CCMC—USAFA Educational Activities

D. J. Knipp
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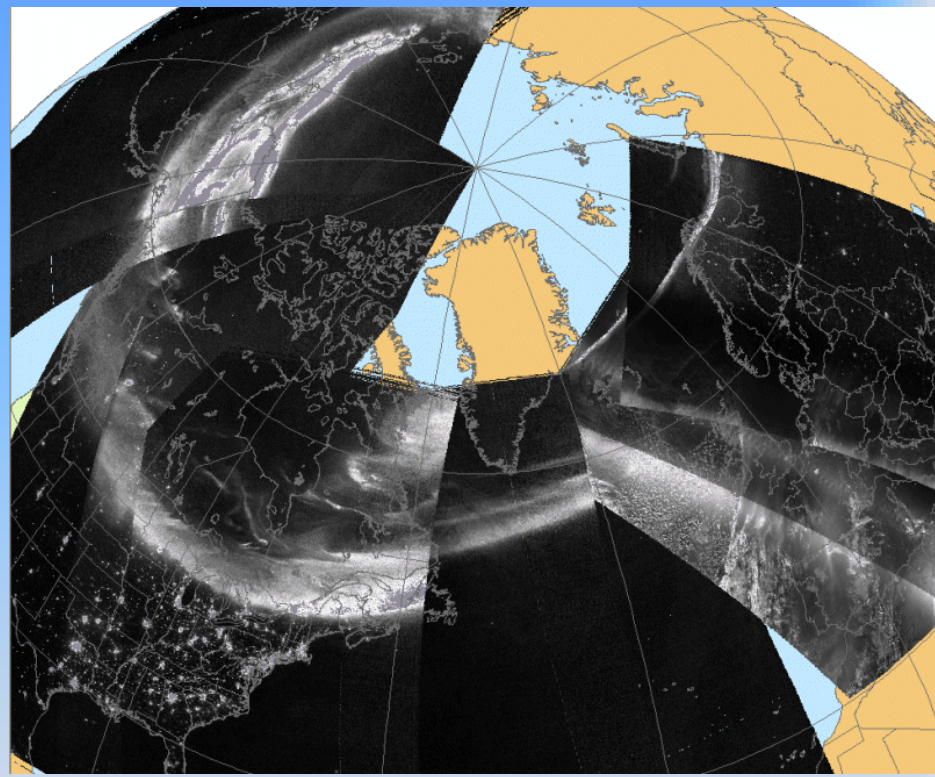
Department of Physics



Contributions by
Jacinda Knoll
C1C Brian Elliott
& Numerous CCMC Modelers

Overview

- Academy Emphasis on Space
- Academy Physics Courses
  - **Physics 371 Astronomy**
  - **Physics 453 Plasma**
  - **Physics 480 Astronomy Laboratory and Instrumentation**
  - **Physics 486 Astrophysics**
  - **Physics 499 Independent Study**
  - **Physics 370 Upper Atmosphere and Geospace Physics**
- Cadet Summer Research
- Future Efforts

Physics 370 Upper Atmosphere and Geospace Physics

- Junior course in Space Environment and Space Weather
- 3 credit course offered each spring
- Prerequisites: Physics I and II
- Required for
  - Meteorology
  - Space Operations
- Optional for Physics
  - Astronautical Engineering
    - Many from Small Satellite Program
  - Basic Sciences

Physics 370 Upper Atmosphere and Geospace Physics

- Enrollment steady at 45-50 each year
  - Largest physics service course offered to non-majors
- Challenging for students
  - Broad Survey of Space Environment Dynamics and Effects
  - 200-300 New Terms
  - Recall and Use Basic Physics They “hoped they could forget”
- Challenging for instructors
  - Diverse Student Backgrounds, GPAs and Math Sophistication
  - Meaningful Problem Sets
  - Visualization
  - Toy Models and not so Toy Models
- Source of CCMC Cadet Summer Researchers

Physics 370 Upper Atmosphere and Geospace Physics

- 40 One Hour Lessons
  - Review relevant Physics I and II
  - Introduce Basic Plasma
  - The Quiescent Space Environment (Linkages)
    - Sun and Upper Atmosphere
    - Solar Wind
    - Magnetosphere
    - Upper Atmosphere
  - The Active Space Environment and Weather (Drivers& Response)
    - Sun and Solar Wind
    - Magnetosphere
    - Upper Atmosphere
  - Impacts
    - Humans and Hardware
    - Signals
    - Systems

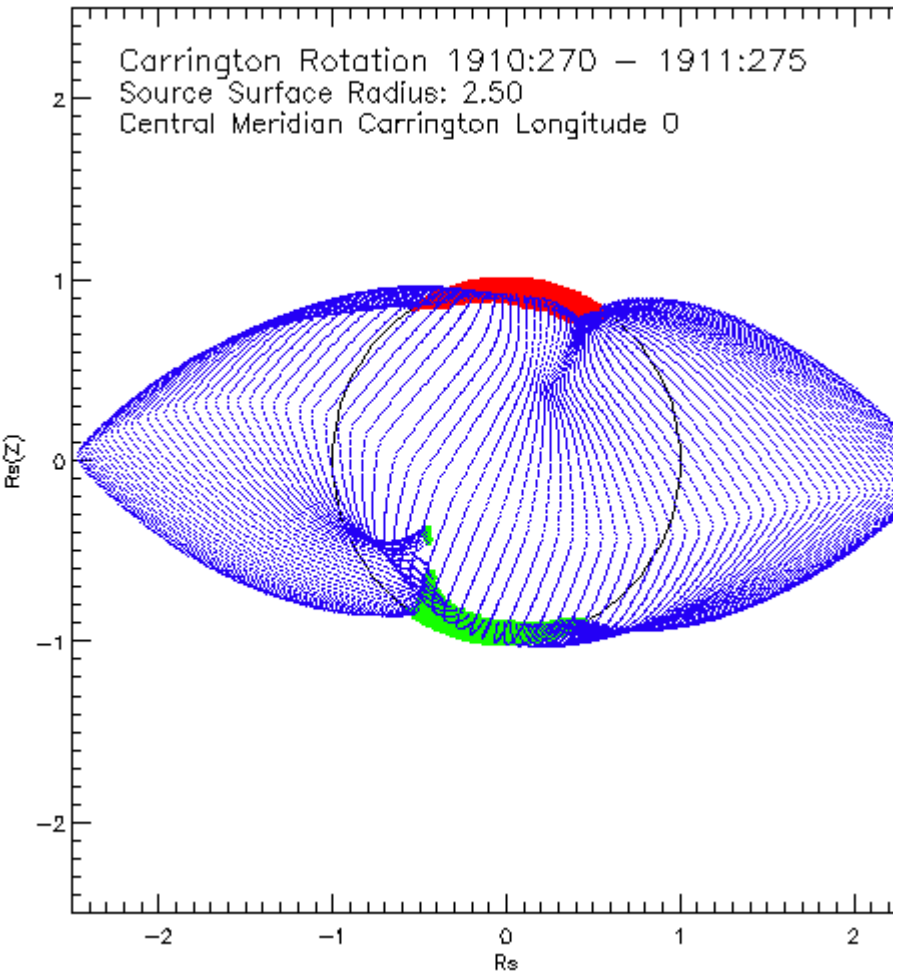
Physics 370 Upper Atmosphere and Geospace Physics

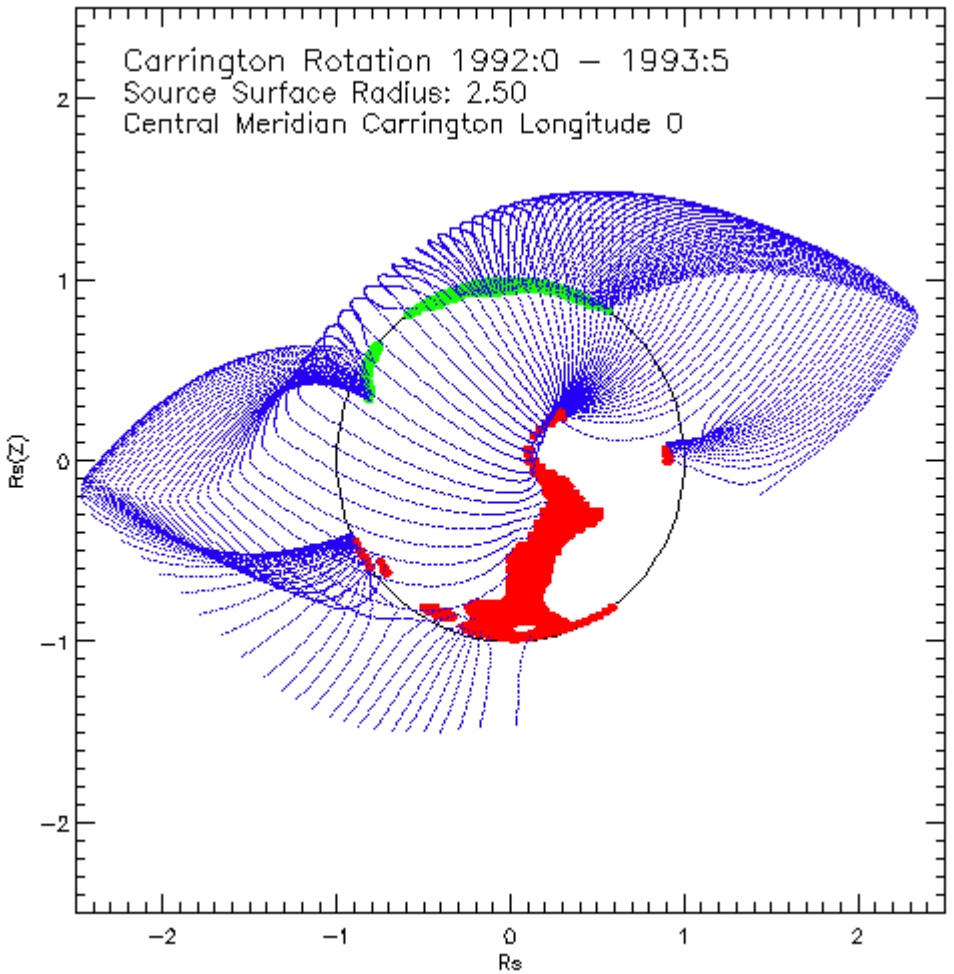
- Learning Challenges
  - Non Black Body Radiation
  - Plasma
  - The Particle Zoo
  - Solar Wind with Embedded Magnetic Field
  - Magnetospheric Convection
  - Plasmasphere-Radiation Belts
  - Magnetosphere-Ionosphere Coupling
  - Thermosphere-Ionosphere Coupling

