Background

The supersonic solar wind produces a termination shock. The interstellar medium (ISM) will form a heliospheric bow shock if it is supersonic with respect to the heliopause. The speed of the ISM is 26 km/s, the magnetosonic velocity is not well known, with estimates of 12 to >26 km/s plausible. Thus it is not certain whether or not a heliospheric bow shock will form. Figure 1 shows a schematic of the geometry.

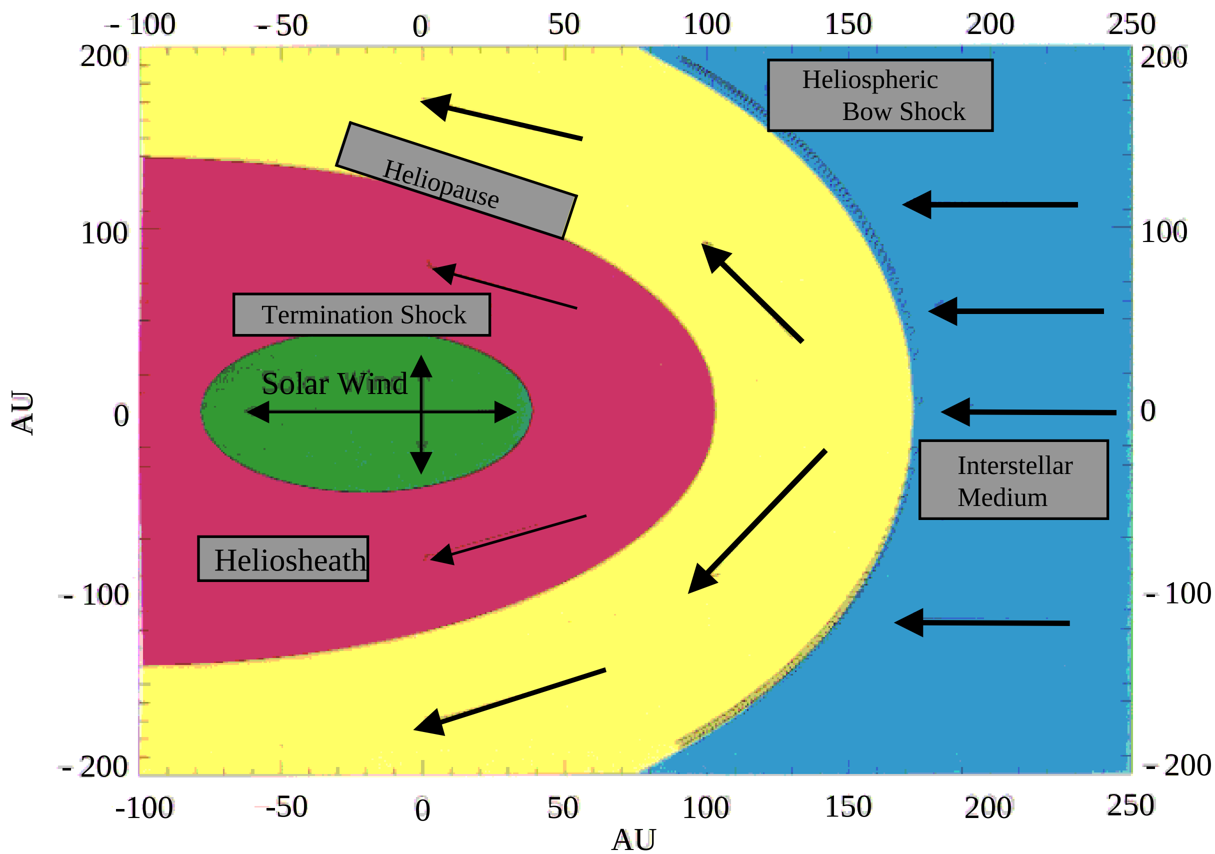

Figure 1. Schematic rendering of the solar wind interaction with the interstellar medium. The solar wind slows at the termination shock and moves downstream. The heliopause separates the solar wind and interstellar medium. If the interstellar medium is supersonic with respect to the heliopause a heliospheric bow shock will form.

New Suggestion

The solar wind dynamic pressure varies by a factor of 2 over a solar cycle, as shown in Figure 2. This variation is characterized by a minimum in pressure at solar maximum and a sharp rise in pressure after solar maximum.

The response of the heliopause to these changes is unknown but is a topic of active modeling work. Assuming instantaneous equilibrium gives the helio-pause position shown in Figure 2 and 300-day smoothed profile of heliopause velocity shown in Figure 3, the heliopause speeds are large compared to the speed of the ISM. For outward motion the ISM is supersonic with respect to the heliopause. For a ISM magetosonic speed of 20 km/s the dividing line between subsonic and supersonic flow is shown by the dotted line in Figure 3 top panel. Thus the ISM would expect to be alternately supersonic and subsonic with respect to the heliopause and the bow shock to dissipate and form.

Predictions

1) When the heliospheric bow shock is present, the ISM will be heated (both the plasma and the neutrals which are coupled to the plasma). This variation should be observable via Earth-based measurements.

2) This process may be related to the generation of the heliospheric radio emmissions. Figure 3 compares the heliopause speed and the spectral density of the 3.11 kHz emissions and shows that the radio emissions lags the outward motion of the heliopause by several years. This is comparable to the time required for the solar wind pressure changes to affect the bow shock.

