

Riley M. Duren
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SUMMARY

I am the Chief Executive Officer and Founder of the non-profit organization [Carbon Mapper](#). I previously served as a [Fellow](#) and Chief Systems Engineer for JPL's Earth Science and Technology Directorate, with a broad portfolio of satellite mission and aircraft instrument development, research and analysis, and applied science spanning NASA's earth system science enterprise. I was also previously a Research Scientist at the University of Arizona.

My team applies a multi-disciplinary approach to climate change decision support with a focus on the carbon cycle using advanced atmospheric observations from land, air and space and multi-scale analytic frameworks to detect, quantify and characterize greenhouse emissions. In 2020 I founded Carbon Mapper with a public good mission to help drive the world toward comprehensive, transparent global monitoring to facilitate science-based decision-making and mitigation of greenhouse gas emissions. I also helped assemble the Carbon Mapper Coalition, including philanthropies, Planet Labs PBC, NASA JPL, and others to launch a constellation of satellites to monitor and rapidly [publish](#) methane and carbon dioxide emissions. Carbon Mapper plays a unique role in the NGO community by helping translate data into action as a trusted agent for policy makers and through active engagement of diverse stakeholders across civil society.

EXPERIENCE

CARBON MAPPER, Pasadena, California

- 2020-present, Chief Executive Officer

UNIVERSITY OF ARIZONA, Tucson, Arizona

- 2019-2024, Research Scientist

JET PROPULSION LABORATORY, CALTECH, Pasadena, California

- 2017 – 2023, Engineering Fellow
- 2008 – 2019, Chief Systems Engineer, Earth Science & Technology Directorate
- 2002 – 2009, Chief Engineer & Project System Engineer, Kepler mission
- 2000 – 2002, Instrument System Engineer, Starlight mission
- 1996 – 2000, Metrology System Engineer, Shuttle Radar Topography Mission (SRTM)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, Kennedy Space Center, Florida

- 1988 – 1995, Payload Integration, Test, Operations Engineer (5 space shuttle missions)

EDUCATION

- Auburn University, Bachelor of Science, Electrical Engineering, 1991

SERVICE

- US National Academy of Sciences: Committee on Earth Science and Applications from Space (2022-present)
- Strategic Advisory Committee: UT Austin's Energy Emissions Modeling and Data Lab (2023-present)

- US National Academy of Sciences: Committee on Developing a Research Agenda for Carbon Dioxide Removal and Sequestration (2017-2018)
- United States Carbon Cycle Science Program: 2nd State Of the Carbon Cycle Report – Writing Team, Decision Support and Urban Chapters (2016-2018)
- California Council on Science & Technology: Steering Committee for Long-term Viability of Natural Gas Storage Facilities (2017-2018)
- NASA Plankton, Aerosol, Cloud, and ocean Ecosystem (PACE): Standing Review Board (2017 – 2018)
- External Advisory Board, NYU Center for Urban Science & Policy (2016-2018)
- External Advisory Board, Greenhouse Gas Management Institute (2012-2018)
- Multiple NASA ROSES review panels

AWARDS

- Principal Investigator, 8 NASA ROSES research grants, 2010-2022
- Co-Principal Investigator, EPA STAR research grant, 2023-present
- Principal Investigator, 2 California Air Resources Board research grants, 2016-2023
- Principal Investigator & Co-Investigator, 2 California Energy Commission research grants, 2016-2019
- Principal Investigator, 1 NIST research grant, 2012-2019
- NASA Group Achievement Awards (8 total, 1991-2023)
- NASA Exceptional Achievement Medals (2001 & 2010)
- NASA Systems Engineering Excellence Award (2010)
- JPL Mariner Award (2016)
- UN Climate Summit, Big Data Project to Watch: Megacities Carbon Project (2014)
- National Academy of Engineering Gilbreth Lecture (2013)
- Engineer’s Council Distinguished Engineering Achievement Award (2012)

