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Energetically Consistent Stochastic and Deterministic Kinetic Energy Backscatter Schemes for Atmospheric Models

Suneet Dwivedi (1,2), Christian L. E. Franzke (2), and Frank Lunkeit (2)

(1) K Banerjee Centre of Atmospheric and Ocean Studies, University of Allahabad, Allahabad, UP 211002, India (suneetdwivedi@gmail.com), (2) Meteorological Institute, Centre for Earth System Research and Sustainability, University of Hamburg, Grindelberg 5-7, D-20144, Hamburg, Germany (christian.franzke@uni-hamburg.de)

Current climate models still suffer from many biases which are partly due to excessive subgrid-scale dissipation. Here we systematically develop energetically consistent stochastic energy backscatter (SEB) and deterministic energy backscatter (DEB) parameterization schemes. We implement our scheme in a spectral atmospheric Global Circulation Model (GCM). It is shown that the SEB scheme performs better than the DEB scheme at low horizontal resolutions (T21 and T31), whereas, the performance of both schemes becomes comparable as the resolution increases to T42 when comparing with our reference simulation at T127 resolution. The energy backscatter parameterization schemes improve eddy variability in low-resolution models and correctly capture the dominant mode of variability. The autocorrelation time scale of low-resolution models is also found to be more consistent with the reference simulation on applying the SEB and DEB parameterizations. Our schemes are also scale adaptive.