SHINE - GEM Killer Electrons Workshop -- Short Summary Boulder, June 1999

- **Dan Baker:** Good correlation between high velocity streams in solar wind and enhancements in the radiation belt electrons with a time lag of 1 or 2 days.
  – The outer radiaton belt is highly dynamic responds to high speed streams & CMEs with a high degree of coherence ... all measurements (Polar, SAMPEX, GOES, LANL, GPS) show same behavior
    - See strong controlling influence of solar wind . Whenever solar wind speed goes above 500 km/s, tend to have an enhancement ... higher speeds -> stronger enhancement. Tend to be no enhancement when speeds < 500 km/s
    - If IMF Bz is south, enhances effect -- possible that substorms produce an intense relatively soft electron seed population when Vsw is high and IMF Bz is south. During this time the radiation belts may actually be depleted. When Vsw begins to decrease, the radiation belts build up

- May 97, SAMPEX: High density region at beginning of storm created a high solar wind dynamic pressure (compressed magnetosphere)and belts became depleted. Then magnetic cloud hit and a powerful and global acceleration occurred at low L values (~3-4).
  - ULF waves were observed at the time of this electron acceleration --> such waves can accelerate electrons through radial diffusion and/or azimuthal pumping
- Solar maximum: electron acceleration dominated by magnetic cloud events ... energy inputs are short-lived compared to high speed streams ... only a modest enhancement of the belts occurs
- Declining phase of the solar cycle: long-lived and steady coronal holes with high speed streams appear -- produce very large long-lived belt enhancements.

- **Delores Knipp:** Some recurrences of a given coronal hole are more effective at producing radiation belt enhancements than others ... why?
  - high Vsw and IMF Bz south produce particularly intense events
  - during high activity intervals, radiation belt fluxes sometimes drop below instrument background levels --> probably evacuated
  - Spring and Fall particularly effective in producing belt enhancements due to higher level of magnetic activity (Russell-McPherron Effect) --> greater substorm seed populations
  - Important D-region and Stratospheric effects (use Nov 93 storm to illustrate) -- UARS measured 30 keV-280 keV electron precipitation --> model shows that ionization from this flux was in excess of normal down to 30 km altitude
    - Large % changes in NO at 100 km across the entire globe --> large changes in dynamics and chemistry. This kind of thing happened repeatedly in 1993 and into 1994. Can have impacts on stratospheric ozone particularly in winter polar regions.

- **Mary Hudson:** Amplitudes of maximum radiation belt fluxes during CME events are comparable to those from high speed streams but more infrequent --> yearly averages lower
  - Discuss 2 types of electron acceleration mechanisms -- one very impulsive associated with high speed shocks; the other is radial diffusion & azimuthal pumping in ULF wave fields
  - Dramatic high energy injection on March 91. Produced a new belt in the slot region that lasted for years. Shock launched a magnetosonic wave that transported and energized solar particles into radiation belts.
    - Necessary ingredient -- a seed population in synch with the pulse -- compare resonant energies for March 91 event:
      - maximum effect for protons is in 3-32 MeV range -- plenty of seed protons in a solar proton event; for electrons is in 4-50 MeV range -- not many electrons at these energies around
      - March 91 event rare but dozen or so similar smaller events during CRRES -- More common for protons because energies in synch are more common in solar proton events.

- May 1998, Aug 1998 events -- high speed streams with -850 km/s. See a tracing and injection of solar protons into low L values
- Compare model of Jan97, May98 and Aug98 electron acceleration events:
  - Take MHD code which used as input actual solar wind parameters-- push electrons in time series. Used AE8 min model as source population for all 3 runs-- look at effectiveness of 3 storms at energizing the electrons. ULF waves are embedded in model output
  - May 98 flux tansported in 7 hrs into low L values. Aug 98 peak inward transport over a period of 9 hrs. Energy peak developed in flux generated for May98 and Aug 98 -- remains monotonic for the Jan 97 event. 15 hours to transport the Jan 97 peak inward.
  - Aug 1998 storm -- lot more power in ULF than for Jan 97. May 98 storm had most spectacular ULF waves.
  - Cranking up convection E field adds to energization by breaking symmetry in orbit and increasing energization during drifts inward. Linear increase in amount of energization with strength of convection.