Relativistic electron flux decay and recovery

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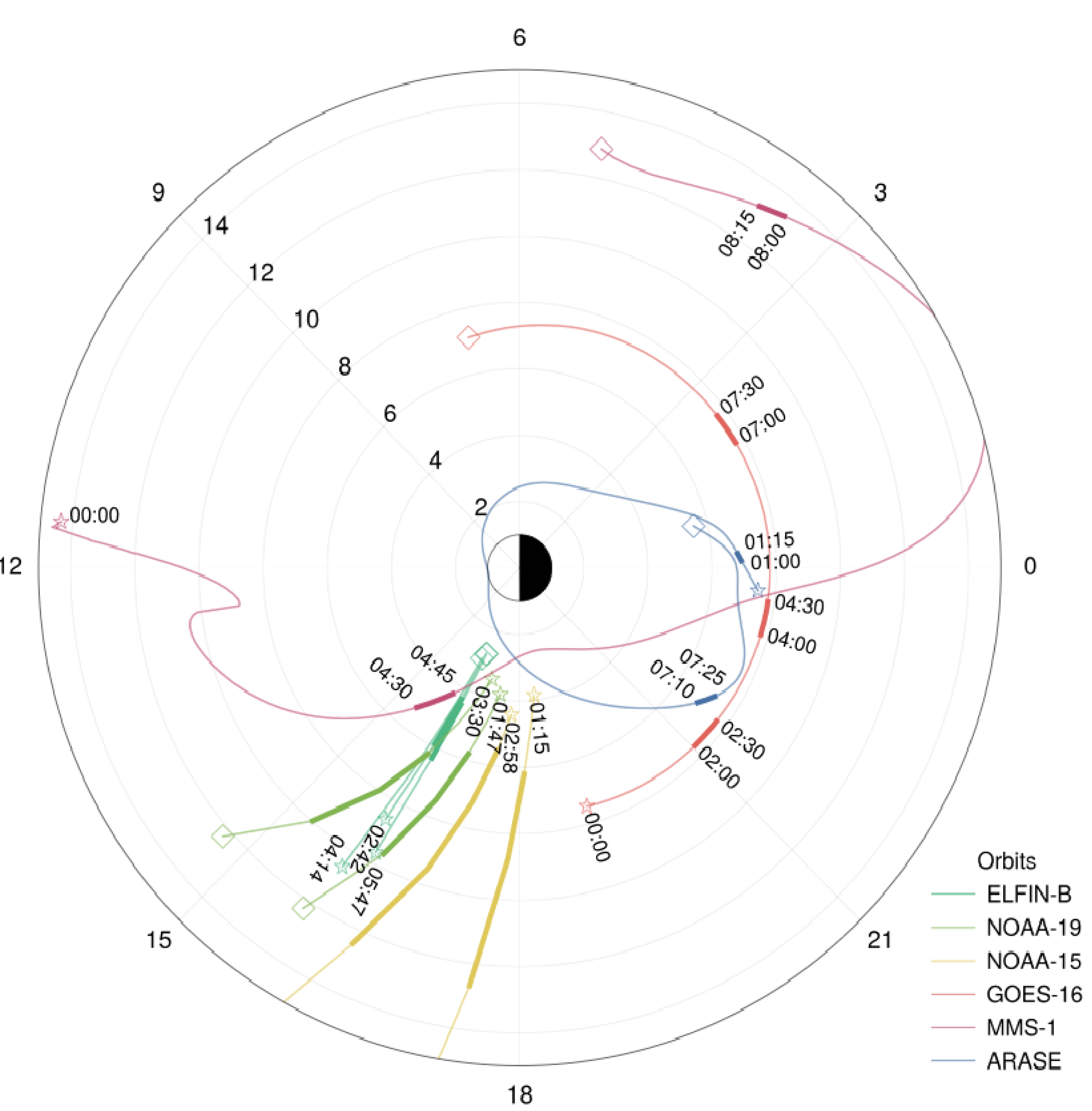
Introduction & Motivation

Relativistic electron flux dynamics in the Earth's inner magnetosphere are largely controlled by electron scattering into the atmosphere via resonant interactions with whistler-mode and electromagnetic ion cyclotron (EMIC) waves.

