

# Kevin W. Bowman

Senior Technical Staff

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## Experience

### **Senior Member of Technical Staff, Jet Propulsion Laboratory, Pasadena, CA - 1997-Present**

- Assimilation and inverse modeling of atmospheric composition including ozone, carbon monoxide, and CO<sub>2</sub> observations into global chemistry and transport models
- Observational constraints on ozone radiative forcing in chemistry-climate models
- Observing system simulation experiments (OSSE) to support mission formulation for atmospheric composition
- Conception and development of non-linear optimal estimation and error analysis algorithms for vertical trace gas retrievals.
- Conception and development of calibration algorithms for Fourier Transform Spectrometers.

### **NASA Graduate Student Researcher's Program Fellow, Georgia Institute of Technology, 1993-1997**

- Wavelet-based algorithms for wavefront estimation and reconstruction in adaptive optical systems.
- Developed wavelet-based Wiener filtering techniques for stationary and non-stationary stochastic processes.

## Education

Georgia Institute of Technology, Georgia - Phd in Electrical Engineering, 1997

Thesis: Application of Wavelets to Adaptive Optical Systems and Multiresolution Wiener Filtering

Georgia Institute of Technology, Georgia - MSEE, 1992

Concentrations: Optics and Signal Processing

Ecole Supérieure d'Electricité (SUPELEC), Metz, FRANCE - Diplôme de Spécialisation en Traitement et Transmission des Informations, 1993

Auburn University, Alabama - Bachelor of Electrical Engineering, 1991

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## Projects

Chemical evolution of Boreal Fires from TES during the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites campaign, (2008-11)

Co-I NASA ROSES 2007 Tropospheric Chemistry: Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS),

Sensor Web Operations Explorer: a tool for exploring the scientific impact of different mission simulations (2006-09)

Co-I NASA ROSES 2005 Advanced Information Systems Technology (AIST)

Analysis of Aura and Related Satellite Observations: Mapping Trace Gas Emissions and Quantifying Long-range Transport of Pollution (2006-09):

Co-I NASA ROSES 2005

Convective scale transport of trace gases assessed with models and satellite observations (2006-09)

Co-I NASA ROSES 2005

Atmospheric Chemical Data Assimilation: A Critical Tool for Enhancing Scientific Return from Space-based Observations and for Defining and Designing New Atmospheric Composition Missions (2005-06)

Co-I JPL Director's Research Discretionary Fund (DRDF)

Parallelization of the GEOS-Chem model on the JPL Institutional Cluster (2004-05)

PI JPL R&TD Strategic Initiative

Assessing the Potential of TES Observations for Mapping Global Sources of Atmospheric Carbon Monoxide (2002-03)

JPL Principle Investigator

(PI)—Caltech President's Fund,

## Awards

NASA Group Achievement Award as a member of the 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 (2005)

## Field Campaigns

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 (2006)

## Professional Activities

JPL Earth system assimilation working group lead (ESAWG) (2007-08)

GEOS-Chem Steering Committee Adjoint Model and Data Assimilation Chair (2009-present)

AGU Fall Meeting (2007). Presiding: Evaluation of Air Quality Models and Assessment of Emissions Inventories Using Bottom-Up and Top-Down Approaches III: Source and State Data Assimilation of Satellite and in Situ Measurements in Atmospheric Chemistry

Member of AGU

Reviewer for Journal of Geophysical Research, Geophysical Research Letters, Atmospheric Chemistry and Physics, Journal of Computational Physics, Applied Optics

### Review panels

Canadian Space Agency (CSA) International Panel Review Solar-terrestrial and Atmospheric Sciences Division (2010)

CNES Infrared Atmospheric Sounder Interferometer (IASI) calibration algorithm review board (2000)

NASA Orbital Carbon Observatory (OCO) internal JPL review panel (2003)

NASA Modeling, Analysis, and Prediction: Climate variability and change review panel (2005)

NASA Measurements, Modeling, and Analyses in Support of AURA and other NASA Satellite Observations of the Earth's atmosphere review panel (2005)

