COMPARING SIMULATED EUV EMISSION WITH STEREO EUVI AND SOHO EIT OBSERVATIONS

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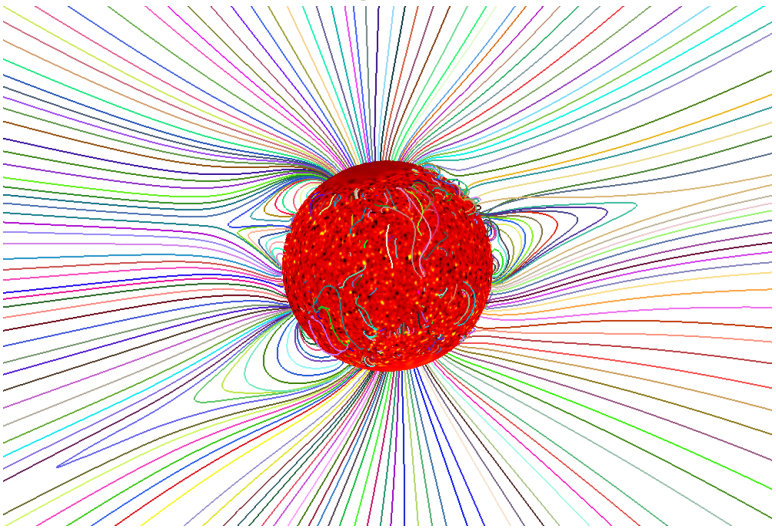
AUGUST 1, 2008 ECLIPSE CORONA PREDICTION

- We predicted what the corona would look like during the eclipse
- The MHD calculation was started on July 23 and posted on our web site on July 27, 2008
- This is our highest resolution calculation ever
- 201 × 191 × 432 mesh points (16.5 million cells) in spherical coordinates (r,θ,ϕ)
- It ran for 3.6 days on 4368 processors of Ranger at the Texas Advanced Computing Center (the fourth fastest supercomputer in the world in June 2008)
- We used SOHO MDI data to specify the magnetic field
- We used our improved energy transport model

August 1, 2008 Total Solar Eclipse

Predicted Magnetic Field Lines



Predicted Polarization Brightness

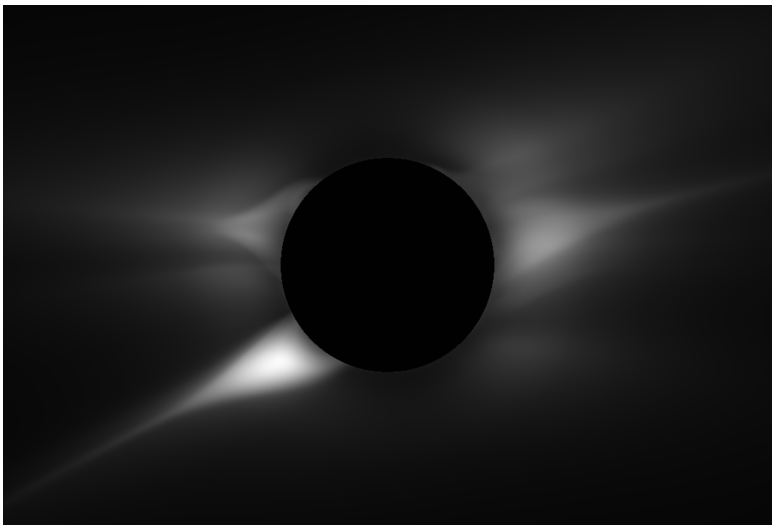
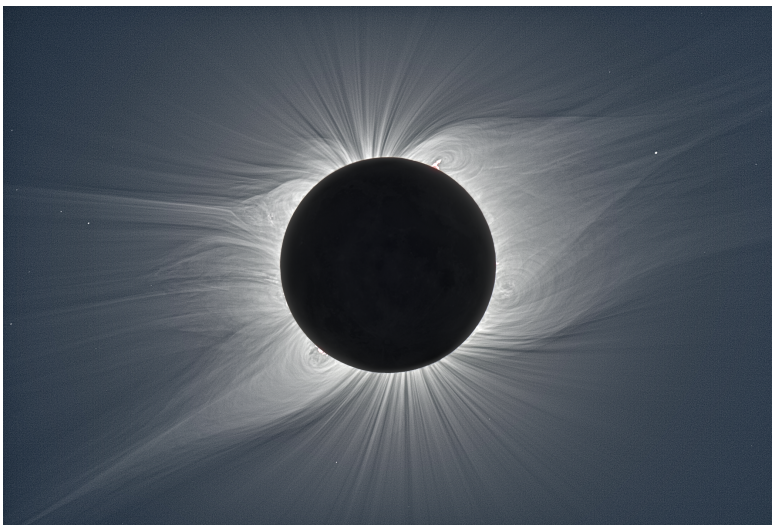


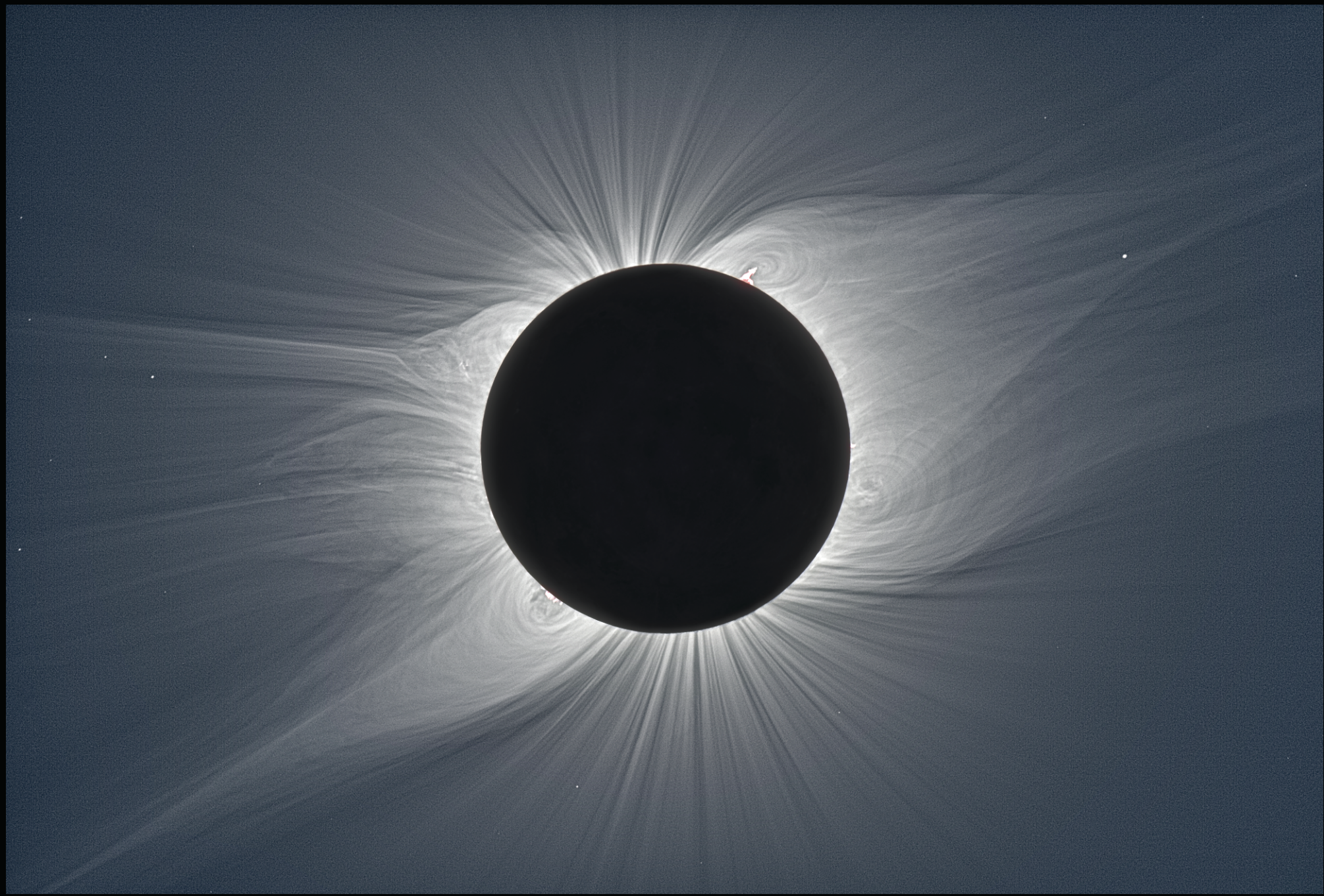
Image from Mongolia (Druckmüller, Aniol, & Rušin)



