Dr. John R Worden

Jet Propulsion Laboratory
California Institute of Technology
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Current Responsibilities

Deputy Section Manager JPL Earth Sciences
Member of the Aura TES Science Team
Member of the OCO-2 Validation Team
Member GEOCAPE Working Group
TEMPO Mission Standing Review Board Science Lead

Research Interests

Remote sensing of the vertical structure of important climate and air-quality tropospheric trace gases such as H_2O and HDO, Ozone, CH_4, CO_2, CO, PAN, and OCS.

Quantifying the natural and anthropogenic processes affecting the water, carbon, and nitrogen cycles, atmospheric chemistry, and their linkages.

Education

Doctorate in Physics
University of Colorado 1996
Thesis: A multi-component model of Solar Irradiance Variability

Bachelor of Science in Physics
University of California at Santa Cruz 1990

Postdocs Mentored

- Dr. Anthony Bloom (2014 – Present) Processes controlling atmospheric CH_4 and CO_2
- Dr. Zhe Jiang (2013 – Present) Sensitivity of Tropospheric ozone to natural and anthropogenic emissions
- Dr. Nicholas Parazoo (2013- Present)
- Dr. Le Kuai (2011 – Present): Remote sensing of CO_2 profiles and tropospheric OCS, Quantifying fluxes of OCS and Methane
- Dr. Richard Dupont (2008 – 2011): Ozone production in boreal fires
- Dr. Jeonghoon Lee (2008 – 2011): Quantifying tropospheric moisture processes using water vapor isotope measurements
- Dr. Sunita Verma (2008 – 2009): Ozone production in boreal fires

Papers Published

I have authored or co-authored over 100 papers on the remote sensing of tropospheric trace gases, the use of water vapor isotopes to show how rainfall evaporation and entrainment affect shallow and deep tropical convection, the role of fires and dynamics on tropospheric ozone and methane, and flux estimates for CO, CO_2, CH_4, and OCS and their process controls.

Current H # of 27

Current list of papers at end of CV or see http://scholar.google.com/citations?user=BPjZUbYAAAAJ&hl=en

Professional Experience

May 2014 – Present: Deputy Section Manager for the JPL Earth Science Section
2010 – May 2014: PI for the Aura TES instrument and Group Supervisor for the Tropospheric Sounding, Assimilation, and Modeling Group, JPL
2007 – 2010: Deputy PI and Group Supervisor for the Aura TES instrument and algorithm team, JPL
2002–2007: Research Scientist, JPL
2000 – 2002: Scientist, Raytheon ITSS: Pasadena
1999 – 2000: Scientist, Atmospheric Environmental Research

Awards

2014 NASA Group Award Aura TES
2008: NASA Group Award Aura TES
2008: JPL Spot Award, OCO tiger team
2007: JPL Ranger Award, For development of the TES water vapor isotope product
2007: JPL Team Award, For reducing L2 processing time in order to meet project processing requirements
2006: JPL Spot Award, TES animation
2005: JPL Team Award, Production of first TES data sets
2004: JPL Bonus Award, Outstanding accomplishment for L2 algorithm development
2004: JPL Team Bonus Award, TES
2001: Raytheon ITSS, Employee of the year

Invited Talks

September 2014: EUMETSAT Conference Keynote (Atmospheric Composition)
"Global Changes In Ozone Pre-Cursor Emissions And The Intercontinental Transport Of Pollution "

June 2014: Goddard Institute of Space Sciences / Columbia University
"Tropospheric Ozone, Composition, and Climate from the Aura Tropospheric emission Spectrometer"

May 2014: Utrecht University, Netherlands
"Tropospheric Ozone, Composition, and Climate from the Aura Tropospheric emission Spectrometer"

April 2014: NASA HQ, Washington D.C.
"Tropospheric Ozone, Composition, and Climate from the Aura Tropospheric emission Spectrometer"

May 2012: ASSFTS, Madison Wisconsin
"Overview of TES project and science"

May 2011: BASIN Isotope Conference, Keystone Colorado
"Aura TES water vapor isotope measurements"

April 2010: Water Isotope Workshop, Paris France
"Aura TES water vapor isotope measurements"

February 2009: Seminar, U. of Toronto
"TES Water Vapor Isotopes, Measurement And Science"

September 2009: Caltech Keck Water Cycle Conference
"Remote Sensing Of Water Vapor And Its Isotopes"

Technical Experience and Knowledge

Computer Languages: IDL, C, C++, Fortran

Developed super computer cluster requirements and algorithms for fast parallel processing of satellite data.

