esiwace
CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER AND CLIMATE IN EUROPE

Final workshop report on results and evaluation of demonstrators

Deliverable D2.1

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About this document

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1. Abstract /publishable summary

A workshop on the global high-resolution demonstrators was held in conjunction with the annual meeting of ESiWACE on 11 March 2019. The results for the atmosphere-only, ocean-only and coupled ocean-atmosphere demonstrators were presented and discussed.
All models that were involved—ICON, IFS, NEMO, EC-Earth—could technically reach the actual resolutions that were targeted in ESiWACE. Yet, significant performance shortfalls in terms of throughput and memory or energy demands were encountered.
Despite the performance shortfalls of the models, discussions on (1) the expected performance gains in the future through advanced model optimisation and the establishment of pre-exascale and exascale supercomputers as well as (2) the great scientific relevance of global high-resolution simulations have significantly impacted the global high-resolution development process in the weather and climate community and contributed to the evolving roadmap towards global kilometre-scale ensemble simulations.

2. Conclusion & Results

The workshop complemented the previously prepared deliverables on each of the global high-resolution demonstrators[1]. It significantly helped to communicate results and findings regarding scalability among the consortium members and beyond our community. This was particularly valuable for targeting long-term efforts of the community to establish kilometre-scale ensemble simulations and to define a roadmap towards this goal. Through the follow up project ESiWACE2, some of the identified challenges—such as preparing high-resolution configurations of the considered models for production runs on the upcoming EuroHPC pre-exascale and exascale systems or enhancing the evaluation of the results through in-situ visualisation and data analytics—will be addressed. However, it has again become clear that significant efforts in terms of funding and in-house contributions are necessary to reach the goal of global kilometre-scale ensemble simulations.

3. Project objectives

This deliverable contributes directly and indirectly to the achievement of all the macro-objectives and specific goals indicated in section 1.1 of the Description of the Action:

Macro-objectives	**Contribution of this deliverable?**
Improve the efficiency and productivity of numerical weather and climate simulation on high-performance computing platforms	Yes
Support the end-to-end workflow of global Earth system modelling for weather and climate simulation in high performance computing environments	Yes
The European weather and climate science community will drive the governance structure that defines the services to be provided by ESiWACE	No

[1] D2.8, D2.9, D2.10, D2.11, D2.12

Foster the interaction between industry and the weather and climate community on the exploitation of high-end computing systems, application codes and services.	Yes
Increase competitiveness and growth of the European HPC industry	No

Specific goals in the workplan	**Contribution of this deliverable?**
Provide **services** to the user community that will impact beyond the lifetime of the project.	Yes
Improve **scalability** and shorten the time-to-solution for climate and operational weather forecasts at increased resolution and complexity to be run on future extreme-scale HPC systems.	Yes
Foster **usability** of the available tools, software, computing and data handling infrastructures.	Yes
Pursue **exploitability** of climate and weather model results.	No
Establish governance of common software management to avoid unnecessary and redundant development and to deliver the best available solutions to the user community.	Yes
Provide **open access** to research results and **open source** software at international level.	Yes
Exploit **synergies** with other relevant activities and projects and also with the global weather and climate community	Yes

4. Detailed report on the deliverable

A workshop on the demonstrators was held on 11 March 2019 in conjunction with the ESiWACE annual meeting, in Hamburg (DE).
The following presentations were given:

- Peter Düben (ECMWF): IFS 1km demonstrator
- Panagiotis Adamidis (DKRZ): The ICON demonstrators
- Miguel Castrillo (BSC): Implementation of EC-Earth 10km global coupled demonstrator and performance analysis
- Sophie Valcke (CERFACS): Global NEMO ORCA-Km

Presentations can be accessed in the Zenodo community: https://zenodo.org/communities/esiwace.
ESiWACE efforts have led to the establishment of global kilometre-scale atmosphere-only demonstrators based on the models IFS and ICON. Despite the use of large node counts of current supercomputers, strong scaling limits of the models have been observed and, partly in conjunction with time-stepping limitations, currently impose significant limits to their actual employment, with shortfall factors of O(20) compared to the target throughput rate of 1 simulated year per (compute) day (SYPD) under the assumption of sufficiently large computer platforms (such as exascale systems).

