

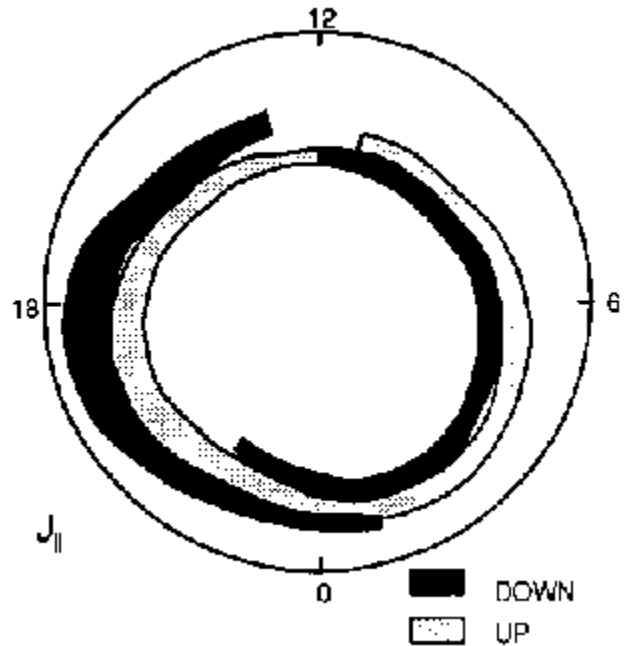
Field-aligned currents

Introduction

Field-aligned currents (FAC, also called the Birkeland currents) are essential to the coupling between the solar wind - magnetosphere system and the ionosphere. The main large scale FAC systems are the Region 1 and 2 currents.

Region 1 currents

- Inner ring driving the R1/R2 system
- Directed into the ionosphere in the morning hemisphere
- Directed out of the ionosphere in the evening hemisphere
 - Relates to the electron precipitation in the region of discrete aurora
- Expands to lower latitudes with increasing activity (see also the auroral ovals)
- Gets weaker during weak activity (northward IMF, i.e., NBZ)
- Maximizes between 0800 and 1000 MLT in the morning side and between 1400 and 1600 MLT in the afternoon side
- Current increase as the electric field associated with the solar wind/IMF increases (but is non-zero even during zero electric field, just like the polar cap potential difference)



Region 2 currents

- Outer ring following the R1 system
- Current directions opposite to the Region 1 system
- Responds to the activity level as Region 1 current ring

Mantle/NBZ currents

- Poleward of the R1 near local noon (see cusp)
- Current directions opposite to the adjacent R1 currents
- Strong IMF By effect: for $B_y > 0$ predominantly upward in the northern hemisphere and downward in the southern, and the other way round for $B_y < 0$
- Strong IMF B_z effect
 - $B_z < 0$: mantle (previously called the cusp) currents (see Lin and Lee, 1994)
 - Well localized, weak currents
 - $B_z > 0$: NBZ currents
 - Expand and become as strong as the weakened R1/R2 currents

Special FAC types

- Substorm current wedge
- Currents in travelling convection vortices

References

- Lin, Y. and L. C. Lee, Generation of Region 1 and mantle field-aligned currents by the secondary rotational discontinuity, in Solar Wind Sources of Magnetospheric Ultra-Low-Frequency Waves, Geophysical Monograph 81, 213-221, 1994.
- Yamamoto, T., S. Inoue, N. Nishitani, M. Ozaki, and C.-I. Meng, A theory for generation of the paired region 1 and region 2 field-aligned currents, J. Geophys. Res., 101, 27199-27222, 1996.