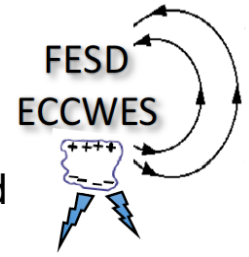



# Electrical Connections and Consequences in the Earth System (ECCWES)



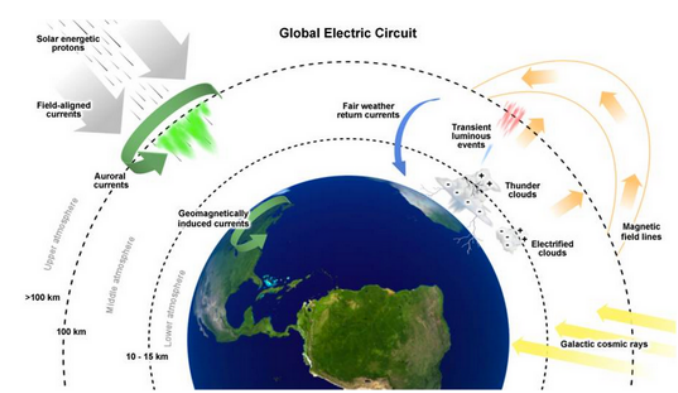
**ECCWES** is a 5-year **Frontiers in Earth System Dynamics (FESD)** project sponsored by the National Science Foundation (Award AGS 1135446, Oct 2011 - Sept 2017 ).



## FESD: ECCWES

### ELECTRICAL CONNECTIONS AND CONSEQUENCES WITHIN THE EARTH SYSTEM

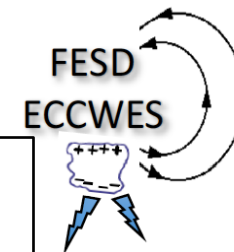
[About](#)   [Research Team](#)   [Research Highlights](#)   [For the Public](#)   [Publications and Reports](#)   [Meetings and Presentations](#)

<p><b>ECCWES</b> is a 5-year <b>Frontiers in Earth System Dynamics (FESD)</b> project sponsored by the National Science Foundation.</p>	 <p style="text-align: center;">Global Electric Circuit</p>	<p>Our goal is to create a realistic global three-dimensional model of <b>Earth's Electrical System</b> from the surface into the ionosphere. We will employ it to better understand how electric fields, electric currents and magnetic fields are redistributed globally in response to lightning discharges, electrified clouds, and disturbances in interplanetary space and the geospace environment.</p>			
<p>Our <b>Research Team</b> is comprised of scientists and students from The University of Colorado, Penn State University and the National Center for Atmospheric Research, with collaborators from around the world. See our <a href="#">video interviews</a> with the research team.</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; padding: 5px; vertical-align: top;"> <p>View our <a href="#">publications</a>, <a href="#">presentations</a>, <a href="#">team meetings</a> and <a href="#">research highlights</a>.</p> </td> <td style="width: 33%; padding: 5px; vertical-align: top;"> <p>View a description of our project for the <b>public</b>, meet our <b>research team</b> and see <a href="#">the current job openings</a>.</p> </td> <td style="width: 33%; padding: 5px; vertical-align: top;"> <p>See the <b>Broader Impacts</b> of our research, and how it will <b>benefit society</b>.</p> </td> </tr> </table>	<p>View our <a href="#">publications</a>, <a href="#">presentations</a>, <a href="#">team meetings</a> and <a href="#">research highlights</a>.</p>	<p>View a description of our project for the <b>public</b>, meet our <b>research team</b> and see <a href="#">the current job openings</a>.</p>	<p>See the <b>Broader Impacts</b> of our research, and how it will <b>benefit society</b>.</p>	<p>You're the <b>01585</b><sup>th</sup> person visiting this site since March 1, 2013.</p>
<p>View our <a href="#">publications</a>, <a href="#">presentations</a>, <a href="#">team meetings</a> and <a href="#">research highlights</a>.</p>	<p>View a description of our project for the <b>public</b>, meet our <b>research team</b> and see <a href="#">the current job openings</a>.</p>	<p>See the <b>Broader Impacts</b> of our research, and how it will <b>benefit society</b>.</p>			

This material is based upon work supported by the National Science Foundation under Grant Number (NSF Award Number AGS 1135446). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

6/20/16
<http://sisko.colorado.edu/FESD/>
1

# FESD-ECCWES Team & Other Participants



## University of Colorado

**Baumgaertner, Andreas**, conductivity modeling  
**Deierling, Wiebke** (also NCAR), **Co-PI**, cloud parameterizations  
**Forbes, Jeffrey**, **PI**  
**Knight, Daniel**, Assessment Specialist  
**Lucas, Greg**, graduate student, GEC modeling  
**Jones, McArthur**, graduate student, NLDN Data Analyses  
**Moudden, Youssef**, Research Associate, NLDN Data Analyses  
**Nealy, Ryan**, graduate student, conductivity modeling  
**Thayer, Jeffrey**, **Co-PI**  
**Zhang, Xiaoli**, Data Analysis, Global source currents and DEMETER LEP investigation

## Penn State

**Mallios, Sotirios**, graduate student, transient discharge modeling  
**Pasko, Victor**, Penn State, **Co-PI**  
**Celestin, Sebastien**, post-doc, transient discharge modeling  
**Jansky, Jaroslav**, post-doc, modeling individual thunderstorms