Contributions from CCMC Models

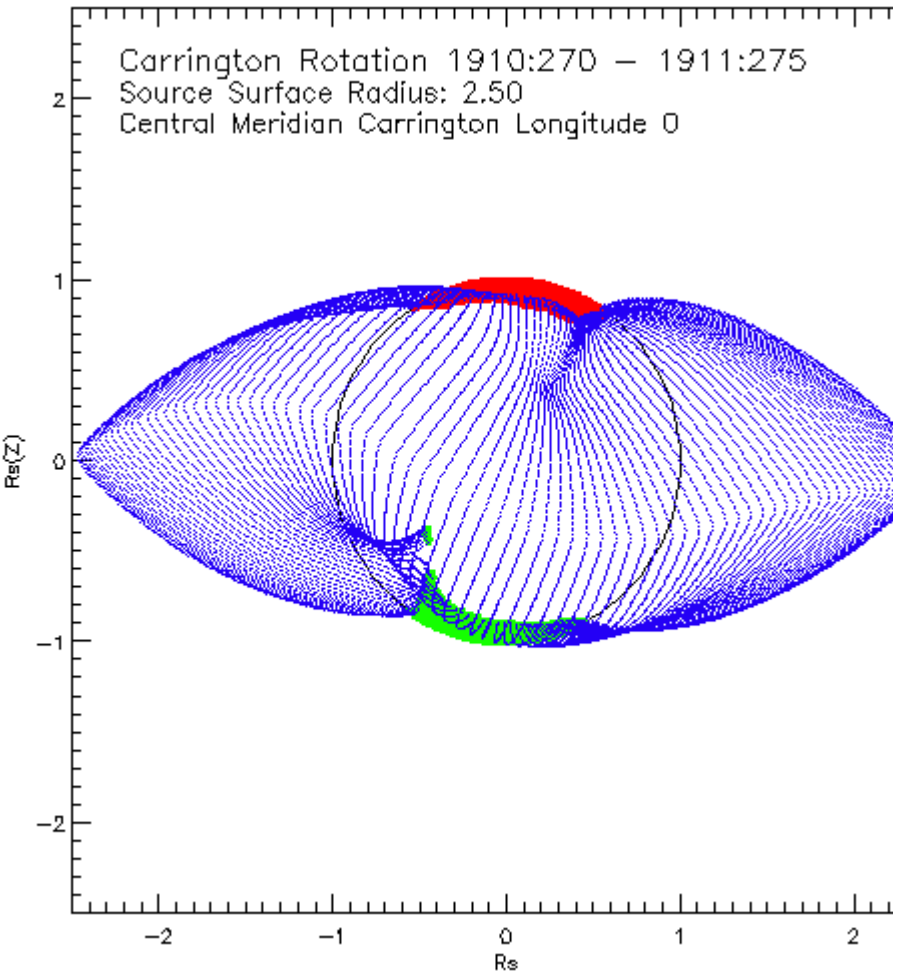
- Solar Coordinates
- Upper Atmosphere
- Corona and Magnetic Field
  - High Speed Streams
  - Closed/Open Field Lines
  - Active Regions
- Magnetospheric Response

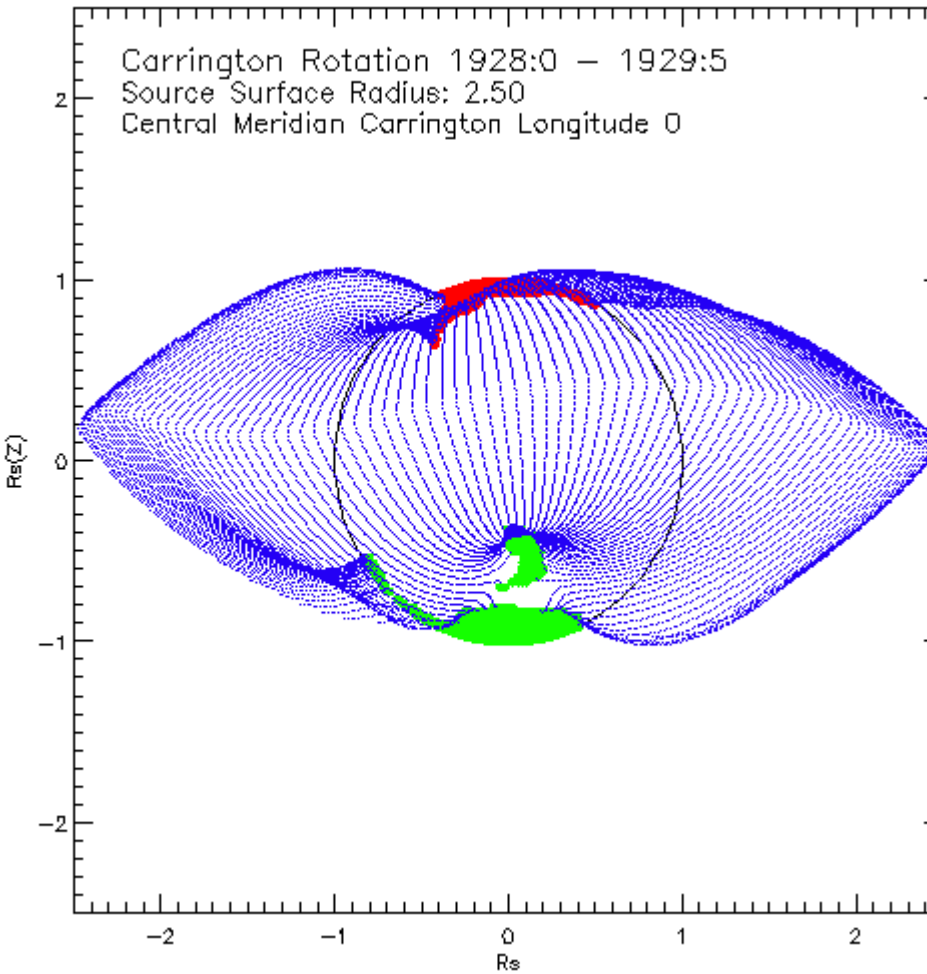
PFSS Synoptic





PFSS Synoptic





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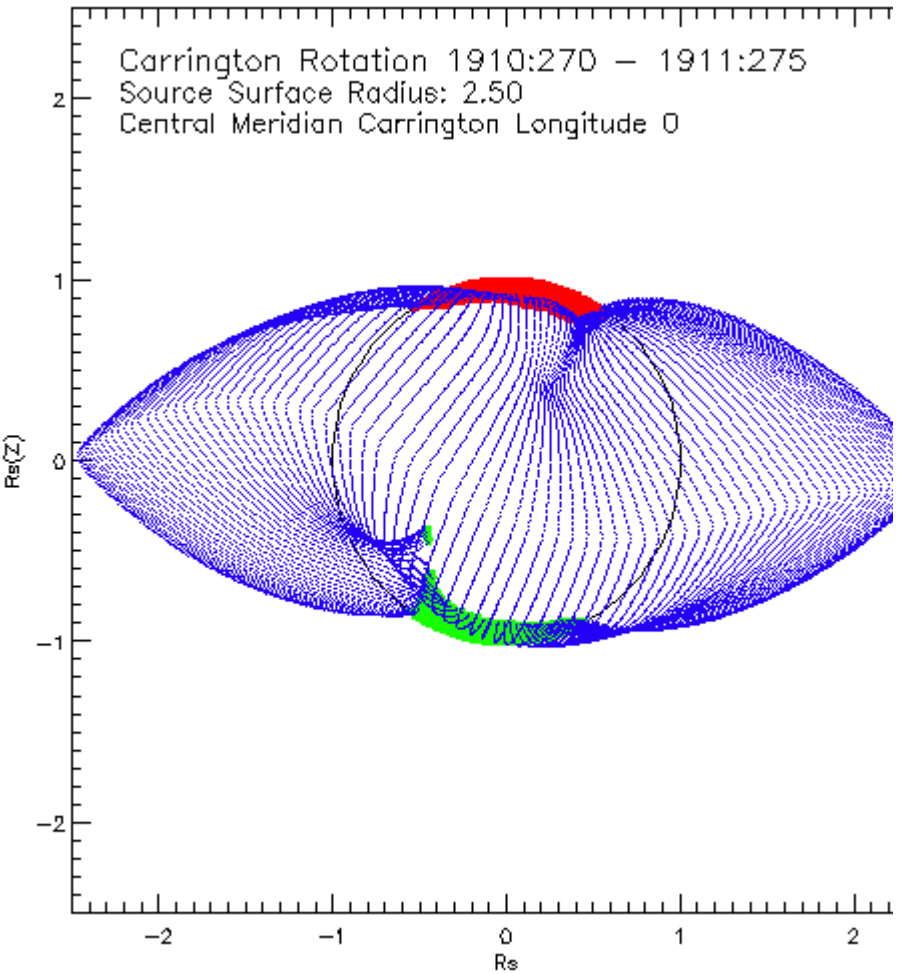

