Nature of Prominences and their role in Space Weather
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A Statistical Study on Characteristics of Disappearing Prominences

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Abstract. Real-time monitoring of filaments is essential for the prediction of their eruption and the ensuing coronal mass ejection (CME). We apply an automated algorithm for the detection and tracking of filaments in full-disc Hα images to obtain their physical attributes. This provides an accurate onset time of the eruption, and also allows us to study the physical characteristics of the erupting filaments in an objective manner.

Introduction

A disappearing prominence, most of the times, is associated with a coronal mass ejection (CME) (Gopalswamy *et al.* 2003). A CME, if directed towards the Earth and carrying a southward magnetic field, can lead to a geomagnetic storm that can cause considerable damage (Srivastava & Venkatakrishnan 2004). If one has to predict the onset of such CMEs, it is essential to monitor filaments seen on the solar disc. For this purpose, an automated algorithm has been developed for detection and tracking of filaments observed in full-disc Hα images (Joshi *et al.* 2010). The algorithm tracks the filaments through the full period of observation to generate their physical attributes such as size and length. In this paper we apply this algorithm to seven filament eruptions and observe their characteristics based on the attributes derived from the algorithm.

Data Selection and Analysis

For this study, we have used full-disc Hα images of the Sun for seven filament eruptions observed from different ground-based observatories. The algorithm is flexible enough to be used on any dataset with only a few minor modifications. On applying a median-based local threshold to the greyscale Hα images we get binary images wherein the filaments are identified as black features on a white disc. The grouping criterion is used to determine the number of filaments in each image, and also the number of fragments that a single filament is split into. Each filament is identified with a unique label in this step. Thereafter, we use labelling criterion which tracks the filaments over successive images, and maintains the labels consistently.

Results

The algorithm provides length and size of the filament, along with the number of fragments that each filament is broken into. Based on the area and length, we derive three more parameters, which are the average area and length before the eruption began, its percentage left behind after the eruption, and the duration of the eruption. This has

Date	Observatory	Area			Length		
		average (10^{-3} disc)	% after eruption	duration (min)	average ($R_\odot$)	% after eruption	duration (min)
20 Jul 2004	MLSO	1.87	44	93	0.38	48	102
28 Jul 2005	MLSO	0.54	14	83	0.03	15	60
19 May 2007	KSO	0.46	22	159	0.14	27	137
01 Aug 2010	KSO	1.03	52	270	0.19	78	201
08 Aug 2012	SMART	1.60	18	180	0.34	23	105
31 Aug 2012	GONG	1.47	10	38	0.33	9	34
19 Feb 2013	KSO	1.10	58	82	0.28	65	69

Table 1. Summary of the seven events analysed using the automated filament detection algorithm. The Hα images used are taken from Mauna Loa Solar Observatory (MLSO), Kanzelhöhe Solar Observatory (KSO), Solar Magnetic Activity Research Telescope (SMART), and Global Oscillation Network Group (GONG).

been summarised in Table 1. To maintain uniformity across different datasets, area is shown as a fraction of the area of solar disc, while the length is shown as a fraction of the solar radius, $R_\odot$. The start of eruption can be approximately determined from the time-lapse movies of Hα images. However, in this table, the start of eruption is chosen as the time when the filament area and length start to decrease from their average values, thereby providing an accurate value based on the attributes from the algorithm.

Summary

The automated filament detection and tracking algorithm was applied on seven filaments observed from different observatories. Qualitatively, we find that the changes in area and length of a filament are proportional. However, we observe that the quantitative measures, duration of eruption and percentage left behind after eruption, are unequal for area and length. It implies that while one parameter may undergo a certain degree of variation, the other may vary slightly differently. We also clearly see from the data that when an eruption/disappearance begins, the number of fragments increase, i.e. the filament breaks up into smaller parts. The breaking up indicates that the whole of the filament becomes unstable at the same time, and there is no preferential point at which the eruption starts. An increase in the number of fragments would prove to be very significant during real-time monitoring of filament.

We would like to extend this work to several more cases. The analysis would also include applying the algorithm to a day before the eruption, thereby allowing a comparison of attributes between a quiet and an eruptive filament. From this study, we would try to establish threshold criterion for the filament eruptions.

References

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