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EDUCATION:

Ph.D., Planetary Sciences, California Institute of Technology, 1999
M.S., Planetary Sciences, California Institute of Technology, 1999
B.S., Physics, Stanford University, 1991

APPOINTMENTS:

2012- : Professor of Planetary Sciences (University of Arizona)
2007-2012: Associate Professor of Planetary Sciences (University of Arizona)
2001-2007: Assistant Professor of Planetary Sciences (University of Arizona)
1999-2001: National Research Council Associate (NASA Ames Research Center)
1999: Postdoctoral fellow (University of Louisville)

PUBLICATIONS IN PEER-REVIEWED JOURNALS:

- Zhao, M., J.G. O'Rourke, J.T. Wright, H.A. Knutson, A. Burrows, J. Fortney, H. Ngo, S. Hinkley, P.S. Muirhead, C. Baranec, R. Riddle, N.M. Law, B.J. Fulton, A.P. Showman, J. Curtis, R. Burruss 2014. Characterization of the atmosphere of the hot Jupiter HAT-P-32Ab and the M-dwarf companion HAT-P-32B. Submitted to *Astrophys. J.*
- Sing, D.K., H.R. Wakeford, A.P. Showman, N. Nikolov, J.J. Fortney, A.S. Burrows, G.E. Ballester, D. Deming, S. Aigrain, J.-M. Desert, N.P. Gibson, G.W. Henry, H. Knutson, A. Lecavelier des Etangs, F. Pont, A. Vidal-Madjar, M.W. Williamson, and P.A. Wilson 2014. HST hot-Jupiter transmission spectral survey: detection of potassium in WASP-32b along with a cloud-deck and Rayleigh scattering. Submitted to *Mon. Not. Roy. Astron. Soc.*
- Nikolov, N., D.K. Sing, A.S. Burrows, J.J. Fortney, G.W. Henry, F. Point, G.E. Ballester, S. Aigrain, P.A. Wilson, C.M. Huitson, N.P. Gibson, J.-M. Desert, A. Lecavelier des Etangs, A.P. Showman, A. Vidal-Madjar, H.R. Wakeford, K. Zahnle 2014. HST hot-Jupiter transmission spectral survey: Haze in the atmosphere of WASP-6b. Submitted to *Mon. Not. Roy. Astron. Soc.*
- Kaspi, Y. and A.P. Showman 2014. Atmospheric dynamics of terrestrial exoplanets over a wide range of orbital and atmospheric parameters. Submitted to *Astrophys. J.*
- Heng, K. and A.P. Showman 2014. Atmospheric dynamics of exoplanets. Invited review for *Annu. Rev. Earth Planet. Sci.*, submitted.
- Wong, I., H.A. Knutson, N.B. Cowan, N.K. Lewis, E. Agol, A. Burrows, D. Deming, J.J. Fortney, B.J. Fulton, J.L. Langton, G. Laughlin, A.P. Showman 2014. Constraints on the atmospheric circulation and variability of the eccentric hot Jupiter XO-3b. Submitted to *Astrophys. J.*
- Lewis, N.K., A.P. Showman, J.J. Fortney, H.A. Knutson, and M.S. Marley 2014. Atmospheric circulation of eccentric hot Jupiter HAT-P-2b. Submitted to *Astrophys. J.*

- Hirata, N., H. Miyamoto, and A.P. Showman 2013. Deposits of the E ring materials on saturnian satellites constrain cryovolcanic activities of Enceladus. *Geophys. Res. Lett.*, in press.
- Teanby, N.A., A.P. Showman, L.N. Fletcher, P.G.J. Irwin 2014. Constraints on Jupiter's stratospheric HCl abundance and chlorine cycle from Herschel/HIFI. *Planet. Space Sci.*, in press.
- Parmentier, V., A.P. Showman, and J. de Wit 2014. EChO's view on gas giant exoplanets atmospheres. *Experimental Astronomy*, in press.
- Zellem, R.T., N.K. Lewis, H.A. Knutson, C.A. Griffith, A.P. Showman, J.J. Fortney, N.B. Cowan, E. Agol, A. Burrows, D. Charbonneau, D. Deming, G. Laughlin, and J. Langton 2014. The 4.5 micron full-orbit phase curve of the hot Jupiter HD 209458b. *Astrophys. J.* 790, 53.
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- Swain, M., P. Deroo, G. Tinetti, M. Hollis, M. Tessenyi, M. Line, H. Kawahara, Y. Fujii, A.P. Showman, and S.N. Yurchenko 2013. Probing the extreme planetary atmosphere of WASP-12b. *Icarus* 225, 432-445.

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- Jackson, B.K., N.K. Lewis, J.W. Barnes, L.D. Deming, A.P. Showman, and J.J. Fortney 2012. The EVIL-MC model for ellipsoidal variations of planet-hosting stars and applications to the HAT-P-7 system. *Astrophys. J.* **751** 112, doi:10.1088/0004-637X/751/2/112.

