A Comprehensive Spatiotemporal Model for Interpolation of Tropospheric Fine Particulate Matter Concentration

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PM2.5, particulate matter with an aerodynamic diameter less than 2.5 μm, contributes greatly to current cardiorespiratory complications. Hence, the importance of modeling and predicting PM2.5 concentrations has become increasingly salient in environmental discourse. While prior models consider multiple source pollutants, most fail to accurately depict the correlation between other sources of pollution, wind patterns, shear, and radial effectiveness. To create a spatiotemporal model, two main factors were combined: weights derived from pseudo-inverses of data matrices, and the direction of wind fields. We assumed that all data points, both existing and interpolated, followed the shape of a Gaussian kernel. Afterward, all interpolated points were physically graphed onto a vector field and manipulated as per the wind patterns in that portion of the field. The interpolated data quantitatively provides not only an exceptional degree of accuracy spatially but maintains such accuracy temporally, and as a proof of concept, we were able to use data from January 2017 to predict ambient PM2.5 concentration in March 2019. Qualitatively, the model accurately shows affected regions, providing the necessary context for improving ambient air quality management.

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