Bayesian estimation and error characterization of large-state space systems

Radiative Transfer in Terrestrial and Solar Atmospheres

Published and In Press (see accepted / submitted at end of document)

1. Bloom AA, Worden J, Jiang Z, Worden H, Kurosu TP, Frankenberg C, et al. Remote-sensing constraints on South Americafire traits by Bayesian fusion of atmospheric and surface data. Geophys. Res. Lett. 2015.

2. Alvarado MJ, Payne VH, Cady-Pereira KE, Hegarty JD, Kulawik SS, Wecht KJ, et al. Impacts of updated spectroscopy on thermal infrared retrievals of methane evaluated with HIPPO data. Atmos. Meas. Tech. 2015;8:965–85.

3. Lacour JL, Clarisse L, Worden J, Schneider M, Barthlott S, Hase F, et al. Cross-validation of IASI/MetOp derived tropospheric δD with TES and ground-based FTIR observations. Atmos. Meas. Tech. 2015;8:1447–66.

4. Sutanto SJ, Hoffmann G, Scheepmaker RA, Worden J, Houweling S, Yoshimura K, et al. Global-scale remote sensing of water isotopologues in the troposphere: representation of first-order isotope effects. Atmos. Meas. Tech. 2015;8:999–1019.

5. Jiang Z, Worden JR, Jones DBA, Lin JT, Verstraeten WW, Henze DK. Constraints on Asian ozone using Aura TES, OMI and Terra MOPITT. Atmospheric Chemistry and Physics. 2015;15:99–112.

6. Huang M, Bowman KW, Carmichael GR, Chai T, Pierce RB, Worden JR, et al. Changes in nitrogen oxides emissions in California during 2005–2010 indicated from top-down and bottom-up emission estimates. Journal of Geophysical Research-Atmospheres. 2014;:1–25.

7. Field RD, Kim D, LeGrande AN, Worden J, Kelley M, Schmidt GA. Evaluating climate model performance in the tropics with retrievals of water isotopic composition from Aura TES. Geophys. Res. Lett. 2014;:n/a–n/a.

8. Neu JL, Flury T, Manney GL, Santee ML, Livesey NJ, Worden J. Tropospheric ozone variations governed by changes in stratospheric circulation. Nature Geoscience. 2014.

9. Herman RL, Cherry JE, Young J, Welker JM, Noone D, Kulawik SS, et al. Aircraft validation of Aura Tropospheric Emission Spectrometer retrievals of HDO / H_2O. Atmos. Meas. Tech. 2014;7:3127–38.

10. Kuai L, Worden J, Kulawik SS, Montzka SA, Liu J. Characterization of Aura TES carbonyl sulfide retrievals over ocean. Atmos. Meas. Tech. 2014;7:163–72.

11. Oetjen H, Payne VH, Kulawik SS, Eldering A, Worden J, Edwards DP, et al. Extending the satellite data record of tropospheric ozone profiles from Aura-TES to MetOp-IASI: characterisation of optimal estimation retrievals. Atmos. Meas. Tech. 2014;7:4223–36.

12. Payne VH, Alvarado MJ, Cady-Pereira KE, Worden JR, Kulawik SS, Fischer EV. Satellite observations of peroxyacetyl nitrate from the Aura Tropospheric Emission Spectrometer. Atmos. Meas. Tech. 2014;7:3737–49.

13. Kahn BH, Irion FW, Dang VT, Manning EM, Nasiri SL, Naud CM, et al. The Atmospheric Infrared Sounder version 6 cloud products. Atmospheric Chemistry and Physics. 2014;14:399–426.

14. Gryazin V, Risi C, Jouzel J, Kurita N, Worden J, Frankenberg C, et al. To what extent could water isotopic measurements help us understand model biases in the water cycle over Western Siberia. Atmospheric Chemistry and Physics Discussions. Copernicus GmbH; 2014;14:9807–30.

15. Wecht KJ, Jacob DJ, Sulprizio MP, Santoni GW, Wofsy SC, Parker R, et al. Spatially resolving methane emissions in California: constraints from the CalNex aircraft campaign and from present (GOSAT, TES) and future (TROPOMI, geostationary) satellite observations. Atmospheric Chemistry and Physics Discussions. Copernicus GmbH; 2014;14:4119–48.

