SGO
UNIVERSITY OF OULU

SOLAR STORMS & PLANETARY WELL-BEING

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THE EARTH

FEB 14, 1990

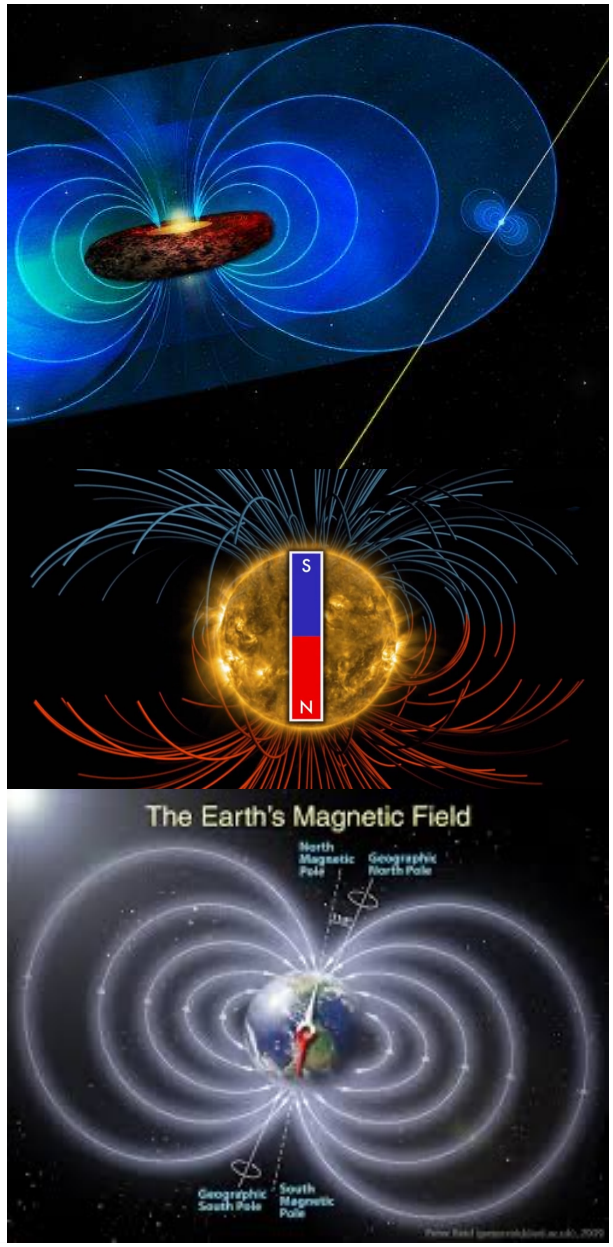
The picture of the Earth taken by NASA's Voyager 1 spacecraft at a distance of 6 billion km from the Sun.


THE EARTH AND THE MOON
18.9.1977
Single frame picture taken by Voyager 1 spacecraft.

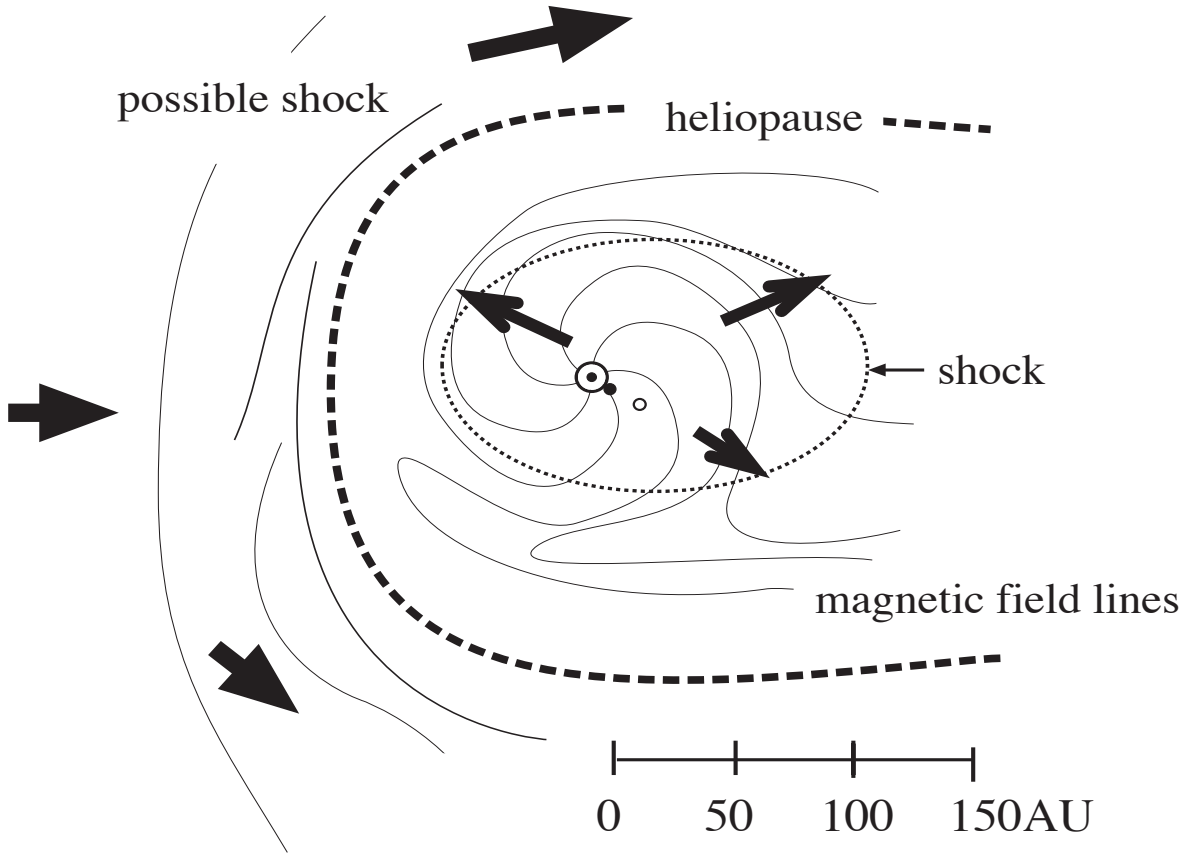
The Milky Way is a magnet.
The Sun is a magnet. The Earth is a magnet.

We live in an electromagnetic world almost without noticing the forces that have an influence on us, on our environment and on the basic functions of our society.

Our lives and homes are filled with devices used every day, which are based on magnetic forces, including cars, computers, microwave ovens, credit cards and cell phones.



Heliospheric shields against interstellar and intergalactic hazards

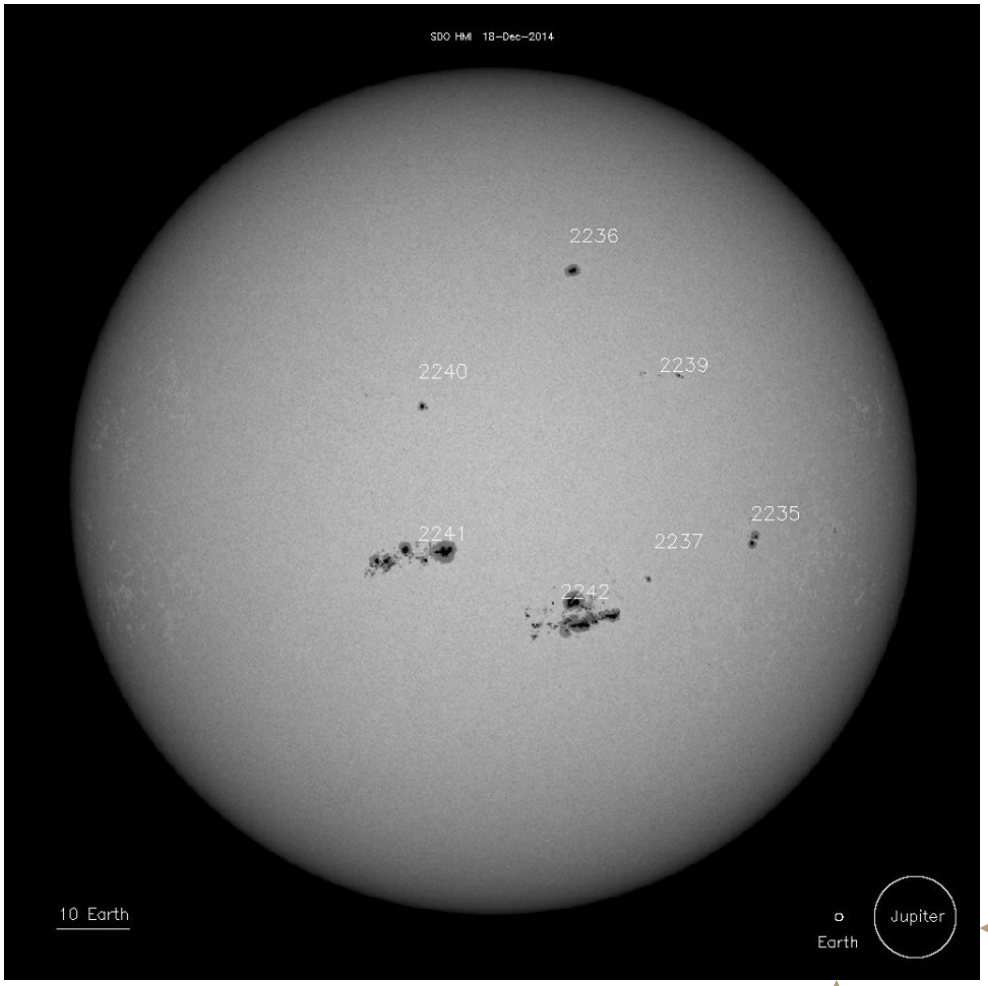


Louis Fizeau & Leon Foucault

First photo of the Sun

The first photo of the Sun made on April 2nd, 1845.

