Pablo **Trefftz Posada**

Multiphase Turbulent Flows · Numerical Methods · High Performance Computing

Department of Aeronautics & Astronautics @ University of Washington, Seattle, WA, USA

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Recent Ph.D. graduate looking for a research scientist position in private industry at the intersection of simulation software and machine learning.

Education

University of Washington

Seattle, WA, USA

Doctor of Philosophy (Ph.D.) in Aeronautics & Astronautics

2015 – 2024

- Thesis title: Direct numerical simulation of droplet-laden homogeneous shear turbulence & a mass-conserving method for gas-liquid flows with phase change
- Supervisor: Prof. Antonino Ferrante
- GPA: 3.78

University of Michigan

Ann Arbor, MI, USA

BSE in Aerospace Engineering

2010 – 2014

- Technical electives: Numerical Methods for Aerospace Engineering, Gas Turbine Propulsion

Summary of Qualifications

Experience

William E. Boeing Department of Aeronautics & Astronautics, University of Washington

Seattle, WA

Lecturer: Aerospace Engineering Colloquium

Jan. 2024 - Jun. 2024

- Developed and presented lectures on a variety of professional development topics to over 100 professional master's degree students.
- Topics covered: technology reviews, writing short reports, writing memos, three-minute oral pitches, utilizing large language models, basic AI theory and applications (machine learning, generative design, computer vision, predictive maintenance).

Research Assistant at Computational Fluid Mechanics Lab

Sep. 2015 - Mar. 2024

Algorithm Development

- Developed a state-of-the-art computational fluid dynamics (CFD) solver for simulating droplet-laden turbulence with phase change that is mass conserving, accurately captures heat and mass transfer across the interface, is capable of handling evaporation and condensation, and parallelizes easily and efficiently.
- Developed a novel method for applying shear-periodic boundary conditions to the Volume of Fluid method for tracking interfaces in multiphase flow simulations. This method allowed for the simulation of homogeneous shear turbulence, a type of turbulent flow with closer similarities to flows observed in engineering applications than previously studied flows.
- Developed FastRK3P*, a CFD solver for variable-density multiphase flows in homogeneous shear turbulence which is 10-40 times faster than previous methods using multigrid solvers.

High Performance Computing Simulations

- Conducted a parametric study of 8 direct numerical simulations of droplet-laden homogeneous shear turbulence, with 432 million unknowns each, to study the effect of mean shear and varying surface tension on turbulence kinetic energy. Simulation parameters were selected for their engineering relevance to spray combustion devices.
- Tested and validated massively parallelized Poisson equation solver on up to 16,384 cores for a simulation with half a trillion unknowns. The Poisson equation is a fundamental partial differential equation with engineering applications such as heat transfer, fluid mechanics, structural mechanics, and electrostatics.

Theoretical Analysis and Post-processing of Big Data

- Derived the turbulence kinetic energy evolution equations for two-fluid homogeneous shear turbulence. Understanding these equations is crucial for modeling multiphase turbulent flows which are prevalent in many engineering applications.
- Created Python scripts using the NumPy, SciPy, and pandas libraries to post-process over 20 TB of simulation data in minutes.
- Performed spatial and temporal statistical analyses of relevant quantities to explain the role of surface tension in droplet-laden homogeneous shear turbulence.
- Generated publication-quality figures using the Python matplotlib library to clearly communicate the results of my simulations to a broader audience.
- Discovered the pathways of turbulence kinetic energy exchange for droplet-laden homogeneous shear turbulence.
- Discovered two new physical mechanisms that explain the modulation of the TKE evolution equation budget terms by the presence of droplets.

Lead Teaching Assistant *Sep. 2022 - Dec. 2023*

- Onboarded all teaching assistants and graders through interactive presentations, to prepare them for their instructional and grading duties. Typically 20-25 teaching assistants and graders every quarter.
- Created and facilitated instructional training sessions on fair and efficient grading, using the Canvas learning management system, and implementing active learning strategies in the classroom.
- Facilitated mid-quarter check-ins and end-of-quarter evaluations for all teaching assistants to improve consistency in the student experience.

Washington NASA Space Grant Consortium *Seattle, WA*

Summer Undergraduate Research Program Director *Jun. 2023 - Aug. 2023*

- Managed program operations, coordinating with 32 faculty members and 12 graduate student leaders to provide paid research experiences for 74 undergraduate students with minimal previous research engagement.
- Developed and presented professional development workshops, equipping students with critical skills in resume building, research abstract writing, and academic presentations.
- Organized the annual Space Grant Poster Symposium, showcasing research contributions from 74 students to 35 research projects through 10 five-minute pitch presentations and 45 poster presentations.

Washington State Academic RedShirt (STARS) Program *Seattle, WA*

Math/Physics Predoctoral Instructor *Jun. 2016 - Jun. 2022*

- Developed curriculum for two courses (STARS Math and STARS Physics) that prepare STARS cohorts for the rigor of the introductory departmental math and physics series. These courses focus on helping students develop strong problem-solving skills.
- Onboarded 8 teaching assistants and aided in their pedagogical training, which was focused on engagement with students and their development.
- Transitioned STARS course curriculum from in-person to fully virtual during the COVID pandemic. Maintained a sense of community within the cohort through continued group problem solving using OneNote class notebooks.
- Created and led accompanying workshops to support students in the introductory physics course through group problem solving, emphasizing the use of correct definitions, and practicing test-taking skills under time pressure.
- Collaborated multiple times a week with STARS staff to discuss student progress and develop plans to support our students that come from low-income, first-generation, and underserved backgrounds.

