

AI/ML in Air Quality and Environmental Health

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HAQAST Madison
May 14, 2026

Overview

- Highlighting applications
 - Satellite data gap filling
 - Data fusion
 - Assessment of environmental impacts
- Considerations for AI/ML applications

Satellite Data Gap Filling

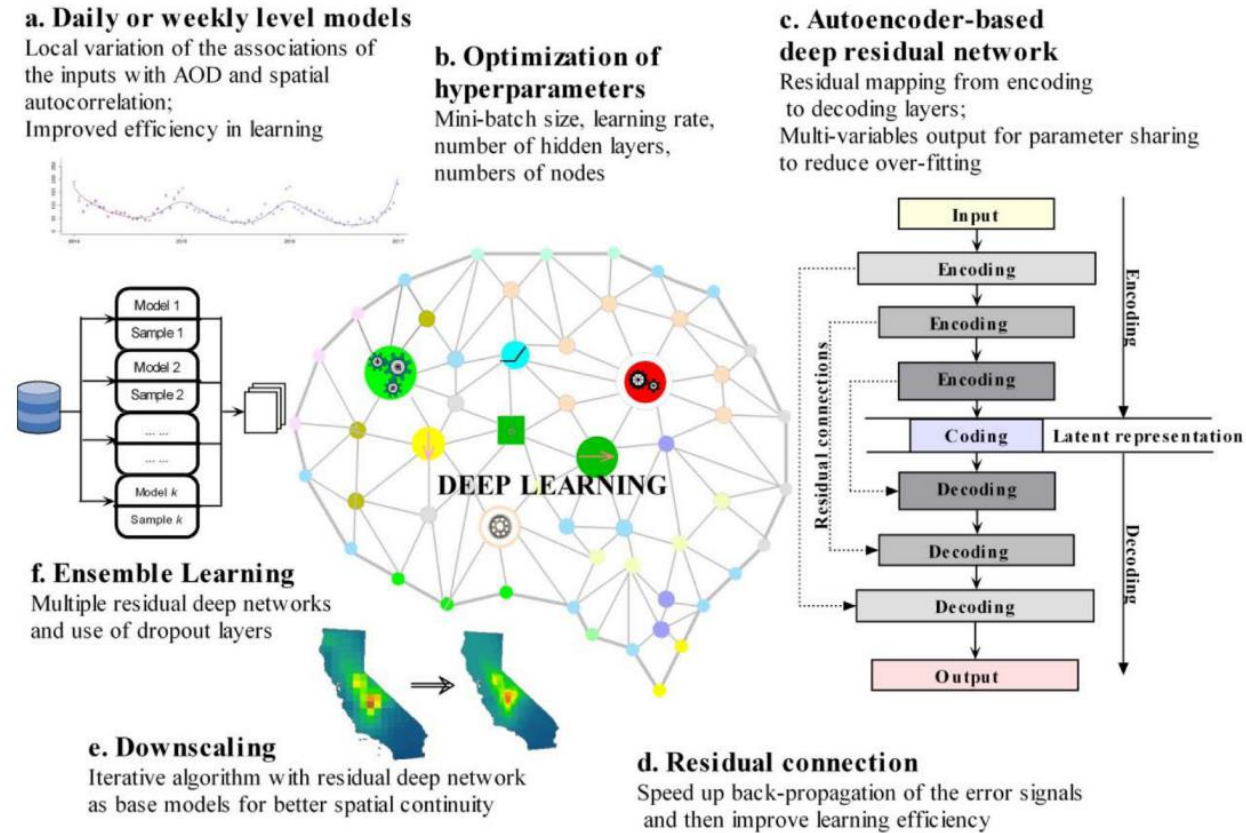


Fig. 3.
Autoencoder-based deep residual neural network modeling framework

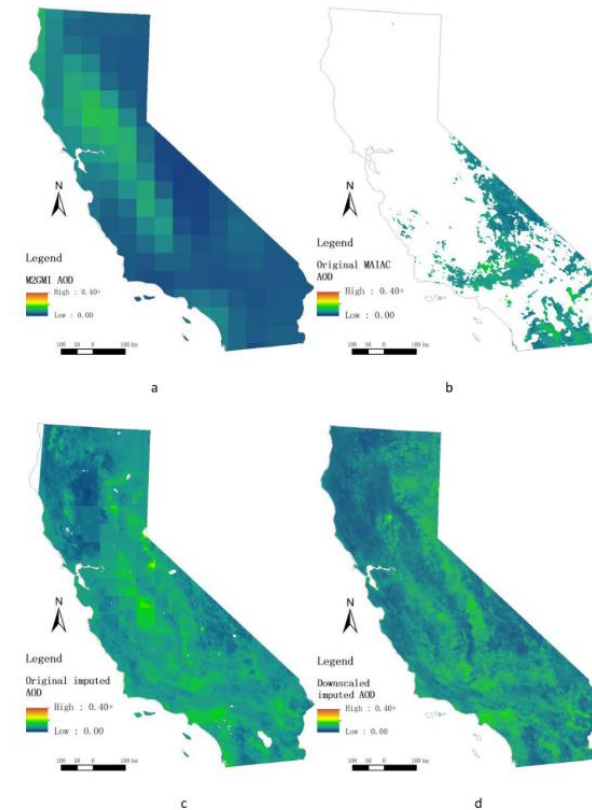
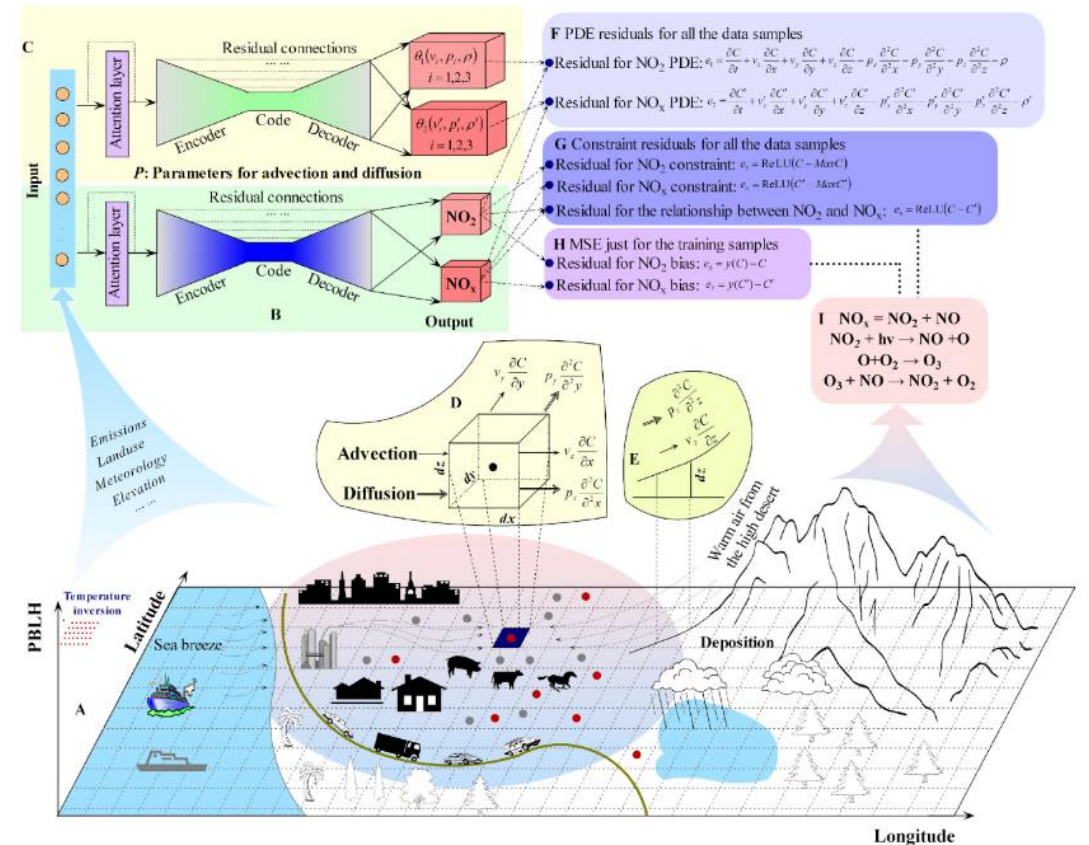
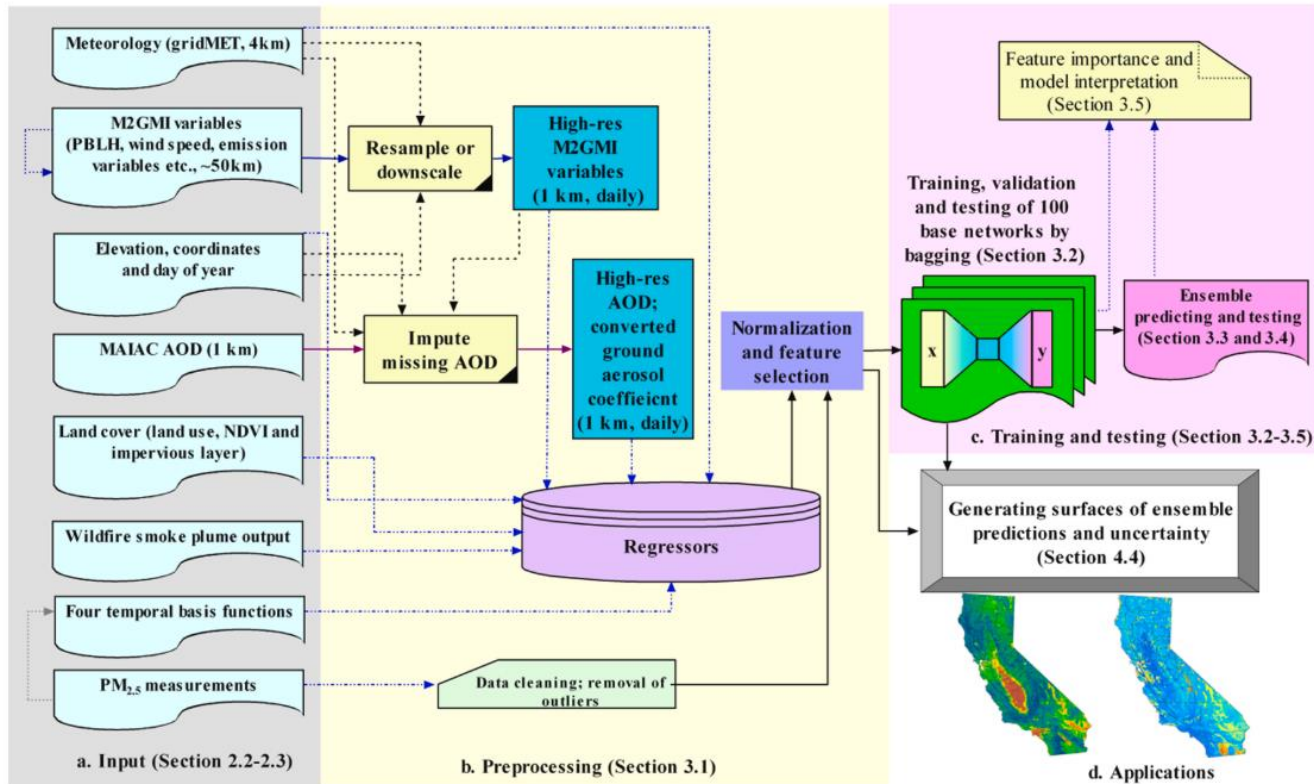


