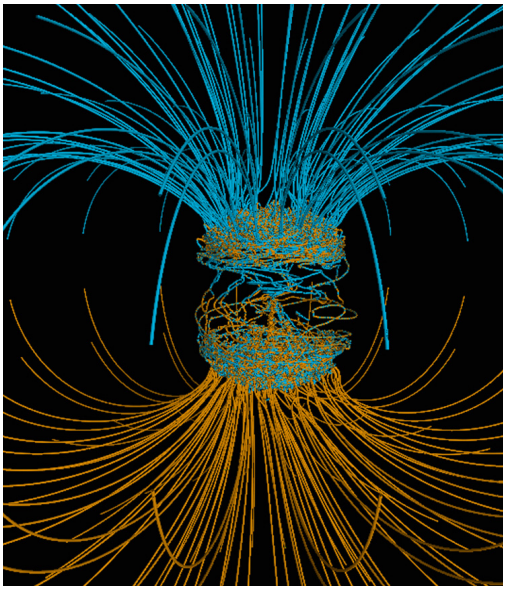
Simulations of Fluid Flows and Magnetic Fields in Giant Planets

Science Mission Directorate

Most people have seen the banded pattern of clouds on the surfaces of giant gas planets such as Jupiter and Saturn, either through telescopes or in NASA mission images. Our simulation research attempts to understand the dynamics within the atmospheres and interiors of these planets and, through comparison of the fundamental fluid dynamics, possibly offer a better understanding of the Earth's atmosphere and oceans.

NASA missions to other planets provide magnificent observations and measurements of their surfaces, and support the Agency's goal to improve our understanding of the solar system's origin and evolution. Using supercomputers, we attempt to explain some of these observations and predict the structure and dynamics in the deep interiors of planets, where observations are not made.



Snapshot of the magnetic field (as magnetic field lines) generated by convection and winds in a simulation of Saturn. Yellow represents outward-directed magnetic field, and blue represents inward-directed field. *Gary A. Glatzmaier, University of California, Santa Cruz*

We use NASA supercomputing resources to simulate the turbulent fluid flows and resulting magnetic fields in our 3D, nonlinear models of gas giants. These systems are programmed to solve for the fluid velocity, magnetic field, and thermodynamic variables throughout our model planet for the tens of millions of time steps required to simulate the magnetohydrodynamics. A typical simulation needs to run for more than a year on hundreds of processors. The resulting data is then analyzed and illustrated in images and movies.

Gary A. Glatzmaier, University of California, Santa Cruz
glatz@es.ucsc.edu