STCE Newsletter

14 Apr 2014 - 20 Apr 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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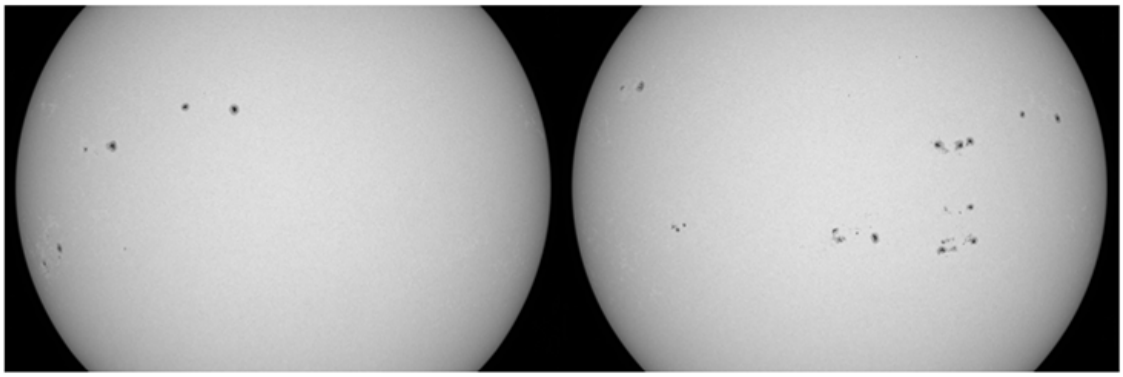
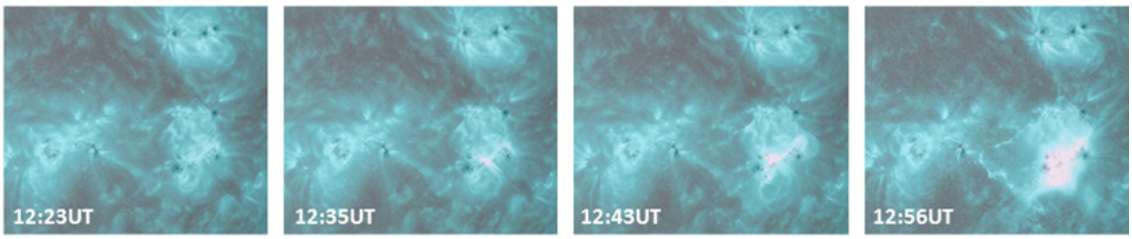
1. The amazing M7 flare

A strong M7 flare occurred in NOAA 2036 on 18 April (peak at 13:03UT). This sunspot region developed on disk in just a few days (image underneath), was magnetically complex but had not produced any strong flare until that day.

