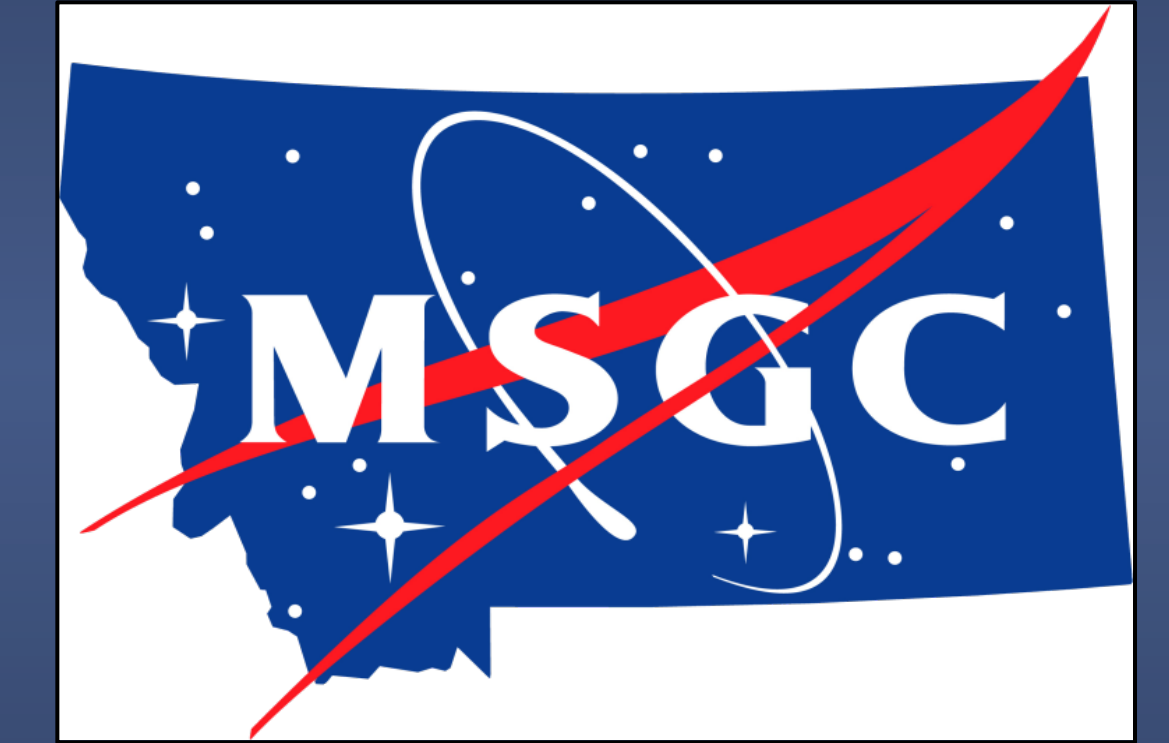




Findings from a Three Year Survey of Coronal Null Points

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Abstract

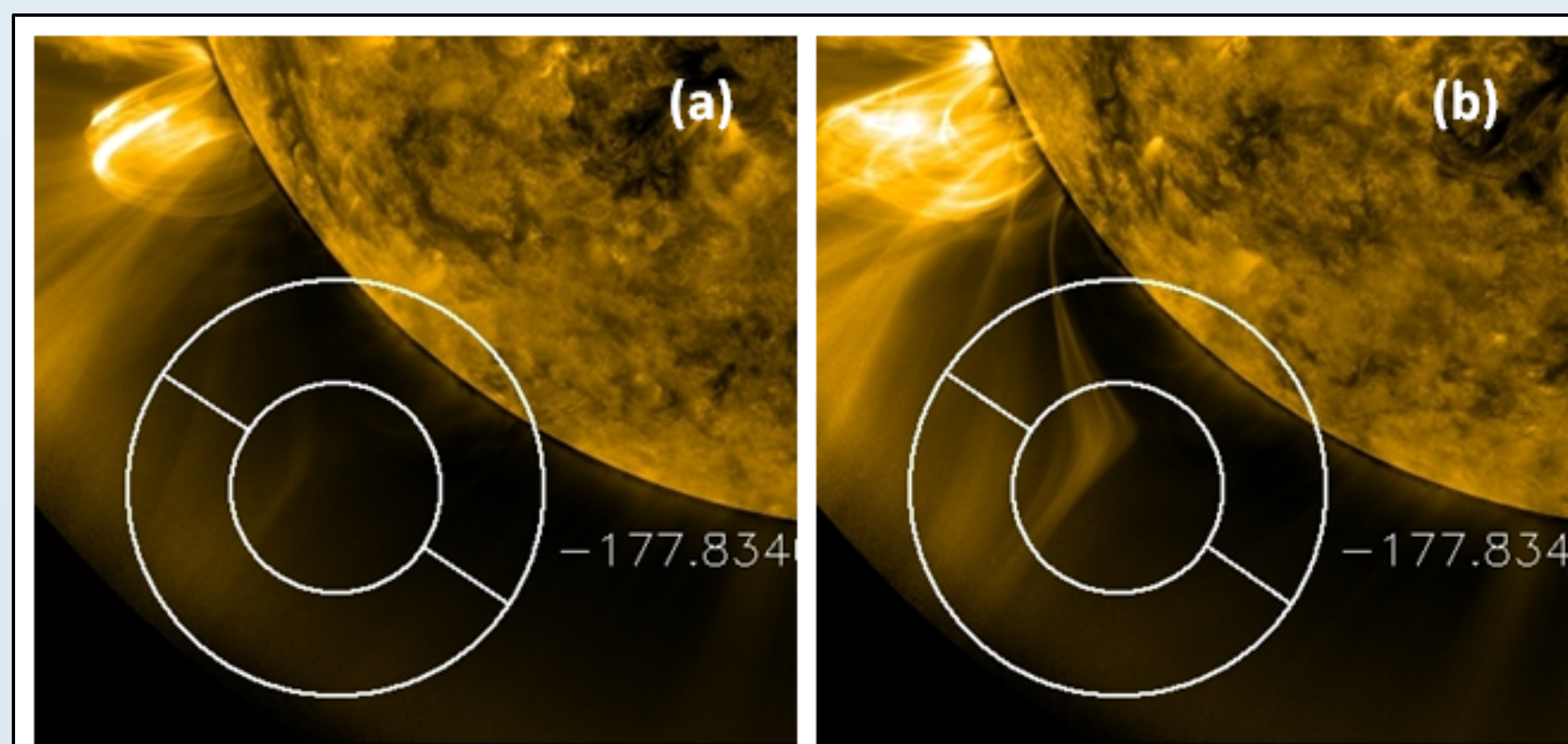
We report the findings from a comprehensive coronal null point (CNP) survey created by Potential Field Source Surface (PFSS) modeling & Solar Dynamics Observatory/Atmospheric Imaging Assembly (SDO/AIA) observations. The locations of magnetic null points in the corona were predicted from the PFSS model for Carrington Rotation 2098 to 2139 and manually compared to contrast enhanced SDO/AIA images in the 171 Å band. *Objective of this work is to determine the observability, lifetime, and distribution of CNPs.*

Background

From conception, magnetic reconnection models have predicted locations in the corona where the magnetic field vanishes [2][7]. The existence of such null points in the corona were first reported from observations taken by Yohkoh/SXT & SOHO/EIT [3], which indicated the presence of a “saddle” structure above an active region.

The generic magnetogram configuration of a CNP consist of an embedded bipolar active region underneath the CNP site [1]. Primary features associated with a CNP are the fan which forms a dome above the photosphere and the spine. The dome acts as a separatrix surface dividing the closed and open field lines. A fan with field lines diverging from CNPs are considered to be a positive null, while converging ones indicate a negative null point [5]. The spine consist of two field lines which terminate at the null point.

Fig. 1 – This shows a CNP which was classified as not observed on 2012/05/06T23:15 (a), but was clearly seen when investigated further with JHelioviewer at 2012/05/07T13:30 (b).



Methodology Overview

The PFSS model, using harmonic coefficients from Wilcox Solar Observatory, was used to establish the locations of CNPs in the SDO/AIA field of view. This was accomplished with the use of Greene’s 3-D bisection method [4] for finding regions containing nulls and then applying Newton’s Method to find their exact location. Next, we determined when the null point would cross either the east or west limb.

