



# Deliverable 6.2

## International user workshop documentation

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## **Collaborations beyond AFFECTS and Acknowledgements**

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## 1. Introduction

This report provides the documentation of the AFFECTS International User Workshop that took place at the Royal Observatory of Belgium on February 28, 2013.

The user workshop was organized in order to provide users with an in-depth, hands-on experience with the latest versions of the AFFECTS space weather products and services. We also took the occasion to acquire user feedback, both through personal contacts and via a questionnaire.

Users were invited through official letters sent by regular mail and by e-mail, including the AFFECTS Advisory Board, ESA and EU representatives. Publicity was made via a flyer during the European Space Weather Week 9 in Brussels (November 5-9, 2012) and at other occasions. Forty-four persons participated in the Workshop.

This report does not cover the user feedback to the presented products, because this topic will be covered in D6.3 “Report on User Workshop Results”, which is due in project month 30 (August 2013).

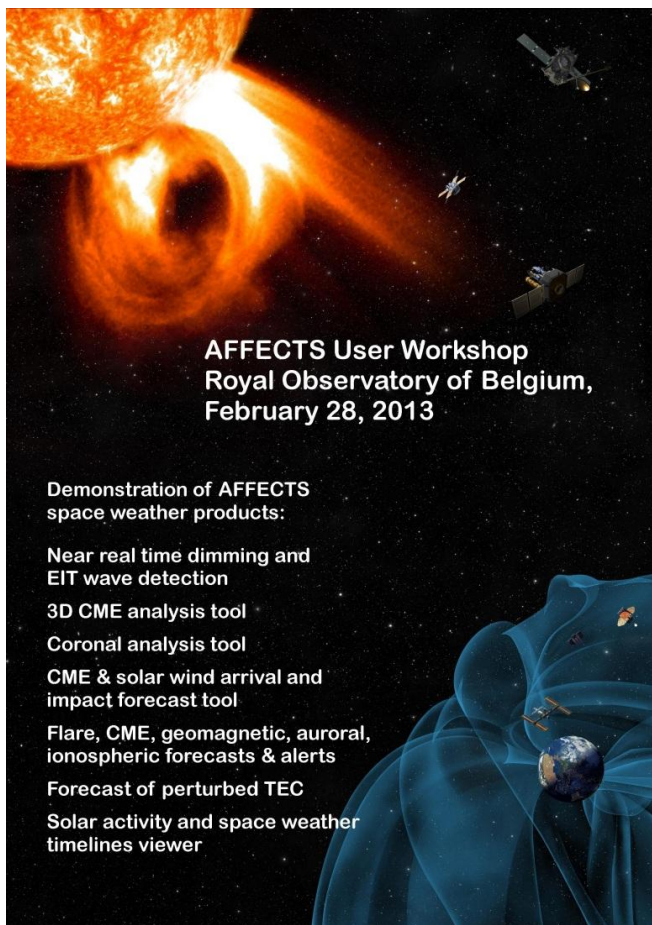


Fig. 1: Publicity flyer for the international user workshop.

## 2. Overview of workshop topics

The workshop was splitted in 2 parts: First, the developed products were presented and explained by the relevant project partners. During the presentations there was time to discuss questions on the product's functionalities as well. In the afternoon we created a fair atmosphere: all products and services were presented at different stands, giving users the possibility of handling the different products by themselves and trying their functionalities.

In the following the agenda, the presentation abstracts, and a link to all presentation slides are provided.

### 2.1 Agenda

The agenda of the user workshop on February 28, 2013 is detailed in Table 1.

09:00	Welcome	V. Bothmer (UGOE), C. Verbeeck (ROB)
09:10	Introduction and today's space weather conditions	V. Bothmer, C. Verbeeck
09:15	Space weather data and services at RWC Belgium	C. Verbeeck
09:30	Solar Demon: Near real-time dimming and EUV wave detection on SDO-AIA	E. Kraaikamp (ROB)
09:45	CAT CME parametrization	J. Hesemann (UGOE)
10:00	3D parametrization of CMEs with the Graduated Cylindrical Shell Model	E. Bosman (UGOE)
10:15	CME arrival, Kp, aurora and GNSS-error forecast	V. Bothmer
10:30 – 11:00	<i>Coffee Break</i>	
11:00	L1 solar wind, aurorae, Kp and GNSS-error alert	M. Venzmer (UGOE)
11:15	Geomagnetic forecast tool	A. Parnowski (SRI NASU-NSAU)
11:25	Real-time determination and monitoring of auroral electrojet boundaries	M. Johnsen (UoT)
11:45	New forecast products for the high latitude ionosphere and its impacts on radio communication and navigation	R. Viereck (NOAA-SWPC)
12:05	Forecast of Total Electron Content over Europe for disturbed ionospheric conditions	J. Berdermann (DLR)
12:25 – 13:25	<i>Group Picture, Lunch Break</i>	
13:25	Forecast System Ionosphere: a new system for predicting space weather effects in Europe	J. Berdermann, H. Barkmann (DLR)
13:45	Early warning for GNSS	J. Berdermann, H. Barkmann
14:05	STAFF: The <b>S</b> olar <b>T</b> imelines viewer for <b>AFF</b> ects	V. Malisse (ROB)

14:20	AFFECTS Demos – Part I	AFFECTS team
15:30 – 16:00	<i>Coffee Break</i>	
16:00	AFFECTS Demos – Part II	AFFECTS team
17:00- 17:30	Wrap up & hands-on space weather forecast	AFFECTS team
18:30	<i>Dinner at Relais de Saint-Job</i> , Place de Saint-Job, 1, 1180 Brussels, <a href="http://www.relaisstjob.be">http://www.relaisstjob.be</a>	

Table 1: The agenda of the AFFECTS User Workshop.

## 2.2 Abstracts

Below, the abstracts are listed for all oral, poster, and demo presentations at the user workshop.

### Space Weather Data and Services at RWC Belgium

*C. Verbeeck on behalf of the RWC team*

The Royal Observatory of Belgium hosts the Regional Warning Center (RWC) Belgium since 2000. We monitor the solar and geomagnetic activity over time scales from the solar cycle (the sunspot index) down to real-time space weather alerts. We will describe the different products that are currently generated and distributed by RWC Belgium, as well as the models, automated detection algorithms and other tools that we employ for this purpose. We will discuss some results on statistical quality control of our forecasts, and will end by a short outlook on future data and services that we anticipate to incorporate into the RWC.

### Solar Demon: Near real-time dimming and EUV wave detection on SDO-AIA

*E. Kraaikamp, C. Verbeeck*

Solar Demon is a near real time dimming and EUV wave detector on quicklook SDO-AIA data. As dimmings and EUV waves are often the precursors of CMEs, careful detection and characterization of these features will aid space weather forecasters, leading to more accurate forecasts. A Solar Demon catalog is planned, which will help further research on dimmings and EUV waves. In this demo, the basic principles of Solar Demon will be illustrated by running it on a few interesting events.

### CAT CME parametrization

*J. Hesemann, G. Millward, V. Bothmer, E. Bosman*

The CME Analysis Tool (CAT) is a modelling tool of NOAA-SWPC developed by G. Millward et al. using a rotationally symmetric cone approach. We present implications of using such a geometric shape for real-time modelling if compared to the GCS geometric approach and its purpose for space weather forecasts for Earth's orbit.

### **3D parametrization of CMEs with the Graduated Cylindrical Shell Model**

*E. Bosman, V. Bothmer, J. Hesemann, M. Venzmer*

The presentation illustrates how the 3D structure of CMEs can be parameterized in real-time based on STEREO/SECCHI beacon data and how the results are used as input for the forecast of space storms at Earth's orbit by ENLIL and other models.

### **CME arrival, Kp, aurora and GNSS-error forecast**

*V. Bothmer, J. Hesemann, M. Venzmer, E. Bosman*

We present our first version of a forecasting tool developed at University of Göttingen which is capable of inferring both CME arrival times and geomagnetic parameters (Kp and Aurora boundary) from real-time geometric modelling using GCS or CAT tools. The tool under development is modular and different methods can be used on each step of the forecast. The essential ingredients of the forecast base on correlated analysis of solar remote sensing and in-situ solar wind data, including theoretical models for CME and solar wind propagation in the inner heliosphere.

### **L1 solar wind, aurorae, Kp and GNSS-error alert**

*M. Venzmer, V. Bothmer, J. Hesemann, E. Bosman*

The RSS feed alerts use in-situ L1 real-time ACE data to provide short-time warnings. The L1 solar wind alert creates a new alert if thresholds of specified solar wind parameters are exceeded. The L1 Kp/aurora alert is used for an empirical Kp estimate with additional auroral boundary information. This RSS feed creates a new alert if the predicted Kp value exceeds a specified threshold.

### **Geomagnetic forecast tool**

*A. Parnowski*

The geomagnetic forecast tool provides near real time forecasts of the geomagnetic indices Dst (1 to 4 hours in advance) and Kp (3 hours in advance). In contrast to other Kp forecasting tools, this one provides forecast of the official Kp index based on 13 stations worldwide, rather than the estimated Kp based only on 1 station. The demo will provide the users with detailed information on the tool's capabilities and operation procedures.

### **Real-time determination and monitoring of the auroral electrojet boundaries**

*M. G. Johnsen*

A method for nowcasting of the auroral electrojet location from real-time geomagnetic data in the European sector is presented. Along the auroral ovals strong electrojet currents are flowing. The variation in the geomagnetic field caused by these space Weather Data and Services at RWC Belgium auroral electrojets are observed on a routine basis at high latitudes using ground-based magnetometers. From latitude profiles of the vertical component of these variations it is possible to identify the boundaries of the electrojets. Using real-time data from ground magnetometer chains is



the only existing method for continuous monitoring and nowcasting of the location and strength of the auroral electrojets in a given sector. This is an important aspect of any space weather program. The method for obtaining the electrojet boundaries is described and assessed in a controlled environment using modelling. Furthermore a provisional, real-time electrojet tracker for the European sector based on data from the Tromsø Geophysical Observatory magnetometer chain is presented.

The relationship between the electrojet and the diffuse auroral oval is discussed, and it is concluded that although there may exist time dependent differences in boundary locations, there exist a general coincidence. Furthermore, it is pointed out that knowledge about the latitudinal location of the geomagnetic activity, that is the electrojets, is more critical for space weather sensitive, ground-based technology than the location of the aurora.

### **New Forecast Products for the High Latitude Ionosphere and its Impacts on Radio Communication and Navigation**

*R. Viereck*

With the expansion of shipping and oil exploration into arctic regions, the importance of accurate specification and forecast of the high latitude ionosphere and its impact on GPS/GNSS and HF Communications is more important than ever. At the NOAA Space Weather Prediction Center, we are developing several new products to address these customer requirements. A new Kp-driven aurora forecast model is under development which will provide 1-3 day forecasts of the location and intensity of the aurora. And new results from a statistical study of the impact of the aurora on GPS systems will allow for a greatly improved specification of when and where the aurora and geomagnetic activity will cause problems for precise satellite navigation.

### **Forecast of Total Electron Content over Europe for disturbed ionospheric conditions**

*J. Berdermann*

A general picture of the occurrence of ionospheric storms as function of local time, season and location is known from numerous studies over the past 50 years. Nevertheless, it is not yet possible to say how the ionosphere will actually respond to a given space weather event because the measurements of the onset time, location of maximum perturbation, amplitude and type of storm (positive or negative) deviate much from the climatology. However, statistical analyses of numerous storm events observed in the Total Electron Content (TEC) since 1995 enable to estimate and predict a most probable upcoming perturbed TEC over Europe based on forecasts of geomagnetic activity. A first approach will be presented here. The forecast of perturbed TEC is part of the Forecast System Ionosphere built under the umbrella of the FP7 project AFFECTS (Advanced Forecast For Ensuring Communication Through Space). It aims to help users mitigating the impact on communication systems.

### **Forecast System Ionosphere: a new system for predicting space weather effects in Europe**

*J. Berdermann, H. Barkmann*

A Forecast System Ionosphere (FSI) is developed as part of the FP7 AFFECTS project (Advanced Forecast For Ensuring Communication Through Space, <http://www.affects-fp7.eu/>), led by University Göttingen. It is intended to help European citizens mitigating the impact of space

weather events on its communications systems. For this purpose the FSI will operationally provide a prediction of space weather related geomagnetic and ionospheric perturbations for Europe. Solar observations and measurements are used for forecasting of geomagnetic activity and Total Electron Content (TEC). Additionally, high latitude geomagnetic monitoring and early warning for GNSS users is incorporated in the FSI. The FSI is developed as a subsystem of the Space Weather Application Center - Ionosphere (SWACI) service (<http://swaciweb.dlr.de/>), running at the DLR in Neustrelitz, using its approved infrastructure.

AFFECTS partners are contributing to the FSI either by provision of data or by delivering processing modules. Here we present the layout and system architecture of the FSI, describing the data input, processing, checking, archiving and output of the FSI.

### **Early warning for GNSS**

*J. Berdermann, H. Barkmann*

The early warning for GNSS users is especially directed to customers of space based radio systems used in telecommunication, navigation/positioning and remote sensing. The warning informs customers and operators of GNSS on approaching space weather events. Thus, GNSS customers and service providers will be aware of potential performance degradation of their systems due to space weather impacts. Based on the early warning, customers shall become prepared to undertake efforts to help mitigate the space weather impacts on the operated systems. The early warning message for GNSS users presented here is recently in its verification phase. The warning message is send automatically to external test users, who will give comments and suggestions to the present service.

