RESOLVING CHALLENGES ASSOCIATED WITH CLIMATE CHANGE MODELLING IN AFRICA

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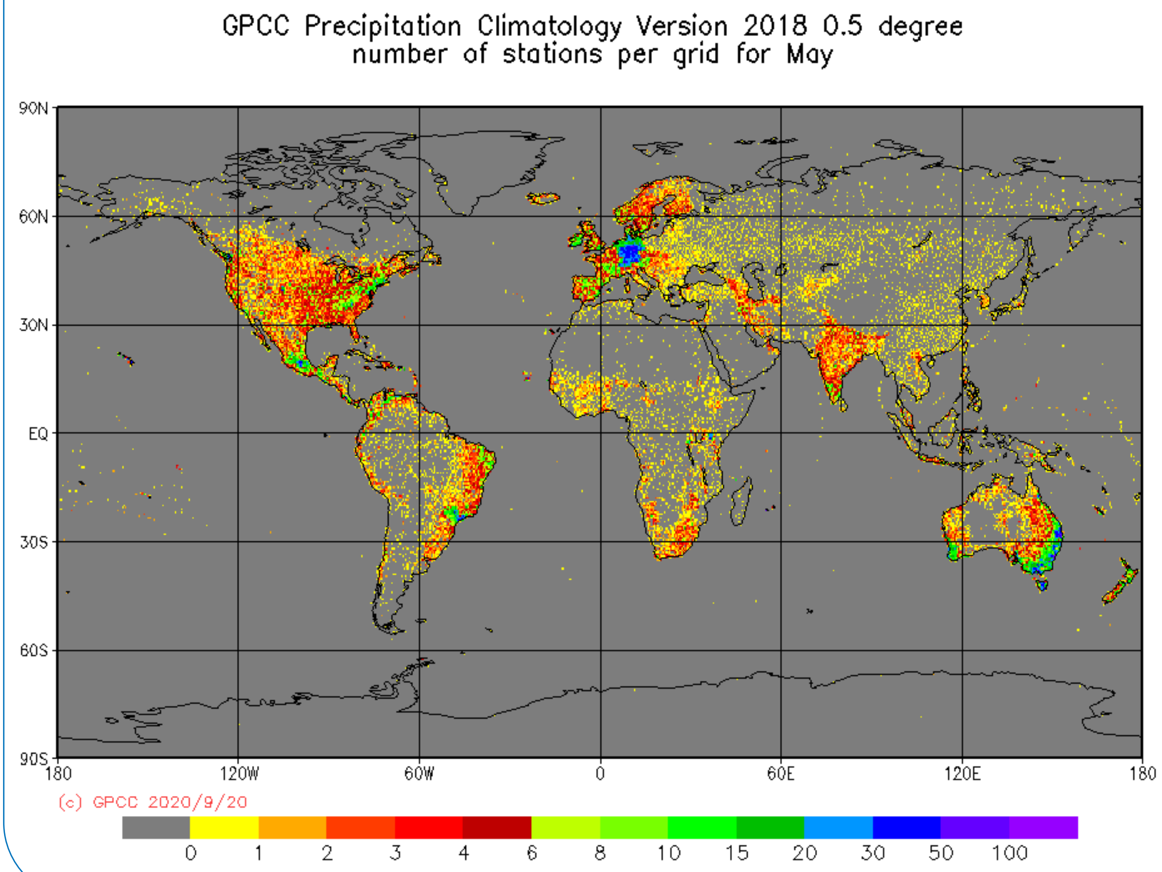


