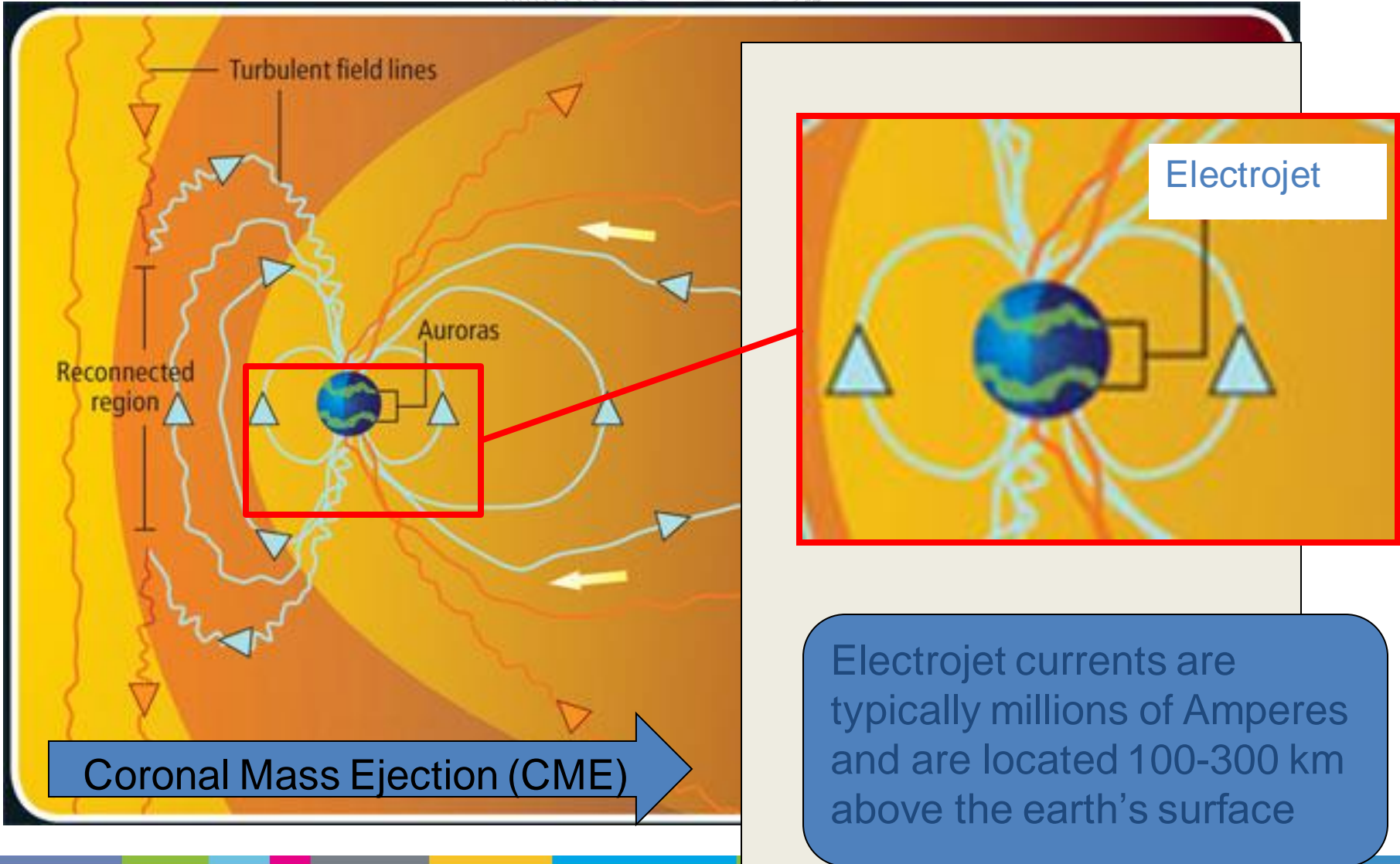