### **STAFF: The Solar Timelines viewer for AFFects**

*V. Malisse, C. Verbeeck*

STAFF, the Solar Timelines viewer for AFFects (<http://www.staff.oma.be>) is a powerful, fast and easy tool for viewing, combining and exporting a whole range of timelines related to solar activity and space weather. Timelines include the International Sunspot Number, the four Lyra EUV channels, the GOES X ray curves, GOES electrons and protons, ACE solar wind parameters and Interplanetary Magnetic field measurements, F10.7 radio flux and various K and A indices. This demo will provide the user a hands-on overview of STAFF.

### **Inter-comparison of EUV data products and their usability for modeling/forecasting ionospheric disturbances**

*R. Brunner, G. Schmidtke, M. Pfeifer*

The EUV Solar Spectral Irradiance (EUV-SSI) plays a major role as the primary energy input into the Ionospheric/Thermospheric (IT) system. Specific solar EUV emissions are to be used to a) recognize geomagnetic disturbances and to estimate their magnitudes, b) to derive information on solar processes relevant to geomagnetic disturbances and c) defining the basis state of the IT system.

End of 2012 a special ISS maneuver (bridging) was achieved in order to perform continuous measurements of SOLAR during a full solar rotation. First results of the inter-comparison of SDO/EVE spectral data with SolACES calibration measurements do agree well with each other.

The inter-comparison is extended from an ISS bridging period back to the beginning of SDO operation in 2010. Based on the combined SEE/TIMED, SDO/EVE and SolACES data the work on EUV-TEC proxy is progressing.

### **SEPS – The low-cost EUV/plasma-sensor: Vision of a sensor network as a versatile data source to support space weather forecasting products**

*R. Brunner, G. Schmidtke, M. Pfeifer*

The SEPS sensor developed by Fraunhofer IPM is a versatile and low-cost EUV and plasma sensor. Being able to measure many different plasma and EUV key parameters a satellite based sensor network could serve as a versatile data source to support space weather simulation and forecast. Beside the working principle of the sensor and first measurement results a vision of such a network is presented.

Online Monitoring of the total EUV flux with temporal resolution of down to 100ms gets thinkable, which makes it possible to identify short-time solar events like flares. Through the combination with other detectors like LEED (Low Energy Electron Detector) and LEPD (Low Energy Proton Detector) more detailed information can be gathered.

## **2.3 Link to Presentation Slides**

All presentations given at the user workshop can be downloaded from the AFFECTS website at <http://www.affects-fp7.eu/news-events/user-ws/>.

## **3. Documentation of AFFECTS products and services**

The next subsections each provide documentation on a specific AFFECTS product or service that was presented at the user workshop.

### **3.1 Solar Demon**

The documentation below corresponds to version 1.0 of *Solar Demon* (2013-03-07).

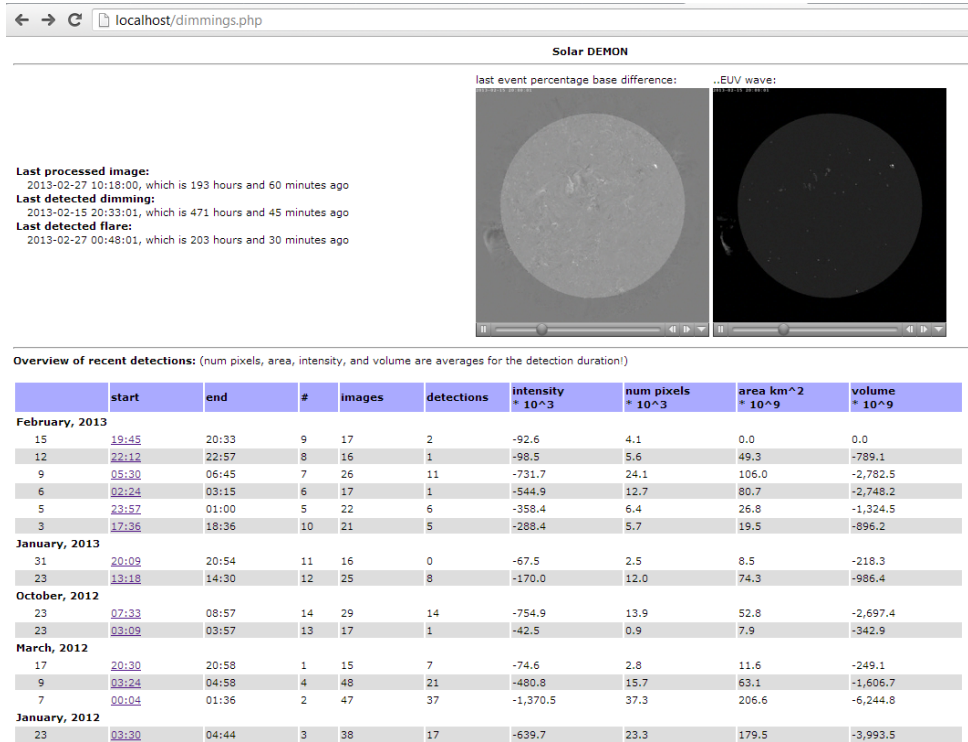
*Solar Demon* (**Solar Dimming and EUV wave Monitor**) is a near real time dimming and EUV wave detector on quick-look SDO-AIA data. As dimmings and EUV waves are often the precursors of CMEs, careful detection and characterization of these features will aid space weather forecasters, leading to more accurate forecasts. Solar Demon can be accessed from <http://www.solardemon.oma.be/>. A Solar Demon catalog is planned, which will help further research on dimmings and EUV waves.

#### **Prerequisites**

- Solar Demon has been tested on Microsoft Internet Explorer, Google Chrome and Mozilla Firefox browsers.
- Apple QuickTime plugin is required to view animations.

## Overview of detected events

The main page of Solar Demon shows an overview of detected events, as well as the current status of the detector, including the last processed image, last detected dimming, and last detection of a flare.



**Fig. 2: An overview of all detections. This is the first view when opening the web page.**

At the top right of the page the latest detections are shown as an animation. Below that, a list of all events can be seen. The list includes the start and end time, the dimming intensity, size, area on the surface of the sun, and a volume measurement which is the multiplication of the dimming area and intensity.

Events are detected 'on-the-fly', the statistics and movies will update as new data is being processed by the Solar Demon monitor. When the user clicks on a start time, it will show the Dimming and EUV wave characteristics of the selected event.

## Dimming and EUV wave characteristics

When an event is selected, a page is shown describing the characteristics of the detected events, including a list of available animations as well as the evolution of the event over time.

Characteristics include the time, intensity, size, volume, location, and the active region which is closest to the detected event. These characteristics are provided for each processed image during which the event was detected. At the top of the page a list of simultaneous flares, their detected brightness, and the location is shown, as well as links to all available animations and graphs of the selected event.

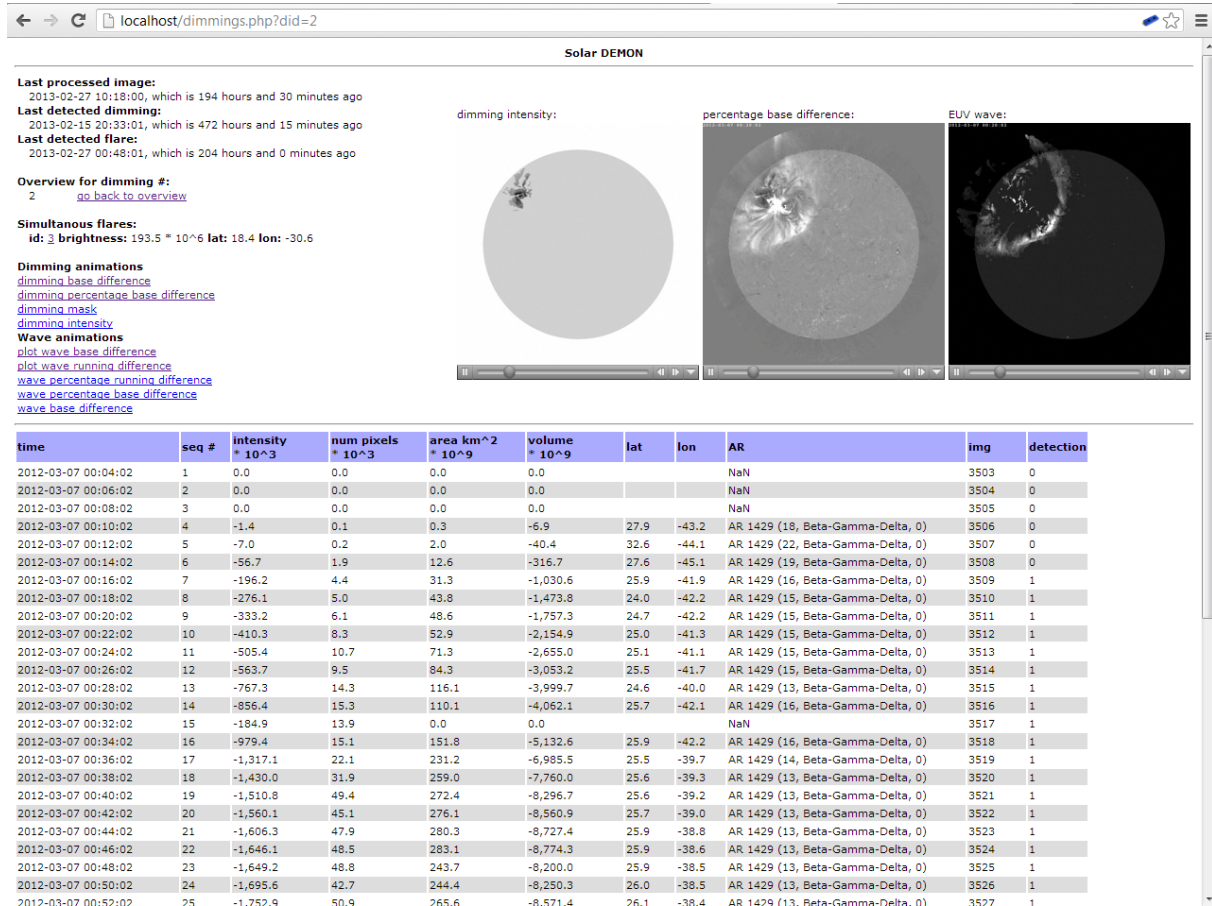


Fig. 3: An event shown in more detail.

## Flare characteristics

**Overview for flare #:**  
3 [back to overview](#)

time	seq #	brightness $\times 10^3$	lat	lon	AR	img
2012-03-07 00:06:02	1	86.1	18.4	-32.2	AR 1429 (3, Beta-Gamma-Delta, 0)	3504
2012-03-07 00:08:02	2	1,756.4	18.1	-30.9	AR 1429 (2, Beta-Gamma-Delta, 0)	3505
2012-03-07 00:10:02	3	1,507.0	17.8	-30.5	AR 1429 (2, Beta-Gamma-Delta, 0)	3506
2012-03-07 00:12:02	4	1,835.1	17.8	-30.9	AR 1429 (2, Beta-Gamma-Delta, 0)	3507
2012-03-07 00:14:02	5	3,050.0	18.1	-31.4	AR 1429 (3, Beta-Gamma-Delta, 0)	3508
2012-03-07 00:16:02	6	3,265.4	18.1	-31.4	AR 1429 (3, Beta-Gamma-Delta, 0)	3509
2012-03-07 00:18:02	7	5,231.5	18.3	-31.2	AR 1429 (3, Beta-Gamma-Delta, 0)	3510
2012-03-07 00:20:02	8	5,536.3	18.2	-31.2	AR 1429 (2, Beta-Gamma-Delta, 0)	3511
2012-03-07 00:22:02	9	5,532.0	18.1	-31.1	AR 1429 (2, Beta-Gamma-Delta, 0)	3512
2012-03-07 00:24:02	10	5,614.4	18.1	-31.0	AR 1429 (2, Beta-Gamma-Delta, 0)	3513
2012-03-07 00:26:02	11	6,184.4	18.2	-31.1	AR 1429 (2, Beta-Gamma-Delta, 0)	3514
2012-03-07 00:28:02	12	6,329.9	18.4	-31.2	AR 1429 (3, Beta-Gamma-Delta, 0)	3515
2012-03-07 00:30:02	13	6,219.2	18.4	-31.2	AR 1429 (3, Beta-Gamma-Delta, 0)	3516

Fig. 4: An overview of a selected flare.

The overview for a selected flare displays the time, brightness, location and the active region closest to the detected flare (including the distance to and string of this active region).

### **Animations and graphs**

Solar Demon automatically produces several types of graphs and animations on-the-fly. A summary is given in the sections below. In all animations the surface area of the sun is highlighted by either a dark or light shade.

- **Dimming intensity animation**

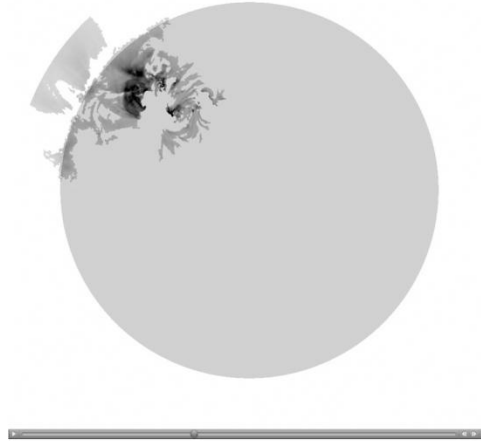


Fig. 5: The shape and intensity of the detected dimming as seen in the dimming intensity animation.

