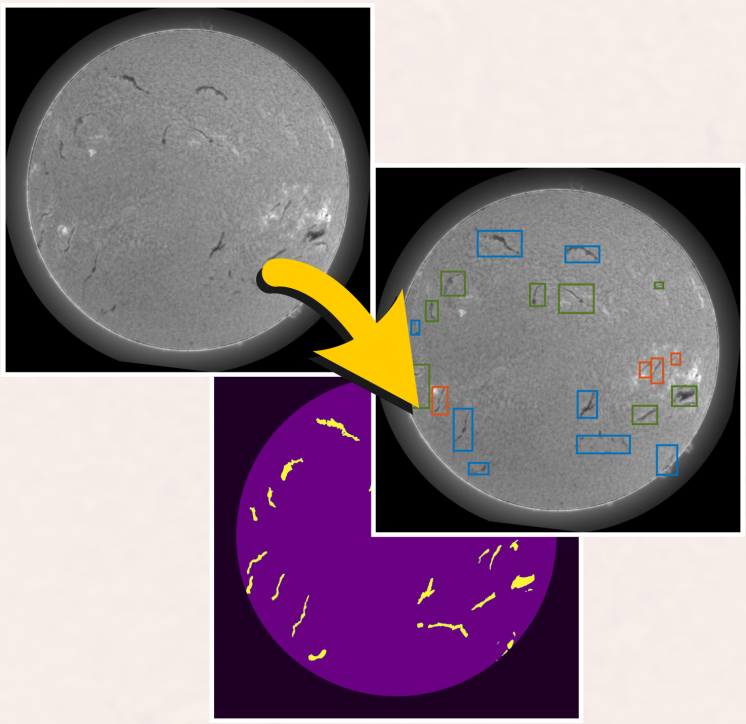
Space Weather Group Portfolio

Last update: 12/2025

PRODUCT

SOLAR FILAMENT DETECTOR AND TRACKER

A comprehensive deep learning framework for automated solar filament analysis using H-alpha telescope images. The system detects, classifies, segments, and tracks solar filaments over time. The framework combines different deep learning architectures and custom tracking algorithms to provide end-to-end filament monitoring capabilities for space weather prediction and solar physics research. The product includes a new manually-labeled dataset optimized for machine learning and space weather applications.

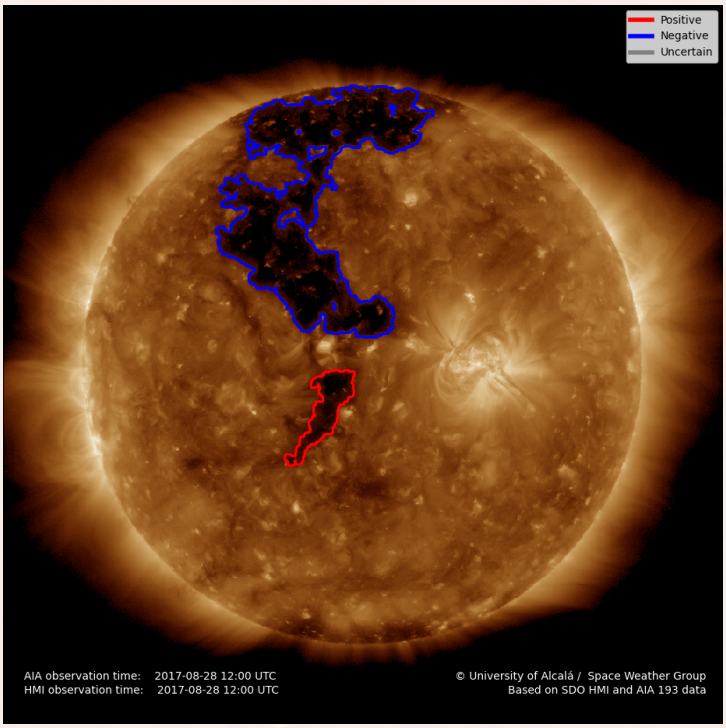


TRL	4
Latency	On demand
Resolution	1 hour
Available at	Internal for scientific use
Available since	Generated internally on demand
Data sources	GONG, MAGFiLO dataset and UAH-SWE's H-alpha telescope
Applications	Communications, Geological prospections, Insurances, Power grid, Railways, Aviation, GNSS, Pipelines, Satellites

PRODUCT

CORONAL HOLE DETECTION

The detection provides outlines of estimated coronal holes over the solar surface. It is derived from overlaid Solar Dynamics Observatory's (SDO) 19.3nm Atmospheric Imaging Assembly (AIA), and Helioseismic and Magnetic Imager (HMI) samples. Polarity identification is only available for historical data. This product is the input of the solar wind speed forecast.



TRL	5
Latency	3h
Resolution	1h
Available at	SeNMEs
Available since	On request from August 2012
Data sources	JSOC
Applications	Communications, Insurances, Power grid, Railways, Aviation, Satellites

Product

Tech report

Universidad de Alcalá

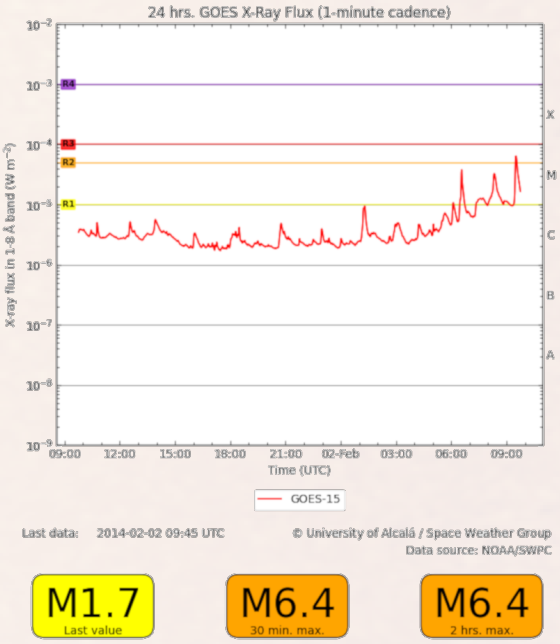
SWE Space Weather Group

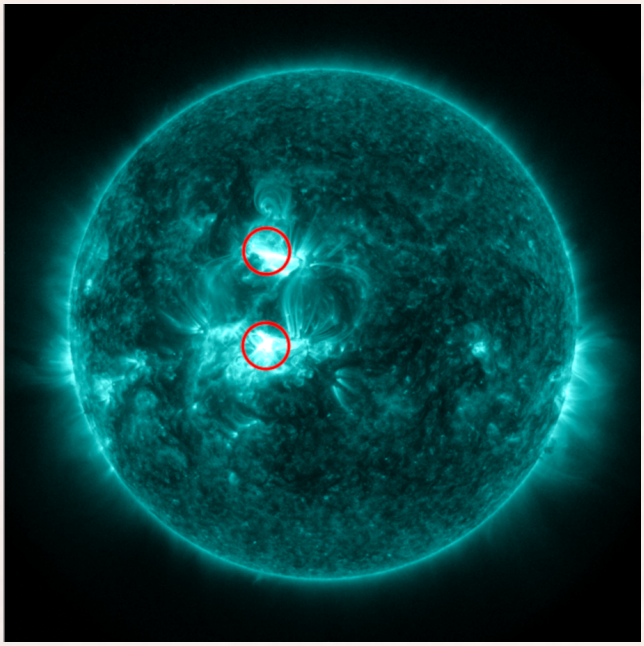
SeNMEs

PRODUCT

FLARE MONITORING TOOL

Uses GOES X-ray data to detect solar flares, and SDO AIA observations to localize them on the solar disc. Intended to identify multiple sources when there is more than one.



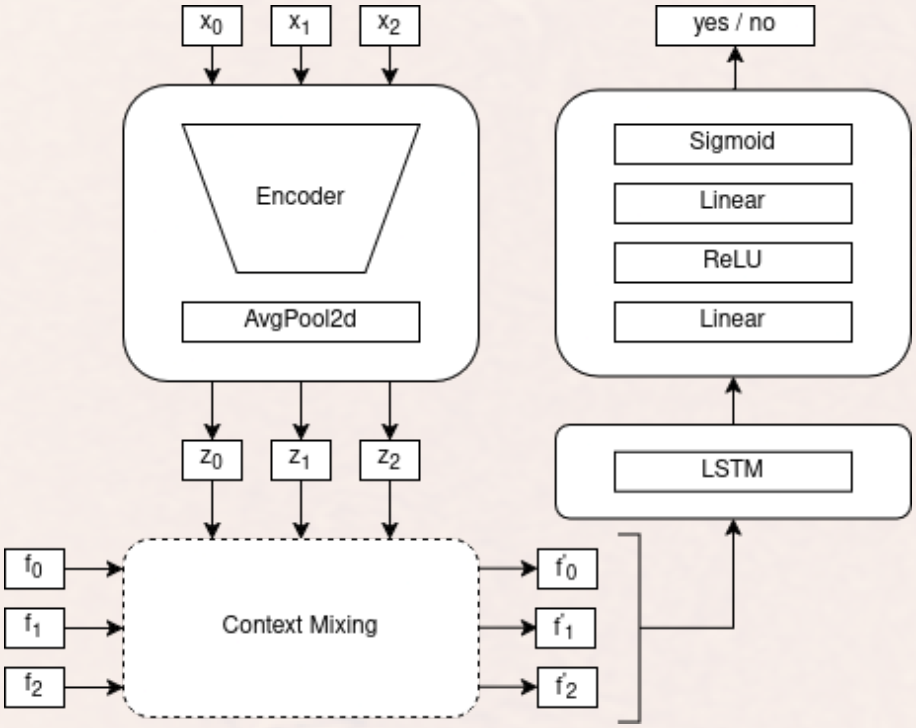


TRL	2
Latency	1 minute (GOES X-ray); on flare occurrence (flare localizer)
Resolution	1 minute (GOES X-ray)
Available at	SeNMEs (GOES X-ray); internal for scientific use (flare localizer)
Available since	Generated internally on demand
Data sources	GOES X-ray flux and SDO AIA 131
Applications	Communications, Geological prospections, Insurances, Power grid, Railways, Aviation, GNSS, Pipelines, Satellites

