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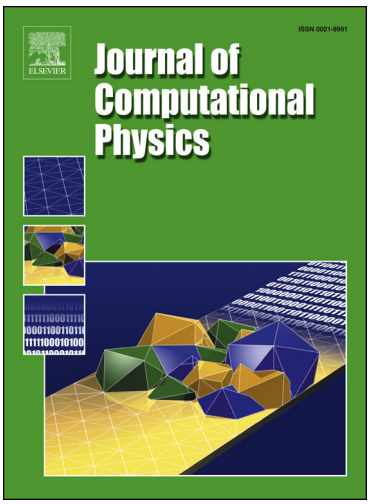

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Gradients estimation from random points with volumetric tensor in turbulence

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Abstract

We present an estimation method of fully-resolved/coarse-grained gradients from randomly distributed points in turbulence. The method is based on a linear approximation of spatial gradients expressed with the volumetric tensor, which is a 3×3 matrix determined by a geometric distribution of the points. The coarse grained gradient can be considered as a low pass filtered gradient, whose cutoff is estimated with the eigenvalues of the volumetric tensor. The present method, the volumetric tensor approximation, is tested for velocity and passive scalar gradients in incompressible planar jet and mixing layer. Comparison with a finite difference approximation on a Cartesian grid shows that the volumetric tensor approximation computes the coarse grained gradients fairly well at a moderate computational cost under various conditions of spatial distributions of points. We also show that imposing the solenoidal condition improves the accuracy of the present method for solenoidal vectors, such as a velocity vector in incompressible flows, especially when the number of the points is not large. The volumetric tensor approximation with 4 points poorly estimates the gradient because of

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