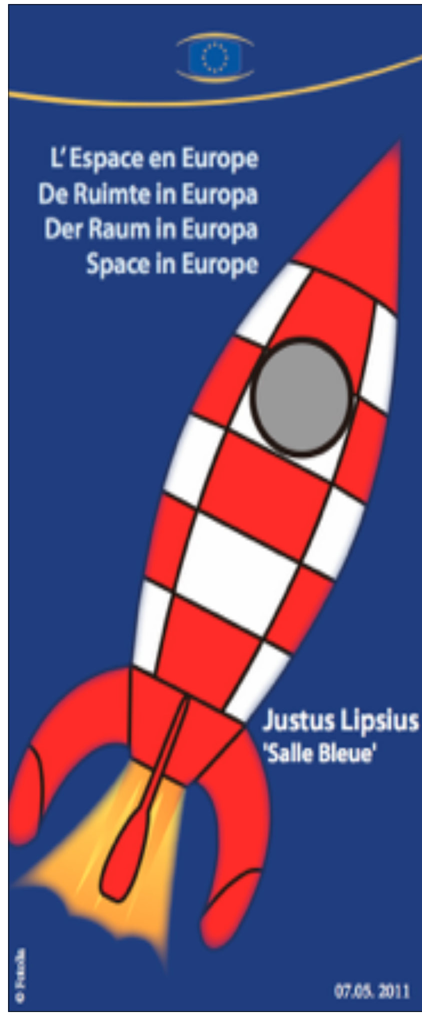
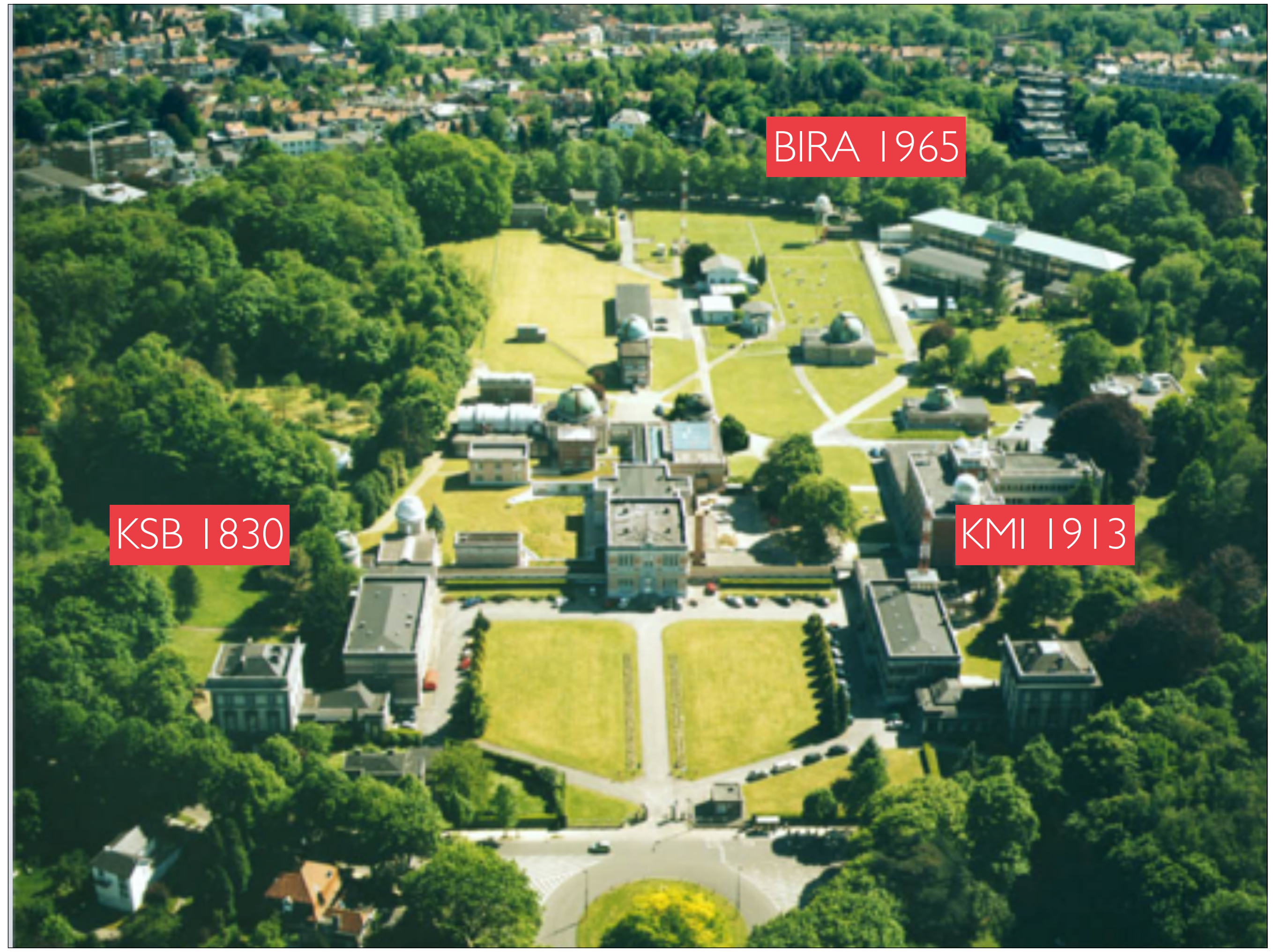


Regisseer je eigen zonnefilm

Bram Bourgoignie - Olivier Lemaitre - Petra Vanlommel
Solar-Terrestrial Centre of Excellence


BIRA 1965
KSB 1830
KMI 1913

OPTIES

Space weather forecast
Disaster movie
JHelioviewer PR movie
Music video clip

You can make use of 'stop motion'

Het **gewone weer** speelt zich af in de onderste laag van de atmosfeer, de thermosfeer.
Als we **hoger** gaan, komen we in ijlere lagen terecht waar **effecten van het ruimteweer** merkbaar zijn. Als we nog hoger gaan komen we in de ruimte terecht waar een bijna vacuum is. Maar niet helemaal. Er zijn nog atomen en ionen die met elkaar interageren ten gevolge van energetische gebeurtenissen die hun oorsprong vinden op de zon.

Sommige van deze effecten zijn nuttig en laten ons toe om bv met radiogolven met elkaar te communiceren over lange afstanden. Er zijn mooie en fascinerende effecten zoals aurora en dan nog andere effecten die we liever niet zouden hebben. Net zoals bij het gewone weer, hangt de impact af van de gebeurtenis en de situatie.

We are all familiar with terrestrial tropospheric weather. It is what we experience all around us; our atmospheric environment. It may be fine, cloudy, stormy or sunny. It may rain or hail. We know about temperature and pressure and humidity. This is all about weather in the lowest 10 km of our atmosphere.
As we go out into space, the atmosphere becomes very thin, until by the time we are in space, it has almost vanished. Almost, but not quite. Even in space there are some atoms which are often moving very quickly. Many forms of energy also move through space and it is the interaction of energy and atoms that produces what we refer to as space weather. In particular, space weather is the changes that occur in the space environment.

The sun is the source of 'normal' terrestrial weather. It is also the primary (but not the only) source of space weather. Most aspects of space weather affect us to some extent. The more our society becomes dependent on technology and the more we utilize space, the more we are affected by space weather. Some aspects of space weather are benevolent, and allow activities not otherwise possible such as long range radio communications. Some aspects are benign but fascinating such as the Aurora, and some are malevolent. Like terrestrial weather, it depends on the situation and the event.

Waarnemingen gaan terug tot het begin van de mensheid.

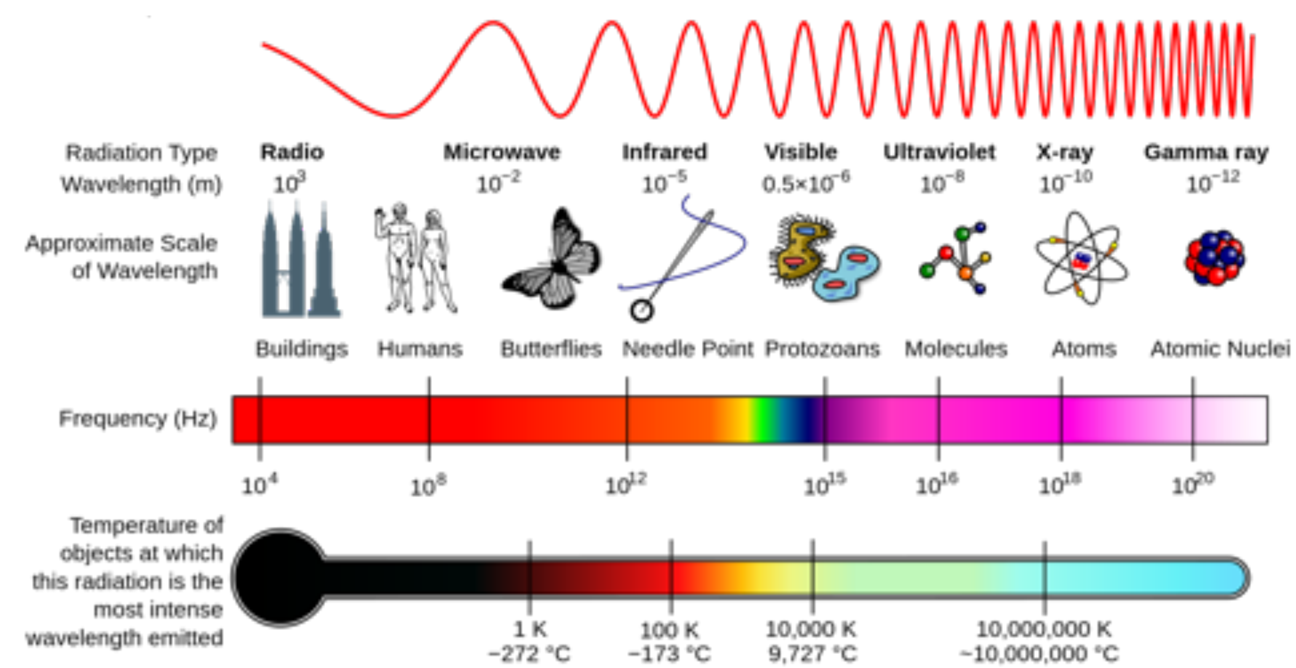
The total solar eclipse of 1 August 2008, observed from Siberia.
What happens:
-visible light from the disc bounces off from plasma in the corona in our direction (Thompson scattering)
-the solar disc is a million times brighter than the corona, the light we see during eclipse is always there but swamped in the much brighter direct light

Seeing the corona 'naturally' is exceptional on astronomical scales:
- the apparent size of moon and star have to match the distance planet-star
- the moon should have no atmosphere
- the planets atmosphere should be transparant


Sunlight is made of many colors. Rainbows let us see all these different colors at the same time.

