Kevin W Bowman

JPL Engineering and Science Directorate Principal

Research

My research interests are centered on understanding the processes controlling the trajectory of atmospheric composition and quantifying their impact on climate, environmental quality, and human health. To that end, I lead teams of scientists to construct end-to-end systems that produce advanced global observational products and integrate them with Earth system modeling through state-of-the-art data assimilation and inverse modeling techniques. We've advanced Earth System sounding that apply innovative multi-instrument atmospheric retrieval techniques to hyperspectral instruments leading to trace gas measurements such as ozone and methane with superior accuracies obtainable from any instrument individually. These in turn have been ingested into chemical data assimilation systems in order to quantify the balance of local and non-local emissions on air quality and climate model evaluation. Similarly, the NASA Carbon Monitoring System Flux (CMS-Flux) ingests multiple carbon cycle measurements into anthropogenic, oceanic, terrestrial, and atmospheric models in order to attribute the CO2 growth rate to spatially-explicit processes. These integrated data are used in turn to quantify the response of carbon to climate variability such as El Ninos, partition the role of direct and indirect effects on carbon dynamics, and provide critical information for assessments such as the Global Stocktake. Taken together, these systems provide a framework for linking climate forcing from short and long-lived climate pollutants to Earth system responses and societal benefits.

Experience

2016–Present **Engineering and Science Directorate Principal**, *Jet Propulsion Laboratory, California Institute of Technology*, Pasadena.

2020–Present **Principal Investigator, Tropospheric Ozone and its Precursors from Earth System Sounding (TROPESS)**, *Jet Propulsion Laboratory, California Institute of Technology*, Pasadena.

2010–Present **Principal Investigator, Carbon Monitoring System Flux Pilot Project**, *Jet Propulsion Laboratory, California Institute of Technology*, Pasadena.

2014–2020 **Principal Investigator, Tropospheric Emission Spectrometer (TES)**, *Jet Propulsion Laboratory, California Institute of Technology*, Pasadena.

2010–2014 **Deputy Principal Investigator, Tropospheric Emission Spectrometer (TES)**, *Jet Propulsion Laboratory, California Institute of Technology*, Pasadena.

2009–Present **Visiting Associate Researcher**, *Joint-Institute for Regional Earth System Science and Engineering (JIFRESSE)*, University of California, Los Angeles.

1997 **NASA Graduate Student Researcher's Program Fellow**, *Georgia Institute of Technology*, Atlanta, Georgia.

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Education

1997 **Phd in Electrical Engineering**, *Georgia Institute of Technology*, Altanta, Georgia.

1993 **Masters of Science in Electrical Engineering**, *Georgia Institute of Technology*, Atlanta, Georgia.

1992 **Diplôme de Spécialisation en Traitement et Transmission des Informations**, *Ecole Supérieure d'Electricité (SUPELEC)*, Metz, France.

1991 **Bachelor of Electrical Engineering**, *Auburn University*, Auburn, Alabama.

Awards

2020 NASA Group Achievement Award-ACT-America

2020 NASA Group Achievement Award-FIREX-AQ

2020 NASA Group Achievement Award-MUSES Algorithm Team

2019 NASA Exceptional Public Service Medal

2015 NASA JPL Voyager Award

2015 NASA Langley, Henry J. Reid Award

2015 NASA Group Achievement Award-Observations for Climate Model Intercomparison

2014 NASA Group Achievement Award-Aura Tropospheric Emission Spectrometer Team

2013 NASA Group Achievement Award-Carbon Monitoring System Flux Project

2009 NASA Group Achievement Award-Aura Science Team Proposal Group

2007 NASA Group Achievement Award-TES Level 2 Algorithm Team

2005 NASA Group Achievement Award-Aura Project

2005 NASA Group Achievement Award–Aura Tropospheric Emission Spectrometer instrument team and the ground data system development teams

