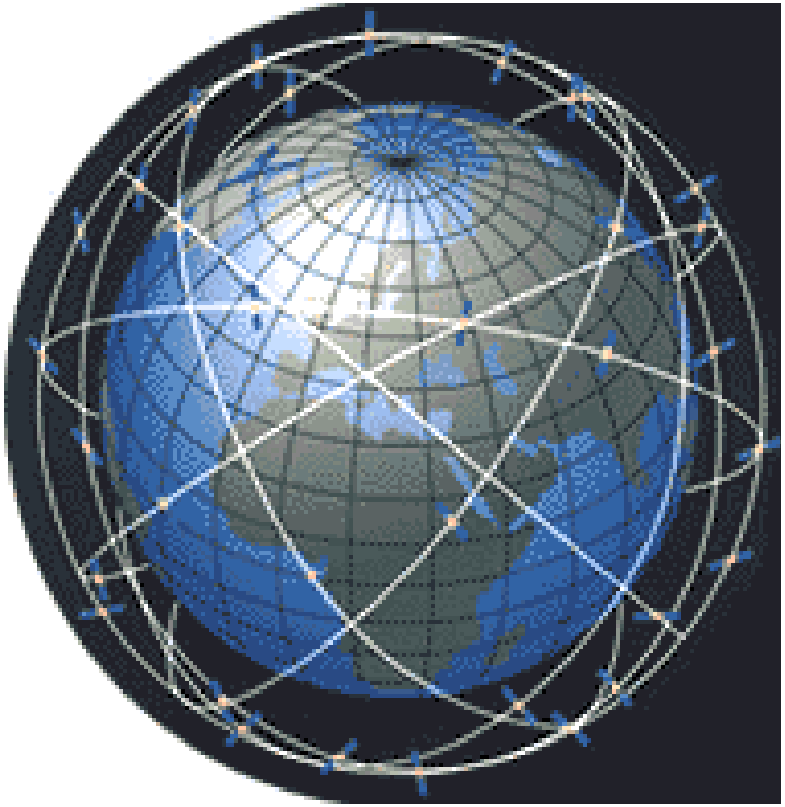

Space-born system
for on-line precursors
monitoring of
eathquakes, natural
and man-made catastrophes



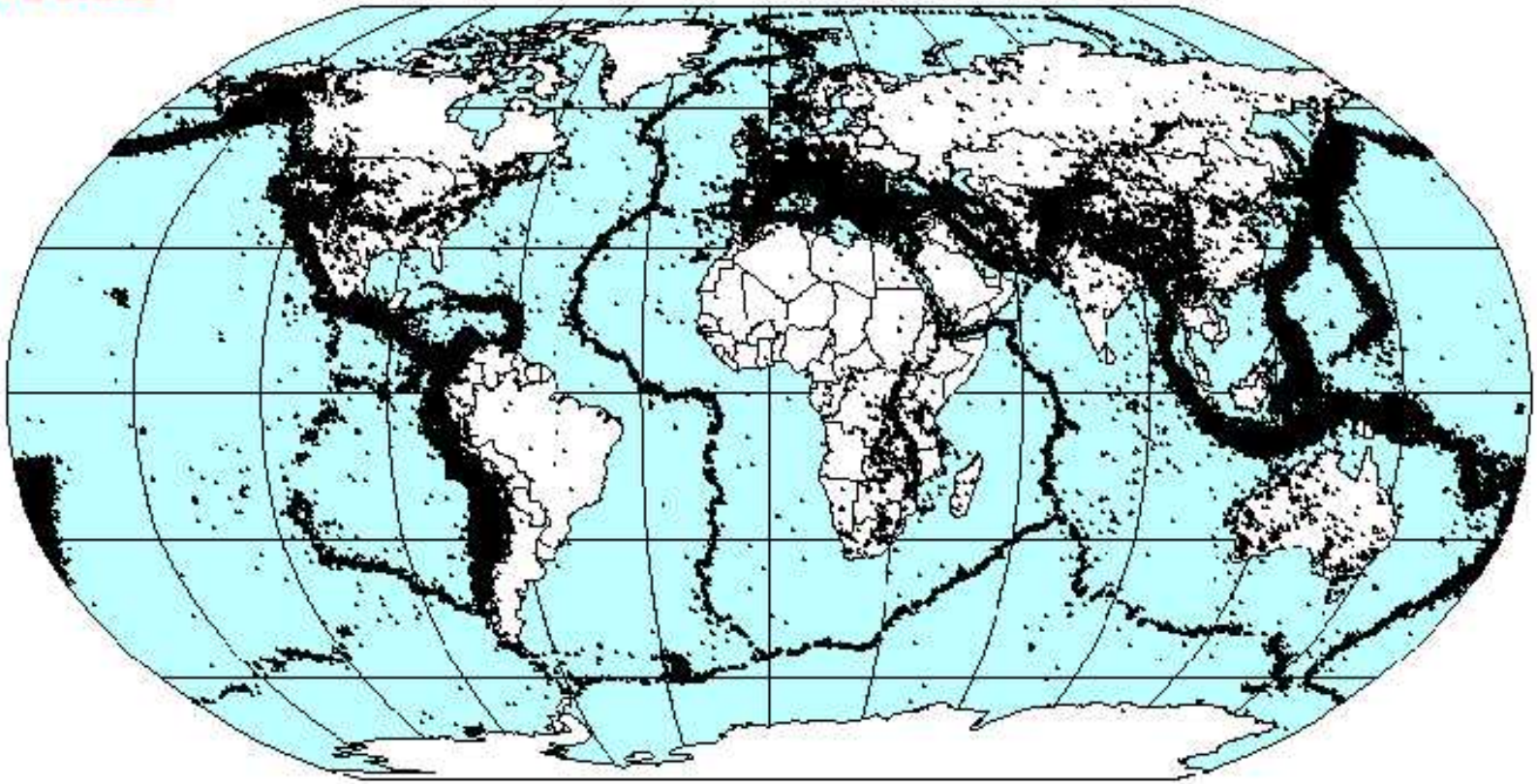
The main goal of the Project

In my brief report, I would like to inform about the work on developing a space-borne system for on-line monitoring of earthquakes, human-associated and natural emergencies that is under the way in Russia.
The Project is based on a set of satellites and is carried out within the frames of the Russian Federal Space Program.

An important element of the Project is the monitoring of earthquake precursors in the ionosphere. The data obtained will be used to forecast major earthquakes and issue the corresponding alerts.

