natESM

DKRZ DEUTSCHES KLIMARECHENZENTRUM

JÜLICH Forschungszentrum | JÜLICH SUPERCOMPUTING CENTRE

DKK Deutsches Klima Konsortium

Federal Ministry of Education and Research

Building the future of Earth System Modeling

How natESM connects people, code, and climate

Iris Ehlert (DKRZ)

Students' responses on menti.com

If Earth System Modeling were a team sport, what would it be?

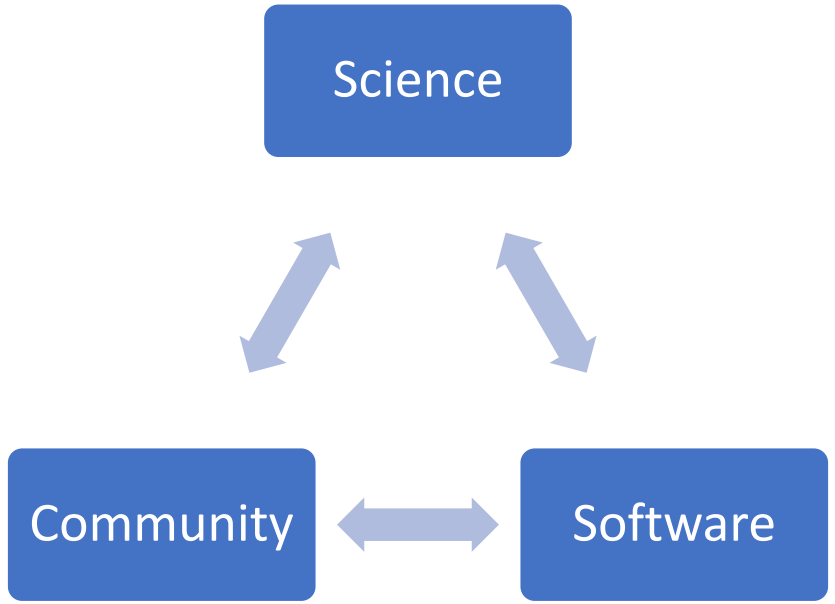
Why natESM?

- Many legacy models → little interoperability
- Local optimizations, duplicated work
- Heterogeneous HPC hardware (CPU, GPU, accelerators)
- Need for sustainable collaboration

The idea in one sentence

natESM is a community-driven effort to future-proof

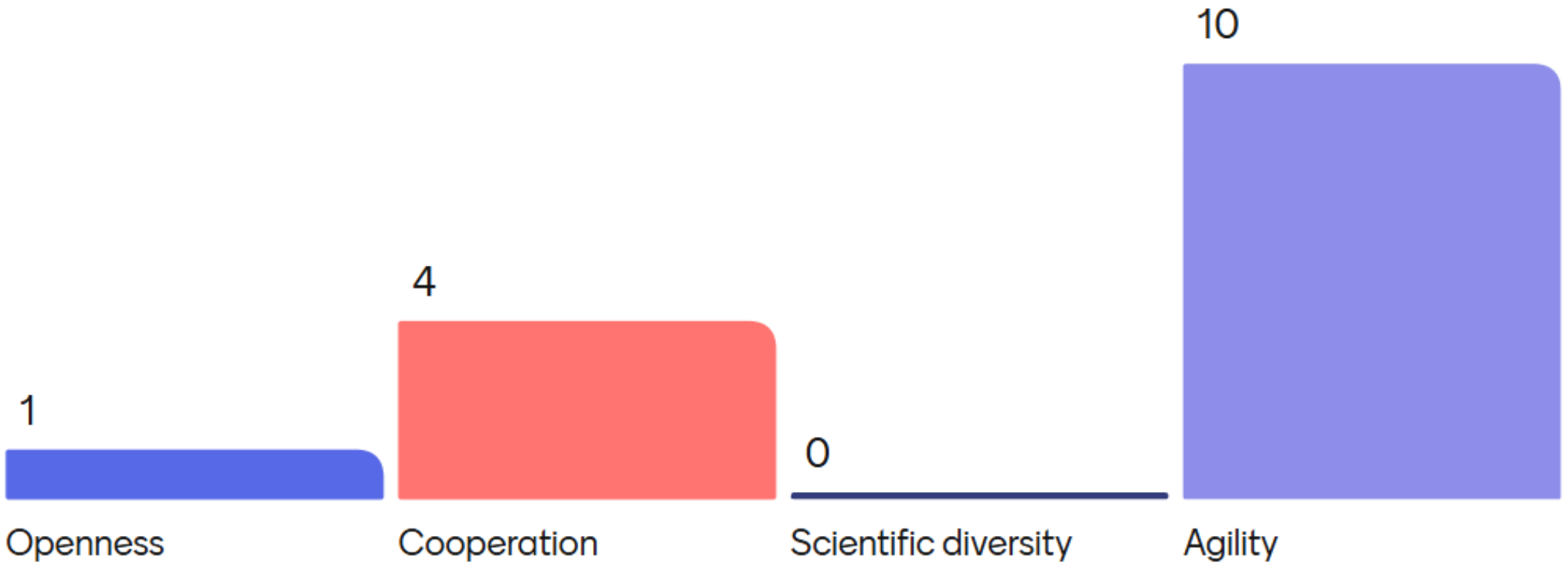
Earth system modeling in Germany — technically, scientifically, and socially.



