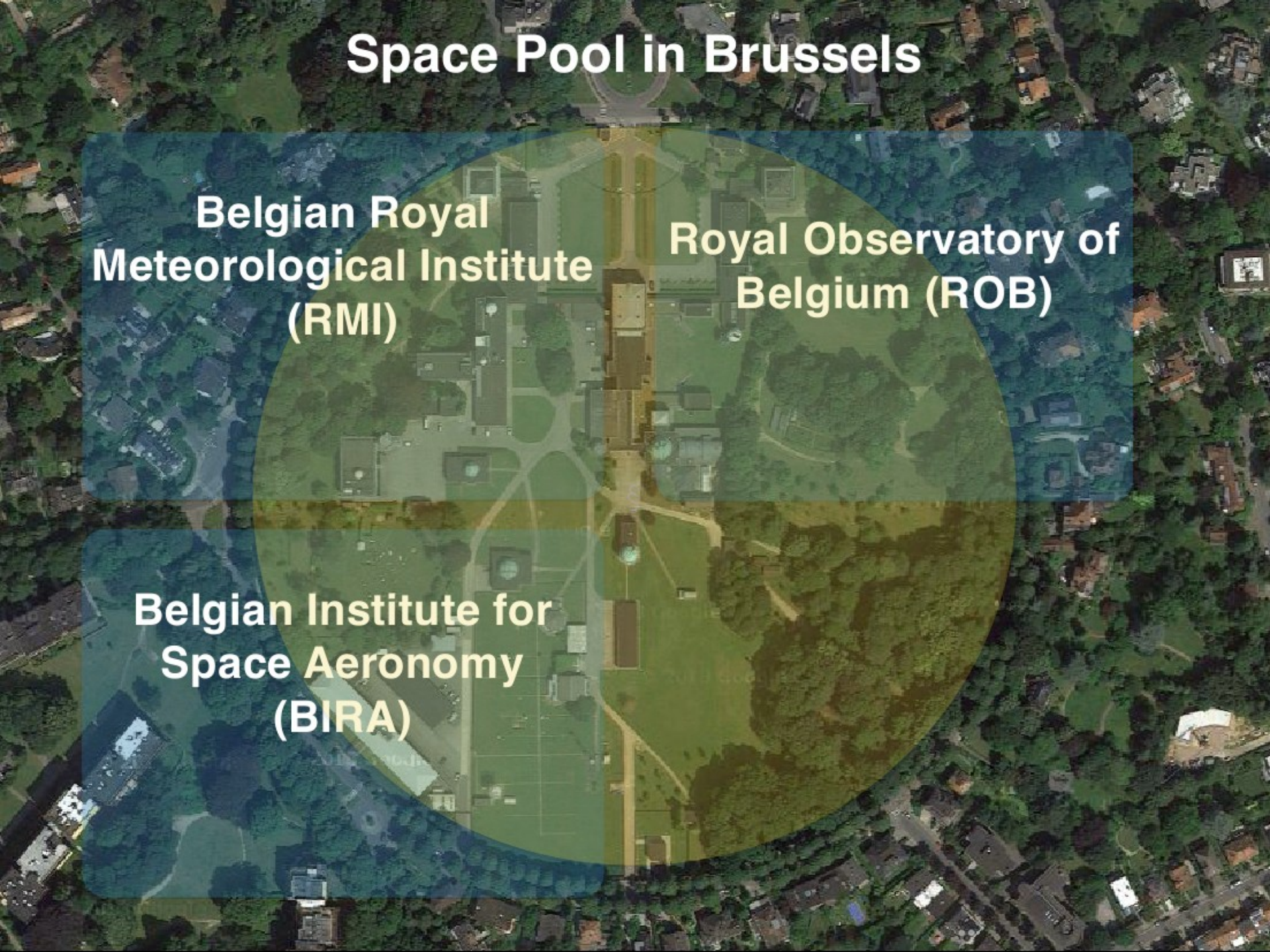
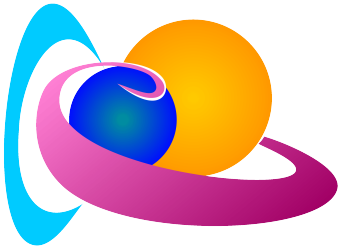
Annual activity report from RWC Belgium for ISES
August, 2014

Jesse Andries
on behalf of the RWC Belgium team


Space Pool in Brussels
Belgian Royal Meteorological Institute (RMI)
Royal Observatory of Belgium (ROB)
Belgian Institute for Space Aeronomy (BIRA)

STCE

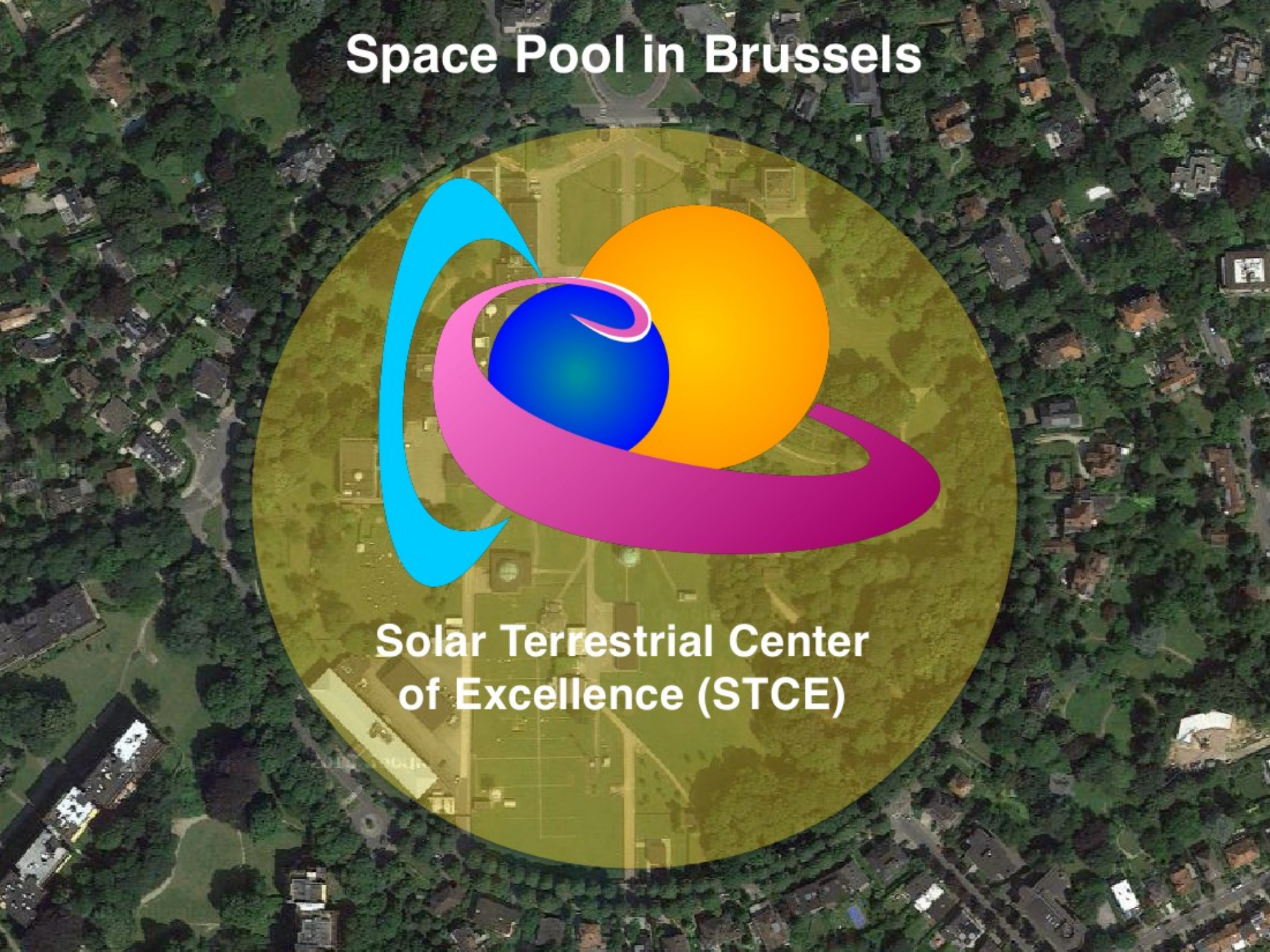


Solar-Terrestrial Centre of Excellence

A coordination of activities in Belgium to consolidate expertise in Sun-Earth connection

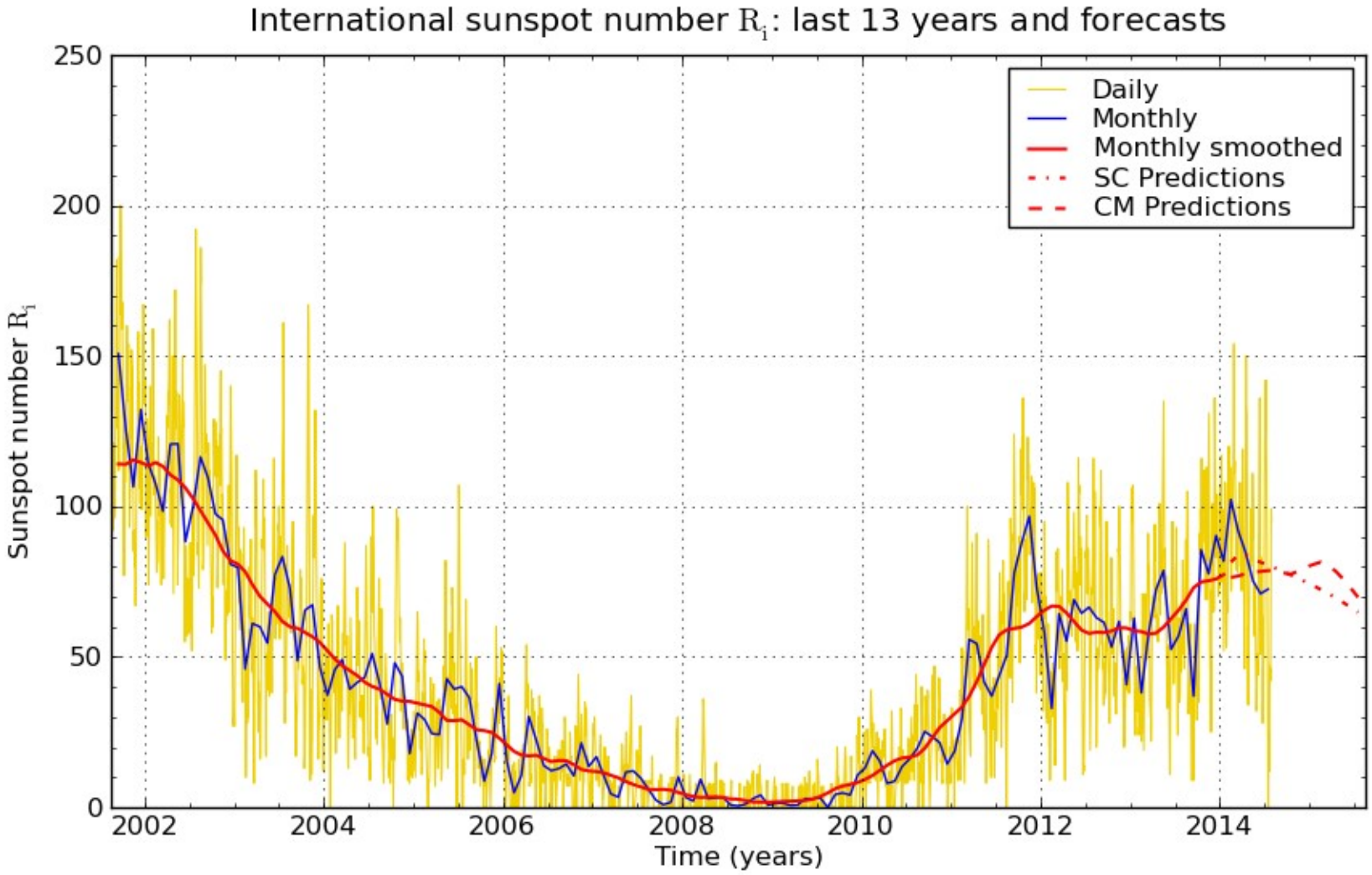
- ✓Strengthening of research trough long-term funding
- ✓Consolidation of know-how and expertise
- ✓Development & Support of operational activities
- ✓Stimulate international participation
- ✓Provide strong visibility through communication
- ✓Administrative support
- ✓Yearly evaluation by external experts