Preliminary Determination of Epicenters
358,214 Events, 1963 - 1998

All events



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2) USUHS, NASA GSFC, Greenbelt, MD 20771 USA

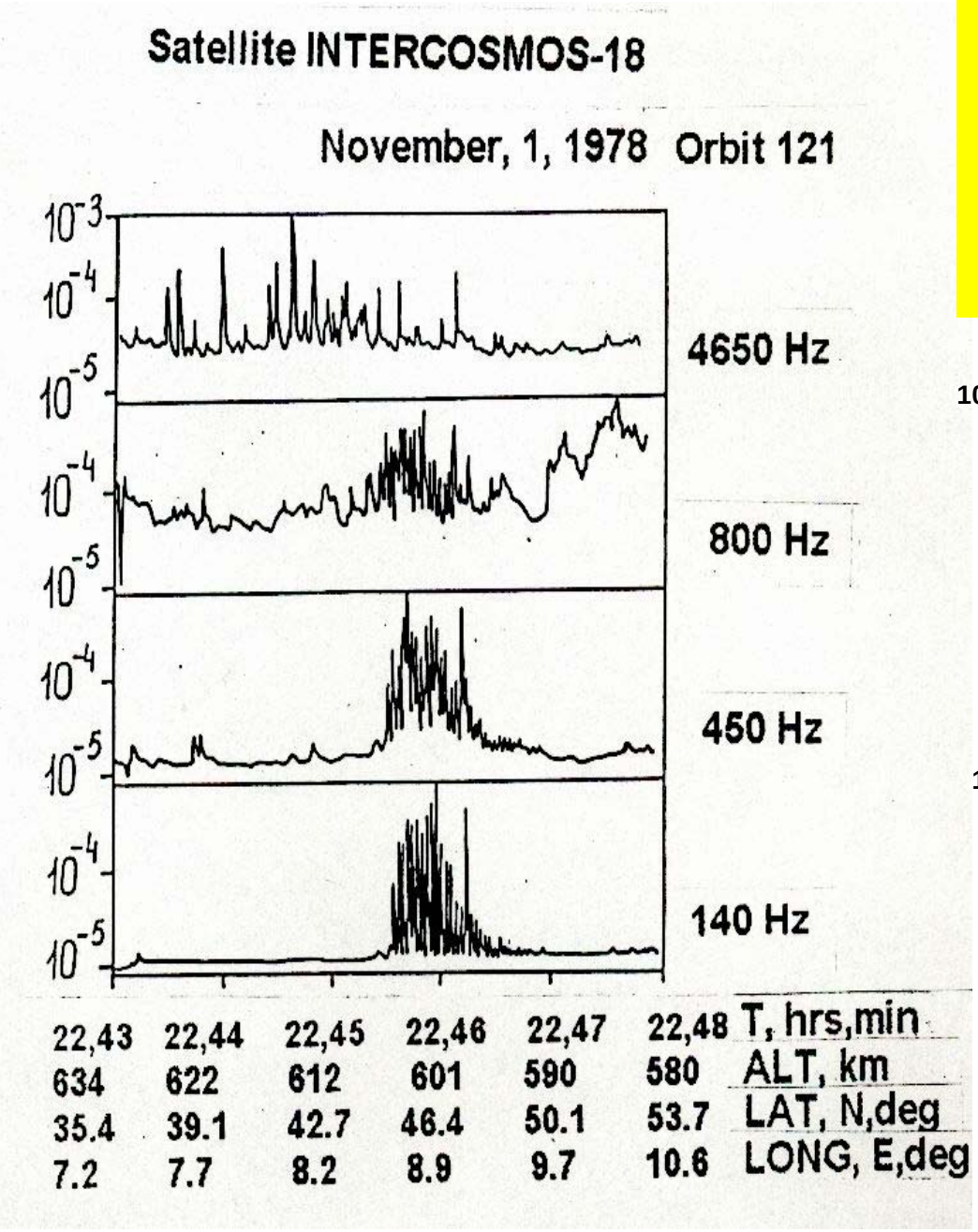
Data Source:
Seismicity Catalogs
Volume 2 Global and Regional, 2150 B. C. - 1996 A. D.
The National Geophysical Data Center and
The National Earthquake Information Center

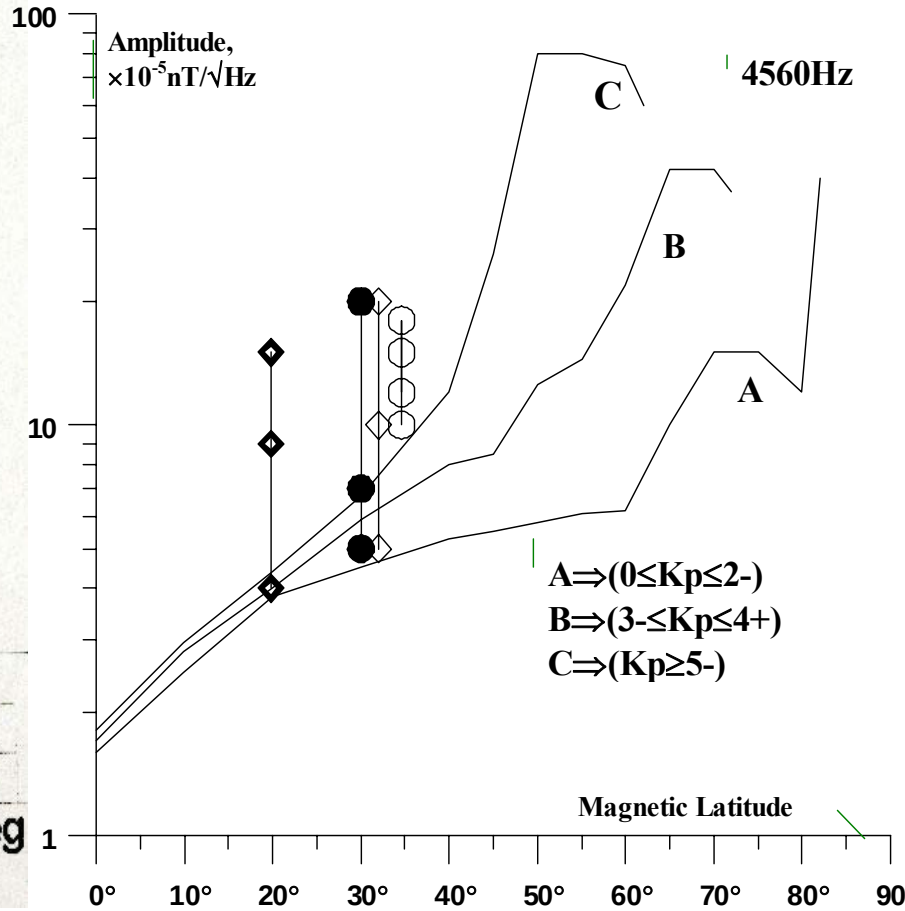
Map prepared in Robinson Projection
with all magnitudes.
August 12, 1998