We can feel heat that comes from the sun.
It keeps us warm on Earth.


FACTOR
TEN
MILLION
-Tayler-
CARTOONSTOCK
.COM
© Original Artist / Search ID: ktyn127
Rights Available from CartoonStock.com



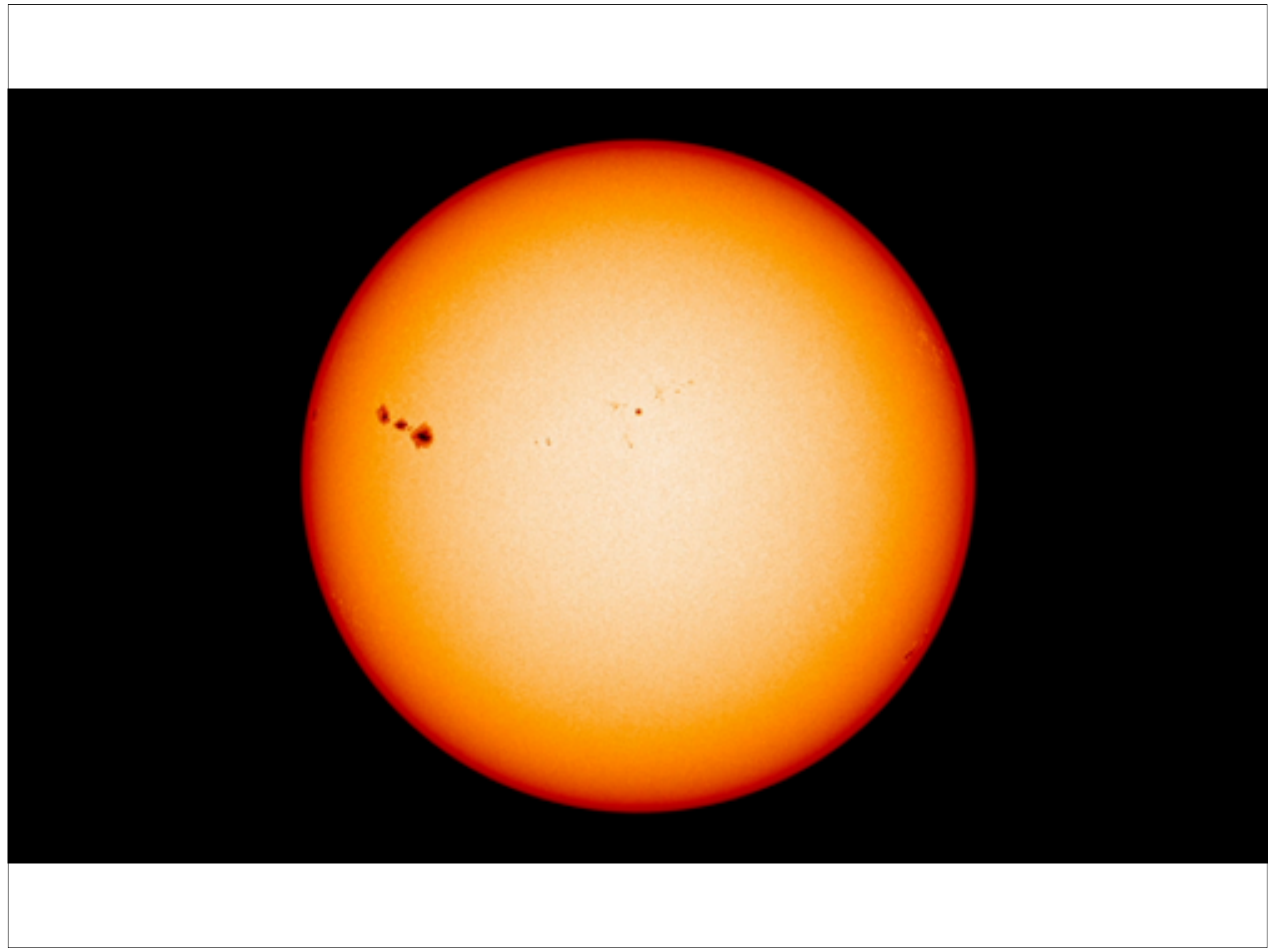
Radiation Type
Wavelength (m)
Radio
10^3
Microwave
10^{-2}
Infrared
10^{-5}
Visible
0.5×10^{-6}
Ultraviolet
10^{-8}
X-ray
10^{-10}
Gamma ray
10^{-12}
Approximate Scale of Wavelength
Buildings
Humans
Butterflies
Needle Point
Protozoans
Molecules
Atoms
Atomic Nuclei
Frequency (Hz)
10^4
10^8
10^{12}
10^{15}
10^{16}
10^{18}
10^{20}
Temperature of objects at which this radiation is the most intense wavelength emitted
1 K
−272 °C
100 K
−173 °C
10,000 K
9,727 °C
10,000,000 K
~10,000,000 °C


01206_230008

Om een object te bestuderen nemen we foto's

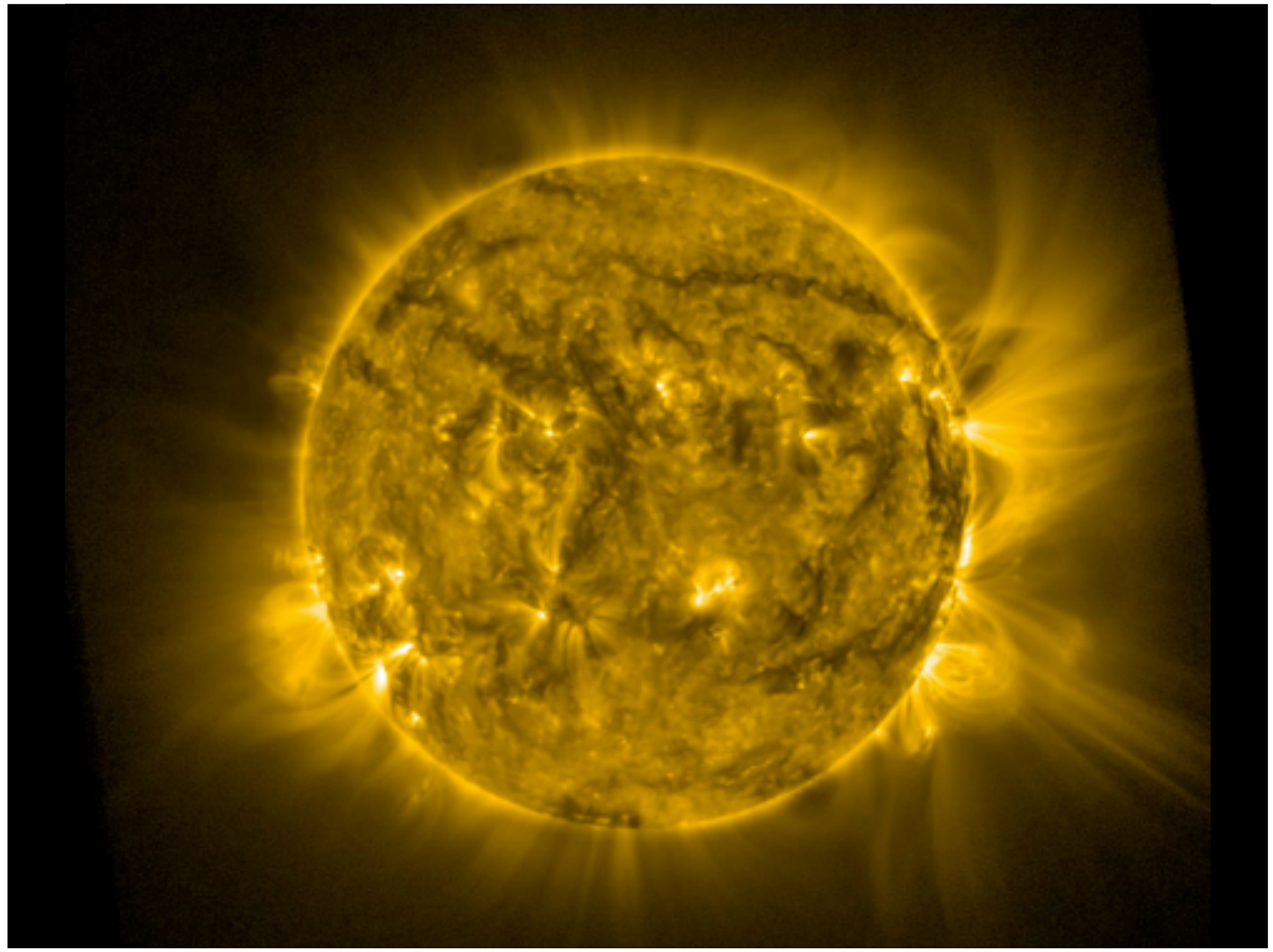
A doctor can use an x-ray camera
to take a special picture of your bones.

These pictures can show doctors parts of your
body that they can't normally see.



