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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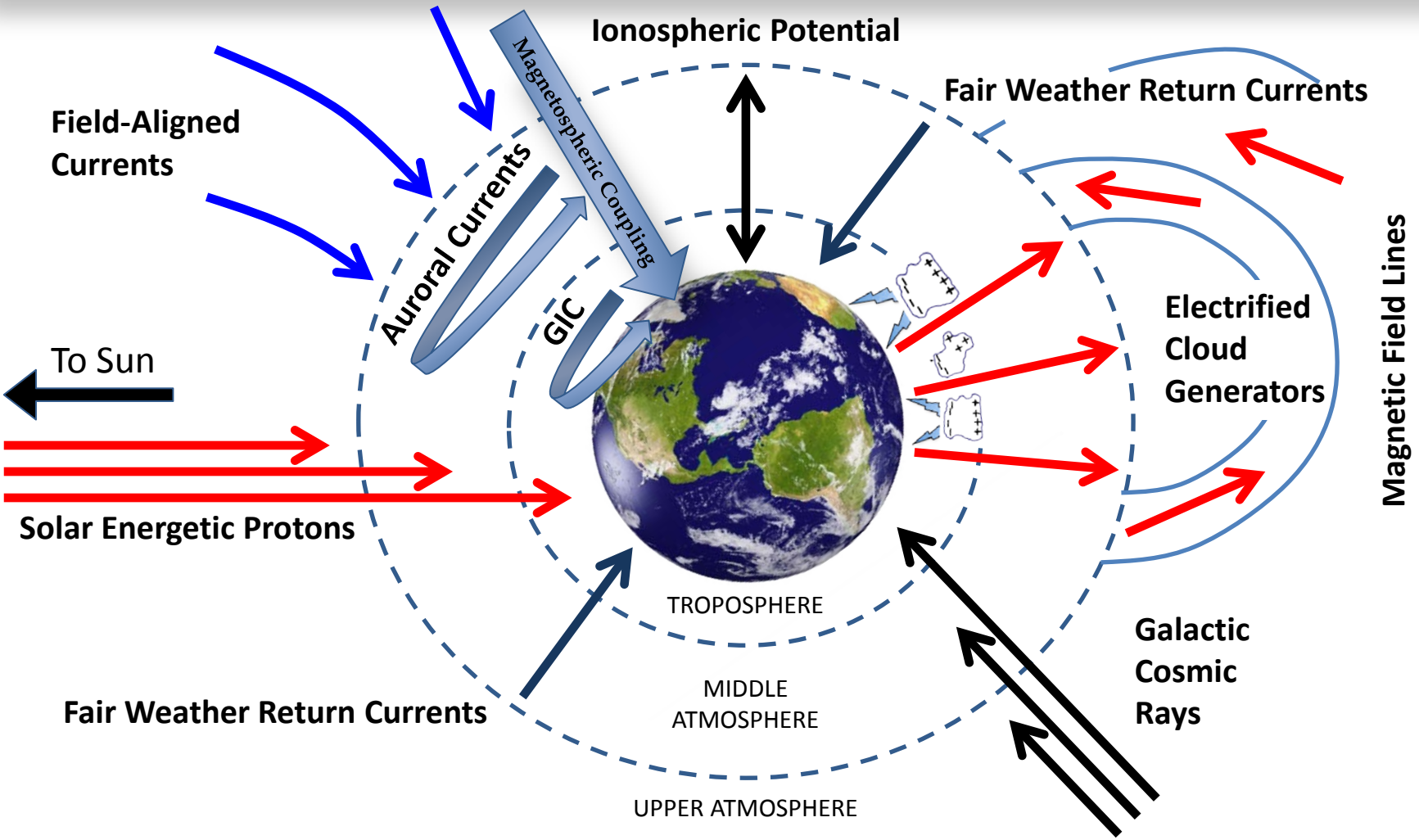