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- Dowling, T.E., M.E. Bradley, E. Colon, J. Kramer, R.P. LeBeau, G.C.H. Lee, T.I. Mattox, R. Morales-Juberias, C.J. Palotai, V.K. Parimi, and A.P. Showman 2006. The EPIC atmospheric model with an isentropic/terrain-following hybrid vertical coordinate. *Icarus* **182**, 259-273.
- Miyamoto, H., J. Haruyama, T. Kobayashi, K. Suzuki, T. Okada, T. Nishibori, A.P. Showman, R. Lorenz, K. Mogi, D.A. Crown, J.A.P. Rodriguez, S. Rokugawa, T. Tokunaga, and K. Masumoto 2005. Mapping the structure and depth of lava tubes using ground penetrating radar. *Geophys. Res. Lett.* **32**, L21316, doi:10.1029/2005GL024159.
- Han, L. and A.P. Showman 2005. Thermo-compositional convection in Europa's icy shell with salinity. *Geophys. Res. Lett.* **32**, L20201, doi:10.1029/2005GL023979.
- Showman, A.P. and L. Han 2005. Effects of plasticity on convection in an ice shell: Implications for Europa. *Icarus* **177**, 425-437.
- Mitri, G. and A.P. Showman 2005. Convective-conductive transitions and sensitivity of a convecting ice shell to perturbations in heat flux and tidal-heating rate: Implications for Europa. *Icarus* **177**, 447-460.
- Miyamoto, H., G. Mitri, A.P. Showman, and J.M. Dohm 2005. Putative ice flows on Europa: geometric patterns and relation to topography collectively constrain material properties and effusion rates. *Icarus* **177**, 413-424.
- Cooper, C.S. and A.P. Showman 2005. Dynamic meteorology at the photosphere of HD 209458b. *Astrophys. J.* **629**, L45-L48.
- Vasavada, A.R. and A.P. Showman 2005. Jovian atmospheric dynamics: an update after Galileo and Cassini. *Reports on Progress in Physics* **68**, 1935-1996.
- Showman, A.P. and I. de Pater 2005. Dynamical implications of Jupiter's tropospheric ammonia abundance. *Icarus* **174**, 192-204.
- Showman, A.P., I. Mosqueira, and J.W. Head 2004. On the resurfacing of Ganymede by liquid-water volcanism. *Icarus* **172**, 625-640.
- Melosh, H.J., Eckholm, A., Showman, A.P., and Lorenz, R. 2004. The temperature of Europa's subsurface water ocean. *Icarus* **168**, 498-502.
- Ingersoll, A.P., T.E. Dowling, P.J. Gierasch, G.S. Orton, P.L. Read, A. Sanchez-Lavega, A.P. Showman, A.A. Simon-Miller, and A.R. Vasavada 2004. Dynamics of Jupiter's atmosphere. Invited review in *Jupiter: the Planet, Satellites, and Magnetosphere*. Cambridge Univ. Press, pp. 105-128.

- Showman, A.P. and L. Han 2004. Numerical simulations of convection in Europa’s ice shell: implications for surface features. *J. Geophys. Res. Planets* **109** (E1), E01010, doi:10.1029/2003JE002103.
- Showman, A.P. and T. Guillot 2002. Atmospheric circulation and tides of “51 Pegasus b-like” planets. *Astron. & Astrophys.* **385**, 166-180.
- Guillot, T. and A.P. Showman 2002. Evolution of “51 Pegasus b-like” planets. *Astron. & Astrophys.* **385**, 156-165.
- Showman, A.P. 2001. Hydrogen halides on Jupiter and Saturn. *Icarus* **152**, 140-150.
- Stratman, P.W., A.P. Showman, T.E. Dowling, and L.A. Sromovsky 2001. EPIC simulations of bright companions to Neptune’s Great Dark Spots. *Icarus* **151**, 275-285.
- Showman, A.P. and T.E. Dowling 2000. Nonlinear simulations of Jupiter’s 5-micron hot spots. *Science* **289**, 1737-1740.
- Showman, A.P. and R. Malhotra 1999. The Galilean Satellites. *Science* **286**, 77-84.
- Showman, A.P. and A.P. Ingersoll 1998. Interpretation of Galileo probe data and implications for Jupiter’s dry downdrafts. *Icarus* **132**, 205-220.
- Showman, A.P., D.J. Stevenson, and R. Malhotra 1997. Coupled orbital and thermal evolution of Ganymede. *Icarus* **129**, 367-383.
- Showman, A.P. and R. Malhotra 1997. Tidal evolution into the Laplace resonance and the resurfacing of Ganymede. *Icarus* **127**, 93-111.

INVITED REVIEW ARTICLES PUBLISHED IN BOOKS:

- Sanchez-Lavega, A., L. Sromovsky, A. Showman, A. Del Genio, R. Young, E. Garcia-Melendo, Y. Kaspi, G.S. Orton, N. Barrado-Izagirre, D. Choi, and J. Barbara 2014. Zonal jets in gas giants. Invited chapter in book on zonal jets (B. Galperin, Editor); submitted.
- Showman, A.P. and T.E. Dowling 2014. Earth as a planet: atmospheres and oceans. Invited article in *Encyclopedia of the Solar System*, 3rd Ed. (T. Spohn, D. Breuer, and T.V. Johnson, Eds.), pp. 423-444.
- Showman, A.P., R.D. Wordsworth, T.M. Merlis, and Y. Kaspi 2013. Atmospheric circulation of terrestrial exoplanets. Invited review for the book *Comparative Climatology of Terrestrial Planets* (S.J. Mackwell et al., Eds.), Univ. Arizona Press. pp. 277-326.
- Showman, A.P., J.Y-K. Cho, and K. Menou 2010. Atmospheric circulation of extrasolar planets. In *Exoplanets* (S. Seager, Ed.), Univ. Arizona Press, pp. 471-516.
- Barr, A.C. and A.P. Showman 2009. Heat transfer in Europa’s icy shell. In *Europa* (R.T. Pappalardo, W.B. McKinnon, and K. Khurana, Eds.), Univ. Arizona Press, pp. 405-430.
- Del Genio, A.D., R.K. Achterberg, K.H. Baines, F.M. Flasar, P.L. Read, A. Sanchez-Lavega, and A.P. Showman 2009. Saturn atmospheric structure and dynamics. In *Saturn from Cassini-Huygens* (M.K. Dougherty, L.W. Esposito, and S.M. Krimigis, Eds.), Springer, New York. pp. 113-160.

