Differential Electron Flux Spectra Measured by the Magnetospheric Multiscale Mission Show Strong Field-aligned Electron Population of Ionospheric Origin

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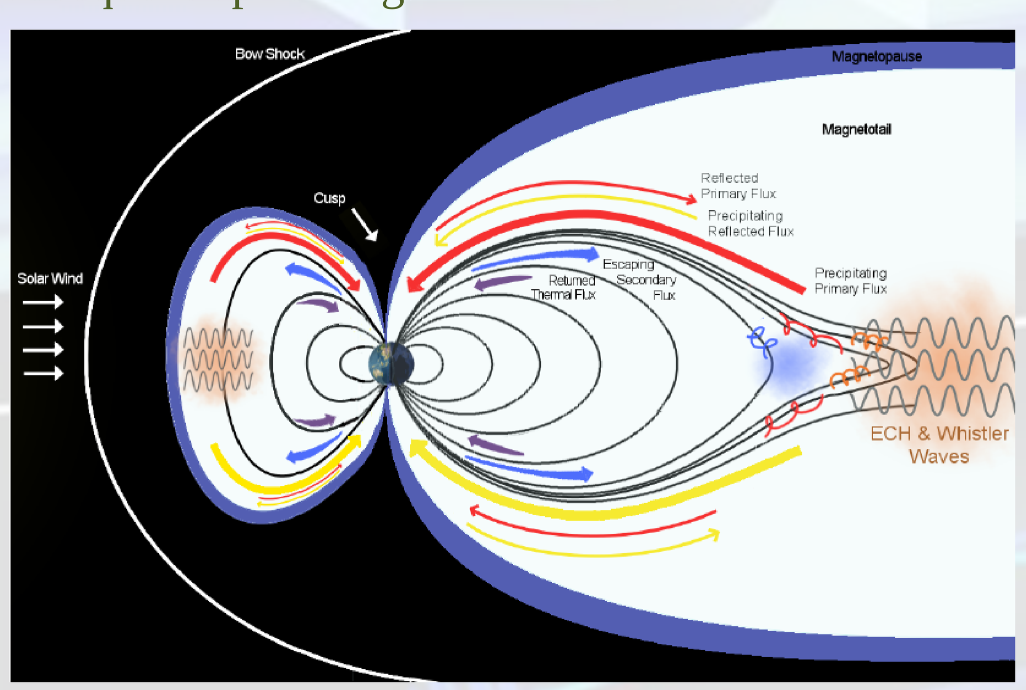
Background

