# THE SIDC

## A EUROPEAN PREDICTION CENTER

David Berghmans, E. Robbrecht, R. Van der Linden
Royal Observatory of Belgium

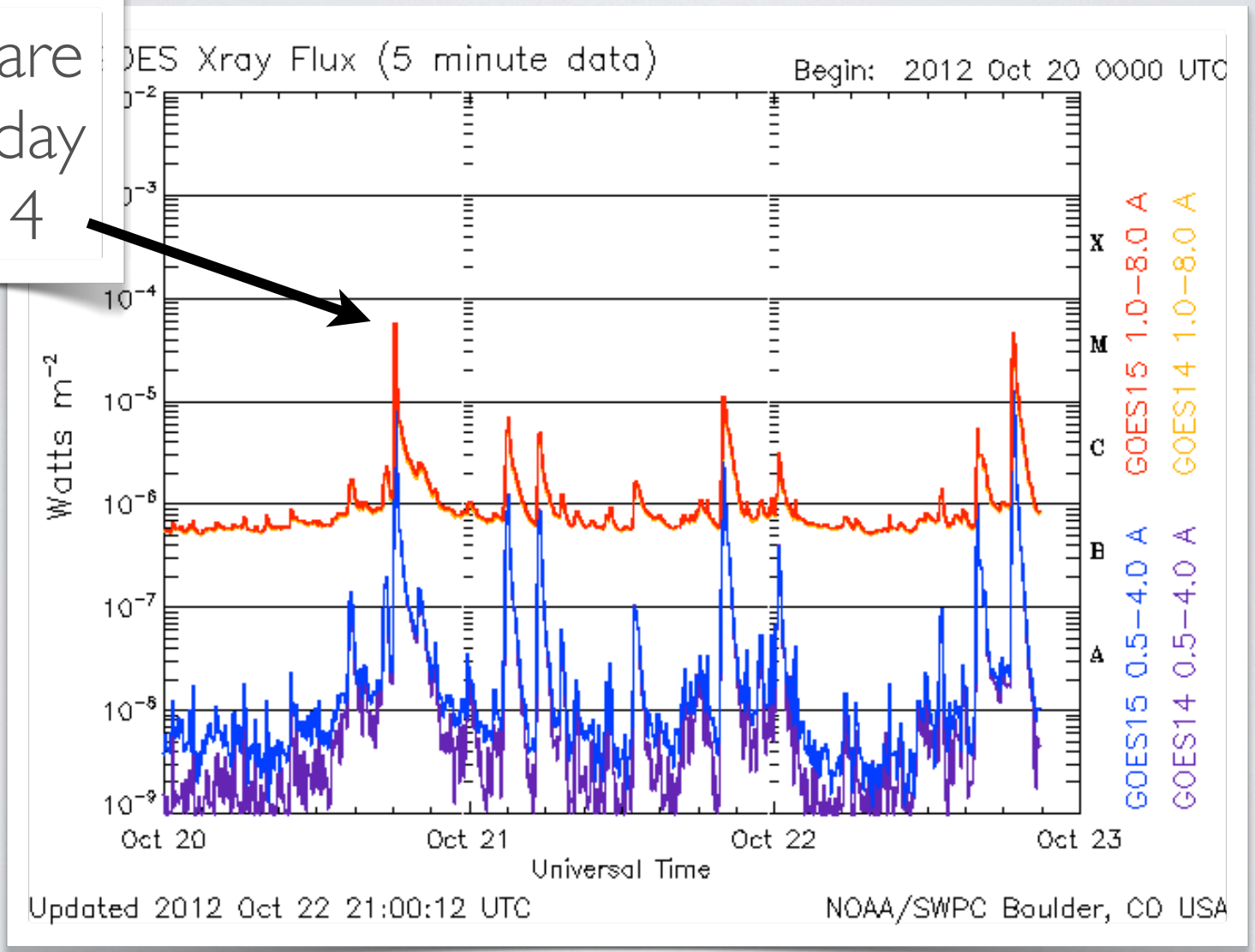
another approach of the talk

# TODAY'S SPACE WEATHER

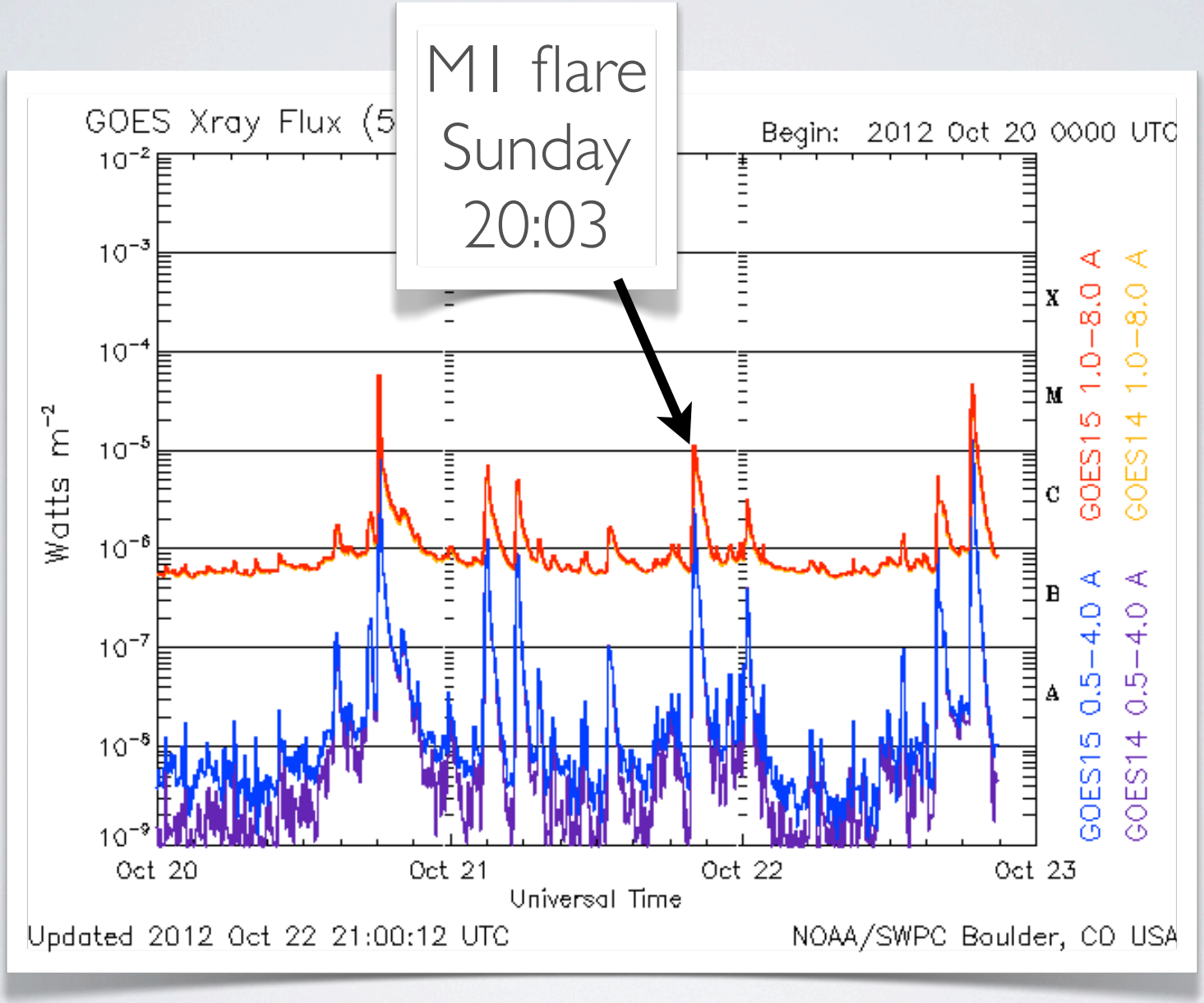
David Berghmans, E. Robbrecht, R. Van der Linden
Royal Observatory of Belgium

