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Fully convective giant planets: internal dynamics and implications for thin shell convection

M. Evonuk (1) and G. Glatzmaier (2)

(1) Institut für Geophysik, ETH Zürich Hönggerberg, 8093 Zürich, Switzerland, (2) Department of Earth and Planetary Sciences, University of California at Santa Cruz, CA 95064 USA

Modeling giant planets without cores is relevant for extrasolar giant planets as well as for Jupiter. We present three-dimensional numerical simulations of thermal convection in a fully convective (without a solid core), non-magnetic, rotating, density-stratified, spherical fluid body. Discontinuous axially aligned vortices spiral prograde, eastward, momentum away from the axis of rotation as a result of vorticity generated by fluid flowing through the density-stratification. The convergence of this nonlinear Reynolds stress maintains a banded pattern of differential rotation with a strong prograde jet at the equator, without the classical vortex stretching of convective columns. Moreover this flow structure preferentially transports heat to high latitudes, which could explain the nearly latitudinally independent surface heat flux on Jupiter given the greater solar insolation at low latitude. This could also have important ramifications for the lower boundary conditions of thin shell simulations.