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A new eddy diffusivity parameterization for ocean models using Assumed Distribution Higher Order closure

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The vertical turbulent flux of heat, mass, and momentum is an important component in the oceanic flows and is fundamental to understanding the global heat budget of ocean and atmosphere. The current state of the science representations of vertical turbulent fluxes are subject to persistent biases stemming from missing physical processes (e.g., Langmuir turbulence, wave breaking) and poor inherent assumptions (e.g., lack of energetic constraints). Here we discuss the first Assumed Distribution Higher Order Closure (ADC) for the ocean. By assuming a probability distribution function relationship between certain quantities (e.g., vertical velocity, potential temperature, salinity etc.) we can construct all higher order moments, overcoming the classic turbulence closure problem. The second moment equations are mathematically consistent with the higher order Reynolds Averaged Navier Stokes equations. Thus, the ADC parameterization has full energetic constraints, includes non-local convective turbulence, and can easily integrate other physical phenomena like Langmuir Turbulence (with appropriate modifications to the momentum equations and turbulent length scales). We have tested the ADC scheme in a single column framework across a range of oceanographically relevant forcing scenarios against Large Eddy Simulation (LES). We find that the ADC scheme has little sensitivity to vertical resolution and timestep and compares well to the LES results.