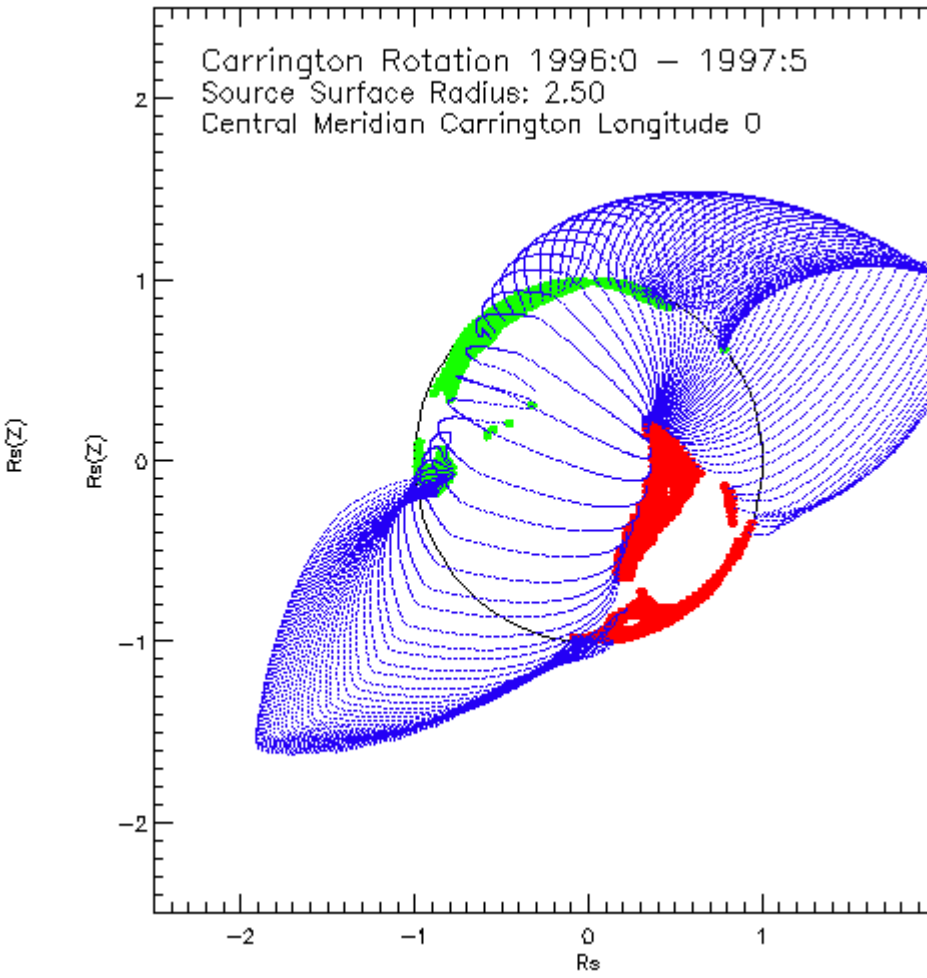

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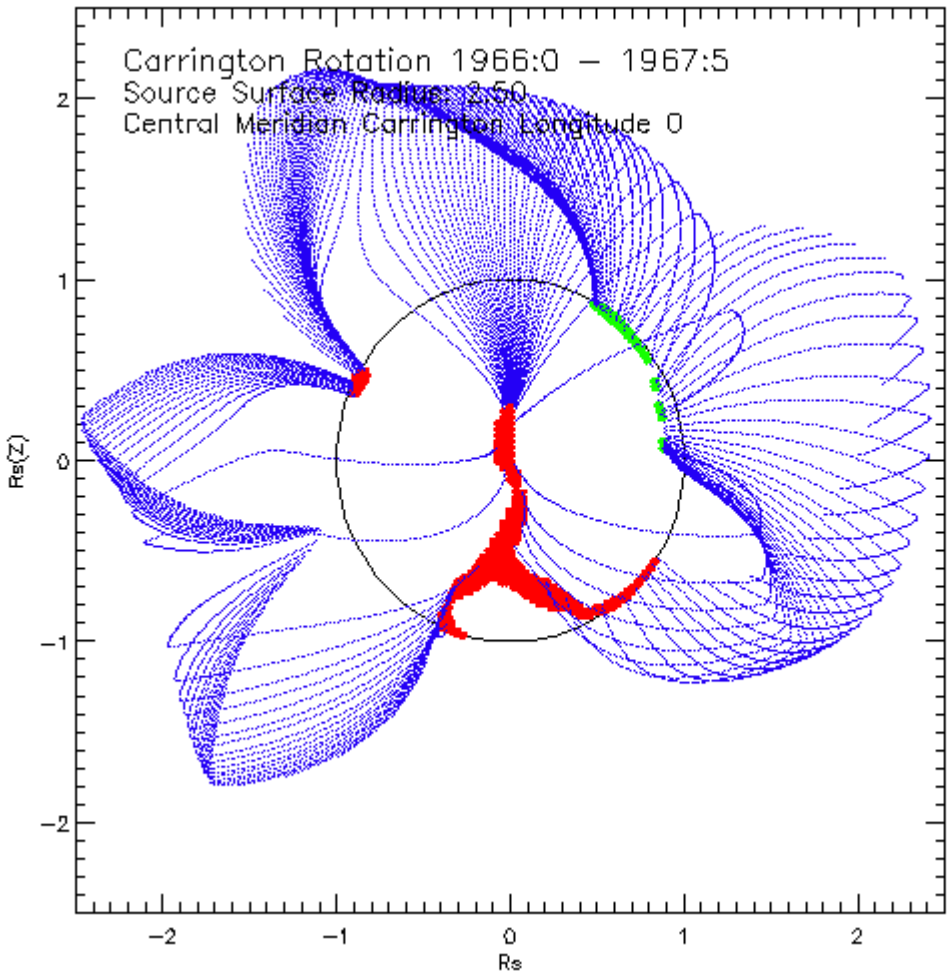
