Project: 105
Project title: ANDIVA (Analyse, Diagnose und Validation)
Report for period 01.01.2025 - 31.12.2025

During the year 2025, the project was mostly used for model calibration/configuration for different applications, as well as data analysis with high computing time and storage requirements. Also testing of analysis/forecast tools for atmospheric river detection on GPUs have been performed. Additionally, resources were used for tasks within the CLM-Community for developing, testing and running specific tools (see below). In this report, we give a short overview of achieved and ongoing research projects.

Testing/Calibrating COSMO/ICON-CLM including Urban Scheme

Within the CORDEX-FPS-Urban project, the added-value of urban parametrization schemes are tested in a coordinated effort. KIT contributes to these modeling activities with the COSMO-CLM and ICON-CLM including the urban scheme in the land surface model Terra (Terra-Urb). We used resources in this project to calibrate and test the urban scheme before starting the official STAGE 1 (Urban simulations over the Paris region; performed in project 1508) simulations in CORDEX FPS-URB_RCC in 2025.

Development of a CMIP6-converter

KIT develops a converter that produces ready-to-use input files based on available CMIP6 data in the DKRZ data pool (pool/data). The overall aim is to build a flexible converter, that produces caf-files (that can be read by either COSMO-CLM and ICON-CLM) from selected CMIP6 models. The caf-files will be used in the next CORDEX activities by various modelling groups around the world (including BMBF-funded UDAG-project 1369). In 2025 still caf-files of additional scenarios have been created. Available caf-files as forcing data can be found in /pool/data/CLMcom/ICON-CLM/gcm/forcing. Further models/scenarios will be considered in the 2026. (https://gitlab.dkrz.de/clm-community/cmip2caf-converter)

Developing, testing, and running of the SPICE and the EvaSuite tool for the CLM-Community

DKRZ resources have been used in 2025, for the development, testing, and evaluation of the CLM Community tools like SPICE (Starter Package for ICON-CLM Experiments) and EvaSuite analysis tool. EvaSuite is a specialized software framework designed for the evaluation of climate model simulations through comparison with gridded reference datasets (which may use either regular or rotated coordinate systems). These reference datasets can be observation-based or model-based. The tool enables the computation of a wide range of performance and skill metrics — currently around 50 different metrics — over user-defined temporal and spatial selections, offering flexibility for a broad spectrum of scientific applications. EvaSuite can operate both as a fully automated component, for example within the SPICE system (a runtime environment for performing climate simulations with the regional climate model ICON-CLM), or as a stand-alone application. Within the CLM Community, EvaSuite provides a standardized framework for the evaluation of climate simulations, ensuring reproducibility and comparability of statistical results. This standardization supports systematic benchmarking of model performance across regions and time periods, enabling researchers to identify biases, improve model accuracy, and make informed decisions in climate modeling and impact assessment. During the reported period, significant effort was dedicated to the optimization of EvaSuite in terms of computational performance, scalability, and usability. The DKRZ computing environment was essential for conducting

large-scale testing and performance tuning on high-resolution datasets, ensuring that the tool performs efficiently under realistic operational workloads.

In addition to software optimization, considerable work was dedicated to documentation, user support, and technical maintenance, including:

- Development of a "Quick Start" guide with installation and execution instructions for new users.
- Preparing a package containing hands-on examples with preprocessed data and executable scripts.
- Detailed instructions for adding/modifying shapefiles, input parameters, and configuration files.
- Restructuring and updating of the documentation framework to improve accessibility, readability, and overall user experience.

Overall, the DKRZ resources played a crucial role in enabling the development, evaluation, and dissemination of SPICE and EvaSuite as a robust and community-oriented tools for climate model application and evaluation. As the final result of this work, we prepared the open releases of the tools:

SPICE - https://doi.org/10.5281/zenodo.10047046
EvaSuite - https://doi.org/10.5281/zenodo.17130606

References:
Geyer, B., Churiulin, E., Jähn, M., Brienen, S., Truhetz, H., Poll, S., & Rockel, B. (2025). SPICE (Starter Package for ICON-CLM Experiments) (v2.3). Zenodo. https://doi.org/10.5281/zenodo.10047046
Petrik, R., Geyer, B., Churiulin, E., Rockel, B., & Braun, C. (2025). EvaSuite (Evaluation Suite for climate data) (v1.0.0). Zenodo. https://doi.org/10.5281/zenodo.17130606

Atmospheric River analysis

ECMWF forecast data and ERA-5 reanalysis was used to validate an atmospheric river (AR detection tool developed on the project. The core objective is to evaluate the tool's performance in a forecast context and explore statistical methodologies to enhance its accuracy. The aim is to contribute directly to improved AR forecasting. Further, we carried out research on the knowledge gap in the lifecycle of extratropical cyclones. We employed composite analysis to systematically investigate the tripartite relationship between the cyclones themselves and their two key associated features: atmospheric rivers and warm conveyor belts. By clarifying the links and interactions between these systems, this research aims to provide a more unified and insightful dynamical picture. This work is part of a PhD project, advancing both the practical forecasting of atmospheric rivers and the fundamental understanding of their parent weather systems.
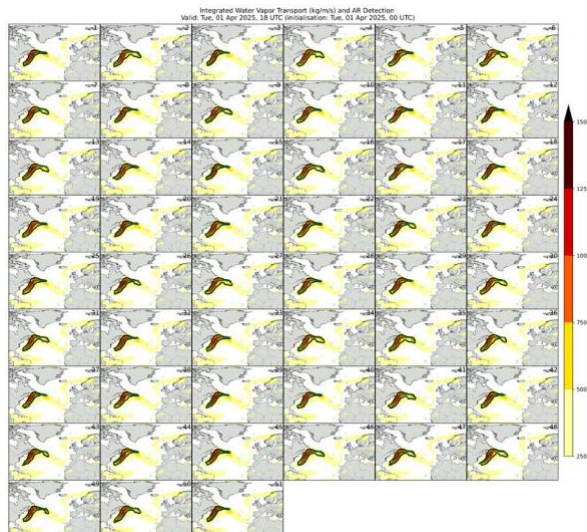
Figure – Application of the atmospheric river detection tool to each one of the 51 members (50 perturbed and one control forecasts) of the ECMWF Forecast Data