The Scale Height of Charged Particles in Jupiter's Magnetosphere

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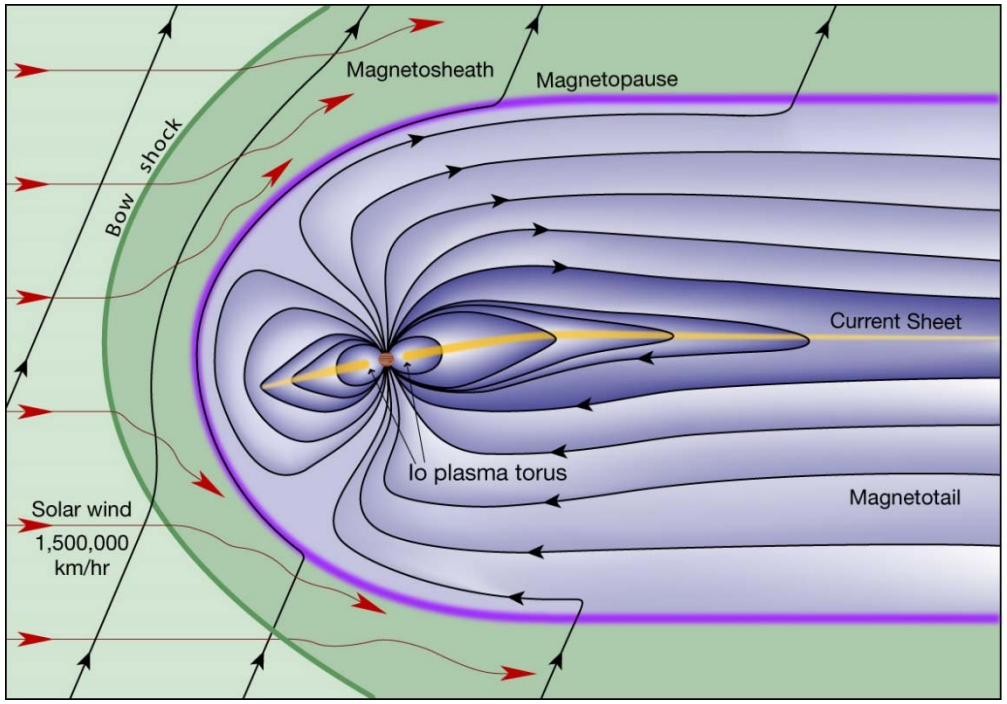
Motivation



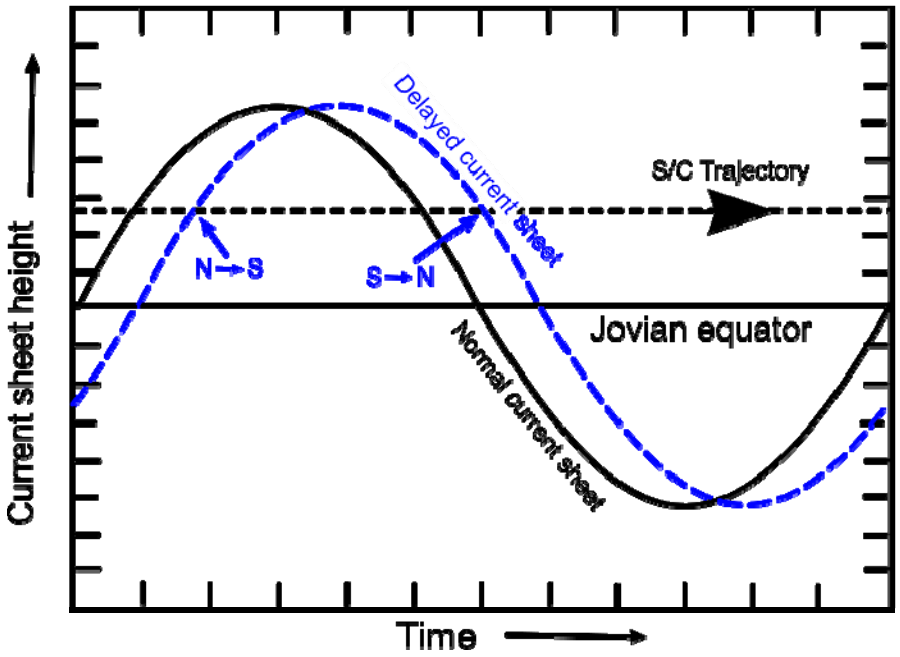
The Jovian current sheet located close to the equatorial plane of Jupiter is the main repository of its Iogenic plasma.