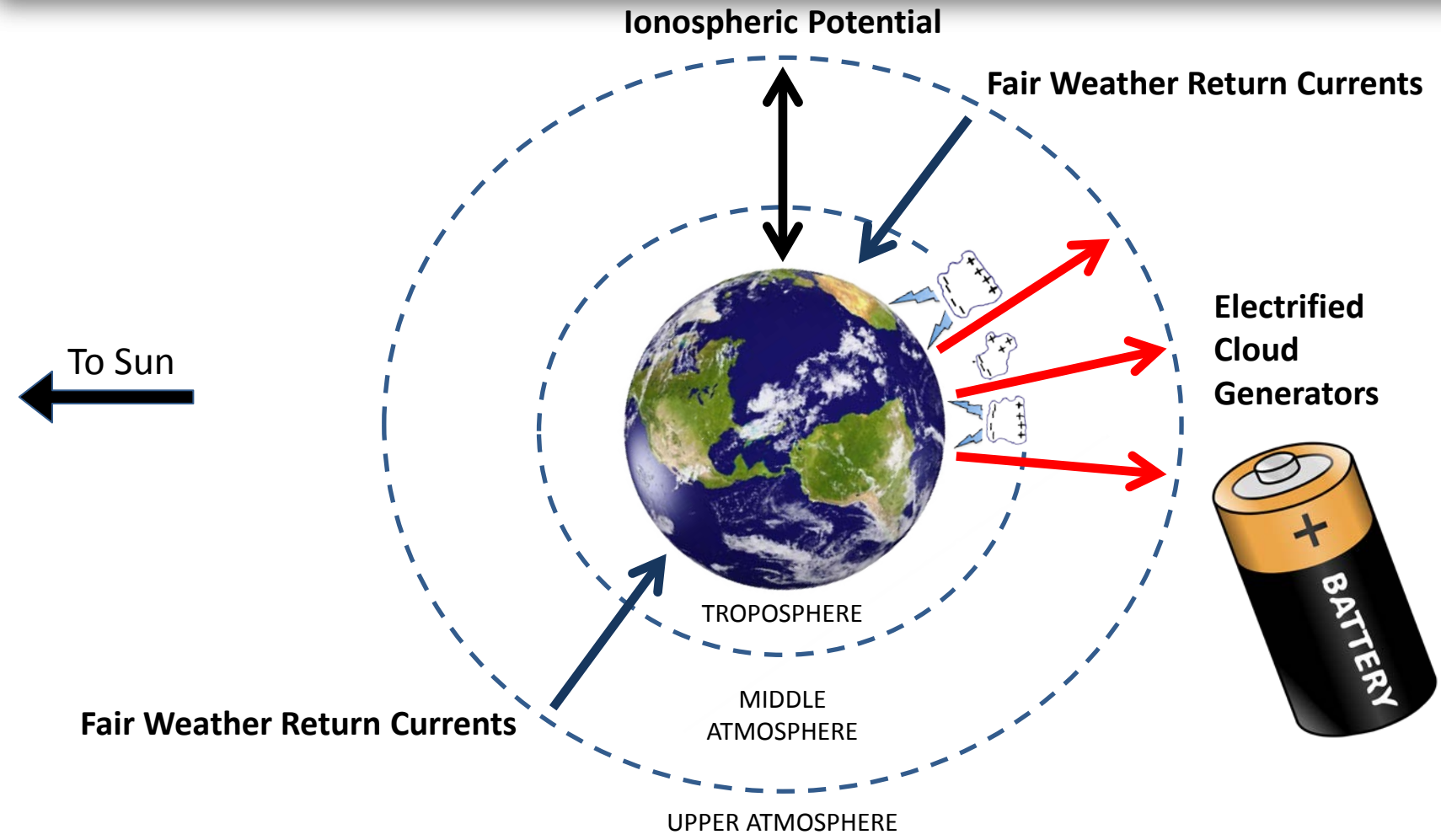
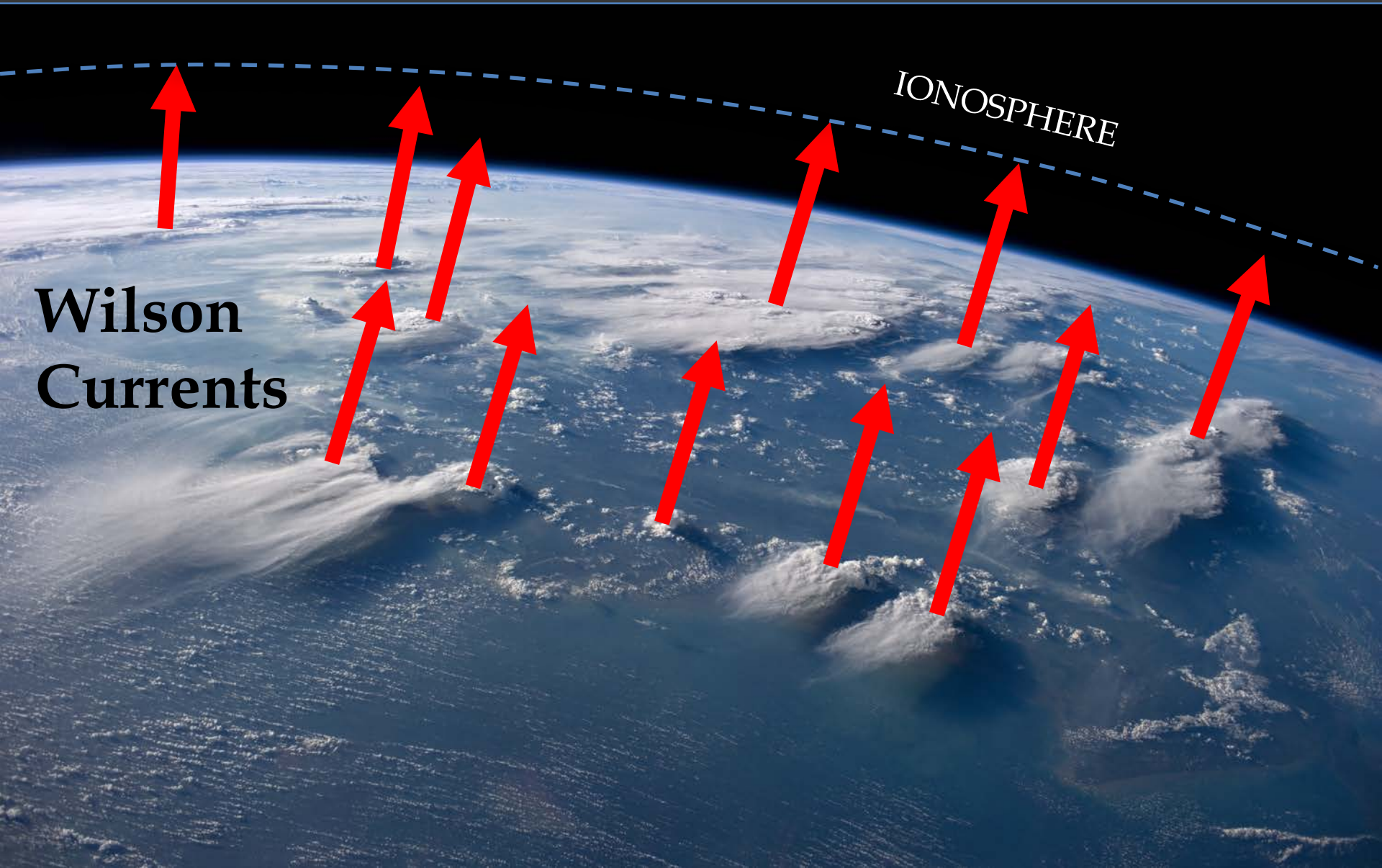
The Global Electric Circuit (GEC)



