NCAR | ATMOSPHERIC CHEMISTRY OBSERVATIONS & MODELING

ACOM Seminar

Development of Spatiotemporal Physically-informed Top-Down NH_3 and NO_X Emissions over the U.S. using an AI Machine-Learning Inverse Modeling System with Observations.

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Link: https://operations.ucar.edu/live-acom

ABSTRACT

Timely accurate estimation of NH_3 and NO_X emissions plays a critical role in forming $PM_{2.5}$ concentrations in the atmosphere. While the bottom-up method can provide an averaged value, the satellite-based top-down methods can generate near-real-time constraints on emissions; however, the existing numerical models (e.g., chemical transport model, CTM) can be computationally expensive, and its efficiency can be largely limited by efforts in dealing with the complex emission-concentration response. However, the computational burden can be significantly improved with the use of a deep neural network trained with CTM simulations, note as DeepCTM. We apply this novel machine-learning-based method (DeepCTM) using a physically informed variational autoencoder (VAE) emission predictor to infer NH_3 emissions from satellite-retrieved and ground-based concentrations of NO_2 and NH_3. The VAE emission predictor has successfully implemented in NO_2 concentrations with the satellite-retrieved surface NO_2 concentrations. The proven interpretability of the VAE emission predictor will be applied using sensitivity analysis by modulating each feature, indicating that NH_3 and NO_2 concentrations and local meteorology are highly correlated for estimating NH_3 emissions. The advantages of the VAE emission predictor in efficiency, flexibility, and accuracy demonstrate its great potential in estimating the latest spatiotemporal emissions and its future applications.

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