



Status report on the current and future satellite systems by ROSHYDROMET/ROSCOSMOS

Presented to CGMS-51 plenary session, agenda item 2

Executive summary

Since CGMS-50 the Russian hydrometeorological satellite constellation has been increased by geostationary meteorological satellite Electro-L N4 launched on 5 February 2023. Now the geostationary constellation of 3 satellites covering the Atlantic, Indian and Pacific ocean areas is fully deployed. The launch of polar-orbiting meteorological satellite Meteor-M N2-3 and highly elliptical orbit meteorological satellite Arctica-M N2 are scheduled by the end of 2023.

Overview - Planning of ROSHYDROMET/ROSCOSMOS satellite systems



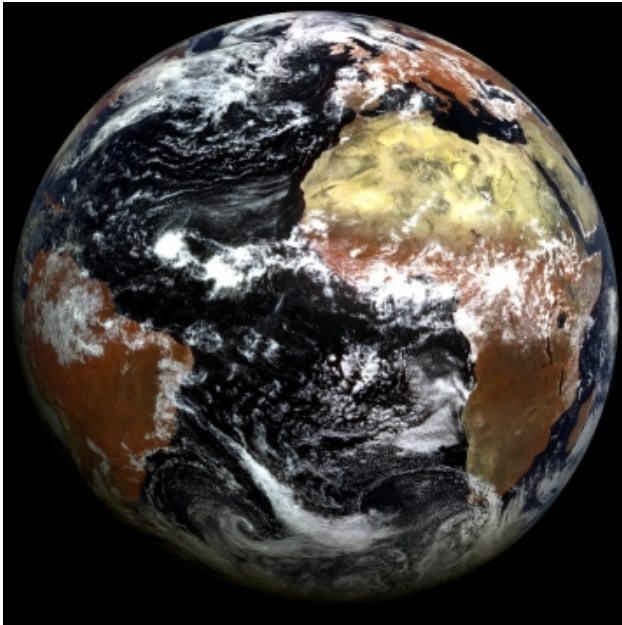
CURRENT GEO SATELLITES

- Electro-L constellation standing points:
 - 14,5°W – Electro-L N2
 - 76°E – Electro-L N3
 - 165,8°E – Electro-L N4
- Instrument payload:
 - MSU-GS imager
 - Heliogeophysical complex GGAK-VE
 - Data collection system
 - COSPAS-SARSAT system
 - direct broadcast HRIT/LRIT
- Objectives of Electro-L mission:
 - Continuous observation of the Earth disc within a radius of 55-60 degrees centered at the sub-satellite point;
 - Simultaneous images of cloud cover and the Earth's surface in 3 visible and 7 infrared channels;
 - Heliogeophysical measurements at geostationary orbit altitudes;
 - Collection and retransmission of the hydrometeorological data from national international platforms (DCPs);
 - Retransmission of the data from Roshydromet regional centers;
 - Data dissemination in HRIT/LRIT formats to national and foreign users

