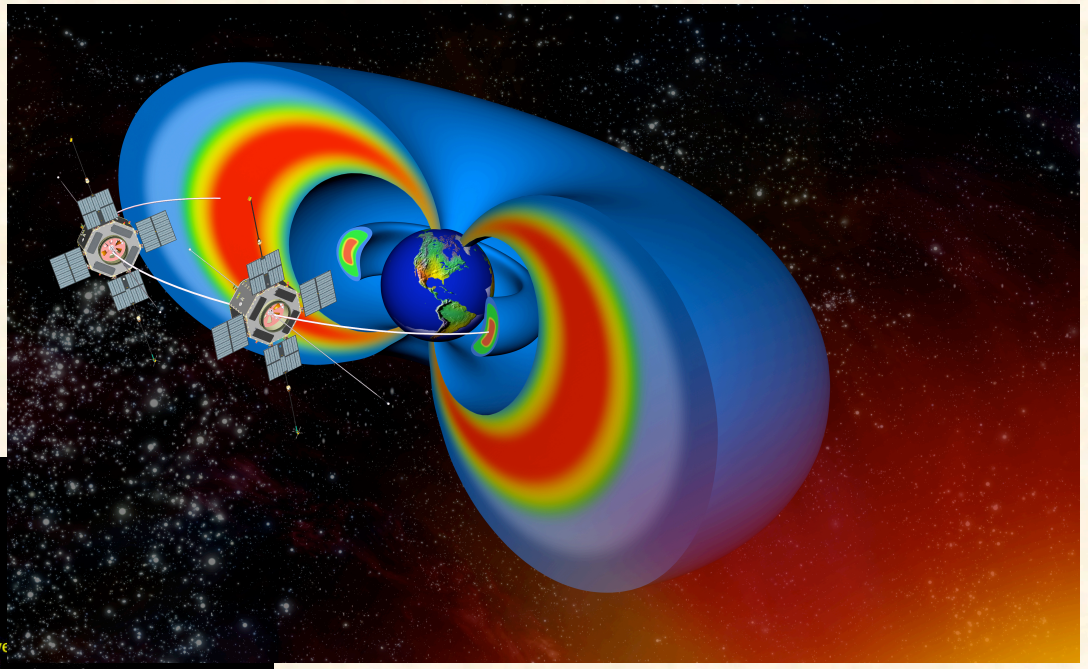
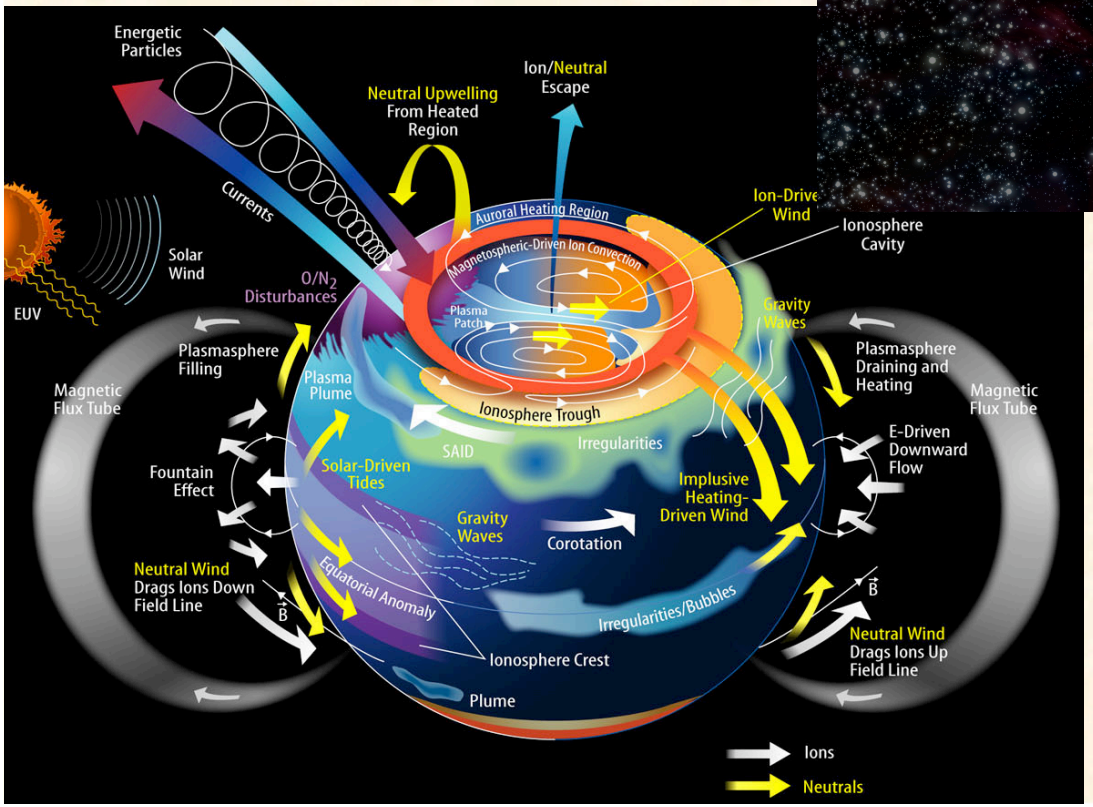
RBSP and the I-T Community