# Flaring activity!

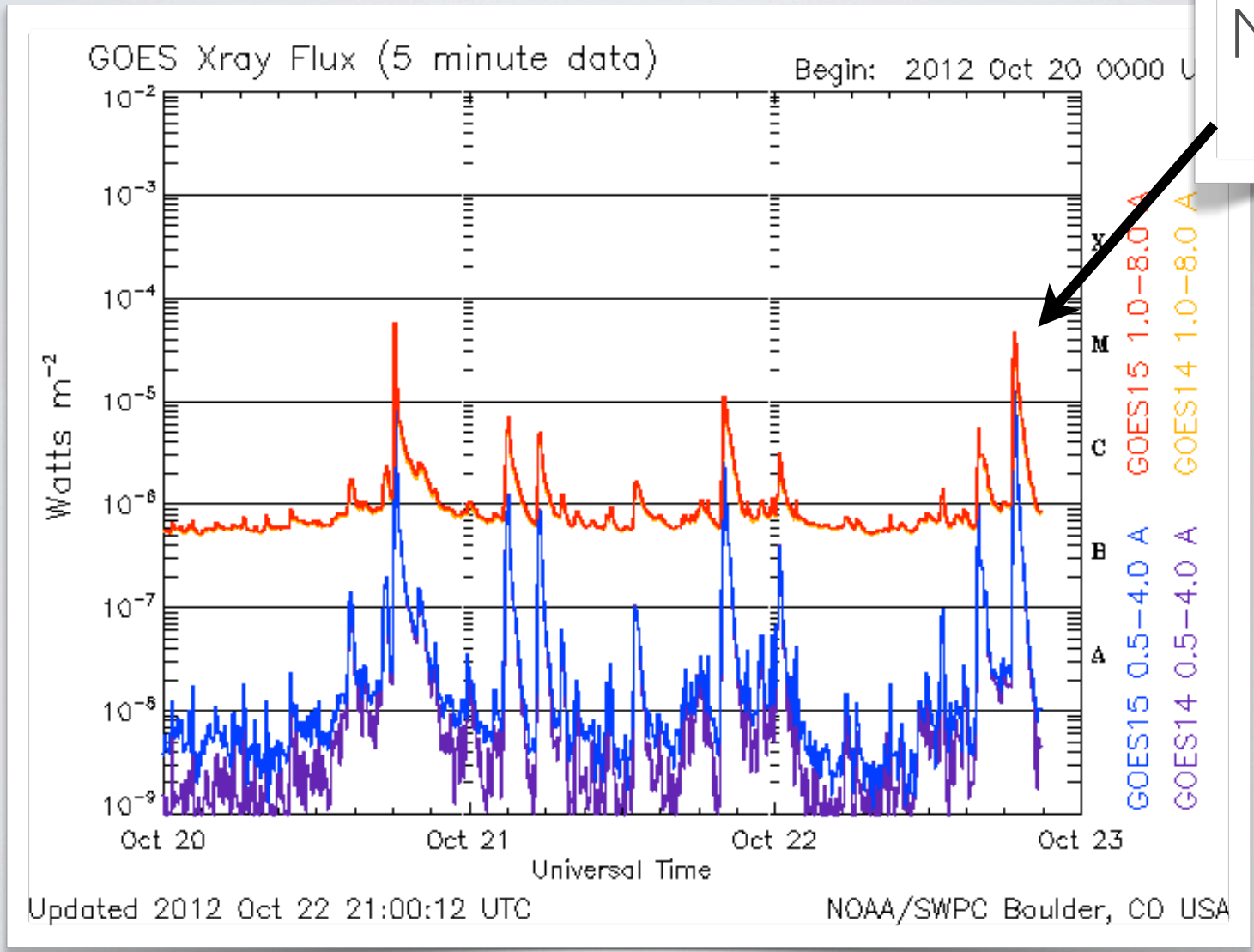
M9 flare
Saturday
18:14



# Flaring activity!



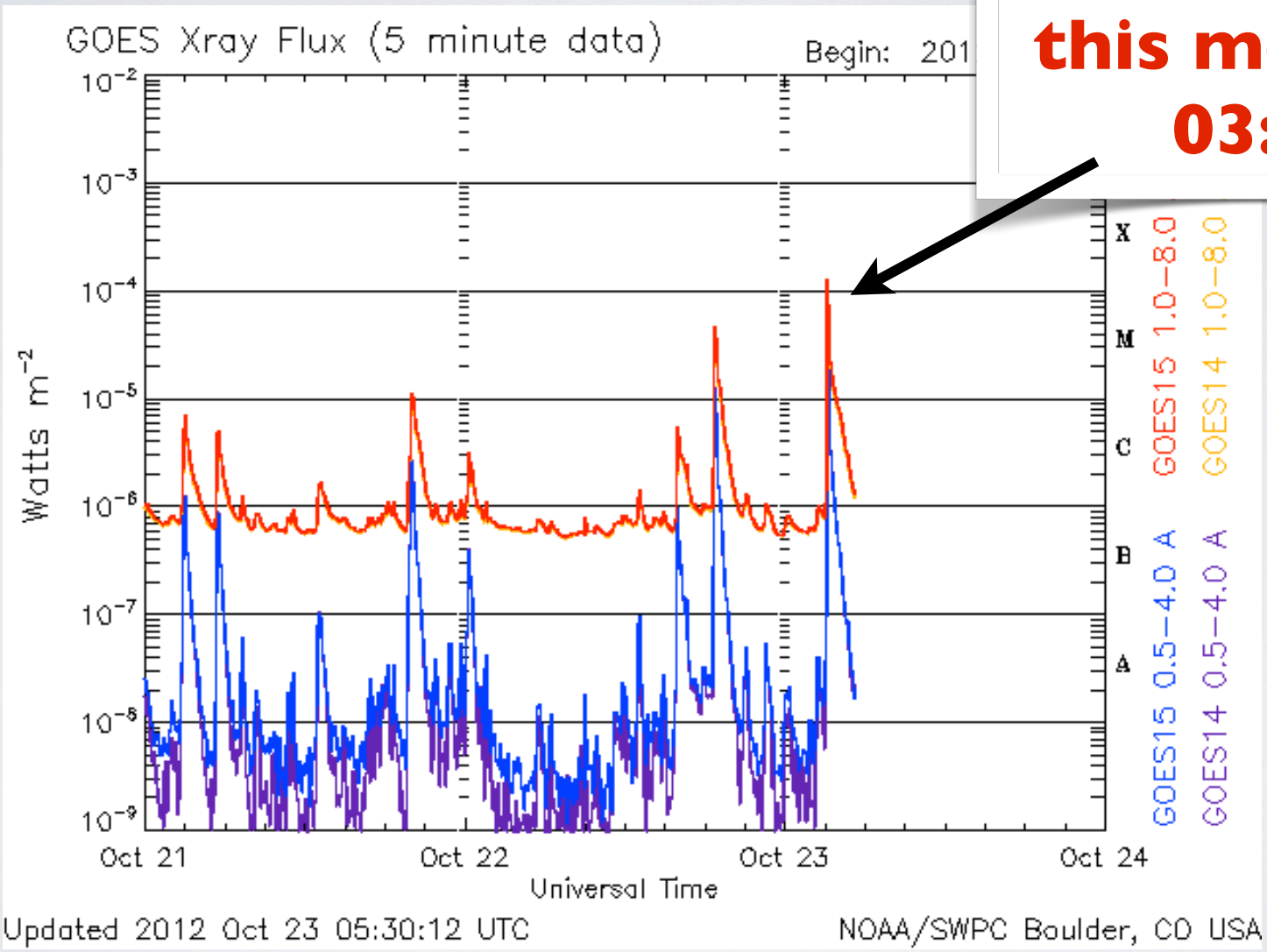
# Flaring activity!




M5 flare
Monday
18:15

# Flaring activity!

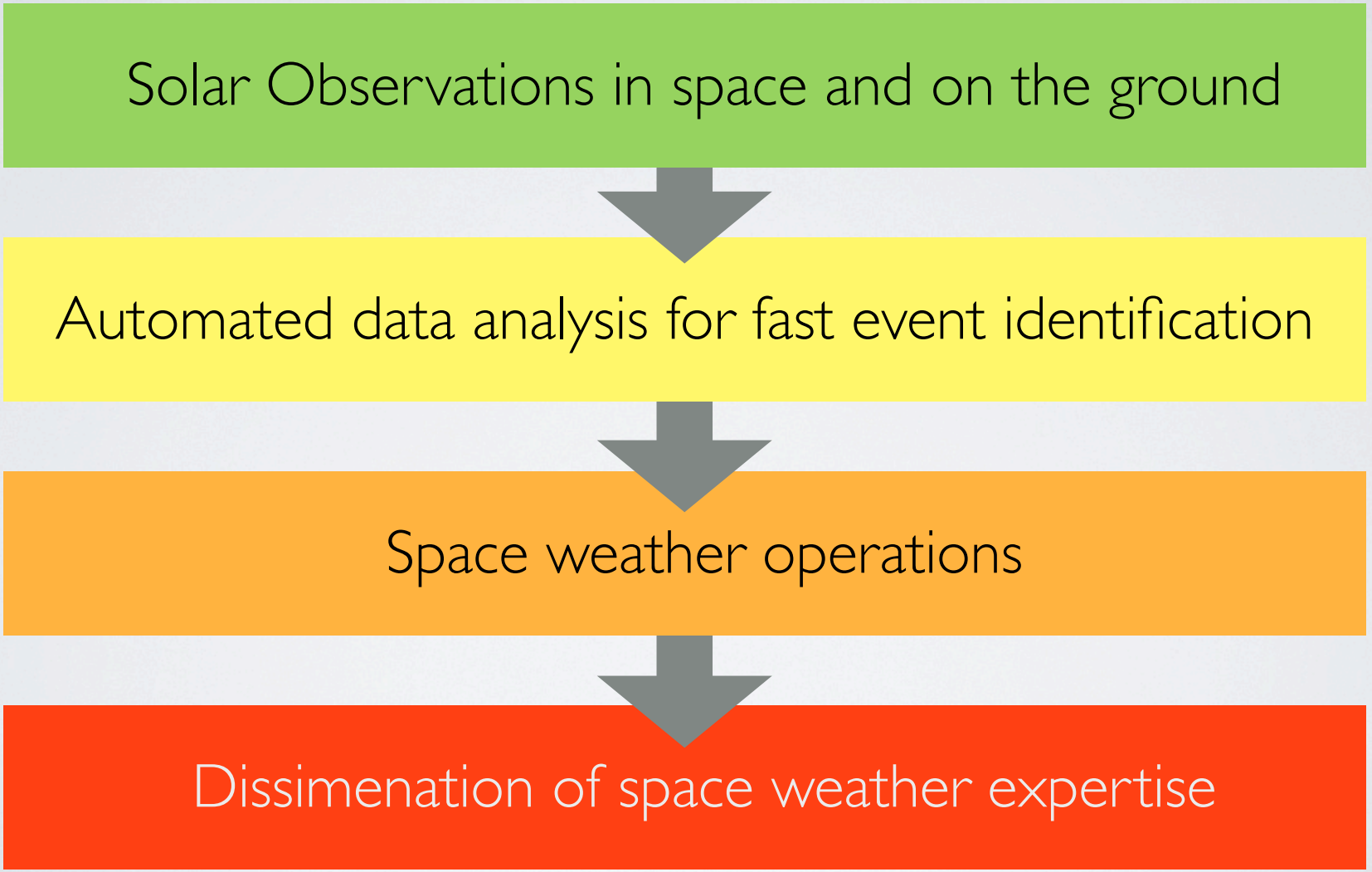
**X1.8 flare this morning 03:17**



# THE SOLAR INFLUENCES DATA ANALYSIS CENTER

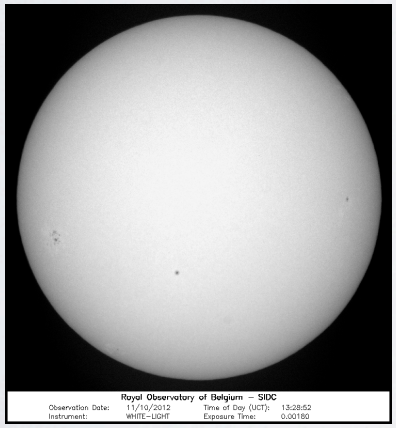
The SIDC is a team of about 40 people at the ROYAL OBSERVATORY OF BELGIUM, located in the green outskirts of Brussels.