Space Pool in Brussels



Solar Terrestrial Center
of Excellence (STCE)

Int. Sunspot Number



Daily Space Weather bulletin

```
:Issued: 2010 Dec 07 1233 UTC
:Product: documentation at http://www.sidc.be/products/meu
#-----------------------------------------------------------------------#
# 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)
- Available for free

- Flare forecast (region / full disc)
- Geomagnetism forecast (A/K)
- F10.7 forecast
- Textual report/forecast
  - Solar weather
  - Solar wind
  - Geomagnetic conditions

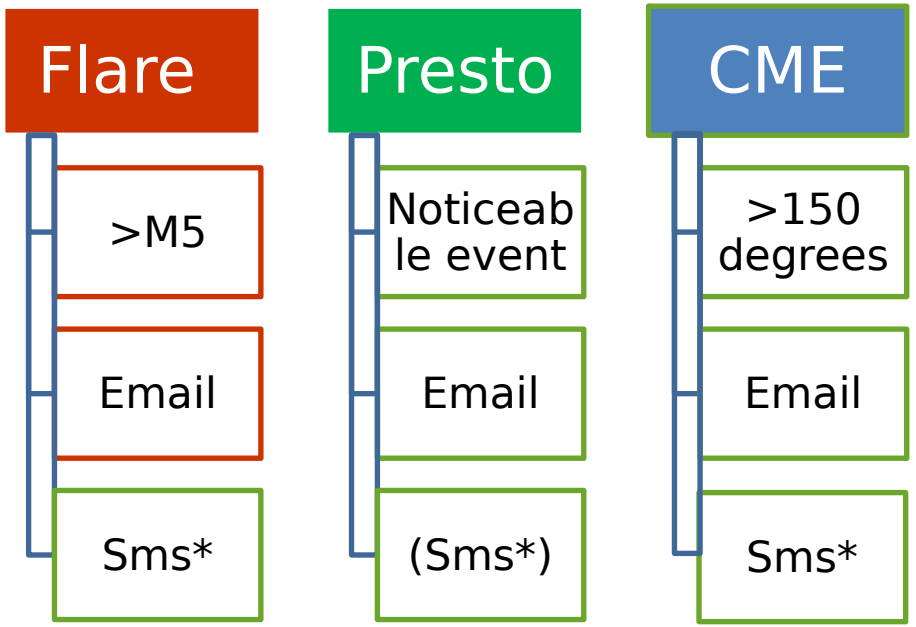
Products: www.sidc.be

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.                                #
#-----------------------------------------------------------------#
```

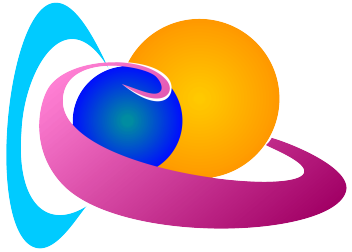


Also for geomagnetism, all quiet, ...

* *Restricted userlist*

Products: www.sidc.be

Recent developments



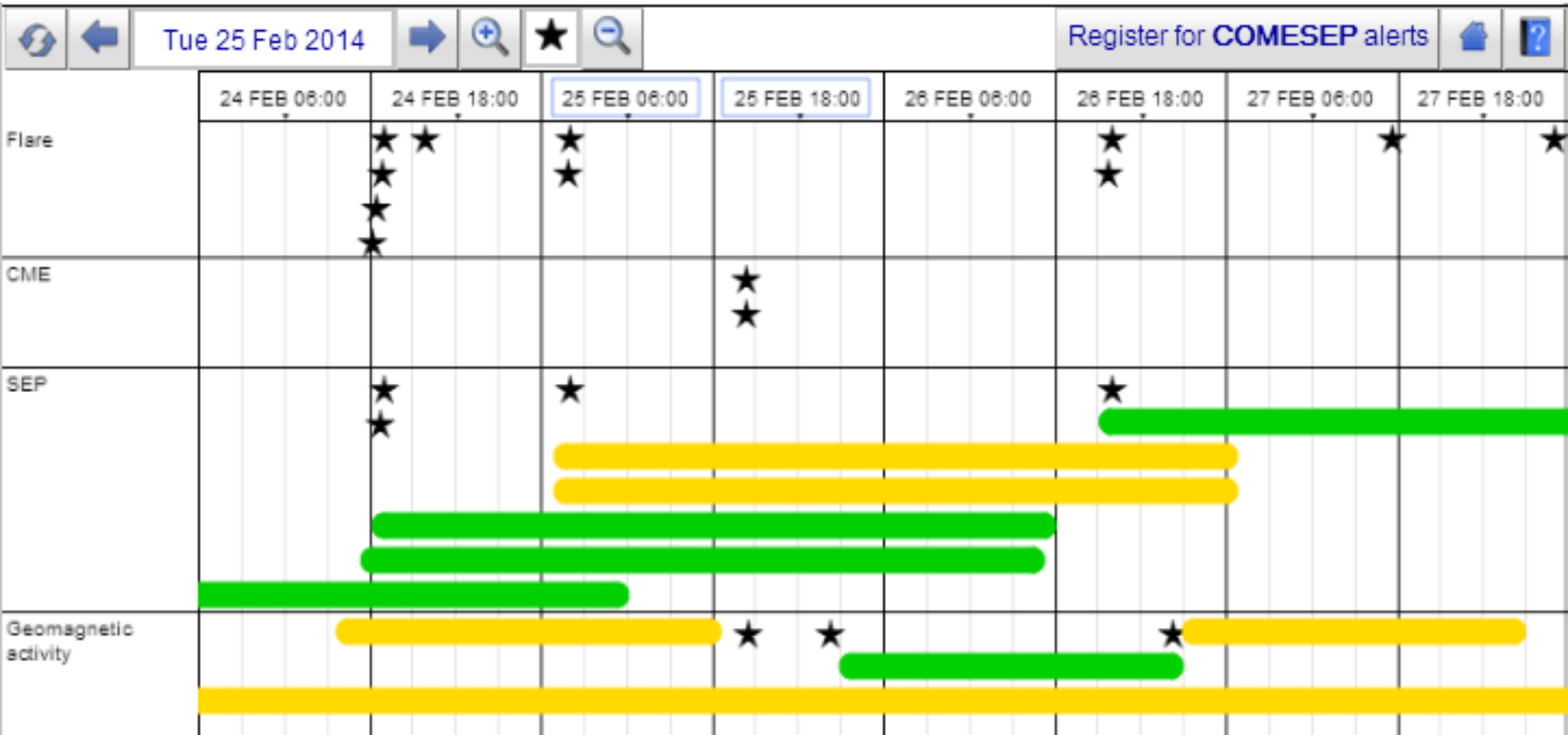
Upgrade of the forecast production platform:

- Back-end data storage
- Unified and centralised management of automated data inflow, processing routines, output procedures (“previmaster”)
- The forecaster/operator interface (“peviweb”): web-based interface with better presentation of the input information as well as model guidance
- Allows flexible integration of different output formats
- Allows automation of forecast verification for continuous QC/QA
- Planned: integration of event follow-up workflow management
- Planned: upgrade of the user interface aspect:
  - Message formats
  - User subscription
  - Flexible user interfaces

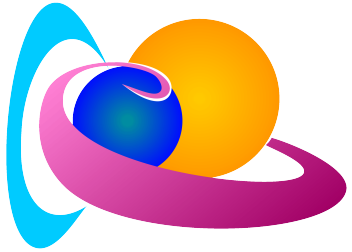
Recent developments

Within consortia with external partners through external project funding

- FP7 COMESEP
  - Automated proton/geomagnetic storm alert service. Seeded by SIDC alerts.
  - Proved very useful in February 2014



Recent developments



- FP7 AFFECTS:
  - Alert service tailored to GNSS users (triggered by SIDC alerts)
  - Solar Demon: flare (as well as dimming and EUV wave) detection algorithm based on SDO AIA 94 data. Running realtime with flare localisation (with AR matching). Timelag mostly < 20 min.
  - Staff: a graphical dynamical time line viewer: with data set/time range selection, on click zoom

Solar Demon - Flare Detection

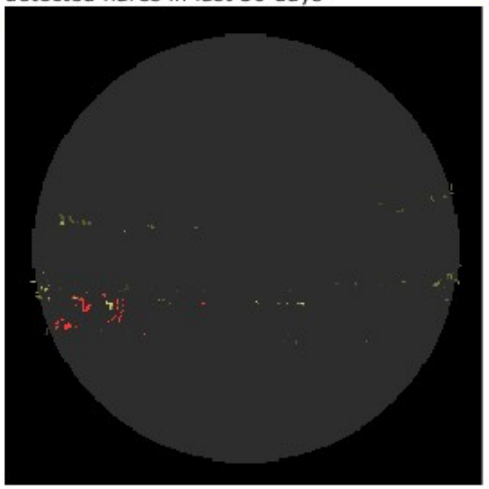
running in real time on SDO/AIA 94 QKL data
3 minute cadence, typical delay 15 minutes
(view all Solar Demon detection tools)

