Statistical magnetospheric location of auroral omega bands obtained by empirical magnetic field models

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- Omega bands are curved aurora forms, appearing as rows of inverted Greek letter Ω drifting eastward
- Their magnetospheric signatures and sources are poorly understood due to a small number of conjugated spacecraft observations
- The goal of the study is to find a characteristic magnetospheric magnetic field configuration corresponding to this type of aurora on the basis of an empirical model and the list of omega bands observed in the Fennoscandian Lapland
Data

- The list of omega bands observed in the Fennoscandian Lapland in the period 1997-2007 (Partamies et al., 2017)

- Corresponding MIRACLE all-sky camera observations

- ASC stations coordinates in MAG system (calculated for 2007):

<table>
<thead>
<tr>
<th>Abbr.</th>
<th>Name</th>
<th>MLat,°</th>
<th>Long,°</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABK</td>
<td>Abisko</td>
<td>66.1</td>
<td>114.6</td>
</tr>
<tr>
<td>KEV</td>
<td>Kevo</td>
<td>66.1</td>
<td>122.6</td>
</tr>
<tr>
<td>KIL</td>
<td>Kilpisjärvi</td>
<td>66.4</td>
<td>117.0</td>
</tr>
<tr>
<td>MUO</td>
<td>Muonio</td>
<td>65.0</td>
<td>118.1</td>
</tr>
<tr>
<td>SOD</td>
<td>Sodankylä</td>
<td>64.0</td>
<td>119.8</td>
</tr>
</tbody>
</table>
Data

• Magnetic field line tracing: IGRF-12 and the empirical model TA16 (*Tsyganenko*&*Andreeva*, 2016)

• TA16 input parameters: : Pdyn, Sym-H, N index (*Newell et al.*, 2007), IMF By

• Footpoints for magnetic field line tracing:

(left) ASC image of $\Omega$-structure, Sodankylä, 20.03.2003; (right) its projection in GEO coordinates at 110 km
Mapping results

- 244 events from the original list
- (A) $\Omega$-projections in GSM equatorial plane
- (B)&(C): occurrence vs MLT and radial distance (Re)
- 90% of events are within 2-4 MLT and R~6.0-13.5 Re
- Maximum at R=8 Re
- Results are in agreement with previously reported case-studies
Magnetospheric magnetic field configuration

Superposed $B(R)$ [left] and $|dB/dR|(R)$ [right] profiles in the vicinity $\pm5$ Re of omega-band projection. Zero-epoch $dR=0$ corresponds to the omega projection.
Magnetospheric magnetic field configuration

- Isotropic boundary algorithm (IBA) method to evaluate the magnetic field configuration in the tail (Sergeev et al., 1993)

- Isotropic boundary: \( R_C / \rho = 8 \)
  
  \( R_C \) – the curvature radius of the field line,
  \( \rho \) – the particle gyroradius

- In the vicinity of omega-band possible source:
  a chaotic motion of 30-keV energetic protons and adiabatic motion of 100-keV electrons

- \( \Rightarrow \) stretched magnetic field lines, but the tail current sheet is rather thick
Summary

• The first statistical study of the omega-bands projections using the large set of the MIRACLE ASC observations and new empirical magnetic field model TA16

• It is demonstrated that 90% of the omega bands map to between 6-13.5 Re (occurrence max at ~8 Re) => region, where rapid flows stop (occurrence rate of RFTs drop at radial distances 10-15 Re) (Schödel et al., 2001)

• Superposed radial profiles of the magnetic field and radial gradient in the tail are calculated => a magnetospheric source of $\Omega$ is located in the transition region between the tail-like and dipolar fields

• In this region: a chaotic motion of 30-keV energetic protons and adiabatic motion of 100-keV energetic electrons
References