Comparison between the predicted eclipse corona from the MHD model and an image taken in Bor Udzuur, Mongolia (© Miloslav Druckmüller, Peter Aniol, and Vojtech Rušin). The eclipse image is a composite of many photographs with different exposures, with considerable sharpening applied to emphasize filamentary structures. The image is oriented so that solar north is 12.1° counterclockwise from the vertical direction. It is evident that the bright features correspond to regions with closed magnetic field lines. Although the model does not reproduce the high-resolution features of the corona, the locations of the major streamers are predicted reasonably well.

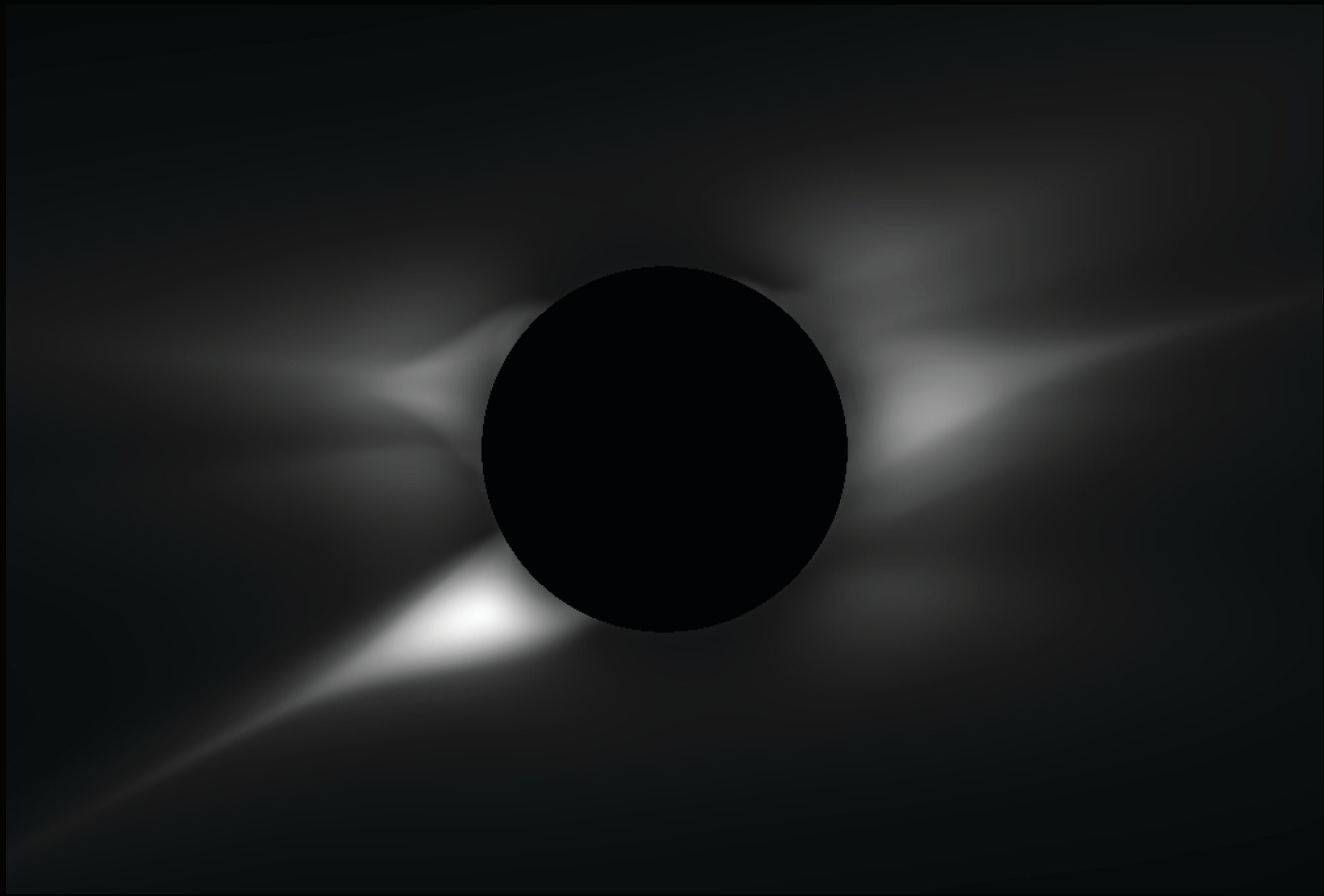
August 1, 2008 Total Solar Eclipse

Image from Mongolia (Druckmüller, Aniol, & Rušin)