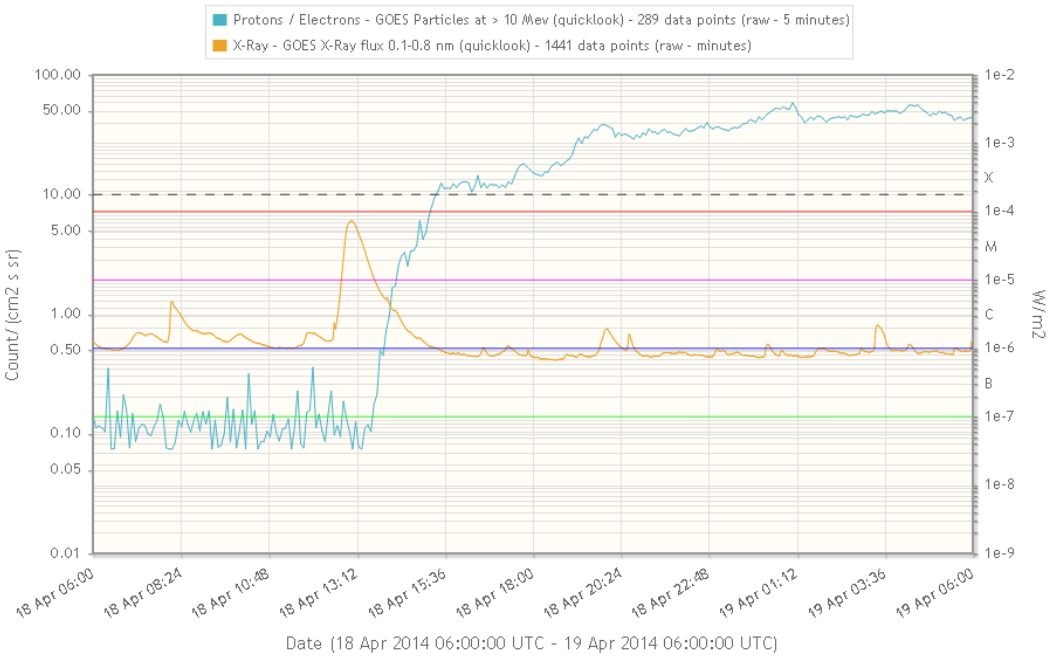


13 April 2014 18 April 2014

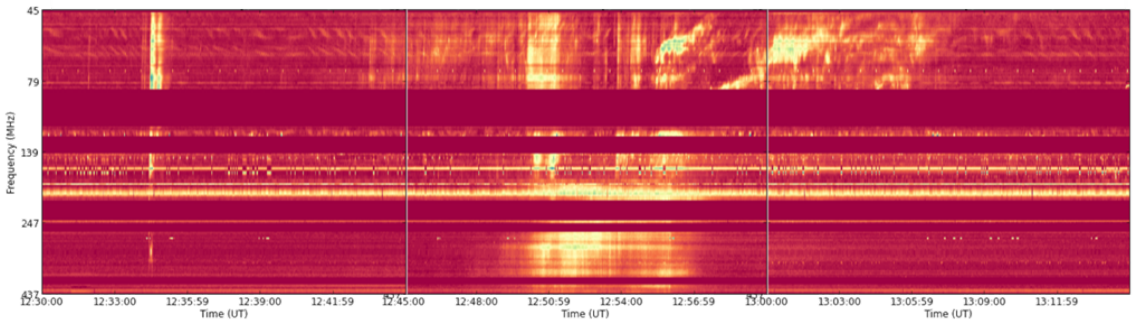
The flare seems to get initiated by a bright jet near the middle cluster of sunspots (image underneath at 12:35UT), apparently destabilizing the overlying magnetic loops (12:43UT) and creating a reconnection and flare. The creation of a transient coronal hole south of the active region can be observed, indicating the ejection of material into space. There was also an EIT-wave (http://stce.be/news/241/welcome.html) associated to this event, which can be seen sweeping towards the Sun's east limb in PROBA2/SWAP difference imagery (one image subtracted from the previous one).



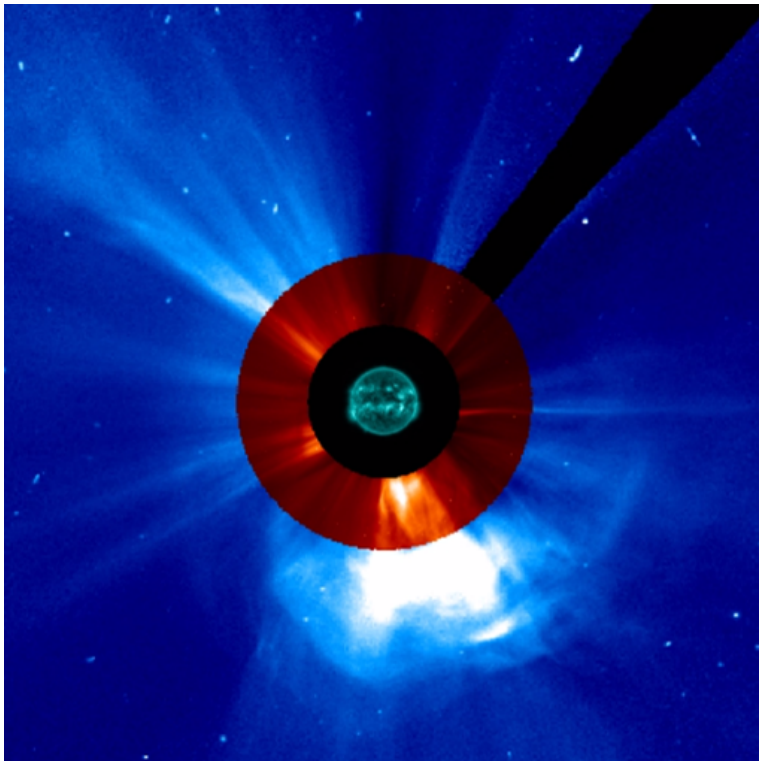
The flare was also accompanied by a proton event (the fifth this year, see http://umbra.nascom.nasa.gov/SEP/). The first protons started to arrive about 1 hour after the onset of the flare, and about 30 minutes after the peak. It was a minor event, reaching a maximum of 58pfu (particle flux unit) early on 19 April.



Radio-bursts accompanying this flare event were observed by the Solar Radio Observatory in Humain (image underneath). The type III burst recorded at 12:35UT coincides with the appearance of the jet seen in EUV (extreme ultraviolet) and a brief hick-up in x-ray flux. Also a Type II burst can be seen (from about 12:54 till 13:03UT) which is indicative of a shock wave moving through the solar atmosphere. The speed of this shock wave was determined to be near 800km/s.



