Patrick C. Campbell, Ph.D., CCM

Research Associate Professor

PERSONAL DETAILS

George Mason University

Cooperative Institute for Satellite Earth System Studies (CISESS)

Center for Satellite and Earth Science Research (CSER)

ARL/NOAA Affiliate

College Park, MD

T: 301-683-1392
M: 307-760-5178
E: pcampbe8@gmu.edu

Portfolio Websites:
www.campbellairquality.com
https://orcid.org/0000-0003-0987-8402
https://www.researchgate.net/profile/Patrick-Campbell-13

AREAS OF EXPERTISE

Air Quality Modeling

Meteorological/Climate Modeling

Land Surface/Flux Modeling

Chemistry and Aerosol Formation

Emissions Processing and Modeling

Ambient Air Measurements and Instrumentation

PERSONAL SUMMARY

"I have a driven and diverse research to application background across areas of atmospheric science focused on photochemical-meteorological modeling of the atmosphere and its constituents for emission, air quality, and climate change studies."

Patrick C. Campbell

BIOSKETCH

I am an atmospheric scientist and research associate professor and associate director at the George Mason University (GMU) Center for Satellite and Earth Science Research (CSER). I am also a NOAA Air Resources Laboratory Affiliate under the Cooperative Institute for Satellite Earth System Studies (CISESS). I work closely with the NOAA-Air Resources Laboratory Chemical Modeling and Emissions Group on scientific research, development, and application of next-generation air-surface exchange, emissions, air quality forecasting models that help protect human and ecosystem health. I have authored/co-authored over 40 scientific publications, received awards for high paper citations and top downloads, and recently received a NOAA Certificate of Accommodation for leading developments of NOAA's operational air quality forecasting systems, as well as the NOAA OAR Team Members of the Year Award in 2024. The focus of my research is on cross-cutting research topics spanning multi-platform observations, modeling, and related applications, with a focus on surface-atmosphere exchange, atmosphere-biosphere-chemical interactions, and multimedia surface fluxes. I have extensive experience in synthesizing multi-platform Earth system measurements using novel data analysis techniques and modeling methods for many pressing environmental issues today. As associate director of both GMU's SESS and new CSER programs, I have spearheaded coordination, training, education, and outreach, including leading the Air Quality Research and Development Consortium (AIRDC). I coordinated both the inaugural and second multi-institute AIRDC workshops at GMU, intended to foster increased communication and collaboration on atmospheric science and air quality topics in the greater Washington D.C. area and beyond. I am also a Certified Consulting Meteorologist (CCM) with the American Meteorological Society, and have worked on consulting, outreach, and education, including environmental and human health impact cases involved in expert witness testimony in federal court cases.

EDUCATION

University of Wyoming **2008 - 2013**
Doctor of Philosophy in Atmospheric Science
Dissertation: "The Climatology, Extent, and Impact of Stratospheric Condensation Nuclei, including their formation in polar regions"

University of Massachusetts at Lowell **2004 - 2006**
Master of Science in Environmental Studies – Atmospheric Science Concentration
Thesis: "A Short Range Ensemble Forecast Experiment on Jet Streaks to Improve Forecasters' Model Diagnoses 2004 – 2006"

University of Massachusetts at Lowell **2000 - 2004**
Bachelor of Science in Meteorology

Patrick C. Campbell, Ph.D., CCM

CERTIFCATIONS

- Certified Consulting Meteorologist (CCM), # 669, American Meteorological Society

AWARDS & DISTINCTIONS

- NOAA OAR Team Members of the Year Award (2024), For outstanding work in improving NOAA's air quality predictions with the implementation of a novel application using satellite data coupled with in-canopy processes.
- NOAA OAR Certificate of Accommodation (2023), For Developing and Implementing the Air Quality Model v6 (*Equivalent to NOAA Federal Silver Medal*)
- NOAA OAR Certificate of Accommodation (2021), For Implementing and Upgrading NOAA's NAQFC (*Equivalent to NOAA Federal Bronze Medal*)
- Top Paper Download for *Campbell et al.* (2018), JAMES, 2018-2019
- NRC Research Fellowship Award, NAS, 2016
- Research Spotlight for *Campbell et al.* (2014), AGU, 2014
- Antarctic Service Medal of the United States of America, NSF, 2012

CONSULTING EXPERIENCE

Independent/Subcontracted Air Quality Consultant. Campbell Air Quality. Legal Case: Slocum et al. v. International Paper et al. Subcontracted work performed for Howard, Reed, and Pedersen, Attorneys at Law. Aug. 2018 – Current

- Air quality modeling dispersion research and expert review/opinions
- Model simulations and quantitative analysis
- Preparation of expert report
- Oral Deposition
- Trial Expert Witness

Independent/Subcontracted Air Quality Consultant. Campbell Air Quality. Technical review of ROXUL Inc. air quality analysis contained in New Source Review (NSR) – Prevention of Significant Deterioration (PSD) permit for construction. Subcontracted work performed for Jane M. Tabb, County Commissioner of Jefferson County, WV. Feb. 2019 – Current

- Air quality modeling and dispersion research and expert/opinions
- Technical review of all air quality modeling and analysis in NSR-PSD application
- Preparation of expert report

FUNDING AND PROJECTS

Title: CISESS: GMU Air Surface Exchange and Atmospheric Composition Research; PI: Patrick C. Campbell; Sponsor: NOAA; Period of Performance: 8/1/2024 – 7/31/2025; Commitment: 12 calendar months.

