RAPID: COLLECTING PERISHABLE CRITICAL INFRASTRUCTURE OPERATIONAL DATA FOR MAY 2024 SPACE WEATHER EVENTS

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National Academies Space Weather Roundtable

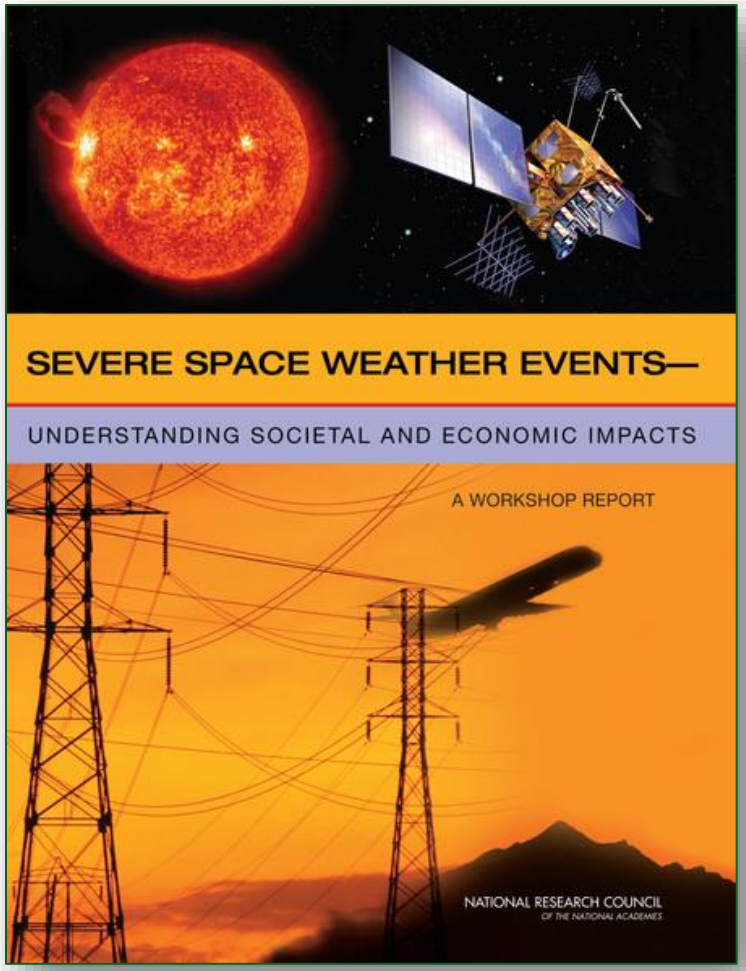
1st October 2024

NSF NSF NCAR Operated by UCAR GEORGE MASON UNIVERSITY

Introductory Overview

1. Background and motivation
2. Future vision
3. NSF RAPID: Studying the May 2024 events.

BACKGROUND



'The title of the workshop on which this report is based, "The Societal and Economic Impacts of Severe Space Weather," perhaps promised more than this subsequent report can fully deliver…

…a quantitative and comprehensive assessment of the societal and economic impacts of severe space weather will be a truly daunting task, and will involve questions that go well beyond the scope of the present report.'

(National Research Council, 2008)

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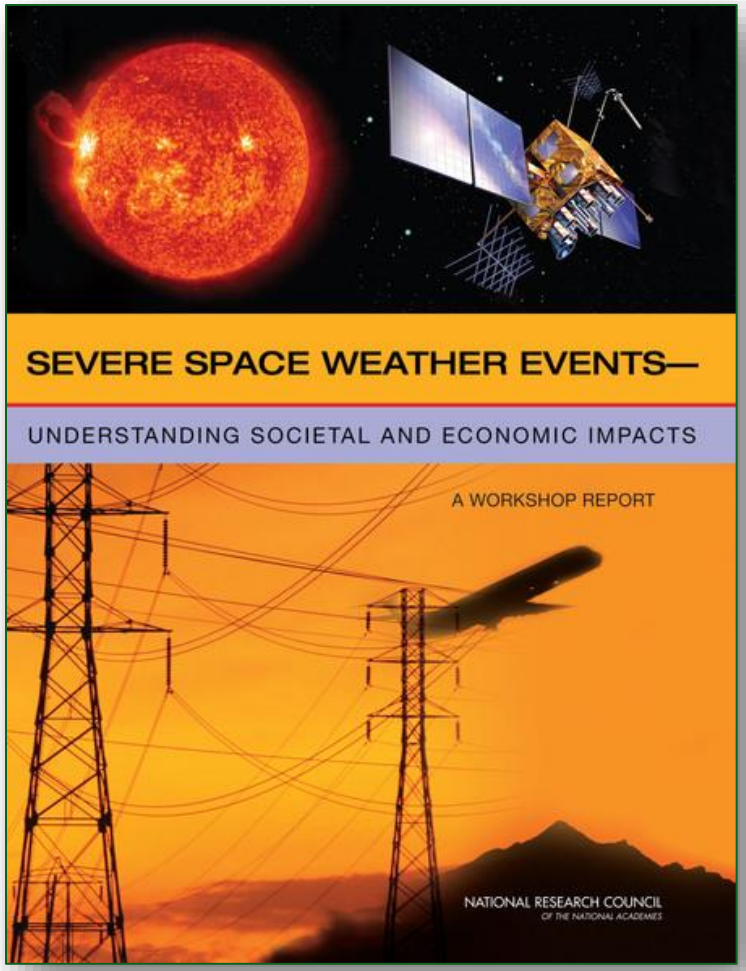

'Limited information was also provided—and captured in this report—on the costs of space weather-induced outages…

… an estimate of $1 trillion to $2 trillion during the first year alone was given for the societal and economic costs of a "severe geomagnetic storm scenario" with recovery times of 4 to 10 years.'