Fig. 9.
For a typical week (12/05/2016–12/11/2016), maps of grid surfaces of a) M2GMI AOD, b) MAIAC AOD with a significant proportion of missing observations, c) imputed MAIAC AOD with original 50 km M2GMI AOD, and d) imputed MAIAC AOD with downscaled 1 km M2GMI AOD

Li, L., Franklin, M., Girguis, M., Lurmann, F., Wu, J., Pavlovic, N., Breton, C., Gilliland, F. and Habre, R., 2020. Spatiotemporal imputation of MAIAC AOD using deep learning with downscaling. Remote sensing of environment, 237, p.111584.

High resolution estimation of pollution concentrations and wildfire smoke

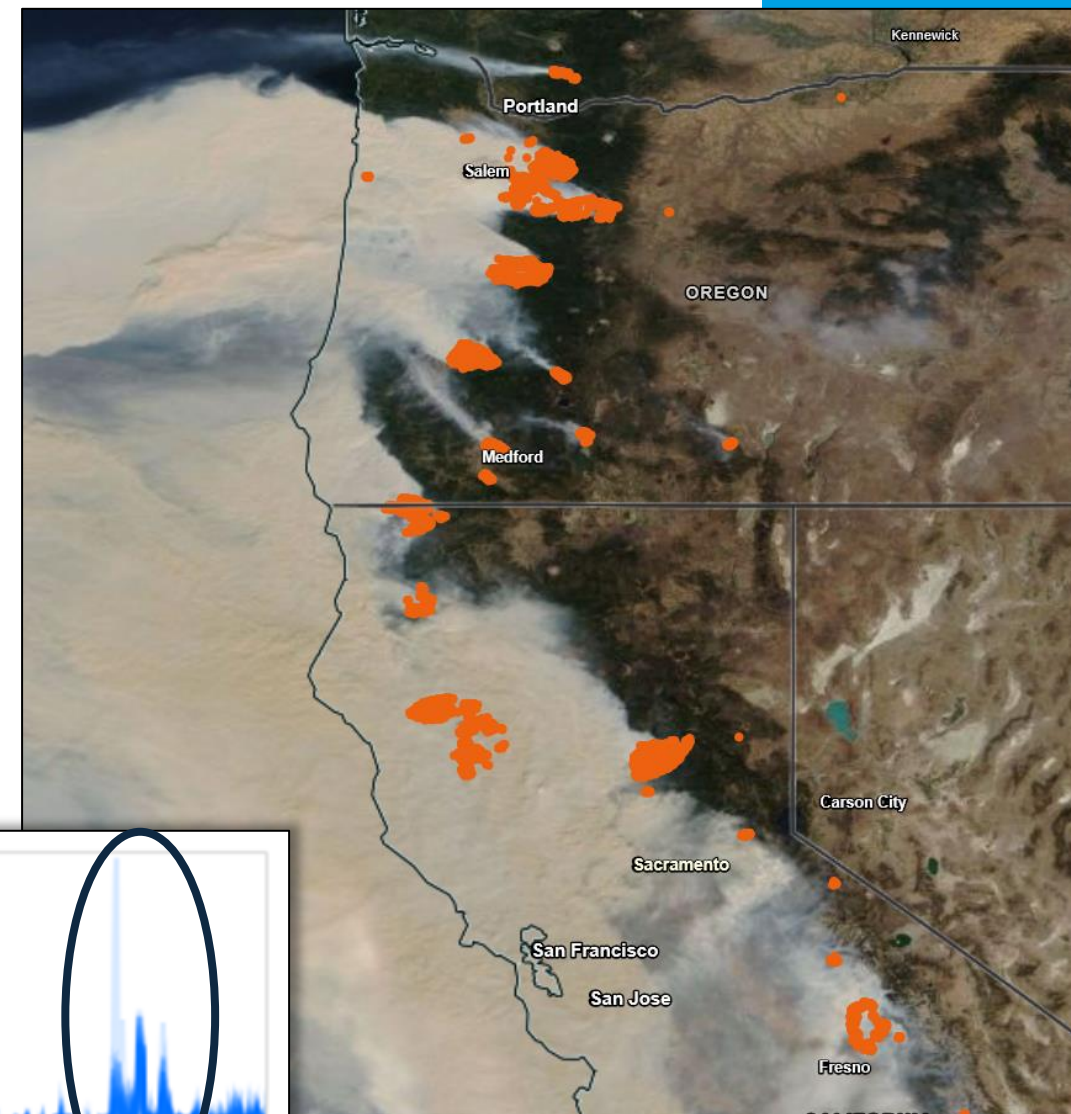
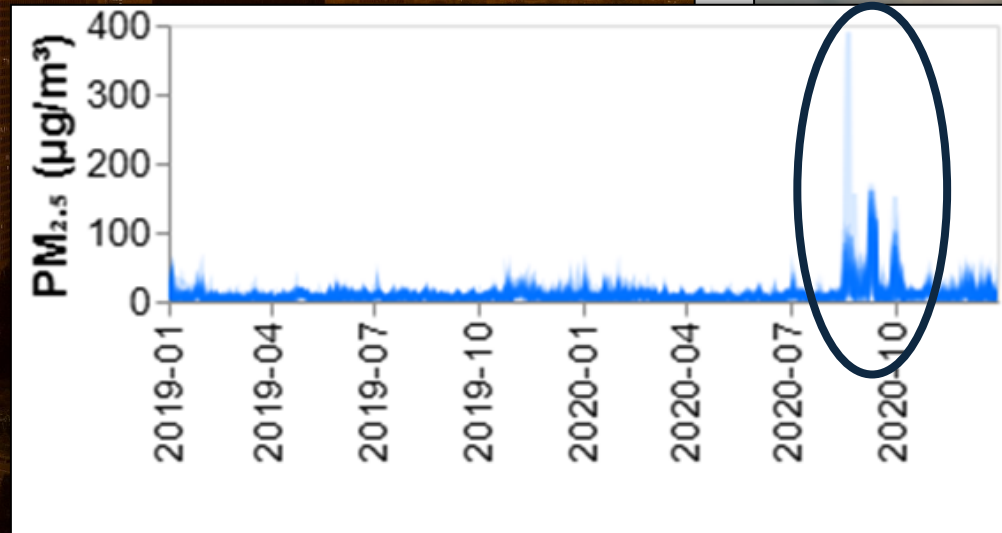
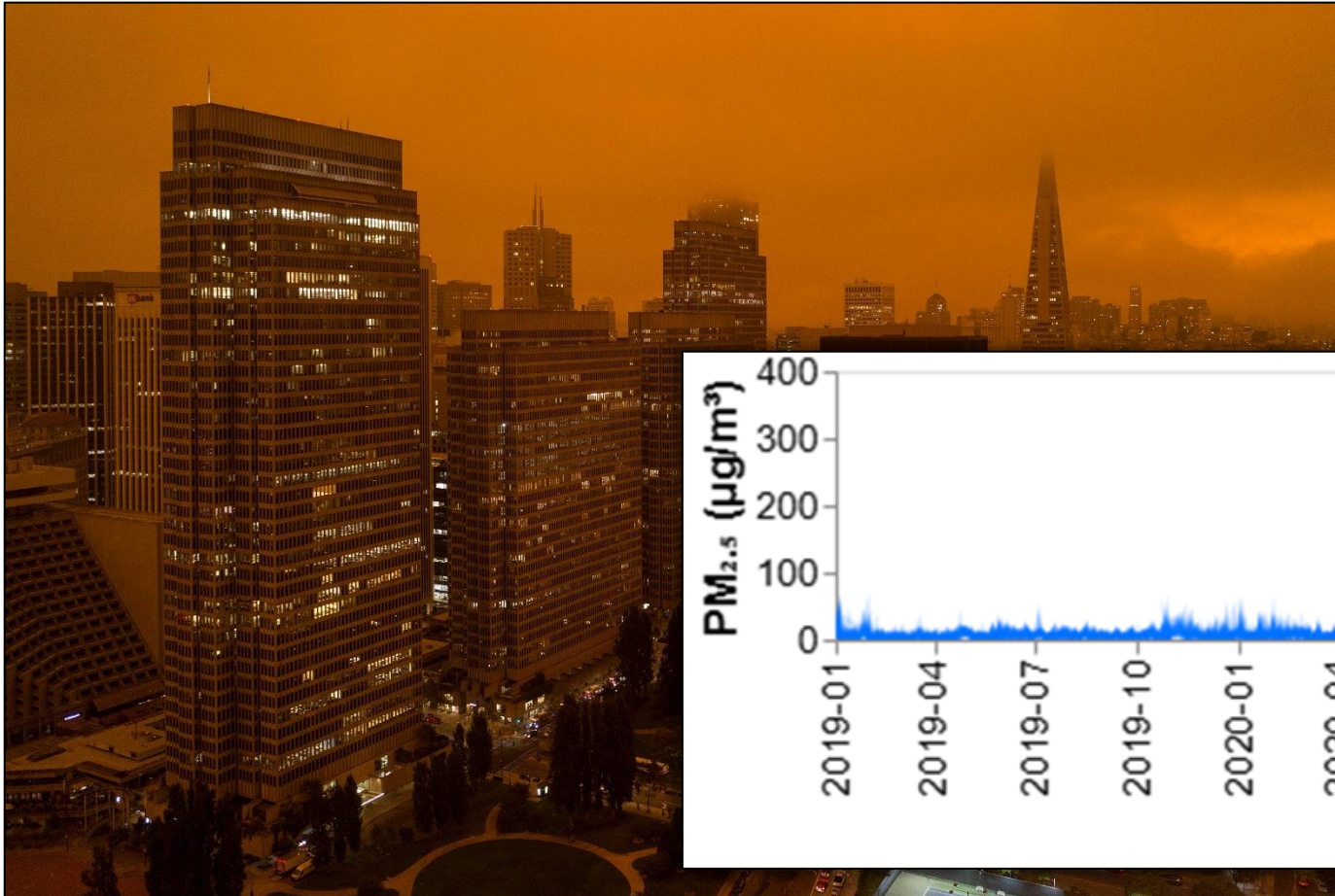


Li, L.; Girguis, M.; Lurmann, F.; Pavlovic, N.; McClure, C.; Franklin, M.; Wu, J.; Oman, L.D.; Breton, C.; Gilliland, F.; et al. Ensemble-Based Deep Learning for Estimating PM_{2.5} over California with Multisource Big Data Including Wildfire Smoke. *Environ. Int.* 2020, 145, 106143, doi:10.1016/j.envint.2020.106143.

