VICTORIA MEADOWS (UNIVERSITY OF WASHINGTON)

RESEARCH INTERESTS:

Venus and Earth observations/characterization, theoretical modeling of terrestrial planetary environments to understand factors affecting habitability, biosignature generation and false positives, and terrestrial exoplanet characterization to search for signs of habitability and life.

PROFESSIONAL PREPARATION:

University of Sydney, PhD (Physics/Astrophysics), 1994
University of New South Wales, B.Sc. (Physics - Class 1 Honors), 1988.

SELECTED PROFESSIONAL EXPERIENCE AND PROFESSIONAL SOCIETIES

2018 – Management Team Member, NASA Nexus for Exoplanet System Science.
2018 – Member, SPARCS Cubesat Mission Team
2017 – Adjunct Professor, Earth and Space Sciences, University of Washington, Seattle, WA
2017 – Visiting Professor, Astrobiology Center, University of Tokyo.
2016 – Member, NASA LUVOIR Science and Technology Definition Team
2015 – Principal Investigator, NASA NExSS Virtual Planetary Laboratory Team Lead
2013 – Full Professor, Astronomy, University of Washington, Seattle, WA
2011 – Director, University of Washington Astrobiology Program, Seattle, WA
2001-2017 Principal Investigator & Executive Council Member, NASA Astrobiology Institute
2013-2016 Member, NASA Exo-C Science and Technology Definition Team
2013-2015 Co-Director for the Santander Summer School in Astrobiology.
2007-2013 Associate Professor, University of Washington, Seattle, WA
2007-2011 NASA EPOXI Mission Science Team
2004-2006 NASA Terrestrial Planet Finder-Coronagraph Science and Technology Defn. Team
2002-2004 NASA Terrestrial Planet Finder Science Working Group
1999-2007 Lead/Associate Research Scientist, Spitzer Science Center, Caltech, Pasadena, CA
1996-2005 Research Scientist – Senior A, Jet Propulsion Laboratory, La Cañada, CA.
1994 – Member of the AAS, AAS-DPS and AGU.

SELECTED HONORS, AWARDS AND COMMUNITY REPRESENTATION:

2018 – SETI Frank Drake Award – for significant contributions astrobiology.
2018 – Chair of the NASA Exoplanet Analysis Group (ExoPAG)
2018 – Member of the NASA Astrophysics Advisory Council
2018 – Member of the National Academy of Sciences Astrobiology Strategy Committee
2018 – Member of the National Academy of Sciences Exoplanet Strategy Committee
2018 – Chair of the Scientific Organizing Committee for the AbSciCon 2019.
2017 – Associate Editor, *Astrobiology* Journal
2014-2016 Google Sci Foo Camp Invitee/Attendee
2015-2016 NASA Astrobiology Strategy author and reviewer.
2015 Bok Lecture, Siding Spring, Australia.
2015 Allison Levick Memorial Lecture, Sydney, Australia
2014-2016 SETI Institute Science Advisory Board
2009 NASA Group Achievement Award – 2008 Astrobiology Roadmap Team
2008-2010 National Academy of Sciences - Frontiers of Science Kavli Fellow
2007-2008 NASA Astrobiology Roadmap Revision Team
2006 NASA Group Achievement Award – Spitzer Deep Impact (DI) Support Team

2005-2008 *Icarus* Editorial Board
2005-2008 Planetary Science Subcommittee of the NASA Advisory Council
2004-2005NASA Universe Roadmap Writing Team – Chair for "Habitable Planets and Life"
2004-2005, NASA Origins Subcommittee of the NASA Space Science Advisory Committee
2005 NASA Group Achievement Award – Spitzer First Look Survey Science Team
2006 NASA Strategic Roadmap on "Telescopic Searches for Habitable Planets
2007 2004 NASA Group Achievement Award – Spitzer Space Telescope Mission Ops Team
2002-2003 NASA Astrobiology Roadmap Team, Origins Roadmap Team and Shared Foundations Roadmap Team.
2001 The JPL Lew Allen Award for Excellence (for leadership in scientific research)
1999-2004, NASA Planetary Systems Science Management Operations Working Group

