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Experiments with a Spectral Convection Model

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ABSTRACT

A new spectral moist convection model that employs both the least assumptions in moist physics and a very accurate solution method is presented. The temperature and pressure in the model are diagnostically determined from thermodynamics. There is no need to predict water vapor and condensate separately; rather, they are diagnostically separated from the predicted total airborne water. The model allows a modular separation of dynamics and thermodynamics; the link between dynamics and thermodynamics is through the pressure gradient force. The modular separation allows the possibility of having a detailed, fine resolution, nonhydrostatic cloud model and a coarse resolution, hydrostatic model which can be run side by side with the identical moist thermodynamics. The height coordinate of the nonhydrostatic model can also extend into the hydrostatic regime. The only differences between the hydrostatic and nonhydrostatic models are spatial resolution and the way vertical motion is computed. We have performed numerical experiments in the nonhydrostatic model for acoustic adjustment and moist convection. The discontinuity in thermodynamics due to phase change is modified in the model by the "gradual saturation" technique.

(Key words: Fourier-Chebyshev spectral method, Acoustic adjustment, Lanczos filter)

1. INTRODUCTION

Global models have become important tools for weather and climate simulations. However, these models have simplified hydrostatic dynamics and coarse vertical and horizontal resolution, so they are unable to explicitly simulate most of the cloud patterns that are crucial to climate dynamics. Because of their important effects on radiative transfer, hydrological cycles and apparent heat sources, moist convections must be more accurately treated in climate models. The real atmosphere contains a myriad of cloud structures which modulate radiative fluxes and which modify atmospheric structure by condensing water at one level and

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