State of NOAA-SEC/CIRES STEREO Heliospheric Models

Dusan Odstrcil

University of Colorado/CIRES & NOAA/Space Environment Center

STEREO SWG Meeting, NOAA/SEC, Boulder, CO, March 22, 2004

Collaborators

- Nick Arge – AFRL, Hanscom, MA
- Chris Hood – University of Colorado, Boulder, CO
- Jon Linker – SAIC, San Diego, CA
- Rob Markel – University of Colorado, Boulder, CO
- Leslie Mayer – University of Colorado, Boulder, CO
- Vic Pizzo – NOAA/SEC, Boulder, CO
- Pete Riley – SAIC, San Diego, CA
- Marek Vandas – Astronomical Institute, Prague, Czech Republic
- Xuepu Zhao – Stanford University, Standford, CA

Supported by AFOSR/MURI and NSF/CISM projects

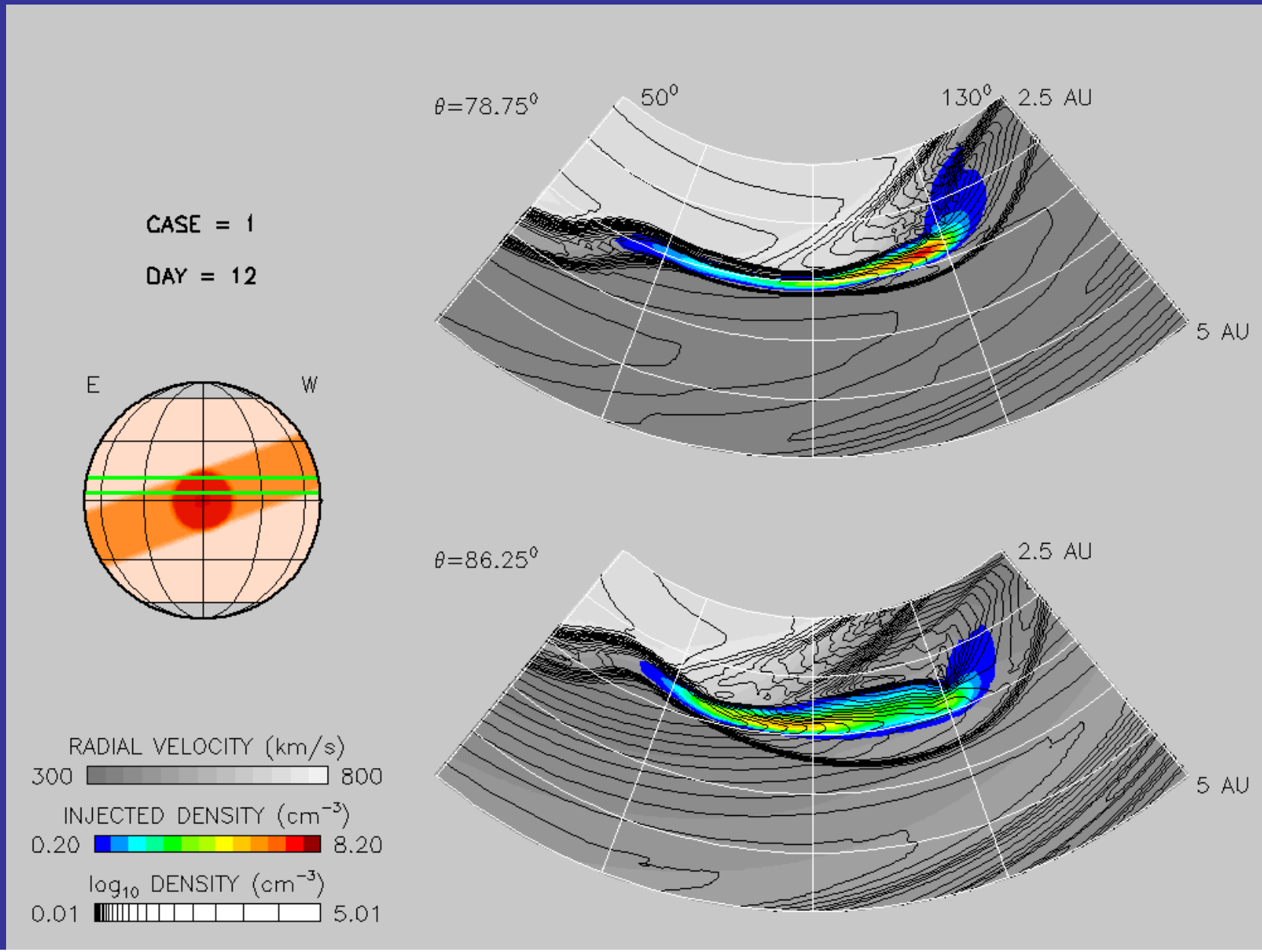
Input Data

- Analytic Models:
  - structured solar wind (bi-modal, tilted)
  - over-pressured plasma cloud (3-D)
  - magnetic flux-rope (3-D in progress)

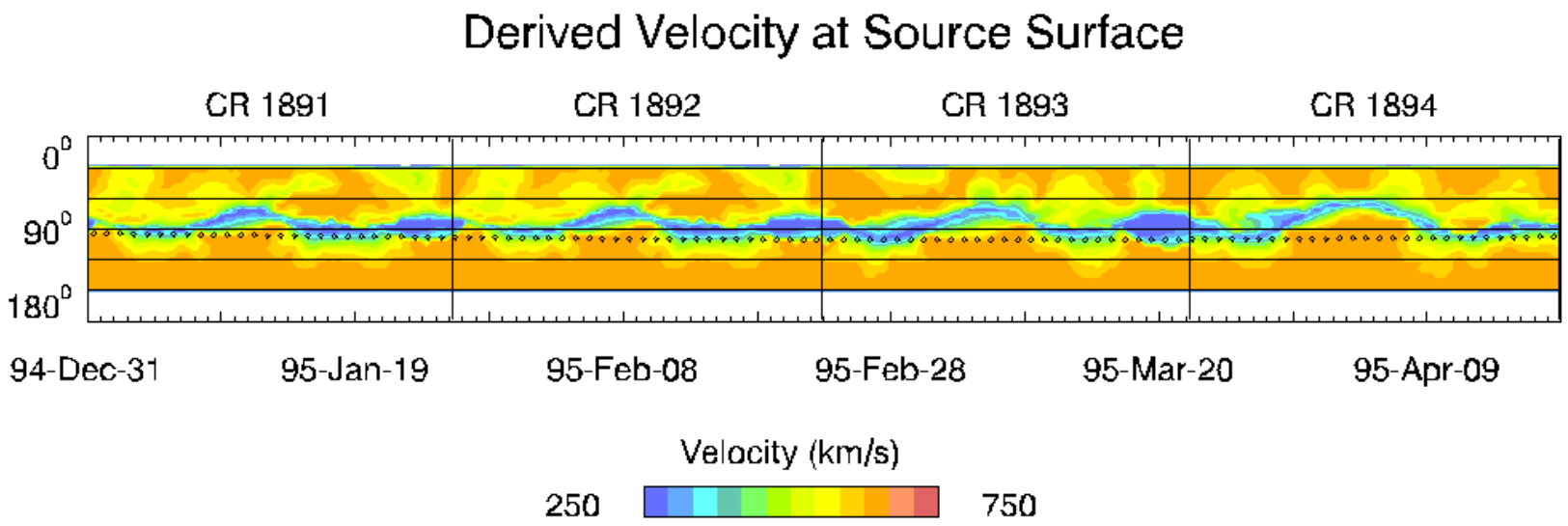
- Empirical Models:
  - WSA source surface
  - SAIC source surface
  - CME cone model (location, diameter, and speed)

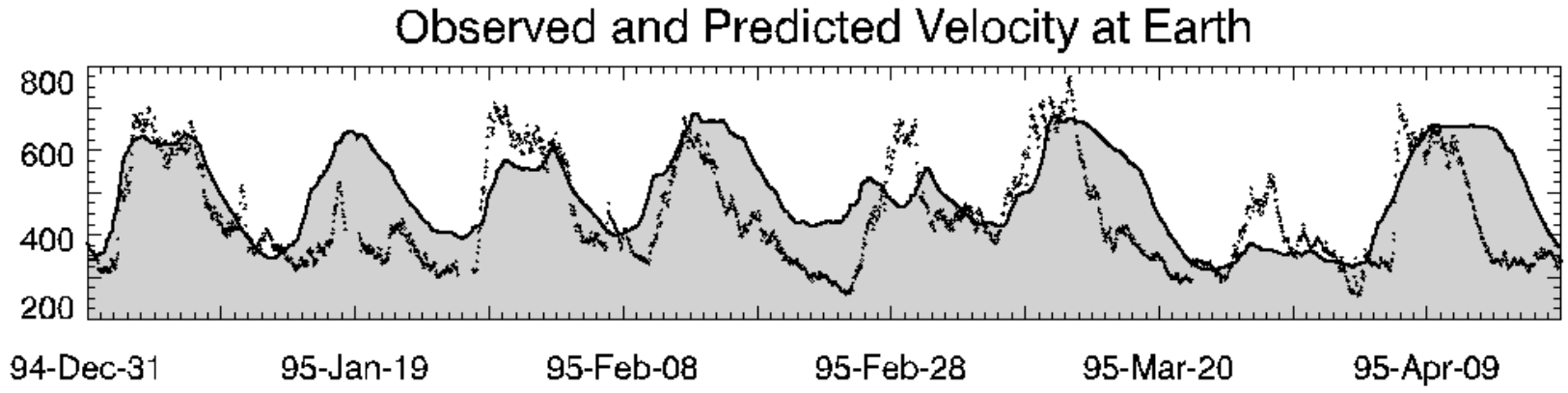
- Numerical Models:
  - SAIC coronal model (ambient + transient outflow)

