OCCURRENCE OF METRIC NOISE STORMS AND THE ONSET OF CORONAL MASS EJECTIONS IN THE SOLAR ATMOSPHERE

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Abstract. We performed a statistical study of the metric noise-storm continuum sources (located close to/off the solar limb, and whose start time are precisely known) observed during the period January 1997 – June 1998. The main results are: (i) a majority of the events considered were temporally followed by a coronal mass ejection off the solar limb, and (ii) the noise-storm sources were located within the angular span of the latter.

1. Introduction

Noise storms are one of the most frequently observed solar activities at meter-decameter wavelengths, and probably were the first detected radio event from the Sun (Hey, 1946). They consist of a background continuum with superimposed bursts of short duration, and are associated with large sunspot groups. It is now well established that their occurrence is closely correlated (both spatially and temporally) with the observed changes in the photospheric magnetic field (McLean, 1981; Brueckner, 1983; Stewart, Brueckner, and Dere, 1986; Bentley *et al.*, 2000). Interestingly, a similar result was arrived at by Lara, Gopalswamy, and DeForest (2000) in connection with the coronal mass ejections (CME), quite recently. There also seems to be a similarity in the source regions of the CMEs and the noise storms; (i) most of the regions with spot areas above $\sim$ 200 millionth of the disk show noise-storm association (Dodson and Hedeman, 1957), as well as sigmoid-to-arcade evolution of structures which in turn are related to the 'halo' CMEs (Canfield, Hudson, and McKenzie, 1999), and (ii) both the CMEs and noise storms are preferentially associated with multi-polar magnetic systems (Elgarøy, 1977; Webb *et al.*, 1997). In view of the above, we carried out a statistical study of metric noise storms and CMEs to determine the temporal/spatial association between them.

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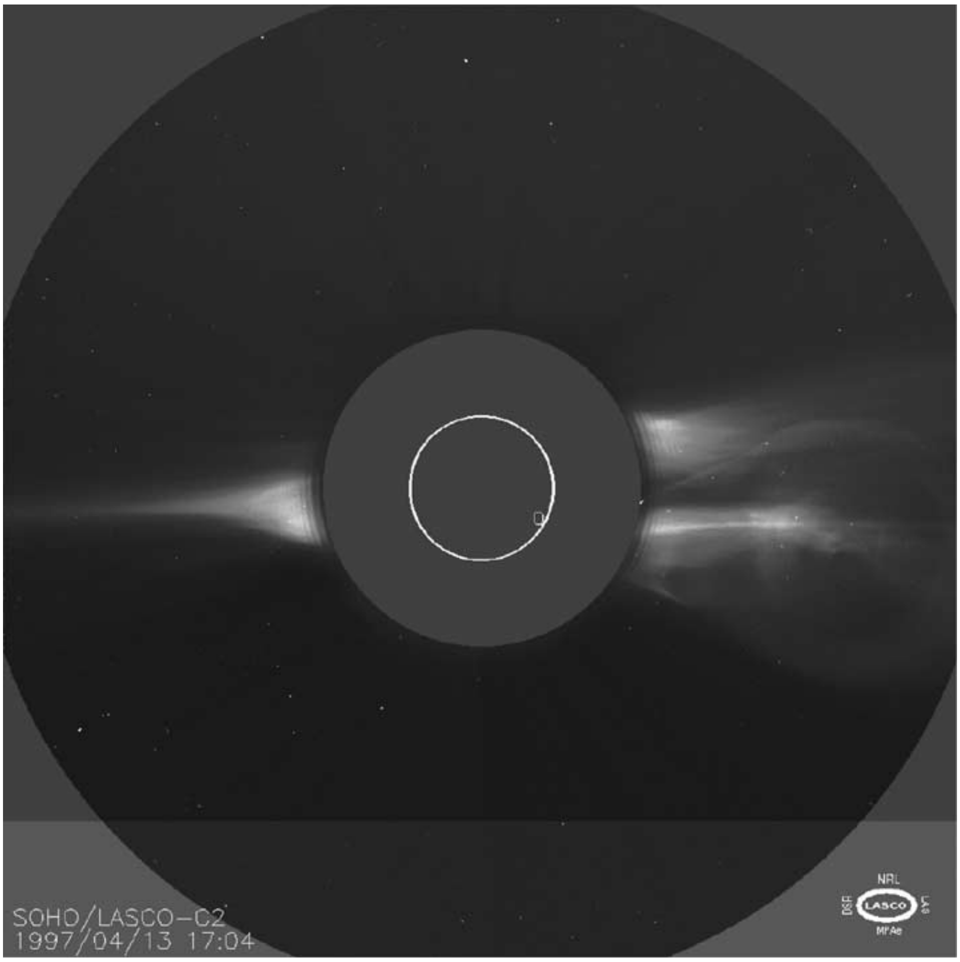

Figure 1. Composite image showing the CME event observed with the LASCO C2 coronagraph on 13 April 1997, and the location of the noise-storm continuum observed on that day (see Table I for the onset details). One can clearly notice that the centroid of the noise-storm continuum (marked 'o') is located within the angular span of the CME. The open circle at the center is the solar limb and the outer bigger circle is the occulting disk of the coronagraph, located at approximately 2.2 R_{Sun} from the center. Solar north and east are straight up and to the left, respectively.