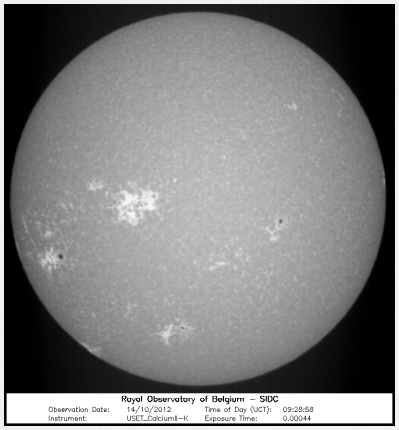
# SIDC RUNS A CHAIN OF SPACE WEATHER ACTIVITIES

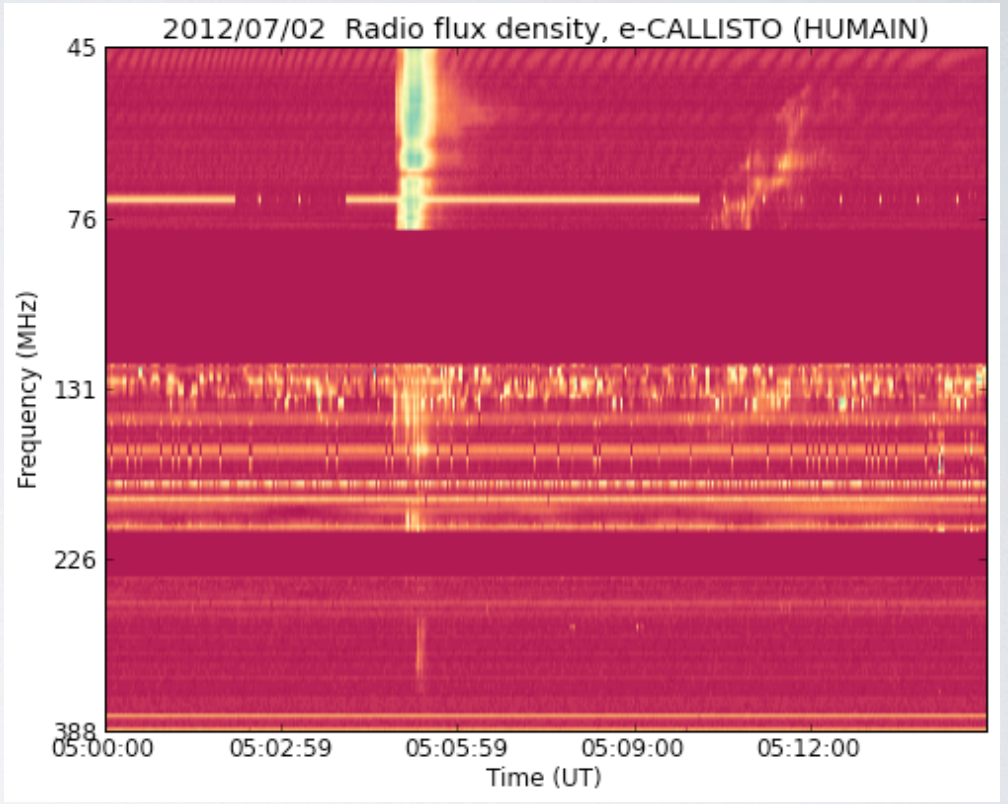


Solar Observations on the ground

# SIDC OBSERVES THE SUN FROM THE GROUND IN THE VISIBLE LIGHT AND RADIO



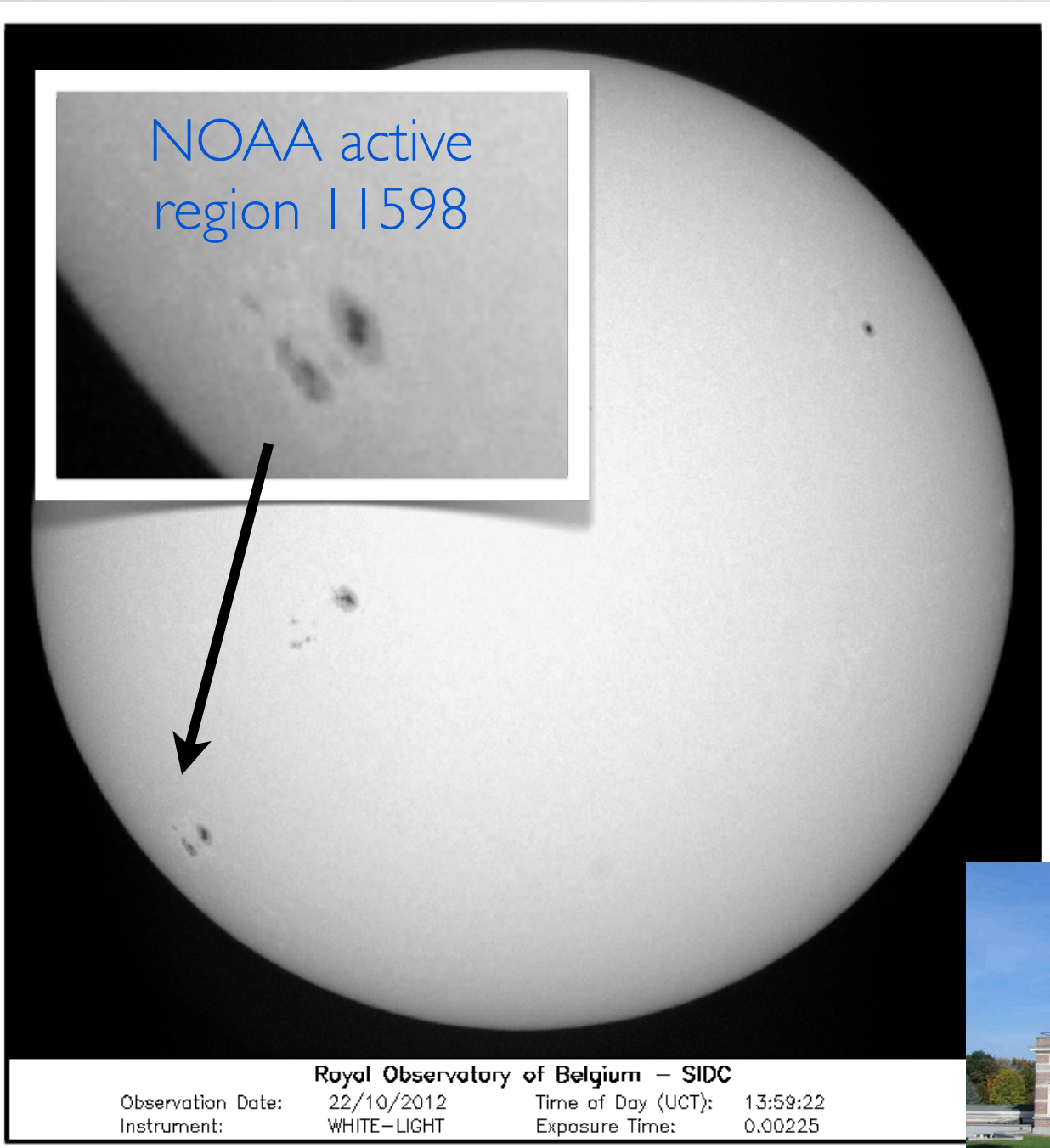




http://sidc.be/uset

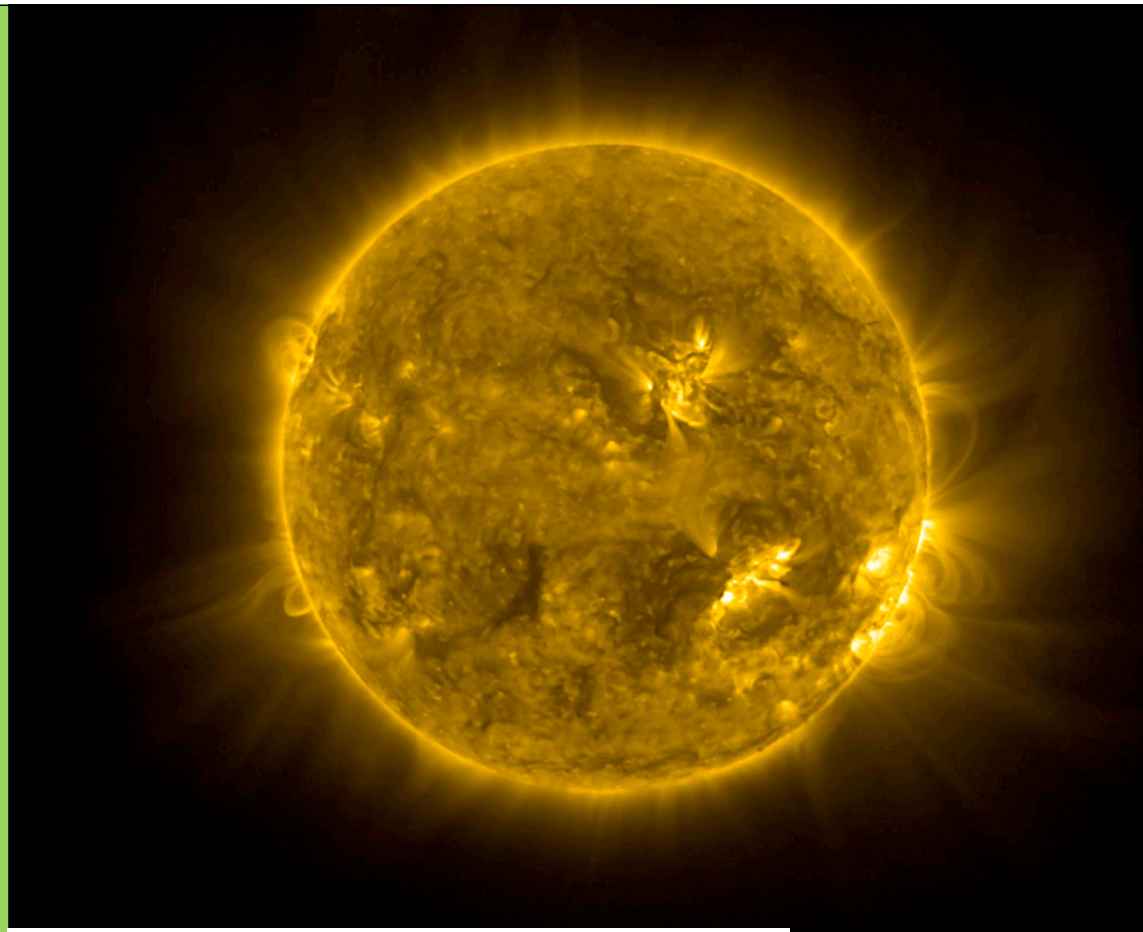
http://sidc.be/humain

# Solar Observations on the ground

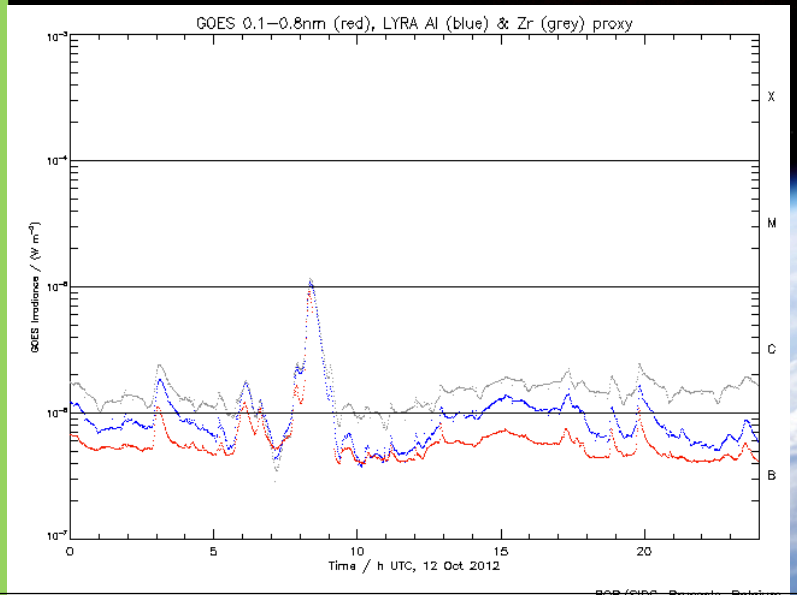



http://sidc.be/uset

Solar Observations in space

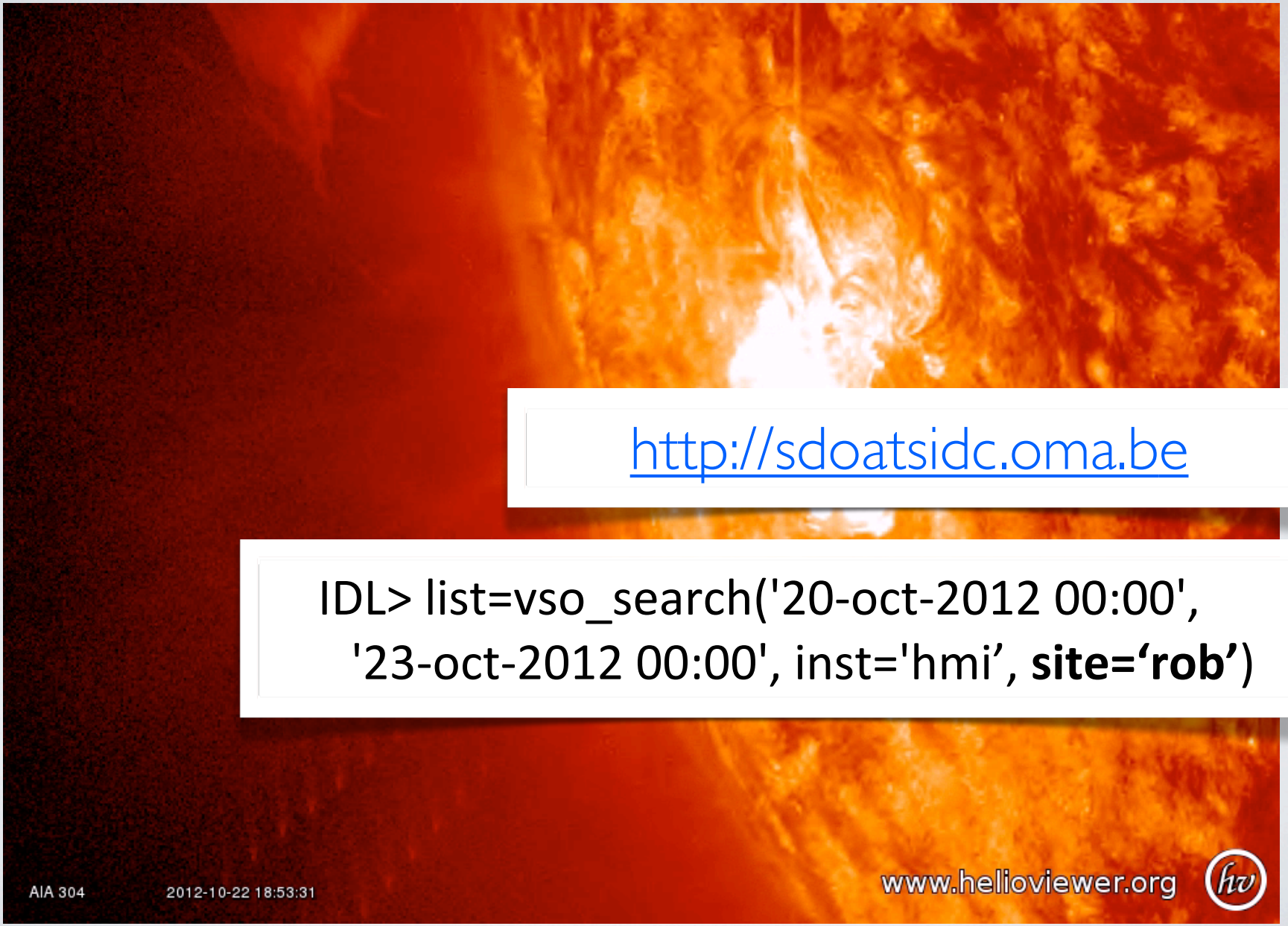


# SIDC Operates the SWAP and LYRA instruments onboard PROBA2




http://sidc.be/proba2

# NOAA active region 11598




http://sdoatsidc.oma.be

```
IDL> list=vso_search('20-oct-2012 00:00',
  '23-oct-2012 00:00', inst='hmi', site='rob')
```

Automated data analysis for fast event identification

# CACTUS 2.5.0

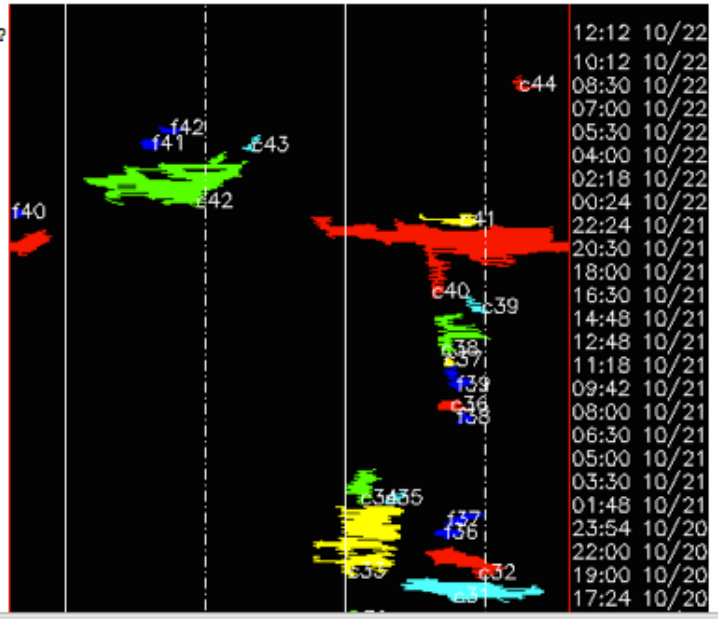
A software package for 'Computer Aided CME Tracking'

http://sidc.be/cactus

## CMEs detected by Cactus

```
:Issued: Mon Oct 22 14:40:33 2012
:Product: CACTus catalogue (http://sidc.be/cactus)
#-------------------------------------------------------------------------
# Instrument: LASCO| Detector: c2 # Instrument: LASCO| Detector: c3
# Threshold : 0.30 | Factor : 2 | Minimal CME width: 5
#
  first c2: 2012/10/16  00:00:06.411 23458707.fts
  last  c2: 2012/10/22  12:12:07.934 23459526.fts
  first c3: 2012/10/16  00:06:06.407 33332833.fts
  last  c3: 2012/10/22  12:06:06.943 33333589.fts
#
#-------------------------------------------------------------------------
# Output: Detected cmemap with the following characteristics:
#
#    CME: CME number
#   Flow: Flow number. Flows are suspicious detections, their color in the detectionmap is dark blue
#     t0: onset time, earliest indication of liftoff
#    dt0: duration of liftoff (hours)
#     pa: principal angle, counterclockwise from North (degrees)
#     da: angular width (degrees),
#      v: median velocity (km/s)
#     dv: variation (1 sigma) of velocity over the width of the CME
#   minv: lowest velocity detected within the CME
#   maxv: highest velocity detected within the CME
#  halo?: II if da>90, III if da>180, IV if da>270, indicating potential halo/partial halo CME
#
```