Our research group at George Mason University (GMU) performs the fundamental Earth System observation and modeling research and applications needed for NOAA and the scientific community. This includes surface-atmosphere exchange processes and emissions, atmospheric composition studies, and meteorological and air quality modeling and forecasting. A key focus area of our CISESS research is to improve the scientific foundation, robustness, and overall understanding using a suite of Earth System models (including weather and atmospheric composition) in the scientific community and those that are part of NOAA's Unified Forecast System (UFS). Under CISESS, our research plan includes activities and goals such as

- Improving atmospheric composition and air quality forecasting models via comprehensive multi-species/platform data, studies, and analyses/evaluations.
- Improved representation of global land surface datasets from satellite observations with novel vegetative in-canopy processes in atmospheric composition models.
- Novel data assimilation and machine learning approaches using both remote sensing and in-situ gas and aerosol observations to improve atmospheric composition predictions.
- Research and development on using multi-platform observations, inversions, and process-based approaches for both anthropogenic and natural emissions sources (e.g., biogenic, windblown dust, and fires).
- Development of high resolution (i.e., 1-km) anthropogenic emissions inventories needed for cross-(global to local)-scale atmospheric composition models.

Title: Beyond the "Big-Leaf" Model at NOAA: Use of Novel Satellite Data and In-Canopy Processes to Improve U.S. Air Quality Predictions; PI: Patrick C. Campbell; Sponsor: NOAA; Period of Performance: 8/1/2022 – 7/31/2025; Commitment: 9 calendar months with Post-Doc supervision.

Project Outputs/Products:

- Development of in-canopy model parameterizations and effects on air quality forecasting under the next-gen Unified Forecast System-Air Quality Model (UFS-AQM)
- Incorporation and testing of novel satellite-based land surface/vegetation data including the Global Ecosystem Dynamics Investigation (GEDI) in the UFS-AQM.

- Full-year simulations and evaluation of the UFS-AQM using both 2D and 3D observations to demonstrate model performance changes and readiness for T2O/R2O transition.

Project Outcomes/Benefits:

- The technology transfer of "state-of-the-science" in-canopy parameterizations and data will improve future operational AQM forecasting models at NOAA.
- Development of the novel canopy process modeling across scales for the UFS, known as canopy-app: https://github.com/noaa-oar-arl/canopy-app
- The in-canopy effects and data implemented in NOAA's UFS-AQM will also be used to help improve future community air quality models as well.

Title: Transitioning GMU Weather-Aware Emission Modeling Capability (WAEMC) to Support National Air Quality Forecast Capability Operations; PI: Bok Haeng Baek; Sponsor: NOAA; Period of Performance: 9/1/2022 – 8/31/2025; Commitment: 1.2 calendar months.

This work will significantly improve the temporal and spatial representations of meteorology-induced emission sources with the direct/indirect feedback meteorology predictions from inline/offline NAQFC which result in improving the regional atmospheric chemicals and aerosol predictions, especially during the high ozone and PM2.5 episodes.

RESEARCH AND PROFESSIONAL EXPERIENCE

Research Associate Professor. Cooperative Institute for Satellite Earth System Studies (CISESS), Center for Spatial Information Science and Systems, George Mason University, ARL/NOAA Affiliate, College Park, MD, 2023 – Current

Research Assistant Professor. Cooperative Institute for Satellite Earth System Studies (CISESS), Center for Spatial Information Science and Systems, George Mason University, ARL/NOAA Affiliate, College Park, MD, 2019 – 2023

- Atmosphere-biosphere interactions, in-canopy modeling, and implications for wildfire behavior, emissions, and air quality forecasting.

- Research, development, and application of in-canopy vegetative parameterizations and models (e.g., “Canopy-App”; Codes: https://github.com/noaa-oar-arl/canopy-app) and implications for next-generation air quality forecasting under the Unified Forecast System (UFS) Air Quality Model (AQM), known formally as the Rapid Refresh Forecast System (RRFS) - Community Multiscale Air Quality (CMAQ) model (currently "Online-CMAQ") (Codes: https://github.com/noaa-oar-arl/AQM/).
- Lead on the development of an Amazon Web Services (AWS) “NACC-Cloud” product that allows users to process and download model-ready NOAA GFSv16 geospatial and meteorological inputs for any user-defined regional CMAQ application worldwide (web-interface: https://nacc.arl.noaa.gov/nacc/).
- Lead developer of the Global Forecast System (GFS)-driven NOAA-EPA Atmosphere Chemistry Coupler (NACC) for the Advanced National Air Quality Forecasting Capability (NAQFC) (Codes: https://github.com/noaa-oar-arl/NACC; https://github.com/noaa-oar-arl/NAQFC)
- Research and development on the NOAA Emission and eXchange Unified System (NEXUS) and connections with next-generation regional and global atmospheric aerosol and composition forecast models (Code: https://github.com/noaa-oar-arl/NEXUS)
- Research on emissions processes and modeling, reactive nitrogen atmospheric deposition and composition, air quality, and implications of air-surface exchange processes on air quality forecasting.
- Research on coupled meteorological, photochemical, and chemical transport/air quality modeling.