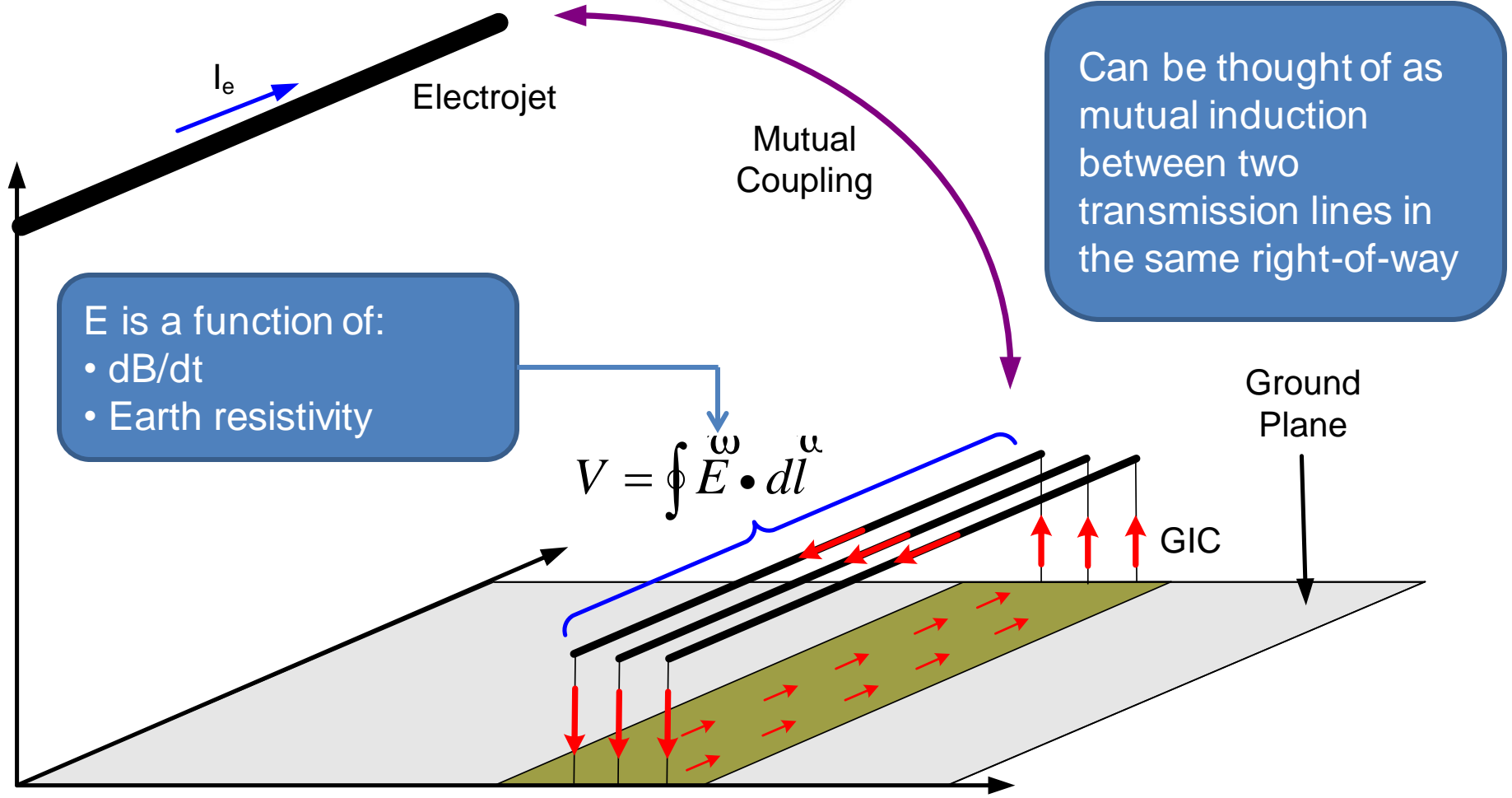


