Geophysical Research Abstracts
Vol. 20, EGU2018-3334, 2018
EGU General Assembly 2018

Tools for providing forecasts of Space Weather at the BepiColombo spacecraft pair during their forthcoming flybys of Venus and Mercury

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Abstract: The BepiColombo Mission to planet Mercury (launch 2018), will include during its Cruise Phase two flybys of Venus and five of Mercury. Its two constituent spacecraft (one provided by ESA – the Mercury Planetary Orbiter/MPO) and the other by JAXA - the Mercury Magnetospheric orbiter/MMO) will perform both autonomous and coordinated observations of the Venusian and Hermean environments during these flyby events. Two state of the art models/tools to predict the arrival of space weather at MPO and MMO during the flybys are presented. These tools comprise theInterplanetary Scintillation 3D-reconstruction Technique (IPS analyses) which was developed in time-dependent form at the University of California, San Diego to provide precise tomographic 3D-reconstructions of the, time-varying, global heliosphere. The other tool ENLIL is a time-dependent 3-D MHD model of the heliosphere which solves equations for: plasma mass; momentum; energy density; and magnetic field; using a Flux-Corrected-Transport (FCT) algorithm. It has already been demonstrated by the authors (PSS, 2017) that the above mentioned tools are individually appropriate to predict the arrival of space weather at the BepiColombo spacecraft pair during their forthcoming Venus flybys. A new algorithm has recently been developed which melds ENLIL with IPS, thereby allowing an iterative use of IPS data to update and fit the modelling by ENLIL of heliospheric structures. This methodology is presented in the present paper and used to retrospectively predict the arrival of solar disturbances at the Mercury Messenger spacecraft during its mission period 2011-2015. The method is demonstrated to yield higher time resolution in providing space weather predictions at BepiColombo during its flybys of Mercury than is obtained using either ENLIL or IPS alone since it can link observations made in-situ with those observed remotely. The time in advance of the flybys planned to be utilized by the Operations Team for uploading commands/information to the spacecraft is very long. Thus, switching-on or switching-off of the payload instruments in advance of significant solar events is presently not feasible. This could result in its only being possible to use the predictions to select those measurements for downloading inferred to importantly illustrate the interaction of Mercury with the disturbed solar wind. Analysis of these data would then be implemented on the ground.