



AFFECTS

Advanced Forecast For Ensuring Communications Through Space

Solar storms are a consequence of sudden eruptions of magnetised gas in the Sun's outer atmosphere. Commonly such storms start with a sudden release of electromagnetic radiation – a solar flare, and by an eruption of a giant cloud of magnetised plasma – a coronal mass ejection (CME). A fast CME also accelerates solar particles to high energies – a solar energetic particle event.

Solar storms affect the Earth environment from the magnetosphere down to the ionosphere, and even to the lower atmosphere climate system. The natural hazards of severe space weather have the potential to catastrophically disrupt the operations of technological systems, such as communication systems and power grids on Earth. Through the AFFECTS project funded by the European Union's 7th Framework Programme, European and US scientists develop an advanced prototype space weather warning system to safeguard the operation of telecommunication and navigation systems on Earth to the threat of solar storms. The project is led by the University of Göttingen's Institute for Astrophysics and comprises world-wide leading research and academic institutions and industrial enterprises from Germany, Belgium, Ukraine, Norway and the United States.



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Funded by the European Union

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Advanced Forecast For Ensuring Communications Through Space (AFFECTS)

Volker Bothmer, Project Coordinator

Cis Verbeeck, presenter

& AFFECTS Team

10th European Space Weather Week, November 18-22, 2013, Antwerp





Outline

1. Objectives
2. Alerts
3. Other products and services
4. Dissemination





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2. Alerts
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AFFECTS Project Objectives

- State-of-the-art analysis and modelling of the Sun-Earth chain of effects on the Earth's ionosphere and their subsequent impacts on communication systems based on multipoint space observations and complementary ground-based data.
- Development of a prototype space weather early warning system and reliable space weather forecasts, with specific emphasis on ionospheric applications.
- Dissemination of new space weather products and services to end users, the scientific community and general public.





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CME/Flare Alerts – Subscription Services

UCMEO 93001 30723 1850/
30722 60624 81254 3062/ 305// 333// 41032
30722 60535 80705 // // // // 1112/
99999

PLAIN

SOHO/LASCO observed an asymmetric HALO CME on July 22, 2013. Event is first seen in C2 beginning 06:24 UT with a bright loop over the Northwest. The event expands with extensions to a full HALO with cavity and core by 07:12 UT. The event continues into the C3 field beginning 06:24-12:54 UT leaving the C3 field at 30Rsun in the Northwest.

Time/height measurements were marked at 5 points in C2 with speeds of 972.3 Km/sec at pa 306 degrees. The event is marked to 8 points in C3. Speeds average through both fields to 1031.6 Km/sec at PA 306 degrees. Acceleration 39.81 m/sec².

- ROB Presto - Flare and Cactus CME alerts
- NOAA-SWPC - PSS
- SOHO/LASCO halo CME alerts
- NRT generated messages



```

From: Solar Windness Data Analysis Center <sdac@oma.be>
Subject: X-Ray CME detection alert from the SWPC/RSC Belgium
Received: 2013 Jun 07 22:23:00
To: Registration@swpc.noaa.gov
Date: 2013 Jun 07 22:23:00 UTC
Product: documentation at http://www.kidp.be/prodofactories
# HALO CME ALERTS from the SDSC (Belgium), generated by CACTUS
# A Halo or partial-halo CME was detected with the following characteristics:
#
#   CR | 000 | pa | dx | v | dv | min | max |
# 005|2813|07|22 06:12| 04 | 344 | 104 | 0444 | 8326 | 8360 | 2430
#
# Details can be found here: http://www.kidp.be/cactus/ows/defectimes.html
#
# 00: onset time, earliest indication of CME
# 005: duration of CME (hours)
# pa: PANGRA2 angle, counter-clockwise from North (degrees)
# dx: angular width of the CME (degrees)
# v: median velocity (km/s)
# dv: variation (3 sigma) of velocity over the width of the CME
# min: lowest velocity detected within the CME
# max: highest velocity detected within the CME
#
# This message is sent whenever a CME wider than 50 degrees is detected by Cactus.
#
# .....
# SDAC: Diffusion Data Analysis Center - RSC Belgium
# Royal Observatory of Belgium
# Fax: +32 (0) 2 379 8124
# Tel.: +32 (0) 2 379 8181
# For more info see http://www.kidp.be/cactus. Please do not reply
# directly to this message, but send comments and suggestions to
# "sdac@oma.be". If you are unable to use that address, use
# "cactus@oma.be" instead.
# To unsubscribe, visit http://www.kidp.be/registration/sub.php
# .....

