

Heliophysics Summer School 2015

Planetary dynamos and their seasons

Part 2

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University of California, Santa Cruz

Terrestrial planets

Earth

Mercury

Mars

Gas giants

Jupiter

Saturn

Ice giants

Uranus

Neptune

Satellites

Ganymede

Moon

Europa

Titan

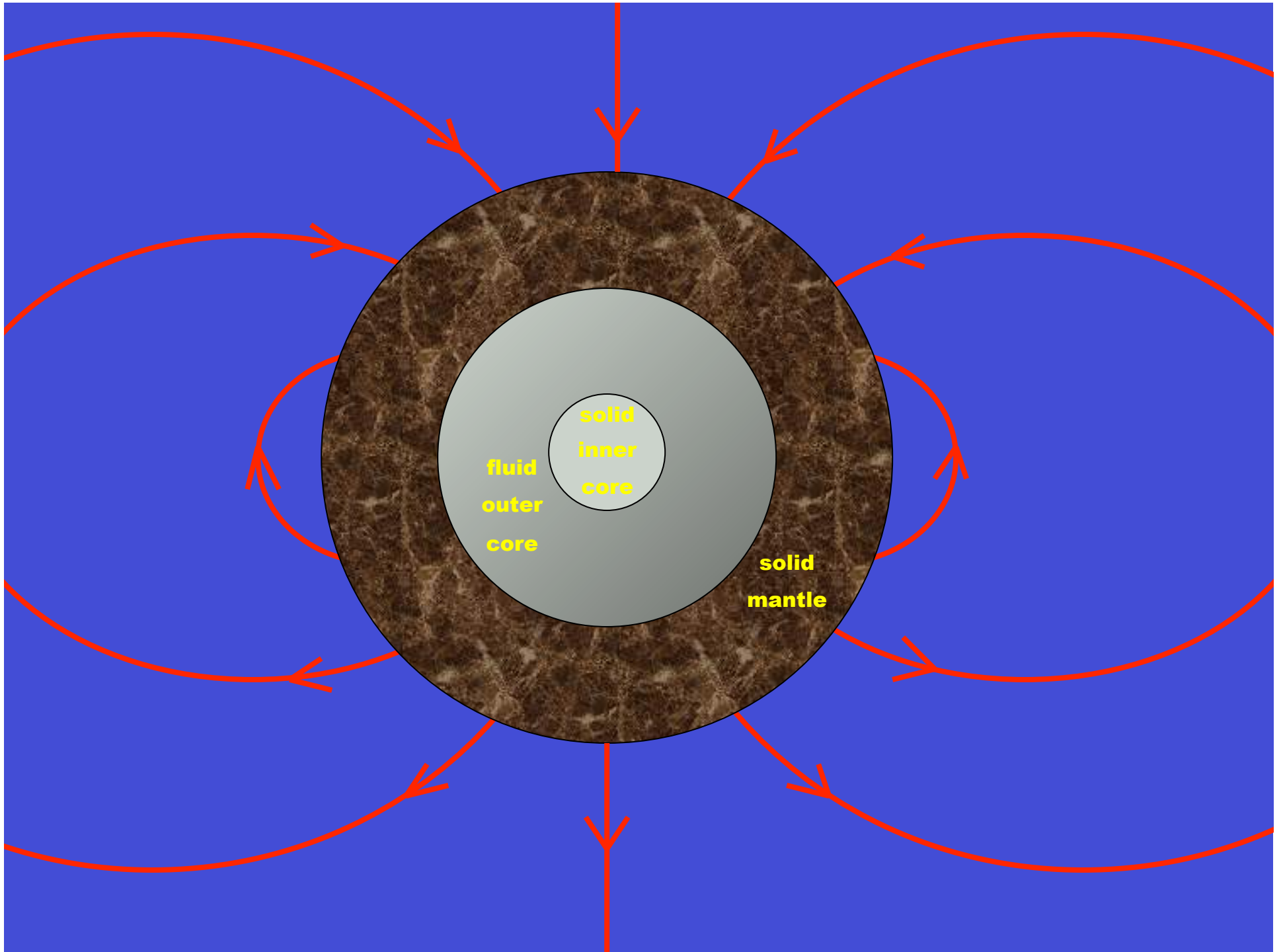
Exoplanets

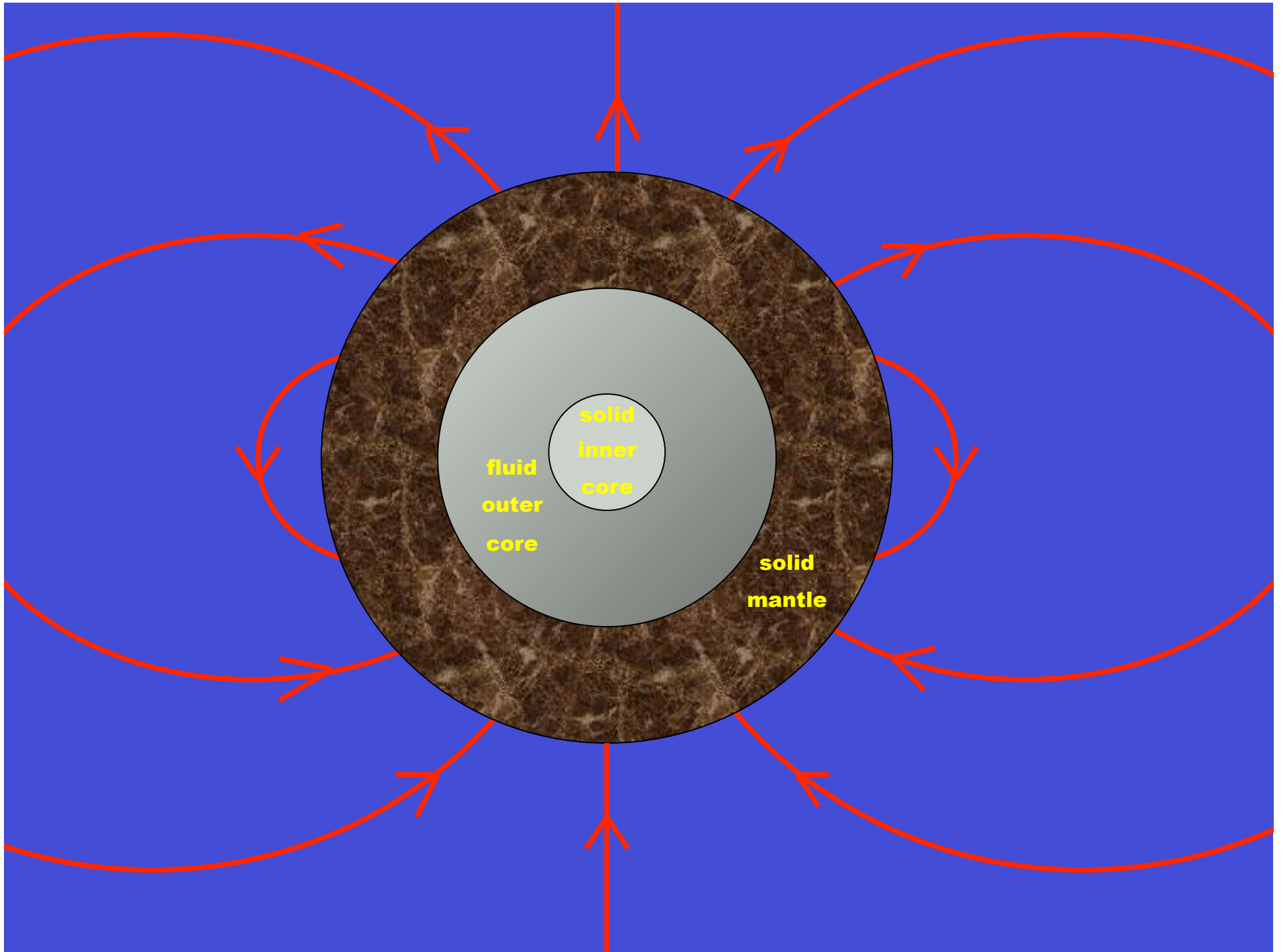
**Stanley and Glatzmaier “Dynamo models for planets other than Earth”
Space Sci Rev and *ISSI* vol 33, “Planetary magnetism” ed, A. Balogh, 2009.**

