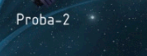
AFFECTS

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 worldwide leading research and academic institutions and industrial enterprises from Germany, Belgium, Ukraine, Norway and the United States.



GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

Fraunhofer IPM

UNIVERSITY OF TROMSØ UiT

ASTRIUM AN EADS COMPANY

DLR

IKQ

PLANETARIUM

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Advanced Forecast For Ensuring Communications Through Space (AFFECTS)

Volker Bothmer, Project Coordinator

FP7 Space Weather Meeting, 3 October 2013, REA, Brussels

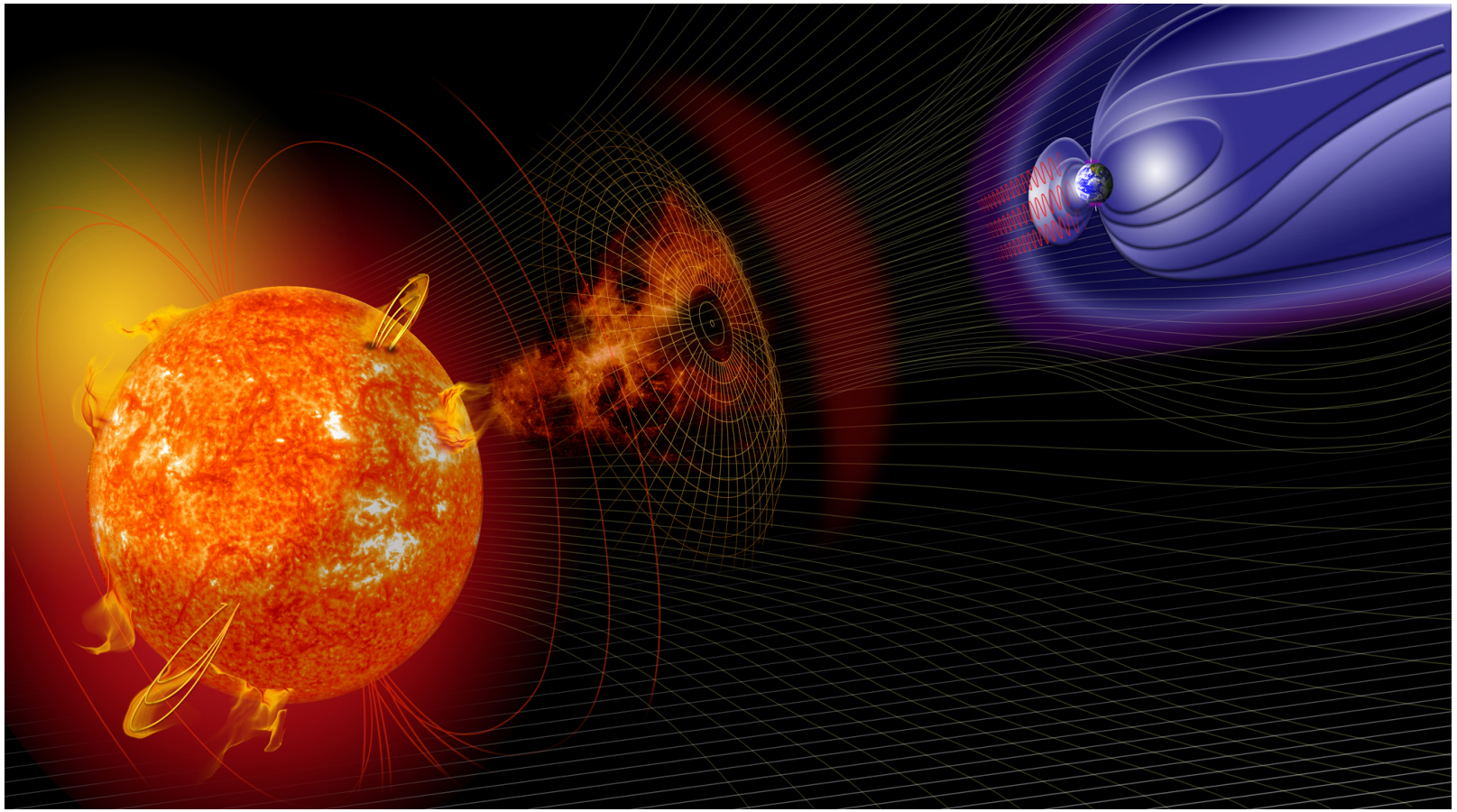
AFFECTS Project Objectives

- 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.

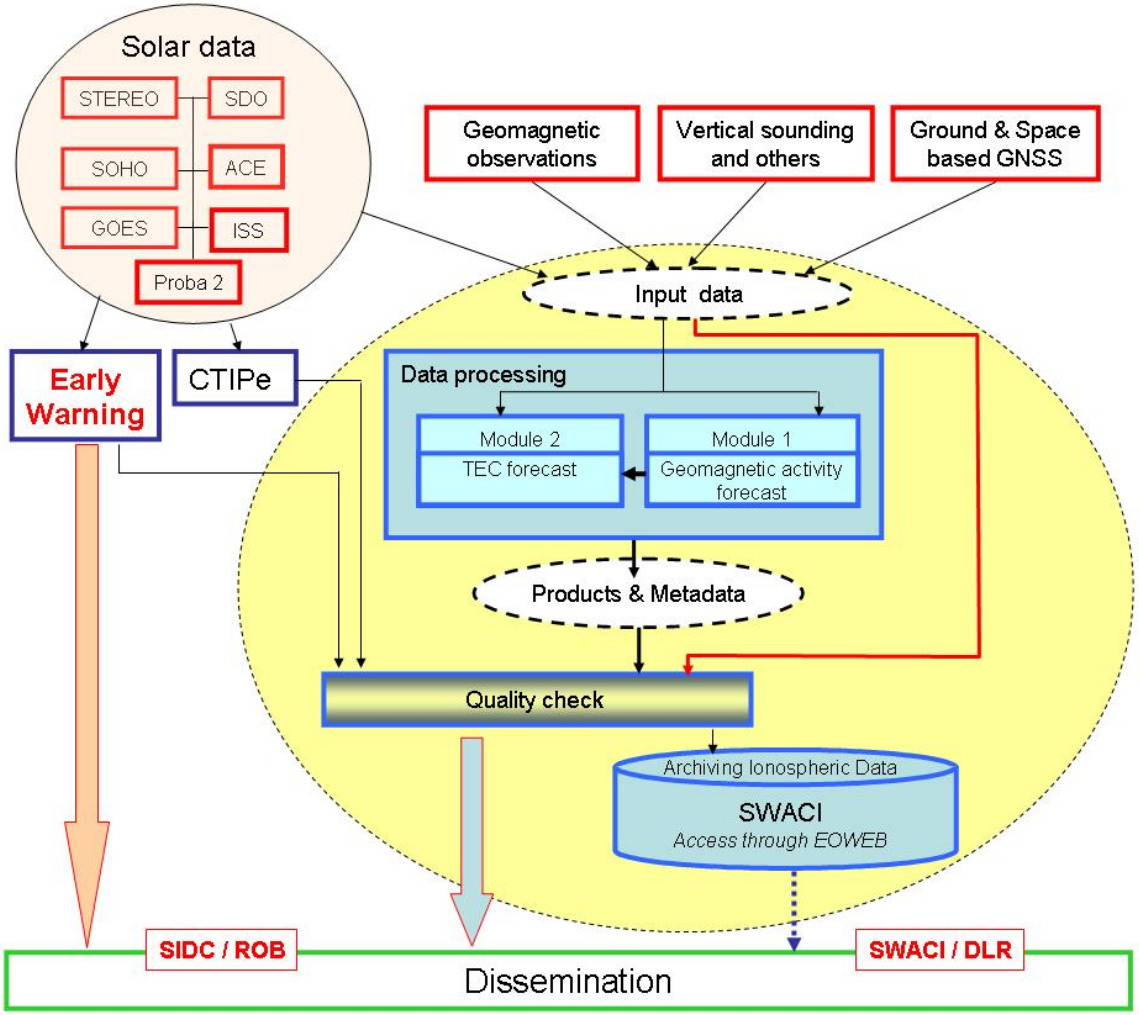
- Dissemination of new space weather products and services to end users, the scientific community and general public.

Solar Storm - CME - heading towards Earth



Courtesy: NASA.

AFFECTS Workflow



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/sec^2.
```

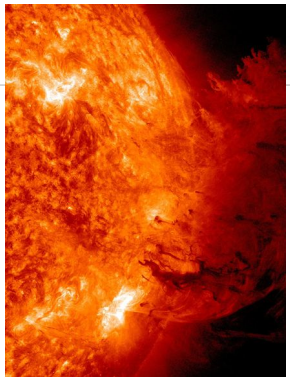
- **ROB Presto - Flare and Cactus CME alerts**
- **NOAA-SWPC - PSS**
- **SOHO/LASCO halo CME alerts**
- **NRT generated messages**

Von Solar Influences Data analysis Center <sidc@oma.be>
Betreff **Halo CME detection alert from the SIDC/RWC Belgium**
Antwort an sidctech@oma.be
An RegisteredUsers@sidc.be

```
:Issued: 2013 Jul 22 2206 UTC
:Product: documentation at http://www.sidc.be/products/cactus
#-----------------------------------------------------------------#
# HALO CME ALERTS from the SIDC (RWC-Belgium), generated by CACTUS  #
#-----------------------------------------------------------------#
  A halo or partial-halo CME was detected with the following characteristics:

           t0      | dt0| pa | da |  v   |  dv | minv| maxv|
023|2013/07/22 06:12| 04 | 144| 360| 0844| 0326| 0309| 1420

Details can be found here: http://www.sidc.oma.be/cactus/out/latestCMEs.html

      t0: onset time, earliest indication of liftoff
     dt0: duration of liftoff (hours)
      pa: principal angle, counterclockwise from North (degrees)
      da: angular width of the CME (degrees),
       v: median velocity (km/s)
      dv: variation (1 sigma) of velocity over the width of the CME
   minvv: lowest velocity detected within the CME
   maxvv: highest velocity detected within the CME


  This message is sent whenever a CME wider than 150 degrees is detected by cactus.

