On the Interpretation of Heliospheric Streamers Observed from SECCHI: Comparison Between Model Calculations and STEREO Observations

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STEREO SWG,

Meredith, NH

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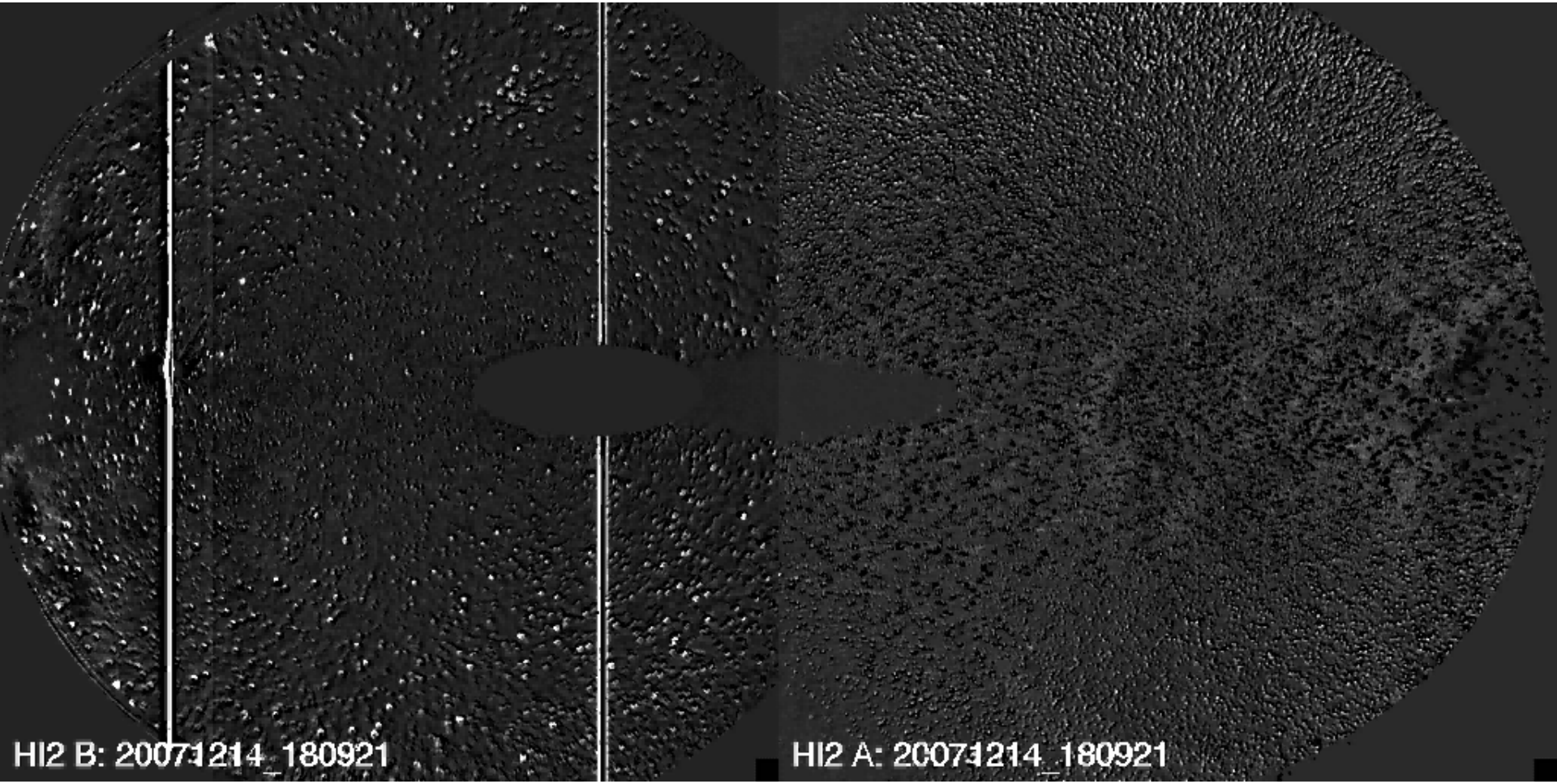


