

Education and training

University of South Florida, Tampa FL	B.A.	1980	Botany
University of South Florida, Tampa FL	M.S.	1984	Plant Physiol. / Physiological Ecology
University of Florida, Gainesville FL	Ph.D.	1989	Molecular Genetics / Epigenetics

Positions and Employment

2020 – Present	Director, Interdisciplinary Center for Biotechnology Research
2019 – 2020	Interim Director, Interdisciplinary Center for Biotechnology Research
2014 – Present	Research Professor, University of Florida
2008 – 2014	Research Associate Professor, University of Florida
2005 – 2008	Associate Scientist (Research Faculty), University of Florida
1996 – 2005	Assistant in HOS (Research Faculty), University of Florida, Gainesville, FL
1990 – 1996	Postdoctoral work, UF and Northwestern University, Evanston, IL
	Graduate Faculty in the Department of Horticultural Sciences
	Graduate Faculty in the Program of Plant Molecular and Cellular Biology (PMCB)
	Graduate Faculty in the UF Genetics Institute

Honors and Special Professional Activities**National and International**

- Fellow of the American Society for Gravitational and Space Research, 2019
- Recipient of the NASA Exceptional Scientific Achievement Medal, 2019
- Executive Board, American Society for Gravitational and Space Research (ASGSR) 2016-2019
- President, American Society for Gravitational and Space Research (ASGSR) 2017-2018
- University of Florida Rep. to Universities Space Research Association (USRA) in 2017 and 2018
- Co-recipient of the NASA Award for Most Compelling Science on the ISS, 2015
- Editor in Chief of Journal *Gravitational and Space Research*, 2009-2017
- Governing Board, ASGSR (2005-2008 and 2013-2016)
- Element Science Lead, Kennedy Space Center, for NASA GeneLab, 2013-2015
- Member of NASA's GeneLab Science Council 2013-2017
- Board Member, Suborbital Applications Researchers Group (SARG), 2012-present
- Orr Reynolds Distinguished Service Award, for "above and beyond the call of duty", 2012
- Board Member of International Space Station Standing Review Board (ISS-SRB), 2011-2012
- Member, Research Performance in Space Station Science Steering Group, 2012
- Past Member, NSF grant panel: Biochemistry of Gene Expression

University of Florida

- Member, UF President Kent Fuchs' [UF Values Council](#), October – December, 2020
- Member, UF Office of Research COVID Return to Work Taskforce, April 2020 – present
- Chair, HOS Faculty Advisory Committee, 2019
- Member, HOS Faculty Advisory Committee, 2016-2018
- Member, ICBR Genomics Advisory Group, 2015-2019
- UF/HOS representative to National Association of Science Writers, November 2013
- Graduate Coordinator, Program in Plant Molecular and Cellular Biology, 2013-2014
- Lead IFAS Cohort Member, March 2012 through March 2013
- Co-Recipient of IFAS High Impact Research Publication Award, 2013

Recent Invitations for presentations, panels and policy (2017-2020)

2020

- Reddit AMA – Plants in Space. Hosted by UF-Explore at AAAS meeting. 2/13/2020
https://www.reddit.com/r/IAmA/comments/f3h9p0/we_are_university_of_florida_research_scientists/?ut
- Invited talk – NASA Center for the Utilization of Biological Engineering in Space (CUBES), 2/18/2020 (conducted on-line)
- Meeting program committee – Annual meeting of the Next-Generation Suborbital Researchers (NSRC) Conference, Broomfield, CO, 3/1/2020
- Invited talk – Next-Generation Suborbital Research Conference. “Genomics Experiments in Human-Tended Suborbital Spaceflights: Using Shuttle and ISS Legacy Sample Handling”. 3/2/2020, Broomfield, CO
- Plantae Webinar – “Plant Careers in Space Biology ” – Co-Organizer and presenter 4/9/2020
<https://plantae.org/plantae-webinar-plant-science-careers-in-space-biology/>
- NASA Explorers Interview – Season 4 of NASA Explorers, S4 Bonus: 20 Years of Science (<https://www.facebook.com/NASAEExplorersSeries/videos/2952062194898764/>) . 6/10/2020
- Science Roundtable with NASA Administrator Bridenstine; among the representatives from UF IFAS and the College of Engineering. 7/24/2020
- NASA Podcast: “Houston We Have a Podcast on plants in space”. 8/13/2020
<https://www.nasa.gov/johnson/HWHAP/plants-in-space>
- Invited Presentation – NASA Web meeting for Space Exploration - Plant and Plant Microbiome Learning Sessions: “Biotechnology tools for Earth and Space Science”. 10/22/2020 <http://www.spaceref.com/news/viewsr.html?pid=54125>
- NASA “Plus 10” lecture – “Plant Molecular Genetics in Space Exploration” 11/13/2020 (<https://www.youtube.com/playlist?list=PL2otGG0bPu59mK9uEEX6EtuThnt3XRHay>)
- Invited talk, Oregon State University, invited for a virtual day visit plus a seminar. “Exploration science – going boldly in plant space biology” 11/19/2020

2019

- Chair, Meeting organizing Committee, Annual Meeting of the American Society of Gravitational and Space Research (ASGSR), Denver CO, November, 2019
- Invitation by George Whitesides (CEO, Virgin Galactic), to represent the science payload community on the New York Stock Exchange floor on the occasion of the public trading of the company, October 28th, 2019
- DLR (German Space Agency) invitation to present science supporting the EVA²-Space proposal to the Helmholtz foundation in Berlin (Germany), October 1st, 2019.
- ELGRA (European Low Gravity Research Association) invitation to speak in the Plenary Symposium of the annual meeting, September 24th, 2019, representing ASGSR (although had to send alternative from ASGSR Governing Board due to scheduling conflict)
- Invited presentation at the Foundation for Food and Agriculture Research (FFAR) workshop for Agricultural Sciences and the Potential for Research on the International Space Station – “Advancing our understanding of metabolic control and what can be learned in space” June 18, 2019

- Cornell University, invited to give the opening presentation at the 8th Annual Cornell Plant Breeding Symposium (Common Plants for Uncommon Goals, April 12th, 2019)
- Invited plenary – International Space Station Research and Development Conference (ISSRDC 2019, Atlanta GA) <https://www.youtube.com/watch?v=26UlxGPUFD0&feature=youtu.be>
- TEDxUF speaker, April 6th, 2019 - Humans are explorers—go boldly https://www.ted.com/talks/anna_lisa_paul_humans_are_explorers_go_boldly
- Meetings with NASA’s Space Technology Mission Directorate (STMD) and Flight Opportunities Program (FOP) leadership (Washington DC, March 12th, 2019)
- Meetings with White House National Space Council representatives (Washington DC, March 6th and 12th, 2019)
- Meetings with NASA’s Science Mission Directorate (SMD) and Cost Analysis Division (CAD) leadership (Washington DC, March 6th, 2019)

