# SWx TREC's Space Weather Data Portal: a launch pad for space weather research

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#### Abstract

One obstacle to space weather research is the practical challenge of accessing relevant data. Space weather data are housed in disparate repositories, each with its own unique focus, be it solar, magnetospheric, atmospheric, or earth-based. Much of the effort spent acquiring data could instead be spent on space weather research and education. To address this problem, the Space Weather Technology, Research, and Education Center (SWx TREC), at the University of Colorado, Boulder, in collaboration with the Laboratory for Atmospheric and Space Physics (LASP), has developed the Space Weather Data Portal (https://lasp.colorado.edu/space-weather-portal), a tool built by and for the space weather community. Through the Data Portal, previously dispersed space weather data are in one unified place, accessible to scientists, students, and curious individuals. The focus is on the users and their ability to discover, display, compare, overplot, and download relevant data. A user can filter for past events then easily display and download data related to that event, from the moment it occurs on the Sun, as it travels through space and the atmosphere, to the impacts it has on the Earth. Analysis of space weather events via the Data Portal has proved useful for forecaster training and online learning. The community-created Event Library is a short-cut to curated data collections that provide narratives for context and serve as launch pads for further space weather exploration. This presentation will highlight contributions to the Data Portal from the community: datasets, event markers, timelines, and narrated data collections. Your contributions are encouraged as new resources and improvements are deployed every few weeks. Through this iterative, collaborative process, the Data Portal aims to increase awareness of space weather and its impacts and decrease the time between research and real-world applications.

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SWx TREC, the University of Colorado Boulder (CU), the Laboratory for Atmospheric Space Physics (LASP), Millersville University





## SELECT EVENTS OF INTEREST

Use event markers on a timeline to find events that meet your criteria.

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The Space Weather Data Portal provides graphical event selectors to help the user vizualize events on a timeline and select a time range of interest.

Filtering on event indices can speed investigation of space weather phenomena. Some common barriers to entry for space weather data include:

- · How do I know where to look?
- What is my time range of interest?
- What kinds of data were available at that time?
- . What are key space weather phenomena?
- · What are relevant indicators of space weather events?
- How do the indices relate to each other?

The Space Weather Data Portal smooths out the discovery process. The time range selector interactively displays events so users can quickly see solar cycles and patterns.

#### Select Time Range

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Scian Fune Display Events (optional) Dst Kp dat at	Solar Flare or above	Solar cycles are clearly visible with solar flare data
	<b>M</b> 2	

Selecting solar flares of class M2 and above clearly delineates solar cycles since data became available in 1975.

Some potential areas for further exploration:

- When are there solar flares but not geomagnetic storms?
- What were the largest geomagnetic storms in Solar Cycle 23?
- · Does solar flare magnitude correlate with geomagnetic storm intensity?

Event filters are optional for discovering data, but they can help the user focus in on an area of interest and spark new research directions.

# QUICKLOOK DATA ACCESS

Play through changes in GOES X-ray and extreme-ultra-violet flux while watching the corresponding SDO AIA images.



(https://lasp.colorado.edu/space-weather-portal/data/display?activerange=%5B1425967200000,1426831200000%5D&outerrange=%5B1262552105447,1559362748308%5D&plots=%5B%7B%22datasets%22:%7B%22noaa\_goes15\_xrs\_1m%2

See how XRS and EUVS peak and subside while there is a large erruption visible on the sun.

See at a glance what data is likely to be available in which time ranges.

- What data was available in 1972?
- What GOES data might be available for my 2010 event?

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A view of some of the datasets available on the data selection page. (https://lasp.colorado.edu/space-weather-portal/data?activerange=%5B1267586905033,1268796379794%5D&outer-range=%5B1215823627360,1278103481143%5D&plots=%5B%5D) (https://lasp.colorado.edu/space-weather-portal/data?active-range=%5B1267586905033,1268796379794%5D&outerrange=%5B1215823627360,1278103481143%5D&plots=%5B%5D)

Display all the SDO suns together and watch an event.



(https://lasp.colorado.edu/space-weather-portal/data/display?active-range=%5B1426363200000,1426449600000%5D&outerrange=%5B1394409600000,1457481600000%5D&plots=%5B%7B%22datasets%22:%7B%22sdo hmib image files%

Sixteen views of the sun (http://lasp.colorado.edu/space-weather-portal/data/display?activerange=%5B1426363200000,1426449600000%5D&outer-

from SDO AIA and SDO HMI. Each view highlights different phenomena and processes in different layers of the Sun's surface.