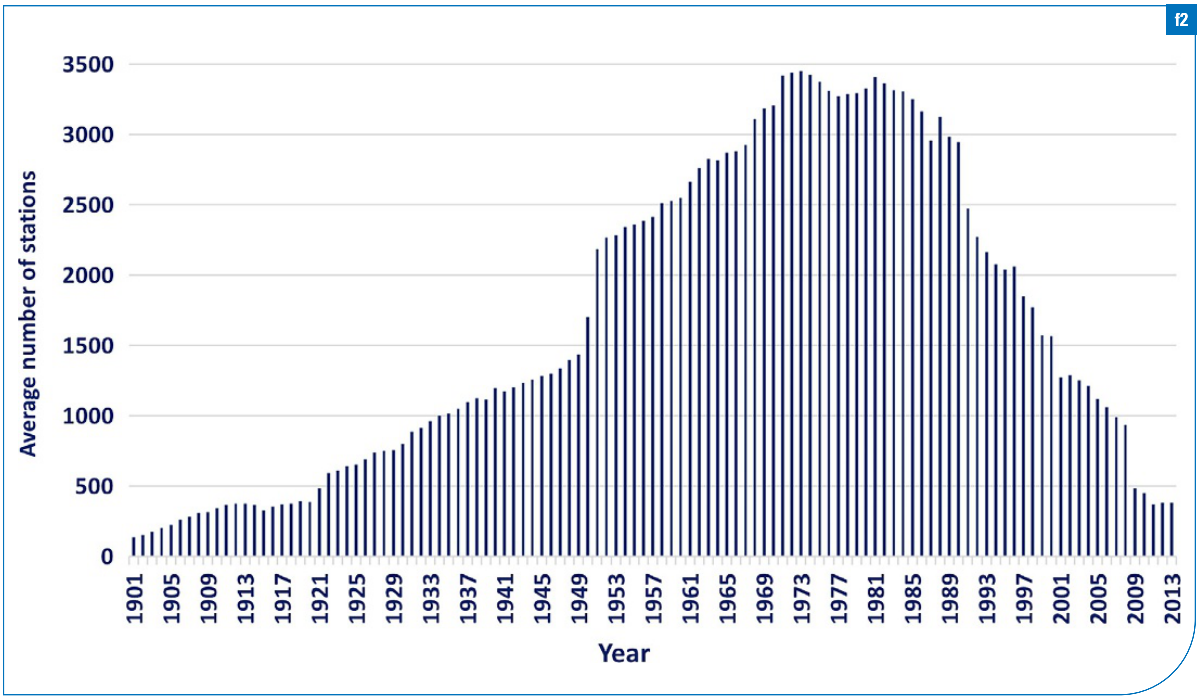
FOCUS AREA

For the practical planning of local issues such as rain-fed agriculture, water resources availability and flood management, African countries need information at a local scale. Recent approaches for obtaining high spatial resolution information are downscaling techniques:

- Statistical downscaling methods, which consist in making an empirical observation-based link between large-scale variables, also called predictors, and local variables called predictants;
- Dynamical downscaling methods, which are based on the use of regional climate model (RCMs). In fact, this method consists in using the outputs of a global climate model (GCM) as boundary conditions to drive the RCM.