2005 Goddard Space Flight Center Group Achievement Award as a member of the Aura Team

Field Campaigns

2019 FIREX-AQ (NOAA/NASA) satellite team member

2016 KORUS-AQ (NASA/Korea) satellite team member

2016 ACT-America (NASA) science team member

2006 INTEX-B/MILAGRO (NASA/NSF) satellite team member

2006 TexAQS/GoMACCS (Texas Air Quality Study/Gulf of Mexico Atmospheric Composition and Climate Study) (NOAA/NASA/Texas) Rapid Science Synthesis (RSS) panel member

Professional Activities

2020–Present JPL Science Understanding through Data Science (SUDS) member

2017–Present External Experts Group European Union–CO2 Human Emissions (CHE) Project

2017–Present Atmospheric Composition Constellation–Committee on Earth Observing Systems, AQ/Carbon Synergies Session Chair

2018–Present GEOS-Chem Steering Committee: Carbon Cycle Co-Chair

2010–2018 Carbon Monitoring System Science-Frameworks Working Group Team Leader

2011 NASA Science Community Workshop on Polar Orbiting IR and MW Sounders Co-Chair

2009–2018 GEOS-Chem Steering Committee: Adjoint Model and Data Assimilation Co-Chair

2007–2008 JPL Earth system assimilation working group lead (ESAWG)

Pedagogy

2008-2017 **Guest Lecturer**, *Inverse Methods*, ESE/GE 152 ATMOSPHERIC RADIATION, Division of Geological and Planetary Sciences, California Institute of Technology.

2016 **Lecturer**, *Global Carbon Cycle*, JPL Summer Climate School.

2011 **Lecturer**, *Inverse Methods and Data Assimilation*, JPL Summer Climate School.

Mentorship

Postdoctoral Advisor **Paul Hamer, Adetutu Aghedo, Min Huang, Nicolas Parazoo, Thomas Walker, Ed Malina, Oscar Nazarret**.

Thesis Committee **Edwin Sarkission (CalState LA), Kumaresh Singh (Virginia Tech), Amir Souri (University of Houston)**.

Intern **Nadia Colombi (UCLA), Oscar Nazarett (UCLA)**.

Media

2020 Response of COVID-19 mitigation on Chinese Air Quality

2018 A tale of three continents: record carbon dioxide growth during the 2015 El Niño

2016 ACT-America Science

2015 Pollution transport seen from TES

Selected Invited Seminars and Presentations

Invited K. Bowman, "The carbon cycle and the global stocktake: Towards seamless carbon prediction", *Department of Statistics, Duke University*, Duke, NC, 2020

K. Bowman, "The global stocktake: A top-down view", *Atmospheric Composition Constellation, Committee on Earth Observing Satellites (CEOS)*, Tokyo, 2019

Invited K. Bowman, "Unweaving the webs of carbon", *EU Carbon Human Emissions Project, Reading, UK,* 2019

K. Bowman, "On the information content of OCO-2", *OCO-2 Science Team Meeting, Boulder, CO,* 2019

Invited K. Bowman, "A global view: the carbon cycle from space", *RECCAP2, Global Carbon Project, Gotemba, Japan*, 2019

Invited K. Bowman et al., "Attribution of Ozone and Methane Radiative Forcing in the Last Decade: A Tale of the Tiger and the Dragon", *Asia Oceania Geosciences Society, Honolulu, Hawaii*, 2018

K. Bowman et al, "A hierarchical framework for emergent constraints: applications to Earth System Forcings and Feedback", *AGU, Washington, D.C.*, 2018

Invited K. Bowman et al, "A New Fast Randomized Optimal Approach for Diagnostic and Optimization (FRODO) Carbon Dioxide Fluxes Inferred from the NASA CMS-Flux", *AGU, Washington D.C.,* 2018

Invited K. Bowman, "Tropospheric Emission Spectrometer: From Mission of Discovery to Earth System Sounder", *Fourier Transform Spectroscopy, Optical Society of America, Singapore,* 2018.

