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## Research Interests

Physical & Computational Oceanography, Machine Learning, Hybrid Climate Modeling, Scientific Software Development, Ocean-Based Carbon Dioxide Removal Research, Mesoscale Eddy Parameterizations, Uncertainty Quantification, Data Assimilation, Adjoint Modeling

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## Education

- 01/2015 - **University of Bergen**, Bergen, Norway
- 08/2019 **Ph.D. in Physical Oceanography**
  - Thesis: *Adjoint Modeling and Observing System Design in the Subpolar North Atlantic*
  - Advisors: Kerim H. Nisancioglu (University of Bergen), Patrick Heimbach (UT Austin)
- 04/2007 - **University of Bonn**, Bonn, Germany
- 02/2013 **Diploma** (equiv. M.Sc. degree) in **Mathematics, with Honors**
  - Specialization: Stochastic Analysis; Minor: Physics
  - Grade Point Average: 1.0, on a scale from 1.0 (excellent) to 4.0 (pass)

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## Research Experience

- 5/2024 - **Staff Scientist**, [\[C\]Worthy](#), Boulder, CO
- present
  - Run simulations with [Oceananigans](#) to investigate uncertainties in carbon dioxide removal strategies, including the impact of ocean circulation and atmospheric forcing on their effectiveness
  - Develop open-source Python package [ROMS-Tools](#) that creates input files for ROMS-MARBL simulations in a fast, reliable, and reproducible way
  - Leverage machine learning tools for the downscaling of ocean velocities to make ocean biogeochemical modeling computationally cheaper and more accurate
- 10/2022 - **Researcher**, *Program in Atmospheric and Oceanic Sciences*, Princeton University
- 4/2024
  - 10/2023 - 4/2024: Associate Research Scholar
  - 10/2022 - 9/2023: Postdoctoral Research Associate
  - Member of the [M2LInES project](#)
  - Worked on offline machine learning approaches for hybrid ocean modeling
  - Trained eddy momentum parameterizations in PyTorch using techniques like Feed Forward Neural Networks with physical constraints and Reinforcement Learning
  - Integrated the machine-learned parameterizations into the MOM6 model to assess their performance in ocean simulations
  - Mentors: Alistair Adcroft & Laure Zanna
- 10/2020 - **Postdoctoral Associate**, *Department of Applied Mathematics*, University of Colorado,
- 09/2022 Boulder
  - Member of the [Ocean Transport and Eddy Energy Climate Process Team](#)
  - Explored eddy energy cycles and parameterizations in isopycnal ocean models
  - Studied how mesoscale eddy parameterizations interact with the ocean model's vertical coordinate system, revealing the consistency between theory and numerical implementations
  - Implemented new [eddy parameterization](#) and [diagnostics](#) into MOM6
  - Developed open-source Python package [GCM-Filters](#) for spatial filtering of gridded geophysical data
  - Mentor: Ian Grooms
- 09/2019 - **Postdoctoral Fellow**, *Oden Institute for Computational Engineering and Sciences*, University of Texas at Austin
- 09/2020
  - Leveraged adjoint modeling and uncertainty quantification for ocean observing system design
  - Mentor: Patrick Heimbach

- 1/2015 - **Graduate Researcher**, *Department of Earth Science*, University of Bergen, Norway
- 06/2018
  - Investigated oceanic teleconnections in the North Atlantic, Nordic Seas, and Arctic Ocean
  - Quantified uncertainties in ocean state estimates for present-day and paleo climates
- 03/2013 - **Doctoral Research Fellow**, *Department of Mathematics*, ETH Zurich, Switzerland
- 08/2014
  - Conducted research in the fields of Geometric Analysis and Partial Differential Equations
  - Assisted in teaching undergraduate and graduate level courses

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## Teaching and Outreach

- 02/2020 **Volunteer**, *Girl Day STEM Festival*, UT Austin
  - Hands-on science activities and demonstrations for elementary and middle school students
- 2008 - 2014 **Teaching Assistant**
  - for 3 graduate level math courses at ETH Zurich, Switzerland (2013 - 2014) with *teaching evaluations*: 4.8 (2013), 4.9 (2014) on a scale from 1 (very bad) to 5 (excellent)
  - for 4 undergraduate level math courses at University of Bonn, Germany (2008 - 2013) and University of Toronto, Canada (2010)