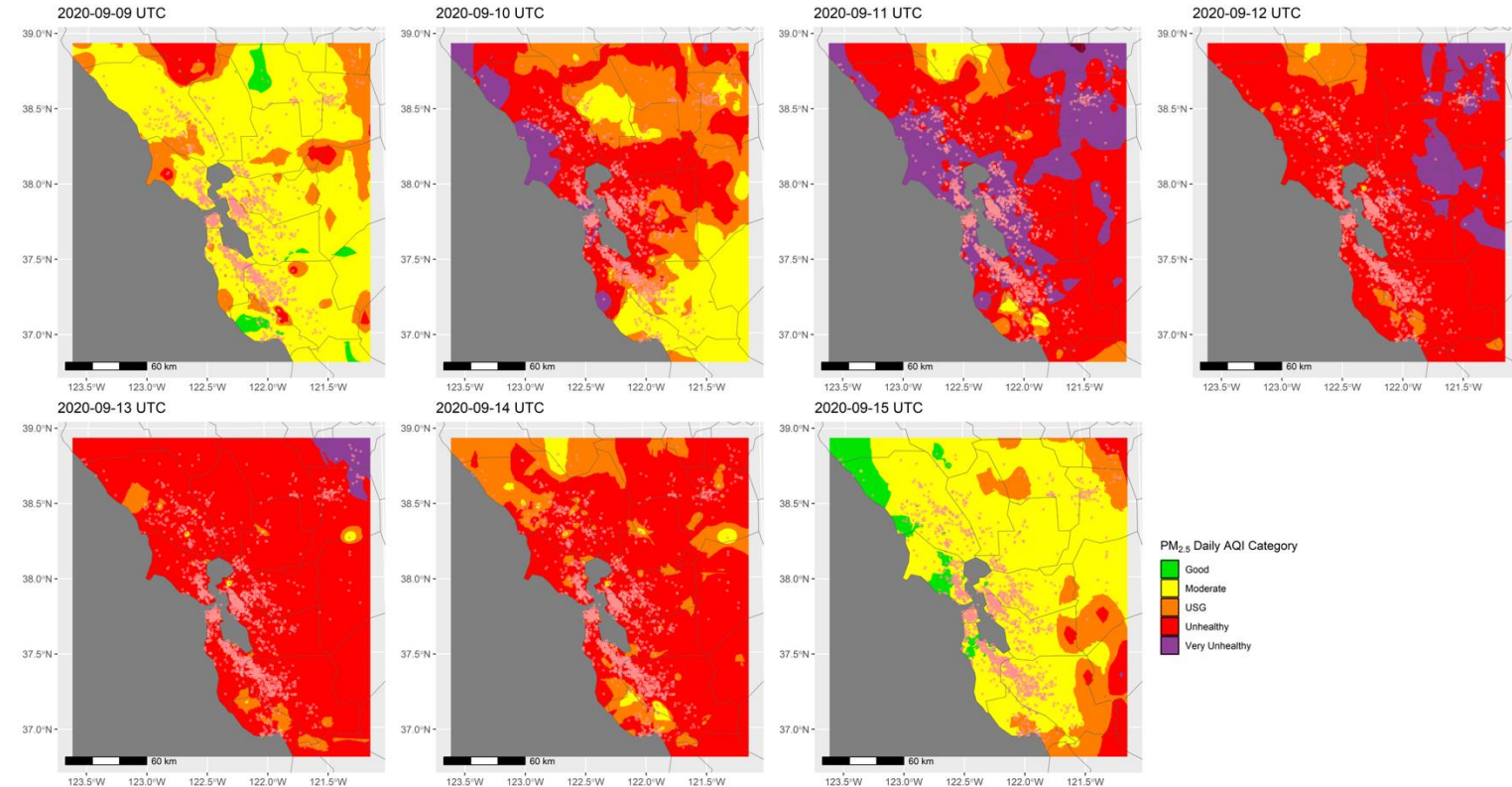
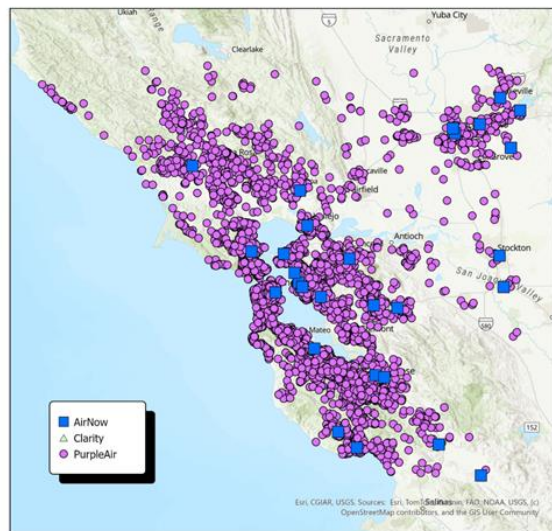
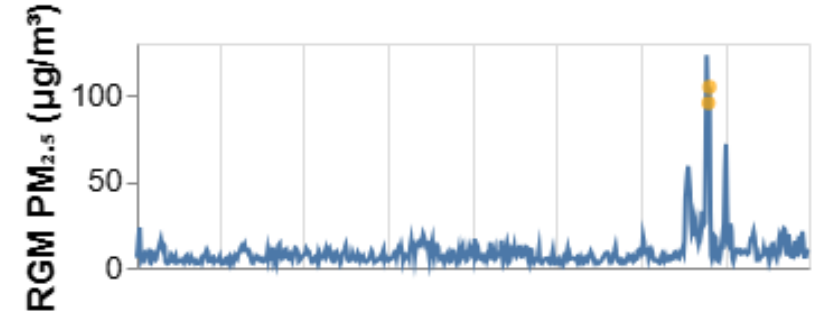
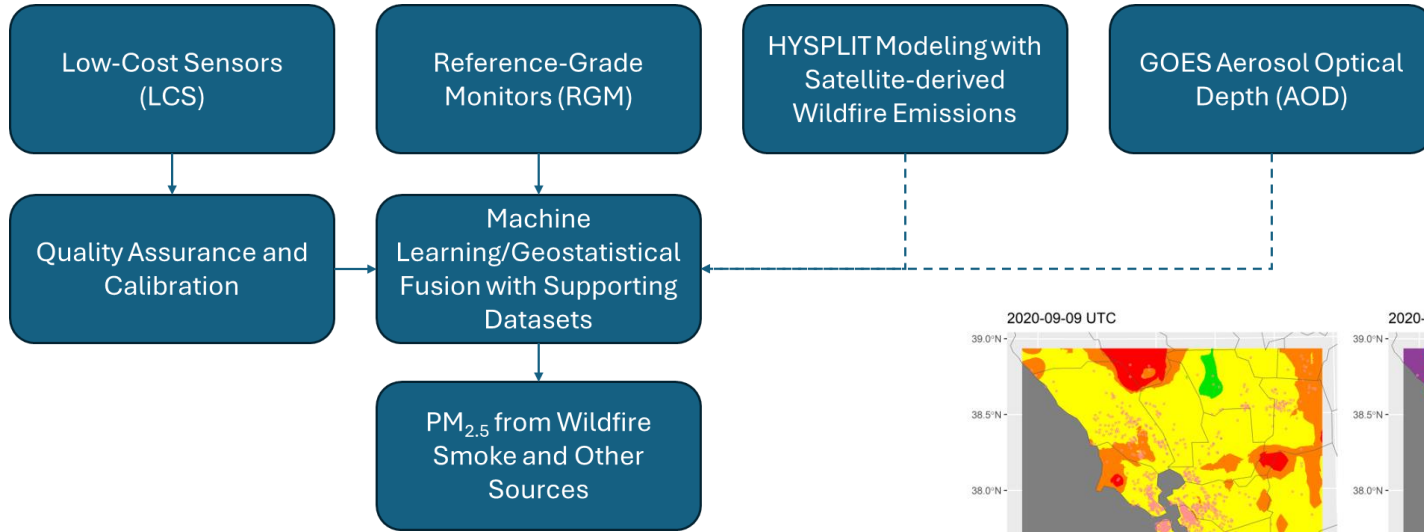
Li, L., Khalili, R., Lurmann, F., Pavlovic, N., Wu, J., Xu, Y., Liu, Y., O'Sharkey, K., Ritz, B., Oman, L. and Franklin, M., 2025. Knowledge-informed deep learning to mitigate bias in joint air pollutant prediction. *Environment international*, p.109915.