Detector 24h operating status:

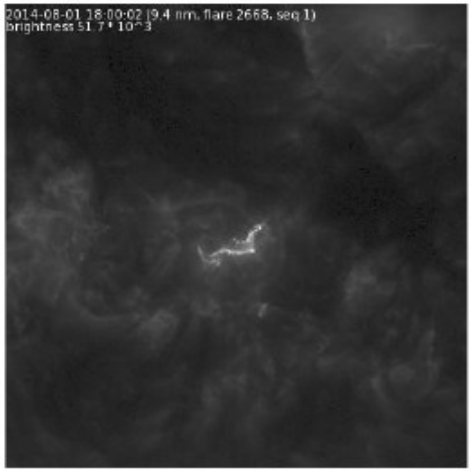
Last processed image:
0 hours and 19 minutes ago (2014-08-01 18:06 UTC)
Last detected flare:
0 hours and 19 minutes ago (2014-08-01 18:06 UTC)

Filters (category)
-- *All classes*
Only C class flares and above
Only M class flares and above
Only X class flares and above
Filters (time)
Show all
-- *Last week*
Last 30 days
Last 365 days

detected flares in last 30 days



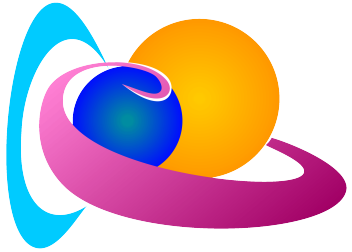
Flare 2668



Overview of flares

	est. class	start	peak	end	#	lat	lon	dist. R⊙	AR	est. flux	GOES flux	GOES peak time		COMESEP	# det.	dimming
August, 2014																
1	M1	18:00	18:06	18:06	2668	-10	-12	0.33	AR 2127	104.5	153.0	18:12	6	2	3	
1	M2	14:48	14:54	15:42	2667	-9	-36	0.66	AR 2130	167.7	**204.0**	14:48	-6	98312	19	
1	B4	13:57	13:57	13:57	2666	-12	-35	0.64	AR 2130	3.6	**24.7**	13:56	-1	0	1	
1	C2	11:39	11:42	12:06	2665	-9	-37	0.68	AR 2130	19.3	48.0	11:43	1	0	10	
1	B5	05:24	05:27	05:30	2664	-19	-30	0.63	AR 2131	4.9	**14.3**	05:23	-4	0	3	
1	B3	03:21	03:21	03:21	2663	-18	-57	0.88	AR 2132	3.4	**14.1**	03:18	-3	0	1	
1	C2	01:18	01:21	01:48	2662	-18	-60	0.91	AR 2132	24.7	**31.6**	01:17	-4	0	11	
1	C9	00:15	00:21	01:15	2661	-17	-60	0.92	AR 2132	86.7	**86.7**	00:18	-3	98308	21	
July, 2014																
31	B9	21:15	21:21	21:27	2660	-12	-48	0.79	AR 2130	9.0	**24.0**	21:17	-4	0	5	
31	B6	18:54	18:57	19:03	2659	-17	-63	0.93		6.3	**19.8**	18:55	-2	0	4	

Forecast Verification



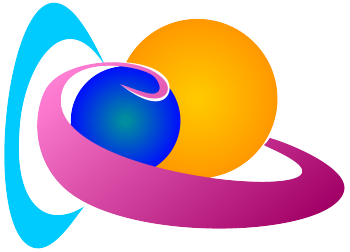
What:
- F10.7 prediction (1, 2, 3 day lead time)
- Full disc flare predictions
- K predictions (max. over 48 hours) (comparison to Chambon-la-foret)

Compared to:
- Persistence
- Recurrence
- Corrected recurrence

How:
- Error analysis with skill scores
- Hit/miss statistics: probability of detection, False alarm ratio, Proportion correctness, Biass, Heidke and True skill score

Results submitted to Journal of Space Weather and Space Climate.

Forecast verification results



F10.7:

- 1-day leadtime: SIDC performs best
- 2,3 day leadtime persistence and corrected recurrence perform better (in terms of long term statistics) → what do we conclude from that?

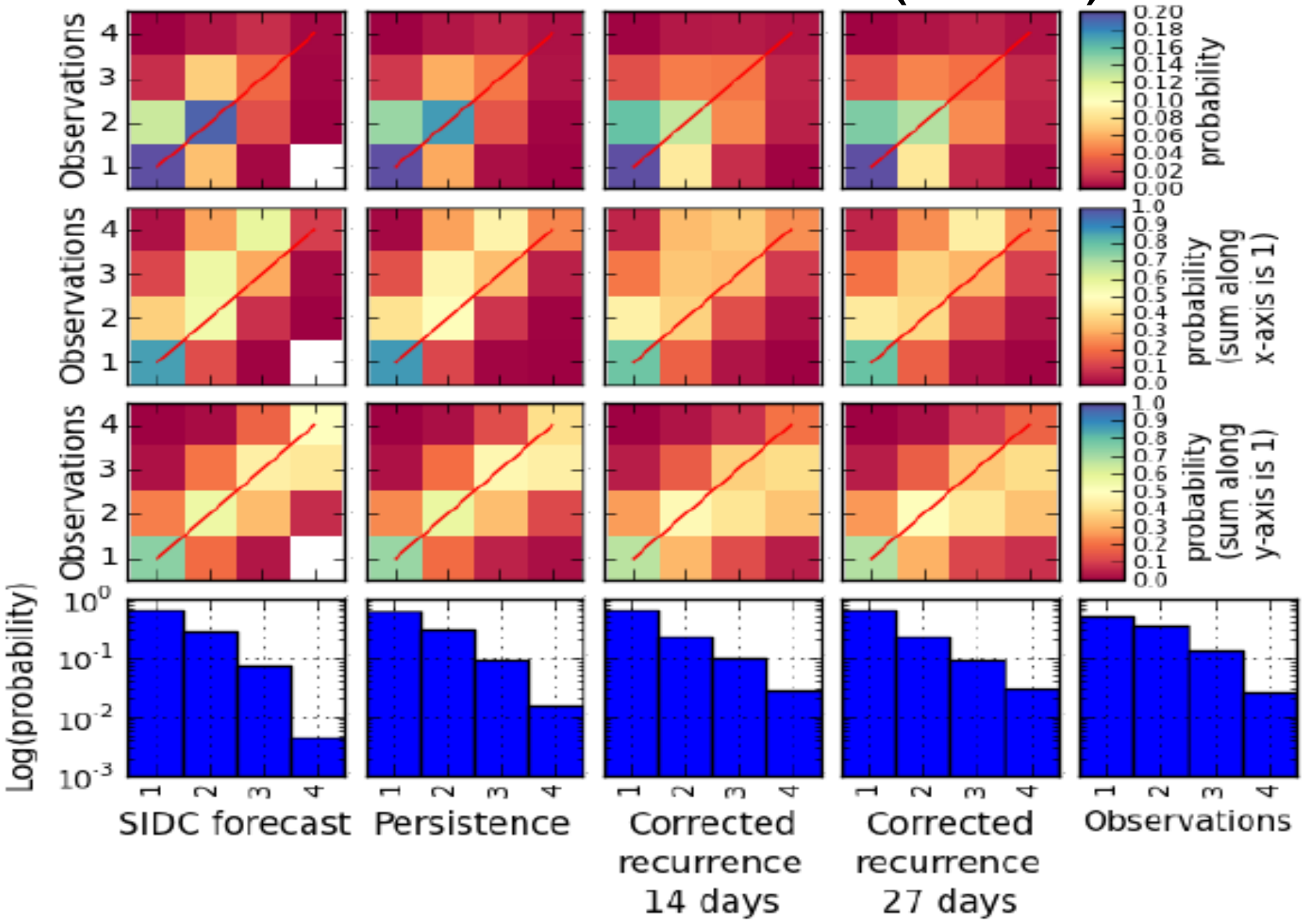
Flaring probability:

- SIDC performs good
- Trend to underestimate M and X flares. Not necessarily bad, this goes hand in hand with few false alerts!
- Error analysis dominated by large periods without flares
- Skill score on hit/miss statistics (M and X) → Proportion correctness is best for SIDC

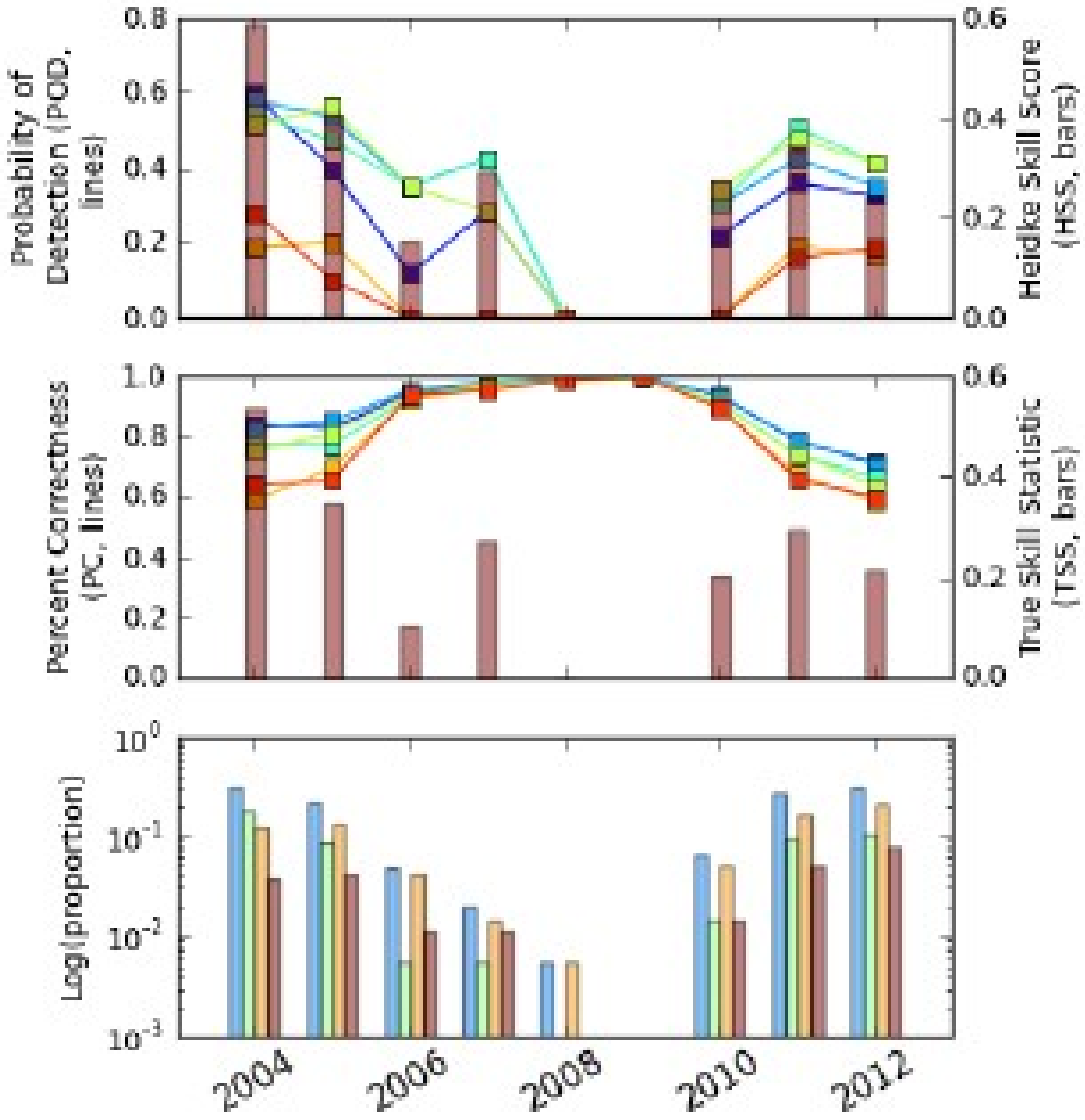
Geomagnetism (K):