- Showman, A.P., K. Menou, and J. Y-K. Cho 2008. Atmospheric circulation of hot Jupiters: a review of current understanding. In *Extreme Solar Systems*, Astronomical Society of the Pacific (ASP) Conference Series, Vol. 398 (D. Fischer, F.A. Rasio, S.E. Thorsett, and A. Wolszczan, Eds.), pp. 419-441.
- Dowling, T.E. and A.P. Showman 2006. Earth as a Planet: Atmosphere and Oceans. In *Encyclopedia of the Solar System*, 2nd Ed., (L.A. McFadden, P. Weissman, and T. Johnson, Eds), Academic Press.
- Ingersoll, A.P. and 8 coauthors including A.P. Showman 2004. Dynamics of Jupiter's atmosphere. In *Jupiter: The Planet, Satellites, and Magnetosphere*, Cambridge Univ. Press, pp. 105-128.
- Showman, A.P. 2002. Planetary atmospheres: Jupiter and the Outer Planets. In *Encyclopedia of Atmospheric Sciences*, Academic Press, pp. 1730-1745.

RECENT INVITED SEMINARS (2007-present):

- July 2014: Invited lectures at Peking University (gave four hour-long lectures)
- April 2014: Salpeter Lecturer at Cornell University; gave four invited colloquia (joint Physics/Astronomy colloquium, Astronomy colloquium, brown-bag astronomy seminar, and Earth and Atmospheric Sciences colloquium)
- April 2014: Ithaca College Physics colloquium
- January 2014: University of Toronto "Planet Day" Astronomy seminar
- October 2013: University of Chicago Department of Geophysical Sciences colloquium
- August 2013: University of Arizona Lunar and Planetary Laboratory Staff Colloquium
- March 2013: National Astronomical Observatory of Japan (NAOJ) colloquium
- March 2013: Kobe University colloquium
- July 2012: Kavli Institute for Astronomy and Astrophysics colloquium, Peking University, Beijing, China
- April 2012: McGill University, Department of Physics colloquium
- March 2012: Institute for Advanced Study (IAS), Princeton University colloquium
- February 2012: U.C. Berkeley Department of Astronomy colloquium
- October 2011: Eidgenossische Technische Hochschule (ETH) astronomy department colloquium
- July 2011: Kavli Institute for Astronomy and Astrophysics colloquium, Peking University, Beijing, China
- July 2011: Astronomy Institute (NAOC), Beijing, China colloquium
- March 2011: University of Toronto Department of Physics colloquium
- April 2010: UCLA Earth & Space Sciences Planetology seminar
- April 2010: California Institute of Technology Planetary Sciences seminar
- March 2010: Princeton/NASA Geophysical Fluid Dynamics Laboratory (GFDL) colloquium

March 2010: Stony Brook University School of Marine and Atmospheric Sciences colloquium

February 2010: Lamont-Doherty Earth Observatory Division of Ocean and Climate Physics seminar

November 2009: University of Florida, Gainesville, physics department colloquium

October 2009: Columbia University Applied Physics and Applied Mathematics (APAM) conference

October 2009: Columbia University Astronomy department lunchtime seminar

July 2009: University of Nantes department of geosciences colloquium, Nantes, France

April 2009: Harvard/Smithsonian Center for Astrophysics (CfA) Institute for Theory and Computation (ITC) colloquium, Cambridge, MA

April 2008: University of Arizona Theoretical Astrophysics Program (TAP) colloquium, Tucson, AZ

March 2008: Massachusetts Institute of Technology Earth, Atmospheric, and Planetary Sciences departmental seminar, Cambridge, MA

April 2007: UCLA Earth & Space Sciences departmental seminar

March 2007: Lowell observatory seminar

February 2007: Planetary Science Institute seminar, Tucson, AZ

February 2007: Goddard Scientific Colloquium, NASA Goddard Space Flight Center, Maryland.

RECENT INVITED TALKS AT CONFERENCES/SYMPOSIA (2007-pres):

Saturn's global circulation. Saturn Science Conference: Saturn in the 21st Century. Madison, Wisconsin, August 4-7, 2014.

The Solar System's giant planets. The 3rd Conference on Earth System Science (CESS), Shanghai, China, July 2-4, 2014.

Atmospheric dynamics of brown dwarfs and directly imaged giant planets. Cool Stars 18. Flagstaff, Arizona, June 9-13, 2014.

I. Atmospheric circulation of terrestrial exoplanets. II. Atmospheric dynamics of brown dwarfs. Exoclimates III: The Diversity of Planetary Atmospheres. Davos, Switzerland, February 9-14, 2014.

Atmospheric dynamics of brown dwarfs. 223rd Meeting of the American Astronomical Society (AAS), January 5-9, 2014.

Atmospheric dynamics of Uranus and Neptune. Keynote lecture at the Lunar and Planetary Laboratory Conference, August 22-23, 2013.

Atmospheric dynamics of exoplanets. Planetary Sciences 50 year Celebration, California Institute of Technology, September 15-17, 2013.

Planetary atmospheric dynamics from Earth to extrasolar giant planets. AGU Chapman conference "Crossing the Boundaries in Planetary Atmospheres: From Earth to Exoplanets," June 24-28, 2013.

Observations and modeling of exoplanet atmospheres. Invited speaker at Committee on Astrobiology and Planetary Science (CAPS) meeting of the Space Studies Board, National Research Council, and the National Academy of Sciences, March 6-8, 2013.

Atmospheric circulation of extrasolar giant planets. Fall AGU meeting, San Francisco, CA, December 3-7, 2012.

Atmospheric dynamics of exoplanets: status and opportunities. Exoplanet Exploration Program Analysis Group (ExoPAG) meeting, Reno, Nevada, October 13-14, 2012.

Invited talk at the XXVIII general assembly of the International Astronomical Union (IAU) meeting, Beijing, China, August 20-31, 2012 (declined).

Invited talk at the Asia-Oceania Geophysical Society (AOGS) conference, Singapore, August 13-17, 2012 (declined).

Atmospheric circulation of terrestrial exoplanets. Conference on Comparative Climatology of Terrestrial Planets, Boulder, CO, June 25-28, 2012.