Post-Doc Research Associate. Department of Atmospheric and Oceanic Science/Cooperative Institute for Climate and Satellites-Maryland, University of Maryland, ARL/NOAA Affiliate, College Park, MD, 2018 - 2019

- Research, development, and evaluation of the Advanced National Air Quality Forecasting Capability (NAQFC).
- Research in coupled meteorological, photochemical, and chemical transport/air quality modeling
- Air quality, deposition, and land-surface flux model development in connection with regional and next-generation global air quality forecast models

NAS/NRC Post-Doc Research Associate. U.S. Environmental Protection Agency, National Exposure Research Laboratory, Durham, NC, 2016 - 2018

- Coupled meteorological, photochemical, and chemical transport/air quality modeling
- Air quality, deposition, and land-surface flux model development in connection with air quality models; including the WRF/Noah-CMAQ land surface model development
- Coupled air quality model evaluation and current-to-future year climate-air quality applications for the U.S.

- Advanced model developments and applications of both offline and coupled versions of WRF/CMAQ and a "next generation" air quality model using MPAS

Post-Doctoral Research Scholar. North Carolina State University, Air Quality Forecasting Laboratory, Raleigh, NC, 2014 - 2016

- Global to regional air quality and climate modeling
- Atmospheric chemistry and aerosol modeling
- Regional emissions modeling using the SMOKE model
- Global emissions processing for regional air quality modeling applications
- Global-to-regional coupled air quality model evaluation and applications
- Model proficiencies in CESM, WRF, WRF/CMAQ, WRF/Chem, and WRF/CAM5

Doctoral Research Assistant/Associate. University of Wyoming, Department of Engineering and Applied Sciences, Laramie, WY, 2008 – 2013

- Optical aerosol instrumentation and multi-media in-situ measurements
- Balloon borne particle, gas, and meteorological measurements in remote locations
- New particle formation and composition in the stratosphere
- Global aerosol modeling using CESM/WACCM/CARMA in the stratosphere
- Climatological data analysis of aerosol concentrations and size distributions
- WRF modeling and observational analysis of drylines in southeast Wyoming

Staff Scientist II – Air Quality Meteorologist. AECOM Environment, Chelmsford, MA, 2006 – 2008

- Comprehensive duties in the areas of meteorological and ambient air quality monitoring
- Data processing and analysis, technical report writing, dissemination of results to clients, air quality network operations, instrumentation and calibration, and gravimetric analysis
- Major project/research scientist for a $PM_{2.5}$ downwash study, while providing technical expertise on local vs. regional $PM_{2.5}$ measurements and modeling
- Performed technical writing for reports and presentation at technical conferences

Field Scientist. Massachusetts Department of Environmental Protection – Air Assessment Branch, Lawrence, MA, 2005 – 2006

- Routine and technical duties in support of air monitoring network operations
- Major project included Photochemical Assessment Monitoring Stations (PAMS) and gas chromatograph sample analysis

LEADERSHIP & ADMINISTRATION

Associate Director. George Mason University's Center for Satellite and Earth Science Research (CSER), **2025 – Current.**

Associate Director. George Mason University's Satellite Earth Systems Studies (SESS) Program, **2023 – Current.** https://sess.science.gmu.edu/

Co-Lead of Executive and Steering Committees. Air Quality Research and Development Consortium (AIRDC). **2023 – Current.** https://sites.google.com/view/airdc2024/home

REFEREED JOURNAL PAPERS
(*Total Citations: 1101, h-index: 19, i10-index: 35*)

43. Rozoff, C. M., Kumar, R., Tang, W., McCarthy, P., Lee, J. A., Alessandrini, S., Campbell, P.C., Tang, Y., Baker, B., and Jeon, C.-H. (2025). Evaluation of the Unified Forecast System Air Quality Model (UFS-AQM) online air quality prediction system during the 2020 US wildfire season. JGR-Atmospheres, under review.

42. Hung, W.-T., Baker, B., Campbell, P. C.,Tang, Y., Ahmadov, R., Romero-Alvarez,J., et al. (2025). Fire Intensity and spread forecAst (FIRA): A machine learning based fire spread prediction model for air quality forecasting application. GeoHealth, 9, e2024GH001253. https://doi.org/10.1029/2024GH001253.

41. Li, W., Tang, B., Campbell, P. C., Tang, Y., Baker, B., Moon, Z., Tong, D., Huang, J., Wang, K., Stajner, I., Montuoro, R., and Gilliam, R. C.: Updates and evaluation of NOAA's online-coupled air quality model version 7 (AQMv7) within the Unified Forecast System (2025). Geosci. Model Dev., https://doi.org/10.5194/gmd-2024-107.

40. Hung, W.-T., Campbell, P. C., Baker, B., (2024). High Resolution Global Land Surface Datasets using Satellite Measurements for Application to Earth System Models. https://doi.org/10.25923/d06p-2333.

39. Simon, H.,. Beidler, J., Baker, K. R., Henderson, B. H., Fox, L. Misenis, C., Campbell, P. C., Vukovich, J., Possiel, N., Eyth, A. (2024). Expediated Modeling of Burn Events Results (EMBER): A Screening-Level Dataset of 2023 Ozone Fire Impacts in the US. Data in Brief, https://doi.org/10.1016/j.dib.2024.111208.