2018

- Invited to participate in NASA’s Centennial Challenges program workshop to help strategize the development of research competition challenges associated with growing plants as a source of food on long duration exploration missions (NASA StarHab Ideation Workshop, KSC, December 3, 2018)
- Invited to the White House for the National Space Council’s roundtable session on microgravity research and development. (White House, Washington DC, October 29, 2018)
- Invited to speak to the Florida Students for the Exploration and Development of Space (Florida SEDS) at UF. Presentation: Going Boldly - Exploration Science in Plant Biology. UF, August 27, 2018
- Invited to present at second annual Coalition for Aerospace and Science & Aerospace Industries Association (CAS – AIA) Showcase of NASA Partnerships & Collaboration Reception Honoring Senator Bill Nelson (Washington DC, July 23, 2018).
- Invited by Dr. Sandra Graham to present to the Committee on Biological and Physical Sciences in Space, National Academies of Science. (Washington DC, March 27, 2018)
- Invitation to make a public presentation at the Graham Center to discuss our Antarctic research and promote the cover story in EXplore magazine. UF, March 22, 2018
- Invited to participate in the Deep Space Gateway Concept Science Workshop to help NASA define the science priorities for future research and exploration objectives outside of Low Earth Orbit. (Denver, CO, February 22, 2018).

2017

- Invited speaker at the Next Generation Suborbital Researchers Conference and panel chair (December, 2017)
 - Panel: Science in Microgravity: *Exploring the Transition to Space*. Panelists, Anna-Lisa Paul, Mark Shelhamer, Peter Lee, Adrienne Dove
 - Invited talk: *Exploration Biology on the Edge of Space*.
- Invited speaker and panelist for the 15th Annual VBC PhD Program Symposium in Vienna (November, 2017)
 - Panel: *Shifting the continuum – Rethinking Facets of Science*. Panelists, John Glass, Brian R. Davis, Anna-Lisa Paul, Xavier Belavaux
 - Symposium: *Expanding the Toolkit*. Speakers, Michael Snyder, Wouter deLaat, Xavier Belvaux, Anna-Lisa Paul

- Carthage College (WI) to give a college-wide Colloquium: “Plant space biology - growing insight on the International Space Station”, Campbell Student Union Auditorium (October, 2017) <https://www.youtube.com/watch?v=dsuZpq19Gwo>
- Invited by Dr. Elliot Meyerowitz to serve on a discussion panel for National Academies Committee Symposium for the Space Studies Board Midterm Assessment Committee. Washington DC, National Academies of Science. (April, 2017)
- Invited by Dr. Mike Roberts (Chief Scientist for the Center for Advancement of Science in Space – CASIS) to serve on a Congressional Science Panel, “*Scientists Bringing International Space Station Research Down to Earth*”. Washington DC. (April, 2017)
- Invited by Dr. Sandra Graham to serve on a discussion panel “*Exploration Systems Interface with Biological and Physical Sciences*” for Space Science Week at the National Academies, before the Committee on Biological and Physical Sciences in Space. Washington DC, National Academies of Science. (March, 2017)

Professional Memberships

Lifetime Member American Society for Gravitational and Space Research (ASGSR) since 1998
 Lifetime Member Maize Genetics Cooperation (MGC) since 1985
 Member American Society for Plant Biology (ASPB) since 1989
 Member American Association of the Advancement of Science (AAAS) since 1989
 Member American Institute of Aeronautics & Astronautics (AIAA) since 2015
 Member Botanical Society of America (BSA) since 2014

Teaching and Advising

Note: I have no teaching FTEs; all classes taught are in addition to appointed faculty duties

Classes taught

Feeding Martians - Space biology and space agriculture (HOS 4932) Spring 2018, 2019, 2020, 2021
 Space Biology (HOS 4905) Fall 2008

Guest lectures in area of expertise:

Plant Behavior (HOS 4932) – gravity perception in plants
 Principles of Horticultural Crop Production (HOS 3020) – space agriculture - taking life with us
 Developmental Psychology (SFC Course DEP2004) – role of epigenetics in populations
 Growing Fruit for Fun and Profit (FRC 1010) – space biology and exploration
 Discovering the Universe (AST 1002) – space biology and exploration
 Introduction to Principles of Physics (PHY 2020) – biophysics of chromatin
 Introduction to Biophysics (PHZ 4710) – chromatin structure and gene architecture
 Advanced genetics (PCB 5065) – chromatin structure and gene architecture

Mentor for Undergraduate Research (HOS4941) (last 10 years)

Katie Teixeira	08/2019 – present
Rachael Tucker,	09/2017 – present
Kailey Tanck	03/2019 – 03/2020
Brandon McKay	08/2019 – 03/2020
Juliana Cromie,	09/2017 – 08/2019
R. Austin Schmidt,	05/2015 – 05/2017
Ana Ward,	09/2015 – 05/2017
Lara Nesralla,	05/2014 – 05/2015
Preston Stern,	05/2014 – 05/2015
Zack Guignardi,	09/2012 – 05/2014

Justin Goodwyn, 01/2011 – 05/2012
 Lauren Frizzell, 09/2010 – 05/2011
 Claire Amalfitano, 01/2009 – 05/2010
 Andrew Sarafan, 09/2009 – 05/2010
 Sausha Toghreanegar, 09/2009 – 05/2010
 Justin Townley, 09/2009 – 05/2010

Graduate Committee Activities (all)

Student Name	Role	Degree	Major	Start	Grad
Brandon Califar	Co-Chair	Ph.D.	Genetics Institute	01/2018	In Prog
Nicole Beisel	Co-Chair	Ph.D.	Plant Molecular and Cellular Biology	01/2018	(wdrew)
Collin Lefrois,	Co-Chair	M.S.	Plant Molecular and Cellular Biology	09/2017	12/2017
Collin Lefrois,	Co-Chair	Ph.D.	Plant Molecular and Cellular Biology	09/2015	(to MS)
Natasha Sng,	Chair	Ph.D.	Plant Molecular and Cellular Biology	07/2013	12/2017
Alexandrea Duscher,	Mamber	Ph.D.	Microbiology and Cell Science	03/2015	05/2019
Danyang Liu,	Member	M.S.	Horticultural Sciences	01/2015	12/2016
Julliany Pereira Silva	Member	Ph.D.	Horticultural Sciences	09/2013	08/2015
Eric Schultz	Co-Chair	Ph.D.	Plant Molecular and Cellular Biology	10/2012	12/2015
Anne Visscher	Member	Ph.D.	Horticultural Sciences	03/2007	08/2009
Tufan Gokirmak	Member	Ph.D.	Plant Molecular and Cellular Biology	08/2006	12/2010
John Mayfield,	Member	Ph.D.	Plant Molecular and Cellular Biology	12/2002	05/2002
Michael Manak	Member	M.S.	Plant Molecular and Cellular Biology	12/2000	12/2001
Carla Lyerly	Member	Ph.D.	Plant Molecular and Cellular Biology	08/1996	05/2001

