

# History and modernity of the study of Space Weather in Russia

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# History and modernity of the study of Space Weather

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At the international level, formulated a series of initiatives on Space Weather, which aims at the development of action plan countries participating in space activities to mitigate the impacts of the factors of Space Weather on space activities. These initiatives emanate from the **Committee on the peaceful uses of outer space (UN COPUOS)** the working group Technical Subcommittee on the Long-term sustainability of outer space activities", by the Scientific Committee on solar-terrestrial physics (**SCOSTEP**) in the framework of the "International initiative on Space Weather", regularly considered at meetings of the **UN COPUOS** from the scientific community in the framework of “Roadmap on Space Weather under the auspices of **COSPAR** and “**International living with a star**”, etc.

Also are exist documents as “Strategy of the United States and on Space Weather" and “Action Plan of the USA Space Weather".

# The United Nations (UN)

The Committee on the peaceful uses of of  
outer space (UN COPUOS)

**Scientific and Technical Subcommittee**

The working group "Long-term sustainable the  
development of space activities"

**The expert group (A, B, C, D)**

**A**

**B**

**C**

**D**

**Expert group C "Space Weather"**

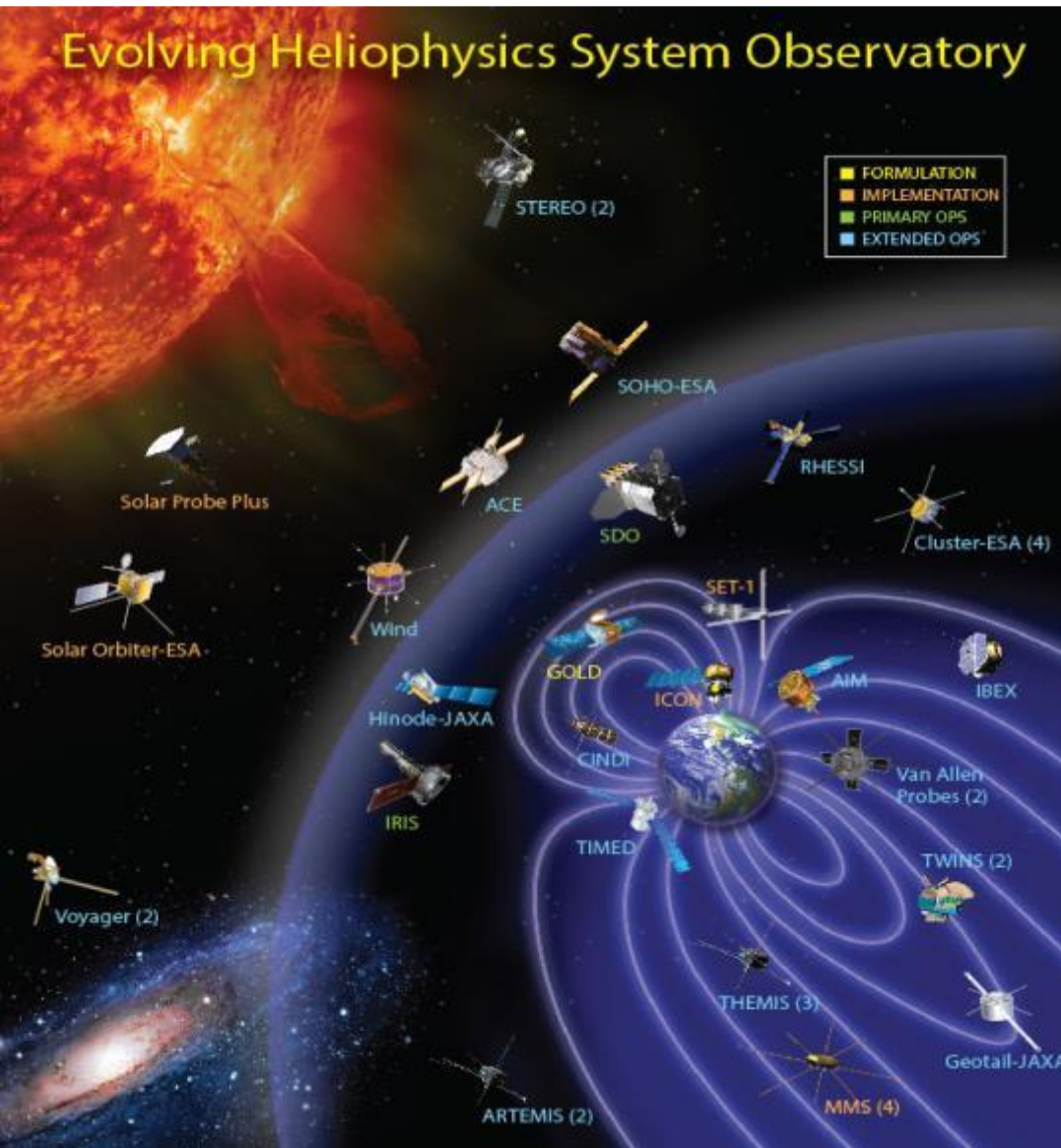
# Expert group C “Space Weather”