Based on the EUV and radio observations, the appearance of a coronal mass ejection (CME) shortly after the flare was no surprise. It showed as a halo around the Sun, indicating that part of this CME was directed towards Earth. The recorded speed was about 1000km/s, but the bulk of the plasma cloud was directed away from the Earth. Around 11:30UT on 20 April, Earth suffered the impact from this CME. Wind speed reached 750km/s, but the magnetic field of the CME was initially positive, eventually resulting in only small negative (southward) excursions. Active conditions were recorded, with a brief episode of a minor geomagnetic storm.

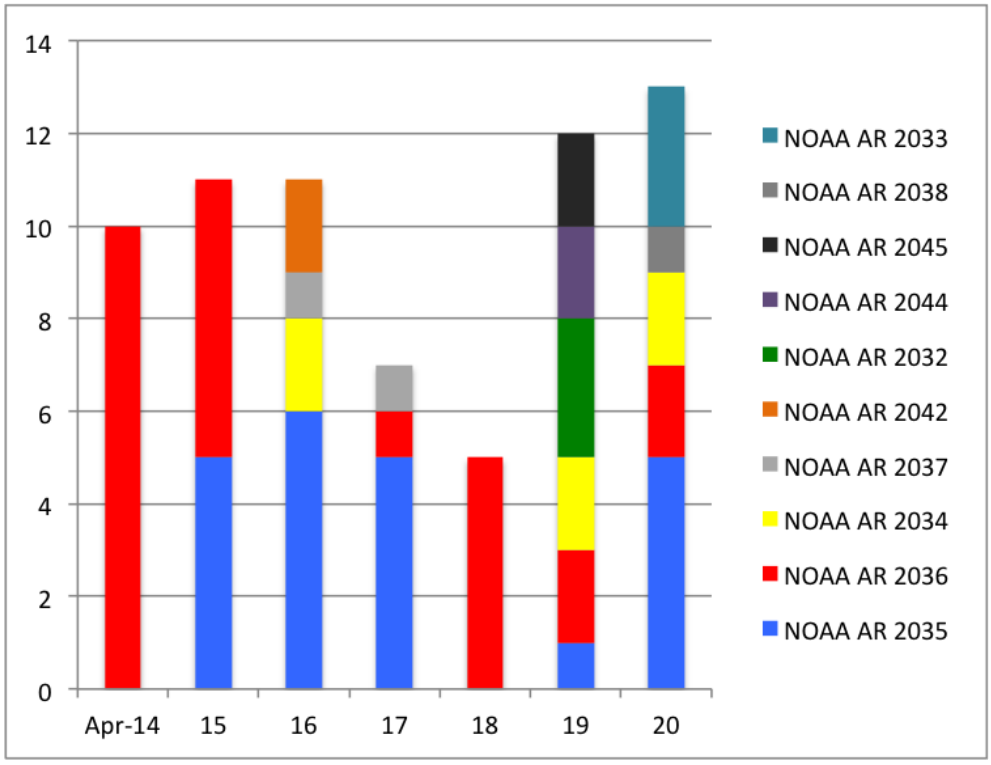


This movie at http://youtu.be/Mrde7doR8rY first shows the sunspot regions in white light, then three clips in SDO/AIA filters of increasing temperature (AIA 304-171-131) overlaid on the white light imagery, a clip combining three SDO-filters (AIA 304-171-094), the PROBA2/SWAP difference imagery (EIT-wave), and ends with the combined SDO/AIA and SOHO/LASCO imagery (CME).

Credits - Data and imagery were taken from PROBA2/SWAP (http://proba2.oma.be/ssa), Humain Radioastronomy Station (http://www.sidc.be/humain/), SDO (http://sdo.gsfc.nasa.gov/data/), SOHO (http://sohowww.nascom.nasa.gov/), Staff (http://sun-ts-dev.oma.be/), and (J)Helioviewer (http://helioviewer.org/).

2. Review of solar activity (14 Apr 2014 - 20 Apr 2014)

Fourteen active regions were reported by NOAA during the week (with numbers between 2032 and 2045) with 10 of them producing in total 67 flares: 65 C-flares and 2 M-flares. AR 2035 (blue) and AR 2036 (Red) dominate the chart below and thus the flaring scenery. It where also these 2 groups that were responsible for the M-flares on April 16 and 18.