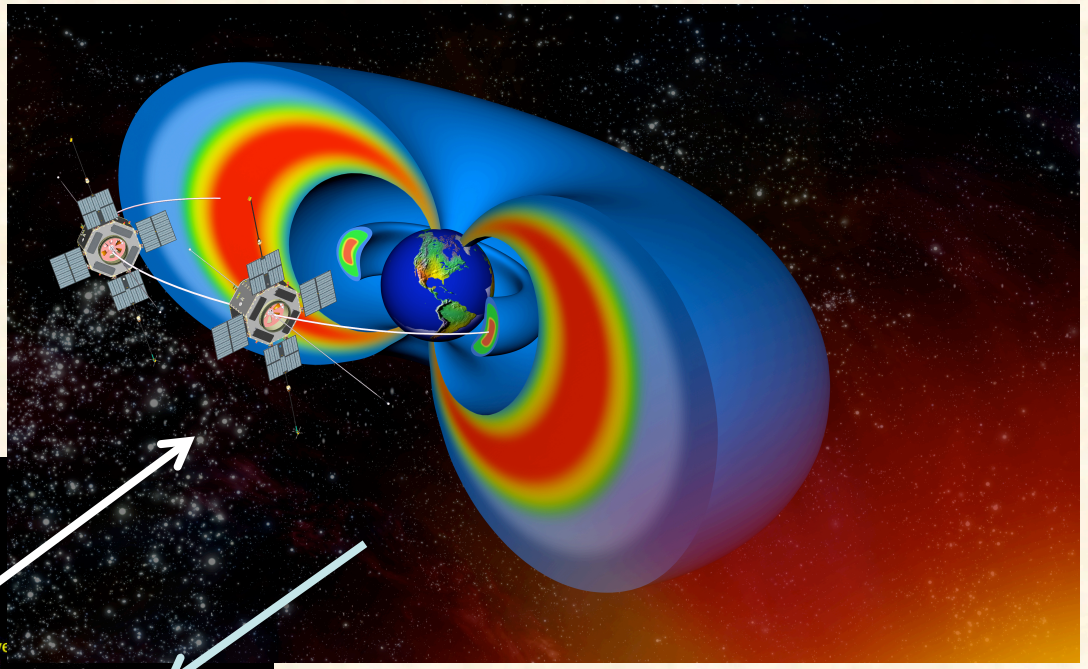


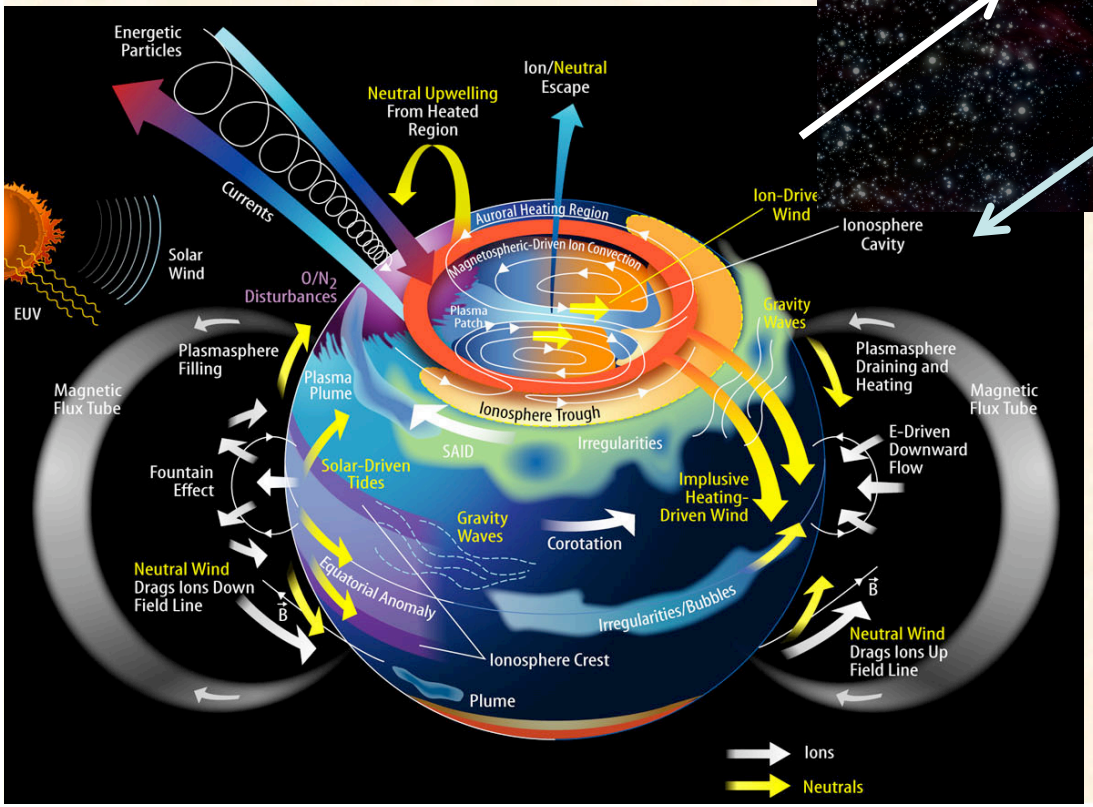


CEDAR-GEM 2011

J. M. Grebowsky, D. Sibeck, S. Kanekal, and Project Science Team

RBSP and the I-T Community





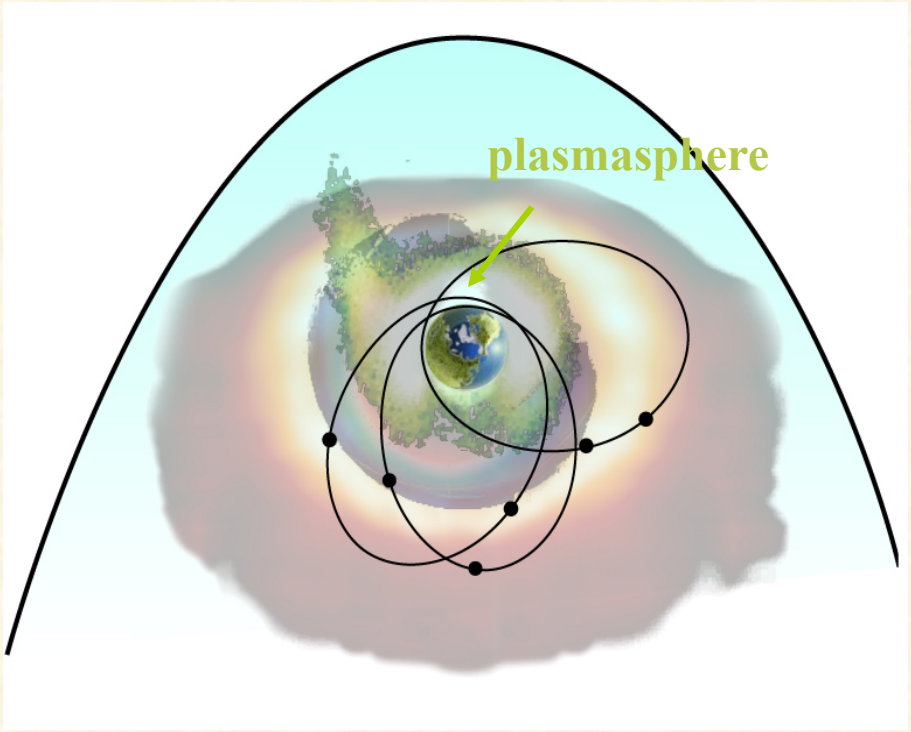
CEDAR-GEM 2011

J. M. Grebowsky, D. Sibeck, S. Kanekal, and Project Science Team

CONTENT

- RBSP Facts and Figures
- Possible Research Areas
- Complementary observations

Mission Architecture



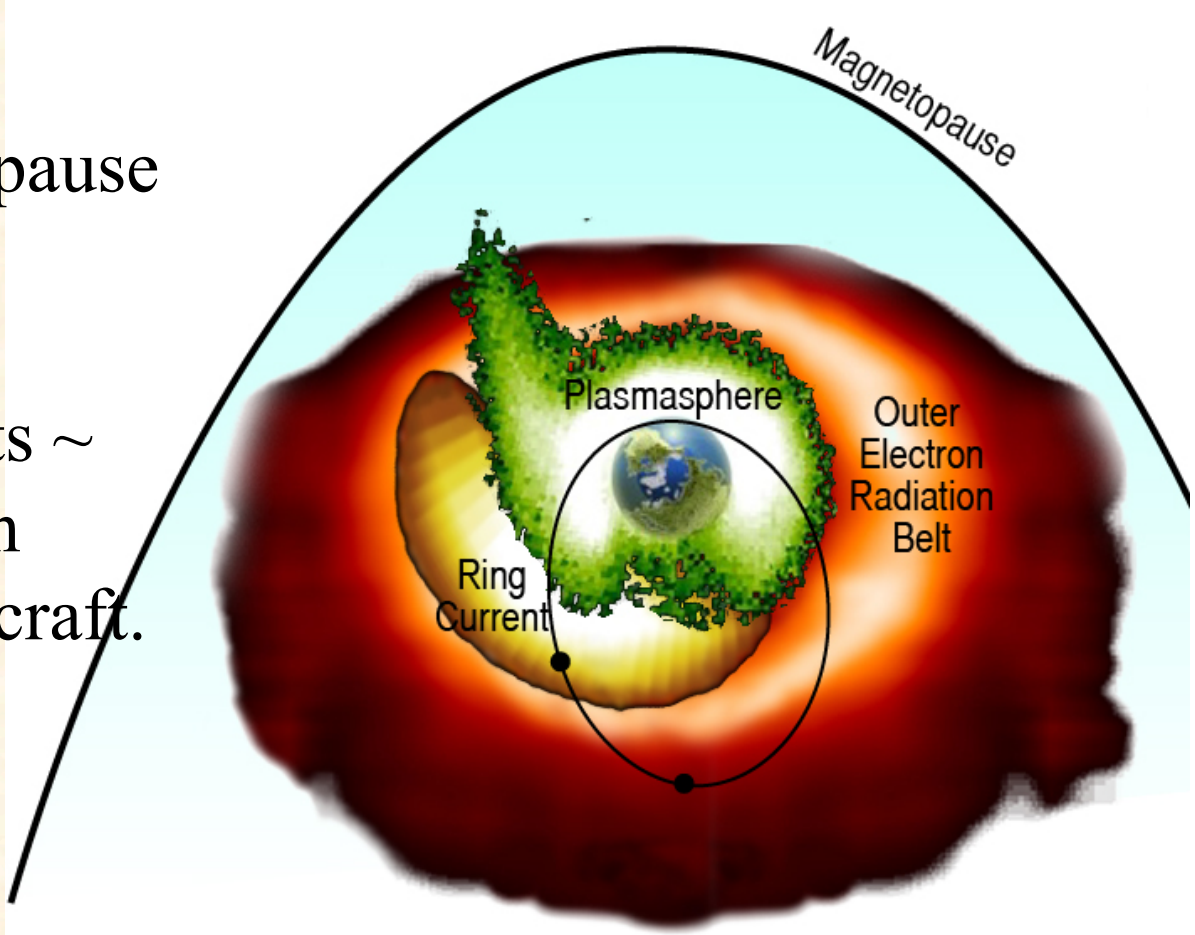
