

ZILU MENG

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EDUCATION

Ph.D. Student in Climate and Atmospheric Sciences

University of Washington

2023 – Present

Advisor: Gregory J. Hakim and Eric J. Steig

GPA: 3.98/4.0

B.S. in Atmospheric Sciences with Honors

Nanjing University of Information Science and Technology (NUIST)

2019 – 2023

Advisor: Tim Li

GPA: 95/100 (Ranked 1st out of 50; Graduated with honors)

RESEARCH INTEREST

Extreme Weather, Data Assimilation, Machine learning, Climate dynamics, El Niño and Southern Oscillation, Paleoclimate Reconstruction,

RECENT EXPERIENCE

Can Deep-learning-based General Circulation Model Simulate the Out-of-sample climate? June.2024–Now

Supervisor: Prof. Gregory J. Hakim (University of Washington)

Seattle, WA

- Executing Neural-GCM, ACE2-ERA5, and DLESyM (deep learning-based general circulation model) under historical forcing (SST and sea ice) from 1890 to 2020 to evaluate their climate performance.
- Out-of-sample tests demonstrate that all three models can reliably simulate climate features beyond the training period, including the ENSO response and atmospheric blocking.

Coupled Seasonal Data Assimilation of Sea Ice, Ocean, and Atmospheric Dynamics over the Last Millennium Dec.2023–Now

Supervisor: Prof. Gregory J. Hakim & Prof. Eric J. Steig (University of Washington)

Seattle, WA

- Developed an “Online” data assimilation (DA) method that integrates forecasts from a coupled ocean-atmosphere-sea-ice model with climate proxy records to create a seasonal-resolution reanalysis dataset of the last millennium.
- Enhanced accuracy and efficiency by implementing a novel season-to-season updating strategy, achieving high correlations with surface temperature reconstructions as well as key oceanic and sea-ice variables.
- Validated the method’s robustness through direct proxy verification, effectively capturing the seasonal evolution of El Niño events and major climate phases such as the Medieval Climate Anomaly and the Little Ice Age.

Reconstructing the Tropical Pacific Upper Ocean using Online Data Assimilation with a Deep Learning model Dec.2023–Dec.2024

Supervisor: Prof. Gregory J. Hakim (University of Washington)

Seattle, WA

- Developed a transformer-based deep learning model that outperformed traditional linear inverse models in forecasting accuracy for the tropical Pacific.
- Employed data assimilation on a sparse observation network to accurately reconstruct monthly upper-ocean spatial fields over timescales ranging from one month to one year.
- Demonstrated that the model’s superior reconstruction skill is driven by its enhanced predictive capabilities.

Prediction of Climate Variability in the Tropical Pacific using ConvLSTM Jul.2021–Dec.2022

Supervisor: Prof. Fei Zheng (Institute of Atmospheric Physics, Chinese Academy of Sciences)

Beijing, China

- Applied ConvLSTM to forecast climate variability in the tropical Pacific Ocean.
- Developed a neural network forecasting system capable of predicting ENSO events up to 18 months in advance.

- Investigated the sources of bias in ConvLSTM predictions.
- Utilized the Grad-CAM method to analyze the attribution patterns associated with El Niño and La Niña events.

SOFTWARE PROJECTS

- **CFR**: Contributed to the development of CFR, a universal framework for climate field reconstruction. ([Try it here](#))
- **Sacpy**: Developed Sacpy, an efficient and user-friendly Python module for statistical analysis of climate data. It has been adopted by over 20,000 users, earned 60 GitHub stars, and achieved more than 100K downloads. ([Try it here](#))
- **Deep Learning for ENSO**: Created a project that leverages deep learning and Grad-CAM to investigate the mechanisms behind El Niño and La Niña events. The associated Zhihu article has reached over 100,000 readers, and the GitHub repository has received 48 stars. ([Try it here](#)) ([Read on Zhihu](#))
- **Prof. John M. Wallace's Website**: Collaborated with Prof. John M. Wallace to design and build his personal website. ([Try it here](#))