#-----------------------------------------------------------------#
# Solar Influences Data analysis Center - RWC Belgium             #
# Royal Observatory of Belgium                                    #
# Fax : 32 (0) 2 373 0 224                                        #
# Tel.: 32 (0) 2 373 0 491                                        #
#                                                                 #
# For more info see http://www.sidc.be/cactus. Please do not reply  #
# directly to this message, but send comments and suggestions to    #
# 'sidctech@oma.be'. If you are unable to use that address, use     #
# 'rvdlinden@spd.aas.org' instead.                                  #
# To unsubscribe, visit http://sidc.be/registration/unsub.php       #
#-----------------------------------------------------------------#
```

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

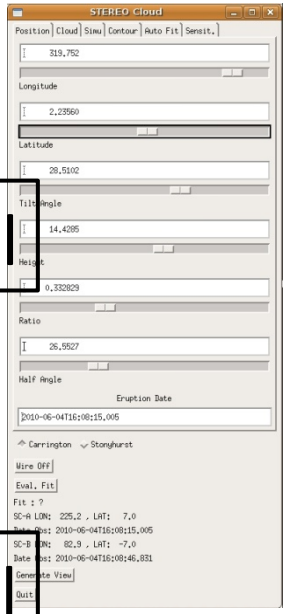
```
Space Weather Message Code: SUMXM5
Serial Number: 104
Issue Time: 2013 Jun 07 2326 UTC

