TITLE: Theoretical Flow Regime Diagrams for the AGCE

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SIGNIFICANT ACCOMPLISHMENTS

The major criterion for the design of the AGCE is that it be possible to realize strong baroclinic instability in the apparatus. To ensure that this criterion is met, accurate calculations to determine the transitions between the stable and unstable flow regimes must be performed for proposed AGCE apparatus configurations. These calculations are being carried out by first determining the axisymmetric basic states with a fully nonlinear, two-dimensional, numerical model and then determining the stability of these basic states to zonal perturbations with a linear numerical model.

The numerical models have been developed and tested The codes in cylindrical form were checked by comparing their predictions with the experimental regime diagram for the differentially heated and rotating cylindrical annulus flows. The spherical terms were checked by comparing numerical predictions with accurate laser-Doppler measurements of homogeneous spin-up in a sphere.

Although it has been decided that the AGCE configuration will consist of a low viscosity silicone fluid contained between two hemispheres with a rigid boundary at the equatorial plane, this still leaves various possibilities with respect to, the radii of the hemispheres, the presence of a high latitude boundary and the boundary temperature distributions. Axisymmetric basic state flows have been computed for fifteen different configurations. Some of these flows have exhibited two-dimensional instability and unsteadiness which presents problems for azimuthal stability analysis.

A spherical annulus configuration which allows only steady basic state flows was chosen for the first set of stability analyses. The most significant accomplishment of FY-84 is that baroclinic instability has been found for this configuration and that the few results obtained to date suggest a regime diagram very different from the cylindrical annulus regime diagram.

FOCUS OF CURRENT RESEARCH ACTIVITIES:

The spherical regime diagram is being completed. Delays have occurred due to slow convergence of the stability code. This code converged rapidly for the cylindrical annulus studies. We are investigating whether the slow convergence is due to numerical or physical reasons.

Regime diagrams for several realistic AGCE configurations will be prepared. The effects of the radial variation of the dielectric body force and the centrifugal force will be included.

PUBLICATIONS SINCE JUNE 1983:

1. A Linear Analysis of the Transition Curve for the Baroclinic Annulus. T. L. Miller and R. L. Gall. Journal of the Atmospheric Sciences, 40 (1983), 2293-2303.

2. Finite-Difference Fluid Dynamics Computer Mathematical Models for the Design and Interpretation of Experiments for Space Flight. G. O. Roberts, W. W. Fowlis and T. L. Miller. NASA Technical Paper, April 1984.