2. Data Set

The information on the noise storms reported was taken primarily from *Solar Geophysical Data* in which the exact location and start time of the events observed with the Nançay radioheliograph (NRH, Kerdraon and Delouis, 1997) are published regularly. We also used data obtained with the Gauribidanur radioheliograph (GRH, Ramesh *et al.*, 1998), wherever applicable. The radio events considered occurred in the time interval $\sim$ 05:00–16:00 UT, the combined observing duration

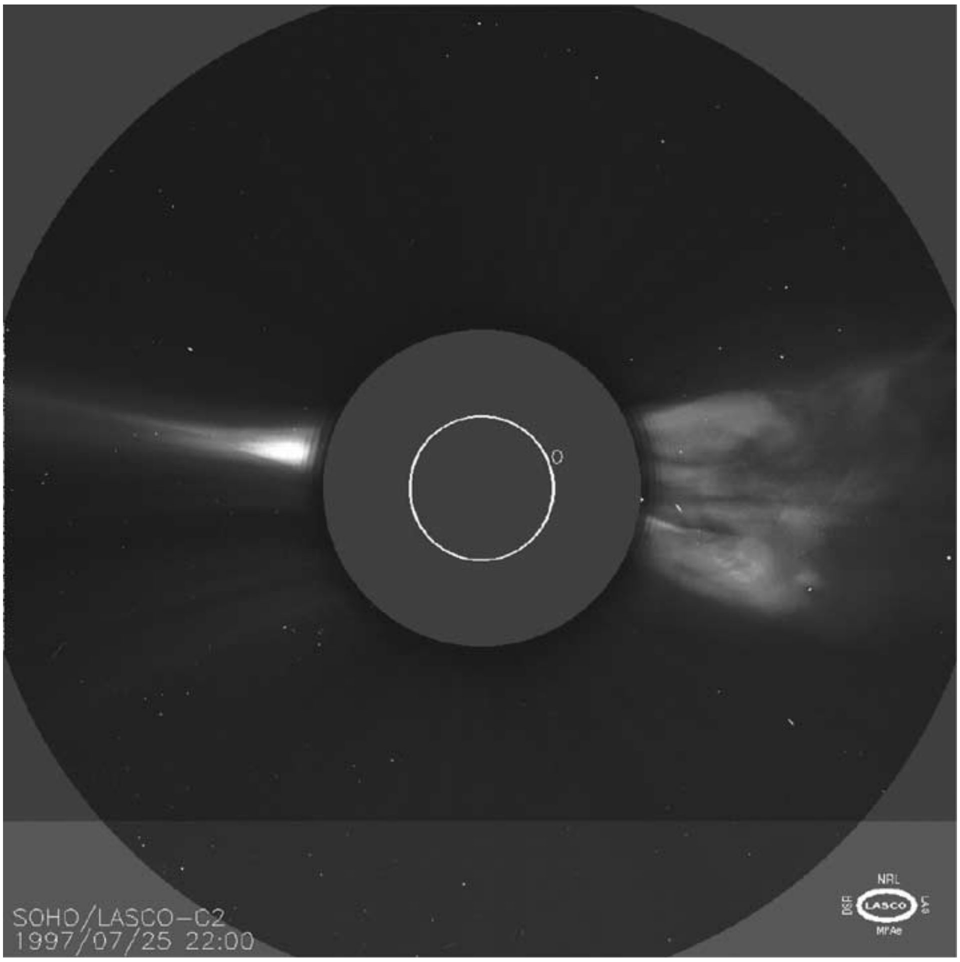

Figure 2. CME event and the noise-storm of 25 July 1997.

of the GRH and NRH. We would like to mention here that the above two are the only instruments presently available for dedicated, imaging observations of the Sun at meter–decameter wavelengths, and hence the time limitation. The CME data reported were taken from the list compiled by St. Cyr based on the observations with the Large Angle and Spectroscopic Coronagraph (LASCO, Brueckner *et al.*, 1995) on board the Solar and Heliospheric Observatory (SOHO), during the period from January 1997 to June 1998. We specifically selected the above period because of the following reasons: (i) two-dimensional radio data giving the location and the precise start time of the noise-storm sources is available only from January 1997, and (ii) it forms a subset of the first period of uninterrupted operation of SOHO, i.e., from January 1996 to June 1998, and a complete list of the white-light CMEs observed with the LASCO is available. Here again, to establish an unambiguous identification, only 'non-halo' CME events, and noise-storm sources

