Quantized Advantages to a Proposed Satellite at L5 from Simulated Full-Field Synoptic Magnetograms

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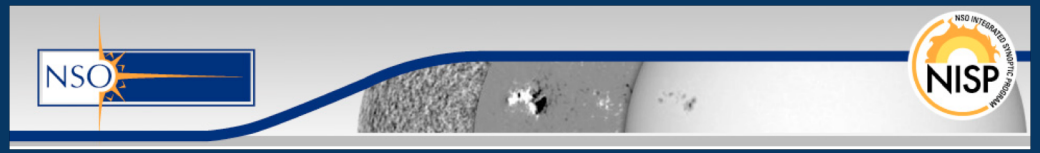

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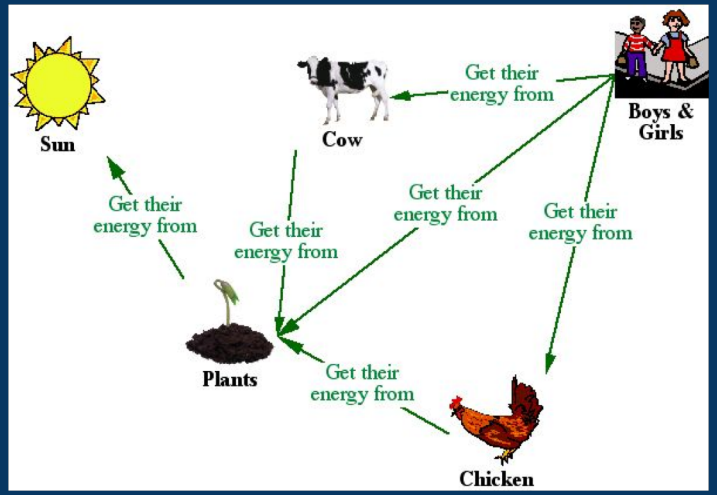
What is the Big Idea?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Cow
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Get their energy from
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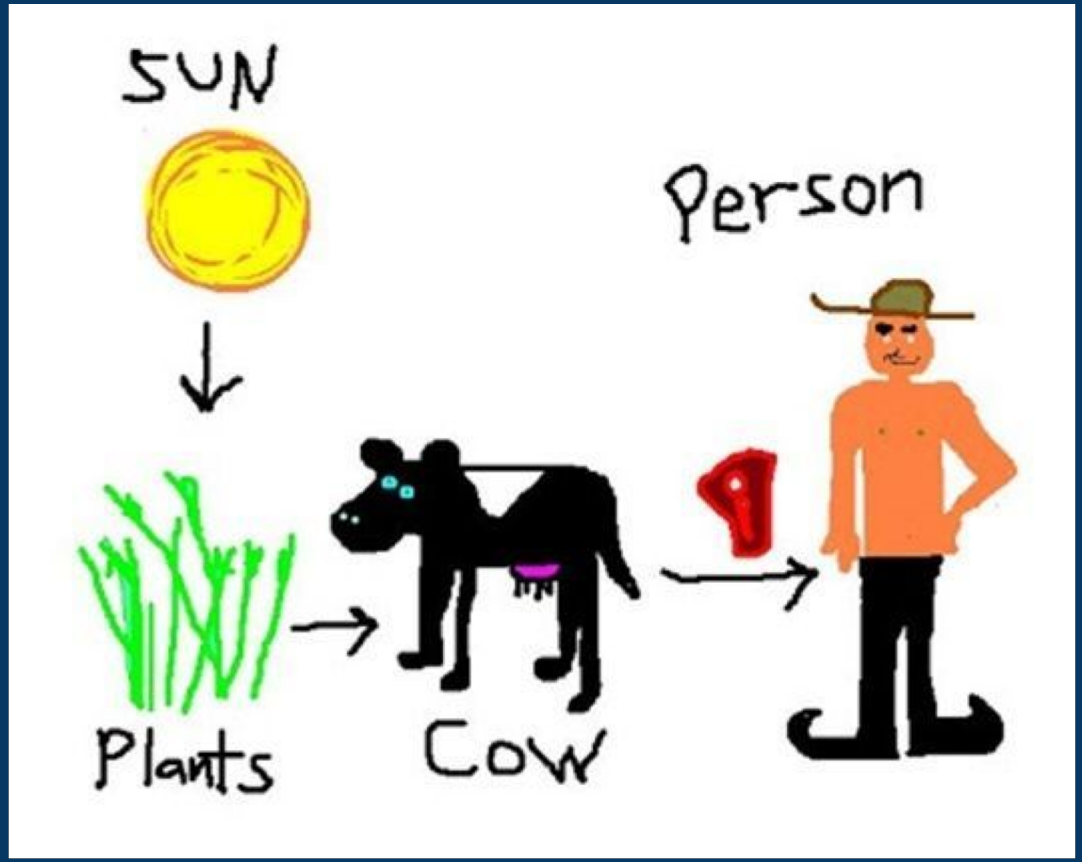
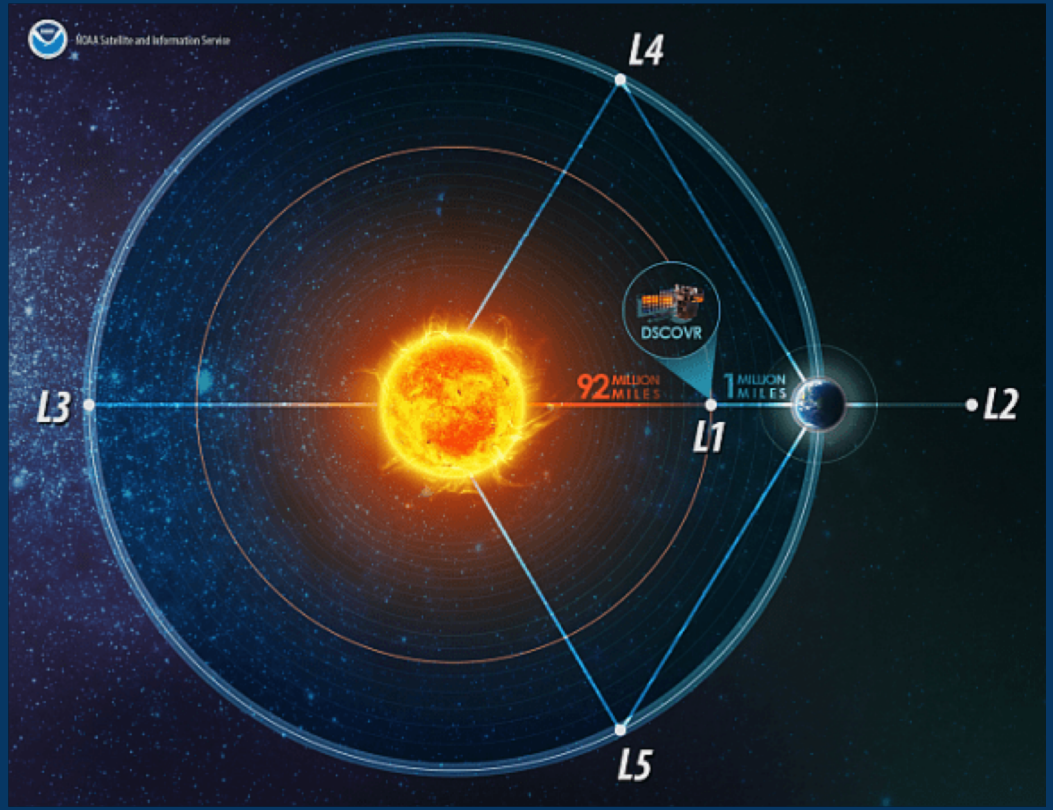