## UCAR

**Al-Momar, Sarah**, **SOARS student**, Valparaiso University  
**Eastburn, Teresa**, Education & Outreach  
**Edwin, Stanley**, **SOARS student**, U. Alaska, Fairbanks  
**Evonosky, William**, **SOARS student**, S. Florida University  
**Haacker-Santos, Rebecca**, SOARS liaison  
**McKoy, Jenine**, **SOARS student**, University of Michigan

## NCAR

**Bayona, Victor**, post-doc, mathematical formulation and modeling  
**Cousins, Ellen**, post-doc, high-latitude ionosphere electrodynamics  
**Fisher, Chris**, software engineer  
**Flyer, Natasha**, NCAR Scientist, mathematical formulation and modeling  
**Foster, Ben**, software engineer  
Goodrich, Lisa  
**Kalb, Christina**, Research Staff, cloud parameterizations  
**Lehto, Erik**, post-doc, mathematical formulation and modeling  
**Maute, Astrid**, NCAR Scientist, Global ionosphere electrodynamics  
**Peterson, Michael**, post-doc, cloud parameterizations, TRMM  
**Richmond, Art**, **Co-PI**  
**Roble, Ray**, GEC advisor  
**Wang, Wenbin**, ionospheric electrodynamics

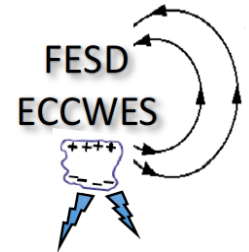
## Collaborators and Other Participants

**Blakeslee, Richard**, NASA MSFC  
**Cnossen, Ingrid**, British Antarctic Survey  
**Egbert, Gary**, Oregon State University  
**Fullekrug, Martin**, University of Bath, UK  
**Liu, Chuntao**, U. Texas, Corpus Christi  
**Mach, Douglas**, NASA Marshall Space Flight Center, University of Alabama at Huntsville  
**Naomi Maruyama**, CU-CIRES  
**Simpson, Jamesina**, Virginia Tech  
**Brian Anderson**, JHU/APL  
**Tinsley, Brian**, U. Texas at Dallas  
**Delores Knipp**, CU  
**Williams, Earle**, MIT  
**Wiltberger, Michael**, NCAR-HAO  
**Zhou, Limin**, East China Normal University

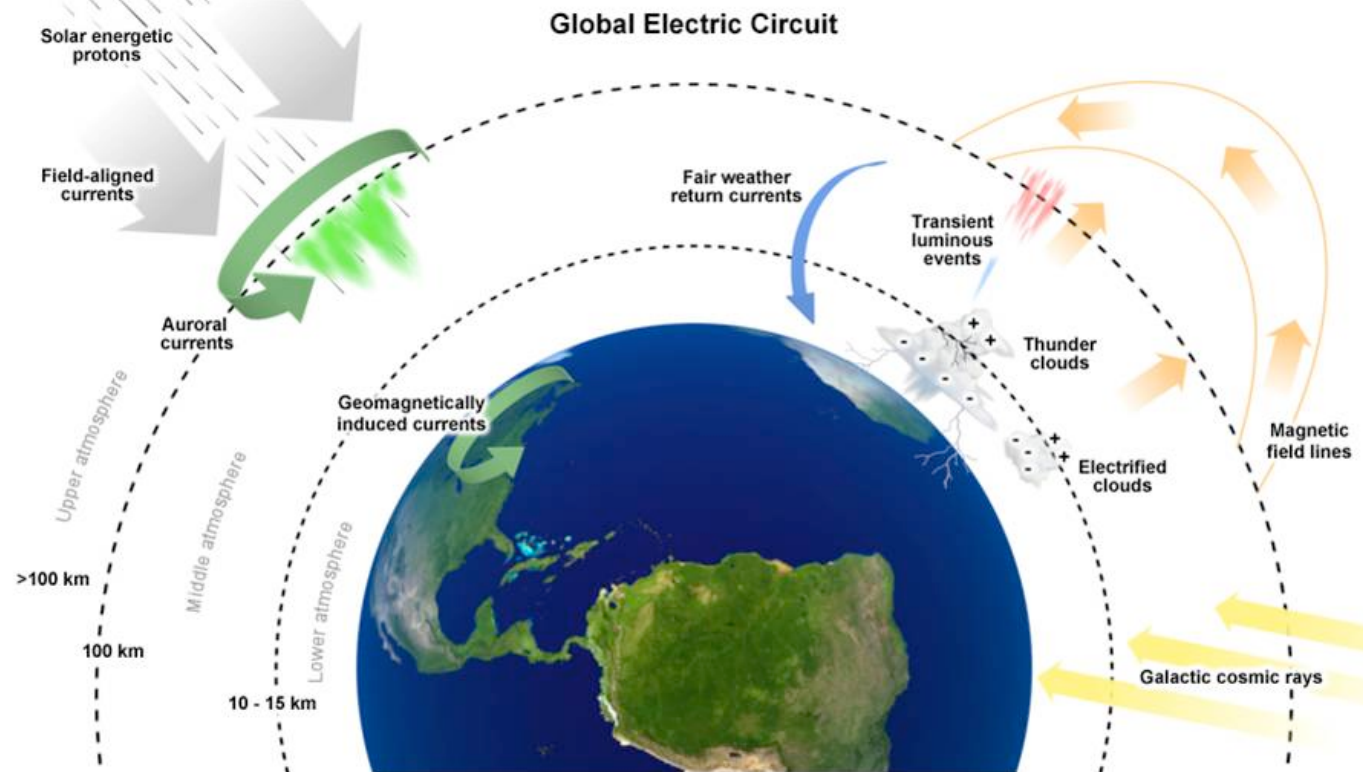
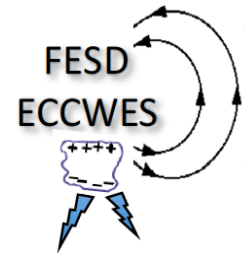
# What is Earth's Electrical System and what is ECCWES About?