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.
```

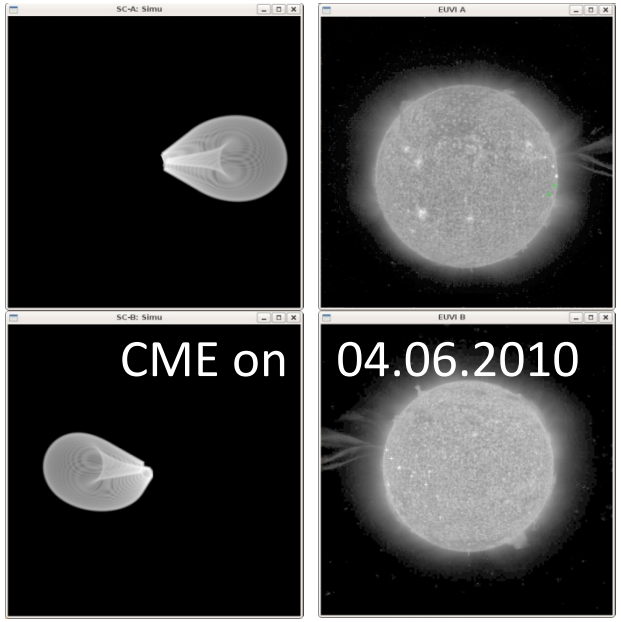


NRT GCS/CAT CME Modeling

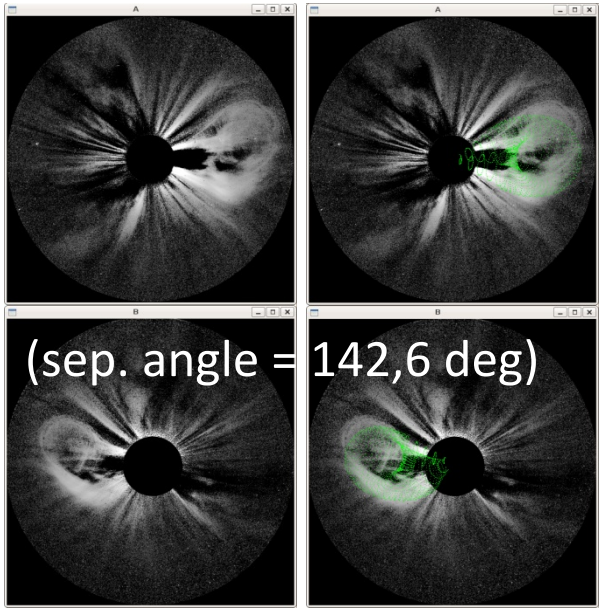
GCS Tool

CAT Tool

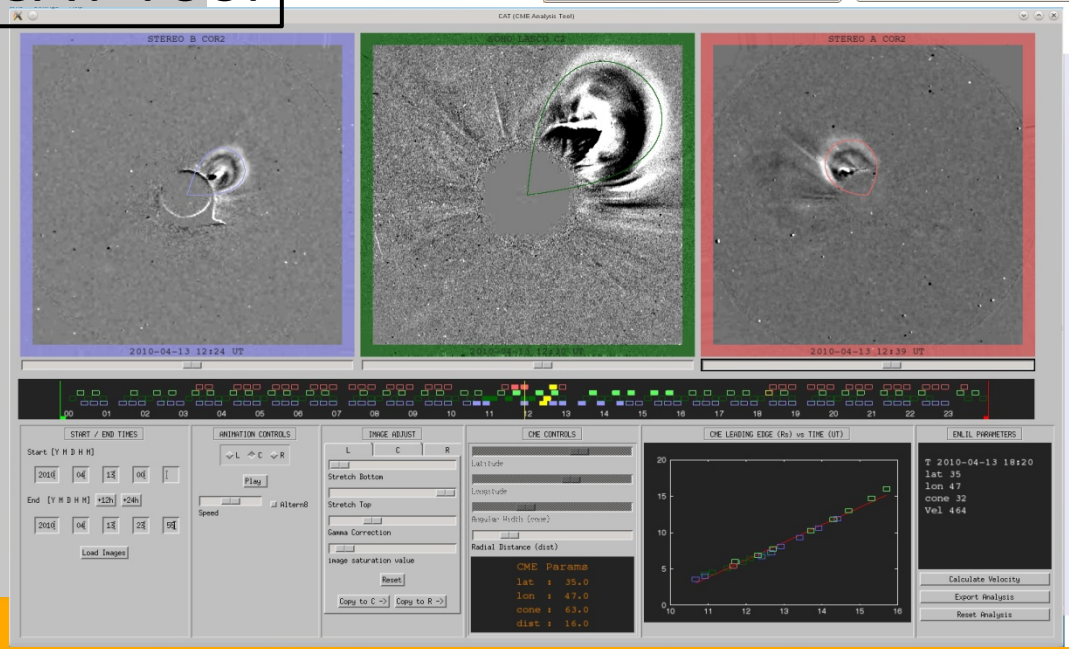




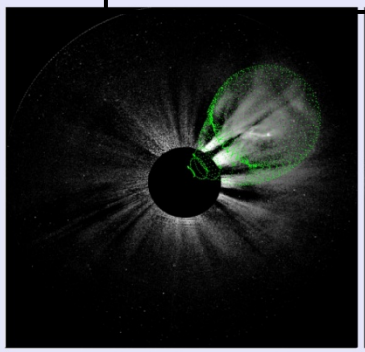
CME on 04.06.2010

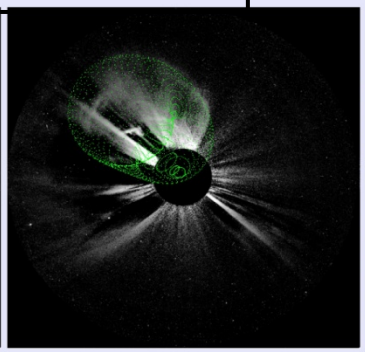


(sep. angle = 142,6 deg)



CME Database





COR2B white-light Coronagraph image with an overlay in green of the GCS wireframe

COR2A white-light Coronagraph image with an overlay in green of the GCS wireframe

Forward-Modeling Code yields the following results.

GCS Fit-Parameter from Modeling:
Carrington Longitude: **159,876**
Carrington Latitude: **35,217**
Tilt Angle: **-21,803**
Height: **14,786**
Ratio: **0,499**
Half Angle: **17,888**

Timestamp of used COR2-Images for Modeling: **20100413 15:08:15**
#formatting: yyyymmdd hhmmss

Warning through AFFECTS Website and Mailing List

AFFECTS Space Weather Reports

Contents [hide]

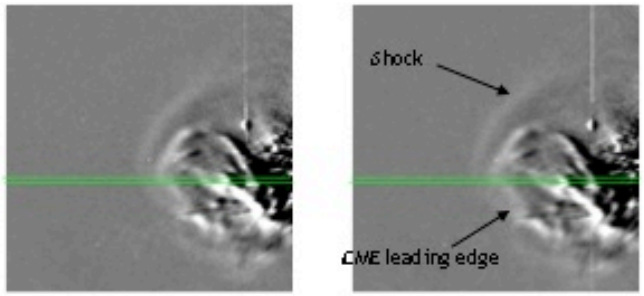
May 15, 2013

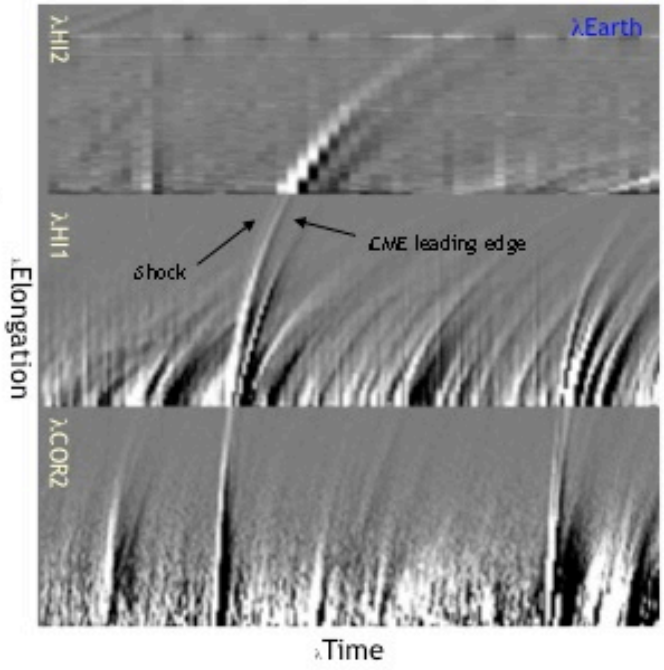
Active region 1748 appeared at the Sun's East limb on May 13, 2013 when it caused on this, the following day and today three X-ray flares with peak intensities in the M to X-range. Three fast CMEs with speeds in the range 1400-2000 km/s were associated with these events. The first two ones are not expected 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.

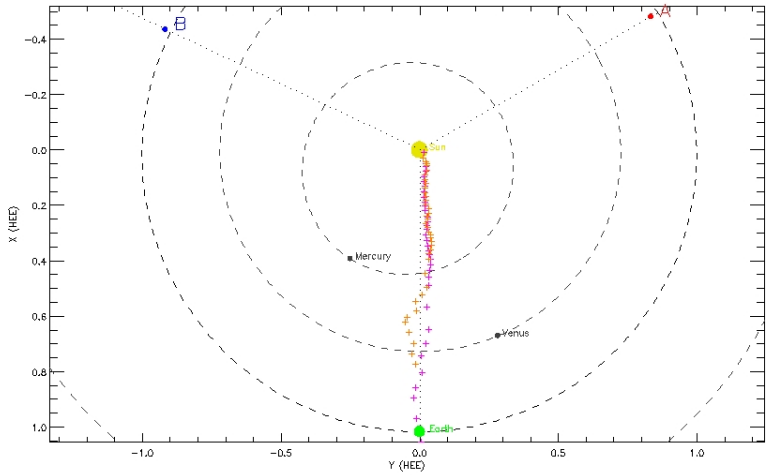
April 12, 2013

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+.

CME tracking with STEREO

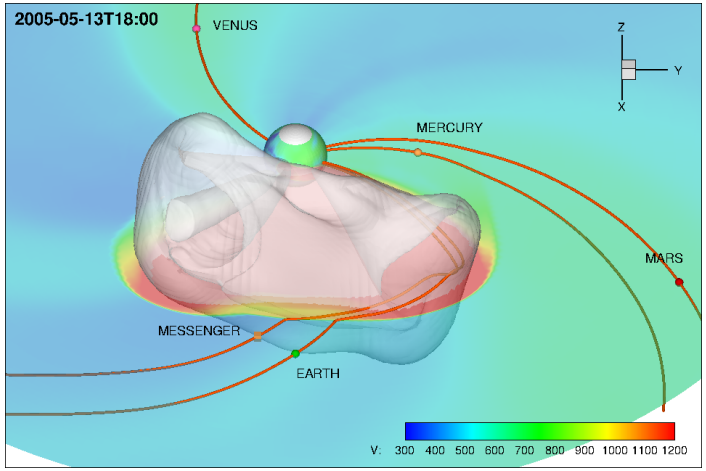


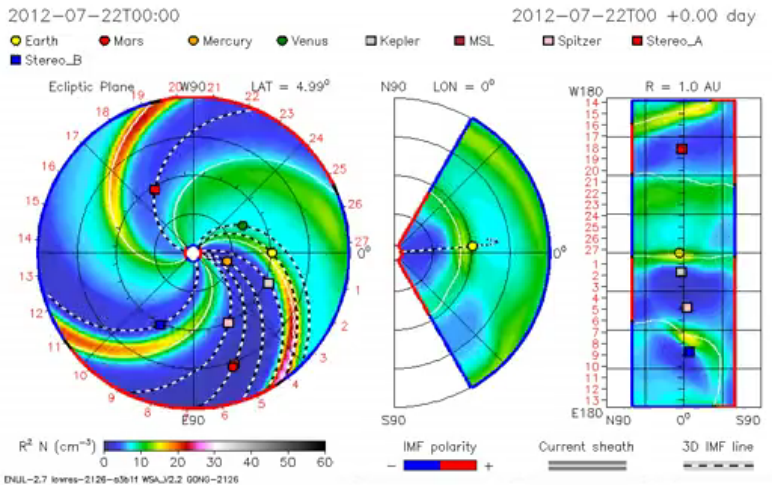




J-map technique;
Courtesy: L. Volpes

CME modeling to Earth - ENLIL

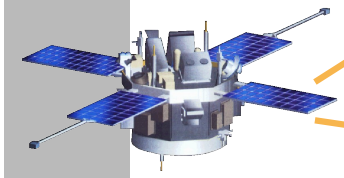




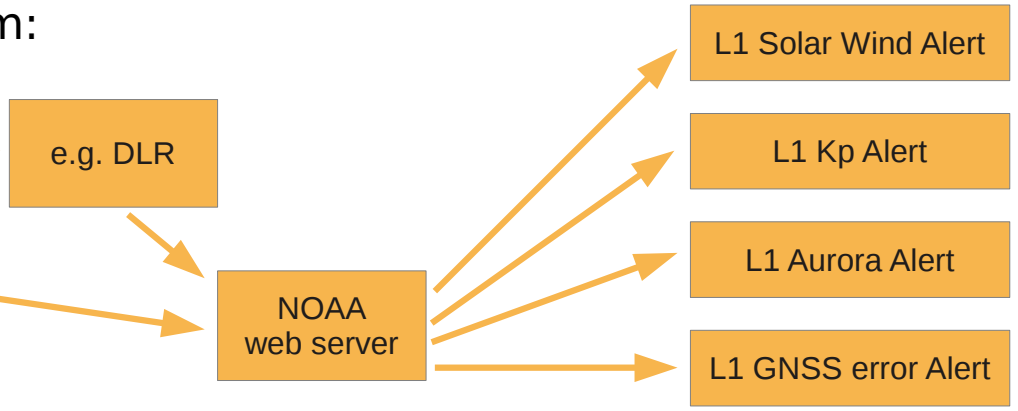
- **Cooperation with NOAA-SWPC model**
- **Cooperation as partner of ILWS proposal (PI: D. Odstrcil)**
- **Input to ENLIL**
  - **CME parametrization (GCS, CAT)**
  - **CME magnetic field structure (B&S FR model)**

L1 Alerts – Provided as RSS-Feeds

Data stream:



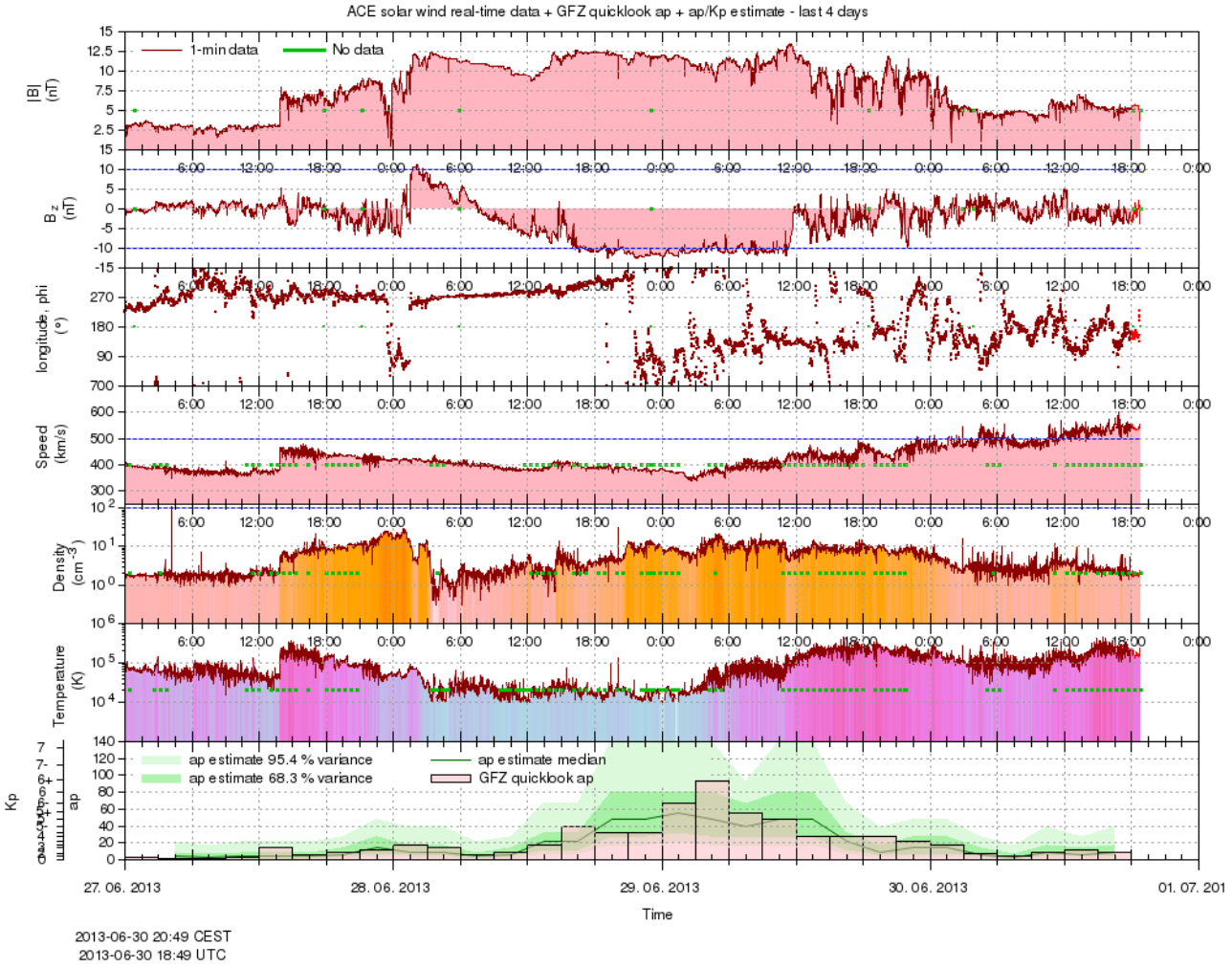
ACE spacecraft.
Credit: NASA



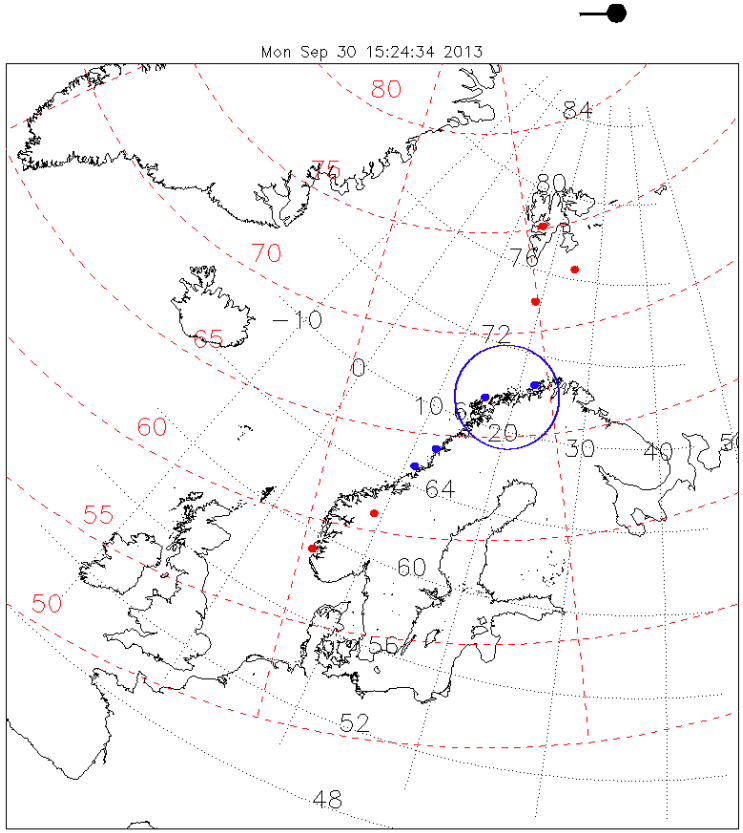
ACE data from MAG and SWEPAM instruments:

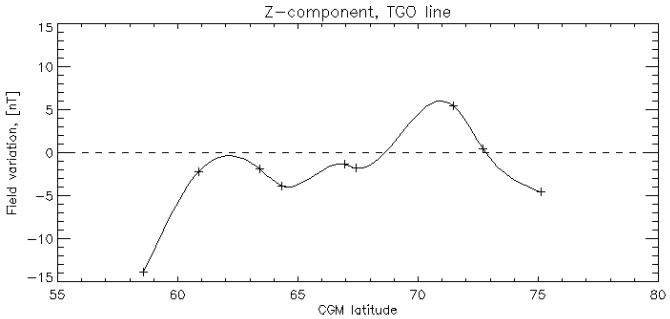
- NOAA/SWPC/RTSW (ACE Real Time Solar Wind, preliminary data)
  - http://www.swpc.noaa.gov/ace/index.html
- CALTECH/ASC (ACE Science Center, level 2 data)
  - http://www.srl.caltech.edu/ACE/ASC/level2/index.html
- NASA/GSFC/SPDF (OMNIWeb interface, level 2 data)
  - http://omniweb.gsfc.nasa.gov

NRT L1 Solar Wind Plot (A Sample)

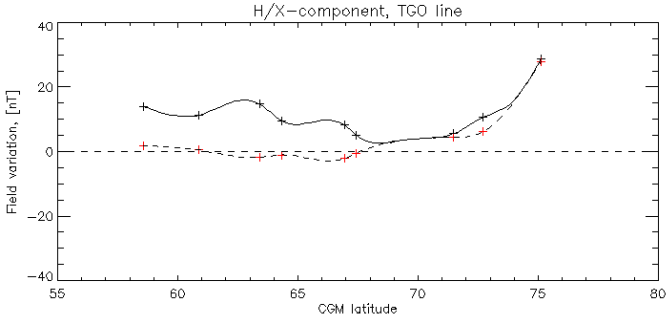


Auroral tracker



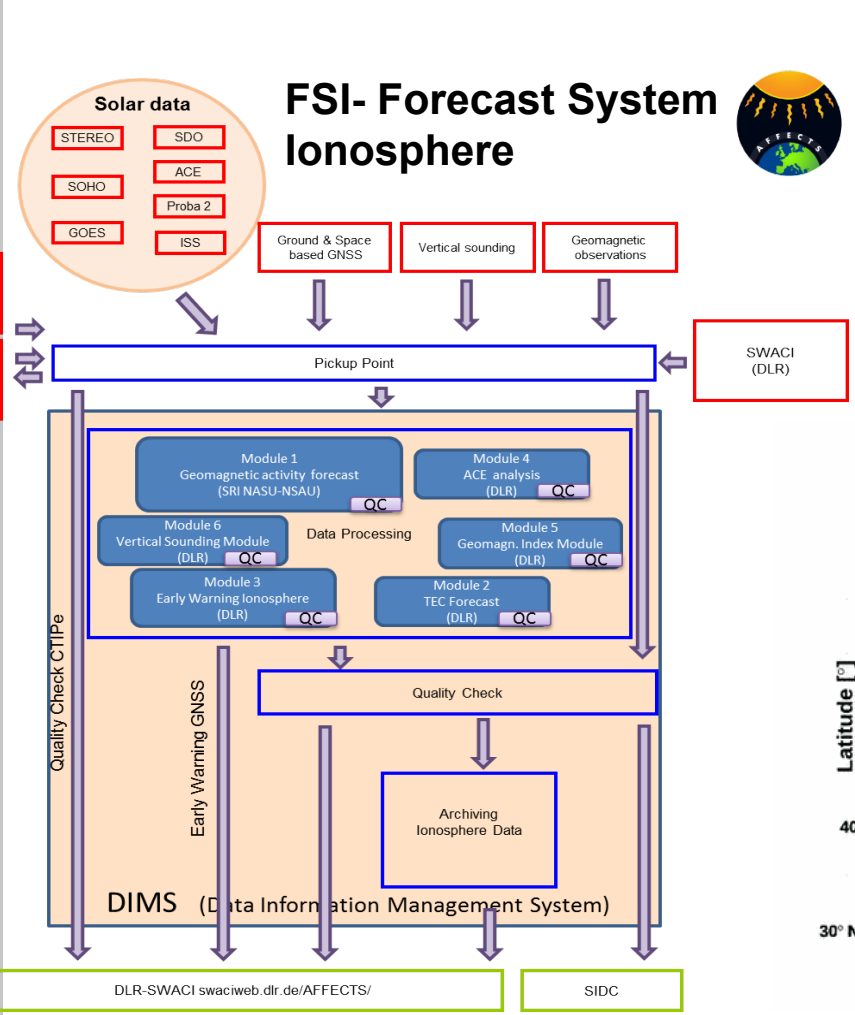


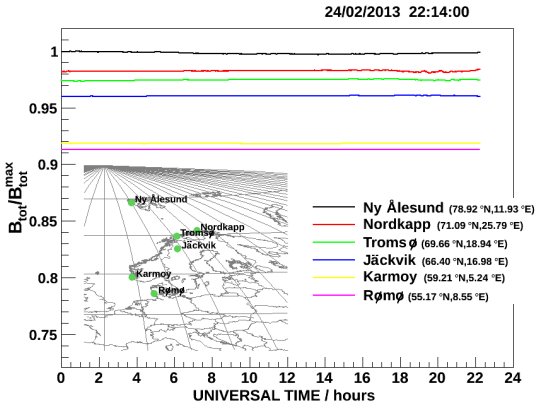
Oval ambigous, variation less than 40 nT

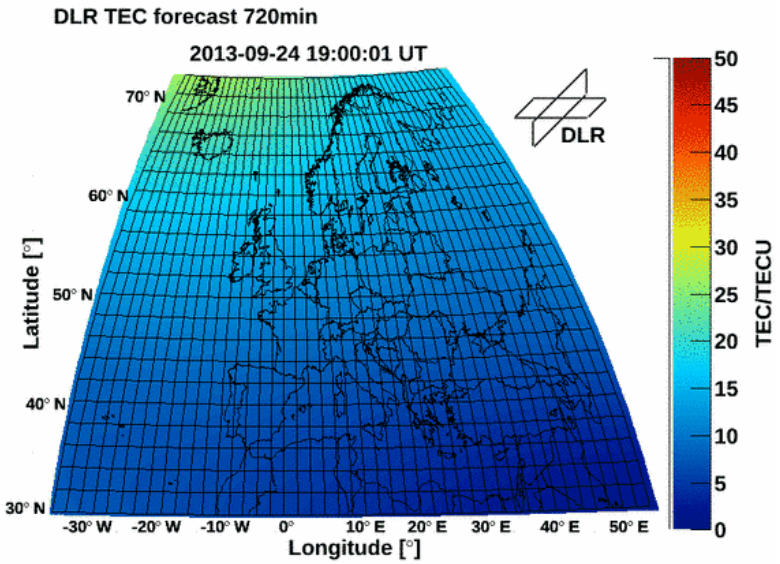


Data time stamp: 30/09/2013 15:23:00

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







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

Main Achievements (1/3)

- Subscription services for ROB and NOAA-SWPC space weather alerts established, including AFFECTS developments (e.g., RSS-alerts).

- Generation of early warnings established – messages sent to DLR and from DLR to GNSS beta testers.

- Near real time data analysis routines (e.g., GCS, CAT, Solar Daemon, STAFF) designed and implemented for CME and flare analysis (source region, topology, direction of propagation, mass estimate, speed, flare intensity).

- CME evolution and forecast routines (BHV method, Cactus) developed/implemented

