Thomas Metcalf SPD Travel Award Report

Consequences of Fields and Flows in the Interior and Exterior of the Sun (COFFIES)
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Blume is a Ph.D. candidate at the University of Colorado Boulder, where she works under the supervision of Dr. Bradley Hindman. She is broadly interested in using a combination of numerical and analytic techniques to study fluid dynamics on big round rotating objects and currently studies inertial oscillations (waves where the restoring force is the Coriolis force) in the solar interior. While inertial oscillations are well-understood in quasi-2D thin fluid shells like the Earth's atmosphere or oceans, such an approximation cannot be made in the solar interior, which presents a mathematical challenge. This work develops our understanding of these waves in a solar-like environment, with the eventual goal of using them as seismic probes of the deep interior.

Effects of density stratification on Rossby waves in deep atmospheres

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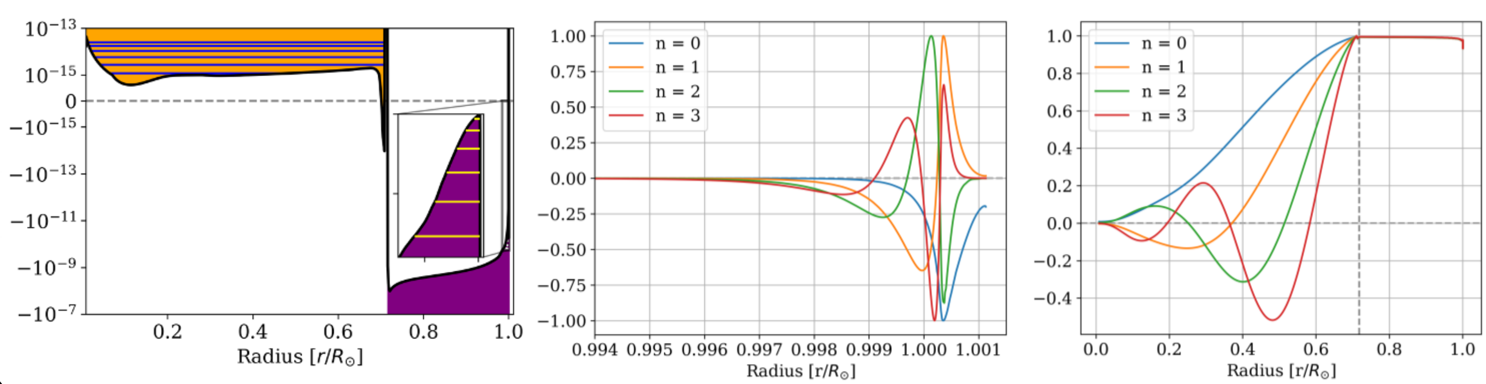
Though Rossby waves have been observed on the Sun, their radial eigenfunctions remain a mystery. The prior theoretical work either considers quasi-2D systems, which do not apply to the solar interior, or only considers fully radiative or fully convective atmospheres. This project calculates the radial eigenfunctions for Rossby waves in a deep atmosphere for a general stratification. Here, we use the beta-plane approximation to derive a vertical equation in terms of the Lagrangian pressure fluctuation, and we then calculate radial eigenfunctions for Rossby waves in a standard solar model, Model S. We find that working in the Lagrangian pressure fluctuation results in cleaner wave equations that lack internal singularities that have been encountered in prior work. The resulting radial wave equation makes it abundantly clear that there are two wave cavities in the solar interior, one in the radiative interior and another in the convection zone (*left*). The radial eigenfunctions for the convection zone modes reveal that these waves primarily exist at the solar surface (*center*). Surprisingly, our calculated radial vorticity eigenfunctions for the radiative interior modes are nearly constant throughout the convection zone (*right*), raising the possibility that they may be observable at the solar surface as well and that we may be observing a combination of modes from two different wave families.



I am very grateful to the organizers of the COFFIES meeting and to the SPD/Thomas Metcalf Travel Award committee for selecting me for this award. This award provided me with the opportunity to convene with my COFFIES collaborators for the first time in person, and I would not have been able to attend without the generosity of the Metcalf family. I had many helpful research conversations and received valuable feedback on this work which I hope will enhance the final product when it is published.