The satellite constellation can provide:

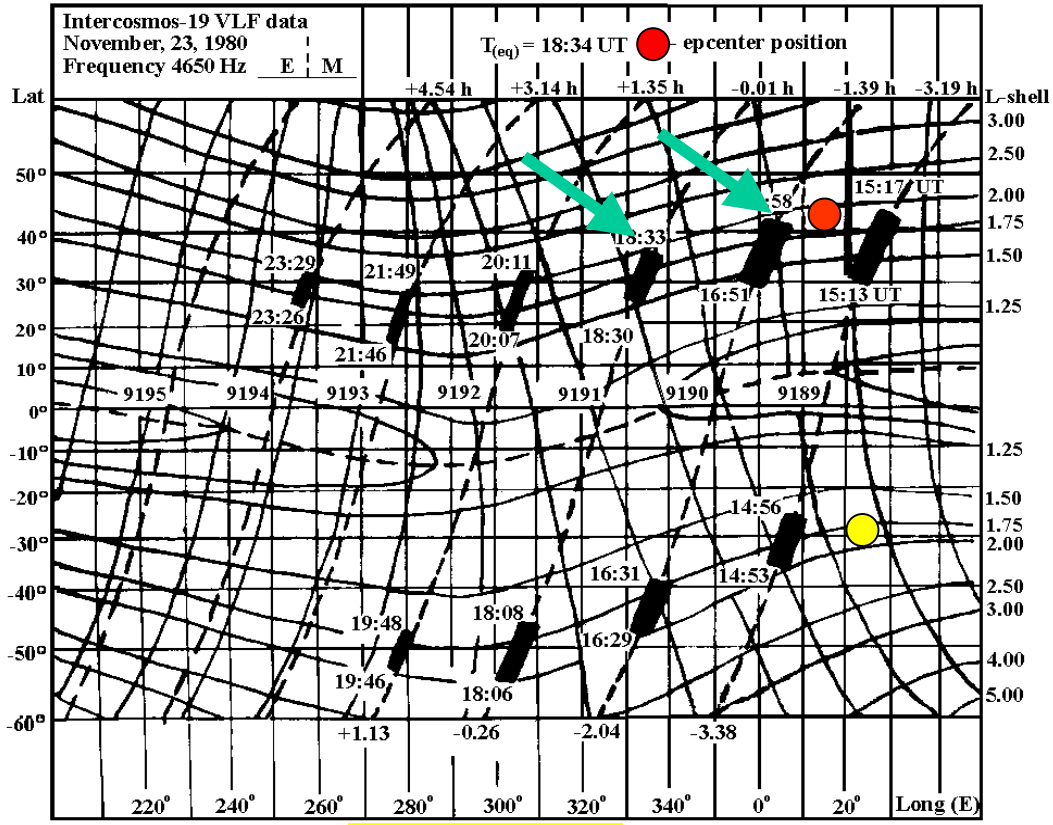
- **Short-term, intermediate term and long-term prognosis of earthquakes, typhoons, hurricanes, tsunami;**
- **Monitoring of radioactive and other contaminations**
- **Evaluation of extreme situations and consequences of catastrophes in regions;**
- **Analysis of influence of solar activity on biological and technogenic system, and also trigger start-up of crisis processes in atmosphere.**