- Two spacecraft, identically instrumented, ~10° inclination orbits with ~9 hour periods.
- Perigee L=1.1 *(~600 km altitude)* *Apogee* L= ~5.8 (*field line maps to ~66° Λ).*
- S/C lap one another 4 times/year
- Apogees precess through 24 hrs in local time over 2 year mission.

Launch: August 2012

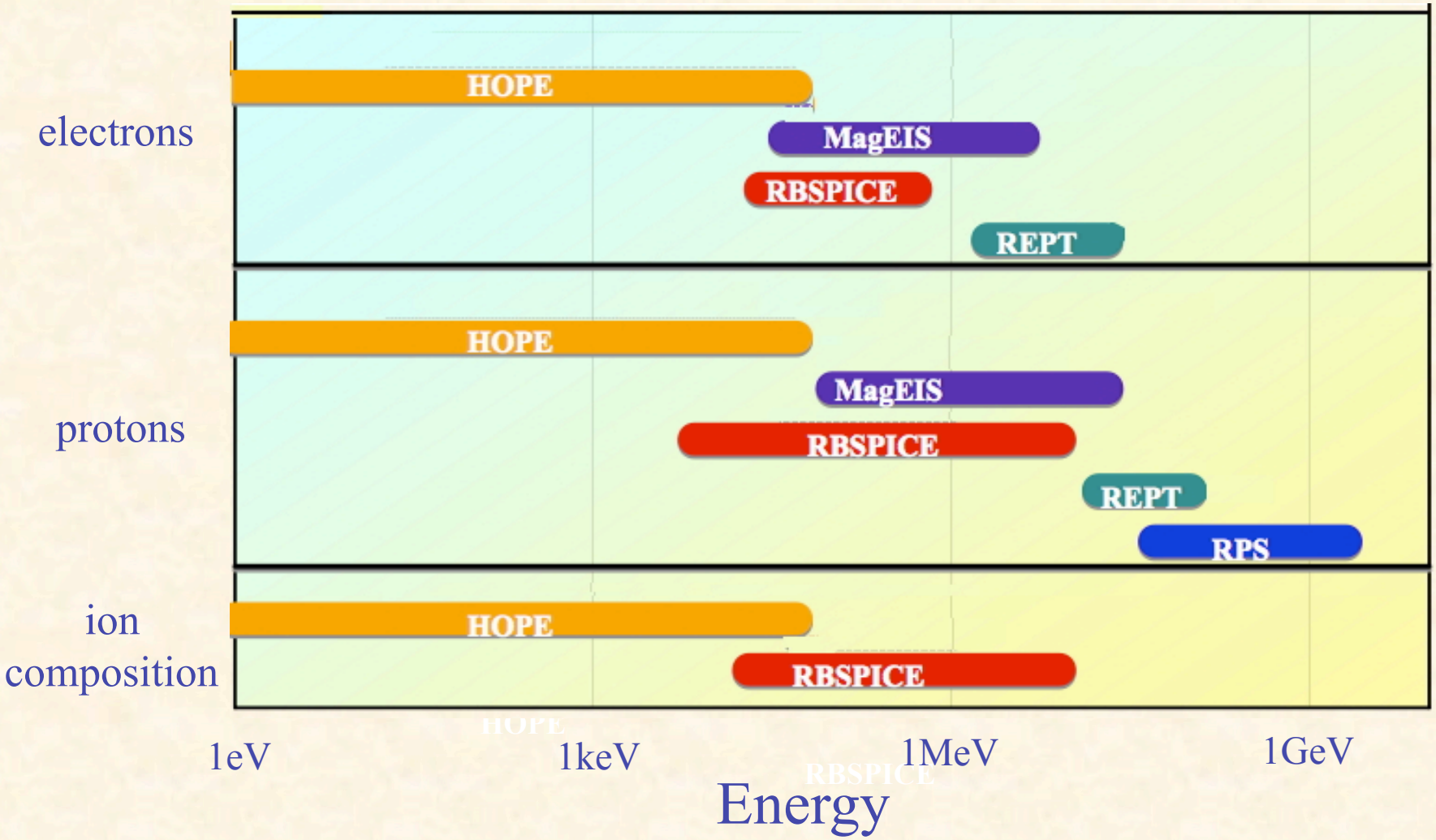
Regions Encountered

Inner Plasmasheet
Ring Current
Radiation Belts
Plasmasphere/Plasmapause

•Provide azimuthal cuts ~ normal to those of high inclination LEO spacecraft.

