On geoeffective active regions
(poster)

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XIV Serbian-Bulgarian Astronomical Conference (XIV SBAC)
23rd – 27th September 2024, Vrnjačka Banja, Serbia

https://www.aob.rs/en/meetings/conferences/354-xiv-serbian-bulgarian-astronomical-conference

Active Region (AR):
"the totality of observable phenomena in a 3D volume represented by the extension of magnetic field from the photosphere to the corona. . ." [van Driel-Gesztelyi et al. 2015] including EM emissions and strong twisted magnetic field emergence

Geomagnetic Storm (GS):
major disturbances in the terrestrial atmosphere caused by the reconnection process between the incoming plasma ejecta in the solar wind and the planetary magnetosphere
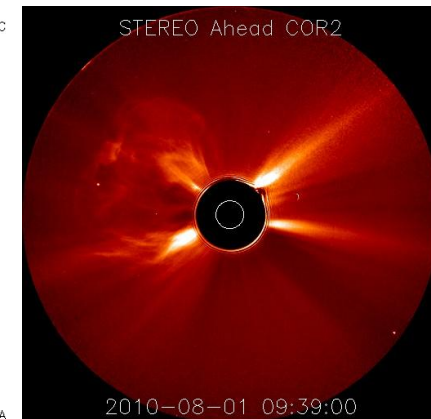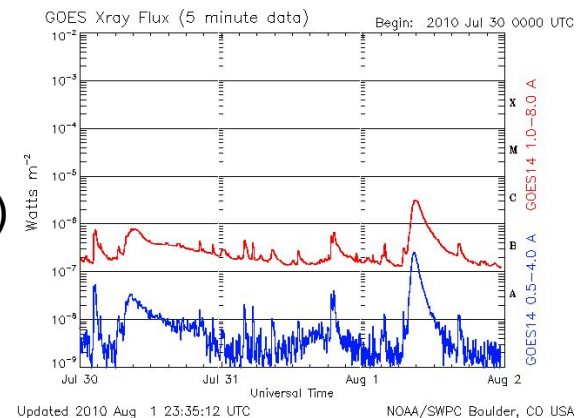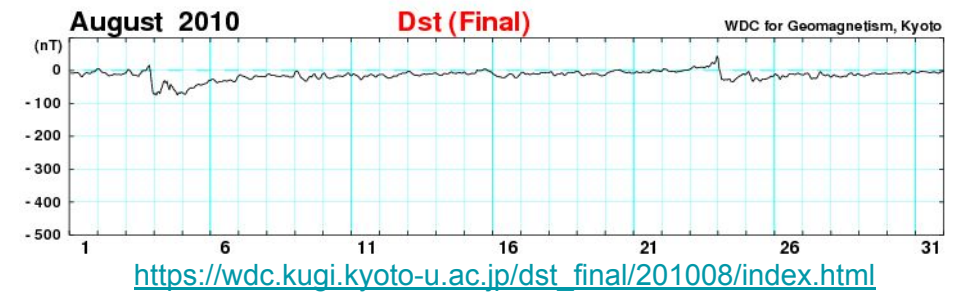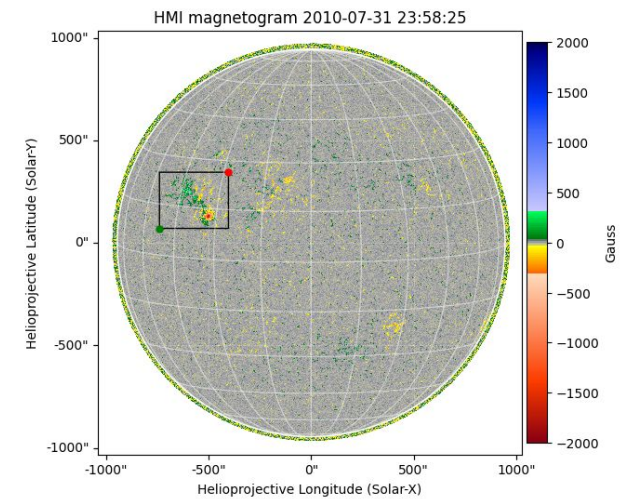
Aim:
to investigate the parameters of ARs leading to GSs (i.e. geoeffective ARs)