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<http://www.youtube.com/watch?v=Kn3SkCzMj5g>



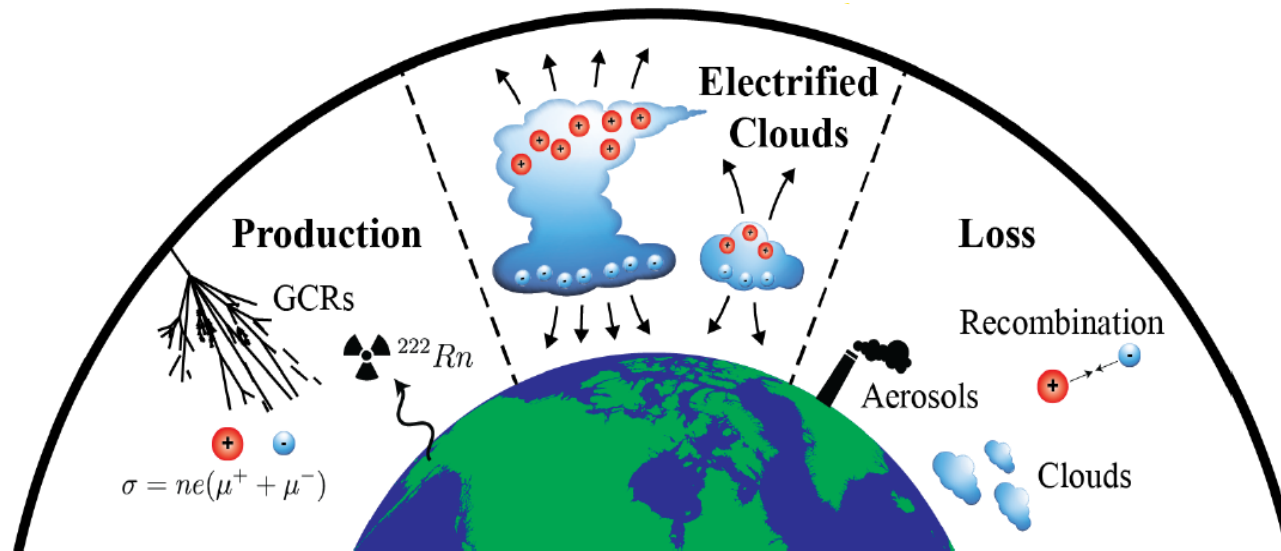
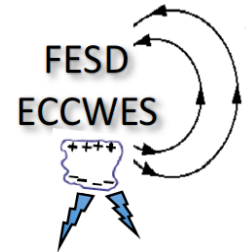
# Earth's Electrical System



## Challenges

- Highly interdisciplinary
- Bridges a broad range of spatial and temporal scales
- New models to be developed
- Few observational constraints exist

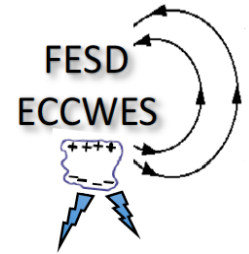
# Processes Defining Atmospheric Conductivity



*Credit: Greg Lucas, CU-Boulder grad student*

- Galactic Cosmic Rays (GCRs)
- Radon (decay product of Radium)
- Aerosols
- Chemical recombination
- Clouds

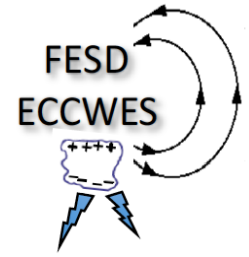
# FESD-ECCWES Objectives



- *Develop a realistic 3-dimensional model of Earth's electrical system from the surface into the ionosphere.*
- *Use this model to better understand how electric fields, electric currents and magnetic fields are redistributed globally in response to lightning discharges, electrified clouds, and disturbances in interplanetary space and the geospace environment.*

<p><b>Develop mathematical constructs and computer code</b> that embody the relevant physical processes</p>	<p><b>Boundary conditions</b> <b>Bottom:</b> surface topography <b>Top:</b> ionospheric potential, currents; magnetosphere-ionosphere coupling</p>	<p><b>Internal Sources:</b> Specify the 3-D time-dependent global distribution of current sources</p>
<p><b>Global atmospheric conductivity distribution:</b> Understand the processes defining conductivity and model them.</p>	<p><b>Develop parameterizations</b> that link observed electrified cloud properties to the currents that they supply</p>	<p><b>Lightning discharges:</b> Understand basic physics, global consequences, and how current is provided to the electrical system</p>

