



# MONITORING CLIMATE WITH THE GLOBAL ELECTRIC CIRCUIT

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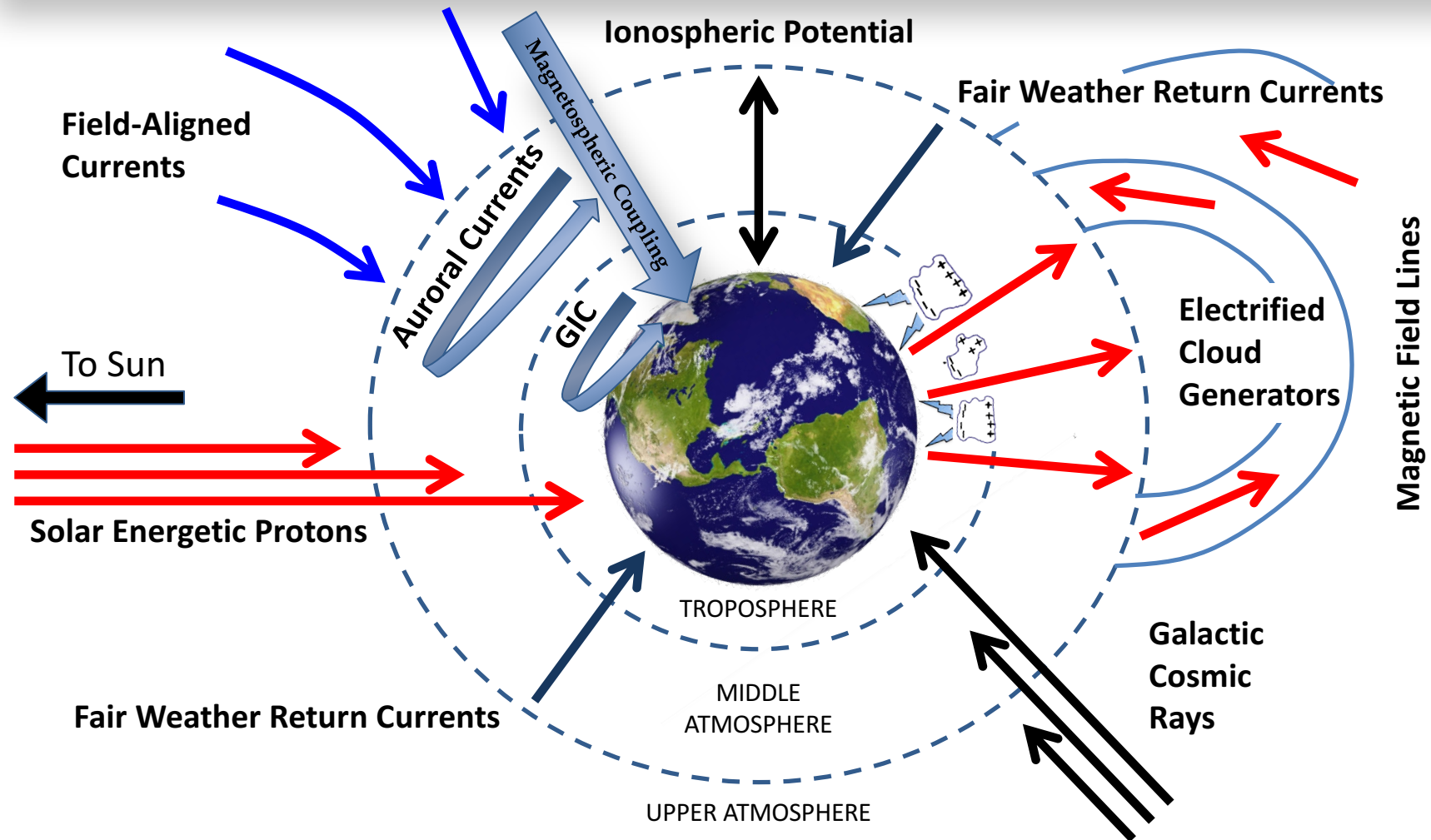
# Outline

- ▣ What is the Global Electric Circuit?
- ▣ Measuring the Global Electric Circuit
- ▣ Conclusions