CURRENT GEO SATELLITES

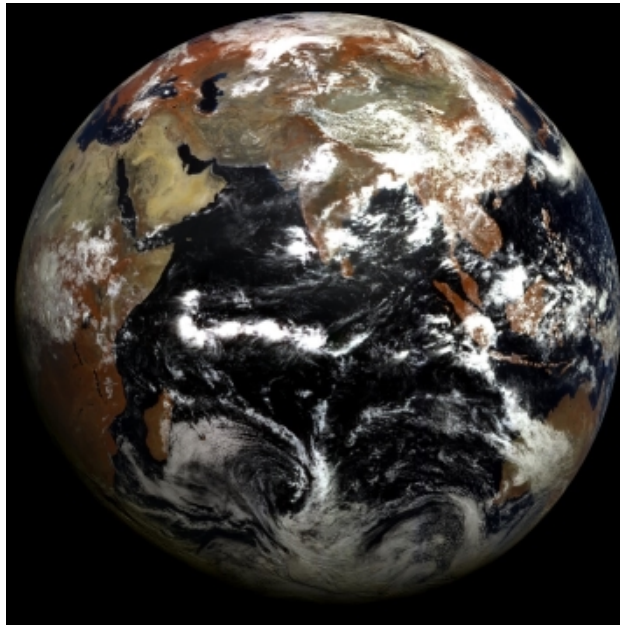
Daytime visible images

Electro-L N2 - 14,5°W



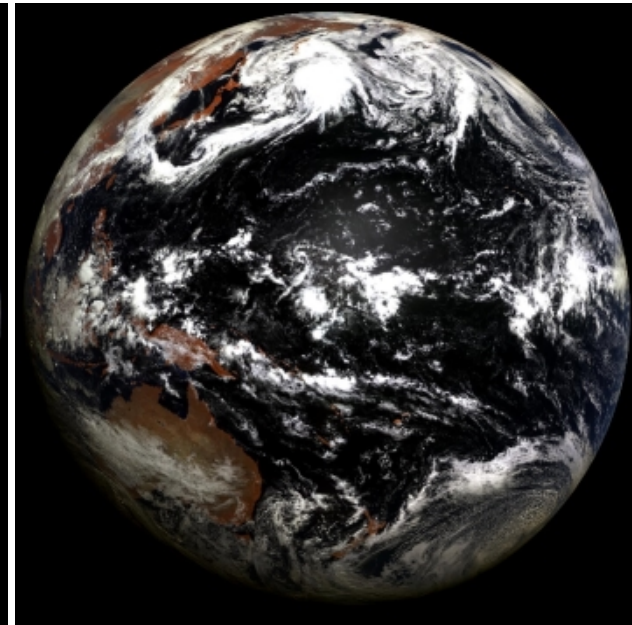
19/06/2003 12:00 UTC

Electro-L N3 - 76°E



19/06/2003 06:00 UTC

Electro-L N4 - 165,8°E



20/06/2003 00:00 UTC

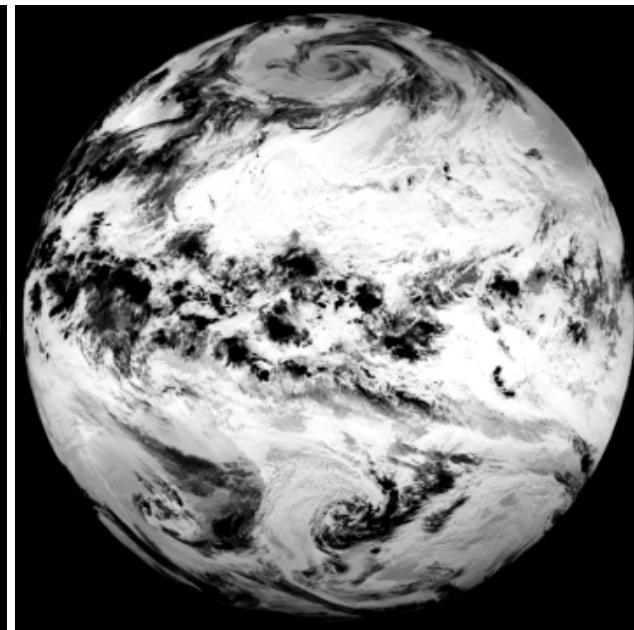
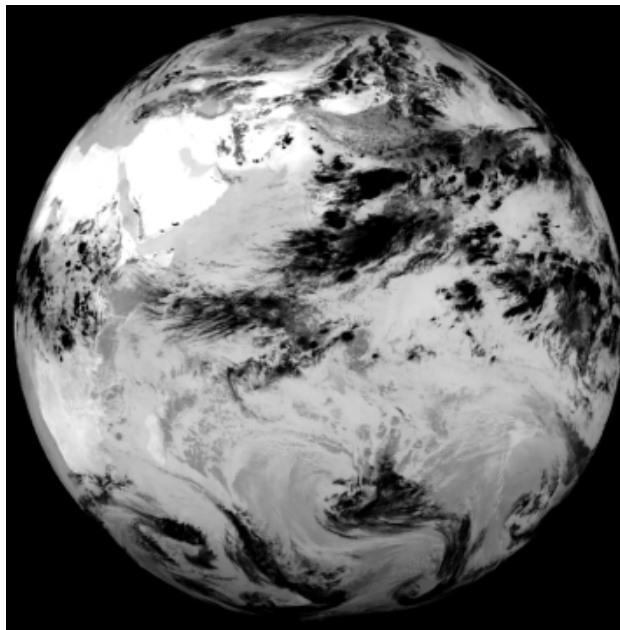
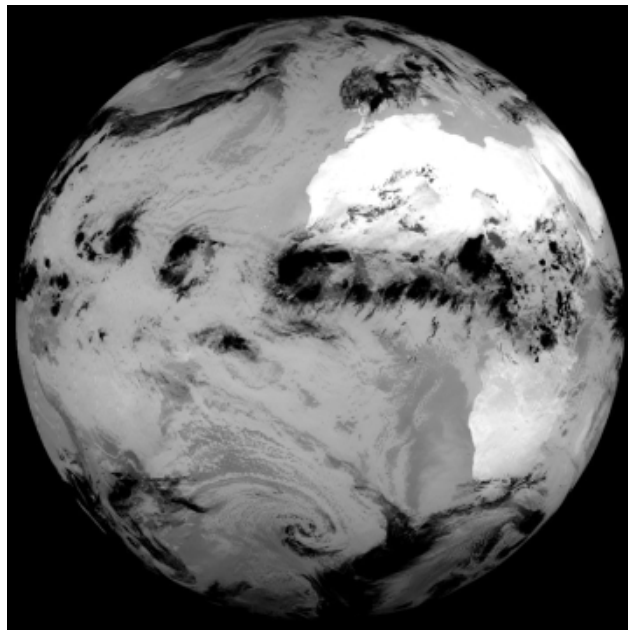
CURRENT GEO SATELLITES

