STCE Newsletter

15 Sep 2014 - 21 Sep 2014

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The Solar-Terrestrial Centre of Excellence (STCE) is a collaborative network of the Belgian Institute for Space Aeronomy, the Royal Observatory of Belgium and the Royal Meteorological Institute of Belgium.

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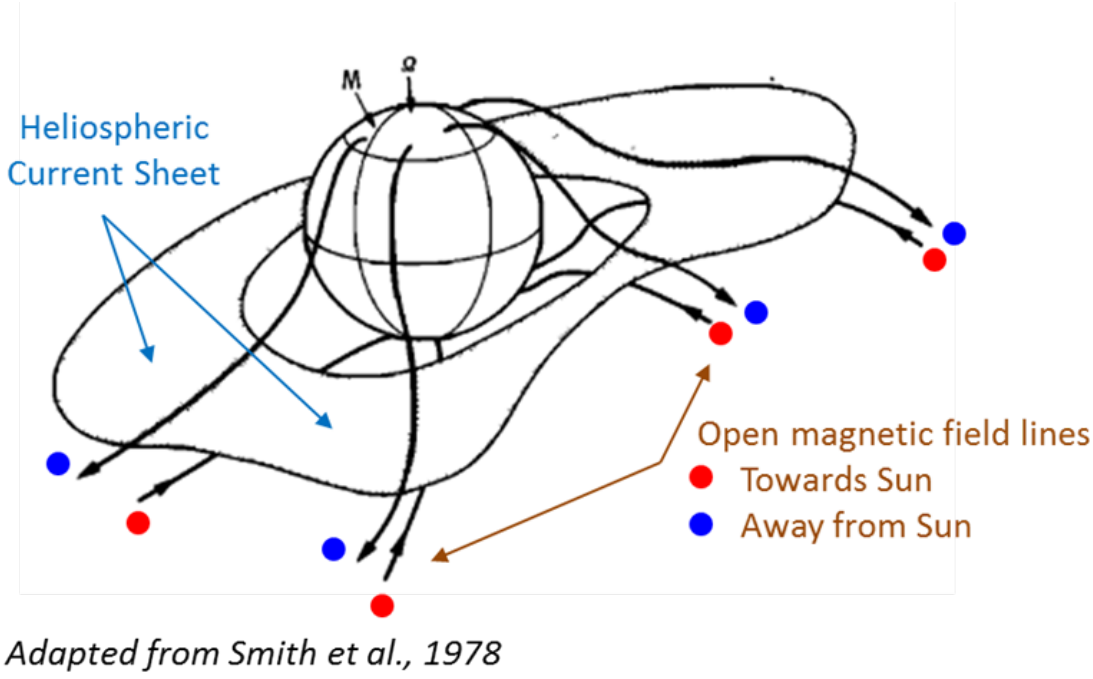
1. SBC or CIR?

It's not so easy to distinguish various transients in in situ data of the solar wind by just looking at the magnetic field and solar wind parameters such as speed, temperature and density. Most can pick out the signature from a coronal mass ejection, featuring increase in magnetic field and decrease in temperature, and sudden increase in density, speed and magnetic field strength if the CME is driving a shock. Things get more complicated when it comes to the effects of Sector Boundary Crossings (SBC) or from the interaction region related to a fast solar wind stream coming from a coronal hole (increase in speed and temperature).
A coronal hole rotates together with the Sun: the associated solar wind structure is therefore called a Co-rotating Interaction Region (CIR). When the coronal hole survives several solar rotations, it is recurring and it's important for medium-term space weather predictions. But let's start by having a look on what SBC and (C)IR actually are.

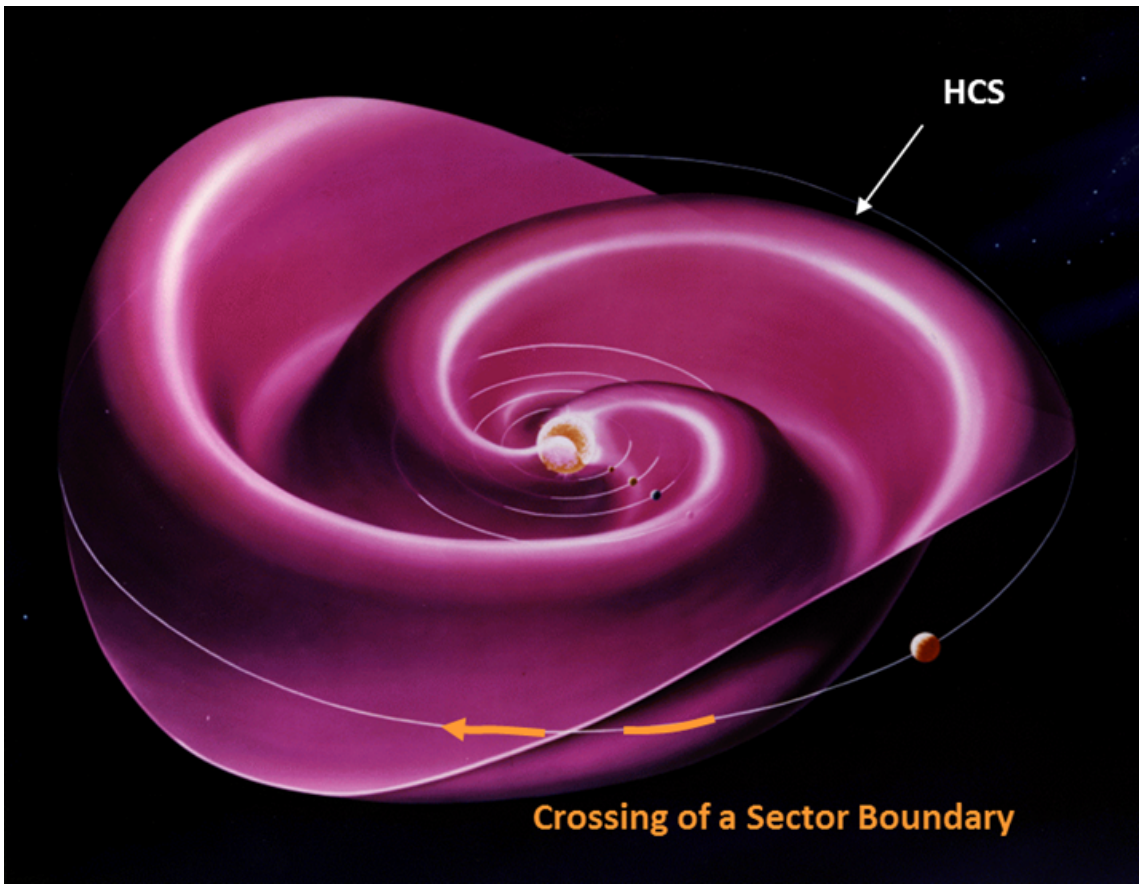
Sector Boundary Crossing

The Sun is a giant magnet with magnetic field lines extending away into space (positive, "away") and other field lines returning from space to the Sun (negative, "towards"), with each solar hemisphere having a different polarity, in general. Along the solar magnetic equator, these opposite field lines run parallel to each other creating a current sheet, which is called the "Heliopsheric Current Sheet" (HCS).



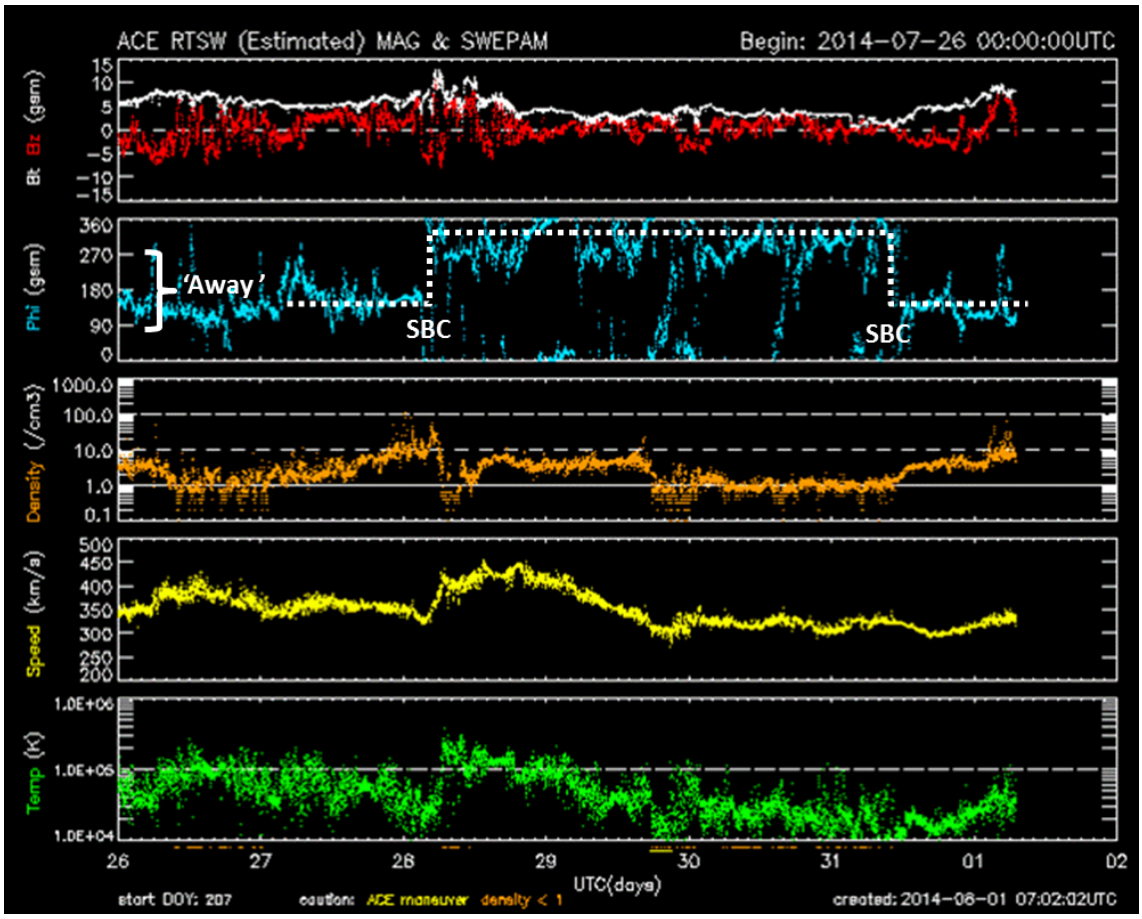
Adapted from Smith et al., 1978

Because the Sun's rotational axis and its magnetic axis are not always aligned, this sheet gets warped. It is often compared to a ballerina skirt. When the Earth traverses such a fold, a change in the orientation of the magnetic field of the solar wind occurs, which is called a Sector Boundary Crossing (SBC). It quite abruptly changes either from "towards" to "away" from the Sun, or from "away" to "towards" the Sun. This orientation is measured by the "Phi angle", which is oriented "away" when values are between 90 and 270 degrees. Though such a crossing usually may be accompanied by a slight change in e.g. solar wind speed or magnetic field strength, this is not a requirement.

