

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



ESM2018, UFZ, Leipzig

Why do we need ESM?

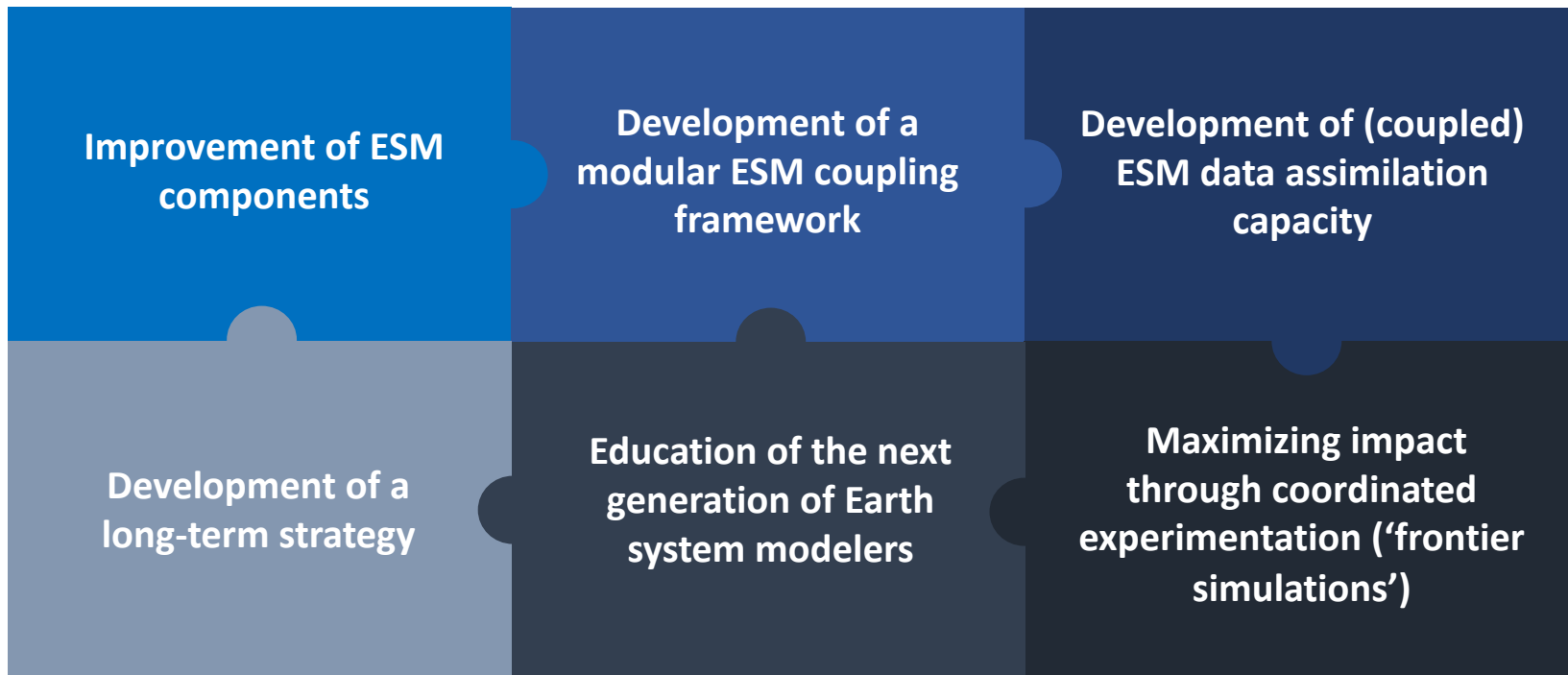
- Progress in science hinges on the availability of **skillful Earth system models**
 - Move toward a more **integrated Earth system science** approach within and among the Helmholtz Association
 - ESMs are excellent '**integrators**'
 - **No single institution** can be world leading in all aspects
- "Modelling capabilities should be strengthened and a clear modelling strategy should be developed" (RF Earth & Environment)

What does ESM do?