```

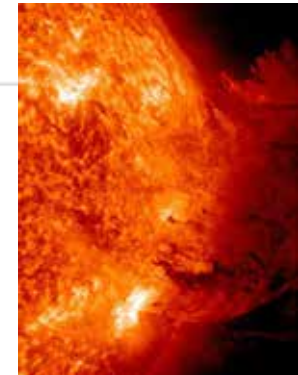
Von SWPC Product Subscription Service <SWPC.Products@noaa.gov>
Betreff: SUMMARY: X-Ray Event exceeded M5 (R2)
An: Volker Bothmer

Space Weather Message Code: SUMXMS
Serial Number: 104
Issue Time: 2013 Jun 07 2326 UTC

SUMMARY: X-ray Event exceeded M5
Begin Time: 2013 Jun 07 2211 UTC
Maximum Time: 2013 Jun 07 2249 UTC
End Time: 2013 Jun 07 2304 UTC
X-ray Class: M5.9
Location: S28W73
NOAA Scale: R2 - Moderate

NOAA Space Weather Scale descriptions can be found at
www.swpc.noaa.gov/NOAAscales

Potential Impacts: Area of impact centered primarily on sub-solar point on the sunlit side of Earth.
Radio - Limited blackout of HF (high frequency) radio communication for tens of minutes.





Early Warning for GNSS Users

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Early Warning Message for GNSS Users

The Early Warning Message is a fast warning for space weather events potentially impacting GNSS measurements. The Early Warning Message for GNSS users is provided by the Central Warning Centre (CWC), Nansen using precise data and long-range information from the Solar Influence Data Centre (SIDC) Brussels.

Current Status:
Status: 2014-04-04 10:25:07
Event: 2014-04-04 09:50:00 (SIDC)

Practical consequence description (SIDC)	SIDC Name
Practical condition of the ionosphere (SIDC)	Minimum SIDC not specified (Warning of SIDC is provided by SIDC) http://www.sidc.be/solar-activity/activities/20140404095000
Geographic location	None
Event program	Ionogram, generated by Solar Influence Data Centre (SIDC), provided after reception of solar and geomagnetic data by http://www.sidc.be/solar-activity/activities/20140404095000

Latest Early Warning Status

Status: 2014-04-04 09:50:07
Source: SWPC (The Office of Space Weather Coordination) - USA

Practical consequence description (SIDC)	None Reported
Practical event time (SIDC)	2014-04-04 09:50:00 (SIDC)
Practical condition of the ionosphere (SIDC)	Minimum SIDC not specified (Warning of SIDC is provided by SIDC) http://www.sidc.be/solar-activity/activities/20140404095000
Practical geographic information (SIDC)	Minimum SIDC not specified (Warning of SIDC is provided by SIDC) http://www.sidc.be/solar-activity/activities/20140404095000
Geographic location (SIDC)	Impact on high frequency, HF radio propagation expected. (Warning of SIDC is provided by SIDC) http://www.sidc.be/solar-activity/activities/20140404095000
Reference program (SIDC)	Not specified
Associated event ID (SIDC)	2014-04-04 09:50:00 (SIDC) http://www.sidc.be/solar-activity/activities/20140404095000
Associated event ID (SWPC)	2014-04-04 09:50:00 (SWPC) http://www.swpc.noaa.gov/products/early-warning

Warning Message by Source:

SWPC:
Early warning messages are the standard for Space Weather. To be able to provide this service to you, we use the standard for High Level.

