Online User Engagement On Agricultural Onset Monitoring in Africa

Introduction to ACMAD's Onset Tool

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Presented by:

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Brief on ACMAD' Mission and Vision

- Created in April 1985 following the droughts of the 70s and 80s ,
- established in Niamey-Niger since October 1992

Continental Weather and Climate Watch Centre for Africa

WMO designated RCC since May 2015 and a Continental MultiHazards Advisory Centre since October 2022

Institution of excellence for the Applications of meteorology for sustainable development

Why is it so important to monitored the onset of the Agricultural season ?

Climate and weather information are key for updating agricultural calendar

Increasing variability of the climate in Africa these last decades make it challenging to update the agricultural calendar based on common method

There is a need to adapt, to develop technologies and adapt method to better respond to farmer needs

For efficient monitoring and forecast,

a more generally applicable methods are required

Grid point based methods

Background: Why is it important?

Over Tropics the temporal variation of rain systems is largely dominated by annual alternation between wet and dry seasons.

The transition period from dry to wet (or wet to dry) seasons over tropical regions have important implications to society.

- For rain-fed agriculture: onset delays can lead to yield loss, affecting not only the local economy but also local and global food security.
- For electricity generation and water management: Late onsets or early demises can negatively impact hydropower generation and water consumption.
- Human health.
  - if the rainy season extends for too long, it can lead post-harvesting loss due to infection by mold, which poses a serious risk to human health.
  - Excess precipitation can also lead to landslides and issues related to water borne diseases.

Therefore, detecting, monitoring, and predicting the timing of rain season have important implications for society.

Background: How?

Usually the methods to identify the timing of the season are classified into two main categories:

✓ Methods based on regional-scale or large scale rain system features.

✓ Methods based on local-scale (i.e., at a single station or grid-point)

Background: How?

Usually the methods to identify the timing of the season are classified into two main categories:

✓ **Methods based on regional-scale or large scale rain system features.**

- ✓ **Regional onset:** ***E.g*** - *day when the ITCZ shift from 5N to 10N*
- ✓ **Dynamical onset***:* ***E.g*** - day when the sign, of the difference of moist-static energy between Sahel and Gulf of Guinea, change from negative to positive (increased warming and moistening of the Sahel)

✓ **Methods based on local-scale (i.e., at a single station or grid-point)**

Background: How?

Usually the methods to identify the timing of the season are classified into two main categories:

✓ Methods based on regional-scale or large scale rain system features.

✓ **Methods based on local-scale (i.e., at a single station or grid-point)**

✓ **Agro method:** date when rainfall accumulated over 3 consecutive days is at least 20 mm and when no dry spell within the next 30 days exceeds 7 days. (Sivakumar, 1988)

✓ **Isochrone method**: "Threshold based" analysis technique

- check the date the for which *a specific fraction of the average rainy-season total rainfall amount has fallen. (Velinga et al., 2013)*
- *Onset date based on the accumulation of rainfall to a predefined threshold, starting from a specific date (Lo et al., 2007)*

✓ "**Harmonic analysis**" of daily time series using the changes occurring in the course of the annual cycle of the precipitations. *(Liebmann and Marengo, 2001; **Dunning et al., 2016**)*

Onset of the Agricultural Season detection at ACMAD

✓ **Core Criteria**	✓ **Simplicity and efficiency** ✓ **Applicable everywhere** ✓ **Meaningful for managerial perspective**

➢ *Onset date based on the accumulation of 50mm rainfall to a predefined threshold, starting from a specific date (Lo et al., 2007).*

50 mm : amount of rainfall required to generate new plant growth after the dry season (Cook and Heerdegen, 2001).

❑ No need of prior knowledge of the climatological annual or wet-season mean
❑ Easily measurable and understandable
❑ Readily applicable for management related decision.

➢ "**Harmonic analysis**" of daily time series using the changes occurring in the course of the annual cycle of the precipitations. *(Liebmann and Marengo, 2001; Dunning et al., 2016)*

❑ Provide the information about the rainfall regime of the location: single or multiple wet season
❑ Give an idea of when to start the monitoring of the season
❑ Further help in season cessation detection.