STEREO-Behind
SECCHI/HI-2

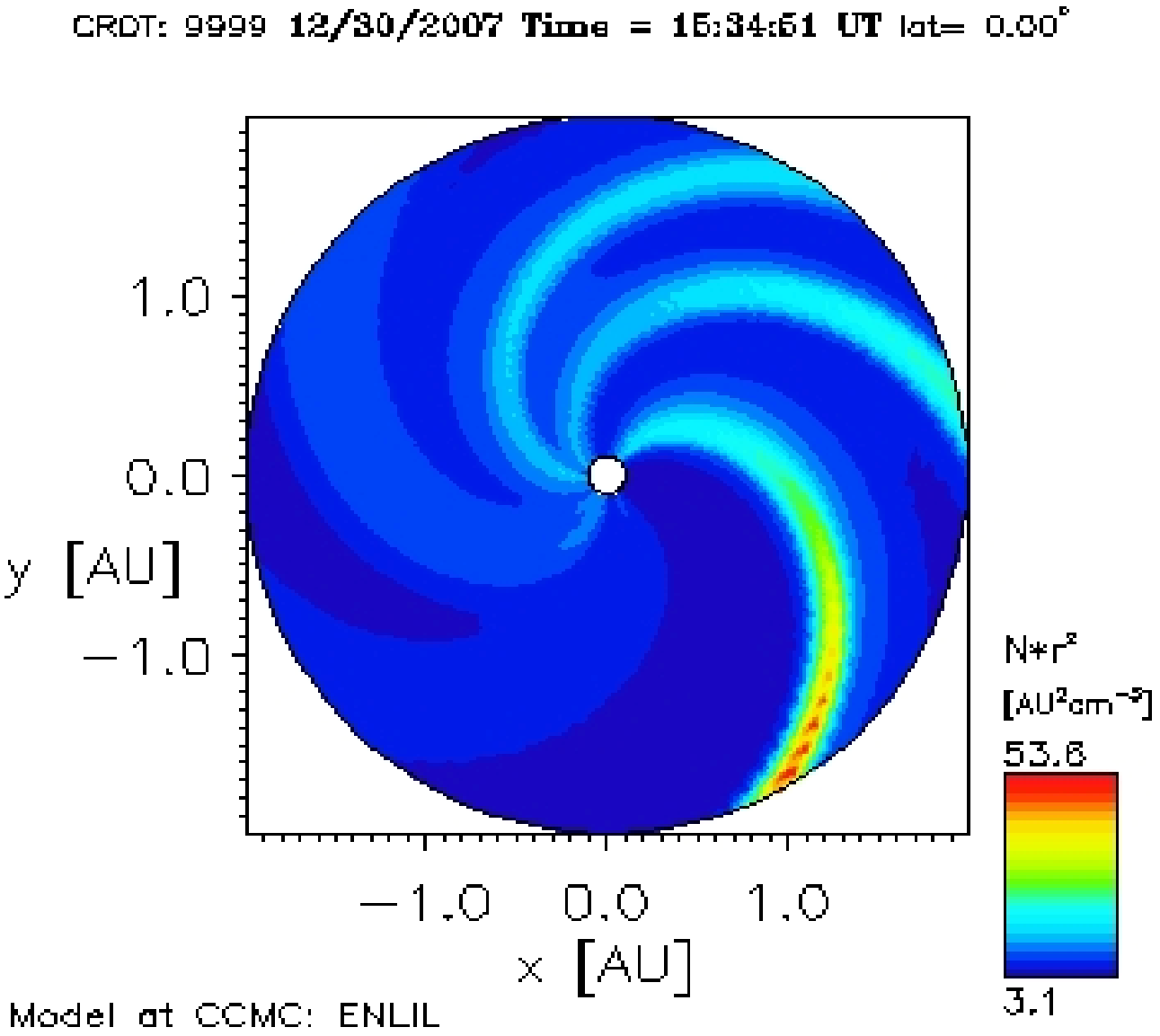
Earth

STEREO-Ahead
SECCHI/HI-2

Electron Density Modeling

- We utilized two codes at the CCMC to define a rectilinear grid of electron density
- Wang-Sheeley-Arge (WSA) Model extrapolates a solar rotation of magnetic field observations to 18 Rsun using the potential field source surface (PFSS) approximation
- Then the ENLIL performs a time-dependent 3D MHD computation to extend the WSA output into the inner heliosphere.
- We adjusted the number of voxels and the outer limit of the computation for this study settling on an array 128^3 and a FOV covering +/- 1.5 AU

