

## 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** 2025

**Project Title:** A High-Resolution Hindcast for the Sahel Region Based on ERA5 data and the MOLOCH model

**Computer Project Account:** SPITCAPE

**Principal Investigator(s):** Valerio Capecchi

**Affiliation:** Consorzio LaMMA, Laboratorio di Meteorologia e Modellistica Ambientale per lo sviluppo sostenibile & Agenzia Nazionale per la Meteorologia e Climatologia "ItaliaMeteo"

**Name of ECMWF scientist(s) collaborating to the project (if applicable)** .....

**Start date of the project:** The project was submitted in 2025 as Late Request for Special Project; here we report the activities carried out during 2025

**Expected end date:** 2028

**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)	4500000	3909071	4500000	4465707
<b>Data storage capacity</b>	(Gbytes)				

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

The Special Project is part of the "SLAPIS Sahel" initiative (<https://climateservices.it/progetto/slapis/>), funded by the Italian Agency for Development Cooperation and implemented by the Polytechnic University of Turin in collaboration with the Institute for Bioeconomy of the National Research Council of Italy (IBE-CNR), the National Meteorology Directorate (DMN) of Niger, and the National Meteorology Agency (ANAM) of Burkina Faso. One of the main objectives of the project is to produce a long-term, high-resolution hindcast for the Sahel region. This is achieved through the dynamical downscaling of the ERA5 reanalysis using the MOLOCH limited-area model. The resulting dataset is intended to support climate services for climatological, agricultural, and hydrological applications. In addition, it will serve as a reference dataset for training a regional, data-driven machine learning (ML) model within the Anemoi framework.

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

The preprocessing and model integration phases were completed without issues. However, a bug in the post-processing code, still under investigation, caused problems in extracting variables on pressure levels. As a result, to date only surface variables have been successfully extracted and archived.

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

During 2026, we plan to complete the second 5-year segment of the hindcast (i.e., 2016–2020) and finalize part of the first 5-year segment (i.e., the whole year 2021 and September/October 2025).

However, because we configured a model integration domain larger than originally planned (see Figure 1), the requested SBU allocation has been underestimated. The expanded domain was designed to encompass the entire Sahel region, rather than being limited to the two countries directly involved in the SLAPIS Project. We believe that this broader dataset may be of significant interest to additional Sahelian countries, National Meteorological Services, and other regional stakeholders.

Using the last version of the model released in December 2025, we also plan to fix the code bug that prevented the extraction of pressure levels variables since they are crucial for possible data-driven model training.

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

None. However, part of the dataset has been transferred to the SLAPIS partners' local servers for verification and further analysis. We plan to submit the dataset for publication in a peer-reviewed scientific journal once the hindcast is complete or, at minimum, after at least 15 years of simulated data have been produced.

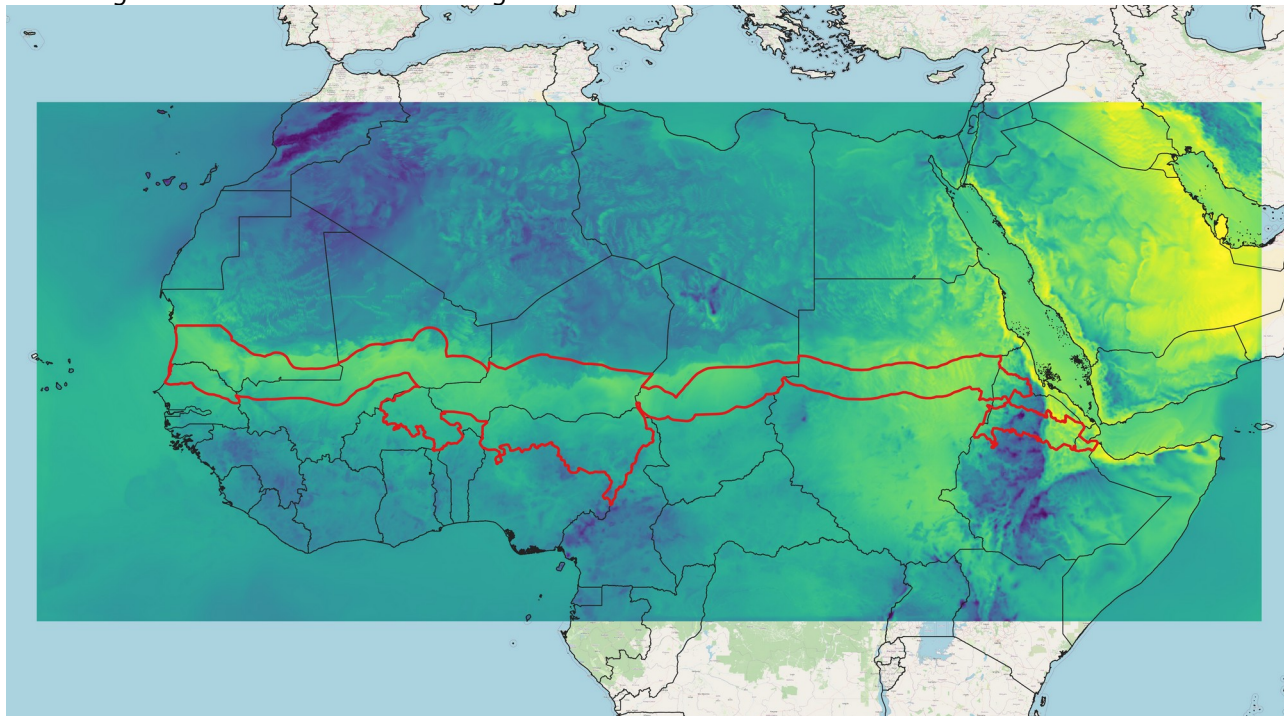
**Summary of results**

Nearly all years included in the first 5-year segment (2021–2025) of the hindcast have been completed; 14 months are still missing, the whole year 2021 and September/October 2025. The original objective of the three-year project was to produce 30 years of model simulations.

However, because the integration domain was defined to be substantially larger than initially planned, we now expect to complete at least 15 years of hindcast simulations. In the following, we describe some details of the methodological approach adopted to perform the simulations.

The simulations were carried out using the MOLOCH model version 25.1, available at: <https://gitlab.com/isac-meteo/globo-bolam-moloch>.

The integration domain is shown in Figure 1



*Figure 1: sample data of the MOLOCH hindcast. The red line indicates the Great Green Wall, <https://www.unccd.int/our-work/ggwi>*

Geographical settings are as follows: grid points 1922x802, grid spacing ~4 km, latitude=(0.0,33.3), longitude=(-25.0, 53.7), vertical levels 70. Model physical settings are detailed in the documentation available on the gitlab repository (only in Italian): [https://gitlab.com/isac-meteo/globo-bolam-moloch/-/blob/main/modelli\\_ISAC\\_corso\\_utenti.pdf?ref\\_type=heads](https://gitlab.com/isac-meteo/globo-bolam-moloch/-/blob/main/modelli_ISAC_corso_utenti.pdf?ref_type=heads) Model experimental design is as follows: initial conditions are provided by the ERA5 data with boundary conditions updated every 3 hours. The MOLOCH simulation starts each day at 18:00 UTC and has a forecast length equal to 30 hours. The MOLOCH model produces outputs every hour over the domain of integration shown in Figure 1. The daily data of the MOLOCH hindcast are built using the last 24 h of the model simulation, while the first 6 hours of integration are considered as spin-up time and thus discarded.

Near surface data (10-metre wind components, 2-metre temperature, total precipitation, latent/sensible heat fluxes, etc...) were extracted in the post-processing phase and were archived on ECFS.