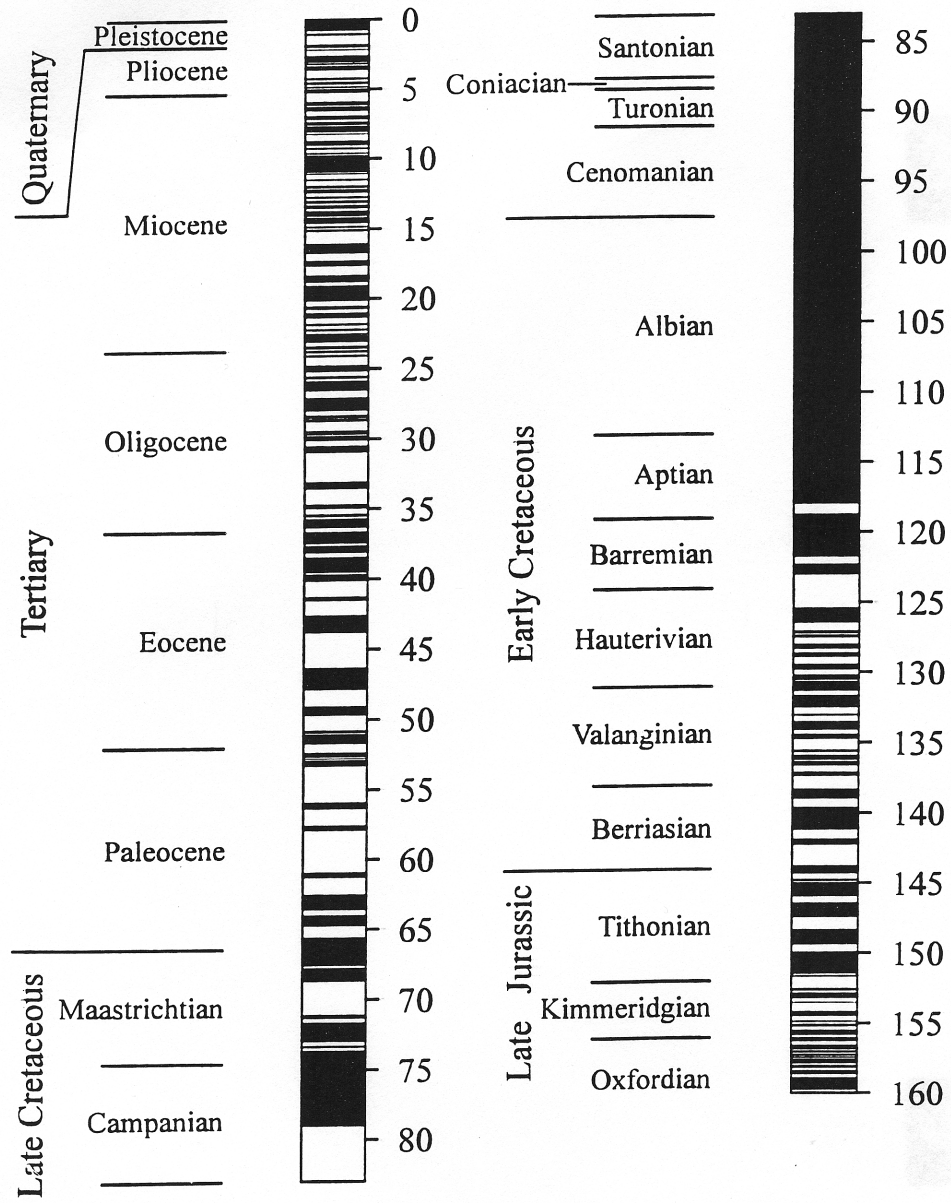
Part 2: Planetary dynamo simulations

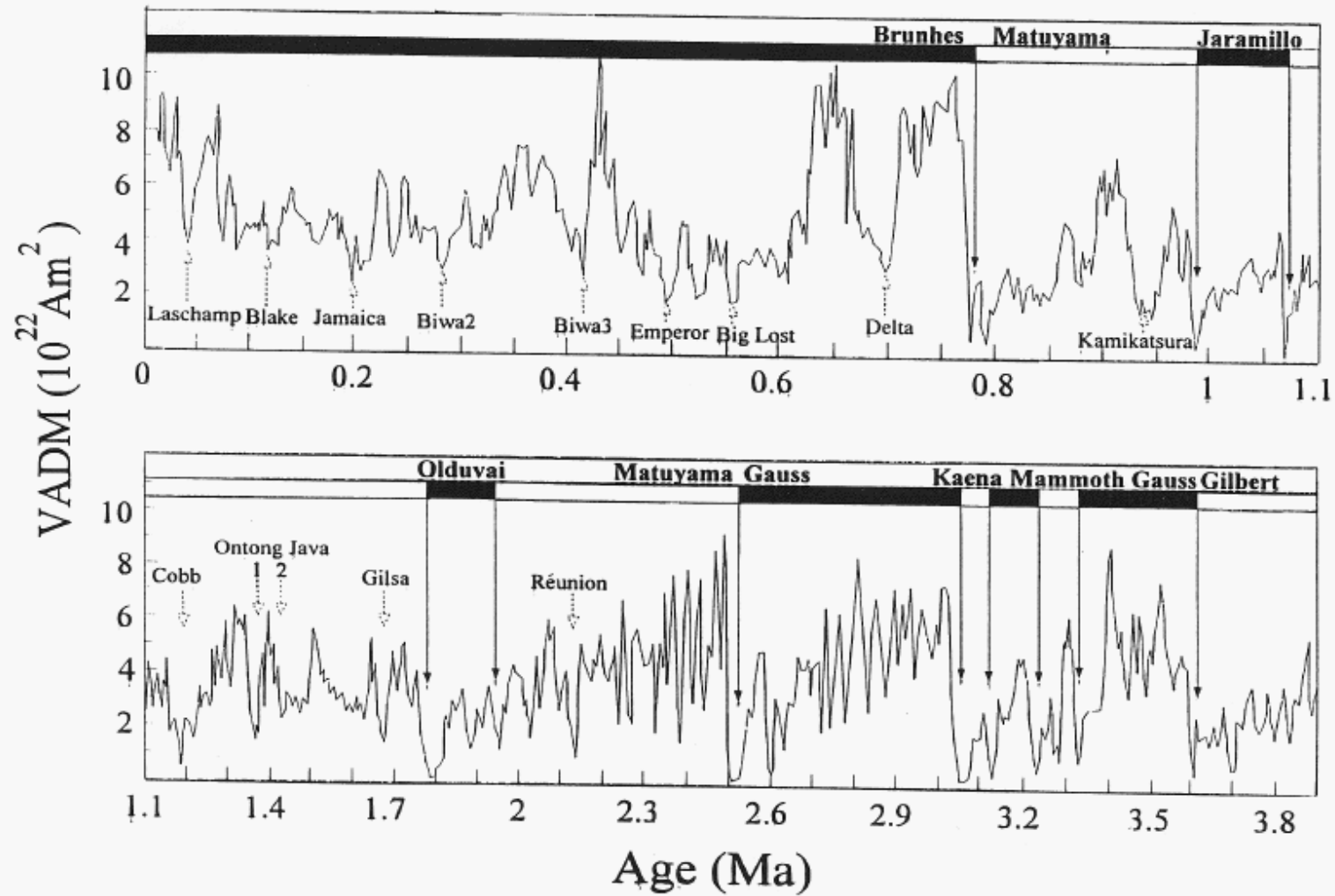
Geodynamo and its dipole reversals (magnetic seasons)

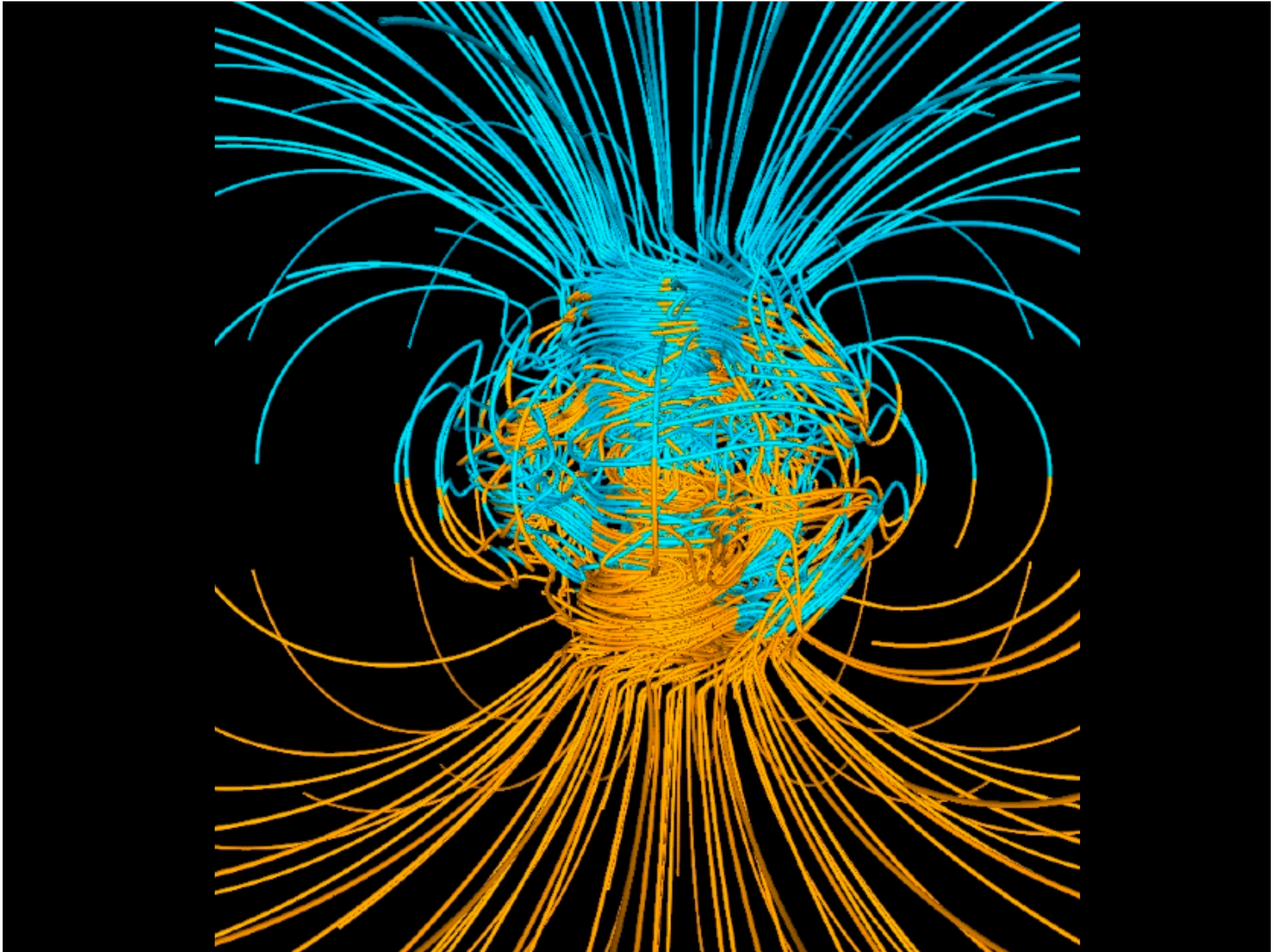
Jovian dynamos and the *Juno* and *Cassini* missions









