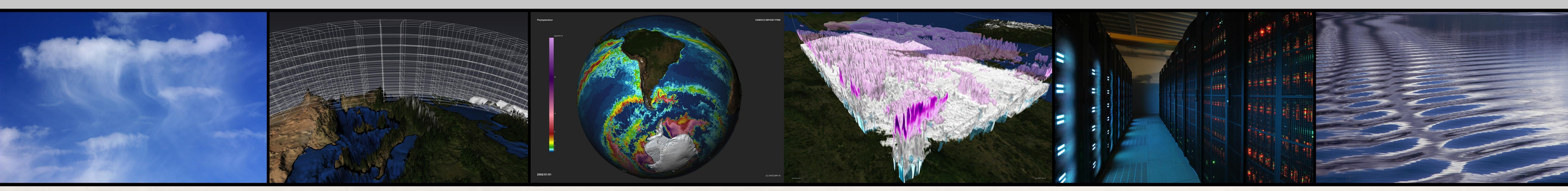
esiwace

CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER AND CLIMATE IN EUROPE

DKRZ DEUTSCHES KLIMARECHENZENTRUM



OVERVIEW

Funding period: 1 Sep 2015 – 31 Aug 2019
Coordination: DKRZ (Joachim Biercamp), ECMWF (Peter Bauer)
Consortium: 16 partners from 7 countries
Call reference: European research infrastructures, EINFRA-5-2015

The **Centre of Excellence in Simulation of Weather and Climate in Europe (ESiWACE)** forms a joint scientific community around **Earth System Modelling** (ESM) from the two communities of **Weather** and **Climate** research by leveraging two established European networks:

- The European Network for Earth System Modelling
- The European Centre for Medium-Range Weather Forecasts

The main objectives of **ESiWACE** are to

- Substantially improve efficiency and productivity of numerical **Weather** and **Climate** simulation on high-performance computing (**HPC**) platforms, strengthening the user-driven evolution of the community software
- Build a critical mass and create expertise to increase the community impact on hardware development towards the extreme scale as well as future international exascale initiatives

PROJECT IMPACTS AND ACHIEVEMENTS

ESiWACE addresses three core themes on the applications' way towards exascale computing:

- **Scalability** of models and tools at extreme scale
  - **Central task: Extreme-scale global high-resolution demonstrators**
    - Single precision tests for Numerical **Weather** Prediction have shown 40% runtime improvement (example model: IFS)
    - Code optimisation for various models and tools (IFS, ICON, EC-EARTH, OASIS, …) used in the community (collaborative effort of **Weather** and **Climate** scientists, computer centres and **HPC** industry)
- **Usability** of **HPC** systems for the ESM workflow
  - Handbooks for application and system software stacks
  - Spack-based solutions for software stack and model deployment
  - Improving robustness and performance of meta-scheduler Cylc
- **Exploitability** of **Weather** and **Climate** data fostering new I/O paradigms
  - Business model development to address cost/benefit balance in data centres
  - Middleware development to alleviate the use of expensive and non-scalable disk resources (collaborative effort of scientists and industry)

ESiWACE impacts the competitiveness of the European **HPC** industry by

- Opening the potential for engendering new products due to co-design with the science community
- Providing input regarding limits of extreme-scale test cases on state of the art hardware
- Providing opportunities for exploitation beyond the project itself
- Enhancing the skills base of staff in both industry and academia

THE STORY CONTINUES: ESiWACE2

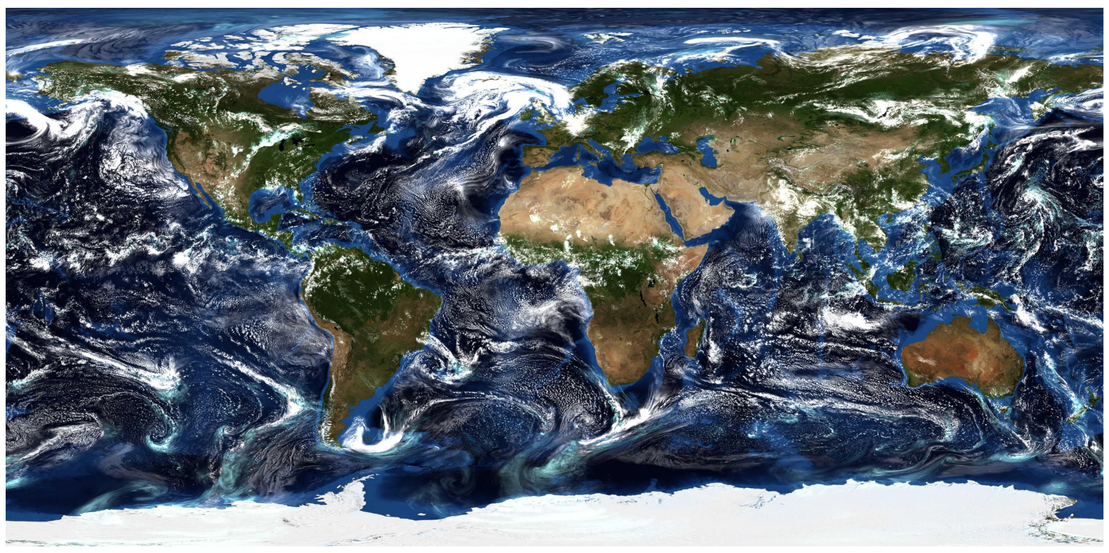
Funding period: 1 Jan 2019 – 31 Dec 2022
Coordination: DKRZ (Joachim Biercamp), ECMWF (Peter Bauer)
Consortium: 20 partners from 9 countries
Call reference: European research infrastructures, INFRAEDI-02-2018

The project will push the global high-resolution demonstrators towards production-ready simulations on European **pre-exascale and future exascale systems**. ESiWACE2 will further focus on exploring and exploiting suitable innovative technologies such as DSLs, on the development of **processing tools** for more efficient I/O and visualisation and on providing enhanced **services, training and benchmarks** for the community.

