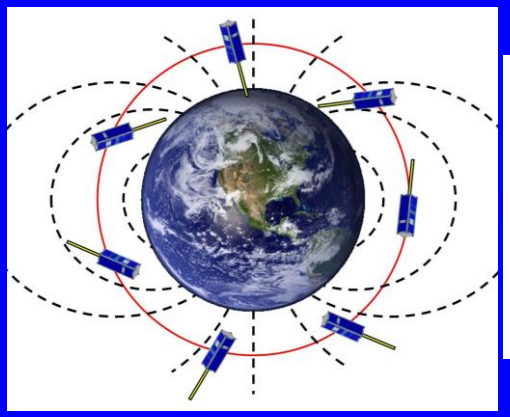
First Results from the Colorado Student Space Weather Experiment (CSSWE): Energetic Particle Distribution in the Near Earth Environment



PI: Xinlin Li, Co-PIs: Scott Palo and Shri Kanekal

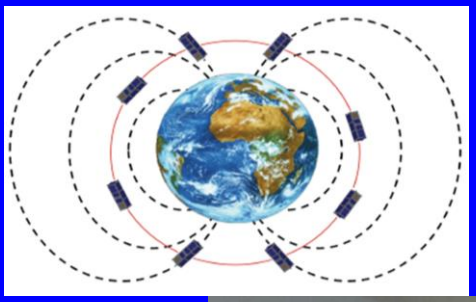
LASP Engineers: Rick Kohnert (chief technical mentor), **Gail Tate** (SW) **+ others**

Student Team: involved over 65 graduate and undergraduate students
Lauren Blum (PM), David Gerhardt (SE), Quintin Schiller (CFO and Instrument)
Other current Ph.D. students: Sam Califf and Hong Zhao
Former Ph.D. students: Drew Turner and Weichao Tu

Funded: 1/1/10 Delivered: 1/9/12

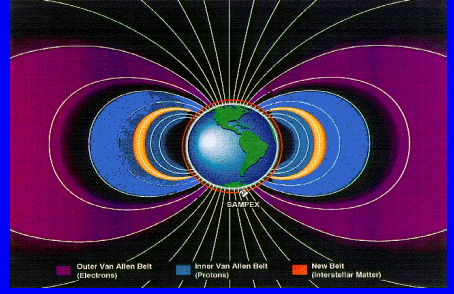
Launched: 9/13/12, NRO (Atlas V) under NASA's ELaNa program

Orbit: ~480 km x 780 km, inclination 65^0



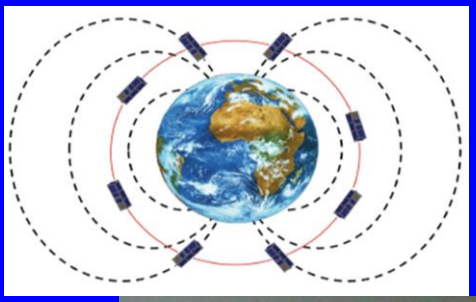
CSSWE: Colorado Student Space Weather Experiment

(Spring of 2010)



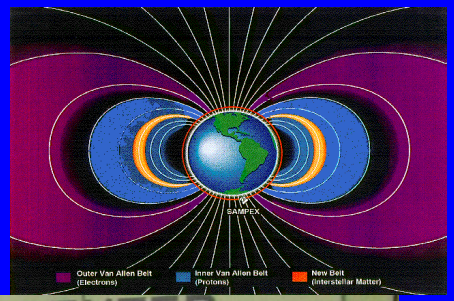
LASP
LABORATORY FOR ATMOSPHERIC AND SPACE PHYSICS

Aerospace Engineering



CSSWE: Colorado Student Space Weather Experiment

(Fall of 2010)



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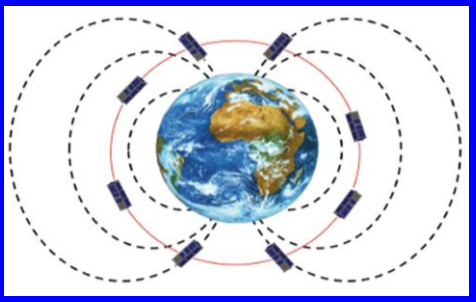
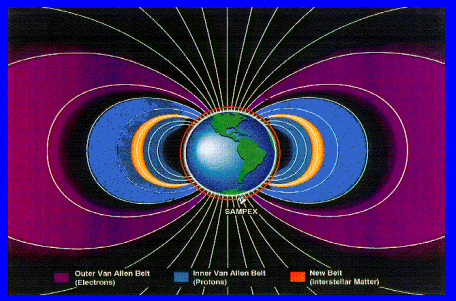


CSSWE: Colorado Student Space Weather Experiment

(Spring of 2011)



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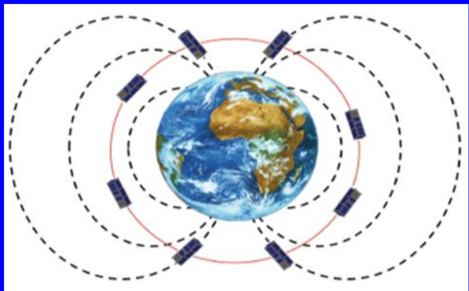
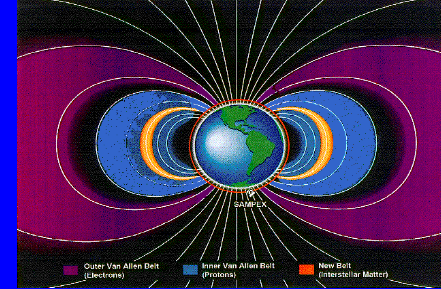
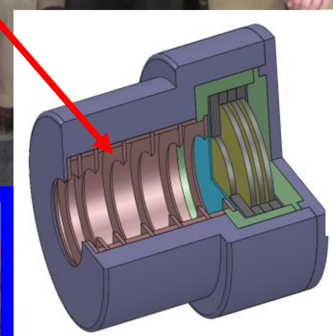
Aerospace Engineering



CSSWE: Colorado Student Space Weather Experiment

(Spring of 2010)



