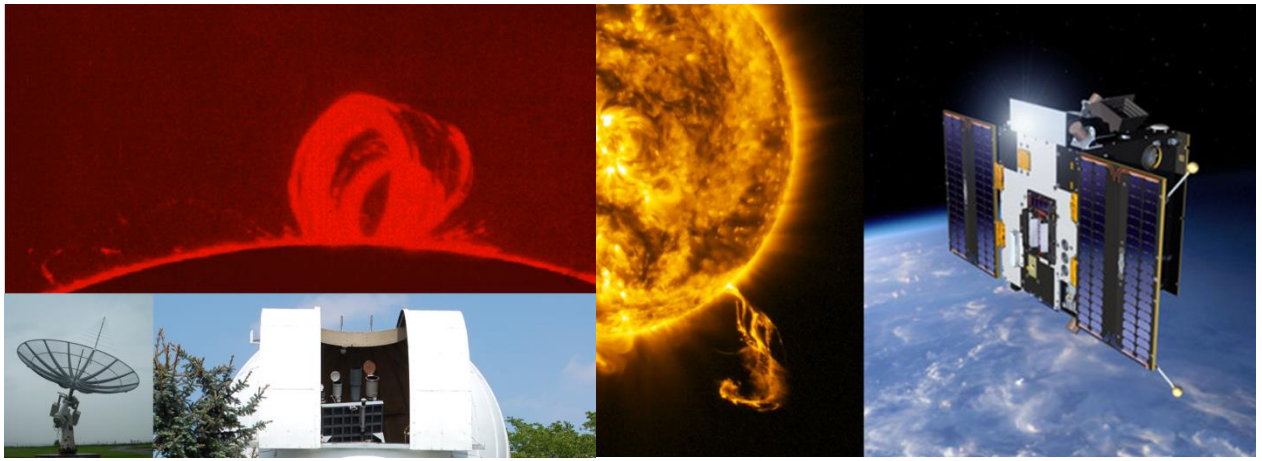
SPACE WEATHER INTRODUCTORY COURSE

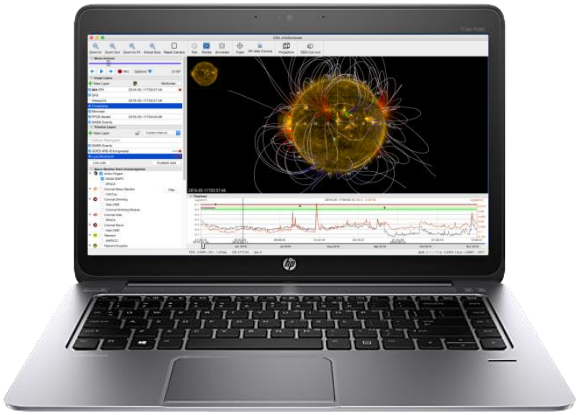
Collaboration of

Solar-Terrestrial Centre of Excellence

Koninklijke luchtmacht

Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu





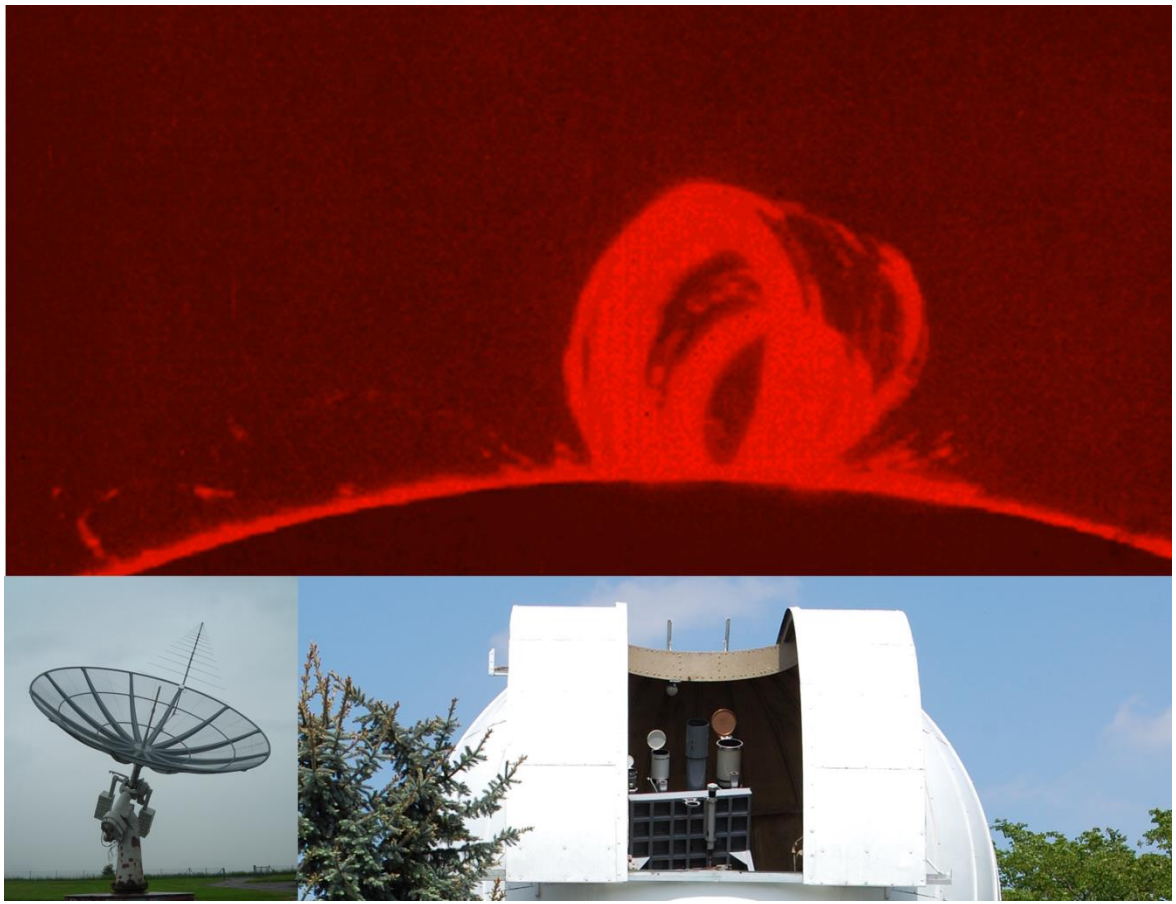
Sensors & measurements

Jan Janssens, Dr Christophe Marqué

Contents

- **Groundbased sensors**
  - Visible light
  - Radio domain
    - Humain
  - Magnetosphere-Ionosphere
  - Geomagnetism
  - Neutron monitors
    - Dourbes

- **Spacebased sensors**
  - GOES
  - SDO
  - PROBA2
  - SOHO
  - ACE
  - DSCOVR
  - STEREO



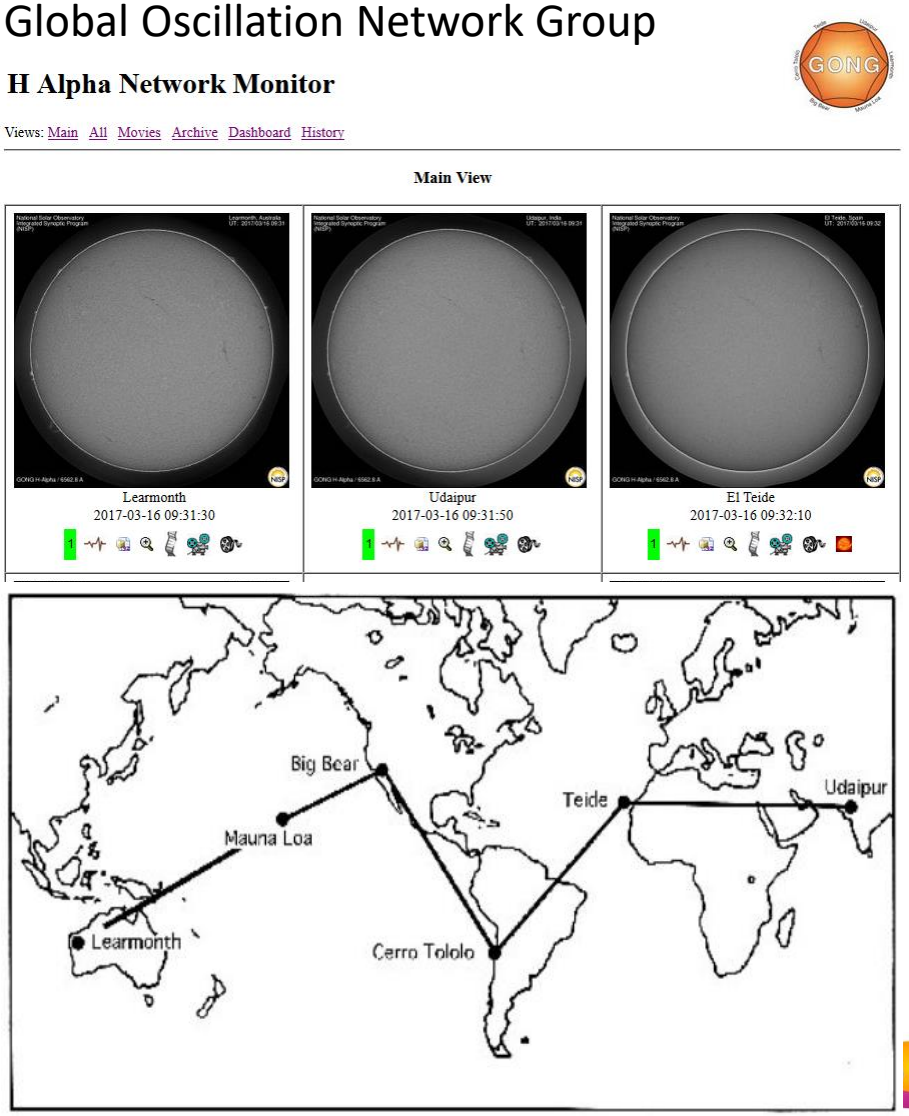
Groundbased sensors

Jan Janssens, Dr Christophe Marqué

Visible light

- GONG Network
  - White Light (WL)
  - H-alpha (Hα)
  - Magnetogram
- SILSO
  - Sunspot number (Sn)
  - USET
    - WL, Hα, CaIIK
    - 250 obs. days / year
- Catania
- NOAA / SOON

Global Oscillation Network Group



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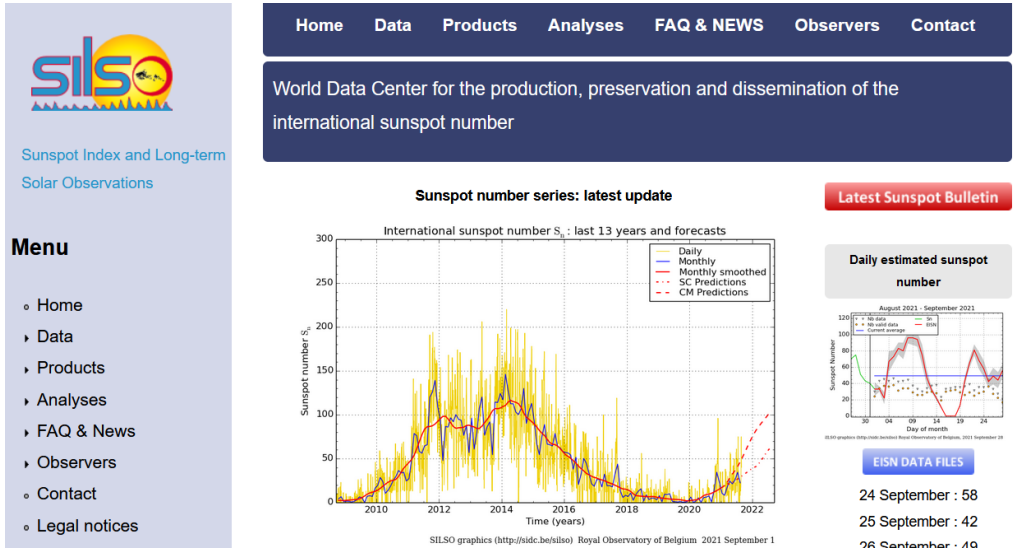
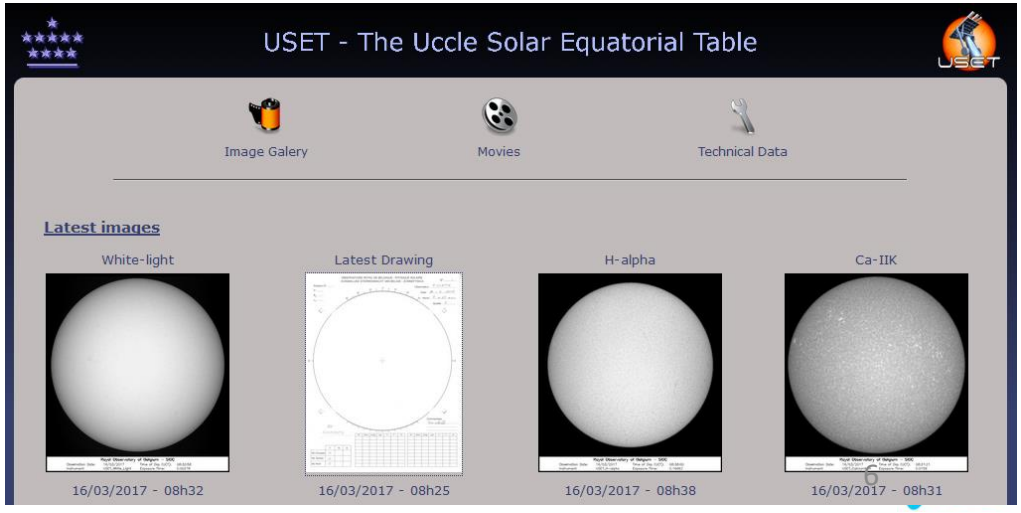
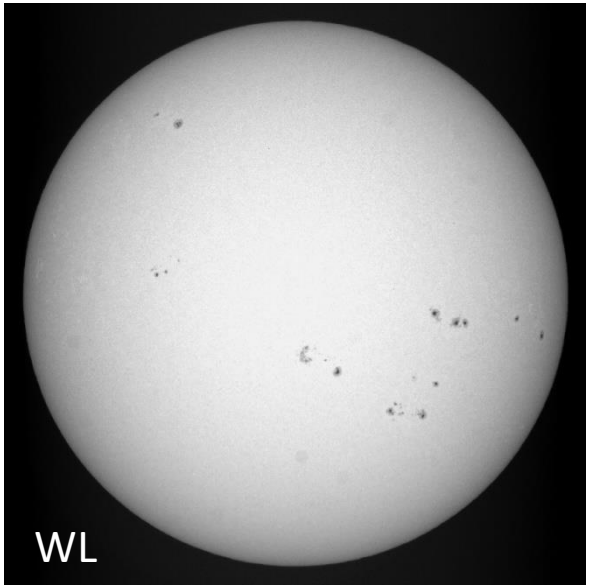
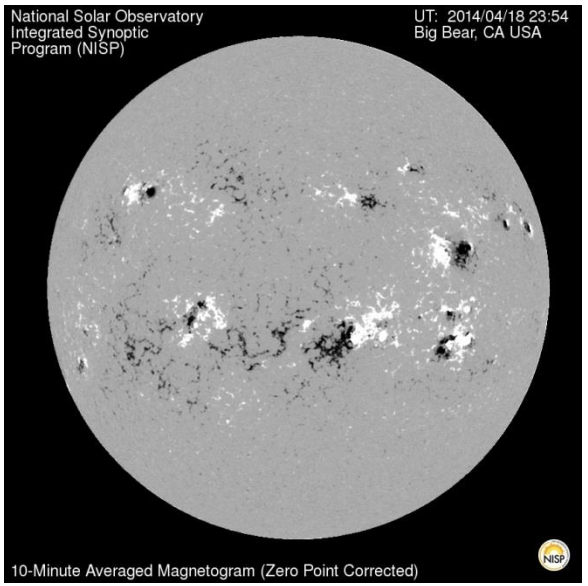
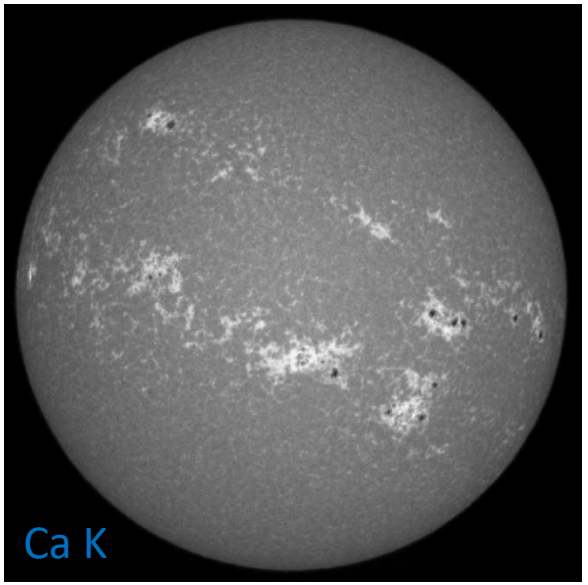


