Operational Control of Radiation Conditions Provided by Space Monitoring Center of Moscow State University

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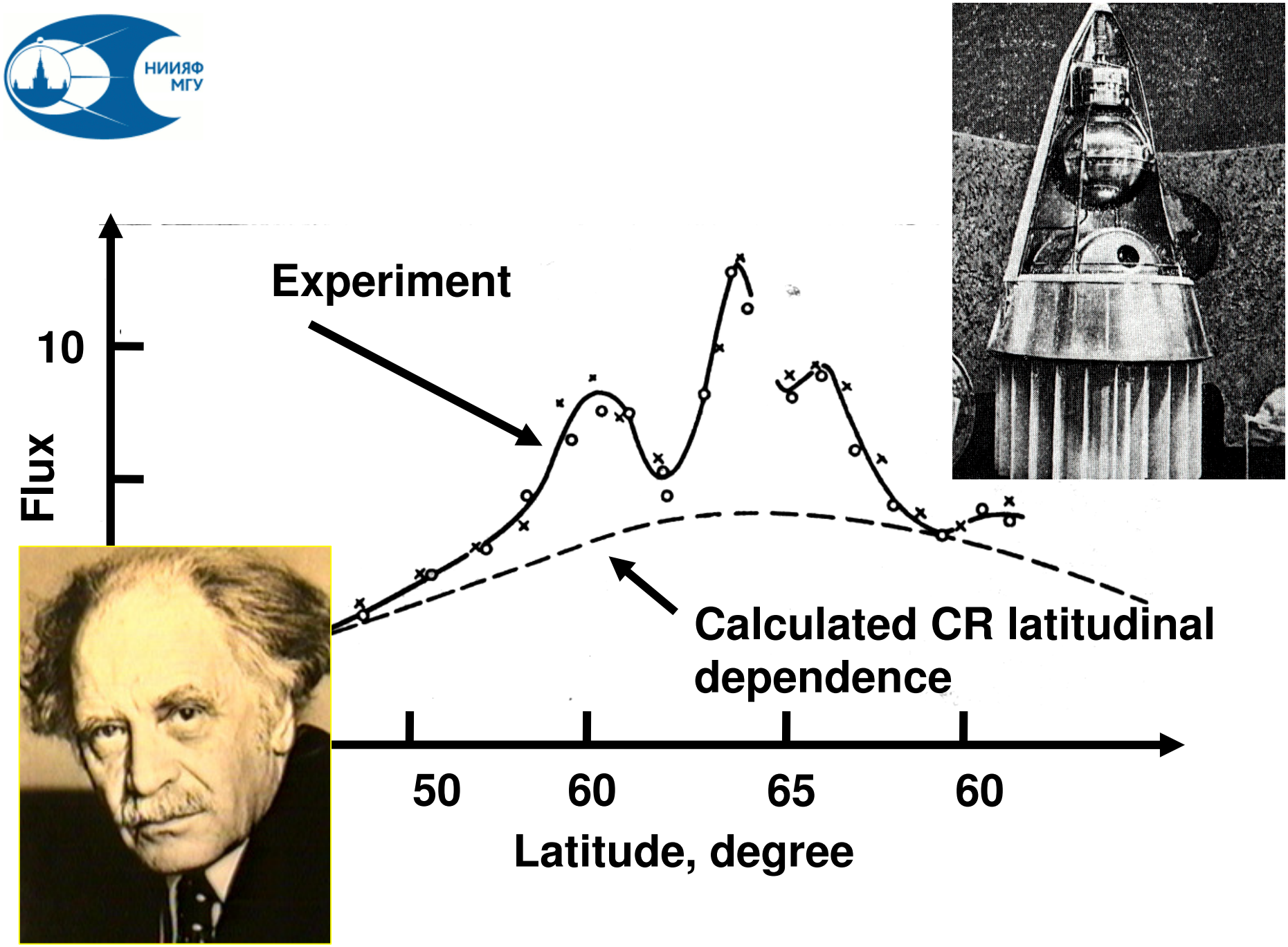
Moscow State University

SSW, Goa, January 22-27, 2016

Outline

- Space Monitoring Data Center of SINP/MSU
- Space Weather Applications
  - Radiation conditions at LEO
- Russian space missions related to SW

Contributions from: M.Panasyuk, L.Zeleny, A. Petrukovich, V.Kuznetsov


Experiment
10
Flux
Calculated CR latitudinal dependence
50
60
65
60
Latitude, degree

Space Monitoring Data Center (SMDC)

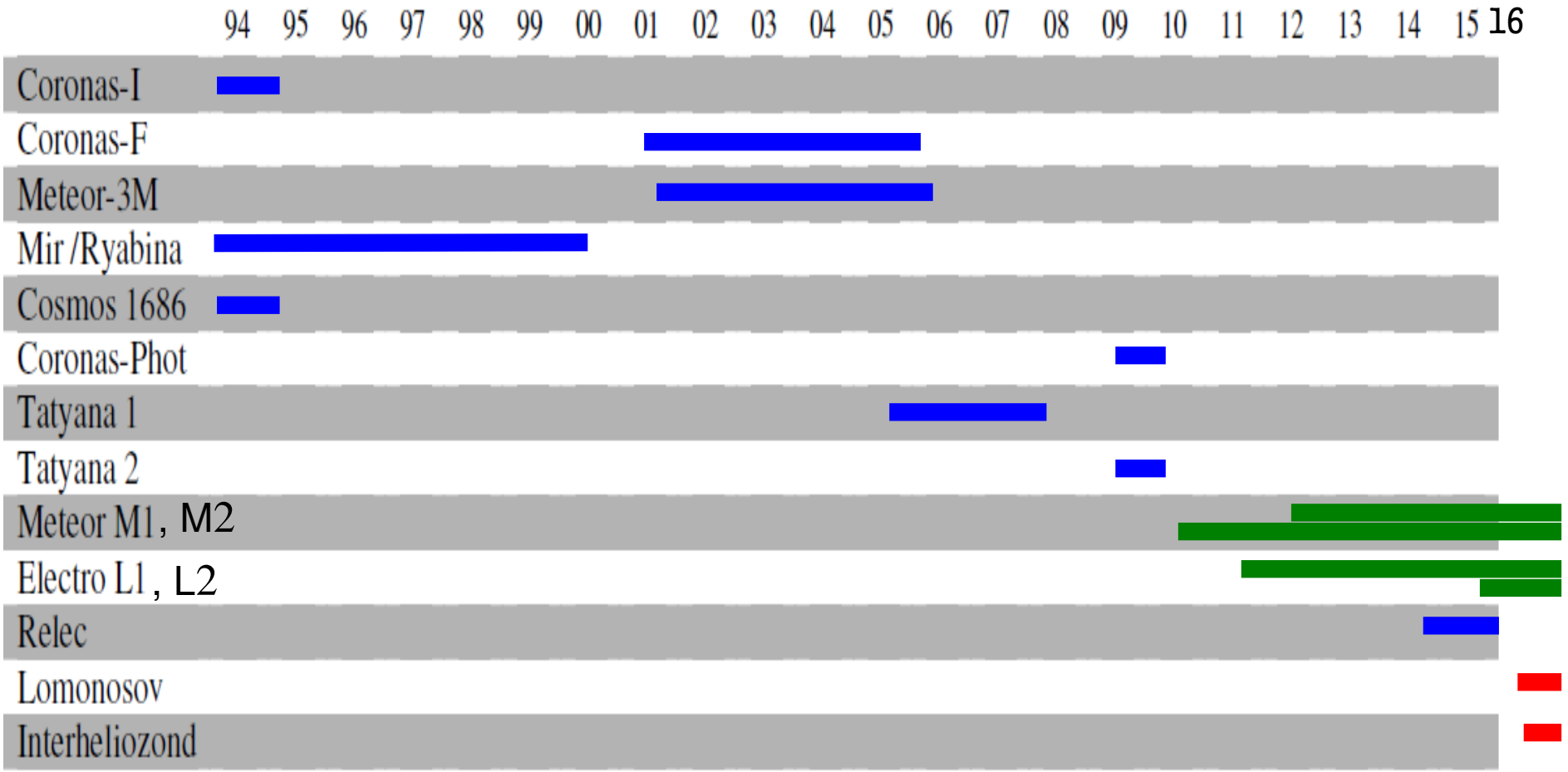
Main Tasks:

