Dipolarizing flux bundles in the cis-geosynchronous magnetosphere: relationship between electric fields and energetic particle injections


2015
A dipolarizing flux bundle (DFB) is a high-$B_z$ flux tube led by a dipolarization front.

The DFB is 1-3 $R_E$ wide in $Y$. 

Dipolarizing flux bundle

Chen and Wolf, [1993]

DFB

Neutral Sheet

Morning Side

Evening Side

Earthward

$B_{GSM}$ [nT]

$B_z$

$B_x$

$B_y$

0459 0500 0501 0502
DFB accelerating particles

- DFBs travel earthward with strong flows.
- The strong flow and magnetic field of the DFB lead to a strong electric field that can accelerate particles.
- If a particle travels through the DFB for multiple times, it can be accelerated to MeV level [Artemyev et al., 2015].
- How important is this mechanism inside GEO?
Two examples

Injection example (Probe A)

No injection example (Probe B)

Pressures [nPa]

Flux [cm\(^{-2}\) s\(^{-1}\) sr\(^{-1}\) keV\(^{-1}\)]
We search for DFBs from RBSP, solely based on sharp $B_z$ enhancement.

We identified 72 DFBs from November 2012 to November 2013.

The occurrence rate inside GEO is $\sim 1/3$ of that in the tail and peaks in the pre-midnight sector.
Statistics

- 25 DFBs in the database are accompanied by injection (proton or electron); 21 are not. (The rest are unclear.)
- All injections accompanying DFBs are dispersionless, suggesting local acceleration.
- The typical electric field of DFBs with injection is three times that of those without.

| $\langle |E| \rangle$ [mV/m] | With injection | Without injection |
|----------------|----------------|------------------|
| Lower Quartile | 3.0            | 1.8              |
| Median         | 6.3            | 2.0              |
| Upper Quartile | 8.0            | 2.5              |

**Table:** $\langle |E| \rangle$ of each DFB is computed as the average DC electric field strength of the 1-min time interval immediately behind the DFB’s leading edge.
Conclusions

These findings suggest:

- The injections are ushered or locally produced by the DFB.
- The DFB’s strong electric field is an important aspect of the injection generation mechanism.