### Selected Conference Presentations and Invited Talks

K. **Bowman**, P. Hamer, *et al*, "Observing System Simulation Experiments (OSSE) in support of GEO-CAPE science and measurement requirements definition", GEO-CAPE Workshop, Maryland, 2009

K. **Bowman**, "GEOS-Chem Adjoint: Status from the Adjoint Working Group", GEOS-Chem User's Group Meeting, Boston, 2009

K. **Bowman et al**, "Observational constraints on the vertical distribution of instantaneous ozone radiative forcing in chemistry climate models", Hemispheric Transport of Air Pollution (HTAP), Paris, 2009

K. **Bowman et al**, "The role of tropospheric ozone in air quality and climate: new insights from satellites, modeling and assimilation", Atmospheric Composition Constellation, ACC-4, Constellation of Earth Observing Systems (CEOS) workshop, Frascati, Italy, 2009

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K. **Bowman et al**, "The information content of HDO: a preliminary inquiry", TES science team meeting, Boulder, CO, 2009

K. **Bowman et al**, "Observational Constraints on climate feedbacks: a pan-spectral approach", CLARREO Science Team Meeting, Langley, VA, 2009

## Publications

### Submitted/in press

A. M. Aghedo, K. W. **Bowman**, H. M. Worden, S. S. Kulawik, D. T. Shindell, J. F. Lamarque, G. Faluvegi, M. Parrington, D. J. A. Jones, and S. Rast, "The vertical distribution of ozone instantaneous radiative forcing from satellite and chemistry climate models", *submitted, JGR*

H. Worden, K. **Bowman**, S. Kulawik, and A. Aghedo, "Instantaneous radiative kernels for tropospheric ozone: Satellite observations of longwave flux sensitivity to ozone from Aura-TES", *submitted, JGR*

J. Lee, J. Worden, D. Noone, K. **Bowman, et al**, "Relating tropical ocean clouds to moist processes using water vapor isotope measurements", *submitted, ACPD*

S. R. Felker, J. L. Moody, A. J. Wimmers, G. Osterman, and K. **Bowman**, "A Multi-sensor Upper Tropospheric Ozone Product (MUTOP) based on TES Ozone and GOES Water Vapor: I. Derivation"

### Published

D. B. A. Jones, K. **Bowman**, J. Logan, C. Heald, J. Liu., M. Luo, J. Worden, and J. Drummond. The zonal structure of tropical O<sub>3</sub> and CO as observed by the Tropospheric Emission Spectrometer in November 2004 Part 1: Inverse modeling of CO emissions. *Atmos. Chem. Phys.*, 9(11):3547–3562, 06 2009/06/03.

K. W. **Bowman**, D. B. A. Jones, J. A. Logan, H. Worden, F. Boersma, R. Chang, S. Kulawik, G. Osterman, P. Hamer, and J. Worden. The zonal structure of tropical O<sub>3</sub> and CO as observed by the Tropospheric Emission Spectrometer in November 2004 Part 2: Impact of surface emissions on O<sub>3</sub> and its precursors. *Atmos. Chem. Phys.*, 9(11):3563–3582, 06 2009/06/03.

M. Parrington, D. B. A. Jones, K. W. **Bowman**, A. M. Thompson, D. W. Tarasick, J. Merrill, S. J. Oltmans, T. Leblanc, J. C. Witte, and D. B. Millet. Impact of the assimilation of ozone from the tropospheric emission spectrometer on surface ozone across north america. *Geophys. Res. Lett.*, 36, 02 2009/02/25.

R. B. Pierce, J. Al-Saadi, C. Kittaka, T. Schaack, A. Lenzen, K. **Bowman**, J. Szykman, A. Soja, T. Ryerson, A. M. Thompson, P. Bhartia, and G. A. Morris. Impacts of background ozone

production on Houston and Dallas, Texas, air quality during the Second Texas Air Quality Study field mission. *J. Geophys. Res.*, **114**, 05 2009.