Sunspots had been by then counted centuries by a naked eye.

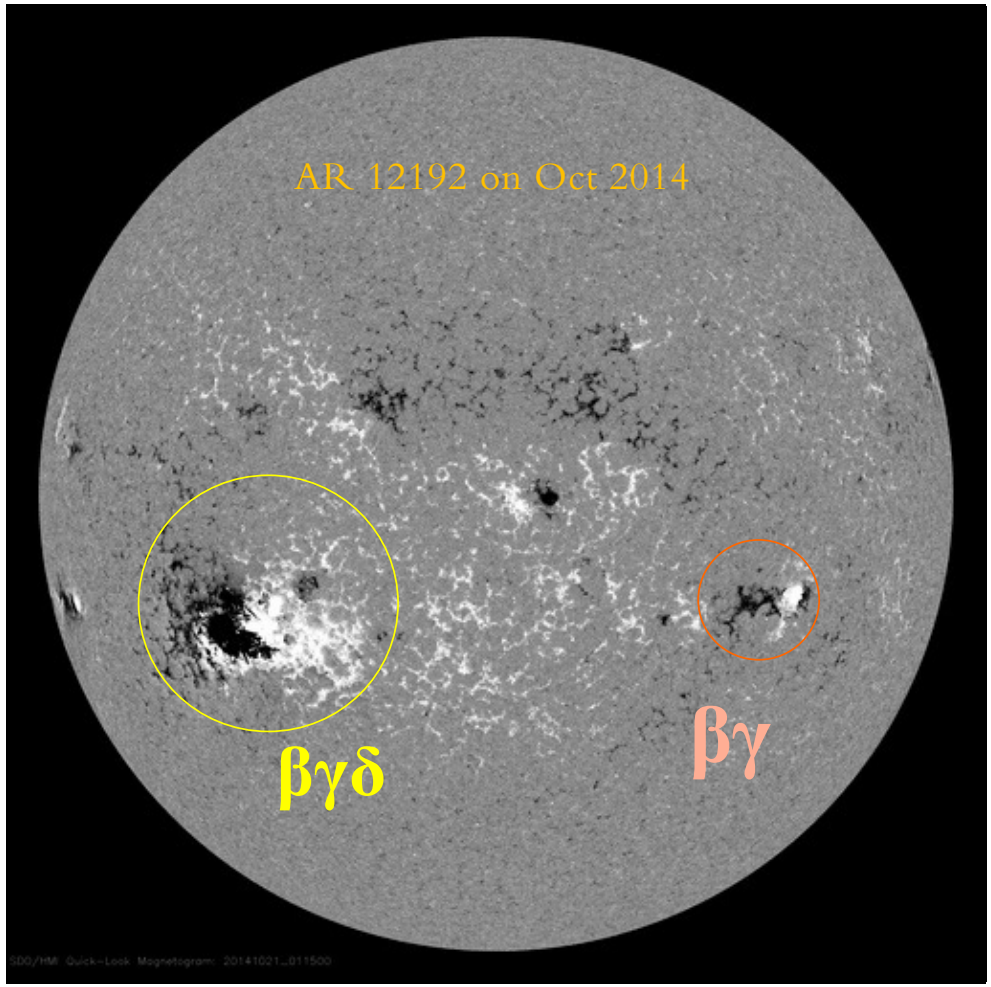


Size of Jupiter

Size of the Earth

Satellite observations

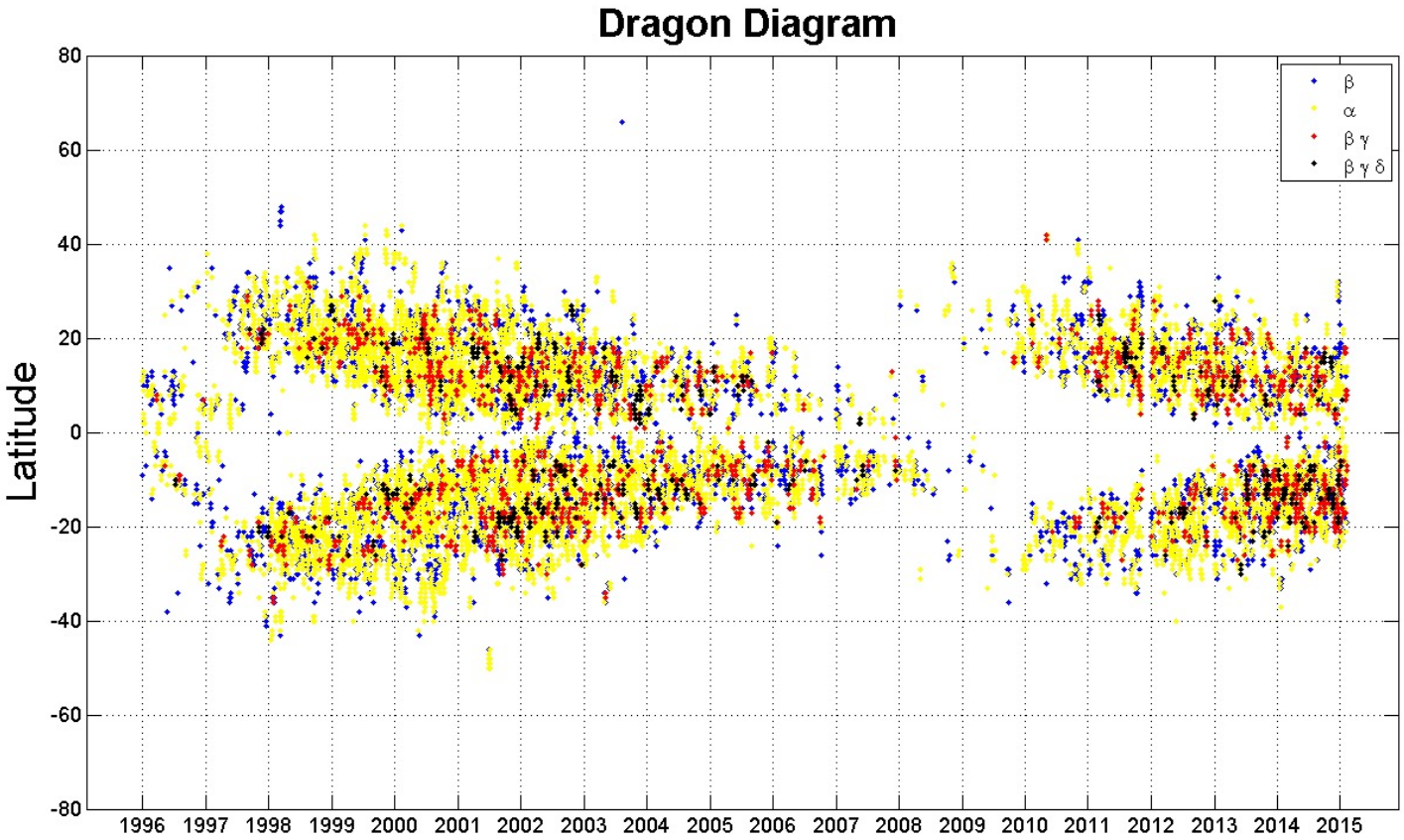
Solar active regions seen by the SDO satellite in 2014.

