Geospace driver effects on electron acceleration and loss in the outer Van Allen belt

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Outline

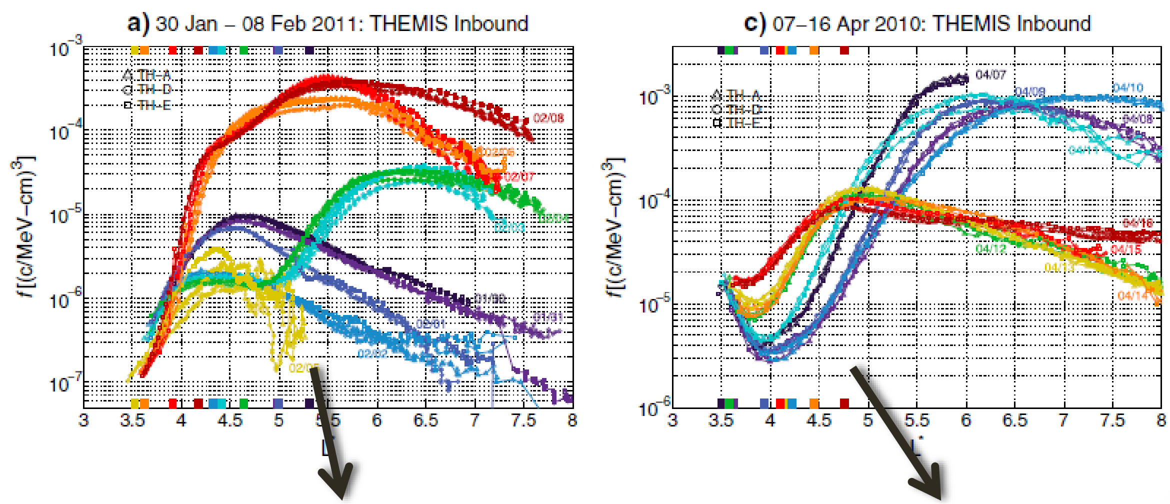
- Motivation – Goal
- Data and analysis
- Statistics and Examples
- Conclusions

Motivation – Goal

1. **Assess the contribution of various mechanisms to the variability of the outer Radiation Belt.**

Previous studies

- Reeves et al. 2003
- Turner et al. 2013 and 2015



Enhancement ~58 %

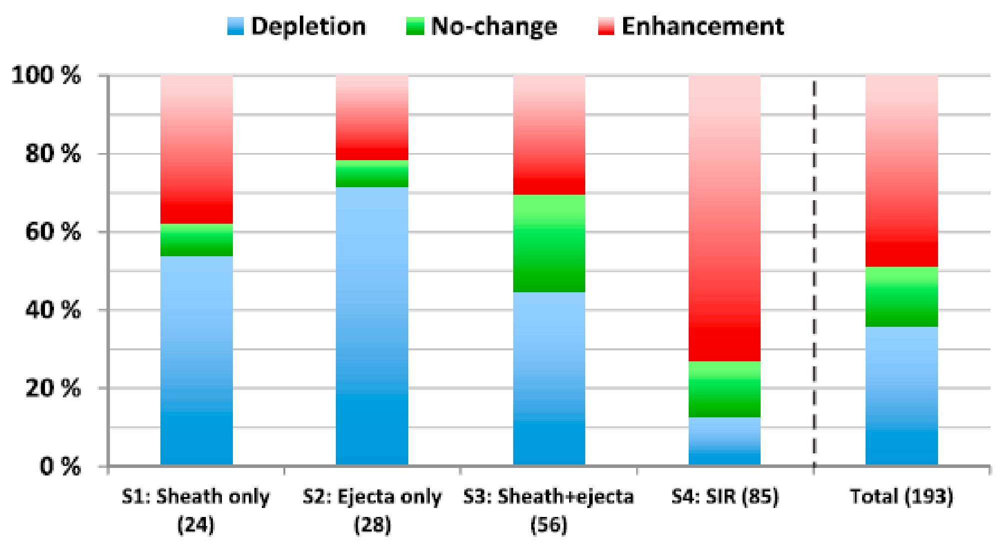
Depletion ~17 %

Motivation – Goal

2. **Investigate and compare the impact of ICMEs and HSSs on the dynamics of relativistic electrons.**