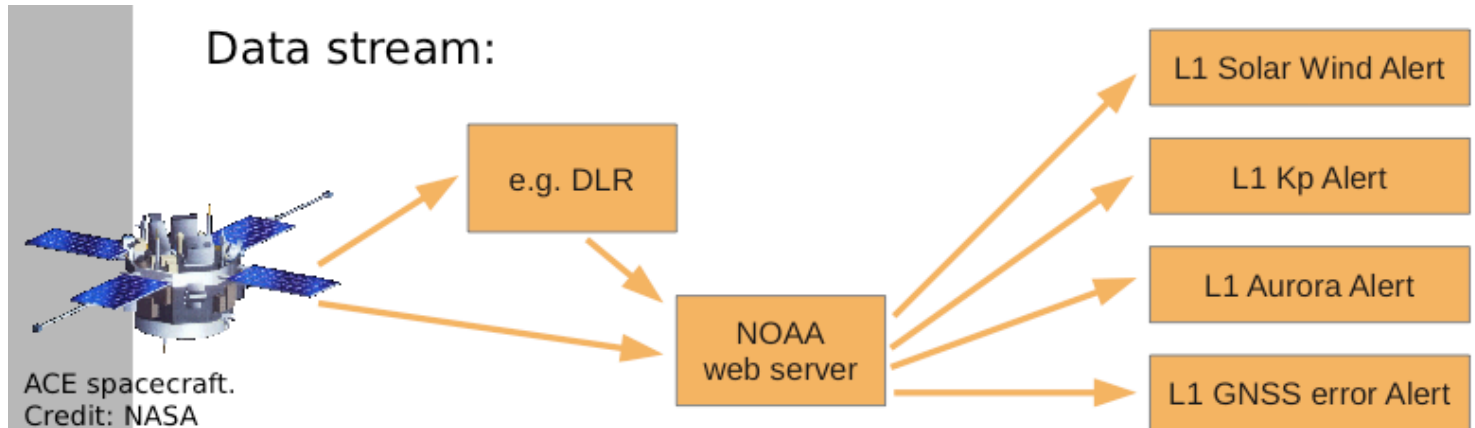
SIDC:
For more information, comments and suggestions on how to improve message please contact: info@sidc.be

Author: Sidc
Author: Solar Influence Data Centre - SIDC
Author: Space Weather Center - SWPC
Author: Nansen
Author: Nansen
Author: Nansen
Author: Nansen
Author: Nansen
Author: Nansen
Author: Nansen
Author: Nansen



Ionospheric disturbance scale	Expected Hazards	Arrival Time	Influenced Area	Condition Ionosphere
I 0	None	none	-	Ionosphere nominal
I 1	Impacts on high frequency (HF) radio propagation expected. Influence on positioning and navigation possible.	Arrival within a rough time period expected.	Rough information on influenced region (polar, mid-latitudes).	Ionosphere disturbed.
I 2	Strong impact on high frequency communication. Satellite navigation errors expected.	Detailed with reliable error estimation	More detailed information on influenced regions (latitude dependent).	Ionosphere strongly disturbed with forecast information due to correlation analysis (Bz - dTEC).

L1 Alerts – Provided as RSS-Feeds



ACE data from MAG and SWEPAM instruments:

- NOAA/SWPC/RTSW (ACE Real Time Solar Wind, preliminary data)
 - <http://www.swpc.noaa.gov/ace/index.html>
- CALTECH/ASC (ACE Science Center, level 2 data)
 - <http://www.srl.caltech.edu/ACE/ASC/level2/index.html>
- NASA/GSFC/SPDF (OMNIWeb interface, level 2 data)
 - <http://omniweb.gsfc.nasa.gov>





Warning through AFFECTS Website and Mailing List

AFFECTS Space Weather Reports

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- [4 February 24, 2013 - Forecast Update](#)
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- [6 January 25, 2013 - General 10 day Forecast](#)
- [7 July 17, 2012 - Comparison of Forecast and Observations](#)
- [8 July 13, 2012 - Solar storm is heading towards Earth](#)
- [9 June 17, 2012 - Perfect match: CME has arrived as predicted](#)
- [10 June 15, 2012 - CME en route to Earth](#)
- [11 June 01, 2012 - Active region and coronal hole](#)
- [12 May 23, 2012 - Decaying active regions](#)
- [13 May 09, 2012 - Large sunspot region not likely to cause major storms at Earth](#)
- [14 May 07, 2012 - Coronal hole on visible solar disk and new active region](#)
- [15 May 03, 2012 - No major solar storms are expected the next days](#)
- [16 April 21, 2012 - Several Active Regions North and South of the Equator](#)
- [17 April 10, 2012 - Equatorial Coronal Holes](#)

May 15, 2013

Active region 1748 appeared at the Sun's East limb on May 13, 2013 when it caused on this, the following day and today three X-ray flares with peak intensities in the M to X-range. Three fast CMEs with speeds in the range 1400-2000 km/s were associated with these events. The first two ones are not expected to cause any impacts at Earth whilst a shock wave is expected to arrive between 06:30 and 12:30 local time (DST) tomorrow on May 16, 2013. The estimated speed at Earth is 1000 km/s. There are no indications that the CME main body will pass the Earth and there are no indicators for a major geomagnetic storm to be happening. The delayed and slow intensity increase in the >10 MeV proton flux is a typical signature for shock wave propagation East of central meridian. It is likely that the next days will be stormy too since besides AR 1748, AR 1745 closer to CM also has potential for causing major solar storms.

