Monitoring Solar Activity and Space Weather -databases and tools

Krzysztof Barczynski[1]

[1]Physikalisch-Meteorologisches Observatorium Davos (PMOD/WRC), Switzerland

graubünden Education and Research.

pmod wrc

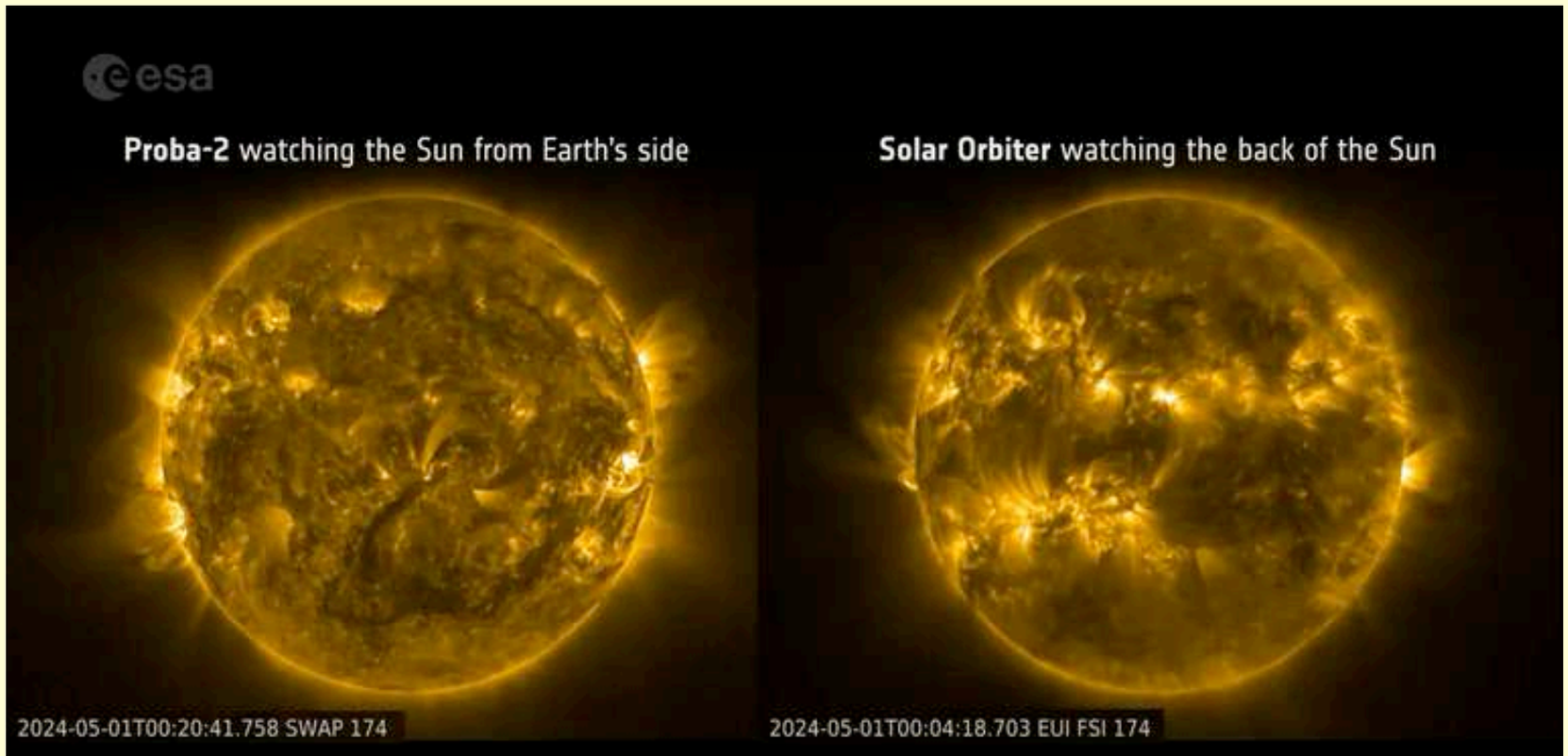
Outlook

- **How does the Sun create space weather?**
  The physics of the Sun and space weather

- **How do we observe the Sun and its impact on space weather?**
  Instruments

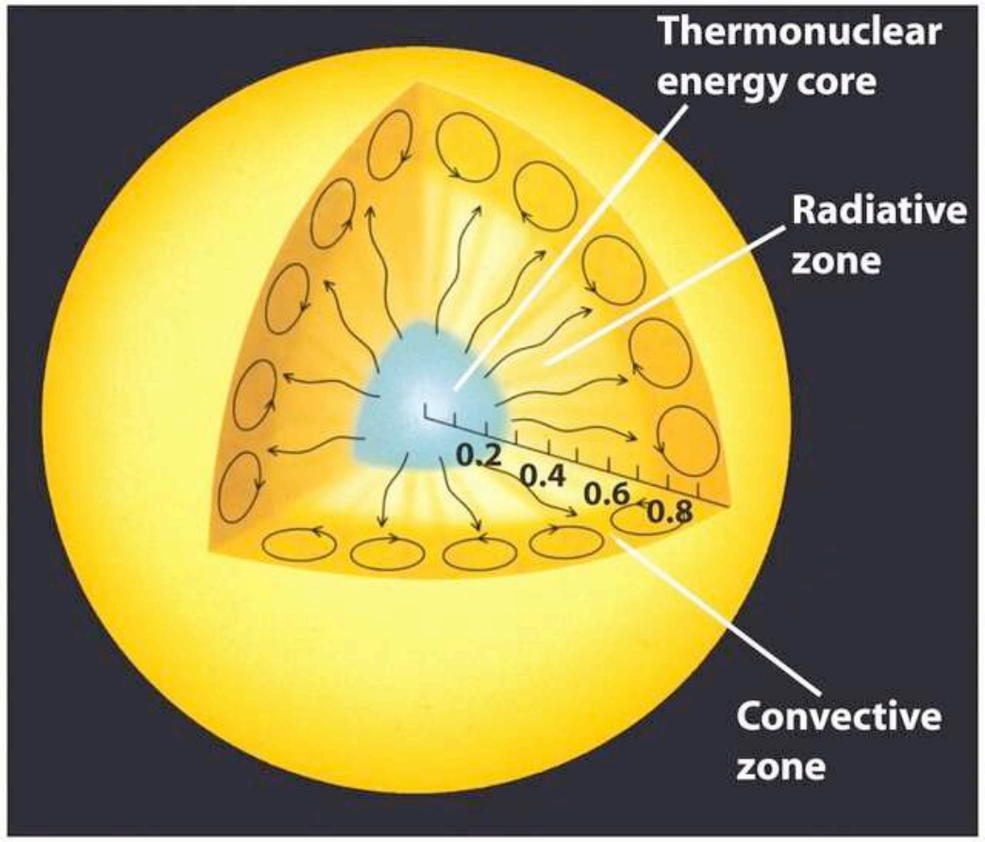
- **Which type of information do we obtain from satellites?**
  The solar observation databases

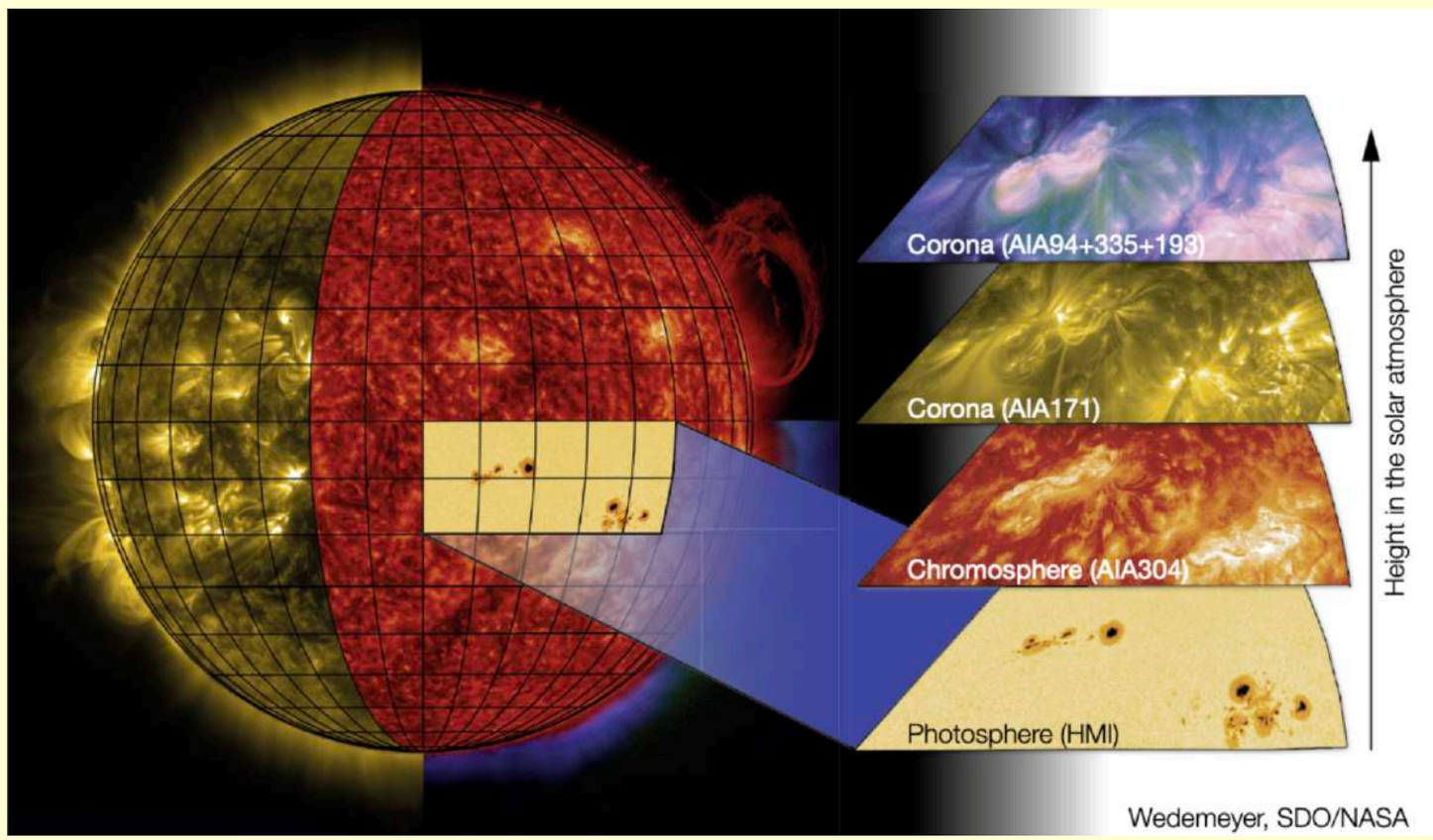
- **Which tools do we use to analyse these observations?**
  Tools

