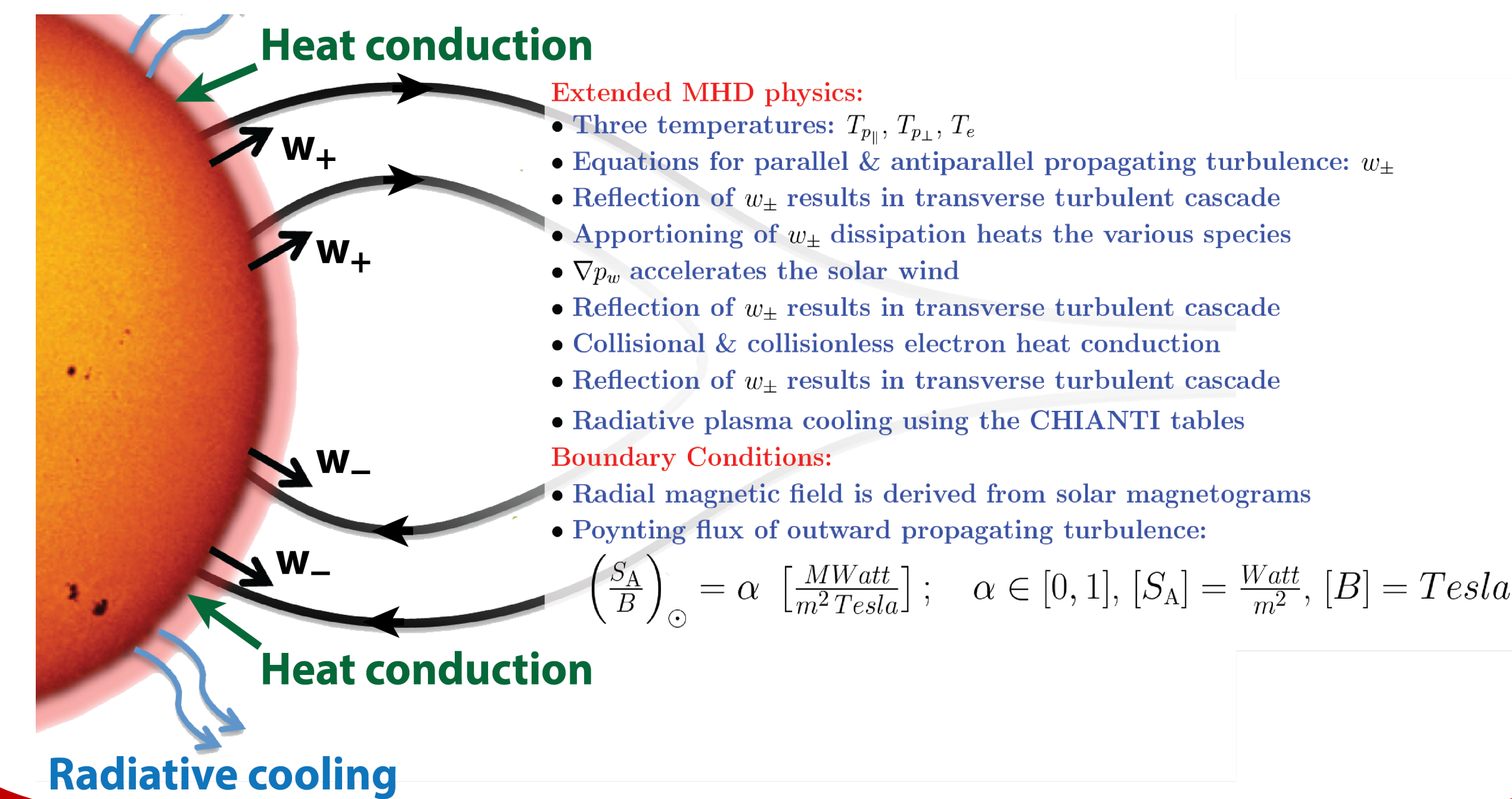


## Next Generation Space Weather Modeling Framework (SWMF) using Data Assimilation and Uncertainty Quantification

- First-principles based models from the Sun to the Earth with data assimilation & uncertainty quantification.
- Provide optimal and quantified probabilistic space weather forecasting.
- High-fidelity & high-skill prediction with a practically useful forecast window.