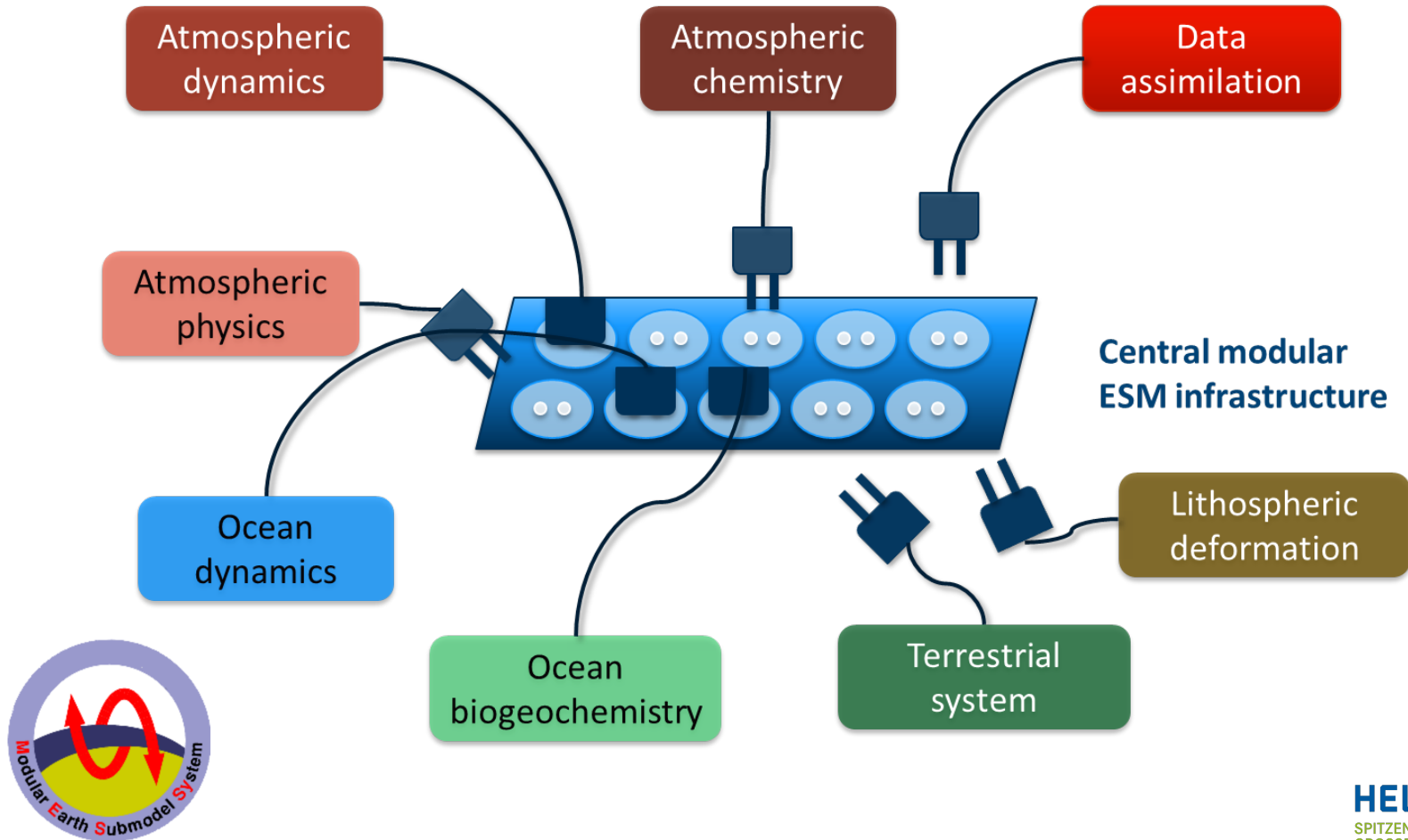
Mission:

Develop, evaluate und apply world-leading Earth system modelling capacity to contribute to solving grand challenges faced by science and society

What does ESM do?



ESM modelling framework



ESM modelling framework



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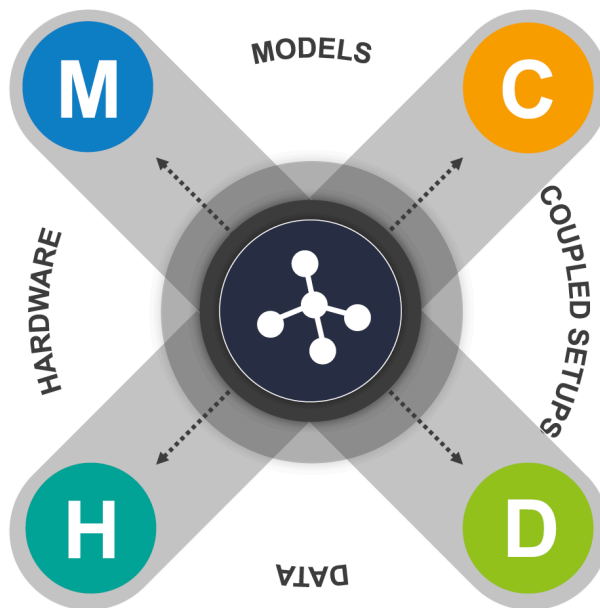
ESM-Tools

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.

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.



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.

Data

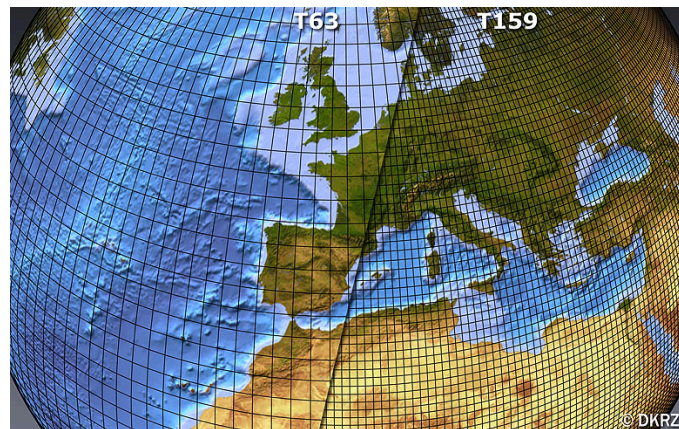
The life cycle of model data has become increasingly important. The tools try to help – by referring to standardized input data pools, managing model output and restarts, and functionality for tar-balling and archiving data. CMOR support is planned.

Development of data assimilation capacity

Observations



Models



- 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

Open-source:
<http://pdaf.awi.de>

Run from laptops to
supercomputers

Apply data assimilation
in real applications

Use to study assimilation
algorithms

Teach data assimilation

Frontier simulations

- 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

Strategic development

- 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)"

ESM Diagnosis

"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

FEATURE 10 October 2018

Could the world's mightiest computers be too complicated to use?

China, Japan and the US are racing to build the first exascale computer – but devising programmes clever enough to run on them is a different story



New Scientist

Totto Renna

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

[@project_esm](https://twitter.com/project_esm)