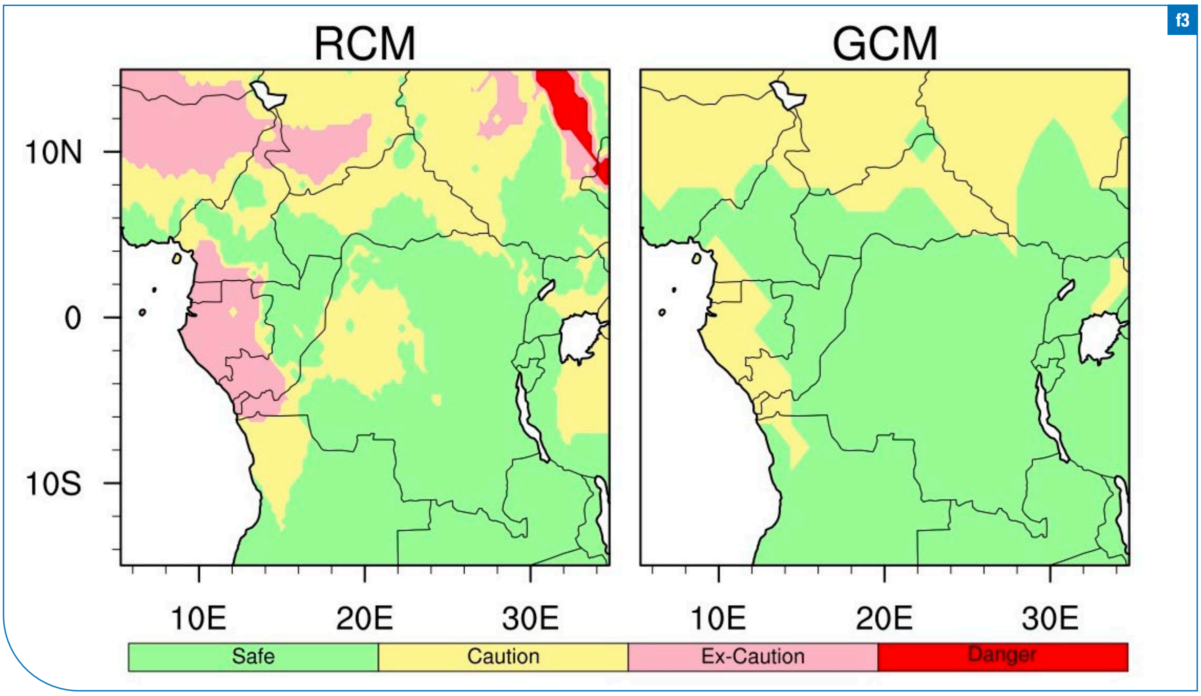
CHALLENGES

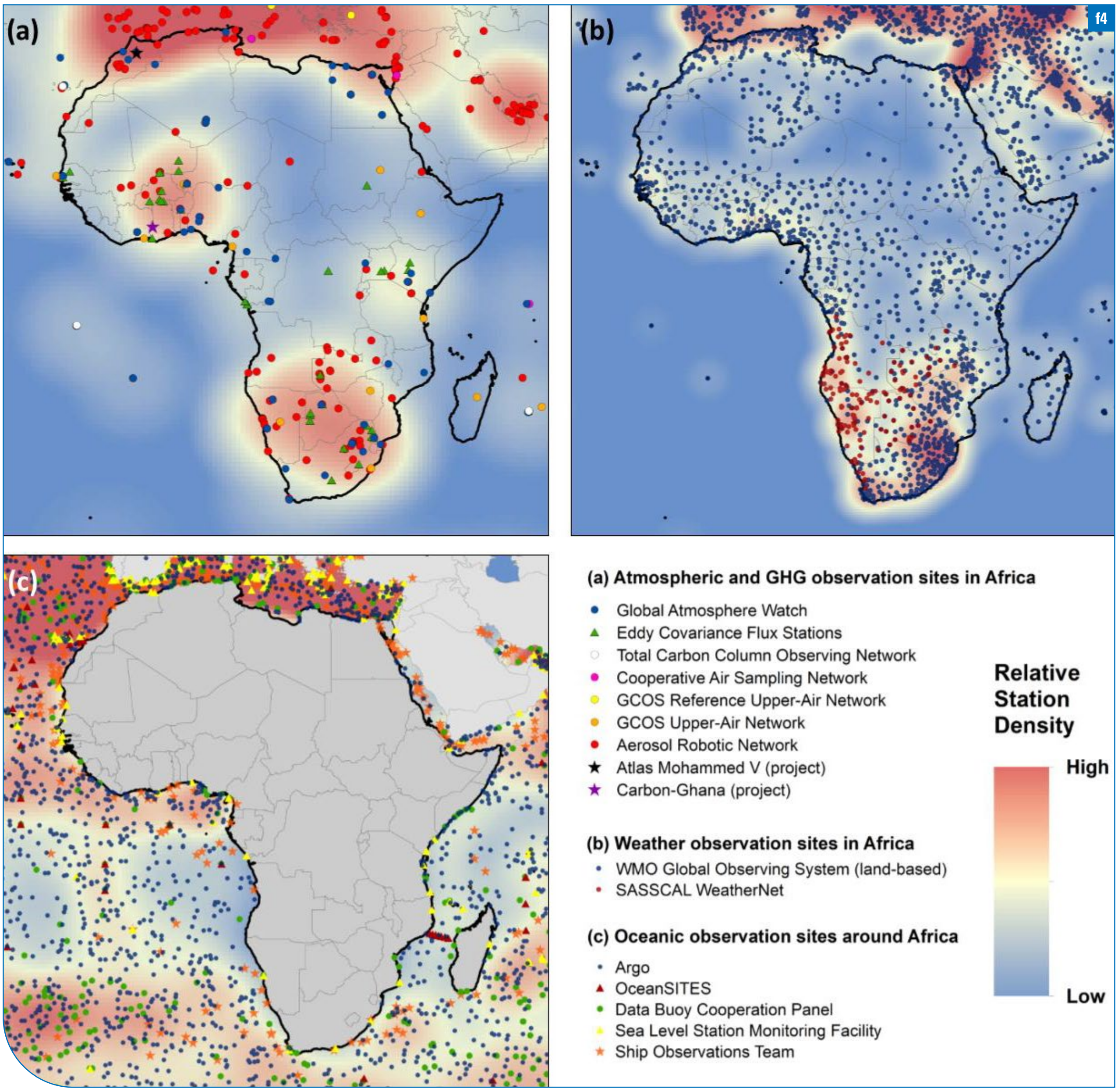
The GCMs are the most widely used instruments so far for studying the impact of climate change in several regions of the world. Generally, these models adequately simulate climate parameters in the present at a global scale. Despite the fact that during the second half of the 20th century, GCMs have proven their ability to reproduce general rainfall trends, they may still have significant limitations in simulating the processes that modulate climate at the regional scale. One of the main limitations of GCMs is the relatively coarse horizontal resolution (~100-300 Km), which affects their ability to predict climate variability in detail and consequently provide limited information about the impacts of climate change at a regional scale. Because of their high resolution (~10-50 Km), regional models offer a solution to this problem by allowing a better capture of local atmospheric phenomena, which plays a role in reducing uncertainties in the prediction of future climate. If we take the case of the simulation of heat stress in Central Africa, it is evident that, contrary to the GCM results, those of the RCM allow for the observation of more details by allowing for the appreciation of all the different categories of stress that may exist in the region, as well as their spatial extent.



