

I am a Physicist specialized on all things scientific computing, with industry experience in data processing and machine learning.

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

## Education

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

present In my PhD project at Niels Bohr Institute (Prof. Markus Jochum), I inferred the relative importance of different 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.

During my PhD, I conducted a 3-month research visit to the Image Processing Lab at the **University of Valencia** (Prof. Gustau Camps-Valls), where I worked on how machine learning can help humans to understand climate models.

Sep 2015 – **Master of Science (MSc) in Physics @ Heidelberg University**

Dec 2016 GPA of 1.2 (“very good”). Specialization in computational physics.

External Master’s thesis “*Frictional Control of Cross-Equatorial Flow*” in Physical Oceanography at Niels Bohr Institute, **University of Copenhagen** (Prof. Markus Jochum).

Sep 2011 – **Bachelor of Science (BSc) in Physics @ Heidelberg University**

Sep 2015 GPA of 1.3 (“very good”).

Bachelor’s thesis “*Numerical Simulations of Soil Water Flow: Implementing and Benchmarking Adaptive Grid Refinement*” at Terrestrial Physics group, IUP Heidelberg (Prof. Kurt Roth).

Exchange year 2013/2014 at **KTH Stockholm**, specializing on computational physics.

## Professional Experience

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

Dec 2018 At DHI GRAS, I built robust data pipelines, powerful statistical tools, and optimized remote sensing workflows.

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

Aug 2017 I developed the first prototype of Veros, a high-performance ocean model in pure Python.

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

*Dec 2016* Working in a small team of developers on a numerical software suite / PDE solver for soil water flow, in C++ and Python.

## 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 good knowledge of scikit-learn, Tensorflow / Keras, PyMC, and JAX.

**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 NumPy, SciPy, matplotlib, xarray, JAX, Numba, and Pandas.

**Other languages** Basic knowledge of 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), testing (pytest), GUI (Qt), continuous integration (Travis CI / Github Actions), and typesetting (L<sup>A</sup>T<sub>E</sub>X).

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

## 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.

## Peer-reviewed Publications

- [1] **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). DOI: 10.1029/2021ms002717. URL: <https://doi.org/10.1029/2021ms002717>.
- [2] **Häfner, D.**, Vicentini, F., “mpi4jax: Zero-copy MPI communication of JAX arrays”. In: *Journal of Open Source Software* 6.65 (Sept. 2021), p. 3419. DOI: 10.21105/joss.03419. URL: <https://doi.org/10.21105/joss.03419>.
- [3] **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). DOI: 10.1175/jtech-d-20-0185.1. URL: <https://doi.org/10.1175/jtech-d-20-0185.1>.
- [4] **Häfner, D.**, Gemmrich, J., Jochum, M., “Real-world rogue wave probabilities”. In: *Scientific Reports* 11.1 (May 2021). DOI: 10.1038/s41598-021-89359-1. URL: <https://doi.org/10.1038/s41598-021-89359-1>.
- [5] Riedel, L., Ríos, S. D., **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. DOI: 10.21105/joss.02313. URL: <https://doi.org/10.21105/joss.02313>.
- [6] **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. DOI: 10.5194/gmd-11-3299-2018. URL: <https://doi.org/10.5194/gmd-11-3299-2018>.

(see also **Google Scholar**)

## Awards & Honors

» (2021) Virtual Outstanding Student and PhD candidate Presentation (vOSPP) by European Geophysical Union.

## References

### **Markus Jochum**

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### **Gustau Camps-Valls**

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### **Johannes Gemmrich**

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