FTE motion: 
Comparison with the Cooling model

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Fear et al. (2005), Geophys. Res. Lett.
Cluster’s Orbit:
Nov 2002 to June 2003

![Graph showing the Cluster's orbit from Nov 2002 to June 2003, with coordinates in GSE (Re) space.](image)
Cooling Model

- Cowley and Owen (1989):

\[ \mathbf{V}_{HTN} = \mathbf{V}_{\text{Sheath}} - V_A \mathbf{\hat{B}}_{\text{Sheath}} \]

\[ \mathbf{V}_{HTS} = \mathbf{V}_{\text{Sheath}} + V_A \mathbf{\hat{B}}_{\text{Sheath}} \]

- Cooling et al. (2001) calculates and integrates these vectors using models for:
  - \( B_{\text{Sheath}} \) (Köbel and Flückiger, 1994)
  - Sheath velocity and density (Spreiter et al., 1966)
Strongly Northward IMF Events

- Equatorward-moving events observed in magnetosheath

- Parallel-streaming accelerated electrons: consistent with southern hemisphere connection (blue path)

- Paths connected to southern hemisphere swept tailward and equatorward by super-Alfvénic magnetosheath flow

- Fear et al. (2005), Geophys. Res. Lett.
Example: 22nd Feb 2003, 01:23 UT

- $V_{\text{FTE}}$ to MP: 4°
- $V_{\text{Plane}}$ to $V_{\text{HTN}}$: 24°

- Model $V_{\text{HTN}}$ path can be traced back to subsolar component X-line

- Antiparallel-streaming electrons observed in magnetosheath
  - Consistent with northern hemisphere connection (red path)

- Maximum model shear is 83°; C3 observed northward/tailward magnetospheric magnetic field
Example: 13\textsuperscript{th} Nov 2002, 00:08 UT

- $V_{\text{FTE}}$ to MP: $17^\circ$
- $V_{\text{Plane}}$ to $V_{\text{HTS}}$: $7^\circ$
- No PEACE data
- Model $V_{\text{HTS}}$ path cannot be traced back to subsolar component X-line unless X-line is shifted significantly
- FTE is observed where model magnetic shear is $172^\circ$
- (Almost) antiparallel reconnection
Conclusions

• Flux transfer events during strongly northward IMF events (clock angle less than 70°) were commonly observed on the post-terminator magnetopause

  – Location, polarity and velocity consistent with a high-latitude X-line, but component reconnection required

  – Observed equatorward motion is due to reconnection in super-Alfvénic flow region
Conclusions

- Cooling model generally describes FTE motion reasonably well
- Many southward/B_\gamma-dominated IMF events consistent with a subsolar component X-line, but some more consistent with a high-latitude antiparallel site