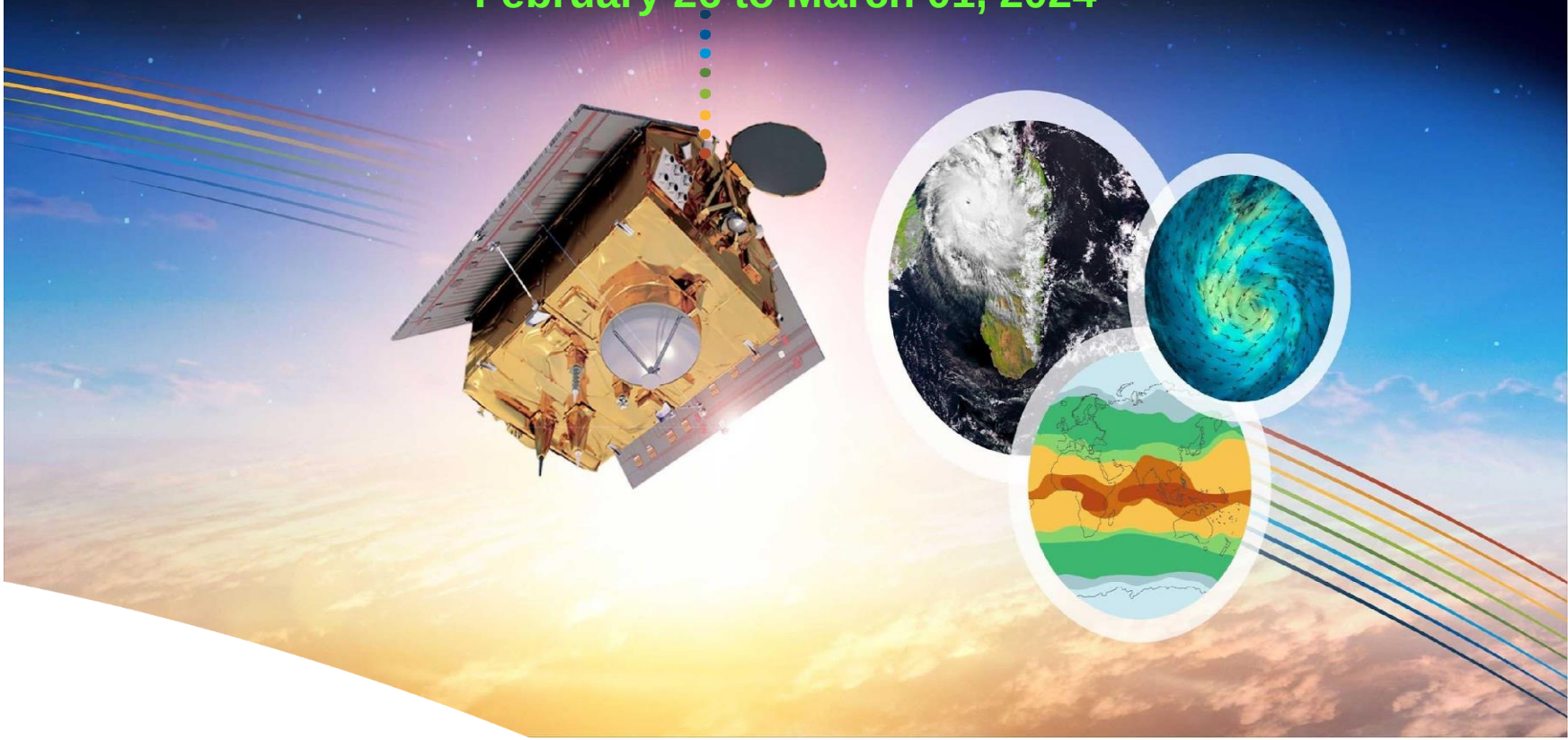
ACMAD

Seasonal Forecasting Workshop on agro-hydro-climatic characteristics of the main rainfall season in the Gulf of Guinea countries / PRESAGG -11