Previous studies

- Borovsky et al. 1996
- Kilpua et al. 2015
- Shen et al. 2017



Data and Methodology

Electron PSD

The electron PSD distribution is calculated from differential fluxes as a function of fixed adiabatic invariants using the method described by *Chen et al., 2005, 2007*.

Pc4-5 waves (2 < f < 22 mHz)

Pc5 wave power is calculated from magnetic field measurements using the method described by *Balasis et al., 2013*.

Lower-band Chorus waves ($0.1f_e < f < 0.5f_e$)

Chorus wave power is estimated from the POES measurements of precipitating electron fluxes using the method described by *Li et al., 2013*.

Data and Methodology

Results Categories

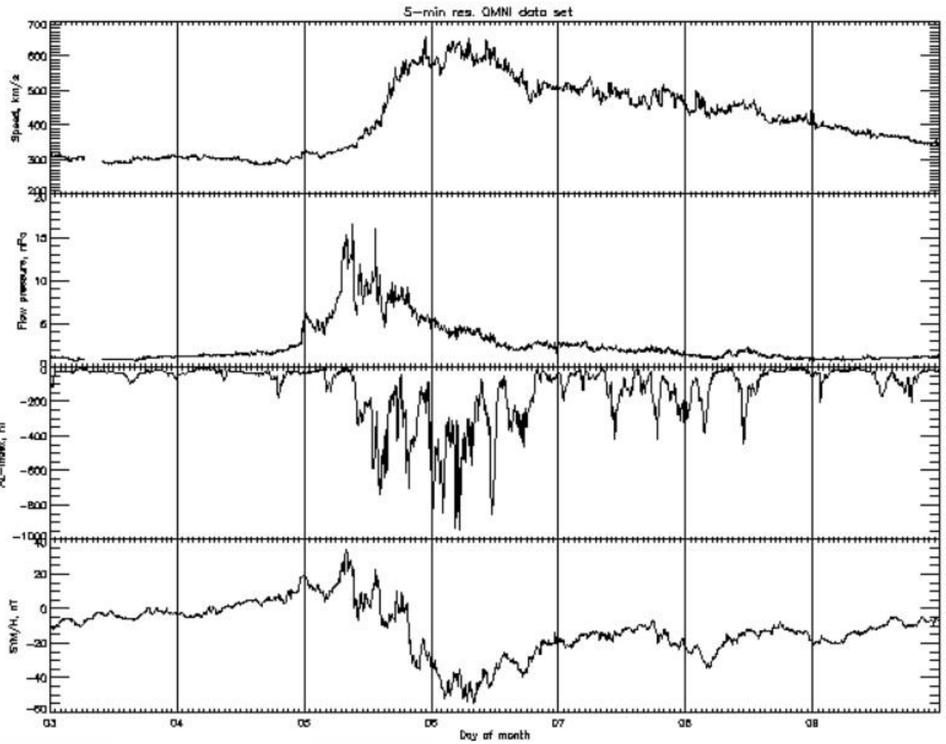
1. μ= 100 MeV/G (seed population), μ> 600 MeV/G (relativistic electrons) and μ> 1800 MeV/G (ultra-relativistic electrons).

2. Inner (L*<4) and outer (L*>4) edge of the electron belt.

3. Equatorially mirroring electrons ($K < 0.05\ G^{1/2}\ R_E$) and off-equatorially mirroring electrons ($K > 0.05\ G^{1/2}\ R_E$).