SELECTED INVITED PRESENTATIONS AT NATIONAL AND INTERNATIONAL CONFERENCES:
2017 November, "Characterizing Terrestrial Planets" plenary at *Habitable Worlds 2017*, Laramie, WY, USA.
2017, April, "Observations to Assess Habitability and Life on Extrasolar Planets" at *Breakthrough Discuss*, Palo Alto, CA, USA.
2016, December, "A Review of Biosignatures" at the National Academy of Sciences workshop on *Searching for Life Across Space and Time*.
2016, September, "The Future Landscape of Exoplanet Astrobiology" at the *Kavli Exofrontiers Symposium*, Cambridge, UK.
2016, July, Opening plenary on "Biosignatures: The State of the Field", at the *NExSS Exoplanet Biosignatures Workshop*, Seattle, USA.
2016, February, Opening plenary on "Factors Affecting the Nature and Identification of Planetary Habitability" at the *Astrophysics of Habitability Conference*, Vienna, Austria.
2016, January, "Exoplanets: A New Era of Comparative Planetology" at the *ELSI Earth-Life Symposium*, Tokyo, Japan.
2015, October, "Prospects for Characterizing Potentially Habitable Planets with JWST" at the ESA/ESTEC *Exploring the Universe with JWST* workshop, Noordwijk, the Netherlands.
2015, June, Plenary Talk on "Exoplanet Habitability", *Astrobiology Science Conference*, Chicago, USA.
2014, November, Invited Plenary on "Exoplanets: A New Era of Comparative Planetology", at the *Division of Planetary Sciences Meeting of the AAS*, Tucson, AZ, USA.

SYNERGISTIC RESEARCH AND COMMUNITY ACTIVITIES
Dr. Meadows is the Principal Investigator for the NASA Astrobiology Institute's Virtual Planetary Laboratory Lead Team, which she founded in 2001, and for which she has won over ~$31M in funding. Her VPL team has developed a strongly interdisciplinary theoretical framework to understand the potential habitability and global signs of life for extrasolar planets. Her team pioneered models of the interactions between a planet, its host star, and its planetary system environment, to understand how these interactions affect a planet's ability to support life. The VPL also determines life's impact on the planetary environment to better understand how to most effectively search for signs of life on distant planets. Her team has grown from 17 original members to 85 researchers at 23 institutions, with expertise spanning many subfields of biology, planetary science and astrophysics. The VPL publishes 40-80 refereed journal papers a year (e.g. https://nai.nasa.gov/media/pdf_annual_reports/NAI_TeamsAR2016-VPL-01.pdf) and served as the inspiration for the NASA NExSS interdisciplinary exoplanet research network. Dr.

Meadows was also a member of the NASA EPOXI mission Science Team, linking VPL modeling and EPOXI data to explore the detectability of signs of habitability and life on the distant Earth. She has extensive experience within NASA in planetary science, Earth science and observational astronomy. She worked on the Hubble Space Telescope's Wide-Field and Planetary Camera-2 Science Team, the Spitzer Space Telescope Science Support Team, served on over 8 NASA panels and advisory committees for exoplanets and astrobiology, and has contributed to 6 Discovery mission proposals for missions to Venus. She has served on several national and international conference organizing committees for planetary and exoplanet science.

STUDENTS, MENTORING AND EDUCATION:

Postdoctoral Scholars and Current Positions

Giovanna Tinetti – Professor, University College London
John Armstrong – Professor, Weber State University
Antigona Segura – Professor, UNAM
Mark Claire – Lecturer, University of St. Andrews
Shawn Domagal-Goldman – Civil Servant Scientist, NASA GSFC
Sean Raymond – Researcher, Laboratoire d'Astrophysique de Bordeaux
Rory Barnes – Assistant Professor, University of Washington
Colin Goldblatt - Assistant Professor, University of Victoria
Peter Driscoll – Staff Scientist, Carnegie Institution of Washington
Benjamin Charnay – postdoc, Observatoire de Paris, Meudon.
Kimberley Bott – postdoc, University of Washington.

