Archiving, Processing and Analysis of Satellite Data

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In recent years, there are the virtual explosive growth in the number of remote sensing satellites and the amount of receiving data.

Archive volumes of ESA mission of Earth remote sensing 1986-2020
(Mirko Albani, 2012)

Volumes of online data archives in IKI 2000-2017

Number of remote sensing satellites 1993—2017
(Union for Concerned Scientists database, 2018)
Explosive growth of possibilities of Earth’s remote sensing systems and volumes of received data requires fundamentally changes in the working schemes in scientific projects.
“Traditional” scheme of remote sensing system data analyses

Ordering and downloading remote sensing data from various sources

Maintaining a local archive of data on user computers

Disadvantages:

- Necessity of deploying costly data storage and processing infrastructure
- Costs of special software development
- Necessity of complex GIS software packages

Work in desktop GIS:
QGIS, ArcGIS, ENVI, ERDAS ...
“Contemporary” scheme of remote sensing system data analyses

Distributed archives and computing resources of different centers

Data and resource services for processing and analysis

Advantages:

- Collective use of centralized resources for data storage and processing
- Using ready-made tools for data processing and analysis
Main Tasks of IKI Earth’s monitoring system

• Automated maintenance of ultra-large distributed archives of satellite data and results of their processing

• Automated data streaming for various information products required for scientific research

• Provision of tools for satellite data processing and analysis using resources of IKI

• Provision of software interfaces to various remote monitoring information systems
Technical Characteristics

- Total volume of online data archives is over 3 Pb
- Enables acquisition and assimilation of about 3 Tb per day
- Total available capacity of online storage servers is about 4 Pb
- Servers that provide distributed access to data - about 20
- Stations and data processing servers - about 100

Information given on 10.12.2019
Mainly focused on using **Russian** and publicly available foreign data

**The system receives information from Russian and foreign satellite data centers for collection, processing and archiving centers.**

**Supports data from more than 40 satellite systems**

**Enables operation with data of more than 30 types of observation devices**

**The depth of archives reaches 35 years**

Information given on 10.12.2019
The Main Data Sources

**Foreign**

- **USGS (USA)**  
  LANDSAT 4,5,7,8  
  EO-1  
  ORBVIEW-3  
  AQUA  
  TERRA  
  Suomi NPP  
  JPSS1 (NOAA20)

- **LANCE (USA)**  
  AQUA  
  TERRA

- **ESA (Europe)**  
  LANDSAT 8, EO-1  
  SENTINEL-1A,1B  
  SENTINEL-2A,2B  
  SENTINEL-3A  
  SENTINEL-5

- **VITO (Belgium)**  
  PROBA_V

- **NCAR (USA)**  
  Meteodata NCEP

**Rosgidromet (SRC "Planeta")**

- ЕЦ НИЦ «Планета» (Moscow)
- СЦ НИЦ «Планета» (Novosibirsk)
- ДЦ НИЦ «Планета» (Khabarovsk)

**Russian satellites:**

- Ресурс-П №1
- Ресурс-П №2
- Ресурс-П №3
- Метеор-М №1
- Метеор-М №2
- Канопус-В
- Канопус-В-ИК
- Канопус-В №3
- Канопус-В №4
- Канопус-В №5
- Канопус-В №6
- Электро-Л №1
- Электро-Л №2

**Foreign satellites:**

- HIMAWARI-8  
  AQUA  
  TERRA  
  NOAA 15,16,18,19  
  Suomi NPP  
  JPSS1 (NOAA 20)  
  METOP-B  
  GOES-E  
  GOES-W  
  MTSAT 2  
  METEOSAT 7  
  METEOSAT 8  
  METEOSAT 10  
  METEOSAT 11

**Research Center for Earth Operative Monitoring (Roscosmos)**  

- Ресурс-П №1  
- Ресурс-П №2  
- Ресурс-П №3  
- Метеор-М №1  
- Метеор-М №2  
- Канопус-В  
- Канопус-В-ИК  
- Канопус-В №3  
- Канопус-В №4  
- Канопус-В №5  
- Канопус-В №6

**IKI (Moscow)**  

- NOAA 18  
- NOAA 19

**Users data**
Examples of current data coverage for level L1B

Modis, coverage on 26.08.2019

KMCC, coverage on 24-26.08.2019

Landsat, coverage on 21-26.08.2019

Sentinel-2, coverage on 21-26.08.2019
Examples of Level 2 products
(session fields of different physical characteristics and indices)

