Eliot Kim

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EDUCATION

University of Washington **Sep. 2024 – Present**
Ph.D., Atmospheric and Climate Science *Seattle, WA*

University of Wisconsin-Madison **Sep. 2019 – May 2023**
B.S., Computer Science; B.S., Statistics; B.S., Mathematics *Madison, WI*

RESEARCH INTERESTS

My main research interest is developing explainable and physically-consistent machine learning for modeling Earth system processes.

RESEARCH EXPERIENCES

Graduate Research Assistant **September 2024 — Present**
Advisor: Prof. Alexander Turner *University of Washington*

- Developing machine learning methods to improve representations of methane in chemistry-climate models.

Research Assistant **September 2023 — Present**
Advisors: Drs. Christoph Keller, Julie Nicely *Global Modeling and Assimilation Office, NASA GSFC*

- Developing machine learning methods to emulate the GEOS-Chem chemical mechanism and optimize satellite data assimilation.
- Using a GEOS-Chem box model to generate data and investigate chemical relationships.
- Investigating the ability of machine learning models to capture physical relationships, such as the Leighton Relationship.

Research Assistant **May 2020 – August 2023**
Advisor: Prof. Tracey Holloway *University of Wisconsin-Madison*

- Investigated the ability of satellite NO_2 data supplemented with location-specific information to estimate the concentration and distribution of NO_2 at the surface.
- Developed machine learning models to classify intensity of emissions plumes over large Texas coal and natural gas power plants using satellite images.
- Updated publicly available WHIPS (Wisconsin Horizontal Interpolation for Satellites) Python package to re-grid several satellite air pollutant products onto custom grids. Enables comparison between satellite and model simulated data.
- Analyzed satellite, model, and emissions inventory NOx and SOx data over Texas power plants to characterize ability of satellites to capture point source pollution.

Research Intern **May 2022 – February 2023**
Advisors: Drs. David John Gagne and John Schreck *National Center for Atmospheric Research*

- Interned in Analytics and Integrative Machine Learning group mentored by Drs. John Schreck and David John Gagne.
- Implemented neural networks with evidential loss functions to predict precipitation type and amount of evidence for each prediction. Analyzed atmospheric sounding inputs from the Rapid Refresh model.
- Used Explainable AI methods (SHAP, Permutation Importance) to analyze the physical consistency of neural network predictions and found physical structure in feature attributions.
- Implemented Active Learning to improve neural network training efficiency by training on the training examples with greatest uncertainty.
- Achieved three-fold accuracy improvement for freezing rain prediction on 20% of the full dataset.

Research Intern **June 2021– September 2021**
Advisor: Prof. Jianwu Wang *NSF Big Data REU, University of Maryland, Baltimore County*

- Harnessed deep learning methods (CNN, ConvLSTM) to predict spatiotemporal Arctic sea ice trends based on ERA5 data. Deployed and optimized models using slurm, Horovod, and Apache Spark.
- Developed multi-task deep learning models and custom loss functions and achieved accuracy improvements over prior literature.

Research Assistant **June 2019 – August 2019**
Advisor: Prof. Gabriel Chan *Humphrey School, University of Minnesota, Twin Cities*

- Analyzed interviews of environmental advocates, policy makers, and energy industry experts to guide policy recommendations for community shared solar energy.
- Learned about complex political, social, and economic factors involved in implementing clean energy solutions.

Research Assistant **June 2018 – August 2018**

Advisor: Prof. Jiarong Hong *University of Minnesota, Twin Cities*

- Designed and constructed vortex ring-generating device to test digital holographic imaging techniques.
- Learned about Arduino, 3D design, 3D printing, laser cutting, and engineering processes.

PUBLICATIONS

* = equal contribution

1. **Eliot Kim**; Ajinkya Kokandakar; Tracey Holloway; Steph Elkins; Monica Harkey; Daniel Goldberg; Colleen Heck (2024). A Comparison of Regression Methods for Inferring Near-Surface NO_2 with Satellite Data. *Journal of Geophysical Research: Atmospheres.* 129. 10.1029/2024JD040906
   - Conducted data processing, experimental design, data analysis, evaluation, and visualization.
   - Led manuscript writing and submission

2. Mitch Bushuk et al. [61 co-authors] (2024). Predicting September Arctic Sea Ice: A Multi-Model Seasonal Skill Comparison. *Bulletin of the American Meteorological Society.*
   - Provided sea ice concentration and sea ice extent predictions from our best-performing deep learning model.

3. John Schreck; David John Gagne; Charlie Becker; William Chapman; Kim Elmore; Da Fan; Gabrielle Gantos; **Eliot Kim**; Dhamma Kimpara; Thomas Martin; Maria Molina; Vanessa Przybylo; Jacob Radford; Belen Saavedra; Justin Willson; Christopher Wirz (Under Review). Evidential Deep Learning: Enhancing Predictive Uncertainty Estimation for Earth System Science Applications. *Artificial Intelligence for the Earth Systems.* https://arxiv.org/pdf/2309.13207.pdf.
   - Contributed to model tuning, explainability analyses, visualization scripts, and active learning experiments.

