Oceanic and tropical with moisture atmospheric models

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In this talk I will present some recent results concerning global regularity of certain geophysical models. This will include the three-dimensional primitive equations with various anisotropic viscosity and turbulence mixing diffusion, and certain tropical atmospheric models with moisture. Moreover, in the non-viscous (inviscid) case it can be shown that there is a one-parameter family of initial data for which the corresponding smooth solutions of the primitive equations develop finite-time singularities (blowup).

Capitalizing on the above results, we can provide rigorous justification of the derivation of the Primitive Equations of planetary scale oceanic dynamics from the three-dimensional Navier-Stokes equations, for vanishing small values of the aspect ratio of the depth to horizontal width. Specifically, we can show that the Navier-Stokes equations, after being scaled appropriately by the small aspect ratio parameter of the physical domain, converge strongly to the primitive equations, globally and uniformly in time, and that the convergence rate is of the same order as the aspect ratio parameter. Furthermore, I will also consider the singular limit behavior of a tropical atmospheric model with moisture, as $\varepsilon \to 0$, where $\varepsilon > 0$ is a moisture phase transition small convective adjustment relaxation time parameter.