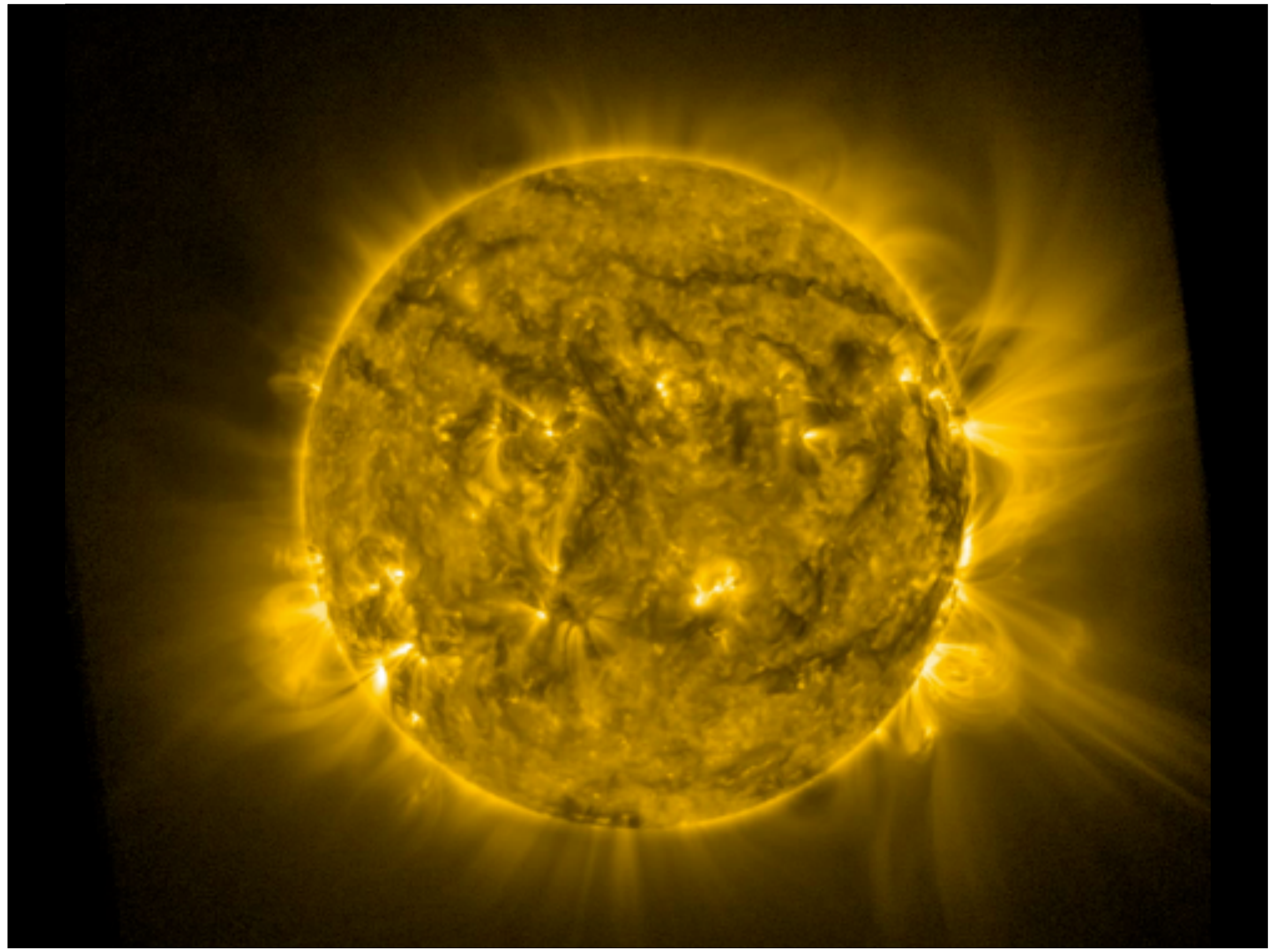
zonnevlekken zijn gelinkt met lichte vlekken in de zonnecorona. Als we nu eens de variatie bekijken in het EUV?

We use many tricks to observe the Sun and its activity. One of them is to look at the Sun using different parts of the light spectrum, thus in different wavelengths. From Earth, with the naked eye, we see the surface of the Sun in white light like this. However, now that I start the movie, you can see how looking at the Sun in other wavelengths from space reveals very different structures and complexity. For this we mainly use extreme ultraviolet wavelengths because we are studying the hot outer region of the Sun, the corona. We see active regions, these are the bright patches, that show up in EUV wavelengths where the sunspots were first seen in white light. We also see the effects of the sun’s magnetic field in the many loops above these sunspots. Each wavelength shows us different aspects and different layers of the solar atmosphere and by combining them, we try to build a complete picture of the solar activity.
Therefore, we have many instruments in space to observe the solar atmosphere. This movie was made combining different observations from the AIA telescope on board the Solar Dynamics Observatory. However, my favourite solar imager is the…



magnetische structuren
die bovendien zeer dynamisch zijn

Variaties in het EUV over een tijdspanne van een aantal carrington rotations

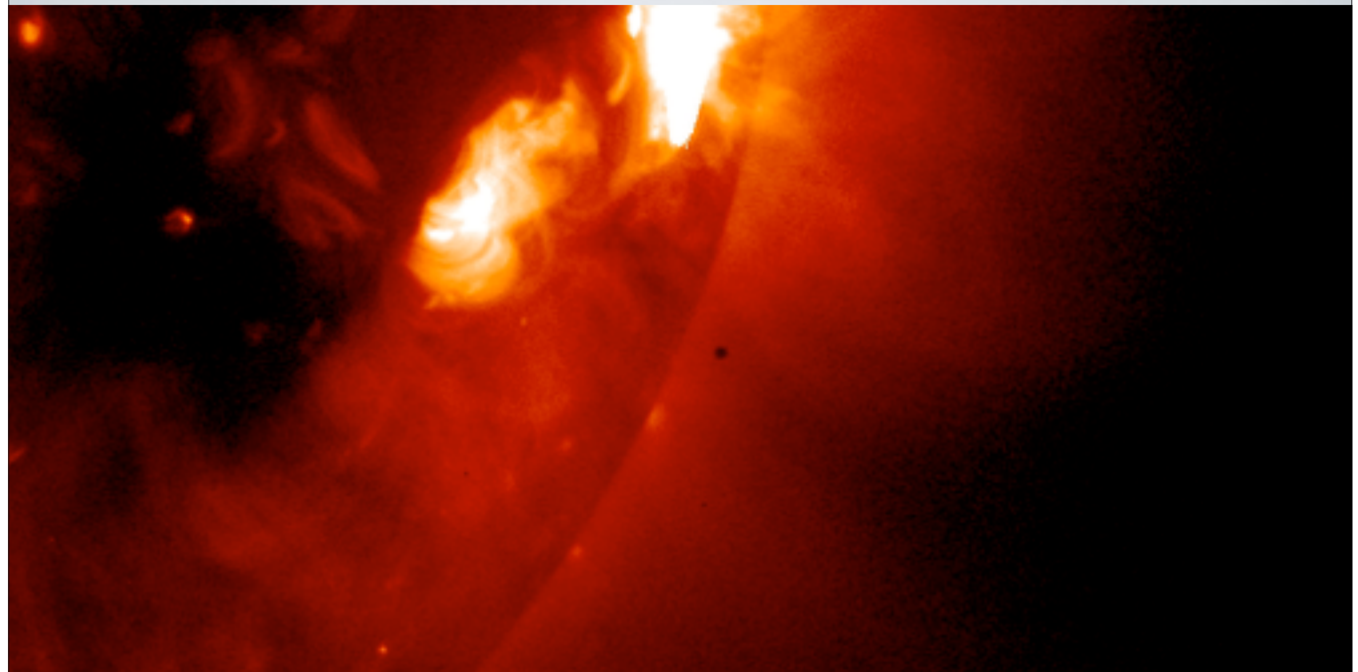


De zon schijnt al sinds mensenheugen. Sinds we bestaan is nog geen enkele zonnestorm geweest die de mensen van de aardbol heeft geveegd. We worden beschermd door de magnetosfeer en door de atmosfeer tegen de energie die de zon continue uitstoot of tegen de plotse energiepieken (zonnestorm).

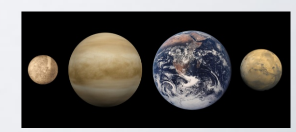
Sinds de start van het ruimtetijdperk, hebben we de zon op andere manieren kunnen bestuderen: dynamisch, energiek, geweldadig.
Samen met de start van het ruimtetijdperk, zijn onze hoogtechnoligische systemen uitgebouwd: navigatie (GNSS), satellieten, radio communicatie, grote energietoevoer...

Met die hoogtechnologische systemen bestuderen we de zon maar tegelijkertijd is onze maatschappij zeer kwetsbaar geworden. Het is een kluwen van afhankelijkheid.