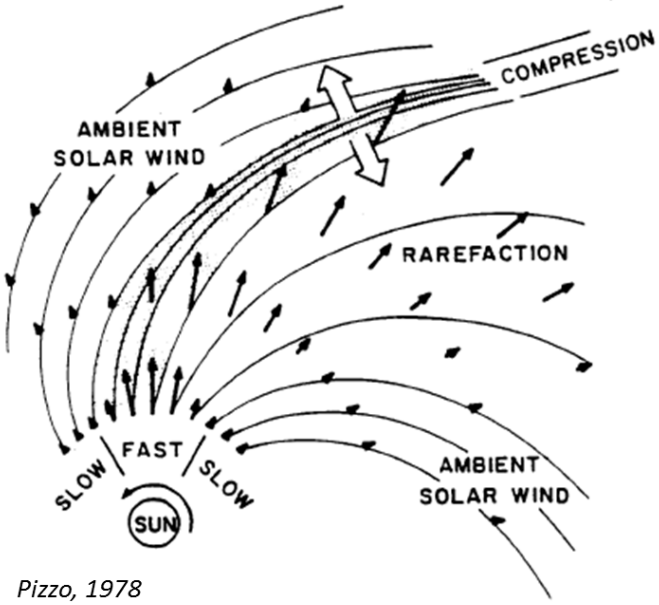


SBCs are usually not associated to big disturbances in the geomagnetic field. A nice example of an SBC occurred late July this year, when early on 28 July the magnetic field changed from "away" to "towards" the Sun, and a few days later (31 July around noon) back to "away" (Phi angle, blue). Though some changes can be seen in the speed (yellow), density (orange) and magnetic field strength (white) of the solar wind, the geomagnetic field remained quiet to unsettled. Data were taken from the ACE satellite (http://www.swpc.noaa.gov/ace/ace_rtsw_data.html).

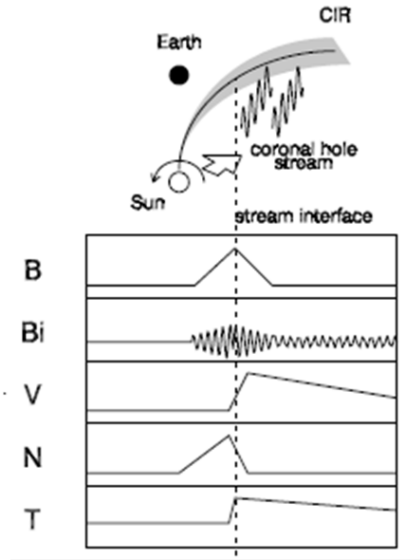
Corotating Interaction Regions



Solar particles can leave the Sun along the open magnetic field lines and at different speeds. Hence, the high speed stream from e.g. a coronal hole may interact with the slower moving normal solar wind ahead. Where the two meet, an interface results in a compressed space of increased density and magnetic field strength. This interface separates the slow from the fast solar wind. At some point in space, the interface becomes a shock, sometimes already at the Sun-Earth distance. Then the speed continues its gradual increase towards the main speed of the coronal hole. As the stream interaction region passes, there's no obvious change in the direction of the magnetic field, which is usually oscillating during that period. As the stream interaction region has passed, the magnetic field assumes the direction of the field embedded in the high speed stream of the coronal hole, which may or may not be the same as that of the slow solar wind.

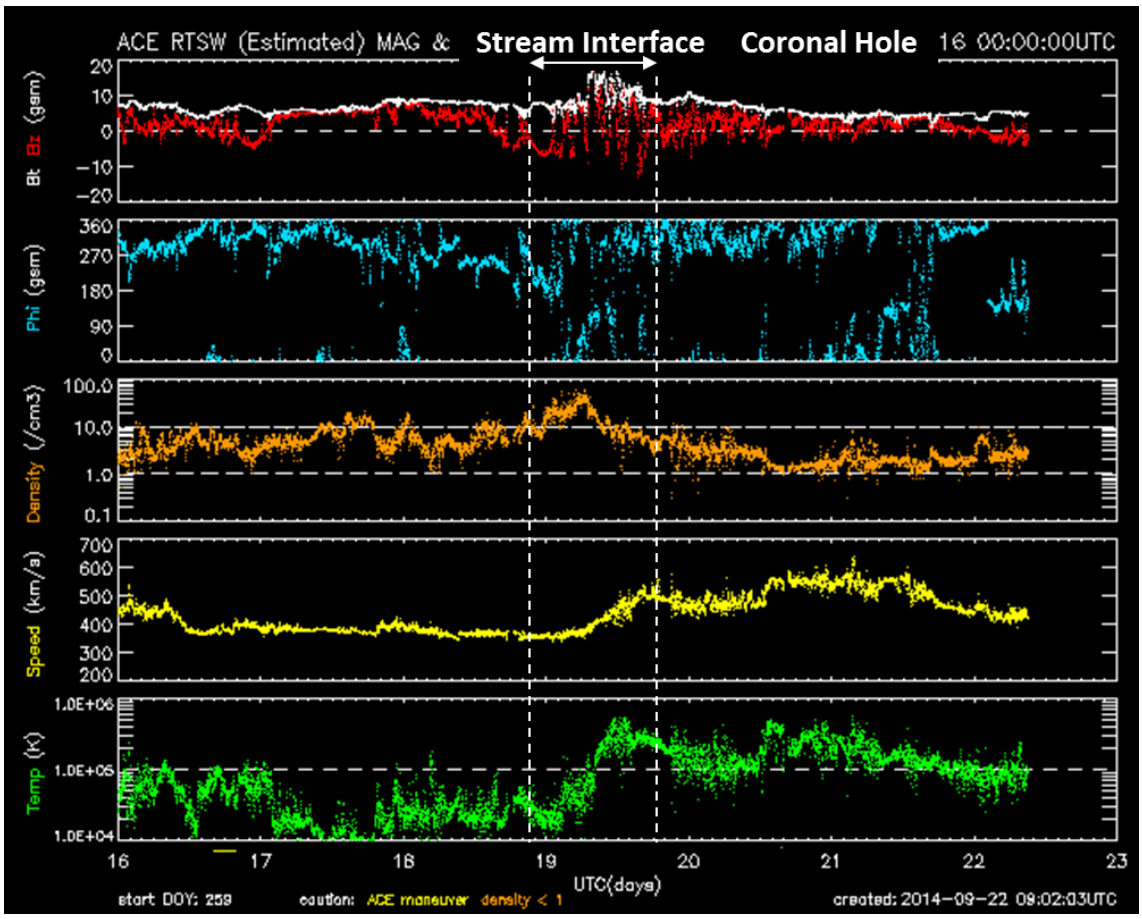


Pizzo, 1978



Kataoka et al., 2006

As it may be clear from this description, (C)IRs can have quite a complex solar wind signature and have the potential to generate somewhat stronger geomagnetic disturbances than SBCs. A nice example just happened last week, when an interaction region related to a negative coronal hole passed by the Earth early on 19 September. Even though no shock was observed and the magnetic field remained mostly directed towards the Sun, the oscillating north-south direction of the magnetic field resulted in minor geomagnetic storming conditions on 19 September. Notice also the low density of the coronal hole's particle stream once the interface has passed. If the coronal hole survives the coming solar rotation, it will sweep again by Earth in little less than one month.



