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Forecasting daily ozone air pollution across Europe with transformers

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Surface ozone is an air pollutant that contributes to hundreds of thousands of premature deaths annually. Accurate short-term ozone forecasts may allow improved policy actions to reduce the risk to health, such as accurate and timely air quality warnings. However, forecasting surface ozone is a difficult problem, as its concentrations are controlled by a number of physical and chemical processes which act on varying timescales. Accounting for these temporal dependencies appropriately is a promising avenue to provide more accurate ozone forecasts. We therefore implement a state-of-the-art transformer-based model, the Temporal Fusion Transformer, trained on observational data from three European countries. In four-day forecasts of daily maximum 8-hour ozone (DMA8), our novel approach is highly skilful (MAE = 4.9 ppb, coefficient of determination R^2 = 0.81), and generalises well to data from 13 European countries unseen during training (MAE = 5.0 ppb, R^2 = 0.78). The model outperforms standard machine learning models on our data, and compares favourably to the performance of other published deep learning architectures tested on different data. Furthermore, we illustrate that the model pays attention to physical variables known to control ozone concentrations, and that the attention mechanism allows the model to use relevant days of past ozone concentrations to make accurate forecasts.

ML method

Transformer

Main air pollutant of interest

Tropospheric ozone and precursors

Primary authors: ARCHIBALD, Alex; GRIFFITHS, Paul (National Centre for Atmospheric Science, Cambridge University); NOWACK, Peer; HICKMAN, Sebastian (Cambridge University)

Presenter: HICKMAN, Sebastian (Cambridge University)

Track Classification: Machine learning applications