- Mission support
- Data collection
- Radiation monitoring and reliable analysis of current space radiation conditions (data + models +visualization)

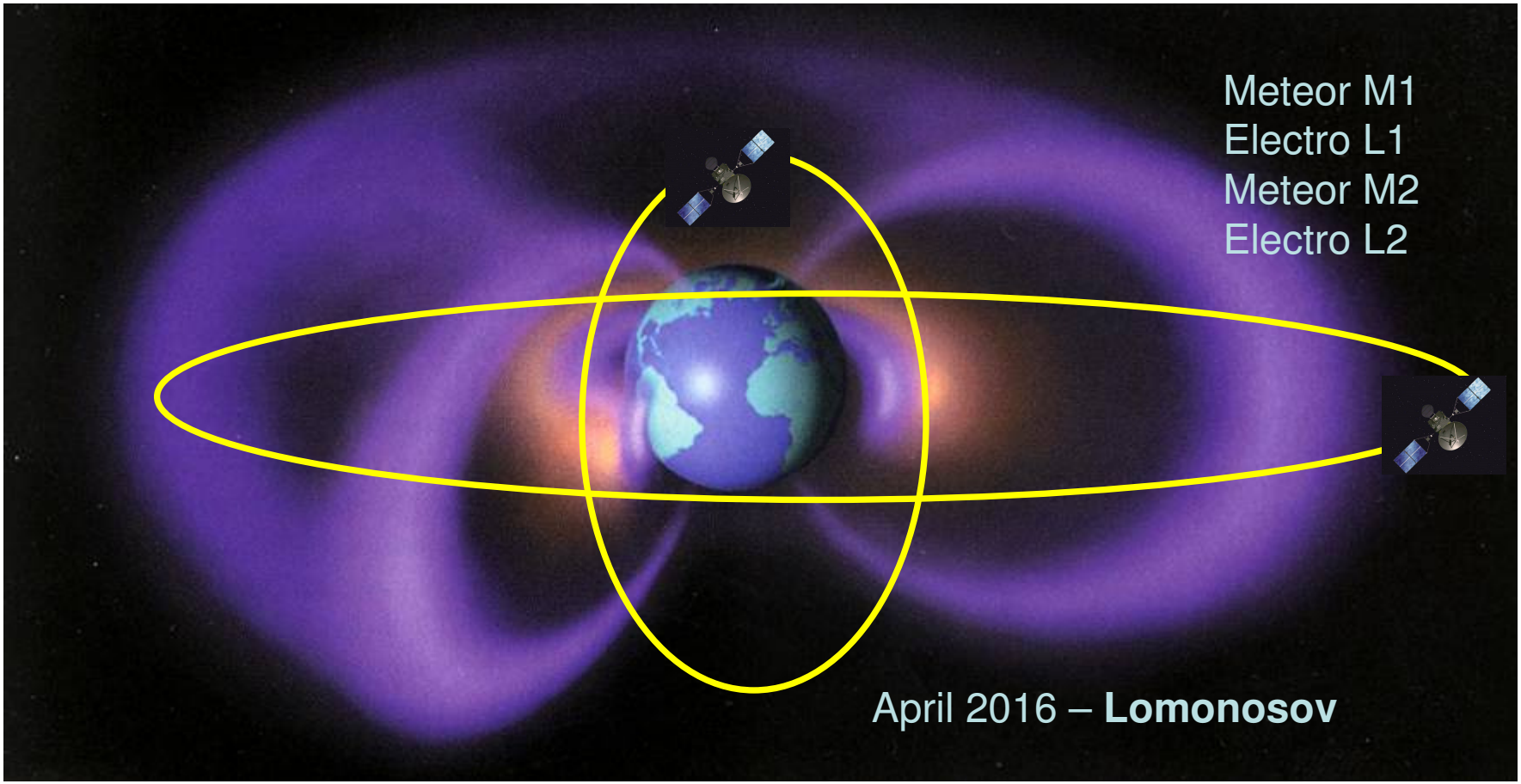
Structure:

- Data center (2005)
- SW center (2012)
- Visualization center

Satellites in DB



Satellites in operation



SINP equipment: radiation monitoring!

Electro-L1, L2

GEO, meteorological (ROSHYDROMET)

Electro-L1

Launch: 20 January, 2011

Nominal parameters of geostationary orbit:

- period of circulation 86164 s;
- Point of standing 76^0 E.L.;

Mass — 1766 kg

Energetic particles instruments:
SKIF-6, SKL-E (SINP MSU)

Protons: 1-320 MeV

Electro-L2

Launch: 11 December, 2015

Nominal parameters of geostationary orbit:

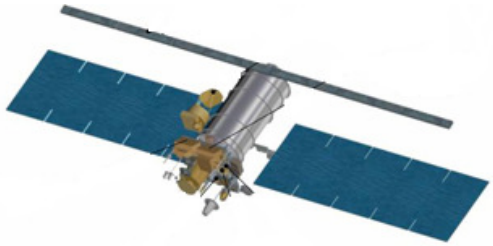
- period of circulation 86164 s;
- Point of standing 77.8^0 E.L.;

Mass — 1855 kg

Energetic particles instruments:
SKIF-6, SKL-E (SINP MSU)

Electrons: 0,03-20 MeV

Meteor-M1, M2



LEO, meteorological (ROSHYDROMET)

Launch 17 September, 2009

Orbit altitude ~ 832 km
(solar-synchronous)

Orbit period – 101.3 min
Inclination ~ 98.068°

Mass — 2700 kg

Energetic particles instruments:
MSGI-M, SKL-M (SINP MSU)

Launch 08 July, 2014

Orbit altitude ~ 825 km
(solar-synchronous)

