*Dynamics of Solar and Stellar Convection Zones and Atmospheres*
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# Chromosphere activity: relations with Solar cycles (SC)

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**Abstract.** The study's focus on the modulation of geomagnetism by low latitude solar magnetically activity, including coronal mass ejections (CMEs), solar flares, and solar energetic particles (SEPs). It mentions the Babcock–Leighton (B-L) dynamo model used to predict sunspot numbers in Solar Cycle 25 (SC25) and highlights the challenges in understanding aspects such as the regeneration of the poloidal field and the occurrence of magnetic regions, active longitudes, and coronal holes. The abstract introduces the study's concentration on the activity of polar regions using chromosphere jets activity proxies and other parameters like polar faculae density and cool ejection events. It also mentions the observation of chromospheric prolateness during the minimum solar activity periods.

**Keywords.** chromosphere, solar cycle, activity, sunspot

## 1. Introduction

The solar activity through the sunspot number (SN) modulates geomagnetism, CMEs, flares, SEPs and associated disturbances. The prediction of the height of the forthcoming SC (expressed by the SN) is since 2019 the subject of many studies. They are mainly based on statistical and/or mathematical and/or Heuristic methods, taking parameters from the analysis of past cycles; they leaded to a predicted SC 25 similar to the low height preceding SC 24, sometimes significantly lower, indeed. Some predictions uses solar activity parameters justified by the solid belief that the solar activity is fully governed by a dynamo mechanism occurring inside the Sun (Filippov and Koutchmy 2002; Filippov et al. 2007; Koutchmy et al. 2022b,a; Siebert et al. 2021; Kosovichev et al. 2020).

## 2. data analysis

The images were obtained from 2010 to 2022, for 13 years data from the area above the coronal holes in the north pole of the Sun, from the release of 304 A due to the Helium 2 resonance line formed at about 50,000 K, taken by the EE telescope (Solar Atmospheric Imaging Collection)(approx. 2340 data). The cadence between frames is 12 seconds (images every minute), in FITS protocol. After obtaining and summing the images on the disk, we attended them using MATLAB software, then we compressed the areas above the coronal holes in the South and North Poles regions to the extent of one column (see Figure 1). The graphs related to these data were plotted (15 data on the 15th day of every month) and measured the width at half the height of the maximum exactly at the first maximum. We recorded them as the width of the chromosphere at this point of the poles of the Sun. This thickness actually shows the width of the area above the

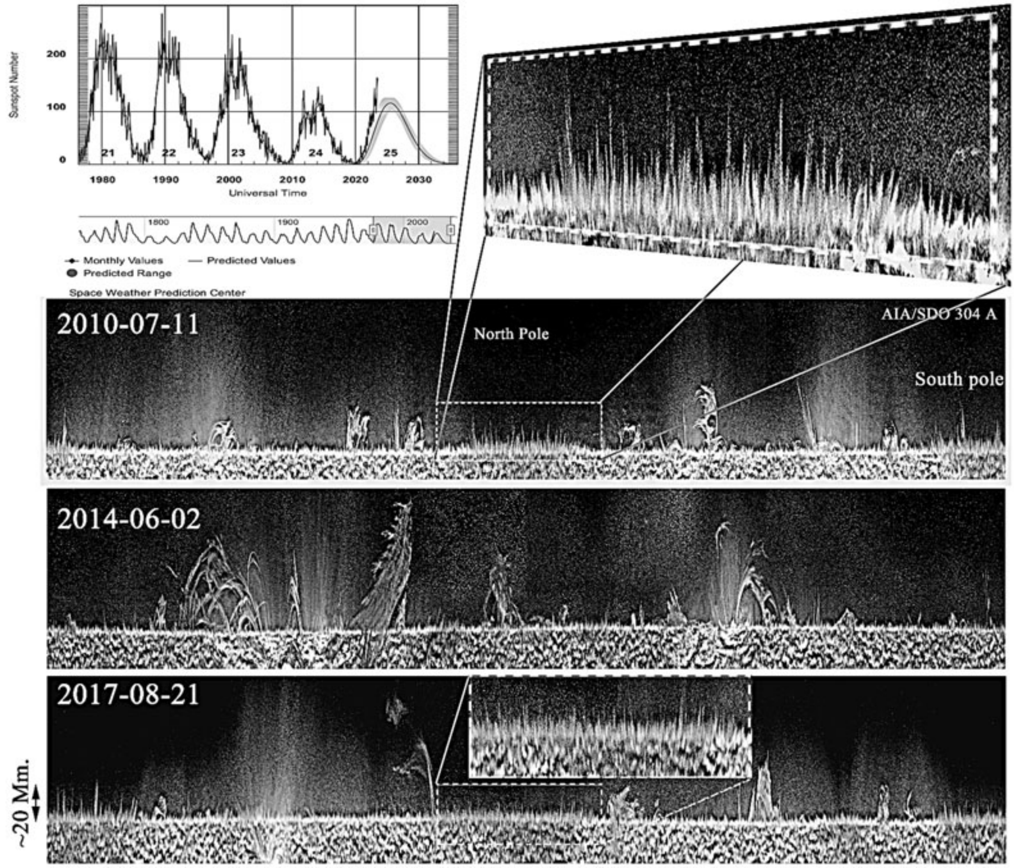


**Figure 1.** Partial frames in R-Theta coordinate, extracted image of a typical three polar regions at time of minimum and maximum activity (2010 minimum, 2014 maximum and 2017 minimum) to demonstrate the "abnormal" thickness of the 304 emissions (due to the HeII resonance line formed around 80 000K). Such extensions were measured during more than a full solar cycle (24th) in both the South and the North regions (fig. 2). Extensions are believed to be due to many ejection events in nearly radial directions called macro-spicules, in contrast to spicules seen everywhere, including regions outside the coronal hole regions. AIA filtergrams of the NSO NASA mission were used after summing original frames for 10 min include 50 successive frames.

coronal cavity where the magnetic field lines and as a result plasma and coronal mass escape into the space, and by measuring and studying it, we can find out the extent of the sun's magnetic activity in that area.