OTHER AFFILIATIONS

- Affiliate, Jet Propulsion Laboratory
- Member, American Geophysical Union

PUBLICATIONS

1. Cusworth, Daniel H., **R. M. Duren**, Alana K. Ayasse, Ralph Jiorle, Katherine Howell, Andrew Aubrey, Robert O. Green, et.al., 2023, “Quantifying Methane Emissions from United States Landfills”, *SCIENCE* 383 (669): 1499-1504, <https://doi.org/10.1126/science.adi7735>
2. Sherwin, E.D., Rutherford, J.S., Zhang, Z., Y. Chen, E. B. Wetherley, P. V. Yakovlev, E. S.F. Berman, B. B. Jones, D. H. Cusworth, A. K. Thorpe, A. K. Ayasse, **R. M. Duren**, A.R. Brandt. “US oil and gas system emissions from nearly one million aerial site measurements”. *NATURE* 627, 328–334. <https://doi.org/10.1038/s41586-024-07117-5>
3. Ravikumar, A., E. Tullos, D.T. Allen, B. Cahill, S.P. Hamburg, D. Zimmerle, T. Fox, M. Caltagirone, L. Owens, R. Stout, A. J. Grimes, T. M. Fernandez, C. Jenks, **R. Duren**, A. Halff, M. D. Bazilian, S. Rucker, 2023. “Measurement-Based Differentiation of Low Emission Global Natural Gas Supply Chains”, *NATURE ENERGY*.

4. Ayasse, A., D.Cusworth, K. O'Neill, J. Fisk, A. K Thorpe, **R. Duren**, 2023. "Performance and Sensitivity of Column-Wise and Pixel-Wise Methane Retrievals for Imaging Spectrometers." *ATMOSPHERIC MEASUREMENT TECHNIQUES* 16 (24): 6065–74. <https://doi.org/10.5194/amt-16-6065-2023>.
5. Cusworth, Daniel H., Andrew K. Thorpe, Charles E. Miller, Alana K. Ayasse, Ralph Jiorle, **Riley M. Duren**, Ray Nassar, Jon-Paul Mastrogiacomo, and Robert R. Nelson. 2023. "Two Years of Satellite-Based Carbon Dioxide Emission Quantification at the World's Largest Coal-Fired Power Plants." *ATMOSPHERIC CHEMISTRY AND PHYSICS* 23 (22): 14577–91. <https://doi.org/10.5194/acp-23-14577-2023>.
6. Thorpe, A.T., R.O. Green, D. R. Thompson, P. G. Brodrick, J. W. Chapman, C.D. Elder, I. Irakulis-Loitxate, D.H. Cusworth, A. K. Ayasse, **R. M. Duren**, et. al., (2023), "Attribution of Individual Methane and Carbon Dioxide Emission Sources Using EMIT Observations from Space." *SCIENCE ADVANCES* 9 (46). <https://doi.org/10.1126/sciadv.adh2391>.
7. Worden, J.R., S. Pandey, Y. Zhang, D. H. Cusworth, Z. Qu, A. A. Bloom, S. Ma, J. D. Maasackers, T. Scarpelli, B. Byrne, **R. Duren**, D. Crisp, D. Gordon, and D. J. Jacob, 2023, "Verifying Methane Inventories and Trends with Atmospheric Methane Data." *AGU ADVANCES* 4 (4). <https://doi.org/10.1029/2023AV000871>.
8. Yadav, V., K. Verhulst, **R.Duren**, A. Thorpe, J. Kim, R. Keeling, R.Weiss, D. Cusworth, M. Mountain, C. Miller, and J. Whetstone, 2023. "A Declining Trend of Methane Emissions in the Los Angeles Basin from 2015 to 2020." *ENVIRONMENTAL RESEARCH LETTERS* 18 (3). <https://doi.org/10.1088/1748-9326/acb6a9>.
9. Thorpe, A. K., E. A. Kort, D. H. Cusworth, A. K. Ayasse, B. D. Bue, V Yadav, D. R. Thompson, et. al., 2023. "Methane Emissions Decline from Reduced Oil, Natural Gas, and Refinery Production During COVID-19d." *ENVIRONMENTAL RESEARCH COMMUNICATIONS* 5 (2). <https://doi.org/10.1088/2515-7620/acb5e5>.
10. Cusworth, D.H., A.K. Thorpe, A.K. Ayasse, D. Stepp, J. Heckler, G. P. Asner, C. E. Miller, J.W. Chapman, M. L. Eastwood, R.O. Green, B. Hmiel, D. Lyon, and **R M. Duren** (2022). "Strong Methane Point Sources Contribute a Disproportionate Fraction of Total Emissions Across Multiple Basins in the United States." *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES* 119 (38), <https://doi.org/10.1073/pnas.2202338119>.
11. **Duren, R.**, D. Gordon, 2022. Tackling unlit and inefficient gas flaring. *SCIENCE*, <https://www.science.org/doi/10.1126/science.ade2315>
12. Jacob, D. J., Varon, D. J., Cusworth, D. H., Dennison, P. E., Frankenberg, C., Gautam, R., Guanter, L., Kelley, J., McKeever, J., Ott, L. E., Poulter, B., Qu, Z., Thorpe, A. K., Worden, J. R., and **Duren, R. M.**, 2022. "Quantifying Methane Emissions from the Global Scale down to Point Sources Using Satellite Observations of Atmospheric Methane." *ATMOSPHERIC CHEMISTRY AND PHYSICS* 22 (14): 9617–46. <https://doi.org/10.5194/acp-22-9617-2022>.
13. Hmiel, Benjamin, David R. Lyon, Jack D. Warren, Jevan Yu, Daniel H. Cusworth, **Riley M. Duren**, and Steven P. Hamburg. 2023. "Empirical Quantification of Methane Emission Intensity from Oil and Gas Producers in the Permian Basin." *ENVIRONMENTAL RESEARCH LETTERS* 18 (2). <https://doi.org/10.1088/1748-9326/acb27e>.
14. Ayasse, Alana K., Andrew K. Thorpe, Daniel H. Cusworth, Eric A. Kort, Alan Gorchoy Negron, Joseph Heckler, Gregory Asner, and **Riley M. Duren**. 2022. "Methane Remote