Analytic Model – Distortion of ICME Study

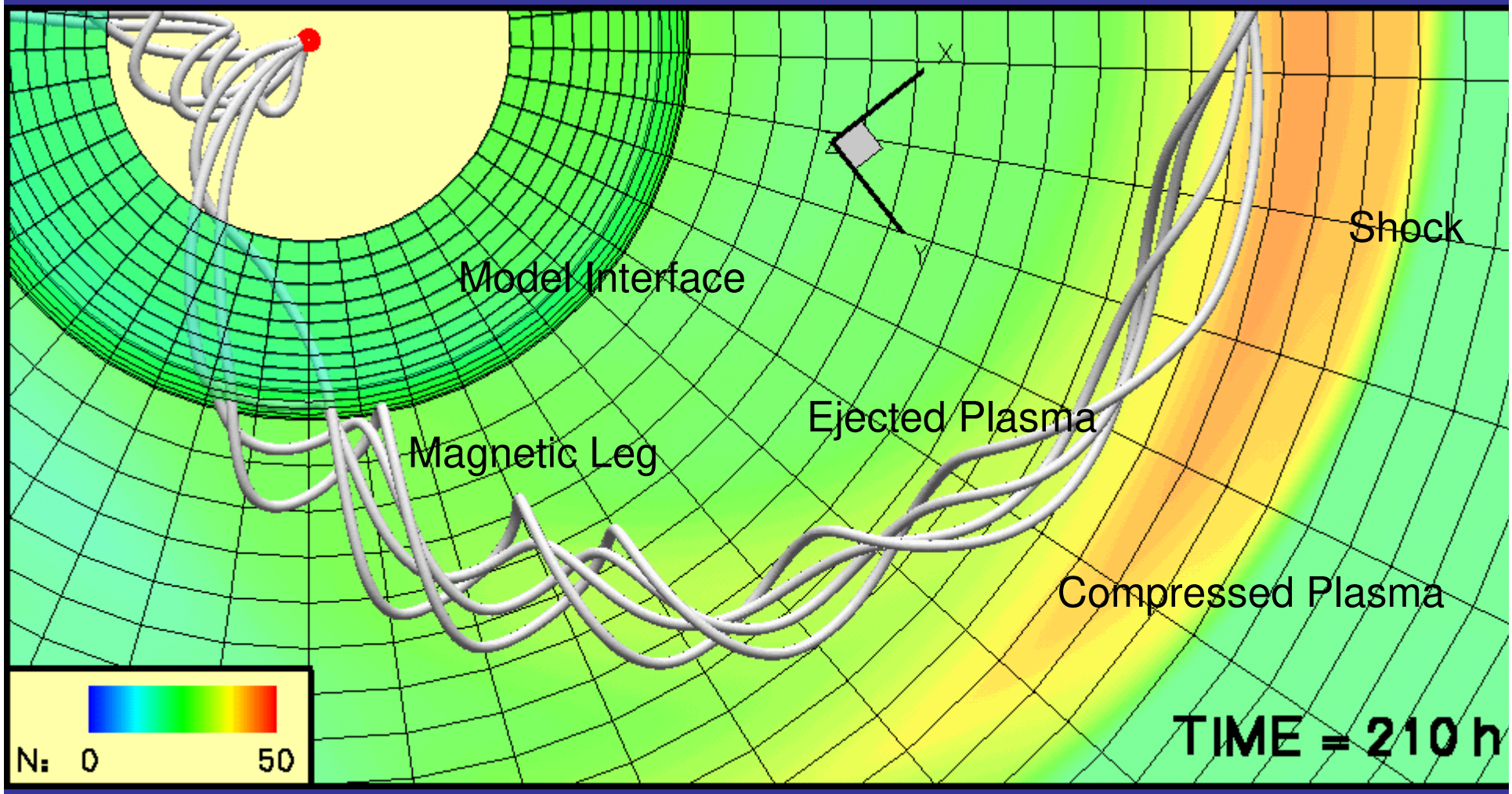


Empirical model - Ambient Solar Wind

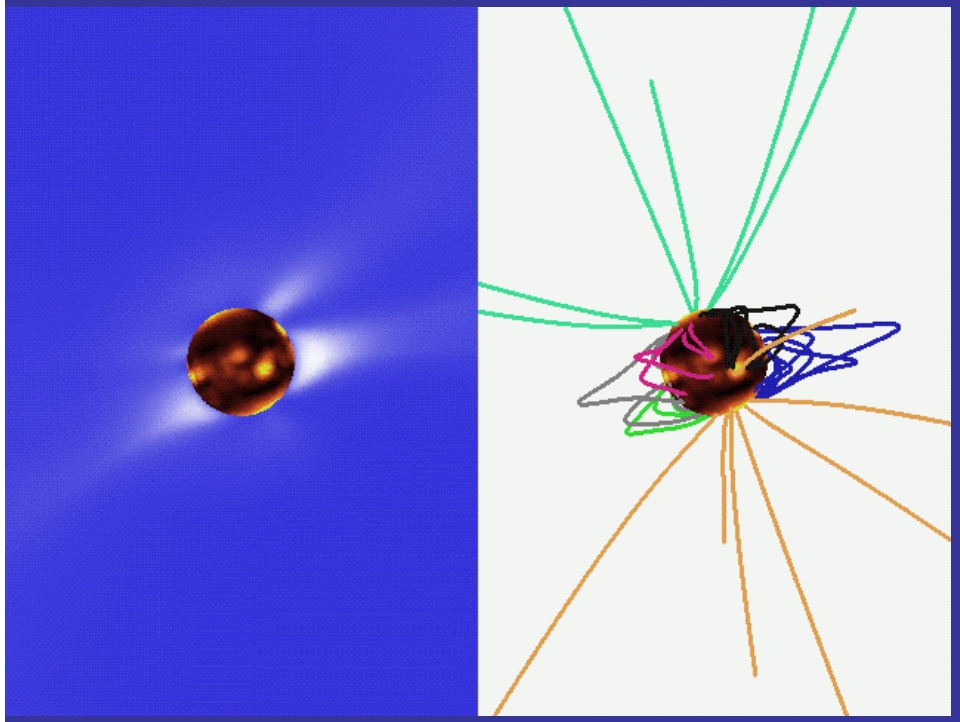




Numerical Model -- Magnetic Flux Rope

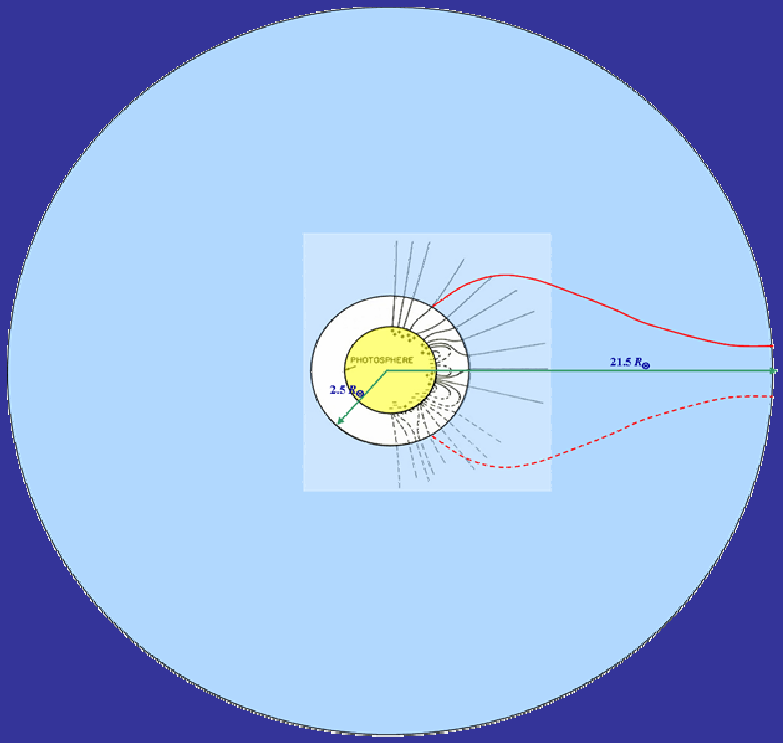


Ambient Solar Wind Models



SAIC 3-D MHD steady state coronal model based on photospheric field maps

[*SAIC maps – Pete Riley*]



CU/CIRES-NOAA/SEC 3-D solar wind model based on potential and current-sheet source surface empirical models

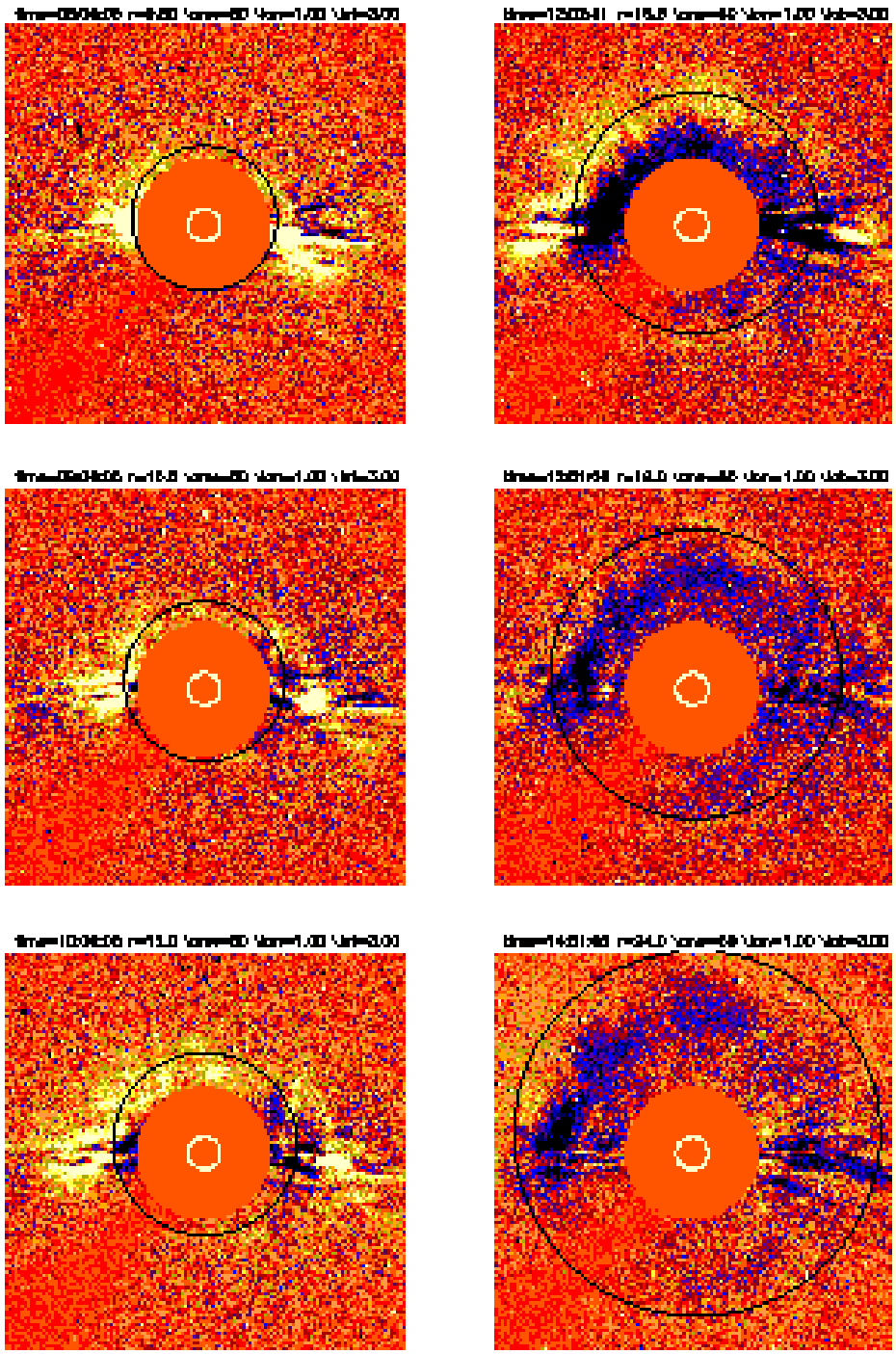
[*WSA maps – Nick Arge*]

CME Cone Model

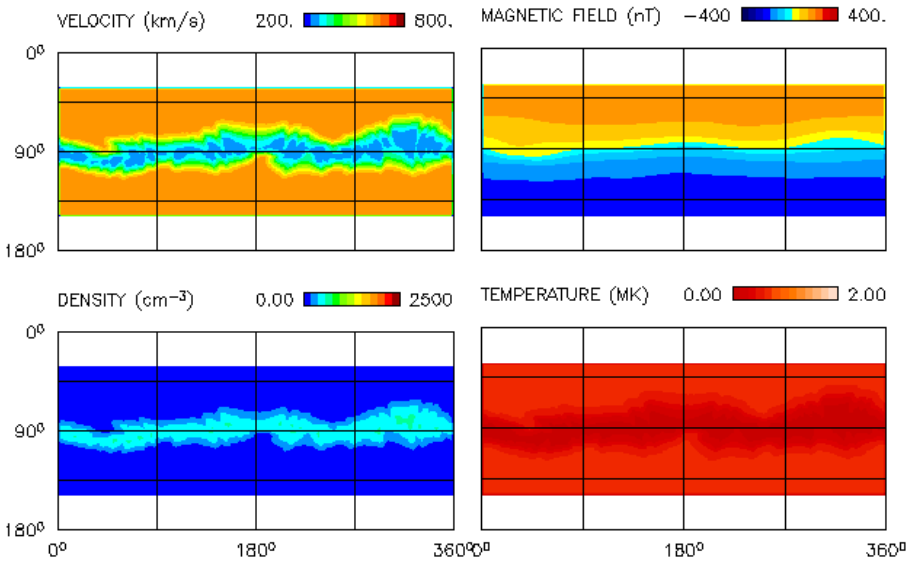
Best fitting for May 12, 1997 halo CME

- latitude: N3.0
- longitude: W1.0
- angular width: 50 deg
- velocity:650 km/s at 24 R_s (14:15 UT)
- acceleration: 18.5 m/s^2