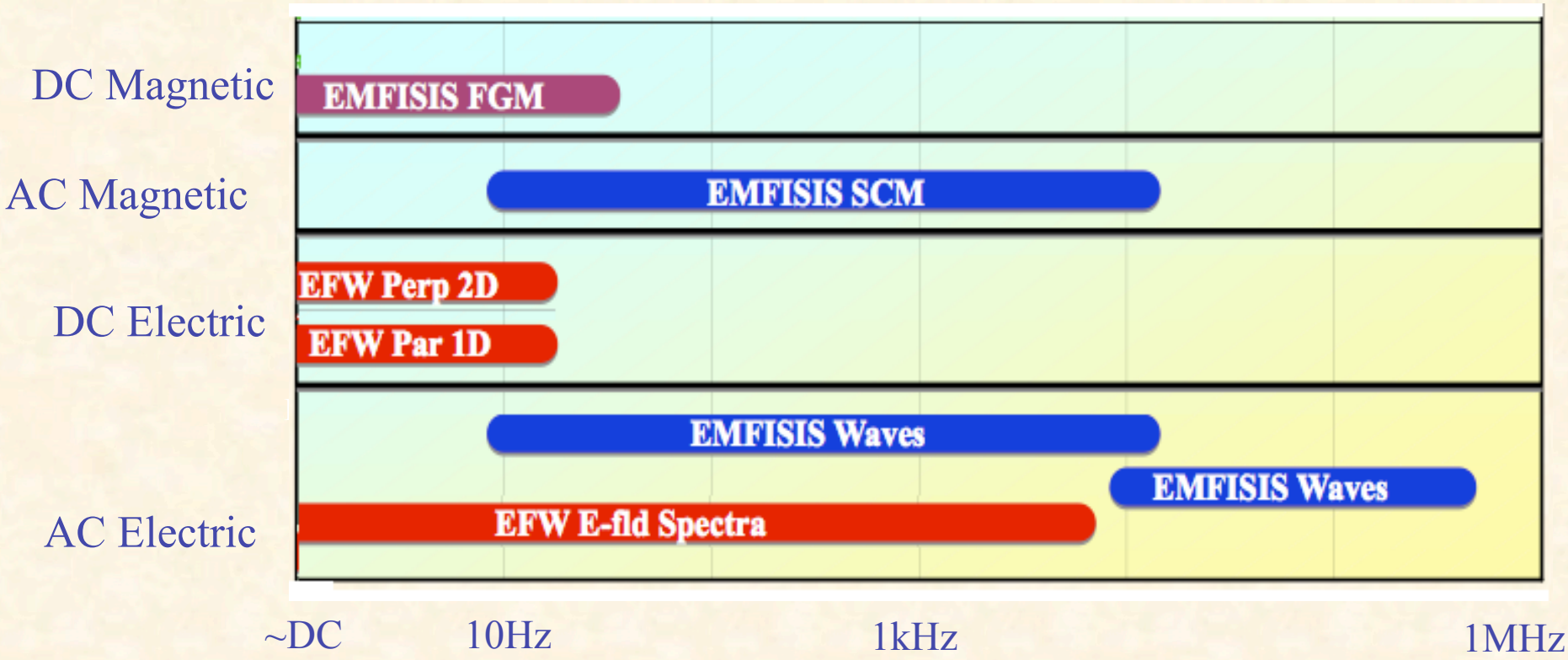


Comprehensive Particle Instrument Coverage



Proton Spectrometer Belt Research/RPS - D. Byers, NRO/J. Mazur, Aerospace
Energetic Particle and Thermal Plasma Instrument/REPT/MagEIS/HOPE - H. Spence, U. N. H.
Radiation Belt Storm Probes Ion Composition Experiment - L. Lanzerotti NJIT

Comprehensive E and B Field Measurements



EFW E-fld Spectra

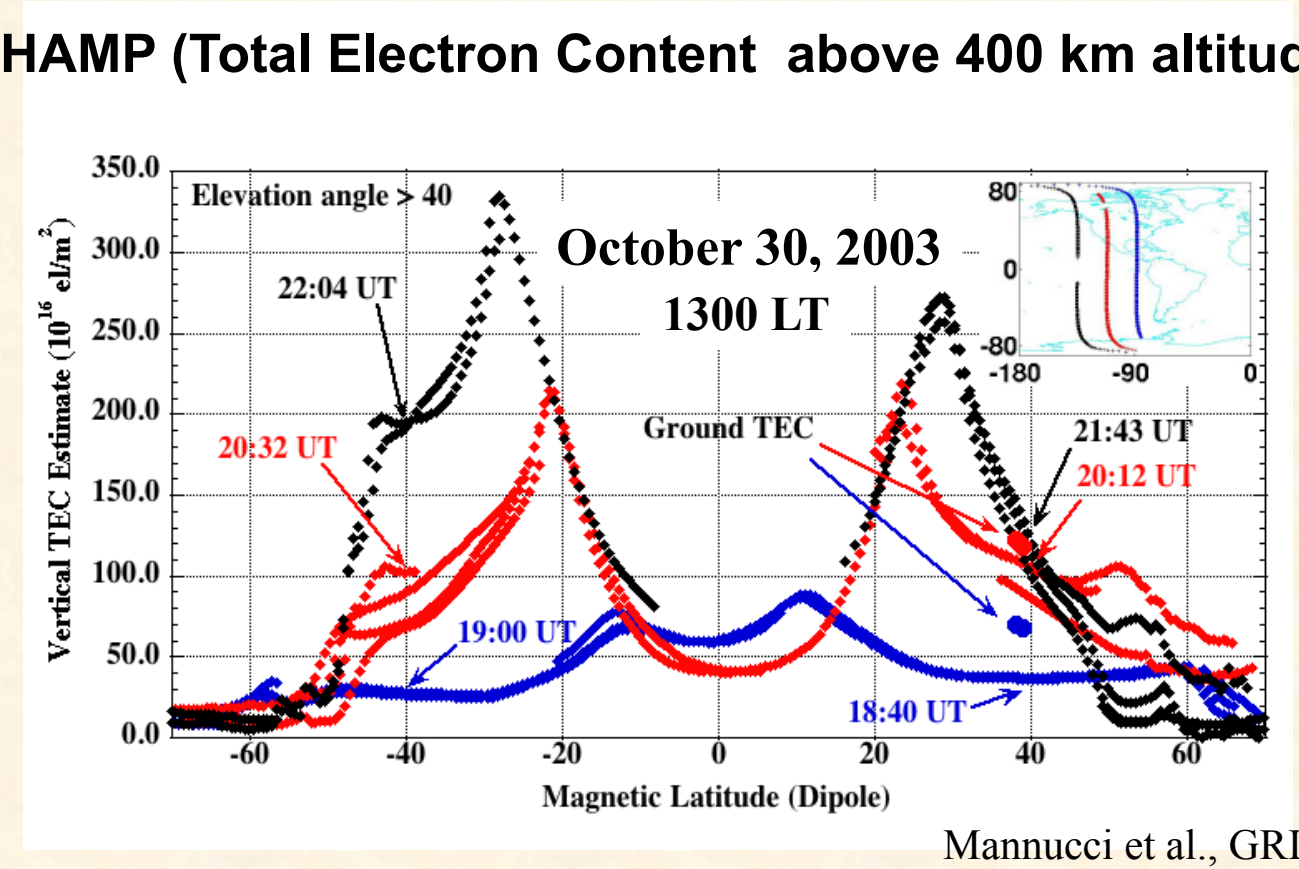
Electric and Magnetic Field Instrument Suite and Integrated Science/WAVES/MAG -C. Kletzing, U. Iowa

Electric Field and Waves - J. Wygant, U. Minnesota

Ionospheric Density Changes During Storms

CHAMP (Total Electron Content above 400 km altitude)