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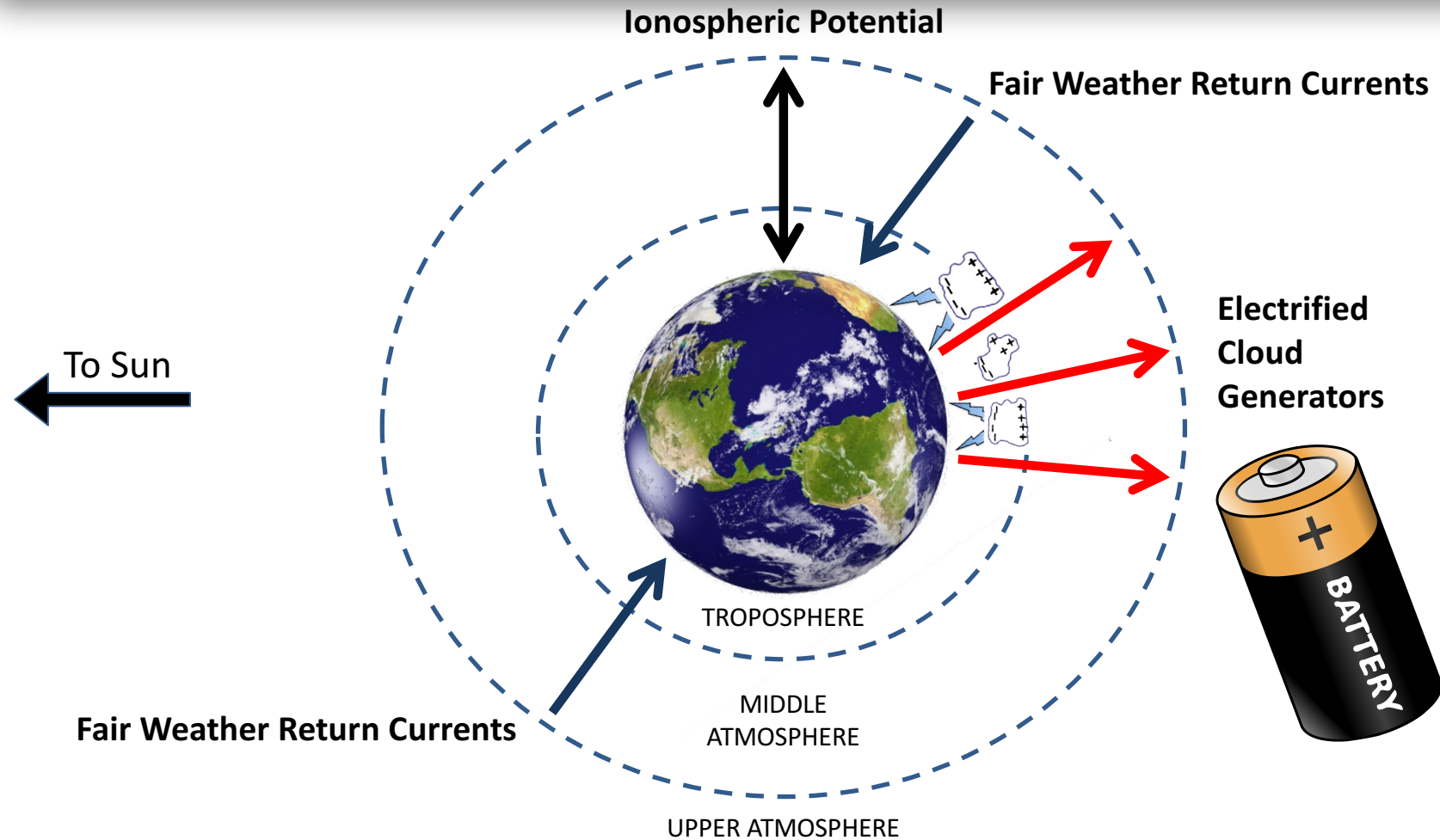
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# The Global Electric Circuit (GEC)