- **Difference image animations**

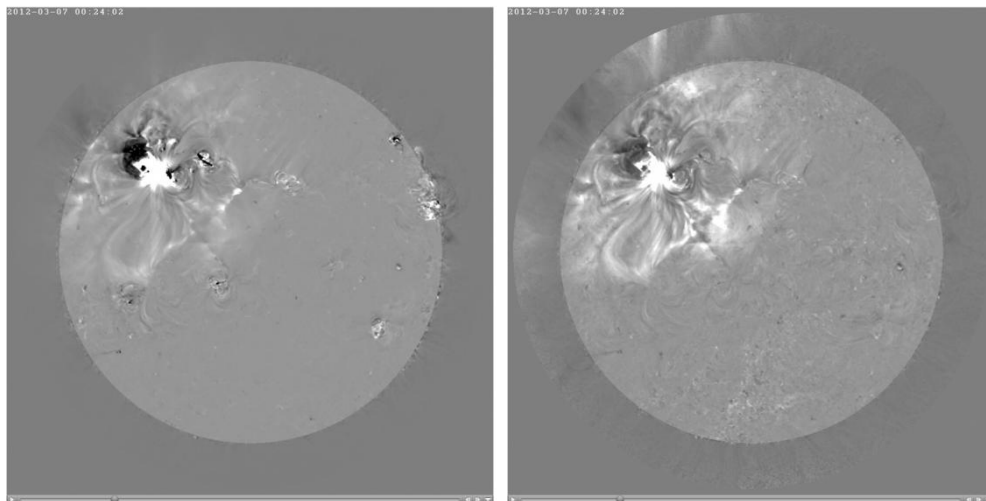


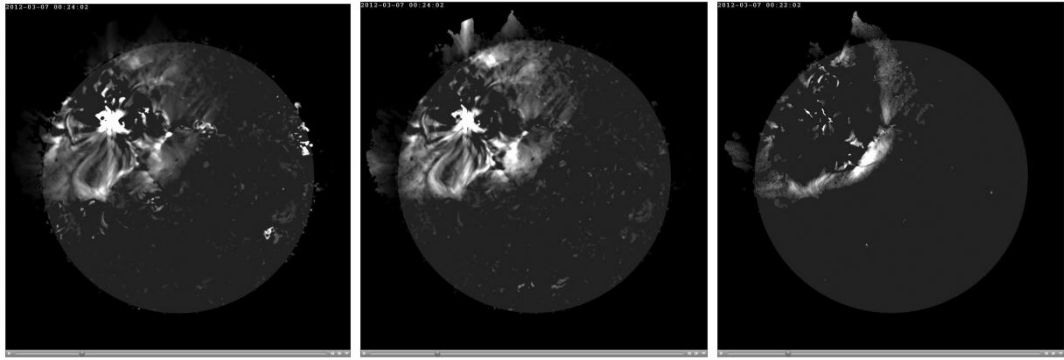
Fig. 6: Animations are created for both base difference images (left) and percentage base difference images (right).

Base difference animations show all the negative and positive intensity changes from the start of the event, by subtracting from each image a pre-event image.

The percentage base difference images are created by dividing each base difference image by the pre-event image. This produces images where changes in darker areas are accentuated and changes in brighter areas are made less apparent.



- **EUV wave difference image animations**

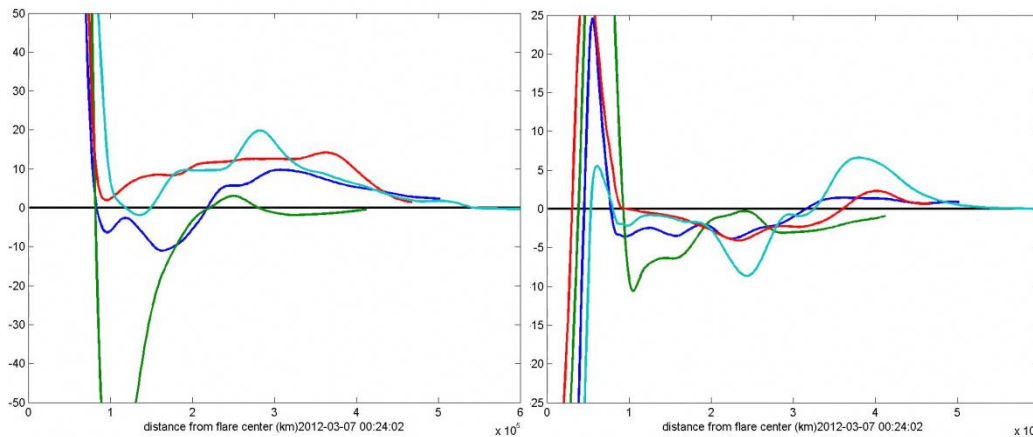


**Fig. 7:** From left to right: base difference, percentage base difference, and percentage running difference animations. Each of these animations show only those areas that were brighter, to accentuate a detected EUV wave.

Three types of animations are created to show a detected EUV wave. All these animations only show details that became brighter compare to a reference image, the areas that became darker are left out to emphasize on the EUV wave.

- A base difference animation shows all changes in the corona that became brighter since the beginning of the event.
- A percentage base difference animation emphasizes on brightness increases in the darker areas of the corona, an increase in brightness in brighter areas are made less apparent.
- A percentage running difference animation shows all changes between two subsequent images and usually shows the front of the EUV wave most clearly. This animation also emphasizes on changes in darker areas of the corona.

- **EUV wave animated graphs**



**Fig. 8:** Radial intensity profiles per quadrant, centered on the eruption for base difference images (left) and running difference images (right).

Two graphs are created showing brightness changes in four quadrants around the center of the detected event. The base difference plot shows absolute brightness changes – both dimming and EUV wave – as a function of the distance to the eruption center. The running difference plot shows more clearly the front of an EUV wave and can be used to calculate the speed of the EUV wave in one of the four quadrants.

The graphs are animated, showing the evolution of the dimming and EUV wave over time. It is possible to show the graphs for specific timestamps within the animations.

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## **3.2 3D CME Modeling Tool**

The documentation below corresponds to version 0.4 of the user’s manual (2013-03-14).

### **General Description**

Since launch of the STEREO twin spacecraft in October 2006 several hundreds of CMEs were observed from different vantage points with the STEREO/SECCHI/COR2 coronagraphs on board the STEREO-A and STEREO-B spacecraft. Pairs of coronagraph images reveal a stereoscopic view of the observed CME, and its 3D structure can be modeled with the Graduated Cylindrical Shell (GCS) model developed by Thernisien, Vourlidas and Howard in 2006 (*Thernisien, Vourlidas, Howard: Forward Modeling of CMEs using STEREO/SECCHI Data, Solar Phys. (2009), 256: 111-130*).

This documentation illustrates how the 3D structure of a typical flux-rope like CME can be parametrized based on STEREO/SECCHI/COR2 near real-time beacon and/or the later on transmitted science data. The obtained results can be used as input to forecast space storms near Earth by the ENLIL code and other models (e.g., BHV) providing CME arrival time and geomagnetic and dTEC (to be completed) impact predictions.

### **Software Installation and Setup**

The CME modeling tool is part of SolarSoft and requires the Interactive Data Language (IDL) installed on a Linux 32/64 bit or Mac system. The software is available at:

- IDL: [www.exelisvis.com](http://www.exelisvis.com) (tested on IDL 6.3, 8.2)
- SSW: [www.lmsal.com/solarsoft/ssw\\_install\\_howto.html](http://www.lmsal.com/solarsoft/ssw_install_howto.html)
- SSWDB: [www.lmsal.com/solarsoft/sswdb\\_install.html](http://www.lmsal.com/solarsoft/sswdb_install.html)

The installation procedures are described in detail on the specified websites. For installing SolarSoft it is important to select the packages “STEREO” and “SECCHI” and for SolarSoft Database the packages

“SECCHI Background cal (Standard) stereo/secchi/backgrounds/a/monthly\_min” and “SECCHI Background cal (Standard) stereo/secchi/backgrounds/b/monthly\_min” for correct data processing. Before starting the modeling tool it is necessary to set up the environment with the following commands ([www.lmsal.com/solarsoft/ssw\\_setup.html](http://www.lmsal.com/solarsoft/ssw_setup.html)):

```
$ csh
$ setenv SSW ../../ssw
$ setenv SSW_INSTR “stereo secchi”
$ source $SSW/gen/setup/setup.ssw.
```

This starts IDL with the SSW Environment and a demo mode of the GCS modeling tool:

```
$ sswidl
$ rtscgcloud,/demo.
```



### **CME Detection**

To model a flux-rope like CME with GCS it is necessary to identify the CME in coronagraphic data to determine modeling timestamps. The STEREO/SECCHI/COR2 synoptic movies on <http://secchi.nrl.navy.mil/sccmovies> allow to find quickly the time  $t_1$  when the CME is best visible in the COR2 field of view for applying the fitting technique and for determining the image  $t_0$  before the CME appears the first time in the COR2 field of view used as baseline for differential imaging. For both timestamps COR2 FITS-files are needed for image processing and for running the modeling tool.

### **Data Acquisition and Processing**

The required data are:

- 3 FITS-files for COR2-A at time  $t_0$
- 3 FITS-files for COR2-B at time  $t_0$
- 3 FITS-files for COR2-A at time  $t_1$
- 3 FITS-files for COR2-B at time  $t_1$
- 1 FITS-file for EUVI-A (at 195 or 304 Å) at time  $t_1$
- 1 FITS-file for EUVI-B (at 195 or 304 Å) at time  $t_1$ .

It is important that the COR2 files are chosen as triples captured in sequence by SECCHI. The wavelength of the EUVI files can be chosen depending on the source region of the CME. In general there are high-resolution science data available three days after recording on board STEREO and low-resolution beacon data (for space weather forecast) which are available via internet within three hours after capturing. The data can be found on:

- SCC: STEREO Science Center @NASA (Science Data for STEREO-A)  
[http://stereosc.nascom.nasa.gov/data/ins\\_data/secchi/L0/a/seq/cor2/](http://stereosc.nascom.nasa.gov/data/ins_data/secchi/L0/a/seq/cor2/)
- SCC: STEREO Science Center @NASA (Beacon Data for STEREO-A)  
<http://stereo-ssc.nascom.nasa.gov/data/beacon/ahead/secchi/cor2/>
- NRL: Naval Research Laboratory (Beacon and Science Data for STEREO)  
[http://sharpp.nrl.navy.mil/cgi-bin/swdbi/secchi\\_flight/img\\_short/form](http://sharpp.nrl.navy.mil/cgi-bin/swdbi/secchi_flight/img_short/form).

After downloading all files the data need to be processed with specific IDL routines (e.g. SECCHI\_PREP) for further usage with the CME modeling tool. A tutorial with a demo IDL script at <http://secchi.nrl.navy.mil/synomaps/scraytrace/dobo/examples.html#tutrtscgcloud> is available by the Naval Research Laboratory which can be used as basic approach.

### **GCS CME Modeling Tool**

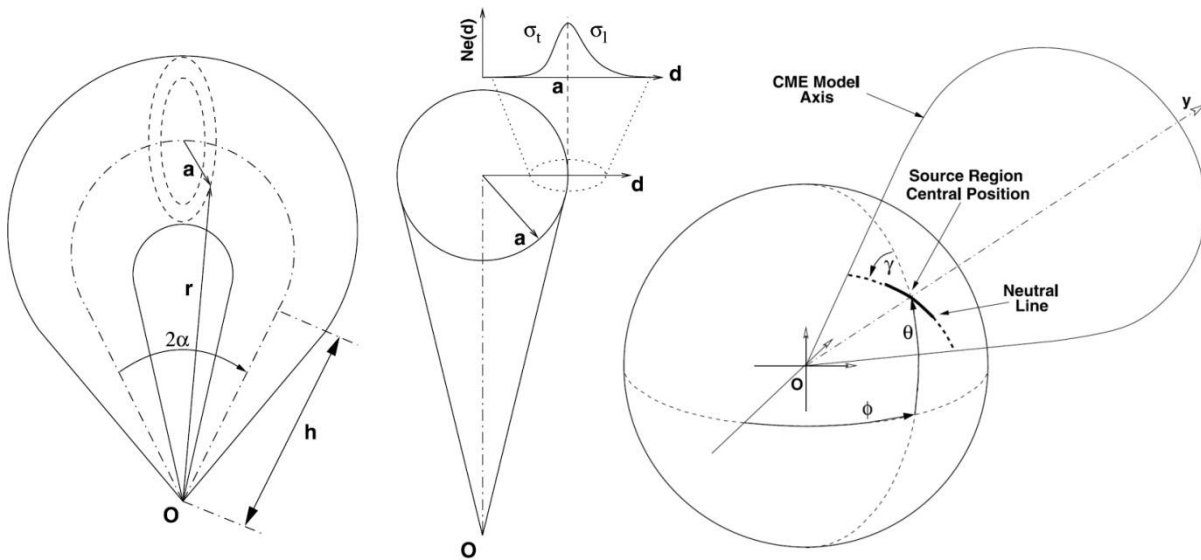
The CME modeling tool uses the geometry of the Graduated Cylindrical Shell (GCS) model to fit a flux-rope like CME to STEREO/SECCHI/COR2 data. The shape of the GCS Model shown in Figure 9 is reminiscent of a hollow croissant and can be parameterized with the following six parameters:

- |                         |                    |                    |
|-------------------------|--------------------|--------------------|
| ▪ Carrington Longitude  | $\Phi$             | [deg]              |
| ▪ Heliospheric Latitude | $\theta$           | [deg]              |
| ▪ Tilt Angle            | $\gamma$           | [deg]              |
| ▪ Height                | $h_{\text{front}}$ | $[r_{\text{sun}}]$ |
| ▪ Half Angle            | $2\alpha$          | [deg]              |
| ▪ Aspect Ratio          | $\kappa = a/r$     | --                 |

Following the tutorial mentioned in Section 4 the GCS CME Modeling Tool is started, providing a graphical user interface (Figure 10) for fitting the CME. The Control Panel on the left shows sliders

to change all six parameters of the GCS visualized with a green wireframe shown in the COR2 images on the right side. In the publication from 2006, Thernisien et al. describe step by step how to adjust all parameters to get an appropriate fit matching the CME observation in STEREO/SECCHI/COR2 data:

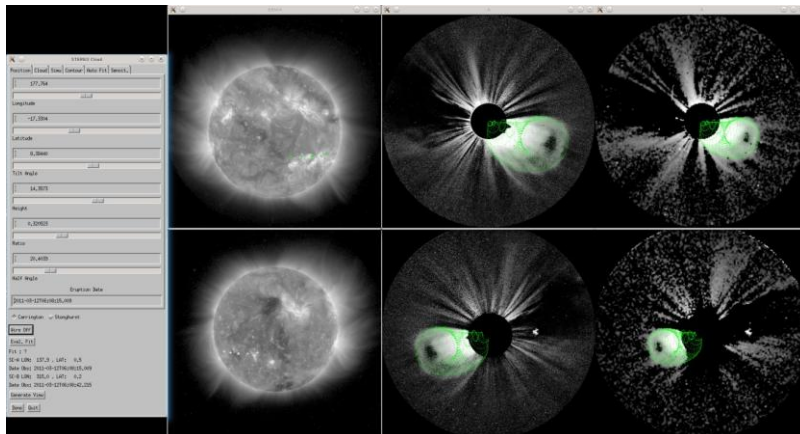
1. Set all parameters to zero and *Height* to  $\approx 10 r_{\text{sun}}$
2. Adjust *Longitude*, *Latitude* and *Height* until a good visual match is achieved.
3. Fit *Aspect Ratio* to describe the spatial extension of the CME.
4. Then adjust the *Half Angle* and *Tilt Angle* to complete the Fit.



