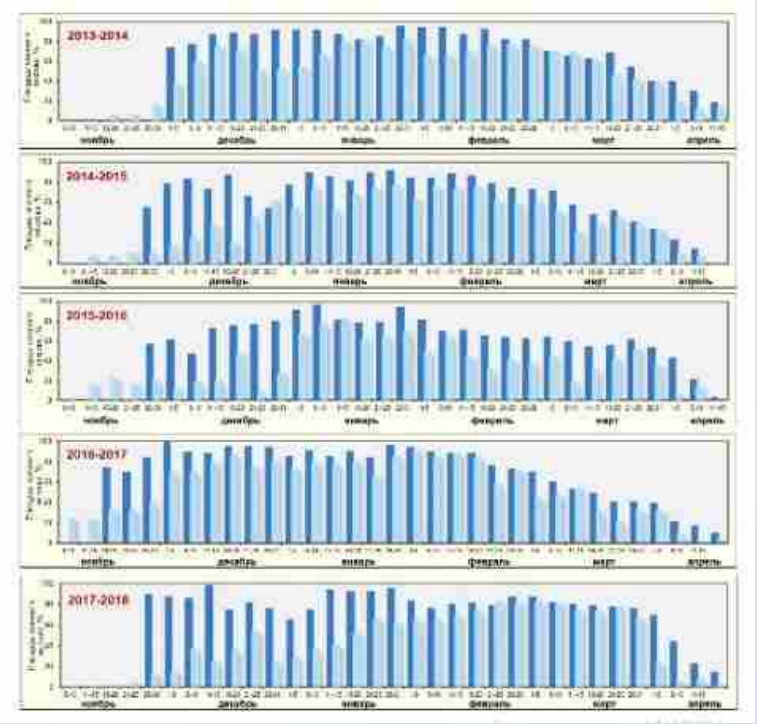
Far Eastern region
(8-day composite product)



NOAA/AMSU

Russian territory
(daily product)

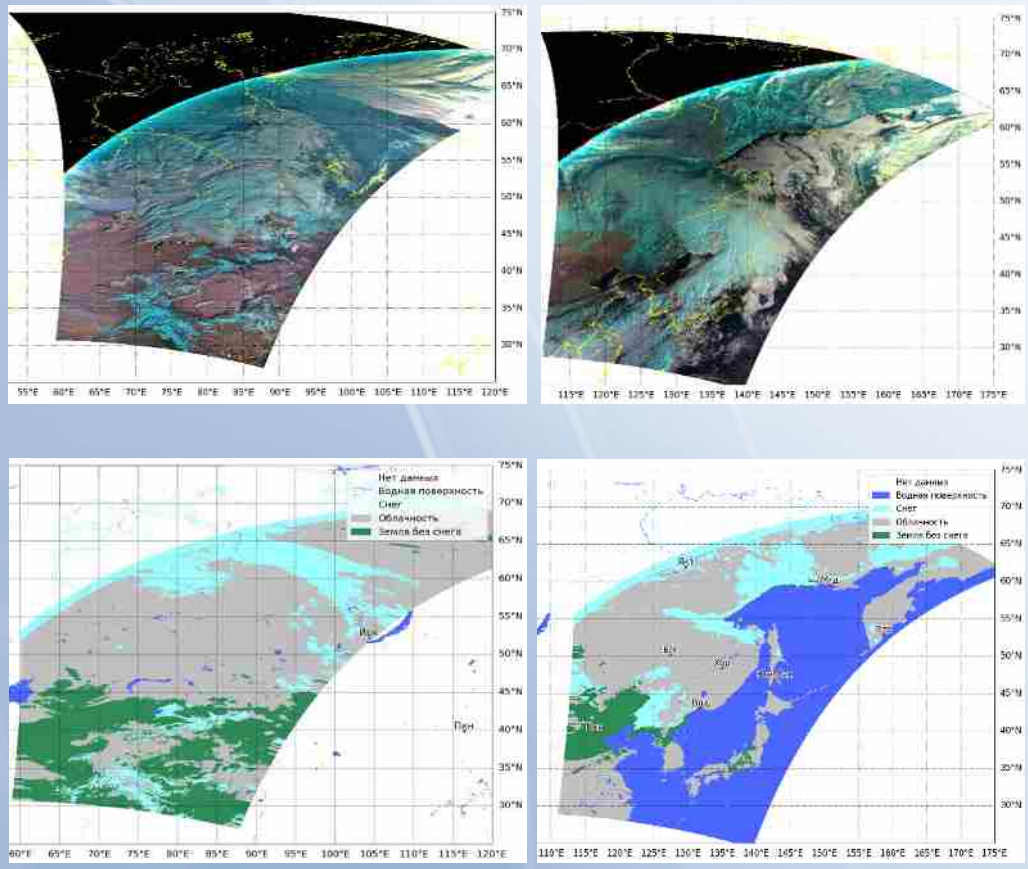
Snow cover monitoring European territory of Russia (2013-2018)



