PHYSICAL MATHEMATICS SEMINAR

Rayleigh-Benard convection with phase transition

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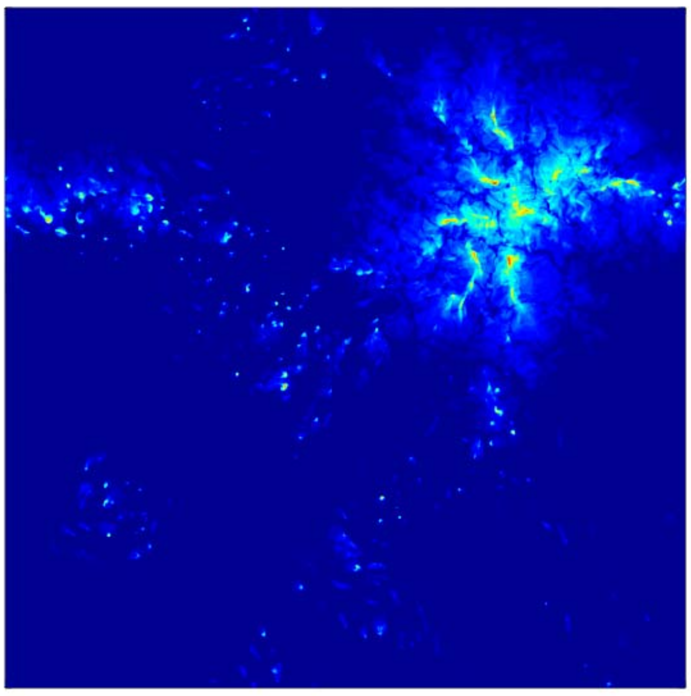
ABSTRACT:

Phase transitions play a key role in the dynamics of atmospheric convection. As air parcels rises, their temperature drops and water vapor condenses, which releases the latent heat of vaporization. While a full accounting of these processes in a realistic model can be quite complex, I will present here a highly idealized representation of the equation of state for moist air, which amounts to expressing the buoyancy of an air parcel as a piecewise linear function of two prognostic thermodynamic variables.

This formulation is implemented in a numerical model which is then used to investigate a moist analog to the Rayleigh-Benard problem. I will show that this moist Rayleigh-Benard convection exhibits some very distinct behavior. In particular, in the frequently observed conditionally unstable regime that is stably stratified for unsaturated air, convection is found to organize within self-aggregated cloudy patches while the unsaturated environment remains quiescent. In addition, this self-aggregated regime is highly inefficient at transporting energy upward, with a proposed upper bound on the Nusselt number that is independent on the Rayleigh number. I will also discuss how radiative cooling can affects the behavior of moist convection and lead to a significant increase in the energy transport.

References:

Pauluis and Schumacher. Idealized moist Rayleigh-Benard convection with piecewise linear equation of state. Commun Math Sci (2010).
Pauluis and Schumacher. Self-aggregation of clouds in conditionally unstable moist convection. PNAS (2011)



Liquid water path in numerical simulation of moist Rayleigh-Benard convection with radiation.

TUESDAY, September 11, 2012
2:30 PM
Building 4, Room 145

Reception at 3:30 PM in Building 2, Room 290
(Math Dept. Common Room)

http://math.mit.edu/pms

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