- Sensing and Emission Quantification of Offshore Shallow Water Oil and Gas Platforms in the Gulf of Mexico." *ENVIRONMENTAL RESEARCH LETTERS* 17 (8).
15. Yu, Jevan, Benjamin Hmiel, David R. Lyon, Jack Warren, Daniel H. Cusworth, **Riley M. Duren**, Yuanlei Chen, Erin C. Murphy, and Adam R. Brandt. 2022. "Methane Emissions from Natural Gas Gathering Pipelines in the Permian Basin." *ENVIRONMENTAL SCIENCE & TECHNOLOGY LETTERS* 9 (11): 969–74.
 16. Lauvaux, T., C. Giron, M. Mazzolini, A. d'Aspremont, **R. Duren**, D. Cusworth, D. Shindell, and P. Ciais. 2022. "Global Assessment of Oil and Gas Methane Ultra-Emitters." *SCIENCE* 375 (6580): 557+. <https://doi.org/10.1126/science.abj4351>.
 17. Ehret, Thibaud, Aurelien De Truchis, Matthieu Mazzolini, Jean-Michel Morel, Alexandre d'Aspremont, Thomas Lauvaux, **Riley Duren**, Daniel Cusworth, and Gabriele Facciolo. 2022. "Global Tracking and Quantification of Oil and Gas Methane Emissions from Recurrent Sentinel-2 Imagery." *ENVIRONMENTAL SCIENCE & TECHNOLOGY LETTERS* 9 (11): 969–74.
 18. J. R. Worden, D. Cusworth, Z. Qu, Y. Yin, Y. Zhang, A. Bloom, S. Ma, B. Byrne, T. Scarpelli, J. D. Maasackers, D. Crisp, **R. Duren**, and D.J. Jacob, 2022. "The 2019 Methane Budget and Uncertainties at 1° Resolution and Each Country Through Bayesian Integration of GOSAT Total Column Methane Data and a Priori Inventory Estimates." *ATMOSPHERIC CHEMISTRY AND PHYSICS* 22 (10): 6811–41. <https://doi.org/10.5194/acp-22-6811-2022>.
 19. Logan E. Mitchell, John C. Lin, Lucy R. Hutyra, David R. Bowling, Ronald C. Cohen, Kenneth J. Davis, Elizabeth DiGangi, **R.M. Duren**, et. al., 2022. "A Multi-City Urban Atmospheric Greenhouse Gas Measurement Data Synthesis." *SCIENTIFIC DATA* 9 (1). <https://doi.org/10.1038/s41597-022-01467-3>.
 20. Zandbergen, Sander R., **Riley Duren**, Paul Giuliano, Robert O. Green, Justin M. Haag, Lori B. Moore, Lucas Shaw, and Pantazis Mouroulis. 2022. "Optical Design of the Carbon Plume Mapper (CPM) Imaging Spectrometer." In *IMAGING SPECTROMETRY XXV: APPLICATIONS, SENSORS, AND PROCESSING*, edited by EJ Ientilucci and CL Bradley. Vol. 12235. Proceedings of SPIE. <https://doi.org/10.1117/12.2633767>.
 21. D H. Cusworth, **R.M. Duren**, A. K. Thorpe, W. Olson-Duvall, J. Heckler, J.W. Chapman, M. L. Eastwood, M. C. Helmlinger, R. O. Green, G. P. Asner, P. E. Dennison, and C. E. Miller, 2021. "Intermittency of Large Methane Emitters in the Permian Basin." *ENVIRONMENTAL SCIENCE & TECHNOLOGY LETTERS* 8 (7): 567–73. <https://doi.org/10.1021/acs.estlett.1c00173>.
 22. Cusworth, D. H., **R. M. Duren**, A.K. Thorpe, S. Pandey, J.D. Maasackers, I. Aben, et al., 2020. "Multisatellite Imaging of a Gas Well Blowout Enables Quantification of Total Methane Emissions." *GEOPHYSICAL RESEARCH LETTERS* 48 (2). <https://doi.org/10.1029/2020GL090864>.
 23. Thorpe, A.K., O'Handley, C., Emmitt, G.D., DeCola, P.L., Hopkins, F.M., Yadav, V., Guha, A., Newman, S., Herner, J.D., Falk, M., **R.M. Duren**, 2021. "Improved Methane Emission Estimates Using AVIRIS-NG and an Airborne Doppler Wind Lidar." *REMOTE SENSING OF ENVIRONMENT* 266. <https://doi.org/10.1016/j.rse.2021.112681>.
 24. Cusworth, Daniel H., **Riley M. Duren**, Andrew K. Thorpe, Michael L. Eastwood, Robert O. Green, Philip E. Dennison, Christian Frankenberg, et al., 2021. "Quantifying Global Power Plant Carbon Dioxide Emissions with Imaging Spectroscopy." *AGU ADVANCES* 2 (2). <https://doi.org/10.1029/2020AV000350>.

