natESM

DKRZ DEUTSCHES KLIMARECHENZENTRUM

JÜLICH Forschungszentrum | JÜLICH SUPERCOMPUTING CENTRE

DKK Deutsches Klima Konsortium

Federal Ministry of Education and Research

Ensuring the future readiness of the natESM system

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What happened up to now?

What actions have we all taken to ensure that Earth system modelling in Germany is prepared for the future?

1

What steps have we collectively taken to pool resources and foster collaboration?

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What progress have we made in developing our Earth system modelling system?

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Efficient evaluation and future-proofing through sprint checks

- **Sprint checks** are now **mandatory** and follow a standardized process
- The **power** of sprint checks:
  - → Significantly improved how we evaluate suitability of code and software for natESM system
  - → Sprint checks help determine whether your code is suitable for natESM system or if it falls short of our requirements
  - → RSEs will provide guidance on suitability and possibilities to integrate software into natESM systems
- The **reward**:
  - → If your code/software is developed sufficiently through our sprint process, it can benefit the entire community once it becomes a natESM component

Improvements in sprint collaboration and evaluation

Status meetings introduced

After one-third of the total sprint duration, a status meeting is conducted to evaluate progress and address any challenges.

Weekly meetings introduced

To enhance RSE–scientist collaboration, we now require a fixed weekly meeting.

Follow-up evaluation one year after completion of sprint

To assess and document whether the sprint, including RSE time and allocated resources, had a lasting effect on natESM.

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Note:

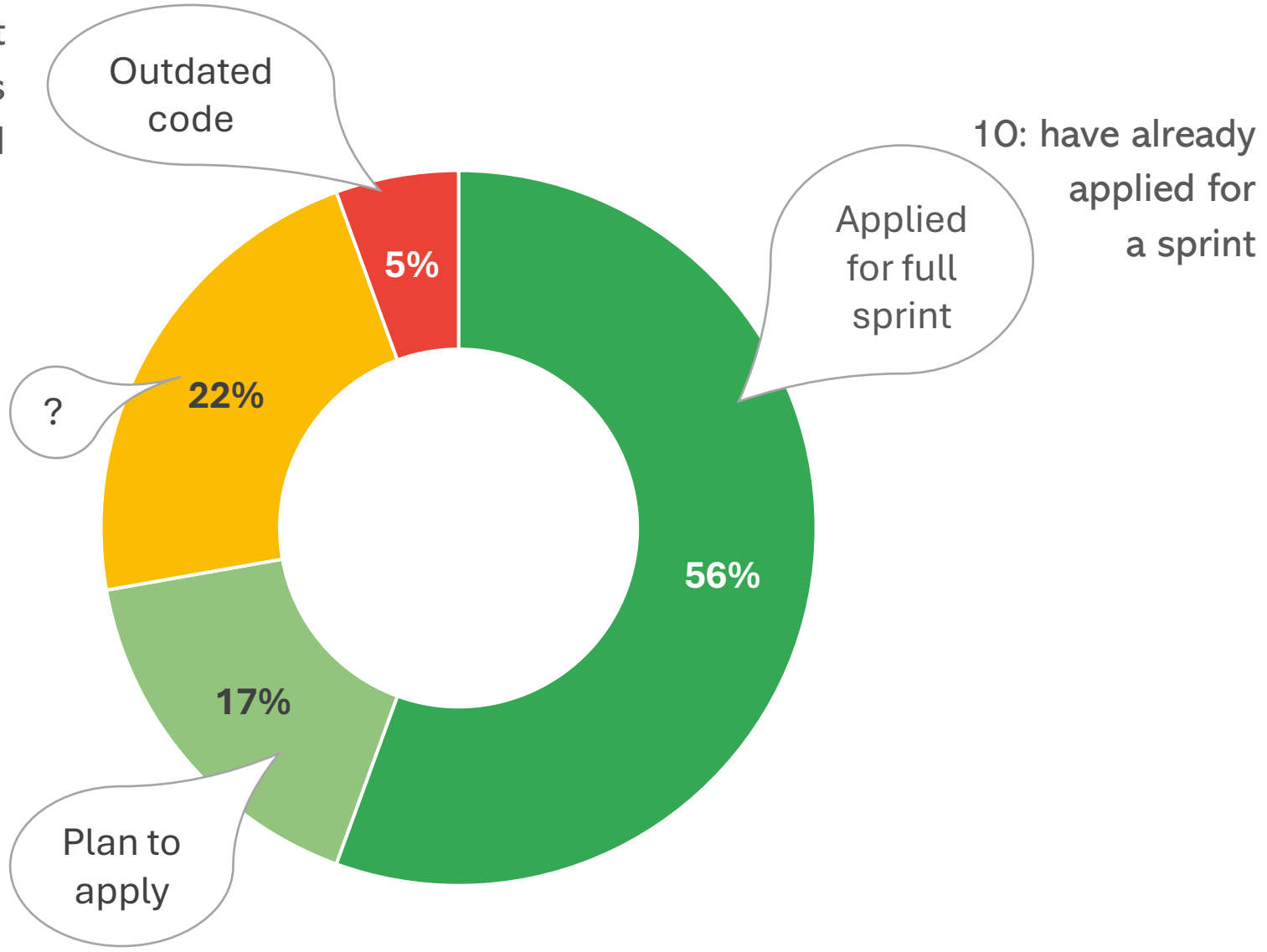
The natESM sprint approach has been listed as a best-practice example in the new IT strategy of the Max Planck Society.