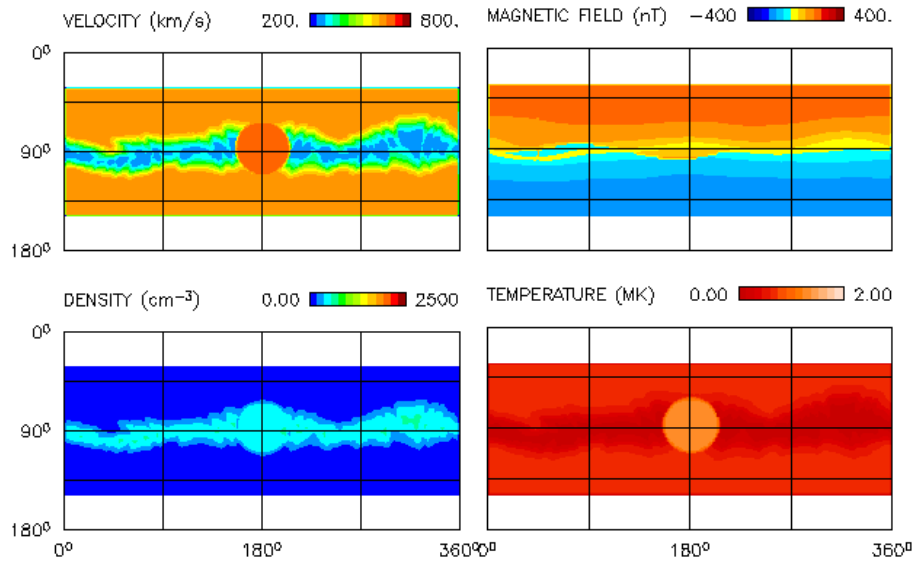
[Zhao et al., 2001]



Boundary Conditions

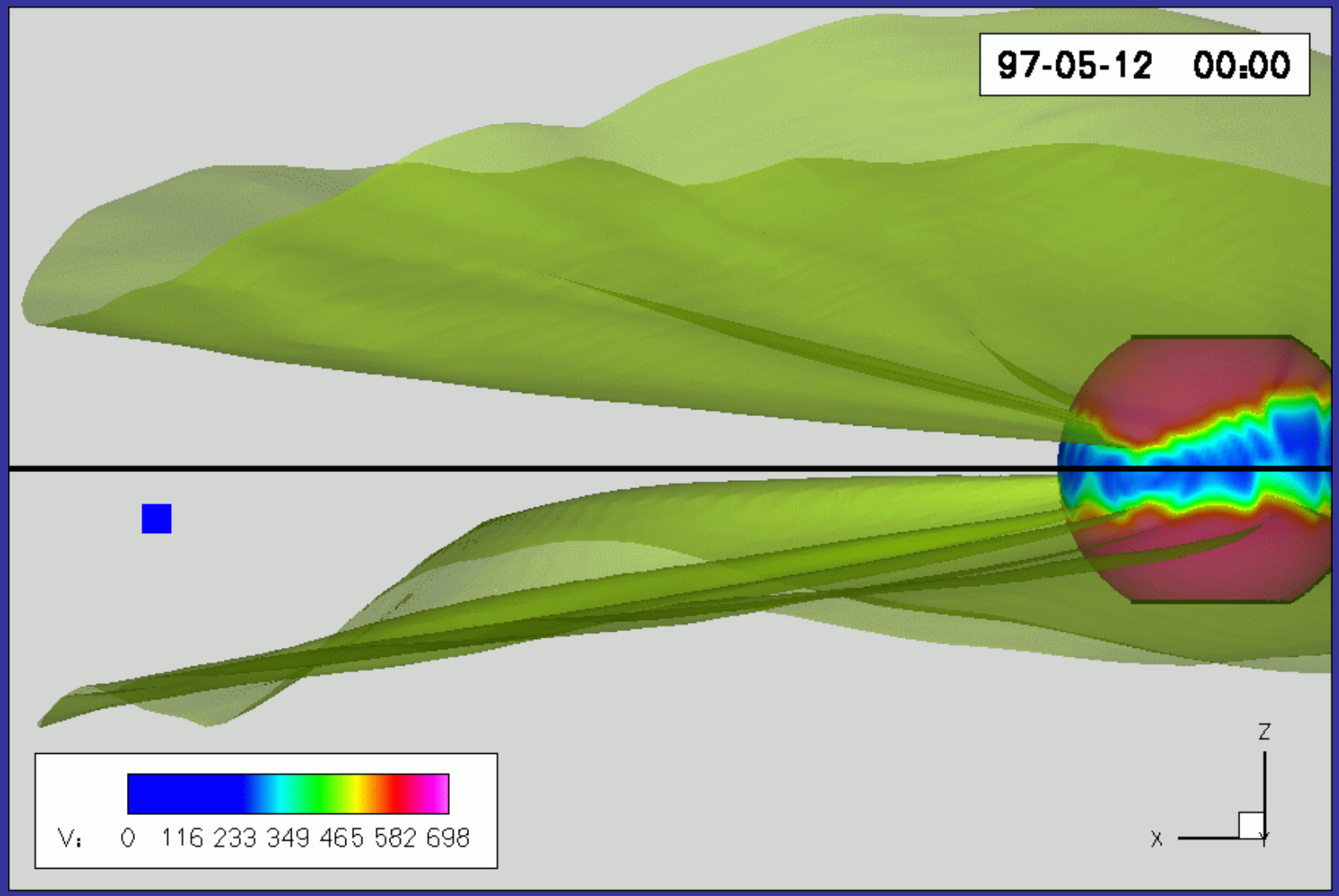


Ambient Solar Wind



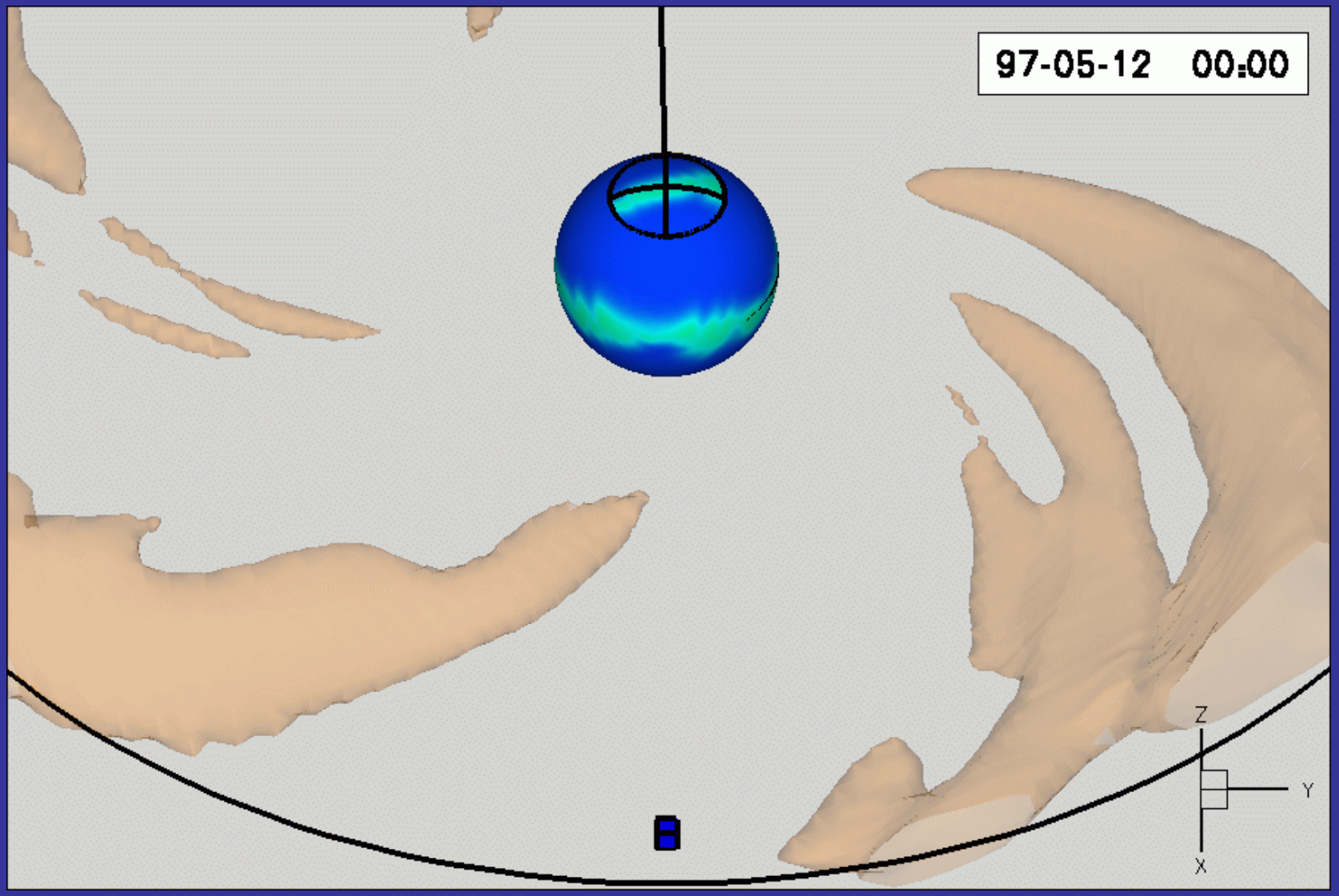
Ambient Solar Wind
+
Plasma Cloud

Latitudinal Distortion of ICME Shape



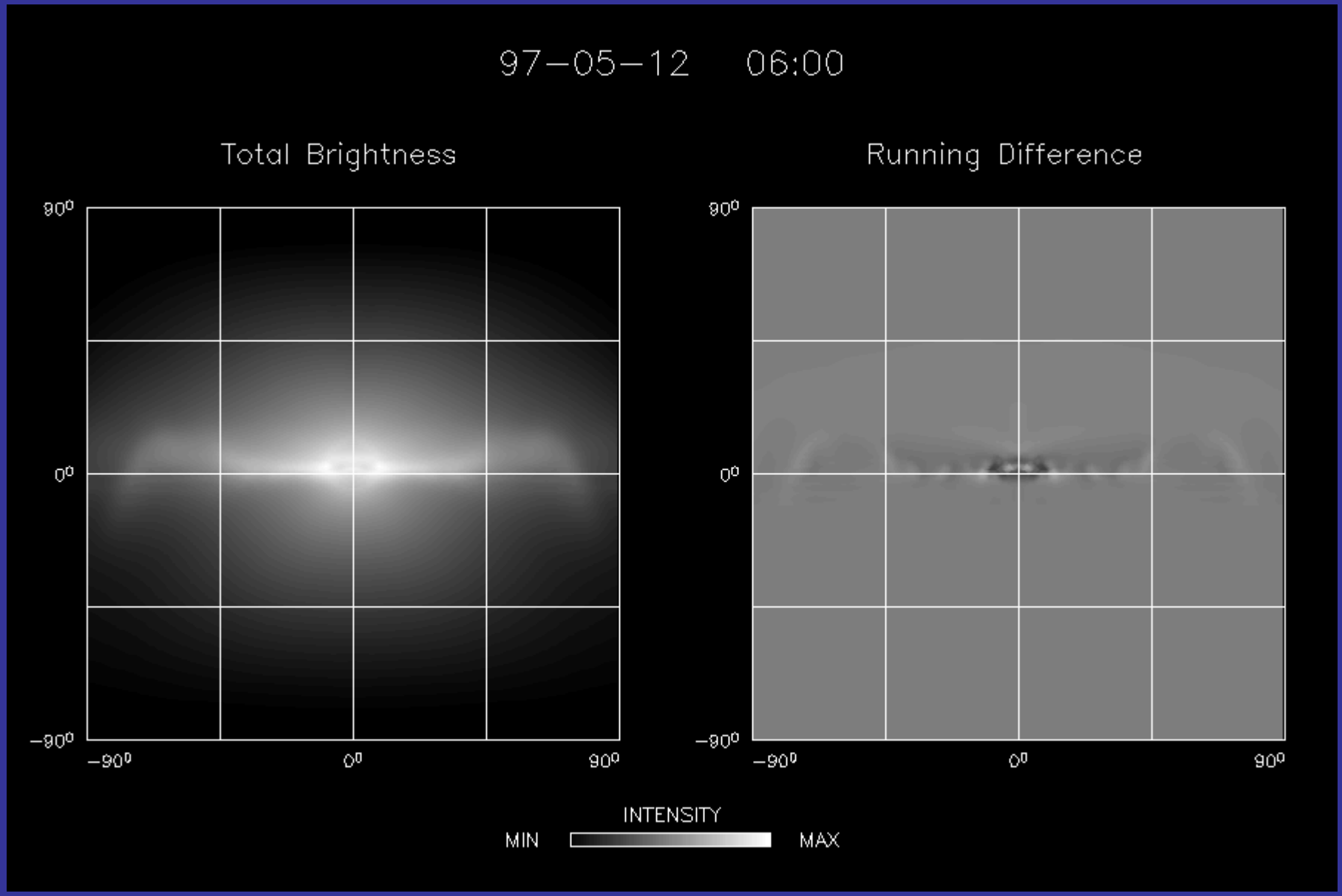
ICME propagates into bi-modal solar wind

