Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Influence of phase changes on Rayleigh-Benard convection[1]
MICHAEL ADLER, KELKEN CHANG, RAYMOND SHAW, Michigan Technological University — How does a condensing trace species influence the convection of an inert carrier gas? The question is relevant to cloud formation at typical atmospheric conditions. We simulate Rayleigh-Benard convection in a cylindrical geometry over a range of Rayleigh numbers for which the flow remains laminar. The top and bottom boundaries are fixed at the equilibrium vapor pressure of the condensable species. The buoyancy is influenced by temperature, vapor, and condensate concentrations. The temperature and vapor fields combine via the Clausius-Clapeyron equation to yield a spatially complex supersaturation field; this, in turn, drives condensation. The temperature field is coupled to the condensation process through latent heating. The resulting volume heat source affects the convection and leads to a height dependent Nusselt number. For fixed Rayleigh number, increasing the temperature difference alters the buoyancy and Nusselt number height profiles. An analytical model for the latent heating profile for the purely diffusive case is shown to predict the correct magnitude of heating. This study sets the stage for experiments that will be carried out in the Michigan Tech Pi-Chamber, an aspect ratio 2 chamber with volume 3.14 m^3 and controlled temperature and water vapor boundaries.

[1]Supported by NSF grant AGS-1039742

Raymond Shaw
Michigan Tech Univ

Date submitted: 01 Aug 2014 Electronic form version 1.4