Orbit period – 101.4 min
Inclination ~ 98.8°

Mass — 2700 kg

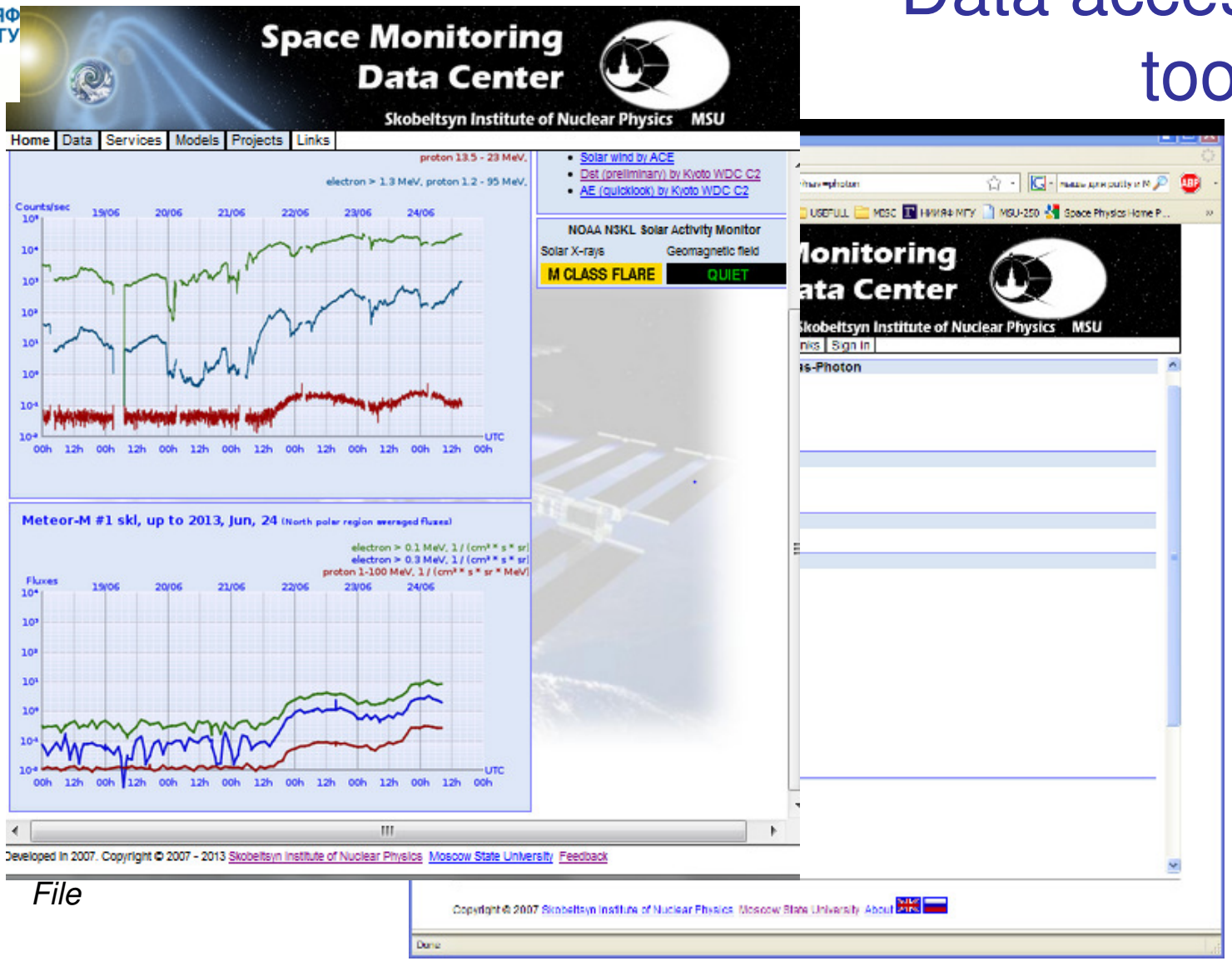
Energetic particles instruments:
MSGI-M, SKL-M (SINP MSU)

Protons: 1-160 MeV Electrons: 0,03-13 MeV Auroral part. 0.03-16 keV

Data access tools

Table

Figure



File

http://smdc.sinp.msu.ru

Space Weather Tools

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Advances in Space Research 55 (2015) 2745–2807

ADVANCES IN SPACE RESEARCH (a COSPAR publication)

www.elsevier.com/locate/asr

Understanding space weather to shield society: A global road map for 2015–2025 commissioned by COSPAR and ILWS

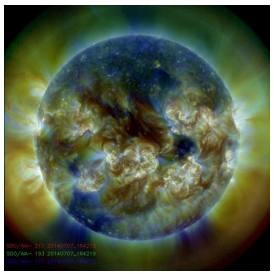
Carolus J. Schrijver [a,*], Kirsti Kauristie [b,*], Alan D. Aylward [c], Clezio M. Denardini [d], Sarah E. Gibson [e], Alexi Glover [f], Nat Gopalswamy [g], Manuel Grande [h], Mike Hapgood [i], Daniel Heynderickx [j], Norbert Jakowski [k], Vladimir V. Kalegaev [l], Giovanni Lapenta [m], Jon A. Linker [n], Siqing Liu [o], Cristina H. Mandrini [p], Ian R. Mann [q], Tsutomu Nagatsuma [r], Dibyendu Nandy [s], Takahiro Obara [t], T. Paul O'Brien [u], Terrance Onsager [v], Hermann J. Opgenoorth [w], Michael Terkildsen [x], Cesar E. Valladares [y], Nicole Vilmer [z]

