The 3D Heliospheric Magnetic Field during Solar Maximum

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From measurements made during the recent slow latitude scan by Ulysses, how has the magnetic field changed from solar minimum to solar maximum? This talk addresses specific questions derived from this more general question. How has the structure associated with fast and slow solar wind streams and their interactions been affected? Do Coronal Mass Ejections significantly restructure the high latitude field? What is the solar origin of the magnetic fields? Is the magnetic flux still uniformly distributed in latitude? How well do solar source surface models describe the sector structure and heliospheric current sheet location at high latitude ? Do Alfven waves continue to be a characteristic feature of fast solar wind streams?

Eslab Symposium
october '00

JPL

SUMMARY

To –70° and 3/4 of Y2000

1. Structure still dominated by IARs/CIRs.
   - ~ Some CMEs observed.
2. Sector Structure is Latitude Dependent and Consistent with Source Surface Models.
   - 4 sectors at ACE, 2 sectors at ULS.
3. Solar Wind, HMF Originate in Low/mid Latitude Coronal Holes.
   - ~Associated with UMRs.
4. r^2B_Y Independent of Latitude.
   - ~Consistent with Magnetic Flux Divergence.
5. Alfvén Waves are Present.
   - ~Long Periods: 1 - 24 Hours.

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SUMMARY

To –60° and 1/2 of Y2000

1. Structure still dominated by IARs/CIRs.
   - ~ Some CMEs observed.
2. Sector Structure is Latitude Dependent and Consistent with Source Surface Models.
   - 4 sectors at ACE, 2 sectors at ULS.
3. Solar Wind, HMF Originate in Low/mid Latitude Coronal Holes.
   - ~Associated with UMRs.
4. r^2B_Y Independent of Latitude.
   - ~Consistent with Magnetic Flux Divergence.
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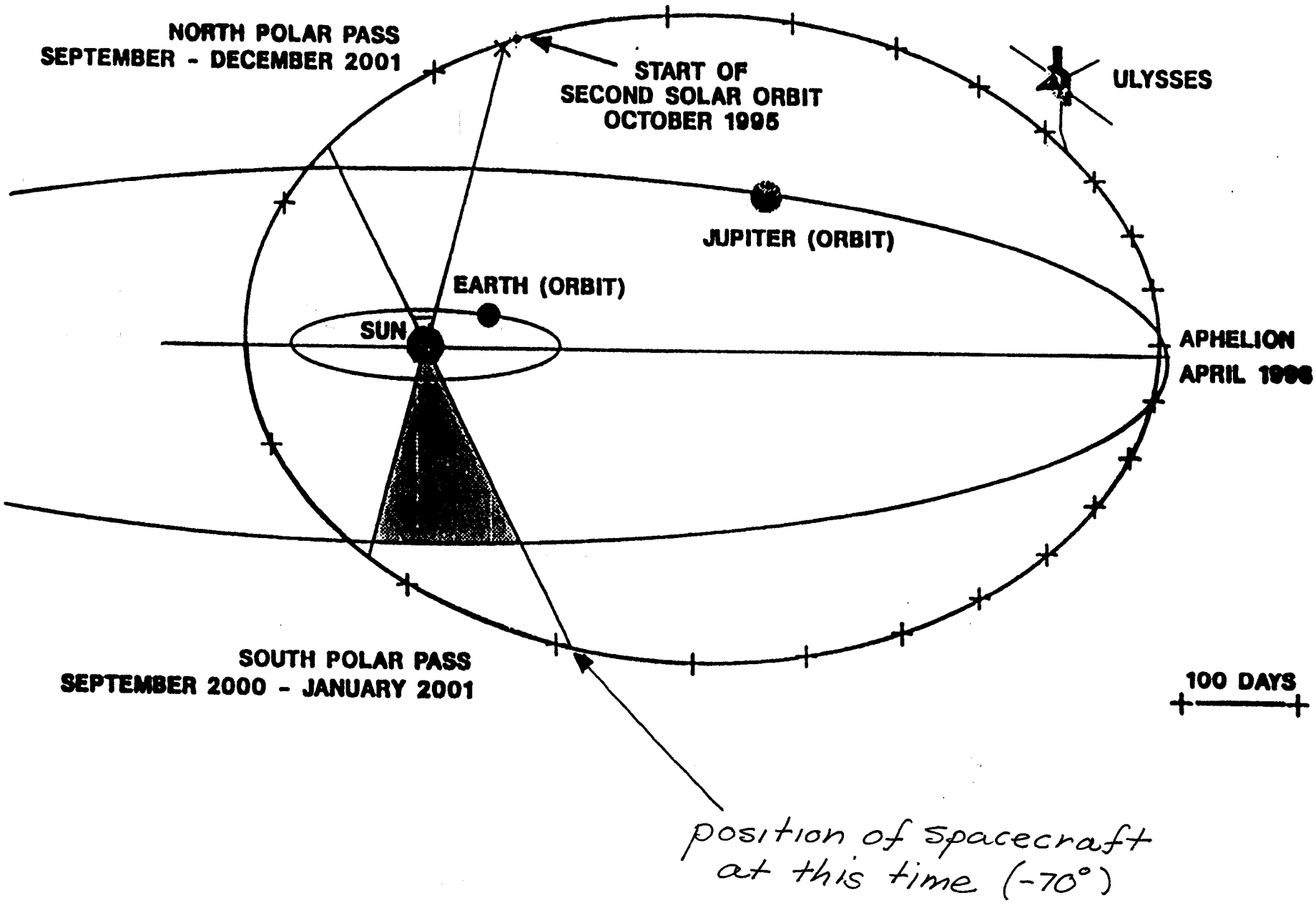
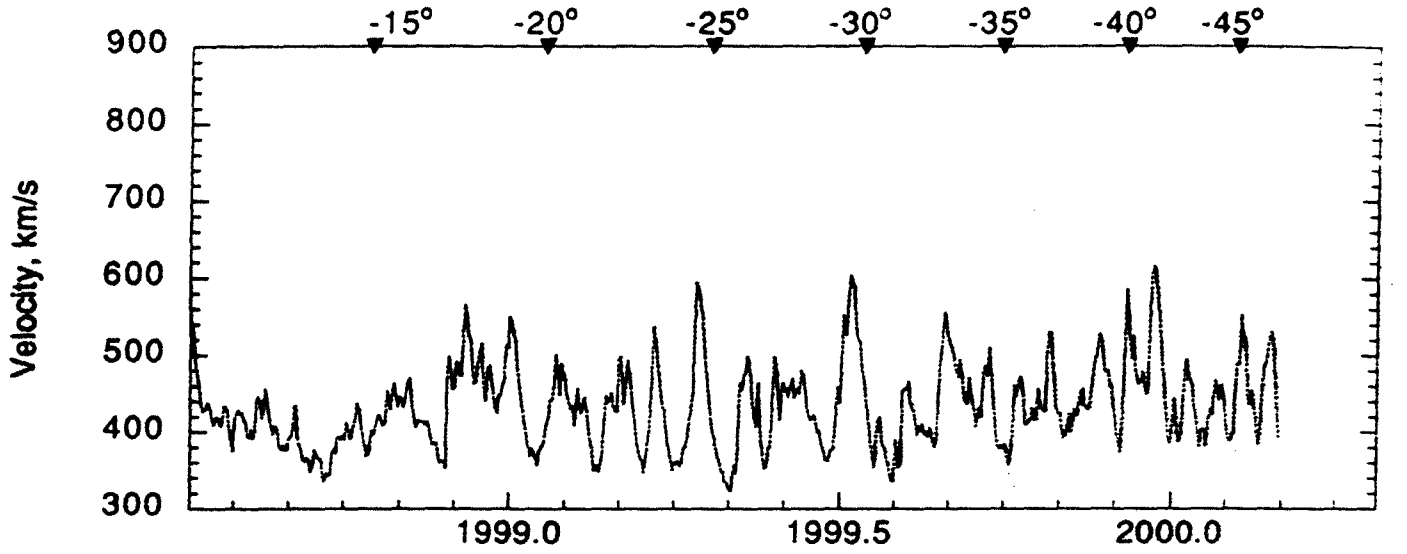
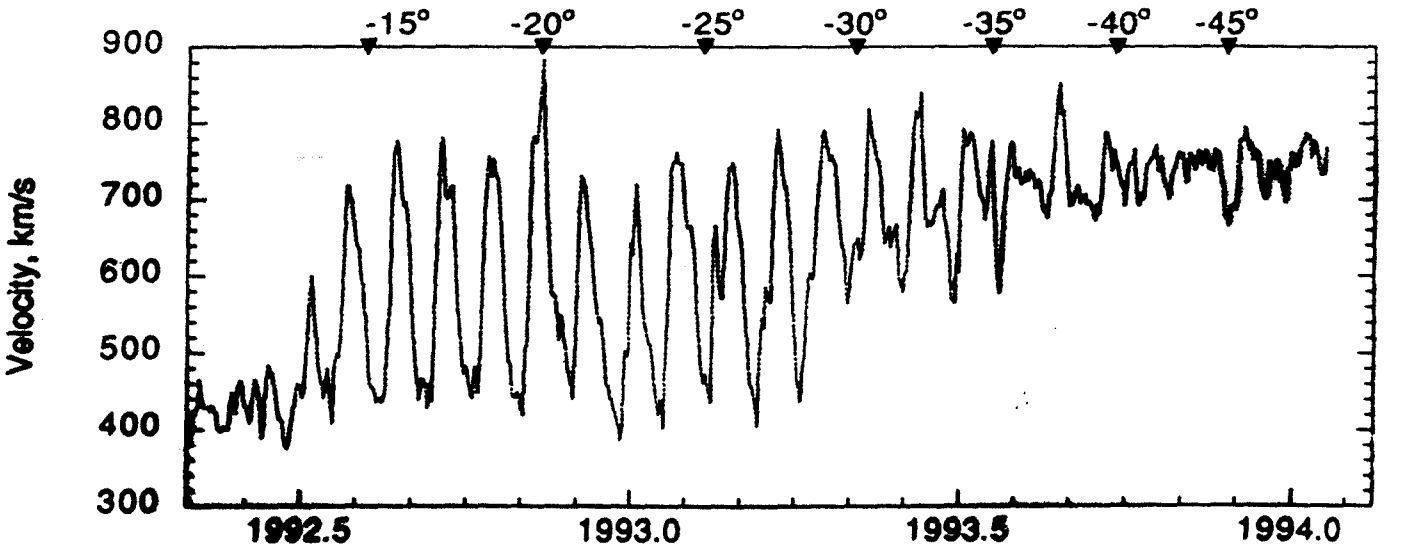
Ulysses second orbit



