

Dr. Robert R. Nelson
Algorithm Scientist
Jet Propulsion Laboratory, California Institute of Technology
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RELEVANT EXPERIENCE

Dr. Nelson is an Algorithm Scientist in the Radiation Sciences group at JPL and serves as the Algorithm Lead for NASA's Orbiting Carbon Observatory-2 and Orbiting Carbon Observatory-3 (OCO-2/3) missions. His expertise lies in refining the accuracy of space-based, near-infrared CO₂ retrievals—a focus he has maintained since his graduate studies. Dr. Nelson's research centers on advancing atmospheric gas and aerosol retrieval algorithms, detecting and quantifying small-scale greenhouse gas sources, and developing novel data products from satellite observations. Notably, he helped lead the development of versions 10 and 11 of the ACOS XCO₂ retrieval algorithm.

EDUCATION

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| • Ph.D. , Atmospheric Science (Colorado State University, Fort Collins, CO) | 4.00 GPA | 2019 |
| • M.S. , Atmospheric Science (Colorado State University, Fort Collins, CO) | 3.98 GPA | 2015 |
| • B.S. , Meteorology (Iowa State University, Ames, IA) | 3.92 GPA | 2012 |

RESEARCH AND PROFESSIONAL EXPERIENCE

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| Algorithm Scientist, NASA Jet Propulsion Laboratory | 2021–Present |
| • Algorithm Lead for both OCO-2 and OCO-3, heading the development of the carbon dioxide retrieval. Member of the Radiation Sciences group. | |
| Postdoctoral Researcher, NASA Jet Propulsion Laboratory | 2019–2021 |
| • Helped advance the OCO-2 and OCO-3 carbon dioxide and MISR aerosol retrieval algorithms working under the guidance of Dr. Annmarie Eldering. | |
| Graduate Research Assistant, Colorado State University | 2012–2019 |
| • Worked under Dr. Christopher O'Dell on the development and improvement of carbon dioxide retrieval algorithms. Took Ph.D. level courses, primarily on radiative transfer and remote sensing topics. | |
| American Meteorological Society Local Chapter Treasurer & Webmaster | 2014–2016 |
| • Various responsibilities as an elected officer of FORT Collins Atmospheric Scientists (FORTCAST). | |
| Senior Thesis, Iowa State University | Fall 2011 |
| • Analyzed the presence of the Madden-Julian Oscillation in the Iowa State University Global Climate Model using a variety of analytic techniques. | |
| Research Intern, University of Oklahoma | Summer 2011 |
| • Compared cloud climatologies from MODIS imagery to mesoscale models to assess systematic differences in cloudiness. | |
| American Meteorological Society Student Chapter President, Iowa State University | May 2011–2012 |

- Led our chapter of the AMS through the 2011-2012 academic year. Responsibilities included organizing educational outreach, fundraising, and promoting both our local and the national AMS chapters.

Research Intern, University of Michigan

Summer 2010

- Researched synoptic and mesoscale influences on mercury wet deposition.

Honors Mentor Program, Iowa State University

Fall 2008

- Created self-organizing maps from North American Regional Climate Change Assessment Program (NARCCAP) data.

TECHNICAL EXPERTISE

- Retrieval algorithm development, machine learning (genetic algorithms, SVD/PCA, clustering), radiative transfer, scientific data visualization
- Python, Git, LaTeX, Unix, Adobe Photoshop; experience with IDL, MATLAB, FORTRAN, NCL

RECOGNITION

- JPL Team Award (OCO-3/EMIT Power Plant Study Team) 2025
- JPL Team Award (Earth Science Senior Review Team) 2023
- JPL Team Award (OCO-3 Geolocation Team) 2023
- JPL Voyager Award (OCO-3 SAMs) 2022
- JPL Team Award (OCO-2 & OCO-3 B10 Development) 2020
- JPL Voyager Award (OCO-3 IOC) 2019
- American Meteorological Society Graduate Fellowship Recipient 2012–2013
- Phi Beta Kappa Honors Society, Iowa State University 2011–2012
- Ernest F. Hollings Scholar, NOAA 2010–2012
- University Honors Program, Iowa State University 2008–2012