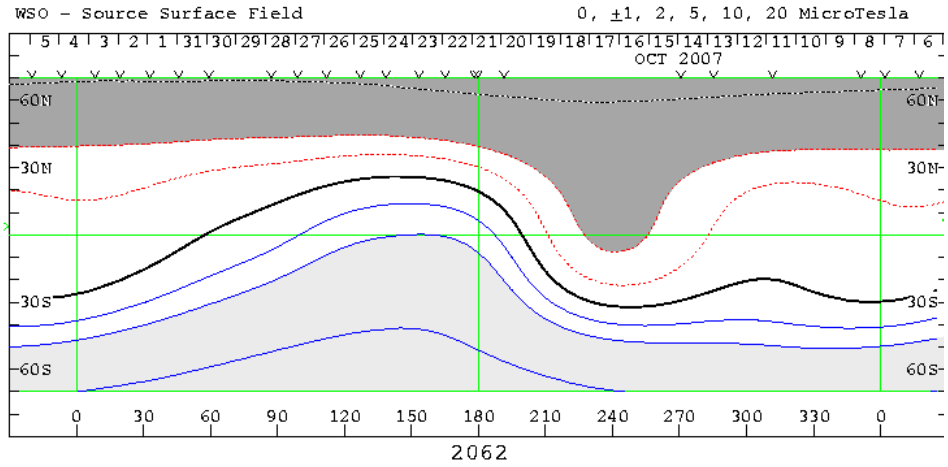
ENLIL Equatorial Slice

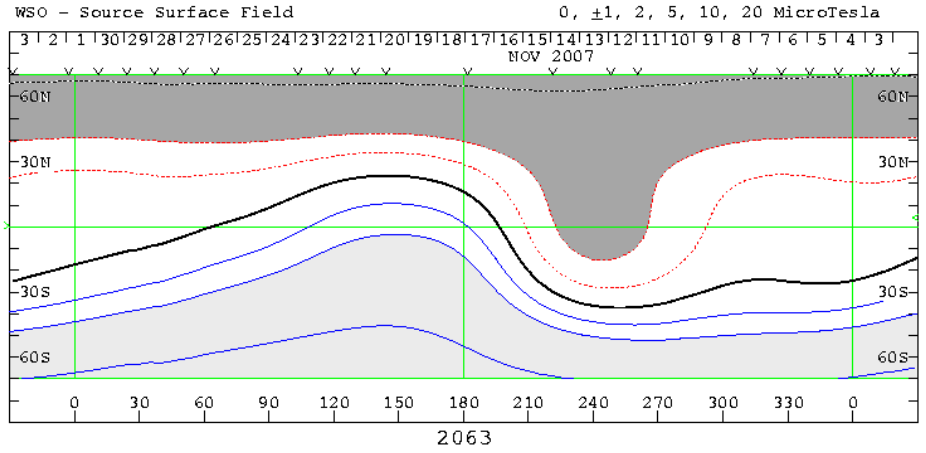


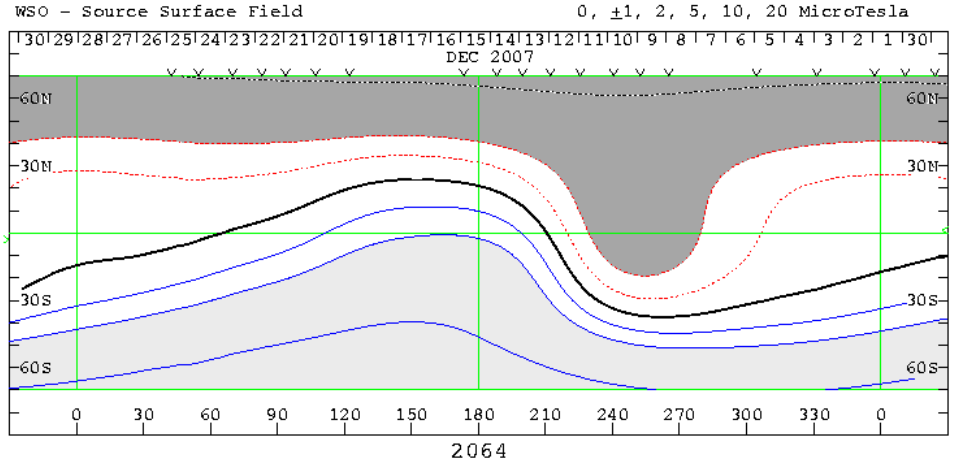
Simulated Images

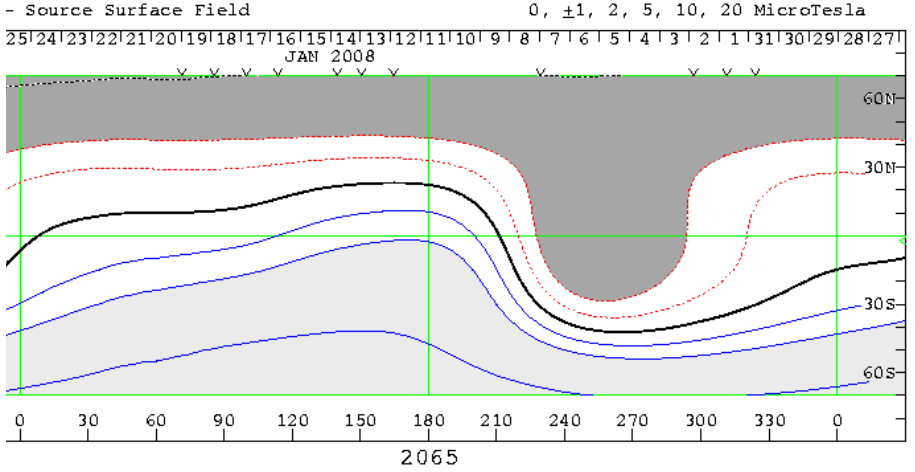
- Each frame is a mosaic of simulated images from 4 viewpoints:
  - View from above the ecliptic, 1 AU away
  - View from within the ecliptic, 20 AU away (Uranus)
  - View from HI-2A 70º x 70º looking to east of Sun
  - View from HI-2B 70º x 70º looking to west of Sun
- We have calculated a sequence of total brightness images from these 4 viewpoints by rotating the cube in 1 degree steps.
- Note that this is a completely static calculation – we are only rotating the electron density cube.