April 12, 2013

On April 11 around 07 UT SOHO and STEREO detected the onset of a CME near CM. The estimated speed of it is 603 km/s in the STEREO/COR2-B field of view. Using the BHV prediction method yields an arrival time of April 14, 03 UT with an in-situ speed of 500 km/s. Based on the B&S flux rope scheme the CME is predicted to be of ENW (SEN) type. A geomagnetic storm is forecasted for April 14, 03 - 15 UT, with a magnitude of about Kp 7+.



Expected Final Result

- Europe's first prototype space weather warning system with specific focus on telecommunication and navigation systems



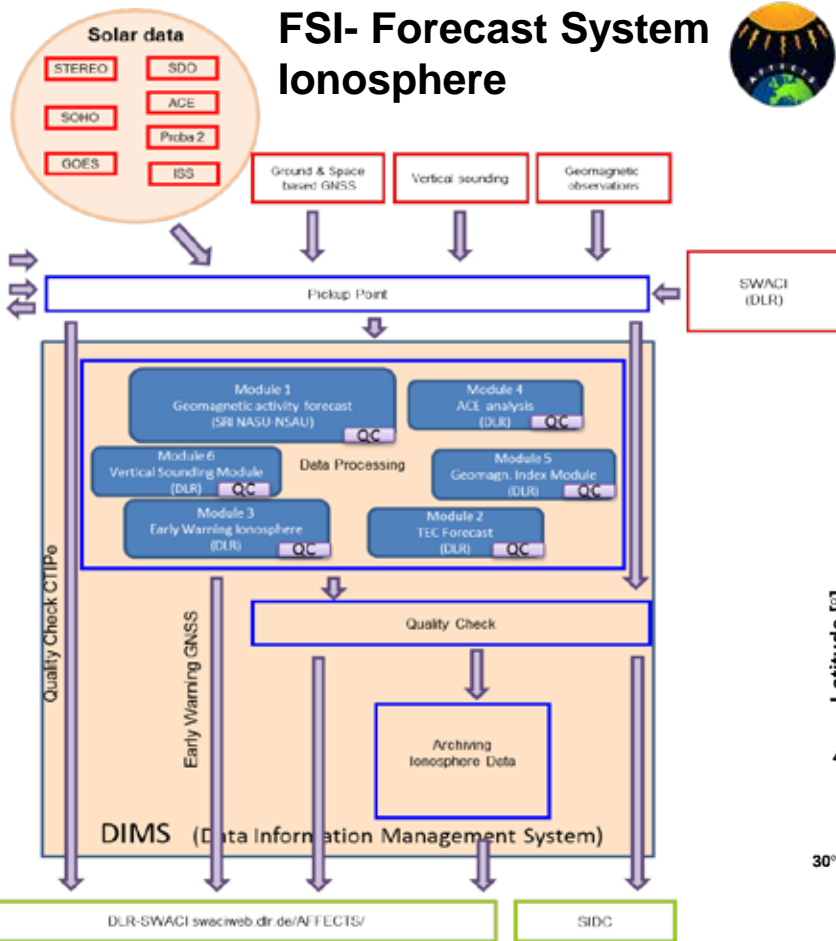


Outline

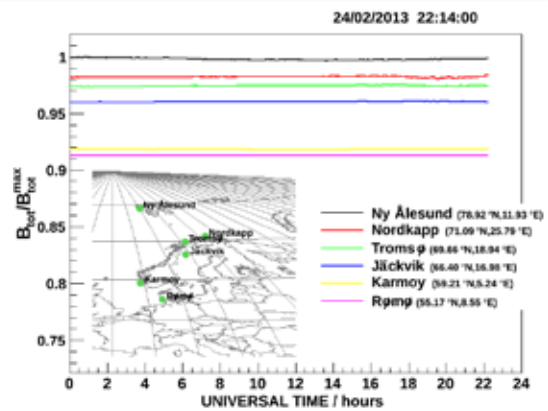
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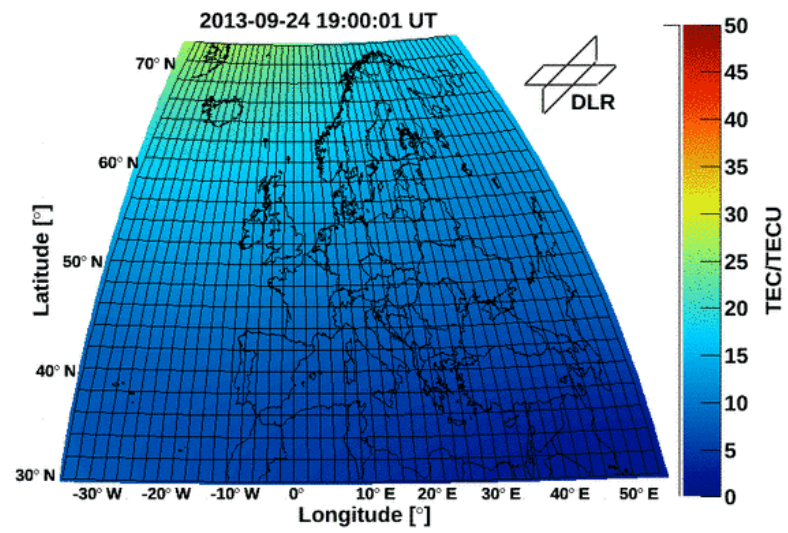
Forecast of „Ionospheric Storms“ and prediction of Total Electron Content (TEC) / „GPS error“



Early Warning Sun (ROB)
Quality Check CTIPe (NOAA)



DLR TEC forecast 720min



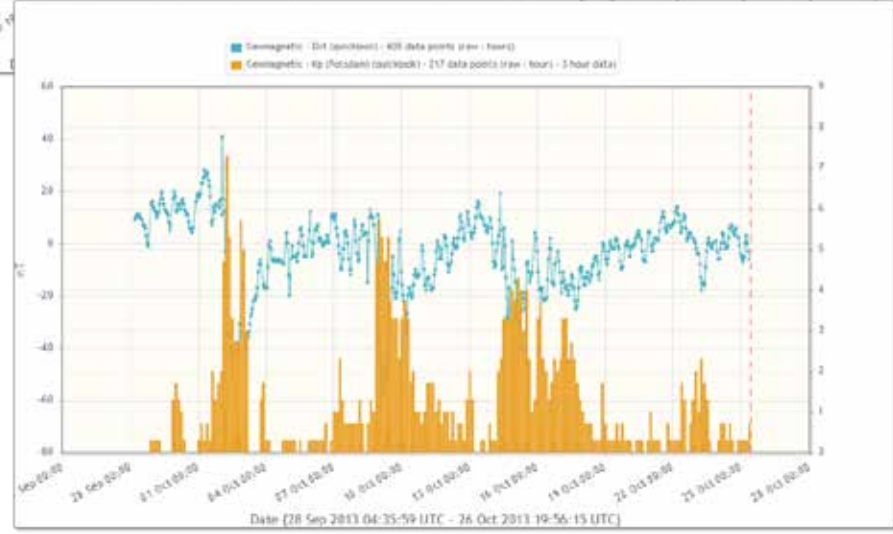
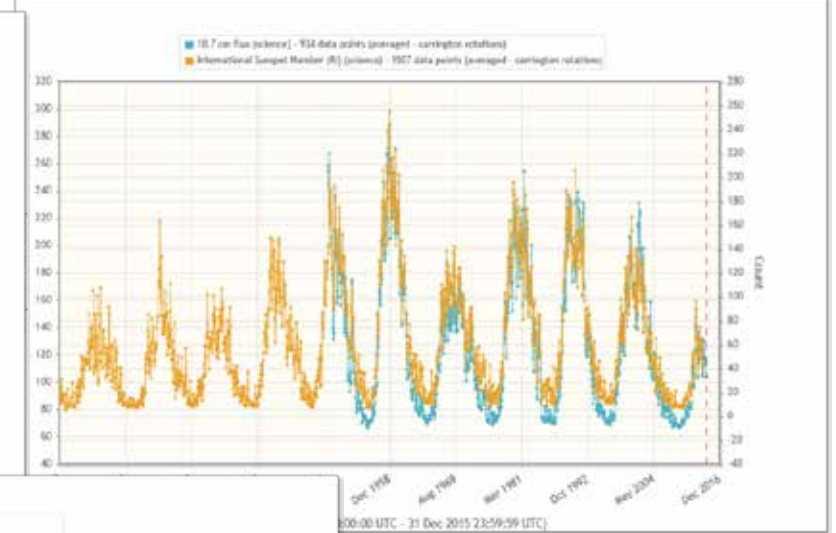
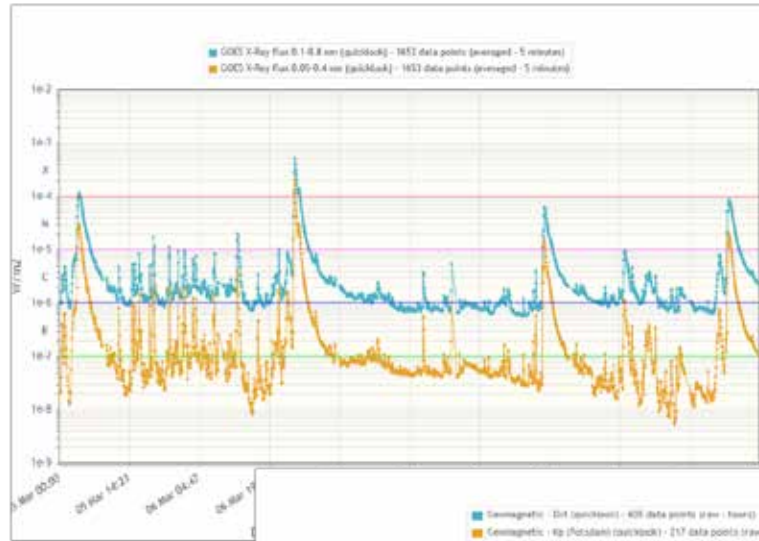
TEC 24 hrs forecast, taking space weather events into account in NRT.





