Advanced Earth System Modelling Capacity (ESM)
Who is involved?

ESM is a Helmholtz-funded project bringing together expertise from eight Helmholtz institution across Germany.

ESM community
Why do we need ESM?

- Progress in science hinges on the availability of skillful Earth system models
- Move toward a more integrated Earth system science approach within and among the Helmholtz Association
- ESMs are excellent 'integrators'
- No single institution can be world leading in all aspects

→ "Modelling capabilities should be strengthened and a clear modelling strategy should be developed" (RF Earth & Environment)
What does ESM do?

Mission:
Develop, evaluate and apply world-leading Earth system modelling capacity to contribute to solving grand challenges faced by science and society.
What does ESM do?

- Improvement of ESM components
- Development of a modular ESM coupling framework
- Development of (coupled) ESM data assimilation capacity
- Development of a long-term strategy
- Education of the next generation of Earth system modelers
- Maximizing impact through coordinated experimentation (‘frontier simulations’)
ESM modelling framework

Atmospheric dynamics

Atmospheric chemistry

Data assimilation

Atmospheric physics

Central modular ESM infrastructure

Ocean dynamics

Ocean biogeochemistry

Terrestrial system

Lithospheric deformation
ESM modelling framework

Models
The Tools provide an easy and standardized way to obtain, configure and compile model components. As of May 2019, we support 10 independent components, including 4 ocean, 2 atmosphere, 1 ice sheet, 1 BGC, 1 GIA model and a coupler, all organized under version control.

Coupled Setups
Out of the mentioned models, a variety of coupled systems can be combined. A graphical interface helps choosing the wanted components. Among the supported combinations are MPIESM, AWICM (1 and 2), FESOM-OIFS and FOCI-OIFS.

Hardware
Currently the Tools are running on 6 HPC systems, holding the machine specifications in a central place that can be used by the models during compile and run time, leaving more time for the user to focus on scientific questions.

Data
The life cycle of model data has become increasingly important. The tools try to help – by referring to standardized input data pools, managing model output and restarts, and functionality for tar-balling and archiving data. CMOR support is planned.
Development of data assimilation capacity

- Initialization of forecasts
- State estimation and monitoring
- Model improvement
- Observing system design
Development of data assimilation capacity

- Provide support for ensemble simulations
- Augment model with data assimilation functionality
- Provide methods for ensemble data assimilation
- Support easy integration of observation operators

**PDAF**
Parallel Data Assimilation Framework

- Run from laptops to supercomputers
- Apply data assimilation in real applications
- Use to study assimilation algorithms
- Teach data assimilation

Open-source: http://pdaf.awi.de
Coordinated approach to numerical experimentation (“community experiments”)

Go beyond the state-of-the-art (e.g. in terms of complexity)

Test of the ESM infrastructure (fit for purpose?)

- Enhanced multiscale global change projections
- Monsoon systems in a changing climate
- European hydro-meteorological extremes in Europe
- Cross-compartmental matter cycling: From land to sea
- Georeservoirs under anthropogenic pressure
- Develop a long-term strategy for the Helmholtz Association
- Contribute to developing a national ESM strategy

“Provide an integrative modelling environment that enables the various communities to easily adapt and apply world-leading modelling systems according to their respective requirements (incl. standard and interfaces)”
“To establish new diagnostic capacities that will be used to directly confront Earth system model simulations with observations on irregular time-space grids.”

- Virtual field campaign capacity for high-resolution atmosphere, ocean and hydrological simulations
- Improved understanding of systematic model errors by exploiting data assimilation
- Value-added information products
The second pillar of ESM

ESM Partition at Jülich Supercomputing Centre
The third pillar of ESM

Pilot Lab Exascale Earth System Modelling (PL-ExaESM): The “scalability program” of the Helmholtz Association
How to reach us

More information can be found on our website

esm-project.net

You can also follow us on Twitter

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