PUBLICATIONS

- **Meng, Z.**, & Polvani M. L. (2025). Reassessing Eurasian Winter Warming Due to Major Volcanic Eruptions using Coupled Seasonal Data Assimilation over the Last Millennium. *npj Climate and Atmospheric Science* (in prep)
- **Meng, Z.**, Hakim, G. J., & Steig, E. J. (2025). Coupled Seasonal Data Assimilation of Sea Ice, Ocean, and Atmospheric Dynamics over the Last Millennium. *Journal of Climate* (under review). <https://arxiv.org/abs/2501.14130>
- **Meng, Z.**, & Hakim, G. J. (2024). Reconstructing the Tropical Pacific Upper Ocean using Online Data Assimilation with a Deep Learning Model. *Journal of Advances in Modeling Earth Systems*, 16, e2024MS004422. <https://doi.org/10.1029/2024MS004422>
- **Meng, Z.**, & Li, T. (2024). Why is the Pacific meridional mode most pronounced in boreal spring? *Climate Dynamics*, 62(1), 459–471. <https://doi.org/10.1007/s00382-023-06914-4>
- Zhu, F., Emile-Geay, J., Anchukaitis, K. J., McKay, N. P., Stevenson, S., & **Meng, Z.** (2023). A pseudoproxy emulation of the PAGES 2k database using a hierarchy of proxy system models. *Sci Data*, 10, 624. <https://doi.org/10.1038/s41597-023-02489-1>
- **Meng, Z.**, Hu, Z., Ai, Z., Zhang, Y., & Shan, K. (2021). Research on Planar Double Compound Pendulum Based on RK-8 Algorithm. *Journal on Big Data*, 3, 11–20. <https://doi.org/10.32604/jbd.2021.015208>

GRANTS

- Undergraduate Scientific Research Fund, Chinese Academy of Sciences, 2021/06-2023/06 (10,000 CNY, Leader)
- Undergraduate Innovation Fund, NUIST, 2020/04-2021/04 (10,000 CNY, Leading Member)

AWARDS AND SCHOLARSHIPS

- **Robert Fleagle Endowed Graduate Support Fellowship** University of Washington, 2023
- **National Scholarship** Ministry of Education, 2021 (Top 0.2%)
- **Presidential Scholarship** NUIST, 2021 (Top 0.3%)
- **Pacemaker to Merit Student** NUIST, 2020, 2021, 2022 (Top 1%)
- **First Prize, National College Students' Higher Mathematics Competition** Chinese Mathematics Association, 2021 (Top 5%)
- **First Class Scholarship** NUIST, 2020, 2021, 2022 (Top 15%)

CONFERENCE PRESENTATION

- AGU Fall Meeting, Washington, D.C., USA, 2024 Dec. Oral Presentation. Title: "Reconstructing the Tropical Pacific Upper Ocean using Online Data Assimilation with a Deep Learning model".
- Graduate Climate Conference, Seattle, WA, USA, 2024 Oct. Title: "Last Millennium Seasonal Reanalysis".
- Nanjing Data Assimilation Workshop, Nanjing, China, 2024 June. Title: "Deep Learning for tropical pacific reconstruction".
- GCC Meeting 2024, Seattle, WA, USA, 2024 May. Title: "Deep Learning for Data Assimilation".
- AGU Fall Meeting, San Francisco, CA, USA, 2023 Dec. Title: "Sacpy: Python Package for Statistical Analysis of Climate".

LEADERSHIP AND SERVICE

Teaching Assistant, University of Washington Dec. 2024 – May. 2025

- Served as a Teaching Assistant for ATMS504 Atmospheric Motions II.
- Delivered laboratory experiment lectures.
- Graded homework assignments, prepared Python code examples, and provided academic guidance.

Class Leader, 2019 Elite Class of Atmospheric Science, NUIST Sep. 2019 – Jun. 2022

- Managed daily class operations and logistics.
- Led the class to earn the "Excellent Class" recognition at NUIST in 2021.

Teaching Assistant, NUIST Sep. 2020 – Jun. 2021

- Assisted in teaching Advanced Mathematics and grading assignments.
- Provided academic support and guidance to students.

PEER REVIEW SERVICE

Earth System Science Data	Atmosphere	Radio Science
Climate Dynamics	Frontiers in Earth Science	Plos One
JGR Machine Learning and Computation		

SKILLS

Programming Skills	Python, Fortran, Matlab, Linux Shell
Climate Models	CESM, ECHAM, Cane-Zebiak Model
Machine Learning	TensorFlow, Pytorch, Scikit-learn
Data Assimilation	Ensemble Kalman Filter, 3D-Var, 4D-Var