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Numerical analysis of scalar dissipation length-scales and their scaling properties PANKAJ VAISHNAVI, ANDREAS KRONENBURG, Imperial College, London SW7 2AZ, UK — Scalar dissipation rate, χ, is fundamental to the description of scalar-mixing in turbulent non-premixed combustion. Most contributions to the statistics for χ come from the finest turbulent mixing-scales and thus its adequate characterisation requires good resolution. Reliable χ-measurement is complicated by the trade-off between higher resolution and greater signal-to-noise ratio. Thus, the present numerical study utilises the error-free mixture fraction, Z, and fluid mechanical data from the turbulent reacting jet DNS of Pantano (2004). The aim is to quantify the resolution requirements for χ-measurement in terms of easily measurable properties of the flow like the integral-scale Reynolds number, Re_δ, using spectral and spatial-filtering [cf. Barlow and Karpetis (2005)] analyses. Analysis of the 1-D cross-stream dissipation spectra enables the estimation of the dissipation length scales. It is shown that these spectrally-computed scales follow the expected Kolmogorov scaling with $Re_\delta^{-0.75}$. The work also involves local smoothening of the instantaneous χ-field over a non-overlapping spatial-interval (filter-width, w_f), to study the smoothened χ-value as a function of w_f, as w_f is extrapolated to the smallest scale of interest. The dissipation length-scales thus captured show a stringent Re_δ^{-1} scaling, compared to the usual Kolmogorov-type. This concurs with the criterion of 'resolution adequacy' of the DNS, as set out by Sreenivasan (2004) using the theory of multi-fractals.

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