**Fig. 9: Geometry of the Graduated Cylindrical Shell (GCS) Model developed by Thernisien, Howard and Vourlidas: Modeling of Flux Rope Coronal Mass Ejections, The Astrophysical Journal, 652: 763-773, 2006.**

## Results

The GCS modeling technique yields a parameterization of a CME observed in the STEREO/SECCHI/COR2 field of view. The results provide - amongst others - information about CME propagation direction, spatial expansion and orientation. Generating several fits in a time sequence make it possible to determine CME speed and temporal evolution. Since the fits are done by hand they exhibit the modelers' subjective perception of the CME's shape and orientation and need some experience. A set of 51 CMEs observed in 2010 has been modeled by Bosman, E., Bothmer, V., Nistico, G., Vourlidas, A., Howard, R., Davies, J.A.: 2012, Three-Dimensional Properties of Coronal Mass Ejections from STEREO/SECCHI Observations, *Solar Phys.*, **281**, 167-185.



**Figure 10: Graphical User Interface of the GCS Modeling Tool. From left to right: Control Panel, EUVI Observations of the Sun at 195 Å, COR2-A/B Observations from science data with a green wireframe representing the GCS fit and COR2-A/B Observations from beacon data with a green wireframe representing the GCS fit. STEREO-A and -B images are shown in the top and bottom row, respectively.**

### **Contact information**

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## **3.3 Geomagnetic forecast tool**

The documentation below corresponds to version 0.3 of the user’s manual (2013-02-01).

### **General description**

The geomagnetic forecast tool (“product”) predicts the Dst index up to 4 hours ahead in near-real time (as soon as data becomes available). The prediction quality is usually on par with best available operational systems or better. The forecast itself typically takes not more than a few seconds. The longest operation is downloading the data, which takes about 2 minutes.

The module is designed to work under Linux OS (tested with Ubuntu 12.04, 12.10, and Centos 6.3). Windows version is available upon request.

Recommended usage: expand the archive in your home directory and add a line

15 \* \* \* \* ~/prepro [JobOrderFile.xml] && ~/farm\_nrt, where [JobOrderFile.xml] is an optional Job Order File name, to your crontab file. Refer to cron manual for details.

### **List of files**

The product consists of the following files:

- prepro                      pre-processor
- farm\_nrt                   processor
- \*.RES and \*.COV        files with model data used by the processor
- README.TXT            this document

### **Pre-processor**

The pre-processor is used to supply NRT data to the processor.

Syntax: ./prepro [JobOrderFile.xml]

It can operate in 2 modes: as a forecast module (with Job Order File) or as a standalone service (without command line parameters).

When used as a forecast module, it performs the following operations:

1. seeks the XML file with the name passed to it as a command-line argument,
2. parses this XML file,
3. fetches the names of data files and other parameters listed therein,
4. checks if the structure of these files matches the template,
5. creates a file “FARM\_NRT.CFG” used by the processor,
6. creates a file “ErrorFile.XML” with errorlevels of each operation performed (0 = OK, 1 = Error).

If some or all of the files are missing or corrupt, it automatically downloads these specific files from the open sources on the Internet.

The structure of the Job Order File should be compliant with the Job Order File used in SWACI system. Please refer to AFFECTS deliverable report D5.1 for more information.

The structure of the data files should match those available from data providers. The product needs the following data (4 files in total):

- hourly ACE MAG and SWEPAM data starting from the first hour of the previous month (their format should match those found at <ftp://ftp.swpc.noaa.gov/pub/lists/ace2>, but with the header reduced to last 3 lines),
- quicklook Dst and Kp data starting from the first hour of the previous month in WDC format (same as used by WDC-C2 Kyoto and GFZ Potsdam).

When used as a standalone service mode, the pre-processor downloads all the necessary data files from the Internet. In both modes the pre-processor should be granted access to the Internet via HTTP and FTP protocols.

### **Processor**

The processor is used to issue the forecast and generate metadata.

Syntax: `./farm_nrt`

The processor is configured through the configuration file `FARM_NRT.CFG`. It is automatically generated by the preprocessor. The explanation of each parameter is given in the configuration file itself. Here only the most important parameters are listed:

- KY – predictand, i.e. which value to forecast (10 = Kp, 11 = Dst, 12 = ap);
- LT – maximum lead time in hours (should be proportional to cadence);
- FNRES and FNCOV – names of `.RES` and `.COV` files with relevant model data (the first entry is for the lead time equal to cadence, the second - for twice the cadence etc. till the maximum lead time);
- FMDAT – format of the file, where the forecast will be written;
- FMDATH – format of the header of the file, where the forecast will be written;
- FNDAT – name of the file, where the forecast will be written (if a file with such filename already exists, it will be overwritten);
- FNMET – name of the file, where the metadata will be written (if a file with such filename already exists, it will be overwritten);
- FN MAG – name of the file with ACE/MAG data;
- FNSWEPAM – name of the file with ACE/SWEPAM data;
- FNKP – name of the file with Kp data;
- FNDST – name of the file with Dst data.

The forecast is output in the following order:

- the number of hours since the beginning of the year;
- the number of hours till the next day (to make plot production easier);
- year;
- month;
- day of month;
- day of year;
- UT hour;
- measured value of the predictand;
- the forecast with once the cadence lead time (i.e. 1h for Dst, 3h for Kp);
- the forecast for twice the cadence lead time, and so on.

If the forecast cannot be issued, the corresponding value will be filled. The metadata format is self-explanatory. The MSE is given in data units, other metrics – in per cent.

### **Known limitations and bugs**

- Run-time error F6511 (variable name not found) occurs when the configuration file is composed incorrectly. Please, stick to the provided example.

- Currently, there are no checks of the filenames provided in the configuration file. It will be implemented in future versions.

### Acknowledgements

We acknowledge the Geoforschungszentrum, Potsdam for the near-real-time Kp data, and the World Data Center for Geomagnetism, Kyoto (WDC-C2) for the near-real-time Dst data.

We thank the ACE MAG and SWEPAM instruments teams and the ACE Science Center for providing the ACE data.

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## 3.4 L1 Solar Wind, Kp, Aurora and GNSS-Error Alerts – via RSS feeds

This is the documentation as of 2013-03-06.

### Overview

The RSS feeds provide L1 near real-time (1-3 min. delays to time of measurement) solar wind based short-term alerts of space weather events and its expected geomagnetic effects derived from correlated analysis of satellite and ground-based data. Real-time in-situ solar wind data from the Advanced Composition Explorer (ACE) spacecraft operating around the Lagrange point 1 (L1) are used to generate “threshold alerts” of solar wind parameters ( $|B|$ ,  $B_z$  and  $V$ ), estimated Kp, auroral boundary and expected GNSS-errors (in progress). The threshold is scalable and in the testing phase.

### Data

The alerts are based on the parameters magnetic field magnitude  $|B|$ , magnetic field z-component  $B_z$  and the solar wind bulk speed  $V$ . Currently the 1-minute real-time data are used. The data are measured by the ACE instruments MAG and SWEPAM and are provided in near real-time by the NOAA Space Weather Prediction Center server (NOAA/SWPC/RTSW ACE Real Time Solar Wind, preliminary data, <http://www.swpc.noaa.gov/ace/index.html>). Ground-based data reception is provided by several antenna stations around the world, including DLR Neustrelitz, Germany.

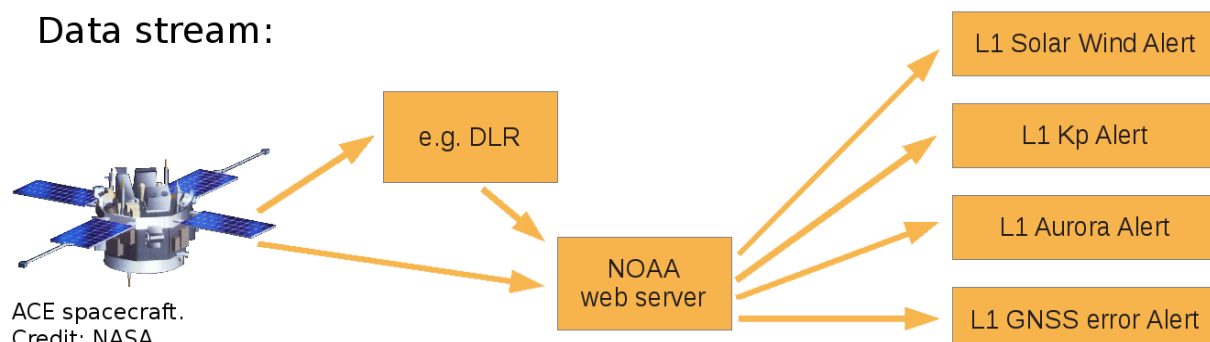


Fig. 11: This figure depicts the flow of data for the various RSS alerts.

### **Description**

The **L1 Solar Wind Alert** generates a new alert if at least one threshold of  $|B|$ ,  $B_z$  or  $V$  is exceeded by the last two hour extrema.

The **L1 Kp Alert** creates a new alert if an estimated Kp index exceeds a specified threshold and the last two hour extrema. The Kp estimate is based on an empirical correlation with solar wind data between 1995 and 2011 (NASA/GSFC/SPDF OMNIWeb interface, level 2 data, <http://omniweb.gsfc.nasa.gov>). The Kp estimate is derived in real-time from the solar wind product  $V \cdot B_z$ .

The **L1 Aurora Alert** produces a new alert if an estimated auroral boundary position moves southern of a certain geomagnetic latitude. The midnight equatorward auroral boundary position is derived via the empirical Kp estimate from tables at SWPC/NOAA (<http://www.swpc.noaa.gov/Aurora/>).

The **L1 GNSS Error Alert** will create a new alert if the specific error threshold is exceeded (the term L1 not to be confused with the L-band GPS carrier signal denoted L1 as well). Ionospheric Total Electron Content (TEC) data of strong Kp storms is used for the estimation of the GNSS error which scales with the TEC value. Work on this alert is currently in progress.

### **RSS subscription**

Rich Site Summary (RSS) web feeds are used to publish frequently updated news. Their standardized XML file format can be accessed by miscellaneous software, such as mobile apps, browsers and email-clients. These RSS readers automatically check the user's subscribed feeds regularly for new content. The following links allow the subscription to the feeds:

- **L1 Solar Wind Alert:**  
[http://www.affects-fp7.eu/rssfeeds/rssfeed\\_sw/rssfeed\\_sw.xml](http://www.affects-fp7.eu/rssfeeds/rssfeed_sw/rssfeed_sw.xml)
- **L1 Kp Alert:**  
[http://www.affects-fp7.eu/rssfeeds/rssfeed\\_kp/rssfeed\\_kp.xml](http://www.affects-fp7.eu/rssfeeds/rssfeed_kp/rssfeed_kp.xml)
- **L1 Aurora Alert:**  
[http://www.affects-fp7.eu/rssfeeds/rssfeed\\_aurora/rssfeed\\_aurora.xml](http://www.affects-fp7.eu/rssfeeds/rssfeed_aurora/rssfeed_aurora.xml)
- **L1 GNSS Error Alert:**

The link will be published on the AFFECTS website.

Example alert:

#### **2013-02-19 17:45 Solar Wind Alert**

02/19/2013 06:51 PM

Last 2 hour extreme values:  $|B| = 7.7$  nT,  $B_z = -4.9$  nT and  $V = 401.8$  km/s. With current threshold values:  $|B| > 1$  nT,  $B_z < -10$  nT and  $V > 600$  km/s.

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### 3.5 Real-time Determination and Monitoring of the Auroral Electrojet Boundaries

This is the documentation as of 2013-03-05.

#### **General description**

The real-time auroral electrojet tracker, which is Deliverable D4.3 in the AFFECTS project, enables the user to monitor the location of the auroral electrojet, and thus the auroral oval, boundaries in the European sector. The tracker uses near real-time data from the Tromsø Geophysical Observatory (TGO) magnetometer network in order to determine the electrojet boundaries, and updates every two minutes, displaying the electrojet boundaries determined from one minute old data.

