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A Tool for Public PM_{2.5}-Concentration Advisory Based on Mobile Measurements

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ABSTRACT

A tool was developed that interpolates mobile measurements of PM_{2.5}-concentrations into unmonitored areas of the Fairbanks nonattainment area for public air-quality advisory. The tool uses simulations with the Alaska adapted version of the Weather Research and Forecasting (WRF) and the Community Modeling and Analysis Quality (CMAQ) modeling system as a database. The tool uses the GPS-data of the vehicle's route, and the database to determine linear regression equations for the relationships between the PM_{2.5}-concentrations at the locations on the route and those outside the route. Once the interpolation equations are determined, the tool uses the mobile measurements as input into these equations that interpolate the measurements into the unmonitored neighborhoods. An episode of winter 2009/10 served as database for the tool's interpolation algorithm. An independent episode of winter 2010/11 served to demonstrate and evaluate the performance of the tool. The evaluation showed that the tool well reproduced the spatial distribution of the observed as well as simulated concentrations. It is demonstrated that the tool does not require a database that contains data of the episode for which the interpolation is to be made. Potential challenges in applying this tools and its transferability are discussed critically.

KEYWORDS

WRF; CMAQ; PM2.5; Air Quality; Interpolation; Arctic

Cite this paper

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References

- [1] H. N. Q. Tran and N. Molders, " Investigations on Meteorological Conditions for Elevated PM2.5 in Fairbanks, Alaska," *Atmospheric Research*, Vol. 99, No. 1, 2011, pp. 39-49. doi: 10.1016/j.atmosres.2010.08.028
- [2] D. W. Wong, L. Yuan and S. A. Perlin, " Comparison of Spatial Interpolation Methods for the Estimation of Air Quality Data," *Journal of Exposure Analysis and Environmental Epidemiology*, Vol. 14, No. 5, 2004, pp. 404-415. doi: 10.1038/sj.jea.7500338
- [3] J. A. Mulholland, A. J. Butler, J. G. Wilkinson and A. G. Russell, " Temporal and Spatial Distributions of Ozone in Atlanta: Regulatory and Epidemiologic Implications," *Journal of Air & Waste Management Association*, Vol. 48, No. 5, 1998, pp. 418-426. doi: 10.1080/10473289.1998.10463695
- [4] D. Pai Mazumder and N. Molders, " Theoretical Assessment of Uncertainty in Regional Averages Due to Network Density and Design," *Journal of Applied Meteorology and Climate*, Vol. 48, No. 8, 2009, pp. 1643-1666.
- [5] J. F. Clarke, E. S. Edgerton and B. E. Martin, " Dry Deposition Calculations for the Clean Air Status and Trends Network," *Atmospheric Environment*, Vol. 31, No. 21, 1997, pp. 3667-3678. doi: 10.1016/S1352-2310(97)00141-6