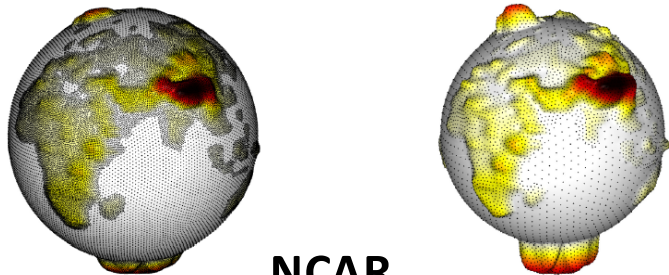
# FESD-ECCWES Investigations



NCAR  
UCAR | **CESM**  
COMMUNITY EARTH SYSTEM MODEL

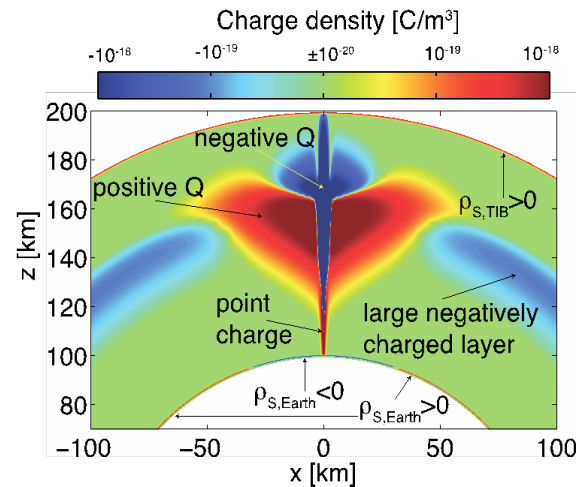
## CU-Boulder

Development of  
Global WACCM-GEC  
Model  
(see following talk  
by Thayer)



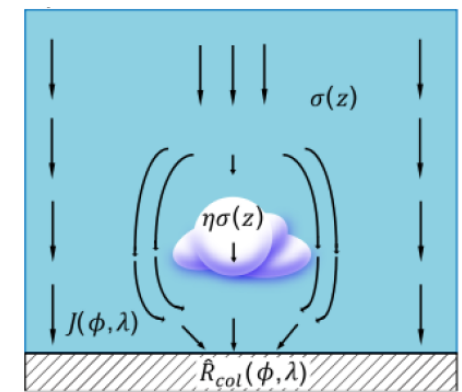
**NCAR**

Introducing the influences of  
topography and point current  
sources: New mathematical  
representations and modeling  
approaches



## Penn State

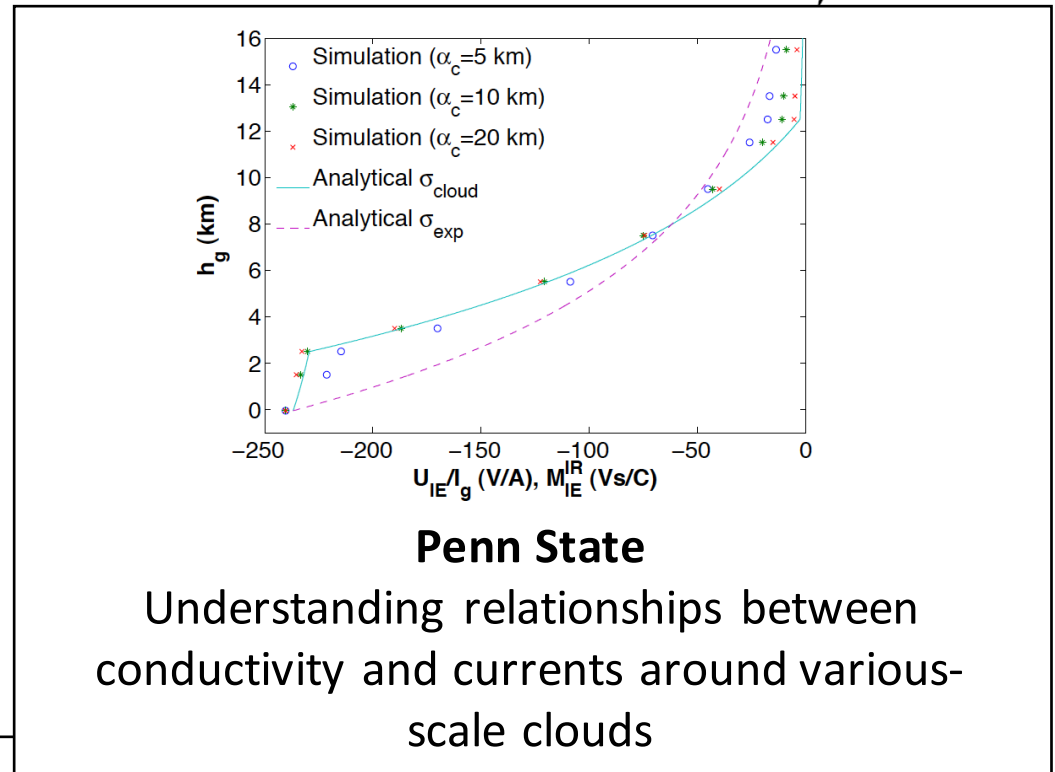
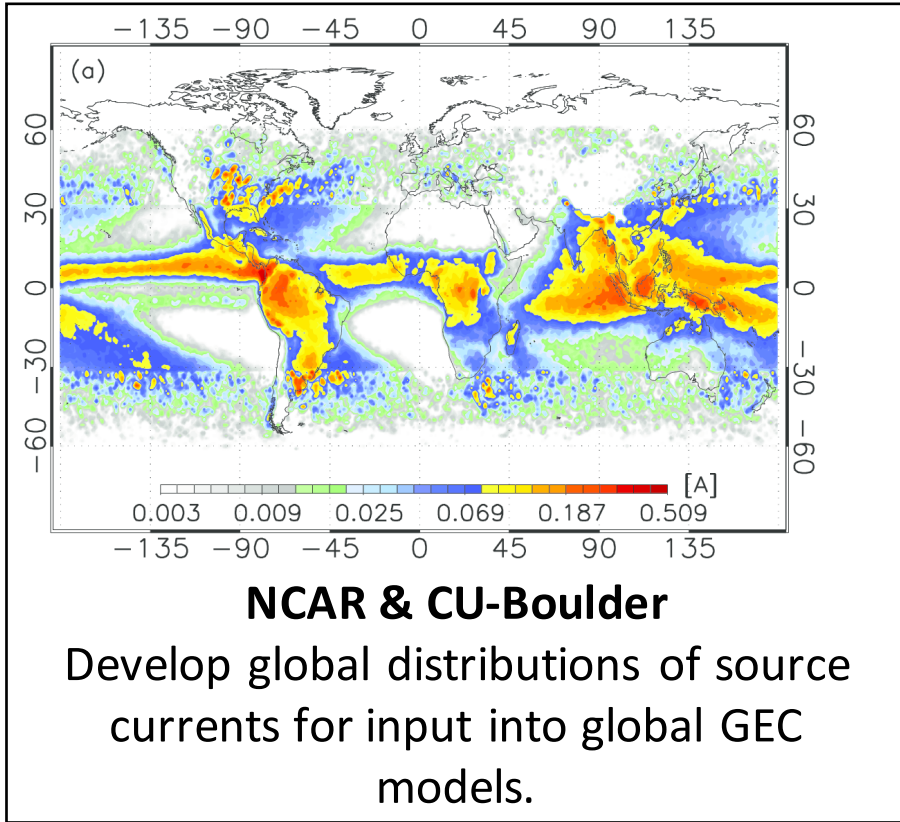
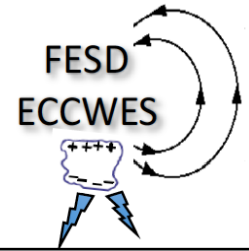
Transient modeling of  
lightning discharges;  
local and global  
effects  
(see Pasko talk on  
Wednesday)