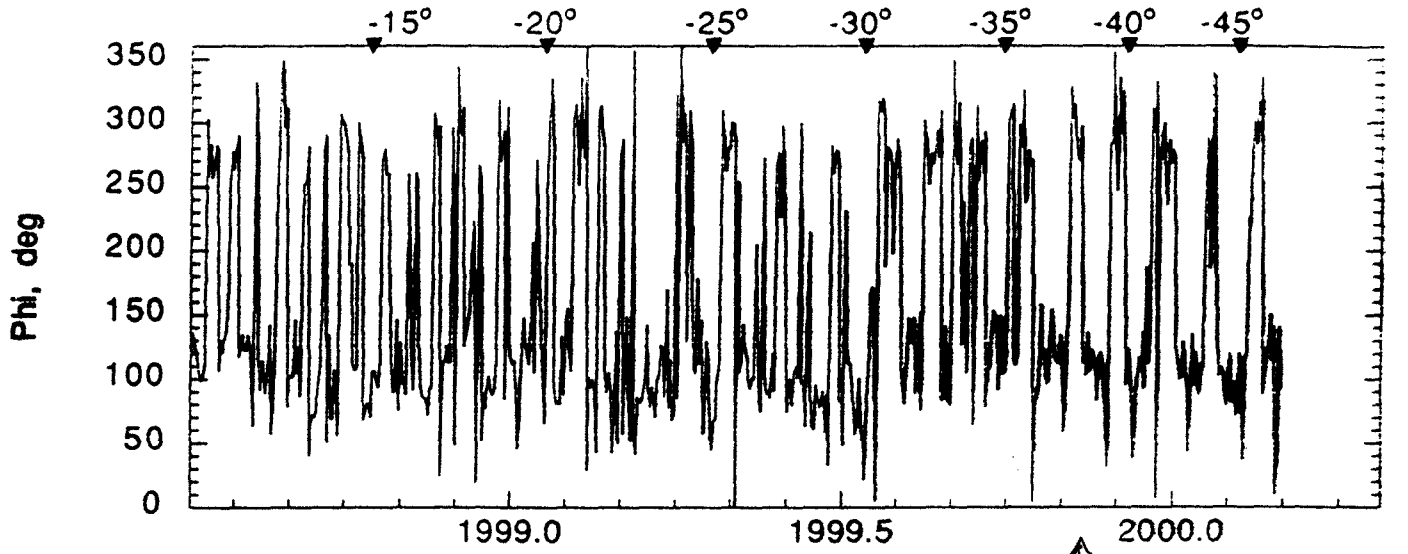
Compares solar wind speed
vs. latitude
at solar minimum (below)
and solar maximum (above)



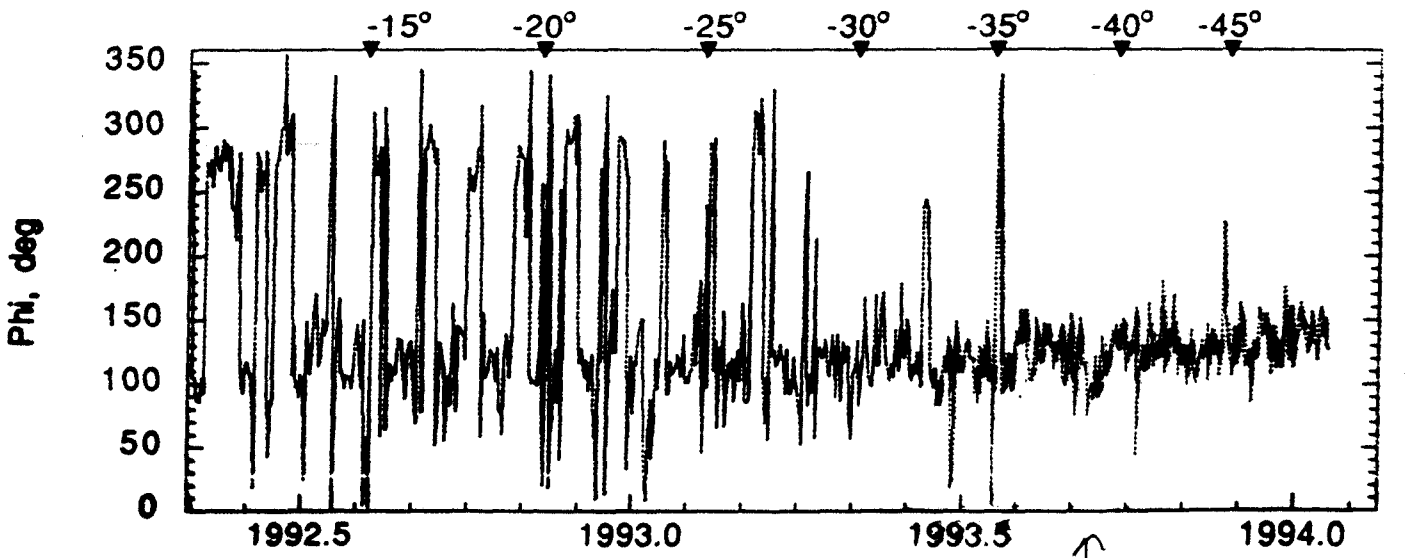


at solar minimum, in high speed
structureless solar wind at
high latitude.

Compares magnetic field spiral angle (phi) at solar minimum (below) and solar maximum (above).

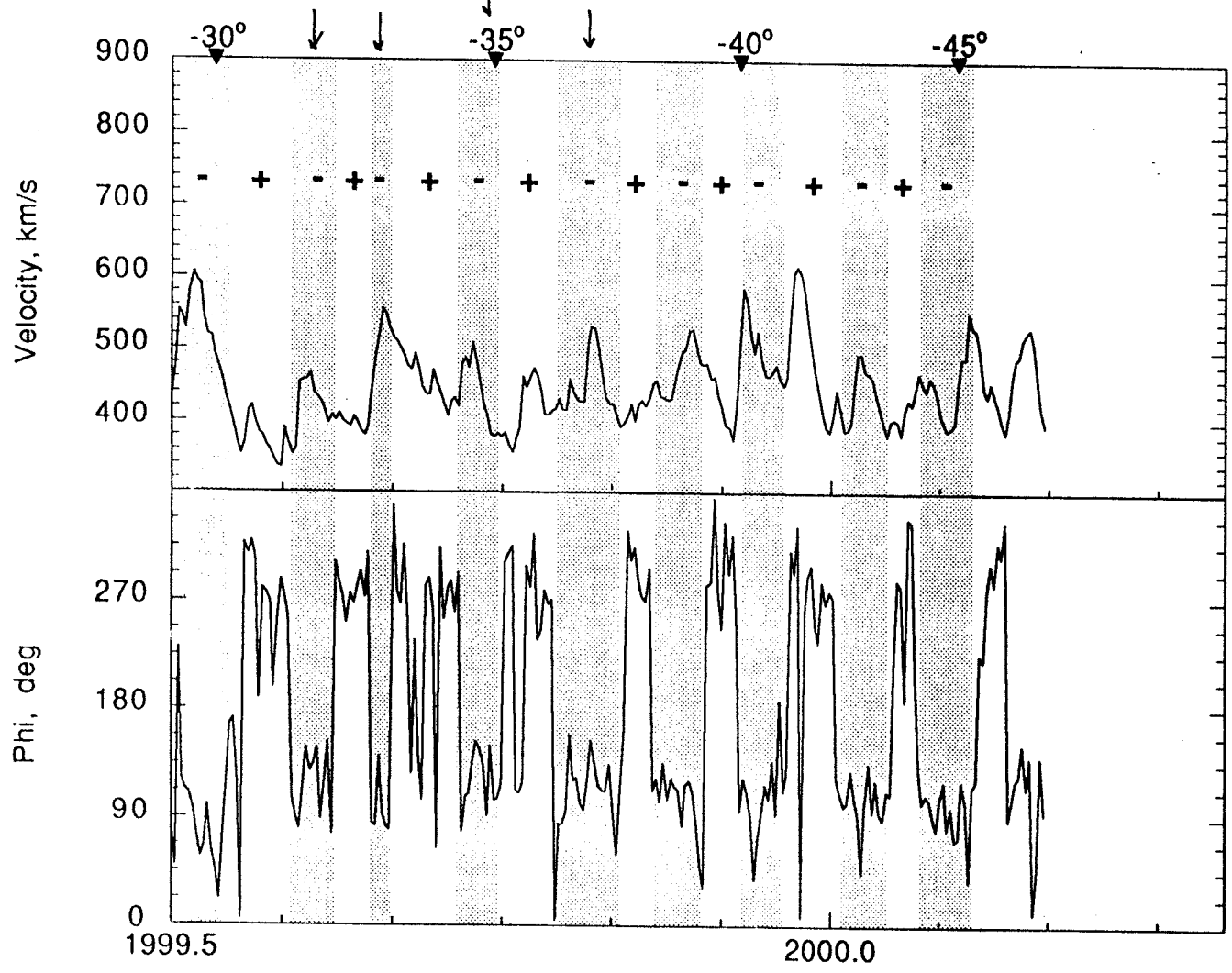


continue to see sector structure at high latitude.