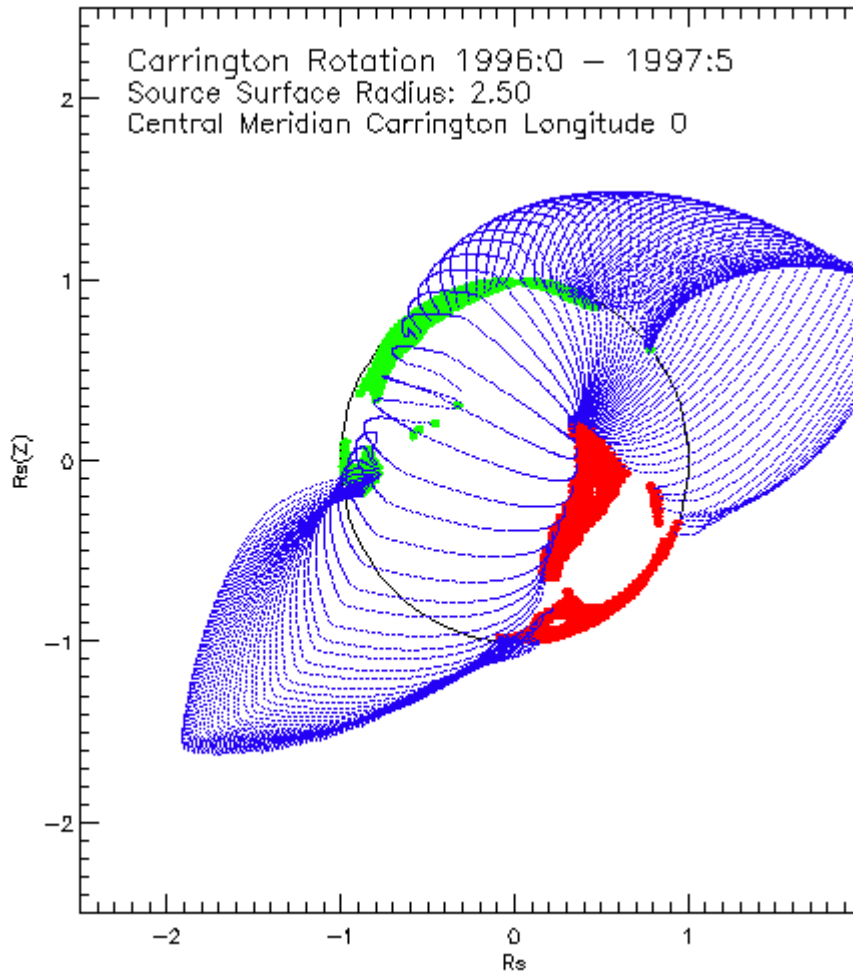
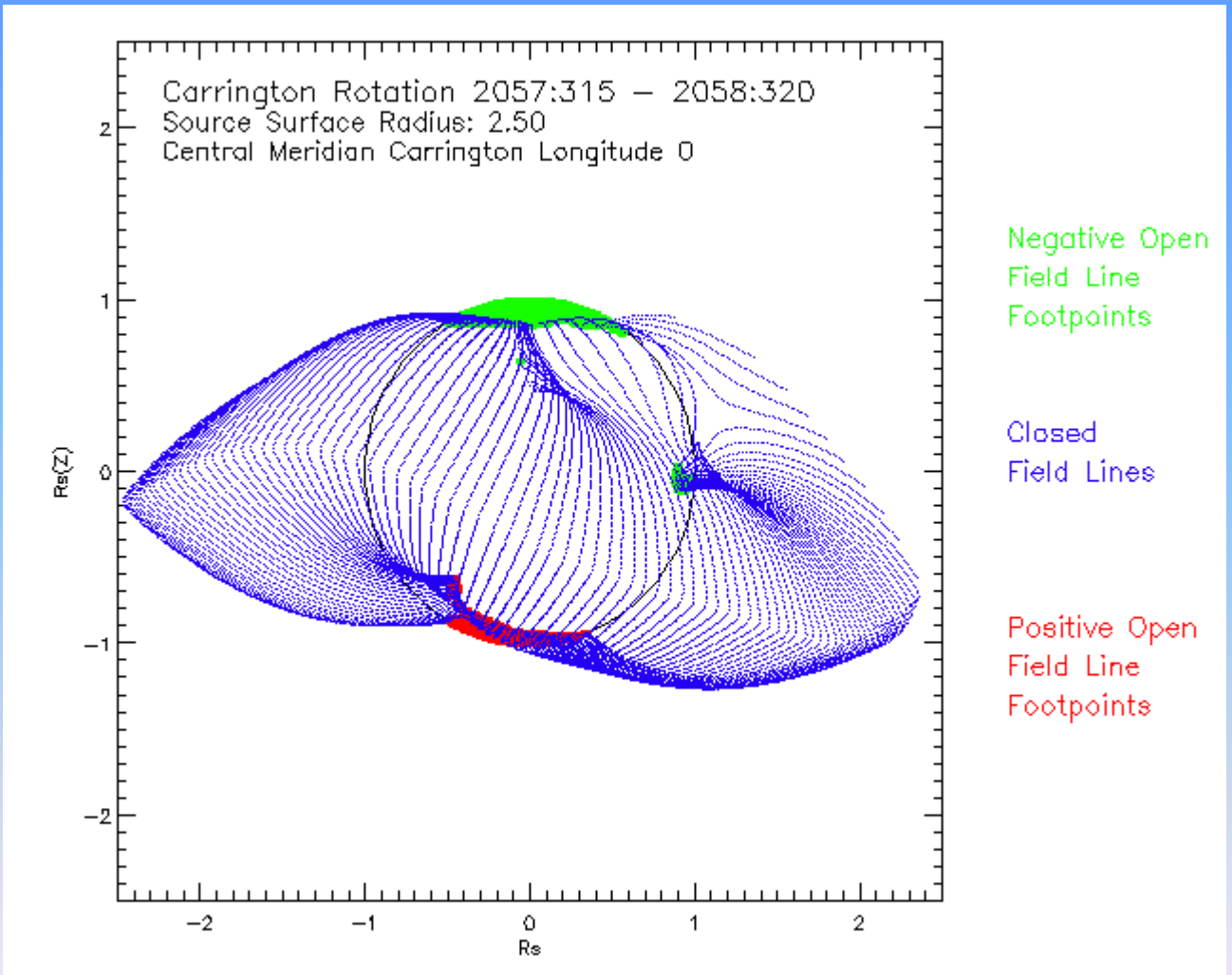
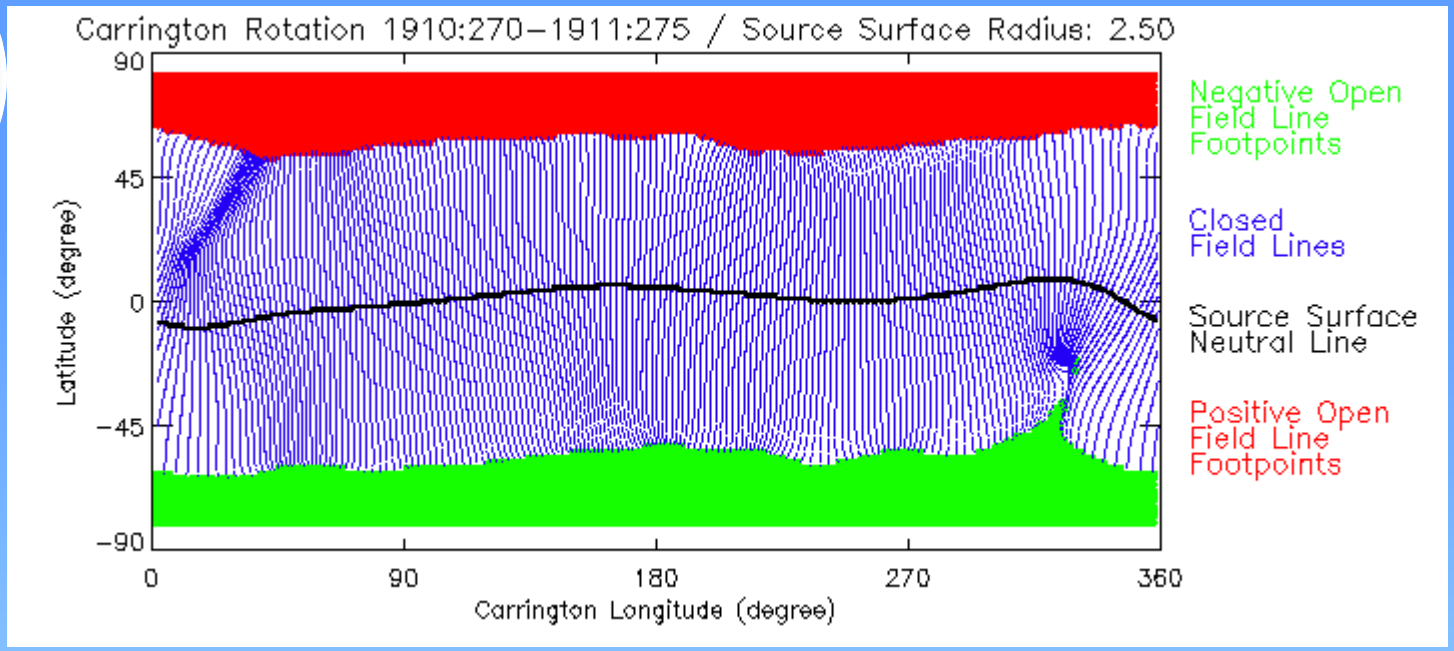