Concerning NEMO, 24000 Broadwell cores were used to measure the performance of a simplified km-scale setup. Assuming perfect scalability on up to 9 000 000 cores, it was inferred that a throughput of 2 SYPD could theoretically be achieved, although at a prohibitive energy cost, based on extrapolation of current architecture energy consumption.
Coupled ocean-atmosphere simulations were established for the models EC-Earth and ICON with 10km-10km (EC-Earth) and 5km-5km (ICON) resolution. For EC-Earth, a throughput rate of up to 0.44 SYPD could be obtained on the supercomputer MareNostrum while the ICON coupled demonstrator performed at 0.05 SYPD on the supercomputer Mistral.
The workshop was based on the following deliverables:

- D2.8: Implementation of IFS global 1km atmosphere-only demonstrator and performance analysis (confidential).
- D2.9: Implementation of ICON global 1km atmosphere-only demonstrator and performance analysis.
- D2.10: Implementation of NEMO global 1km ocean-only demonstrator and performance analysis.
- D2.11: Implementation of EC-Earth 10km global coupled demonstrator and performance analysis.
- D2.12: Implementation of ICON 10km global coupled demonstrator and performance analysis.

The deliverables were complemented by a discussion, and results and findings were communicated among and beyond the consortium. This was found particularly valuable for targeting long-term efforts of the community to establish kilometre-scale ensemble simulations and to define a roadmap towards this goal.

Picture 1 Workshop participants on 11 March 2019 in Hamburg. Credit: C.Bearzotti (DKRZ)

Through the project ESiWACE2, some of the identified challenges—such as preparing high-resolution configurations of the considered models for production runs on the upcoming EuroHPC pre-exascale and exascale systems or enhancing the evaluation of results through in-situ visualisation and data analytics—will be addressed. However, it has again become clear that significant efforts in terms of funding and in-house contributions are necessary to reach the goal of global kilometre-scale ensemble simulations.

5. References *(Bibliography)*

P. Dueben, N. Wedi, P. Bauer, S. Saarinen, D. Thiemert. Implementation of IFS global 1km atmosphere-only demonstrator and performance analysis (D2.8). 2017[2]

P. Neumann, J. Biercamp, I. Fast. Implementation of ICON global 1km atmosphere-only demonstrator and performance analysis (D2.9), https://doi.org/10.5281/zenodo.1226909, 2017

E. Maissonave, C. Levy, S. Masson. Implementation of NEMO global 1km ocean-only demonstrator and performance analysis (D2.10), https://doi.org/10.5281/zenodo.2596982, 2019

K. Seradell, M. Acosta, M. Castrillo. Implementation of EC-Earth 10km global coupled demonstrator and performance analysis (D2.11), https://doi.org/10.5281/zenodo.2596984, 2019

P. Neumann. Implementation of ICON 10km global coupled demonstrator and performance analysis (D2.12), https://doi.org/10.5281/zenodo.2596976, 2019

6. Dissemination and uptake

6.1 Uptake by the targeted audience

As indicated in the Description of the Action, the audience for this deliverable is the general public (PU).

6.2 This is how we are going to ensure the uptake of the deliverables by the targeted audience

Outcomes of the workshop discussions feed into the evolving deliverable D1.2: Roadmap to the implementation of 1km ESM ensembles, to be submitted to the European Commission by end of July 2019. This deliverable is going to be available in Zenodo in open access.

7. The delivery is delayed: ☐ Yes ☒ No

8. Changes made and/or difficulties encountered, if any

None.

9. Sustainability

9.1. Lessons learnt: both positive and negative that can be drawn from the experiences of the work to date

See the considerations under section 4.

9.2 Links built with other deliverables, WPs, and synergies created with other projects

The workshop complemented work described in the deliverables D2.8, D2.9, D2.10, D2.11, D2.12 and reference therein. Discussions from the workshop feed into the deliverable D1.2 to be submitted by end of July 2019.

10. Full track of dissemination activities

[2] This deliverable is confidential: accessible only to the European Commission and the consortium. An abstract is available in Zenodo.

Type of dissemination and communication activities	Details	Location , dates	Audience	Zenodo record / link to website	Estimated number of persons reached
Organisation of a workshop	Final workshop on results and evaluation of demonstrators	11 March 2019, Hamburg (DE)	Scientific Community (higher education, Research), Industry	Several records available here: https://zenodo.org/communities/esiwace	40

Peer reviewed articles

None.

Publications in preparation OR submitted

None.

Intellectual property rights resulting from this deliverable

None.