However, variations in its thickness and therefore the plasma content of the current sheet with radial distance and local time are hard to get from a single spacecraft measurements.

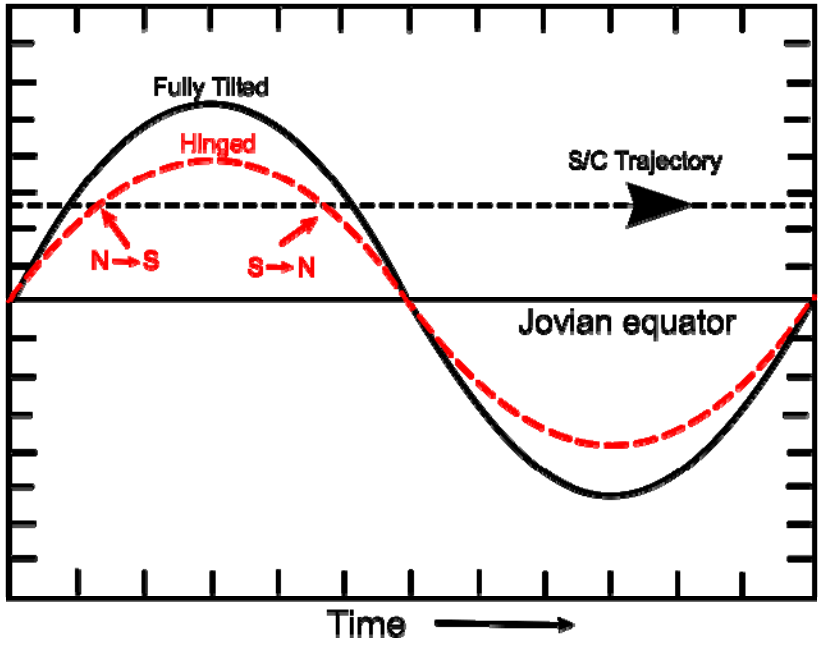
- Using a new technique to determine the instantaneous motion of Jupiter's current sheet relative to the spacecraft, we have shown that the current sheet is extremely thin in the dawn sector and very thick in the dusk sector.
- In this presentation, we look at the plasma content of the current sheet and show that the current sheet and the plasma sheet have similar scale lengths.