Onset of the Agricultural Season detection at ACMAD

Monitoring	✓ Identification of the monitoring period ✓ Climatological onset dates detection ✓ Yearly date detection ✓ Observed Onset Status (Early, Normal or Late)
Forecast	✓ Analog years ✓ S2S model output ✓ Prospective Onset Status (Early, Normal or Late)

Onset of the Agricultural Season detection at ACMAD

Monitoring: Method and procedure

From a given station or Grid point:

1. Climatological dates detection:

1. Derive the climatological daily mean rainfall time series
2. Compute the climatological cumulative daily rainfall time series Q(t)
3. Retrieve the 75% and 125% of climatological cumulative daily rainfall series.
4. Identify the dates at which each of the above cumulative curves reach the 50 mm threshold: **C** for the climo, **L** and **E** for the 75% and 125% curves respectively

2. Yearly date detection

1. Compute the cumulative time of the current (or any given)
2. identify the date (**D**) at which the 50 mm threshold is reached

3. Monitoring : onset Status

- ❑ If **D** < **E** then the current year has **early start**.
- ❑ If **E** < **D** < **C** then the current year has **normal to early start**.
- ❑ If **C** < **D** < **L** then the current year has **normal to late start**.
- ❑ If **L** < **D** then the current year has **late start**.

Onset of the Agricultural Season detection at ACMAD

Operational Forecast: Method and procedure

From a given station or Grid point:

1. Climatological dates detection:

1. Derive the climatological daily mean rainfall time series
2. Compute the climatological cumulative daily rainfall time series Q(t)
3. Retrieve the 75% and 125% of climatological cumulative daily rainfall series.
4. Identify the dates at which each of the above cumulative curves reach the 50 mm threshold: **C** for the climo, **L** and **E** for the 75% and 125% curves respectively

2. Sequence of forecasting the onset date

1. For each analog year identified, compute using their respectively agricultural onset date (**Da**), as described on the previous slide

1. For the current year, if the onset is not reach:
   1. Append the daily forecast (from model) to the current observed data and
   2. compute the cumulative daily time series
   3. identify the forecast date (**Dm**) at which the 50 mm threshold is reached

3. Scenarios: Onset not observed yet

- ❑ If last date of observation (**O**) < **L**,
  - ❑ if the models cannot detect (NA) the onset date the analog approach is used**, and the forecasted onset is given by Da**
  - ❑ otherwise, **Dm** is the forecasted onset

- ❑ If last date of observation (**O**) > **L**, the onset is late and a tentative date is given by **Da**, from the analog approach

4. Prospecitve onset Status

- ❑ If **D** < **E** then the current year has **early start**.
- ❑ If **E** < **D** < **C** then the current year has **normal to early start**.
- ❑ If **C** < **D** < **L** then the current year has **normal to late start**.
- ❑ If **L** < **D** then the current year has **late start**.

Detection of the Start of the monitoring and Forecast period

The “**Harmonic analysis**” method : under the hood

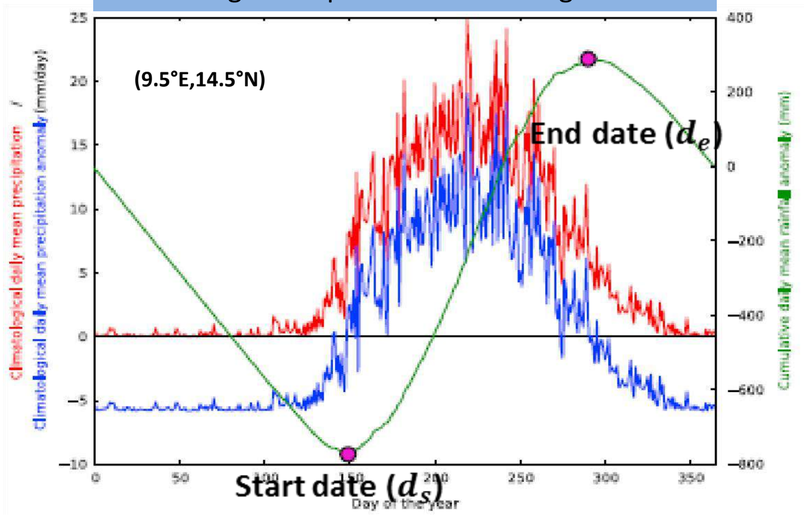
Dunning, Caroline M., Emily CL Black, and Richard P. Allan. "The onset and cessation of seasonal rainfall over Africa." Journal of Geophysical Research: Atmospheres 121.19 (2016).