TEC



Mannucci et al., GRL 2005

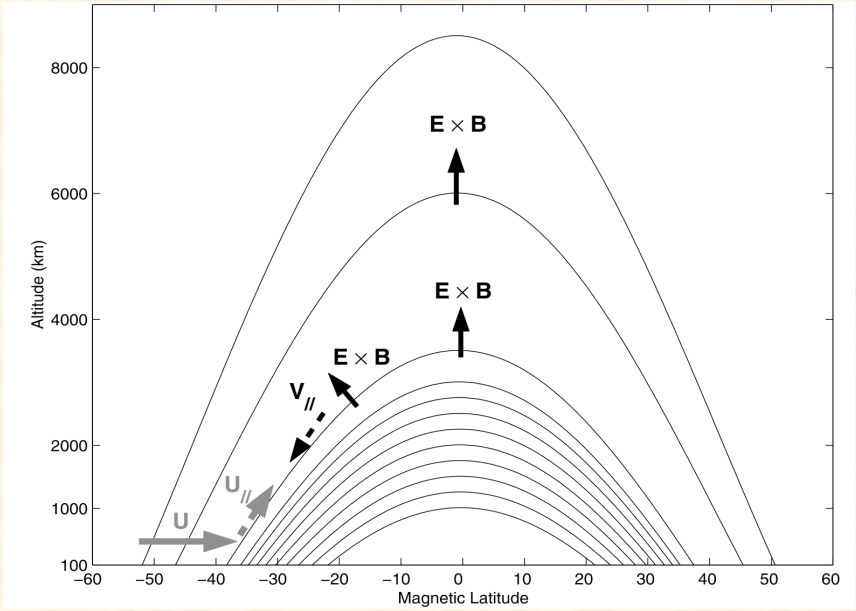
Mag Lat

•Both electric fields and atmospheric winds can cause large sudden rearrangements of the topside ionosphere during magnetic storms.

RBSP provides electric field measurements mapping to the regions where these perturbations occur

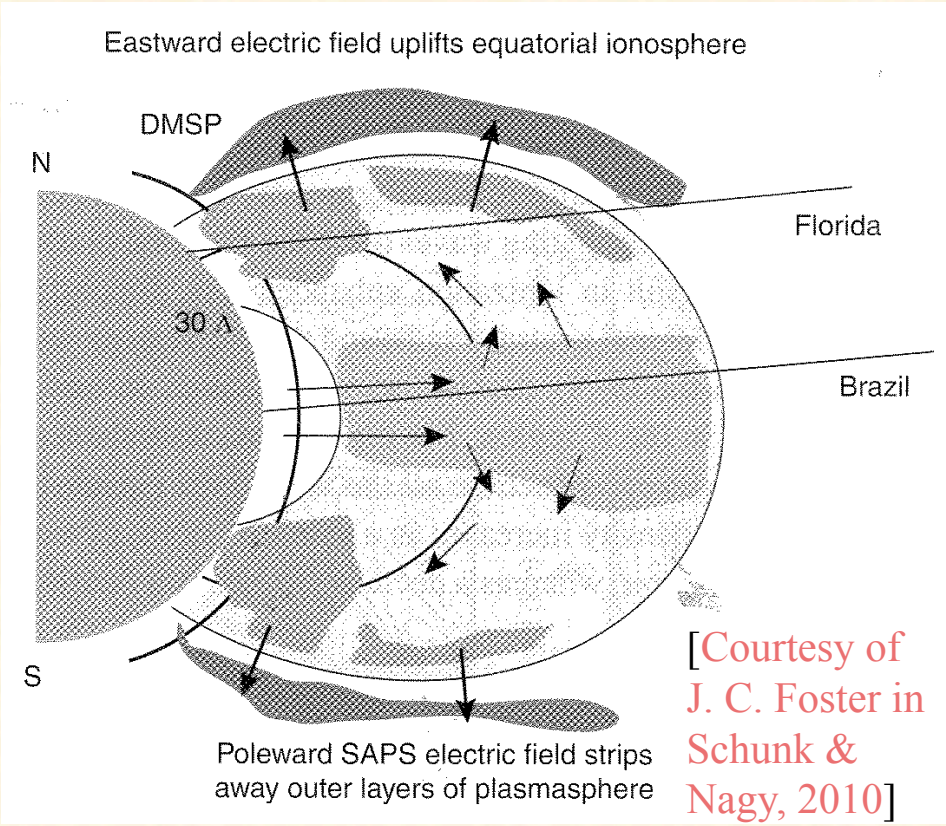
Equatorial Fountain Effects

Altitude



Latitude

Sheffield University Plasmasphere Ionosphere Model (SUPIM) [*CH Lin et al., 2005*]



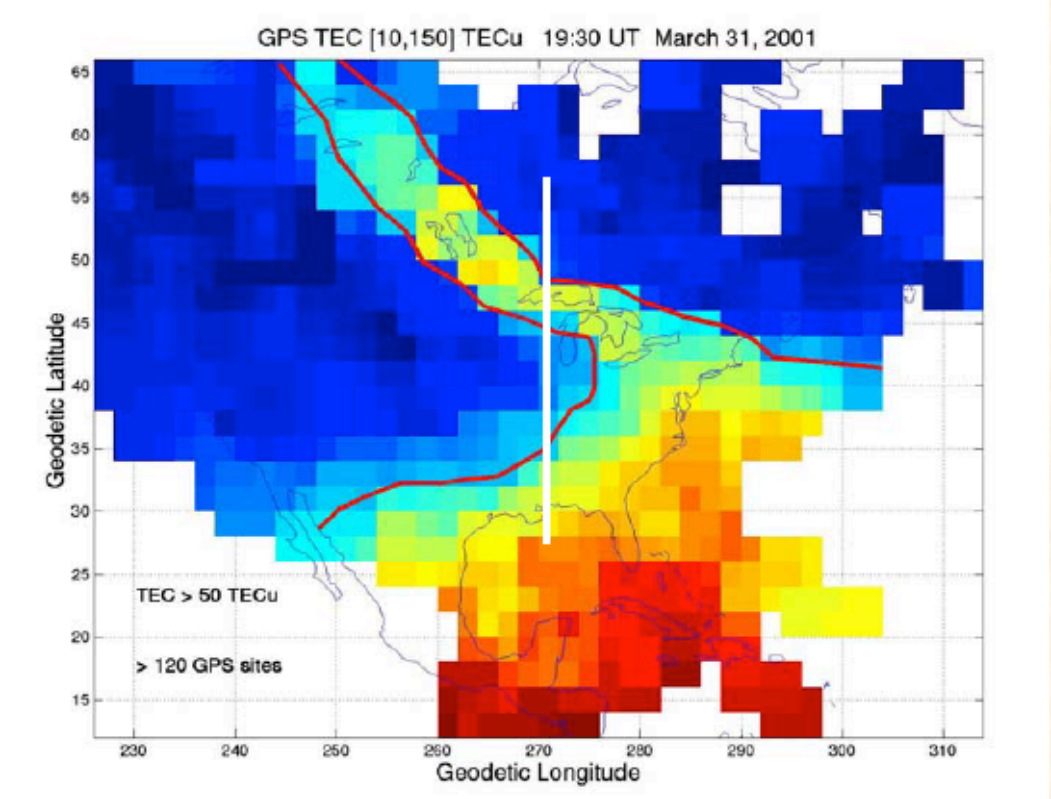
[Courtesy of J. C. Foster in Schunk & Nagy, 2010]

•Disturbed evolution of equatorial fountain can lead to stripping of outer layers of plasmasphere

RBSP observes the E-field changes and outer plasmasphere structures connected to ionospheric patches.