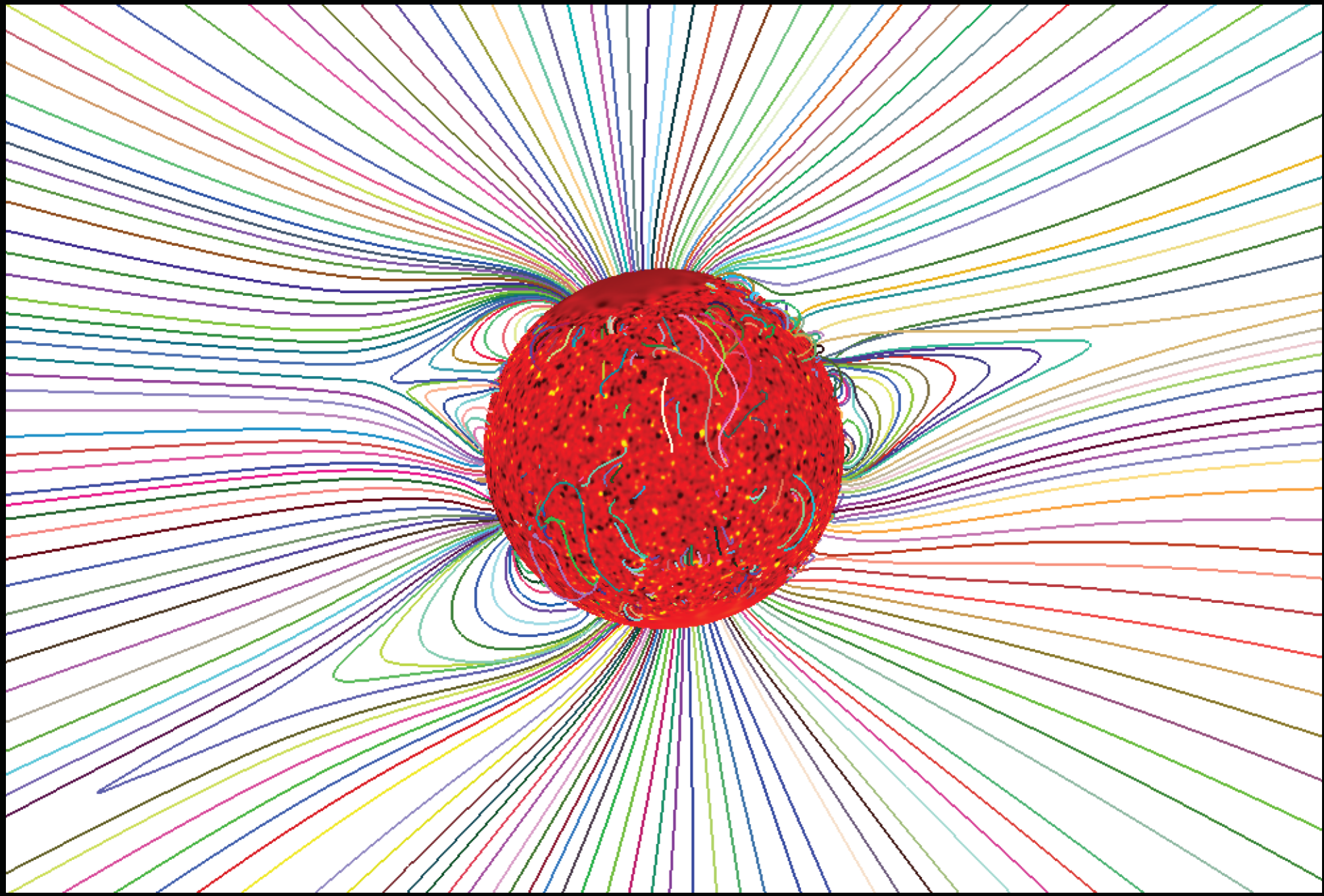
August 1, 2008 Total Solar Eclipse

Predicted Polarization Brightness



August 1, 2008 Total Solar Eclipse

Predicted Magnetic Field Lines



CONSTRAINING CORONAL HEATING MODELS WITH EUV AND X-RAY EMISSION OBSERVATIONS

- The Sun was very quiet during June 25 – July 22, 2008 (CR 2071 and 2072)
- This time period corresponds to the MDI magnetic field data we used for our calculation
- This is a good time to assess how well we are heating the corona
- From our MHD calculation we can simulate the UV and X-ray emission
- Comparing this simulated emission with observations (e.g., STEREO EUVI and SOHO EIT) is an excellent way to constrain coronal heating models

CALIBRATING EUVI AND EIT EMISSION

- Getting **quantitative** emission (calibrated) **is essential** for this task
- I am a novice user of STEREO data
- I used `secchi_prep` to calibrate the EUVI emission and `eit_prep` to calibrate EIT emission
- Command:

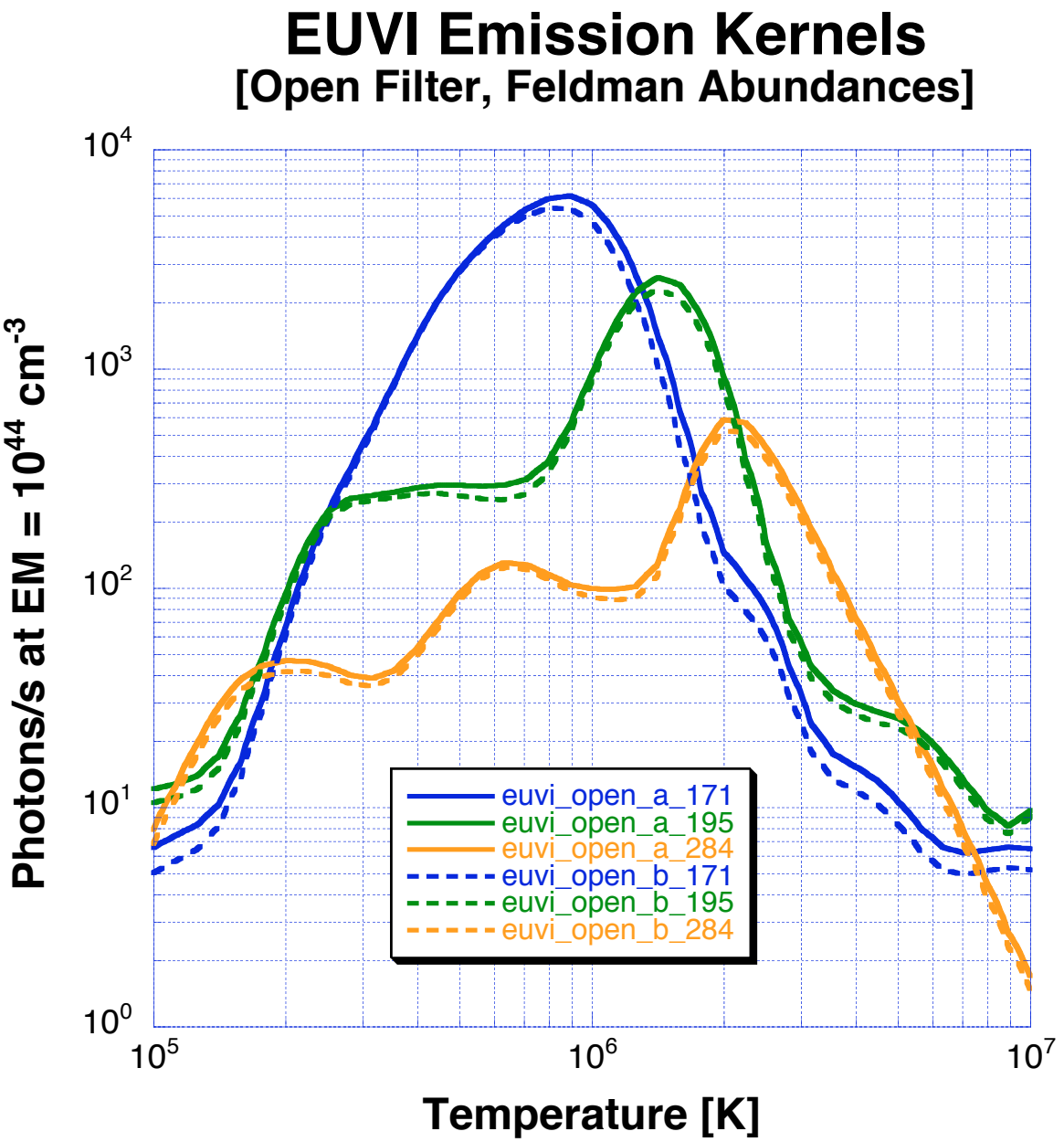
```
secchi_prep,infile,header,image,/rotate_on,/rotcubic_on
```

```
rsun=header.rsun
dx=header.cdelt1
dy=header.cdelt2
xc=header.crpix1
yc=header.crpix2
for i=0,nx-1 do x[i]=(i+1-xc)*dx/rsun
for i=0,ny-1 do y[i]=(i+1-yc)*dy/rsun
```