Publications

Publications – 90 Refereed

1. Califar B, Zupanska A, Callaham J, Bamsey, M, Graham, T, Paul A-L, Ferl RJ (2021) Shared Metabolic Remodeling Processes Characterize the Transcriptome of *Arabidopsis thaliana* within Various Suborbital Flight Environments. *Gravitational and Space Research* (in Press)
2. Tucker R, Callaham J, Zeidler C, Paul A-L, Ferl RJ (2020) NDVI imaging within exploration growth modules –study from EDEN ISS Antarctica. *Life Sciences in Space Research* 26 (<https://doi.org/10.1016/j.lssr.2020.03.006>)
3. Califar B, Sng NJ, Zupanska A, Paul A-L, Ferl RJ (2020) Root Skewing-Associated Genes Impact the Spaceflight Response of *Arabidopsis thaliana*. *Frontiers in Plant Science* 11:239
4. Zeidler C, Zabel P, Vrakking V, Dorn M, Bamsey M, Schubert D, Ceriello A, Fortezza R, De Simone D, Stanghellini C, Kempkes F, Meinen E, Mencarelli A, Swinkels GJ, Paul A-L, Ferl RJ (2019) The Plant Health Monitoring System of the EDEN ISS Space Greenhouse in Antarctica During the 2018 Experiment Phase. *Front Plant Sci* 10: 1457
5. Zhou M, Sng NJ, LeFrois CE, Paul A-L, Ferl RJ. (2019). Epigenomics in an extraterrestrial environment: organ-specific alteration of DNA methylation and gene expression elicited by spaceflight in *Arabidopsis thaliana*. *BMC genomics*, 20: 205.
6. Zupanska AK, LeFrois C, Ferl RJ, Paul A-L. (2019). HSFA2 Functions in the Physiological Adaptation of Undifferentiated Plant Cells to Spaceflight. *International Journal of Molecular Sciences*, 20
7. Beisel NS, Noble J, Barbazuk WB, Paul A-L, Ferl RJ. (2019). Spaceflight-induced alternative splicing during seedling development in *Arabidopsis thaliana*. *Npj Microgravity*, 5: 9.

8. Sng N, Kolaczowski B, Ferl RJ, Paul A-L (2019) A New Member of the CONSTANS-Like Protein Family is a Regulator of ROS Homeostasis and Spaceflight Physiological Adaptation. *AoB Plants*, 11: ply075.
9. Krishnamurthy A, Ferl RJ, Paul A-L, (2018) Comparing RNA-Seq and microarray gene expression data in two zones of the Arabidopsis root apex relevant to spaceflight. *Applications in Plant Sciences*, 6: e01197
10. Califar BM, Tucker R, Cromie J, Sng N, Schmitz RA, Callaham JA, Barbazuk B, Paul A-L, Ferl RJ. 2018. Approaches for Surveying Cosmic Radiation Damage in Large Populations of Arabidopsis thaliana Seeds – an Antarctic Example. *Gravitational and Space Research*, 6: 54-73
11. Beisel N, Callaham J, Sng N, Taylor DJ, Paul A-L, Ferl RJ (2018) Utilization of Single-Image Normalized Differential Vegetation Index (SI-NDVI) for Early Plant Stress Detection. *Applications in Plant Sciences* 6: e01186
12. Sng, N., A.-L. Paul, and R. J. Ferl. (2018). Phenotypic characterization of an Arabidopsis T-DNA insertion line SALK_063500. *Data in Brief* 18: 913-919.
13. Paul A-L, Sng NJ, Zupanska AK, Krishnamurthy A, Schultz ER, Ferl RJ (2017) Genetic dissection of the Arabidopsis spaceflight transcriptome: Are some responses dispensable for the physiological adaptation of plants to spaceflight? *PLoS One* 12: e0180186
14. Zupanska AK, Schultz ER, Yao J, Sng NJ, Zhou M, Callaham JB, Ferl RJ, Paul A-L (2017) ARG1 Functions in the Physiological Adaptation of Undifferentiated Plant Cells to Spaceflight. *Astrobiology* 17: 1077-1111
15. Paul A-L, Zhou M, Callaham JB, Reyes M, Stasiak M, Riva A, Zupanska AK, Dixon MA, Ferl RJ (2017) Patterns of Arabidopsis gene expression in the face of hypobaric stress. *AoB Plants* 9: plx030
16. Zhou M, Callaham JB, Reyes M, Stasiak M, Riva A, Zupanska AK, Dixon MA, Paul A-L, Ferl RJ (2017) Dissecting Low Atmospheric Pressure Stress: Transcriptome Responses to the Components of Hypobaric Stress in Arabidopsis. *Front Plant Sci* 8: 528
17. Zhou M, Paul A-L, Ferl RJ (2017) Data for characterization of SALK_084889, a T-DNA insertion line of Arabidopsis thaliana. *Data in Brief* 13: 253-258
18. Schultz ER, Zupanska AK, Sng NJ, Paul A-L, Ferl RJ (2017) Skewing in Arabidopsis roots involves disparate environmental signaling pathways. *BMC Plant Biol* 17: 31
19. LeFrois CE, Zhou M, Amador DM, Sng N, Paul A-L, Ferl RJ (2016) Enabling the Spaceflight Methyloome: DNA Isolated from Plant Tissues Preserved in RNAlater™ Is Suitable for Bisulfite PCR Assay of Genome Methylation. *Gravitational and Space Research* 4: 28-37
20. Schultz ER, Paul A-L, Ferl RJ (2016) Root Growth Patterns and Morphometric Change Based on the Growth Media. *Microgravity Sci Technol*: 1-11
21. Ferl RJ, Paul A-L (2016) The effect of spaceflight on the gravity-sensing auxin gradient of roots: GFP reporter gene microscopy on orbit. *Npj Microgravity* 2: 15023
22. Paul A-L, Ferl RJ (2015) Spaceflight exploration in plant gravitational biology. *Methods in molecular biology* 1309: 285-305
23. Ferl R.J., Koh J., Denison F., Paul A-L. (2015) Spaceflight Induces Specific Alterations in the Proteomes of Arabidopsis. *Astrobiology* 15: 32-56 (and cover article)
24. Gokirmak T, Denison FC, Laughner BJ, Paul A-L, Ferl RJ (2015) Phosphomimetic mutation of a conserved serine residue in Arabidopsis thaliana 14-3-3omega suggests a regulatory role of phosphorylation in dimerization and target interactions. *Plant physiology and biochemistry : PPB / Societe francaise de physiologie vegetale* 97: 296-303
25. Bamsey M.T., Paul A-L., Graham T., Ferl R.J. (2014) Flexible imaging payload for real-time