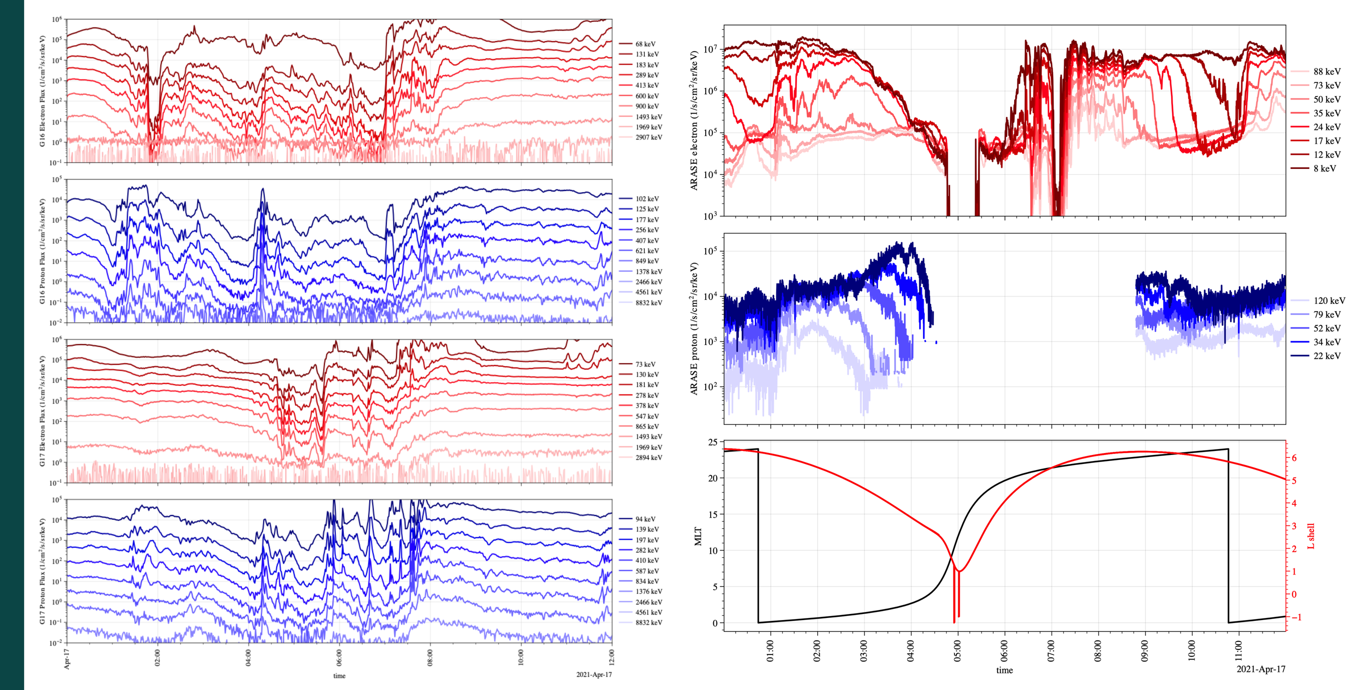
ELFIN and POES spacecrafts recording trapped and precipitating particle fluxes at low altitude, together GOES, Van Allen Probes, ERG (ARASE) and MMS spacecrafts measuring waves and trapped particle fluxes at high altitude, provide a unique opportunity to study the dynamics of relativistic electron fluxes and their relation to wave activity.