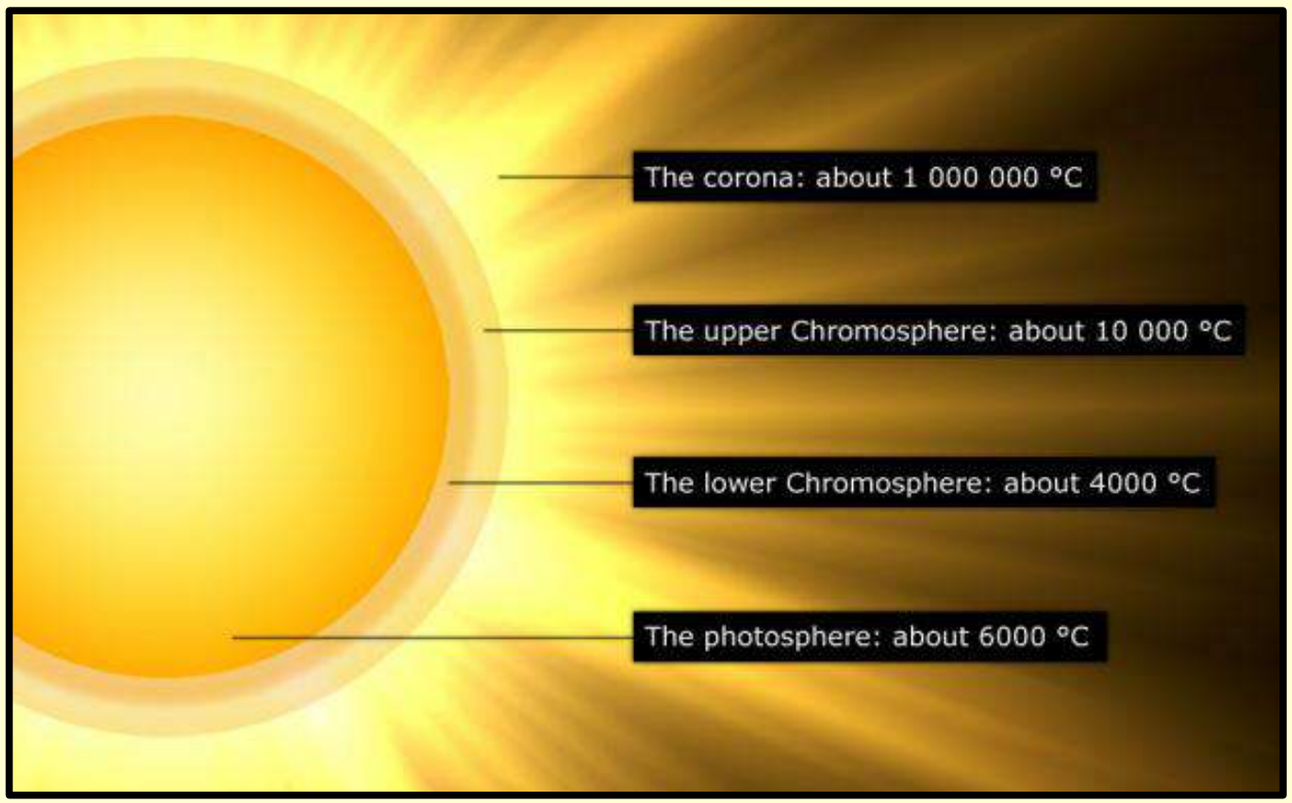


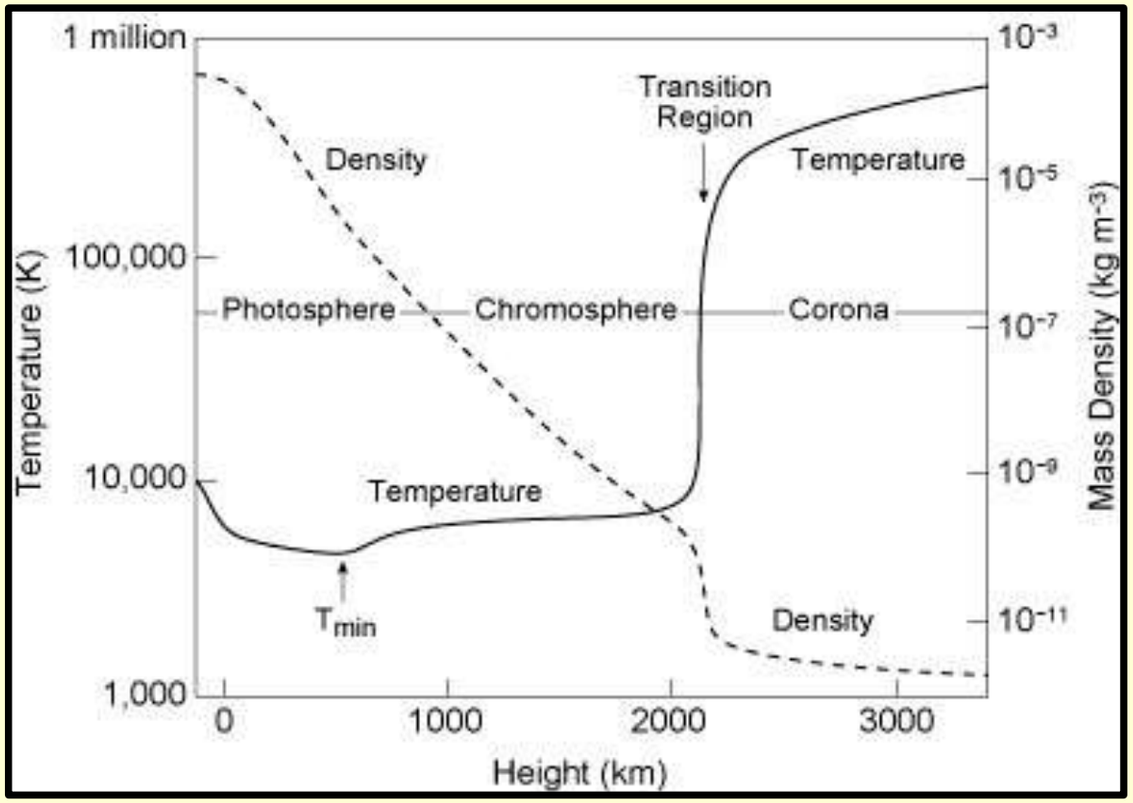
The physics of the Sun & solar activity

The solar atmosphere



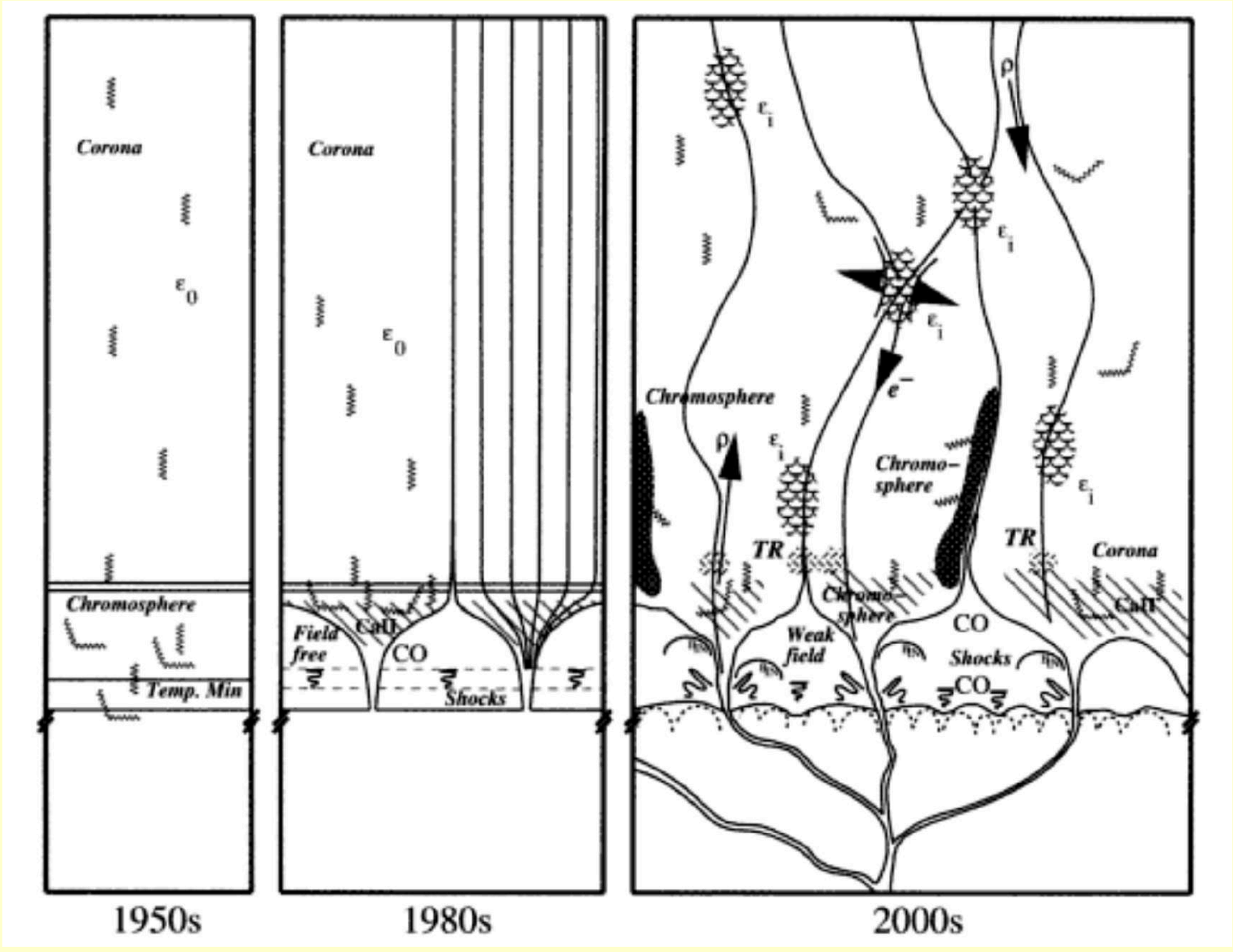






1) Illustration: Per Byhring; 2) Eugene Avrett, Smithsonian Astrophysical Observatory