Accra, GHANA

February 26 to March 01, 2024



ClimSA

INTRA-ACP CLIMATE SERVICES AND RELATED APPLICATIONS PROGRAMME

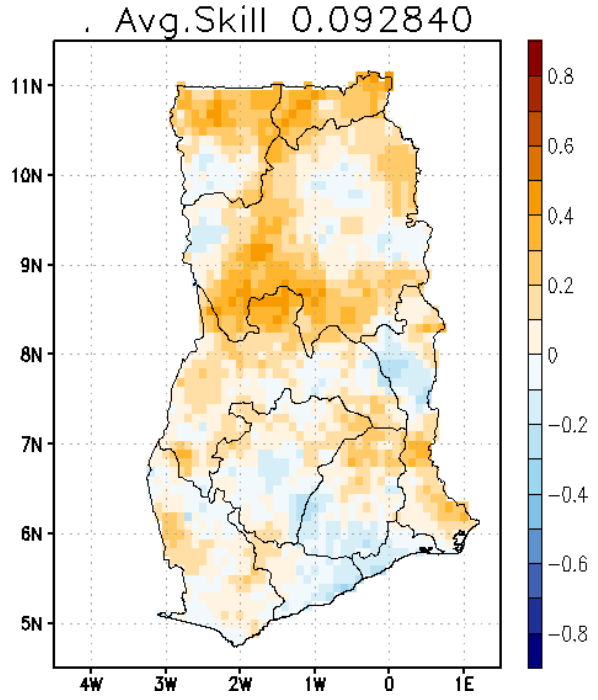
An initiative of the Organisation of African, Caribbean and Pacific States funded by the European Union

Introduction to Statistical Downscaling

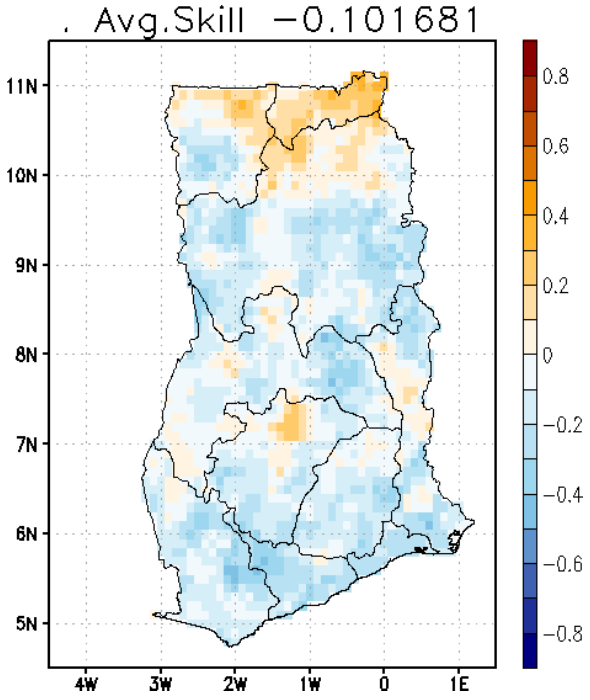
Prepared By: ACMAD Team

Overall Performance of dynamical models raw output over Ghana during the main rainfall seasons

AMJ using Mar IC



ASO using Jul IC



When dealing with models, be aware that:

- **Dynamical models often have systematic errors:** - bias in the mean - bias in the amplitude - bias in the shape of the anomaly pattern
- **Detecting and Correcting such systematic errors is a possible way out:** Transform the raw output in forecasts that are better fit to users needs.

Terminology

Downscaling – Process of derivating local or regional-scale information from larger scale modeled or observed data.

Downscaling for forecasting – translation of a forecast to a spatial and/or temporal resolution that is finer than that of the original forecast.