Het is het magnetisch

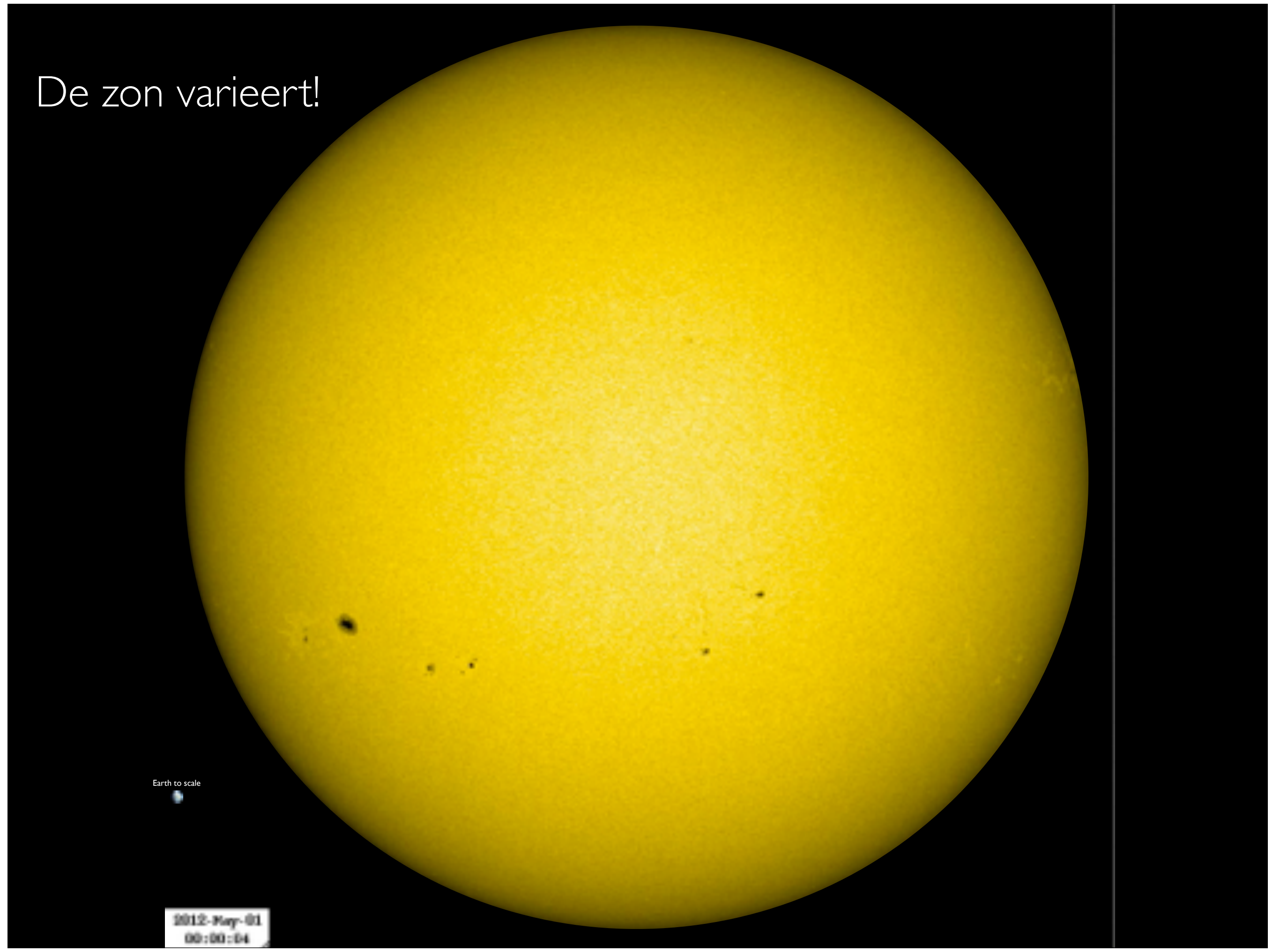


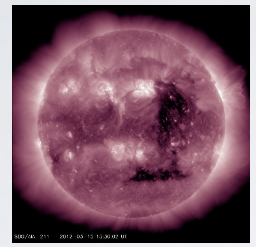
MERCURIUS OVERGANG

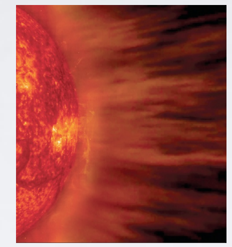


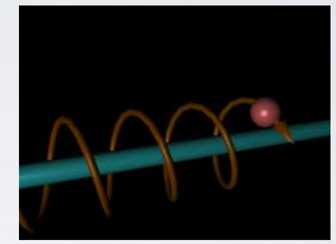
De zon waargenomen in X-straling door het instrument XRT op de satelliet Hinode (8 november 2006) met op de voorgrond de overgang van Mercurius. In tegenstelling tot de zon, schijnt Mercurius niet in X-straling en is deze planeet dus zichtbaar als een kleine, donkere stip die zich over het scherm beweegt. Merk op hoe klein deze planeet is in vergelijking met de actieve gebieden op de zon (de zeer heldere vlekken).

Mercurius, Venus, Aarde en Mars
jupiter saturnus uranus neptunus


De zon varieert!
Earth to scale
2012-May-01
00:00:04

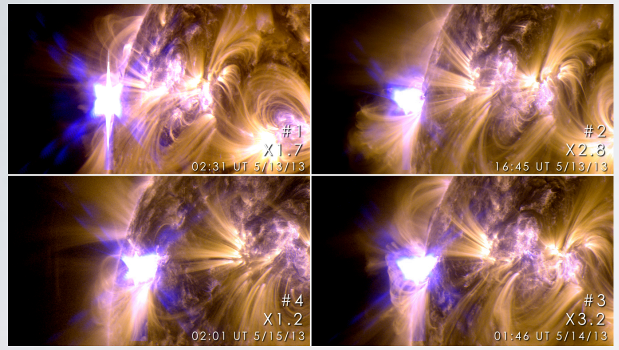


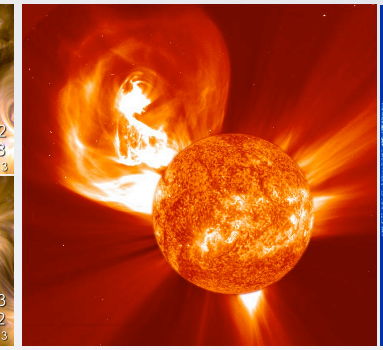
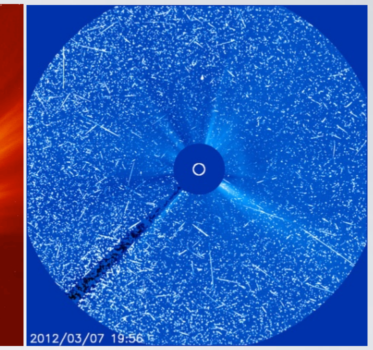




straling - massa - deeltjes

DE ZON VERLIEST ENERGIE
RUIMTEKLIMAAT

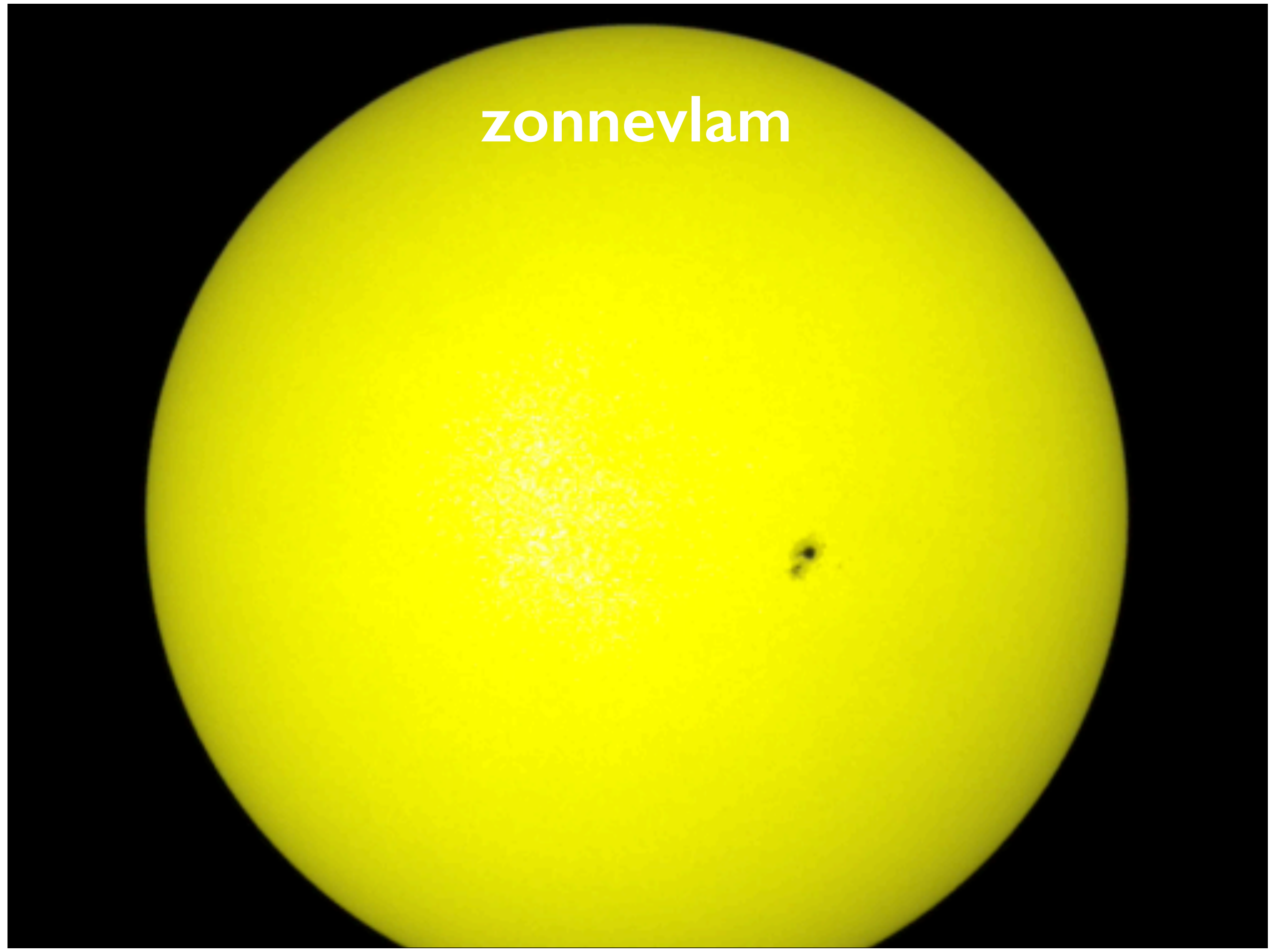


zonnevlam - CME - protonstorm

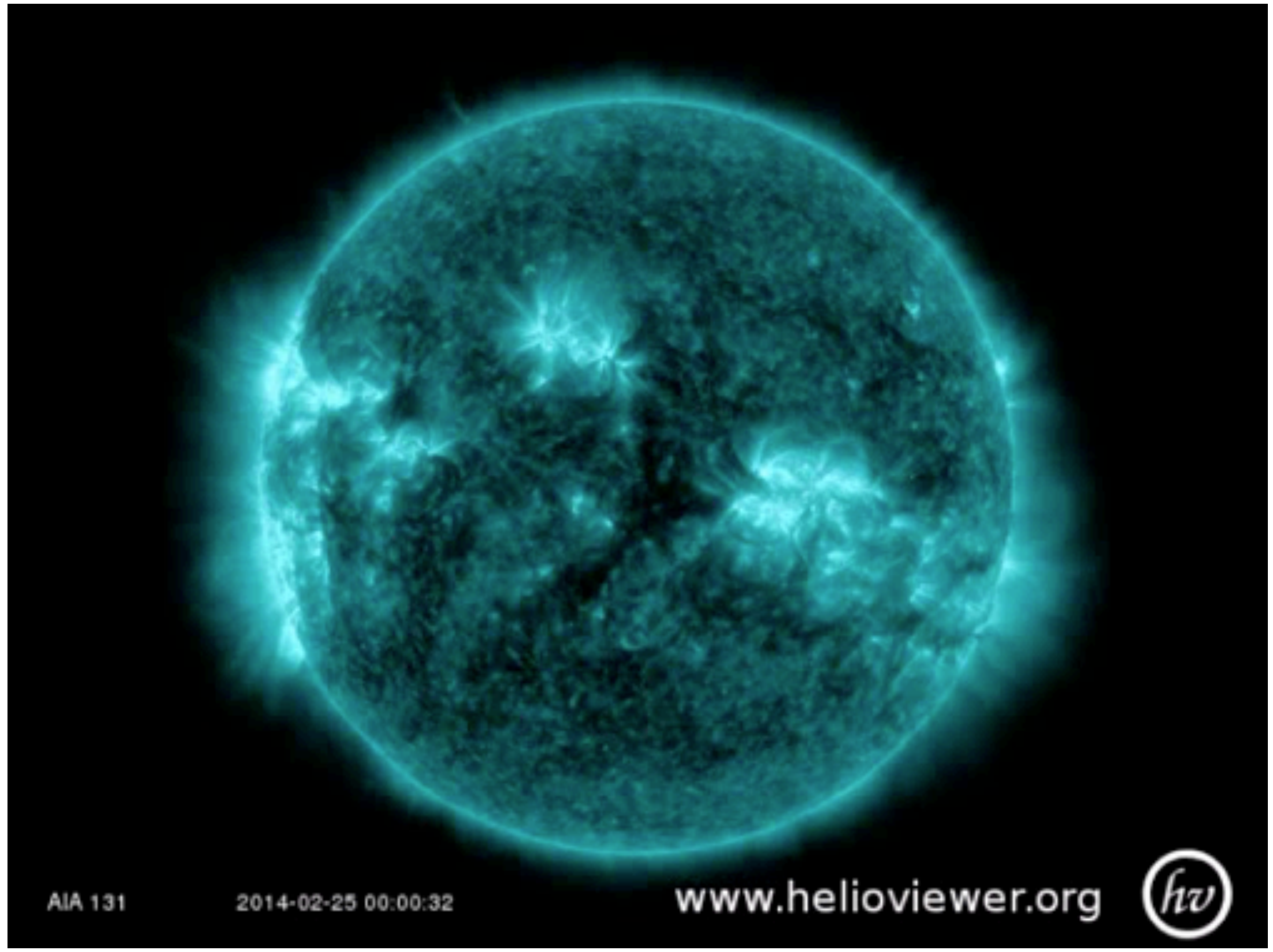
DE ZON VERLIEST ENERGIE RUIMTEWEER

Explosies van licht en explosies waarbij gaswolken en geladen deeltjes vanaf de Zon in de ruimte worden geblazen

