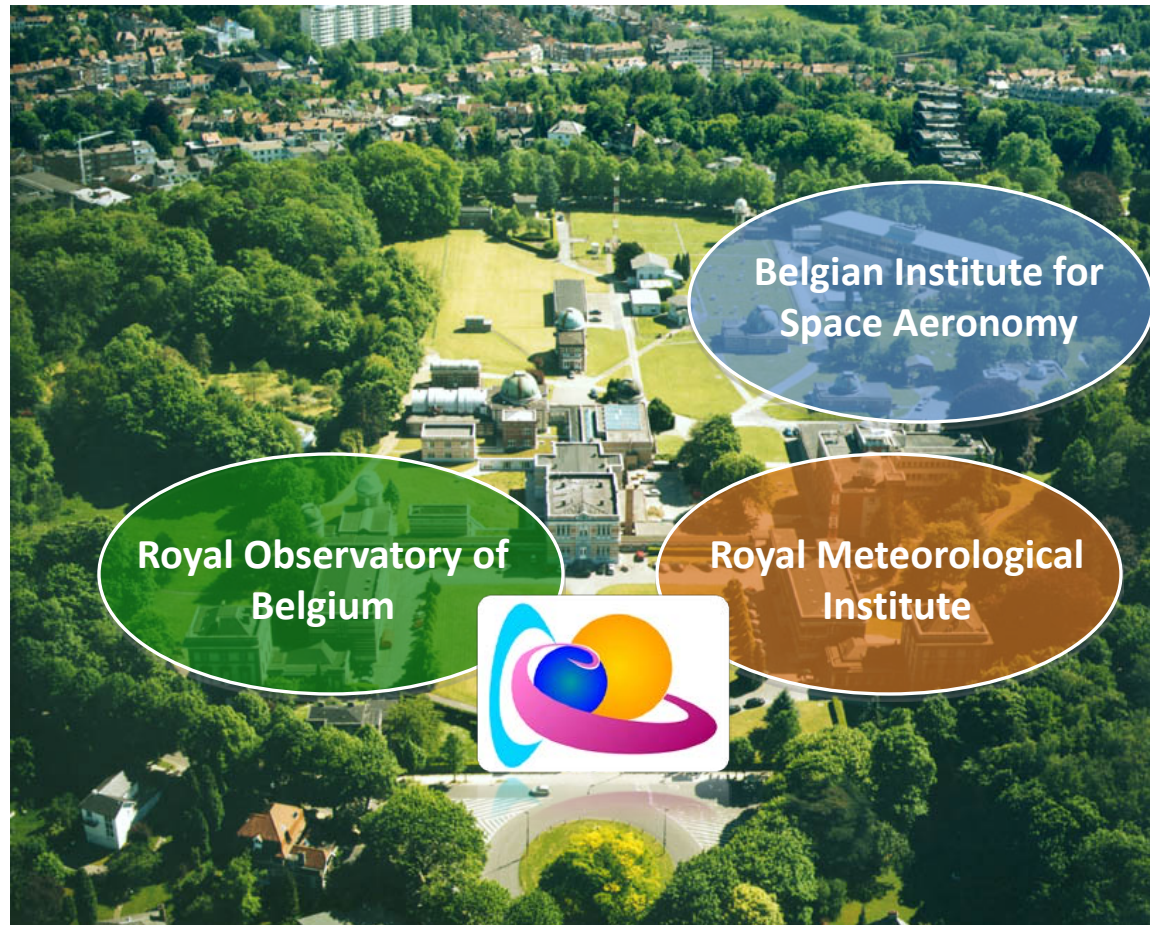


Space Weather Data and Services at RWC Belgium

Cis Verbeeck on behalf of the RWC team

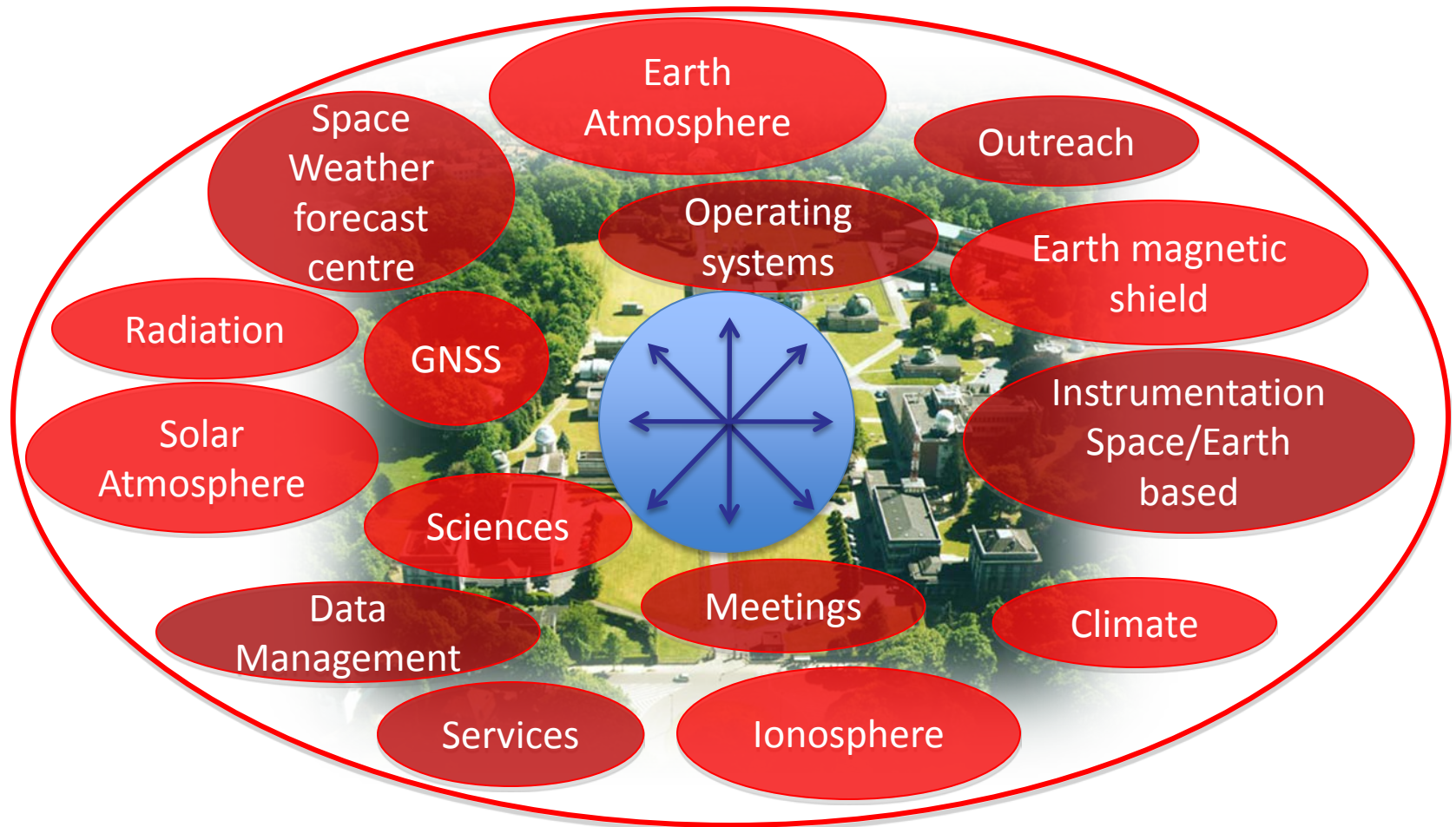


Solar-Terrestrial Center of Excellence



From Sun to Earth

Broad support – in house expertise

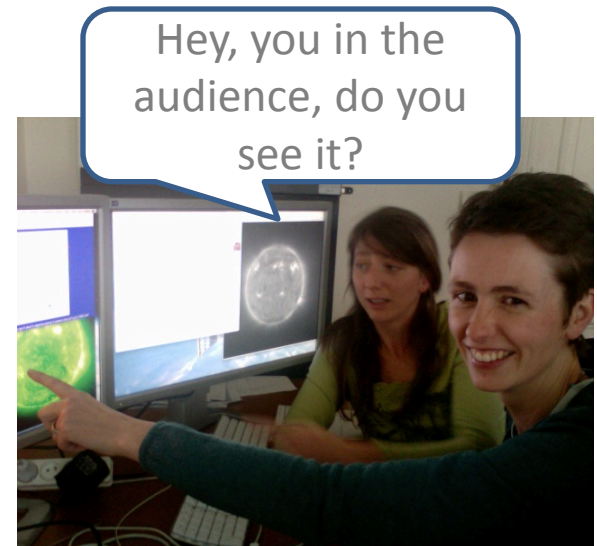
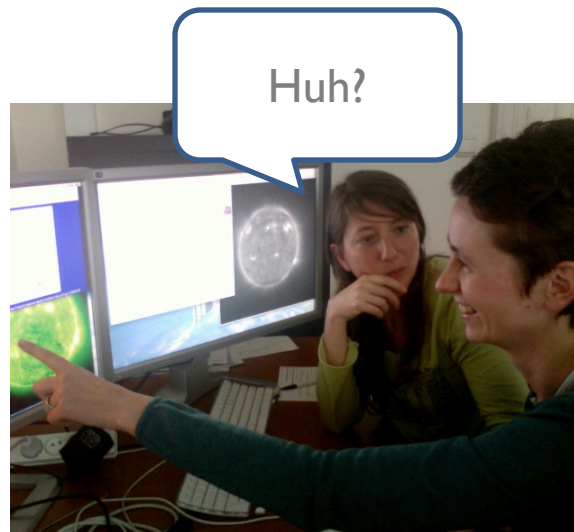
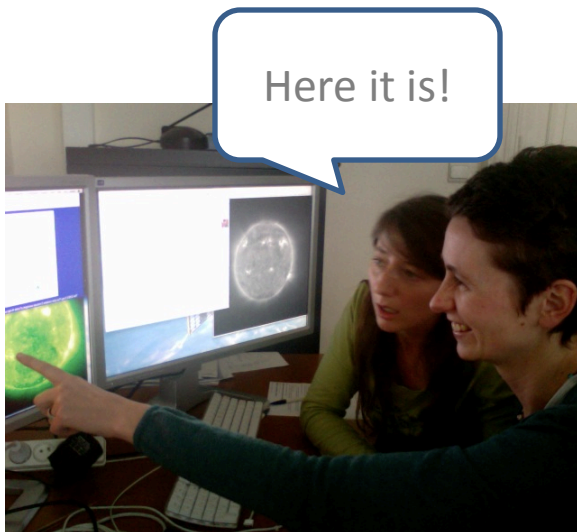
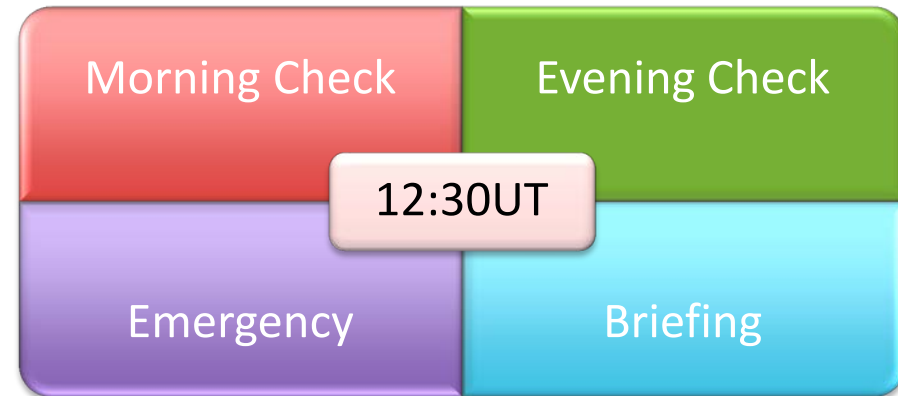


Internal support

Space Weather Forecasting

Space Weather Forecasting

- RWC Belgium since 2000
- Team of 10 forecasters
- Duty cycle of 1 Week
- 16/24h human monitoring
- Weekly briefing



Necessity of a team

What do we forecast?

- Flares:
 - large and sudden release of energy in the solar atmosphere
 - several classes of flares: C, M and X-flares
 - estimate probability: <50% C, >50% C, >50% M, >50% X-flares
- K-index:
 - overall geomagnetic activity
 - forecast over 3 days in intervals of 3 hours
 - ranges from 0 to 9
- Proton events
- F10.7:
 - solar radio flux at 10.7cm
 - forecast over 3 days

Products & services

Daily Space Weather bulletin

```
:Issued: 2010 Dec 07 1233 UTC
:Product: documentation at http://www.sidc.be/products/men
#-----#
# DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC
# (RWC Belgium)
#-----#
SIDC URSIGRAM 01207
SIDC SOLAR BULLETIN 07 Dec 2010, 1222UT
SIDC FORECAST (valid from 1230UT, 07 Dec 2010 until 09 Dec 2010)
SOLAR FLARES : Quiet conditions (<50% probability of C-class flares)
GEOMAGNETISM : Quiet (A<20 and K<4)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 07 Dec 2010 10CM FLUX: 089 / AP: 002
PREDICTIONS FOR 08 Dec 2010 10CM FLUX: 089 / AP: 004
PREDICTIONS FOR 09 Dec 2010 10CM FLUX: 090 / AP: 006
COMMENT: The large filament on the south-east side of the Sun has
erupted yesterday afternoon around 15:35 UT. This was clearly observed
in PROBA2/SWAP and SDO/AIA data. Also STEREO/A COR2 images show the
event, starting at 18:54 UT. The direction of the associated CME suggest
the impact of this event on the Earth will be limited. The CME speed as
measured by CACTUS is approximately 550 km/s.
We expect quiet solar conditions for the coming days. A shock in the
solar wind speed was observed by ACE yesterday due to a sector boundary
change. The solar wind speed is still low around 380 km/s. There may be
unsettled geomagnetic conditions towards the end of the forecasting
period due to a recurrent coronal hole wind stream.
```

Daily @12:30UT

Email

Fixed format – software readable

Free and Complete information

Fast & automated alerts

```
:Issued: 2010 Mar 14 1304 UTC
:Product: documentation at http://www.sidc.be/products/presto
#-----#
# FAST WARNING 'PRESTO' MESSAGE from the SIDC (RWC-Belgium)
#-----#
A halo CME starting most probably from NOAA AR 11054 (there is an EIT
data gap that prevents more definitive conclusions) have been seen on