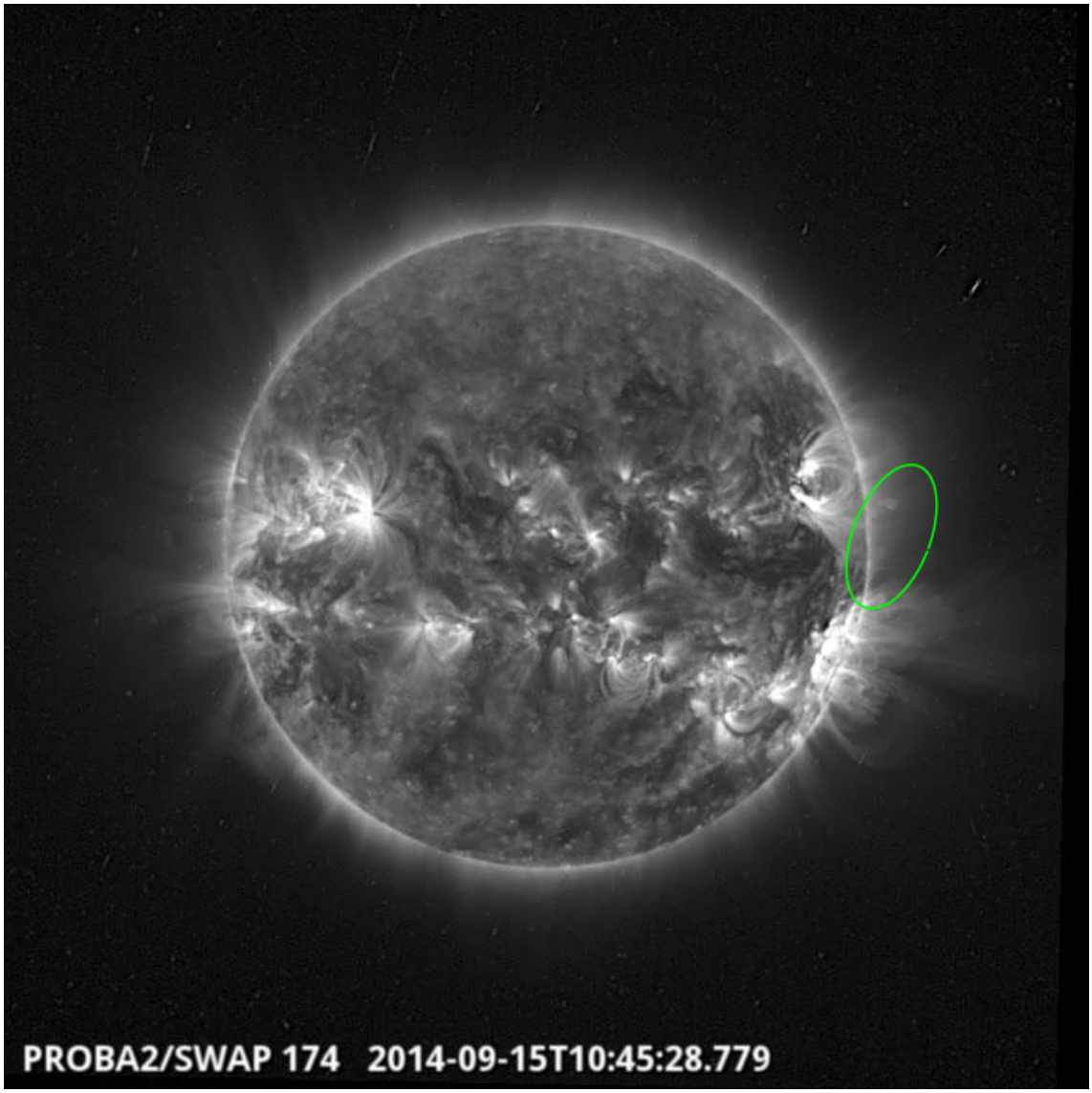
2. PROBA2 Observations

Solar Activity

Solar flare activity fluctuated between low and moderate during the week.
In order to view the activity of this week in more detail, we suggest to go to the following website from which all the daily (normal and difference) movies can be accessed: http://proba2.oma.be/ssa
This page also lists the recorded flaring events.

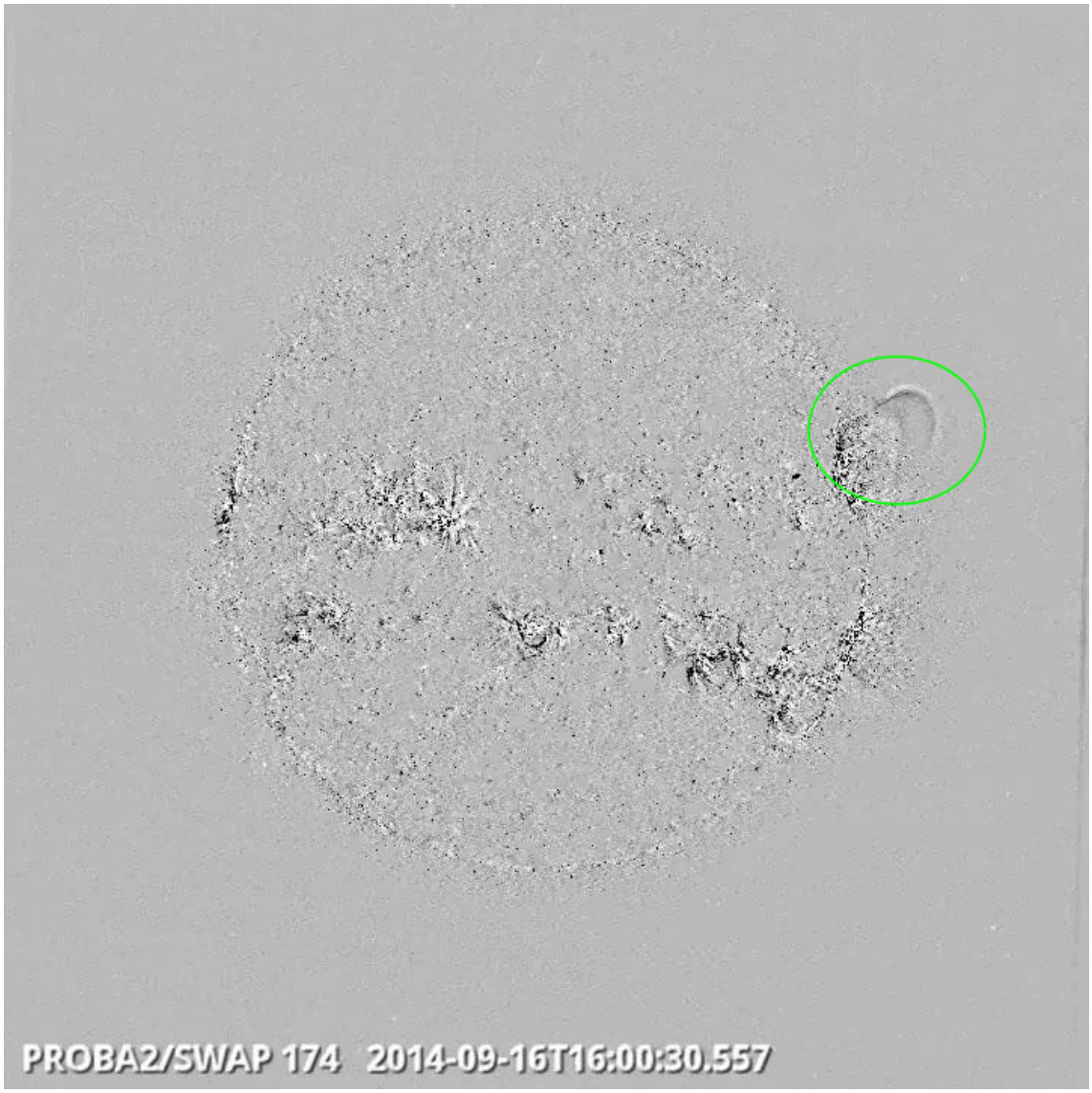
A weekly overview movie can be found here (SWAP week 234).
http://proba2.oma.be/swap/data/mpg/movies/WeeklyReportMovies/WR234_Sep15_Sep21/weekly_movie_2014_09_15.mp4
Details about some of this week's events, can be found further below.

Monday Sep 15



Eruption on the west limb @ 10:45 SWAP image
Find a movie of the events here (SWAP movie)
http://proba2.oma.be/swap/data/mpg/movies/20140915_swap_movie.mp4

Tuesday Sep 16

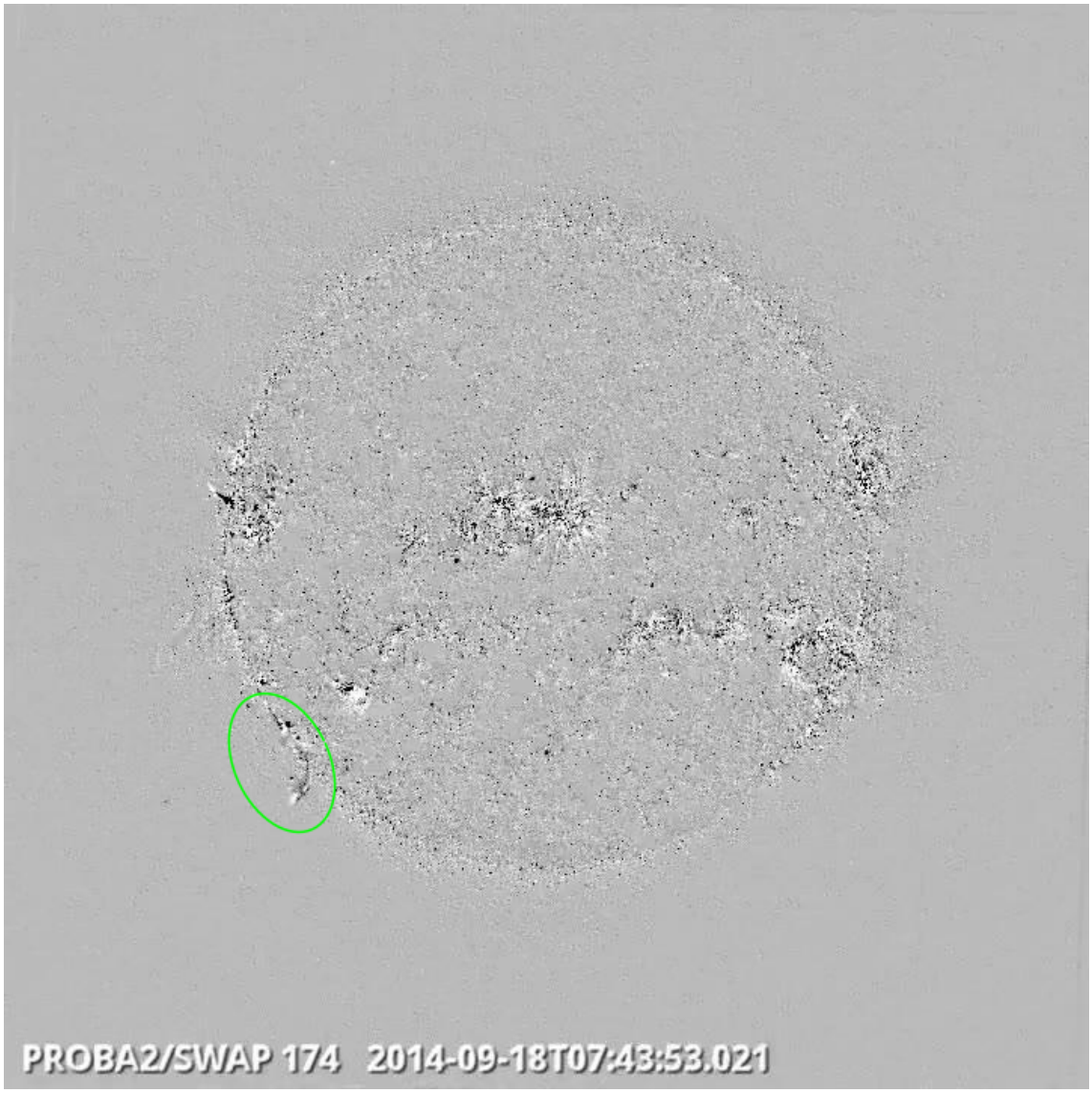


Loop expansion on the west limb @ 16:00 SWAP difference image
Find a movie of the events here (SWAP difference movie)
http://proba2.oma.be/swap/data/mpg/movies/20140916_swap_diff.mp4

