Intelligent Databases and Machine-Learning Analysis Tools for Heliophysics

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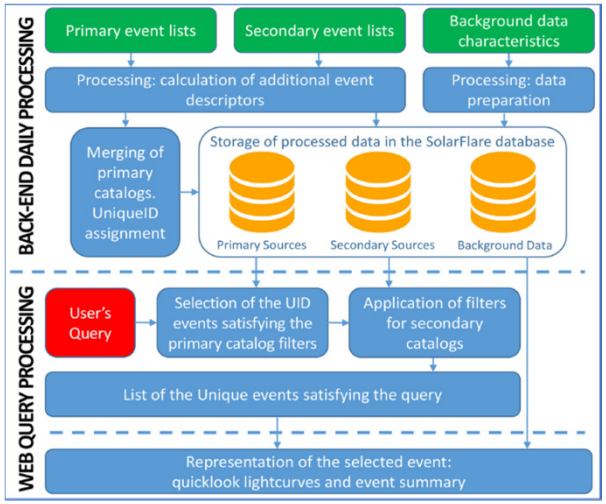
HELIOPORTAL: INTERACTIVE MULTI-INSTRUMENT DATABASE OF SOLAR FLARES (IMIDSF)

Our long-term goal is to create a database containing and integrating records and descriptors of solar transient events, active regions, and observations, which will allow the users to access data both before and after the integration, perform comprehensive data requests and directly use received data for forecasting purposes

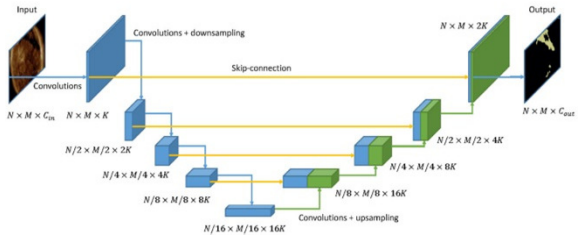


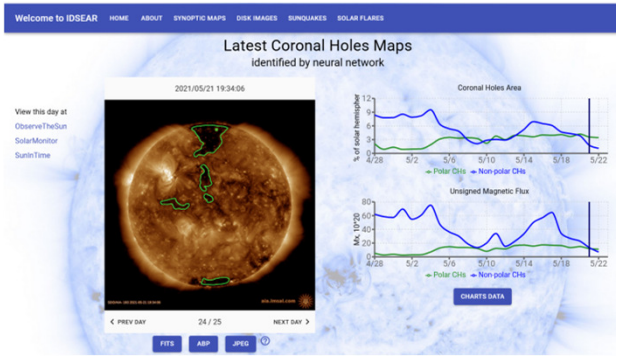
A major milestone of this project is the development of HELIOPORTAL hosted at the NASA Ames Research Center and implementation of the Interactive Multi-Instrument Database of Solar Flares (IMIDSF) as a title project at Helioportal. The key features of IMIDSF are the following:

1. Integration of flare events from different flare catalogs (GOES, RHESSI, HEK, Hinode, Fermi GBM, Konus-WIND, the OVSA flare catalogs). "One flare – one result" philosophy.
2. Search of the flare events based on their physical descriptors (both those stored in the catalogs and calculated), availability of observations (IRIS and Nobeyama observational filters are available), or presence of accompanying events (solar energetic particles, coronal mass ejections, etc.)
3. Detailed look at the particular event which includes quick-look light curves (GOES, NORP and ESP/EVE SDO), cross-mission summary for each event, user-defined searches for similar events. IMIDSF and Helioportal are available at https://solarflare.njit.edu/ and https://helioportal.nas.nasa.gov.

MACHINE-LEARNING DATABASE OF CORONAL HOLES (CH)

Identification of solar Coronal Holes (CHs) provides information both for operational space weather forecasting and long-term investigation of solar activity. Due to different appearances of disk images and synoptic maps, the algorithms for CHs segmentation are typically elaborated independently. In contrast, we suggest the idea that the concept of CHs should be similar for both cases. This motivates us to investigate universal models that can learn a CHs segmentation in disk images and reproduce the same segmentation in synoptic maps. In our research, we demonstrate that Convolutional Neural Networks (CNN) can be considered as such universal models.

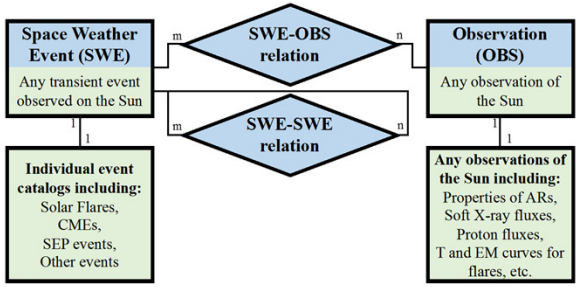


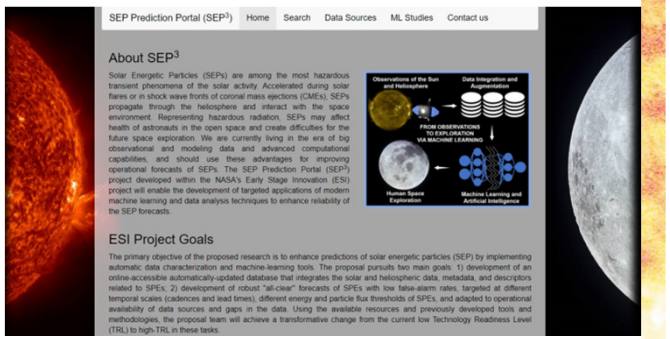


We have employed the machine-learning technique to automatically identify and analyze the solar coronal holes in near-real time from the NASA Solar Dynamics Observatory mission data. The results are posted in the project web site http://sun.njit.edu.

SOLAR ENERGETIC PARTICLES PREDICTION PORTAL (SEP)

To support the project data needs, we are currently developing an online-accessible database of SPE-related data, metadata, and data products (SEP3 project). The database will be available online for broader research community from the NJIT web server.





Core features of the portal include:
Various SPE-related sources collected in one place: 1) properties of active regions (PIL, SHARP, Solar Region Summary records); 2) GOES proton and SXR fluxes; 3) NOAA records of the radio bursts, flares, and SPEs; 4) SOHO/EPHIN energetic particle data; 5) OULU neutron monitor data; 5) CACTUS CME catalog records MySQL database schema developed and optimized to efficiently handle the data queries necessary for the project Intuitive Web application with API-based online access to database entries and data products (under development).

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