The Role of the Plasmasphere in Radiation Belt Particle Energization and Loss

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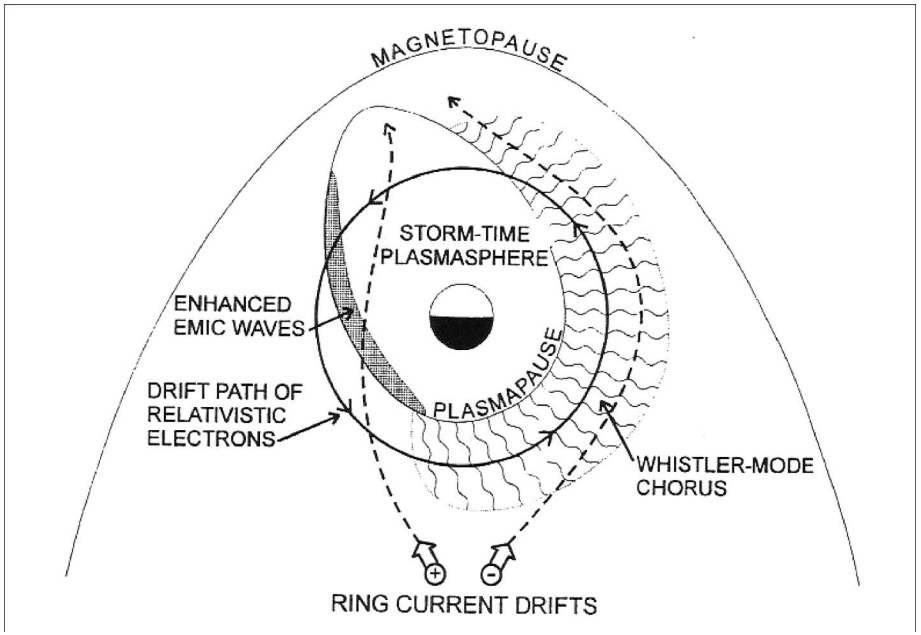
Outline

- Background
  - ionospheric signatures of plasmapause
- Method
  - use of DMSP observations of LIT to identify plasmapause
  - map plasmapause locations to equatorial plane
  - compare with IMAGE plasmasphere observations and SAMPEX energetic particle observations
- Results

Plasmasphere-radiation belt connection

- Plasmapause (PP) correlates with inner edge of outer radiation belt
- Wave-particle interactions are central to this correlation, e.g.:
  - EMIC waves inside PP scatter radiation belt particles into loss cone
  - whistler-mode chorus outside PP energizes radiation belt particles over multiple orbits



(Summers *et al.*, 1998, *JGR, 103*:20487)

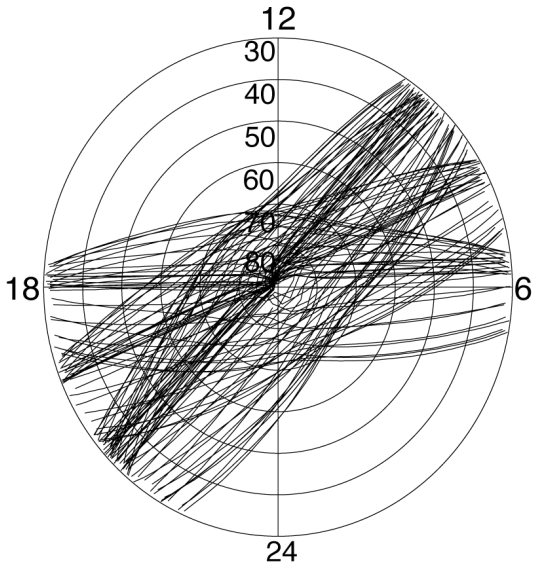
Plasmapause signatures in ionosphere

- Several ionospheric signatures of the plasmapause have been proposed, including:
  - midlatitude electron density trough - TEC - SETE
  - precipitating electron boundary - LIT - SARS
- Generally not a one-to-one correspondence between any of these and the plasmapause
- Light ion trough (LIT) is proposed as one of the more consistent signatures (Taylor and Walsh, 1972, *JGR, 77*:6716; Horwitz *et al.*, 1990, *JGR, 95*(A6):7949)
- Some have found the LIT tends to be equatorward of other plasmapause identifications (Foster *et al.*, 1978, *JGR, 83*:1175; Grebowsky *et al.*, 1978, *PSS, 26*:651)