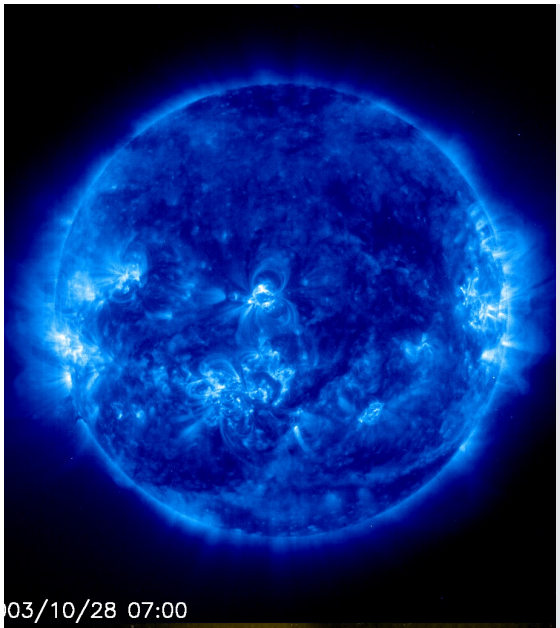


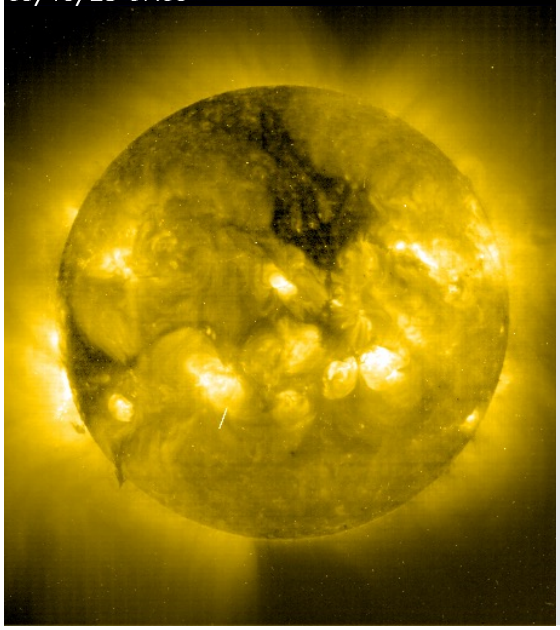
Solar active regions

Magnetic morphology of solar active regions play an important role on solar storm development.

Complexity of solar active region magnetic field



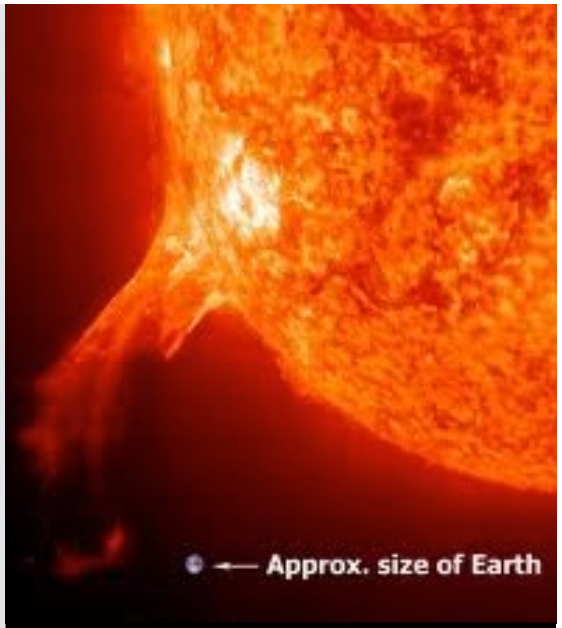


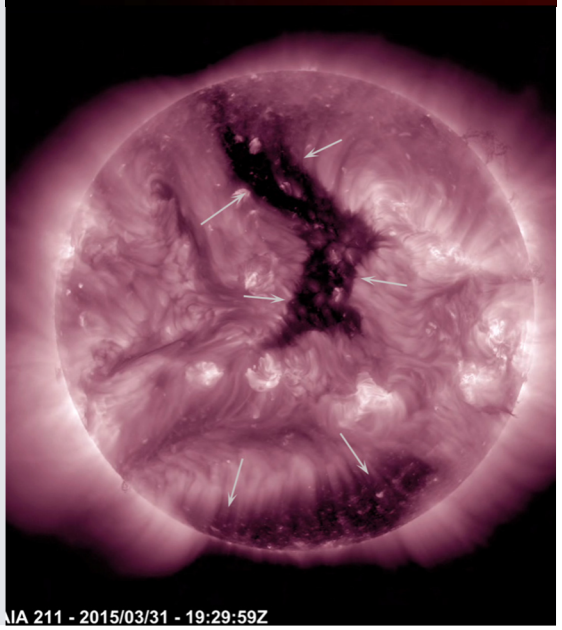


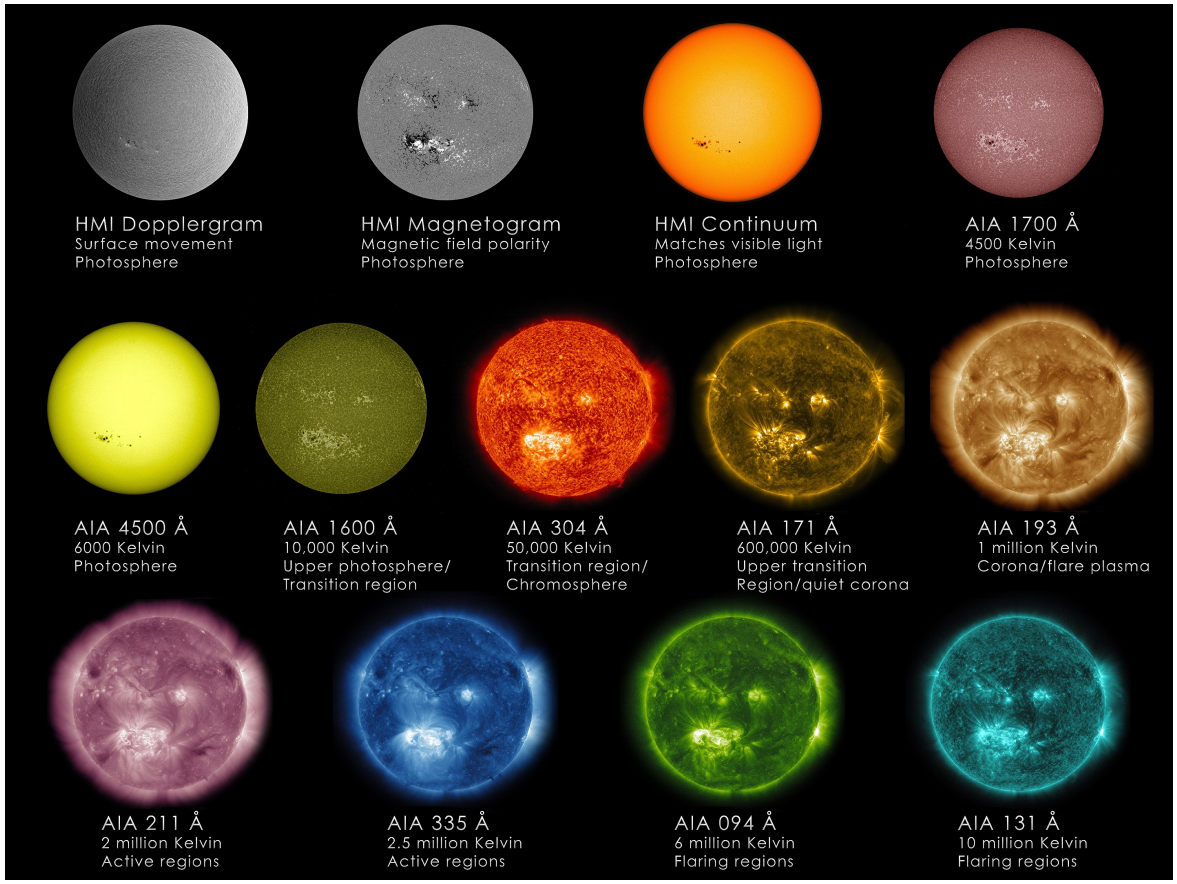
The heat of the Sun enables
the life on the Earth

HOWEVER …

Sun is a stormy star which erupts
complex magnetic clouds and
energetic particles to the heliosphere.



