LATE REQUEST FOR AN EMI R&D PROJECT 2026–2028

Country/Organisation:	Department of Physics and Astronomy (DIFA) ”Augusto Righi”, University of Bologna, Bologna, Italy
Principal Investigator[1]:	Dr Alice Portal
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Project Title:	Seasonal Outlooks for Climate Adaptation in Sub-Saharan Africa

To make changes to an existing project please submit an amended version of the original form

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** …………..	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2026	
Would you accept support for 1 year only, if necessary?	YES x	NO ☐

Computer resources required for project year:		**2026**	**2027**	**2028**
High Performance Computing Facility	[SBU]	4 million	4 million	4 million
Graphics Processing Unit Cluster-A	[GBU]	-	-	-
Graphics Processing Unit Cluster-B	[GBU]	-	-	-
Accumulated data storage (total archive volume)[2]	[GB]	20,000	30,000	40,000

[1] The Principal Investigator will act as contact person for this EMI R&D Project and, in particular, will be asked to register the project, provide annual progress reports of the project’s activities, etc.
[2] These figures refer to data archived in ECFS and MARS. If e.g. you archive x GB in year one and y GB in year two and don’t delete anything you need to request x + y GB for the second project year etc.
[3]The number of vGPU is referred to the equivalent number of virtualized vGPUs with 8GB memory.

EWC resources required for project year:		2026	2027	2028
Number of vCPUs	[#]			
Total memory	[GB]			
Storage	[GB]			
Number of vGPUs[3]	[#]			

Continue overleaf.

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Extended abstract

All EMI R&D Project requests should provide an abstract/project description including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The completed form should be submitted/uploaded at https://www.ecmwf.int/en/research/special-projects/special-project-application/special-project-request-submission.

Following submission by the relevant Member State the EMI R&D Project requests will be published on the ECMWF website and evaluated by ECMWF and its Scientific Advisory Committee. The requests are evaluated based on their scientific and technical quality, and the justification of the resources requested. Previous EMI R&D Project reports and the use of ECMWF software and data infrastructure will also be considered in the evaluation process.

Requests exceeding 10,000,000 SBU should be more detailed (3-5 pages).

Project Description

Climate change poses increasingly severe challenges to agricultural communities across Sub-Saharan Africa, which are badly informed about new risks related to evolving climate conditions. This EMI R&D project provides the scientific and computational structure for devising monthly-frequency climate services for Sub-Saharan Africa. Building on the ongoing collaboration between the University of Bologna, ARPAE, and two ALBATROSS[2] project hubs—the Keta Basin in Ghana, in partnership with the Ghana Meteorological Agency, and Tamatave in Madagascar, in partnership with Bôndy International—we will develop seasonal climate outlooks to support local farmers, initially focusing on these two regions. The operational products will be thought of in order to be easily applicable to other regions and communities in Sub Saharan Africa. Our main goal is to transform raw seasonal forecast data from the Copernicus Climate Change Service (C3S) into calibrated, verified, and operational products that support agricultural planning and climate risk management.

Objectives

Seasonal climate forecasts are openly available through the Copernicus Climate Change Service, yet their direct application in decision-making contexts remains limited by several factors. Raw model outputs often exhibit systematic biases relative to local observed conditions and high inter-model spread in performance. Moreover, the information provided through coarse meteorological fields does not translate into actionable indicators useful to farmers and local authorities.

The hub users within ALBATROSS have expressed clear information needs centred on the agricultural calendar and on the farmers' demands. They seek reliable outlooks on when the rainy season will begin, how long it will last, and whether seasonal totals of precipitation and evapotranspiration are likely to fall below, near, or above normal. They demand guidance on expected soil moisture conditions that influence planting decisions, and on early warning of drought or flood risk that may determine adjustments in crop management.

To meet these needs, the project pursues three interconnected objectives.

1. We will calibrate seasonal precipitation and evapotranspiration forecasts from nine C3S seasonal models to observed conditions across our target regions.
2. We will conduct a comprehensive skill assessment to determine how well each model—or combination of models—predicts the variables and indicators relevant to our users.
3. We will develop operational pipelines that retrieve, process, and disseminate user-targeted seasonal outlooks. This will be done to produce timely climate services, with the objective of making them sustainable beyond the project lifetime.