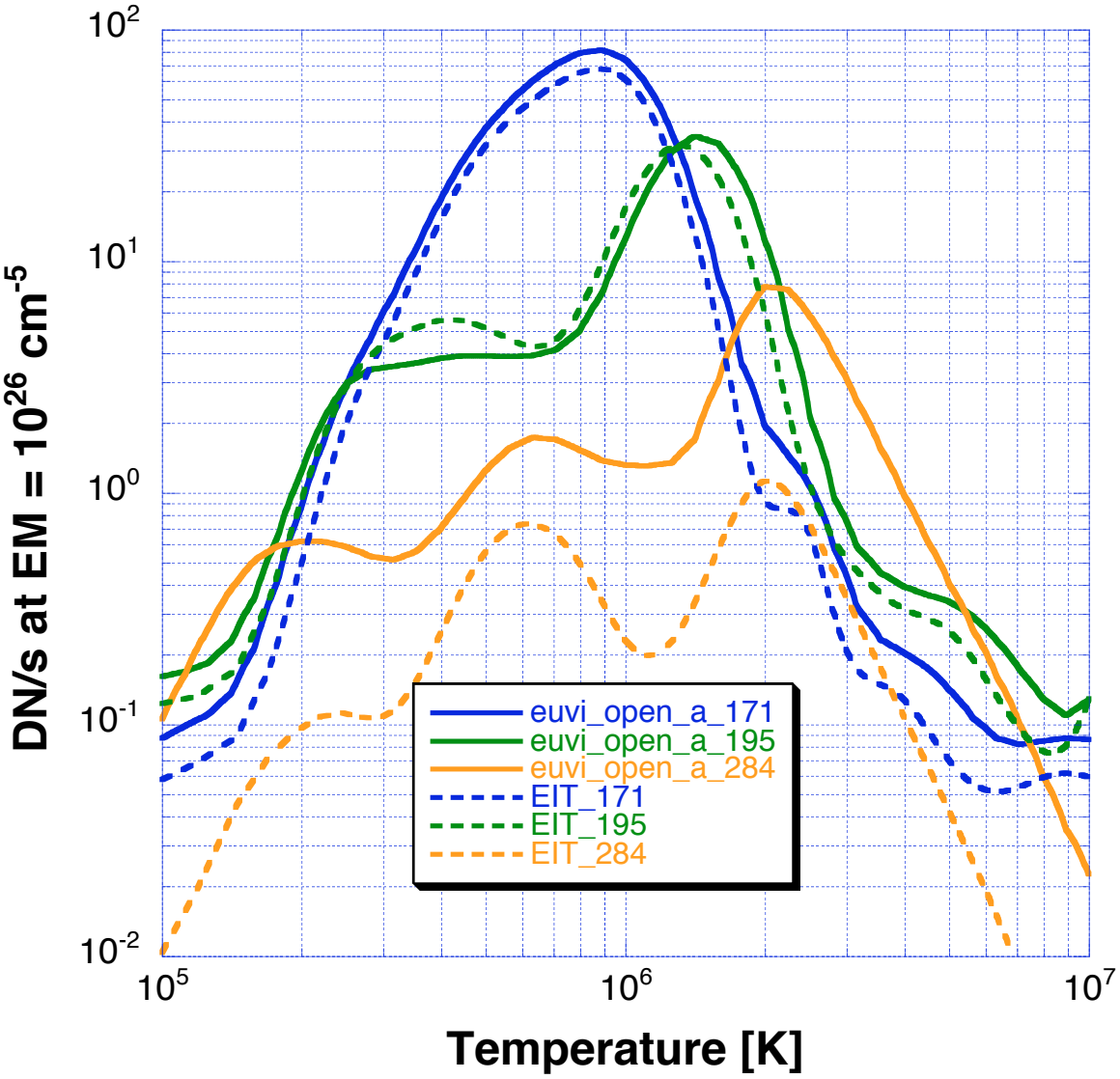
- This seems to give stable magnitudes of emission and looks reasonable

- We correct for the B_0 angle, the CMD longitude, the size of the Sun, and we use absolute emission scales
- To compute synthetic emission from the MHD simulation I constructed emission kernels using `euvi_flux`:

```
f=euvi_flux(temp,171,/ahead,/Feldman,/photon,filter='open')
```


EUVI Emission Kernels
[Open Filter, Feldman Abundances]
Photons/s at EM = 10^44 cm^-3
10^4
10^3
10^2
10^1
10^0
10^5
10^6
10^7
Temperature [K]
euvi_open_a_171
euvi_open_a_195
euvi_open_a_284
euvi_open_b_171
euvi_open_b_195
euvi_open_b_284

EUVI vs EIT Emission Kernels

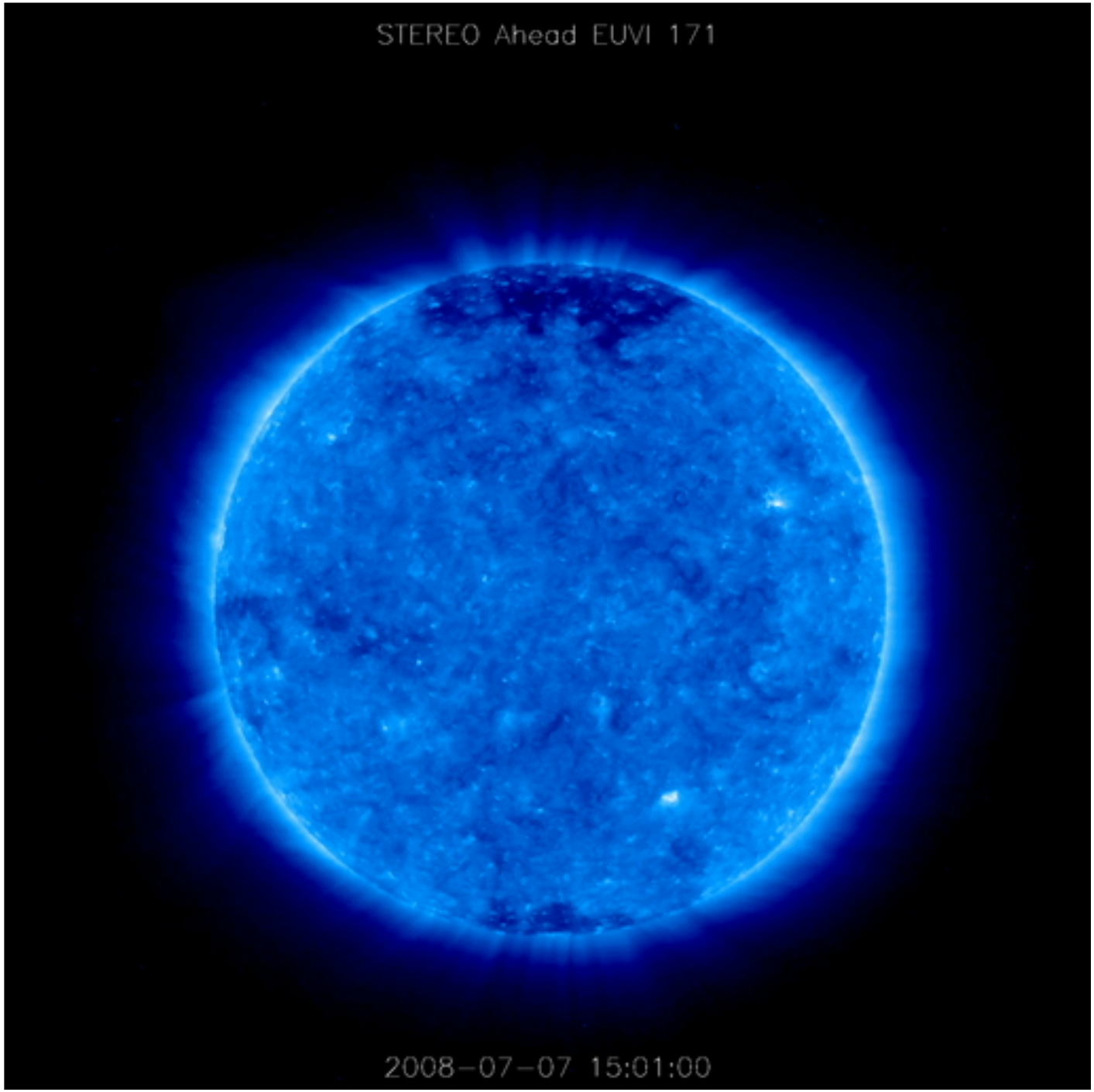


ODDITIES WITH STEREO DATA

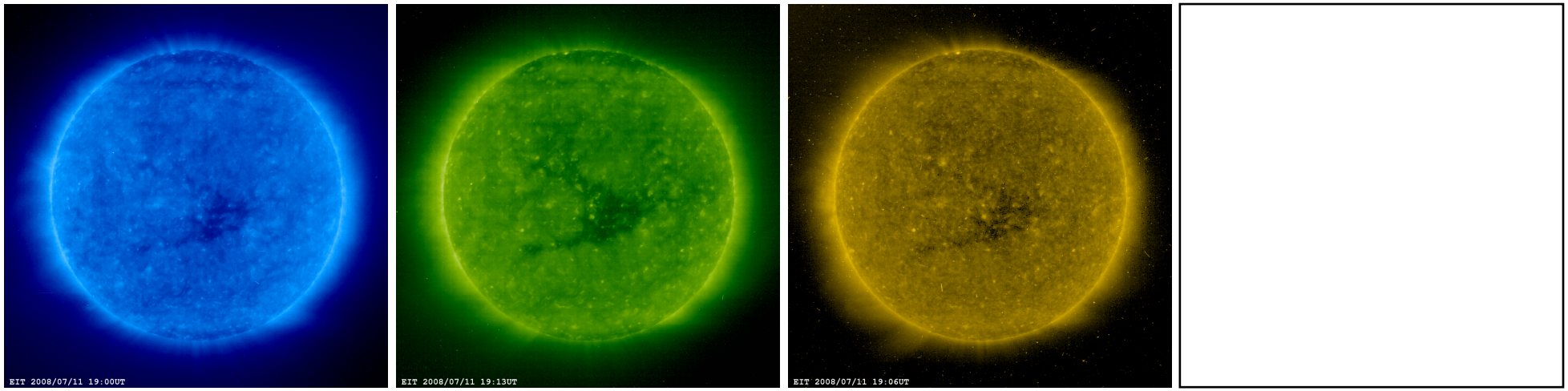
- I am a novice user of STEREO data
- During June 25 – July 22, 2008 I came across 5 periods with bad pointing out of 864 selected images
- Bad frames near these times and dates:

```
20080630_114630_n4euB_284.jpg
20080630_154630_n4euA_284.jpg
20080630_155530_n4euA_195.jpg
20080707_155830_n4euA_171.jpg
20080707_155830_n4euB_171.jpg
```