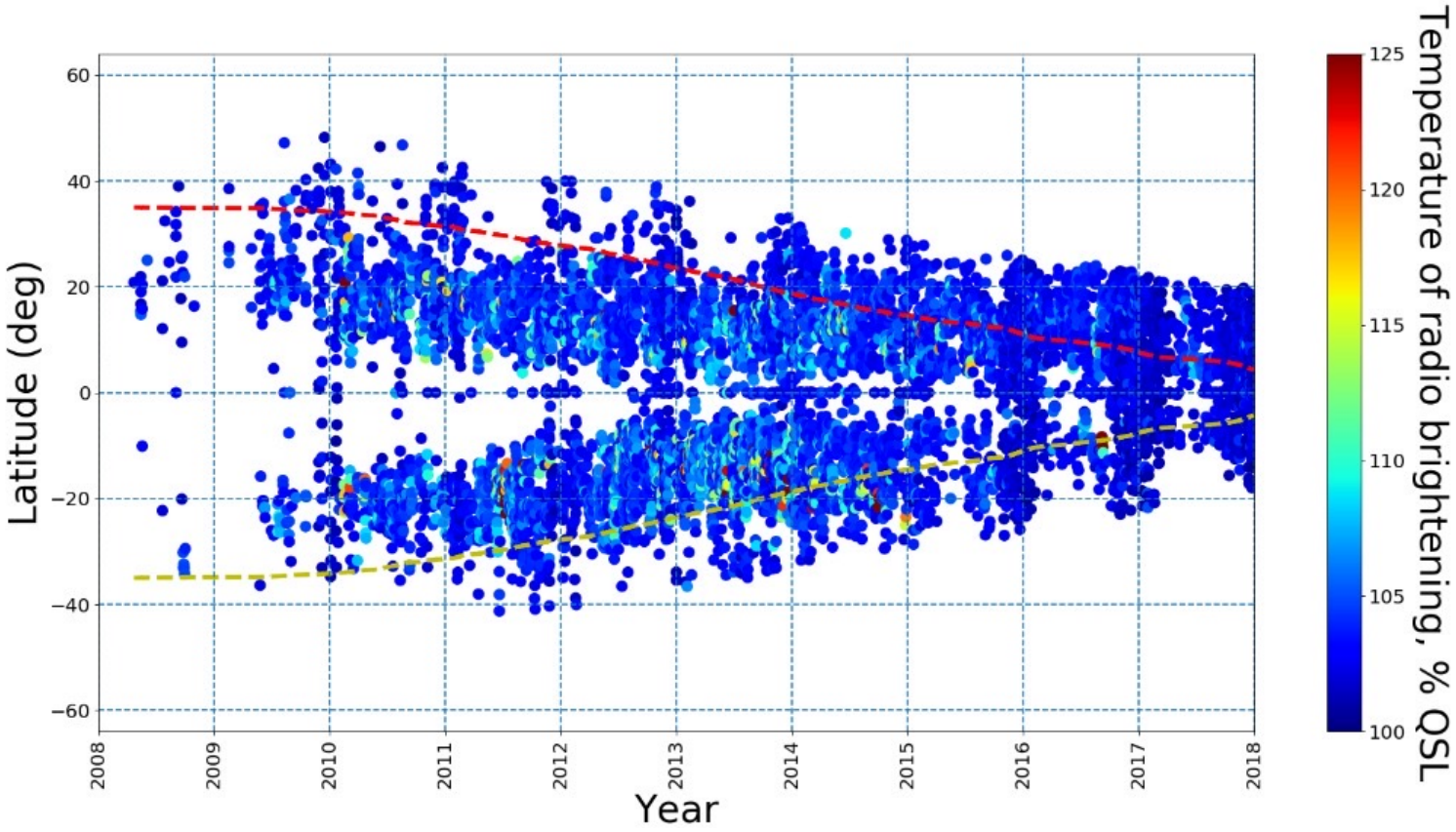




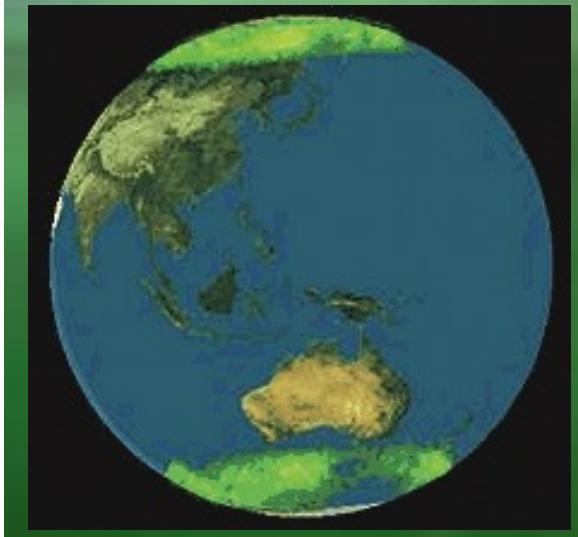
SOLAR OBSERVATIONS IN DIFFERENT WAVELENGTHS

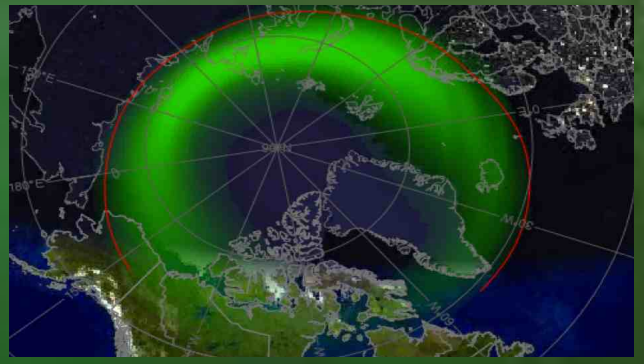
Different observations for different tasks