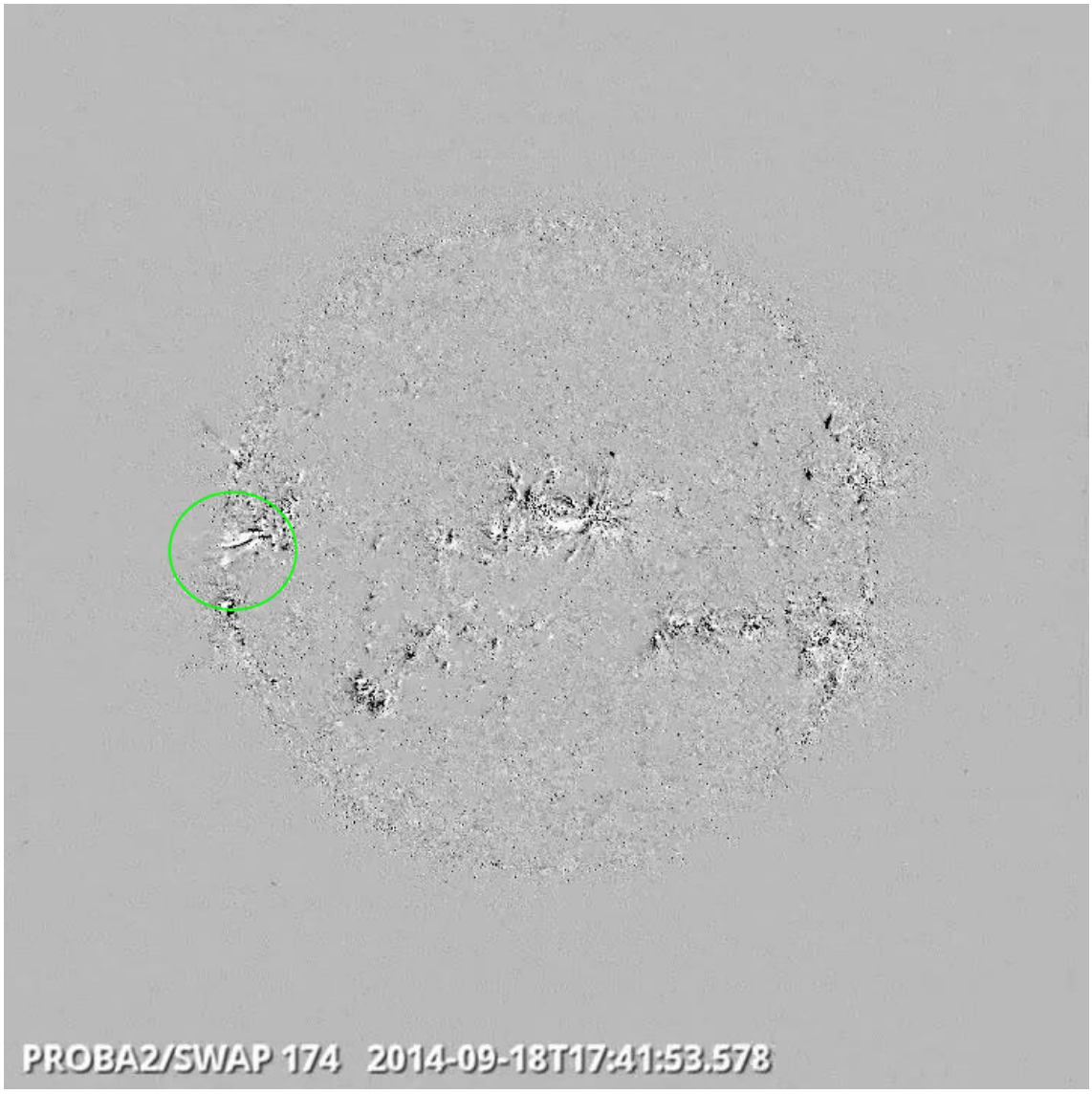
Wednesday Sep 17

Eruption on the west limb @ 12:55 SWAP difference image
Find a movie of the event here (SWAP difference movie)
http://proba2.oma.be/swap/data/mpg/movies/20140917_swap_diff.mp4

Thursday Sep 18

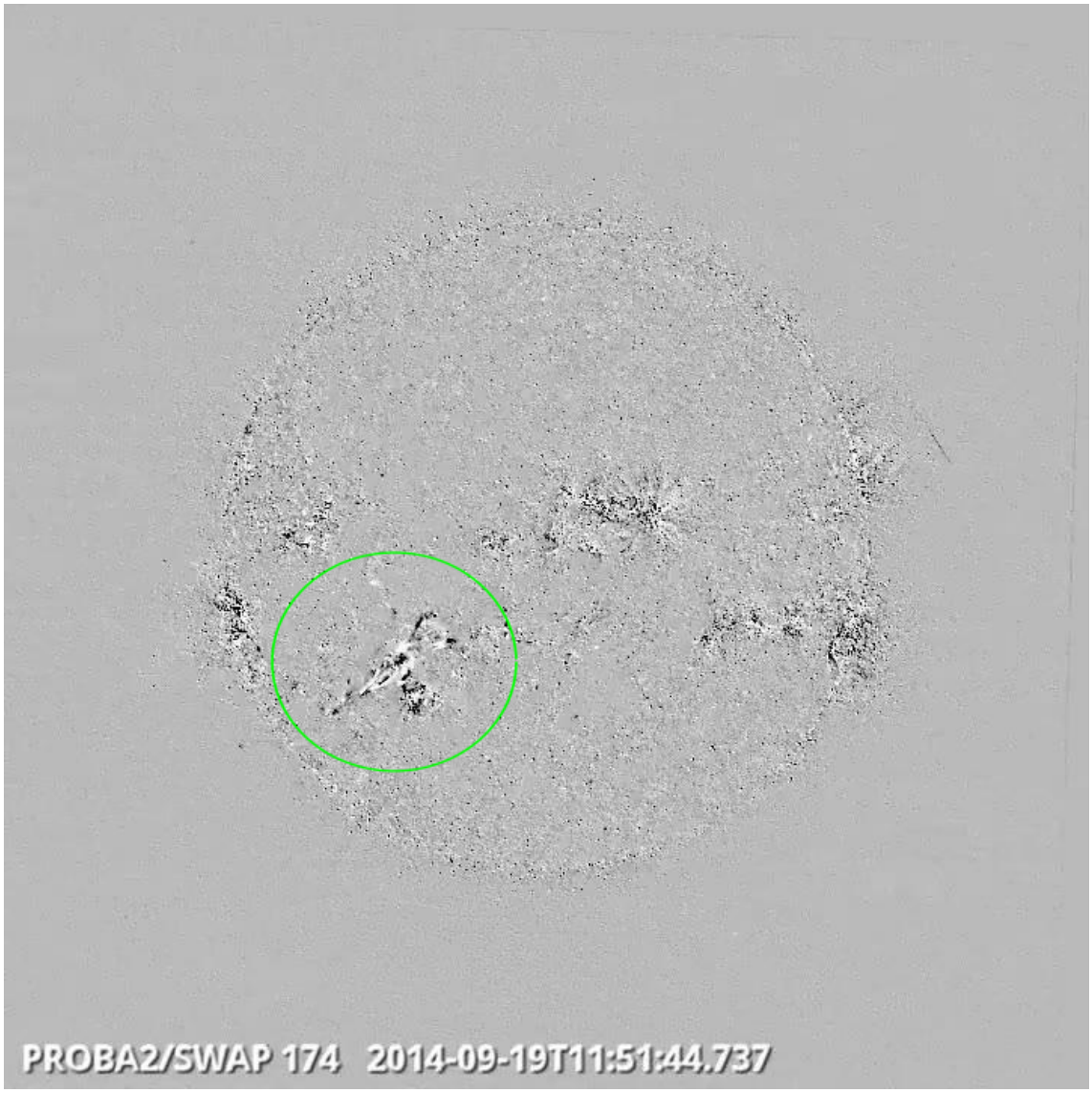


Eruption on east limb @ 07:43 SWAP difference image
Find a movie of the event here (SWAP difference movie)
http://proba2.oma.be/swap/data/mpg/movies/20140918_swap_diff.mp4

