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Filter length scale for continuum modeling of subgrid physics

JULIAN SIMEONOV, JOSEPH CALANTONI, Naval Research Laboratory, Stennis Space Center — Modeling the wide range of scales of geophysical processes with direct numerical simulations (DNS) is currently not feasible. It is therefore typical to explicitly resolve only the large energy-containing scales and to parameterize the unresolved small scales. One approach to separate the scales is by means of spatial filters and here we discuss practical considerations regarding the choice of a volume averaging scale L. We use a macroscopically homogeneous scalar field and quantify the smoothness of the filtered field using a noise metric, ν, defined by the standard deviation of the filtered field normalized by the domain-averaged value of the field. For illustration, we consider the continuum modeling of the particle phase in discrete element method (DEM) simulations and the salt fingers in DNS of double-diffusive convection. We find that ν^2 follows an inverse power law dependence on L with an exponent and coefficients proportional to the domain-averaged field value. The empirical power law relation can aid in the development of continuum models from fully resolved simulations while also providing uncertainty estimates of the modeled continuum fields.

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