25. Foote, Markus D., Philip E. Dennison, Patrick R. Sullivan, Kelly B. O'Neill, Andrew K. Thorpe, David R. Thompson, Daniel H. Cusworth, **Riley Duren**, and Sarang C. Joshi. 2021. "Impact of Scene-Specific Enhancement Spectra on Matched Filter Greenhouse Gas Retrievals from Imaging Spectroscopy." *REMOTE SENSING OF ENVIRONMENT* 264. <https://doi.org/10.1016/j.rse.2021.112574>.
26. V. Yadav, S. Ghosh, K. Mueller, A. Karion, G. Roest, S.M. Gourdji, I. Lopez-Coto, K. R. Gurney, N. Parazoo, K. R. Verhulst, J. Kim, S. Prinzivalli, C. Fain, T. Nehrkorn, M. Mountain, R. F. Keeling, R. F. Weiss, **R. Duren**, C. E. Miller, J. Whetstone (2021). The impact of COVID-19 on CO₂ emissions in the Los Angeles and Washington DC/Baltimore metropolitan areas. *GEOPHYSICAL RESEARCH LETTERS* 48, <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021GL092744>
27. Irakulis, I., L.Guanter, Yin-Nian Liu, D.J. Varon, J. D. Maasackers, Y.Zhang, A. K. Thorpe, **R. M. Duren**, et. al., (2021). Satellite-based Survey of Extreme Methane Emissions in the Permian Basin, *SCIENCE ADVANCES*, <https://www.science.org/doi/10.1126/sciadv.abf4507>
28. Cusworth, D. H., **Duren, R. M.**, Yadav, V., Thorpe, A. K., Verhulst, K., Sander, S., et al, (2020). Synthesis of methane observations across scales: Strategies for deploying a multitiered observing network. *Geophys. Res. Let.*, 47, e2020GL087869. <https://doi.org/10.1029/2020GL087869>
29. Miller, J.B., S.J. Lehman, K. Verhulst, C.E. Miller, **R.Duren**, V.Yadav, S. Newman, C. Sloop (2020). Large and seasonally varying biospheric CO₂ fluxes in the Los Angeles megacity revealed by atmospheric radiocarbon, *Proc. Natl Acad. Sci.*
30. Borchardt, J., Gerilowski, K., Krautwurst, S., Bovensmann, H., Thorpe, A. K., Thompson, D. R., Frankenberg, C., Miller, C. E., **Duren, R. M.**, and Burrows, J. P. (2020). Detection and Quantification of CH₄ Plumes using the WFM-DOAS retrieval on AVIRIS-NG hyperspectral data, *ATMOSPHERE MEASUREMENT TECHNIQUES* <https://doi.org/10.5194/amt-2020-275>, 2020.
31. Thorpe, A.K., **Duren, R.**, Conley, S., Prasad, K., Bue, B., Yadav, V., Foster, K., Rafiq, T., Hopkins, F., Smith, M. and Fischer, M.L., 2020. Methane emissions from natural gas storage in California, *ENVIRONMENTAL RESEARCH LETTERS*
32. Borucki, W., J. Jenkins, **R. Duren**, Science Merit Function for the KEPLER Mission, *JOURNAL OF ASTRONOMICAL TELESCOPES AND SYSTEMS* 6(04) DOI:[10.1117/1.JATIS.6.4.044003](https://doi.org/10.1117/1.JATIS.6.4.044003)
33. Rafiq, T., **R. Duren**, A. Thorpe, K. Foster, R.Patarsuk, C.E. Miller, and F.M. Hopkins (2020). Source Attribution of Methane Point Source Emissions using Airborne Imaging Spectroscopy and the Vista-California Methane Infrastructure Dataset, *ENVIRONMENTAL RESEARCH LETTERS*. 15 124001 DOI 10.1088/1748-9326/ab9af8
34. Guha, A., S. Newman, D. Fairley, T. M. Dinh, L. Duca, S.C. Conley, M. L. Smith, A. K. Thorpe, **R. M. Duren**, D.H. Cusworth, K. T. Foster, M.L. Fischer, S. Jeong, N. Yesiller, J.L. Hanson, and P. T. Martien (2020). Assessment of Regional Methane Emission Inventories through Airborne Quantification in the San Francisco Bay Area, *ENVIRONMENTAL SCIENCE AND TECHNOLOGY* 54 (15), 9254-9264 , DOI: 10.1021/acs.est.0c01212
35. Cusworth, D.H., **Duren, R.M.**, Thorpe, A.K., Tseng, E., Thompson, D.R., Guha, A., Newman, S., Foster, K., Miller, C.E. (2020). Using remote sensing to detect, validate, and quantify methane emissions from California solid waste operations. *ENVIRONMENTAL RESEARCH LETTERS*. 15 054012 DOI 10.1088/1748-9326/ab7b99