## Recommendations for the mitigation of space weather for space activities

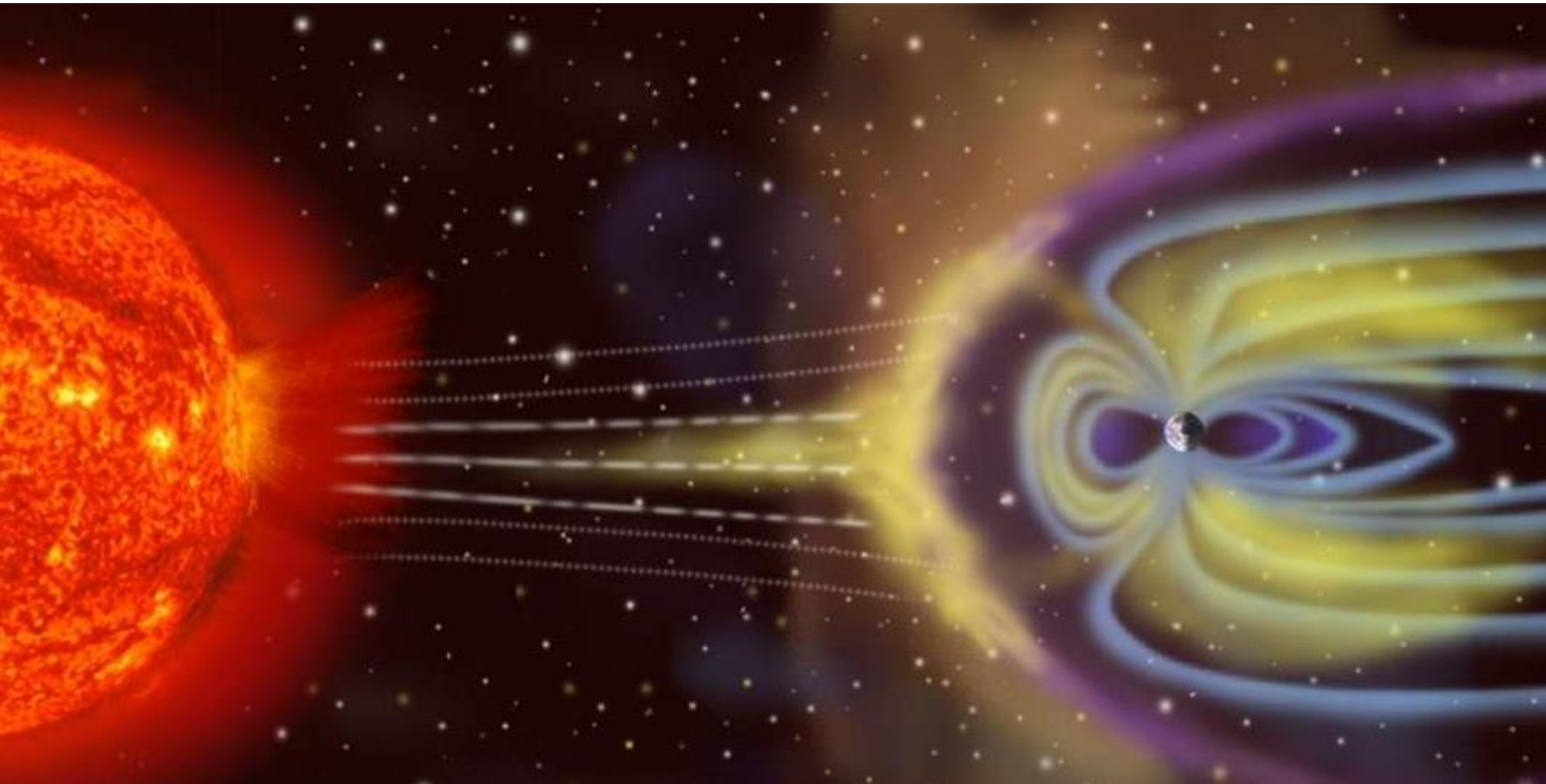
- 1. A consistent approach to monitoring and studying space weather:**
  - modeling of space weather phenomena and their dynamics;
  - drawing up of forecasts;
  - research of influence of space weather on technical systems;
  - development and implementation of technical standards for design and the manufacture of satellites and other space and ground equipment.
- 2. Consolidate the results of all observations** for the purpose of receiving a comprehensive picture of the status of space weather.
- 3. International cooperation and coordination** of stakeholders of the parties around the world to lasting improvements in the area space weather:
  - to create a joint satellite observation system;
  - providing secure access to reports;
  - capacity development in the field of service and maintenance of global consistency of end-products users.

# UN global observing system and monitoring



- 18 operating missions on (29 spacecrafts)  
Voyager-2, Geotail, Wind, SOHO, ACE, Cluster-4, TIMED, RHESSI, TWINS-2, Hinode, STEREO-2, THEMIS/ARTEMIS-5, AIM, CINDI, IBEX, SDO, Van Allen Probes-2, IRIS.
- 9 missions in preparation  
SET, MMS, SOC, ICON, GOLD, Interheliozond, Resonance, Ionosonde, Solar Orbiter, Solar Probe Plus.

# Space Weather – solar and geomagnetic activity



2<sup>nd</sup> International Conference and Exhibition on “**Satellite & Space Missions**”, July 21-23, 2016  
Berlin, Germany

# Aurora the only manifestation of Space Weather available to the naked tool man



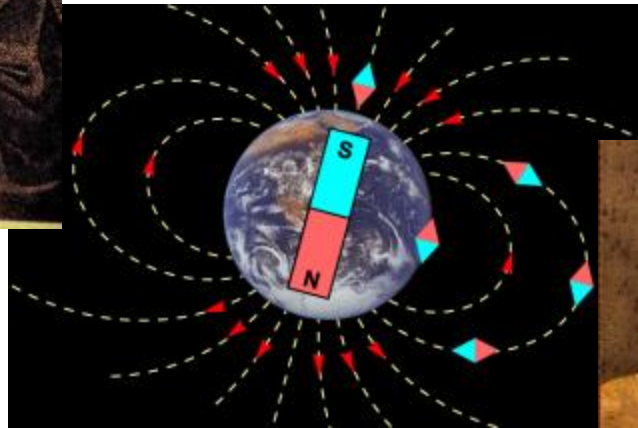
2<sup>nd</sup> International Conference and Exhibition on “Satellite & Space Missions”, July 21-23, 2016  
Berlin, Germany





1600

William Gilbert explained the work of the compass  
the Earth's magnetic field as a whole



1806

Alexander von Humboldt noticed the trembling of  
the magnetic needle during the Aurora.