PRODUCT

FLARE FORECASTING

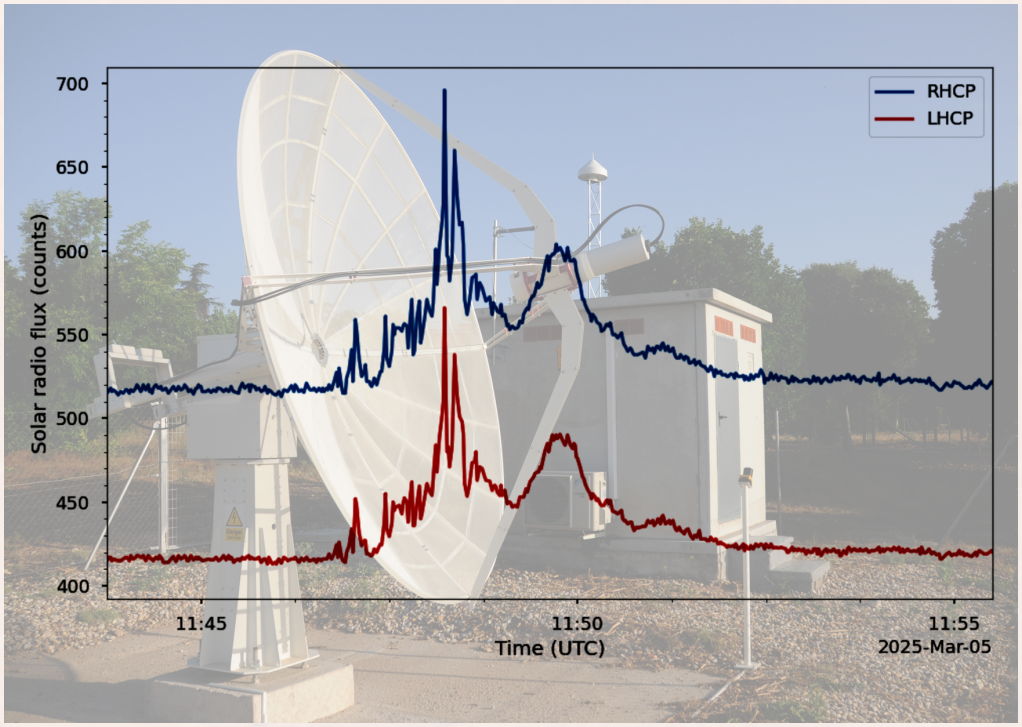
A neural network to forecast the occurence of C.5 or higher flares in the upcoming 24-hours. It relies on photospheric magnetic field observations—such as line-of-sight (LoS) and vector magnetograms—to derive physical quantities statistically associated with flare occurrence. Also uses parameters including the total unsigned magnetic flux, the shear angle between the observed and potential transverse magnetic field, the vertical current density, and the current helicity density. Testing accuracy reaches 93%.



TRL	2
Latency	On demand
Resolution	24 hours
Available at	Internal for scientific use
Available since	Generated internally on demand
Data sources	SDO, SHARP
Applications	Communications, Geological prospections, Insurances, Power grid, Railways, Aviation, GNSS, Pipelines, Satellites

1.42 GHz Solar Radio Burst Monitoring Tool

Product for monitoring solar radio bursts at 1.42 GHz, distinguishing between right-hand and left-hand circular polarization. These bursts are often associated with eruptive solar flares, and can disrupt GNSS signals and L-band air traffic control radars, both of which are sensitive to polarization. This product gets the observations from our Solar Radio Telescope and works in strong synergy with our GNSS monitoring tool, enabling a comprehensive assessment of the cause-and-effect relationship. At this stage the flux observations are pending calibration and a latency improvement.



TRL	3
Latency	1 day
Resolution	<1 second
Available at	Internal for scientific use
Available since	June 2025
Data sources	UAH-SWE's 1.42 GHz Solar Radio Telescope
Applications	Communications, Geological prospections, Insurances, Power grid, Railways, Aviation, GNSS, Pipelines, Satellites

PRODUCT

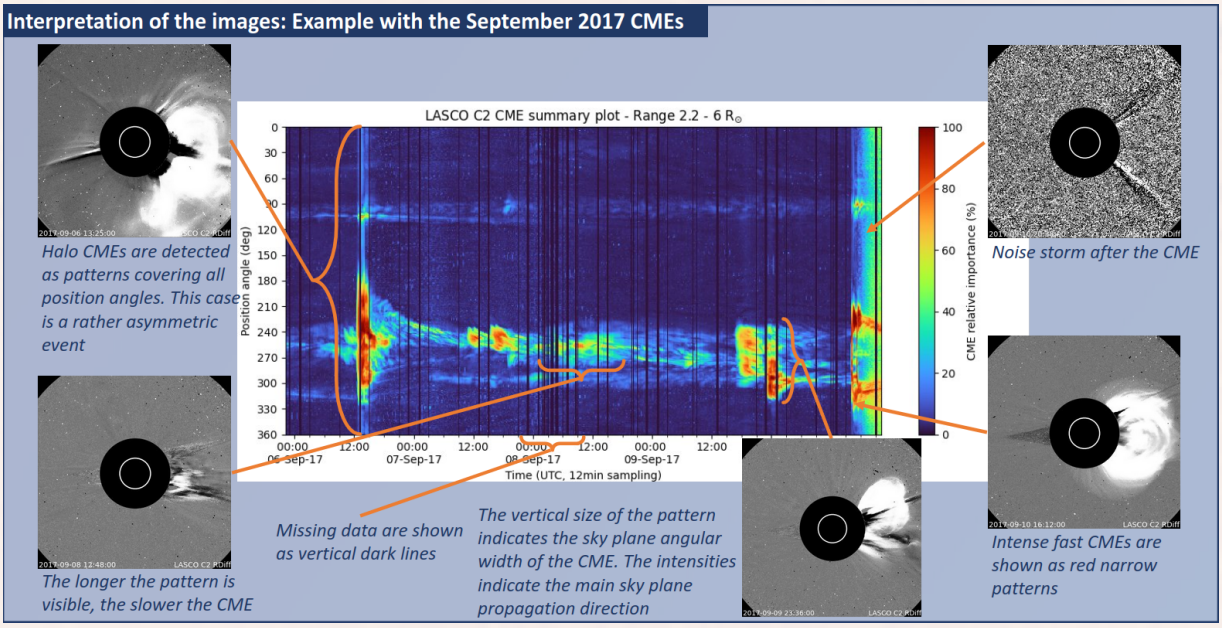
Universidad de Alcalá

SWE Space Weather Group

PRODUCT

ACME - AUTOMATED CORONAL MASS EJECTION SUMMARIZER

Condenses time series of coronagraph images into a single summary image for efficient monitoring of coronal mass ejections (CMEs). The image encodes CME occurrence, relative importance, angular width, and direction in the plane of the sky. ACME summary plots can also be used in automated CME detection and characterization tools, and significantly reduce input size for integration into AI models.