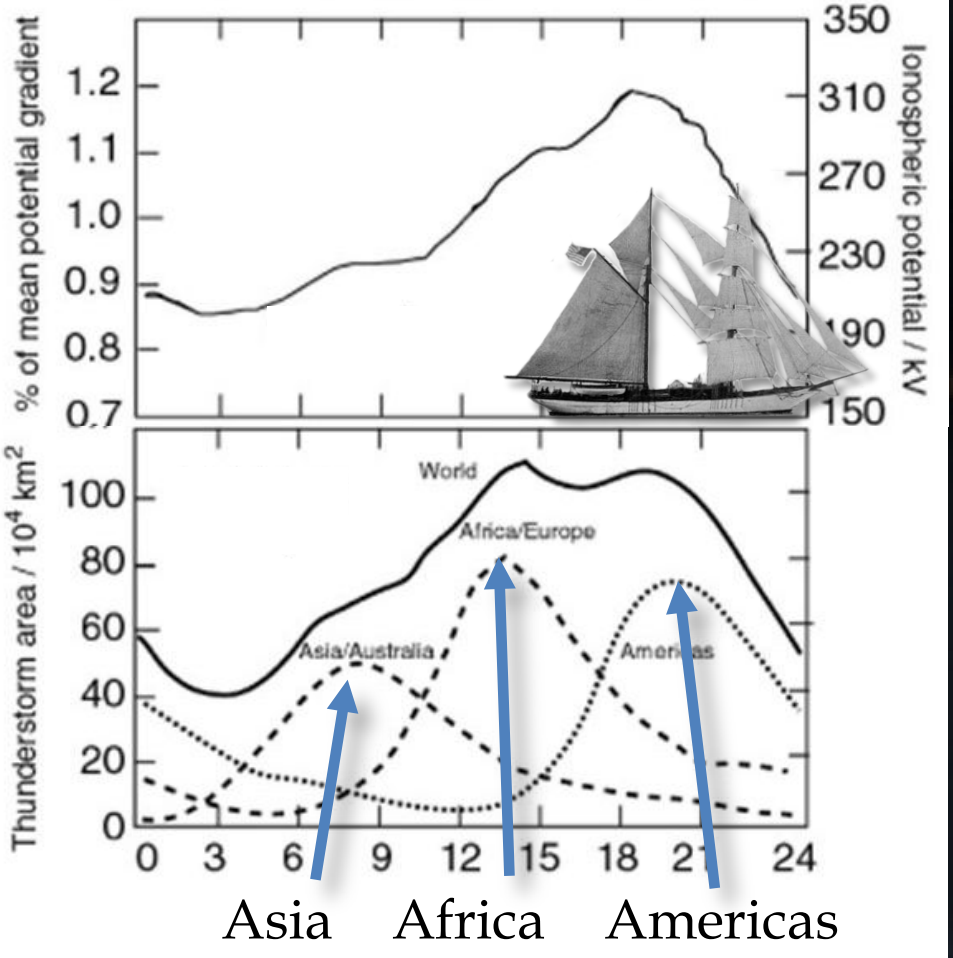
The GEC: Lower Atmosphere



Electrified Weather "Batteries"



