SF2A 2006
D. Barret, F. Casoli, T. Contini, G. Lagache, A. Lecavelier, and L. Pagani (eds)

MAGNETIC SOURCES OF FLARES AND CMES IN OCTOBER 2003

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Abstract. We present the data analysis of an observing campaign on October 2003 with the objective of understanding the onset of Coronal Mass Ejections (CME) and solar flares. The magnetic field was observed with THEMIS and MDI, the chromosphere with the MSDP operating on THEMIS, the EUV images with SOHO/EIT and TRACE, the X-rays with RHESSI. Two examples of flares will be presented: the 28 Oct 2003 X17 flare and the 20 October 2003 M1.9 flare. The magnetic field analysis of the active regions is done using a linear-force-free field code. The X17 flare is at the origin of a halo CME while the M1.9 flare has no corresponding CME. Before the X17 flare there was a pre-flare event which allowed to change the connectivities in a first phase and to destabilize the stressed field in a second phase producing the X17 flare. A compact twisted emerging flux was responsible of the M1.9 flare, which remains a compact flare due to very tied overlaying loops. These two examples illustrate the major role of the magnetic configuration involved on the flare physical characteristics.

1 Introduction

After October 19, 2003, and for about two weeks, the Sun displayed an extraordinary level of activity. Twelve X-class (X-ray GOES classification) flares and many smaller ones (lower class) were observed. Other phenomena were associated with these flares, including coronal mass ejections (CMEs) and strong fluxes of accelerated particles (electrons, protons and neutrons). The extremely high level of activity resulted from the formation of three β-γ-δ sunspot groups (NOAA 10484, 10486, 10488). Eight of the X-flares started in active region (AR) 10486.

2 Observations and modeling

We presented two different cases of flares: an eruptive flare accompanied with CME and a confined flare without CME.

For strong flares it is particularly important to understand what happens long before the eruption, how the eruptive instability was built-up and how the magnetic energy is released. In the case of X17 flare on October 28, 2003 there was a quadrupolar reconnection before the main flare (Schmieder et al. 2006, Mandrini et al. 2006), but no null point was found in the magnetic topology analysis using the linear-free field approximation (Fig. 1). It seems that the reconnection occurs in quasi-separatrix layers configuration (Démoulin et al. 1997). The main stored energy is not released during the pre-event but the release can occur when the overlying magnetic field is removed as proposed by Antiochos et al. (1999). This ejection leads to a large halo CME.

On October 20, 2003 the active region NOAA 10484 is complex (Fig. 2). However the energy is released progressively as the field lines change of connectivity, with no sudden reconnection. Multiple reconnections are identified. That explains why the region produced only a relatively small flare and why the flare stayed confined and did not produce a CME (Berlicki et al 2006, Li et al 2005).

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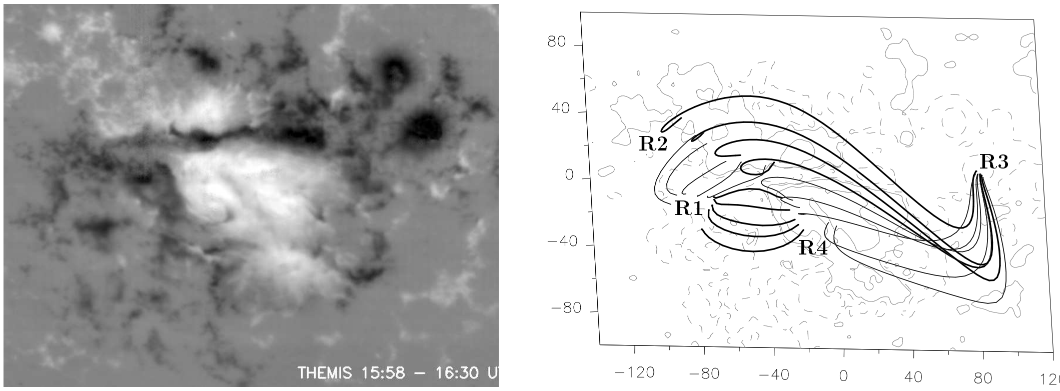

Fig. 1. (left panel) High-resolution THEMIS/MSDP magnetic field map obtained of the AR NOAA 10486 at 15:15–16:30 UT, (right panel) extrapolation of the magnetic field lines over the AR (contours of the magnetic field) with the locations of four ribbons, signatures of heating during reconnection

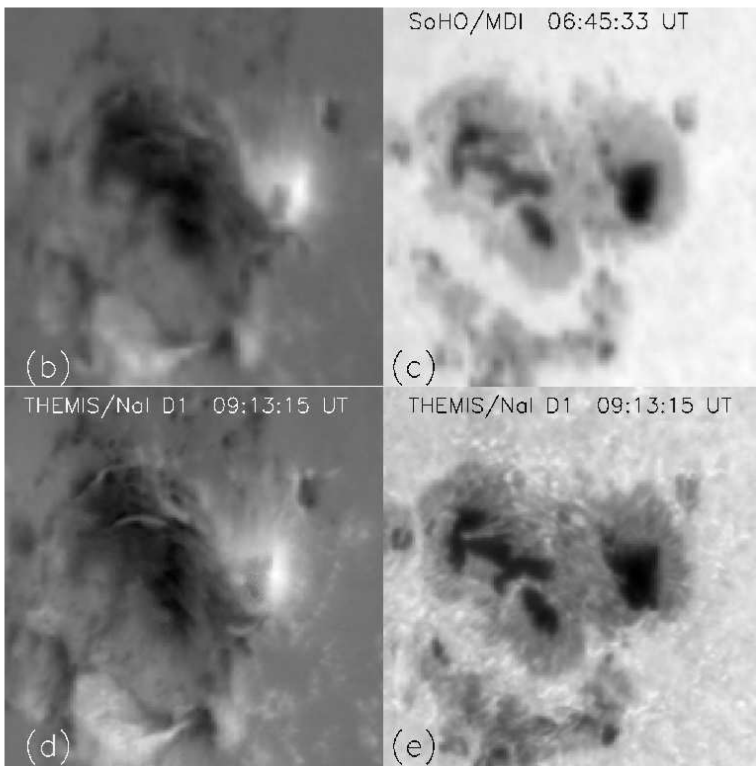

Fig. 2. Magnetogram at 07:59 UT (b) and intensity image at 06:46 UT (c) observed by SOHO/MDI (NOAA 10484). Magnetogram and intensity image (d, e) with high resolution observed by THEMIS in the MSDP mode at Na I line 5896 ± 0.1Å.

References

Antiochos, S.K., DeVore, C.R., & Klimchuk, J.A. 1999, ApJ, 510, 485

Berlicki, A., Mein, P., & Schmieder, B. 2006, A&A, 445, 1127

Démoulin, P., Bagala, L.G., & Mandrini, C.H. 1997, A&A, 325, 305

Li, H., Berlicki, A., & Schmieder, B. 2005, A&A, 438, 325

Mandrini, C.H., Démoulin, P., Schmieder, B., et al. 2006, Solar Phys., in press

Schmieder, B., Mandrini, C.H., Démoulin, P., et al. 2006, Adv. Sp. Res., 37, 7, 1313