Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Magnetic resonance imaging study of Rayleigh-Benard convection in near and supercritical hexafluoroethane JOSHUA M. BRAY, SARAH L. CODD, Mechanical and Industrial Engineering, Montana State University, JOSEPH D. SEYMOUR, Chemical and Biological Engineering, Montana State University — Rayleigh-Benard convection (RBC) has been extensively studied; however, the regime of temperature and pressure above the critical point (Tc, Pc) remains largely unexplored experimentally. In this regime, convection modes are sensitive to divergence in various transport properties, providing a unique model system for many geophysical flows and allowing access to high Rayleigh numbers Ra, of order 10^{13}. We present magnetic resonance imaging (MRI) analysis of RBC in a supercritical fluid. Spatially resolved velocity images and ensemble-averaged transport dynamics were acquired non-invasively for C_2F_6 (Tc = 20 C, Pc = 31 bar) in a low aspect ratio chamber at pressures 32 bar and 70 bar with and without a 2.5 C temperature gradient. With no applied gradient, within the temperature control resolution of +/-0.1 C, convection at 70 bar is minimal, but is rapid at 32 bar due to near-critical density divergence. The velocity profile is concentric, in contrast to a single convective cell in non-critical fluids. An applied temperature gradient produced turbulent flow, destabilizing the concentric velocity distribution at 70 bar and generating incoherent fluid motion at 32 bar. Near and supercritical fluids provide a model system for tuning fluid dynamics through thermodynamics.

Joshua M. Bray
Mechanical and Industrial Engineering, Montana State University

Date submitted: 03 Aug 2012 Electronic form version 1.4