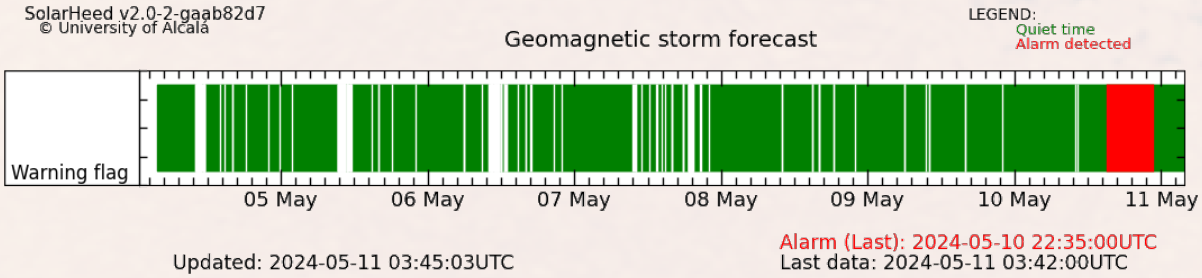
TRL	4
Latency	15 minutes
Resolution	12 minutes for SOHO, 15 minutes for STEREO
Available at	SeNMEs
Available since	Only real-time available
Data sources	STEREO COR2, and SOHO LASCO C2 and C3
Applications	Communications, Geological prospections, Insurances, Power grid, Railways, Aviation, GNSS, Pipelines, Satellites

STEREO C2 LASCO C2 LASCO C3

Universidad de Alcalá SWE Space Weather Group SeNMEs

GEOMAGNETIC STORM OCCURRENCE

SolarHeed provides a real-time alert of geomagnetic storms based on the IMF data, and thus, the product is not affected by the lack of solar wind plasma data, which usually occurs during severe geomagnetic activity). The alert is triggered when a significant disturbance in the Bz component of the IMF is detected.



TRL	8
Latency	15 minutes
Resolution	1 minute
Available at	SeNMEs, ESA-SWE (G.128)
Available since	Only real-time available
Data sources	SWPC
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

ESA G.128

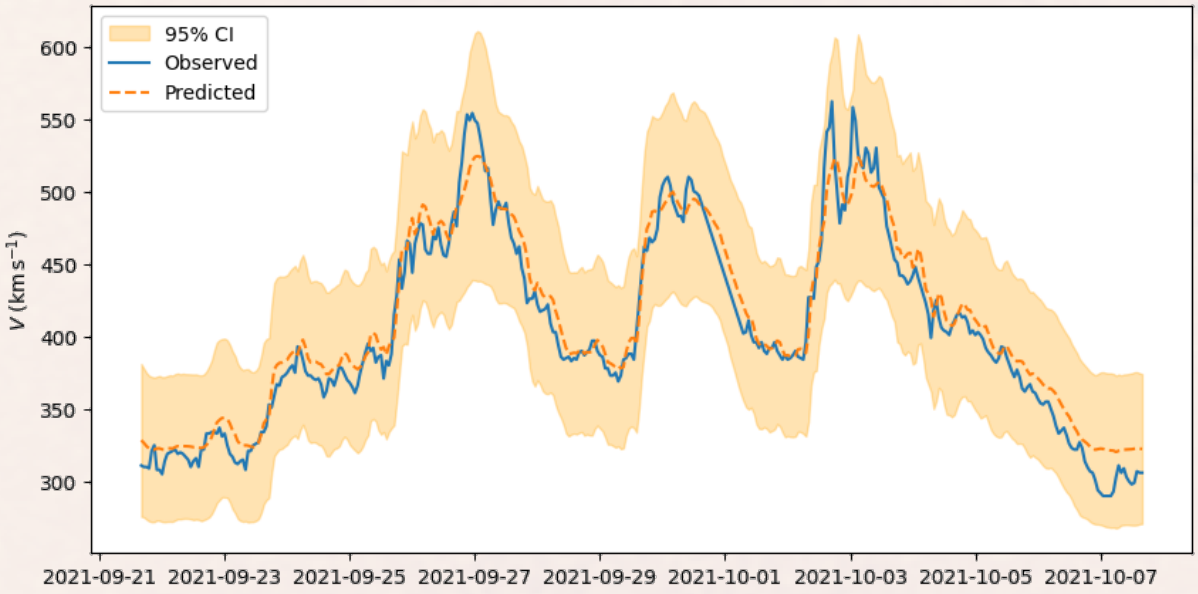
Article

PRODUCT

PRODUCT

SOLAR WIND SPEED FORECAST

Probabilistic forecast of hourly average solar wind speed with a lead time of five days, denoting a 95% prediction interval. It is derived from our coronal hole measurements product and current observations of solar wind properties retrieved from the Space Weather Prediction Center (SWPC).

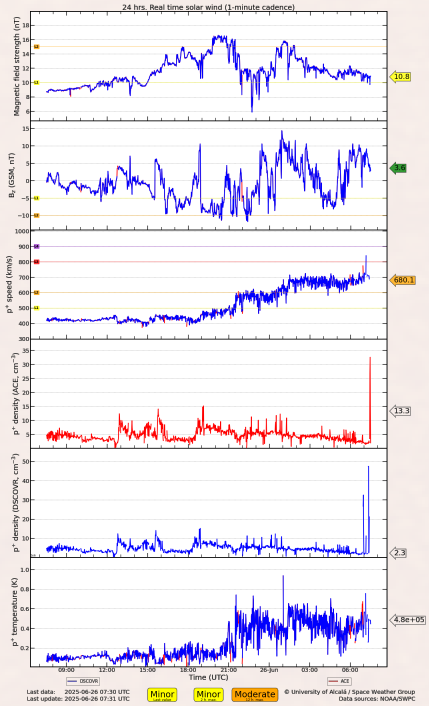


TRL	3
Latency	1 hour
Resolution	1 hour
Available at	Internal for scientific use
Available since	Generated internally on demand
Data sources	JSOC, SWPC
Applications	Communications, Insurances, Power grid, Railways, Aviation, Pipelines, Satellites

PRODUCT

SOLAR WIND SEMAPHORE

The Solar Wind Semaphore (SoWiSe) is a real-time solar wind monitoring tool, which thresholds for warning on interplanetary magnetic field strength, Bz and proton speed.



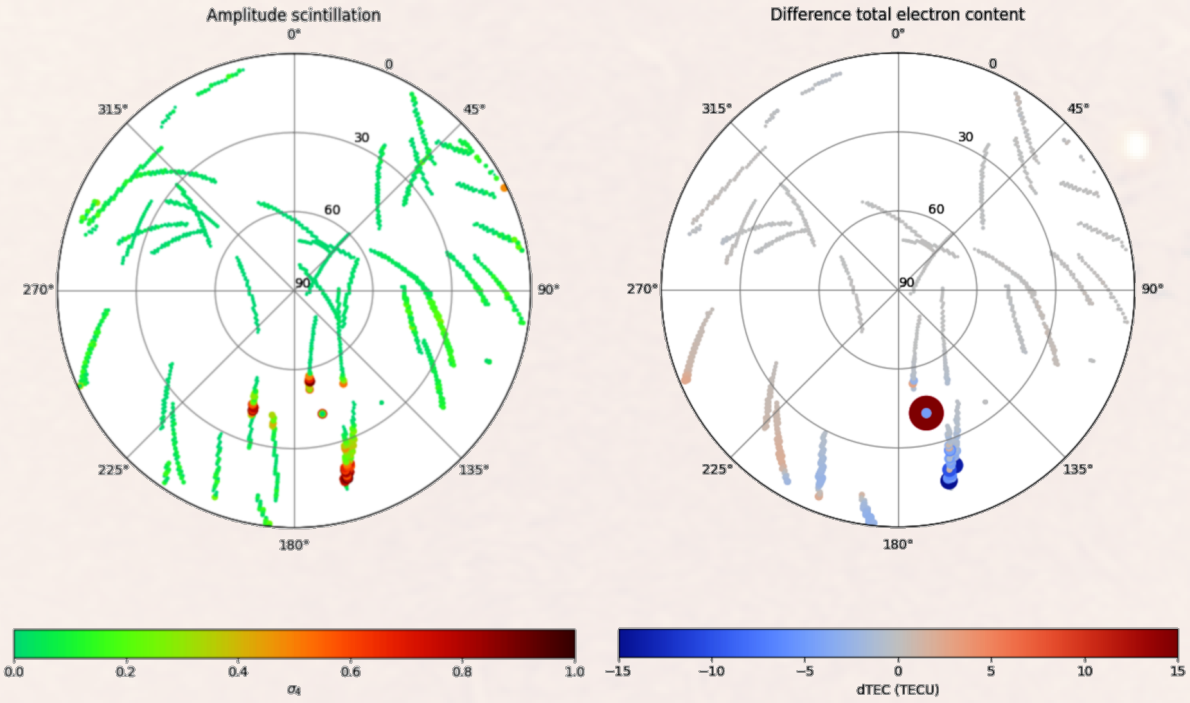
TRL	3
Latency	1 minute
Resolution	1 minute
Available at	SeNMEs
Available since	Only real-time available
Data sources	ACE, DSCOVR
Applications	Communications, Power grid, Aviation, GNSS, Satellites

Product

PRODUCT

GNSS-Derived Ionospheric Indices

Provides real-time monitoring of GNSS-derived ionospheric indices such as scintillation (phase and amplitud) and electron content (TEC and dTEC). Observations are obtained from our dedicated GNSS station.

