

Introduction

- FLARECAST (Flare Likelihood And Region Eruption foreCASTing)** is a European Union Horizon 2020 project that aims to develop an automated solar flare forecasting system with an unmatched accuracy.
- A central FLARECAST work packages is the implementation of both **existing and newly developed algorithms** that extract solar active-region (AR) properties showing a flare-forecasting capability (see Table 1).

Table 1. AR properties considered in FLARECAST

Data Source	Property Group
SWPC catalogues	Solar Region Summary (SRS) properties
	GOES soft X-ray flare events
Line-of-sight magnetograms	SMART-derived properties
	B_{eff} (effective connected magnetic field strength)
	Fractal and multifractal parameters
	Fourier and CWT power spectral indices
	Decay index
	Magnetic polarity inversion line properties
	3D magnetic null point
	Ising energy
	Magnetic helicity injection rate proxy
Vector magnetograms	SHARP properties
	Magnetic helicity injection rate
	Magnetic energy injection rate
	Non-neutralized currents
	Diverging/converging/shear flows
Intensity images	Flow field properties

- FLARECAST** will combine AR properties calculated from **SDO/HMI** data with state-of-the-art prediction algorithms.

AR Properties

Considered properties characterize different areas/aspects of the active region:

- Total MPIL length
- Schrijver's R

MPIL

- Ratio L/h_{\min} for L_{\max}

CORONA*

AR PHOTOSPHERE

- B_{eff}
- Ising energy
- Fourier power spectral index, α

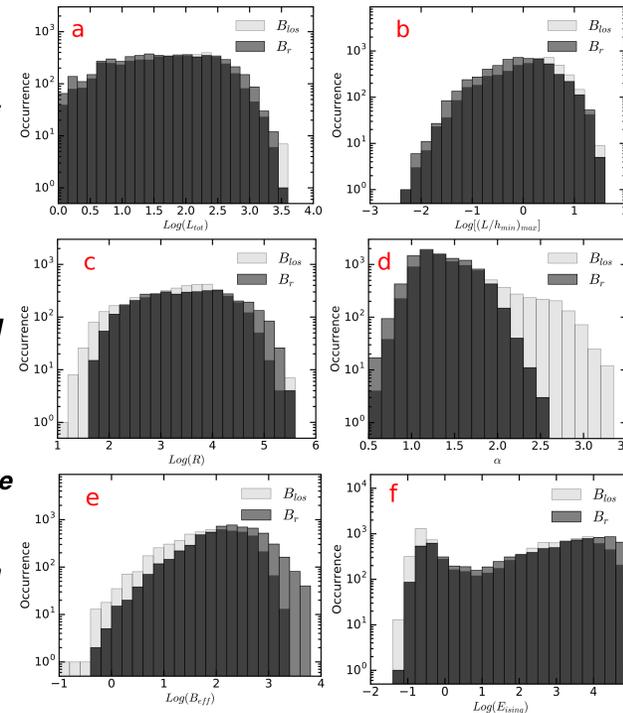
* By means of potential field extrapolation or photospheric proxies

L_{\max} = Longest MPIL
 h_{\min} = height for $n = n_c = 1.5$

B_{los} vs B_r

- Data sample: randomly-selected 25% of days between September 2012 and May 2016 @ 6-hr cadence (Total: 47,151 SDO/HMI SHARP CEA NRT files)
- Focus on B_{los}/B_r differences on computation of parameters:
 - Total length of MPILs, **b)** ratio of MPIL length to h_{\min} for longest MPIL segment, **c)** Schrijver's R value, **d)** Fourier spectral power index, **e)** Effective connected magnetic field strength, **f)** Ising energy.

Figure 2. Histograms of Active Region's properties. Note the differences between B_{los} and B_r derived distributions. Parameters **b, c, e, and f** for the B_r distribution are shifted to higher values in comparison to B_{los} .



- Differences between B_{los} - and B_r - derived distributions: minor (L_{tot} & $(L/h_{\min})_{\text{max}}$), intermediate (R , B_{eff} & E_{ising}), major (α).

Loc. Dependence

- Scatter plots (panels a,c,e): parameter(B_r) vs parameter(B_{los}) for $|\text{LON}| < 60^\circ$, $60^\circ < |\text{LON}| < 75^\circ$, $|\text{LON}| > 75^\circ$
- HG grid plots (panels b,d,f): parameter(B_r) - parameter(B_{los}) as function of LON and LAT.

