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3D dynamical structuring of a high latitude erupting prominence: I- Analysis of the cool plasma flows before the eruption

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Abstract. Both the origin of the quiescent prominences and their eruption related to CMEs are still a matter of extended studies. The small scale dynamic aspects like vortex structures and counter- flows are now seriously taken into account having in mind that the flows are a good proxy of the line of force of the omnipresent but rather unknown in detail force free or not magnetic field. Large scale vortex has been detected in a high latitude prominence observed on November 13- 14, 2011 before its eruption.

Keywords. prominence eruption, quiescent, flows, turbulence, counter- flows, vortices, tornado

1. Observations and data processing

A high latitude prominence was observed on November 13- 14, 2011 see Fig. 1 (left panels), using high resolution Hα fast imaging (60 fps; .5/px) refractor (diameter=100mm) equipped with a Coronado, to look at the fine scale structure and its dynamics. This hedgerow quiescent type prominence with many vertical flow lines, indeed erupted the following day (Koutchmy II in this issue). The filter bandwidth (.07 nm) is marginally sensitive to both transverse motions (Doppler-Fizeau effect) and optical thickness effects. Image processing was used to reconstruct images at a 15 s cadence with overlaps to remove seeing effects. Each reconstructed image is the consequent result of processing 1800 individual images resulting in a resolution significantly better than the SDO/AIA resolution achieved with the latest 304 filtergrams of 4Kpx size. The very high signal/noise ratio permits an analysis of proper motions inside the entire prominence keeping an excellent and homogeneous resolution (Fig. 1). The origins of vertical structures with elongated features moving up and down and vortices of different scales are considered.

2. Results

Using a Fourier local correlation tracking algorithm combined with the 3D analysis, our results demonstrate that prior to the prominence eruption, radial counter-flows with

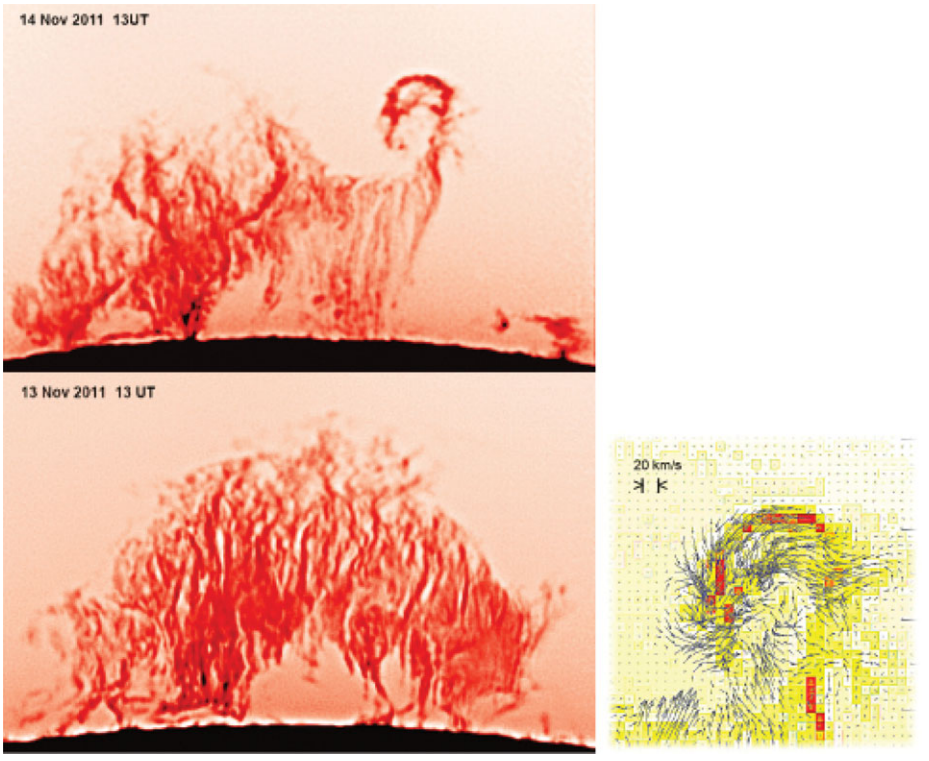

Figure 1. (*left panels*) Sample of a reconstructed negative image taken in Hα at 24 hours interval. (*right panel*) Instantaneous flow map computed using the LCT code from images taken 1 min apart at a time near the beginning of the sequence. The scale is given at top in a zoomed-in view of the part with a well developed vortex structure.

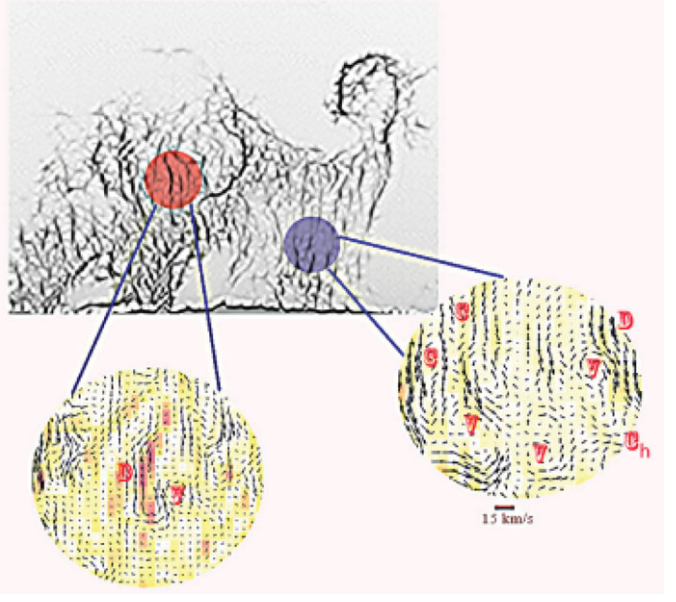

Figure 2. Zooming of the flow map to illustrate the occurrence of D- downflows; V- vortices; C- counterflows in vertical direction (Ch- in horizontal direction)

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vortices are observed in threads with a dominant downward motion of plasma blobs or plasmoids see Fig. 2. Many examples of vortices of different scales are evidenced. Down flows are clearly still dominant on Nov. 14 as shown by a histogram analysis. A typical large-scale vortex structure is analyzed in detail (see Fig. 1 right panel), showing a possible 3D behavior. A movie was provided as well as, for the first time, artificially produced stereograms to illustrate the 3D behavior. The Hα prominence is indeed insulated inside a complex coronal temperature structure showing strong vortex motion of chromospheric temperature plasma still suspended and confined by the magnetic field half a day prior to the eruption. The 3D coronal surrounding evidenced using the AIA images is impressive, including hot plasma in the bottom part.

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