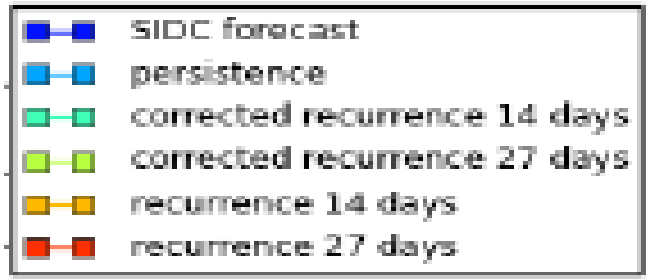
- SIDC performs good
- Low K overestimated / high K underestimated: convolution between probability of occurrence and event level
- Skill scores on hit/miss statistics (K>4) → Proportion correctness and also Probability of detection is best for SIDC

Forecast verification (Flare)

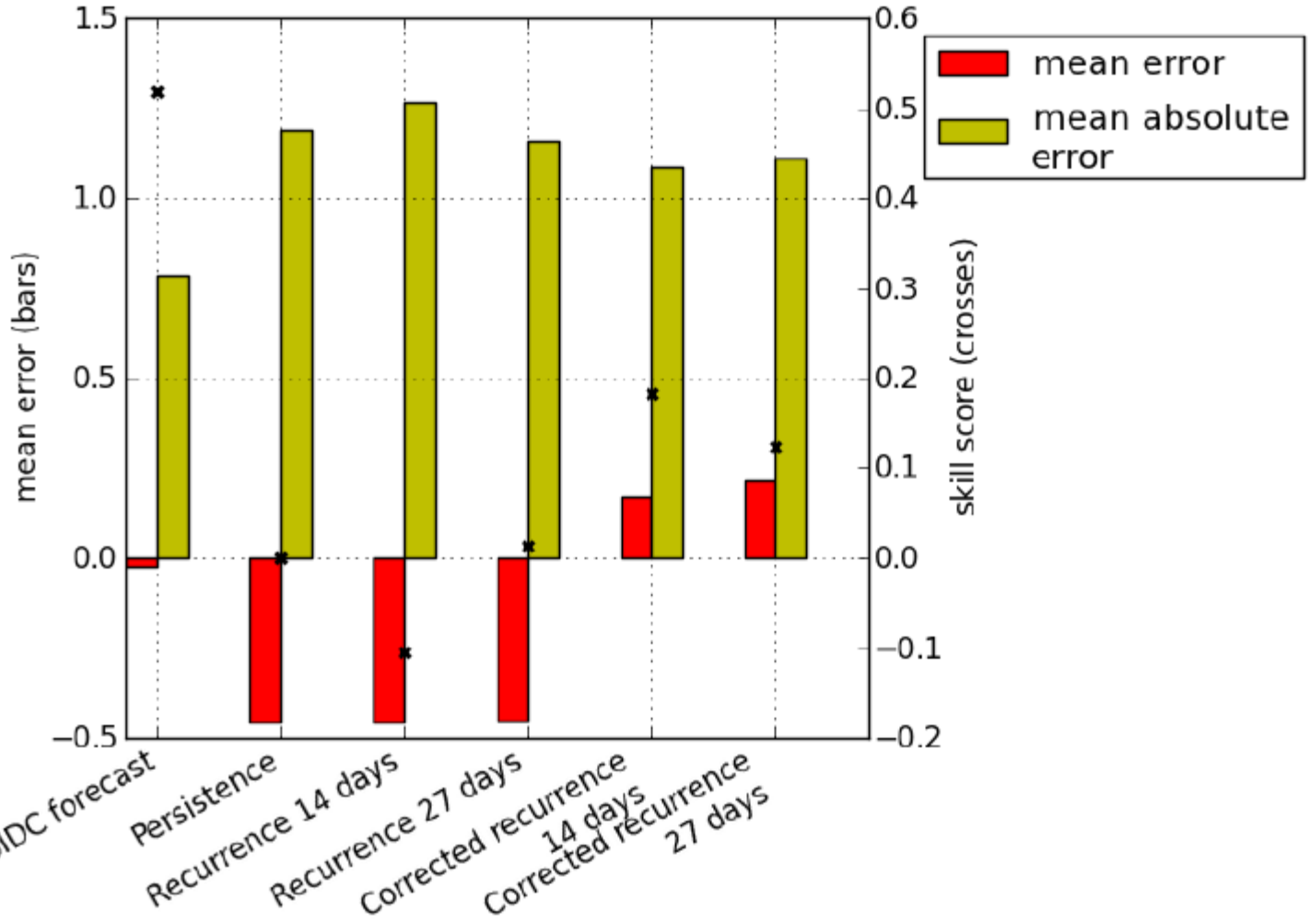


Forecast verification (Flare)