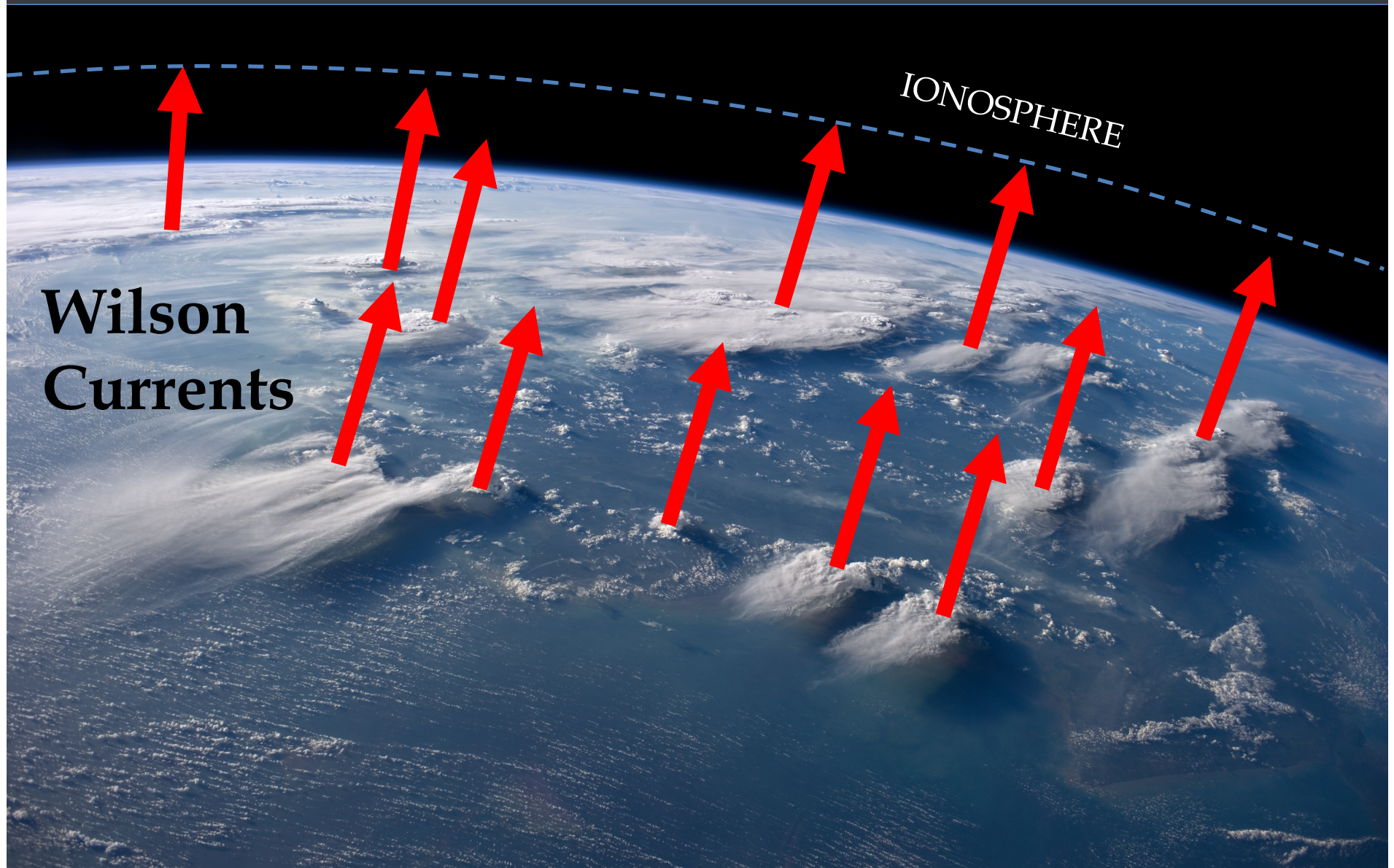




# The GEC: Lower Atmosphere



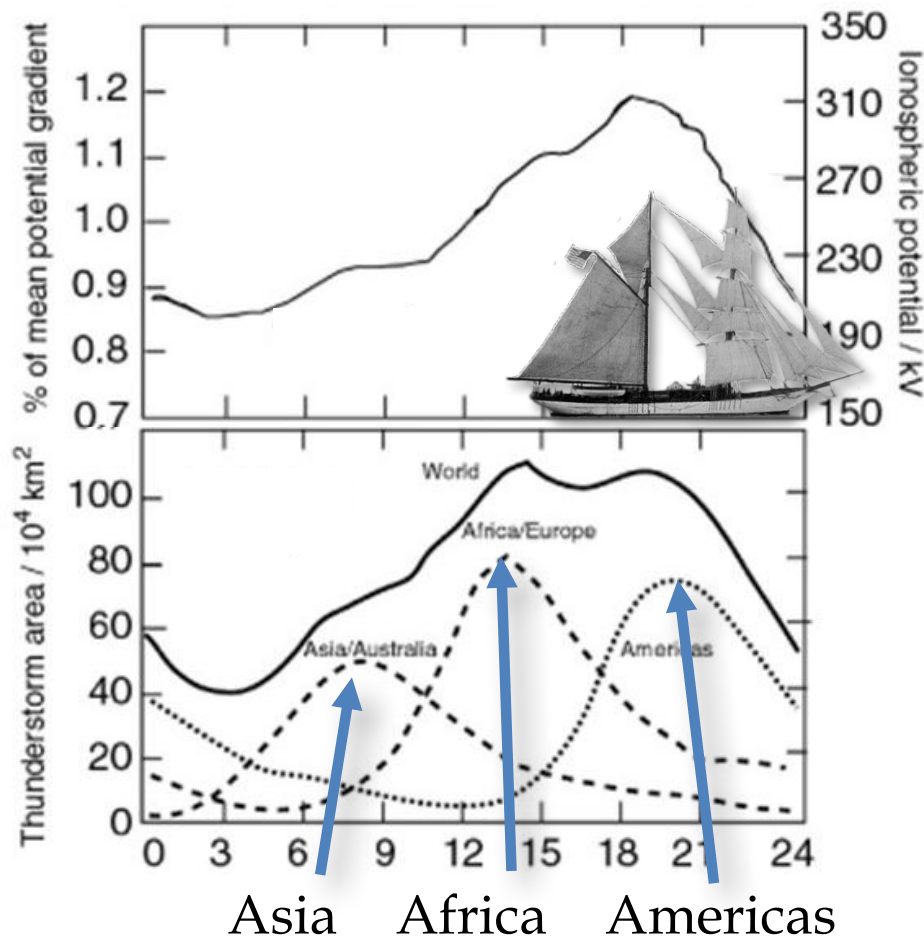
# Electrified Weather “Batteries”