36. **Duren, R. M.**, Andrew K. Thorpe, Kelsey T. Foster, Talha Rafiq, Francesca M. Hopkins, Vineet Yadav, Brian D. Bue, et al. 2019. "California's Methane Super-Emitters." *NATURE* 575 (7781): 180+. <https://doi.org/10.1038/s41586-019-1720-3>.
37. Ware, J., E.A. Kort, **R. Duren**, K. Verhulst, V. Yadav (2019). Detecting Urban Emissions Changes and Events with a Near Real Time Capable Inversion System, *JOURNAL OF GEOPHYSICAL RESEARCH – ATMOSPHERES*, <https://doi.org/10.1029/2018JD029224>
38. Yadav, Vineet, **Riley Duren**, Kim Mueller, Kristal R. Verhulst, Thomas Nehrkorn, Jooil Kim, Ray F. Weiss, et al. 2019. "Spatio-Temporally Resolved Methane Fluxes from the Los Angeles Megacity." *JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES* 124 (9): 5131–48. <https://doi.org/10.1029/2018JD030062>.
39. Gurney, K. R., Patarasuk, R., Liang, J., Song, Y., O'Keeffe, D., Rao, P., Whetstone, J. R., **Duren, R. M.**, Eldering, A., and Miller, C.: The Hestia Fossil Fuel CO₂ Emissions Data Product for the Los Angeles Megacity (Hestia-LA), *EARTH SYSTEM SCIENCE DATA* <https://doi.org/10.5194/essd-2018-162> (2019).
40. Cusworth, D., Jacob, D., Varon, D., Miller, C.C., Lu, X., Chance, K., Thorpe, A., **Duren, R.**, Miller, C., Thompson, D., Frankenberg, C., Guanter, L., Randles, C. (2019). Potential of next-generation imaging spectrometers to detect and quantify methane point sources from space, *ATMOSPHERE MEASUREMENT TECHNIQUES*, <https://doi.org/10.5194/amt-12-5655-2019>
41. Kuai, L., O.V. Kalashnikova, F. Hopkins, G. Hulley, H. Lee, M. J. Garay, **R. Duren**, J. Worden, S.Hook (2019). Quantification of ammonia emissions with high spatial resolution thermal infrared observations from the Hyperspectral Thermal Emission Spectrometer (HyTES) airborne instrument, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 12, no. 12, pp. 4798-4812, Dec. 2019, doi: 10.1109/JSTARS.2019.2918093
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43. He, L., Zhao-Cheng Zeng, T. Pongetti, C. Wong, J.Liang, K. Gurney, S Newman, V.Yadav, K. Verhulst, C.Miller, **R. Duren**, C. Frankenberg, P. Wennberg, R. Shia, Y. Yung and S. Sander (2019). Leakage from natural gas usage correlates with seasonal methane emissions in Los Angeles, *GEOPHYSICAL RESEARCH LETTERS*.
44. Jongaramrungruang, S., Frankenberg, C., Matheou, G., Thorpe, A., Thompson, D. R., Kuai, L., and **Duren, R.** (2019). Towards accurate methane point-source quantification from high-resolution 2D plume imagery, *ATMOSPHERIC MEASUREMENT TECHNOLOGY*, doi: 10.5194/amt-2019-173, <https://www.atmos-meas-tech-discuss.net/amt-2019-173/>
45. Ayasse, A.K., Dennison, P.E., Foote, M., Thorpe, A.K., Joshi, S., Green, R.O., **Duren, R.M.**, Thompson, D.R. and Roberts, D.A. (2019). Methane Mapping with Future Satellite Imaging Spectrometers. *REMOTE SENSING*, 11(24), p.3054.
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49. Thorpe, A.K., Frankenberg, C., Thompson, D.R., **Duren, R.M.**, Aubrey, A.D., Bue, B.B., Green, R.O., Gerilowski, K., Krings, T., Borchard, J., Kort, E.A., Sweeney, C., Conley, S., Roberts, D.A., Dennison, P.E. (2017). Airborne DOAS retrievals of methane, carbon dioxide, and water vapor concentrations at high spatial resolution: application to AVIRIS-NG. *ATMOSPHERIC MEASUREMENT TECHNOLOGY*, doi: 10.5194/amt-2017-51.
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53. Hulley, G.C., **R. Duren**, S.J. Hook, F. Hopkins, N. Vance, et al. (2016). High spatial resolution imaging of methane and other trace gas sources with the airborne Hyperspectral Thermal Emission Spectrometer, *ATMOSPHERIC MEASUREMENT TECHNOLOGY*, 2016), doi:10.5194/amt-2016-8
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SELECTED INVITED TALKS, PANELS, TESTIMONY