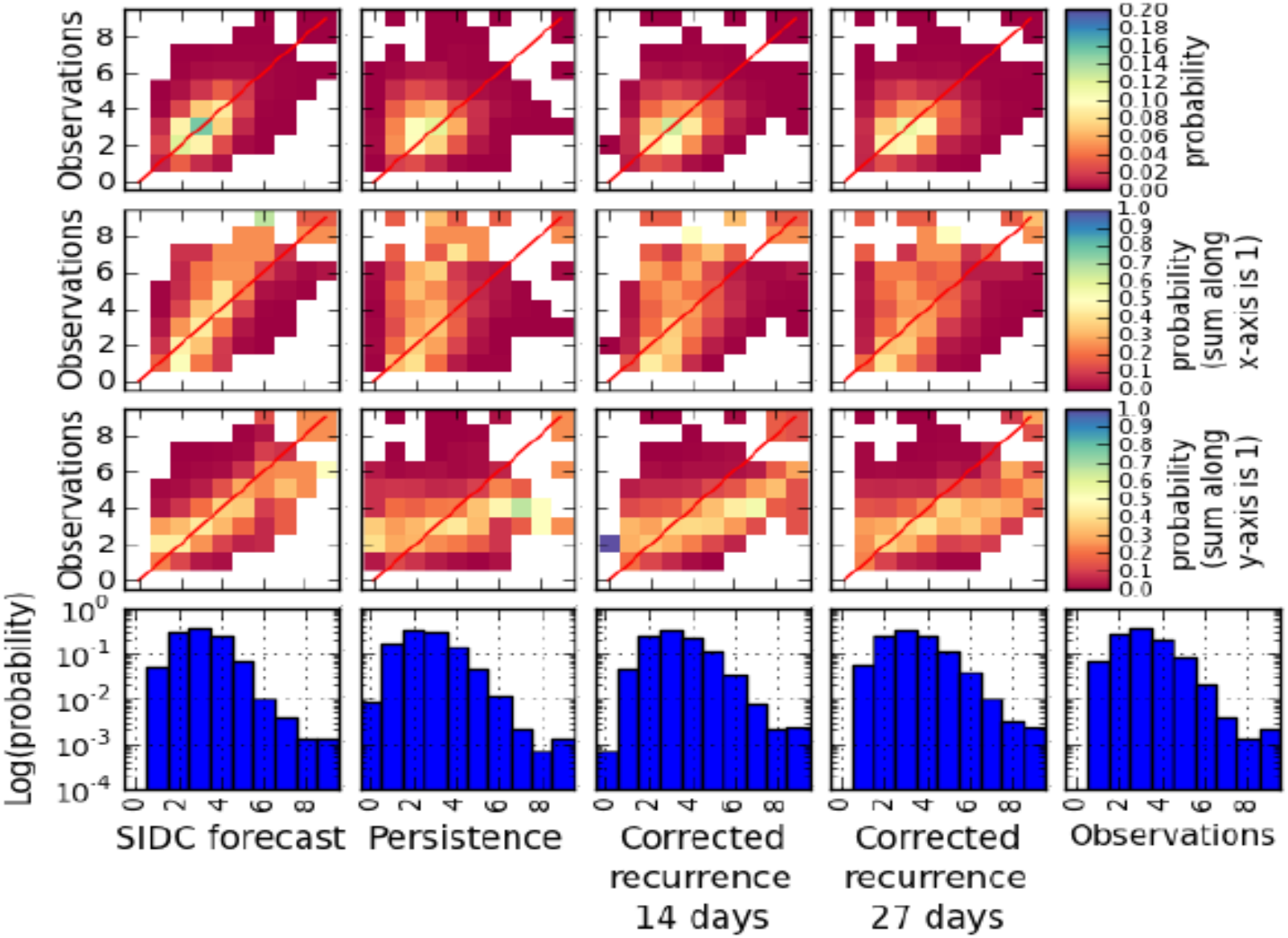




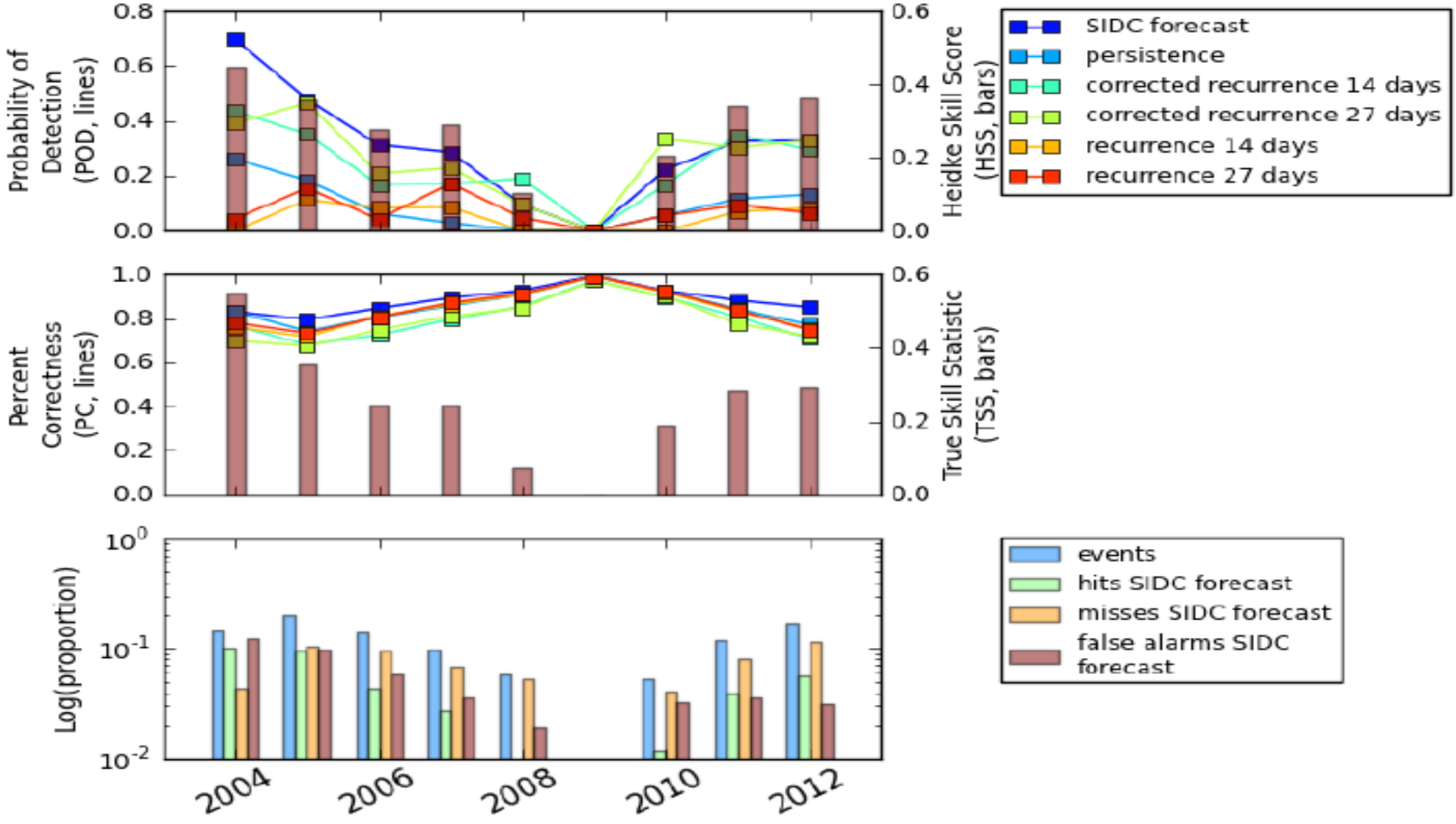
Forecast verification (K)



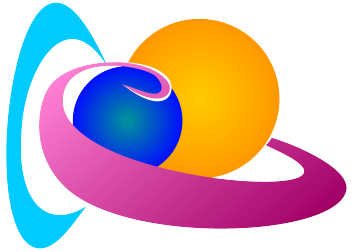
Forecast verification (K)



Forecast verification (K)



Forecast verification

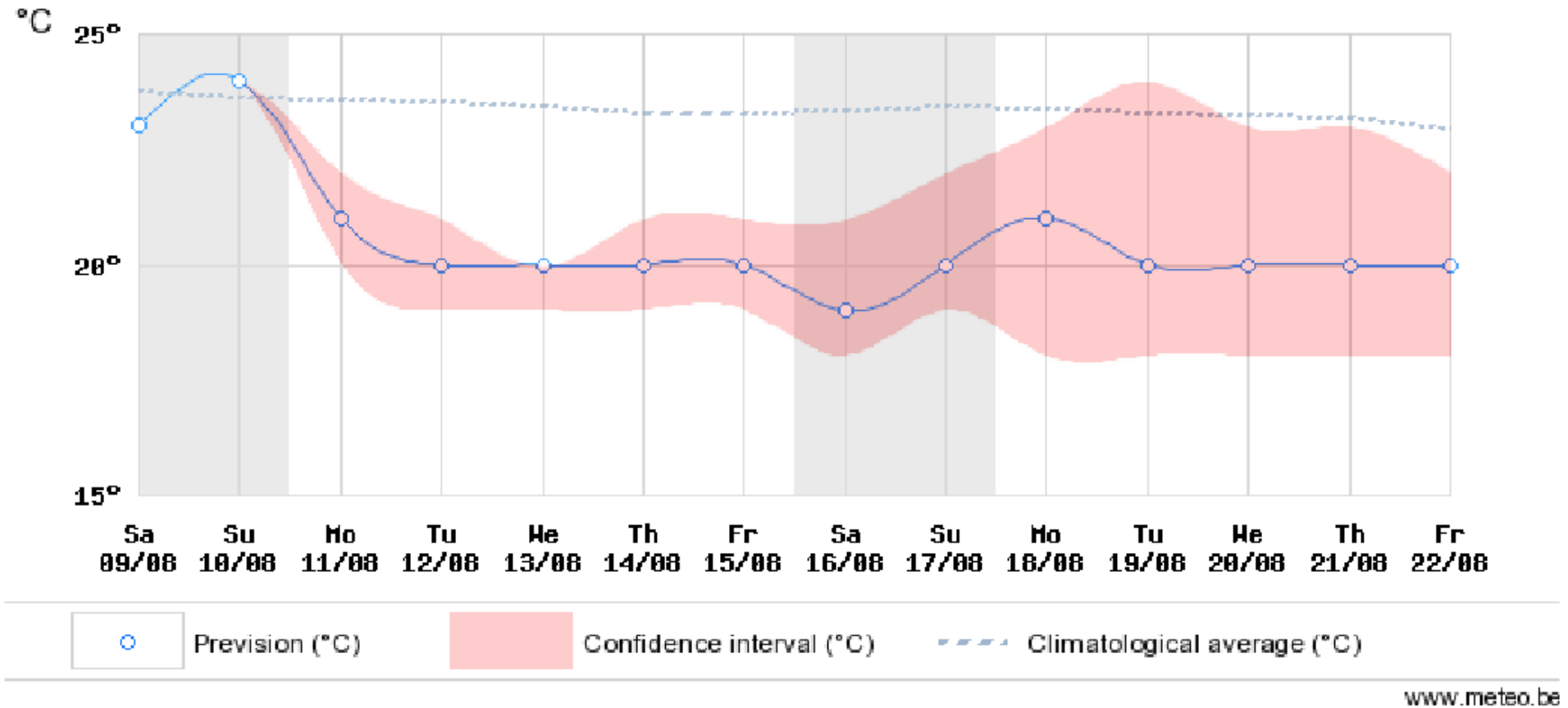


What are the right statistics to be used?

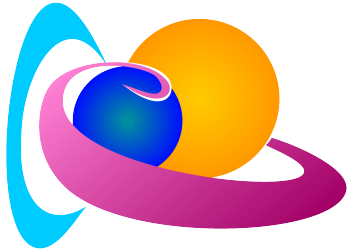
- What is the meaning of your forecast?:
  "eruptive= C-flares likely, probability > 50%"
  often chosen if computed probability=75%
  → you expect to be wrong 1 out of 4 times!!
- Convolution of event probability and event level (and event timing uncertainty)
- Probability of detection vs. false alerts: What does the user want?

- Communication of error bars to the user?

Error bars


°C
25°
20°
15°
Sa 09/08
Su 10/08
Mo 11/08
Tu 12/08
We 13/08
Th 14/08
Fr 15/08
Sa 16/08
Su 17/08
Mo 18/08
Tu 19/08
We 20/08
Th 21/08
Fr 22/08
Prevision (°C)
Confidence interval (°C)
Climatological average (°C)
www.meteo.be