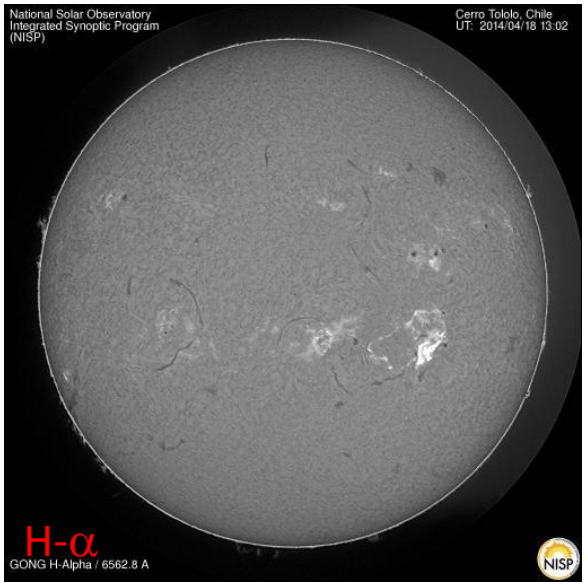


Ground views from the Sun









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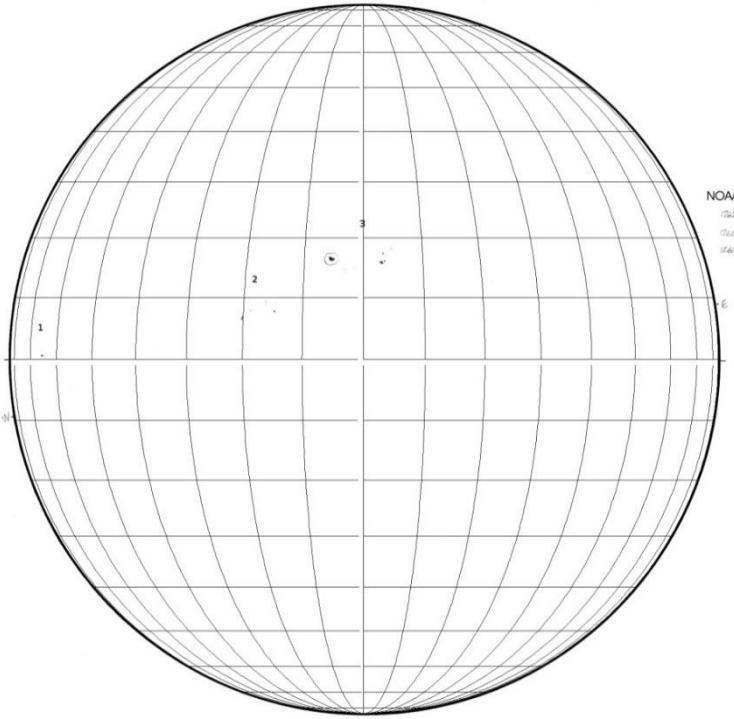

INAF - CATANIA OSSERVATORIO ASTROFISICO

SUNSPOT OBSERVATIONS (U.T.)

year	month	day	hour	min	P	Bo	Lo
2017	JAN	24	09	20	-8.84	-0.40	150.68

Obs. P.COSTA S 2 Q 2 R 52

NOAA	g	cat	s	p	z	lat	long	A(mm)
12626	1	48	00	02	A	09N	66W	000,50
12627	2	80	01	06	C	06N	16W	002,50
12628	3	81	02	12	D	12N	02E	016,00
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
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	20							
	21							
	22							
	23							
	24							
	25							
	26							
	27							
	28							
	29							

Catania info (Last update: 2017-Jan-24)						NOAA info (Last update: 2017-Jan-24)					Probabilities for			
Number	area	nspots	Zurich	Longitude	Latitude	Number	Macintosh	Mag. type	Longitude	Latitude	C flare	M flare	X flare	Proton
78	1	2	A	66.0	7.0	2626	Hsx	Alpha	63.0	8.0	--	--	--	--
80	3	7	C	16.0	6.0	2627	Dai	Beta	12.0	6.0	--	--	--	--
81	19	14	D	-2.0	12.0	2628	Dso	Beta	-7.0	12.0	--	--	--	--

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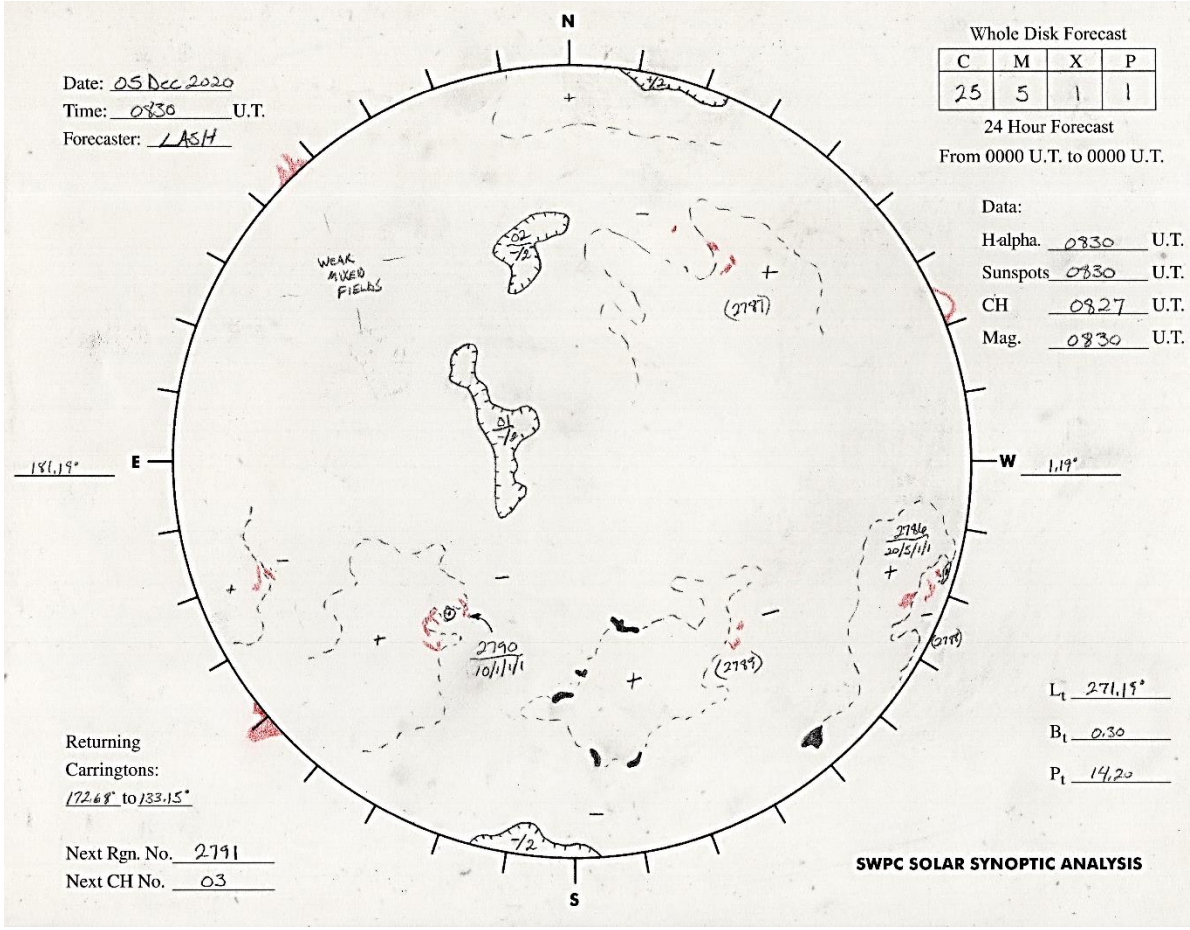

:Issued: 2014 Apr 17 1325 UTC
:Product: documentation at http://www.sidc.be/products/tot
#----------#
DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC
#----------#
SIDC URSIGRAM 40417
SIDC SOLAR BULLETIN 17 Apr 2014, 1304UT

SIDC FORECAST (valid from 1230UT, 17 Apr 2014 until 19 Apr 2014)
SOLAR FLARES : Active (M-class flares expected, probability >=50%)
GEOMAGNETISM : Quiet (A<20 and K<4)
SOLAR PROTONS : Quiet

PREDICTIONS FOR 17 Apr 2014 10CM FLUX: 180 / AP: 013
PREDICTIONS FOR 18 Apr 2014 10CM FLUX: 184 / AP: 007
PREDICTIONS FOR 19 Apr 2014 10CM FLUX: 188 / AP: 005

Catania & NOAA regions

COMMENT: Eleven sunspot groups were reported by NOAA today. NOAA ARs 2035,2036, and 2037 (Catania numbers 24, 25, and 26 respectively) maintain the beta-gamma configuration of the photospheric magnetic field. The strongest flare of the past 24 hours was the M1.0 flare peaking at 19:59 UT yesterday in the NOAA AR 2035 (Catania number 24). The flare was associated with an EIT wave and a weak coronal dimming, but the associated CME was narrow and is not expected to arrive at the Earth.
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TODAY'S ESTIMATED ISN : 145, BASED ON 17 STATIONS.
99999

Sunspot numbers

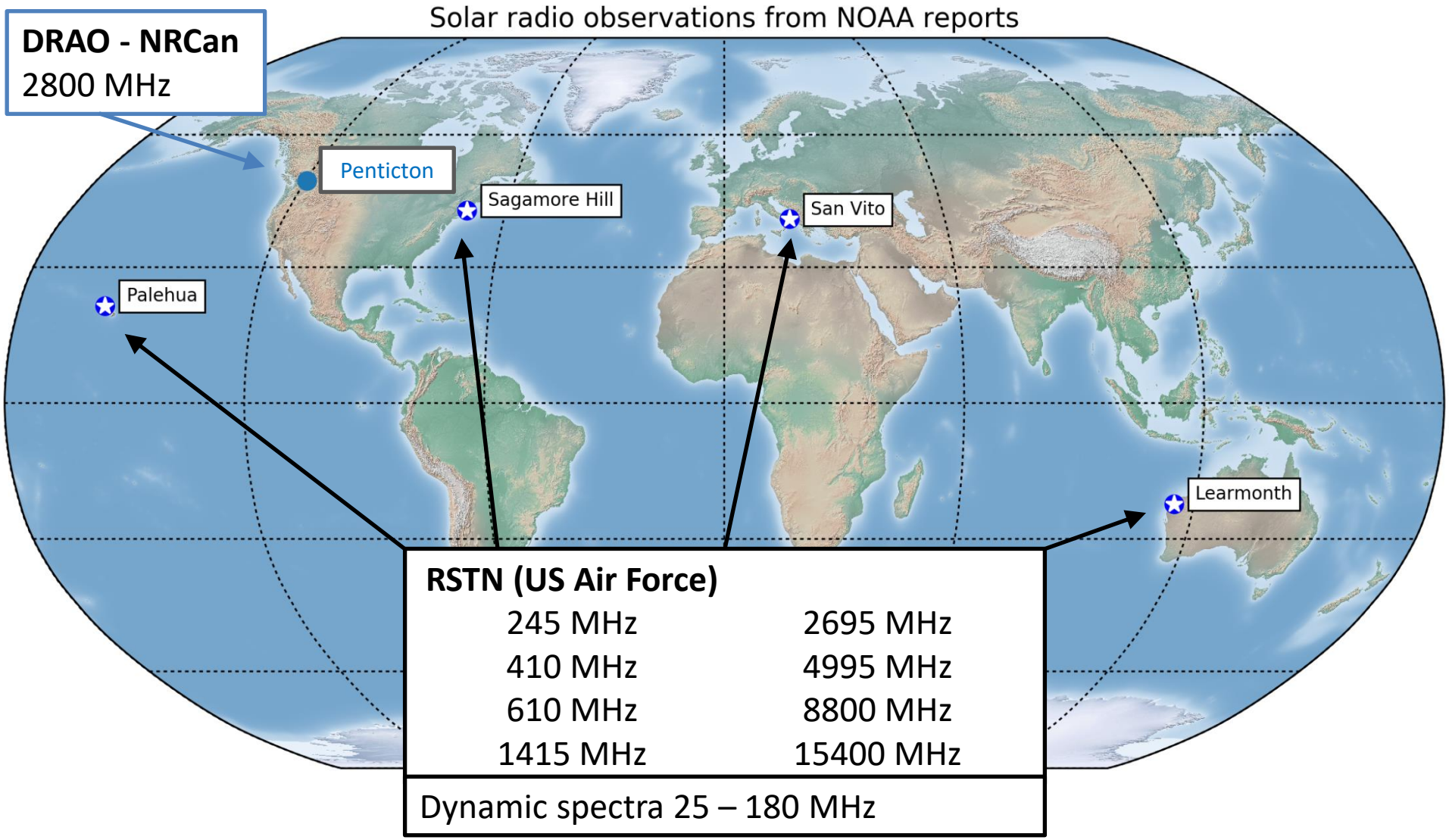
SOLAR INDICES FOR 16 Apr 2014
WOLF NUMBER CATANIA : ///
10CM SOLAR FLUX : 184
AK CHAMBON LA FORET : 012
AK WINGST : 004
ESTIMATED AP : 004
ESTIMATED ISN : 139, BASED ON 29 STATIONS.

NOTICEABLE EVENTS SUMMARY

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	Catania/NOAA	RADIO_BURST_TYPES
16	1954	1959	2004	S14E09	M1.0	1N		24/2035	II/2

END

Radio observations



RSTN (US Air Force)

245 MHz	2695 MHz
410 MHz	4995 MHz
610 MHz	8800 MHz
1415 MHz	15400 MHz

Dynamic spectra 25 – 180 MHz

DRAO: Dominion Radio Astrophysical Observatory – NRCan: Natural Resources Canada RSTN: Radio Solar Telescope Network

Radio burst magnitudes

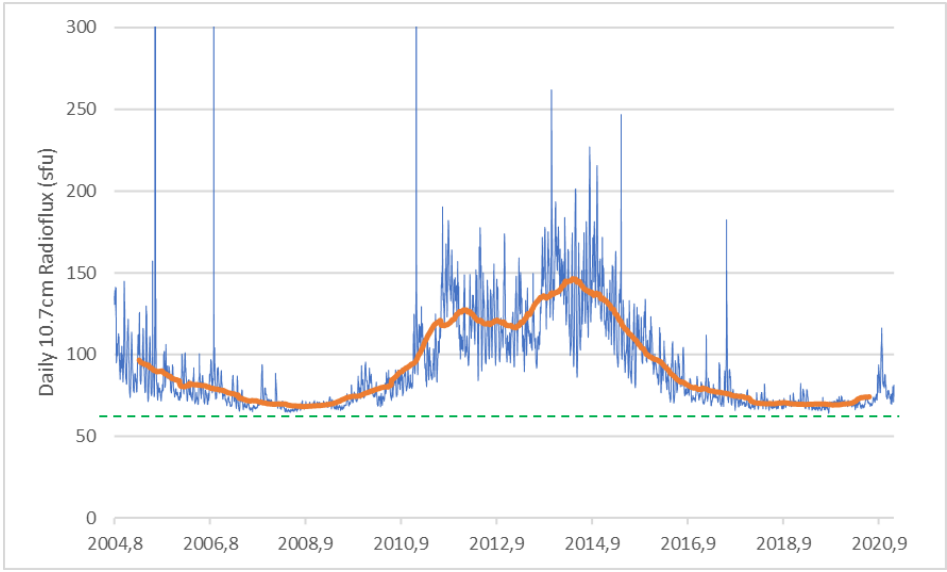
Typ. Quiet Sun values [SFU]

Frequency	Solar min.	Solar max. (Z=200)
245 MHz	10	15
410 MHz	25	35
610 MHz	30	45
1415 MHz	50	100
2695 MHz	70	200
2800 MHz	70	200
4995 MHz	100	200
8800 MHz	220	290
15400 MHz	580	650

1 sfu = 1 solar flux unit = 10^{-22} W·m^{-2}·Hz^{-1}

Penticton

- Flux measurement at 2800 MHz (10.7 cm), 100 MHz bandwidth
- 3 times per day
- “official” value for the day is the one of 20:00 UT (local noon)
- Accuracy:
  - < 100 sfu: 1 sfu
  - > 100 sfu: 1% of flux
- Uncorrected for solar flares
- R-, S-, Q-component



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AK WINGST : 004
ESTIMATED AP : 004
ESTIMATED ISN : 139, BASED ON 29 STATIONS.