Local location of the Current Sheet

Delayed current sheet



Hinged current sheet



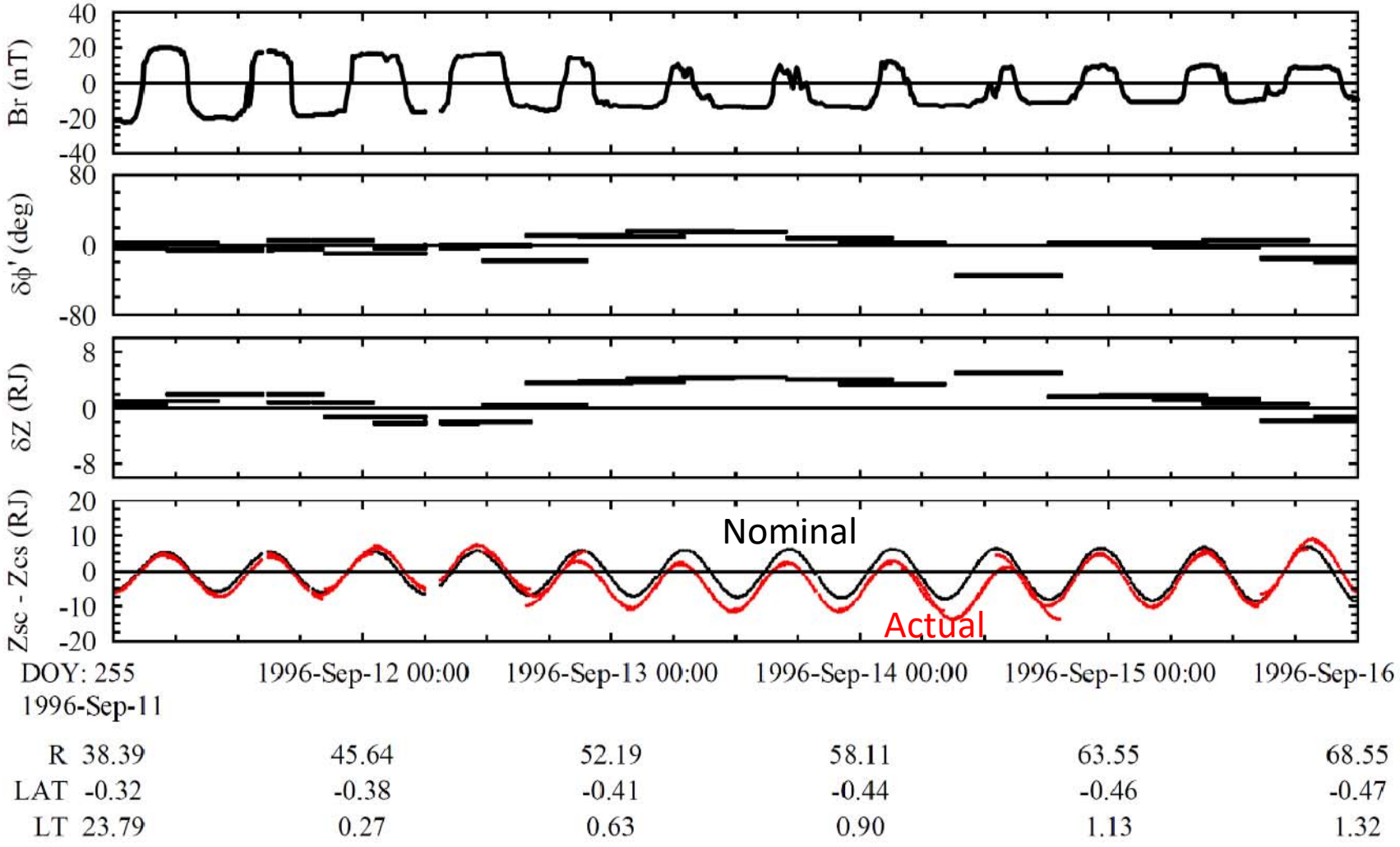
When a N→S crossing occurs followed by a S→N crossing:

$$\phi_1 - \phi_I' = -(\phi_2 - \phi_I') \Rightarrow \phi_I' = (\phi_1 + \phi_2)/2$$