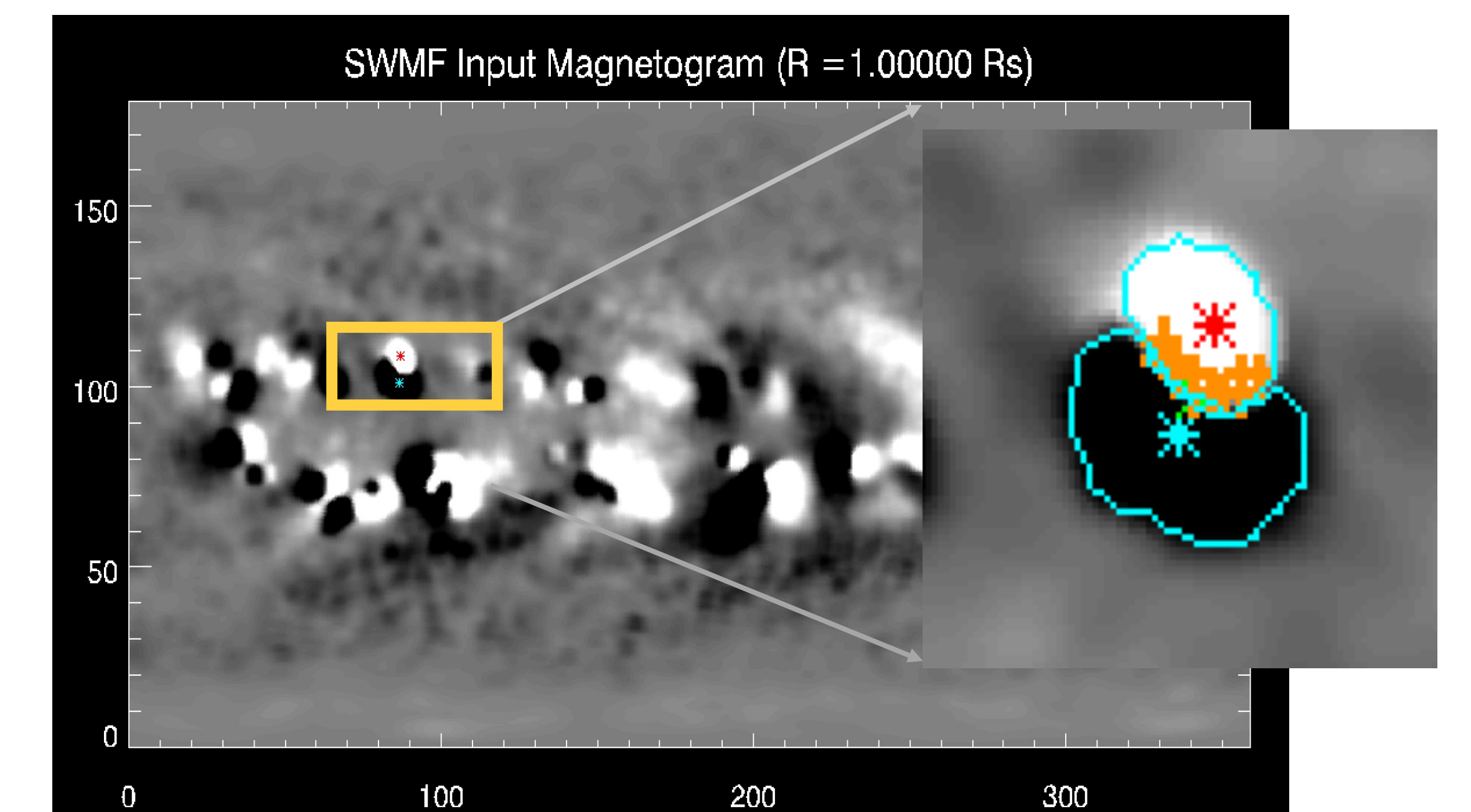
## Alfven Wave Solar Wind atmosphere Model (AWSoM)

- AWSoM is a 3D physics-based MHD model extending from the lower transition region into the solar corona and the inner heliosphere.
- Inner boundary input is obtained from the photospheric magnetic field observations.



