

Future-proofing climate modelling for HPC systems

STFC Hartree® Centre worked with the Met Office to develop PSyclone, an open-source code which enables faster, more energy-efficient climate simulations.

Challenge

Ocean models play a crucial role in advancing our understanding of the Earth's climate and improving weather forecasting accuracy. One of the most widely used ocean models is the Nucleus for European Modelling of the Ocean (NEMO), a complex system relied upon by global organisations such as the Met Office, the European Centre for Medium-Range Weather Forecasts (ECMWF) and many more. NEMO's performance has been limited by a lack of compatibility with modern computing architectures like GPUs, which are now foundational in the world's most powerful supercomputers. This creates a significant challenge. Without GPU compatibility, ocean and climate simulations take longer, cost more and limit their accuracy. The main challenge for scientists was finding a way to modernise the modelling for emerging computing architectures without disrupting scientific workflows or compromising reliability.

Approach

Our experts worked with the Met Office to address this challenge by developing PSyclone an open-source code transformation tool that automates the process of converting code like NEMO for GPU use. Instead of altering the source code directly, users create a short Python "recipe" which PSyclone applies to thousands of lines of their code. This transforms the code for specific GPU targets while preserving its scientific output. PSyclone has now been integrated into NEMO's official build system. This means scientists can now build GPU-compatible versions of NEMO without changing their workflows. With contributions from international partners, including the National Oceanography Centre (NOC), this tool continues to evolve and offers a scalable path to modernising complex scientific software and improve weather prediction.

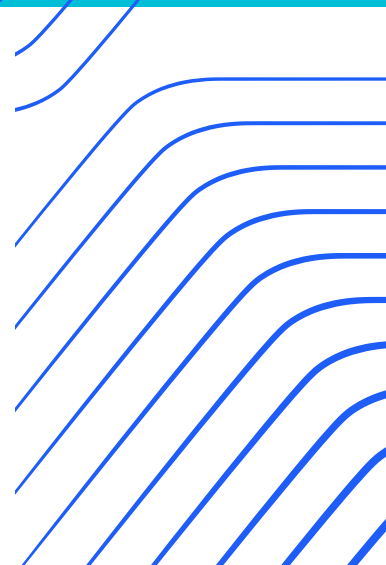
"PSyclone has now become a part of the official build system for Nemo, so when you download Nemo, you get PSyclone as part of the build system, which is a key part of the Met Office's weather forecasting system."

Andrew Porter
Hartree Centre

Credit: Canva

Benefits

PSyclone is a breakthrough in making one of the world's most influential ocean models ready for the future of high performance computing. By enabling NEMO to run on GPU-powered systems, researchers and forecasters can significantly reduce simulation times, leading to more energy-efficient modelling with improved accuracy. This breakthrough allows the Met Office and other institutions to deliver faster, more accurate weather and climate forecasts. By removing the need for oceanographers to understand the complexities of GPU programming, PSyclone lowers the barrier to modernising climate models, helping scientists better prepare for climate-related risks and help future-proof climate models.



At a glance

- PSyclone automates GPU code transformation for complex ocean modelling systems
- Removes need for oceanographers to learn complex GPU programming languages
- Enables faster, more precise weather and climate forecasts globally
- Open-source tool developed with Met Office and international research partners

Who we are

The Hartree Centre was created by UK Government to help businesses and public sector organisations accelerate the adoption of high performance computing (HPC), big data analytics, artificial intelligence (AI) and quantum technologies. We play a key role in realising UK Government's Industrial Strategy by stimulating applied digital research and innovation, creating value for the organisations we work with and generating economic and societal impact for the UK. We are proud to be part of UK Research and Innovation.

What we do

- Boost productivity and innovation for industry
- Offer training and skills development
- Provide insights into future technologies
- Give tailored business development support
- Build bespoke small teams around your project