User impact



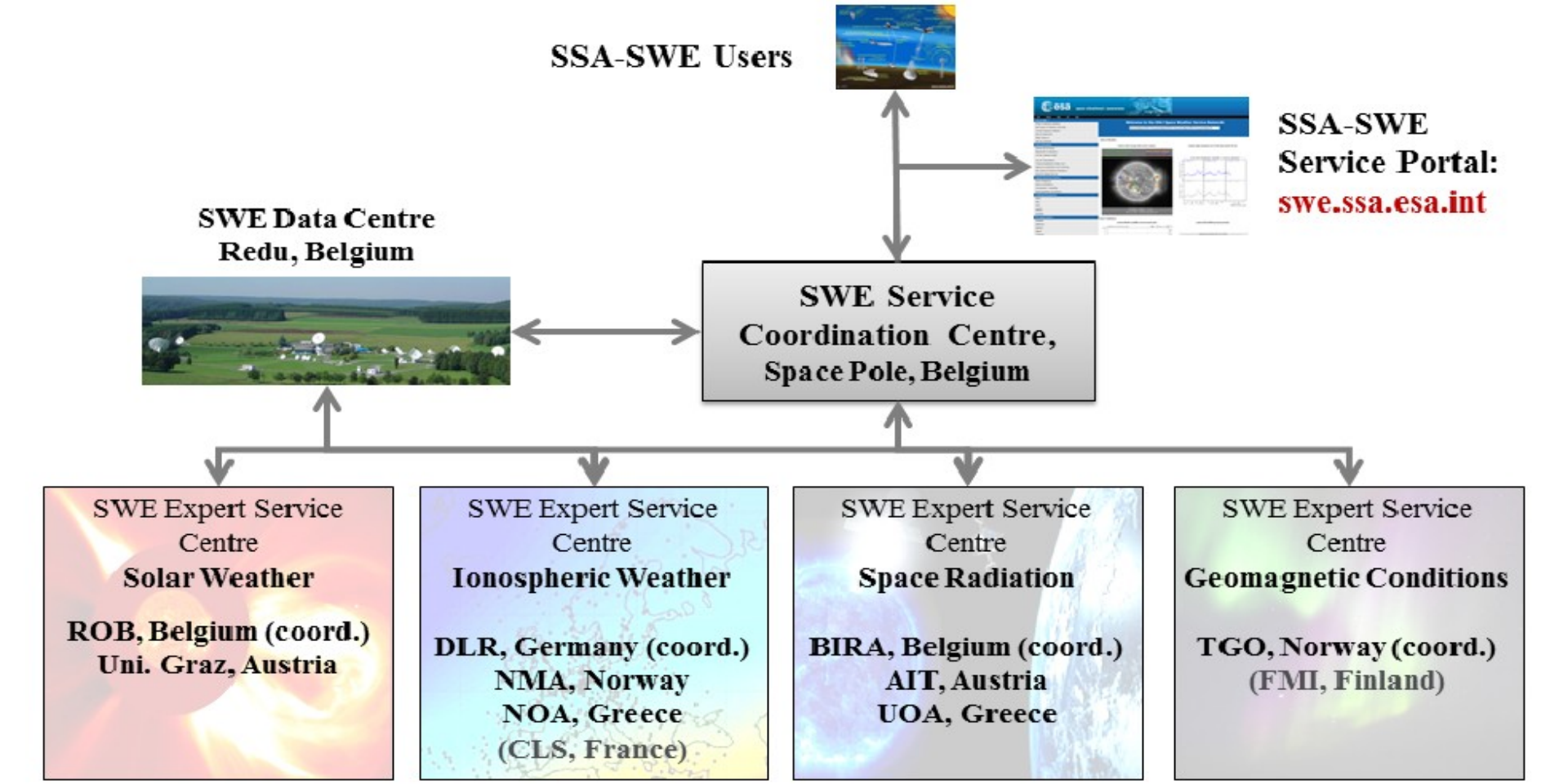
User base keeps increasing:
- 2000+ subscriptions
- Most popular: daily bulletin, fast alerts

Increased and more concrete interest/questions from:
- civil protection authorities
- aviation authorities
- Defence
- private communication companies

→ Concrete requests for better interfacing to their operations

ESA-SSA SWE

SSA/SWE Precursor Service System in 2012



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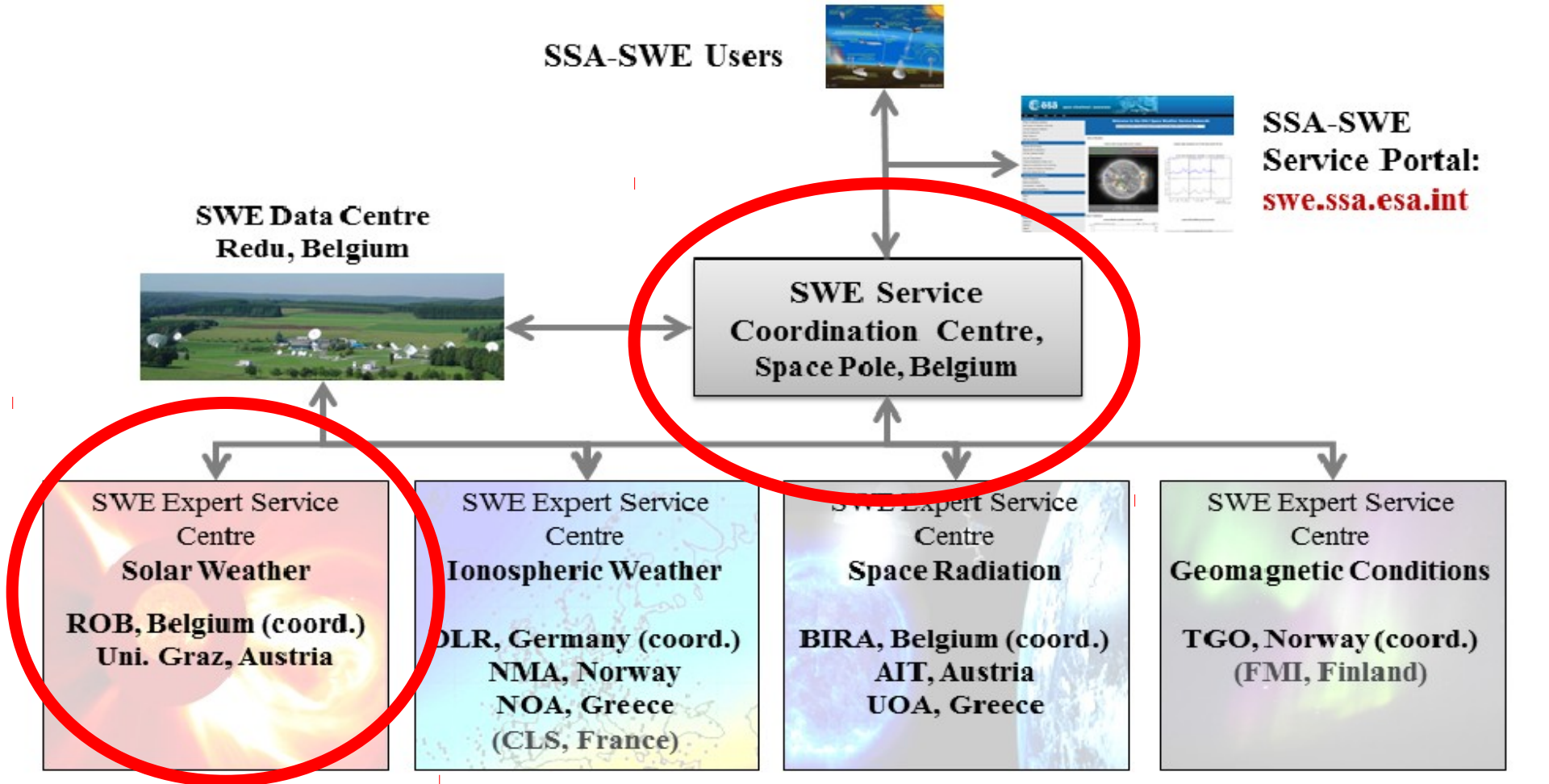
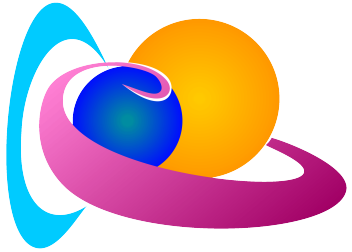


ESA-SSA SWE



ESA-SSA:

- Optional program: phase 2 started recently
- 3 Segments: Space Weather, Near Earth Objects, Space Surveillance and Tracking

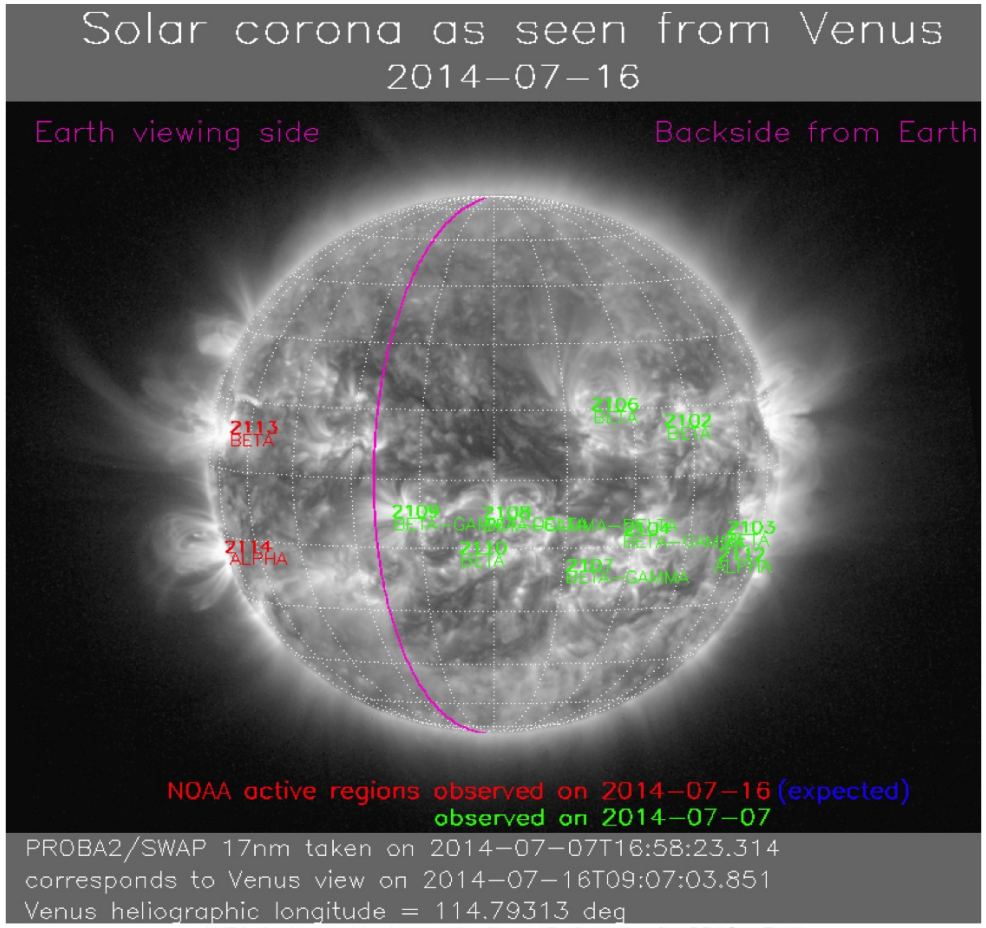
SWE:

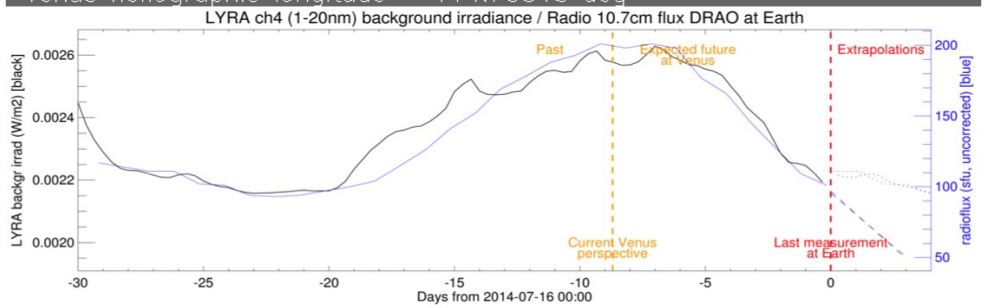
- SSCC operation from Space Pole Brussels (BISA lead) (awaiting ESA decision on follow-on contract)
- ESC Solar Weather coordination (awaiting ESA decision on follow-on network development contract)

