

EDUCATION

- 2020 PhD in Mechanical Engineering
Western Michigan University, Kalamazoo, MI
Dissertation: *Accumulation of Polar Vorticity in Giant Planet Atmospheres:
Towards a Three-Dimensional Theory.*
Committee: William Liou, Tianshu Liu, Parvitz Merati, Kunio Sayanagi
- 2008 Master of Science in Mechanical Engineering
Western Michigan University, Kalamazoo, MI
- 1994 Bachelor of Science in Aerospace Engineering
Embry-Riddle Aeronautical University

RESEARCH INTERESTS

I am interested in understanding how convective activity, waves, and other atmospheric phenomena influence the formation and evolution of vortices and jet streams on the giant planets (Jupiter, Saturn, Uranus, and Neptune) and on exoplanets. To carry out my investigations, I apply shallow water and hydrostatic primitive equation numerical models, and I desire to develop more advanced numerical models applicable for giant atmospheres. To extract dynamical information (e.g., wind and vorticity fields) from spacecraft mission data, I use the Optical Flow technique to conduct cloud tracking. Additional research interests include modeling the interiors of icy satellites, terrestrial and giant planets. I also have a keen interest in developing spacecraft missions to planetary bodies. Some broad research questions I seek to answer from my research are:

How are jets, vortices, and circulation patterns on the giant planets generated and maintained by small-scale turbulence?

What is the nature and role of moist convection in generating the large-scale structures observed on the giant planets?

What are the mechanisms behind the formation and maintenance of polar vortices on the giant planets, and how does this knowledge contribute to understanding polar vortices on terrestrial planets?

TEACHING APPOINTMENTS

GRADUATE

- 2012 Part-time Instructor Western, Michigan University
- *Theoretical and Computational Fluid Mechanics*, one section of 8 students
Designed course. Implemented multiple lectures in geophysical fluid dynamics for engineering students.

UNDERGRADUATE

- 2017 Part-time Instructor, Western Michigan University
- *Introduction To Mechanical Engineering*, one section of 120 students. Supervised two teaching assistants.
 - *Material Science I*, one section of 63 students. Supervised one teaching assistant.
 - *Thermodynamics I*, one section of 47 students. Supervised one teaching assistant.
- 2016 Part-time Instructor, Western Michigan University
- *Material Science I*, two sections of 34 and 38 students each. Supervised one teaching assistant.
 - *Thermodynamics I*, one section of 38 students.
- 1995 Adjunct Instructor Greenbrier Community College
- *Developmental Algebra*, two sections of 45-50 students each.

PEER-REVIEWED PUBLICATIONS

- Brueshaber, S.R.**, and Sayanagi, K.M. *Effects of Forcing Scale and Intensity on the Emergence and Maintenance of Polar Vortices on Saturn and the Ice Giants*. Icarus (2020) (In Review)
- Glenn S. Orton, Fachreddin Tabataba-Vakili, Gerald Eichstädt, John Rogers, Candice Hansen, Tom Momary, Andrew P. Ingersoll, **Shawn R. Brueshaber**, Michael H. Wong, Amy A. Simon, Michael Ravine, Michael Caplinger, Chloe Thepenier, Hamish Nicholson. *A Survey of Small-Scale Waves and Wave-Like Phenomena in Jupiter's Atmosphere Detected by JunoCam*. Journal of Geophysical Research-Planets, 125, e2019JE006369. <https://doi.org/10.1029/2019JE006369>
- Liu, T., Sayanagi, K.M., and **Brueshaber, S.R.**, Ingersoll, A.P., Dyudina, U.A., Ewald, S.P. *Saturn's North Polar Structure Extracted from Cloud Images by the Optical Flow Method*. Journal of Geophysical Research-Planets, 15 October 2019, <https://doi.org/10.1029/2019JE005974>
- Brueshaber, S.R.**, Sayanagi, K.M., and Dowling, T.E. *Dynamical Regimes of Giant Planet Polar Vortices*. Icarus (2019) 323, 46-61. doi.org/10.1016/j.icarus.2019.02.001
- Samuel M. Howell, Luoth Chou, Michelle Thompson, Michael C. Bouchard, Sarah Cusson, Matthew L. Marcus, Harrison Brodsky Smith, Srinivasa Bhattaru, John J Blalock, **Shawn Brueshaber**, Siegfried Ettl, Erica Jawin, Kelly Miller, Maxime Rizzo, Kathryn Steakley, Nancy H Thomas, Kimberly Trent, Melissa Ugelow, Charles John Budney and Karl L Mitchell. *Camilla: A centaur reconnaissance and impact mission concept*. Planetary and Space Science (2018) 164, 184-193. doi.org/10.1016/j.pss.2018.07.008

