

Characterizing the Impact of Alfvén Wave Forcing in Interplanetary Space on the Distribution of Near-Earth Solar Wind Speeds

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Broadly, solar wind source regions can be classified by their magnetic topology as intermittently and continuously open to the heliosphere. Although solar wind speed is a rough proxy for source region, it cannot unambiguously identify source region topology. Early models of solar wind acceleration cannot account for the fastest, nontransient speeds near Earth; energy must be deposited beyond the Sun, likely from Alfvén waves or thermal pressure gradients depending on the source region.

Using near-Sun observations of the solar wind's kinetic energy flux, we predict the expected flux near Earth and find that the near-Sun measurements are sufficient to account for the distribution of the fastest, nontransient speeds in the fast solar wind. Applying a recently developed model of solar wind evolution in the inner heliosphere, we attribute the acceleration required to produce these speeds to continuous Alfvén wave energy deposition during propagation through interplanetary space. We infer that the solar wind's Alfvénicity can map near-Earth observations to their source regions because the Alfvén wave forcing experienced in transit is a consequence of source region topology.