Simultaneous IR 10,8 mkm images

Electro-L N2 - 14,5°W

Electro-L N3 - 76°E

Electro-L N4 - 165,8°E



21/06/2003 12:00 UTC

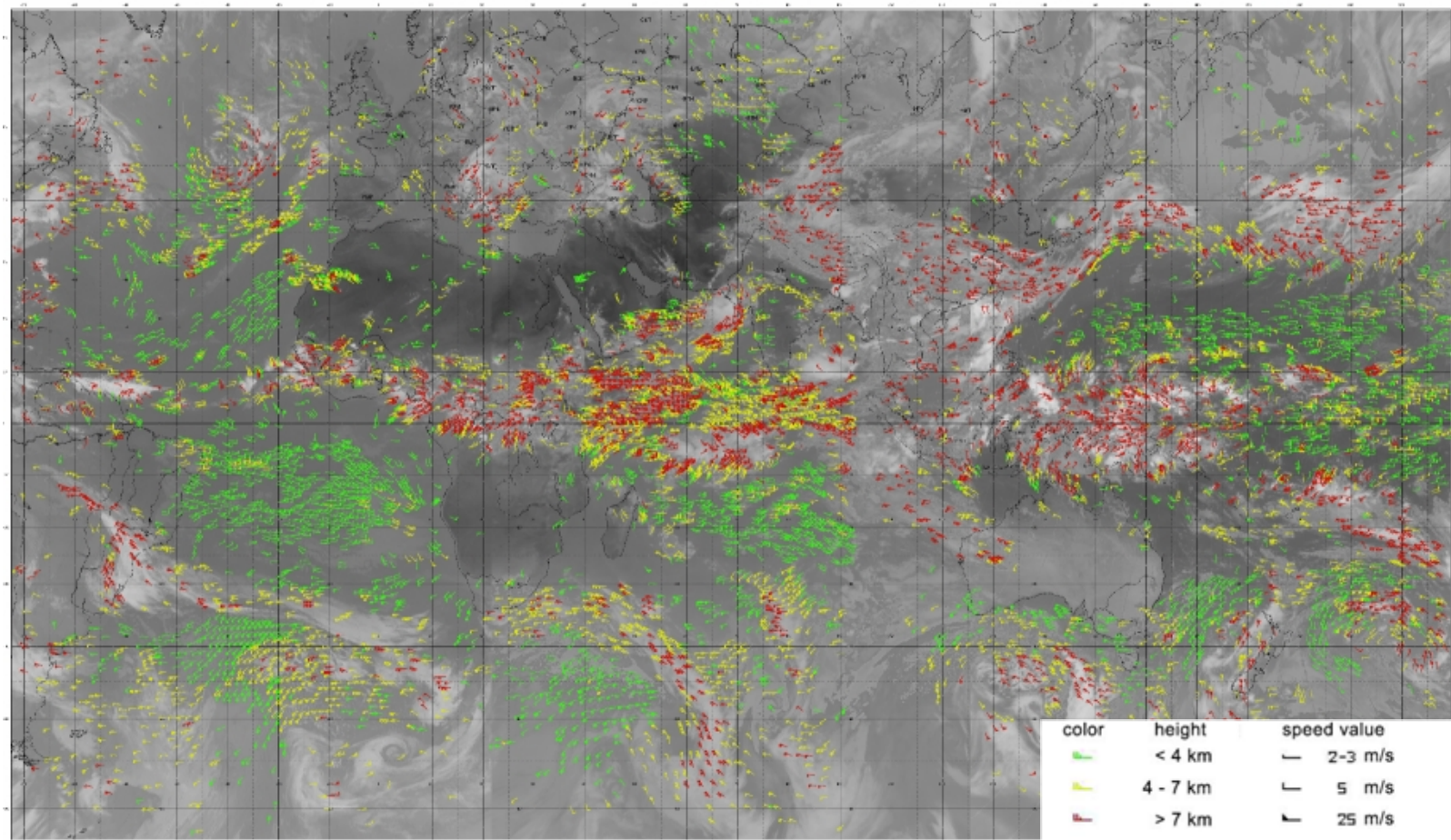
CURRENT GEO SATELLITES

Global Map of Atmospheric Motion Vectors based on Electro-L N2, N3 & N4

N2 - 14,5°W

N3 - 76°E

N4 - 165,8°E



15/06/2003 12:00 UTC

**Coordination Group for
Meteorological Satellites**

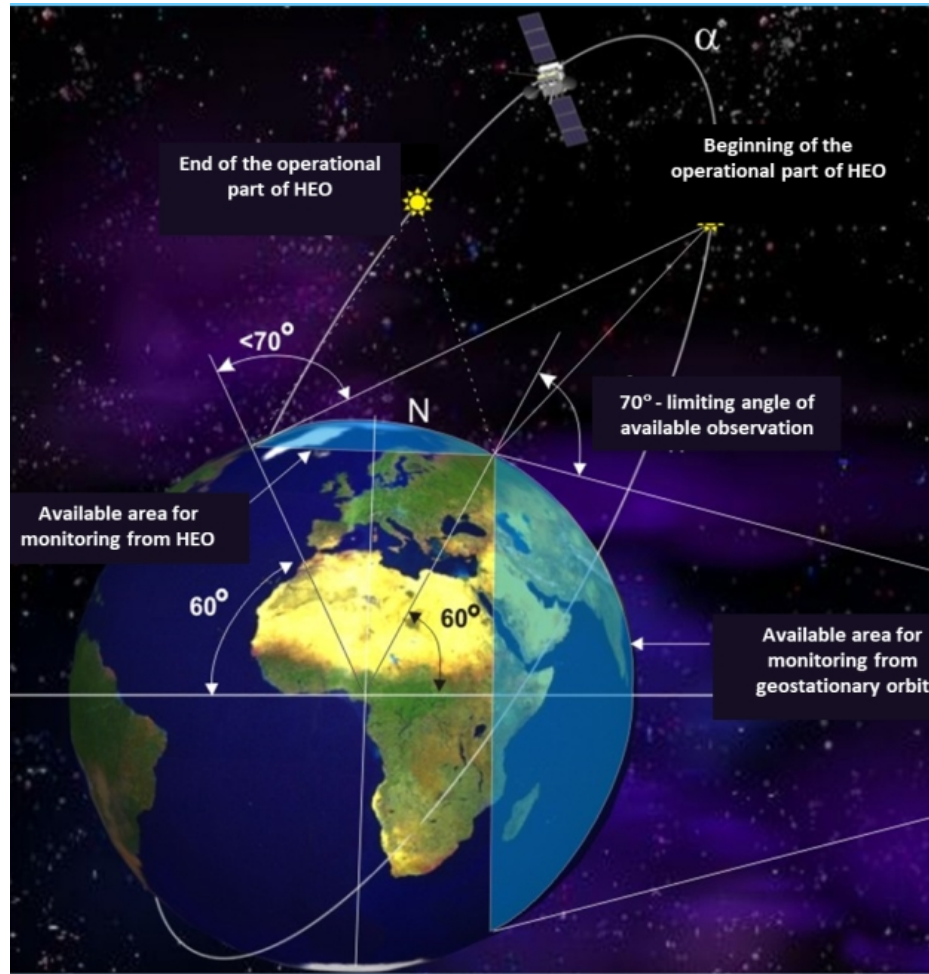


CURRENT LEO SATELLITES

- Two Meteor-M series satellites are now operational on sun-synchronous orbit with ~820 km height, 98.8° inclination:
 - Meteor-M N2 - “morning” orbit, ascending equator crossing time ~ 9:30
 - Meteor-M N2-2 - “afternoon” orbit, ascending equator crossing time ~ 15:00
- Meteor-M N2 is now ~9 years old and off the planned life span
- Instrument payload operational for now:
 - Meteor-M N2:
 - GGAK-M Heliogeophysical Measurements Suite Meteor-M N2-2:
 - MSU-MR Scanning Radiometer (1 km spatial resolution multichannel scanning unit, 6 channels, VIS/IR)
 - KMSS VIS Scanning Imager (6 channels implemented by 3 cameras, 50 m and 100 m spatial resolution)
 - GGAK-M Heliogeophysical Measurements Suite
- The main objective of Meteor-M mission is to provide global observations of the Earth's surface and the atmosphere for the following purposes:
 - Weather analysis and forecasting on global and regional scales;
 - Global climate change monitoring;
 - Sea surface observations;
 - Space weather analysis and prediction (solar wind, ionosphere research, Earth's magnetic field, etc.)
- Meteor-M LEO constellation is planned to consist of 4 spacecrafts to provide meteorological data over Russian Federation at least 8 times per day at synoptic time

CURRENT HEO SATELLITES

Arctica-M N1: First meteorological satellite in HEO (“Molniya” orbit) continuing successful operation



Parameter	Value
<i>Orbit:</i>	
Apogee, km	40 000
Perigee, km	1 000
Inclination, deg	63,4
Period, h	12
1 st apogee longitude, deg	25 W
2 nd apogee longitude, deg	155 E
Full number of MSU-GS/A spectral channel	10
Spectral range, μm	from 0,5 to 12,5
<i>Resolution (at nadir):</i>	
- VIS-channel, km	1
- IR-channel, km	4
<i>Frequency of Arctic region' observation, min:</i>	
- regular mode	30
- frequent mode	15

