STCE Newsletter

21 Sep 2015 - 27 Sep 2015

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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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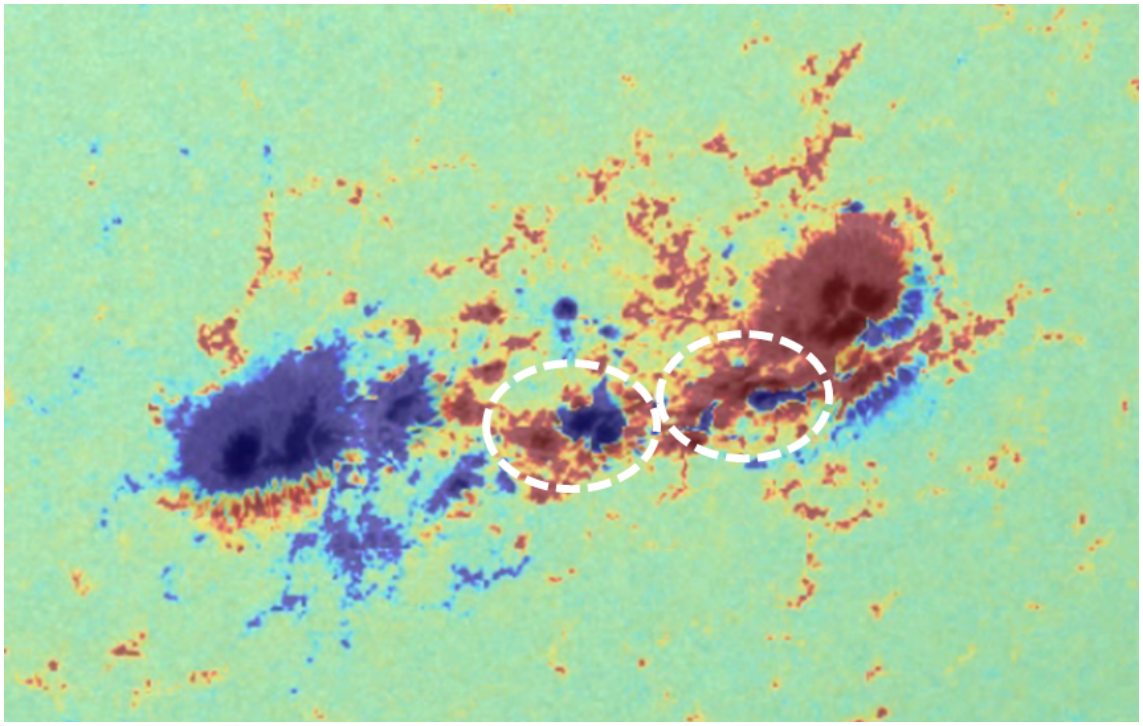
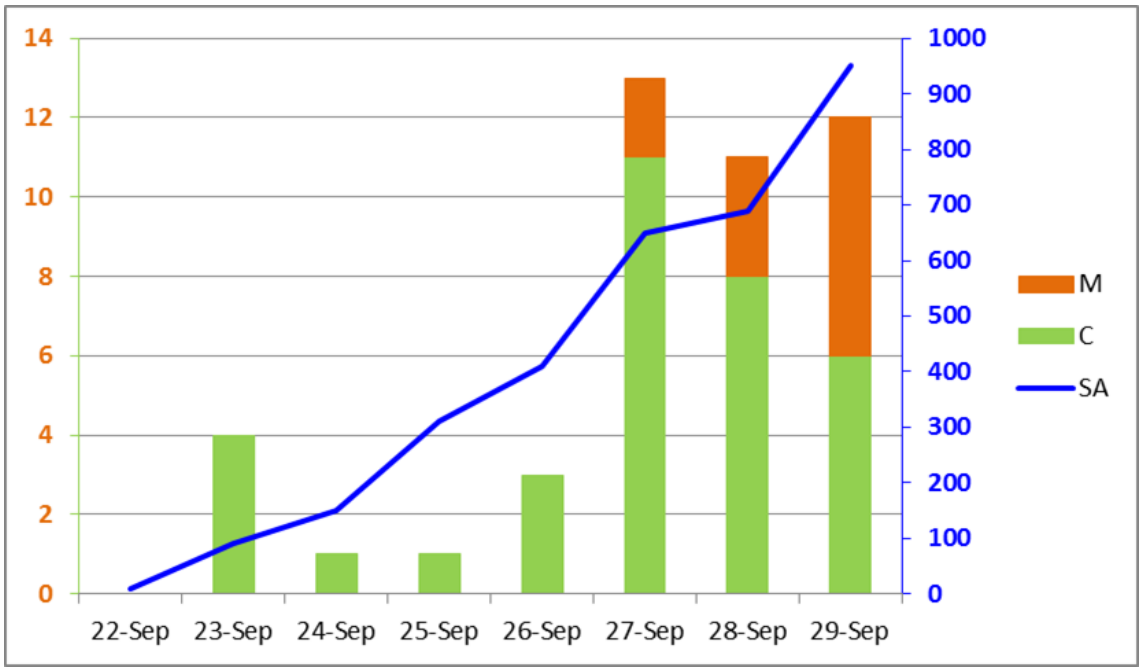
1. Rise and Shine!...

