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3D ballistic solar wind extrapolation. — We created a 3D method for extrapolating background solar wind speed in the inner heliosphere [1]. Our approach employs a pressure-corrected ballistic extrapolation method that uses solar coronal models as input data. The applied correction prevents the unphysical interactions between slow and fast plasma packets in our model. We also consider the coronal differential rotation which improves the fit compared to calculations with rigid rotation. The versatility of our model allows it to work with any input data providing solar wind speed on the solar source surface, making it applicable to various 2D solar corona maps, such as the WSA or the AWSoM datasets. The method propagates the solar wind from the solar source surface in 3D in the inner heliosphere, covering latitudes between ±50°. An example of the results can be seen in Figure 1. We validated our model using ACE solar wind measurements, demonstrating good correlation between our model and the measurements.

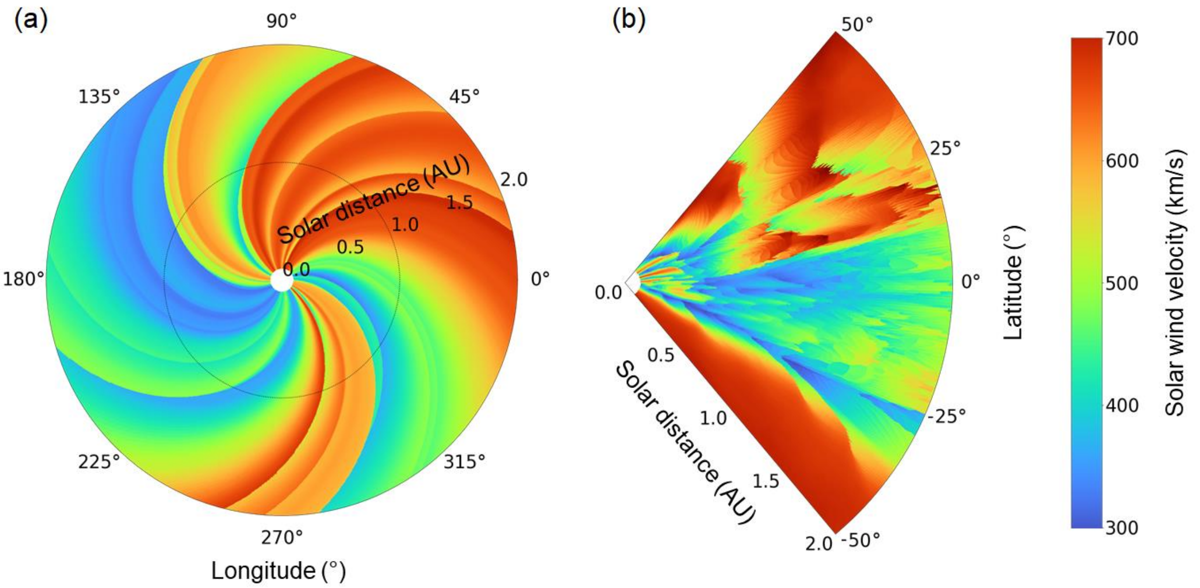

Figure 1. Solar wind speed in the Heliosphere according to our model (an example).

The effects of space weather on cometary ions. — We investigated the behavior of medium-energy cometary water-group ions based on Rosetta measurements during the high-activity period of Comet 67P (May to December 2015). Rosetta observed recurrent medium-energy ion peaks with maximum energies between 50 and 1000 eV while travelling in the magnetosphere of Comet 67P. We examined the connection between the solar wind dynamic pressure and the quantity and energy of these medium-energy ions. We established a strong correlation between solar wind dynamic pressure and the quantity of medium-energy ions. Although ion energy also changes depending on the solar wind pressure variations, we show that this parameter is significantly influenced by other factors, such as the production rate of the comet and the distance from the nucleus. The observed strong correlations can be explained by assuming that the source surface of these ions moves inward and outward, responding to fluctuations in solar wind pressure [2].

Directional discontinuities in the inner heliosphere. — The solar wind carries the magnetic field of the Sun frozen into its plasma. Abrupt changes in the direction of this magnetic field are called directional discontinuities, which can be caused by the spacecraft piercing boundaries of independent plasma regions, or by magnetic field disturbances travelling in the plasma. The former type is called tangential discontinuity (TD), the latter rotational discontinuity (RD). Differentiating between the two types is very important, but it is very difficult using spacecraft measurement data. In our paper [3], we provide a simple new method based on a comprehensive analysis of several plasma parameters, but requiring only magnetic field data in its final form, which can distinguish RDs and TDs better than previous methods. We also analyze the physical properties of the two populations.

References:

[1] https://doi.org/10.1051/swsc/2024010

[2] https://doi.org/10.1093/mnras/stae1556

[3] https://doi.org/10.1051/0004-6361/202450684