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Space weather predictions of CMEs and SEPs through the inner heliosphere

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Coronal mass ejections (CMEs) and solar energetic particles (SEPs) are manifestations of the dynamic and explosive nature of solar activity and major drivers of space weather events. They often occur in concert, especially in the case of large and fast CMEs that are associated with strong flares and that are able to accelerate SEPs at the shocks ahead of them. Modelling efforts that aim to forecast and mitigate the effects of these solar phenomena range from empirical to analytical to numerical. Although the primary focus of space weather forecasts is naturally on Earth, the increased amount of heliospheric and planetary missions launched in the past ~15 years has provided new opportunities for CME and SEP measurements at other locations in the inner solar system. This has resulted in the possibility to test space weather forecasting models at multiple locations well separated in both heliocentric distance and longitude within the same event, which in turn represents a novel way to benchmark and validate the present capabilities.

In this presentation, we will first briefly review the current status of CME and SEP space weather forecasting, with particular attention given to the main challenges to overcome for advancing predictions. We will then present a few examples of CME and SEP events that were detected in situ at multiple locations in the inner heliosphere and show forecasting—or actually hindcasting—results for each of them. Finally, we will conclude by addressing possible future improvements that take advantage of model validation via multi-spacecraft measurements.