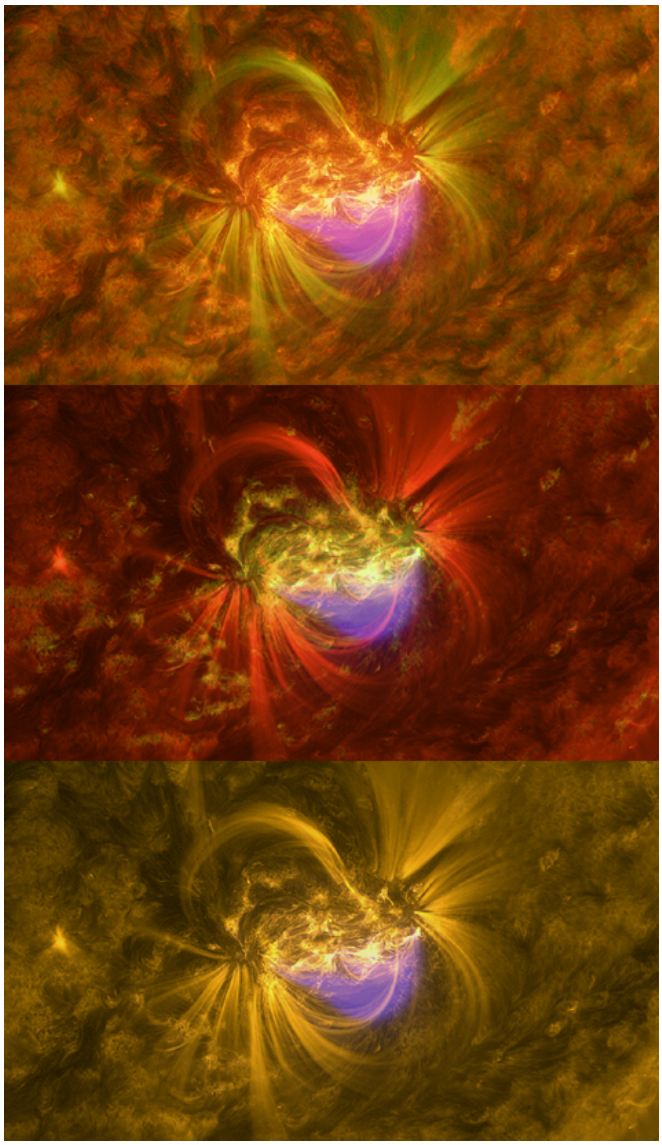
And that's exactly what active region NOAA 2422 did last week. From nothing, it started to emerge on 22 September as a simple bipolar sunspot region. Over the next few days, it developed into a fully mature sunspot group, gradually increasing its magnetic complexity. Until the 26th, it produced only a handful of C-class flares. However, by then, it had developed significant delta structures (spots of opposite magnetic polarity within the same penumbra) in its middle portion. This resulted in the production of M-class ("medium") flares starting on 27 September, with a major M7 flare on 28 September peaking at 14:58UT. The party continued on 29 September, with multiple M-class flares from this very active region.



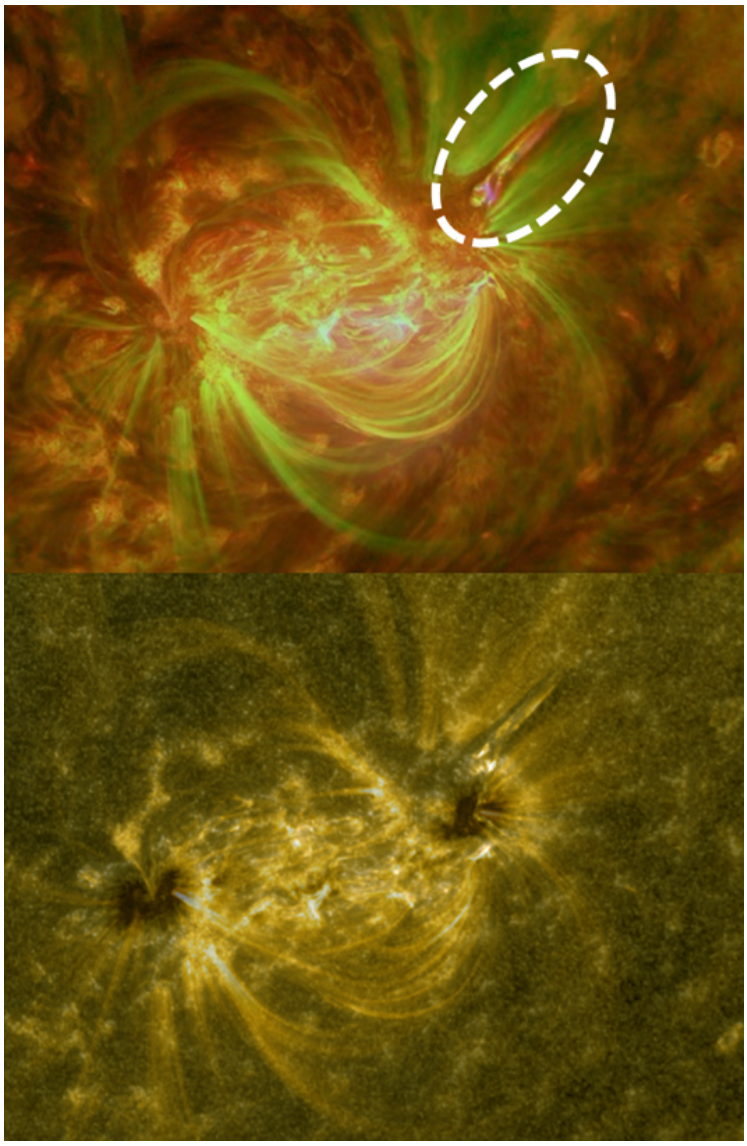
The image above shows the complex magnetic configuration of NOAA 2422 during the afternoon of 28 September. A magnetogram is laid over the continuum ("white light") image. The red color means a positive magnetic field, i.e. field lines coming out of the solar surface, whereas the blue color represents a negative magnetic field. The two delta structures, resp. the main middle spots and the structure to the lower left of the main leading spot, can easily be recognized. The graph underneath shows the evolution of NOAA 2422's sunspot area (blue line), as well as the daily number of C- and M-class flares it produced. The sunspot area is expressed in millionths of a solar hemisphere (MH), with 1000 MH corresponding to about 6 times the total surface area of the Earth.