38. Huang, J., Stajner, I., Montuoro, R., Yang, F., Wang, K., Huang, H.-C., Jeon, C.-H., Curtis, B., McQueen, J., Liu, H., Baker, B., Tong, D., Tang, Y., Campbell, P. C., Grell, G., Frost, G., Schwantes, R., Wang, S., Kondragunta, S., Li, F., and Jung, Y. (2024). Development of the next-generation air quality prediction system in the Unified Forecast System framework: Enhancing predictability of wildfire air quality impacts. BAMS, https://doi.org/10.1175/BAMS-D-23-0053.1.

37. Hung, W.-T., Campbell, P. C., Moon, Z., Saylor, R., Kochendorfer, J., Lee, T. R., Massman, W., (2024). Evaluation of an In-Canopy Wind and Wind Adjustment Factor Model for Wildfire Spread Applications Across Scales. Journal of Advances in Modeling Earth Systems, https://doi.org/10.1029/2024MS004300.

36. Li, Y., Tong, D., Makkaroon, P., DelSole, T., Tang, Y., Campbell, P. C., Baker, B., Cohen, M., Darmenov, A., Ahmadov, R., James, E., Hyer, E., Xian, P. (2024). Multi-Agency Ensemble Forecast of Wildfire Air Quality in the United States: Toward Community Consensus of Early Warning. BAMS. https://doi.org/10.1175/BAMS-D-23-0208.1

35. Makkaroon, P., D. Q. Tong, Y. Li, E. J. Hyer, P. Xian, S. Kondragunta, P. C. Campbell, Y. Tang, B. D. Baker, M. D. Cohen, A. Darmenov, A. Lyapustin, R. D. Saylor, Y. Wang, and I. Stajner (2023). Development and Evaluation of a North America Ensemble Wildfire Forecast: Initial Application to the 2020 Western United States "Gigafire". J. Geophys. Res. Atmos., 128, 22. https://doi.org/10.1029/2022JD037298.

34. Golbazi, M., Alessandrini, S., Kumar, Mcarthy, P., Campbell, P. C., Bhardwaj, P., He. C., McQueen, J. (2023). Enhancing fine particulate matter forecasts across the Contiguous United States (CONUS) during wildfires using Analog-based post-processing methods. Atmospheric Environment, 316. https://doi.org/10.1016/j.atmosenv.2023.120165.

33. Christopoulos, J., Tong, D., Ma, Siqi, Campbell, P. C. (2023). Impacts of the COVID-19 Economic Slowdown on Soybean Crop Yields in the United States. Sci Rep 13, 12574 (2023). https://doi.org/10.1038/s41598-023-39531-6.

32. Campbell, P.C.; Jiang, W.; Moon, Z.; Zinn, S.; Tang, Y. NOAA's Global Forecast System Data in the Cloud for Community Air Quality Modeling. Atmosphere 2023, 14, 1110. https://doi.org/10.3390/atmos14071110.

31. Jena, C.; Zhang, Y.; Wang, K.; Campbell, P.C. Decadal Application of WRF/Chem under Future Climate and Emission Scenarios: Impacts of Technology-Driven Climate and Emission Changes on Regional Meteorology and Air Quality. Atmosphere 2023, 14, 225. https://doi.org/10.3390/atmos14020225.

30. Jeong, G.-R.; Baker, B.; Campbell, P.C.; Saylor, R.; Pan, L.; Bhattacharjee, P.S.; Smith, S.J.; Tong, D.; Tang, Y. Updating and Evaluating Anthropogenic Emissions for NOAA's Global Ensemble Forecast Systems for Aerosols (GEFS-Aerosols): Application of an SO2 Bias-Scaling Method. Atmosphere 2023, 14, 234. https://doi.org/10.3390/atmos14020234

29. Li, Y., Tong, D., Ma, S., Freitas, S. R., Ahmadov, R., Sofiev, M., Zhang, X., Kondragunta, S., Kahn, R., Tang, Y., Baker, B., Campbell, P. C., Saylor, R., Grell, G., and Li, F.: Impacts of estimated plume rise on PM2.5 exceedance prediction during extreme wildfire events: A comparison of three schemes (Briggs, Freitas, and Sofiev), EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-713, 2022.

28. Tang, Y., Campbell, P. C., Lee, P., Saylor, R., Yang, F., Baker, B., Tong, D., Stein, A., Huang, J., Huang, H.-C., Pan, L., McQueen, J., Stajner, I., Tirado-Delgado, J., Jung, Y., Yang, M., Bourgeois, I., Peischl, J., Ryerson, T., Blake, D., Schwarz, J., Jimenez, J.-L., Crawford, J., Diskin, G., Moore, R., Hair, J., Huey, G., Rollins, A., Dibb, J., and Zhang, X.: Evaluation of the NAQFC Driven by the NOAA Global Forecast System Version 16: Comparison with the WRF-CMAQ Downscaling Method During the Summer 2019 FIREX-AQ Campaign, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2022-356, 2022.

27. Campbell, P. C., D. Tong, R. Saylor, Y. Li, S. Ma, X. Zhang, S. Kondragunta, and F. Li (2022). Pronounced increases in nitrogen emissions and deposition due to the historic 2020 wildfires in the western U.S. STOTEN, 839, 156130. https://doi.org/10.1016/j.scitotenv.2022.156130.