LASCO-C2 at 01:31 UT, it is a fast one according to CACTUS (1656 km/s).
It is expected to arrive to the Earth on March 17-18.
```

```
:Issued: 2007 Jun 04 0551 UTC
:Product: documentation at http://www.sidc.be/products/flaremail
#-----#
# Large flare alerts from the SIDC (RWC-Belgium), detected in GOES
# X-ray data
#-----#
A class X1.0 solar X-ray flare occurred on 2007/06/04 with peak time
05:13 UT
#-----#
# 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 information, see http://www.sidc.be. 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.
```

Flare

>M5

Email

Sms*

Presto

Noticeable
event

Email

Sms*

CME

>150
degrees

Email

NEW: AFFECTS machine readable
CME arrival alert

www.sidc.be

*since 2011

Monthly & weekly bulletins

- Provisional Sunspot Indices
- Medium-term forecast of sunspot index
- Table of Solar and Geomagnetic activity indices
- Table of noticeable events ($> M$ flare)
- Forecasts of returning major sunspot groups
- Solar and Geomagnetic Activity report:
a general description of the solar and
geomagnetic conditions during the month.
- If applicable: a “hot items” section
- STCE Newsletter

SIDC Product matrix

Mail header	SIDC code	format	Frequency	Source
PRESTO ALERT	presto	Plain text	ASAP, when needed	SIDC (RWC-Belgium)
Boumeuss	bms	Encoded data (ISES)	Daily	SEC (RWC-Boulder)
SIDC Indaa message	ind	Encoded data (ISES)	Weekly	SIDC (RWC-Belgium)
SIDC MAA message	maa	Encoded data (special format)	Weekly	SIDC (RWC-Belgium)
Indices K Canberra	kcan	Encoded data (ISES)	Weekly	Canberra (Australia)
INDICES K WINGST	wng	Encoded data (ISES)	Daily	Wingst (Germany)
SIDC Ionospheric Data	ion	Encoded data (ISES)	Daily	Lannion (France) and Ebre (Spain)
GEOALERT BOULDER	geo	Encoded data (ISES)	Daily	SEC (RWC-Boulder)
UMAGF Messages from Moscow	mos	Encoded data (ISES)	Daily	RWC Moscow
SIDC Ursigram	meu	Encoded data (ISES)	Daily	SIDC (RWC-Belgium)
SIDC Weekly Bulletin	bul	Plain text	Weekly	SIDC (RWC-Belgium)
Monthly Ri_hemispheric Report	ri_hemispheric	Plain text	Monthly	SIDC (RWC-Belgium)
Monthly Ri Report	ri	Plain text	Monthly	SIDC (RWC-Belgium)
SIDC Monthly Bulletin of Solar and Geomagnetic Activity	mobu	Plain text	Monthly	SIDC (RWC-Belgium)
SIDC-NEWS	qua	Plain text	Quarterly	SIDC (RWC-Belgium)
Indices K Hartland	khar	Encoded data (ISES)	Weekly	Hartland (UK)
SIDC ursigram	uge	Encoded data (ISES)	Daily	SIDC (RWC-Belgium)
Messages UMAGF	menv	Encoded data (ISES)	Daily	SIDC (RWC-Belgium)
GEOALERT SIDC	xut	Encoded data (ISES)	Daily	SIDC (RWC-Belgium)
SIDC ursigram	tot	Encoded data (ISES)	Daily	SIDC (RWC-Belgium)
Start/End of all quiet alert from the SIDC/RWC Belgium	quieta	Plain text	ASAP, when conditions warrant	SIDC (RWC Belgium)

Home

General info

Jobs and Students

Projects

Publications

Sunspots

Software

Educational

Local Solar

Observations

Space Weather

services

Real Time Data

Seminars

esww9



39.977733,-105.2749...