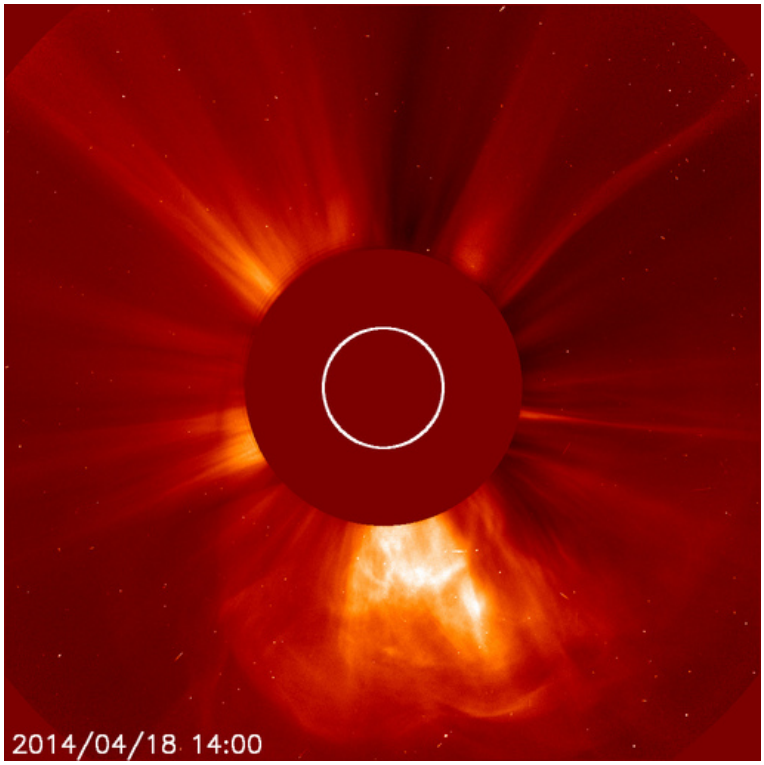


The M1.0 flare peaked at 19:59 UT on April 16 in the NOAA AR 2035 (Catania number 24). The flare was associated with an EIT wave and a weak coronal dimming, but the associated CME was narrow and did not arrive at the Earth.

An event with a space weather impact

An M7.3 flare peaked at 13:03 UT on April 18 in the NOAA AR 2036 (Catania number 25). The flare is visible on the SDO/AIA 193 movie as a light flash in the SE of the solar disk: http://www.stce.be/movies/20140418_aia_193.mp4

Solar Demon (http://solardemon.oma.be) detected a solar dimming at the time of the flare. This indicates that a CME is possibly associated with the event. And indeed, a full halo CME appeared in the SOHO/LASCO FOV at 13:25 UT. The resulting ICME arrived at the Earth on April 20 (see Review of Geomagnetic Activity).



The halo CME also produced a proton event at energies above 10 MeV that lasted for almost two days. Right after the arrival of the associated shock-like structure at the Earth on April 20 (see below), the proton flux at energies above 10 MeV decreased to values below the threshold of the proton event.

Check the SOHO/LASCO chronograph difference movie: the halo CME comes into the C2 FOV less than 30 minutes after the flare peak, the white and black dots appearing after the eruption are the protons that hit the detecter of the chronograph.

http://www.stce.be/movies/20140418_d2.mpg

3. Noticeable Solar Events (14 Apr 2014 - 20 Apr 2014)

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	TYPE	Cat	NOAA
16	1954	1959	2004	S14E9	M1.0	1N		II/2	24	2035
18	1231	1303	1320		M7.3			CTM/1000I/1V/2IV/2VI/2II	25	2036

