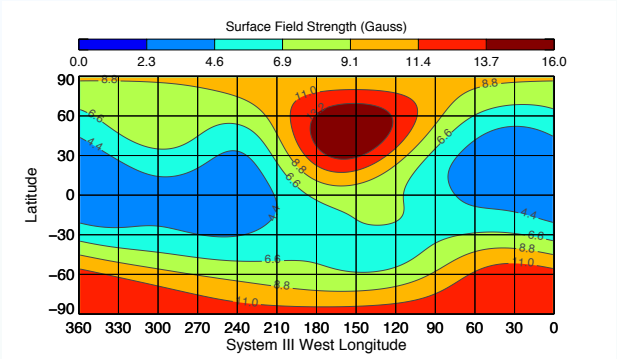
Fluxes within Io Oval: North vs. South

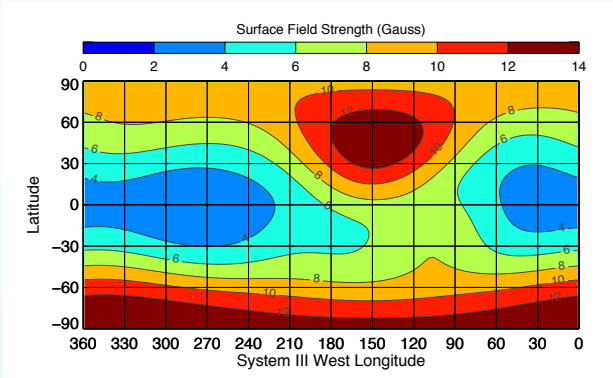
Drake A. Ranquist
LASP and University of Colorado – Boulder

Introduction

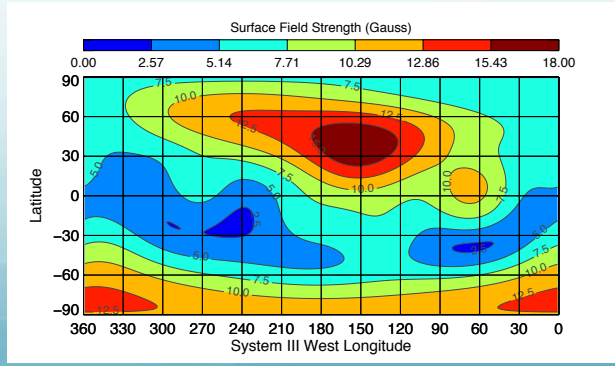
- The internal magnetic field models of Jupiter seem to have stronger magnetic fields in the northern hemisphere than in the south
- Flux, through the ovals created by Io's footprints, should be equal for the north and south



VIP4



VIT4

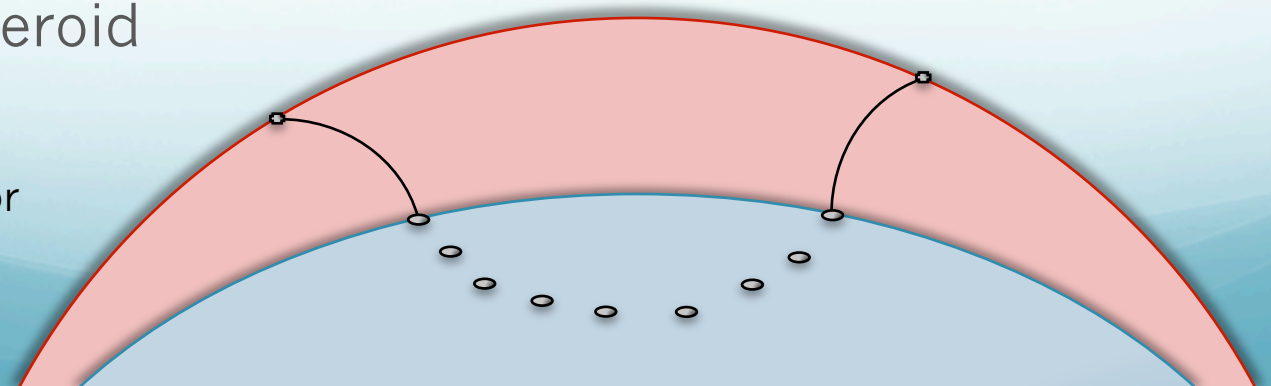


VIPAL

Step 1: Trace Io Footprints Onto Sphere

- Io Footprints come from Bertrand Bonfond and is reproduced in Hess et al. (2011)
- For each model, we trace along the magnetic field lines that pass through the Io footprints from an oblate spheroid to a spherical surface
  - 1/oblateness = 15.41
  - Step Size of Trace = 0.0001 R_J
  - Easier to integrate over a sphere than an oblate spheroid