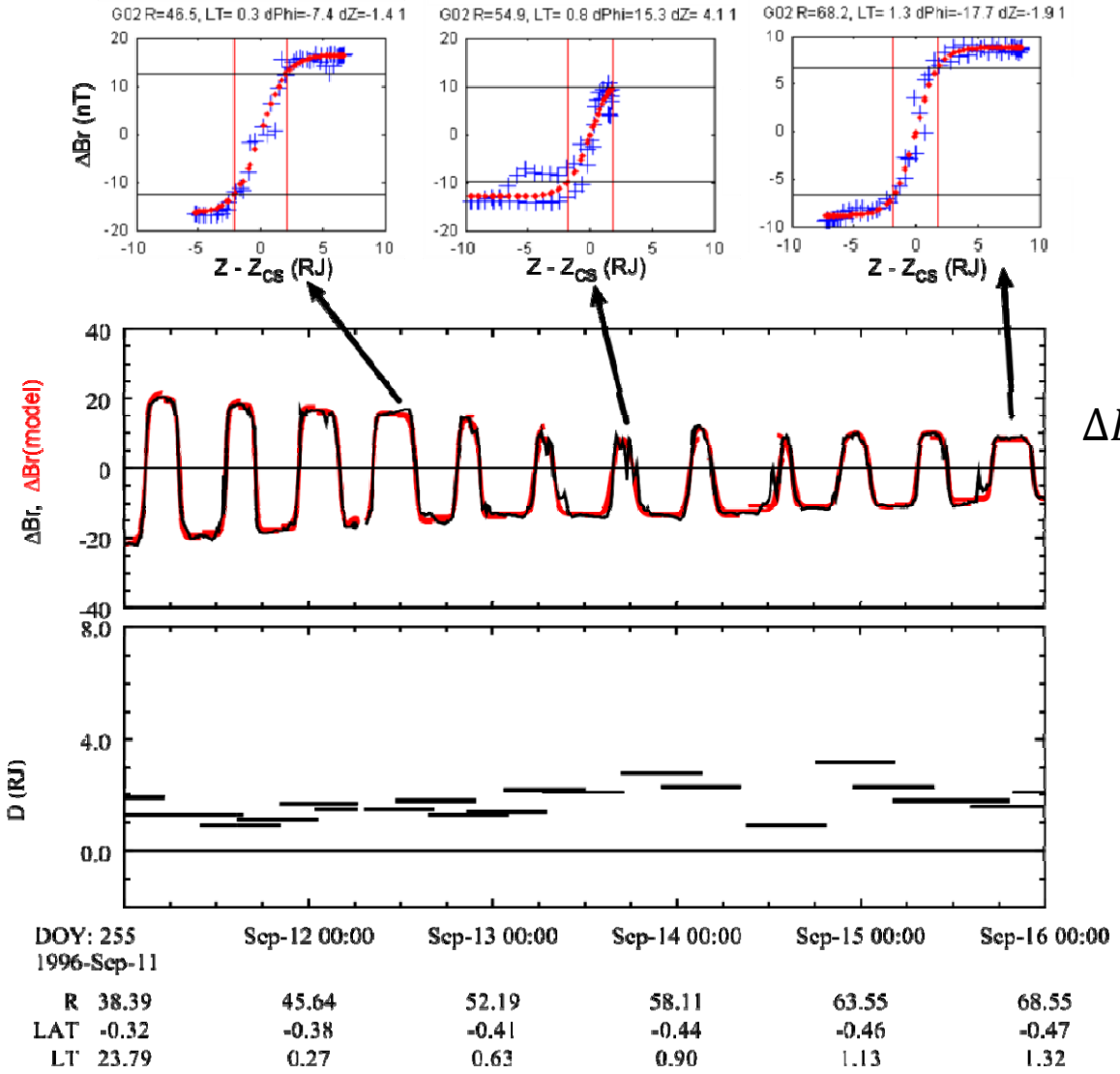
When a S→N crossing occurs followed by a N→S crossing:

$$-(\phi_1 - \phi_I') = 2\pi + (\phi_2 - \phi_I') \Rightarrow \phi_I' = (\phi_1 + \phi_2)/2 + \pi$$

Modeling spacecraft's instantaneous distance from the current sheet.