Spatial Downscaling: Refers to the methods used to derive climate information at finer spatial resolution from coarser spatial resolution GCM output

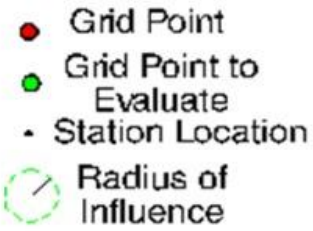
Temporal Downscaling: derivate of finer-resolution (e.g daily) temporal information from coarser-scale (monthly, seasonal) temporal GCM output

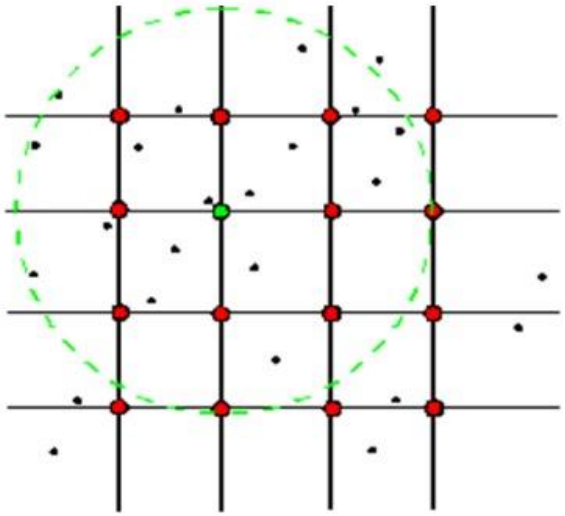
Downscaling/Upscaling: What?

Gridding of Station Data (cont'd)

