Brief Description of the Model

• SPRINTS integrates pre-eruptive metadata and forecasts from the MAG4 system with post-eruptive metadata to produce high fidelity and pre- to post-eruptive transitional forecasts for:
  • Flares
  • SEPs
  • CMEs
  • HSSs
• MAG4 makes a forecast from a magnetogram
  • E.g., flaring rates associated with AR PIL parameters
• Catalogs of the four solar-driven events are created by automatic detections employed on 30+ years of GOES X-ray and particle data as well as 20+ years of ACE and DSCOVR solar wind data.
• Generates pre- and post-eruptive forecasts based on catalogued events and supporting metadata (e.g., NASA FFT modules, SHARPS)
• Leverages machine-learning techniques to make predictions including regression and classification methods such as decision trees, random forests, and k-nearest neighbor.
Model results: September 2017

Overall:

- MAG4 pre-eruptive flare forecast probabilities generally reflect AR 12673 flaring activity except near-limb.
- SPRINTS post-eruptive solar particle model correctly predicts the onset of the three defined events and the 10 MeV flux evolution for two.
- Automated forecast systems with frequent observational inputs (e.g., not NOAA SWPC 12 hour forecast cadence) and prediction outputs are critical due to AR emergence and evolution.

### Forecasts for 9/4 at 23:40.
- Predicts the radiation event prior to being observed.
- MAG4 probabilities of M-X- and M-class flares steadily increase.
- SWPC forecasts have been static for almost 12 hours.
- Predicts the 10 MeV channel to have a peak of 10 pfu while observed event achieves a peak of 140 pfu.

### Description of 4-day forecasts

#### Radio Blackout (solar flare) forecast window
- MX – MAG4 X-flare forecast probability (24 hour-outlooks).
- NX – NOAA X-flare forecast probability (24, 48 and 72 hour-outlooks).
- MM – MAG4 M- and X-flare combined forecast probability (24 hour-outlooks).
- NM – NOAA M-flare forecast probability (24, 48 and 72 hour-outlooks).

#### Radiation (solar particle event) forecast window
- NS – NOAA solar energetic particle S1 forecast (24, 48 and 72 hour-outlooks).

### Forecasts for 9/07 at 15:45.
- Predicts the radiation event prior to one being measured.
- Over-predicts the profile with $10^4$ pfu for 10 MeV when a peak of ~300 pfu was observed.
  - See the blue-dashed line in the Radiation observation plot.
**Model results: Sept 2017 cont.**

**Forecasts for 9/10 at 16:00.**
- Because optimal observational view of the active region is beyond MAG4 prediction capabilities, all MAG4 predictions are now at 0%.
- Human-in-the-loop from SWPC/USAF have predictions that are non-zero based on human-digested information.
- The radiation time-evolution prediction was triggered due to the currently ongoing limb flare; prior to any radiation event observed.

**Forecasts for 9/12 at 12:45.**
- After almost two days of having a locked-in forecast we see the time-evolution prediction of the radiation changed and closely matches the initial observations of the event with the blue-dashed line.

Watch full forecast movie here (~90 seconds): SPRINTS-MAG4-SWPC Sept 2017
Discussion questions

• How did your optimized run results differ from the initial run?
  • No optimization pursued.

• What aspects of the event does your model capture well, and what aspects were more difficult to capture?
  • Demonstrates benefit of pre- post- eruptive SEP model
  • Difficult for pre-eruptive forecasting for limb events (MAG4; flares)

• What are the next steps for your modeling technique?
  • More data!
    • Type II radio bursts
    • CME kinematics (CORIMP)
  • MAG4: train on flare integrated flux!
    • Key to connecting pre- post- eruptive models b/c X-ray fluence is more important than flare magnitude for SEP predictions
    • Likely to improve flare predictions too as it is more related to total AR energy released
  • MAG4 forecasts out to 60 deg using vector magnetograms
  • Validate, validate, validate!