A movie concerning NOAA 2422 can be seen at https://youtu.be/qy7pr3yuJNk The first clip shows the general evolution of the sunspot region in white light as it transits the solar disk (22-29 September). It is followed by a movie of the magnetogram (see above for the color code) lasting from 14:00 till 24:00UT on 28 September. Then follow 3 clips, each lasting from 14:00 till 19:00UT, and showing mainly the M7.6 flare and subsequent post-flare coronal loops as seen in SDO's extreme ultraviolet filters. The first 2 clips differ little from each other, as both are based on AIA 304 ("cool" temperatures of about 80.000 degrees; reddish colors), AIA 171 (around 700.000 degrees; greenish colors), and AIA 131 (several million degrees; bluish colors). However, in the second clip, the red and green components of the AIA 304 and 171 filters have been switched, with the red colors now displaying the post-flare coronal loops, adding to a rather dramatic effect. The third clip only shows the medium (AIA 171; yellowish colors) and high temperatures (AIA 131; bluish). Underneath is a still from each of the three clips, always at 15:29UT. Notice the "blue" blob of very hot plasma hovering over NOAA 2422. Also interesting is that, so far, most of these M-class flares were not associated with an obvious coronal mass ejection.



Another interesting feature is the series of jet-like eruptions to the north of the leading spot, such as e.g. around 17:41UT (image underneath). The movie shows at least 6 obvious jets in a timeframe of only 5 hours. They seem to be related to a small spot of opposite polarity near the northern edge of the leading spot's penumbra (see also the magnetogram above). More on jets can be found in the 05 February 2015 news item at http://www.stce.be/news/293/welcome.html



Images courtesy of SDO (http://sdo.gsfc.nasa.gov/data/aiahmi/) and (J)Helioviewer (http://helioviewer.ias.u-psud.fr/helioviewer/#).

2. crème de la crème at ESWW12

We selected a crème de la crème series of daily ESWW12 keynotes, to let yourself being immersed in special space weather topics:

- SSA SWE Segment status and prospects by Juha-Pekka Luntama
- Solar energetic particles: data environments, forecasting and impact by Tom Berger
- What do we know of solar flares? by Hugh Hudson
- Geomagnetically Induced Currents and Power Grids by Antti Pulkkinen
- Rosetta: flying through gas and dust by Andrea Accomazzo
- Model Validation and Metrics Studies for Space Environment Predictions by Masha Kuznetsova
- Planetary Space Weather in the Outer Heliosphere by Chris Arridge
- GAIA: First year flight operations in L2 environment by Federico Di Marco
- Neutron Monitors to study Space Weather in the Earth's Atmosphere and near-Earth by Erwin Flueckiger
- Radiation Belt Modeling and Forecasts: Limitations, Challenges and Future Needs by Reiner Friedel

The keynotes are plenary and scheduled before the sessions to allow you to get acquainted to the subjects of the day: http://www.stce.be/esww12/program/keynotes.php

3. PROBA2 Observations (21 Sep 2015 - 27 Sep 2015)

Solar Activity

Solar flare activity fluctuated between very 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: http://proba2.sidc.be/swap/data/mpg/movies/weekly_movies/weekly_movie_2015_09_21.mp4 (SWAP week 287).