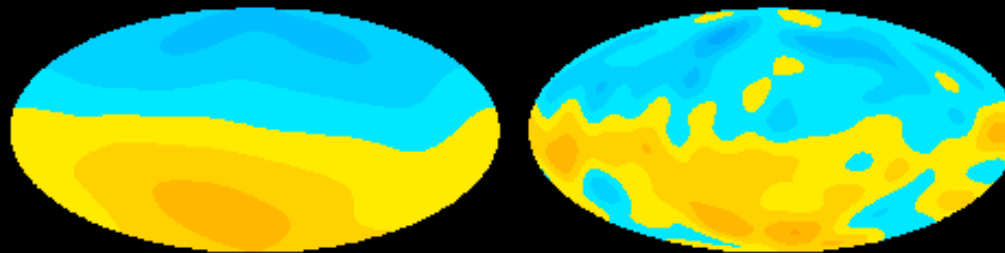


Radial Component of the Magnetic Field

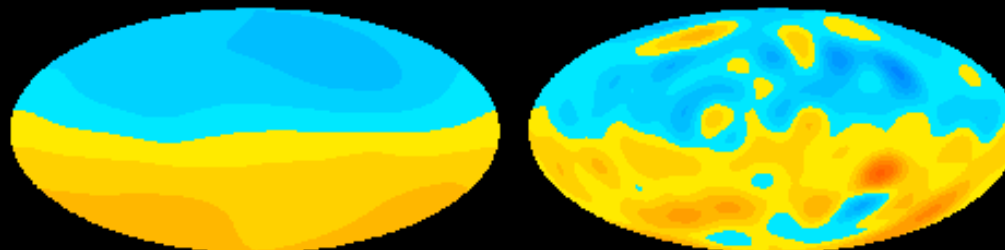
At surface

At core-mantle boundary

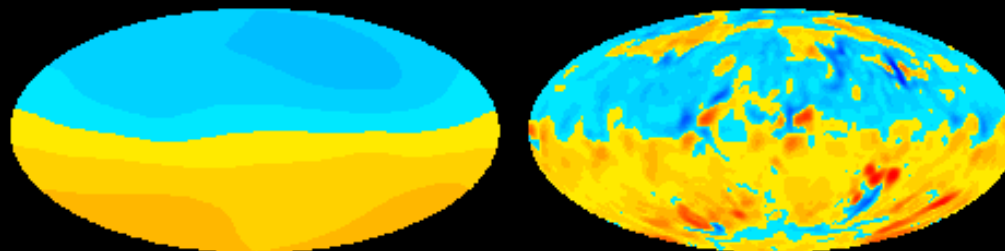
Geomagnetic field (1980) up to degree 12



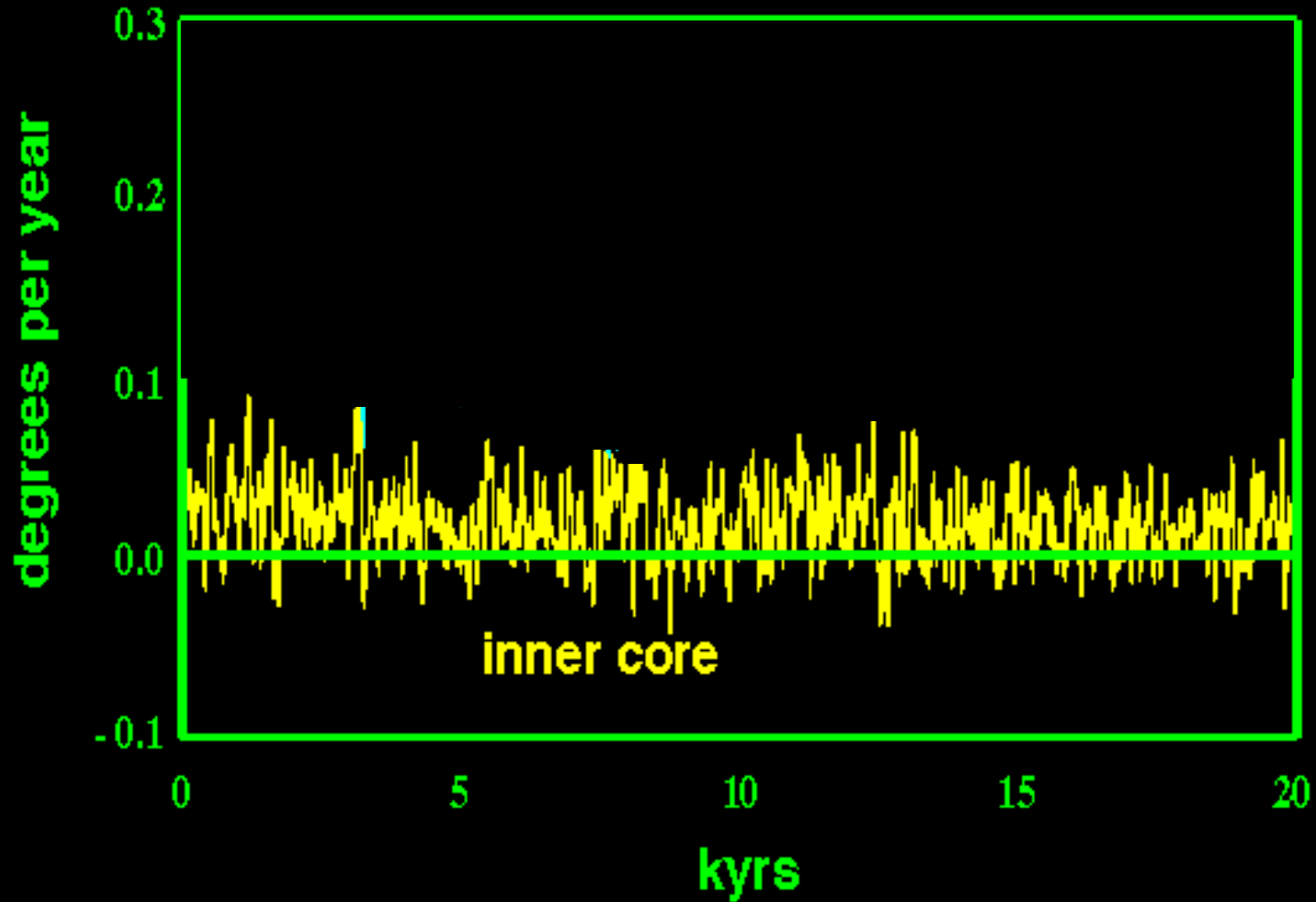
G-R simulation plotted up to degree 12



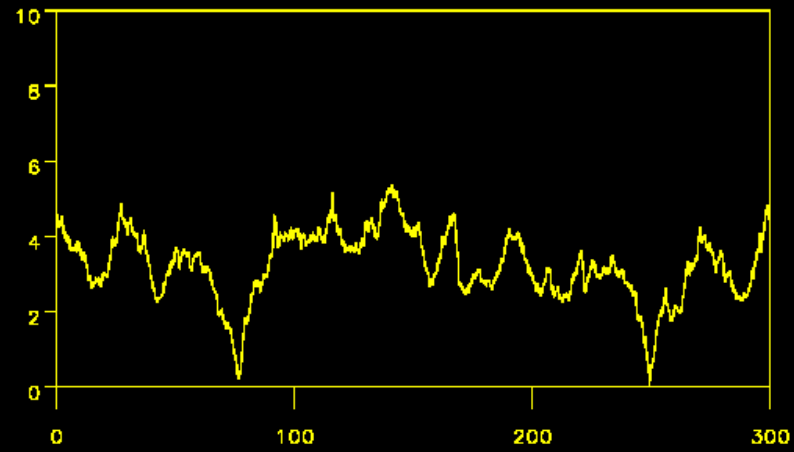
G-R simulation up to degree 95



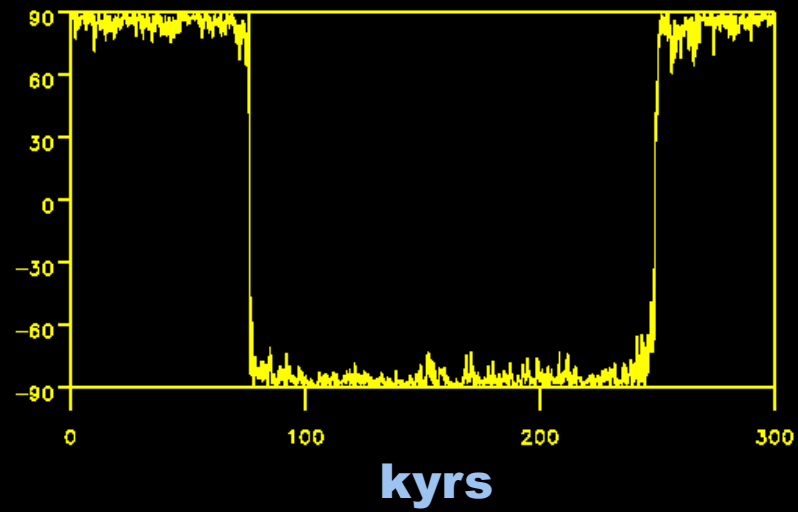
Inner core super-rotation with gravitational coupling between inner core and mantle