Method: DMSP

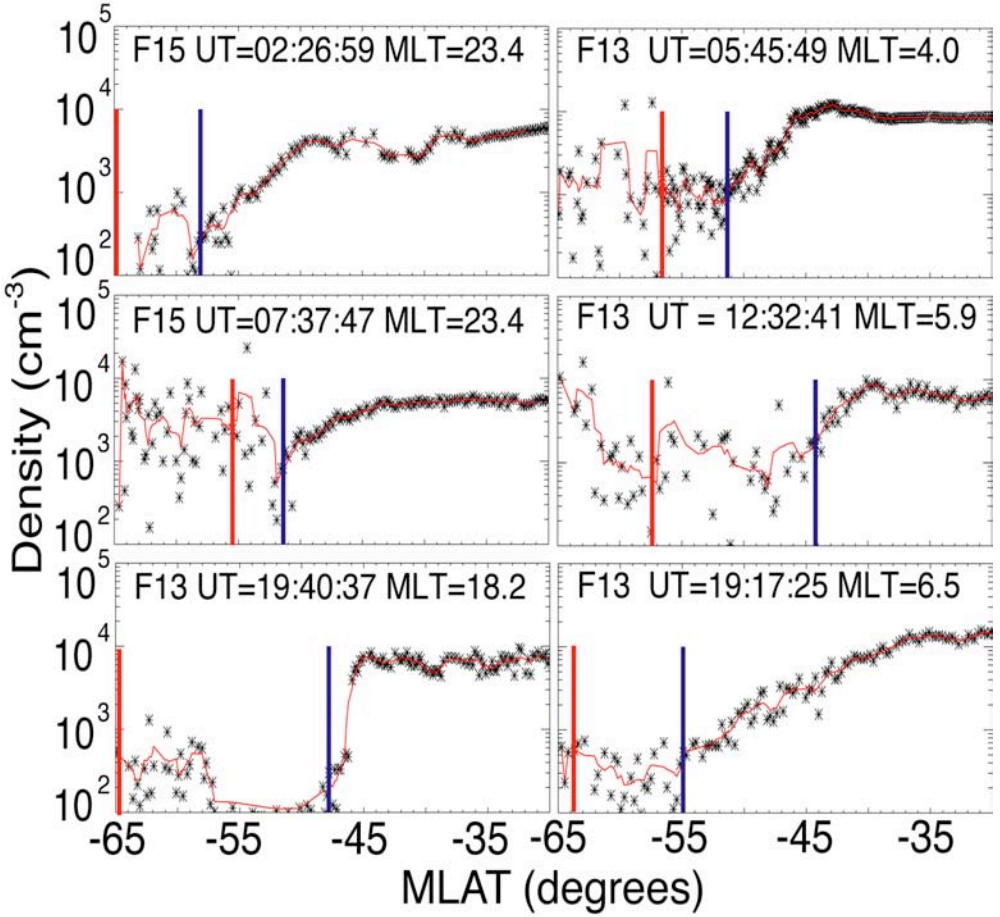
- DMSP satellites: sun-synchronous circular orbits near 840 km alt., 101 min. period, 99° inclination
- 3-4 satellites in operation continuously over 10+ years
- Instruments include Retarding Potential Analyzer providing ion density, composition, temperature
- Plot illustrates polar coverage in one day from four DMSP satellites (F11-F14) in MLAT-MLT
  - provides ~50% MLT coverage at 40°, ~75% coverage at 60°

