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Snappy and to the point.

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ABSTRACT

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1. INTRODUCTION

Here's some introductory words where we talk about (maybe?) the convective conundrum, and recent efforts to try to model the conductivity of the solar convection zone properly. We talk about how those efforts try to resolve the convective conundrum by properly driving the convection at the proper scales (e.g., towards the top of the domain?). We also mention that those studies make little to no mention of the Mach number.

It has been hypothesized that convection in the Sun is at low Rossby number, which is to say that the convective flow speeds are small compared to rotational influences. If this is the case, it is important to study low Mach number convection in order to properly understand the convective dynamics deep in the solar interior. Low Mach number convection is inherently coupled with small fluctuations compared to the background state, and so we hypothesize that in low Ma convection, it is not important to use a fully nonlinear conductivity profile. This will also likely affect the degree of overshoot into the stable layer below, and the overshoot should become less as the Mach number decreases.

In this letter we study convection in the presence of a realistic radiative conductivity profile. We study a Kramer's-like opacity for free-free radiative interactions, just like the deep layers of the solar convection zone. We study both a fully nonlinear conductivity and a conductivity which (is constant in time?) (only depends on the mean stratification?). We study both of these effects at high and low Mach number in order to determine the importance of nonlinear conductivities at low Mach number.

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2. EXPERIMENT

The atmosphere initially consists of two polytropic layers. The upper layer is adiabatically stratified, and the lower layer is stably stratified. Here's the equations for the atmosphere we use:

Here's the nondimensionalization of our atmosphere:

Here's our conductivity profile, diffusivities, control knobs:

Here's our numerical methods:

3. RESULTS

Here's a figure that shows how Reynolds number and Mach number scale with epsilon / Ra:

Here's a figure that shows the evolved stratification at high Ma (fully nonlinear vs. not) and the evolved stratification at low Ma (fully nonlinear vs. not).

Here's a figure that shows the importance of nonlinearities in the conductivity at both high and low Ma.

Here's a figure that shows either overshoot at high vs low Ma, or a pretty figure of dynamics. Probably that one.

4. CONCLUSIONS

What have we learned about opacity? Where are nonlinearities important? Where are they unimportant?