(National Research Council, 2008)

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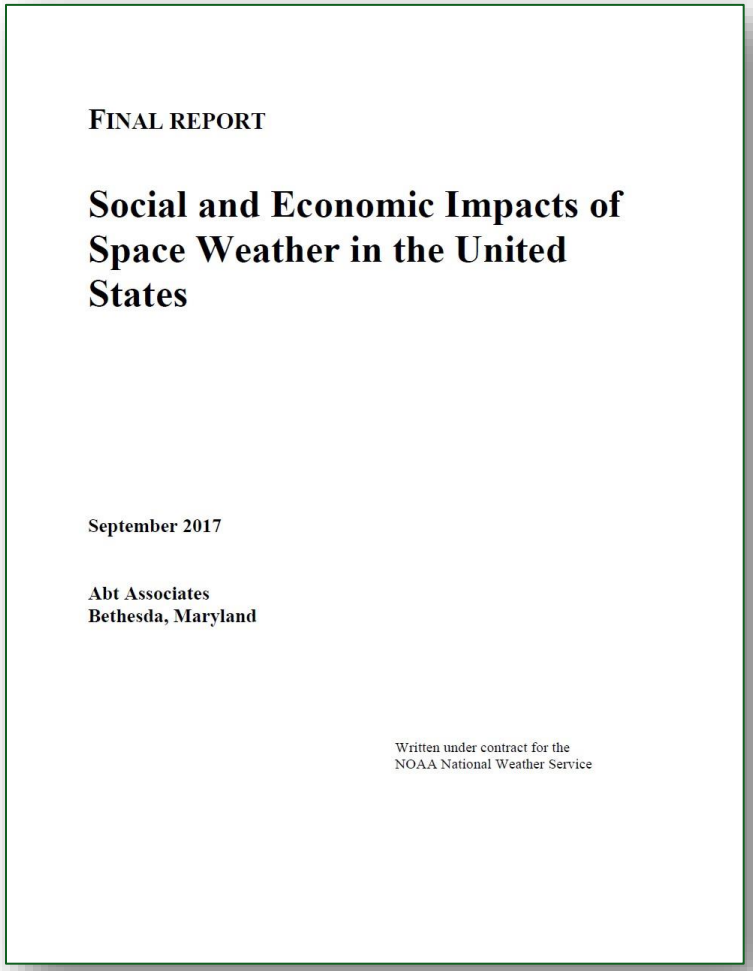

FINAL REPORT

Social and Economic Impacts of Space Weather in the United States

September 2017

Abt Associates
Bethesda, Maryland

Written under contract for the
NOAA National Weather Service

'The social and economic impacts of space weather intersect the fields of physics, engineering, industry operations, and economics…

…the problem requires analytical mapping of space weather events and the physical effects by sector to the downstream social and economic impacts.

…stakeholders engaged in this study emphasized that it is intractable at this point in time to rigorously connect the magnitude of a space weather event to our list of physical effects and ultimately to the types and sizes of the impacts that may result.'

(Abt Associates, 2017, for NOAA NWS)

Research Consortium Members

Core Team

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Lucy Wilkerson
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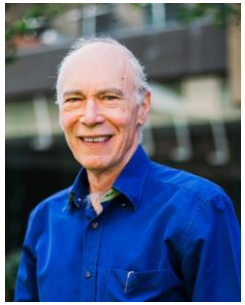
Research Affiliates



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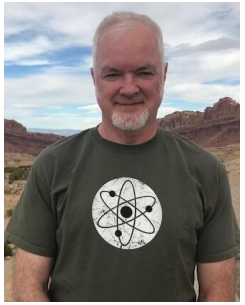
UCT

