

# 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

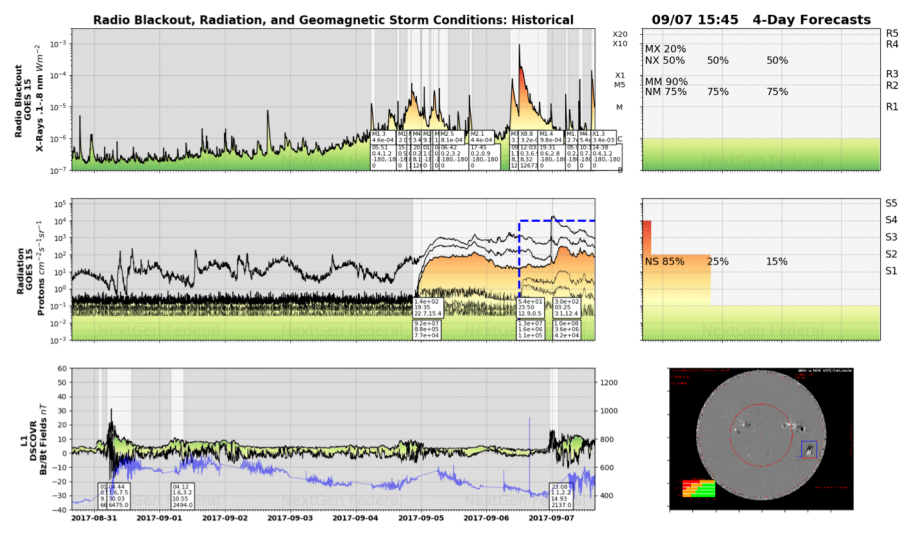
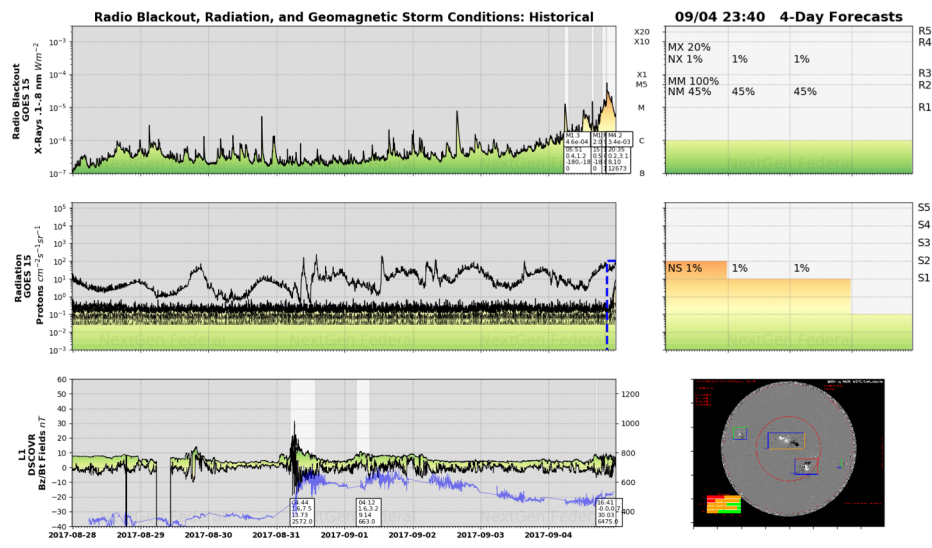
## Description of 4-day forecasts

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)



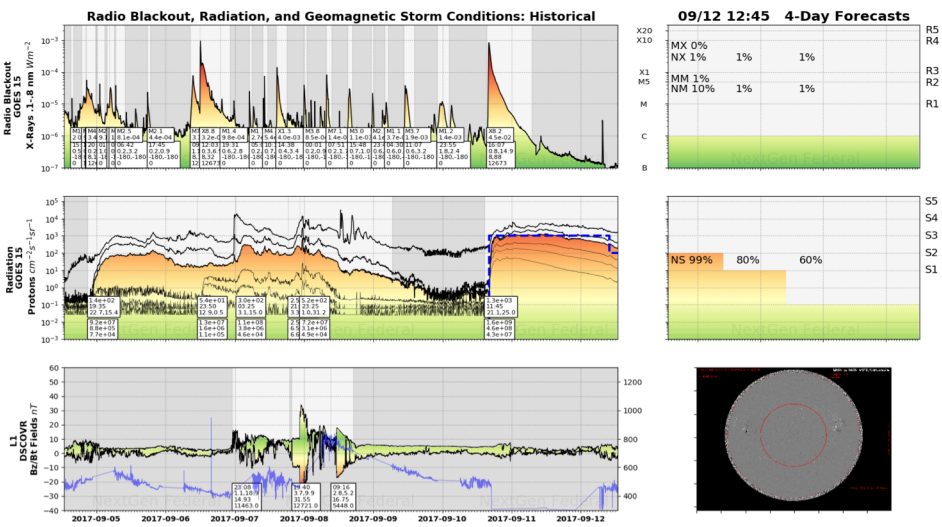
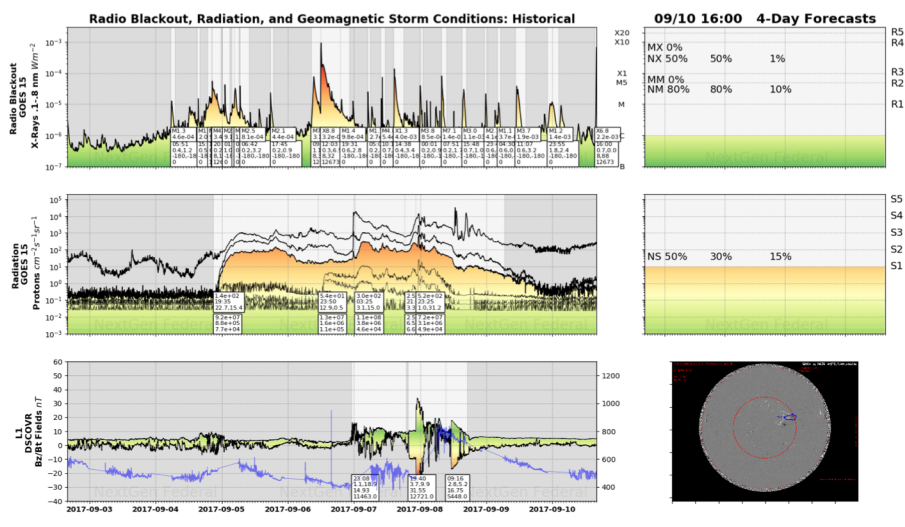
### Forecasts for 9/4 at 23:40.

- 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

### 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  $\sim 300$  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!