

Russian polar meteorological satellite system

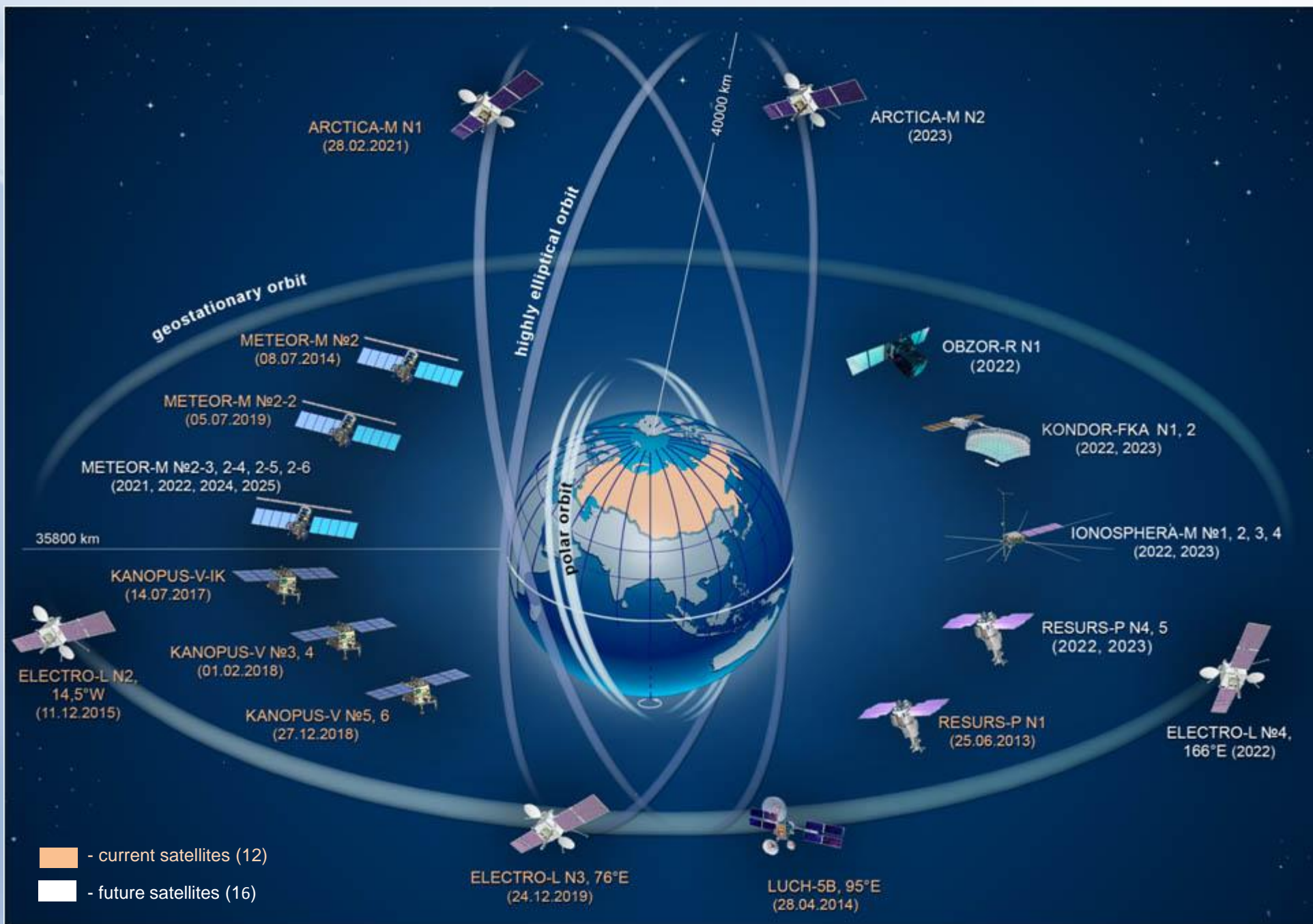
Sergey Uspensky, SRC Planeta, ROSHYDROMET



Overview

Russian meteorological polar-orbiting satellite system of Meteor-M series is now being developed according to Russian Federal Space Program 2016-2025. Meteor-M constellation should comprise of four meteorological satellites on sun-synchronous orbits. Meteor-M satellites are manufactured by VNIIEM Corporation and planned for both morning and afternoon orbits. The payload of Meteor-M satellites should include, among others, scanning radiometers of visible and IR range, and atmospheric IR and microwave sounders. A brief description is given of existing atmospheric sounders (infrared Fourier transform spectrometer IKFS-2 and microwave radiometer MTVZA-GY) flying on Meteor-M №2, № 2-2 satellites. The launch of the next Meteor-M N2-3 satellite is scheduled for 1Q 2022. As for forthcoming instruments, the enhanced IR and microwave sounders IKFS-3, MTVZA-GY-MP should be developed and launched after 2025. General technical characteristics of mentioned sensors are presented.