- fluorescent biological imaging in parabolic, suborbital and space analog environments. *Life Sciences in Space Research* 3: 32-44
26. Parsons-Wingerter P, Vickerman MB, Paul A-L, Ferl R.J. (2014) Mapping by VESGEN of Leaf Venation Patterning in Arabidopsis with Bioinformatic Dimensions of Gene Expression. *Gravitational and Space Research* 2: 68-81
 27. Sng N., Callahan J., Ferl R.J., Paul A-L. (2014) Arabidopsis thaliana for spaceflight applications - preparing dormant biology for passive stowage and on orbit activation. *Gravitational and Space Research* 2: 81-89
 28. Denison, F.C., T. Gokirmak, and R.J. Ferl, (2014) Phosphorylation-related modification at the dimer interface of 14-3-3 ω dramatically alters monomer interaction dynamics. *Archives of Biochemistry and Biophysics*, 2014. 541: p. 1-12.
 29. Schultz, E.R., K.L. Kelley, A.-L. Paul, and R.J. Ferl, (2013) A Method for Preparing Spaceflight RNAlater-Fixed Arabidopsis thaliana (Brassicaceae) Tissue for Scanning Electron Microscopy. *Applications in Plant Sciences*,. 1(8): p. 1300034
 30. Paul A-L, AK Zupanska^p, ER Schultz, Ferl RJ (2013) Organ-specific remodeling of the Arabidopsis transcriptome in response to spaceflight. *BMC Plant Biology*. 13:112.
 31. Zupanska AK, RJ Ferl, FC Denison^p, A-L Paul. (2013) Spaceflight engages heat shock protein and other molecular chaperone genes in Arabidopsis tissue culture cells *American Journal of Botany*. 100(1):235-248.
 32. Paul A-L, R Wheeler, H Levine, RJ Ferl. (2013) Fundamental plant biology enabled by the space shuttle *American Journal of Botany*. 100(1):226-234.
 33. Abboud T, A Berinstain, M Bamsey, RJ Ferl, A-L Paul, T Graham, MA Dixon, D Leonardos, M Stasiak, and R Noumeir. (2013) Multispectral Plant Health Imaging System for Space Biology and Hypobaric Plant Growth Studies. *Insciences Journal* 03:24-44.
 34. Abboud T, M Bamsey, A-L Paul, T Graham, S Braham, R Noumeir, A Berinstain, and RJ Ferl (2013) Deployment of a fully-automated green fluorescent protein imaging system in a high arctic autonomous greenhouse. *Sensors*. 13:3530-3548.
 35. Schultz ER, KL Kelley, A-L Paul, and RJ Ferl. (2013) A Method for Preparing Spaceflight RNAlater-Fixed Arabidopsis thaliana (Brassicaceae) Tissue for Scanning Electron Microscopy. *Applications in Plant Sciences*. 1(8):130003.
 36. Paul A-L, CE Amalfitano, RJ Ferl. (2012) Plant growth strategies are remodeled by spaceflight. *BMC Plant Biology*. 12:232.
 37. Paul A-L, FC Denison, ER Schultz, AK Zupanska, RJ Ferl (2012) 14-3-3 phosphoprotein interaction networks - does isoform diversity present functional interaction specification? *Frontiers in Plant Science* 3: 190.
 38. Schultz E, A Zupanska, S Manning-Roach, J Camacho, H Levine, A-L Paul and RJ Ferl (2012) Testing the Bio-compatibility of Aluminum PDFU BRIC Hardware. *Gravitational and Space Biology* 26(2): 48-63.
 39. Paul A-L, A Zupanska, DT Ostrow, Y Zhang, Y Sun, J-L Li, S Shanker, WG Farmerie, CE Amalfitano, RJ Ferl. Spaceflight transcriptomes: unique responses to a novel environment (2012) *Astrobiology* 12(1): 40-56.
 40. Mayfield J.D, A-L Paul, RJ Ferl (2012) The 14-3-3 proteins The 14-3-3 proteins of Arabidopsis regulate root growth and chloroplast development as components of the photosensory system. *J. Experimental Botany* (doi: 10.1093/jxb/ers022).
 41. Denison F., A-L. Paul, AK Zupanska, RJ Ferl, (2011) 14-3-3 Proteins in Plant Physiology. *Seminars*

in *Cell and Developmental Biology* 22(7): 720-727.

42. Paul A-L and Ferl RJ (2011) Using green fluorescent protein (GFP) reporter genes in RNAlater™ fixed tissue. *Gravitational and Space Biology* 25(1): 40-43.
43. Paul A-L, MS Manak, JD Mayfield, MF Reyes, WB Gurley, and RJ Ferl. (2011) Parabolic flight induces changes in gene expression patterns in *Arabidopsis thaliana*. *Astrobiology* 2011 Oct;11(8):743-58.
44. Ferl RJ, A Zupanska, A Spinale, D Reed, S Manning-Roach, G. Guerra, D. Cox, A-L Paul (2011) Performance of KSC Fixation Tubes with RNAlater for orbital experiments: a case study in ISS operations for molecular biology. *Advances in Space Research* 48: 199-206.
45. Gokirmak T, A-L Paul, RJ Ferl (2010) Plant phosphopeptide-binding proteins as signaling mediators. *Curr Opin Plant Biol* 13: 527-532.
46. Visscher AM, A-L Paul, M Kirst, CL Guy, AC Schuerger, and RJ Ferl (2010) Responses of wildtype *Arabidopsis* and ion transporter mutants to high levels of magnesium sulfate; consequences for (extra)terrestrial plant growth. *PLoS One* 5(8): e12348.
47. Ferl RJ, A-L Paul (2010) Lunar Plant Biology – A Review of the Apollo Era. *Astrobiology* 10: 261-74.
48. Bamsey M, A Berinstain, T Graham, P Neron, S Giroux, RJ Ferl, A-L Paul, Dixon MA (2009) Developing strategies for automated remote plant production systems: Environmental control and monitoring of the Arthur Clarke Mars Greenhouse in the Canadian High Arctic. *Advances in Space Research* 44: 1367-1381.
49. Visscher, AM, A-L Paul, M Kirst, AK Alling, S Silverstone, G Nechitailo, M Nelson, WF Dempster, M Van Thillo, JP Allen, RJ Ferl. (2009) Effects of a Spaceflight Environment on Heritable Changes in Wheat Gene Expression. *Astrobiology* 9: 359-67.
50. Paul, A-L, L Liu, S McClung, B Laughner, S Chen and RJ Ferl (2009) Comparative Interactomics: Analysis of *Arabidopsis* in vivo 14-3-3 complexes reveals highly conserved 14-3-3 interactions between humans and plants. *J Proteome Res* 8:1913-1924.
51. Paul, A-L, M Bamsey, A Berinstain, S Braham, P Neron, T Murdoch, T Graham. and RJ Ferl (2008). Deployment of a Prototype Plant GFP Imager at the Arthur Clarke Mars Greenhouse of the Haughton Mars Project. *Sensors*, 8: 2762-2773.
52. Folta KM, A-L Paul, JD Mayfield, RJ Ferl (2008) 14-3-3 isoforms participate in red light signaling and photoperiodic flowering. *Plant Signaling and Behavior* 3(5): 304 – 306.
53. Paul A-L, KM Folta, RJ Ferl (2008) 14-3-3 Proteins, red light, and photoperiodic flowering: A point of connection? *Plant Signaling and Behavior* 3(8) ISSN: 1559-2324.
54. Mayfield JD., KM Folta, A-L Paul, RJ Ferl (2007) The 14-3-3 proteins μ (μ) and ν (ν) influence transition to flowering and early phytochrome response. *Plant Physiology* 145(4): 1692–1702.
55. Sabina RL, A-L Paul, RJ Ferl, B Laber, SD Lindell (2007) Adenine Nucleotide Pool Perturbation Is a Metabolic Trigger for AMP Deaminase Inhibitor-Based Herbicide Toxicity. *Plant Physiology*. 143:1752.
56. Paul A-L and RJ Ferl, MW Meisel, (2006) High magnetic field induced changes of gene expression in *Arabidopsis*. *Biomagnetic Research and Technology* Dec 22;4(1):7 doi:10.1186/1477-044X-4-7.
57. Richards, JT, KA Corey, A-L Paul, RJ Ferl, RM Wheeler, AC Schuerger (2006) Implications for Low-Pressure Bioregenerative Life Support Systems for Human Exploration Missions and Terraforming on Mars. *Astrobiology* 6:851-66.
58. Davis, JCh, A-L Paul, RJ Ferl, MW Meisel (2006) Topographical imaging technique for qualitative