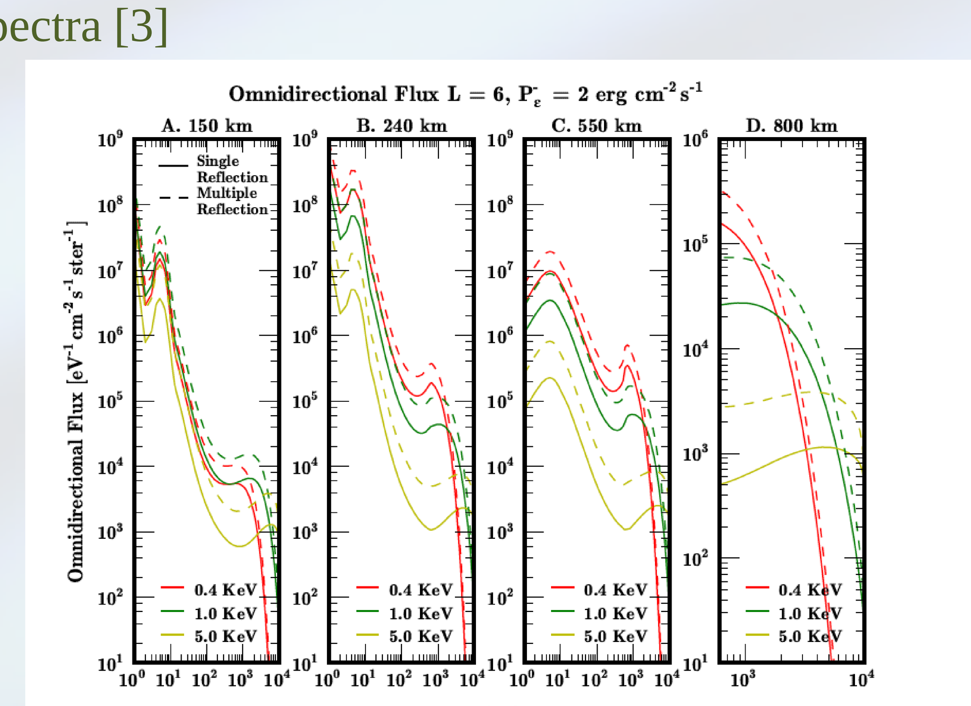
Motivation and Context

The Magnetospheric Multiscale (MMS) fleet, launched by NASA on Mar. 13th 2015, is an elliptical, formation-flying mission whose primary purpose is studying magnetic reconnection [1]. Fitted with an array of particle and field instruments, MMS spends between 12-14 hours each orbit in its science region of interest (sROI ~ $\geq 9R_e$). When the fleet is in the sROI but away from the magnetopause, there are opportunities to observe/measure secondary electron fluxes of ionospheric origin generated by precipitating magnetospheric superthermal electrons.

Precipitating superthermal electrons are one of the main mechanisms contributing to ionospheric mass escape [2]. They form an additional source of ionization via impact and generally lead to heating and subsequent upflowing.



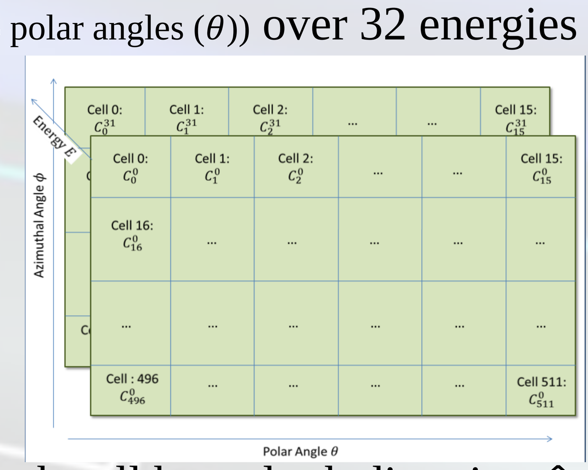
Superthermal electron physics, as studied extensively in [3-4], identifies the importance of multiple reflections between the conjugate ionospheric footprints of closed field lines. These counterstreaming fluxes interact with the replenished population and secondary fluxes leading to distinct spectra [3]