16. Neu JL, Hegglin MI, Tegtmeier S, Bourassa A, Degenstein D, Froidevaux L, et al. The SPARC Data Initiative: Comparison of upper troposphere/lower stratosphere ozone climatologies from limb-viewing instruments and the nadir-viewing Tropospheric Emission Spectrometer (TES). Journal of Geophysical Research-Atmospheres. Wiley Online Library; 2014.

17. Samuels Crow KE, Galewsky J, Hardy DR, Sharp ZD, Worden J, Braun C. Upwind convective influences on the isotopic composition of atmospheric water vapor over the tropical Andes. Journal of Geophysical Research-Atmospheres. Wiley Online Library; 2014.

18. Luo M, Read W, Kulawik S, Worden J, Livesey N, Bowman K, et al. Carbon monoxide (CO) vertical profiles derived from joined TES and MLS measurements. Journal of Geophysical Research-Atmospheres. 2013;118:10, 601–10, 613.

19. Worden J, Jiang Z, Jones DBA, Alvarado M, Bowman K, Frankenberg C, et al. El Nino, the 2006 Indonesian Peat Fires, and the distribution of atmospheric methane. Geophys. Res. Lett. 2013;:n/a–n/a.

20. Risi C, Noone D, Frankenberg C, Worden J. Role of continental recycling in intraseasonal variations of continental moisture as deduced from model simulations and water vapor isotopic measurements. Water Resour. Res. 2013;49:4136–56.

21. Parazoo NC, Bowman K, Frankenberg C, Lee J-E, Fisher JB, Worden J, et al. Interpreting seasonal changes in the carbon balance of southern Amazonia using measurements of XCO 2and chlorophyll fluorescence from GOSAT. Geophys. Res. Lett. 2013;40:2829–33.

22. Li K-F, Tian B, Tung K-K, Kuai L, Worden JR, Yung YL, et al. A link between tropical intraseasonal variability and Arctic stratospheric ozone. Journal of Geophysical Research-Atmospheres. 2013;118:4280–9.

23. Lee J-E, Frankenberg C, van der Tol C, Berry JA, Guanter L, Boyce CK, et al. Forest productivity and water stress in Amazonia: observations from GOSAT chlorophyll fluorescence. Proceedings of the Royal Society B: Biological Sciences. 2013;280:20130171–1.

24. Jiang Z, Jones DBA, Worden HM, Deeter MN, Henze DK, Worden J, et al. Impact of model errors in convective transport on CO source estimates inferred from MOPITT CO retrievals. Journal of Geophysical Research-Atmospheres. 2013;118:2073–83.

25. Lee J, Worden J, Koh D-C, Yoshimura K, Lee J-E. A seasonality of δD of water vapor (850-500 hPa) observed from space over Jeju Island, Korea. Geosci J. 2013;17:87–95.

26. Frankenberg C, Wunch D, Toon G, Risi C, Scheepmaker R, Lee J-E, et al. Water vapor isotopologue retrievals from high-resolution GOSAT shortwave infrared spectra. Atmos. Meas. Tech. 2013;6:263–74.

27. Kuai L, Worden J, Kulawik S, Bowman K, Lee M, Biraud SC, et al. Profiling tropospheric CO_2 using Aura TES and TCCON instruments. Atmos. Meas. Tech. 2013;6:63–79.

28. Verstraeten WW, Boersma KF, Zörner J, Allaart MAF, Bowman KW, Worden JR. Validation of six years of TES tropospheric ozone retrievals with ozonesonde measurements: implications for spatial patterns and temporal stability in the bias. Atmos. Meas. Tech. 2013;6:1413–23.

29. Worden HM, Edwards DP, Deeter MN, Fu D, Kulawik SS, Worden JR, et al. Averaging kernel prediction from atmospheric and surface state parameters based on multiple regression for nadir-viewing satellite measurements of carbon monoxide and ozone. Atmos. Meas. Tech. 2013;6:1633–46.

30. Bowman KW, Shindell DT, Worden HM, Lamarque JF, Young PJ, Stevenson DS, et al. Evaluation of ACCMIP outgoing longwave radiation from tropospheric ozone using TES satellite observations. Atmospheric Chemistry and Physics. 2013;13:4057–72.

31. Fu D, Worden JR, Liu X, Kulawik SS, Bowman KW, Natraj V. Characterization of ozone profiles derived from Aura TES and OMI radiances. Atmospheric Chemistry and Physics. 2013;13:3445–62.