Liling Huang
GMU / Dominion



Jeffrey Love
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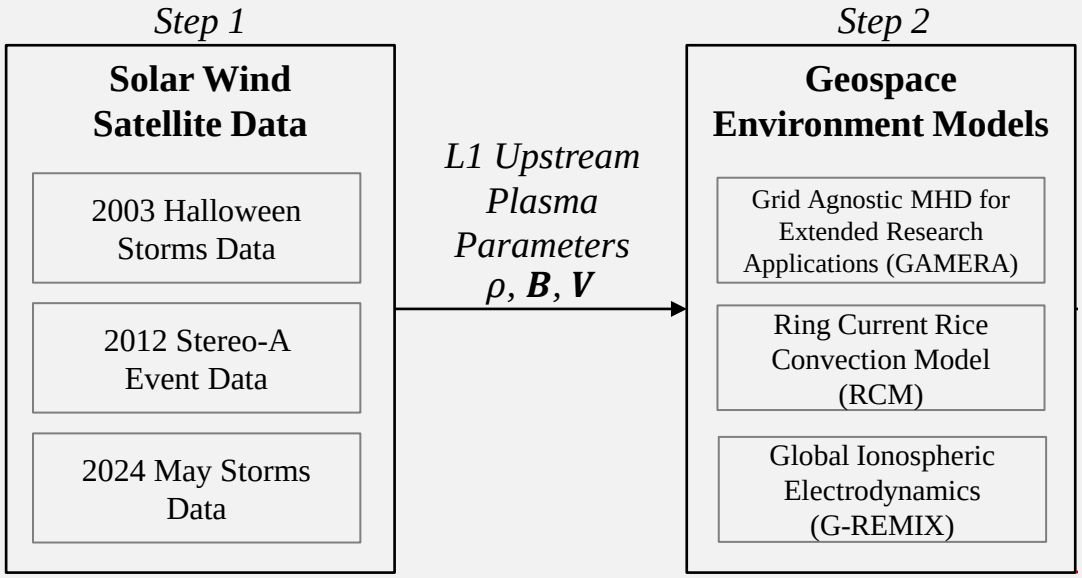
Greg Lucas
UoC Boulder

Richard Horne
BAS

Coupled Modeling of Space Weather Socio-Economic Impacts with Quantified Uncertainties



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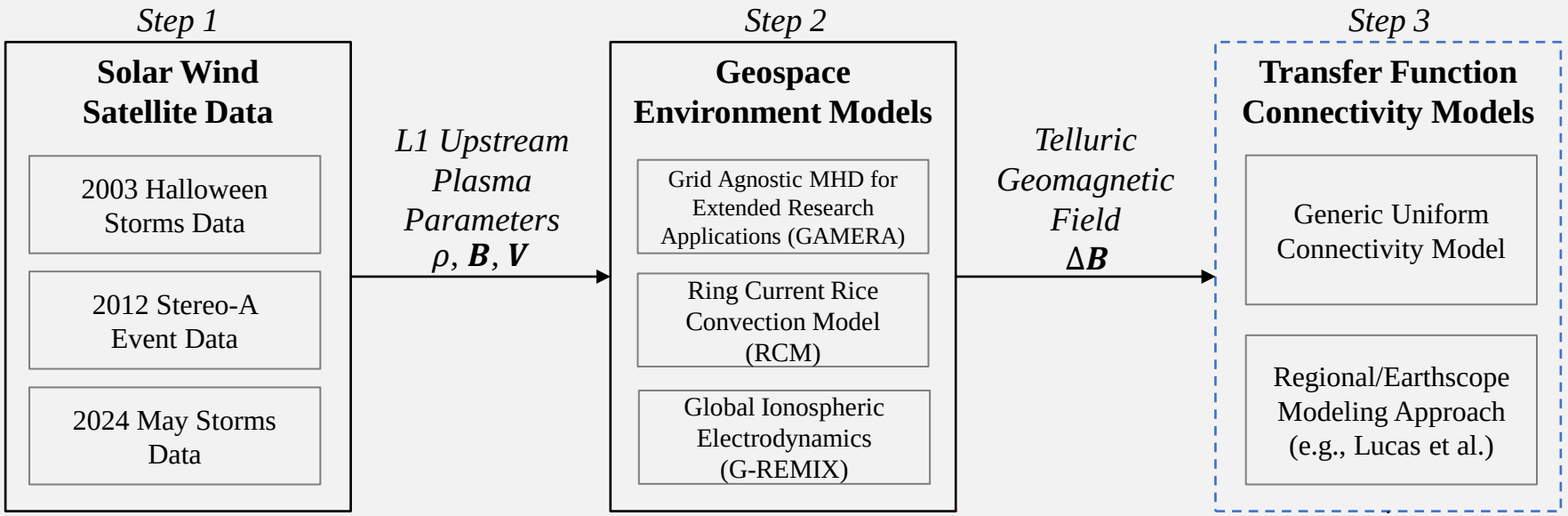