Space Weather Power System Impacts and PJM Response

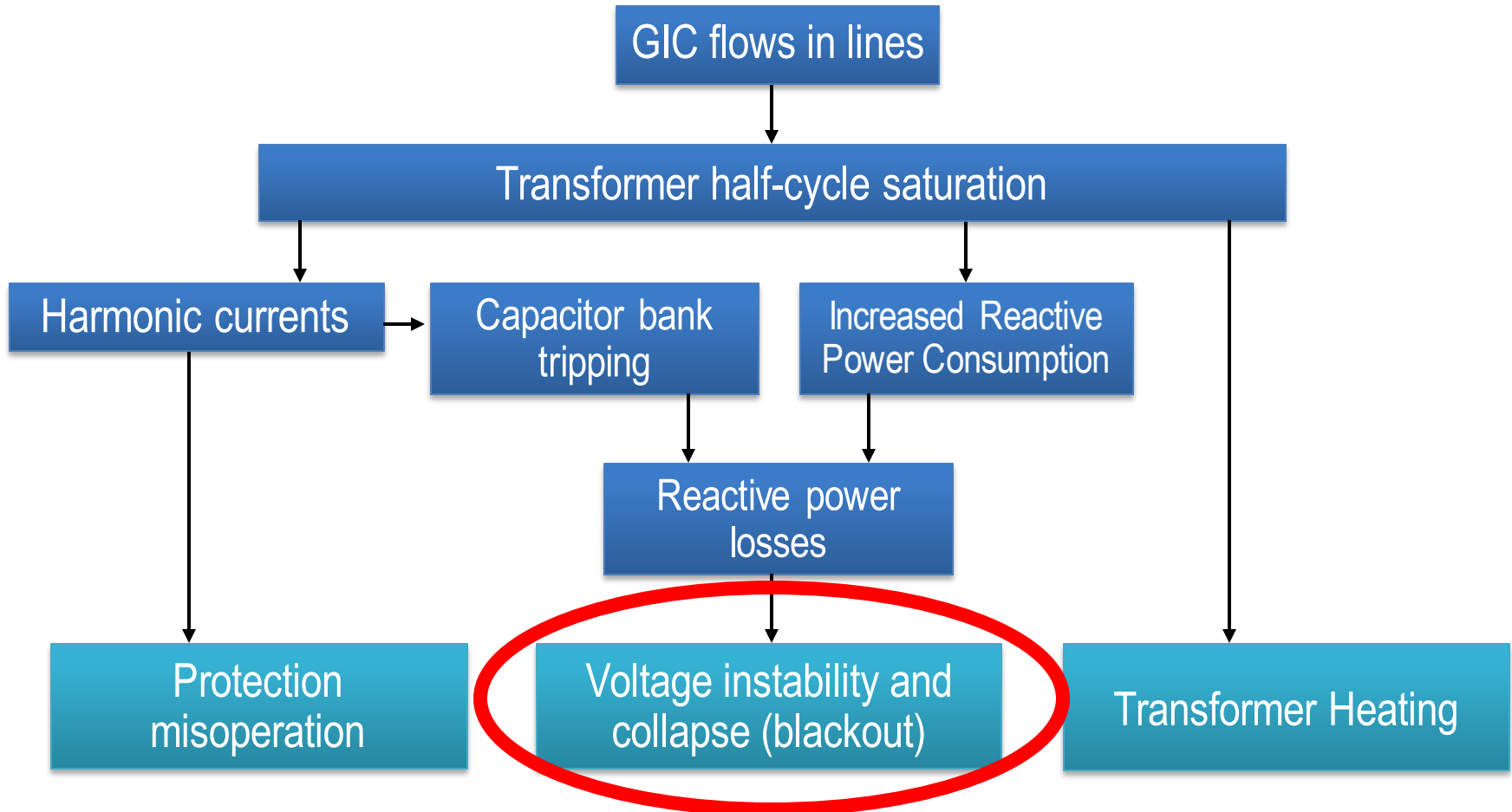
Space Weather As a Global Challenge
Embassy of Italy
May 18, 2017

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Executive Director, Infrastructure Planning
PJM Interconnection