Graduate Students and Current Positions

Tyler Robinson (Astronomy & Astrobiology) – Assistant Professor, NAU
Aomawa Shields (Astronomy & Astrobiology) – Assistant Professor, UC-Irvine
Amit Misra (Astronomy & Astrobiology) – Computer Programmer, Microsoft
Giada Arney (Astronomy & Astrobiology) – Civil Servant Scientist, NASA/GSFC
Eddie Schwieterman (Astronomy & Astrobiology) –NAI Postdoctoral Fellow, UC-Riverside
Jacob Lustig-Yaeger (Astronomy & Astrobiology) – Graduate student, UW
Andrew Lincowski (Astronomy & Astrobiology) – NESSF Graduate Research Fellow, UW
Lupita Tovar (Astronomy & Astrobiology) – NSF Graduate Research Fellow, UW

Dr. Meadows served on the doctoral committees for PhD graduates Lucianne Walkowicz (Adler Planetarium/Library of Congress Chair of Astrobiology), Nick Cowan (Assistant. Professor., McGill U.), Nate Kaib (Assistant. Professor., U. Oklahoma), Mark Claire (Lecturer U. St. Andrews), Darci Snowdon (Assistant Professor, Central Wash. U.), Rika Anderson (Assistant Professor, Carleton College), Meg Smith (Aerospace Corp.), Elena Amador (Postdoctoral Scholar, Caltech), Rodrigo Luger (Postdoctoral Scholar, Flatiron Institute), Russell Deitrick (U. Bern, Switzerland), Matt Tilley (Postdoctoral Scholar, UW). In addition to her own students, Dr. Meadows is also on the doctoral committees for Astronomy graduate student David Fleming; Earth and Space Sciences & Astrobiology PhD student Josh Krissansen-Totton, and Aeronautics and Astronautics PhD student Osa Igbinosun.

Dr. Meadows is also the Director of the UW Astrobiology Graduate Program, with 33 students and 14 faculty. Founded in 1998, the program now spans 11 academic units at the University of Washington, and is concentrated in Astronomy, Earth and Space Sciences, Oceanography,

Biology, Microbiology, Environmental & Forest Sciences, Atmospheric Sciences, and Aeronautics & Astronautics. The UW's Astrobiology Program has been recognized as the most comprehensive and cohesive graduate program in Astrobiology in the nation, encompassing research on the origin and evolution of life on Earth, life in extreme environments, habitability and life in the Solar System, the detection and characterization of habitable exoplanets, and space exploration. As Director, Dr. Meadows designed and implemented an interdisciplinary Dual-Title PhD Degree Program in both a student's home department & Astrobiology, which has been offered by the UW Astrobiology Program since 2012. Fifteen students have since graduated with dual-title PhDs in Astronomy and Astrobiology, Oceanography and Astrobiology, Biology and Astrobiology, and Earth and Space Sciences and Astrobiology. Since its inception, the UW Astrobiology Program has also graduated 30 PhDs with a Graduate Certificate in Astrobiology.

SELECTED RELEVANT PUBLICATIONS: (***Graduate Students***, *Postdocs*, ***Undergraduates***)
(256 publications total, over 90 in refereed journals, and 2 book chapters)

Meadows V.S., Barnes R.K. (2018) Factors Affecting Exoplanet Habitability. In: Deeg H., Belmonte J. (eds) Handbook of Exoplanets. Springer, Cham, DOI: https://doi.org/10.1007/978-3-319-30648-3_57-1

Meadows, V.S., Reinhard, C.T., ***Arney, G.N.,*** Parenteau, M.N., ***Schwieterman, E.W***., Domagal-Goldman, S.D., ***Lincowski, A.P***., Stapelfeldt, K.R., Rauer, H., DasSarma, S. and Hegde, S., Siegler, N., ***Lustig-Yaeger, J***., (2018). Exoplanet Biosignatures: Understanding Oxygen as a Biosignature in the Context of Its Environment, *Astrobiology*, 18(6), 630-662.