CURRENT HEO SATELLITES

- Primary objectives of Arctica-M mission:
 - Continuous observation of Arctic and contiguous region
 - Simultaneous images of cloud cover and the Earth's surface in 10 visible and infrared channels
 - Heliogeophysical measurements at orbit altitudes (electromagnetic solar radiation, corpuscular radiation and terrestrial magnetic fields)
 - The development and maintaining the national data collection system, collection of the hydrometeorological data from national and international platforms
 - Two-way radio communication with stations of Roshydromet hydrometeorological network

- Arctica-M N1 payload includes:
 - MSU-GS/VE imager in 3 visible channels (1 km spatial resolution) and 7 IR channels (4 km spatial resolution)
 - GGAK-VE Heliogeophysical Measurements Suite
 - Data collection system (DCS)

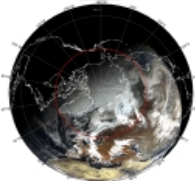
- Arctica-M N1 satellite is functional without limitations

CURRENT HEO SATELLITES

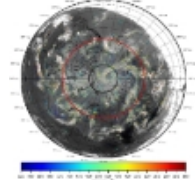
Arctica-M applications

Weather forecasting

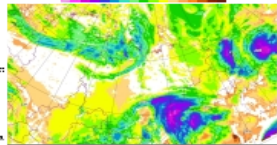
Animated maps



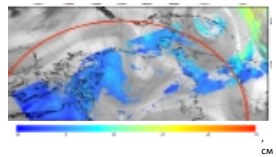
AMVs



Cloud top temperature, cloud top height

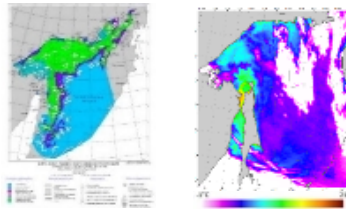


Total water content

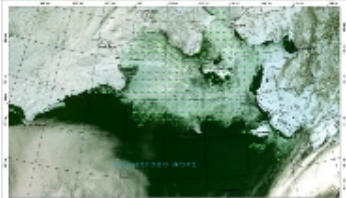


Sea and ice analysis

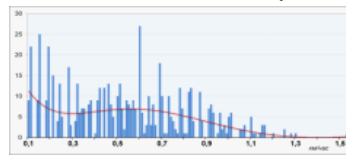
Ice cover and temperature maps



Ice drift

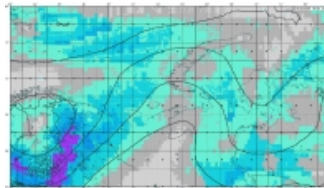


Ice drift velocity

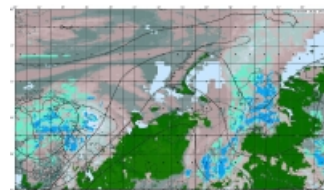


Aviation-related products

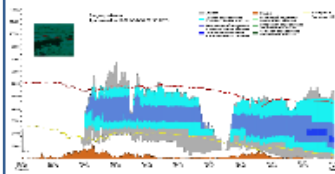
Near-surface wind gusts speed



Precipitation area and intensity

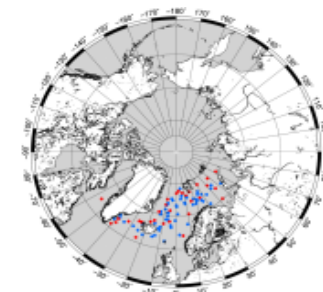
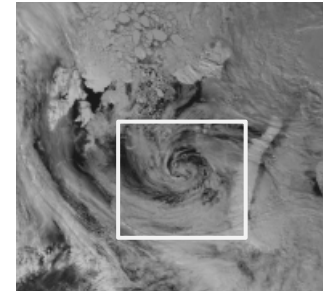


Vertical sections of clouds and ice



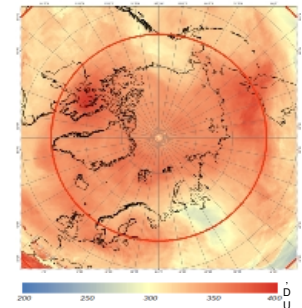
Natural hazards

Polar mesoscale cyclones

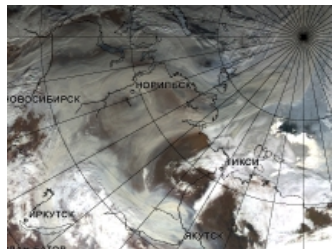
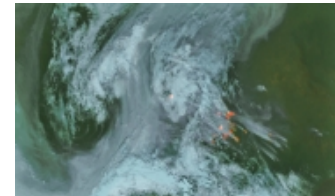