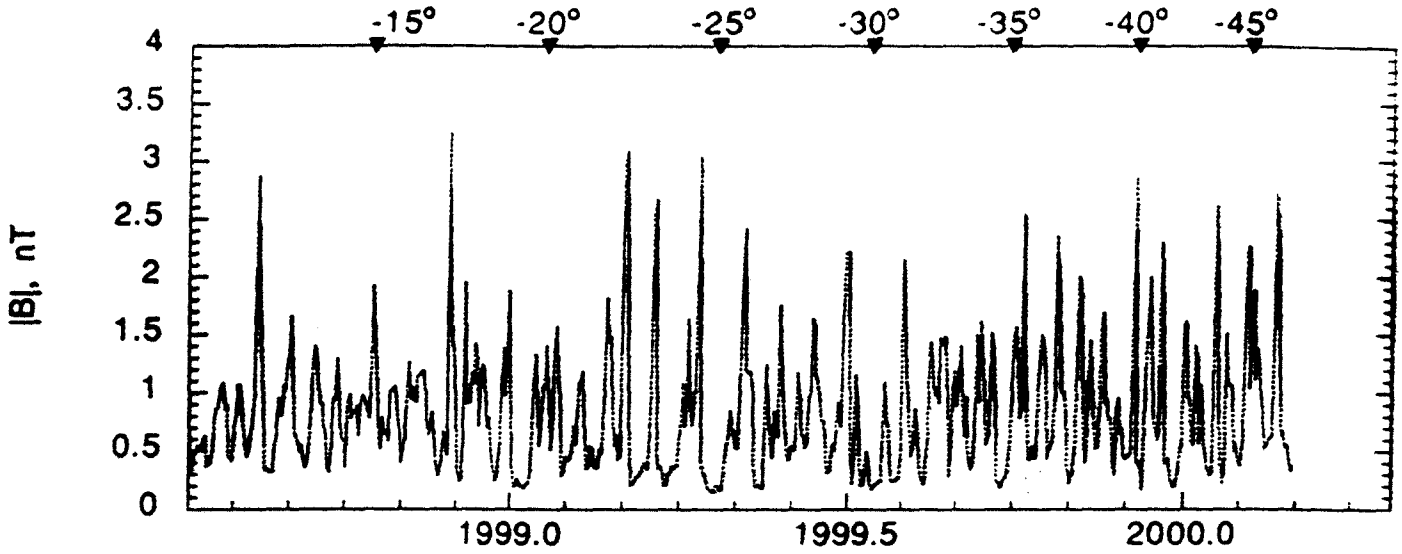


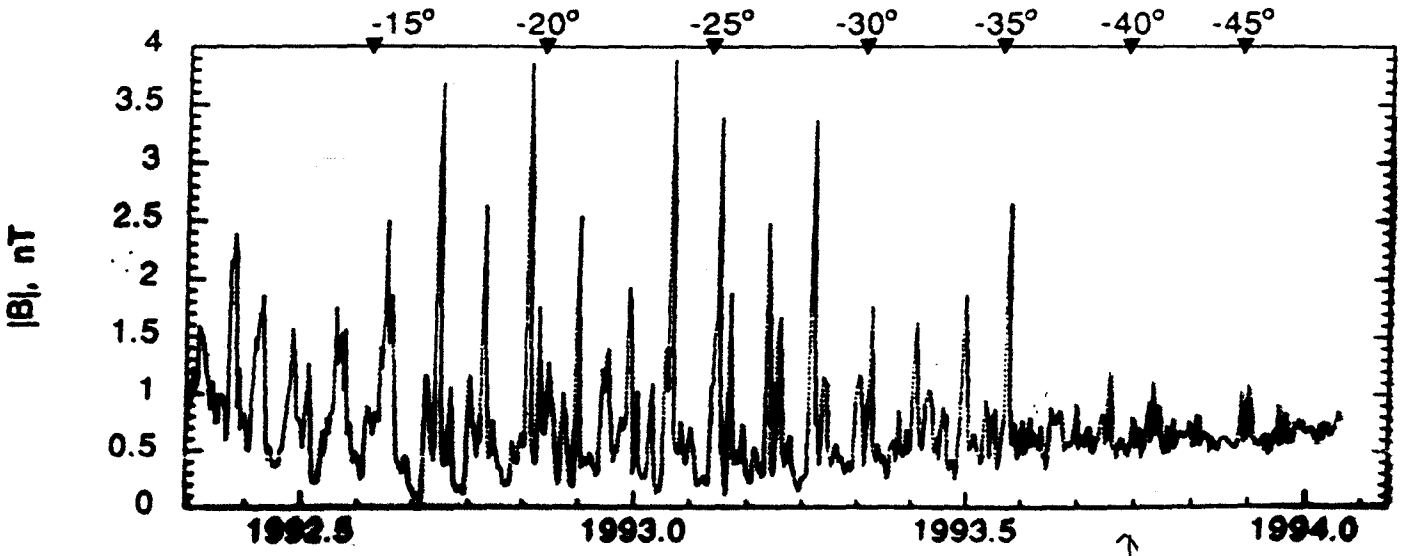
absence of sector structure

Compares solar wind speed (above) and spiral angle (below) - Note correlation between high speeds and negative sectors



Compares magnetic field strength at solar minimum (below) and solar maximum (above).



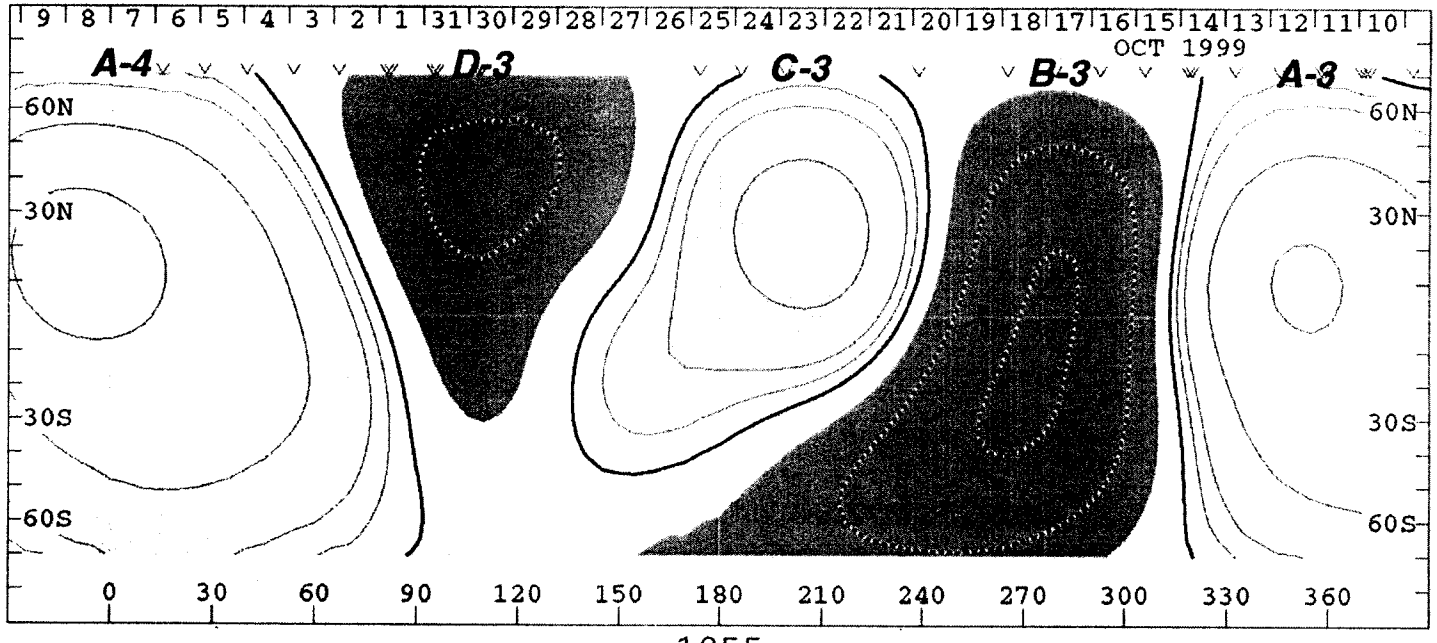


Note absence of "structure".

Magnetic field at solar wind "source surface" at 2.5 solar radii –
See 4 sectors in north and two in south –
Labelled A, B, C, D (increasing time)
"3" refers to third repitition of this pattern.