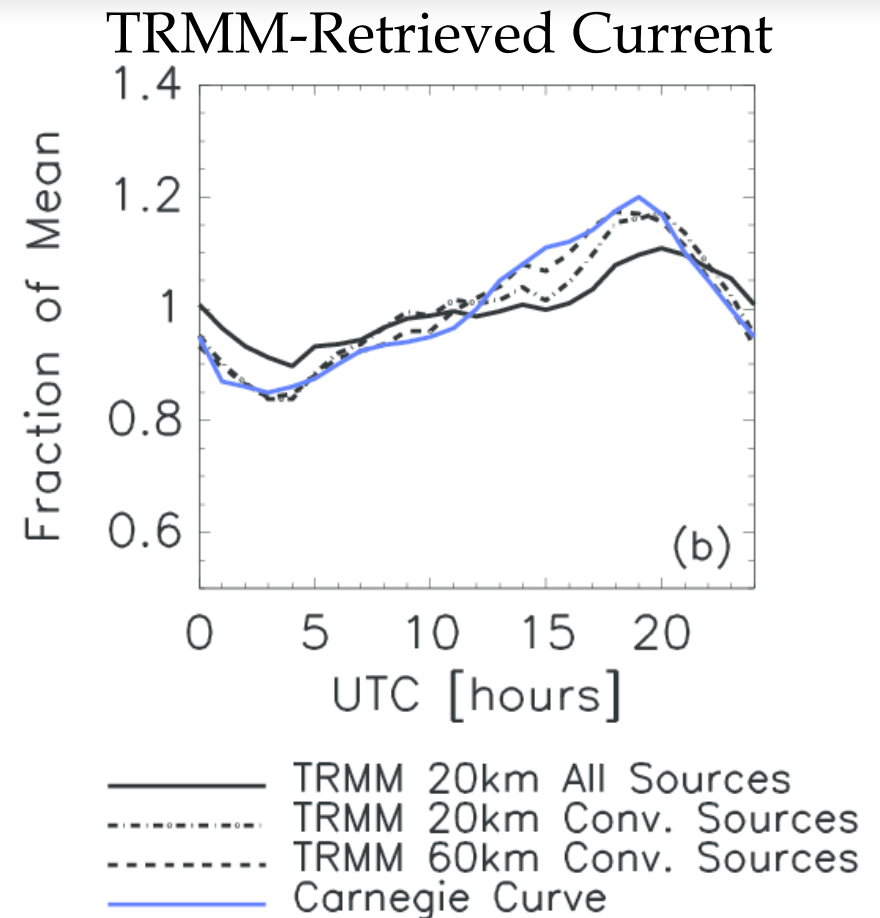
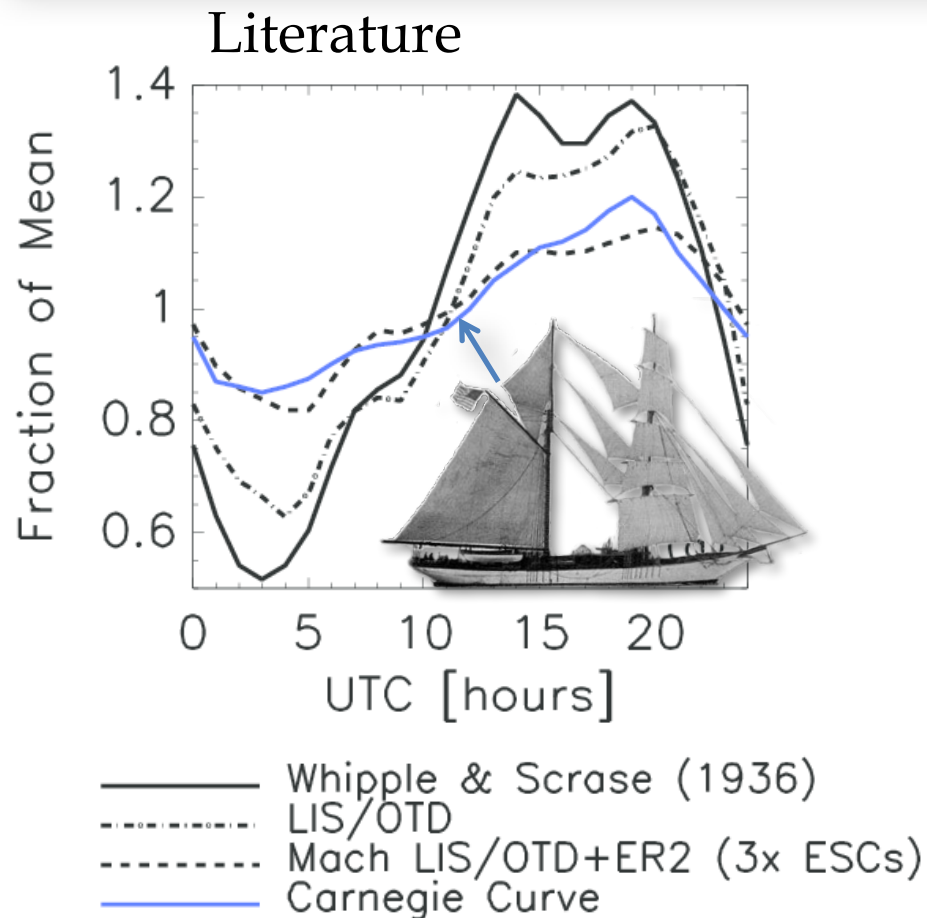
# The Carnegie Curve

- Fair-weather electric field measurements by *The Carnegie*
  - The Carnegie Curve
- Thunderstorm area used as a proxy for Wilson current
  - Total source current