analysis of microarray data. *BioTechniques* 41: 554-558.

59. Stutte, GW, O Monje, RD Hatfield, A-L Paul, RJ Ferl, CG Simone (2006) Microgravity Effects on leaf morphology, cell structure, carbon metabolism and mRNA expression of dwarf wheat *Planta* 224:1038-1049.
60. Ferl, RJ, AC Schuerger, A-L Paul, MA Dixon, P Fulford and C McKay (2006) Mars plant biology: A workshop report and recommendations for plant biology in the exploration era. *Habitation* 11:1-4.
61. Paul A-L and Ferl R.J. (2006) The Biology Of Low Atmospheric Pressure- Implications For Exploration Mission Design And Advanced Life Support. *Gravitational and Space Biology* 19:3-17.
62. Paul, A-L, P Sehnke, RJ Ferl (2005) Isoform specific subcellular localization among 14-3-3 proteins in *Arabidopsis* appears to be driven by client interactions. *Molecular Biology of the Cell* 16: 1735-43.
63. Paul, A-L, MP Popp, WB Gurley, C Guy, KL Norwood and RJ Ferl (2005) *Arabidopsis* gene expression patterns are altered during spaceflight. *Advances in Space Research* 36:1175-1181.
64. Paul A-L, HG Levine, W McLamb, KL Norwood, D Reed, GW Stutte, HW Wells, RJ Ferl, (2005) Plant molecular biology in the space station era: Utilization of KSC Fixation Tubes with RNAlater. *Acta Astronautica* 56:623-8.
65. Paul, A-L, AC Schuerger, M Popp, JT Richards, M Manak, RJ Ferl (2004) *Arabidopsis* Gene Expression at Low Atmospheric Pressure. *Plant Physiology* 134:215-223.
66. Paul A-L, T Murdoch, E Ferl, HG Levine, RJ Ferl (2003). The TAGES Imaging System: Optimizing a Green Fluorescent Protein Imaging System for Plants. SAE Technical Paper 2003-01-2477 ICES Warrendale, PA: SAE International.
67. Paul, A-L, and RJ Ferl. (2002). Molecular aspects of stress gene regulation during spaceflight. *J. Plant Growth Regulation* 21:166-176.
68. Ferl, RJ, R Wheeler, HG Levine, A-L Paul. (2002) Plants in Space. *Curr Opin Plant Biol* 5:258-263.
69. Ferl, RJ, A Schuerger, A-L Paul, WB Gurley, K Corey, R Buckland (2002) Plant Adaptation to low atmospheric pressures. *Life Support Biosph Sci* 8:93-101.
70. Manak, MS., A-L Paul, PC Senhke, RJ Ferl (2002) Remote sensing in planta: transgenic plants as monitors of exogenous stress perception in real-time. *Life Support Biosph Sci* 8:83-91.
71. Paul, A-L, C Daugherty, E Bihn, D Chapman, K Norwood, RJ Ferl. (2001) Transgenic plant biomonitors: Stress gene biocompatibility evaluation of the Plant Growth Facility for PGIM-01. SAE Technical Paper 2001-01-2181 ICES Warrendale, PA: SAE International.
72. Paul, A-L, C Daugherty, E Bihn, D Chapman, K Norwood, RJ Ferl (2001) Transgene Expression Patterns Indicate that Spaceflight Affects Stress Signal Perception and Transduction in *Arabidopsis*. *Plant Physiology* 126:613-621.
73. Paul A-L, C Semer, T Kucharek, RJ Ferl (2001) The fungicidal and phytotoxic properties of benomyl and PPM™ in supplemented agar media supporting transgenic *Arabidopsis* plants for a Space Shuttle flight experiment. *Journal of Applied Microbiology and Biotechnology* 55:480-480.
74. Paul A-L, RJ Ferl (1999) Higher-order chromatin structure: looping long molecules. *Plant Molecular Biology* 41:713-720.
75. Paul A-L, RJ Ferl (1998) Higher order chromatin structures in maize and *Arabidopsis*: Direct measurement of chromatin domain loops. *The Plant Cell* 10:1349-1359.
76. Paul A-L, RJ Ferl (1998) Permeabilized *Arabidopsis* protoplasts provide new insight into the chromatin structure of three plant alcohol dehydrogenase genes. *Developmental Genetics*, 22:7-16.
77. Paul A-L, RJ Ferl (1997) In vivo footprinting in *Arabidopsis*. *Methods in Molecular Biology*, 82:417-429.

