

## Accepted Manuscript

Structures of scalar transport in a turbulent channel

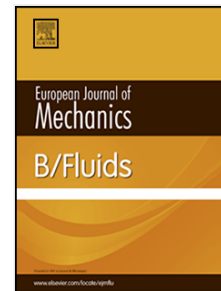
Suranga Dharmarathne, Murat Tutkun, Guillermo Araya, Luciano Castillo

PII: S0997-7546(15)20085-4

DOI: <http://dx.doi.org/10.1016/j.euromechflu.2015.06.010>

Reference: EJMFLU 2910

To appear in: *European Journal of Mechanics B/Fluids*



Please cite this article as: S. Dharmarathne, M. Tutkun, G. Araya, L. Castillo, Structures of scalar transport in a turbulent channel, *European Journal of Mechanics B/Fluids* (2015), <http://dx.doi.org/10.1016/j.euromechflu.2015.06.010>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

# Structures of scalar transport in a turbulent channel

Suranga Dharmarathne<sup>a</sup>, Murat Tutkun<sup>b,c</sup>, Guillermo Araya<sup>a</sup>, Luciano Castillo<sup>a,\*</sup>

<sup>a</sup>Department of Mechanical Engineering, Texas Tech University, Lubbock, TX-79409, USA

<sup>b</sup>Department of Process and Fluid Flow Technology, Institute for Energy Technology (IFE),  
2027 Kjeller, Norway

<sup>c</sup>Department of Mathematics, University of Oslo, Blindern, 0316 Oslo, Norway

## Abstract

Direct numerical simulation (DNS) of a turbulent channel with temperature treated as a passive scalar at a moderate Reynolds number ( $Re_\tau = 395$ ) was performed to investigate the large scale motions responsible for scalar transport. Structures are elicited by using three dimensional two-point correlations. Complete three dimensional structure of cross correlations between velocity and scalar fluctuations are evaluated for the first time. The results show that the organized motions which are responsible for transporting streamwise component of the turbulence kinetic energy, scalar variance, and streamwise heat flux are very similar only in the viscous sublayer. However, the large scale motions (LSMs) which transport streamwise component of the turbulent kinetic energy, scalar variance, and streamwise heat flux are clearly distinct to each other beyond the buffer region. In addition, comprehensive three dimensional two-point correlation data imply that LSMs which are responsible for carrying most of the Reynolds stresses are not exactly the same as those that transport most of the scalar fluxes in both inner and outer regions of the turbulent boundary layer. Analysis of the length scales of correlations revealed that the growth of LSMs which influence both momentum and thermal transport is linear. Comparison of physical extents of LSMs which are responsible for transporting Reynolds stresses and wall-normal heat fluxes reveals that Reynolds analogy holds for scalar transport by the LSMs in the boundary layer.

**Keywords:** DNS, Large-scale motions, Scalar transport, Correlation, Turbulent channel

**2010 MSC:** 00-01, 99-00

---

\*Corresponding author

Email addresses: [suranga.dharmarathne@ttu.edu](mailto:suranga.dharmarathne@ttu.edu) (Suranga Dharmarathne),  
[murat.tutkun@ife.no](mailto:murat.tutkun@ife.no) (Murat Tutkun), [g.araya@ttu.edu](mailto:g.araya@ttu.edu) (Guillermo Araya),  
[luciano.castillo@ttu.edu](mailto:luciano.castillo@ttu.edu) (Luciano Castillo)

Download English Version:

<https://daneshyari.com/en/article/7051254>

Download Persian Version:

<https://daneshyari.com/article/7051254>

[Daneshyari.com](https://daneshyari.com)