WILCOX SOLAR OBSERVATORY

WSO - Source Surface Field 0, ±1, 2, 5, 10, 20 MicroTesla

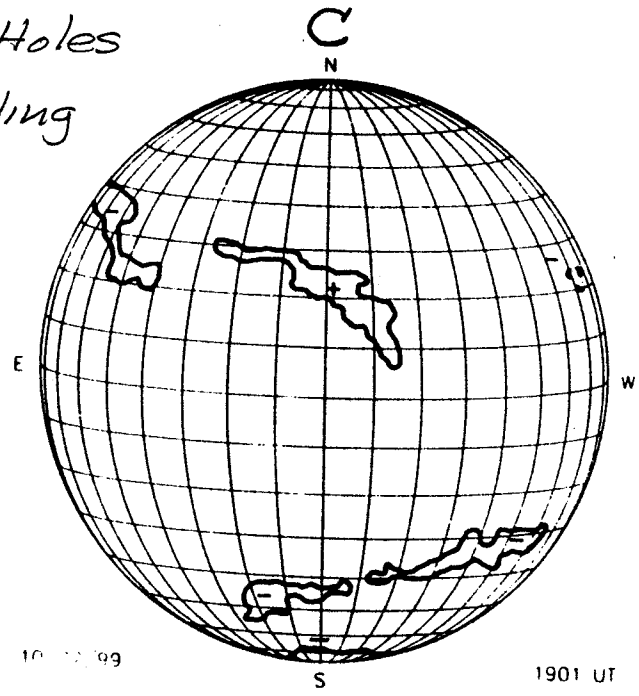


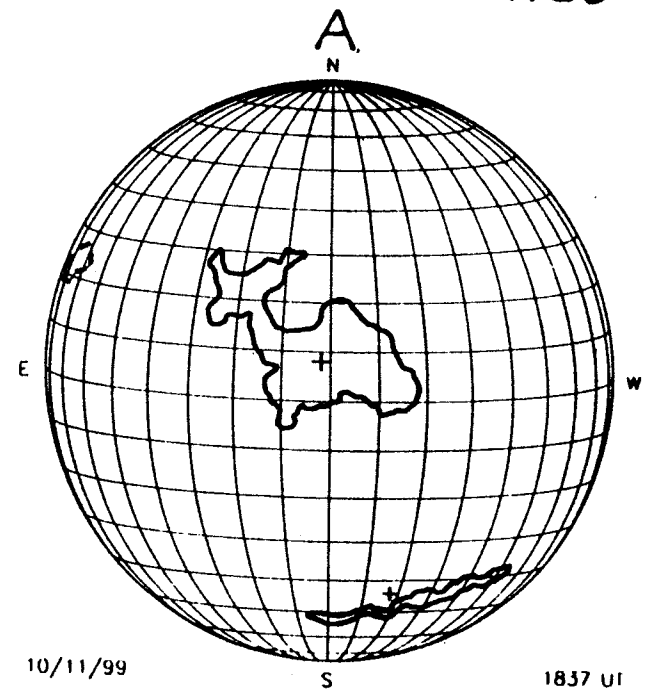
1955

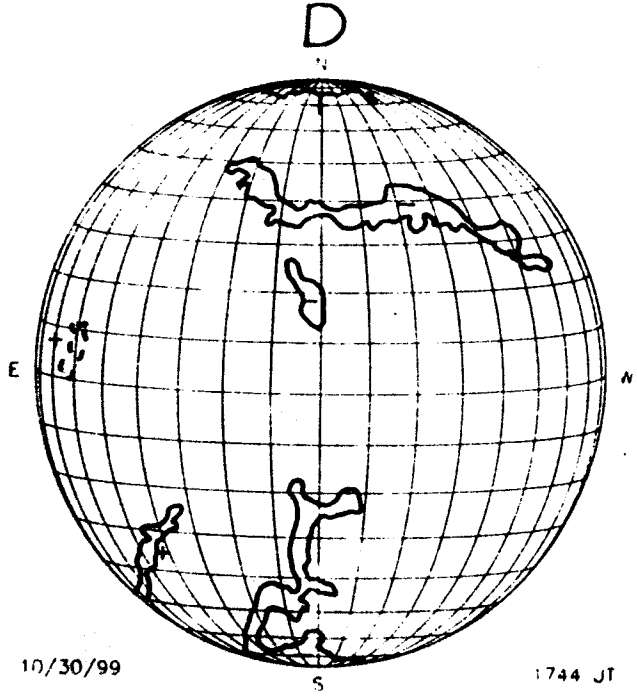
KITT PEAK CORONAL HOLE MAPS HE I 1083 nm

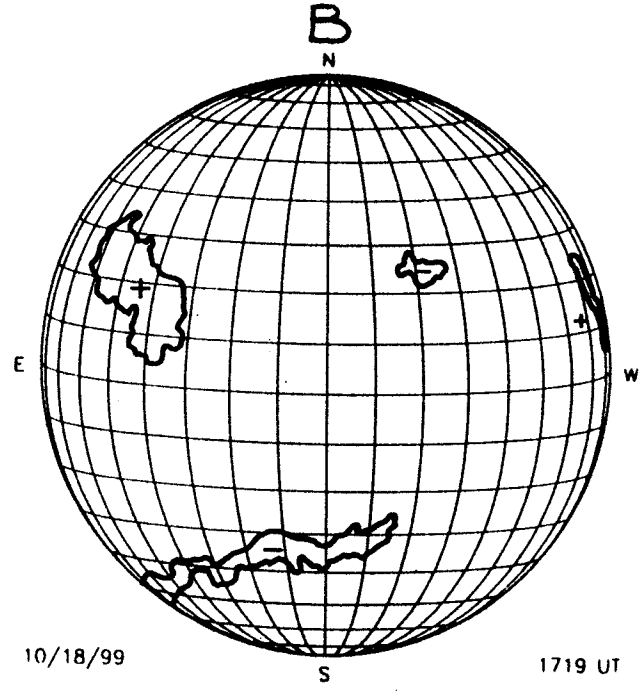
CR 1955

Coronal Holes corresponding to sectors A, B, C, D





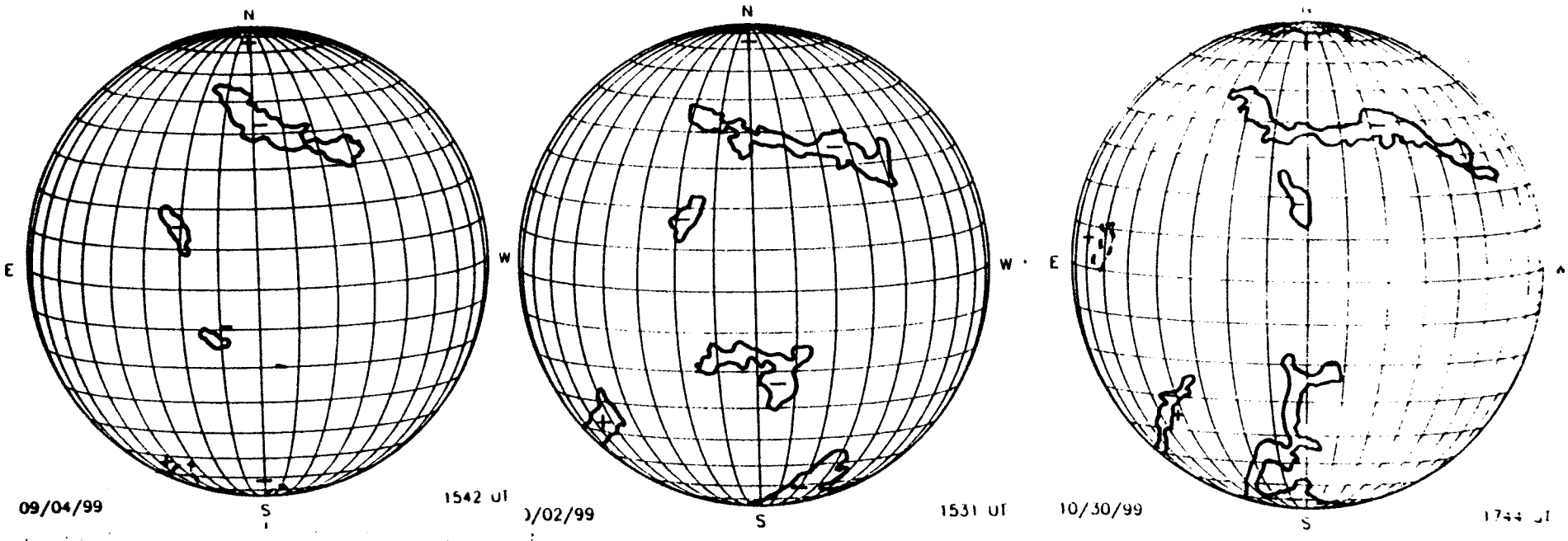




KITT PEAK CORONAL HOLE MAPS HE I 1083 nm

Sector D

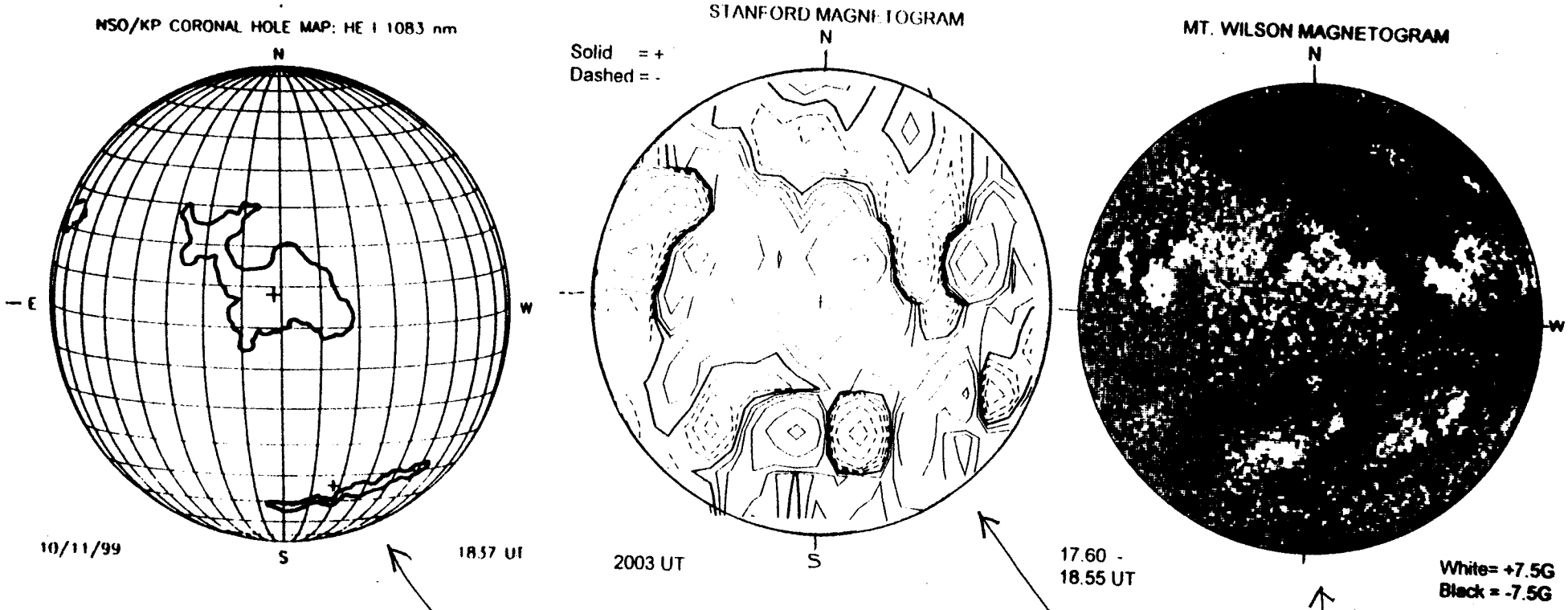
shows recurrence of coronal hole associated with sector D over 3 solar rotations —