Observations from Sun to Earth

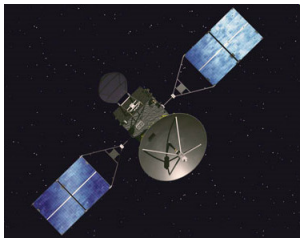
http://swx.sinp.msu.ru

Data involved

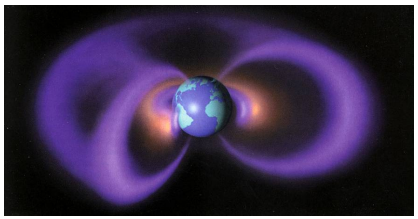
- Sun observations



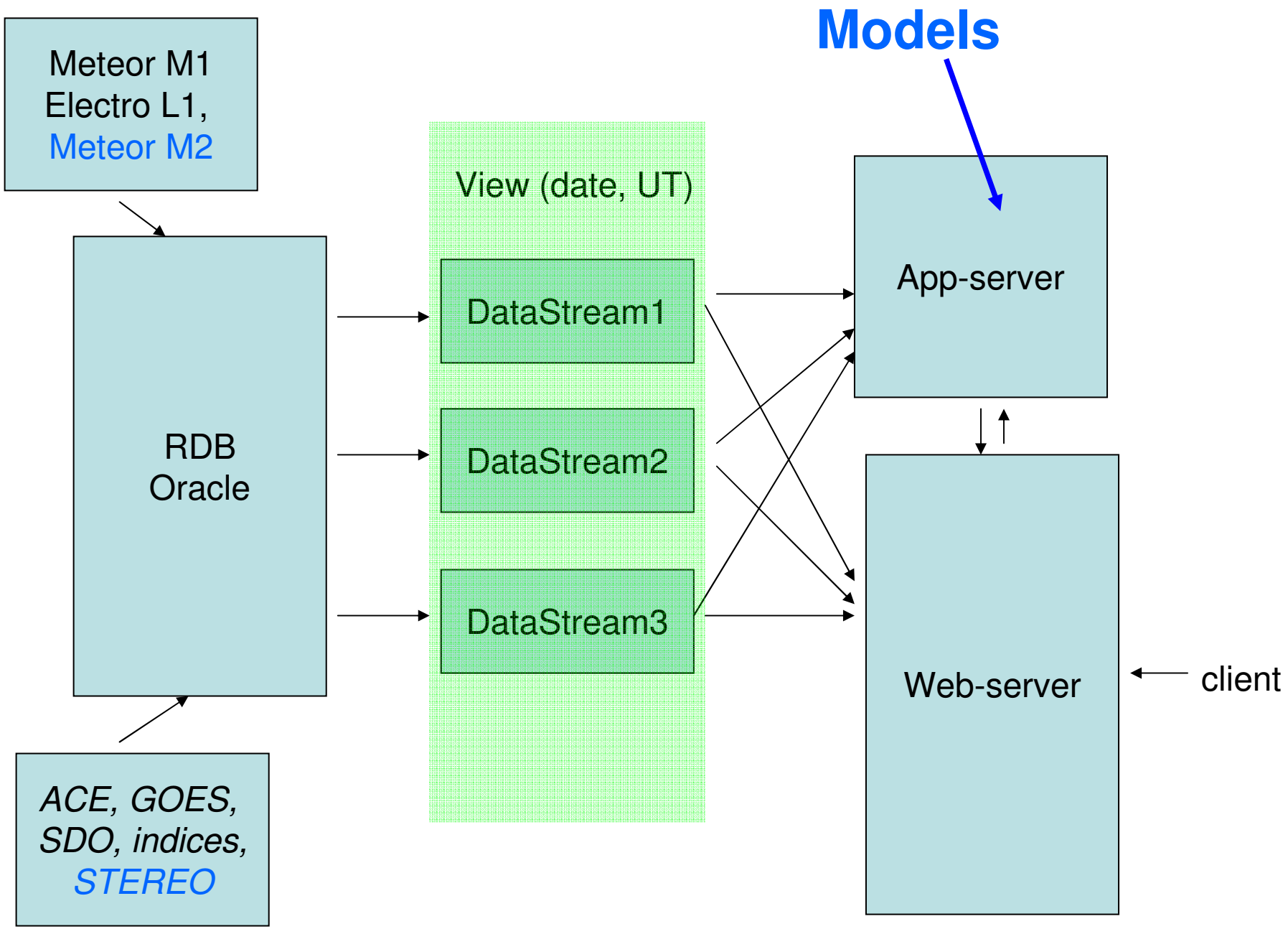
- Solar wind parameters

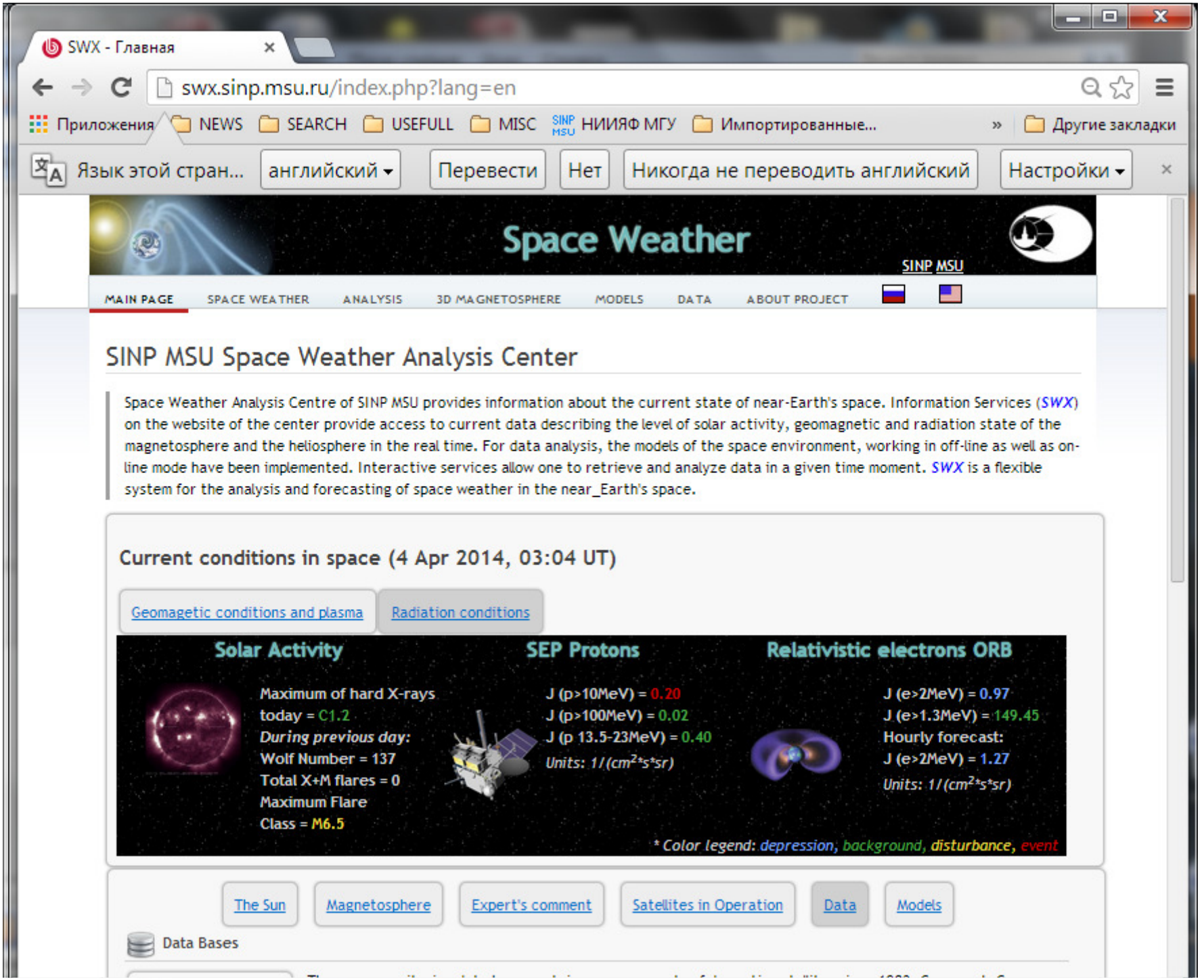


- Particle fluxes in the magnetosphere



Operational services: Data + Models

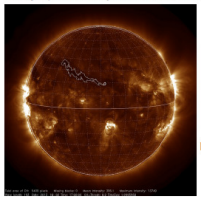

Models
Meteor M1
Electro L1,
Meteor M2
View (date, UT)
App-server
RDB
Oracle
DataStream1
DataStream2
DataStream3
Web-server
client
ACE, GOES,
SDO, indices,
STEREO


SWX - Главная
swx.sinp.msu.ru/index.php?lang=en
Приложения
NEWS
SEARCH
USEFULL
MISC
НИИЯФ МГУ
Импортированные...
Другие закладки
Язык этой стран...
английский
Перевести
Нет
Никогда не переводить английский
Настройки
Space Weather
SINP MSU
MAIN PAGE
SPACE WEATHER
ANALYSIS
3D MAGNETOSPHERE
MODELS
DATA
ABOUT PROJECT
SINP MSU Space Weather Analysis Center
Space Weather Analysis Centre of SINP MSU provides information about the current state of near-Earth's space. Information Services (SWX) on the website of the center provide access to current data describing the level of solar activity, geomagnetic and radiation state of the magnetosphere and the heliosphere in the real time. For data analysis, the models of the space environment, working in off-line as well as on-line mode have been implemented. Interactive services allow one to retrieve and analyze data in a given time moment. SWX is a flexible system for the analysis and forecasting of space weather in the near_Earth's space.
Current conditions in space (4 Apr 2014, 03:04 UT)
Geomagetic conditions and plasma
Radiation conditions
Solar Activity
Maximum of hard X-rays today = C1.2
During previous day:
Wolf Number = 137
Total X+M flares = 0
Maximum Flare Class = M6.5
SEP Protons
J (p>10MeV) = 0.20
J (p>100MeV) = 0.02
J (p 13.5-23MeV) = 0.40
Units: 1/(cm²*s*sr)
Relativistic electrons ORB
J (e>2MeV) = 0.97
J (e>1.3MeV) = 149.45
Hourly forecast:
J (e>2MeV) = 1.27
Units: 1/(cm²*s*sr)
* Color legend: depression, background, disturbance, event
The Sun
Magnetosphere
Expert's comment
Satellites in Operation
Data
Models
Data Bases

Состояние околоземного космического пространства
02 October 2013, 12:00 UT

1 Солнечная активность

Текущее изображение Солнца (УФ, λ = 193 Å)