Evolution of Density Structure

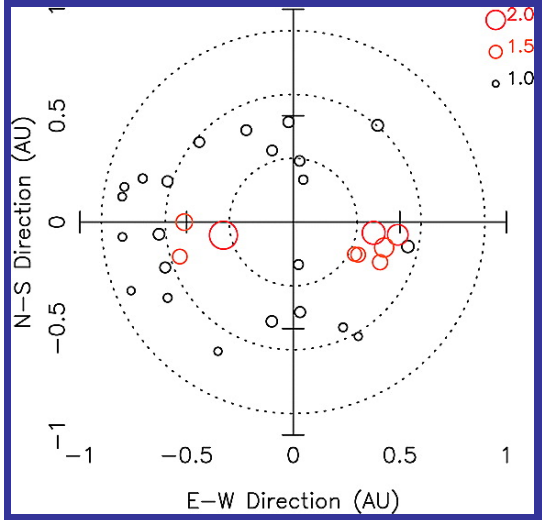


ICME propagates into the enhanced density of a streamer belt flow

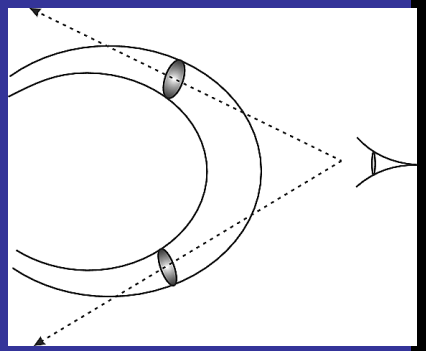
Synthetic White-Light Imaging

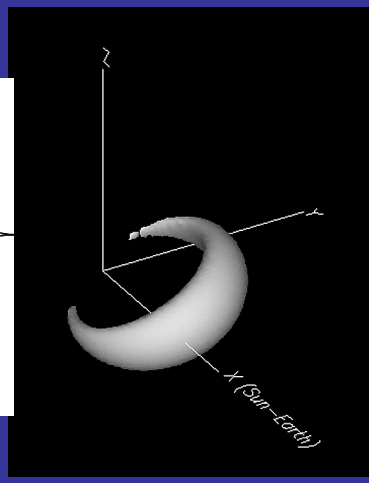


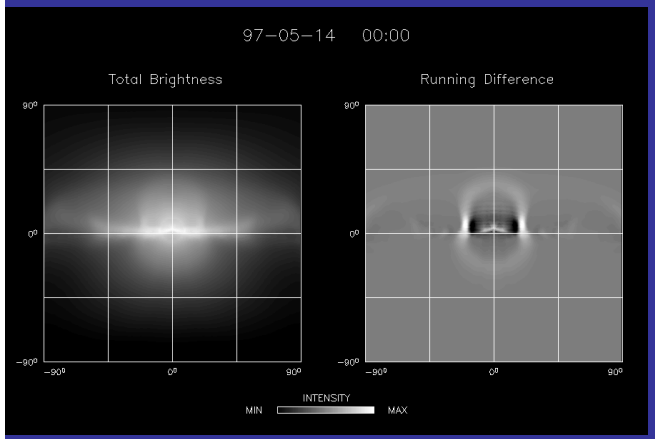
Appearance of Transient Density Structure



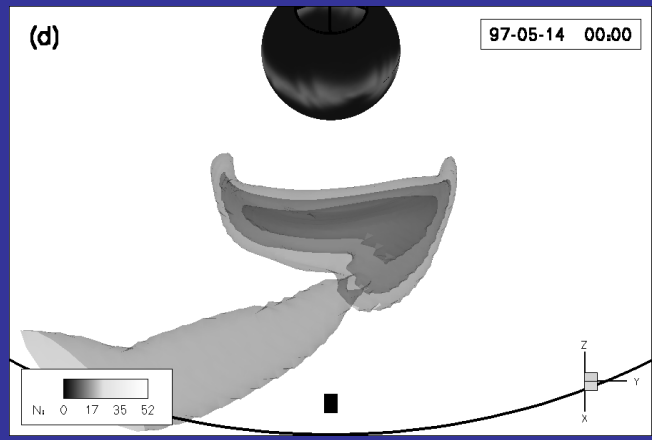
IPS observations detect interplanetary transients that sometime show two enhanced spots instead of a halo ring [*Tokumaru et al., 2003*]



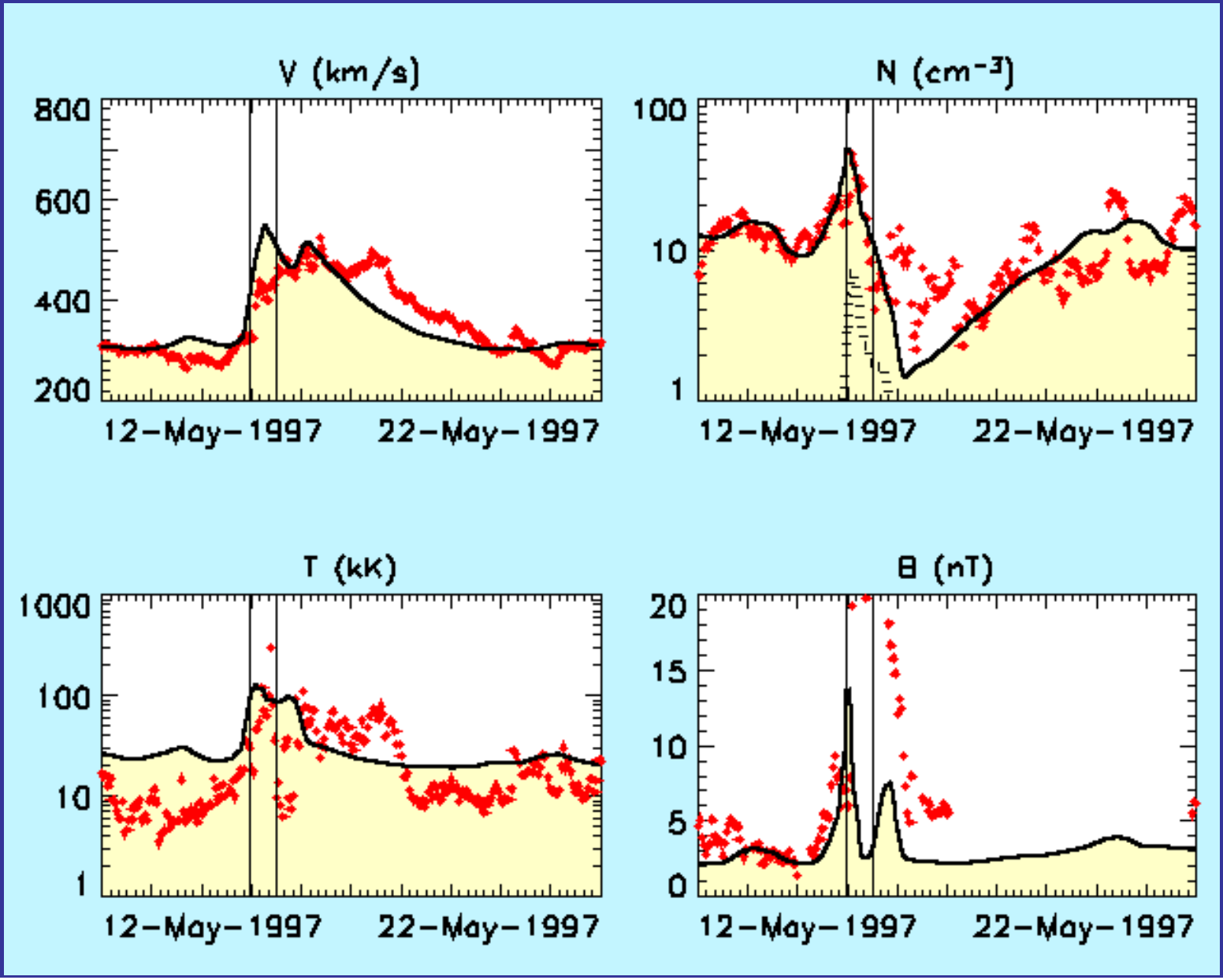




MHD simulation shows a dynamic interaction between the ICME and ambient solar wind that: (1) forms an arc-like density structure; and (2) results in two brighter spots in synthetic images