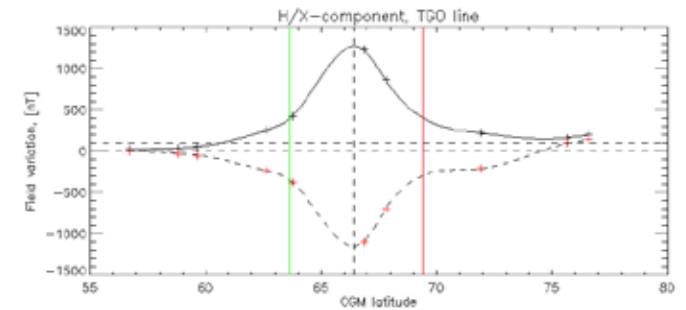
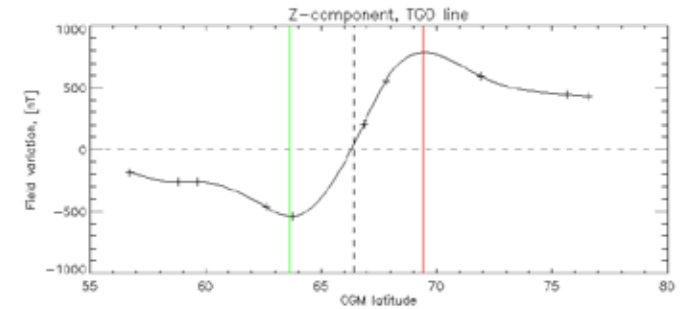
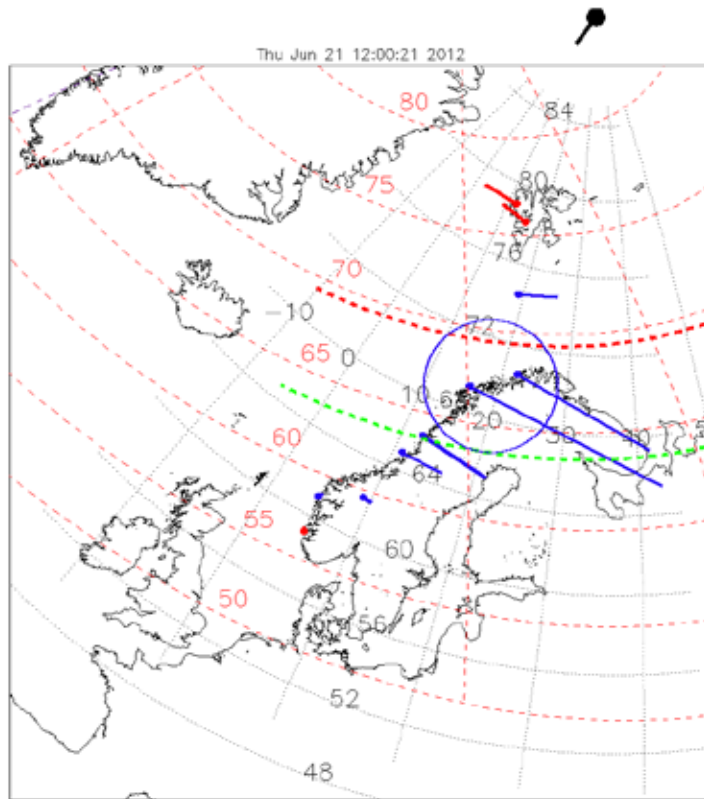
Solar Timelines viewer for AFFECTS (STAFF)