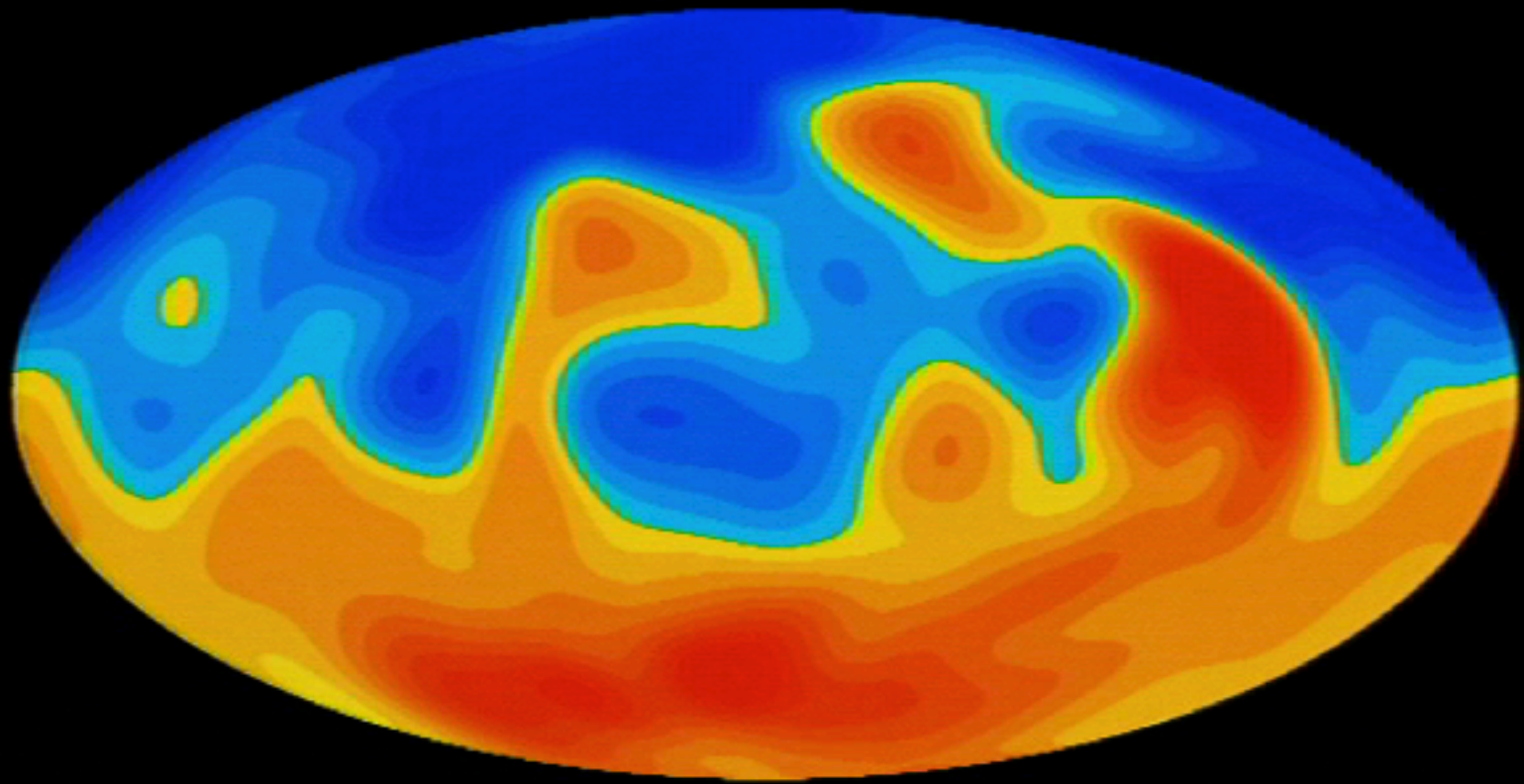


Dipole moment

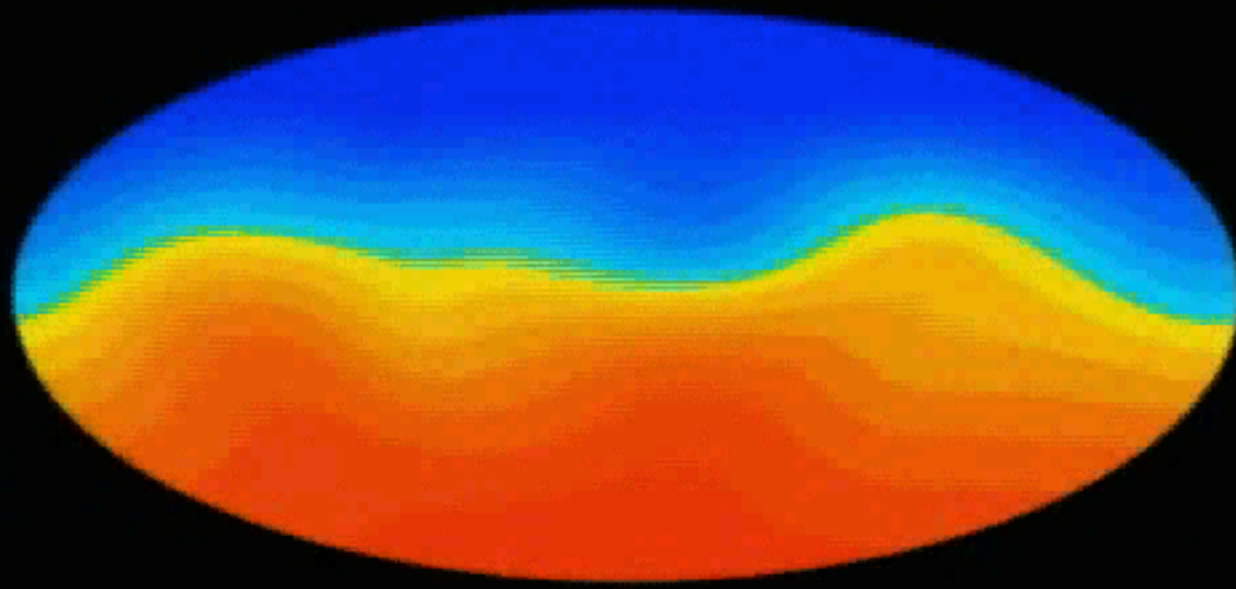


Pole latitude

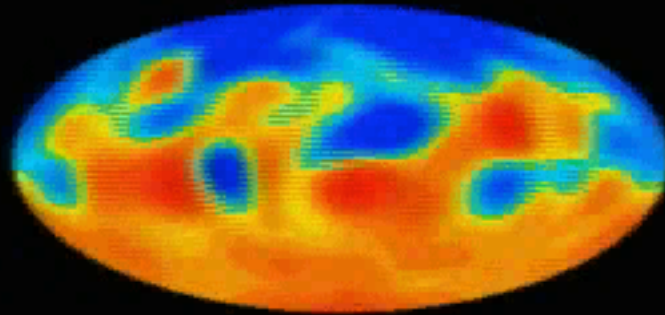


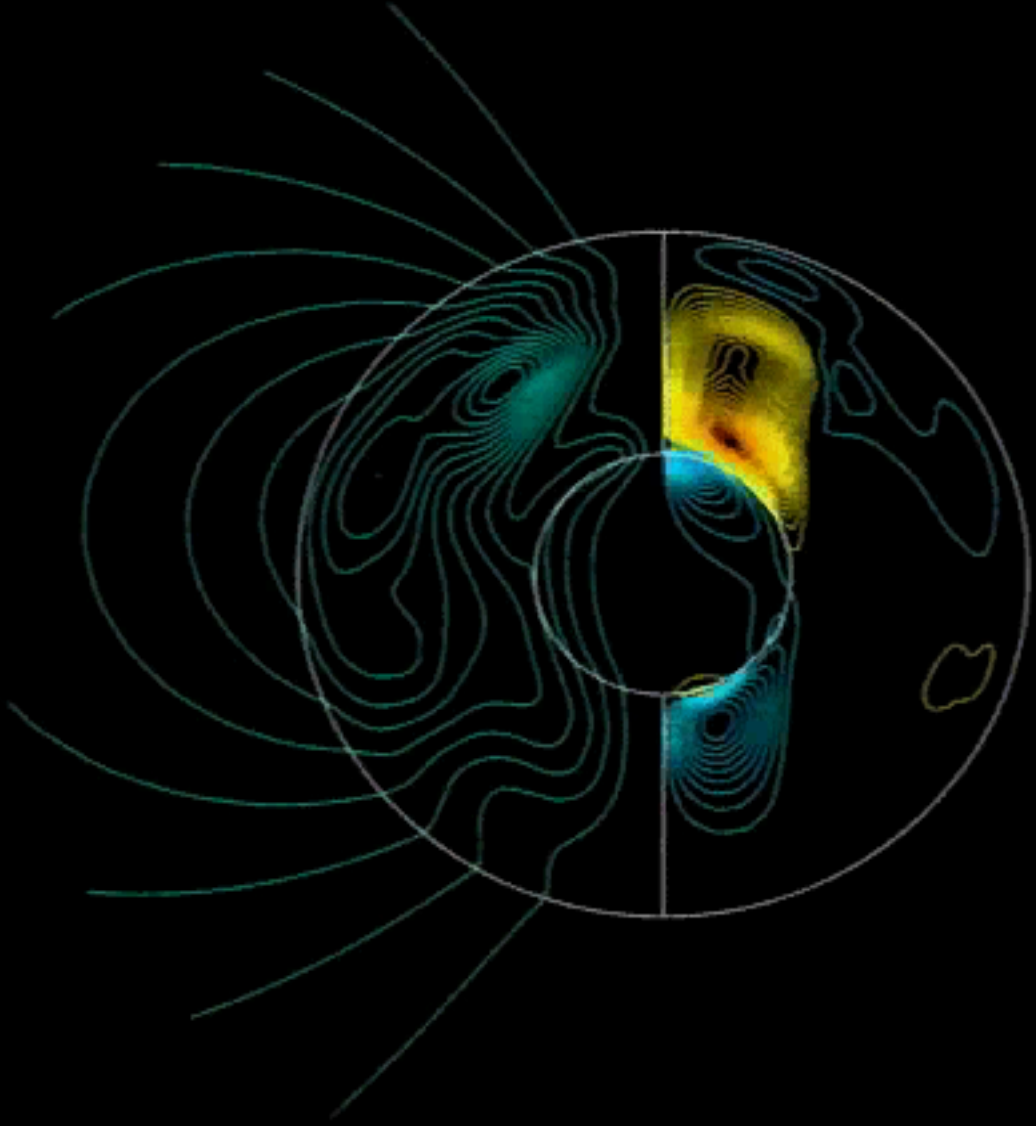


Surface of the Earth



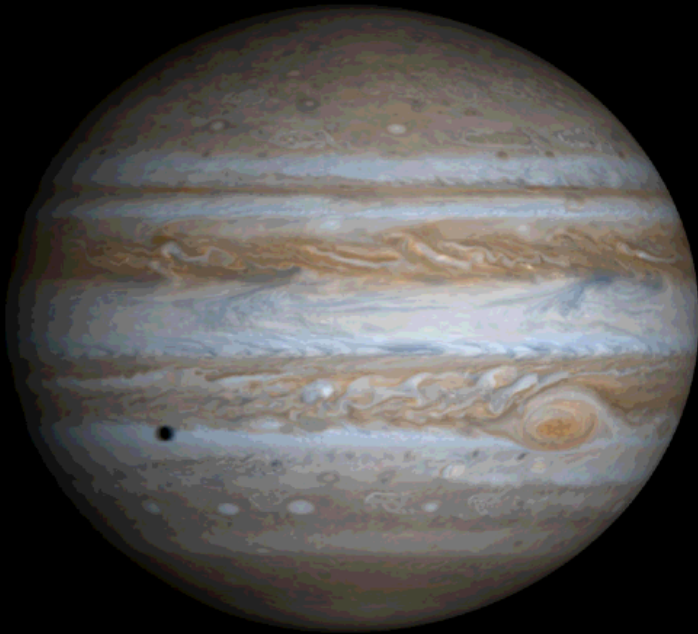