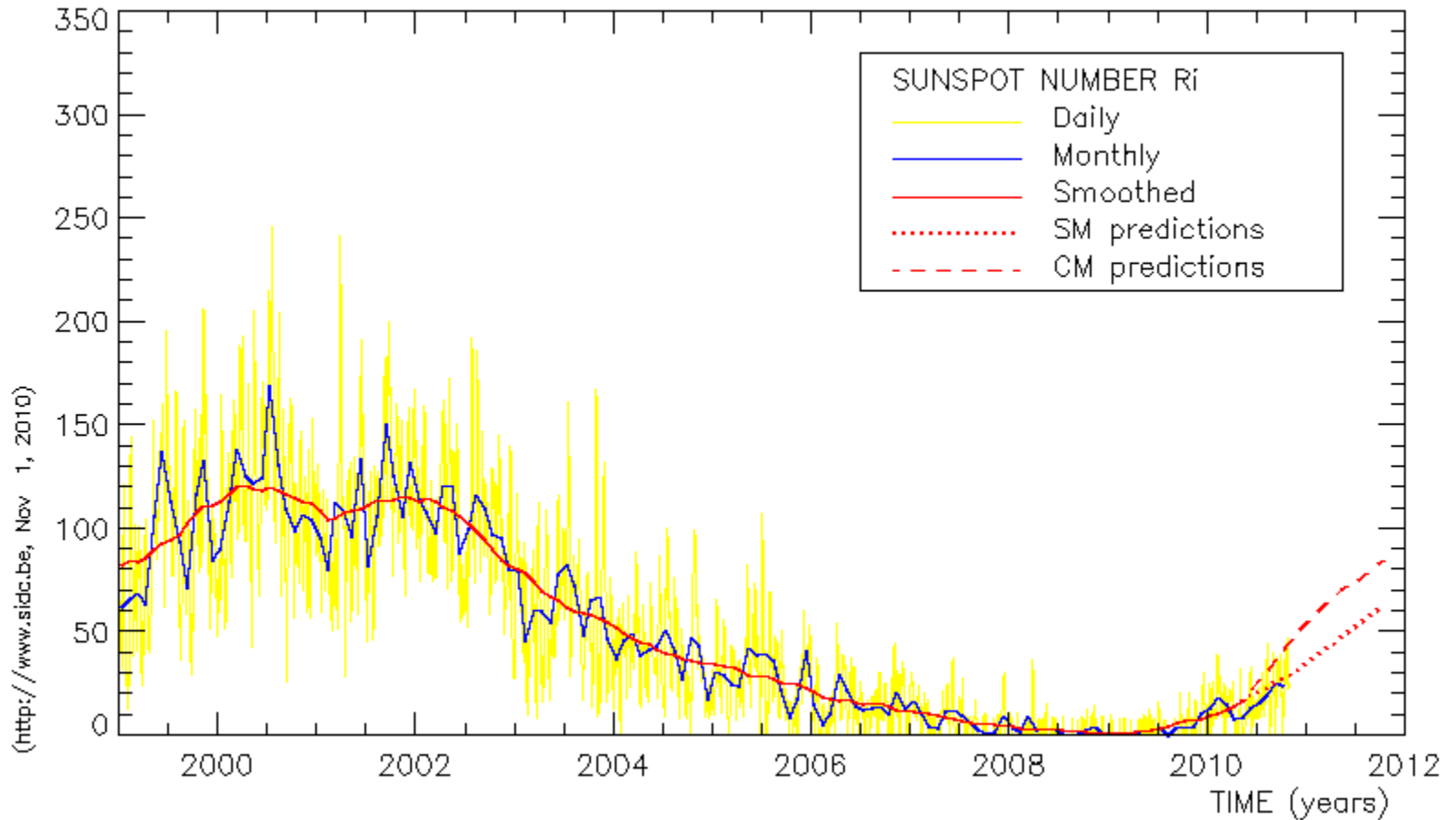
SIDC - Solar Influen...

C:\cis\SIDC\present...

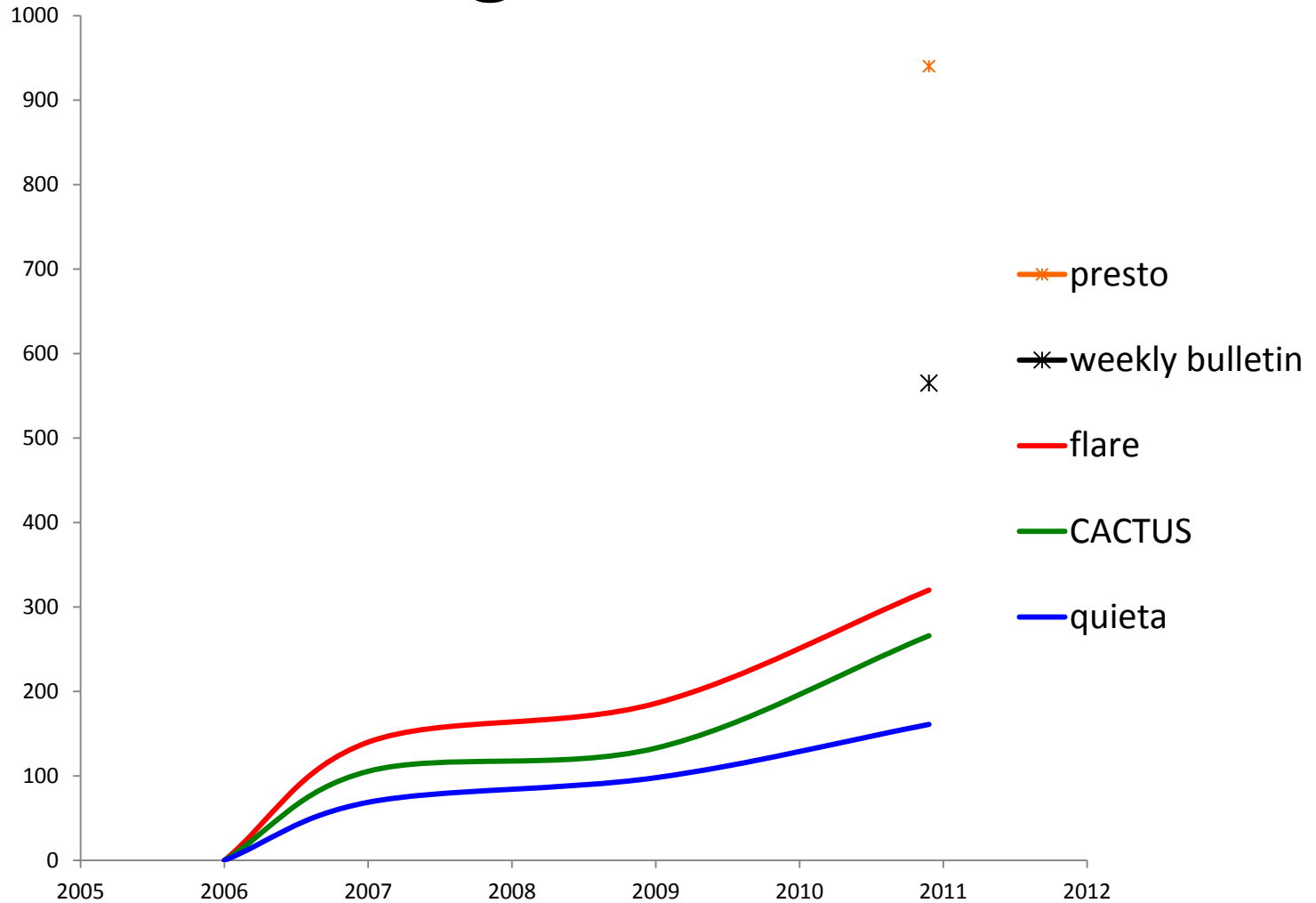
RWC Belgium.ppt

Ppt0000018.ppt [All...

WDC product: International Sunspot Number



Product registrations



Media storm in Belgian press on Feb 16 2011

A press release was sent out on Feb 15 at 14 UT to announce the first activity of solar cycle 24. The media attention on 16-17 Feb was enormous. Television interviews, radio interview, news paper reports ... The central question was: “When and where will we see aurora in Belgium?”

Initial speed of cloud, based on beacon STEREO data was estimated at 1000 km/s, with arrival around morning Feb 17. HI data was crucial in determining the arrival time for around 1 UT 18th.

The media storm stopped before the geomagnetic storm begun. Bz was mostly positive and the CME speed had speed of 800 km/s , not enough to create a big storm.

Forecasters discussed via email to help forecaster in interpreting the data.

Issues: How to cope with large media attention,
 how to coordinate?



Supporting tools

STAFF – Solar Timelines viewer for AFfects



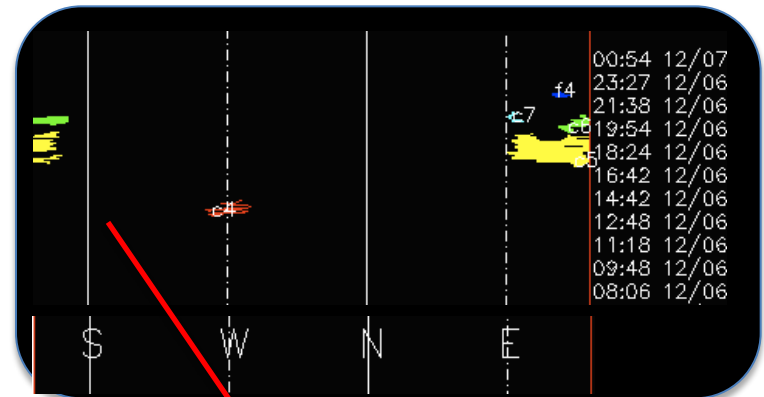
CACTus - Computer Aided CME Tracking

CME
Parameters

Applicable to
different
coronagraphs

Difference
movies

Halo Alert
service



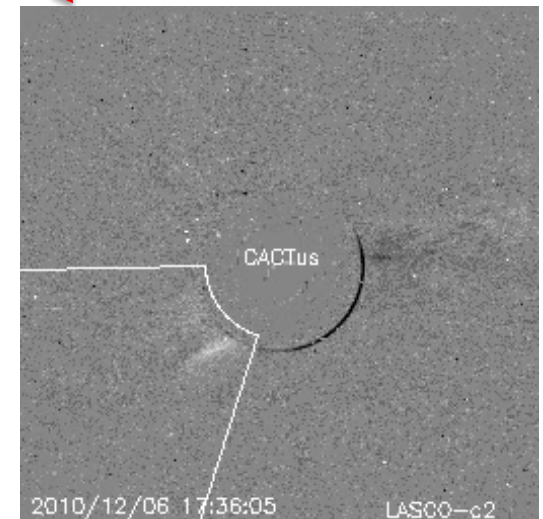
CACTUS

A software package for 'Computer Aided CME Tracking'