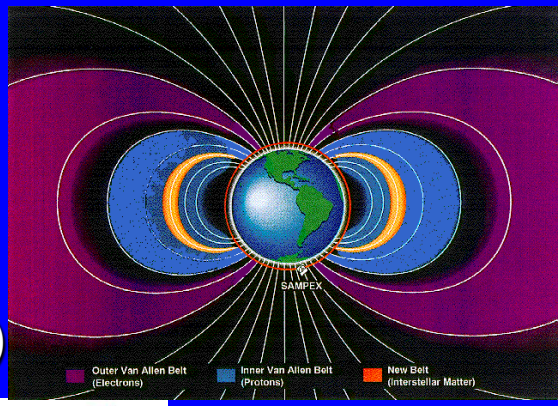


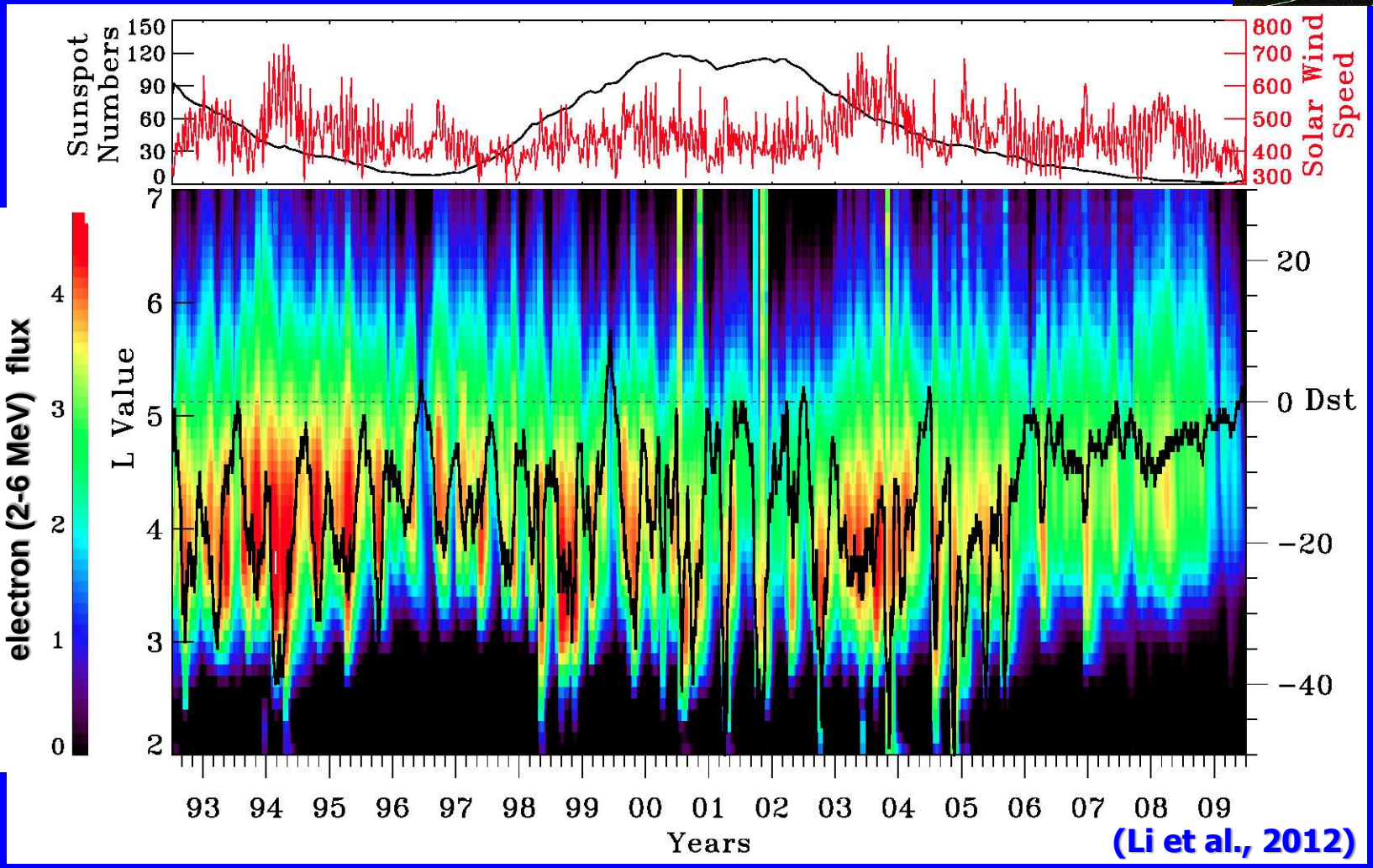
Relativistic Electron and Proton Telescope integrated little experiment (REPTile)

LABORATORY FOR ATMOSPHERIC AND SPACE PHYSICS

Outer Radiation Belt Electrons Measured by SAMPEX

(launched on 7/03/92: 550km × 675km, 82°, re-entered on 11/13/12)

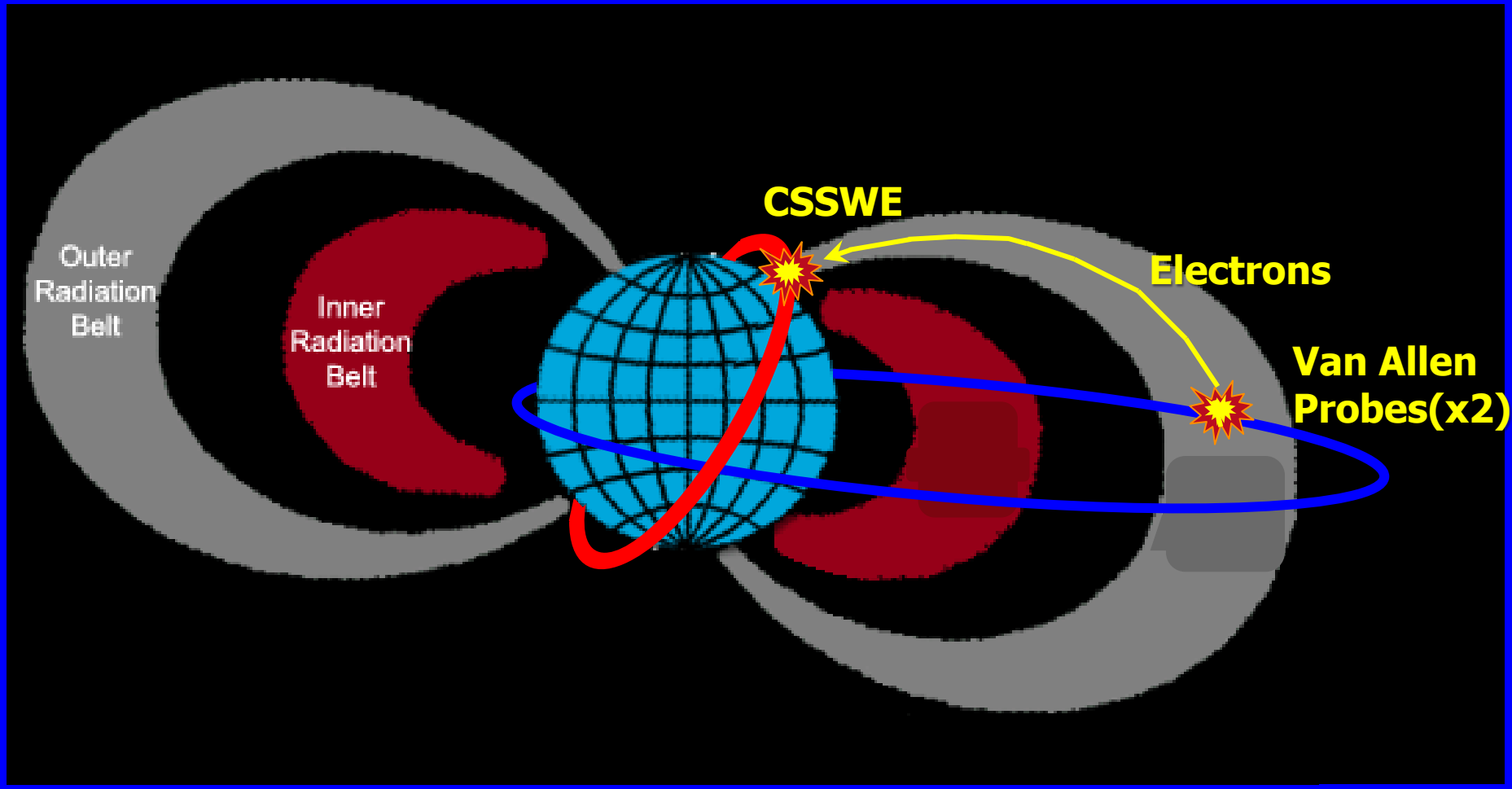




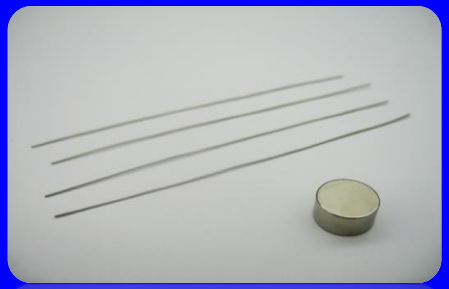
(Li et al., 2012)

Concurrent measurements with NASA/Van Allen Probes

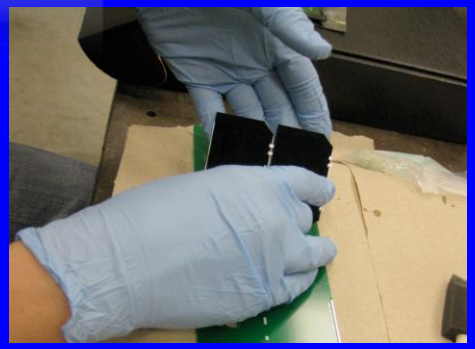
(orbits: 605km x 30410km and 635km x 30540km , inclination: 10^0)



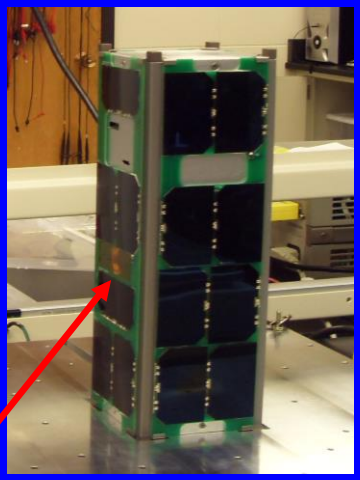
Passive Attitude Control: bar magnet & hysteresis rods

