RELATIONSHIP BETWEEN DISCONTINUITIES AND ALFVEN WAVES AS FUNCTIONS OF RADIAL DISTANCE AND LATITUDE: ULYSSES

D.T. Tsurutani, C. Ho, E.J. Smith, B.E. Goldstein, M. Neugebauer and J.S. Mok (Jet Prop. Lab., 4800 Oak Grove Dr., Pasadena, Calif., USA)
A. Balogh and D.J. Southwood (Imperial College, London, England)
W.C. Feldman (Los Alamos Nat. Lab., Los Alamos, New Mexico, USA)

We examine the normalized rate of occurrence of discontinuities as Ulysses travels from 1 to 5 AU and then to high heliographic latitudes. High discontinuity occurrence rates are found in two regions of interplanetary space: in stream-stream interaction regions and in Alfvenic wave intervals typically associated with the trailing portions of high speed streams. For the latter case, the discontinuity rate remains high even as the Alfven wave amplitude declines. The relationship between discontinuities and Alfven waves becomes particularly clear at high latitudes. As Ulysses enters a high-speed stream from a polar coronal hole the field is characterized by continuous Alfven waves with $\delta B/B \approx 1.2$. The discontinuity rate is ≈ 150 / day, approximately 2-3 times higher than that found in the ecliptic plane at 1 AU. We have also examined the detailed relationship between these discontinuities and Alfven waves. We find that the discontinuities are an integral part of the Alfven waves, comprising $\approx$ 180 deg phase rotations and the slow rotating part of the Alfven waves, the return $\approx$ 180 deg phase rotations. We argue that these nonlinear Alfven waves have been steepened and the discontinuities represent the steepened edges.