RSEs have completed 18 sprint checks up to now

1: code simply doesn't meet the technical requirements of natESM

4: did not submit a sprint application despite successful sprint check ;-(

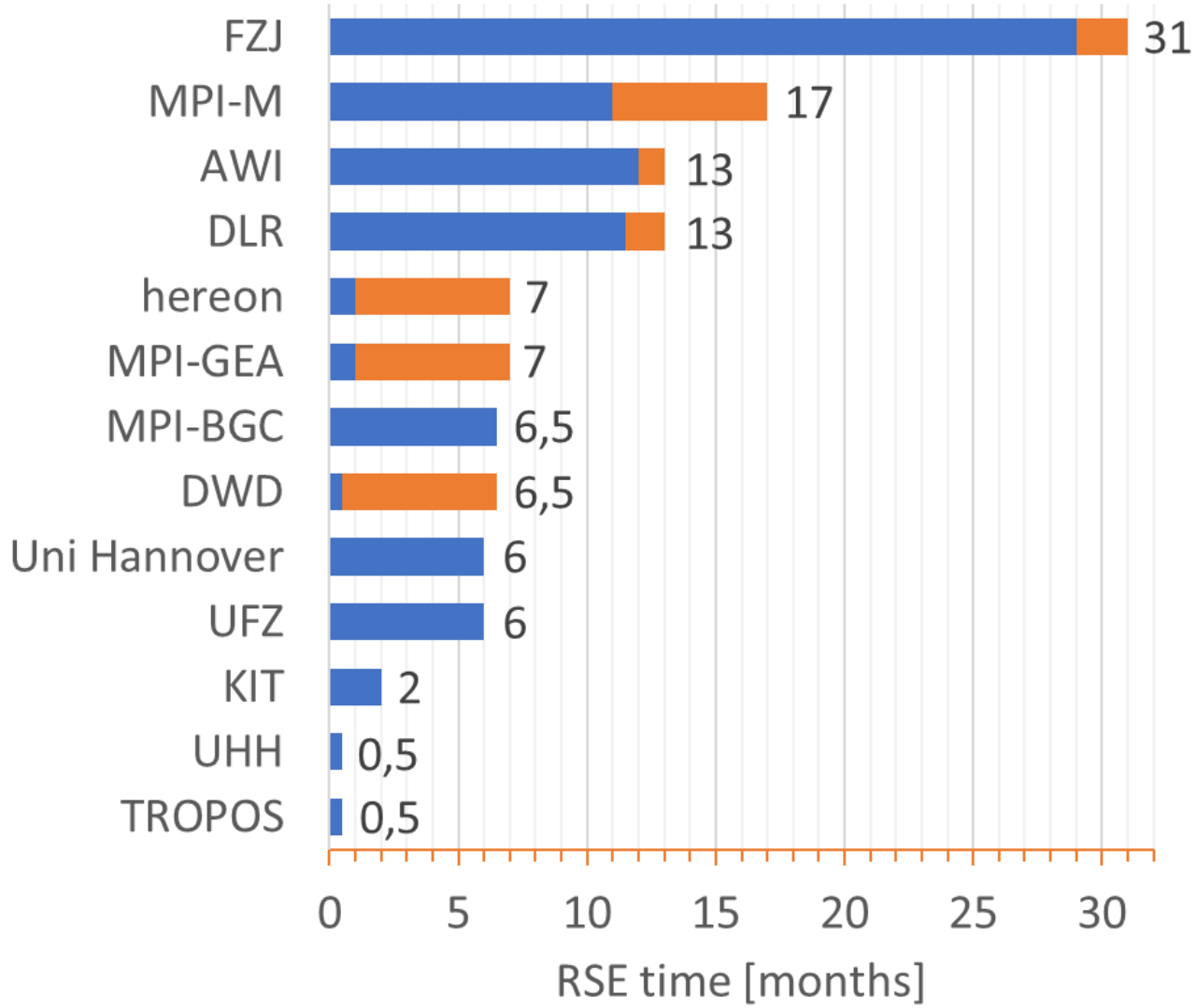
3: plan to apply



Completed total of 13 sprints (5 since last workshop)

01	**ICON-Art**	KIT	Analysis of ART code for GPU porting
02	**ICON-mHM-YAC**	UFZ	Online coupling mHM into ICON using YAC
03	**FESOM**	AWI	Port FESOM 2.1 to JUWELS booster and Levante- GPU
04	**ParFlow**	FZJ	Port ParFlow to AMD GPUs, inspection of RAPID Memory Manager and Hipification, performance analysis
05	**MESSy**	FZJ	Optimize data transfers between host (CPU) and device (GPU)
06	**ESMValTool**	DLR-PA	Updating the remaining non-lazy preprocessor functions to be memory efficient AND updating ESMValCore
07	**HAMOCC**	MPI-M	Concurrent HAMOCC on GPU
08	**MESSy-ComIn**	DLR-PA	Couple MESSy to ICON via ComIn
09	**LAGOOn**	FZJ	Develop concept and provide first implementation of Lagrangian-transport-modeling framework
10	**IQ**	MPI-BGC	Stepwise port of IQ code to GPUs based on established workflow followed for ICON-GPU implementation with OpenACC
11	**modLSMcoup**	FZJ	Develop proof-of-concept for modular coupling of land surface and implement YAC coupler in ICON-eCLM coupling
12	**CLEO**	MPI-M	Coupling CLEO to ICON with YAC
13	**PALM**	Uni Hannover	Porting those of the PALM modules related to urban processes (especially radiation) to GPUs

RSE time provided to the community since project start



Used RSE time

Time spent by RSEs on sprints

Reserved RSE time

Time reserved for sprints

How you can contribute to building natESM

Apply for sprints

We encourage everyone to consider submitting a sprint-check request and, if it turned out that your software meets the needs of our community, a sprint application.

We need your feedback on your sprint experience!

Please complete our survey on your sprint experience.

If you haven't applied for a sprint or sprint check yet, please take a moment to answer the survey, so we can better understand any obstacles.