78. Bihn, EA, A-L Paul, SW Wang, GW Erdos, RJ Ferl (1997) Localization of 14-3-3 proteins in the nuclei of Arabidopsis and Maize. *Plant Journal*, 12:1439-1445.
79. Paul, A-L, RJ Ferl (1997) The anoxic response of three Adh genes: in vivo and in vitro footprinting of DNA/protein interactions describe multiple signaling connections. *Annals of Botany*, 79:33-37.
80. Lu, G^P, A-L Paul, DJ McCarty, RJ Ferl (1996) Transcription factor veracity: is GBF3 responsible for ABA-regulated expression of Arabidopsis Adh? *The Plant Cell*, 8:847-857.
81. Sehnke, PC, L Pedrosa, A-L Paul, AE Frankel, RJ Ferl (1994) Expression of active, processed ricin in transgenic tobacco. *J. Biol. Chem.*, 269: 22473-22476.
82. Paul, A-L , RJ Ferl (1994) In Vivo Footprinting Identifies an Activating Element of the Maize Adh2 Promoter Specific for Root and Vascular Tissues. *The Plant Journal* 5:523-33.
83. Paul, A-L, RJ Ferl (1993) Osmium tetroxide footprinting of a scaffold attachment region in the maize Adh1 promoter. *Plant Molecular Biology* 22:1145-1151.
84. Ferl, RJ , A-L Paul (1992) Chemical detection of Z-DNA within the maize Adh1 promoter. *Plant Molecular Biology* 18:1181-1184.
85. Paul, A-L, RJ Ferl (1991) In vivo footprinting reveals unique cis-elements and different modes of hypoxic induction in maize Adh1 and Adh2. *The Plant Cell* 3:159-168.
86. Paul, A-L and RJ Ferl (1991) Adh1 and Adh2 regulation. *Maydica* 36:129-131.
87. McKendree, WL, A-L Paul, AJ DeLeslie^P , RJ Ferl (1990) In vivo and in vitro characterization of protein interactions with the dyad G-box of the Arabidopsis Adh gene. *The Plant Cell* 2:207- 214.
88. Paul, A-L, RJ Ferl, GS Boudreaux^S , MW Meisel (1989) A simple optoelectric device for controlling an electrophoresis apparatus. *Rev. Sci. Instruments* 60:3072-3073.
89. Paul, A-L, V Vasil, IK Vasil , RJ Ferl (1987) Constitutive and anaerobically induced DNase I hypersensitive sites in the 5' region of the maize Adh1 gene. *Proceedings of the National Academy of Sciences USA (PNAS)* 84:799-803.
90. Herrin, DL, AS Michaels , A-L Paul (1986) Regulation of genes encoding the large subunit of ribulose-1,5-bisphosphate carboxylase and the photosystem II polypeptides D-1 and D-2 during the cell cycle of *Chlamydomonas reinhardtii*. *J. Cell Biol.* 103:1837-1845

Publications – Invited Book Chapters and Methods Papers

1. Paul, A-L., R.J. Ferl, B. Klingenberg, J.S. Brooks, A.N. Morgan, J. Yowtak, and M.W. Meisel, Strong magnetic field induced changes of gene expression in Arabidopsis, in *Materials Processing in Magnetic Fields*, H.J. Schneider-Muntau and H. Wada, Editors. 2005, World-Scientific: Singapore. p. 238-242.
2. Paul, A-L. and R.J. Ferl, Gene expression in space biology experiments, in *Plant Biotechnology 2002 and Beyond.*, I.K. Vasil, Editor. 2003, Kluwer Academic Press. p. 342-347.
3. Ferl, R.J. and A-L. Paul, Genome organization and expression, in *Biochemistry and Molecular Biology of Plants*, W.G. B. Buchanan, R. Jones, Editor. 2000, American Society of Plant Physiologists: Rockville, MD. p. Chapter 7.
4. Paul, A-L. and R.J. Ferl, In vivo footprinting in Arabidopsis, in *Methods in Molecular Biology*. 1997. p. 417-429.
5. Vega-Palas, M.A., A-L. Paul , and R.J. Ferl, Chromatin, in *Methods in Plant Molecular Biology.*, J.A. Bryant, Editor. 1996, Academic Press. p. 13-38.
6. Paul, A-L. and R.J. Ferl, Genomic Sequencing in Maize, in *The Maize Handbook*, M. Freeling and V. Walbot, Editors. 1994, Springer-Verlag. p. 579-585.

7. Daugherty, C.J., M. Rooney, A-L. Paul, N.C. DeVetten, M.A. Vega-Palas, G.H. Lu, W.B. Gurley, and R.J. Ferl, Environmental stress and gene regulation, in *Arabidopsis*, C. Somerville and E. Meyerowitz, Editors. 1994, Cold Spring Harbor. p. 769-806.
8. Paul, A-L. and R.J. Ferl, Analyses of Plant Chromatin and In vivo Protein-DNA Interactions. In: *Plant Molecular Biology Manual*, I3: 1-20. 1994, Kluwer Academic Publications (2nd edition). S.B. Gelvin, R.A. Schilperoort and D.P.S. Verma, eds.
9. Paul, A-L. and R.J. Ferl, Assays for studying chromatin structure, R.A.S.a.D.P.S.V. S.B. Gelvin, Editor. 1989, Kluwer Academic Publications.
10. Paul, A.-L. and R.J. Ferl, Chromatin structure and gene regulation., in *Cell culture and Somatic Cell Genetics of Plants Vol. 6 Molecular Biology of Nuclear Genes.*, J. Schell and I.K. Vasil, Editors. 1989, Academic Press.
11. Paul, A-L. and R.J. Ferl, Chromatin structure of plant genes, in *Chromosomes: Eukaryotic, Prokaryotic and Viral*. 1989, CRC Press.
12. Ferl, R.J., In vivo detection of protein DNA interactions, in *Methods in Plant Molecular Biology*, S. Gelvin, Editor. 1989, Martin Nijhoff Press.
13. Paul, A-L., M. Ashraf, S. Bollinger, and R.J. Ferl, Architecture of the 5' flanking regions of the maize Adh genes., in *Architecture of Eukaryotic genes.*, G. Kahl, Editor. 1988, VCH Press.
14. Ferl, R.J. and A-L. Paul, Methods of Chromatin structure analysis, in *Methods in Plant Molecular Biology.*, S. Gelvin, Editor. 1988, Martinus Nijhoff Press.

Publications – Text Book

1. Ferl, R.J. and A-L. Paul, (2000) Genome organization and expression. Chapter 7 **In Biochemistry and Molecular Biology of Plants**, American Society of Plant Biologists, Rockville, MD, pp. 312-356. B. Buchanan, W. Gruissem, R. Jones eds.