26. Campbell, P. C., Y. Tang, P. Lee, B. Baker, D. Tong, R. Saylor, A. Stein, F. Yang, J. Huang, H.-C. Huang, J. McQueen, I. Stajner, J. Sims, J. Tirado-Delgado, Y. Jung, F. Yang, T. Spero, and R. Gilliam (2022). Development and evaluation of an advanced National Air Quality Forecast Capability using the NOAA Global Forecast System version 16. Geosci. Model Dev., 15, 3281–3313. https://doi.org/10.5194/gmd-15-3281-2022.

25. Ma, S., D. Tong, L. Lamsal, J. Wang, Y. Tang, R. Saylor, T. Chai, P. Lee, P. C. Campbell, B. Baker, S. Kondragunta, L. Judd, and I. Stajner (2021). Improving predictability of high ozone episodes through dynamic boundary conditions, emission refresh and chemical data assimilation during the Long Island Sound Tropospheric Ozone Study (LISTOS) field campaign. Atmospheric Chemistry and Physics, 21, 16531–16553. https://doi.org/10.5194/acp-21-16531-2021.

24. Lin, H., D. J. Jacob, E. W. Lundgren, M. P. Sulprizio, C. A. Keller, T. M. Fritz, S. D. Eastham, L. K. Emmons, P. C. Campbell, B. Baker, R. D. Saylor, R. Montuoro (2021). Harmonized Emissions Component (HEMCO) 3.0 as a versatile emissions component for atmospheric models: application in the GEOS-Chem, NASA GEOS, WRF-GC, CESM2, NOAA GEFSAerosol, and NOAA UFS models, Geoscientific Model Development, https://doi.org/10.5194/gmd-14-5487-2021.

23. Gonzalez, A., Millet, D., Yu, X., Wells, K., Griffis, T., Baier, B., Campbell, P. C., Choi, Y., DiGangi, J., Gvakharia, A., Halliday, H., Kort, E., McKain, K., Nowak, J., Plant, G. (2021). Fossil vs. non-fossil CO sources in the US: New airborne constraints from ACT-America and GEM. Geophysical Research Letters, https://doi.org/10.1029/2021GL093361.

22. Campbell, P. C., D. Tong, Y. Tang, B. Baker, P. Lee, R. Saylor, A. Stein, S. Ma, and L. Lamsal (2021). Impacts of the COVID-19 Economic Slowdown on Ozone Pollution in the U.S. Atmospheric Environment, https://doi.org/10.1016/j.atmosenv.2021.118713.

21. Qu, Z., D. J. Jacob, R. F. Silvern, V. Shah, P. C. Campbell, L. C. Valin, and L. T. Murray (2021). US COVID-19 shutdown shows importance of background NO2 in inferring nitrogen oxide (NOx) emissions from satellite NO2 observations. Geophysical Research Letters, https://doi.org/10.1029/2021GL092783.

20. Gilliam, R.C., J.A. Herwehe, O.R. Bullock Jr., J.E. Pleim, L. Ran, P. C. Campbell, and H. Foroutan (2021). Establishing the Suitability of the Model for Prediction Across Scales for Global Retrospective Air Quality Modeling. Journal of Geophysical Research: Atmospheres. https://doi.org/10.1029/2020JD033588.

19. Chen, X., Y. Zhang, K. Wang, D. Q. Tong, P. Lee, Y. Tang, J. Huang, P. C. Campbell, J. T. McQueen, H. O. T. Pye, B. N. Murphy, D. Kang. 2021. Evaluation of the offline-coupled GFSv15-FV3-CMAQv5.0.2 in support of the next-generation National Air Quality Forecast Capability over the contiguous United States. Geoscientific Model Development, Preprint. https://gmd.copernicus.org/articles/14/3969/2021/.

18. Tang, Y., H. Bian, Z. Tao, L. D. Oman, D. Q. Tong, P. Lee, P. C. Campbell, B. Baker, S. Lu, L. Pan, J. Wang, J. T. McQueen, I. Stajner. 2021. Comparison of Chemical Lateral Boundary Conditions for Air Quality Predictions over the Contiguous United States during Intrusion Events. Atmospheric Chemistry and Physics Discussions. https://doi.org/10.5194/acp-21-2527-202.

17. Tang, Y., D. Q. Tong, K. Yang, P. Lee, B. Baker, A. Crawford, W. Luke, A. Stein, P. C. Campbell, A. Ring, J. Flynn, Y. Wang, J. T. McQueen, L. Pan, J. Huang, and I. Stajner. 2020. Air quality impacts of the 2018 Mt. Kilauea Volcano eruption in Hawaii: A regional chemical transport model study with satellite-constrained emissions. Atmospheric Environment, 237, https://doi.org/10.1016/j.atmosenv.2020.117648.