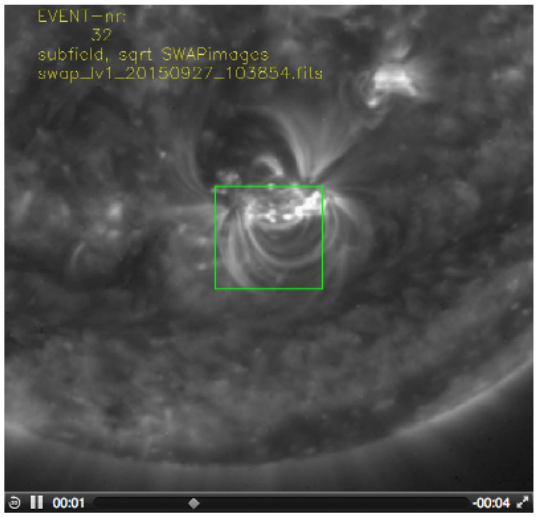
Details about some of this week's events:

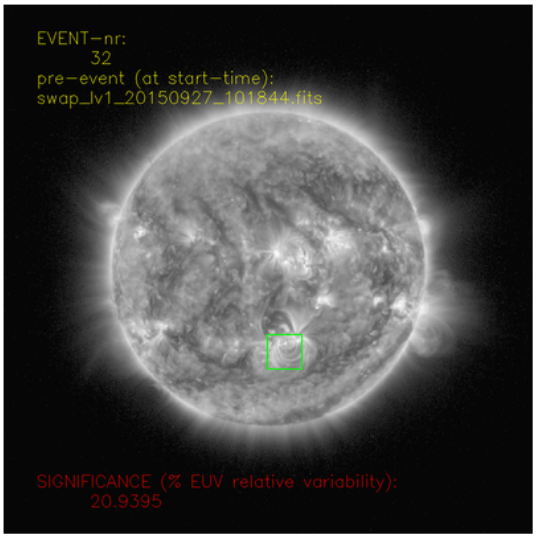
Solar activity increased towards the end of the week. AR 2422 produced two M-class flares on 2015-09-27: an M1.9 flare peaking around 10:40 UT and an M1.0 flare peaking around 21:00 UT.
Below we provide SWAP images from the time when these M-flares occurred on 2015-Sep-27. The annotated snapshots are produced by the Solar Feature Automated Search Tool (SoFAST). This tool detects dynamic solar events in EUV images from SWAP in near real-time. The snapshots illustrate the location of the flare on the solar disk (right) and a zoomed image (left).

The complete SoFAST online event list and additional plots are available on http://www.sidc.be/sofast.

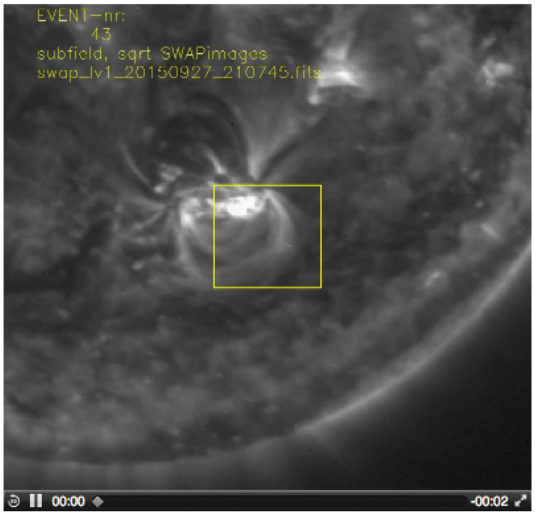
Sunday Sep 27:

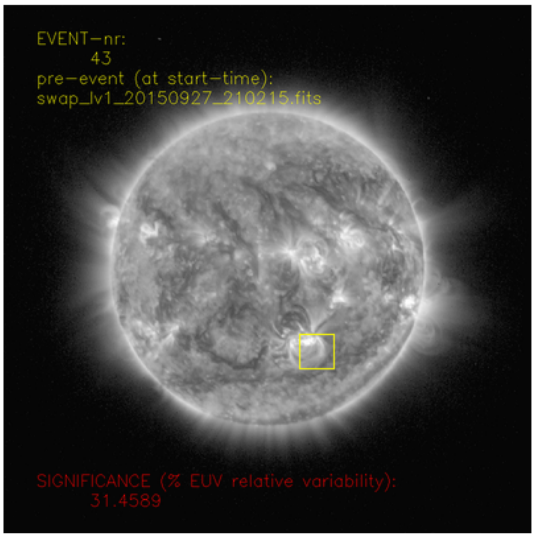
M1.9 flare peaking around 10:40 UT





M1.0 flare peaking around 21:00 UT

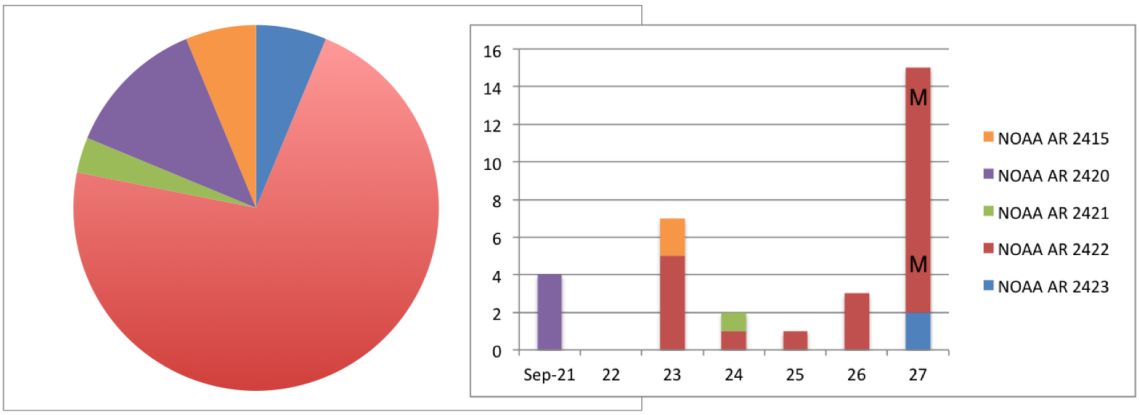




4. Review of solar activity

Eleven active regions were observed by NOAA during the week, with the NOAA AR numbers (corresponding Catania numbers in the brackets): 2415 (31), 2418 (32), 2419 (no Catania number), 2420 (38), 2421 (37), 2422 (39), 2423 (36), 2424 (40), 2425 (41), 2426 (42), 2427 (no Catania number). The flaring activity was variable from day to day, with NOAA ARs 2415, 2420, 2421, 2422, and 2423 producing flares above the B9.9-level. The strongest flare of the week was the M1.9 flare peaking at 10:40 UT on September 27 in the NOAA AR 2422 (Catania number 39). This group also released the second M-flare of this week on September 27. None of the flares was associated with an Earth-directed CME.

Distribution of >B flares, Aug 24 – 30, 2015



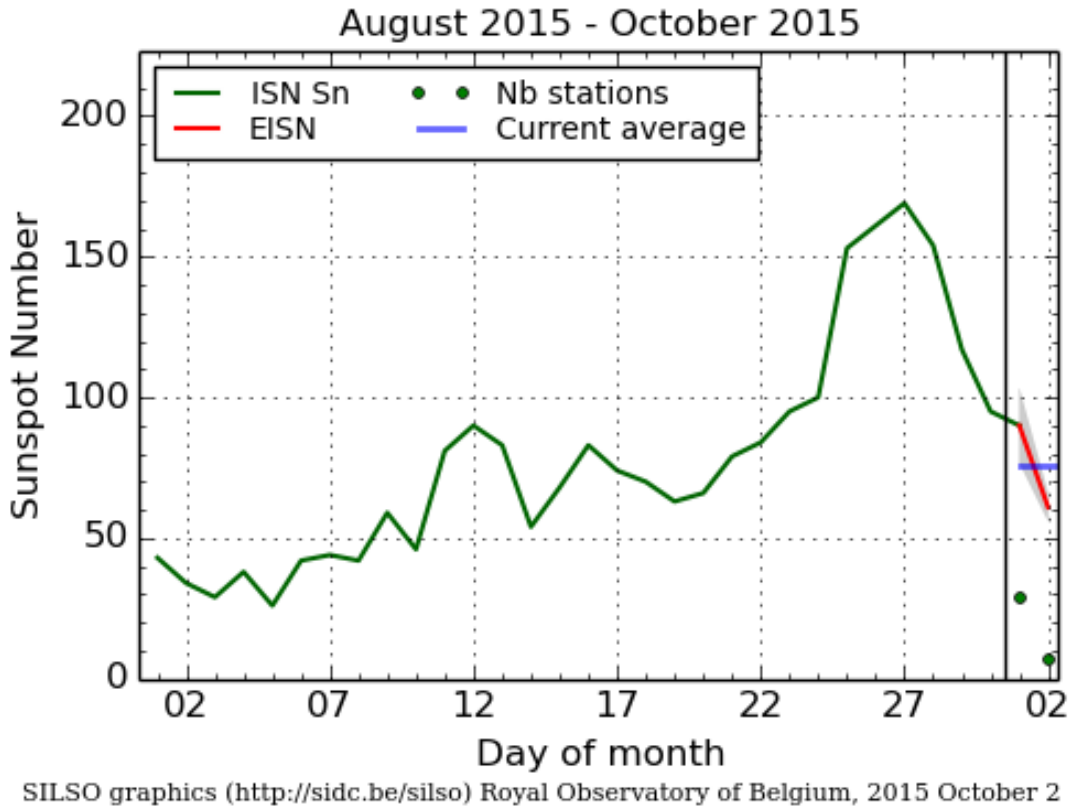
The left chart gives an overview of the total number of flares per NOAA AR region for the indicated week. *None* indicates that the flare site is not linked with one particular active region. The right chart gives an overview of the flaring activity per NOAA AR per day.