Details and graphs for CME0005

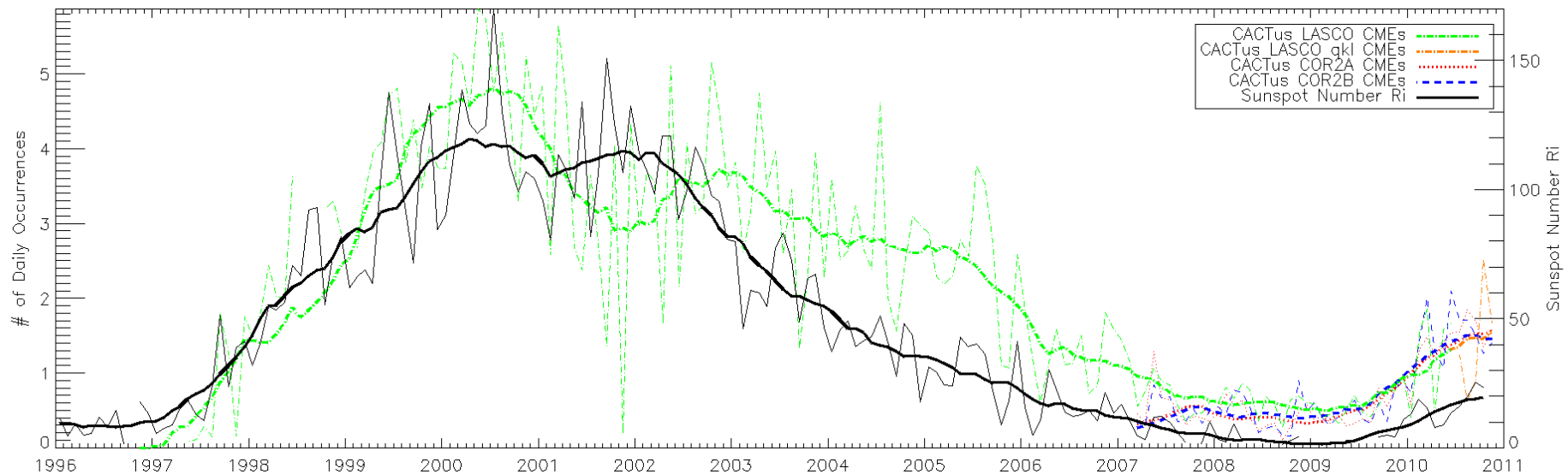
#	CME	t0	dt0	pa	da	v	dv	minv	maxv	halo?
0005		2010/12/06 18:12	02	127	072	0508	0052	0401	0590	

<http://www.sidc.be/cactus>



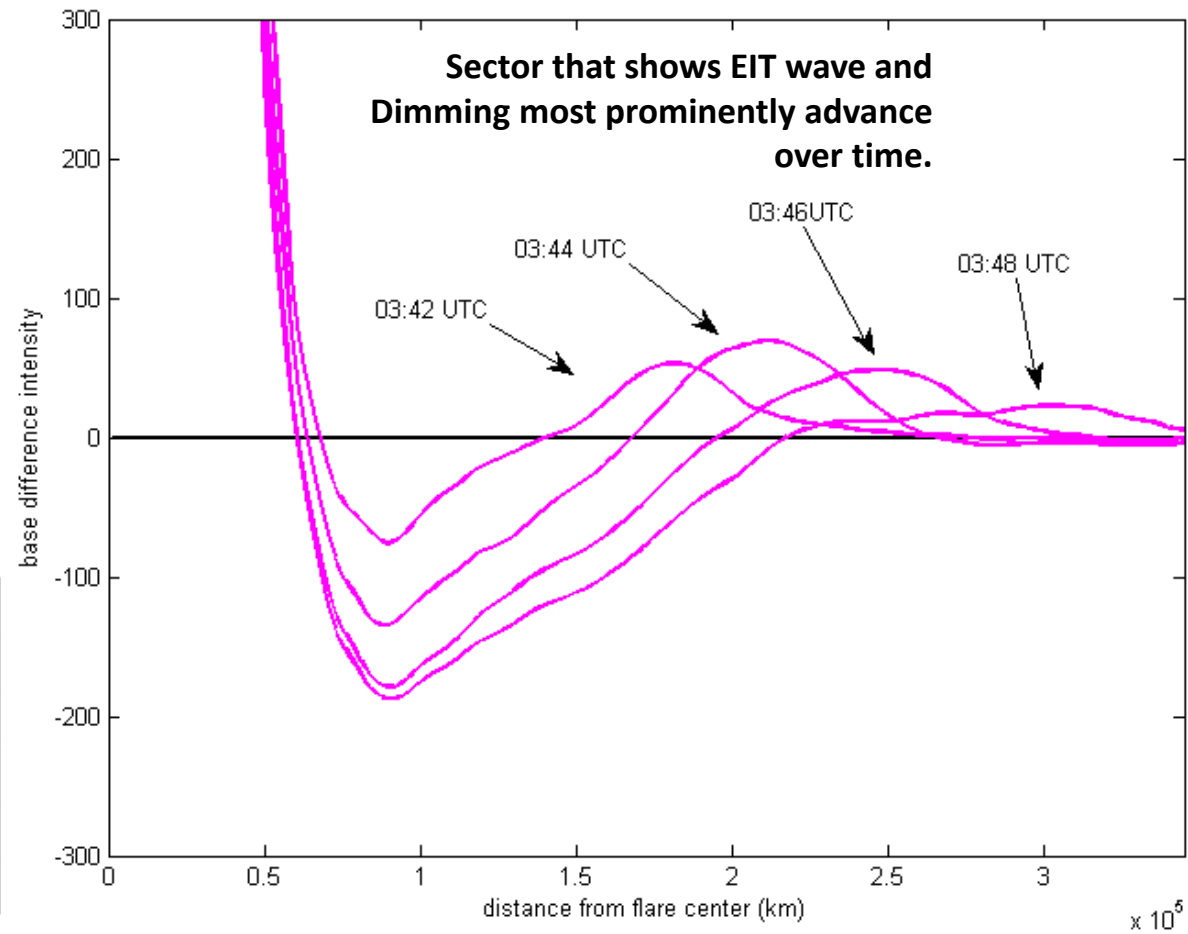
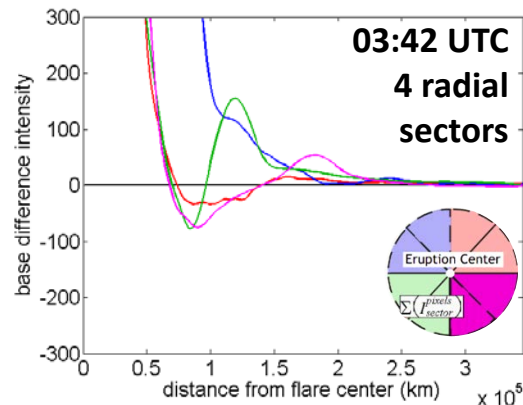
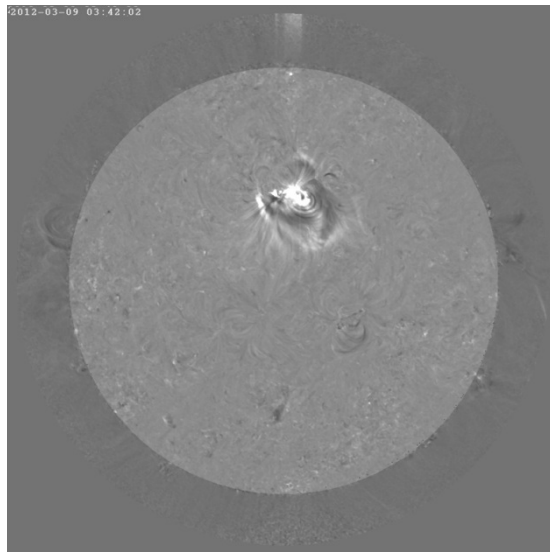
CACTus – CME catalogs

- SOHO-LASCO: since 04/1997
- STEREO/COR2 A and B: since 03/2007
- Real-time: based on LASCO Quick-look;
 - STEREO data has a latency of 3 days.