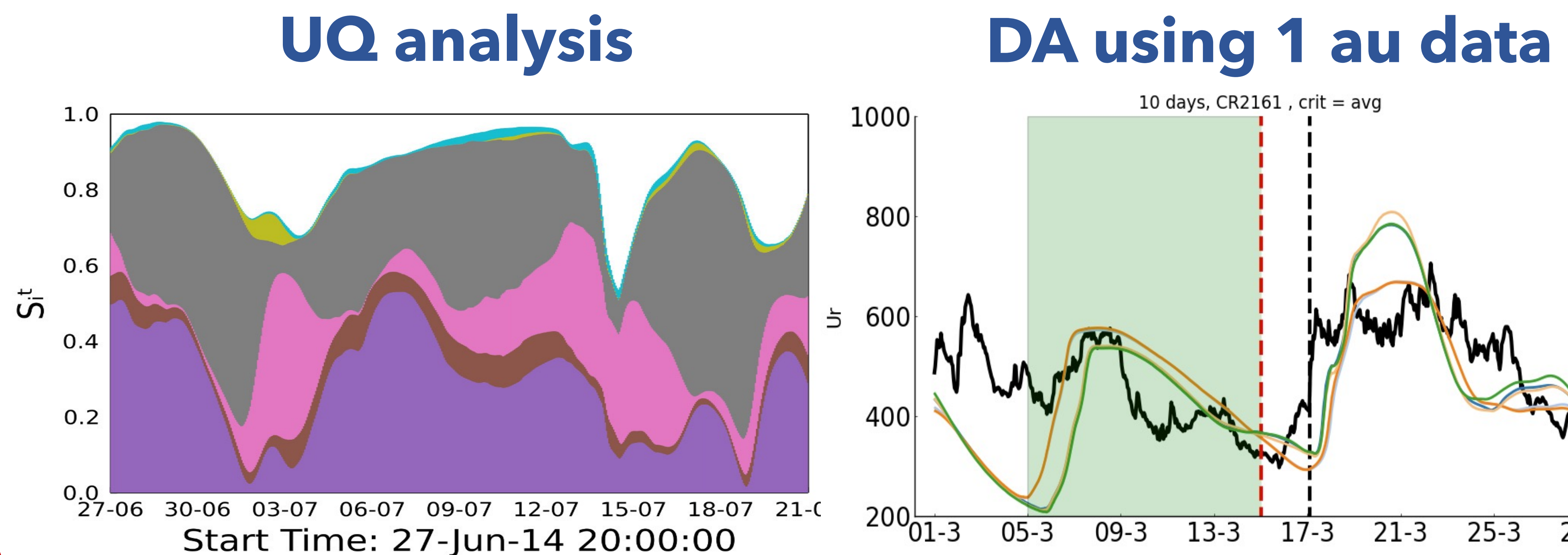
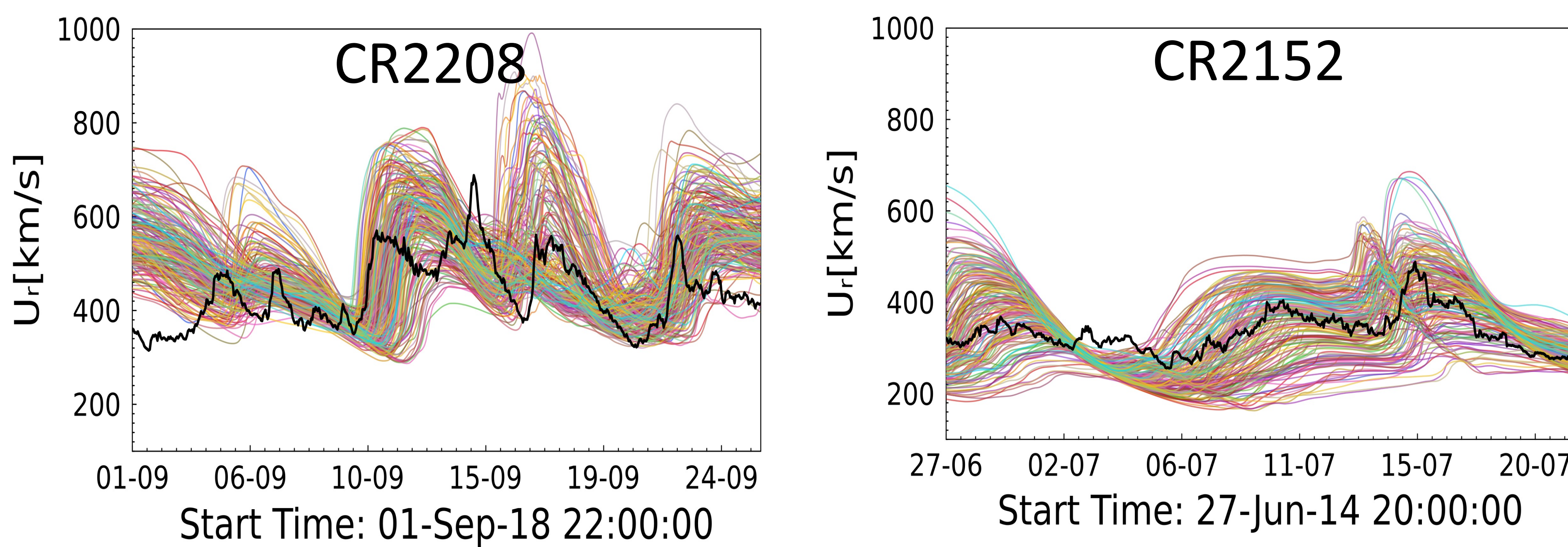
## Eruptive Event Generator with Gibson & Low (EEGGL)

- Generalized, automated numerical tool to parameterize a CME flux-rope based on Gibson & Low flux-rope configuration.
- User defined input/selection of erupting AR, initial CME speed and observed magnetic field map.