Whipple and Scrase, 1936

# Approximating The Carnegie Curve



Peterson et al., 2016

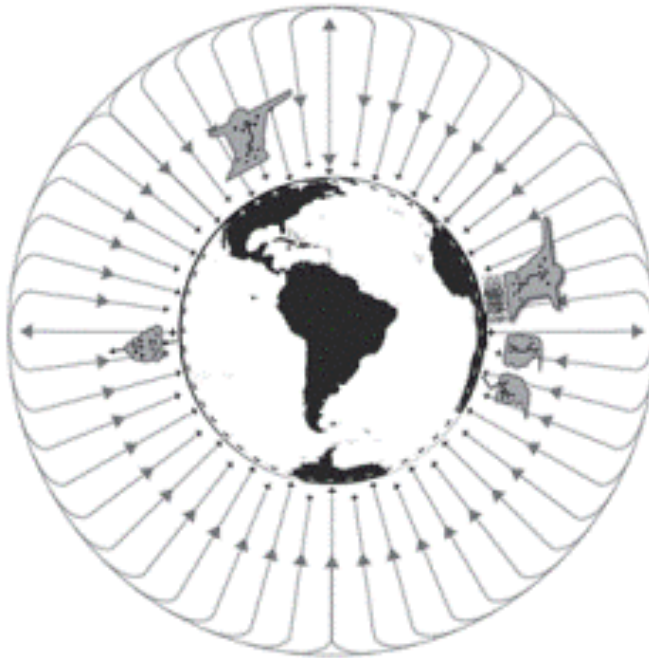


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# The GEC and Climate

**DC Global Circuit**



**Integrator of Electrified Weather**

**AC Global Circuit  
Schumann Resonances**



**Integrator of Global Lightning**

# Fair-Weather Electric Fields

- ▣ Benefits
  - Modern measurements of Carnegie Curve
  - Can observe over various time scales
- ▣ Caveats
  - Local effects contaminate signal
  - Disagreement between sites



Photo credit: Australian Antarctic Division



# Ionospheric Potential

## ▣ Benefits

- Direct balloon measurements of Ionospheric Potential
- “Preferred” quantity by atmospheric electricians

## ▣ Caveats

- Local→global effects contaminate signal

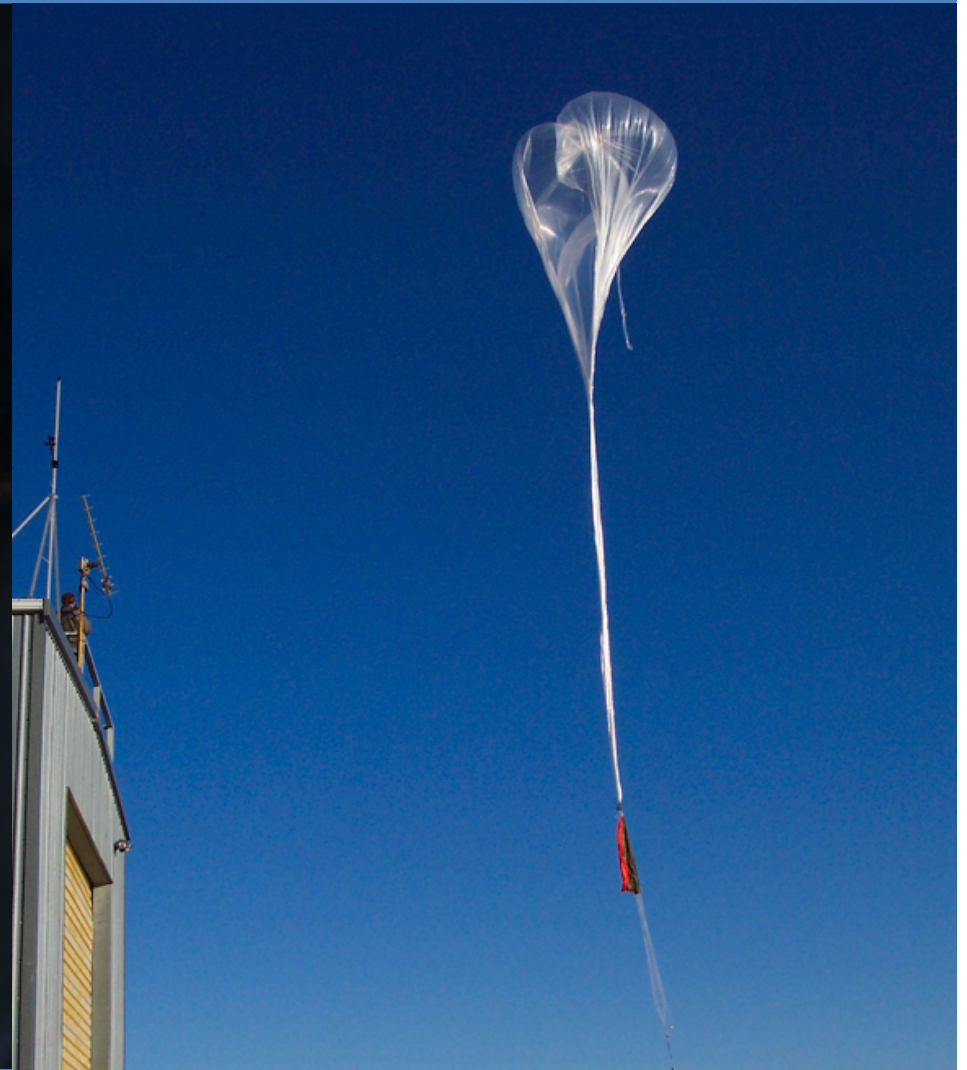


Photo credit: NASA



# Wilson Current Retrievals

## ▣ Benefits

- Passive microwave algorithm produces best Carnegie curves
- Long record
- Only sensitive to changes in convection