Once the CNP locations were determined, a thorough manual inspection was made, with SDO/AIA 171 Å, to find evidence of a CNP. A radial gradient filter was applied for contrast enhancing all the 171 Å images to expedite the visual inspection process [8].

Information regarding the spine orientation and the location of the predicted null (enclosed by region reflecting the spatial resolution of the PFSS model) are then added to each cataloged CNP image (see Fig. 3).

An additional check was made with the use of JHelioviewer to ensure that nulls were not missed due to any temporal uncertainty in the predicted crossing time, as shown in Fig. 1. Every CNP crossing was double checked by examining images +/-36 hours from the predicted crossing time at a 25 minute cadence.

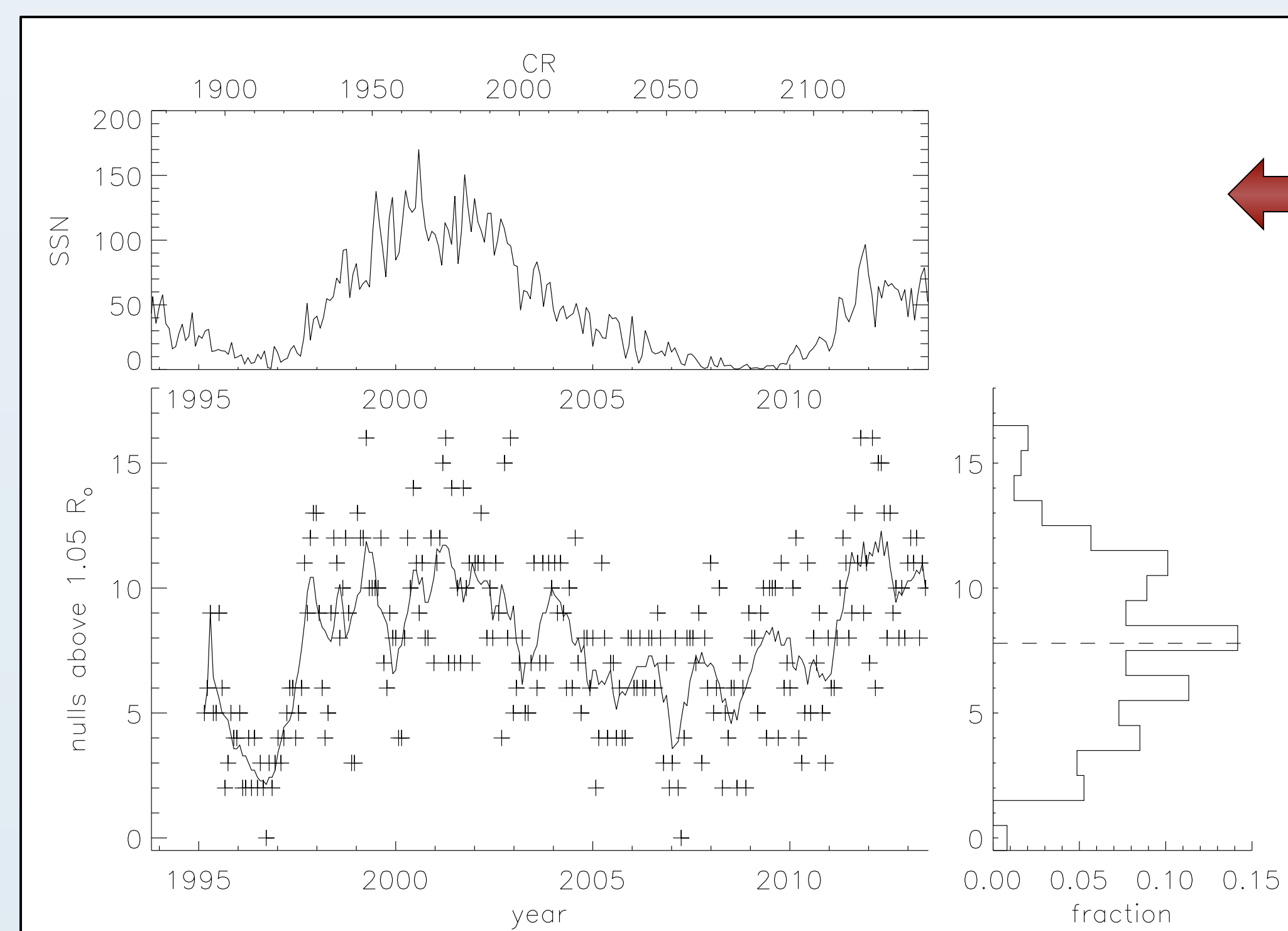


Fig. 2 – Examples of observed CNPs in the compiled catalog. (a) & (b) are examples of pseudo-streamers and (c)-(f) show helmet streamers. (c) & (d) also show a nice outline of a spine. (g) & (h) are examples of features described as “mono-streamers”. (f) & (g) illustrate how some observed CNPs might be open to interpretation.

Results

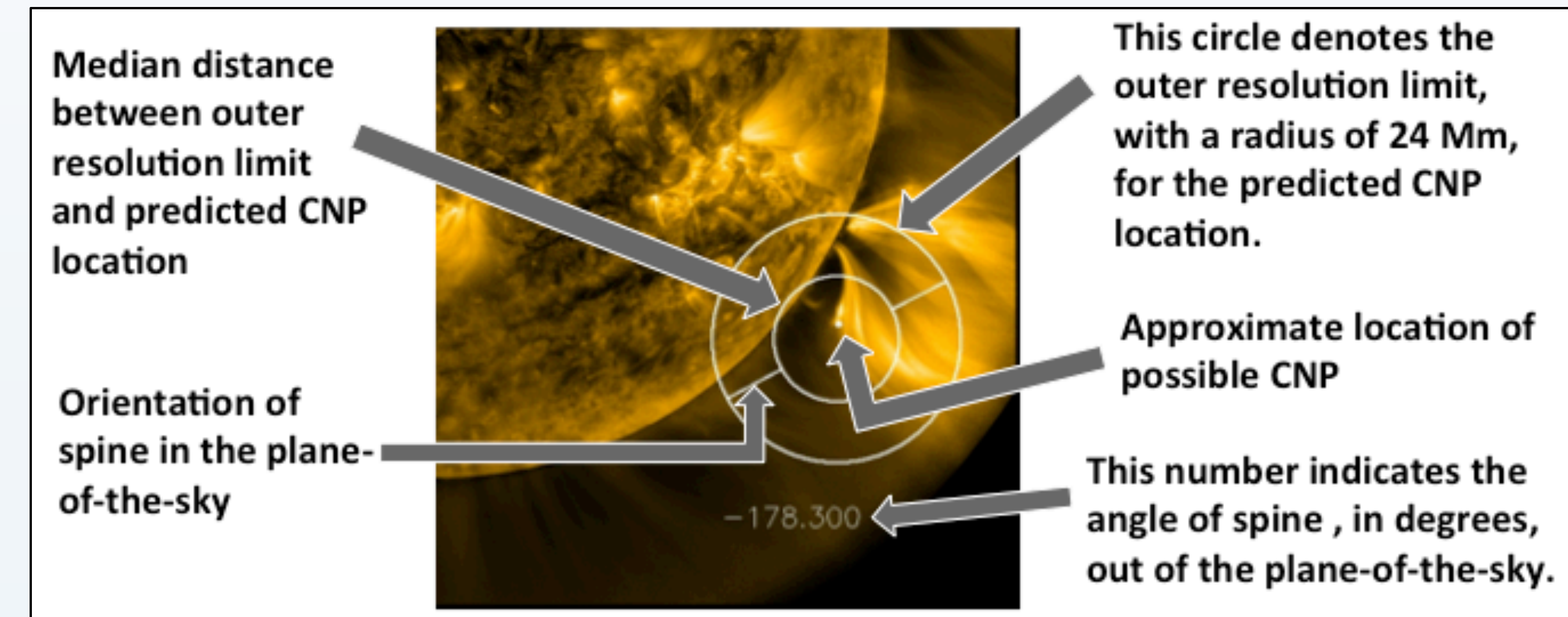


Fig. 3 – Error templates, like the one shown to left, were overlaid onto all of the contrast enhanced images in the CNP catalog.

