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Space weather modelling with EUHFORIA

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Solar Coronal Mass Ejections (CMEs) are large-scale eruptive events in which large amounts of plasma (up to 1013-1016 g) and magnetic field are expelled into interplanetary space at very high velocities (typ. 450 km/s, but up to 3000 km/s). When sampled in situ by a spacecraft in the interplanetary medium, they are termed Interplanetary CMEs (ICMEs). They are nowadays considered to be the major drivers of "space weather" and the associated geomagnetic activity. The detectable space weather effects on Earth appear in a broad spectrum of time and length scales and have various harmful effects for human health and for our technologies on which we are ever more dependent. Severe conditions in space can hinder or damage satellite operations as well as communication and navigation systems and can even cause power grid outages leading to a variety of socio-economic losses.

We aim at developing an advanced space weather forecasting tool, combining the MHD solar wind and CME evolution model EUHFORIA[1] with the Solar Energetic Particle (SEP) transport and acceleration model PARADISE[2]. We will first introduce EUHFORIA and PARADISE and then elaborate on our plans of to model the geo-effectiveness of impacts and mitigation to avoid (part of the) damage, including that of extreme events, related to solar eruptions, solar wind streams, and SEPs, with particular emphasis on its application to forecast Geomagnetically Induced Currents (GICs) and radiation on geospace. We will report on the status of the new global MHD coronal model (COCONUT), the improved heliospheric wind and CME evolution model (ICARUS), and the new advanced flux-rope CME models we are developing. The novel tool will be accessible by the whole space weather community via the ESA Space Weather Service Network as it will be integrated in the Virtual Space Weather Modelling Centre (VSWMC)[3].

References

[1] J. Pomoell and S. Poedts: "EUHFORIA: EUropean Heliospheric FORecasting Information Asset", J. of Space Weather and Space Climate, 8, A35 (2018). DOI: https://doi.org/10.1051/swsc/2018020

[2] N. Wijsen, "PARADISE: a model for energetic particle transport in the solar wind". Dissertation presented in partial fulfilment of the requirements for the degree of Doctor of Science (PhD): Mathematics (KU Leuven) and the degree of Doctor of Physics (Universitat de Barcelona). April 2020.

[3] S. Poedts, A. Kochanov, A. Lani, C. Scolini, C. Verbeke, S. Hosteaux, E. Chané, H. Deconinck, N. Mihalache, F. Diet, D. Heynderickx, J. De Keyser, E. De Donder, N.B. Crosby, M. Echim, L. Rodriguez, R. Vansintjan, F. Verstringe, B. Mampaey, R. Horne, S. Glauert, P. Jiggens, R. Keil, A. Glover, G. Deprez, J.-P. Luntama: "The Virtual Space Weather Modelling Centre", J. of Space Weather and Space Climate, 10, Art. 14 (2020). Open Access DOI: 10.1051/swsc/2020012

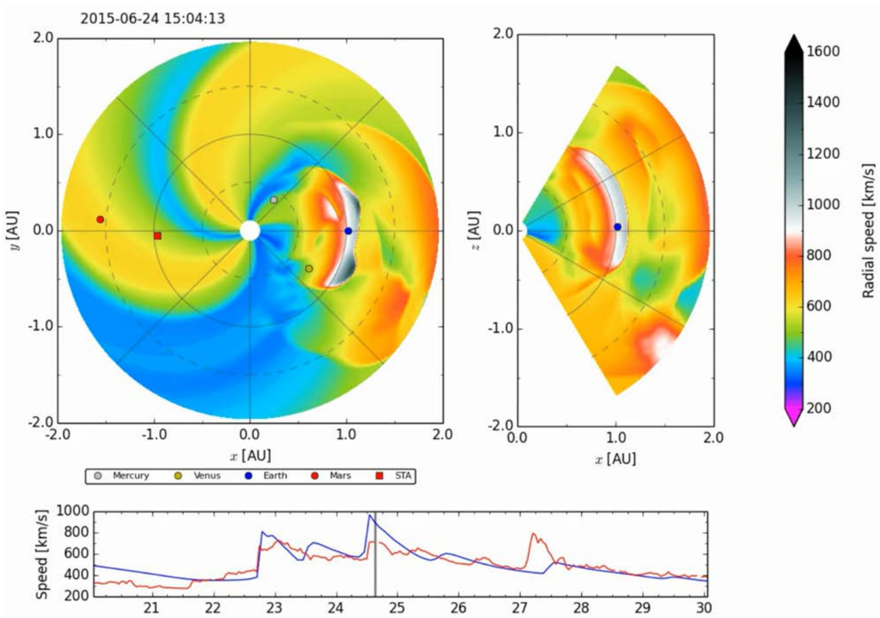

Figure 1. Snapshot of a forecast simulation with EUHFORIA, showing the radial velocity in the equatorial plane (top left, viewed from above) and in the meridional plane through the position of Earth (top right, side view). Bottom: comparison of simulated (in blue) and measured (ACE, in red) radial velocity at L1 [from Pomoell & Poedts 2018].

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