DMSP Coverage October 19, 1998



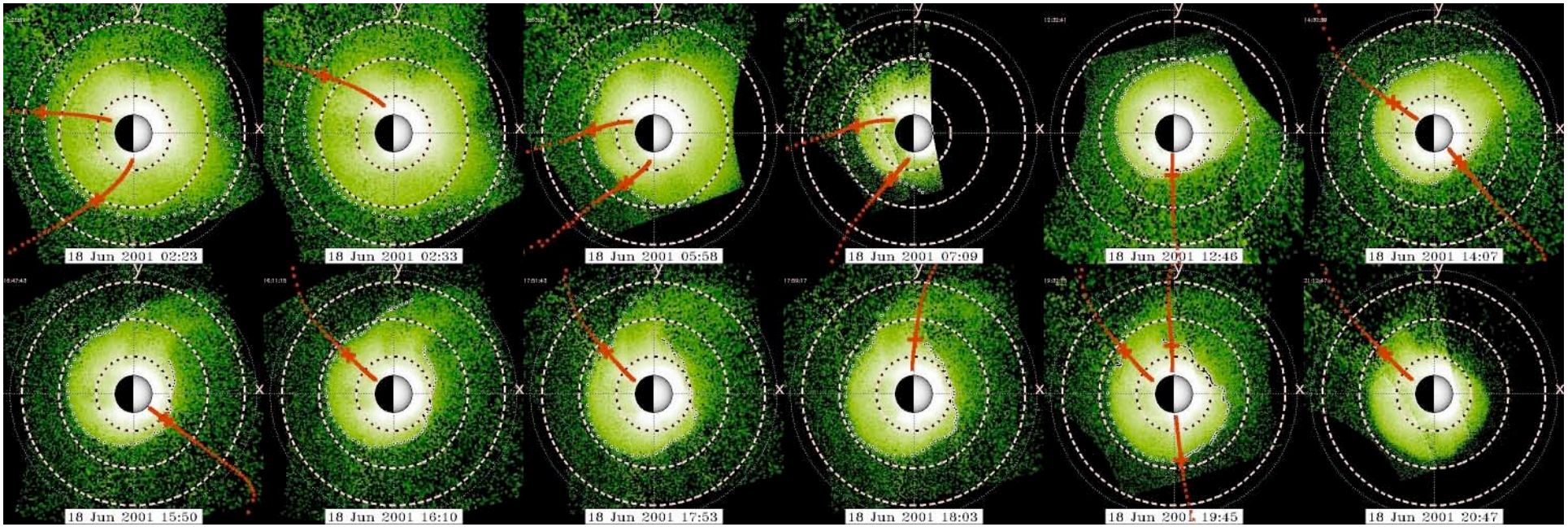
Method: LIT identification

- We use LIT as identification of plasmapause
- Plots show DMSP H^+ density vs. MLAT, smoothed density in red
- Vertical red line is equatorward electron precipitation boundary
- Semi-automatic procedure picks PP identification at blue line
- Location is mapped to high altitude plasmapause along magnetic field lines using epoch-appropriate IGRF internal field and Tsyganenko external field