<http://www.staff.oma.be>





Auroral electrojet tracker



Data time stamp: 18/06/2012 03:00:00





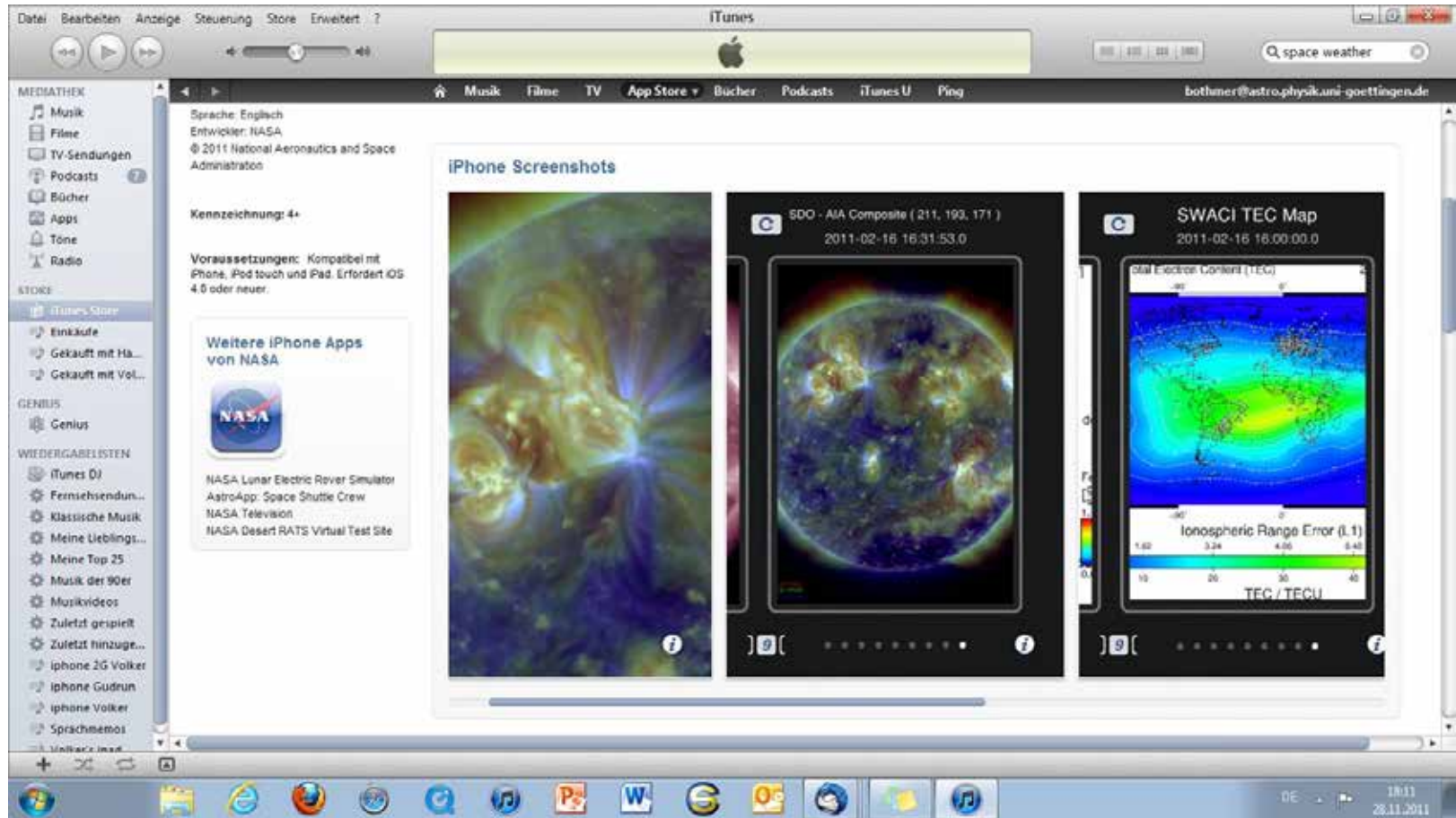
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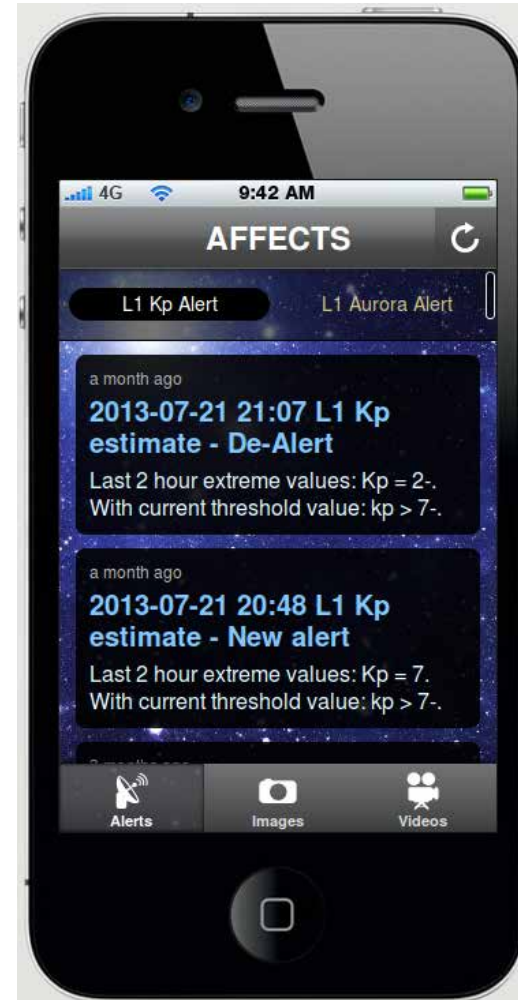




