

Four Top Tier Challenges for Space Weather Research for the Next Decade

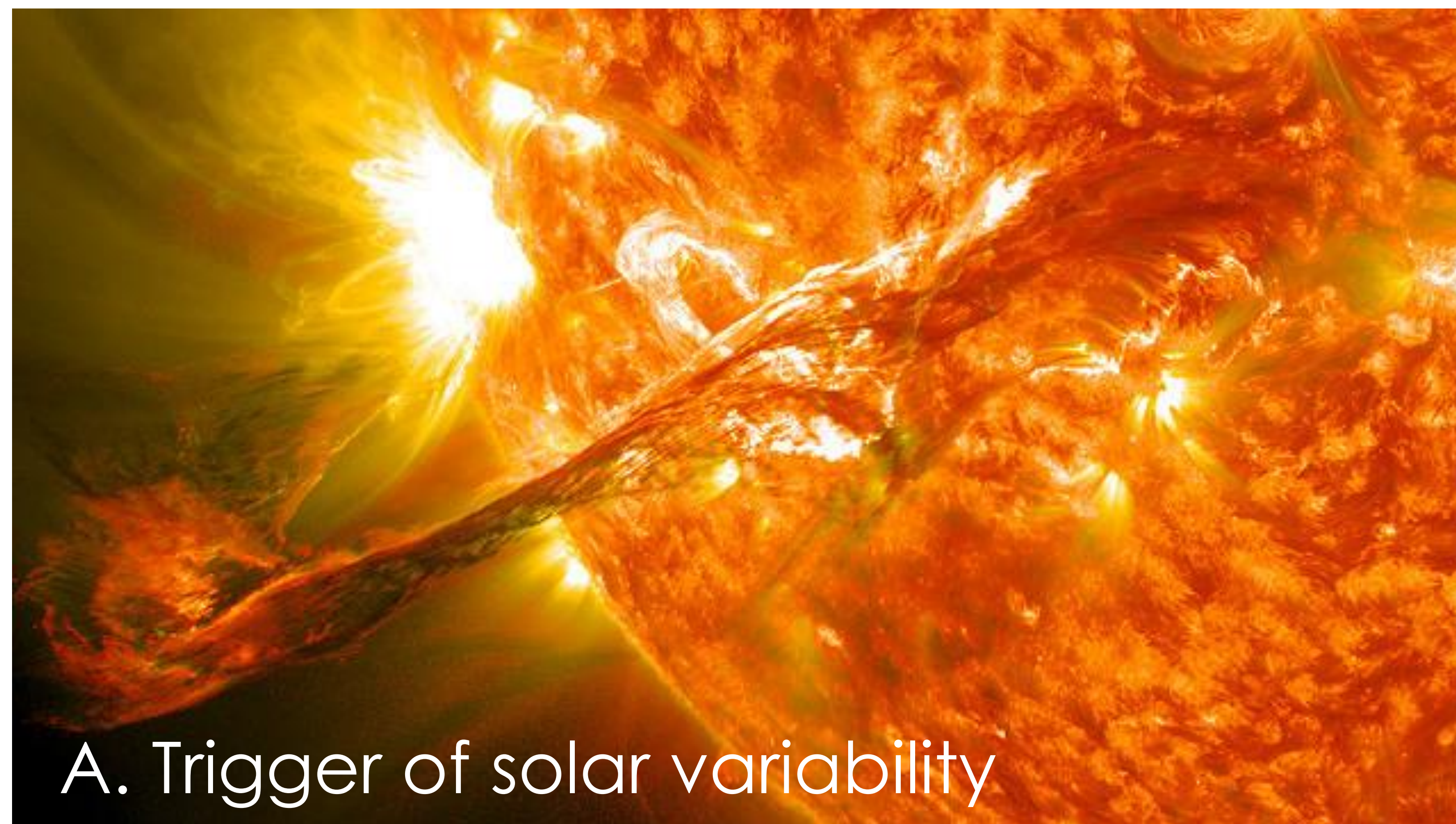
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Challenges

- Trigger of Solar Variability
- Acceleration of Mass and Energy
- Geoeffectiveness
- Ionospheric Variability

