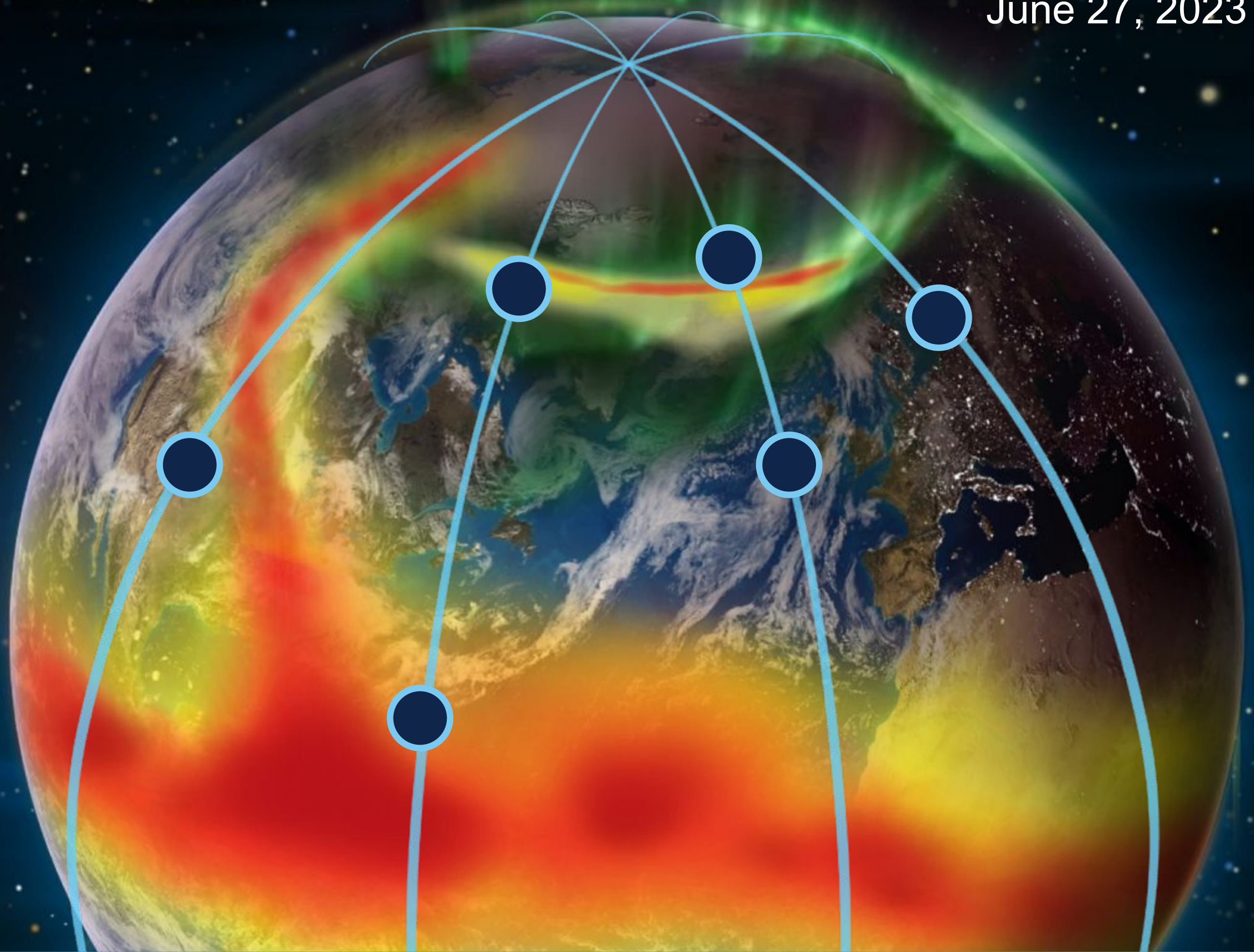
CEDAR GDC Workshop
June 27, 2023

The Comprehensive Auroral Precipitation Experiment (CAPE) for GDC