Storm Selection Criteria

1. Solar wind speed approximately constant and less than 400 km/s for at least a day before the main phase of the storm.
2. Solar wind dynamic pressure approximately constant and less than 3 nPa for at lea
3. Only one pressure pulse ICME).
4. No significant substorm pressure pulse (AL > -30
5. Clear minimum and reco



Events Statistics: Storms

- **40 Storms** (2013 – 2017)
  - **10 Intense Storms** (Sym-H_{min} < -100 nT)
    - **3 HSS**
    - **7 ICME**
  - **16 Moderate Storms** (-100 nT < Sym-H_{min} <-50 nT)
    - **8 HSS**
    - **8 ICME**
  - **14 Weak Storms** (-50 nT < Sym-H_{min} <-30 nT)
    - **10 HSS**
    - **4 ICME**

Events Statistics:

Equatorially mirroring electrons (K<0.05 $G^{1/2} R_E$)

Seed Population

μ= 100 MeV/G

L*<4

- ~72% resulted in PSD Increase (**dominated by ICMEs**)
- ~28% resulted in PSD Depletion

L*>4

- ~80% resulted in PSD Increase (**dominated by ICMEs**)
- ~20% resulted in PSD Depletion

Events Statistics:

Equatorially mirroring electrons ($K<0.05\ G^{1/2}\ R_E$)

Relativistic Population

μ= 600 MeV/G

L*<4

- ~55% resulted in PSD Increase (dominated by ICMEs)
- ~45% resulted in PSD Depletion (dominated by HSSs)

L*>4

- ~72% resulted in PSD Increase (dominated by ICMEs)
- ~28% resulted in PSD Depletion (dominated by HSSs)

Events Statistics:

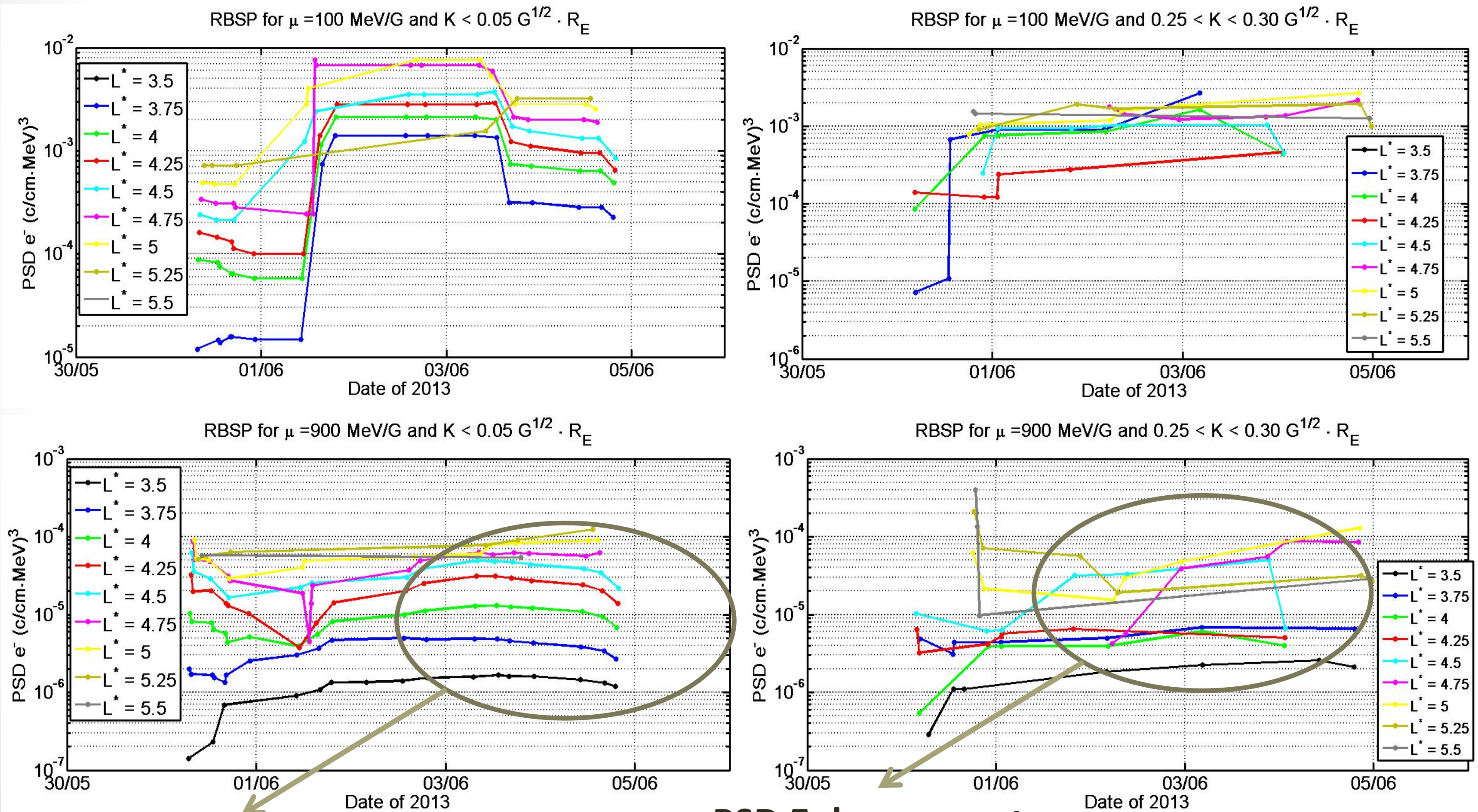
Equatorially mirroring electrons (K<0.05 $G^{1/2}$ R_E)