32. Kulawik SS, Worden JR, Wofsy SC, Biraud SC, Nassar R, Jones DBA, et al. Comparison of improved Aura Tropospheric Emission Spectrometer CO_2 with HIPPO and SGP aircraft profile measurements. Atmospheric Chemistry and Physics. 2013;13:3205–25.

33. Worden HM, Deeter MN, Frankenberg C, George M, Nichitiu F, Worden J, et al. Decadal record of satellite carbon monoxide observations. Atmospheric Chemistry and Physics. 2013;13:837–50.

34. Worden J, Wecht K, Frankenberg C, Alvarado M, Bowman K, Kort E, et al. CH_4 and CO distributions over tropical fires during October 2006 as observed by the Aura TES satellite instrument and modeled by GEOS-Chem. Atmospheric Chemistry and Physics. 2013;13:3679–92.

35. Brown D, Worden J, Noone D. Characteristics of tropical and subtropical atmospheric moistening derived from Lagrangian mass balance constrained by measurements of HDO and H2O. Journal of Geophysical Research-Atmospheres. 2013;118.

36. Hurley JV, Galewsky J, Worden J, Noone D. A test of the advection-condensation model for subtropical water vapor using stable isotopologue observations from Mauna Loa Observatory, Hawaii. J. Geophys. Res. 2012;117:D19118.

37. Lee J-E, Lintner BR, Neelin JD, Jiang X, Gentine P, Boyce CK, et al. Reduction of tropical land region precipitation variability via transpiration. Geophys. Res. Lett. 2012;39:L19704.

38. Lee J-E, Risi C, Fung I, Worden J, Scheepmaker RA, Lintner B, et al. Asian monsoon hydrometeorology from TES and SCIAMACHY water vapor isotope measurements and LMDZ simulations: Implications for speleothem climate record interpretation. J. Geophys. Res. 2012;117:D15112.

39. Worden HM, Cheng Y, Pfister G, Carmichael GR, Zhang Q, Streets DG, et al. Satellite-based estimates of reduced CO and CO2 emissions due to traffic restrictions during the 2008 Beijing Olympics. Geophys. Res. Lett. 2012;39:L14802.

40. Natarajan M, Pierce RB, Schaack TK, Lenzen AJ, Al-Saadi JA, Soja AJ, et al. Radiative forcing due to enhancements in tropospheric ozone and carbonaceous aerosols caused by Asian fires during spring 2008. J. Geophys. Res. 2012;117:D06307.

41. Risi C, Noone D, Worden J, Frankenberg C, Stiller G, Kiefer M, et al. Process-evaluation of tropospheric humidity simulated by general circulation models using water vapor isotopic observations: 2. Using isotopic diagnostics to understand the mid and upper tropospheric moist bias in the tropics and subtropics. J. Geophys. Res. 2012;117:D05304.

42. Risi C, Noone D, Worden J, Frankenberg C, Stiller G, Kiefer M, et al. Process-evaluation of tropospheric humidity simulated by general circulation models using water vapor isotopologues: 1. Comparison between models and observations. J. Geophys. Res. 2012;117:D05303.

43. Worden J, Kulawik S, Frankenberg C, Payne V, Bowman K, Cady-Peirara K, et al.

Profiles of CH_4, HDO, H_2O, and N_2O with improved lower tropospheric vertical resolution from Aura TES radiances. Atmos. Meas. Tech. 2012;5:397–411.

44. Wecht KJ, Jacob DJ, Wofsy SC, Kort EA, Worden JR, Kulawik SS, et al. Validation of TES methane with HIPPO aircraft observations: implications for inverse modeling of methane sources. Atmospheric Chemistry and Physics. 2012;12:1823–32.

45. Walker TW, Jones DBA, Parrington M, Henze DK, Murray LT, Bottenheim JW, et al. Impacts of midlatitude precursor emissions and local photochemistry on ozone abundances in the Arctic. J. Geophys. Res. 2012;117:D01305.

46. Li K-F, Tian B, Waliser DE, Schwartz MJ, Neu JL, Worden JR, et al. Vertical structure of MJO-related subtropical ozone variations from MLS, TES, and SHADOZ data. Atmospheric Chemistry and Physics [Internet]. 2012;12:425–36. Available from: http://www.atmos-chem-phys.net/12/425/2012/

47. Frankenberg C, Hasekamp O, O'Dell C, Sanghavi S, Butz A, Worden J. Aerosol information content analysis of multi-angle high spectral resolution measurements and its benefit for high accuracy greenhouse gas retrievals. Atmos. Meas. Tech. 2012;5:1809–21.

