

# NASA LWS institute: GIC Working group & connection to CCMC

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### NASA LWS Institute concept

- You can read the program's version at http:// www.vsp.ucar.edu/Heliophysics/science-LWS.shtml.
- Pl's interpretation:
  - Space weather version of the International Space Science Institute (ISSI).
  - Interdisciplinary, international.
  - End-user focus, which is really good → basic scientific research feeding into applications addressing the hazard.



### GIC group goals

- Identify, advance, and address the open scientific, engineering, applications etc questions pertaining to GIC.
- Advance predictive modeling of GIC.

Establish new personal connections and collaborations!



### The team

#### **Core members**

A. Pulkkinen (PI) NASA Goddard Space Flight Center

E. Bernabeu (Co-lead) PJM

A. Viljanen Finnish Meteorological Institute

R. Pirjola Finnish Meteorological Institute and Natural Resources Canada

D. Boteler Natural Resources Canada

J. Eichner Munich-Re, Germany

A. Thomson (Co-lead) British Geological Survey

P. Cilliers South African National Space Agency

D. Welling University of Michigan

N. Savani George Mason University and Naval Research Laboratory

R. Weigel George Mason University

J.J. Love US Geological Survey

C. Balch NOAA Space Weather Prediction Center

C. Ngwira The Catholic University of America

G. Crowley Atmospheric & Space Technology Research Associates, LLC

A. Schultz Oregon State University

R. Kataoka National Institute of Polar Research, Japan

B. Anderson Applied Physics Laboratory

D. Fugate Electric Research & Management

J. Simpson University of Utah



### The team

#### **Advisory members**

M. MacAlester Federal Emergency Management Agency
R. Waggel Federal Energy Regulatory Commission

M. Olson North American Electric Reliability Corporation

S. Mahmood Department of Homeland Security

J. Ostrich Department of Energy

R. Lordan Electric Power Research Institute

#### **Observing members**

C.T. Gaunt University of Cape Town, South AfricaC. Felton Civil Contingencies Secretariat, UK



# The team





### Deliverables

- The group's work will lead to:
  - i. A peer-reviewed p view of the field or and the status of t publication will als addressing the key need to be solved for improvements in models and predictions.
     + technical articles addressing the identified issues
     → Articles to appear in the AGU Space Weather LWS Institute Special Collection improvements in models and predictions.
  - ii. A working group report informing the LWS community about the work performed during the workshops. The report will include a roadmap for the future directions of the Working Group.



A

Partner's System

Integration into

& Validation

Development, Testing,

ery & Feasibility

**PHASE II** 

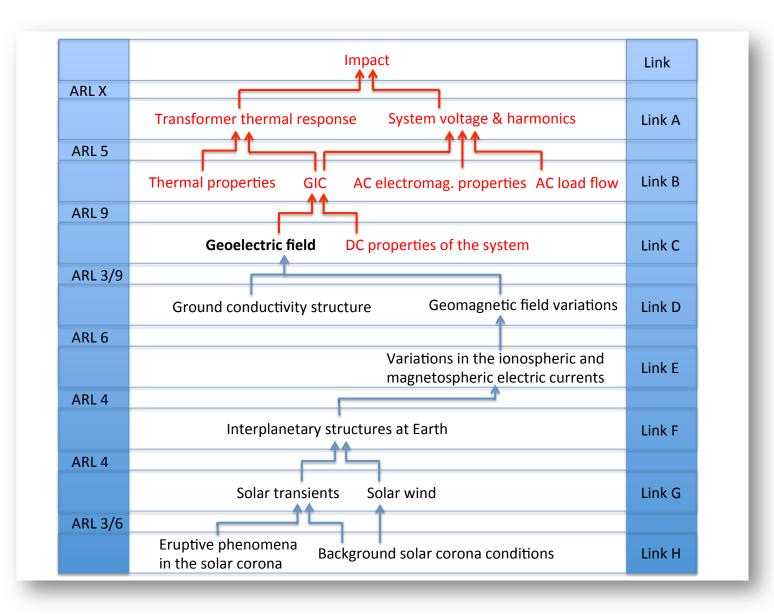
PHASE III

Approved, Operational Deployment & Use in decision making (Sustained Use) ALL Milestone below this point COMPLETED? ARL 9 ☐ Sustained use of application system in decision making context ALL milestones below this point COMPLETED? Application Completed & Qualified (Functionality Proven) ARL 8 ☐ Finalized application system tested, proven operational, and shown to operate as expected within user's environment ☐ Application qualified and approved by user for use in decision making activity ☐ User documentation and training completed ALL milestones below this point COMPLETED? Application Prototype in Partner's decision making (Functionality Demonstrated) ARL 7 ☐ Prototype application system integrated into end-user's operational environment ☐ Prototype application functionality tested & demonstrated in decision making activity ALL milestones below this point COMPLETED? Demonstration in Relevant Environment (Potential Demonstrated) ARL 6 ☐ Prototype application system beta-tested in a simulated operational environment ☐ Projected improvements in performance of decision making activity demonstrated in simulated operational environment ALL milestones below this point COMPLETED? Validation in Relevant Environment (Potential Determined) ARL 5 ☐ Application components integrated into a functioning prototype application system with realistic supporting elements ☐ The application system's potential to improve the decision making activity determined and articulated (e.g., projected impacts on cost, functionality, delivery time, etc.) ALL milestones below this point COMPLETED? Initial Integration & Verification (Prototype/Plan) ARL 4 ☐ Components of eventual application system brought together and technical integration issues worked out Organizational challenges and human process issues identified and managed ALL milestones below this point COMPLETED? Proof of Application Concept (Viability Established) ARL 3 Components of application tested and validated independently ☐ Detailed characterization of user decision making process completed (e.g., preapplication baseline performance, mechanisms, and limitations) ☐ Convincing case for the viability of the application concept made ALL milestones below this point COMPLETED? Application Concept (Invention) ☐ Application components formulated and created ☐ Decision making activity to be enhanced by the application identified ☐ Plans to better characterize the decision making activity developed Milestones below completed, or in progress? Basic Research (Baseline Ideas) ARL 1 ☐ Ideas for how specific research results could enhance decision making developed ☐ Baseline support research identified and documented (i.e., results on the theory, models, remotely sensed products, and other current or planned measurements needed to support the application idea) – whether done by the PI's Team or not

e



### The systems science





# Backup



### Key open questions

- 1) 1D, 2D, 3D modeling of the geomagnetic induction and GIC.
  - How much our GIC modeling improves by moving from 1D to 2D and 3D modeling of the geomagnetic induction?
  - Under what conditions 1D approach becomes insufficient?
- 2) How can we improve the work on extreme GIC event scenarios?
  - Improved statistics?
  - Improved modeling, improved understanding of the physics of extremes?
  - What are the theoretical upper bounds for the extreme GIC events?
- 3) What is the optimal number and distribution of B-field measurements for GIC modeling purposes?
  - -Can we build and utilize "representative grid" in the analyses?



## Key open questions

- 4) "GIC-index' development.
  - What could be a good new indicators for GIC activity?
  - How can we package B-field information into data products that are useful for the end-users?
- 5) Model validation.
  - How can we study and characterize key model (interplanetary transient, geospace, induction, ground model) accuracy for GIC applications?
  - How can we build realistic error bars for our end-products?
  - Localized geoelectric field enhancements? Can our models reproduce those?
- 6) How to improve predictive GIC modeling?
  - How can we improve lead-time and accuracy?
  - Should we focus on specific transient features and geospace processes?