DIRECT CORRELATIONS BETWEEN CORONAL TRANSIENTS
AND INTERPLANETARY DISTURBANCES*

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Abstract. Major interplanetary shock waves have often been successfully associated with major solar flares. The interplanetary response to weaker solar events, e.g., eruptive prominences (EP) and slow coronal transients, is far less pronounced. Recently, progress has been made by combining the newly-available data of white-light-coronagraph measurements from the earth-orbiting satellite P78/1 (these data show the development of coronal transients between 2.5 and 10 Re), in-situ plasma measurements from the HELIOS solar probes positioned mostly above the Sun's limb at solar distances between 60 and 200 Re (showing the reactions of the interplanetary plasma), ground based Hα-coronagraphs (showing in a few cases the evolution of EP's from the Sun's limb up to 1.5 Re).

In the years 1979 to 1981 about 25 uniquely associated events were identified, 19 of which allow some detailed analysis. The events can be sorted into three main categories:
- The 'flare-type': 13 events, probably all of them flare-related, transient speeds $v_t$ from 560 to 1460 km s$^{-1}$, no evidence for post-acceleration of the transient (indicating impulsive injection), all transients followed by drastic interplanetary shock waves, some of them probably involving magnetic clouds.
- The 'EP-type': 4 events, none of them flare-related, at least one was observed as an Hα-EP, transient speed from 200 to 410 km s$^{-1}$, all post-accelerated (indicating 'driven' injection), all followed by shocks with at least one magnetic cloud, one showing presence of He$^+$ and O$^2+$ behind the shock.
- The 'NCDE-type': 2 events, one observed as an He-EP, the other without known solar source, $v_t = 130$ and 470 km s$^{-1}$, one post-accelerated, the other one not, considerable density increase in interplanetary plasma (however, in pressure equilibrium with surroundings), one event including shock, the other not. These two events may not belong to the same category.

Our results are not completely consistent with previous work which is mainly based on data from the Skylab era, 1973/74. This could be due to the different phase in the solar cycle. The study is being continued.

1. Introduction

This paper reports on an extensive study that is in progress. The study is being carried out as a close collaboration between the group at Naval Research Laboratory that built the white-light-coronagraph onboard the P78/1 satellite and the groups at the MPI für Aeronomie and the MPI für Extraterrestrische Physik that built the plasma instruments aboard the HELIOS solar probes.

The unprecedented capabilities of this cooperative study become immediately obvious from the orbit configuration of HELIOS 1 as shown in Figure 1. Due to the orbital period of HELIOS 1, a few days more than half a year, the kind of 'Figure 8' orbit (relative to the Earth–Sun line) has slowly turned around in the years since the HELIOS 1 launch in December 1974. Therefore HELIOS 1 spent as much as 85% of the time in 1979 to 1981 within a ±30° range in longitude above the east or west limb of the Sun. That explains why HELIOS 1 is ideally suited to pick up in situ any disturbances that had previously crossed the coronagraph's field of view which

* Presented at the Fifth International Symposium on 'Solar-Terrestrial Physics', held at Ottawa, Canada, May 1982.
surrounds the whole Sun's limb. During much shorter time intervals the HELIOS 2 probe – the orbit is not shown here – also came into favorable positions.

Since the launch of P78/1 in March 1979 until present we could gather a set of simultaneous data covering nearly three years around the past maximum of solar activity, including the whole International Solar Maximum Year. The measurements are still in progress.

Unfortunately, associations between coronal and interplanetary transients are not at all positive in most cases, mainly because there are often just too many transients and because of inevitable gaps in both data streams. However, up to now we have been able to identify about 25 uniquely associated events. Nineteen of them can be evaluated in some detail. Presenting and discussing their common features, as well as their differences, is the subject of this paper.

2. Coronal Transients – a Brief Summary

Coronal transients were studied extensively during the Skylab mission in 1973/74, at a time quite close to solar activity minimum. (For a general survey of these results the reader is referred to a recent review by MacQueen, 1980.) Within 227 days a total of 110 transients had been observed with the white-light-coronagraph. Forty per cent of those were related to flares, 50% to eruptive prominences (EP) without flares; 70% were related to EP including flares (Munro et al., 1979). Rust et al. (1979) investigated 24 of the best documented transients in more detail. They reported the average speed of flare-related transients to be 672 km s$^{-1}$ and for EP-related events 420 km s$^{-1}$. Gosling