10.7cm Radio flux

NOTICEABLE EVENTS SUMMARY
DAY BEGIN MAX END LOC XRAY OP 10CM Catania/NOAA RADIO_BURST_TYPES
16 1954 1959 2004 S14E09 M1.0 1N 24/2035 II/2
END

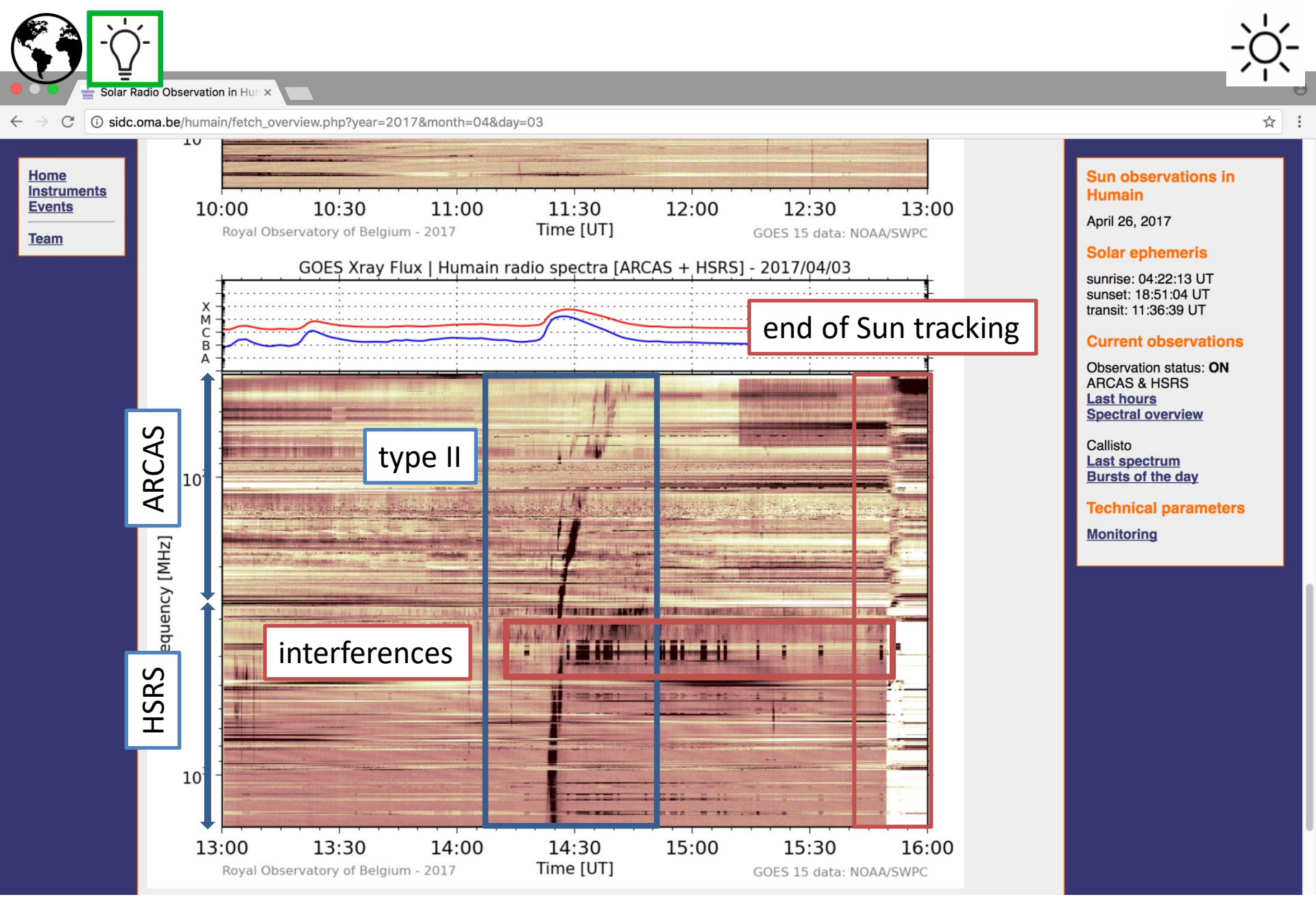
Humain: Solar instruments

- 6-m dish
- Automated operations, Sun tracking ~7h30 – 16h00 UT
- VHF antenna (piggy back)
- UHF antenna at focus

- VHF antenna (45 – 450 MHz)
  - Callisto receiver
  - ARCAS receiver
- UHF antenna (275 – 1495 MHz)
  - HSRS receiver

Data available in near realtime
https://www.sidc.be/humain/home

- VHF: Very High Frequency (30-300 MHz)
- UHF: Ultra High Frequency (300-3000 MHz)
- Callisto: Compound Astronomical Low cost Low frequency Instrument for Spectroscopy and Transportable Observatory
- ARCAS: Augmented Resolution Callisto Spectrometer
- HSRS: Humain Solar Radio Spectrograph


Solar Radio Observation in Hu
sidc.oma.be/humain/fetch_overview.php?year=2017&month=04&day=03
Home
Instruments
Events
Team
10:00
10:30
11:00
11:30
12:00
12:30
13:00
Time [UT]
Royal Observatory of Belgium - 2017
GOES 15 data: NOAA/SWPC
GOES Xray Flux | Humain radio spectra [ARCAS + HSRS] - 2017/04/03
X
M
C
B
A
end of Sun tracking
ARCAS
HSRS
type II
interferences
13:00
13:30
14:00
14:30
15:00
15:30
16:00
Time [UT]
Royal Observatory of Belgium - 2017
GOES 15 data: NOAA/SWPC
Sun observations in Humain
April 26, 2017
Solar ephemeris
sunrise: 04:22:13 UT
sunset: 18:51:04 UT
transit: 11:36:39 UT
Current observations
Observation status: ON
ARCAS & HSRS
Last hours
Spectral overview
Callisto
Last spectrum
Bursts of the day
Technical parameters
Monitoring

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Radio bursts

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END

Magnetosphere - Ionosphere

Magnetosphere

- Magnetometers
- Neutron monitors
- …

⇒ **Magnetosphere**

⇒ **SWx effects**

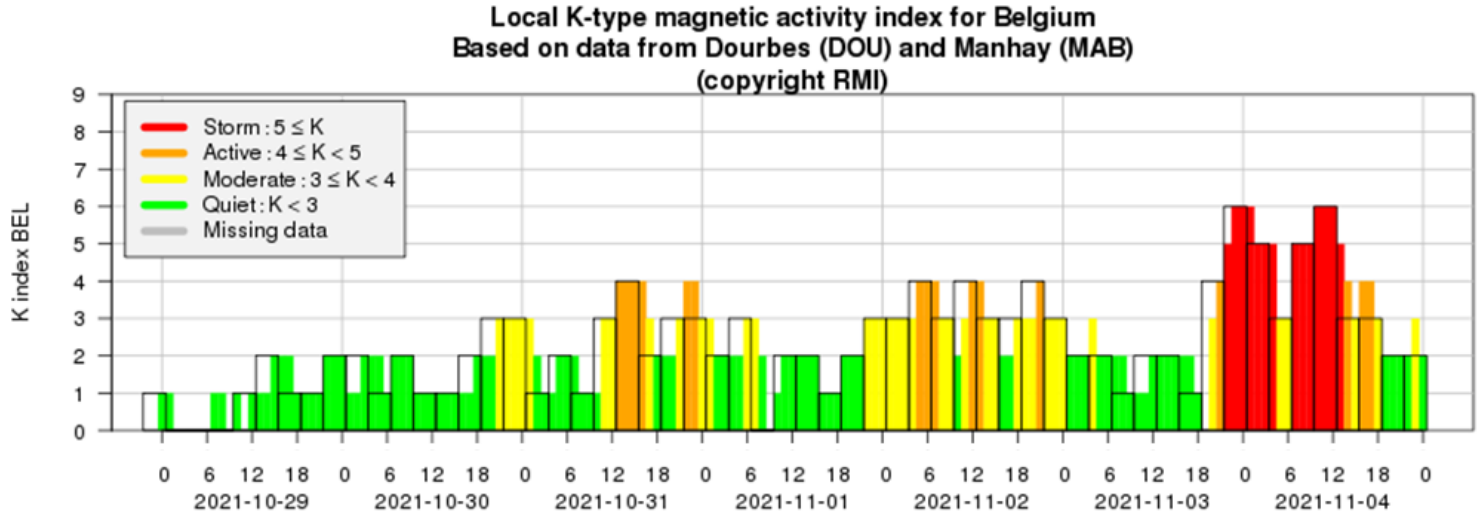
Ionosphere

- Ionospheric sounders
- Riometers
- …

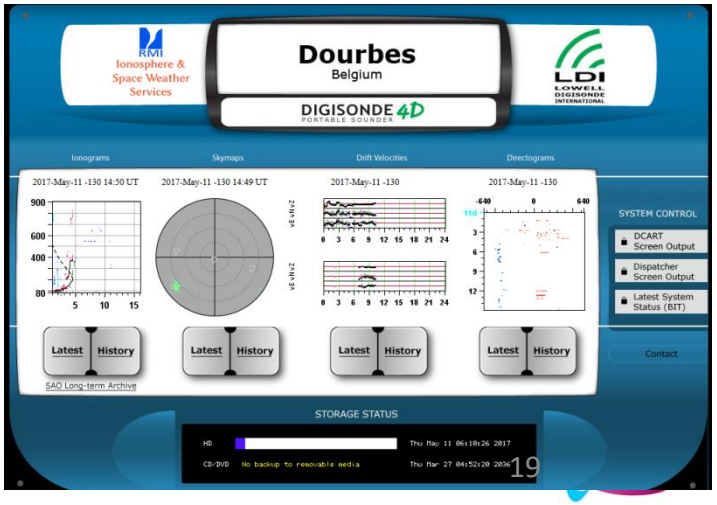
⇒ **SWx effects – Aviation**

⇒ **Ionosphere**

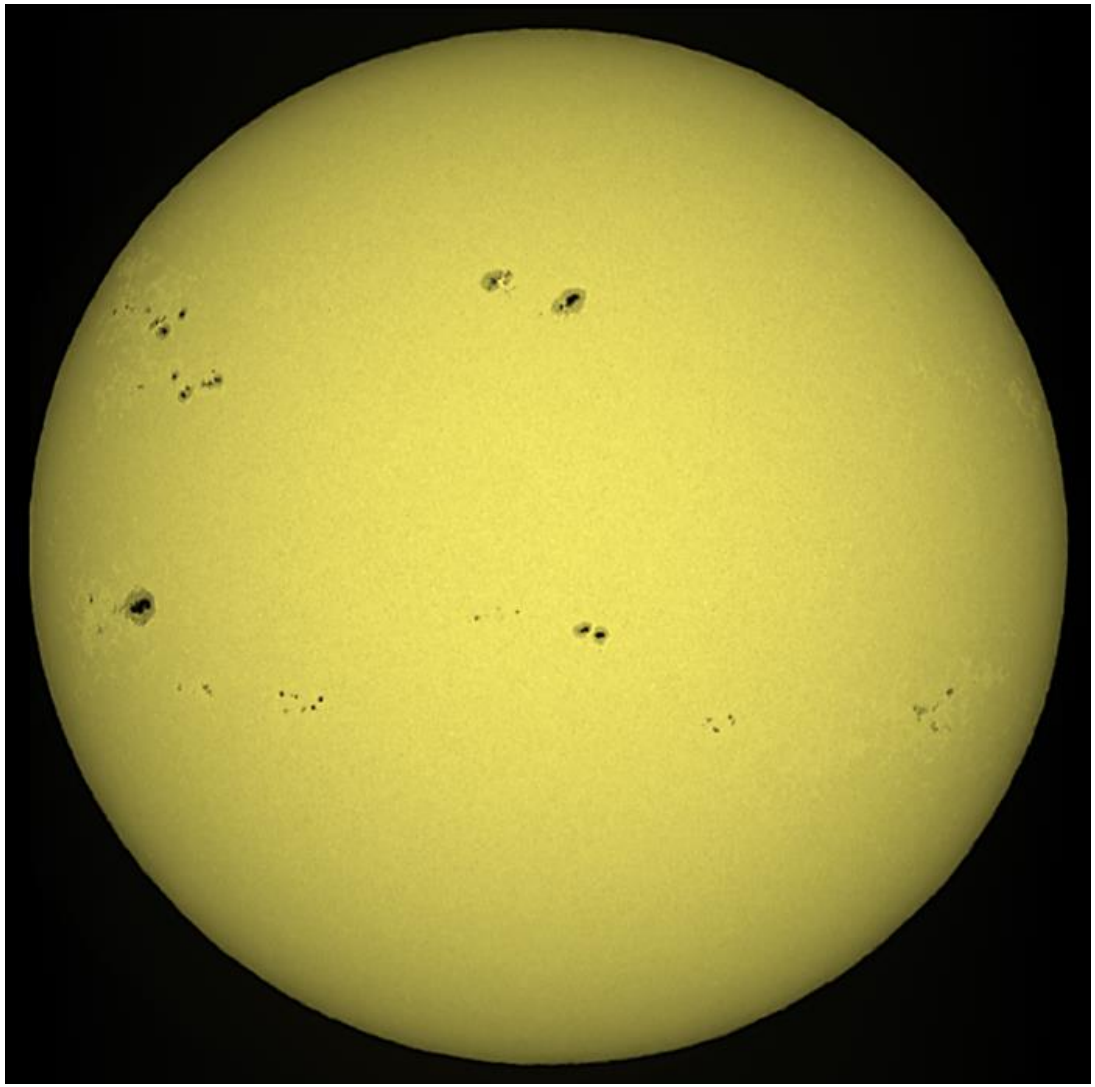
Dourbes


Local K-type magnetic activity index for Belgium
Based on data from Dourbes (DOU) and Manhay (MAB)
(copyright RMI)
Storm : 5 ≤ K
Active : 4 ≤ K < 5
Moderate : 3 ≤ K < 4
Quiet : K < 3
Missing data
K index BEL
0 1 2 3 4 5 6 7 8 9
0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0 6 12 18 0
2021-10-29 2021-10-30 2021-10-31 2021-11-01 2021-11-02 2021-11-03 2021-11-04


NMDB
neutron monitor database
Neutron Monitor Database
NMDB STATIONS
COSMIC RAYS NOW !
DATA AND PRODUCTS
TECHNICAL DOCS
NMDB BROCHURES
PUBLIC OUTREACH
NEWS
BOOK NAVIGATION
NMDB Stations
Data and Products
NMDB Documentation
Public Outreach
Work Packages and Project Groups
Meetings and Events
NMDB news
Contact Us
Impressum
NAVIGATION
NMDB site materials
USER LOGIN
NMDB: REAL-TIME DATABASE FOR HIGH RESOLUTION NEUTRON MONITOR MEASUREMENTS
DATA & PRODUCTS
PUBLIC OUTREACH
COSMIC RAYS NOW!
WHO WE ARE
TRAINING


RMI
Ionosphere & Space Weather Services
Dourbes
Belgium
DIGISONDE 4D
PORTABLE SOUNDER
LDI
LOWELL DIGISONDE INTERNATIONAL
Ionograms
Skymaps
Drift Velocities
Directograms
2017-May-11 -130 14:50 UT
2017-May-11 -130 14:49 UT
2017-May-11 -130
2017-May-11 -130
SYSTEM CONTROL
DCART Screen Output
Dispatcher Screen Output
Latest System Status (BIT)
Contact
Latest
History
SAO Long-term Archive
STORAGE STATUS
HD
CD/DVD
No backup to removable media

What are we looking at?



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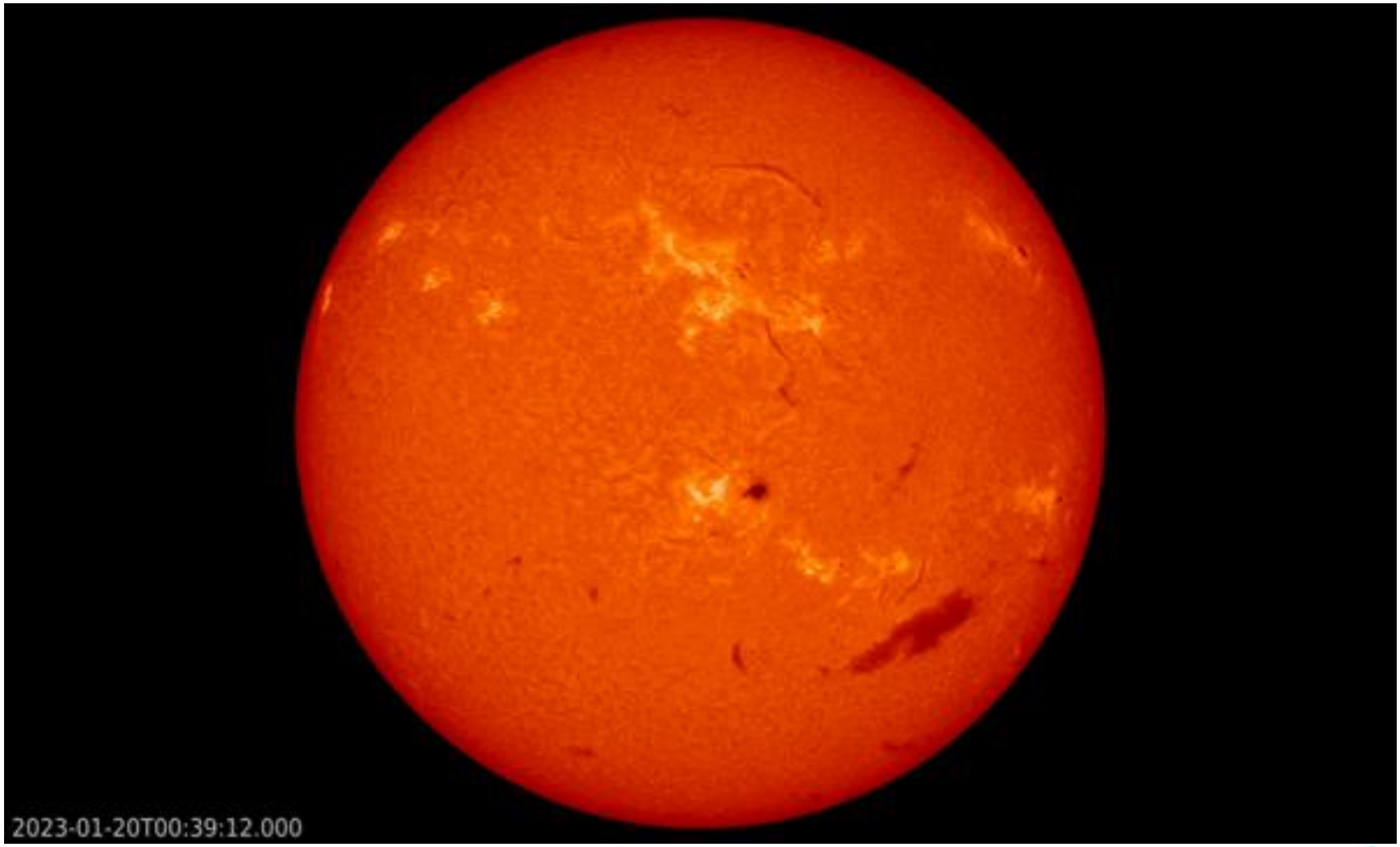
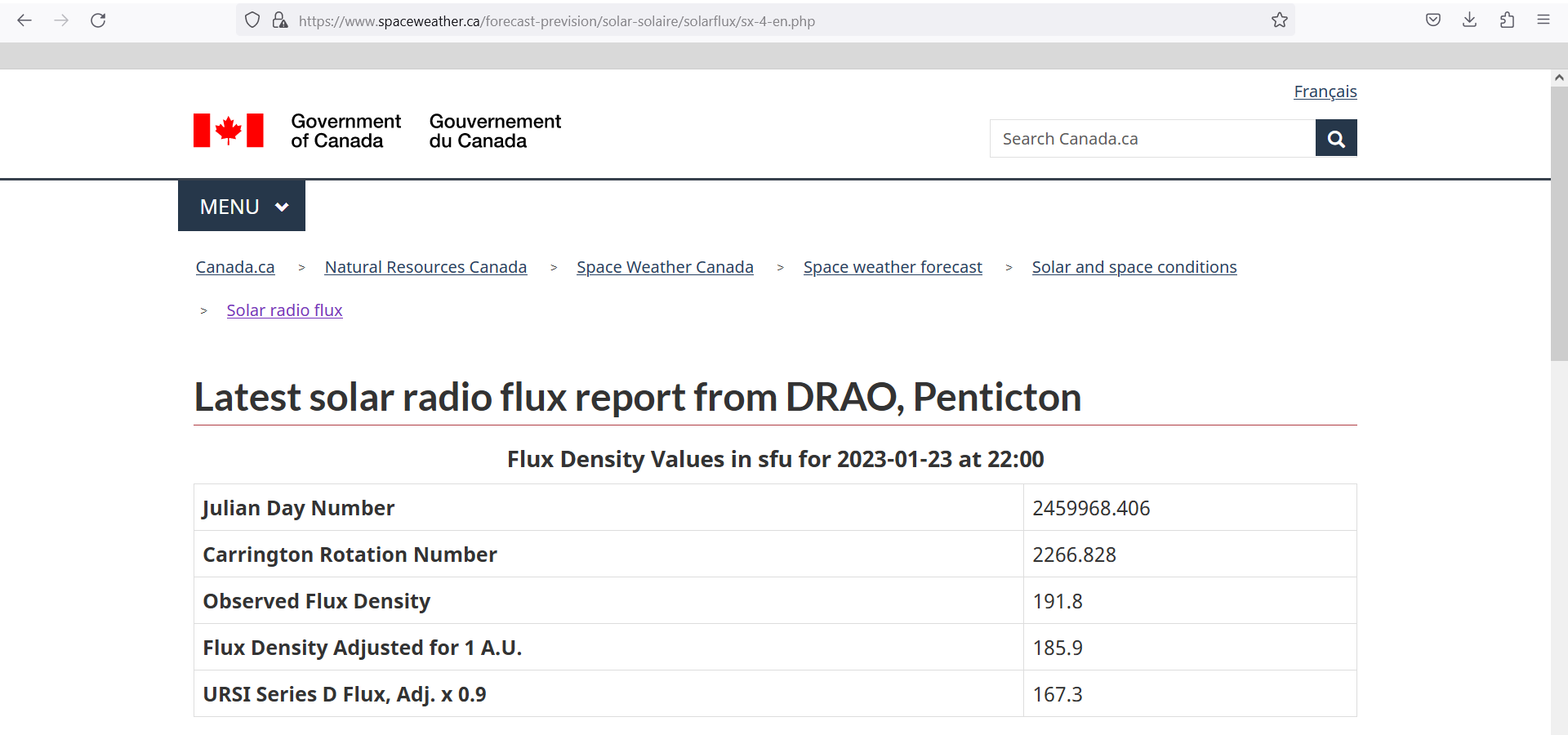