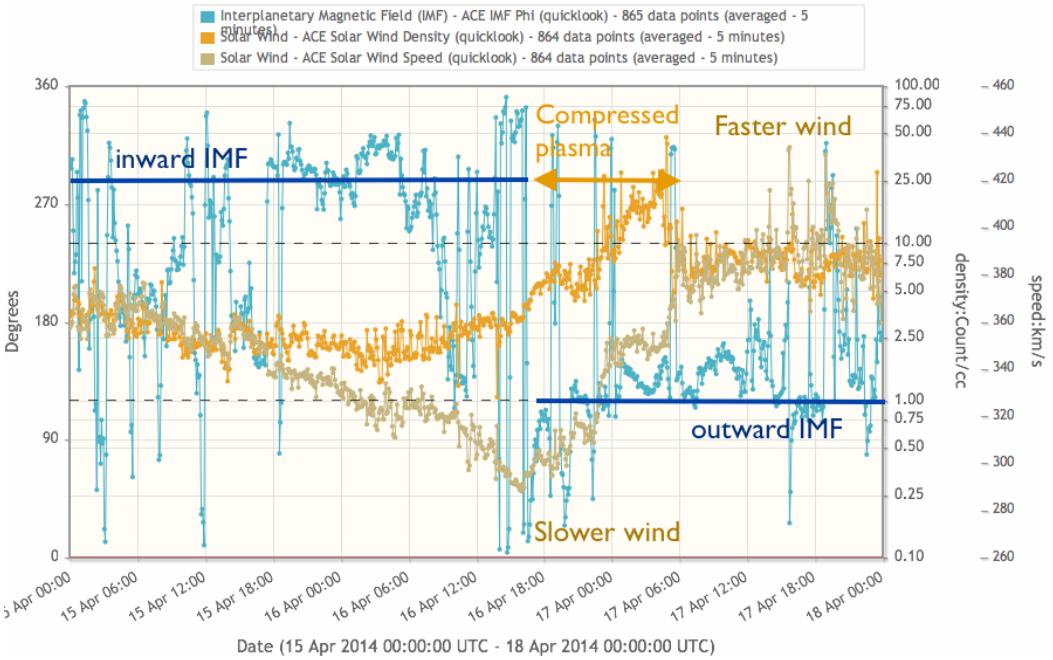
LOC: approximate heliographic location
XRAY: X-ray flare class
OP: optical flare class
10CM: peak 10 cm radio flux
TYPE: radio burst type
Cat: Catania sunspot group number
NOAA: NOAA active region number

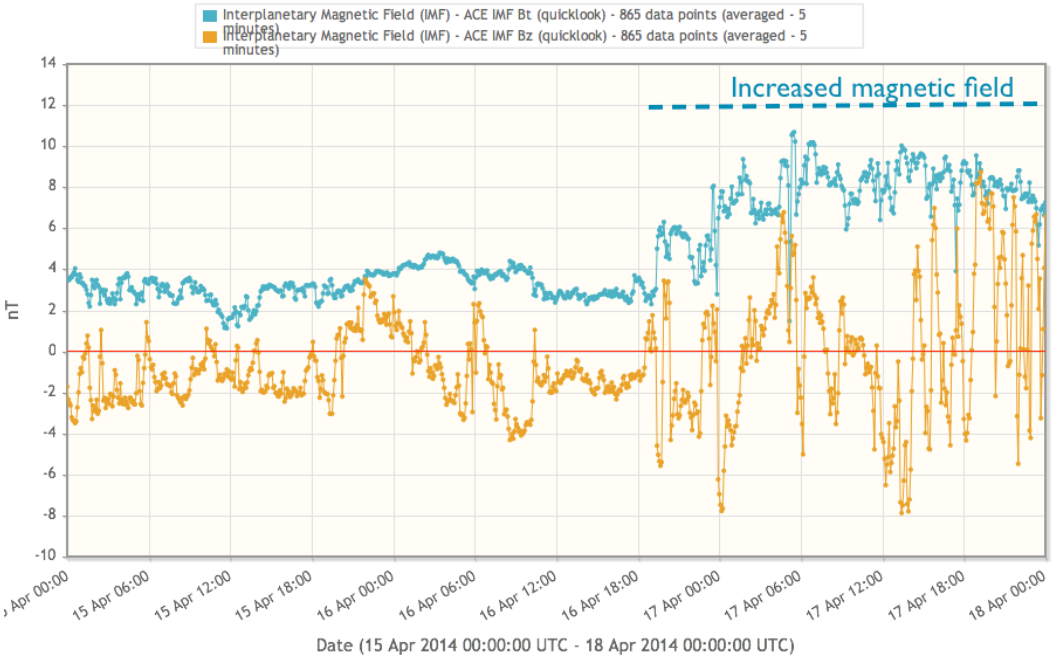
4. Review of geomagnetic activity (14 Apr 2014 - 20 Apr 2014)

Sector Boundary Crossing and Slow/Fast

In the beginning of the week the Earth was situated inside a slow solar wind flow and the geomagnetic conditions were quiet. Late on April 16 an interplanetary sector boundary arrived. The Earth passed from a sector with a magnetic field pointing towards the Sun (Phi between roughly 270 and 360 degrees) to

a sector with a magnetic field pointing away from the Sun (Phi between roughly 90 and 180 degrees). The blue lines shows the inward and outward interplanetary magnetic field (IMF).
The sector boundary crossing was followed by a compression region at the interface between a slow and a faster solar wind flow. The plasma in a compression region is compressed in terms of density (orange) and magnetic field (blue, second graph). The solar wind speed increased gradually to around 500 km/s on April 18 (see ACE graph below)