## CU-Boulder

Modification of  
conductivity by  
clouds

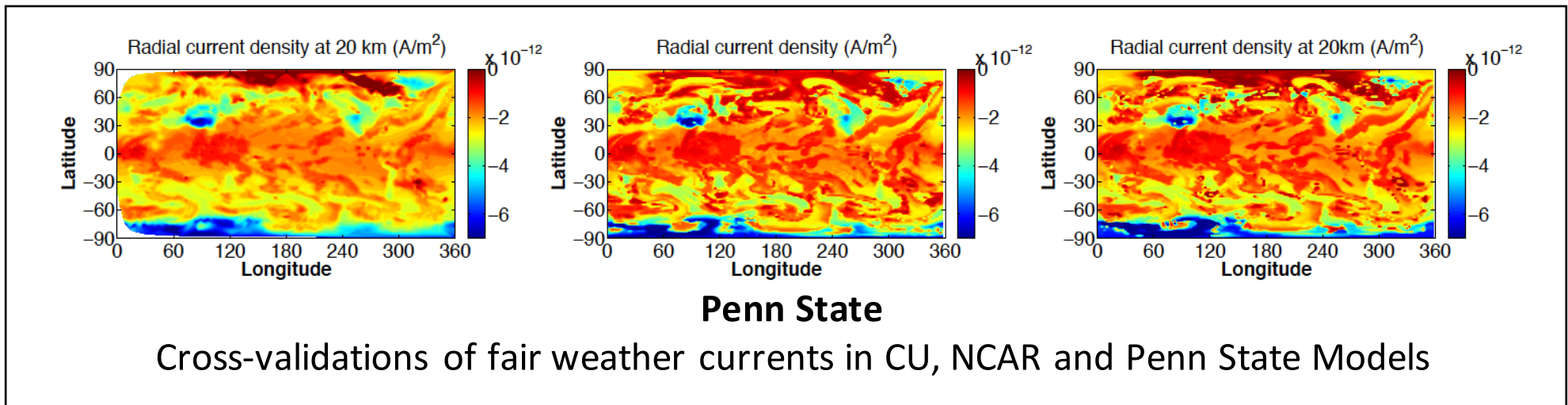
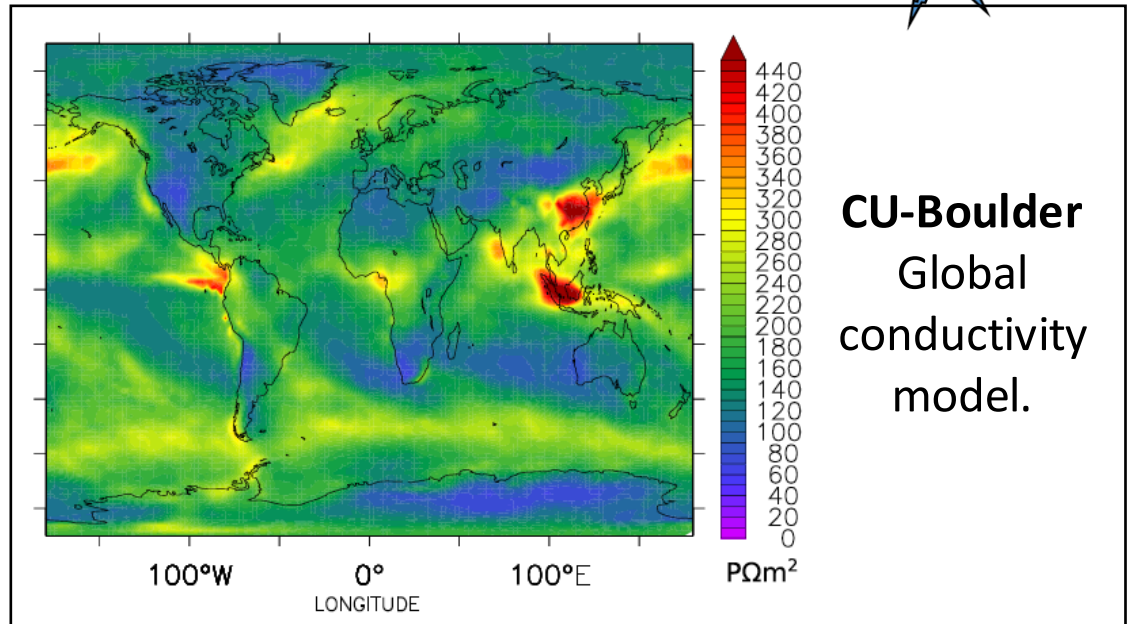
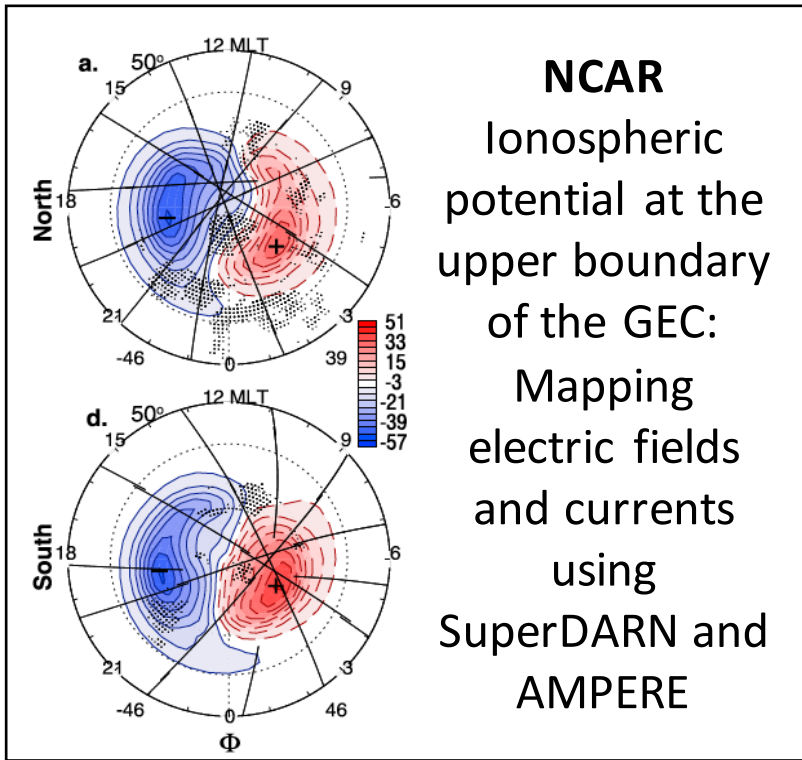
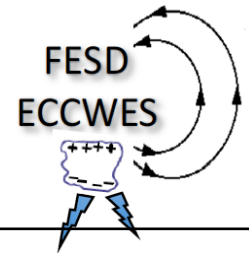
# FESD-ECCWES Investigations