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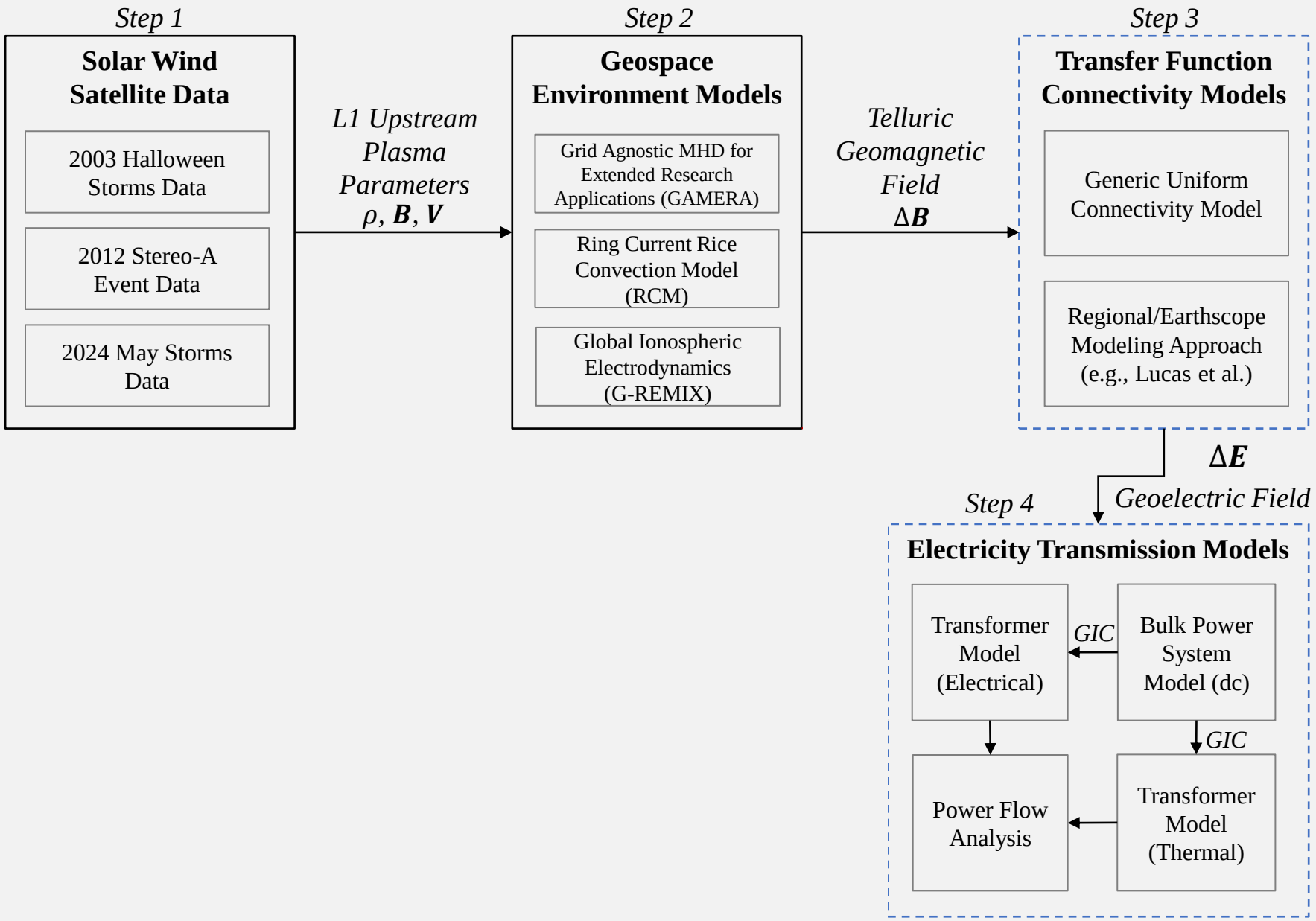

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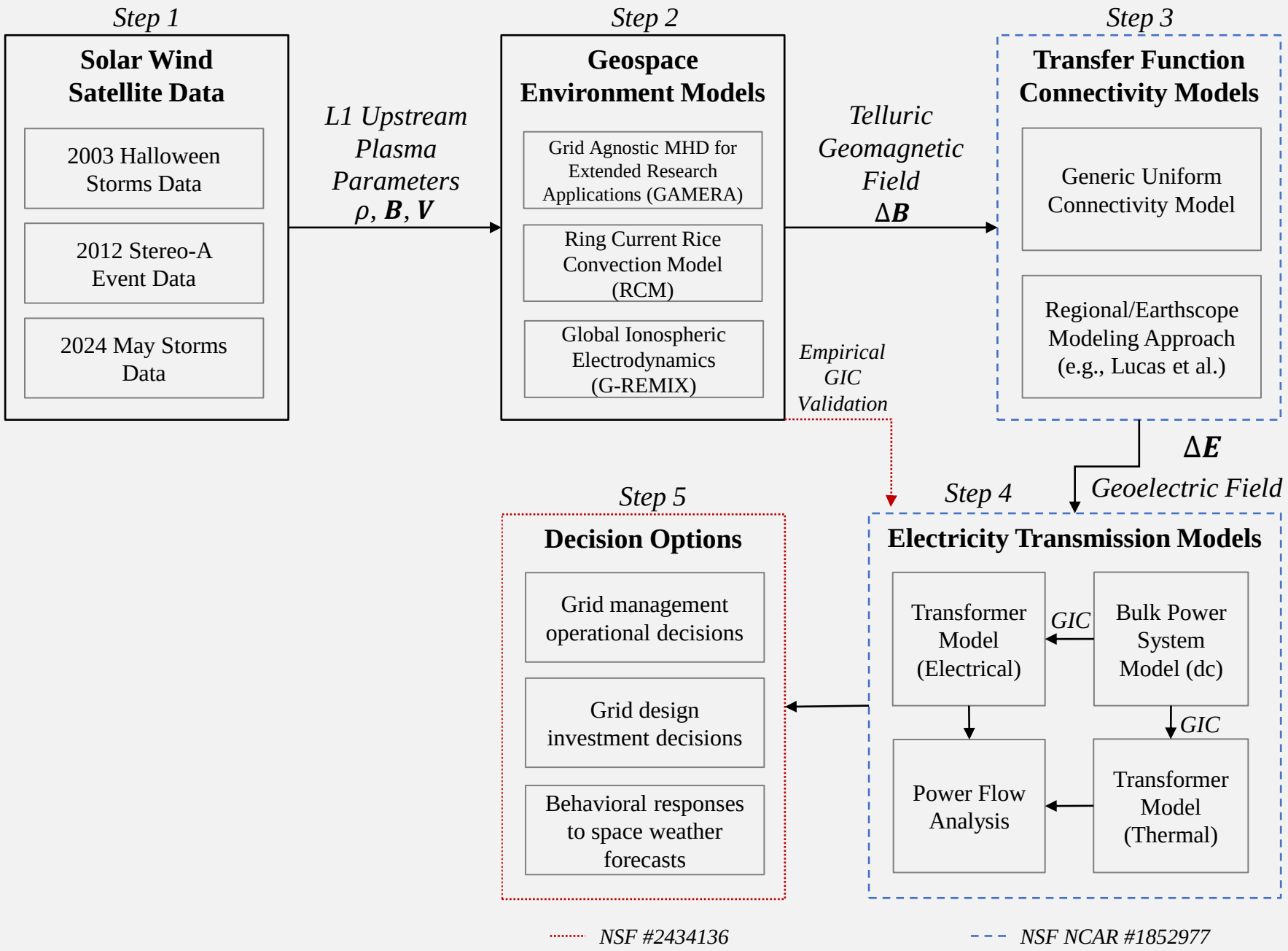