	01 October, 12h	Максимум за 24 часа	Текущее
Относительная геоэффективная площадь корональных дыр	**0.5**%	**1.2**%	**0.5**%
Максимальный класс рентгеновского излучения	**B3.3**	**B6.1**	**B3.4**
Число Вольфа	**59**	**59**	**59**

Источники данных: SDO (NASA), GOES (NOAA), ЦОКМ (НИИЯФ МГУ)

2 Геомагнитная обстановка на орбите Земли

Dst-индекс за неделю, нТл

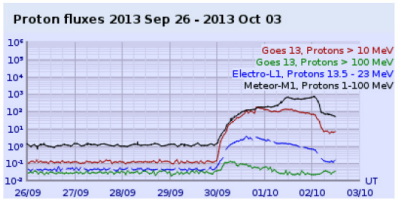
	01 October, 12h	Экстремум за 24 часа	Текущее
Давление солнеч-ного ветра:	**1.0** нПа	**41.6** нПа	**6.1** нПа
KP-индекс	**2+**	**7+**	**3-**
Dst-индекс	**11.0** нТл	**-75.0** нТл	**-63.0** нТл

Источники данных: ACE (NASA), GFZ (Potsdam), WDC-2 (Kyoto), ЦОКМ (НИИЯФ МГУ)

3 Радиационная обстановка

3.1 Солнечные космические лучи

Потоки за неделю, $(см^2*с*ср)^{-1}$

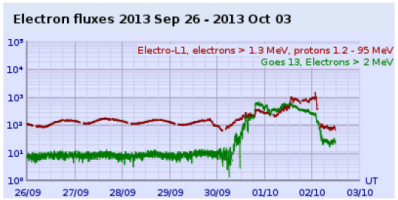


Потоки протонов	01 October, 12h	Среднее за 24 часа	Текущее
E 1-100МэВ	**643.55**	**273.10**	**50.08**
E>10МэВ	**127.86**	**37.82**	**6.99**
E 13.5-23МэВ	**1.31**	**0.39**	**0.15**
E>100МэВ	**0.02**	**0.02**	**0.03**

Источники данных: GOES (NOAA), ЦОКМ (НИИЯФ МГУ)

3.2 Релятивистские электроны внешнего радиационного пояса

Потоки за неделю, $(см^2*с*ср)^{-1}$



Потоки электронов	01 October, 12h	Среднее за 24 часа	Текущее
E>1.3МэВ	**455.6**	**387.3**	**68.0**
E>2МэВ	**475.0**	**140.4**	**26.2**

Источники данных: GOES (NOAA), ЦОКМ (НИИЯФ МГУ)

Обозначения: — понижение (только для электронов); — норма; — повышение; — событие.

Центр Оперативного Космического Мониторинга
НИИ Ядерной Физики МГУ

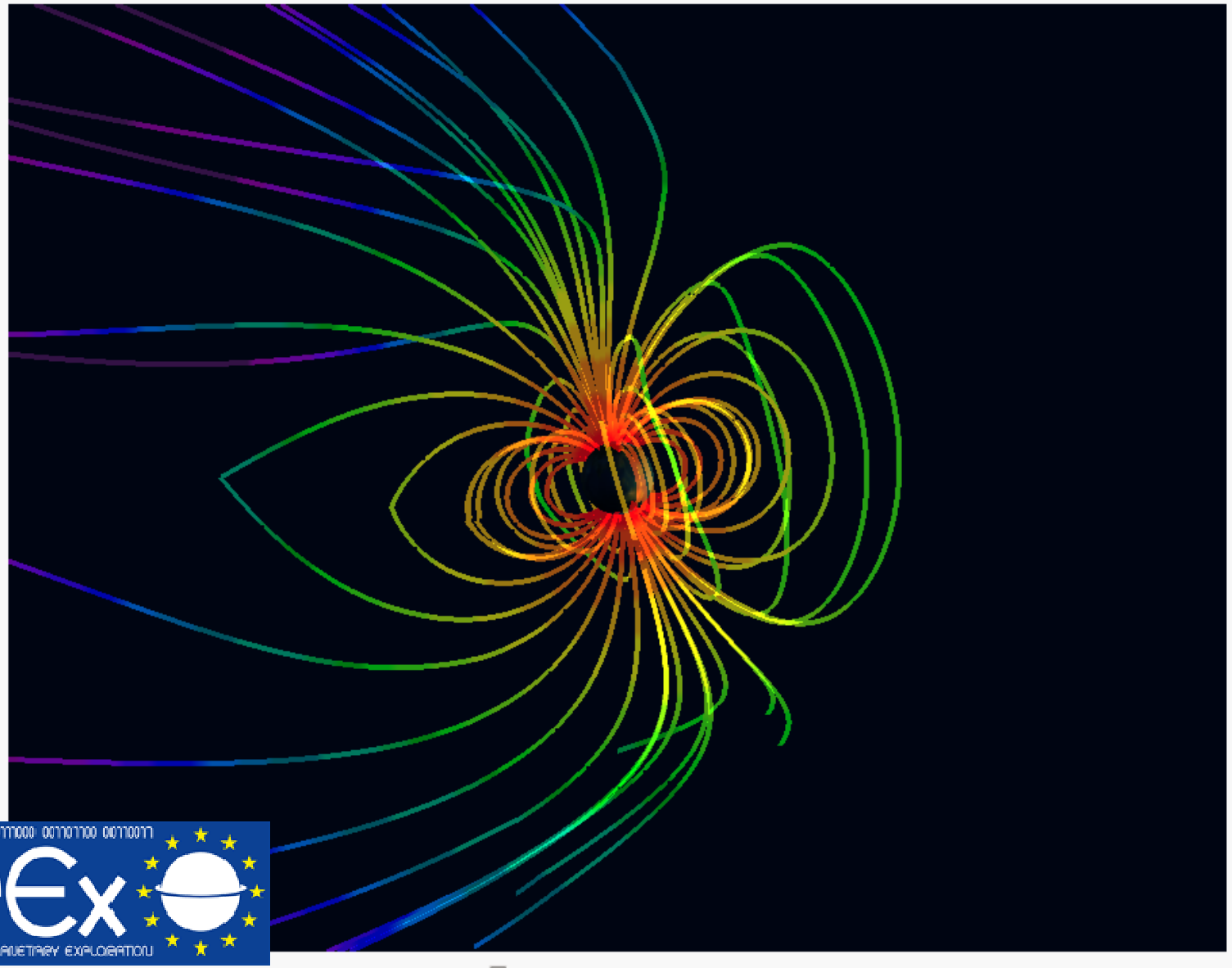
http://smdc.sinp.msu.ru
smdc@sinp.msu.ru

Operational models

- ACE data propagation and stand-off distance
- Particle spectra at LEO
- Coronal Holes total area RT estimation and SW velocity forecasting at L1
- Dst forecasting
- Magnetospheric magnetic field
- Relativistic electron fluxes at GEO
- High-latitude boundary of the outer radiation belt
- …