Play the images with 'sync' and 'loop' selected to see an event erupt in multiple Angstroms, all on the same screen.



(https://lasp.colorado.edu/space-weather-portal/data/display?active-range=%5B1426363200000,1426449600000%5D&outer-

The same event on the Sun (2015-03-14) (http://lasp.colorado.edu/space-weather-portal/data/display?active-range=%5B1426363200000,1426449600000%5D&outer-in

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#### EXPLORE SPACE WEATHER EVENTS

Researchers, educators, and students can use the Space Weather Data Portal (https://lasp.colorado.edu/space-weather-portal) to discover, display, and download relevant space weather data, all in one place.

lasp.colorado.edu/space-weather-portal (https://lasp.colorado.edu/spaceweather-portal)



(https://lasp.colorado.edu/space-weather-portal/data/display?active-range=%5B1425967200000,1426831200000%5D&outerrange=%5B1262552105447,1559362748308%5D&plots=%5B%7B%22datasets%22:%7B%22noaa\_goes15\_xrs\_1m%22:%5B%22shortwave%22%5D,%22noaa\_goes15\_evvs%22:%5B%

View sun-to-mud data for the 2015 St. Patrick's Day solar storm (https://lasp.colorado.edu/space-weather-

portal/data/display?active-range=%5B1425967200000,1426831200000%5D&outer-range=%5B1262552105447,1559362748308%5D&plots=%5B%7B%22datasets%22:%7B%22noaa\_goes15\_xrs\_1m%22:%5B%22shortwave%22%5D,%22noaa\_gc all on one screen. Click image to link to live site.

LaTiS Technology

The Space Weather Data Portal uses the LaTiS API

(https://github.com/latis-data/latis) to access data at its source (see

Lindholm and Lindholm). The Data Portal is not a repository that stores

data. Instead, it is an entry point to multiple, dispersed, established

respositories that house data relevant to space weather research. This "portal" modelenabled by the LaTiS access layer-decreases duplication and reduces confusion about the definitive source of a dataset.

#### SAVE AND SHARE YOUR SELECTIONS

#### Tell a space weather story.

https://lasp.colorado.edu/space-weather-portal/event-library (https://lasp.colorado.edu/space-weather-portal/event-library)



**Save** your selections with a copy of the URL. This will serve as a shortcut or bookmark to return to that selection of data.

Share your selections with colleagues and students by sending them your link.

See something cool? Add your observations to the Event Library (https://lasp.colorado.edu/space-weather-portal/event-library).

SWX TREC	Space Wea Data Poi	ther rtal		₪ <b>S</b> LASP
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	Jul 2020	2 Jul 2020 20	Nov 2019	Ĩ
	Dual Flare Event of 6 September 2017 2017-09-06 to 2017-09-07 Rhiannon M. Fleming	Radio Blackout Solar Event in Sweden, 3–4 November 2015 2015-11-0 to 2015-11-07 Cameron Gontestd	10-September-2017 Ground-Level-Event Radiation Storm 2017-08-10 to 2017-08-12 Thomas Berger	
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	Include a title, the link, your name, opti	ional email, and a brief description.		

(https://lasp.colorado.edu/space-weather-portal/event-library)

To contribute to the Event Library (https://lasp.colorado.edu/space-weatherportal/event-library), send your link from the Space Weather Data Portal to:

space-weather-portal@lists.lasp.colorado.edu

Include a title, the link, your name, optional email, and a brief description.

Recent contributions to the Event Library (https://lasp.colorado.edu/spaceweather-portal/event-library) were made as part of an undergraduate 2020 summer internship program at Millersville University supervised by Dr. Richard Clark and Dr. Tamitha Skov. Each student was assigned a paper about a space-weather event with clear societal impacts. After reading the paper, each student created an entry for the Event Library (https://lasp.colorado.edu/spaceweather-portal/event-library) describing the event and linking to data to illustrate the event's impact.

### CONTRIBUTE TO THE SPACE WEATHER DATA PORTAL

Help make this community tool better, faster.

#### Contact the Space Weather Data Portal

space-weather-portal @lists.lasp.colorado.edu

- · Request additional datasets
- Suggest new features
- · Provide a use case to speed your research
- · Add features to ease classroom use
- · Contribute a narrated event to the Event Library
- (https://lasp.colorado.edu/space-weather-portal/event-library)
- . Report a problem
- · Suggest an improvement

Let us know what you think. We look forward to hearing from you.