FUNDED PROPOSALS

- Co-I, “*A CMS prototype framework to deliver urban sectoral emission estimates*” (PI: A. Chatterjee, NASA JPL) CMS ROSES 2023
- Co-I, “*Reducing Biases in OCO-2/3 Retrievals Using Machine Learning-Based Aerosol Priors*” (PI: V. Natraj, NASA JPL) OCO ROSES 2023
- Co-I, “*Reducing Satellite-measured XCO₂ biases via Optimization of Aerosol Schemes in Physics-based Retrievals*” (PI: C. O’Dell, CSU) OCO ROSES 2023
- Co-I, “*Boundary Layer Measurement with Combined Near- and Thermal-Infrared Observation*” (PI: B. Irion, NASA JPL) DSI ROSES 2021
- Co-I, “*A scalable framework for assessing variability in CO₂ point sources using multiple satellite instruments*” (PI: D. Cusworth, NASA JPL) OCO ROSES 2020
- Co-I, “*Reducing OCO-2 regional biases through novel 3D cloud, albedo, and meteorology estimation*” (PI: S. Kulawik, NASA AMES) OCO ROSES 2020

TEACHING

Summer School for Inverse Modeling of Greenhouse Gases (SSIM-GHG)	June 2024, July 2025
<ul style="list-style-type: none"> • Co-instructor for trace gas retrievals 	
Colorado State University Atmospheric Radiation Teaching Assistant	Spring 2015
<ul style="list-style-type: none"> • Assisted Dr. Chris O'Dell in teaching Atmospheric Radiation by grading assignments, creating homework and test questions and modules, and helping students succeed. 	
Colorado State University Programming Teaching Assistant	Spring 2014
<ul style="list-style-type: none"> • Assisted students with programming problems in multiple languages including MATLAB, IDL, Python, FORTRAN, and NCL. 	
Iowa State University Freshman Honors Program Leader	Fall 2009
<ul style="list-style-type: none"> • Led a diverse group of students toward completing common goals. Learned how to effectively prepare syllabi, manage class time, and successfully motivate students. 	

PUBLICATIONS

- Keely, W., Mauceri, S., **Nelson, R.**, Laughner, J., O'Dell, C. W., Massie, S., Baker, D., Kiel, M., Lamminpää, O., Hobbs, J., Chatterjee, A., Taylor, T., Wennberg, P., Crowell, S., Stephens, B., and Payne, V.: Uncertainty-aware machine learning bias correction and filtering for OCO-2: 2, *Earth and Space Sci.*, 12, e2025EA004329, doi:10.1029/2025EA004329, 2025.
- Mauceri, S., Keely, W., Laughner, J., O'Dell, C. W., Massie, S., **Nelson, R.**, Baker, D., Kiel, M., Lamminpää, O., Hobbs, J., Chatterjee, A., Taylor, T., Wennberg, P., Crowell, S., Stephens, B., Payne, V. H.: Uncertainty-aware machine learning bias correction and filtering for OCO-2: 1, *Earth and Space Sci.*, 12, e2025EA004328, doi:10.1029/2025EA004328, 2025.
- Sanghavi, S., Frankenberg, C., **Nelson, R. R.**, O'Dell, C., Rosenberg, R., Joiner, J.: Impact of Raman scattering on SIF retrievals from hyperspectral satellite observations, *Geophys. Res. Lett.*, 52, e2024GL112777, doi:10.1029/2024GL112777, 2025.
- Nelson, R. R.**, Kulawik, S. S., O'Dell, C., McDuffie, J., and Eldering, A.: Improving OCO-2 XCO₂ retrievals through the scaling of singular value decomposition-based temperature and water vapor profiles, *Earth Space Sci.*, 12, e2024EA003975, doi:10.1029/2024EA003975, 2025.
- Virtanen, T. H., Sundström, A.-M., Suhonen, E., Lipponen, A., Arola, A., O'Dell, C., **Nelson, R. R.**, and Lindqvist, H.: A global perspective on CO₂ satellite observations in high AOD conditions, *Atmos. Meas. Tech.*, 18, 929–952, doi:10.5194/amt-18-929-2025, 2025.
- Moeini, O., Nassar, R., Mastrogiacomo, J.-P., Dawson, M., O'Dell, C. W., **Nelson, R. R.**, Chatterjee, A.: Quantifying CO₂ emissions from smaller anthropogenic point sources using OCO-2 target and OCO-3 snapshot area mapping mode observations, *J. Geophys. Res. Atmos.*, 130, doi:10.1029/2024JD042333, 2025.
- Nelson, R. R.**, Cusworth, D. H., Thorpe, A. K., Kim, J., Elder, C. D., Nassar, R., and Mastrogiacomo, J.-P.: Comparing point source CO₂ emission rate estimates from near-simultaneous OCO-3 and EMIT observations, *Geophys. Res. Lett.*, 51, doi:10.1029/2024GL113002, 2024.
- Cusworth, D. H., Thorpe, A. K., Miller, C. E., Ayasse, A. K., Jiorle, R., Duren, R. M., Nassar, R., Mastrogiacomo, J.-P., and **Nelson, R. R.**: Two years of satellite-based carbon dioxide emission quantification at the world's largest coal-fired power plants, *Atmos. Chem. Phys.*, 23, 14577–14591, doi:10.5194/acp-23-14577-2023, 2023.