Ultra Relativistic Population

M > 1800 MeV/G

- **L*<4**
  - ~49% resulted in PSD Increase
  - ~51% resulted in PSD Depletion (**dominated by HSSs**)
- **L*>4**
  - ~60% resulted in PSD Increase
  - ~40% resulted in PSD Depletion

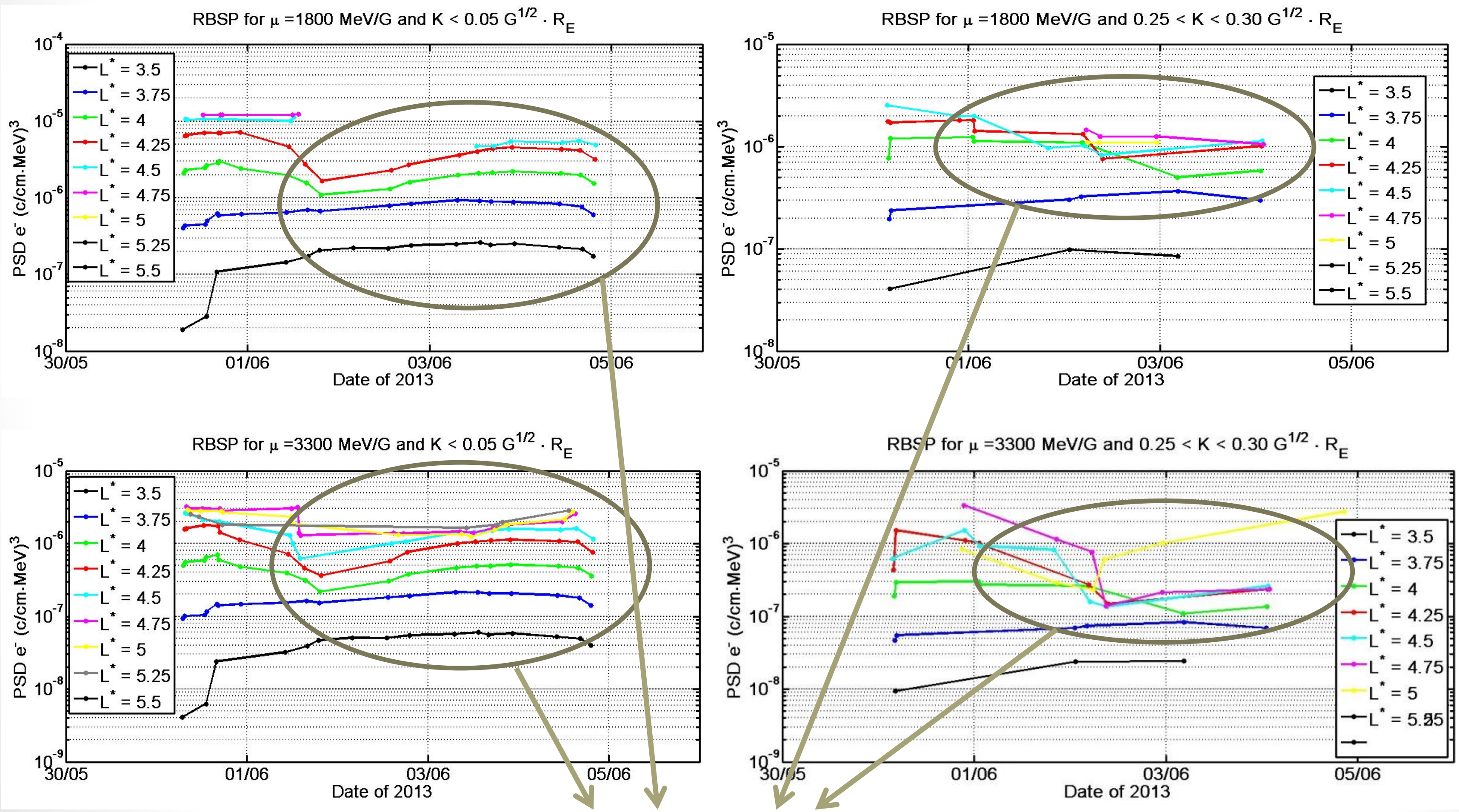
The Case of May 30 – June 4, 2013 Event



PSD Enhancement

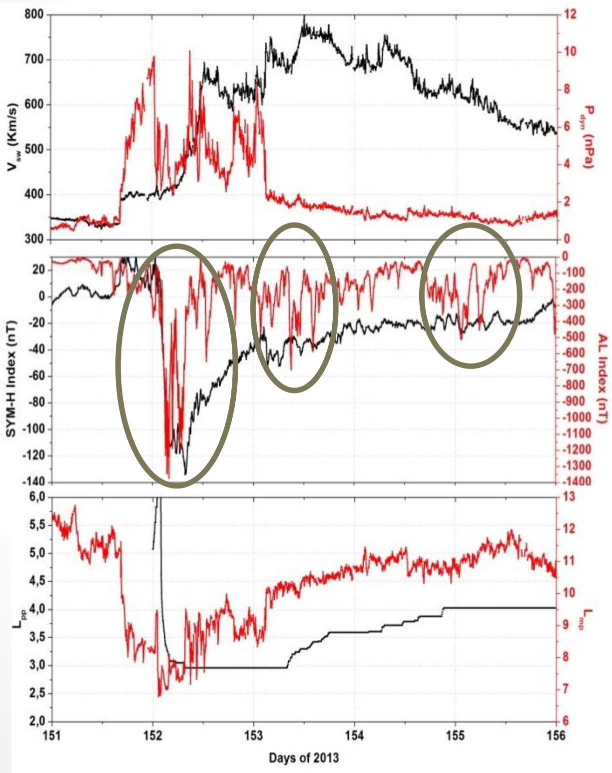
PSD Depletion

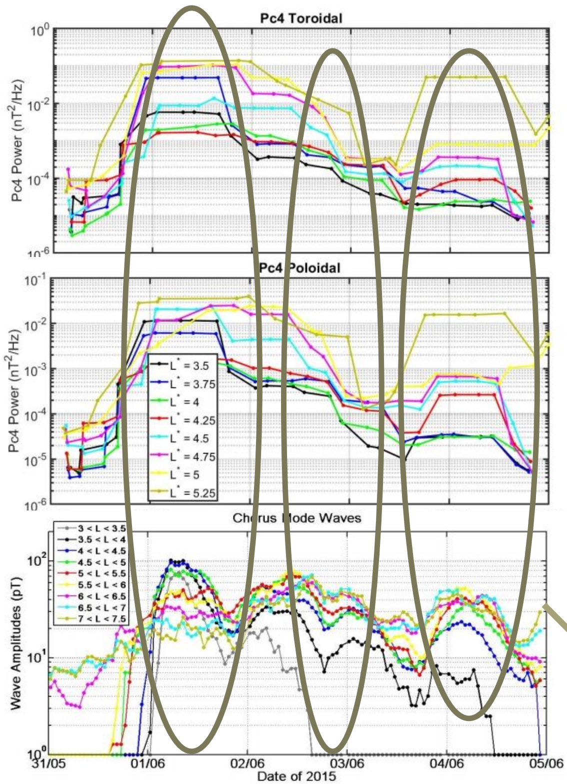
The Case of May 30 – June 4, 2013 Event



PSD Depletion

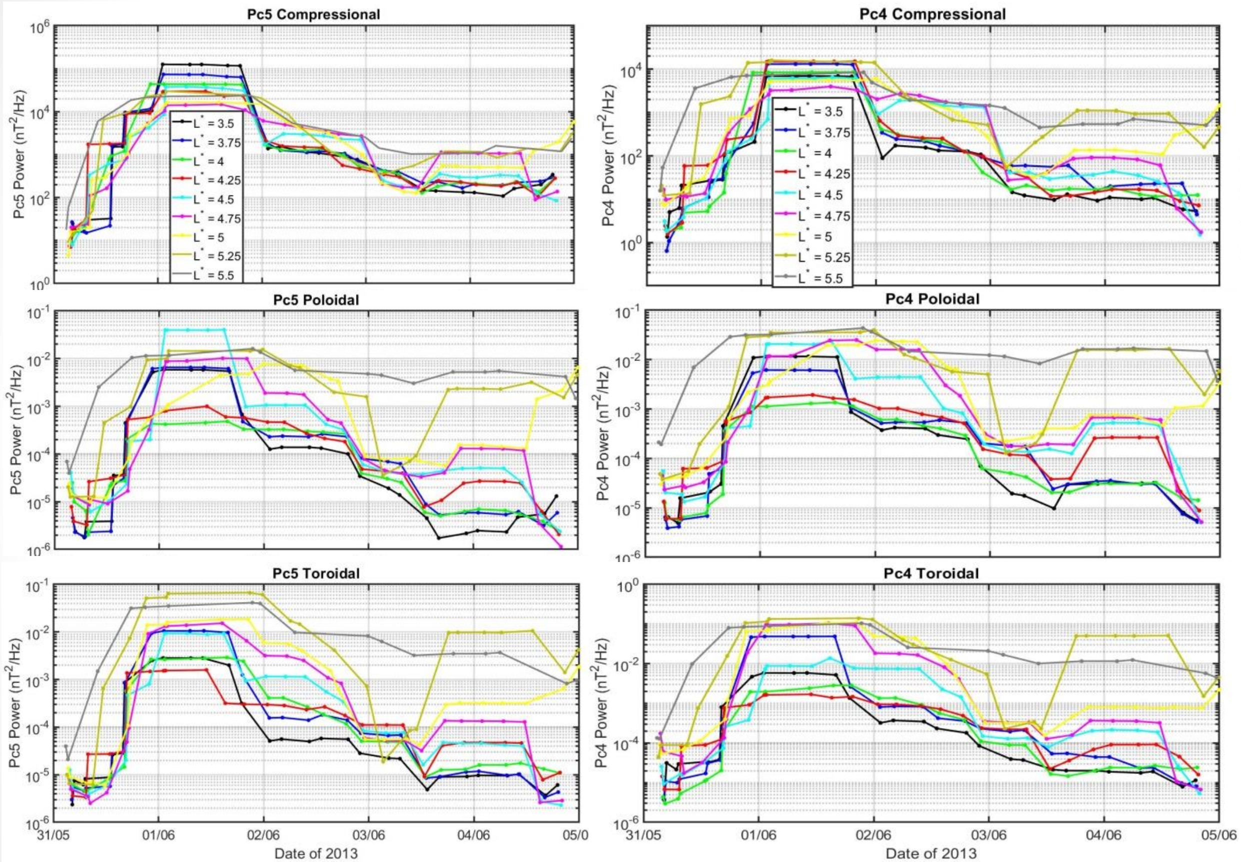