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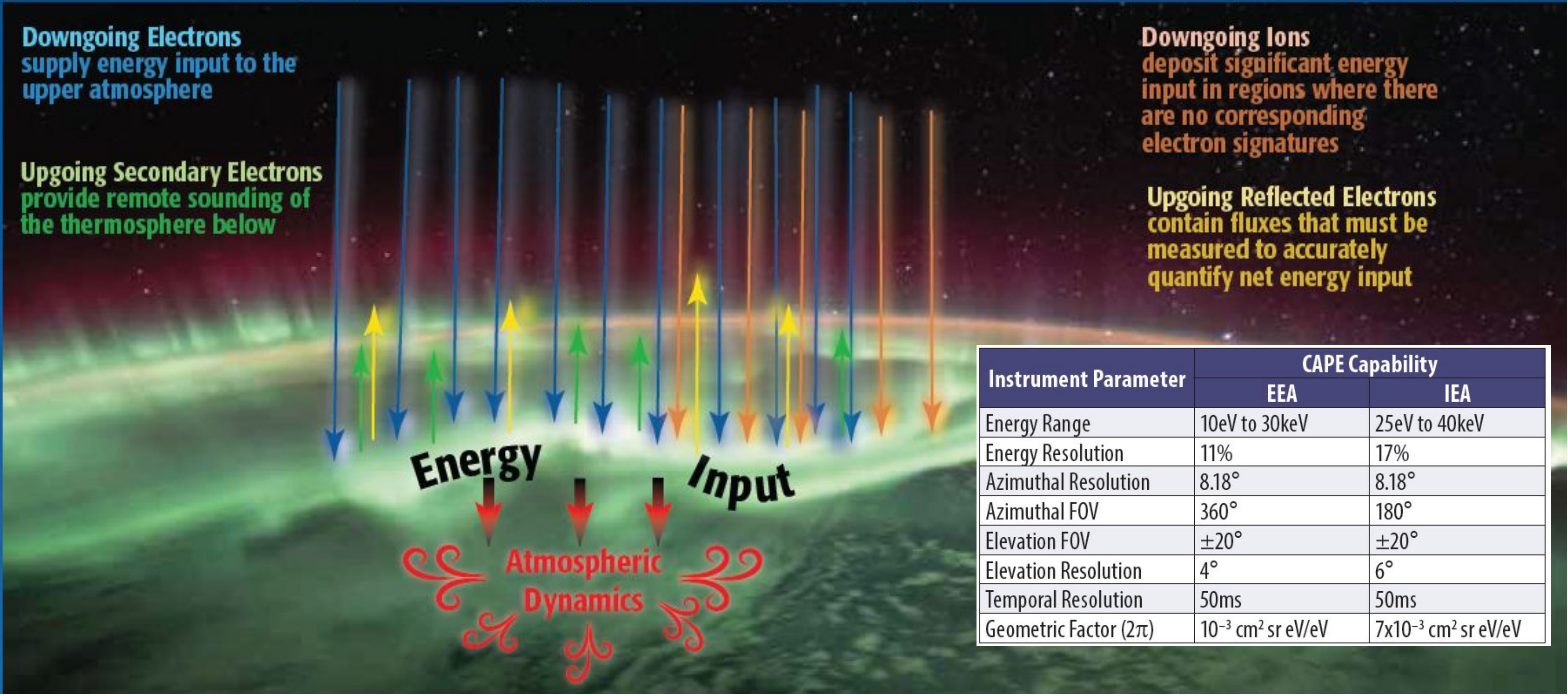
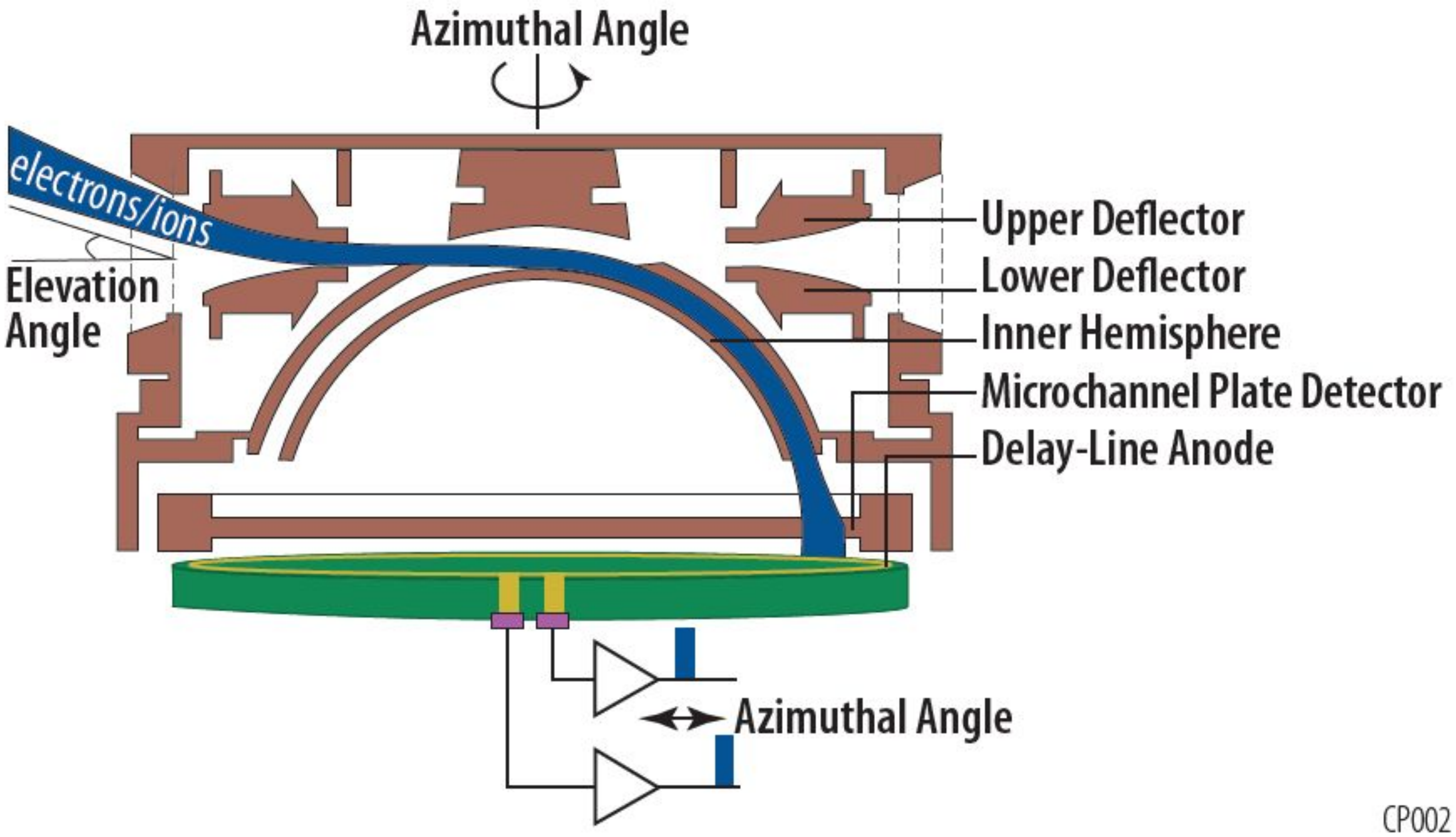
CAPE Science Goals and Objectives

