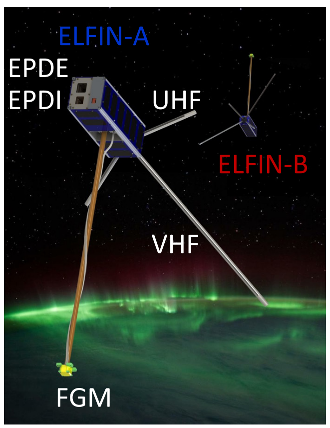
SXYYZ-00. ELFIN observations of energetic electron precipitation and backscatter: implication for losses, atmospheric effects, and magnetospheric populations.

V. Angelopoulos, E. Tsai, C. Wilkins, X.-J. Zhang, J. Liu, A. Runov, A. Artemyev, L. Iglesias & The ELFIN Team

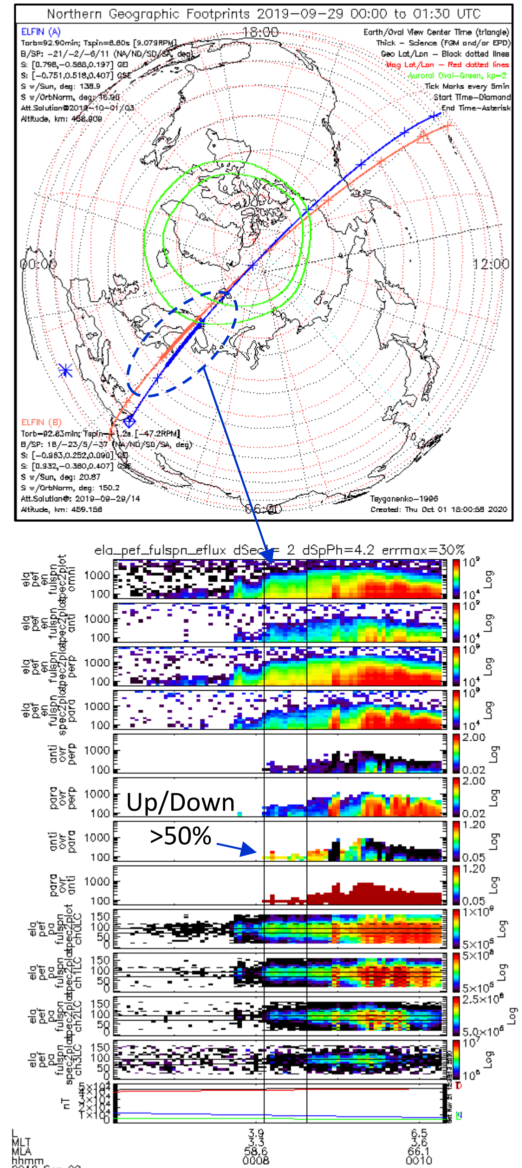
(i)

What is ELFIN? A NASA/NSF - funded dual CubeSat mission (L: Sep. 2018, INC=94 º, ALT=460km, Lifetime= 2.5 yr).
Mission Goal: Reveal dominant wave-loss mechanism of relativistic "killer" electrons (0.5-2MeV) from Earth's radiation belts.
How does it work? Measures, for the first time, the pitch-angle and energy spectra of electrons. Determines if these bear the characteristic signatures of scattering by the main expected scatterer, EMIC waves, or other waves. Spin-plane controlled to contain Earth's B-field.
Instruments: Primary: EPDE for e^- (50-5000keV), and FGM for DC B-field & waves
Operations: UCLA Ground Station + Wallops and Stellar Station (Japan).