VLF EM precursor at onboard satellite IK-18

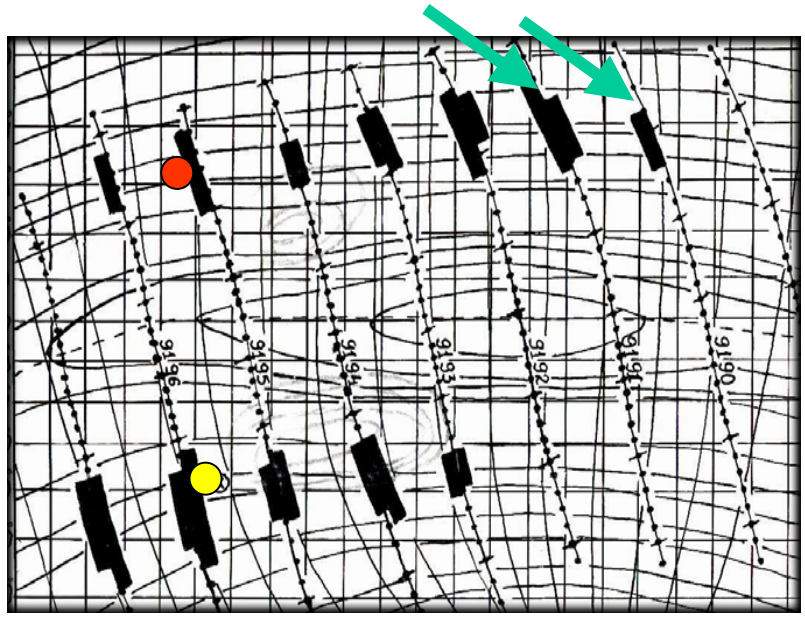




Magnetic conjuction of EM noise belts before and after Earthquake 23.11.80

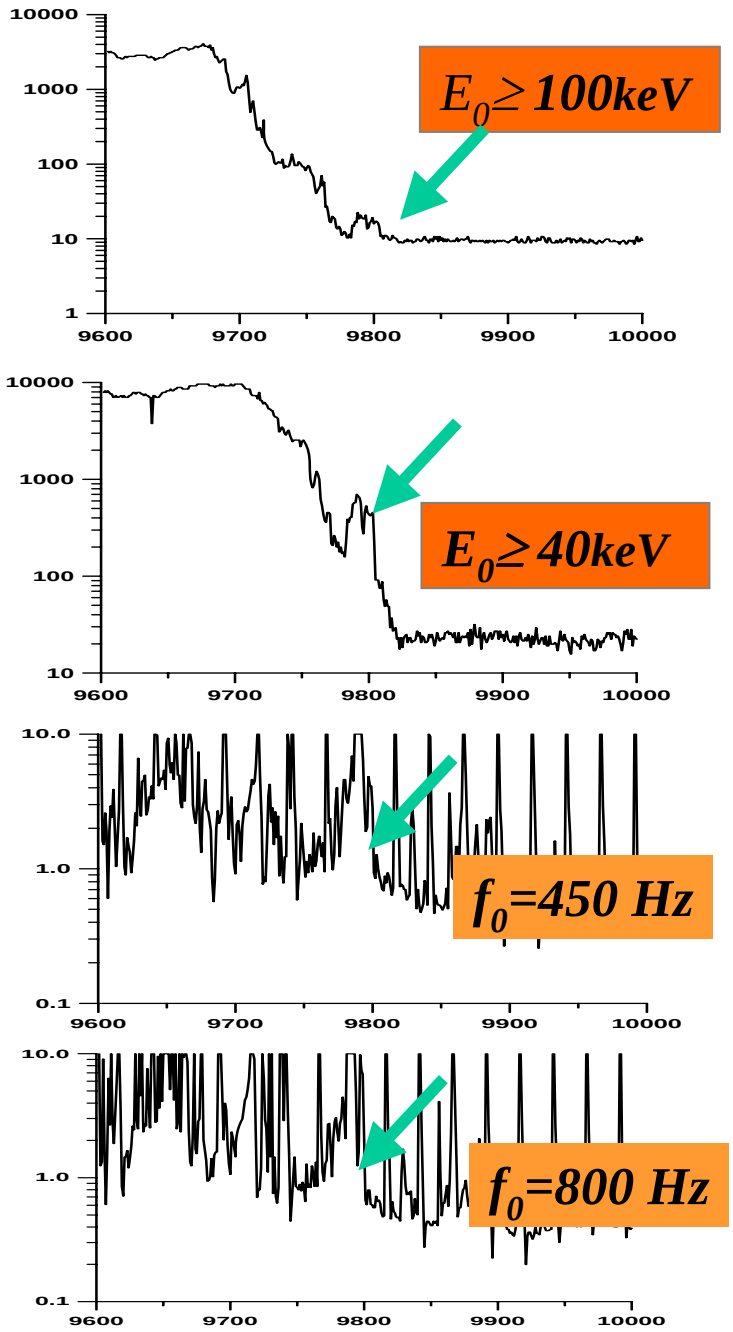


Night, 04 LT



Sunlight, 16 LT

Ruzhin Yu.Ya., and V.I. Larkina, Magnetic Conjunction and Time Coherency of Seismoionosphere VLF Bursts and Energetic Particles. Proceed.13th Wroclaw EMC Symposium (URSI) , PP.645-648, (1996)



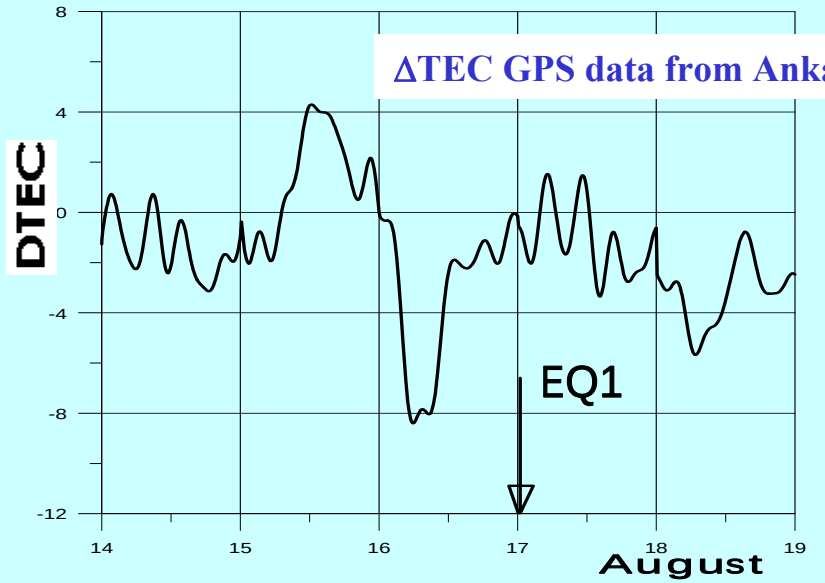
EQ precursors as VLF and energetic particles space anomalies

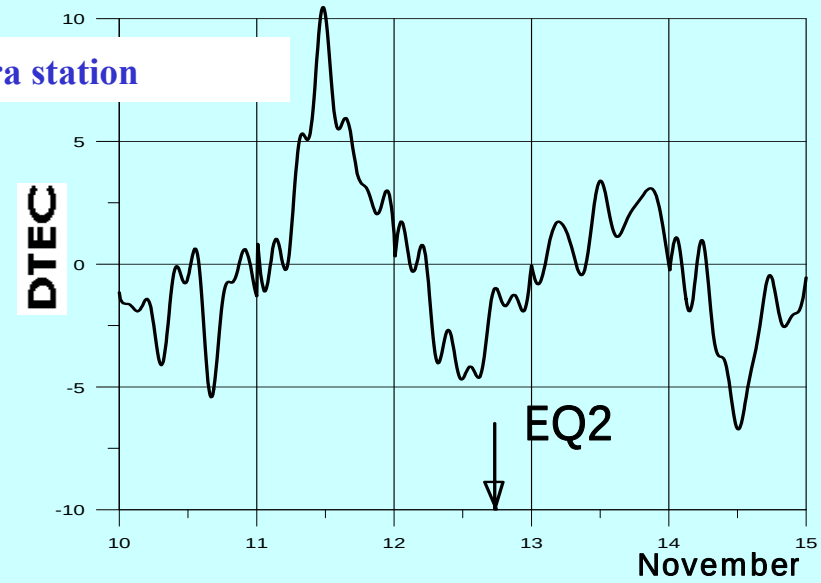
Particle flux of energy E_0 (in counts per second) and VLF emission (f_0) of 'Intercosmos-19' onboard registration are shown. The precursor particles pulse is marked by arrow. Pulse duration is about one minute (or 400 km along the satellite orbit).

Ruzhin Yu.Ya., and V.I. Larkina, Magnetic Conjunction and Time Coherency of Seismoionosphere VLF Bursts and Energetic Particles. Proceed.13th Wroclaw EMC Symposium (URSI) , PP.645-648, (1996)

TEC earthquakes precursors registration

The sequence of the two Turkish earthquake of 1999 (August 17 and November 12) with magnitude more than 7.0 which occur practically at the same localisation (only 100km difference) could be as rare object of intensive investigation by involving all possible experimental data of classic seismomonitoring as well as some kind of atmosphere and ionosphere available data.