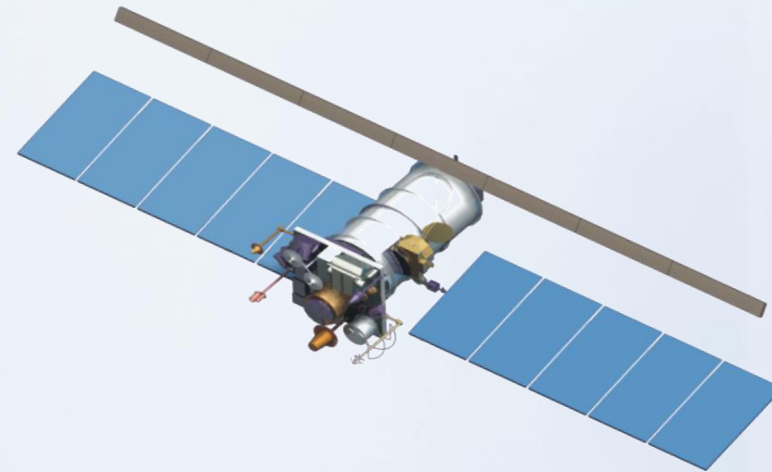
RUSSIAN EARTH OBSERVATION SATELLITE SYSTEM



METEOR-M General Design



Meteor-M N2 was launched
on **July 8, 2014**
Meteor-M N2-2 was launched
on **July 14, 2019**



In-orbit mass – 2700 kg

Payload mass – 1200 kg

Lifetime – 5 years

Orbit – Sun-synchronous

Altitude – 830 km

Data dissemination format – HRPT/LRPT

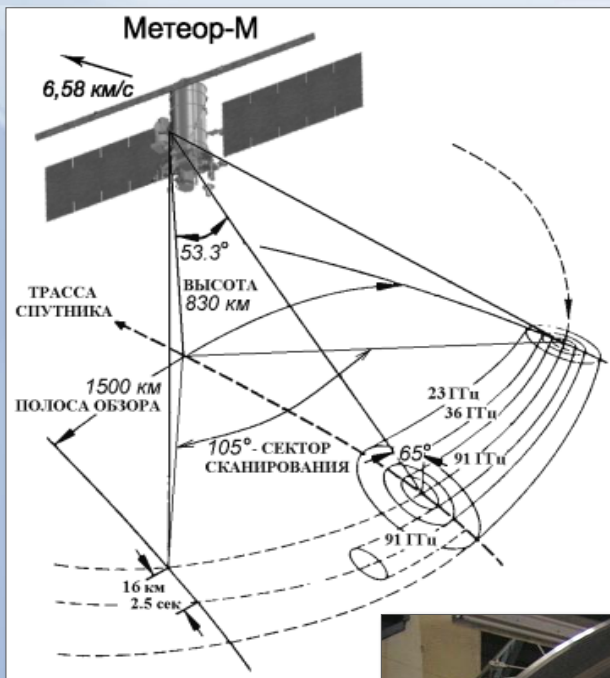
Meteor-M № 2, 2-2, 2-3, 2-4, 2-5

Basic Instruments Specifications

Instrument	Application	Spectral band	Swath-width (km)	Resolution (km)
MSU-MR Low-resolution multi-channel scanning unit	Global and regional cloud cover mapping, ice and snow cover observation, forest fire monitoring...	0,5 – 12,5µm (6 channels)	3000	1 x 1
KMSS Visible spectrum scanning imager	Earth surface monitoring for various tasks (floods, soil and vegetation cover state, 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, sea surface wind	10,6-183,3 GHz (26 channels)	2600	12 – 75
IKFS-2 Advanced IR sounder (infrared Fourier-spectrometer)	Atmospheric temperature and humidity profiles	5-15 µm	2000	35
“Severjanin-M” * , BRLK Synthetic aperture radar	All-weather Ice coverage monitoring	9500-9700 MHz	600	0,4 x 0,5
GGA-K-M Heliogeophysical instrument suite	Heliogeophysical data providing			
BRK SSPD Data Collection System	Data retransmission from DCP			