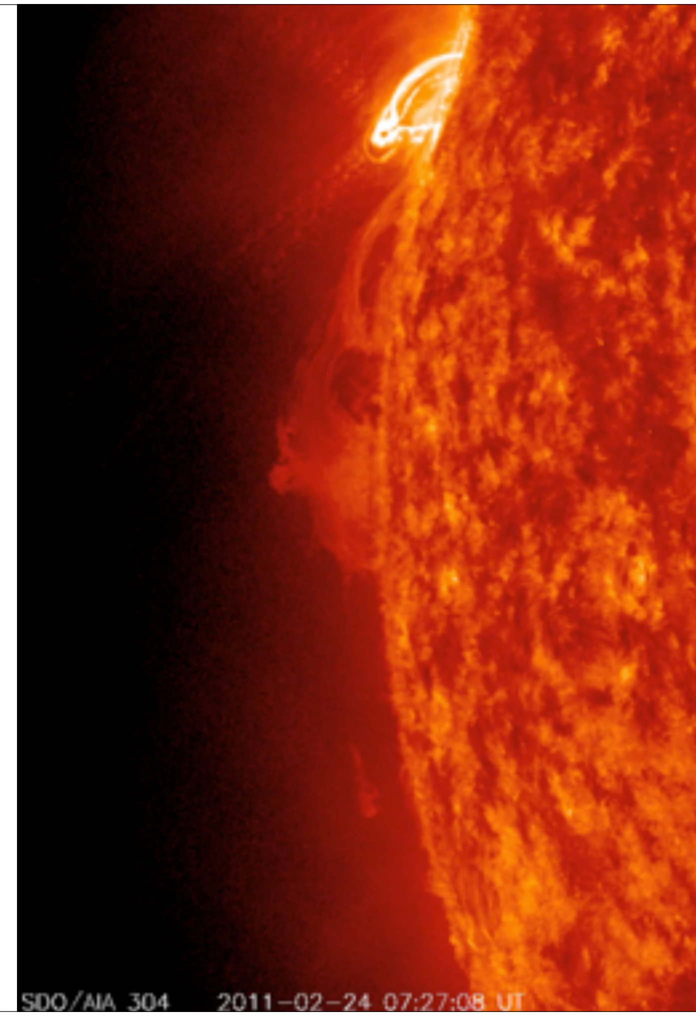


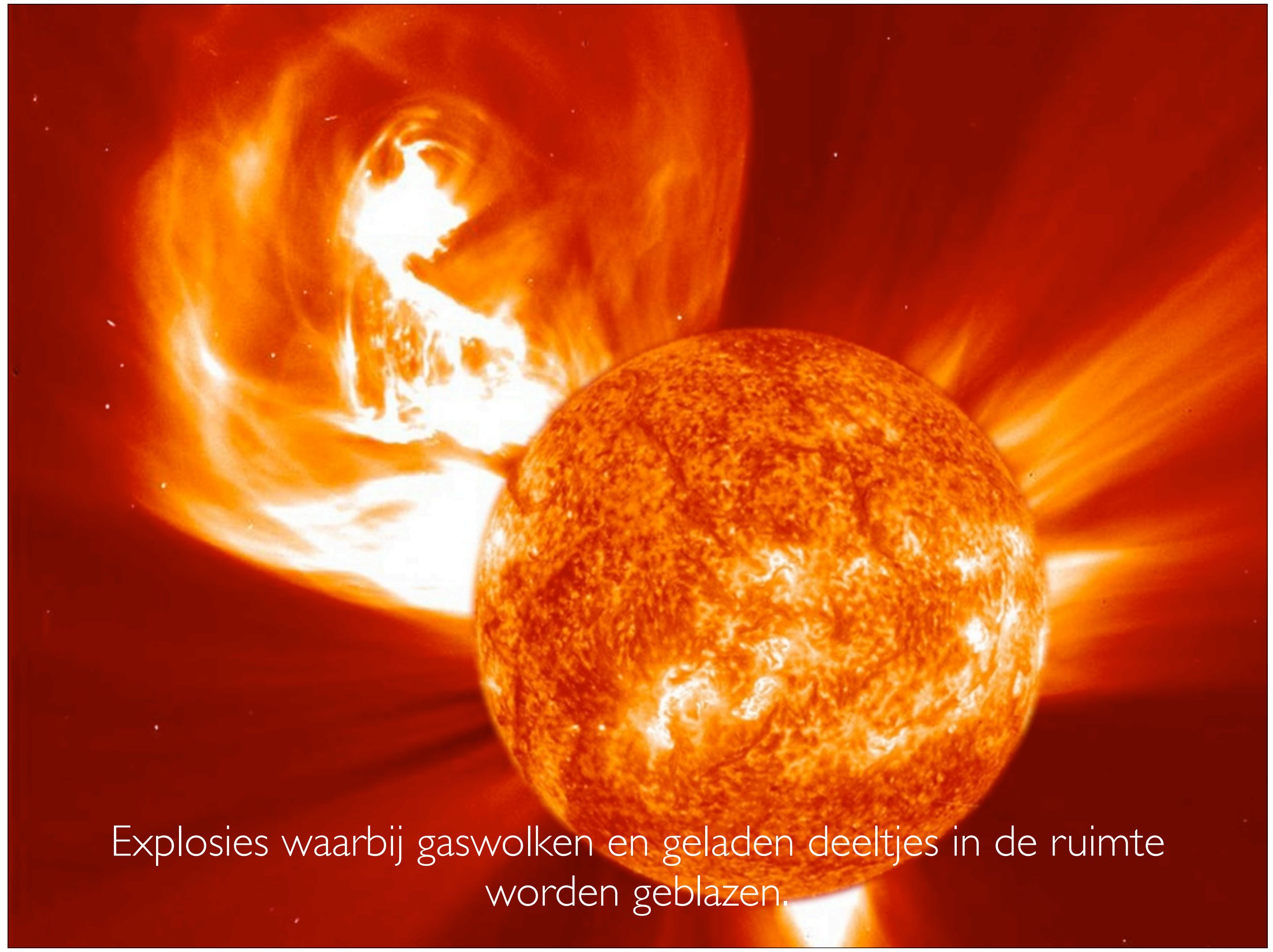
zonnevlekken —> zonnevlammen —> zonne-activiteit — meer een directe meeting van energie-input in het aardsysteem.

licht-erupties
als we nu eens al het licht bestuderen dat de zon uitstraalt. Misschien varieert het hier