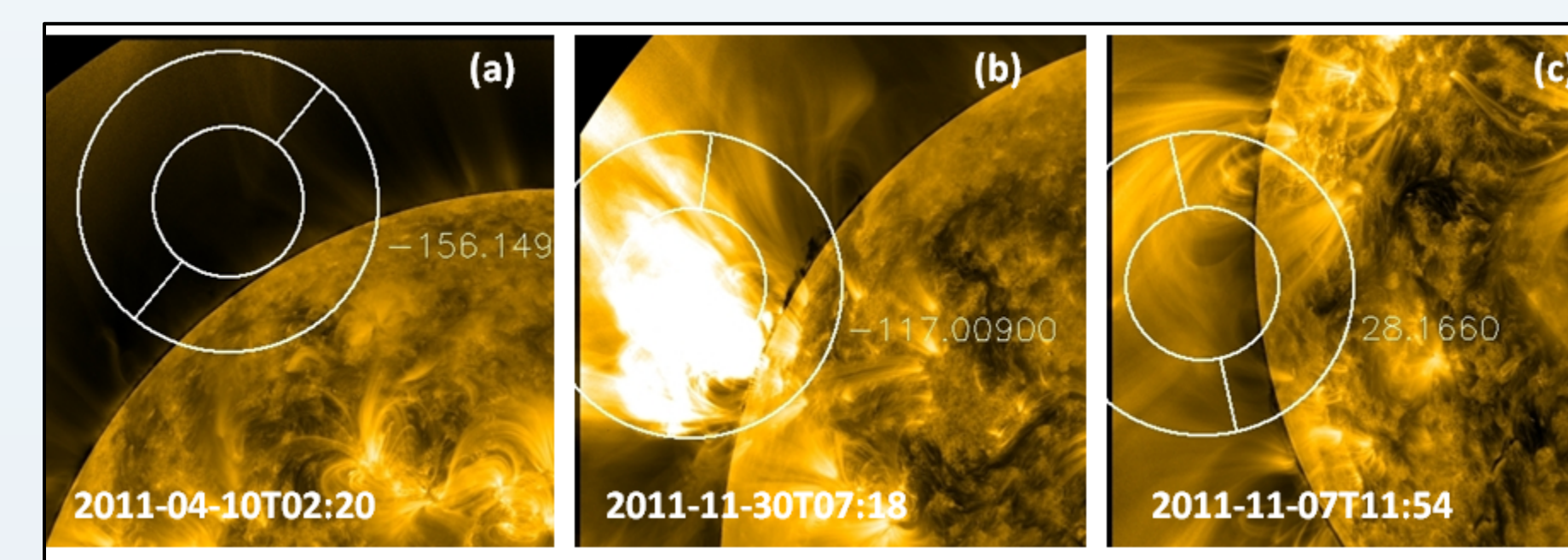


Fig. 4 – This shows some examples of CNPs which were classified as not observed at a predicted location as a result of (a) no emitting plasma, (b) image saturation, or (c) undistinguishable structure.

Fig. 5 – The distribution of predicted null points found in the PFSS fields vs. height. The solid curve shows the average number of null points, in a single Carrington rotation, above a given height. The lower axis shows height in Mm above the solar surface, while the upper axis shows the height in solar radii. The dash curve shows the distribution found in [6].