- *UN Framework Convention on Climate Change*, Conference of Parties, Sharm El Sheikh, 2022
- *California Air Resources Board Meeting*, testimony on Oil and Gas rule, Sacramento, 2023
- *National Petroleum Council*, Greenhouse Gases study workshop, Ft Collins 2023
- *European Geophysical Union*, Vienna, 2023
- *Global Methane, Climate and Clean Air Forum*, Washington, 2022
- *Summit of the Americas, Methane Mitigation Leadership in the Americas*, Los Angeles, 2022
- *US House of Representatives Committee on Science, Space and Technology*, testimony on Detecting and Quantifying Methane Emissions from the Oil and Gas Sector, Washington, 2022
- *California Department of Food and Agriculture Board Meeting*, Sacramento, 2022
- *National Academy of Science BASC study: Greenhouse Gas Emissions Monitoring, Inventories, and Data Integration*, Washington, 2022.
- *UN Framework Convention on Climate Change*, Conference of Parties, Glasgow, 2021
- *Methane Detection Technology Workshop*, US EPA, 2021
- *US House of Representatives Space & Aeronautics Subcommittee*, testimony on NASA's Earth Science and Climate Change Activities, Washington, 2021
- *CH₄ Connections*, Understanding Methane Emissions from NG Systems, Ft Collins, 2021
- *American Geophysical Union*, San Francisco, 2020
- *AAAS annual meeting*, California Methane Monitoring, Austin, 2018
- *Gas Technology Institute*, Methane monitoring, Ft Collins, 2018
- *Gordon Conference on Climate Engineering*, Engineering Aspects & Outdoor Experimentation, 2017
- *National Academy of Science - Polar Research Board*, Arctic Climate Interventions, Washington, 2016
- *DOE Workshop on Research Strategies on Oil and Gas Sector Methane Emissions*, Washington, 2016