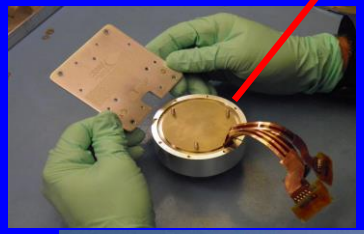


Solar cell mounting

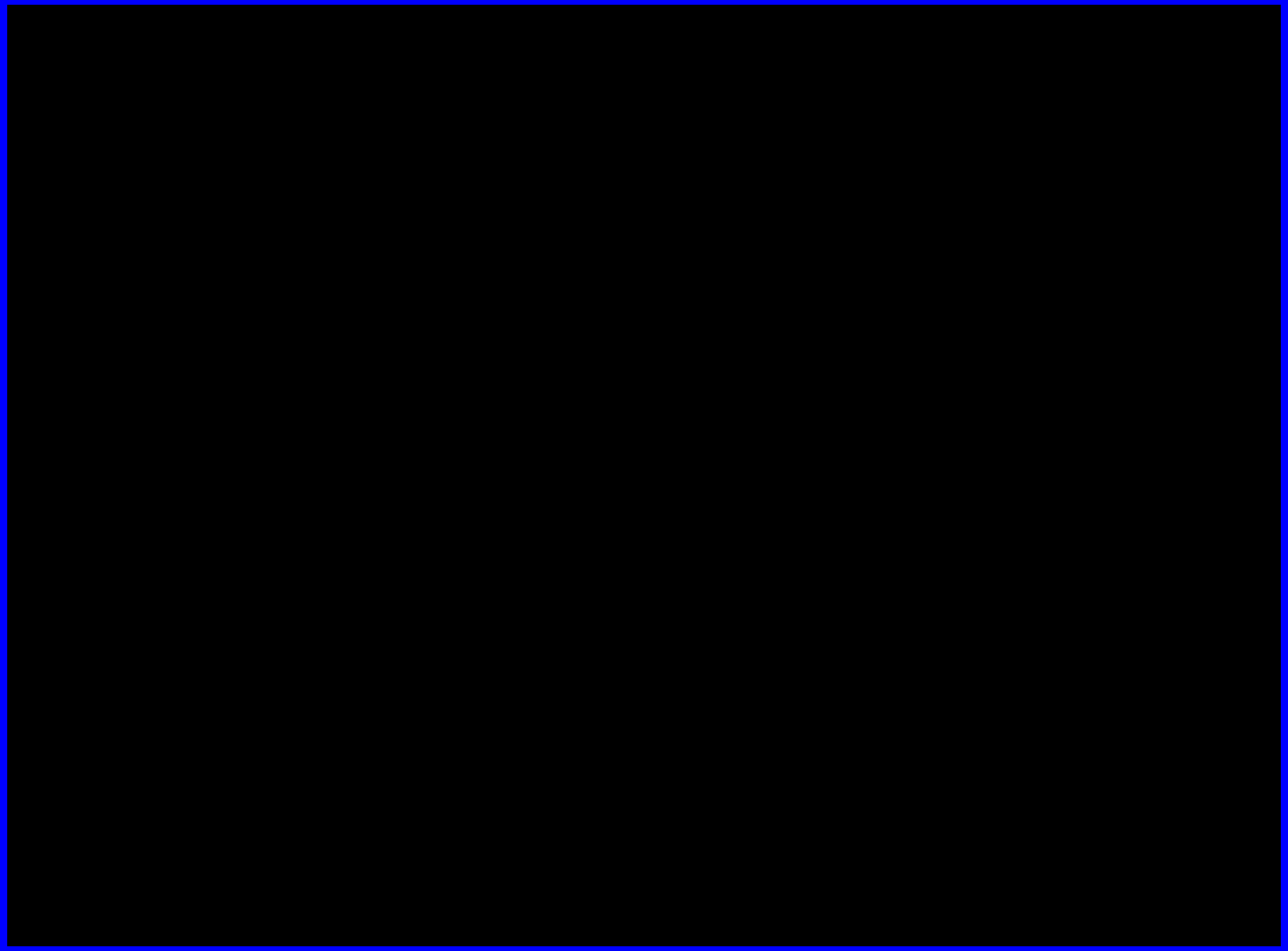


System testing and debugging





REPTile assembly



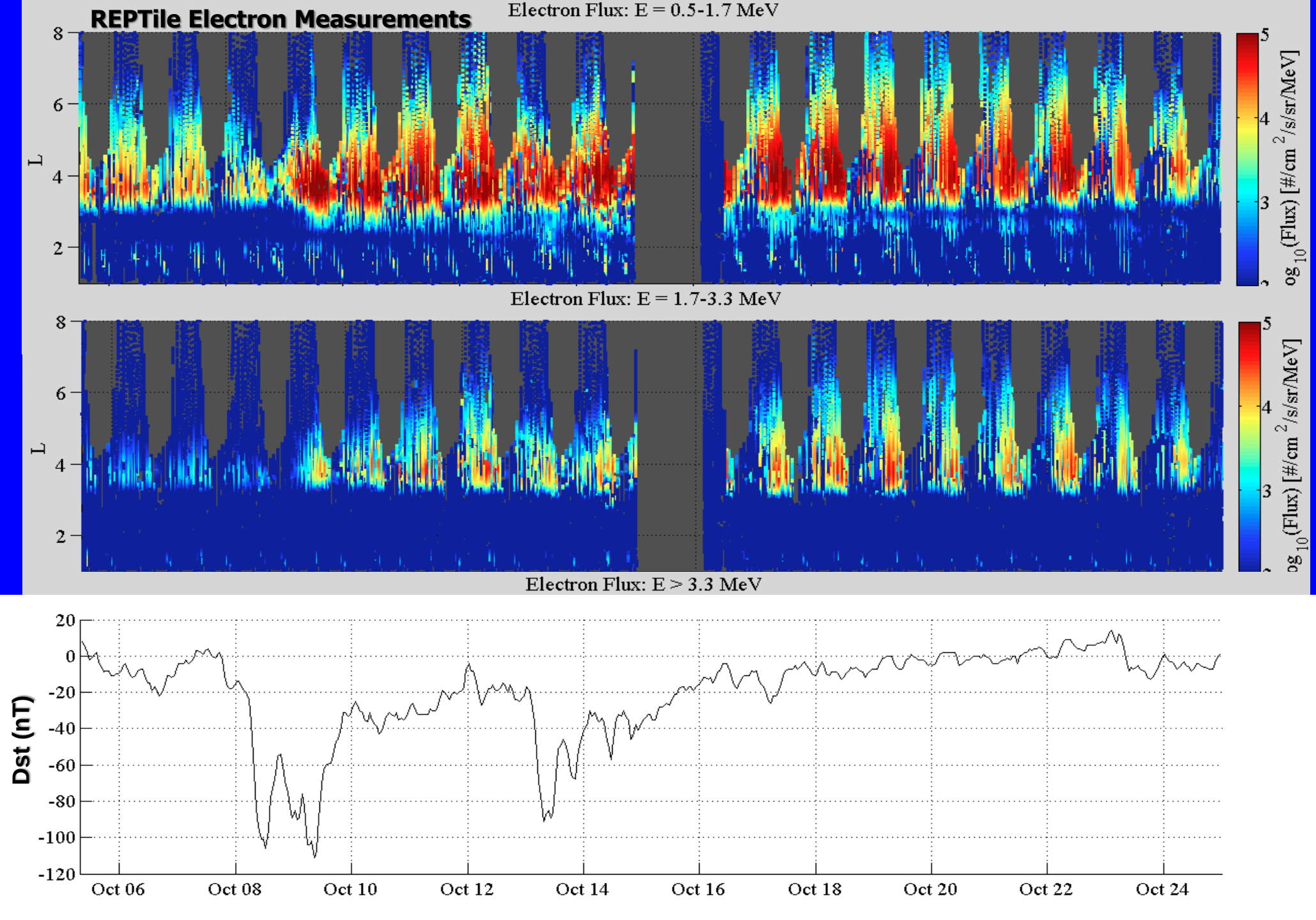
Launched on 9/13/12, we received beacon packets during its first over pass

Commissioning phase completed on 10/04/12 and Particle detectors were turned on

The data are very clean, far exceeding expectation!

