

Michael J. Garay

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive, MS 233-200
Pasadena, CA 91109-8099

Work Phone: (818) 393-1148
Cell Phone: (626) 379-9027
Email: Michael.J.Garay@jpl.nasa.gov

Research Interests

- 1-dimensional and 3-dimensional polarized radiative transfer
- Satellite remote sensing of clouds and aerosols and related physical processes
- Multi-instrument data fusion and multi-platform sensor webs
- Machine learning techniques including support vector machines
- Data analysis and visualization

Biographical Sketch

I am currently a member of the Multi-angle Imaging SpectroRadiometer (MISR) science team working at the Jet Propulsion Laboratory (JPL) on both aerosol and cloud retrieval algorithms. My work focuses on algorithm improvement, testing, validation, and the dissemination of scientific results using the MISR instrument. I am also working on tasks related to the Multiangle SpectroPolarimetric Imager (MSPI), a successor to MISR being developed and tested at JPL. These tasks involve polarized radiative transfer simulations, data visualization, and analysis. Previously, I have worked on a number of projects at JPL including automatic image classification using support vector machines, multi-instrument and multi-platform data fusion, sensor webs, and feature identification and tracking. I have extensive experience with data visualization and analysis using a variety of satellite, airborne, and ground-based instruments.

I graduated from the University of Toledo in Ohio in 1995, where I was a National Merit Scholar, obtaining degrees in both Physics and English Literature with Honors. In 1996, I enrolled in the physics graduate program at the University of Arizona. The following year, I transferred to the Atmospheric Sciences Department. In 2002, I left the University of Arizona for the University of California, Los Angeles (UCLA). I joined the MISR team at JPL in 2003 as an Academic Part Time Intern. I received my Master's Degree in Atmospheric Sciences from UCLA in 2004.

Relevant Professional Experience

2011 – Present	Research Technologist III	<i>Jet Propulsion Laboratory</i>
2007 – 2011	Senior Physics Engineer I	<i>Raytheon, Pasadena</i>
2003 – 2007	Academic Part Time Intern	<i>Jet Propulsion Laboratory</i>
2002 – 2003	Graduate Teaching Assistant	<i>Department of Atmospheric Sciences, University of California, Los Angeles</i>
2000, 2001 Summer	Instructor	<i>Department of Atmospheric Sciences, University of Arizona</i>
1999 – 2002	Graduate Research Assistant	<i>Department of Atmospheric Sciences, University of Arizona</i>
1998 – 1999	Graduate Teaching Assistant	<i>Department of Atmospheric Sciences, University of Arizona</i>
1997 – 1998	Graduate Research Assistant	<i>Department of Atmospheric Sciences, University of Arizona</i>
2000, 2001 Summer	Instructor	<i>Department of Atmospheric Sciences, University of Arizona</i>
1996 – 1997	Graduate Teaching Assistant	<i>Physics Department, University of Arizona</i>

Education

2004	M. S.	Atmospheric Sciences	<i>University of California, Los Angeles</i>
1995	B. S.	Physics	<i>University of Toledo, Ohio</i>
1995	B. A.	English Literature (with Honors)	<i>University of Toledo, Ohio</i>

Fellowships and Awards

2014	NASA Group Achievement Award AirMSPI Field Campaign Team	<i>National Aeronautics and Space Administration</i>
2014	NASA Group Achievement Award SEAC4RS	<i>National Aeronautics and Space Administration</i>
2012, 2013	Jet Propulsion Laboratory Team Bonus Award	<i>Jet Propulsion Laboratory, California Institute of Technology</i>
2008	Space Act Board Award	<i>National Aeronautics and Space Administration</i>

1996	Graduate Student Award	<i>Physics Department, University of Arizona</i>
1995	Ernest Wayne Dewey Memorial Scholarship	<i>University of Toledo</i>
1995	Henkel National Merit Scholarship	<i>University of Toledo</i>
1995	Henkel Scholarship	<i>University of Toledo</i>
1995	James G. Southworth Scholarship	<i>University of Toledo</i>
1991 – 1994	National Merit Scholarship	<i>University of Toledo</i>