SUN
Person
Plants
Cow

Lagrange Pt. 5

The NSO provides 24/7 coverage of the full-disk solar magnetic field.

Currently, we can only observe the Sun's Earth facing side.

Lagrange Pt. 5 lies 60 degrees behind the Earth in its orbit around the Sun.



https://www.universetoday.com/wp-content/uploads/2016/07/point_of_lagrange1_big-resize-580x449.png

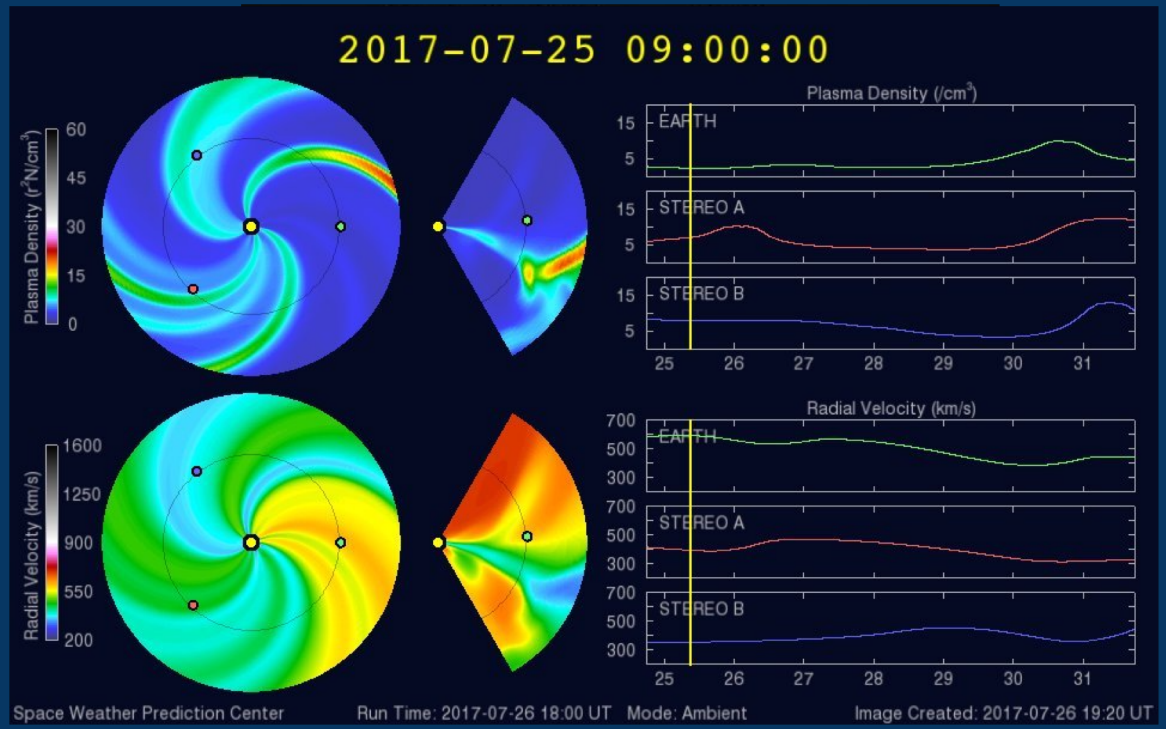
Advantages to L5

An additional 60 degrees of visibility of the Solar surface.

These 60 degrees crucially contain the solar longitudes about to rotate towards earth.

Different view of the poles with a different tilt angle

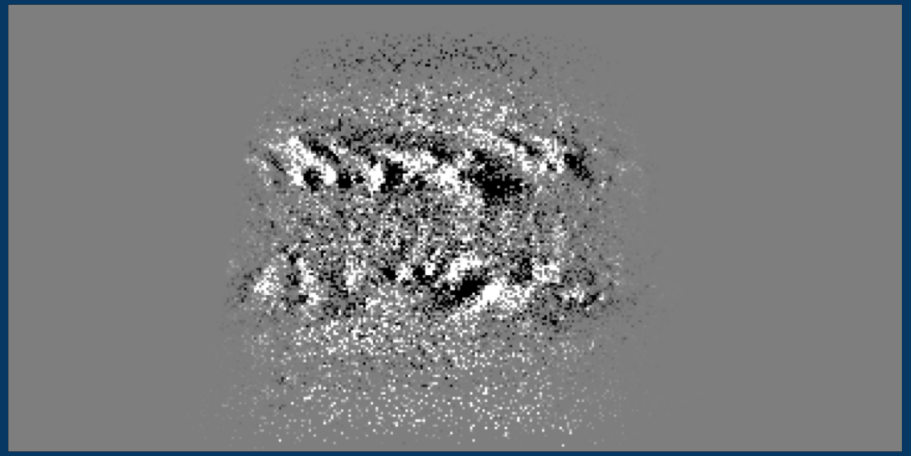
We could sooner predict dangerous events. (CME's, flares, solar wind etc.)