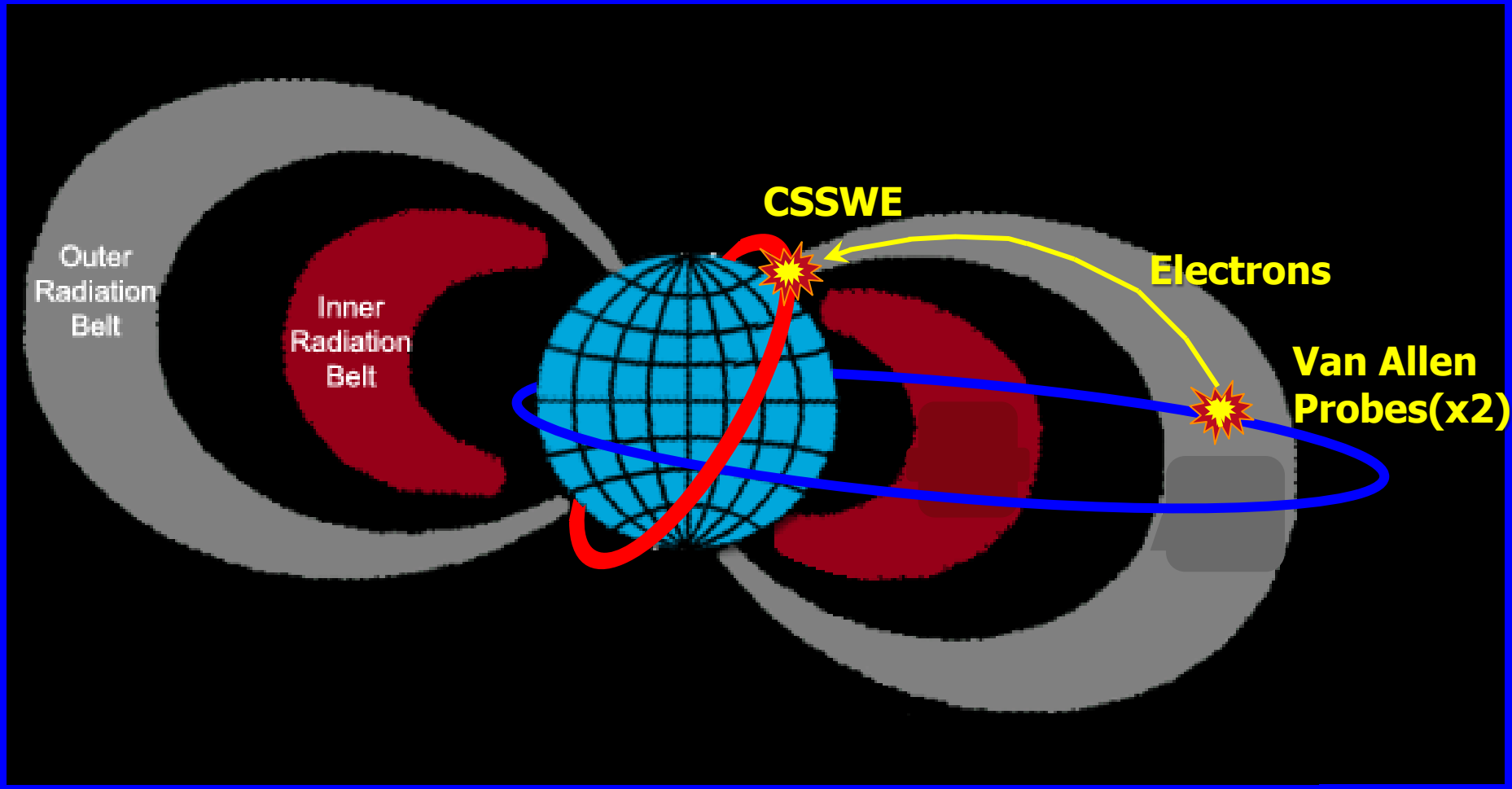
	Channel 1	Channel 2	Channel 3
Electrons	0.5-1.7 MeV	1.7-3.3 MeV	>3.3 MeV
Protons	9-18 MeV	18-30 MeV	30-40 MeV

Three-month science mission (full success) was completed on 1/05/13. We are now into the extended mission phase, focusing more on data analysis and modeling.


REPTile Electron Measurements
Electron Flux: E = 0.5-1.7 MeV
Electron Flux: E = 1.7-3.3 MeV
Electron Flux: E > 3.3 MeV
L
log10(Flux) [#/cm2/s/sr/MeV]
Dst (nT)
Oct 06
Oct 08
Oct 10
Oct 12
Oct 14
Oct 16
Oct 18
Oct 20
Oct 22
Oct 24

Concurrent measurements with NASA/Van Allen Probes

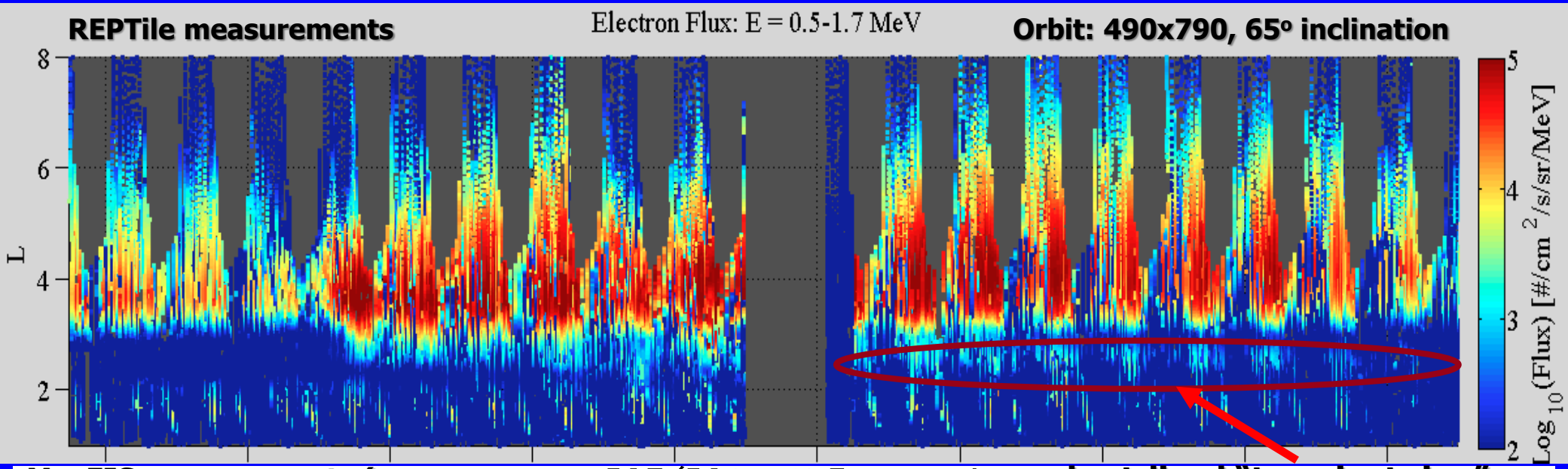
(orbits: 605km x 30410km and 635km x 30540km, inclination: 10^0)

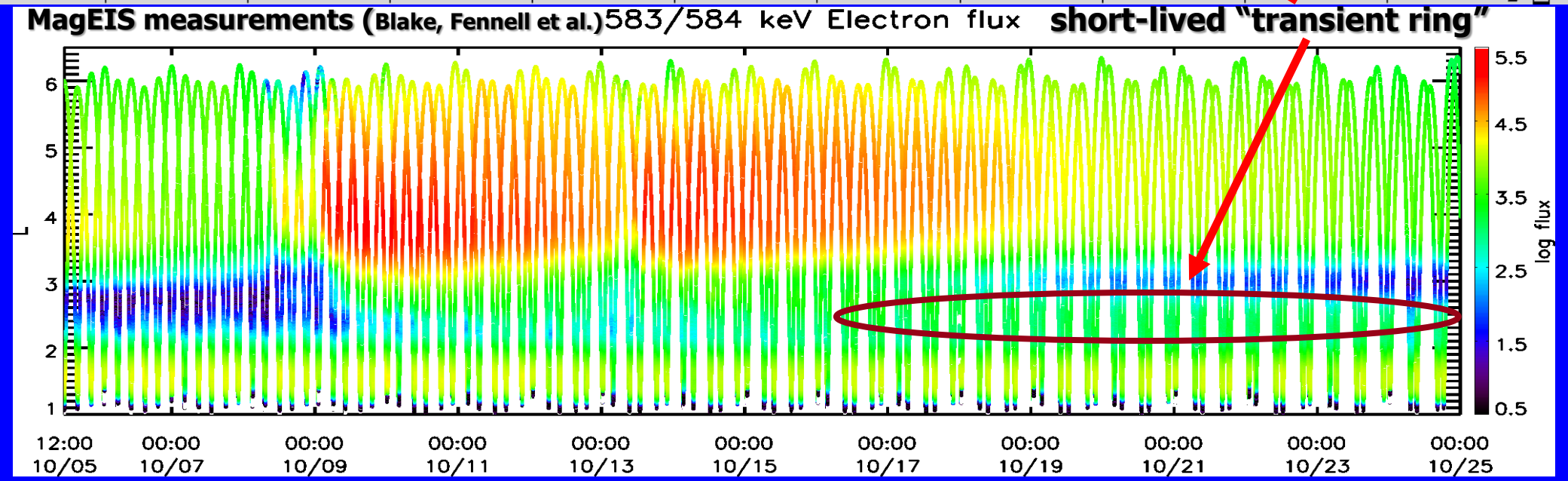


Comparison REPTile and MagEIS (~ 0.5 MeV):

(1) ~ 0.5 MeV electrons go deep, pass slot region and merge with inner belt

(2) Detailed structures: including so called “transient ring”