Surface of the Outer Core



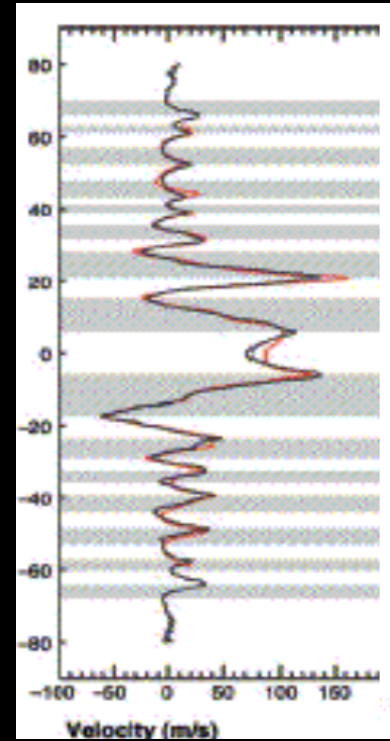


Jovian dynamos and the *Juno* and *Cassini* missions

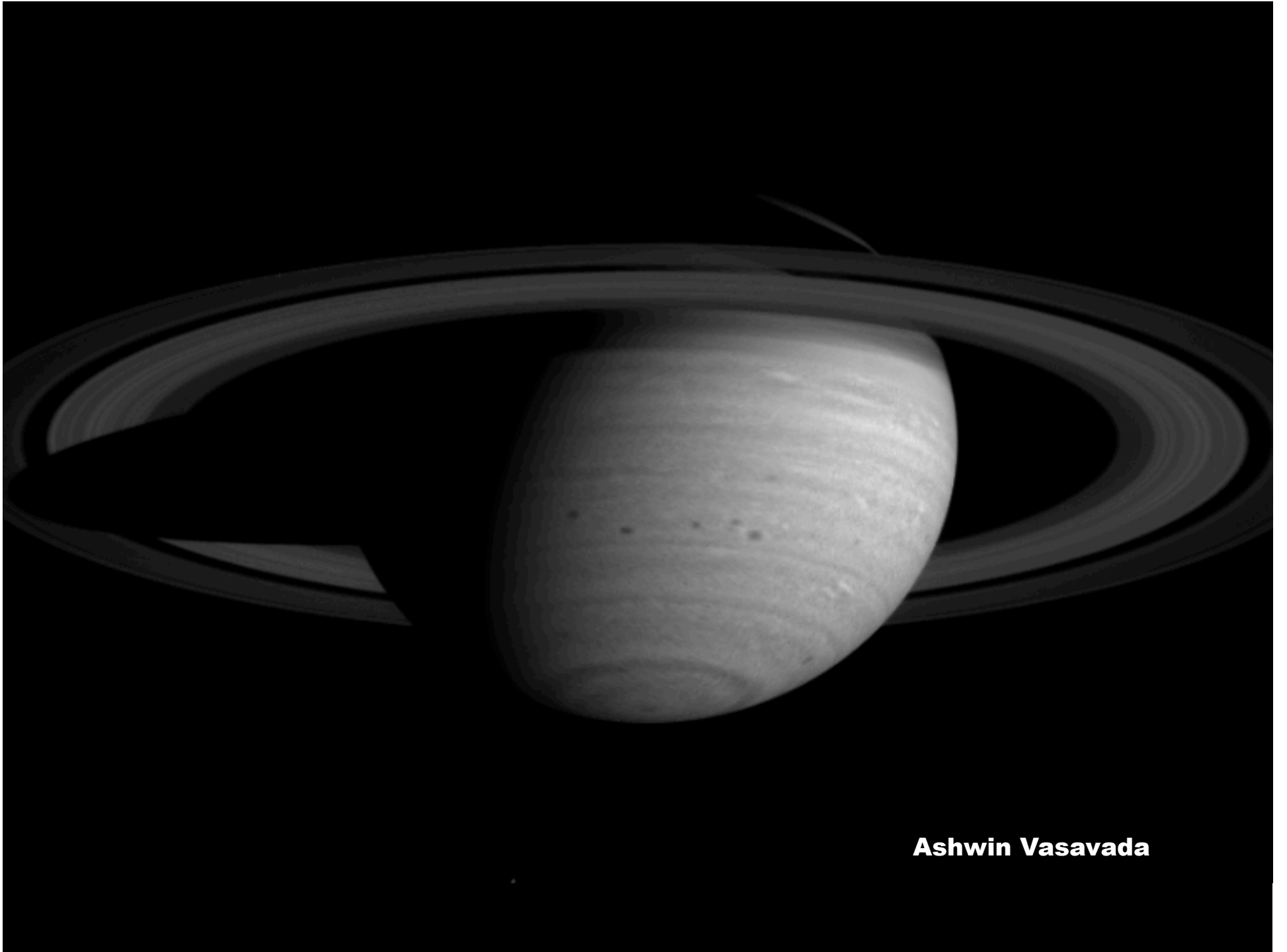
Surface observations of Jupiter



banded atmospheric clouds

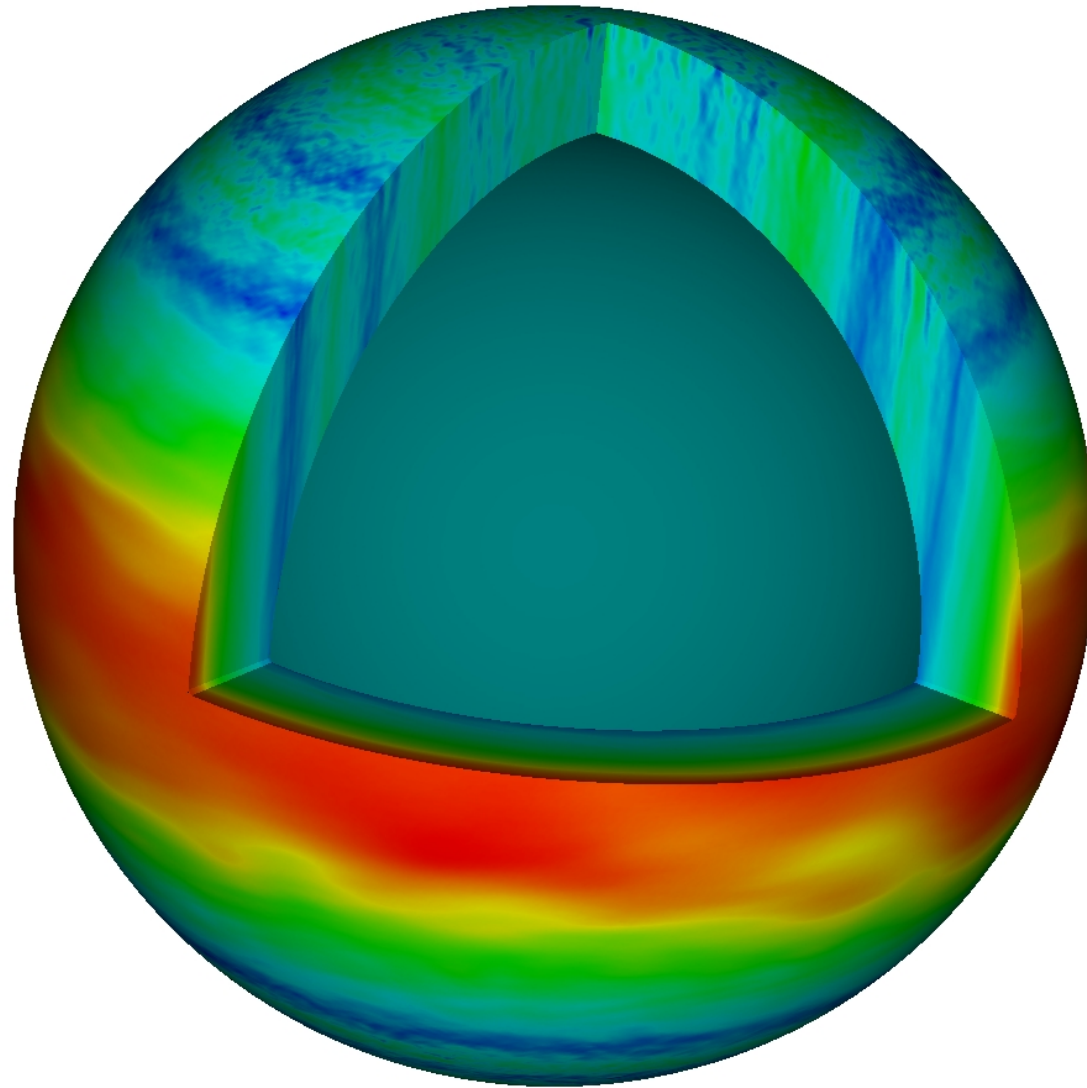


banded zonal winds



