Job-Training on New Generation of Seasonal Forecast in West Africa and the Sahel

AGHRYMET RCC-WAS

2024-10-15

Table of contents

Background 3

Workshop Objectives 5

I Week 1- Overview: Climate and its variability in WAS, Scientific Fundation for Seasonal Forecasts, WASS2S Approaches. 6

1 Climate and its variability in West Africa and the Sahel 8

2 Seasonal Forecasts: Scientific fundations, approaches... 9

3 New generation of Seasonal Forecasts in West Africa and the Sahel. 10

4 Overview of Data Structures in Python and the Libraries NumPy and Xarray. 11

5 NMME and C3S Models in Climate Data Store and IRI Data Library 13

6 Observational dataset. 15

7 Validation of Dynamical Seasonal Forecast. 16

II Week 2- Statistical seasonal climate forecasting with applications 17

III Timeline 18

Background

AGRHYMET RCC-WAS plays a leading role in climate services and agro-hydro-meteorological monitoring in the region. In recent years, AGRHYMET has committed to strengthening its forecasting capacities in line with World Meteorological Organization (WMO) Decision 9 (EC-72). This decision emphasizes the need for objective, operational, transparent, and scientifically rigorous seasonal forecasting methods. The guidelines provided by WMO in 2020 on operational practices for objective seasonal forecasting offer the necessary framework to guide regional centers and National Meteorological and Hydrological Services (NMHSs) in transitioning towards more standardized and automated forecasting systems.

To achieve these objectives, AGRHYMET has initiated efforts to improve the reproducibility of seasonal forecasts by automating key steps in the forecasting process. This transition is crucial to ensuring that the forecasting process becomes not only more consistent but also more accessible for future evaluations and improvements. Phase I of the project "Accelerating Impacts of CGIAR Climate Research for Africa" (AICCRA) has played a central role in this transition. AICCRA focuses on strengthening climate services in Africa, and in this context, AGRHYMET has leveraged the project to develop and implement innovative forecasting tools. One of the key outcomes of these efforts is the development and deployment of PyCPT (Python Climate Predictability Tool) which automates the statistical methods used for seasonal forecasts. [PyCPT]() is a powerful tool that enhances the traceability and reproducibility of forecasts, facilitating the evaluation and refinement of forecasting methodologies. Thanks to PyCPT, seasonal forecasts no longer rely on manual adjustments and subjective consensus processes, leading to more consistent and scientifically defensible results.

Beyond automation, AGRHYMET is also exploring new technological opportunities to further improve forecasting capabilities. The use of artificial intelligence (AI) and machine learning (ML) is currently being explored as a way to enhance the accuracy and speed of seasonal and sub-seasonal forecasts. AI-based approaches offer the ability to analyze large datasets, recognize complex patterns, and make forecasts that are more adaptive to changing climate conditions. These technologies promise to complement existing methods and provide more robust and reliable forecasts, especially in a region as complex and variable as West Africa and the Sahel.

AGRHYMET's ongoing work includes a comprehensive assessment of these new methods in comparison to existing ones. This evaluation aims to measure the effectiveness of AI and machine learning tools, as well as traditional statistical methods, in generating accurate and actionable seasonal forecasts. Additionally, the possibility of combining these new methods with traditional ones is being explored to create consolidated forecasts that leverage the strengths of each approach. The goal is to produce forecasts that are not only more reliable but also more useful for end-users, such as farmers, water resource managers, and policymakers across the region.

In response to these advancements, AGRHYMET recognizes the need to strengthen the capacities of its partners across West Africa and the Sahel. Many countries in the region depend on seasonal forecasts to make critical decisions that affect their economies and societies, particularly in the areas of agriculture, disaster risk management, and water resource planning. It is essential that NMHSs and other relevant institutions are equipped with the knowledge and skills needed to use both traditional and new forecasting methods to achieve broader goals of climate resilience and sustainable development in the region. This training workshop is therefore designed to address this capacity-building need by training participants from 17 West African countries on the full range of seasonal and sub-seasonal forecasting methodologies. The workshop will provide participants with practical experience in using wass2s. Additionally, the training will focus on evaluating the different methodologies, helping participants understand the strengths and limitations of each approach and how they can be applied in their respective national contexts.

Workshop Objectives

The main objectives of this training workshop are to:

1. Introduce and train participants on new methods and tools currently being explored for seasonal forecasting;
2. Provide hands-on experience in the comprehensive evaluation of new methods to facilitate an understanding of their strengths and weaknesses in the context of forecasting for West Africa and the Sahel;
3. Master the combination of the most effective methods to generate more consolidated and accurate seasonal forecasts for the region;
4. Equip participants with the skills necessary to implement these forecasting methodologies operationally within their institutions, thereby improving forecasting services and climate services across the region.

Part I

Week 1- Overview: Climate and its variability in WAS, Scientific Fundation for Seasonal Forecasts, WASS2S Approaches.

Timeline

Time	Monday	Tuesday	Wednesday	Thursday	Friday
08:30 - 10:00	Opening and Presentation of Participants	Overview of Data Structures in Python and the Libraries NumPy and Xarray (K. Arsène & al.)	Overview of Data Structures in Python and the Libraries NumPy and Xarray (K. Arsène & al.)	Access Dynamical Model data for Seasonal Forecasting (H. Mandela)	Observational Datasets and Their Improvements (H. Mandela & al.)
Break					
10:30 - 12:30	Climate and its Variability in West Africa and the Sahel (H. Mandela)	Overview of Data Structures in Python and the Libraries NumPy and Xarray (K. Arsène & al.)	Overview of Data Structures in Python and the Libraries NumPy and Xarray (K. Arsène & al.)	Access Dynamical Model data for Seasonal Forecasting (H. Mandela & al.)	Validation of Dynamical Seasonal Forecasts (H. Mandela)
Break					
14:00 - 17:30	Seasonal Forecasts: Scientific foundations, Approaches, … (H. Mandela) → Next Generation of Seasonal Forecasting in West Africa and The Sahel (H. Mandela)	Overview of Data Structures in Python and the Libraries NumPy and Xarray (K. Arsène & al.)	Debrief with Participants (K. Arsène & al.)	Observational Datasets and Their Improvements (H. Mandela)	Validation of Dynamical Seasonal Forecast (H. Mandela & al.)

