Variations of Substorm Recovery Time Scales

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Introduction and Previous Work

Quantitative description of auroral substorm development:

1) **Energetics:**
   - Hemispheric Power, $HP = \sum Q_i A_{ij}$
     where $Q_i = $ energy flux; $A_{ij} = $ area of pixel $(i,j)$

2) **Time scales:**
   - **Expansion time**
   - **Recovery time**

**New results**

- Our goal: extend the analysis of Chua et al. [2004] to include ~4000 substorms observed by IMAGE FUV compiled by Frey and Mende [2006]
- We start with (very) small subset: 12 substorms  →  10 during winter, only 2 during summer
- Determine recovery time scale, $\tau$, for each substorm

**Total of all substorms:**
- Average $\tau$: $37.6 \pm 19.7$ minutes
- Median $\tau$: 41.3 minutes

**Winter substorms:**
- Average $\tau$: $38.9 \pm 21.0$ minutes
- Median $\tau$: 46.2 minutes

**Summer substorms:**
- Average $\tau$: $31.3 \pm 14.1$ minutes
- Median $\tau$: 41.3 minutes

**Interpretation, Summary, & Conclusions**

- Our observed median winter substorm recovery time scale is 10 – 15 minutes longer than Chua et al.’s [2004]
  → Caveats: 1) small sample size: 10 vs. > 200 substorms
  2) differences in instruments/filter responses may lead to discrepancies (?)
- We find no significant seasonal variation in substorm recovery time scales in contrast to Chua et al. [2004]
  → However, we used a statistically insignificant data set (especially for summer substorms – only 2!)

**Why should there be seasonal variations in substorm recovery time scales?**

- Suppression of auroral in sunlight [e.g., Newell et al., 2001]:
  Increased solar EUV flux → increased cold plasma density & ionospheric conductivity
- Cold plasma effectively “shorts out” parallel electric fields
  (or, to put it another way.)
- Cold plasma density is sufficient to carry current driven by the magnetosphere without parallel potentials
- Intense auroral structures have shorter lifespans in sunlight
  → Conductivity can play a major role in substorm dynamics

**Future Work**

- Include (many) more IMAGE FUV substorms
- Investigate how differences in instruments/filter responses impact recovery time scales
- Simultaneous, conjugate substorm observations

**Caveats:**
- Implications for auroral conjugacy:
  - Statistically, auroral substorms last longer in darkness (winter) than in sunlight (summer)
  - More energy deposited in dark hemisphere