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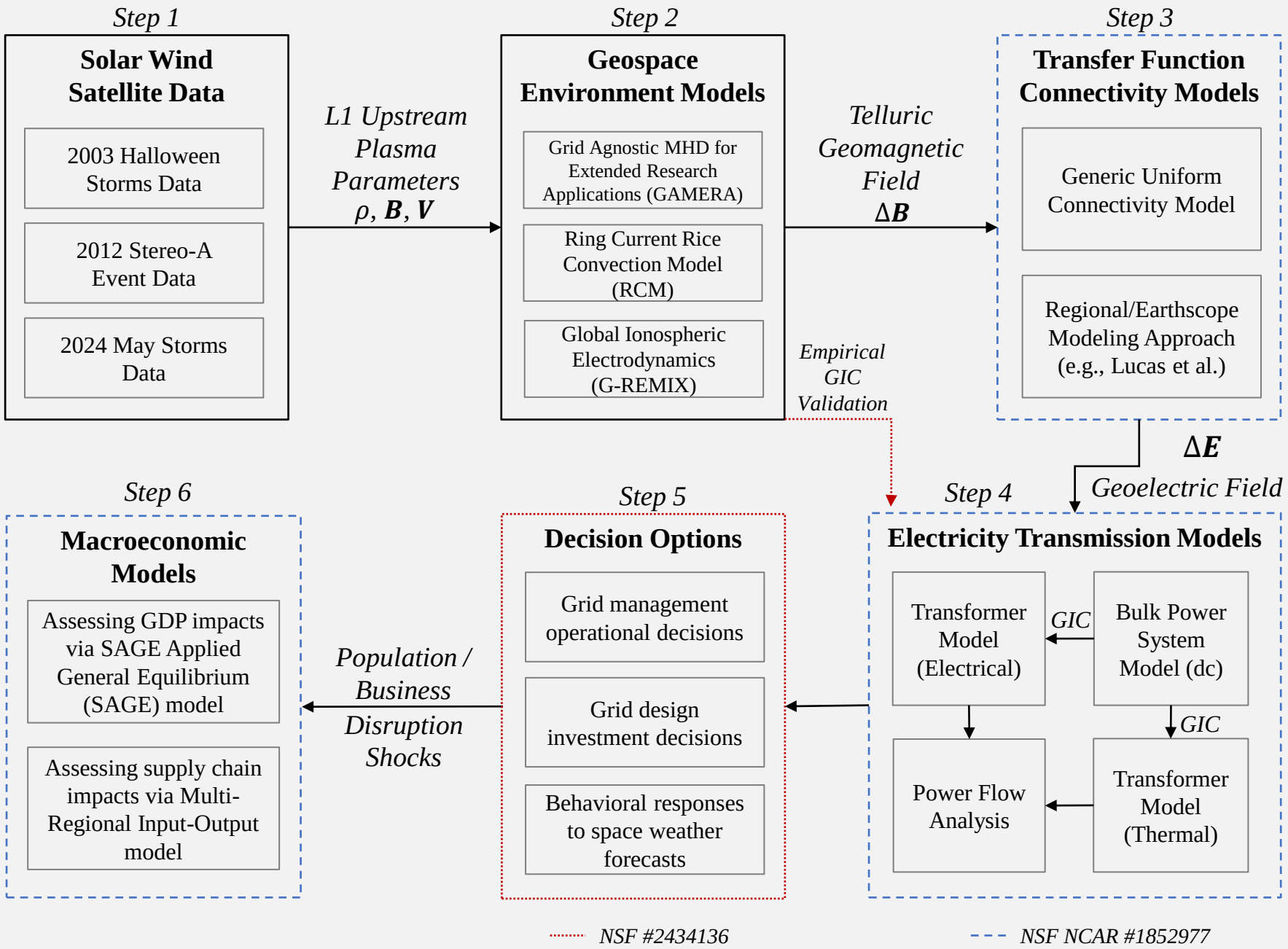
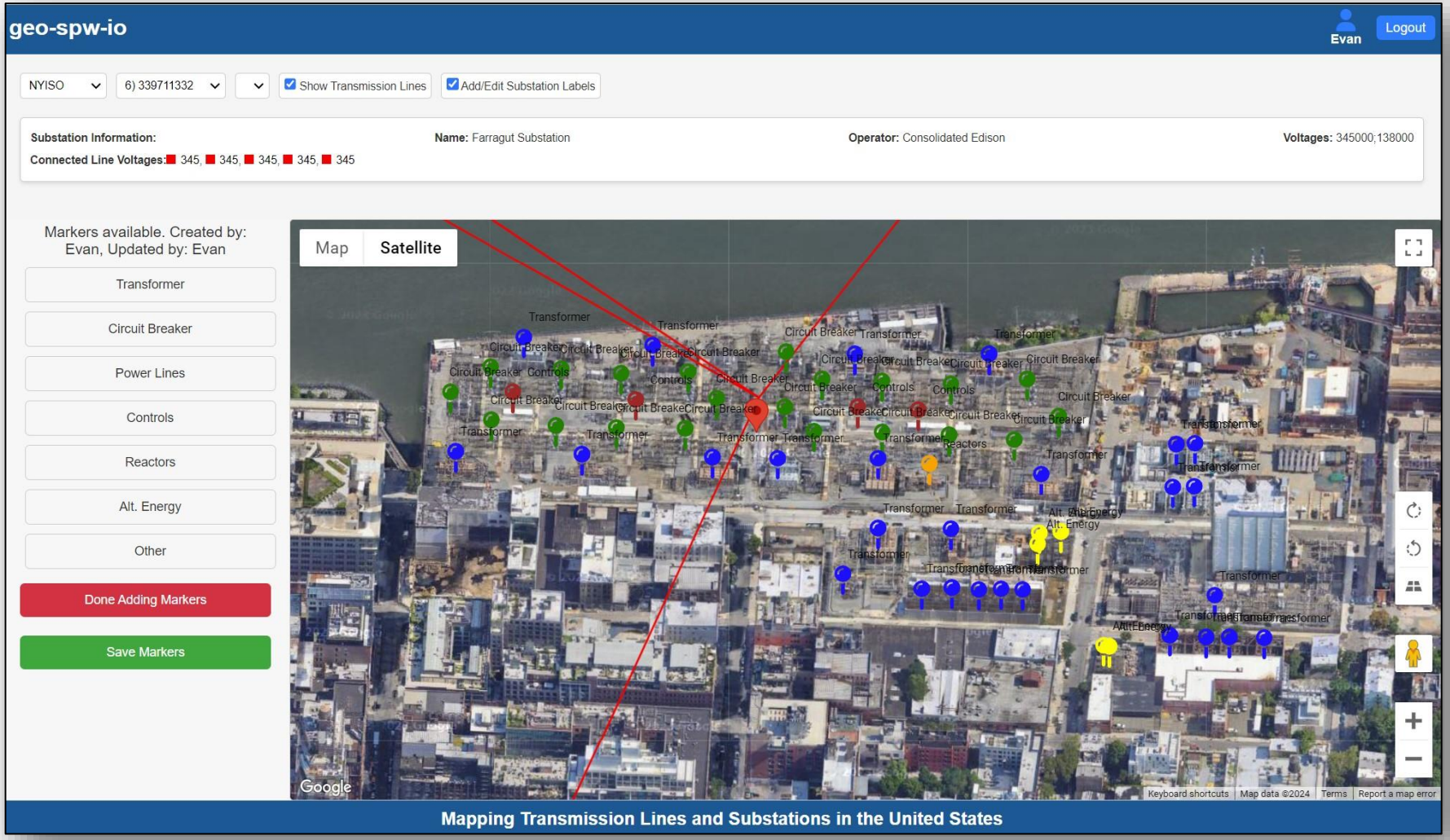