Continuation into Polar Cap

Foster, Report of Joint TR&T and FST Workshop 2008



GPS TEC data

Latitude

Longitude

•Ionization tongues in the polar cap: plasma from below $\Lambda = 40°$ is transported poleward.

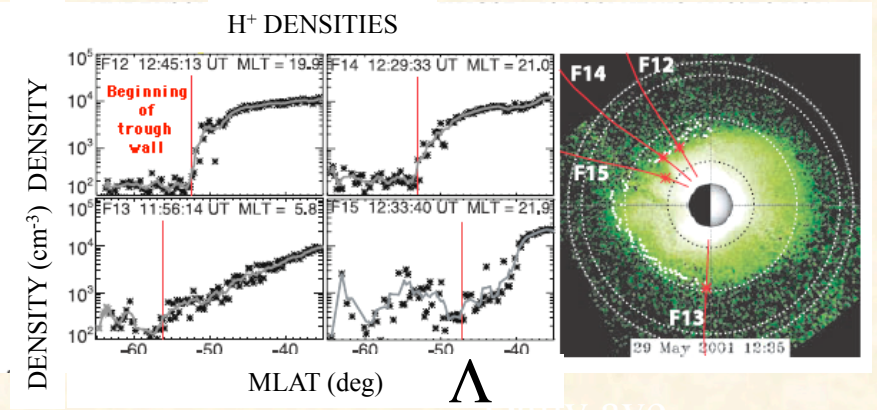
•Expansions of the polar convection pattern can transport middle latitude plasma to high latitudes.

RBSP measures the *ring current-driven changes in electric fields and convection that can produce the Sub Auroral Polarization Streams (SAPS) responsible for the plasma evolution.*

Plasmapause and Precipitation in Ionosphere

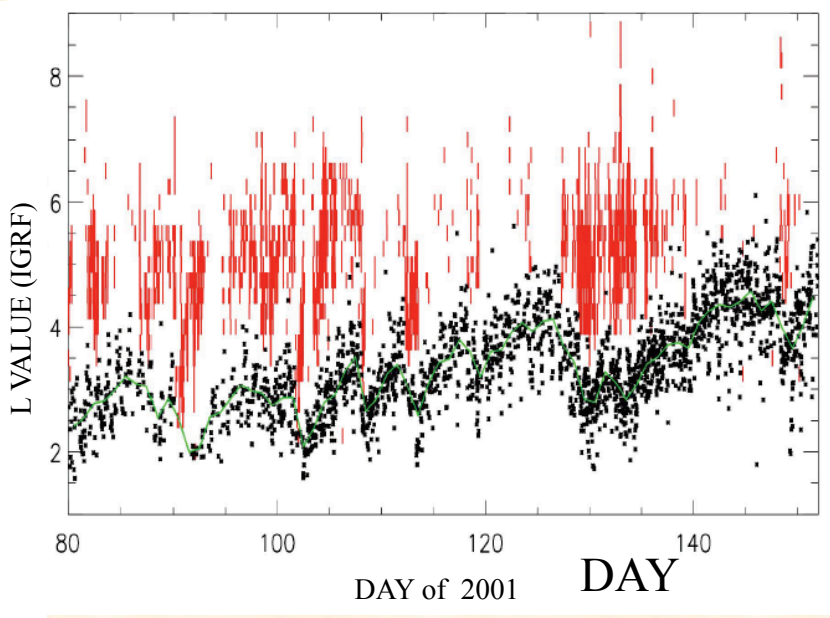
- Ionospheric light ion (H^+) trough wall corresponds to equatorial plasmapause?
- Motions of the LIT follow motions of the inner L-edge of the plasma sheet (identified from equatorward edge of auroral precipitation) and microbursts of relativistic electrons.
- *RBSP provides plasma sheet and plasmapause boundaries for correlations with I-T parameters.*

n



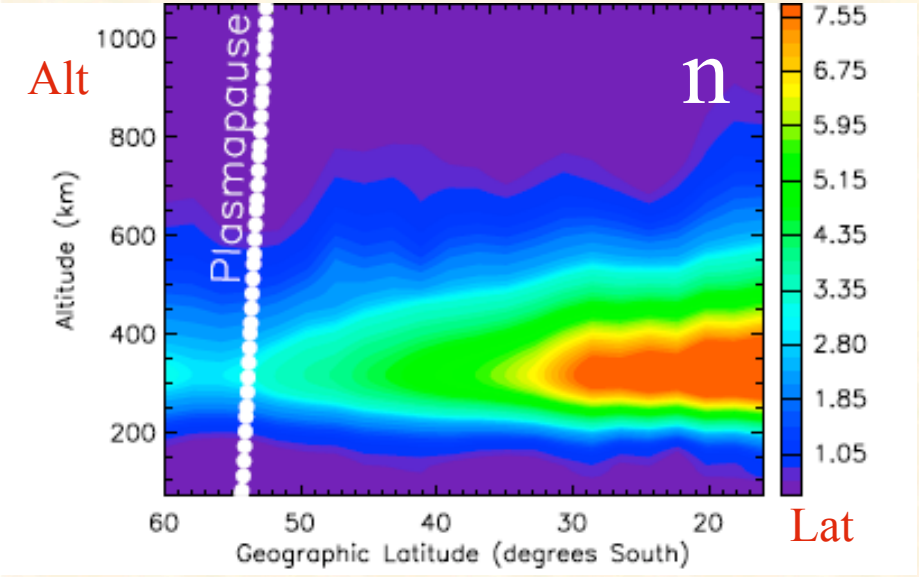
DMSP H^+ trough wall position correlates well with the near simultaneous IMAGE UV measured plasmapause (Anderson et al., GRL, 2008).

L

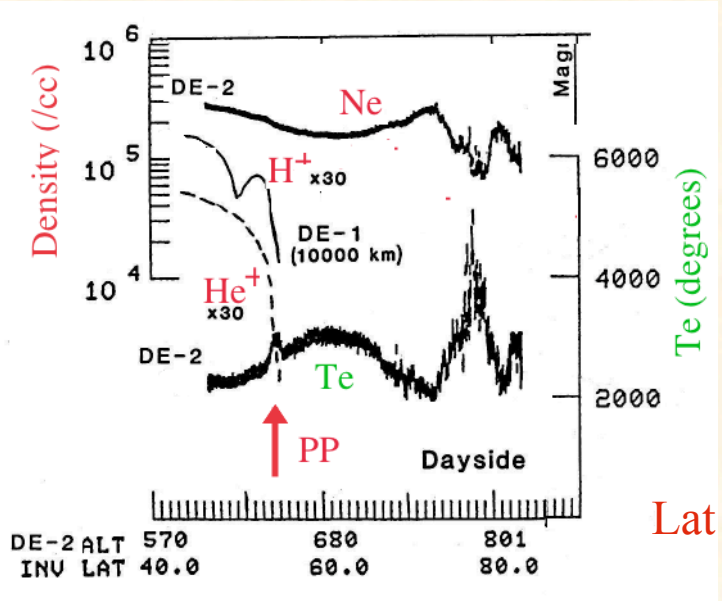


SAMPEX relativistic microbursts compared to DMSP PP locations (Johnston et al., JGR, 2008).