Magnetic storm – change 1-10% of the Earth's field

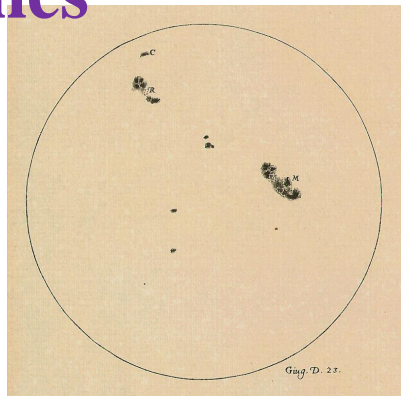
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# Sunspots occasionally seen since ancient times



1128

First known image of the spots.  
Medieval English chronicle

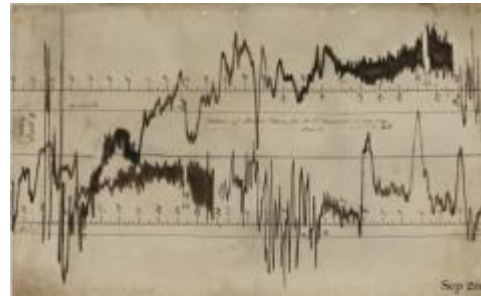
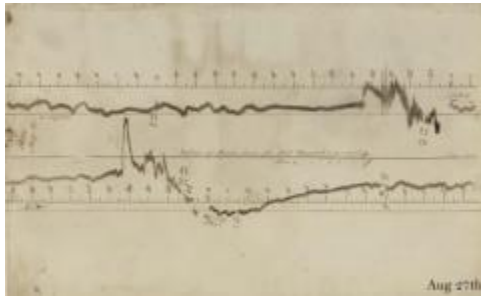
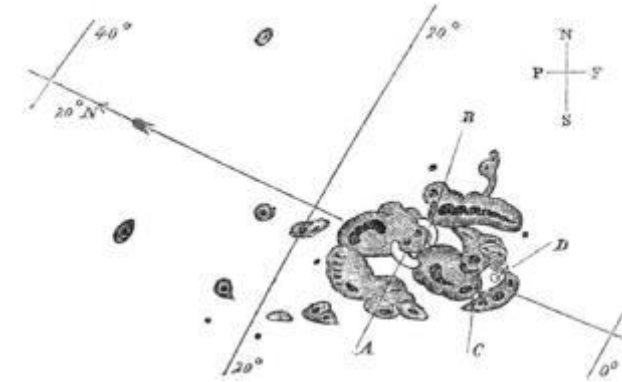


1612. Galileo. First spots  
scientific observation



# Sunspots and magnetic storms

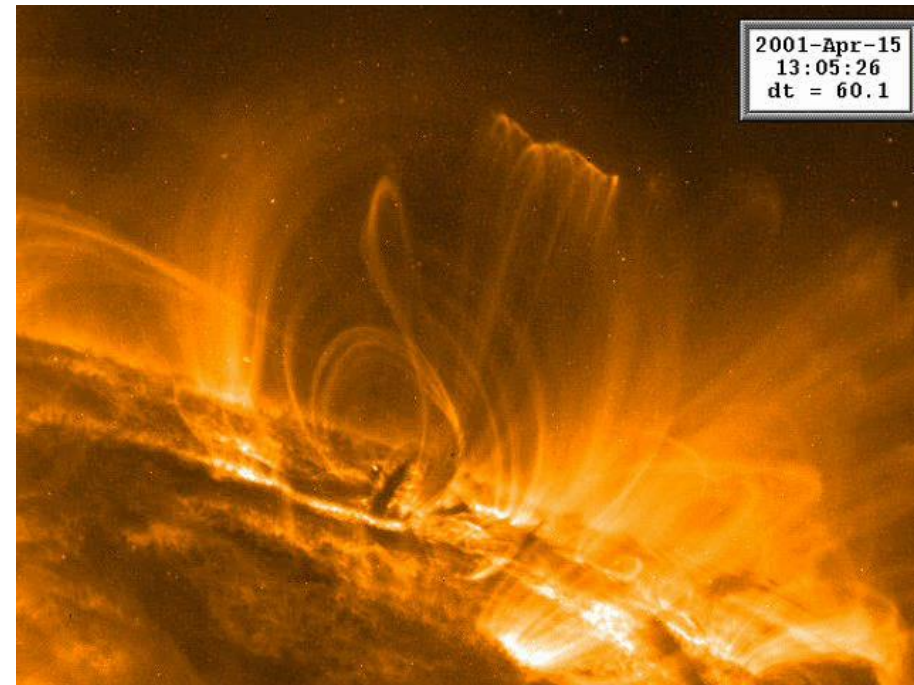
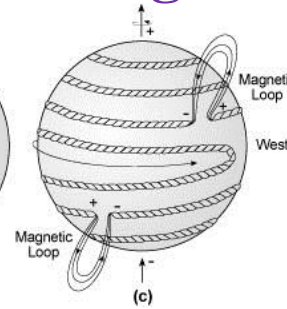
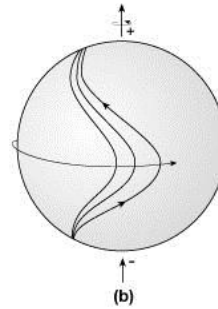
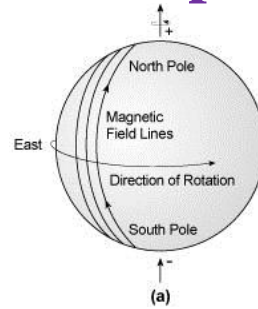
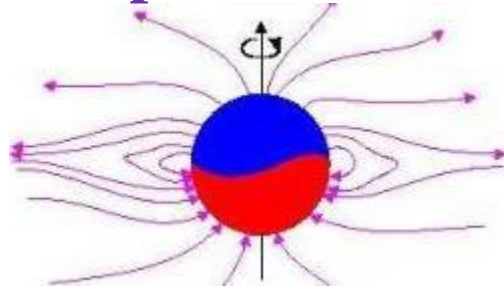
1859. Richard Carrington. First observation of a solar flare for the first time clearly mapped sunspots, flare, auroras and magnetic storm