The Case
of May 30 – June 4, 2013 Event

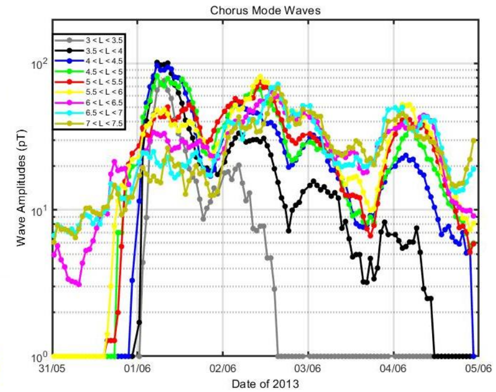


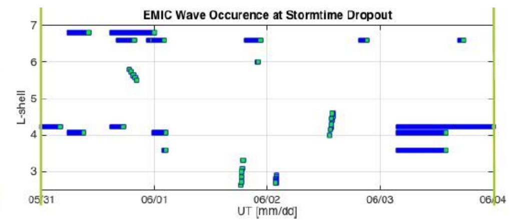


Correlation of Pc4 frequency range waves with substorm activity and Chorus

20130531 Depletion Event

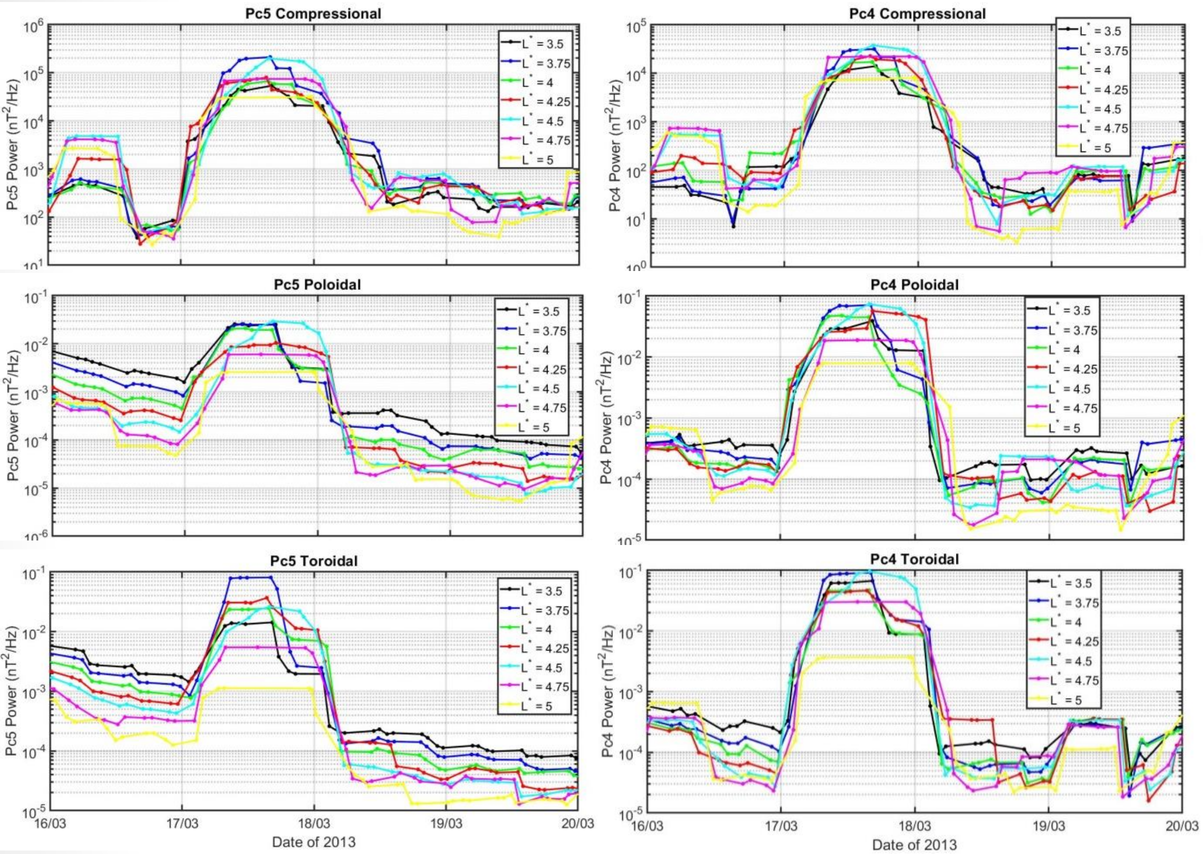


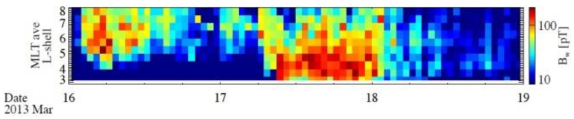


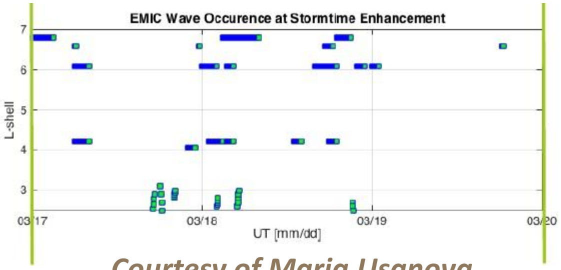


Courtesy of Maria Usanova

20130317 Enhancement Event







Courtesy of Maria Usanova

Conclusions