A New Nationwide Extra High Voltage Transmission Grid Model for GIC Vulnerability Assessment



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NSF RAPID: Collecting Perishable Critical Infrastructure Operational Data for May 2024 Space Weather Events

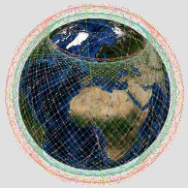
Sectors

Railroad Infrastructure Operators

Aircraft Operators

Electricity Transmission Operators

Telecoms (inc. Satellite Operators)



Oil and Gas Prospecting and Extraction

Road Infrastructure Operators

Objectives

1. Collecting and documenting operational logs from critical infrastructure operators (power and satellites)
2. Gathering contextual narratives on the effectiveness of operational decisions (power and satellites, plus forecasters & government)
3. Surveying global impacts and mitigation decisions (All sectors, plus forecasters & government)

Outputs

Research Impacts

Open Access Peer-Reviewed Papers/Data

US Leadership at International Conferences

Broader Impacts

Protecting National Security

STEM Education of Aspiring Scientists/Engineers

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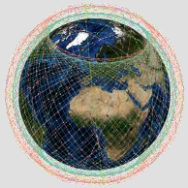

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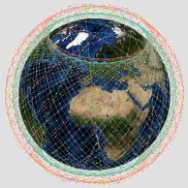

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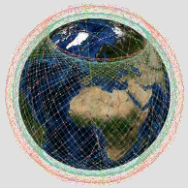