Atmospheres of extrasolar planets: a new frontier. Conference on Planetary Origins and Frontiers of Exploration, held at Weizmann Institute of Science, Israel, May 27-June 3, 2012.

Jets on giant planets. International Space Science Institute (ISSI) workshop on zonal jets, Bern, Switzerland, March 5-9, 2012.

Giant planet atmospheric dynamics. Workshop on Saturn, California Institute of Technology, Pasadena, CA, February 3, 2012.

Atmospheric circulation of giant planets inside and outside the solar system. Conference on Exoclimates II: the Diversity of Planetary Atmospheres, held at Aspen Center for Physics, Aspen, CO, January 16-20, 2012.

Atmospheric circulation of extrasolar giant planets. Fall AGU meeting, San Francisco, CA, December 5-9, 2011.

Atmospheric circulation of hot Jupiters. At “Frontiers in Computational Astrophysics: Particles and Flames in Radiative and Magnetic Flows” conference, held in Lyon, France, October 11-15, 2010.

Icy satellite interiors: Highlights and role of laboratory investigations. Laboratory Experimental Studies for Astrophysics and Planetary Sciences (LEAPS) Focus Workshop, sponsored by the AAS Working Group on Laboratory Astrophysics. Pasadena, CA, October 3, 2010.

Atmospheric dynamics of hot Jupiters. At “Exoclimates: Exploring the Diversity of Planetary Atmospheres” conference, held in Exeter, UK, September 7-10, 2010.

Multi-dimensional hydro simulations of substellar atmospheres. At “Cool Stars 16: 16th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun.” August 29 - 2 September 2010, Seattle, WA.

Hot Jupiter and giant planet circulation models. At “Exoplanets Rising: Astronomy and Planetary Science at the Crossroads” conference, sponsored by the Kavli

- Institute for Theoretical Physics, held in Santa Barbara, CA, March 29 - April 2, 2010.
- Generation of zonal jets by large-scale latent heating on the giant planets. At the Planetary Atmospheres session of the American Meteorological Society annual meeting, Atlanta, GA, held January 18-21, 2010.
- Hot planets meet cool theory: atmospheres and interiors of giant planets. At the University of Central Florida Winter Workshop 2010: “Exoplanets for Planetary Scientists,” Orlando, FL, January 6-8, 2010.
- Atmospheric circulation of giant planets inside and outside the solar system. Winter Workshop on Planetary Astrophysics, Kavli Center for Astronomy and Astrophysics (KIAA), Beijing, China, December 12-18, 2009.
- Global climate models. At the 2009 Sagan Exoplanet Summer Workshop on “Exoplanetary Atmospheres,” California Institute of Technology, Pasadena, CA, held July 20-24, 2009.
- Atmospheric circulation and its variability on the giant planets. American Geophysical Union, Spring Meeting 2009, abstract #U11A-04.
- Dynamics of hot Jupiter atmospheres. At the “Molecules in the Atmospheres of Extrasolar Planets” conference, Observatoire de Paris, Paris, France, November 19-21, 2008.
- Effects of moist convection on the large-scale circulation of giant planets. At the Outer Planets Assessment Group (OPAG) meeting, Tempe, AZ, November 6-7, 2008.
- Effects of moist convection on the large-scale circulation of giant planets. At the 5th Asia-Oceania Geosciences Society conference, held in Busan, Korea, June 16-20, 2008.
- Dynamics of hot Jupiter atmospheres. At International Astronomical Union (IAU) Symposium No. 253, “Transiting Exoplanets,” held at the American Academy of Arts & Sciences, Cambridge, MA, May 19-23, 2008.
- Ganymede. At the “Jupiter-Europa International Science Workshop,” Frascati, Italy, held April 21-22, 2008.
- Zonal jets on giant planets. Workshop “Zonal jets in rotating turbulent flows of cryogenic helium” (hosted by Boris Galperin), College of Marine Science, University of South Florida, February 25-26, 2008.
- Atmospheric dynamics of giant planets. Workshop on Planetary Atmospheres, held November 6-7, 2007 in Greenbelt, Maryland. LPI Contribution No. 1376, p.107-108.
- The diversity of atmospheric circulations on extrasolar giant planets. American Astronomical Society, DPS meeting #39, #12.04; Bulletin of the American Astronomical Society, Vol. 39, p.431, Orlando, FL, held Oct 7-12, 2007.
- The Convective Dynamics of Icy Satellites and Implications for Surface Evolution. Workshop on “Ices, Oceans, and Fire: Satellites of the Outer Solar System,” held August 13-15, 2007. Boulder, Colorado, LPI Contribution No. 1357, p.124.

Atmospheric dynamics of Jupiters (hot and not). At the 2007 Michelson Summer Workshop: “Planetary Transits: Detection to Characterization,” held at NASA Ames Research Center, July 23-27, 2007.

Atmospheric dynamics of hot Jupiters. At the “Extreme Solar Systems” conference, Santorini, Greece, held June 25-29, 2007.

CURRENT GRANTS:

Atmospheric circulation of brown dwarfs and directly imaged giant planets (A.P. Showman, PI). NSF Astronomy program. 2013-2016. \$349,768.

Atmospheric circulation of brown dwarfs (A.P. Showman, PI). NASA Earth and Space Sciences Fellowship. \$90,000. 2014-2017.

Constraining moist convection in gas giant atmospheres using observations and modeling of the 2010 Great White Spot on Saturn (Yuan Lian, PI; A.P. Showman, Co-I). NASA Outer Planets Research Program. 2014-2018. \$518,098.

Numerical simulations of magnetism in hot Jupiter atmospheres (Tami Rogers, PI; A.P. Showman, Co-I). NASA Astrophysics Theory Program. 2013-2016. \$367,937.

Atmospheric circulation of hot Jupiters (A.P. Showman, PI). NASA Origins program. 2012-2015. \$348,794.

