Project Details

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Topic: Understanding the Large-Scale Evolution of the Solar Wind

Project Title:
The Alfvénic Slow Solar Wind Over Multiple Solar Cycles

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Summary:
SCIENCE GOALS AND OBJECTIVES: The slow solar wind is of great value for further investigations in regard to both science and application concerns. In general, the slow solar wind shows low Alfv nicity, which measures the correlation of the magnetic field and solar wind velocity fluctuations. However, the Helios spacecraft recorded high Alfv nicity slow solar wind at around 0.3 AU from the Sun, and the observations suggest this kind of slow solar wind shares similar characteristics as the fast solar wind. Following studies find the Alfv nic slow solar wind (ASSW) both at around 1 AU and in the inner heliosphere, and the results further indicate the ASSW and fast solar wind are similar in both macro and micro scales, implying the ASSW should also originate from the coronal holes. Additionally, the latest Parker Solar Probe (PSP) spacecraft has observed prevalent ASSW in the inner heliosphere, suggesting the ASSW could contribute to the network of slow solar wind. However, contradictory conclusions on the origin of ASSW are implied by different works, the reason could be the choice of different observations and/or the different methodologies. We note that most of previous works associated with the ASSW are mainly focused on the comparisons of different solar streams with several selected intervals or limited dataset, and there still lacks a comprehensive study of the ASSW with large dataset through different solar cycles to uncover the distributions, evolutions, and origins of the ASSW. Therefore, it is greatly valuable to investigate the ASSW over multiple solar cycles with multiple datasets. In this project, we want to focus on the following aspects:
" Distributions. We will identify the ASSW intervals in different solar cycles and build a large dataset with several spacecraft observations with a powerful machine learning technique. This dataset can give global distributions of the ASSW over several solar cycles. In this way, we want to show how the solar activities control the large-scale variations of ASSW with less uncertainty, and to identify how much the ASSW contributes to the slow solar wind at different phase of solar cycles.
" Evolutions. The Alfv nicity of solar wind will reduce with distances, so we observe less ASSW at 1 AU. Therefore, it is worth to investigate the radial evolutions of the ASSW.
" Origins. The limited dataset and different methodologies in the analysis of ASSW may bring uncertainties to identify the origins. Therefore, based on the large dataset, we plan to use both multi-event study and statistical method to compare the properties, especially the compositional signatures, of highly ASSW with other solar winds. Moreover, we will use the Potential-Field Source-Surface (PFSS) model to trace the ASSW back to the Sun. Combining the observations and model results, we want to figure out the origins of ASSW.

MISSION DATA: We will use the in-situ data from the Helios, Ulysses, Wind, ACE, PSP and Solar Orbiter. The combinations of multiple datasets over several solar cycles from the inner heliosphere to 1 AU can help study the ASSW thoroughly.

METHODOLOGY: Using the Helios, Ulysses, Wind, ACE, PSP and Solar Orbiter observations, we will first identify the intervals of the ASSW with machine learning technique. In the following, we will investigate their properties and distributions with solar cycles. Then, we will compare the inner heliosphere observations with that at 1 AU to figure out the radial evolutions of the ASSW. Moreover, we will trace the ASSW back to the source regions with PFSS model. Finally, we will combine the model results with the compositional signatures to identify the origins of ASSW.

RELEVANCE: The proposed works on the Alfv nic slow wind over multiple solar cycles are highly relevant to the Focused Science Topics of the Living With a Star Science: Understanding the Large-Scale Evolution of the Solar Wind throughout the Heliosphere through the Solar Cycle".

Publication References:

no references