Concrete activities:

- GAIA launch and insertion manoeuvre support (December, January)
- Support for Venus Express Aerobreaking campaign (May through to July, 2014)

VEX Aerobreaking support



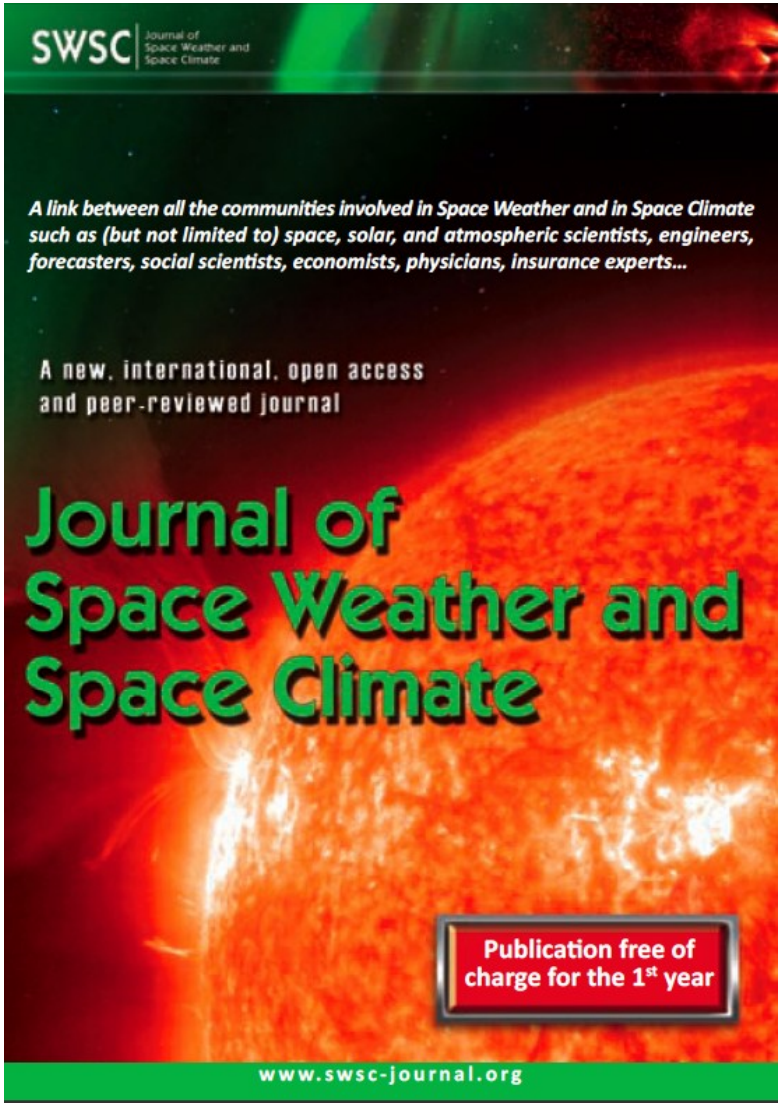


Observations from earth advanced in time for Venus relevance:

- SWAP image with AR annotation
- F10.7 and LYRA background irradiance

Solar activity reports adjusted for Venus position (CME effectiveness)

Dissemination



cost ES0803

- Open access journal realized by COST ES0803
- Financially supported by STCE (Belgium)
- Secretarial office: STCE (Belgium)
- http://www.swsc-journal.org

Dissemination: European Space Weather Week

11th edition!

When: November 17 – 21, 2014

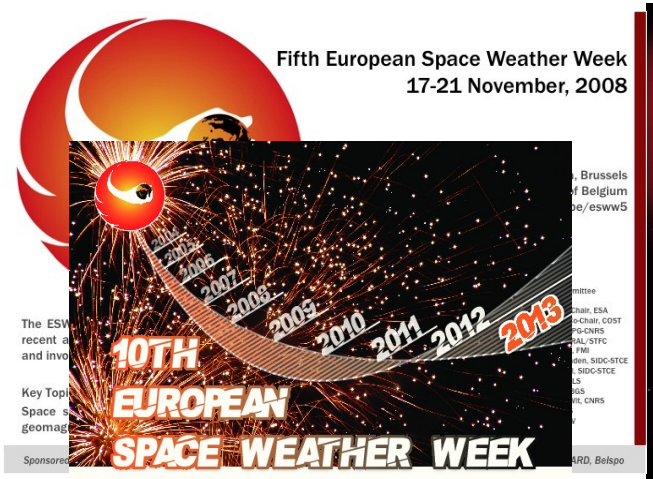
Where: Liège, Belgium

Web: www.sidc.be/esww11

- This year's event will again highlight key innovations in space weather research, applications and services.
- The meeting will also focus on current challenges and actions necessary in moving towards a sustainable Space Weather Infrastructure able to meet the requirements of a diverse end-user community.

Dissemination: European Space Weather Week

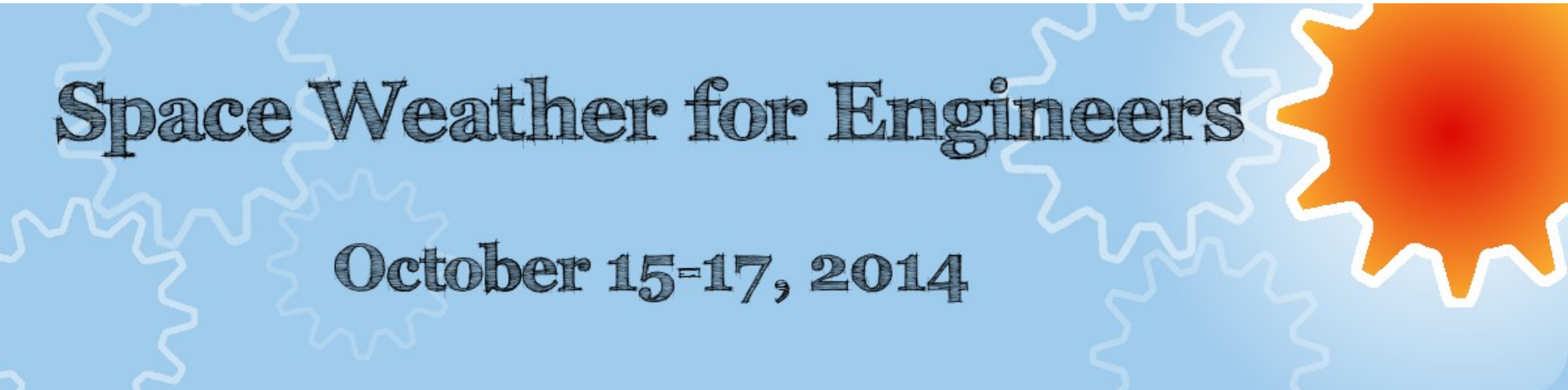
Previous editions



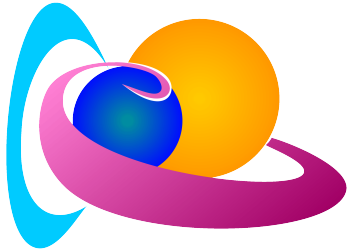
Dissemination: SW4E

Space Weather School

- Targeted at engineering personnel from Industry
- Aims to increase awareness of available space weather data that can help them in safeguarding their infrastructure and operations
- First edition 2013
- Second edition 2014, October 15-17
  HF communication, trans-ionospheric propagation and GNSS signal precision
- http://www.stce.be/sw4e/



Data for SW operations

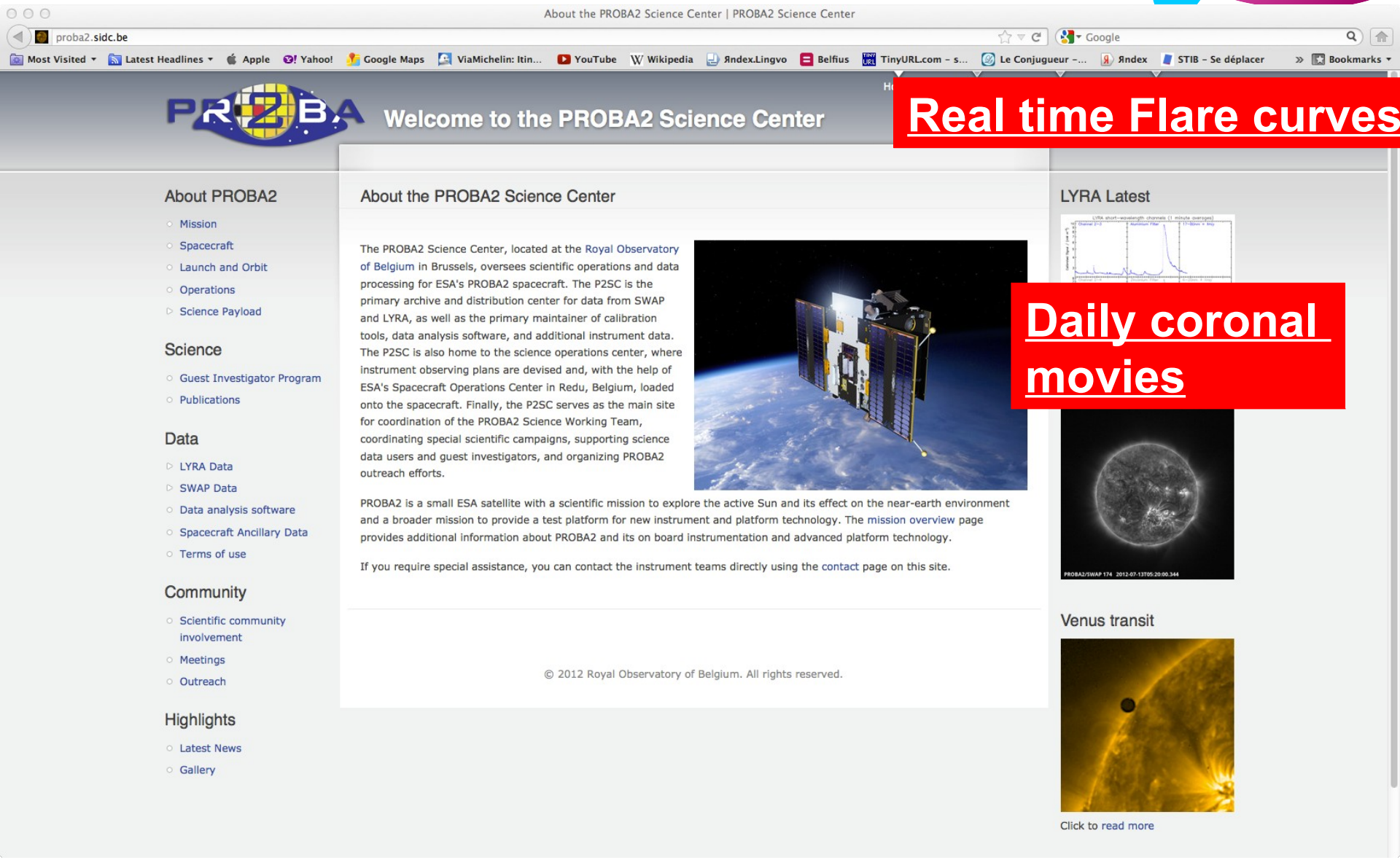


1. PROBA2 – SWAP & LYRA
2. Humain – Radio data
3. USET – White light and chromosphere
4. SDO – Data archive and dissemination