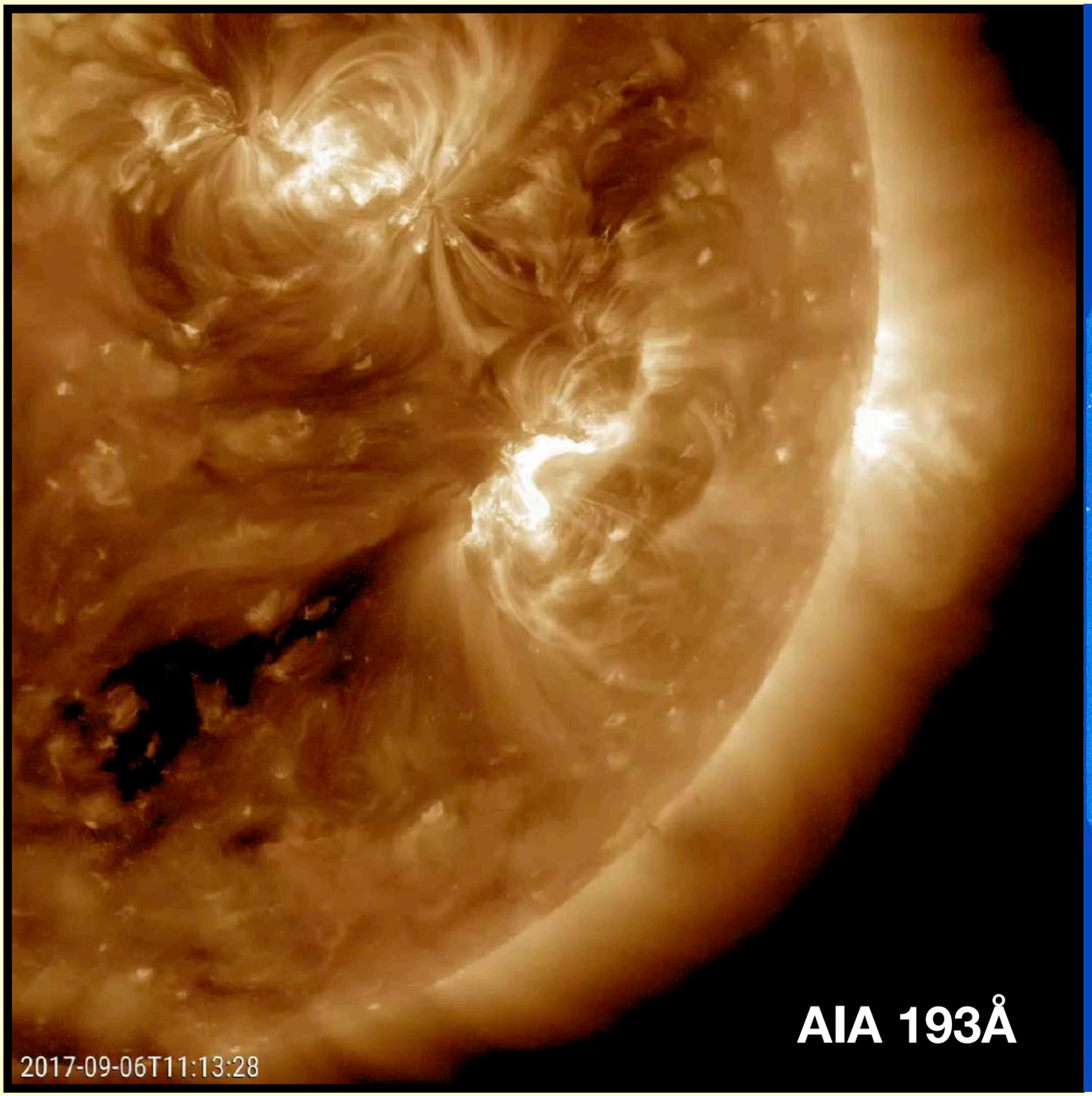
The solar atmosphere



Schrijver, 2001

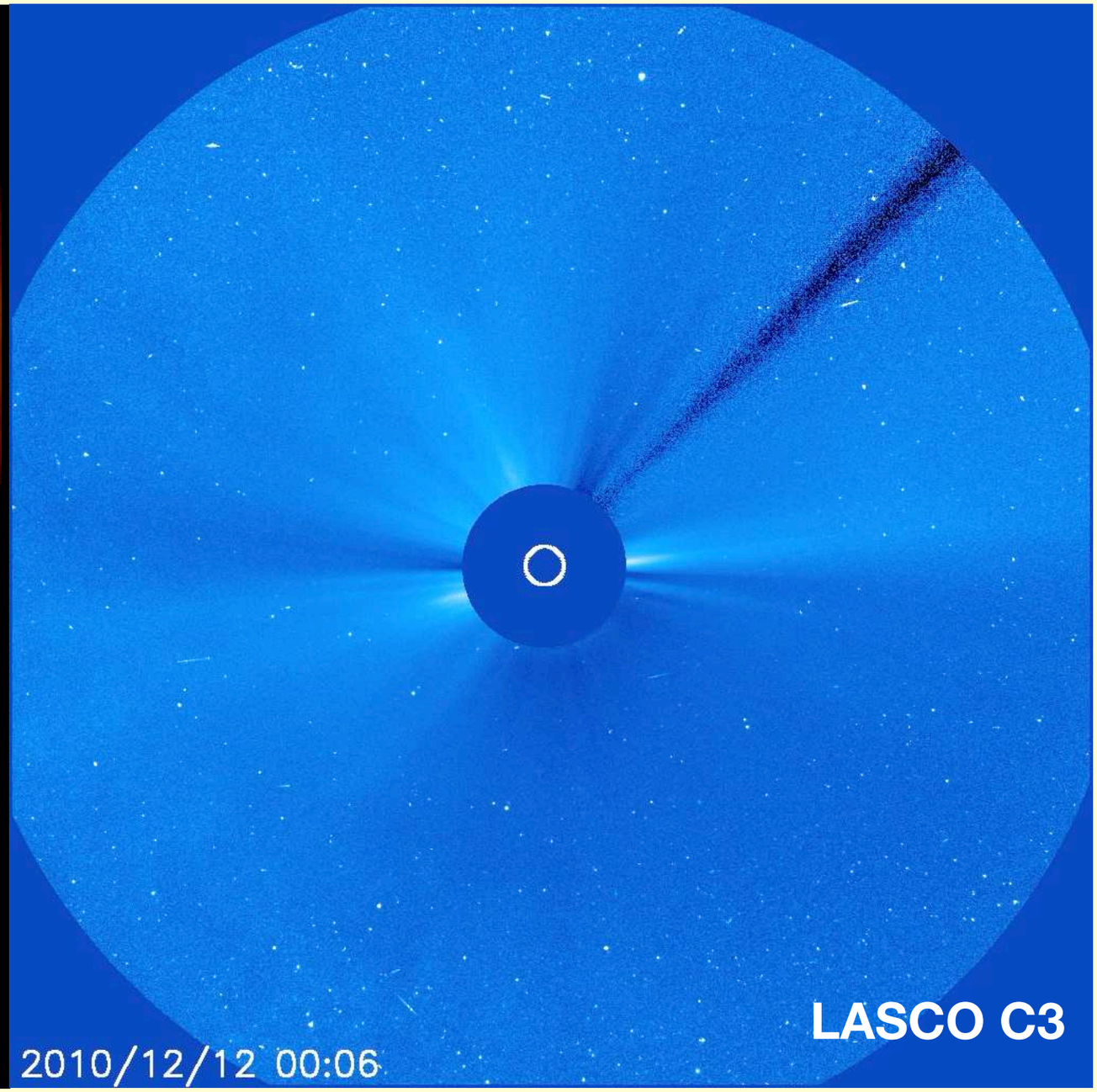
Eruptive events

Solar flare



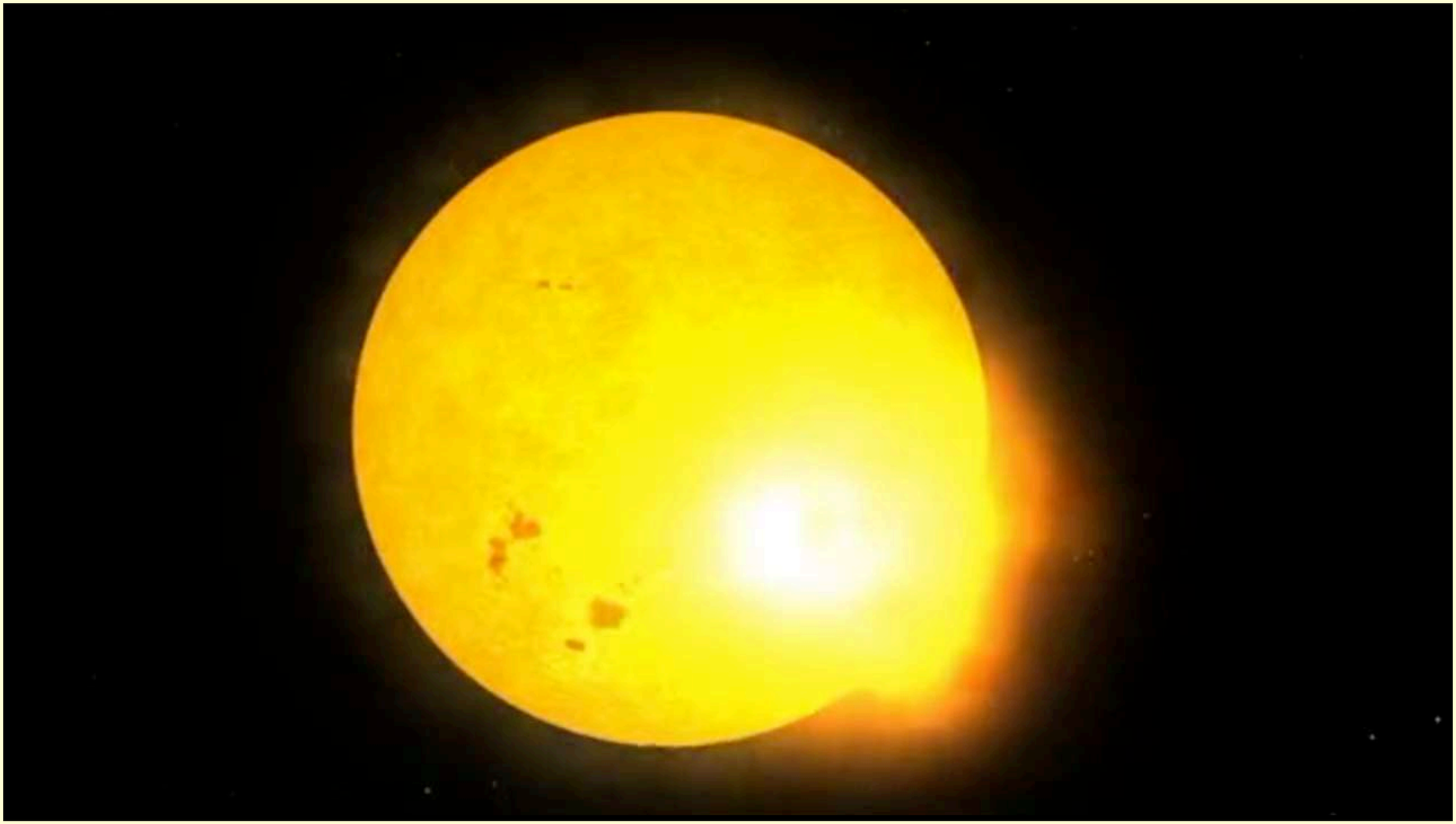
NASA/GSFC/ Solar Dynamics Observatory

Coronal Mass Ejection (CME)



NASA, ESA /Solar and Heliospheric Observatory

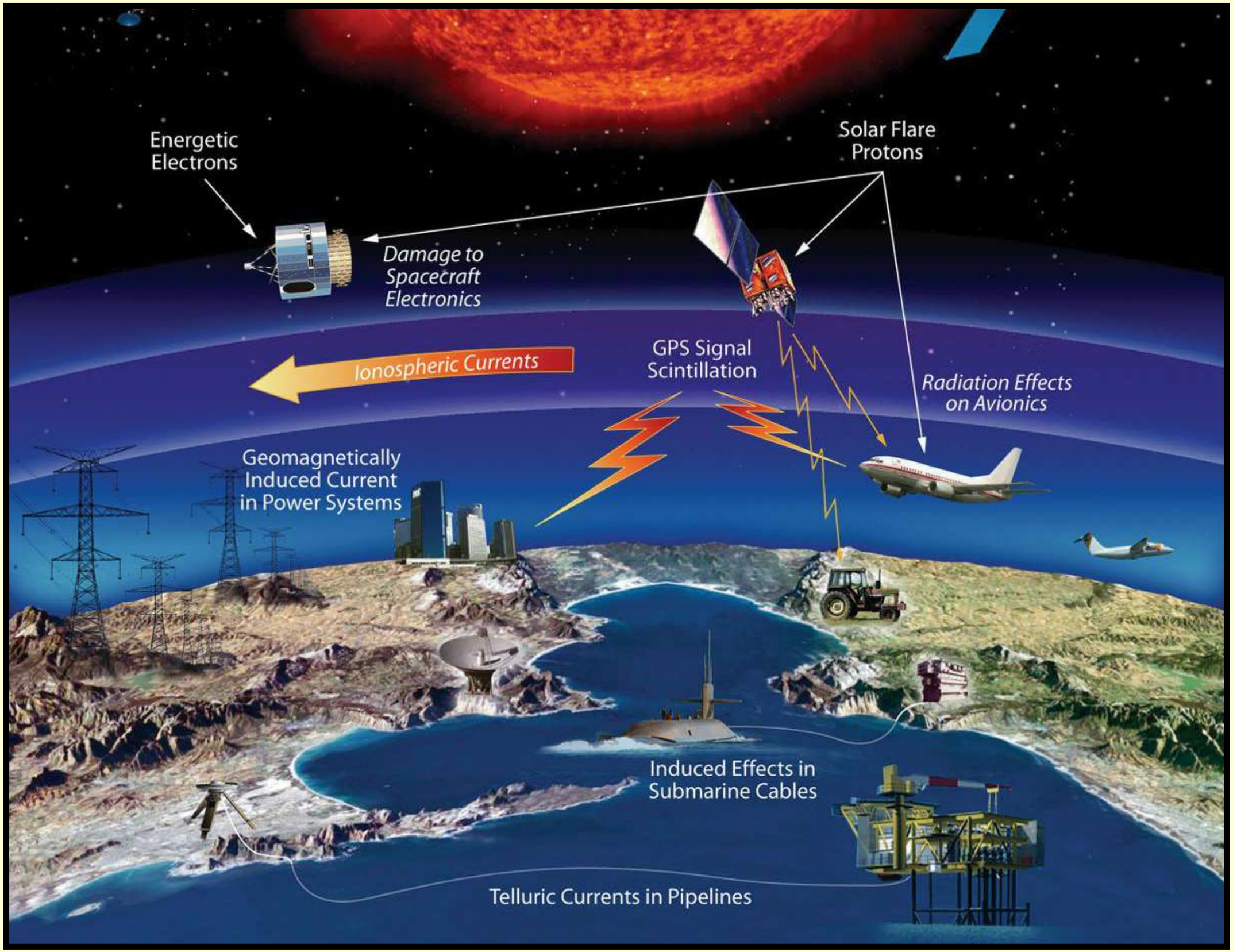
Space weather



NASA

-magnetic fields
-particles (ion, proton, electron, alpha)

Geomagnetic storm



NASA

Solar activity impact

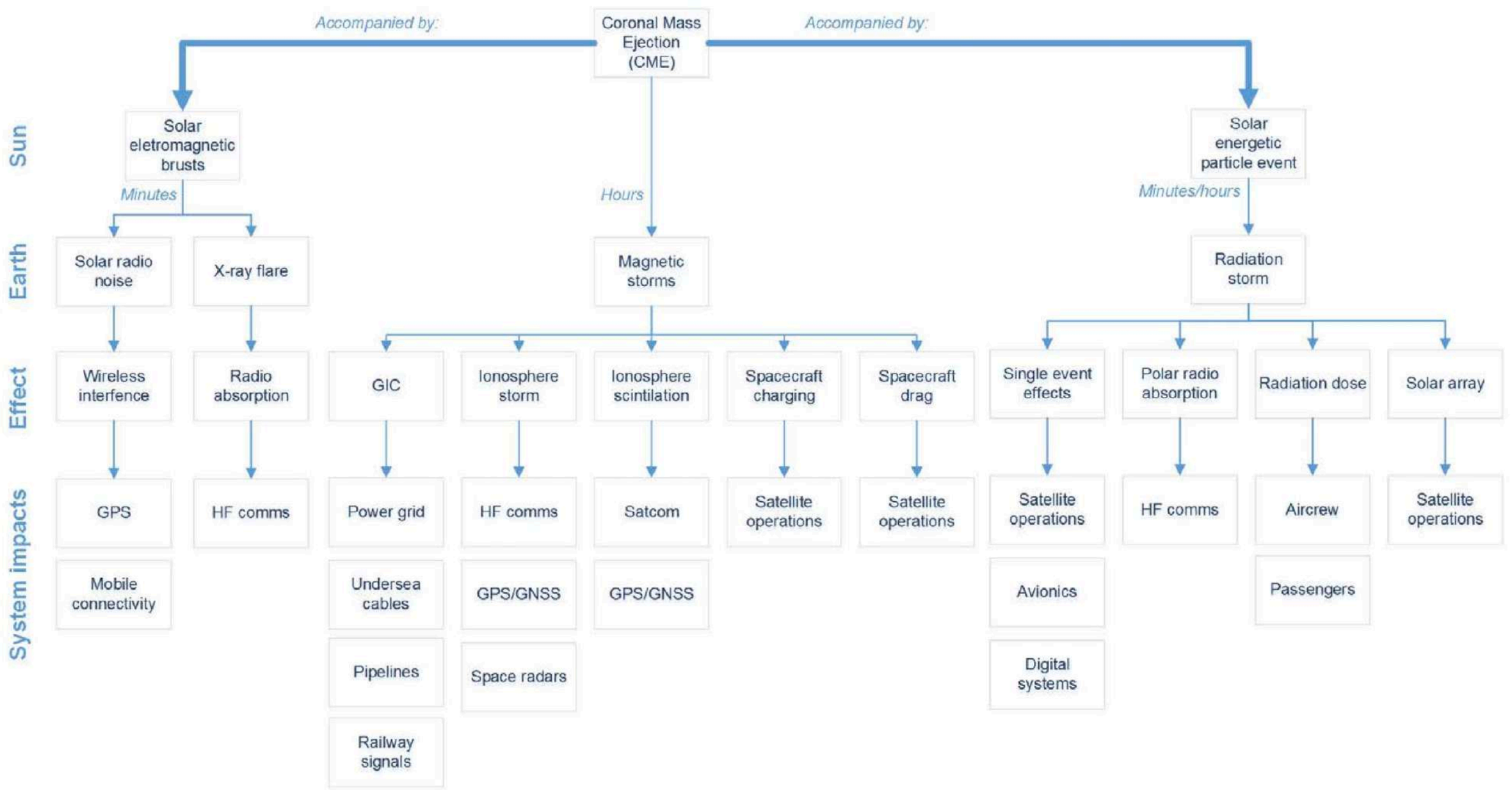


Figure 23: Scenario impact tree (Adapted from Hapgood et al. 2012)