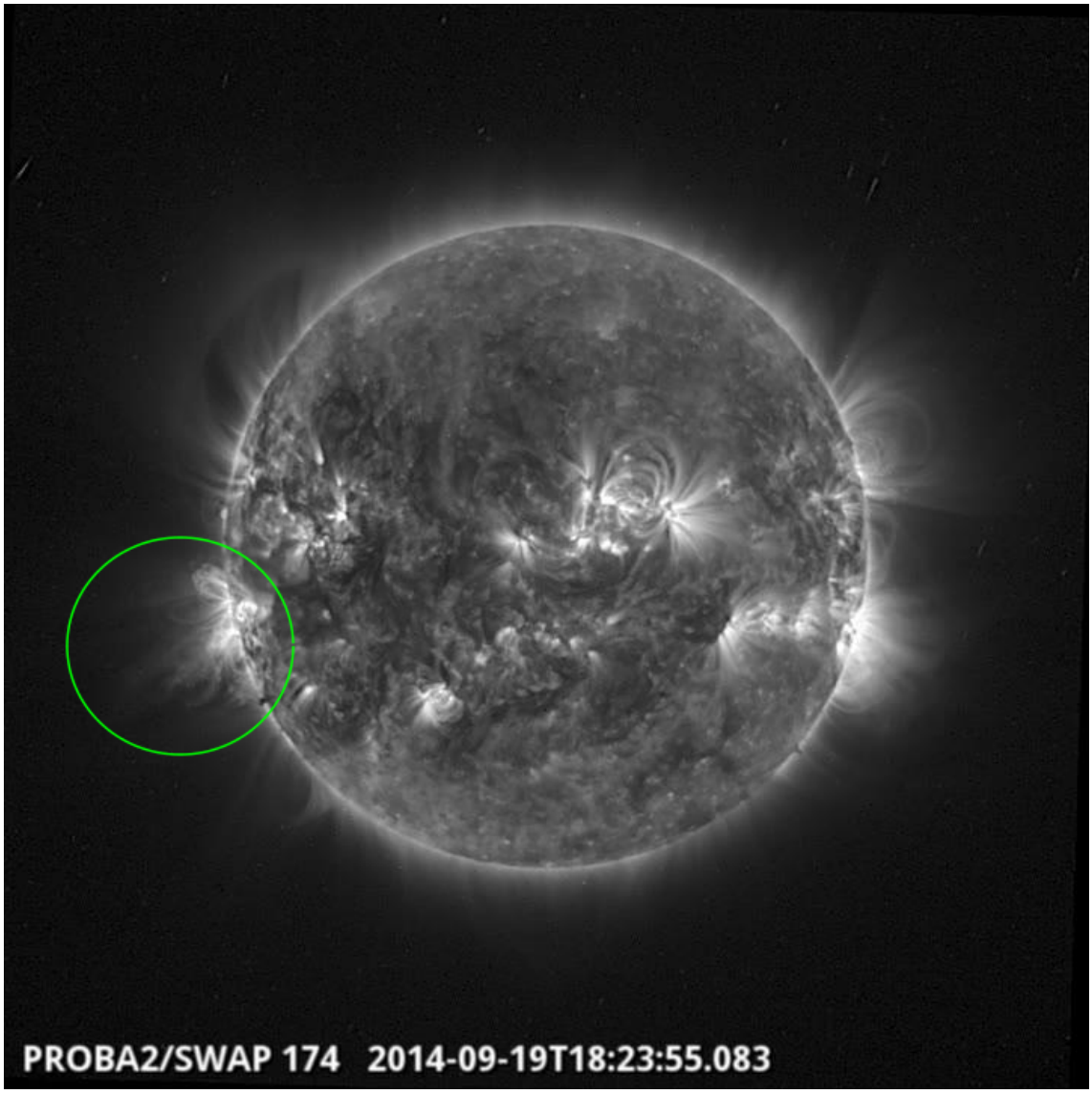


Eruption on east limb @ 17:41 SWAP difference image
Find a movie of the event here (SWAP difference movie)
http://proba2.oma.be/swap/data/mpg/movies/20140918_swap_diff.mp4

Friday Sep 19

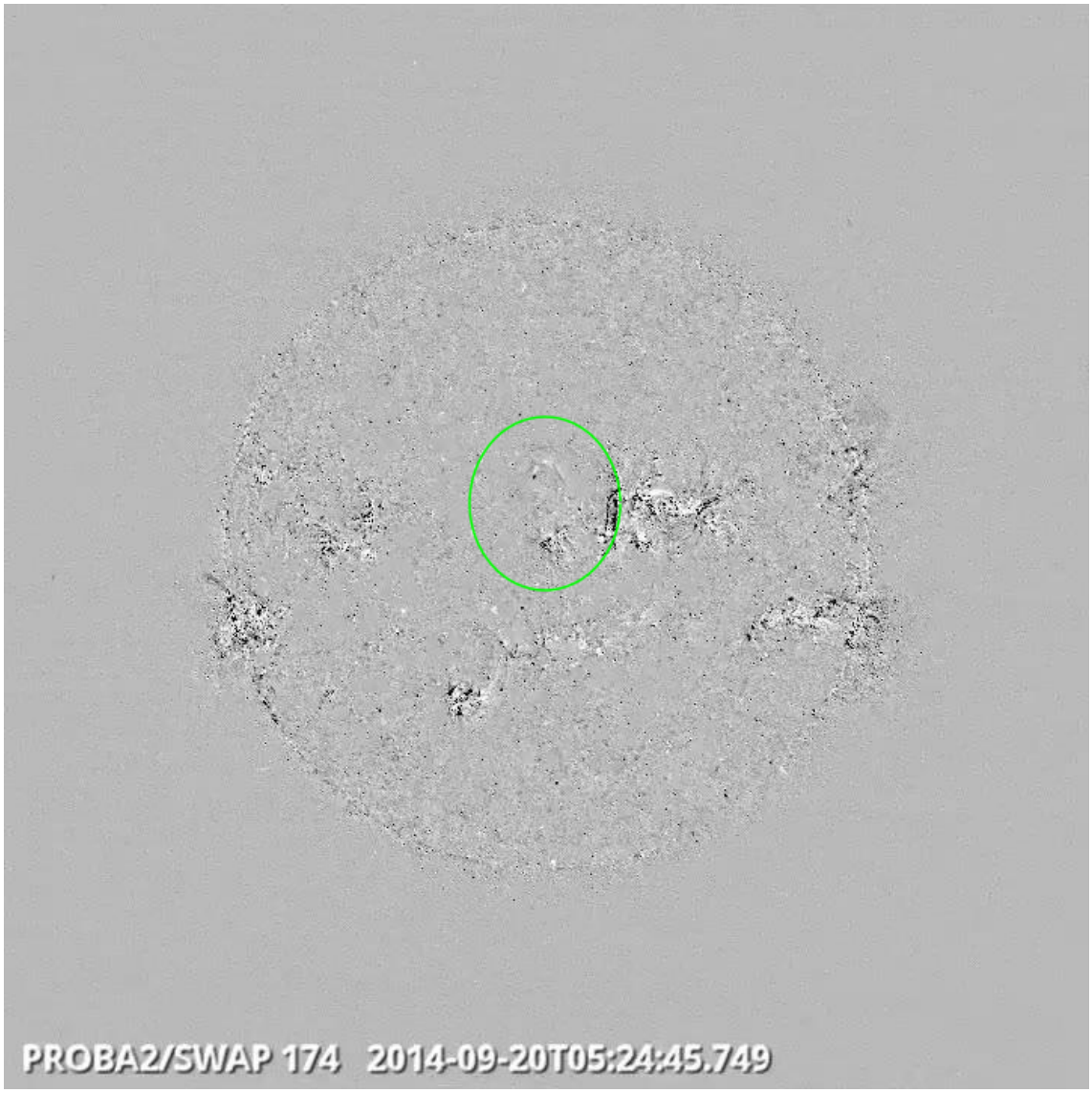


Filament eruption or flow on the south east quad @ 11:51 SWAP difference image
Find a movie of the event here (SWAP difference movie)
http://proba2.oma.be/swap/data/mpg/movies/20140919_swap_diff.mp4



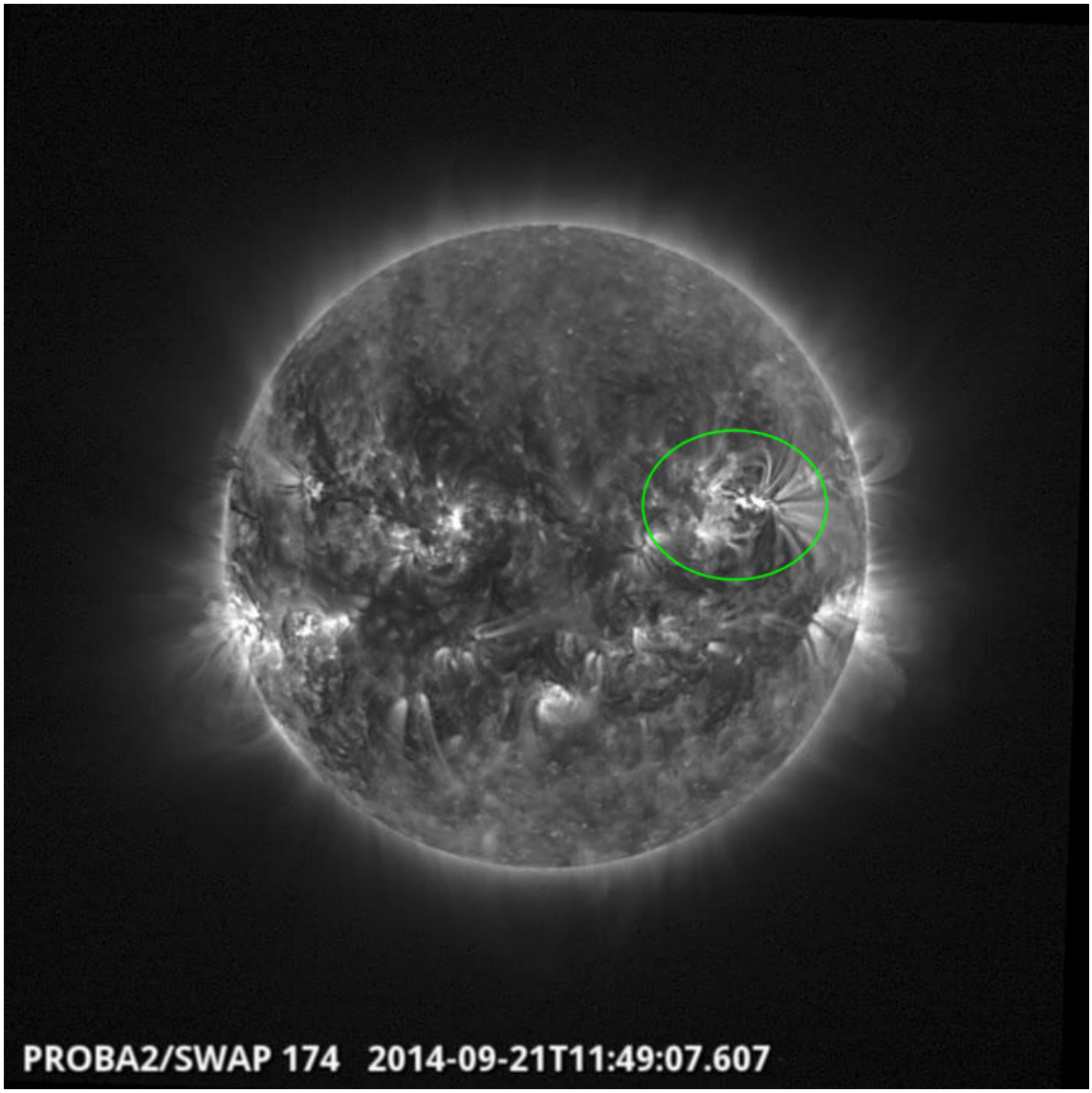
Eruption on the east limb @ 18:23 SWAP image
Find a movie of the event here (SWAP movie)
http://proba2.oma.be/swap/data/mpg/movies/20140919_swap_movie.mp4

