Samuel Frederick

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EDUCATION

M.S. in Atmospheric Sciences *Expected Spring 2024*
University of Illinois at Urbana-Champaign

- *Thesis Topic*: Particle-resolved LES simulations to evaluate the impact of spatial heterogeneity on CCN activity
- *Advisor*: Nicole Riemer

B.S. in Physics, Minor in Applied Mathematics *May 2019*
Davidson College

- *Physics Honors Thesis*: *"Modeling Stability of Magnetars and Accompanying Internal Magnetic Fields with Applications to Continuous Gravitational Wave Detection"*

RESEARCH EXPERIENCE

Graduate Research Assistant *August 2022 - Present*
Department of Atmospheric Sciences, University of Illinois

- Utilize an aerosol modeling framework coupling the particle-resolved model PartMC to the Weather Research and Forecasting (WRF) model configured for large-eddy simulations (LES)
- Quantify the importance of the particle-resolved treatment and high spatial resolution on estimating CCN activity by comparing CCN estimates against simulation results using the modal MAM3 model and coarser spatial resolutions

ORAU National Student Services Contract *October 2019 - July 2022*
U.S. EPA Office of Research and Development, RTP, NC

- Designed, developed, and implemented an open-source Python library *sensortoolkit* for analyzing air sensor data against collocated regulatory-grade measurements. A class-based architecture and methodology for ingesting sensor data from a variety of formats allow broad utilization across sensor models and pollutants. Statistical analysis modules were included for calculating U.S. EPA's performance targets and metrics for air quality sensors, and testing reports are generated for summarizing sensor performance
- Contributed to the development of U.S. EPA performance targets, metrics, and protocols for $PM_{2.5}$ and O_3 air sensor evaluations, designed technical reporting templates for indicating air sensor evaluation against performance targets and metrics
- Developed modular computational tools for assisting U.S. EPA colleagues with ongoing research projects, including large-volume data acquisition via various air monitoring platform APIs and NowCast AQI estimation for constraining correction equation model error for use by air sensors displayed on the Fire and Smoke Map developed by AirNow & the U.S. Forest Service

Undergraduate Honors Thesis Research *August 2018 - May 2019*
Department of Physics, Davidson College

- Constructed a C-based computational model for magnetar stellar structure with strong magnetic fields by implementing magnetohydrodynamic simulation via the PLUTO code for astrophysical gas dynamics
- Quantified structural deformation due to magnetic field strength via measurement of stellar ellipticity by evaluating changes to the principal moments of inertia of the star
- Determined estimates for continuous gravitational wave strain resulting from stellar deformation assuming axisymmetric deformations orthogonal to the rotational axis
- Manuscript published in the May 2021 issue of the Monthly Notices of the Royal Astronomical Society

PUBLICATIONS

1. K.K. Barkjohn, A.L. Holder, **S.G. Frederick**, A.L. Clements. Correction and Accuracy of PurpleAir $PM_{2.5}$ Measurements for Extreme Wildfire Smoke. Sensors 2022, 22, 9669. DOI: 10.3390/s22249669
2. "Modeling Magnetohydrodynamic Equilibrium in Magnetars with Applications to Continuous Gravitational Wave Production". **S.G. Frederick**, K.L. Thompson, M.P. Kuchera. Monthly Notices of the Royal Astronomical Society, Volume 503, Issue 2, May 2021, Pages 2764–2775. DOI: 10.1093/mnras/stab625.

TECHNICAL REPORTS

1. "Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors - Use in Ambient, Outdoor, Fixed Site, Non-Regulatory Supplemental and Informational Monitoring Applications". R. M. Duvall, A. L Clements, G. Hagler, A. Kamal, V. Kilaru, L. Goodman, **S.G. Frederick**, K.K. Barkjohn, I. VonWald, D. Greene, T. Dye. Feb 2021. EPA Science Inventory Link.
2. "Performance Testing Protocols, Metrics, and Target Values for Ozone Air Sensors - Use in Ambient, Outdoor, Fixed Site, Non-Regulatory Supplemental and Informational Monitoring Applications". R. M. Duvall, A. L Clements, G. Hagler, A. Kamal, V. Kilaru, L. Goodman, **S.G. Frederick**, K.K. Barkjohn, I. VonWald, D. Greene, T. Dye. Feb 2021. EPA Science Inventory Link.