3D-magnetosphere

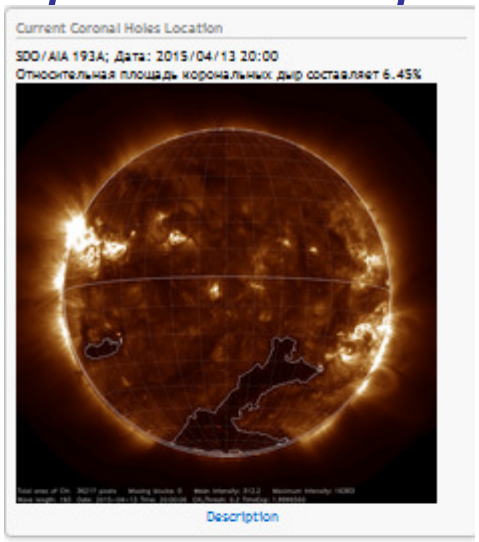
http://swx.sinp.msu.ru/3d.php?lang=en

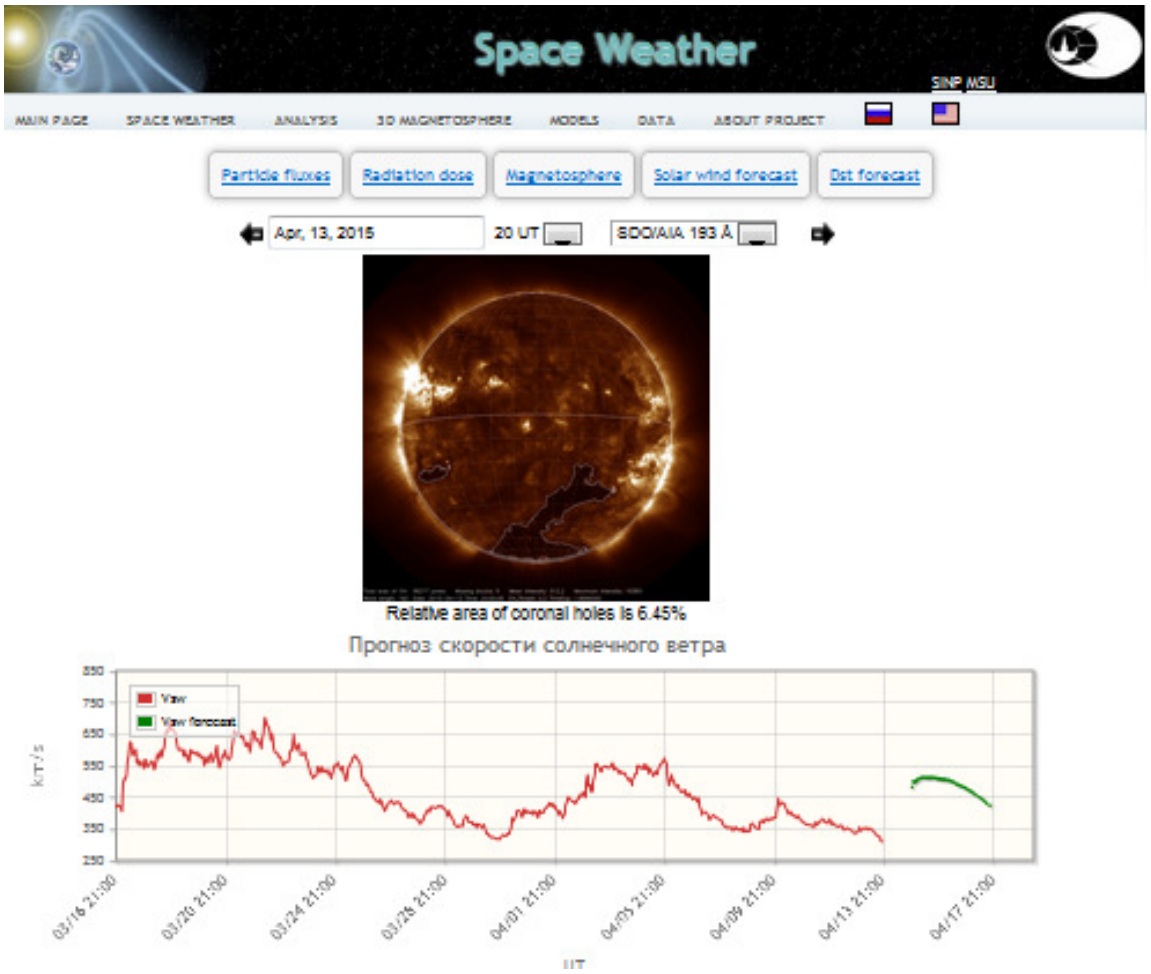


Enable Earth Rotation Mode

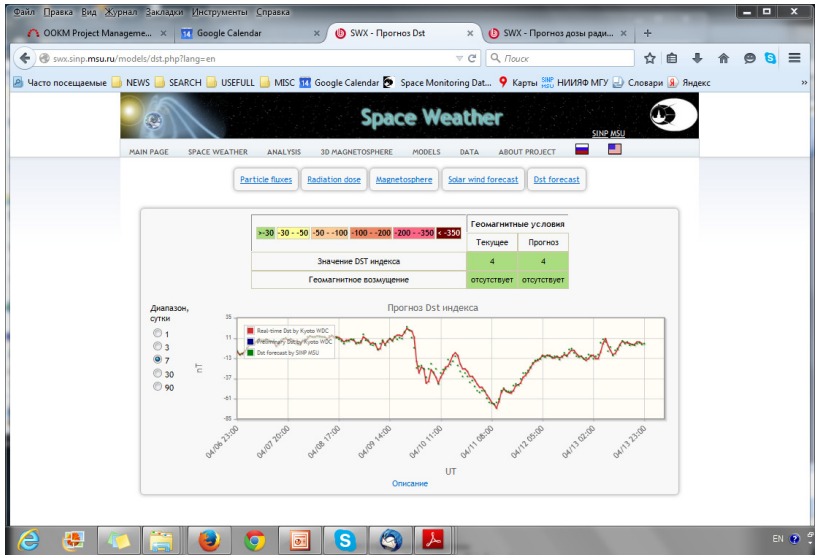
Solar Wind Velocity Forecast

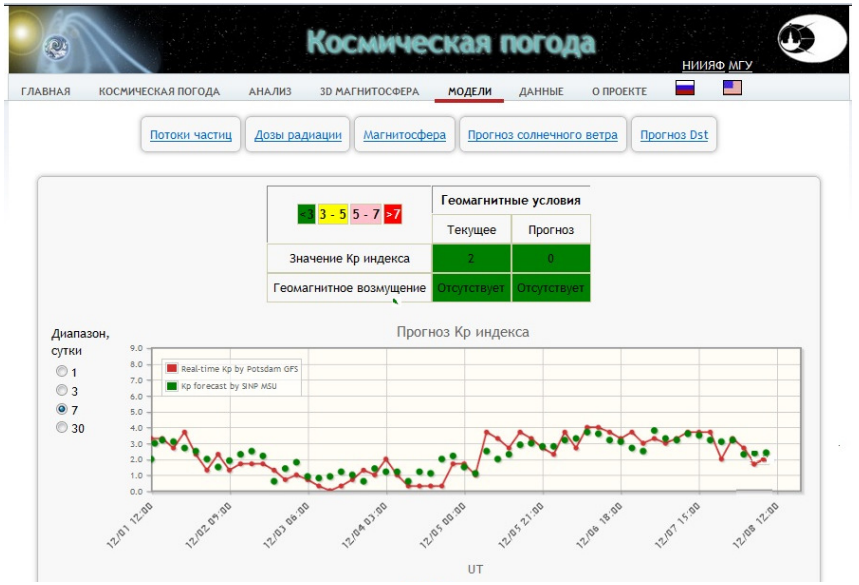
http://swx.sinp.msu.ru/models/solar_wind.php?lang=en

