Project: **1036**
Project title: **ArctiC Amplification: Climate Relevant Atmospheric and SurfaCe Processes, and Feedback Mechanisms, (AC)³ – Leipzig University contribution**
Principal investigator: **Johannes Quaas**
Report period: **2025-11-01 to 2026-10-31**

This project is about five sub-projects in which Leipzig University contributes to the (AC)³ collaborative research project.

D01: no contributions in reporting period.

D02: Recent studies suggest that air-mass intrusions bring large amounts of moisture and aerosols into the Arctic, significantly impacting clouds and the Arctic climate system. These events are referred to as Atmospheric Rivers (AR) and Aerosol Atmospheric Rivers (AAR), respectively. An AR detection algorithm has been untilized to identify and analyze extreme aerosol and moisture transport events from mid-latitudes to the Arctic. The effect of AAR on AR cloud microphysics was evaluated using the DARDAR and CloudSat datasets available on Levante. The result was that cloud phase revealed a higher cloud-top ice fraction when the aerosol concentration is elevated during ARs (Fig. 1). Currently, a manuscript is in perparation and is expected to be submitted soon.

D04: Analyses of ocean tracer simulations with FESOM2 demonstrated that the high-resolution configuration using the TRAC mesh (1.96 million surface nodes, with variable resolution ranging from 4.5 to 60 km) substantially improves the representation of Arctic Ocean circulation compared with the low-resolution configuration using the standard CORE2 mesh. The simulated tracers were used to estimate water-mass mixing ratios based on ventilation ages within the inverse Gaussian transit-time distribution (IG-TTD) framework. These estimates were combined with an analysis of cold halocline layer (CHL, Metzner and Salzmann, 2023) characteristics to investigate changes in upper-ocean mixing and stratification and their implications for upper-ocean heat redistribution and transport (Al Hajjar and Salzmann, 2026).

E01: Analyses of the changing role of convection for Arctic amplification. In this reporting period, no model simulation where performed but analyses made use of available CMIP6 and ERA 5 data in */pool/data/* to detect and quantify the changing role of convection in the Arctic.

E06: The initial development phase of ICON-ART in its isotope enhanced configuration (ICON-ART-iso) has been completed. In collaboration with Harald Sodemann (University of Bergen) and Hartmut Bösch (University of Bremen), several test simulations were performed and a suitable ICON-ART-iso setup was established. The next step is the evaluation of ICON-ART-iso against COSMOiso simulations and satellite observations from IASI, with a particular focus on the region around Svalbard, covering March 2021, which will be used as a reference for the model evaluation.

References

Al Hajjar, K. and Salzmann, M. Investigating Arctic Ocean Mixing and Heat Distribution Using High-Resolution FESOM2 Simulation. ESS Open Archive, https://doi.org/10.22541/essoar.176797753.39390144/v2, 09 June 2026.

Metzner, E. P. and Salzmann, M.: Technical note: Determining Arctic Ocean halocline and cold halostad depths based on vertical stability, Ocean Sci., 19, 1453–1464, https://doi.org/10.5194/os-19-1453-2023, 2023.

Figures

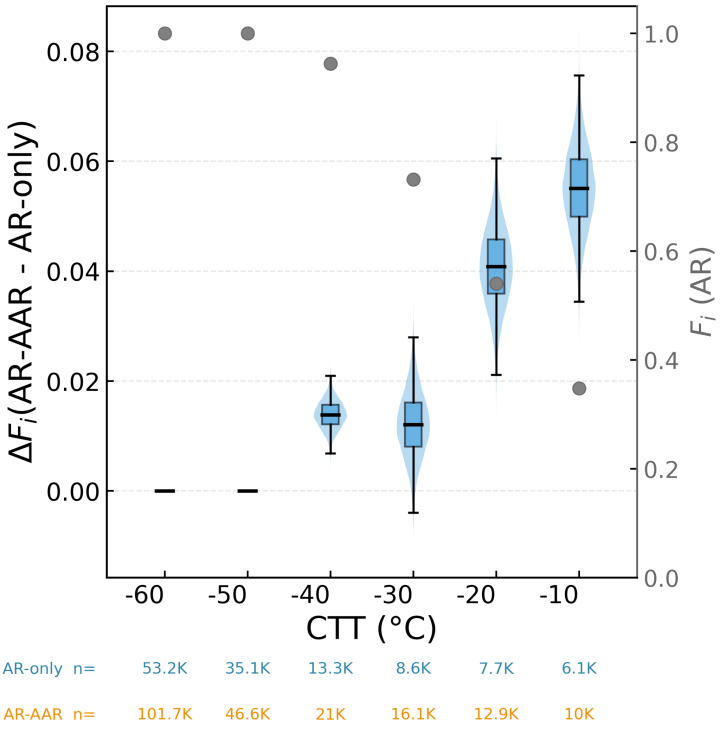


Fig. 1: Fraction of ice clouds vs. all clouds (F_i) as difference between aerosol-atmospheric rivers (AR-AAR) and atmospheric rivers without specific aerosol transport (AR-only) as a function of cloud top temperature (CTT). Grey markers indicate AR-only F_i as function of temperature.