WSO Source Surface Maps Rotations 2062-2063

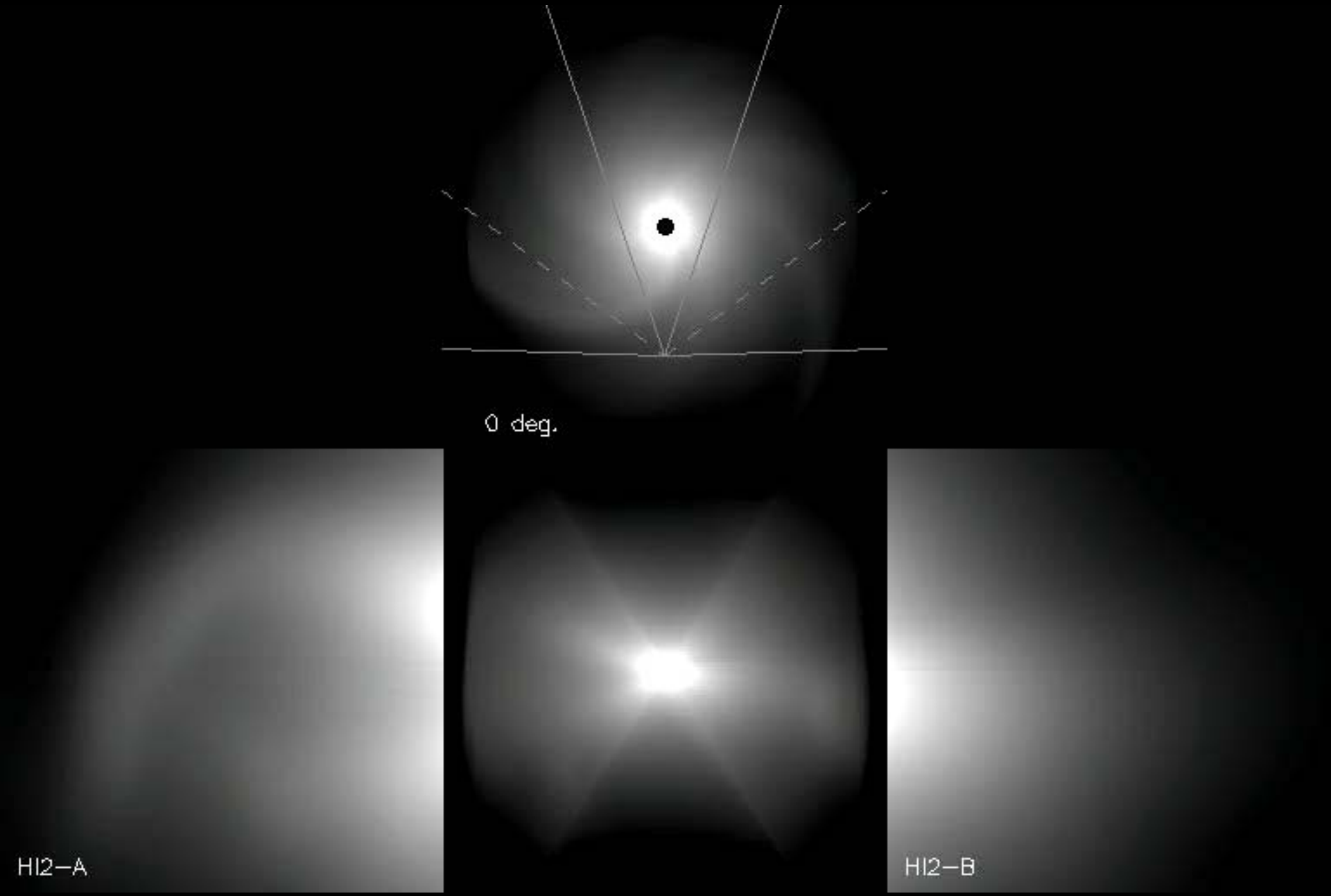








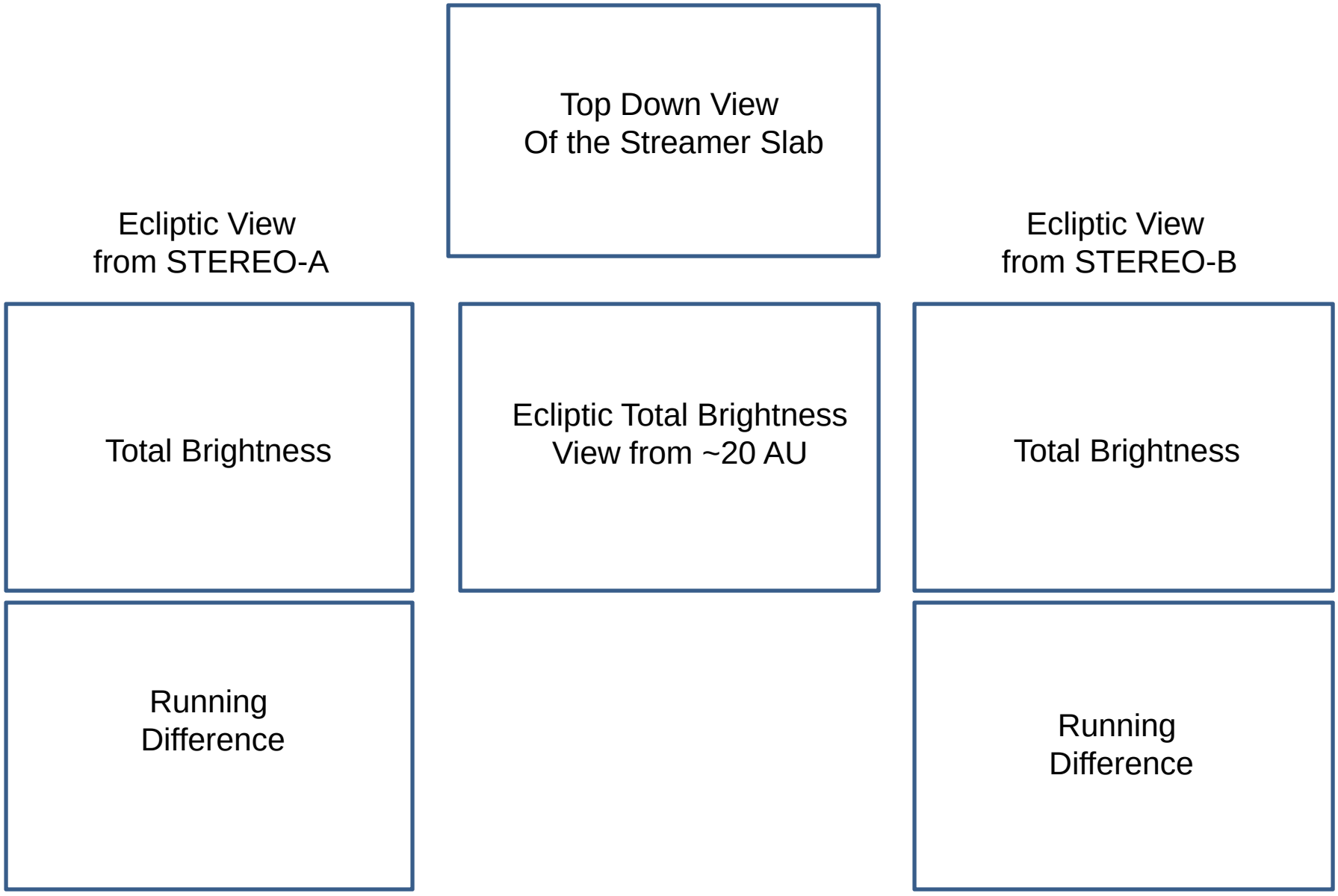
CR 2062



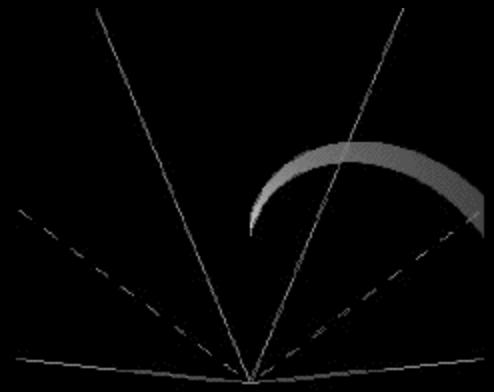
CR 2063

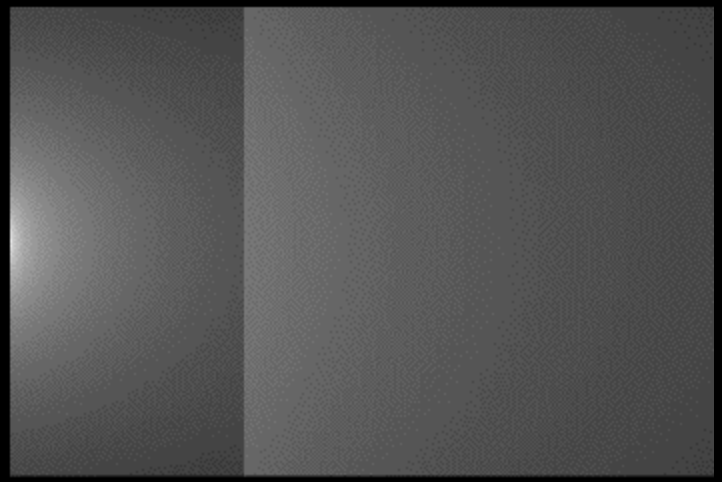
- You can see that the ENLIL code doesn't match the observations from both STEREO-A and B for either CR 2062 or CR 2063.
- We decided to step back and do some simple modeling to see if we can learn what is happening
- We started with the analytic formulation of the Heliospheric Current Sheet by Jokipii (1981)
  - This did not generate the right brightness enhancements, we thought due to the steepness of the function
  - We adjusted the exponent of the sine function, which helped but not sufficiently.
- We then generated a simple density enhancement of a vertical wall (~50 degrees latitude) along an Archimedean spiral generated at different constant speeds.
- In the next slides we show some movies of our simulations

