Determining the evolution and propagation of a CME flux rope from the Sun to Mars

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Coronal mass ejections (CMEs) are the major drivers of space weather phenomena at the Earth. They form in the solar atmosphere as helical magnetic field structures known as flux ropes. The key parameter that defines the ability of a CME to drive geomagnetic storms is the North-South magnetic field component. One of the most significant problems in current long-term space weather forecasts is that there is no practical method to measure the magnetic structure of CMEs routinely in the corona. The magnetic structure of erupting flux ropes can however be inferred based on the properties of the CME's source region characteristics. These proxies allow to reconstruct the "instrinsic flux rope type" at the time of the eruption.
However, the knowledge of the flux rope's magnetic structure at the Sun does not always imply a successful prediction of the magnetic structure at the Earth. This is because CMEs can change their orientation due to deflections, rotations, and deformations. We present here an example of a CME for which we have determined the magnetic structure when launched from the Sun by using a synthesis of indirect proxies based on multiwavelength remote-sensing observations. When compared to the *in situ* counterpart at the Earth, this CME presents a different magnetic configuration. We study the CME early evolution on the solar disc and in coronagraph images, and then follow its propagation through heliospheric imagery data. We then study the CME structure *in situ* at Venus, Earth, and Mars. We aim at determining if the difference in the CME orientations at the Sun and at Earth is given by rotation of the flux rope axis, by the spacecraft crossing distance from the CME nose, by local distortions in the CME body, or by a combination of all of these.