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Investigating the role of the foreshock in solar wind-magnetosphere coupling

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Forecasting space weather in a reliable manner is becoming increasingly needed in our modern society which relies heavily on space technologies. This requires a detailed understanding of the entire space weather chain, from the eruption of solar transients at the Sun through their propagation in the interplanetary medium to their interaction with the Earth's magnetosphere. Regarding this last part, we can now estimate with reasonable accuracy whether a magnetic storm will occur, based on in situ observations near the L1 point. Forecasting the timing and the magnitude of the peak intensity of the storm, as well as its effects in the different regions of the magnetosphere, is still challenging. Understanding the interplay between the different regions of the near-Earth space and their response to solar transients is therefore necessary to improve our forecasting capabilities.
In this project, we focus on the role played by the outermost region of the Earth's environment, the foreshock. We investigate how the foreshock properties evolve from quiet solar wind conditions to storm-time conditions, and whether these changes can affect in turn how solar transients interact with the magnetosphere. The aim of this study is to assess whether these effects should be taken into account in refined space weather models. This project is carried out in the framework of a Marie Sklodowska-Curie Individual Fellowship for the period 2017-2019. Furthermore, this work is largely based on numerical simulations performed with the Vlasiator code, whose development has been made possible by two ERC grants. As the project is still ongoing, we will report on the progress made so far, about halfway through its total duration, and present results concerning the evolution of the foreshock properties.