“Orange Sky Day” smoke impacts in San Francisco

Sept 9, 2020 (through Sept 14)



Machine learning estimation of wildfire smoke



Environmental Impact of Air Pollution

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Empirical nitrogen and sulfur critical loads of U.S. tree species and their uncertainties with machine learning

Nathan R. Pavlovic^{a,*}, Shih Ying Chang^a, Jiaoyan Huang^a, Kenneth Craig^a, Christopher Clark^b, Kevin Horn^c, Charles T. Driscoll^d

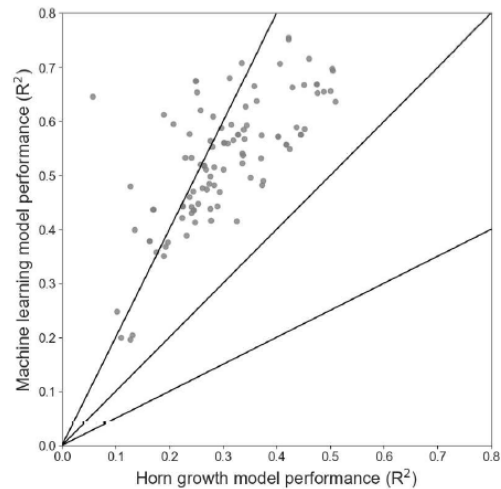


Fig. S2. Model performance comparison between the ML growth model and the performance of the parametric growth model reported by Horn et al. (6). Lower, middle, and upper solid lines indicate the 2:1, 1:1, and 1:2 lines, respectively.