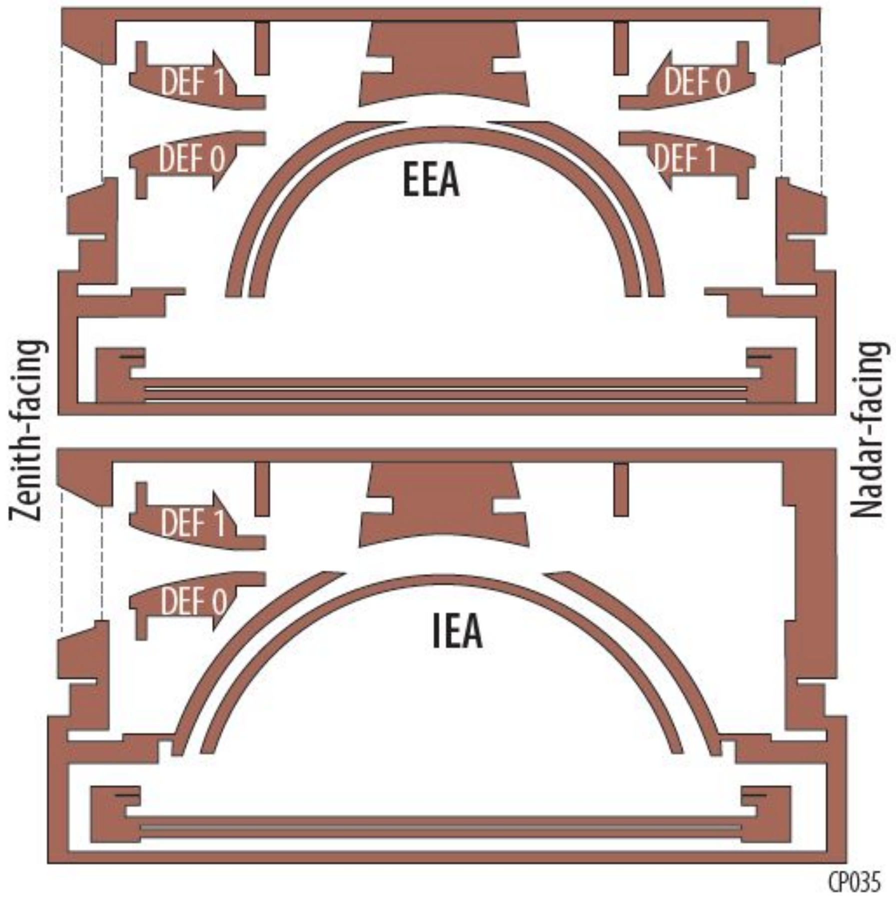
CAPE measures charged-particle energy inputs into the upper atmosphere and traces their impacts on global dynamics