FACTS AND FIGURES

The African continent has a very low density of rain gauge stations, and long-time-series for recent years are often limited and poorly available. Thus, the scarcity of quality data is one of the main limiting factors when attempting to assess climatic conditions and changes across the African continent. The primary source of most climate data in Africa is through a network of weather stations, which are scattered disproportionately across the landscape. As of October 2018, of 162 active earth observation missions for non-commercial and non-military use in the database of earth observation satellites only 103 could provide potentially relevant environmental data for the African continent and the surrounding oceans (Beck et al, 2019). Moreover, most stations are concentrated in or near major cities or easily accessible locations, disregarding regions with rough or inhospitable terrain - e.g. mountains and deserts. Additionally, this observational network can be poorly maintained and rarely serviced, mostly due to limited investment in the respective country's climate infrastructure (Dinku 2019). The historical data gathered from this network covers only a few decades, in good cases, and are typically riddled with missing information, incorrect capture, and incomplete conversion between the metric and imperial system. Alternative options to the observation network include satellite data or such proxies. The storage of this data is usually undertaken by the relevant government branch or even by private groups, which introduces accessibility challenges, either through legal restrictions, lack of knowledge of the pertinent branch that hosts the data



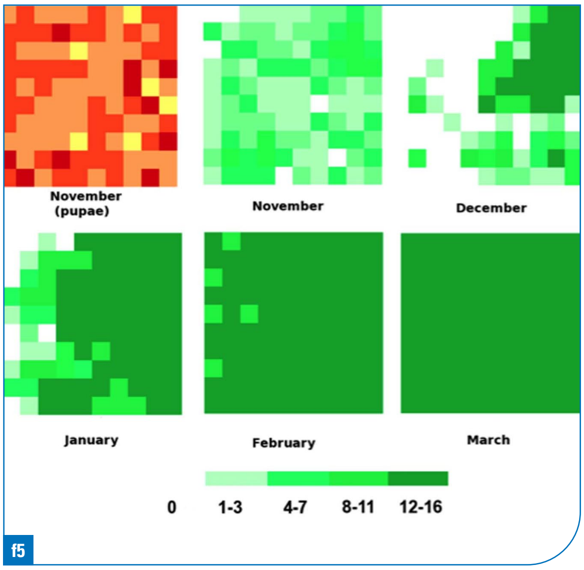


repository, and/or high access costs (Dinku 2019). Thus, sharing of data beyond the initial user is rather limited. Furthermore, due to low financial investment, the availability of the latest products and tools is minimal, leading to a lack of dissemination of skills.