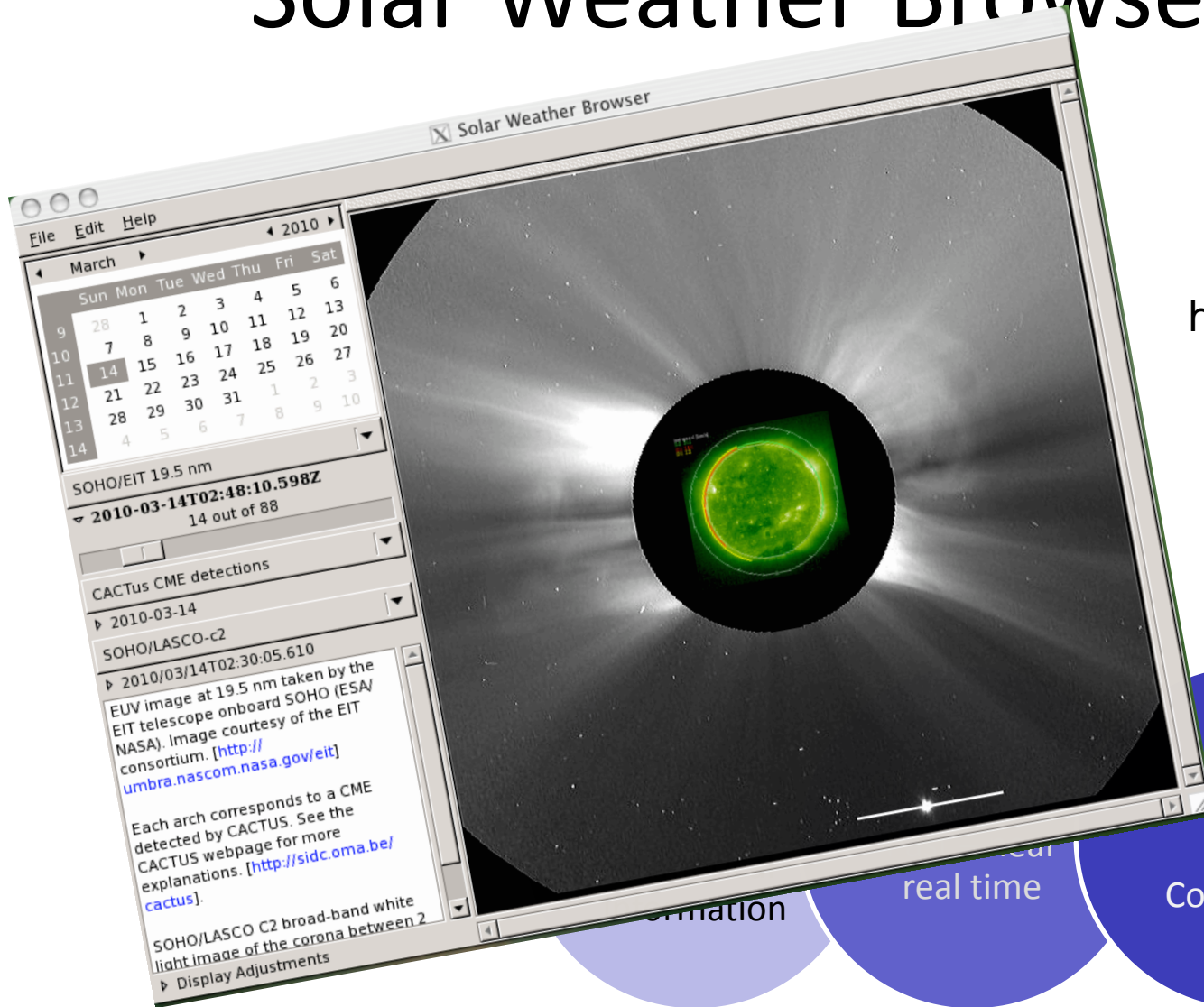


<http://www.sidc.be/cactus>

Solar Demon: dimming & EUV wave detector



Solar Weather Browser



<http://www.sidc.be/swb>

Information

real time

Movies
Zoom
Combining

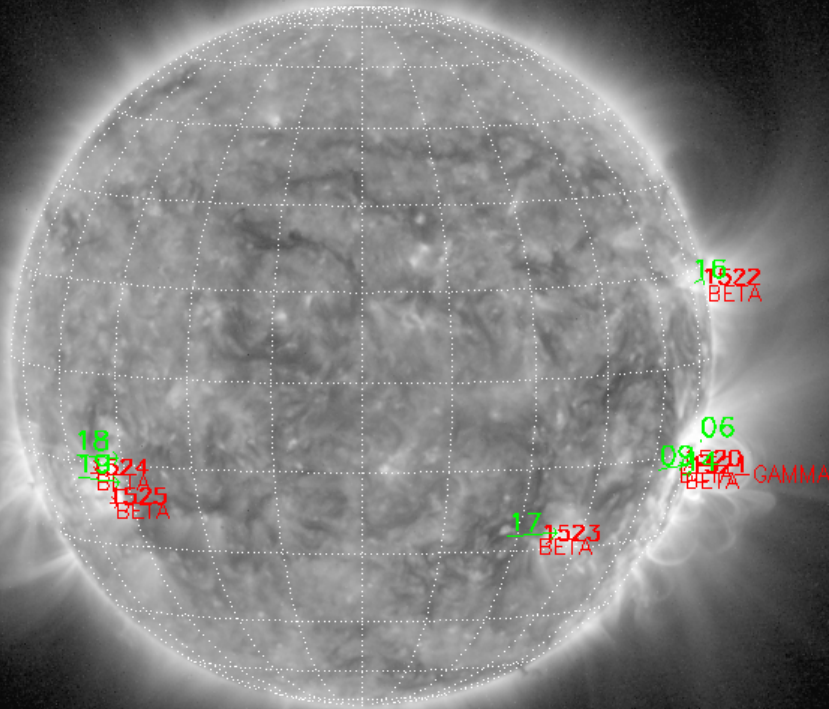
Easy
browsing

Interactive solar map

Catania sunspot groups

2012-07-17T08:06

NOAA AR/sunspot
NOAA Halpha plage
NOAA expected region
2012-07-18T00:30



Provides flaring stats and probabilities per AR

<http://sidc.oma.be/html/Solarmap.html>

PROBA2/SWAP 17nm
2012-07-18T04:25:10.267

Interactive flare tool

Space Situational Awareness, services provided by PROBA2 | PROBA2 Science Center - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Space Situational Awareness, services pr... +

p2web.oma.be/ssa?date=2012-07-18

Ask.com

Home SSA Services Contact Acknowledgments

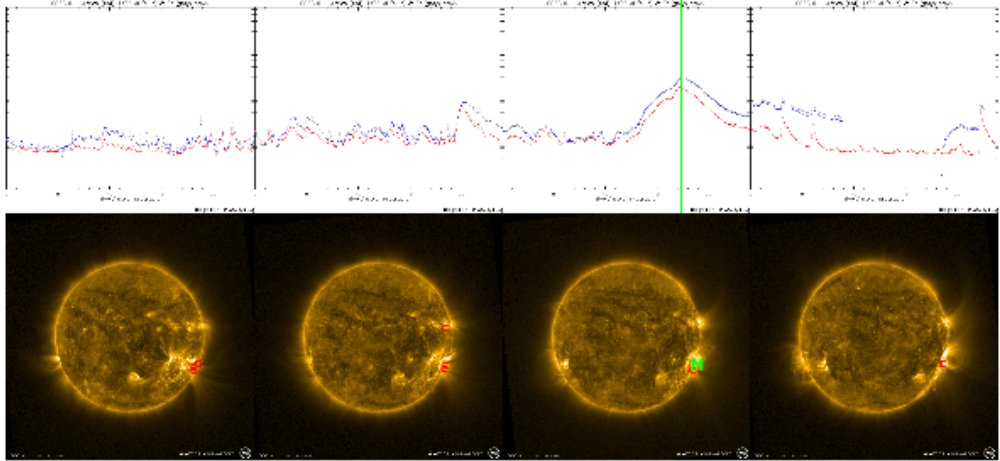
PROBA2 Welcome to the PROBA2 Science Center

Home

Space Situational Awareness, services provided by PROBA2

<<<27d <<4d <1d 1d> Today

2012-07-15 2012-07-16 2012-07-17 2012-07-18



SWAP movie | SWAP diff

Date	Start	Peak	Stop	Flare class	Location	NOAA region
2012-07-18	22:03	22:18	22:33	C4.5	//	//
2012-07-18	05:55	06:02	06:09	C3.0	S17W81	1520
2012-07-18	02:57	03:09	03:17	C3.9	S17W78	1520
2012-07-17	12:03	17:15	19:04	M1.7	S16W70	1520
2012-07-17	05:52	06:05	06:10	C1.5	S22W77	1521

3275 Apache Rd, Bo... Space Situational A... C:\cis\SIDC\present... Microsoft PowerPoi... Adobe Photoshop FR

CME velocity estimation tool

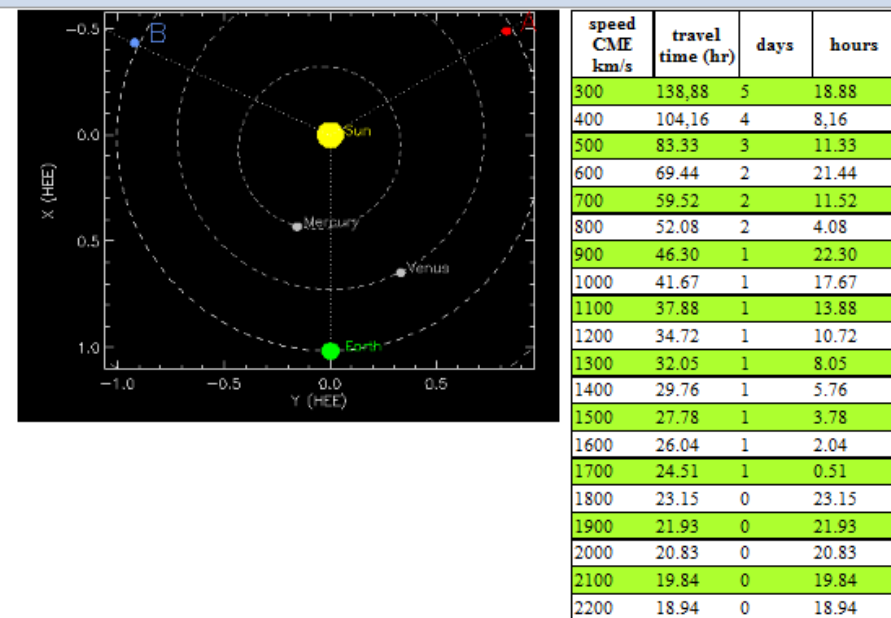
Cor2 speed calculator - Mozilla Firefox

File Edit View History Bookmarks Tools Help

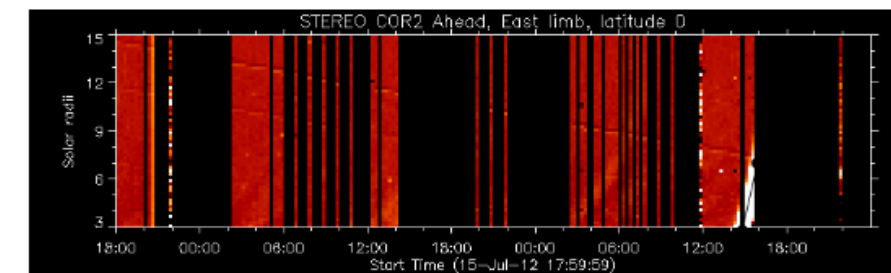
Solar Weather Forecast Cor2 speed calculator