The Carnegie Curve

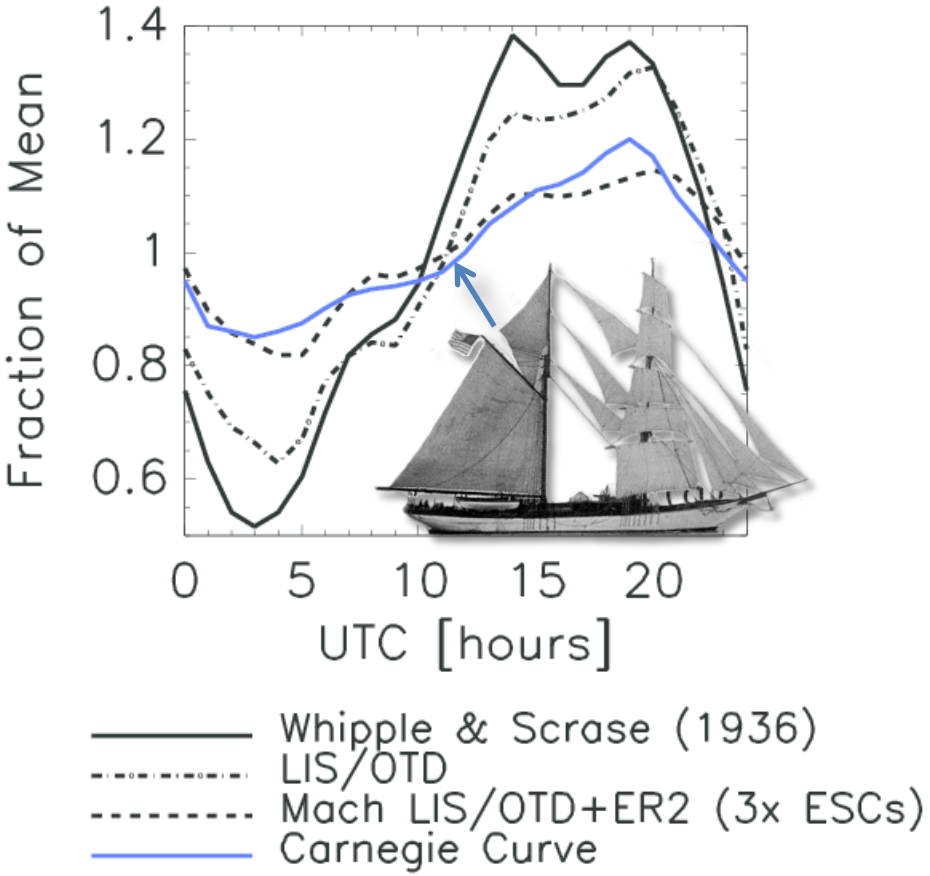


- Fair-weather electric field measurements by *The Carnegie*
  - The Carnegie Curve
- Thunderstorm area used as a proxy for Wilson current
  - Total source current