What solar parameter is this website reporting?



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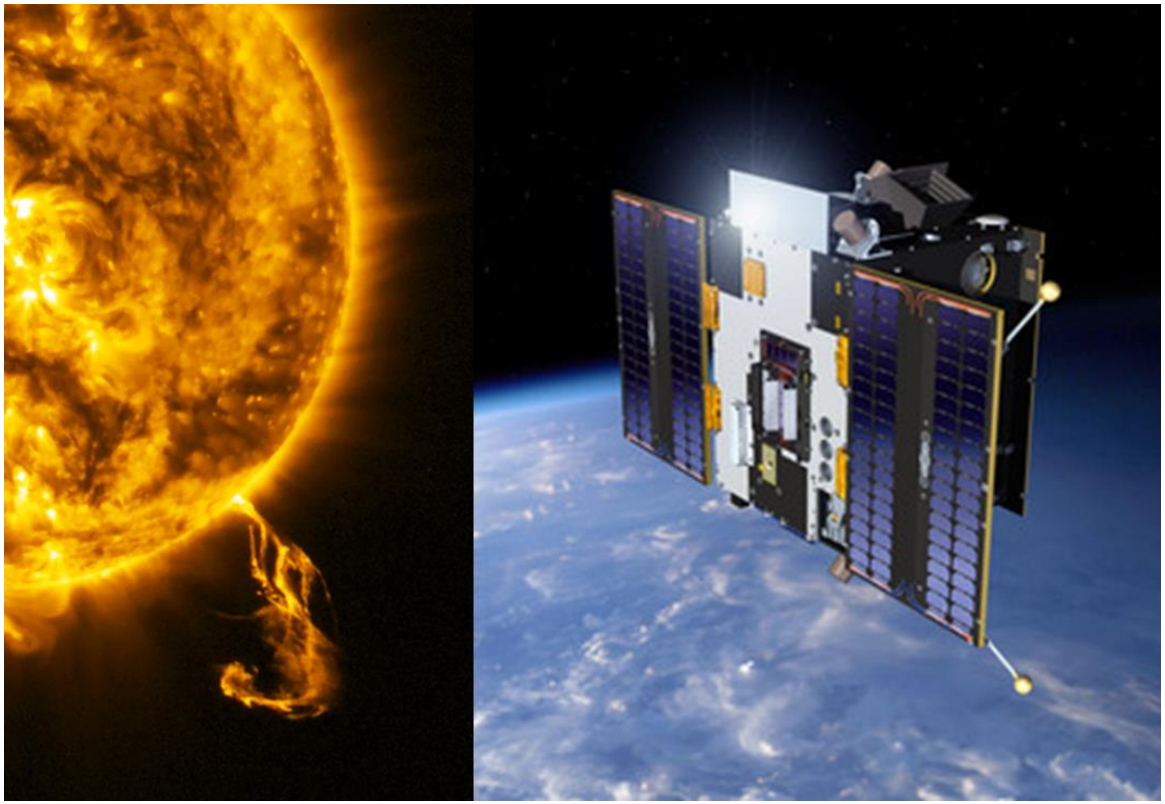
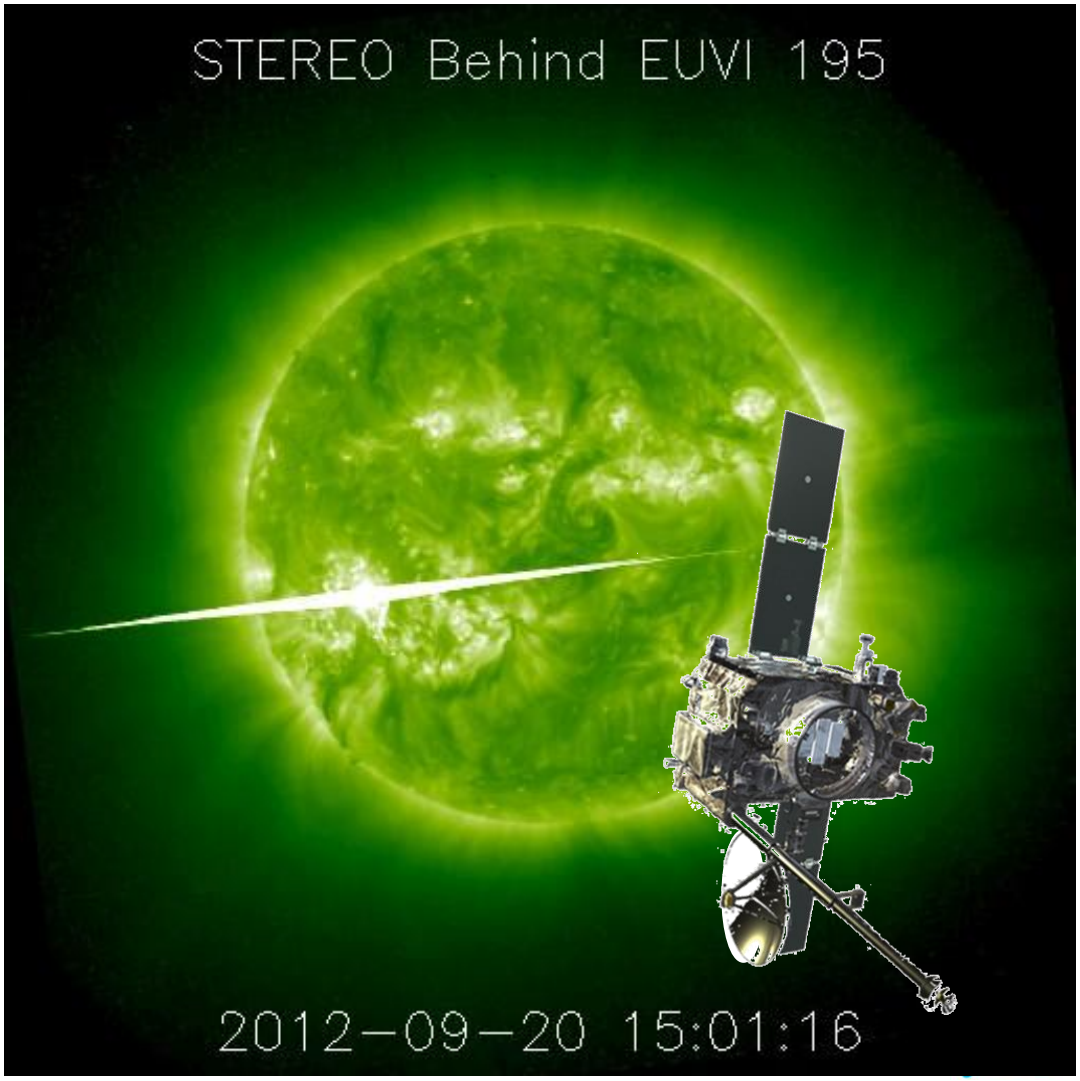


Spacebased sensors

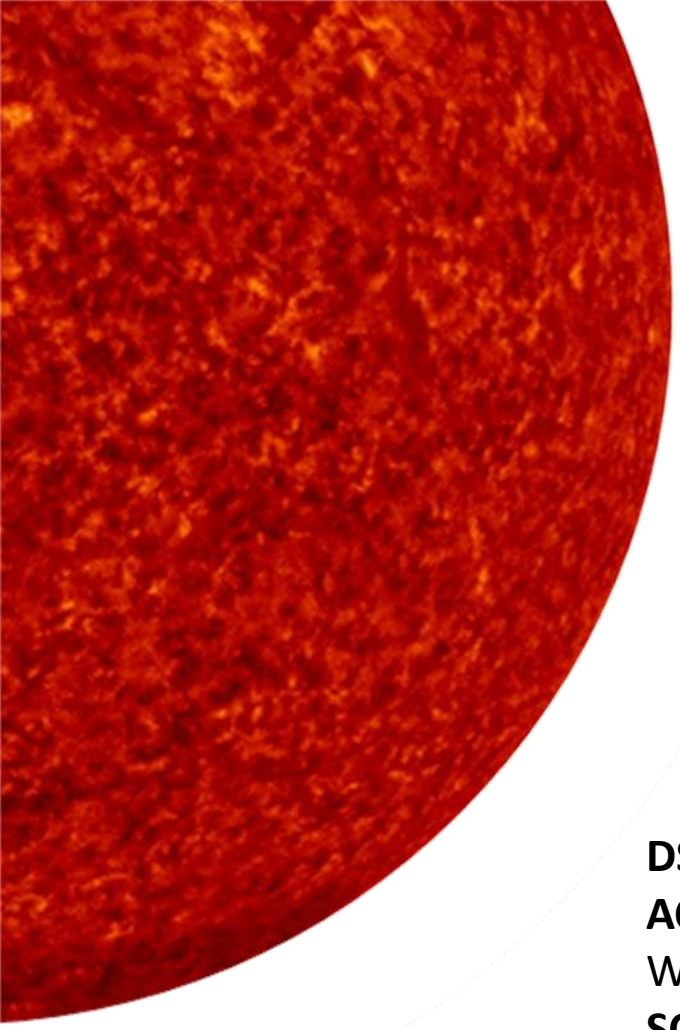
Jan Janssens

Why do we need SWx satellites?

- EUV and X-ray (solar atmosphere)
  - Flares & Coronal holes
- Coronagraphs
- Solar wind (in-situ)
- Solar farside
  - 20 September 2012
  - 23 July 2012
  - …
- Radio
  - Triangulation
  - Low frequencies
- Science
- White light (24hrs)
- …



Satellites



GOES
SDO

INTEGRAL

PROBA2
HINODE

L1

DSCOVR
ACE
WIND
SOHO

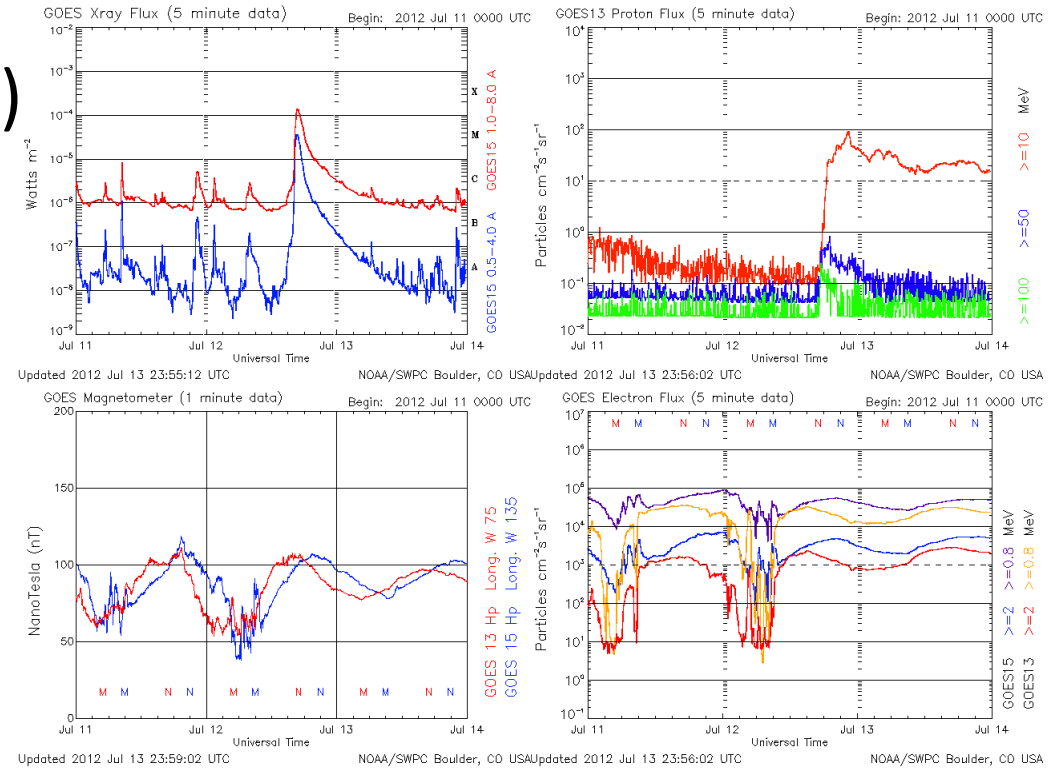
STEREO

γ/X-ray/EUV
Coronagraph
Solar Wind
Particle flux

GOES

Geostationary Operational Environmental Satellite

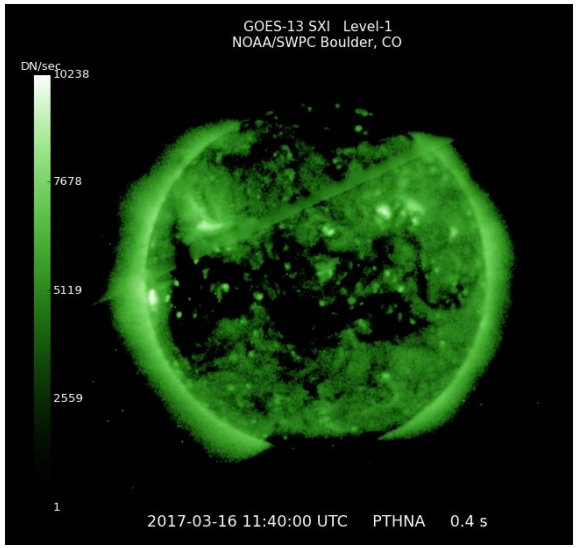
- X-ray flux
  - X-ray Sensor (XRS)
- Proton flux
- Magnetic field
- Electron flux
- Imagery