- **The mean onset/demise date**
  - Using the daily $(\mathbf{Q_i})_{\mathbf{i=1Jan-31Dec}}$ Climatological fields at each grid points
    - Compute the Climatological daily mean rainfall $\mathbf{Q}$
      - Compute the Climatology cumulative daily rainfall anomaly $\mathrm{C(d)}$ **on each** $\boldsymbol{d}$

$$\boldsymbol{C(d) = \sum_{i=1Jan}^{d} Q_i - \overline{Q}}$$

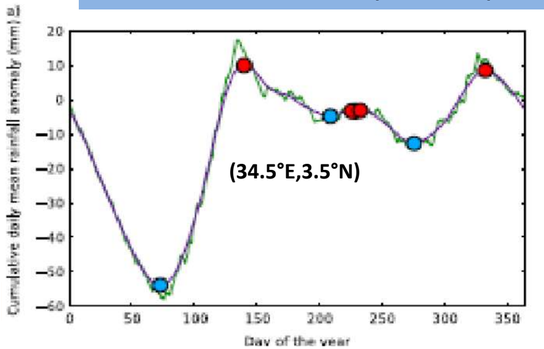
      - accumulated precipitation anomalies experience local minima/maxima at the beginning and end dates of the rainy season
  - For the bimodal regime
    - Season Duration : 30 days and over
    - Pause between 2 season: at least 20 days
  - Climatological dry areas : grid points with less than 10% of rainy days per year

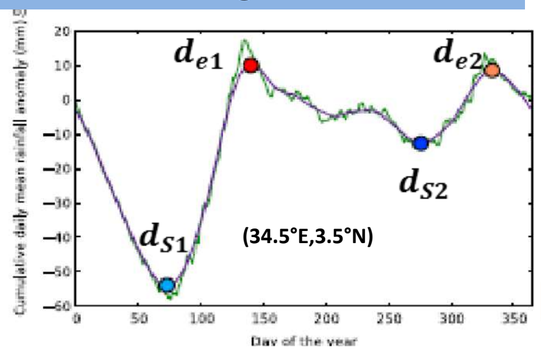
Single wet period : Annual Regime



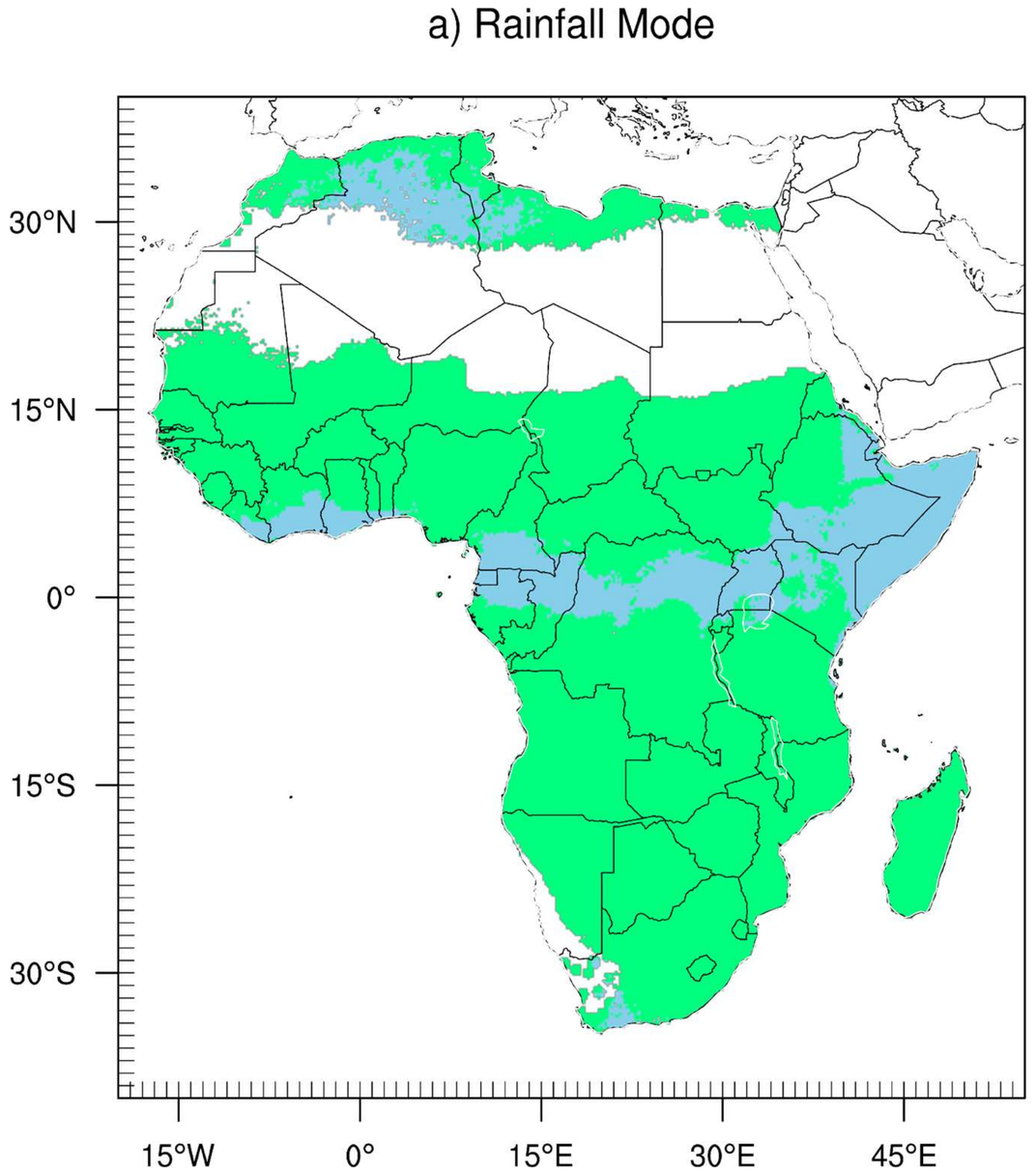
Climatology cumulative daily rainfall anomaly