Instrument Parameter	CAPE Capability	
	EEA	IEA
Energy Range	10eV to 30keV	25eV to 40keV
Energy Resolution	11%	17%
Azimuthal Resolution	8.18°	8.18°
Azimuthal FOV	360°	180°
Elevation FOV	±20°	±20°
Elevation Resolution	4°	6°
Temporal Resolution	50ms	50ms
Geometric Factor (2π)	10^{-3} cm² sr eV/eV	7x10^{-3} cm² sr eV/eV

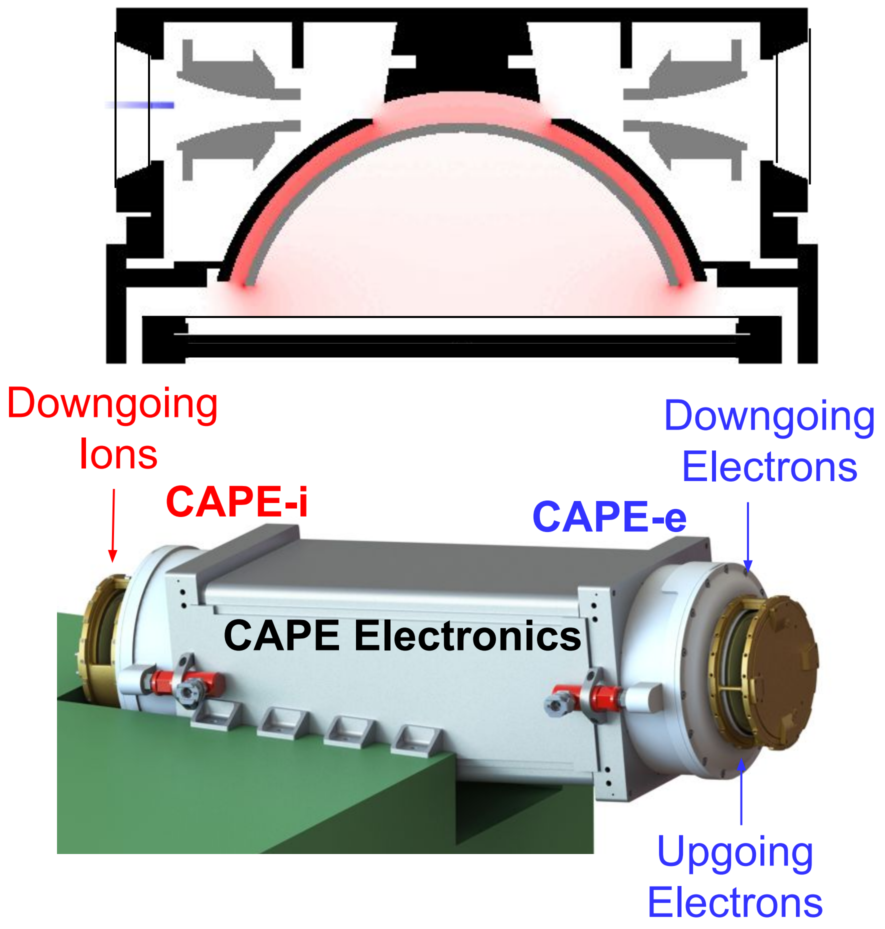
CAPE Investigation Implementation