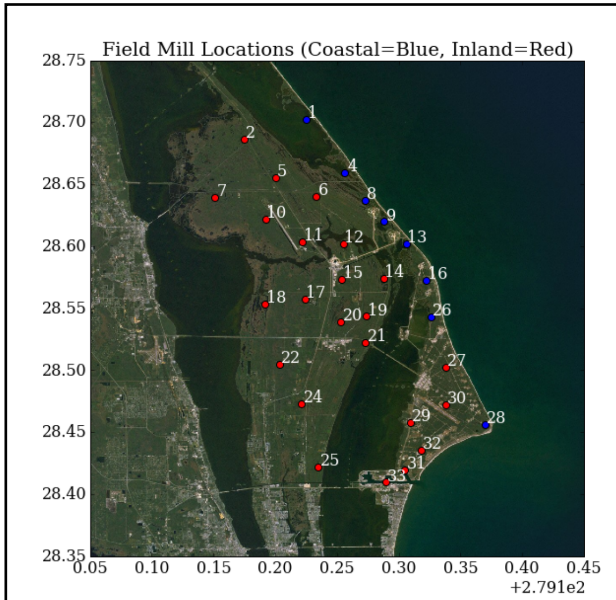
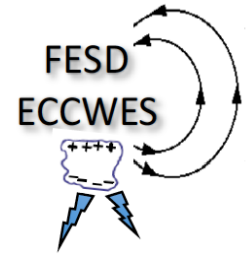
**NCAR, Penn State, CU-Boulder**  
Use measurements from thunderstorm overflights to parameterize relationships between thunderstorm and electrified non-lightning cloud properties and source currents