.....methodology adopted

- Ferret Algorithm
- Barnes Algorithm

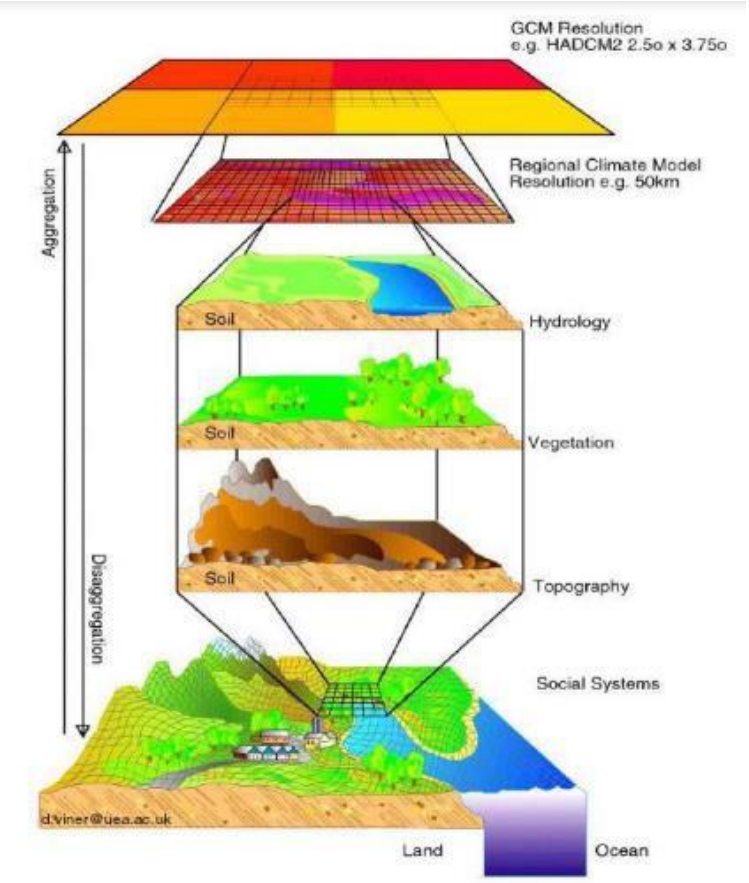




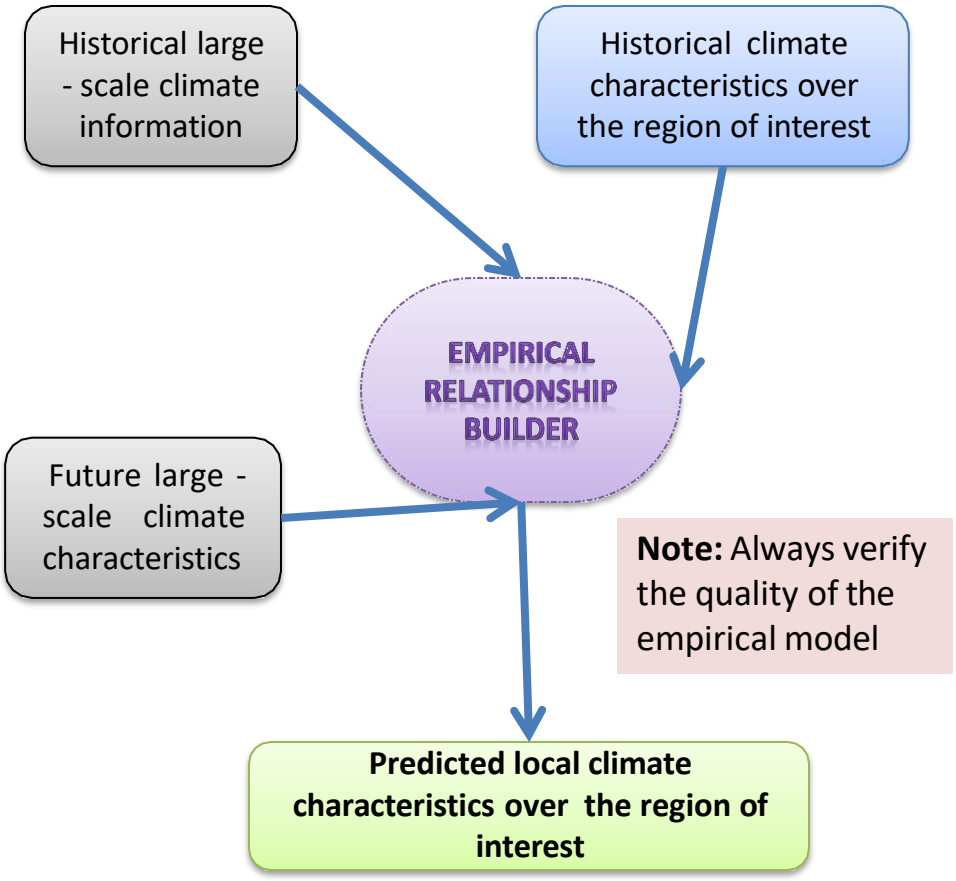
- Station Coordinate Algorithm

On the Downscaling Methods

Dynamical - relies on the use of a regional climate model (RCM), similar to a GCM in its principles but with high resolution. RCMs take the large-scale atmospheric information supplied by GCM output and detailed descriptions of physical processes in order to generate realistic climate information at a finer spatial resolution.



Statistical - involves the establishment of empirical relationships between historical large-scale atmospheric and local climate characteristics. In other words, large-scale GCM outputs are used as predictors to obtain local variables or predictands.



Statistical-dynamical - this method statistically pre-filters GCM outputs into a few characteristic states that are further used in RCM simulation. More complex but is less computational demanding in comparison to dynamical downscaling.

The most common methods for Statistical Downscaling

- **Simple Regression** - A **univariate** predictor and a **univariate** predictand:
  $y = ax + b$

- **Multiple Regression** - **Two** or **More** Predictor , and a **single** predictand
  $y = a_0 + a_1x_1 + a_2x_2 + \ldots + a_nx_n$ (case of n predictors)
  -- e.g., **Principal Components Regression (PCR)**

- **Multiple (Pattern) Regression** - **Two** or **More** predictors, and **two** or **more** predictands
  $y = Ax + b$ (A is matrix)
  -- e.g., **Canonical Correlation Analysis (CCA)**

➢ **Advantages**
- Relatively straightforward to apply
- Employs full range of available predictor variables

➢ **Disadvantages**
- Requires normality of data (e.g., monthly, seasonal average)
- Cannot be applied to non-normal distributions (e.g., daily rainfall)
- Not suitable for extreme events