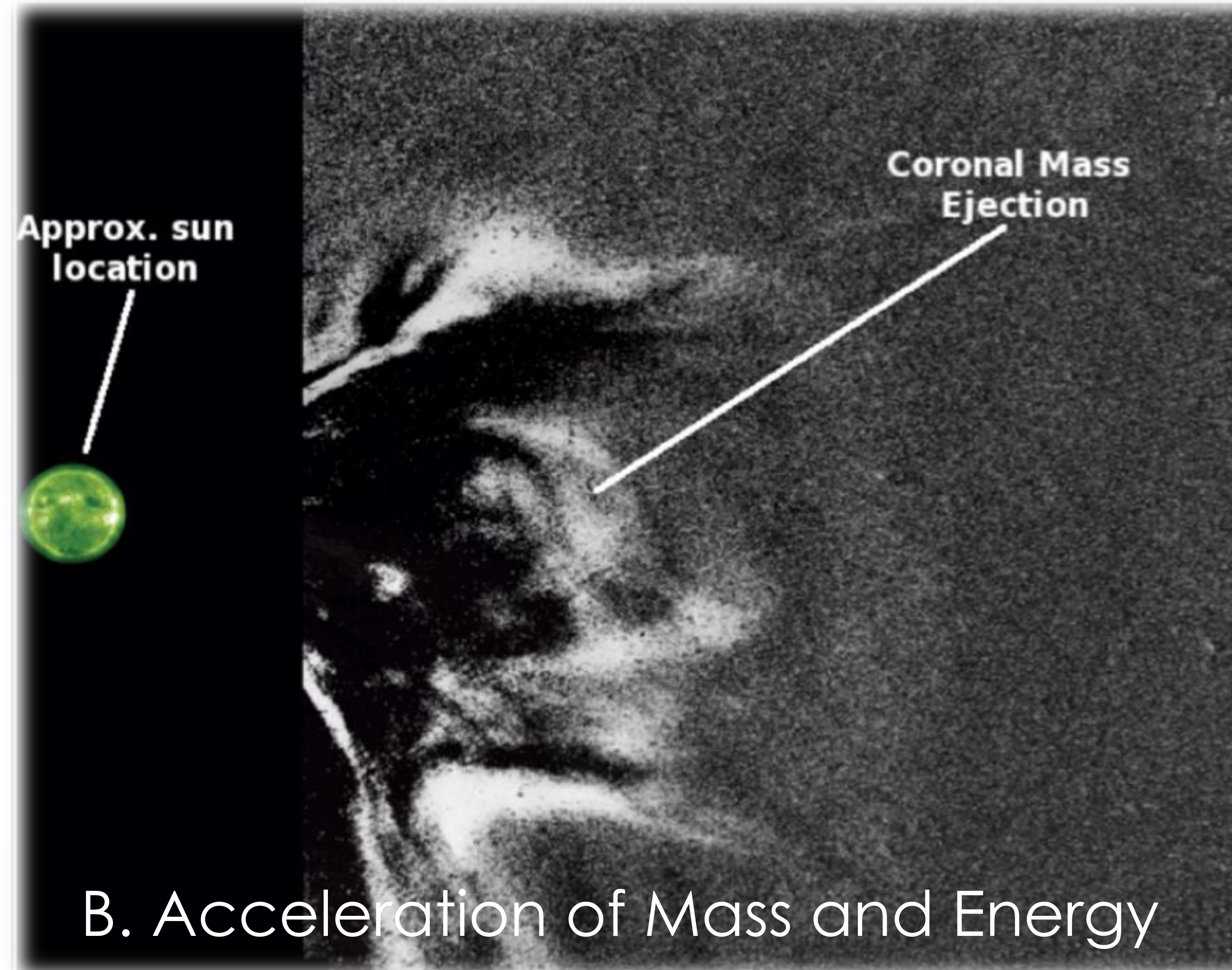
Context:

- Space Weather Enterprise, US Space Weather Action Plan
- International Living With a Star, International Space Weather Initiative
- NOAA, NASA, NSF, ESA
- COSPAR/ILWS Understanding space weather to shield society: A global road map for 2015–2025 (DOI: 10.1016/j.asr.2015.03.023)
- Academia, Commercial, Government, National, International