16. Campbell, P. C., Bash, J. O., Herwehe, J. A., Gilliam, R. C., & Li, D. 2020. Impacts of Tiled Land Cover Characterization on Global Meteorological Predictions Using the MPAS-A. Journal of Geophysical Research: Atmospheres, 125, e2019JD032093. https://doi.org/10.1029/2019JD032093

15. Uttamang, P., P. C. Campbell, V. P. Aneja, A. F. Hanna, 2019, A multi-scale model analysis of ozone formation in the Bangkok Metropolitan Region, Thailand, Atmospheric Environment, 229, 117433. https://doi.org/10.1016/j.atmosenv.2020.117433

14. Campbell, P. C., J. Bash, C. Nolte, T. Spero, E. J. Cooter, K. Hinson, L. Linker, 2019, Projections of Atmospheric Nitrogen Deposition to the Chesapeake Bay Watershed, J.Geophys. Res. Biogeosci., 124. https://doi.org/10.1029/2019JG005203

13. Campbell, P. C., Bash, J. O., & Spero, T. L., 2018, Updates to the Noah land surface model in WRF-CMAQ to improve simulated meteorology, air quality, and deposition. Journal of Advances in Modeling Earth Systems, 11. https://doi.org/10.1002/2018MS001422

12. Campbell, P. C., F. Yan, Z. Lu, Y. Zhang, and D. Streets, 2018, Impacts of Transportation Sector Emissions on Future U.S. Air Quality in a Changing Climate. Part I: Projected Emissions, Simulation Design, and Model Evaluation, Environmental Pollution, 238, 903-917, https://doi.org/10.1016/j.envpol.2018.04.020.

11. Campbell, P., F. Yan, Z. Lu, Y. Zhang, and D. Streets, 2018, Impacts of Transportation Sector Emissions on Future U.S. Air Quality in a Changing Climate. Part II: Air Quality Projections and the Interplay between Emissions and Climate Change, Environmental Pollution, 238, 918-930. https://doi.org/10.1016/j.envpol.2018.03.016.

10. Campbell, P., Y. Zhang, R. Leung, J. Fan, Q. Zhang, and Y. Zhang, 2017, Evaluation of a Multi-scale WRF-CAM5 Simulation during the 2010 East Asian Summer Monsoon, Atmospheric Environment, 169, 204-217. https://doi.org/10.1016/j.atmosenv.2017.09.008.

9. Yahya, K., K. Wang, P. Campbell, Y. Chen, T. Glotfelty, J. He, M. Pirhalla, and Y. Zhang, 2017, Decadal Application of WRF/Chem for Regional Air Quality and Climate Modeling over the U.S. under the Representative Concentration Pathways Scenarios. Part 1: Model Evaluation and Impact of Downscaling, Atmospheric Environment, 152, 562 – 583. https://doi.org/10.1016/j.atmosenv.2016.12.029.

8. Yahya, K., P. Campbell, and Y. Zhang, 2017, Decadal Application of WRF/Chem for Regional Air Quality and Climate Modeling over the U.S. under the Representative Concentration Pathways Scenarios. Part 2: Current vs. Future Simulations, Atmospheric Environment, 152, 584 – 604. https://doi.org/10.1016/j.atmosenv.2016.12.029.

7. Yahya, K., K. Wang, P. Campbell, T. Glotfelty, J. He, and Y. Zhang, 2015, Decadal evaluation of regional climate, air quality, and their interactions using WRF/Chem Version 3.6.1, Geosci. Model Dev., 8, 6707-6756. https://doi.org/10.5194/gmd-9-671-2016.

6. Campbell, P., Y. Zhang, K. Yahya, K. Wang, C. Hogrefe, G. Pouliot, C. Knote, A. Hodzic, R. San Jose, J. Perez, P. J. Guerrero, R. Baro, and P. Makar, 2015, A Multi-Model Assessment for the 2006 and 2010 Simulations under the Air Quality Model Evaluation International Initiative (AQMEII) Phase 2 over North America: Part I. Indicators of the Sensitivity of O_3 and $PM_{2.5}$ Formation Regimes, Atmospheric Environment, 115, 569 – 586. https://doi.org/10.1016/j.atmosenv.2014.12.026.

5. Bergmaier, P. T., B. Geerts, Z. Wang, B. Liu, and P. Campbell, 2014, A Dryline in Southeast Wyoming. Part II: Airborne Raman Lidar Observation, Mon. Wea. Rev., 142, 2961-2977. https://doi.org/10.1175/MWR-D-13-00314.1.

4. Campbell, P., M. Mills, and T. Deshler, 2014, The global extent of the midstratospheric CN layer: A three dimensional modeling study, J.Geophys. Res. Atmos., 119, 1015 – 1030, https://doi.org/10.1002/2013JD020503.

3. Campbell, P., and T. Deshler, 2014, Condensation nuclei measurements in the midlatitude (1982–2012) and Antarctic (1986–2010) stratosphere between 20 and 35 km, J. Geophys. Res. Atmos., 119. https://doi.org/10.1002/2013JD019710.

2. Campbell, P., B. Geerts, P. T. Bergmaier, 2014, A Dryline in Southeast Wyoming. Part I: Multiscale Analysis Using Observations and Modeling on 22 June 2010. Mon. Wea. Rev., 142, 268–289. doi: http://dx.doi.org/10.1175/MWR-D-13-00049.1

1. Gazeaux, J., Clerbaux, C., George, M., Hadji-Lazaro, J., Kuttippurath, J., Coheur, P.-F., Hurtmans, D., Deshler, T., Kovilakam, M., Campbell, P., Guidard, V., Rabier, F., and Thépaut, J.-N., 2013, Intercomparison of polar ozone profiles by IASI/MetOp sounder with 2010 Concordiasi ozonesonde observations, Atmos. Meas. Tech., 6, 613-620. https://doi.org/10.5194/amt-6-613-2013.