www.sidc.be/rwc/cor2speed/cor2speed.html?dateinput=20120717&satelliteSelection=ahead#canvas_position

Ask.com



Select the satellite and date: 20120717 COR2 ahead find jplots



- Pick the satellite and date (format YYYYMMDD starting from 20110816). The date you picked is located in the last 24 hours in the
- Press enter or click find jplots
- Move the mouse over JPlot to make sure the correct image is displayed
- Set first point by clicking the JMap
- Set second point by clicking the JMap
- Read your speed
- Click third time to restart

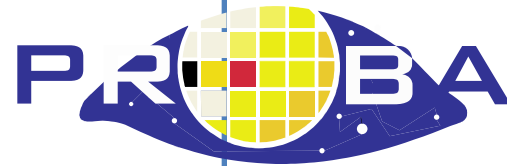
Speed : 742 km/s

ROB data for SW operations

1. PROBA2 – SWAP & LYRA
2. Humain – Radio data
3. USET – White light and chromosphere
4. SDO – Data archive and dissemination

ROB data for SW operations

1. PROBA2 – SWAP & LYRA



2. Humain – Radio data

3. USET – White light and chromosphere

4. SDO – Data archive and dissemination

<http://proba2.oma.be/>

About the PROBA2 Science Center | PROBA2 Science Center - Mozilla Firefox

File Edit View History Bookmarks Tools Help

About the PROBA2 Science Center | PRO... +

← proba2.oma.be



Ask.com



Welcome to the PROBA2 Science Center

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Acknowledgments

About PROBA2

- Mission
- Spacecraft
- Launch and Orbit
- Operations
- Science Payload

Science

- Guest Investigator Program
- Publications

Data

- LYRA Data
- SWAP Data
- Data analysis software
- Spacecraft Ancillary Data
- Terms of use

Community

- Scientific community involvement
- Meetings
- Outreach

About the PROBA2 Science Center

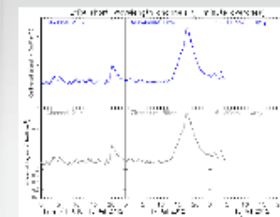
The PROBA2 Science Center, located at the Royal Observatory of Belgium in Brussels, oversees scientific operations and data processing for ESA's PROBA2 spacecraft. The P2SC is the primary archive and distribution center for data from SWAP and LYRA, as well as the primary maintainer of calibration tools, data analysis software, and additional instrument data. The P2SC is also home to the science operations center, where instrument observing plans are devised and, with the help of ESA's Spacecraft Operations Center in Redu, Belgium, loaded onto the spacecraft. Finally, the P2SC serves as the main site for coordination of the PROBA2 Science Working Team, coordinating special scientific campaigns, supporting science data users and guest investigators, and organizing PROBA2 outreach efforts.

PROBA2 is a small ESA satellite with a scientific mission to explore the active Sun and its effect on the near-earth environment and a broader mission to provide a test platform for new instrument and platform technology. The [mission overview](#) page provides additional information about PROBA2 and its on board instrumentation and advanced platform technology.

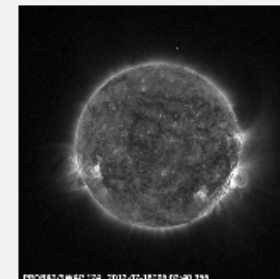
If you require special assistance, you can contact the instrument teams directly using the [contact](#) page on this site.



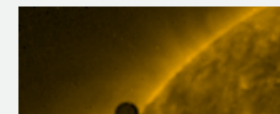
LYRA Latest



SWAP Latest



Venus transit



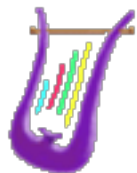
39.977733,-105.2749...

About the PROBA2 ...

C:\cis\SIDC\space w...

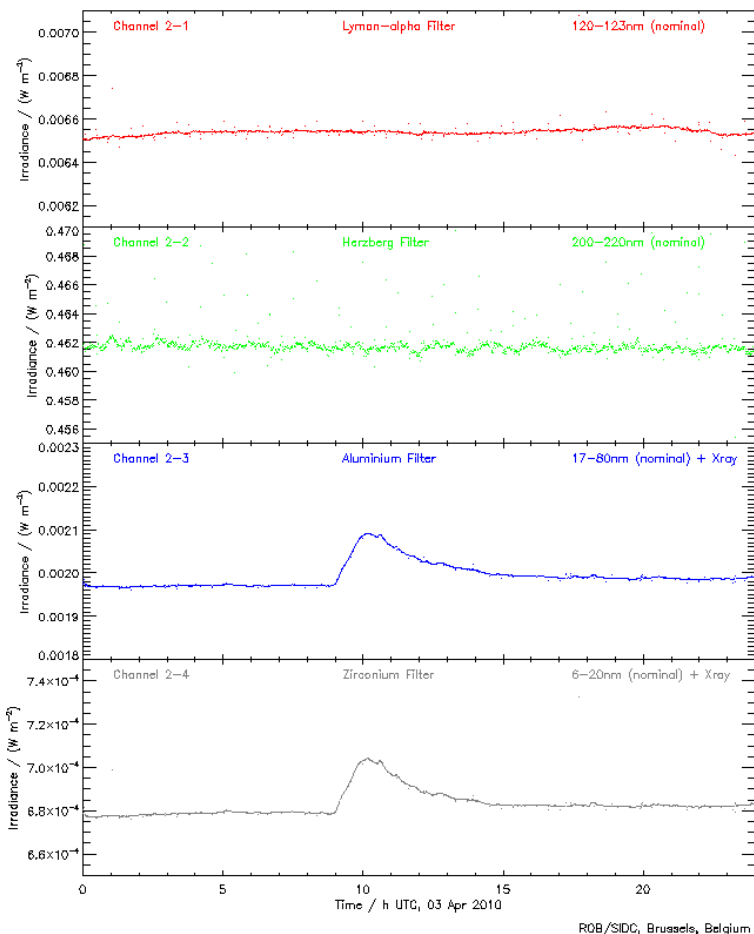
RWC Belgium.ppt

FR



LYRA (onboard PROBA-2)

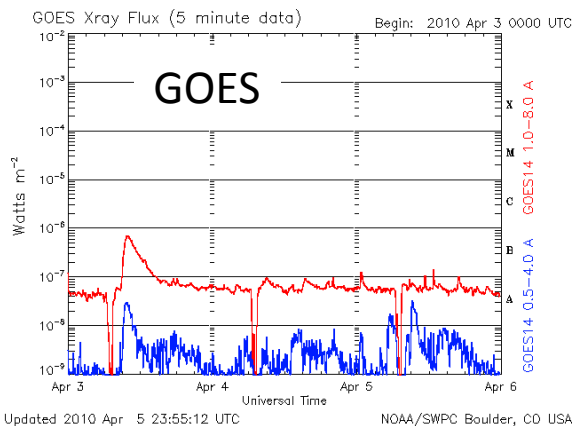
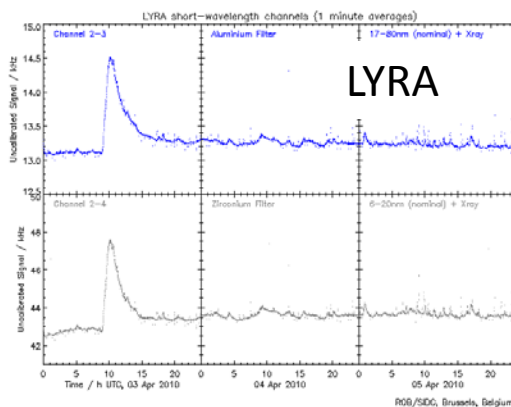
- X and UV photometer, 4 passbands