Ecological applications

Total ozone content

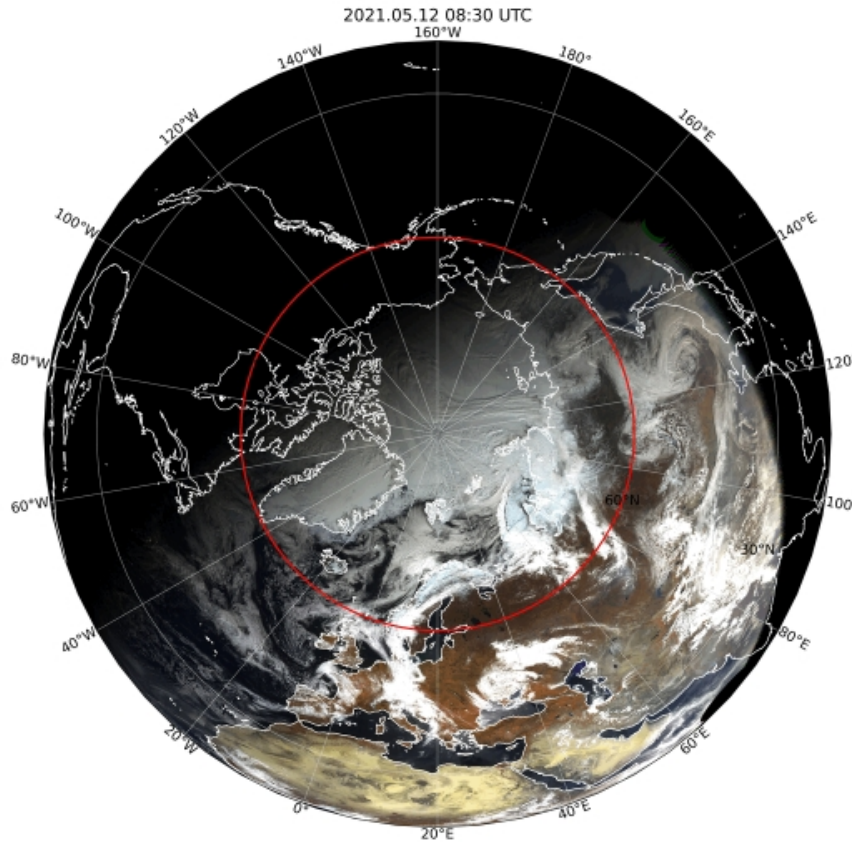


Forest fires

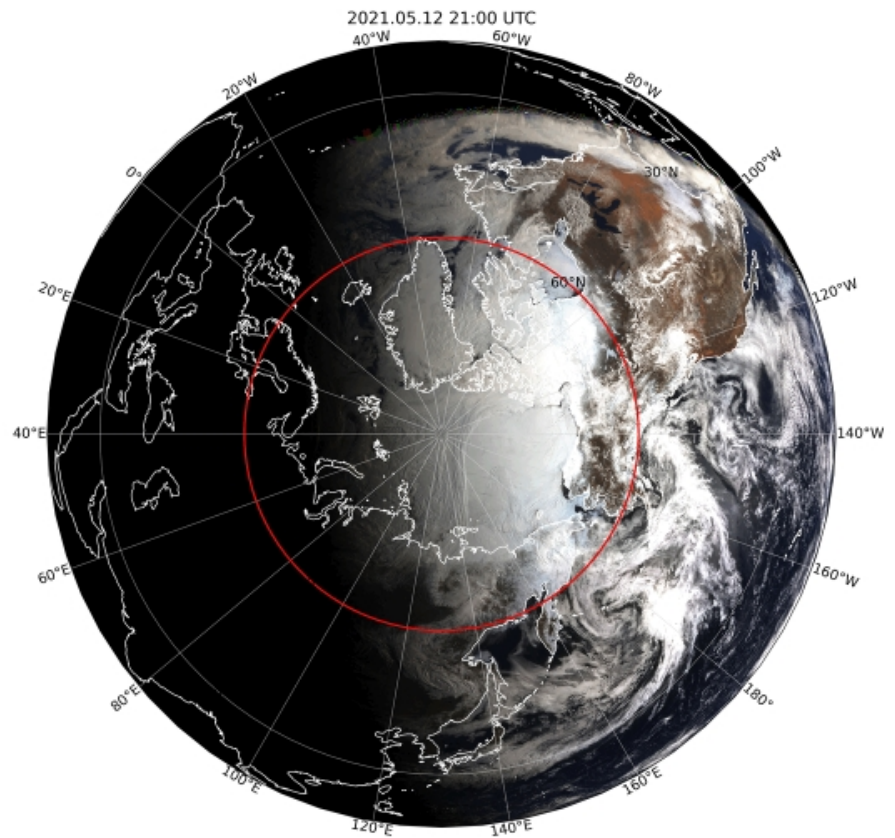


CURRENT HEO SATELLITES

Cloud animation in VIS based on Arctica-M N1 data



“Eastern” pass



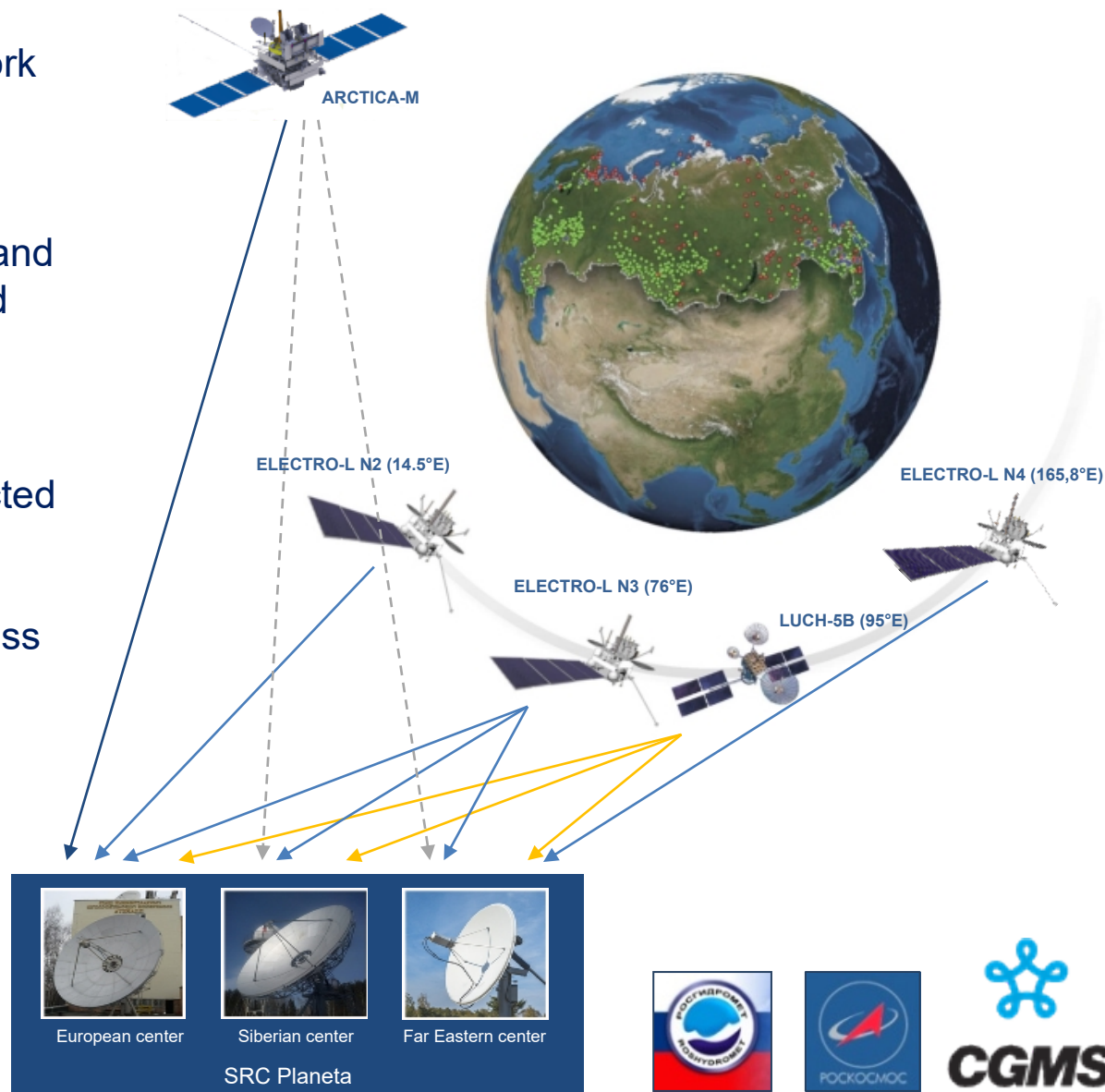
“Western” pass

Animated maps from 15/30 min scans allows to track the evolution of clouds in the daytime

CURRENT GEO/HEO SATELLITES

DCS comprises of the network of DCPs at Roshydromet's observational sites, relay transponders at Russian satellites of Electro-L, Luch and Arctica-M series, and ground receiving stations at SRC Planeta satellite centers.

Data is currently being collected from 696 Roshydromet's observation network (●●●), including 141 difficult to access stations (●).



