Documentation for the Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD), 1998-2019, V4.GL.03

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Abstract

The Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD), 1998-2019, V4.GL.03 consists of annual concentrations (micrograms per cubic meter) of all composition ground-level fine particulate matter (PM2.5). This data set combines AOD retrievals from multiple satellite algorithms including the NASA MODerate resolution Imaging Spectroradiometer Collection 6.1 (MODIS C6.1), Multi-angle Imaging SpectroRadiometer Version 23 (MISRv23), MODIS Multi-Angle Implementation of Atmospheric Correction Collection 6 (MAIAC C6), and the Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) Deep Blue Version 4. The GEOS-Chem chemical transport model is used to relate this total column measure of aerosol to near-surface PM2.5 concentration. Geographically Weighted Regression (GWR) is used with global ground-based measurements from the World Health Organization (WHO) database to predict and adjust for the residual PM2.5 bias per grid cell in the initial satellite-derived values.

These estimates are primarily intended to aid in large-scale studies. Gridded data sets are provided at a resolution of 0.01 degrees to allow users to agglomerate data as best meets their particular needs. Data sets are gridded at the finest resolution of the information sources that were incorporated, but do not fully resolve PM2.5 gradients at the gridded resolution due to influence by information sources at coarser resolution. The data are distributed as GeoTIFF files and are in WGS84 projection.

Data set citation: Hammer, M. S., A. van Donkelaar, C. Li, A. Lyapustin, A. M. Sayer, N. C. Hsu, R. C. Levy, M. J. Garay, O. V. Kalashnikova, R. A. Kahn, M. Brauer, J. S. Apte, D. K. Henze, L. Zhang, Q. Zhang, B. Ford, J. R. Pierce, and R. V. Martin. 2022. Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD), 1998-2019, V4.GL.03. Palisades NY: NASA Socioeconomic Data and Applications Center. https://doi.org/10.7927/fx80-4n39. Accessed DAY MONTH YEAR.

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We appreciate feedback regarding this data set, such as suggestions, discovery of errors, difficulties in using the data, and format preferences. Please contact:

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I. Introduction

The Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD), 1998-2019, V4.GL.03 data set utilizes NASA's MODIS C6.1, MISR v23, MAIAC C6, and SeaWiFS Optical Aerosol Depth (AOD) data to produce a collection of 22 gridded data files of annual concentrations (micrograms per cubic meter) of all composition ground-level fine particulate matter (PM2.5). There is one grid for each year for the period 1998 to 2019, at a spatial resolution of 0.01 degrees (i.e., grid cells 1.1 km on a side at the equator). The annual estimates were generated following a Geographically Weighted Regression (GWR) technique (van Donkelaar et al., 2016). The grids were developed from the ASCII data files for each year in Esri ArcGIS.

II. Data and Methodology

A detailed description of the methodology is provided in Hammer et al. (2020) available at: https://doi.org/10.1021/acs.est.0c01764.

Detailed description of satellite AOD sources, GEOS-Chem simulation, and the algorithm for calculating PM2.5 estimates is available at: https://pubs.acs.org/doi/suppl/10.1021/acs.est.0c01764/suppl_file/es0c01764_si_001.pdf.

CIESIN converted All Composition Satellite-Derived PM2.5, at 35% RH [ug/m3] at 0.01° × 0.01° w/GWR adjustment [.asc.zip] to GeoTIFF for the years 1998 to 2019.

III. Data Set Description(s)

Data set description:
The PM2.5 grids consist of concentrations (micrograms per cubic meter) of all composition ground-level fine particulate matter (PM2.5) per 0.01 degree grid cells for each of the twenty-two years for the period 1998 to 2019.

Data set web page:
SEDAC URL: https://sedac.ciesin.columbia.edu/data/set/sdei-global-annual-gwr-pm2-5-modis-misr-seawifs-aod-v4-gl-03
Permanent URL: https://doi.org/10.7927/fx80-4n39

Data set format:
The data are available in GeoTIFF format as downloadable zip files. Each downloadable is a compressed zip file containing: 1) GeoTIFF for the year, and 2) PDF documentation.