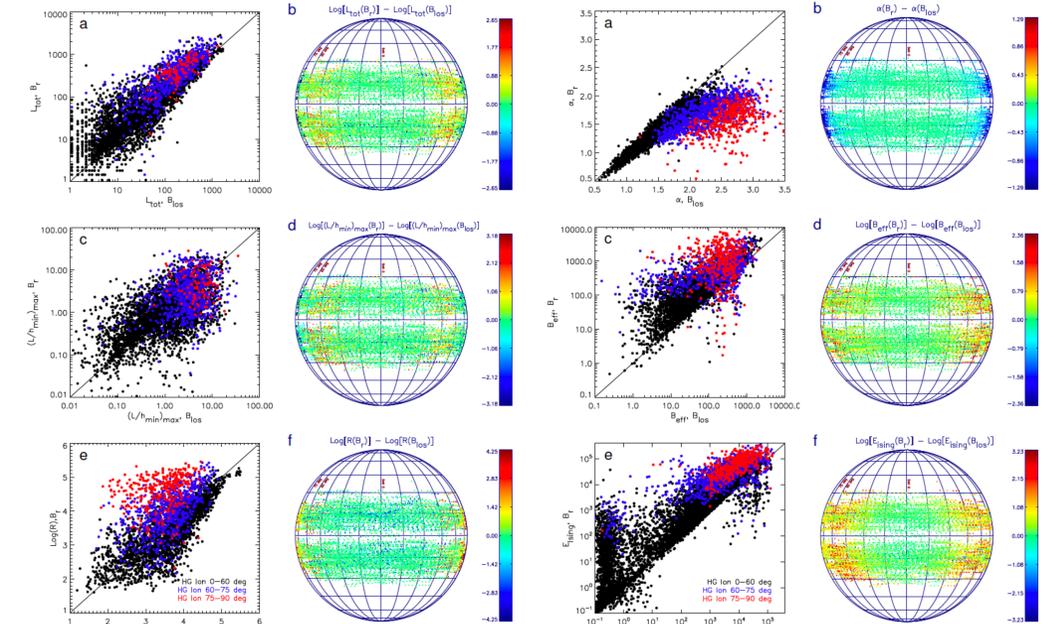


Figure 3. Scatter and HG grid plots for: L_{tot} , $(L/h_{\min})_{\text{max}}$, $\text{Log}(R)$.

Figure 4. Scatter and HG grid plots for: α , B_{eff} , E_{ising}

In panels b, d, and f (Figures 3 and 4): **Yellow-to-red** symbols represent parameter(B_r) > parameter(B_{los}). **Green-to-blue** symbols represent parameter(B_r) < parameter(B_{los})

- Most parameters show a power-law relation between B_r and B_{los} with different levels of scatter.
- Parameters α & R seem more sensitive to AR location in choice of B_r or B_{los} .
- Biggest differences seen for $|\text{LON}| > 45^\circ$. For $|\text{LON}| < 45^\circ$ B_{los} and B_r provide virtually no difference for all parameters.

Flare Association

- SHARP regions associated with GOES soft X-ray flares that subsequently occur from that SHARP field-of-view within the following 24 hr. Figure 5 shows the sample fractions of parameter values that produce flaring at C-class or above. Uncertainties correspond to Poisson error bars.

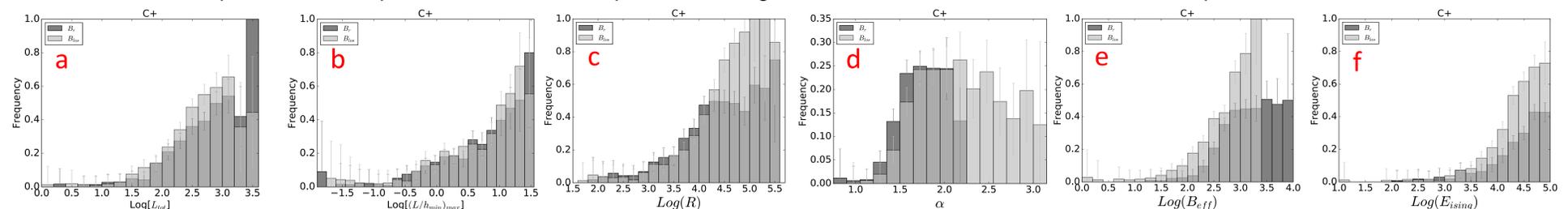


Figure 5. Flaring association for the calculated active region's properties. Most parameters calculated with B_{los} see more flares at lower values compared to B_r . Different flaring association implies properties from both components should be used. The advantage of using either B_{los} or B_r (when or where) will be determined by prediction methods.

References

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