REQUEST FOR A SPECIAL PROJECT 2026–2028

MEMBER STATE:	Denmark
Principal Investigator[1]:	Dr Jose Abraham Torres Alavez
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Project Title:	260 years of African climate: Transient projections with HCLIM

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 ☒	NO ☐

Computer resources required for project year:		**2026**	**2027**	**2028**
High Performance Computing Facility	[SBU]	60,000,000	60,000,000	25,000,000
Accumulated data storage (total archive volume)[2]	[GB]	250,000	250,000	72,000

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

Continue overleaf.

[1] The Principal Investigator will act as contact person for this Special 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.

Principal Investigator: Dr Jose Abraham Torres, Researcher, DMI

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Extended abstract

Overview

We are requesting a large number of computational resources for a special project to run very high-resolution regional-dynamical downscaling over the pan-African CORDEX domain as defined in Giorgi et al. (2015). The Danish Meteorological Institute (DMI) is planning to contribute to the CORDEX-CORE (Georgi et. Al., 2022) downscaling of CMIP6 GCMs over the pan-African domain — a region for which the number of available high-resolution simulations remains critically low. While only a few institutions have historically participated in CORDEX downscaling over Africa, the more pressing issue is that very few CORDEX-CORE simulations currently exist for the continent, creating a significant gap in the data needed to support climate impact assessments and adaptation planning. This effort is driven by DMI's current project in an African country focussing on strengthening the provision of climate services, particularly through improved access to future climate projections. With plans to expand this support to additional countries across Africa, the project's inception phase revealed a clear shortfall in high-resolution regional climate data available for Africa. This recognition has motivated DMI to contribute to the next round of CORDEX-CORE activities, with the aim of enhancing the availability of high-resolution simulations to better inform climate risk management and adaptation across the region. For this initiative, DMI will run the Harmonie Climate model (Mottram et al., 2017) at a resolution of ~12km, providing climate projections based on transient 130-year simulations (1970-2100) under the shared socio-economic pathway 3-7.0 (SSP3-7.0). These simulations will be driven by two general circulation models (GCM) selected based on the CORDEX-Africa model selection process done.

The total of the budget requested will be used to run climate simulation of one member of each model during 2025-2026, with additional simulations or models investigated in subsequent years. We aim to assess changes in climate from an ERA-5 hindcast and to compare with projections forced by two GCMs (likely MPI-ESM1-2-LR and EC-EARTH), with subsequent years including simulations forced with other ESMs as required. We plan that all outputs will be made open access and CORDEX compliant.

Science Plan

Africa, the second-largest continent, spans over 30 million square kilometres and straddles the equator, resulting in a climate that varies dramatically from arid deserts like the Sahara to lush rainforests and temperate highlands. The continent's diverse geography, combined with global atmospheric phenomena like the El Niño-Southern Oscillation (ENSO) and monsoon systems, creates complex regional climate patterns that are difficult to model accurately using Global Climate Models (GCMs, Zaroug et. Al., 2014, Kothe et. Al., 2015, Akinsanola et al., 2025). As climate change intensifies, these models struggle to predict localized impacts, leading to greater uncertainty in projections, particularly in terms of shifting rainfall patterns, drought frequency, and extreme weather events, all of which pose significant risks to Africa's agriculture, water resources, and ecosystems (Akinsanola et al., 2025).

In this project, we will examine the likely future of Africa climate under the scenarios SSP3-7.0 from 1970 to 2100.

1. The first three months will be mostly used to do the model evaluation simulations, using the ERA5 reanalysis.
2. The second phase will focus on completing outstanding simulations based on the two CMIP6 GCMs identified through the model selection process conducted by other international institutions.

The Africa domain (Figure 1) is complicated, as the continent covers a large area hence climate simulations over this area at 12km spatial resolution will be computationally demanding. However, downscaling CMIP6 GCMs over Africa to ~12 km resolution under the CORDEX framework enables more accurate representation of regional climate processes, such as topography-driven rainfall and extreme events, which are poorly captured at coarser scales (Georgi et. Al., 2022. This high-resolution data is essential for climate impact assessments and adaptation planning across the continent.