Preliminary Flare List

October 2010

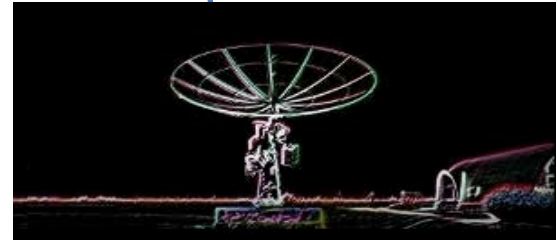
Day	Event	Begin	Max	End	Obs	Q	Type	Loc/Frq	Particulars
01	5960	0452	0456	0458	G14	5	XRA	1-8A	B2.4 4.7E-05
01	5980	0743	0759	0802	G14	5	XRA	1-8A	B3.7 2.3E-04
01	6020	0925	1001	1051	G14	5	XRA	1-8A	B5.3 1.8E-03
02	6040	0839	0851	0900	G14	5	XRA	1-8A	B5.0 4.2E-04
02	6080	2331	2337	2343	G14	5	XRA	1-8A	B1.9 1.1E-04
03	6100	0409	0438	0503	G14	5	XRA	1-8A	B2.3 6.1E-04
03	6110	1920	1923	1925	G15	5	XRA	1-8A	B1.2 1.7E-05
03	6120	2143	2146	2149	G14	5	XRA	1-8A	B1.7 3.6E-05



Info: mariedo@oma.be

ROB data for SW operations

1. PROBA2 – SWAP & LYRA
2. Humain – Radio data
3. USET – White light and chromosphere
4. SDO – Data archive and dissemination



Humain Radioastronomy Station

Royal Observatory of Belgium

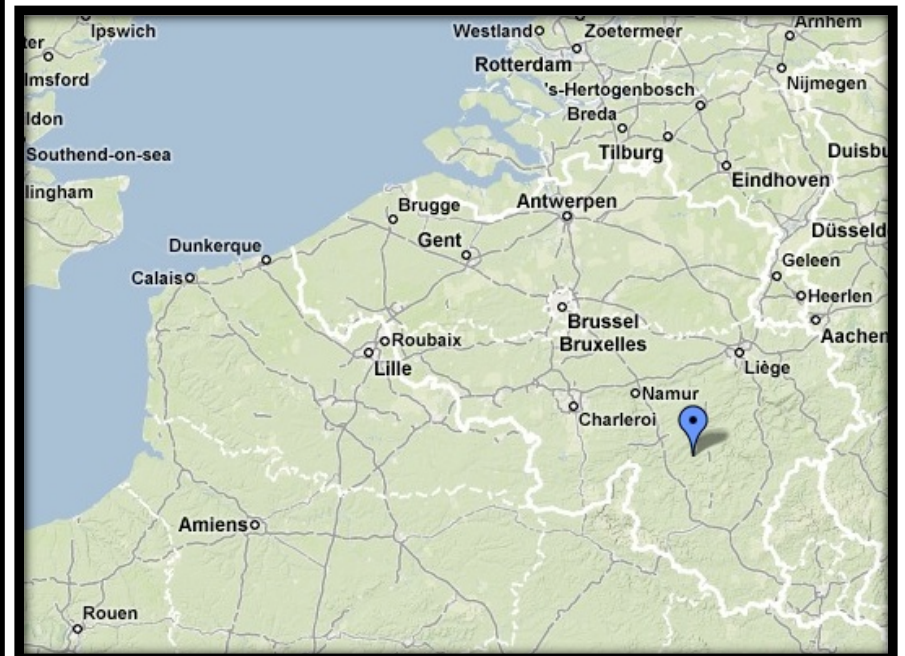


One goal is to provide near real-time monitoring of solar activity for the SIDC forecasts.

Two kinds of instruments:

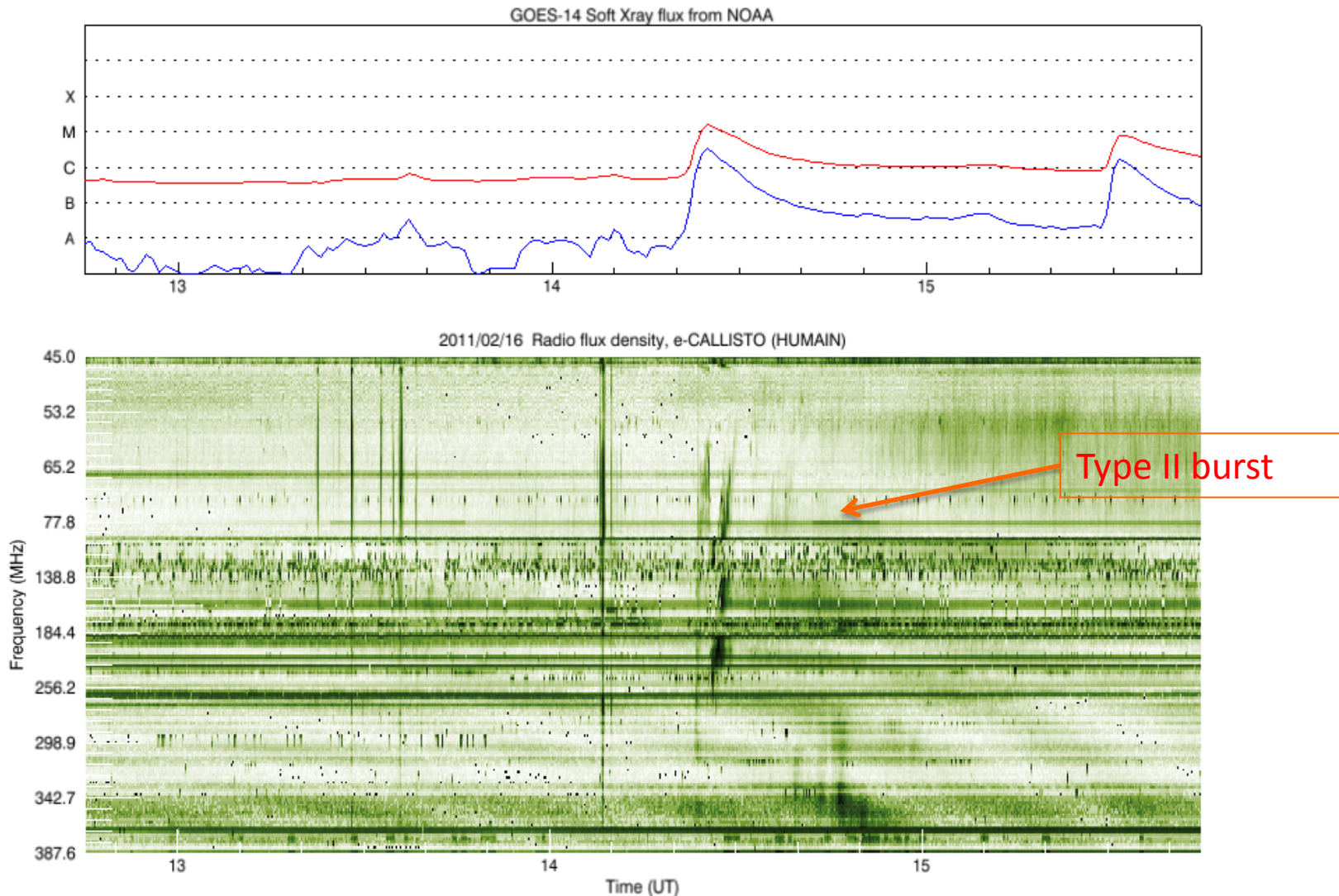
- Radiospectrographs: observation of radio bursts linked to flares and CMEs
- Radiometers: Single frequency flux monitoring for flares and daily irradiance variation (e.g.: F10.7cm)

- Callisto spectrograph (45-400 MHz) plugged to a Sun-tracking log-periodic antenna
- Observations since May 2008
- Data online within 15 min
- Part of the CALLISTO network
- Website: <http://sidc.be/humain>
- Info: Christophe.marque@oma.be



- Project started in 2008, in the framework of the Solar-Terrestrial Center of Excellence
- Current infrastructure is being refurbished (radiotelescopes, equipment)
- It involves currently a team of 4 people at SIDC

Examples of observations



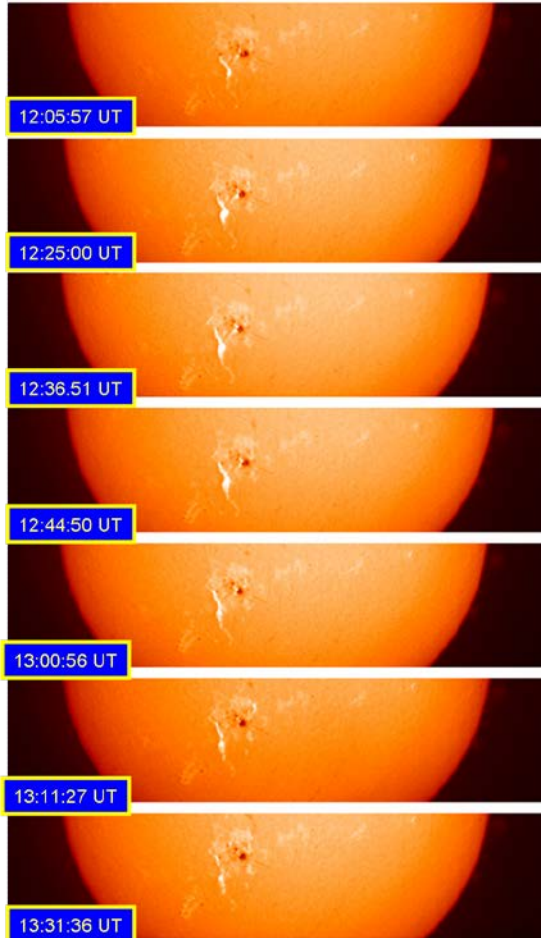
ROB data for SW operations

1. PROBA2 – SWAP & LYRA
2. Humain – Radio data
3. USET – White light and chromosphere
4. SDO – Data archive and dissemination





