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Magnetic lasso: a new solar wind propagation method and its application concerning space weather at 67P/C-G

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Abstract

Concerning the increasing number of heliospheric space missions it is a key issue to foresee space weather conditions in the spacecraft's and the target object's neighborhood. Solar wind parameters are propagated to outer orbits by several ballistic and magnetohydrodynamic (MHD) methods. MHD models describe the underlying physical processes more realistic, but computations are time-demanding. Ballistic models are simple, computationally fast and need only input data. They work quite well closer to the Sun, where MHD effects have smaller amplitudes.
The ballistic model presented here is enhanced by adjusting for the target movement during the propagation time through the following method: First, a dataring is created around the Sun containing solar wind parameters for each Carrington longitude, based on ACE data. It is assumed that solar wind parameters from the same source are constant for one solar rotation.
The second step is the actual propagation where we are trying to find the magnetic field line connecting the target object with a certain longitude of the source surface at the Sun. The field line has to meet two criteria. First, there is a criteria for its shape: it has to meet the target object at the right place, second, it has to get to the right place at the right time. Both criteria depend on solar wind velocity. This search is carried out by a minimum variance analysis.
Once the proper magnetic field line is found, solar wind bulk velocity, density and magnetic field polarity is propagated assuming no change during travel time. The method was tested successfully during the Rosetta mission. While the spacecraft was investigating the close environment of the comet Churyumov-Gerasimenko it was necessary to know the properties of the ambient solar wind in order to evaluate data and account for the dynamic changes.