

I am a scientist and software engineer specialized on all things scientific computing, with industry experience in data processing and artificial intelligence (formerly known as machine learning).

My main research interest is “human learning”: How can we build machines that teach us something about our physical world?

Professional Experience

- Apr 2022 – present* **Senior Research Engineer — R&D lead @ Pasteur Labs**
I lead a team of highly skilled individuals building cutting-edge software for scientific advances at the interface between physical simulators and modern AI.
- 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**
I developed the first prototype of Veros, a high-performance ocean model in Python.
- Jun 2014 – Dec 2016* **Research assistant @ Institute of Environmental Physics**
Working in a small team of developers on a numerical software suite for soil water flow (discontinuous Galerkin PDE solver), in C++ and Python.

Education

- Dec 2018 – Apr 2022* **PhD in Physical Oceanography @ University of Copenhagen**
In my PhD project 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 – Dec 2016* **External Master’s thesis in Physical Oceanography @ University of Copenhagen**
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.

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. It 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 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 on [GitHub](#))

Programming and Technology

ML frameworks I am familiar with modern machine learning workflows and have deep knowledge of JAX, scikit-learn, Tensorflow / Keras, and PyMC.

Python I have both deep and broad experience within the Python ecosystem, especially concerning (but not limited to) **data analysis, machine learning, visualization, and scientific computing**. I love working with the modern scientific Python stack and am well-versed with libraries like JAX, PyTorch, matplotlib, xarray, Numba, and Pandas. I have probably used most of the libraries in the PyData ecosystem at some point.

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 (Travis CI / 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 big projects on GitHub.
- » 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 Teaching Assistant (TA) assignments in Physics MSc courses at the Niels Bohr Institute. Nominated for biannual TA prize in 2021.

Theses Co-supervisor to 1 BSc student and 1 MSc student at NBI. 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

Markus Jochum

Professor, Niels Bohr Institute,
University of Copenhagen,
Denmark
mjochum@nbi.ku.dk

Gustau Camps-Valls

Professor, Image Processing Lab,
University of Valencia, Spain
gustau.camps@uv.es

Johannes Gemmrich

Research Scientist, Physics &
Astronomy, University of Victoria,
Canada
gemmrich@uvic.ca