#### ACKNOWLEDGMENTS

Thanks to the CU Boulder Chancellor's Office for providing the seed funding for SWx TREC and the Space Weather Data Portal.

Thanks to LASP for hosting the site and providing critical infrastructure.

Thanks to the LASP Web Team for contributing libraries on the front end, LaTiS on the backend, and the infrastructure that ties it all together and keeps deployments updating and running smoothly.

Special thanks to Richard Clark, Tamitha Skov, and the dedicated students from Millersville University who contributed events to the Event Library: Cameron Gonetski, Rhiannon Flemming, Lauren Coca, Kerstin Gillespie, and Samuel Reams.

## ABSTRACT

One obstacle to space weather research is the practical challenge of accessing relevant data. Space weather data are housed in disparate repositories, each with its own unique focus, be it solar, magnetospheric, atmospheric, or earth-based. Much of the effort spent acquiring data could instead be spent on space weather research and education.

To address this problem, the Space Weather Technology, Research, and Education Center (SWx TREC), at the University of Colorado, Boulder, in collaboration with the Laboratory for Atmospheric and Space Physics (LASP), has developed the Space Weather Data Portal (https://lasp.colorado.edu/space-weather-portal), a tool built by and for the space weather community.

Through the Data Portal, previously dispersed space weather data are in one unified place, accessible to scientists, students, and curious individuals. The focus is on the users and their ability to discover, display, compare, overplot, and download relevant data. A user can filter for past events then easily display and download data related to that event, from the moment it occurs on the Sun, as it travels through space and the atmosphere, to the impacts it has on the Earth.

Analysis of space weather events via the Data Portal has proved useful for forecaster training and online learning. The community-created Event Library (https://lasp.colorado.edu/space-weather-portal/event-library) is a short-cut to curated data collections that provide narratives for context and serve as launch pads for further space weather exploration.

This presentation will highlight contributions to the Data Portal from the community: datasets, event markers, timelines, and narrated data collections. Your contributions are encouraged as new resources and improvements are deployed every few weeks. Through this iterative, collaborative process, the Data Portal aims to increase awareness of space weather and its impacts and decrease the time between research and real-world applications.

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Mogenetic Field 16-Second Level 2 Data	Display Type	Variables           Bx GSEc           Bx GSM           By GSEc           By GSEc           By GSM           Bz GSM           Magnitude           dBrms	Start Date Sep 02, 1997	End Date Jan 05, 2020
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Monard Read Particle Data     Solar Environmentary      Solar Env	Display Type	Workstes           Ib 0:056           By 0:056           By 0:054           By 0:054 <t< td=""><td>Start Date Sep 02, 1997 Aug 30, 1997 Feb 04, 1998</td><td>End Date Jan 05, 2020 Dec 30, 2019 May 07, 2019</td></t<>	Start Date Sep 02, 1997 Aug 30, 1997 Feb 04, 1998	End Date Jan 05, 2020 Dec 30, 2019 May 07, 2019
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LUCEPHEND DAL MANNEL D		Watales           Ib 0.636;           By 0.636;           By 0.636;           By 0.636;           By 0.634;           By 0.644;           P1           P4	Start Date           Sep 02, 1997           Aug 30, 1997           •           Feb 04, 1998           Jun 03, 2019	End Date Jan 05, 2020 Dec 30, 2019 May 07, 2019 Feb 10, 2019 Jan 16, 2019
		Watales           Ib 0.636:           By 0.636:           By 0.638:           B	Skert Date           Skep 02, 1997           Aug 30, 1997           Peb 04, 1998           Jun 03, 2019           Jun 08, 2019	End Date Jan 05, 2020 Dec 30, 2019 May 07, 2019 Jan 16, 2019
USCHERE Commenter water and a second construction of the second constructio		Watabas           Br GGBC           Br GGBA           Pre           Pre <td< td=""><td>Skert Date           Skep 02, 1997           Aug 30, 1997           Feb 04, 1998           Jun 00, 2019</td><td>End Date Jan 05, 2020 Dec 30, 2019 Ney 07, 2019 Feb 10, 2019 Jun 16, 2019</td></td<>	Skert Date           Skep 02, 1997           Aug 30, 1997           Feb 04, 1998           Jun 00, 2019	End Date Jan 05, 2020 Dec 30, 2019 Ney 07, 2019 Feb 10, 2019 Jun 16, 2019
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(https://agu.confex.com/data/abstract/agu/fm20/3/2/Paper\_747723\_abstract\_718468\_0.png)

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