J. Worden, D. B. A. Jones, J. Liu, M. Parrington, K. **Bowman**, I. Stajner, R. Beer, J. Jiang, V. Thouret, S. Kulawik, J.-L. F. Li, S. Verma, and H. Worden. Observed vertical distribution of tropospheric ozone during the asian summertime monsoon. *J. Geophys. Res.*, **114**, 07 2009.

S. Verma, J. Worden, B. Pierce, D. B. A. Jones, J. Al-Saadi, F. Boersma, K. **Bowman**, A. Eldering, B. Fisher, L. Jourdain, S. Kulawik, and H. Worden. Ozone production in boreal fire smoke plumes using observations from the tropospheric emission spectrometer and the ozone monitoring instrument. *J. Geophys. Res.*, **114**, 01 2009.

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K. Singh, P. Eller, A. Sandu, D. Henze, K. **Bowman**, M. Kopacz, and M. Lee. Towards the construction of a standard adjoint geos-chem model. In *SpringSim '09: Proceedings of the 2009 Spring Simulation Multiconference*, pages 1–8, San Diego, CA, USA, 2009. Society for Computer Simulation International.

H. M. Worden, K. W. **Bowman**, J. R. Worden, A. Eldering, and R. Beer. Satellite measurements of the clear-sky greenhouse effect from tropospheric ozone. *Nature Geoscience*, 20 April 2008.

M. Parrington, D. B. A. Jones, K. W. **Bowman**, L. W. Horowitz, A. M. Thompson, D. W. Tarasick, and J. C. Witte. Estimating the summertime tropospheric ozone distribution over North America through assimilation of observations from the Tropospheric Emission Spectrometer. *J. Geophys. Res.*, **113**, 2008.

S. S. Kulawik, K. W. **Bowman**, M. Luo, C. D. Rodgers, and L. Jourdain. Impact of nonlinearity on changing the a priori of trace gas profile estimates from the Tropospheric Emission Spectrometer (TES). *Atmospheric Chemistry and Physics*, **8**(12):3081–3092, 2008.

A. Eldering, S. S. Kulawik, J. Worden, K. **Bowman**, and G. Osterman. Implementation of cloud retrievals for TES atmospheric retrievals: 2. Characterization of cloud top pressure and effective optical depth retrievals. *J. Geophys. Res.*, **113**, 2008.

J. Fishman, K. W. **Bowman**, J. P. Burrows, A. Richter, K. V. Chance, D. P. Edwards, R. V. Martin, G. A. Morris, R. B. Pierce, J. R. Ziemke, J. A. Al-Saadi, J. K. Creilson, T. K. Schaack, and A. M. Thompson. Remote sensing of tropospheric pollution from space. *Bulletin of the American Meteorological Society*, **89**(6):805–821, 2008.

J. Logan, I. Megretskaja, R. Nassar, L. T. Murray, L. Zhang, K. W. **Bowman**, H. M. Worden, and M. Luo. Effects of the 2006 El Niño on tropospheric composition as revealed by data from the Tropospheric Emission Spectrometer (TES). *Geophys. Res. Lett.*, **35**, 15 February 2008.

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L. Zhang, D. J. Jacob, K. F. Boersma, D. A. Jaffe, J. R. Olson, K. W. **Bowman**, J. R. Worden, A. M. Thompson, M. A. Avery, R. C. Cohen, J. E. Dibb, F. M. Flock, H. E. Fuelberg, L. G. Huey, W. W. McMillan, H. B. Singh, and A. J. Weinheimer. Transpacific transport of ozone pollution and the effect of recent asian emission increases on air quality in north america: an integrated analysis using satellite, aircraft, ozonesonde, and surface observations. *Atmospheric Chemistry and Physics*, 8(20):6117–6136, 2008.

J. Al-Saadi, A. Soja, R. B. Pierce, J. Szykman, C. Wiedinmyer, L. Emmons, S. Kondragunta, X. Zhang, C. Kittaka, T. Schaack, and K. **Bowman**. Intercomparison of near-real-time biomass burning emissions estimates constrained by satellite fire data. *J. Appl. Remote Sens.*, 2(021504), 30 May 2008.