Solar activity impact

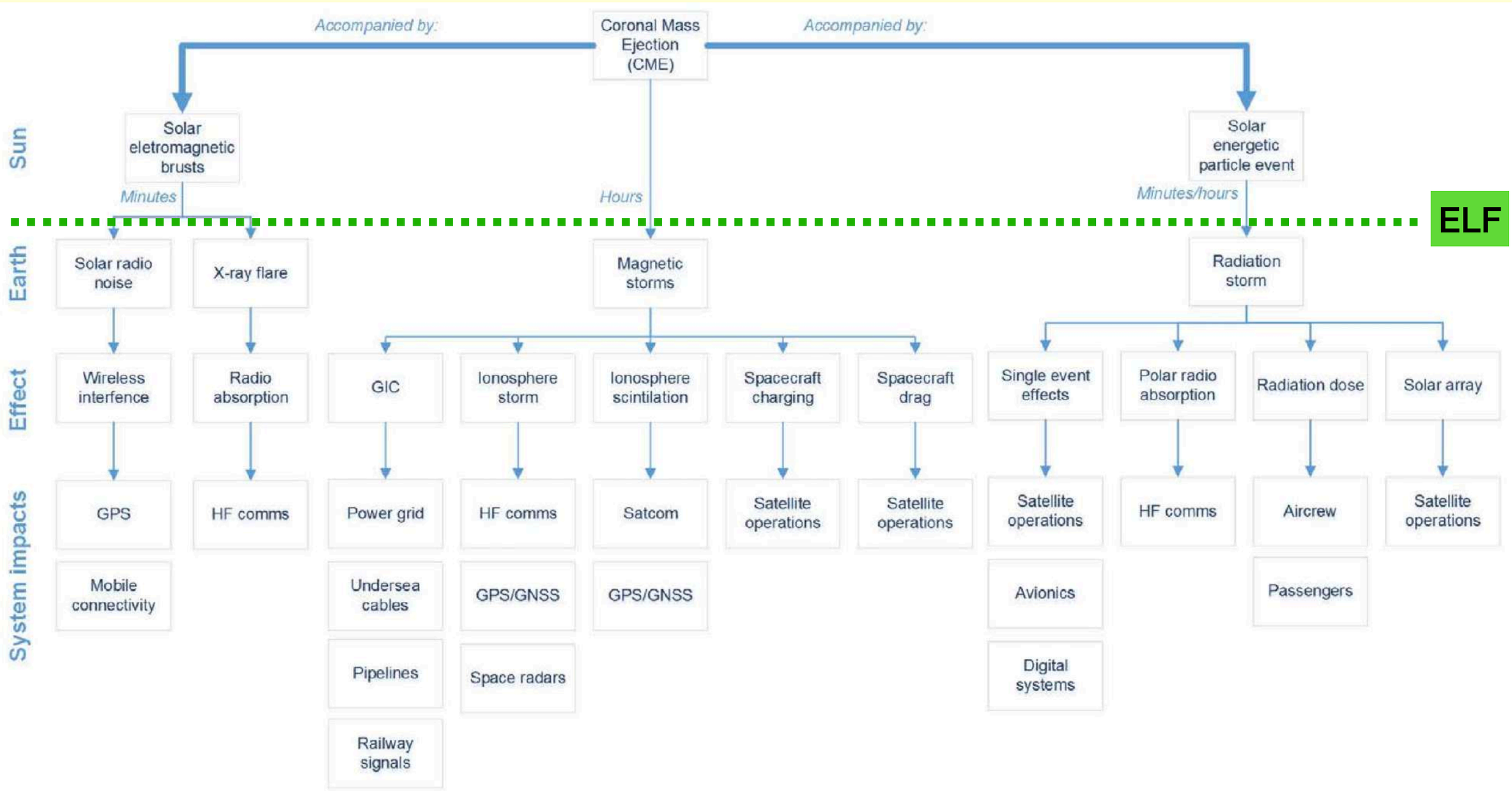
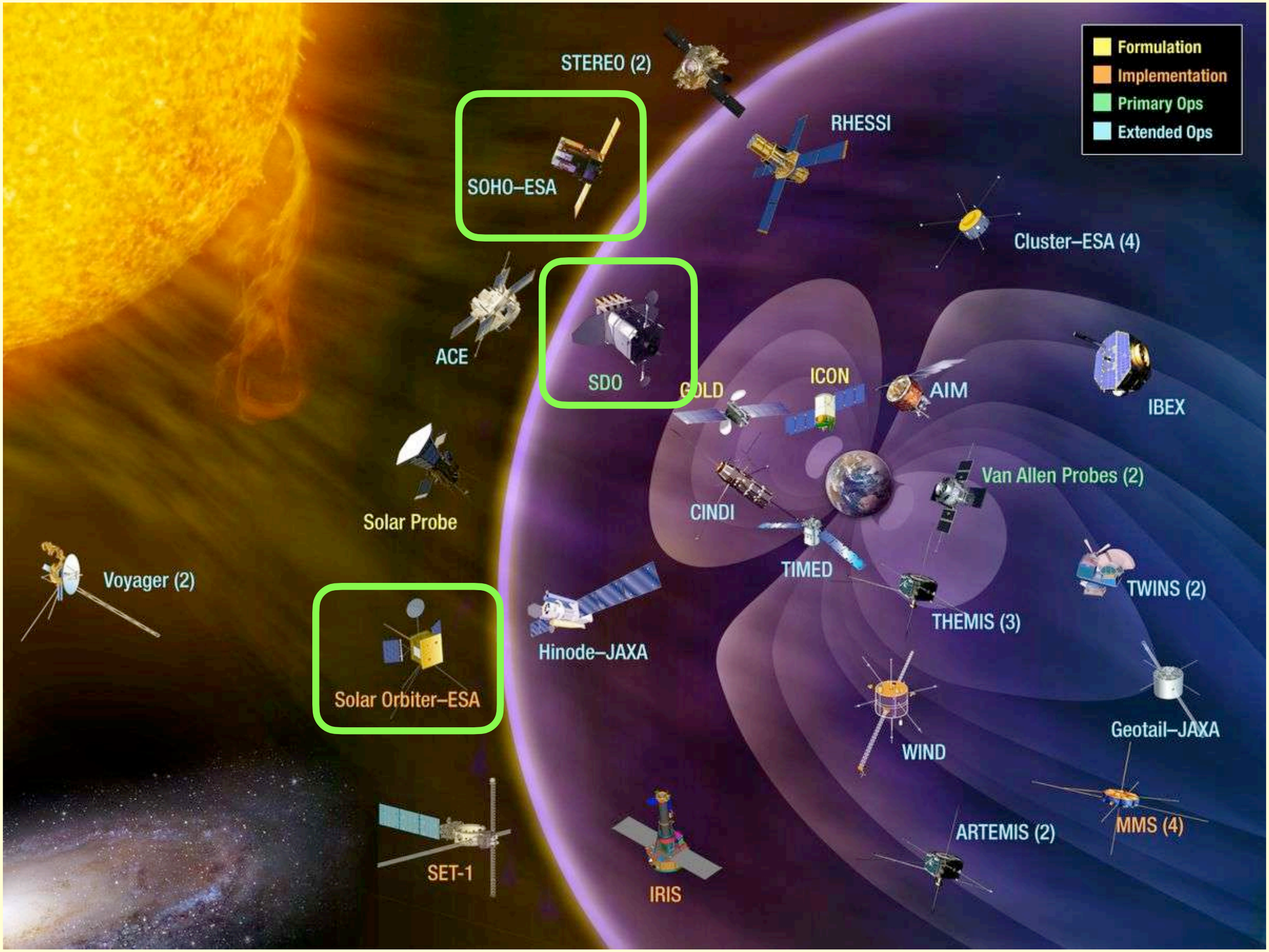


Figure 23: Scenario impact tree (Adapted from Hapgood et al. 2012)

Instruments

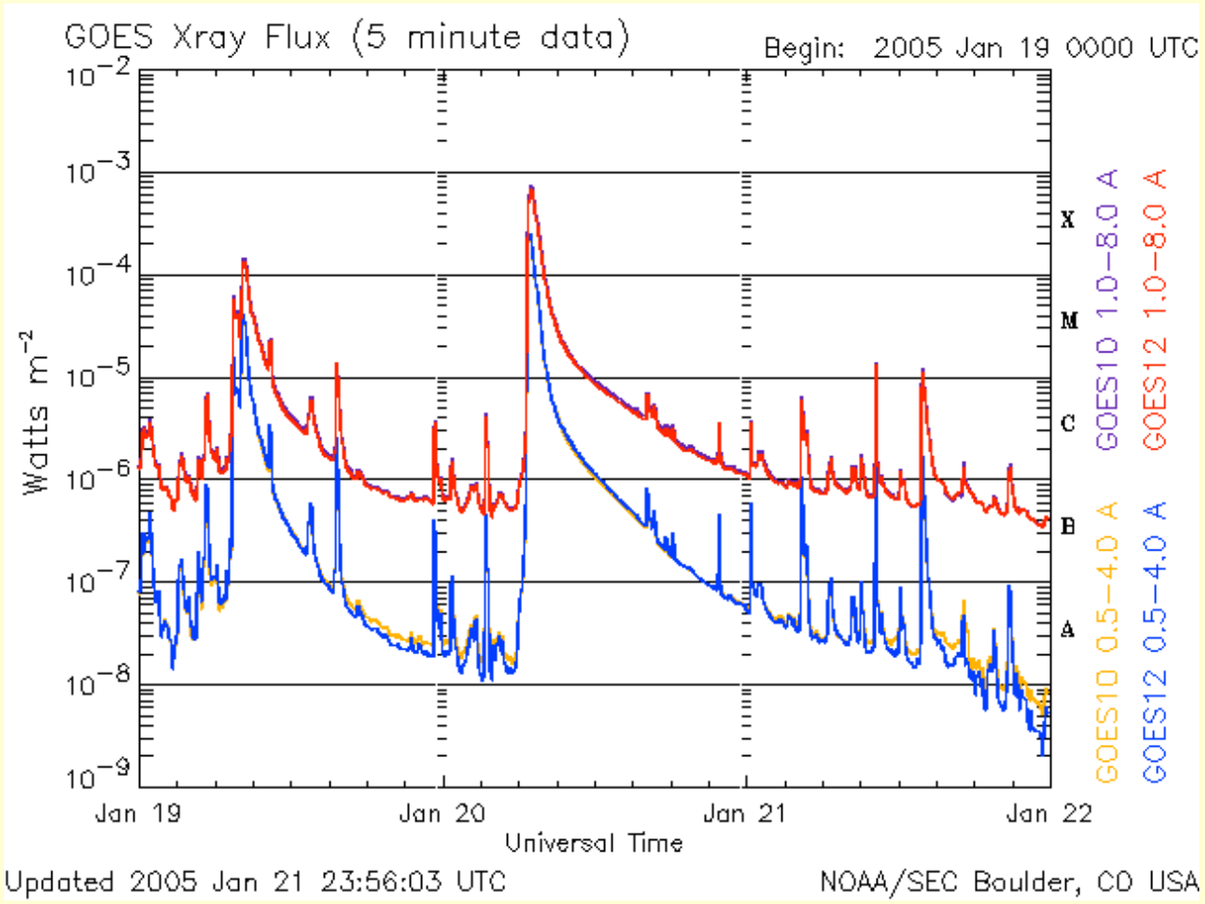
Overview by solar databases



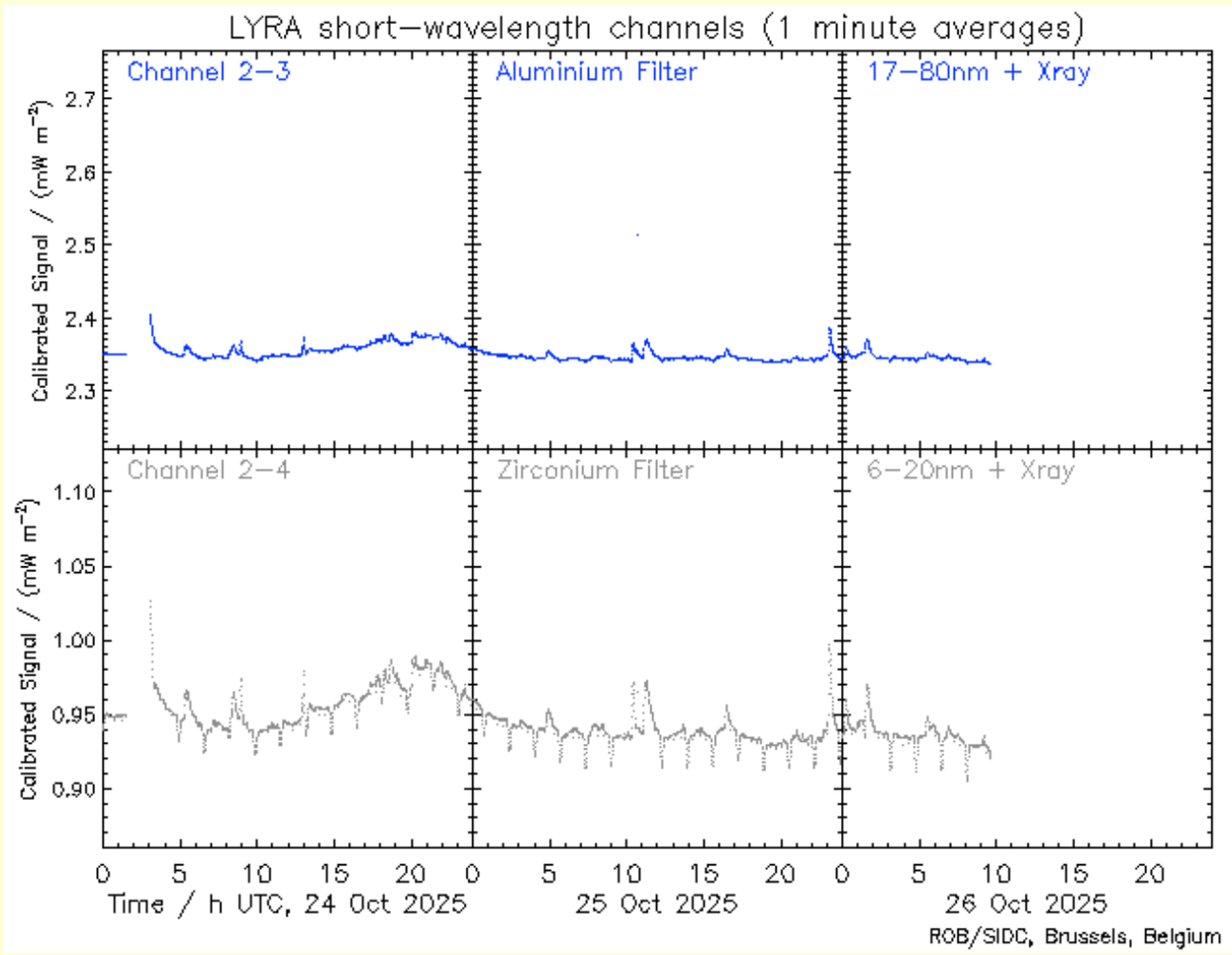
GOES and PROBA-2

- **Geostationary Operational Environmental Satellite (GOES)**

-Family of satellite operating since 1975 (4 active, 20 launched)
-classification of solar flares