Peer-Reviewed Publications

- M. G. Tosca, D. J. Diner, **M. J. Garay**, and O. V. Kalashnikova, "Human-caused fires limit convection in tropical Africa: First temporal observations and attribution," *Geophysical Research Letters*, 42, 6492–6501, doi:10.1002/2015GL065063, 2015.
- Y.-C. Chen, M. W. Christensen, D. J. Diner, and **M. J. Garay**, "Aerosol-cloud interactions in ship tracks using Terra MODIS/MISR," *Journal of Geophysical Research: Atmospheres*, 120, 2819–2833, doi:10.1022/2014JD022736, 2015.
- S. Li, R. Kahn, M. Chin, **M. J. Garay**, and Y. Liu, "Improving Satellite-Retrieved Aerosol Microphysical Properties Using GOCART Data," *Atmospheric Measurement Techniques*, 8, 1157–1171, doi:10.5194/amt-8-1157-2015, 2015.
- M. G. Tosca, D. J. Diner, **M. J. Garay**, and O. V. Kalashnikova, "Observational Evidence of Fire-Driven Reduction of Cloud Fraction in Tropical Africa," *Journal of Geophysical Research: Atmospheres*, 119, 8418–8432, doi:10.1002/2014JD021759, 2014.
- D. J. Diner, F. Xu, **M. J. Garay**, J. V. Martonchik, B. E. Rheingans, S. Geier, A. Davis, B. R. Hancock, V. M. Jovanovic, M. A. Bull, K. Capraro, R. A. Chipman, and S. C. McClain, "The Airborne Multiangle SpectroPolarimetric Imager (AirMSPI): A New Tool for Aerosol and Cloud Remote Sensing," *Atmospheric Measurement Techniques*, 6, 2007–2025, doi:10.5194/amt-6-2007-2013, 2013.
- S. Li, **M. J. Garay**, L. Chen, E. Rees, and Y. Liu, "Comparison of GEOS-Chem Aerosol Optical Depth with AERONET and MISR Data Over the Contiguous United States," *Journal of Geophysical Research: Atmospheres*, 118, 11,228–11,241, doi:10.1002/jgrd.50867, 2013.
- M. L. Witek, **M. J. Garay**, D. J. Diner, and A. Smirnov, "Aerosol Optical Depths Over Oceans: A View from MISR Retrievals and Collocated MAN and AERONET In Situ Observations," *Journal of Geophysical Research: Atmospheres*, 118, 1–14, doi:10.1002/2013JD020393, 2013.
- D. L. Nelson, **M. J. Garay**, R. A. Kahn, and B. A. Dunst, "Stereoscopic Height and Wind Retrievals for Aerosol Plumes with the MISR Interactive eXplorer," *Remote Sensing*, 5, 4593–4628, doi:10.3390/rs5094593, 2013.
- O. V. Kalashnikova, **M. J. Garay**, J. V. Martonchik, and D. J. Diner, "MISR Dark Water Aerosol Retrievals: Operational Algorithm Sensitivity to Particle Non-Sphericity," *Atmospheric Measurement Techniques*, 6, 2131–2154, doi:10.5194/amt-6-2131-2013, 2013.
- J. R. Banks, H. E. Brindley, C. Flamant, **M. J. Garay**, N. C. Hsu, O. V. Kalashnikova, L. Klüser, and A. M. Sayer, "Intercomparison of Satellite Dust Retrieval Products Over the West African Sahara During the Fennec Campaign in June 2011," *Remote Sensing of Environment*, 136, 99–116, doi:10.1016/j.rse.2013.05.003, 2013.
- A. L. Ekstrand, P. W. Webley, **M. J. Garay**, J. Dehn, A. Prakash, D. L. Nelson, K. G. Dean, and T. Steensen, "A Multi-Sensor Plume Height Analysis of the 2009 Redoubt Eruption," *Journal of Volcanology and Geothermal Research*, 259, 170–184, doi:10.1016/j.jvolgeores.2012.09.008, 2013.
- D. J. Diner, R. A. Hodos, A. B. Davis, **M. J. Garay**, J. V. Martonchik, S. V. Sanghavi, P. von Allmen, A. A. Kokhanovsky, and P. Zhai, "An Optimization Approach for Aerosol Retrievals Using Simulated MISR Radiances," *Atmospheric Research*, 116, 1–14, doi:10.1016/j.atmosres.2011.05.020, 2012.