PRESENTATIONS (***presenter)**

1. "Communication of $PM_{2.5}$ Air Sensor Performance Evaluations in the Field Using EPA's Recommended Performance Metrics and Target Values". **S.G. Frederick***, R.M. Duvall, K.K. Barkjohn, C. Johnson, A.L. Clements. Association for Aerosol Research Conference. (Virtual, Oct 2021). EPA Science Inventory Link.
2. "Application of EPA's Recommended $PM_{2.5}$ Air Sensor Performance Metrics and Targets to Sensor Field Evaluations at Research Triangle Park". **S.G. Frederick***, K.K. Barkjohn, R.M. Duvall, C. Johnson, A.L. Clements. U.S. EPA Moment of Science, Air and Energy Connections Seminar. (Virtual, Apr 2021). EPA Science Inventory Link.
3. "Air Sensors: PurpleAir, AirNow Fire and Smoke Map, and Air Sensor Use Internationally". K.K. Barkjohn*, **S.G. Frederick***, A.L. Holder, A.L. Clements, Embassy Air Quality Fellows Program, U.S. Department of State. (Virtual, Dec 2020). EPA Science Inventory Link.
4. "Performance Evaluations of Air Sensors at EPA's AIRS Site". **S.G. Frederick***, K.K. Barkjohn, C. Johnson, R. Yaga, A.L. Clements. U.S. EPA $PM_{2.5}$ Implementation Workgroup. (Virtual, Aug 2020).
5. "Performance Evaluations of $PM_{2.5}$ Sensors in Research Triangle Park". **S.G. Frederick***, K.K. Barkjohn, C. Johnson, R. Yaga, A.L. Clements. U.S. EPA Air Sensor Webinar. (RTP, NC, Jan 2020).
6. "Modeling Structural and Magnetic Field Stability in Magnetars with Applications to Continuous Gravitational Wave Production". **S.G. Frederick***. Thesis Defense, Davidson College Department of Physics. (Davidson, Apr 2019).
7. "Highly Magnetic Stars and Continuous Gravitational Wave Production". **S.G. Frederick***, K.L. Thompson, M.P. Kuchera. Public talk, Charlotte Amateur Astronomers' Club. (Charlotte, NC, Mar 2019).
8. "Modeling Stability of Magnetic Fields in Magnetars". **S.G. Frederick***, K.L. Thompson, M.P. Kuchera. Davidson College Department of Physics Winter Symposium. (Davidson, Dec 2018).
9. "Radio Observations of Intermittent Pulsars and Interstellar Clouds". **S.G. Frederick***, K.L. Thompson. Davidson College Department of Physics Winter Symposium. (Davidson, Dec 2017)

POSTER PRESENTATIONS (⋆presenter)

1. "Interrogating the impact of spatial heterogeneity in aerosols on structural uncertainty using large-eddy simulations". **S. Frederick**⋆, M. Mohebalhojeh, J. Curtis, M. West, and N. Riemer. American Chemical Society Spring Meeting, Indianapolis, IN, Mar 2023.
2. "sensortoolkit: A Python Library for Standardizing the Ingestion, Analysis, and Reporting of Air Sensor Data for Performance Evaluations". **S.G. Frederick**⋆, K. Barkjohn, R. Duvall, A. Clements. Air Sensor International Conference, Pasadena, California, May 11 - 13, 2022. EPA Science Inventory Link.
3. "Performance Evaluations of Six $PM_{2.5}$ Sensors in Research Triangle Park, NC". **S.G. Frederick**⋆, K.K. Barkjohn, C. Johnson, I. VonWald, A.L. Clements. American Association for Aerosol Research. (Virtual, Oct 2020). EPA Science Inventory Link.
4. "Impacts of Data Completeness on Hourly Averaged PurpleAir $PM_{2.5}$ Concentrations During Smoke Events". **S.G. Frederick**⋆, K.K. Barkjohn, A.L. Holder, A.L. Clements. American Association for Aerosol Research. (Virtual, Oct 2020). EPA Science Inventory Link.
5. "Performance Evaluations of Six $PM_{2.5}$ Sensors in Research Triangle Park, NC". **S.G. Frederick**⋆, K.K. Barkjohn, C. Johnson, R. Yaga, A.L. Clements. Air Pollution Monitoring for Communities Grantee Meeting. (RTP, NC, Feb 2020).
6. "PurpleAir $PM_{2.5}$ U.S. Correction and Performance During Smoke Events". K. Johnson⋆, A. Holder, **S. Frederick**, A. Clements. Air Pollution Monitoring for Communities Grantee Meeting. (RTP, NC, Feb 2020).
7. "Modeling Structural and Magnetic Field Stability in Magnetars". **S. Frederick**⋆, K.L. Thompson, M.P. Kuchera. 233rd Meeting of the American Astronomical Society. (Seattle, WA, Jan 2019). Bibcode link.
8. "HI Observations of Intermittent Pulsars". **S. Frederick**⋆, K.L. Thompson. Davidson College Alenda Lux Research Symposium. (Davidson, NC, May 2018).
9. "Determining the Excitation Temperature of M57 via Spectral Analysis". **S. Frederick**⋆. Quadrennial SPS Physics Congress. (San Francisco, CA, Nov 2016)

SKILLS

Software Proficiency:	Python (pandas, NumPy, statsmodels, Matplotlib, seaborn), Bash, Git, LaTeX, VisIt, Microsoft Office
Language:	Goethe-Zertifikat B1 for German

LEADERSHIP AND OUTREACH

Graduate Student Ambassador *September 2022 - Present*
University of Illinois, Department of Atmospheric Sciences

- Act as a contact point for prospective graduate students, aid in answering questions about the department and the application process
- Collaborate with fellow student ambassadors to plan and host prospective graduate student webinar events

Vice President for Professional Affairs *April 2017 - April 2019*
Davidson College Society of Physics Students (SPS)

- Organized preparatory seminars with departmental faculty for students planning on taking the Physics Subject GRE

- Assisted with SPS sponsored events, including star gazing parties with the public and Space Day events aimed at encouraging scientific enthusiasm and engagement among local community families with school-age children
- Active chapter engagement led to national SPS recognition via an Outstanding SPS Chapter Award for the 2017-2018 academic year
- Inducted as a member of Sigma Pi Sigma, the national physics honors society division of SPS

Davidson College Symphony Orchestra **Davidson, NC**
Cellist *August 2015 - May 2016*

Boy Scouts of America **Valdese, NC**
Eagle Scout, Patrol Leader *Spring 2014*