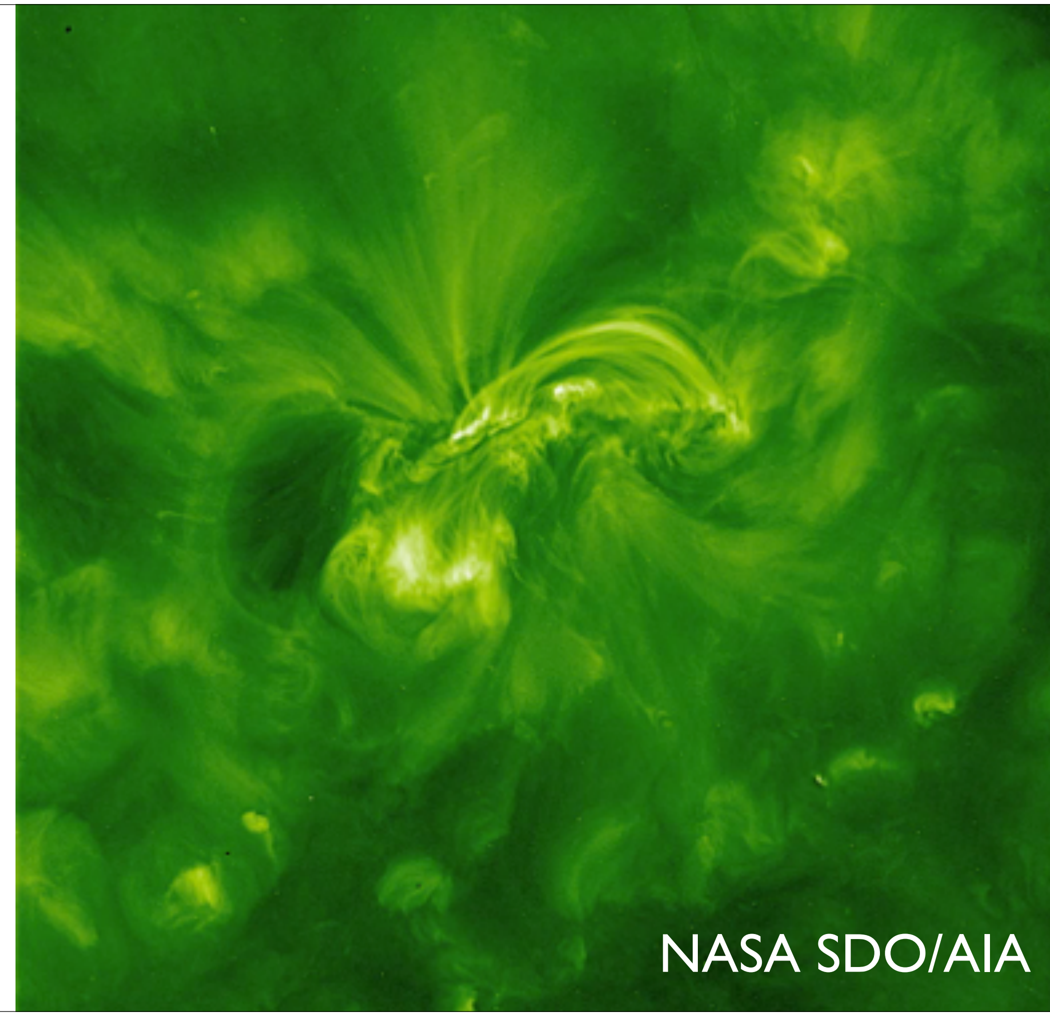


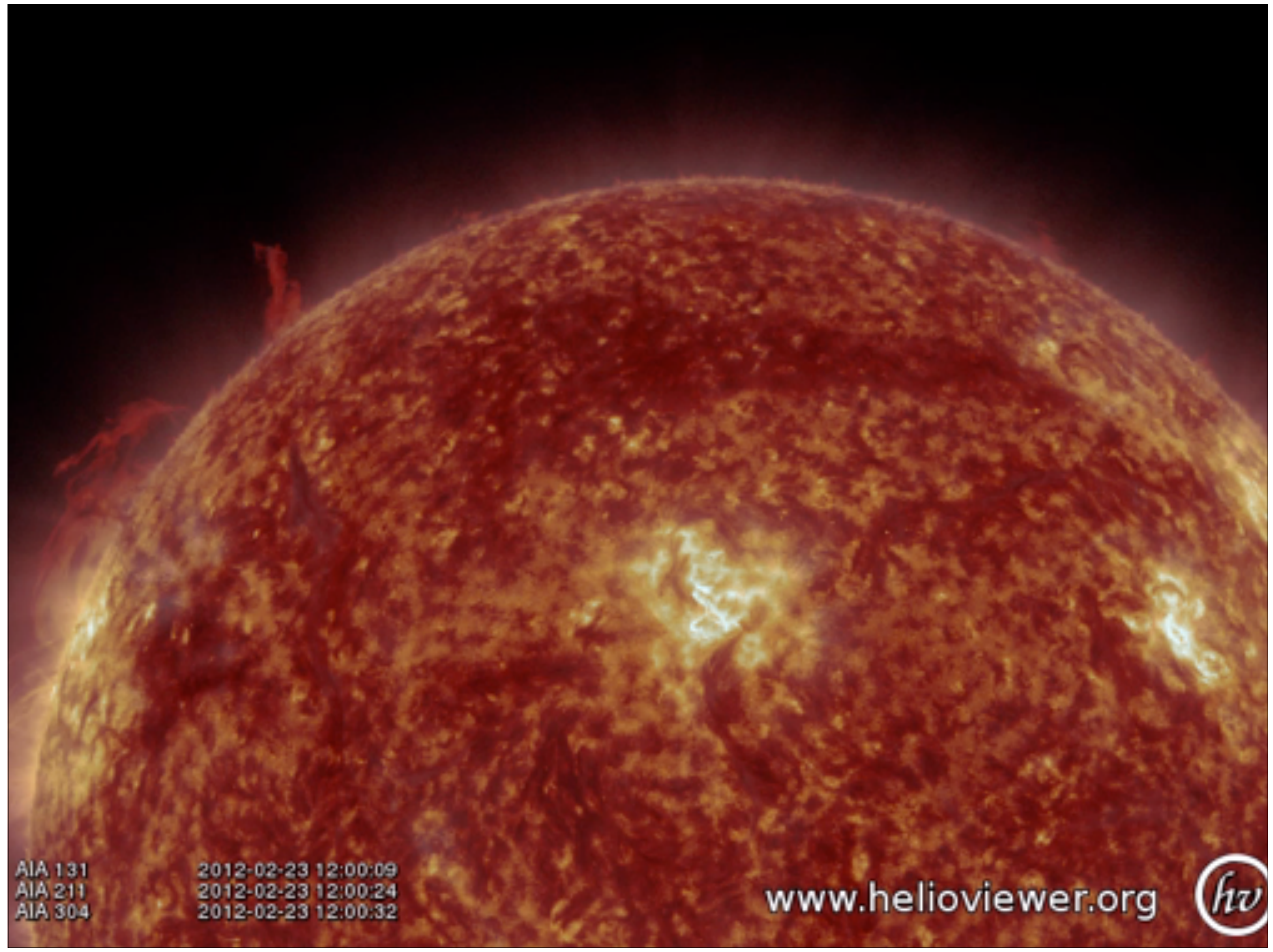
je ziet naast de lichtflitsen ook nog ‘iets’ anders wegvliegen


SDO/AIA 304 2011-02-24 07:27:08 UT

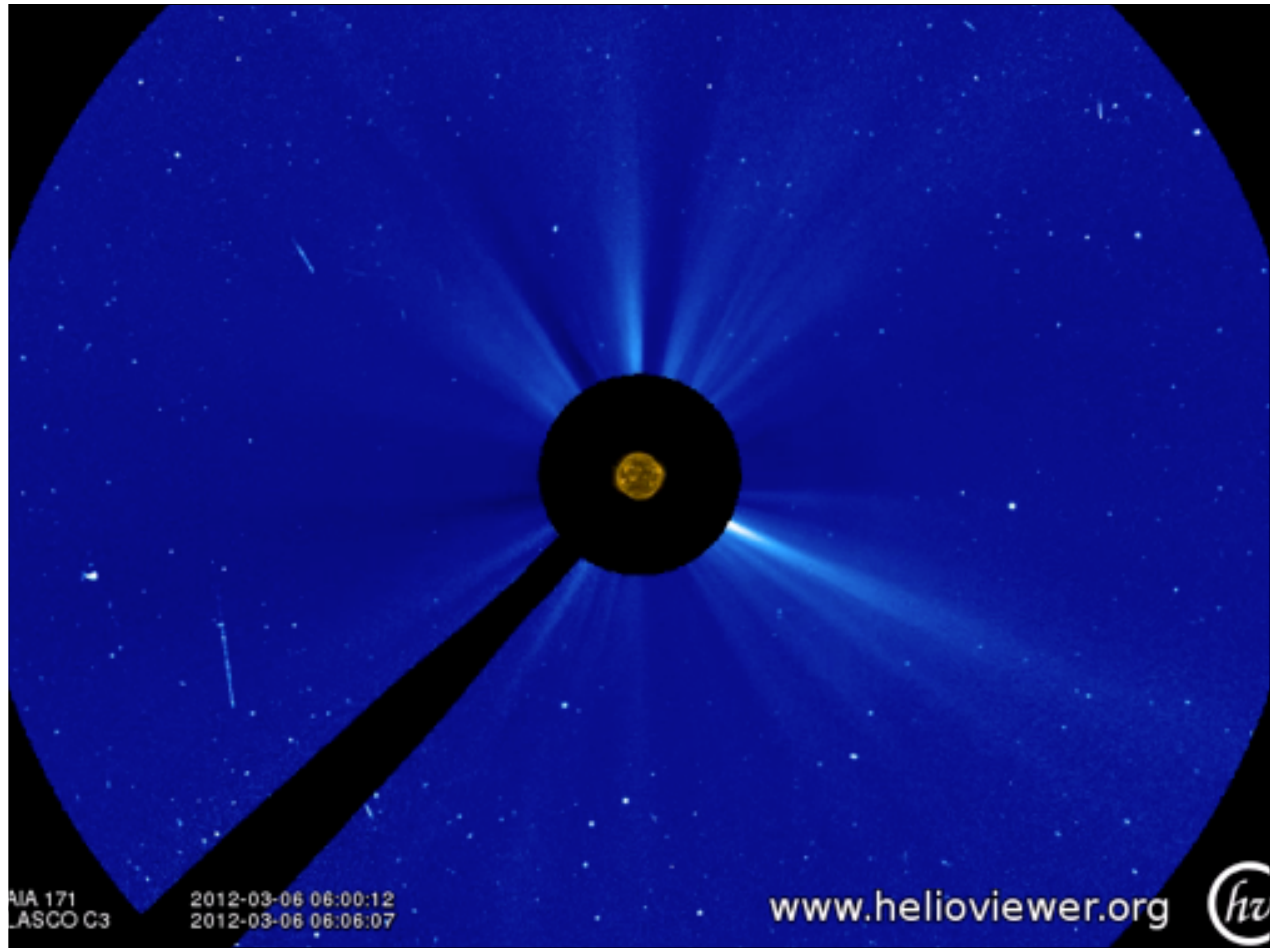


Explosies waarbij gaswolken en geladen deeltjes vanaf de Zon in de ruimte worden geblazen

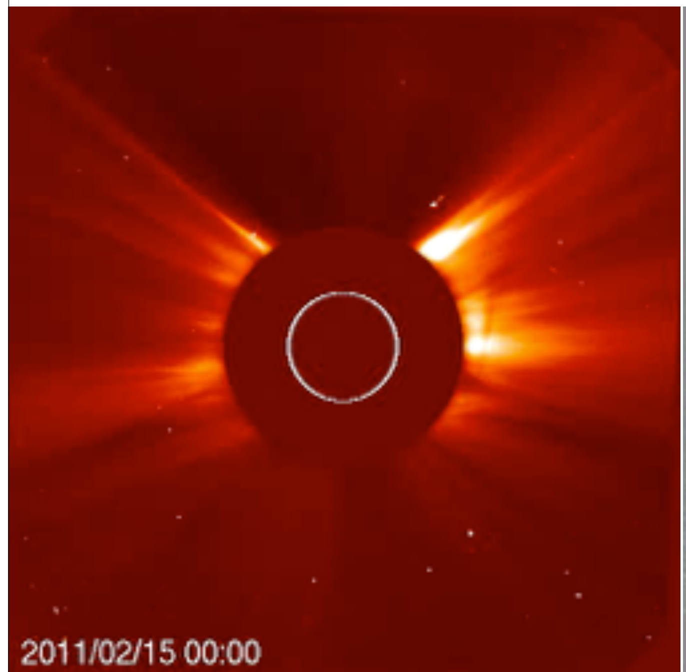

NASA SDO/AIA

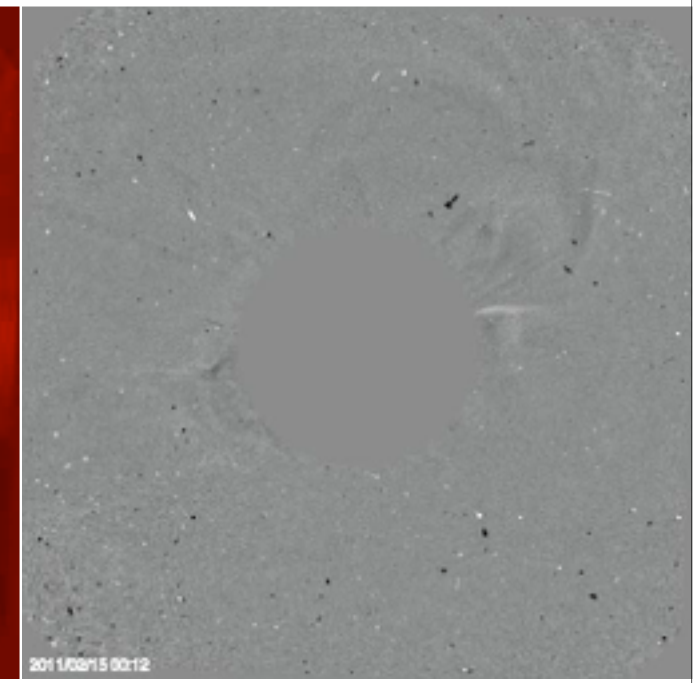


An at least 400.000 km long filament in the northeast solar quadrant erupted in the night of 23-24 February, without leaving an x-ray signature. Usually, a shock wave spreads out from the blast side in a more or less round shape. However in this case, because of the length of the filament, the solar tsunami spread parallel from where the filament originally was located. This "canyon-of-fire" as it was soon dubbed on the internet, raced away with speeds up to 20.000 km/h and swiftly covered a transient coronal hole (dark patch to the lower right of the erupted filament) that was generated earlier by the eruption.