*only for Meteor-M N2

Microwave Imager/Sounder MTVZA-GY



Scheme of scanning



Instrument MTVZA-GY

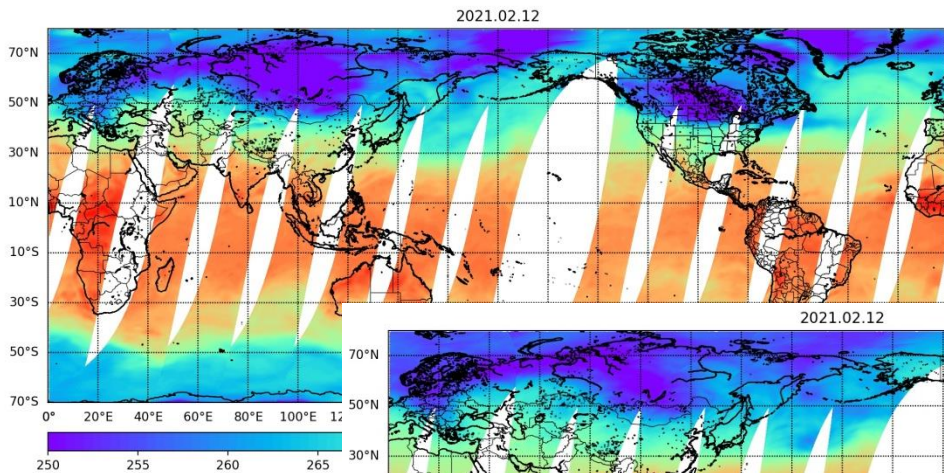
Parameter	Value
Frequencies, GHz	10.6, 18.7, 23.8, 36.5, 52-57, 91, 183.31
Channels	29
Antenna Aperture, cm	65
Spatial Resolution, km	16-198
Sensitivity, K/pixel	0.3-1.7
Calibration Accuracy, K	< 1
Swath Width, km	1800
Conical Scanning Period, s	2.5
Data Rate, Kbit/s	35
Mass, kg	94
Power, W	80

MTVZA-GY atmospheric sounding channels

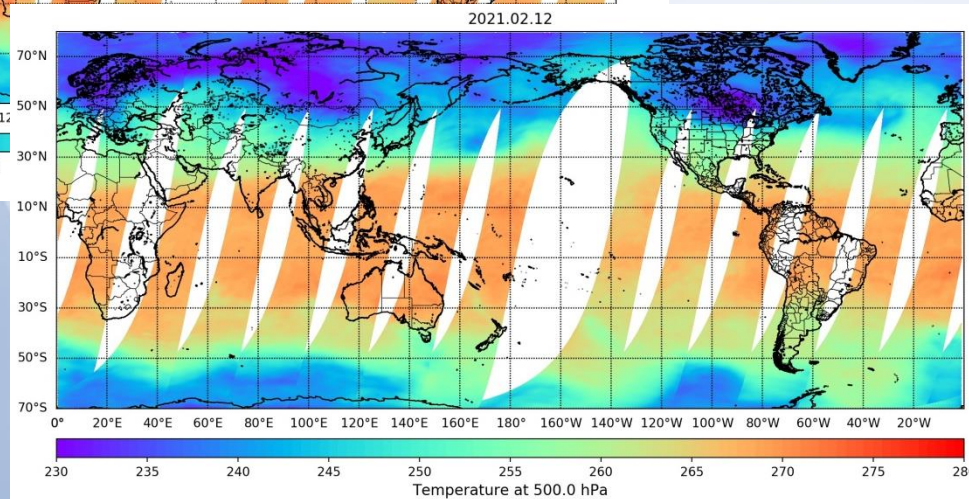
Channel	Central Frequency, GHz	Number of Passbands	Polarization	Passband (-3 dB), MGz	Pixel size, km×km	Antenna beam, km×km	Sensitivity, K/pixel	Peak Weight Function, km
O1(15)	52.80	1	V	400	21x48	32x32	0.4	2
O2(16)	53.30	1	V	400	21x48	32x32	0.4	4
O3(17)	53.80	1	V	400	21x48	32x32	0.4	6
O4(18)	54.65	1	V	400	21x48	32x32	0.4	10
O5(19)	55.63	1	V	400	21x48	32x32	0.4	14
O6(20)	$F_0 \pm 0.1$	4	H	50	21x48	48x48	0.4	20
O7	$F_0 \pm 0.05$	4	H	20	21x48	48x48	0.7	25
O8	$F_0 \pm 0.025$	4	H	10	21x48	48x48	0.9	29
O9	$F_0 \pm 0.01$	4	H	5	21x48	48x48	1.3	35
O10	$F_0 \pm 0.005$	4	H	3	21x48	48x48	1.7	42
HO1	183.31 ± 7.0	2	V	1500	9x21	32x32	0.5	1.5
HO2	183.31 ± 3.0	2	V	1000	9x21	32x32	0.6	2.9
HO3	183.31 ± 1.4	2	V	500	9x21	32x32	0.8	5.3