#### **Auroral oval determination by means of geomagnetic measurements – Concept**

Large currents flows along the auroral ovals, these are termed the auroral electrojets. In the dusk sector in the northern hemisphere the electrojet flows eastward, and in the dawn sector it flows westward. The electrojets in relation to the auroral oval is illustrated in a simplified manner in Figure 12. In the figure, the auroral oval is seen from above, the number 12 in the upper part indicates magnetic local time and, thus, the direction towards the sun. Crosses and dots indicate currents flowing into and out of the ionosphere, solid arrows represents electrical fields. The dotted lines represent currents induced by the presence of the electrical fields and the vertical geomagnetic field. As is seen, in the dusk sector (left part of the figure), the Eastward electrojet is indicated within the oval. On the other side, in the dawn sector (right part of the figure), the Westward electrojet is indicated.

The magnetic field disturbances created by the auroral electrojets are observed on a routine basis from any magnetometer station located at auroral latitudes. Since the electrojets are intimately connected to the auroral oval, and both are aligned in the east-west direction (along the magnetic latitudes), the latitudinal magnetic signature of the electrojet may be used in order to identify its position, and hence the position of the auroral oval. Furthermore, since the oval width and location is governed by the interaction between the geomagnetic field and the solar wind and therefore will change with time, its dynamic behaviour may be tracked using latitudinally spaced ground-based magnetometers.

#### **The latitudinal signature of the auroral electrojet**

As discussed above, the electrojets flow in the eastward and westward direction of the auroral oval in the dusk and dawn sectors, respectively. Any current will induce its own magnetic field, and it is this field which is observed as a magnetic field variation at stations at auroral latitudes. The latitudinal, magnetic signature of the electrojets may be simulated assuming they are sheet currents flowing 110 km above ground. This is illustrated for a situation in the auroral oval close to the dusk meridian in Figure 13, indicated by a red line in Figure 01. The coordinate system used in the simulations is the XYZ system commonly used in geomagnetic observations, the x-axis points northwards, the y-axis points eastwards and the z-axis points downwards. In the bottom panel of Figure 02 the current system as function of latitude is shown. At low latitudes the current is zero, between 65 and 75 degrees the eastward electrojet is flowing, hence the positive sign. North of the electrojet there is a weaker polar cap return current flowing towards the sun/dayside. In the top panel the resulting magnetic field variation owing to the currents in the x-component is shown, the x-component is here the horizontal component. As can be seen the magnetic field increases to a maximum close to the middle of the electrojet, and it decreases below zero further north where the oppositely directed polar cap current is situated. It can also be seen, that the x-component variation is dispersed latitudinally relative to the electrojet and, thus, cannot be used to determine



the extent of the oval. However, looking at the middle plot of Figure 13, we clearly see that the z-component (i.e. the vertical component) of the magnetic field variation gets a local maximum and minimum at the equatorward and poleward edge of the electrojet, respectively. This can be used to determine the location of the auroral oval boundaries. In the case of a westward electrojet, the signs of the results in Figure 13 needs to be changed, otherwise the result is the same.

Hence, we summarize that in the dusk sector, the equatorward edge of the auroral oval is represented by a maximum in the ground magnetic field variation z-component and the poleward edge is represented by a minimum. In the dawn sector it is opposite, the auroral oval equatorward edge is represented by a minimum in the z-component and the poleward edge by a maximum.

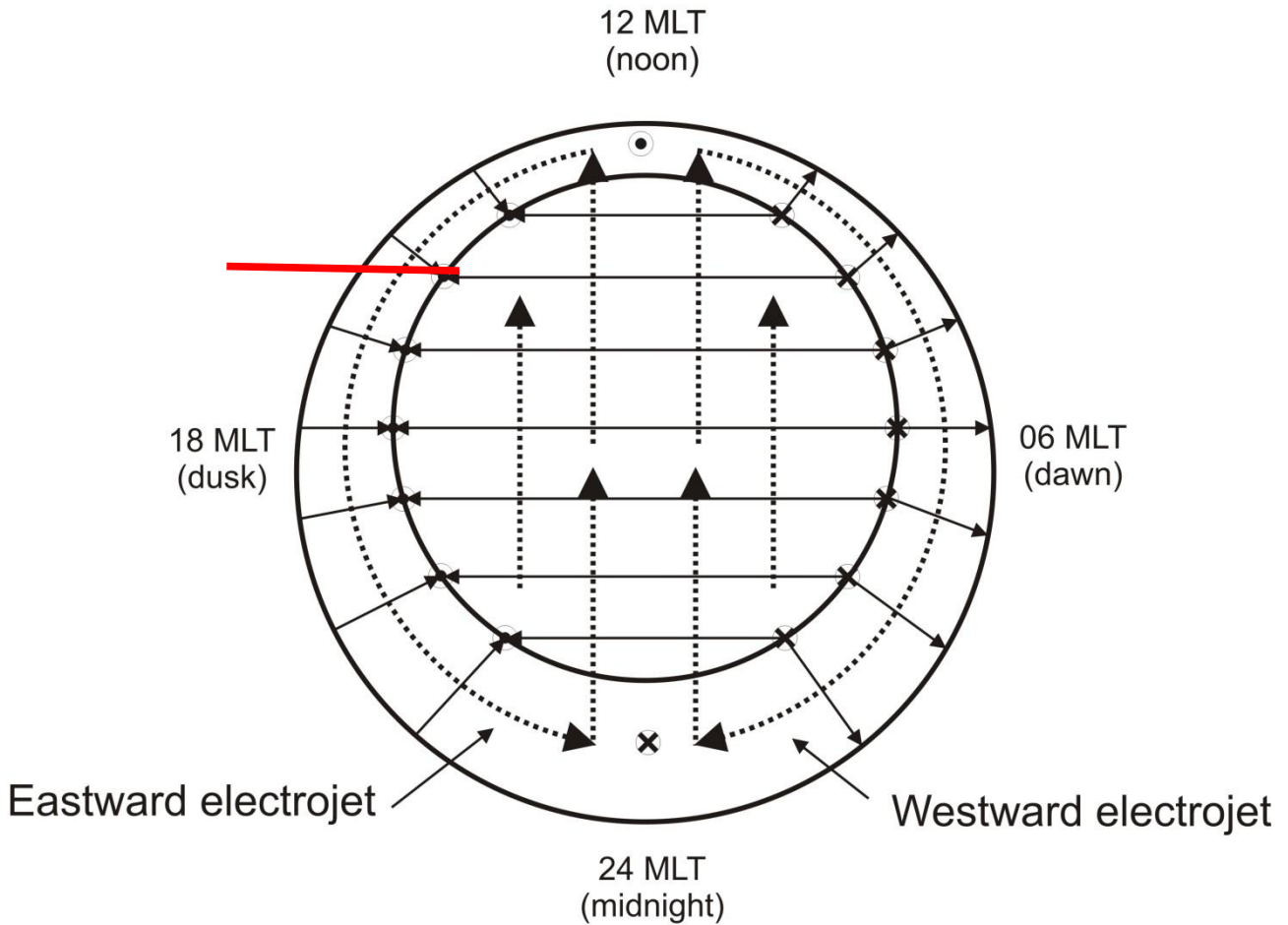


Fig. 12: The Relationship between auroral oval and electrojets.

### **Presentation of auroral electrojet tracker**

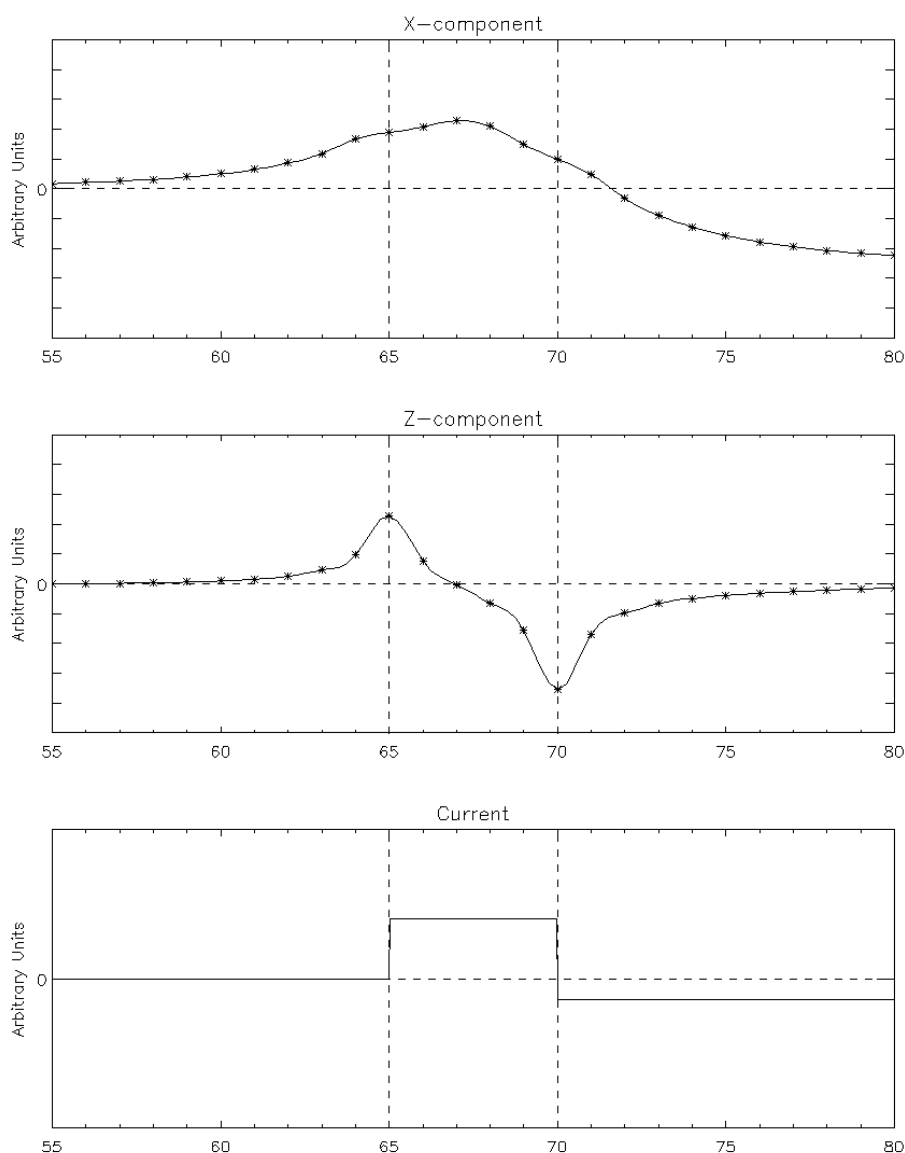
The TGO magnetometer network is evenly spaced in latitude in a north-south manner, which makes its measured data an excellent starting point for a provisional auroral alert and tracking system.

The tracker consists of two graphical parts and one numerical part. The graphical parts are displayed presented together with a short description at the following URL: <http://fox.phys.uit.no/AFFECTS/>. The first graphical part is a map where the poleward and equatorward edges of the auroral oval, determined from the magnetic field variation z-component, are indicated as green and red dashed lines. In addition plots where the relevant components of the geomagnetic field variations as function of latitude are displayed. The time of the last oval determination is indicated on top of the map, and the corresponding time stamp for the data used



is indicated in the bottom right corner. The second graphical part is a graphical representation of the strength and latitude of the maximum in geomagnetic variations in the European sector, it may be referred to as an activity indicator. The activity is indicated by a bar updating in real-time according to the maximum magnetic field variation (x-component) found in the data. The scale chosen to indicate the activity goes from 0 to 10 and is related linearly to the interval 0 – 3000 nT. Values corresponding to quiet, moderate, disturbed and extraordinary conditions are marked. The bar is accompanied with another display indicating the latitude of the maximum disturbance. The third part is an ascii file, which is updated in near real-time, containing numerical values of the poleward and equatorward edges of the auroral oval at present and the previous three hours. The ascii-file can be found on the following URL: [http://fox.phys.uit.no/AFFECTS/RT\\_oval\\_location.dat](http://fox.phys.uit.no/AFFECTS/RT_oval_location.dat).

For the tracker data from 9 of TGO's 14 magnetometers have been used in order to get as even latitudinal spacing between them as possible. At each location the local coordinate system has been rotated around the vertical axis in such a way that the observed magnetic field variations are with respect to the local magnetic field dipole meridian rather than the geographic meridian. Natural splines have been fit to the x- and z-components in order to get a latitudinal profile with higher resolution.