  - to use derived CME parameters as input to calculate arrival time of CME (and shock) at Earth.
  - to forecast based on dedicated solar wind, geomagnetic and GNSS data analysis the space weather impacts (Kp, GNSS error are generated, CME speed, Bz).

Main Achievements (2/2)

- Updated warning message for CME arrival time at Earth and expected impact parameters (Kp, GNSS error, aurora) is generated for major events to subscribed users within 1-2 hours after storm onset and posted at AFFECTS website.

- CME tracked to Earth with STEREO based on jmap-technique developments.

- ENLIL modeling (cooperation with NOAA-SWPC, http://www.swpc.noaa.gov/wsa-enlil/, and NASA/GSFC).

- CME arrival at L1 and its key parameters are measured by ACE in NRT. RSS-alerts based on solar wind changes, latitude of auroral oval, Kp values and GNSS errors are distributed on average 1-2 minutes later. Can be received by mobile devices. See AFFECTS “Services”.

Main Achievements (3/3)

- Geomagnetic forecast implemented in FSI.
- TEC forecast is provided by DLR through the SWACI website, available through “Services” at AFFECTS website.
- Auroral Electrojet Tracker established, available through “Services” at AFFECTS website.
- “STAFF Viewer” developed and implemented.
- Definition of an EUV-TEC index for use in the FSI system.
- Joint CTIPe modeling evelopment, comparison and validation by DLR, NOAA-SWPC.

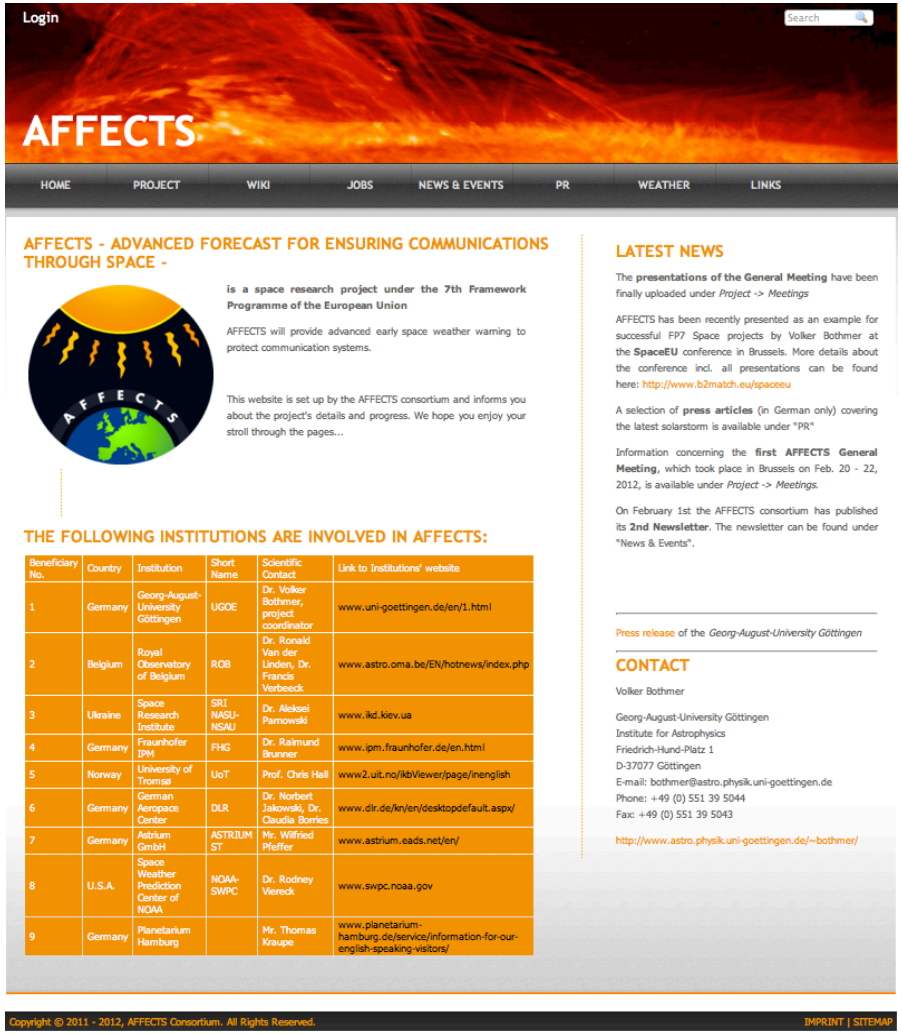
Expected Final Result

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

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)

AFFECTS Website - www.affects-fp7.eu

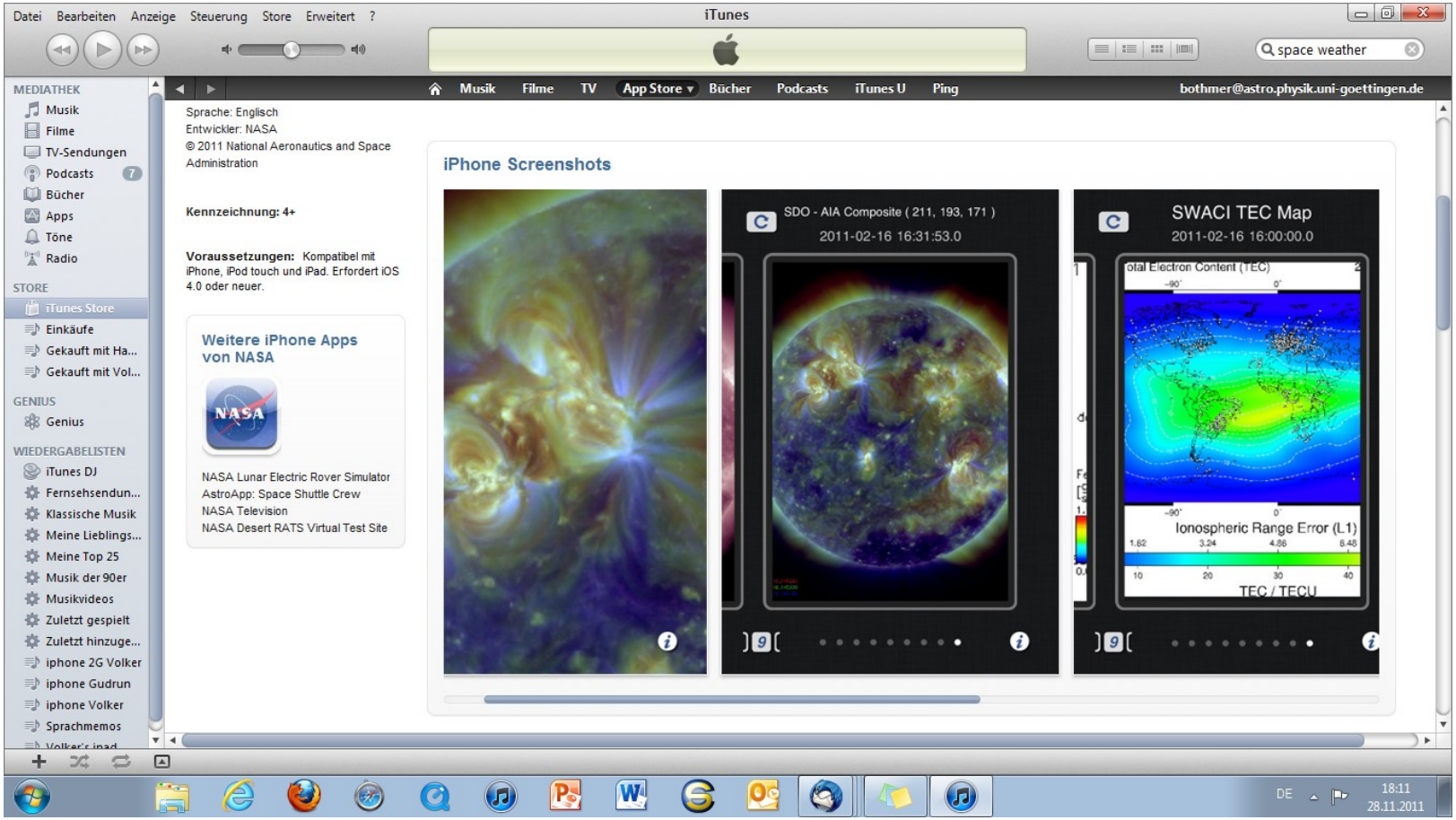


- Website includes Wiki engine

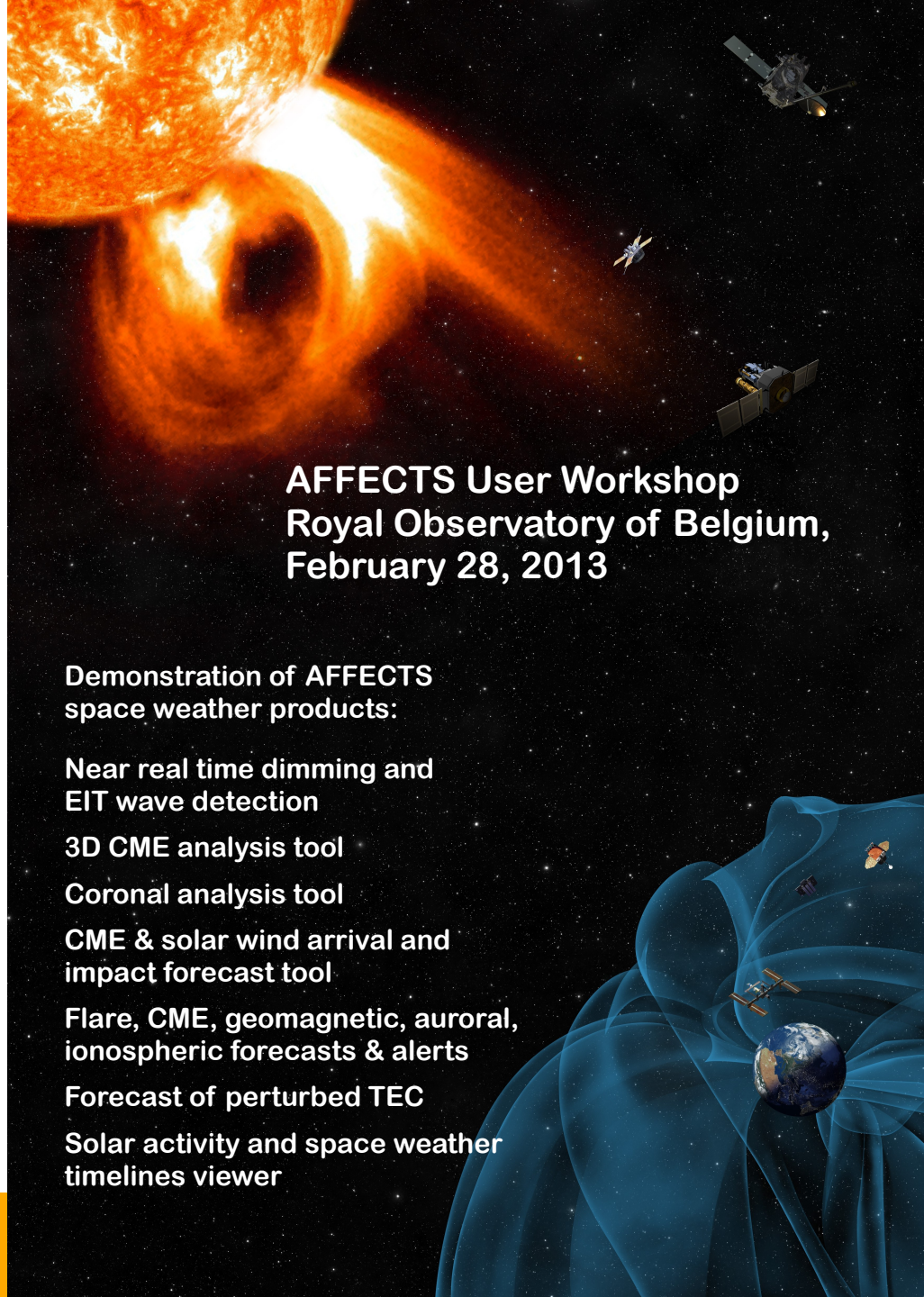
Provides

- 3 monthly AFFECTS Newsletter
- PR Material (Trailer, press releases, meeting reports)
- Weather reports and alerts
- Space Weather services
- Links to partner sites and other useful resources

NASA Space Weather Apps



AFFECTS International User Workshop



L1 Alert Poster

AFFECTS FP7 REA

L1 Solar Wind, Kp, Aurora and GNSS Error Alerts

Venzmer, Malte[1]; Bothmer, Volker[1];
Hesemann, Jonas[1]; Bosman, Eckhard[1]

[1] Institute for Astrophysics, University of Göttingen, GERMANY

Institut für Astrophysik Göttingen

0 Overview

Short-time warnings of severe space weather effects are provided via RSS feeds.Panel 1 covers the used solar wind data, panel 2 explaines RSS feeds and the other four handle the different RSS feed alerts:

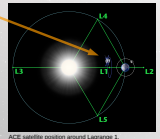
- L1 Solar Wind Alert (established)
- L1 Kp Alert (preliminary)
- L1 Aurora Alert (preliminary)
- L1 GNSS Error Alert (in progress)

1 L1 ACE solar wind data

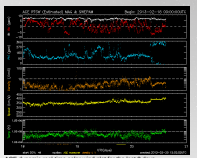
The Advanced Composition Explorer (ACE) spacecraft is positioned at the Lagrange 1 point (L1) since its launch in 1997 by NASA.

In-situ solar wind parameters allow short-term forecast (~15 min):

- ~3 minutes data delay to availability at SWPC server
- L1 to Earth travel time 12 - 60 min depending on speed (2000 - 400 km/s)



ACE satellite position around Lagrange 1.
Credit: NASA/H. Zell


ACE dynamic real-time solar wind plot for the last 3 days.
Credit: SWPC/NOAA

The real-time data is provided online. The instruments MAG and SWEPAM aboard ACE measure the following solar wind parameters:

- Magnetic field strength
- Magnetic field orientation
- Proton density
- Bulk speed
- Ion temperature

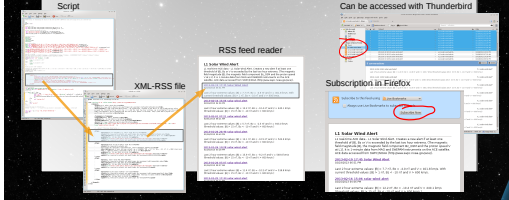
Real-time data available from SWPC/NOAA:
http://www.swpc.noaa.gov/ftpmenu/lists/ace.html

2 RSS feeds

RSS icon