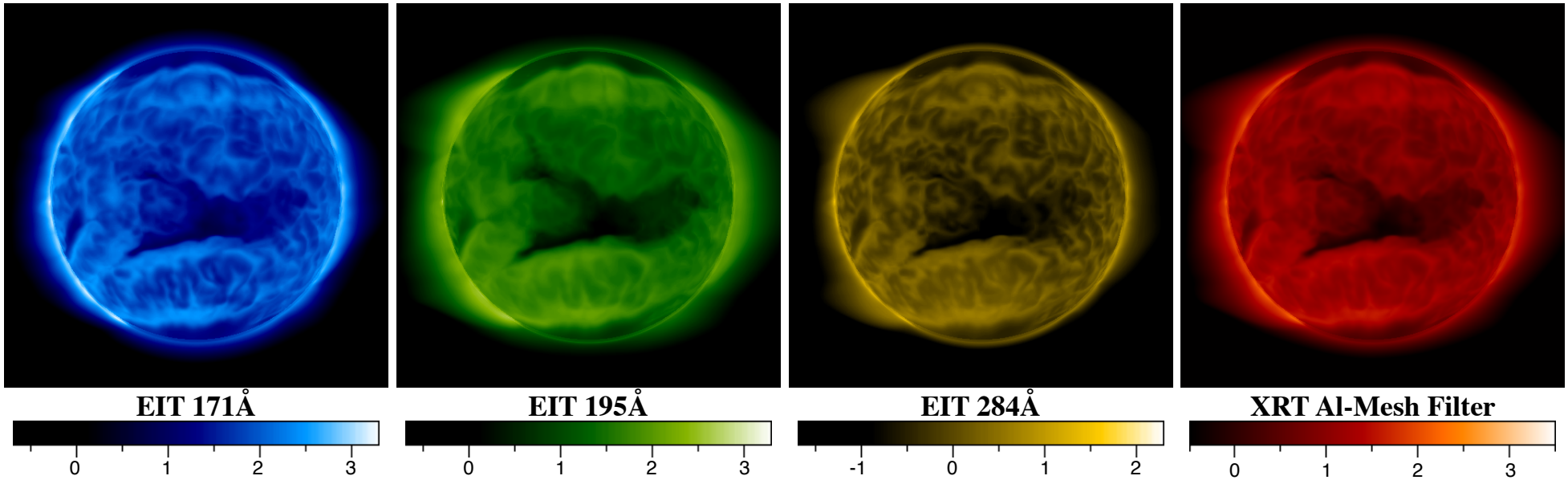
- I also noticed a slight abrupt clockwise rotation (a few degrees) in STEREO B (between 2008/06/27 20:15 and 2008/06/28 00:45) that seemed to persist. This did not seem to happen to STEREO A.


STEREO Ahead EUVI 171
2008-07-07 15:01:00

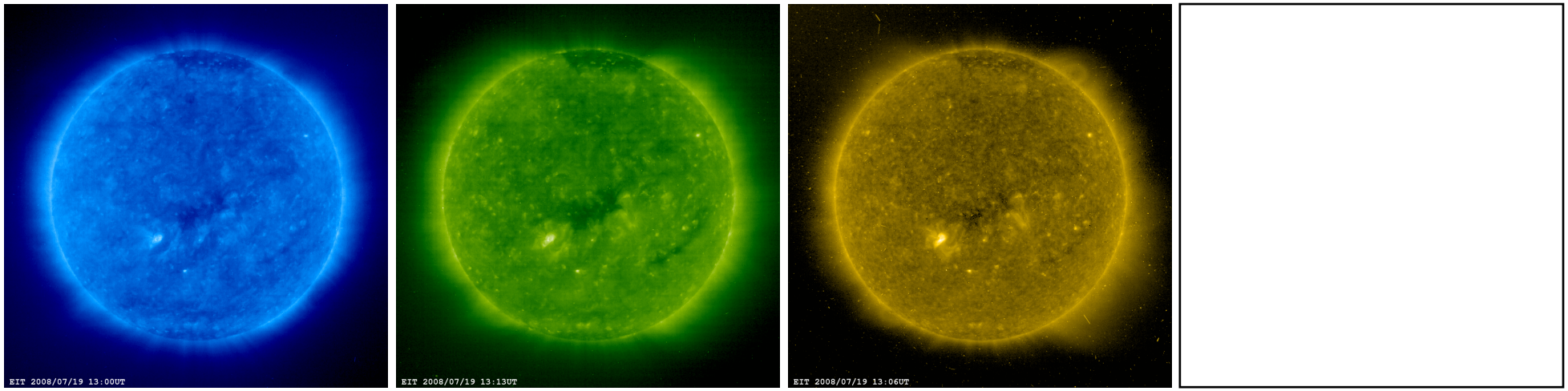
Observed EIT Emission on July 11, 2008 near 19:06UT [Log_{10}DN/s]



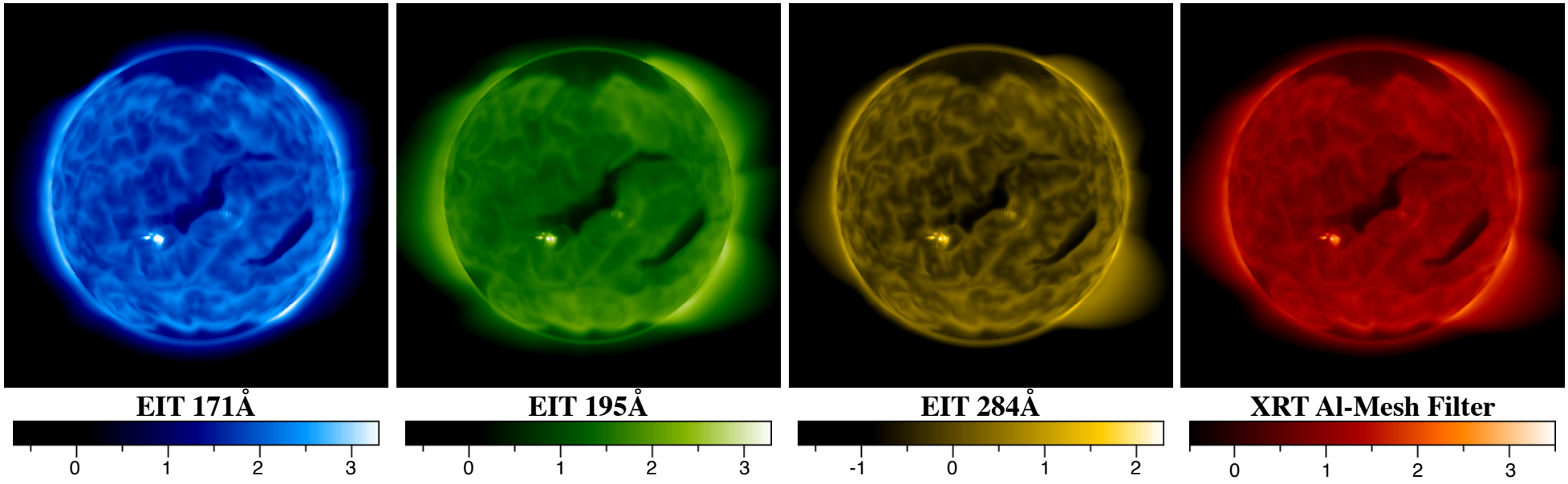
Simulated EIT Emission [Log_{10}DN/s]



