Project: **1070**

Project title: **Atmospheric Research with ICON-ART (ARIA)**

Principal investigator: **Ali Hoshyaripour, Karlsruhe Institute of Technology**

Report period: **2026-01-01 to 2026-12-31**

The ARIA numerical experiments on Levante in 2026 are separated in five groups. In the reporting period, project 1070 used about 18,000 node-hours (Nh) on Levante CPU until October 2026, i.e. 90 % of the 20,000 Nh granted. Production experiments accounted for 91 % of this consumption; model development and testing accounted for 9 %. Because the granted allocation was about one fifth of the request, we cancelled experiments that could not be postponed (ML chemistry, GLORI ARI), reduced the number of simulations (storyline dust) and prioritized runs needed for theses and dissertations (vegetation fires/SOA, fire dynamics). Table 1 summarizes the experiments, including the simulated period per run.

Table 1: Requested, granted and used node-hours on Levante CPU in the reporting period

Experiment	Requested Nh	Used Nh	Runs done/ planned (days/run)	Note
Storyline dust	27,000	3,500	18/120 (5 d)	Significantly reduced; ensemble sufficient for the MSc thesis, not for a publication
Veg. fires and SOA	33,600	12,100	10/24 (7 d)	Reduced; sensitivity analysis sufficient for the MSc thesis; remaining runs continue in 2027
GLORI ARI	3,600	**0**	0/40	Cancelled; could not be postponed
Fire dynamics	1,260	700	2/4 (5 d)	Reduced
Chemistry with ML	24,000	**0**	0/4	Cancelled; could not be postponed
Model development	10,000	1,700	–	Significantly reduced
Total	**99,460**	**18,000**		**Granted: 20,000 Nh**

1. Saharan dust in a warmer climate: a storyline approach

A master's thesis (Hosseinnezhad Barirani, 2026) tested how a +4 K background modifies the Saharan dust event of 14–18 March 2022 and its radiative effect over Baden-Württemberg. AWI-CM1 runs nudged to ERA5 for present-day and +4 K states initialized five-day ICON-ART runs (global 0.5°, nest 0.25°), with ten members per state. Under +4 K, dust emission over North Africa decreased by 13.7 %, because friction velocity exceeded its threshold less often, and dust AOD over Baden-Württemberg by 7.3 %. The daytime surface shortwave dust radiative effect nevertheless strengthened from −12.0 ± 4.6 to −29.4 ± 3.0 W m^{-2} (Fig. 1; all ten pairs consistent, $p < 0.001$), as the vertical structure of the plume changed. Aerosol–cloud processes were not active, and one event cannot constrain future dust frequency.

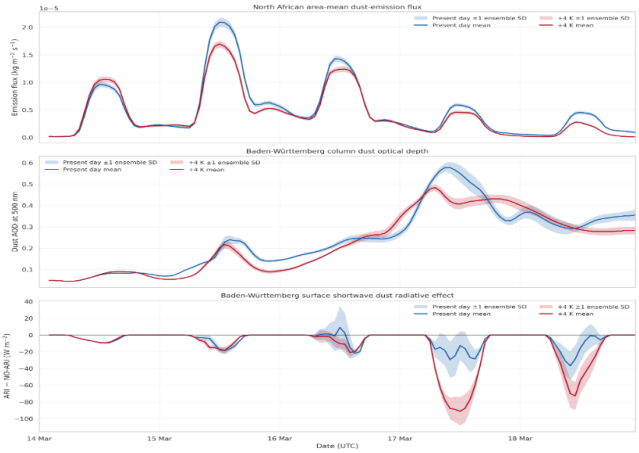


Figure 1: Figure 1: Ensemble mean ± 1 SD, present day (blue) and +4 K (red): North African dust emission, and dust AOD and surface shortwave dust radiative effect over Baden-Württemberg.

2. Wildfire plume rise and fire–atmosphere coupling

Fire dynamics: For the 2019/2020 Australian New Year fires, Muth et al. (2026) extended the plume-rise model in ICON-ART (6.6 km) with fire-induced heat and moisture release and aerosol–radiation interaction (ARI). Heat release raised the plume substantially; moisture release mainly added cloud. ARI first lowered the injection height but caused lofting from the second day on. Only the combination reproduced the observed aerosol layer in the UTLS. Unser et al. (2026) showed at three resolutions that the underestimation of plume height grows at coarser resolution, and proposed a resolution-dependent enhancement of the heat-release term that improves agreement with observations. As a fast alternative to coupled fire models, Moradpour et al. (2026) trained a convolutional neural network on WRF-SFIRE simulations that predicts fire spread and intensity (R^2 = 0.84 for the ground heat flux).

3. SOA formation in wildfire plumes

We implemented a simplified SOA scheme in ICON-ART following Jo et al. (2023). VOC emissions from anthropogenic (EDGAR), biomass-burning and biogenic (MEGAN, online) sources are combined into a single precursor (SOAE) using species-specific yields, from 0.04 for isoprene to 0.80 for SVOC. SOAE is converted to a semi-volatile gas (SOAG) with an e-folding lifetime of one day, which partitions to the particle phase (C^* = 1 µg m^{-3}, ΔH = 131 kJ mol^{-1}) and is removed by deposition and photolysis. The scheme runs stably, and a first global simulation for 2020 gives plausible annual-mean surface SOA distributions (Fig. 2). For wildfire plumes, 10 of the 24 planned sensitivity runs were completed, which is sufficient for the ongoing master's thesis. The remaining runs and the evaluation against observations continue in 2027.

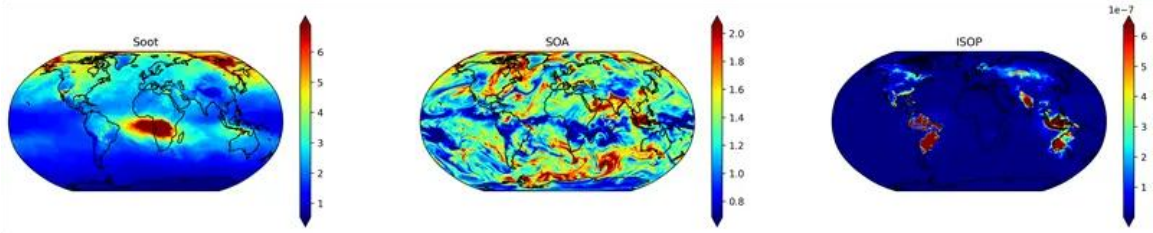


Figure 2: Annual average of surface concentrations in 2020

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4. Model development

ICON-ART version 2025.10 is documented in Hoshyaripour et al. (2026). Development and testing used 1,700 Nh in 2026.

References

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Unser, T., Muth, L. J., Hoose, C., and Hoshyaripour, G. A.: Influence of model resolution on simulated extreme wildfire plume heights during the 2019/2020 Australian New Year event, J. Geophys. Res. Atmos., 131, e2025JD046190, doi:10.1029/2025JD046190, 2026.

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