Statistics of contribution of energetic electron precipitations: ELFIN and DMSP observations

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Introduction - Energetic Electron Precipitation

Energetic electron precipitation couples magnetosphere and ionosphere
DMSP provides low-energy measurements (30 keV) ELFIN extends to higher energies (50 keV to 6 MeV)

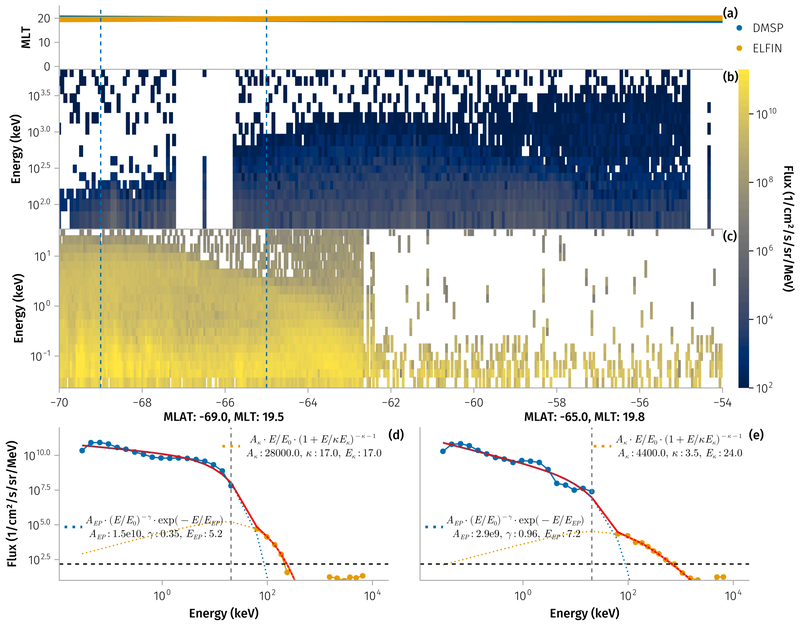

Figure 1: Example of a satellite conjunction event observed between 2021-12-01T22:19 and 2021-12-01T22:28. Panels (a–c) are plotted against magnetic latitude (MLAT): (a) the magnetic local time (MLT); (b) the precipitating electron flux measured by ELFIN; and (c) the electron flux measured by DMSP. Panels (d-e) display the precipitating flux spectra from both satellites, averaged over 0.5° MLAT bins.

Model - Predict Precipitating Electron Flux

Final products: 1. Event catalog and 2. empirical, data-driven model.

```
using DEEEP # DmspElfinEnergeticElectronPrecipitation

model = load_flux_model()

# Evaluate flux at specific geophysical conditions: Location: 65° MLat,
6 MLT (dawn sector), Activity: Moderate (AE = 150 nT)
j_Efunc = model(; mlat=65.0, mlt=6.0, ae=150.0)

E = 10.0 # [keV]
flux_10keV = j_Efunc(E) # Calculate flux at a specific energy

energies = 10 .^ range(log10(0.03), log10(1000), length=100)  # 0.03 -
1000 keV
spectrum = j_Efunc.(energies) # Generate the full energy spectrum
```

Results - MLAT-MLT-AE Dependence

Our analysis reveals that energetic flux, number flux, average energy and kappa parameter exhibit a strong dependence on MLAT, MLT, and geomagnetic activity.

- The strongest energy and number fluxes occur in the **dawn** sector at high magnetic latitudes (65°–75°), the relative contribution of energetic particles exhibits an **anti-correlated** behavior.
- The energetic (> 30 keV) component makes a substantial contribution to the total energy flux in the **dusk** sector, emphasizing the importance of accounting for this population to accurately characterize magnetosphere–ionosphere coupling.

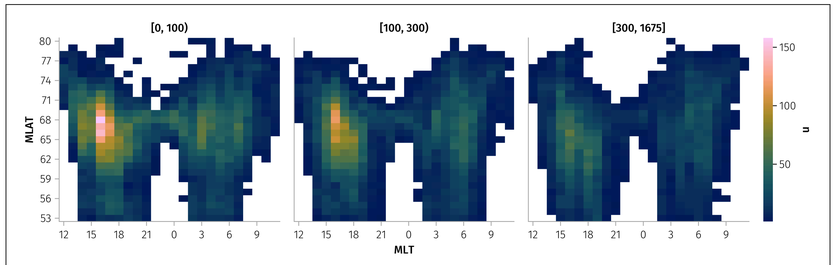

Figure 2: The total number of MLAT-averaged spectral samples across different MLT and MLAT regions, sorted the AE index.