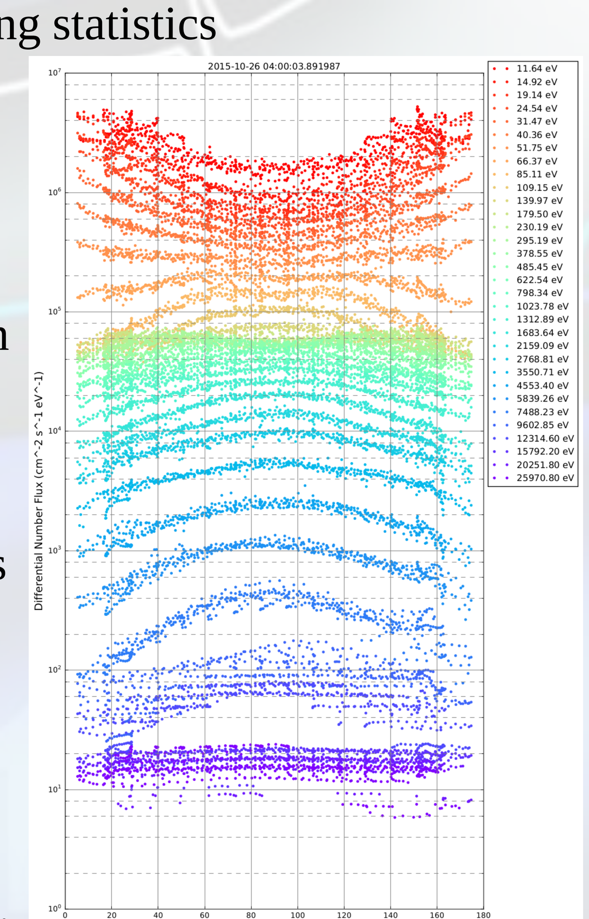
Results

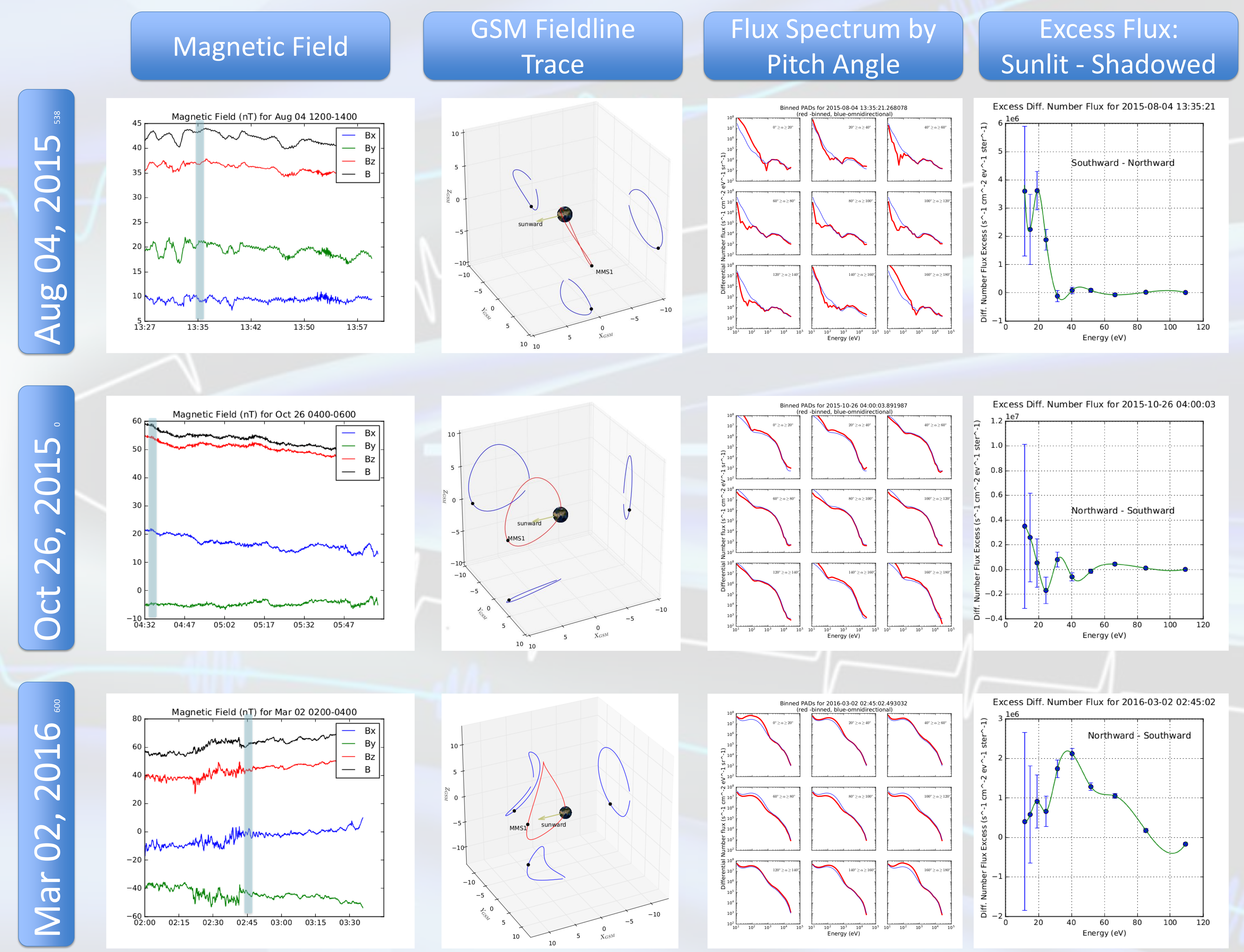
Data Analysis and Methodology

- FPI electron skymaps consist of measured counts distributed over 512 cells ($I = 0 \ldots 511$; 32 azimuth (ϕ) × 16 polar angles (θ)) over 32 energies [5]



- Each cell has a look direction $\hat{n}_I(\phi,\theta)$ with a corresponding flow direction $\hat{v}_I = -\hat{n}_I$
- Magnetic field in the instrument frame $\vec{B}_{DBCS}$ used to construct pitch angle distribution for each cell, $\alpha_I = \cos^{-1}(\hat{v}_I \cdot \vec{B}_{DBCS})$
- Considered error sources: a) Spacecraft potential, b) Instrument-generated photoelectrons, c) Poisson-noise/counting statistics
- Data analyzed during stable magnetic field conditions when the observatory sits in the magnetosphere on closed filed lines (columns 1 and 2)
- Collecting data into discrete bins provides survey spectra (column 3) and excess spectra between sunlit and shadowed conjugate footprints (column 4).





Conclusions & Future Work

- **We present experimental observations of binned pitch angle distributions and excess secondary flux between sunlit and shadowed conjugate points for 3 survey cases distributed in the magnetosphere**
- Each magnetic field configuration gives a unique signature that will inform the identification of the appropriate wave-particle interaction (e.g. ECH, Whistler Chorus, etc.) that scatters plasma sheet electrons into the precipitating population
- Improvements in correcting for instrument-generated photoelectrons is needed to improve knowledge of low-energy electron distributions in the counter-streaming fluxes

References

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