K. Bowman et al, "Detection of fossil fuel emission trends across the globe: Challenge of natural variability" *Integrated Carbon Observingy System (ICOS), Prague, Czech Republic,* 2018

K. Bowman and M. Lee, "Impact of Local and Non-local Sources of Pollution on Background US ozone: Potential of the LEO and GEO Sounders Composition Constellation", *GEO-CAPE final science team meeting, College Park, MD*, 2018

Dynamic Publications

Google Scholar

Publons

Publications

Rebecca R. Buchholz, Helen M. Worden, Mijeong Park, Gene Francis, Merritt N. Deeter, David P. Edwards, Louisa K. Emmons, Benjamin Gaubert, John Gille, Sara Martínez-Alonso, Wenfu Tang, Rajesh Kumar, James R. Drummond, Cathy Clerbaux, Maya George, Pierre-François Coheur, Daniel Hurtmans, Kevin W. Bowman, Ming Luo, Vivienne H. Payne, John R. Worden, Mian Chin, Robert C. Levy, Juying Warner, Zigang Wei, and Susan S. Kulawik. Air pollution trends measured from Terra: CO and AOD over industrial, fire-prone, and background regions. *Remote Sensing of Environment*, 256:112275, 2021.

Hayoung Park, Sujong Jeong, Hoonyoung Park, Lev D. Labzovskii, and Kevin W. Bowman. An assessment of emission characteristics of Northern Hemisphere cities using spaceborne observations of CO2, CO, and NO2. *Remote Sensing of Environment*, 254:112246, 2021.

John Worden, Sassan Saatchi, Michael Keller, Anthony Bloom, Rong Fu, Sarah Worden, Junjie Liu, Nicholas Parazoo, Joshua B. Fisher, Helen Worden, Yi Yin, Kevin Bowman, Pierre Gentine, Alexandra G. Konings, Gregory R. Quetin, Mathew Williams, John.T. Reager, Armineh Barkhordarian, Kristen Fahy, Mingjie Shi, and David Schimel. Satellite Observations of the Tropical Terrestrial Carbon Balance and Interactions with the Water Cycle During the 21st Century. *Reviews of Geophysics*, 2021.

A. Anthony Bloom, Kevin W. Bowman, Junjie Liu, Alexandra G. Konings, John R. Worden, Nicholas C. Parazoo, Victoria Meyer, John T. Reager, Helen M. Worden, Zhe Jiang, Gregory R. Quetin, T. Luke Smallman, Jean-François Exbrayat, Yi Yin, Sassan S. Saatchi, Mathew Williams, and David S. Schimel. Lagged effects regulate the inter-annual variability of the tropical carbon balance. *Biogeosciences*, 17(24):6393–6422, 2020.

B. Byrne, J. Liu, A. A. Bloom, K. W. Bowman, Z. Butterfield, J. Joiner, T. F. Keenan, G. Keppel-Aleks, N. C. Parazoo, and Y. Yin. Contrasting Regional Carbon Cycle Responses to Seasonal Climate Anomalies Across the East-West Divide of Temperate North America. *Global Biogeochemical Cycles*, 34(11), 2020.

B. Byrne, J. Liu, M. Lee, I. Baker, K. W. Bowman, N. M. Deutscher, D. G. Feist, D. W. T. Griffith, L. T. Iraci, M. Kiel, J. S. Kimball, C. E. Miller, I. Morino, N. C. Parazoo, C. Petri, C. M. Roehl, M. K. Sha, K. Strong, V. A. Velazco, P. O. Wennberg, and D. Wunch. Improved Constraints on Northern Extratropical CO2 Fluxes Obtained by Combining Surface-Based and Space-Based Atmospheric CO2 Measurements. *Journal of Geophysical Research: Atmospheres*, 125(15), 2020.

D. Carroll, D. Menemenlis, J. F. Adkins, K. W. Bowman, H. Brix, S. Dutkiewicz, I. Fenty, M. M. Gierach, C. Hill, O. Jahn, P. Landschützer, J. M. Lauderdale, J. Liu, M. Manizza,

J. D. Naviaux, C. Rödenbeck, D. S. Schimel, T. Van der Stocken, and H. Zhang. The ECCO-Darwin Data-assimilative Global Ocean Biogeochemistry Model: Estimates of Seasonal to Multi-decadal Surface Ocean pCO2 and Air-sea CO2 Flux. *Journal of Advances in Modeling Earth Systems*, 2020.

