

Project: **1448**

Project title: **First steps towards the realisation of the Tipping Point Modelling Intercomparison Project (TIPMIP): Results from coupled Earth system models**

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Report period: **2025-05-01 to 2026-04-30**

Summary

In the last year, TIPMIP has started with the actual model intercomparison process, using the first set of outputs from Tier 1 ESM experiments. Levante has and will play a central role in this as a centralized computational platform for data sharing and analysis. The first datasets from TIPMIP-Ocean will also soon be available, from experiments where the impact of anthropogenic forcings on AMOC stability is studied. These will also be used in another set of intercomparison studies. Furthermore, we also plan to use these outputs to drive simulations of ice sheets, biosphere, and permafrost subsystems, and study their responses as well. The experimental protocols for these three domains have been in continuous development, and are close to completion.

Advances for each modelling domain

Earth System Models

The ESM domain has reached a major milestone with the submission of the [TIPMIP-ESM Protocol](#) (Jones et al., 2025). On the technical front, all participating models have finished their core simulations, and a few groups have gone further by providing additional experiments and larger ensembles.

To keep things moving, DKRZ is currently hosting the central data exchange between our modeling teams and analysts. This setup is already fueling the first wave of multi-model analysis (MMA) papers, which we expect to submit by June 2026. DKRZ is also serving as the primary analysis space for the MMA papers currently in progress.

Looking ahead, we are using the current ESM output to pin down the forcing data for standalone models. These early results are also proving essential for shaping our next-tier development plans.

Ocean

The Ocean domain completed its protocol in late March and made it available as a [preprint](#) (Swingedouw et al., 2026). The essential purpose of the experiments is to provide additional information on the influence of freshwater released by melting ice sheets, which may be poorly

represented in CMIP simulations. So the models will run experiments to assess their sensitivity to this additional forcing and its potential consequences. The protocol includes 4 main experiments and a wide range of tiers. It is expected that there will be broad participation, but so far, the contributors for tier 1 are 8 models for Experiment A, 3 for Experiment B, 11 for Experiment C, and 5 for Experiment D.

The DKRZ will be central to organizing the data this year. It is expected that many contributors will generate their model outputs by June 2026 and that some data must be available in the DKRZ for mutual sharing among the groups and MMA production. The final stepstone will be to publish this data in the DKRZ/ESGF node by September 2026. Some participants will need different amounts of storage before and after the CMOR final versions are available for ESGF. Everything aligns with the additional resources contemplated in this round.

Ice sheets

Within this allocation period, the experimental protocol for assessing ice-sheet tipping risks in Greenland and Antarctica in TIPMIP-ICE SHEETS has been defined with feedback from various groups in the ice-sheet modelling community. The protocol will be outlined in a respective paper (Winkelmann/Klose et al., to be submitted). The experiments in TIPMIP-ICE SHEETS will be based on changes in polar climate derived from TIPMIP ESMs. For this purpose, a processing pipeline (including, e.g. regridding and extrapolation of data using CDO/NCO tools as well as Python) has been developed to make the TIPMIP-ESM output applicable to stand-alone ice-sheet models.

Permafrost

To determine appropriate forcing conditions for land surface models (LSMs) participating in the TIPMIP permafrost domain, analysis of the TIPMIP-ESM ensemble (Jones et al., 2025) has been conducted. This work informs the design of both Tier 1 and Tier 2 forcing protocols. During the reporting period, we completed three analyses: 1) sensitivity of temperature response to CO₂ increase; 2) regional temperature and precipitation response to global warming; 3) preliminary assessment of permafrost area reversibility. The design of the Tier 2 experiment forcing protocol is currently underway. The Tier 2 approach is based on targeted modification of hydrometeorological boundary conditions, including temperature, precipitation and snow cover, to selectively accelerate permafrost degradation beyond what is achieved under standard warming scenarios. This will allow investigation of non-linear responses, tipping thresholds and irreversibility under amplified forcing conditions.