4. ***Eliot Kim**; *Peter Kruse; Skylar Lama; Jamal Bourne; Michael Hu; Sahara Ali; Yiyi Huang; Jianwu Wang (2021). Multi-Task Spatiotemporal Deep Learning Based Arctic Sea Ice Prediction. *2021 IEEE International Conference on Big Data (Big Data).* 1847. 10.1109/BigData52589.2021.9671491.
   - Conducted exploratory data analysis, data processing, model training, and visualization.
   - Led manuscript writing and submission.

5. Monica Harkey; Tracey Holloway; **Eliot Kim**; Kirk Baker; Barron Henderson (2020). Satellite Formaldehyde to Support Model Evaluation. *Journal of Geophysical Research: Atmospheres.* 126. 10.1029/2020JD032881.
   - Added compatability with TROPOMI and QA4ECV data to WHIPS, a Python package for re-gridding satellite data onto user-defined grids.

PRESENTATIONS

1. Machine Learning-Based Adjoint Emulation for Chemical Data Assimilation in the NASA GEOS Modeling System. Poster. *American Geophysical Union Annual Meeting 2024*, Washington, D.C., Dec 2024.

2. Machine Learning-Based Adjoint Emulation for Chemical Data Assimilation in the NASA GEOS Modeling System. Oral Presentation. *Statistical Learning in Atmospheric Chemistry Group*, Virtual, Sep 2024.

3. Machine Learning-Based Operator for Chemical Data Assimilation in the NASA GEOS Modeling System. Oral Presentation. *NASA-UIUC Machine Learning Applications for Air Quality Workshop*, Virtual, Feb 2024.

4. First Steps Toward Implementing a Machine Learning-Based Operator for Chemical Data Assimilation in the NASA GEOS Modeling System. Oral Presentation. *American Geophysical Union Annual Meeting 2023*, San Francisco, California, Dec 2023.

5. Explainable and Efficient Neural Networks for Predicting Winter Weather Precipitation Type. Poster. *American Meteorological Society 103rd Annual Meeting*, Denver, Colorado, Jan 2023.

AWARDS

College of Environment Endowed Scholarship **September 2024**

University of Washington

- Awarded top-off funding as one of the top applicants to the College of Environment graduate programs for Fall 2024.

Hilldale Research Fellowship **August 2022**

University of Wisconsin-Madison

- Awarded research and travel funding for project to study agreement between TROPOMI satellite data and surface-level NO_2 pollution.

IEEE BigData 2021 Student Travel Award **December 2021**

University of Maryland, Baltimore County

- Support for attending and presenting at the 2021 IEEE International Conference on Big Data.

Welton Summer Sophomore Apprenticeship **May 2020**

University of Wisconsin-Madison

- Awarded for project to compare Aerosol Optical Depth from satellite observations and air quality models.

Lockheed Martin Scholarship **June 2018**

University of Wisconsin-Madison

- Awarded for 1st place in Hovercraft event at 2018 Science Olympiad National Tournament.

RESEARCH COMPETITIONS

ProjectX **September 2020 – January 2021; September 2021 – January 2022**

- International machine learning research competition for undergraduates organized annually by University of Toronto AI Club. Co-led a team of five other UW-Madison students, Dr. Steven Schrodi, and Dr. Mark Keller.
- **2021**: Trained artificial neural networks to predict glucose levels in mice based on gene expression data across five tissues. Conducted feature importance analysis to determine the metabolic pathways associated with glucose levels.
- **2020**: Implemented machine learning models (Random Forests, ANN, Convolutional LSTM) to predict spread of wildfire air pollutants in Northern California based on atmospheric and meteorological variables.

LEADERSHIP AND EXTRACURRICULARS

Undergraduate Statistics Club **Spring 2020 – Fall 2022**

Vice President and President *University of Wisconsin-Madison*

- Organized speaker events, student panels, workshops, and month-long data analysis competition.

Data Science Club **Spring 2020 – Fall 2022**

Board Member and Co-President *University of Wisconsin-Madison*

- Inaugurated a data science hackathon, organized student project opportunities, and hosted industry speakers and workshops.

RELEVANT COURSEWORK

Statistics

- Deep Learning; Machine Learning; Matrix Methods for Machine Learning; Time Series Analysis

Computer Science

- Operating Systems; Algorithms; Database Management; Data Structures

Advanced Mathematics

- Combinatorics; Real Analysis; Topology; Stochastic Processes; Probability Theory; Linear Optimization; Scientific Computing

Earth Science

- Air Quality Analysis; Atmospheric and Oceanic Dynamics; Atmospheric Motions

PROFESSIONAL MEMBERSHIPS

American Meteorological Society **2022 - Present**
American Geophysical Union **2022 - Present**

TOOLS AND SKILLS

Programming: Python, C, Java, JavaScript, R, Fortran, SQL, bash
Technologies/Frameworks: Git/GitHub, slurm, PBS, Apache Spark, Docker
Languages: English (native), Korean (fluent), Spanish (intermediate)
Other Activities: Piano (classical, jazz), Reading, Running