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## Funded Grants

- 08/2021- **NSF CSSI Grant**, *National Science Foundation*, \$166,590
- 07/2025
  - **Project**: Collaborative Research: Frameworks: Convergence of Bayesian inverse methods and scientific machine learning in Earth system models through universal differentiable programming
  - Role: Principal Investigator (Lead PI: Patrick Heimbach, UT Austin)

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## Awards and Scholarships

- 2022 **Outstanding Reviewer Award**, *for the Journal of Advances in Modeling Earth Systems (JAMES)*, American Geophysical Union (AGU)
- 04/2019 **Rising Stars in Computational & Data Sciences**, *Oden Institute for Computational Engineering and Sciences*, University of Texas at Austin
  - Selected for competitive, international career event for women in Computational & Data Sciences
- 03/2018 **Best Presentation Award**, *Research School on Changing Climates in the Coupled Earth System*, Sommarøy, Norway
- 02/2013 **Award "Diploma with Honors"**, *Department of Mathematics*, University of Bonn, Germany, for graduating with highest possible grade point average
- 2008 - 2012 **German Academic Scholarship Foundation Award**, *Studienstiftung des deutschen Volkes*, for outstanding academic achievements (given to top 0.5% of students in Germany)

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## Mentoring

- 2022 - **PhD Co-Advisor**
  - present for graduate student Sarah Williamson at UT Austin
- February **Open Hackathons Mentor**
  - 2025 for a project that uses the Julia-based ocean model [Oceananigans](#)
- 2021 - 2022 **Mentor**
  - for a coding project as part of [OceanHackWeek 2022](#)
  - for 4 students as part of the [SOARS](#) program, the [PROGRESS](#) mentorship program, and the [ASLOMP](#) mentorship program

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## Professional Service

Peer review service

Geophysical Research Letters, Journal of Advances in Modeling Earth Systems, Journal of Climate, Journal of Physical Oceanography, Journal of Open Source Software

Review of proposals

Panelist for reviewing NASA ROSES proposals

Organization of Conferences

02/2024 Co-Convener for the session “Advances in Data Science for Ocean Uncertainty Quantification”, Ocean Sciences Meeting 2024.

08/2022 Co-Organizer of [OceanHackWeek 2022](#).

02/2022 Co-Convener for the session “Mesoscale Eddy Energy and Ocean Transport”, Ocean Sciences Meeting 2022.

Membership of Scientific Projects and Societies

09/2022 - NEMO working group on machine learning and model uncertainty  
present

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## Publications

Journal Articles

- J10 D. Balwada, ..., **N. Loose**, ..., L. Zanna. Learning Machine Learning with Lorenz-96, *Journal of Open Source Education*, 7(82), 241, doi: [10.21105/jose.00241](#).
- J9 S. Yu, ..., **N. Loose**, ..., M.S. Pritchard. ClimSim: A Large Multi-Scale Dataset for Hybrid Physics-ML Climate Emulation, *Advances in Neural Information Processing Systems*, vol. 36, Dec. 2023, pp. 22070–84, URL. Won award for [Outstanding Datasets and Benchmarks Papers](#).
- J8 **N. Loose**, G.M. Marques, A. Adcroft, S. Bachman, S.M. Griffies, I. Grooms, R.W. Hallberg and M. Jansen. Comparing two parameterizations for the restratification effect of mesoscale eddies in an isopycnal ocean model, *Journal of Advances in Modeling Earth Systems*, doi: [10.1029/2022MS003518](#).
- J7 **N. Loose**, S. Bachman, I. Grooms and M. Jansen. Diagnosing scale-dependent energy cycles in a high-resolution isopycnal ocean model, *Journal of Physical Oceanography*, doi: [10.1175/JPO-D-22-0083.1](#).
- J6 G. Marques, **N. Loose**, E. Yankovsky, J. Steinberg, C-Y Chang, N. Bhamidipati, A. Adcroft, B. Fox-Kemper, S. Griffies, R. Hallberg, M. Jansen, H. Khatri and L. Zanna. NeverWorld2: An idealized model hierarchy to investigate ocean mesoscale eddies across resolutions, *Geoscientific Model Development* 15, no. 17: 6567-79, doi: [10.5194/gmd-15-6567-2022](#).
- J5 **N. Loose**, R. Abernathey, I. Grooms, J. Busecke, A.P. Guillaumin, E. Yankovsky, G. Marques, J.M. Steinberg, A.S. Ross, H. Khatri, S.D. Bachman, L. Zanna, P. Martin. GCM-Filters: A Python Package for Diffusion-based Spatial Filtering of Gridded Data, *Journal of Open Source Software*, 7(70), 3947, 2022. doi: [10.21105/joss.03947](#).
- J4 I. Grooms, **N. Loose**, R. Abernathey, J.M. Steinberg, S.D. Bachman, G. Marques, A.P. Guillaumin, E. Yankovsky. Diffusion-Based Smoothers for Spatial Filtering of Gridded Geophysical Data, *Journal of Advances in Modeling Earth Systems*, 13, e2021MS002552, 2021. doi: [10.1029/2021MS002552](#).
- J3 **N. Loose** and P. Heimbach. Leveraging Uncertainty Quantification to Design Ocean Climate Observing Systems, *Journal of Advances in Modeling Earth Systems*, 13, e2020MS002386, 2021. doi: [10.1029/2020MS002386](#).