Figure Exaggerated for Emphasis



Step 2: Rotate Ovals to the Equator

- Differential areas are more constant along the equator of a sphere than the poles
- In spherical coordinates, a rotation of 90° is:

$$\theta' = \arccos(\sin\theta \sin\phi)$$

$$\phi' = -\arctan(\cot\theta \sec\phi)$$

- Each point must be rotated back to the poles to calculate the magnetic field using:

$$\theta' = \arccos(-\sin\theta \sin\phi)$$

$$\phi' = \arctan(\cot\theta \sec\phi)$$

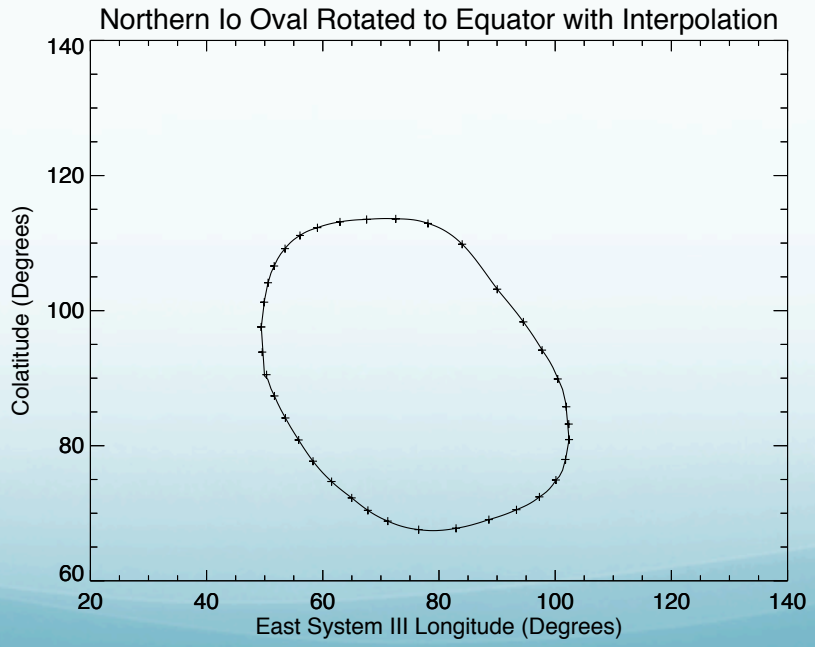
- Must correct for ambiguity of arctangent

Step 3: Interpolate Between Io Footprints

- To determine the boundaries of the surface integral, must interpolate between the 36 Io footprints
- Used IDL's INTERPOL command with a Spline fit
  - Cubic spline to the nearest four neighbors
  - Done twice. Once for the upper half of the oval and once for the lower half of the oval
- Used five times + 1 the number footprints, spread evenly over longitude

Step 4: Numerically Integrate

- Solve for the flux by multiplying B_r by the differential area $r^2 \sin\theta d\theta d\phi$ over the entire oval
  - r = 1 R_J on the sphere
- We use a differential angle of 0.01° for both dθ and dϕ



Results

	VIP4	VIT4	VIPAL
North (TWb)	4.062	3.885	3.856
South (TWb)	-4.010	-4.086	-3.680
-North/South	**1.013**	**0.9509**	**1.048**

Conclusions

- There is a discrepancy between the north and south of:
  - VIP4: 1.3%
  - VIT4: 4.9%
  - VIPAL: 4.8%
- Removing interpolation only creates a 0.2% increase in discrepancy
- Adding the atmosphere reduces the discrepancy by 0.5%
- Maybe errors in footprint locations can account for this?
  - Not likely to be a big enough factor
- This method could be another constraint on future magnetic field models