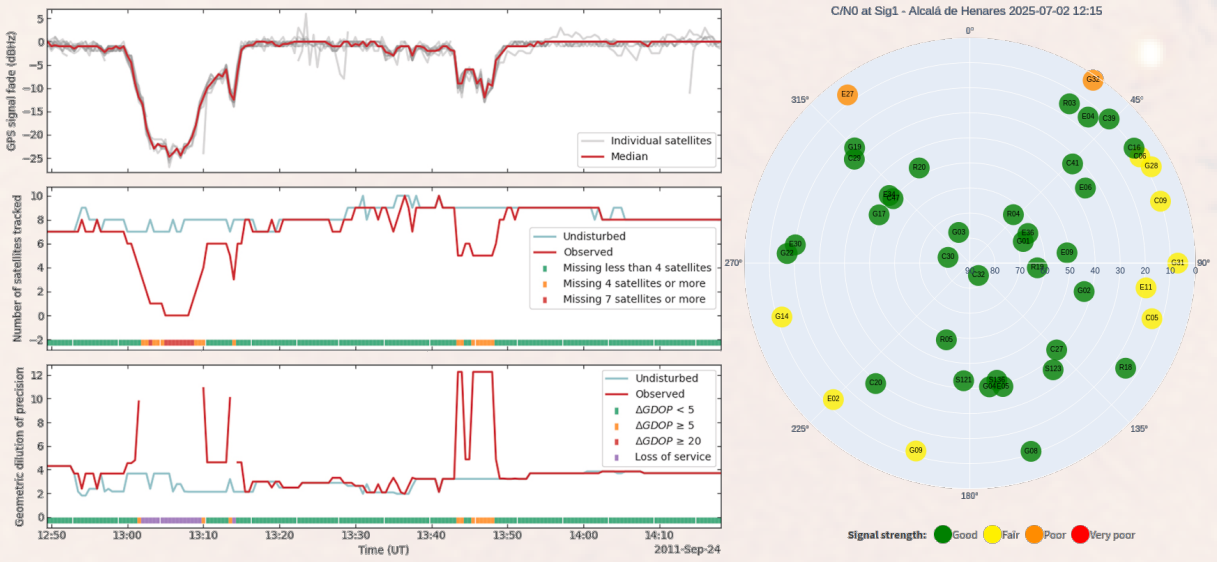


TRL	3
Latency	15 minutes
Resolution	15 - 60 s, depending on observable
Available at	Internal for scientific use
Available since	February 2025 (limited availability starting December 2023)
Data sources	UAH-SWE's GNSS Station
Applications	Communications, Geological prospections, Insurances, Power grid, Railways, Aviation, GNSS, Pipelines, Satellites

PRODUCT

GNSS Signal Quality Monitor

Provides real-time monitoring of GNSS signal quality using indicators such as carrier-to-noise ratio, geometric dilution of precision, and satellite availability. Data is primarily sourced from our dedicated GNSS station, but with the capacity of integrating data from external providers such as the International GNSS Service (IGS).



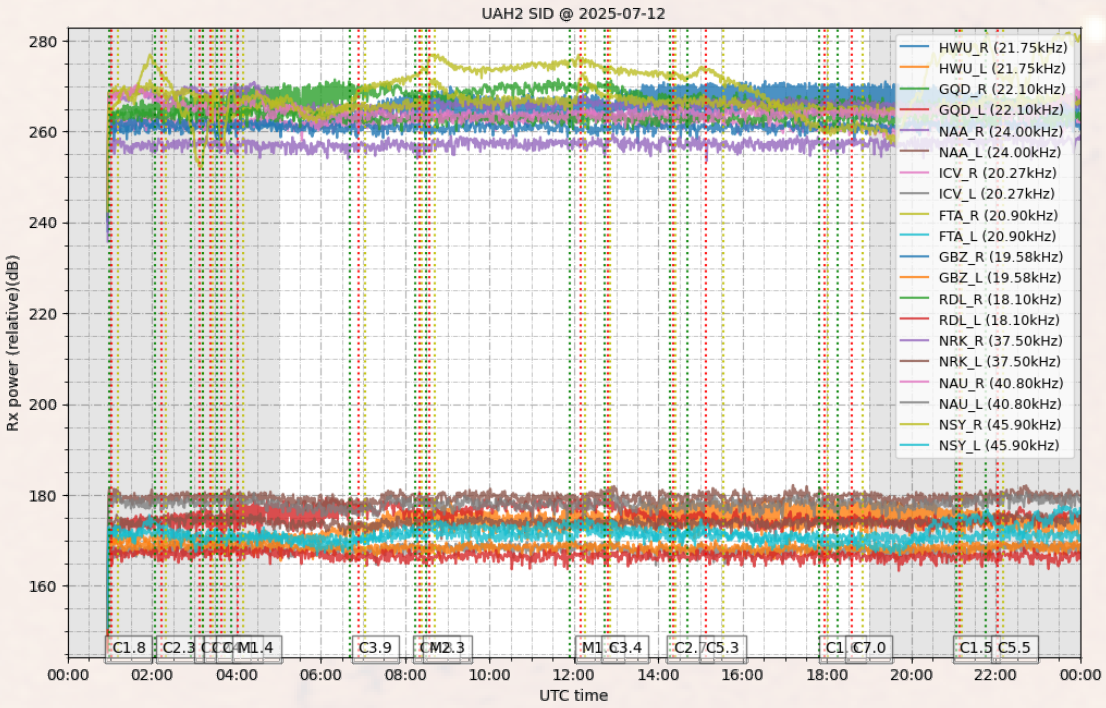
TRL	3
Latency	15 minutes
Resolution	1/50 - 60 s, depending on observable
Available at	Internal for scientific use
Available since	February 2025 (limited availability starting December 2023)
Data sources	UAH-SWE's GNSS Station; IGS
Applications	Communications, Geological prospections, Insurances, Power grid, Railways, Aviation, GNSS, Pipelines, Satellites

Universidad de Alcalá

SWE Space Weather Group

SUDDEN IONOSOSPHERIC DISTURBANCE MONITOR

A SID (Sudden Ionosospheric Disturbance) monitoring station is a specialized ground-based system that continuously records variations in Very Low Frequency (VLF) radio signals to detect sudden changes in the ionosphere caused by solar activity. Its primary strength lies in its ability to store large amounts of time-stamped signal data, allowing for detailed post-event analysis. By identifying anomalies in signal patterns, the station can pinpoint ionospheric disturbances associated with solar flares and other space weather events. This stored information is essential for space weather meteorology, as it enables us to correlate signal disruptions with solar phenomena and improve forecasting models.



TRL	2
Latency	3 minutes
Resolution	1 minute
Available at	Internal for scientific use
Available since	September 2024
Data sources	UAH-SWE's VLF antena
Applications	Communications

Product

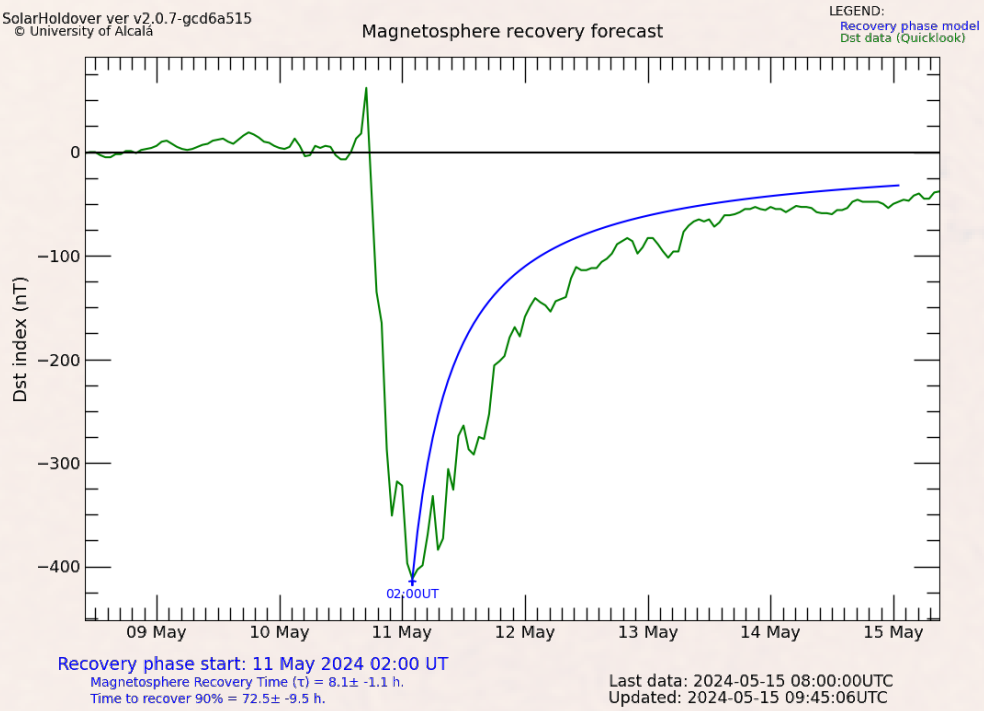
Universidad de Alcalá

SWE Space Weather Group

PRODUCT

GEOMAGNETIC STORM RECOVERY PHASE

This product is a prediction of a geomagnetic storm recovery phase. It provides the theoretical expectations following an hyperbolic decay model and computed when the Dst index is below -100 nT.