PFSS Synoptic

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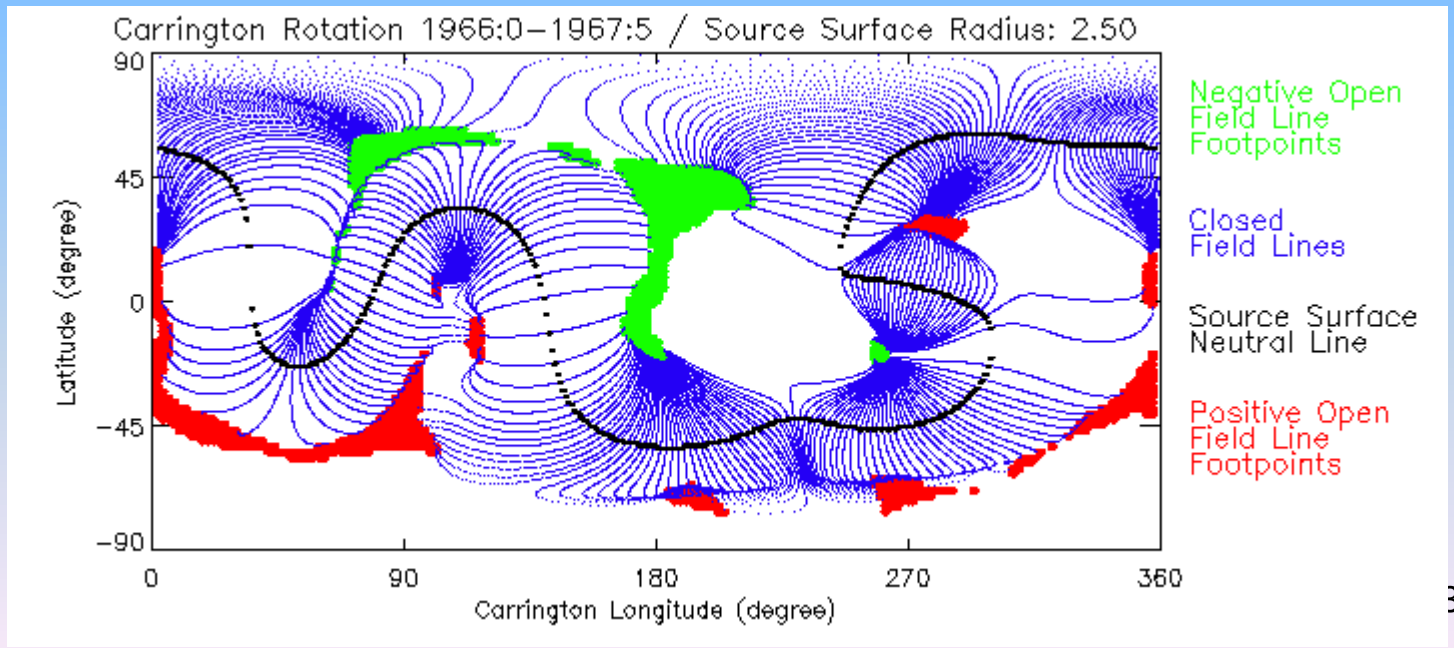
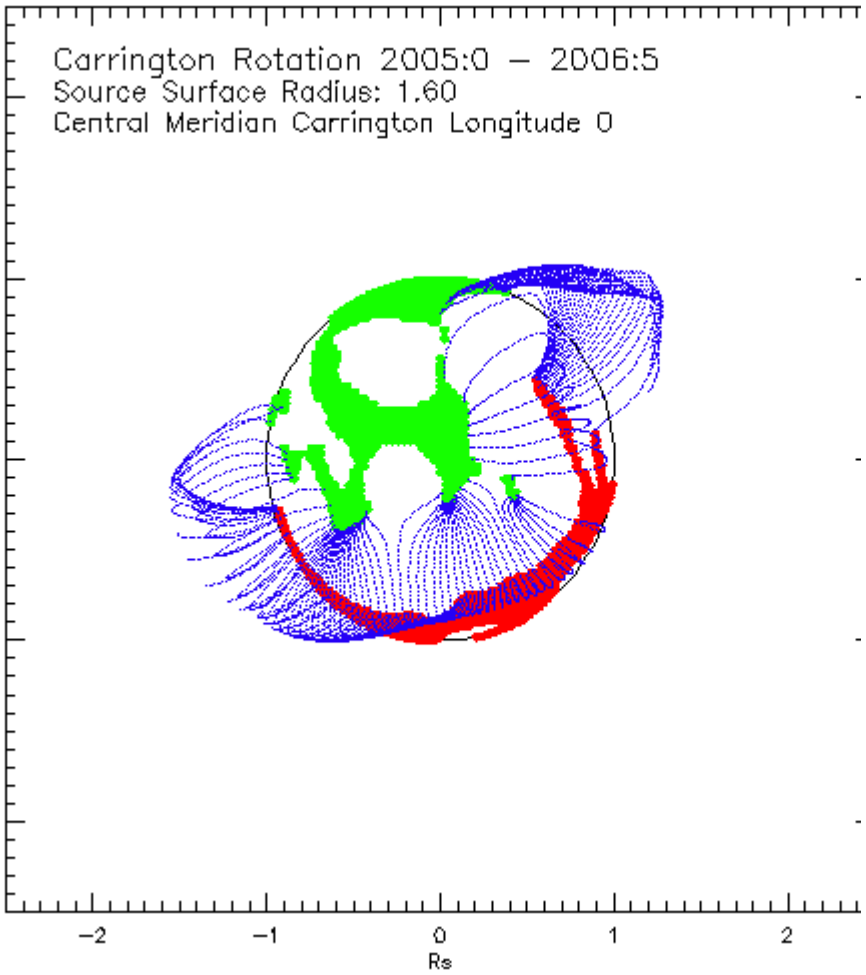
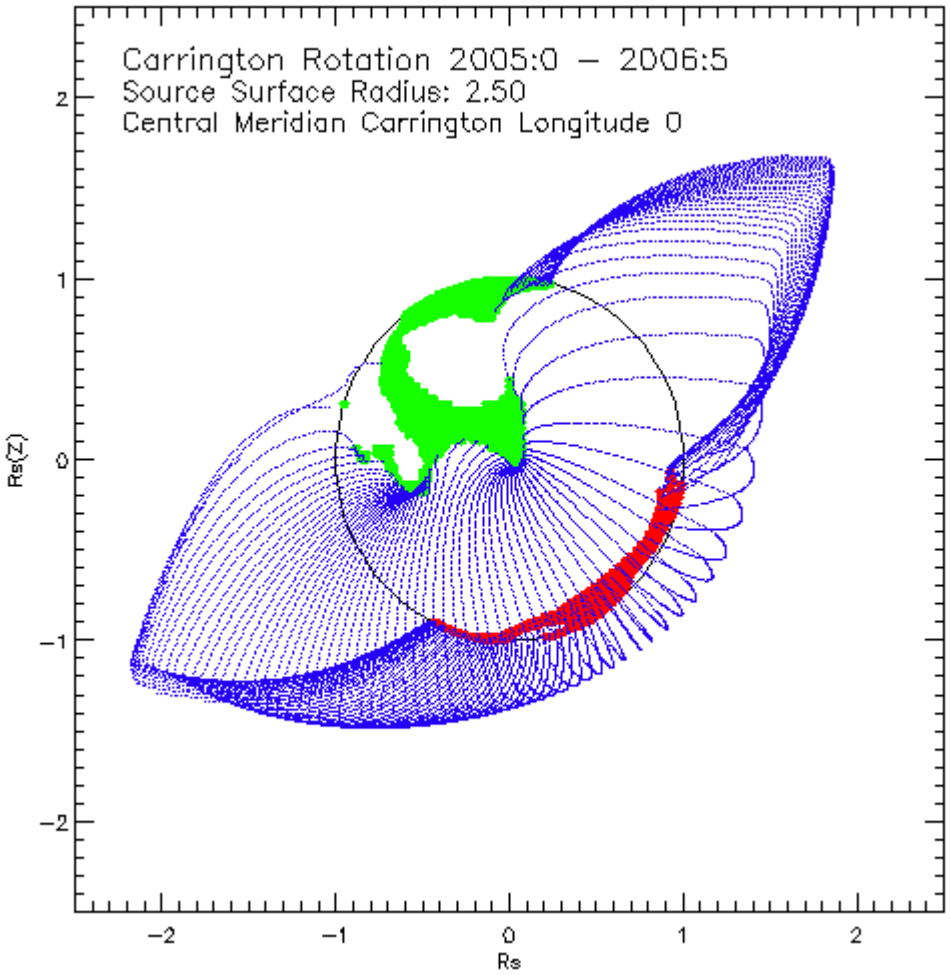
90
45
0
−45
−90
Latitude (degree)
0
90
180
270
360
Carrington Longitude (degree)
Negative Open Field Line Footpoints
Closed Field Lines
Source Surface Neutral Line
Positive Open Field Line Footpoints

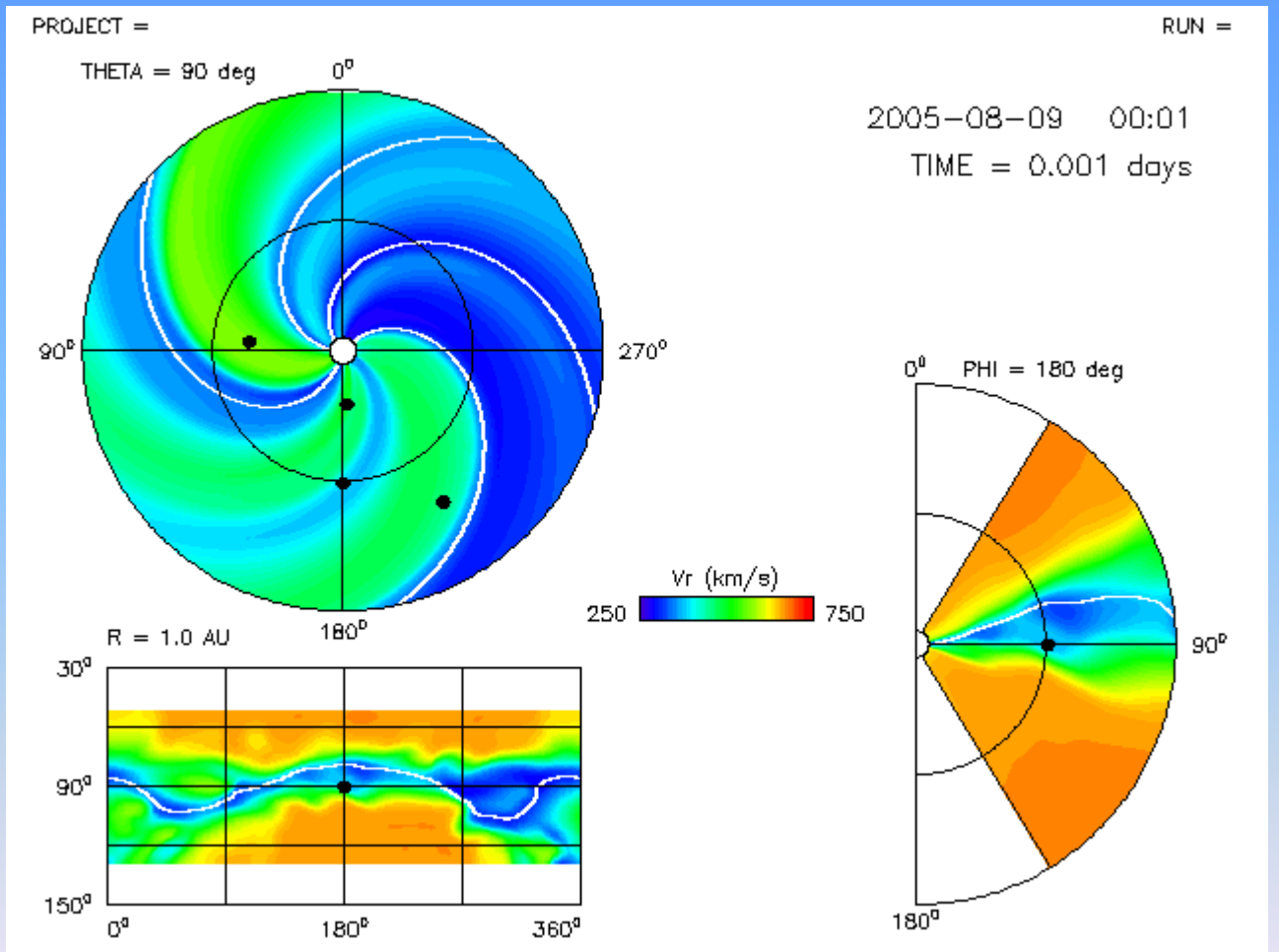

Carrington Rotation 1966:0–1967:5 / Source Surface Radius: 2.50
90
45
0
−45
−90
Latitude (degree)
0
90
180
270
360
Carrington Longitude (degree)
Negative Open Field Line Footpoints
Closed Field Lines
Source Surface Neutral Line
Positive Open Field Line Footpoints