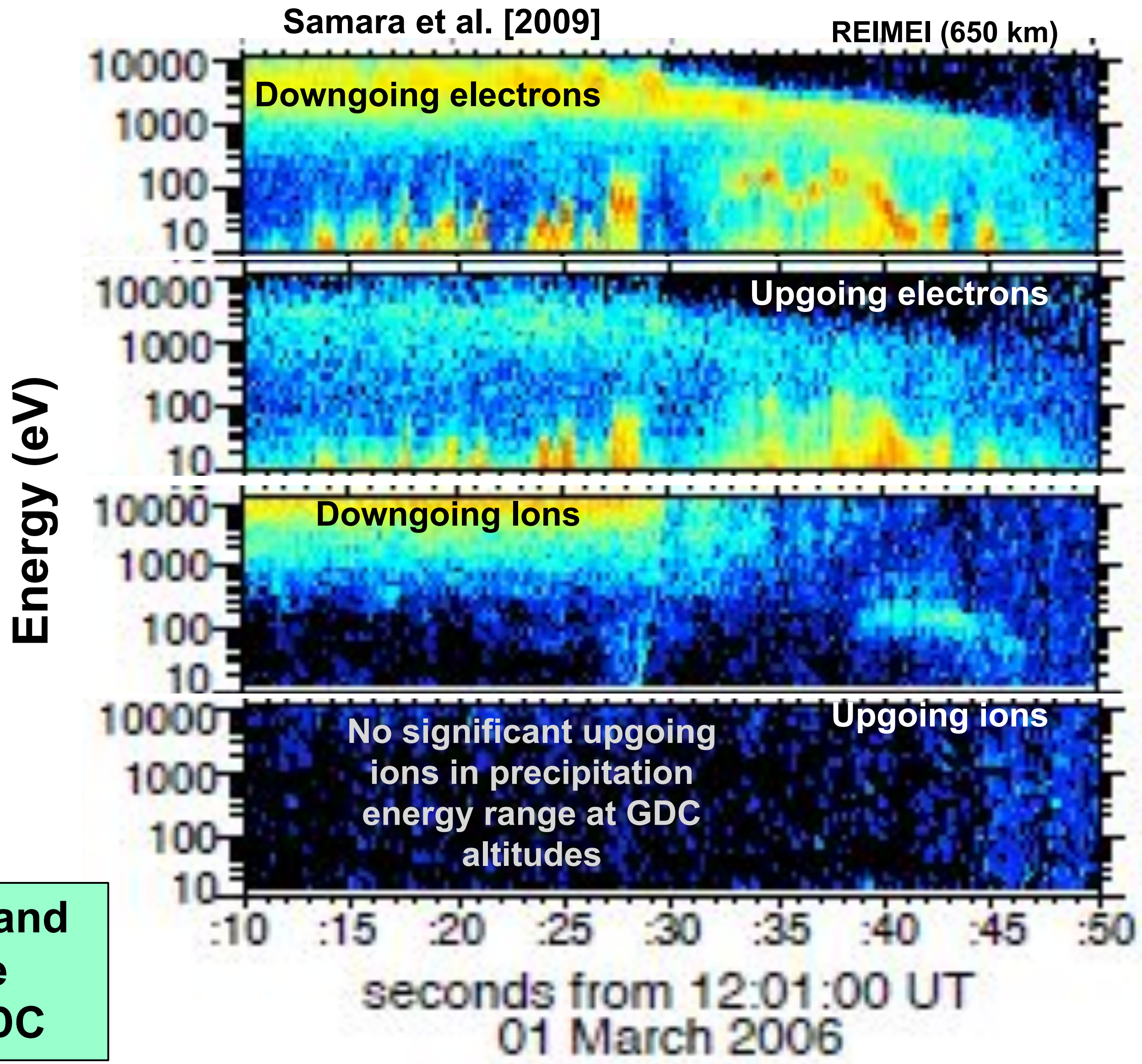




CAPE is comprised of two top-hat electrostatic analyzers with deflection plates and delay-line anodes for azimuthal position sensing

CAPE Measurements





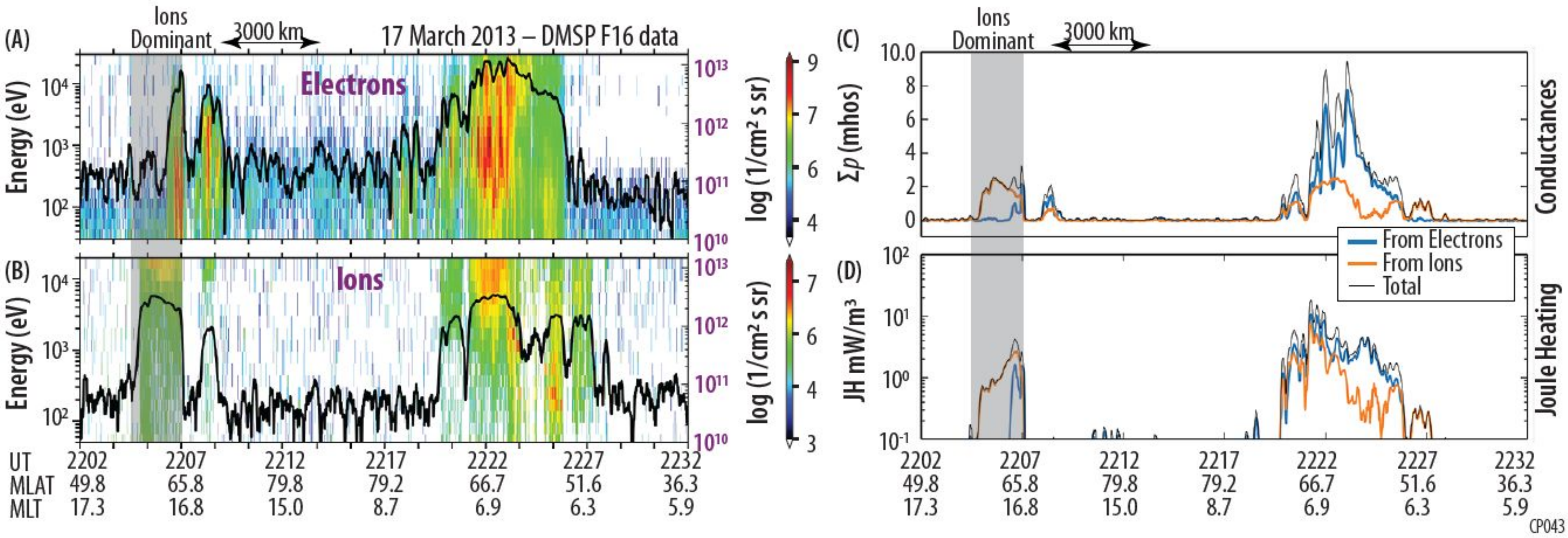
Combining data taken at different voltages and from different CAPE sensors leads to the precipitation measurements needed for GDC