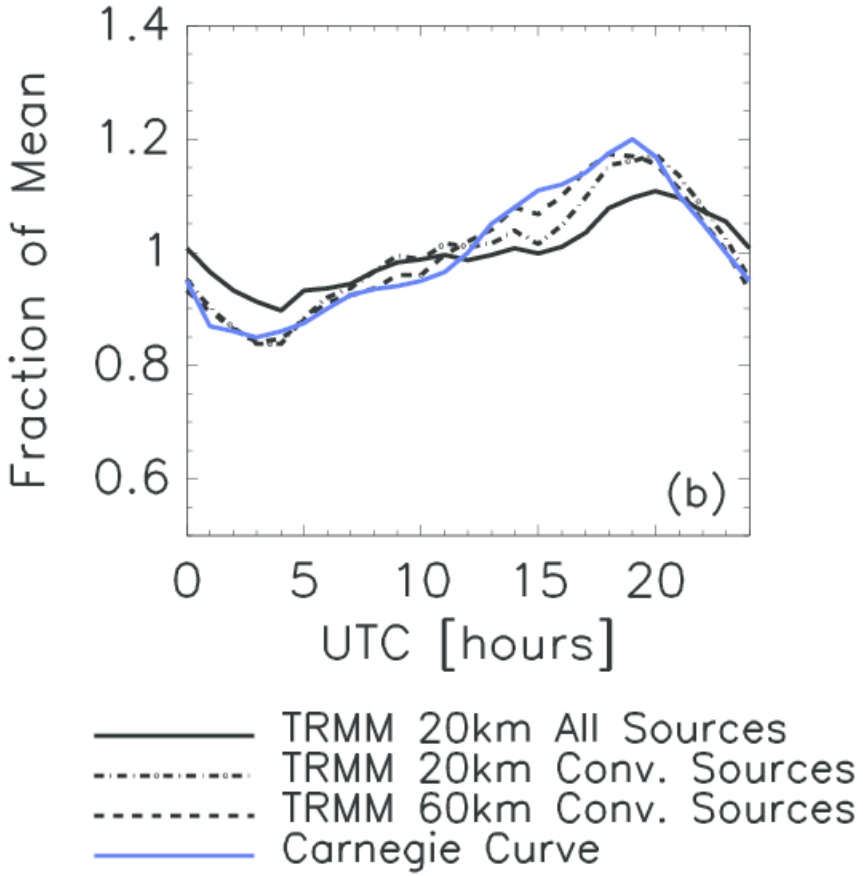
Whipple and Scrase, 1936

Approximating The Carnegie Curve

Literature



TRMM-Retrieved Current



Peterson et al., 2016

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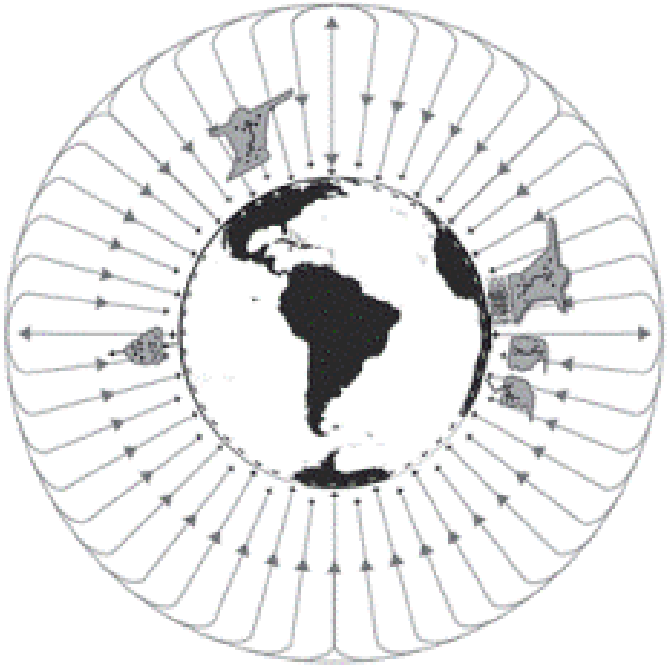
The GEC and Climate