Extramural Funding in last 10 years

Role	Agency	Grant Title & Dates	Award
Co-PI	NASA	NRA NNH18ZTT001N-FG: Appendix B – Suborbital Biology The role of Ca ²⁺ signaling during the early events of plant adaptation to spaceflight 10/20/2019 - 10/19/2022	\$298,000
Co-PI	NASA-FO	SpaceTech-REDDI-2019 - 80HQTR19NOA01-19FO-F1 – Biological Imaging in support of Suborbital and Exploration Science 10/20/2019-10/19/2021	\$461,949
PI	NASA	Epigenetic Adaptation to the Spaceflight Environment - Genomic Change Induced by Generations in Space. 9/2018 – 8/2021	\$511,983
Co-PI	NASA-FO	Human tended space biology: Enabling suborbital genomics and gene expression. R.J. Ferl (PI) and A-L. Paul (CoPI). 7/2018 – 6/2021.	\$299,838
Co-PI	NASA	Spectral imaging within the EDEN ISS project – an Antarctic analog for enhancing exploration life support. 2017-2019.	\$286,690
PI	NASA	Epigenetic change in <i>Arabidopsis thaliana</i> in response to spaceflight 2014-2018	\$449,176
Co-PI	FSGC	UF in the Antarctic EDEN module in collaboration with the DLR 2016-2018	\$25,000

PI	CASIS	Molecular Biology of Plant Development in the Spaceflight Environment II. 2015-2018.	\$182,929
PI	NASA-ESC	Bioinformatics support for NASA's GeneLAB 2014-2016	\$280,299
Co-PI	NASA	Early stage plant adaptation to spaceflight - molecular responses of Arabidopsis to the transition from terrestrial environment to space. 2014-2017	149,619
PI	NASA	Epigenetic change in Arabidopsis thaliana in response to spaceflight. 2014-2017	\$448,238
Co-PI	NASA	Molecular Responses of Arabidopsis to the Low Atmospheric Pressures of Spaceflight Vehicles and Planetary Habitats. 2014-2017.	\$522,611
PI	CASIS	Molecular Biology of Plant Development in the Spaceflight Environment. 2013-2015	\$49,405
PI	FSGC	Crew-Assisted and Crew-Autonomous Biological Imaging in Parabolic and Suborbital Vehicles. 2012-2013	\$10,000
PI	NASA	Cell Signaling in Undifferentiated Cells - Perceiving the Spaceflight Environment without Specialized Tissues. 2012-2014	\$245,453
Co-PI	NASA	Molecular Biology of Growth and Cell Remodeling within the Spaceflight Environment. 2012-2014	\$482,207
PI	NASA	The impact of spaceflight on Arabidopsis: Deep sequencing and DNA arrays as collaborative readouts of the transcriptome of Arabidopsis seedlings and undifferentiated cells in space. 2010-2012	\$145,910
PI	NASA	Gene Expression and Molecular Signaling in Spaceflight Environments. 2009-2013	\$283,608
Co-PI	NASA	Leveraging Shuttle/ISS science, hardware and operations to enable in situ biology analyses in planetary analog environments. 2009-2011	\$62,553
Co-PI	NASA	Transgenic plant biomonitors of spaceflight exposure – telemetric data collection. 2007-2012	\$712,025
Co-PI	NASA	Functional genomics of plant response & adaptation to low atmospheric pressure. 2004-2007	\$170,344
Co-PI	UF/FSU SRI	Pathfinder biology in the suborbital realm, UF/FSU Space Research Initiative	\$68,763
Co-PI	UF- Res Op. Seed Fund	Multi-Spectral Imaging of Biological Payloads: Targeting Science for Small Satellites and Landers. 2009-2011	\$85,674
TOTAL grant funding in last 10 years			\$6,232,274

Education and Public Outreach Activities (selected)

Video Interviews

Women in Science Instagram story for Friday, Feb. 9th, 2018, ahead of the UN's Women and Girls in

Science Day. : https://twitter.com/ISS_Research/status/962796712241672192

Scientists on a mission to feed Mars – University of Florida News 2/2017. A public outreach description and video set surrounding our most recent space biology launch to the ISS <https://social.shorthand.com/UFNews/uytChfNBEE/space-plants>

UF Space Plants (<http://ufspaceplants.org/>). 2016 – present. Our outreach web page, which contain links to our plant space biology research program, as well as blogs and twitter reads about our research.

The Conversation. 8/2015 The Conversation is an independent source of news and views from the academic and research community, delivered direct to the public. This article focused on our space biology research <https://theconversation.com/taking-plants-off-planet-how-do-they-grow-in-zero-gravity-45032> .

NPR Science Friday. Our research was featured on NPR Science Friday on the day of the premier of the movie “The Martian”. It was used to illustrate how real space plant biology is getting us closer to the goal of taking our biology to other planets <https://www.sciencefriday.com/videos/plants-in-space/>

Scientific Thinking & Educational Partnership (STEP) program A series of science videos for lesson plans related to the concept of researching and growing plants in spaceflight and novel planetary environments. These are posted on the UF Genetics web site (<http://www.youtube.com/user/UFGENETICS/videos>) and on YouTube, for instance:

Zero-G parabolic aircraft research - <http://www.youtube.com/watch?v=purGp-1juCE>

Reporter gene technology - <https://www.youtube.com/watch?v=IvmPc4j25ao>

Haughton Mars Project on-site Outreach Science report. Worked with the Educational Outreach officer to create a video broadcast from the Devon Island (Canadian High Arctic) research station describing our work in this Mars Analog site (<http://marsonearth.org/dr-anna-lisa-paul-faculty-university-of-florida/>)

A variety of Public Outreach articles and interviews for NASA... for instance:

CARA https://www.nasa.gov/mission_pages/station/research/news/Putting_Down_Roots_In_Space

Darwin and skewing - <https://science.nasa.gov/science-news/news-articles/space-gardening>

Cultivating Plant Growth in Space - <https://www.youtube.com/watch?v=9MfWARdoF-o>

GFP plants - https://science.nasa.gov/science-news/science-at-nasa/2013/06may_arabidopsis / <https://www.youtube.com/watch?v=50LgSJhHCy4>

ISS update on plants in space - <https://www.youtube.com/watch?v=xLYeZKDv0Ig>

A variety of Public Outreach interviews for the University of Florida... for instance:

Plant research in space - <https://www.youtube.com/watch?v=EMTSwbEYFtY>

Arctic Mars Analog research site - <https://www.youtube.com/watch?v=2gkf4rh5HKQ>

Mission to Mars - <https://www.youtube.com/watch?v=UKKYNBXXCs4>

A sampling of local Education and Public Outreach events include:

TEDxUF Teaching Lab: 4/2019. A booth run primarily by Jordan Callaham (lab manager) at the Center for Performing arts in the day of my TEDx talk. We set up demonstration materials and small, interactive projects that highlighted aspects of our space biology program. The idea being to connect the broader picture of our research to the topic of my presentation.

Planting Science - Agronomy Feeds the World Module - Spring 2017. Conducted a video classroom interactive lecture focused on plant biology and agriculture in extreme environments, including spaceflight and analog environments. Class of Rebecca Schroeder (HS, Indianapolis, IN).

UF/IFAS TailGator: 9/2016. A public outreach event held in the fall to showcase IFAS research programs; attended hundreds of undergraduate students and members of the community. The estimated contact at the table was 500 people over 3 hours.