- J2 **N. Loose**, P. Heimbach, H. Pillar and K.H. Nisancioglu. Quantifying Dynamical Proxy Potential through Shared Adjustment Physics in the North Atlantic, *Journal of Geophysical Research: Oceans* 125, no. 9, 2020. doi: [10.1029/2020JC016112](https://doi.org/10.1029/2020JC016112). Selected as [Eos Research Spotlight](#).
- J1 Y. Fujii, ..., **N. Loose**, ..., N. Usui. Observing System Evaluation Based on Ocean Data Assimilation and Prediction Systems: On-Going Challenges and a Future Vision for Designing and Supporting Ocean Observational Networks, *Front. Mar. Sci.* 6:417, 2019. doi: [10.3389/fmars.2019.00417](https://doi.org/10.3389/fmars.2019.00417).

#### Thesis

- T1 **N. Loose**. Adjoint Modeling and Observing System Design in the Subpolar North Atlantic, *Ph.D. Dissertation*, University of Bergen, 2019. <http://bora.uib.no/handle/1956/24456>.

## Selected presentations

### 5 Selected Talks

- 04/2022 **Ocean Sciences Meeting 2022, Online**  
Diagnosing scale-dependent Lorenz and Bleck energy cycles in a high-resolution layered model
- 01/2022 **12th Symposium on Advances in Modeling and Analysis Using Python, AMS Meeting, Online**  
GCM-Filters: A Python Package for Spatial Filtering Analysis of Gridded Data from Ocean and Climate Models ([slides](#))
- 01/2022 **20th DRAKKAR Ocean Modelling Workshop (Invited Keynote Talk), Online**  
Leveraging Uncertainty Quantification to Design Ocean Climate Observing Systems
- 12/2021 **Ocean Circulation and Climate Dynamics Colloquium, GEOMAR Kiel, Online**  
Oceanic teleconnections in the North Atlantic: From dynamical proxy potential to observing system design
- 07/2018 **Workshop on Sensitivity Analysis and Data Assimilation in Meteorology and Oceanography, Aveiro, Portugal**  
Uncertainty Quantification as a Tool for Observing System Design - An Oceanographic Perspective

## Field Work

- 07/2017 - **East Greenland Ice-Core Project (EastGRIP), Greenland**  
08/2017 ○ Drilled shallow ice cores, conducted surface measurements and lab work in the science trench
- 08/2016 - **G.O. Sars, Irminger Sea**  
09/2016 ○ Collected physical oceanographic data and marine sediment cores for the [ice2ice](#) project (ERC)

## Technical Strengths

- **Computer Languages:** Python (xarray, dask, numpy, scipy, PyTorch), Julia, FORTRAN, MATLAB, shell scripting
- **MLOps:** Weights & Biases to track and manage ML experiments
- **Software Contributions:** [ROMS-Tools](#), [GCM-Filters](#), [MOM6](#), [ClimaOcean](#), [ClimSim](#), [MITgcm](#)
- **Visualization & Design:** Cartopy, Matplotlib, L<sup>A</sup>T<sub>E</sub>X, HTML
- **Data & Databases:** NetCDF, Zarr
- **Platforms:** HPC, JupyterLab, GitHub