Solar telescope USET



White light	Quick-look & Fitsfiles
H-alpha	Quick-look & Fitsfiles
Sunspot drawing	Digitization completed
Ca II K-images	Quick-look & Fitsfiles (Q3 2011)



Data is available via website:
www.sidc.be

Data will be available via the
SODA (SOTERIA VSO)

Info: frederic.clette@oma.be

ROB data for SW operations

1. PROBA2 – SWAP & LYRA
2. Humain – Radio data
3. USET – White light and chromosphere
4. SDO – Data archive and dissemination





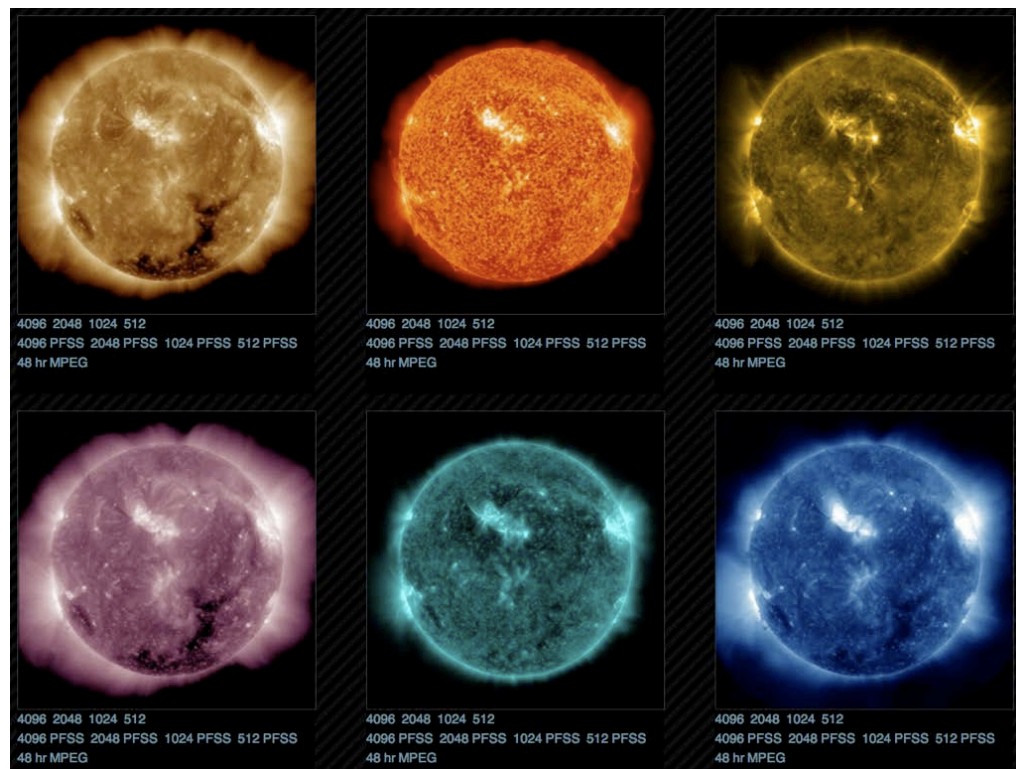
DO data archive at ROB

- Download images from ROB: use same routines but specify site='rob'

```
IDL> list=vso_search('1-aug-2010 00:00','1-aug-2010 00:02', inst='hmi', site='rob')
```

```
IDL> a=vso_get(list[6:7])
```

- <http://wissdom.oma.be>
- latest movies: www.sidc.be
- Info: verodelo@oma.be



Funding through projects

SEVENTH FRAMEWORK PROGRAMME (EC)

SOTERIA

Solar-terrestrial investigations and archives

GOAL:

Improve forecasting capability through improved data access and modeling

LEAD:

K.U.Leuven, Belgium

ROB:

- Sunspot indices and proxy studies
- Distribution of data and dissemination (SODA)

ROB-lead: D. Berghmans

COMESEP

CMEs and SEPs: forecasting the space weather impact

GOAL:

set up a risk-alert space weather forecasting system

LEAD:

BISA, Belgium

ROB contribution:

- CME research & historical SSN data
- Automated detection
- Risk alert system (likelihood x impact)

ROB-lead: E. Robbrecht

Funding through projects

SEVENTH FRAMEWORK PROGRAMME

AFFECTS

Advanced Forecast For Ensuring Communications Through Space

GOAL:

Modeling the chain of effects down to the ionosphere, targeted to GNSS users

LEAD:

UGOE, Germany

ROB:

- Early SW warning system, timelines, automated detections
- Product dissemination through RWC

ROB-lead: C. Verbeeck

eHeroes

Environment for Human Exploration and Robotic Experimentation in space

GOAL:

set up a risk-alert space weather forecasting system

LEAD:

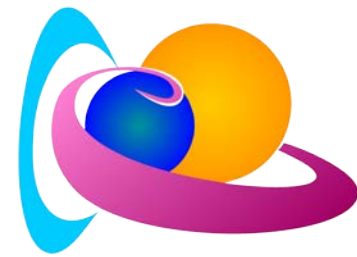
K.U.Leuven, Belgium

ROB contribution:

- research: magnetic reconnection
 - FAST track analysis group
- Documentation, News, education

ROB-lead: P. Vanlommel

Funding through projects



Grantholder:
Ronald Van der Linden

WP 2: Space weather
products and services
Lead: R. Van der Linden

WP 3: Exploitation,
Dissemination,
Education, Outreach
Lead: P. Vanlommel

SSA activities at SIDC

ESA's Space situational Awareness

Preparatory Programme 2009-2011



SN-1 – Space Weather Segment Precursor Services - Part 1:
Definition and service consolidation

Task 1: European Assets and services review – *finished*

Task 4: Initial 4-month operation of the services

→ Data centre located in Redu, Belgium (ESA premises)

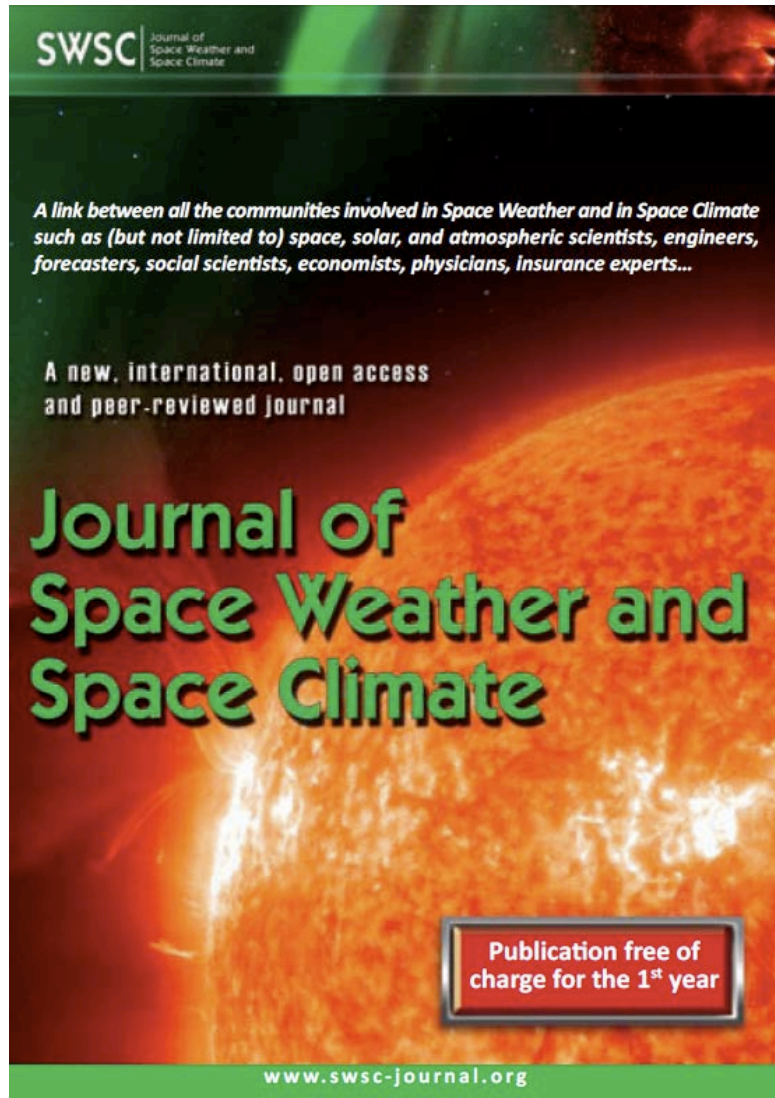
→ SW Services Coordination Centre is hosted by STCE, Brussels

Task 5: Assessment and user feedback

CO-1 - Requirements and evaluation

ROB: SW Expert for revision of Customer requirement documents

Space weather journal !



- A realization from COST ES0803
- Financially supported by STCE (Belgium)
- Secretarial office:
Sophie Raynal, STCE (Belgium)
- Needs publications!
- → <http://www.swsc-journal.org>

European Space Weather Week



10th edition

When: November 18 – 22, 2013

Where: Belgium

Web: sidc.be/esww10 (soon)

306 participants
during ESWW8
from all over the
world

Focus of ESWW9 on European space weather landscape, innovations and key challenges in space weather science, solar variability effects on climate, coupled space weather modeling, spacecraft operations and space weather, space weather in the solar system.

Previous editions



Future plans

- Quality Control: lessons learned
- Collaboration with NOAA-SWPC
- Research to operations
- Virtual modeling center (KUL)
- Improve accessibility of products

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