## ▣ Caveats

- Low-earth orbit measurements provide infrequent snapshots

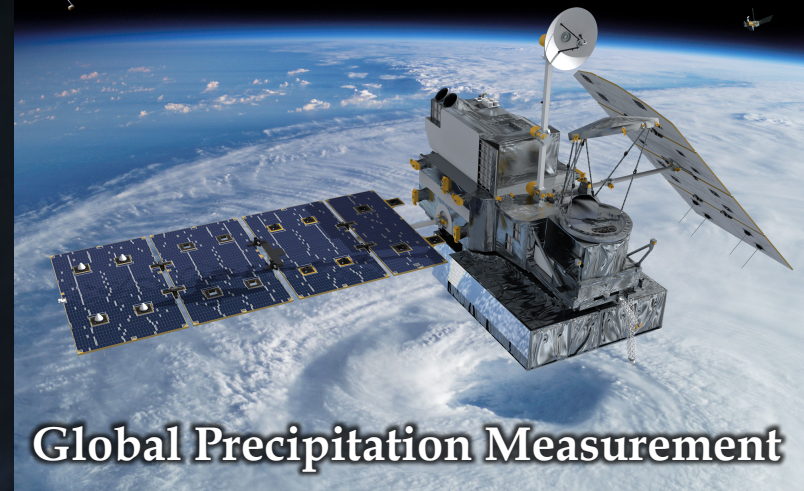
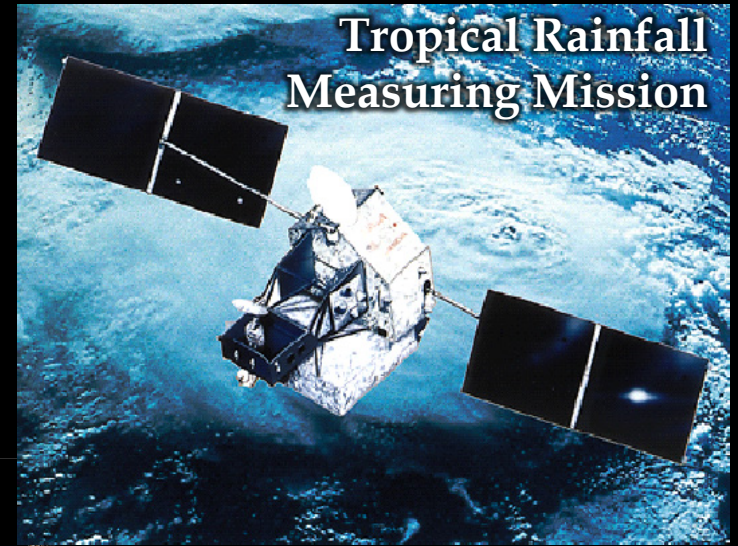


Photo credit: NASA

# GOES-R Total Lightning

## ▣ Benefits

- Geostationary total lightning measurements
- High detection efficiency
- Only sensitive to changes in convection