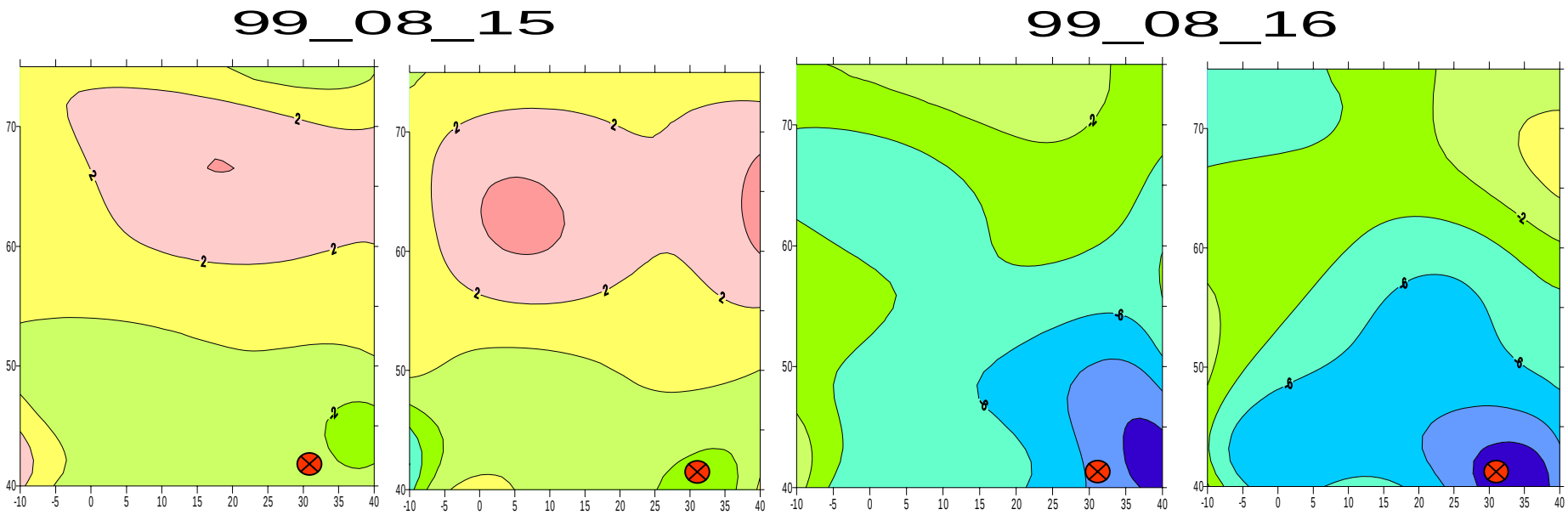
Turkey, 17.08.1999, M=7.8

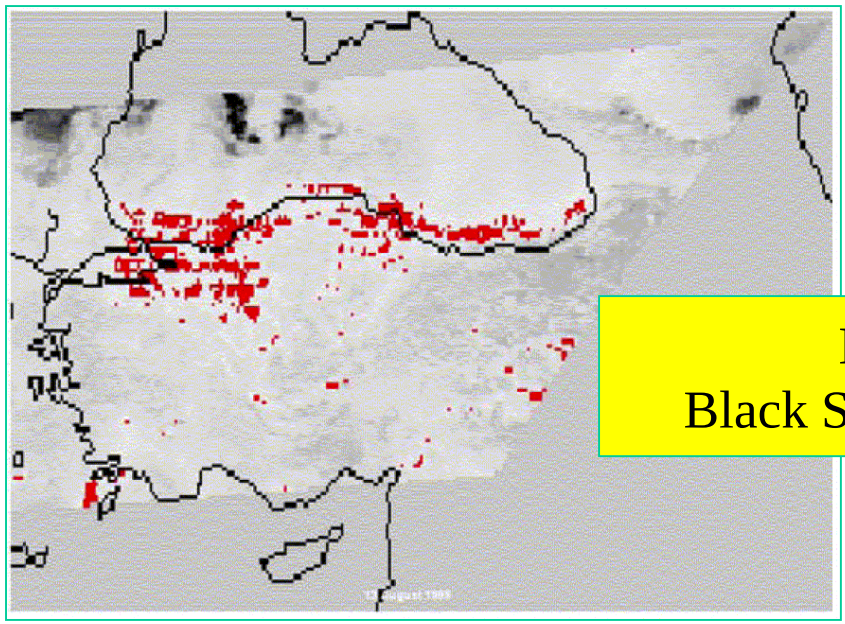
The Izmit earthquake occurred at 00:01:39 UT (3:01 a.m. local time), and was centred at 40.702 N., 29.987 E., which places the epicentre about 11 kilometres South-East of the Izmit.

Turkey, 12.11.1999, M=7.5

The second earthquake (EQ2) with magnitude of 7.5 occurred at November 12,1999 (16:57:19 UT) on the short distance (less of 100km) from EQ1 epicentre and was centred at 40.8N, 31.2E.