- *solid snow cover (Meteor-M / MSU-MR)*
- *dry snow cover (NOAA/AMSU)*

Snow Cover Monitoring based on MSU-MR / Meteor-M N2

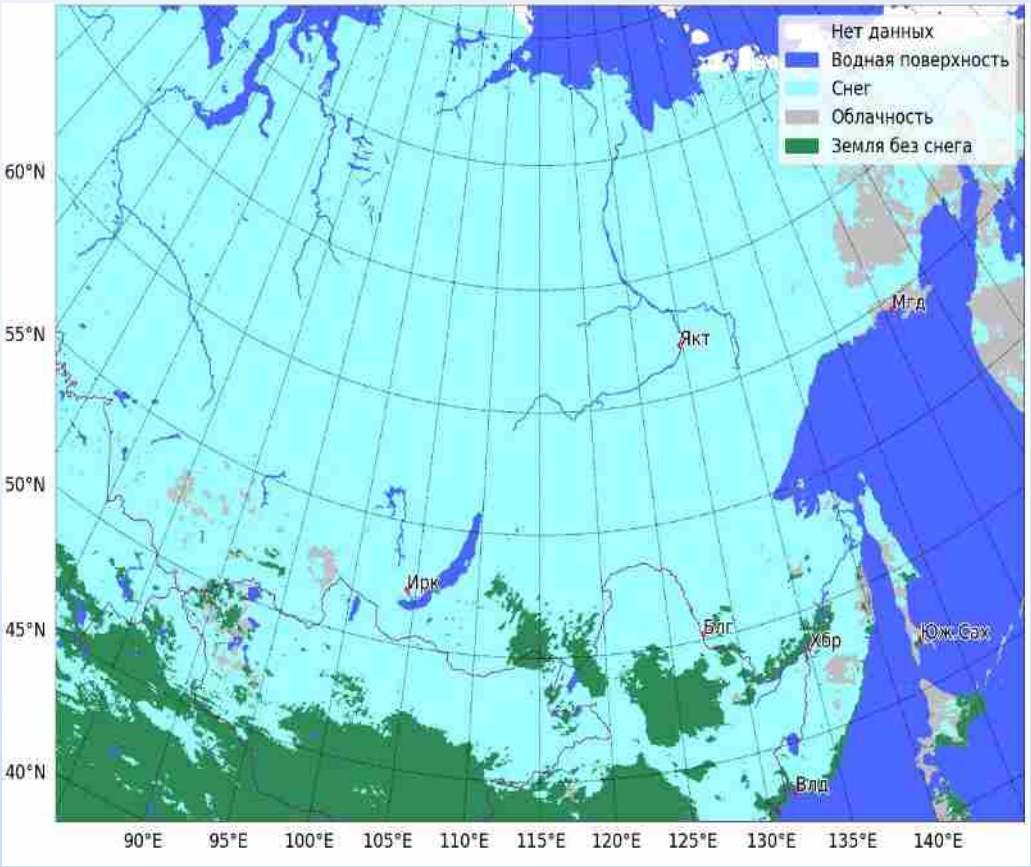
Daily snow cover mask



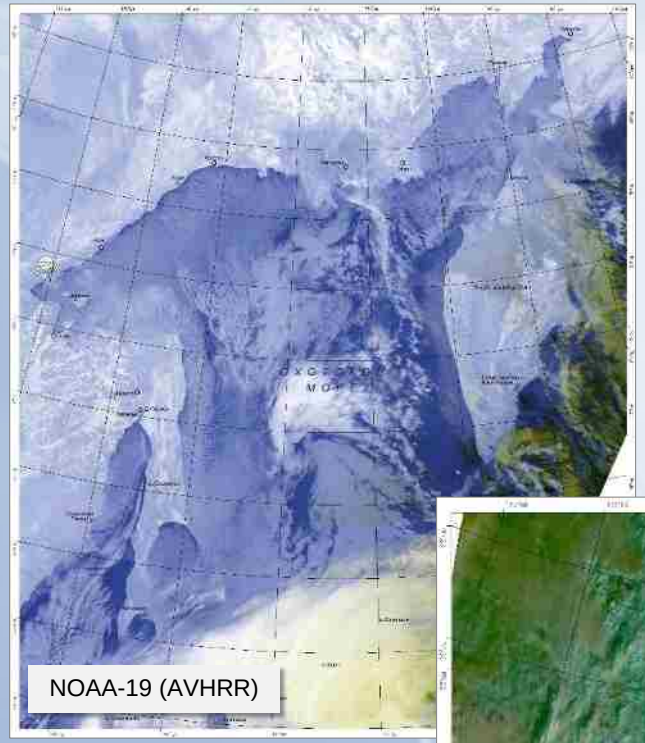
Siberian region

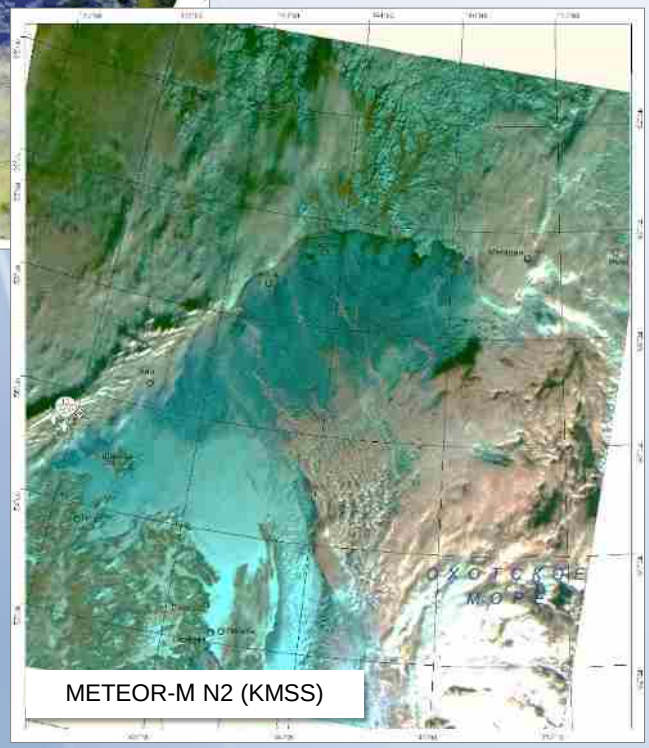
Far Eastern region

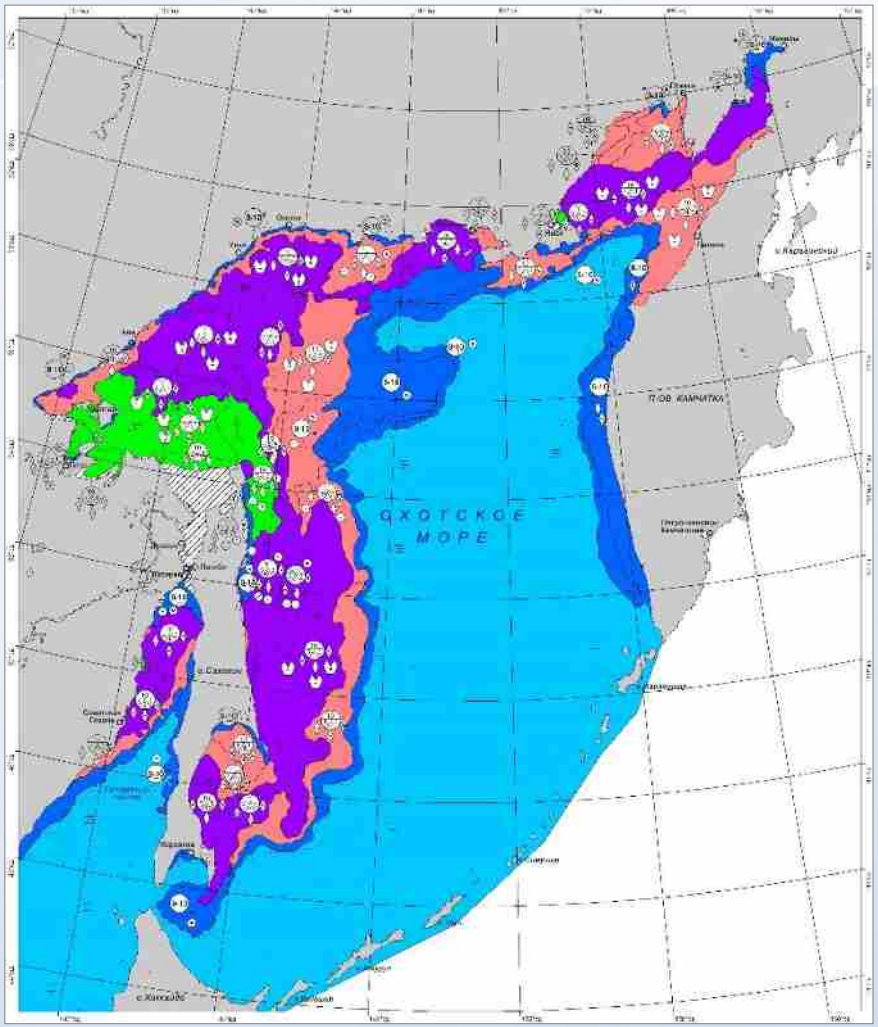
Snow cover map (8-day composite product)



Ice Cover Monitoring: Sea of Okhotsk







Ice Cover Map: Sea of Okhotsk 22-24.01.2019

PACK ICE DEVELOPMENT (cm):
- ice-free
- nilas (10)
- grey ice (10-15)
- grey-white ice (15-30)
- thin first-year ice (30-70)

FAST ICE DEVELOPMENT (cm):
- young ice (10-30)
- thin first-year ice (30-70)
- medium first-year ice (70-120)
- thick first-year ice (>120)
- old ice (>200)

FORMS OF FLOATING ICE (m):
- new ice
- pancake ice (0.3-3.0)
- ice cake (2-20)
- small floes (20-100)
- medium floes (100-500)
- big floes (500-2000)