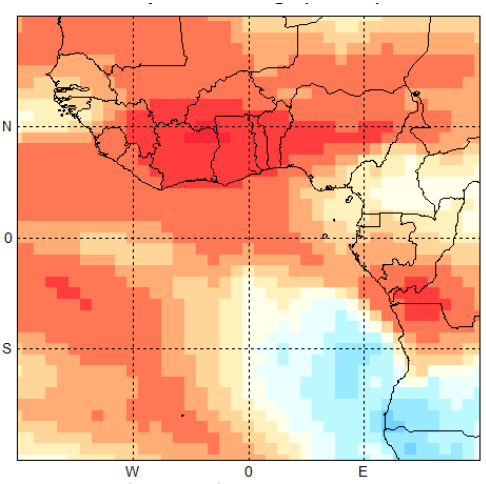
Other methods: Weather Classification (Analog, Cluster Analysis, Artificial Neural Network, Self Organizing Map), **Weather Generator,** …

The fundamental basis of spatial downscaling is the assumption that significant relationships exist between local and large-scale climate

Example:

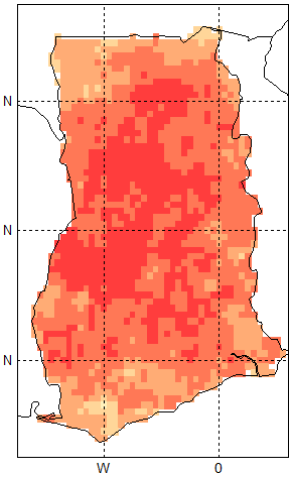
Using CCA, we intend to measure the ability of statistical downscaling to help in the forecasting of the ASO rainfall Season over Ghana.

Predictor:
ASO (Jul IC) precipitation hindcast from NMME ensemble mean

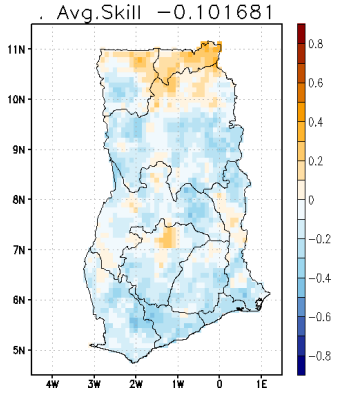


Predictor domain

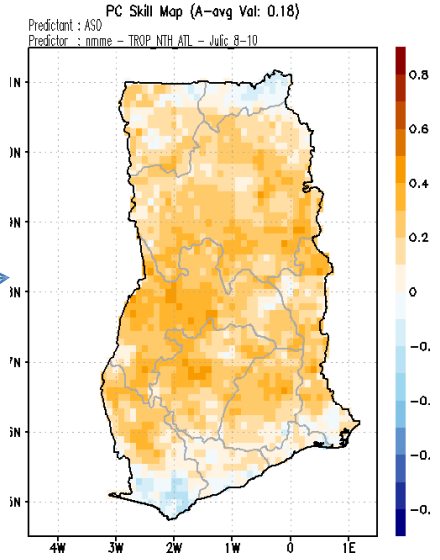
Predictand:
historical Precipitation recorded during ASO season over Ghana



Predictand domain



raw model performance



Pearson correlation skill Map after the downscaling

Downscaling process adds information to the coarse GCM output so that information is more realistic at a finer scale, capturing sub-grid scale contrasts and inhomogeneities.

Takeaways

❑ When dealing with models, be aware that:

- Dynamical models often have systematic errors: - bias in the mean - bias in the amplitude - bias in the shape of the anomaly pattern
- Detecting and Correcting such systematic errors is a possible way out: Transform the raw output in forecasts that are better fit to users needs.
- GCMs provide information at scales that are too coarse for decision makers

❑ Numerous techniques, such as Downscaling, have been developed to provide climate information at scales more relevant to decision makers.

❑ Downscaling process adds information to the coarse GCM output so that information is more realistic at a finer scale, capturing sub-grid scale contrasts and inhomogeneities.