5. Noticeable Solar Events (21 Sep 2015 - 27 Sep 2015)

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	TYPE	Cat	NOAA
27	1020	1040	1046	S22W8	M1.9	1F			39	2422
27	2054	2100	2115	S21W16	M1.0	1N		III/1	39	2422

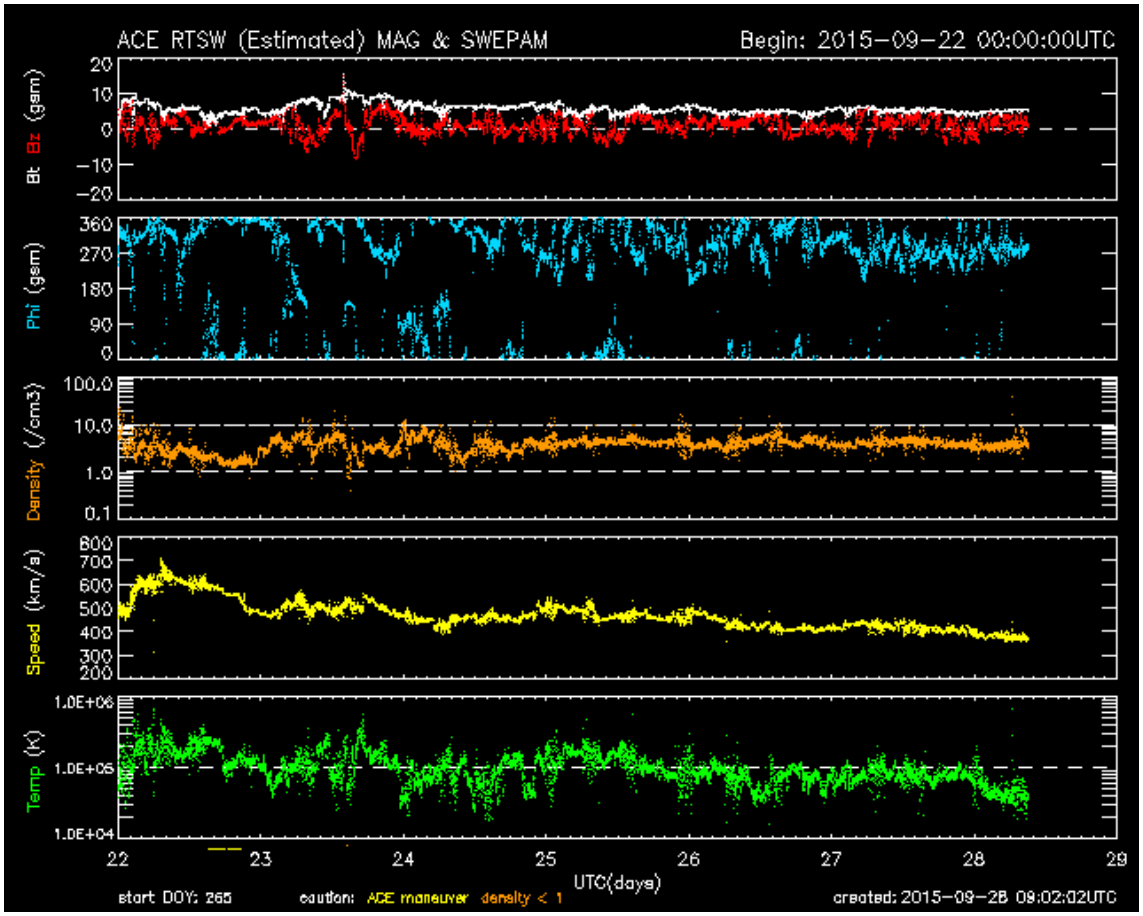
LOC: approximate heliographic location
XRAY: X-ray flare class
OP: optical flare class
10CM: peak 10 cm radio flux
TYPE: radio burst type
Cat: Catania sunspot group number
NOAA: NOAA active region number

6. The International Sunspot Number



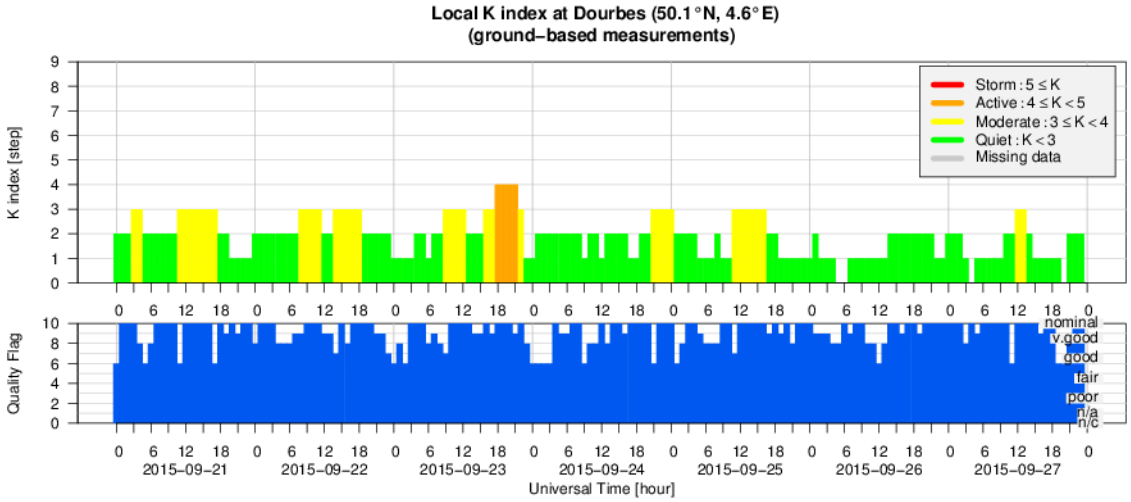
The daily Estimated International Sunspot Number (EISN, red curve with shaded error) derived by a simplified method from real-time data from the worldwide SILSO network. It extends the official Sunspot Number from the full processing of the preceding month (green line). The plot shows the last 30 days (~ one solar rotation). The horizontal blue line shows the current monthly average, while the green dots give the number of stations included in the calculation of the EISN for each day.