$F_0=57.290344\pm 0.3222$ GHz

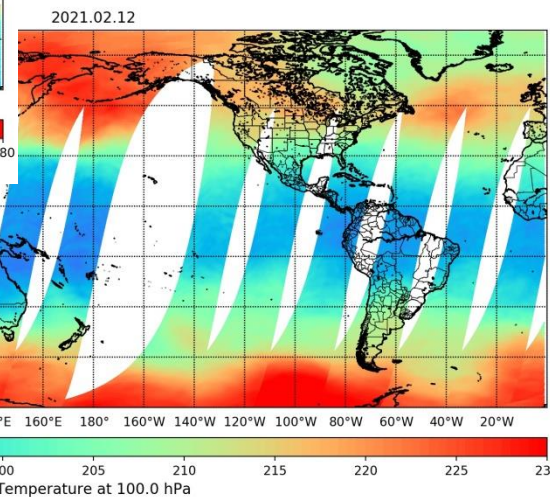
Temperature fields retrieved from MTVZA-GY/Meteor-M N2-2 data (21 March 2021)



850 hPa

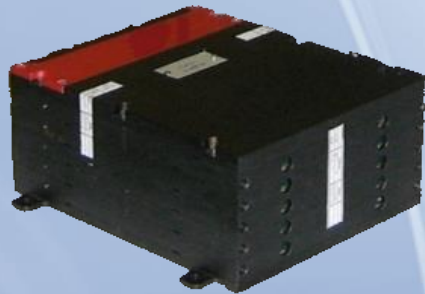


500 hPa



100 hPa

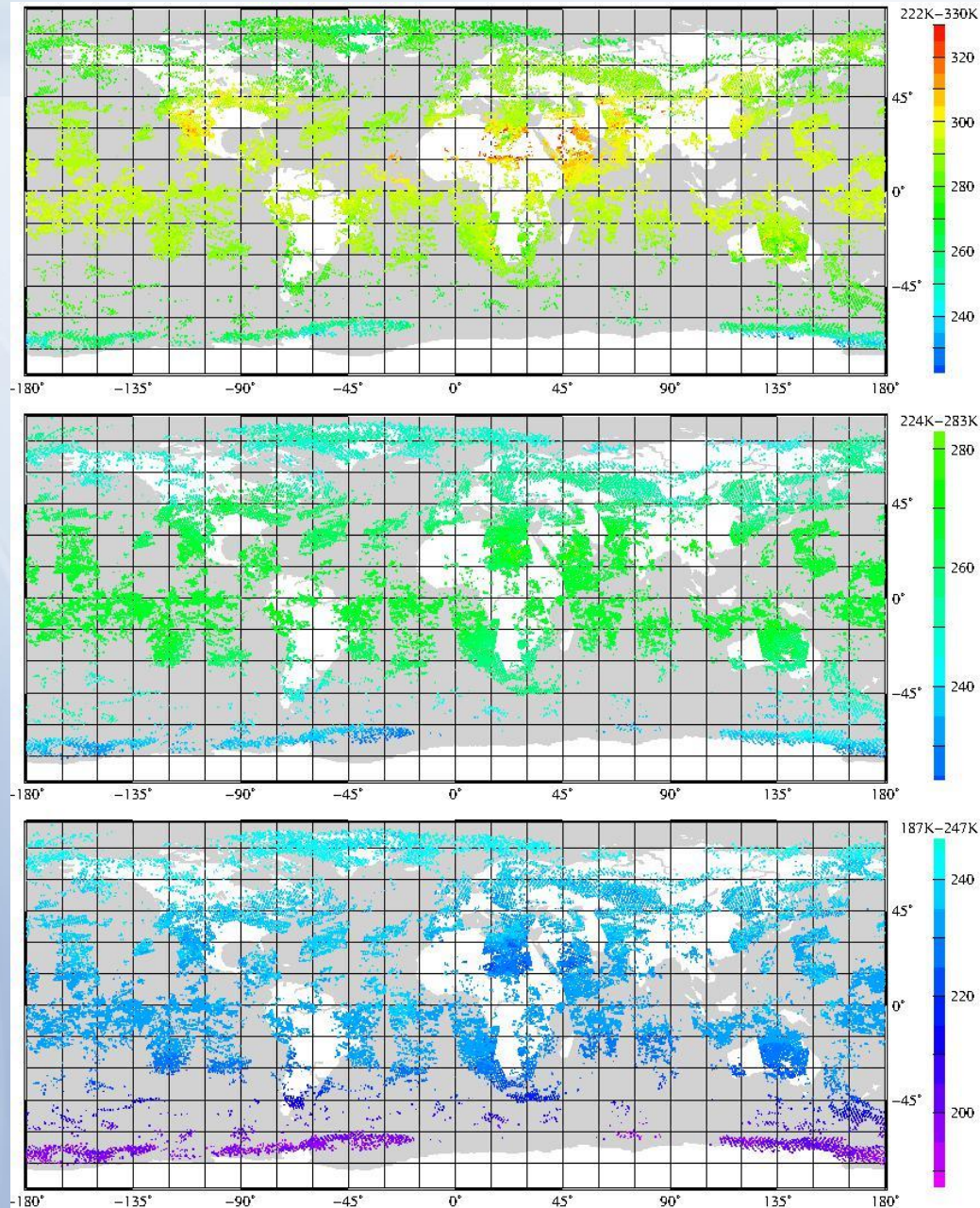
Advanced IR Sounder IKFS-2



Parameter	Units	Value
Spectral range: wavelength wave number	μm cm^{-1}	5-15 2000-665
Reference channel wavelength	μm	1.06
Maximum optical path difference (OPD)	mm	17
Angular size of FOV	mrad	40 x 40
Spatial resolution (at sub-satellite point)	km	35
Swath width and spatial sampling	km	2500, 110 2000, 100
Duration of the interferogram measurement	s	0.5
Dynamic range		2^{16}
Mass	kg	45-50
Power	W	50

Spectral range	Absorption band	Application
665 to 780 cm^{-1}	CO_2	Temperature profile
790 to 980 cm^{-1}	Atmospheric window	Surface parameters (T_s , ϵ_v), cloud properties
1000 to 1070 cm^{-1}	O_3	Ozone sounding
1080 to 1150 cm^{-1}	Atmospheric window	T_s , ϵ_v ; cloud properties
1210 to 1650 cm^{-1}	H_2O , N_2O , CH_4	Moisture profile, CH_4 , N_2O , column amounts

Temperature fields retrieved from IKFS-2/Meteor-M N2 data



06.06.2021 Meteor-M #2 IKFS-2 Temp. 26924 retrievals 925/500/10 hPa

Comparison of IR sounder IKFS-3 with CrIS/SNPP, IASI/Metop, IASI-NG/Metop-SG

IKFS-3	