DC Global Circuit



Integrator of Electrified Weather

AC Global Circuit
Schumann Resonances

Integrator of Global Lightning

Williams, 2013

Fair-Weather Electric Fields

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

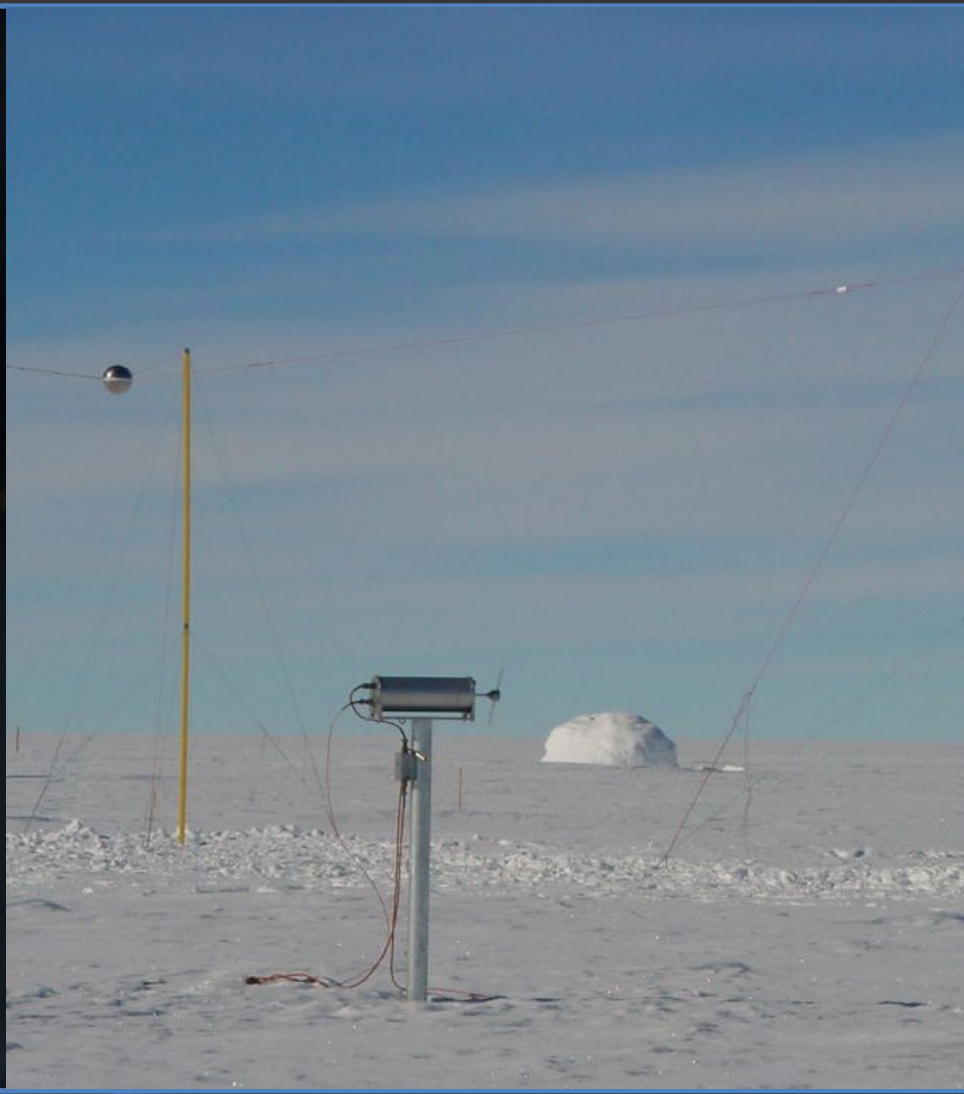


Photo credit: Australian Antarctic Division

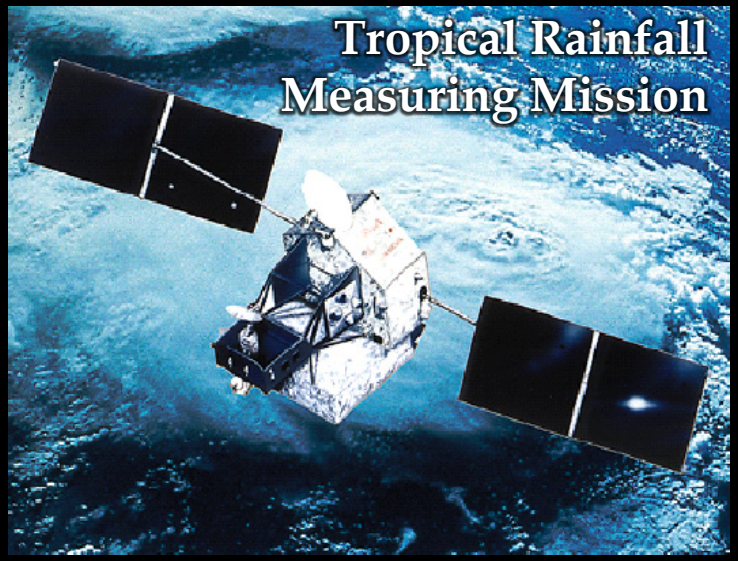
Ionospheric Potential

- 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



Global Precipitation Measurement

Photo credit: NASA

GOES-R Total Lightning

- Benefits
  - Geostationary total lightning measurements
  - High detection efficiency
  - Only sensitive to changes in convection
- Caveats
  - Hemispheric coverage

