ACE News #143 -- October 17, 2011
Radial Variation of the Solar Wind Temperature-Speed Relationship

The solar wind temperature (T) and speed (V) are usually well correlated except in Interplanetary Coronal Mass Ejections (ICMEs). This lack of correlation is a widely used ICME signature. Near Earth (1 AU) the temperature-speed (T-V) relationship is typically well described by a single linear fit; however, we find the relationship significantly evolves with distance. Often scatter plots of temperature and speed are used to examine the relationship, but the large number of overlapping points and large spread make it difficult to determine the T-V distribution shape. To eliminate this problem, we bin the data in both T and V color-coding the number of samples in given bins (top row). Close to the Sun (<0.52 AU) the Helios measurements indicate a sharp transition between the fast and slow wind (top-left panel). In the ACE measurements (~1AU), the fast-slow wind transition is softer (top-middle). At ~2.5 AU in the Ulysses measurements a population of points with higher temperatures begins to develop, and by 4 AU this heated component is well developed (top-right). Using a running speed-time slope criterion to sort compressions and rarefactions reveals dynamic interactions, which occur when solar wind parcels of different speeds encounter one another (bottom row). At distances less than 0.52 AU, the compression and rarefaction T-V curves overlap, but beyond 4 AU the separation is dramatic. By comparing the color distribution (top-right) to the line plot (bottom-right), it is clear that the heated component is compressed material.

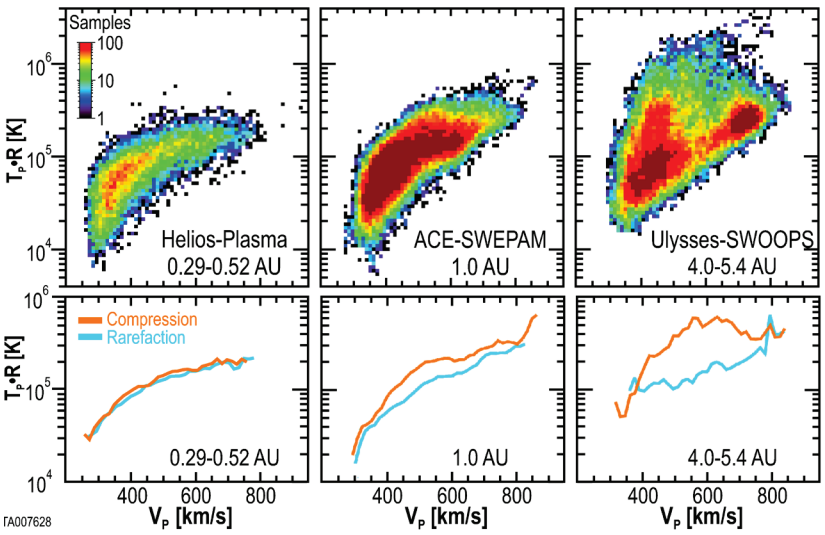

Figure: *Solar wind speed and temperature normalized by the radial distance (to remove spherical expansion affects) measurements from Helios, ACE, and Ulysses for given distance ranges with Interplanetary Coronal Mass Ejections removed.* ***Top Row:*** *Binned temperature and speed measurements with color indicating the number of samples.* ***Bottom Row:*** *Corresponding average temperatures binned by speed separately for compressions and rarefactions.*

Since sorting compressions and rarefactions clearly demonstrates dynamic effects, our techniques can be applied to outer heliospheric measurements to examine how the T-V relationship is affected by the solar wind interacting with interstellar pickup ions. Solar Orbiter and Solar Probe Plus should observe a sharper fast-slow wind transition, and the solar wind variability should reflect source properties and not dynamic interactions. These missions may resolve multiple sources of the slow wind, and determine why moderate speed wind (500-650 km/s) originates from small coronal holes and edges of large coronal holes. The moderate wind may be from a boundary layer region in the photosphere or chromosphere at the edges of large holes (with small holes being mostly boundary layer), a difference in acceleration in the corona, or additional fast-slow wind dynamic interaction in the low corona not distinguishable by 0.29 AU.

Submitted by Heather A. Elliott & David J. McComas (Southwest Research Institute), Carl. J. Henney (Air Force Research Laboratory), and Charles W. Smith, & Bernard J. Vasquez (University of New Hampshire). Address comments or questions to helliott@swri.edu. See http://www.srl.caltech.edu/ACE/ACENewsArchives.html for earlier ACE News item archives.