Robert L. Herman, John Worden, David Noone, Dean Henze, Kevin Bowman, Karen Cady-Pereira, Vivienne H. Payne, Susan S. Kulawik, and Dejian Fu. Comparison of optimal estimation HDO/H2O retrievals from AIRS with ORACLES measurements. *Atmospheric Measurement Techniques*, 13(4):1825–1834, 2020.

Le Kuai, Kevin W. Bowman, Kazuyuki Miyazaki, Makoto Deushi, Laura Revell, Eugene Rozanov, Fabien Paulot, Sarah Strode, Andrew Conley, Jean-François Lamarque, Patrick Jöckel, David A. Plummer, Luke D. Oman, Helen Worden, Susan Kulawik, David Paynter, Andrea Stenke, and Markus Kunze. Attribution of Chemistry-Climate Model Initiative (CCMI) ozone radiative flux bias from satellites. *Atmospheric Chemistry and Physics*, 20(1):281–301, 2020.

Enhui Liao, Laure Resplandy, Junjie Liu, and Kevin W. Bowman. Amplification of the Ocean Carbon Sink During El Niños: Role of Poleward Ekman Transport and Influence on Atmospheric CO2. *Global Biogeochemical Cycles*, 34(9), 2020.

Junjie Liu, Latha Baskaran, Kevin Bowman, David Schimel, A. Anthony Bloom, Nicholas C. Parazoo, Tomohiro Oda, Dustin Carroll, Dimitris Menemenlis, Joanna Joiner, Roisin Commane, Bruce Daube, Lucianna V. Gatii, Kathryn McKain, John Miller, Britton B. Stephens, Colm Sweeney, and Steven Wofsy. Carbon Monitoring System Flux Net Biosphere Exchange 2020 (CMS-Flux NBE 2020). *Earth System Science Data Discussions*, 2020:1–53, 2020.

Junjie Liu, Latha Baskaran, Kevin Bowman, David Schimel, A. Anthony Bloom, Nicholas C. Parazoo, Tomohiro Oda, Dustin Carroll, Dimitris Menemenlis, Joanna Joiner, Roisin Commane, Bruce Daube, Lucianna V. Gatii, Kathryn McKain, John Miller, Britton B. Stephens, Colm Sweeney, and Steven Wofsy. Carbon Monitoring System Flux Net Biosphere Exchange 2020 (CMS-Flux NBE 2020). *Earth System Science Data Discussions*, 2020:1–53, 2020.

Marcos Longo, Sassan Saatchi, Michael Keller, Kevin Bowman, António Ferraz, Paul R. Moorcroft, Douglas C. Morton, Damien Bonal, Paulo Brando, Benoît Burban, Géraldine Derroire, Maiza N. dos-Santos, Victoria Meyer, Scott Saleska, Susan Trumbore, and Grégoire Vincent. Impacts of Degradation on Water, Energy, and Carbon Cycling of the Amazon Tropical Forests. *Journal of Geophysical Research: Biogeosciences*, 125(8), 2020.

Joannes D. Maasakkers, Daniel J. Jacob, Melissa P. Sulprizio, Tia R. Scarpelli, Hannah Nesser, Jianxiong Sheng, Yuzhong Zhang, Xiao Lu, A. Anthony Bloom, Kevin W. Bowman, John R. Worden, and Robert J. Parker. 2010–2015 North American methane emissions, sectoral contributions, and trends: a high-resolution inversion of GOSAT satellite observations of atmospheric methane. *Atmospheric Chemistry and Physics Discussions*, 2020:1–28, 2020.

K. Miyazaki, K. Bowman, T. Sekiya, Z. Jiang, X. Chen, H. Eskes, M. Ru, Y. Zhang, and D. Shindell. Air Quality Response in China Linked to the 2019 Novel Coronavirus (COVID-19) Lockdown. *Geophysical Research Letters*, 47(19), 2020.

