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In Marriage of Model and Numerics, Glimpses of the Future¹

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University of Colorado Boulder — A newly defined concept of m -refinement (model-refinement), which provides two-way coupling of physical models and numerical methods, is employed to study the Reynolds scaling of SCALES with constant levels of fidelity. Within the context of wavelet-based methods, this new hybrid methodology provides a hierarchical space/time dynamically adaptive automatic smooth transition from resolving the Kolmogorov length-scale (WDNS) to decomposing deterministic-coherent/stochastic-incoherent modes (CVS) to capturing more/less energetic structures (SCALES). This variable fidelity turbulence modeling approach utilizes a unified single solver framework by means of a Lagrangian spatially varying thresholding technique. The fundamental findings of this computational complexity study are summarized as follows: 1) SCALES can achieve the objective of “controlling the captured flow-physics as desired” by profoundly small number of spatial modes; 2) Reynolds scaling of constant-dissipation SCALES is the same regardless of fidelity of the simulations; 3) the number of energy containing structures at a fixed level of resolved turbulent kinetic energy scales linearly with Re ; and 4) the fractal dimension of coherent energy containing structures is close to unity.

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