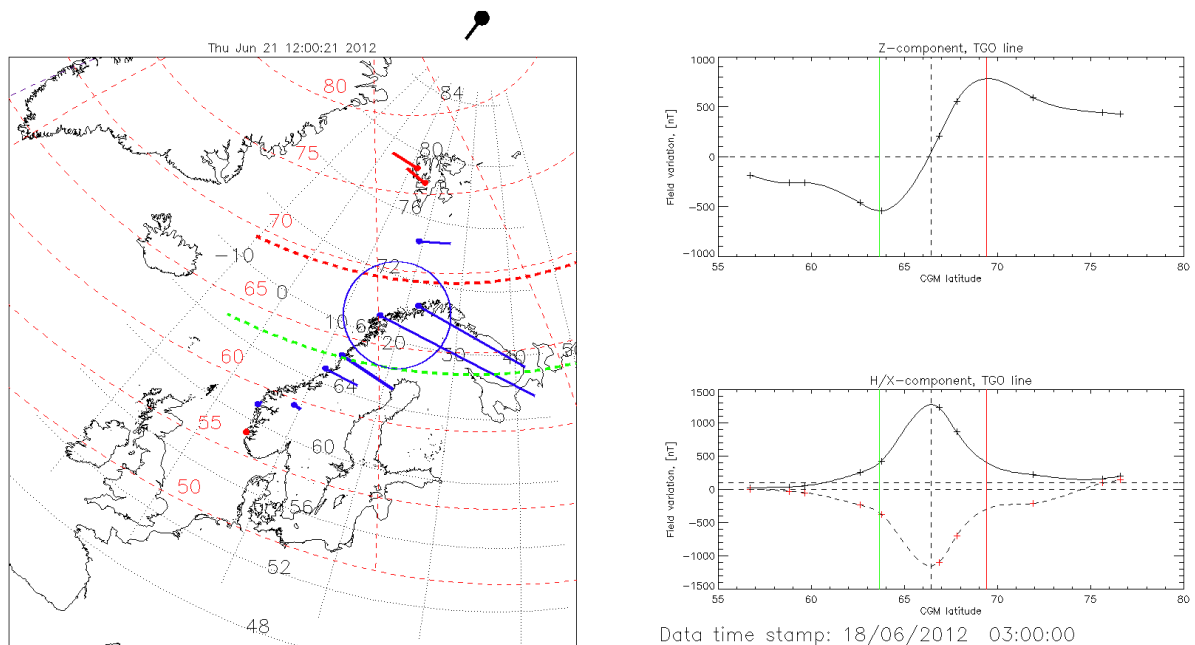


**Fig. 13:** Simulated magnetic field signature of eastward electrojet as function of latitude.

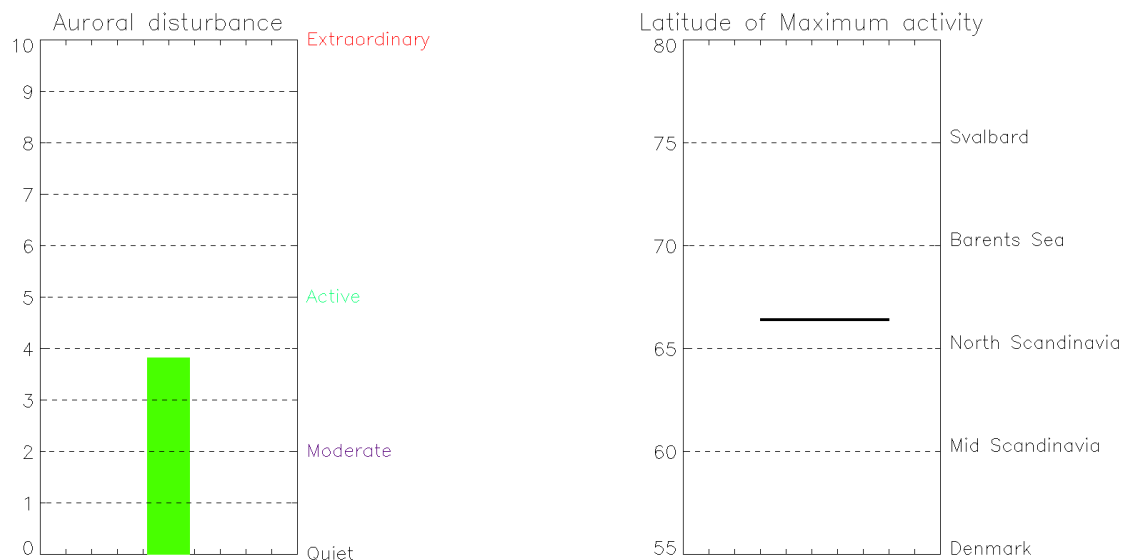
Owing to the uncertainties in quiet-time determination of the measured magnetic field, it has proved impossible to get meaningful latitudinal profiles of the magnetic field variations under very quiet conditions. Therefore the auroral electrojet determination is turned off when the maximum in the absolute value of the x-component reaches values of less than a threshold currently set to 40 nT. This is displayed as a message in the graphical display and as NaN (not a number) in the ascii file.

Owing to the greater complexity of the current systems near magnetic noon (cusp) and midnight (Harang discontinuity), the oval determination from the z-component is turned off in the intervals UT 07.00 – 11.00UT and UT 19.00 – 22.00. However, in order to indicate where the oval is located and the degree of activity, the maximum in the x-component and latitude for it, is still found during these intervals (see second graphic display).

In Figure 14 the obtained auroral oval edges from the magnetic signature of the westward electrojet in the dawn sector, are presented in the same fashion as in the graphical display on the web page of the tracker. Comparing with the simulations in Figure 13 it is seen that the signature of the electrojet as obtained from the TGO magnetometers is very similar. The arrows indicate the strength of the local geomagnetic disturbance (magnetic equivalent convection), and the blue circle shows the field of view of the TGO all-sky camera (<http://fox.phys.uit.no/ASC/>). In Figure 15 the activity indicator, which is the second graphical display of the auroral electrojet tracker, is shown for the same event as displayed in Figure 14. As can be seen, for this case, the activity is rather high and situated in northern Fennoscandia.



**Fig. 14: Acquired auroral oval boundaries in dawn sector using the AFFECTS auroral electrojet tracker.**



**Fig. 15: Activity indicator for the same event as presented in Figure 14.**

The obtained auroral boundaries are also stored in an ASCII file. The data are presented in the following format:

*DD MM YEAR HH MM SS Oval(poleward) Oval(equatorward)*

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## **3.6 Early Warning Message for GNSS Users**

### **General description**

The *Early warning message for GNSS users* is especially directed to customers of space based radio systems used in telecommunication, navigation/positioning and remote sensing. The warning shall inform customers and operators of GNSS about approaching space weather events. Thus, GNSS customers and service providers will be aware of potential performance degradation of their systems due to space weather impacts. Based on the early warning, customers shall become prepared to undertake efforts to help mitigate the space weather impacts on the operated systems. The customer himself has to estimate the risk of his decisions with respect to the concrete GNSS application or service he is involved in or is operating. The early warning for GNSS users is done by distribution of a message which contains information primarily directed to users of GNSS systems. It uses solar alerts disseminated by ROB and translates it to the special information needed by GNSS users. The “Early warning message for GNSS users” is part of the Forecast System Ionosphere (FSI) developed within the AFFECTS project.

The screenshot shows the SWACI-AFFECTS website interface. The main content area displays an "Early Warning Message for GNSS users" with a green header. The message text states: "This Early Warning Message is a fast warning for space weather events potentially impacting GNSS measurements. The Early Warning Message for GNSS users is generated at the German Aerospace Center (DLR) Neustrelitz using presto alert and ursigram information from the Solar Influence Data Center (SIDC) Brussels." Below this, a "Current Status" section shows a table with green rows indicating a "Normal" disturbance scale and "none" hazards. A "Last Early Warning Issue" section shows a table with yellow rows indicating a "Disturbed" disturbance scale and expected geomagnetic disturbances. The right sidebar includes an "Aktueller Status" section with a login button, a "Benutzername: bask.be.swaci" field, and an "Abmelden" button. Logos for the European Union, DLR, and IKQ are also present.

Fig. 16: Early Warning Message on the SWACI-AFFECTS website.

Every interested person, company or institute can request this service by signing in on the SWACI-AFFECTS website. Each registered user shall be able to unsubscribe from the user list at any time. This option is implemented to a service provided on the SWACI-AFFECTS website.

The warning message send automatically to external users contains a html file with a graphical presentation of the warning and a xml-file with all information's.

The xml file can be used for further processing in other processor systems. The warning message also properly links to additional webpages showing nowcast and forecast of the ionosphere.

### Limitations

The Early Warning for GNSS user is now in its test and verification phase and will become accessible for the public by end of II/2013. Recent test user are kartverket – Norwegian Mapping Authority, Axio-Net and the German Aerospace Center (DLR).

It is expected that more information's enter the warning message in accordance with the continuous development within AFFECTS in the third year.

### Contact information

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Early Warning: <http://swaciwebdevelop.dlr.de/early-warning-gnss/>

### 3.7 Forecast System Ionosphere

#### General description

A *Forecast System Ionosphere (FSI)* has been developed as part of the FP7 AFFECTS project. It is intended to help European citizens mitigating the impact of space weather events on its communications systems. For this purpose the FSI will operationally provide a prediction of space weather related geomagnetic and ionospheric perturbations for Europe. Solar observations and measurements are used for forecasting of geomagnetic activity and Total Electron Content (TEC).

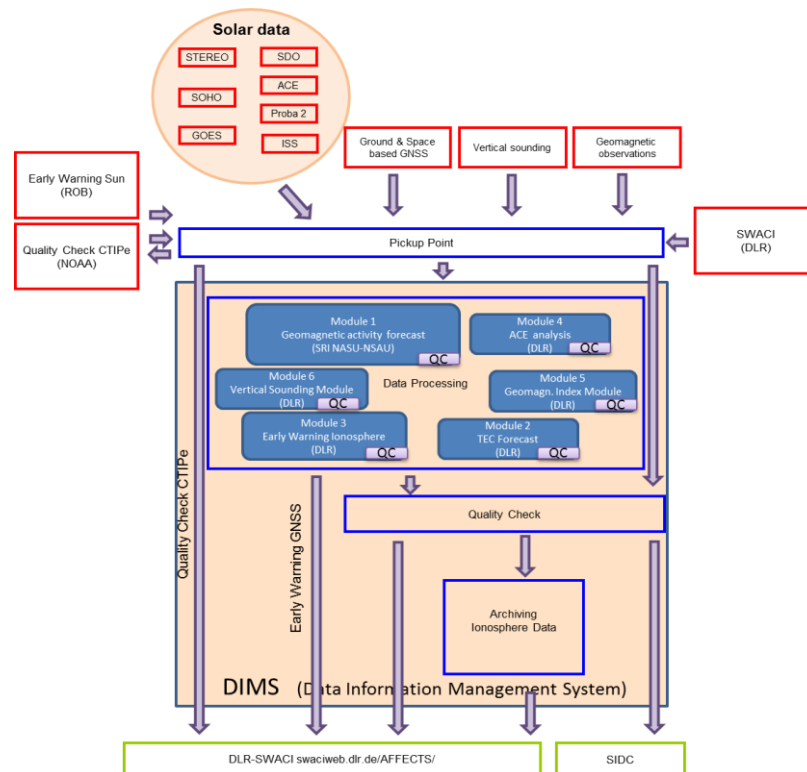


Fig. 17: Overview of the components and data flow of the FSI.

Additionally, high latitude geomagnetic monitoring and early warning for GNSS users is incorporated in the FSI. An overview of the FSI modules is presented in Figure 17, whereas Table 2 provides specific details.

## List of Modules

Modules	Description
<b>Module 1: Geomagnetic Activity Forecast</b>	The geomagnetic forecast module predicts the geomagnetic index Dst 3 hours in advance. Kp or ap forecast can also be provided.
	Input ACE data for last 24 hours Previous Dst values for last 40 days.
	Output Dst forecast (3h lead time, 1 h cadence)
	Other parameter
<b>Module 2: TEC Forecast</b>	The Total Electron Content (TEC) forecast module is designed to predict TEC over Europe 6, 12 & 24 hours in advance. The advantage of this TEC forecast module is the use of a new TEC perturbation model, which predicts TEC during ionospheric disturbances caused by strong solar wind. Therefore it uses geomagnetic forecast and ACE solar wind measurements.
	Input EU TEC map nowcast Dst forecast ACE measurements
	Output EU TEC forecast map EU TEC quality map
	Other parameter F10.7cm radioflux index
<b>Module 3: Early Warning Message</b>	This module generates an early warning message which is primarily directed to users of GNSS systems. It uses solar alert disseminated by ROB and translates it to the special needs of GNSS users.
	Input Presto alert (ROB) ACE measurements
	Output Early warning message Statistics
	Other parameter
<b>Module 4: ACE Analysis</b>	The ACE analysis module applies pre-analysis and correlations studies on ACE measurements in preparation for the TEC forecast module.
	Input ACE measurements EU TEC map nowcast
	Output ACE analysis, ACE Plot
	Other parameter
<b>Module 5: Geomagnetic Index</b>	Magnetometer measurements which are provided for the AFFECTS consortium are analyzed and prepared to be used for TEC forecast.
	Input Magnetometer measurements
	Output Magnetometer chain data plot

Modules	Description
	Other parameter
<b>Module 6: Vertical Sounding</b>	The slab thickness is calculated on the basis of vertical sounding data and TEC measurements.
	Input
	Vertical sounding EU TEC maps
	Output
	Slab thickness profiles
	Other parameter

Table 2: Detailed description of FSI modules.

### Contact information

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FSI: <http://swaciwebdevelop.dlr.de/forecast-system-ionosphere/>

### 3.8 Solar Timelines viewer for AFFects (STAFF)

The documentation below corresponds to STAFF version 2.0 (2013-01-09).

The STAFF viewer is available online at <http://www.staff.oma.be>.

#### Introduction

The *STAFF viewer* is a web based application that can show the timelines for several types of solar measurements like X-Ray, EUV, Solar wind, Interplanetary Magnetic Field, ... The data is imported in near-real time and can go back several years. The viewer also allows the user to zoom in or out a time frame and to combine the plots as desired.

Prerequisites:

- Javascript should not be blocked from the user's webbrowser.
- STAFF has been tested on Internet Explorer, Safari, Chrome and Firefox.

Figure 19 shows the first view a user gets when he or she visits the STAFF web page. We can distinguish the following parts, which will be discussed separately in the following subsections:

1. Links to several third party websites related to STAFF. Links open in a new window.
2. Menu for some advanced options like export, additional information and help.
3. Clicking slides a part of the page open and allows the user to (de)select timelines.
4. Clicking slides a part of the page open and allows the user to change the time window
5. This part shows the actual plot.

## Links



Fig. 18: Links.