Kazuyuki Miyazaki, Kevin Bowman, Takashi Sekiya, Henk Eskes, Folkert Boersma, Helen Worden, Nathaniel Livesey, Vivienne H. Payne, Kengo Sudo, Yugo Kanaya, Masayuki Takigawa, and Koji Ogochi. An updated tropospheric chemistry reanalysis and emission estimates, TCR-2, for 2005–2018. *Earth System Science Data Discussions*, pages 1–64, 2020.

Kazuyuki Miyazaki, Kevin Bowman, Takashi Sekiya, Henk Eskes, Folkert Boersma, Helen Worden, Nathaniel Livesey, Vivienne H. Payne, Kengo Sudo, Yugo Kanaya, Masayuki Takigawa, and Koji Ogochi. Updated tropospheric chemistry reanalysis and emission estimates, TCR-2, for 2005–2018. *Earth System Science Data*, 12(3):2223–2259, 2020.

Kazuyuki Miyazaki, Kevin W. Bowman, Keiya Yumimoto, Thomas Walker, and Kengo Sudo. Evaluation of a multi-model, multi-constituent assimilation framework for tropospheric chemical reanalysis. *Atmospheric Chemistry and Physics*, 20(2):931–967, 2020.

Gregory R. Quetin, A. Anthony Bloom, Kevin W. Bowman, and Alexandra G. Konings. Carbon Flux Variability From a Relatively Simple Ecosystem Model With Assimilated Data Is Consistent With Terrestrial Biosphere Model Estimates. *Journal of Advances in Modeling Earth Systems*, 12(3), 2020.

Yi Yin, A. Anthony Bloom, John Worden, Sassan Saatchi, Yan Yang, Mathew Williams, Junjie Liu, Zhe Jiang, Helen Worden, Kevin Bowman, Christian Frankenberg, and David Schimel. Fire decline in dry tropical ecosystems enhances decadal land carbon sink. *Nature Communications*, 11(1):1900, 2020.

Martha P. Butler, Thomas Lauvaux, Sha Feng, Junjie Liu, Kevin W. Bowman, and Kenneth J. Davis. Mass-conserving coupling of total column CO2 (XCO2) from global to mesoscale models: Case study with CMS-Flux inversion system and WRF-Chem (v3.6.1). *Geoscientific Model Development Discussions*, pages 1–35, 2019.

Alexandra G. Konings, A. Anthony Bloom, Junjie Liu, Nicholas C. Parazoo, David S. Schimel, and Kevin W. Bowman. Global satellite-driven estimates of heterotrophic respiration. *Biogeosciences*, 16(11):2269–2284, 2019.

Joannes D. Maasakkers, Daniel J. Jacob, Melissa P. Sulprizio, Tia R. Scarpelli, Hannah Nesser, Jian-Xiong Sheng, Yuzhong Zhang, Monica Hersher, A. Anthony Bloom, Kevin W. Bowman, John R. Worden, Greet Janssens-Maenhout, and Robert J. Parker. Global distribution of methane emissions, emission trends, and OH concentrations and trends inferred from an inversion of GOSAT satellite data for 2010–2015. *Atmospheric Chemistry and Physics Discussions*, pages 1–36, 2019.

Joannes D. Maasakkers, Daniel J. Jacob, Melissa P. Sulprizio, Tia R. Scarpelli, Hannah Nesser, Jian-Xiong Sheng, Yuzhong Zhang, Monica Hersher, A. Anthony Bloom, Kevin W. Bowman, John R. Worden, Greet Janssens-Maenhout, and Robert J. Parker. Global distribution of methane emissions, emission trends, and OH concentrations and trends inferred from an inversion of GOSAT satellite data for 2010–2015. *Atmospheric Chemistry and Physics*, 19(11):7859–7881, 2019.

