Electrical Connections and Consequences Within the Earth System

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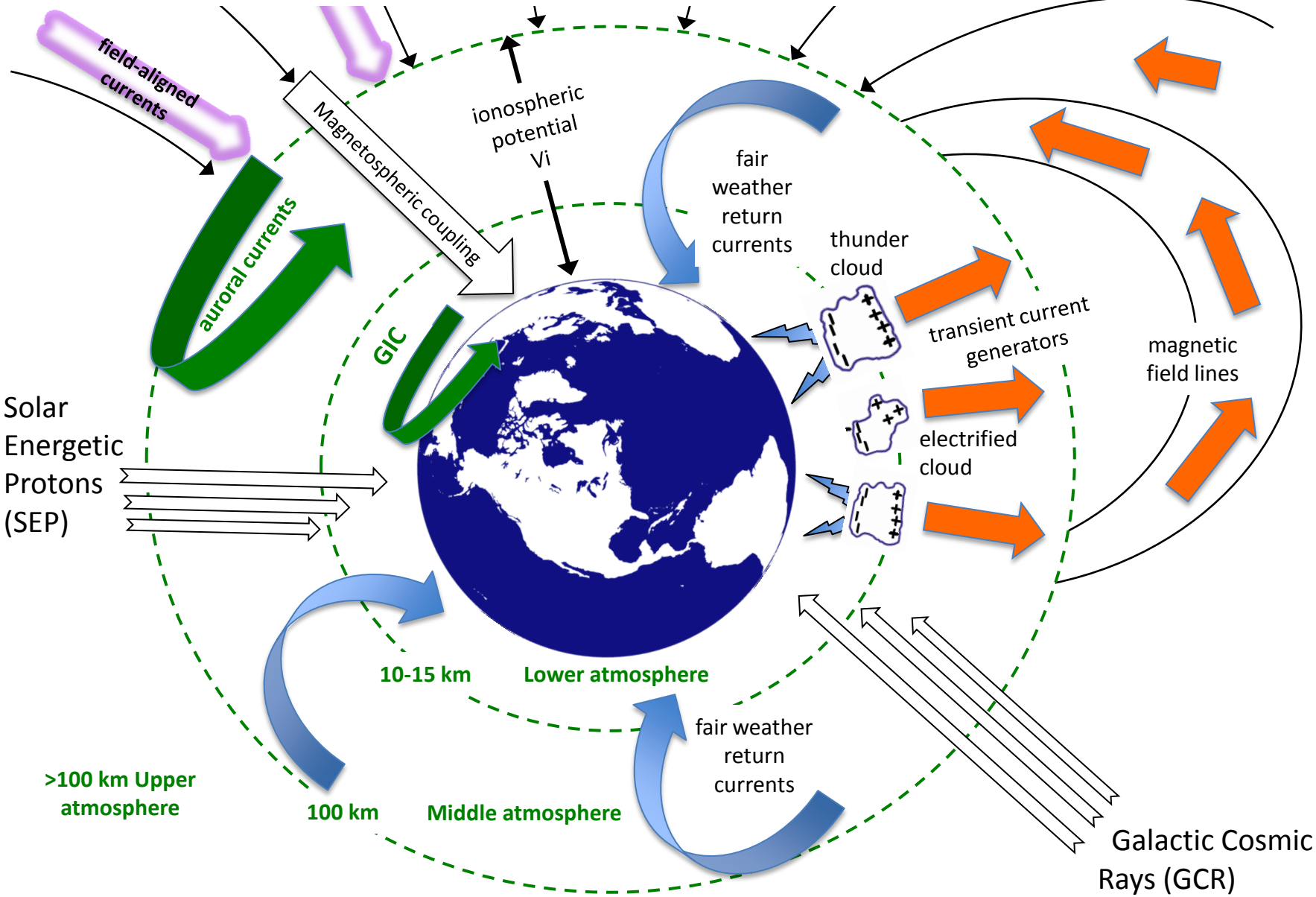
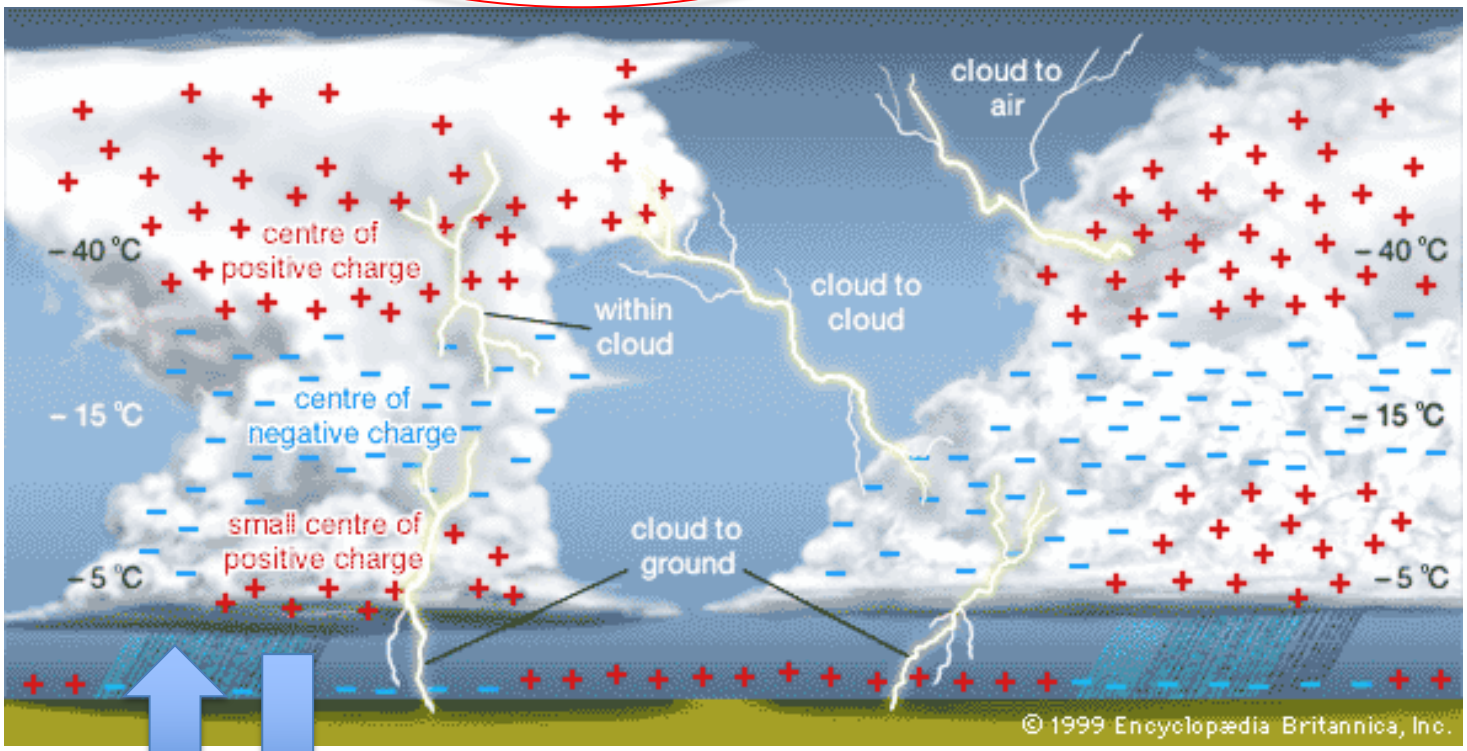
V. Pasko, S. Celestin (Pennsylvania State U.)



