Air Force Research Laboratory

GOES Particle Observations: An AFRL perspective of AF needs

13 April 2015

Shawn L. Young
W. Robert (Bob) Johnston
Air Force Research Laboratory

Integrity ★ Service ★ Excellence

DISTRIBUTION STATEMENT A – Unclassified, Unlimited Distribution

AFRL Interests

Spacecraft design: Help customers develop cost-effective satellite designs that will minimize space weather impacts - Help them, "operate through the storm."

- AFRL leads the collaborative development of the AP9/AE9/SPM climatological radiation belt/plasma models.

"What do you mean our satellites were in 'safe mode' when they launched their strike against us?! - What ***is*** 'space weather' anyway?"

"So, about our retaliatory rhetoric and public accusations ... You, see when our satellite failed above your country our initial anomaly assessment didn't identify space weather."

Anomaly Attribution/Risk Assessment:

- Effort: Develop hazard specification/forecast capabilities.
- Purpose: Support spacecraft operators and mission planners in their anomaly assessment and risk mitigation efforts.

Doctor Strangelove stills copyright: Copyright (c) MCMLXIII Hawk Films Ltd. All Rights Reserved

Bottom Line Up-Front

- **GOES observations are important for climatology**
  - Historical archives have contributed to AP9.
  - New observations may be important for AE9/SPM.
- **GOES particle obs. are essential inputs to hazard specs.**
  - Observations support GEO hazard specifications.
  - Will be important/necessary inputs to hazard specifications elsewhere.
- **GOES particle observations will be necessary for forecasts**
  - The current >2MeV electron forecasts require them.
  - Provide current state at GEO.
  - Low energy particles will be “seed” populations (lower boundaries/statistical correlations).
- **Wish list**
  - Additional pitch angle resolution for electrons.
  - On-board data storage to fill gaps.

Current GOES particle data uses

- **Climatology:**
  - Energetic protons are not trapped at GEO, but the SEPs were essential for cross-calibrating data sets for AP9.
  - Electron observations lacked pitch angle information and had few energy bins so were not included in AE9.

- **Geosynchronous Hazard Specifications:**
  - >2 MeV electron observations are used to drive internal charging hazard specifications.
  - Energetic proton observations are used for single event effect and event total dose hazard specifications.

New uses of GOES particle data

- **Climatology:**
  - We hope to use electron and plasma data in AE9 and SPM
  - GOES could contribute to a planned AP9 solar proton module
- **Hazard Specifications:**
  - Warm plasma (>5keV) obs. for surface charging index
  - Energetic Electron observations used for radiation belt model (data assimilation, boundary conditions etc.)
  - SEP/heavy ion observations mapped inside GEO for single event effect and total dose hazard specifications.
- **Hazard Forecast**
  - >2 MeV electrons to drive a hazard forecast.
  - Initial and boundary conditions/statistical correlations†

† e.g. Turner, D. L. and X. Li (2008), doi:10.1029/2007SW00354

Wish List

- **Additional pitch angle resolution for electron observations**
  - Better boundary conditions for radiation belt models
  - Better inputs for AE9
- **Onboard storage to fill data gaps**
  - Missing data will be beneficial for anomaly resolutions.