

Interactive comment on “Photospheric vortex flows close to the polarity inversion line of a fully emerged active region” by Jean C. Santos and Cristiano M. Wrasse

Anonymous Referee #2

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General comments

The article entitled "Photospheric vortex flows close to the polarity inversion line of a fully emerged active region" presents a new approach to evidence the occurrence of vortices in the magnetic flux fields in solar active regions. In the methodology presented, the occurrence of vortices is associated with the presence of critical points. And they are evidenced from the evolution of the component of the photospheric magnetic field in the line of sight in a region near the polarity inversion line (PIL) of a solar active region fully established, that is, that it was not in an emergency or evanescence stage. Both the original approach and the results (somehow expected) suggesting the

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turbulent nature of the flow around the polarity inversion line are interesting and, in my point of view, deserve to be shared through the publication of the article.

The manuscript, in general, is written well, the data and the methodology are clearly presented. Just like the results. Anyway, I highlight below some points and questions about the text, with the intention of trying to contribute to improve the article. Some comments are only suggestions, which authors should accept if they think they are appropriate.

Section 2 Data and Methodology

In this section, the choice of the active region NOAA 9289, located at the southern solar hemisphere, and the companions between December 31, 2000 and January 3, 2001, is cited. As the magnetogram (MDI) taken on January 2, 2001 and shown in figure 1, this region is located very close to the center of the Sun.

Questions: Does the methodology used necessarily require that the analyzed region to be close to the center of the solar disk, to avoid projection effects?

Does the positional variation of the active region during the 3.6 days whose evolution accompanied carry some implication of the determinations of the evolution of the magnetic field along the line of sight (BLOS)? In addition, it is mentioned that a range of 192 min. was considered for the BLOS data, in this time interval, the variations in flows and speeds may be significant for the establishment of the obtained vorticity patterns? What considerations, implications, approximations (if any) should be made in the case of an active region close to the solar limb, for example? The authors should comment on all this aspects.

Even if these aspects or requirements are not problems for application of the method, the authors could perhaps comment on this. If there is a limitation of time interval (days), considering the displacement of the active region to follow the evolution of the active region for evidence of vortices.

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In the beginning (first sentence) of page 4, the authors describe that at time $t = 1920$ min. begins to form a negative polarity region (N1), connected to the active region main negative polarity, and two small positive polarity regions, one northern of the negative polarity (P1) and other southern (P2). However, in the previous frame shown in figure 2 for $t = 1728$ min. (or even for $t = 1532$ min.) these same N1, P1 and P2 regions are already identifiable. My question: what criterion (visual only?) was used to identify these instants and stages (coalescence of polarity fragmentation and establishment / structuring of regions with well defined polarities) from the magnetogram images?

Page 7 Figure 3: Colors and symbols (asterisks) used, especially yellow, to show the location of the critical points (asterisks) (blue: Saddle Point, red: Attracting Node / Focus, yellow: Repelling Node / Focus) are small and difficult to see without magnification.

Section 2.1

I suggest using the same notation to denote the components x and y (x, y). In the equations and matrices they are typed in italics and in the text they are not.

In the last sentence of page 5, the authors state that "Critical points are the salient features of a flow pattern". This statement seems somewhat vague, must be better clarified (based on what consideration or criterion) or referenced.

Section results

Suggestion: Presented sequentially the figures 4 and 5 (top and bottom panels), according to the results they want to present. In the first paragraph of the section – results, the authors cite that they first investigated the fractal dimension of flowing 2D structures, the results of which appear only in the bottom panel of Figure 5. However, the authors cite the Figure 5 (velocity) before the Figure 4.

In my opinion, it might be more coherent to present the results sequentially. First the velocity values (figure 5 top), then the evolution of the regions which present velocity

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above that calculated from the velocities of figure 5 (figure 4). Finally, the fractal dimensions (Figure 5 bottom). For readers, it may not be clear which parameters were determined from which others. Maybe it separates them in 3 figures (4, 5 and 6).

They were select only the critical points classified as Attracting Focus, which represent vortices that converge to this particular point. Were identified any points scored as Repelling Focus? They represent vortices as well, but diverging. Can do these critical points also contribute to the nature of plasma turbulence?

And on the saddle points, in the conclusion the authors mention that they are the types of critical points more common. However, in the present work, they do not mention how many saddle points were detected and what they represent in this analysis of the dynamics of the plasma and the flux of the photospheric magnetic field. However, in the present work they do not mention how many saddle points was detected and what they represent in this analysis of the dynamics of the plasma and the flux of the photospheric magnetic field.

On the determination of velocities. Figure 5 (bottom) shows the velocity values. It may be noted that the error bars are large (on the order of $\sim 100\%$ (!).) Discuss the implications of these errors in identifying critical points and vorticity.

The values of the fractal dimension also have variations shown in Figure 5 (bottom). How to interpret these fluctuations in the fractal dimension during the evolution of the region around the PIL?

Figure 7 (page 11). Abbreviations of the critical points presented in the caption of figure 7 are not in the text. I suggest including it in the caption.

Conclusions

The complex and turbulent nature of the configuration and evolution of the photosphere magnetic field associated with the active regions is relatively well established. The results presented in this paper, even if only for one case analyzed, reinforce this previous

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evidence in the case of the flow around the PIL. It is give emphasis to the innovative methodology presented.

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