AIA 171
LASCO C3
2012-03-06 06:00:12
2012-03-06 06:06:07
www.helioviewer.org

HALO CME

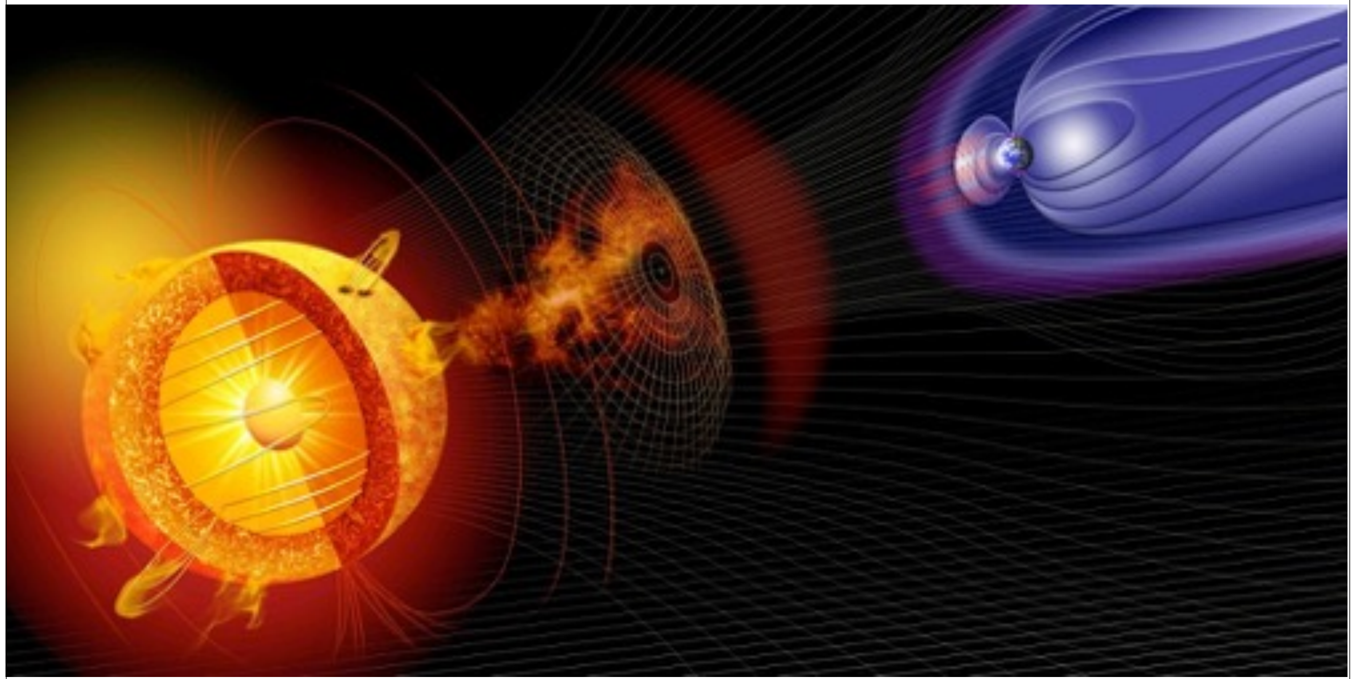




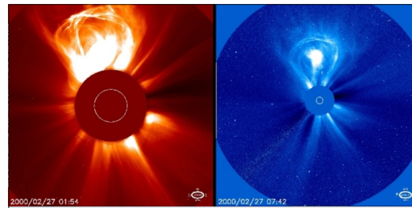
SOHO / LASCO c2 running difference

CMEs cause the most extreme geomagnetic storms. Therefore, there is great interest in understanding the properties of CMEs, especially when they have a halo signature around the solar disk that indicates the CME is aimed at Earth.
Furthermore, if the CME results in a magnetic cloud with a strong and out of ecliptic magnetic field,forecasts are likely for strong to extreme storms.

Het aardmagnetisch schild beschermt ons tegen ruimtewolken.

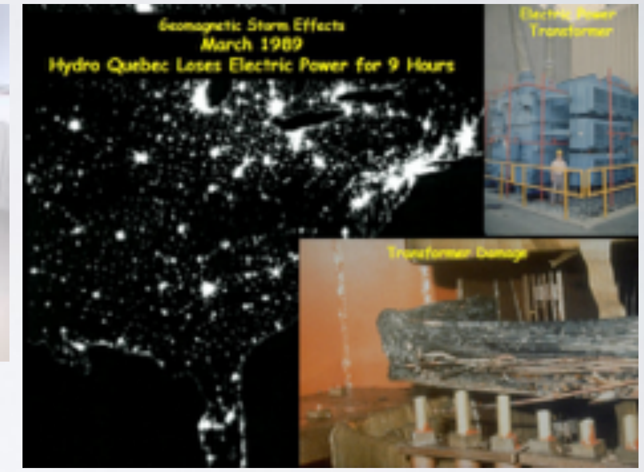



De aardatmosfeer beschermt ons tegen deze lichtstormen



GEVOLGEN

- GIC
- GNSS
- Aurora
- Drag on satellites



Malmö Blackout - Oct 30, 2004

- About 50 000 customer were without electricity in Malmö, Sweden for 20-50 minutes
- First known power grid blackout due to GIC in Europe
- An overcurrent relay was too sensitive to the third harmonic of 50 hZ. It has been replaced by a less sensitive relay later.

Global Navigation Satellite System

September 2, 1859, disruption of telegraph service.

One of the best-known examples of space weather events is the collapse of the Hydro-Québec power network on March 13, 1989 due to geomagnetically induced currents (GICs). Caused by a transformer failure, this event led to a general blackout that lasted more than 9 hours and affected over 6 million people. The geomagnetic storm causing this event was itself the result of a CME ejected from the sun on March 9, 1989.

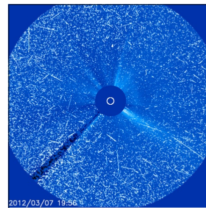
Galaxy 15 is an American telecommunications satellite which is owned by Intelsat. It was launched for and originally operated by PanAmSat, and was subsequently transferred to Intelsat when the two companies merged in 2006. It was originally positioned in geostationary orbit at a longitude of 133° West, from where it was used to provide communication services to North America. **In April 2010, Intelsat lost control of the satellite, and it began to drift away from its orbital slot, with the potential to cause disruption to other satellites in its path.**

3 april : B7 zonnevlam, CME-flank kan eventueel langs de aarde afschampen

5 april : K=5,6 — Galaxy 15 anomaly

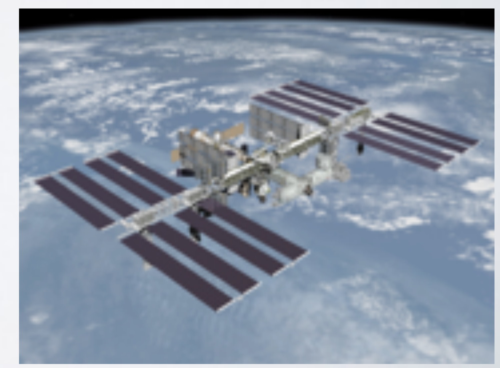
near equinox en op moment net aan middernacht kant aarde, langs de kant van zonsopkomst (dawn)

On 27 December 2010, Intelsat reported that the satellite had rebooted as per design and the command unit was responding to commands again. In addition, the satellite had been secured in safe mode and the potential for interference issues from Galaxy 15 had ceased.[1] [2] On 14 January 2011 the satellite was located near 93° west,[3][4] where further testing is scheduled to be performed.[5] On March 18, 2011, Galaxy 15 has been re-certified from the FAA and is now sending GPS signal corrections. Intelsat repositioned Galaxy 15 back to its original location on April 4, 2011.[6][dated info]



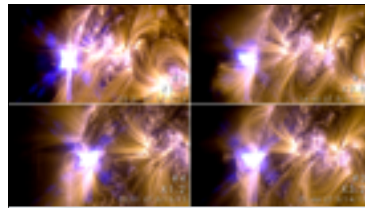
GEVOLGEN

- Polar flights
- Astronauts
- Electronics
- Satellites: anomalies/loss



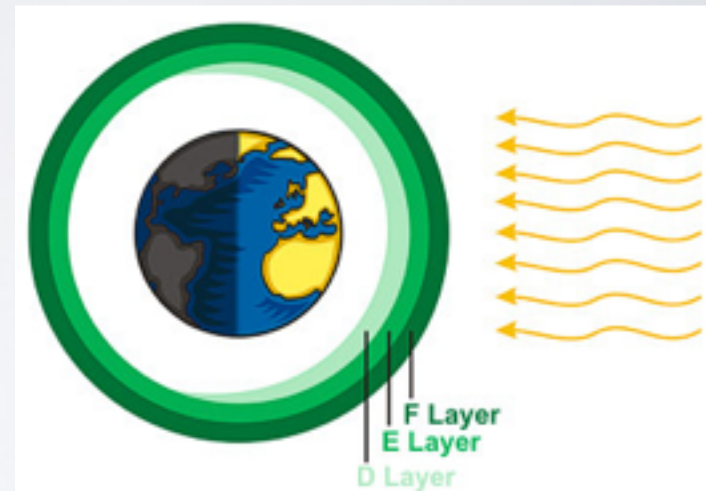
Today, airlines fly over 7,500 polar routes per year. These routes take aircraft to latitudes where **satellite communication cannot be used,** and flight crews must rely instead on high-frequency (HF) radio to maintain communication with air traffic control, as required by federal regulation. During certain space weather events, solar energetic particles spiral down geomagnetic field lines in the polar regions, where they **increase the density of ionized gas**, which in turn affects the propagation of radio waves and can result in **radio blackouts**. These events can last for several days, during which time aircraft must be diverted to latitudes where satellite communications can be used.

dodelijke stormen
No large Solar Energetic Particles events have happened during a manned space mission. However, such a large event happened on August 7, 1972, between the Apollo 16 and Apollo 17 lunar missions. The dose of particles would have hit an astronaut outside of Earth's protective magnetic field, had this event happened during one of these missions, the effects could have been life threatening.