1843. Samuel Schwabe. First discovered the 11-year cyclicality in solar spots



# Sunspots the result of the presence of a magnetic field and rotation



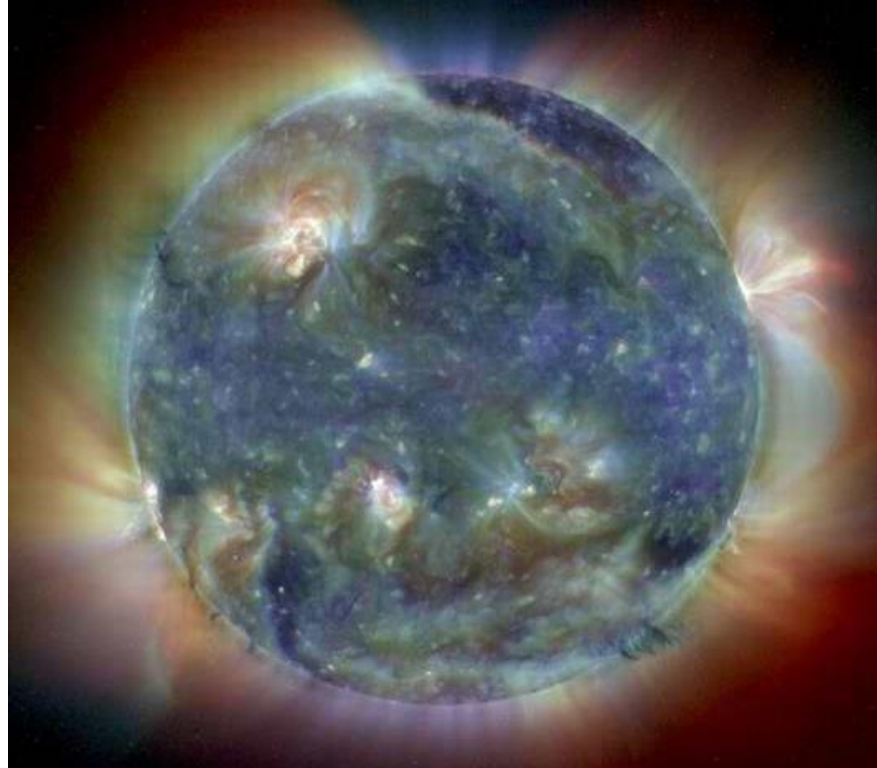
Spot – the area of high of the magnetic field. Magnetic field obscures the flow of energy from the depths of the Sun, this area is colder looks darker on a bright background