- *AIAA Space Forum*, Earth Observations: Space and the Paris Agreement, Long Beach, 2016
- *American Geophysical Union*, Climate Intervention Research, San Francisco, 2015
- *AAAS annual meeting*, Geoengineering risks/challenges, San Jose, 2015
- *California Climate Symposium*, Megacities Carbon Project and CA methane, Sacramento, 2015
- *Bureau International des Poids et Mesures meeting on Greenhouse Gas monitoring*, Megacities Carbon Project, Paris, 2015
- *UN Framework Convention on Climate Change*, Conference of Parties, Lima, 2014
- *California Air Resources Board*, directors meeting, Megacities Carbon Project, Sacramento, 2014
- *Council on Foreign Relations*, Geoengineering risks, Washington, 2014
- *Bipartisan Policy Center*, Solar Radiation Management field research, Washington, 2014
- *American Geophysical Union*, San Francisco, 2014
- *National Academy of Engineering*, Geoengineering, Irvine, 2013
- *Von Karman Lecture Series*, Geoengineering and Climate Intervention, Pasadena, 2013
- *Defense Science Board Task Force on Climate Change*, Arlington, 2011
- *AAAS*, Carbon Monitoring Systems, Washington, 2010 and 2009
- *Intergovernmental Panel on Climate Change (IPCC) Task Force on Inventories, Expert Meeting on Greenhouse Gas Inventory Validation and Uncertainties*, Utrecht, 2010
- *US Senate Science and Technology Caucus*, Washington, 2010
- *National Academy of Engineering Frontiers of Engineering*, Kepler mission, Irvine, 2009
- *International Council On Systems Engineering (INCOSE)*, Keynote Speaker, Syracuse, 2005.

PUBLIC OUTREACH

- Print, television, and radio interviews with the *Associated Press*, *Reuters*, *Marketplace*, *Washington Post*, *New York Times*, *NPR*, *BBC*, *PBS News Hour*, *Los Angeles Times*, *KCRW*, *KQED*, *KCET*, *Nature news*, *New Yorker*, *NBC Nightly News*, *Bloomberg*, *Agence France-Presse*, *Climate Wire*, *Earth magazine*, *Science Now*, *Scientific American*, *Space News*, *Voice of America*, *The Weather Channel*, *Barron's*, *Blue Dot Report*, *Vox*, *Reveal*, others.
- Numerous public lectures 2000-present