**Temperature of sea surface**

**Index FAI**

**Vegetation index NDVI**

**Radar vegetation index NRVI**

The overwhelming number of Level 2 products is generated dynamically, online.
Level 3 products - cloud-free time composites
Cloud-free composite images at a resolution of 250-500 m are created for different observation periods: season, month, week, day.
Example of cloud-free composite image with Proba V (100 m)

Winter season composite (data via Proba V)

Cloud-free composite images at a resolution of 50-100 m are created for different observation periods: season, month, week, day.
Example of cloud-free composite image with Landsat (30 m)

Summer season composite (data by Landsat 7 and 8)

Cloud-free composite images at a resolution of 10-30 m are created for different observation periods: season, month, week, day (in construction).
Level 4 products
(different thematical products)

Maps of the vegetation cover in Russia.
Updated annually.

Maps of the dominant tree species.
Updated annually.

Information on forest natural fires and their consequences.
Updated daily.

Trunk wood stocks.
Updated annually.
How can data be provided

• Via “Vega-Science” system, together with satellite data processing and analysis tools

• Via software interfaces (APIs) that allow online access to the information from various scientific projects

• Automatically transferred for the various scientific projects
VEGA-Science - service for information support of scientific studies on biosphere dynamics and its interaction with other components of geosystem based on EO data.
The VEGA-Science system is a tool for distributed work with satellite data (search, selection, processing and analysis) for a variety of scientific projects.

The service is based on archives of satellite data and results of their processing by IKI zone of interest.

The system allows to work with both archive and operational data.
Possibility to conveniently obtain and analyze both historical and current data

Change of land use structure in Usvyatsky district, Pskov region

May 16, 1984. Landsat 5

May 17, 2019. Landsat 8
Examples of instruments

- Analysis of multitemporal data
- Joint analysis of different information
- Data classification
- Temporal data analysis
### Examples of systems

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<tr>
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<th>Image</th>
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<td>System of work with remote hydrometeorological monitoring data</td>
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<td>Monitoring system for aquatic biological resources</td>
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<td>Agricultural Census Remote Control System</td>
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VEGA-GEOGLAM is global agricultural monitoring service aimed to perform EO and in-situ data analysis over JECAM test-sites.
Vega-Science today

By the amount of data available for operation

One of the ten in the world
(after USGS, NOAA, GOOGLE, ESA, CNSA)

According to online data (over 3 Pb)

Close to the world’s top five
(after USGS, NOAA, GOOGLE)

In terms of the capabilities of online data analysis tools - one of the three in the world
(comparable to GOOGLE EARTH ENGINE)
- Development of new tools, services and systems for solving various scientific tasks and providing scientific projects
- Development of technologies for distributed work with Earth remote sensing data from Space
- New thematic information products formed on the basis of remote sensing data (first of all "automatic")
- Development of specialized distributed information nodes
Welcome to VEGA-Science!

VEGA-Science - satellite service for collective use, oriented on information support of scientific studies on status and dynamics of biosphere and its interaction with other components of ecosystem.

Development and support of service VEGA-SCIENCE is provided by the Russian Academy of Sciences' Space Research Institute - IKI (Department of Satellite Monitoring Technologies).

The service is based on long-term archives of satellite data and information products received on their basis, that characterizing vegetation cover conditions in the Northern Eurasia, including Russia and neighboring countries. There are data in the archives on any area of this territory since the beginning of the twenty-first century.

Service VEGA-SCIENCE, in particular, allows to analyze condition of vegetation cover using the time series of vegetation indices, its seasonal and long-term dynamics for any individual site or polygon specified by the user.

The main requirement for access to VEGA-SCIENCE is the agreement of its potential users on free disclosure of provided to the system information to all users of the service for scientific objectives. To realize applied commercial projects, create specialized monitoring systems of renewable biological resources and environment you can use options of satellite service VEGA-PRO.

VEGA-SCIENCE today is a unique scientific installation (UNU "BS IKI-Monitoring"), which is part of the Center for collective use of scientific equipment (CCU). "IKI-Monitoring"

How to use the demo version of the service

To work with the demo version of VEGA-SCIENCE service log in with the username demo and password demo. The demo version allows you to...

VEGA-SCIENCE is one of the core services of VEGA-CONSTELLATION - a VEGA information systems family for vegetation monitoring using satellite remote sensing data.