



# **Solar Storm Risk to the North American Grid**

**April 2, 2014**

**Lisa Wei, Staff Scientist**

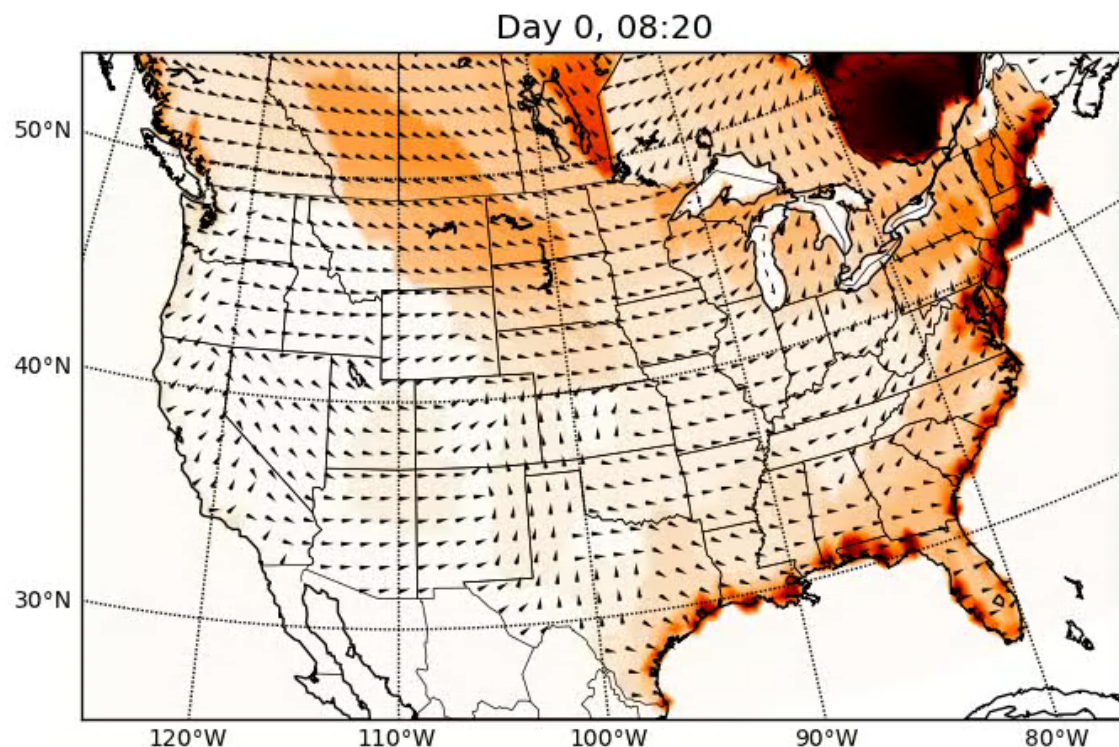
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# Surface Electric Fields During Carrington-Level Storms