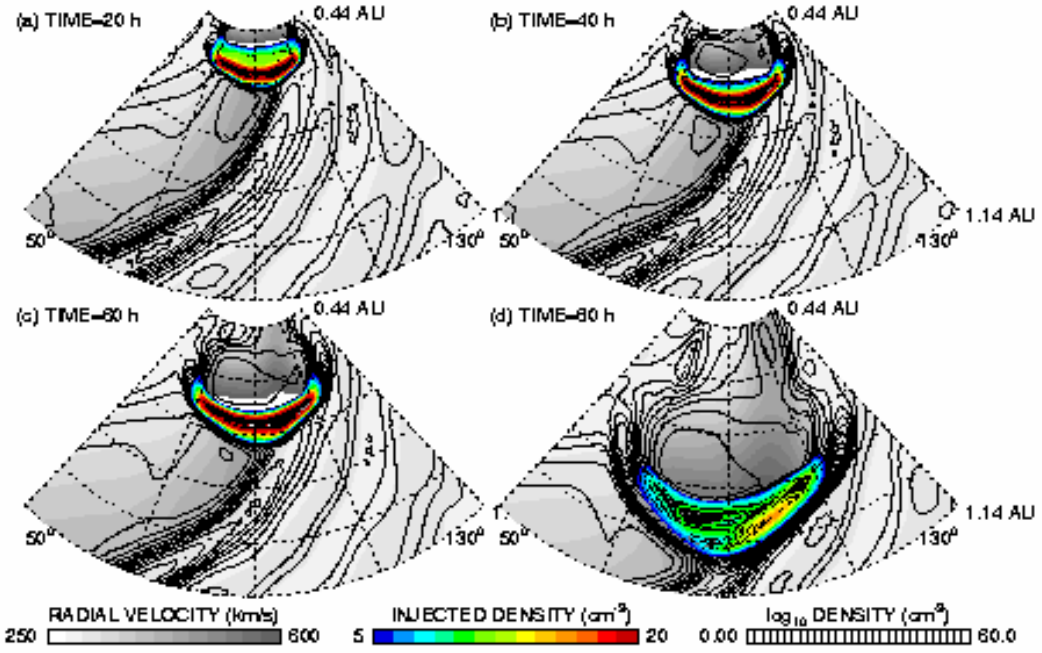


Evolution of Parameters at Earth

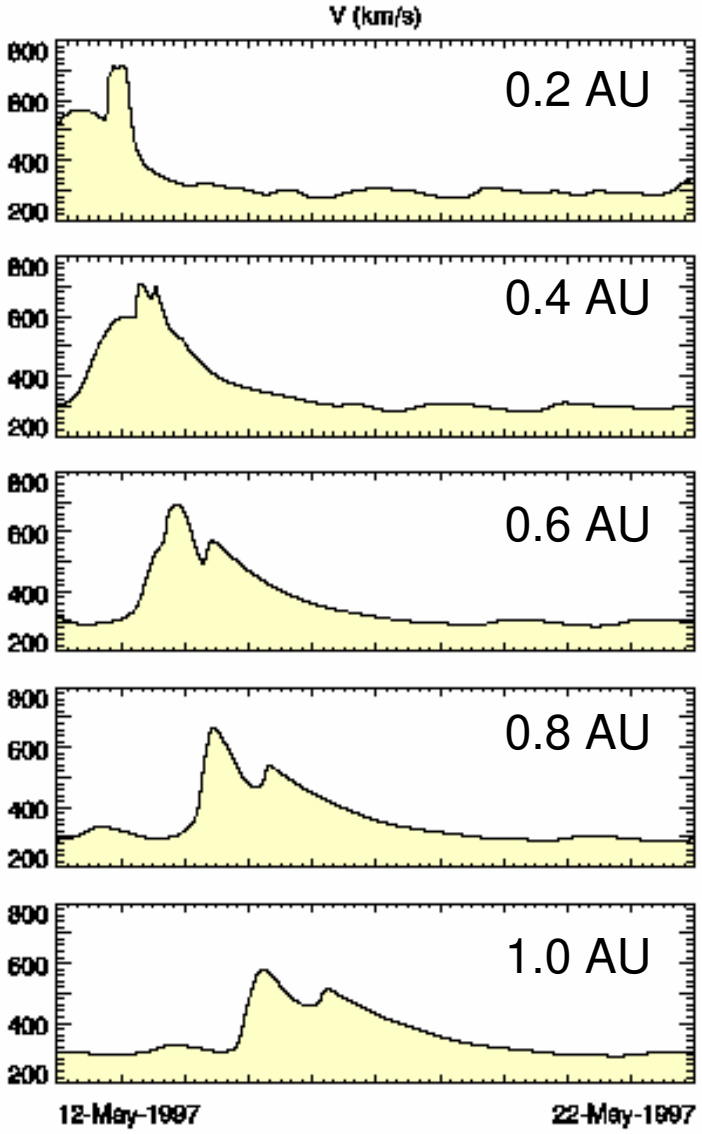


May 12, 1997 – Interplanetary Shock

Distribution of parameters in equatorial plane



Evolution of velocity on Sun-Earth line

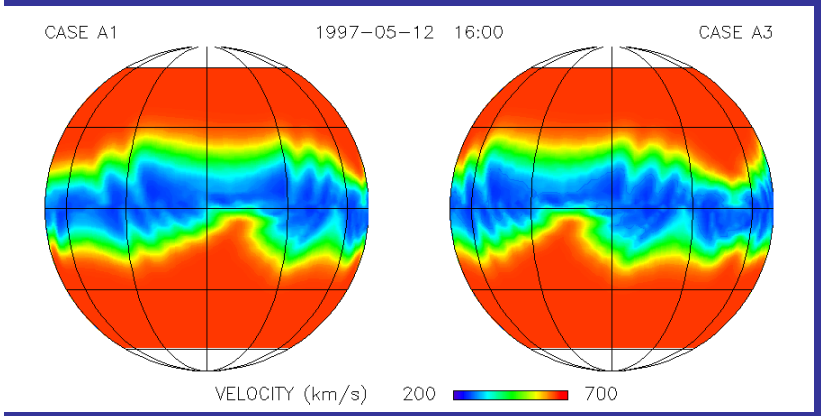


- Shock propagates in a fast stream and merges with its leading edge

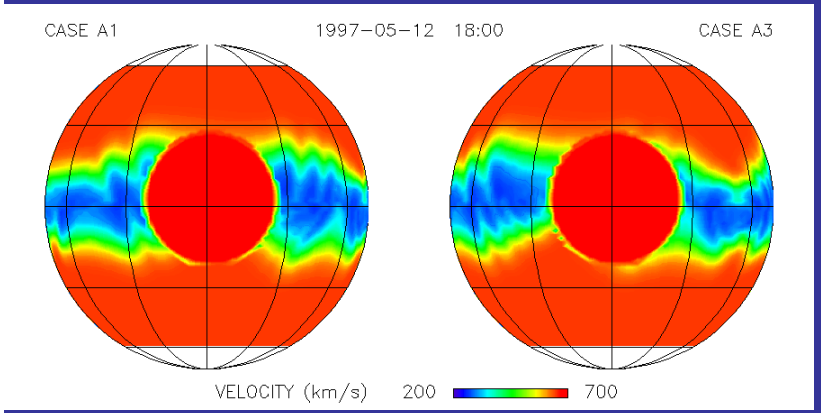
Fast-Stream Position

[*SAIC maps -- Pete Riley*]

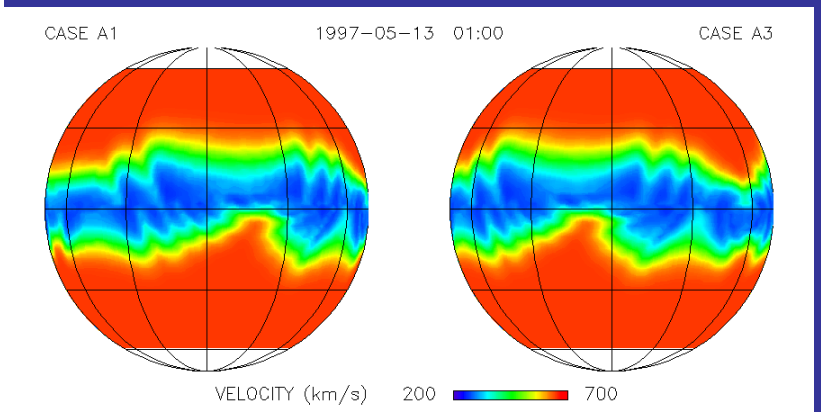
Case A1 Case A3



Ambient state before the CME launch



Disturbed state during the CME launch

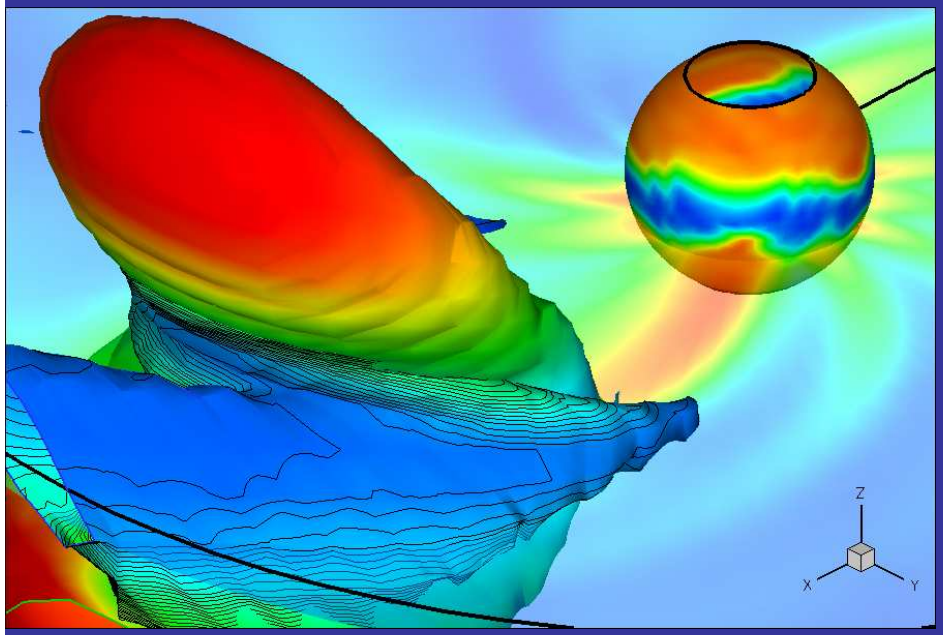


Ambient state after the CME launch

Effect of Fast-Stream Position

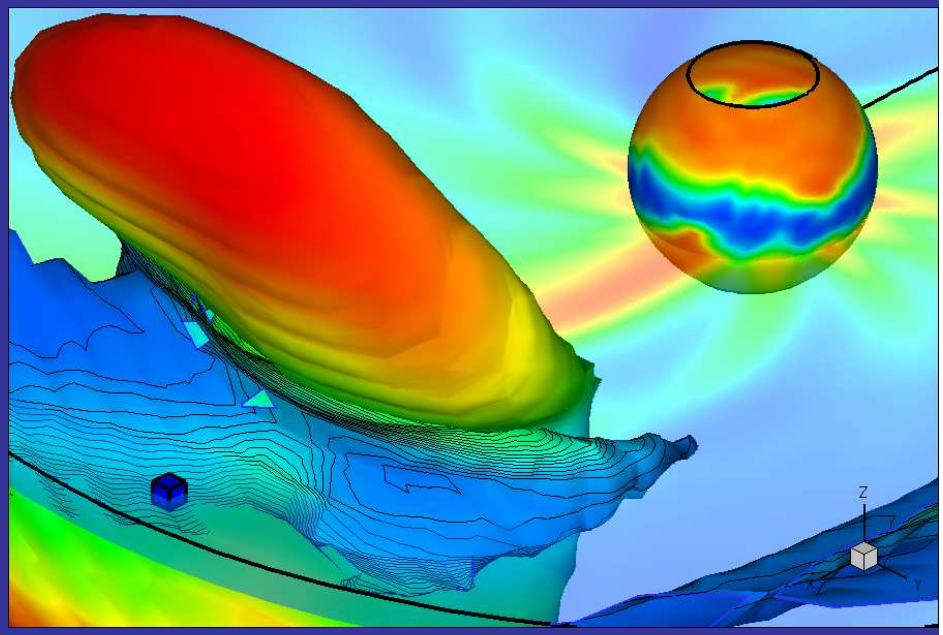
[*SAIC maps -- Pete Riley*]

Case A1



Earth : Interaction region followed by shock and CME (*not observed*)

Case A3

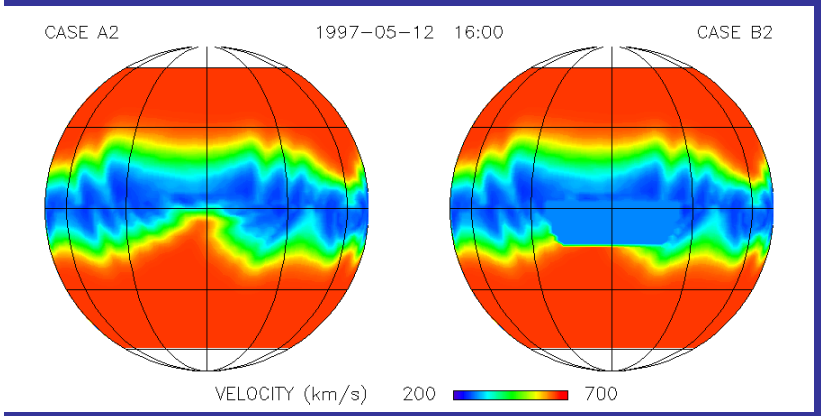


Earth : Shock and CME (*observed but 3-day shift is too large*)

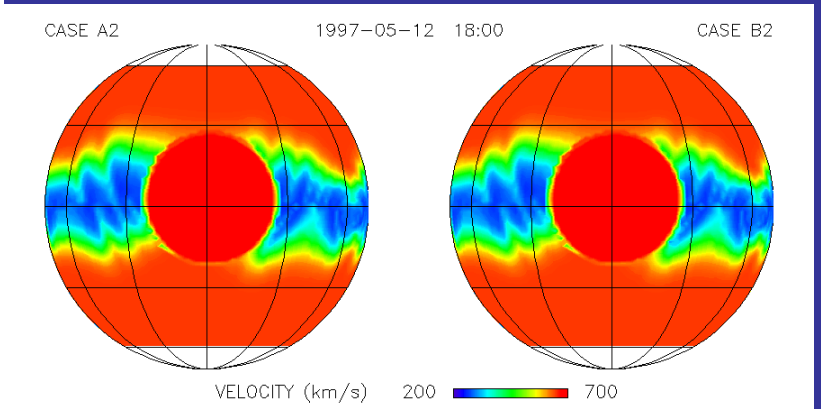
Fast-Stream Evolution

[*SAIC maps -- Pete Riley*]

