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Statistical Mechanics of Rossby wave

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In order to study nonlinear behaviors of geophysical fluid dynamics, several approaches are applicable. Statistical mechanics is one of them. It derives statistical means of physical quantities regardless of the ways of nonlinear interactions, though the fluid is assumed to be inviscid and in statistical equilibrium. From this viewpoint, many studies have been made.

In this study, the author proposes a different way to apply statistical mechanics to geophysical fluid dynamics. In general, geophysical fluids are characterized by waves, such as Rossby wave, internal gravity wave and so on. And, one of the traditional ways of statistical mechanics is for waves. It is well known that the application of statistical mechanics to electromagnetic waves results in Stefan Boltzmann law of radiation. The application to sound wave derives the theory of the heat capacity of solid states. Accordingly, it is natural to adopt the traditional way to the waves in geophysical fluids.

This study shows that statistical mechanics of 2D Rossby waves could be constructed. The energy spectrum obtained in this study found to coincide with the results for the fully nonlinear turbulence on 2D β plane ([1], [2]). In this report, other physical quantities and the implications of "thermodynamics" of Rossby waves is discussed.

[1] Kraichnan, R. H., 1967, The Phys. Fluids 10, 1417-1423

[2] Salmon, R., Holloway, G., and Hendershott, M.C., 1976, J. Fluid Mech., 75, 691-703