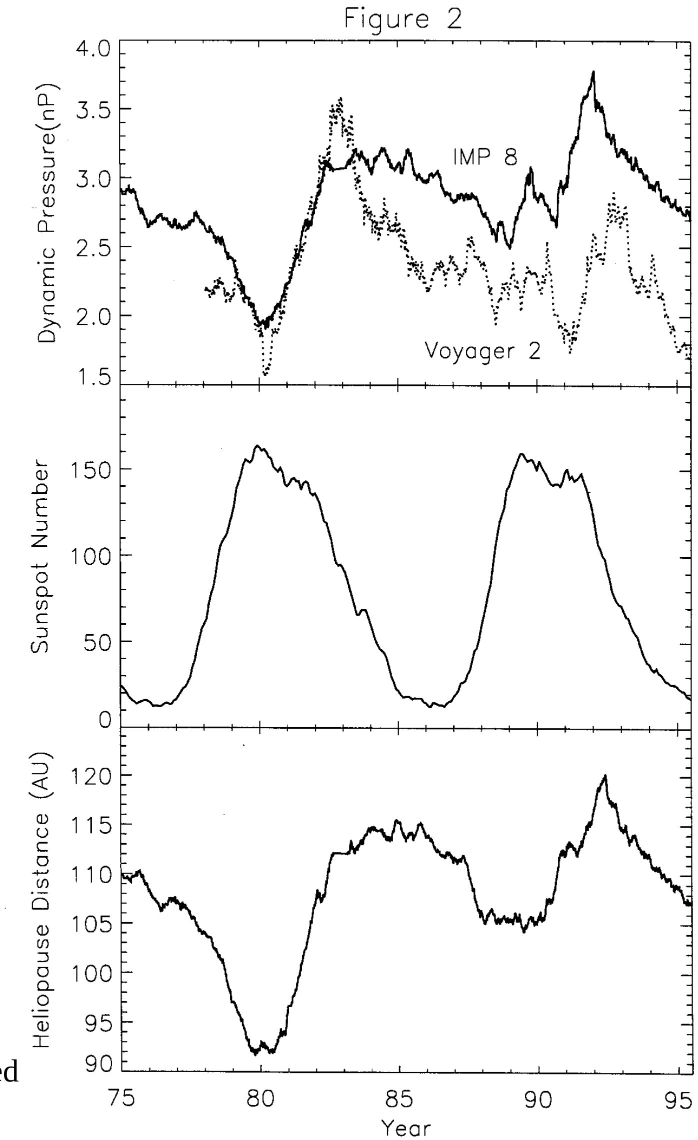

Figure 2. Plot of thesolar wind pressurefrom IMP 8 and Voyager 2, the sunspot number, and the equilibrium heliopause distance. The solar wind pressure changes by roughly a factor of 2 over a solar cycle, probably leading to changes in theheliopause position.

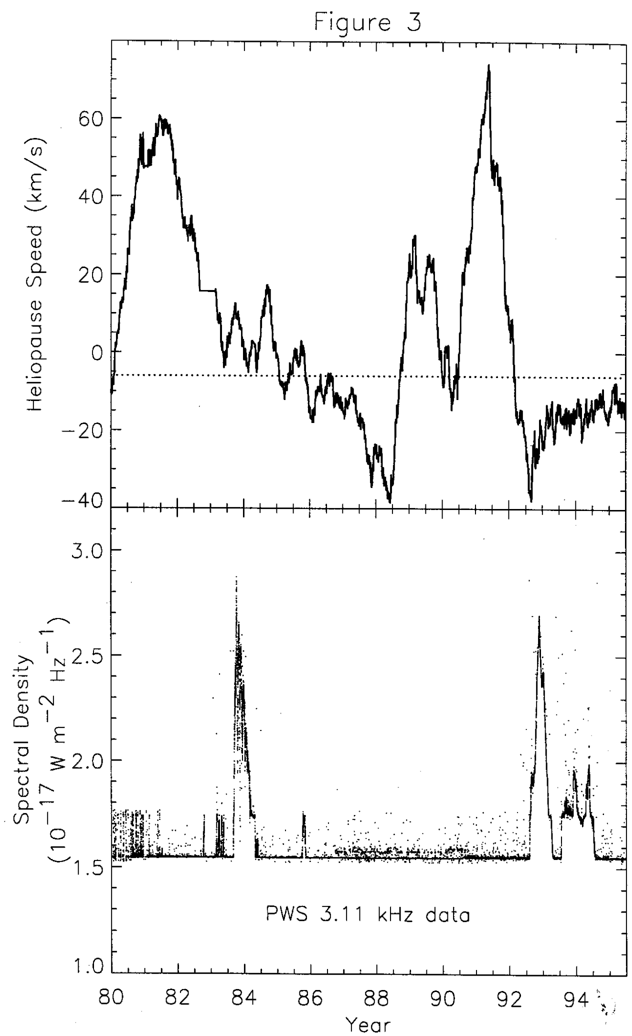

Figure 3. Plot of the heliopause speed assuming a rough equilibrium is maintained with the solar wind pressure. The dotted line is the dividing line between regimes where a bow shock will and will not form. When the heliopause speed is above the dotted line a shock should form, when the heliopause speed is below the dotted linea shock will not form. This graph suggests the shock may dissipate over the solar cycle. The bottom panel shows the Plasma Wave 3.11 kHz observations. The plot suggests a relation between outward motion of the heliopause and the start of the emissions with a 2-3 year lag.