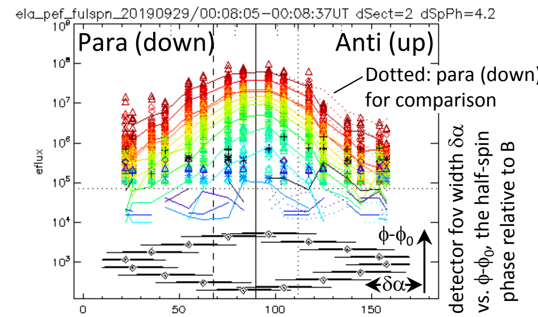
What did we find? Precipitating fluxes cause atmospheric backscattering at a lower energy, that depend on down-going spectra. The backscattered electrons are a very significant fraction (20-100%) of down-going flux during low precipitation (down/perp <10%) and very high precipitation (down/perp >50% to >1MeV). They represent a significant reduction in ionospheric energy deposition and modify magnetospheric populations and wave excitation therein.

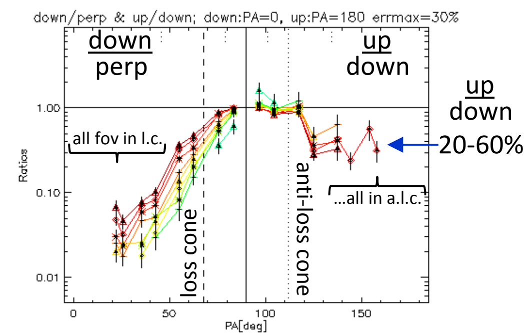
Low Precipitation (down/perp: <10%) (ii)



(iii)

For time interval between vertical lines in previous plot: pitch-angle spectra for 16 log-spaced E's between 50keV - 6MeV (red-to-black)



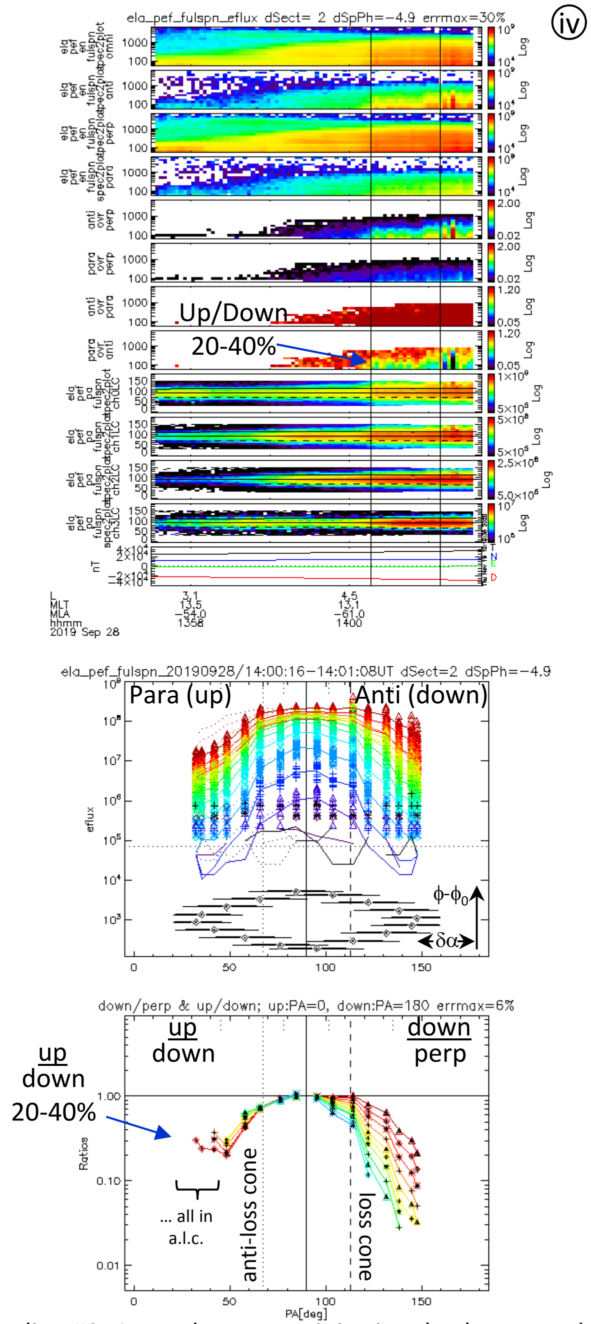


Finding #1 (Backscatter @ Low Precipitation)

The up and down fluxes tend to become comparable. Their ratio typically becomes >20% and often >60%. Ratios of r~1 are also an attribute of noise (δr/r~1/√N, where N= # of counts). Large ratios (near 1) are often seen as energy increases and counts become low, but this is not always physical. Proper statistics must be applied, as done here.