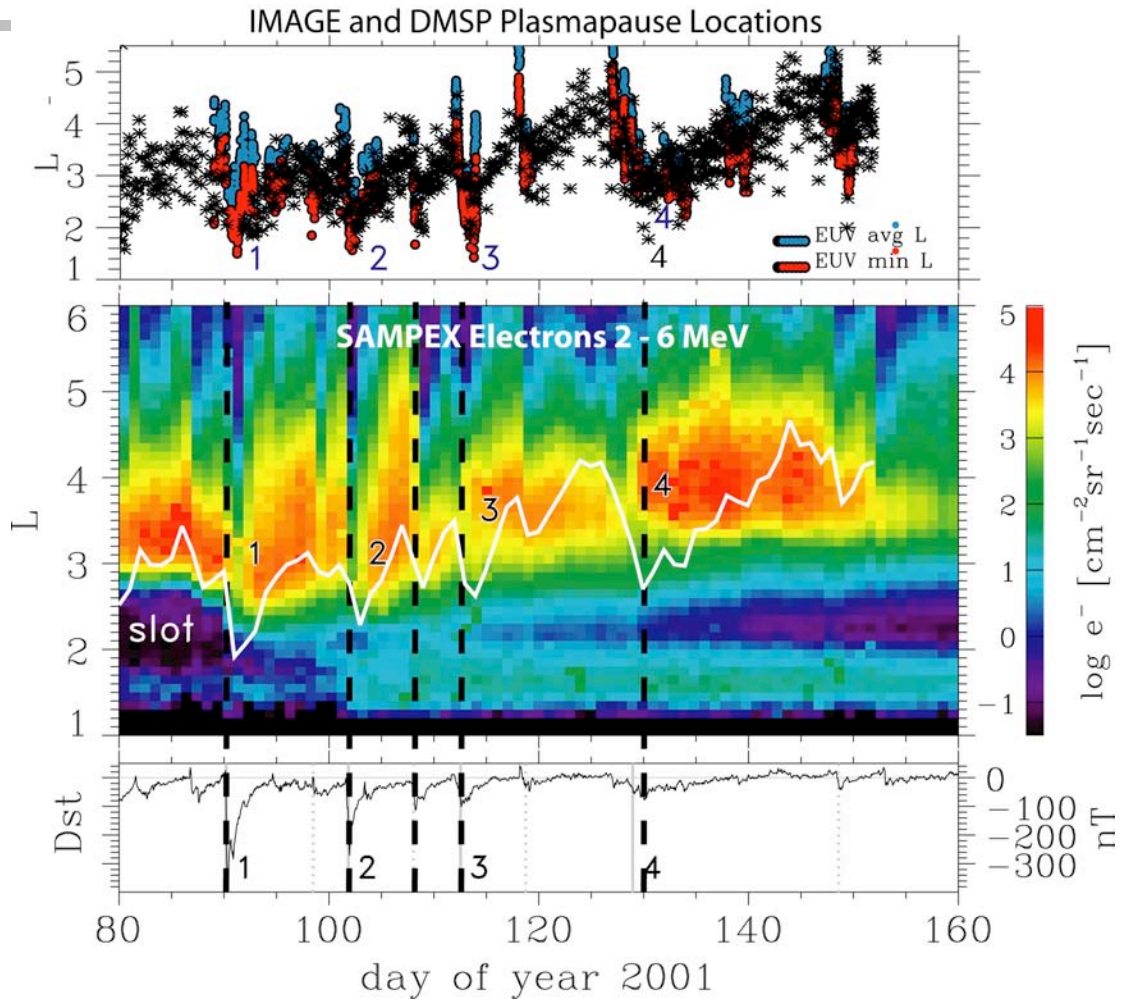
Results: comparison to IMAGE

- For 18 June 2001, plots show IMAGE EUV images of plasmasphere projected to SM X-Y plane, Sun at right
- Red lines show mappings of DMSP orbit track to SM X-Y plane, red cross shows identified plasmapause



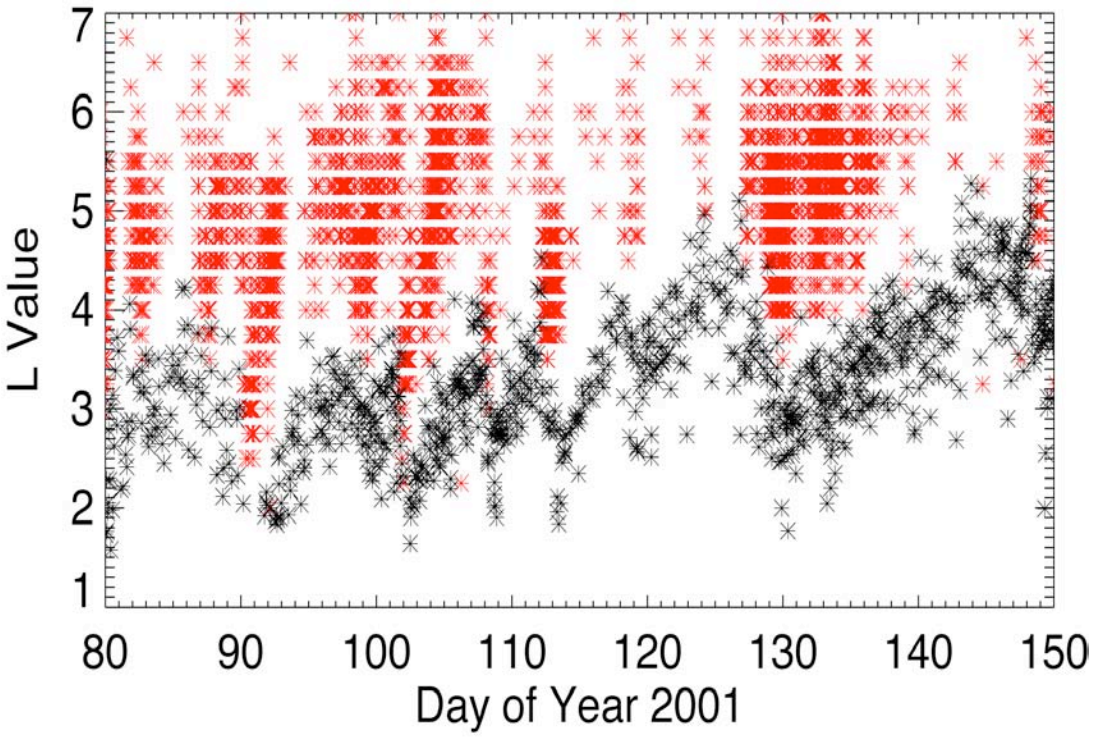
Results: comparison to SAMPEX

- For 72-day period in 2001, we obtained 1790 plasmapause IDs
- top: PP IDs from DMSP (black) compared to IMAGE
- middle: daily average of our PP IDs (white) compared to SAMPEX electron flux
- Correlation in PP movement and Dst, movement of inner edge of outer radiation belt



Results: comparison to SAMPEX

- red: SAMPEX-identified microbursts
  - microbursts are short (~1 s) bursts of precipitating relativistic electrons observed at low altitudes; found associated with whistler chorus (O'Brien *et al.*, 2003, *JGR, 108*(A8):1329)
- black: all DMSP-based plasmapause IDs



Conclusions

- We have obtained initial results from a method of identifying the plasmapause using DMSP observations of the LIT.
- Comparisons show good correlation with IMAGE plasmapause IDs and SAMPEX radiation belt flux and microburst observations.
- This approach will be applied to full DMSP database: 10+ years of observations--covering full lifetime of SAMPEX.
- Database will be used for event studies and to statistically analyze correlation of plasmapause-radiation belt dynamics.