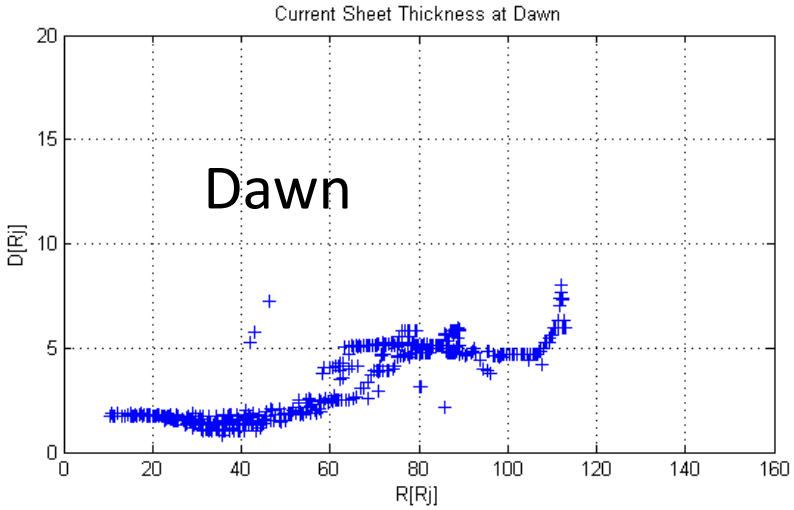


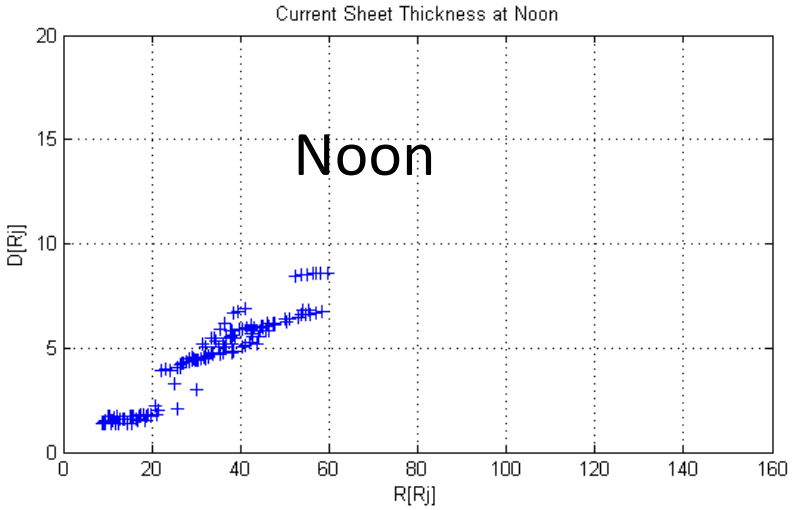
Current sheet thickness from fitting ΔBr to the Harris Current Sheet Equation

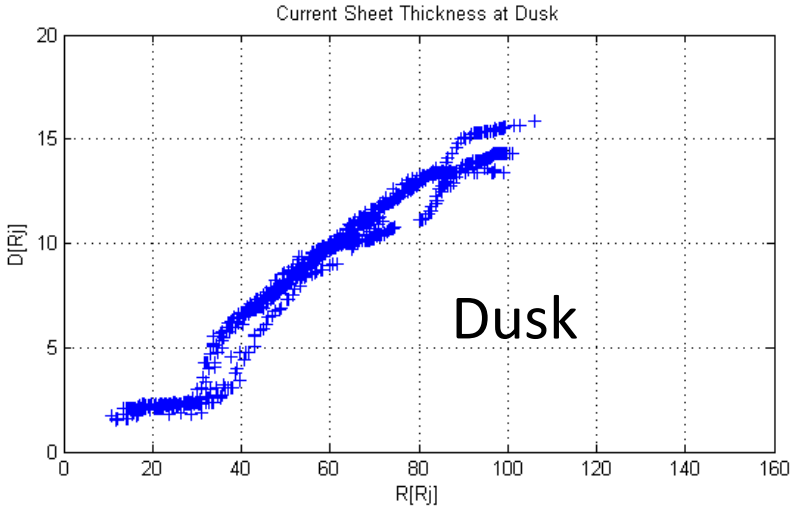


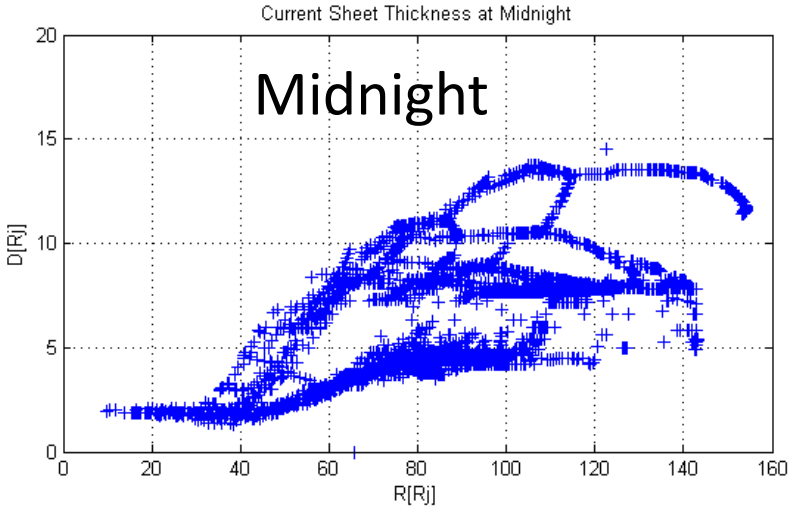
$$\Delta B_r = B_L \tanh\left(\frac{z - z_{cs}}{D}\right)$$

