

Joint Bulgarian-Austrian Investigations of Solar **Chromospheric and Coronal Activity**



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

Abstract: We present work carried out during the joint Bulgarian-Austrian research project on solar chromospheric and coronal activity. The aims of the project are to develop observing capability in Bulgaria to complement Austrian monitoring instruments, and to study chromospheric signatures of quiet sun and pre-eruptive active regions and multi-wavelength manifestation of solar eruptive phenomena, their morphology and kinematics. We have recently set up a narrow field of view solar imaging system at Belogradchik Astronomical Observatory, equipped with a DayStar Energy Rejection Filter (ERF) and a Hydrogen Alpha (Hα) Quantum filter, which is used to capture high-resolution images of solar prominences and sunspots, and is complementary to the Kanzelhohe Patrol Instrument (KPI). A recent study presents a quantitative comparison between confined, eruptive and all M-class solar flares over the last two solar cycles. The properties of the SFs, related radio bursts and the parent sunspots (Hale type and total area) were examined. We have recently developed hybrid (algorithmic and machine learning) models for automated segmentation of on-disk solar features (prominences and filaments) using Kanzelhöhe Observatory data. Here we showcase these and other results.



Project Aims

- 1. To set up a Bulgarian Chromospheric Telescope (BCT), and develop standardized solar observing methodology and products, complementary to the Kanzelhohe Patrol Instrument (KPI) by means of strong technical cooperation between the team members.
- 2. To carry out combined solar observations with the two instrument suites and external (freely available space-based) resources, in order to study chromospheric signatures of quiet sun and pre-eruptive active regions and multi-wavelength manifestation of solar eruptive phenomena, their morphology and kinematics.

Work Packages

Work Package #1

Technical support of NAO-Rozhen Chromosphere Telescope and observation campaigns with KSO facilities

- Task 1.1: Telescope installation
- Task 1.2: Data processing Task 1.3: Observation Campaign
- Task 1.4: Image enhancement

Work Package #2

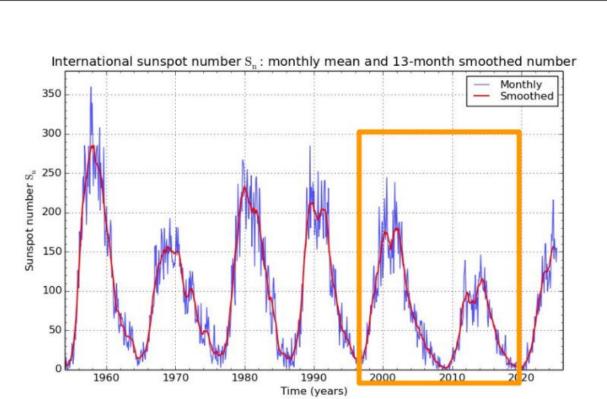
Joint investigations of solar chromospheric and coronal activity

- Task 2.1: Chromospheric Signatures of Quiet Sun and Pre-**Eruptive Configurations**
- Task 2.2: Multi-wavelength study of solar activity phenomena, their morphology and kinematics

Results II

- M-class: GOES soft X-ray (1-8 A) flux, 10^-5 to 10^-4 W/m^2 https://www.swpc.noaa.gov/products/goes-x-ray-flux
- Confined: no associated (parent) coronal mass ejection (no magnetized plasma eruptions) & no particle events
- Time coverage: 1997-2009 & 2010-2019 https://www.sidc.be/SILSO/monthlyssnplot
- Event sample: ~990
- Analyses: timings, location, sunspot type, radio burst (II & III type) associations

(e-poster)



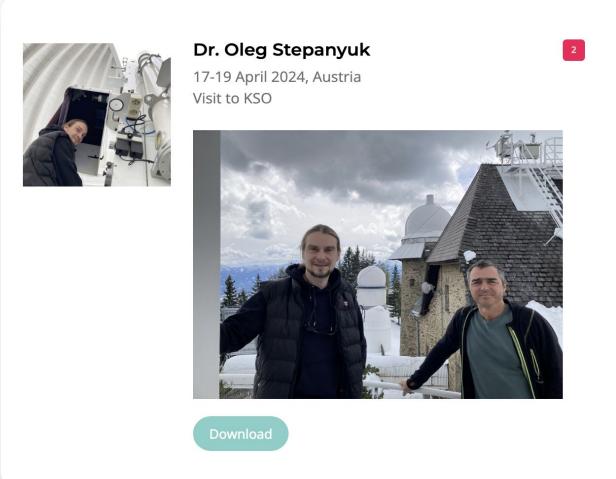
Confined vs. eruptive M-class flares in solar cycles 23 and 24