Multiple wet periods : Biannual Regime





Rainfall Regime

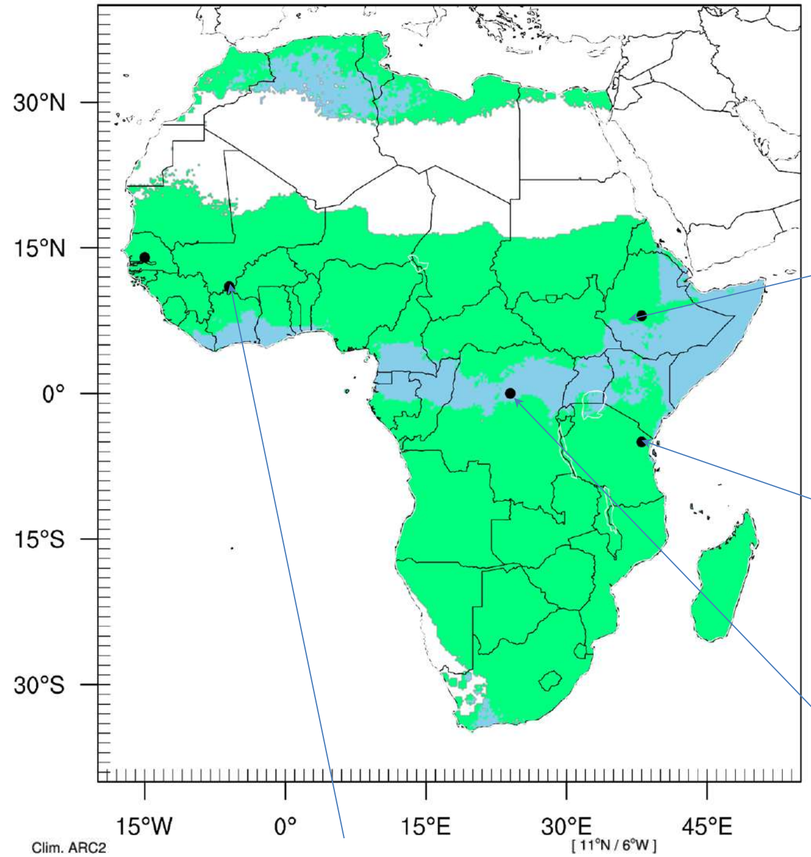


- ✓ Dry mask for area with less than 100 mm/year
- ✓ Season length : > 30 days

Time series for selected points

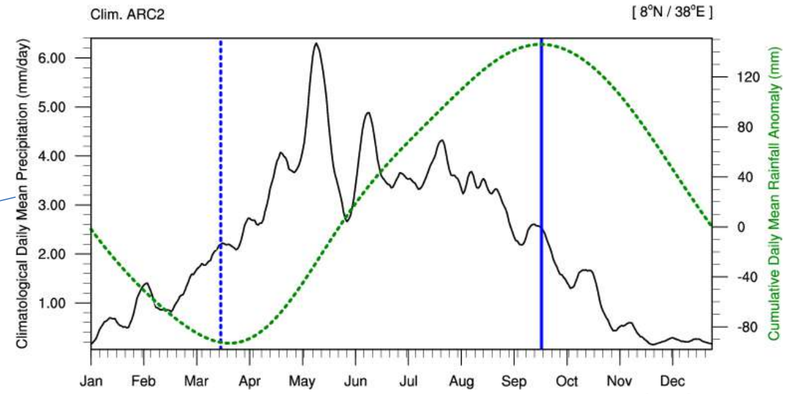
- Solid black curve : Mean Precipitation Annual Cycle
- Dash green curve: Smoothed Accumulated Precipitation Anomalies
- Vertical lines delineated the wet season - dash and solid are for the onset and the demise of season respectively