| # CME | t0 | dt0 | pa | da | v | dv | minv | maxv | halo? |
|---|---|---|---|---|---|---|---|---|---|
| 0044 | 2012/10/22 09:36 | 01 | 116 | 014 | 0384 | 0034 | 0324 | 0424 | |
| 0043 | 2012/10/22 04:48 | 01 | 300 | 010 | 1475 | 0456 | 0643 | 1736 | |
| 0042 | 2012/10/22 00:36 | 04 | 245 | 104 | 0305 | 0026 | 0243 | 0348 | II |
| 0041 | 2012/10/21 21:24 | 01 | 067 | 036 | 0619 | 0328 | 0139 | 0905 | |
| 0040 | 2012/10/21 21:24 | 07 | 075 | 192 | 0449 | 0064 | 0273 | 0606 | III |
| 0039 | 2012/10/21 16:36 | 01 | 085 | 016 | 0325 | 0019 | 0304 | 0357 | |
| 0038 | 2012/10/21 14:48 | 03 | 076 | 034 | 0235 | 0154 | 0139 | 0686 | |
| 0037 | 2012/10/21 12:12 | 01 | 069 | 008 | 0225 | 0021 | 0206 | 0259 | |
| 0036 | 2012/10/21 09:12 | 01 | 070 | 018 | 0337 | 0265 | 0138 | 0976 | |
| 0035 | 2012/10/21 03:24 | 01 | 033 | 012 | 0142 | 0033 | 0140 | 0222 | |
| 0034 | 2012/10/21 03:24 | 02 | 012 | 022 | 0141 | 0060 | 0136 | 0260 | |
| 0033 | 2012/10/20 23:36 | 07 | 009 | 056 | 0142 | 0003 | 0136 | 0152 | |
| 0032 | 2012/10/20 18:48 | 04 | 078 | 050 | 0291 | 0097 | 0143 | 0446 | |
| 0031 | 2012/10/20 18:48 | 02 | 082 | 090 | 0345 | 0074 | 0192 | 0462 | |
| 0030 | 2012/10/20 16:12 | 01 | 006 | 006 | 0138 | 0000 | 0137 | 0139 | |
| 0029 | 2012/10/19 21:24 | 01 | 068 | 026 | 0290 | 0133 | 0144 | 0624 | |
| 0028 | 2012/10/19 19:00 | 02 | 326 | 078 | 0413 | 0069 | 0238 | 0543 | |
| 0027 | 2012/10/19 18:48 | 01 | 310 | 014 | 1524 | 0065 | 1388 | 1602 | |
| 0026 | 2012/10/19 16:48 | 01 | 059 | 008 | 0553 | 0604 | 0135 | 1736 | |
| 0025 | 2012/10/19 14:36 | 01 | 168 | 014 | 0976 | 0402 | 0679 | 1689 | |
| 0024 | 2012/10/19 14:24 | 01 | 083 | 016 | 1041 | 0539 | 0131 | 1736 | |
| 0023 | 2012/10/19 13:36 | 01 | 252 | 010 | 0473 | 0241 | 0137 | 0868 | |
| 0022 | 2012/10/19 08:48 | 01 | 310 | 010 | 0139 | 0002 | 0137 | 0143 | |



Automated data analysis for fast event identification

# CACTUS

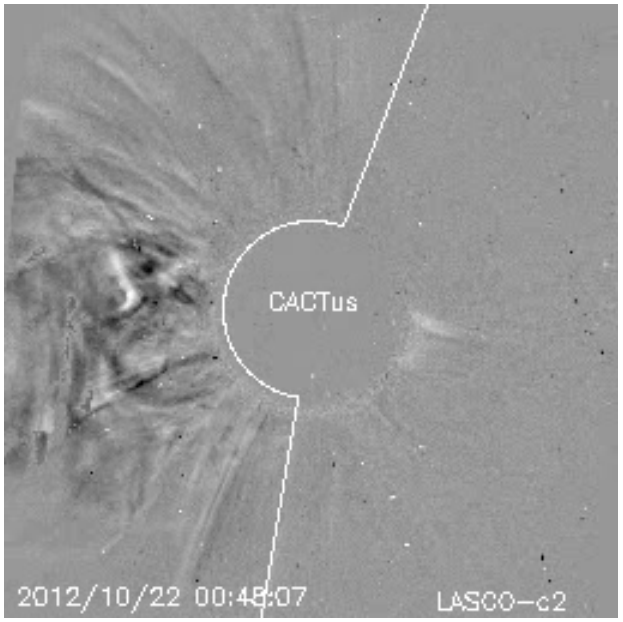
A software package for 'Computer Aided CME Tracking'

http://sidc.be/cactus

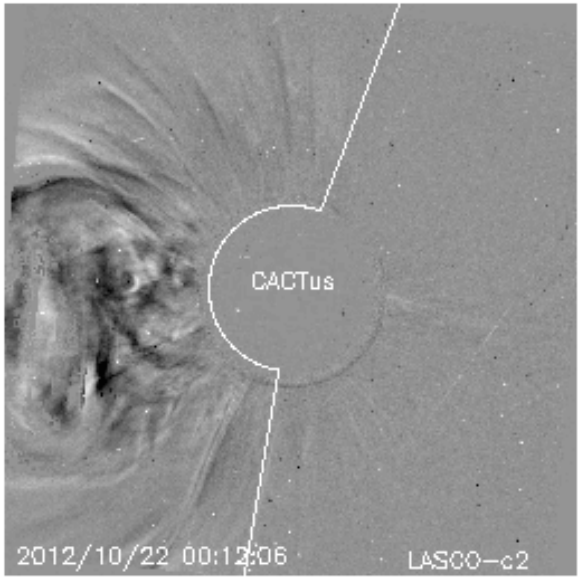
## Details and graphs for CME0040

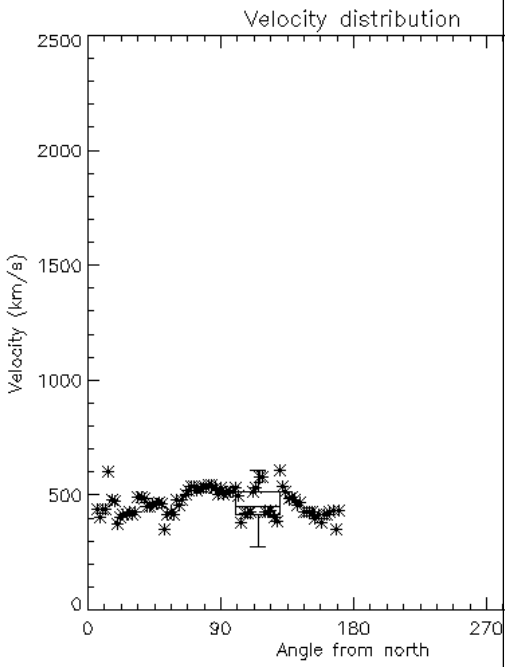
| # CME | t0 | dt0 | pa | da | v | dv | minv | maxv | halo? |
|---|---|---|---|---|---|---|---|---|---|
| 0040 | 2012/10/21 21:24 | 07 | 075 | 192 | 0449 | 0064 | 0273 | 0606 | III |

**CME Movie :: Download ::**




**Sample Image**



Automated data analysis for fast event identification

http://sidc.be/sofast

SoFAST Diagostics

solwww.oma.be/users/sol/latestEvents/sofast_out.html

SSA Radio Science @ STCE beursduivel.be David Bergh...r Citations Appelboom ...m Auctions The Top 5 Fr... Cirtex Blog The Astrophysical Journal hoogstamboomgaard

SoFAST Diagostics

# SoFAST 1.2.0

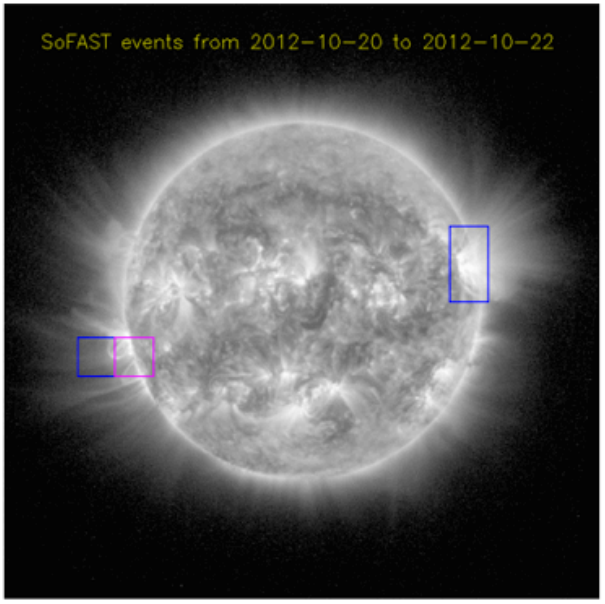
The 'Solar Flare Automated Search Tool'

## EUV-flares detected by SoFAST

```
:Issued: Mon Oct 22 19:32:50 2012
:Product: SoFAST catalogue (http://www.sidc.be/sofast)
#-------------------------------------------------------------------------
# Instrument: SWAP| Detector: CMOS APS 1024 x 1024
# Flare-threshold : 2 | Rebinsize : 16 | Maxhits : 4 | Offset : 65
# Modus : (1) SW service
#
  first SWAP image this run: swap_lv1_20121020_000059.fits
  last  SWAP image this run: swap_lv1_20121022_171156.fits
#
#
#-------------------------------------------------------------------------
# Output: Detected EUV-flare list with the following characteristics:
#
#   EUV FLARE:          FLARE number
#   date:               Day of observation
#   start:              Start time, earliest indication of detection (hh:mm UT)
#   end:                End time, last indication of detection (hh:mm UT)
#   pos:                Derived position (Heliographic coordinates)
#   size:               Spatial size of event in number of macropixels
#   #images:            Duration of event in number of images (dt)
#   EUV-significance:   EUV relative variability, in %.
#                       Flare-related activity typically shows EUV-significance >8%
#
# EUV FLARE |     date     | start | end   |    pos    | size | #images | EUV-significance
  006       | 2012-10-21   | 22:29 | 22:49 |  N19W86   | 002  |   006   |      004 %
  005       | 2012-10-21   | 21:50 | 22:49 |  S18E83   | 001  |   018   |      010 %
  004       | 2012-10-21   | 05:14 | 05:27 |  S18E83   | 001  |   006   |      004 %
  003       | 2012-10-21   | 04:43 | 05:05 |  S18E83   | 001  |   005   |      003 %
  002       | 2012-10-20   | 19:29 | 19:49 |  S18E83   | 001  |   009   |      005 %
  001       | 2012-10-20   | 18:11 | 18:35 |  S18E83   | 002  |   010   |      016 %
```

