



## L1 observations and geoeffectivity consecutive to the frontside halo coronal mass ejections (CMEs) of year 2002

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Bocchialini *et al.* (2018) showed that among the 28 frontside halo coronal mass ejections (CMEs) with a visible source seen on the Sun in 2002, 21 are unambiguously associated with sudden storm commencements (SSCs). Based on velocity comparisons (LASCO, L1, and ballistic velocities), we look for association between these 28 halo CMEs and shock-like discontinuities observed in solar wind and interplanetary magnetic field (IMF) observations at L1. Geoeffectivity is tested on Dst, am, PCN, and auroral indices responses.

The present work complements the Bocchialini's study by analysing systematically all the 28 halo CMEs, including the seven halos CMEs not associated with SSCs. Source locations, potential L1 signatures and geoeffectivity of these seven halo CMEs provide an overview of the properties related to halo CMEs in 2002, complementing Bocchialini's *et al.* results. None of the discontinuities possibly associated to each of the seven halo CMEs corresponds to a clear ICME signature, based on our observations and on existing catalogs, showing that the central regions of the halo CMEs are not passing L1.

From the L1 observations of frontside CME halos observed in 2002, we conclude that halo CMEs not associated with SSCs in 2002 are non-geoeffective. We also note that all halo CMEs observed in 2002 and associated with ICMEs or magnetic clouds at L1 are also associated with SSCs. The work leading to this paper has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870437 for the SafeSpace (Radiation Belt Environmental Indicators for the Safety of Space Assets) project.