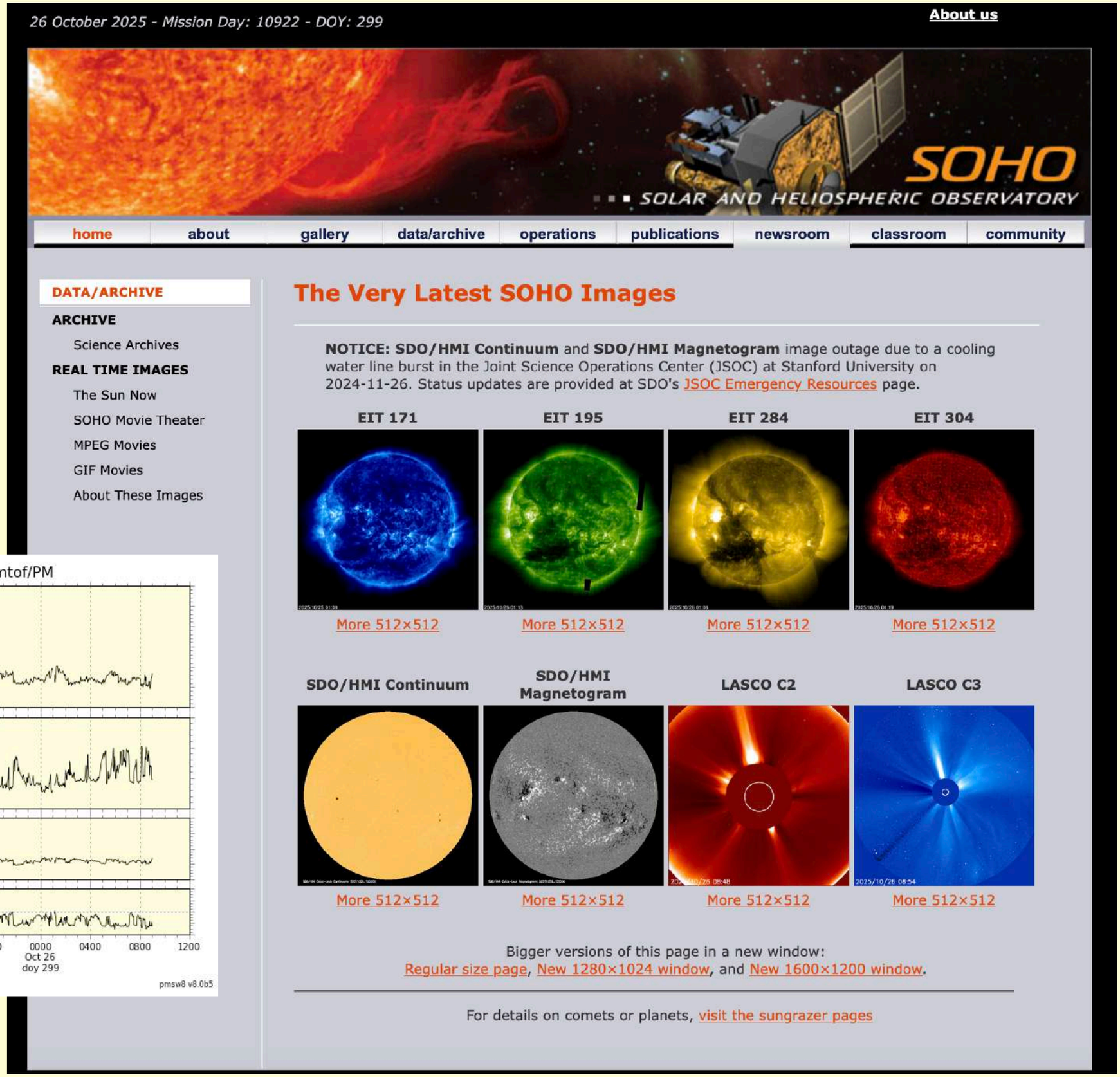
- **PRoject for Onboard Autonomy-2 (PROBA-2)**

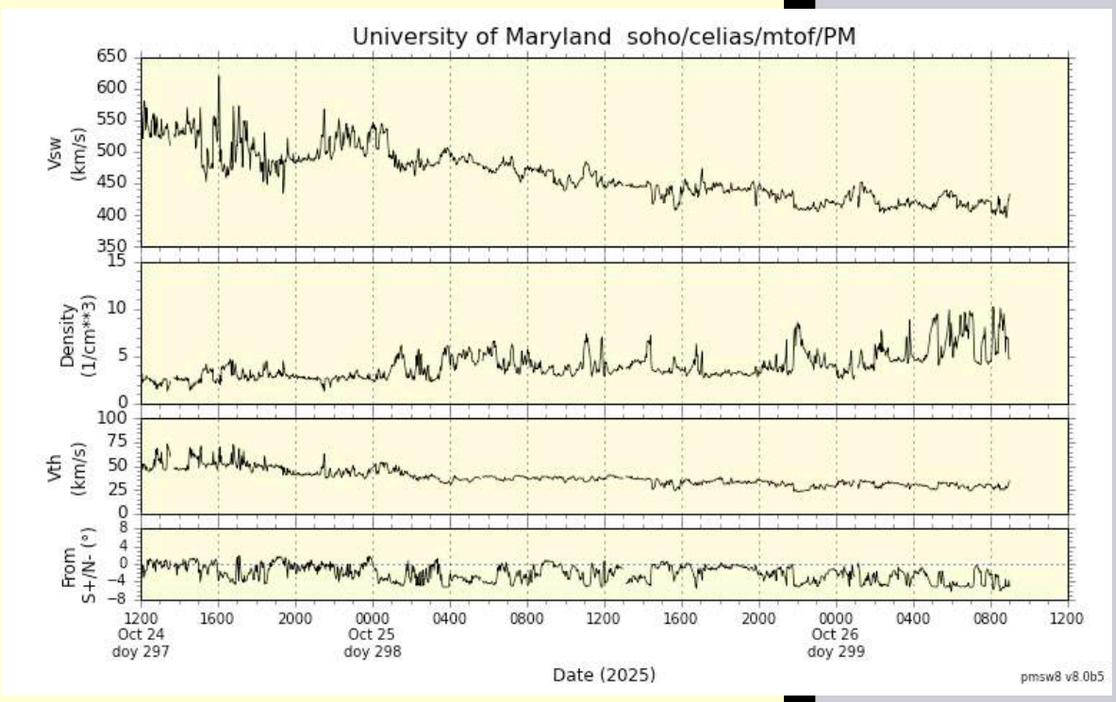


https://proba2.sidc.be/data/LYRA

Solar and Heliospheric Observatory (SOHO)

- Launch 2 December 1995

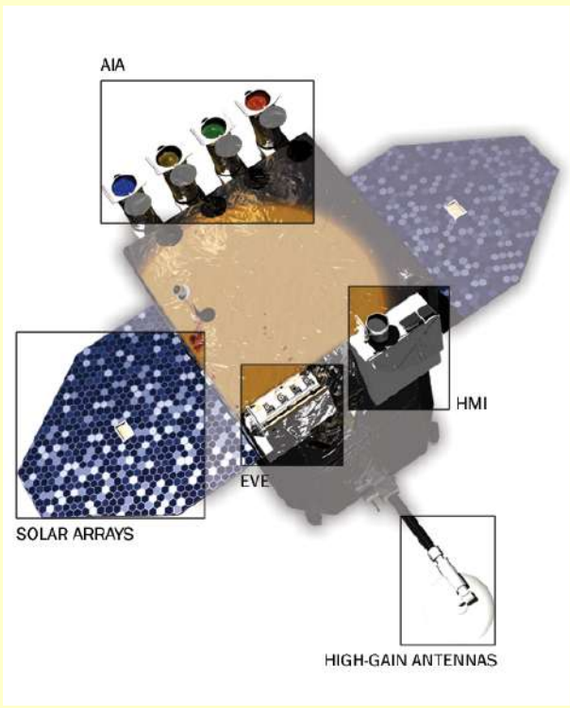




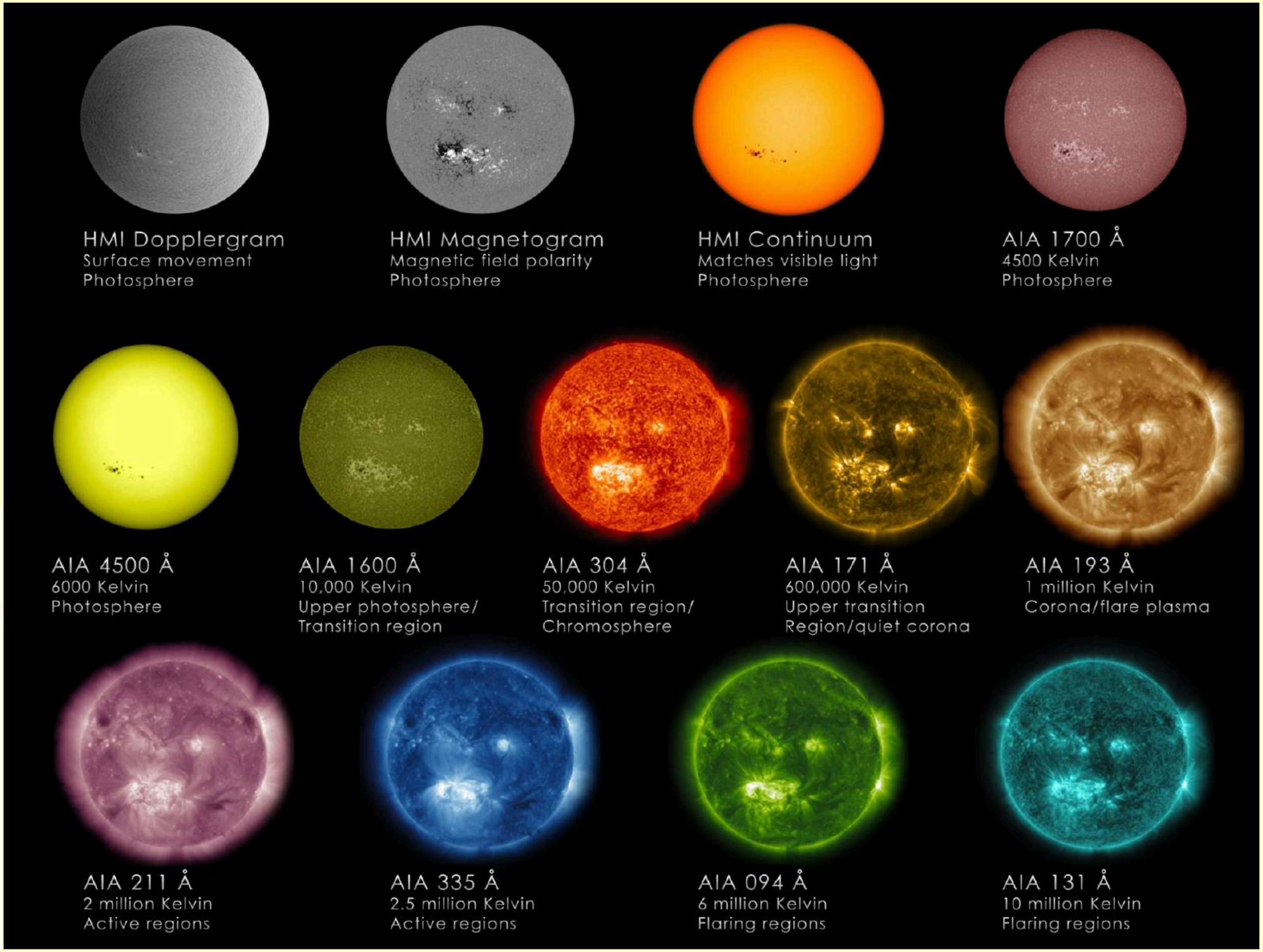
SDO (Solar Dynamics Observatory)

- Launch 11 February 2010

(NASA)



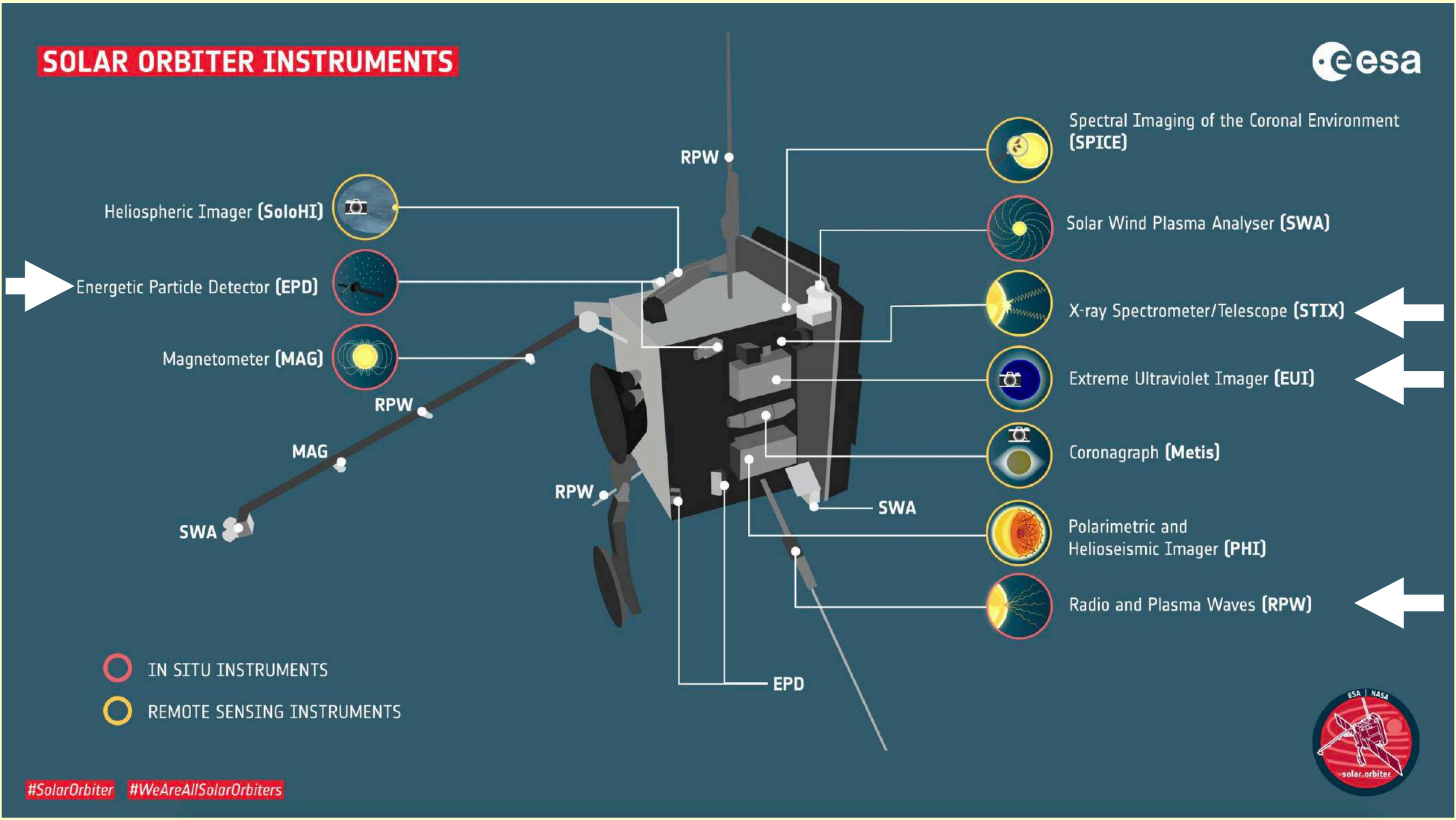
Solar Dynamics Observatory (NASA)