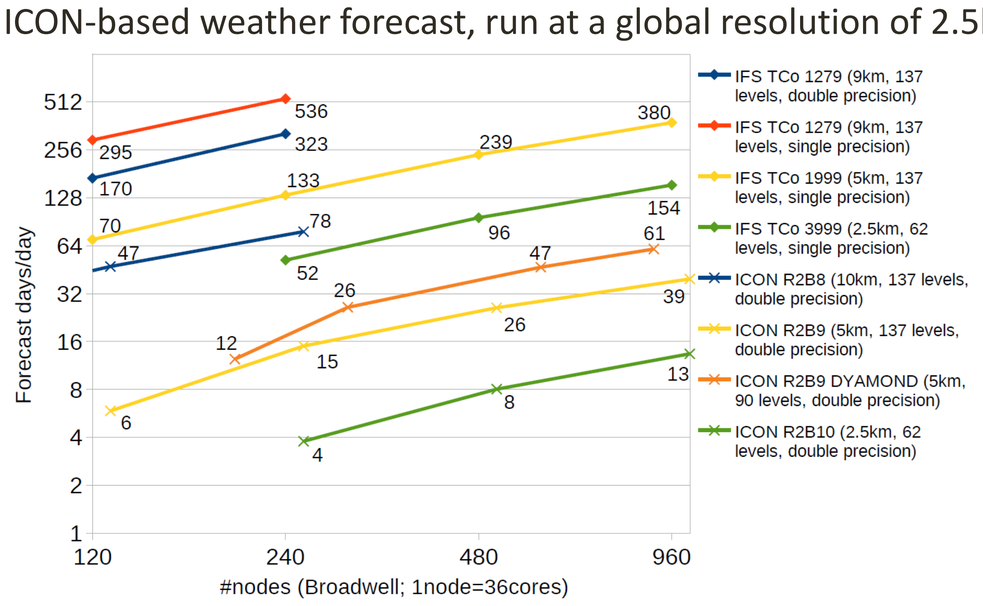
THE CENTRAL DELIVERABLE: GLOBAL HIGH-RESOLUTION DEMONSTRATORS

ESiWACE will deliver **global high-resolution demonstrators of atmosphere-only, ocean-only and coupled ocean-atmosphere simulations**; a key target is to reach spatial resolutions of ca. 1 km that allow simulating convective clouds and small-scale ocean eddies. This will provide much more fidelity in the representation of high-impact regional events. The demonstrators will allow for computability estimates for these configurations at exascale. They are based on widely used European models (IFS, ICON, NEMO, EC-EARTH). In this context, ESiWACE has been strongly supporting the intercomparison project DYAMOND, integrating both views on performance and science case.

ATMOSPHERE-ONLY DEMONSTRATORS



Global ICON-based weather forecast, run at a global resolution of 2.5km.



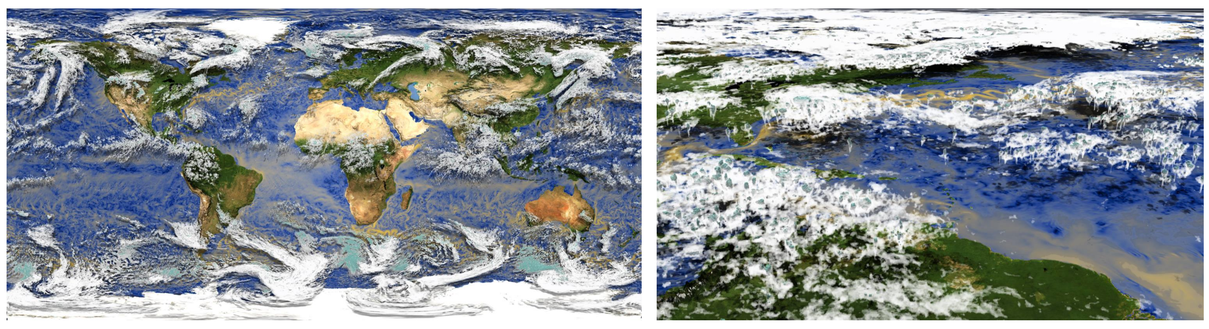
Scalability of global high-resolution atmosphere-only simulations using the models IFS and ICON (no I/O). Despite significant achievements for extreme scale simulations, even more effort is required to push the models towards production readiness (target throughput: ca. 365 forecast days/day).

References:

T.C. Schulthess, P. Bauer et al. IEEE Comput. Sci. Eng. 21(1), 2019, https://doi.org/10.1109/MCSE.2018.2888788

P. Neumann, P. Düben et al. Philos. Trans. Royal Soc. A 377(2142), 20180148, 2019, https://royalsocietypublishing.org/doi/pdf/10.1098/rsta.2018.0148

ICON-BASED COUPLED OCEAN-ATMOSPHERE DEMONSTRATOR



Visualisation of cloud water and ocean currents in a 5km-5km ocean-atmosphere simulation. Left: Global view. Right: Zoom into Carribean sea.
A throughput of ca. 20 simulated days/day was achieved on 500 Broadwell nodes (platform: Mistral, DKRZ).

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