ABSTRACT

Context. The Sun is approaching the peak of its activity in cycle 25, making space weather predictions increasingly challenging as small-scale structures on its surface evolve rapidly. The main goal in space weather research is to enhance forecasts and prediction processes and to do so we need to have a reliable prediction of the solar wind, which transports the transient processes like the CMEs. In space weather, a complete forecasting model is made of two parts: a coronal model (up to 0.1 AU) coupled with an heliospheric model (from 0.1 AU to 2 AU).

Aims. In our work, we aim to better understand the solar corona so that we will better predict the solar wind, and this within an operational timing. This is especially true for the fast solar wind and at the maximum of activity.

Methods. To do so, we have two main focuses using Wind Predict (our magneto-hydrodynamic code which models the wind in the solar corona): improve the simulation itself or improve its post-processing. On one hand, we aim to incorporate a time dependency within the boundary conditions at the solar surface. This will allow the solar wind predictions to update in sync with magnetograms every two hours. To achieve this, we are basing our study on the work of *Lionello et al., 2023*. Our goal is to create a test case where the time evolution is known. Once we have established this time evolution in Wind Predict, we will test the configuration with discontinuous maps. In order to reconstruct interpolations, we will not only need the magnetic field but also the electric field. On the other hand, we want to focus on a more operational aspect: we will use the coupling of heliospheric models with Wind Predict, which together form a complete forecasting model. To achieve this, we will automatically correct our Wind Predict solution using empirical formulae to improve especially the description of the fast solar wind.

Results. We successfully created a functioning test case. We now have the time evolution of the physical parameters (magnetic field, velocity, pressure, density, etc.) for a Sun with differential rotation. This allows us to begin comparing our "test" data. For the second project, we began by correcting the wind speed. The correction is made using empirical formulae developed by Wang, Sheeley and Arge, based on the idea that, far from the Sun, the speed of the solar wind depends on the path that the wind took as it passed through the lower corona. After implementing the corrections, we found that we could indeed reproduce both fast and slow wind. To continue this work, we will extend the routine to correct the other physical parameters.

Conclusions. To conclude, we have seen that there are ways to improve predictions with low computational costs. Moreover, introducing time dependency in Wind Predict would be beneficial, as it allows the integration of data from both Earth and Solar Orbiter (far side observations). The more comprehensive our solar maps are, the more accurate the predictions will become. In the future, we also plan to test our improved coupling with an heliospheric model by comparing it to existing forecasts.