**CLICK IMAGE**
to see the complete SWAP movie during this run (with indication of detected events)

**PROBA2 is currently in eclipse season. SoFAST detections might be affected**



Automated data analysis for fast event identification

SoFAST Diagostics

solwww.oma.be/users/sol/latestEvents/EUVflare_001/FLARE.html

SSA Radio Science @ STCE beursduivel.be David Bergh...r Citations Appelboom ...m Auctions The Top 5 Fr... Cirtex Blog

SoFAST Diagostics

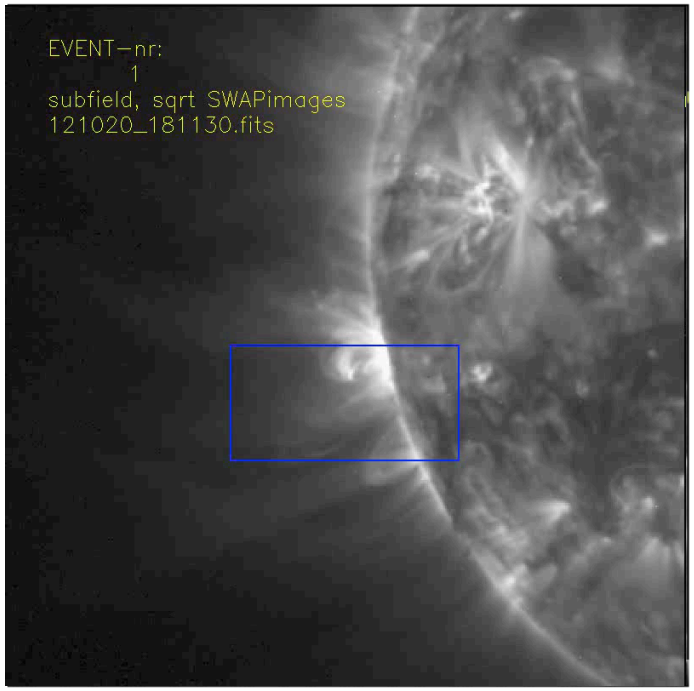
# SoFAST 1.2.0

The "Solar Flare Automated Search Tool"

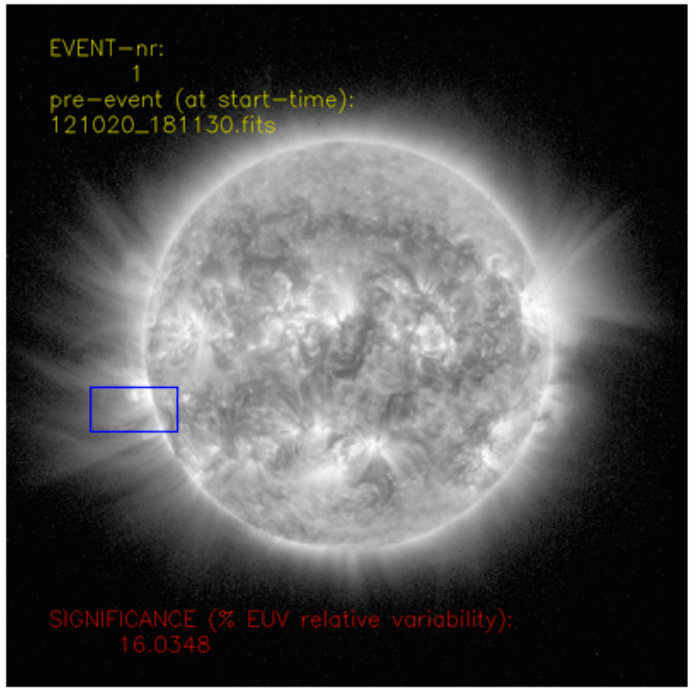
## Details and graphs for EUVflare_001

| # EUV FLARE | date | start | end | pos | size | #images | EUV-significance |
|---|---|---|---|---|---|---|---|
| 001 | 2012-10-20 | 18:11 | 18:35 | S18E83 | 002 | 010 | 016 % |