SDO images (NASA)

Solar Orbiter

- Launch 10 February 2020



The solar observation databases

PROBA-2 database

EUROPEAN SPACE AGENCY | SCIENCE & TECHNOLOGY

Proba-2 Science Archive

P2SA 1.2.0

Instrument

All

Select Data Type

All

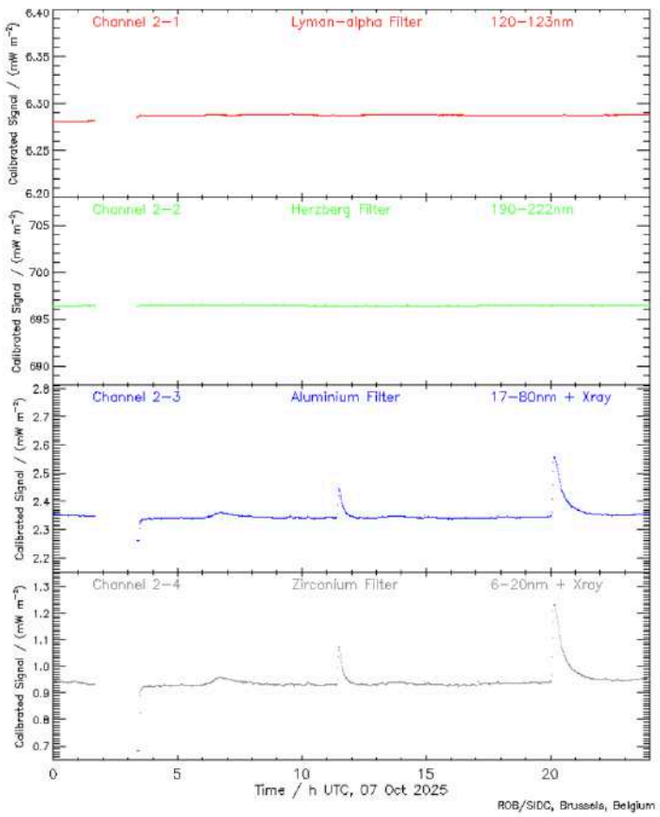
Select Date

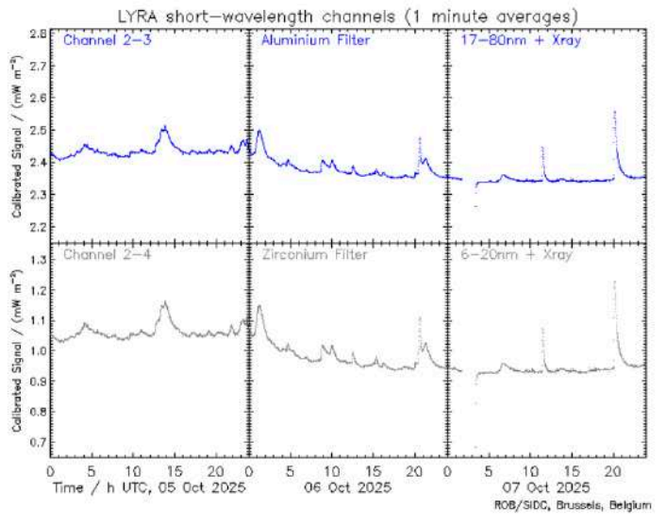
« ‹ Oct 2025

M	T	W	T	F	S	S
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

Date: ('yyyy-MM-dd')

2025-10-07





Download ALL

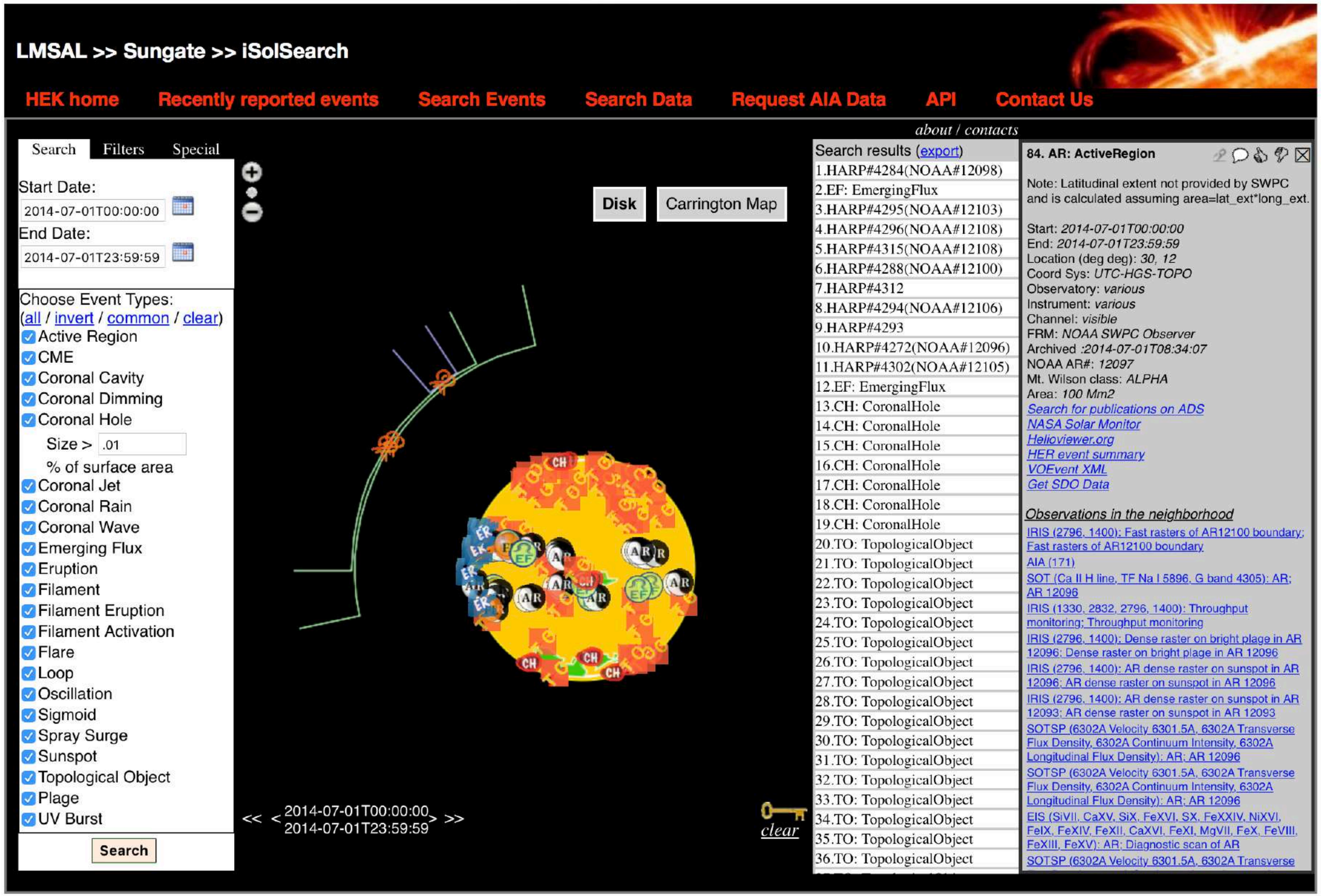
Only DATA

Only Preview

TERMS AND CONDITIONS PRIVACY POLICY COOKIE POLICY COPYRIGHT © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED.

https://p2sa.esac.esa.int/p2sa/#quicklook

Heliospheric Event Knowledgebase (HEK)



-data since 1975

http://www.lmsal.com/hek/index.html
https://www.lmsal.com/isolsearch

CACTUS (CME catalogue)

CACTUS 2.5.0

A software package for 'Computer Aided CME Tracking'

CMEs detected by Cactus

```
:Issued: Sat Oct 25 01:58:52 2025
:Product: CACTus catalogue (http://sidc.be/cactus)
#-------------------------------------------------------------------------
# Instrument: LASCO| Detector: c2 # Instrument: LASCO| Detector: c3
# Threshold : 0.30 | Factor : 6 | Minimal CME width: 5
#
  first c2: 2025/09/30  00:00:07.589 23860062.fts
  last  c2: 2025/10/25  00:12:07.520 23862971.fts
  first c3: 2025/09/30  02:06:07.399 33848194.fts
  last  c3: 2025/10/24  20:42:07.470 33851111.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?
  0120|2025/10/23 19:00| 06 | 196| 062| 0120| 0219| 0072| 0993|
  0119|2025/10/23 17:12| 01 | 314| 086| 0726| 0201| 0238| 1096|
  0118|2025/10/23 15:24| 04 | 183| 032| 0080| 0016| 0074| 0131|
  0117|2025/10/23 12:00| 03 | 184| 006| 0996| 0808| 0070| 1953|
  0116|2025/10/23 10:36| 02 | 346| 046| 0446| 0055| 0337| 0578|
  0115|2025/10/23 06:48| 01 | 063| 008| 0234| 0052| 0195| 0327|
  0114|2025/10/23 05:24| 00 | 326| 018| 0600| 0041| 0558| 0664|
  0113|2025/10/23 05:12| 02 | 323| 020| 0343| 0015| 0318| 0361|
  0112|2025/10/22 22:24| 01 | 067| 020| 1644| 0694| 0390| 1736|
  0111|2025/10/22 22:24| 09 | 155| 176| 0206| 0046| 0065| 0339|  II
  0110|2025/10/22 21:48| 01 | 270| 026| 0856| 0401| 0459| 1733|
  0109|2025/10/22 21:36| 01 | 002| 030| 0625| 0297| 0312| 1358|
  0108|2025/10/22 21:36| 01 | 324| 054| 1171| 0293| 0637| 1838|
  0107|2025/10/22 21:12| 01 | 006| 006| 0386| 0072| 0306| 0504|
  0106|2025/10/22 12:48| 01 | 240| 014| 0651| 0007| 0651| 0664|
  0105|2025/10/22 11:00| 01 | 311| 056| 0419| 0052| 0315| 0496|
  0104|2025/10/22 07:36| 01 | 087| 008| 0433| 0032| 0388| 0473|
  0103|2025/10/22 04:36| 01 | 017| 008| 0844| 0078| 0692| 0868|
  0102|2025/10/22 01:36| 02 | 356| 026| 0793| 0473| 0345| 1738|
  0101|2025/10/21 23:24| 02 | 311| 012| 0459| 0251| 0260| 0822|
  0100|2025/10/21 22:12| 01 | 356| 018| 0338| 0126| 0115| 0503|
  0099|2025/10/21 21:12| 01 | 121| 032| 1838| 0177| 1420| 1953|
  0098|2025/10/21 20:24| 04 | 112| 342| 1077| 0556| 0264| 2016|  IV
  0097|2025/10/21 14:24| 03 | 314| 034| 0450| 0076| 0347| 0637|
  0096|2025/10/21 08:24| 01 | 337| 056| 0484| 0046| 0446| 0612|
  0095|2025/10/21 03:36| 01 | 032| 038| 1041| 0466| 0250| 1953|
  0094|2025/10/20 22:12| 01 | 326| 026| 0403| 0017| 0376| 0422|
  0093|2025/10/20 15:48| 01 | 320| 046| 0331| 0032| 0271| 0411|
  0092|2025/10/20 15:48| 01 | 309| 096| 0405| 0084| 0248| 0589|  II
  0091|2025/10/20 11:36| 02 | 316| 022| 0243| 0012| 0233| 0260|
  0090|2025/10/20 11:00| 01 | 025| 012| 1420| 0402| 0644| 1567|
```

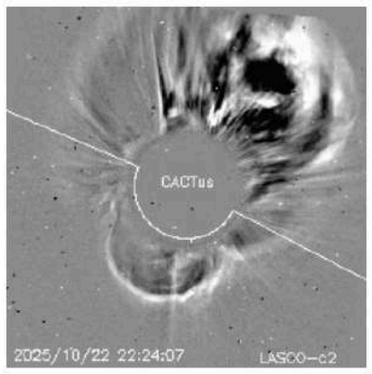
CACTUS

A software package for 'Computer Aided CME Tracking'

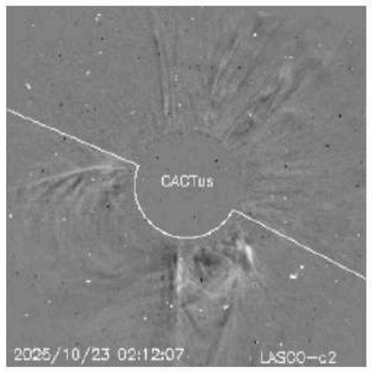
Details and graphs for CME0111

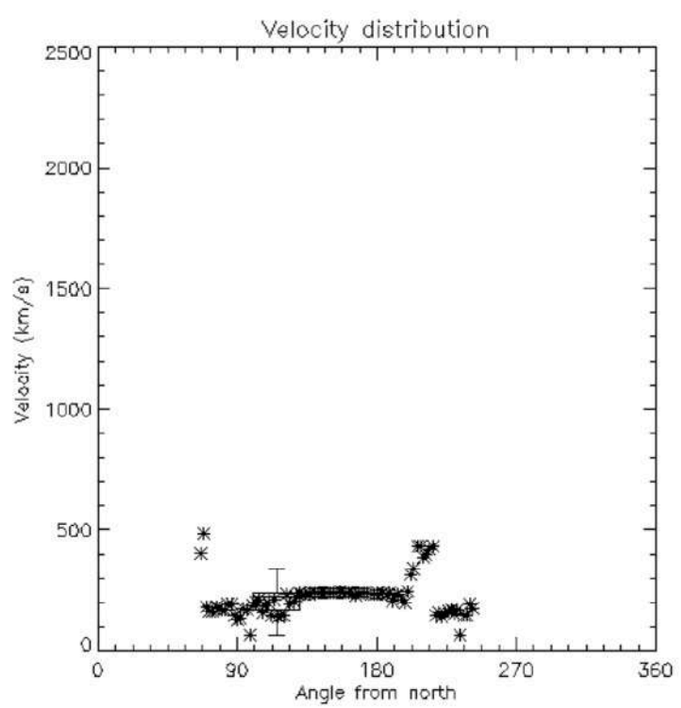
```
# CME |          t0      | dt0| pa | da |  v   |  dv  | minv| maxv| halo?
  0111|2025/10/22 22:24| 09 | 155| 176| 0206| 0046| 0065| 0339|  II
```