CAPE Science Goals and Objectives

CAPE Science Goals	Goal 1: Determine how global and regional structure in auroral precipitation drives high latitude ion and neutral structure and dynamics.				Goal 2: Determine the dominant pathways through which high latitude particle energy forcing leads to (global) ionospheric-thermospheric dynamics.	
CAPE Science Objectives	***SO1***: Establish the scale sizes at which high latitude particle energy input enters the ionosphere-thermosphere system and determine which are more impactful for ion and neutral dynamics.	***SO2***: Reveal how the persistence and evolution of high latitude particle precipitation at different scale sizes modulate its impact on ion and neutral dynamics.	***SO3***: Quantify the impact of the energy distribution of precipitating electrons on the ionospheric and thermospheric state.	***SO4***: Quantify the impact of ion precipitation induced energy deposition and ionization on the ionospheric and thermospheric state.	***SO5***: Establish how the dynamics of high latitude particle energy input contribute to the generation of propagating structures in the ionosphere and thermosphere away from the auroral zone.	***SO6***: Map auroral particle precipitation to neutral molecular composition changes, and their contribution to global ion and energy losses.

CAPE provides observations of the particle energy inputs that enable the determination of the spatiotemporal scales and characteristics that are most impactful to Ionosphere-Thermosphere dynamics