Format of Movies



300 km/s



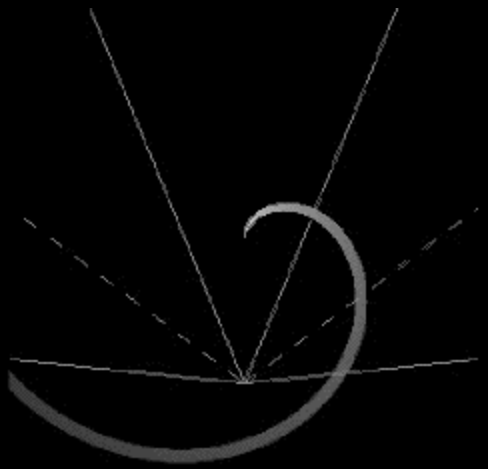


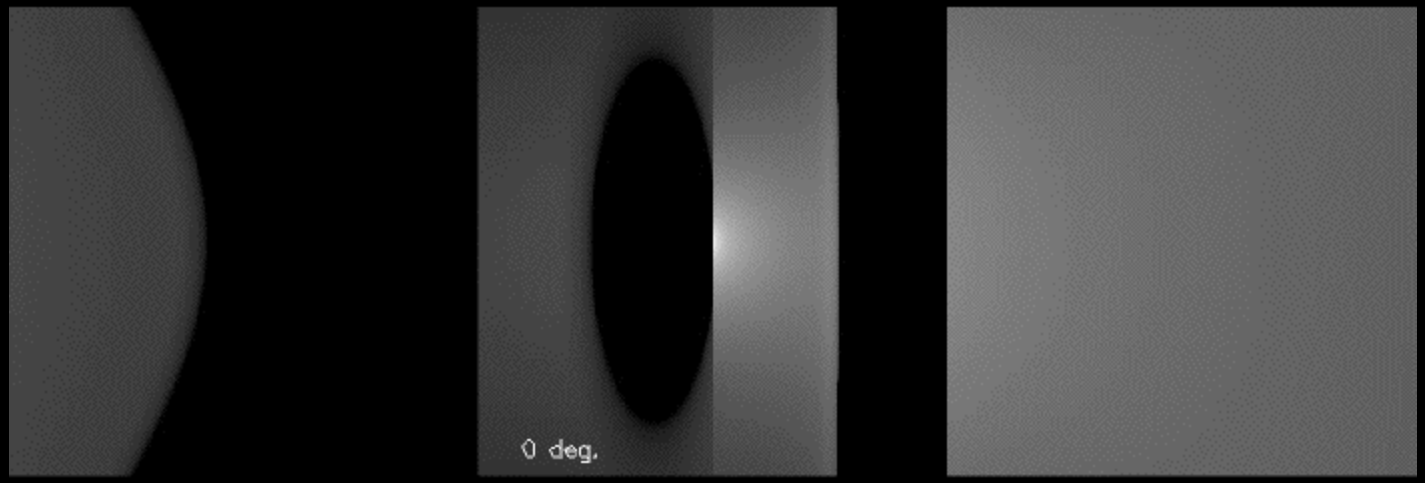
0 deg.

