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Prediction of the Dst index with magnetic field observations in the inner heliosphere

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The prediction of the effects of interplanetary coronal mass ejections (ICMEs) on Earth strongly depends on knowledge of the properties of the interplanetary magnetic field (IMF), especially it's southward component (Bz), acting as a main driver for geomagnetic storms.

We are using data from a spacecraft located in the inner heliosphere, Venus Express (VEX) at 0.72 AU and will provide a proof-of-concept for predicting an ICMEs arrival time and speed at 1AU, the ICMEs Bz component at Earth and the resulting Dst index by only using data measured by VEX.

To forecast the Dst index, the two well established Dst models from Burton et al. (1975) and O'Brien & McPherron (2000) are used. In combination with a drag based model (Vršnak et al. 2013) and the WSA/ENLIL model the ICMEs arrival speed at Earth is obtained. Additionally, a power law (Leitner et al. 2007) is used to scale the magnetic field from 0.72 to 1 AU.

Investigation of an ICME in June 2012 shows already promising results for the Dst index (predicted: -96 nT $\pm$ 17nT, observed: -86 nT), as well as for the arrival speed (predicted: 531 km $s^{-1} \pm$ 23 kms^{-1}, observed: 490 $kms^{-1} \pm$ 30 kms^{-1}) and timing ($\sim$6h $\pm$ 1h late of true arrival) . An advantage of this method is the high prediction lead time of $\sim$21 hours compared only $\sim$40-60 minutes, using an L1 located spacecraft.

To further investigate the feasibility of this method, data from any spacecraft temporarily located between Sun and Earth can be used. It is possible to extend this method to arbitrary spacecraft alignments and also to apply it to data from Helios or future space missions like Solar Orbiter and Solar Probe Plus. The techniques we develop could be routinely applied to a mission that forms an artificial Lagrange point along the Sun-Earth line, e.g. for a Sunjammer or Heliostorm mission.