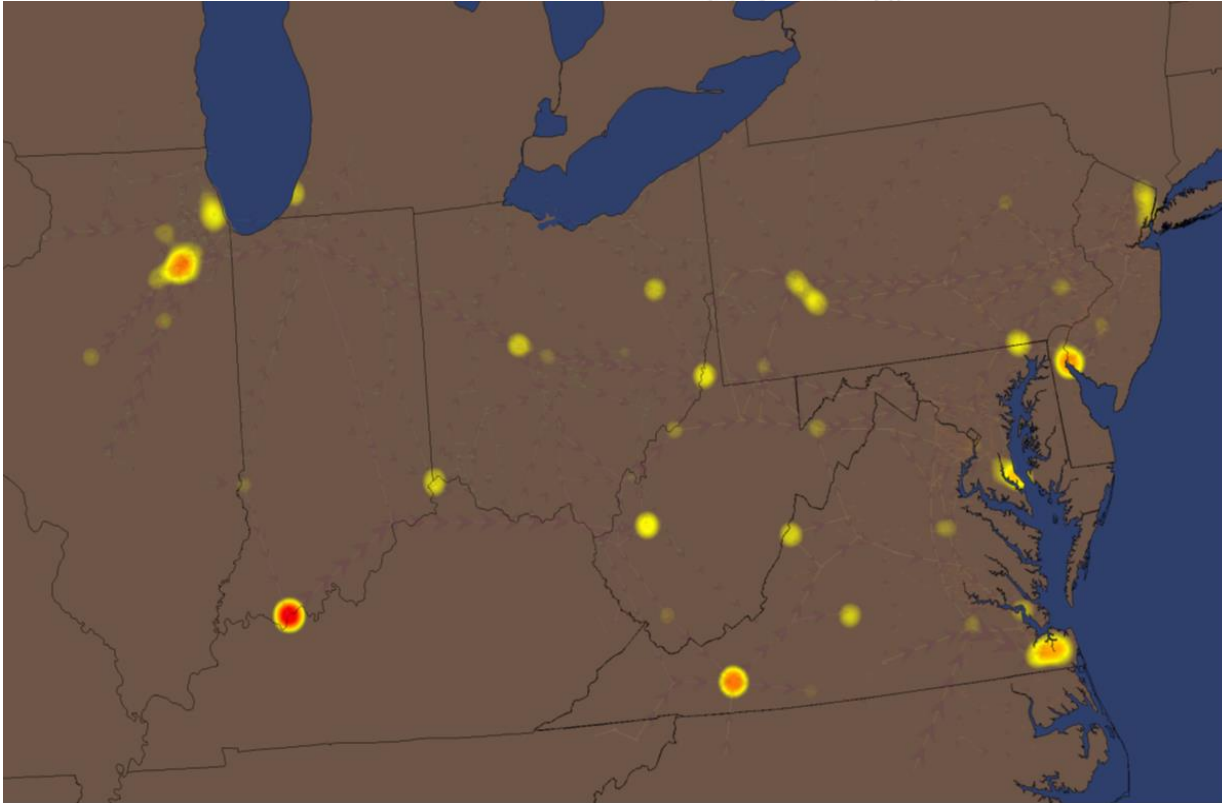
Induced Currents are “Quasi-dc” (mHz)



- Prepare (before the event)
 - Alerts/Warnings issues by Space Weather Prediction Center 1-3 days in advance and monitored by PJM
 - Perform sensitivity studies ensure adequate system resiliency for future operating periods
- Monitor (during the event)
 - GIC Detectors are in place at ~50 locations to watch for GMD impacts in real time
 - Adjust/operate more conservatively based on system conditions

- Requires a **GMD Vulnerability Assessment** of the system for its ability to withstand a Benchmark GMD Event without causing a wide area blackout, voltage collapse, once every 5 years
- Requires a **Transformer thermal impact assessment** to ensure that all high-side, wye grounded transformers connected at 200kV or higher will not overheat based on the Benchmark GMD Event

NERC: North American Electric Reliability Corporation--mission is to assure the reliability of the bulk power system in the US, Canada, and northern Mexico



GIC intensity is a function of many variables, including:

- System topology
- Magnetic field strength and orientation
- Ground conductivity
- Proximity to water (read: ocean)

- PJM
 - Operational procedures in place since after the 1989 Hydro Quebec blackout (and compliant with NERC Standard EOP-010)
 - PJM members have installed ~50 GIC detectors around the system and the data is telemetered into PJM
 - PJM, Dominion, AEP to participate with NASA on a research program to use ground measurement devices to validate electric field models
- Industry
 - Awareness is increasing and a number of systems are installing detectors. GIC calculation is now included in power analysis software
 - American Transmission (Wisconsin) has installed a GIC blocking device
 - NERC planning standard (NERC Standard TPL-007) will require network analysis and transformer thermal assessment