K. Miyazaki, T. Sekiya, D. Fu, K. W. Bowman, S. S. Kulawik, K. Sudo, T. Walker, Y. Kanaya, M. Takigawa, K. Ogochi, H. Eskes, K. F. Boersma, A. M. Thompson, B. Gaubert, J. Barre, and L. K. Emmons. Balance of Emission and Dynamical Controls on Ozone During the Korea-United States Air Quality Campaign From Multiconstituent Satellite Data Assimilation. *Journal of Geophysical Research: Atmospheres*, 124(1):387–413, 2019.

Andrew E. Schuh, Andrew R. Jacobson, Sourish Basu, Brad Weir, David Baker, Kevin Bowman, Frédéric Chevallier, Sean Crowell, Kenneth J. Davis, Feng Deng, Scott Denning, Liang Feng, Dylan Jones, Junjie Liu, and Paul I. Palmer. Quantifying the Impact of Atmospheric Transport Uncertainty on CO2 Surface Flux Estimates. *Global Biogeochemical Cycles*, 33(4):484–500, 2019.

John R. Worden, Susan S. Kulawik, Dejian Fu, Vivienne H. Payne, Alan E. Lipton, Igor Polonsky, Yuguang He, Karen Cady-Pereira, Jean-Luc Moncet, Robert L. Herman, Fredrick W. Irion, and Kevin W. Bowman. Characterization and evaluation of AIRS-based estimates of the deuterium content of water vapor. *Atmospheric Measurement Techniques*, 12(4):2331–2339, 2019.

Yi Yin, Kevin Bowman, A Anthony Bloom, and John Worden. Detection of fossil fuel emission trends in the presence of natural carbon cycle variability. *Environmental Research Letters*, 14(8):084050, 2019.

Kevin W. Bowman, Noel Cressie, Xin Qu, and Alex Hall. A Hierarchical Statistical Framework for Emergent Constraints: Application to Snow-Albedo Feedback. *Geophysical Research Letters*, 45(23):13,050–13,059, 2018.

Dejian Fu, Susan S. Kulawik, Kazuyuki Miyazaki, Kevin W. Bowman, John R. Worden, Annmarie Eldering, Nathaniel J. Livesey, Joao Teixeira, Fredrick W. Irion, Robert L. Herman, Gregory B. Osterman, Xiong Liu, Pieternel F. Levelt, Anne M. Thompson, and Ming Luo. Retrievals of tropospheric ozone profiles from the synergism of AIRS and OMI: methodology and validation. *Atmospheric Measurement Techniques*, 11(10):5587–5605, 2018.

R. M. B. Harris, L. J. Beaumont, T. R. Vance, C. R. Tozer, T. A. Remenyi, S. E. Perkins-Kirkpatrick, P. J. Mitchell, A. B. Nicotra, S. McGregor, N. R. Andrew, M. Letnic, M. R. Kearney, T. Wernberg, L. B. Hutley, L. E. Chambers, M.-S. Fletcher, M. R. Keatley, C. A. Woodward, G. Williamson, N. C. Duke, and D. M. J. S. Bowman. Biological responses to the press and pulse of climate trends and extreme events. *Nature Climate Change*, 8(7):579–587, 2018.

Junjie Liu, Kevin Bowman, Nicholas C Parazoo, A Anthony Bloom, Debra Wunch, Zhe Jiang, Kevin R Gurney, and Dave Schimel. Detecting drought impact on terrestrial biosphere carbon fluxes over contiguous US with satellite observations. *Environmental Research Letters*, 13(9):095003, 2018.

Junjie Liu, Kevin W. Bowman, David Schimel, Nicolas C. Parazoo, Zhe Jiang, Meemong Lee, A. Anthony Bloom, Debra Wunch, Christian Frankenberg, Ying Sun, Christopher W. O'Dell, Kevin R. Gurney, Dimitris Menemenlis, Michelle Gierach, David Crisp, and Annmarie Eldering. Response to Comment on "Contrasting carbon cycle responses of the tropical continents to the 2015–2016 El Niño". *Science*, 362(6418):eaat1211, 2018.