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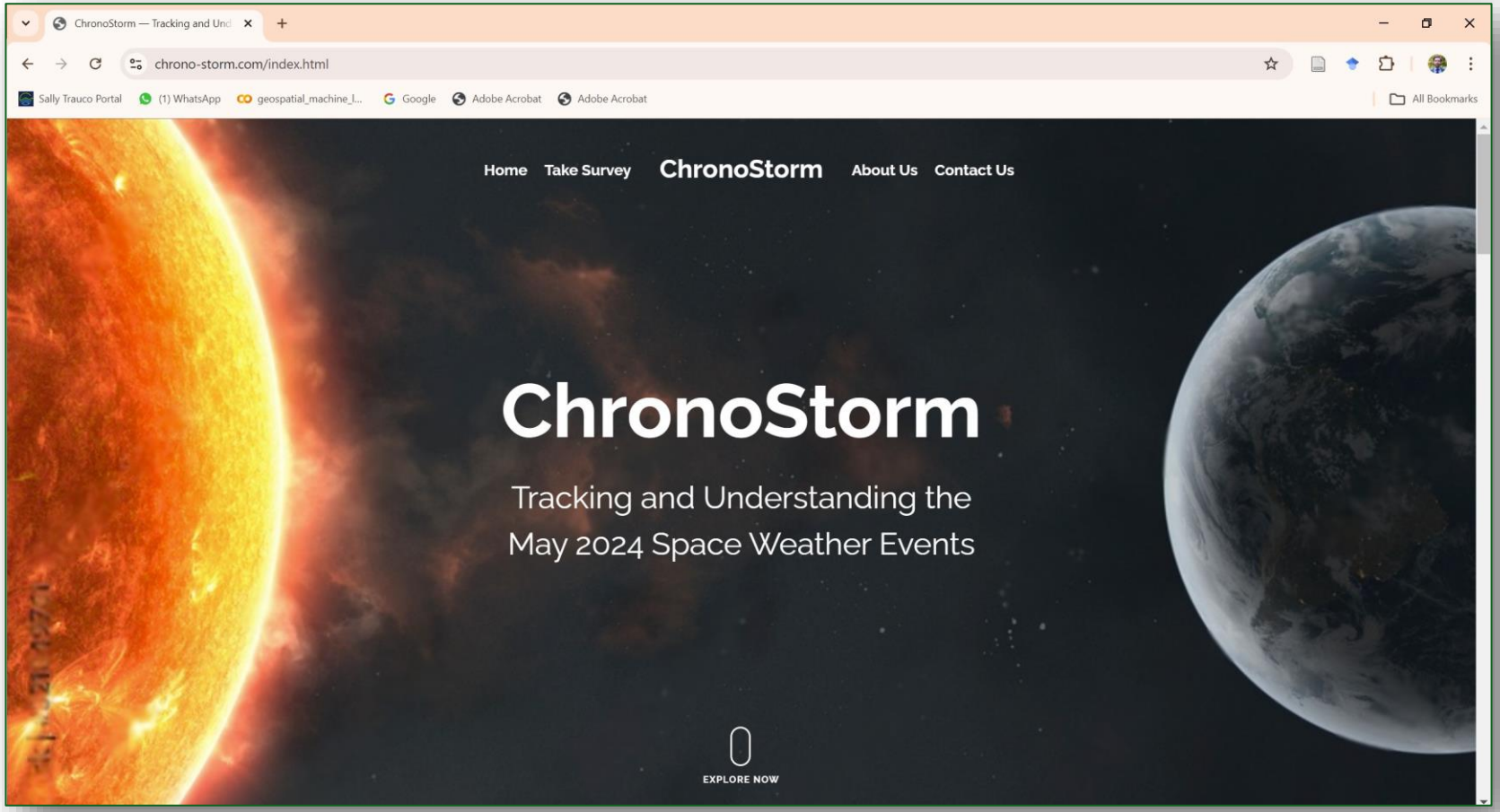
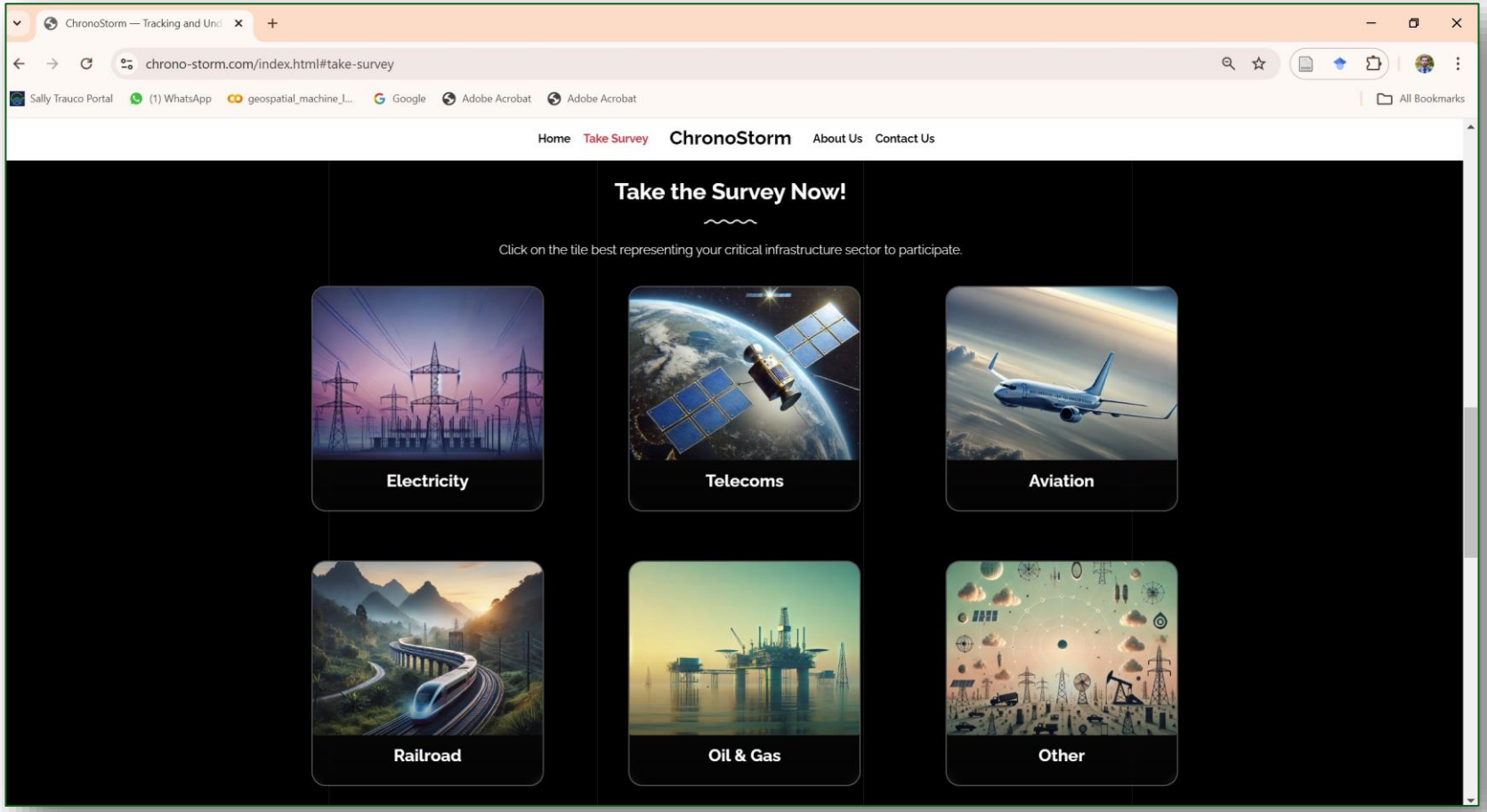
Critical Infrastructure Sector Survey