Solar radio disturbances in 37 GHz

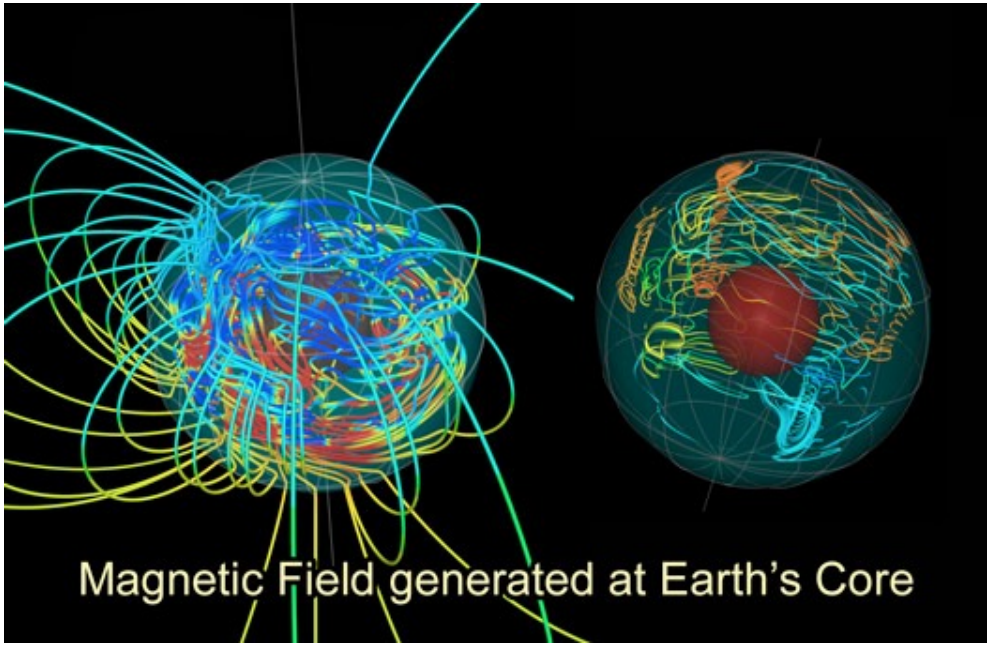


Solar storm effects are seen in auroral ovals

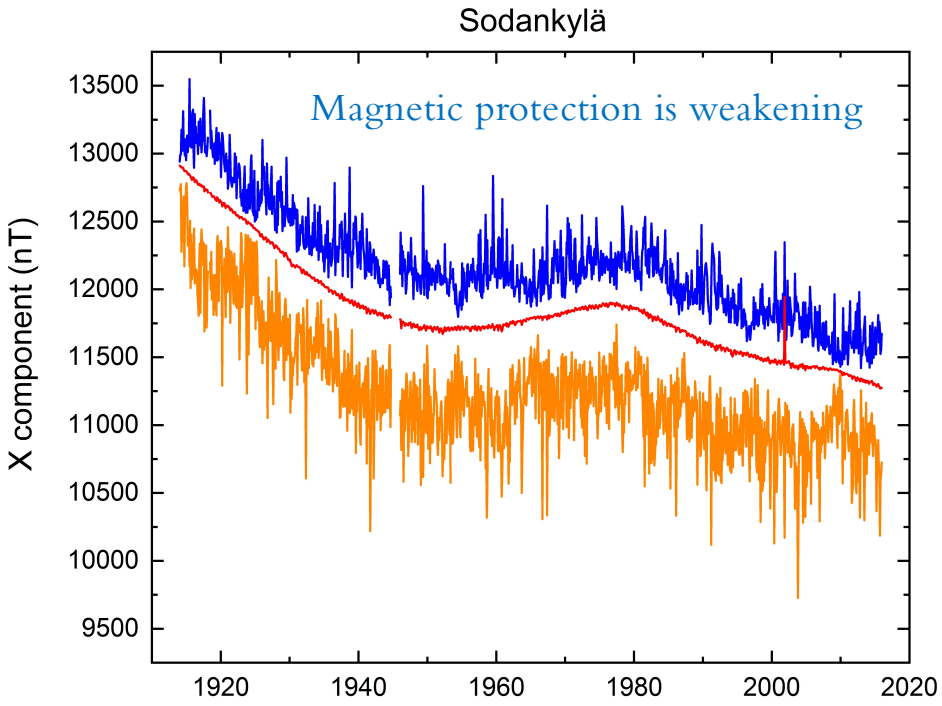




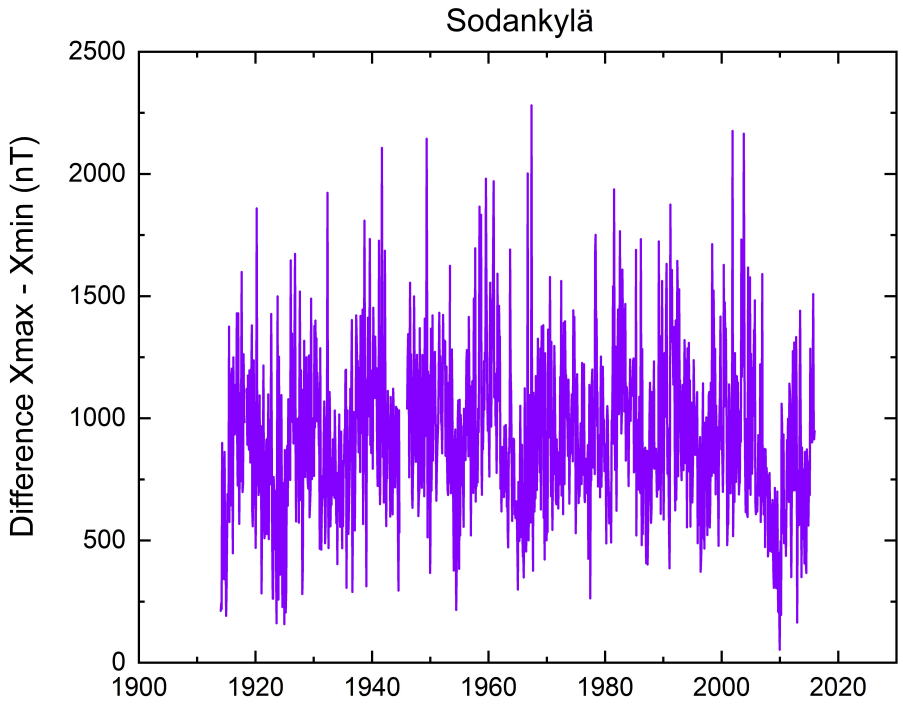
THE EARTH MAGNETIC FIELD ENABLES THE PLANETARY WELL-BEING



Magnetic climate for the last century



Extreme disturbances are becoming more common

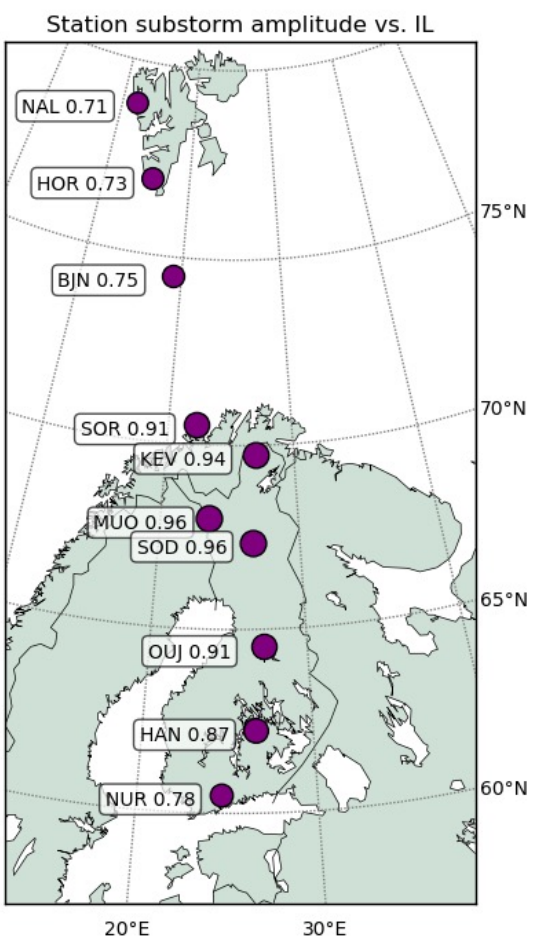


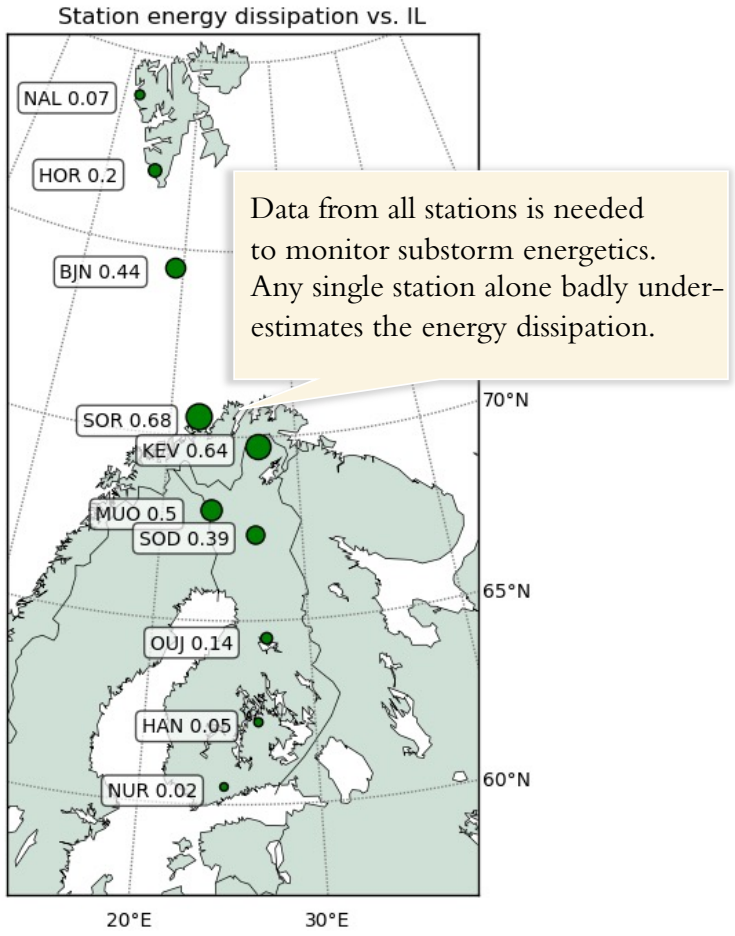
Similarity of the magnetic environment in Sodankylä
Dissimilarity increases toward positive y-axis.

Auroral substorm observations by measurement networks

Substorm intensity best detected close to Sodankylä SOD

BUT all stations can be quite well used.

