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Mixing length and scale-to-scale kinetic energy transfer in the wake of a fractal tree[1] KUNLUN BAI, CHARLES MENEVEAU, JOSEPH KATZ, Mechanical Engineering and CEAFM, Johns Hopkins University — To study the dynamics of turbulence interacting with multi-scale objects, we measure turbulence structure in the wake of a fractal tree-like object in a water channel, using PIV. The eddy viscosity is obtained from the correlation of mean shear and Reynolds shear stress distributions across the wake. We address the question whether a mixing length-scale can be identified in this flow, and if so, how it relates to the geometric length-scales in the pre-fractal object. One approach is based on spectral distributions. Another more practical approach is based on length-scale distributions evaluated using fractal geometry tools. These models agree well with the measured mixing length indicating that information about multi-scale clustering of branches has to be taken into account. To explore the energy transfer at different scales, data are spatially filtered at various scales and the subgrid-scale flux among scales is evaluated. In contrast to regions characterized by a single length scale (bottom of the tree) where a classical inertial range cascade behavior is observed with scale-independent flux, at heights where multiple branch generations interact with the flow, we find that the energy flux depends strongly on the filter size, increasing with smaller filter sizes. The results can be explained by production at multiple-scales.

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