Abstract

The systematic monitoring of the solar wind in high-cadence and high-resolution heliospheric images by the Solar-Terrestrial Relation Observatory (STEREO) spacecraft allows us to study the long-term spatial and temporal evolution of variable mass flows from the Sun to 1 AU.

As part of the FP7 HELCATS project, we derived a catalogue listing the properties of 190 corotating density structures (CDS) from 2007 to 2014. We present the first long-term analysis of solar wind structures advected by the background solar wind imaged by STEREO-A (STA). The spatial-temporal evolution of each of these structures is derived by using well-established techniques.

Arrival times are predicted at different probes in the inner heliosphere and compared with direct in-situ measurements. We show that speeds derived by our catalogue track well the long-term variation of the radial speed of the slow solar wind. These findings have direct implications for space-weather predictions.

Methods

Each STEREO spacecraft carries a suite of imagers - the SECCHI package. Here we use the Heliospheric Imagers (HI) to track individual density features between 30 Rs and 1 AU. Maps of brightness variations are created by extracting a band of pixels situated along a constant position angle (equatorial plane here) and displaying this band as a function of time.

Each track is the white-light signature of a strong density inhomogeneity moving radially outward. When emitted by a single source region at the Sun a density inhomogeneity moving radially outward. Each track is the white-light signature of a strong density feature (top panel) and solar wind speed (bottom). Red vertical lines are predicted arrival times and black diamonds) lie close to the inversion of the field sign (sector boundaries).

Long-Term Tracking

Predictions of arrival times at 1 AU (Stereo-B here) for every event allow to directly compare with the in-situ data. Generally, the predicted time is close to the stream interface (density peak and transition from slow to fast solar wind) at 1 AU.

Distance to the Heliospheric Current Sheet is closest for the real fit points than for random points. Clear association with the HCS.

Nature of CDSs

Polarity of Magnetic Field at 2.5 Rsun in the plane of Carrington latitude vs time, CDS source points (red diamonds) lie close to the inversion of the field sign (sector boundaries).

Conclusion

A new catalogue of bright corotating structures is presented here. It starts at the beginning of the STEREO mission (2007) and goes up to 2014. The emergence of transients evolving into CIRs at 1 AU is clearly evidenced by running difference time-elongation images and gives a characteristic signature pattern.

Our results show that under quiet solar activity conditions the heliospheric imaging can be used to systematically track all CDSs. Under the strong solar activity the field-of-view is strongly perturbed by a frequent CMEs activity.

The average CDSs speed from our list is found to be 311 km/s. The long-term speed variations seen in HI follow closely the slow solar wind inside the compression region of CIRs. It is also found that the predicted arrival time of these structures at 1 AU is ~11 hours accurate.

The position of the source points on the Sun provided a strong tendency of clustering around the coronal neutral line and the heliospheric current sheet.

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