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### Digital reputation

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ResearchGate: Research Interest Score: 81.4 | Citations: 73 | h-index: 5

Google Scholar: 14 documents | Citations: 56 | h-index: 5

### Researcher profile

I am a polar climate scientist interested in sea ice prediction and change. Sea ice is the thin layer of frozen ocean that exists at the high latitudes. It affects regional and global climate, provides a natural habitat for endemic species, and also a platform for connecting Arctic communities. The ability to predict sea ice on timescales ranging from days to decades is therefore important for both society and the environment. I use a variety of methods to study sea ice and the polar climate system, including machine learning, data assimilation, and numerical modelling. I therefore work with large-scale observations in the form of satellite data, and also numerical climate models. Some of my past work has used machine learning to perform seasonal forecasting of Arctic sea ice, and optimal interpolation of sea ice altimetry data sets. My current work focuses on how observational data can be used to understand climate model errors through data assimilation and machine learning. Both as a framework for improving prediction capabilities and reducing uncertainty in future climate change projections. I am passionate about open science and strive to make all my data and code openly available. See my GitHub (<https://github.com/William-gregory>) for code on topics ranging from data assimilation, to principal component analysis, complex networks, and other machine learning topics.

### Education

- 28/12/2021 **PhD in Climate Science** – Department of Earth Sciences, University College London, United Kingdom. Thesis title: *Machine learning tools for pattern recognition in polar climate science*. Supervisors: Michel Tsamados, Julianne Stroeve.
- 15/09/2014 **MSc in Petroleum Geophysics** – Department of Earth Science and Engineering, Imperial College London, United Kingdom. Thesis title: *Finite Difference modelling to understand the nature of wave propagation at salt-sediment interfaces*. Supervisor: Jenny Collier. *Distinction*.
- 15/06/2013 **BSc in Geology with Geophysics** – Department of Geology, University of Leicester, United Kingdom. *1<sup>st</sup> class honours*.

### Current position

19/01/2022 – present **Postdoctoral Research Associate** – Princeton University, Princeton, United States of America. P.I: Mitchell Bushuk.

### Peer-reviewed publications

- **Gregory, W.**, MacEachern, R., Takao, S., Lawrence, I.R., Nab, C., Deisenroth, M., Tsamados, M. 2024. Scalable interpolation of satellite altimetry data with probabilistic machine learning. *Nature Communications*. 15, 7453.
- Bushuk, M., ..., **Gregory, W.**, et al. 2024. Predicting September Arctic sea ice: a multi-model seasonal skill comparison, *Bulletin of the American Meteorological Society*. 105, E1170-E1203.
- **Gregory, W.**, Bushuk, M., Zhang, Y., Adcroft, A., Zanna, L. 2024. Machine learning for online sea ice bias correction in global ice-ocean simulations. *Geophysical Research Letters*. 51, e2023GL106776.
- Zhang, Y., Bushuk, M., Winton, M., Hurlin, W., **Gregory, W.**, Landy, J.C., Jia, L. 2023. Improvements in September Arctic sea ice predictions via assimilation of summer CryoSat-2 sea ice thickness observations. *Geophysical Research Letters*. 50, e2023GL105672.

- **Gregory, W.**, Bushuk, M., Adcroft, A., Zhang, Y., Zanna, L. 2023. Deep learning of systematic sea ice model errors from data assimilation increments. *Journal of Advances in Modeling Earth Systems*. 15, e2023MS003757.
- Nab, C., Mallett, R., **Gregory, W.**, Landy, J.C., Lawrence, I.R., Willatt, R., Stroeve, J., Tsamados, M. 2023. Synoptic variability in satellite altimeter-derived radar freeboard of Arctic sea ice. *Geophysical Research Letters*. 50, e2022GL100696.
- **Gregory, W.**, Stroeve, J., Tsamados, M. 2022. Network connectivity between the winter Arctic Oscillation and summer sea ice in CMIP6 models and observations. *The Cryosphere*. 16, 1653-1673.
- **Gregory, W.**, Lawrence, I.R., Tsamados, M. 2021. A Bayesian approach towards daily pan-Arctic sea ice freeboard estimates from combined CryoSat-2 and Sentinel-3 satellite observations. *The Cryosphere*. 15, 2857-287.
- **Gregory, W.**, Tsamados, M., Stroeve, J., Sollich P. 2020. Regional September sea ice forecasting with complex networks and Gaussian processes. *Weather and Forecasting*. 35(3), pp.793-806.

### Manuscripts under review

Balwada, D., ..., **Gregory, W.**, et al. 2023. Learning machine learning with Lorenz-96. Submitted to *Journal of Open Source Education*.