Schwieterman, E.W., Kiang, N.Y., Parenteau, M.N., Harman, C.E., DasSarma, S., Fisher, T.M., ***Arney, G.N***., Hartnett, H.E., Reinhard, C.T., Olson, S.L. and **Meadows, V.S**., (2017) Exoplanet Biosignatures: A Review of Remotely Detectable Signs of Life, *Astrobiology*, 18(6), 663-708.

Meadows, V.S., ***Arney, G.N., Schwieterman, E.W., Lustig-Yaeger, J., Lincowski, A.P., Robinson, T.,*** *Domagal-Goldman, S.D., Barnes,* R.K., Fleming, D.P**.,** ***Deitrick, R. and Luger, R.*** et al., (2018). The Habitability of Proxima Centauri b: Environmental States and Observational Discriminants, *Astrobiology,* 18(2), 133-189.

Meadows, V.S., (2017) Reflections on O_2 as a Biosignature in Exoplanetary Atmospheres, *Astrobiology*, 17(10), 1022-1052.

Luger, R*.,* ***Lustig-Yaeger, J***., Fleming, D.P., ***Tilley, M.A***., Agol, E., **Meadows, V.S**., Deitrick, R. and Barnes, R., 2017. The Pale Green Dot: A Method to Characterize Proxima Centauri b Using Exo-Aurorae. *The Astrophysical Journal*, *837*(1), p.63.

Arney, G. N., **Meadows, V. S**., Domagal-Goldman, S. D., Deming, D., Robinson, T. D. Tovar, G., Wolf, E. T., Schwieterman, E., (2017), Pale Orange Dots: The Impact Of Organic Haze On The Habitability And Detectability Of Earthlike Exoplanets, Ap. J., 836(1), p49.

Kopparapu, R., Wolf, E. T., Haqq-Misra, J., Yang, J., Kasting, J. F., **Meadows, V**., Terrien, R., Mahadevan, S. (2016) The inner edge of the habitable zone for synchronously rotating planets around low-mass stars using general circulation models, Ap.J., 819, 84.

Agol, E., *Jansen, T*., Lacy, B., ***Robinson, TD***, **Meadows, V**. (2016), The Center of Light: Spectroastrometric Detectino of Exomoons, Ap. J., 812 (1), 5

Shields, A., *Barnes, R*., Agol, E., *Charnay, B*., Bitz, C., **Meadows, V. S**., (2016) The effect of orbital configuration on the possible climates and habitability of Kepler-62f. *Astrobiology* 16(6) 443-464

Arney, G., *Domagal-Goldman, S.D.,* **Meadows, V.S.***,* Wolf, E.T.***, Schwieterman, E.,*** *Charnay, B., Claire, M.,* ***Hébrard, E. and Trainer, M.G.*****, (2016).** The pale orange dot: the spectrum and habitability of hazy Archean Earth**.** *Astrobiology*, *16*(11), pp.873-899.

Schwieterman, E.W., Meadows, V. S., *Domagal-Goldman, S. D.*, Deming, D., ***Arney, A. N., Luger, R.***, Harman, C., ***Misra, M.****, Barnes, R.*, (2016), Identifying Planetary Biosignature Impostors: Spectral features of CO and O_4 resulting from abiotic O_2/O_3 production. *Ap. J. Lett.*, 819: L13.

Charnay, B., **Meadows, V.S.**, ***Misra, A.***, Leconte, J., ***Arney, G.*** (2015) 3D modeling of GJ1214b's atmosphere: formation of inhomogeneous high clouds and observational implications. *ApJL*, **813**: L1.