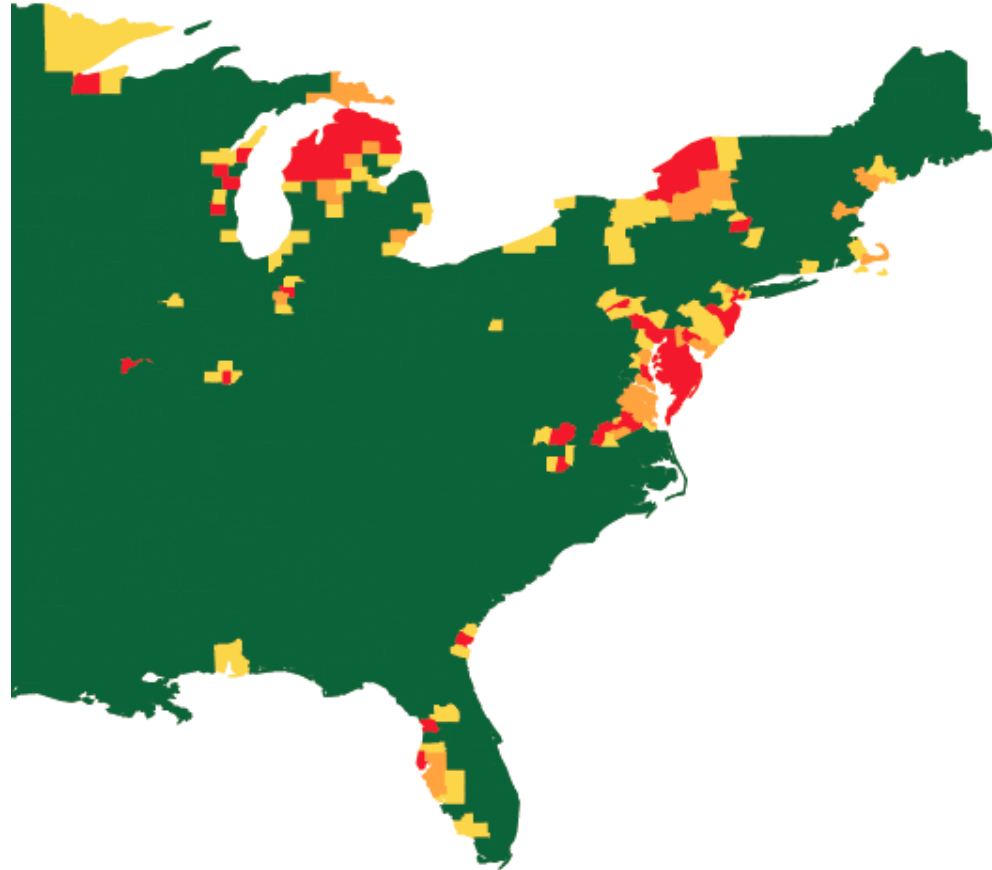


- Major storms can last for days
- Rapidly varying electric fields induce high amplitude currents along transmission lines
- Large variations along the Atlantic & Gulf Coast