Saturday Sep 20



Eruption on the Sun centre @ 05:24 SWAP difference image
Find a movie of the event here (SWAP difference movie)
http://proba2.oma.be/swap/data/mpg/movies/20140920_swap_movie.mp4

Sunday Sep 21

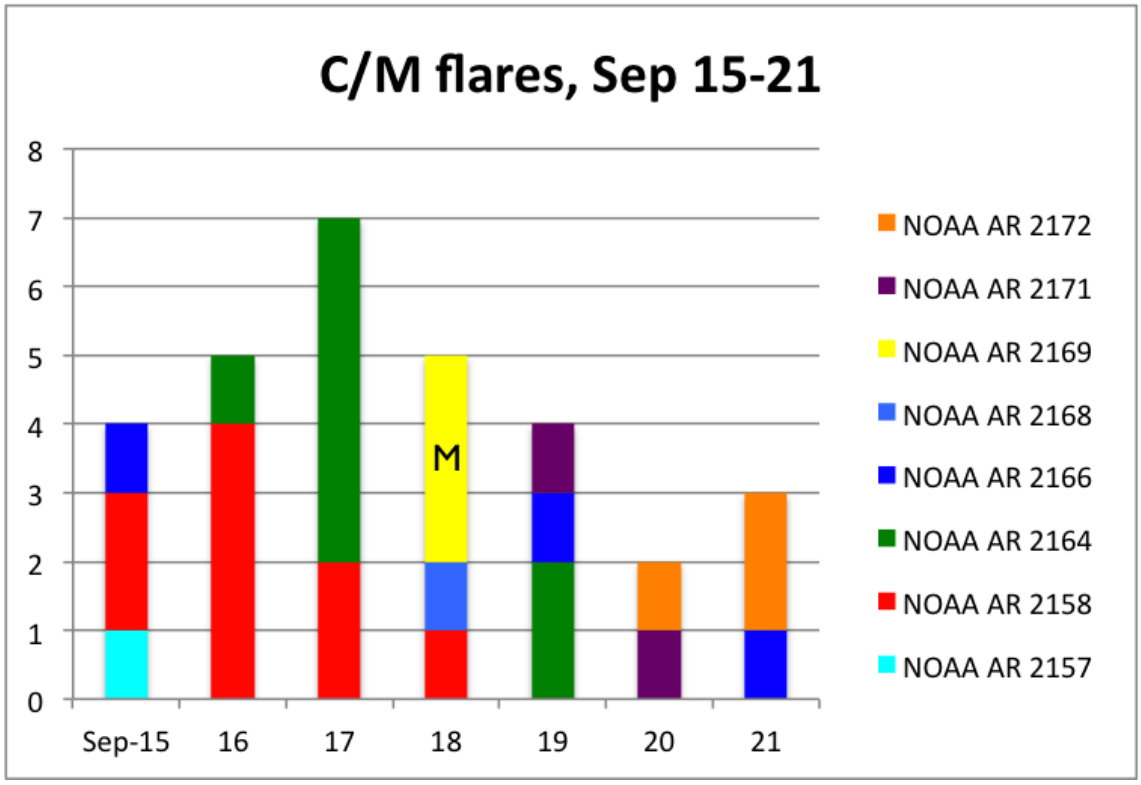


Eruption on the north west quad @ 11:49 SWAP image
Find a movie of the event here (SWAP movie)
http://proba2.oma.be/swap/data/mpg/movies/20140921_swap_movie.mp4

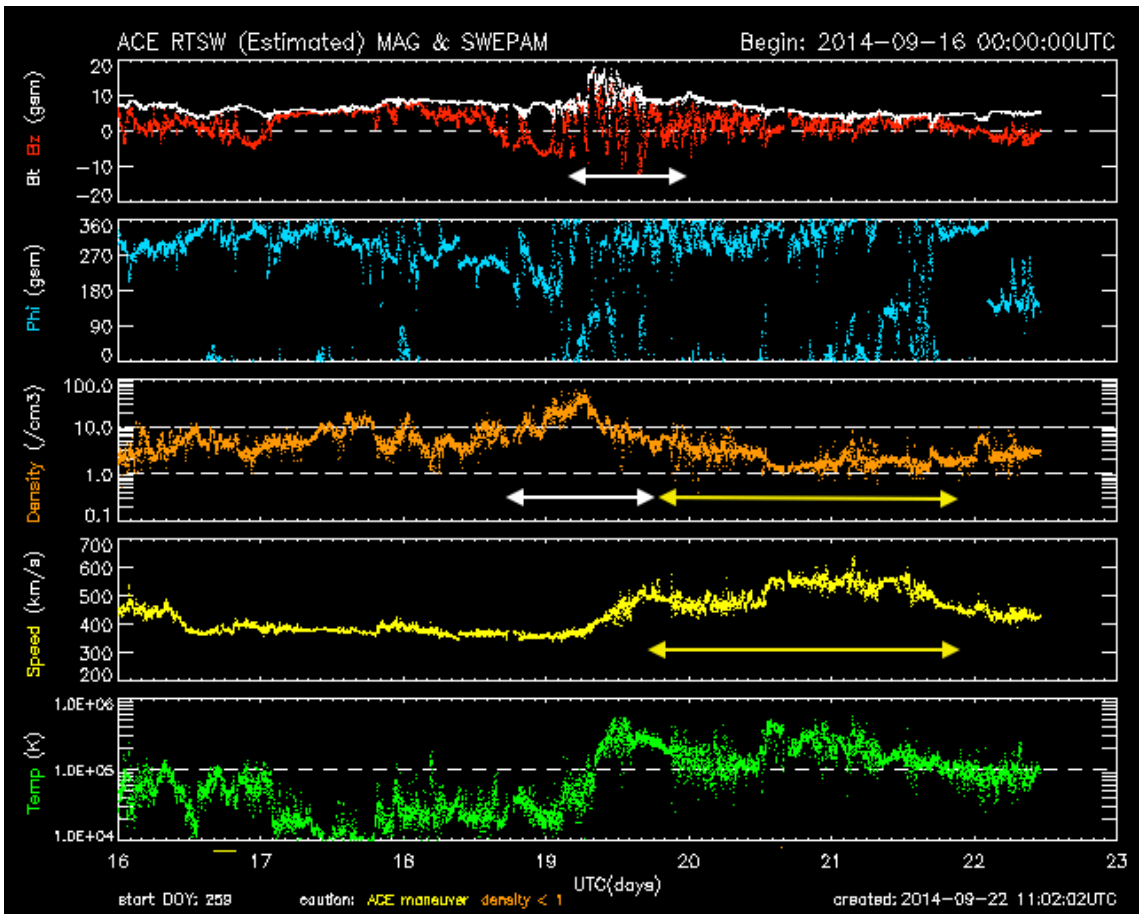
3. Review of solar and geomagnetic activity : this week with 'do your own research with HEK'

Geomagnetic activity

Eight active regions contributed to the flaring activity which remained at or below the C-class, except from an M1.2 flare from NOAA AR 2169 with peak at 08:41 UT on September 18. The distribution of the flares over the week and the active regions are put in the chart below.