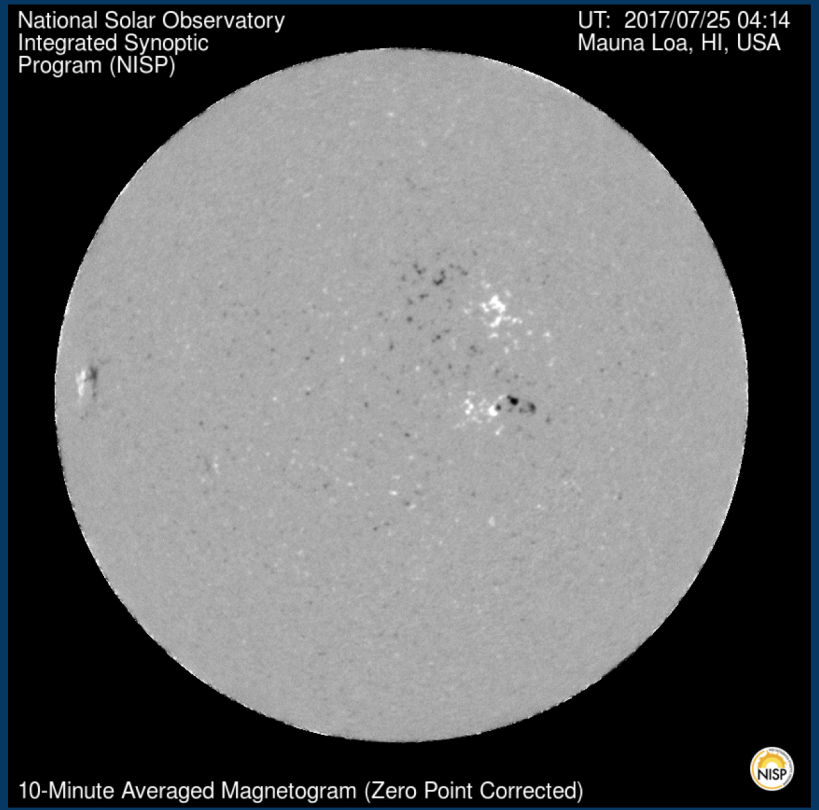


http://www.swpc.noaa.gov/products/wsa-enlil-solar-wind-prediction

Magnetograms

Real-time snapshots of Solar magnetic activity





Flux-Transport Model

We cannot observe the entire solar surface at once.

Instead, we've used a full-surface flux transport model to represent an instantaneous, full-surface magnetogram.

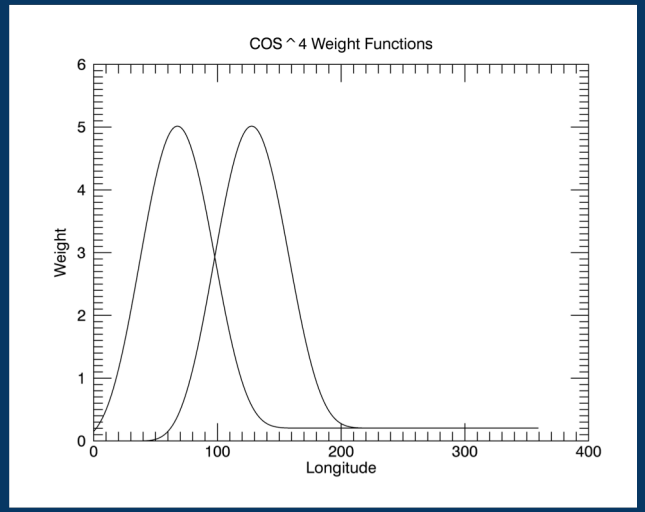
Essentially, because we can't see the entire surface, we used a model of the entire solar surface to which we will use to take synthetic observations.

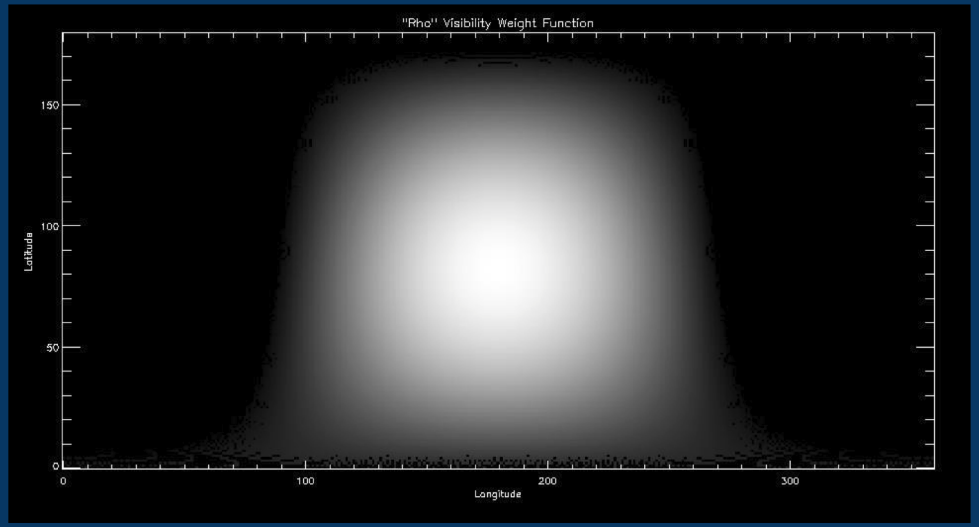
Weight Functions

Simulated synoptic magnetograms from a solar flux-transport model, not from data instruments.

Multiply a series of weight functions to the flux-transport model to simulate observations from Earth and L5.

These snapshots are combined to form full-field synoptic maps.