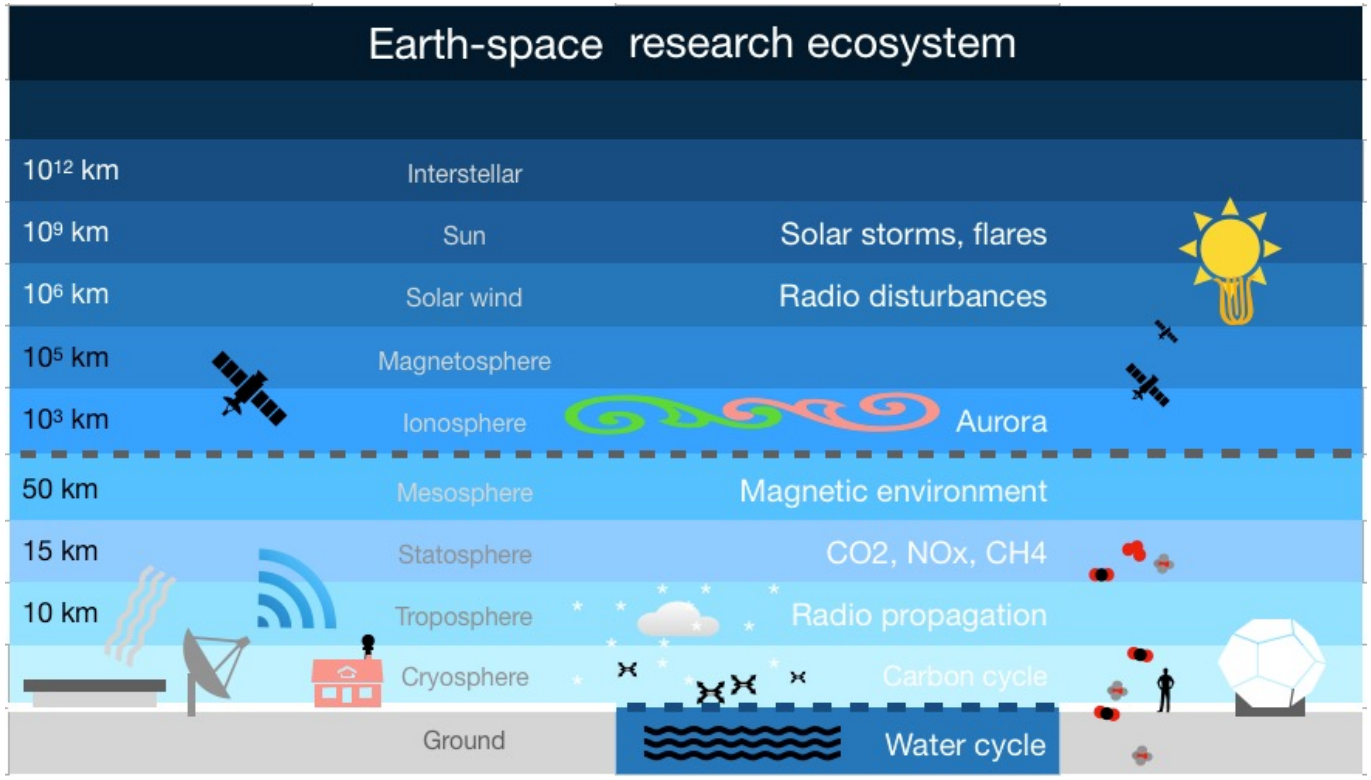




Data from all stations is needed to monitor substorm energetics. Any single station alone badly under-estimates the energy dissipation.

Infrastructures in the Space Campus in Tähtelä

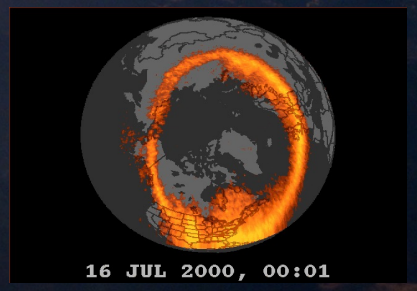
Research and technology infrastructures for the polar region and space safety

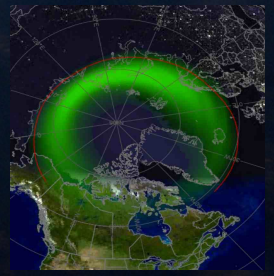


LappiSat-1 aurora satellite & satellite program

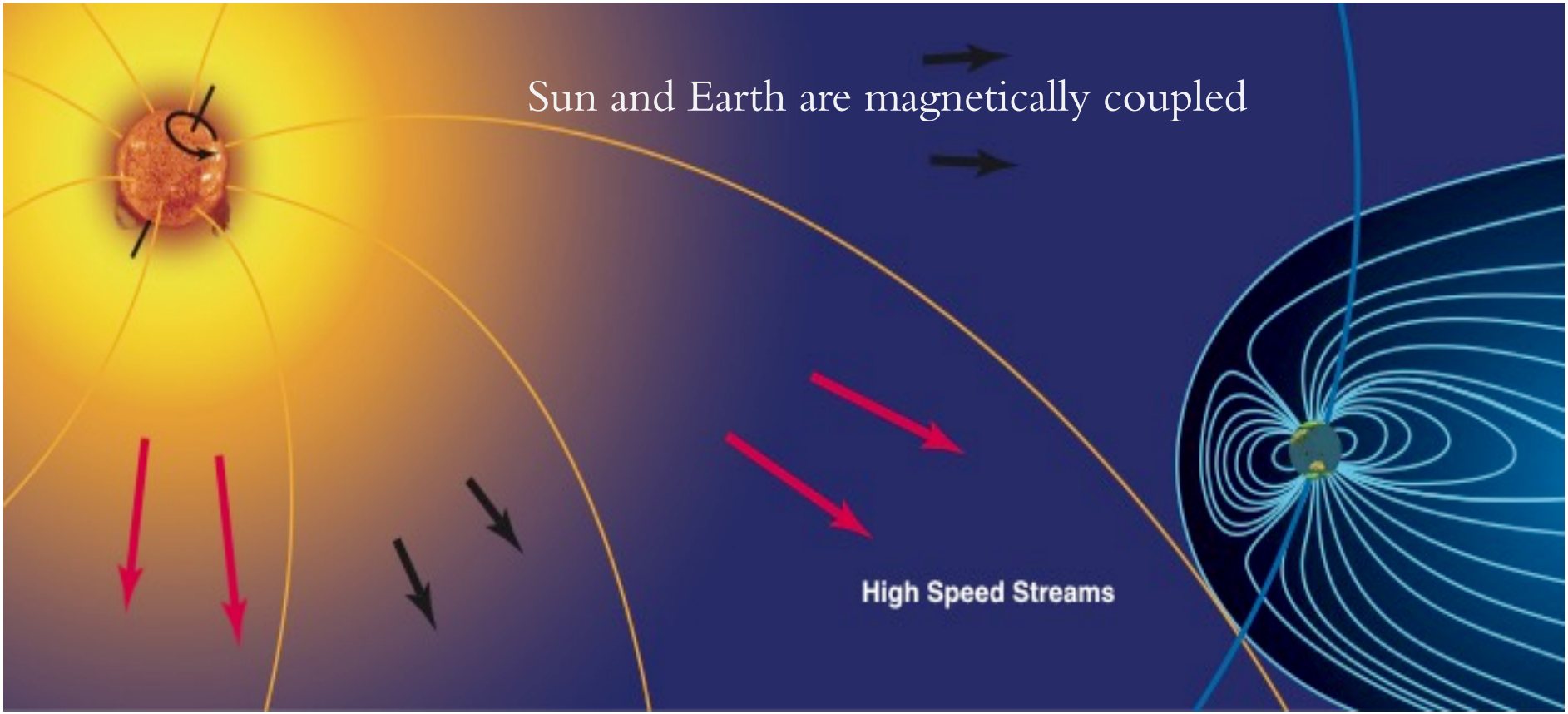
Better knowledge on the changing Arctic

Real-time observations on auroral region





Solar & terrestrial magnetic fields and Earth's atmosphere protect the critical infrastructure and life on the Earth.



- In a typical solar storm the solar wind speed is above 700 km/s.
- Known measured extreme speeds are around 2000 km/s giving 20 h transport time.
- Carrington storm transportation time has been estimated to be about 17 hours, corresponding to solar wind speeds 2450 km/s.
- Compare the speed of bullet, which is only 700 m/s.