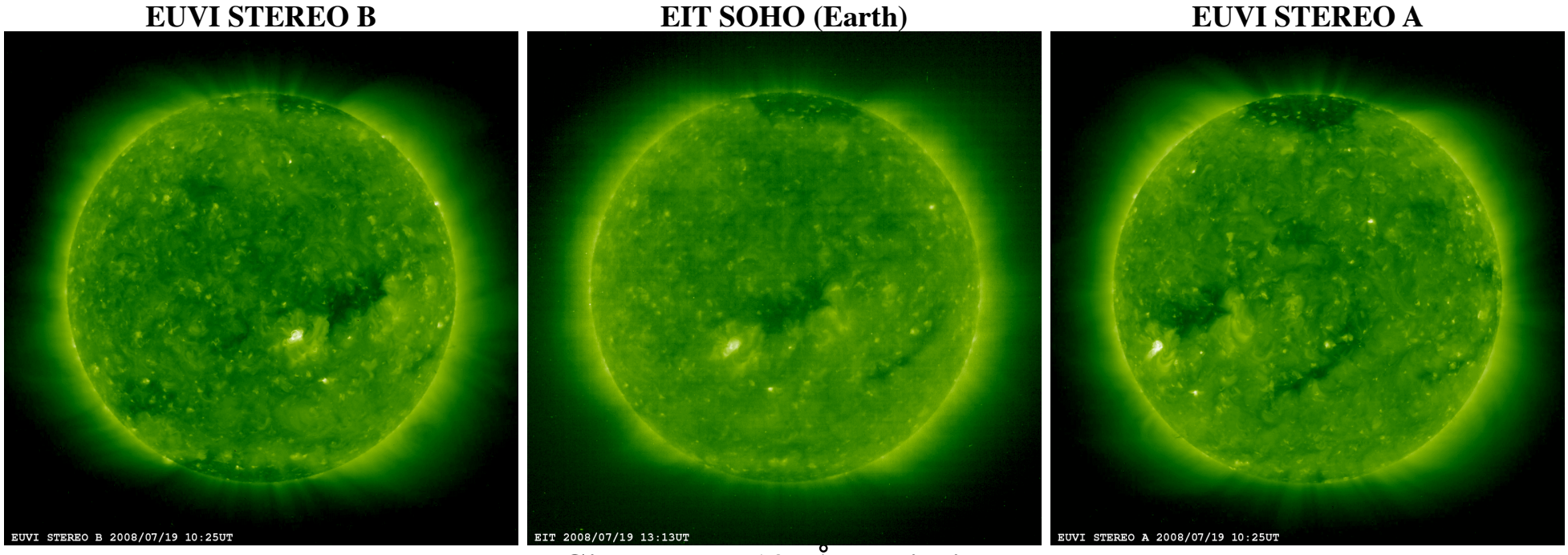
Observed EIT Emission on July 19, 2008 near 13:06UT [Log_{10}DN/s]



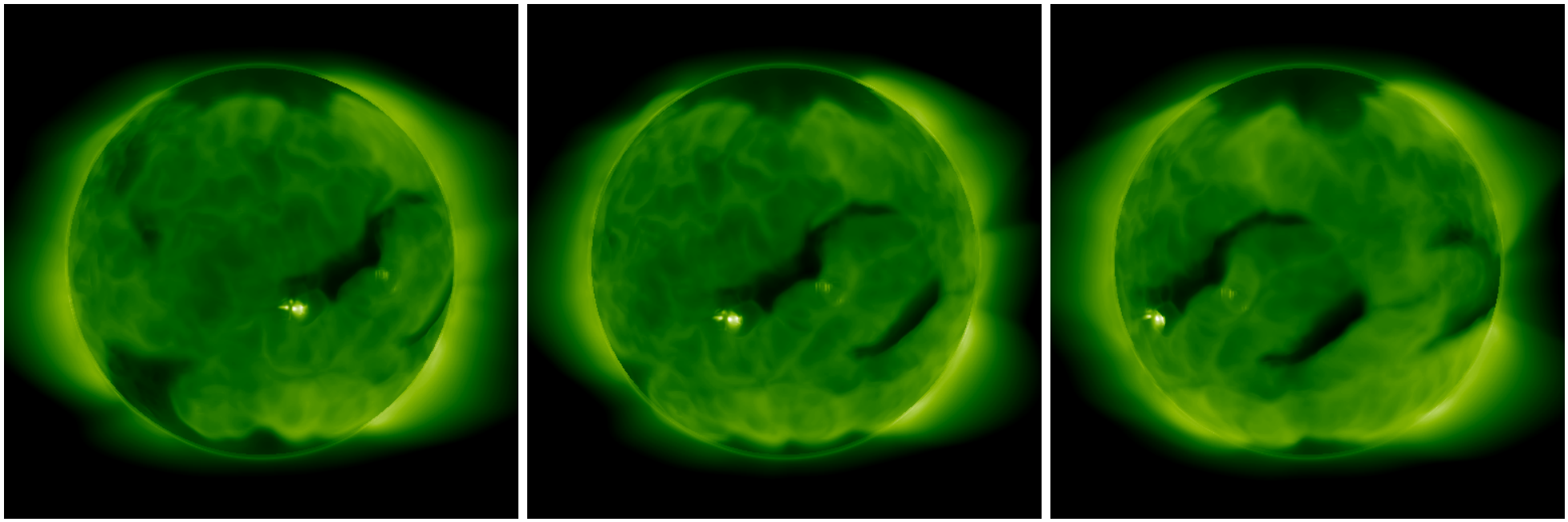
Simulated EIT Emission [Log_{10}DN/s]