CONFERENCE PRESENTATIONS

- Shawn Brueshaber** *Giant Planet Polar Vortices*. Dynamics of Rotating Fluids Conference 2020. Oxford Univ. Oxford, UK.
- Shawn Brueshaber**, Kunio Sayanagi, Timothy Dowling, *Polar Vortex Dynamics on Gas and Ice Giant Planets*. Ice Giants 2020 Workshop, Royal Society. London, UK.

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Candice J. Hansen, **Shawn Brueshaber**, Glenn Orton, Thomas Momary, Scott J. Bolton, *JunoCam Images of Castellanus Clouds on Jupiter*, #P44A-05. AGU Fall 2019 Meeting. (Oral Presentation)

S.R. Brueshaber, S. M. Howell, L. Chou, M. Thompson, S. Cusson, M. Marcus, M.C. Bouchard, H. Brodsky Smith, S. Bhattaru, J. J. Blalock, S. Eggl, E. R. Jawin, K. E. Miller, M. Rizzo, K. Steakley, N. H. Thomas, K. Trent, M. Ugelow, C. J. Budney and K. L. Mitchell.
Camilla: A New Frontiers Class Centaur/Reconnaissance Mission Concept from the 2017 NASA-JPL Planetary Science Summer Seminar. Centaur Exploration Workshop. March 6-8, 2019. (Invited Talk)

Brueshaber, S.R., Sayanagi, K.M. & Dowling, T.E., *Polar Vortex Dynamics on Gas and Ice Giant Planets*. Abstract ID #422623; American Geophysical Union, Fall 2018 Meeting. (Poster Presentation)

Brueshaber, S.R., Sayanagi, K.M., Dowling, T.E. *Dynamical Regimes of Giant Planet Polar Vortices from Shallow Water Modeling*. Abstract #507.02; 50th American Astronomical Society Division of Planetary Sciences Conference. (Oral Presentation)

M. C. Bouchard, S. M. Howell, L. Chou, M. Thompson, S. Cusson, M. Marcus, H. Brodsky Smith, S. Bhattaru, J. J. Blalock, **S. Brueshaber**, S. Eggl, E. R. Jawin, K. E. Miller, M. Rizzo, K. Steakley, N. H. Thomas, K. Trent, M. Ugelow, C. J. Budney and K. L. Mitchell.
Flyby and Impact of Chariklo: A New Frontiers Class Centaur/Reconnaissance Mission Concept from the 2017 NASA-JPL Planetary Science Summer Seminar. 49th Lunar and Planetary Science Conference 2018. (Poster Presentation)

Brueshaber, S.R., and Sayanagi, K.M., *Dynamics of Giant Planet Vortices*. Abstract #501.01; 48th American Astronomical Society Division of Planetary Sciences Conference. (Oral Presentation)

Brueshaber, S.R., and Sayanagi, K.M., *Numerical Simulations of Saturn's Polar Cyclones* Abstract #422.27; 46th American Astronomical Society Division of Planetary Sciences Conference. (Poster Presentation)