TRL	8
Latency	15 minutes
Resolution	1 hour
Available at	SeNMEs, ESA-SWE (G.129)
Available since	Only real-time available
Data sources	KyotoWDC
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

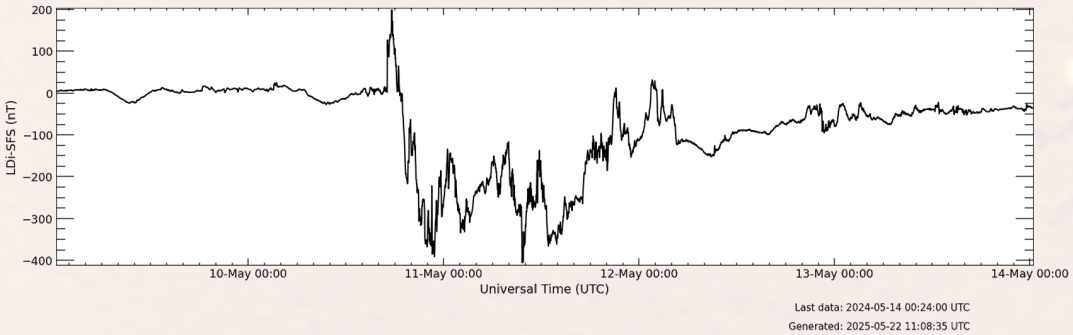
ESA G.129

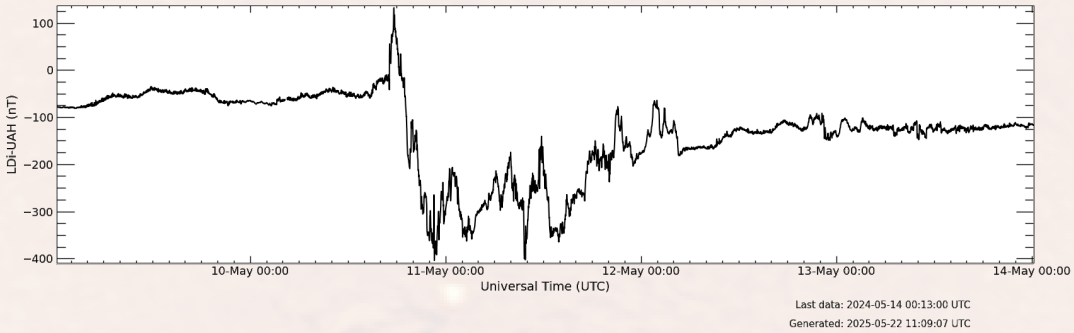
Article

PRODUCT

LOCAL DISTURBANCE INDEX

The Local Disturbance index is a real-time geomagnetic index that quantifies local disturbances in the Earth's magnetic field using data from ground-based magnetometer stations. The magnetic field measurements are processed to remove the regular daily and secular variation, allowing for accurate monitoring of short-term geomagnetic activity. LDi is designed for use in monitoring, diagnostics, and forecasting applications related to space weather impacts on technological systems. The procedure used to generate the index is patented by the University of Alcalá's Space Weather Group.





TRL	8
Latency	15 minutes
Resolution	1 minute
Available at	SeNMEs, ESA-SWE (G.172)
Available since	Depending on station
Data sources	SFS's, COI's and UAH-SWE's magnetometers
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

ESA G.172

Patent

Universidad de Alcalá

SWE Space Weather Group

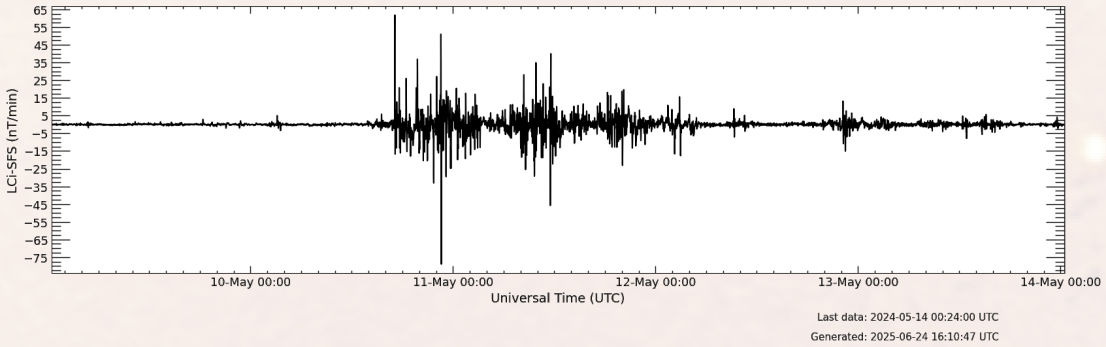
SeNMEs

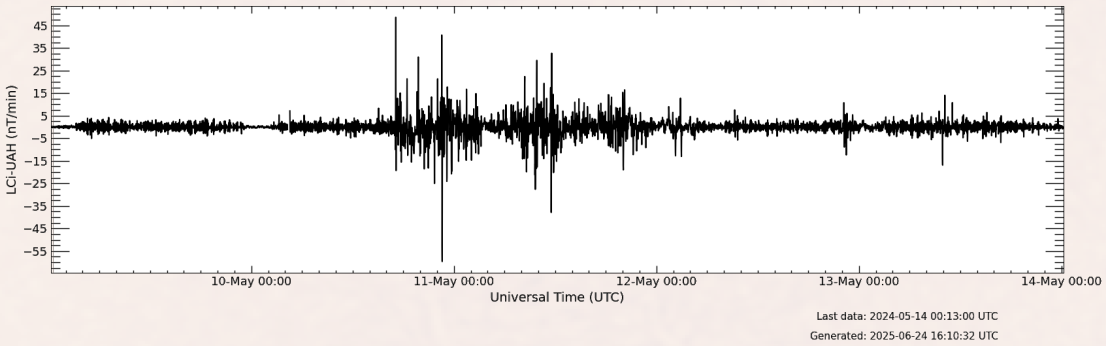
esa

PRODUCT

LOCAL CURRENT INDEX

The Local Current index is a real-time geomagnetic index derived from the LDi. It is a proxy for the geomagnetic induced currents (GICs) in the Earth's surface, which can affect technological systems such as power grids and pipelines.





TRL	8
Latency	15 minutes
Resolution	1 minute
Available at	SeNMEs, ESA-SWE (G.173)
Available since	Depending on station
Data sources	LDi
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

ESA G.173

Article

Universidad de Alcalá

SWE Space Weather Group

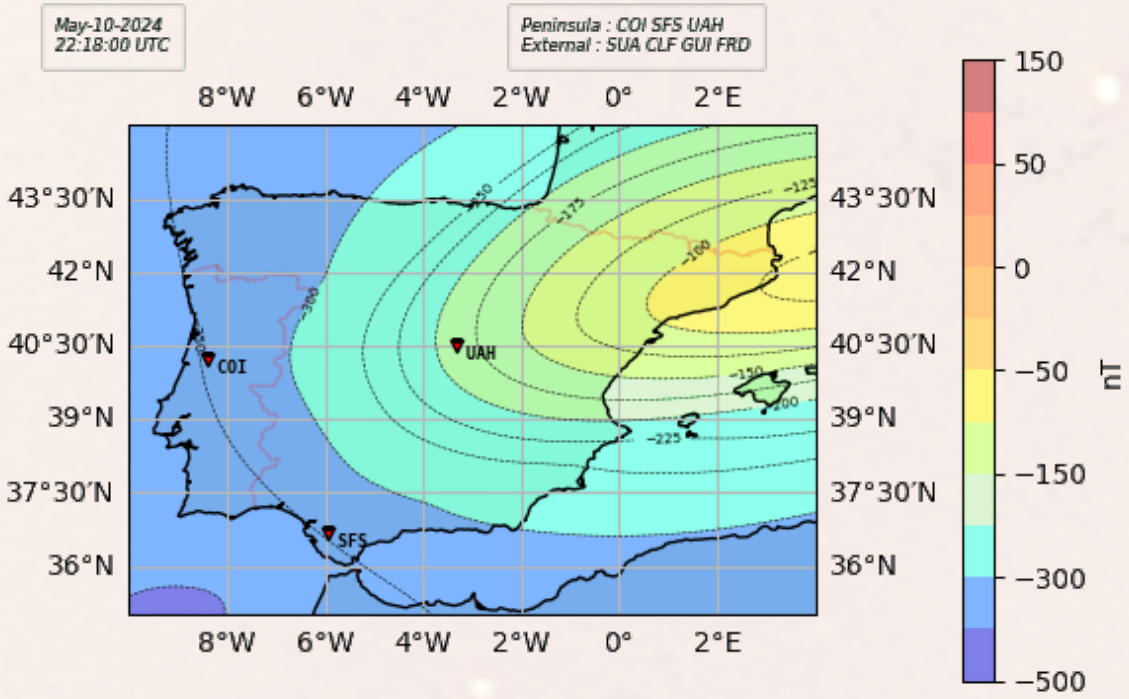
SeNMEs

esa

PRODUCT

IBERIAN LOCAL DISTURBANCE MAP

The map provides a regional view of the quantification of the horizontal magnetic disturbance isocontours at a specific location using the Local Disturbance index (LDi) for several locations and extrapolating the values for rest of locations shown on the map. It makes use of the horizontal component of the magnetic field registered at several specific stations (Peninsula observatories). External locations, outside the map, are used for a better extrapolation of the data at points covering the region of the map.