From left to right each image is a link to:

- The AFFECTS web site.
- The European FP7 project web site.
- The homepage of the Royal Observatory of Belgium.
- The STCE homepage.

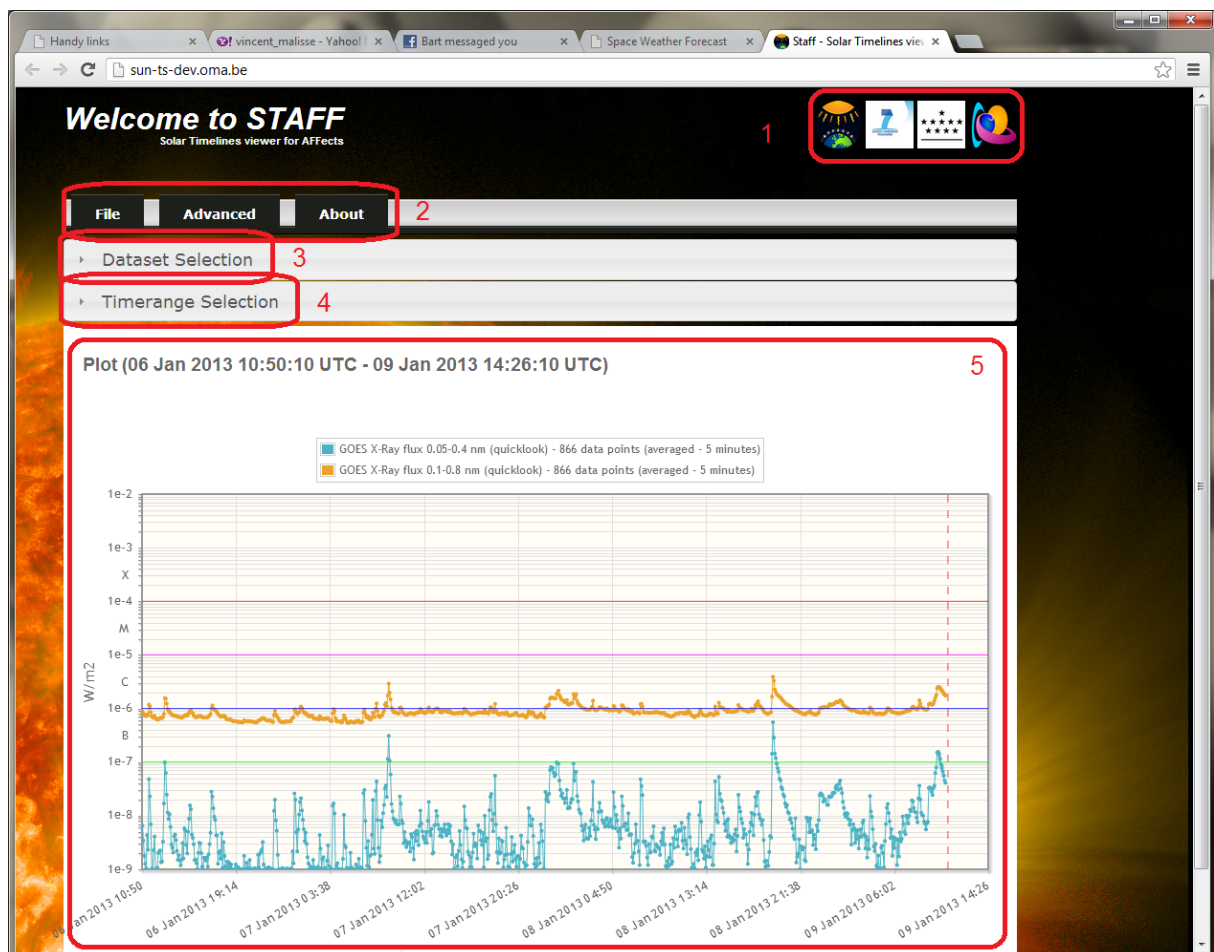


Fig. 19: First view when opening the STAFF web page.



## Menu

**Note:** All dialogs can be closed by clicking on the cross on the top right.

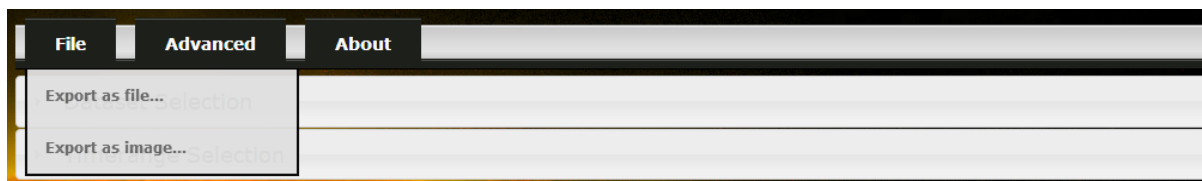



Fig. 20: Menu – File.

If you hover over the menu item “File” a dropdown is shown with the following options:

- **Export as file**

Allows the user to export the current shown plot as data to a txt, xls or csv formatted file. When clicking the menu-item a popup dialog will open allowing the user to review the data.



Clicking on the export button (  ) gives the user the option to export that timeline to a certain fileformat and whether the full dataset should be exported. The export is per timeline, not for the full plot.

**Note:** Exporting the full dataset is potentially dangerous as it can be a huge amount of data.

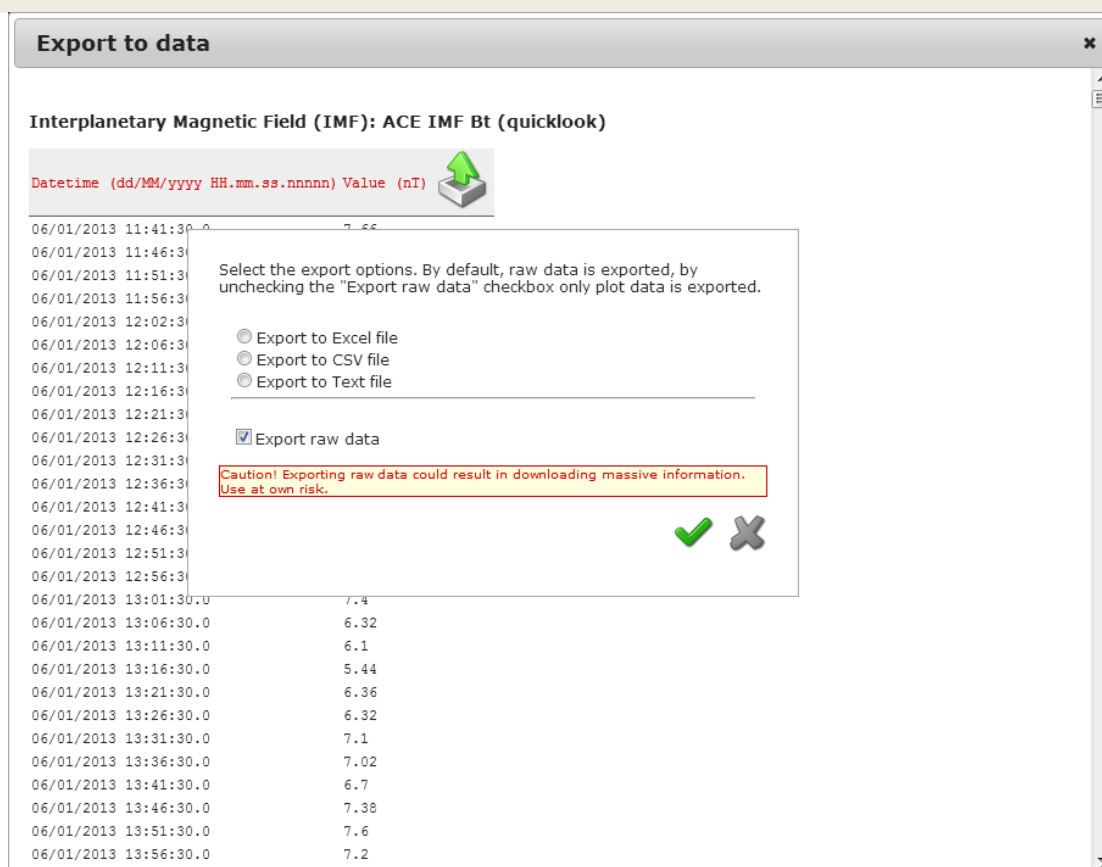




Fig. 21: Exporting data.

With the buttons OK/Cancel (   ) the user can confirm or cancel the options.

- **Export as Image**

Allows the user to export the current shown plot as an image. When clicking the menu-item a popup dialog will open allowing the user to review the prepared image, including the copyright print. By right-clicking the image and selecting “Save as...” in the popup menu, the image can be saved to disc.

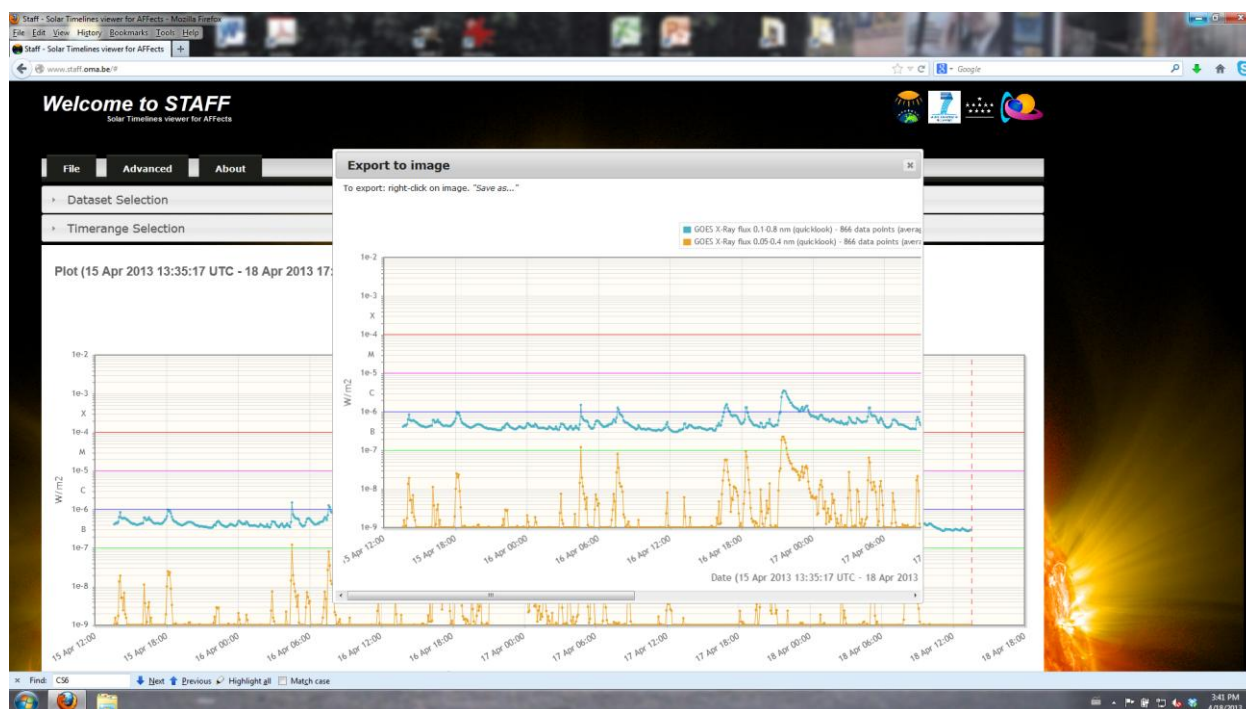


Fig. 22: Exporting as an image.

**Note:** The full image will be downloaded. The dialog can only show part of the image at one time due to size constraints. The full image can be reviewed by using the horizontal scrollbar.

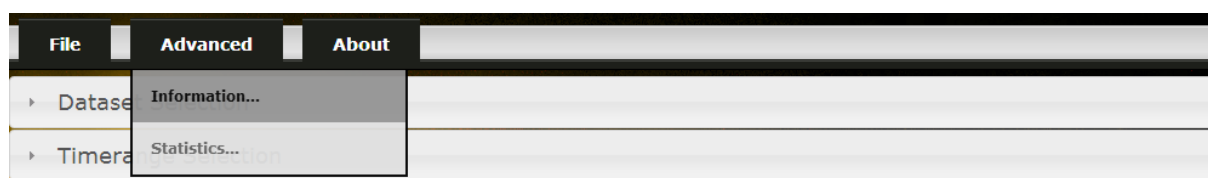


Fig. 23: Menu – Advanced.

If you hover over the menu item “File” a dropdown is shown with the following two options:

- **Information:** This option will show where the information comes from which can be files, a database or some ground station.

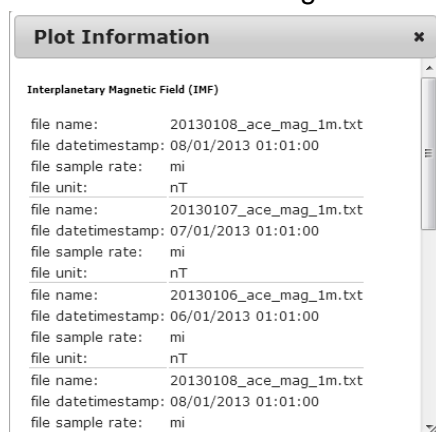


Fig. 24: The information about the current plot.

- **Statistics:** This option will open a new page that shows for each plot the oldest datapoint, the newest datapoint, the lowest value, the highest value and the amount of records of the raw data. Not all datasets have the same time range, which is why this page can be useful to retrieve a valid plot. If a plot turns out empty, this should be the first place to look.