Extrasolar storms: the physics and chemistry of evolving cloud structures in brown dwarf atmospheres. Daniel Apai, PI. (Joint Spitzer/Hubble proposal to observe brown dwarfs.) 2012-2014. \$753,397.

Jets on the giant planets (A.P. Showman, PI). NASA Planetary Atmospheres program. 2010-2014. \$448,000.

Life on the Edge: Planetary atmospheres in extreme environments. (H. Knutson, PI; A.P. Showman, Co-I). NASA Spitzer Space Telescope. 2011-2014. 2011-2015. \$367,840.

Mapping Weather on brown dwarfs (J. Radigan, PI; A.P. Showman, Co-I). NASA Spitzer Space Telescope. 2011-2015. \$44,000.

The atmospheric structure of giant hot exoplanets (D. Deming, PI; A.P. Showman, Co-I). NASA Hubble Space Telescope. 2010-2014. \$522,325.

An optical transmission spectral survey of hot-Jupiter exoplanetary atmospheres (D. Sing, PI; A.P. Showman, Co-I). Hubble Space Telescope. 2012-2015. \$546,430.

SERVICE (NATIONAL/INTERNATIONAL, 2007-PRESENT):

Nominated and elected to the Committee of the Division of Planetary Sciences of the American Astronomical Association (2006-2009), which represents over 1200 planetary scientists internationally

Selected to participate in the Science Definition Team (SDT) for the NASA Jupiter System Observer (JSO) mission study (2007). For the final report see http://solarsystem.nasa.gov/multimedia/downloads/JSO_Public_Report_FC.pdf.

Selected to participate in Science Definition Team for the NASA Europa-Jupiter System Mission (EJSM) study, which includes the Europa orbiter as a central component. The mission was selected by NASA to be the next Outer Planets flagship mission. For the final report see <http://opfm.jpl.nasa.gov/europajupitersystemmissionejsm/>.

Participated in Ph.D. thesis defense exams for Lena Zuchowski (Oxford University, 2009) and Emily Rauscher (Columbia University, 2010).

Participated in Telescope Allocation Committee (TAC) peer-review panels for the National Optical Astronomy Observatories (NOAO) (spring 2011, fall 2011, spring 2012, fall 2012, spring 2013) and NASA Keck time (fall 2010, spring 2011, fall 2011).

Participated in peer review panels for NASA grant programs (on average one panel per year since 2000, including several times as chair).

External referee for NASA Planetary-Atmospheres, NASA Origins, NASA Planetary Geology & Geophysics, NASA Exobiology, NASA Outer Planets Program, NASA Mars Data Analysis Program, NASA Postdoctoral Program, NSF atmospheric science, Netherlands Organization for Scientific Research (NWO) National Science Council, UK AURORA program, and UK Science and Technology Facilities Council (STFC).

Reviewer (~ 71 reviews total since 2007) for *Icarus* 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014; *PNAS* 2014; *Geophysical Research Letters* 2007, 2008, 2009, 2011; *Proceedings of the Royal Astronomical Society* 2013; *Journal of Geophysical Research: Planets* 2008, 2009, 2010; *Earth and Planetary Science Letters* 2013; *Astrophysical Journal* in 2007, 2008, 2009, 2010, 2011, 2013; *Astrophysical Journal Letters* 2007, 2013; *Astrobiology* 2007, 2008; *Physics of Earth and Planetary Interiors* 2007; *J. Atmospheric Sciences* 2009, 2010, 2013; *Quarterly J. Royal Meteorological Soc.* 2009; *Philosophical Transactions A* 2008; *Planetary & Space Science* 2009, 2010; *Astronomy & Astrophysics* 2008, 2013; *Science* 2011; *Nature* 2007, 2008, 2009, 2010, 2011, 2013, 2014; *Monthly Notices Royal Astronomical Society* 2010, 2011, 2012, 2013; de Pater and Lissauer's *Planetary Sciences* book; *Europa* book (Univ. Arizona Press) 2008.

Member of Scientific Organizing Committee for "Planetary Atmospheres 2007" conference held Nov 6-7, 2007, Greenbelt, Maryland.

Jointly chaired sessions at the 2009 DPS meeting (Puerto Rico) and the 2010 Exoplanets conference (Exeter, UK). Selected to participate in panel discussion on exoplanets at 2007 DPS meeting (Orlando, Florida).

Member of the Local Organizing Committee (childcare subcommittee) for the 2008 Division of Planetary Sciences (DPS) meeting of the American Astronomical Society (Ithaca, NY, October 2008).

Participated in NASA Research & Analysis Management Operations Working Group (MOWG), to advise NASA on health of R&A programs, 2008.

Advisory council for NASA Planetary Data Systems (PDS) node, 2009-.

Participated in panel to redraft AGU’s position statement on Earth and space sciences (entitled “NASA: Earth and Space Sciences at Risk”), 2009.

Member of Scientific Organizing Committee for conference “Exoclines 2010” conference held in Exeter, UK, Sept 7-10, 2010.

Co-convener (along with Mark Richardson) for planetary atmospheres session held at the American Meteorological Society annual meeting, 16-21 January, 2010.

Invited to participate in panel discussion to provide feedback to AGU about the future of AGU, 2010.

Member of Scientific Organizing Committee for 5th Subaru International Conference: “Exoplanets and Disks: Their formation and diversity II,” Kona, Hawaii, December 9-12, 2013.

Member of Scientific Organizing Committee for conference “Exoclines III: The Diversity of Planetary Atmospheres” to be held in Davos, Switzerland, February 9-14, 2014.

Member of Scientific Organizing Committee for Division of Planetary Sciences (DPS) conference, Tucson, AZ, November 2014.

Editor, *Icarus*, 2014-

SERVICE (UNIVERSITY OF ARIZONA, 2007-present):

Departmental Committees:

2014-2015: Library committee (chair); recruitment committee; LPL Awards committee; pre-tenure teaching, advising, and review committee.