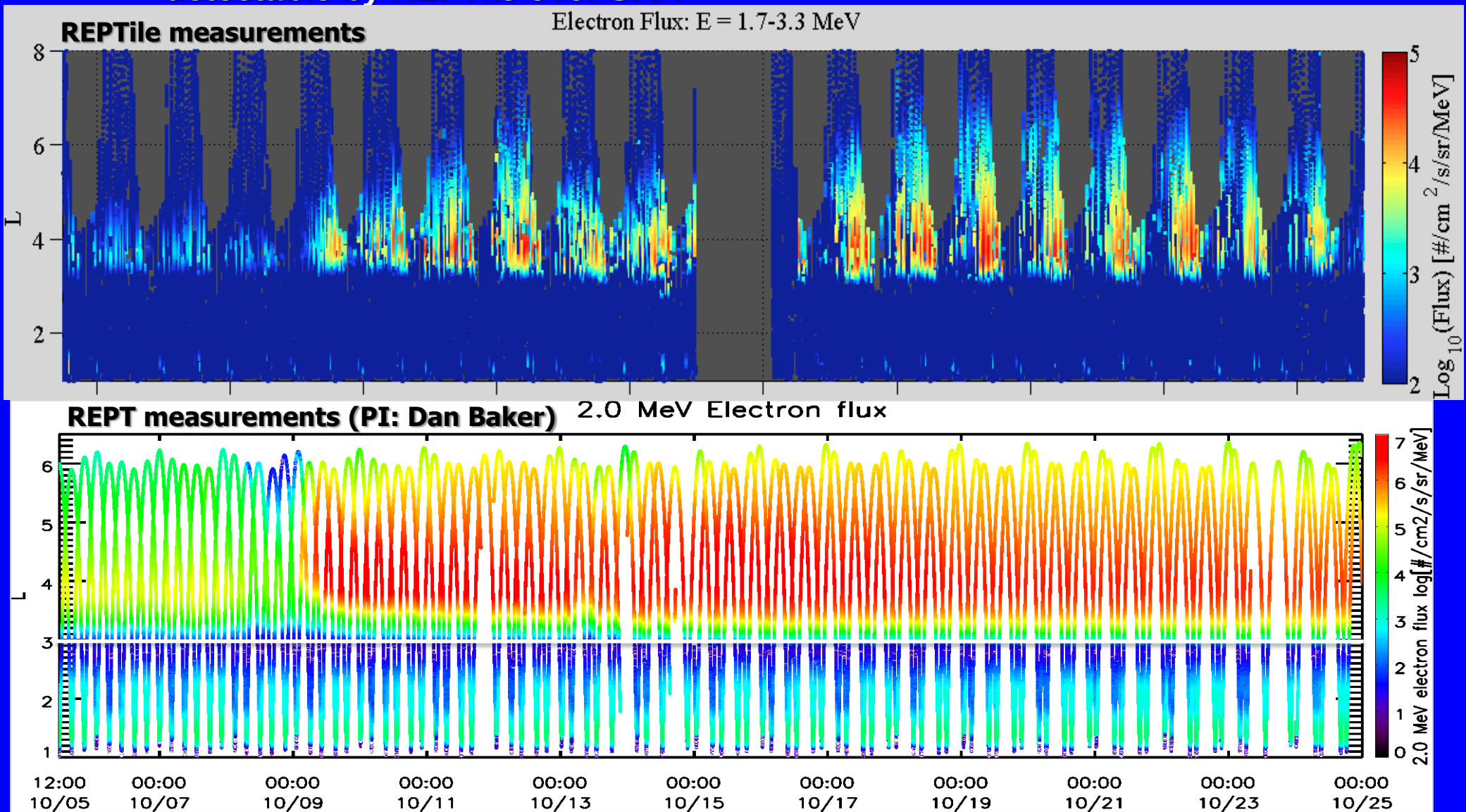




Comparison REPTile and REPT (>1.77 MeV):

(1) Outer belt electrons dynamic with continuous PA scattering, but stayed at L≥3, and no "transit ring"

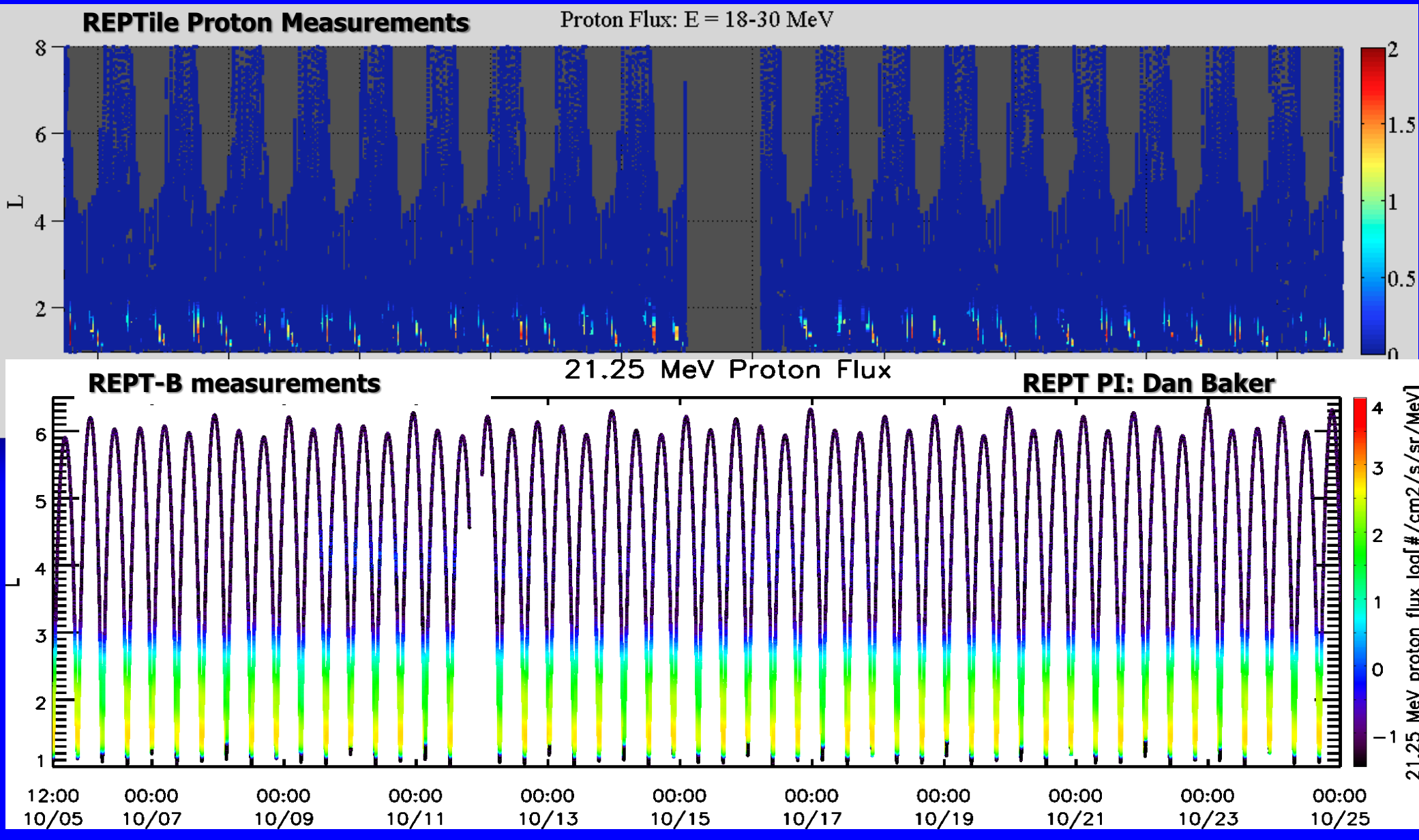
(2) Inner belt electrons stable, confined to the equatorial region, only detectable by REPTile over SAA