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.sidc.be



Data for SW operations

1. PROBA2 – SWAP & LYRA
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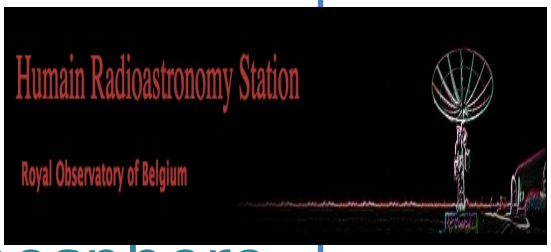


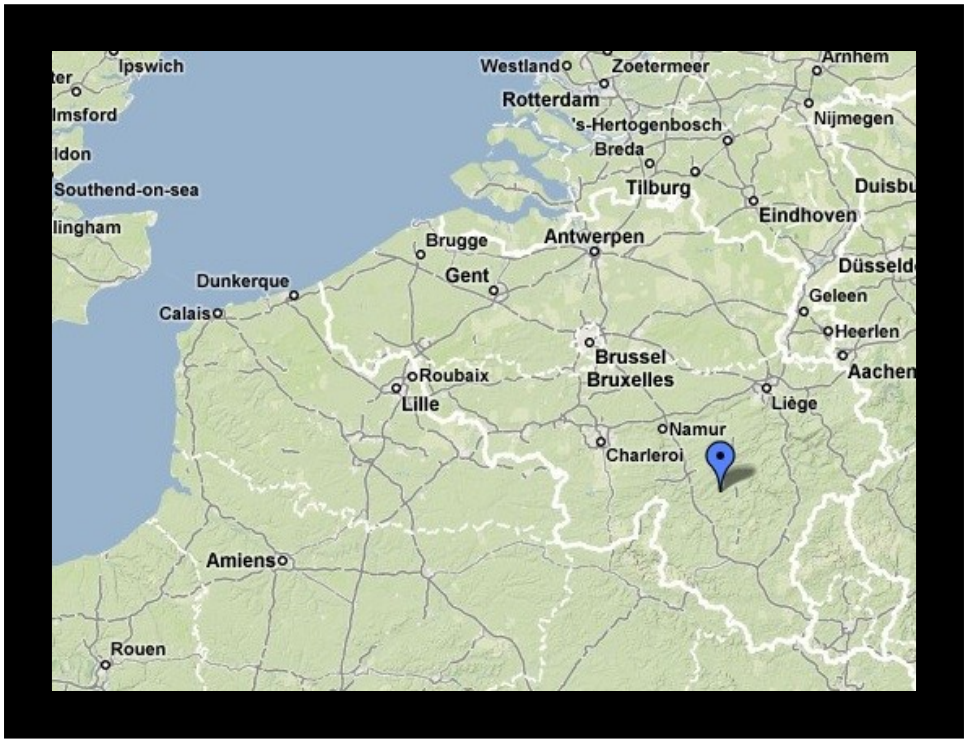
Humain Radioastronomy Station

Royal Observatory of Belgium

Provide near real-time monitoring of solar activity for the SIDC forecasts.

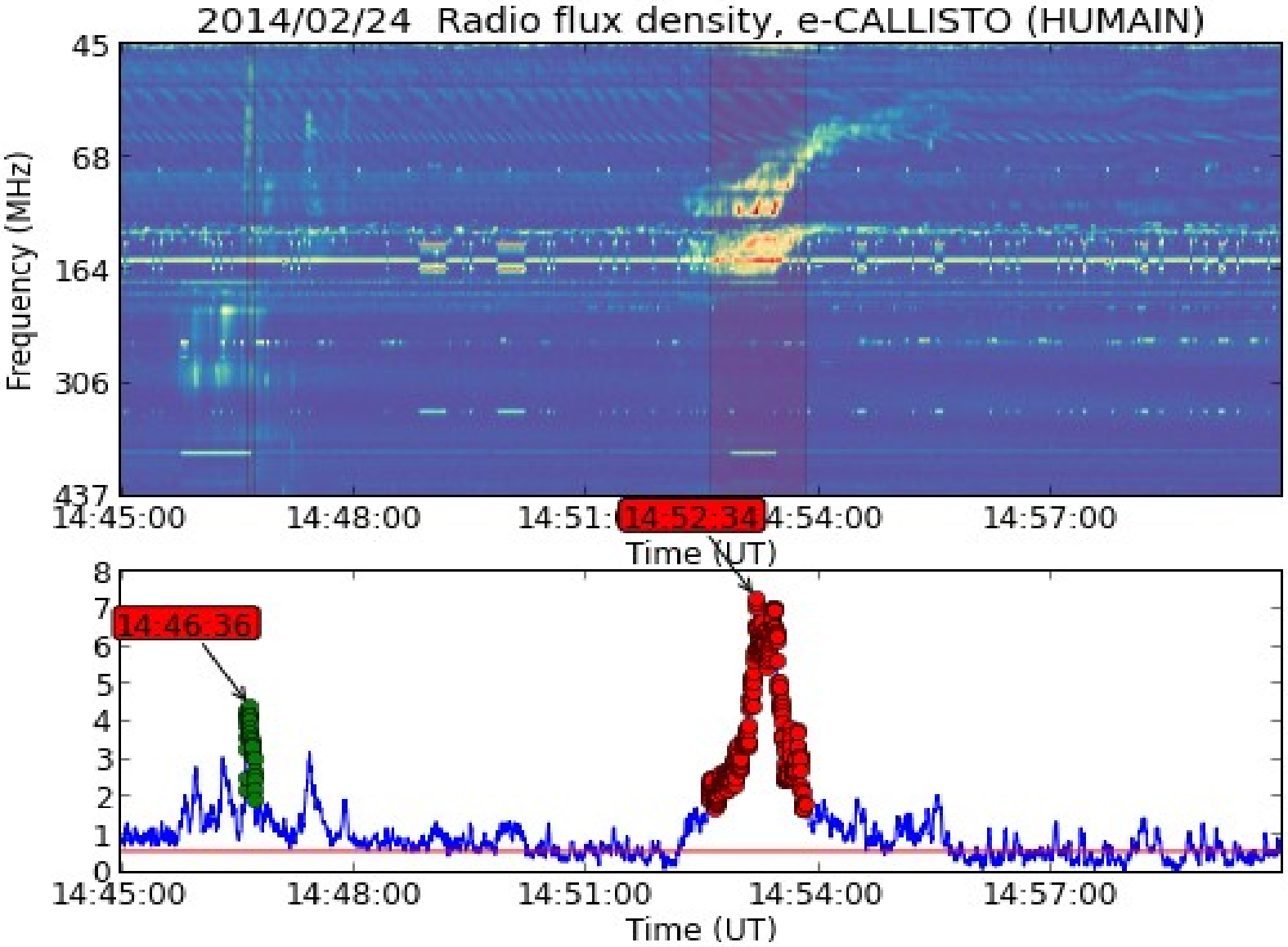
Two kinds of instruments:

- 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
- Automated Burst detection



- Project started in 2008: refurbishment
- Planned switch to digital receivers
- Part of the CALLISTO network
- Website: **http://sidc.be/humain**
- Info: Christophe.marque@oma.be

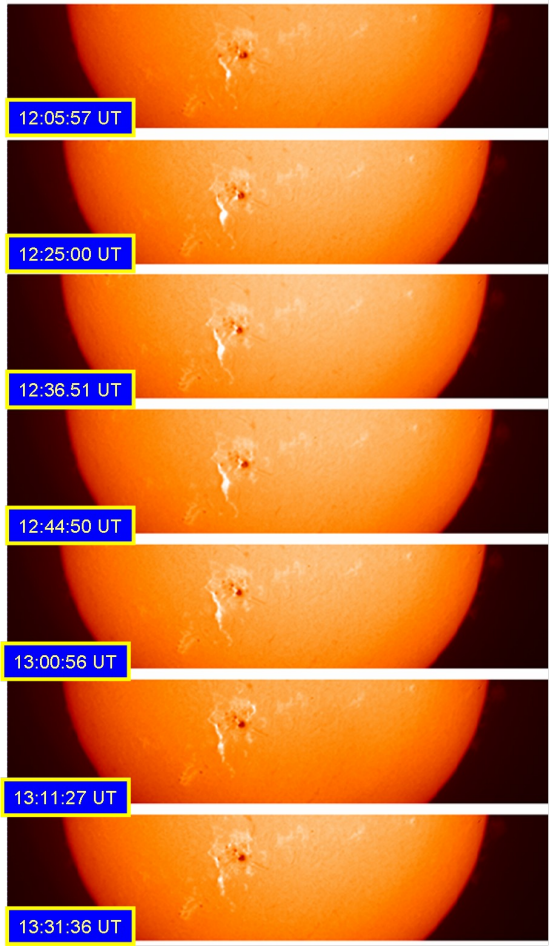
Autom. Burst detection



Data for SW operations

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

Solar telescope USET



White light	Quick-look & FITS ffiles
H-alpha	Quick-look & FITS files
Sunspot drawing	Digitization completed
Ca II K-images	Successful first light on July 11, 2012!

Data is available via website: www.sidc.be

Planned: production of USSPS data in coordination with Catania

Info: frederic.clette@oma.be

Data for SW operations

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

SDO
SIDC

SDO 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.
- Info: verodelo@oma.be