Current Flow in Thunderstorms

Conduction currents from cloud tops, net positive current toward electrosphere

Transient currents



Precipitation, Corona (or point-discharge) and Lightning current, negative & positive current measured at ground

Convection current

Wiebke Deierling

Thunderstorms & Global Electric Circuit

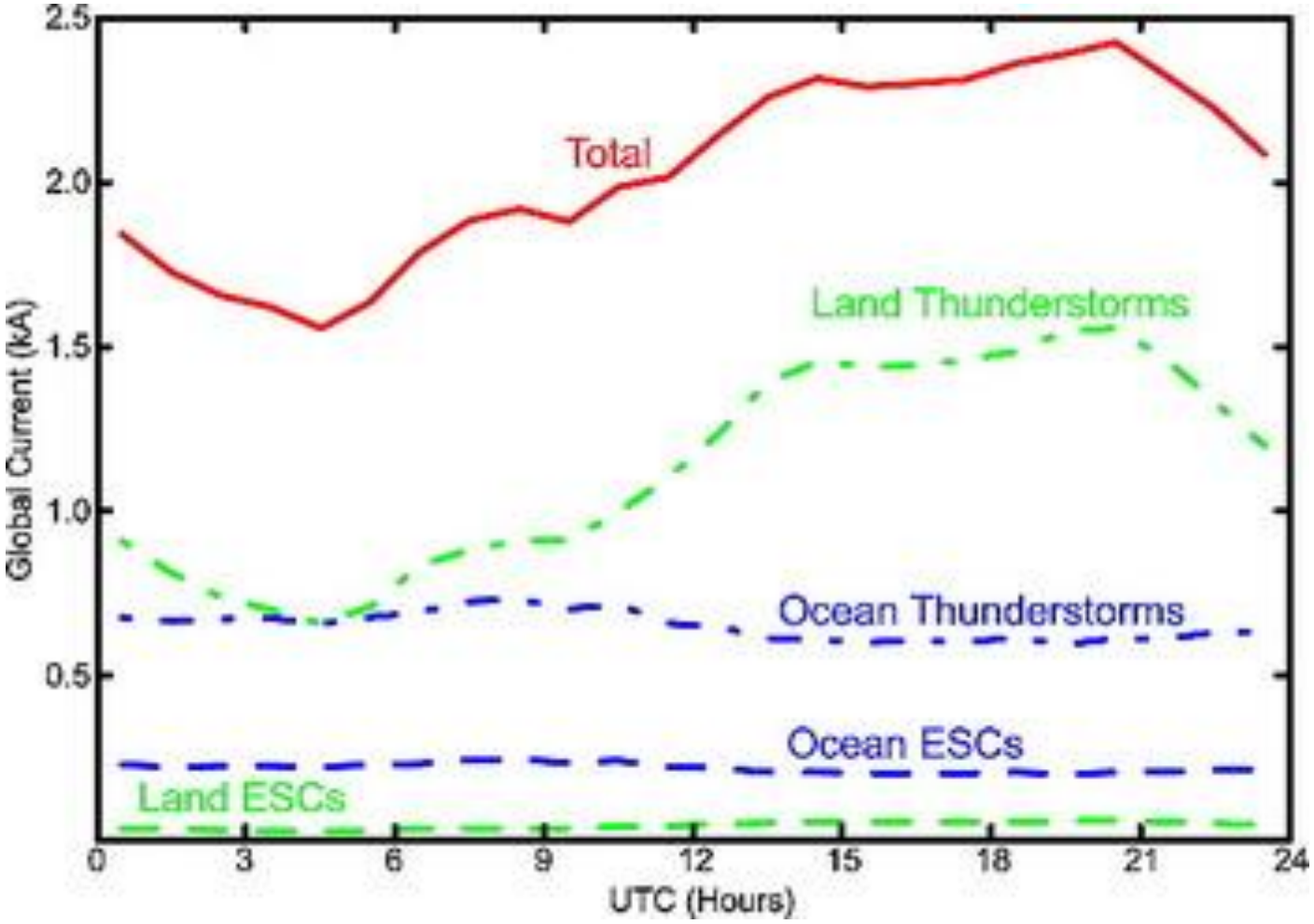
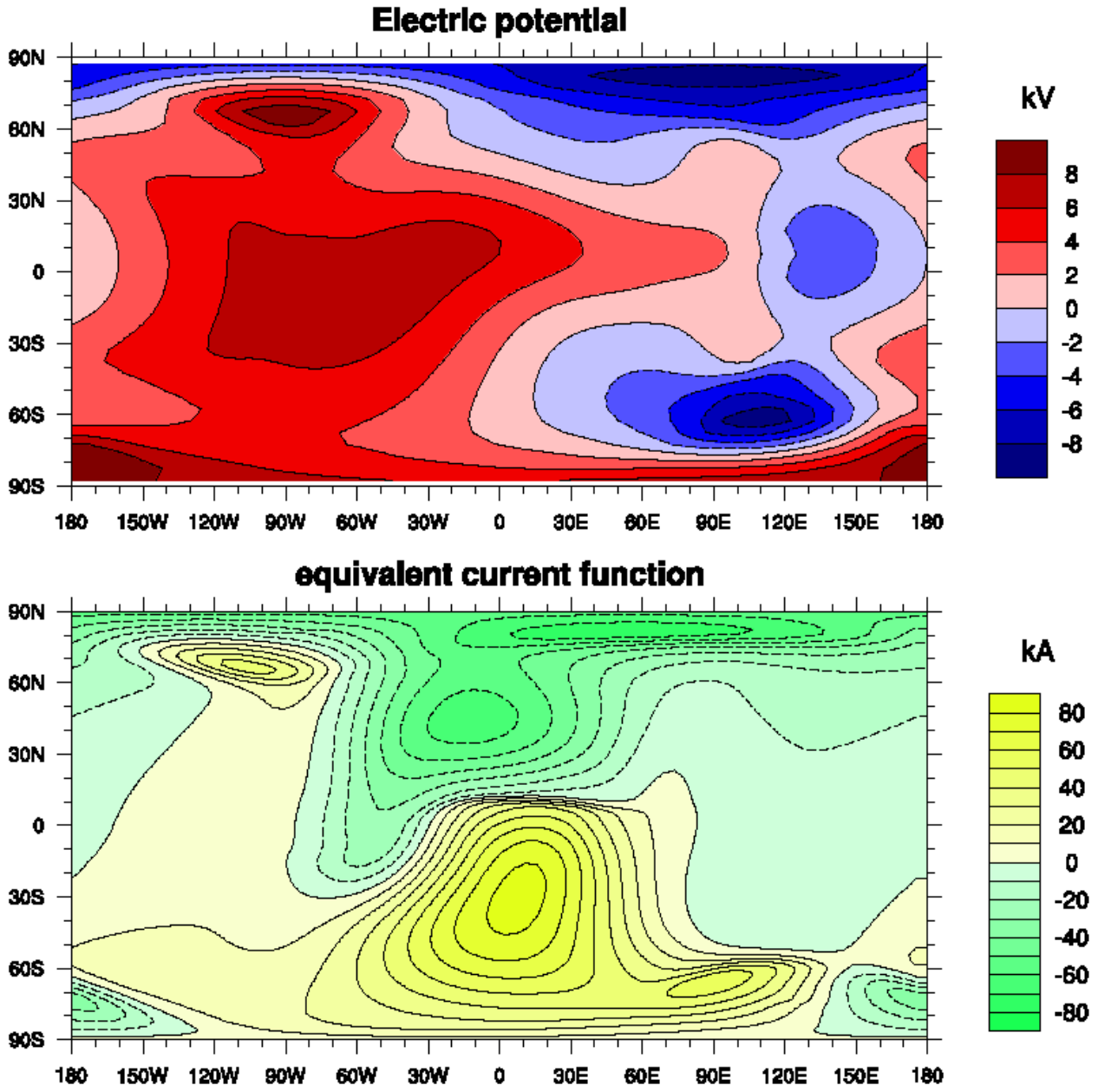
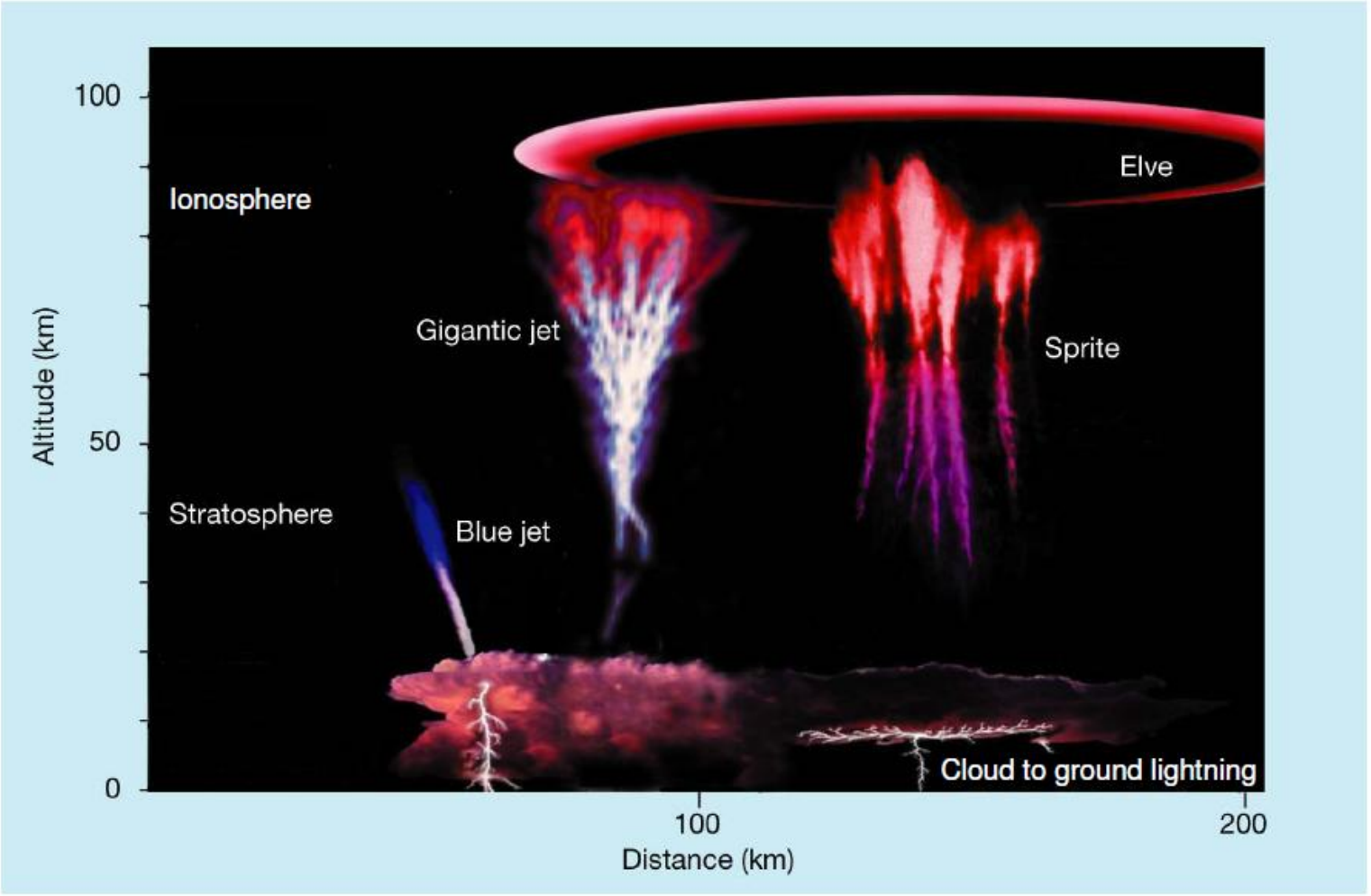