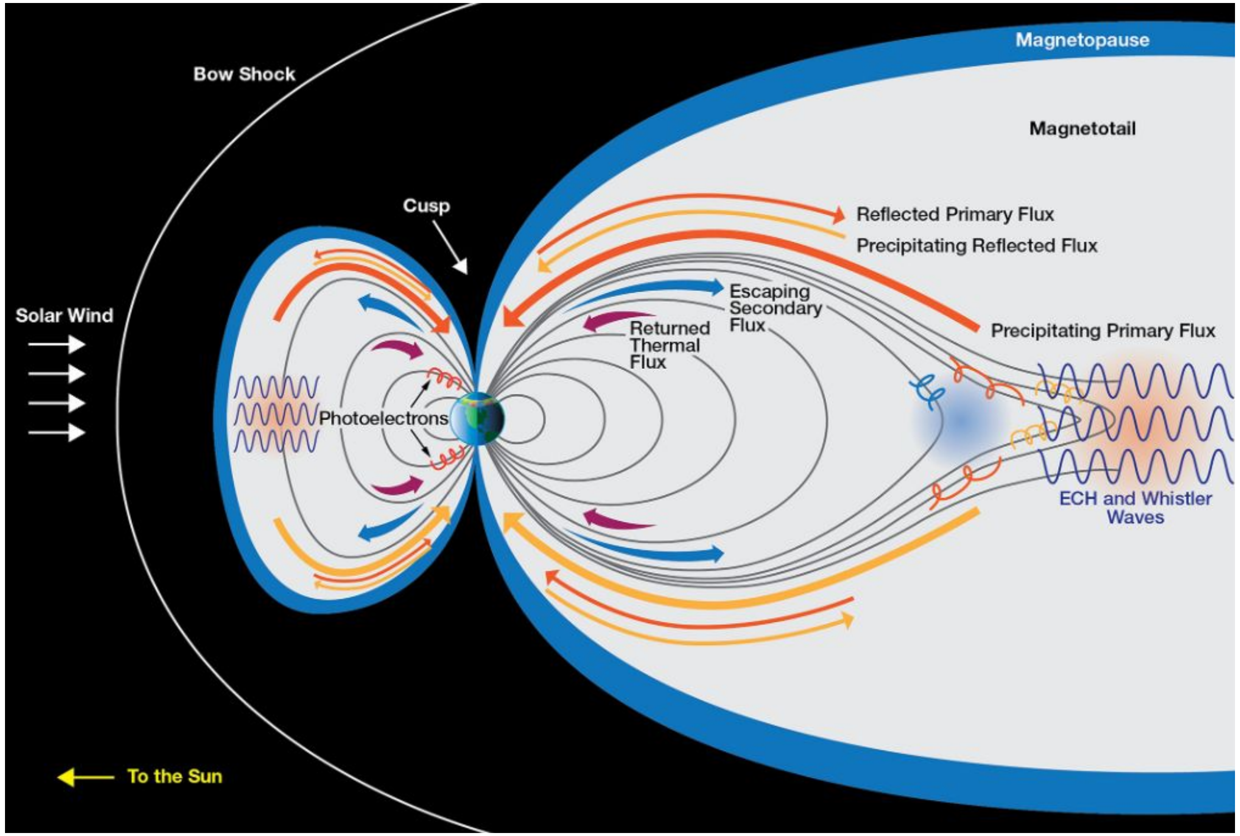
CAPE Science Goals and Objectives

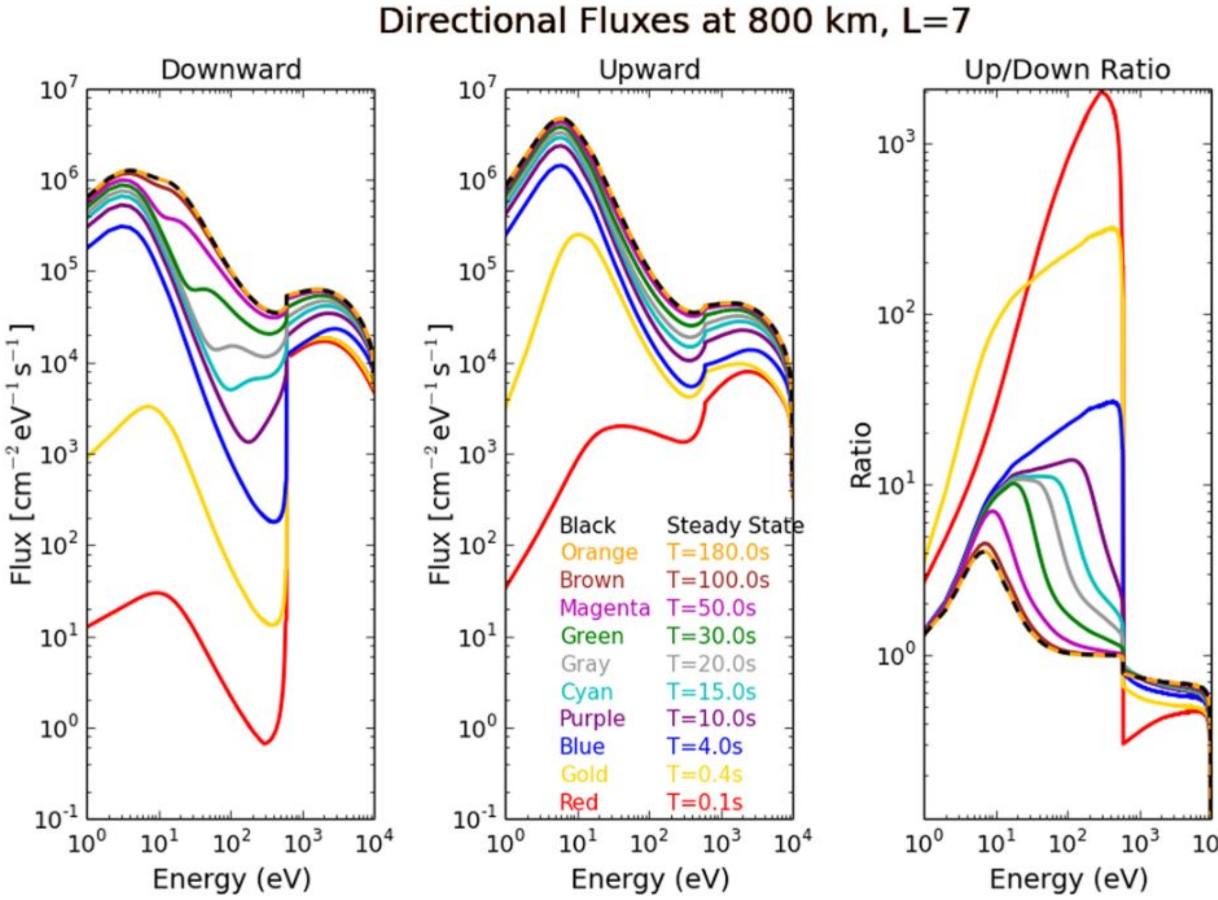


CAPE observes fluxes of ions above 20 keV that produce significant ionization and heating near dusk in the absence of meaningful electron precipitation, especially during times of high geomagnetic activity