Junjie Liu, Kevin Bowman, Nicholas C Parazoo, A Anthony Bloom, Debra Wunch, Zhe Jiang, Kevin R Gurney, and Dave Schimel. Detecting drought impact on terrestrial biosphere carbon fluxes over contiguous US with satellite observations. *Environmental Research Letters*, 13(9):095003, 2018.

David M. J. S. Bowman, Grant J. Williamson, John T. Abatzoglou, Crystal A. Kolden, Mark A. Cochrane, and Alistair M. S. Smith. Human exposure and sensitivity to globally extreme wildfire events. *Nature Ecology & Evolution*, 1(3):0058, 2017.

K. W. Bowman, J. Liu, A. A. Bloom, N. C. Parazoo, M. Lee, Z. Jiang, D. Menemenlis, M. M. Gierach, G. J. Collatz, K. R. Gurney, and D. Wunch. Global and Brazilian Carbon Response to El Niño Modoki 2011–2010. *Earth and Space Science*, 4(10):637–660, 2017.

Karen E. Cady-Pereira, Vivienne H. Payne, Jessica L. Neu, Kevin W. Bowman, Kazuyuki Miyazaki, Eloise A. Marais, Susan Kulawik, Zitely A. Tzompa-Sosa, and Jennifer D. Hegarty. Seasonal and spatial changes in trace gases over megacities from Aura TES observations: two case studies. *Atmospheric Chemistry and Physics*, 17(15):9379–9398, 2017.

Min Huang, Gregory R. Carmichael, R. Bradley Pierce, Duseong S. Jo, Rokjin J. Park, Johannes Flemming, Louisa K. Emmons, Kevin W. Bowman, Daven K. Henze, Yanko Davila, Kengo Sudo, Jan Eiof Jonson, Marianne Tronstad Lund, Greet Janssens-Maenhout, Frank J. Dentener, Terry J. Keating, Hilke Oetjen, and Vivienne H. Payne. Impact of intercontinental pollution transport on North American ozone air pollution: an HTAP phase 2 multi-model study. *Atmospheric Chemistry and Physics*, 17(9):5721–5750, 2017.

Le Kuai, Kevin W Bowman, Helen M Worden, Robert L Herman, and Susan S Kulawik. Hydrological controls on the tropospheric ozone greenhouse gas effect. *Elem Sci Anth*, 5(0):10, 2017.

Junjie Liu, Kevin W. Bowman, David S. Schimel, Nicolas C. Parazoo, Zhe Jiang, Meemong Lee, A. Anthony Bloom, Debra Wunch, Christian Frankenberg, Ying Sun, Christopher W. O'Dell, Kevin R. Gurney, Dimitris Menemenlis, Michelle Gierach, David Crisp, and Annmarie Eldering. Contrasting carbon cycle responses of the tropical continents to the 2015–2016 El Niño. *Science*, 358(6360):eaam5690, 2017.

Kazuyuki Miyazaki, Henk Eskes, Kengo Sudo, K. Folkert Boersma, Kevin Bowman, and Yugo Kanaya. Decadal changes in global surface NOx emissions from multi-constituent satellite data assimilation. *Atmospheric Chemistry and Physics*, 17(2):807–837, 2017.

Kazuyuki Miyazaki and Kevin Bowman. Evaluation of ACCMIP ozone simulations and ozonesonde sampling biases using a satellite-based multi-constituent chemical reanalysis. *Atmospheric Chemistry and Physics*, 17(13):8285–8312, 2017.

John R. Worden, Gary Doran, Susan Kulawik, Annmarie Eldering, David Crisp, Christian Frankenberg, Chris O'Dell, and Kevin Bowman. Evaluation and attribution of OCO-2 XCO2 uncertainties. *Atmospheric Measurement Techniques*, 10(7):2759–2771, 2017.

Wayana Dolan, Vivienne H. Payne, Susan S. Kualwik, and Kevin W. Bowman. Satellite observations of ethylene (C2H4) from the Aura Tropospheric Emission Spectrometer: A scoping study. *Atmospheric Environment*, 141:388–393, 2016.