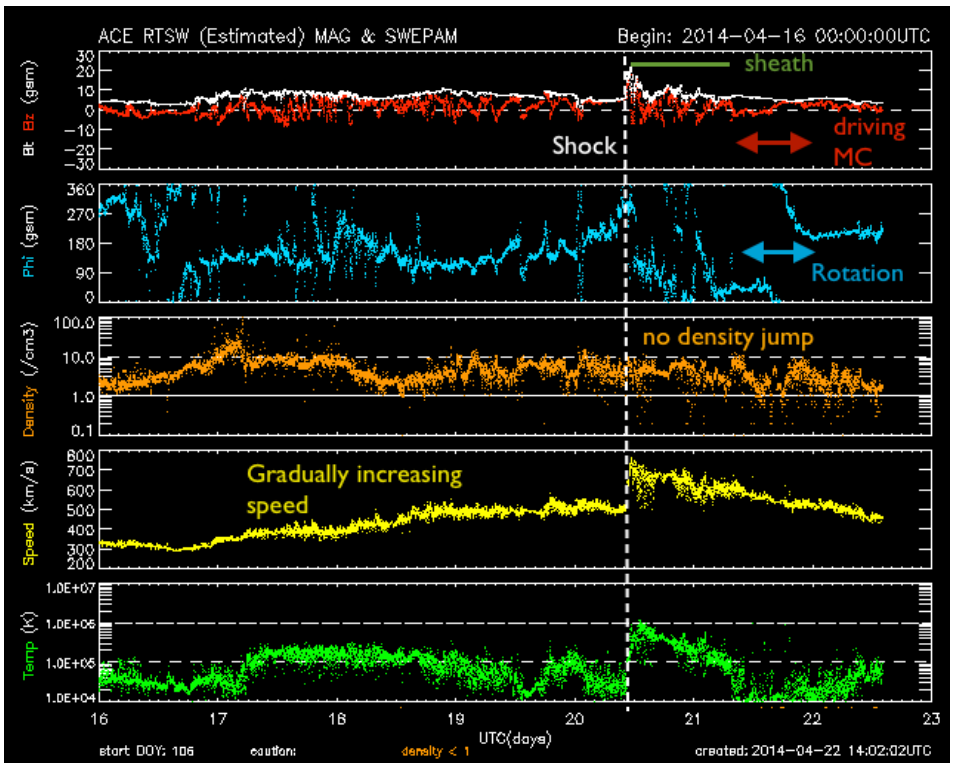




The geomagnetic situation remained mostly quiet, with only several occasional intervals of K = 4 reported by Dourbes, IZMIRAN and NOAA on April 19.

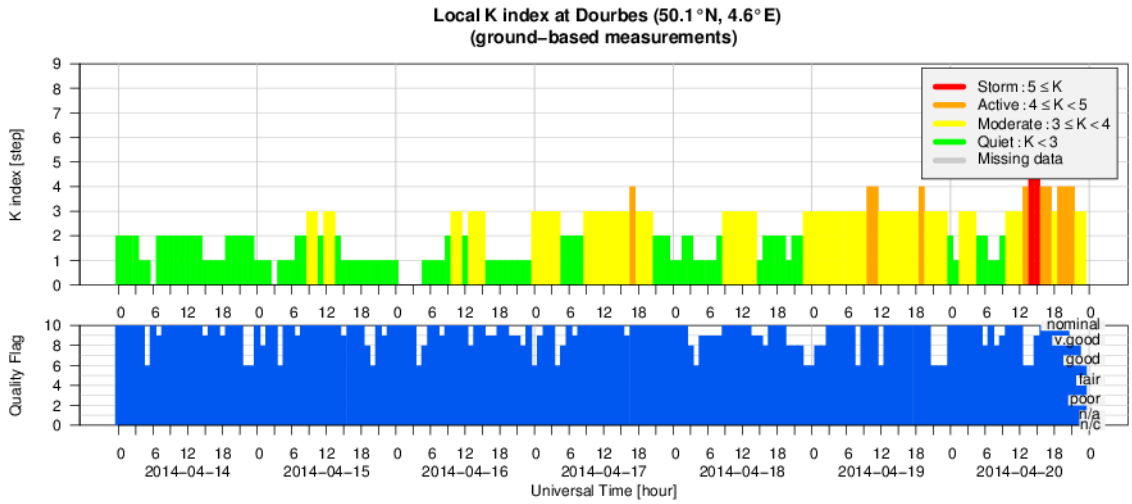
Shock

The arrival of an interplanetary shock-like structure was detected on April 20. ACE recorded jumps of the solar wind speed, temperature, and the interplanetary magnetic filed (IMF) magnitude at 10:23 UT. SOHO/CELIAS detected a jump of the density at 10:22 UT, but the jump of the speed was detected only 20 to 30 minutes later.