## Ensemble Modeling for background solar wind

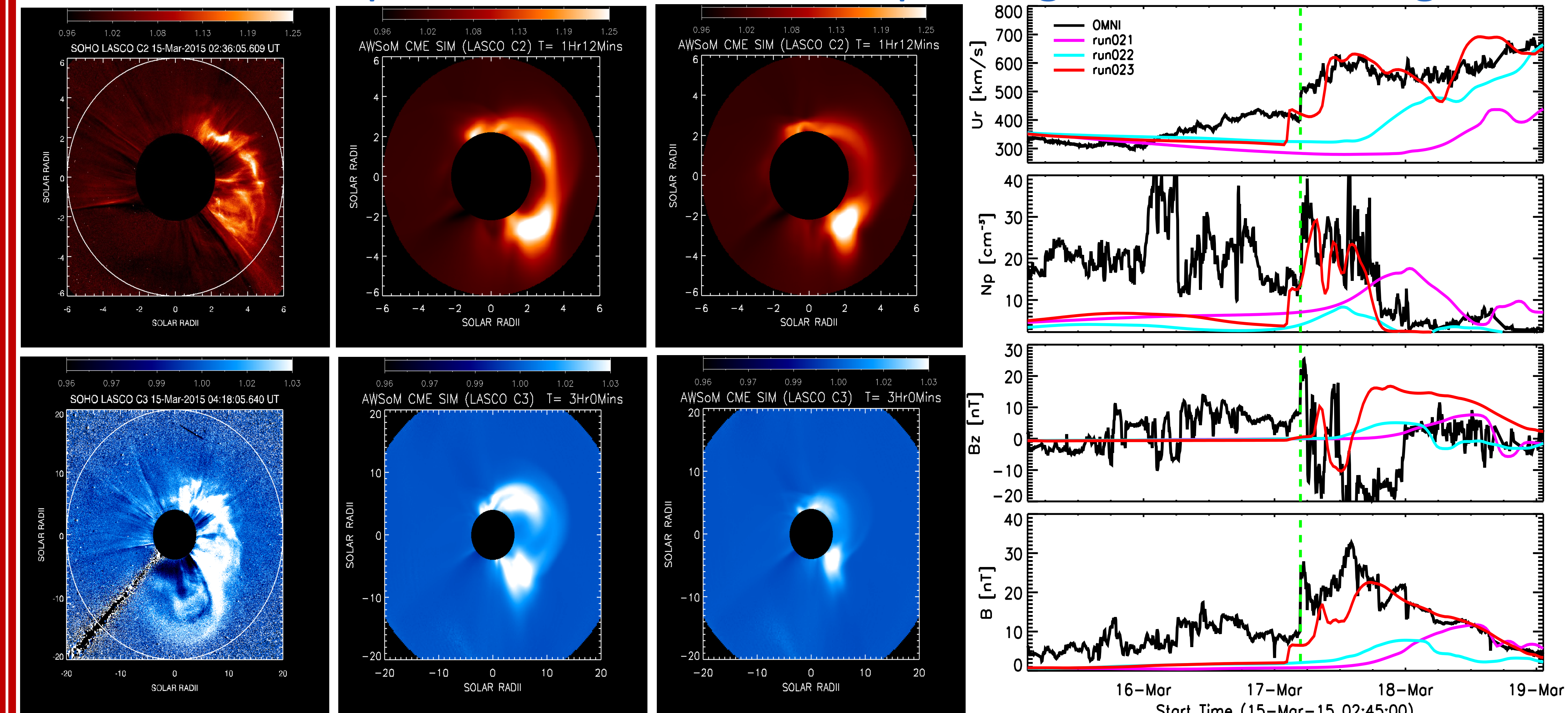
- AWSoM MHD model is used to model the solar wind between the Sun and the Earth.
- Ensemble simulations  $\sim 200$  done based on a multi-dimensional parameter space covering solar minimum and maximum period.



Identify best backgrounds ( $\sim 5$ ) to launch CMEs into.

## Ensemble Modeling for CMEs

- Initial estimates of flux-rope parameters from EEGGL.
- Ensemble CME runs  $\sim 300$  (200 randomized on 5 backgrounds + 20x5 runs with fixed CME params and different backgrounds).
- **Dominant parameter is the flux-rope magnetic field strength.**



**Correlation of white light edge speed with arrival time can be used to improve forecast.**

