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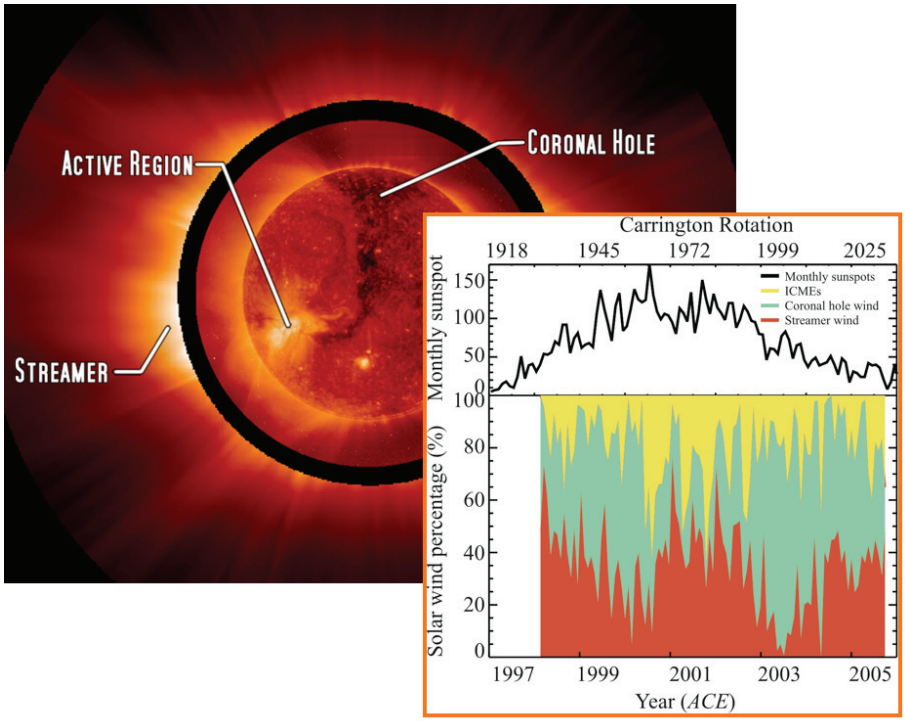
Global Distribution of Slow Solar Wind during Solar Cycle 23



Based on the temporal and spatial behavior of solar wind plasma, there appear to be at least three distinctly different source regions near the Sun (see left side of the figure). It is generally agreed that coronal holes are the origin of the faster, cooler, and steadier solar wind. There is also agreement about the association of interplanetary coronal mass ejections (ICMEs) with CMEs near the Sun. However, there is a third type of wind, usually called the slow wind, whose origin is not understood, even though it has been observed since the beginning of the space age. In general, slow solar wind is observed near heliospheric current sheets associated with coronal streamers, which often overlay active regions. It is puzzling that the elemental and charge state compositions of slow and fast wind are so different.

This study focuses on the overall contributions of each of the solar wind sources during the solar cycle. Unusually hot charge-state distributions of oxygen in the solar wind provide one of the most reliable signatures for ICME plasma (ACE News #84). Similarly, cool oxygen charge-state distributions are a reliable signature of coronal-hole wind, while the slow wind has intermediate charge-states. All three solar wind types can be identified by their charge-state signatures without assumptions about the dynamic evolution of the solar wind, making it possible to analyze the distribution of streamer wind (slow wind), coronal-hole wind (fast wind), and ICME wind during the solar cycle and relate these to the evolving structure and topology of the global solar magnetic field.

The measured distributions (based on ACE/SWICS data) are shown on the right side of the figure along with the sunspot number as a solar cycle signature. Most strikingly, streamer solar wind provides a substantial (~43% on average) and often dominant part of the solar wind plasma near Earth, as shown in red. The percentage of ICME-associated wind (yellow) strongly depends on solar activity. Coronal holes provide ~37% of the solar wind near Earth. Comparisons with potential field models indicate that the width of the slow solar wind regime around the heliospheric current sheet is ~ 23° during the entire solar cycle.

This is the first comprehensive analysis of the near-Earth solar-wind composition over an entire solar cycle. It provides important parameters for models of the origin of steamer wind. Clearly, this wind is an important part of the heliosphere and not just a boundary effect near coronal holes.

This item was contributed by Liang Zhao and Thomas Zurbuchen of the University of Michigan. See http://www.srl.caltech.edu/ACE/ACENews_Archives.html for an archive of earlier ACE News items. Address comments and questions to lzh@umich.edu.