Dejian Fu, Kevin W. Bowman, Helen M. Worden, Vijay Natraj, John R. Worden, Shanshan Yu, Pepijn Veefkind, Ilse Aben, Jochen Landgraf, Larrabee Strow, and Yong Han. High-resolution tropospheric carbon monoxide profiles retrieved from CrIS and TROPOMI. *Atmospheric Measurement Techniques*, 9(6):2567–2579, 2016.

Junjie Liu, Kevin W. Bowman, and Meemong Lee. Comparison between the Local Ensemble Transform Kalman Filter (LETKF) and 4D-Var in atmospheric CO2 flux inversion with the Goddard Earth Observing System-Chem model and the observation impact diagnostics from the LETKF. *Journal of Geophysical Research: Atmospheres*, 121(21):13,066–13,087, 2016.

Junjie Liu and Kevin Bowman. A method for independent validation of surface fluxes from atmospheric inversion: Application to CO2. *Geophysical Research Letters*, 43(7):3502–3508, 2016.

Joannes D Maasakkers, Daniel J Jacob, Melissa P Sulprizio, Alexander J Turner, Melissa Weitz, Tom Wirth, Cate Hight, Mark DeFigueiredo, Mausami Desai, Rachel Schmeltz, Leif Hockstad, Anthony A Bloom, Kevin W Bowman, Seongeun Jeong, and Marc L Fischer. Gridded National Inventory of U.S. Methane Emissions. *Environmental Science & Technology*, 2016.

Georgios Matheou and Kevin W. Bowman. A recycling method for the large-eddy simulation of plumes in the atmospheric boundary layer. *Environmental Fluid Mechanics*, 16(1):69–85, 2016.

Kazuyuki Miyazaki and Kevin Bowman. Evaluation of ACCMIP ozone simulations using a multi-constituent chemical reanalysis. *Atmospheric Chemistry and Physics Discussions*, pages 1–39, 2016.

N. Bousserez, D. K. Henze, A. Perkins, K. W. Bowman, M. Lee, J. Liu, F. Deng, and D. B. A. Jones. Improved analysis-error covariance matrix for high-dimensional variational inversions: application to source estimation using a 3D atmospheric transport model. *Quarterly Journal of the Royal Meteorological Society*, 141(690):1906–1921, 2015.

H. Brix, D. Menemenlis, C. Hill, S. Dutkiewicz, O. Jahn, D. Wang, K. Bowman, and H. Zhang. Using Green's Functions to initialize and adjust a global, eddying ocean biogeochemistry general circulation model. *Ocean Modelling*, 95:1–14, 2015.

F. Deng, D. B. A. Jones, T. W. Walker, M. Keller, K. W. Bowman, D. K. Henze, R. Nassar, E. A. Kort, S. C. Wofsy, K. A. Walker, A. E. Bourassa, and D. A. Degenstein. Sensitivity analysis of the potential impact of discrepancies in stratosphere–troposphere exchange on inferred sources and sinks of CO2. *Atmospheric Chemistry and Physics*, 15(20):11773–11788, 2015.

S. Doniki, D. Hurtmans, L. Clarisse, C. Clerbaux, H. M. Worden, K. W. Bowman, and P.-F. Coheur. Instantaneous longwave radiative impact of ozone: an application on IASI/MetOp observations. *Atmospheric Chemistry and Physics*, 15(22):12971–12987, 2015.

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Le Kuai, John R Worden, Elliott J Campbell, Susan S Kulawik, King-Fai Li, Meemong Lee, Richard J Weidner, Stephen A Montzka, Fred L Moore, Joe A Berry, Ian Baker, Scott A Denning, Huisheng Bian, Kevin W Bowman, Junjie Liu, and Yuk L Yung. Estimate of carbonyl sulfide tropical oceanic surface fluxes using Aura Tropospheric Emission Spectrometer observations. *Journal of Geophysical Research: Atmospheres*, 120(20):11,012–11,023, 2015.

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