Rich Site Summary (RSS) web feeds are used to publish frequently updated news. Their standardized XML file format can be viewed by many different feed readers like mobile apps, browsers or email-clients. The RSS reader automatically checks the user's subscribed feeds regularly for new content and allows users to avoid manually inspecting all of the websites they are interested in.

For the provision of the RSS feeds a script is running on our server. It frequently (5 min) downloads and processes ACE real-time data. A XML-RSS file is produced, which can be read by feed readers.



3 L1 Solar Wind Alert

RSS feed: L1 Solar Wind Alert

This feed creates a new alert if thresholds of specified solar wind parameters are exceeded. It uses like all L1 alerts 1-minute real-time data from ACE.

With the actual threshold values (|B| = 15 nT, Bz = 10 nT and V = 600 km/s) 31 warnings were triggered since September 2012.

Example warning:

4 L1 Kp Alert

RSS feed: L1 Kp Alert

Extreme solar wind affects the Earths magnetosphere. Kp is a geomagnetic disturbance index, introduced by Bartels in 1948 at the Institute for Geophysics, Göttingen University.

This feed provides warnings of possible strong Kp conditions. It creates a new alert if the estimated Kp exceeds a specified threshold.

Since October 2012 there were no alerts (threshold: Kp = 7-).

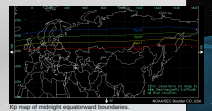
Example warning:

5 L1 Aurora Alert

RSS feed: L1 Aurora Alert

The equatorward auroral boundary position correlates with the Kp index. The auroral position is derived via an estimated Kp index from L1 solar wind data.

The current threshold is 52.2° geomagnetic latitude, which gave no alerts since January 2013.


Kp map of midnight equatorward boundaries.
Credit: NOAA/SEC Boulder CO

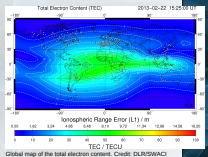
Example warning:

6 L1 GNSS Error Alert

RSS feed: L1 GNSS Error Alert

Global navigation satellite systems (GNSS) have positioning errors. The ionospheric part of this error (up to ~30 m) scales with the Total Electron Content (TEC) of the ionosphere.

TEC data of strong Kp storms is provided by DLR and data evaluation that leads to a RSS alert is in progress.



Global map of the total electron content. Credit: DLR/SWACI

Links to RSS alerts

L1 Solar Wind Alert
www.astro.physik.uni-goettingen.de/~mvenzmer/rssfeed/rssfeed.xml

L1 Kp Alert
www.astro.physik.uni-goettingen.de/~mvenzmer/rssfeed_kp/rssfeed_kp.xml

L1 Aurora Alert
www.astro.physik.uni-goettingen.de/~mvenzmer/rssfeed_aurora/rssfeed_aurora.xml

Contact details

Malte Venzmer

Institute for Astrophysics
University of Göttingen, Germany

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mvenzmer@astro.physik.uni-goettingen.de

Acknowledgement

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CME Parametrization Poster

AFFECTS FP7 REA

How to parametrize a CME with the GCS Model

E. Bosman, V. Bothmer, J. Hesemann, M. Venzmer
University of Göttingen, GERMANY

Introduction

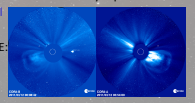
Since launch of the STEREO twin spacecraft in October 2006, 1071 large-scale flux-rope like CMEs were identified in STEREO/SECCHI/COR2 observations between January 2007 and December 2011. This presentation illustrates how the 3D structure of typical flux-rope like CMEs can be parameterized in real-time based on STEREO/SECCHI/COR2 beacon and/or science data with the GCS Forward-Modeling Technique developed by Thernisien et al. for flux-rope CMEs.
The results are used as input for the forecast of space storms at Earth's orbit by ENLIL and other models.

Software Installation

1. IDL (www.exelisvis.com) Installation on Linux 32/64bit
2. Installation of SolarSoft