SOLUTION

Many practices can be used to deal with the challenges associated with obtaining data for climate change modelling:

- First, the density of the stations in developing countries, specially sub-Saharan African (SSA) countries has to be increased, so that observational historical climate data can be more accurate. This would ease modelling works such as assessment of heat stress, modelling of diseases, economic modelling, crop modelling, etc., in such a way as to account for small geographic units. For instance, crop modelling requires daily weather data such as minimum temperature, maximum temperature, solar radiation, and rainfall.
- Second, there could be an improvement in the understanding of physical processes.
- Third, data assimilation methods could be improved.



- Fourth, the spatial resolution of the regional climate models can be increased to yield data for finer geographic units. This would be achieved through heavy investment in climate modelling. The representation of the most energetic processes is made possible through high spatial resolution. Modelling requires future climate data with respect to different climate scenarios. Thus, high resolution climate data are of paramount importance to capture the specificities of the various geographic units. However, increase in spatial resolution in climate models is not to be at the expense of superior simulations.

Dataset	Spatial extent	Temporal extent	Data input	Spatial resolution	Temporal resolution
GPI	40ºN - 40ºS	1986 - present	TIR	2.5º	Monthly
GPCP	Global	1917 - present	TIR, PMW, gauge	2.5º	Pentad, monthly
NOAA-CPC ARC	40ºN - 40ºS 20ºW - 55ºE	1983 - present	TIR, gauge	0.1º	Daily
CHIRPS	50ºN - 50ºS	1981 – near present	TIR, gauge	0.05º	Pentad
TAMSAT	Africa	1983 - present	TIR, gauge	0.0375º	Dekadal

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HOW CAN THE CLIMAPAFRICA PROGRAM CONTRIBUTE TO ADRESS THE CHALLENGE?

climapAfrica program can contribute to solving this challenge in the following ways:

(i) climapAfrica program can help sponsor and organize stimulating workshops that focus on identifying the specific sources, where specific kinds of data for climate change modelling can be found.

(ii) climapAfrica program can also assist in inviting top scientists from German higher institutions, with specialization in different types of climate modelling research areas, to deliver online seminars and workshops to all the climapAfrica Work Groups (WGs). Such workshops and seminars will focus on how to identify specific sources of hidden but publicly-available sources of scarce climate change modelling data, share knowledge about how to implement methods to extract such kind of data, share learning on the necessary software to analyse such data, and advise on how to interpret the results generated or produced by such software.

(iii) climapAfrica program can also encourage different WorkGroups (WGs) to collaborate on ethical data sharing and interdisciplinary and cross-disciplinary research collaborations.

(iv) climapAfrica program can also promote exchange programs among different WGs in order to encourage innovative climate change modelling approaches and data usage.

The thematic working groups are composed of postdoctoral fellows and African alumni of German funding initiatives with expertise in the field of climate research. **LINK to climapAfrica working group:** Climate change and Modelling

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LINK to profiles of all climapAfrica postdocs fellows of this working group

LINK to profiles of all climapAfrica alumni experts of this working group

PHOTOS AND GRAPHICS

f1: Number of stations per 0.5° grid box for May 2020 worldwide used in Global Precipitation Climatology Project (GPCC). Map is generated using GPCC's Visualizer, https://kunden.dwd.de/GPCC/Visualizer | f2: Time series of average number of stations used in the GPCC full-data product over Africa (15°W–45°E and 30°S–30°N): Source: Dinku, 2019 | f3: Spatial distribution of heat stress categories over Central Africa for the 1986-2005 period | f4: Observational sites of selected net-works and their relative density for (a) ground-based atmospheric and greenhouse gas, (b) ground-based meteorological and (c) oceanic observation on and around the African continent. Note that the operational status of each station has not been taken into account since this information was not available for all networks (Beck, et al 2019) | f5: Model Simulation run results for Anopheles female adult mosquito dynamics over a 10X10 grid from the onset to the peak of the wet season. First box represents initial pupal distribution among properties. Source: Oluwagbemi et al., 2013 (Legend for f5: Predictions from AnoSpEx Model about mosquito population, distribution and dynamics over a 10X10 grid; the model was driven by weather station-collection data (temperature(minimum, maximum, average), relative humidity, saturation deficit, etc)), based in the Johns Hopkins Malaria Research Institute (JHMRI) malaria research field station and training center Macha, Zambia)