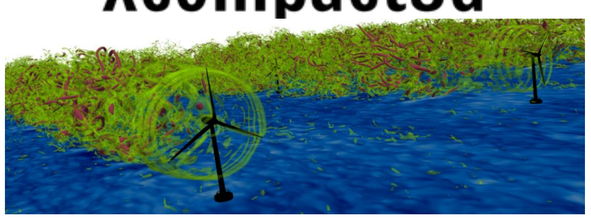
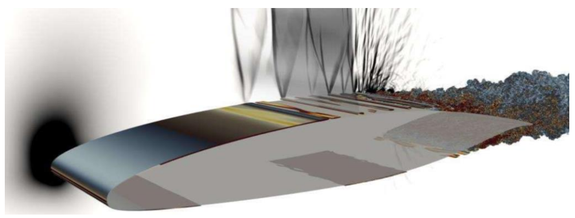
CCP Turbulence

Three finite-difference flow solvers

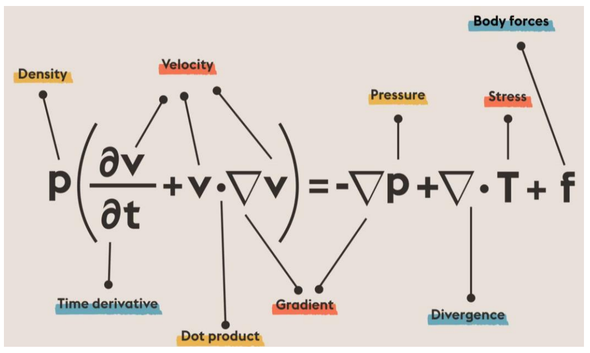
Xcompact3d

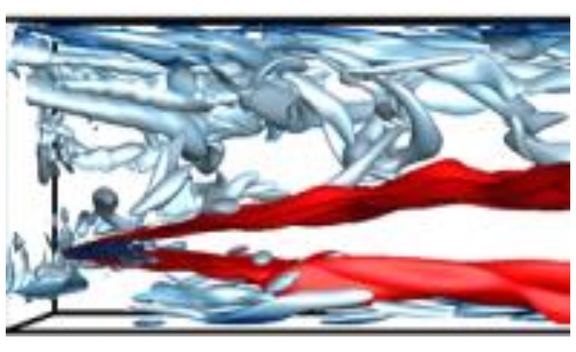


OpenSBLI



SENGA2





Navier-Stokes equations to solve

High-impact use cases

- Wind Energy (power optimisation, wind farm design, blade load)
- Green Aviation (less noise, better aerodynamic performance, transonic aircraft)
- Net-Zero Combustion (High hydrogen content & sustainable fuels)

Objectives

- Supporting the UK turbulence community for large-scale compute
- Supporting two High End Computing consortia (~300 researchers)
- Exascale-ready flow solvers, I/O & Machine Learning tools
- Use of the Domain Specific Language library OPS and the 2DECOMP&FFT library for CPU and GPU capabilities
- Knowledge exchange activities: training materials, hackathons, social media, outreach videos, cross-cutting collaborations

Strategy

- OPS: Domain Specific Language strategy for multiblock structured meshes (OpenSBLI & SENGA2)
- 2DECOMP&FFT: Fortran-based library based on a 1D/2D domain decomposition for structures meshes with 3D Fast Fourier Transforms
- The capability, reliability and robustness of these open-source tools will be increased for use on exascale systems

Recent activities

- UK Turbulence consortium annual meeting in Cambridge, March 2025 (115 attendees)
- Benchmarking of our solvers on EUROHPC machines (CPUs and GPUs)
- Maintenance and support of our solvers, making sure they are optimized, robust and reliable with the latest versions of libraries and compilers on CPUs and GPUs
- Addition of new capabilities for our solvers (particles tracking, magnetohydrodynamic turbulence, mixed precision simulations, enhanced I/O capabilities via the ADIOS2 library, GPU kernels for AMD/NVIDIA/Intel GPUs, proper CI infrastructure)

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