Ford Motor Company *Livonia, MI*

Cylinder Block Manufacturing Engineer *Jun. 2014 - Jun. 2015*

- Analyzed stack-up calculations on 300+ features and determined machining order to meet required cycle time.
- Engaged in simultaneous engineering with machine suppliers to ensure their manufacturing equipment produced parts that met GD&T specifications within cycle time.

Technical Expertise

- Proficient in Python (NumPy, SciPy, Numba, pandas), Fortran, MPI, MATLAB, LaTeX; familiar with C++, OpenMP, OpenACC; previously used CUDA, Simulink, Ansys Fluent, STAR-CCM+, OpenFOAM, AutoCAD, SOLIDWORKS, CATIA
- Experienced with Git, SVN, CMake, Tecplot, Unix/Linux, Microsoft Office

Relevant Coursework

AA 598: Designing and Building Applications for Extreme Scale Systems

- This course introduces students to the features of extreme scale systems and how to use performance modeling to design, implement, and tune large-scale applications in simulation and data-intensive science.
- Final project: Characterizing 1D domain decomposition vs. 2D domain decomposition parallelism for a 3D Poisson solver.

ME 574: Introduction to Applied Parallel Computing for Engineers

- Utilization of GPU-based parallel computing for engineering applications. Basics of hardware and software for GPU-based parallel computing. Introduction to GPU programming, language extensions, and interfaces. Introduction to parallel methods for numerical analysis and digital design. Applications in imaging, inspection, and computer-aided design. Hands-on experience creating GPU-powered parallel applications.
- Final project: Parallelizing a 2D Incompressible N-S Solver with CUDA. (Video presentation)

Honors & Awards

2024	**Nominated for Distinguished Dissertation Award**, University of Washington, Seattle	*Seattle, WA, USA*
2022	**Nominated for College of Engineering Student Award: Teaching**, College of Engineering, University of Washington, Seattle	*Seattle, WA, USA*
2017	**SIAM CSE17 Broader Engagement Selected Participant**, Sustainable Horizons Institute	*Atlanta, GA, USA*
2016	**20 Twenties Award**, Penton's Aviation Week and AIAA	*Washington, D.C., USA*
2015	**Ruth C. Hertzberg Fellowship**, College of Engineering, University of Washington, Seattle	*Seattle, WA, USA*
2015	**Theodore H. and Marie M. Sarchin Endowed Fellowship in Engineering**, College of Engineering, University of Washington, Seattle	*Seattle, WA, USA*
2015	**Paul A. Carlstedt Endowed Fellowship in Aeronautics and Astronautics**, William E. Boeing Department of Aeronautics & Astronautics, University of Washington, Seattle	*Seattle, WA, USA*

Publications

Refereed archival journal publications

J03 Equations of turbulence kinetic energy for gas-liquid flows with phase change — *2024*

Adidela N., ***Trefftz-Posada P.*** *& Ferrante A.*

Journal of Fluid Mechanics - in prep.

J02 A coupled volume-of-fluid and pressure-correction method for incompressible gas-liquid flows with phase change — *2024*

Dodd M., ***Trefftz-Posada P.*** *& Ferrante A.*

Journal of Computational Physics - in prep.

J01 On the interaction of Taylor length-scale size droplets and homogeneous shear turbulence — *2023*

Trefftz-Posada P. *& Ferrante A.*

Journal of Fluid Mechanics, Vol. 972, A9, pp. 1-39

Conference papers refereed by abstract only

CA02 Direct numerical simulation of droplet laden homogeneous shear turbulence — *Kobe, Japan*, *April 2-7, 2023*

Trefftz-Posada P. *& Ferrante A.*

11th International Conference on Multiphase Flow (ICMF)

CA01 Direct numerical simulation of droplet laden homogeneous shear turbulence: numerical method and flow physics — *Maui, Hawaii, USA*, *July 11-15, 2022*

Trefftz-Posada P. *& Ferrante A.*

11th International Conference on Computational Fluid Dynamics (ICCFD)

Abstracts, letters, non-refereed papers, technical reports

A05 DNS of droplet-laden homogeneous shear turbulence — *Indianapolis, IN, USA*, *November 2022*

Trefftz-Posada P. *& Ferrante A.*

75th American Physical Society Meeting, Division of Fluid Dynamics

A04 FastRK3P*: a fast and stable pressure-correction method for two-fluid incompressible homogeneous shear turbulence — *Venice, Italy*, *September 28-30, 2022*

Trefftz-Posada P. *& Ferrante A.*

4th International Conference on Numerical Methods in Multiphase Flows (ICNMMF)

A03 Effects of droplet deformation and breakup/coalescence on turbulence kinetic energy — *Seattle, WA, USA*, *November 2019*

Ferrante A. & ***Trefftz-Posada P.***

72nd American Physical Society Meeting, Division of Fluid Dynamics

A02 Direct numerical simulation of droplet-laden homogeneous shear turbulence — *Seattle, WA, USA*, *November 2019*

Trefftz-Posada P. *& Ferrante A.*

72nd American Physical Society Meeting, Division of Fluid Dynamics

A01 On the interaction of homogeneous shear turbulence and droplets of Taylor length-scale size — *Atlanta, GA, USA*

Trefftz-Posada P. *& Ferrante A.* — *November 2018*

71st American Physical Society Meeting, Division of Fluid Dynamics

Invited Lectures and Seminars

2024 **University of Washington Aeronautics & Astronautics Fluids Seminar** — *Seattle, WA, USA*