HI2–A

HI2–B

200 km/s

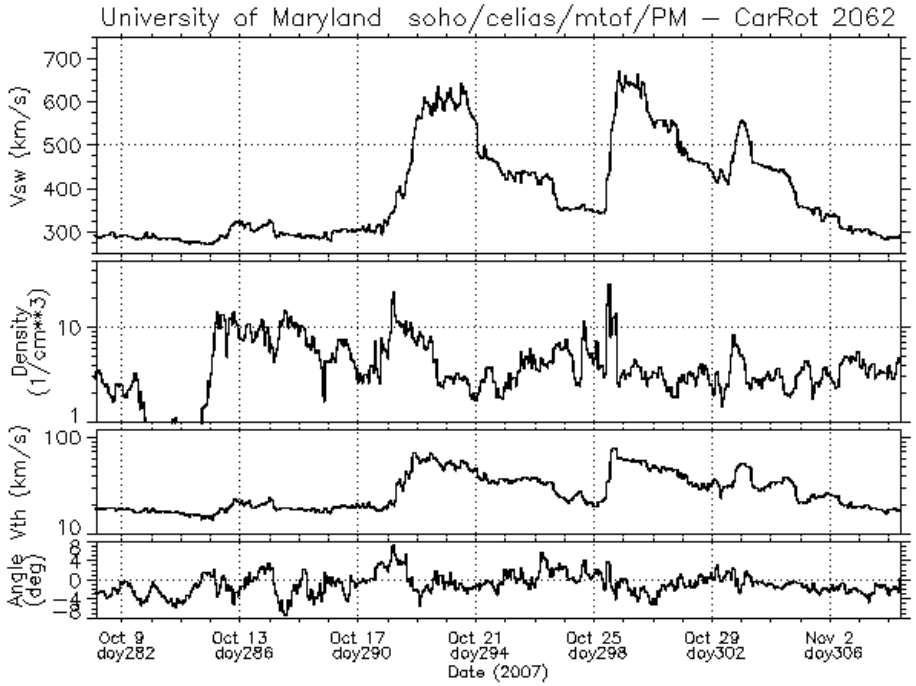


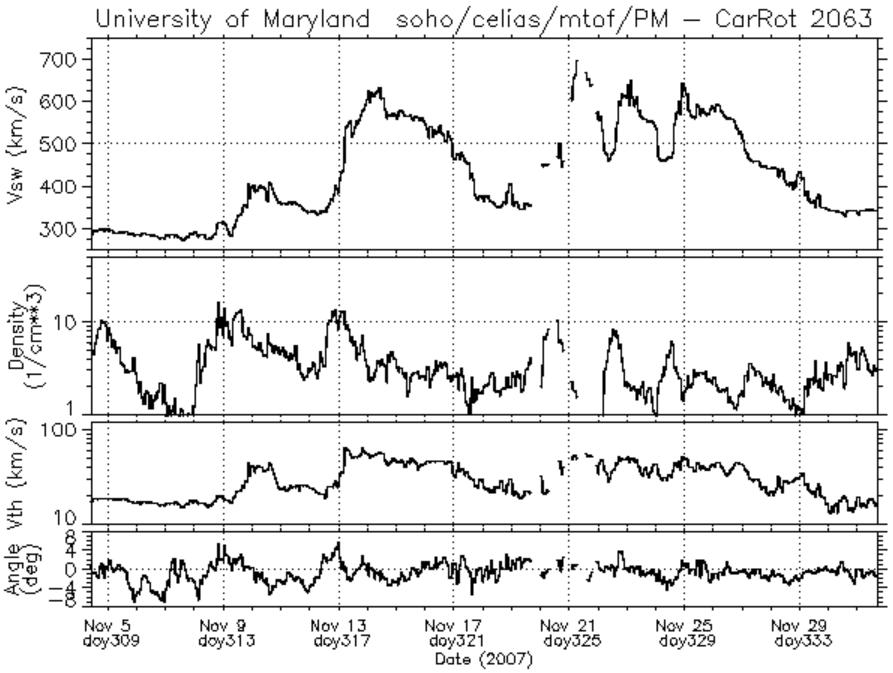


HI2–A

HI2–B

Celias/MTOF/PM





Note the speed of the high density stream is decreasing down to ~300 km/s

Summary (1)

- We have rotated a static heliospheric electron density distribution computed from ENLIL for 4 rotations and simulating the Thomson scattered brightness distribution
  - The polar coronal holes are quite stable and visible out to many AU
  - The HI-2A (East Limb) simulated view is quite different from the HI-2B (West Limb) simulated view.
- HOWEVER, the simulations don’t agree with the observations! The HI-2B shows the CIRs quite clearly, whereas the simulation doesn‘t.

Summary (2)

- A study of a simple streamer/HCS model shows that the HI2-A/B behavior is very dependent on the outflow speed of the streamer. Also note the effect of running differences.
- HI2-A shows the streamer slightly behind the east limb and is able to follow the stream all the way to the S/C as it rotates.
- HI2-B does not see the stream until it sweeps over the S/C and then can follow it through the field as it moves away from the S/C
- Speeds of >400 km/s do not show the stream structure in HI2-B, 300 km/s a little and 200 km/s very much.
  - The curvature of the streamer (determined by its outflow speed) is necessary to see the stream.
- But the 1AU speed is about 300 km/s. Is this due to some local structure within the streamer due to the compression caused by the high speed stream?