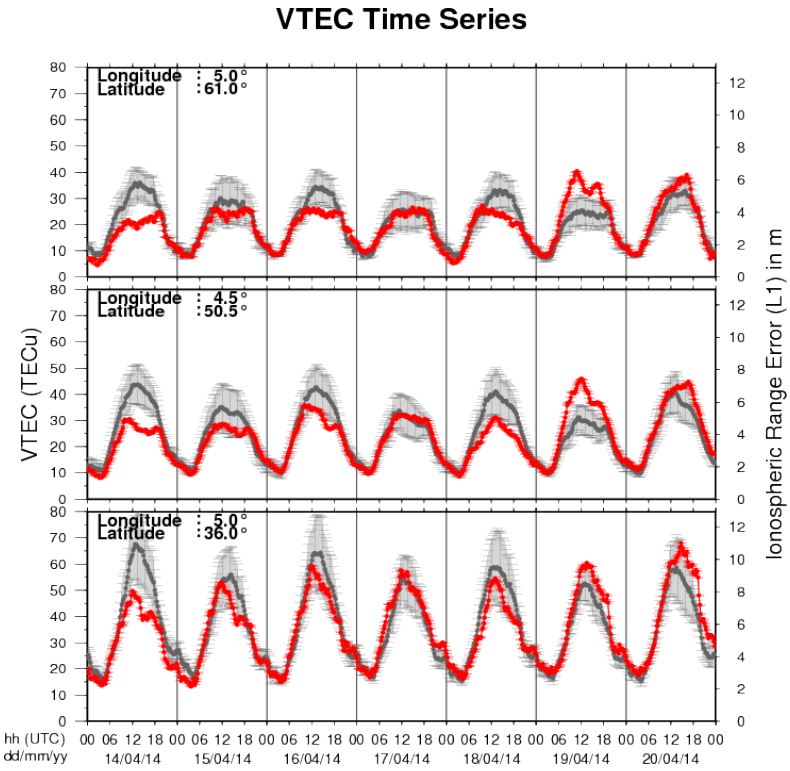


Therefore, this discontinuity does not seem to be a typical ICME-driven fast forward shock as ACE did not detect a jump of the density at all, and jumps of the density and the solar wind speed detected by SOHO/CELIAS were not simultaneous. The structure was followed by a sheath-like region (green line in ACE graph above) that lasted until the arrival of the driving magnetic cloud (MC, red arrow) on April 21. The magnetic field vector in the MC rotated slowly from +/- 45 to +/- 180 degrees (Phi, blue arrow). This ICME corresponds to the halo CME observed on the Sun on April 18. During intervals of the strongest IMF magnitude in the sheath-like region (up to 22 nT), the north-south IMF component Bz was not particularly strong and fluctuated in its direction. Only active and minor geomagnetic storm conditions (K index of 4 and 5) resulted, as reported by Dourbes, IZMIRAN and NOAA. Weak geomagnetic impact of this event is probably due to a glancing encounter with the ICME, as evidenced by the long interval (almost a day) between the arrivals of the shock-like structure and of the magnetic cloud.

5. Geomagnetic Observations at Dourbes (14 Apr 2014 - 20 Apr 2014)



6. Review of ionospheric activity (14 Apr 2014 - 20 Apr 2014)



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

EGU General Assemby in Vienna, Austria

Start : 2014-04-27 - End : 2014-05-02
The EGU General Assembly 2014 will bring together geoscientists from all over the world to one meeting covering all disciplines of the Earth, planetary and space sciences. The EGU aims to provide a forum where scientists, especially early career researchers, can present their work and discuss their ideas with experts in all fields of geosciences.

STCE workshop on degradation and inter-calibration of instruments observing in the SXR-EUV range in Brussels, Belgium

Start : 2014-06-10 - End : 2014-06-11
The STCE workshop 'Inter-Calibration and Degradation of EUV Instruments' aims at understanding the differences observed between the various instruments observing in the SXR-EUV range and at analyzing the ageing effects that affect their results. It targets imagers as well as spectrometers and photometers. The workshop will be followed by two days of working sessions (June 12-13) organized by the Solar EUV Irradiance Working Group (also supported by the STCE). These working sessions are in the continuity of similar events organized in 2011, 2012 and 2013, but they are open to new participants and you are welcome to join if you are interested.
Website:
http://www.stce.be/euvworkshop2014/

3rd SWARM science meeting in Copenhagen, Denmark

Start : 2014-06-19 - End : 2014-06-20
During the summer of 2014 DTU Space will host the 3rd Swarm Science Meeting, sponsored by the European Space Agency, ESA . This meeting will take place at the IDA Conference Centre in Copenhagen on June 19th to 20th 2014 and is open to the science community at large.
Website:
http://congrexprojects.com/2014-events/Swarm/home