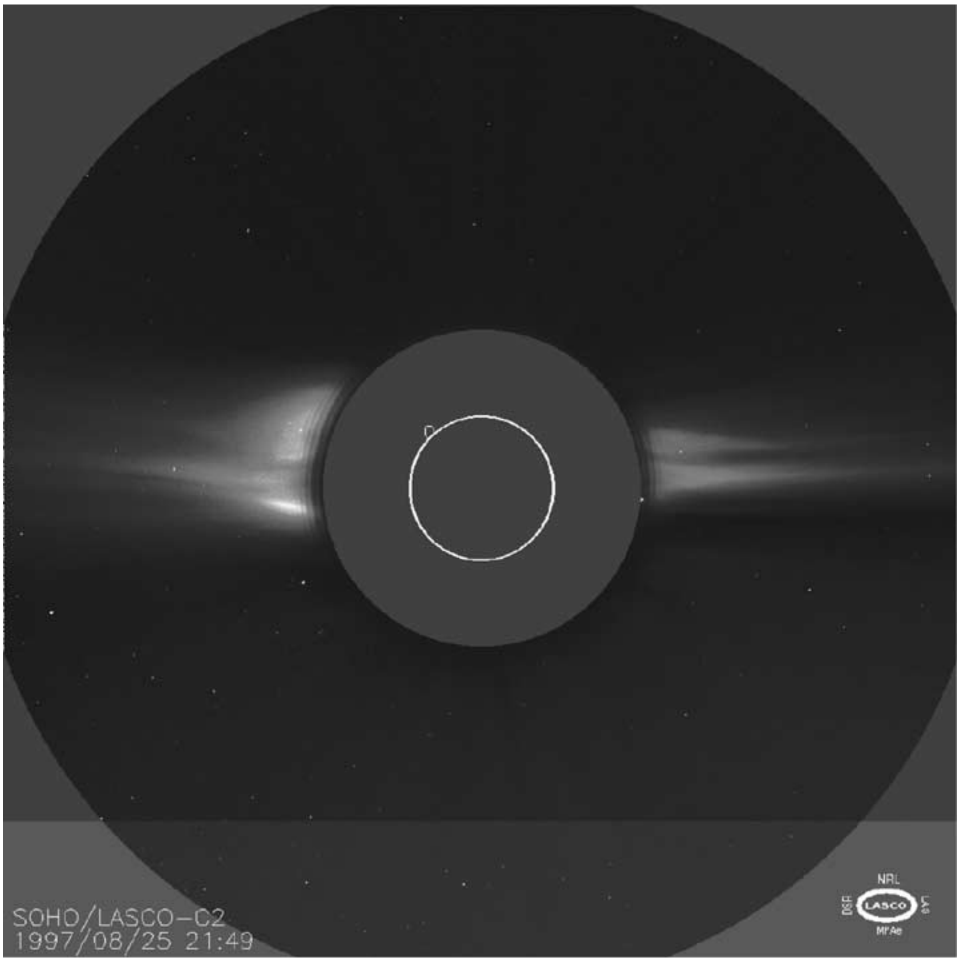

Figure 3. CME event and the noise-storm of 25 August 1997.

located close to/off the solar limb were considered for the present study (Table I). One can notice that except for the events of 6 March and 26 July 1997, each one of the noise storms was temporally followed by a mass ejection. Also they were located within the angular span of the latter. Figures 1–4 illustrate the above spatial association for a few of the bright CMEs in Table I. We would like to add here that the relationship between the noise storms and the CMEs listed in Table I is unique and that no CME event took place on the solar surface in the time interval between their occurrence.