NASA Space Weather Apps



Space Weather App - Demo





AFFECTS

International User Workshop



**AFFECTS User Workshop
Royal Observatory of Belgium,
February 28, 2013**

**Demonstration of AFFECTS
space weather products:**

**Near real time dimming and
EIT wave detection**

3D CME analysis tool

Coronal analysis tool

**CME & solar wind arrival and
impact forecast tool**

**Flare, CME, geomagnetic, auroral,
ionospheric forecasts & alerts**

Forecast of perturbed TEC

**Solar activity and space weather
timelines viewer**

AFFECTS Dissemination activities

- Logo, available as sticker
- Trailer (2 min. HD Video)
- Flyer
- YouTube Video (EU)
- Planetarium Hamburg Show “Flammender Himmel” featuring AFFECTS
- Widespread Media coverage (TV, GEO, Radio, WWW, newspaper)
- Collaboration with infoNetwork
- International User Workshop at ROB (28 February 2013)
- Poster (2 versions)
- Website services incl. RSS-feeds
- Dedicated E/PO events (e.g., “Nacht des Wissens” @ UGOE)
- Space Weather Apps (e.g., 3D Sun, Sun Viewer,
- DVD, bluray, memory sticks
- Presentations at major meetings (EGU, ESWWT, national meetings)
- Joint publication (e.g. for JSWSC, AGU Space Journal)



DON'T LET THE SUN GO DOWN ON YOU WATCH OUT FOR SOLAR STORMS

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Funded by the European Union

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STEREO A

ACE

SOHO

SDO

Proba-2

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