Figure 8. Global electric circuit total generator current. The curves are calculated by combining the LIS-OTD data and our storm overflight data. The mean current for land ESCs is 0.04 kA. The mean currents for ocean ESCs and thunderstorms are 0.22 and 0.65 kA, respectively. The mean current for land thunderstorms is 1.13 kA, and the total mean current is 2.04 kA. From Mach et al. 2011

Ionospheric electric potential and current, 12 UT, March



Lightning-Related Middle Atmospheric Transient Luminous Events



[Lyons et al., BAMS, 84, 445, 2003; Pasko, Nature, 423, 927, 2003]

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Project Goals

- Understand how and why the GEC varies in response to meteorological, solar, galactic, and magnetospheric influences.
- Understand how the sub-ionospheric part of the GEC and the ionosphere are mutually linked.
- Create a validated global high-resolution model of the GEC that will enable realistic emulation of the above, and that is integrated with the Whole Atmosphere Community Climate Model (WACCM).

Science Questions

- How does the spatial-temporal variability of electrified clouds and lightning translate to global GEC characteristics?
- How much do individual lightning discharges and TLEs influence the GEC?
- How do different levels of solar and geomagnetic activity influence the GEC?
- How does the GEC affect the ionosphere, and what factors determine strong aurorally-generated magnetic fields?