Current Sheet Thickness with Radial Distance



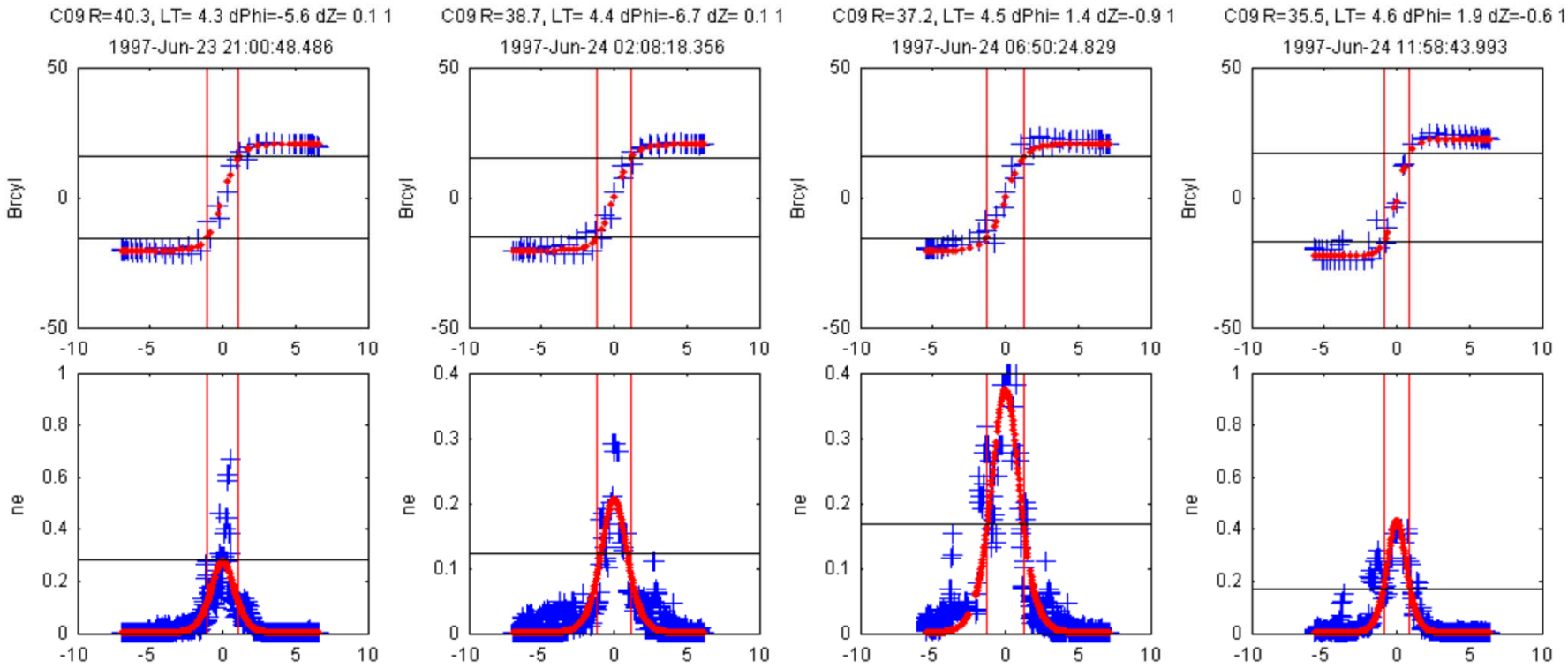






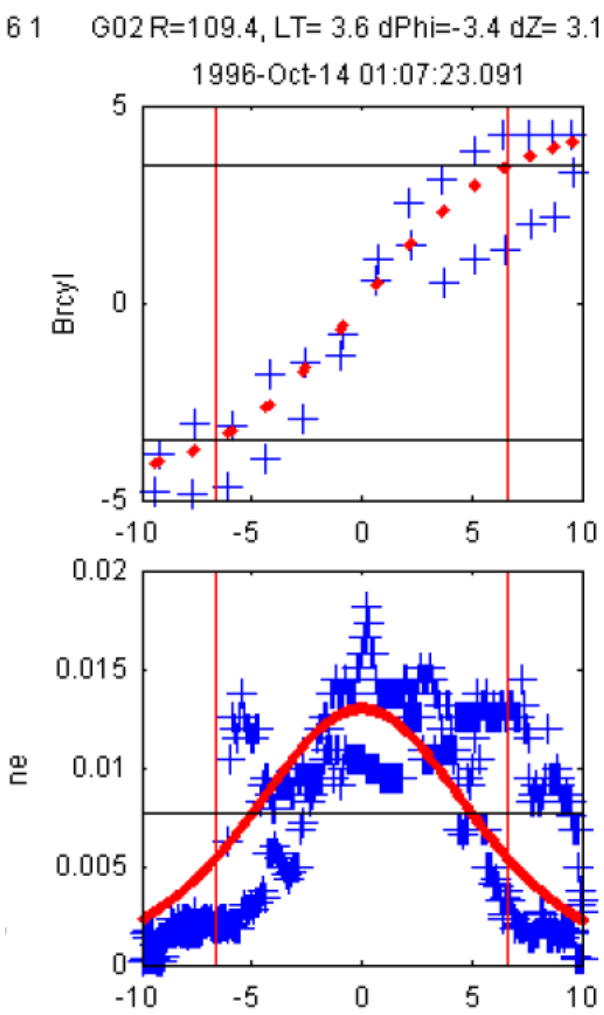
Simultaneous fits to magnetic field and electron density (Galileo C9, Middle magnetosphere)