CAPE Science Goals and Objectives

Khazanov and Glocer, 2020





CAPE measures upgoing electrons that encode information about M-I-T coupling, the time history of precipitation structures, and provide critical validation data for models of the neutral atmosphere below GDC

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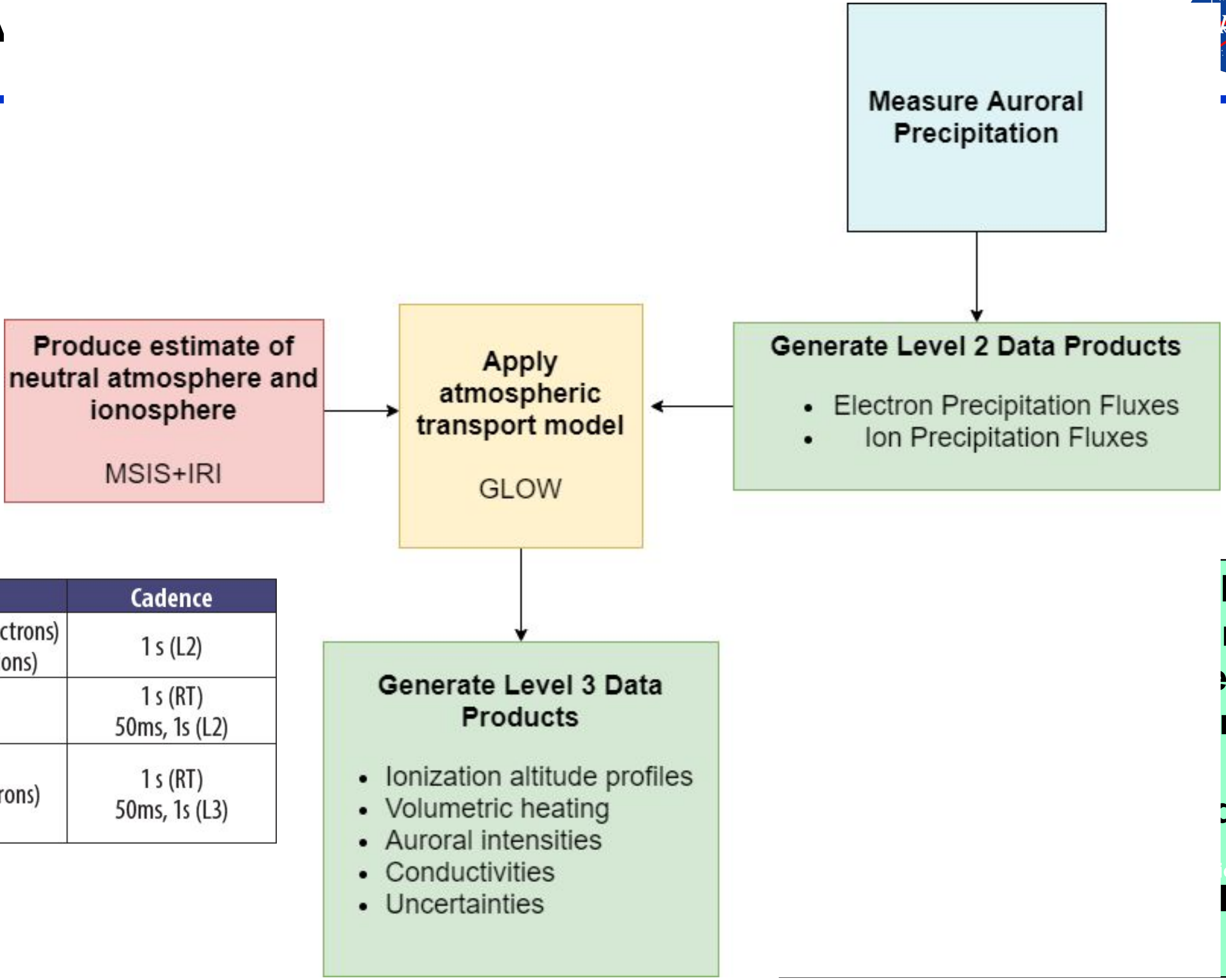

Data Product	Format	Cadence
Differential Energy flux ($cm^{-2}s^{-1}$ sr^{-1} eV/eV)	Time series x 32 energies x 44 angles (electrons) Time series x 32 energies x 22 angles (ions)	1 s (L2)
Total Energy Flux (mW/m^2)	Time series x (ions, electrons)	1 s (RT) 50ms, 1s (L2)
Average Energy (eV)		
Ionization Rate ($cm^{-3}s^{-1}$)	Time series x 68 altitudes x (ions, electrons)	1 s (RT) 50ms, 1s (L3)
Heating Rate (eV $cm^{-3}s^{-1}$)		
Conductance (S)		

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Measurements of the Upper Atmosphere