# FESD-ECCWES Investigations

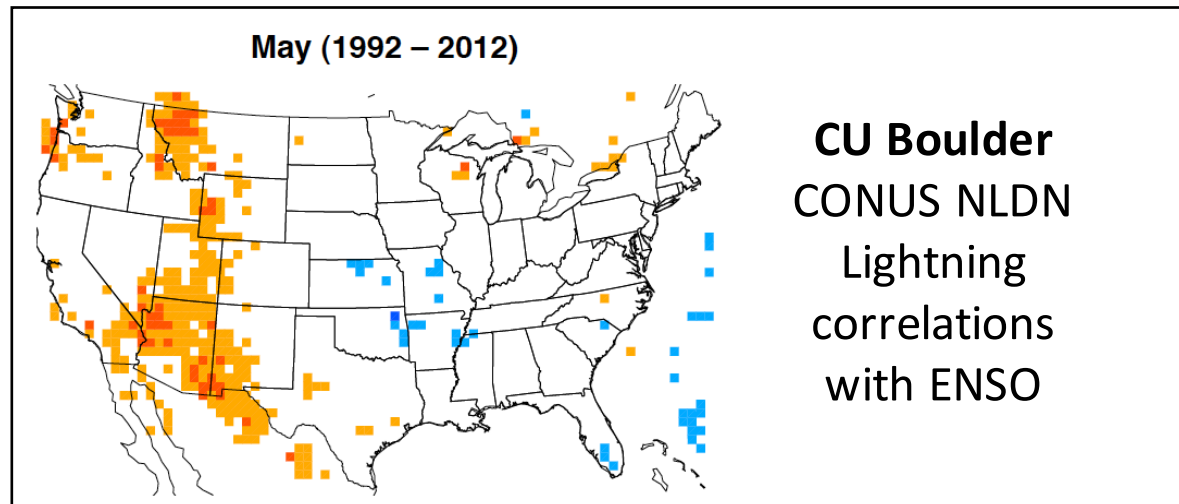
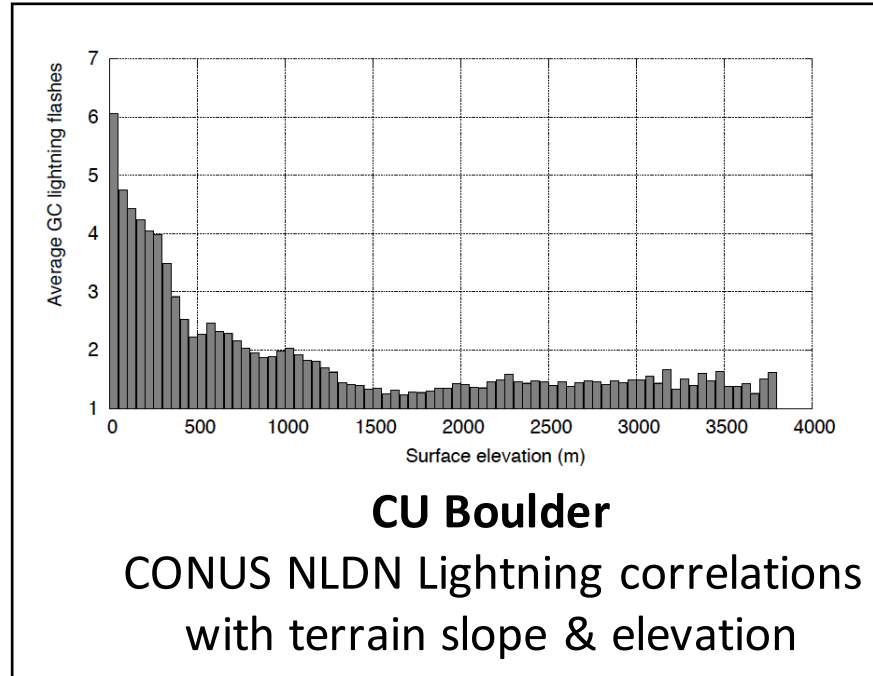


# FESD-ECCWES Investigations

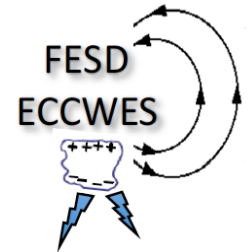


## CU-Boulder

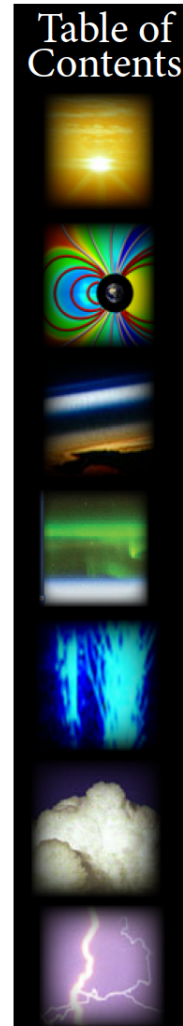
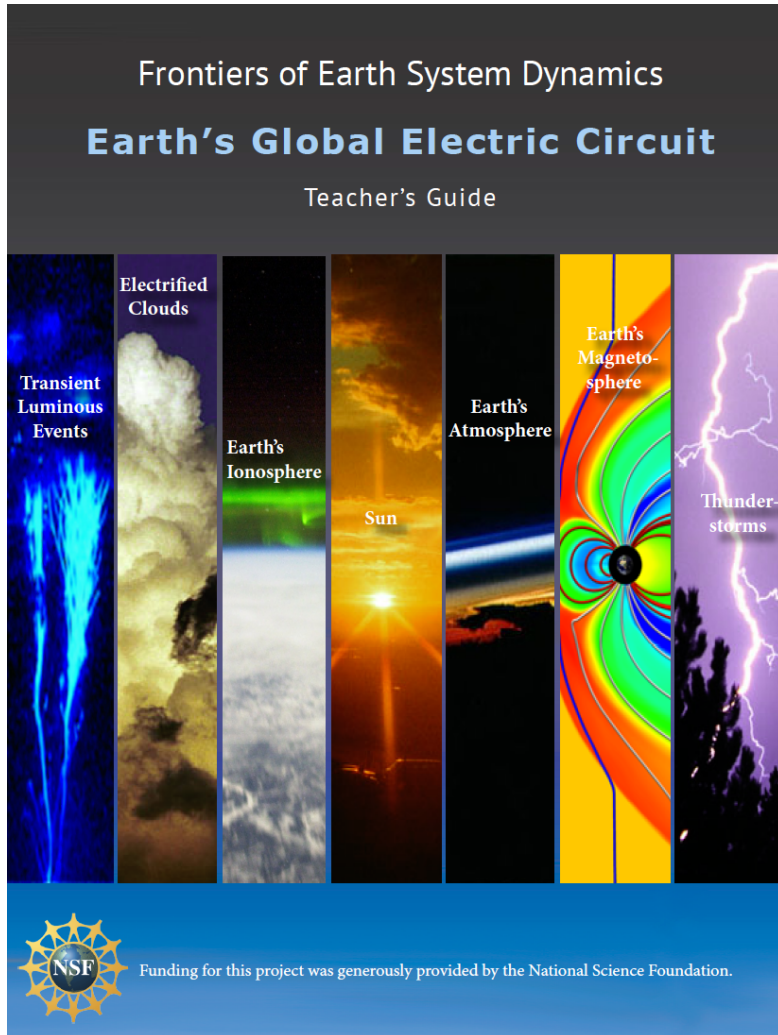
Atmospheric electricity on a local scale: Analysis of field-mill electric field measurements around KSFC; Inland vs. coastal effects, diurnal wind patterns, etc.