Luger, R., *Barnes, R.*, Lopez E., Fortney J., Jackson B., and **Meadows V**. (2015) Habitable Evaporated Cores: Transforming Mini-Neptunes into Super-Earths in the Habitable Zones of M Dwarfs, *Astrobiology,*15(1): 57-88. doi:10.1089/ast.2014.1215.

Robinson, T.D., Ennico, K., **Meadows, V.S**., Sparks, W., Bussey, D.B.J., ***Schwieterman, E.W., Breiner, J.*** (2014) Detection of Ocean Glint and Ozone Absorption Using LCROSS Earth Observations, *Ap. J.*, 787, 171.

Arney, G.**, Meadows, V**., Crisp, D., Schmidt, S.J., Bailey, J., *Robinson, T.* (2014) Spatially resolved measurements of H_2O, HCl, CO, OCS, SO_2, cloud opacity, and acid concentration in the Venus near-infrared spectral windows, *JGR (Planets)* 119, 1860-1891

Domagal-Goldman, S.D., Segura, A., Claire, M.W., Robinson, T.D., **Meadows, V.S** (2014) Abiotic Ozone and Oxygen in Atmospheres Similar to Prebiotic Earth, Ap. J., 792, 90.

Misra, A., **Meadows, V**., *Claire, M.*, Crisp, D., (2014) Using Dimers to Measure Biosignatures and Atmospheric Pressure for Terrestrial Exoplanets, *Astrobiology* 14, 67-8

Domagal-Goldman, S., **Meadows, V. S.**, *Claire, M.*, Kasting, J., 2011, Using biogenic sulfur gases as remotely detectable biosignatures on anoxic planets, *Astrobiology*, 11(5), 419.

Meadows, V. S. and Seager, S., (2010) Terrestrial Planet Atmospheres and Biosignatures, in *Exoplanets* ed. S. Seager, Tucson, AZ, University of Arizona Press, 441-470.

Robinson, T. D., **Meadows, V. S**., Crisp, D. (2010) Detecting Oceans on Extrasolar Planets Using the Glint Effect, *ApJ* **721** L67-L71

Segura, A., Walkowicz, L., **Meadows, V.**, Kasting, J., Hawley, S., 2010, The Effect of a Strong Stellar Flare on the Atmospheric Chemistry of an Earth-like Planet Orbiting an M dwarf, *Astrobiology*, 10(7), 751-771.

Cowan, N. B., Agol, E., **Meadows, V**., ***Robinson. T.***, Livengood, T., Deming, D., Lisse, C.M., A'Hearn, M. F., Wellnitz, D. D., Seager, S., Charbonneau, D., 2009, Alien Maps of an Ocean-Bearing World, *Ap. J.,* 700(2), 915-923.

Meadows, V. S. (2008). Planetary environmental signatures for habitability and life. In *Exoplanets* (pp. 259-284). Springer, Berlin-Heidelberg.

Kiang, N. Y., *A. Segura, G. Tinetti*, Govindjee, R. E. Blankenship, M. Cohen, J. Siefert, D. Crisp, **V. S. Meadows**, 2007, "Spectral Signatures of Photosynthesis. II. Coevolution with Other Stars and the Atmosphere on Extrasolar Worlds, *Astrobiology*, 7(1), 252-274.

Segura, A., **Meadows, V. S**., Kasting, J. F., Crisp, D., Cohen, M., 2007, Abiotic formation of O_2 and O_3 in high-CO_2 terrestrial atmospheres, *Astron. & Astrophys.*, 472(2), pp.665-679

Segura, A., J.F. Kasting, **V. Meadows**, M. Cohen, J. Scalo,. D. Crisp, *R. A. H. Butler*, *G. Tinetti*, 2005, Biosignatures from Earth-like planets around M dwarfs, *Astrobiology*, 5(6): 706.

Meadows V. S., Crisp D, Ground-based near-infrared observations of the Venus night side: the thermal structure and water abundance near the surface, *J. Geophys. Res. - Planets*, 101, 4595-4622, 1996.