

# SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

**Reporting year** 2024.....

**Project Title:** Coupled climate simulations using the ICON model  
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**Computer Project Account:** SPDEKHAI.....

**Principal Investigator(s):** Pavel Khain.....  
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**Affiliation:** Israel Meteorological Service  
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**Name of ECMWF scientist(s) collaborating to the project**  
(if applicable) .....  
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**Start date of the project:** 1.1.2024.....

**Expected end date:** 31.12.2026.....

**Computer resources allocated/used for the current year and the previous one**  
(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
<b>High Performance Computing Facility</b>	(units)			303M	10.5M
<b>Data storage capacity</b>	(Gbytes)			630K	0

### **Summary of project objectives** (10 lines max)

Generally, the project goal is to advance climate-modelling focusing on coupled atmosphere-ocean simulations. The main objectives are: (1) Performing climate uncoupled simulations for the years 1950-2100 using the ICON model at a resolution of 12 km over the Mediterranean region and at a resolution of 2.5 km over the East Mediterranean; (2) Performing a 1000-year global simulation with ICON-Seamless (coupled configuration) with a horizontal resolution of about 80 km in the atmosphere and 40 km in the ocean; (3) Performing several research simulations on past periods of the ICON/NEMO coupled system with the aim of calibrating and adapting it to future coupled climate runs, both for the Mediterranean and European setups.

### **Summary of problems encountered** (10 lines max)

Two problems encountered during the first half year of the project (1.1.2024-30.6.2024). These problems were related to objectives (1) and (3) above. In relation to objective (1), prior to running 150 years simulation, there was a need to tune the ICON-CLM model over the Mediterranean, reducing biases and enabling it to reproduce the historical trends. This work was performed (as part of the CLM COPAT working group) on a different computer, and took longer than was expected. Meanwhile, we successfully established a working environment (SPICE) for running ICON-CLM on ATOS and the plan is to initiate 150 years simulation during the next month (July 2024). In relation to objective (3), we encountered technical difficulties to couple ICON to NEMO-MED ocean model. After significant support from colleagues from DWD, Hereon, Meteo-France and CERFACS, we have managed to perform a short historical simulation on ATOS, which we now analyse.

### **Summary of plans for the continuation of the project** (10 lines max)

The plans remained unchanged. In relation to objective (1), we plan to initiate 150 years simulation in 12 km resolution during the next month (July 2024). Following this simulation, we will perform a nested 2.5 km simulation over the same period. In relation to objective (2), the plan is to perform the simulations during 2025. In parallel to the 150-years simulation (objective 1), we plan to continue the work on ICON-NEMO-MED coupling, aiming to reproduce the historical evolution correctly, both in the atmosphere and the sea.

### **List of publications/reports from the project with complete references**

International presentations:

1. Uzan, L., E. Vadislavsky, P. Khain, M. Cohen, I. Carmona and Y. Levi “Calibration of ICON-CLM in the East Mediterranean region”, the ICCARUS (ICON/COSMO/CLM/ART USER Seminar) (4-8.3.2024), DWD Headquarters in Offenbach, Germany.
2. Vadislavsky E. and P. Khain: “Coupling ICON-CLM to NEMO-MED over the Mediterranean”, the ICCARUS (ICON/COSMO/CLM/ART USER Seminar) (4-8.3.2024), DWD Headquarters in Offenbach, Germany.
3. Vadislavsky E., P. Khain, L. Uzan, Y. Levi and A. Givati: “Coupling ICON-LAM to NEMO-MED at IMS”, the 8th Med-CORDEX workshop (14-16.5.2024), Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) in Rome, Italy.

Internal reports:

4. Leenes Uzan et al.: “Climate model calibration and simulations plan: status report for the Climate Center Committee”, Report #2, April 2024.

## Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

During the first half year of the project (1.1.2024-30.6.2024) we have focused on two topics: tuning the ICON-CLM model over the Mediterranean in order to make it suitable for climate simulations, and coupling ICON to NEMO-MED ocean model.

As part of the first topic, we were able to tune the cloud cover, slightly reducing the global radiation bias. Moreover, we have used soil water content dependent albedo tuning which significantly reduced skin and 2m temperature biases. Finally, we have tuned turbulence parameters in stable stratification, reducing 2m temperature and relative humidity biases. As mentioned above, we plan to initiate 12 km resolution 150-years ICON-CLM simulation on ATOS@ECMWF during the next month (July 2024). In parallel, we are currently working on tuning the 2.5 km ICON-CLM, which will be ready for 150-years nested simulation after the end of 12 km resolution simulations.

As part of the second topic, with the support of colleagues from DWD, Hereon, Meteo-France, CERFACS and others, we successfully established a coupled ICON-NEMO-MED environment on ATOS@ECMWF. To our knowledge, this is the first time ICON was coupled to NEMO-MED. Following this achievement, several historical years of coupled ICON-NEMO-MED simulation were performed. Verification of the sea surface temperature (SST) versus buoy data over the Eastern Mediterranean reveal realistic yearly maximum temperatures, but too low minimum temperatures. Preliminary analysis suggest that the problem is related to incorrect initialization of temperature and salinity profiles. Moreover, we suspect that there is a problem in the water budget, with underestimated evaporation as compared to the rain and runoff sources. An attempt to force ocean initialization with ORAS5 and OSTIA SST reanalyses instead of slow damping towards the initial conditions yield model instability near the strait of Gibraltar. After these technical issues are solved, we will initiate coupled historical research simulations, following the project plan.

As explained in the “Summary of problems encountered” and “Summary of plans for the continuation of the project” sections above, in July 2024 we plan to increase significantly the usage of computing resources and the data storage capacity. According the project plan, we plan to utilize the remaining ~290M SBU and 630K Gbytes data storage during the next half year.