CR 1953 CR 1954 CR 1955

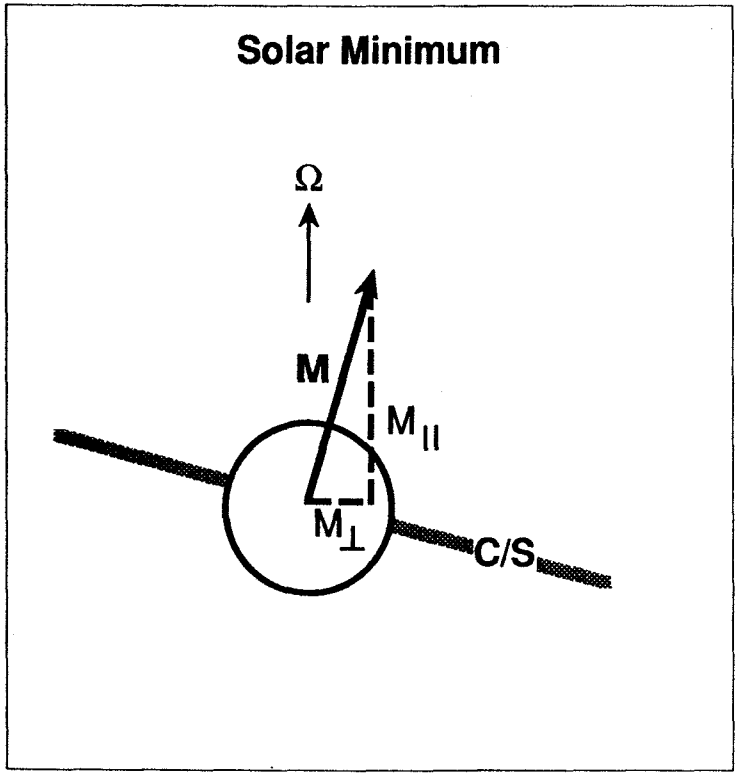
photospheric magnetic fields corresponding to coronal hole, sector A, and two magnetograms
- Stanford : low resolution
- Mt. Wilson : high resolution

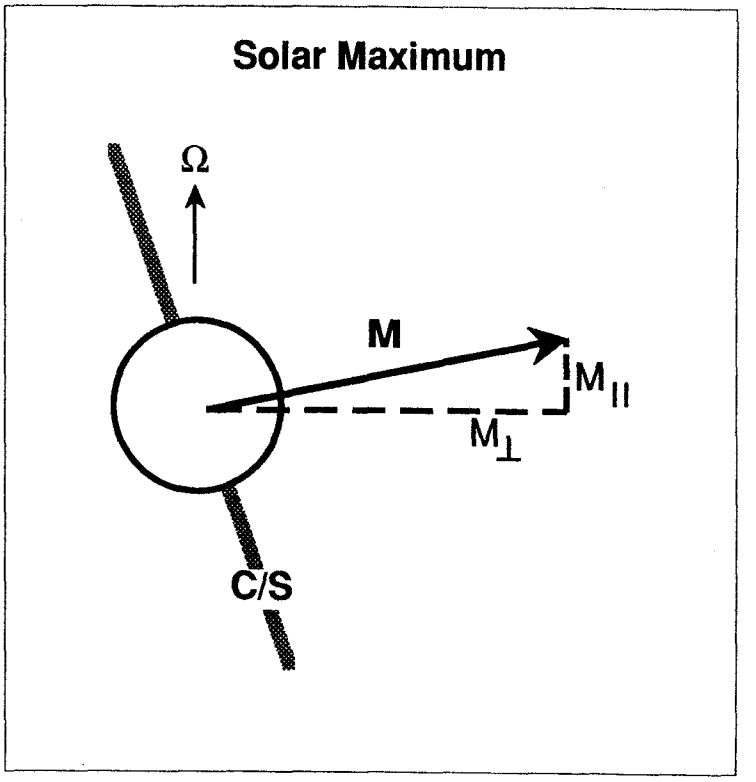
OCTOBER 11, 1999 Sector A



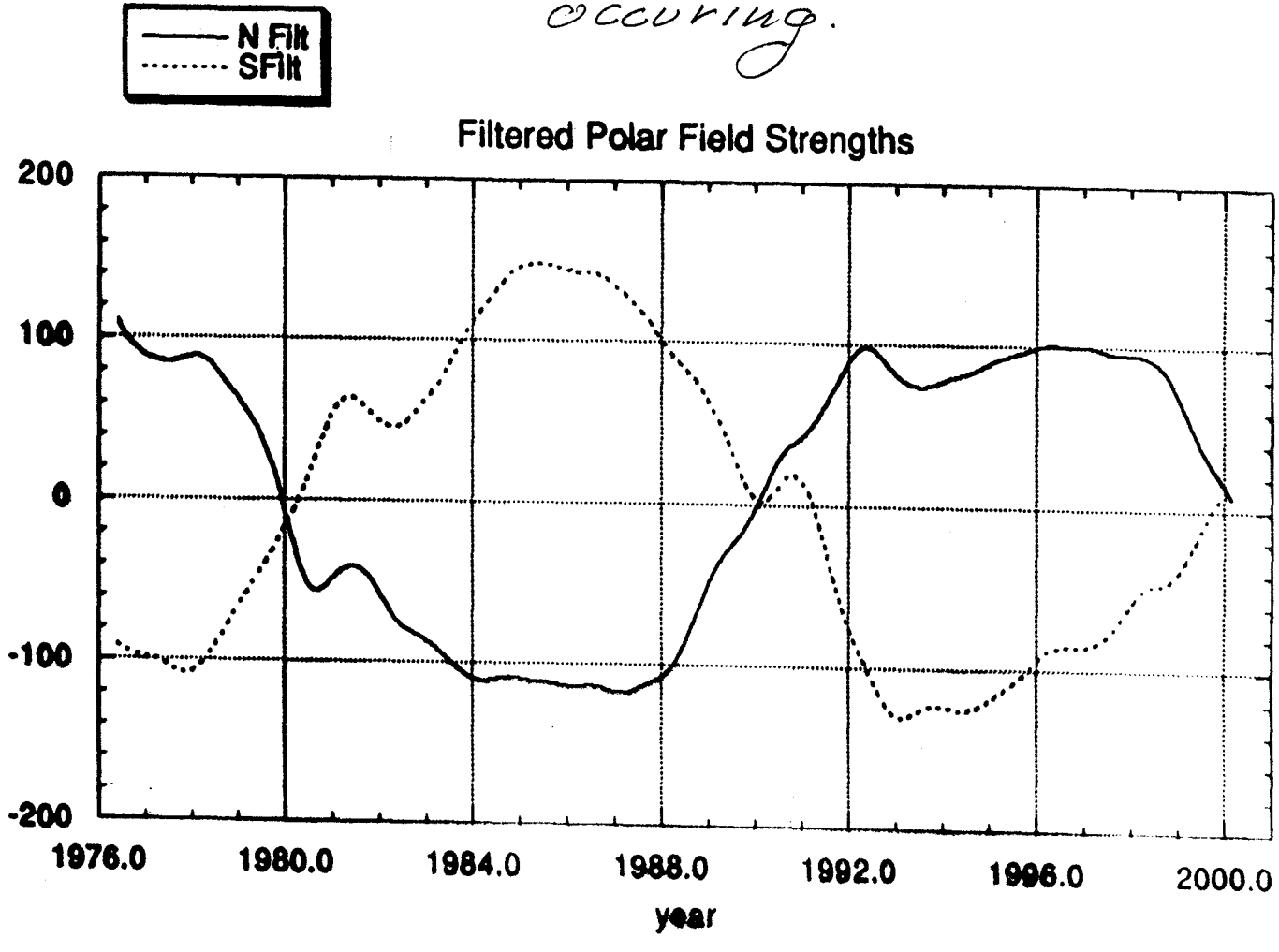
coronal holes coincide with sector A and unipolar magnetic regions

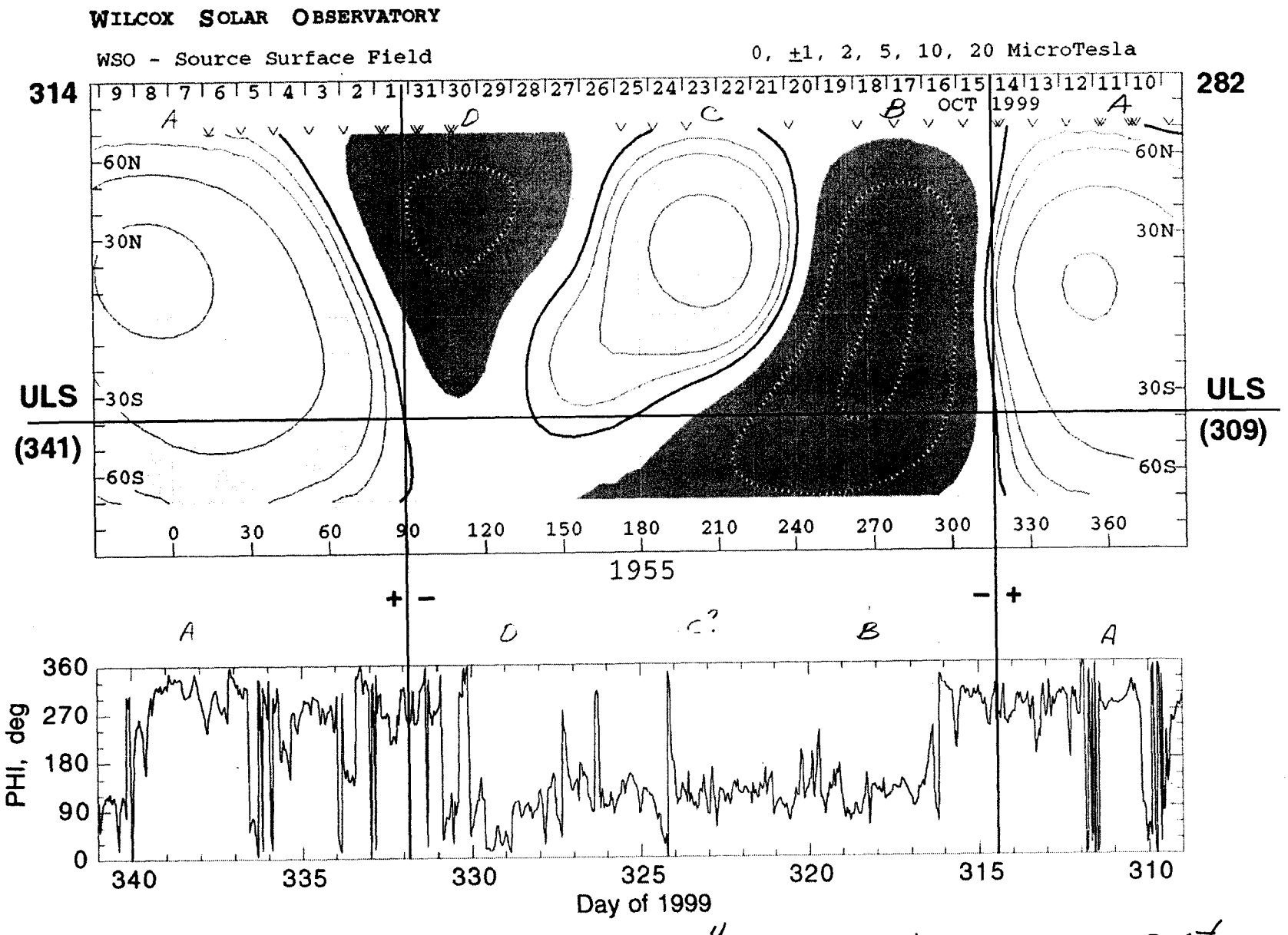
shows how tilt of sun's magnetic dipole and heliospheric current sheet change between sunspot minimum and maximum.