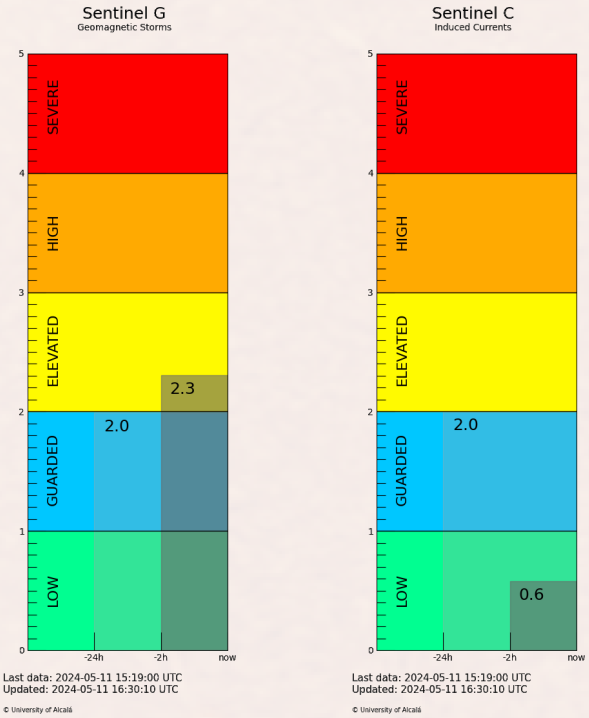
TRL	8
Latency	15 minutes
Resolution	1 minute
Available at	ESA-SWE (G.174)
Available since	November 2023
Data sources	LDi
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

ESA G.174

PRODUCT

SENTINELS

The sentinels are a color code scale indicating the level of disturbance according to the LDi (geomagnetic disturbance or Sentinel G) and LCi (induced currents risk or Sentinel C) for the Iberian peninsula. The scale for the sentinels has been designed based on the historical distribution function for the LDi and LCi of the Iberian peninsula.



TRL	8
Latency	15 minutes
Resolution	1 minute
Available at	SeNMEs, ESA-SWE (G.131 & G.132)
Available since	Only real-time available
Data sources	SFS's LDi and LCi, UAH-SWE's LDi and LCi
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

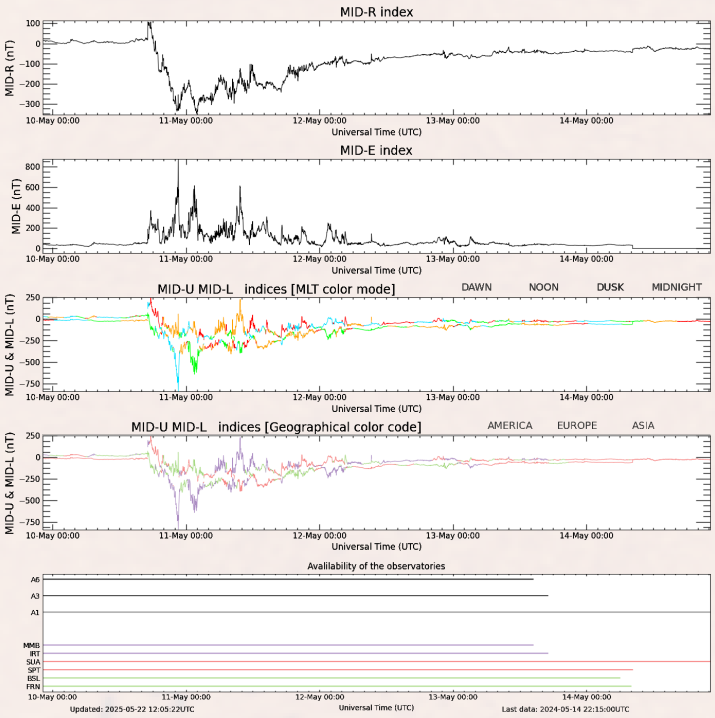
ESA G.131

ESA G.132

PRODUCT

MID LATITUDE INDICES: RING CURRENT (MID-R) AND ELECTROJET (MID-E)

Mid-latitudes around 40 degrees are influenced by phenomena typical of both high and low latitudes, making them a complex region for interpreting geospatial conditions. This complexity is heightened by the drifting focus of the Solar Quiet (Sq) ionospheric current system. To address these challenges, we compute the LDi for multiple stations to produce global geomagnetic indices: MID-R and MID-E that are focused on the ring current and electrojet. These indices provide upper and lower envelopes of the superposed data from the stations used as function of UTC.

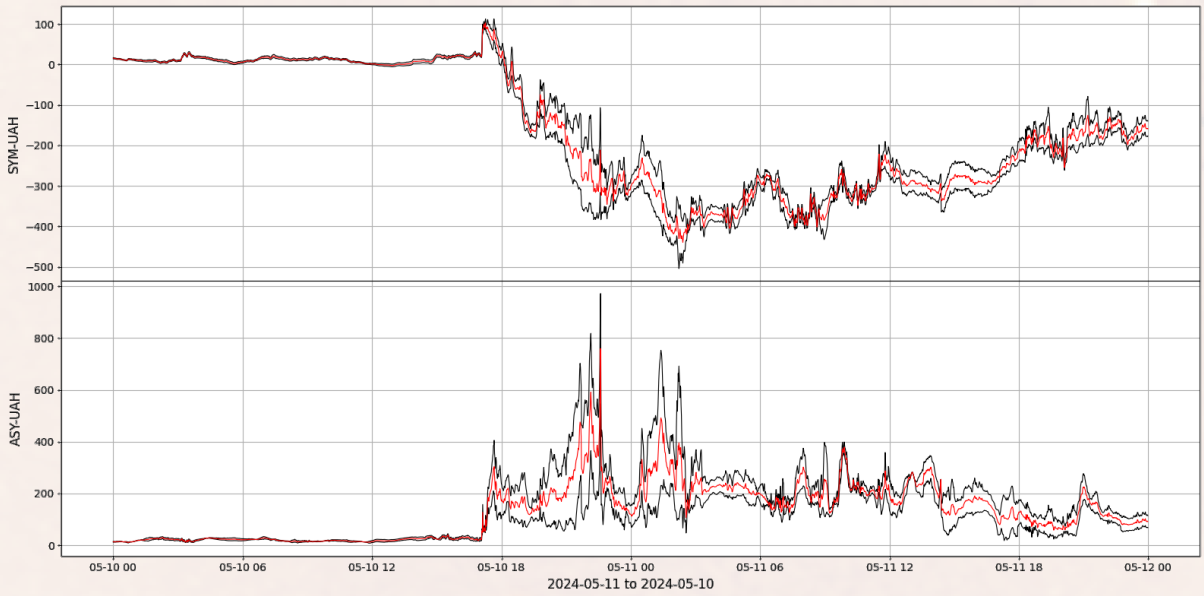


TRL	8
Latency	15 minutes
Resolution	1 minute
Available at	SeNMEs, ESA-SWE (G.175)
Available since	January 2022
Data sources	INTERMAGNET
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

ESA G.175

SYM-H AND ASY-H NOWCAST

This product computes a proxy for SYM-H and ASY-H indices in real-time using the LDi indices for the same sectors as used in the SYM-H computed by KyotoWDC. As there are sectors with multiple observatories available, all combinations are computed, providing an index range. This improves the resilience of the product in case of unavailability of one or more observatories, while also provides the uncertainty in the KyotoWDC published index. The final index provided is the average for such range. This product is used as input for the forecasting products.



