Using HATS Databases to Evaluate Subfilter-Scale Rate Equations for LES

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Our ability to simulate turbulence over a wider range of scales in atmospheric and oceanic boundary layers using the technique of large-eddy simulation (LES) is rapidly advancing due to growth in parallel computing. However, despite their power LES models are not free of empiricism. They require a parameterization of the motions not resolved by the grid mesh, *i.e*., the subgrid-scale (or subfilter-scale) fluxes. The majority of geophysical and engineering LES codes rely on a parameterization, the Smagorinsky model that was developed based primarily on theoretical arguments - these assumptions however are frequently violated in the practice of LES, especially near boundaries and in regions of strong stable stratification. In this presentation, I will describe results from the recent series of Horizontal Array Turbulence Study field campaigns, *viz.,* (HATS, OHATS and CHATS), whose primary goal is to measure subfilter-scale motions in outdoor environments using arrays of sonic anemometers. These surface layer observations can be used to test parameterizations in LES codes but also provide insight into the stochastic nature of subgrid-scale dynamics, *e.g.*, the importance of energy backscatter, the transition between mesoscale and LES closures (the “Terra Incognita”, Wyngaard, 2004), and the effect of stratification. The emphasis in this talk will be on evaluating and comparing isotropic and non-isotropic production terms in rate equations for subgrid-scale momentum and scalar fluxes. This will quantify assumptions used in classic Smagorinsky closures.