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An Investigation into Variable Topography in a Baroclinic Annulus

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For first year of work of this project, a differentially-heated annulus was used to investigate sloping convection. To this end two studies were made, each motivated by a numerical investigation that had discovered new phenomena in computational annuli models. The results of these studies provided a greater understanding of the annulus, allowing improvement of the experimental arrangement for future work. Subsequent years of this project will be focussed on the issue of topography, with the theme considered via a review of the most notable outstanding questions found in the literature. It was decided that the topographic investigation will examine the viability of less-idealised topography, in particular by investigating the effect of using a superposition of wavenumbers rather than a simple sinusoid.

The superposition to be employed was chosen from a Fourier analysis of Martian topography – at a certain latitude ($\sim$40°S), wavenumber-1 and wavenumber-3 are dominant. Utilising the amplitude and phase differences, a superposition of these wavenumbers was created, to be investigated in comparison to simple wavenumber-3 sinusoid. In this way, a rough model of the Martian topography can also be studied. It is hoped that this experiment will provide solutions to the various unresolved questions mentioned previously, such as the growth-rate and time-scale of the various topographically forced oscillations and perturbations, the existence of multiple equilibria with less-idealised topography and the mechanism of generation of Low Frequency Variation (LFV). Thermal topography, or azimuthally-varying heating, is also up for investigation. By using flat heating elements on the base of the annulus, the differential-heating caused by the thermal differences between land and sea in the tropics can be recreated, permitting simulation of the Walker Circulation. Adaptations to the study of tidally-locked exoplanets are also possible. Finally, oceanic topography will also be explored via partial barriers. Partial barriers serve to block part of the flow (either radially or vertically) and will be employed to study the effects of continental shelves on the ocean basin.

All of these studies can be interchanged and combined with each other, allowing a large range of experiments to be proposed (for example, mixing partial barriers and thermal topography would allow for the study of monsoon conditions). Preliminary results and initial observations will be available for presentation.