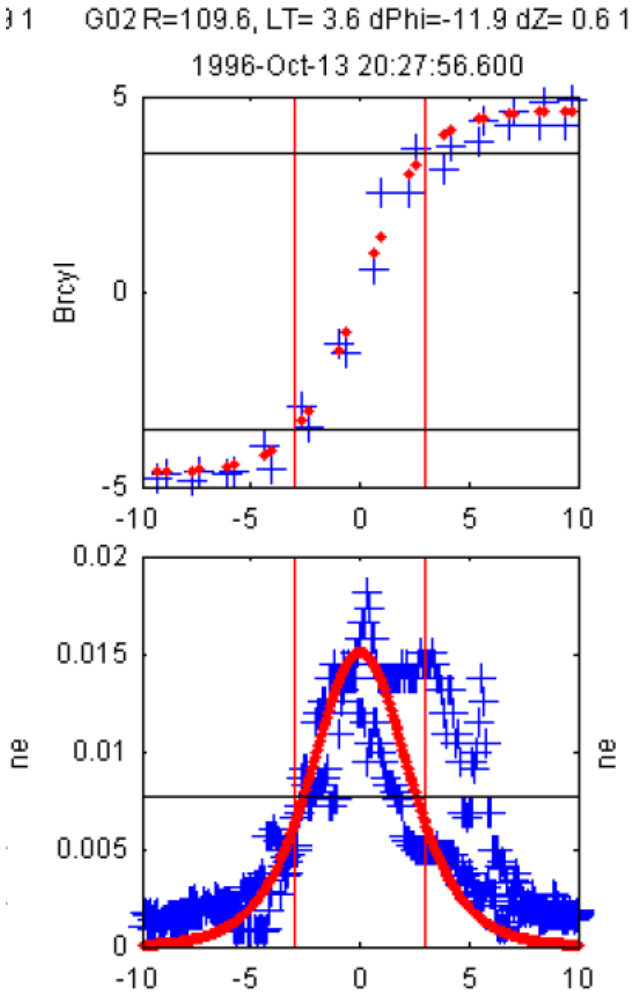
$$\Delta B_r = B_L \tanh\left(\frac{z - z_{cs}}{D}\right) \qquad N_e = N_{e0}\,\mathrm{Sech}^2\mathrm{h}\left(\frac{z - z_{cs}}{D}\right)$$