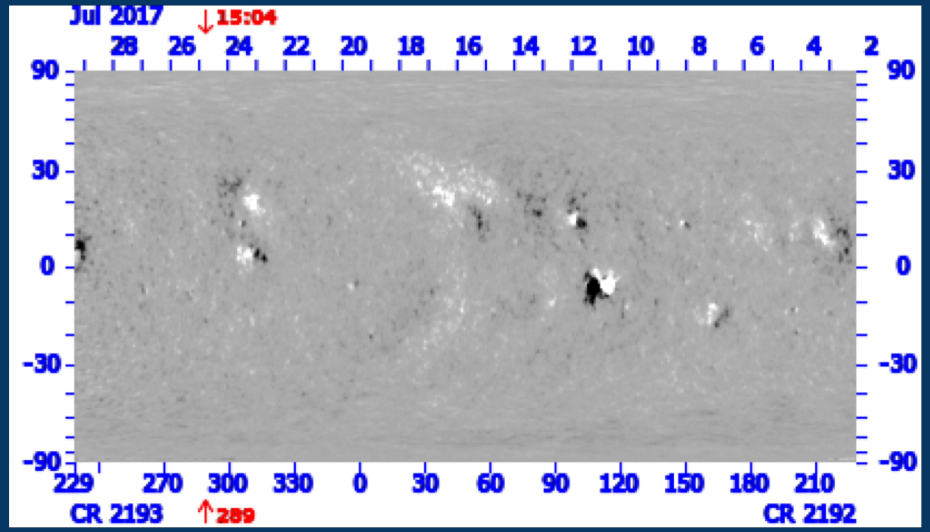




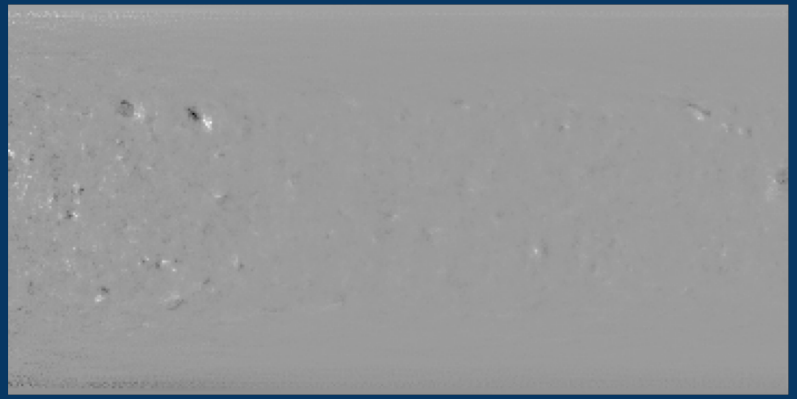
Synoptic Magnetograms

Near real-time approximations full surface magnetic activity.

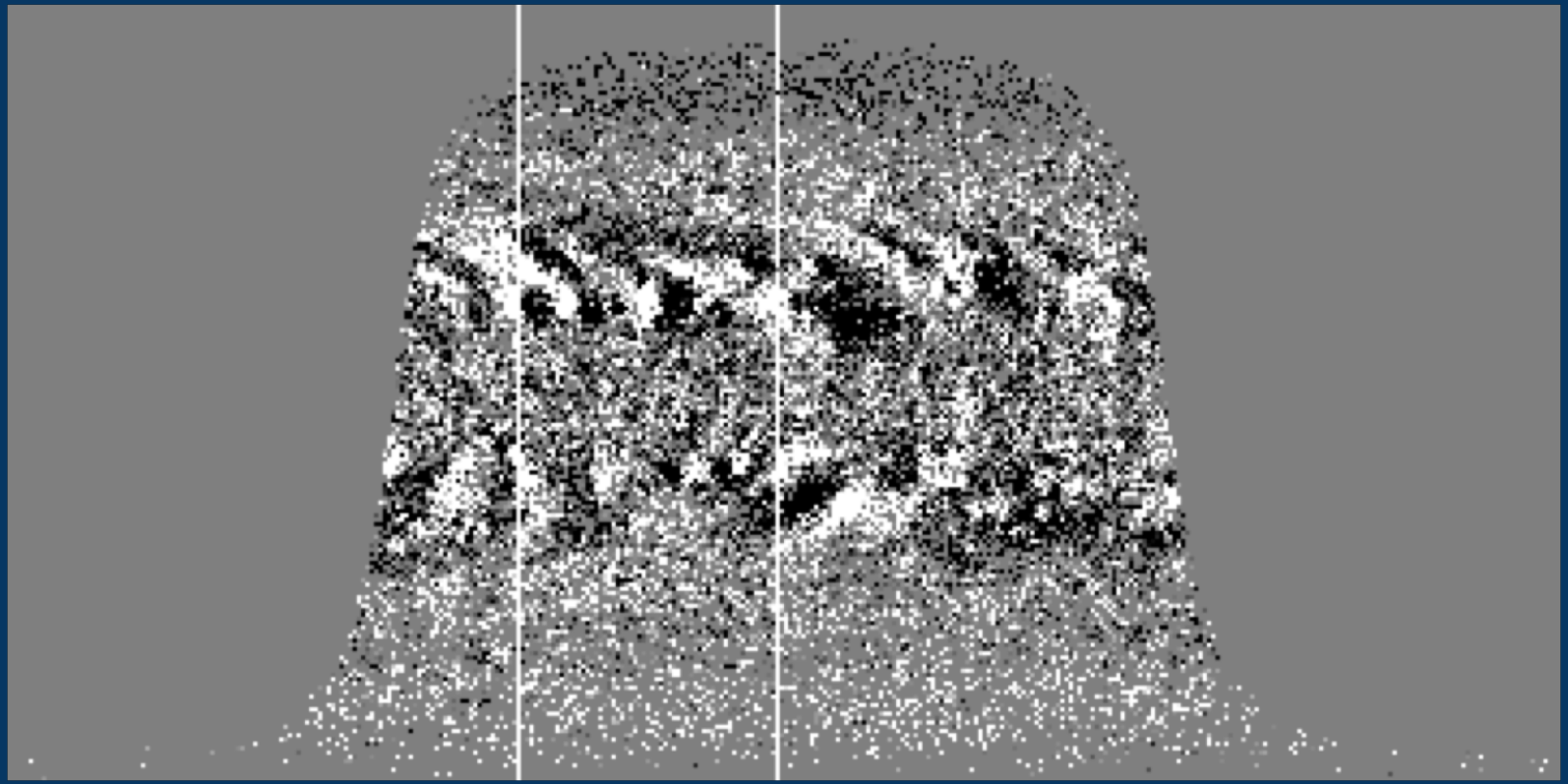
Can quantify the advantages by comparing the simulated magnetograms to the flux-transport model.