R. Nassar, J. Logan, H. Worden, I. A. Megretskaia, K. **Bowman**, G. Osterman, A. M. Thompson, D. W. Tarasick, S. Austin, H. Claude, M. K. Dubey, W. K. Hocking, B. J. Johnson, E. Joseph, J. Merrill, G. A. Morris, M. Newchurch, S. J. Oltmans, F. Posny, and F. Schmidlin. Validation of Tropospheric Emission Spectrometer (TES) Nadir Ozone Profiles Using Ozonesonde Measurements. *J. Geophys. Res.*, 113, 2008.

G. Osterman, S. Kulawik, H. Worden, N. Richards, B. Fisher, A. Eldering, M. Shephard, L. Froidevaux, G. Labow, M. Luo, R. Herman, and K. **Bowman**. Validation of tropospheric emission spectrometer (TES) measurements of the total, stratospheric and tropospheric column abundance of ozone. *J. Geophys. Res.*, 113, October 2008.

M. W. Shephard, H. M. Worden, K. E. Cady-Pereira, M. Lampel, M. Luo, K. W. **Bowman**, E. Sarkissian, R. Beer, D. M. Rider, D. C. Tobin, H. E. Revercomb, B. M. Fisher, D. Tremblay, S. A. Clough, G. B. Osterman, and M. Gunson. Tropospheric emission spectrometer spectral radiance comparisons. *J. Geophys. Res.*, 113, 2008.

R. Beer, M. W. Shephard, S. S. Kulawik, S. A. Clough, A. Eldering, K. W. **Bowman**, S. P. Sander, B. M. Fisher, V. Payne, M. Luo, G. B. Osterman, and J. R. Worden. First satellite observations of lower tropospheric ammonia and methanol. *Geophys. Res. Lett.*, 35, 2008.

Worden, J, D. Noone, K.W. **Bowman**, et al, "Importance of rain evaporation and continental convection in the tropical water cycle", *Nature*, 445, 2007, doi:10.1038/nature05508

Preliminary Findings from the Second Texas Air Quality Study (TexAQS II) A Report to the Texas Commission on Environmental Quality by the TexAQS II Rapid Science Synthesis Team, October, 2006, K.W. **Bowman**-RSS team member, available at

[http://www.tceq.state.tx.us/assets/public/implementation/air/am/workshop/20061012-13/RSST\\_Preliminary\\_Findings\\_Report\\_20061031.pdf](http://www.tceq.state.tx.us/assets/public/implementation/air/am/workshop/20061012-13/RSST_Preliminary_Findings_Report_20061031.pdf)

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L. Zhang, D. J. Jacob, K. W. **Bowman**, et al. "Ozone-CO correlations determined by the TES satellite instrument in continental outflow regions." *Geophys. Res. Lett.*, 33, 2006.

Richards, N. A. D., Q. Li, K. W. **Bowman** et al, "Assimilation of TES CO into a global CTM: First results", *Atmos. Chem. Phys. Discuss*, 6:11727–11743, 2006

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Worden, J, X. Liu, K.W. **Bowman** et al,(2007) "Improved Tropospheric Ozone Profiles using OMI and TES Radiances", *Geophys. Res. Lett.*, 34, L01809, 10.1029/2006GL027806

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Rinsland, C. P., M. Luo, J. A. Logan, R. Beer, H. M. Worden, J. R. Worden, K. **Bowman**, et al, "Nadir Measurements of carbon monoxide distributions by the Tropospheric Emission

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Spectrometer onboard the Aura Spacecraft: Overview of analysis approach and examples of initial results, *Geophys. Res. Lett.*, 33, L22806, doi:10.1029/2006GL027000, November 22, 2006.

Worden, H., R. Beer, K.W. **Bowman**, et al, "TES level 1 algorithms: interferogram processing, geolocation, radiometric, and spectral calibration", *IEEE Transactions on Geoscience and Remote Sensing*, Volume 44, Issue 5, May 2006 Page(s):1288 - 1296

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**Bowman**, K.W., H.M. Worden, and R. Beer, "Instrument line-shape modeling and correction for off-axis detectors in Fourier-transform spectrometry" (2000), *Appl. Optics*, Vol 39, No. 21

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