Project: 105
Project title: ANDIVA (Analyse, Diagnose und Validation)
Report for period 01.01.2026 - 31.12.2026

During the year 2026, the project was mostly used for model calibration/configuration tests for different applications, as well as data analysis (Atmospheric Rivers) that require high computational and storage requirements. 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.

Development of a CMIP6-converter

KIT has developed a converter that produces ready-to-use input files based on available CMIP6 data in the DKRZ data pool (pool/data). The caf-files can be read by either COSMO-CLM and ICON-CLM as initial and boundary data and are available for selected CMIP6 models. The caf-files will are used for the ongoig CORDEX activities by various modelling groups around the world. In 2026 still caf-files of additional scenarios have been created and a bug in MIROC6 caf files has been corrected. All caf-files are available in /pool/data/CLMcom/ICON-CLM/gcm/forcing. Further models/scenarios will be considered in the 2027. (https://gitlab.dkrz.de/clm-community/cmip2caf-converter)

Developing, testing, and running of CLM-Community tools (SPICE, EvaSuite UrbnPlots)

EvaSuite[1] is a modular software framework developed for the standardized evaluation of regional climate model simulations against observational and model-based reference datasets. It supports approximately 50 statistical performance and skill metrics, with flexible spatial and temporal selections. EvaSuite can be used as a standalone application or integrated into larger evaluation systems, such as SPICE, ensuring reproducible and comparable scientific results. Development activities focused on improving computational efficiency, scalability, usability, and overall reliability of EvaSuite, particularly through the development and testing of version ***1.0.4.*** Key improvements included restructuring the documentation[2] using MkDocs, simplifying the execution workflows and SLURM job configurations, modernizing the Python installation procedure, and improving system configuration and diagnostics. Development of v***ersion v2.0*** is ongoing.

SPICE[3] provides a framework for setting up, running, and managing regional climate simulations with ICON-CLM. It combines data pre-processing, model execution, archiving, and post-processing, with the option to integrate evaluation tools such as EvaSuite. During 2026, development activities focused on preparation *SPICE version 2.4*, with improvements to workflow stability, usability, maintainability, and compatibility with HPC environments. This included reviewing and refining job execution procedures, simulation configurations, data processing workflows, and supporting utilities, along with updates to the documentation[4].

UrbanPlots[5] is a new visualization and analysis tool working with high resolution ICON climate model data over urban areas. It focuses on the spatial representation and analysis of urban climate simulations, with support for integrating *OpenStreetMap (OSM)* data and the possibility to incorporate additional geographical and thematic layers. This allows climate model results to be visualized and interpreted in the context of urban structures and geographical features. During 2026, development focused on establishing the initial functionality of *UrbanPlots*, implementing workflows for processing and visualizing high resolution ICON data, and integrating *OpenStreetMap* layers. The tool was designed with a flexible structure to support additional spatial datasets and visualization capabilities in future versions. Documentation is available online.

ClimSuite AI Agent is a new AI-assisted platform designed to simplify the configuration, validation, and execution of climate analysis workflows through a conversational interface. The current implementation focuses on UrbanPlots, allowing users to configure and run analysis workflows using natural language instructions instead of manually editing configuration files. The platform combines *LangGraph* based AI agent orchestration with a *Streamlit* web interface and dedicated services for configuration management, dataset validation, and controlled workflow execution. This tool is currently in a developing state and will be continued in 2027.

Links:

[1] *https://gitlab.dkrz.de/clm-community/public/evasuite*

[2] https://clm-community.gitlab-pages.dkrz.de/public/evasuite/

[3] https://gitlab.dkrz.de/clm-community/public/spice

[4] https://clm-community.gitlab-pages.dkrz.de/public/spice/

[5] https://gitlab.dkrz.de/clm-community/public/evasuite-addons/evasuite_urbanplots

Atmospheric River analysis

Composite-based analysis of the linkage among Atmospheric Rivers (ARs), Warm Conveyor Belts (WCBs) and Extratropical Cyclones (ETCs) and improvement predictability of extreme precipitation events through the AR-WCB-ETC combined forecasts:

Operational models often struggle to accurately represent the timing and location of AR-related precipitation extremes, partly because they may not adequately resolve the mesoscale dynamics that govern the interaction between the AR's moisture plume and the WCB's ascent. The finding that precipitation maxima are displaced from the IVT core (Figure 1) underscores the need for forecast verification metrics that assess not just the AR's position and intensity but also the model's ability to correctly simulate the location of frontal ascent and embedded convection. Rather than evaluating each system in isolation, we combine ensemble forecasts of ARs, WCBs and ETCs into a single, physically based indicator of the risk of extreme precipitation. AR detection, WCB identification and ETC tracking are applied to each of the 51 members of the ECMWF Ensemble Forecast System, yielding probabilistic forecasts for each system and, more importantly, for their co-occurrence and relative positioning (e.g., the AR moisture plume overlapping the WCB ascent region in the warm sector of the cyclone). These combined probabilities are verified against ERA5 and surface precipitation observations, and compared with the ensemble precipitation forecast itself, to assess whether the joint AR-WCB-ETC signal provides earlier or more reliable warnings of extreme precipitation at different lead times.

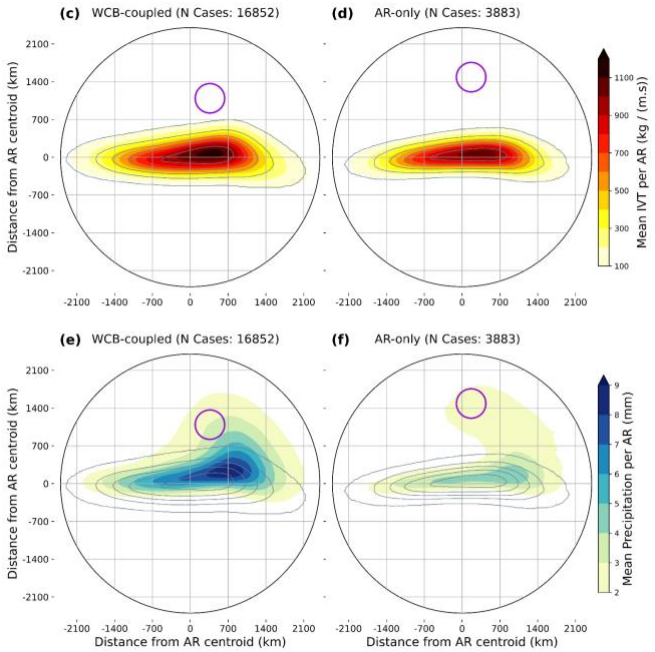


Figure 1 *– Composite fields centered on AR centroids for events with (left column) and without (right column) the WCB ascent phase: (c, d) IVT (kg m-1 s-1); (e, f) total precipitation (mm). The (0, 0) point marks the AR centroid. Purple circle represents the location of the low-pressure center from the SLP composite. Grey contours show the relative frequency of AR occurrence (drawn at 20% intervals, from 10% to 90%).*