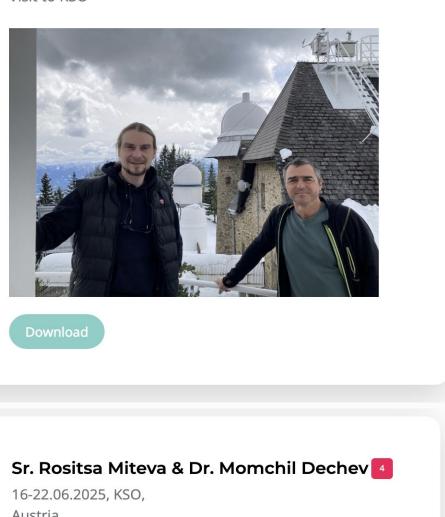
SILSO graphics (http://sidc.be/silso) Royal Observatory of Belgium 2025 March

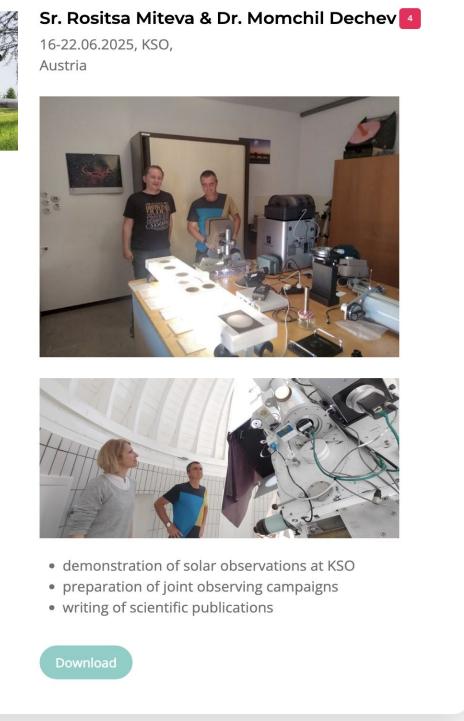
- Rositsa Miteva¹ and Werner Pötzi² sciences, 1784 Sofia, Bulgaria ² Institute of Physics, Kanzelhöhe Observatory for Solar and Environmental Research, iversity of Graz, 8010 Graz, Austria rmiteva@nao-rozhen.org (Submitted on 09.04.2025; Accepted on 25.04.2025)
- Abstract. This report presents a quantitative comparison between confined, eruptive and all (2177) M-class solar flares (SFs) over the last two solar cycles (SC) and separately in SC 23 and 24. The properties of the SFs, related radio bursts and the parent sunspots (Hale type and total area) are examined. The differences are presented and discussed in the framework Key words: solar flares: solar cycle; sunspot type

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Work Visits BG-AU

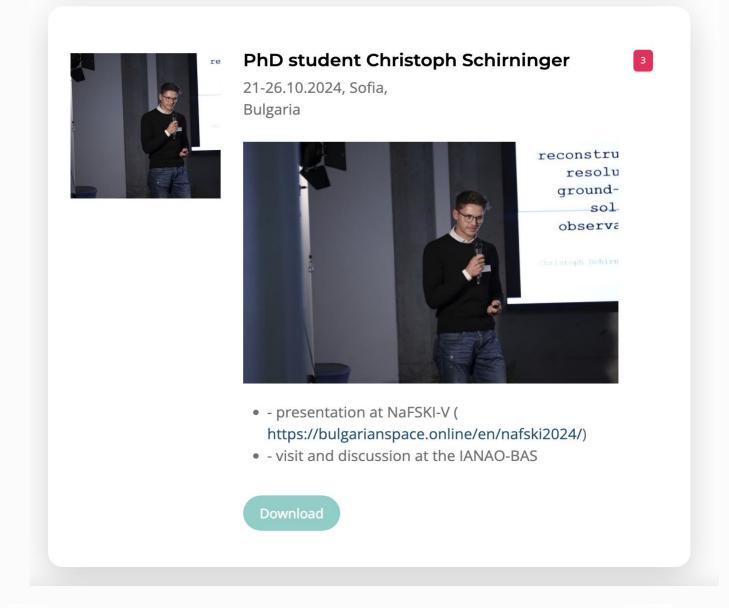






corr_matrix_0: spearman correlation

Figure 2. Spearman correlation coefficients between the SW and SHARP parameters.