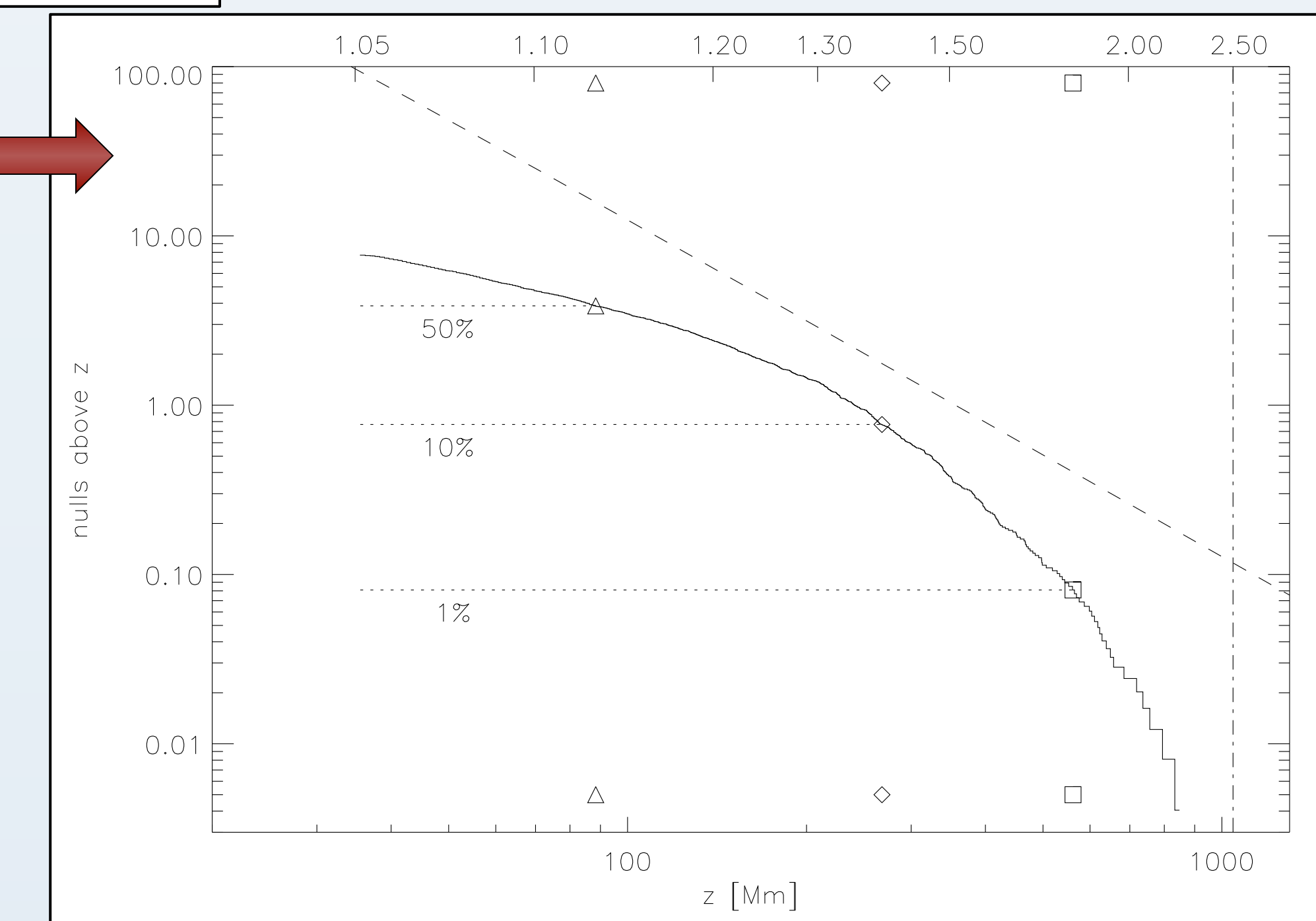
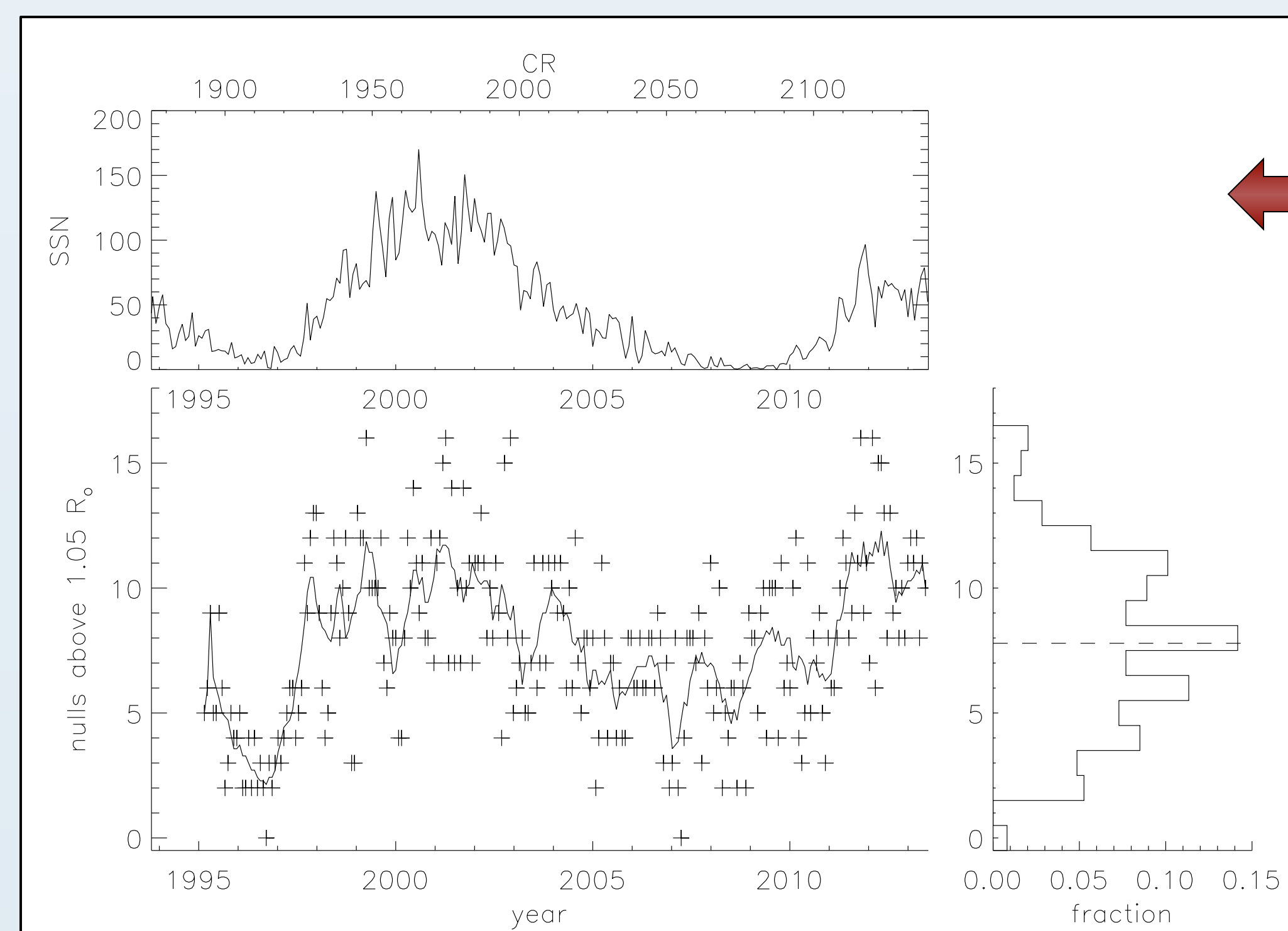