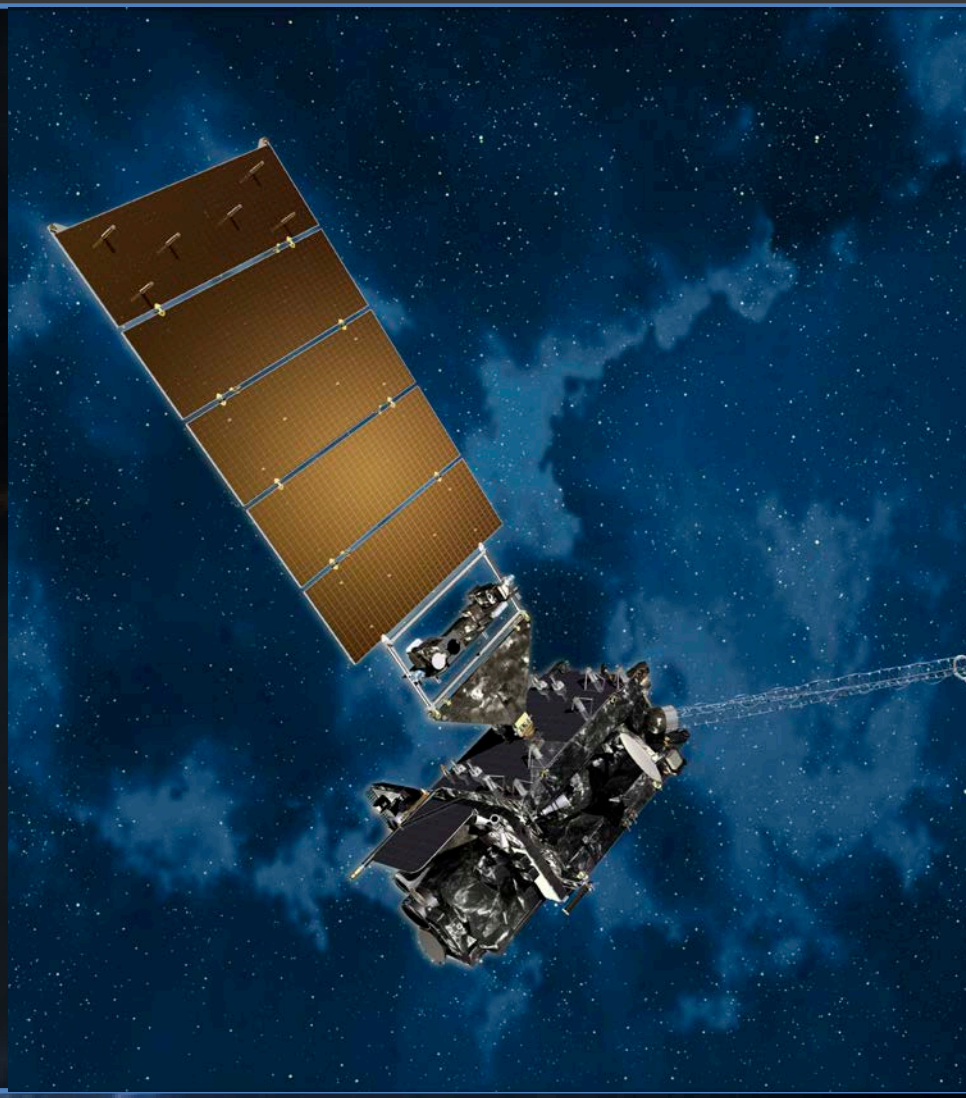
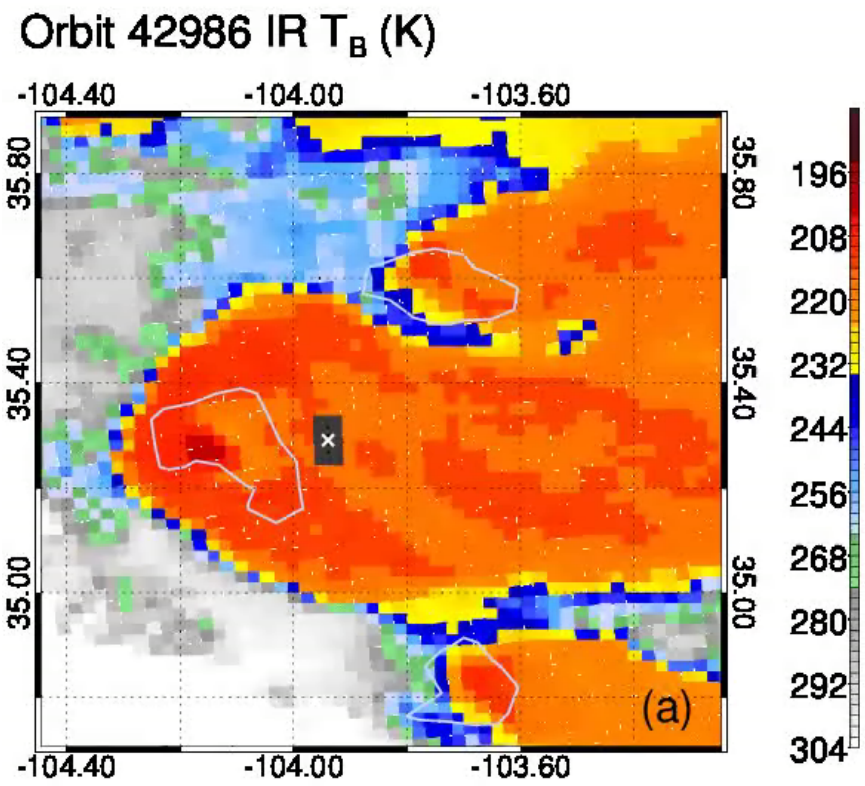
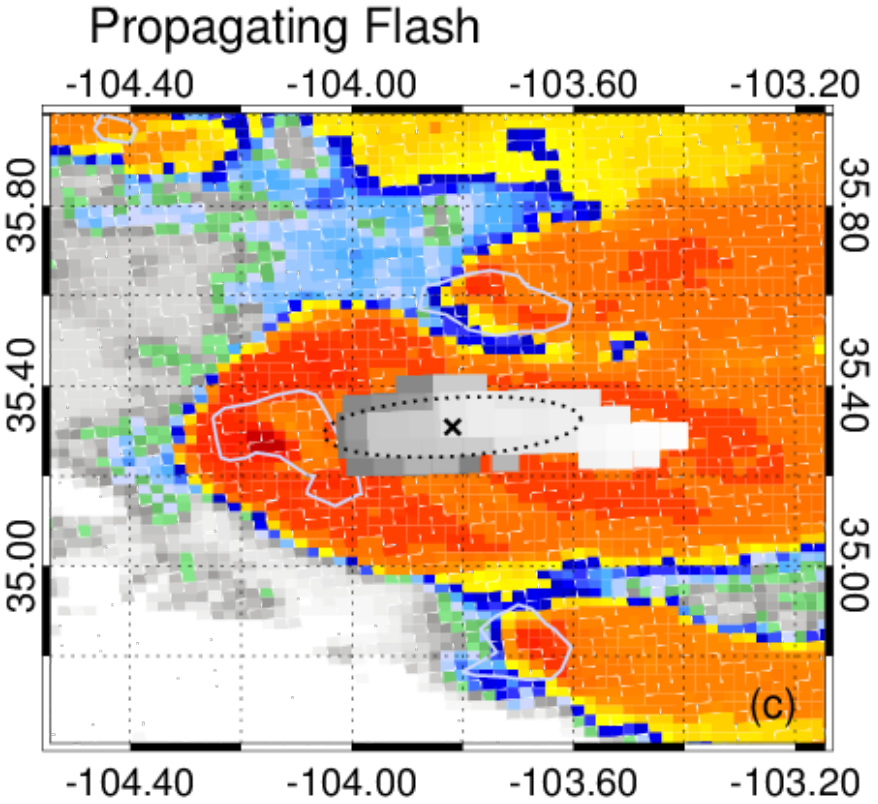