Solar storm travel time is between 2-3 days

Even less than a day in an extreme cases

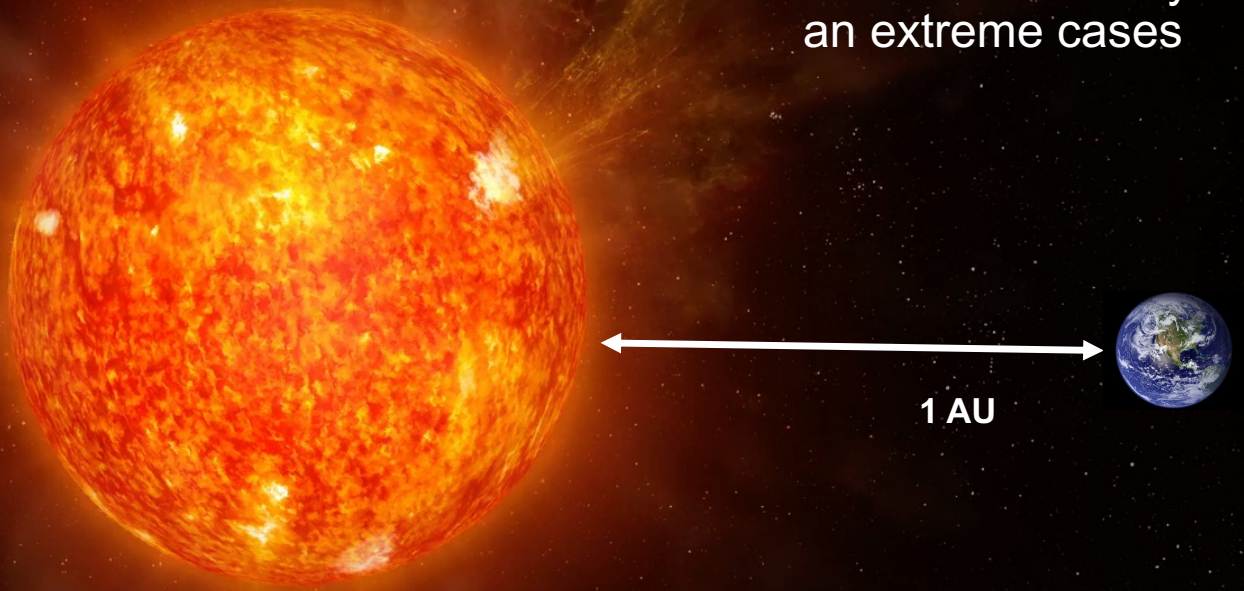
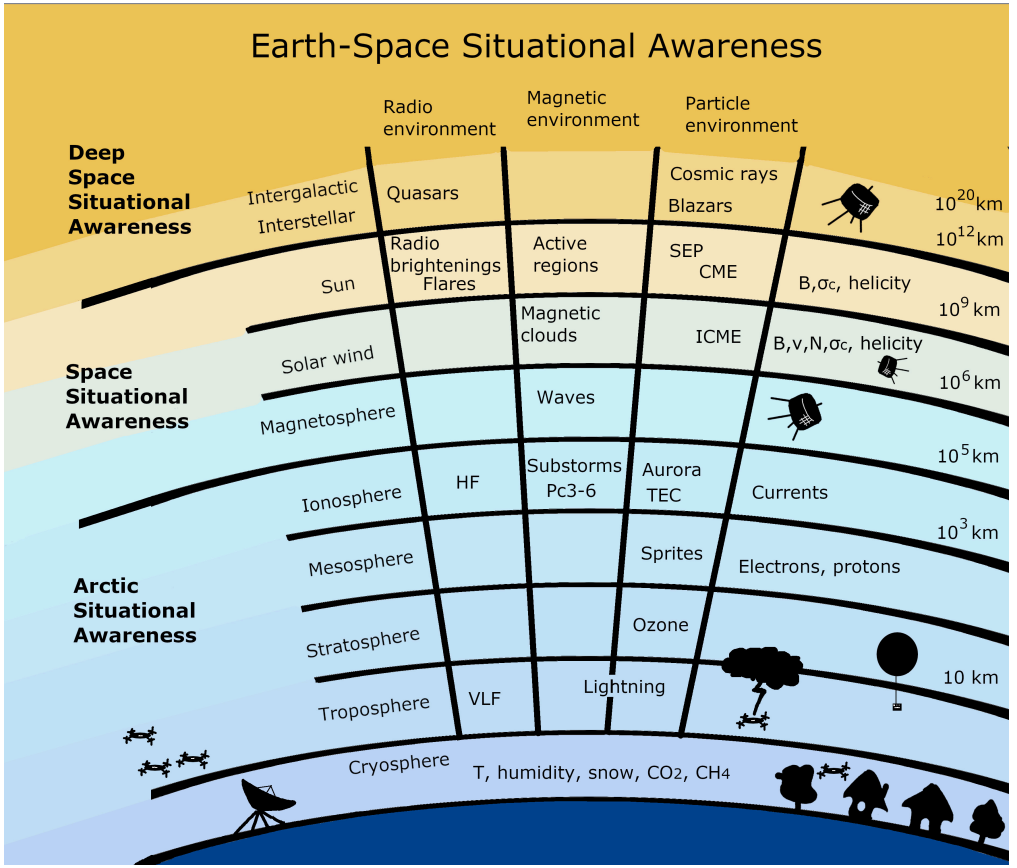


Image credit:
NASA/Goddard

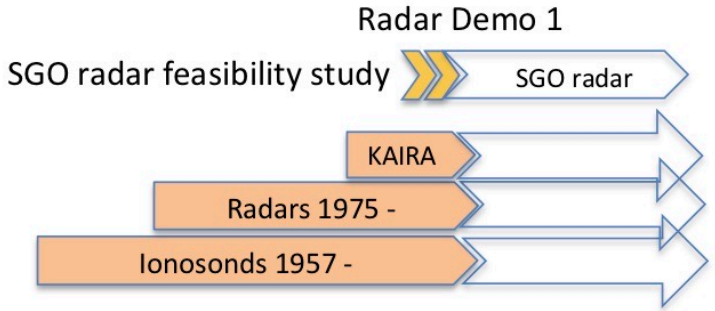
EARTH-SPACE RESEARCH ECOSYSTEM (E2S)

@FIRI INFRASTRUCTURE ROAD MAP



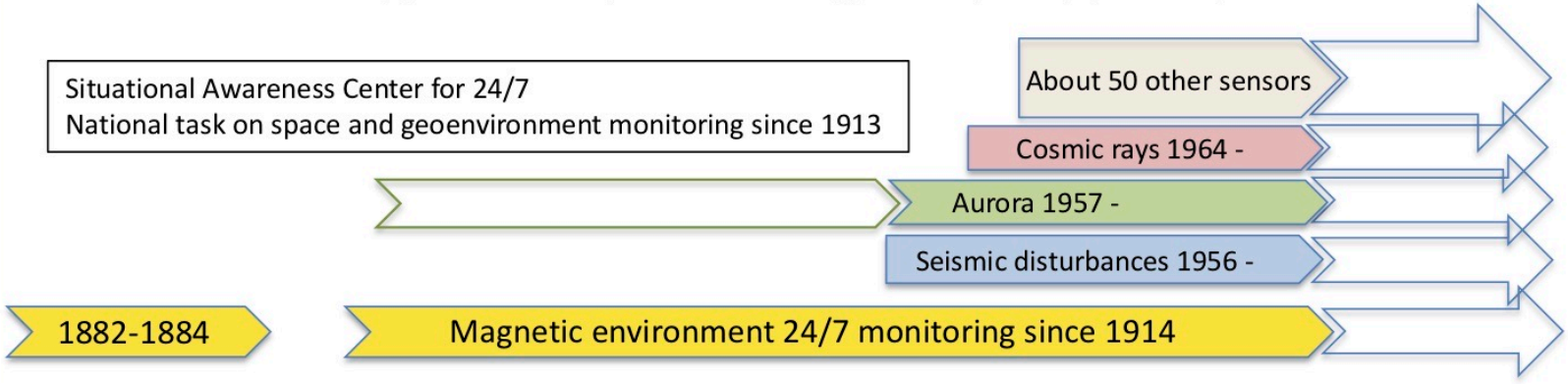
Radars and SST-capability (SST)

What is measured? Content and structure of ionosphere, satellite orbits, Space debris, solar storms, flares, radio disturbances.



Space weather monitoring and situational awareness (SSA/SWE)

What is monitored? Space weather and space climate, geohazards, auroral substorms, particle storms, cosmic rays, seismic hazards, GPS-disturbances, pulsations, waves, space safety.



More information:

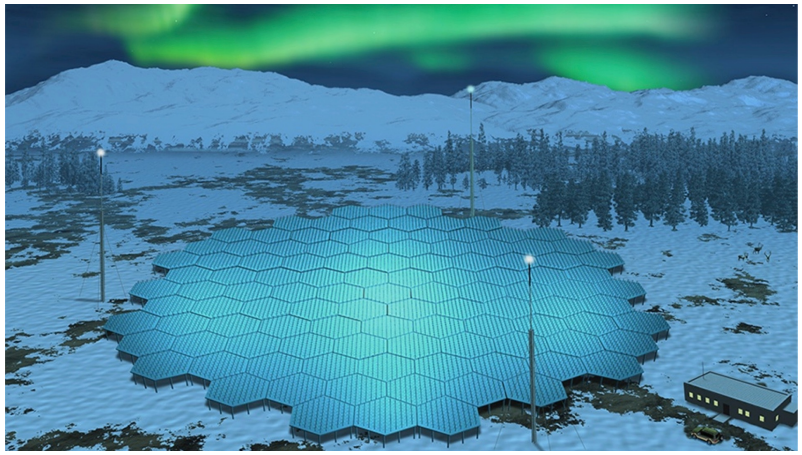
www.sgo.fi
Eija.Tanskanen@sgo.fi

Sodankylä Geophysical Observatory

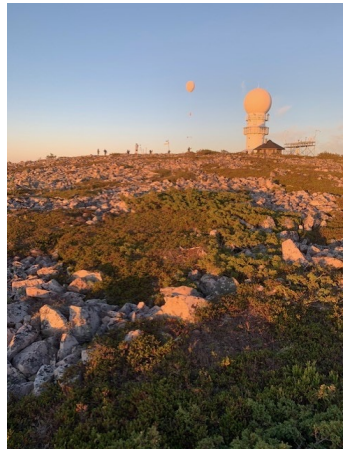
Drone fleet

* Unique measurements, 24/7 monitoring and in-house built instruments
* Observational geo and space physics and forefront research
* National task on the geo- and space environment monitoring since 1913