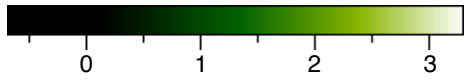


Observed 195Å Emission on July 19, 2008 near 13:06UT

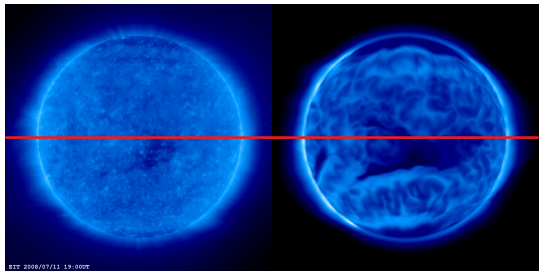


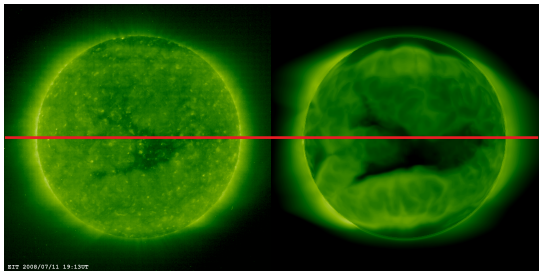
Simulated 195Å Emission

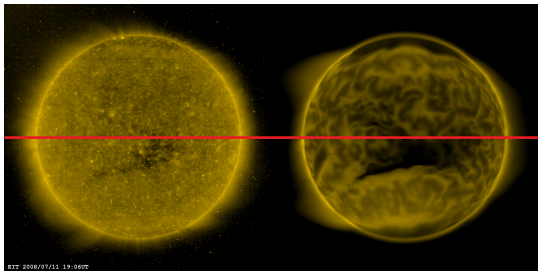


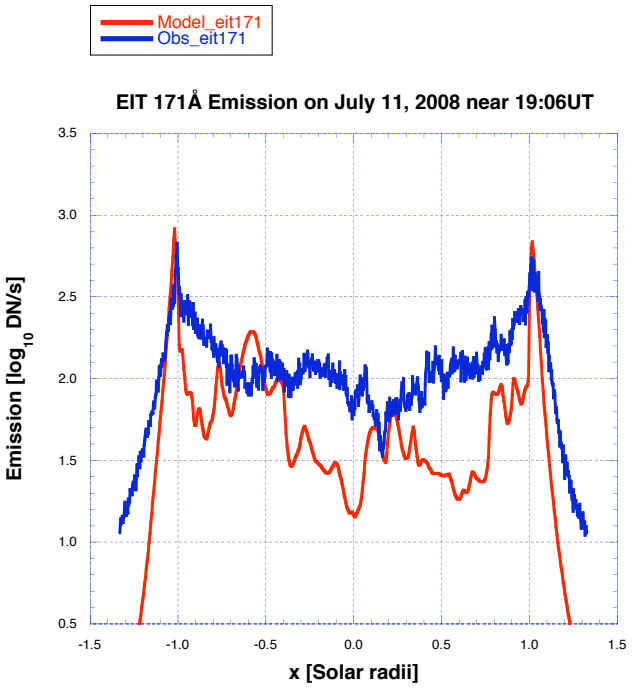


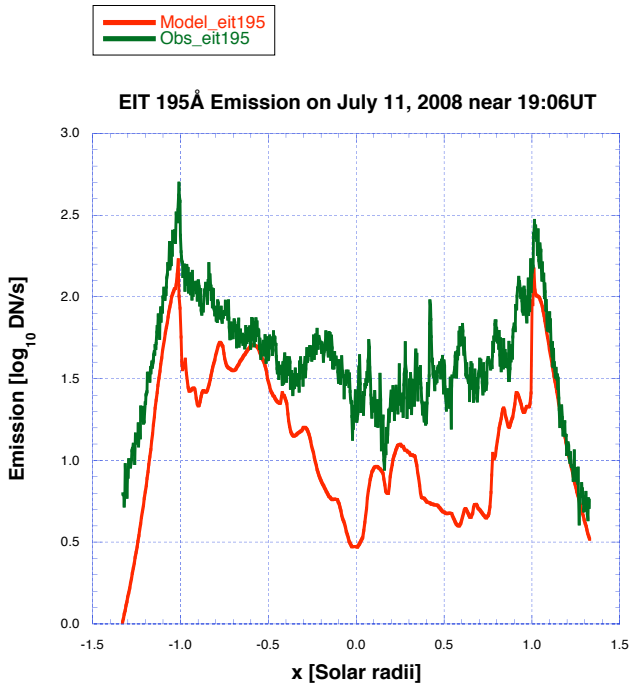
Comparing EIT Emission with Simulated Emission on July 11, 2008 near 19:06UT (Equatorial Cut)

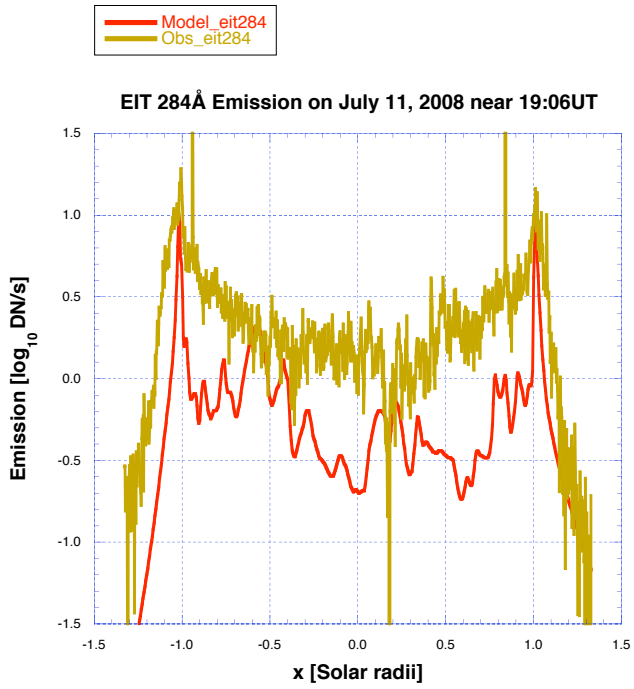




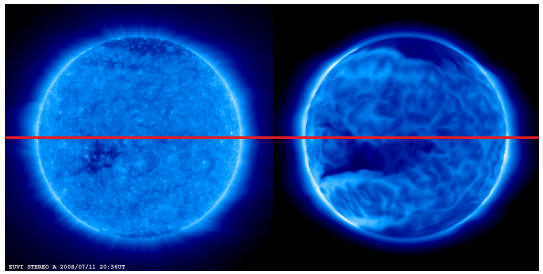


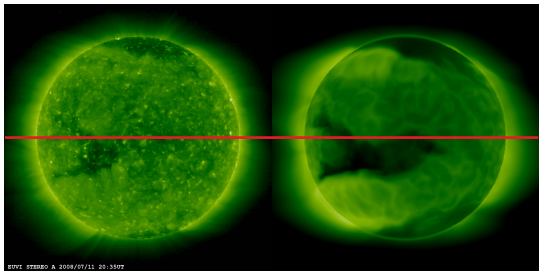


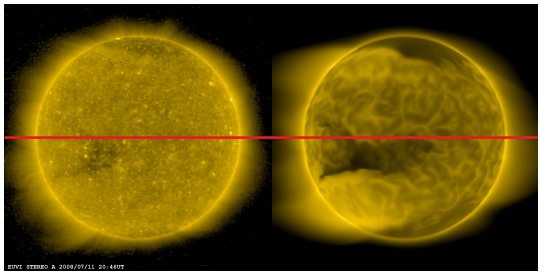


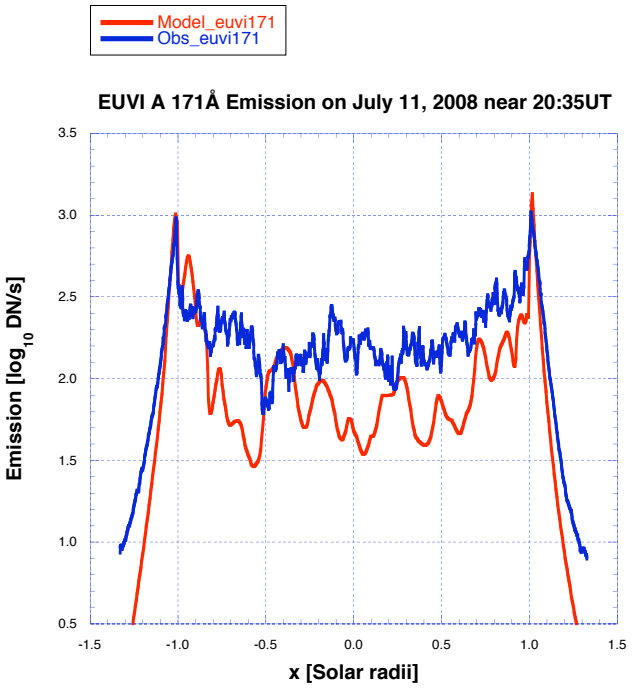


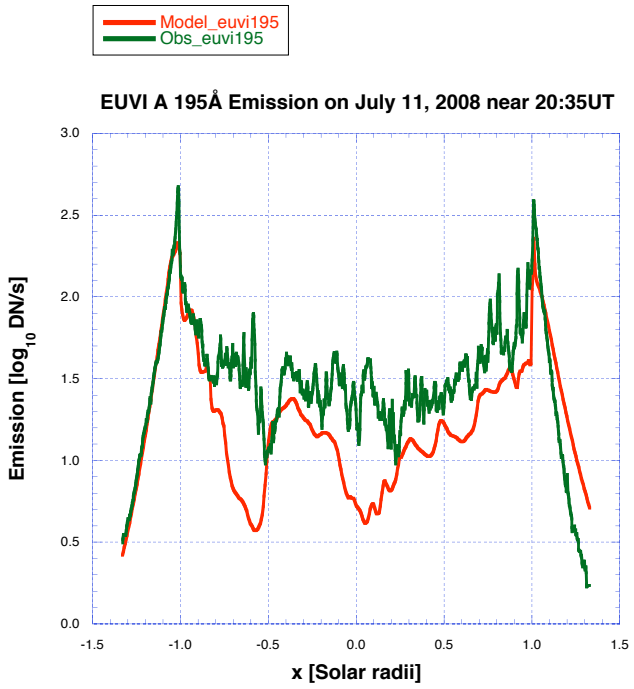
Comparing EUVI A Emission with Simulated Emission on July 11, 2008 near 20:35UT (Equatorial Cut)