CME Movie :: Download ::



Sample Image





Latest CME detections overview page

-data since 1997

https://www.sidc.be/cactus/catalog.php

The Comprehensive Solar Energetic Electron event Catalogue (CoSEE-Cat)

The Comprehensive Solar Energetic Electron event Catalogue (CoSEE-Cat)

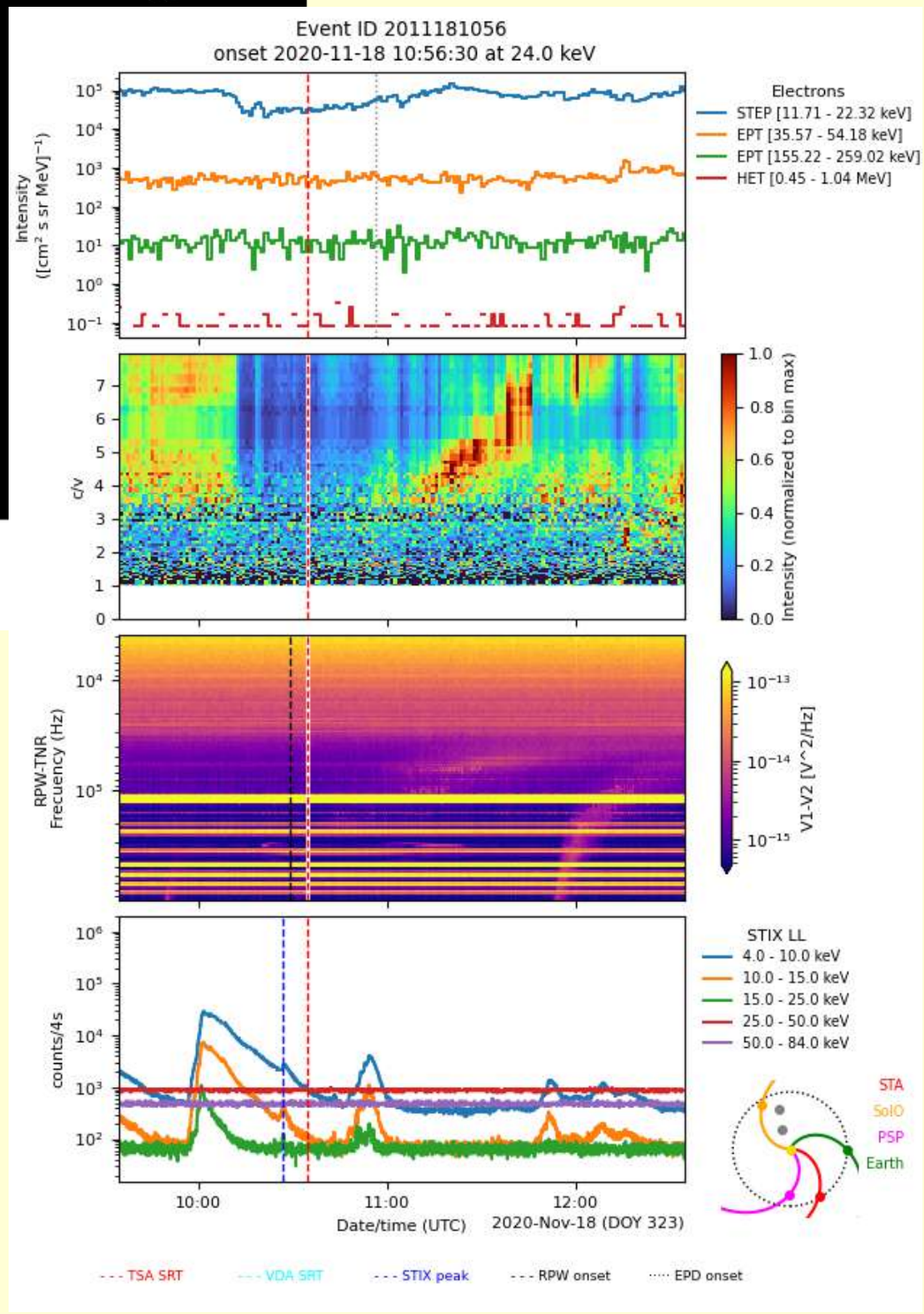
-the most details overview of the solar energetic events ever

-data from 8 Solar Orbiter instruments

-information from the source region and in-situ measurements

-300 events publicly available (768 events detected)

-publicly available data: 2020 - 2023 (2025)



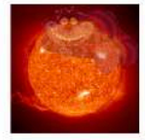
-data since 2020

https://coseecat.aip.de/

VSO (Virtual Solar Observatory)

VSO Time / Instrument Search Form

Version 1.4



All from Source	Instrument	Date Range
BBSO	BBSO	2000.07.05 →
ChroTel	ChroTel	2012.04.01 →
EUNIS	LONGWAVE-LOBE-06	2006.04.12 – 2006.04.12
	LONGWAVE-LOBE-07	2007.11.06 – 2007.11.06
	LONGWAVE-SLIT-06	2006.04.12 – 2006.04.12
	LONGWAVE-SLIT-07	2007.11.06 – 2007.11.06
	SHORTWAVE-LOBE-06	2006.04.12 – 2006.04.12
	SHORTWAVE-LOBE-07	2007.11.06 – 2007.11.06
	SHORTWAVE-SLIT-06	2006.04.12 – 2006.04.12
	SHORTWAVE-SLIT-07	2007.11.06 – 2007.11.06
Evans	spectroheliograph	1996.02.05 – 1999.05.28
GOES-12	SXI-0	2001.09.10 →
GONG	Big Bear	2006.08.15 →
	Cerro Tololo	2006.08.15 →
	El Teide	2006.08.15 →
	Learmonth	2006.08.15 →
	MERGED GONG	2001.07.22 →
	Mauna Loa	2006.08.15 →
	Udaipur	2007.04.10 →
Hi-C	Hi-C	2012.07.11 – 2012.07.11
Hinode	EIS	2006.10.23 →
	SOT	2006.10.23 →
	XRT	2006.10.23 →
HXECLIPSE	HXECLIPSE	1869.08.07 – 2009.07.22
IRIS	IRIS	2013.07.16 →
ISOON	ISOON	2003.01.02 – 2012.04.18
IVM	IVM	1999.11.24 – 2003.12.19
KANZ	KANZ	2001.02.07 →
KPVT	512-channel magnetograph	1974.02.01 – 1993.04.10
	spectromagnetograph	1992.04.19 – 2003.09.21

Start: 2019 Jun 05 / 12 : 00

End: 2019 Jun 05 / 15 : 59

All Month All Day

Search Clear

https://sdac.virtualsolar.org/cgi/search

Joint Science Operations Center (JSOC)

JSOC Data Export reset page Turn Help Off 1 Requests Pending , Loading...

JSOC Data Export Request Generation

Help with Error Messages Release Notes

If the Method is changed from "url_quick" or "url_direct" you will have additional options to specify. "url-direct" is temporarily disabled.

After the request is submitted for Methods of "url", "ftp", "url-tar" or "ftp-tar" you will recieve ON THIS PAGE a "Request_ID" that will be used to access the data when it is ready.

If you enter an email address you will be notified when the data is ready. If you do not provide an email address you must leave this page open or save the Request_ID in order to access the data.

RecordSet from file	☐	Check box to allow upload of RecordSet list file, file will be requested after Submit button click.
RecordSet	hmi.sharp_cea_720s[377][2011.02.15_00:00:00_TAI-2011.02.15_04:00:00_TAI]{Bp,Br,	Lookdata
Record Limit	none	Optional manual limit to number of records to export.
Record Count	21	Recount Limit for AIA to about 15,000 and for HMI about 30,000 in each request.
Method	url	Choose method, url_quick or url for now. url_quick implies protocol of "as-is"
Filename Format	hmi.sharp_cea_720s.{HARPNUM}.{T_REC:A}	File name template.

Processing

- ☐ no_op - none ☐ hide
- ☐ aia_scale - Scale image to 0.6 arcsec/pixel (compatible with 2D dataseries with CTYPE1 == HPLN-TAN and CTYPE2 == HPLT-TAN only)
- ☐ HmiB2ptr - Convert HMI B_720s to Phi,Theta,R coordinates
- ☐ resize - Resize and rotate if needed, use sub-pixel registration
- ☐ im_patch - Extract sub-frame
- ☑ maproj - Extract a sub-frame and remap to a chosen projection.
- ☐ rebin - Rebin with boxcar or gaussian smoothing

Maproj

Projected Patch Extract - used to export sub-frames from a sequence of images. The extracted patches are remapped to the requested projection. The patch will be tracked at the Carrington rate. The location of the extracted sub-frame must be specified in Carrington latitude and longitude. The recordset should be specified fully. For the time being, for AIA at lower cadence use one of the time slotted series: aia.lev1_euv_12s, aia.lev1_uv_24s, or aia.lev1_vis_1h

Options	Visible grid spacing in degrees, none	NOAA AR number: 11158 at 2011.02.13_23:59:59Z
CLong	034	Carrington longitude of patch center. ☐ Check for disk center longitude.
CLat	-20	Latitude of patch center.
MapProjection	Plate Carree - simple latitude vs lor	
MapScale	0.00179	Scale in degrees per pixel after mapping. Choose <= 0.00179
Width	800	Width of extracted patch in pixels.
Height	400	Height of extracted patch in pixels.
Verify	Check params	OK to submit

Protocol	FITS	Choose protocol, "FITS", "JPEG", "MPG", "MP4", or "as-is". Note uncompressed FITS not an option
Notify	solarmail	Provide your email address for notification. If Requestor is your SolarMail name you may use "solarmail" here.
Requestor	none	Provide your identifier, e.g. your SolarMail name.

Check Params for Export Notify field must be set before submit.

Not Ready To Submit Please only click once for export request.

☐ check to show export params.