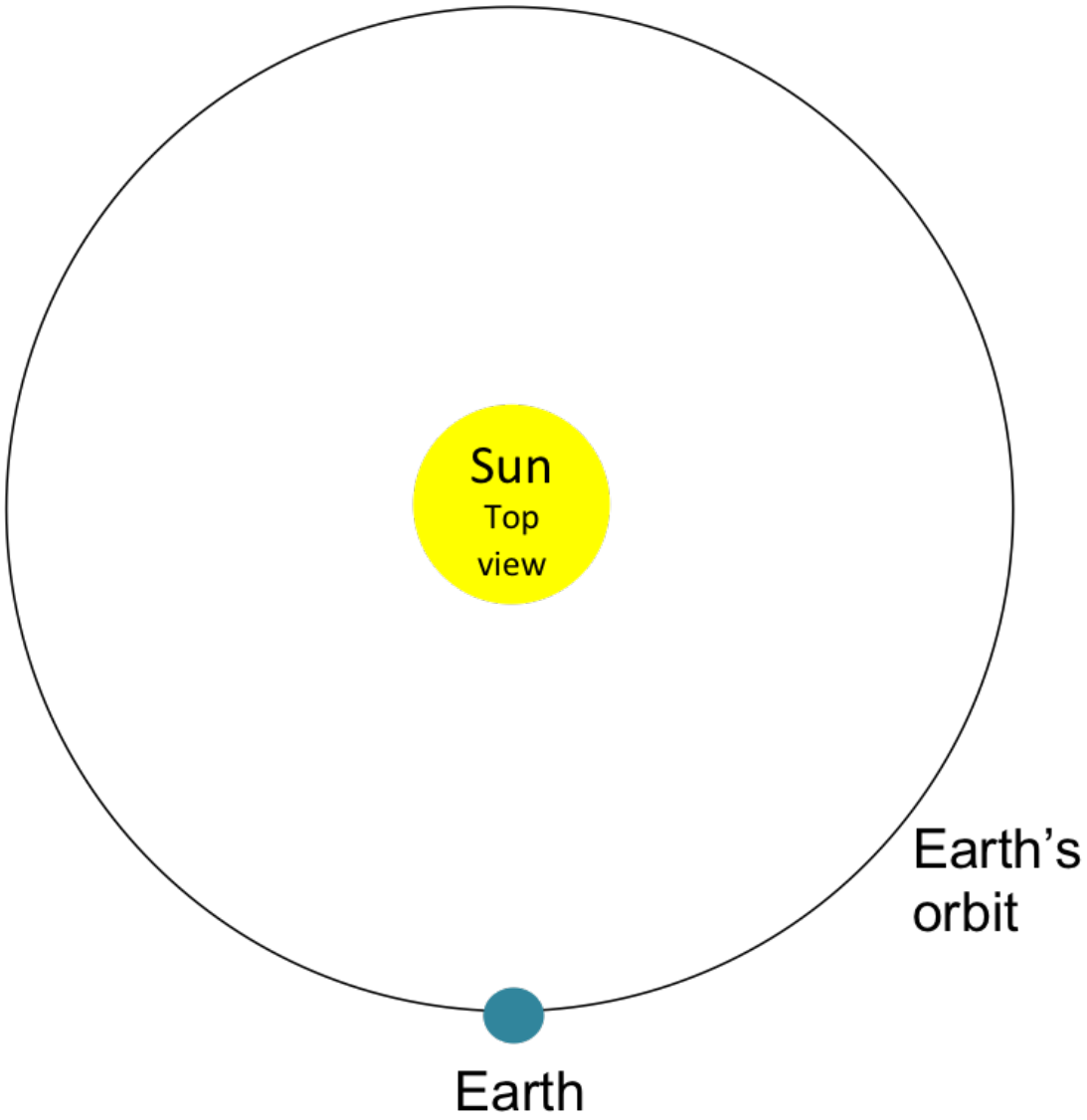


On September 19 a corotating-interaction region (CIR) between a fast and slow solar wind arrived at ACE. This is a region where the fast solar wind catches up with the slow solar wind ahead piling up magnetic plasma. The density and magnetic field strength increases in that region (white arrows). This more dense region is followed by plasma with a higher speed and lower density (yellow arrow).

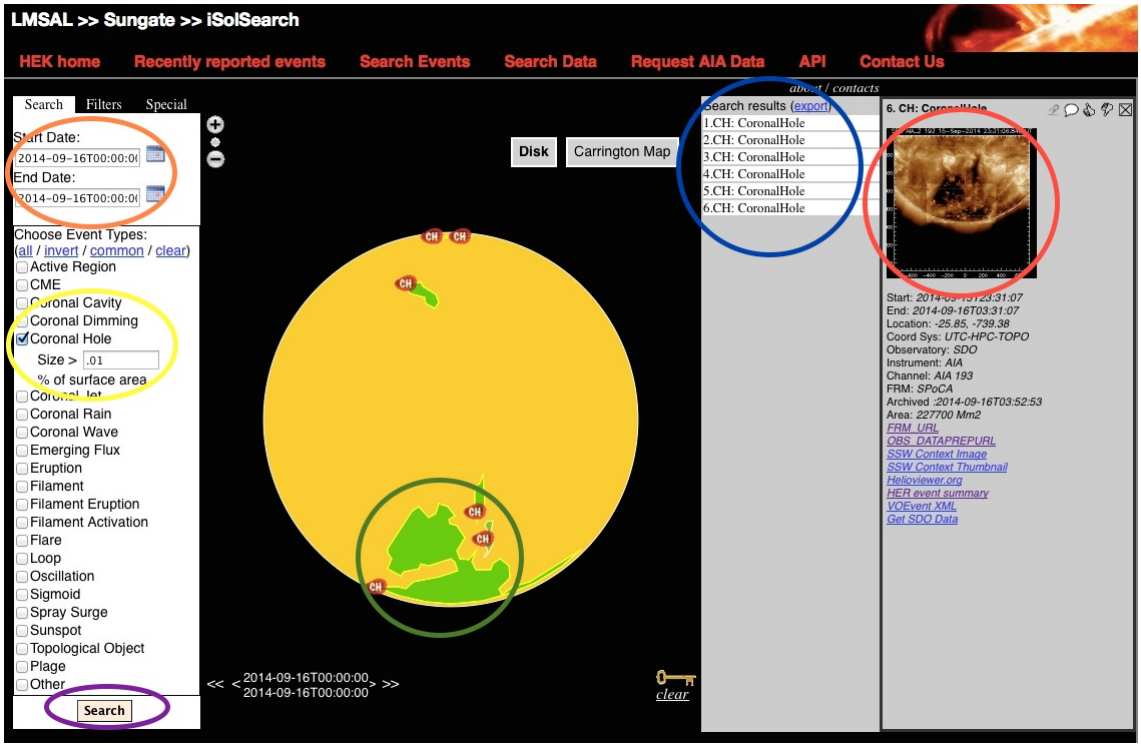


Do it yourself

Usually, it is a coronal hole (CH) that is behind such a solar wind behaviour. We call it co-rotating because the CH rotates together with the Sun and ACE which is situated at the L1 point (1AU, just in front of Earth) would measure the same behaviour of the solar wind linked with the CH if it was located at another point on the orbit of Earth.



It was probably the CH in the southern atmosphere that passed the central meridian on September 15. A nice tool to get an overview of coronal holes (and other solar events) is the iSolSearch which allows you to browse through the Heliophysics Events Knowledgebase developed at LMSAL: http://www.lmsal.com/isolsearch
For this particular example: go to September 16 (orange), choose 'Coronal Hole' Event Type (yellow), click 'Search' (purple). On the yellow ball, the coronal holes are drawn in green. If you click on a Search result (blue) in the right menu, the feature you are interested in, will appear in a real solar image (red).



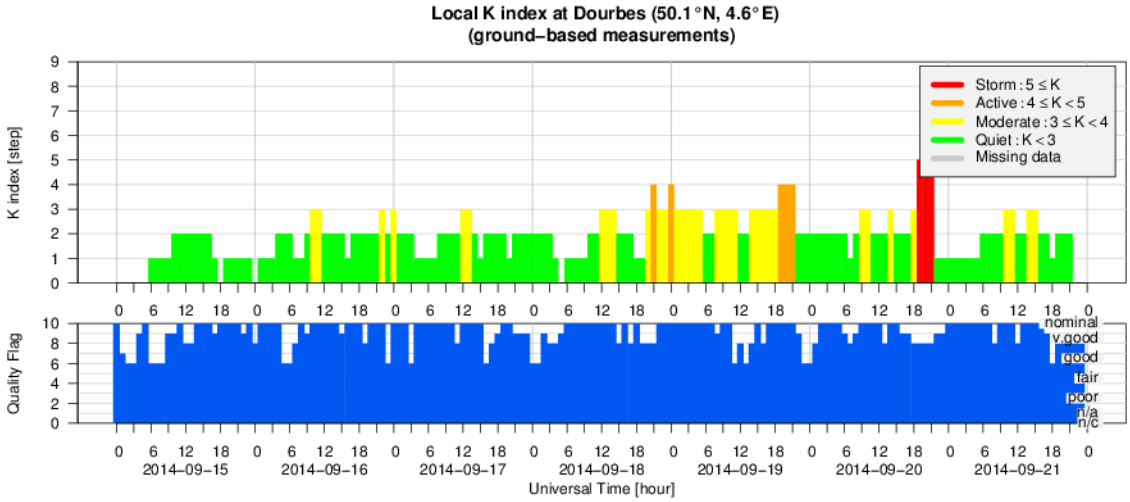
The interplanetary magnetic field magnitudes reached 18 nT causing minor geomagnetic storm conditions at planetary levels (Kp = 5).