Novelty:
to investigate in detail the link between SHARP parameters (SDO/HMI instrument) and parameters of GSs (Dst index), SFs (class), and CMEs (speed & AW)

https://doi.org/10.3390/atmos15080930

https://astro.bas.bg/project-sun/

https://wdc.kugi.kyoto-u.ac.jp/dst_final/201008/index.html

https://solarmonitor.org/

https://cdaw.gsfc.nasa.gov/CME list/daily_movies/2010/08/01/

Methodology

Space-weather HMI Active Region Patch (SHARP) products:

http://jsoc.stanford.edu/doc/data/hmi/sharp/sharp.htm

- USFLUX: Total unsigned flux [Mx];
- MEANGAM: Mean inclination angle, γ [degrees];
- MEANGBT: Mean value of the total field gradient [G/Mm];
- MEANGBZ: Mean value of the vertical field gradient [G/Mm];
- MEANGBH: Mean value of the horizontal field gradient [G/Mm];
- MEANJZD: Mean vertical current density [mA/m^2];
- TOTUSJZ: Total unsigned vertical current [A];
- MEANALP: Mean twist parameter, α [1/Mm];
- MEANJZH: Mean current helicity [G^2/m];
- TOTUSJH: Total unsigned current helicity [G^2/m];
- ABSNJZH: Absolute value of the net current helicity [G^2/m];
- SAVNCPP: Sum of the absolute value of the net currents [A];
- MEANPOT: Mean photospheric excess magnetic energy density [Ergs/cm^3];
- TOTPOT: Total photospheric magnetic energy density [Ergs/cm^3];
- MEANSHR: Mean shear angle for B$_{total}$ [degrees];
- R$_{VALUE}$: Unsigned flux, R | [Mx].

SHARP data:
12 min cadence [Bobra et al. 2014]
R$_{value}$ [Schrijver 2007]
⇒ SHARP values taken prior to the SF onset

Event list:
64 events (2010-2023)

Correlation analyses:
- Pearson & Spearman coefficients, standard error
- Scatter plots