2013-2014: Graduate Admissions & Advising committee (chair); pre-tenure teaching, advising, and review committee

2012-2013: Graduate Admissions & Advising committee (chair), Theoretical Astrophysics Program (TAP) steering committee, pre-tenure advising committee

2011-2012: Graduate Admissions & Advising committee (chair); library committee (chair); organizer of Theoretical Astrophysics Program (TAP) colloquium series

2010-2011: library committee (chair); Graduate Admissions & Advising committee; pre-tenure advising committee; curriculum committee; organizer of Theoretical Astrophysics Program (TAP) colloquium series.

2009-2010: None [on sabbatical]

2008-2009: Library committee (chair), graduate admissions & advising committee; computer committee; pre-tenure advising committee (chair), organizer of Theoretical Astrophysics Program (TAP) colloquium series.

2007-2008: Library committee (chair), graduate admissions & advising committee; pre-tenure advising committee; LPL strategic planning committee; computer committee; journal club; organizer of Theoretical Astrophysics Program (TAP) colloquium series.

Oral qualifying exams for graduate students: ~31 in total, with ~10 since 2007: Brian Jackson (February 2007), Eric Palmer (April 2007 and fall 2007), Nikole Lewis (November 2009), Lissa Ong (November 2009), Catherine Elder (January 2011), Christa van Laerhoven (April 2011), Juan Lora (December 2011), Tiffany Kataria (December 2011), Rob Zelle (December 2011)

M.S.-defense exams: Diana Smith (April 2008) and Maki Hatori (July 2008).

University of Arizona Ph.D. thesis-defense exams: ~20 in total, with 13 since 2007: Gwen Bart (April 2007), Kunio Sayanagi (May 2007), Michael Bland (April 2008), John Moores (May 2008), Yuan Lian (spring 2009), Brian Jackson (April 2009), David Choi (November 2009), Lena Zuchowski (Oxford, spring 2009), Emily Rauscher (Columbia University, May 2010), Nikole Lewis (April 2012), Christa van Laerhoven (April 2014), Juan Lora (June 2014) Tiffany Kataria (August 2014). On the Ph.D. thesis committees of Catherine Elder, Rob Zelle, Xianyu Tan, and Tad Komacek.

Helped spearhead a plan to coordinate atmospheres-related teaching efforts across the Atmospheric Science and Planetary Sciences departments at the University of Arizona.

Joint professor in the ATMO department (2004-present).

OUTREACH:

RECENT PUBLIC TALKS:

Classroom science presentation for elementary school students, Ventana Vista Elementary School, Tucson AZ, February 2013

Public lecture at the Lunar & Planetary Laboratory, University of Arizona, November 2012: “Weather and climate on planets orbiting other stars: a new frontier in planetary science.”

Public lecture at Flandrau Planetarium February 2007: “Saturn: The Ringed Planet.”

Public lecture at Kitt Peak June 2007: “Jupiter: Jewel of the Night Sky.”

PUBLICITY/OUTREACH:

I was interviewed in four TV episodes of *The Universe*, which aired on the history channel in 2007-2008. Interviewed in TV show *How the Universe Works 2* for the Discovery Channel in 2011. Interviewed in 2012 in TV show *Fastest Winds in the Solar System* for the Weather channel (which aired in 2013). I regularly give interviews to reporters at a wide range of publications, leading to numerous general-interest articles about various topics in planetary science that quote me as an expert.

A major feature article in *The Arizona Daily Star* focused exclusively on my work (“Planetary Weatherman’s data mind blowing,” December 26, 2008).

My research has been written up numerous times in the popular press, including *USA Today*, space.com, spaceref.com, spaceflightnow.com, spacedaily.com, rednova.com, Astrobiology magazine (www.astrobio.net), *Space News*, *Astronomy*,

Science News, *Popular Science*, bulletin of the British Astronomical Association, and *Mercury* magazines, as well as on several smaller publications. Invited to write press releases and participate in press conferences at annual DPS planetary science meetings and other venues in 2009, 2008, 2007, 2005 and 2001.

Invited by *Nature* to write three News & Views articles (Showman, A.P. 2008, “Extrasolar planets: A whiff of methane,” *Nature* **452**, 296-297; Showman, A.P. 2009, “Windy clues to Saturn’s spin,” *Nature* **460**, 582-583; Showman, A.P. “Astrophysics: Portrait of a dynamic neighbour,” *Nature* **505**, 625-626).

Invited to participate in “Scitini,” a University of Arizona-sponsored meeting between professors and journalists, 2011.

Judge for “Art of Planetary Science” art show held at Lunar and Planetary Laboratory at University of Arizona, December 2013

Helped construct a website to educate the general public about global warming, called “Climate Cure 2025,” which launched in fall 2006.

COURSES TAUGHT (2007-PRESENT):

Fall 2007: Atmo/PtyS 541A, “Dynamic Meteorology.” Enrollment: 7. This is a core course required for all graduate students in the Department of Atmospheric Sciences; it provides a thorough quantitative introduction to the dynamics of weather and climate.

Fall 2007: PtyS 195A, “First-year colloquium: Planetary climate.” Enrollment: 30. This course gives undergraduates (primarily freshmen) an overview of the climate of Earth and other planets.

Spring 2008: PtyS 512, “Planetary Global Tectonics.” Enrollment: 8. This is a core course required for all graduate students in the Department of Planetary Sciences; it provides a quantitative overview of tectonics, planetary heat loss, and aspects of geophysics relevant for planetary science.

Fall 2008: PtyS 517, “Atmospheres and remote sensing.” A core course required for all graduate students in the Department of Planetary Sciences; provides a quantitative overview of planetary atmospheres, including atmospheric thermodynamics, radiative transfer, dynamics, cloud physics, and applications to planets. Enrollment:13.

