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Optimizing Atmospheric Monitoring Networks Using Bayesian Methods and Genetic Algorithms for Multiple Objectives

The monitoring of atmospheric plumes using a network of sensors is complicated by many constraints such as interfering plumes, and sensor placement, cost and performance. The presence of interfering plumes can confound efforts to discriminate a specific source, while network optimization is rarely independent of cost or placement constraints. The use of Bayesian methods and Genetic Algorithms offer a way to optimize monitoring networks with multiple objectives in mind and accounting for the presence of background interference. An example considering overall network performance and cost is discussed. The use of a multiple objective approach, considering both sensor cost and performance for a network of six sensors, is determined from a computationally determined Pareto frontier of optimized network options. The example demonstrates how such methods can help analyze the discrepancy between models and observations and thus provide an economic and scientific rationale to include additional sources, exclude certain sensors, or to explore specific sensors and their surrounding environment at higher fidelity. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344.

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