48. Barth MC, Lee J, Hodzic A, Pfister G, Skamarock WC, Worden J, et al. Thunderstorms and upper troposphere chemistry during the early stages of the 2006 North American Monsoon. Atmospheric Chemistry and Physics. 2012;12:11003–26.

49. Cady-Pereira KE, Shephard MW, Millet DB, Luo M, Wells KC, Xiao Y, et al. Methanol from TES global observations: retrieval algorithm and seasonal and spatial variability. Atmospheric Chemistry and Physics. 2012;12:8189–203.

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51. Field RD, Risi C, Schmidt GA, Worden J, Voulgarakis A, LeGrande AN, et al. A Tropospheric Emission Spectrometer HDO/H_2O retrieval simulator for climate models. Atmospheric Chemistry and Physics. 2012;12:10485–504.

52. Parrington M, Palmer PI, Henze DK, Tarasick DW, Hyer EJ, Owen RC, et al. The influence of boreal biomass burning emissions on the distribution of tropospheric ozone over North America and the North Atlantic during 2010. Atmospheric Chemistry and Physics. 2012;12:2077–98.

53. Noone D, Galewsky J, Sharp ZD, Worden J, Barnes J, Baer D, et al. Properties of air mass mixing and humidity in the subtropics from measurements of the D/H isotope ratio of water vapor at the Mauna Loa Observatory. J. Geophys. Res. 2011;116:D22113.

54. Yoshimura K, Frankenberg C, Lee J, Kanamitsu M, Worden J, Röckmann T.

Comparison of an isotopic atmospheric general circulation model with new quasi-global satellite measurements of water vapor isotopologues. J. Geophys. Res. 2011;116:D19118.

55. Frankenberg C, Fisher JB, Worden J, Badgley G, Saatchi SS, Lee J-E, et al. New global observations of the terrestrial carbon cycle from GOSAT: Patterns of plant fluorescence with gross primary productivity. Geophys. Res. Lett. 2011;38:L17706.

56. Worden J, Noone D, Galewsky J, Bailey A, Bowman K, Brown D, et al. Estimate of bias in Aura TES HDO/H_2O profiles from comparison of TES and in situ HDO/H_2O measurements at the Mauna Loa observatory. Atmospheric Chemistry and Physics [Internet]. 2011;11:4491–503. Available from: http://www.atmos-chem-phys.net/11/4491/2011/

57. Lee J, Worden J, Noone D, Bowman K, Eldering A, Legrande A, et al. Relating tropical ocean clouds to moist processes using water vapor isotope measurements. Atmospheric Chemistry and Physics. Copernicus GmbH; 2011;11:741–52.

58. Nassar R, Jones DBA, Kulawik SS, Worden JR, Bowman KW, Andres RJ, et al. Inverse modeling of CO_2 sources and sinks using satellite observations of CO_2 from TES and surface flask measurements. Atmospheric Chemistry and Physics. 2011;11:6029–47.

59. Risi C, Bony S, Vimeux F, Frankenberg C, Noone D, Worden J. Understanding the Sahelian water budget through the isotopic composition of water vapor and precipitation. J. Geophys. Res. 2010;115:D24110.

60. Nassar R, Jones DBA, Suntharalingam P, Chen JM, Andres RJ, Wecht KJ, et al. Modeling global atmospheric CO_2 with improved emission inventories and CO_2 production from the oxidation of other carbon species. Geosci. Model Dev. [Internet]. 2010;3:689–716. Available from: http://www.geosci-model-dev.net/3/689/2010/

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Geophys. Res [Internet]. 2009;114:D13304. Available from: http://www.agu.org/pubs/crossref/2009/2008JD010560.shtml

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67. Verma S, Worden J, Pierce B, Jones DBA, Al-Saadi J, Boersma F, et al. Ozone production in boreal fire smoke plumes using observations from the Tropospheric Emission Spectrometer and the Ozone Monitoring Instrument. J. Geophys. Res. 2009;114:D02303.

68. Bowman K, Jones D, Logan J, Worden H, (null), Chang R, et al. The zonal structure of tropical O3 and CO as observed by the Tropospheric Emission Spectrometer in November 2004–Part 2: Impact of surface emissions on O3 and its precursors. Atmos. Chem. Phys. 2009;9:3563–82.

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