Plasma allows us to "see" magnetic field

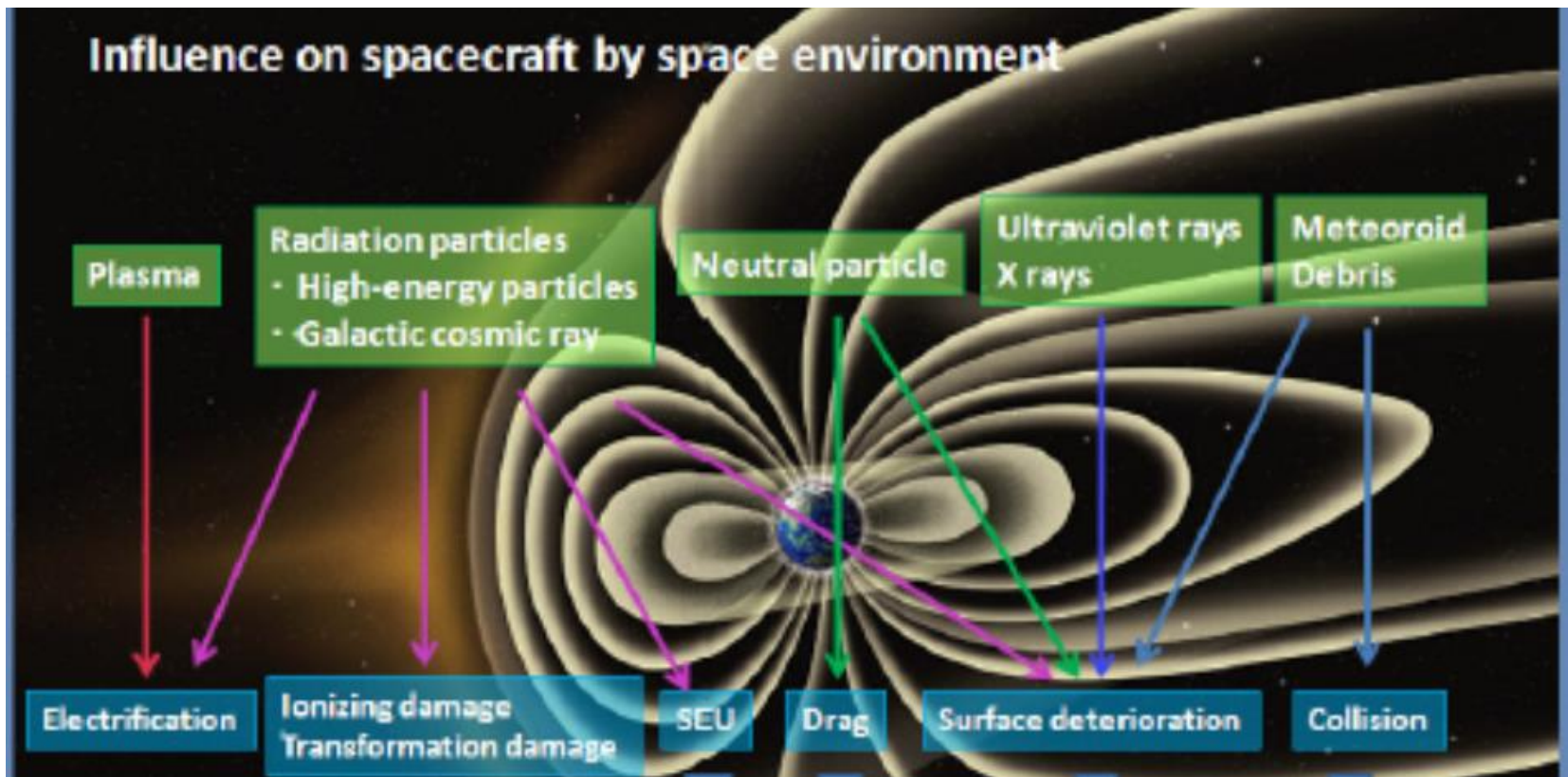


## **Magnetic storm.**

**This is a significant perturbation of the magnetosphere, caused by an abnormal increase in the solar wind and interplanetary magnetic field**



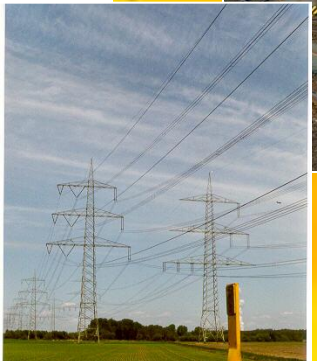
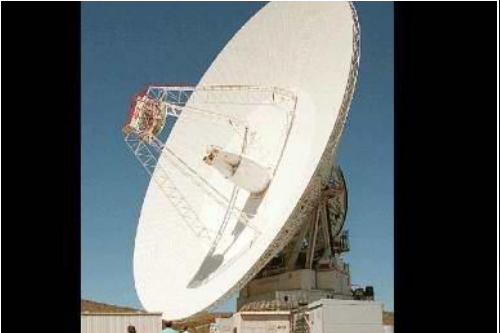
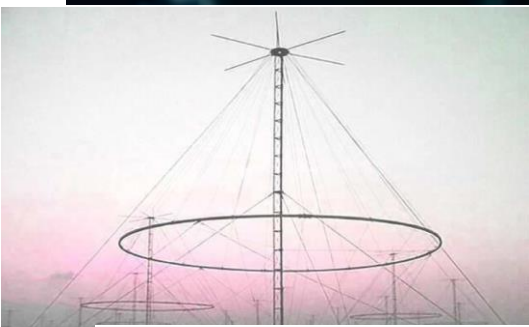
**Storm - induced average magnetic cloud, has energy  $10^{16}$ - $10^{17}$   
Joules ~ 10 megatons**



### Current Factors:

- Solar short-wave radiation 8 min.
- Solar cosmic rays 1-12 hours
- Magnetic cloud (magnetic storm) 2-3 days
  - Magnetospheric radiation
  - Inhomogeneity of the magnetosphere and ionosphere
  - Variations of the geomagnetic field

