

I am a physical scientist and research engineer specialized on all things scientific computing, with industry experience in scientific machine learning / AI, data engineering, and engineering leadership in a research setting.

My main research interest is “human learning”: How can we build machines that teach us to understand and navigate the physical world?

Professional Experience

Apr 2022 – present **Staff Research Engineer — R&D lead @ Pasteur Labs**

My team and I build efficient, scalable software for scientific advances at the interface between physical simulators and modern machine learning. As R&D lead, I guide the team in technical decision making, execution, and research-to-product transitions.

Sep 2017 – Dec 2018 **Software development specialist @ DHI GRAS**

At DHI GRAS, I built robust data pipelines, powerful statistical tools, and optimized remote sensing workflows.

Jan 2017 – Aug 2017 **Scientific assistant @ Niels Bohr Institute**

During this time, I developed the first version of the Veros ocean model, a full-fledged, distributed ocean model in Python (see software projects).

Jun 2014 – Dec 2016 **Research assistant @ Institute of Environmental Physics**

Developing a numerical software suite for the simulation of soil water flow (discontinuous Galerkin PDE solver), in C++ and Python.

Education

Dec 2018 – Apr 2022 **PhD in Physical Oceanography @ University of Copenhagen**

Conducted at the Niels Bohr Institute (Prof. Markus Jochum). I inferred the relative importance of hypothesized causes of extreme ocean waves (“rogue waves”) in the real world. To this end, I analyzed over 1 Terabyte of observational data with data mining and probabilistic machine learning to extract robust, causal insights.

Sep 2021 – Dec 2021 **Research visit @ University of Valencia**

During my 3-month research visit to the Image Processing Lab (Prof. Gustau Camps-Valls) I investigated how machine learning can help humans to understand climate models.

- Sep 2015* – **External Master’s thesis in Physical Oceanography @ University of Copenhagen**
- Dec 2016* Working with state-of-the-art climate models, I learned how to process and analyze large quantities of data, and became familiar with geoscientific modeling and high-performance computing.
- Sep 2011* – **BSc and MSc in Physics @ Heidelberg University**
- Dec 2016* GPA of 1.3 and 1.2, respectively (“very good”). Exchange year at KTH Stockholm in 2014. Specialization on computational physics.

Academic Grants and Projects

Co-PI, MADGOD

I am a co-PI on the MADGOD project, which aims to develop a new generation of machine learning algorithms for the prediction and understanding of dynamical processes in the Earth system (supervising 1 PhD student).

Software Projects

Veros — A high-performance ocean model in pure Python

I am the main developer and maintainer of Veros, a full-fledged primitive equation ocean model capable of accurate, realistic simulations of the global ocean. Veros leverages the JAX library for state-of-the-art performance on CPU and GPU clusters. <https://github.com/team-ocean/veros>

Terracotta — A light-weight geospatial raster tile server

Terracotta is a minimal, east-to-use, cloud-ready raster tile server, leveraging the cloud-optimized GeoTiff format and a modern geospatial Python stack. <https://github.com/DHI-GRAS/terracotta>

mpi4jax — Zero-copy MPI communication of JAX arrays

mpi4jax enables zero-copy, multi-host communication of JAX arrays, even from compiled code and from GPU memory. <https://github.com/mpi4jax/mpi4jax>

(see all projects on [GitHub](#))

Programming and Technology

ML frameworks I am intimately familiar with modern machine learning and data workflows, and are a power user of the JAX library ecosystem. Also scikit-learn, Tensorflow / Keras, and PyMC3.

Python I have both deep and broad experience up and down the modern Python stack, especially concerning **data analysis, machine learning, visualization, and scientific computing**, but also general SWE and application development. Be it NumPy, JAX, Numba, Cython, pydantic, streamlit, xarray, pandas, flask, FastAPI, flake8, ruff, uv, matplotlib, pyvista — I have used Python in all its facets.

Other languages Decent knowledge of C and object-oriented programming in C++, including debugging applications with GDB. Elementary knowledge of OpenCL / CUDA.

Tools Experience with tools handling version control (git), documentation (Sphinx, Doxygen), build systems (CMake), deployment (Docker), MLOps (Azure ML), testing (pytest), GUI (Qt), continuous integration (Github Actions), and typesetting (L^AT_EX).

I am comfortable working in all operating systems, and am familiar with basic administration tasks, including all major cloud providers.

