ABSTRACT SF2A 2026

Improving solar wind models for space weather: time-dependency and fast solar wind for coronal models

The Sun reached the peak of its activity in cycle 25, making space weather predictions increasingly challenging as small-scale structures on its surface evolve rapidly. 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.

To do so, we have two main focuses using our magneto-hydrodynamic code Wind Predict: improve the simulation itself or improve its post-processing. On one hand, we aim to incorporate 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, or even more frequently thanks to an interpolation between them. 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. 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.

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. Furthermore, our model is now able to update the solar wind solution along with magnetograms. Eventually, we found the best method of interpolation of the surface magnetic field, we only need its implementation for time-dependency in Wind Predict. For the second approach, we began by correcting the wind speed, as a test to determine the best method. The first correction is made using empirical formulae developed by Wang, Sheeley and Arge and the second one uses *Réville et al., 2023* results. After implementing the corrections, we found that we could indeed reproduce both fast and slow wind, and we extended the routine to correct the other physical parameters. After a comparison to a more physical version of Wind Predict which includes heating by Alfvén waves (WP-AW), we are currently doing some tests to find our own WP-adapted empirical correction.

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). In the future, we also plan to test our improved coupling with an heliospheric model by comparing it to existing forecasts.