**The Earth is inside a  
huge electromagnetic  
installation:**

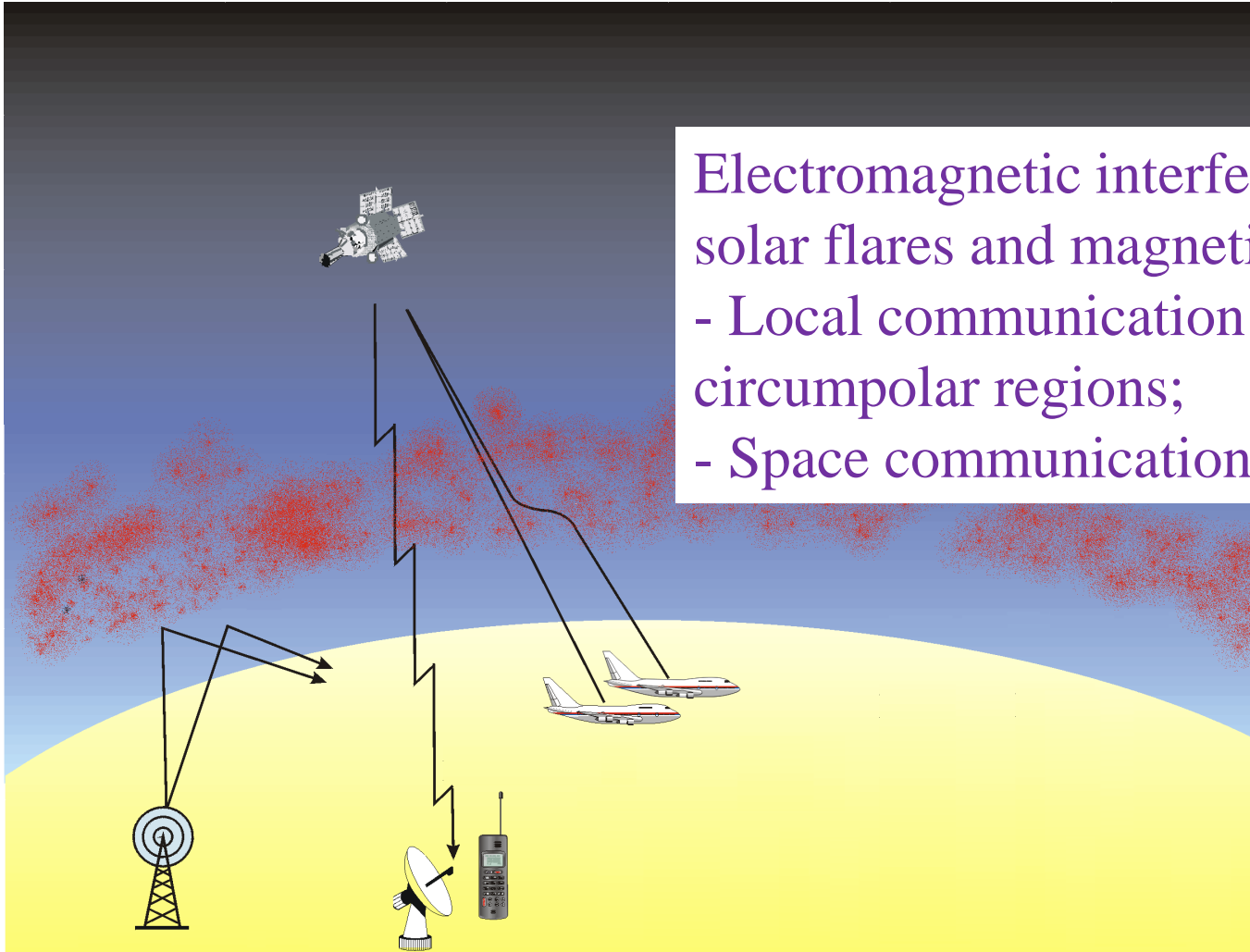


**electromagnetic interference  
on equipment:  
communication, power lines,  
exploration, pipelines,  
railways, automation**



# Telecommunications.

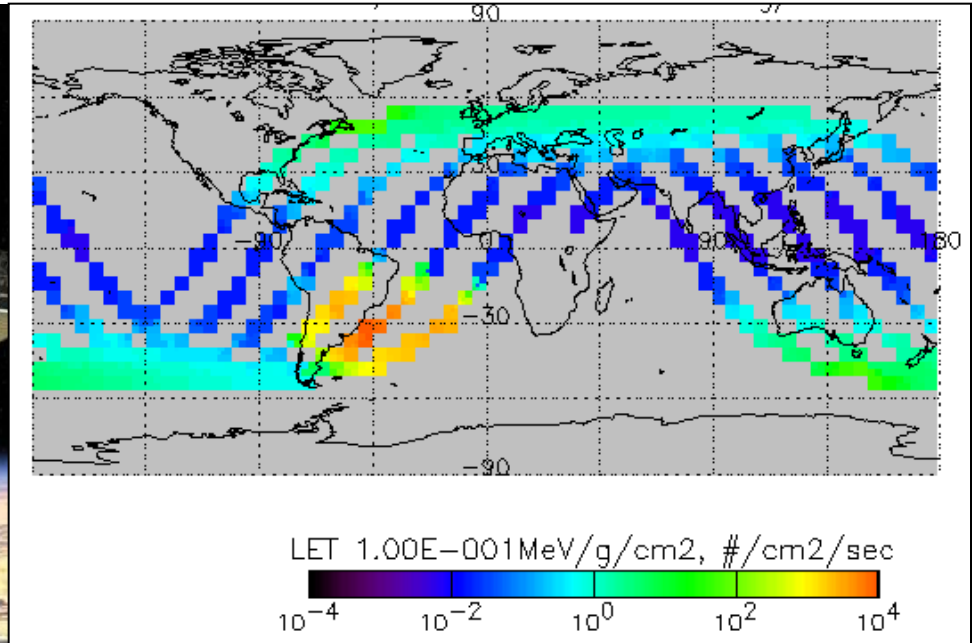
ionosphere – the upper layer of the atmosphere (100-400 km),  
ionized by solar radiation - environment for propagation



Electromagnetic interference (EMI) after  
solar flares and magnetic storms:

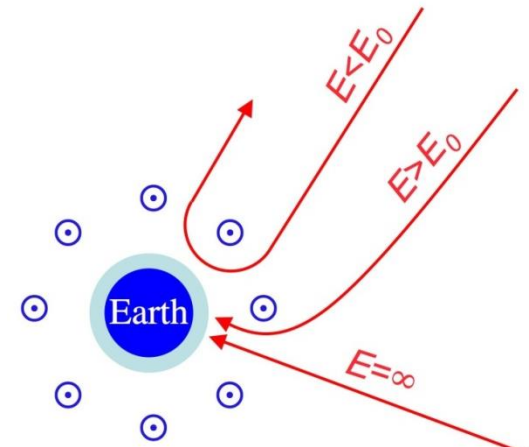
- Local communication in the  
circumpolar regions;
- Space communications GPS/GLONASS

# Radiation hazard for astronauts



On the ISS, the radiation dose is acceptable the protection housing and the Earth's magnetic field. During solar flares you cannot go into space.

Outside of the magnetosphere recruited for the year lethal dose: the restriction on flights to other planets.



# Solar activity and climate

The sun is a stable star.