   SSW: www.lmsal.com/solarsoft/ssw_install_howto.html [*]
3. Installation of SolarSoft Database
   SSWDB: www.lmsal.com/solarsoft/sswdb_install.html
4. Setting SSW Environment for IDL (described here [*])
5. Start IDL with SSW:
   $ sswidl
   $ rtsccguicloud,/demo

CME Detection

1. Detection of CME on 12.03.2011 in COR2 synoptic movies at:
   http://secchi.nrl.navy.mil



2. UTC Time t_0 without CME:
   2011-03-11 @ 20:08:15
   UTC Time t_1 with CME:
   2011-03-12 @ 05:08:15
   (for Beacon-Data)

3. Required Data:
   t_0 : 3x COR2A, 3x COR2B FTS files 1x EUVI-A, 1x EUVI-B FTS file
   t_1 : 3x COR2A, 3x COR2B FTS files 1x EUVI-A, 1x EUVI-B FTS file

Data Acquisition

Websites:

SCC: Solar Science Center @NASA
http://stereosc.nascom.nasa.gov/data/ins_data/secchi/L0/a/seq/cor2/
Science Data

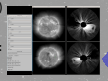
http://stereo-ssc.nascom.nasa.gov/data/beacon/ahead/secchi/cor2/
Beacon Data

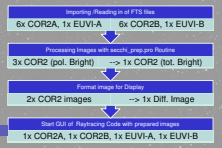
NRL: Naval Research Laboratory, STEREO - Payload Operation Center
http://sharpp.nrl.navy.mil/cgi-bin/swdbi/secchi_flight/img_short/form
Science and Beacon Data

Data Processing - Overview

For Modeling with Science and/or Beacon data a Tutorial is available on:
http://secchi.nrl.navy.mil/synomaps/scray trace/dobo/examples.html#tutrtsccguicloud
(with IDL Code example)

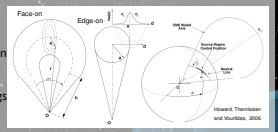
GUI of Raytracing Code:





GCS Model

Model Parameter and Electron density distribution:



2α : Angle between both legs
h : Height of the legs
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h_{front} : Distance between O (sun center) & leading edge
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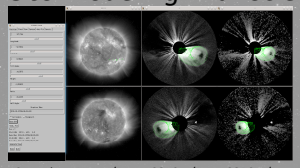
Φ : Longitude **θ** : Latitude

GCS Modeling with Science/Beacon data



Control Panel | EUVI-A/B at 195 Å | COR2-A/B fit with science data | COR2-A/B fit with beacon data

1. Set all Parameters to Zero and *Height* to ≈10 r_{sun}.
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3. Fit *Aspect Ratio* to describe the spatial extension of the CME.
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GCS-Parameter	Value*
Carrington Lon. [deg]	177.8
Heliosph. Lat. [deg]	-17.3
Tilt Angle [deg]	8.4
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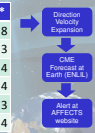

Generating several fits in a time sequence allows speed determination and CME evolution for a better CME forecast.
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Contact details:

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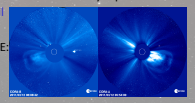

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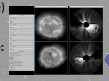

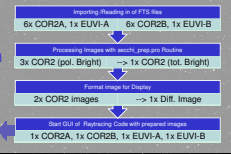

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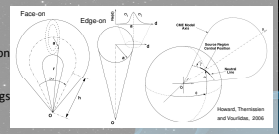

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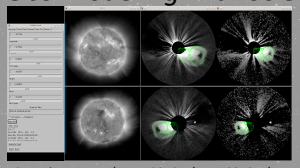

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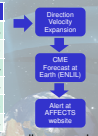

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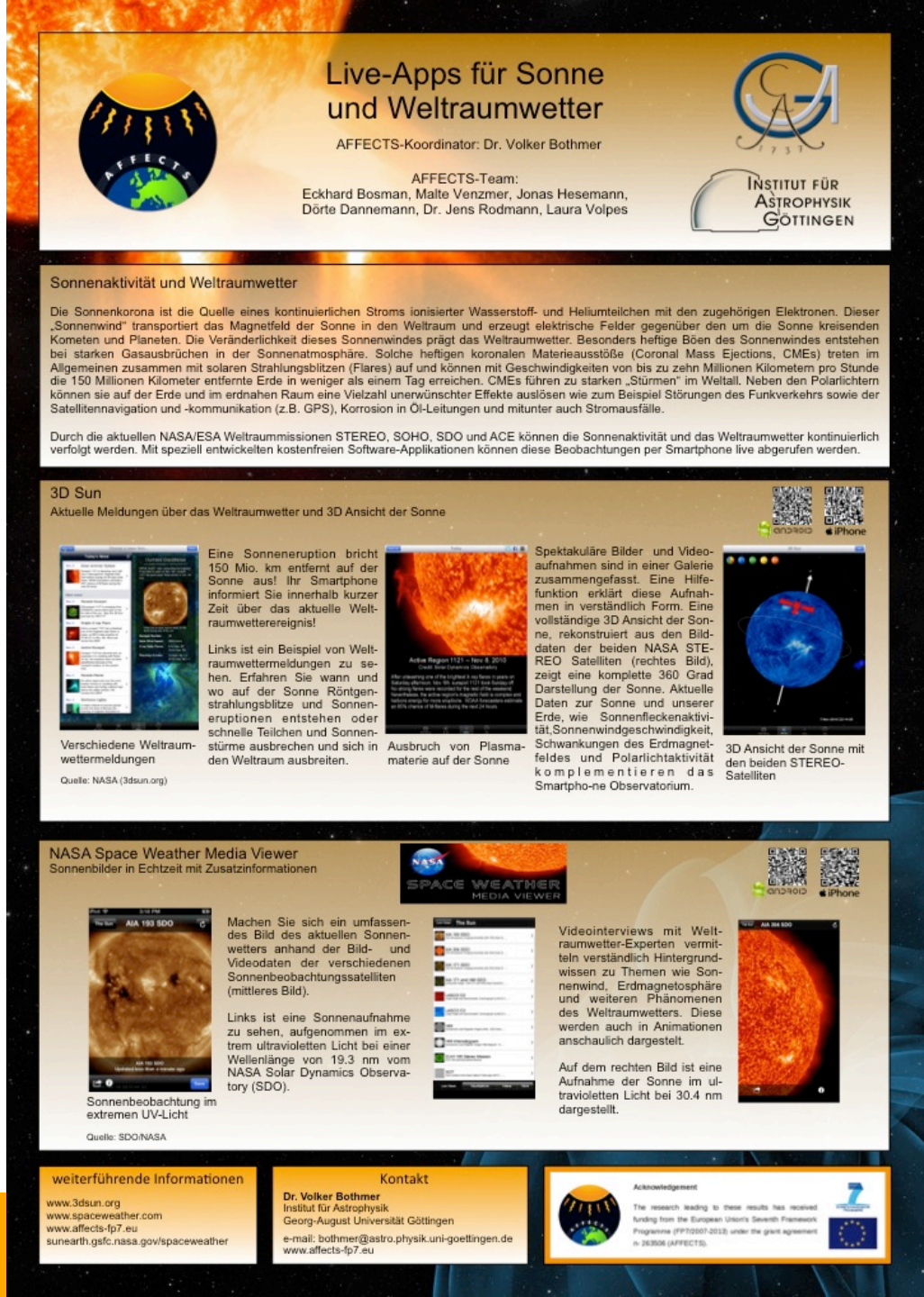
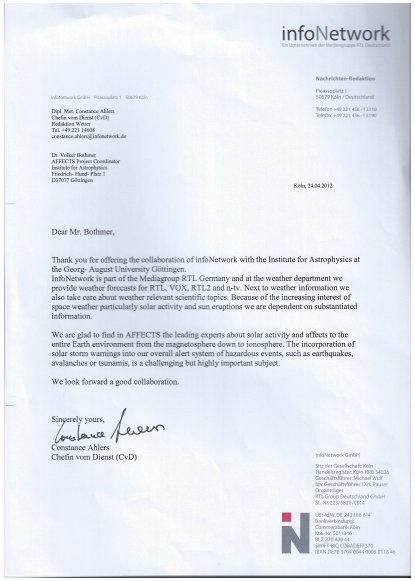
Space Weather App Poster



Sample Forecast for Individuals


infoNetwork

Nachrichten-Redaktion

Dipl. Met. Constance Ahlers
Chefin vom Dienst (CvD)
Redaktion Wetter
Tel. +49 221 14608
constance.ahlers@infonetwork.de

Dr. Volker Bothmer
AFFECTS Project Coordinator
Institute for Astrophysics
Friedrich- Hund- Platz 1
D37077 Göttingen

Köln, 24.04.2012

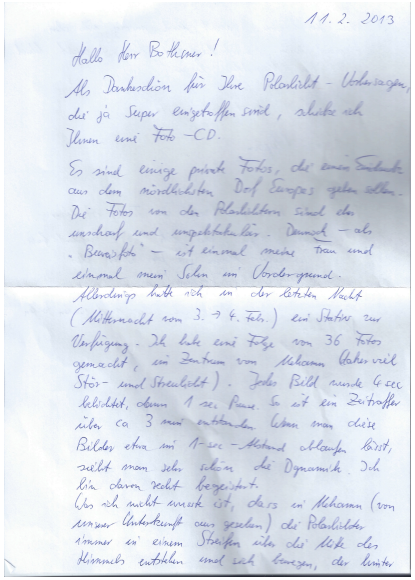
Dear Mr. Bothmer,