We analyzed electron PSD profiles for 40 storm events of various intensity:

1. Seed population enhanced in most cases (~80 %) for both inner and outer edge of electron belt (ICME-driven storms).
2. Relativistic population enhanced in most cases (~70 %) only at the outer ($L^*>4$) edge of the electron belt (ICME-driven storms). All depletions are mostly associated with HSSs.
3. Ultra-relativistic population ($\mu>1800$ MeV/G) shows no profound distinction but almost all depletion events are associated with HSSs

Conclusions

We analyzed electron PSD profiles for 40 storm events of various intensity:

4. Differences in K exist for the seed and relativistic electron population but not the ultra-relativistic (μ>1800 MeV/G).
5. ~80 % of the intense storms resulted in PSD enhancement for all μ, K and L* values.
6. Most of the weak storms resulted in PSD enhancement for L*>4 and most of them associated with HSSs.
7. In ~85 % of the events Pc4-5 frequency range waves are well correlated with substorm activity and chorus waves.

Conclusions

Comparison of the 2 contradicting events showed that:

1. The depletion event has more prolonged periods of enhanced Pc4-5 ULF wave and chorus activity as well as more EMIC wave events throughout the period.
2. The enhancement event has pronounced Pc4-5 and chorus activity only during the main phase of the storm.

Thank you for your Attention

POSTER PRESENTATION (Tuesday, 6 March 2018: 15:30-18:30)

T-2

Association of Pc4-5 waves with near-equatorial electron fluxes during substorm activity (330793)