- Nelson, R. R.**, Witek, M. L., Garay, M. J., Bull, M. A., Limbacher, J. A., Kahn, R. A., Diner, D. A.: Improving the coverage of MISR aerosol retrievals over shallow, turbid, and eutrophic waters, *Atmos. Meas. Tech.*, 16, 4947–4960, doi:10.5194/amt-16-4947-2023, 2023.
- Taylor, T. E., O'Dell, C. W., Baker, D., Bruegge, C., Chang, A., Chapsky, L., Chatterjee, A., Cheng, C., Chevallier, F., Crisp, D., Dang, L., Drouin, B., Eldering, A., Feng, L., Fisher, B., Fu, D., Gunson, M., Haemmerle, V., Keller, G. R., Kiel, M., Kuai, L., Kurosu, T., Lambert, A., Laughner, J., Lee, R., Liu, J., Mandrake, L., Marchetti, Y., McGarragh, G., Merrelli, A., **Nelson, R. R.**, Osterman, G., Oyafuso, F., Palmer, P. I., Payne, V. H., Rosenberg, R., Somkuti, P., Spiers, G., To, C., Wennberg, P. O., Yu, S., Zong J.: Evaluating the consistency between OCO-2 and OCO-3 XCO₂ estimates derived from the NASA ACOS version 10 retrieval algorithm, *Atmos. Meas. Tech.*, 16, 3173–3209, doi:10.5194/amt-16-3173-2023, 2023.
- Bell, E., O'Dell, C. W., Taylor, T. E., Merrelli, A., **Nelson, R. R.**, Kiel, M., Eldering, A., Rosenberg, R., Fisher, B.: Exploring bias in OCO-3 Snapshot Area Mapping mode via geometry, surface, and aerosol effects, *Atmos. Meas. Tech.*, 16, 109–133, doi:10.5194/amt-2022-241, 2023.
- Nassar, R., Moeini, O., Mastrogiacomo, J. P., O'Dell, C. W., **Nelson, R. R.**, Kiel, M., Chatterjee, A., Eldering, A. and Crisp, D.: Tracking CO₂ emission reductions from space: A case study at Europe's largest fossil fuel power plant, *Front. Remote Sens.*, 3, 98, doi:10.3389/frsen.2022.1028240, 2022.
- Wu, D., Liu, J., Wennberg, P. O., Palmer, P. I., **Nelson, R. R.**, Kiel, M., Eldering, A.: Towards sector-based attribution using intra-city variations in satellite-based emission ratios between CO₂ and CO, *Atmos. Chem. Phys.*, 22, 14547–14570, doi:10.5194/acp-2021-1029, 2022.
- Taylor, T. E., O'Dell, C. W., Crisp, D., Kuze, A., Lindqvist, H., Wennberg, P. O., Chatterjee, A., Gunson, M., Eldering, A., Fisher, B., Kiel, M., **Nelson, R. R.**, Merrelli, A., Osterman, G., Chevallier, F., Palmer, P. I., Feng, L., Deutscher, N. M., Dubey, M. K., Feist, D. G., García, O. E., Griffith, D. W. T., Hase, F., Iraci, L. T., Kivi, R., Liu, C., de Mazière, M., Morino, I., Notholt, J., Oh, Y.-S., Ohyama, H., Pollard, D. F., Rettinger, M., Roehl, C. M., Schneider, M., Sha, M. K., Shiomi, K., Strong, K., Sussmann, R., Té, Y., Velasco, V. A., Vrekoussis, M., Warneke, T., Wunch, D.: An eleven year record of XCO₂ estimates derived from GOSAT measurements using the NASA ACOS version 9 retrieval algorithm, *Earth Syst. Sci. Data*, 14, 325–360, doi:10.5194/essd-14-325-2022, 2022.
- Nelson, R. R.**, Eldering, A., Crisp, D., Merrelli, A. J., O'Dell, C. W.: Retrieved wind speed from the Orbiting Carbon Observatory-2, *Atmos. Meas. Tech.*, 13, 6889–6899, doi:10.5194/amt-13-6889-2020, 2020.
- Johnson, M. S., Schwandner, F. M., Potter, C. S., Nguyen, H. M., Bell, E., **Nelson, R. R.**, Philip, S., O'Dell, C. W.: Carbon dioxide emissions during the 2018 Kilauea volcano eruption estimated using OCO-2 satellite retrievals, *Geophys. Res. Lett.*, 47, e2020GL090507, doi:10.1029/2020GL090507, 2020.
- Taylor, T. E., Eldering, A., Merrelli, A., Kiel, M., Somkuti, P., Cheng C., Rosenberg, R., Fisher, B., Crisp, D., Basilio, R., Bennett, M., Cervantes, D., Chang, A., Dang, L., Frankenberg, C., Haemmerle, V. R., Keller, G. R., Kurosu, T., Laughner, J. L., Lee, R., Marchetti, Y., **Nelson, R. R.**, O'Dell, C. W., Osterman, G., Pavlick, R., Roehl, C., Schneider, R., Spiers, G., To, C., Wells, C., Wennberg, P. O., Yelamanchili, A., Yu, S.: OCO-3 early mission operations and initial (vEarly) XCO₂ and SIF retrievals, *Remote Sens. Environ.*, 251, 112032, doi:10.1016/j.rse.2020.112032, 2020.
- Sanghavi, S., **Nelson, R.**, Frankenberg, C., Gunson, M.: Aerosols in OCO-2/GOSAT retrievals of XCO₂: an information content and error analysis, *Remote Sens. Environ.*, 251, 112053, doi:10.1016/j.rse.2020.112053, 2020.
- Kulawik, S. S., O'Dell, C., **Nelson, R. R.**, and Taylor, T. E.: Validation of OCO-2 error analysis using simulated retrievals, *Atmos. Meas. Tech.*, 12, 5317–5334, doi:10.5194/amt-2018-368, 2019.