Inner and Outer Corona





Cone Model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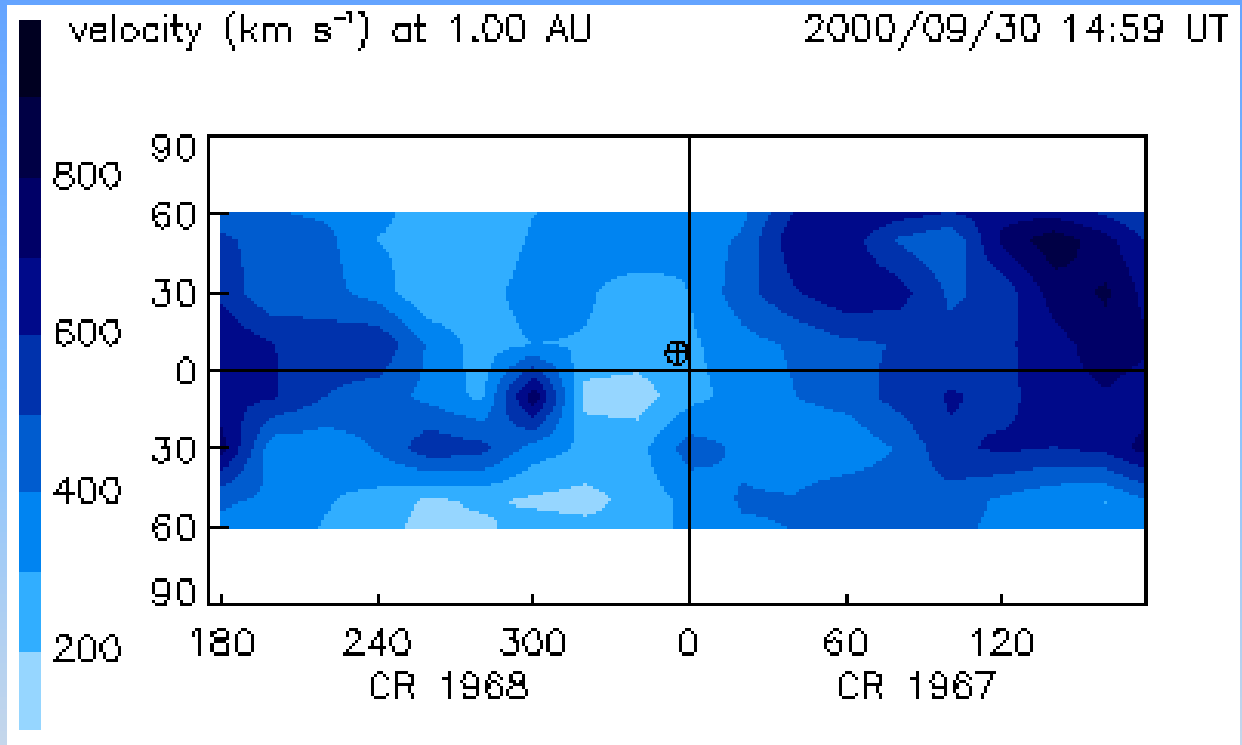
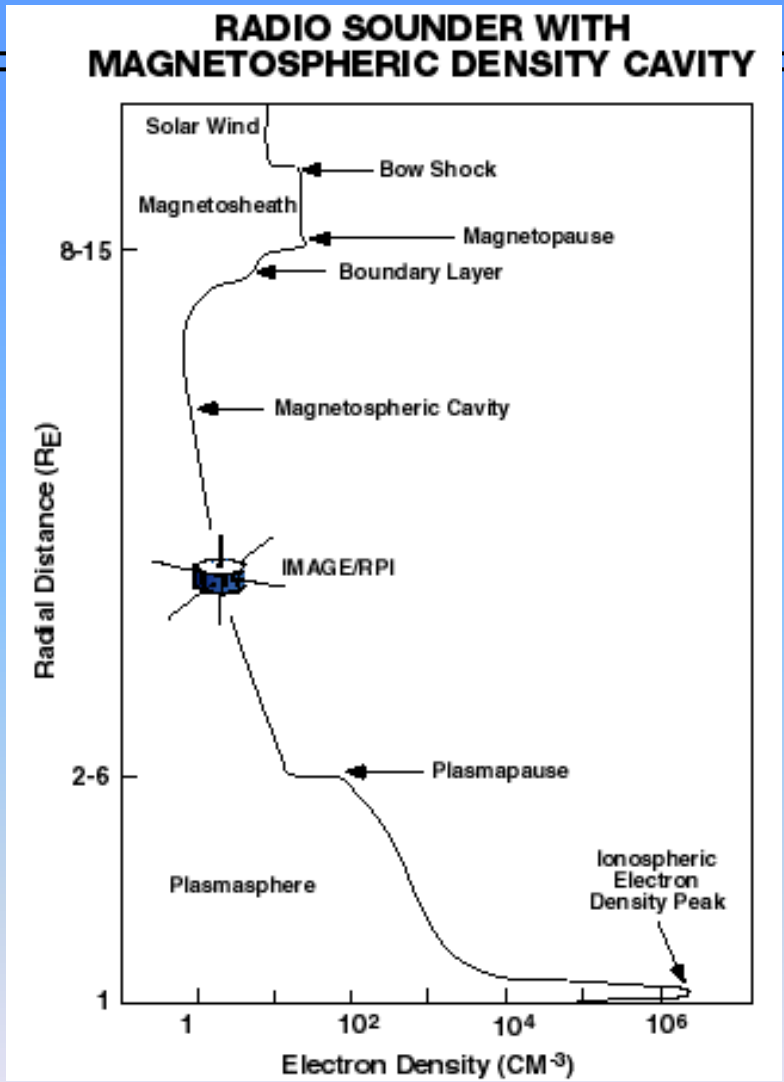
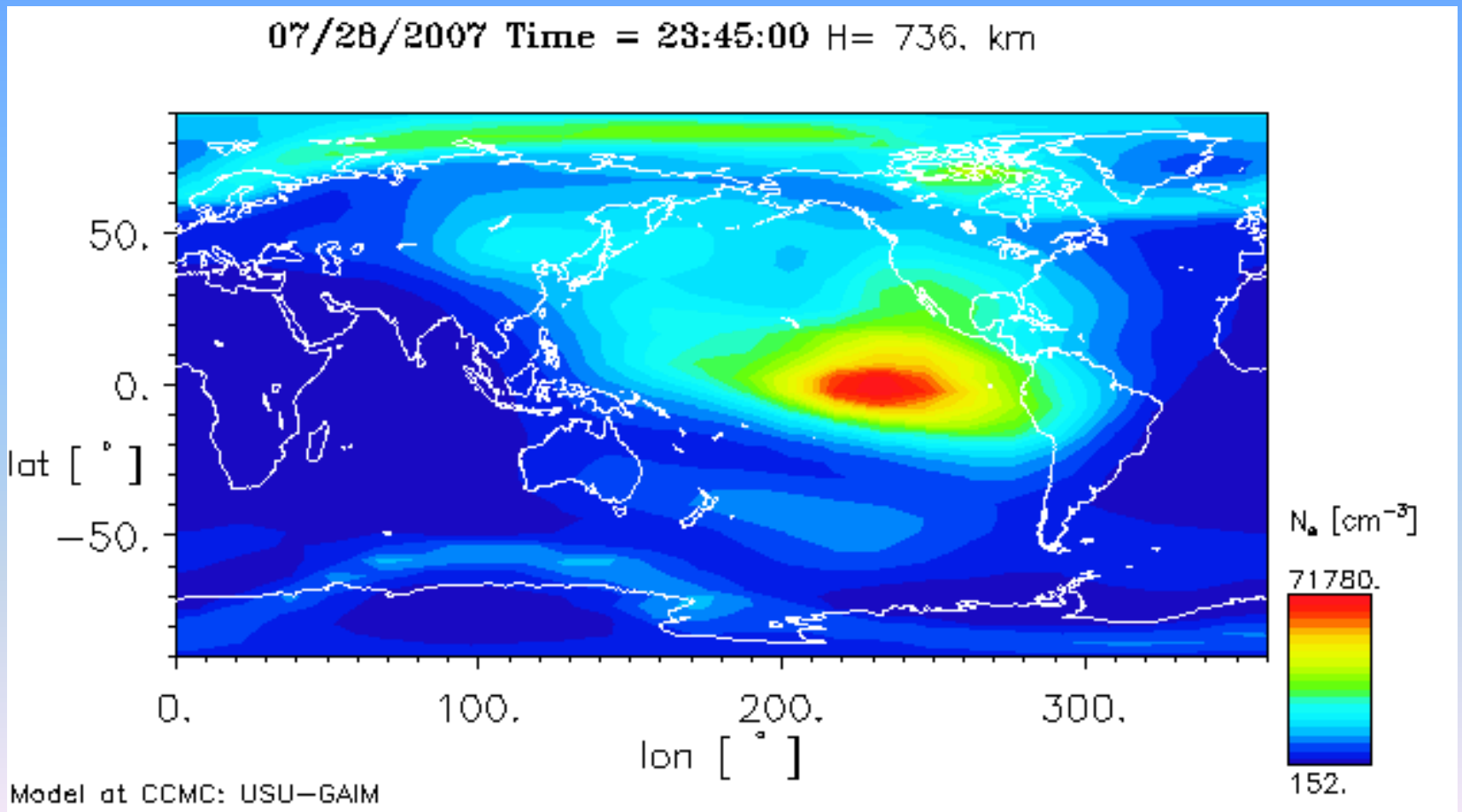
RUN =
THETA = 90 deg
0°
2005-08-09 00:01
TIME = 0.001 days
90°
270°
180°
Vr (km/s)
250
750
R = 1.0 AU
30°
90°
150°
0°
180°
360°
0°
PHI = 180 deg
90°
180°