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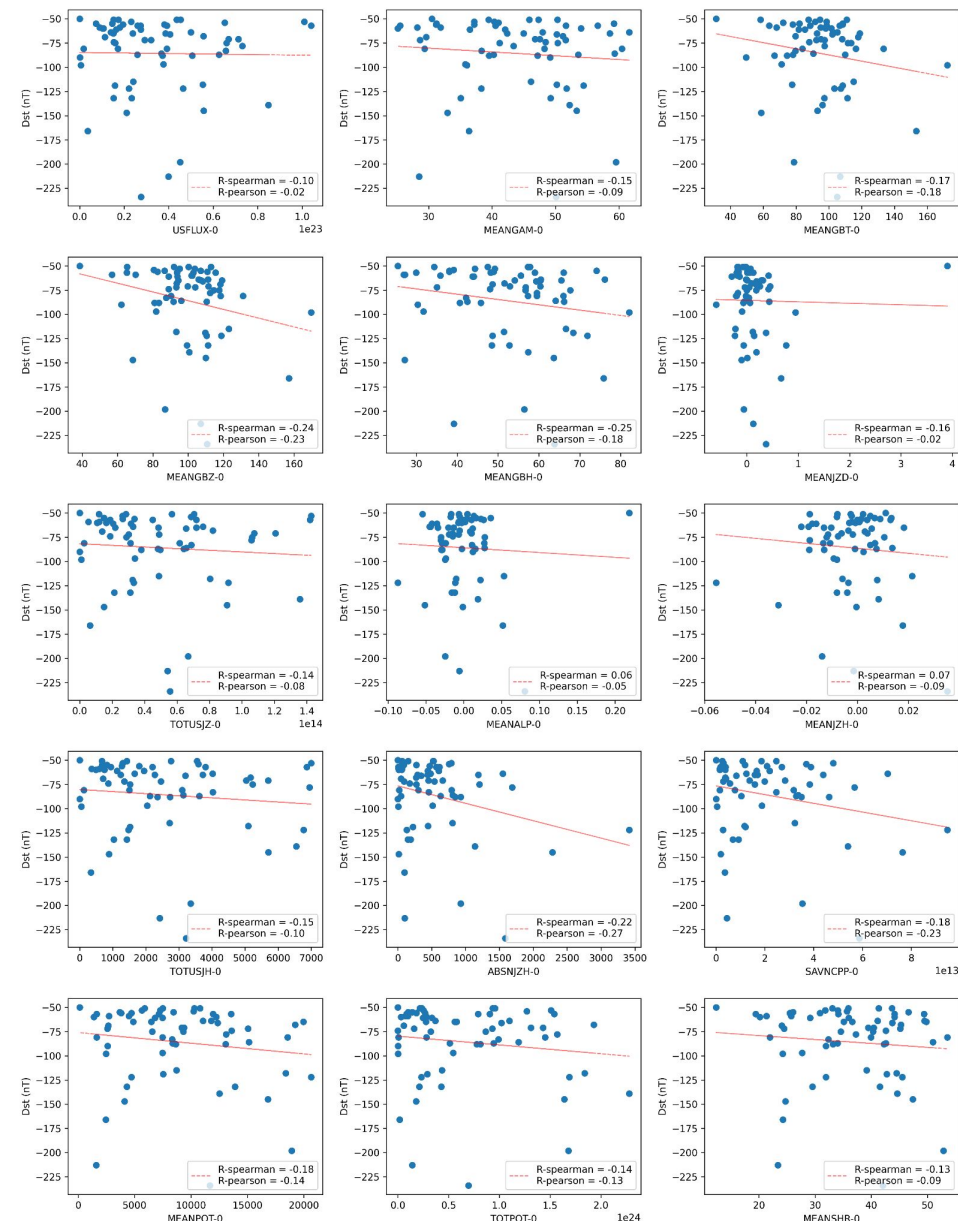