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Scaling properties of the mean equation for passive scalar in turbulent channel flow ANG ZHOU, University of New Hampshire, SERGIO PIROZZOLI, University of Rome La Sapienza, JOSEPH KLEWICKI, University of New Hampshire, University of Melbourne — Data from numerical simulations of fully developed turbulent channel flows subjected to a uniform and constant heat generation are used to explore the scaling behaviors admitted by the mean equation for passive scalar transport. The analysis proceeds in a manner similar to previous studies of mean momentum transport. Based on the relative magnitude of terms, the leading order balances in the equation organize into a four layer structure. The wall-normal widths of the layers exhibit significant dependencies both on Reynolds and Prandtl number, and these dependencies are analytically surmised and empirically validated. The passive scalar equation also admits an invariant form on each of a hierarchy of scaling layers. As with the momentum case, this hierarchy is quantified by its inner-normalized widths. The present findings indicate that the layer width distribution is increasingly approximated by a linear function of wall normal position with increasing ratio of Reynolds number to Prandtl number on a domain of the hierarchy where the molecular diffusion effect loses leading order. The analysis indicates that across this domain the square of the slope of the width distribution function is equivalent to the scalar Karman constant as Reynolds number goes to infinity. The data provide convincing evidence in support of this finding.

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