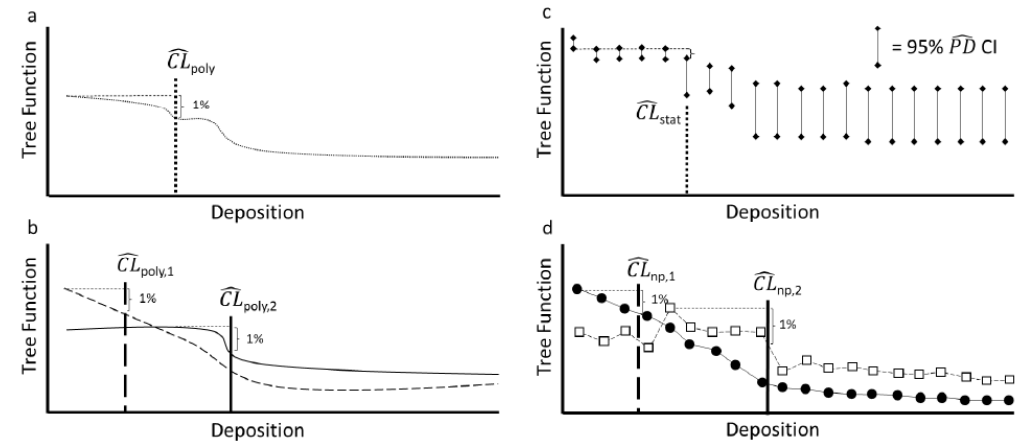
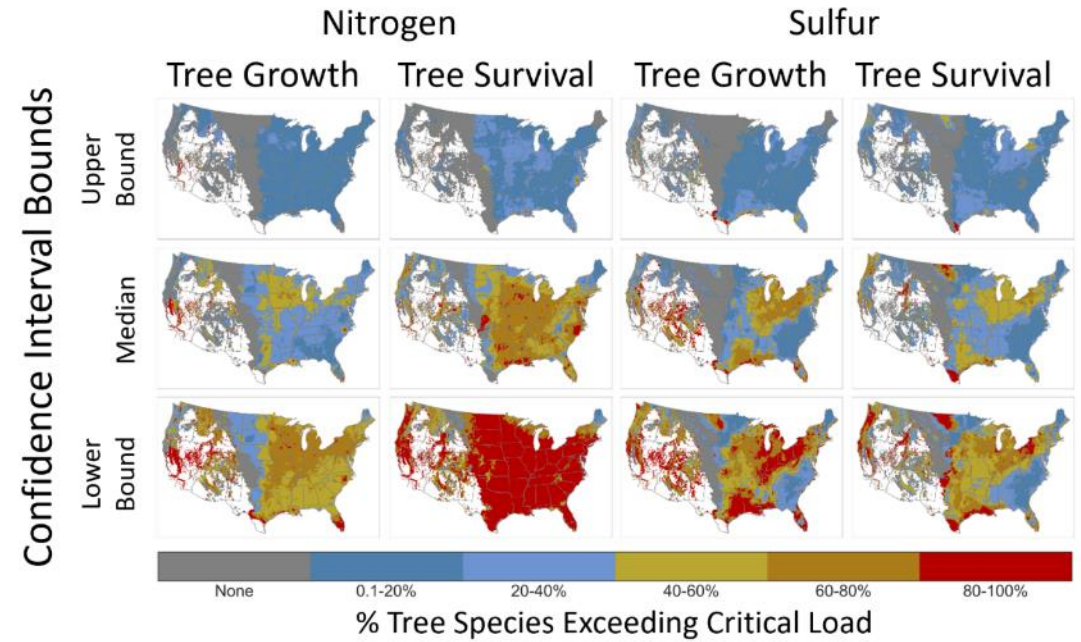


Fig. S4. Visual representation of the CL calculation for (a) $\widehat{CL}_{poly,x}$, (b) bootstrapped $\widehat{CL}_{poly,b}$, (c) bootstrapped \widehat{CL}_{stat} , and (d) bootstrapped $\widehat{CL}_{np,b}$. The curves in (a) and (b) represent polynomial fit curves, the bars in (c) represent the 95% CI of the bootstrapped \widehat{PD} , and the points in (d) represent \widehat{PD} estimates from individual bootstraps.

JGR Atmospheres

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Quantification of Ozone Exposure Impacts and Their Uncertainties on Growth and Survival of 88 Tree Species Across the United States

[Nathan R. Pavlovic](#) , [Shih Ying Chang](#), [Kenneth J. Craig](#), [Charles R. Scarborough](#), [Justin G. Coughlin](#), [Jeffrey D. Herrick](#), [Charles T. Driscoll](#)

First published: 17 June 2025 | <https://doi.org/10.1029/2024JD042000>

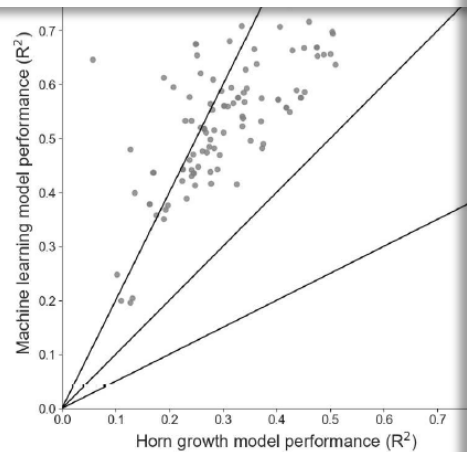
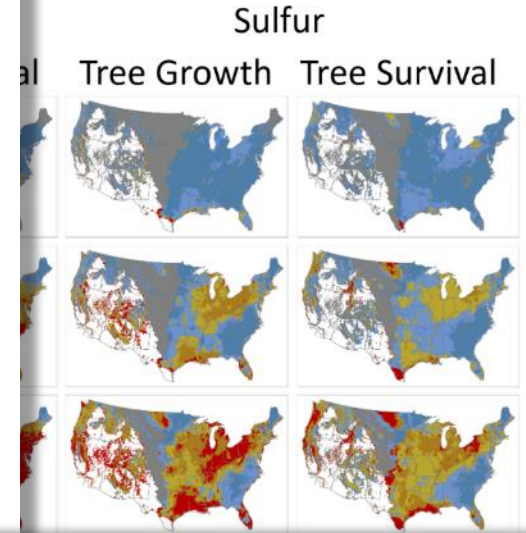


Fig. S2. Model performance comparison between the ML growth model and parametric growth model reported by Horn et al. (6). Lower, middle, and upper 1:1, and 1:2 lines, respectively.