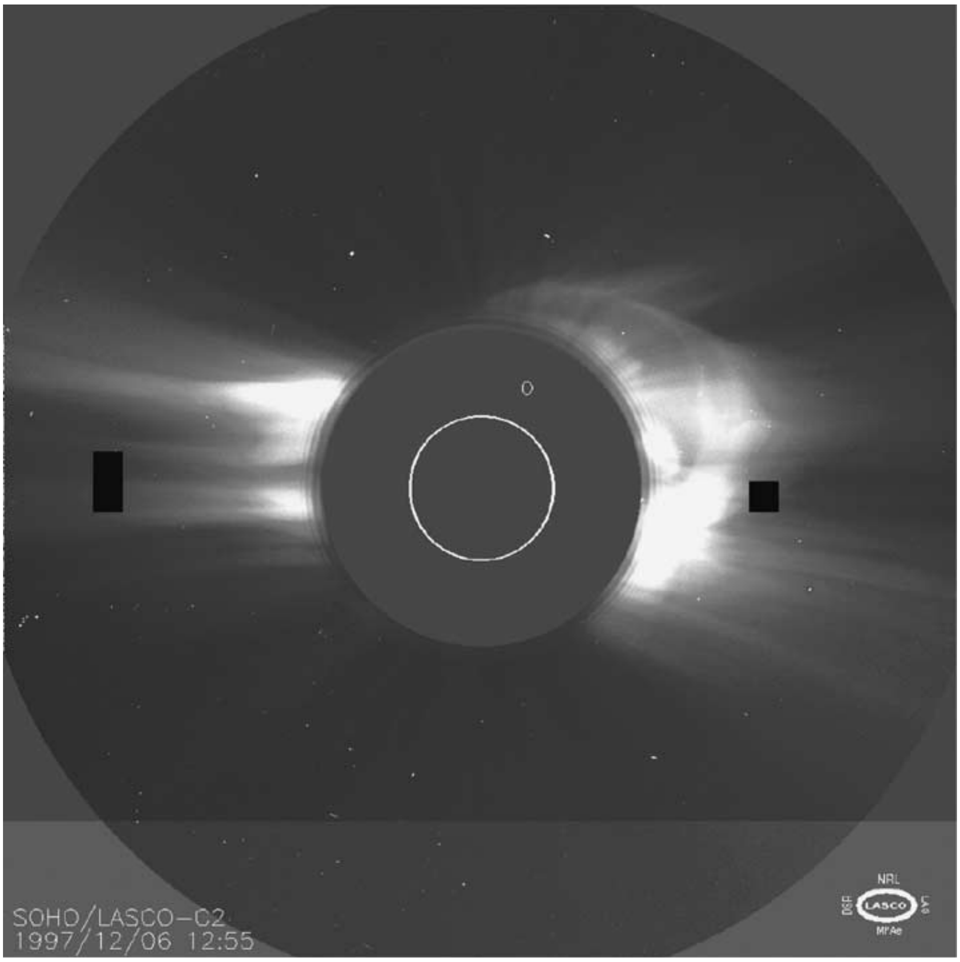

Figure 4. CME event and the noise-storm of 6 December 1997.

3. Discussions and Conclusions

We carried out a statistical study of the metric noise storms (located close to/off the solar limb, and whose locations are precisely known) observed during the period January 1997 – June 1998, in the time interval $\sim$ 06:00–16:00 UT. Out of the 12 noise storms which met the above requirements, 10 events were temporally followed by a CME. The time delay varied from about 1 to 14 hours. Also they were located within the angular span of the latter. In this connection, we would like to point out that Kerdraon *et al.* (1983) had shown earlier that the occurrence of metric noise storms is systematically associated with the addition of new material in the solar corona. Case studies of specific noise-storm events have also shown that they are limited to the eventual site of a CME, despite the existence of a number of active regions on the disk at the time of observation (Habbal *et al.*, 1996;

TABLE I

Details of CME and metric noise-storm data

Date	Noise-storm		CME	
	Location (solar radii)	Start time	Position angle	Time[a]
6 Mar. 1997	1.20 E 0.17 N	09:40 UT	–	–
28 Mar. 1997	1.07 E 0.22 S	11:00 UT	080–140°	18:17 UT
3 Apr. 1997	1.21 E 0.48 S	13:00 UT	075–111°	18:57 UT
13 Apr. 1997	0.73 W 0.50 S	06:00 UT	239–281°	16:12 UT
25 July 1997	0.95 W 0.37 N	11:40 UT	240–298°	21:01 UT
26 July 1997	1.15 W 0.33 N	09:30 UT	–	–
25 Aug. 1997	0.82 E 0.71 N	10:50 UT	045–103°	18:08 UT
30 Sept. 1997	1.11 W 0.68 S	11:00 UT	235–285°	01:29 UT[b]
6 Nov. 1997	1.24 W 0.04 N	13:15 UT	256–286°	00:43 UT[b]
28 Mar. 1998	0.33 W 1.23 S	12:26 UT	261–297°	13:06 UT
13 Apr. 1998	1.14 W 0.34 S	12:20 UT	175–247°	18:27 UT
11 June 1998	1.60 E 0.13 N	11:00 UT	068–114°	00:01 UT[b]

[a]Time corresponding to first sighting in the LASCO C2 coronagraph.
[b]Observed the following day.

Ramesh, Subramanian, and Sastry, 1999). These point to a possible association between the metric noise storms and CMEs since one of the suggested reasons for the occurrence of the latter is an interaction between the existing field lines, and evolving active regions (Feynman and Martin, 1995; Chen and Shibata, 2000).

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