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Sol-Terra: A Roadmap for Operational Coupled Sun-to-Earth Space Weather Forecasting

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The ability to accurately forecast space weather is still far behind terrestrial weather forecasts. In the recently opened Met Office Space Weather Operations Centre, highly-trained forecasters use computer models to help provide warnings of possible events and their potential impacts. The objective is to improve forecast accuracy via both better models and a coupled system that represents the whole Sun-Earth environment.

Many research models have been developed internationally, but typically they focus only on specific areas of the Sun-Earth system; there is a pressing need for a detailed assessment of their suitability to operate within a coupled space weather forecast system. For a given model to be appropriate for operational forecasting, it is crucial for them to meet certain requirements: they should be robust, validated, capable of producing timely forecasts, able to couple to other models, and they should adopt good quality software engineering principles to facilitate maintenance and evolution.

The goal of the Sol-Terra project is to produce a roadmap for a future coupled Sun-to-Earth operational space weather forecasting system covering domains from the Sun down to the ionosphere and the Earth's neutral atmosphere. We surveyed what models are available globally, and assessed how they met the requirements detailed above. From the models surveyed, we selected a set of candidate models suitable for use in operational space weather forecasting, and architecture options for realising such an operational system were studied.

We present the principal findings of the Sol-Terra project, a roadmap for the realisation of an operational coupled Sun to Earth space weather forecast modelling system, and the main areas where further work is needed and best practice can be applied. The methodology used is not only useful for space weather applications, but potentially also for the development of other coupled modelling systems within the weather and climate domain.