GRANTS & CONTRIBUTIONS TO PROPOSALS Total personal award to date: **\$549,201**

NASA Solar Systems Workings Program, NNH19ZDA001-N-SSW, *funded (\$402,401)*
Modeling of Dark Anticyclonic Vortex Formation on Ice Giant Planets.
PI: Dr. Kunio M. Sayanagi, Science PI: Shawn Brueshaber

Dissertation Completion Fellowship, 2019 Western Michigan University, *funded (\$20,800)*

NASA Solar Systems Workings Program, NNH18ZDA001-N-SSW, *submitted*
Modeling of Vortex Evolution on Solar System Giant Planets.
PI: Dr. Kunio M. Sayanagi, Science PI: Shawn Brueshaber

NASA Cassini Data Analysis Program, #NNH18ZDA001N, *submitted*
Saturn's Time-Dependent Volatile Structure and Transport Using Cassini Observations.
PI: Dr. Csaba Patolai, Collaborator: Shawn Brueshaber

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NASA Earth and Space Science Fellowship, 2016-2019. Proposal #16-Planet16F-0082, *funded (\$125,000)*. *Accumulation of Polar Vorticity, Towards a Three-Dimensional Theory*

PI: Dr. William Liou, Student/Science PI: Shawn Brueshaber

Patricia L. Thompson Dissertation Award, 2016 Western Michigan University, *funded (\$1,000)*

PUBLIC TALKS & PRESENTATIONS

2020 *Polar Vortices on Giant Planets: Results from Atmospheric Modeling*. Univ. of Leicester, Leicester, UK.

2020 *I Know Nothing about Uranus (or Neptune). Why we need to Explore the Ice Giants*. Custer Series Lecture, Western Michigan University. Kalamazoo, MI

2019 *Astronomy on Tap. Weather and Climate on the Gas Giant Planets*. Lansing, MI.

2017 *Weather and Climate in the Solar System*. Kalamazoo Nature Center, Summer Science Seminar Series. Kalamazoo, MI

2015 *Accumulation of Polar Vorticity*. Western Michigan University. Kalamazoo, MI
Mechanical and Aerospace Engineering Department Seminar Series Talk

INDUSTRY EXPERIENCE

JET PROPULSION LABORATORY, Pasadena, CA. 2020-present

Juno Mission Postdoctoral Scholar

Responsible for coordinating Earth-based observations of Jupiter to support Juno mission.

PARKER, Otsego, MI. 2014-2015

New Product Development Engineer

Responsible for developing new products for Parker Fluid Connector Systems Division.

- Designed, constructed, and programmed the data acquisition system for a large flow bench to calibrate new wireless flow sensors for compressed gas applications.
- Improved the design of 900 MHz flow sensors for industrial compressed gas applications.
- Served as project manager for a research and development project in conjunction with The Ohio State University involving sensors for detection and fault analysis in predictive algorithms.
- Left position to pursue doctoral research full-time.

PRATT INDUSTRIES, Bridgman, MI. 2013

Finite Element/Stress Analyst

Responsible for developing Pratt's capabilities for linear static and nonlinear stress analysis using Ansys simulation software.

- Successfully developed process from design conception through stress analysis including contact, non-linear effects, and sub-modeling. Dynamic analyses were also developed.
- Job position terminated after loss of several highly anticipated and necessary contracts financially pressured the company to reduce engineering staff.

DUNCAN AVIATION, Battle Creek, MI. 2007-2013

Structural Engineer/Analyst

Responsible for stress analysis upon various aircraft interior modifications, antenna installations, and damage tolerance evaluations/analyses. Work completed using guidance from Interior and Structural UMs/DERs. Analysis tools at include finite elements, spreadsheets, design manuals, classical analysis techniques, and other non-computer based methods.