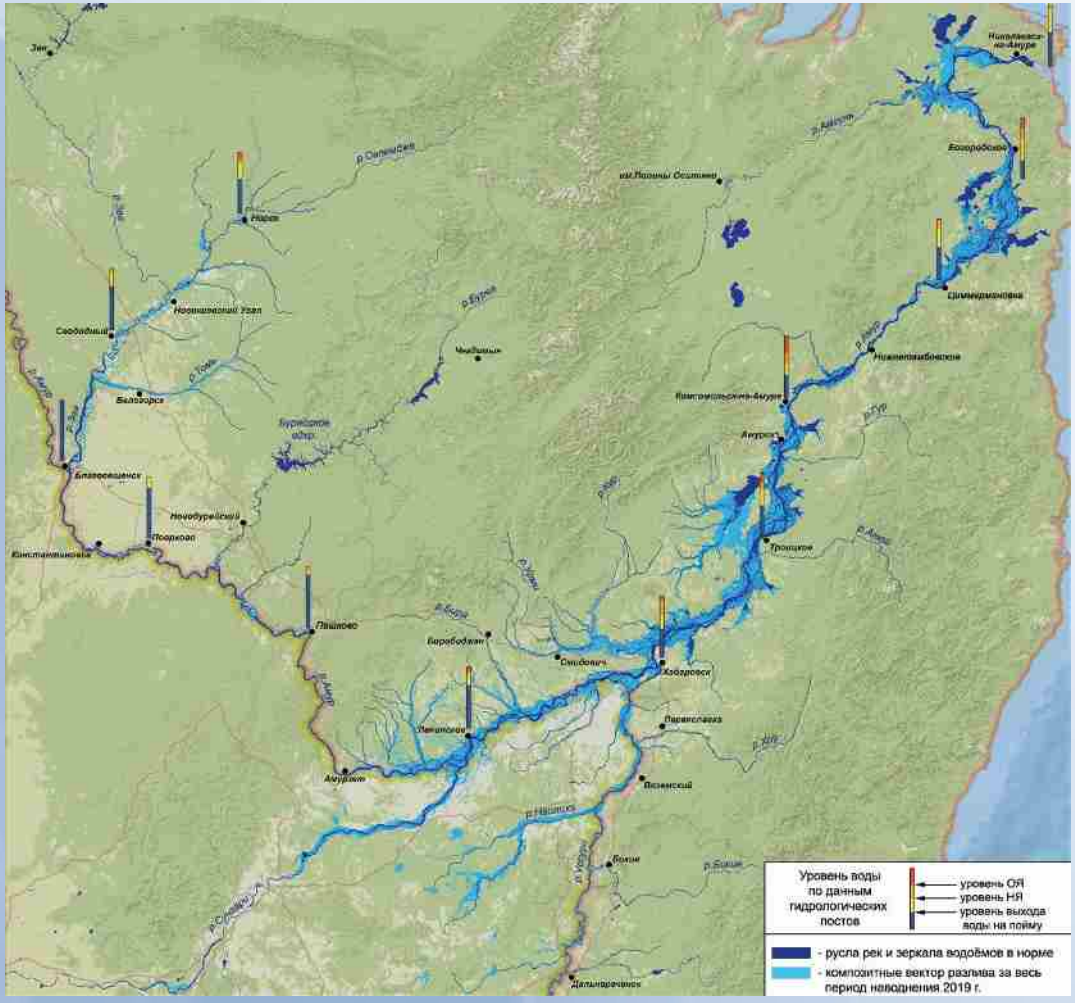
GENERAL CHARACTERISTICS:

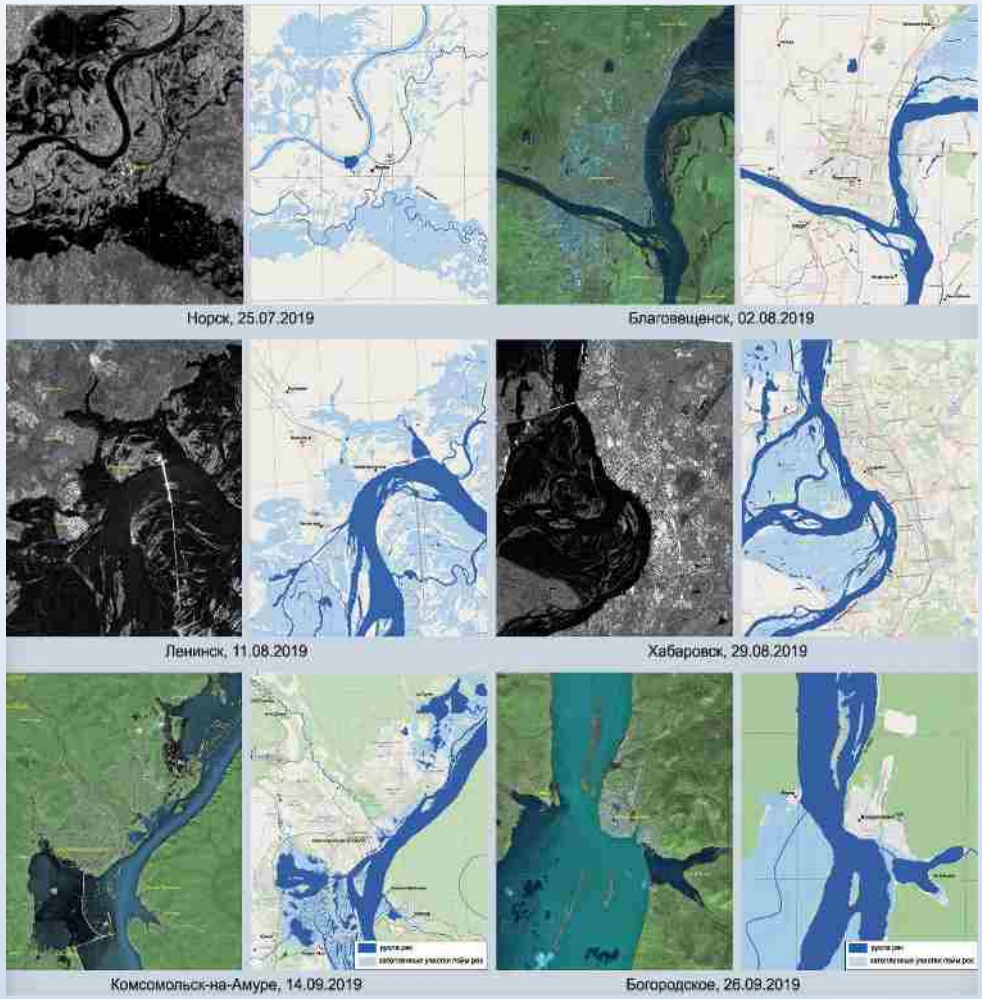
(1-3) – total ice concentration in tenths

– 10 - total ice concentration in tenths
6 - partial concentration of the thickest ice
4 - partial concentration of the less thickest

FLOOD MONITORING

Flood Monitoring 2019: Amur River Basin



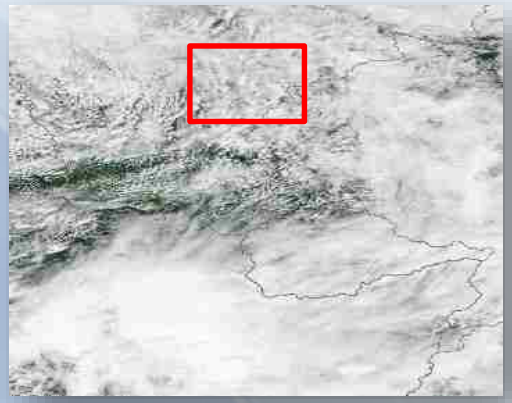


August - October 2019

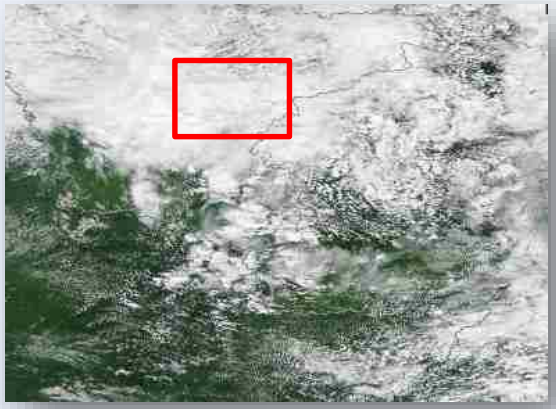
(Resurs-P, Kanopus-V, Meteor-M N2, Landsat-8, TERRA, AQUA, Sentinel-1,2)