Plasmasphere - Ionospheric Structure



GPS tomographic log electron density profiles at night and plasmapause from IMAGE (Yixengoh et al., GRL, 2005).



Plasmapause in H^+ at high altitudes from DE-2 does not have a signature in Ne at lower DE-2 altitude in the daytime, but there is an electron temperature signature (Brace et l988).

•Mid-latitude electron density trough minimum has been associated with plasmapause. This relation depends on altitude – most obvious on dayside where F region does not show a prominent mid-latitude depression but has a PP signature in the electron temperature.

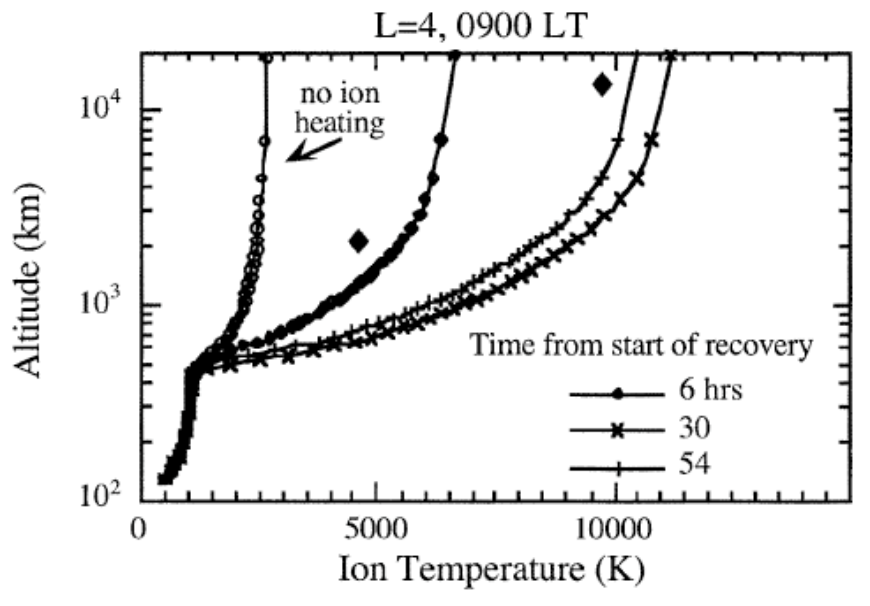
RBSP observations of particle populations and heating processes can be used to help resolve the relationships between the middle latitude ionospheric and outer plasmasphere structures.

Ring Current Ionosphere Heating

•Ring current plasmas heat the plasmasphere via Coloumb and wave-particle interactions

•Ion and electron heating of the ionosphere can excite stable auroral red (SAR) arcs at middle latitudes

•Ionospheric temperatures control ionospheric density distributions, composition, neutral distributon.

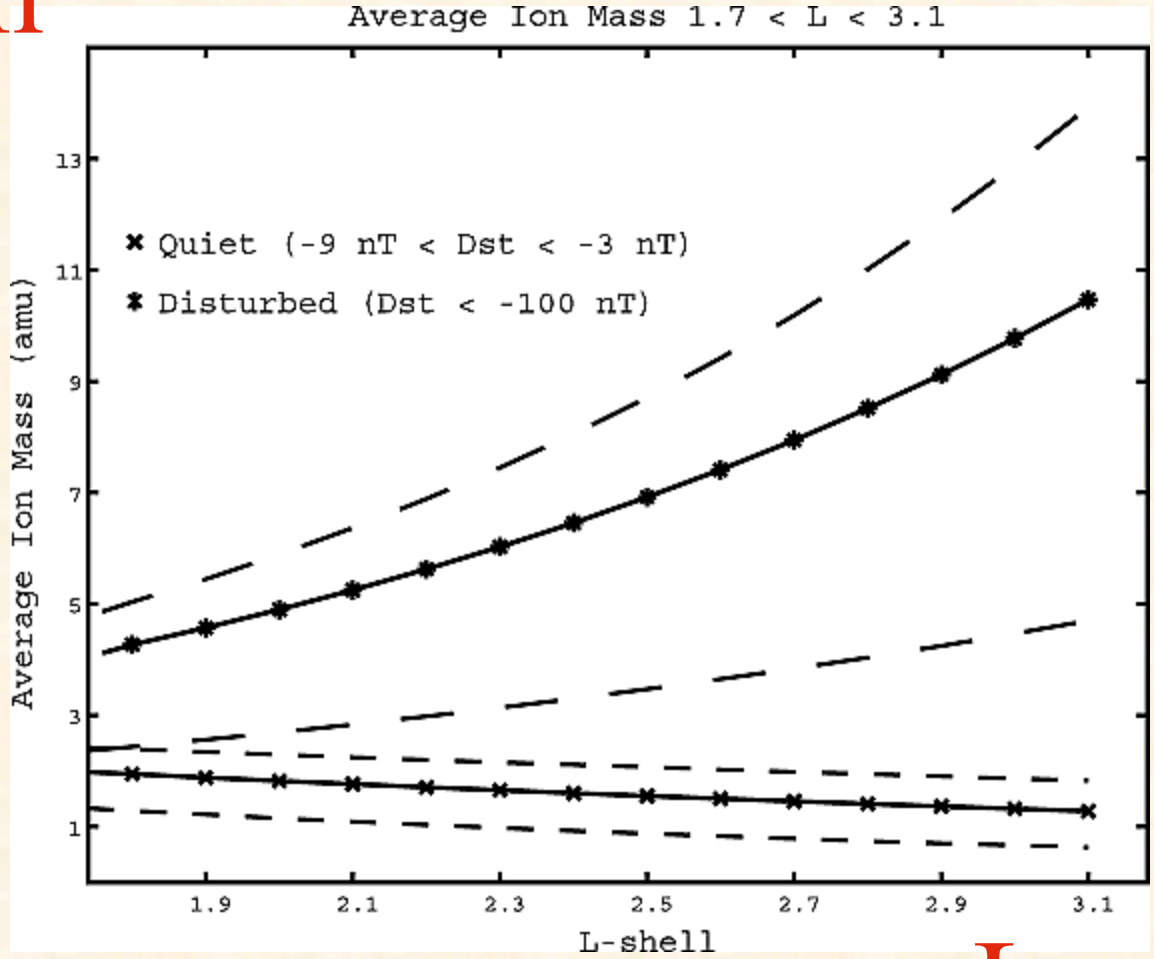


Modeled ring current heating in recovery phase of storm. Diamonds are averaged DE RIMS measurements. (Fok et al., 2005)

The sources of ring current plasma and wave-collision processes leading to ionospheric heating will be measured by RBSP, so measurements in the ionosphere along with RBSP data can be used to resolve the ionospheric heating source and specify ring current heating better.