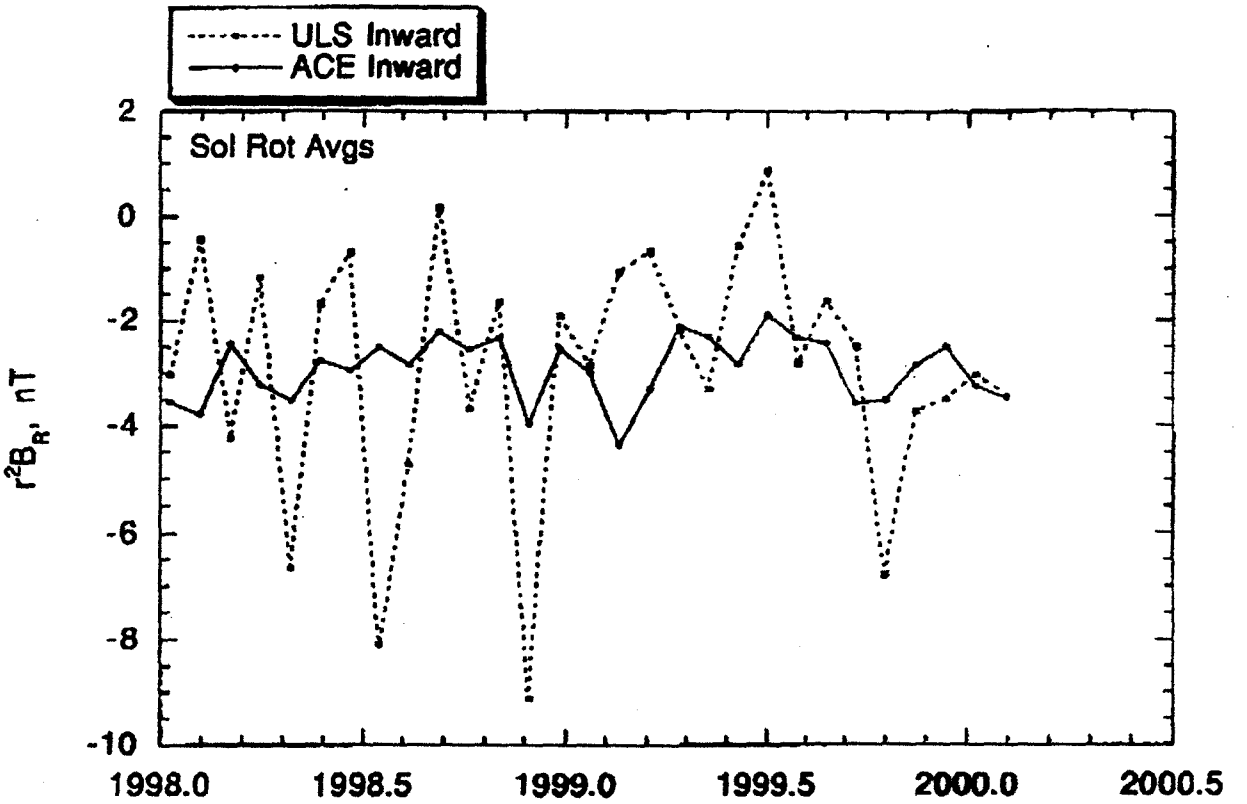
Recent measurements showing the reversal in polarity of the sun's polar cap magnetic fields is already occuring.





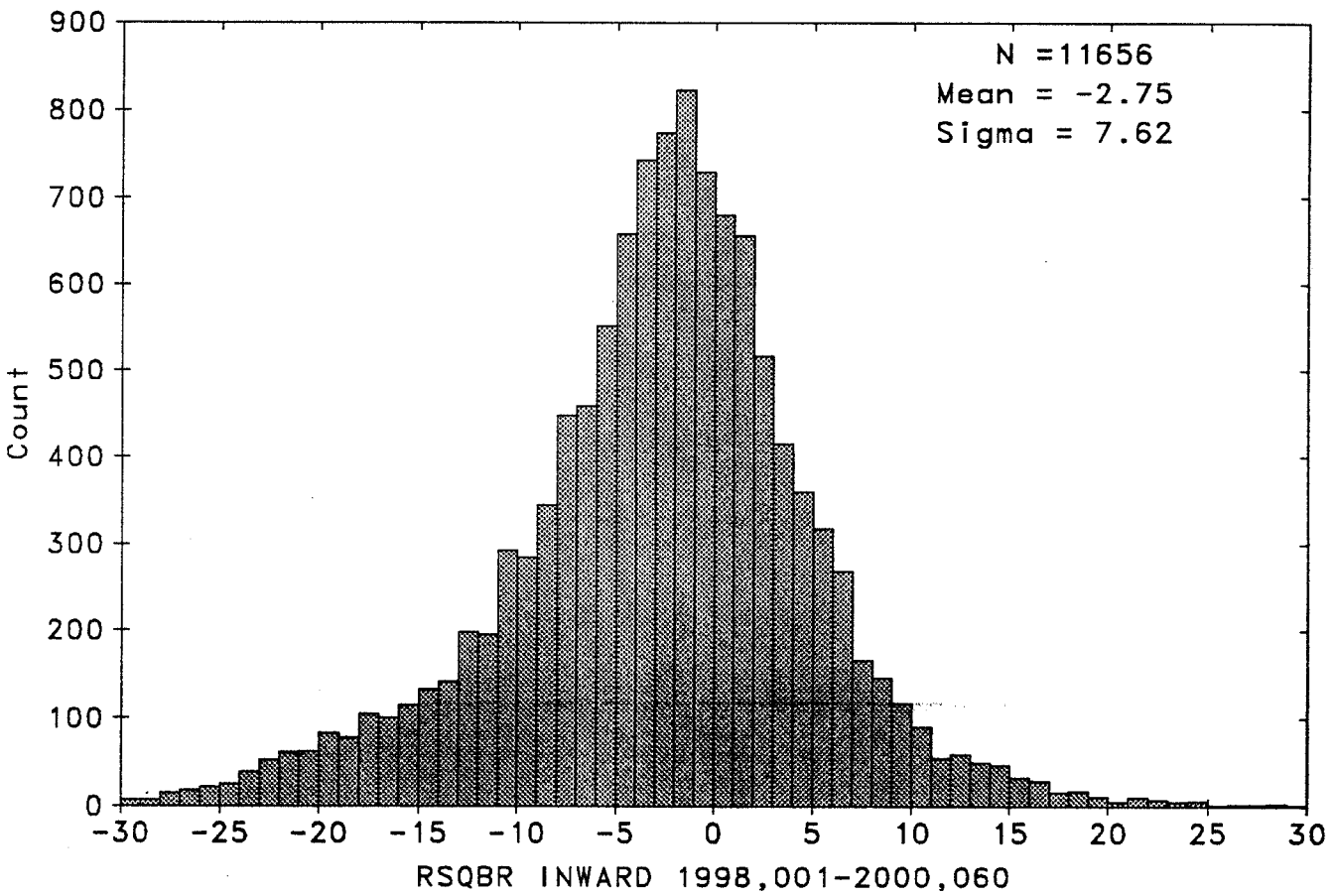
Compares location of "heliospheric current sheet" at "source surface" coincides with current sheet crossings observed at Ulysses.

the magnetic flux
given by $r^2 B_r$
as observed at Ulysses
is independent of latitude
on average.



the Ace data obtained in
the ecliptic show that no
significant time dependence
is involved.