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Fostering collaboration within the community

1. Offering **technical training sessions**
    1. Training on ComIn and YAC (July 2024): Focusing on the integration of our infrastructure components
    2. Training on GPU Programming (July 2024): Dedicated to GPU programming techniques
    3. Training on Software Engineering Aspects of Composed Earth System Models (November 2024): Covered topics such as integrating smaller components with core components and asynchronous execution of code components

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UPCOMING:

DWD Academic ICON Course

July 21-25, 2025

In collaboration with natESM, this course will familiarize users with the ICON and ICON-ART models, hosted at DKRZ in Hamburg.

understand

obstacles.

SCAN ME

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2. Distributing updates on natESM developments, upcoming events, and community achievements through **newsletters and website**, keeping members informed and fostering communication within the community
3. Highlighted the value of **open development** practices in our last deep dive, emphasizing transparency and collective problem-solving within the community
4. Use of **GitLab** to represent our natESM system and foster open development, enabling seamless collaboration and transparency across the community

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Initiate working groups

Currently, no active working group

Great opportunity to collaborate on topics of interest with colleagues from other institutions, without any obligations.

Land-ice component, education website, summer school

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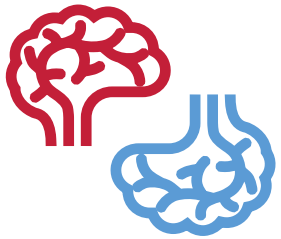

Shape workshops

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Focus workshops are great to kickstart a working group. Reach out to Iris, and we'll help organize it to meet your needs.

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Expanding natESM system with Extended Core Components

Core

Fundamental models for basic Earth system modeling. It's natESM's responsibility to seamlessly integrate core components into natESM system.
Currently: ICON-A, FESOM, ICON-O

Extended Core

Comprehensive models for Earth-system interactions. It's natESM's responsibility to seamlessly integrate extended-core components into natESM system.
Currently: ICON-Art

Infrastructure

Tools and interfaces that connect core and extended core components, ensuring seamless functionality. It's natESM's responsibility to oversee integration of these components into the system.
Currently: YAC, ComIn

Impact

Specialized models enabling one-way interactions within the system. natESM assists with their integration to expand the modeling system's reach and functionality.
Currently: None

Optional

Community-suggested models for future integration, visible for exploration but not part of the main system. These can become extended core components if they meet our acceptance criteria as outlined in the natESM strategy.
Currently: 46 (30 with more details)

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Showcase models

So far, you provided 46 optional components, 30 of which have dedicated pages with more detailed information.

Our GitLab enables transparency across the community.

Summary and Outlook

Summary

We are committed to ensuring transparency in presenting our system. However, much work remains to expand it so that our ESM framework comprehensively covers the entire Earth system. This will require all of us to collaborate and work towards a common goal.

The cooperation and dedication of contributing organizations are crucial for natESM. Formal contracts are impractical; voluntary participation is key, given the evolving priorities of model-developing institutions.

The lessons learned from our sprints are vital. RSEs continue to improve their skills, enhancing their ability to support our core and infrastructure components.

The steering group evaluates the inclusion of components based on technical criteria and sprint outcomes. Unsustainable components will be removed to ensure the continued relevance and effectiveness of natESM.

Outlook

natESM2 proposal submitted

natESM2 project-proposal highlights

Unlike model-development projects like WarmWorld, natESM integrates these developments into a cohesive ESM framework.

natESM complements these projects by enhancing non-fluid components such as biogeochemistry, land processes, atmospheric chemistry, and land ice, ensuring broader, community-wide impact.

By incorporating machine learning, we aim to improve usability of model results for Earth system and climate applications.

ML will support downscaling and extrapolating data for various impacts, and enhance collaboration within our community.

Goal is to make our services more accessible and appealing to more institutions.

We want to facilitate access to the following well-defined model configurations:

1. Ensemble simulations (1-2 centuries; ocean, atmosphere, carbon cycle)
2. Ensemble simulations (millennia; ocean, atmosphere, carbon cycle, ice sheets, solid Earth)
3. Air-quality simulations (atmospheric chemistry, aerosols, possibly ocean)
4. Ultra-high-resolution simulations (atmosphere and ocean at ultra-high resolutions)