# Education and Public Outreach



## Teacher's Guide

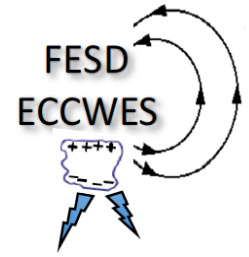


### TABLE OF CONTENTS

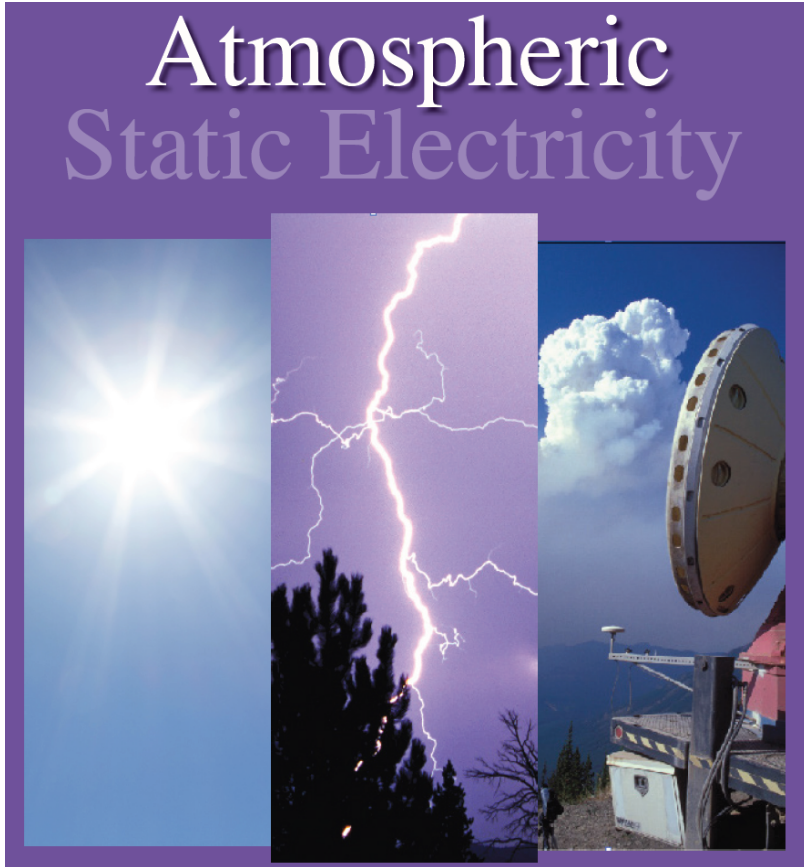
Frontiers of Earth System Dynamics: Earth's Global Electric Circuit

GLOBAL ELECTRIC CIRCUIT GUIDE.....	3
EARTH'S ELECTRIFIED ATMOSPHERE	
Earth's Global Electric Circuit.....	5
Earth's Sun.....	7
Earth's Magnetosphere.....	8
Earth's Atmosphere.....	9
Earth's Ionosphere.....	11
Transient Luminous Events (TLEs).....	13
Earth's Clouds.....	15
Earth's Lightning and Electrified Storms.....	16
MEET THE SCIENTISTS.....	17
RESOURCES.....	19
Educational Sites .....	20
Websites and Other Resources .....	22
Atmosphere Graphic.....	23
Global Electric Circuit Graphic.....	24
GLOSSARY of TERMS.....	26

# Education and Public Outreach



## *Electrifying Hands-on Activities for Students*



National Center for Atmospheric Research  
University Corporation for Atmospheric Research  
UCAR Center for Science Education  
Boulder, Colorado

[scied.ucar.edu](http://scied.ucar.edu)

Static Electricity Tubes

How Far is That Storm?

Make Your Own Lightning!



**ELECTRIFYING  
DEMONSTRATIONS**