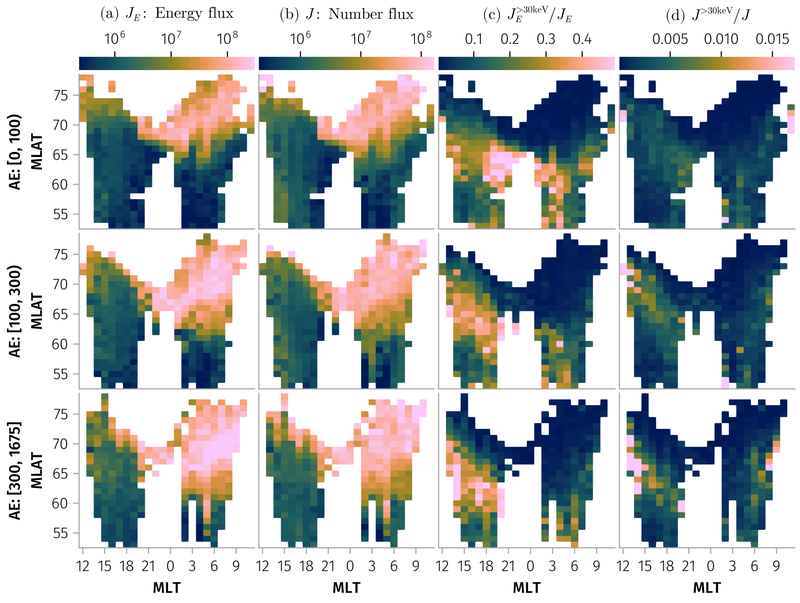

Figure 3: Median distributions of (a) total energy flux [keV cm^{-2} s^{-1} sr^{-1}], (b) total number flux [cm^{-2} s^{-1} sr^{-1}], and (c-d) fractional contribution of energetic particles (>30 keV) to total energy and number flux.

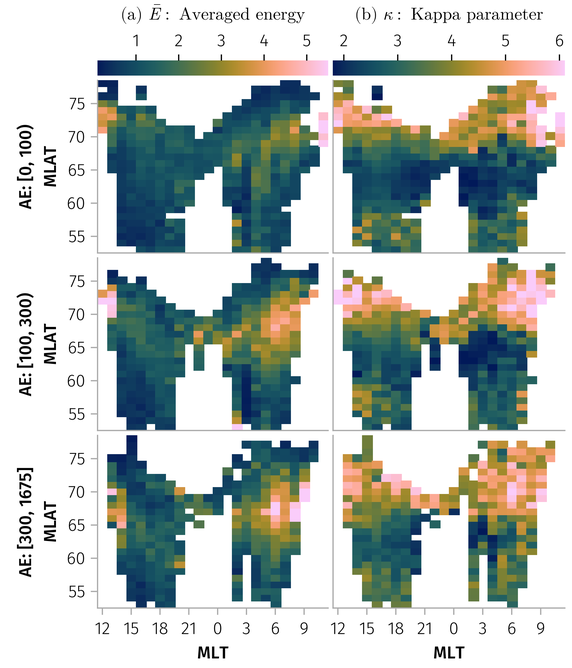

Figure 4: Median distributions of (a) averaged energy ($\overline{E}$) [keV] and (b) kappa parameter (κ) as functions of MLT, MLAT and AE index levels.

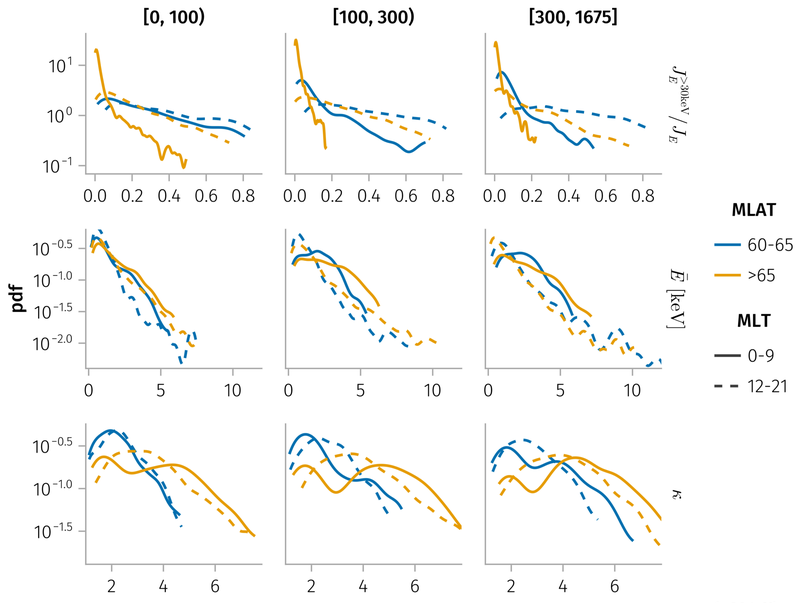

Figure 5: Probability density functions of (a) the energy flux ratio $\frac{J_E^{\{>30\text{ keV}\}}}{J_E}$, (b) the mean energy $\overline{E}$ [keV], and (c) the kappa parameter κ. Distributions are organized by three AE index ranges (0–100, 100–300, and $>$ 300 nT), two MLT sectors (12–21 and 0–9), and two MLAT bands (60°–65° and $>$ 65°).