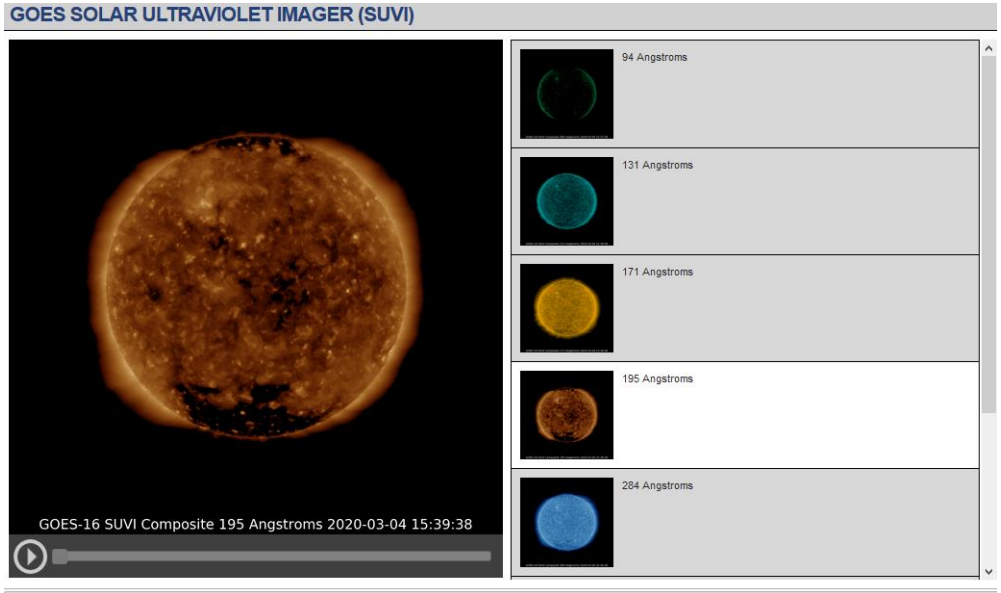


GOES

Geostationary Operational Environmental Satellite

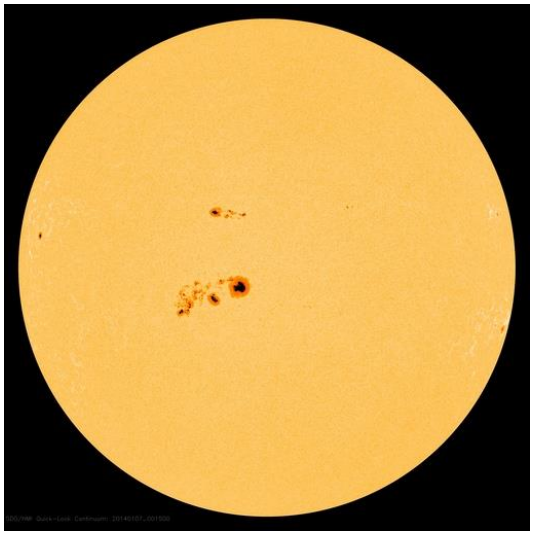
- X-ray flux
- Proton flux
- Magnetic field
- Electron flux
- Imagery
  - GOES-12-15
    - X-ray: SXI
      - Solar X-ray Imager
      - Discontinued
  - GOES-16-17
    - EUV: SUVI
      - Solar Ultraviolet Imager
      - Operational





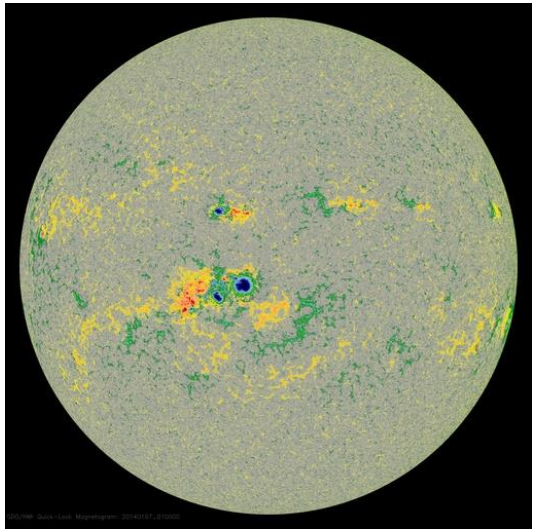
SDO

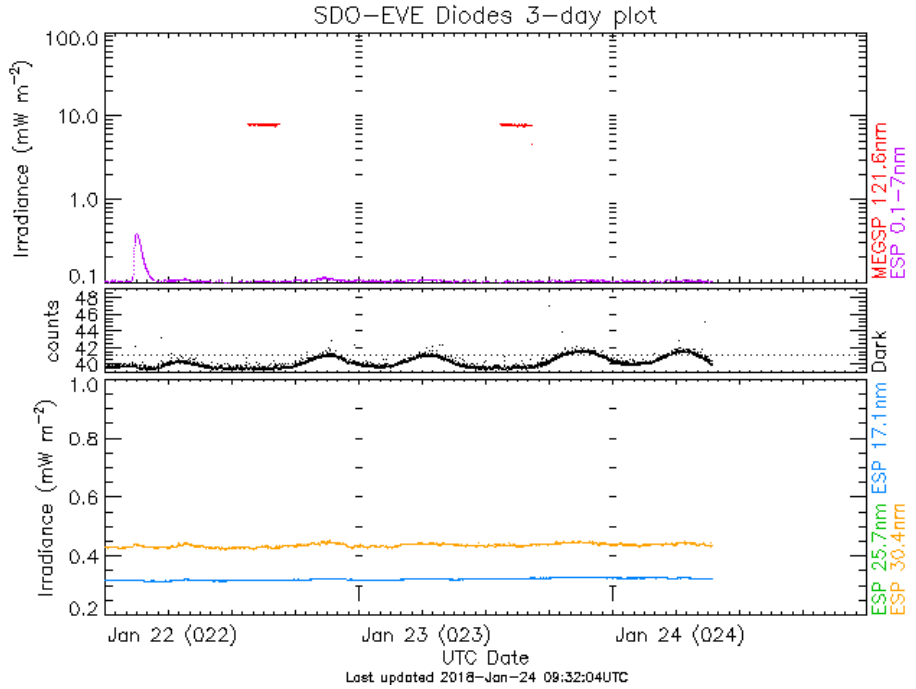
Solar Dynamics Observatory



< HMI

- Helioseismic and Magnetic Imager
- « White light » and Magnetograms





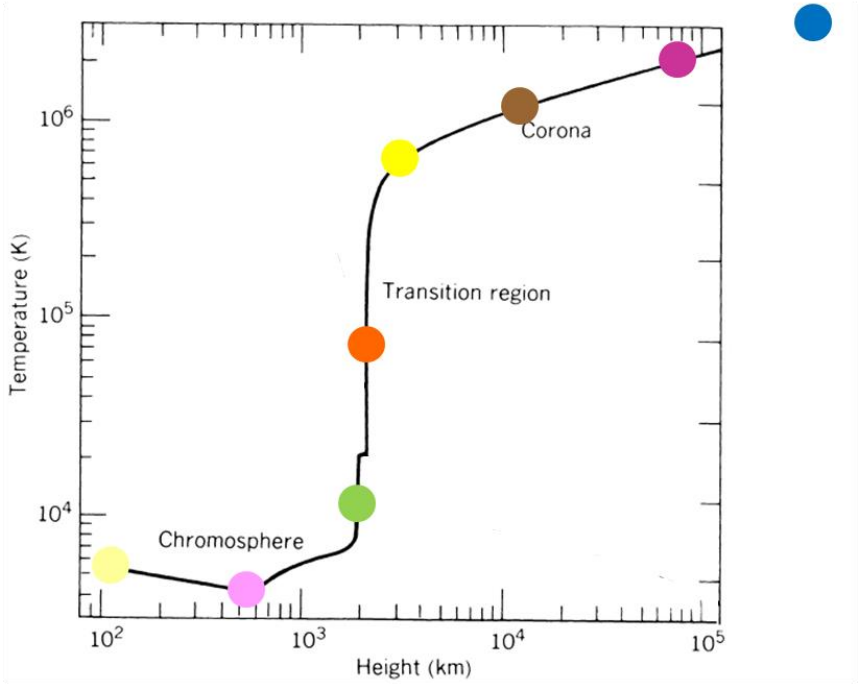
EVE ^

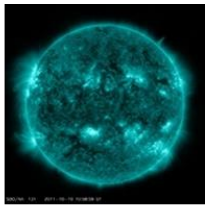
- Extreme ultraviolet Variability Experiment
- Scaled to GOES x-ray measurements

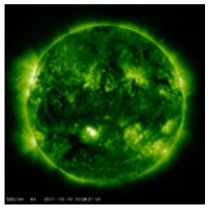
SDO

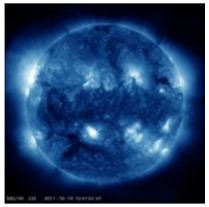
Solar Dynamics Observatory

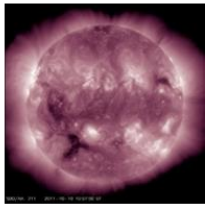
- AIA
  - Atmospheric Imaging Assembly
  - EUV imagery in 9 filters
  - Some filters peak at multiple temperatures
  - AIA 4500 no longer in use