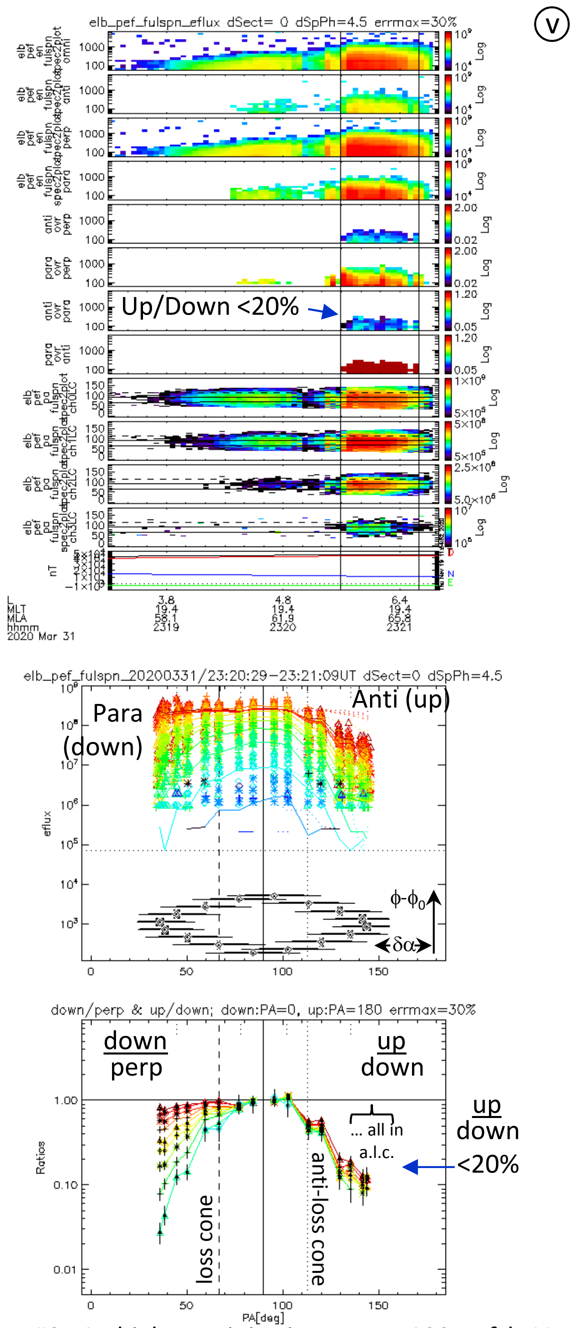
The 3 events below show how the up/down ratio changes w/ precipitation intensity.

Moderate Precipitation (down/perp: 10-50%)