Himawari-8 Cloud-Free Composite

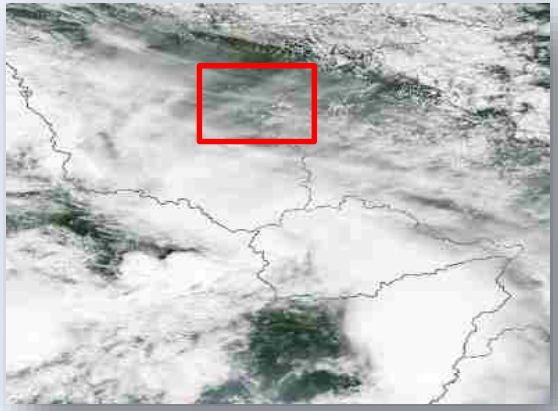
Terra, 26.07.2019



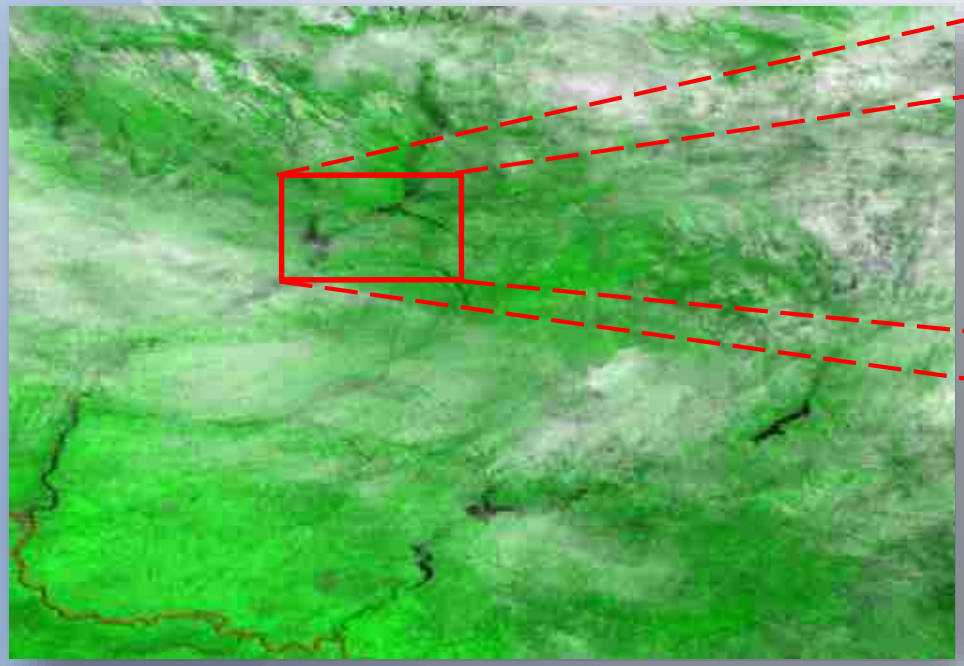
Terra, 27.07.2019



Terra, 28.07.2019



Himawari-8, 26.07.2019 – 28.07.2019



Potential flooded areas

Extreme Flooding in Irkutsk Region
Tulun city (2019)

The first flood wave *The second flood wave*

Satellite Imageries

29 June *01 July* *10 July* *31 July* *02 August* *05 August*

Flood maps

(Kanopus-V/PSS, MSS, Sentinel-2/MSI)

- *flooded area*

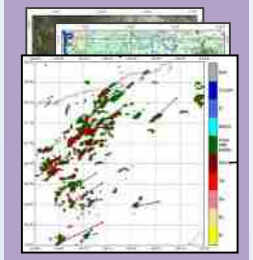
Territorial Information System: Far Eastern Region

GIS «Meteo-DV» provides processing, archiving and visualization of various data types: meteorological, hydrological, aerological, NWP output, ecological, geophysical and satellite-based products. The system utilizes the WEB and GIS technologies and is targeted on data provision to the local decision makers on the natural hazardous in the Far Eastern region.

In-situ data

Satellite data

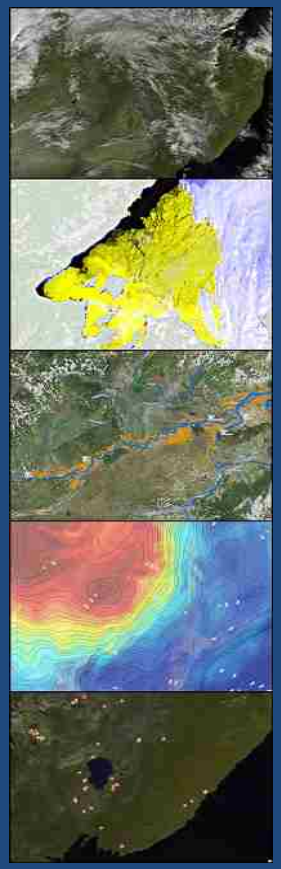
Forecast data



GLOBAL DATABASE OF PRODUCTS FOR THE FAR EASTERN REGION

USERS

Geoinformation System (GIS)