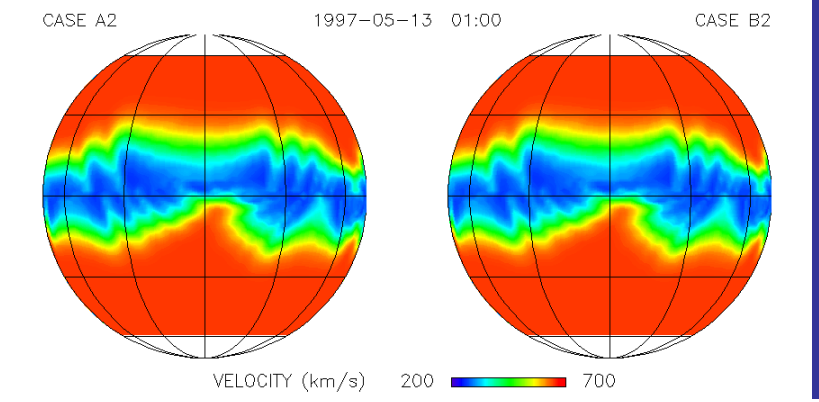
Case A2 Case B2



Ambient state before the CME launch



Disturbed state during the CME launch

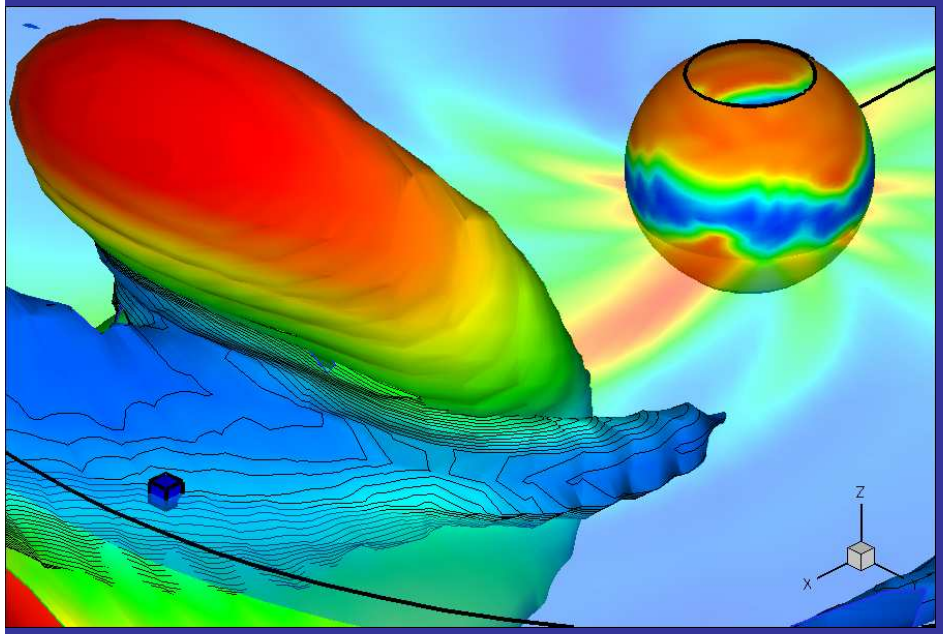


Ambient state after the CME launch

Effect of Fast-Stream Evolution

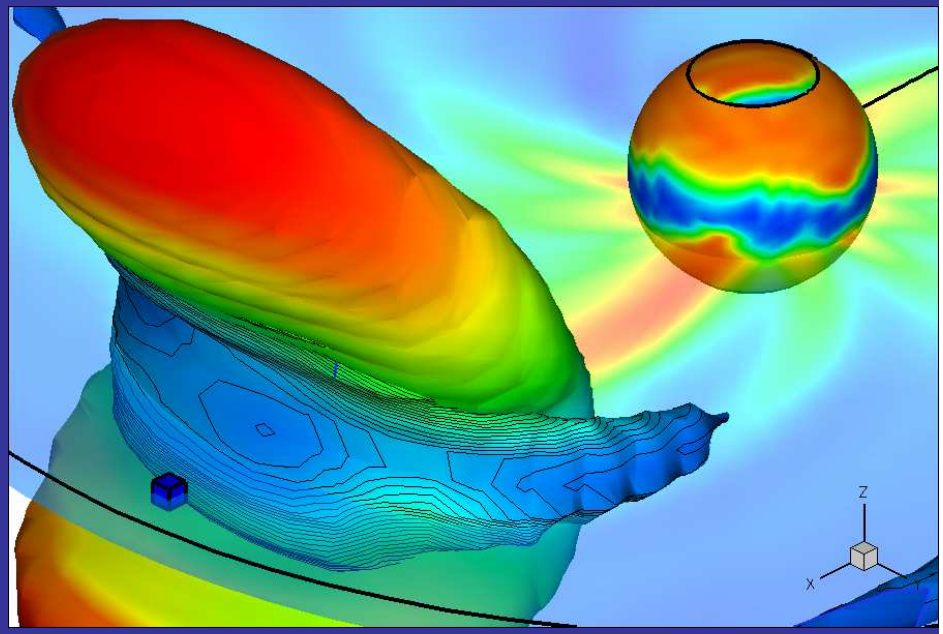
[*SAIC maps -- Pete Riley*]

Case A2



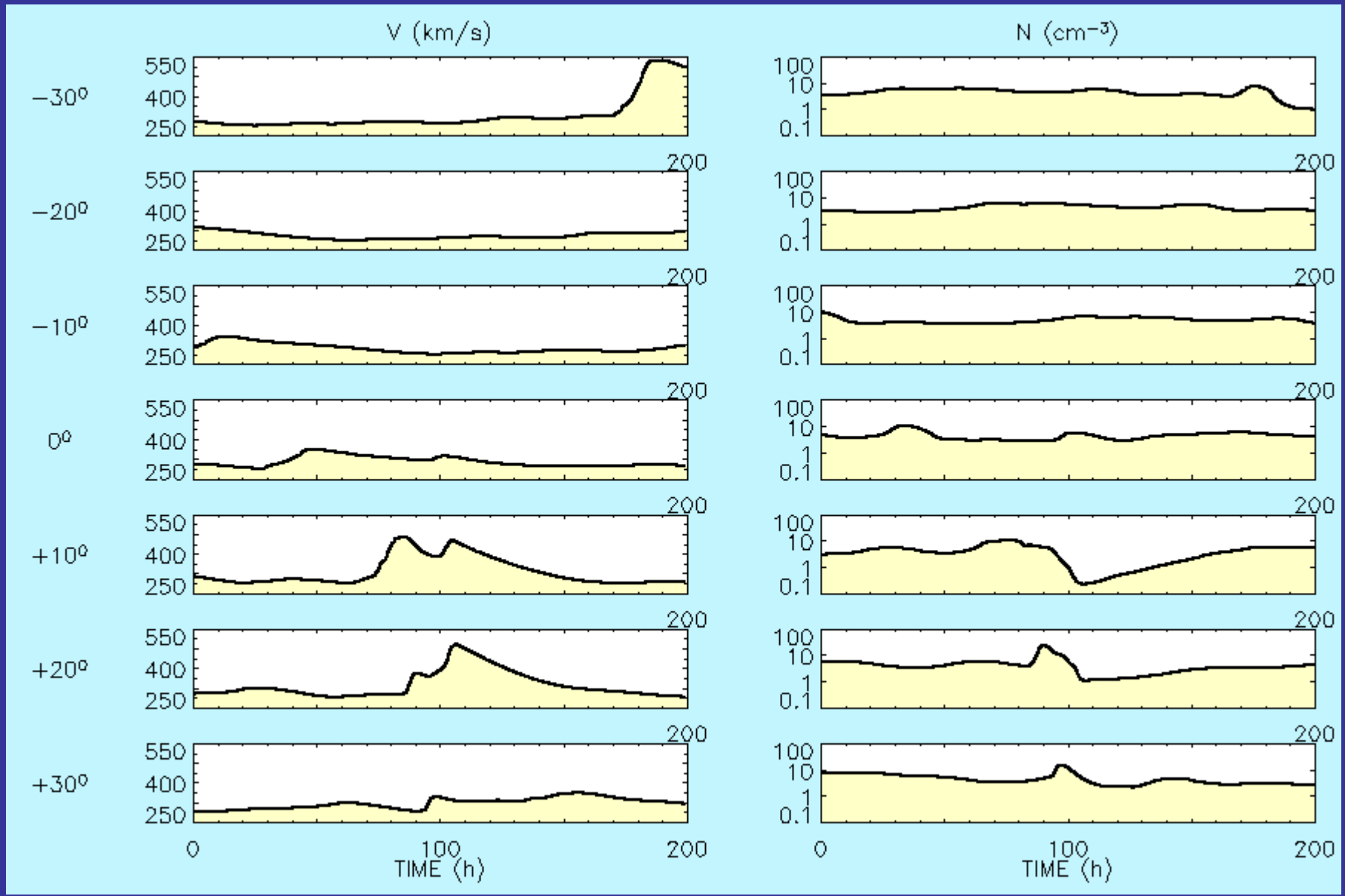
Earth : Interaction region followed by shock and CME (*not observed*)

Case B2

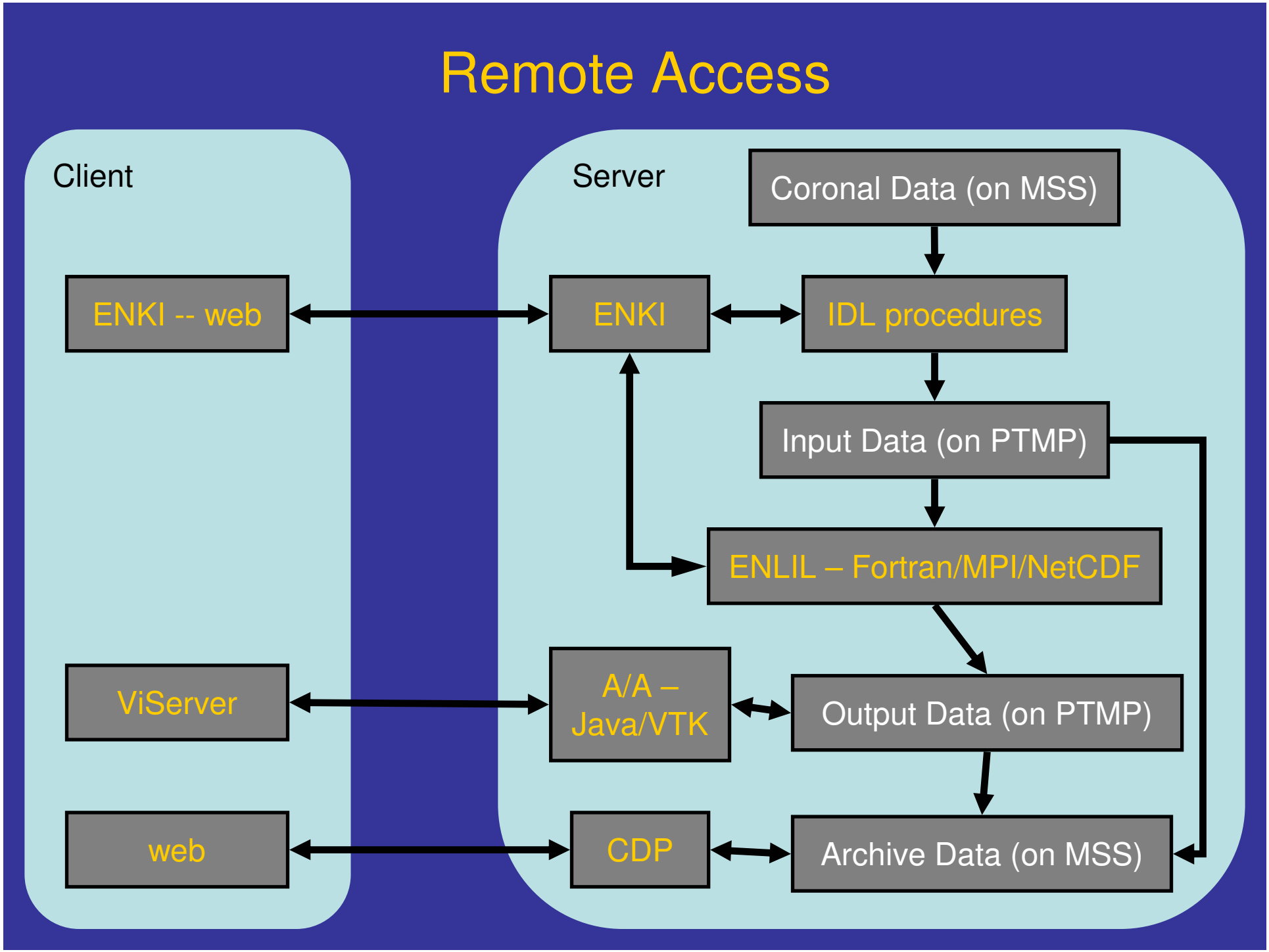


Earth : Shock and CME (*observed but shock front is radial*)