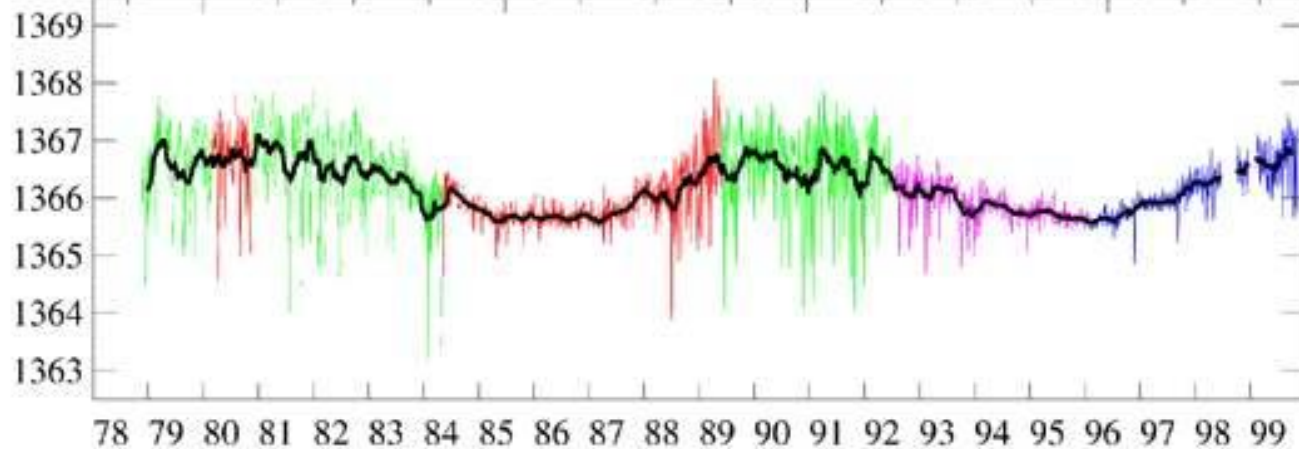
The flow of solar radiation –

**THE SOLAR CONSTANT~ 1.5 kW per 1 sq. m.**

The 11-year  
period in the  
annual rings



The effect of the solar variability not  
more than 0.1% of the solar constant

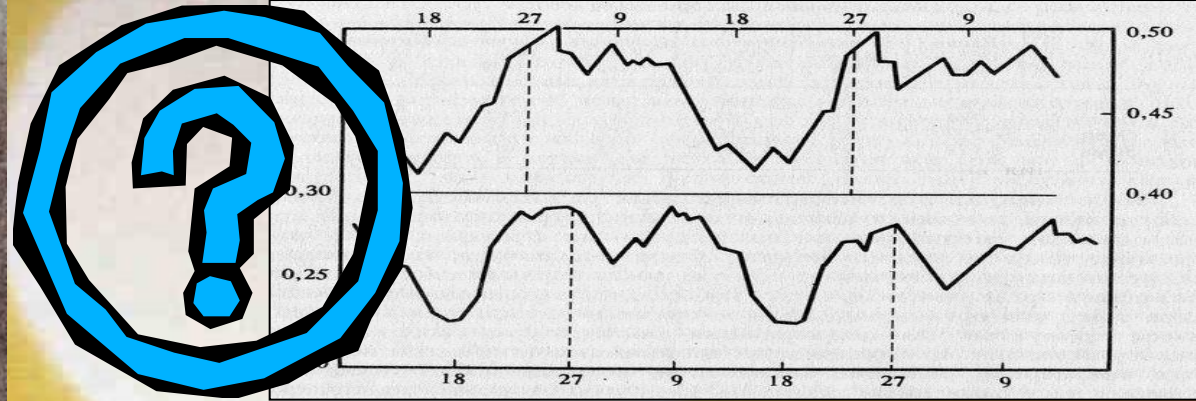


# Heliobiology

27-day periodicity mental disorders  
1932



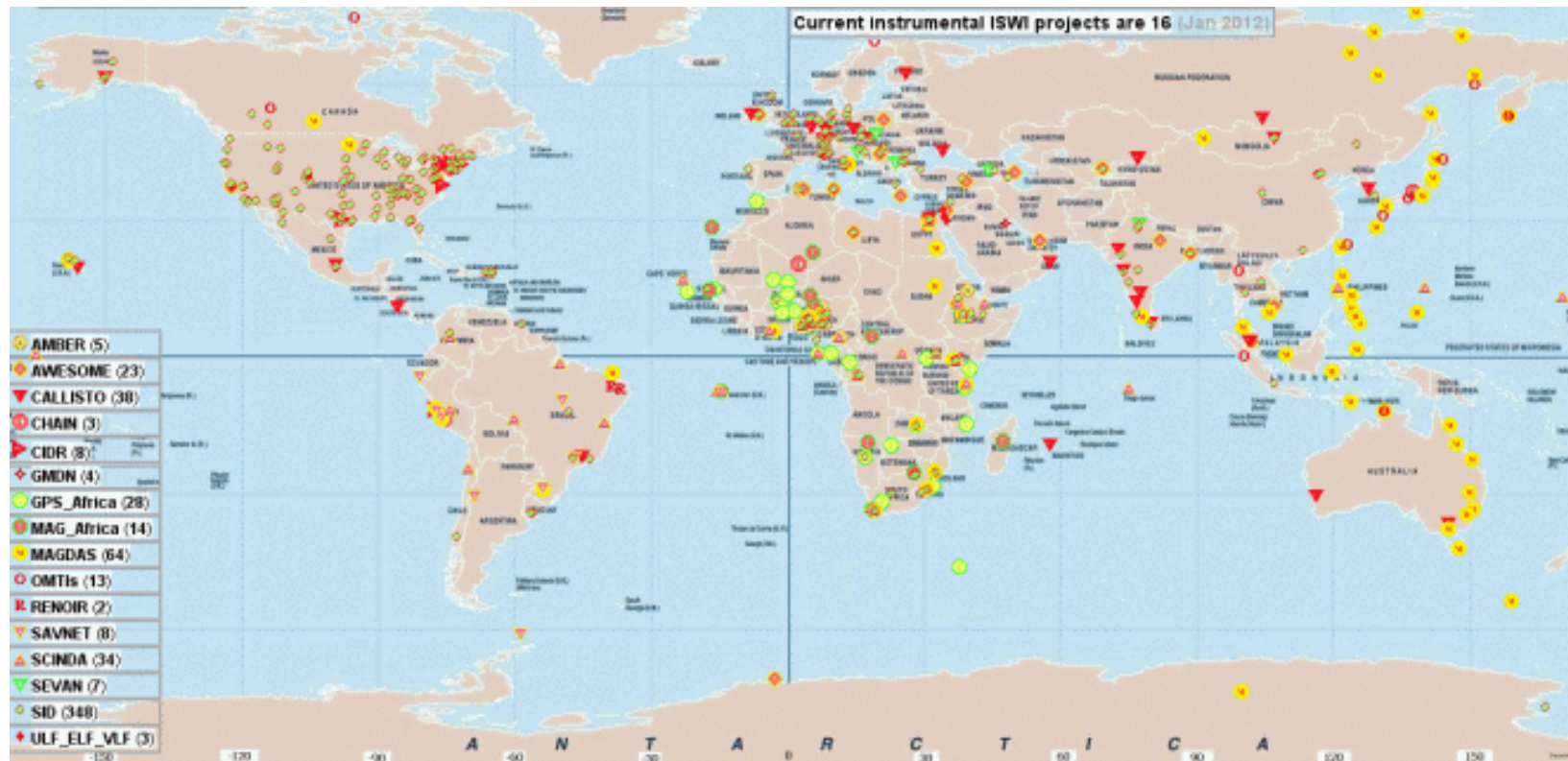
Alexander  
Leonidovich  
Chizhevsky  
1897 -1964