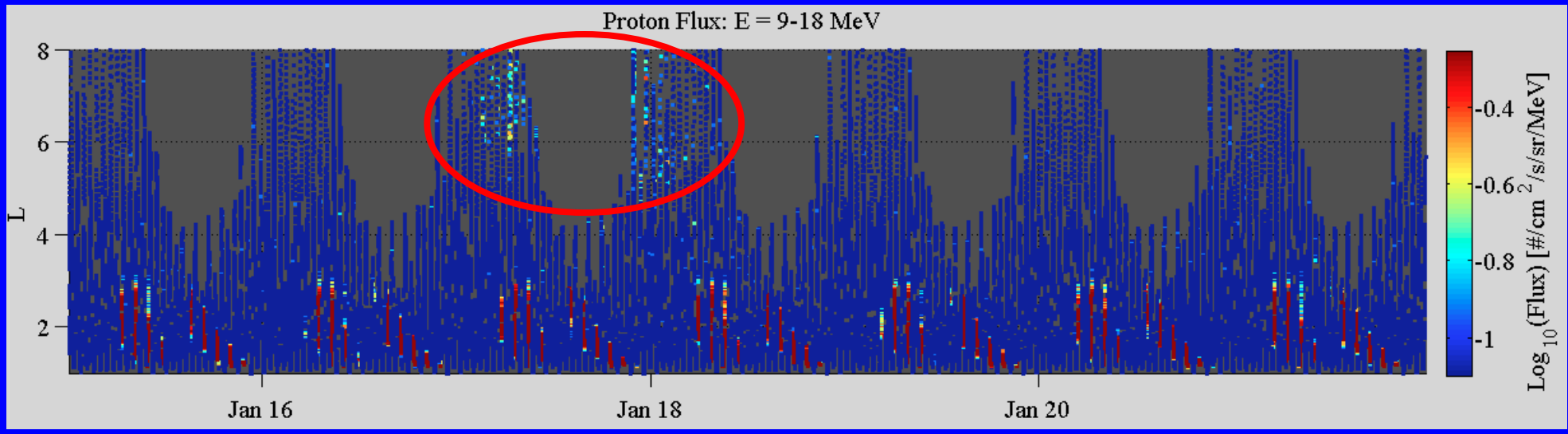
Comparison between REPT and REPTile:

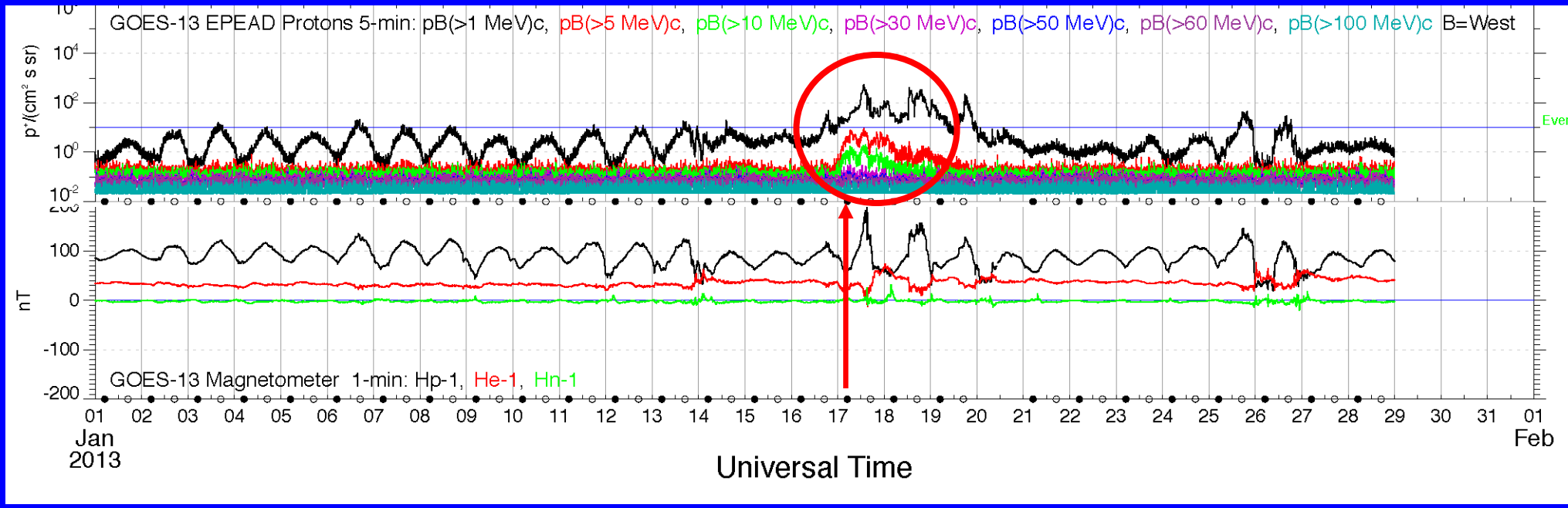
(1) Very few energetic protons in the outer belt

(2) Inner belt protons stable, confined to the equatorial region

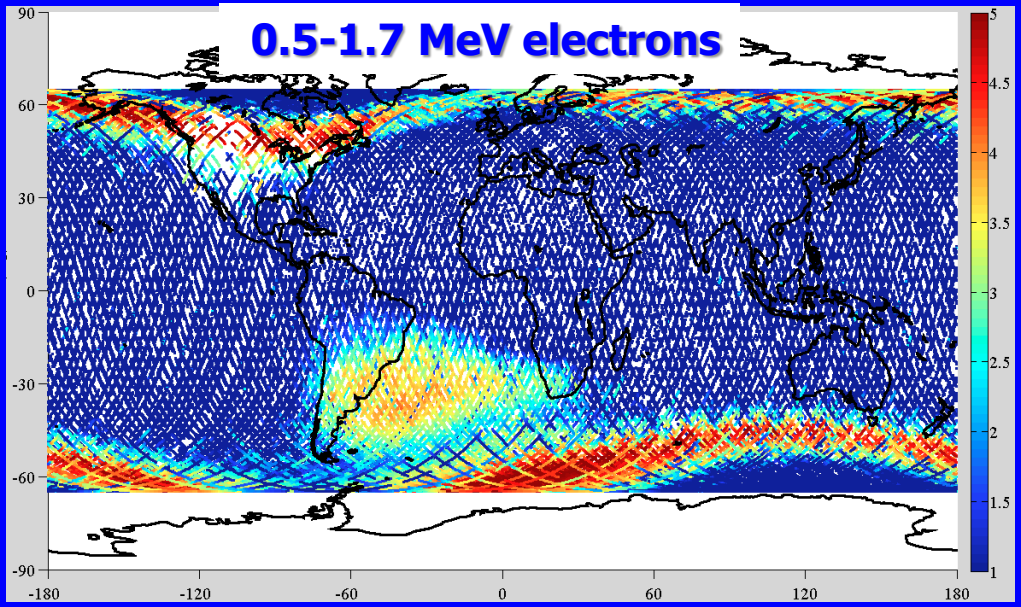


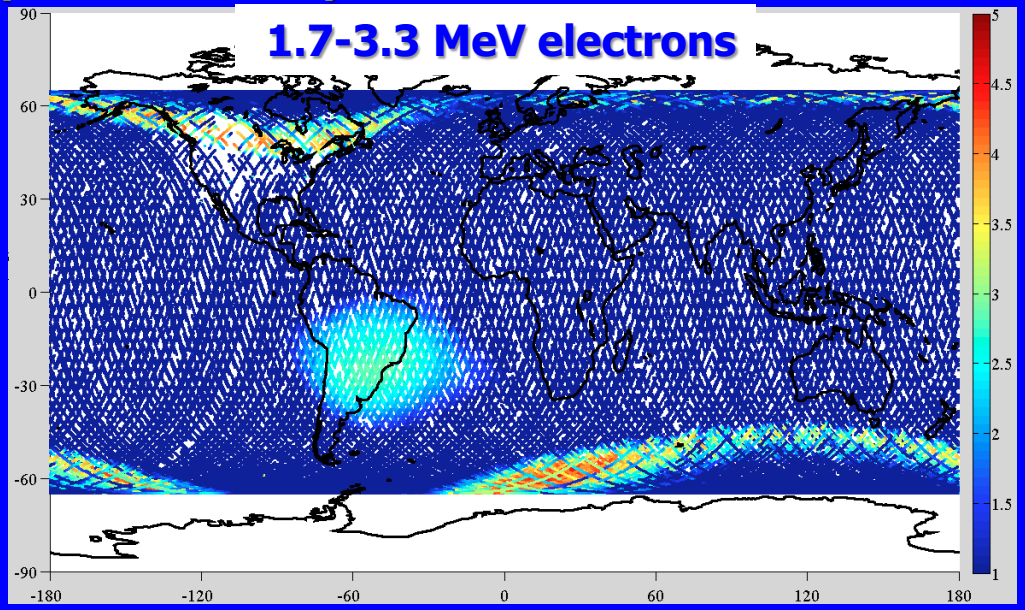
A small SEP event was measured by REPTile and GOES –13