8. New documents in the European Space Weather Portal Repository

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

STCE Annual Report 2012

The STCE Annual Report 2012 is a compilation of the activities done in 2012 within the frame of the Solar-Terrestrial Centre of Excellence (STCE). This report continues the style from the previous edition. Hence, as it is targeting a more general public, it presents only a selection of the 2012-activities in easy-to-digest summaries. These summaries emphasize the intense collaboration between the institutes at the Space Pole, as well as with our external partners. We hope you enjoy this report, which features articles on the evolution of the solar activity, the 9th European Space Weather Week, PROBA2, Integrated Water Vapor observations, SIMBA the nanosatellite, user applications such as STAFF, LIDAR, and ionospheric models, and much more... Happy reading!
http://www.spaceweather.eu/en/repository/show?id=494

eHEROES - CME tracking from STEREO image data de-projected by different methods

http://www.spaceweather.eu/en/repository/show?id=492

eHEROES - Systematic testing of different de-projection methods for STEREO imagery

http://www.spaceweather.eu/en/repository/show?id=497

eHEROES - Review on remote-sensing observations of successive CMEs and CME-CME interaction

http://www.spaceweather.eu/en/repository/show?id=498

STCE - PROBA Workshop: Belspo perspective

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the perspective of Belspo on the PROBA series and the Belgian involvement in the European space programmes.
http://www.spaceweather.eu/en/repository/show?id=501

STCE - PROBA Workshop: small can be GREAT

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the perspective of QinetiQ Space on the PROBA series.
http://www.spaceweather.eu/en/repository/show?id=502

STCE - PROBA Workshop: Proba-1 and -V from an EO perspective

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on Proba-1 and Proba-V as part of the ESA's Earth Observation Programme.
http://www.spaceweather.eu/en/repository/show?id=503

STCE - PROBA Workshop: PROBA2

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet about the PROBA2 science operations.
http://www.spaceweather.eu/en/repository/show?id=504

STCE - PROBA Workshop: PROBA-V

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the new operational mission PROBA-V, an earth observing satellite.

http://www.spaceweather.eu/en/repository/show?id=505

STCE - PROBA Workshop: Operation

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet about the operations at the PROBA satellites "nursery".
http://www.spaceweather.eu/en/repository/show?id=506

STCE - PROBA Workshop: PROBA-V experimental moon calibration method

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on a PROBA-V experimental moon calibration method.
http://www.spaceweather.eu/en/repository/show?id=507

STCE - PROBA Workshop: EPT onboard PROBA-V

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the instrument aspects, operations and science of the Energetic Particle Telescope (EPT) onboard of PROBA-V.
http://www.spaceweather.eu/en/repository/show?id=508

STCE - PROBA Workshop: coronal imaging with PROBA2/SWAP

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the challenges and successes of the coronal images SWAP onboard of PROBA2.
http://www.spaceweather.eu/en/repository/show?id=509

STCE - PROBA Workshop: Solar Irradiance Measurements with LYRA

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the Large-Yield Radiometer (LYRA) onboard of PROBA2. LYRA measures the solar irradiance in 4 bandpasses with 3 types of detectors.
http://www.spaceweather.eu/en/repository/show?id=510

STCE - PROBA Workshop: micro-cameras on PROBA-1 and 2

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the results and operations of the micro-cameras onboard of PROBA-1 and PROBA2.
http://www.spaceweather.eu/en/repository/show?id=511

STCE - PROBA Workshop: LEO impacts

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the impacts of the Low Earth Orbit radiation environment on PROBA satellites.
http://www.spaceweather.eu/en/repository/show?id=512

STCE - PROBA Workshop: ALTIUS

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on ALTIUS, an Atmospheric Limb Tracker for Investigation of the Upcoming Stratosphere.
http://www.spaceweather.eu/en/repository/show?id=513

STCE - PROBA Workshop: PROBA-3

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the future PROBA-3 satellite. PROBA-3 consists of 2 spacecraft flying in formation. The inner-satellite acts as the occulter for a chronograph observing the solar atmosphere.
http://www.spaceweather.eu/en/repository/show?id=514

STCE - PROBA Workshop: OLIVIA

Presentation given at the STCE Workshop Science and science operations of the PROBA satellite fleet on the study of a Passive Companion Micro-Satellite to the SAOCOM-1B Satellite of Argentina, for bistatic and interferometric SAR applications.
http://www.spaceweather.eu/en/repository/show?id=515