Project: 1406

Project title: **RESM4CORDEX (Regional Earth System Model simulations for CORDEX)**

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

Summary

RESM4CORDEX evaluates and CMORises the simulations of the Hereon Regional Earth System Model GCOAST and contributes them to EURO-CORDEX. In the report period, two GCOAST configurations were used:

- NECOS: NEMO3.6 + ECOSMO coupled via FABM, forced by ERA5 and ORAS5
- AHOIB1-1: CCLM6.0 + NEMO3.6 + HD5.2 + ECOSMO coupled via OASIS3-MCT and FABM, over the EURO-CORDEX domain with ocean coupling over the North Sea and Baltic Sea

The simulations were computed with resources of bg1315 (CoastalFutures) and gg0302 (Regional Atmosphere Modelling). bg1406 was used for evaluation, preparation for CMOR and archiving.

The main results of the period are:

(1) The atmospheric output of two AHOIB1-1 hindcasts was CMORised and published on ESGF.

(2) The initial-state part of the Baltic Sea salinity bias was identified and removed by a cold start; a remaining bias in the coupled run motivates hypothesis H3 of the 2027 request.

(3) The bias in short wave downward radiation (SWDN) of CCLM was quantified, and the bias correction and coupling method were revised accordingly.

Simulations (IDs as in the 2027 request)

ID	*Version*	*Simulation*	*Period*	*Years*	*Forcing*	*Status*	*Storage (TiB)*
S2	*NECOS4*	*Hindcast, cold start*	*1959–2021*	*63*	*ERA5 & ORAS5*	*Finished*	*32*
S4	*AHOIB1-1*	*Hindcast, warm start*	*1959–2021*	*63*	*ERA5 & ORAS5*	*Finished; atm. CMORised, on ESGF (v1-r1)*	*44.2*
S5	*AHOIB1-1*	*Hindcast, cold start*	*1959–2021*	*63*	*ERA5 & ORAS5*	*Finished; atm. CMORised, on ESGF (v1-r2)*	*68*
S6	*AHOIB1-1*	*Hindcast, SWDN +10 %, state-variable coupling*	*1959–2021*	*63*	*ERA5 & ORAS5*	*Running*	*68 (est.)*
S7	*AHOIB1-1*	*Historical, S6 setup*	*1950–2014*	*65*	*MPI-ESM1-2-HR*	*Finished, under analysis*	*76*
S8	*AHOIB1-1*	*SSP3-7.0, S6 setup*	*2015–2100*	*86*	*MPI-ESM1-2-HR*	*Running, end Jan–Feb 2027*	*101 (est.)*

Scientific results

Baltic Sea salinity and initial conditions

The earlier NECOS2 run had a salinity bias in the Baltic Sea. It was restarted from a spin-up that still contained the discharge error and lacked the corrected Neva mouth. A cold start (NECOS3) removed this

bias. NECOS3 was then rerun as NECOS4 because the initial silicate concentration for ECOSMO had accidentally been doubled; this changed only the ecosystem variables, not the ocean physics. NECOS4 was evaluated against in situ observations, CMEMS and ORAS5. The evaluation showed that NECOS4 performs well. A manuscript summarizing the evaluation results is in preparation.

The coupled hindcast S4 has the same initial-salinity problem because it was also started from a biased initial state. S5 was therefore run with a cold start. The salinity bias of S4 hardly affects the atmospheric variables. In the cold-start run S5, a salinity bias larger than in NECOS4 remains, which motivates hypothesis H3 of the 2027 request.

Shortwave radiation and coupling method

Compared with ERA5 (the atmospheric forcing for NECOS), CCLM underestimates SWDN by 5–20 %. Without correction, this leads to a cold SST bias of 1–2 °C in the Baltic Sea. With SWDN increased by 20 % before passing it to NEMO, S5 shows a warm SST bias of 0.5–1 °C. S6 therefore uses a +10 % correction. S6 also changes from mixed coupling to state-variable coupling, making the coupled ocean forcing consistent with NECOS4. In mixed coupling (S5), NEMO computes latent and sensible heat fluxes itself and averages them with the CCLM fluxes (Ho-Hagemann et al., 2024). In state-variable coupling, NEMO receives the same type of variables from CCLM as it receives from ERA5 in NECOS4. The historical (S7) and scenario (S8) runs use the S6 setup.

Contribution to EURO-CORDEX

The CMORised atmospheric data of S4 and S5 are published on ESGF as GCOAST-AHOIB1-1.v1-r1 and v1-r2. They are used in several ongoing EURO-CORDEX joint publications, where they perform well. S6, S7 and S8 will be CMORised and published once finished.

Use of resources

bg1406 used 5,664 of the granted 7,500 node hours. These went into three tasks: preparing the S4 and S5 output for CMOR (126 simulation years), evaluation scripts, and archiving to HSM. Preparing the atmospheric output of S4 and S5 (126 simulation years) for CMOR used about 252 Nh in total, i.e. about 2 Nh per simulation year. The preparation consists of several scripts: cropping all 2D variables, processing each 3D variable separately, correcting time labels and converting time intervals. This value is the basis of the estimate in Table 1 of the 2027 request. In 2026, the CMORisation of S4 and S5 was carried out by DKRZ (M. Schupfner) and is therefore not included in the bg1406 usage. Of the granted 221 TiB on /work, 168 TiB are in use (Oct 2026), mainly the atmospheric time series of S3, S4 and S5, the archiving buffer and an older standalone CCLM run that will be deleted.

Deviations from the plan

The 2025 request planned test simulations with GCOAST-AHOI3 (ICON-RESM: ICON-CLM, ICON-O in limited-area mode and HD) at ~3 km over the EURO-CORDEX domain. ICON-RESM has not yet been made available to us, so these tests were not carried out. They are not part of the 2027 request.

Publications

- GCOAST-AHOIB1-1.v1-r1 and v1-r2, atmospheric data on ESGF (https://metagrid-ceda.east.esgf.io)
- NECOS4 performance evaluation, manuscript in preparation (Mashayekh et al., 2026)
- GCOAST-AHOIB1-1 performance evaluation, manuscript in preparation (Ho-Hagemann et al., 2026)
- Contributions to ongoing EURO-CORDEX joint publications: Overall evaluation (Fernandez et al., 2026); Surface wind climatology (Gutiérrez et al., 2026); Köppen–Trewartha climate classification (Szabó et al., 2026); Precipitation extremes (Evin et al., 2026), etc.