Fig. 6 – The distribution of predicted null points found in the PFSS fields vs. time. Plusses in the central panel show the number of null points in each rotation; the solid curve is a smoothed version. The right panel shows a histogram of the numbers in each rotation with the mean indicated with a horizontal dashed line. The International sunspot number is plotted along the top.



Conclusions

- An image catalog and a comprehensive list of results are available online
- 31% of the predicted nulls were found in the corresponding SDO/AIA images.
- An equatorial population of CNPs is present throughout the solar cycle.
- Over half of the observed CNPs last long enough to be visible at both limbs
- CNPs do not act as a reliable proxy for determining asymmetry in north and south hemisphere solar activity.
- Radial distribution of predicted CNPs from PFSS model agree reasonably with results found in Longcope and Parnell [6].
- The predicted crossing times were sufficient enough for determining the presences of CNPs, with an error in classification made 6.7% of the time.

For More Information

The coronal null point catalog can be found at:

http://solar.physics.montana.edu/mfreed/Null_point_research/Research_Null_Points.html

or



Contact Info:

I will be at my poster between 5:30 to 6:30 on June 4th.

Please feel free to text or email me if you have any questions or comments.

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References

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- [7] Sweet, P.A.: 1958, *Electromagnetic Phenomena in Cosmical Physics IAU Symposium 6*, 123.
- [8] Information on the IDL radial gradient filter used here can be found at <http://aia.cfa.harvard.edu/rfilter.shtml>