### Presentations in conferences

- **Gregory, W.**, Bushuk, M., Zhang, Y., Adcroft, A., Zanna, L. Towards improving numerical sea ice predictions with data assimilation and machine learning. Cross-VESRI Convening 2024, Cambridge UK, 7–10 Jul 2024. *Oral*
- **Gregory, W.**, Bushuk, M., Zhang, Y., Adcroft, A., Zanna, L. Towards improving numerical sea ice predictions with data assimilation and machine learning. EGU General Assembly 2024, Vienna Austria, 14–19 Apr 2024, EGU24-11288. *Oral*
- **Gregory, W.**, Bushuk, M., Zhang, Y., Adcroft, A., Zanna, L. Machine learning for online sea ice bias correction within global ice-ocean simulations. AGU Ocean Sciences Meeting 2024, New Orleans USA, 19–23 Feb 2024. *Oral*
- Zanna, L., Sane, A., Zhang, C., Balwada, D., Perezhogin, P., **Gregory, W.**, Busecke, J., Adcroft, A., Reichl, B., Bushuk, M., Lu, F., Abernathey, R., Shao, A., Fernandez-Granda, C. The New Generation of Global Climate Models Enhanced by Machine Learning. AGU Fall Meeting 2023, San Francisco USA, 11-15 Dec 2023. GC21A-05. *Oral*
- MacEachern, R., Tsamados, M., **Gregory, W.**, Lawrence, I.R., Takao, S. Fast interpolation of satellite altimetry data with probabilistic machine learning and GPU. EGU General Assembly 2023, Vienna Austria, 23–28 Apr 2023, EGU23-17323. *Oral*
- **Gregory, W.**, Bushuk, M., Adcroft, A., Zhang, Y., Zanna, L. Deep learning of systematic sea ice model errors from data assimilation increments. EGU General Assembly 2023, Vienna Austria, 23–28 Apr 2023, EGU23-10351. *Oral*
- **Gregory, W.**, Bushuk, M., Adcroft, A., Zhang, Y., Zanna, L. Using deep learning to predict systematic model error from sea ice data assimilation increments in a fully coupled climate model. AGU Fall Meeting 2022, Chicago USA, 12–16 Dec 2022. C52C-0383. *Poster*
- Bushuk, M., ..., **Gregory, W.**, et al. A multi-model comparison of September Arctic sea ice seasonal prediction skill. AGU Fall Meeting 2022, Chicago USA, 12–16 Dec 2022. GC52B-02. *Oral*
- **Gregory, W.**, Lawrence, I.R., Tsamados, M. A Bayesian approach towards daily pan-Arctic sea ice freeboard estimates from combined CryoSat-2 and Sentinel-3 satellite observations. EGU General Assembly 2021, Vienna Austria, 19–30 Apr 2021, EGU21-11462. *Oral*
- **Gregory, W.**, Tsamados, M., Stroeve, J., Sollich, P. Random Walks through Climate Networks: Sea Ice Prediction with Bayesian Inference. EGU General Assembly 2021, Vienna Austria, 4–8 May 2020, EGU20-20595. *Poster*

### Invited presentations for seminars

- 24/06/2024 – “From component to coupled: evaluating the performance of a machine-learned sea ice bias correction scheme in fully-coupled seasonal predictions.” Nansen SuperIce Webinar. *Virtual*
- 14/06/2024 – “Towards improving numerical sea ice predictions with data assimilation and machine learning.” NOAA Arctic All Hands Meeting. *Virtual*

- 01/05/2024 – “Applications of machine learning to sea ice data assimilation.” 10<sup>th</sup> US Climate Modeling Summit. NOAA Geophysical Fluid Dynamics Laboratory, Princeton USA.
- 12/04/2024 – “Towards a machine-learned sea ice model parameterization from data assimilation increments.” Euro-Mediterranean Center on Climate Change (CMCC), Bologna Italy.
- 09/11/2022 – “Deep learning of systematic model biases from data assimilation increments.” New York University Courant Institute of Mathematical Sciences Guest Seminar Series, New York USA.
- 27/05/2022 – “Machine learning tools for pattern recognition in polar climate science.” EGU General Assembly 2022, Vienna Austria, EGU22-12785.
- 05/03/2020 – “Machine learning in climate science.” UK Government Digital Service, London UK.

### Scholarships and awards

- 25/09/2017 – Scholarship for the London Natural Environment Research Council (NERC) Doctoral Training Partnership (DTP), including £7000 research funds, £66,212 stipend, and £18,000 tuition.
- 09/2013 – Full MSc scholarship of £25,000 from British Petroleum.
- 15/06/2013 – Shell Geophysics Prize of £250 for highest achievement in BSc Geophysics program.
- 15/06/2012 – Departmental award of £50 for academic excellence in BSc Geophysics program.