# Dominant Power Outage Risk Factors

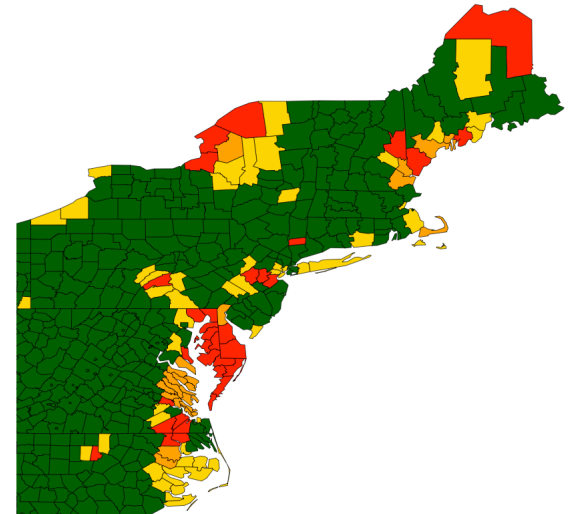
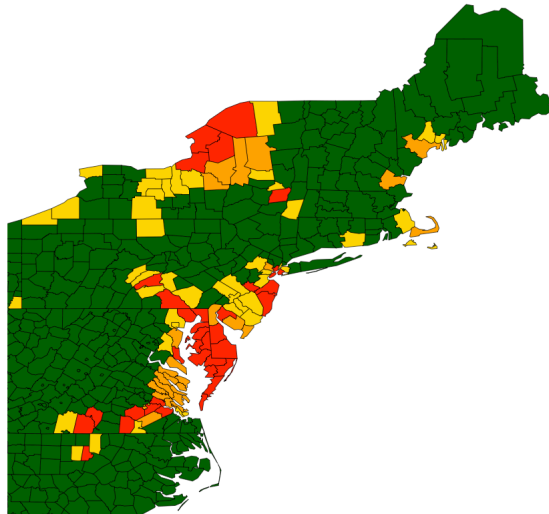
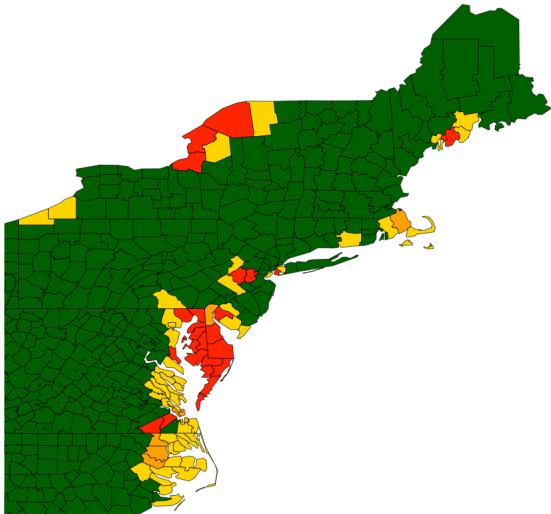
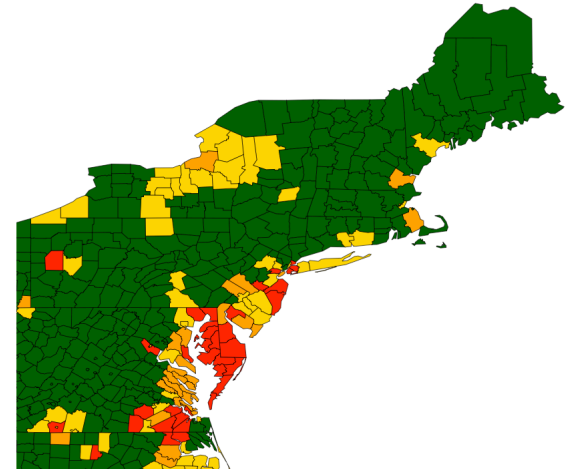
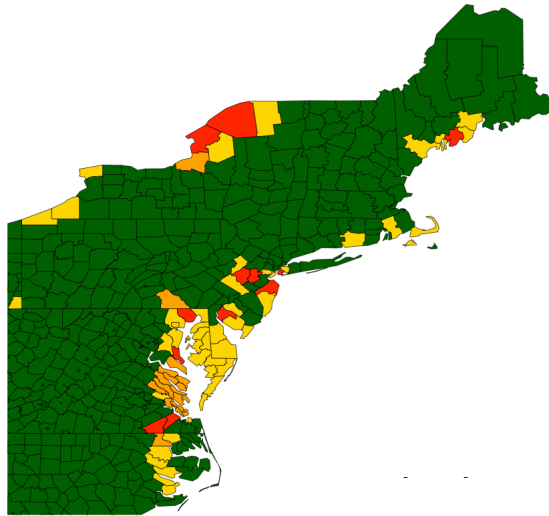
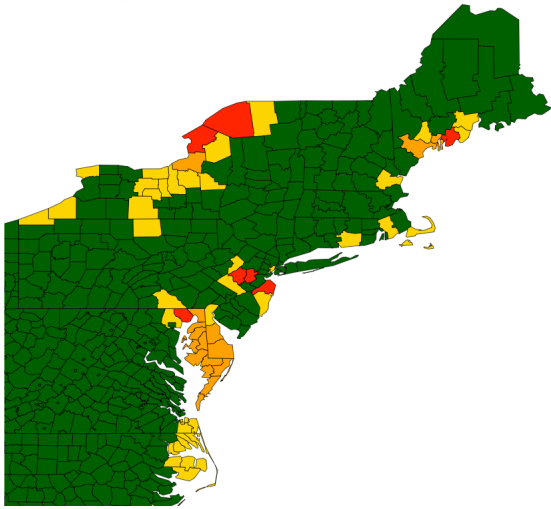
Outage risk factors include:

- Magnetic latitude
- Coastal proximity
- Ground conductivity
- Transmission line voltage
- Transmission line length
- Transformer construction



Outage scenario by county from a Carrington-level storm simulation

# Outage Scenarios from Carrington-Level Storm



# Economic Cost

- 20-40 million without power
- Outage durations of 16 days to 1-2 years
  - Duration depend largely on the availability of spare replacement transformers and crew
  - Failure of a few transformers serving a highly populated area can result in prolonged outage
- Total economic cost for such a scenario is estimated at \$0.6-2.6 trillion USD for a single event
  - Hurricane Sandy = \$68 billion
  - Hurricane Katrina = \$108 billion

# Contact Information

Lisa Wei, Ph.D.  
Atmospheric and Environmental Research  
131 Hartwell Avenue  
Lexington, MA 02421

Direct line: 781-761-2261  
Email: [lwei@aer.com](mailto:lwei@aer.com)