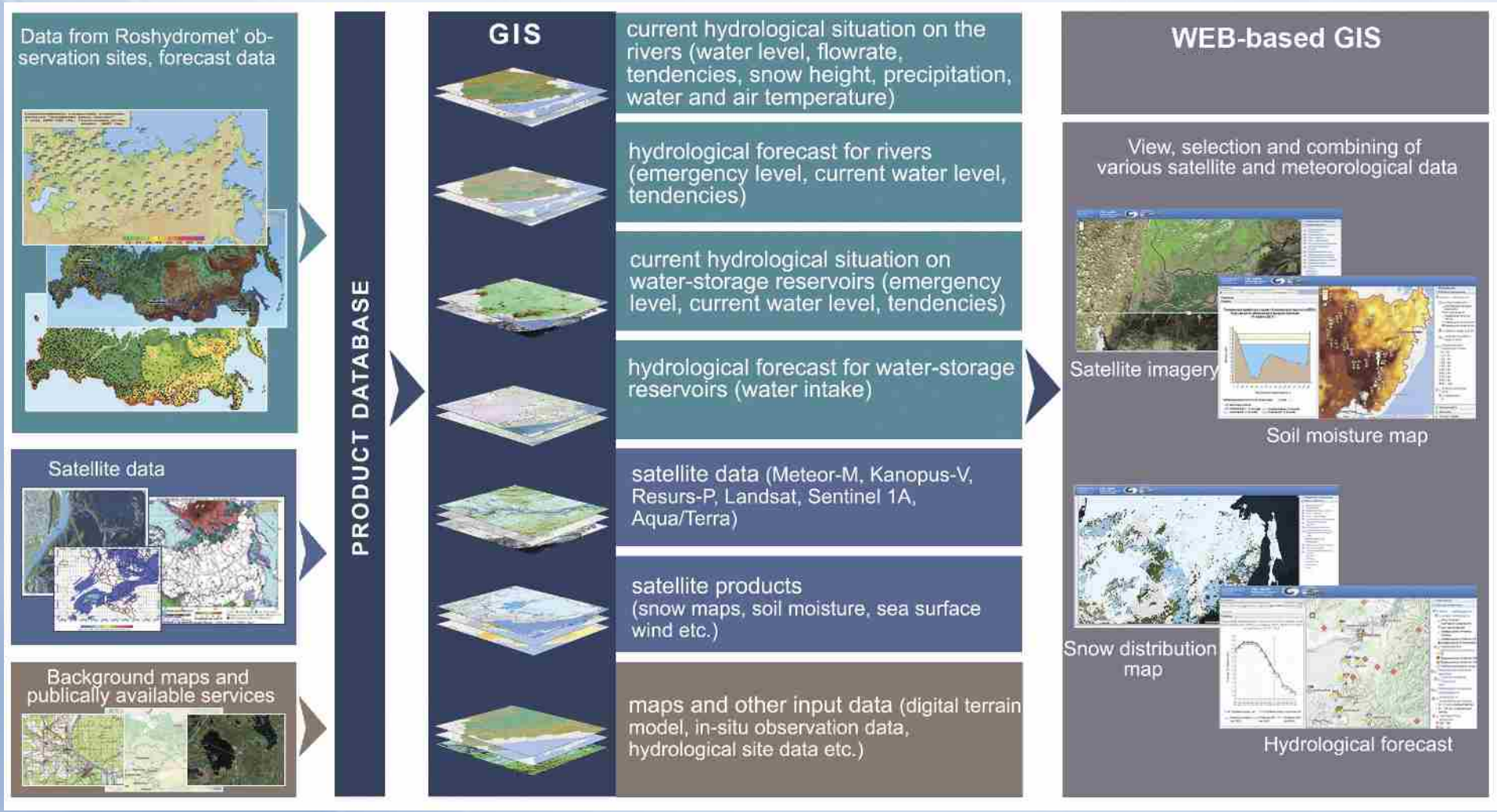


- satellite data: *Meteor-M (MSU-MR), TERRA/AQUA (MODIS), Meteor-M (KMSS), Kanopus-V (MSS), Landsat-8 (OLI), Resurs-P (SHMSA)*
- hydrological data: *water level, snow cover depth, snow water equivalent, soil moisture, flooded area, snow cover maps, snow cover boundary, water level forecast, flood forecast consultation*
- oceanographic data: *ice cover conditions, near-sea surface wind vectors, sea level*
- meteorological data: *in-situ data, cloud cover images, pressure, precipitation, cloudiness*
- aerological data: *air-sounding data, objective analysis, maximum wind speed, tropopause, temperature profile, geopotential profile, humidity profile, wind speed and direction, temperature forecast, geopotential profile forecast, humidity forecast, wind speed and direction forecast*
- geophysical data: *observational sites*
- environmental data: *background radiation, hot spots, forest fires map*

Web-interface of GIS System «METEO-DV»

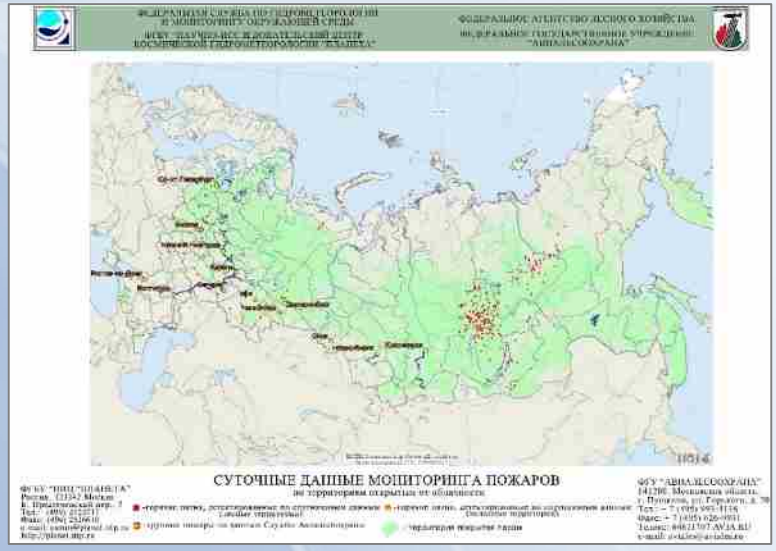
Problem-oriented Information System: Flood Monitoring, Forecasting and Early Warning

«GIS Amur» relies on combination of in-situ data from Roshydromet' observation network, satellite data and hydrological modelling and forecasting data for Amur river basin. The system utilizes the WEB and GIS technologies and is targeted on data provision to the local authorities in order to minimize the damage caused by high water.

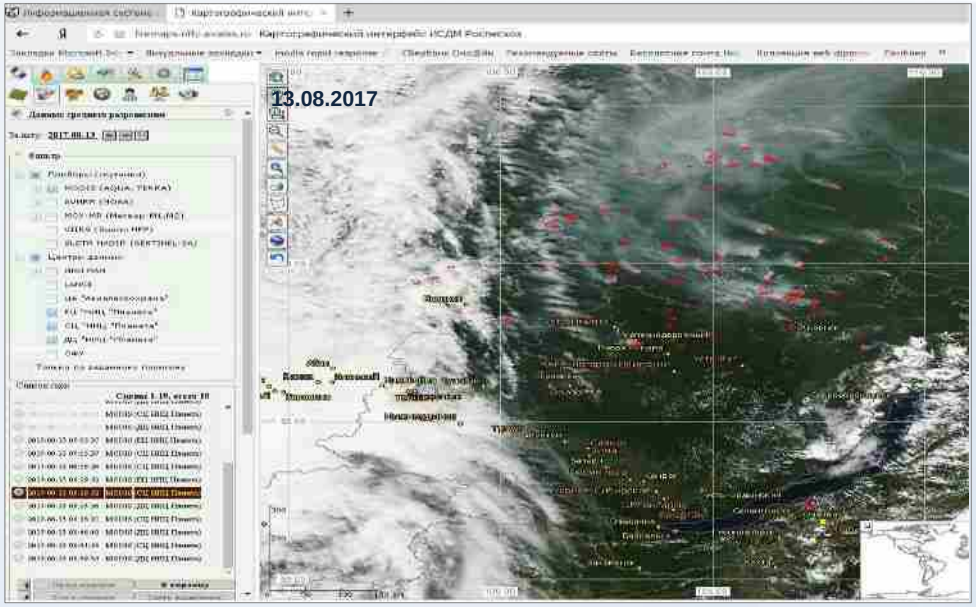


FIRE MONITORING

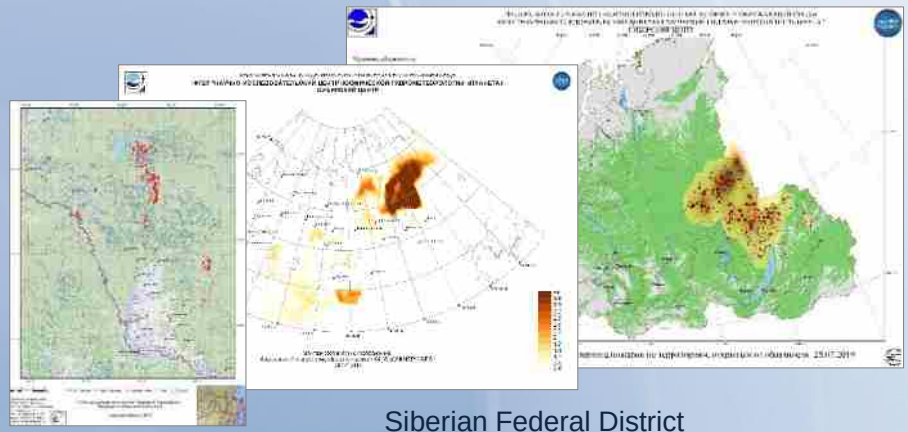
Problem-oriented Information System: Forest Fire Monitoring



