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predictions and uncertainty estimation using adaptively designed ensembles for radiological plume modeling

Better characterization of meteorological uncertainty is needed within a dispersion modeling framework so that plausible ranges of predictions from radiological releases to the atmosphere (e.g. nuclear power plant, nuclear detonation) can be accurately communicated to decision makers. Largely for computational reasons, atmospheric model ensembles typically utilize a reduced set of physics configurations that often fail to fully explore the uncertainty range of atmospheric phenomena key to dispersion modeling processes, such as surface energy exchange, cloud formation, precipitation, and atmospheric stability. To address this research need, we use machine learning and adaptive statistical methods to optimize the ensemble design to capture the key sources of meteorological uncertainty specific to a region, period, and atmospheric release scenario. Without having to run a full ensemble, this methodology samples and iteratively learns about the atmospheric model physics options that affect plume predictions. Statistical methods are used to quantify the contributions to the ensemble variance in radiological deposition and recommend additional model physics configuration to run. This work will develop a computationally efficient and statistically robust method to provide probabilistic plume predictions for real-time consequence management and expert assessment of airborne radiological material.

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