Photo credit: NOAA/NASA


Orbit 42986 IR T_B (K)
-104.40
-104.00
-103.60
35.80
35.40
35.00
196
208
220
232
244
256
268
280
292
304
(a)


Propagating Flash
-104.40
-104.00
-103.60
-103.20
35.80
35.40
35.00
(c)

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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:

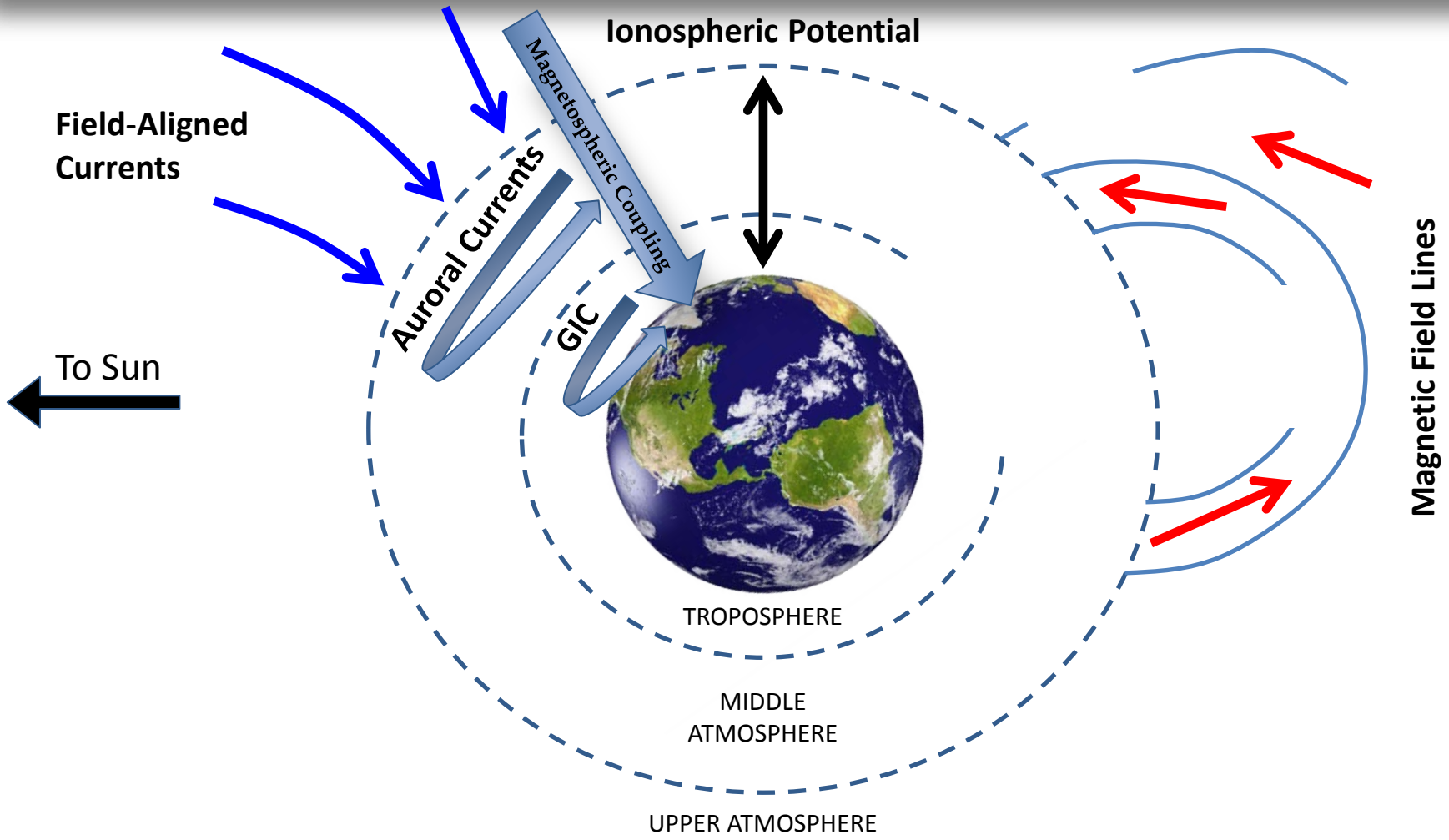
Peterson, M. J., C. Liu, D. Mach, W. Deierling, C. Kalb, 2016: A TRMM/GPM Assessment of the Temporal Variations of the Global Electric Circuit Source Current, *J. Geophys. Res.*, in preparation

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]

ADDITIONAL SLIDES

The GEC: Upper Atmosphere



The GEC: Geospace