

Source identification of environmental pollutants based on tracer dispersion in reversed flow field

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This study presents a novel method for identifying the source of an environmental pollutant continuously released from a point source in a turbulent flow field at a statistically steady state. The method employs the analysis of tracer dispersion in a reversed flow field (RFF) released from observation points of the pollutant. The RFF is artificially produced from the forward flow field (FFF); the direction of temporal progress and velocity vectors are produced in the opposite direction to those in the FFF.

Based on the probabilistic behavior of a virtual particle in the flow fields, we derived a symmetric property of the expected staying time (EST) of a pollutant and tracer particles in the FFF and RFF. The symmetry of the EST is an indication of the duality of the scalar fields, which states that a measured concentration of the pollutant and a distribution of the EST of the tracer give the estimated source strength as a function of the source position. When multiple observation points are available, the source position can be determined by the uniqueness of the estimated source strength at a point.

This paper introduces the basic idea of the present method based on a physical consideration of the particle behavior in the RFF. An example of the source identification procedure is also presented for pollutant dispersion in a two-dimensional uniform flow field.