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Large-eddy simulation of stable atmospheric boundary layers to develop better turbulence closures for climate and weather models ELIE BOU-ZEID, JING HUANG, Princeton University, JEAN-CHRISTOPHE GOLAZ, Geophysical Fluid Dynamics Laboratory — A disconnect remains between our improved physical understanding of boundary layers stabilized by buoyancy and how we parameterize them in coarse atmospheric models. Most operational climate models require excessive turbulence mixing in such conditions to prevent decoupling of the atmospheric component from the land component, but the performance of such a model is unlikely to be satisfactory under weakly and moderately stable conditions. Using Large-eddy simulation, we revisit some of the basic challenges in parameterizing stable atmospheric boundary layers: eddy-viscosity closure is found to be more reliable due to an improved alignment of vertical Reynolds stresses and mean strains under stable conditions, but the dependence of the magnitude of the eddy viscosity on stability is not well represented by several models tested here. Thus, we propose a new closure that reproduces the different stability regimes better. Subsequently, tests of this model in the GFDL's single-column model (SCM) are found to yield good agreement with LES results in idealized steady-stability cases, as well as in cases with gradual and sharp changes of stability with time.

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