Thank you for offering the collaboration of infoNetwork with the Institute for Astrophysics at the Georg- August University Göttingen.
InfoNetwork is part of the Mediagroup RTL Germany and at the weather department we provide weather forecasts for RTL, VOX, RTL2 and n-tv. Next to weather information we also take care about weather relevant scientific topics. Because of the increasing interest of space weather particularly solar activity and sun eruptions we are dependent on substantiated information.

We are glad to find in AFFECTS the leading experts about solar activity and affects to the entire Earth environment from the magnetosphere down to ionosphere. The incorporation of solar storm warnings into our overall alert system of hazardous events, such as earthquakes, avalanches or tsunamis, is a challenging but highly important subject.

We look forward a good collaboration.

Sincerely yours,
Constance Ahlers
Chefin vom Dienst (CvD)


11. 2. 2013

Hallo Herr Bothmer !

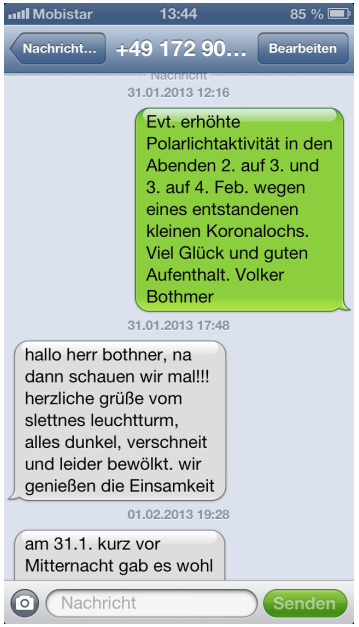
Als Dankeschön für Ihre Polarlicht - Vorhersage, die ja Super eingetroffen sind, schicke ich Ihnen eine Foto -CD.

Es sind einige private Fotos, die einen Studenten aus dem nördlichsten Dorf Europas gefallen sollen. Die Fotos von den Polarlichtern sind die unscharf und unbrauchbar. Dennoch - als „Beweisfoto" - ist einmal mein Frau und einmal mein Sohn im Vordergrund.

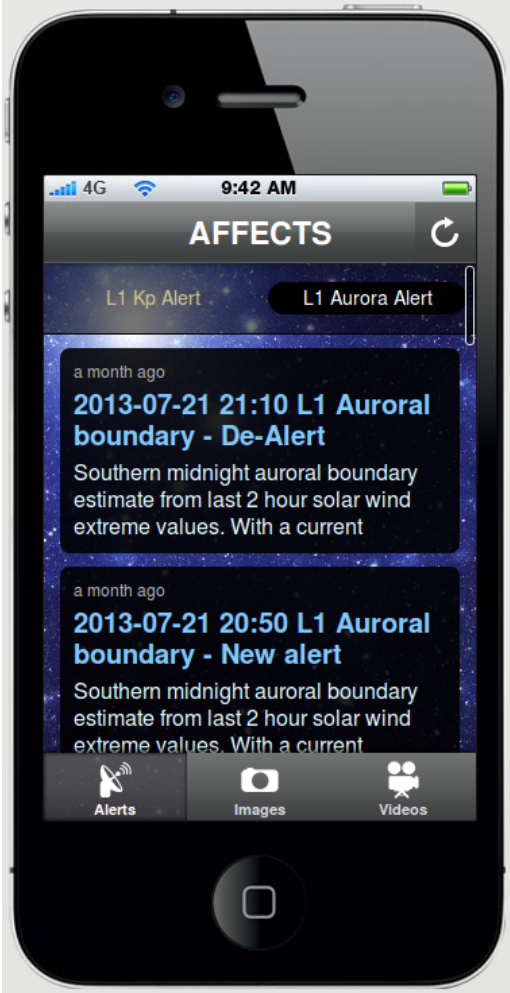
Allerdings habe ich in der letzten Nacht (Mitternacht von 3. → 4. Feb.) eine Sichtung zur Verfügung. Ich habe eine Folge von 36 Fotos gemacht, ein Zentrum von Nikamm (sehr viel Stör- und Streulicht). Jedes Bild wurde 4 sec belichtet, dann 1 sec Pause bis es ein Zeitraffer über ca 3 min entstanden. Wenn man diese Bilder etwa im 1-sec - Abstand ablaufen lässt, sieht man sehr schön die Dynamik. Ich bin davon recht begeistert.

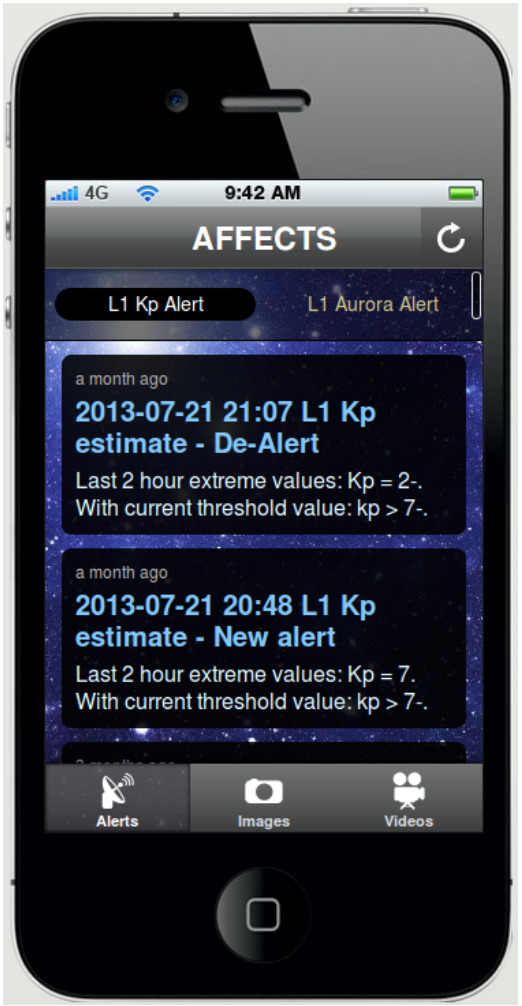
Wie ich mehrt weiß ist, dass in Mehamn (von seiner Unterkunft aus gesehen) die Polarlichter immer in einem Streifen über die Nacht des Himmels entstehen und sich bewegen, der bunte

SMS Aurorae Test-Service

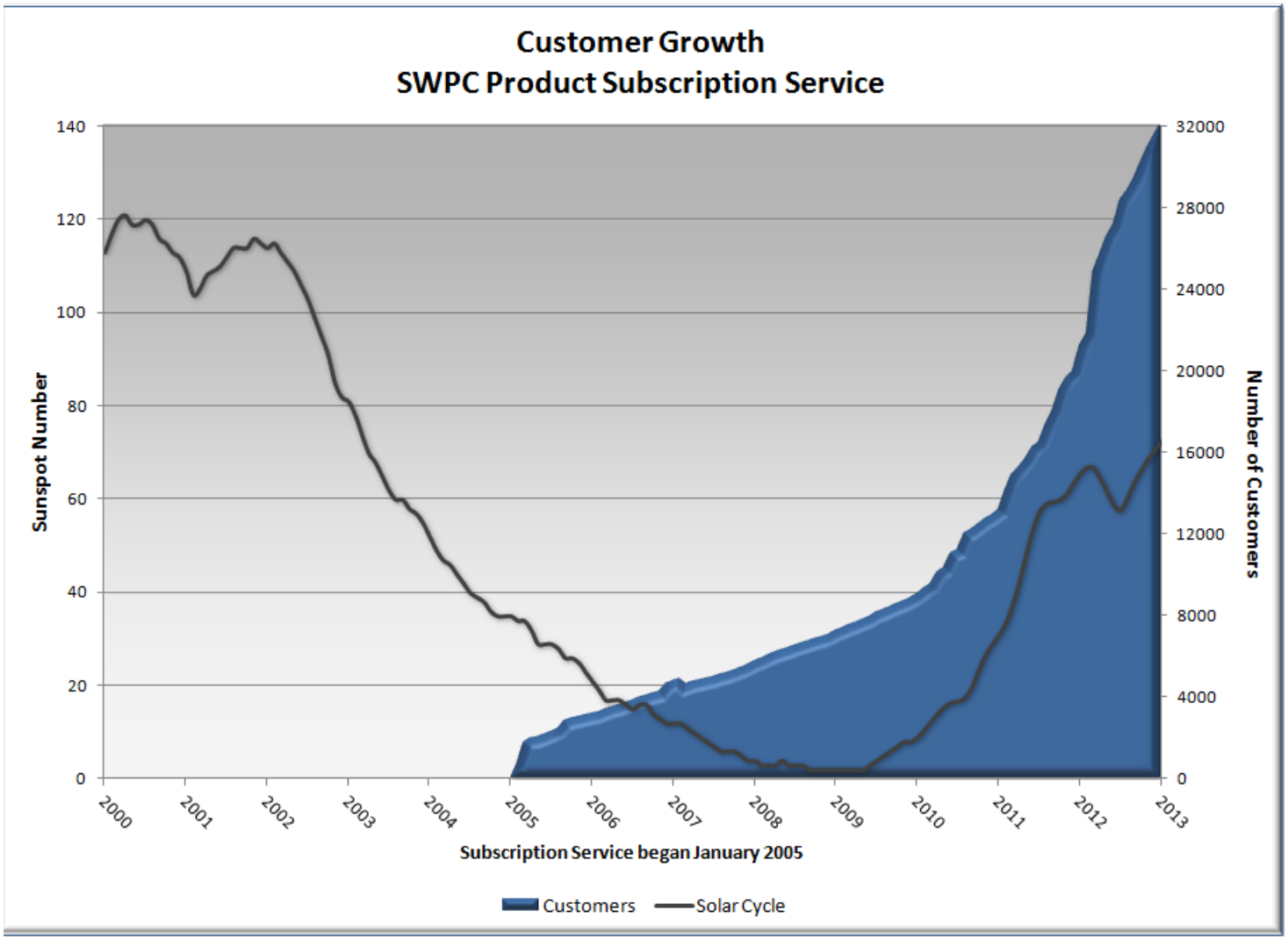


Space Weather App - Demo

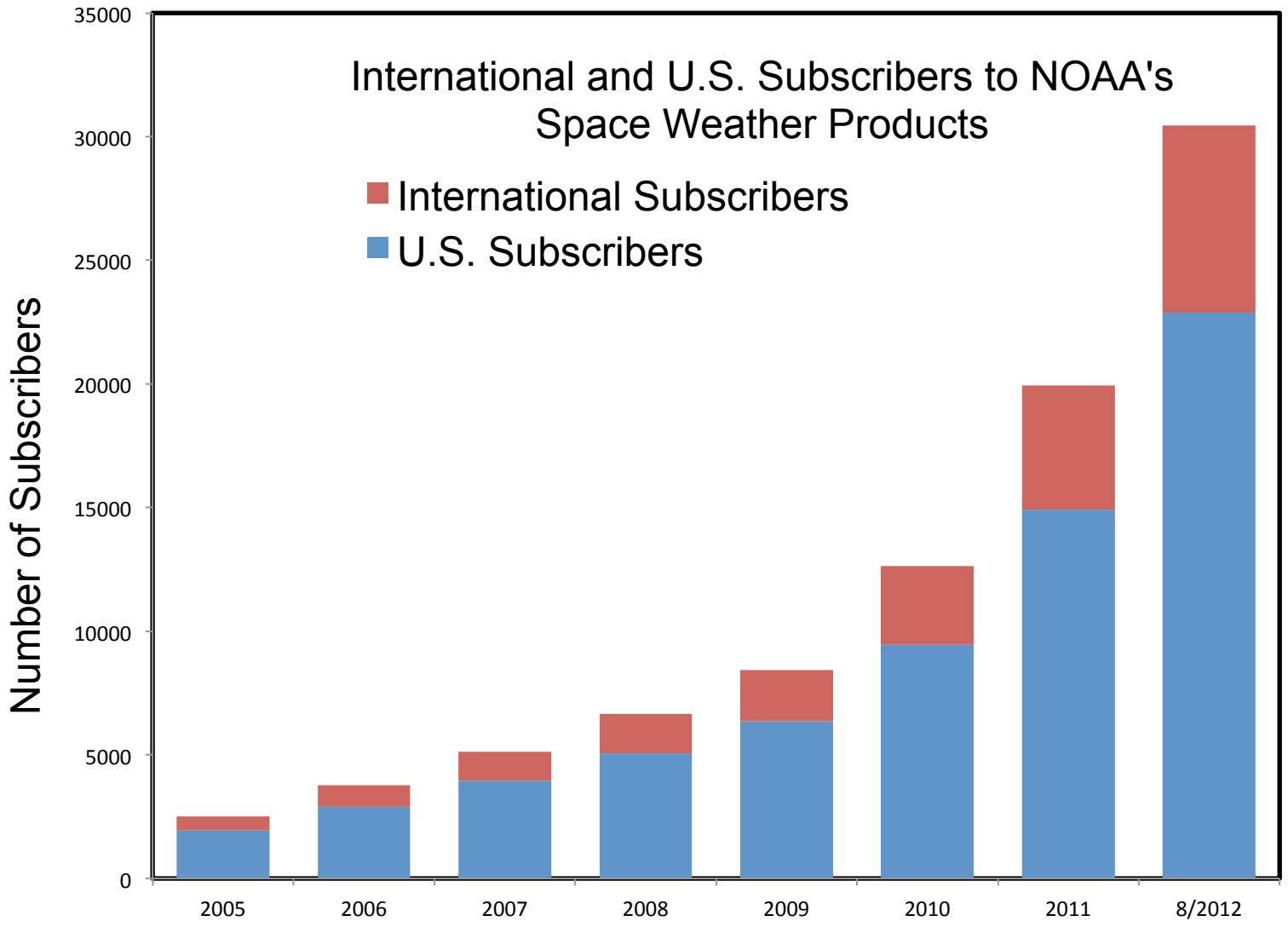




Growing Number of End Users (e.g., NMA, Axio-Net, Fugro, etc.) and feedback (e.g., AFFECTS User WS)



Subscribers



SWx Customers (A Sample)

Airlines	Surveying and Mapping	Electric Power	Satellites
Aer Lingus	AE & E Trucking, Etc., LLC	Allegheny Power	Lucent Technologies
Air Canada	AEI-CASE Engineering	Ameren Corporation	AeroMap U.S.
Air China	Airmag Surveys	Bechtel Nevada	Aerospace Corporation
Air Europa	Associated Engineers, Inc	Bonnevill Power Administration	Alcatel Space
Air Line Pilots Association	Athens Group (oil & gas)	Central Maine Power	American Space Culture Foundat
Air New Zealand	Baker Hughes (drilling)	Cleco Power LLC	AMSAT-France
AirMed Inc.	Banks		
Airservices Australia	Barr E		erospace
Alaska airlines	Benne		g
Allied Pilots Association	Black		dian Space Agency
ALPA Japan	Carve		a Space Surveillance Centre
American Airlines	Christ		Globe
American Eagle airlines	Clarid		tar
American Trans Air	Consu		n Reconnaissance Systems
Boeing / Flight Test	DGR (		al Dynamics C4S
British Airways	Diamo		sat
Bushmail	Earth		at
Cathay Pacific Airway	Easter		pace Systems Division
Continental Airlines	Excel		Aerospace Exploration Agency
Emirates	Geocc		ommunications
FedEx	GeoL		eed Martin
German ALPA	Global		Skynet
Icelandic ALPA	GRW		hay Satellite Corporation
Irish Aviation Authority	Halcy		Space Science Systems, Inc.
Jet Aviation Business Jets	J. D. E		AT Info
korean air	Johns		kies Satellites
