



# HELIO Use Case 1: Heliospheric Variability

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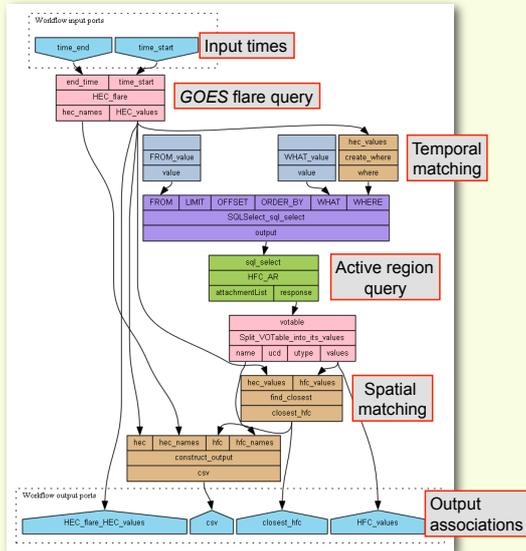
## The Challenge:

To use HELIO to study the statistical occurrence of features (active regions, coronal holes, filaments) and events (interaction regions, energetic particle events, magnetospheric substorms) through the heliosphere, and the relationships that exist between them.

## Study B: Solar Activity Variability

The association between flare events and automatically feature-detected active regions was determined.

This study uses a Taverna workflow (see MyExperiment page at <http://tinyurl.com/HELIO-VariabilityChallenge> or scan QR code) to combine SQL queries to the separate HELIO Feature Catalog (HFC) and HEC services.

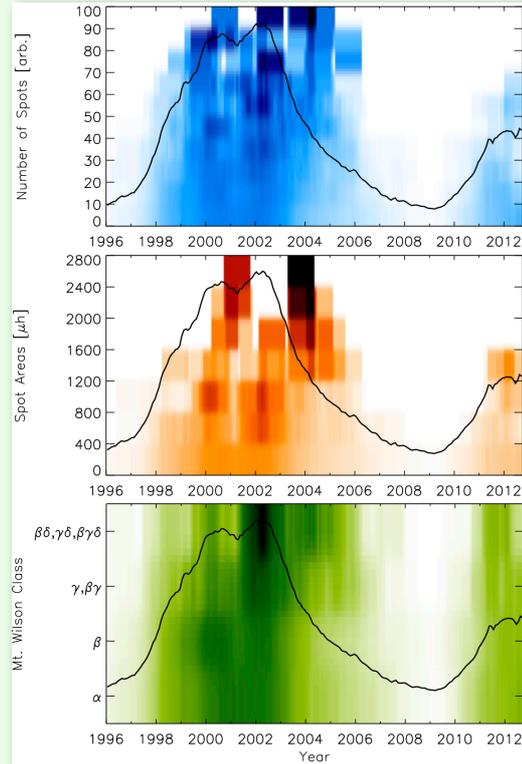


Taverna workflow combining queries to the HEC (GOES flares) and the HFC (e.g., SMART-detected active regions). Flare entries were restricted to those above the C1.0 level with locations, while active regions were only extracted within 12 hours of flare times and within 5 degrees (to allow for solar rotation).

## Study A: Solar Feature Variability

The solar cycle dependence of NOAA active region physical properties and Mt. Wilson magnetic class were determined through cycles 23 and 24.

This study made use of SQL queries to the HELIO Event Catalog (HEC) service, which can be easily altered to investigate only flaring active regions.

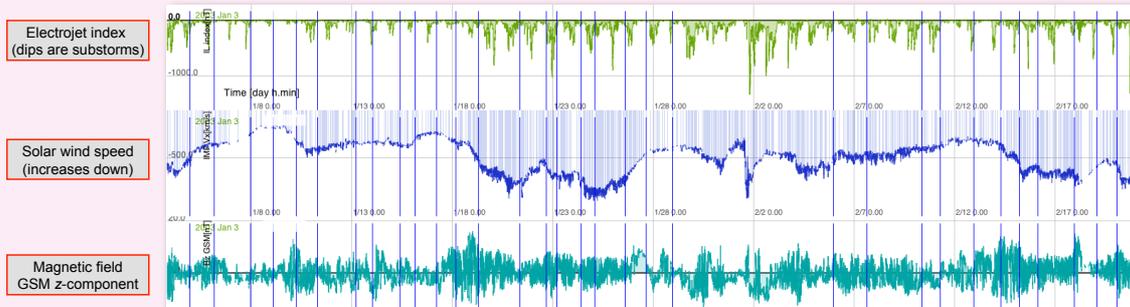


Variation of NOAA active region number of spots (upper), spot area (middle), and Mt. Wilson magnetic class (lower). In each panel, the black curve shows smoothed sunspot number. Note, each property distribution over time shows percentage occurrence of that property (i.e., same colour = same percent).

## Study C: Planetary Magnetosphere Variability

An initial investigation was performed into connections between substorms in Earth's magnetosphere and the solar sources of solar wind stream interaction regions.

This study can be implemented using a workflow and the HELIO propagation service to map leading edges of coronal hole fast solar wind streams out to 1 AU.



Two month comparison (January-February 2003) of HFC coronal hole detections (blue vertical lines) with westward electrojet index (green curve; an Earth magnetosphere substorm identifier), bulk solar wind speed (blue curve; on a reversed y-axis), and interplanetary magnetic field GSM z-component (turquoise curve; field magnitude parallel to Earth's magnetic axis). Coronal hole data were exported from HELIO SQL query as a CSV file to import into Substorm Zoo.