Florida Museum of Natural History. 11/2013 and 11/2015. Community open house presentation: Space biology exhibit at the seventh annual Starry Night event: “Space Biology – UF Science on the International Space Station”. Rob Ferl and I gave an interactive presentation that connects with local school children as well as interested adults in the community.

She’s A Scientist, Florida Gateway Girl Scout Council: 11/2014 This was an event intended to showcase different opportunities in science and research to girls between 8 and 16. Explained aspects of our space biology research work and provided a small research project to take home. Approximately 125 youth attended and 200 home research projects distributed.

Gainesville Gator Exchange Rotary. 9/2013. I was invited to give a luncheon presentation to members of the Rotary. I presented: “Tools of exploration in space biology” and then led a discussion on how these tools interface with the general public.

Science Café for the Florida Museum of Natural History. 9/2012. An interactive presentation sponsored by the FMNL and held at a local restaurant. Rob Ferl and I presented: Going Boldly: Astrobiology, Space Biology and Seeking the Meaning of Life off Earth.

Institute for Learning in Retirement. 10/2010. A community retirement program that organizes seminar series. I was invited to present a seminar and interactive discussion session in the “Women in Science” series. I presented: “Exploring a Career in Science - From Genetics to Spaceflight”.

Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) presentation in 2010. MANRRS is a national organization of undergraduate, graduate and professional members dedicated to promote career development, academic success, and social interaction. Strongly supportive of women in science.

AP Biology lectures and laboratory set-up at Gainesville High school 2009/2010. I worked with the AP Biology class with three projects throughout the 2009/2010 academic year: 1) Set up a mock forensic DNA laboratory, providing restricted DNA, DNA stains and electrophoresis equipment. Also made a presentation. 2) provided the class with a set of “Ground Controls” during the first leg of a Spaceflight Experiment, and 3) provided a lecture and presentation of conducting a spaceflight experiment and conducting research in extreme environments. Class interactions include questions and answers on the material presented, but also discussions on practical issues such as how to keep a good science notebook and prepare for a career in science and technology.

Elementary and Middle School Education Science projects 2001 - 2008 . I designed a variety of educational outreach experiments for local Elementary and Middle School classrooms. The subject matter has included geology (making “metamorphic cake” and “sugar cube karst”), space biology (growing tomato seeds that have been exposed to spaceflight environments, plus numerous demonstrations of spaceflight experiments and parabolic flights) and molecular biology (conducting a mock forensic CSI-like experiment that demonstrated the concepts of plasmid DNA, restriction endonucleases and gel electrophoresis).

Space Agriculture in the Classroom Aspects of our research program was featured in the magazine *Growing Space* (volume 3, p7). I worked with the organizers to create lesson plans and kits (Arabidopsis seeds, micro planting supplies) for middle and high school science teachers.

Community Outreach – Florida Association of Agricultural Educators (FAAE) Technical Update I contributed to a workshop that included a presentation (*Growing plants off-planet – What do we need to know before we go?*), the live demonstration of GFP biosensor plants with GFP fluorescent imaging hardware, and the development of education kits to grow Arabidopsis plants.

International Activities

Canada

Mars atmosphere analog studies at the University of Guelph CESRF (2002-present):

Collaborations in the efficacy of using hypobaric environments in controlled agriculture, with a focus on planetary greenhouses. Publications: Paul et al. 2017, Zhou et al, 2017a; Zhou et al., 2017b; Abboud et al 2013a; Paul et al. 2008; Paul and Ferl 2006; Paul et al. 2004.

Guest lecture in a freshman agricultural science class taught by Professor Mike Dixon (10/2012). The class introduces students to the concepts of alternative agriculture, including concepts such as controlled, extraterrestrial greenhouses.

Collaborator on the Research Project: Innovative Technologies In Challenging Environments (InTICE), awarded to Mike Dixon, Professor and Director of Controlled Environment Systems Research Facility. InTICE is sponsored by the Canadian Space Agency as part of CSA's Class Grant and Contribution Program to Support Research, Awareness and Learning in Space Science and Technology. The grant is a major component of a Collaborative Research and Development (CRD) project associated with the Natural Sciences and Engineering Research Council (NSERC) of Canada. The technology development and research activities are fundamental to the overall goals of the NSERC, and comprises an international collaboration among the CSA, the University of Guelph, the University of Florida and COM DEV Canada Ltd. My contribution involves the design of fluorescent reporter genes biology, and the imaging of these plants, for applications in protected agriculture.

Arctic Research in the Canadian High Arctic (2006 - 2011 summer seasons)

Research participant at the Houghton Mars Project, Devon Island, Nunavut, Canada. Summer research season 2006 – 2011. Conducted two areas of research: a survey of the ability to detect life signatures in impact breccia in the Martian and lunar analog regions of the Houghton Impact Crater, and the integration and characterization of telemetric imaging hardware in a Martian analog greenhouse (Arthur Clarke Mars Greenhouse; Publications Abboud et al 2013b; Bamsey et al. 2010; Paul et al. 2008).

Germany

German Space Agency (DLR), Bremen Germany (2016 - present)

I am a team member on the EDEN-ISS project, a multi-national project supported by the German Space Agency (DLR) and the European Union (EU) Horizon 2020 Research and Innovation Program. I, and my colleague Rob Ferl, were the representatives for NASA and the United States among 16 other nations. The goal of the EDEN ISS project is to advance controlled environment agriculture technologies beyond the state-of-the-art. It focuses on ground demonstration of plant cultivation technologies and their application for spaceflight and planetary applications. We brought expertise and experience in plant growth in spaceflight environments, along with spaceflight experience in using specific informative imaging capabilities, to the EDEN-ISS project. In particular, to develop and supply to the project dual wavelength imagers and imaging procedures within the EDEN ISS facilities and provide image processing and analysis. The technology for specific dual wavelength Spectral Imaging builds on NASA ISS plant imaging technologies with the Advanced Biological Research System (ABRS) and Advanced Plant Habitat (APH) on the ISS as well as Earth-Imaging concepts such as NDVI and MODIS to produce a novel image-based plant health monitoring and plant science capability. Basically, image data from dual wavelength cameras will be downlinked from the Antarctic EDEN Mobile Test Facility (MTF) for community open science analyses with respect to plant health. (Publications: Beisel et al., 2018; Zeidler et al, 2019).

Antarctica

The German-Based Alfred Wegener Institute supported expedition associated with the EDEN-ISS project (above). Paul and colleague Ferl were invited to join the EDEN-ISS Team on the ice at the Neumayer III (NMIII) research station in Antarctica. We were funded by NASA to participate and connect the two space agencies for the unified goal for the functionalization of plant growth in support of human exploration in spaceflight and future planetary habitats. Imaging technologies developed as part of ongoing ISS science by us were deployed within the Antarctic EDEN ISS plant production unit to provide tele-science support and plant science analytics to better understand the responses of plants, as well as production support to optimize plant performance.