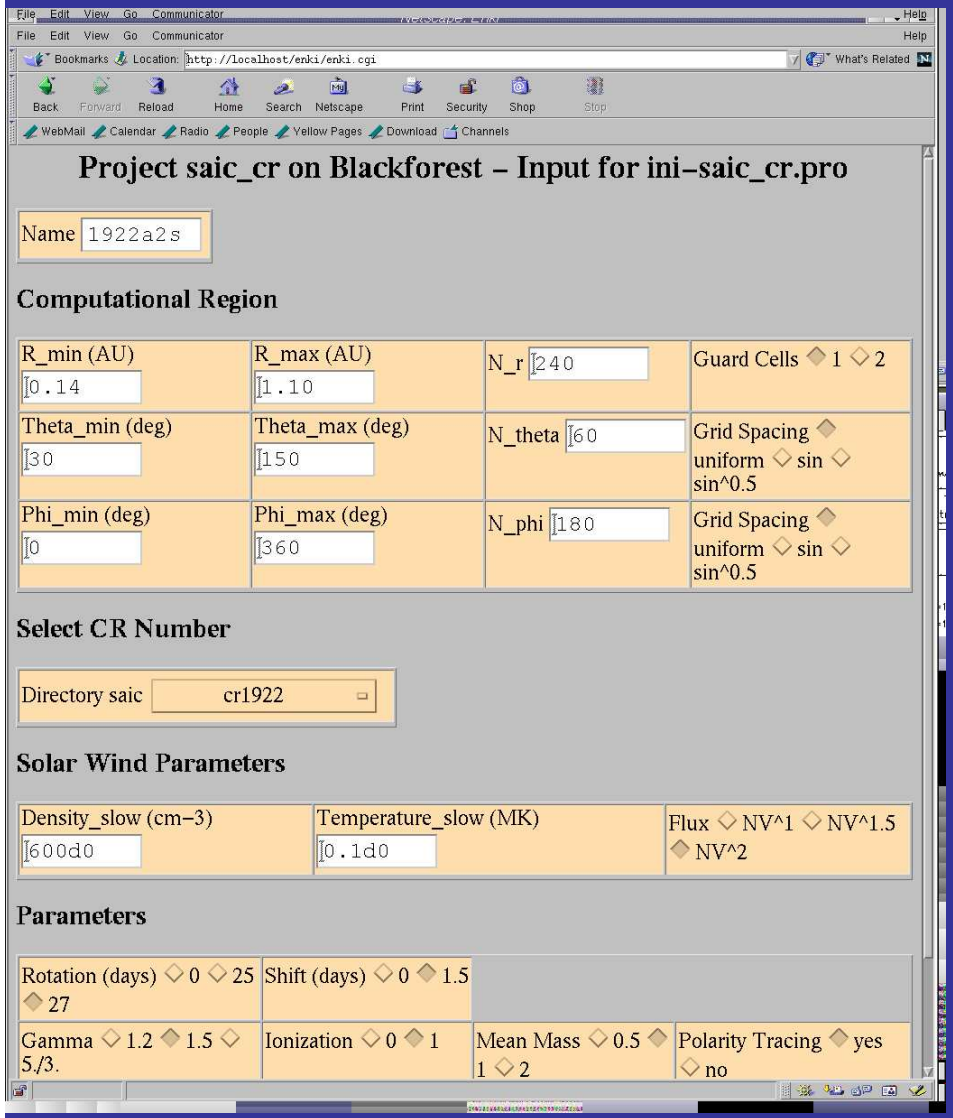
Evolution of Parameters at Earth

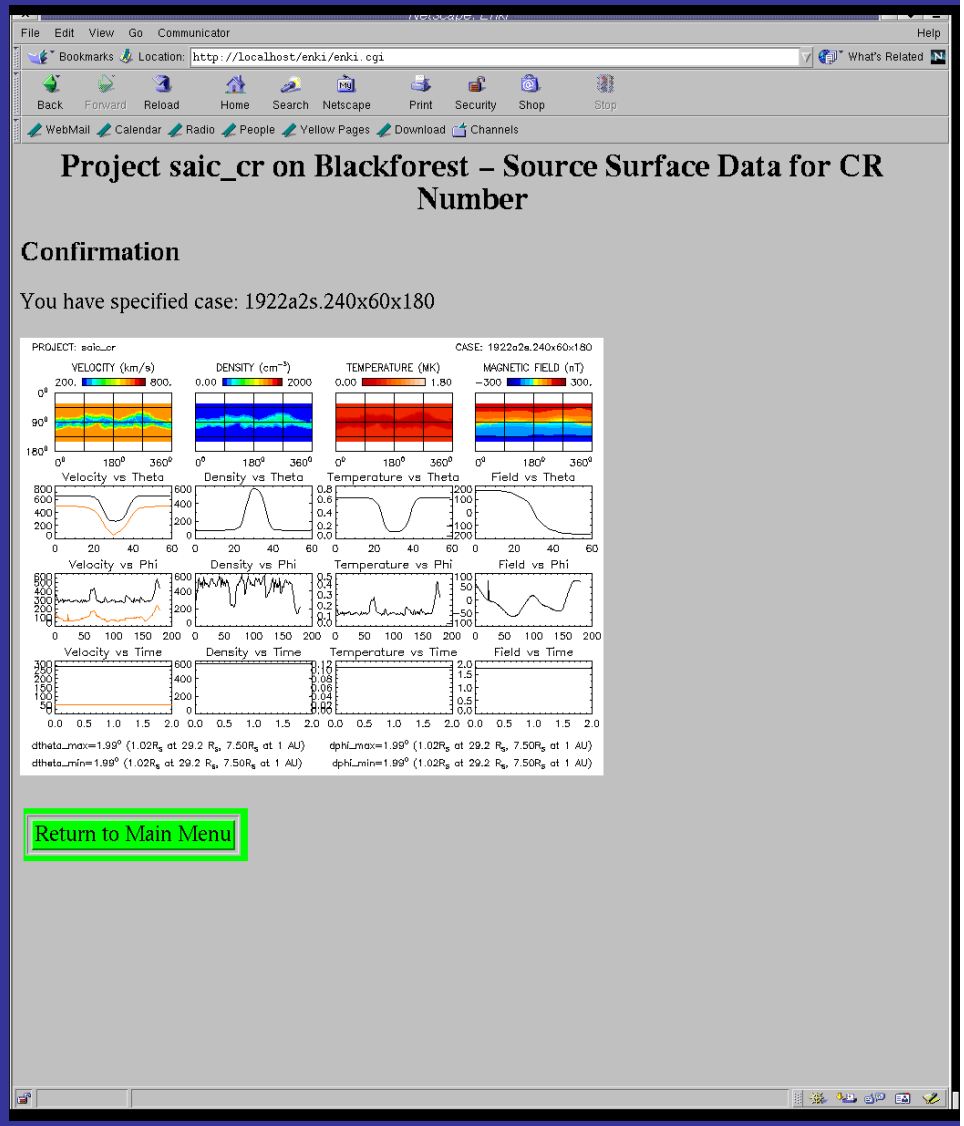


Remote Access

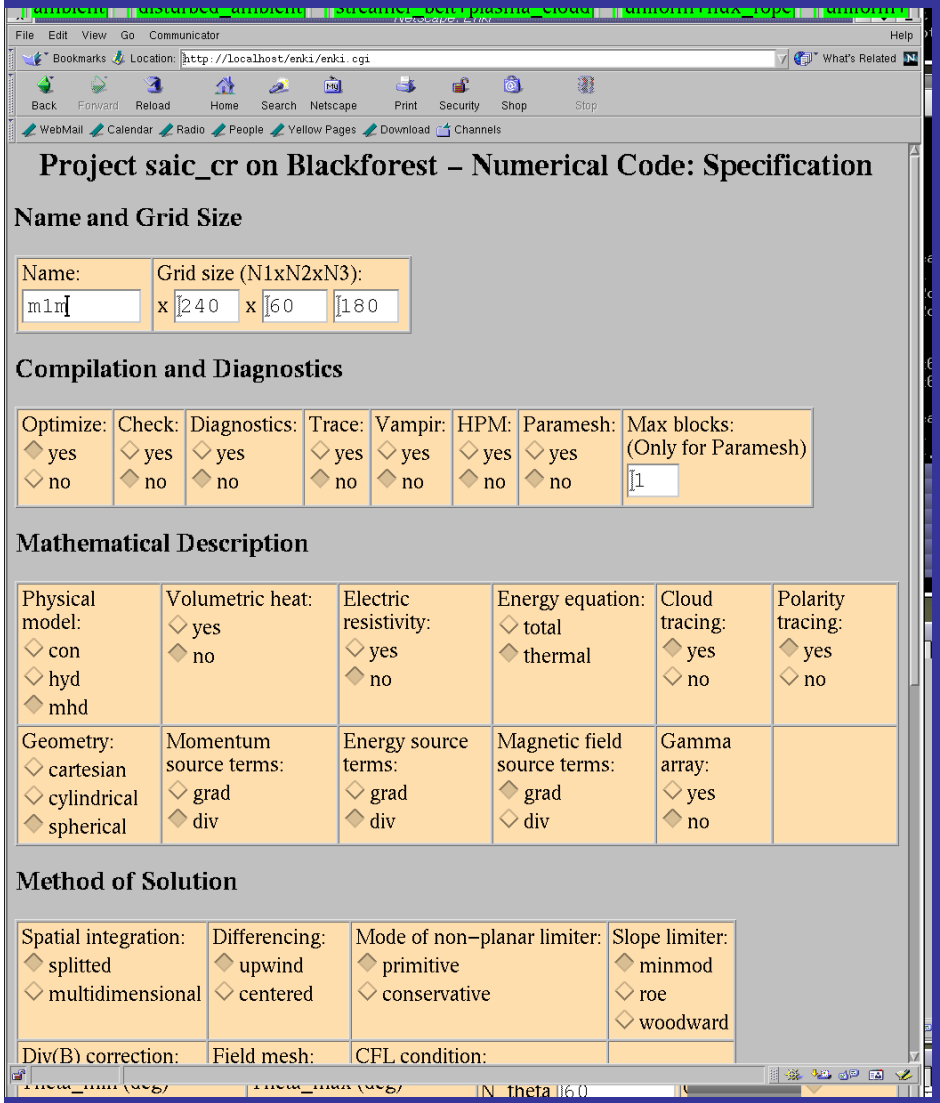


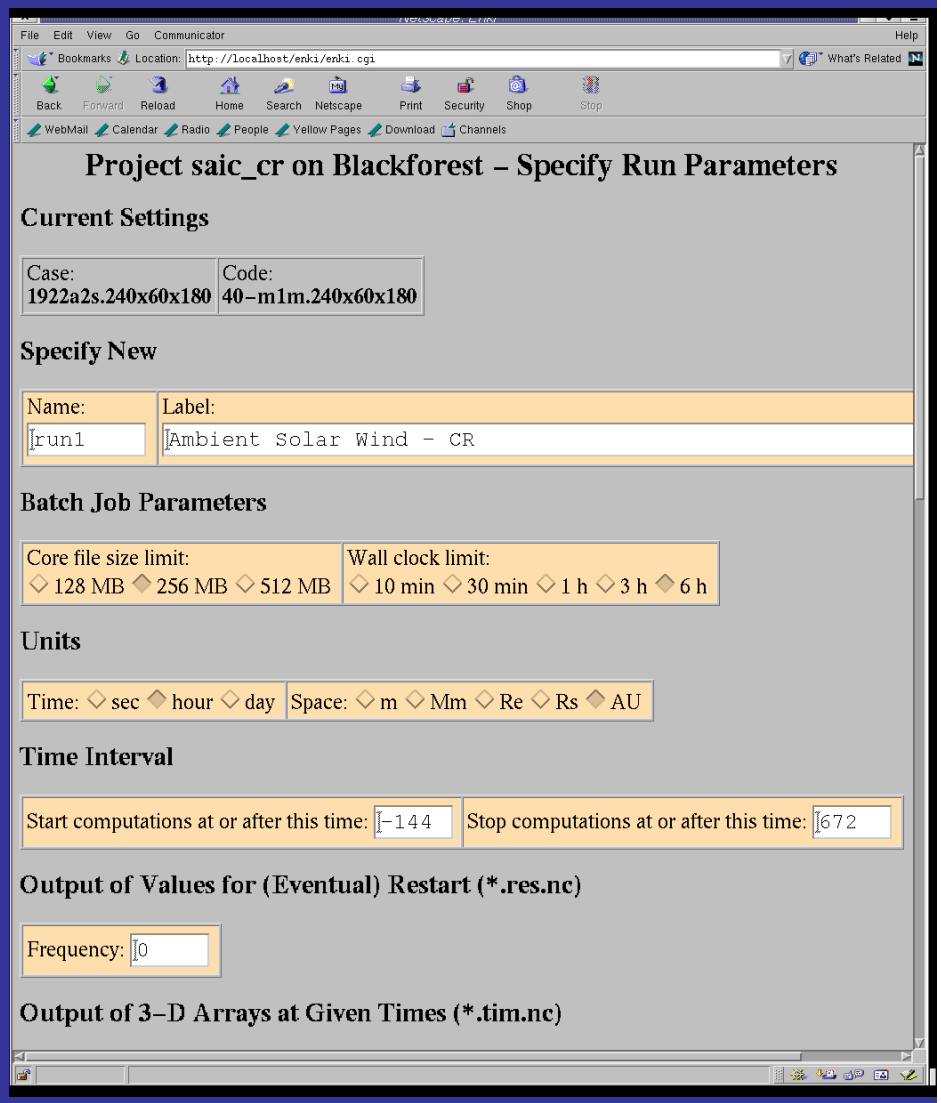
ENKI – Interface to ENLIL



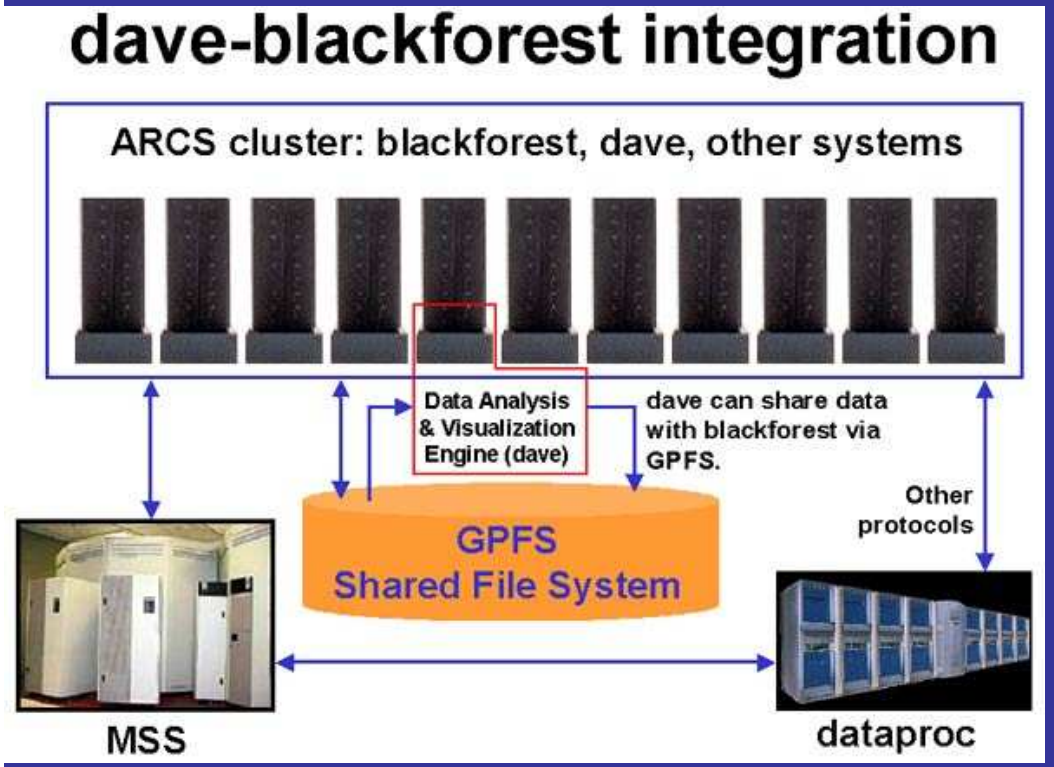


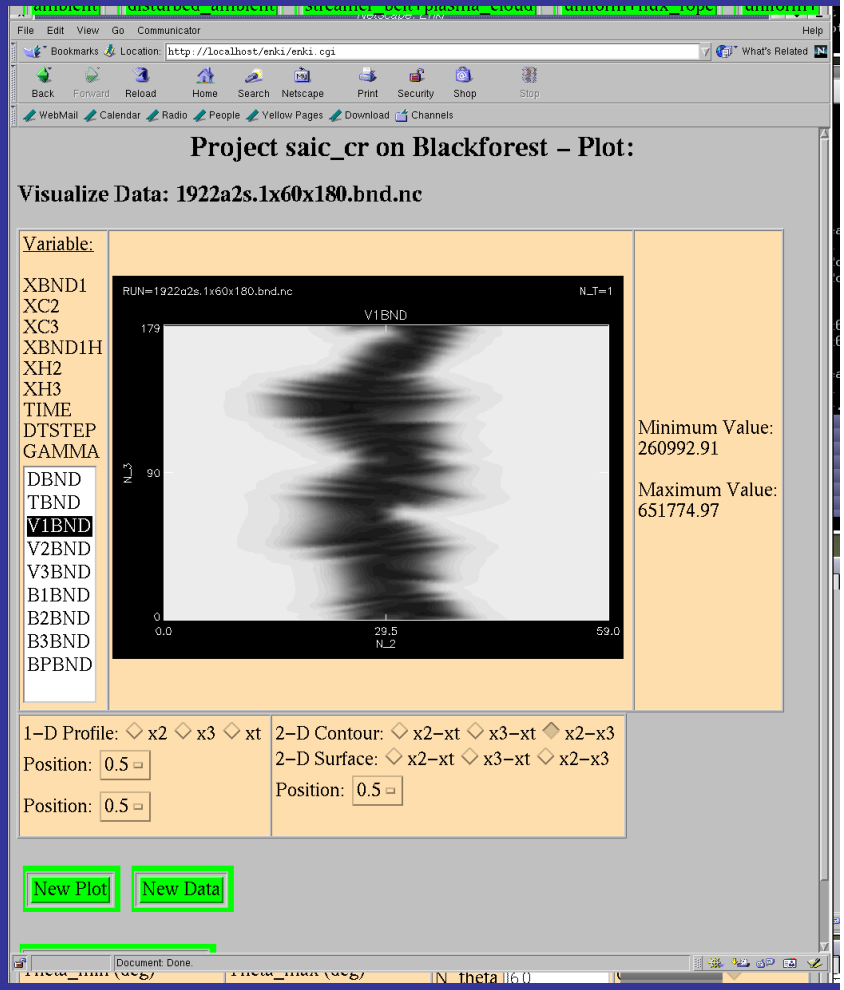
