



Subgrid-scale physics under strongly stable atmospheric stratification: the SNOHATS experiment

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Stably stratified atmospheric flows are usually characterized by weak and highly anisotropic turbulence, gravity waves, instabilities, and meandering motions that are not observed in neutral or convective atmospheric flows. These features complicate both modeling and sensing in stable atmospheric boundary layers. On the modeling side, the main problem is that the classic parameterizations of the unresolved scales, such as subgrid scale turbulence in Large Eddy Simulation (LES), are often found to be inadequate for stable conditions. To address these concerns, a field study (SNOHATS) was held at the extensive "Plaine-Morte" glacier in the Swiss Alps (3000 m) from February to April 2006. The snow cover provided stable stratification of the flow over long periods. Two horizontal arrays of vertically separated 3D sonic anemometers were deployed to allow two dimensional filtering and computation of the full three-dimensional strain rate tensors.

First, SGS dissipations of turbulent kinetic energy (TKE) and temperature variance were compared to the dissipations of these quantities computed from second and third order structure functions (of velocity and temperature). The match between the SGS and structure function dissipation estimates was remarkably good. The Smagorinsky subgrid scale model for LES was then tested. The general results from SNOHATS for the Smagorinsky model agree with previous findings (Kleissl et al., 2003; 2004): as the stability increases the model coefficient decreases and the SGS Prandtl number increases. However, several periods were detected where the turbulence and SGS dynamics were not in line with our classic understanding of ABL flows; for example, the TKE was increasing despite an increase in stability and the model coefficients were

decreasing despite an increase in TKE.

This led us to reconsider some basic questions about turbulence and SGS physics in stable flows: How does turbulence interact with other stable flow features? What is the main function of the subgrid scales under strong stable stratification?