Project: **1235**

Project title: **NextGEMS**

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Report period: **2025-11-01 to 2026-10-31**

nextGEMS uptake in 2026 beyond the project's end

Thanks to DKRZ's generous offer to continue hosting and supporting access to the nextGEMS simulation data throughout 2026, the scientific community was able to continue exploiting these simulations beyond the formal project period. This continued access supported ongoing work by Master's students, PhD students, postdoctoral researchers and other scientists and led to further scientific results and publications in 2026.

A recent example of this continued scientific uptake in 2026 is a publication in *Science Advances (Carniel et al. 2026)*. The authors used the kilometre-scale ICON and IFS-FESOM nextGEMS simulations to demonstrate that coarse model grids can underestimate local coastal humid-heat extremes, with spatial smoothing reducing daily maximum wet-bulb temperature extremes by up to 8°C. The nextGEMS simulations are particularly valuable to be hosted at DKRZ at high resolution for this analysis because their native resolution allows local coastal extremes to be represented explicitly, whereas precisely this information is suppressed when the fields are coarse-grained.

A second example is Brunner et al. (2026), who evaluated the spatial patterns of surface temperature in the kilometre-scale nextGEMS simulations in the context of 150 coupled global climate models developed over the past three decades. They found that the kilometre-scale IFS-FESOM simulation outperforms even the best CMIP6 models, despite the comparatively limited tuning of these new model configurations. Importantly, the comparison also shows that high resolution alone is not sufficient to improve model skill, providing both strong evidence for the quality of IFS-FESOM and guidance for the further development of global storm-resolving climate models.

Performed new simulations in 2026

As part of the DYAMOND 3 protocol (Takasuka et al., 2024), the nextGEMS DKRZ compute project decided to contribute by running the ICOsahedral Non-hydrostatic model (ICON) in its global atmosphere-only storm-resolving model (Hohenegger et al., 2023) with a horizontal grid spacing of 2.5 km. This means that convection is explicitly resolved. Compared to the ICON run used in the Global Hackathon 2025, where two IFS configurations and the initial ICON simulation had been provided, there are changes in the parameterisations:

- Changes in the approximation of terminal velocities of hydrometeors (Ortega et al., 2026; Fiévet et al., 2026).
- Correction of a bug in the roughness length calculation (https://gitlab.dkrz.de/icon/icon-mpim/-/merge_requests/1068)
- Effective wind is calculated including ocean currents.
- Additional vertical mixing due to the Louis formulation was deactivated over land.
- Radiation tuning at TOA to get TOA energy balance. This has been taken from the JCP project (https://gitlab.dkrz.de/sapphire-experiments/jcp)

The simulation is integrated for 14 months, starting on the 1st of January, 2020, and using a prescribed sea surface temperature field, as well as prescribed sea ice. Technical details of the simulation are:

- The time step is 20 seconds.
- 512 nodes are used.
- The throughput (τ) is 0.0234 simulated days per day per node.
- With this τ, 435 200 node hours are needed to complete the simulation.
- The output is on the Healpix grid, from zoom 11 to zoom 0, including 2D and 3D variables. The total amount of data is ~196 TB. Variables are described in https://gitlab.dkrz.de/icon/icon-mpim/-/work_items/510.

At the moment, the simulation is in January 2021 and we expect to finish the simulation with the remaining resources. One of the aspects that the simulation should simulate correctly is the structure of the tropical rain belt. Figure 1 shows the structure of the tropical rainbelt for the first 12 months of simulation (January to December 2020). As expected, the simulation reproduces the observed structure of the tropical rainbelt.

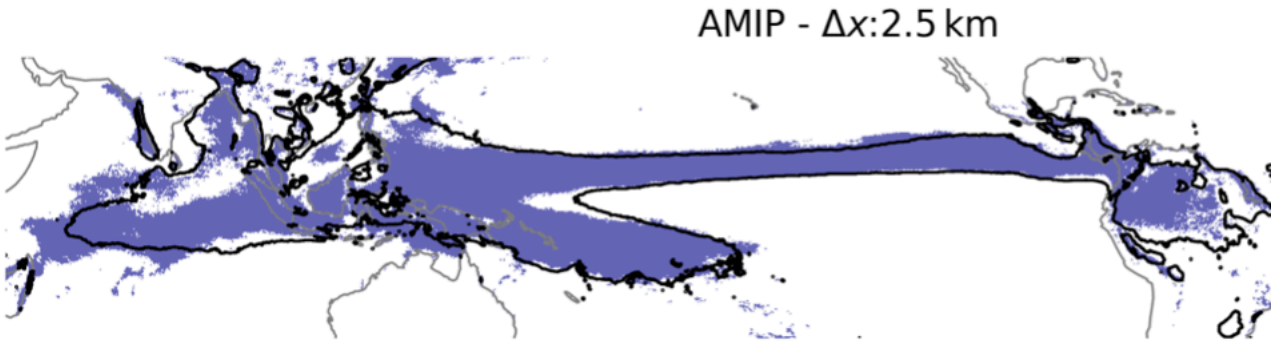


Figure 1. Tropical rainbelt in ICON (blue shaded) and IMERG (black contour). The tropical rainbelt is the quantile 80th of the yearly mean, 2020 for ICON and 2001-2023 climatology for IMERG.

Although the formal nextGEMS project has ended, this simulation builds directly on the nextGEMS modelling developments and contributes them to the international DYAMOND3 intercomparison, thereby allowing the nextGEMS developments to continue to be scientifically exploited and evaluated.

References:

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