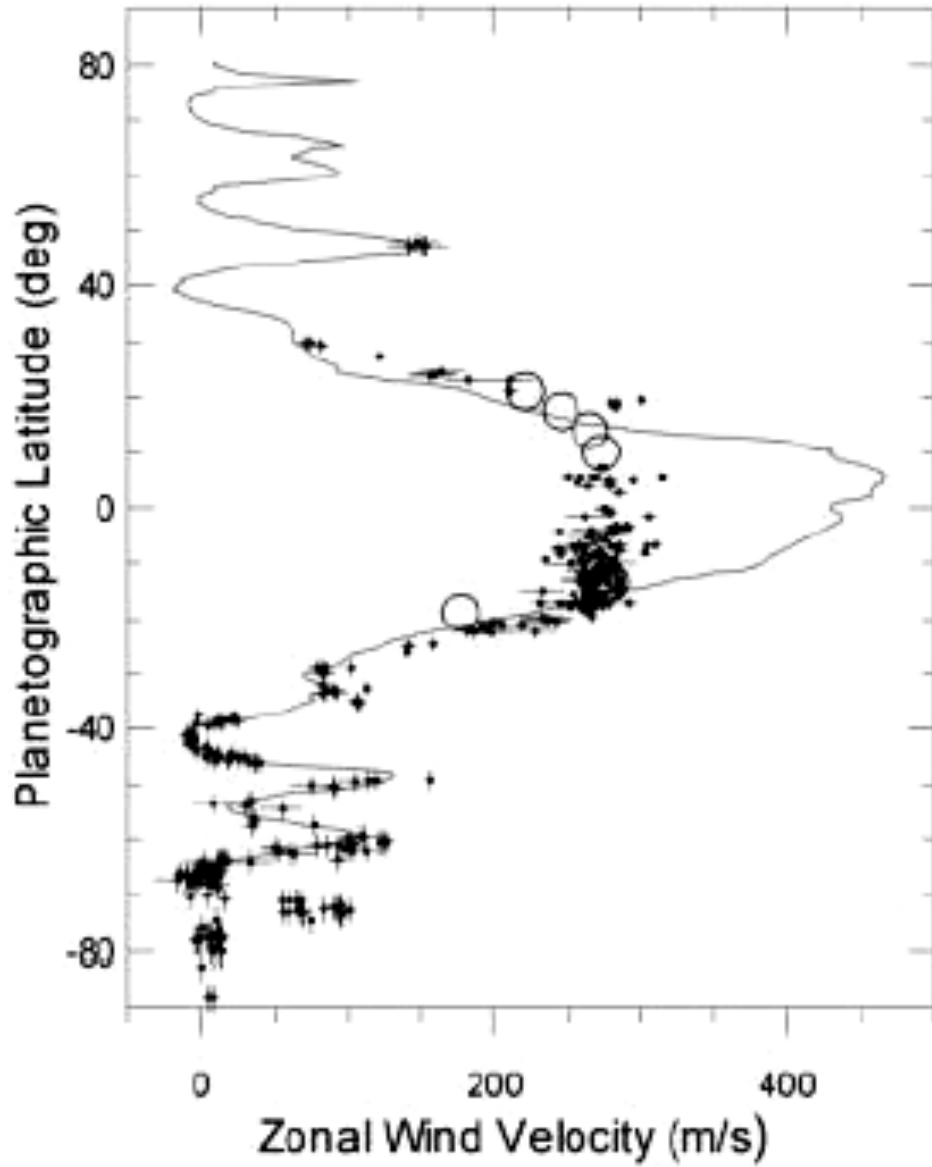
Ashwin Vasavada

Latitudinally banded zonal winds



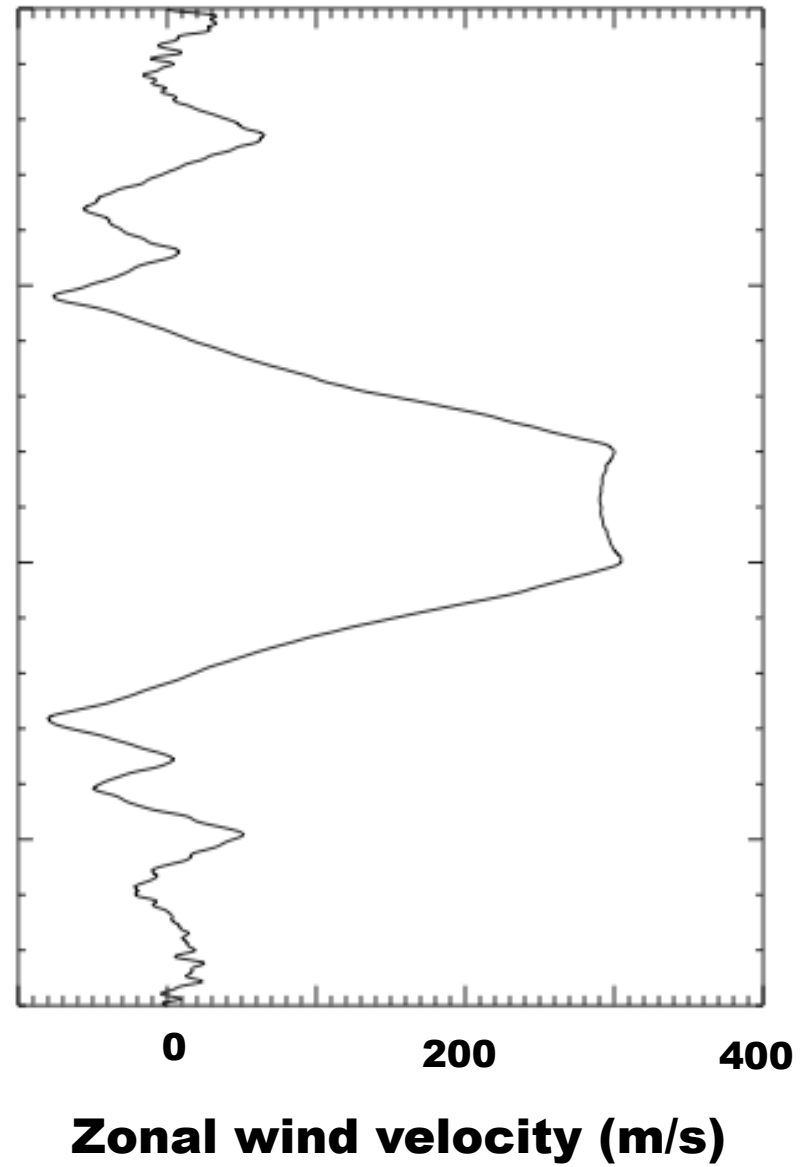
thin shell model

Saturn



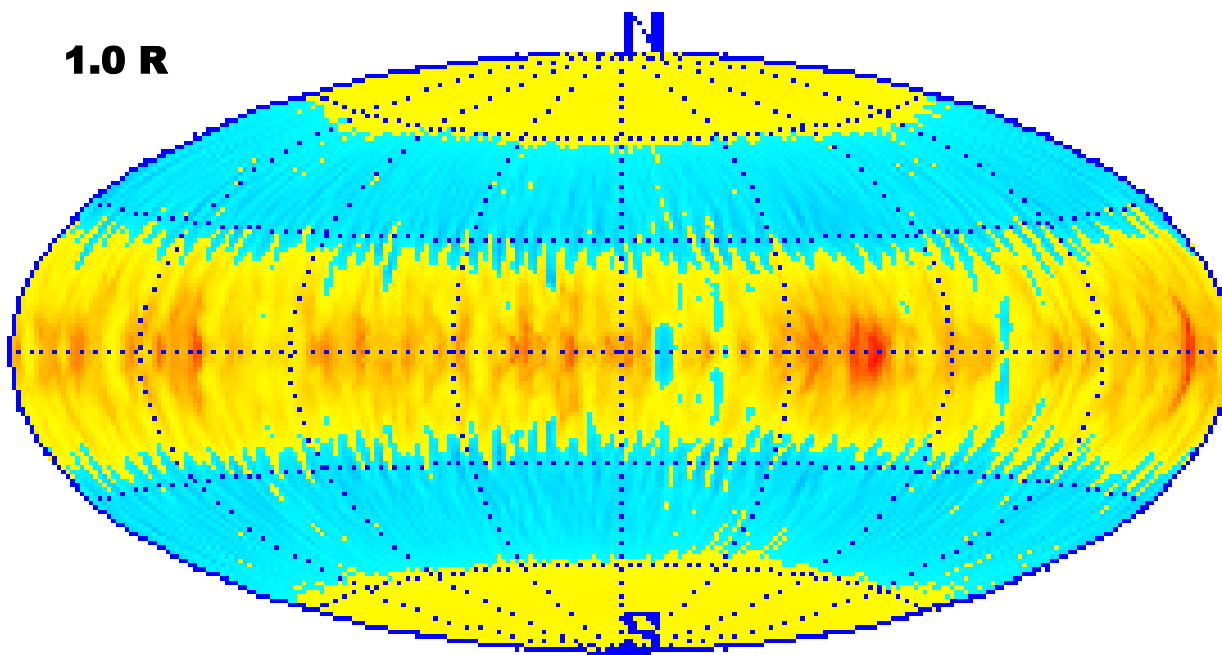
Sanchez-Lavega et al., 2003

"Saturn" simulation

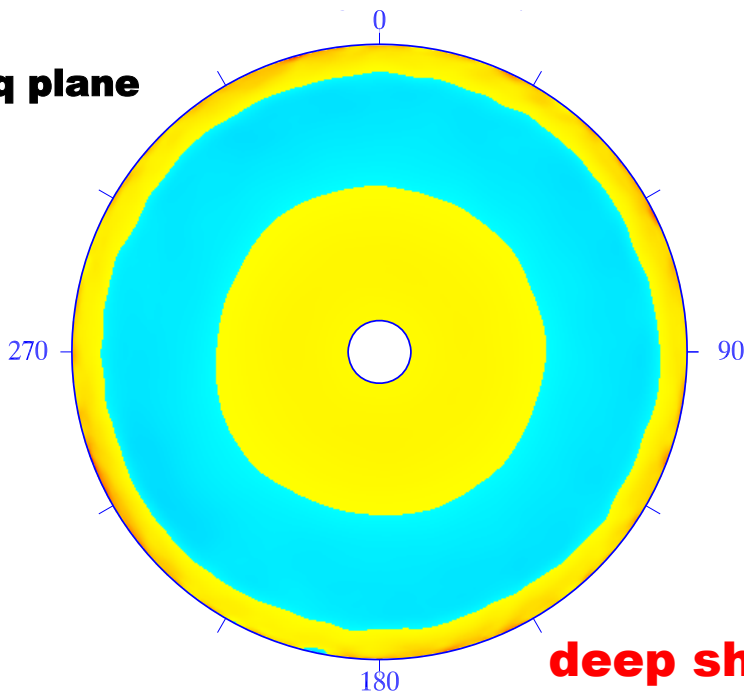