## ▣ Caveats

- Hemispheric coverage

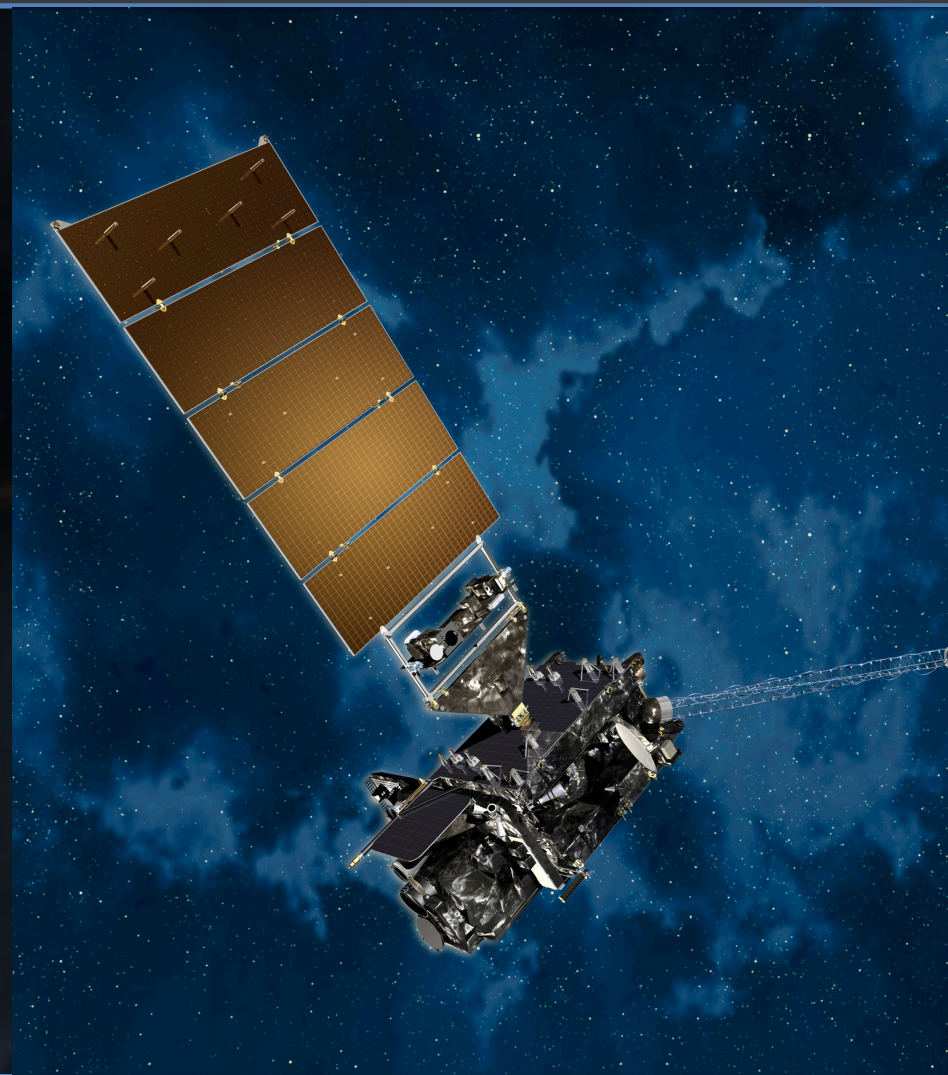
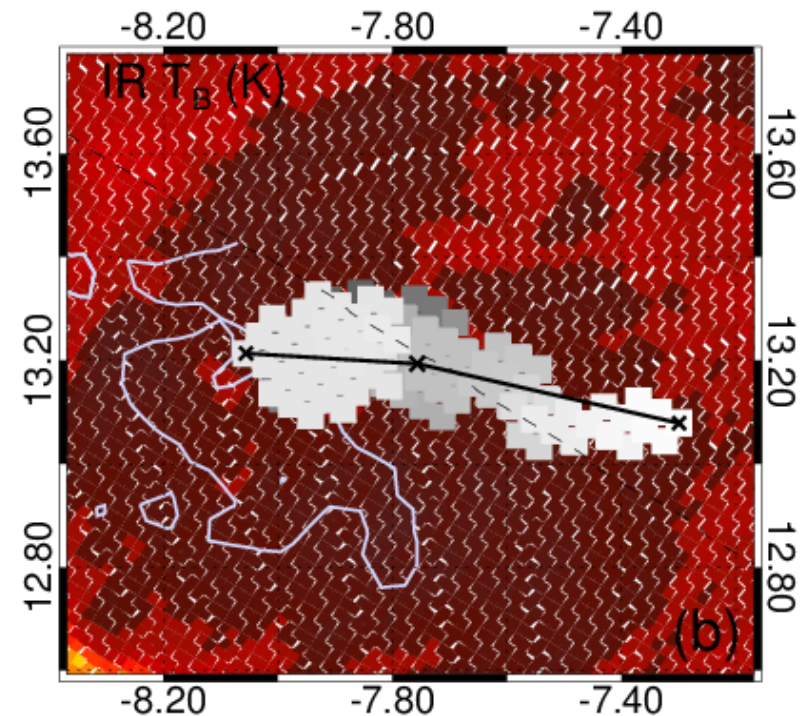
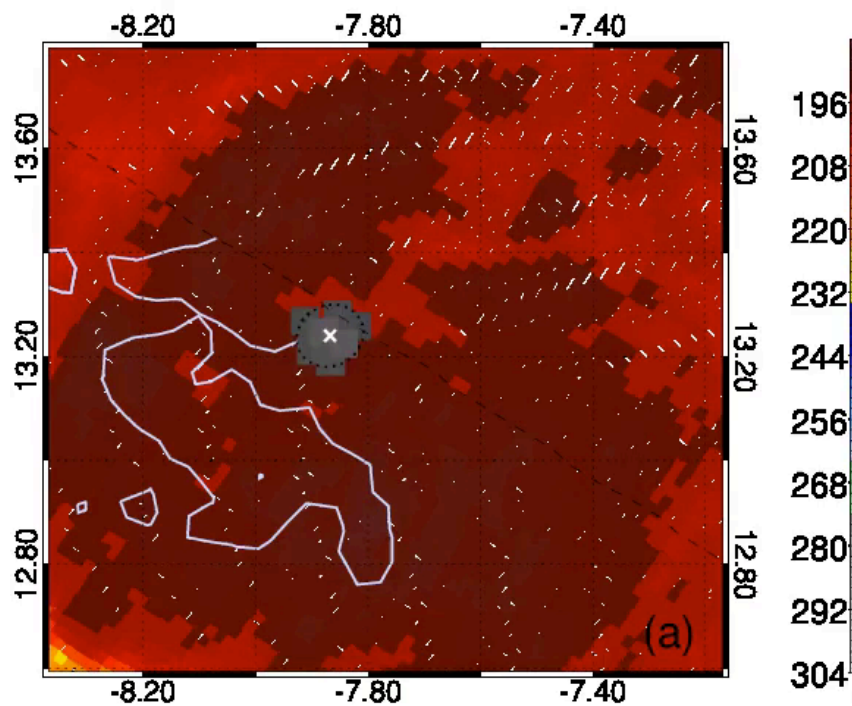


Photo credit: NOAA/NASA

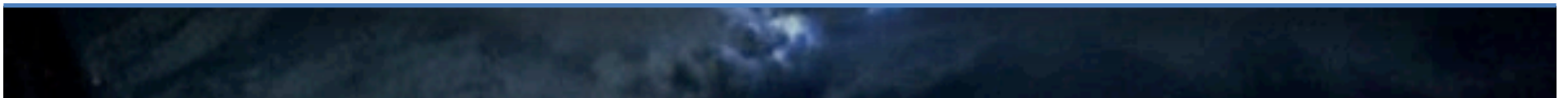


# Optical Flash Structure

Orbit 37795 IR  $T_B$  (K)



V2.



