

# Samuel Frederick

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## EDUCATION

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### M.S. in Atmospheric Sciences

May 2024

University of Illinois at Urbana-Champaign

- *Thesis Topic*: Idealized particle-resolved large-eddy simulations to evaluate the impact of emissions 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

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### Graduate Research Assistant

August 2022 - Present

Department of Atmospheric Sciences, University of Illinois

- Utilize the particle-resolved aerosol model [PartMC](#) coupled to the Weather Research and Forecasting (WRF) model configured for large-eddy simulations (LES)
- Quantify the impact of emissions spatial heterogeneity on CCN activity across numerous idealized emissions scenarios.

### 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<sub>2.5</sub> and O<sub>3</sub> 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

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1. K.K. Barkjohn, A.L. Holder, **S.G. Frederick**, A.L. Clements. Correction and Accuracy of PurpleAir PM<sub>2.5</sub> Measurements for Extreme Wildfire Smoke. *Sensors* 2022, 22, 9669. DOI: [10.3390/s22249669](https://doi.org/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](https://doi.org/10.1093/mnras/stab625).

## TECHNICAL REPORTS

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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)

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1. “Idealized particle-resolved large-eddy simulations to evaluate the impact of emissions spatial heterogeneity on CCN activity”. **S.G. Frederick\***, M. Mohebalhojeh, J. Curtis, M. West, N. Riemer. Departmental seminar, University of Illinois Urbana-Champaign Department of Climate, Meteorology, and Atmospheric Sciences. Dec 2023.
2. “Idealized particle-resolved large-eddy simulations to evaluate the impact of emissions spatial heterogeneity on CCN activity”. **S.G. Frederick\***, M. Mohebalhojeh, J. Curtis, M. West, N. Riemer. International Aerosol Modeling Algorithms Conference. Dec 2023.
3. “Communication of PM<sub>2.5</sub> 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](#).
4. “Application of EPA’s Recommended PM<sub>2.5</sub> 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](#).
5. “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](#).
6. “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<sub>2.5</sub> Implementation Workgroup. (Virtual, Aug 2020).
7. “Performance Evaluations of PM<sub>2.5</sub> 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).
8. “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).

9. “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).
10. “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).
11. “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)

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1. “Quantifying structural uncertainty in the aerosol modeling hierarchy: particle-resolved modeling on LES scales”. J. Curtis, **S. Frederick**, Z. D’Aquino, M. Mohebalhojeh, N. Riemer, M. West. Atmospheric Radiation Measurement Atmospheric System Research Principal Investigator meeting, Bethesda, MD, Aug 2023.
2. “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.
3. “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](#).
4. “Performance Evaluations of Six PM<sub>2.5</sub> 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](#).
5. “Impacts of Data Completeness on Hourly Averaged PurpleAir PM<sub>2.5</sub> 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](#).
6. “Performance Evaluations of Six PM<sub>2.5</sub> 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).
7. “PurpleAir PM<sub>2.5</sub> 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).
8. “Modeling Structural and Magnetic Field Stability in Magnetars”. **S. Frederick\***, K.L. Thompson, M.P. Kuchera. 233<sup>rd</sup> Meeting of the American Astronomical Society. (Seattle, WA, Jan 2019). [Bibcode link](#).
9. “HI Observations of Intermittent Pulsars”. **S. Frederick\***, K.L. Thompson. Davidson College Alenda Lux Research Symposium. (Davidson, NC, May 2018).
10. “Determining the Excitation Temperature of M57 via Spectral Analysis”. **S. Frederick\***. Quadrennial SPS Physics Congress. (San Francisco, CA, Nov 2016)

## SKILLS

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**Software Proficiency:** Python (NumPy, Matplotlib, pandas), Fortran, C++, Bash, Git,  $\LaTeX$ , VisIt, Microsoft Office

**Language:** Goethe-Zertifikat B1 for German

## LEADERSHIP AND OUTREACH

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### **Treasurer**

*September 2023 - Present*

*University of Illinois, Department of Atmospheric Sciences Student Organization*

- Manage graduate student organization finances including coordinating dues, issuing reimbursements, and maintaining banking ledger
- Assist in planning and coordinating social events

### **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*