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- [6] M. Fuentes and A. E. Raftery, " Model Evaluation and Spatial Interpolation by Bayesian Combination of Observations with Outputs from Numerical Models," *Biometrics*, Vol. 61, No. 1, 2005, pp. 36-45. doi:10.1111/j.0006-341X.2005.030821.x
- [7] S. E. Peckham, J. D. Fast, R. Schmitz, G. A. Grell, W. I. Gustafson, S. A. McKeen, S. J. Ghan, R. Zaveri, R. C. Easter, J. Barnard, E. Chapman, M. Salzmann, C. Wiedinmyer and S. R. Freitas, " WRF/Chem Version 3.1 User' s Guide," 2009. http://ruc.noaa.gov/wrf/WG11/Users_guide.pdf
- [8] D. W. Byun and K. L. Schere, " Review of the Governing Equations, Computational Algorithms, and Other Components of the Models-3 Community Multiscale Air Quality (CMAQ) Modeling System," *Applied Mechanics Reviews*, Vol. 59, No. 2, 2006, pp. 51-77. doi:10.1115/1.2128636
- [9] N. M?lders and K. Leelasakultum, " CMAQ Modeling: Final Report Phase I," 2011, p. 62.
- [10] B. J. Gaudet and D. R. Stauffer, " Stable Boundary Layers Representation in Meteorological Models in Extremely Cold Wintertime Conditions," Report to the US Environmental Protection Agency, 2010, p. 60.
- [11] S.-Y. Hong and J.-O. J. Lim, " The WRF Single-Moment 6-Class Microphysics Scheme (WSM)," *Journal Korean Meteorological Society*, Vol. 42, No. 2, 2006, pp. 129-151.
- [12] G. A. Grell and D. Dévényi, " A Generalized Approach to Parameterizing Convection Combining Ensemble and Data Assimilation Techniques," *Geophysical Research Letters*, Vol. 29, No. 14, 1693, 2002, p. 4.
- [13] M.-D. Chou and M. J. Suarez, " An Efficient Thermal Infrared Radiation Parameterization for Use in General Circulation Models," *NASA—Technical Memorandum*, Vol. 3, No. 3, 1994, p. 85.
- [14] E. J. Mlawer, S. J. Taubman, P. D. Brown, M. J. Iacono and S. A. Clough, " Radiative Transfer for Inhomogeneous Atmospheres: Rrtm, a Validated Correlated-K Model for the Longwave," *Journal of Geophysical Research*, Vol. 102, No. D14, 1997, pp. 16663-16682. doi:10.1029/1997JD00237
- [15] J. Barnard, J. Fast, G. Paredes-Miranda, W. Arnott and A. Laskin, " Technical Note: Evaluation of the WRF-Chem ' Aerosol Chemical to Aerosol Optical Properties' Module Using Data from the Milagro Campaign," *Atmospheric Chemistry and Physics*, Vol. 10, No. 15, 2010, pp. 7325-7340. doi:10.5194/acp-10-7325-2010
- [16] Z. I. Janji?, " The Step-Mountain Eta Coordinate Model: Further Developments of the Convection, Viscous Sublayer and Turbulence Closure Schemes," *Monthly Weather Review*, Vol. 122, No. 5, 1994, pp. 927-945. doi:10.1175/1520-0493(1994)122<0927:TSMECM>2.0.CO;2
- [17] T. G. Smirnova, J. M. Brown, S. G. Benjamin and D. Kim, " Parameterization of Cold Season Processes in the Maps Land-Surface Scheme," *Journal of Geophysical Research*, Vol. 105, No. D3, 2000, pp. 4077-4086. doi:10.1029/1999JD901047
- [18] N. M?lders and G. Kramm, " Influence of Wildfire Induced Land-Cover Changes on Clouds and Precipitation in Interior Alaska—A Case Study," *Atmospheric Research*, Vol. 84, No. 2, 2007, pp. 142-168. doi:10.1016/j.atmosres.2006.06.004
- [19] N. M?lders and G. Kramm, " A Case Study on Wintertime Inversions in Interior Alaska with WRF," *Atmospheric Research*, Vol. 95, No. 2-3, 2010, pp. 314-332. doi:10.1016/j.atmosres.2009.06.002
- [20] D. W. Byun, J. E. Pleim, R. T. Tang and A. Bourgeois, " Science Algorithms of the Epa Models-3 Community Multiscale Air Quality (CMAQ) Modeling System— Chapter 12: Meteorology-Chemistry Interface Processor (MCIP) for CMAQ Modeling System," Technical Report to US Environmental Protection Agency, 1999, p. 91.
- [21] G. Yarwood, S. Rao, M. Yocke and G. Z. Whitten, " Updates to the Carbon Bond Chemical Mechanism: CB05," Final Report to the US Environmental Protection Agency, 2005. <http://www.camx.com>
- [22] F. S. Binkowski and S. J. Roselle, " Models-3 Community Multiscale Air Quality (CMAQ) Model Aerosol Component, 1, Model Description," *Journal of Geophysical Research*, Vol. 108, No. D6, 2003, p. 18. doi:10.1029/2001JD001409
- [23] J. S. Chang, R. A. Brost, I. S. A. Isaksen, S. Madronich, P. Middleton, W. R. Stockwell and C. J. Walcek, " A Three-Dimensional Euleadan Acid Deposition Model: Physical Concepts and Formulation," *Journal Geophysical Research*, Vol. 92, No. D12, 1987, pp. 14,681-14,700. doi:10.1029/JD092iD12p14681
- [24] B. Schell, I. J. Ackermann, H. Hass, F. S. Binkowski and A. Ebel, " Modeling the Formation of Secondary Organic Aerosol within a Comprehensive Air Quality Model System," *Journal of*

