Abstract Submitted
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A modulated gradient model for scalar transport in large-eddy simulation of the atmospheric boundary layer HAO LU, St. Anthony Falls Laboratory, University of Minnesota, FERNANDO PORTE-AGEL, School of Architecture, Civil and Environmental Engineering, École Polytechnique Fédérale de Lausanne (EPFL) — As a simple alternative to the standard eddy-diffusivity closure, a nonlinear subgrid-scale (SGS) flux model is introduced and implemented in simulations of a neutral atmospheric boundary layer with a constant surface flux. This approach is based on the Taylor expansion of the SGS flux, and employs the local equilibrium hypothesis to evaluate the SGS velocity scale and the SGS scalar concentration scale. To resolve the instability issue of the original gradient model and ensure numerical stability, we adopt a clipping procedure to avoid local negative SGS production of the scalar variance. The model formulation using constant coefficients is assessed through a systematic comparison with well-established theoretical predictions and reference results of various flow statistics. Simulation results obtained with the use of this new model show good agreement with the reference results and a significant improvement compared to results obtained using traditional eddy-diffusivity models. For instance, the new model can deliver the expected surface-layer similarity (logarithmic) scalar profile and power-law scaling of the power spectrum of scalar fluctuation. Simulations using the new model also yield reasonable flow structures and scalar statistics.

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