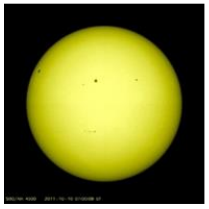


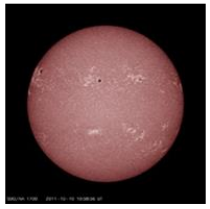

131Å

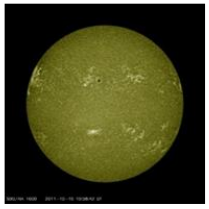

094Å

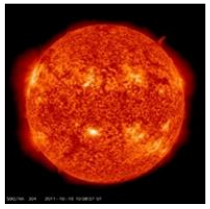

335Å

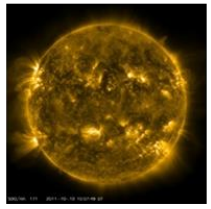

211Å

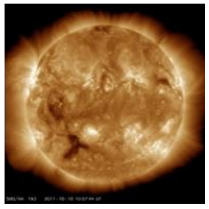

4500Å


1700Å


1600Å


304Å

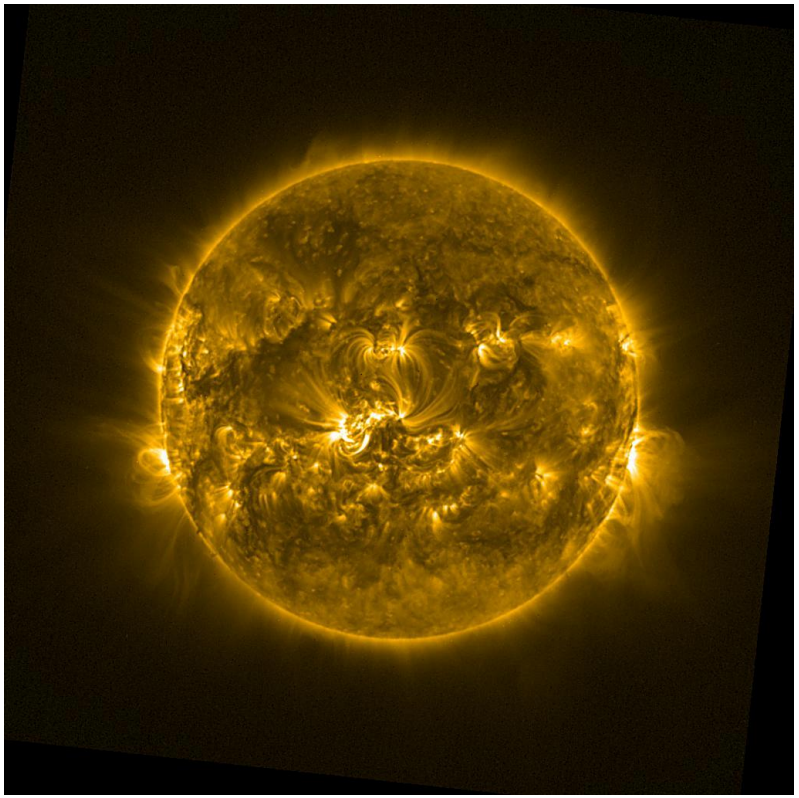

171Å


193Å

PROBA2

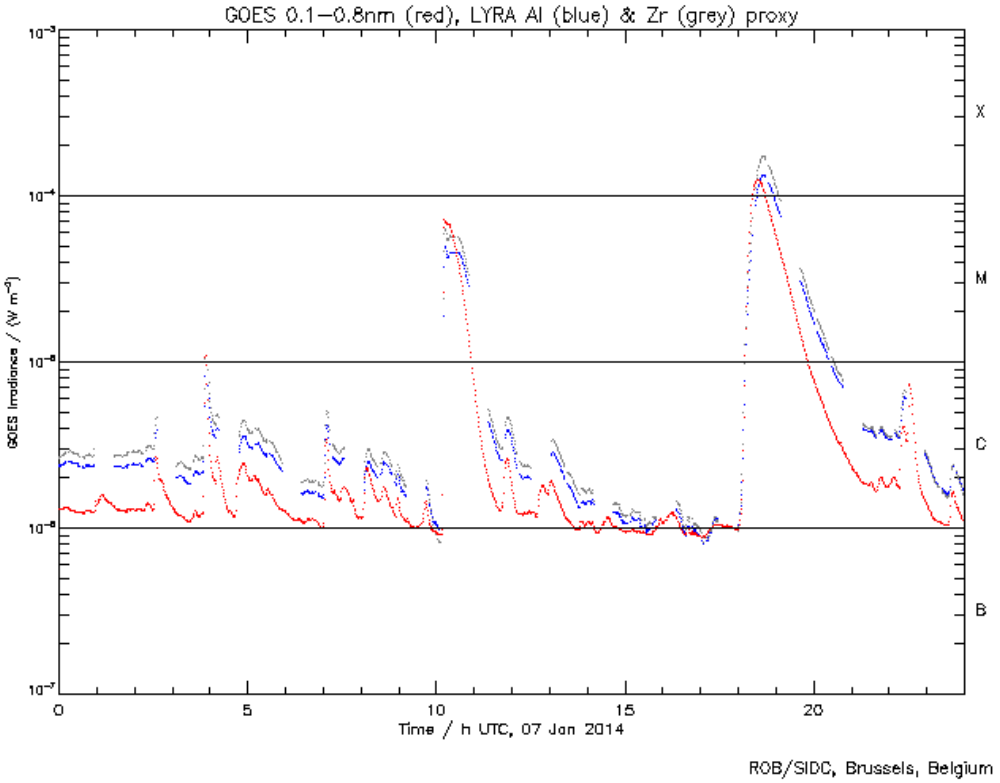
PRoject for OnBoard Autonomy

SWAP



Sun Watcher using APS detector and image Processing

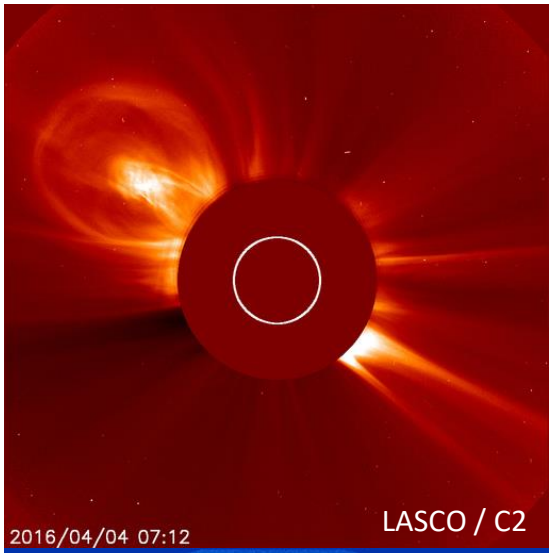
LYRA

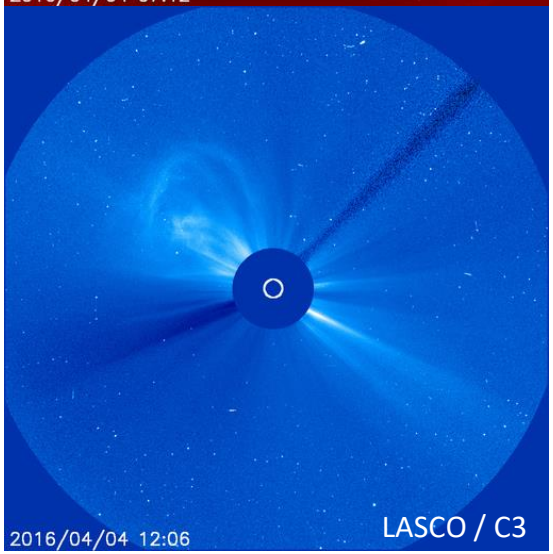


Large Yield RAdiometer

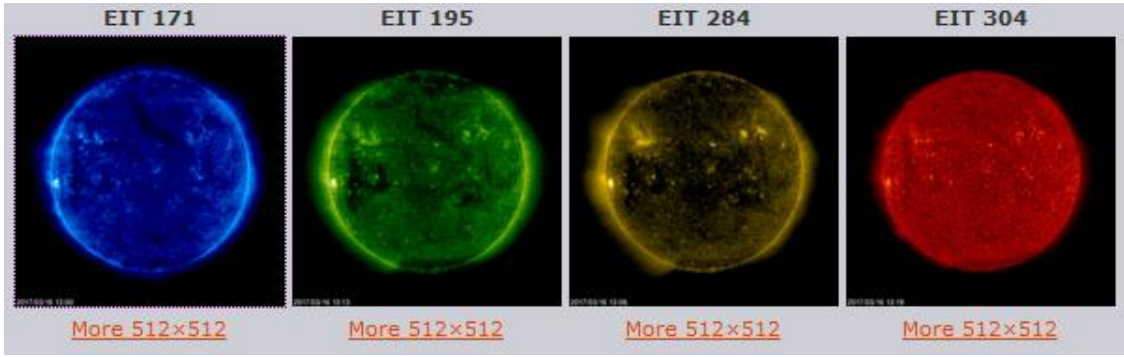
SOHO

SOlar & Heliospheric Observatory

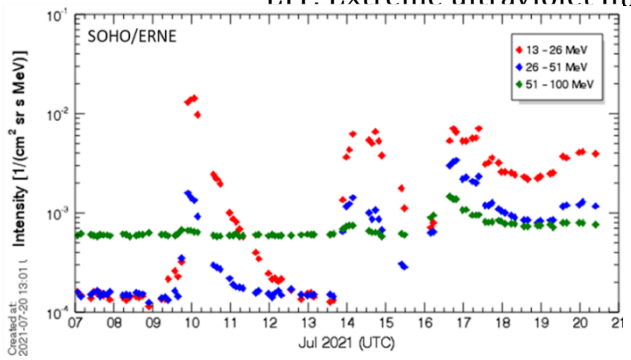


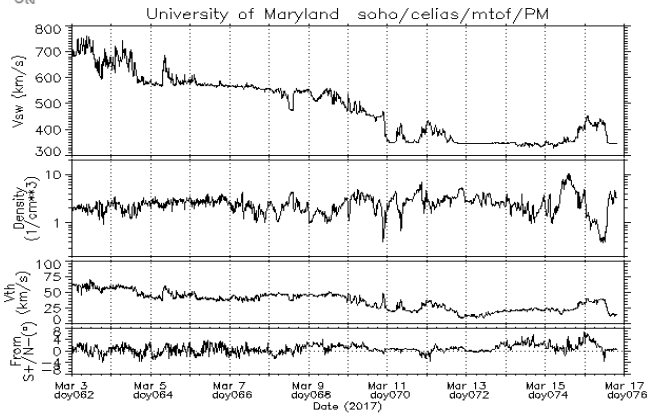


LASCO: Large Angle Spectrometric Coronagraph



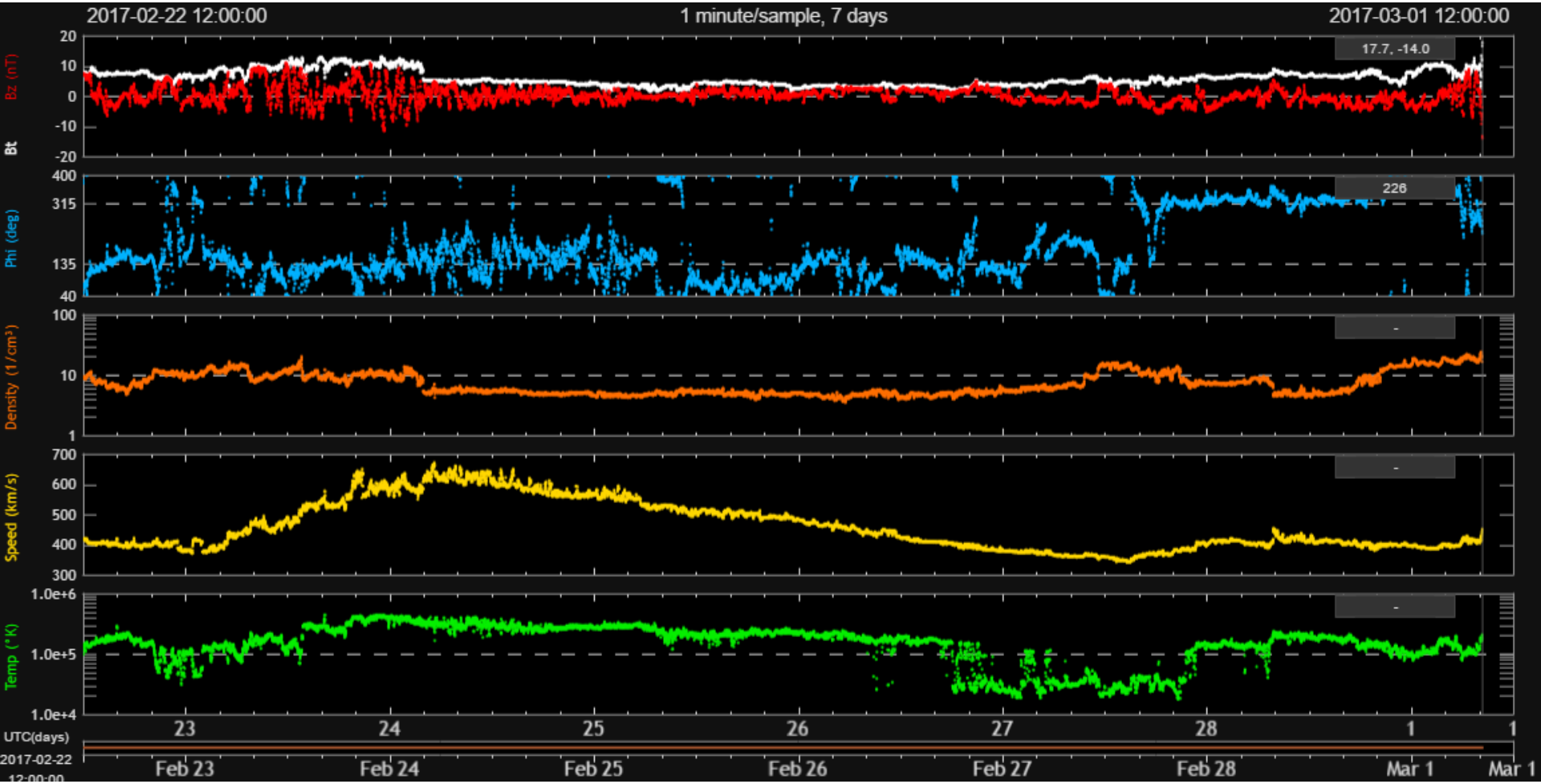
EIT: Extreme ultraviolet Imaging Telescope





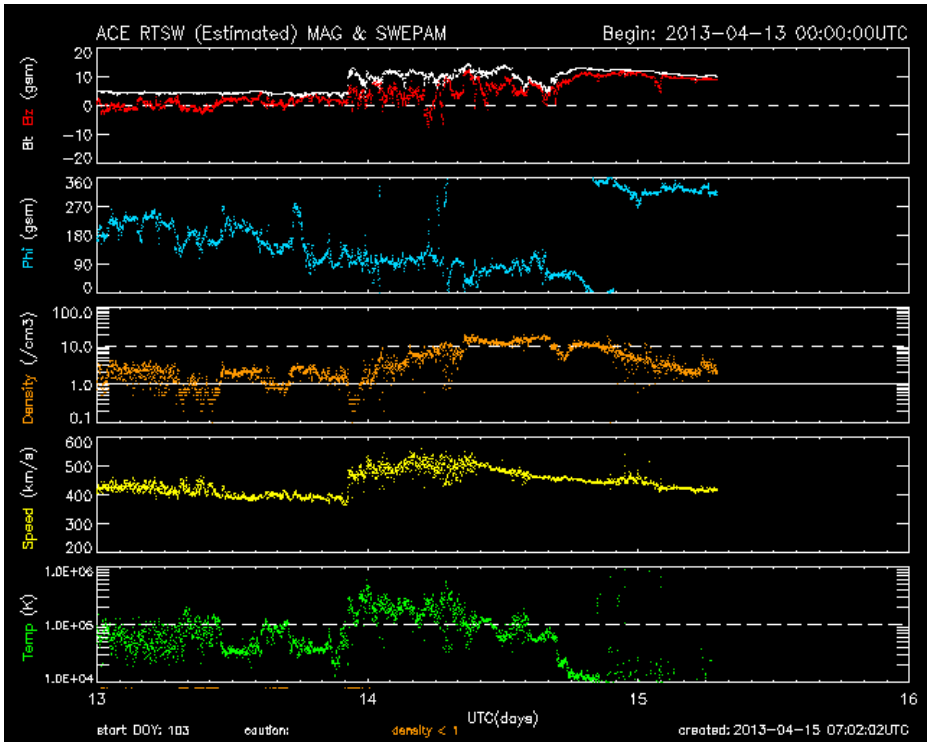
DSCOVR

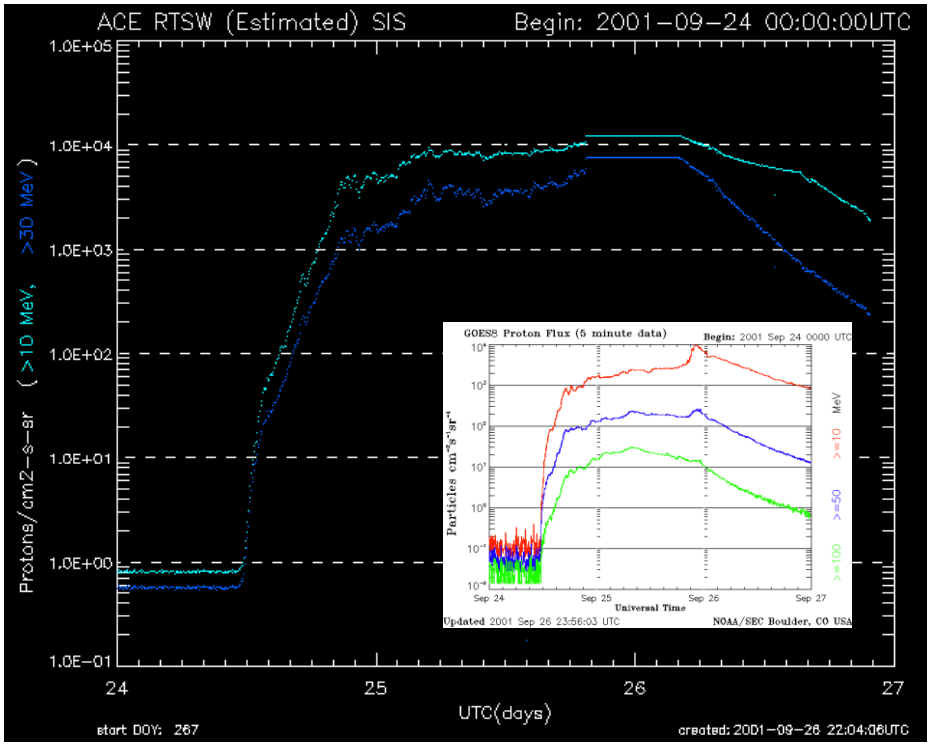
Deep Space Climate Observatory



ACE

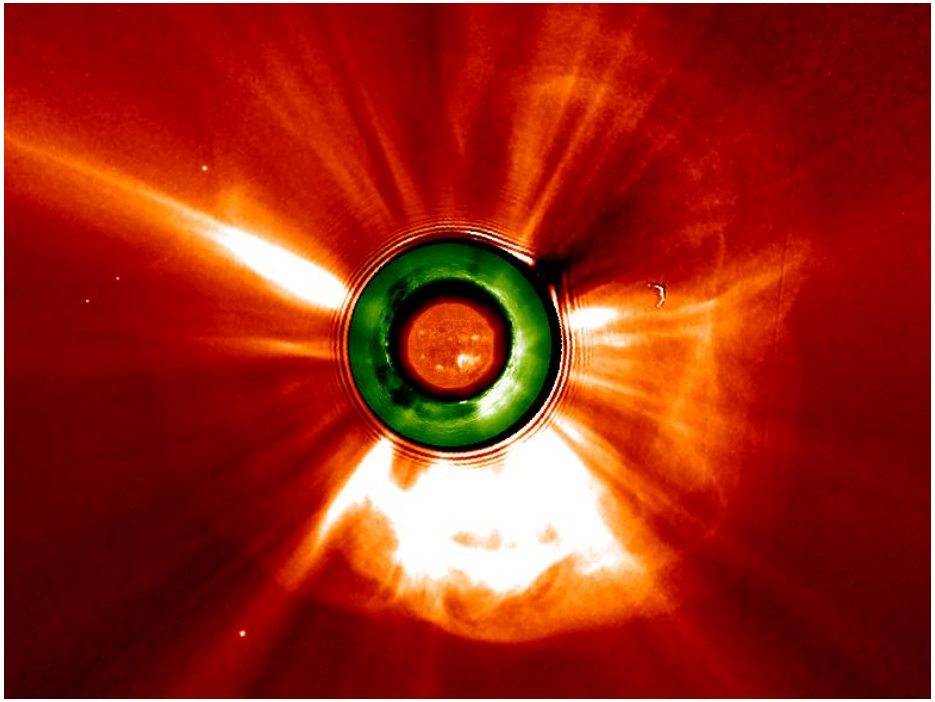
Advanced Composition Explorer



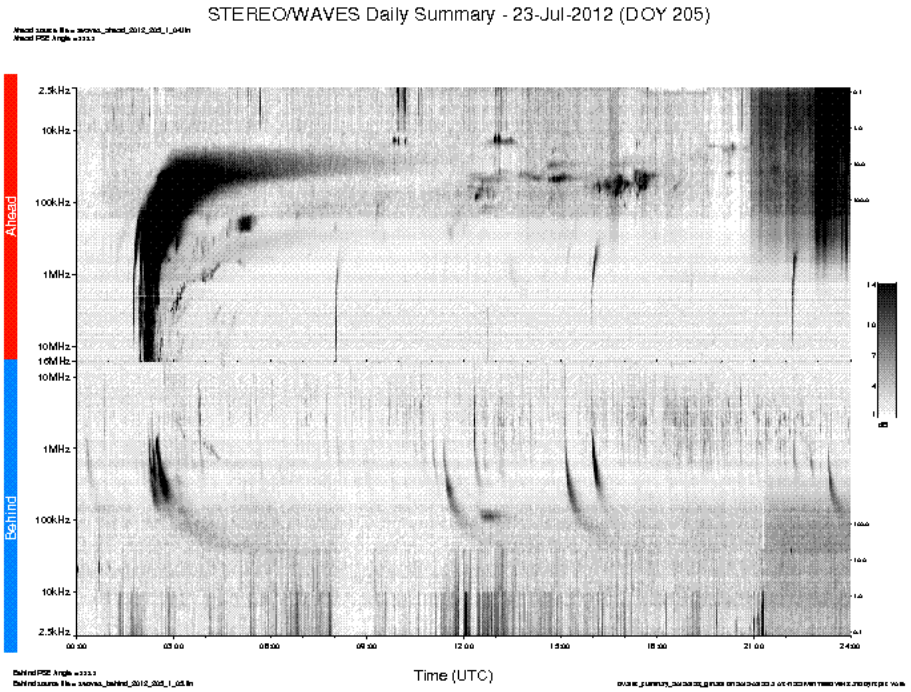


STEREO

Solar-TErrestrial RElations Observatory



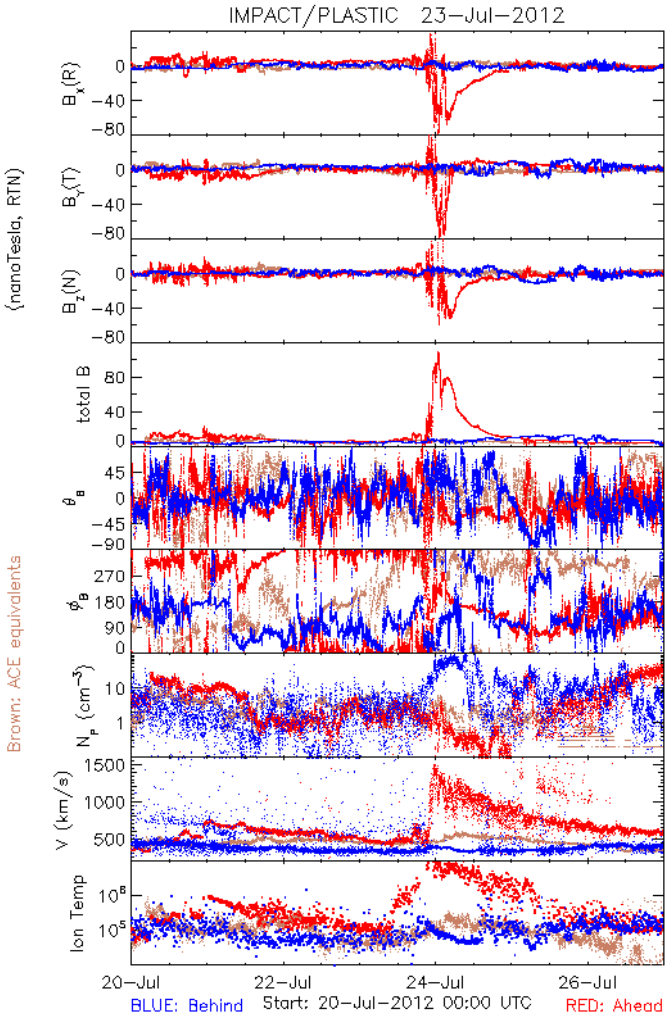
EUVI: Solar EUV imager
COR: Coronagraphs
HI: Heliospheric Imagers

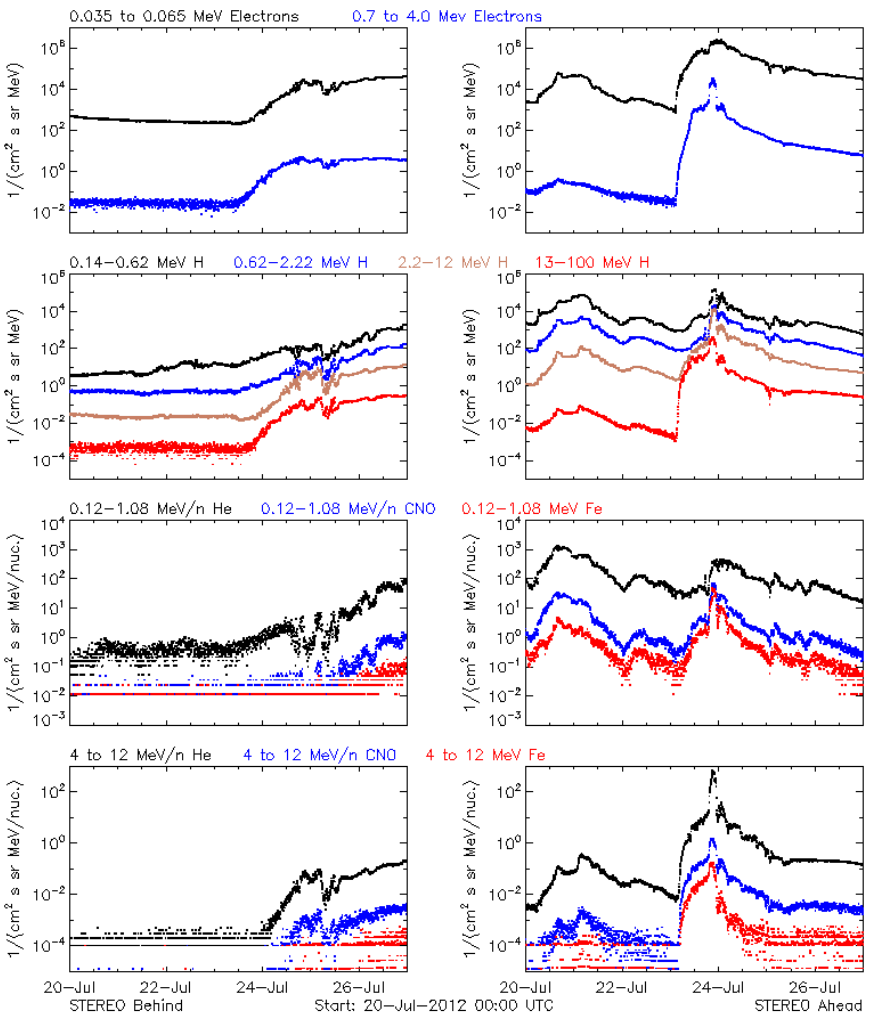


WAVES: radio observations

STEREO

Solar-TErrestrial RElations Observatory





PLASTIC: Solar wind data

IMPACT: Solar energetic particles

:Issued: 2014 Apr 17 1325 UTC
:Product: documentation at http://www.sidc.be/products/tot
#----------#
DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC
#----------#
SIDC URSIGRAM 40417
SIDC SOLAR BULLETIN 17 Apr 2014, 1304UT

Finding your way in the URSIgram

SIDC FORECAST (valid from 1230UT, 17 Apr 2014 until 19 Apr 2014)
SOLAR FLARES : Active (M-class flares expected, probability >=50%)
GEOMAGNETISM : Quiet (A<20 and K<4)
SOLAR PROTONS : Quiet

PREDICTIONS FOR 17 Apr 2014 10CM FLUX: 180 / AP: 013
PREDICTIONS FOR 18 Apr 2014 10CM FLUX: 184 / AP: 007
PREDICTIONS FOR 19 Apr 2014 10CM FLUX: 188 / AP: 005

COMMENT: Eleven sunspot groups were reported by NOAA today. NOAA ARs 2035,2036, and 2037 (Catania numbers 24, 25, and 26 respectively) maintain the beta-gamma configuration of the photospheric magnetic field. The strongest flare of the past 24 hours was the M1.0 flare peaking at 19:59 UT yesterday in the NOAA AR 2035 (Catania number 24). The flare was associated with an EIT wave and a weak coronal dimming, but the associated CME was narrow and is not expected to arrive at the Earth.
We expect further flaring activity on the C-level, especially in the NOAA ARs 2035 and 2037 (Catania numbers 24 and 26 respectively) as well as in the NOAA AR 2042 (no Catania number yet) that yesterday appeared from behind the east solar limb, with a good chance for an M-class event.