TRL	7
Latency	15 minutes
Resolution	1 minute
Available at	SeNMEs
Available since	January 2023
Data sources	INTERMAGNET
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

Product

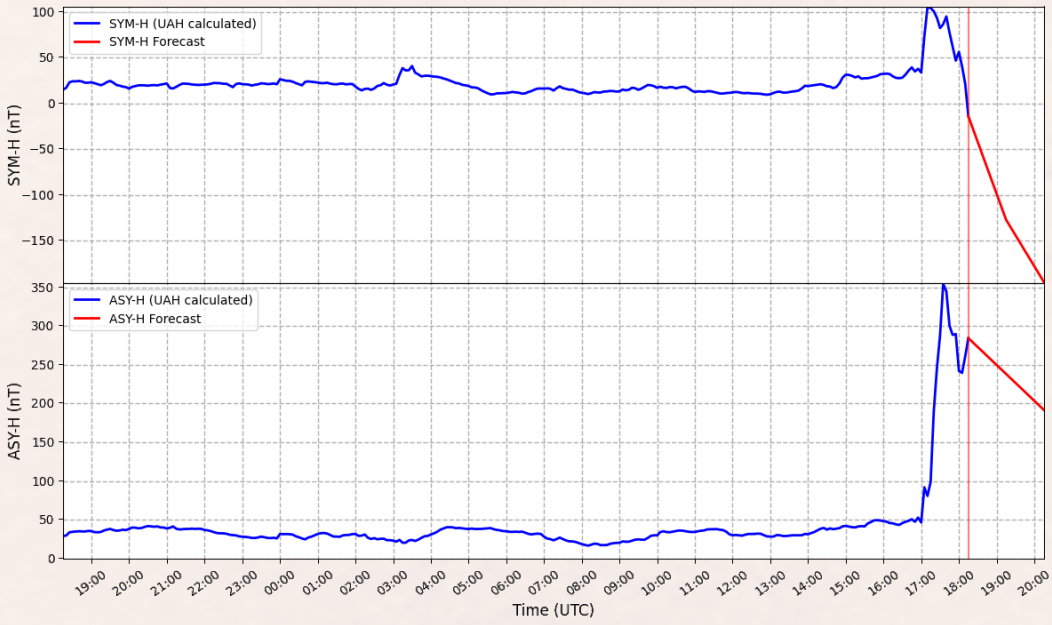
Article

PRODUCT

PRODUCT

SYM-H AND ASY-H 2-HOURS FORECAST

This product implements a Deep Neural Network that combines LSTM and CNN layers to forecast the SYM-H and ASY-H geomagnetic indices one and two hours ahead. It operates in real time using the previous 200 minutes of IMF measurements from ACE along with SYM-H and ASY-H indices as inputs. The product has been validated over the past two solar cycles and provides real time metrics to assess the accuracy of the forecasts.



Last data: 2024-May-10 18:15 UTC
Last updated: 2024-May-10 18:50 UTC

Prediction metrics: Mean Absolute Error (MAE)

```
SYM-H 1-hour  MAE last 24h: 8.104 nT | last 30d: 5.750 nT
SYM-H 2-hours MAE last 24h:11.450 nT | last 30d: 7.675 nT
ASY-H 1-hour  MAE last 24h:16.252 nT | last 30d:18.160 nT
ASY-H 2-hours MAE last 24h:22.869 nT | last 30d:25.516 nT
```

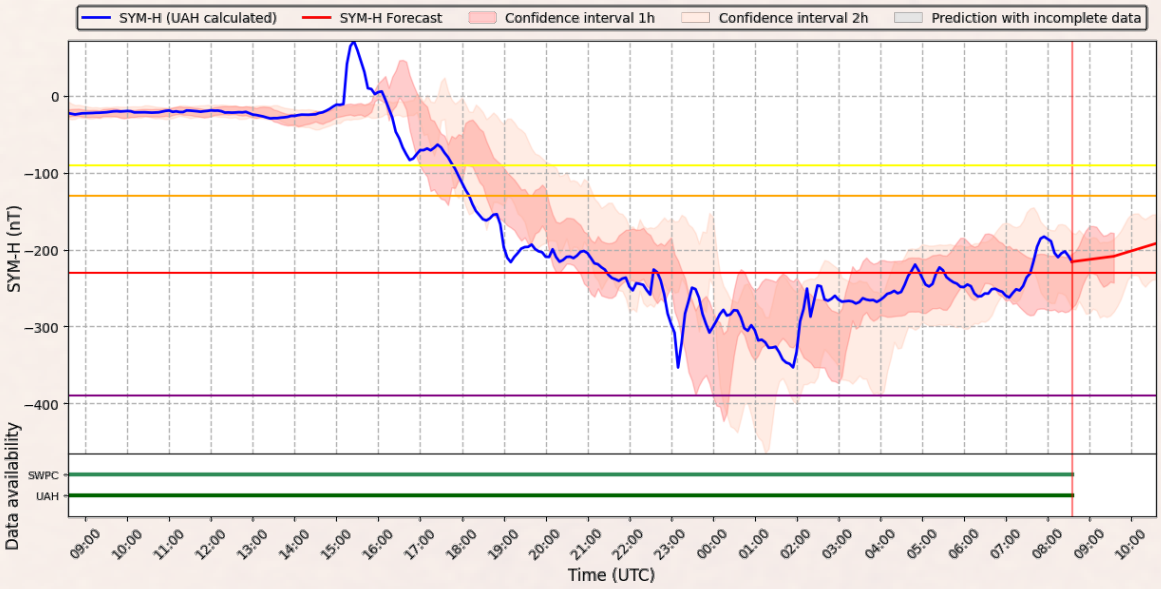
TRL	8
Latency	15 minutes
Resolution	1 hour
Available at	SeNMEs, ESA-SWE (G.176)
Available since	January 2024
Data sources	SWPC, UAH-SWE's SYM-H nowcast
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

ESA G.176

Article

SYM-H 2-hours Forecast with Confidence Interval

This product implements a Deep Neural Network to accurately forecast the SYM-H geomagnetic index. It uses IMF and solar wind plasma features from ACE and the SYM-H index to forecast the SYM-H for the next 1 to 2 hours. To quantify the uncertanty the model also forecast a 90% coverage confidence interval.



Last data: 2024-Oct-11 08:35 UTC
Last updated: 2024-Oct-11 09:18 UTC

Data source: NOAA/SWPC/UAH

TRL	6
Latency	15 minutes
Resolution	1 hour
Available at	SeNMEs
Available since	June 2024
Data sources	SWPC, UAH-SWE's SYM-H nowcast
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

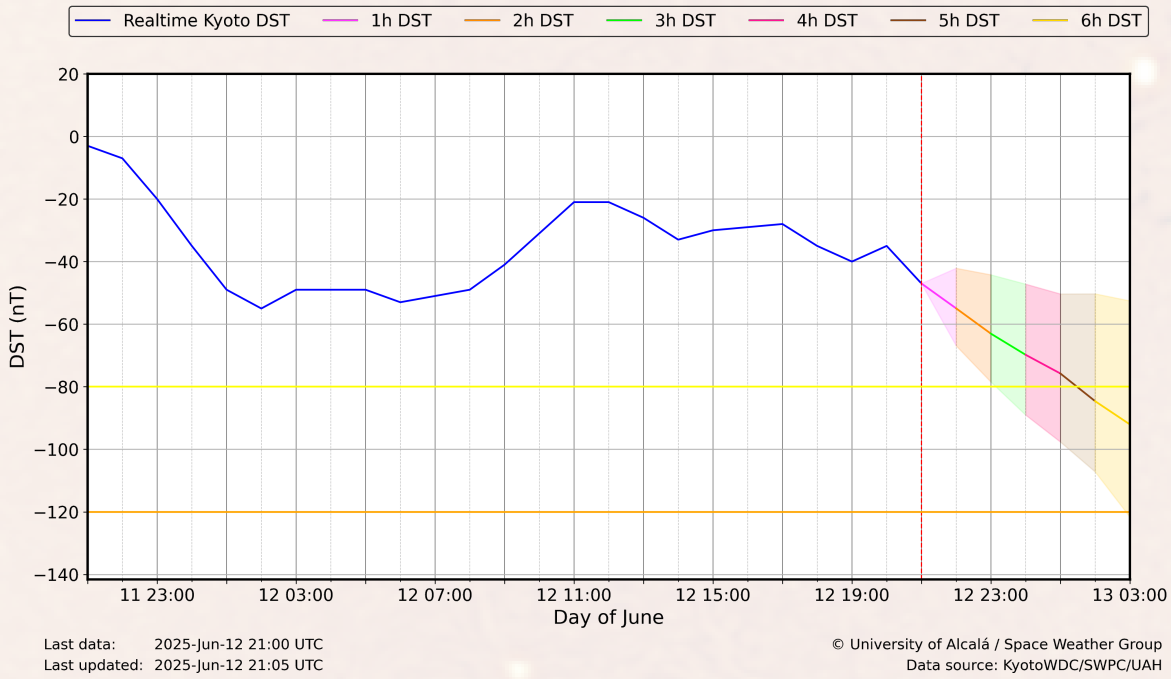
Product

Article

PRODUCT

DST 6-HOURS FORECAST

This products is a neural network with attention mechanism that recursively forecast the Dst 1 to 6 hours. It uses ACE's plasma and IMF data and the real time Dst from KyotoWDC. The model also quantifies the uncertainty of the forecast with a 90% confidence interval. The accuracy is operationally viable up to 3 hours for the main phase of a CME storm and up to 6 hours for the recovery phase or disturbances caused by high-speed streams and quiet time.