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# Conclusions

- ▣ The Global Electric Circuit (GEC) provides a natural framework for monitoring changes in electrified weather across the globe
- ▣ The GOES-R satellite is set to become an unprecedented resource for monitoring total lightning activity and the GEC

# QUESTIONS?

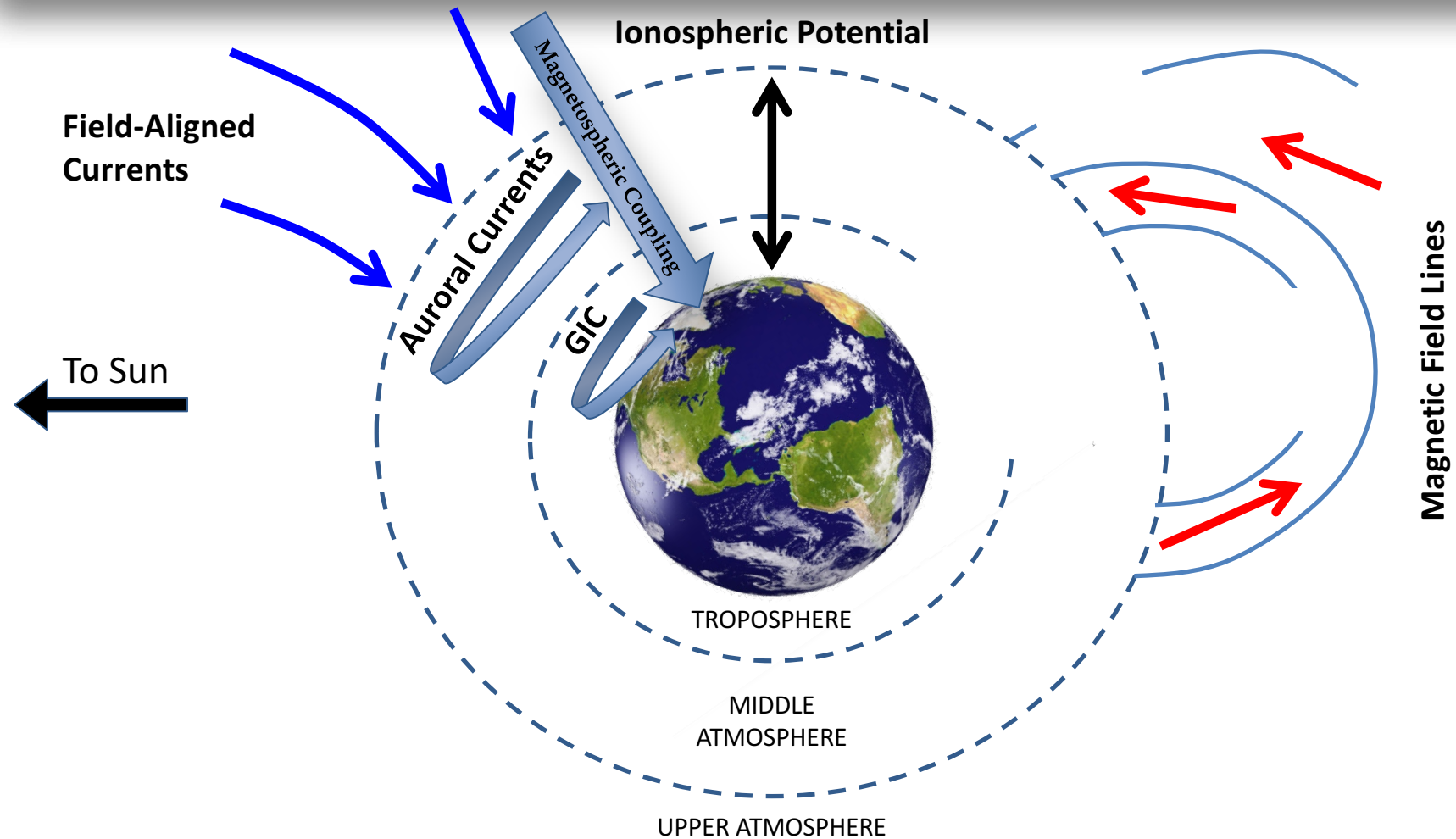
## References:

- Peterson, M. J., C. Liu, D. Mach, W. Deierling, C. Kalb, 2016: A TRMM/GPM Assessment of the Temporal Variations of the Global Electric Circuit Source Current, *J. Geophys. Res.*, in preparation
- Whipple, F. J. W., and F. J. Scrase, 1936: Point discharge in the electric field of the earth. *Geophys. Mem*, 68, 7, 1-20
- Williams, 2013: Research. Accessed 28 November 2016. [Available online at: <http://web.mit.edu/earlerw/www/Research.html>]

The background of the slide is a dark, deep blue or black space filled with wispy, glowing clouds of light blue and white, resembling a nebula or interstellar dust. The text "ADDITIONAL SLIDES" is centered in a bold, white, sans-serif font with a slight 3D effect. The slide is framed by a thin blue border on the left and right sides.

**ADDITIONAL SLIDES**

# The GEC: Upper Atmosphere





# The GEC: Geospace