**EUV flare Movie :: Enlarge and/or Download ::**



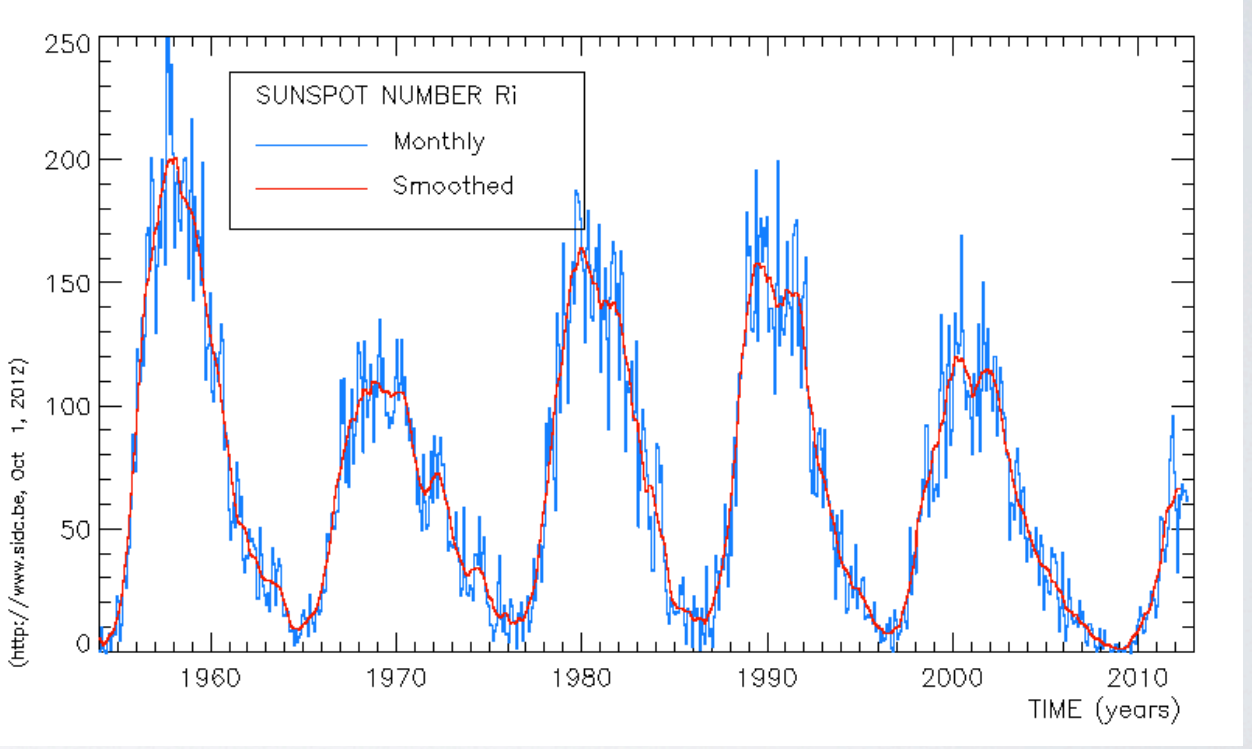

**Sample Image**




2012-10-20

Space weather operations at SIDC

# SIDC PRODUCES THE INTERNATIONAL SUNSPOT INDEX



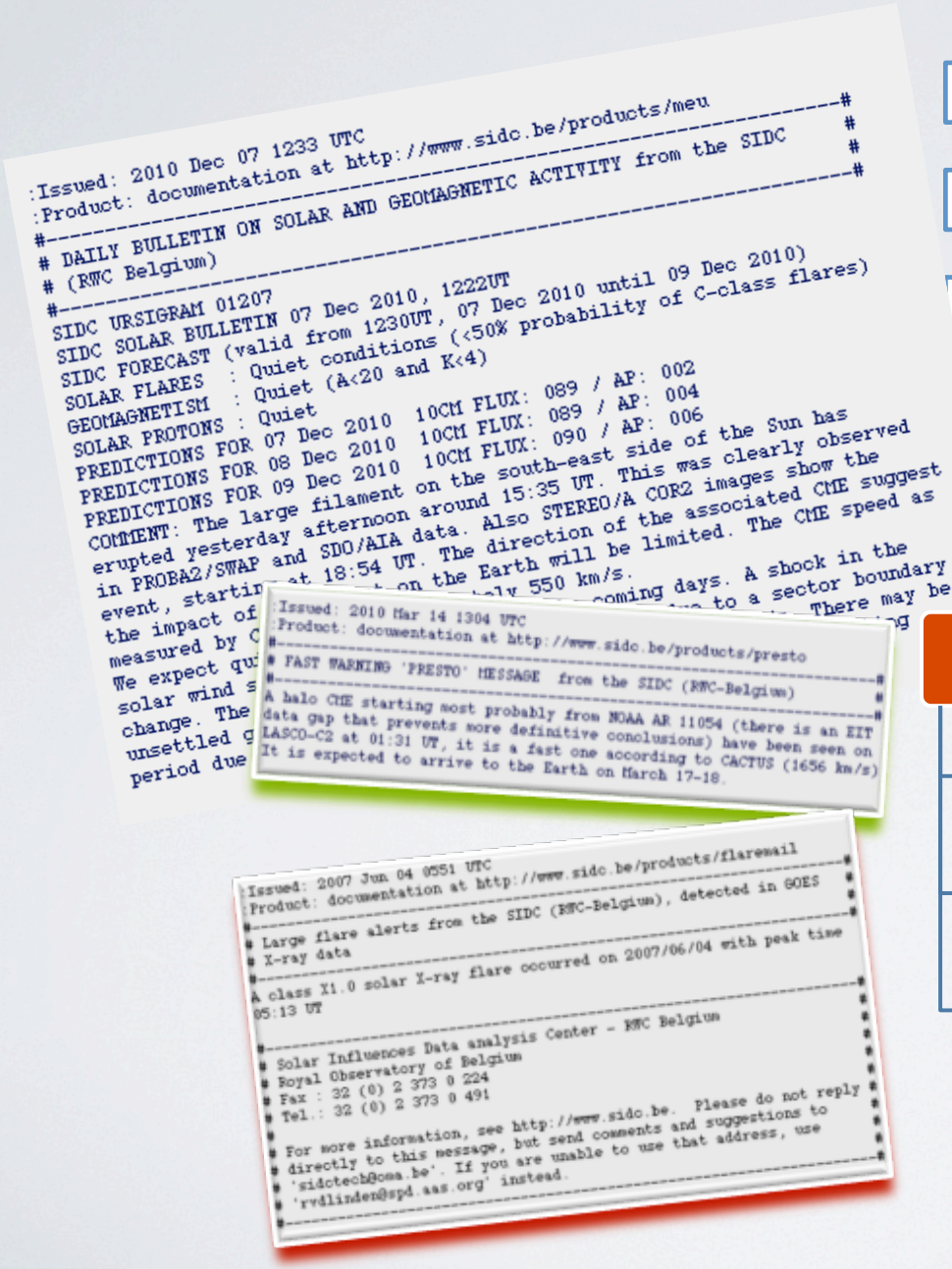

ICSU WORLD DATA SYSTEM

ICSU
International Council for Science

http://sidc.be/silso

Space weather operations at SIDC

# REGIONAL WARNING CENTER BELGIUM



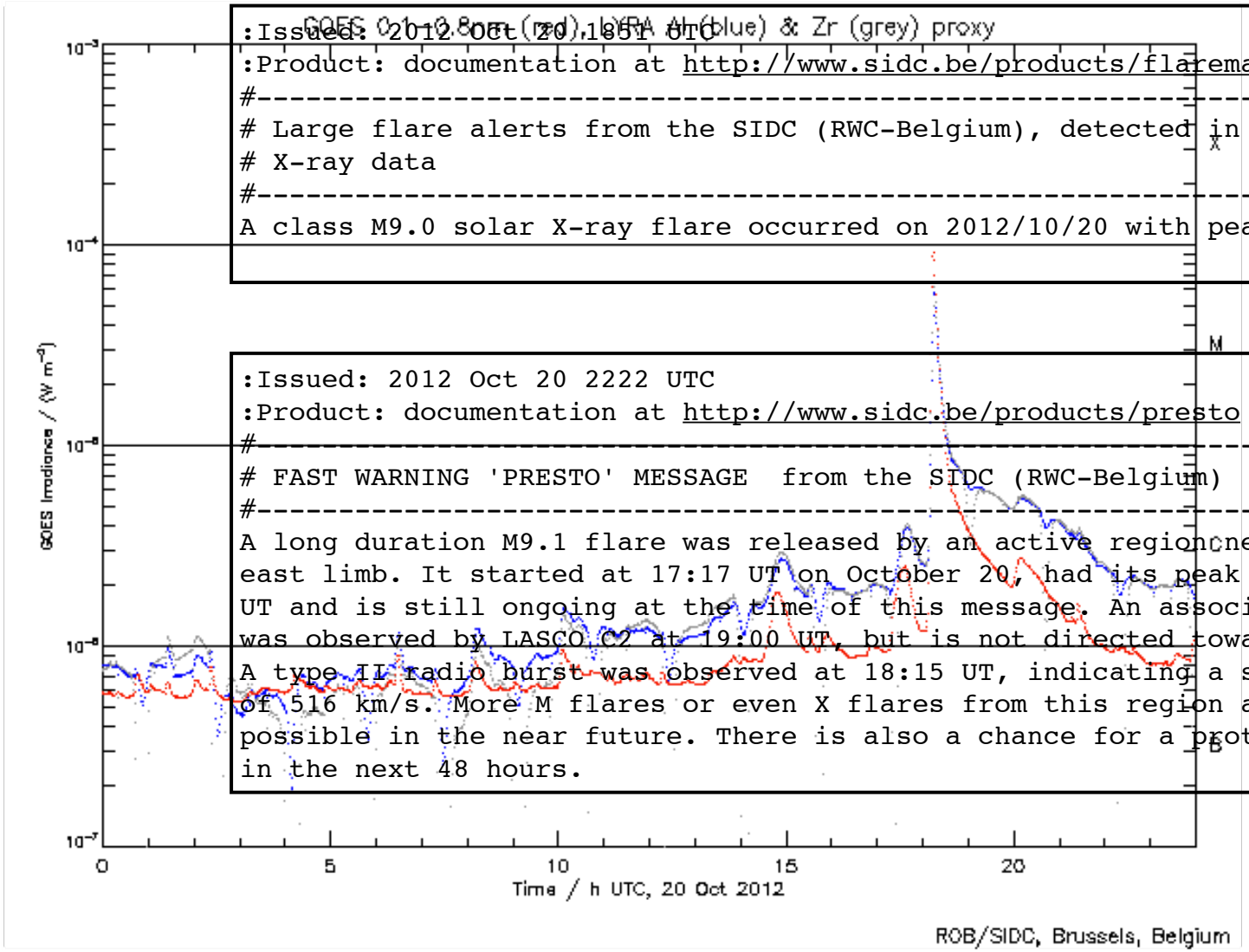

- Daily @12:30UT
- Email
- Fixed format – software readable
- Free and Complete information

| Flare | Presto | CME |
|---|---|---|
| >M5 | Noticeable event | >150 degrees |
| Email | Email | Email |
| Sms* | Sms* | |

# LYRA onboard PROBA2

http://proba2.sidc.be/ssa

Space weather operations at SIDC




```
:Issued: 2012 Oct 20 1851 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 M9.0 solar X-ray flare occurred on 2012/10/20 with peak time 18:14UT
```

```
:Issued: 2012 Oct 20 2222 UTC
:Product: documentation at http://www.sidc.be/products/presto
#-----------------------------------------------------------#
# FAST WARNING 'PRESTO' MESSAGE  from the SIDC (RWC-Belgium)         #
#-----------------------------------------------------------#
A long duration M9.1 flare was released by an active region near the
east limb. It started at 17:17 UT on October 20, had its peak at 18:14
UT and is still ongoing at the time of this message. An associated CME
was observed by LASCO C2 at 19:00 UT, but is not directed towards Earth.
A type II radio burst was observed at 18:15 UT, indicating a shock speed
of 516 km/s. More M flares or even X flares from this region are
possible in the near future. There is also a chance for a proton storm
in the next 48 hours.
```

Space weather operations at SIDC

# Yesterday's flare was predicted

```
:Issued: 2012 Oct 22 1239 UTC
:Product: documentation at http://www.sidc.be/products/meu
#-----------------------------------------------------------------#
# DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC  #
# (RWC Belgium)                                                   #
#-----------------------------------------------------------------#
SIDC URSIGRAM 21022
SIDC SOLAR BULLETIN 22 Oct 2012, 1233UT
SIDC FORECAST (valid from 1230UT, 22 Oct 2012 until 24 Oct 2012)
SOLAR FLARES   : Active (M-class flares expected, probability >= 50%)
GEOMAGNETISM   : Quiet (A<20 and K<4)
SOLAR PROTONS  : Warning condition
PREDICTIONS FOR 22 Oct 2012  10CM FLUX: 150 / AP: 001
PREDICTIONS FOR 23 Oct 2012  10CM FLUX: 152 / AP: 003
PREDICTIONS FOR 24 Oct 2012  10CM FLUX: 152 / AP: 003
COMMENT: M-flares are likely. NOAA AR 1598 are a high probability to
produce more M-flares. The geomagnetic conditions at the moment are
quiet. We expect them to stay like this for the next 48 hours. The
proton flux has not increased. We issued a warning condition. A proton
event can occur if NOAA AR 1598 stays at the same activity level.
```