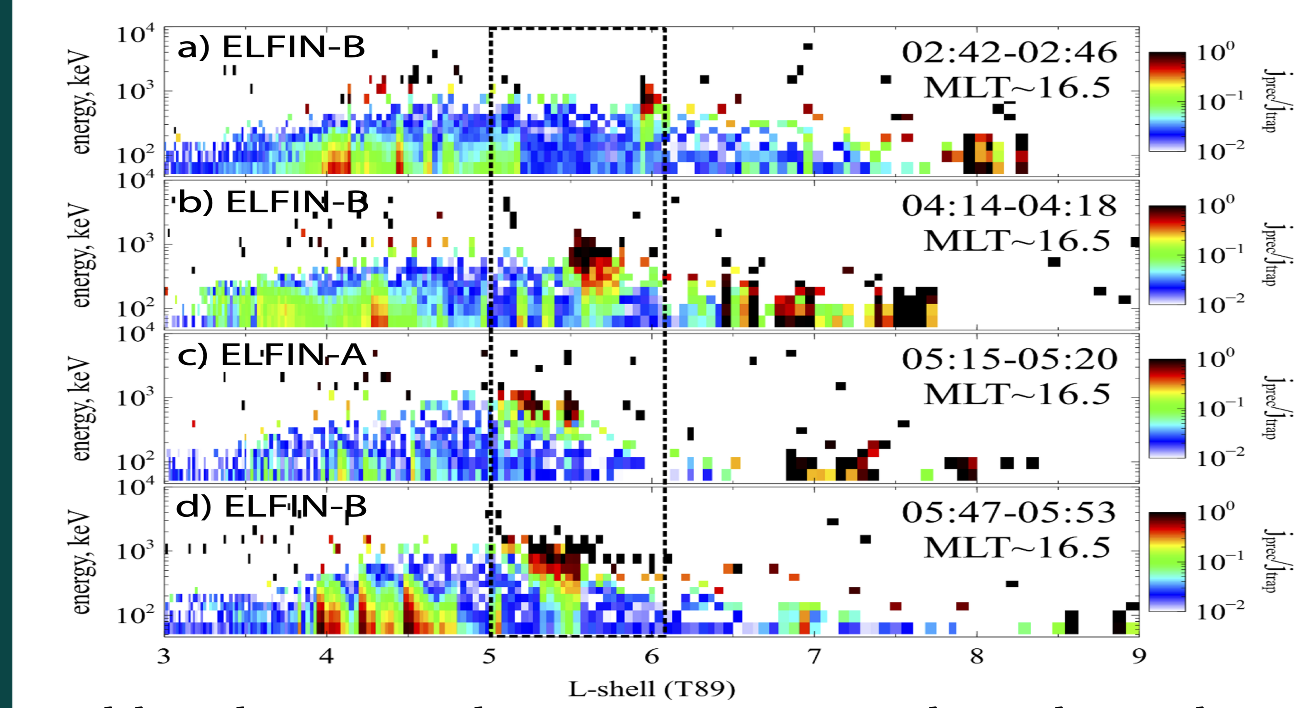


Strong EMIC and chorus wave-driven electron losses do not necessarily correspond to a simultaneous decrease of trapped electron fluxes. Both local electron energy PSD gradients and radial PSD gradients and injections can balance such wave-driven losses.

- At ~ 01:15 UT ERG observed strong electron injections likely supporting whistler-mode wave generation
- At 01:30-02:30 UT GOES16&17 observed strong ion injections that arrived at ELFIN's MLT driving EMIC wave generation
- At 02:40-06:00 UT ELFIN observed continuous precipitation of relativistic electrons at MLT~ 16; NOAA/POES observations suggest precipitations are located right at the inner edge of the ion plasma sheet; whistler-mode waves recorded by ERG (at MLT ~ 20) continuously scatter relativistic electrons from higher equatorial pitch-angles into the pitch-angle range resonating with EMIC waves
- At 07:10-07:30 UT ERG and GOES16&17 observed a strong electron injection: dispersionless on ERG (MLT ~ 20) and dispersive on GOES 17 (MLT ~ 4); This injection appears to restore electron fluxes and to largely compensate losses from EMIC wave-driven scattering.