Fall 2008: PtyS 195A, “First-year colloquium: Planetary climate.” Enrollment: 18.

Spring 2009: PtyS 594A, “Planetary geology field practicum” (with Shane Byrne). Official enrollment: 2 (although ~12 students actually attended). In this course, students participate in a geology field trip that introduces them to the geology and geophysics of Earth and the other planets.

Fall 2010: PtyS 512, “Planetary Global Tectonics.” Enrollment: 12.

Spring 2011: PtyS 522, “Planetary Climate.” Enrollment: 11. This is a new graduate elective course, designed by Showman and offered for the first time this semester.

Provides a graduate-level survey of the physical, chemical, and geological principles governing climate on terrestrial planets, including Earth, Venus, Mars, Titan, and extrasolar planets in the habitable zones of other stars.

Spring 2012: PtyS 517, “Atmospheres and remote sensing.” Enrollment: 13.

Fall 2012: ATMO/PtyS 641, “Advanced atmospheric dynamics.” Enrollment: 5.
This is a new graduate elective course, designed by Showman and offered this semester for the first time. Provides an advanced graduate-level survey of the theory of atmospheric dynamics and application thereof to explain the observed circulations on Earth, Mars, Venus, Titan, and the giant planets.

Spring 2013: PtyS 512, “Planetary Global Tectonics.” Enrollment: 11.

Spring 2014: PtyS 517, “Atmospheres and remote sensing.” Enrollment: 8.

Fall 2014: PtyS 512, “Planetary Global Tectonics.” Enrollment ~10.

INDIVIDUAL STUDENT CONTACT:

Advising:

19 graduate students advised to date:

I was the Ph.D. thesis advisor for Curtis Cooper (PtyS), Kunio Sayanagi (physics), Michael Bland (PtyS), Yuan Lian (PtyS), David Choi (PtyS), Nikole Lewis (PtyS), and Tiffany Kataria (PtyS), who received their Ph.D. under my direction in 2006, 2007, 2008, 2009, 2009, 2012, and 2014, respectively.

I am currently the Ph.D. advisor of two additional PtyS graduate students: Catherine Elder, who will obtain her Ph.D. in 2015, and Xianyu Tan, who will receive his Ph.D. in ~2018.

I provided advising to atmospheric science graduate students William Valine, Andrew Penny, and Adam Gray. I helped advise Amanda Proctor (PtyS) and provided occasional advising to John Keller (PtyS).

I helped advise Giuseppe Mitri, who received his Ph.D. from Universita d’Annunzio in Pescara, Italy, January 2005, and subsequently (along with Jonathan Lunine) advised him as a postdoc from 2004-2006.

I advised four graduate students on research projects at the International Summer Institute for Modeling in Astrophysics in Beijing, China, in summer 2011; this included Daniel Perez-Becker (graduate student at U.C. Berkeley), Xi Zhang (graduate student at the California Institute of Technology, currently Bisgrove Fellow at LPL), Vivien Parmentier (graduate student at the Observatoire de la Cote d’Azur in Nice, France) and Beibei Liu (graduate student at Peking University in Beijing, China). The projects with Parmentier, Liu, and Perez-Becker have already been published in peer-reviewed journals.

Mentoring:

As described above, I have mentored ~19 graduate students on research projects, teaching them much about their specific projects, the process of doing science, and other aspects of their careers.

My contact with undergraduates in PtyS 206 led several of my enrolled students to invite me to the Sigma Chi Faculty Appreciation Dinner.

I was twice singled out for “special praise” as being “particularly inspirational” to one or more graduating students in the College of Science Exit Survey for graduating students (May 2006 and September 2007)

While under my guidance, my graduate students have received significant honors for our work together. Of the nine graduate students that received (or are currently working toward) their Ph.D. with me, seven have won prestigious national merit-based awards to fund their research: Curtis Cooper won a NASA Graduate Student Researcher’s Program (GSRP) Fellowship; Michael Bland, Nikole Lewis, David Choi, Catherine Elder, and Xianyu Tan all won NASA Earth and Space Science Fellowships (NESSF); and Tiffany Kataria won the Harriet G. Jenkins Pre-doctoral Fellowship (JFPF) award. Moreover, Curtis Cooper, Michael Bland, David Choi, and Nikole Lewis all won the prestigious Lunar and Planetary Laboratory’s Kuiper Award (in 2006, 2007, 2010, and 2012, respectively), which is given annually to the strongest and most promising graduate student involved in research at LPL. Curtis Cooper also won the University of Arizona Theoretical Astrophysics Program “best student paper” award for our paper Cooper and Showman (2005, Dynamic meteorology at the photosphere of HD 209458b, *Astrophys. J.*, **629**, L45-L48).

Faculty advisor of clubs:

I was the informal faculty advisor for an LPL graduate student group, “Climate Cure 2025,” which focused on increasing public awareness of the science of global climate change with a specific emphasis on creating Podcast interviews of climate experts (see www.lpl.arizona.edu/climate2025/).

I regularly participate in the LPL geology field trips, which are 3–5-day-long trips that happen once per semester.

Ph.D. Theses directed:

- Curtis Cooper (graduation May 2006), Thesis title: *Meteorologies of Brown Dwarfs and Extrasolar Giant Planets*. Current position: Research Scientist, Sandia National Laboratory, Albuquerque, New Mexico.
- Kunio Sayanagi (graduation May 2007), Thesis title: *Numerical Modeling of Atmospheric Jet Streams on Jupiter and Saturn: Their Formation and Stability*. Current position: Assistant professor (tenure track) at Hampton University, Virginia.
- Michael Bland (graduation May 2008), Thesis title: *The Tectonic, Thermal, and Magnetic Evolution of Icy Satellites*. Current position: Research scientist, Washington University (with Prof. William McKinnon).