ENLIL
High Speed Streams




RADIO SOUNDER WITH
MAGNETOSPHERIC DENSITY CAVITY
Solar Wind
Bow Shock
Magnetosheath
Magnetopause
Boundary Layer
Magnetospheric Cavity
IMAGE/RPI
Plasmapause
Plasmasphere
Ionospheric
Electron
Density Peak
8-15
2-6
1
Radial Distance (R_E)
1
10^2
10^4
10^6
Electron Density (CM^{-3})

Ionosphere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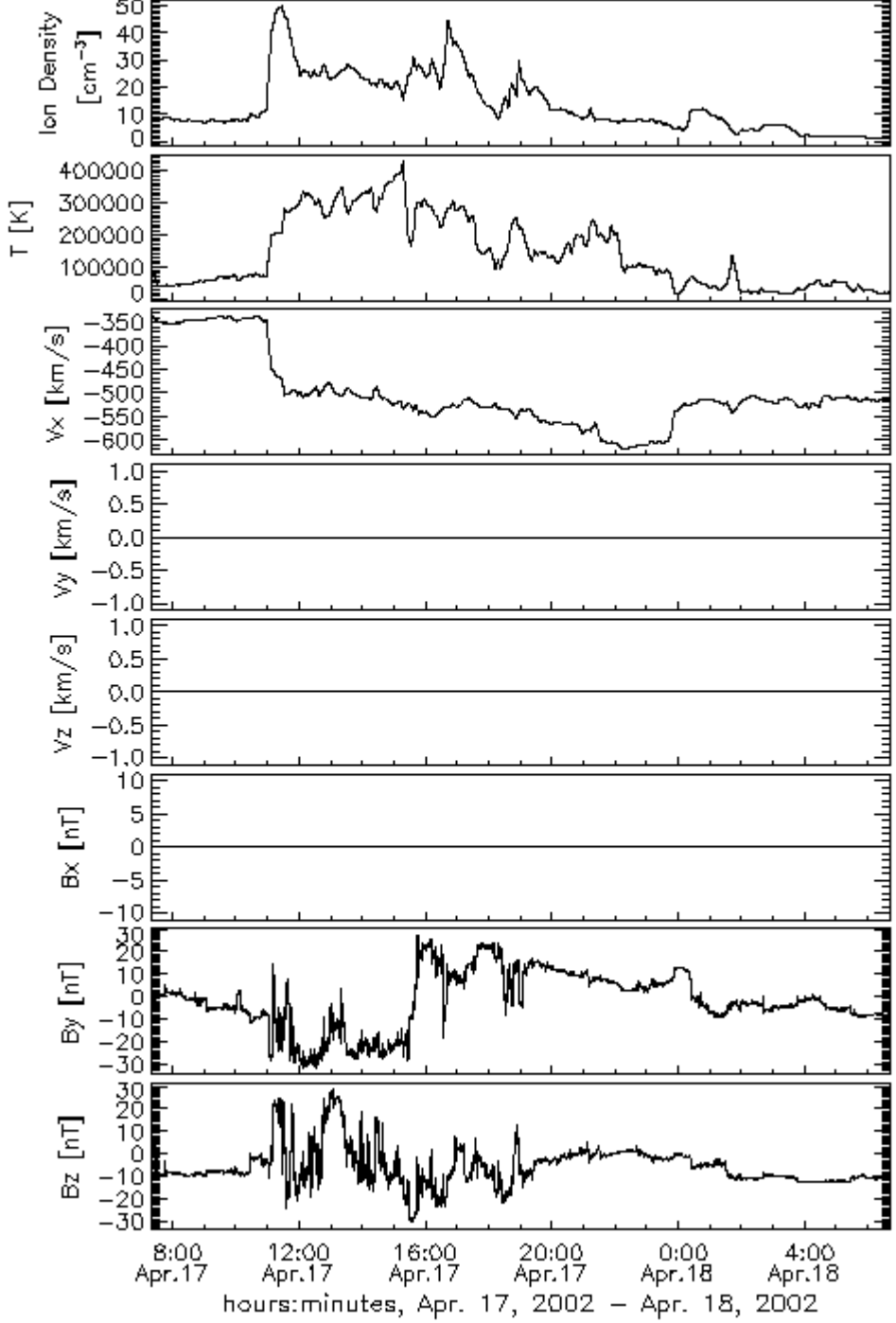
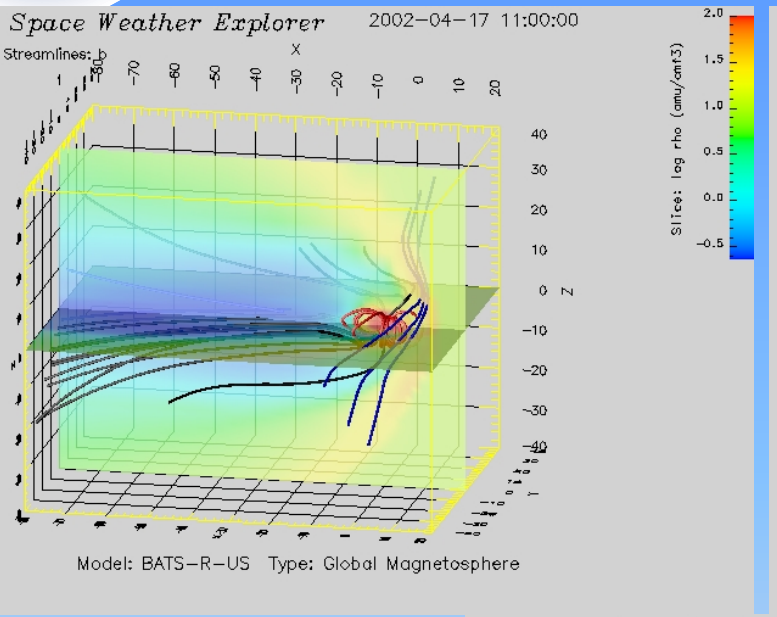
50.
0.
−50.
lat [°]
0.
100.
200.
300.
lon [°]
N$_e$ [cm^{-3}]
71780.
152.
Model at CCMC: USU−GAIM

End of Course Diagnostic: What do you expect?

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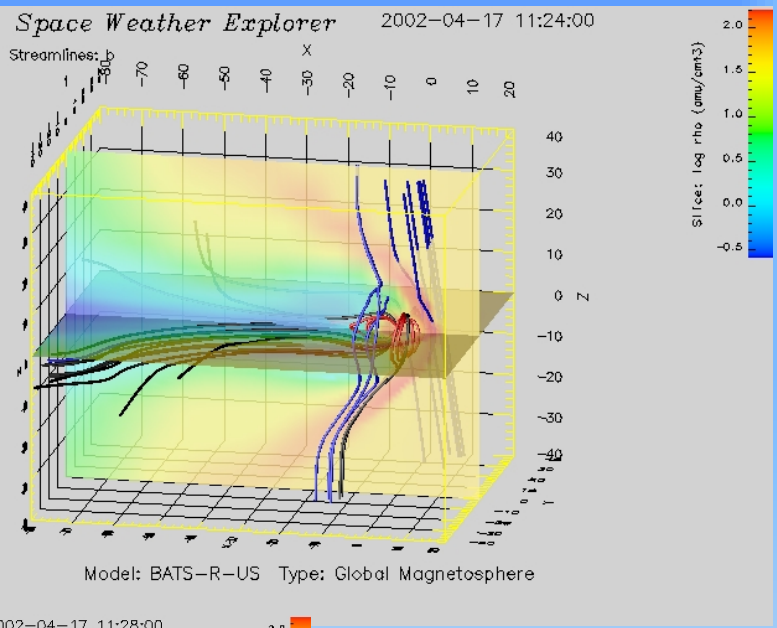
Streamlines:
Slice: log rho (amu/cm^3)
Model: BATS-R-US Type: Global Magnetosphere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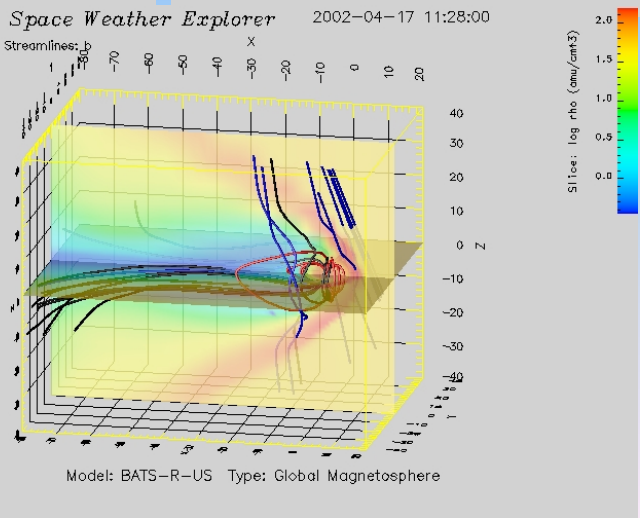
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Streamlines:
Slice: log rho (amu/cm^3)
Model: BATS-R-US Type: Global Magnetosphere