Daily forest fires monitoring: Russian Federation



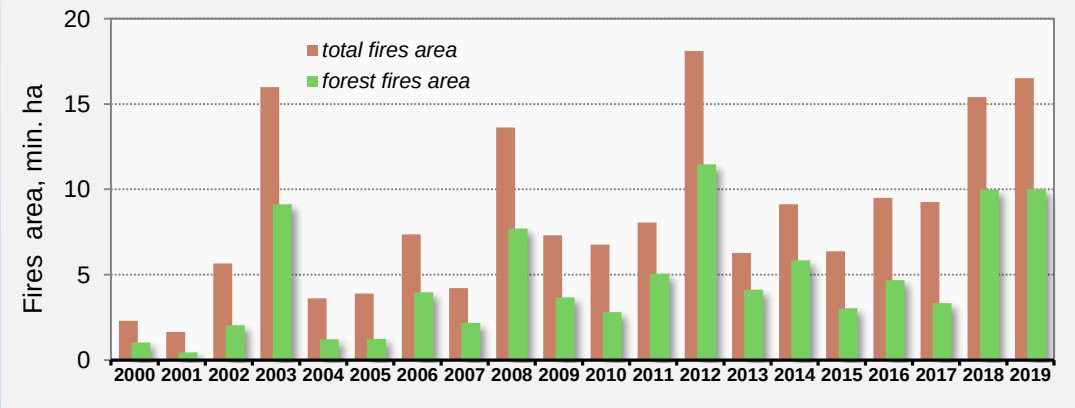
Combination of various satellite data for fires monitoring



Siberian Federal District

Amur Region

Regional forest fires monitoring

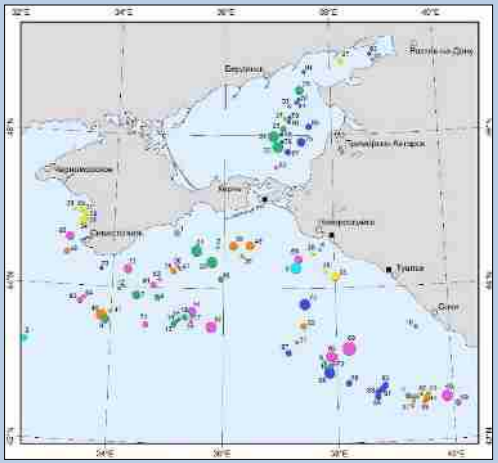


Fires area

WATER POLLUTION MONITORING

Problem-oriented Information System: Water Pollution Monitoring

Composite products

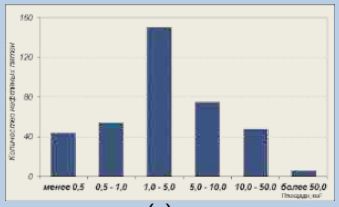


Oil slick distribution in terms of month of detection

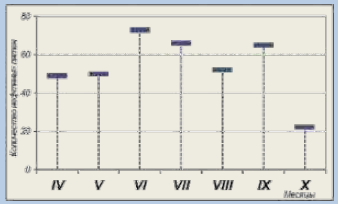
April May June July August September October

Oil slicks areas: 0-1 1-5 5-10 10-50 > 50 км²

Complex map of oil slick distribution

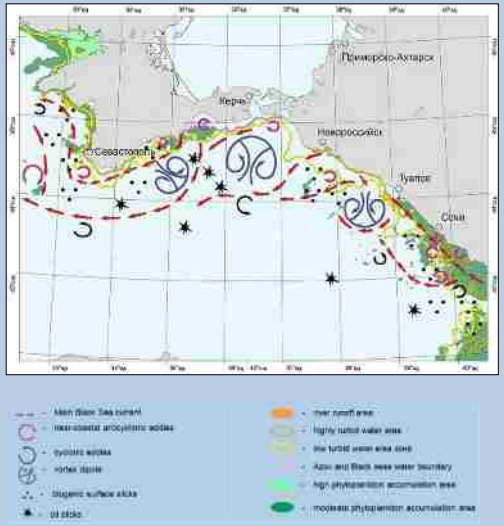


(a)

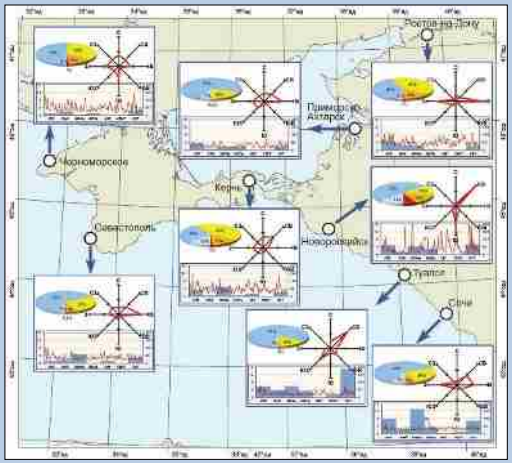


(b)

Oil slick distribution in terms of spill area (a) and month of detection (b)



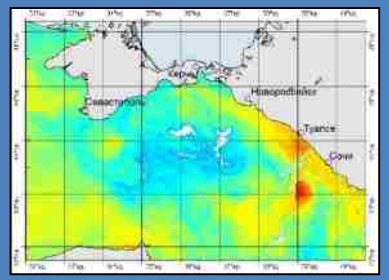
Complex map of water environmental conditions



- wind rose
- wind speed distribution (%)
- precipitation (mm)
- wind speed (m/s)

In-situ data

Operational products

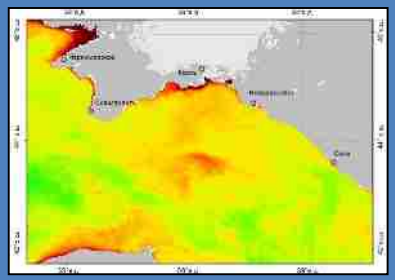


TERRA/MODIS

Sea surface temperature

18 19 20 21 22 23 24 25 26 27 28°C

Sea surface temperature map

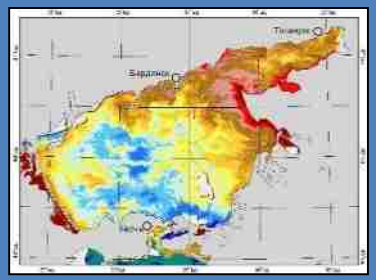


TERRA/MODIS

Chlorophyll-a concentration, mg/m3

0.02 0.08 0.28 1.06 4.00

Chlorophyll-a concentration map



AQUA/MODIS

Water turbidity category

low high

Water turbidity map

SENTINEL-1B/SAR-C

Oil slicks from ships

TERRA/MODIS

Water motion map

VEGETATION COVER MONITORING

Problem-oriented Information System: Agricultural Monitoring

The system provides joint analysis of satellite data and in-situ agrometeorological data for the territory of Russia. It aims on data provision on agrometeorological monitoring and agricultural crop assessment to decision makers and national research institutions.

Input data

Data from Roshydromet' observational network of agrometeorological stations

Satellite data

NCEP reanalysis data

Background maps and publically available services

PRODUCTS DATABASE

Raster and vector data in GIS environment

Maps of agrometeorological parameters:
soil surface temperature, dynamics of vegetation development and others.

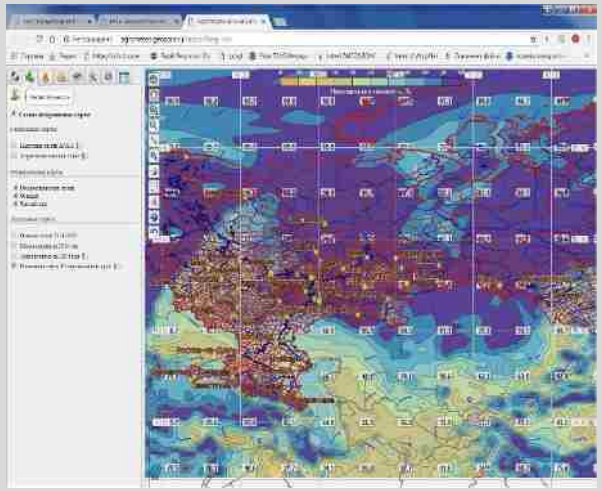
Satellite data:
Sentinel-2/MSI, Landsat-7,8, NPP/VIIRS, NOAA/AVHRR, EOS/MODIS, Meteor-M/MSU-MR

Satellite-based products:
soil moisture, minimum daily temperature, precipitation, sunshine duration, NDVI

NCEP meteorological data:
maximum and minimum temperature, relative humidity, atmospheric pressure, cloudiness, precipitation and others.