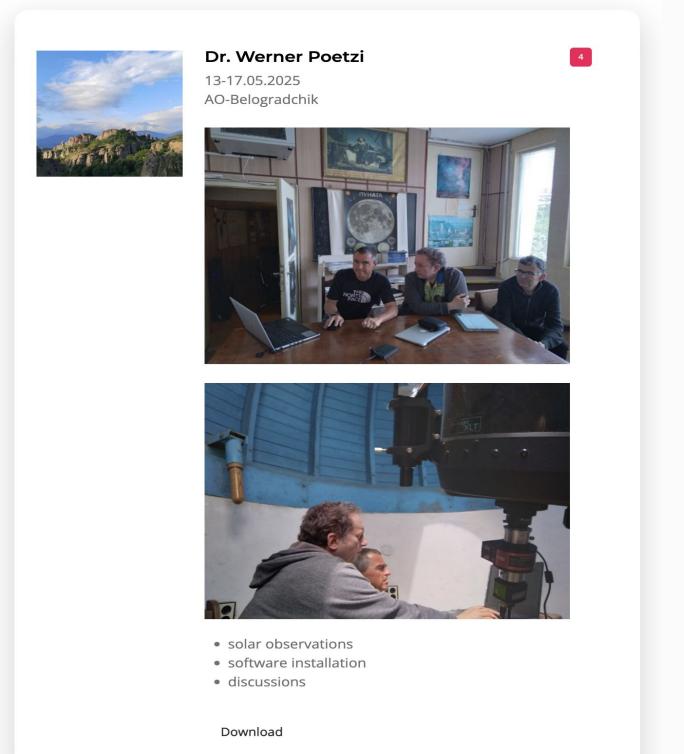


Work Package #3

Dissemination of the project results

Task 3.2: Scientific dissemination

• Task 3.1: Project web-site



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Abstract: Geomagnetic storms (GSs) are major disturbances in the terrestrial atmosphere caused by the reconnection process between the incoming plasma ejecta in the solar wind and the planetary

magnetosphere. The strongest GSs can lead to auroral displays even at lower latitudes, and cause both

satellite and ground-based infrastructure malfunctions. The early recognition of geoeffective events based on specific features on the solar photosphere is crucial for the development of early warning

systems. In this study, we explore 16 magnetic field parameters provided by the Space-weather

HMI Active Region Patch (SHARP) database from the SDO/HMI instrument. The analysis includes

64 active regions that produced strong GS during solar cycle (SC) 24 and the ongoing SC25. We present the statistical results between the SHARP and solar parameters, in terms of Pearson and

Keywords: active regions; geomagnetic storms; photospheric magnetic fields; solar flares; coronal

(Selected) SHARP parameters seem to be more

promising for exploring the (photospheric) link

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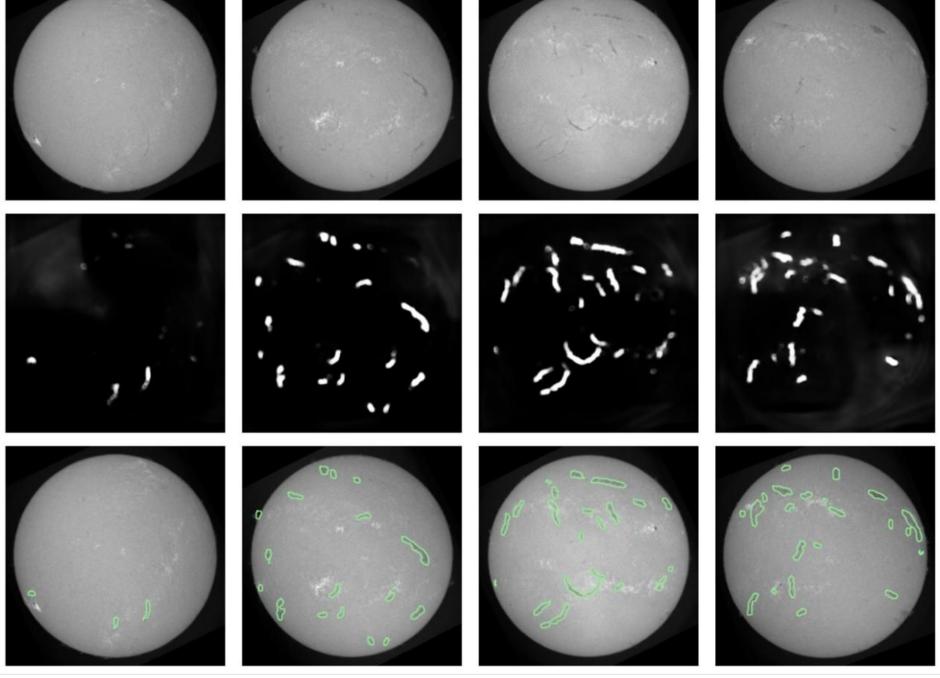
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Spearman correlation coefficients, and discuss their space weather potential.

to SFs and/or CMEs, not to GSs.