ENKI – Interface to ENLIL



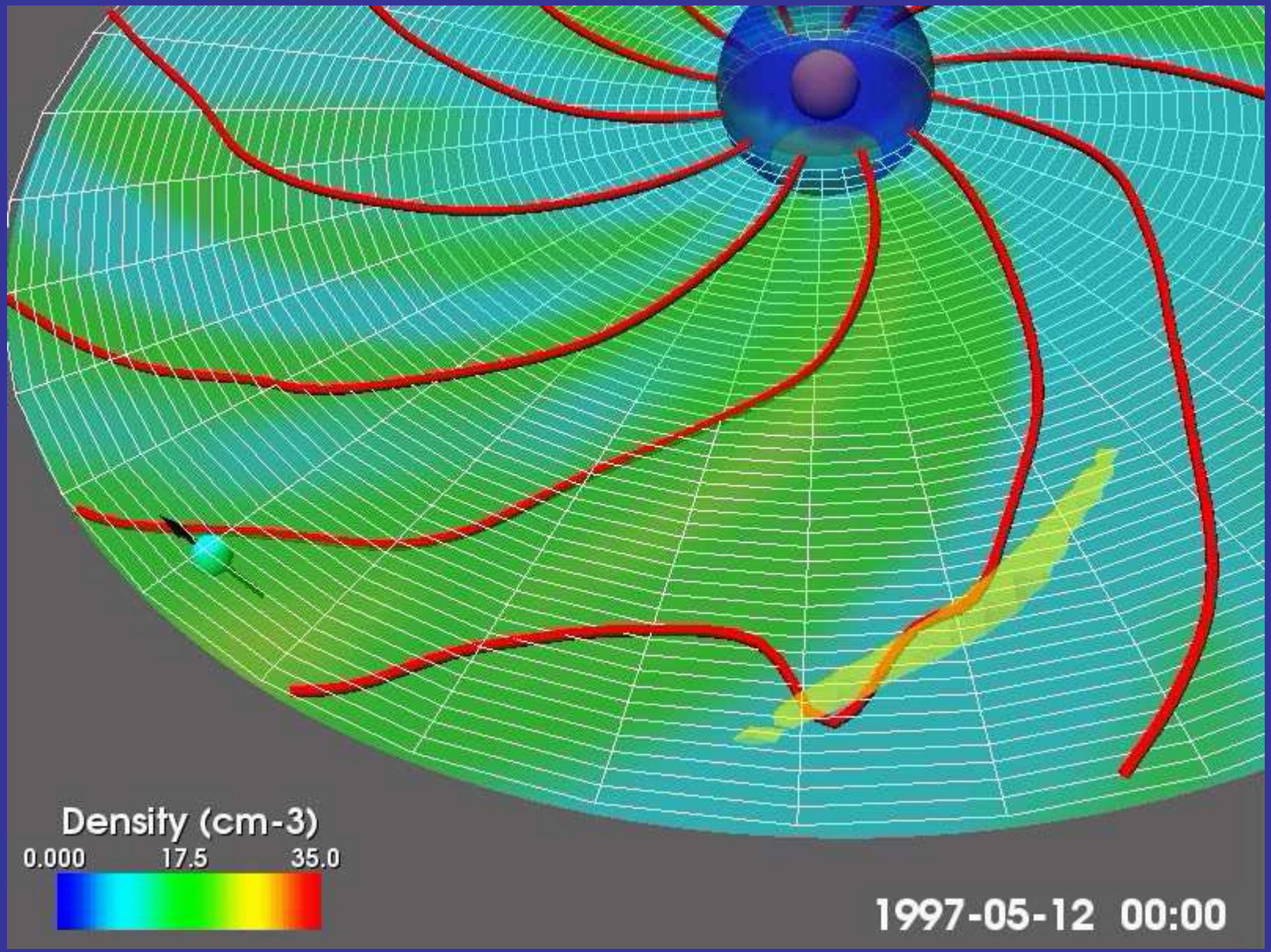


Remote Visualization: ENKI--IDL





Preview of data before downloading processing and visualization, archiving, etc.

Plot 1-D profiles and 2-D contours or surfaces of 1-D, 2-D, or 3-D data

Interplanetary Disturbances