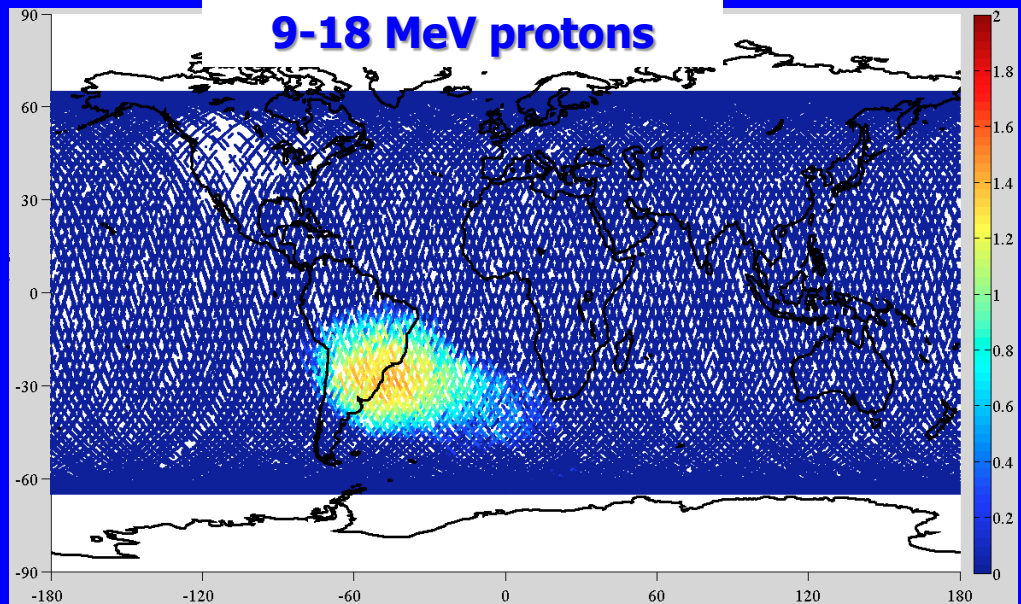


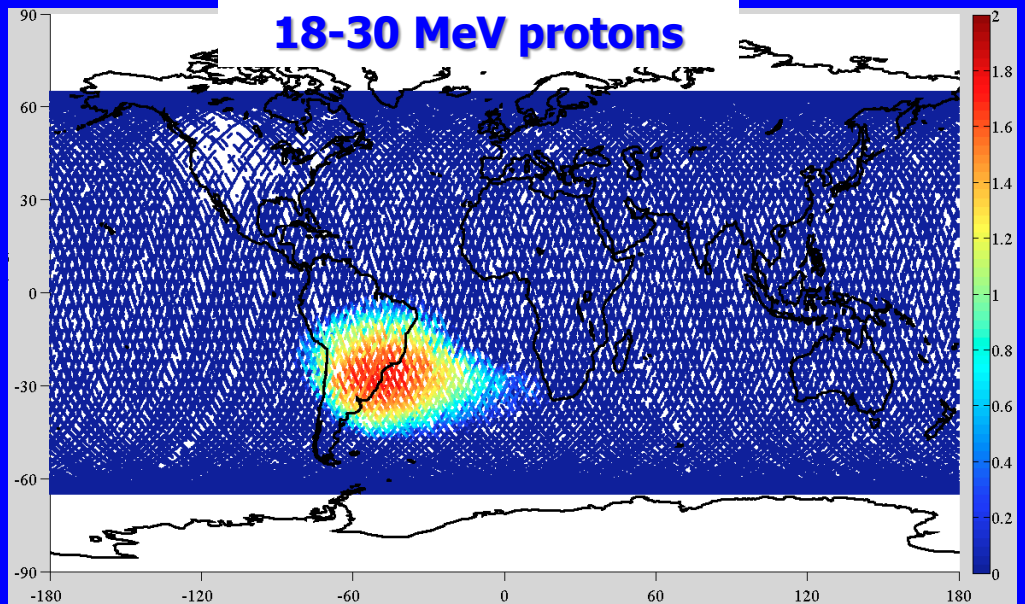


Measurements of electrons & protons from REPTile provide a clear picture of energetic particles (electrons and protons) in the near Earth environment (10/5-25/2012)