> 1500 registered users at http://sidc.be/registration/

Space weather operations at SIDC

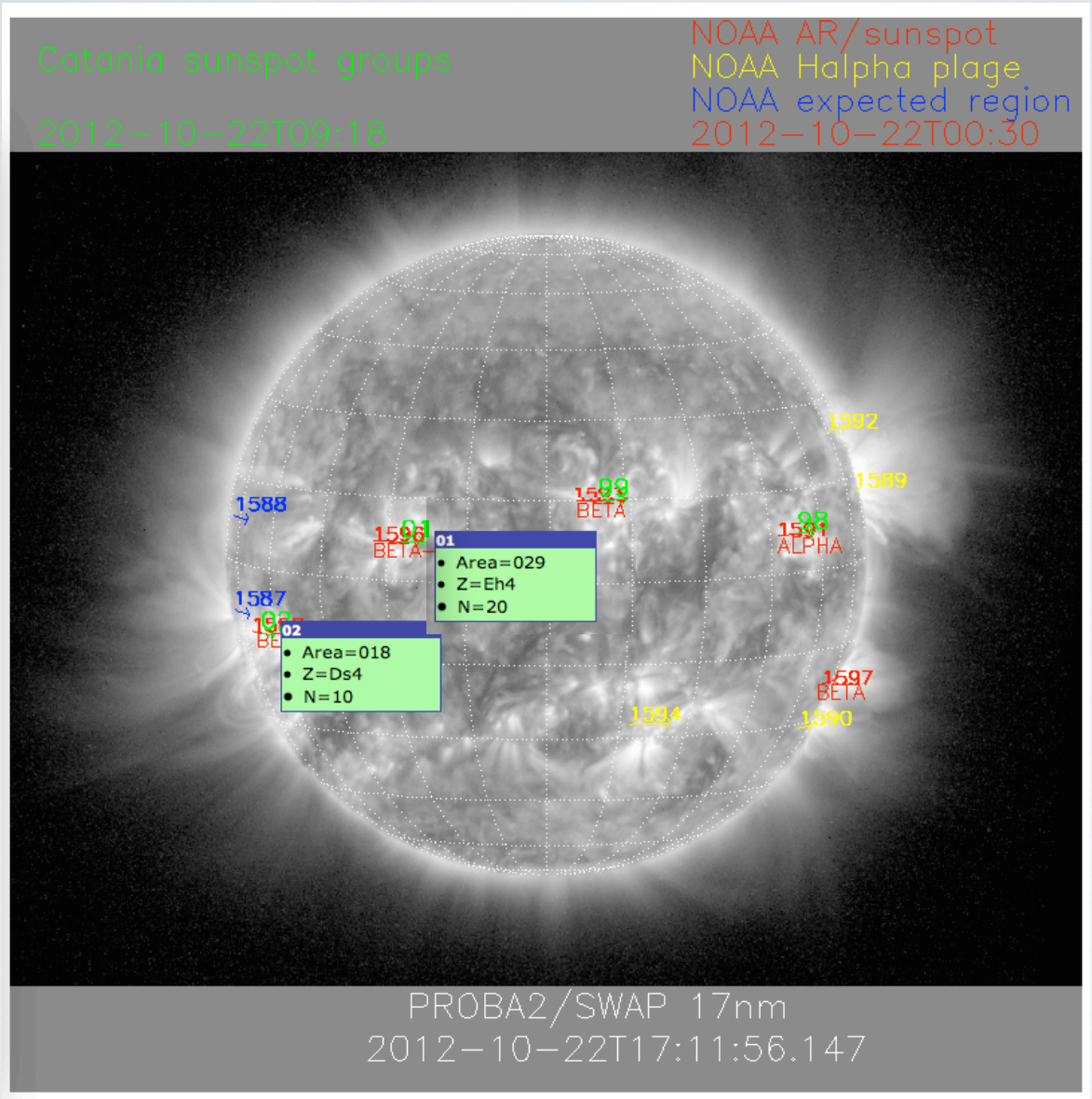
# Yesterday's flare was predicted

| Flare Prediction | ... in the next 24 hours ... | Regional Warning Centers |
|---|---|---|
| major flares | >50% chance for X-flares | |
| active | >50% chance for M-flares | Tokyo, Bejing,Brussels, Boulder |
| eruptive | >50% chance for C-flares | Sydney |
| quiet | <50% chance for C-flares | |


International Space Environment Service
http://www.ises-spaceweather.org

Space weather operations at SIDC

# Flare forecasting is possible ... McIntosh (Solphys 1990)




| Z/McI-class | C-class | M-class | X-class |
|---|---|---|---|
| Axx | 3 | 0 | 0 |
| Bxo | 5 | 1 | 0 |
| Bxi | -1 | -1 | -1 |
| Hrx | 5 | 0 | 0 |
| Cro | 10 | 1 | 0 |
| Cri | -1 | -1 | -1 |
| Hax | 7 | 2 | 0 |
| Cao | 17 | 2 | 0 |
| Cai | 37 | 19 | 0 |
| Hsx | 4 | 1 | 0 |
| Cso | 13 | 2 | 0 |
| Csi | -1 | -1 | -1 |
| Dro | 19 | 5 | 0 |
| Ero | -1 | -1 | -1 |
| Fro | -1 | -1 | -1 |
| Dri | 49 | 0 | 0 |
| Eri | -1 | -1 | -1 |
| Fri | -1 | -1 | -1 |
| Dao | 26 | 6 | 0 |
| Eao | 36 | 10 | 0 |
| Fao | 43 | 15 | 0 |
| Dai | 48 | 12 | 2 |
| Eai | 57 | 21 | 1 |
| Fai | 65 | 33 | 3 |
| Dso | 23 | 4 | 0 |
| Eso | 22 | 6 | 0 |
| Fso | 21 | 14 | 0 |

http://sidc.be/html/Solarmap.html

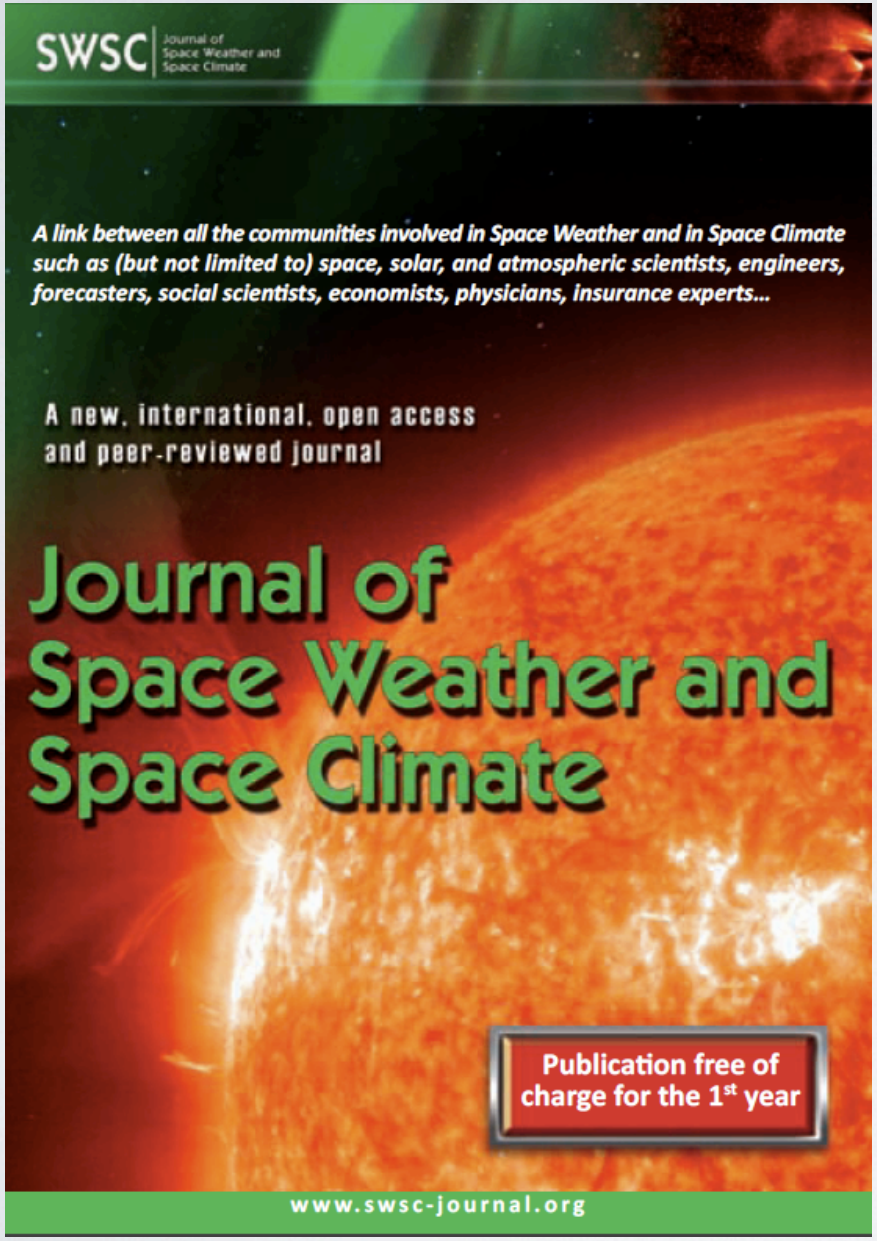
Dissimenation of space weather expertise

# Organization of European Space Weather week (since 2006)



http://sidc.be/esww9/

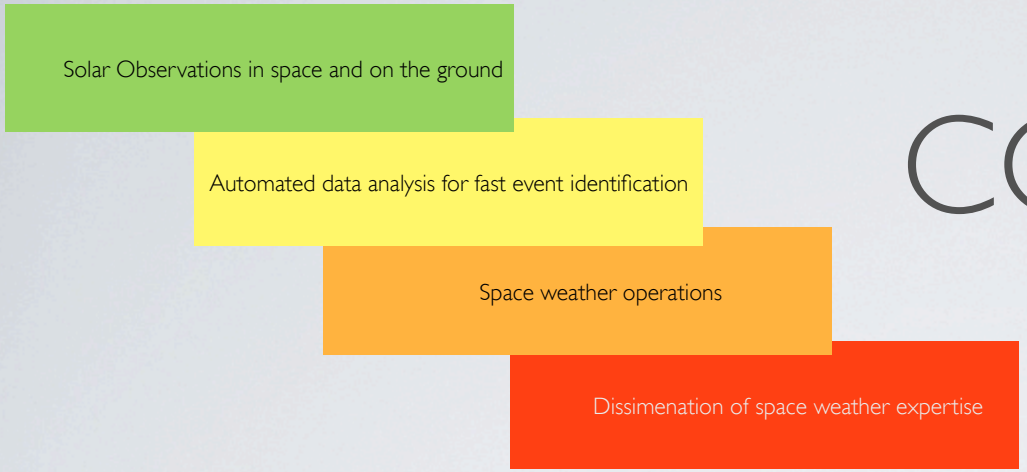
Dissimenation of space weather expertise




# SIDC hosts the editorial office

cost ES0803

http://www.swsc-journal.org




# CONCLUSIONS

The SIDC at the Royal Observatory of Belgium is a research group for Solar Physics and Space Weather. We are enthusiastically looking forward to further collaborate with European partners in the Space Situational Awareness Program of ESA.

http://sidc.be

# FUNDING & SUPPORT

Royal Observatory of Belgium

Solar Terrestrial Center of Excellence


Belgian Space Policy


European Space Agency


International Space Environment Service


EU - Framework 7

http://sidc.be