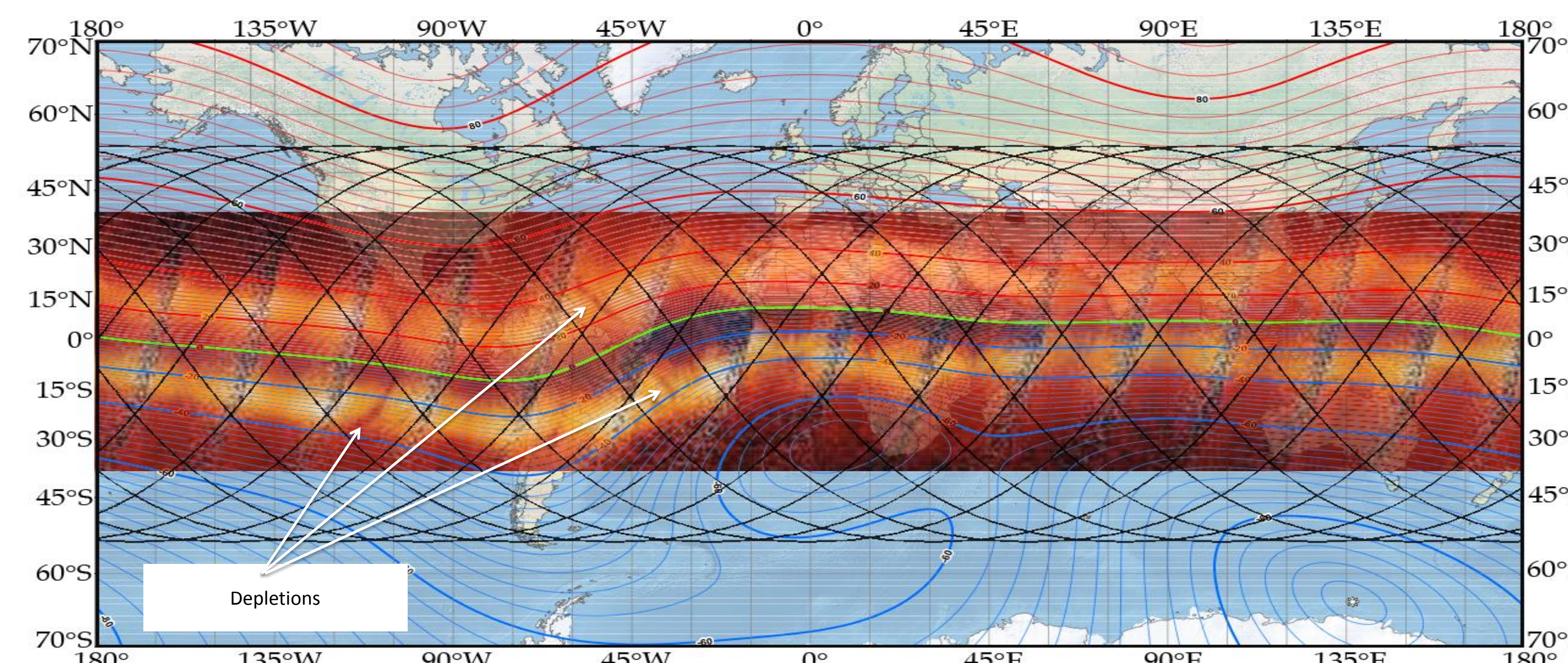
A. Trigger of solar variability

- Understanding the underlying mechanisms
 - Interior
 - Magnetic atmosphere
- High resolution observations, models,
- Prediction of solar eruptive events, their magnitude, content, direction . . .
- Coupling of surface to the extended solar atmosphere



B. Acceleration of Mass and Energy

- The temporal evolution of the magnetic content of the interplanetary solar wind
- Time, energy, mass, space, velocity, polarity
- What observations needed to drive and constrain models?
- Spaceborne assets impacted
- Coupling of solar wind to geospace



UV Airglow images from TIMED GUVI clearly showing the equatorial anomaly with embedded depletions that have penetrated through the F peak. Green, Red and Blue traces show the magnetic equator and positive and negative dip angles. 52° inclination ground tracks are superimposed as black traces.

D. Ionospheric variability

- Solar driver vs upper atmospheric driver?
- On a day-to-day basis, this unresolved challenge impacts the greatest number of assets



Orange outlines highlight the areas in the U.S. that are most vulnerable to electrical outages due to a severe geomagnetic storm, according to a 2008 report from the National Research Council. Credit: Kathleen Cantner, AGI

C. Geoeffectiveness

- Geospace does not always respond as we understand it should
- More than solar wind IMF and momentum
- Large dynamic range of scales in space, time, mass, and energy
- Passive Recipient vs Active Participant
- Understanding our planet is just as important and understanding our space

Conclusions

- SWx Science challenges require observations, models, and monitoring
- SWx Science challenges will not be resolved overnight
- Humanity's dependence on evolved technology continues to drive SWx science challenges

Summary Remarks

- SWx Science extends beyond understanding how nature works.
- SWx Science also includes understanding how technology responds to natural variability – e.g. surface charging, deep dielectric energy deposition, organic radiation damage
- Effective SWx Science must be intentional, and is separate from the pursuit of natural science understanding
- SWx Science has a tremendous potential over the next decade