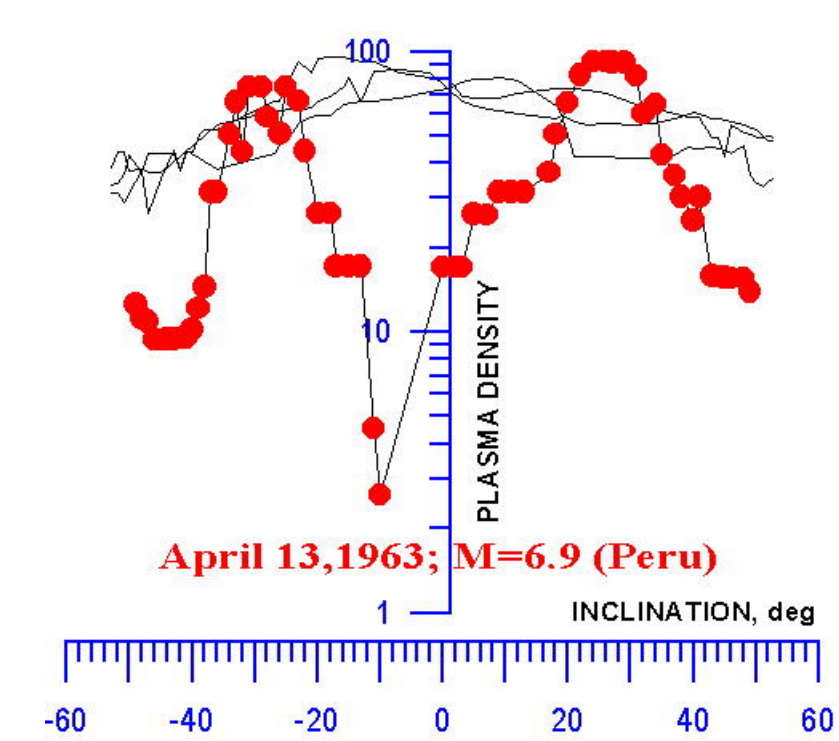
TEC earthquakes precursors



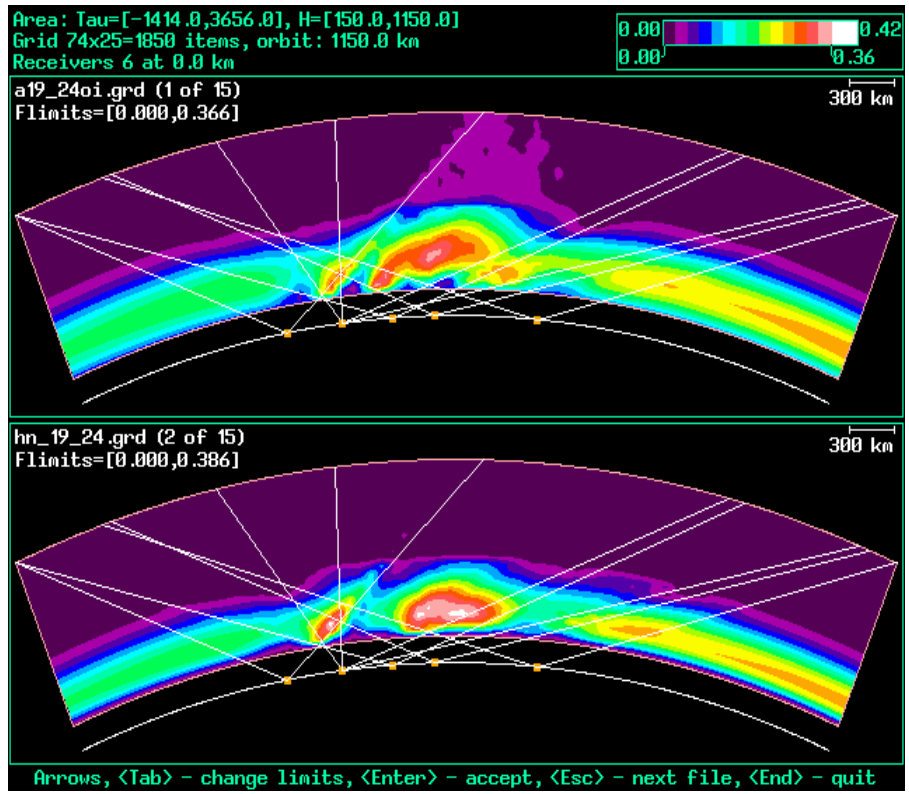


IR temperatures anomalies,
Black Sea/Turkey area, 16th August, 1999

Equatorial ionosphere reaction on earthquake preparation stage



The plasma structure in the equatorial pre - midnight ionosphere one day before the pending Peru earthquake (red circles). Data top sounding by satellite Aloutte-2 (Canada)



Kunitsyn V.E., Tereshchenko E.D.

Ionospheric Tomography. Springer-Verlag, Berlin, 2003

Main Measured Parameters

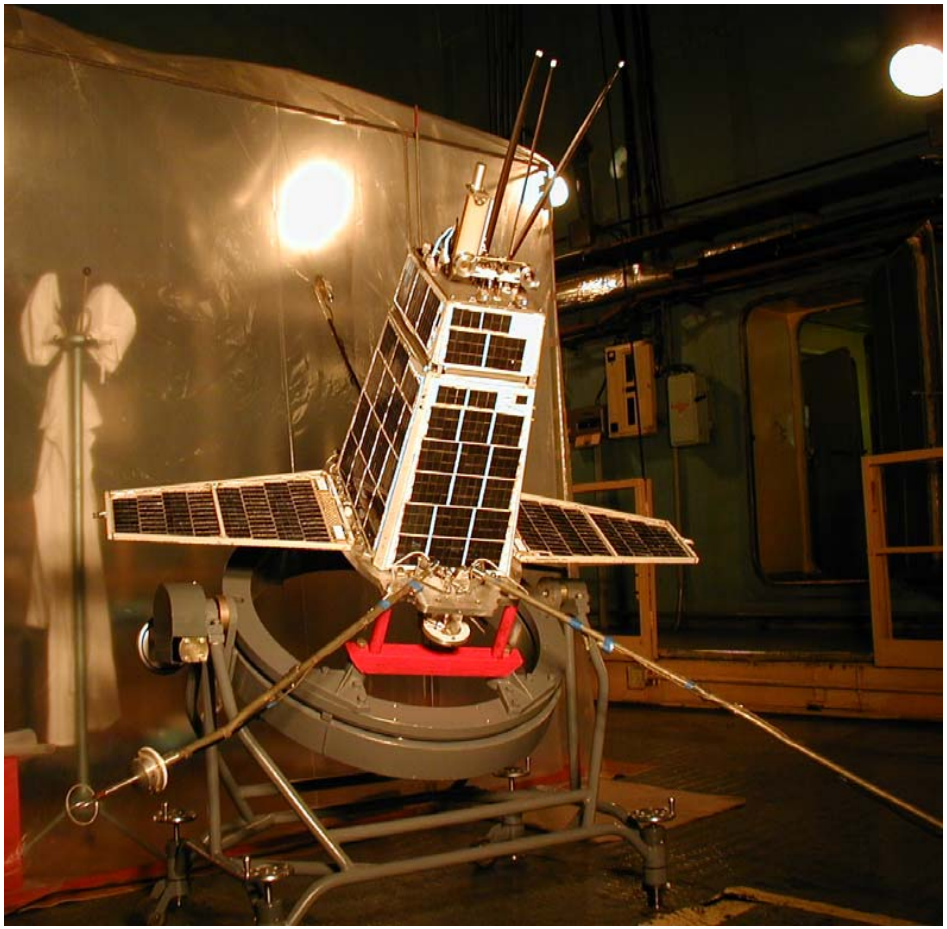
- Electromagnetic emissions (ELF-VLF and HF)
- Electrical and magnetic fields
- Ionosphere plasma density
- Temperature of electrons and ions
- Ion-mass spectral components
- Power spectrum of energetic electrons/ions (> 15 keV)
- Intensity of the IR radiation

- **The space system for on-line monitoring of earthquakes, human-associated and natural hazargs is intended to provide the customer with real-time information on emergency situations on the basis of continuous survey of the Earth's surface and recording of anomalous physical phenomena in the Earth's atmosphere, ionosphere, and magnetosphere.**
- **The Space System is designed in such way that allows the integration of data with the similar-purpose foreign space systems.**
- **The Space System is created on the basis of compact unified space platforms.**

The first (experimental) stage in creating the Space System is the launch of a small spacecraft Compass-2.