Notice, the peak electron density is around 0.4 cm^{-3}

Thick current sheet/plasma sheet



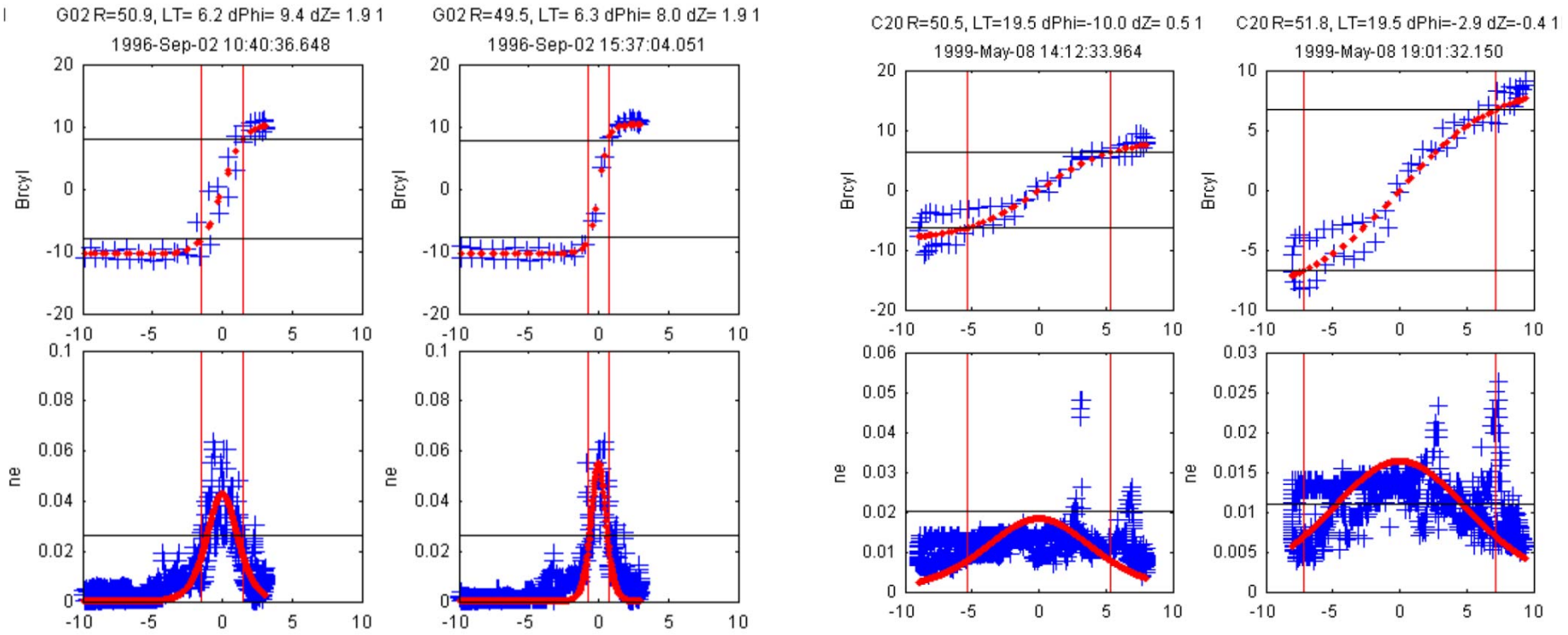


Notice, the peak electron density in thick current sheet is < 0.02 cm^{-3}

Local time difference in electron density (R=50 R_J)

Dawn sector fits

Dusk sector fits



At the same radial distance, the dusk current sheet is thicker but the electron density is lower. This suggests that as the plasma rotates from dawn to dusk, the plasma scale height increases but the density of the plasma goes down.

Conclusions

- The average half-thickness of the Jovian current sheet in the dawn sector inside of 40 R_J is 1.5 R_J. It then steadily increases to 5 R_J, by a radial distance of 80 R_J.
- The duskside current sheet also has a half-thickness of 1.5 R_J close to Jupiter but it increases to 5 R_J near a radial distance of 40 R_J and further increases to > 15 R_J in the outer magnetosphere.
- At the same radial distance, the dusk current sheet is thicker than the dawn current sheet but its electron density is lower. This suggests that as the plasma rotates from dawn to dusk, the plasma scale height increases but the density of the plasma goes down, keeping the plasma content equal.