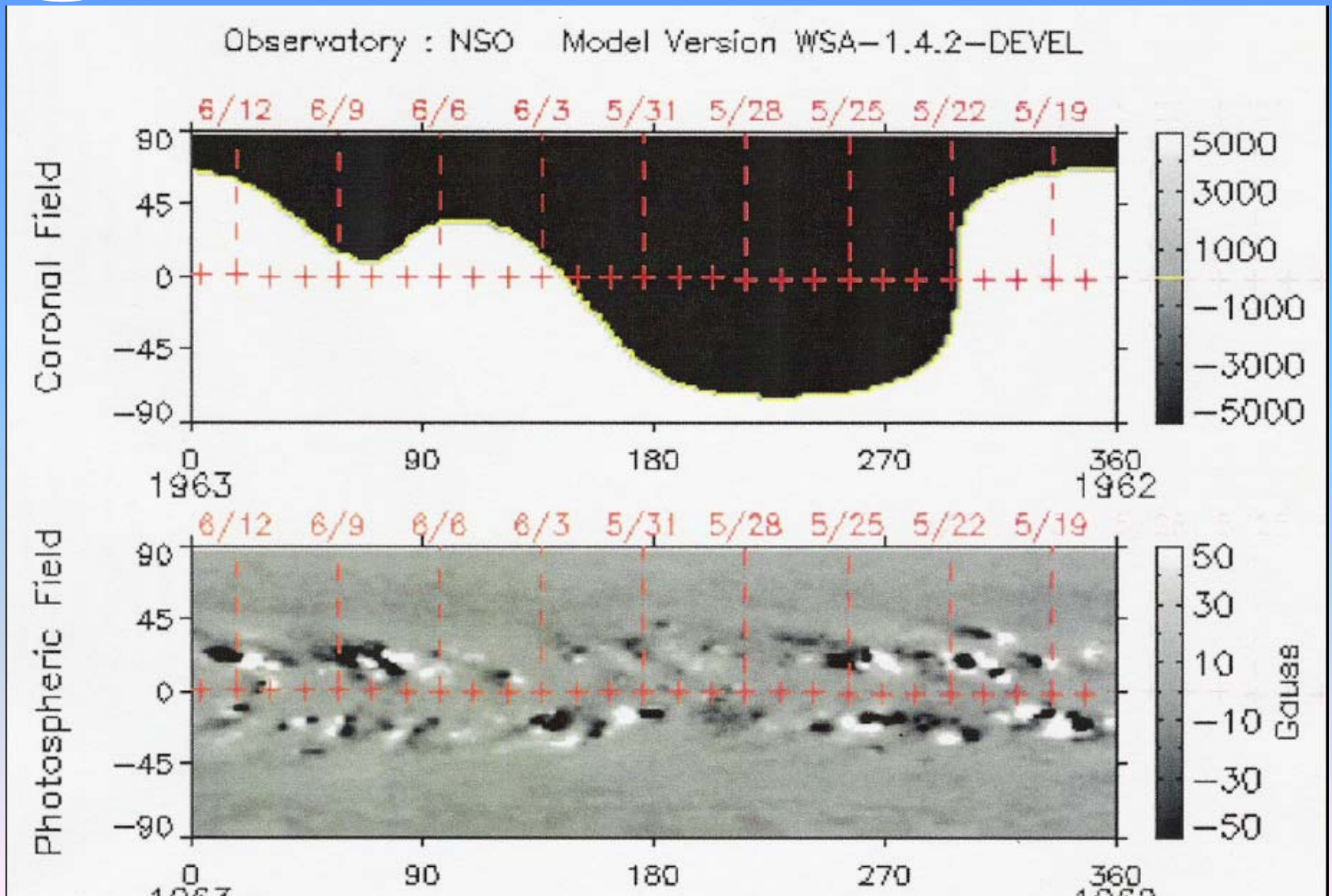
Cadet Summer Research

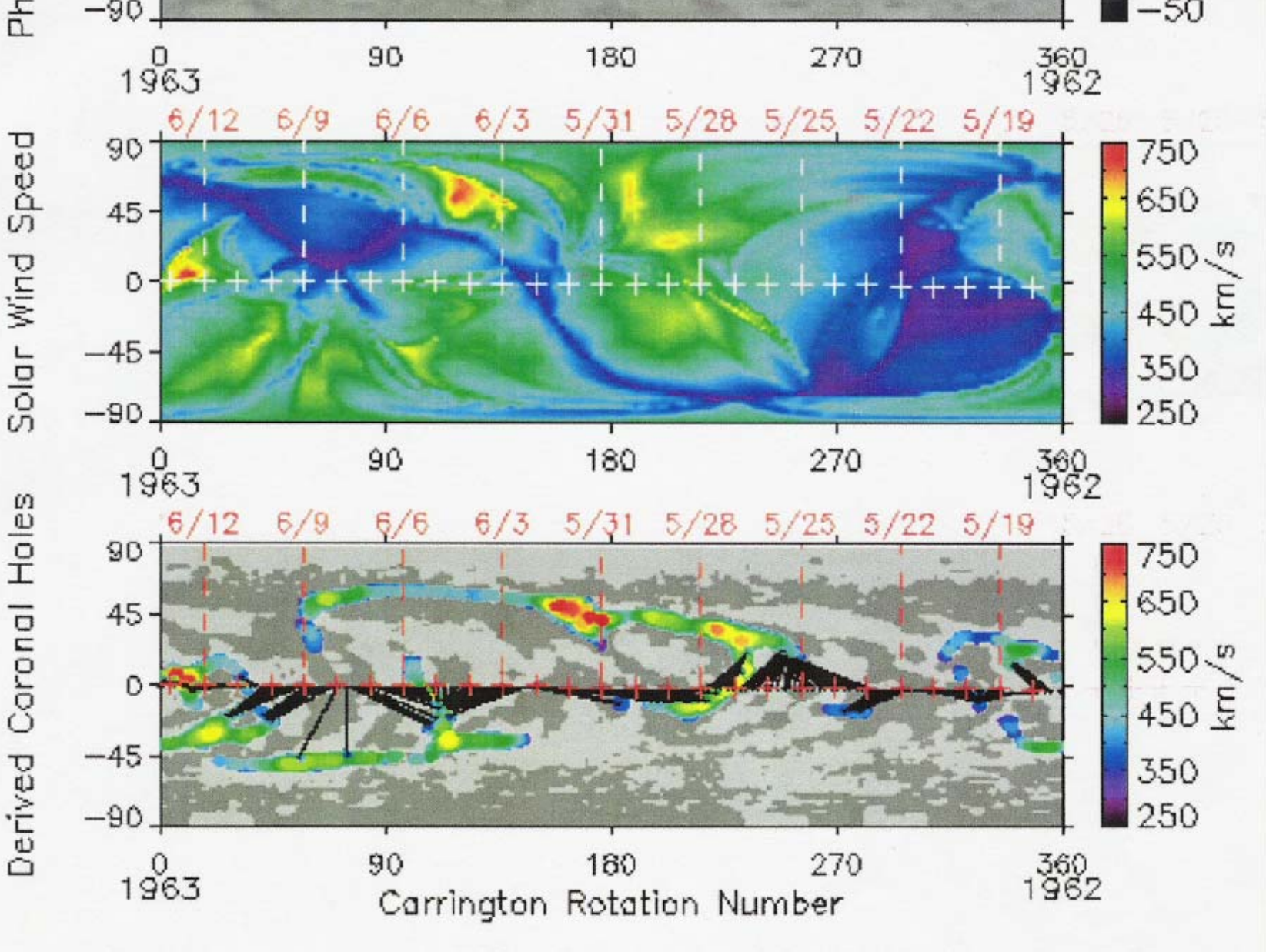
- 5-6 Week Program
  - Late May through June
- Rising Seniors
- DoD Relevance
- Real Research Experience

Cadet Summer Research

- Jalene Bremer -2004
  - Exercise and Compare Models
  - Mag-Iono Model Response to Varying Solar Wind Conditions
  - BATSRUS, Open-GGCM, Weimer
  - Presentation at Space Weather Week
- Brian Elliott – 2007
  - Model Verification and Validation
  - ENLIL, WSA, PFSS, Magnetograms
    - Field line trace for energetic particles
  - Presentation at Space Weather Week
  - Presentation at Undergraduate Research Forum

WSA
Synoptic Views




Solar Wind Speed
Derived Coronal Holes
6/12 6/9 6/6 6/3 5/31 5/28 5/25 5/22 5/19
90
45
0
−45
−90
0
90
180
270
360
1963
1962
750
650
550
450
350
250
km/s
Carrington Rotation Number

Future

- Ionosphere Runs
  - in Support of FalconSAT 3

  Pre-Post Instruction Evaluation

  Lab Development for Short Course