Clear-Air Turbulence Simulation and Observation - Implications for Parameterization

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Improved understanding of clear-air turbulence is critical for a host of important applications, including aircraft safety, atmospheric optical distortion, contaminant dispersal, and subgrid-scale (SGS) turbulence parameterization for regional and larger scale atmospheric models. However, current efforts to model atmospheric turbulence under stably stratified conditions rely too heavily on convenient but inappropriate mathematical assumptions and mean statistical formulations that are applied at cut-off wavelengths lying outside the range of scales for which they were originally formulated. As such, the resulting models 1) are often internally inconsistent, 2) do not provide meaningful uncertainty estimates, and 3) are unable to realistically estimate parameters, such as the Richardson number, that are used to adapt them for stable stratification. Petascale computing systems promise increased resolution that may mitigate some of these difficulties, but we must first work to better understand the relevant length and time scales and the detailed dynamics involved so that we may successfully develop parameterizations appropriate for the different model filter widths at which they will be employed.

In this talk I will present detailed simulations of isolated atmospheric dynamical processes that give rise to clear-air turbulence (e.g., wind shear and gravity-wave breaking) and which provide several surprises; I will provide comparisons with atmospheric measurements that validate the unexpected results; and I will discuss implications for using high-resolution process studies like these to construct meaningful SGS parameterizations for larger-scale models.