Forecasting space weather: modern community simulation tools and frameworks

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Solar Coronal Mass Ejections (CMEs) are large-scale eruptive events in which large amounts of plasma (up to 10^{13}-10^{16} 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.

Therefore, the International Space Environment Service (ISES) has set up a collaborative network of 16 space weather service-providing warning centres around the globe, delivering coordinated operational space weather services for the benefit of the extensive user community. In order to improve the forecasts and predictions, NASA, ESA and other agencies have set-up space weather modelling frameworks. We will discuss how such frameworks enable to run and couple different space weather models, and to validate their results by comparing them with those of other similar models and, where possible, to in-situ data. Examples of such frameworks are the Community Coordinated Modeling Center (CCMC, NASA GSFC), the Space Weather Modeling Framework (SWMF) at the Center for Space Environment Modeling (CSEM) at the University of Michigan, and ESA's novel Virtual Space Weather Modeling Centre (VSWMC) that is being developed. The latter one includes space weather models that are geographically distributed and will be demonstrated.