Data set downloads:
sdei-global-annual-gwr-pm2-5-modis-misr-seawifs-aod-v4-gl-03-YYYY-geotiff.zip

where YYYY are years 1998 through 2019.

IV. How to Use the Data

The raster data in GeoTIFF format can be used directly in mapping and geospatial analysis.

V. Potential Use Cases

Prior versions of these data have been used extensively in public health applications, especially in conjunction with population data to estimate exposure levels.

VI. Limitations

The current data set has all composition PM2.5 concentration values for the benefit of researchers focusing on anthropogenic sources of PM2.5. However, there is higher uncertainty in the PM2.5 values in regions (especially Central Asia and North Africa) with high contributions from mineral dust, mostly a result of sparse ground-based monitoring and challenging conditions for measurement retrieval and simulation. Hence, there are higher degrees of uncertainty in these regions compared to other parts of the world, even after excluding the natural sources.

Note that these estimates are primarily intended to aid in broad area studies. Gridded data sets are provided to allow users to aggregate data to spatial units that suit their needs. Data sets are gridded at the finest resolution of the information sources that were incorporated. These data are not intended for studies examining intra-urban differentials in PM2.5, for example, or other small area research. In situ data are more appropriate at those scales.

VII. Acknowledgments

Funding for dissemination of this data set was provided under the U.S. National Aeronautics and Space Administration (NASA) contract 80GSFC18C0111 for the continued operation of the Socioeconomic Data and Applications Center (SEDAC), which is operated by the Center for International Earth Science Information Network (CIESIN) of Columbia University.

VIII. Disclaimer

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IX. Use Constraints

X. Recommended Citation(s)

Data set(s):

Hammer, M. S., A. van Donkelaar, C. Li, A. Lyapustin, A. M. Sayer, N. C. Hsu, R. C. Levy, M. J. Garay, O. V. Kalashnikova, R. A. Kahn, M. Brauer, J. S. Apte, D. K. Henze, L. Zhang, Q. Zhang, B. Ford, J. R. Pierce, and R. V. Martin. 2022. Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD), 1998-2019, V4.GL.03. Palisades NY: NASA Socioeconomic Data and Applications Center. https://doi.org/10.7927/fx80-4n39. Accessed DAY MONTH YEAR.

Scientific publication:

Hammer, M. S., A. van Donkelaar, C. Li, A. Lyapustin, A. M. Sayer, N. C. Hsu, R. C. Levy, M. J. Garay, O. V. Kalashnikova, R. A. Kahn, M. Brauer, J. S. Apte, D. K. Henze, L. Zhang, Q. Zhang, B. Ford, J. R. Pierce, and R. V. Martin. 2020. Global Estimates and Long-Term Trends of Fine Particulate Matter Concentrations (1998–2018). Environmental Science & Technology 54 (13): 7879–7890. https://doi.org/10.1021/acs.est.0c01764.

XI. Source Code

No source code is provided.

XII. References

Hammer, M. S., A. van Donkelaar, C. Li, A. Lyapustin, A. M. Sayer, N. C. Hsu, R. C. Levy, M. J. Garay, O. V. Kalashnikova, R. A. Kahn, M. Brauer, J. S. Apte, D. K. Henze, L. Zhang, Q. Zhang, B. Ford, J. R. Pierce, and R. V. Martin. 2020. Global Estimates and Long-Term Trends of Fine Particulate Matter Concentrations (1998–2018)**.** *Environmental Science & Technology* 54 (13): 7879–7890. https://doi.org/10.1021/acs.est.0c01764.

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XIII. Documentation Copyright and License

Appendix 1. Data Revision History

No revisions have been made to this data set. However, it supersedes the Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD) with GWR, 1998−2016 data set.

Appendix 2. Contributing Authors & Documentation Revision History

Revision Date	ORCID	Contributors	Revisions
January 11, 2022	0000-0002-8875-4864	T. Chai-Onn, A. de Sherbinin	This document is the 1st instance of documentation.