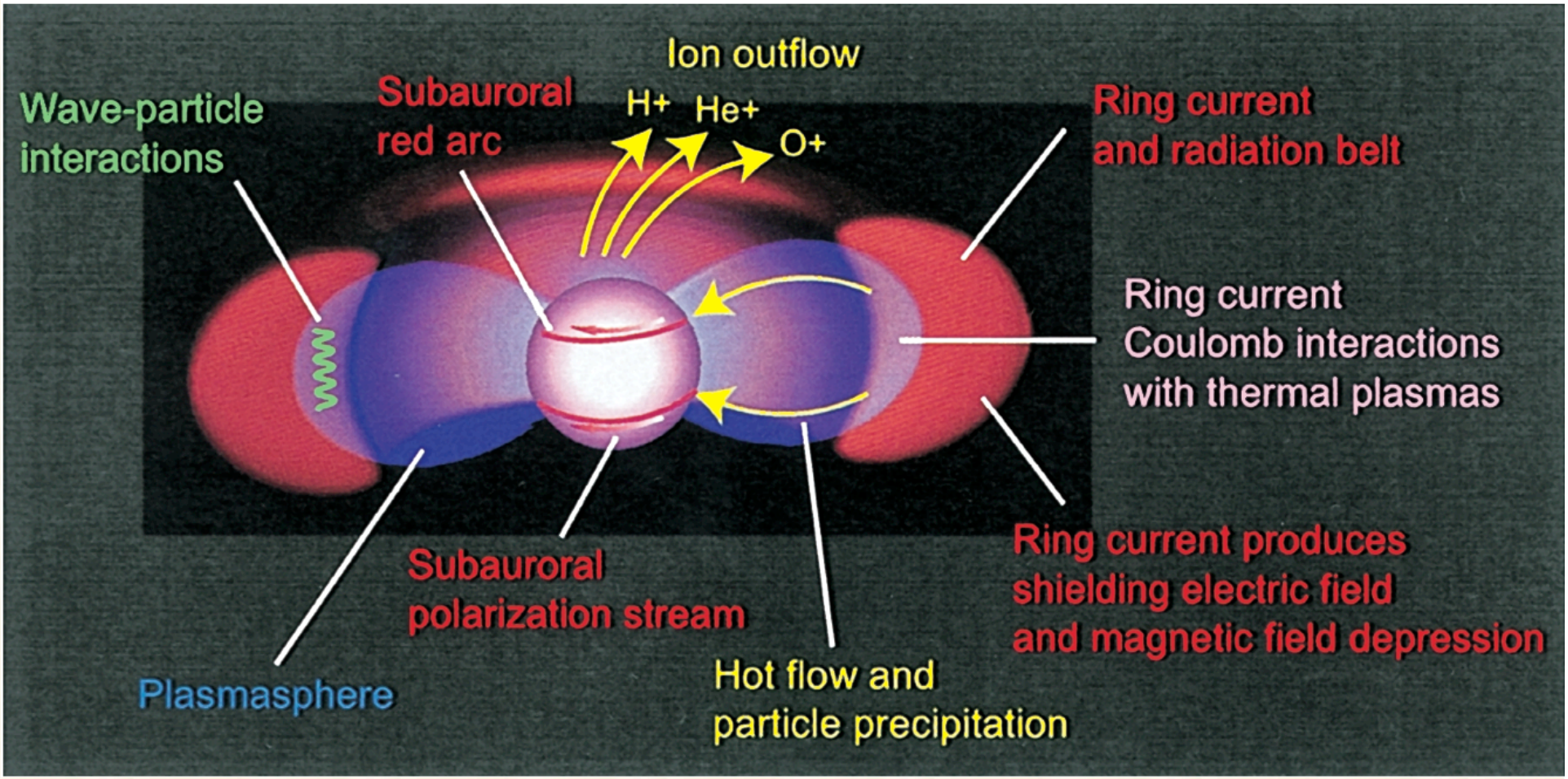
Connection to Ground-based Magnetometers

- RBSP provides in situ measurements of
- 1. the plasmaspheric mass density profiles.
- 2. ULF waves
- deduced from ground measurements.



From MEASURE chain
Berube et al., GRL, 2005

Coupled Magnetosphere Ionosphere/ Thermosphere System



RBSP observations relevant to a wide array of phenomena

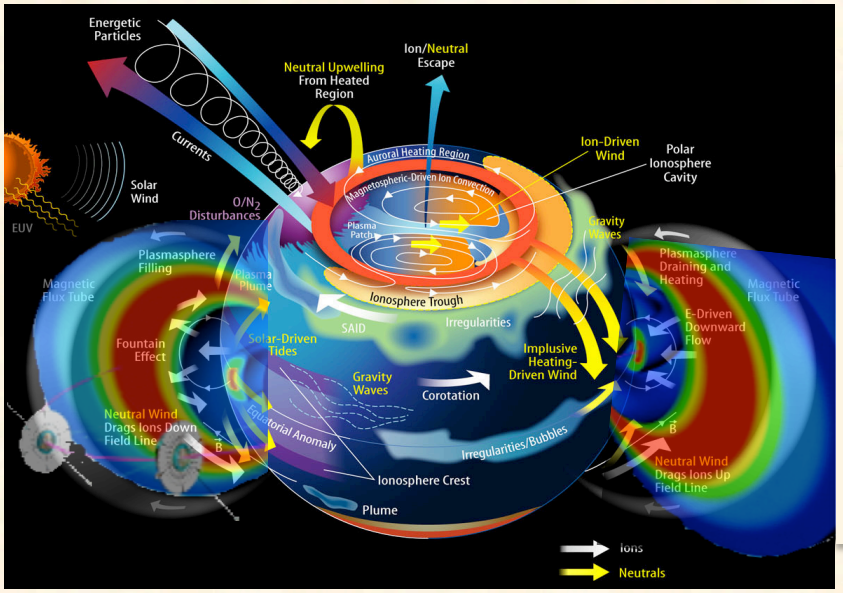
I-T Inputs to RBSP Science

- *Electric field/ion drift measurements*
  - Global context
- *Information on ion source and loss processes*
  - Ring current ion source
  - Precipitation regions
- *Ionospheric density morphology*
  - Conductivity, origin of E-field structures
  - Plasmasphere, plasmapause structures
- *Magnetic Fields and Wave observations*
  - Plasmasphere density profiles
  - Near-Earth traces of magnetospheric waves

RBSP Inputs to I-T Studies

- *Electric Field measurements*
  Middle-, low-latitude ionospheric dynamics, SAPS
  Drainage plume dynamics.
- *Ring Current Populations*
  Ionospheric heating, E field shielding, Sub-auroral arcs.
- *B field:*
  Field-line configuration for ionosphere-magnetosphere coupling. Ring current contribution to near Earth B changes
- *Energetic Particle Precipitation*
  Direct production of ionization in E region
- *Plasmasphere densities - plasmapause*
  Relation to ionosphere structures.
  Source region for stimulating deposition and IT heating

One Integral System



Mike Mendillo once said: "*Space age is 50 years old next year – is the best we can come up with is one big satellite to solve all our problems. If you want to attack a global problem, we need a global measurement system. We cannot find out everything from a single orbit at a single local time.*"

With RBSP's 2-spacecraft mission and anticipated IT measurement resources, we will have such a multi-component system in place to attack many of the global-scale coupling problems in the inner magnetosphere.

The RBSP measurements will be enabling.
Now is the time to begin thinking about including these assets into ***your*** *own research plans.*
We welcome your participation.