natESM guiding principles (values)

🌍 Openness | 🤝 Cooperation | 🔬 Scientific diversity | ⚡ Agility

Which natESM value do you think is hardest to achieve in practice?



Governance & services

Steering committee

- Define strategy, governance, basic configurations, working groups
- Members represent core components and their institutional responsibility
- Composed of community members

Process coordinator

RSE support team

- Conducts and organizes **sprints** together with applicants
- Quality control
- Manages Git repositories
- Gives advice and help for working groups
- Integrates **components of the full ESM system**

Community

Volunteers for cooperation in working groups, makes their models available for rest of community, defines focus workshops, and applies for sprints

Architecture snapshot: components of the natESM system

Core

Fundamental models for basic Earth system modeling.
Currently: ICON-A, FESOM, ICON-O

Extended Core

Comprehensive models for Earth-system interactions.
Currently: ICON-Art

Infrastructure

Tools and interfaces that connect core and extended core components, ensuring seamless functionality.
Currently: YAC, ComIn

Impact

Specialized models enabling one-way interactions within the system.
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)

The sprint process

- Up to 6 months intensive collaboration
- RSE + scientists = joint development
- Sprint check mandatory before funding
- Weekly sprint-team meetings, documented outcomes
- Mattermost
- Empowers scientists to continue

Sprint check → Proposal → KickOff → Status meeting → Report

Example: The CLEO sprint (Jan-Aug 2024, PhD student project)

Sprint team

Scientist: Clara Bayley (PhD student, MPI-M)

RSE: Wilton Jaciel Loch (DKRZ)

Objectives

- Couple CLEO ↔ ICON via YAC (one-way → two-way prep)
- Add domain decomposition & parallelization

Outcomes

- One-way coupling operational
- Parallelization functional
- New ICON microphysics group formed

Relevance

- PhD-led sprint with RSE + institutional support
- Shows how natESM empowers young scientists

Students' responses on menti.com

Pretend you had six months and expert RSE support — what would you tackle?

Validating the model with observation?

Readying models for exascale computing

natESM in action – achievements & challenges

Phase 1 (2022-2025)

- ~20 sprints since 2022 (ICON-ART, FESOM-GPU, HAMOCC, MESSy, PISM…)
- Strong performance gains (up to ×10 speed-up on GPUs)
- Defined core, extended core, and infrastructure components
- Working groups
- Yearly community workshops, focus workshops, and technical trainings