Probably has a small effect on the human body manifests itself individually more likely to have unhealthy people mechanism of the effect is unclear

# International initiative on space weather (SCOSTEP)

## Distribution of instruments across the globe



17 existing networks and chains of similar devices that measure different characteristics of solar activity, ionosphere, atmosphere, geomagnetic field and cosmic rays. 100 countries used by over 1000 instruments provided by 16 developed countries.

Part of Russia: 3 magnetometers – Cape Schmidt, Magadan, Paratunka;  
2 camera and optical IR range – Magadan, Paratunka; 1 solar radio spectrometer – Badary (Irkutsk).

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# Space Weather forecast - the Sun

rotation period of 27 days



2003/10/24 00:00

The forecast for the month-  
forecast return active region  
(spots)

The forecast for the week the  
stain is already visible on the left  
of the disk.

Forecast for two or three days  
the more and more dynamic the  
spot, the greater the likeli hood  
of outbreaks

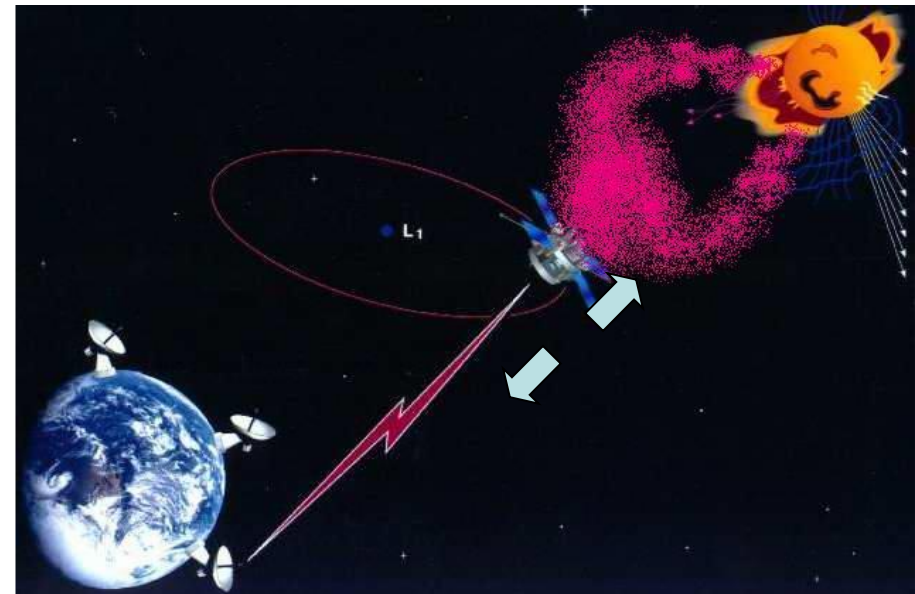
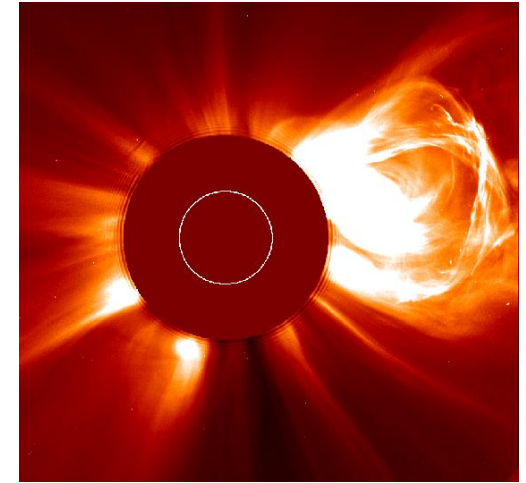
# Space Weather forecast - the Earth

The forecast for the week the stain is already visible on the left of the disk

Forecast for two or three days the more and more dynamic the spot, the greater the likelihood of outbreaks

The forecast for 1-2 hours monitoring the solar wind before Earth.

Reliability >90%



# SPACE WEATHER



With the star we were lucky...



# SPACE WEATHER

With the star we were lucky...

**THANK YOU FOR ATTENTION!**