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[2] The ALBATROSS project (Advancing knowledge for Long-term Benefits and climate Adaptation ThRough hOlistic climate Services and nature-based Solutions) is funded under Horizon Europe and coordinated by the University of Bologna. Its primary aim is to develop participatory climate adaptation strategies. The consortium is composed of 18 European and African partners.

Methodological Approach

The scientific work begins with the acquisition of two complementary datasets. On the model side, we will retrieve hindcast and forecast archives from several seasonal forecasting systems available through C3S, covering the period 1993-now. The hindcasts (i.e., retrospective forecasts initialised with observed conditions from 1993 to 2016) are essential for training calibration algorithms and estimating forecast skill. On the observational side, we will download reference daily datasets including MSWEP precipitation data and ERA5-Land temperature statistics, which are known to provide reliable satellite- and gauge-derived observations for the regions of interest. All datasets will be standardised to common spatial grids and temporal aggregations.

Calibration will proceed through bias correction methods such as quantile mapping to adjust the distributional properties of daily model outputs toward those of observations. Skill assessment will employ both deterministic and probabilistic verification metrics. Finally, we will operationalise these methods within workflows that retrieve new forecast data as it becomes available, apply calibration, and generate output products formatted for hub users.

Products will include six-months predictions of accumulated soil-humidity anomalies, combining the sum of precipitation and evapotranspiration by merging observations and forecasts, and probabilistic forecasts of rain season onset and duration. Based on these, crop calendars highlighting informed shifts in agricultural activities and alerts for elevated drought or flood risk will be provided. All outputs will be designed in collaboration with ALBATROSS hub partners to ensure clear communication and support in contexts with varying levels of technical abilities.

Computational Resources and Code

The computational requirements of this project arise from the size of the datasets involved and from the methods required for calibration, skill assessment and operational product development. Data storage demands are substantial because we will retain multi-decadal hindcast and forecast archives from several seasonal forecasting systems over Sub-Saharan Africa. We estimate total storage requirements of approximately 40 TB over the duration of the project.

Computational demands are driven by several factors. Processing hindcast archives across several models, dozens of ensemble members, multiple lead times, and three decades of initialisations involves operations on tens of thousands of individual forecast fields. Calibration and skill assessment must be performed for each model, ensemble member, lead time, and grid point and require code parallelisation across multiple processors. We estimate a total of roughly 200,000 core-hours per project year.

Access to ECMWF resources is particularly valuable for this project because the C3S seasonal forecast archives are hosted on ECMWF infrastructure. **We require real-time access to operational forecasts in order to be able to deliver timely seasonal outlooks**. Furthermore, the parallel computing capabilities available at ECMWF are well suited to the highly parallel nature of our workflows.

All code developed for this project will be written in Python, leveraging the libraries for scientific computing and geospatial data analysis. Core data structures will use xarray for multi-dimensional arrays. Heavy computational tasks will be parallelised using Dask. Data will be stored primarily in NetCDF-4 format. All code will be maintained using Git in a repository that includes full documentation to ensure reproducibility.

Expected Outcomes and Impact

This project will deliver several concrete outputs. Hub-specific reports and scientific papers will document the performance of C3S seasonal models over Sub-Saharan Africa for variables and indices relevant to agricultural decision-making, providing a reference for future climate service development in the region. Calibrated forecast datasets will be produced for Ghana and Madagascar, correcting model biases and improving the reliability of probabilistic seasonal predictions. Operational seasonal outlook products, including maps of accumulated soil humidity, probabilistic forecasts of rain season timing, and drought/flood risk indices, will be delivered to hub partners on a monthly basis after product development is completed. Technical documentation and open-source code will be published to enable partners to extend the operational chain after the termination of the project.

The impact of this work extends beyond the technical products. By providing community hubs with reliable, locally calibrated seasonal information, we enable farmers and local decision-makers to adjust planting dates, select appropriate crop varieties, and prepare for climate risks. This anticipatory capacity is fundamental to climate adaptation, reducing losses from climate extremes. The methodologies developed here will be easily transferable to other regions of Sub-Saharan Africa, contributing to the broader goal of extending climate services to populations which are extremely vulnerable to climate change.