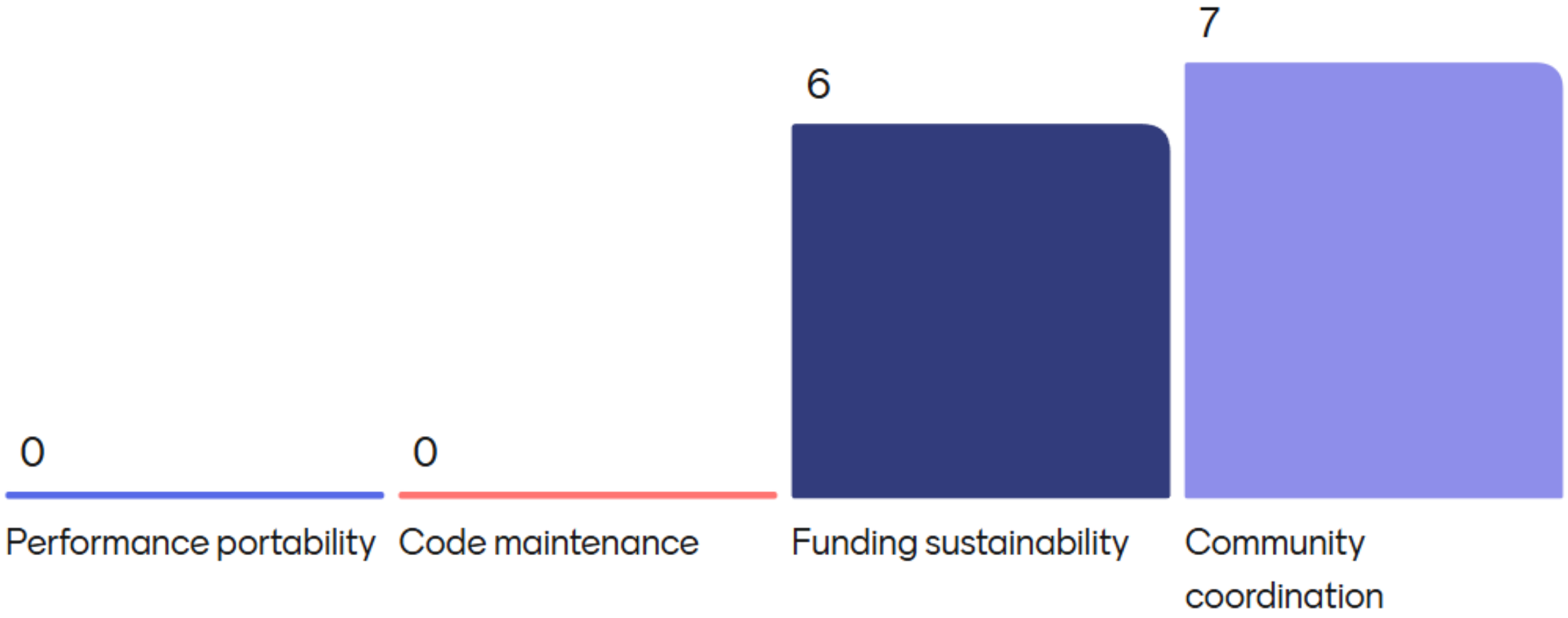
Phase 2 (2025-2029)

- Establish four community-supported model configurations:
  1. Century-scale ensembles (climate change, CMIP, IPCC),
  2. Millennial-scale ensembles (paleo, long-term futures),
  3. Air-quality simulations (chemistry, aerosols, pollution),
  4. Ultra-high-resolution simulations (km-scale atmosphere & ocean)
- Integrate more components (land, land ice, ocean biogeochemistry…)
- 6 RSEs (4 at DKRZ, 2 at JSC)
- Expanding sprint support and training formats
- Engaging impact modelling community

Students' responses on menti.com

What do you think is the biggest challenge for a national modeling system?

Performance portability | Code maintenance | Funding sustainability | Community coordination



How you can get involved

- Start with an idea (e.g., coupling, a diagnostic tool, or a model extension)
- Discuss it with your supervisor, then contact me
- Together with the Steering Committee and RSE team, we check if the idea fits into the natESM framework
- If yes, we identify a supporting institute (Helmholtz, Leibniz, MPG, …) that can maintain it beyond your PhD
- Once everything aligns, you can apply for a sprint --- strengthen your code, gain visibility, and contribute to a national modelling system

Key takeaways

natESM brings together people, code, and institutions — to build a shared, future-proof Earth system modeling capability for Germany.

- **Integration needs collaboration:** no single institution can do this alone.
- **Sprints turn ideas into impact:** focused, supported, and visible work.
- **Collaboration beats isolation**: strategy grows from daily practice.
- **Sustainable code = shared responsibility**: Sustainable code needs institutional homes.

- **The next idea might be yours** ☺.

Questions & contact

Get in touch if you have an idea for a sprint or a training need.

Contact

Dr. Iris Ehlert (Process coordinator)
Phone: +49 40 460 094 289
Email: ehlert@dkrz.de

Learn more at:
https://nat-esm.de