TRL	5
Latency	1 hour
Resolution	1 hour
Available at	SeNMEs
Available since	May 2025
Data sources	KyotoWDC, SWPC
Applications	Communications, Geological prospections, Insurances, Power grid, Railways

Product

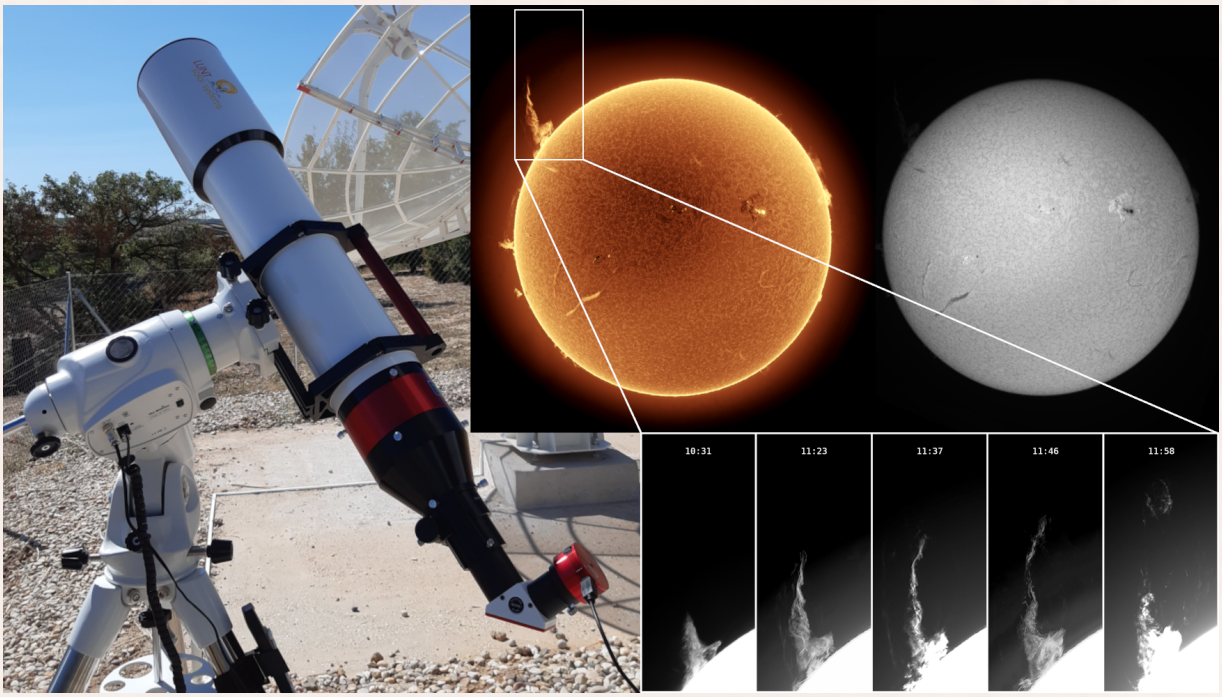
PRODUCT

INSTRUMENT

H-ALPHA SOLAR TELESCOPE

Lunt 130 mm telescope with H-alpha filter and ASI 533 MM camera for observations of the solar chromosphere. Pending installation in dome and robotization.
Used in the following products:

- Solar filament detector and tracker

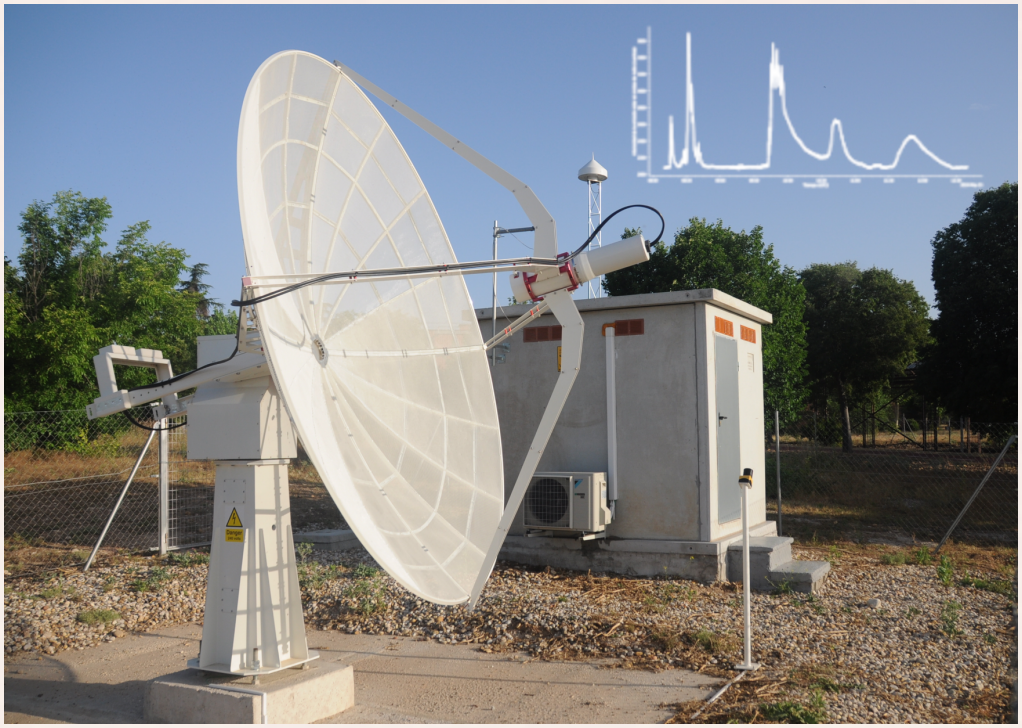


INSTRUMENT

1.42 GHz Solar Radio Telescope

SPIDER 300A Mark II radio telescope with H142 receiver. Located at the University of Alcalá Space Weather Station. Continuously monitors solar radio burst occurrence from sunrise to sunset at 1.42 GHz, capturing both left and right circular polarization. Pending calibration and latency improvement.
Used in the following products:

- 1.42 GHz solar radio burst monitoring tool



INSTRUMENT

GNSS Station

GNSS station with a Septentrio PolaRx5S receiver and PolaNt Choke Ring B3/E6 antenna, located at the University of Alcalá Space Weather Station. It monitors satellite signal integrity and ionospheric indices. The station currently tracks GPS, Galileo, GLONASS, BeiDou, SBAS, and NavIC constellations across all available frequencies.
Used in the following products:

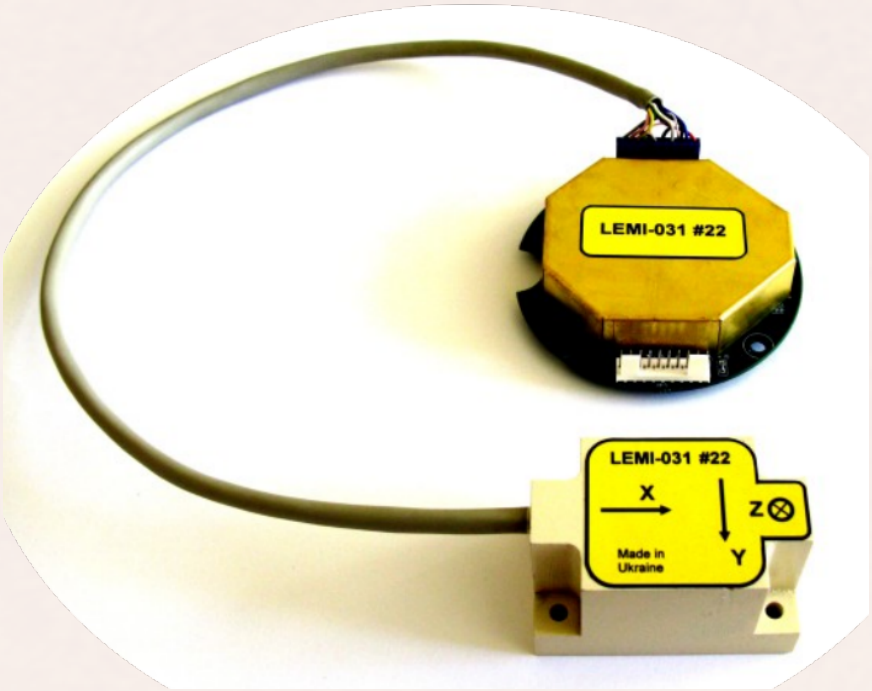
- GNSS-derived ionospheric indices
- GNSS signal quality monitor

INSTRUMENT

MAGNETOMETER LEMI-031

Low power flux-gate magnetometer LEMI-031 is intended for the monitoring of three components of the magnetic field vector in land conditions. The instrument is specially designed for battery powered applications and has differential outputs for easy coupling with analogue to digital converter. Several know-hows are used to keep the power consumption of LEMI-031 magnetometer at world lowest level.
Used in the following products:

- LDi and derived products



INSTRUMENT

VERY LOW FREQUENCY RADIO RECEIVER

Very Low Frequency (VLF) communications refer to radio waves in the 3 to 30 kHz range, which can penetrate seawater and travel long distances by reflecting between the Earth's surface and the ionosphere. This makes them ideal for communication with submarines. Additionally, VLF signals are highly sensitive to changes in the ionosphere, which is influenced by solar activity such as solar flares and geomagnetic storms. By monitoring variations in VLF signal strength and propagation, we can indirectly study solar activity and its effects on Earth's upper atmosphere. This is a made in-house instrument.
Used in the following products:

- Sudden Ionosospheric Disturbance monitor