Forecasting Solar Energetic Particle Events

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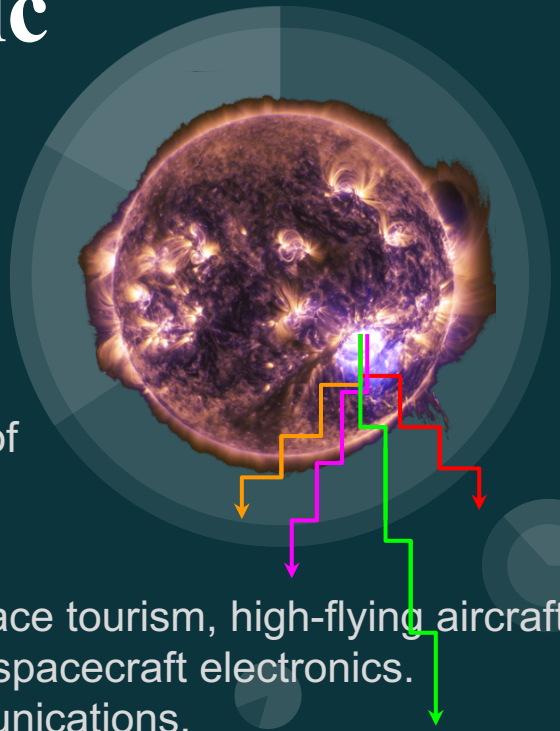

Solar Energetic Particles (energetic protons > 10 MeV) accelerated in solar flares and in shocks created ahead of coronal mass ejections.

Impacts:

- Radiation hazard for manned space flights, space tourism, high-flying aircraft.
- Spacecraft malfunction due to interaction with spacecraft electronics.
- HF radio blackouts affecting long range communications.

Objective: Improve upon the proton prediction model (PROTONS) currently in operations at NOAA Space Weather Prediction Center.

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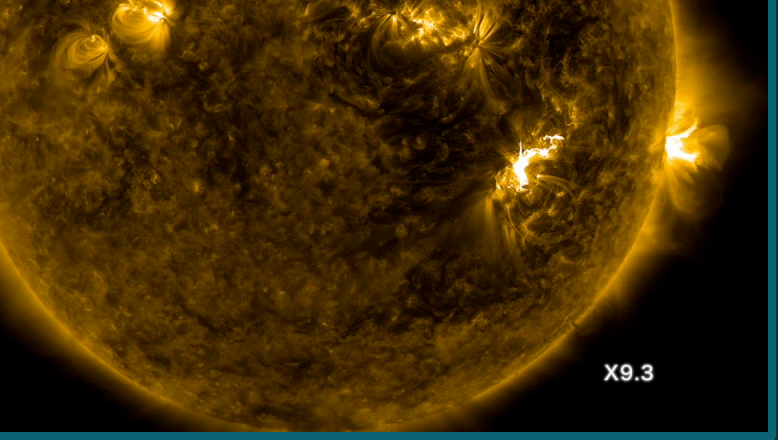

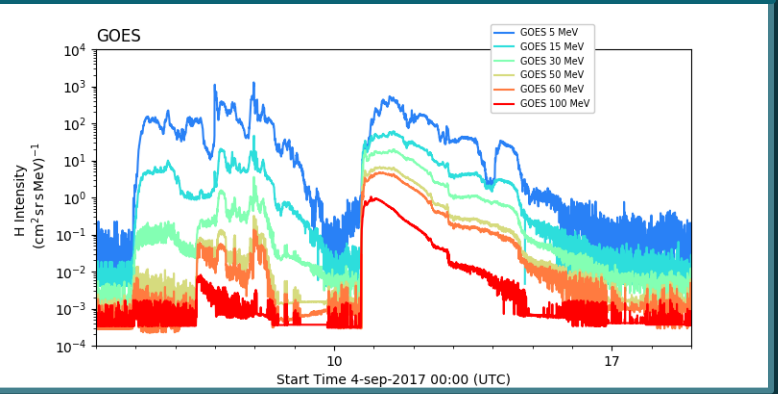

Solar Flare (top) and Energetic Particles observed at Earth in September 2017.

SEP Modeling / Forecasting

- Current physics based models are not capable of providing forecasts in real time. Empirical model required to relate real-time observables to a timely forecast.
- Compiled dataset (Balch, 2008) available for SEP event and control events in the years 1986-2004 - needs to be updated for current solar cycle.
- Initial features used in the Balch 2008 paper (FL size, FL location, CME speed, CME width, radio burst occurrence, etc.) but should be expanded - particularly for new relationships detailed in recent literature.
- All data publicly available.

Machine Learning Approach

- Generate features from observables which are known to provide some predictive capabilities for the forecasting of SEPs.
- A requirement of the model is a probabilistic SEP forecast:
  - Begin by investigating results of a Logistic Regression.
  - Consider SVM and KNN models to assess the feasibility of classifying events through different techniques, regardless of a probabilistic output.
- Feature ranking:
  - Investigation of feature importance within each class. Remove features exhibiting minimal predictive capabilities.
  - Lasso regularization may help identify correlated features which are redundant within the model.
- New features, which prove to have significant predictive capabilities could inform future mission/instrument requirements.