CONFERENCE PROCEEDINGS

2. Campbell, P., Y. Zhang, F. Yan, Z. Lu, and D. Streets, 2015, Impacts of Emissions Changes from the Transportation Sector on Future U.S. Air Quality, Air and Waste Management Association's 108th Annual Conference and Exhibition, June 2015, Raleigh, NC.

1. Campbell, P., and T. Deshler, 2013, Stratospheric condensation nuclei: A climatology in the mid-latitude and Antarctic regions, American Institute of Physics Conference Proceedings, 19th International Conference on Nucleation and Atmospheric Aerosols, June 2013, Fort Collins, CO.

RECENT CONFERENCE PRESENTATIONS (< 3 years)

11. Ivanova, I., Campbell, P.C. et al. (2024). Explicit Effects of Forest Canopy Shading & Turbulence on Boundary Layer Ozone in UFS-SRW Air Quality Model. 2024 AGU Meeting, Washington D.C., 2024.

10. Campbell, P.C. et al. (2024). Increasing trend in contributions of climate-driven wildfires to nitrogen deposition in the western U.S. 2024 AGU Meeting, Washington D.C., December 2024.

9. Campbell, P. C. et al. (2024). Landscape fires, nitrogen emissions, and deposition: Implications for downwind ecosystems. 23rd Annual CMAS Conference, Chapel Hill, NC. October 2024.

8. Campbell, P.C. et al. (2024). Development of Canopy-App for Atmospheric Composition Modeling Across Scales. 2024 AMS Meeting, Baltimore MD, January 2024.

7. Campbell, P.C. et al. (2023). Beyond the Big-Leaf Model for NOAA's Unified Air Quality Forecasting Capabilities. 22st Annual CMAS Conference, Chapel Hill, NC. October, 2023.

6. Moon, Z., Campbell, P.C. et al. (2023). A Model for Forest Canopy Effects on Weather and Atmospheric Composition in the NOAA Unified Forecast System. 35th Conference on Agricultural and Forest Meteorology/14th Fire and Forest Meteorology Symposium/Sixth Conference on Biogeosciences, Minneapolis, MN. May 2023.

5. Hung, W.-T., Baker, B., Campbell, P.C. et al. (2023). Development and evaluation of a machine learning based wildfire spread prediction model for regional air quality forecasting. 35th Conference on Agricultural and Forest Meteorology/14th Fire and Forest Meteorology Symposium/Sixth Conference on Biogeosciences, Minneapolis, MN. May 2023.

4. Campbell, P.C. et al. (2023). Beyond the Big-Leaf Model for NOAA's Unified Air Quality Forecasting Capabilities. 35th Conference on Agricultural and Forest Meteorology/14th Fire and Forest Meteorology Symposium/Sixth Conference on Biogeosciences, Minneapolis, MN. May 2023.

3. Campbell, P.C. et al. (2022). Pronounced increases in nitrogen emissions and deposition due to the historic 2020 wildfires in the western U.S. National Atmospheric Deposition Program 2022 Fall Meeting, Knoxville, TN. (Virtual). November, 2022.

2. Campbell, P.C. et al. (2022). Use of NOAA's Global Forecast System Data in the Cloud for Community Air Quality Modeling. 21st Annual CMAS Conference, Chapel Hill, NC. October, 2022.

1. Campbell, P.C. et al. (2022). Impacts of Wildfire Emissions on Nitrogen Deposition in the U.S. International Association of Wildland Fire, Fire & Climate Conference, Pasadena, CA. (Virtual). May 2022.

Patrick C. Campbell, Ph.D., CCM

MODELING EXPERIENCE

- NOAA-EPA Atmosphere Chemistry Coupler (NACC)
- National Air Quality Forecasting Capability (NAQFC)
- Harmonized Emissions Modeling Component (HEMCO)
- NOAA Emission and Exchange Unified System (NEXUS)
- Unified Forecast System Air Quality Model (UFS-AQM), "Online-CMAQ"
- Offline Community Multi-scale Air Quality (CMAQ) Model
- Global Forecast System (GFS)
- Global Ensemble Forecast Systems for Aerosols (GEFS-Aerosols)
- Unified Forecast System for Aerosols (UFS-Aerosols)
- Advanced Research Weather Research and Forecast (WRF-ARW) Model
- Coupled WRF/CMAQ Model
- Online Coupled WRF/Chem Model
- Noah Land Surface Model
- Online Coupled WRF/CAM5 Model
- Sparse Matrix Operator Kernel Emissions (SMOKE) Model
- NCAR Community Earth System (CESM) Model
- Whole Atmosphere Community Climate Model (WACCM)
- Community Aerosol and Radiation Model for Atmospheres (CARMA)
- Environmental Policy Integrated Climate (EPIC)
- Model for Predictions Across Scales (MPAS)