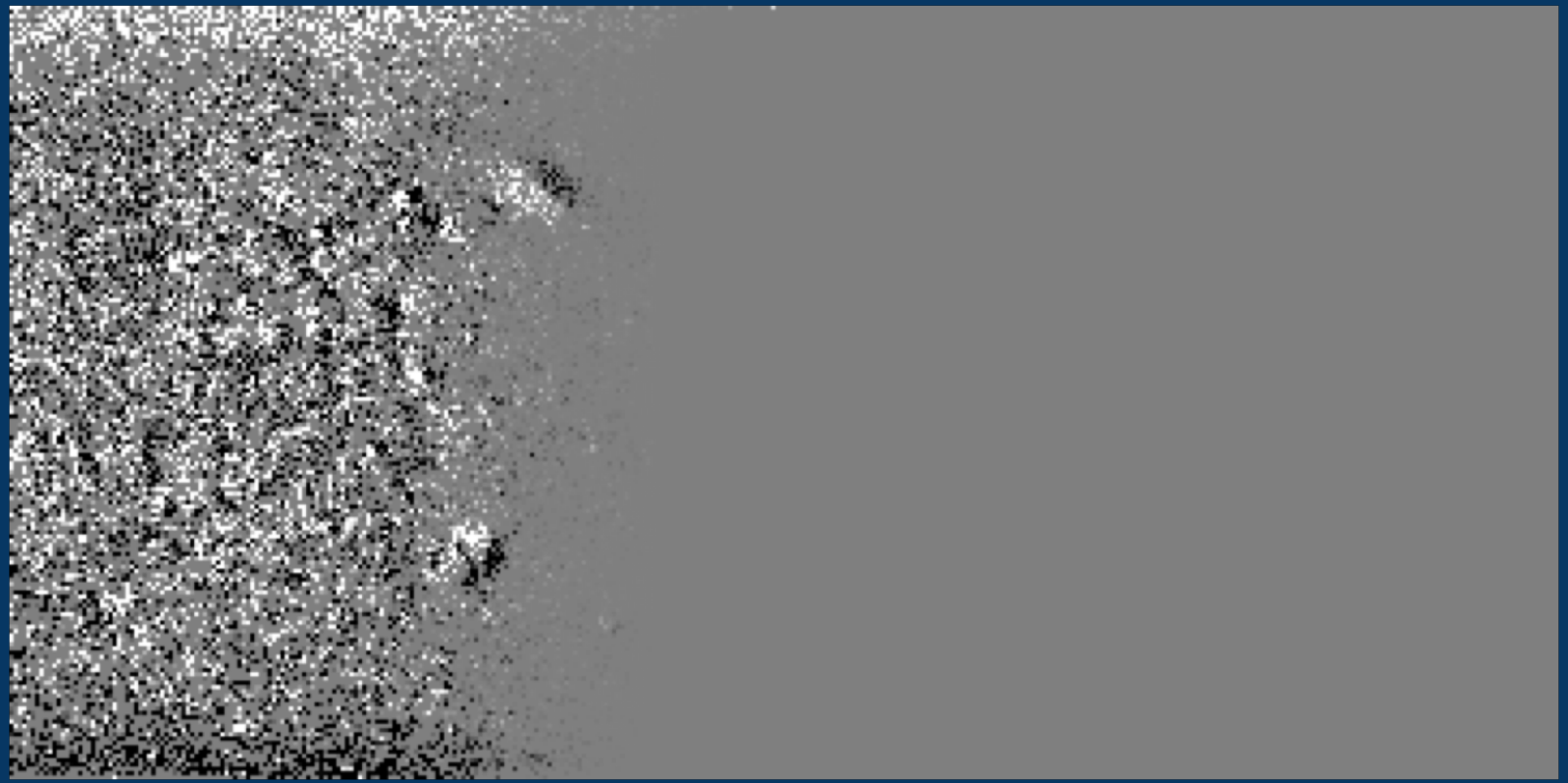
https://gong2.nso.edu/products/tableView/table.php?configFile=configs/synopticMaps.cfg