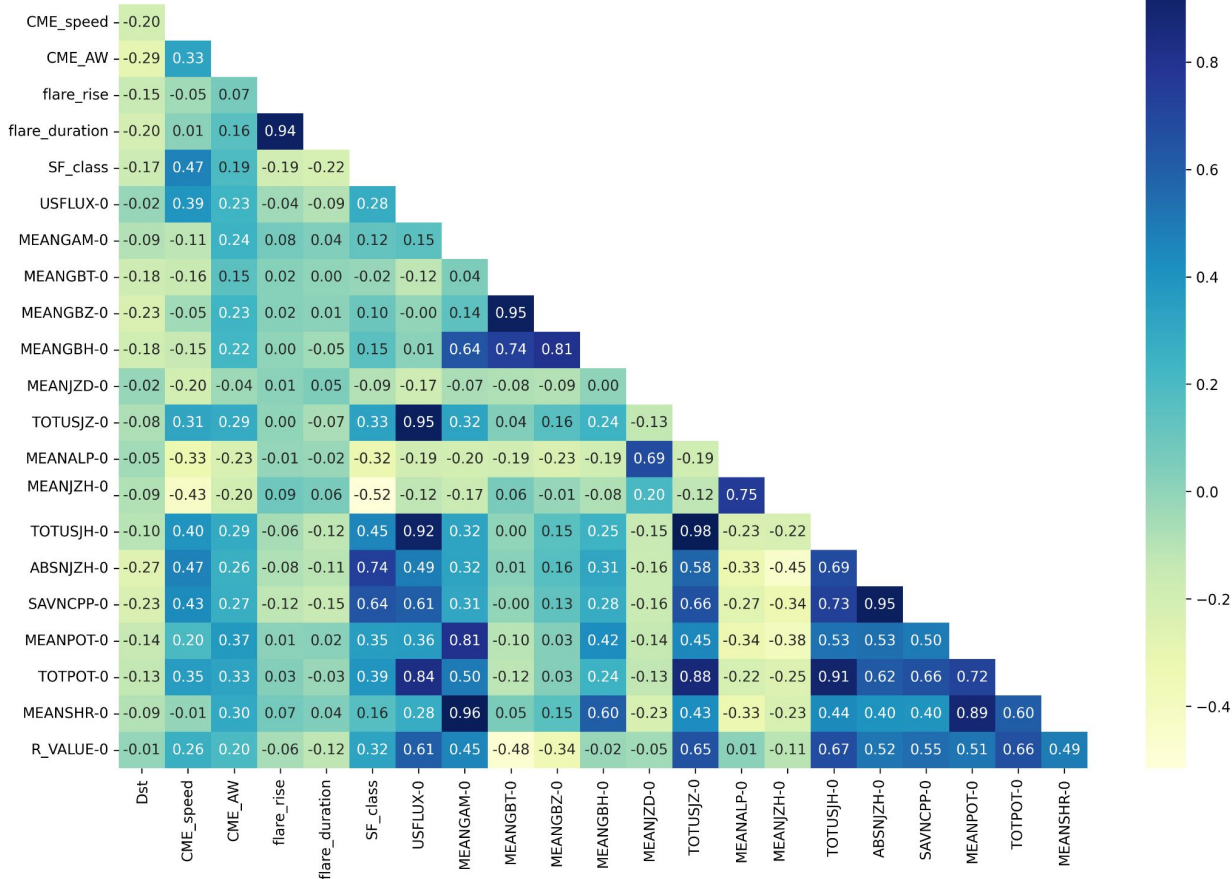
https://astro.bas.bg/project-sun/