Zonal winds (differential rotation)

1.0 R

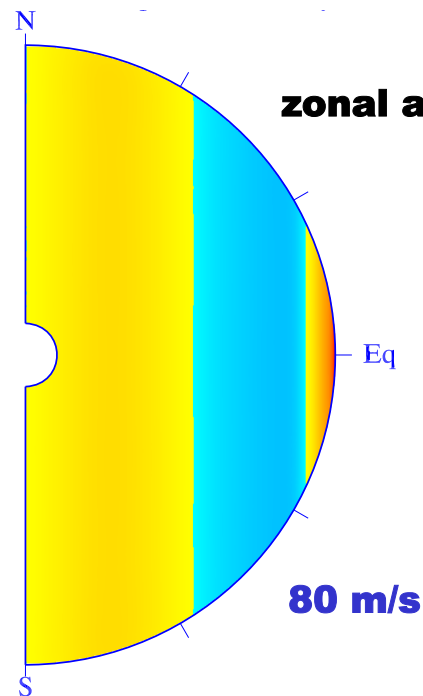


eq plane

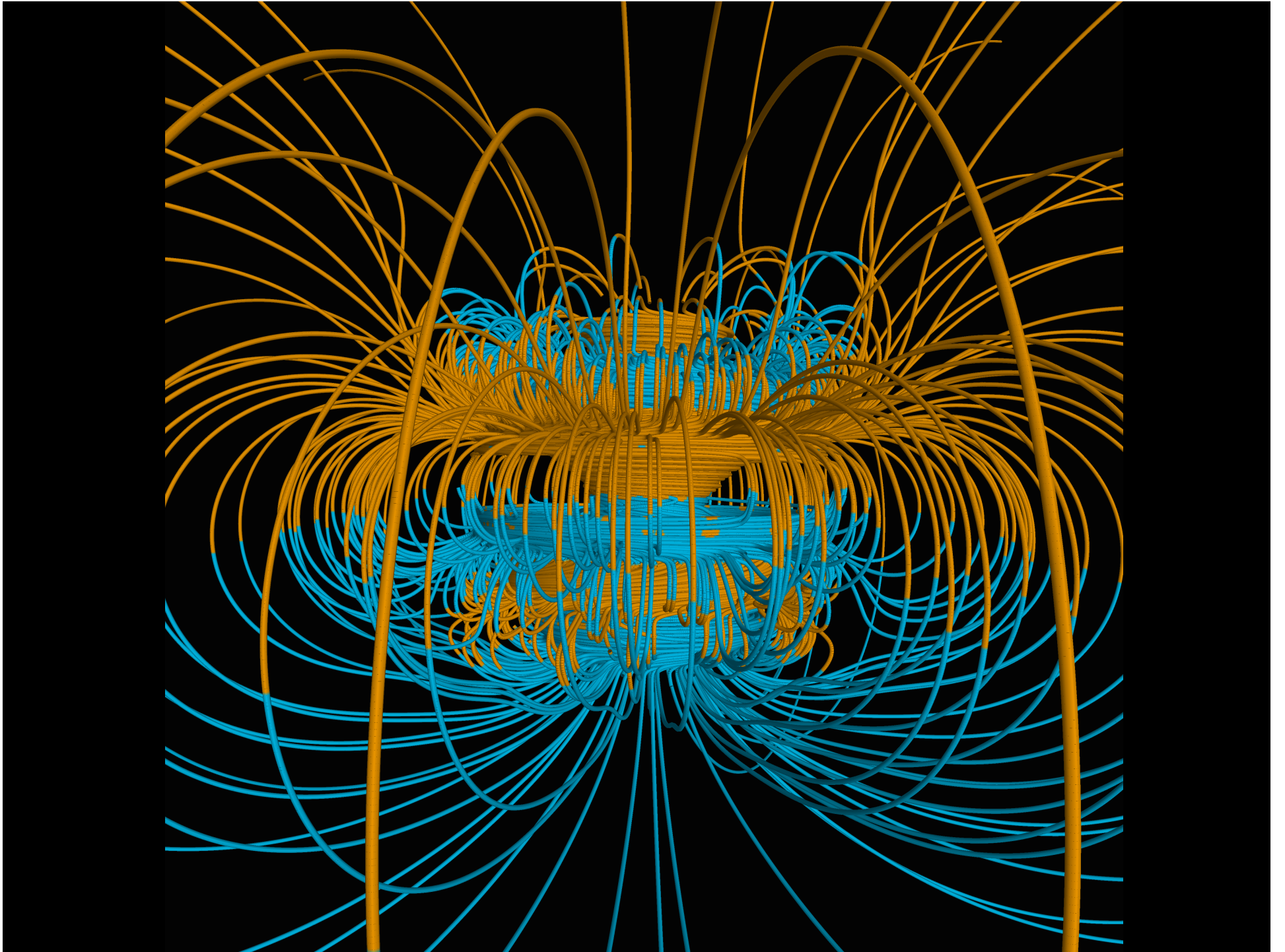


deep shell model

zonal ave



80 m/s

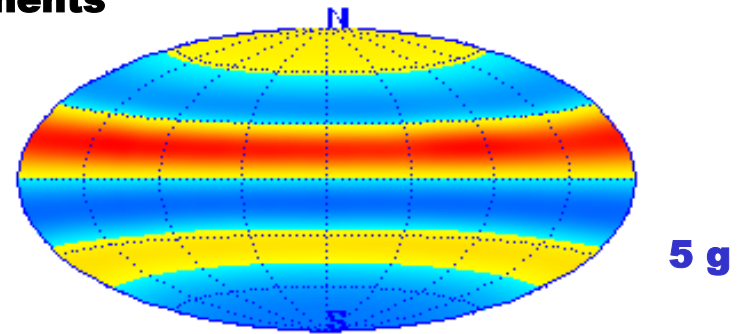
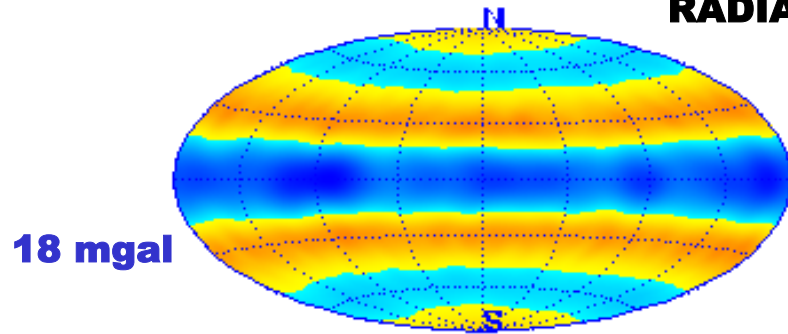