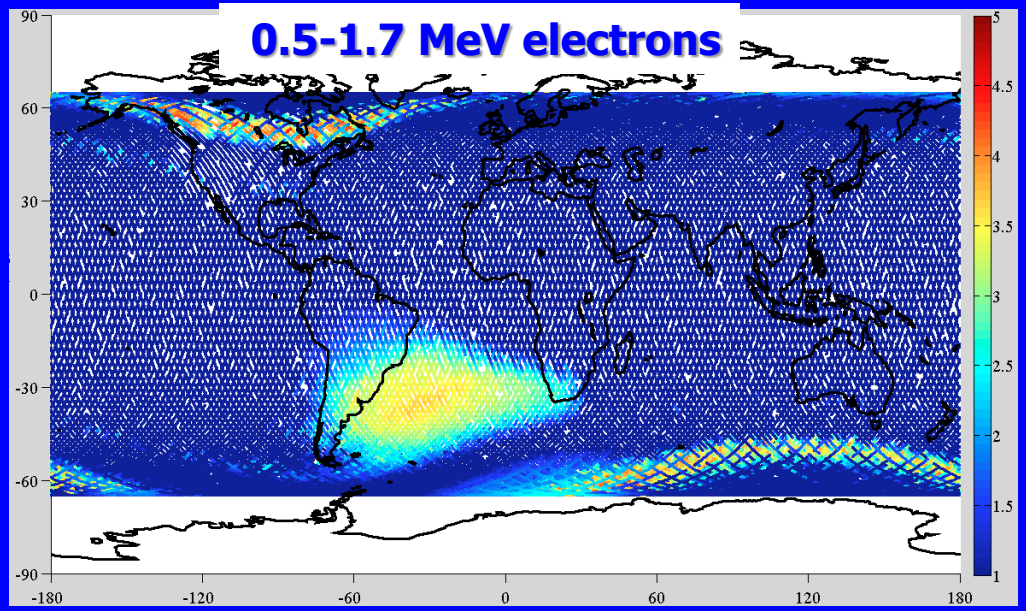


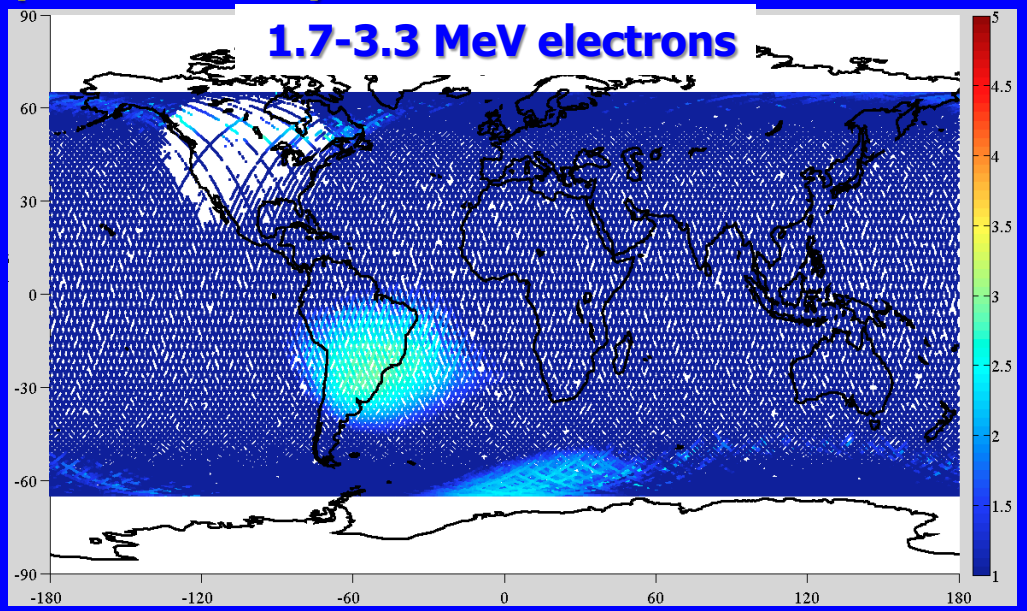


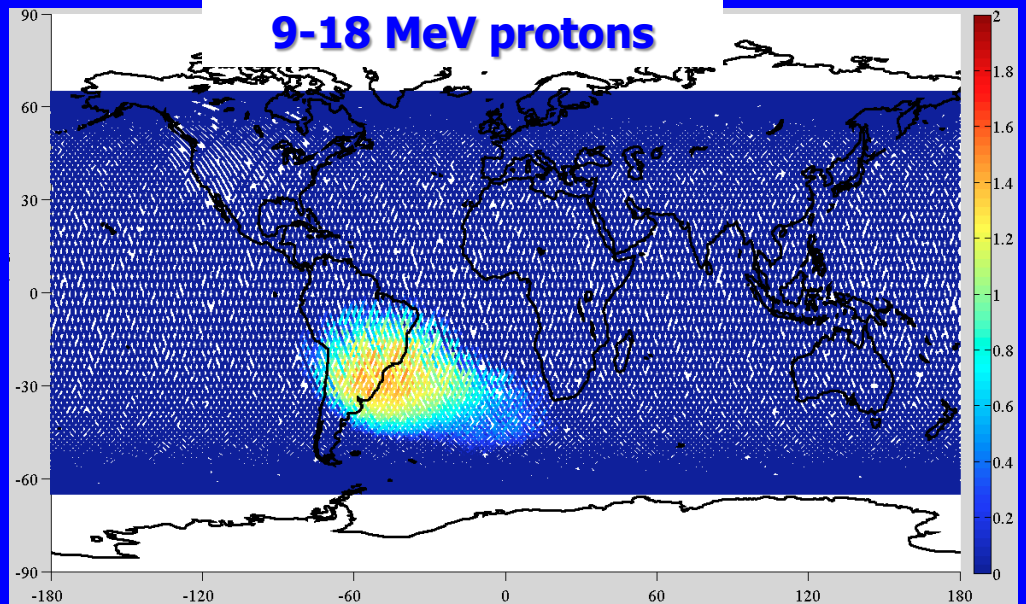


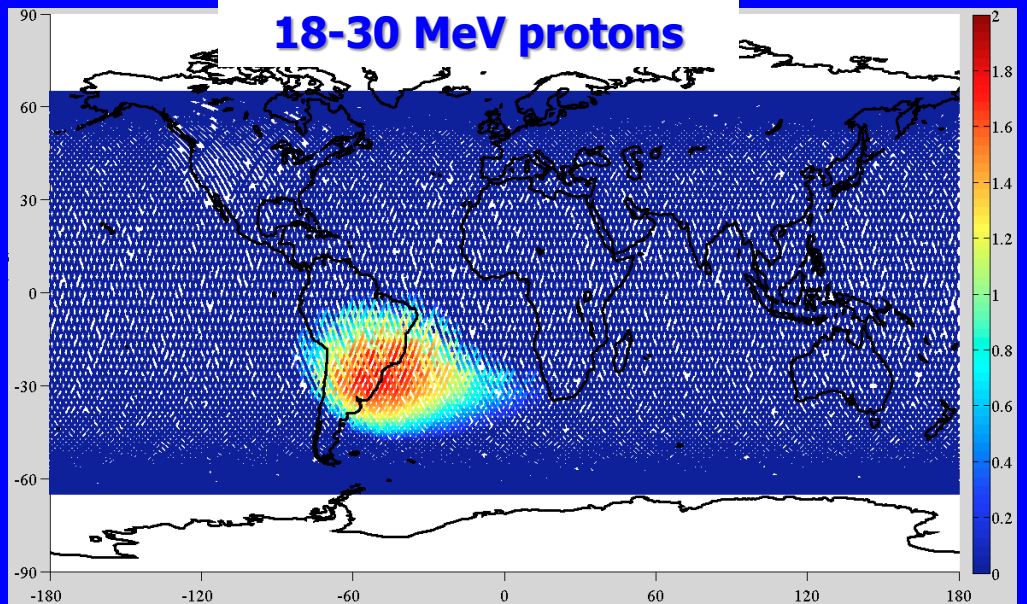


Measurements of electrons & protons from REPTile provide a clear picture of energetic particles (electrons and protons) in the near Earth environment (1/1-31/2013)





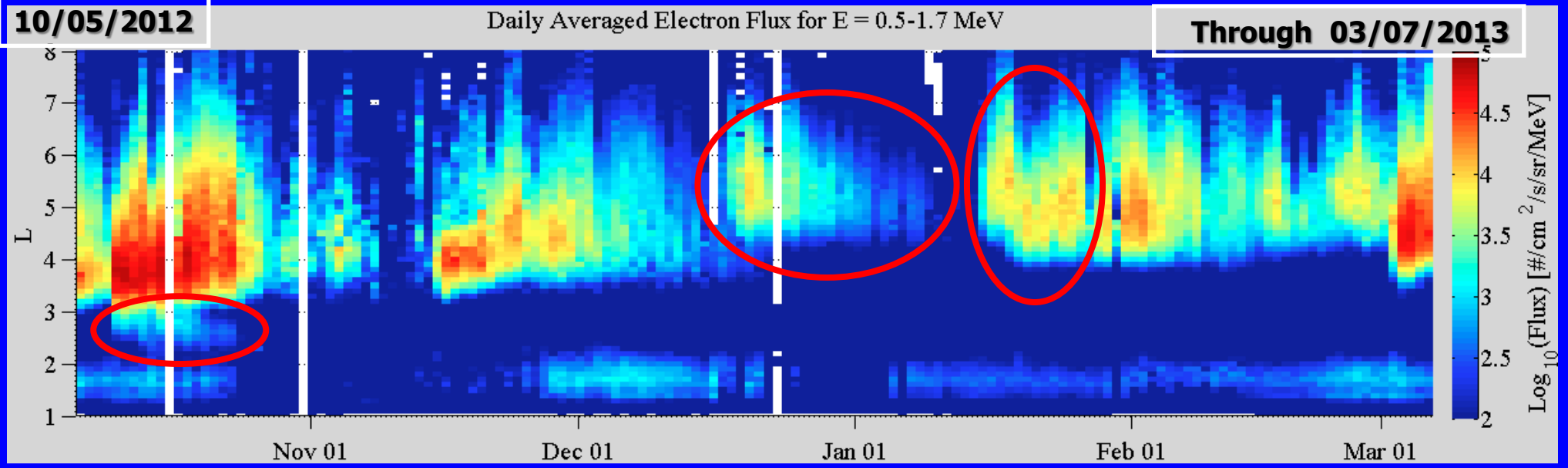


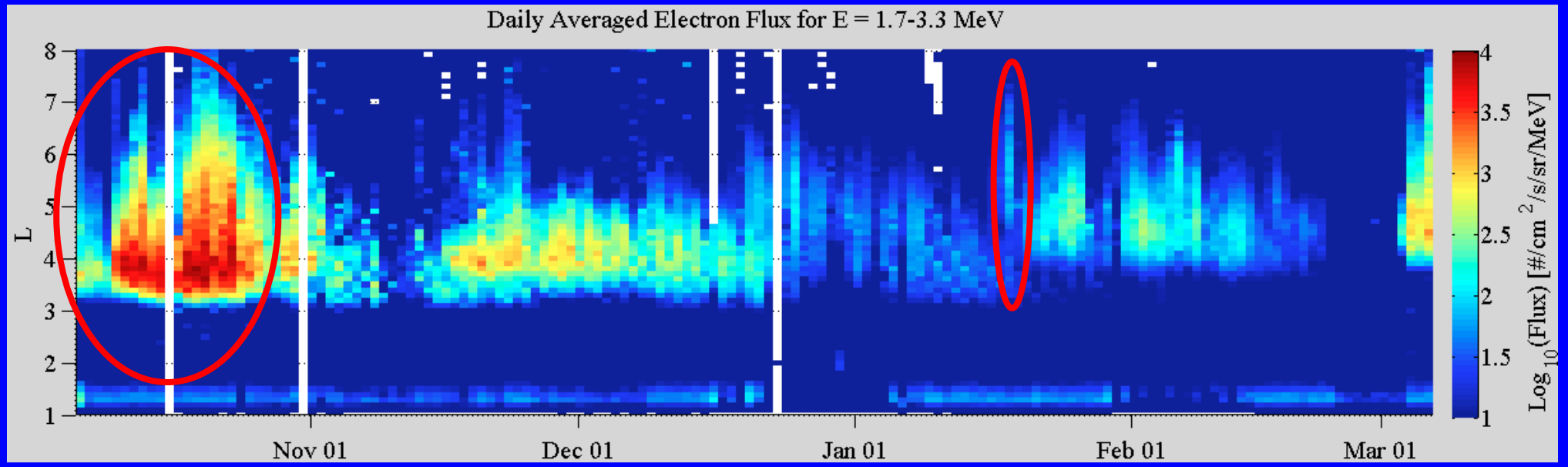


REPTile electron measurements since launch

10/05/2012

Through 03/07/2013





Conclusions

Our tiny CubeSat has been operating over five months, providing clean measurements of energetic electrons and protons → a BIG success in education, engineering, and science! → A Proof!

Combined measurements with other missions such as NASA/Van Allen and THEMIS Probes provide a better characterization of the inner and outer belts (for both e^- and p^+):

(1) penetration depth is energy dependent
(2) energy spectrum is L dependent
(3) inner belt is well confined to the equatorial region

data analysis and modeling continue → in-depth science results

CubeSat Mission Website: *http://lasp.colorado.edu/home/csswe/*