Other Skills & Interests

- » Strong **mathematical and analytical skills**, and an affection for data.
- » Good theoretical foundation of **applied mathematics and scientific computing** (including ODE / PDE solvers, numerical optimization, signal processing, and automatic differentiation).
- » A knack for probabilistic reasoning and **Bayesian data analysis**. I like to make my assumptions and uncertainties explicit.
- » I am passionate about **open-source software development**, and have contributed code to several large projects on GitHub (and started my own).
- » A special interest in **effective communication** through writing, oral presentations, and data visualization. I take the quality of my publications seriously, and love to present my work.
- » **Languages**: German (native), English (fully proficient), Swedish (proficient), Danish (elementary).

Teaching

Courses 3 TA assignments in Physics MSc courses at the Niels Bohr Institute. Nominated for biannual TA prize in 2021.

Theses Formal co-advisor to 1 PhD student, 1 MSc student, 1 BSc student at Niels Bohr Institute. Closely involved in 5 MSc projects from other departments / universities.

Invited Talks

- » (2022) “JAX of all trades — GPU-accelerated ocean modelling in Python”. Keynote presentation @ DRAKKAR ocean modelling workshop (virtual).
- » (2022) “Painless science posters”. Presentation @ EGU webinar “Be ready to be a great conference presenter” (virtual).

Awards & Honors

- » (2022) Diploma of Excellence (top 10 PhD thesis of 2022) by Faculty of SCIENCE, University of Copenhagen.
- » (2021) Virtual Outstanding Student and PhD candidate Presentation (vOSPP) by European Geophysical Union.

Peer-reviewed Publications

- [1] **Häfner, D.**, Gemmrich, J., Jochum, M., “Machine-guided discovery of a real-world rogue wave model”. In: *Proceedings of the National Academy of Sciences* 120.48 (Nov. 2023). ISSN:

- 1091-6490. DOI: 10.1073/pnas.2306275120. URL: <http://dx.doi.org/10.1073/pnas.2306275120>.
- [2] **Häfner, D.**, Nuterman, R., Jochum, M., “Fast, Cheap, and Turbulent—Global Ocean Modeling With GPU Acceleration in Python”. In: *Journal of Advances in Modeling Earth Systems* 13.12 (Dec. 2021). ISSN: 1942-2466. DOI: 10.1029/2021ms002717. URL: <http://dx.doi.org/10.1029/2021MS002717>.
 - [3] **Häfner, D.**, Vicentini, F., “mpi4jax: Zero-copy MPI communication of JAX arrays”. In: *Journal of Open Source Software* 6.65 (Sept. 2021), p. 3419. ISSN: 2475-9066. DOI: 10.21105/joss.03419. URL: <http://dx.doi.org/10.21105/joss.03419>.
 - [4] **Häfner, D.**, Gemmrich, J., Jochum, M., “FOWD: A Free Ocean Wave Dataset for Data Mining and Machine Learning”. In: *Journal of Atmospheric and Oceanic Technology* (May 2021). ISSN: 1520-0426. DOI: 10.1175/jtech-d-20-0185.1. URL: <http://dx.doi.org/10.1175/JTECH-D-20-0185.1>.
 - [5] **Häfner, D.**, Gemmrich, J., Jochum, M., “Real-world rogue wave probabilities”. In: *Scientific Reports* 11.1 (May 2021). ISSN: 2045-2322. DOI: 10.1038/s41598-021-89359-1. URL: <http://dx.doi.org/10.1038/s41598-021-89359-1>.
 - [6] Riedel, L., Ríos, S. O. D. L., **Häfner, D.**, Klein, O., “DORIE: A Discontinuous Galerkin Solver for Soil Water Flow and Passive Solute Transport Based on DUNE”. In: *Journal of Open Source Software* 5.52 (Aug. 2020), p. 2313. ISSN: 2475-9066. DOI: 10.21105/joss.02313. URL: <http://dx.doi.org/10.21105/joss.02313>.
 - [7] **Häfner, D.**, Jacobsen, R. L., Eden, C., Kristensen, M. R. B., Jochum, M., Nuterman, R., Vinter, B., “Veros v0.1 – a fast and versatile ocean simulator in pure Python”. In: *Geoscientific Model Development* 11.8 (Aug. 2018), pp. 3299–3312. ISSN: 1991-9603. DOI: 10.5194/gmd-11-3299-2018. URL: <http://dx.doi.org/10.5194/gmd-11-3299-2018>.

(see also [Google Scholar](#))

References

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