

Abstract Submitted
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An eigen-ensemble-variational algorithm for identifying scalar sources from remote measurements in turbulent environments¹ QI WANG, TAMER ZAKI, Johns Hopkins University — The ability to identify the location and intensity of a scalar source in turbulent environment from remote measurements is obfuscated by the stochasticity of turbulent eddies and by diffusion. An algorithm is proposed to solve this inverse problem, which relies on estimating the left and right singular vectors of the scalar impulse-response system, or its eigen-sources and eigen-measurements. The projection of the true source onto an eigen-source is proportional to the projection of the sensor signal onto the corresponding eigen-measurement, and the proportionality is given by the singular value. When only the sensor signal is available, the unknown source is identified by requiring that it accurately reproduces this proportionality. A pre-requisite of the algorithm is knowledge of the eigen-spectrum of the system, which can be available from historical data or approximated using proper orthogonal decomposition of the observation matrix from an ensemble of trial sources. We demonstrate that using only five ensemble members, the source location and intensity are predicted with less than 10% error, and we quantify the effect of sensor noise. Furthermore, the algorithm utilizes forward simulations only and can be easily adopted with expanding time horizon of measurement.

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