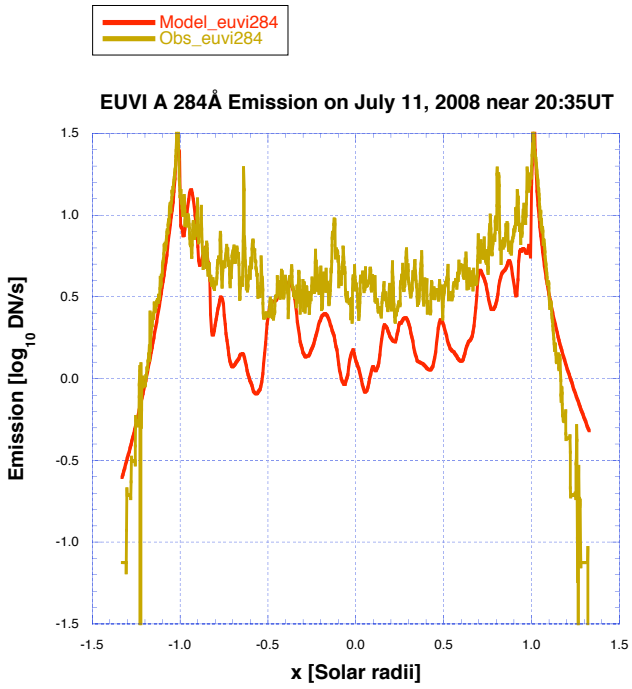




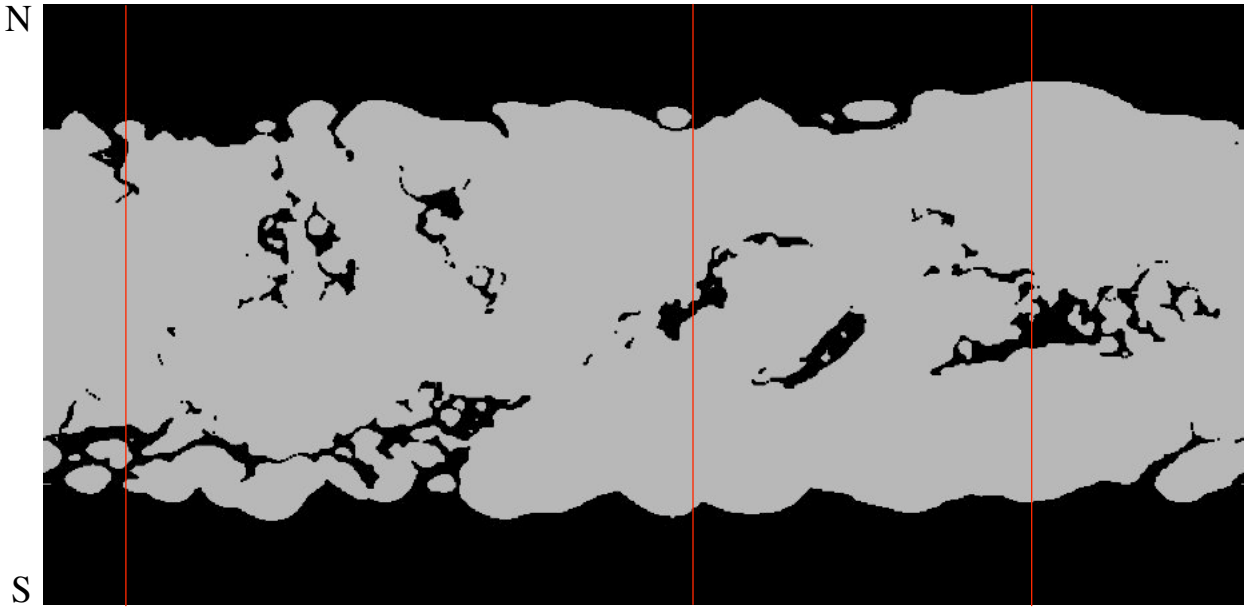






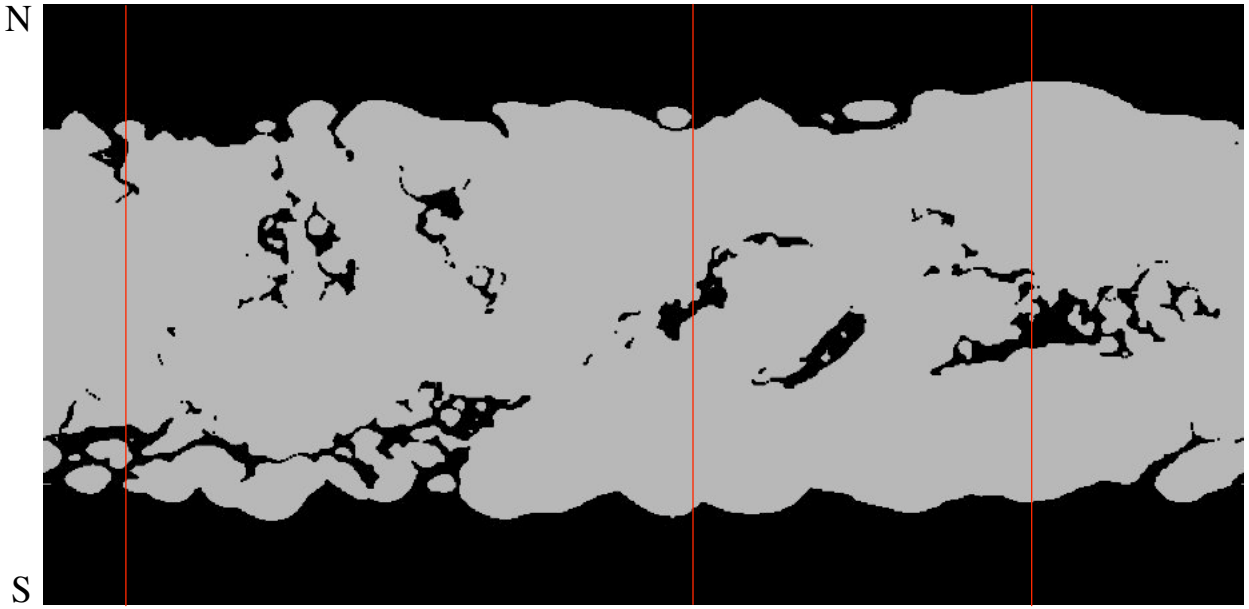


MHD Model Coronal Holes



Source-Surface Model Coronal Holes ($R_{ss} = 2.0R_s$)

MHD Model Coronal Holes



Source-Surface Model Coronal Holes ($R_{ss} = 2.5R_s$)

PRELIMINARY IMPRESSIONS

- Our coronal heating model needs improvement!
- On the other hand, the model is beginning to look real!
- The calibrated EUVI and EIT data seem to be roughly consistent, though there are differences that need to be understood
- Generally we seem to be heating too little
- On the other hand, we seem to open up too many coronal holes
- Our coronal holes are too dark
- Our neural lines show up too dark
- Caveats: is the calibration of the observations correct?

FUTURE WORK

- The present model can be tweaked a bit to improve it
- In the future we will be taking a more fundamental approach toward a more self-consistent coronal heating and solar wind acceleration specification based on an input of waves and their subsequent dissipation (a la Velli *et al*., Cranmer & van Ballegooijen)