Magnetic measurements since 1914

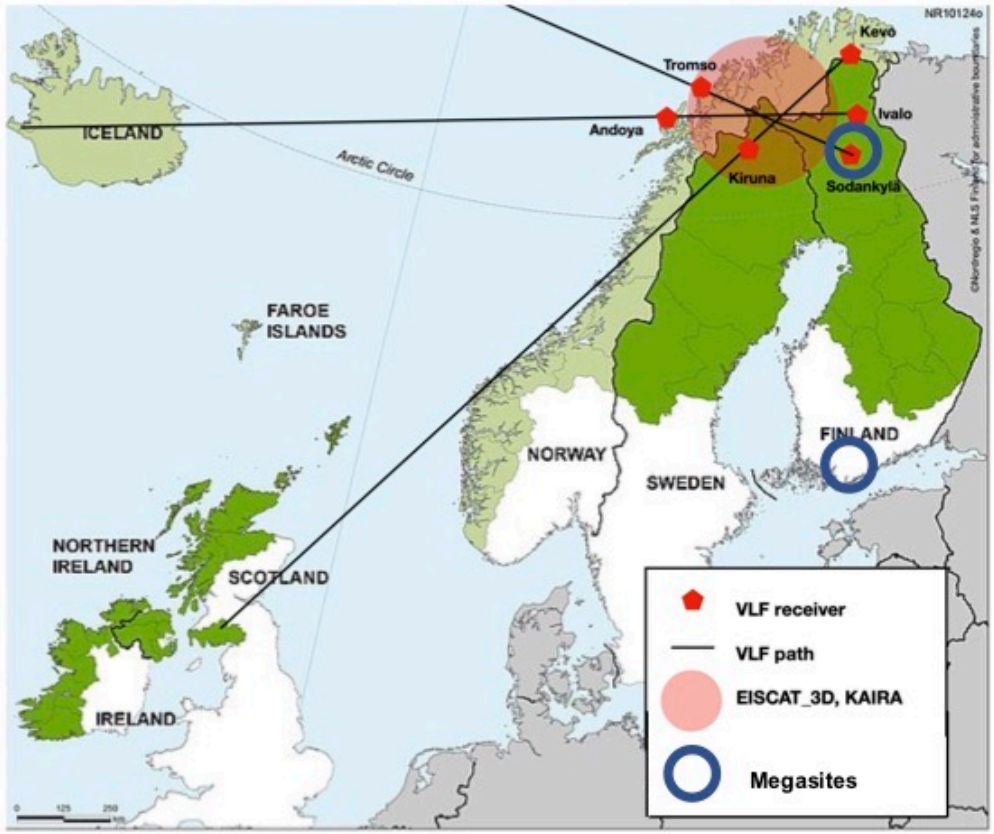


Atmospheric and solar observations

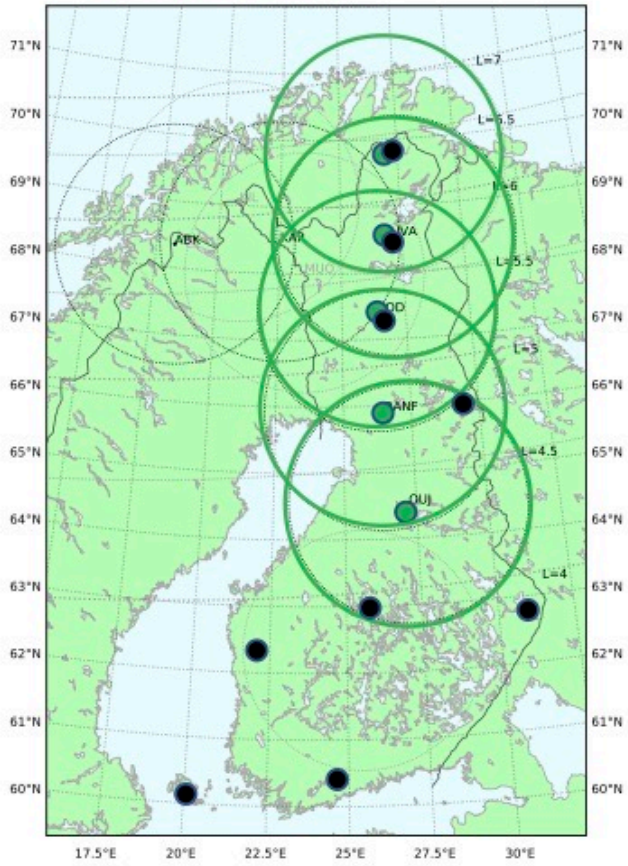


Stratospheric balloons and satellites

Tähtelä and Metsähovi megasites, KAIRA and new VLF network



All-sky cameras



Yhteiskunnan perustoimintojen turvaaja

Reilu sata vuotta ympäristön monitorointia observatoriolla

Satelliittiturvallisuus

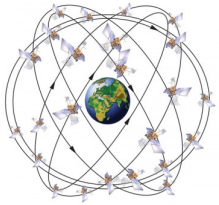
Valtakunnallinen ja kansainvälinen tehtävä geoympäristön ja avaruuden monitoroinnista vuodesta 1913.

SGO:n yli 70 sensoria monitoroivat lähiympäristön ja avaruuden tilannekuvaa ympäri vuorokauden ja vuoden.

Avaruussääpalveluita (> 150) yhteiskunnan eri sektoreille.

Navigointi, säteilyturvallisuus

Viestintä



Energiahuolto

Paikannus

Synkronoidut järjestelmät

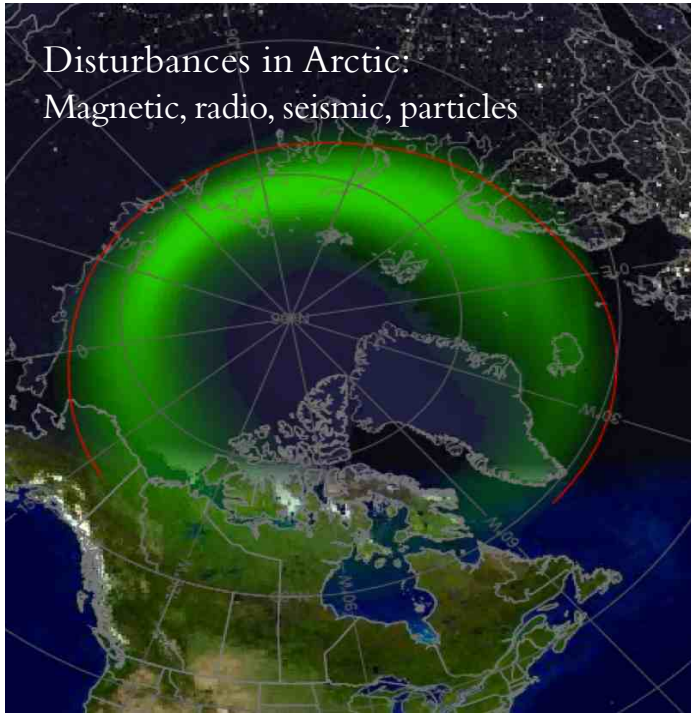
Ydinturvallisuus

Sähkö

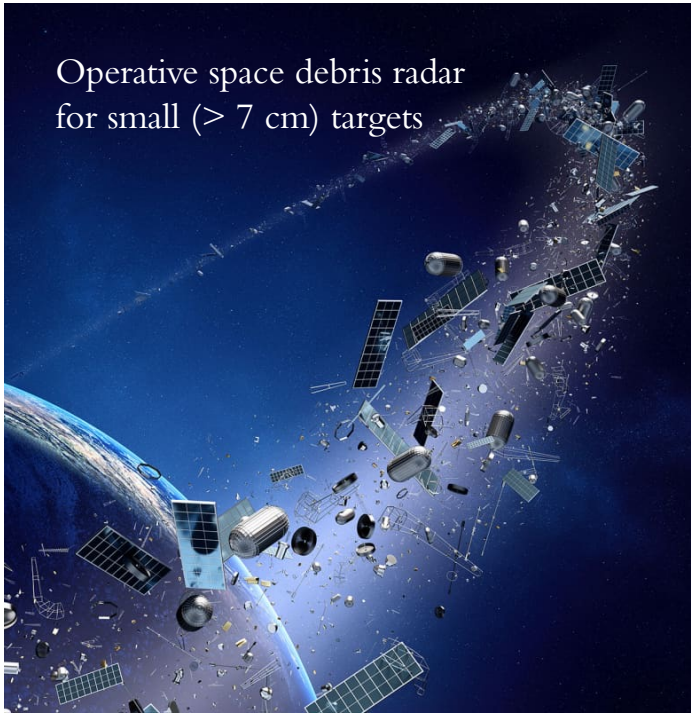
Geohazards and space safety

Widely acknowledged in the risk assessments

Finland joined to ESA/SSA program in 2010
National risk assessments since 2015
Regional risk assessment, 2021



National risk assessment, 2018
Regional risk assessment, 2021



Regional risk assessment, 2021.
Finland aims to join to EU/SSA.