- S. Scollo, R. A. Kahn, D. L. Nelson, M. Coltell, D. J. Diner, **M. J. Garay**, and V. J. Realmuto, "MISR Observations of Etna Volcanic Plumes," *Journal of Geophysical Research–Atmospheres*, 117, D06210, doi:10.1029/2011JD016625, 2012.
- O. V. Kalashnikova, **M. J. Garay**, A. B. Davis, D. J. Diner, and J. V. Martonchik, "Sensitivity of Multiangle Photo-Polarimetry to Vertical Layering and Mixing of Absorbing Aerosols: Quantifying Measurement Uncertainties," *Journal of Quantitative Spectroscopy and Radiative Transfer*, 112, 2149–2163, doi:10.1016/j.jqsrt.2011.05.010, 2011.
- R. A. Kahn, **M. J. Garay**, D. L. Nelson, R. C. Levy, M. A. Bull, D. J. Diner, J. V. Martonchik, E. G. Hansen, L. A. Remer, and D. Tanré, "Response to 'Toward unified satellite climatology of aerosol properties. 3. MODIS versus MISR versus AERONET'," *Journal of Quantitative Spectroscopy and Radiative Transfer*, 112, 901–909, doi:10.1016/j.jqsrt.2010.11.001, 2011.
- M. J. Garay**, and M. C. Burl, "Adaptive Sky: From Instrument Pixels to a Sensor Web Gestalt," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 3, 481–487, doi:10.1109/JSTARS.2010.2052790, 2010.
- R. A. Kahn, B. J. Gaitley, **M. J. Garay**, D. J. Diner, T. F. Eck, A. Smirnov, and B. Holben, "MISR Global Aerosol Product Assessment by Comparison with AERONET," *Journal of Geophysical Research-Atmospheres*, 115, D23209, doi:10.1029/2010JD014601, 2010.
- S. R. Mims, R. A. Kahn, C. M. Moroney, B. J. Gaitley, D. L. Nelson, and **M. J. Garay**, "MISR Stereo-heights of Grassland Fire Smoke Plumes in Australia," *IEEE Transactions on Geoscience and Remote Sensing*, 48, 25–35, doi:10.1109/TGRS.2009.2027114, 2010.
- A. A. Kokhanovsky, J. L. Deuzé, D. J. Diner, O. Dubovik, F. Ducos, C. Emde, **M. J. Garay**, R. G. Grainger, A. Heckel, M. Herman, I. L. Katsev, J. Keller, R. Levy, P. R. J. North, A. S. Prikhach, V. V. Rozanov, A. M. Sayer, Y. Ota, D. Tanré, G. E. Thomas, and E. P. Zege, "The Inter-Comparison of Major Satellite Aerosol Retrieval Algorithms Using Simulated Intensity and Polarization Characteristics of Reflected Light," *Atmospheric Measurement Techniques*, 3, 909–932, doi:10.5194/amt-3-909-2010, 2010.
- K. Mueller, **M. J. Garay**, L. Di Girolamo, V. Jovanovic, and C. Moroney, "MISR Cloud Motion Vector Product Algorithm Theoretical Basis," *JPL D-64973*, 22 pp., 2010.
- R. A. Kahn, D. L. Nelson, **M. J. Garay**, R. C. Levy, M. A. Bull, D. J. Diner, J. V. Martonchik, S. R. Paradise, E. G. Hansen, and L. A. Remer, "MISR Aerosol Product Attributes, and Statistical Comparisons with MODIS," *IEEE Transactions on Geoscience and Remote Sensing*, 47, 4095–4114, doi:10.1109/TGRS.2009.2023115, 2009.
- E. Anderes, B. Yu, V. Jovanovic, C. Moroney, **M. Garay**, A. Braverman, and E. Clothiaux, "Maximum Likelihood Estimation of Cloud Height from Multi-angle Satellite Imagery," *The Annals of Applied Statistics*, 3, 902–921, 2009.
- D. L. Wu, S. A. Ackerman, R. Davies, D. J. Diner, **M. J. Garay**, B. H. Kahn, B. C. Maddux, C. M. Moroney, G. L. Stephens, J. P. Veefkind, and M. A. Vaughn, "Vertical Distributions and Relationships of Cloud Occurrence Frequency as Observed by MISR, AIRS, MODIS, OMI, CALIPSO, and CloudSat," *Geophysical Research Letters*, 36, L09821, doi:10.1029/2009GL037464, 2009.
- M. J. Garay**, S. P. de Szoek, and C. M. Moroney, "Comparison of Cloud-top Heights Retrieved from ISCCP, MODIS, and MISR with Coincident Ship-based Measurements for the Marine Stratocumulus Region off the Western Coast of South America," *Journal of Geophysical Research-Atmospheres*, 113, D18204, doi:10.1029/2008JD009975, 2008.
- M. C. Burl, **M. J. Garay**, C. Averill, B. J. Bornstein, L. Mandrake, J. Ng, Y. Wang, "Adaptive Sky Sensor Web: Novel Multi-Instrument, Multi-Satellite Observations of Volcanic Ash Clouds," *IET 4th International Conference on Intelligent Environments*, (July 2008).

