SF2A 2021
A. Siebert, K. Baillié, E. Lagadec, N. Lagarde, J. Malzac, J.-B. Marquette, M. N'Diaye, J. Richard, O. Venot (eds)

PREDICTING THE HEIGHT OF THE SOLAR CYCLE 25 THROUGH POLAR REGIONS ACTIVITY

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Abstract. We describe and discuss the reasons why we believe the forthcoming solar cycle (SC) 25 will be significantly higher than what was predicted by NASA in 2019.

Keywords: solar cycle prediction, cycle 25, polar regions activity, polar faculae, macro-spicules, polar mini ejections

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. The most popular dynamo model being the Babcock-Leighton model describing the transformation of a general dipolar field of the rotating Sun into a toroidal field through the differential rotation visualized near the surface. The regeneration of the dipolar field is another aspect of the model that is left not well understood. Several puzzling features like the M- regions, the active longitudes, the occurrence of long- live big single sunspots, the cyclonic and the widely distorted behavior of extended interacting active regions, the occurrence of Coronal Holes not predictable by dynamo effect, the polar regions cycles and/or recurrences, and finally the large dispersion of heights of SN cycles etc. are however the subject of hot debates. More important for practical obvious reasons is the prediction of the solar cyclesin advance Nandy (2021)

2 Observations, discussion and conclusion

It has been naively suggested (following the Ohl's law) that the Polar Regions activity, with the occurrence of recurrent geo-activity in the years around the solar minimum of SC n is rather correlated with the height of the n+1 SC. Accordingly the height of the following SC could be predicted; additionally, there is now a growing consensus on the key role of polar magnetic fields as seeds for the SC Makarov et al (1987).

We looked at the activity of Polar Regions using proxies: i/ density of polar faculae from visually evaluated HMI of SDO mission W-L filtergrams; ii/ numbers of cool ejection events from a 15 Years survey of the Pic du Midi CLIMSO $H\alpha$ observations Noëns et al. (2000); iii/ averaged extensions of the 304 shell in Polar Regions related to the polar CHs macro- spicules activity. Time variations of these 3 parameters qualitatively point to a SC 25 that could reach high levels, of order of 2 times the height of the SC 24, in contrast with the moderate height predicted by the SC 25 Prediction Panel of NASA and NOAA (Chair: Doug Biesacker). The reason of this discrepancy is not clear. We better wait the occurrence of the double maximum of SC 25 in 2025-26 to

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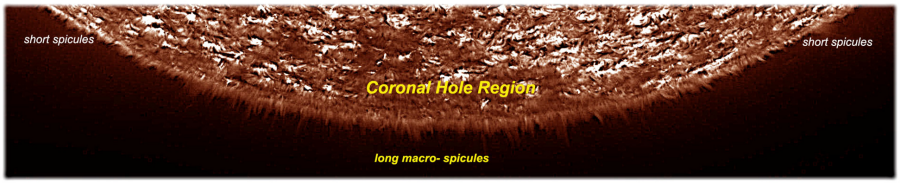

Fig. 1. Partial frame reconstructed image of a typical polar region at time of minimum activity to demonstrate the "abnormal" thickness of the 304 emissions (due to the HeII resonance line formed around 50 000K) in this polar region. Such extensions were measured during more than 1 solar cycle in both the South and the North regions. 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.

go further with the interpretetion. Another interesting parameter seemingly related to this topic is the definite observation of the chromospheric prolateness (ovalisation) in the Years of the minimum of 2018- 2020 that was discovered in the Years 1998- 2020 (before SC 23) and that was not well measured in 2010- 11 (before SC 24). In rather "cool" spectral lines, the smoothed upper edge of the solar chromosphere is prolate in the North-South direction at the epoch of minimum solar activity Filippov et al. (2000).

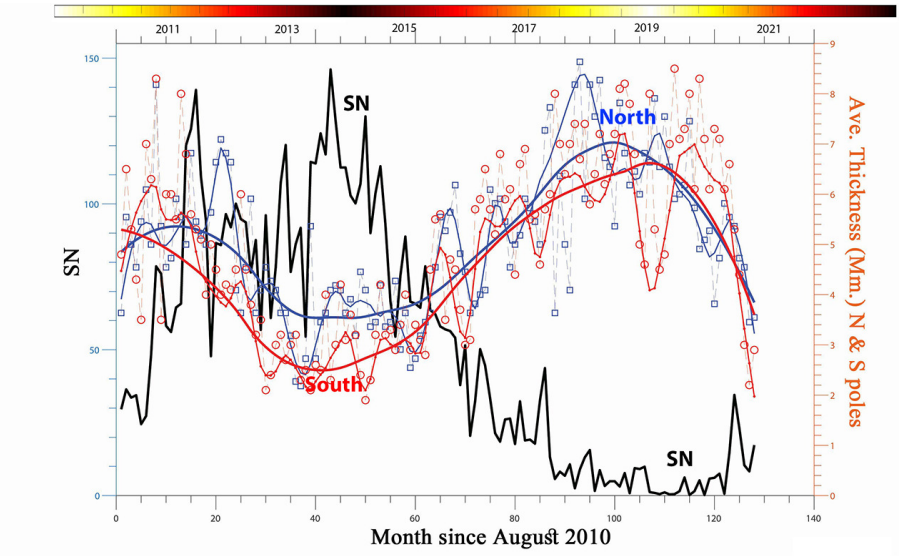

Fig. 2. Variations of the apparent "thicknesses" of the transition region polar regions shells as measured using the 304 emissions (He II) from AIA images of the SDO mission-NASA. Both the North (N) in blue and the South (S) in red poles are showing an extended shell ofmacro-spicules activity at Years 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.

Acknowledgements. We acknowledge the HMI and AIA/SDO mission of NASA consortium for the easy access of calibrated data.

References

Filippov, B. Koutchmy, S. Vilinga, J. (2000) Solar Phys. 196, 311- 320;(2007) Astron. Astrophys. 464, 1119
Noëns J.C., Wurmser O., 2000, Astrophysics and Space Science, 273, 17
Makarov, V.I., Leroy, J.L., Noëns, J.C., 1987, Soviet Astronomy, 31, 560
Nandy, D. (2021) Solar Phys., in press