Synoptic Magnetograms

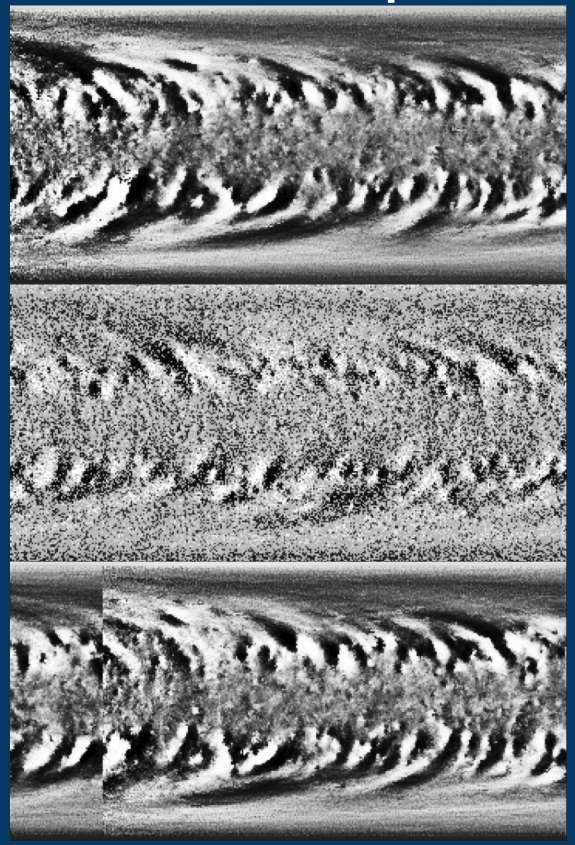


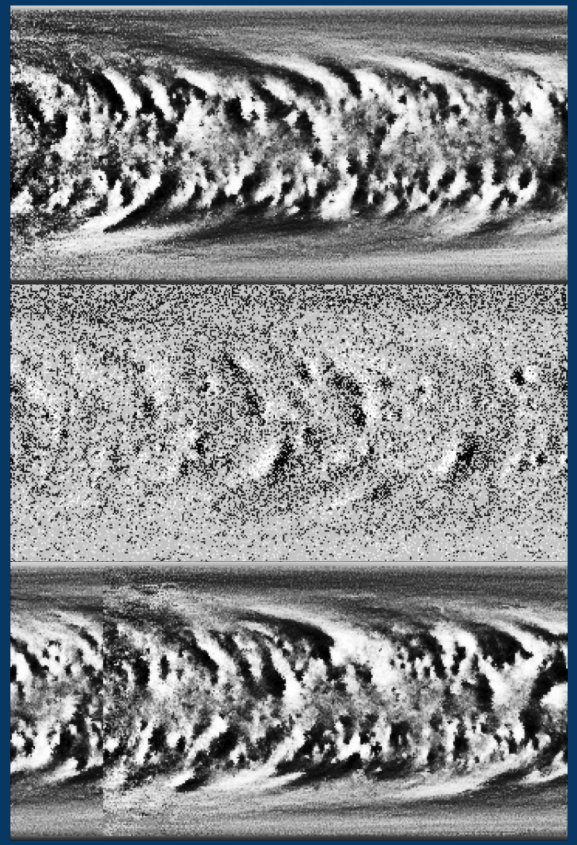
Near Real-Time Synoptic Magnetograms

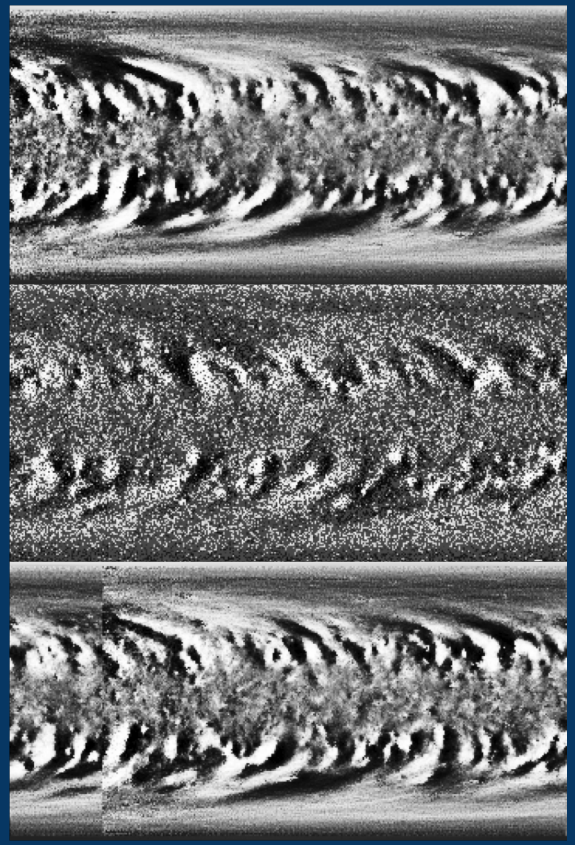


Comparisons and Analysis

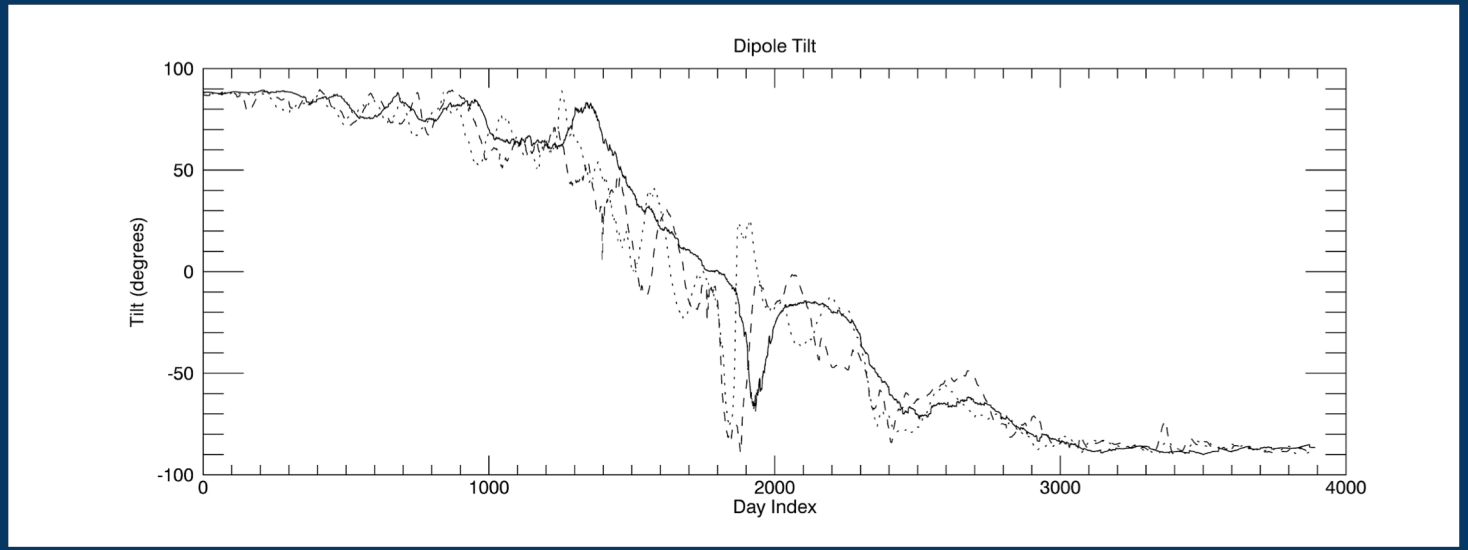
Three Maps:





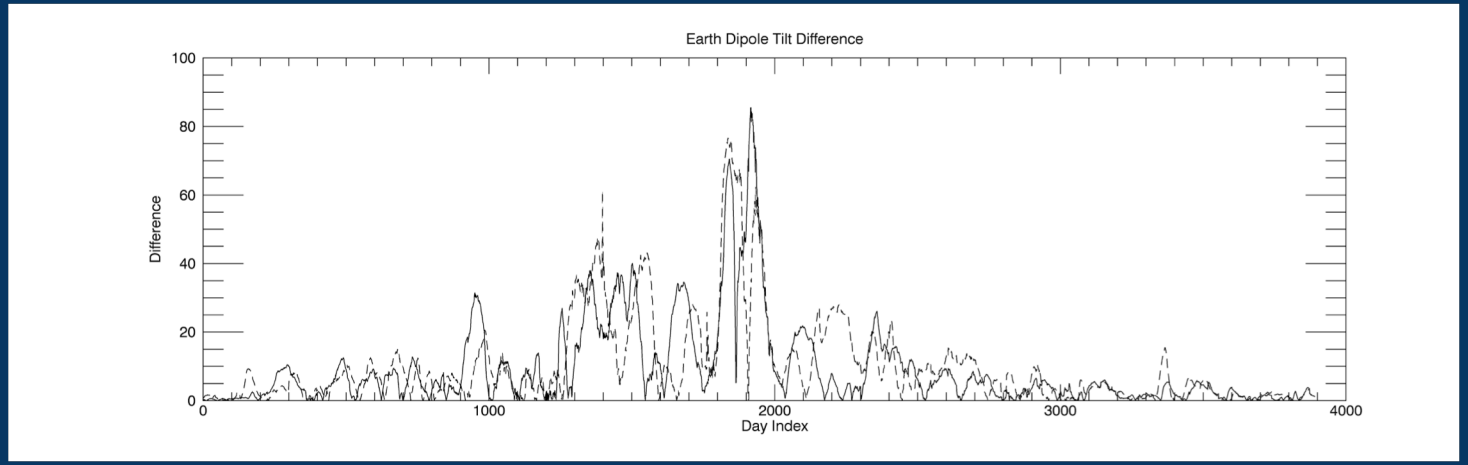


Dipole Coefficients



By calculating and comparing the dipole coefficients, we can see how far off the models were from the full-field flux transport model.

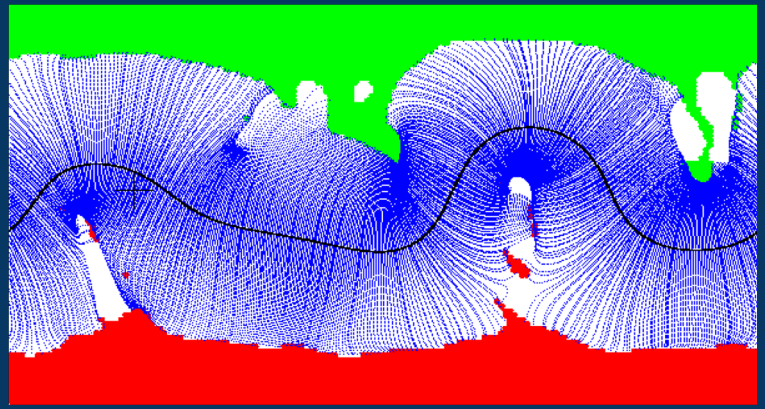
Dipole Differences

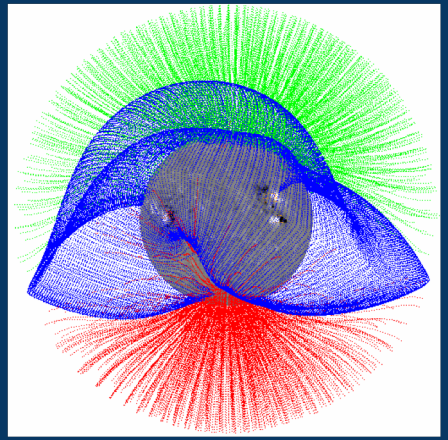


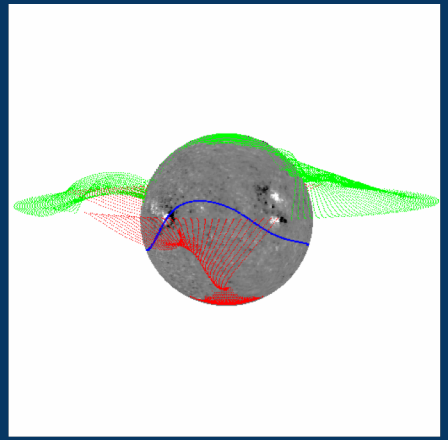
After finding the magnitude of the difference, I plotted them against each other to compare respective accuracies.

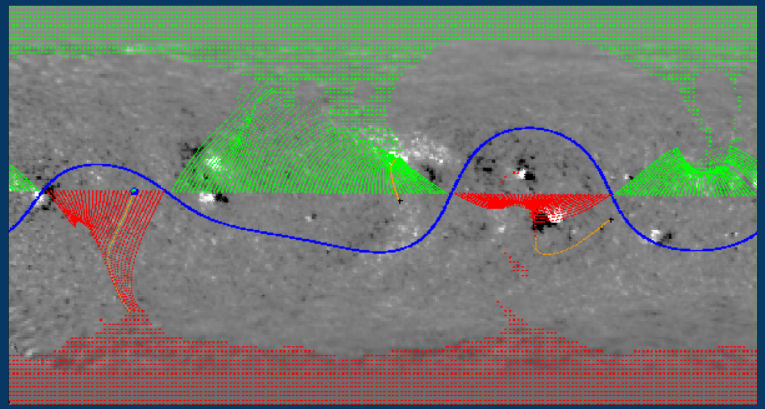
Potential-Field Source-Surface Model (PFSS)

The PFSS Model takes a full-field magnetogram and extrapolates an approximation of the coronal magnetic field.





