THE GRADUATE SCHOOL
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DISSERTATION DEFENSE
of

Jose Humberto Garcia

FOR THE DEGREE

DOCTOR OF PHILOSOPHY

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Examining Committee Members:
Stephen McCormick, John Ruge, Marian Brezina, Frank, Bryan

OUTLINE OF STUDIES

Major Field: Applied Mathematics

BIOGRAPHICAL NOTES

- M.S., University of Colorado, 2004
- M.S., University of Colorado, 2001
- B.S., University of the Andes, Mérida, Venezuela, 1996

THESIS

Complete title of thesis:
Beta-Plane Approximation of Wind Driven Ocean Circulation using a First Order System Least-Squares Formulation.

Faculty Advisor Thomas Manteuffel

ABSTRACT

Earth's oceans represent roughly 70% of the total surface of the planet. Their sheer size and the nature of salty water as a fluid, makes them the biggest repository of heat for the planet and as such, it makes them very significant in driving many of the complex phenomena of Earth's climate. Ocean models give us a glimpse into the nature of the oceans and are essential tools for understanding the Earth's climate.

A fundamental component of an Earth's Ocean model is its dynamical core, which simulates the movement of the fluid in a rotational frame of reference. For this research, the model is described by the Incompressible Navier-Stokes equations in a rotational frame of reference.

We present an alternative First Order Least-Squares Finite Element formulation for the numerical solution of the stationary linear problem. The formulation is considered in all three spatial dimensions, i.e., without the hydrostatic hypothesis most often used in other numerical models based on the hydrostatic primitive equations.

In order to validate the computer model, a classical experiment for Beta-Plane approximation of wind driven ocean circulation is utilized. To this extend, the sliced cylinder model introduced by Pedlosky & Greenspan (1967) defines the physical domain. The focus of the validation process is the analysis of the solution for two expected phenomena, the thin Ekman layers induced in the system as well as the east-west asymmetry of the pressure field for the interior circulation.