Staff Statistics - Google Chrome  
sun-ts-dev.oma.be/Statistics.jsp

**Staff Statistics**

Datetime format: ddMMyyyy HH:mm:ss.SSS

**EUV**

Category	Sub-Category	Minimum Datatimestamp	Maximum Datatimestamp	Minimum Value	Maximum Value	Record Count
Lya Aluminium	science - centiseconds	06/01/2010 17:02:10.535	28/08/2012 05:49:38.051	1.3772897E-8	1.7940023E-8	1888062035
Lya HeI3646	science - centiseconds	06/01/2010 17:02:10.535	28/08/2012 05:49:38.051	1.6077209E-6	2.5376821E-6	1890981425
Lya Lyman Alpha	science - centiseconds	06/01/2010 17:02:10.535	28/08/2012 05:49:38.051	1.7289896E-7	2.1040114E-8	1888060581
Lya Zirconium	science - centiseconds	06/01/2010 17:02:10.535	28/08/2012 05:49:38.051	1.0843656E-9	2.3985018E-9	1888264232

**Geomagnetic**

Category	Sub-Category	Minimum Datatimestamp	Maximum Datatimestamp	Minimum Value	Maximum Value	Record Count
At Chambon-La-Forêt	quicklook - days			0.0	0.0	0
At Dourbes	quicklook - days			0.0	0.0	0
K Chambon-La-Forêt	quicklook - days			0.0	0.0	0
K Dourbes	quicklook - days			0.0	0.0	0
Kp (K values planetary index)	quicklook - days	27/09/2011 22:00:00.000	25/12/2011 21:00:00.000	1.0	7.0	32

**Interplanetary Magnetic Field (IMF)**

Category	Sub-Category	Minimum Datatimestamp	Maximum Datatimestamp	Minimum Value	Maximum Value	Record Count
ACE IMF Bz	quicklook - minutes	04/11/2012 00:00:00.000	09/01/2013 11:59:00.000	0.1	23.0	94597
ACE IMF Bx	quicklook - minutes	04/11/2012 00:00:00.000	09/01/2013 11:59:00.000	-15.4	17.3	94597
ACE IMF By	quicklook - minutes	04/11/2012 00:00:00.000	09/01/2013 11:59:00.000	-21.2	21.5	94597
ACE IMF Bz	quicklook - minutes	04/11/2012 00:00:00.000	09/01/2013 11:59:00.000	-19.4	20.4	94597
Ace IMF Phi	quicklook - minutes	04/11/2012 00:00:00.000	09/01/2013 11:59:00.000	0.0030912	359.1449	95341
ACE IMF Bz	science - minutes	05/02/1998 00:00:00.000	20/07/2012 23:59:00.000	0.18	9999.99	7601760
ACE IMF Bx	science - minutes	05/02/1998 00:00:00.000	20/07/2012 23:59:00.000	-49.51	9999.99	7601760
ACE IMF By	science - minutes	05/02/1998 00:00:00.000	20/07/2012 23:59:00.000	-50.94	9999.99	7601760
ACE IMF Bz	science - minutes	05/02/1998 00:00:00.000	20/07/2012 23:59:00.000	-65.57	9999.99	7601760
Ace IMF Phi	science - minutes	05/02/1998 01:22:00.000	19/07/2012 11:57:00.000	0.03871339	359.9754	5128795

Fig. 25: Statistics.

**Note:** This screen can be set next to the normal application for re-use.

**Note:** Statistics are updated once a day.

If you hover over the menu item “About” a dropdown is shown with the following four options:

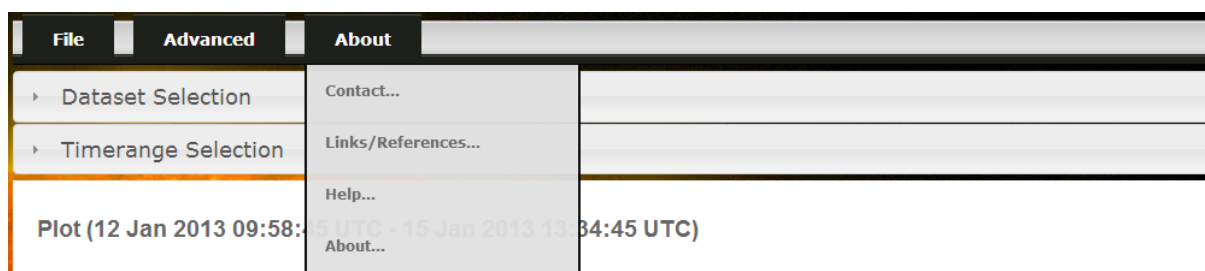




Fig. 26: Menu – About.

- **Contact:** This allows a user to contact the site administrator. The user just needs to fill in the required data similar like sending an email. With the buttons OK/Cancel (   ) the user can send or cancel the email.

Contact

Do you have remarks or questions?  
You can drop them here.

Name:

E-mail:

Subject:

Message:



 

Fig. 27: Contact form.

- **Links/References:** Shows a popup with links to related sites.



Fig. 28: Links.

- **Help:** Shows a popup with a quick help guide on the topics of the application. Navigation is also through a menu.

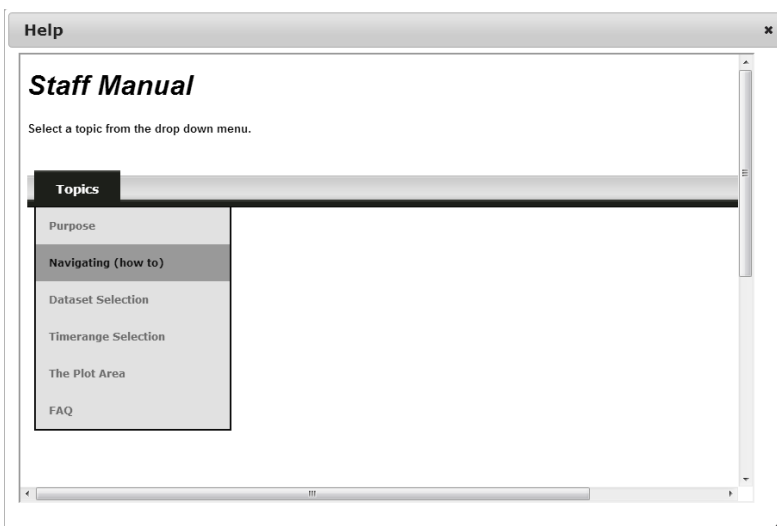


Fig. 29: Help.

- **About:** Shows quick information about STAFF.

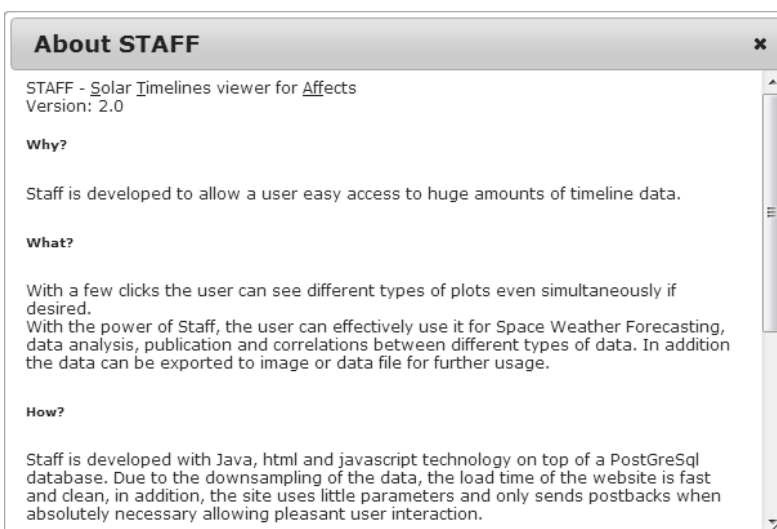


Fig. 30: About.

## Dataset Selection

Clicking on the bar opens a part of the website previously not visible.

This part allows you to select any selection of the available timeline data sets. A green V marker (✓) means the plot is selected, a red cross marker (✗) is unselected. By default the GOES X-Ray long and short bands are selected.

**Note:** Though perhaps personal preference, more than 3 selections make the plots very hard to read.

## Time range Selection

When clicking on the bar a new part of the website opens allowing the user to select a desired time range and order the application to draw the plot with the selected settings.

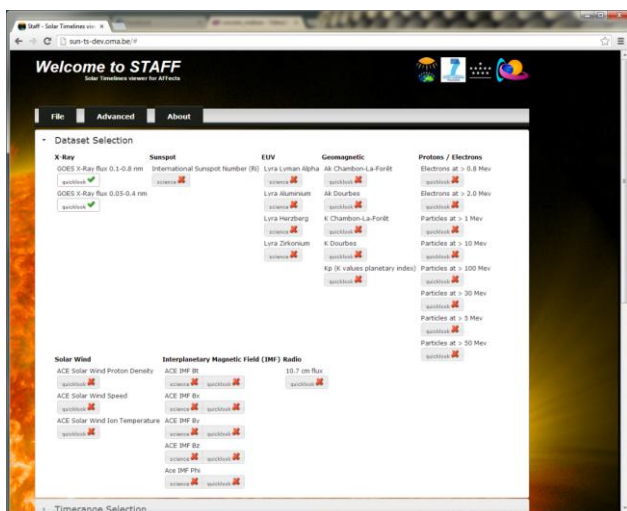


Fig. 31: Dataset selection.


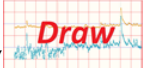


Fig. 32: Time range selection.

The user can select a defined time range using start – end-date times or select a pre-defined duration ranging from the last minute to the last year. By default the last three days is selected.

Using the « and » buttons the application will calculate a shift in the selected timerange earlier or later. E.g. when a timerange of 3 months was selected, the buttons will shift the start and end time by 3 months. This action can be repeated. Notice that when the duration radiobutton was selected, it will be unselected and the start-end radiobutton will be selected instead.

**Note:** The timerange automatically adds 5% when selecting a “last ...” duration (e.g., “last 3 days”) so that the current time does not fall off the plot.

The draw button (  ) will execute the selections the user made and fetch the data from the server to draw the plot. Notice that when the user changed something the button turns red (  ) indicating the drawn plot might not correspond to the user’s selections.

## Plot Area

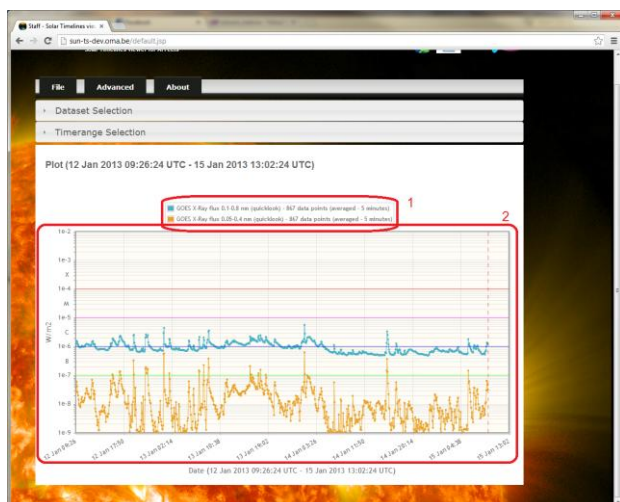


Fig. 33: Plot area.

The plot area consists of:

### 1. The legend

This contains information about which color each dataset has as well if it is quicklook, science or predictions, how many points were selected from the dataset and if it is averaged and to what level. In this case the blue curve is the goes Long quicklook data on 5 minute averages that has 867 data points.

### 2. The plot

The plots are dynamically adapted to the selected plots. That means that each plot can have a different Y-axis defined (linear or logarithmic) or show different markers. The label on the Y-Axis is defined by the selected dataset. Multiple Y-axes are possible.

The X-axis is dynamically built up depending on the timerange selected and the dataset selected. The vertical striped red line is the current datetime. If you drag a square on the plot the application will horizontally zoom in on the data. As long as you don't use the draw button the application will remember the previous zoom level and by doubleclicking the plot area the application will zoom out again.

**Note:** Due to the limitations of the used plotting library, zooming will not go further than about an hour. Zooming in further can be done by using the timerange selection option.

To improve speed, the amount of data points is limited to 2000 per selected dataset. The STAFF application determines the correct downsample level based on the highest resolution of the raw (not downsampled) data and the selected timerange. It is therefore possible that a zoomed in plot has more data points than a zoom level higher.

The following table gives the downsample levels supported by STAFF. However, datasets are downsampled only, if the highest resolution is minutes, there will be no second or millisecond data for example.

Milliseconds
Centiseconds
Deciseconds
Seconds
Minutes
Hours
Days
Carrington Rotations
Years

Table 3: Downsample levels.

### **Contact information**

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## **4. Summary and conclusions**

Detailed documentation was provided about eight AFFECTS space weather products and services that were presented at the international user workshop on February 28, 2013.

## **5. Perspectives**

Each one of the products and services described above will be maintained and improved over years to come. The details will be written down in Deliverable D6.4 (“Report on Long-Term Product Sustainability”, month 34).

Results and user feedback from the international User Workshop will be provided in Deliverable D6.3 (“Report on User Workshop Results”), month 30.

## **6. Appendix**

### **6.1 List of acronyms**

<b>ACE</b>	<b>A</b> dvanced <b>C</b> omposition <b>E</b> xplorer
<b>EUV</b>	<b>E</b> xtreme <b>U</b> ltra <b>V</b> iolet (emission)
<b>GOES</b>	<b>G</b> eostationary <b>O</b> perational <b>E</b> nvironmental <b>S</b> atellite
<b>Lyra</b>	<b>L</b> arge <b>Y</b> ield <b>R</b> adiometer
<b>N/A</b>	<b>N</b> ot <b>A</b> pplicable
<b>STCE</b>	<b>S</b> olar- <b>T</b> errestrial <b>C</b> enter of <b>E</b> xcellence