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Quantitative multi-spacecraft observation of magnetic cloud erosion by magnetic reconnection during propagation.

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Magnetic clouds, a subset of interplanetary coronal mass ejections, are characterized by a twisted magnetic flux rope topology. During propagation, the structure interacts with its environment and may thus at least partially reconnect, potentially eroding away part of the original magnetic cloud flux impinging on Earth. In the present study, we quantitatively analyse the complex interaction that occurred between a magnetic cloud (MC), the solar wind ahead of it, and a trailing high-speed stream observed by STEREOA, B and ACE. We first determine the orientation of the flux rope using different methods at the different spacecraft. We then estimate the amount of eroded magnetic flux, and associated errors, based on the observation of azimuthal flux imbalance during the spacecraft sampling of the flux rope. We show that small deviations in cloud axis determinations have a large impact on the estimated eroded flux. However, the combination of careful error analyses, combined with other signatures observed in the data (e.g., at the front and rear of the magnetic cloud) permit to demonstrate the occurrence of erosion with confidence.