THE APPROACH



Sectoral Focus



Power Grid Survey Example

Pre-event preparation and analysis:

a) Does your organization officially/unofficially have concerns about GIC? *[open response box]*
b) Have you consistently undertaken GMD vulnerability assessments of your stations prior to the May 2024 storms? *[open response box]*
c) How would you describe your preparation protocols if you received an extreme event warning? *[open response box]*
d) Do you use GIC blockers in your facilities? *[open response box]*
e) Please provide any additional information you are willing to share in the box below: *[open response box]*

During the event:

a) Please select any of the mitigation decisions you undertook to protect your system: [*list of NERC options*]
b) How did you manage power fluctuations taking place on your system? [*open response box*]
c) Were any of the outcomes your system experienced unexpected? [*open response box*]

Post-event:

a) Did you experience any failures/anomalies during the storm *[open response box]*
b) Were any substation/asset components damaged and in need of attention/repair? *[open response box]*
c) Do you plan to begin/change how you undertake future GMD vulnerability assessments? *[open response box]*

Generic Operator information will be collected on company size and operating country/region

Power Grid Interview Example

1) What characteristics does your system have?
    a. System highest voltage (kV)
    b. Largest transformer (MVA)
    c. No. of transformers with highest voltage winding >200 kV
2) What GMD, GIC measurement facilities does your system have?
    a. What, where, when, file names, access levels etc.?
    b. For measurement sites, how many transformers are present?
    c. For each transformer, what is the ID, power rating, high voltage rating, low/lower voltage rating/s, type of winding (checklist: 3x1-phase bank or 3-phase; auto- or 2- or 3-winding, etc)?
    d. GIC instrument name/type?
3) Do you have transformer profiles for recent GMD events?
    a. Transformer ID
    a) Busbar voltage profiles
    b) Busbar harmonic voltage (power quality, THDv) profiles – measurement system?
    c) Transformer automatic tap changer (OLTC) tap-position profile or operation record
    d) Data location, file name, access
4) Do you have line profiles for recent GMD events?
    a. Line ID
    a) Power, reactive power profiles – file name
    b) Current profiles – file name
    c) Harmonic current (power quality, THDi) profiles – file name
5) Did you carry out post-event inspections/incidents?
    a. Dissolve gas analysis data records
    a) Dissolved gas analysis interpretations
    b) Any unusual conditions, observations?

Q&A, Next Steps

1. Avoiding duplication with other surveys.
2. Making best use of the survey opportunity (taking advantage of academic freedoms).
3. What information is needed for improving:
   a) Scientific/engineering modeling and simulation activities.
   b) Space weather mitigation and policy decisions.

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