Project: **1469**

Project title: **CAP7 -- The German Contribution to the 7th Coupled Model Intercomparison Project (CMIP7)**

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

Maximum of 2 pages including figures. 9 pt minimum font size.

CAP7 has made good progress. The decision was made to produce the concentration-driven experiments of ICON-XPP, which are scheduled before emission-driven simulation, on the DWD computer (RCL). This partly explains why only ~66% of the CPU node hours have been used so far[1] . AWI simulations and emission-driven simulations using ICON-XPP-ED are still going ahead on Levante (table 1). ICON-XPP-ED has only just started its PIcontrol simulation because coupling in the QUINCY land surface model required a retuning of the model. However, increased usage of ICON-XPP-ED is anticipated for the remainder of the year as this model is now rapidly approaching the point when multiple runs will be branched off this PIcontrol simulation. These runs are all scheduled to be produced on Levante as QUINCY has not been vectorized and thus cannot be run on the DWD machine.

Disk space has proven a bigger constraint than CPU limitations. ICON-XPP simulation results have largely been mirrored to Levante for CMORization and possible archiving. CMORization is still not fully operational, causing a backlog of data on disk. We have received an additional 500 TByte of temporary diskspace to alleviate this problem.

The current status of the ICON-XPP contribution to CMIP7 is that a growing list of simulations is complete and mirrored to Levante. The plan is to produce 5 members each of all scenarios. For the concentration-driven side of the ICON-XPP submission, and given that three of seven scenarios are as yet incompletely defined, we are on schedule to completely deliver alll ICON-XPP simulations planned under the CAP7 project. Three more scenarios will become available in 2027. Assuming no constraints on disk space, it will take us <2 months to fully deliver all planned simulations for these additional scenarios once the forcing data is available. Table 1 has a list of completed simulations. These data are currently awaiting CMORization and submission to the ESGF.

We have used 1.2 Mio node hours, 0.6 Mio remaining.

Experiment	Length / Period	Status ICON-XPP	Status ICON-XPP-ED	AWI-ESM3-veg-HR	AWI-ESM3-cc-LR
PIcontrol	500	complete	In prep	256/400y	1x in production
4xCO2	300	complete		165/400y	1x in prep
1pctCO2	150	complete		complete	1x in prep
historical	1850-2021	5x complete		96/172y	1x in prep
AMIP	1979-2021	complete		1x in prep	1x in prep
PiClim-control	40	complete		20/40y	1x in prep
PiClim-anthro	40	complete		1x in prep	1x in prep
PiClim-4xCO2	40	complete		1x in prep	1x in prep
Scen-H	2022-2100	5x complete		1x in prep	1x in prep
Scen-M	2022-2100	5x complete		1x in prep	1x in prep

Scen-VL	2022-2100	5x complete		in 2027 *	1x in prep
Scen-HL	2022-2100	5x complete		in 2027 *	1x in prep
Scen-H-ext	2101-2150	3x complete		in 2027 *	1x in prep
Scen-M-ext	2101-2150	3x complete		in 2027 *	1x in prep
Scen-VL-ext	2101-2150	3x complete		in 2027 *	1x in prep

Table 1: Status of the simulations at the end of the 2026 reporting period.

Scientifically, ICON-XPP has been shown to be a middle-of-the-road model with its Equilibrium Climate Sensitivity and Transient Climate response values almost exactly matching the best estimates of the 6th Assessment Report of IPCC (3 and 1.8 K, respectively). The historical evolutions of global-mean surface-air temperature (GMSAT) and ocean heat content are quite near observational benchmarks. Sea ice extent is biased (with too much ice occurring in the Arctic, and Southern-Ocean summer ice underestimated); however substantial ice loss is modelled for the Arctic and much smaller ice loss for the Antarctic, in agreement with observations. The model is struggling with the El Niño / Southern Oscillation (it does not well represent its geographical footprint). The annular modes are well represented. The Quasi-Biennial Oscillation has roughly the right periodicity and morphology, but its amplitude is too small.

Remaining tasks include production of more simulations with ICON-XPP, with a target of 5 ensemble members for all 7 scenarios including their extensions to 2150, completion of CMORization, and archiving of the large amounts of data. Archiving the data will allow us to free up disk space, so more simulations can be produced. This is a slow process; archiving will therefore be split between Levante and the DWD archive, SKY. The speed of archival will eventually determine how quickly more simulations can be produced. Similarly, for ICON-XPP-ED operational production of more DECK and ScenarioMIP simulations is now beginning.

The AWI contribution uses AWI-ESM3 (OpenIFS 48r1, FESOM2, LPJ-GUESS) in two configurations. The high-resolution veg-HR (OpenIFS Tco319, about 30 km; FESOM2 on the eddy-permitting DARS2 mesh, 2 to 33 km; interactive vegetation) runs the concentration-driven experiments. 1pctCO2 (150 years) is complete, and 4xCO2 (165 of 400 years), PIcontrol (256 of 400 years) and the first historical simulation (up to 1945) are in production (Table 1). The control climate is stable, with a drift of less than 0.01 K per century. With an Equilibrium Climate Sensitivity of 4.3 K and a Transient Climate Response of 2.3 K, veg-HR is more sensitive than the IPCC AR6 best estimates and its CMIP6 predecessor AWI-CM-1-1-MR (3.2 and 2.1 K). It runs at 7 simulated years per day on 125 nodes; CMORization of the first veg-HR experiment is ongoing and will be finished this year. The lower-resolution cc-LR adds ocean biogeochemistry and an interactive carbon cycle for the emission-driven experiments. We used the reporting period to spin up and tune it: the pre-industrial climate has a top-of-atmosphere imbalance of about 0.3 W m^{-2} with realistic sea-ice cover and Atlantic overturning, the carbon pools are close to stable, and the production version has been frozen (AWI-ESM3 v3.5.0-cc). Its control simulation is in production, with the remaining experiments to follow.

* Limited compute ressources in 2026 did not allow for parallel production of all 7 scenarios.