### Teaching/Supervising experience

- 01/2022 – 09/2022. Co-supervised **MSc student project**, Department of Computer Science, University College London. Primary project supervisor: Prof. Marc Deisenroth.
- 01/2020 – 04/2020. Postgraduate teaching assistant in **Geodynamics**, Department of Earth Sciences, University College London. Course leader: Prof. Nicolas Brantut.
- 01/2020 – 04/2020. Postgraduate teaching assistant in **Ocean Physics**, Department of Earth Sciences, University College London. Course leader: Dr. Michel Tsamados.
- 11/2019. Postgraduate teaching assistant in **Principles of Climate**, Department of Earth Sciences, University College London. Course leader: Prof. Julianne Stroeve.
- 10/2018 – 12/2019. Postgraduate teaching assistant in **Foundations of Physical Geoscience**, Department of Earth Science, University College London. Course leader: Prof. Lidunka Vocablo.
- 10/2018 – 10/2020. Postgraduate teaching assistant in **Introduction to Matlab**, Department of Earth Sciences, University College London. Course leader: Danuta Kaminski.
- 01/10/2018 – 02/10/2018. Field assistant on London NERC Doctoral Training Partnership field course to Norfolk UK with the University College London Department of Earth Science.

### Professional experience

- 10/11/2014 – 28/07/2017. **Depth Imaging Geophysicist**. Petroleum Geo-Services Ltd. Line manager: Dr. Rachel Collings.
- 15/06/2012 – 15/09/2012. **Geotechnical field assistant**. Mineral Exploration Network, Finland.

### Training

- 10/07/2024 – 12/07/2024. Summer school for technical skills training. Institute of Computing for Climate Science (ICCS), Cambridge, UK.
- 11/01/2019 – Postgraduate Teaching Assistant training. University College London Arena One Gateway.
- 09/2017 – 12/2017. Statistics in environmental science. London NERC DTP skills training. Course lead: Prof. Richard Chandler.

### Participation in Projects

- 19/01/2022 – present. Postdoctoral Research Associate on **Multi-scale Machine Learning In** coupled Earth System modeling (M<sup>2</sup>LInES) project. Funded by Schmidt Sciences. PI: Prof. Laure Zanna.

### Mobility

- 19/01/2022 – present **Postdoctoral Research Associate** – Princeton University, Princeton, United States of America. P.I: Mitchell Bushuk.
- 15/06/2012 – 15/09/2012. **Geotechnical field assistant**. Mineral Exploration Network, Finland.

## Services

- AGU Fall Meeting 2024 co-convener/chair for session: “*NG011-II. Data Driven Science: Developments in Machine Learning Subgrid-Scale Parameterizations and in Reanalyses across Earth System Modeling*”
- Reviewer for international journals: The Cryosphere, Journal of Advances in Modeling Earth Systems, American Meteorological Society (AMS) Journal of Climate, Climate Dynamics, Quarterly Journal of the Royal Meteorological Society, AMS AI for Earth Systems.
- Reviewer for National Science Foundation (NSF) proposal in Arctic Natural Sciences program
- European Geosciences Union member
- American Geophysical Union member

## Skills

- Sea ice models: Sea Ice Simulator version 2 (SIS2)
- Ocean models: Modular Ocean Model (MOM6)
- Coupled climate models: Seamless system for Prediction and EArth system Research (SPEAR)
- Statistical techniques: Gaussian processes, neural networks, principal component analysis, relevance vector machines, complex networks, data assimilation
- Programming languages: Python, Matlab, Fortran
- Software: Data Assimilation Research Testbed (DART)
- Machine learning libraries: PyTorch, Tensorflow
- Field skills: geological field mapping and deployment of geophysical instruments

## Collaborators

Dr. Mitchell Bushuk (NOAA GFDL), Dr. Yong-Fei Zhang (Princeton University), Dr. Alistair Adcroft (Princeton University), Prof. Laure Zanna (New York University), Dr. Michael Winton (NOAA GFDL), William Hurlin (NOAA GFDL), Dr. Liwei Jia (NOAA GFDL), Dr. Michel Tsamados (University College London), Prof. Julianne Stroeve (University of Manitoba), Dr. Isobel Lawrence (European Space Agency), Dr. So Takao (California Institute of Technology), Prof. Marc Deisenroth (University College London), Dr. Jack Landy (Arctic University of Norway), PhDc Carmen Nab (University College London), Dr. Robbie Mallett (Arctic University of Norway), Dr. Rosemary Willatt (University of Northumbria), Dr. Alek Petty (University of Maryland).

## Outreach

- 12/12/2023. AI is transforming climate forecasts for melting sea ice. *Advanced Science News Article* (<https://www.advancedsciencenews.com/ai-is-transforming-climate-forecasts-for-melting-sea-ice/>)
- 11/2023 – 07/2024. Project development co-chair for the Climatedatch Academy outreach programme (<https://neuromatch.io/climate-science/>). Responsible for managing individuals developing material for student projects. *Virtual*.
- 11/2022 – 07/2023. Curriculum content reviewer for the Climatedatch Academy outreach programme. Responsible for reviewing all content relating to fundamentals of climate science. *Virtual*.
- 28/06/2022. Delivered a presentation on Equality, Diversity and Inclusion (EDI) progress within NOAA and GFDL. *GFDL, Princeton USA*.
- 05/12/2016. Delivered science outreach presentations to year 10 and 12 students. *King Solomon Academy school, London UK*.

## Languages

English (native), Spanish (basic)