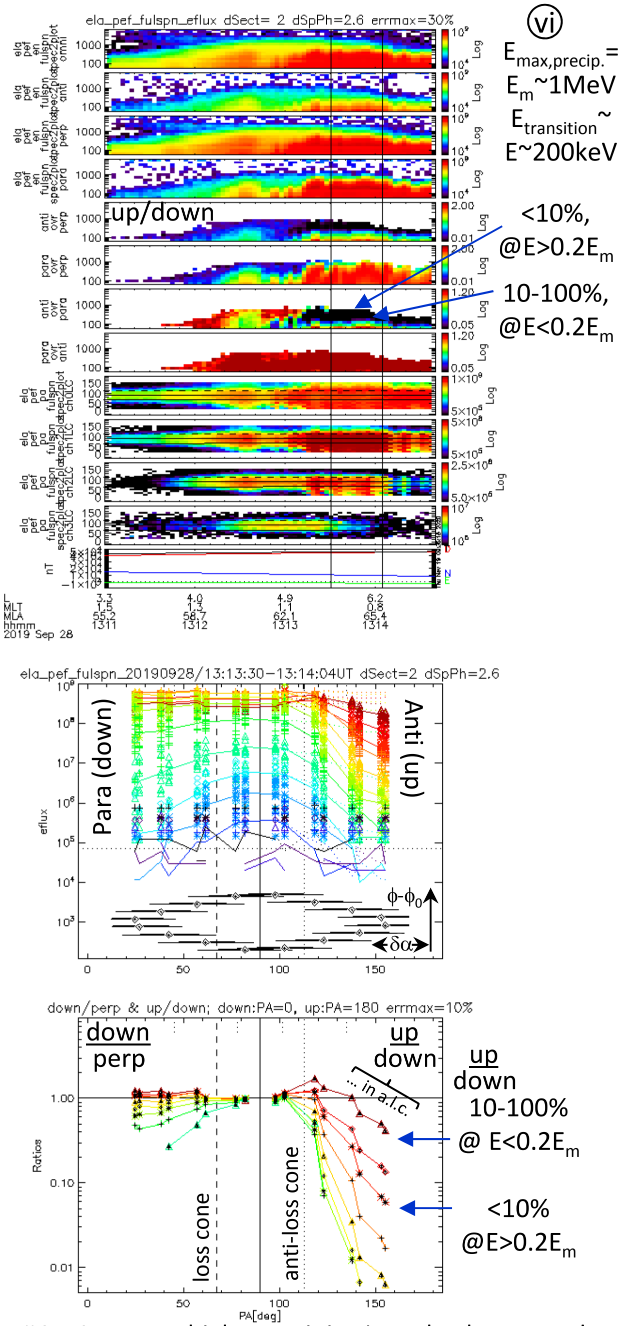
Finding #2: At moderate precipitation, backscattered fluxes are also moderate (up/down: 20-40%)

<u>High Precipitation (down/perp >50% to 100s of keV)</u>



<u>Finding #3: At high precipitation up to 100s of keV, backscattered fluxes are suppressed (up/down: <20%)</u>

Very High Precipitation (down/perp >50% to >1 MeV)



Finding #4: At very high precipitation, backscattered fluxes: high (10-100%) @ $E<0.2E_m$, low (<10%) @ $E>0.2E_m$

Statistical Assessment: We have examined >150 cases at various MLTs and MLATs; they exhibit behavior consistent with the examples shown. (vii)

Summary of Findings

For Down/Perp:	Up/Down is:
<10% (low precipitation)	20-100%
10-50% (moderate, up to E_m)	20-40% (< E_m)
>50% (high, up to E_m 100s keV)	<20%
>50% (high, up to E_m>1MeV)	10-100% ($E<0.2E_m$)
	<10% ($E>0.2E_m$)

Interpretation

In the absence of fast precipitation due to waves or curvature scattering, atmospheric scattering dominates a slow e- loss at 1-10% of perp, by acting on the dominant, trapped population. This creates both up and down electrons at comparable fluxes.

Under moderate precipitation, down-going fluxes dominate, as their scattering by the atmosphere produces fewer e- backscattered at lower energies. As the precipitation intensifies, the backscattering to precipitation ratio is progressively further suppressed.

As precipitation intensifies at energies E_m~1MeV or greater, more backscattered e- at low energies are created by atmospheric interactions at fluxes that can exceed those of down-going electrons. This must depend on the precipitation spectrum (it should be true for hard spectra or those peaked at high energy).

Conclusions

Given that down-going electrons generate a significant flux (10-100%) of backscattered electrons, previous assumptions about ionospheric losses need to be reconsidered. Backscattering needs to be parametrized and duly incorporated in atmospheric, ionospheric and magnetospheric models.

Acknowledgements

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