Results

The parameters for the total flux, current, current
helicity, magnetic energy density, and shear angle show
moderate-to-strong correlations also with the SF class
and the CME parameters but not with the Dst index.

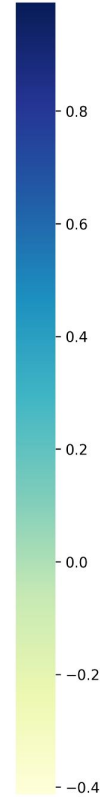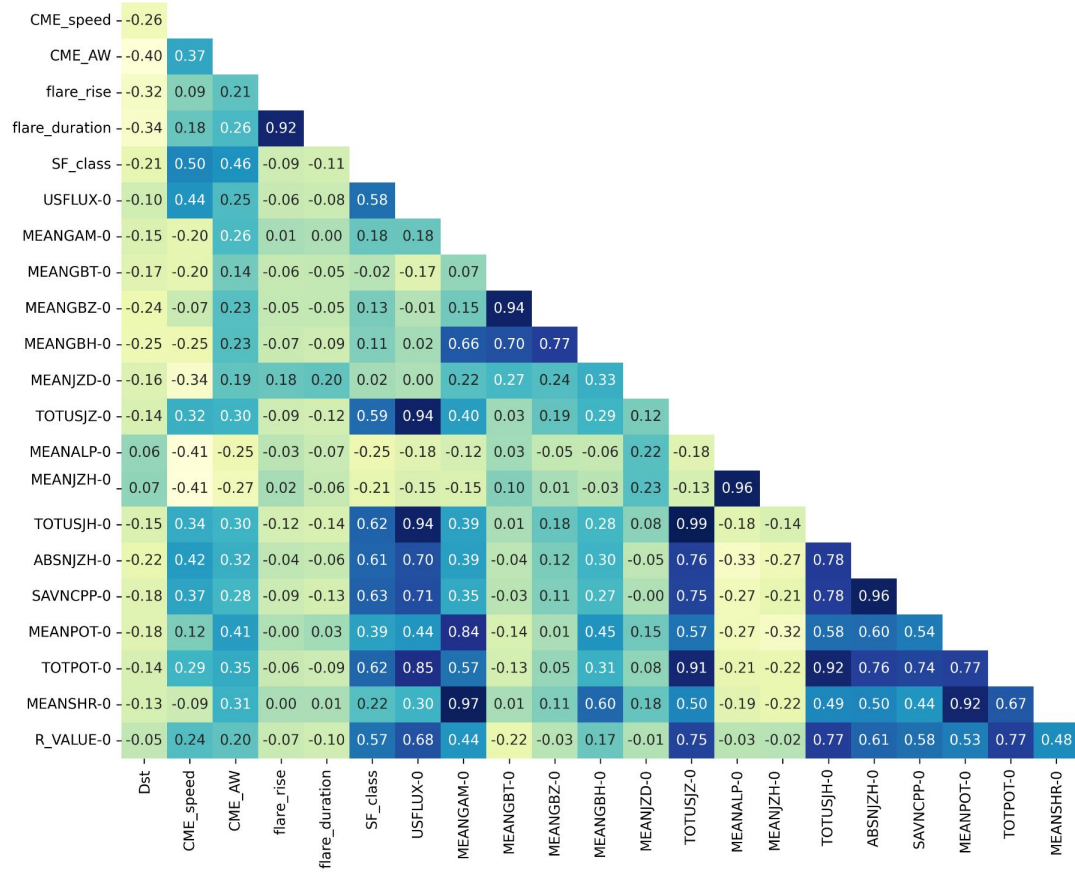corr_matrix_0: pearson correlation
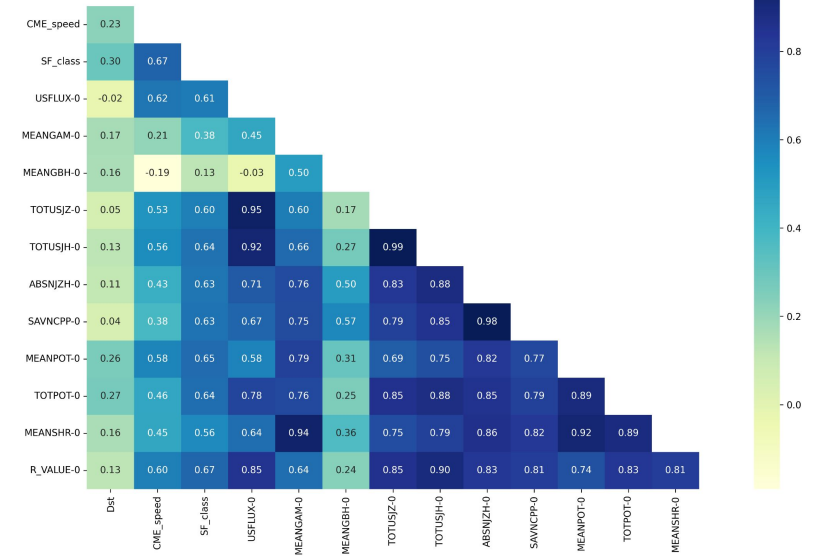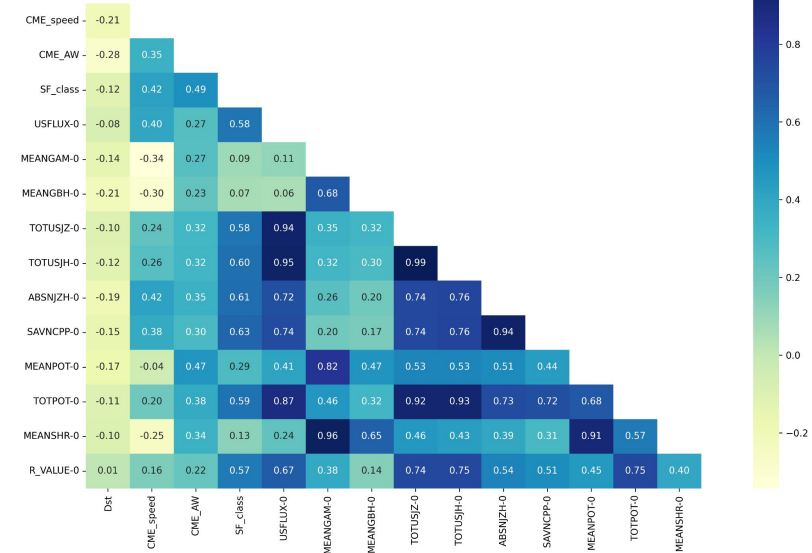
https://astro.bas.bg/project-sun/

Results

corr_matrix_0: spearman correlation

corr_matrix_0_strong: spearman correlation

corr_matrix_0_weak: spearman correlation

Full version for strong and weak GSs: online
https://astro.bas.bg/project-sun/EventList.php