IN SITU MEASUREMENT EXPERIENCE

- Detailed Aircraft Field Campaign Trace Gas and Aerosol Measurements (e.g., 2019 FIREX-AQ)
- Ground-Based Trace Gas and $PM_{2.5}$ Networks (e.g,. U.S. EPA/AQS and AirNow)
- Optical Particle Counters
- Condensation Nuclei Counters
- Laser Particle Counters
- Electrochemical Cell Ozonesondes
- Differential Mobility Analyzers
- Scanning Mobility Particle Sizers
- Condensation Particle Counters

SATELLITE DATA ANALYSIS EXPERIENCE

- Global Ecosystem Dynamics Investigation (GEDI) LIDAR
- Moderate Resolution Imaging Spectroradiometer (MODIS)
- Visible Infrared Imaging Radiometer Suite (VIIRS)
- Ozone Monitoring Instrument (OMI)
- SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMCHY)

SCIENTIFIC COMPUTER PROGRAMMING EXPERIENCE

- FORTRAN
- Python
- Interactive Display Language
- R

DATA ANALYSIS AND VISUALIZATION PROFICIENCIES

- NCAR Command Language (NCL)
- Python
- UNIX C Shell Scripting
- Integrated Data Viewer (IDV)

- Visualization Environment for Rich Date Interpretation (VERDI)
- Microsoft Office and Adobe Suites

CLOUD DATABASE AND HPC EXPERIENCE

- Amazon Web Services (S3 and HPC platforms)

LARGE DATABASE MANAGEMENT EXPERIENCE

- MYSQL

COMPUTATIONAL PROPOSAL EXPERIENCE

3. Extreme Science and Engineering Discovery Environment (XSEDE) – Texas Advanced Computing Center's (TACC) Stampede Dell Linux Cluster, Completed performance testing for selected model systems, October 2015.

2. National Energy Research Scientific Computing Center's (NERSC) Edison Cray XC30 Cluster, Completed performance testing for selected model systems, September 2015.

1. National Center for Atmospheric Research (NCAR), Computational & Information Systems Laboratory's Yellowstone High-Performance IBM iDataPlex Cluster, Completed performance testing for selected model systems, March 2015 and September 2015.

PROFESSIONAL MEMBERSHIPS, REVIEWERSHIPS, AND EDITORIAL BOARDS

- Member, CCM, *American Meteorological Society*
- Member, *American Geophysical Union*
- Reviewer, *Bulletin of the American Meteorological Society*
- Reviewer, *Scientific Reports*
- Reviewer, *Nature Geosciences*
- Reviewer, *Weather and Forecasting*
- Reviewer, *Geophysical Research Letters*
- Reviewer, *Geoscientific Model Development*
- Reviewer, *Journal of Advances in Modeling Earth Systems*
- Reviewer, *Atmospheric Chemistry and Physics*
- Reviewer, *Environmental Pollution*
- Reviewer, *Atmospheric Environment*
- Reviewer, *Journal of Geophysical Research: Atmospheres*
- Reviewer, *Journal of Environmental Sciences*
- Reviewer, *Atmosphere*
- Reviewer, *Aerosol and Air Quality Research*
- Review Editor, *"Review Editor on the Editorial Board of Air Pollution Management", Frontiers in Environmental Engineering"*
- Editor, *"Improving Air Quality Predictions and Assessment Across Scales", Atmosphere*
- Editor, *"PM2.5 Predictions in the USA", Atmosphere*

MENTORSHIP

Post-Doctoral Fellows:

1. Dr. Gill-Ran Jeong, GMU. 2021-2023.
2. Dr. Wei-Ting Hung, GMU. 2021 – present
3. Dr. Irena Ivanova, GMU. 2023 – present
4. Dr. Chi-Tsan Wang, GMU. 2023 – present
5. Dr. Margaret Marvin, GMU. 2023 – present
6. Dr. Beiming Tang, GMU. 2023 – present
7. Dr. Wei Li, GMU. 2023 - present

NOAA Student Researchers/Affiliates:

1. Julianna Christopoulos, NOAA/Cornell University. 2020-2023

Patrick C. Campbell, Ph.D., CCM

OTHER PRESS AND OUTREACH

- NOAA-ARL Weekly News: NOAA-OAR 2024 Team Member of the Year Award. https://www.arl.noaa.gov/weekly-news-november-25-2024/
- "Greater D.C. Area Atmospheric Composition and Modeling Workshop" https://sess.science.gmu.edu/greater-d-c-area-atmospheric-composition-and-modeling-workshop/
- "NOAA OAR Certificate of Accommodation (2021), For Implementing and Upgrading NOAA's National Air Quality Forecasting CapabilityNOAA OAR Certificate of Accommodation (2021)" https://sess.science.gmu.edu/noaa-oar-certificate-of-accommodation-2021-for-implementing-and-upgrading-noaas-national-air-quality-forecasting-capabilitynoaa-oar-certificate-of-accommodation-2021/
- "NOAA Upgrades Key Air Quality Prediction Model" https://sess.science.gmu.edu/noaa-upgrades-key-air-quality-prediction-model/
- "George Mason University Scientist Contributes to the latest WMO Air Quality and Climate Bulletin" https://sess.science.gmu.edu/gmu-scientist-contributes-to-the-latest-wmo-air-quality-and-climate-bulletin/
- "The Climate-Composition Connection: How Changes in Human and Natural Emissions Affect Climate and Air Quality". Virtual Seminar given to New York State Master Teacher Program. April 24, 2021. Flyer and feedback.