4. Noticeable Solar Events

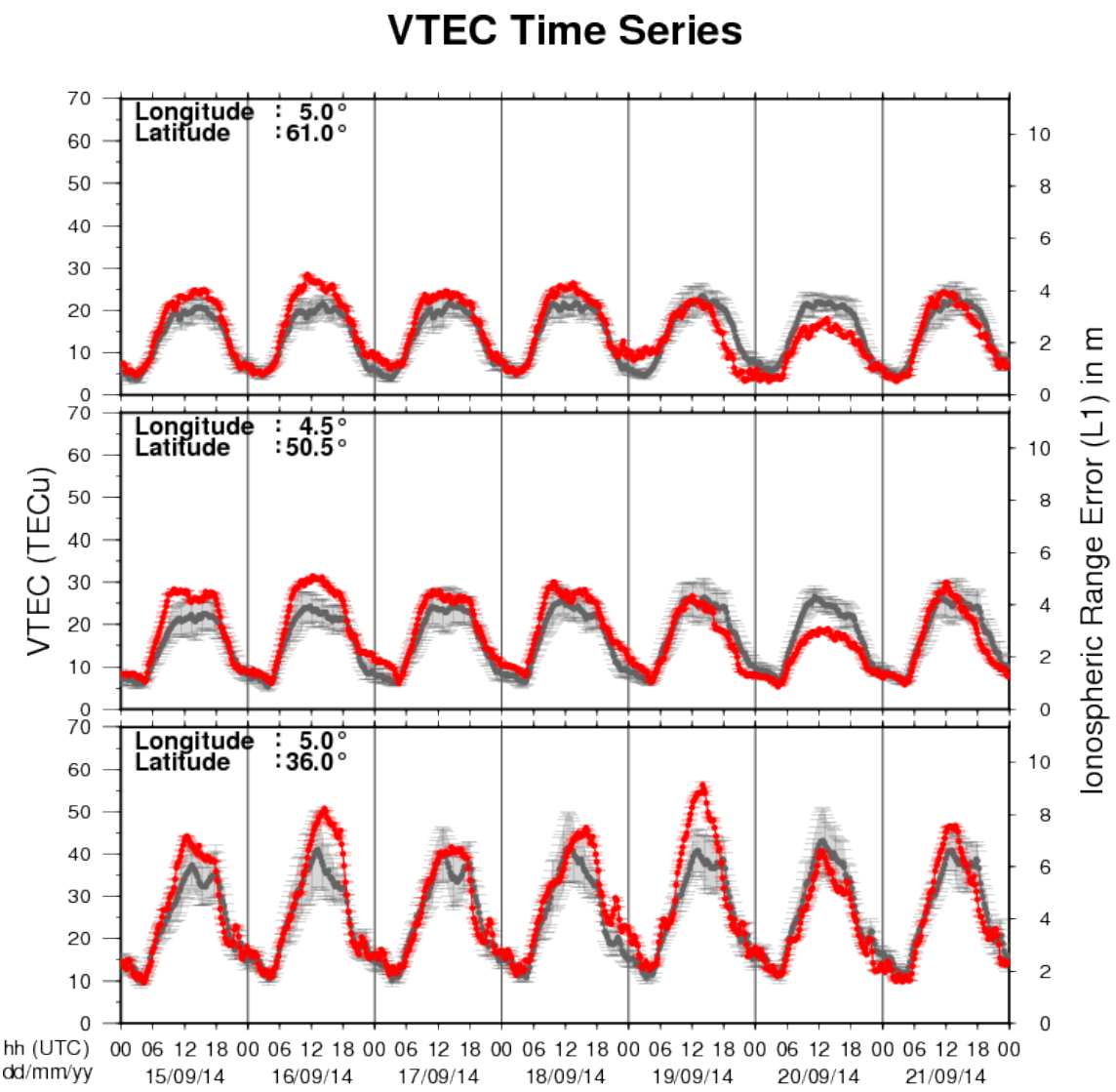
DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	TYPE	Cat	NOAA
18	0837	0841	0853	N8E70	M1.2	SN	72	III/2II/2		2169

LOC: approximate heliographic location
XRAY: X-ray flare class
OP: optical flare class
10CM: peak 10 cm radio flux
TYPE: radio burst type
Cat: Catania sunspot group number
NOAA: NOAA active region number

5. Geomagnetic Observations at Dourbes



6. Review of ionospheric activity



The figure shows the time evolution of the Vertical Total Electron Content (VTEC) (in red) during the last week at three locations:
a) in the northern part of Europe(N61°, 5°E)
b) above Brussels(N50.5°, 4.5°E)
c) in the southern part of Europe(N36°, 5°E)
This figure also shows (in grey) the normal ionospheric behaviour expected based on the median VTEC from the 15 previous days.

The VTEC is expressed in TECu (with TECu=10^16 electrons per square meter) and is directly related to the signal propagation delay due to the ionosphere (in figure: delay on GPS L1 frequency).
The Sun's radiation ionizes the Earth's upper atmosphere, the ionosphere, located from about 60km to 1000km above the Earth's surface.The ionization process in the ionosphere produces ions and free electrons. These electrons perturb the propagation of the GNSS (Global Navigation Satellite System) signals by inducing a so-called ionospheric delay.

See http://stce.be/newsletter/GNSS_final.pdf for some more explanations ; for detailed information, see http://gnss.be/ionosphere_tutorial.php

7. Future Events

For more details, see http://www.spaceweather.eu/en/event/future

2014 Conference on Big Data from Space (BiDS '14) in Frascati, Italie

Start : 2014-11-12
This conference aims to bring together researchers, engineers, users in the area of Big Data in the Space sector.
The focus is on the whole data lifecycle, ranging from data acquisition by spaceborne and ground-based sensors to data management, analysis and exploitation in the domains of Earth Observation, Space Science, Space Engineering, Space Weather, etc.
Special emphasis will be put on highlighting synergies and cross-fertilization opportunities from domains like Climate Change, Solid Earth Science, Planetary Sciences, Life Science, Astrophysics, High Energy Physics, Social Sciences, etc.
We expect this conference to:
* contribute towards a common "Big Data from Space" scientific and programmatic framework
* widen competences and expertise of universities, labs and industrial actors
* foster networking of experts and users towards better access and sharing of data, tools and resources
* leverage innovation, spin-in, spin off of technologies, and business development arising from research and industry progress
Website:
http://congrexprojects.com/2014-events/BigDatafromSpace/objectives

European Space Weather Week in LiÃ¨ge, Belgium

Start : 2014-11-17 - End : 2014-11-21
The 11th Edition of the European Space Weather Week will take place on 17-21nd November 2014 in Liège, Belgium.
The ESWW will again adopt the central aim of bringing together the diverse groups in Europe working on different aspects of Space Weather. This includes but isn't limited to the scientific community, the engineering community, applications developers, service providers and service end users.
The meeting organisation is coordinated by the Belgian Solar-Terrestrial Centre of Excellence (STCE), ESA and the Space Weather Working Team. The local organisation is done by the STCE.
Website:
http://www.stce.be/esww11/

2014 AGU Fall Meeting in San Fransisco, USA

Start : 2014-12-15 - End : 2014-12-19
The AGU Fall Meeting is the largest worldwide conference in the geophysical sciences, attracting more than 22,000 Earth and space scientists, educators, students, and other leaders. For 46 years, energized and passionate Earth and space scientists from around the world gather at the AGU Fall Meeting to connect with colleagues, broaden their knowledge base, and embrace the joy of science. The 2014 meeting takes place Monday 15 - Friday 19 December 2014.
Several sessions about space weather are foreseen:
*
When and Why Does Space weather Forecasting Fail?
*
Addressing Operational Space Weather Needs
*
Near Real Time Data for Earth Science and Space Weather Applications
*
Understanding Hemispheric Asymmetry and Space Weather
*
Connection of Solar Events With the Variability of Space Environments

*
Bz from the Sun to the Earth: Observations and Modeling
*
Solar Sources and Heliospheric Consequences of Coronal Mass Ejections in Solar Cycle 24
*
Advances in Ionospheric Forecasting - Modeling, Observations, and Validation
Abstract Submission Deadline: August 6, 2014
Website:
http://fallmeeting.agu.org/2014/

Measurement Techniques for Solar and Space Physics, in Boulder, CO, USA

Start : 2015-04-20 - End : 2015-04-24
This gathering was born out of the desire to collect in one place the latest technologies required for advancement of science in the discipline of Solar and Space Physics. In doing so, it was recognized that the two 1998 volumes of 'Measurement Techniques in Space Plasmas' (Particles and Fields) have been a valuable reference and resource for advanced students and scientists who wish to know the fundamentals of measurement techniques and technology.
Website:
https://mtssp.msfc.nasa.gov/

26th General Assembly of the International Union of Geodesy and Geophysics (IUGG) in Prague, Czech Republic

Start : 2015-06-22 - End : 2015-07-02
We invite contributions on novel inversion methods with application across the geosciences. Of particular interest are 3D imaging, joint inversion of geodetic, geophysical and geochemical datasets, and multi-disciplinary interpretation approaches such as integration of gravity, EM and seismic data or thermo-mechanical modelling studies constrained by physical parameters.
Modelling of Space Weather Effects: Solar, Magnetospheric and Earth Resistivity Constraints (IAGA, IAMAS)
In this symposium we welcome contributions on all aspects of the modelling of space weather and its effects, from the Sun to Earth. This includes the modelling of the various interactions between travelling solar storms and the solar wind, magnetosphere, ionosphere and solid Earth and the validation of models through measurements. Contributions on models developed to aid end-users, such as satellite and power grid operators, survive the impact of space weather are also encouraged.
Website:
http://www.iugg2015prague.com/joint-inter-association-symposia.htm#JA

8. New documents in the European Space Weather Portal Repository

See http://www.spaceweather.eu/en/repository

STCE - Space weather services and products: Solar Cycle

Presentation given during a users' visit about the STCE operational space weather services and products.
http://www.spaceweather.eu/en/repository/show?id=534

STCE - Space weather services and products: COMESEP

Presentation given during a users' visit about the STCE operational space weather services and products.
http://www.spaceweather.eu/en/repository/show?id=535

STCE - Space weather services and products: SIDC

Presentation given during a users' visit about the STCE operational space weather services and products.
http://www.spaceweather.eu/en/repository/show?id=536

STCE - Space weather services and products: Regional Warning Center

Presentation given during a users' visit about the STCE operational space weather services and products.
http://www.spaceweather.eu/en/repository/show?id=537

STCE - Space weather services and products: Solar radio observations

Presentation given during a users' visit about the STCE operational space weather services and products.
http://www.spaceweather.eu/en/repository/show?id=538

STCE - Space weather services and products: Ruimteweer

Presentation given during a users' visit about the STCE operational space weather services and products.
http://www.spaceweather.eu/en/repository/show?id=539

STCE - Space weather services and products: Sola Demon

Presentation given during a users' visit about the STCE operational space weather services and products.
http://www.spaceweather.eu/en/repository/show?id=540

STCE - Space weather services and products: SSA Space Weather Coordination Centre

http://www.spaceweather.eu/en/repository/show?id=541