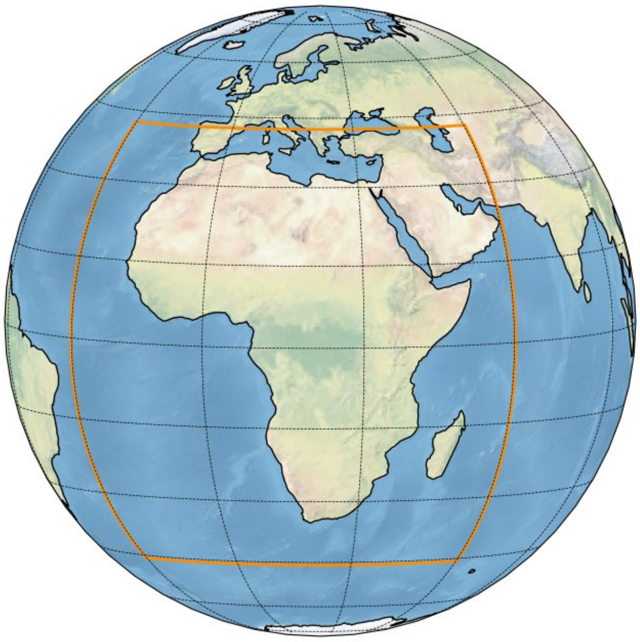

Figure 1: Final CORDEX Africa domain. Figure by S. Nangombe.

We have calculated the SBUs required in this special project as:

HCLIM with ALADIN physics at 12km resolution:

AFR12_MPI-LR: one transient simulation (1x130 yr) for Africa: 130yr * 0.55 MSBUs/yr = 71.5 MSBUs.

For a three-year special project. This is augmented with 2 extra million SBUs to account for process studies, with a total of 145 MSBU (for 260yr of simulation).

Storage:

HCLIM uses approximately 2.2TB per simulated year for 11-km pan-Africa (most fields one hour).

2.2TB/yr * 130 yr = 286 TB (572 TB for 260yr of simulation)

We will supplement where necessary with national quota.

Science Outcomes

The proposed high-resolution downscaling simulations over Africa will be processed according to the prescribed formats of CORDEX (Giorgi et al. 2015) and made available via the ESGF server nodes as part of the CMIP6-based CORDEX-CORE contributions to regional climate modelling in Africa. This high-resolution downscaling simulations initiative aim to address a critical gap of limited high-resolution climate simulations available over Africa. The outcomes of the simulations will help bridge this gap by delivering high resolution and region-specific projections of temperature, rainfall, and extreme events, thereby enhancing understanding of future climate risks to the continent. These improved datasets will support national and local governments, and development partners in designing science-backed targeted adaptation and resilience strategies as well as supplying the scientific evidence needed for climate change reporting obligations (e.g., Nationally Determined Contributions). They will also benefit key sectors such as agriculture, water resources, energy, and health by enabling more informed planning and decision-making. Additionally, the simulations will contribute to disaster risk reduction through improving early warning systems and preparedness for events like future droughts, floods, and heatwaves. Beyond operational uses, the simulations will strengthen regional climate science capacity by providing valuable resources for academic research, training, and model development. For example, the downscaling will be conducted in collaboration with researchers at the Ghana Meteorological Agency, fostering capacity building in dynamical model downscaling.

References

1. Akinsanola, A. A., C. N. Wenhaji, R. Barimalala, P-A. Monerie, R. D. Dixon, A. T. Tamoffo, M. O. Adeniyi et al. "Modeling of Precipitation over Africa: Progress, Challenges, and Prospects." *Advances in Atmospheric Sciences* (2025): 1-28.
2. Giorgi, Filippo, Erika Coppola, Daniela Jacob, Claas Teichmann, Sabina Abba Omar, Moetasim Ashfaq, Nikolina Ban et al. "The CORDEX-CORE EXP-I initiative: description and highlight results from the initial analysis." *Bulletin of the American Meteorological Society* 103, no. 2 (2022): E293-E310.
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4. Kothe, Steffen, Daniel Lüthi, and Bodo Ahrens. "Analysis of the West African Monsoon system in the regional climate model COSMO-CLM." *International journal of climatology* 34, no. 2 (2014).
5. Mottram, Ruth, Kristian Pagh Nielsen, Emily Gleeson, and Xiaohua Yang. "Modelling Glaciers in the HARMONIE-AROME NWP model." *Advances in Science and Research* 14 (2017): 323-334.
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