FUTURE GEO SATELLITES

Mission	Operator(s)	Orbit	Launch planned	Instruments
Electro-L N5	ROSHYDROMET /ROSCOSMOS	GEO, standing point TBD	2025	MSU-GS, GGAK-VE, DSC, COSPAS-SARSAT, direct broadcast HRIT/LRIT
Electro-M N1	ROSHYDROMET /ROSCOSMOS	GEO, standing point TBD	>2025	<ul style="list-style-type: none"> - MSU-GSM imager with ~20 channels, - hyperspectral sounder IKFS-GS, - lightning detector, - radiation balance radiometer, - heliogeophysical complex KGI, - DSC, - COSPAS-SARSAT, - direct broadcast HRIT/LRIT
Electro-M N2	ROSHYDROMET /ROSCOSMOS	GEO, standing point TBD	>2026	
Electro-M N3	ROSHYDROMET /ROSCOSMOS	GEO, standing point TBD	>2029	

- Electro-L N5 is the serial satellite planned for maintain the current constellation
- New generation GEO satellite series Electro-M with extended useful payload is planned to start after 2025

FUTURE LEO SATELLITES

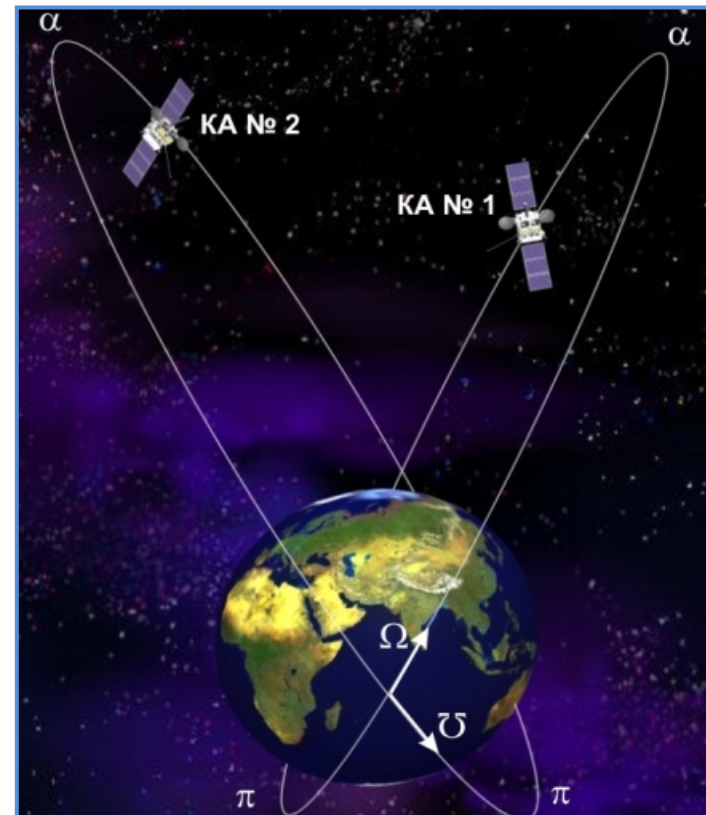
Mission	Operator(s)	Orbit	Launch planned	Instruments
Meteor-M N2-3	ROSHYDROMET /ROSCOSMOS	LEO, ECT 9:00 desc	27/06/2023	<ul style="list-style-type: none"> • MSU-MR • MTVZA-GY • IKFS-2 • KMSS • DCS • MeteoSAR • GGAK-M2 • dissemination HRIT/LRIT • COSPAS-SARSAT
Meteor-M N2-4	ROSHYDROMET /ROSCOSMOS	LEO, ECT TBD	2024	
Meteor-M N2-5	ROSHYDROMET /ROSCOSMOS	LEO, ECT TBD	2025	
Meteor-M N2-6	ROSHYDROMET /ROSCOSMOS	LEO, ECT TBD	>2025	
Meteor-MP N1	ROSHYDROMET /ROSCOSMOS	LEO, ECT TBD	>2026	<ul style="list-style-type: none"> • MSU-MR-MP (20 channels) • MTVZA-MP • IKFS-3 • SA-MP • SCAT-MP • ARMA-MP • KGI-MP • DCS • dissemination HRIT/LRIT • COSPAS-SARSAT

- Meteor-M N2-3 to N2-6 will be serial identic satellites to form LEO constellation
- Meteor-MP will start next generation LEO constellation with improved characteristic and new payload incl. scatterometer, radio occultation sounding, greenhouse gas spectrometer

FUTURE HEO SATELLITES

Mission	Operator(s)	Orbit	Launch planned	Instruments
Arctica-M N2	ROSHYDROMET /ROSCOSMOS	HEO Molnya Orbit	2023	<ul style="list-style-type: none"> • MSU-GS/HE • GGAK-VE • DSC
Arctica-M N3	ROSHYDROMET /ROSCOSMOS	HEO Molnya Orbit	TBD	
Arctica-M N4	ROSHYDROMET /ROSCOSMOS	HEO Molnya Orbit	TBD	
Arctica-M N5	ROSHYDROMET /ROSCOSMOS	HEO Molnya Orbit	TBD	
Arctica-M N6	ROSHYDROMET /ROSCOSMOS	HEO Molnya Orbit	TBD	

- Arctica-M N2 will provide continuous quasi-stationary observation of arctic region
- The HEO constellation of 4 spacecraft will allow to double the periodicity of observation from two angles



Thanks for attention!