Cartographic and other auxiliary data
(Federal Registration Service' maps: cadastre, land classification, digital elevation model and others)

WEB-services for remote users



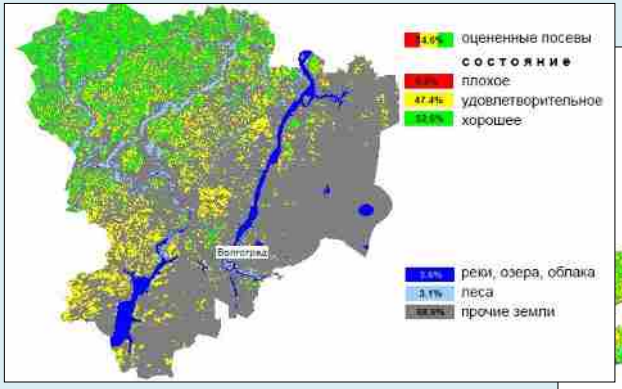
Browsing, selection, integration, and export of different types of satellite-based products and agrometeorological data

USERS:
Roshydromet, Ministry of Agriculture and etc.

http://agrometeo.geosmis.ru/

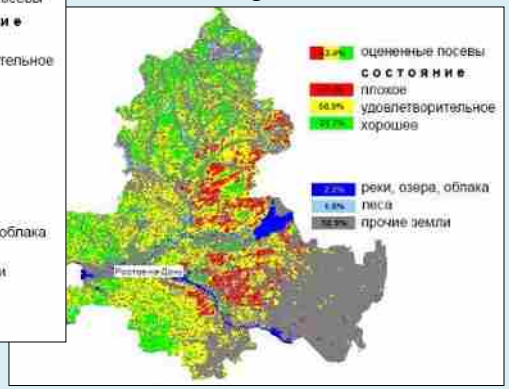
Agricultural Crop Condition Monitoring

Cereal crops conditions: Russian federal subjects

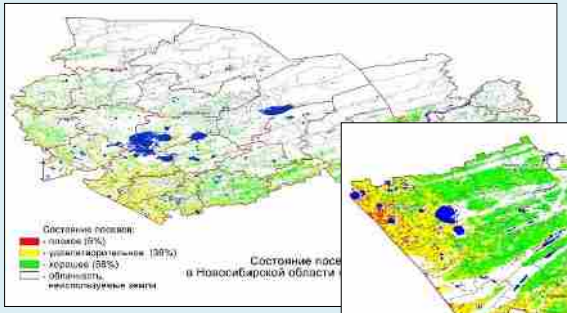


Volgograd region

Rostov region

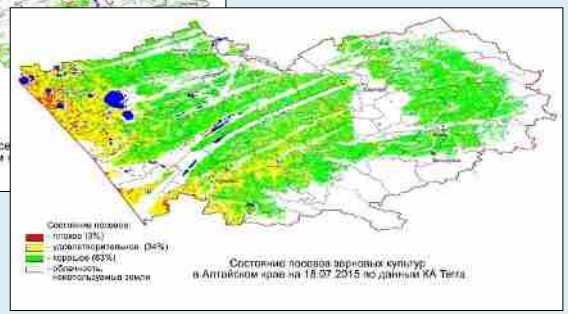


NOAA/AVHRR



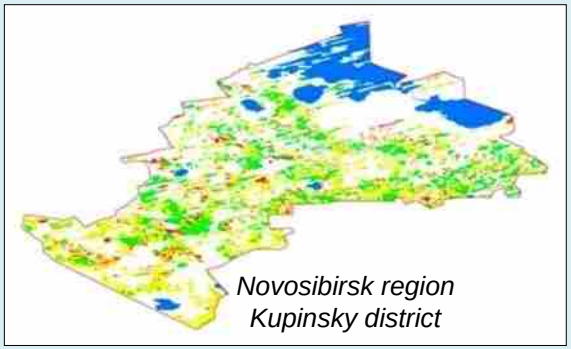
Novosibirsk region

Altai region



TERRA/MODIS

Cereal crops conditions: Russian administrative districts and farms

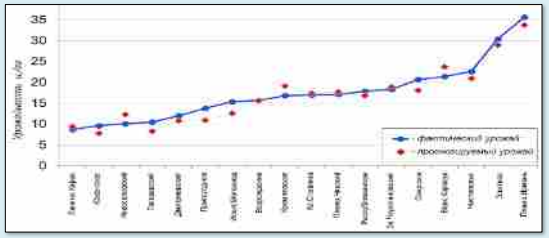


Novosibirsk region
Kupinsky district

- poor crop conditions (10%)
- satisfactory crop conditions (28%)
- good crop conditions (62%)
- clouds, unused lands

TERRA/MODIS

Novosibirsk region
Kupinsky district
Novoselskoe farm

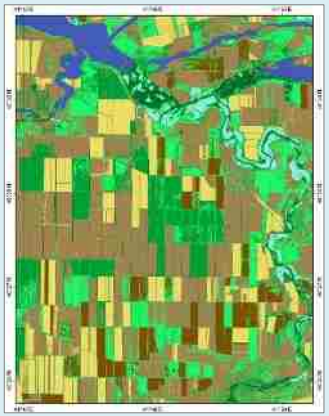


Spring wheat yield forecasting and its actual productivity: Novosibirsk region' farms