## 3. Result

The study examined various proxies to assess the activity of polar regions in relation to Solar Cycle 25 (SC25). The density of polar faculae, evaluated from WL filtergrams of the SDO mission, showed a definite increase before SC25, contradicting the low amplitude predicted by the NASA Solar Cycle 25 Prediction Panel. Similarly, the number of cool ejection events observed in Halpha observations suggested that SC25 could reach higher levels compared to the panel's moderate prediction. These off-disk parameters provided more convincing evidence than classical on-disk observations. Additionally, the study noted the observation of chromospheric prolateness (ovalisation) in the years preceding the minimum solar activity, as seen in cool spectral lines like Halpha and the H and K

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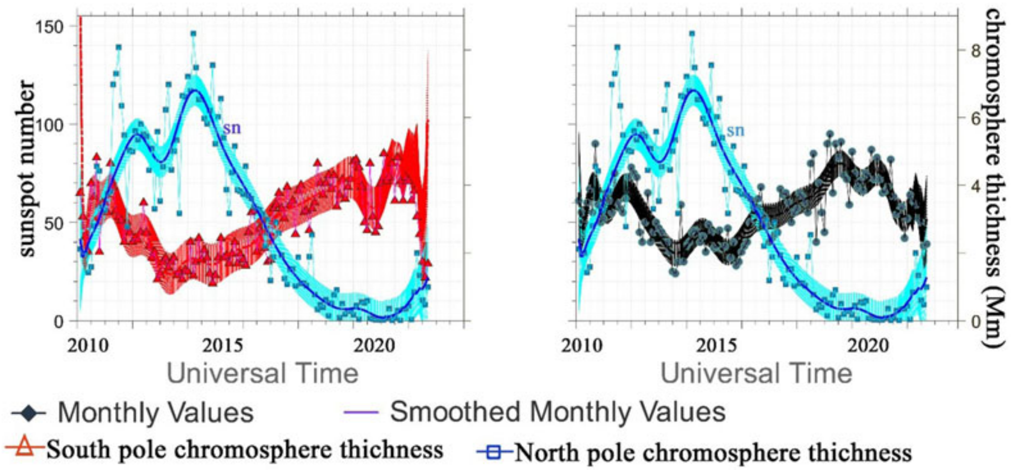


**Figure 2.** The results of measuring the FWHM of the 304 A shell for the last SC24. Again in both hemisphere we recorded a more important activity reflected by the FWHM thickness of the 304 A shell before the SC25 compared to the level recorded before the SC24. Apparent "thicknesses" Variations of the transition region polar regions shells as measured using the 304 emissions (He II) from AIA/SDO. Both the North (N) in red and the South (S) in black poles are showing an extended shell of macro-spicules activity at Years of the solar minima but during the last period around 2019, an enhanced activity is recorded suggesting that the next SC 25 will be high. In black line the "sn" during the same period of time.

lines of CaII. The prolateness was observed in full disk images and indicated a north-south elongation of the solar chromosphere during the minimum periods (figure 2).

## 4. Discussion

The study highlights the discrepancies between the predictions of the NASA Solar Cycle 25 Prediction Panel and the observations based on various proxies. The increase in the density of polar faculae and the number of cool ejection events suggest a higher level of solar activity for SC25 than initially predicted. The authors note that off-disk observations provide more reliable indications of solar activity than on-disk observations. The observation of chromospheric prolateness during the minimum solar activity periods raises interesting questions about the behavior of the solar chromosphere and its connection to solar cycles. The study suggests further investigation of this topic and plans to revisit the chromospheric prolateness near the time of solar minimum. Overall, the results and discussion highlight the complexity of predicting solar cycles and the importance of considering various proxies and observational techniques to gain a comprehensive understanding of solar activity.

## References

Filippov, B. & Koutchmy, S. L. 2002, About the prominence heating mechanisms during its eruptive phase. *Solar Physics*, 208, 283–295.

Filippov, B., Koutchmy, S. L., & Vilinga, J. 2007, On the dynamic nature of the prolate solar chromosphere: jet formation. *Astronomy and Astrophysics*, 464, 1119–1125.

Kosovichev, A., Strassmeier, S., & Jardine, M. 2020, Solar and stellar magnetic fields: Origins and manifestations. *Solar and Stellar Magnetic Fields: Origins and Manifestations*, 354.

Koutchmy, S., Filippov, B., Tavabi, E., Noëns, J., & Wurmser, O. 2022,a Acta astrophysica taurica. *Acta Astrophysica Taurica*,.

https://doi.org/10.1017/S1743921323004295 Published online by Cambridge University Press

Koutchmy, S. L., Filippov, B., Tavabi, E., Noens, J.-C., & Wurmser, O. Polar regions activity and the prediction of the height of the solar cycle 25 2022,b.

Siebert, A., Baillie, K., Lagadec, E., Lagarde, N., Malzac, J., Marquette, J., N'Diaye, M., Richard, J., & Venot, O. 2021, Sf2a-2021: Proceedings of the annual meeting of the french society of astronomy and astrophysics.