- ODA (in-house Federal Aviation Administration ‘Designated Engineering Representative’) Unit Member Candidate.
- Developed in-house damage tolerance methodology for fuselage pressure vessel penetrations for antenna installations.
- Initiated and implemented finite element analysis methodology and acquisition of software for use in company stress analysis.
- Developed a training program for engineering project management and design engineers that supervise or conduct stress analysis.
- Mentored two junior level engineers.
- Aiding senior engineers to develop and train non-degreed engineering personnel in the basics of statics and strength of materials to enhance their design skills.
- Conducted numerous stress analyses and designs for modifications and alterations on Part 23, 25, and 29 aircraft. Worked with company and consultant DERs for approvals, including aircraft monument (galley, closets, etc...) design and stress analyses and antenna installations and design and stress analyses on Part 25 aircraft.
- Assisted company DERs with numerous STC projects on Part 25 and some with Part 26 requirements.

ALLIANT ENGINEERING, Kalamazoo, MI. 2005-2007

Senior Engineer/Consultant

Responsible for program and personnel management, design, FEA, mechanical/structural analyses, design of experiment, patent research, and classical mechanical analysis for various engineering projects at a consulting and design firm in aviation, medical, automotive, and architecture industries.

- Research into natural convection-heat transfer effects for a fire suppression system design subjected to sub-zero conditions. CFD and physical testing used to study the physics of the system.
- Structural analysis and design for a large outdoor rotating sculpture including load spectra estimation and fatigue analysis.
- Completed Finite Element Analysis on several hydraulic components and systems for the Boeing 787 Dreamliner while on assignment at Parker-Abex Company. Static strength, fatigue, and vibration analyses were all employed on this project. Wrote technical reports for all analyses and worked with a consultant DER for approval of reports.
- Performed impact analyses on molded plastic parts using both FEA and classical structural analyses techniques.
- Co-Created a patentable design for a carbon composite powered parachute aircraft.

WHIRLPOOL CORPORATION, St. Joseph, MI. 2004-2005

Project Engineer

Responsible for project engineering and management of several dishwasher projects. Projects included:

- Fully integrated drying improvement and simultaneous cost savings on dishwasher models.
- Performed magnetic valve actuation design on a plastic tub dishwasher line.
- Quick wash cycle research improvement.
- Flow loss reduction on multilevel dishwasher design including spray arms.

JDM ENGINEERING AND DESIGN, LLC, Kalamazoo, MI. 2001-2004

Program Manager/Sr. Mechanical Engineer

Responsible for program and personnel management, design, finite element modeling (FEM; stress and heat transfer), design of experiment, patent research, and classical mechanical analysis for various engineering projects at a consulting and design firm.

- Responsible for linear FEA and analysis project management for hydraulic and electrical line structural brackets on the Airbus A380 aircraft including fatigue analysis.
- Responsible for linear FEA and design for a new composite ultralight sport aircraft in a compressed time frame. Patent pending with this product.
- Conducted Stress Analysis on Boeing 747-400ER fuel transfer system including fatigue.
- Performed linear FEA, redesign, and patent research on a large mobile scaffold assembly including non-linear material effects.
- Initiated research into composites design and analysis suitable for product development.
- Participated in managerial decisions concerning projects to quote, capital investments, and personnel selection.
- Head of Engineering Analysis division.

THE JOHNSON CORPORATION, Three Rivers, MI. 1998-2001

R&D Engineer/Analyst

Responsible for research and product development of various steam and water condensate components. Research tools included direct experimentation and Computational Fluid Dynamics (CFD) software packages, as well as Finite Element Analysis (FEA) software. Provided test program guidance and direction to upper-level management.

- Incorporated Computational Fluid Dynamics (CFD) software into product development.
- Performed numerous heat transfer studies (FEA) for temperature measuring designs.
- Assisted Quality Department as an internal auditor.
- Implemented a comprehensive test program to develop and evaluate the performance of steam jet pumps.
- Designed a robust variable orifice product (patentable device) in a very short period saving the company a large contract and preventing a \$1,000 fee per-day fine.
- Company safety team member.