- Nelson, R. R.:** Aerosol parameterizations in space-based near-infrared retrievals of carbon dioxide, doctoral dissertation, Colorado State University, Libraries, 2019.
- Nelson, R. R.** and O'Dell, C. W.: The Impact of Improved Aerosol Priors on Near-Infrared Measurements of Carbon Dioxide, *Atmos. Meas. Tech.*, 12, 1495–1512, doi:10.5194/amt-12-1495-2019, 2019.
- O'Dell, C. W., Eldering, A., Wennberg, P. O., Crisp, D., Gunson, M. R., Fisher, B., Frankenberg, C., Kiel, M., Lindqvist, H., Mandrake, L., Merrelli, A., Natraj, V., **Nelson, R. R.**, Osterman, G. B., Payne, V. H., Taylor, T. E., Wunch, D., Drouin, B. J., Oyafuso, F., Chang, A., McDuffie, J., Smyth, M., Baker, D. F., Basu, S., Chevallier, F., Crowell, S. M. R., Feng, L., Palmer, P. I., Dubey, M., García, O. E., Griffith, D. W. T., Hase, F., Iraci, L. T., Kivi, R., Morino, I., Notholt, J., Ohyama, H., Petri, C., Roehl, C. M., Sha, M. K., Strong, K., Sussmann, R., Te, Y., Uchino, O., and Velazco, V. A.: Improved retrievals of carbon dioxide from Orbiting Carbon Observatory-2 with the version 8 ACOS algorithm, *Atmos. Meas. Tech.*, 11, 6539–6576, doi:10.5194/amt-11-6539-2018, 2018.
- Nelson, R. R.**, Crisp, D., Ott, L. E., O'Dell, C. W.: High-accuracy measurements of total column water vapor from the Orbiting Carbon Observatory-2, *Geophys. Res. Lett.*, 43, 12261–12269, doi:10.1002/2016GL071200, 2016.
- Nelson, R. R.**, O'Dell, C. W., Taylor, T. E., Mandrake, L., and Smyth, M.: The potential of clear-sky carbon dioxide satellite retrievals, *Atmos. Meas. Tech.*, 8, 1671–1684, doi:10.5194/amt-9-1671-2016, 2016.
- Taylor, T. E., O'Dell, C. W., Frankenberg, C., Partain, P. T., Cronk, H. Q., Savtchenko, A., **Nelson, R. R.**, Rosenthal, E. J., Chang, A. Y., Fisher, B., Osterman, G. B., Pollock, R. H., Crisp, D., Eldering, A., and Gunson, M. R.: Orbiting Carbon Observatory-2 (OCO-2) cloud screening algorithms: validation against collocated MODIS and CALIOP data, *Atmos. Meas. Tech.*, 9, 973–989, doi:10.5194/amt-9-973-2016, 2016.
- Nelson, R. R.:** The impact of aerosols on space-based retrievals of carbon dioxide, master's thesis, Colorado State University, Libraries, 2015.
- Nelson, R. R.:** Measuring atmospheric carbon dioxide from space, *Physics Today*, doi:10.1063/PT.5.4006, 2014.