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Data-constrained magnetohydrodynamics simulations of the solar atmosphere using the Bifrost code

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Data-constrained magnetohydrodynamics (MHD) simulations initialised with magnetic field extrapolations based on photospheric magnetograms have been quite successful in capturing many aspects of energetic events in the solar corona, like flare reconnections and coronal mass ejections. On the other hand, radiative-MHD codes like Bifrost initialised with analytical inputs have provided very realistic simulations of the solar atmosphere by including the physics of non-equilibrium states and radiative transfer. This work aims at setting up data-constrained simulations with the Bifrost code to study energetic events in the solar corona. As a first step, we perform MHD simulations using the Bifrost code, with the bottom boundary set at the photosphere. This allows us to take high-resolution photospheric magnetograms from the Swedish Solar Telescope (SST) directly as input for the lower boundary. To fine-tune the code parameters, we perform two sets of simulations initialised with: (a) analytical non-force-free-field (NFFF) input having a sheared-arcade geometry, which is known to produce magnetic flux rope through reconnections in other MHD simulations, (b) magnetic field obtained from NFFF extrapolations based on a photospheric magnetogram observed from SST having a dipolar geometry. We show that in the analytical case we can reproduce the flux rope formation, while the NFFF-initiated case shows a self-consistent evolution which is comparable to the SST chromospheric observations. We thus conclude that NFFF-initiated MHD simulations based on photospheric magnetograms can be very helpful in understanding coronal dynamics and needs to be developed further.

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