Agricultural Land Monitoring

KANOPUS-V N4/PSS,MSS

Rostov region, Russia

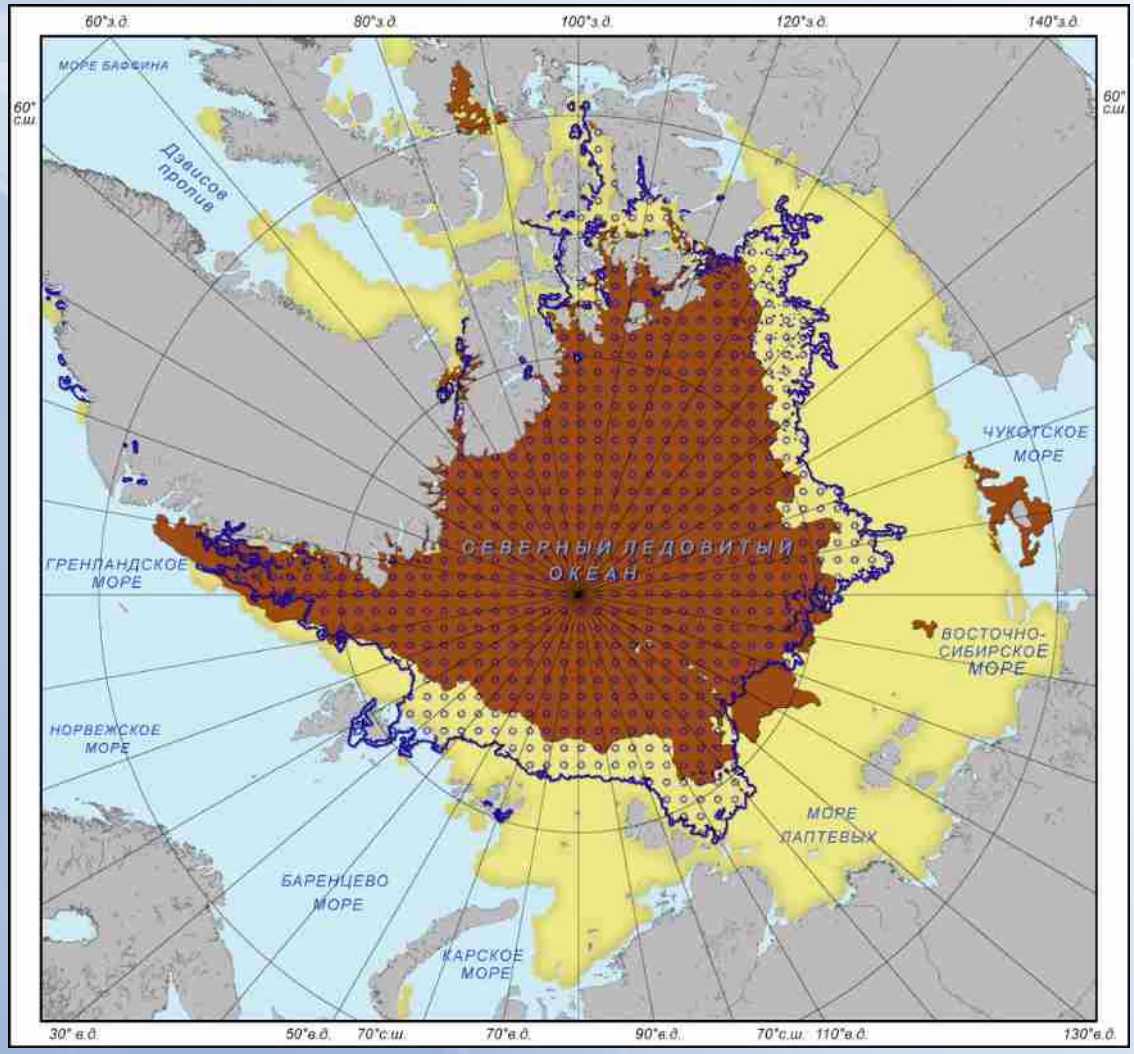


Agricultural land map based on automated unsupervised classification

- water bodies
- wetlands
- bare soils (fallow lands)
- soil after harvesting, plowed land
- stubble after harvesting
- satisfactory crop conditions
- good crop conditions
- dense vegetation in the floodplain


CLIMATE CHANGE
MONITORING

Sea Ice Cover Dynamics in Arctic Region



Minimum sea ice extent

In 2019

- *16.09.2019* - ***4,07*** *million km²*

Minimum

- *16.09.2012* - ***3,51*** *million km²*

Maximum

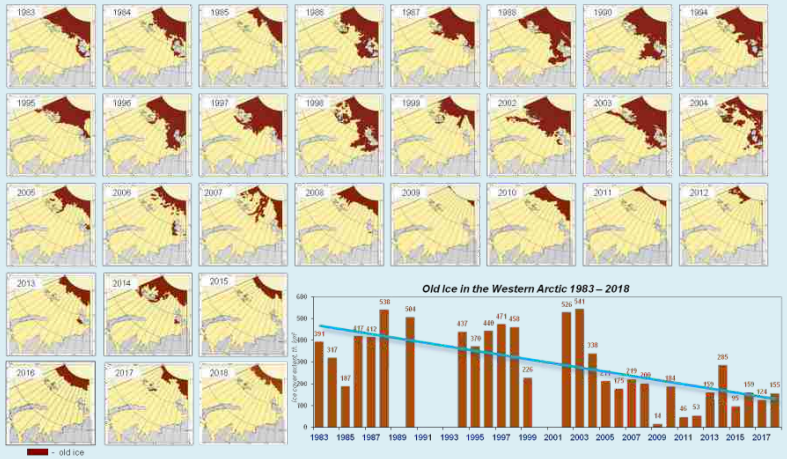
- *10.09.1996* - ***8,27*** *million km²*

The product is based on microwave (active, passive), visible and infrared data from Russian (OKEAN, METEOR series) and foreign (Metop, NOAA, EOS series) satellites.

- *sea ice concentration of 0-10%*
- *land*

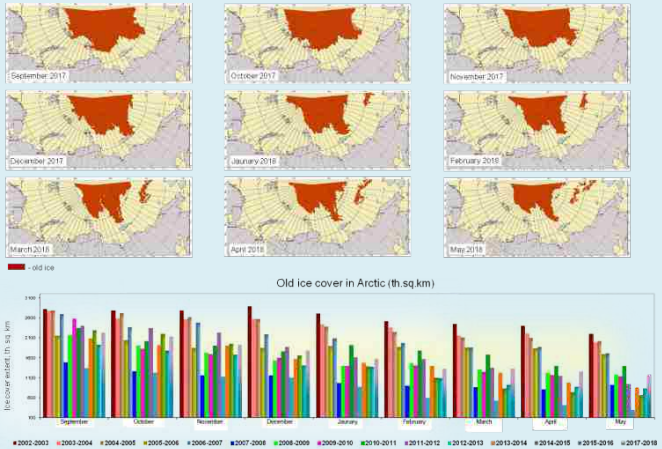
Global Climate Change Monitoring

Dynamics of Old Ice in the Western Arctic, 1983-2018



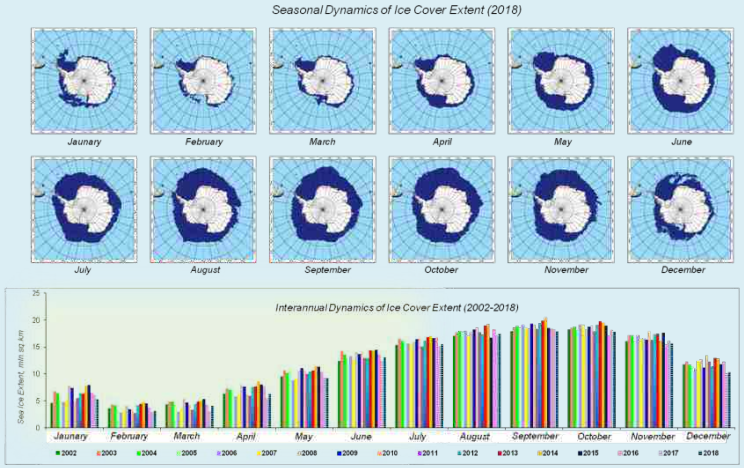
OKEAN satellite,1983 -1999, QuikSCAT/SeaWinds, ENVISAT/ASAR, AQUA/AMSR-E, MetOp/ASCAT, Oceansat-2/OSCAT, Meteor-M №2/ BRLK "Severyanin-M", Sentinel/SAR-C, 2002-2018

Dynamics of Old Ice in the Russian Arctic, 2002-2018



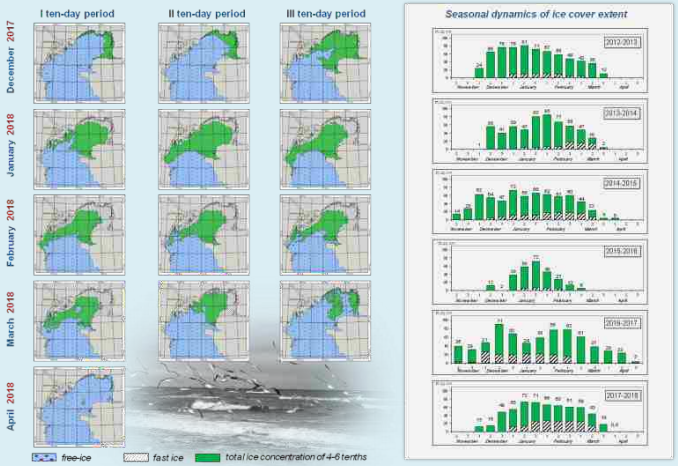
Metop-A/ASCAT, EOS/AMSR-E,MODIS, Meteor-M/MSU-MR, NOAA/AVHRR, Sentinel/SAR-C

Dynamics of Antarctic Ice Cover, 2002-2018



Metop/ASCAT, Oceansat-2/OSCAT, Meteor-M/MSU-MR

Dynamics of Caspian Sea Fast and Drift Ice, 2012-2018



NOAA/AVHRR, TERRA, AQUA/MODIS, Sentinel/SAR-C

Thank you!