

STRUCTURE OF COHERENCE BETWEEN MAGNETIC FIELDS
AT ACE AND GOES-10

Thomson, D.J.
Queen's University.

The presence of persistent periodic components in earth's ionosphere and magnetosphere have been reported for decades but have remained controversial. Here I show evidence that they are forced by the normal modes of the sun and describe some of the reasons for the controversy.

First, coherences computed between the Y and Z (duskward and poleward) components of the magnetic field at the ACE spacecraft are found to be highly coherent with the hn and hp (\approx East and North) components of the magnetic field on the GOES-10 geosynchronous satellite out to the common Nyquist frequency of $\approx 8mHz$. (The radial components appear to be less coherent.) This coherence is easily detected using multitaper methods and, on single blocks of several days duration, it is typical to have more than 50% of the estimates above the nominal 90% point with particularly high coherences in the $3mHz$ band associated with solar p -modes. AS a specific example, the magnitude-squared-coherence (MSC) between ACE Z and GOES hn in Jan. 1999 exceeded 0.94 between ~ 2800 and $3300\mu Hz$, significant at over 7σ . Canonical coherences between the two pairs of components at ACE and GOES are even higher. Despite the presence of such high coherences on individual blocks of a few day's duration, simple calculations of the long-term average coherence give low values. There appear to be three distinct reasons for this: First, the ratio of peak-to-background spectrum at ACE has a pronounced two cycle/year dependency that is 180 degrees (3 months) out-of-phase with the usual Russell-McPherron dependency of geomagnetic "disturbances" Second, the phase of the coherences computed at different times vary. Third, as one should expect, the coherences between ACE and GOES shifted by one cycle/day ($11.57\mu Hz$) are commonly higher than coherences at the same frequency. Thus, taking data segments too short to resolve a few μHz give particularly unreliable coherences.

An explanation for these observations is that, in the solar g - and p -mode bands, the phase estimates imply propagation at nearly the speed of light (that is the fast plasma mode) but, above the p -mode band, propagation drops to the Alfvén speed. The velocity of propagation in a plasma depends critically on the plasma density, so the varying density of the solar wind modulates the phase shift seen between ACE and GOES. The modal signals are also coherent with solar surface velocity measured by the GONG network, pointing unequivocally to a solar source.

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1. (a)

David J. Thomson
411 Jeffery Hall,
Dept. of Mathematics and Statistics
Queen's University
Kingston, ON
K7L 3N6 Canada
djt@mast.queensu.ca

(b) (613) 533-2426

(c) (613) 533-2964

2. C - Signals and Systems

3. (a)

4. C - Contributed Paper

5. Statistical signal processing of waves in random media. Talk could also go in a Comm. B or H section.