- Yuan Lian (graduation May 2009), Thesis title: *Numerical Simulations of Atmospheric Dynamics on the Giant Planets*. Current position: Research Associate, Ashima Research, Pasadena, California.
- David Choi (graduation December 2009), Thesis title: *The Meteorology of Giant Planets Revealed Through Automated Cloud Feature Tracking*. Current position: Scientific Engineer at Raytheon, Washington, DC.
- Nikole Lewis (graduation August 2012): Thesis title: *Atmospheric circulation of eccentric extrasolar giant planets*. Current position: Sagan Fellow at the Massachusetts Institute of Technology.
- Tiffany Kataria (graduation December 2014): Thesis title *Atmospheric Circulation of Hot Jupiters and Super Earths*.

Ph.D. Theses/Dissertations in Progress:

- Catherine Elder: “Coupled orbital and thermal evolution of Io,” scheduled graduation ~May 2014.
- Xianyu Tan: “Atmospheric circulation of brown dwarfs and directly imaged giant planets,” scheduled graduation ~2018.

Postdoctoral scholars advised:

- Giuseppe Mitri 2004-2006
- David Choi 2009-2011
- Emily Rauscher 2010-2012
- Michael Sussman 2012-present
- Xi Zhang 2012-present

DEVELOPMENT AND SCHOLARLY ACTIVITY SUPPORTING TEACHING:

I have developed 8 courses so far: Ptys 206, Ptys 195A, Ptys 517, ATMO/Ptys 541A, Ptys 512, Ptys 594A, Ptys 522, and ATMO/Ptys 641.

I have designed two completely new courses—which did not previously exist—that have now been approved by the University. The first is Ptys 522, “Planetary Climate,” which I taught for the first time during spring 2011. The second is ATMO 641, “Advanced dynamics,” which I taught for the first time in fall 2012.

With Caitlin Griffith, Roger Yelle, and faculty from the atmospheric sciences department, I helped to organize and have continued to maintain a formal agreement between LPL and the Department of Atmospheric Sciences to cross-fertilize the teaching programs of our two departments; as a result of this, I am joint faculty in ATMO, teach in that department, and regularly receives ATMO students in my planetary atmospheres courses (Ptys 517 and 522). This interaction has

even led to cross-fertilization with research; for example, one of the ATMO students in my class did a term project that we recently published as a JGR article about turbulence on Saturn.

For each of my graduate classes (Ptys 517, ATMO/Ptys 541A, Ptys 512, PtyS 522, and ATMO/PtyS 641), I developed a comprehensive set of notes — essentially a 200-page informal textbook in each case — that I handed out to the students. (See for example www.lpl.arizona.edu/~showman/climate/planetary-climate.pdf for the set for Ptys 522.) I eventually plan to write one or more textbooks based on these notes.

For my graduate atmospheres classes, I performed a suite of numerical simulations of atmospheric flow using cutting-edge atmospheric circulation models. These instructional simulations are focused on illustrating key aspects of atmospheric dynamics. I made movies and stills of the simulations that I showed during class, and these have been quite helpful in aiding the students' understanding of the mathematical derivations done in class. I plan to expand this effort and eventually make a website offering these visualizations to the general public.

Developed an extensive series of in-class participatory activities for my PtyS 206 class. My PtyS 206 and PtyS 195A courses involved the use of substantial web-based resources.

STUDENT EVALUATION OF TEACHING (2007-present):

ATMO/Ptys 541A, Fall 2007: Of 7 students responding, 85% ranked the course as very good or excellent, and 100% ranked the instructor as very good or excellent.

Ptys 195A, Fall 2007: Of 29 students responding, 93% ranked the course as very good or excellent, and 100% ranked the instructor as very good or excellent.

Ptys 512, Spring 2008: Of 8 students responding, 100% ranked the course as very good or excellent, and 100% ranked the instructor as very good or excellent.

Ptys 517, Fall 2008: Of 13 students responding, 85% ranked the course as very good or excellent, and 85% ranked the instructor as very good or excellent.

Ptys 195A, Fall 2008: Of 12 students responding, 83% ranked the course as very good or excellent, and 100% ranked the instructor as very good or excellent.

Ptys 594A, Spring 2009: Of 4 students responding, 100% ranked the course as very good or excellent, and 100% ranked the instructor as very good or excellent.

Ptys 512, Fall 2010: Of 12 students responding, 100% ranked the course as very good or excellent, and 100% ranked the instructor as very good or excellent.

Ptys 522, Spring 2011: Of 10 students responding, 100% ranked the course as very good or excellent, and 100% ranked the instructor as very good or excellent.

Ptys 517, Spring 2012: Of 13 students responding, 55% ranked the course as very good or excellent, and 82% ranked the instructor as very good or excellent.

ATMO/Ptys 641, Fall 2012: Of 6 students responding, 100% ranked the course as very good or excellent, and 100% ranked the instructor as very good or excellent.

AWARDS AND HONORS:

2014 *Salpeter Lecturer, Cornell University*

2011 *Faculty mentor, International Summer Institute for Modeling in Astrophysics (ISIMA), Kavli Institute for Astronomy & Astrophysics, Peking University*

2003, 2005 *Visiting Fellow, Cornell University*

1999-2001 *National Research Council Associateship award*

Awarded to top applicants nationwide; provided full postdoctoral funding

1999 *American Astronomical Society (Planetary Section) Travel Grant Recipient*

Awarded to top students and recent graduates; pays for conference travel costs

1992-1995 *National Science Foundation Graduate Fellowship*

Awarded to the top few applicants nationwide; provides graduate school funding

1994, 1995 *Lunar and Planetary Institute Visiting Graduate Fellowship*

Funds graduate student projects at the LPI

1989, 1990 *Planetary Society Fellowship Winner*

Awarded to the top 5 applicants (nationwide) with interest in planetary science

1990-present *Member, Sigma Xi Scientific Honor Society*