TI AUTOMOTIVE (BUNDY CORPORATION), Warren, MI, 1997-1998

Product Engineer

Responsible for design, validation, and program management of fluid system components, primarily for fuel systems. Analysis and design of quick connectors was achieved by providing guidance to CAD designers and lab technicians, development of DFMEAs, structural computations, review of testing data,

consultation with injection molding and metal suppliers and interaction with customer representatives, account managers, and purchasing.

- Lobbied various business unit managers to provide extra funds for laboratory equipment that benefited all business units.
- Developed large volume anti-freeze quick connector for General Motors on short notice.
- Suggested, lobbied extensively, and evaluated Finite Element Analysis (FEA) software for use in metal and plastic quick connector design.
- Planned a research program in conjunction with R&D, suppliers, and business team managers to develop FEA parameters for chemically altered plastic materials for use in design validation.
- Investigated a failure of a product line, discovered a manufacturing-induced failure and proposed a successful remedy.

TECH SPEC, INC., Midland, MI, 1996

Applications Engineer

Responsible for technical consultation on various linear motion products and machine tool components at an industrial distributor. Performed numerous load, lifetime, and structural calculations, established an alternative parts list, technical training seminars, and wrote product description articles in company newsletter.

- Created an effective engineering position from an ill-defined set of management goals. Accomplished this task in conjunction with outside sales and customer input.
- Analyzed customer designs and bearing/machine tool component applications, and built MathCAD documents that were provided to the customer with technical suggestions and recommendations.
- Conducted numerous product/application training seminars for customers and inside personnel in order to increase customer satisfaction and sales.
- Employee of the Month (August 1996).

PROFESSIONAL DEVELOPMENT & CONFERENCE PARTICIPATION

- 2020 Ice Giants 2020 Workshop, London, UK.
- 2019 American Geophysical Union Fall Meeting
- 2019 Outer Planet Assessment Group Summer Meeting
- 2019 Centaur Exploration Workshop
- 2018 American Geophysical Union Fall Meeting
- 2018 AAS 50th Division of Planetary Sciences Conference
- 2018 USGS Integrated Software for Imagers and Spectrometers software (ISIS) training
- 2017 JPL Planetary Science Summer Seminar, Propulsion and UV Instrument Lead

Highly selective, 12-week-long spacecraft mission planning and proposal experience culminating in an intensive one-week exercise at JPL. Using both the \$1B New Frontiers-class mission and the \$450M Discovery-class mission, 18 PhD candidates and post-docs designed a spacecraft with a well-developed set of science mission objectives. These objectives stemmed from fundamental questions about the solar system to result in instrument-selection and instrument requirements for a mission to Chariklo 10199, a centaur located 18AU from the sun. Concept development of the spacecraft was achieved in a partnership with JPL's "Team-X," a concurrent engineering team specifically tasked with designing a spacecraft to the detail necessary for a successful NASA mission proposal.

- 2017 AAS 49th Division of Planetary Sciences Conference
- 2017 IPPW (International Planetary Probe Workshop) & Ocean Worlds Short Course, 14th Conference
- 2016 AAS 48th Division of Planetary Sciences Conference
- 2016 Grant Writing Seminar, “The Dissertation Completion Fellowship”
- 2016 Grant Writing Seminar, “Research and Travel Grants”
- 2015 Ansys Fluent (Computational Fluid Dynamics Software)
- 2015 Design for Six Sigma
- 2014 AAS 46th Division of Planetary Sciences Conference
- 2014 LabVIEW I and II Software Training
- 2014 Solid Edge Inventor CAD Software Training
- 2013 Ansys Mechanical Finite Element and Computational Fluid Dynamics Software Training
- 2013 Advanced Fatigue and Damage Tolerance Seminar, University of Washington
- 2011 NEiNASTRAN Laminate and Sandwich Composite Stress Analysis Software Training
- 2010 Federal Aviation Administration’s Organizational Delegated Authority Training
- 2009 Federal Aviation Administration’s Designated Engineering Representative Seminar
- 2008 Fatigue and Damage Tolerance Seminar, University of Washington
- 2008 Linear-Static Finite Element Analysis with NeNaSTRAN Software
- 2007 Fundamentals of Aircraft Design and Analysis, Kansas University
- 2007 Junior Chamber International “DESIGNER” (Developing Training Programs)
- 2006 Project Management Professional Course, Project Management International
- 2004 Junior Chamber International “PRIME” (Training the Trainer)
- 2004 Junior Chamber International “ACHIEVE” (Fundamentals of Non-Profit Organizations)
- 2004 Junior Chamber International “LEAD” (Fundamentals of Leadership Development)
- 2004 Design Failure Modes and Effects Analysis Training
- 2000 Michigan Occupational Safety and Health Administration Training
- 1997 Eight Discipline - Root Cause Analysis
- 1997 Selection of Material for Plastic Parts
- 1997 Designing Plastic Parts for the Injection Molding Process
- 1996 Synergistic Sales Training