Results III

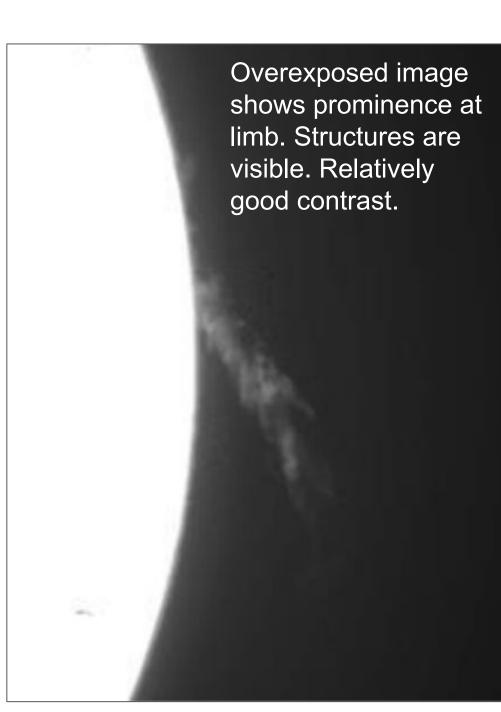
- Adopted our wavelet and data-driven image segmentation techniques for ground-based optical instrument data (K-Cor, Kanzelhöhe, Belogradchik, Rozhen data)
- Trained and optimized a U-Net ensemble of models for filament recognition and tracking
- Used Kanzelhöhe full-disk synoptic observations for training data
- Average IOU 0.76 on validation set
- Figure shows sample output masks (middle row) and overlays on observations (bottom row)



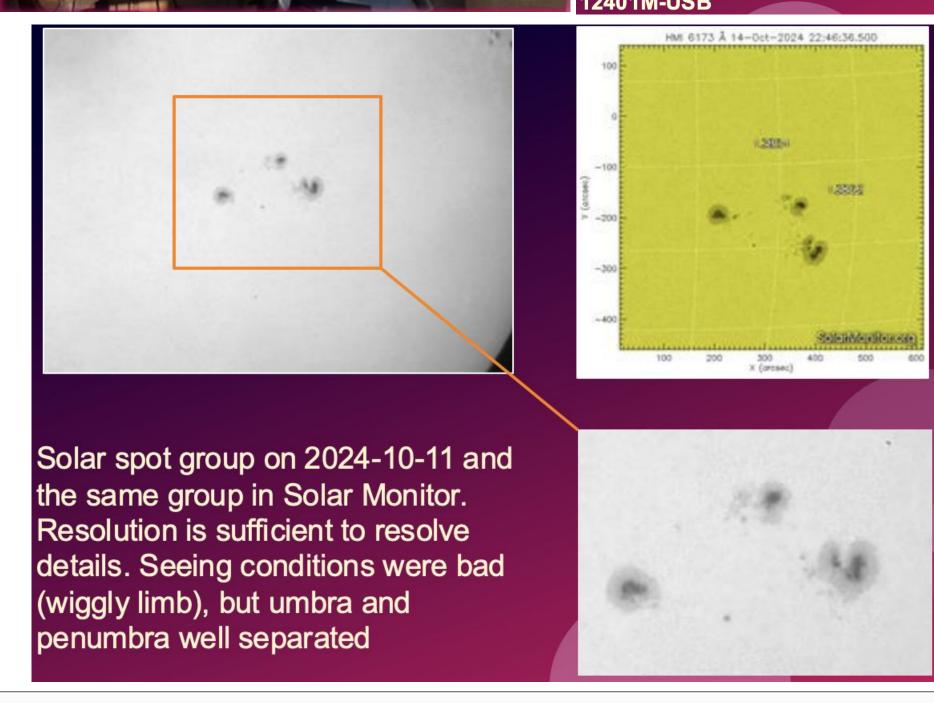
Stepanyuk et al., in prep.

Results IV

- Developed a new synoptic H-alpha imaging system at Belogradchik Observatory
- System currently in testing
- Initial results: successful observations of active regions and prominences
- Development of observational products for serving online







Acknowledgements

Results I

flare_duration - -0.34 0.18 0.26 0.92

MEANGAM-0 -- 0.15 -0.20 0.26 0.01 0.00 0.18 0.

MEANGBT-0 - -0.17 -0.20 0.14 -0.06 -0.05 -0.02 -0.17 0.07

MEANGBZ-0 --0.24 -0.07 0.23 -0.05 -0.05 0.13 -0.01 0.15 0.94

MEANGBH-0 - -0.25 -0.25 0.23 -0.07 -0.09 0.11 0.02 0.66 0.70 0

MEANJZD-0 - -0.16 -0.34 0.19 0.18 0.20 0.02 0.00 0.22 0.27 0.24 0

0.06 -0.41 -0.25 -0.03 -0.07 -0.25 -0.18 -0.12 0.03 -0.05 -0.06 0.22 -0.18

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atmosphere

Parameter Study of Geoeffective Active Regions

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References

MDPI

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