Spectral bands	645...2760 cm ⁻¹ (3.6-15.5 μm)
LW, cm ⁻¹	645...1200
MW, cm ⁻¹	1200...2000
SW, cm ⁻¹	2000...2760
Spectral resolution, cm⁻¹	0.25 /0.125
Band width, km	1000/2000
Spatial Resolution ,km	14

	IASI	IASI-NG
Spectral bands	8461 spectral channels 15.50 .. 3.63 μm (645 – 2760 cm ⁻¹)	16 920 spectral channels 15.50 .. 3.63 μm (645 – 2760 cm ⁻¹)
Spectral Resolution	0.25 cm ⁻¹	0.125 cm ⁻¹
Spatial Resolution, km	H 12/ V 1	H 12/ V 1
Band width, km	2130	2130

CrIS			
Spectral bands	1305 spectral channels 3.92 .. 15.38 μm, Spectral resolution 0.625 cm ⁻¹		
	LWIR	MWIR	SWIR
cm ⁻¹	650-1095	1210-1750	2155-2550
μm	15.38-9.14	8.26-5.71	4.64-3.92
Spatial Resolution, km	H14/ V 1		
Band width, km	2200		

METEOR-MP Basic Payload (Meteorological)

- Low-resolution multi-channel scanning radiometer;
- Visible spectrum scanning imager (moderate resolution multispectral imaging system);
- Infrared Fourier-transform spectrometer;
- Atmospheric composition spectrometer;
- Microwave imager-sounder (module for temperature and humidity sounding of the atmosphere);
- Side-looking radar system;
- Radio-occultation instrument;
- Data collection system;
- Heliogeophysical instruments suite;
- 137MHz data downlink system;
- 1.7GHz data downlink system;
- X-band data downlink system.

Thank you!

