



THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

PHD STUDENT SEMINAR

Multi-Scale Hourly NO_x Emission Inversion Using a Deep Learning Surrogate Framework

By

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Abstract

Accurate NO_x emission inventories at high spatiotemporal resolution are essential for air quality modeling and pollution control. In this talk, we present an emission inversion framework that couples the WRF-CAM_x modeling system with a temporal U-Net surrogate model. The surrogate learns the nonlinear response of surface NO₂ concentrations to NO_x emissions and meteorological conditions from multi-year CAM_x simulations. Grid-level hourly emissions are then updated through constrained gradient descent using surface NO₂ observations. The framework is applied across three nested domains (27, 9, and 3 km) covering East Asia to the Greater Bay Area (GBA) for 2017–2022. Spatial validation at held-out monitoring stations confirms consistent improvement in NO₂ simulation, with correlation coefficients increasing by 0.17-0.41 across all domains and seasons.

The inversion corrects both the magnitude and spatial distribution of prior emissions. At the regional scale, emissions in the North China Plain and East China are reduced while those in the Northwest and Southwest increase. Within the GBA, emissions are redistributed from core cities to peripheral cities. Over 2017-2022, grids in GBA with higher urban fraction exhibit declining emission trends, while less urbanized areas remain stable or increase slightly. The updated emissions show a unimodal diurnal profile peaking between 10:00 and 16:00 local time, consistent across all GBA cities and years.

Date : 27 April 2026, Monday

Time : 11:00am

Venue : Room 4475 (Lifts 25/26)

All are Welcome!