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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

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Dear Referee,

thank you very much for your comments and questions, they certainly helped to improve the quality of the article. Below I have tried to answer most of your comments and questions.

Abstract: "Using this method. . ." this sentence is not in continuation with the earlier, confusing which method

Answer: The sentence was rewritten in the revised version of the manuscript.

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Discussion paper

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Section 2: cadence & resolution of the MDI B_LOS needs to be mentioned. It is related to the discussion of the LCT method employed on them.

Answer: The information about cadence & resolution of the MDI B_LOS was inserted in the revised version of the manuscript.

P.4, paragraph “To determine the velocity field. . .”, FLCT is a method is valid for the intensity based images. However, magnetic fields on the sun evolve according to the magnetic induction equation, so LCT is to be modified accounting the induction equation. You may refer to Schuck (2005) for the differential affine velocity estimator (DAVE) technique. However, I would suggest to check the detection of the same critical points in the flow patters derived from DAVE. I am sure that the flow patterns of vortical nature would exhibit enhanced curvature with DAVE. This needs to be properly discussed. Also please mention the size of the apodising window used.

Answer: LCT/FLCT is the easiest method to implement and requires only the information about the temporal evolution of the LOS component of the magnetic field. This was the main reasons the method was used to obtain the horizontal velocity. In the revised version of the manuscript we discuss the weakness of the LCT/FLCT method and the corrections suggested by different methods available (ILCT/MEF/DAVE). The information about the size of the apodizing window is already mentioned in the revised version of the manuscript.

I have some issue with the cadence of the B_los used. A cadence of 192minutes is too high to track flow velocity and you would loss the vortical patterns. Assuming a 0.5 km/s velocity, in 192 minutes, the motion is around 8 arcsec. Then the critical points found with the velocity field in hand are of major concern. How about using HMI

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magnetograms at a higher cadence ?

Answer: The reason we have used MDI data is that we wanted to investigate a fully emerged active region that presented rotation in at least one of the main polarities to cause shear in the PIL. The selected active region has been already described in Zhu 2012 and presented those characteristics. We have used 96 min full disk MDI data and have applied LCT/FLCT to cadences 96, 192, 288, . . . The selected cadence presented the best result in terms of velocity field obtained using LCT/FLCT and vortex detection.

P.7, I would suggest to write a brief description on the box-counting method. How does it relates to the kolmogorov power law. This information is needed from a new reader perspective.

Answer: A description of the box-counting method and its relation to turbulence, with references, is presented in the revised version of the manuscript.

Regarding the critical points detection, I have a concern on the threshold of the magnetic field. Usually, the flow velocity is somewhat noisy in the weak-field regions, of course that is the key issue for the discussion of the turbulent nature of the plasma. Then the identified critical points, Figure 6, in the weak field regions especially in the PIL regions are subjective.Please provide a solid justification.

Answer: This is a difficulty associated to the analysis of the flow field around the polarity inversion line. The noise level of MDI full disk 96 min is about 7.6 gauss and the method for detection is sensitive to the velocity far from the location of the critical point. This give us some confidence that the critical points that are large enough and are captured at least in part in the motion of stronger magnetic field structures are actually there. However, there is no way to be 100% sure about the small vortexes detected in noise level magnetic field regions.

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p.7, “Since the fully developed turbulence consists of a hierarchy. . .”, it could be, but in the presence of the magnetic field, it can be quenched, then there is point to think why the vortices are found only at certain points. I mean to ask, what about the power law at the places other than critical points. Generally, turbulence is present every on the sun, then what kind of power is expected for example in some what magnetic field regions. Is the geometrical method used still applicable there?

Answer: Abramenko V. I. has investigated the multifractal nature of the magnetic field of active regions and studied the power spectrum of the magnetic field, showing that it presents turbulent characteristics (a linear region in the power spectrum with Kolmogorov type power law). The geometrical method is already used to study the multifractal nature of active regions and we plan to use it to further investigate the evolution of active regions under turbulent diffusion, after emergence.

Please also note the supplement to this comment:
https://www.ann-geophys-discuss.net/angeo-2019-33/angeo-2019-33-AC1-supplement.pdf

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