Its main objectives are to test and refine the monitoring techniques for detecting the earthquake ionospheric precursors in various regions over the world and to accumulate experimental and statistical data for increasing reliability of the forecast of major earthquakes (M>5).

Technical data of "COMPASS-2" SC



Micro-satellite "Compass" was developed and produced by SRC "Makeyev Design Bureau" in cooperation with IZMIRAN.

The first launch was in December 2001, the second launch will be in 2006.

Satellite mass (scientific equipment), kg 80(20)

Volume for equipment, dm3 67

Average orbit power consuption 25 W

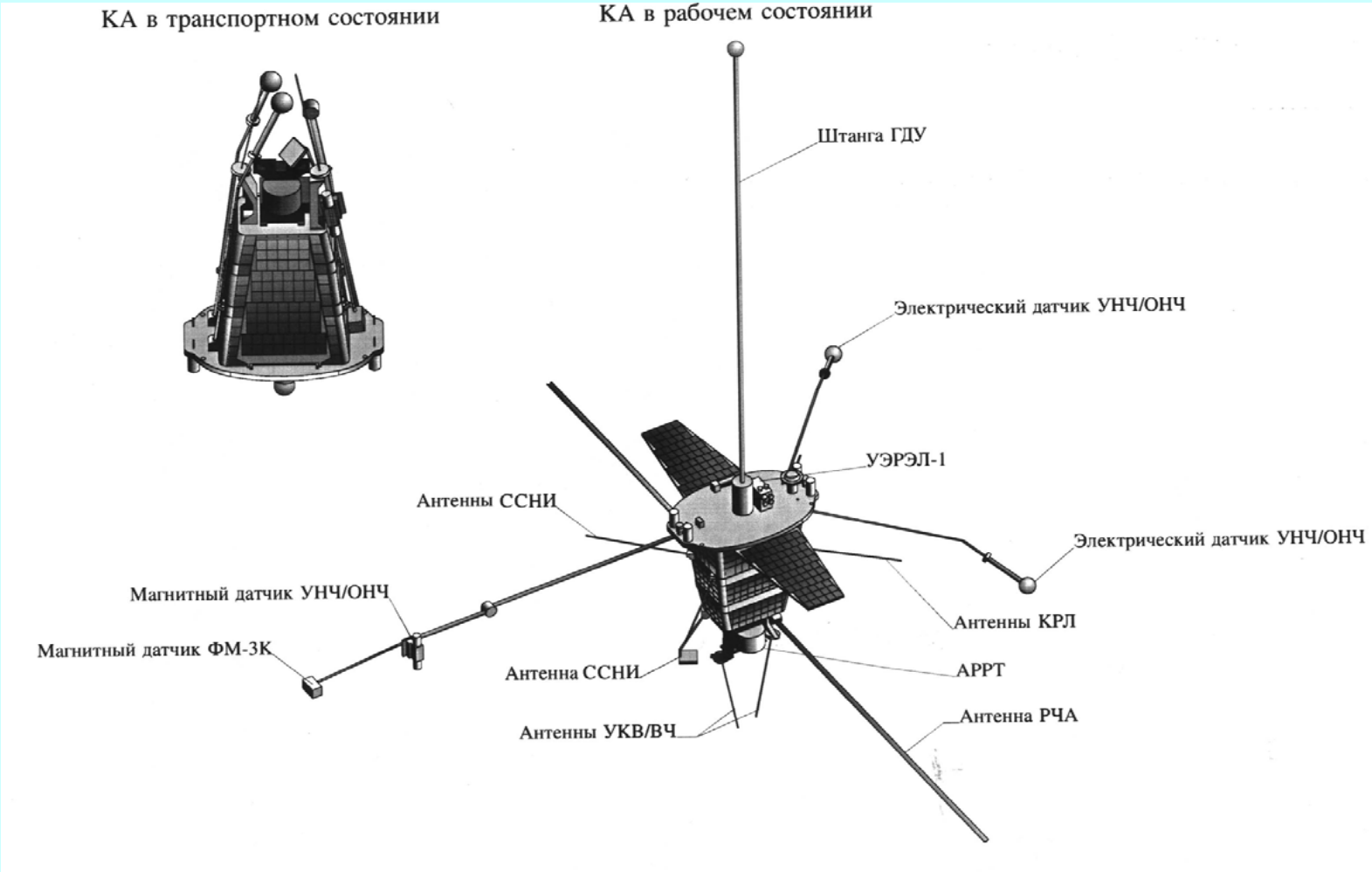
Attitude control accuracy, angular min 1

S/C mission lifetime – 3 years at least

Orbit parameters:

