

# Complex network analysis of wind tunnel experiments on the passive scalar dispersion in a turbulent boundary layer

G. Iacobello <sup>1</sup>, L. Ridolfi <sup>2</sup>, M. Marro <sup>3</sup>, P. Salizzoni <sup>3</sup>, and S. Scarsoglio <sup>1</sup>

<sup>1</sup> Department Mechanical and Aerospace Engineering, Politecnico di Torino, Turin, Italy

<sup>2</sup> Department Environmental, Land and Infrastructure Engineering, Politecnico di Torino, Turin, Italy

<sup>3</sup> Laboratory of Fluid Mechanics and Acoustics, Ecole Centrale de Lyon, Ecully, France

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## Abstract:

The characterization of pollutant transport is crucial for the analysis and modeling of the atmospheric boundary layer [1]. In this work, experimental data of passive scalar plumes in a turbulent boundary layer are investigated. The experiments are performed in a wind tunnel where the passive scalar is injected through an L-shaped tube located at  $z/\delta = 0.24$ , with  $\delta$  the boundary layer thickness. Specifically, two source configurations are analyzed for two different tube diameters,  $D = 3$  mm and  $D = 6$  mm. The streamwise,  $u$ , and wall-normal,  $w$ , velocity components, and the concentration,  $c$ , are measured at different distances from the source and at various wall-normal and spanwise locations. The corresponding time-series are recorded for  $T = 180$  s with a sampling frequency of 1000 Hz. A sketch of the experimental setup and representative time-series at fixed spatial location is reported in Fig. 1a.

By exploiting the recent advances of complex networks theory, the velocity and concentration time-series are mapped into networks, where each time-sample corresponds to a node. Different algorithms to construct a network from a time-series are explored. One of the simplest and most adopted approaches is the *visibility algorithm* [2, 3]. In a visibility-based network a link exists if the straight line connecting two data-samples lies above the other in-between data. Accordingly, a visibility network is built for each velocity and concentration time-series at different measurement locations (e.g., see Fig. 1b). The resulting network topology inherits the temporal features of the mapped time-series, revealing non-trivial information of the underlying transport process. Due to their versatility, complex networks offer a powerful and synthetic tool for the analysis of turbulent transport and mixing.

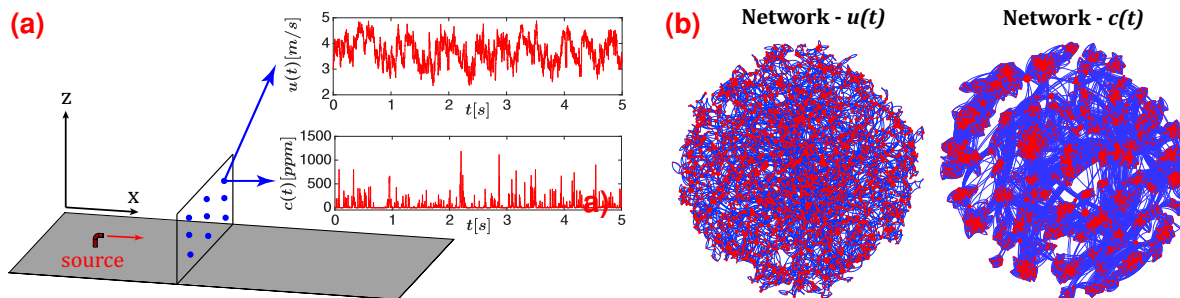


Figure 1: (a) Sketch of the wind tunnel set-up and representative velocity and concentration time-series; (b) Networks built from the time-series shown in panel (a).

## References

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