Since yesterday evening the Earth is situated inside a solar wind structure with an elevated interplanetary magnetic field magnitude (occasionally up to 10 nT). It may be a weak ICME or the compression region on the flank of an ICME that missed the Earth. The solar origin of this structure is not clear. The north-south magnetic field component Bz was not strong, so no significant geomagnetic disturbance resulted (K index stayed below 4). Currently the solar wind speed is around 380 km/s and the IMF magnitude is around 8 nT.
We expect quiet to unsettled (K index up to 3) geomagnetic conditions, with active geomagnetic conditions (K = 4) possible, but unlikely.

TODAY'S ESTIMATED ISN : 145, BASED ON 17 STATIONS.
99999

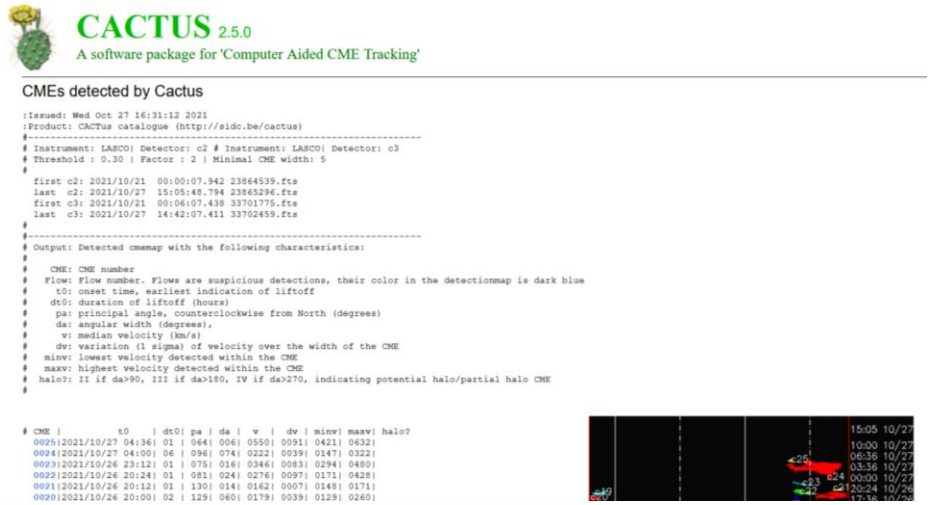
Satellites and instruments

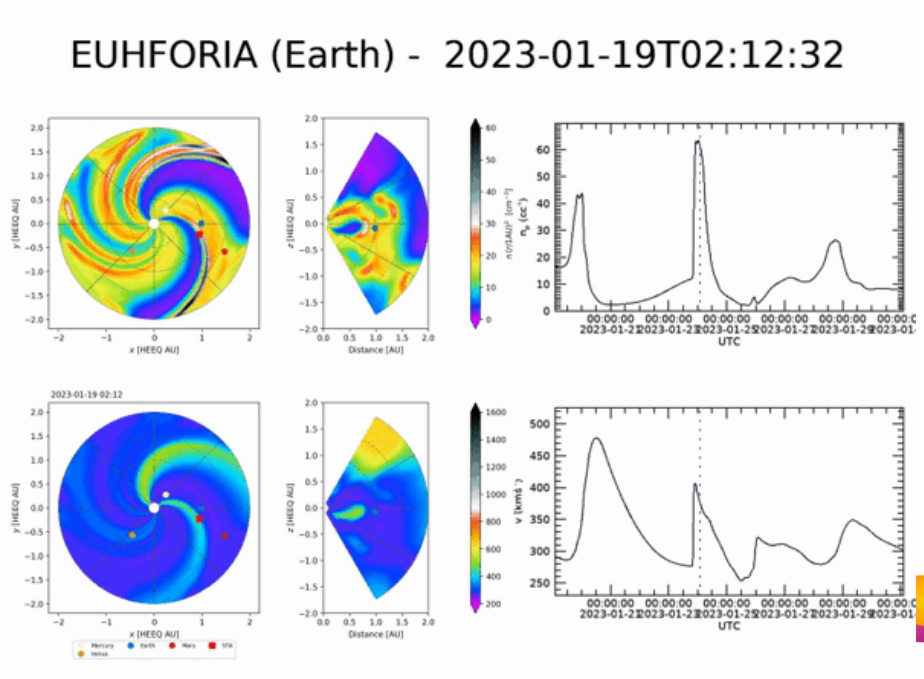
SOLAR INDICES FOR 16 Apr 2014
WOLF NUMBER CATANIA : ///
10CM SOLAR FLUX : 184
AK CHAMBON LA FORET : 012
AK WINGST : 004
ESTIMATED AP : 004
ESTIMATED ISN : 139, BASED ON 29 STATIONS.

NOTICEABLE EVENTS SUMMARY
DAY BEGIN MAX END LOC XRAY OP 10CM Catania/NOAA RADIO_BURST_TYPES
16 1954 1959 2004 S14E09 M1.0 1N 24/2035 II/2
END

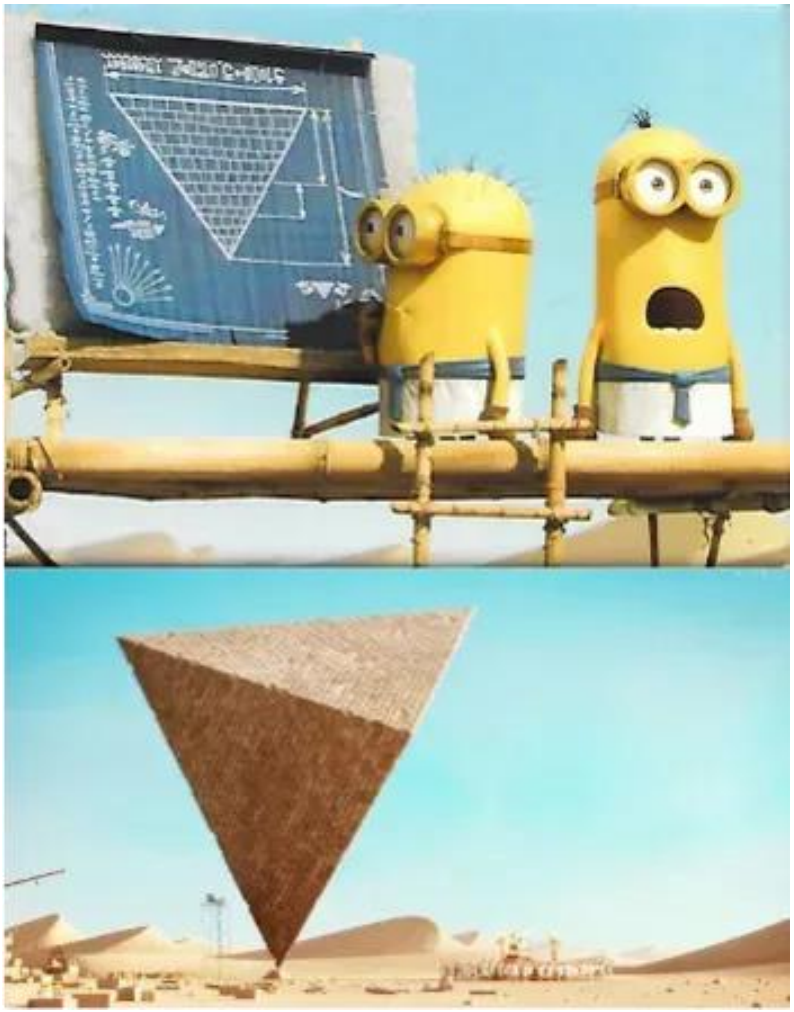
Tools

- Various
  - Solar Map
  - Solar Demon
  - CACTus
  - Drag model
  - JHV (SWHV)
  - STAFF
  - COR2 J-plots
  - COMESEP
  - EUHFORIA
    - WSA-ENLIL (SWPC)





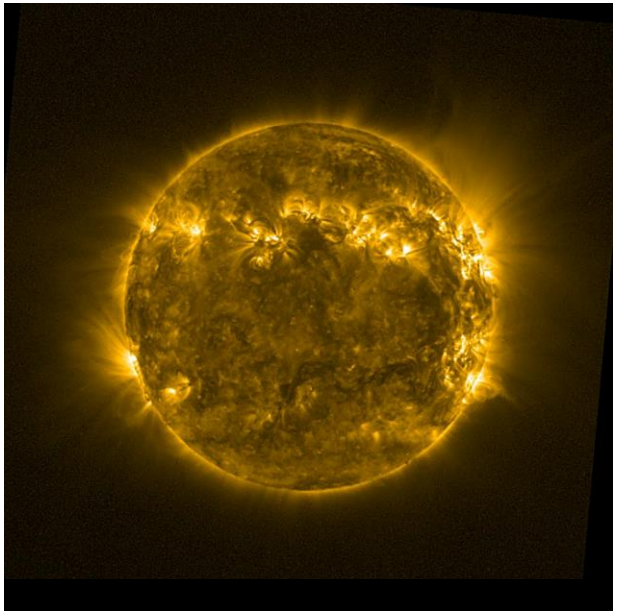
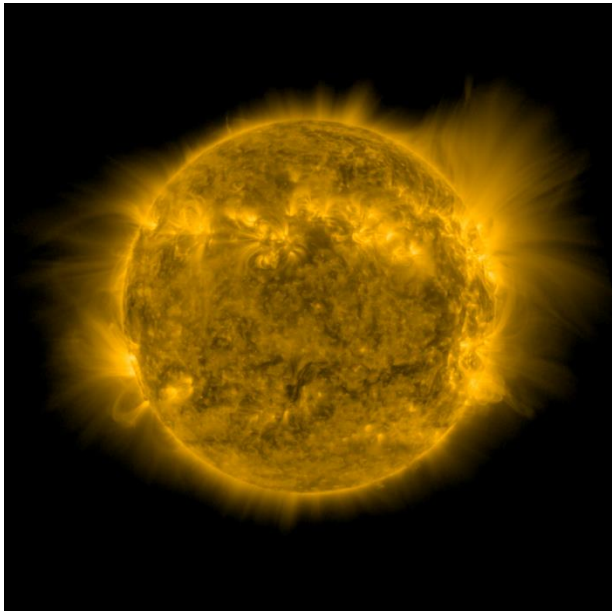
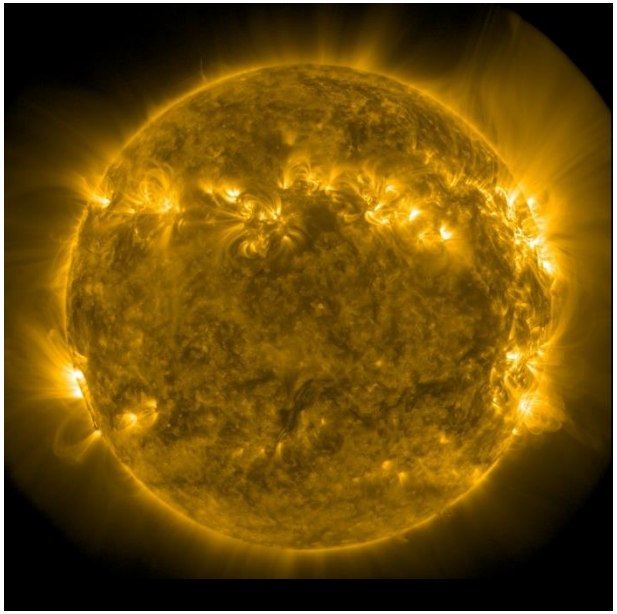
Reversed engineering



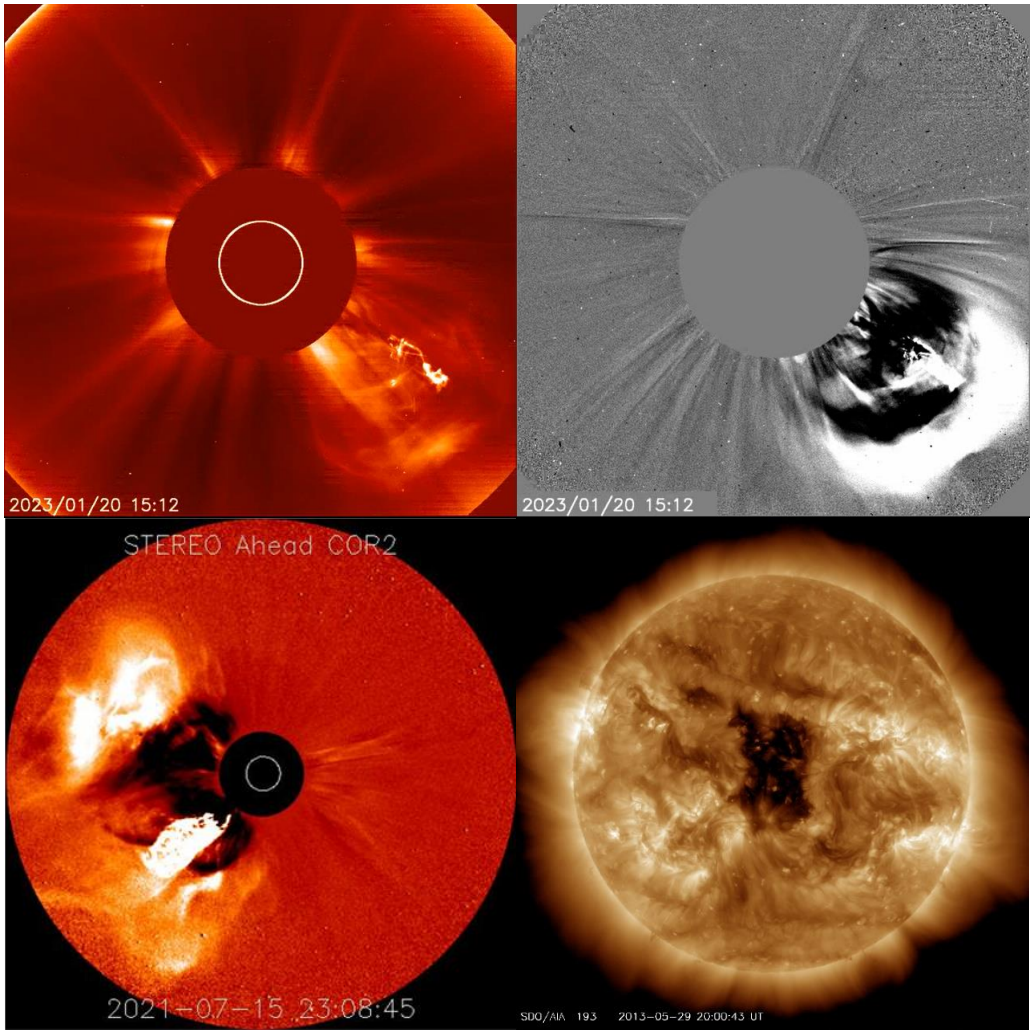
Exercises

What are we looking at? Images, graphs, and tools.