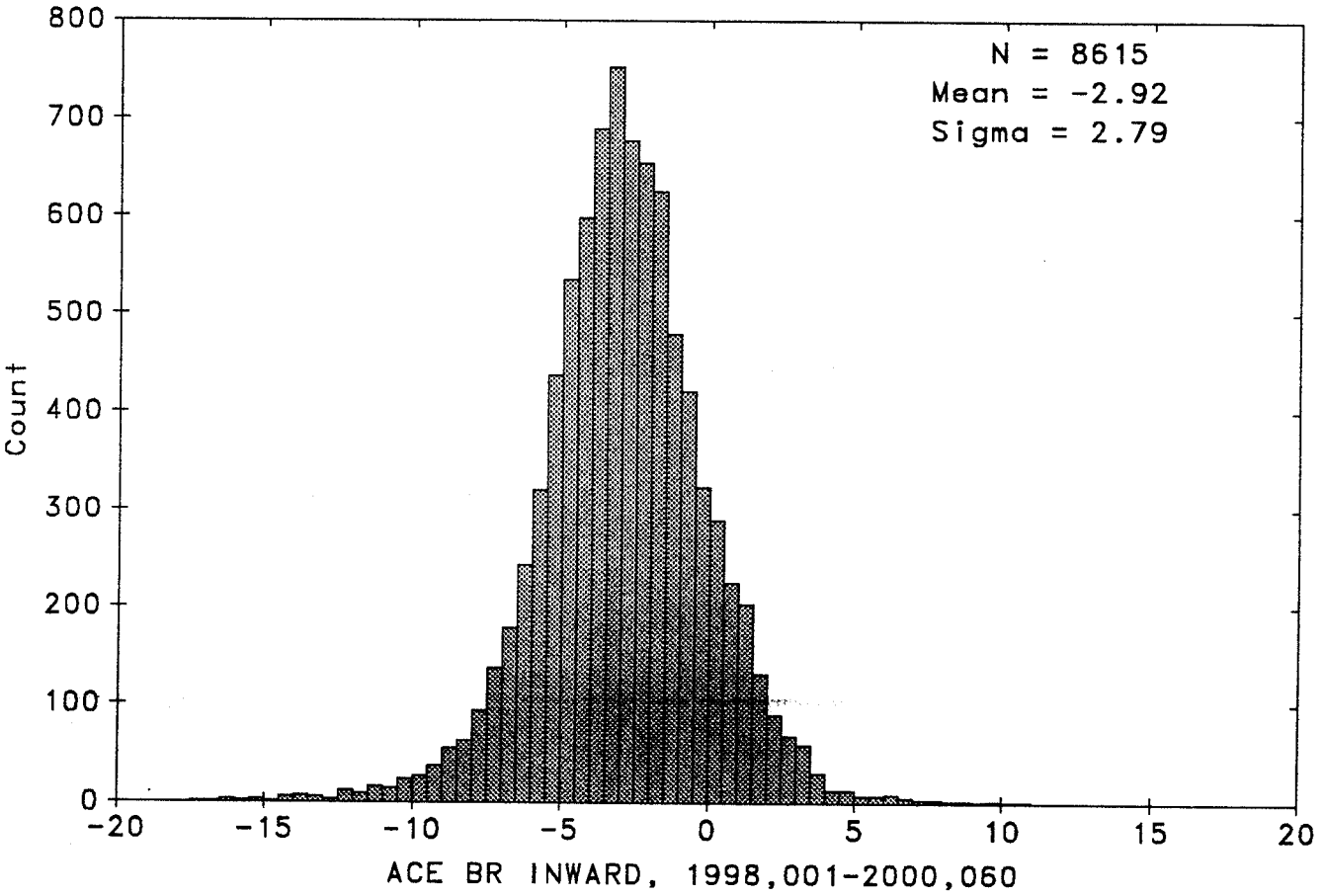
Histogram of $r^2 B_r$ values observed at Ulysses.
Note mean value = -2.8 nT(AU)^2



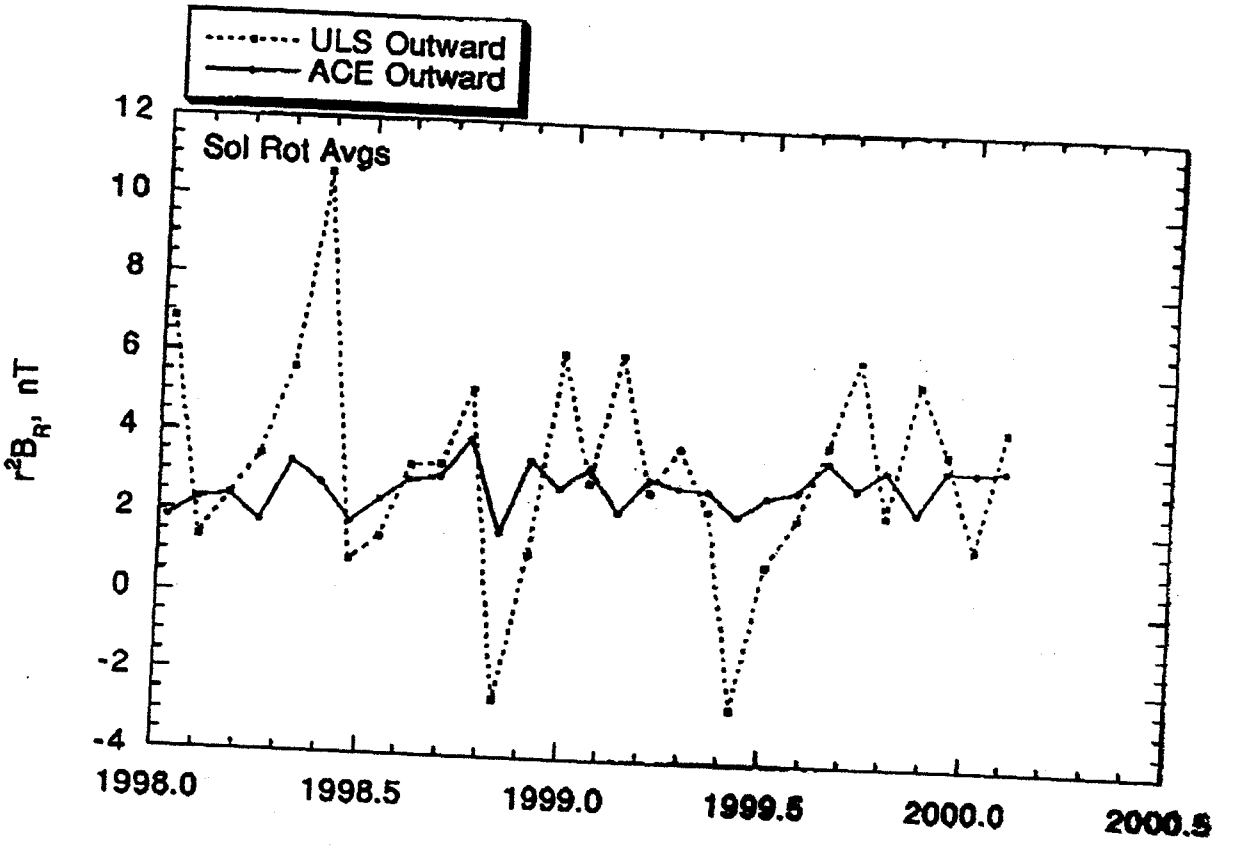
Histogram of B_r observed at ACE –

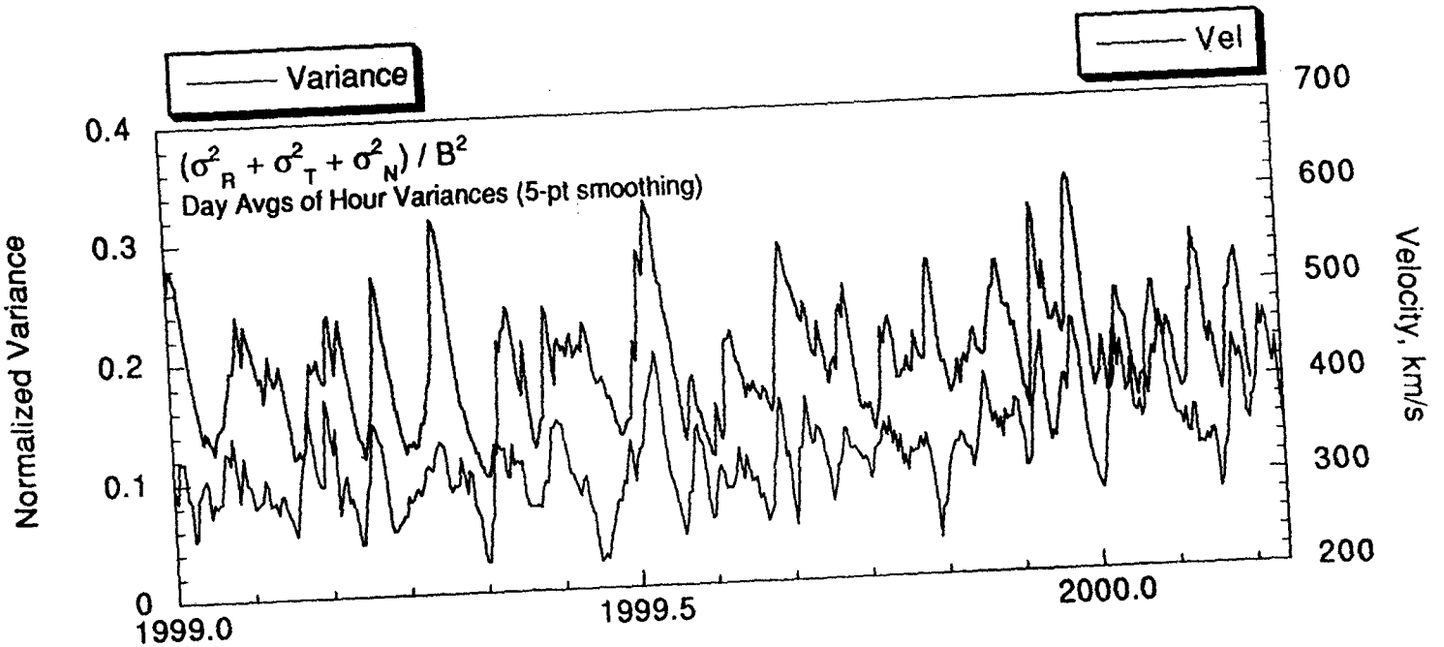
Note mean value = −2.9 nT

– essentially the same as at Ulysses (at high latitude).