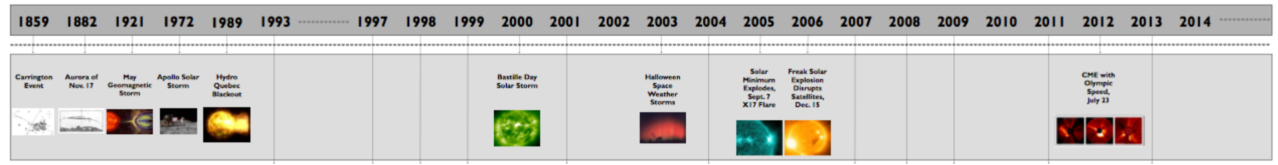
GEVOLGEN

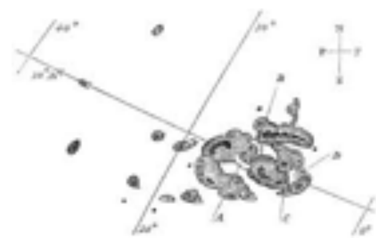
- GNSS
- Radio communication
- Drag on satellites

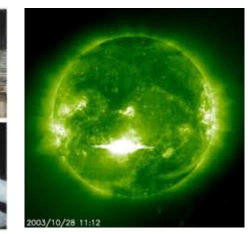


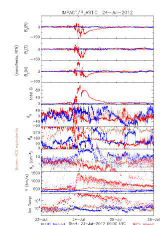
Global Navigation Satellite System

EXTREME EVENTS









24 juli 2012: bijna hit

From August 28 through September 2, 1859, numerous sunspots were observed on the Sun.
On August 29, southern aurorae were observed as far north as Queensland in Australia.[3]
Just before noon on **September 1**, the English amateur astronomers Richard Carrington and Richard Hodgson independently made the first observations of a solar flare.[4] The **flare was associated with a major coronal mass ejection** (CME) that travelled directly toward Earth, taking **17.6 hours** to make the 93 million mile journey. It is believed that the relatively high speed of this CME (typical CMEs take several days to arrive at Earth) was made possible by a prior CME, perhaps the cause of the large aurora event on August 29, that "cleared the way" of ambient solar wind plasma for the Carrington event.[4]

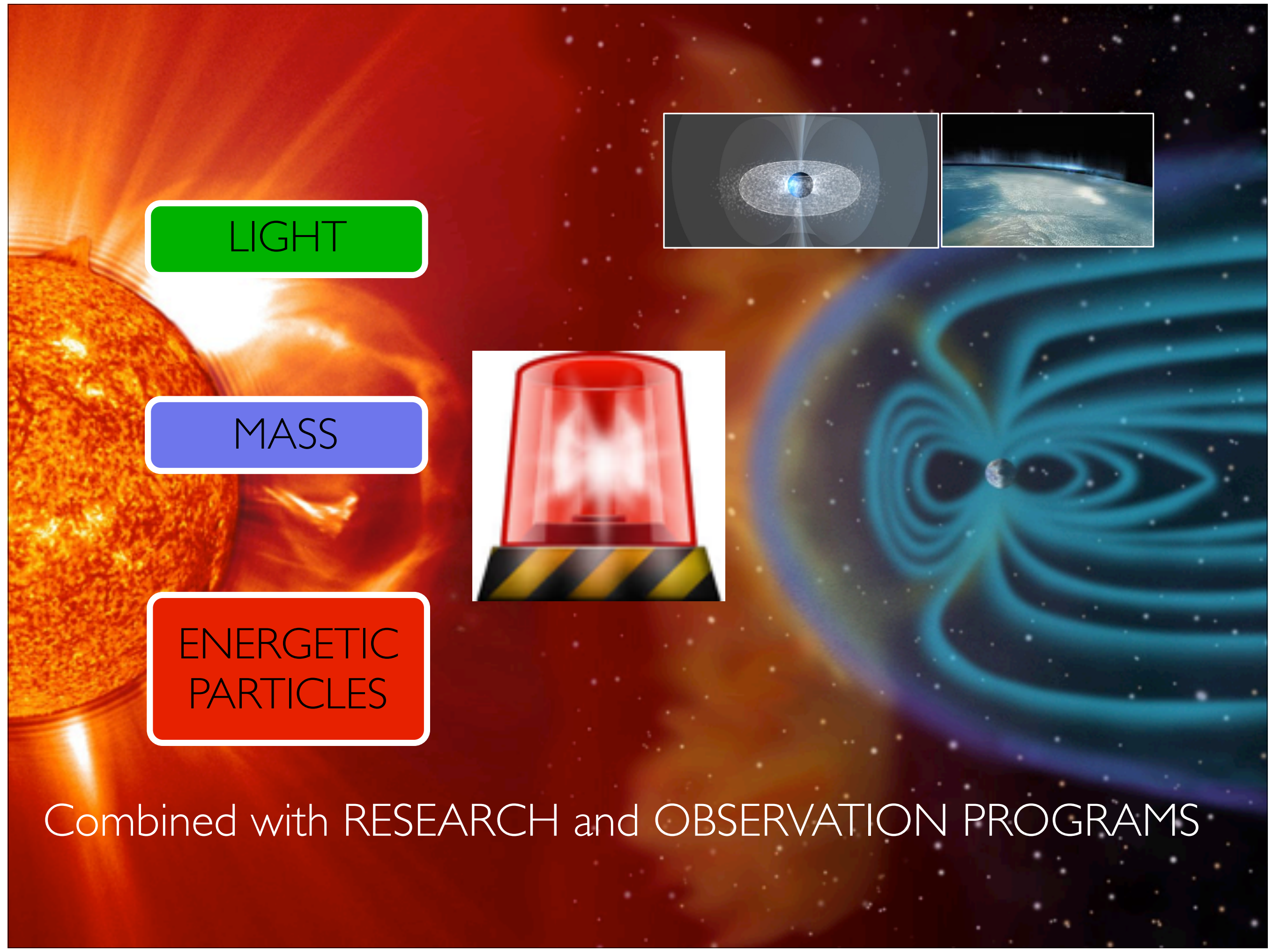
Because of a simultaneous "crochet" observed in the Kew Observatory magnetometer record by Scottish physicist Balfour Stewart and a geomagnetic storm observed the following day, Carrington suspected a solar-terrestrial connection. Worldwide reports on the effects of the geomagnetic storm of 1859 were compiled and published by Elias Loomis, which support the observations of Carrington and Stewart.
On September 1–2, 1859, one of the largest recorded geomagnetic storms (as recorded by ground-based magnetometers) occurred. Aurorae were seen around the world, those in the northern hemisphere even as far south as the Caribbean; those over the Rocky Mountains were so bright that their glow awoke gold miners, who began preparing breakfast because they thought it was morning.[4] People who happened to be awake in the northeastern US could read a newspaper by the aurora's light.[5] The aurora was visible as far from the poles as Cuba and Hawaii.[6]
Telegraph systems all over Europe and North America failed, in some cases giving telegraph operators electric shocks.[7] Telegraph pylons threw sparks.[8] Some telegraph systems continued to send and receive messages despite having been disconnected from their power supplies.[9]
On Saturday, September 3, 1859, the Baltimore American and Commercial Advertiser reported, "Those who happened to be out late on Thursday night had an opportunity of witnessing another magnificent display of the auroral lights. The phenomenon was very similar to the display on Sunday night, though at times the light was, if possible, more brilliant, and the prismatic hues more varied and gorgeous. The light appeared to cover the whole firmament, apparently like a luminous cloud, through which the stars of the larger magnitude indistinctly shone. The light was greater than that of the moon at its full, but had an indescribable softness and delicacy that seemed to envelop everything upon which it rested. Between 12 and 1 o'clock, when the display was at its full brilliancy, the quiet streets of the city resting under this strange light, presented a beautiful as well as singular appearance."[10]
In June 2013, a joint venture from researchers at Lloyd's of London and Atmospheric and Environmental Research (AER) in the United States used data from the Carrington Event to estimate the current cost of a similar event to the US alone at $0.6–2.6 trillion.[11]

http://science.nasa.gov/science-news/science-at-nasa/2008/06may_carringtonflare/

At 11:18 AM on the cloudless morning of Thursday, September 1, 1859, 33-year-old Richard Carrington—widely acknowledged to be one of England's foremost solar astronomers—was in his well-appointed private observatory. Just as usual on every sunny day, his telescope was projecting an 11-inch-wide image of the sun on a screen, and Carrington skillfully drew the sunspots he saw.

Right: Sunspots sketched by Richard Carrington on Sept. 1, 1859. Copyright: Royal Astronomical Society: more.
On that morning, he was capturing the likeness of an enormous group of sunspots. Suddenly, before his eyes, two brilliant beads of blinding white light appeared over the sunspots, intensified rapidly, and became kidney-shaped. Realizing that he was witnessing something unprecedented and "being somewhat flurried by the surprise," Carrington later wrote, "I hastily ran to call someone to witness the exhibition with me. On returning within 60 seconds, I was mortified to find that it was already much changed and enfeebled." He and his witness watched the white spots contract to mere pinpoints and disappear.
It was 11:23 AM. Only five minutes had passed.
Just before dawn the next day, skies all over planet Earth erupted in red, green, and purple auroras so brilliant that newspapers could be read as easily as in daylight. Indeed, stunning auroras pulsated even at near tropical latitudes over Cuba, the Bahamas, Jamaica, El Salvador, and Hawaii.

Sign up for EXPRESS SCIENCE NEWS delivery
Even more disconcerting, telegraph systems worldwide went haywire. Spark discharges shocked telegraph operators and set the telegraph paper on fire. Even when telegraphers disconnected the batteries powering the lines, aurora-induced electric currents in the wires still allowed messages to be transmitted.
"What Carrington saw was a white-light solar flare—a magnetic explosion on the sun," explains David Hathaway, solar physics team lead at NASA's Marshall Space Flight Center in Huntsville, Alabama.


LIGHT
MASS
ENERGETIC PARTICLES
Combined with RESEARCH and OBSERVATION PROGRAMS

PROBA2, gebouwd in België
Instrumentenbeheer vanuit Brussel