Wiebke Deierling and Tina Kalb

Parameterization of current sources in WACCM

Investigate if we can parameterize electric currents via microphysical and dynamical model parameters (based on empirical relationships) that are already available from WACCM

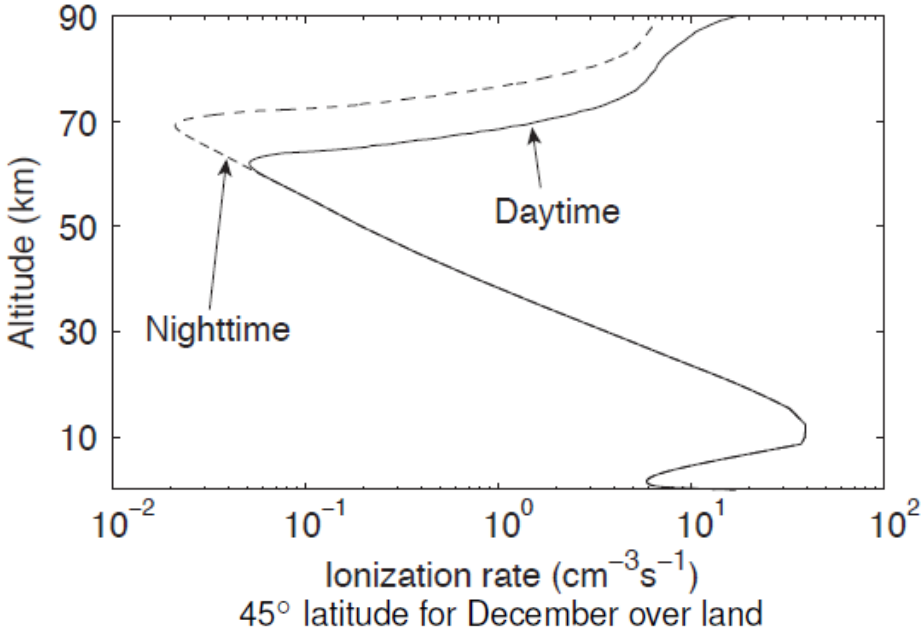
Some parameters we plan to test are:

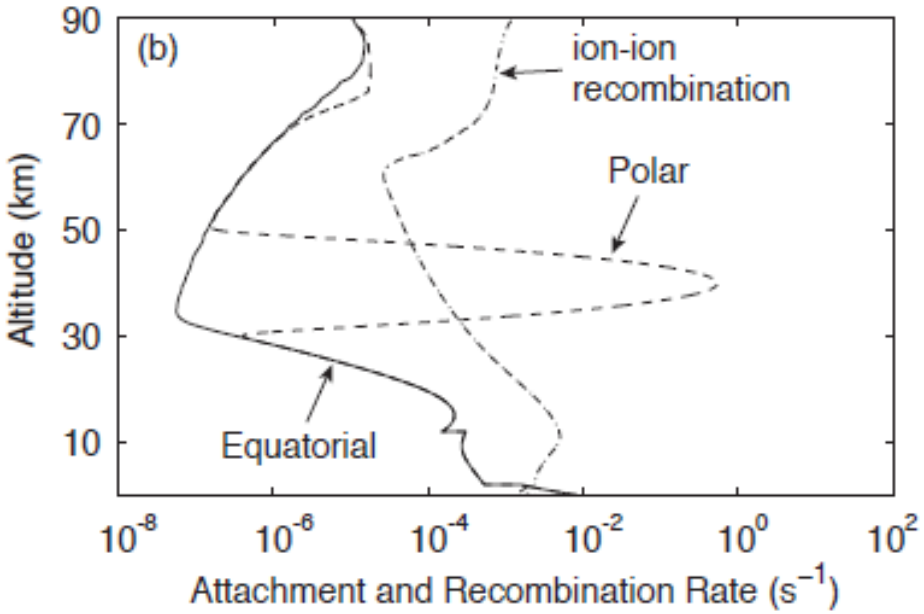
-Cloud height
-Vertical velocity (pressure)
-Convection mass flux from ZM deep
-Convective precipitation rate from ZM deep
-Grid box averaged cloud ice amount
-Fractional ice content within cloud
-Convective cloud cover
-Fractional occurrence of shallow convection
-Prognostic in-cloud ice mixing ratio?
-In-cloud ice water path
-Convective precipitation rate (liquid + ice)

-lightning NO source (to back out estimated lightning activity)

Sebastien Celestin and Victor Pasko

Modeling the Ion Conductivity at High Altitude





Daytime for July over the ocean

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Connections with WACCM

- Use WACCM variables to parameterize cloud current sources.
- Use WACCM chemistry and aerosol frameworks to model atmospheric conductivity.
- Develop ionospheric electrodynamics module for WACCM.
- Develop global electrical circuit model with a view to possible future integration into WACCM.