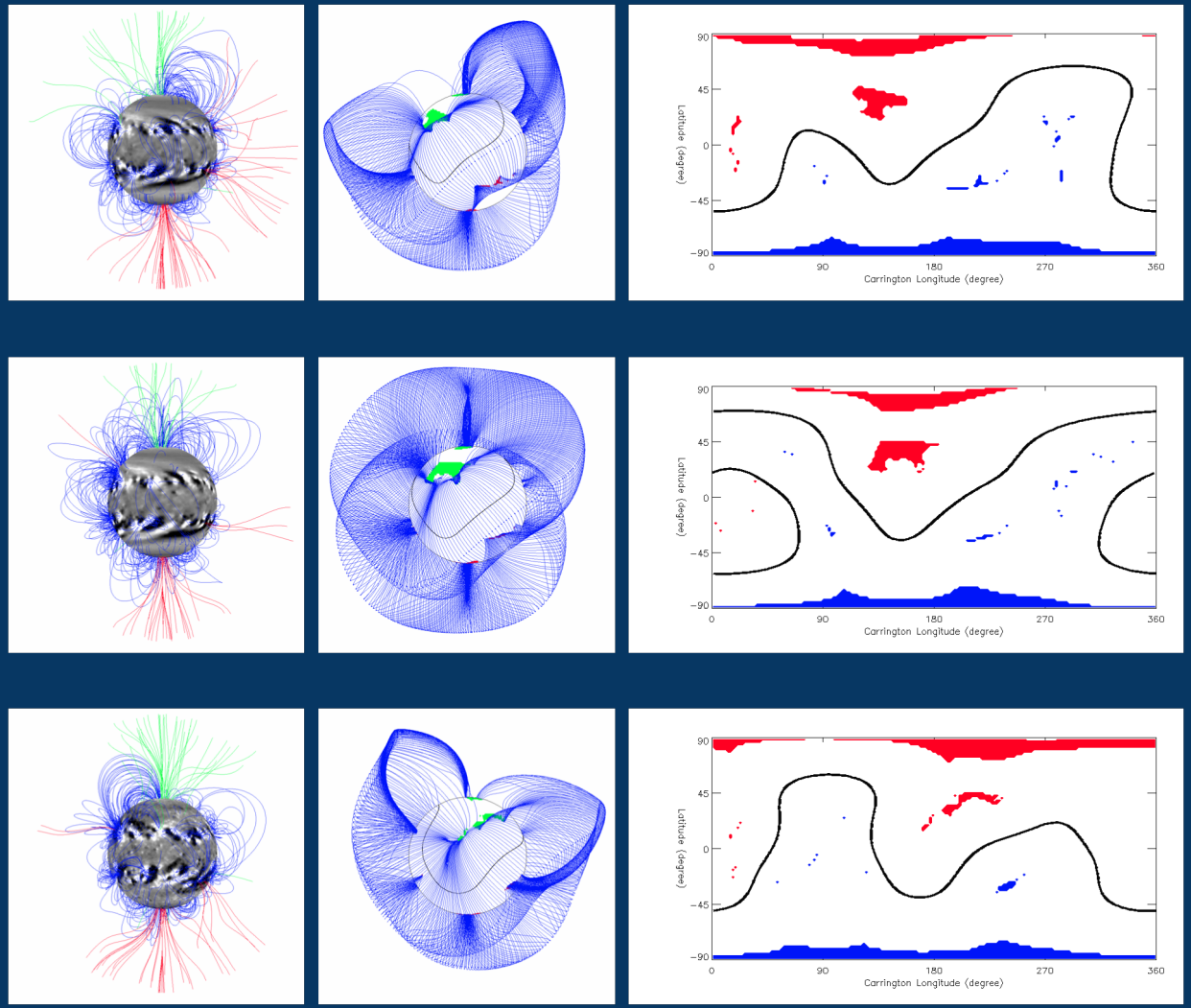




PFSS Results

Large Dipole difference magnitudes chosen. These are the easiest to quantify.

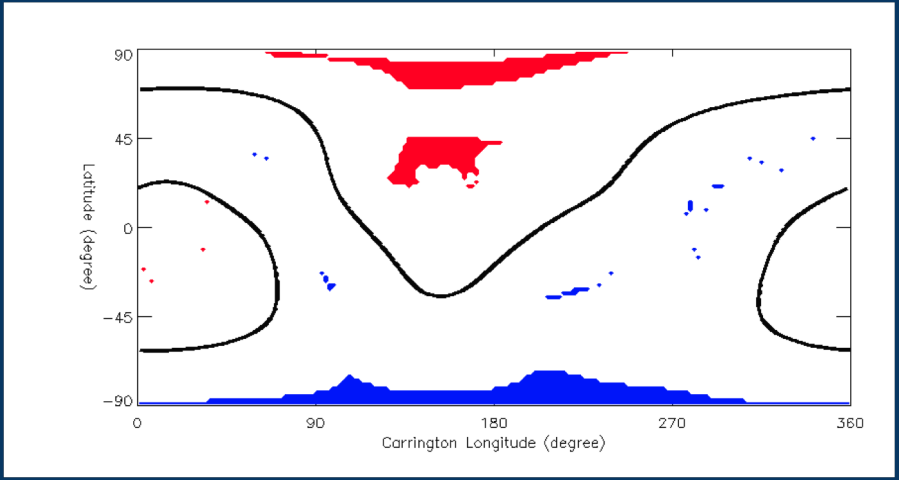
Hoping to see Earth-L5 model correlate with flux-transport model better than Earth only.

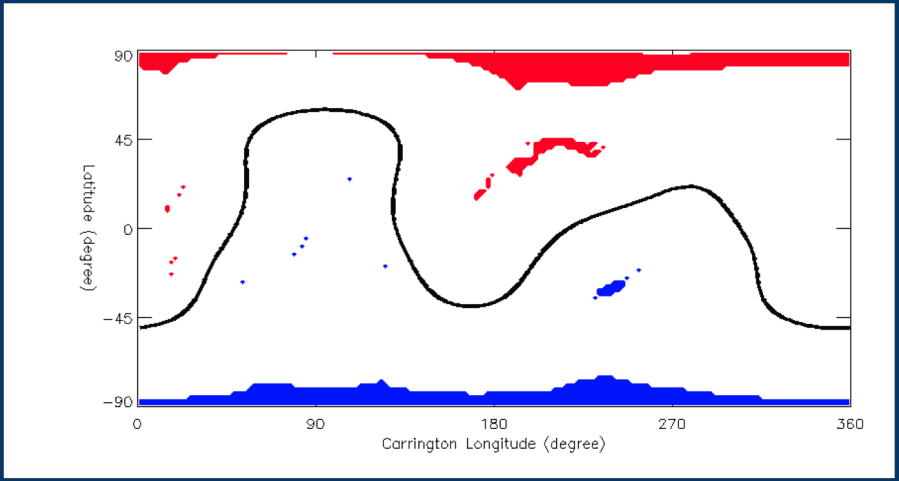


Drawing Conclusions

Intuitively, the benefits for a satellite at L5 should be obvious.

Because the neutral lines are not similar in shape, I was led to believe there was an error in the simulation.





What’s Next?

Currently, we are searching for the root error in the simulation.

The most probable error location is in the synoptic map creation.

BIG IDEA: With a quantified advantage to magnetograms from L5 combined with those from Earth/L1 we can get the ball rolling on improved data collection and analysis, improving our ability to forecast space weather.

Questions

Works Cited

Mackay, Duncan H., et al. “Impact Of An L5 Magnetograph On Nonpotential Solar Global Magnetic Field Modeling.” *The Astrophysical Journal*, vol. 825, no. 2, Dec. 2016, p. 131., doi:10.3847/0004-637x/825/2/131.

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