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Characterizing localized nitrogen sensitivity of tree species and the associated influences of mediating factors

[Justin G. Coughlin](#), [Shih Ying Chang](#), [Kenneth Craig](#), [Charles Scarborough](#), [Charles T. Driscoll](#), [Christopher M. Clark](#), [Nathan R. Pavlovic](#)

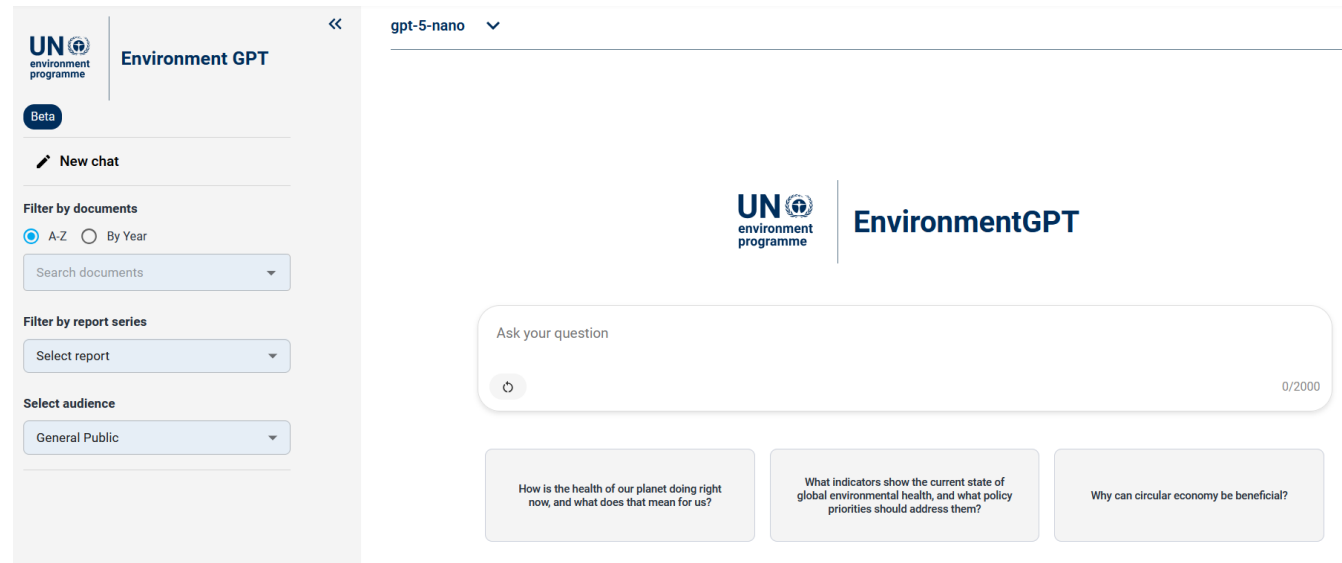
First published: 03 July 2024 | <https://doi.org/10.1002/ecs2.4925> |

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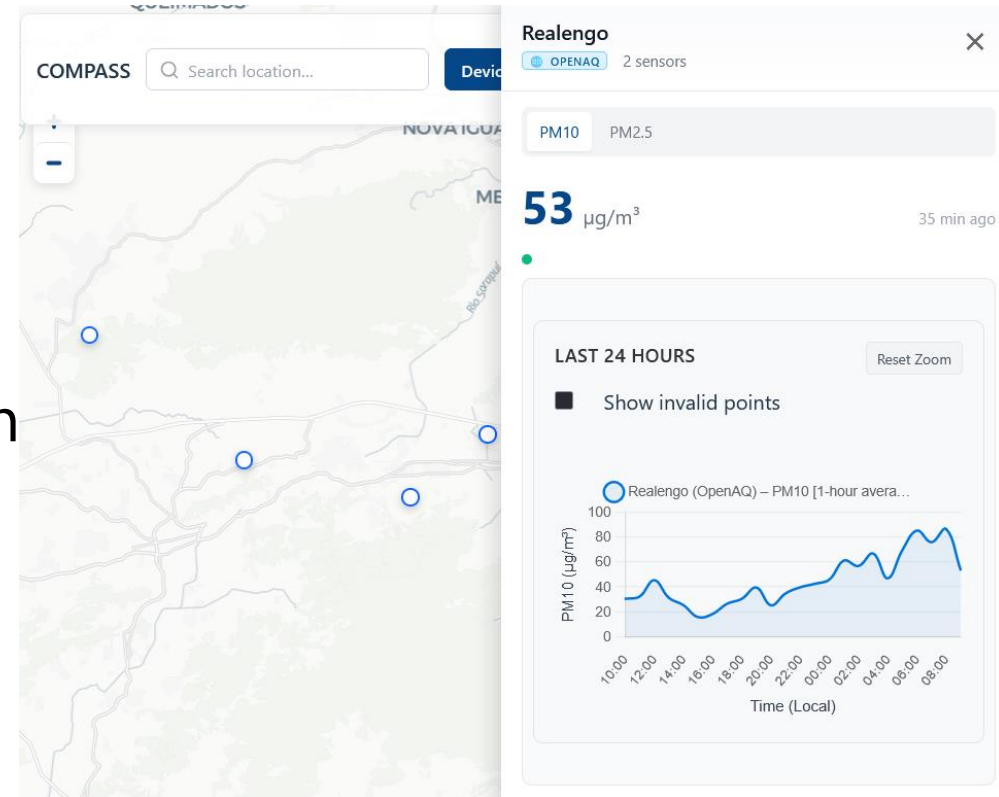
Considerations for AI/ML Applications

- **Emerging AI directions**
 - Knowledge-informed models
 - Model interpretation techniques
 - LLMs and multi-modal models
 - Foundation models and digital twins
 - Physical model emulation
- **Challenges**
 - Transferability
 - Trust and validation
 - Equity
 - Action and decision-making



Considerations for AI/ML Applications

- **Data quality, quantity, and representativeness are critical**
 - Satellite data provide important spatial coverage to applications
 - Ground (and other) measurements remain critical



Open-Source Data
Management System
<https://cleanaircompass.org/>





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