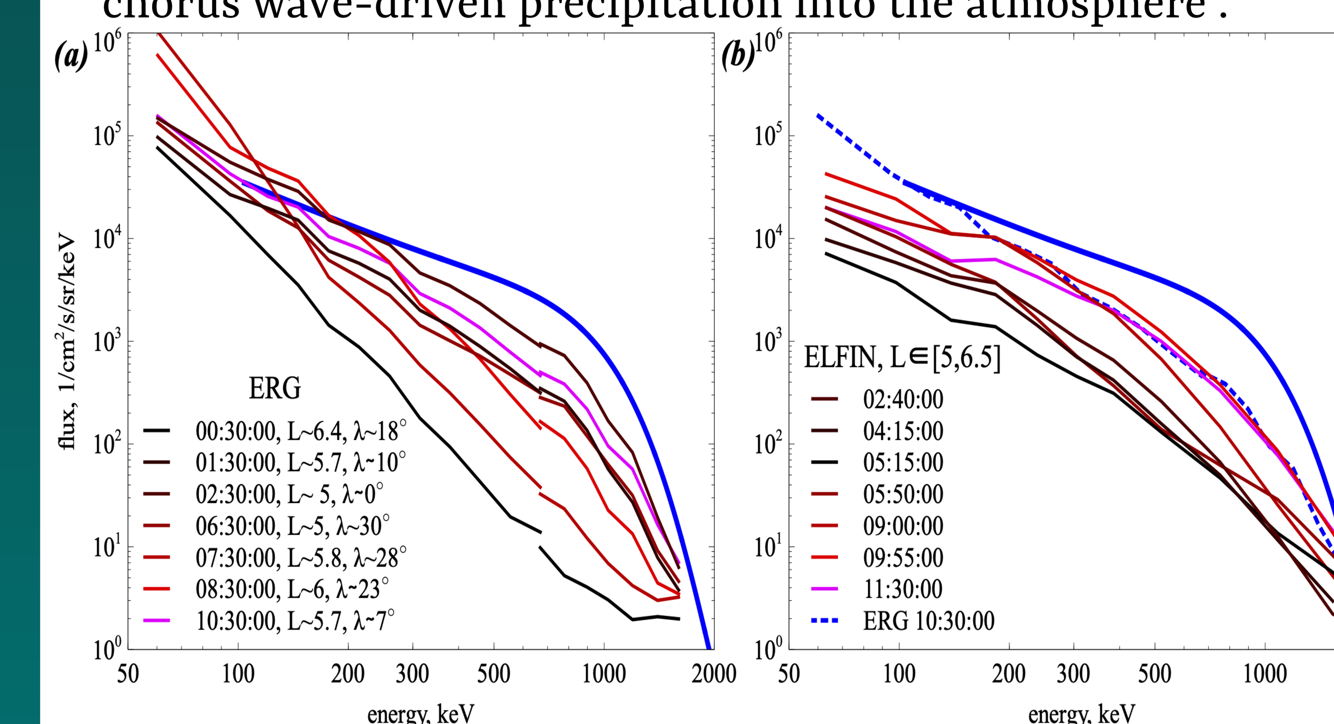
Observations





- Although ELFIN and POES measurements have shown that EMIC and chous waves did efficiently precipitate 0.1-1.5 MeV electrons in the outer radiation belt during this event, trapped electron fluxes actually increased at nearly all energies.

- Combining theoretical estimates of electron quasi-linear pitch-angle and energy diffusion by chorus and EMIC waves with statistics of their wave power distribution, we have shown that long-lasting electron losses driven by EMIC waves may not deplete 0.1-1.5 MeV electron fluxes in the outer radiation belt over the long run (>8 hours) in the case of **a sufficiently negative derivative of the electron PSD** f(E), compensating relativistic electron losses due to EMIC and chorus wave-driven precipitation into the atmosphere .



(a) Trapped electron flux energy spectra J(a=90°, E) (black to magenta curves) measured by ERG near the magnetic equator at different times, and projected to the equator by assuming a typical shape J(a=90°)/J(a) ~ 1/sin a, with sin a ~ (B(λ=0°)/B(λ))^1/2. The approximate steady-state spectrum shape J(E) expected to be reached asymptotically in time in the presence of both **EMIC and chorus wave-driven pitch-angle and energy diffusion** is also shown (blue curve).
(b) Same as (a) but measured by ELFIN at low altitude at different times and projected to the equator.