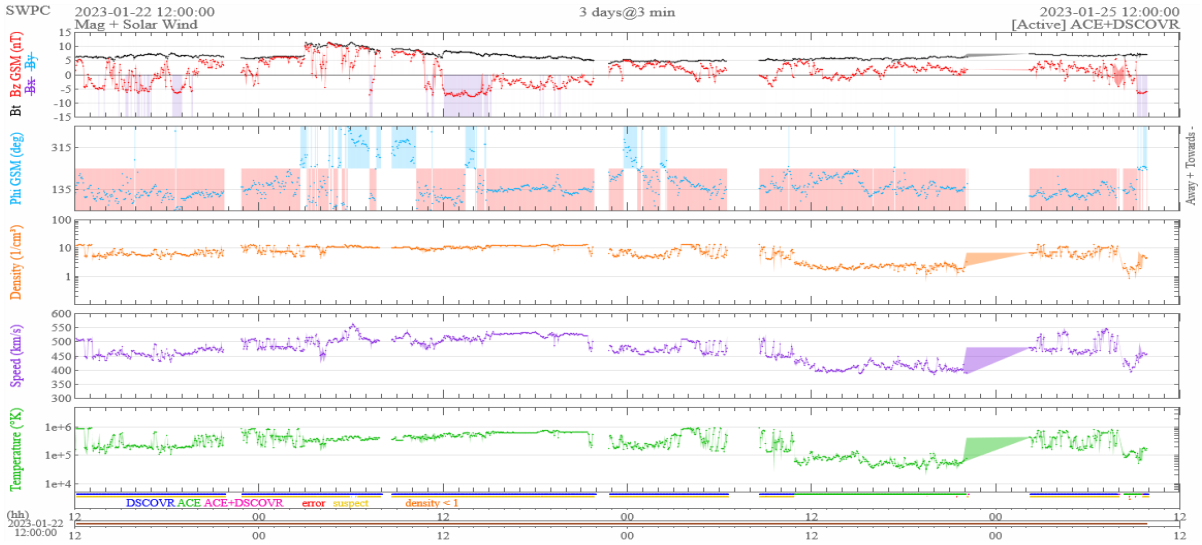
What are we looking at?
Which is the SDO image?

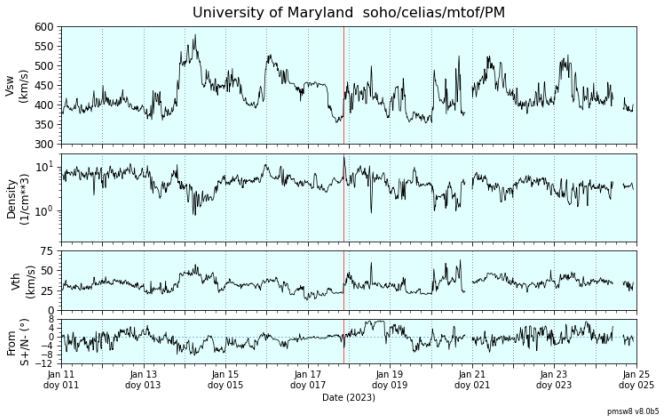




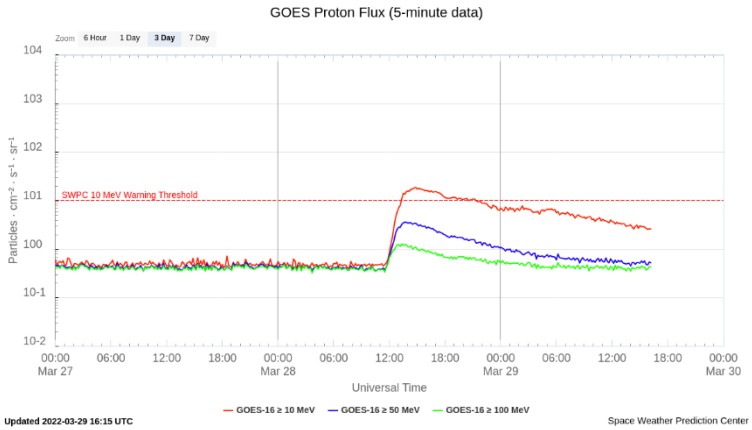
Which is not a coronagraphic image?



Which of the following graphs is not related to solar wind data?







Which of the following tools is not used for CME analysis?

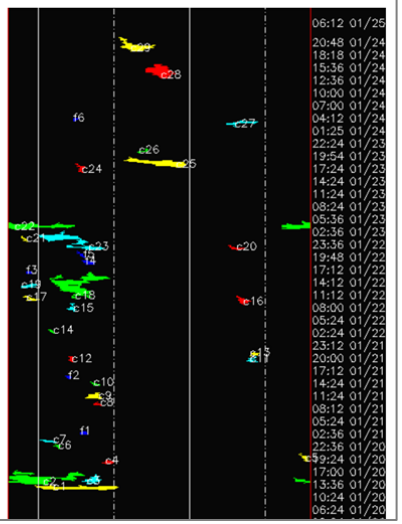
CACTUS 2.5.0

A software package for 'Computer Aided CME Tracking'

CMEs detected by Cactus

```
:Issued: Wed Jan 25 07:31:52 2023
: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: 2023/01/19  00:00:07.717 23921607.fts
  last  c2: 2023/01/25  06:12:07.480 23922356.fts
  first c3: 2023/01/19  01:42:07.444 33751846.fts
  last  c3: 2023/01/24  20:30:07.494 33752485.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?
0029	2023/01/24 21:12	04	298	042	0679	0063	0578	0822	
0028	2023/01/24 15:24	03	326	034	0257	0029	0223	0322	
0027	2023/01/24 04:12	01	063	036	0231	0053	0181	0332	
0026	2023/01/23 19:48	01	305	012	1444	0165	1225	1631	
0025	2023/01/23 19:24	02	319	072	0363	0046	0244	0437	
0024	2023/01/23 19:12	02	230	010	0171	0058	0137	0289	



Forecasting the Arrival of ICMEs: The Drag-Based Model

Basic DBM | Advanced DBM | Documentation

CME take-off **date**:	Jan 25 2023
CME take-off **time** (UTC):	10 h 24 min
R_0 - starting radial distance of CME (R_S)	20
v_0 - speed of CME at R_0 (km/s)	1000
Γ - drag parameter (10^{-7} km^{-1})	0.2
w - asymptotic solar wind speed (km/s)	450
R_{target} - target heliocentric distance (AU)	1

Calculate | Reset!

Drag-Based Model has performed **720** successful calculations (since 26.12.2012).

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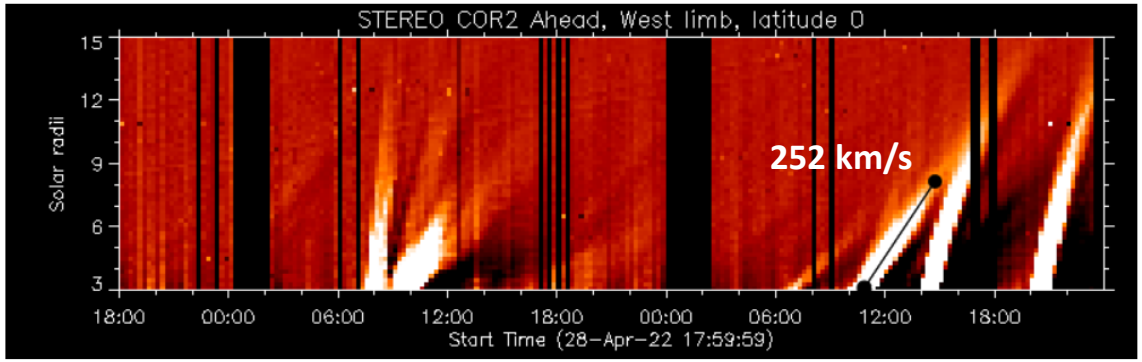

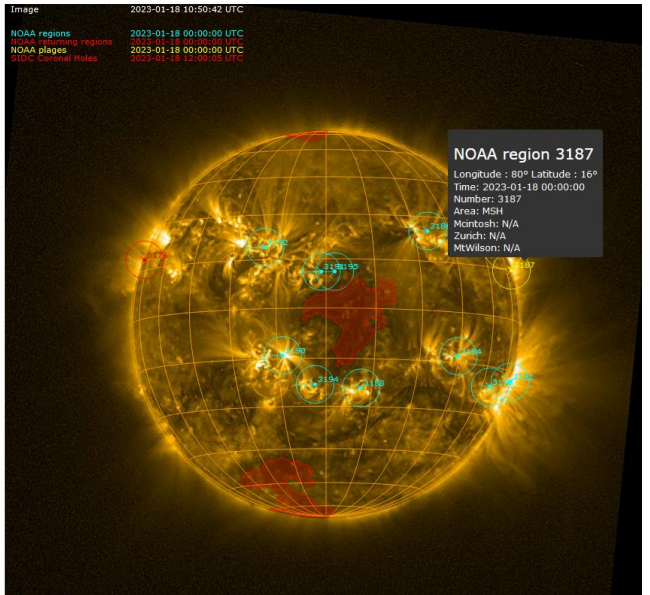

Exercises

Identify the ground-based stations, satellites, sensors, tools,… in the following URSIgrams (Comment)

URSIgram 1

```
:Issued: 2020 Feb 27 1230 UTC
:Product: documentation at http://www.sidc.be/products/tot
#-----------------------------------------------------------------#
# DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC  #
#-----------------------------------------------------------------#
SIDC URSIGRAM 00227
SIDC SOLAR BULLETIN 27 Feb 2020, 1230UT
SIDC FORECAST (valid from 1230UT, 27 Feb 2020 until 29 Feb 2020)
SOLAR FLARES  : Quiet conditions (<50% probability of C-class flares)
GEOMAGNETISM  : Quiet (A<20 and K<4)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 27 Feb 2020  10CM FLUX: 071 / AP: 010
PREDICTIONS FOR 28 Feb 2020  10CM FLUX: 071 / AP: 006
PREDICTIONS FOR 29 Feb 2020  10CM FLUX: 071 / AP: 004
COMMENT: Solar activity was at very low levels. The Sun is still spotless, but this may change
as two small active regions at resp. latitudes S10 and N25 are about to rotate over the east limb
as seen in SDO/AIA and STEREO-A/EUVI imagery. No earth-directed coronal mass ejections (CMEs) have
been observed in available coronagraphic imagery. The greater than 10 MeV proton flux was at
nominal values. Some small and patchy equatorial coronal holes (CHs) are present on the solar disk.

Solar activity is expected to remain at very low levels.

Solar wind conditions were at background levels. Solar wind speed varied steadily between 330 and
370 km/s (ACE). Bz undulated between -5 and +5 nT. The direction of the interplanetary magnetic
field (phi angle) was variable. Geomagnetic conditions were at quiet levels, with an unsettled
episode (09-12UT) recorded at Dourbes.

Geomagnetic activity is expected to remain mostly at quiet levels, with an isolated unsettled
interval remaining possible.
```


URSIgram 2

```
:Issued: 2018 Oct 13 1230 UTC
:Product: documentation at http://www.sidc.be/products/tot
#-----------------------------------------------------------------#
# DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC  #
#-----------------------------------------------------------------#
SIDC URSIGRAM 81013
SIDC SOLAR BULLETIN 13 Oct 2018, 1230UT
SIDC FORECAST (valid from 1230UT, 13 Oct 2018 until 15 Oct 2018)
SOLAR FLARES  : Quiet conditions (<50% probability of C-class flares)
GEOMAGNETISM  : Minor storm expected (A>=30 or K=5)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 13 Oct 2018  10CM FLUX: 072 / AP: 006
PREDICTIONS FOR 14 Oct 2018  10CM FLUX: 072 / AP: 029
PREDICTIONS FOR 15 Oct 2018  10CM FLUX: 072 / AP: 021
COMMENT: Beta region NOAA AR 2724 near the East limb has produced a B2.1 flare peaking at 01:50UT
on October 12, associated with a Type II radio burst observed at Learmonth, and a B7.1 flare
peaking at 14:08 UT, associated with a Type II radio burst registered in Humain. The chance for a
C flare in the next 24 hours is estimated at 35%.

No Earth-directed Coronal Mass Ejections (CMEs) were observed in available coronagraphic imagery.

The greater than 10 MeV proton flux was at nominal levels in the past 24 hours, and is expected to
stay at nominal levels in the next 24 hours.

Solar wind speed near Earth as registered by DSCOVR decreased from about 400 to 340 km/s about in
the past 24 hours. The Interplanetary Magnetic Field (IMF) was predominantly directed away from
the Sun and its magnitude varied between about 1 and 8 nT. Bz was never below -5 nT.  A high speed
stream from a negative polarity equatorial coronal hole is expected to arrive at Earth near the
start of October 14, enhancing the solar wind conditions.

Quiet geomagnetic conditions (K Dourbes between 1 and 2; NOAA Kp between 1 and 3) were registered
in the past 24 hours. Quiet to unsettled levels (K Dourbes < 4) are expected on October 13. Active
geomagnetic levels (K Dourbes = 4) are possible on October 14 and 15 due to the expected arrival
of a high speed stream from a negative polarity equatorial coronal hole, with a chance for minor
storm (K Dourbes = 5) intervals.
```


URSIgram 3

```
:Issued: 2017 May 24 1310 UTC
:Product: documentation at http://www.sidc.be/products/tot
#-----------------------------------------------------------------#
# DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC  #
#-----------------------------------------------------------------#
SIDC URSIGRAM 70524
SIDC SOLAR BULLETIN 24 May 2017, 1310UT
SIDC FORECAST (valid from 1230UT, 24 May 2017 until 26 May 2017)
SOLAR FLARES  : Quiet conditions (<50% probability of C-class flares)
GEOMAGNETISM  : Active conditions expected (A>=20 or K=4)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 24 May 2017  10CM FLUX: 076 / AP: 004
PREDICTIONS FOR 25 May 2017  10CM FLUX: 075 / AP: 007
PREDICTIONS FOR 26 May 2017  10CM FLUX: 076 / AP: 013
COMMENT: Over the past 24 hours solar activity has been very low. There has been one B4.4 flare
peaking at 14:21 UT on 23-May-2017, coming from NOAA Active Region (AR) 2660 (McIntosh class:Bxo;
Mag.Type:Beta). There are three more decaying NOAA AR on the visible side of the solar disk. Solar
activity is expected to remain low over the next 24 hours with a probability of C-class flares.

A slow partial halo CME, with projected speed of about 192 km/s and angular width of about 122
degrees, was detected at 05:24 UT by CACTUS on 23-May-2017. The PROBA2/SWAP images analysis indicates
strong dimming near solar disk centre as the source of the CME. WSA-ENLIL model predicts the arrival
of CME at Earth around noon on 26-May-2017.

The total electron flux for electrons with energies above 2 MeV reached high levels. The total proton
flux for protons with energies above 10 MeV remained at background level. The greater than 2 MeV
electron flux is expected to reach high levels today and tomorrow (25-May-2017) in response to
elevated solar wind speeds.

The solar wind speed decreased from about 520 km/s to values around 470 km/s during last 24 hours.
The total interplanetary magnetic field (IMF) strength, as recorded by the DSCOVR satellite, was
around 4 nT. Bz fluctuated between -3 and +3 nT being mostly negative. Geomagnetic conditions were
ranged K Dourbes between 1 and 3; NOAA Kp between 1 and 2. The geomagnetic field is expected to be
quiet today and tomorrow. Unsettled to active conditions are expected, with a minor storm possibility
after noon 26-May-2017 due to the arrival of the 23-May-2017 CME.
```


URSIgram 4

:Issued: 2017 Oct 21 1236 UTC
:Product: documentation at http://www.sidc.be/products/tot
#---#
DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC
#---#
SIDC URSIGRAM 71021
SIDC SOLAR BULLETIN 21 Oct 2017, 1236UT
SIDC FORECAST (valid from 1230UT, 21 Oct 2017 until 23 Oct 2017)
SOLAR FLARES : C-class flares expected, (probability >=50%)
GEOMAGNETISM : Active conditions expected (A>=20 or K=4)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 21 Oct 2017 10CM FLUX: 077 / AP: 017
PREDICTIONS FOR 22 Oct 2017 10CM FLUX: 077 / AP: 007
PREDICTIONS FOR 23 Oct 2017 10CM FLUX: 077 / AP: 007
COMMENT: From the East limb, returning NOAA region 2682 produced a long duration M1.1 flare peaking at 23:28 UT on October 20. An associated dimming was detected by Solar Demon, and an associated Type II radio burst was observed by Palehua at 23:35 UT with a corresponding speed of 344 km/s. SOHO LASCO C2 and C3 and STEREO COR2 A have observed an associated bright CME, first seen in LASCO C2 at 00:00 UT on October 21, from the northeast to the southeast. Analysis of COR2 A jplots revealed a plane of sky speed of about 385 km/s, yielding a full speed of 770 km/s. Due to the position of the source, this CME will not be geoeffective. C flares are likely in the next 24 hours (70% probability), with a chance for an M flare (30% probability).

No Earth-directed Coronal Mass Ejections (CMEs) were observed in available coronagraphic imagery.

The greater than 10 MeV proton flux was at nominal levels.

A small, fast forward shock in the solar wind occurred at 5:16 UT on October 21. Solar wind speed registered by DSCOVR jumped from about 340 to 365 km/s, while the magnitude of the Interplanetary Magnetic Field (IMF) jumped from about 4 to 6 nT. Current solar wind speed is about 360 km/s and current IMF magnitude is about 8.5 nT. The IMF was directed away from the Sun until it started pointing towards the Sun around 7:40 UT on October 21. Quiet to unsettled conditions (K Dourbes between 1 and 3; NOAA Kp between 1 and 2) were registered in the past 24 hours. There is a chance for active geomagnetic levels (K Dourbes = 4) on October 21. Quiet to unsettled geomagnetic levels (K Dourbes < 4) are expected on October 22 and 23.

Summary

- Both ground- and space-based data and imagery are used in SWx
  - Depends on the SWx user community and the purpose
  - Tools
- Multiple stations are a must
  - Back-up, cross-check & continuous monitoring
  - Reversed engineering
- Exercises