- altitude, km 400/500… 62
- inclination, deg 79

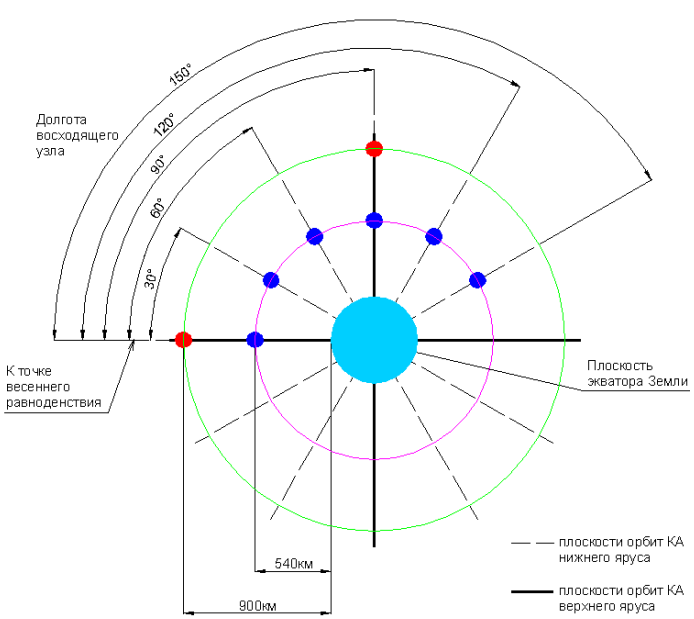
“COMPASS” microsatellite

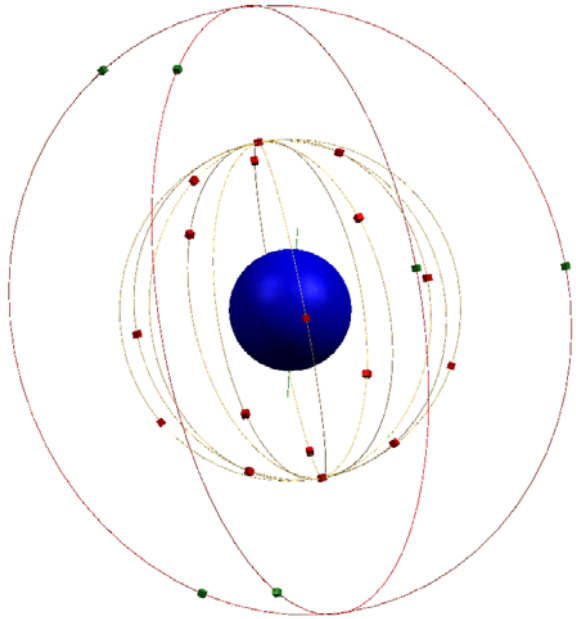


Scientific instrumentation

- **The Space System consists of a low orbital group of four satellites (orbital altitude of 400-500 km) and one upper spacecraft (orbital altitude of 900-1000 km).**
- **Such a system of orbiters will provide global information for the given areas with a periodicity at least once a day.**
- **The active lifetime of the spacecraft complex is no less than 5 years.**

The Orbital Structure

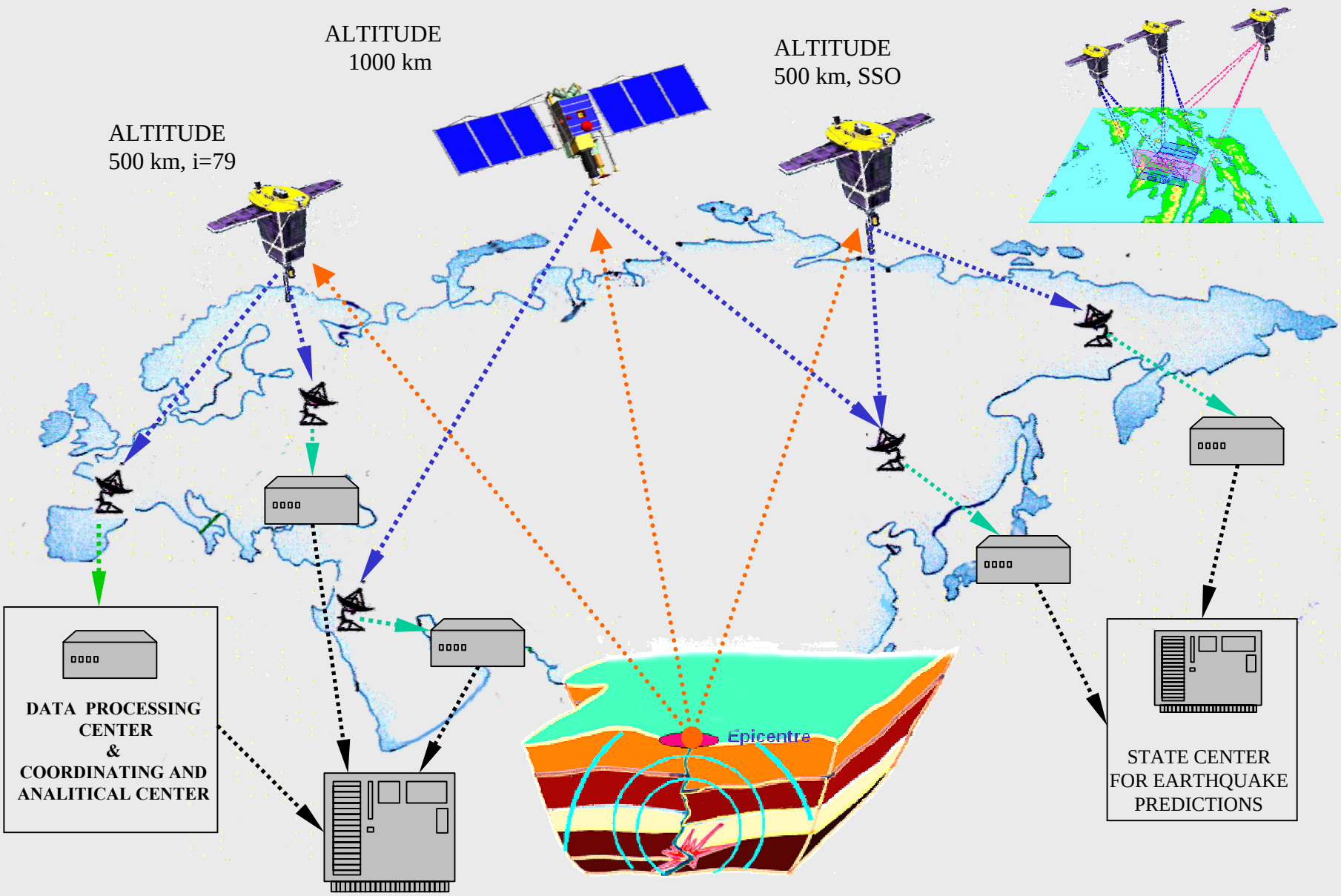




•the «COMPASS» S/C orbital constellation of the lower level (of 400-500 km altitude) – LEO-1; 4 satellites,

•the S/C orbital constellation of the upper level (of 900-1100 km altitude) – LEO-2; 1-2 satellites.

SPACE & GROUND SEGMENT CONCEPT



Satellite Mission Control Center

Pedestal and flight control center antennas (new pedestal with 4M parabolic antenna planned in near future)

Satellite flight control center of IZMIRAN (Troitsk, Moscow region, Russia)

Conclusion:

The main problems to be solved with the Space System

- to conduct global space monitoring of the anomalous physical phenomena in the Earth's lithosphere, underlying terrain, atmosphere, ionosphere, and magnetosphere that arise as a result of human-associated and natural emergencies;
- to perform a prompt analysis of the recorded disturbances of physical parameters, to reveal precursors of strong earthquakes, and to warn of the probable emergency situations;
- to observe and record consequences of earthquakes, human-associated and natural disasters, including the wood fires and other fast-developing events;
- to conduct a global survey of the ionosphere and ecological monitoring of the environment;
- other tasks of interest to various institutions and services.