Lufthansa	Jones		pace Technology
Lufthansa Cargo	marine R/D Survey	Puget Sound Energy	North Star Data
Northwest Airlines	NC Geodetic Survey	Soreq NRC	Northrop Grumman
Oslo Lufthavn AS	Nexen Inc. (oil)	Swedish Geological Survey	Oceaneering Space Systems
Qantas Airways	NOVA Engineering & Consulting, Int'l.	Texas-New Mexico Power	Omnistar, Inc.
Raytheon Aircraft Co.	NYS Professional Engineer	Transpower NZ Ltd	ORBCOMM
SCTA	Old Dominion Freight Lines	US NRC	Orbital Sciences Corp
SkyWest Airlines	Olson Trucking	We Energies	PT Asia Cellular Satelitte
Sun Country airlines	Oxy (oil & gas)	Western Area Power Admin.	Raytheon
Sundt air (Norway)	Pape-Dawson Engineering		Rockwell Collins, Inc.
Swales Aerospace	PGS Onshore		SES Americom
United Airlines	Planning Consultants, Inc.		SES ASTRA
APLA, Argentina	Portland Natural Gas Transmission		Sirius Satellite Radio
ATA Airlines	Raymac Surveys		Skyway, Inc.
NetJets	Schlumberger Drilling & Measurements		Space Engineering Development
North American Airlines	Seelye		Space Imaging

- **Every Major Airline (world wide)**
- **Every Major US Power Company**
- **Every Major Satellite Company (world wide)**
- **US Federal Agencies**
  - **Department of Defense.**
  - **NASA**
  - **Department of Energy**
  - **Department of Homeland Security**
  - **Federal Aviation Administration**

- **32,000 Specific Customers**
- **15 – 20 Million Web Hits a day**

Cooperation with other projects (1/3)

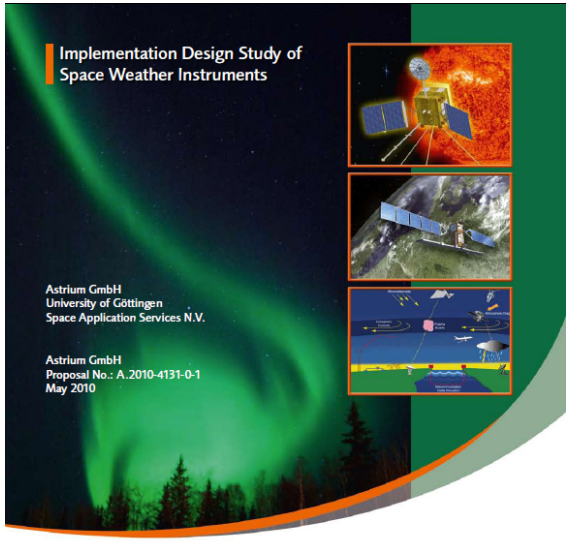
- Forecast of solar wind speed and geomagnetic activity (UGOE with UGraz COMESEP team (M. Temmer, A. Veronig).
- ESA SN-II study – Implementation Design Study of Space Weather Instruments (UGOE, Astrium Satellites).
- ILWS (UGOE with D. Odstrcil as PI, ENLIL data driven modeling).
- NRI NASU-NSAU in “Resonance” (Russia) project through forecast of ULF geomagnetic pulsations and in “Ionosat” project (Ukraine).

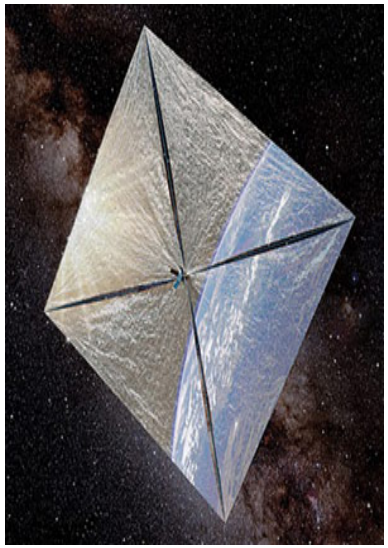
Cooperation with other projects (2/3)

- Partners follow internationally shared data and model strategy (ESA-ESTEC, Korean RRA, Rosh Hydromet, UK Met Office, RWC Tokyo, UK Met Office, Australia IPS).
- Definition of an EUV-TEC index for use in the FSI (FHG with University of Leipzig).
- Analysis of EUV data products (FHG with LASP, Boulder - Space Environment: SDO, California, UCL: SOHO/SEM - PMOD, CH), LATMOS.
- Investigation of magnetic connection oinfluence on SEPn events (UGOE in eHEROES consortium).

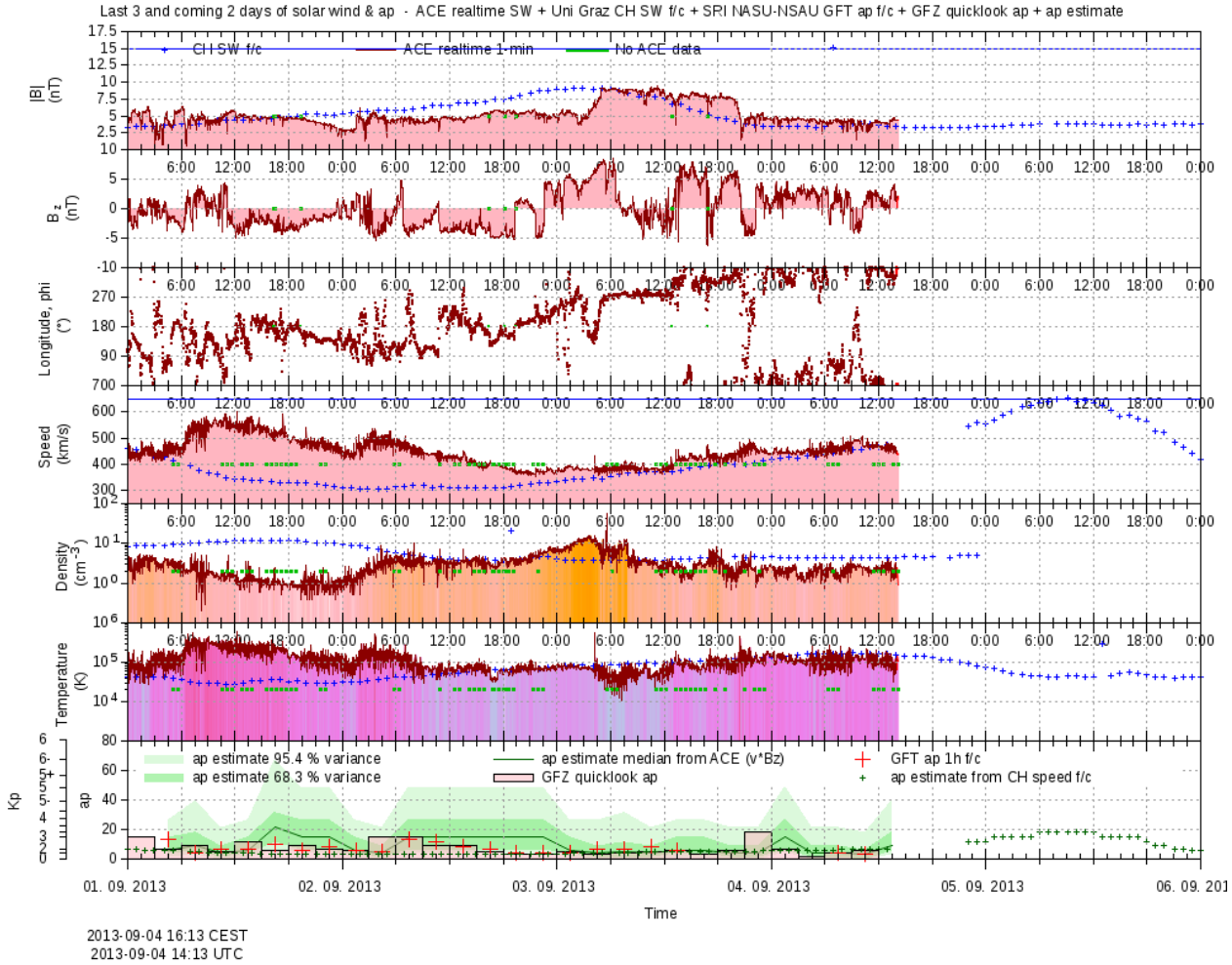
Cooperation with other projects (3/3)

- Increase of storm warning time and impact mitigation (UGOE in DLR, ESA Solar Sail WG).





NRT Forecast



Ideas for exploitation and way forward

Space weather is global and therefore, requires global participation and coordination to address the growing needs of customers and the services they require. Future projects shall therefore address:

- Test-bed studies to improve and further validate the developed space weather early warning system and its services and products with emphasis on data-driven modelling.
- Development of the prototype space weather early warning system into a long-term operational facility and support of the ESA SSA program, including international collaborations.
- Optimisation of the services and products for the end users, scientific community and general public and for use in future space weather projects and missions.

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

AFFECTS

Advanced Forecast For Ensuring Communications Through Space

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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