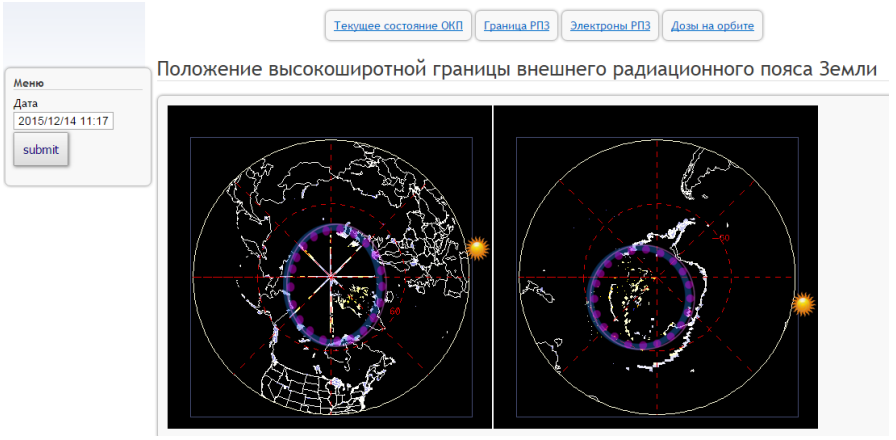




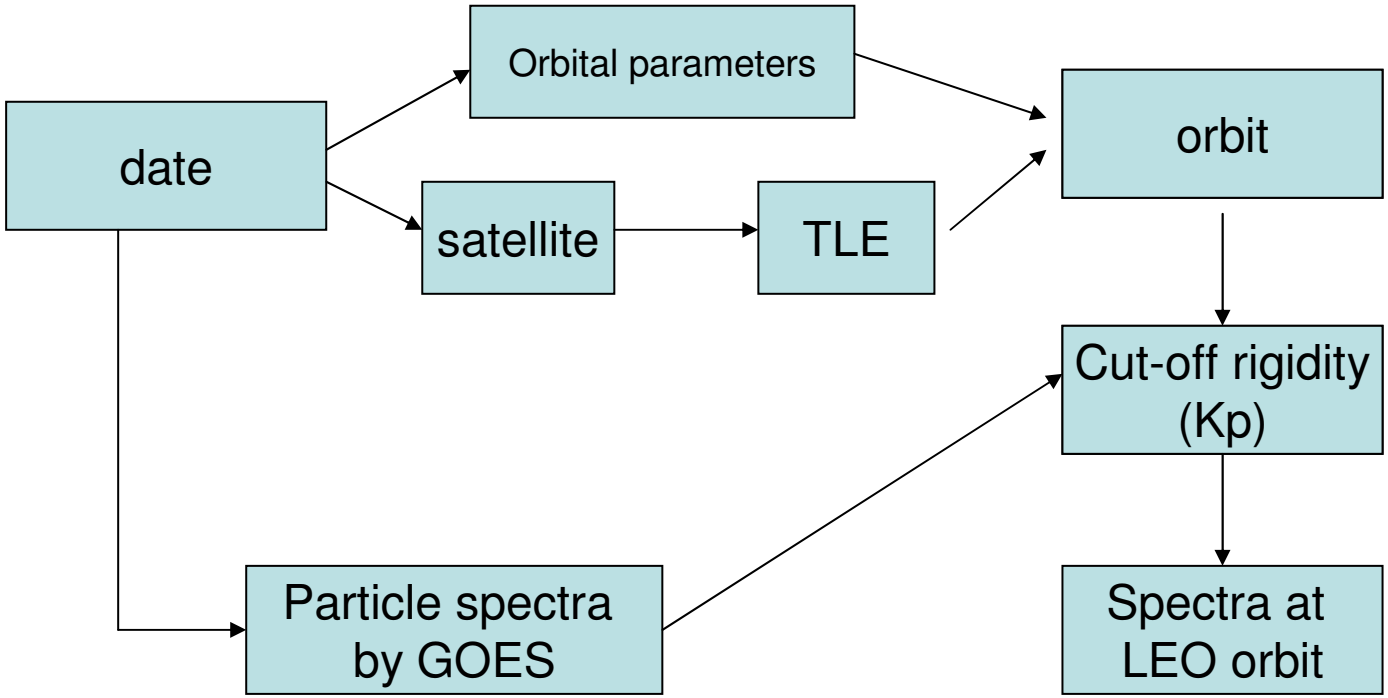
Forecasting applications





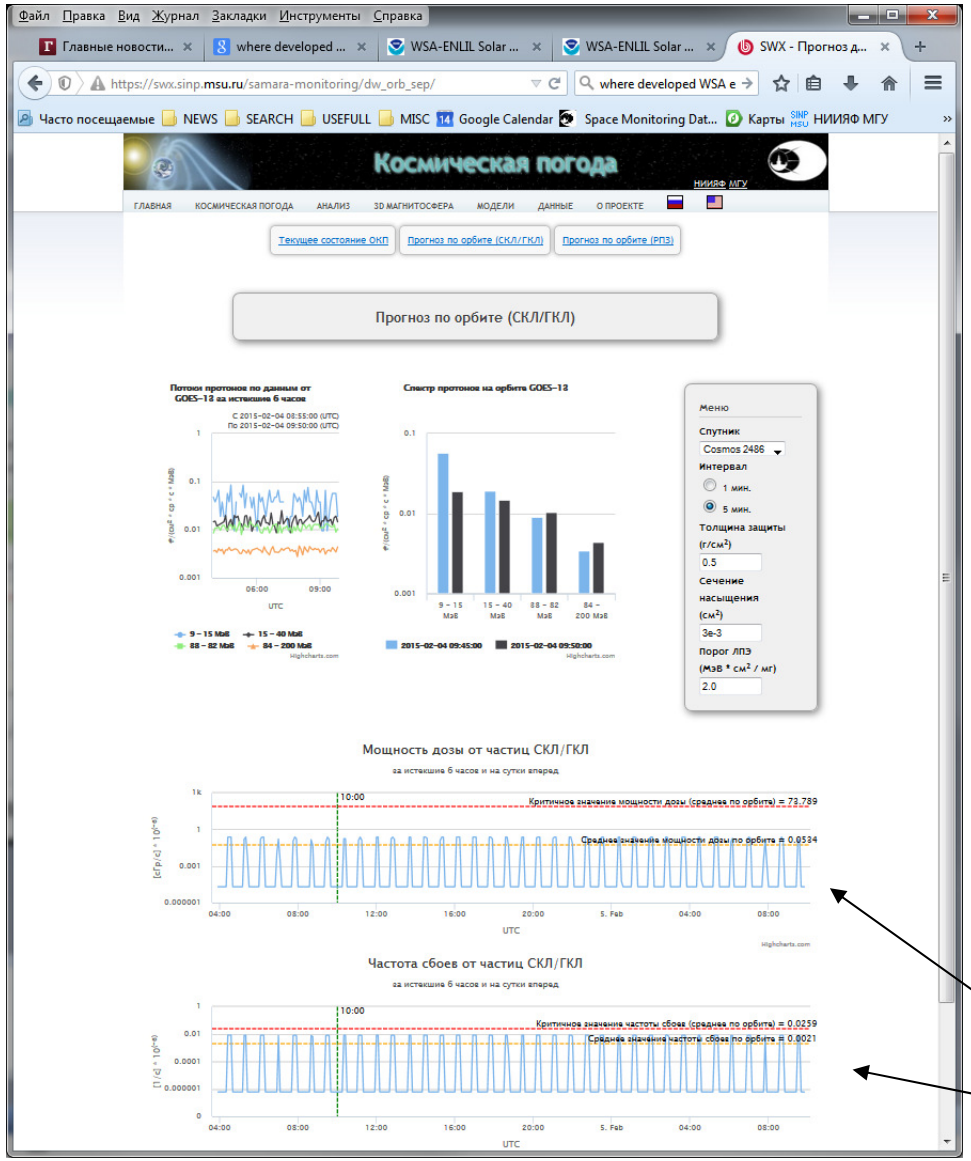


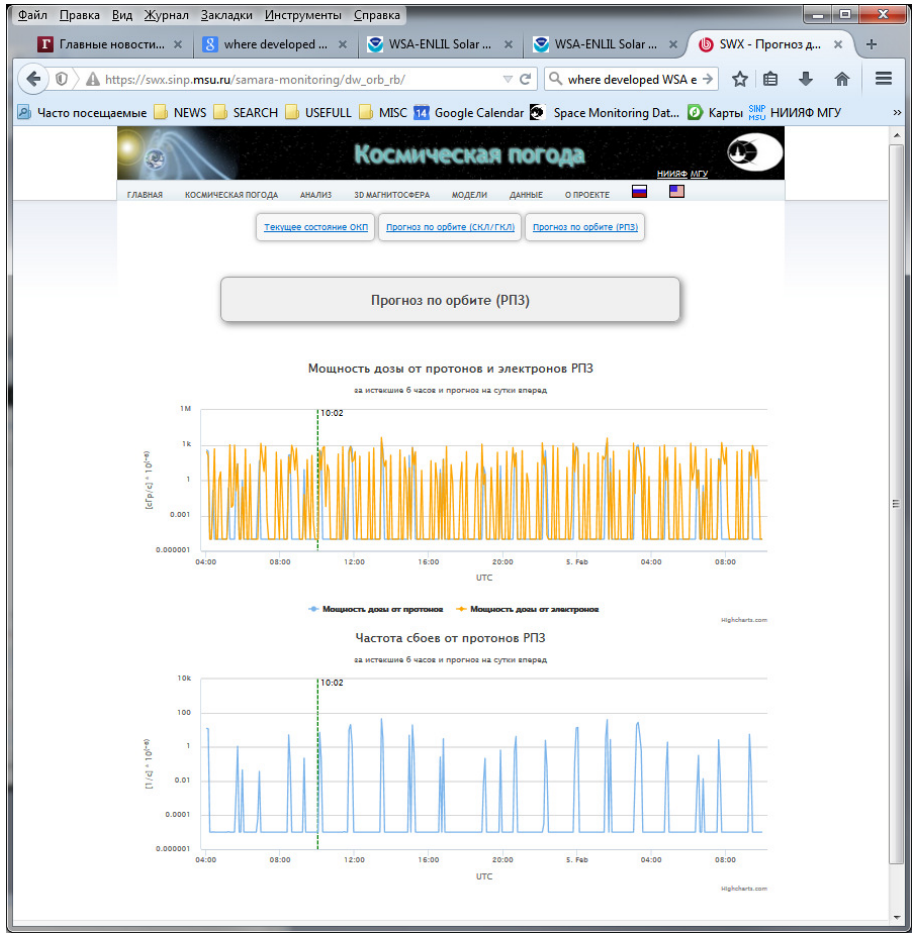
Particle spectra at LEO orbits



Input from NORAD, NOAA/GOES, Potsdam (Kp)

Dose Rate onboard LEO SC





Dose Rate

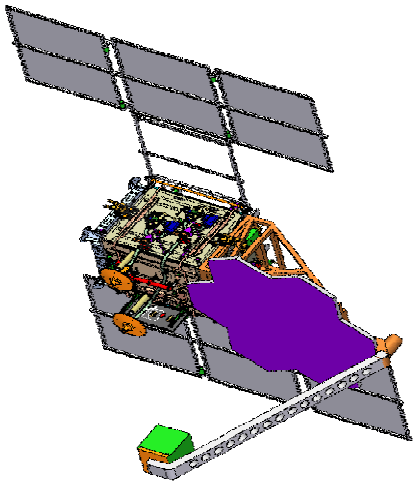
SEE Rate

New Data Source: “Lomonosov” Mission

LEO, scientific (MSU)

- Study of ultra-high energy cosmic rays
- Phenomena in hard x-rays and soft gamma-rays (0.05-1.0 MeV)
- Search and detection of optical transients accompanying gamma-ray bursts
- study of transient luminosity events in the Earth atmosphere
- Magnetosphere physics research, monitoring of radiation conditions in the near-Earth’s space

Launch: 2016
LEO orbit – 550 km
Mass — 250 kg



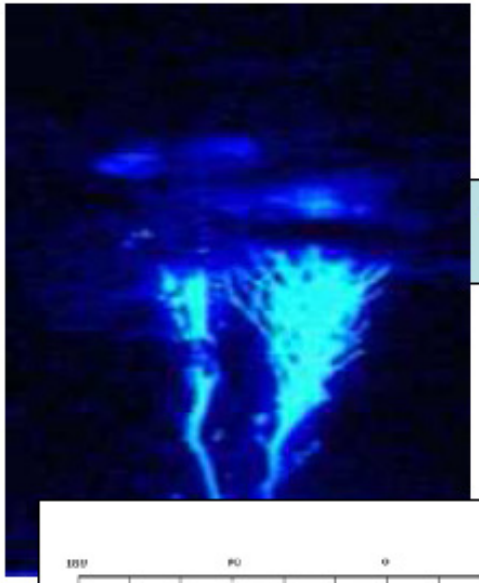
PL – M.Panasyuk

Equipment

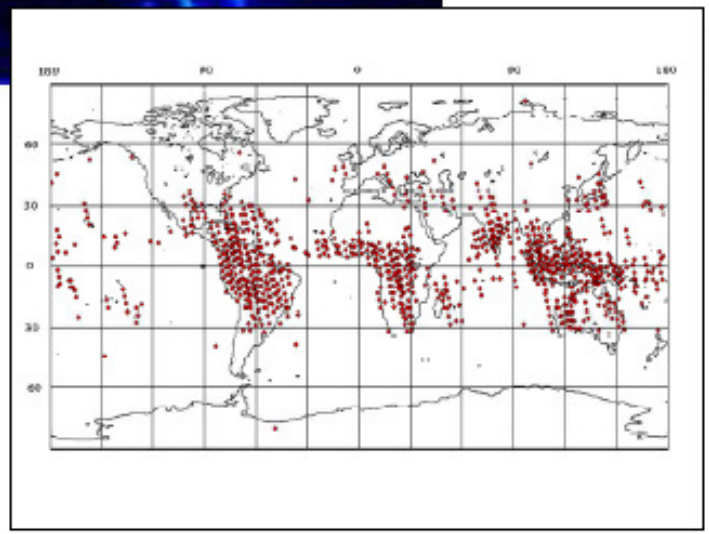
1. TUS - for UHCR cascade detection and TLE study;
2. BDRG - for gamma-ray burst monitoring;
3. SHOK - wide-field camera for study GRBs optical counterparts;
4. MTEL or UFFO - for astrophysical observations in UV
5. DEPRON - dosimeter for radiation background study.
6. ELFIN – magnetic field, energetic particles

Instruments onboard: TUS

Goal: Transient Luminous Events measurements



TUS- UV telescope



nadir

Instruments onboard: ELFIN-L

- Magnetometer and charged particle detector (Joint UCLA and SINP MSU project)
- **Energy range**: 30 keV – 4,1 MeV in 16 chanels.
- **Dimensions:**200x100x720 mm.
- **Mass:** 3±1 kg;
- **Telemetry:** 10 Mb/day;
- **Power cons:** 5 W

Conclusions

- **Space monitoring data center of MSU gives access to satellite data via Web-site *http://smdc.sinp.msu.ru***
- **SMDC provides real-time analysis of physical conditions in the near-Earth space based on data and models via Web-site *http://swx.sinp.msu.ru***
- **SMDC provides operational services for space operators**