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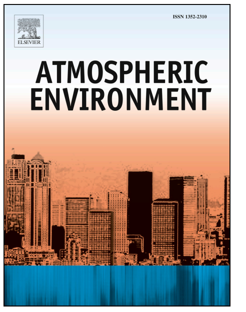

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Fugitive Emission Source Characterization Using a Gradient-Based Optimization Scheme and Scalar Transport Adjoint

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Abstract

Fugitive emissions are important sources of greenhouse gases and lost product in the energy sector that can be difficult to detect, but are often easily mitigated once they are known, located, and quantified. In this paper, a scalar transport adjoint-based optimization method is presented to locate and quantify unknown emission sources from downstream measurements. This emission characterization approach correctly predicted locations to within 5 m and magnitudes to within 13% of experimental release data from Project Prairie Grass. The method was further demonstrated on simulated simultaneous releases in a complex 3-D geometry based on an Alberta gas plant. Reconstructions were performed using both the complex 3-D transient wind field used to generate the simulated release data and using a sequential series of steady-state RANS wind simulations (SSWS) representing 30 s intervals of physical time. Both the detailed transient and the simplified wind field series could be used to correctly locate major sources and predict their emission rates within 10%, while predicting total emission rates from all sources within 24%. This SSWS case would be much easier to implement in a real-world application, and gives rise to the possibility of developing pre-computed databases of both wind and scalar transport adjoints to reduce computational time.

Keywords
Fugitive emissions; source quantification; source characterization; leak location; leak quantification; adjoint