Jeffrey Utley

PhD Candidate | Synthetic Data Generation, Statistical Modeling & Imaging

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U.S. Citizen | SECRET eligibility through Aug 2028

RESEARCH & TECHNICAL SUMMARY

- PhD candidate developing statistically validated synthetic data generation algorithms and reproducible scientific software for turbulence-driven imaging and simulation.
- Targeting national laboratory Research Scientist / Staff Research roles and R&D industry roles. Focus areas: modeling/estimation/simulation; computational imaging; signal processing; scientific software.
- Validated algorithms on measured wind-tunnel datasets; collaborated with AFRL/AFIT staff and briefed technical progress.
- Production-minded research software: modular, versioned, installable packages with reproducible results and publishable outcomes.

TECHNICAL SKILLS

- METHODS: synthetic data generation; inverse problems and parameter estimation; spectral analysis (FFT, PSD, PCA); numerical optimization (first-order methods; Mirror Descent); Bayesian inference (coursework).
- PROGRAMMING LANGUAGES: Python, C/C++, MATLAB, Julia.
- SCIENTIFIC COMPUTING & DATA (COURSEWORK/RESEARCH/PROJECTS): NumPy (FFT), SciPy, pandas, Matplotlib, Jupyter; seaborn (coursework); OpenCV (research/projects).
- ML FRAMEWORKS (COURSEWORK/TOOLS): PyTorch, JAX.
- COMPUTATIONAL ENVIRONMENTS (COURSEWORK/RESEARCH/PROJECTS): Linux/UNIX; bash/shell scripting; SSH; Slurm (HPC job scheduling on Purdue clusters); Make (coursework).
- DEVELOPMENT & REPRODUCIBILITY TOOLS (COURSEWORK/RESEARCH/PROJECTS): pip; conda; Git/GitHub; setuptools/pyproject (research/projects); LaTeX; Vim, PyCharm, Visual Studio.

EDUCATION

PhD, Mathematics — Purdue University Expected May 2027
GPA: 4.00 | Concentration: Computational Science

BS, Mathematics (Honors) — University of Tennessee May 2022
GPA: 3.98 | Minor: Computer Science

RESEARCH EXPERIENCE

Graduate Research Assistant — Purdue University Jan 2023 – Present

Advisors: Prof. Gregery Buzzard & Prof. Charles Bouman

- Develop and validate synthetic phase-screen generation algorithms from measured turbulence data; coordinate results and software deliverables with AFRL/AFIT collaborators.
  - Fourier-based method (BoilingFlow implementation): parameter estimation validated on measured + simulated turbulence; spatial-anisotropy extension validated on measured data.
  - Data-driven method: validated on measured wind-tunnel datasets via temporal/spatial statistics matching.
- Deliver reproducible research software and technical results: modular, version-controlled code; first-author SPIE proceedings; coordination with AFRL/AFIT collaborators.

Doctoral Research Fellow (ORISE) — AFIT (virtual) May 2025 – Aug 2025

Mentor: Prof. Matthew Kemnetz

- Contributed to the Purdue–AFRL/AFIT collaboration with a focus on the Fourier-based method; delivered weekly virtual technical briefings to AFIT staff; supported a SPIE conference-paper deliverable.

AFRL Scholars Program (USRA) — AFRL May 2024 – Aug 2024

Mentor: Prof. Matthew Kemnetz

- Contributed to the Purdue–AFRL collaboration by developing and evaluating the data-driven method; delivered an end-of-summer technical briefing to AFRL staff; supported a separate SPIE conference-paper deliverable.

ALGORITHMIC CONTRIBUTIONS

- Data-driven method (new): developed a novel synthesis algorithm that improves match to measured spatiotemporal statistics relative to Fourier-based baselines.
- Fourier-based method (existing): developed an automated calibration/parameter-estimation method to match measured spatiotemporal statistics (distribution matching) and implemented a spatial-anisotropy extension.

SOFTWARE PROJECTS

AOModel — installable Python package implementing the data-driven ReVAR algorithm for aero-optic modeling and synthetic phase screen generation. Validated on two wind-tunnel datasets (worst-case NRMSE = 4% for temporal power spectrum match). Includes package installation scripts, thorough documentation, and reproducible examples. https://github.com/jeffreyutley/aomodel_public.

BoilingFlow — installable Python package (Anaconda; NumPy/SciPy; FFT/PSD matching) implementing the Fourier-based phase-screen generation method; validated on two wind-tunnel datasets (worst-case NRMSE = 12% for temporal power spectrum match). Includes package installation scripts. https://github.com/jeffreyutley/boiling_flow.

PUBLICATIONS

Conference Proceedings

Utley, J., Buzzard, G., Bouman, C., & Kemnetz, R. (2025). Boiling flow parameter estimation from boundary layer data. SPIE. DOI: 10.1117/12.3063655. Preprint: arXiv:2602.10394.

Utley, J., Buzzard, G., Bouman, C., & Kemnetz, R. (2024). Data-driven synthetic wavefront generation for boundary layer data. SPIE. DOI: 10.1117/12.3027740. Preprint: arXiv:2409.04873.

Preprints (Under Review)

Utley, J., Buzzard, G., Bouman, C., & Kemnetz, R. ReVAR: A data-driven algorithm for generating aero-optic phase screens. Under review. https://arxiv.org/abs/2604.02326.

Utley, J., Buzzard, G., Bouman, C., & Kemnetz, R. Boiling flow estimation for aero-optic phase screen generation. Under review. https://arxiv.org/abs/2601.12171.

PRESENTATIONS

- **Electronic Imaging 2026** – "ReVAR: A data-driven algorithm for generating aero-optic phase screens."
- **SPIE Optics + Photonics 2025** — "Boiling flow parameter estimation from boundary layer data."
- **Electronic Imaging 2025** — "Synthetic wavefront generation for aero-induced turbulence using boundary layer data."
- **SPIE Optics + Photonics 2024** — "Data-driven synthetic wavefront generation for boundary layer data."
- **Directed Energy S&T Symposium 2024** — "Synthetic Wavefront Generation for Aero-Optics Correction."

ADDITIONAL RESEARCH

- Stochastic modeling of beetle infestations (Midwest REG, University of Michigan, Aug 2023).
- Undergraduate research in complex analysis resulting in a peer-reviewed journal article: Lind, J. & Utley, J. (2022). Involve, 15(3), 447–474. https://doi.org/10.2140/involve.2022.15.447
- Additional software (undergraduate): ModifiedBleatAlgorithm — MATLAB implementation of the algorithm from the above journal article. https://github.com/jeffreyutley/Modified-BLEAT-Algorithm

TEACHING, AWARDS & LEADERSHIP

- TEACHING: Instructor (University of Michigan, Wolverine Pathways, 2022–2023); Graduate TA (Purdue, 2022); Undergraduate TA (University of Tennessee, 2020–2022).
- LEADERSHIP: Vice President, SIAM Student Chapter (Purdue), 2024–Present; Co-organizer, CCAM Lunch Seminar (Purdue Mathematics), 2025-Present.
- SERVICE: Reviewer, Optical Engineering (SPIE), 2025–Present (2 manuscripts).
- AWARDS: SPIE Student Conference Support Award (2024); Purdue CoS Travel Award (2024); John H. Barrett Prize (2022).