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SHORT ABSTRACT

Calibrating ensemble predictions from the Jack Rabbit III international model inter-comparison exercise

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Abstract text *(maximum 350 words.)*

Structural uncertainty describes the discrepancy between a model and reality, and may arise through computational and observational limitations, model simplification, and genuine uncertainty about reality. The Jack Rabbit III (JRIII) international model inter-comparison exercise, which aims to inform the new JRIII trial design for large-scale releases of anhydrous ammonia, presents an opportunity to study the structural uncertainty in dispersion modelling. By combining a range of dispersion modelling approaches, including computational fluid dynamics, Gaussian puff, and integral models, within an ensemble framework, the uncertainty can be quantified and its impact can be minimized for downstream analysis and decision making.

Ideally, structural uncertainty is addressed within a Bayesian framework, through model selection/averaging (if the ensemble includes a sufficiently high-fidelity description of reality), or using Bayesian model stacking (when all models are misspecified to some degree). However, these approaches can require an inhibitive number of model runs. An alternative low burden approach is to post-process the point predictions from the individual models to form a probabilistic ensemble prediction. Typically, a mixture or regression model is constructed, with component weights optimized against historical data to improve predictive power and help quantify the structural uncertainty. The ability of ensemble methods to improve predictive power has long been recognized in weather forecasting and climate science, and recently has even been successfully applied to combine COVID-19 projections.

Here we evaluate the performance of Ensemble Model Output Statistics (EMOS) calculated from all available models to calibrate ensemble predictions for the centerline concentration of selected trials data. Dependent on sufficient data, we will also investigate the utility of EMOS with spatio-temporally varying weights (estimated via

strictly proper scoring rules), that reflect the different strengths of the alternative modelling approaches.

Motivation*

Structural uncertainty in models is an often overlooked source of error that can propagate to downstream analysis and decision making. Where predictions from multiple alternative models are available, ensemble methods allow this uncertainty to be quantified and minimized, while improving predictive power. The motivation for undertaking the current work is to understand how an ensemble approach could be used to improve the design of the future JRIII experiments, incorporating the results from the ongoing model inter-comparison exercise.

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