7. Review of geomagnetic activity

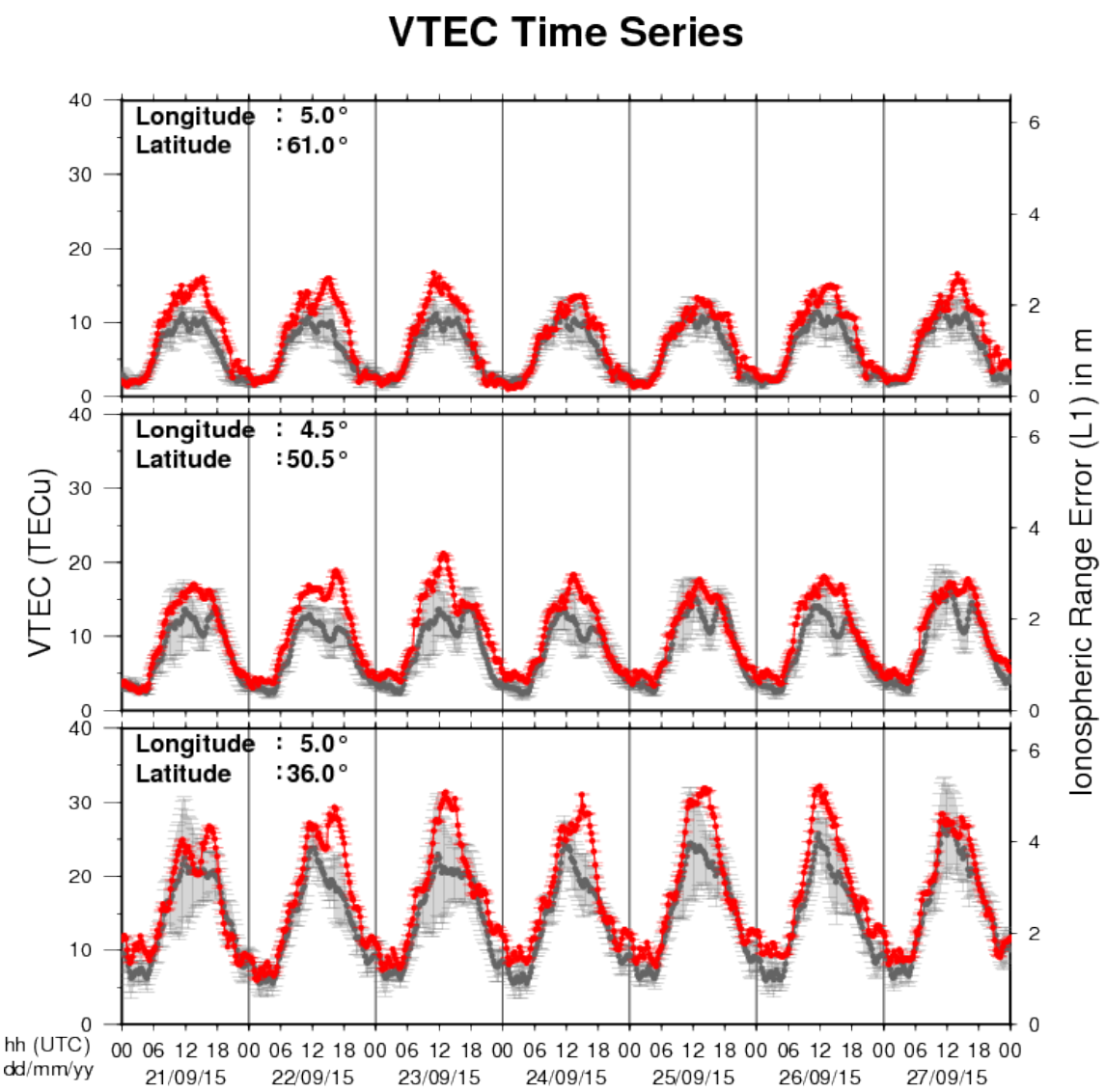


Solar wind measured by ACE in the L1 point near the Earth was very variable during the week but without clear structuring. The solar wind speed was varying between less than 400 km/s and almost 700 km/s. Even if the interplanetary magnetic field magnitude was reaching 10 nT at times, the geomagnetic activity was mostly at the quiet to unsettled levels. Only one interval of active conditions (K = 4) was reported by Dourbes, IZMIRAN, and NOAA (in the evening of September 23).