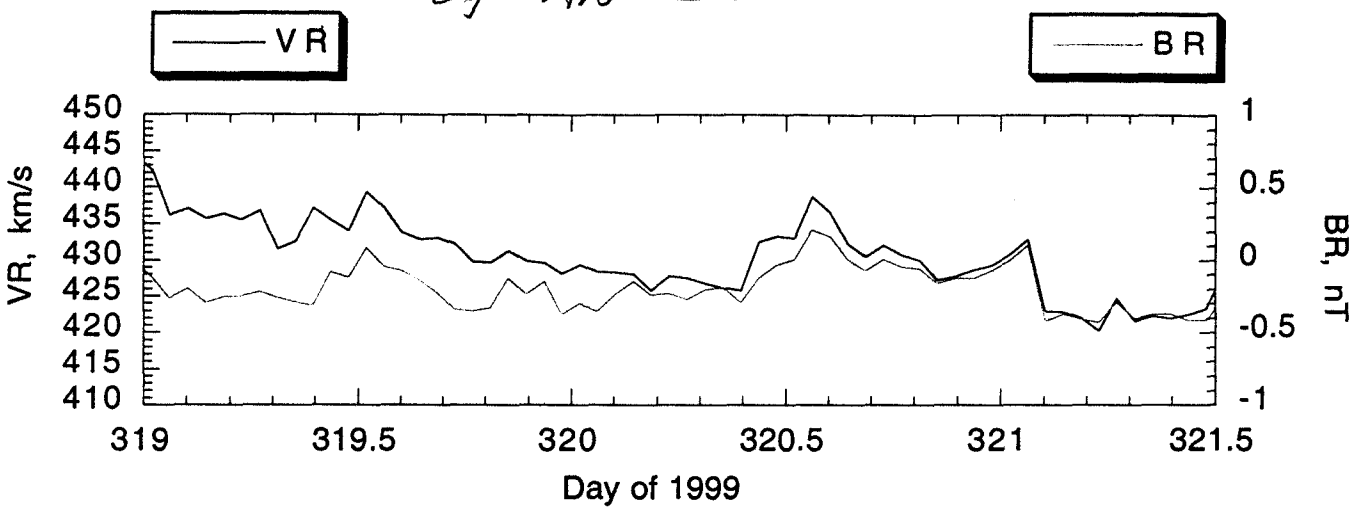
Comparison of $r^2 B_r$ at Ulysses and B_r at ACE during ascent of Ulysses in latitude - For outward sector

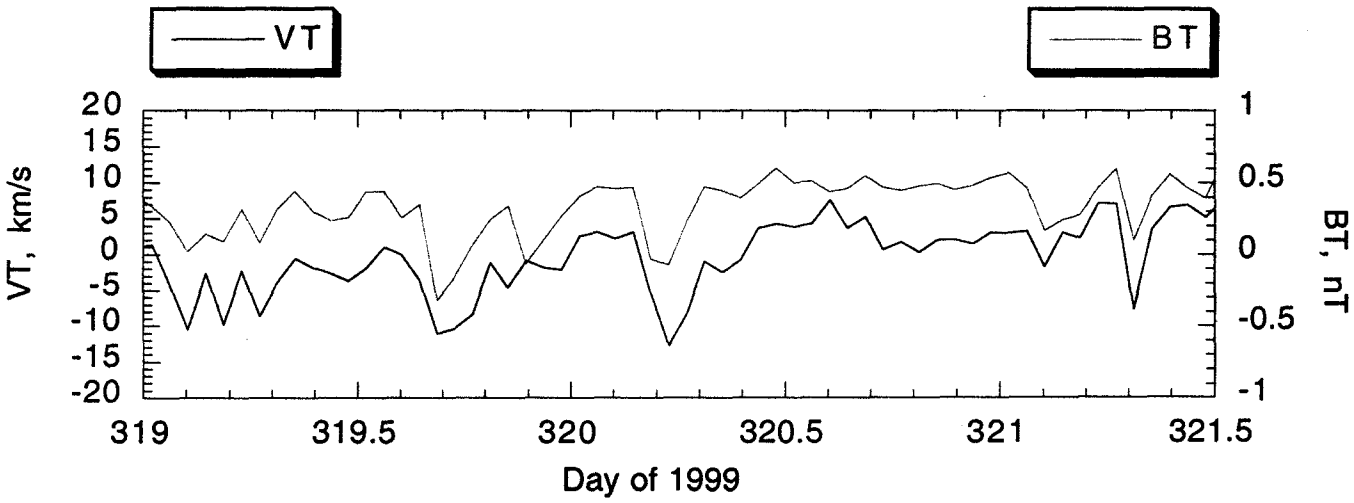


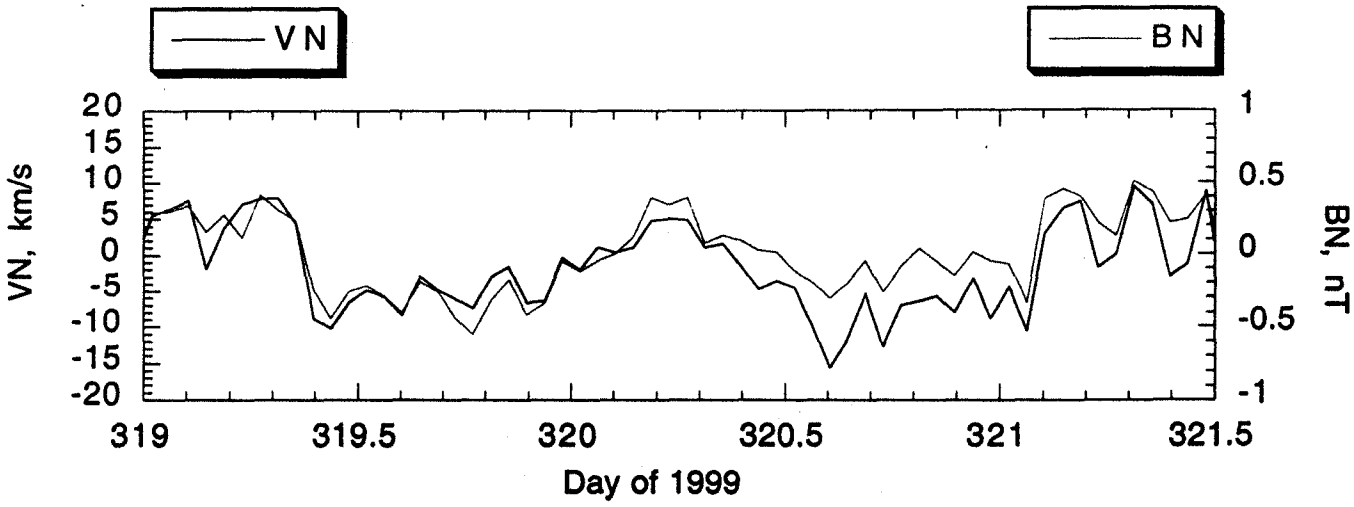


Comparison of solar wind speed and magnetic field fluctuations (variance) during ascent of Ulysses in latitude.

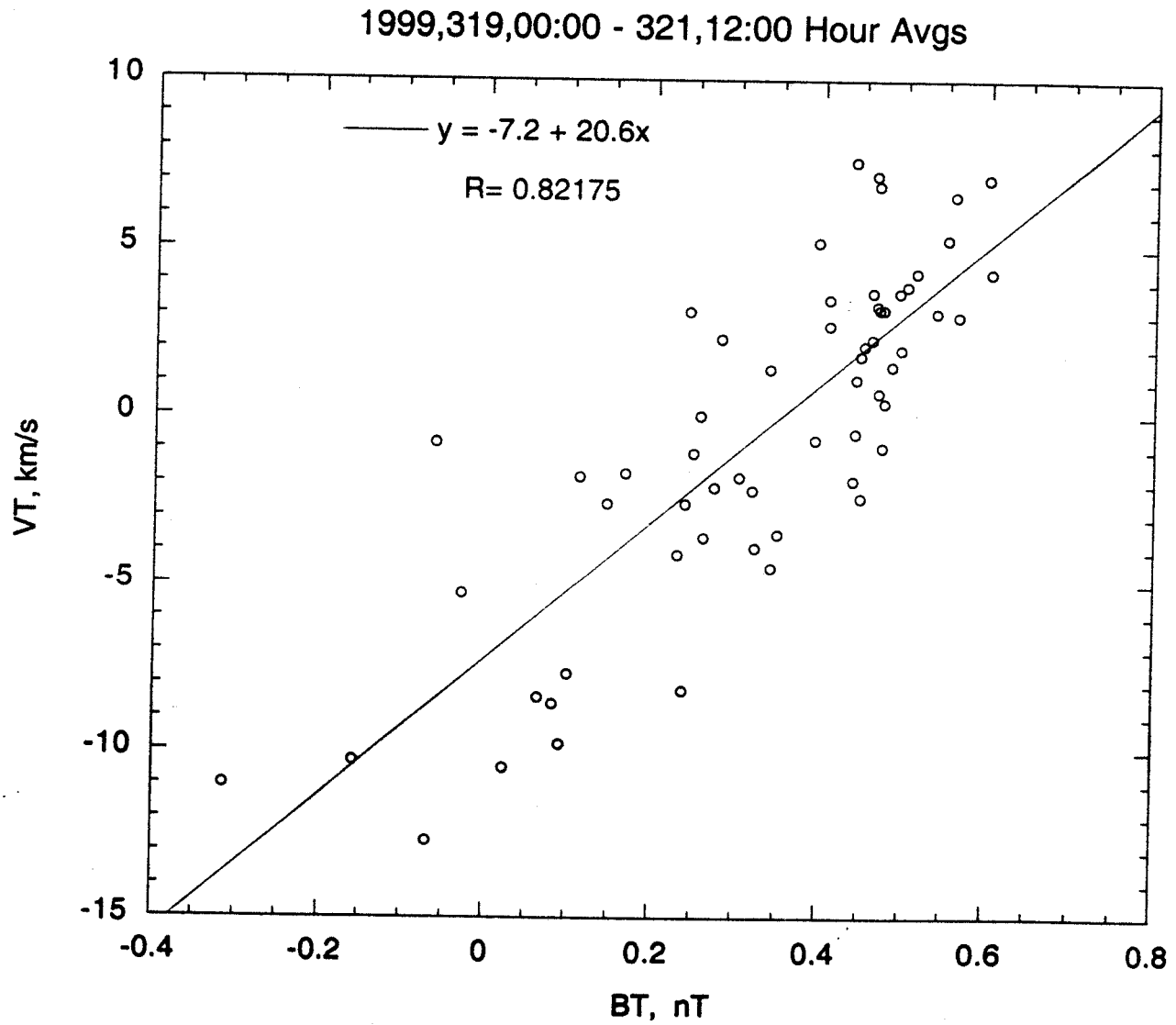
Correlations between $\delta\vec{v}$ and $\delta\vec{B}$ indicate the presence of Alfven waves –







Correlagram of solar wind velocity variations and magnetic field variations indicating the presence of Alfven waves -



the positive correlation for a negative sector shows the waves propagate outward from the sun.

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To –70° and 3/4 of Y2000

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   - ~ Some CMEs observed.
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