- [25] R. J. Yamartino, " Nonnegative, Conserved Scalar Transport Using Grid-Cell-Centered, Spectrally Constrained Blackman Cubics for Applications on a Variable-Thickness Mesh," *Monthly Weather Review*, Vol. 121, No. 3, 1993, pp. 753-763. doi:10.1175/1520-0493
- [26] J. E. Pleim and J. S. Chang, " A Non-Local Closure Model for Vertical Mixing in the Convective Boundary Layer," *Atmospheric Environment*, Vol. 26A, No. 6, 1992, pp. 965-981.
- [27] N. Molders, H. N. Q. Tran, P. Quinn, K. Sassen, G. E. Shaw and G. Kramm, " Assessment of WRF/Chem to Simulate Sub-Arctic Boundary Layer Characteristics During Low Solar Irradiation Using Radiosonde, Sodar, and Surface Data," *Atmospheric Pollution Research*, Vol. 2, 2011, pp. 283-299. doi:10.5094/APR.2011.035
- [28] N. Molders, H. N. Q. Tran, C. F. Cahill, K. Leelasakultum and T. T. Tran, " Assessment of WRF/Chem PM_{2.5}-Forecasts Using Mobile and Fixed Location Data from the Fairbanks, Alaska Winter 2008/09 Field Campaign," *Atmospheric Pollution Research*, Vol. 3, 2012, pp. 180-191. doi:10.5094/APR.2012.018
- [29] C. J. Coast, Jr., " High-Performance Algorithms in the Sparse Matrix Operator Kernel Emissions (Smoke) Modeling System," *Ninth AMS Joint Conference on Applications of Air Pollution Meteorology with A&WMA*, 1996, pp. 584-588.
- [30] M. R. Houyoux, J. M. Vukovich, C. J. Coats, N. J. M. Wheeler and P. S. Kasibhatla, " Emission Inventory Development and Processing for the Seasonal Model for Regional Air Quality (Smraq) Project," *Journal of Geophysical Research*, Vol. 105, No. D7, 2000, pp. 9079-9090. doi:10.1029/1999JD900975
- [31] N. Molders, H. N. Q. Tran and K. Leelasakultum, " Investigation of Means for PM_{2.5} Mitigation through Atmospheric Modeling—Final Report," 2011, p. 75.
- [32] C. F. Cahill, " Asian Aerosol Transport to Alaska during ACE-Asia," *Journal of Geophysical Research*, Vol. 108, No. 8664, 2003, p. 8.
- [33] T. T. Tran, G. Newby and N. Molders, " Impacts of Emission Changes on Sulfate Aerosols in Alaska," *Atmospheric Environment*, Vol. 45, No. 18, 2011, pp. 3078-3090. doi:10.1016/j.atmosenv.2011.03.013
- [34] H. von Storch and F. W. Zwiers, " *Statistical Analysis in Climate Research*," Cambridge University Press, Cambridge, 1999.
- [35] J. C. Chang and S. R. Hanna, " Air Quality Model Performance Evaluation," *Meteorology and Atmospheric Physics*, Vol. 87, No. 1-3, 2004, pp. 167-196. doi:10.1007/s00703-003-0070-7
- [36] J. W. Boylan and A. G. Russell, " PM and Light Extinction Model Performance Metrics, Goals, and Criteria for Three-Dimensional Air Quality Models," *Atmospheric Environment*, Vol. 40, No. 26, 2006, pp. 4946-4959. doi:10.1016/j.atmosenv.2005.09.087
- [37] J. Devore, " *Probability and Statistics for Engineering and the Sciences*," 6th Edition, Brooks/Cole, Belmont, 2004.
- [38] S. Weisberg, " *Applied Linear Regression*," 3rd Edition, Wiley, New York, 2005. doi:10.1002/0471704091
- [39] Y. Zhang, M. K. Dubey, S. C. Olsen, J. Zheng and R. Zhang, " Comparisons of WRF/Chem Simulations