Fields displayed in spherical surfaces at $r = 1.07 R_J$ (*Juno's* perijove)

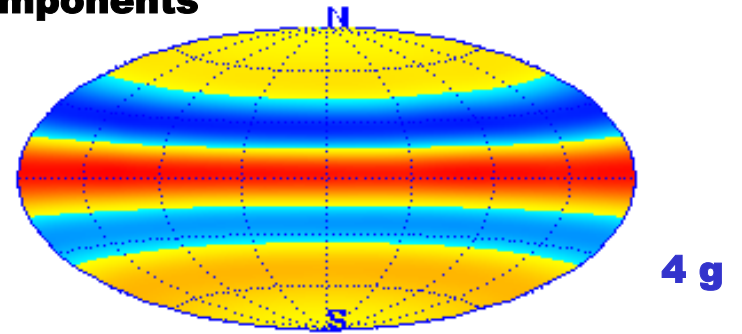
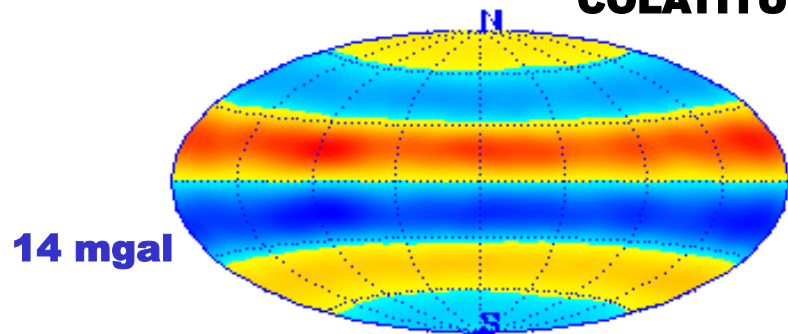
perturbed gravity field

magnetic field

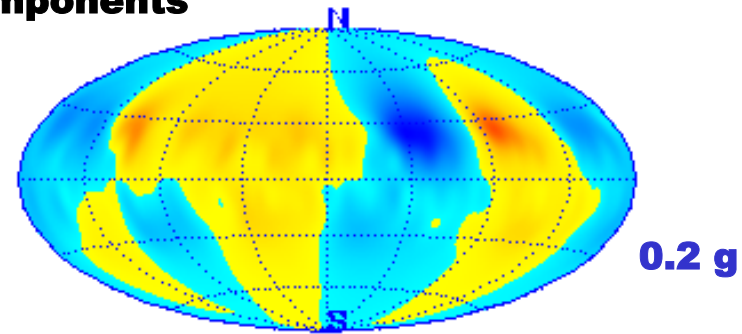
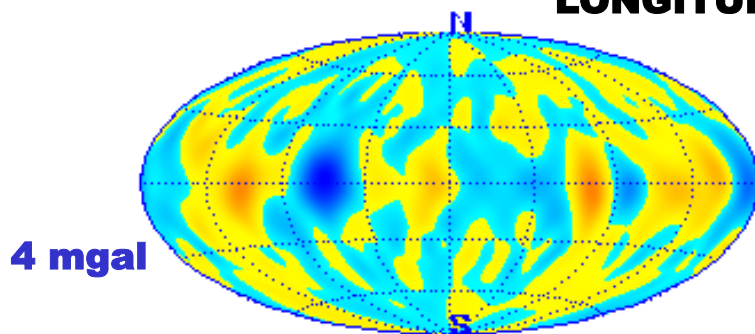
RADIAL components



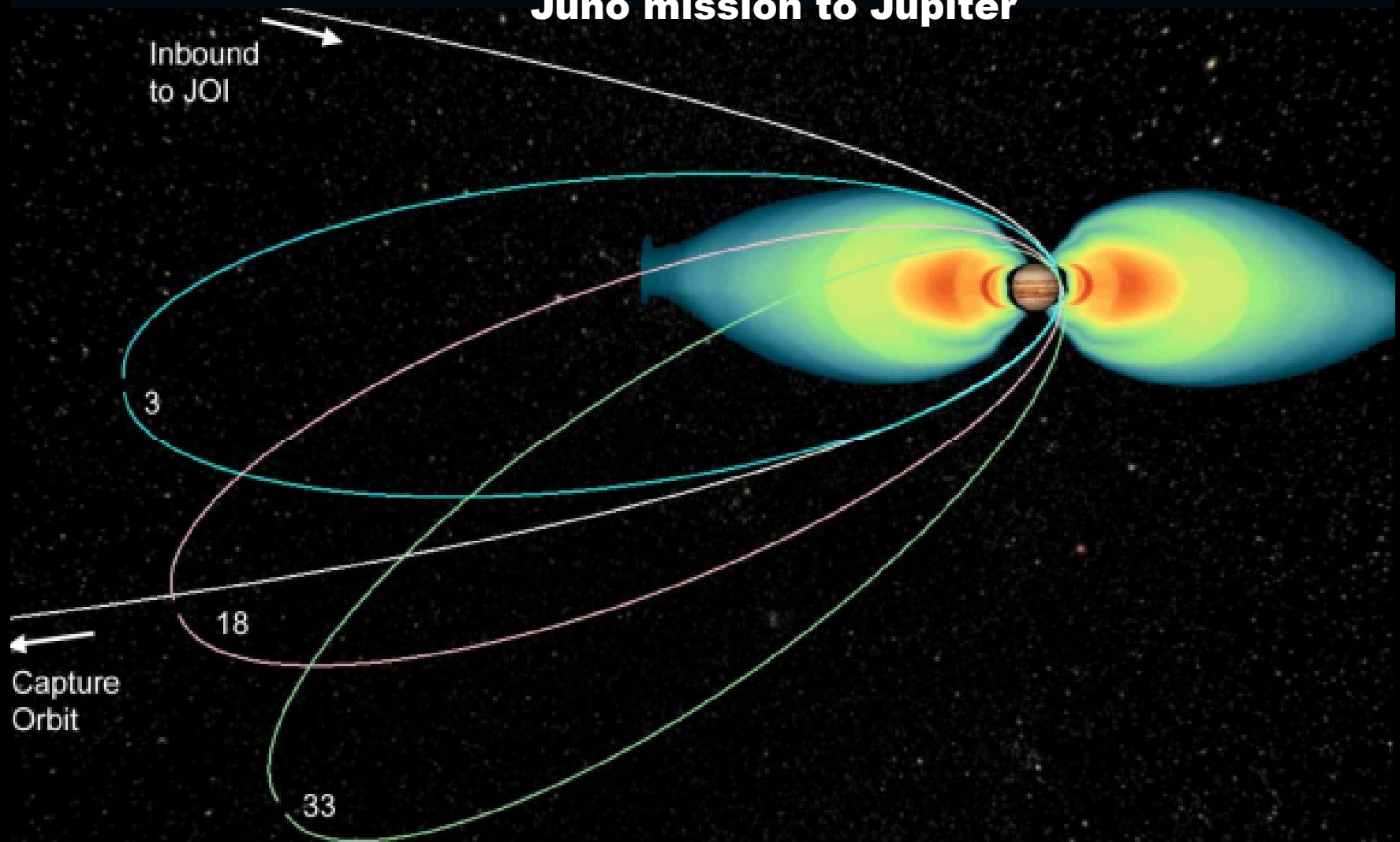
COLATITUDINAL components



LONGITUDINAL components



Juno mission to Jupiter



***Juno* mission to Jupiter
(and *Cassini Grand Finale* mission to Saturn)**

If no banded axisymmetric structures were observed in *Juno's* magnetic and gravity data, all strong zonal winds on Jupiter's surface are likely shallow atmospheric features.

If only broad-banded axisymmetric structures were observed in *Juno's* magnetic and gravity data (as in these simulations), Jupiter's broad low-latitude jets likely extend through the deep interior, but the narrow high-latitude jets are likely shallow atmospheric features.

If banded axisymmetric structures were observed at all latitudes in *Juno's* magnetic and gravity data, the zonal winds on Jupiter likely all extend well below the surface, possibly down to a double-diffusive stable stratification in which internal gravity waves exist.