PROFESSIONAL SERVICE and MEMBERSHIP

- 2019-present Letters to a Pre-Scientist
- 2019 Executive Secretary, NASA Grant Panel
- 2018 Division of Planetary Sciences 50th Conference, Co-Chair Giant Planet Atmospheres II Session
- 2018-present American Geophysical Union Student Member
- 2012-present Western Michigan University Professional Instructors Organization
- 2017-present NASA Science Mission Directorate Grant Panelist
- 2001-present Kalamazoo Junior Chamber
- 2001-2012 Junior Chamber International
- 2001-2012 United States Junior Chamber
- 2001-2012 Michigan Junior Chamber

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AWARDS

2017 Western Michigan University, All University Graduate Teaching Effectiveness Award
2017 Western Michigan University, Department Graduate Teaching Effectiveness Award
2013 Kalamazoo Junior Chamber – Honorary Life Membership
2007 Michigan Junior Chamber – Presidential Medallion
2006 United States Junior Chamber – Dennis Hamilton Memorial Award
2004 Michigan Junior Chamber – Presidential Medallion
2004 Michigan Junior Chamber – Seiji Horiuchi Memorial Award
2004 United States Junior Chamber – Debate Competition 1st Place

EXTRACURRICULAR VOLUNTEERING ACTIVITIES

2008 Membership Development Vice President, Kalamazoo Junior Chamber
2006 Vice President, Michigan Junior Chamber
2005 Region Director, Michigan Junior Chamber
2004 Program Manager, Michigan Junior Chamber
2003 Individual Development Vice President, Kalamazoo Junior Chamber
2002 Management Vice President, Kalamazoo Junior Chamber
2001 Director, Kalamazoo Junior Chamber
1995-1996 National Weather Service Certified Weather Observer
1989-1992 Air Force Reserve Officer Training Corps

MEDIA & PUBLIC ARTICLES

“What would happen if you could skydive off the International Space Station?”
Business Insider, July 15, 2018
Technical contributors: **Shawn R. Brueshaber** & Kunio M. Sayanagi

REFERENCES

Dr. Kunio M. Sayanagi
Associate Professor
Atmospheric & Planetary Sciences Department
Hampton University
Email: kunio.sayanagi@hampton.edu
Phone: 757.728.6745
Relationship: Dissertation Committee
Member/Mentor

Dr. Koorosh Nagshineh
Department Chair and Professor
Dept. of Mechanical and Aerospace Engineering
Western Michigan University
Email: koorosh.naghshineh@wmich.edu
Phone: 269.276.3292
Relationship: Department Chair & Supervisor for
Teaching Appointments

Dr. Karl Mitchell
Scientist
Jet Propulsion Laboratory
Email: Karl.L.Mitchell@jpl.nasa.gov.
Phone: 818.393.5519
Relationship: Mentor for Planetary Science
Summer Seminar

Dr. Timothy E. Dowling
Professor
Department of Atmospheric Science
University of Louisville
Email: timothy.dowling@louisville.edu
Phone: 502.852.3927
Relationship: Research Collaborator

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Dr. William W. Liou

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Relationship: Dissertation Committee Chairman