8. Geomagnetic Observations at Dourbes (21 Sep 2015 - 27 Sep 2015)



9. Review of ionospheric activity (21 Sep 2015 - 27 Sep 2015)



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

10. Future Events

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

The Dynamic Sun - Exploring the Many Facets of Solar Eruptive Events in Potsdam, Germany

Start : 2015-10-26 - End : 2015-10-29
Erupting prominences/filaments, surges, flares, and coronal mass ejections (CMEs) are prominent examples of the dynamic Sun. Multi-wavelength and multi-instrument observations have the potential to reveal highly energetic physical processes on the Sun reaching from the photosphere, over the chromosphere and the transition region, to the corona and beyond. Solar physicists have nowadays access to a suite of new ground-based observing facilities including, for example, the 1.5-meter GREGOR solar telescope at the Observatorio del Teide, Tenerife, Spain, the European Low Frequency Array (LOFAR), the Atacama Large Millimeter/Submillimeter Array (ALMA) in Chile, and the Coronal Multi-Channel Polarimeter for Slovakia (COMP-S) at Lomnicky Peak Observatory. A powerful fleet of space missions, for example, the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI), the Japanese Hinode, and the Solar Dynamics Observatory (SDO), adds more capabilities to investigate magnetic fields, complex plasma flows, and accelerated particle, and thermal properties of solar eruptive events. In the tradition of the series of Â»Potsdam ThinkshopsÂ«, we invite instrument specialists, observers, modellers, and theorists to exchange ideas, to stimulate discussion, to initiate future collaborations among participants, and to attract new users of instruments by showcasing the capabilities. The aim is to make progress towards a comprehensive description of solar eruptive events effectively aggregating their global properties as well as their highly dynamic fine structure. Thinkshop 12 takes place at the science park Â»Albert EinsteinÂ«, home to AIP's Great Refractor and the Solar Observatory Einstein Tower at the Telegraphenberg.
Website:
https://thinkshop.aip.de/12/cms/

IRIS-5 Workshop in Pune, India

Start : 2015-10-26 - End : 2015-10-29
The IRIS-5 workshop will be conducted at the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, India from October 26-29, 2015. This workshop is mainly aimed at the participants who could not attend IRIS-4, which is being held at Boulder, USA. Therefore, set up of the IRIS-5 workshop would be essentially be very similar to that of IRIS-4.
The main aim of the workshop is to introduce the Interface Region Imaging Spectrometer (IRIS) to students and young post docs. This would be done through tutorials on IRIS data analysis, physics of optically thick radiative transfer, MHD simulations of the solar atmosphere related to IRIS and hydrodynamic simulations of flares. There will be lectures as well as hands on sessions.
Website:
http://www.iucaa.ernet.in/~solar/Welcome.html

Solar Storm Early Forecasting in Copenhagen, Denmark

Start : 2015-11-09 - End : 2015-11-11
The fundamentally most important source of inner heliospheric plasma physics and space weather is the active Sun, its solar active region eruptions. Prediction of the evolution and influence of solar active regions on solar storms in the near-Earth environment is of particular interest to several forecasting institutions, industrial stakeholders, and the public in general.
State-of-the-art solar storm prediction tools are limited to monitoring solar active regions, registering eruptions and mass ejections while attempting, then, at extrapolating subsequent evolution and spatio-

temporal propagation: no realistic physics-based and data-driven synthesis tool exists, which is capable of predicting when a solar flare will be triggered, or when a Coronal Mass Ejection will be launched into inter-planetary space. In short, we are not yet able to answer the question: When and why do solar storms launch?
Our meeting will be focused around initiation of space weather events at the Sun. We will discuss and develop three major challenges, and we aim to develop a draft resolution road-map for those challenges during the meeting.
Website:
https://indico.nbi.ku.dk/conferenceDisplay.py?confId=817

Workshop on Solar Astronomy Big Data - IEEE ICDM in Atlantic City, NJ, USA.

Start : 2015-11-13 - End : 2015-11-13
With the launch of NASA's Solar Dynamics Observatory (SDO) mission on 02/11/2010, researchers in solar physics have entered the era of Big Data. The Atmospheric Imaging Assembly (AIA) instrument on SDO provides imaging data and the Helioseismic and Magnetic Imager (HMI) instrument on SDO provides magnetic field data. Both instruments record data at a high spatial resolution and a time cadence, amounting to about 1 Petabyte of scientific data each year. The Big Data challenges in Solar Astronomy are expected to grow even further with the inauguration of the NSF funded Daniel K. Inouye Solar Telescope (DKIST), currently under construction in Hawaii. This telescope is expected to generate: 3-5 Petabytes of data per year.

The Scientific Foundation of Space Weather

Start : 2016-06-27 - End : 2016-07-01
Website:
http://www.issibern.ch/program/workshops.html