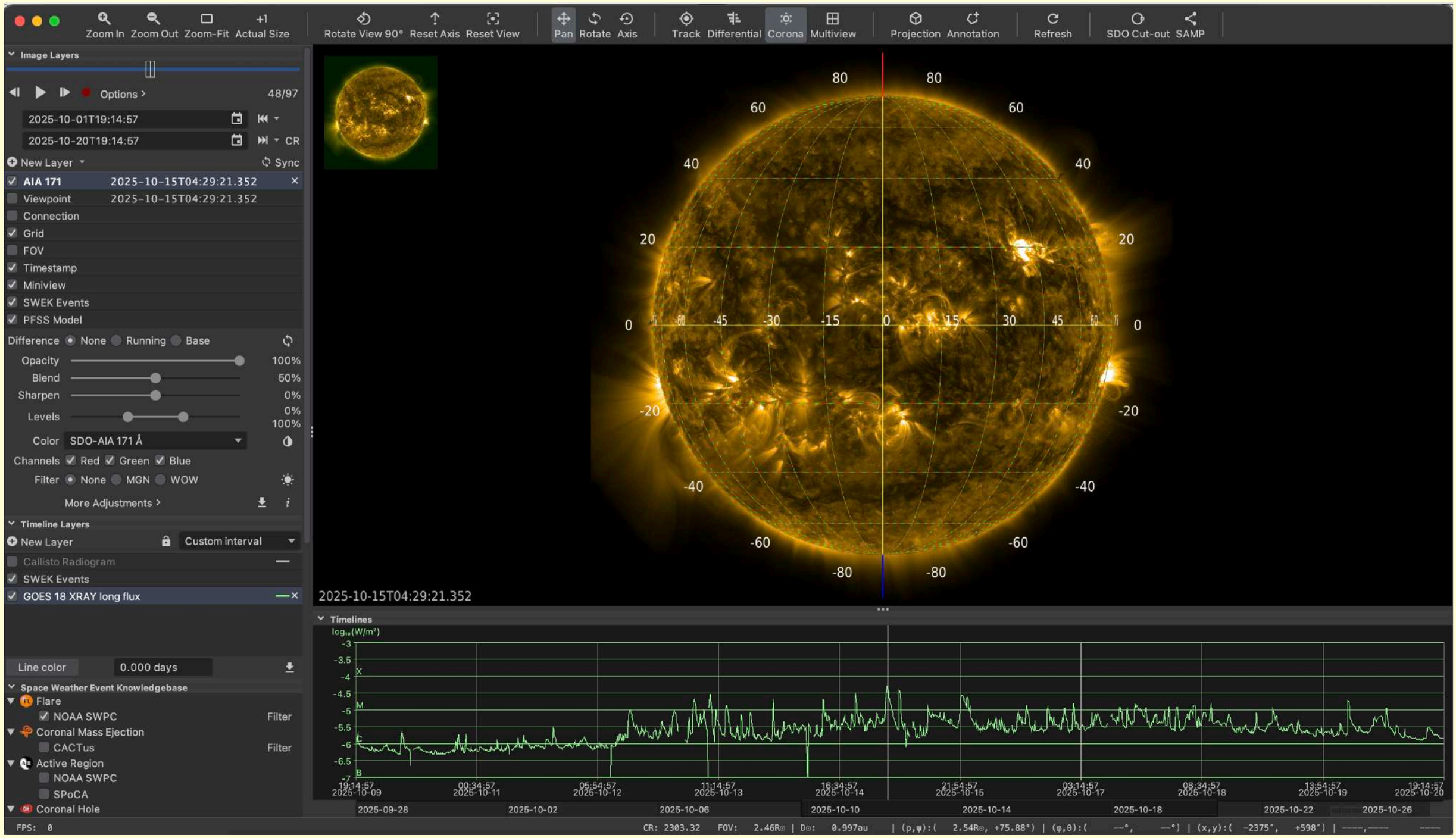
Home page for: SDO-JSOC

http://jsoc.stanford.edu

Tools to solar data analysis

JHelioviewer

-JHelioviewer -tool to check the solar structures and activity



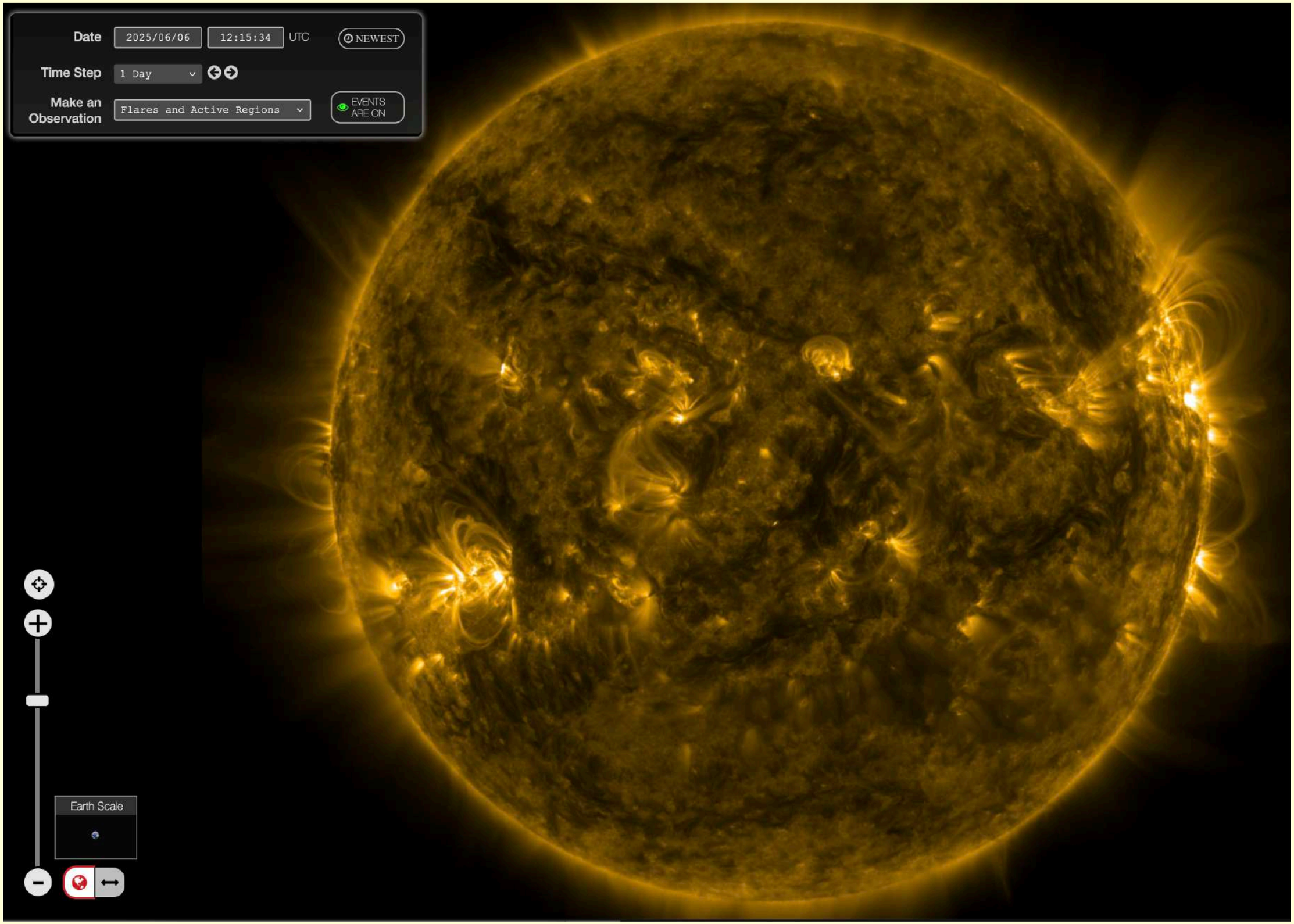
-images, movie and goes data about class of the solar flare

—> presentation JHelioviewer

https://www.jhelioviewer.org/

Helioviewer

-Helioviewer -webpage version of JHelioviewer (fast data check)



https://student.helioviewer.org/

Advance tools: SunPy

-SunPy -Python package to analyse Solar Physics data

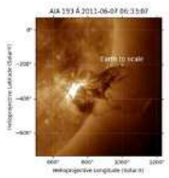
SunPy | About | Documentation | Packages | Get Help | Contribute | Blog | Cite SunPy | Search ⌘ + K

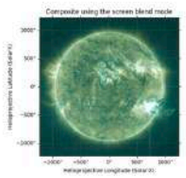
sunpy 7.0.3 documentation

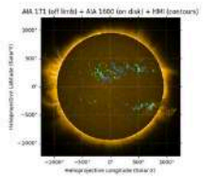
- The sunpy tutorial
- Example Gallery
  - Acquiring Data
  - Map
  - Combining, Co-aligning, and Reprojecting Images
  - Time Series
  - Coordinates, times, and units
  - Plotting
  - Differential Rotation of the Sun
  - Saving and Loading Data
  - Computer Vision Techniques
  - Showcase
- How-To Guides
- Topic Guides
- Reference
- Release History
- Acknowledging or Citing SunPy
- Known Issues

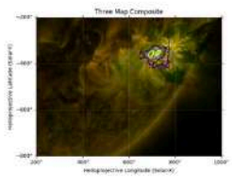
Plotting

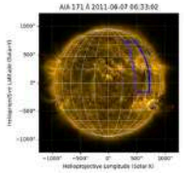
Examples of visualizing supported data types

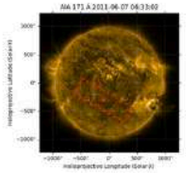

Adding an Earth scale image

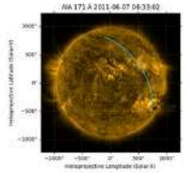

Blending maps together

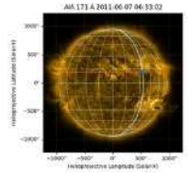

Combining off-limb and disk maps

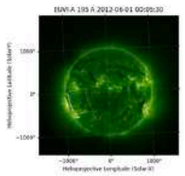

Creating a Composite Plot with Three Maps

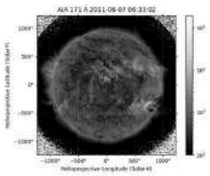

Drawing a latitude-longitude quadrangle

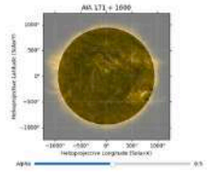

Drawing a rotated rectangle on a map

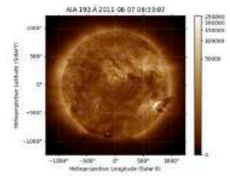

Drawing and using a Great Arc


Drawing heliographic longitude and latitude lines


Drawing the Extent of a WCS


Editing the colormap and normali… Map


Fading between two maps


Finding Local Peaks in Solar Data

On this page
- Sample data
- Acquiring Data
- Map
- Combining, Co-aligning, and Reprojecting Images
- Time Series
- Coordinates, times, and units
- Plotting
- Differential Rotation of the Sun
- Saving and Loading Data
- Computer Vision Techniques
- Showcase

Back to top

stable

https://sunpy.org/

Advance tools: SolarSoftWare *(SSW)*

-IDL package to analyse Solar Physics data

SolarSoft

SolarSoftWare *(SSW)* Installation *S.L.Freeland*

Desired *SSW* Host	Installation Type	Installation Source	Transfer Protocol
sohoftp.nascom.nasa.gov	New Installation	Internet	cURL (use if FTP not available on server or client)

Enter desired local path for top level **SSW** tree.
You may select one of suggested locations from menu or enter an explicit path if you don't like any of those options.
If this is an **Upgrade** rather than a **New Installation** then your path *must* match your existing **SSW** top level path.

SSW Path Suggestions **-OR-** Explicit Path:

Client Side Proxy IP (e.g. If $http_proxy is defined @Your site) :

SSW Site email contact (*USER@HOSTNAME*):

Select those SolarSoft instruments which you plan to analyze at your site:
(don't overthink it - easy to add others later via ssw_upgrade...)

SDO: [AIA ☐] [HMI ☐] [EVE ☐]

GOES-R Series [SUVI ☐ *GOES {16,17,18,19}*]

GOES-N Series [SXI ☐ *GOES {13,14,15}*]

Solar Orbiter [STIX ☐] [SPICE ☐] [SOLOHI ☐]

Parker Solar Probe [WISPR ☐]

SOHO: [EIT ☐] [LASCO ☐] [CDS ☐] [SUMER ☐] [MDI ☐] [UVCS ☐]

Hinode: [EIS ☐] [SOT ☐] [XRT ☐]

Proba2: [SWAP ☐] [LYRA ☐]

Orbital Observatories [IRIS ☐] [HESSI ☐] [TRACE ☐] [SMEI ☐] [HXRS ☐] [BATSE ☐] [SPARTAN ☐] [Hi-C ☐]

Optical Observatories: [SOON ☐] [NSO ☐] [MEES ☐] [LaPalma SVST ☐]

Radio Observatories: [ETHZ ☐] [NRH ☐] [NoRH ☐] [NoRP ☐] [OVSA ☐] [LOFAR ☐]

Virtual Observatories: [CoSEC ☐] [EGSO ☐] [VSO ☐] [Ontology ☑] [HELIO ☐]

STEREO: [SECCHI ☐] [SSC ☐] [PLASTIC ☐] [IMPACT ☐]

Yohkoh: [SXT ☐] [BCS ☐] [HXT ☐] [WBS ☐]

Packages: [BINARIES ☑] [SUNSPICE ☐] [SPEX ☐] [CHIANTI ☐] [PINTofALE ☐] [XRAY ☐] [PFSS ☐] [S3DRS ☐]
[FESTIVAL ☐] [CORIMP ☐] [MKIT ☐] [Panorama ☐] [HYDROSTATIC ☐] [FINDSTUFF ☐] [ANDRIL ☐] [LPARL ☐] [VDEM ☐] [ANA ☐] [ZTOOLS ☐] [MJASTEREO ☐] [NGDC ☐] [CMES ☐] [CACTUS ☐] [NLFFF ☐] [NRL ☐] [AZAM ☐] [GX_SIMULATOR ☐]
[SWPC_CAT ☐] [DESAT ☐] [FORWARD ☐] [EUVDECONPAK ☐] [GSFIT ☐] [DEM_SITES ☐] [CATCH ☐] [SIMPLE_REG_DEM ☐] [DEMREG ☐]

SMM: [XRP ☐] [UVSP ☐] [HXRBS ☐] [CP ☐] [GRS ☐] [HXIS ☐] [ACRIM ☐]

Generate Installation Script | Reset **(to re-initialize all fields)**

NOTE: For more extensive SolarSoft data base (SSWDB) information, including additional Ancillary data bases, see the SSWDB installation and upgrade document

https://www.lmsal.com/solarsoft/

Thank you for your attention!

krzysztof.barczynski@pmodwrc.ch

graubünden Education and Research.

pmod wrc

Appendix

Solar radiation storms

Solar Radiation Storms

Scale	Description	Effect	**Physical measure** (Flux level of >= 10 MeV particles)	**Average Frequency** (1 cycle = 11 years)
S 5	**Extreme**	**Biological:** Unavoidable high radiation hazard to astronauts on EVA (extra-vehicular activity); passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** Satellites may be rendered useless, memory impacts can cause loss of control, may cause serious noise in image data, star-trackers may be unable to locate sources; permanent damage to solar panels possible. **Other systems:** Complete blackout of HF (high frequency) communications possible through the polar regions, and position errors make navigation operations extremely difficult.	10^5	Fewer than 1 per cycle
S 4	**Severe**	**Biological:** Unavoidable radiation hazard to astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** May experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency can be degraded. **Other systems:** Blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.	10^4	3 per cycle
S 3	**Strong**	**Biological:** Radiation hazard avoidance recommended for astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** Single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. **Other systems:** Degraded HF radio propagation through the polar regions and navigation position errors likely.	10^3	10 per cycle
S 2	**Moderate**	**Biological:** Passengers and crew in high-flying aircraft at high latitudes may be exposed to elevated radiation risk. **Satellite operations:** Infrequent single-event upsets possible. **Other systems:** Small effects on HF propagation through the polar regions and navigation at polar cap locations possibly affected.	10^2	25 per cycle
S 1	**Minor**	**Biological:** None. **Satellite operations:** None. **Other systems:** Minor impacts on HF radio in the polar regions.	10	50 per cycle

NOAA

Geomagnetic storms

Geomagnetic Storms

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
G 5	**Extreme**	**Power systems:** Widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. **Spacecraft operations:** May experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. **Other systems:** Pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).	Kp = 9	4 per cycle (4 days per cycle)
G 4	**Severe**	**Power systems:** Possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. **Spacecraft operations:** May experience surface charging and tracking problems, corrections may be needed for orientation problems. **Other systems:** Induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).	Kp = 8, including a 9-	100 per cycle (60 days per cycle)
G 3	**Strong**	**Power systems:** Voltage corrections may be required, false alarms triggered on some protection devices. **Spacecraft operations:** Surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. **Other systems:** Intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).	Kp = 7	200 per cycle (130 days per cycle)
G 2	**Moderate**	**Power systems:** High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. **Spacecraft operations:** Corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. **Other systems:** HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).	Kp = 6	600 per cycle (360 days per cycle)
G 1	**Minor**	**Power systems:** Weak power grid fluctuations can occur. **Spacecraft operations:** Minor impact on satellite operations possible. **Other systems:** Migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).	Kp = 5	1700 per cycle (900 days per cycle)

NOAA

G2, G3 - events in last week