Participant exercise time in green

1 Climate and its variability in West Africa and the Sahel

Facilitator: **Mandela HOUNGNIBO**

keys points:

- West African Climate and Trends,
- Climate characteristics in West Africa and the Sahel,
- Key factors influencing climate variability,
- ...

Download materials here

2 Seasonal Forecasts: Scientific fundations, approaches...

Facilitator: **Mandela HOUNGNIBO**

keys points:

- Scientific fundations,
- Main approaches in seasonal forecasts,
- Uncertainty and its taking account,
- ...

Download materials here

3 New generation of Seasonal Forecasts in West Africa and the Sahel.

Facilitator: **Mandela HOUNGNIBO**

keys points:

- Approaches in seasonal forecasts in West Africa and the Sahel,
- Brief on methods and tools used in seasonal forecasts,
- ...

Download materials here

4 Overview of Data Structures in Python and the Libraries NumPy and Xarray.

Facilitator: **Mandela HOUNGNIBO**

keys points: Python builtin data structures and data science package (Numpy and Xarray, …)

> **I highly recommend to install WSL on your computer** if you have a Windows OS (10 and 11). It will allow you to run Linux commands on your Windows machine. Here is the link to install WSL.

1. Download and Install miniconda

- For Windows, download the executable here
- For Linux (Ubuntu), in the terminal run:

```
sudo apt-get update
sudo apt-get upgrade
sudo apt-get install wget
wget -c -r https://repo.anaconda.com/miniconda/Miniconda3-latest-Linux-x86_64.sh --no-ch
bash Miniconda3-latest-Linux-x86_64.sh
```

- Managing environments with conda

It is strongly recommended to read conda cheatsheets here or Getting Started with Conda. here are some important conda command you will use along the training:

```
# to create an environment:
conda create -n your_environment_name

# to activate your environment:
conda activate your_environment_name

# to desactivate your environment:
conda deactivate your_environment_name

# to install packages in your environment:
```

```
conda install package_name

# to list all the packages in your environment:
conda list

# to see all the environments on your system:
conda info --envs

# conda remove your environment
conda env remove -n your_environment_name
```

2. Specific indication for the training

For this training, I export my environment to a file called `environment.yml`. You can download it here. go to the directory where the file is located and run the following command in the terminal:

````
# create the environment from the environment.yml file
conda env create -f environment.yml -n WAS_S2S
<!-- ``` -->
This command line will reproduce my environment in your computer with specific package, run t
we will create an environment called WAS_S2S and install some packages in it.

3.  Introduction to JupyterLab

[JupyterLab](https://jupyterlab.readthedocs.io) will be our primary method for interacting wi

``` bash
jupyter lab --ServerApp.iopub_data_rate_limit=1.0e20
````

4. Download notebooks here and unzip it in your working directory.
````

5 NMME and C3S Models in Climate Data Store and IRI Data Library

Facilitator: **Mandela HOUNGNIBO**

1. Create CDS API key and use it to download NMME and C3S models data from the Climate Data Store (CDS) and IRI Data Library.

- Create an account with Copernicus by signing up here
- Once you successfully create an account, kindly log in to your Copernicus account and click on your name at the top right corner of the page. Note your "UID" and "Personal Access Token key".

2. Configure .cdsapirc file.

In your activated terminal, kindly initiate the Python interpreter by entering the command python3. Subsequently, carefully copy and paste the below code, ensuring to replace "Personal Access Token" with yours.

```python
import os

config_data = '''url: https://cds.climate.copernicus.eu/api
key: Personal Access Token
verify: 0
'''

path_to_home = "/".join([os.path.expanduser('~'),".cdsapirc"])

if not os.path.exists(path_to_home):
    with open(path_to_home, 'w') as file:
        file.write(config_data)

print("Configuration file created successfully!")
```

3. Install the CDS API package.

In your terminal, kindly install the CDS API package by entering the command below:

```
pip install 'cdsapi>=0.7.2'
```

6 Observational dataset.

7 Validation of Dynamical Seasonal Forecast.

Part II

Week 2- Statistical seasonal climate forecasting with applications

Part III

Timeline

Time	Monday	Tuesday	Wednesday	Thursday	Friday
08:30 - 10:00	Review installation	Debrief with Participants	Observational Datasets	Validation of Dynamical Seasonal Forecast	Participants Presentations on Validation
Break					
10:30 - 12:30	Climate and its Variability in West Africa and the Sahel	Seasonal Forecasts: Scientific foundations, Approaches, …	Validation of Dynamical Seasonal Forecast	Validation of Dynamical Seasonal Forecast	Participants Presentations on Validation
Break					
14:00 - 17:00	Overview of Data Structures in Python and the Libraries NumPy and Xarray	NMME and C3S Models in Climate Data Store and IRI Data Library	Validation of Dynamical Seasonal Forecast	Validation of Dynamical Seasonal Forecast	PyCPT and Xcast Installation

Participant exercise time in green