- M. C. Burl, **M. J. Garay**, C. Averill, B. Bornstein, L. Mandrake, Y. Wang, and J. Ng, “Generation of Object-Centric Datasets with Adaptive Sky,” *NASA Earth Science Technology Conference*, (June 2008).
- M. C. Burl, **M. J. Garay**, Y. Wang, J. Ng, “Adaptive Sky: A Feature Correspondence Toolbox for a Distributed Cloud Monitoring Sensor Web,” *IEEE Aerospace Conference*, (March 2008).
- R. A. Kahn, **M. J. Garay**, D. L. Nelson, K. K. Yau, M. A. Bull, B. J. Gaitley, J. V. Martonchik, and R. C. Levy, “Satellite-derived Aerosol Optical Depth Over Dark Water from MISR and MODIS: Comparisons with AERONET and Implications for Climatological Studies,” *Journal of Geophysical Research-Atmospheres*, *112*, D18205, doi:10.1029/2006JD008175, 2007.
- B. H. Kahn, E. Fishbein, S. L. Nasiri, A. Eldering, E. J. Fetzer, **M. J. Garay**, and S.-Y. Lee, “The Radiative Consistency of Atmospheric Infrared Sounder and Moderate Resolution Imaging Spectroradiometer Cloud Retrievals,” *Journal of Geophysical Research-Atmospheres*, *112*, D09201, doi:10.1029/2006JD007486, 2007.
- M. J. Garay**, and D. J. Diner, “Multi-angle Imaging SpectroRadiometer (MISR) Time-Lapse Imagery of Tsunami Waves from the 26 December 2004 Sumatra-Andaman Earthquake,” *Remote Sensing of Environment*, *107*, 256–263, 2007.
- D. Mazzoni, **M. J. Garay**, R. Davies, and D. Nelson, “An Operational MISR Pixel Classifier using Support Vector Machines,” *Remote Sensing of Environment*, *107*, 149–158, 2007.
- R. F. Cahalan, L. Oreopoulos, A. Marshak, K. F. Evans, A. B. Davis, R. Pincus, K. H. Yetzer, B. Mayer, R. Davies, T. P. Ackerman, H. W. Barker, E. E. Clothiaux, R. G. Ellingson, **M. J. Garay**, E. Kassianov, S. Kinne, A. Macke, W. O’Hirok, P. T. Partain, S. M. Prigarin, A. N. Rublev, G. L. Stephens, F. Szczap, E. E. Takara, T. Várnai, G. Wen, and T. B. Zhuravleva, “The I3RC: Bringing Together the Most Advanced Radiative Transfer Tools for Cloudy Atmospheres,” *Bulletin of the American Meteorological Society*, *86*, 1275–1293, 2005.
- D. Mazzoni, Á. Horváth, **M. J. Garay**, B. Tang, and R. Davies, “A MISR Cloud-Type Classifier Using Reduced Support Vector Machines,” *Eighth Workshop on Mining Scientific and Engineering Datasets (MSD’05)*, (April 2005).
- M. J. Garay**, D. M. Mazzoni, R. Davies, and D. Diner, “The Application of Support Vector Machines to the Analysis of Global Datasets from MISR,” *Proceedings of the 4th Conference on Artificial Intelligence, American Meteorological Society*, (January 2005)
- M. J. Garay**, R. Davies, C. Averill, and J. A. Westphal, “Actinoform Clouds: Overlooked Examples of Cloud Self-Organization at the Mesoscale,” *Bulletin of the American Meteorological Society*, *85*, 1585–1594, 2004.

Book Chapter

- S. Granger, R. Raskin, and **M. J. Garay**, “Integrating remote sensing observations and model results for weather studies,” in *Mapping and Modeling Weather and Climate with GIS*, L. Armstrong, K. Butler, J. Settelmaier, T. Vance, and O. Wilhelmi (eds.), Esri Press, Redlands, CA, 2015.

Academic Theses

The Angular Nature of the Shortwave Radiation Reflected from the Earth Observed by GOES-10, Master's Thesis, University of California, Los Angeles, CA, 153 pp., 2004.

Sensitive Dependence: Wallace Stevens and Chaos, Honor's Thesis, University of Toledo, Toledo, OH, 40 pp., 1995.

Professional Affiliations

American Association for the Advancement of Science

American Geophysical Union

American Meteorological Society

Service

Southern Arizona Regional Science Fair (SARSEF) Judge (2001)

District-wide Emphasis on Science Education Reform in Tucson (D.E.S.E.R.T) Participating Scientist (2000–2001)

I have served as a peer-reviewer for:

- Annales Geophysicae
- Atmospheric Chemistry and Physics
- Atmospheric Environment
- Atmospheric Measurement Techniques
- Atmospheric Research
- Earth and Planetary Science Letters
- Geoscience and Remote Sensing Letters
- IEEE Transactions on Geoscience and Remote Sensing
- Journal of Geophysical Research – Atmospheres
- Monthly Weather Review
- Remote Sensing
- Remote Sensing of Environment

Field Campaigns

NASA Studies of Emissions & Atmospheric Composition, Clouds & Climate Coupling by Regional Surveys (SEAC⁴RS), Palmdale, CA and Houston, TX, August – September, 2013.

NASA Polarimeter Definition Experiment (PODEX), Palmdale, CA, January – February 2013.

Texas Air Quality Study / Gulf of Mexico Atmospheric Composition and Climate Study, Houston, TX, August – September 2006.