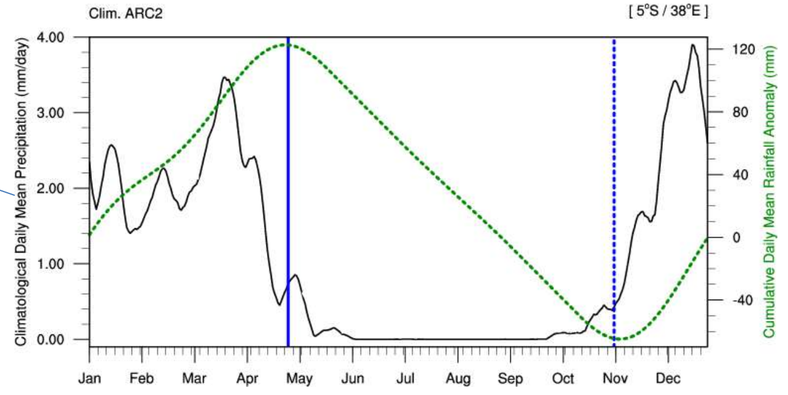
a) Rainfall Mode

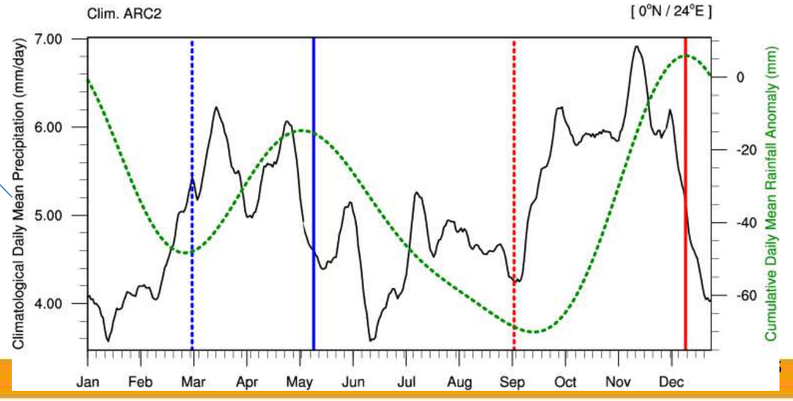


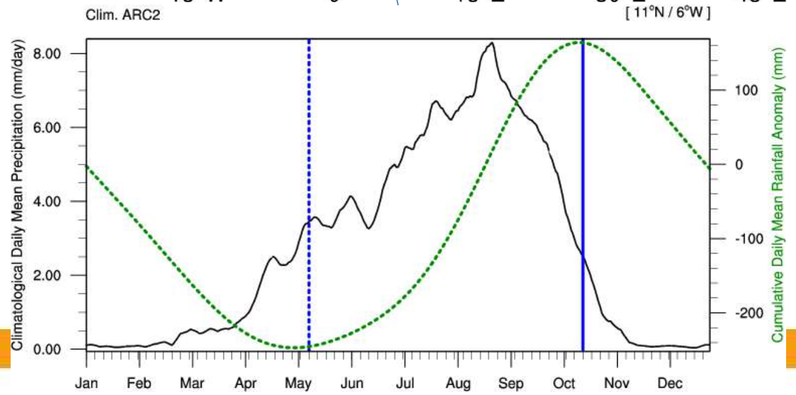
Biannual Regime

Annual Regime









Identification of Analog years

Analog Forecasting : Definition and Usefulness

Definition	✓ **Analog:** something that is similar or comparable to something else either in general or in some specific detail : something that is analogous to something else ✓ **Analog Forecasting:** a method that compares current weather patterns to similar patterns from the past in order to make prediction

Analog years were useful in talking with farmers:

➢ Agricultural producers use historical events—recent past experiences and historical narratives—to construct local knowledge to assess, quantify, and manage current and future risks.

SEASONAL FORECASTING APPROACH:

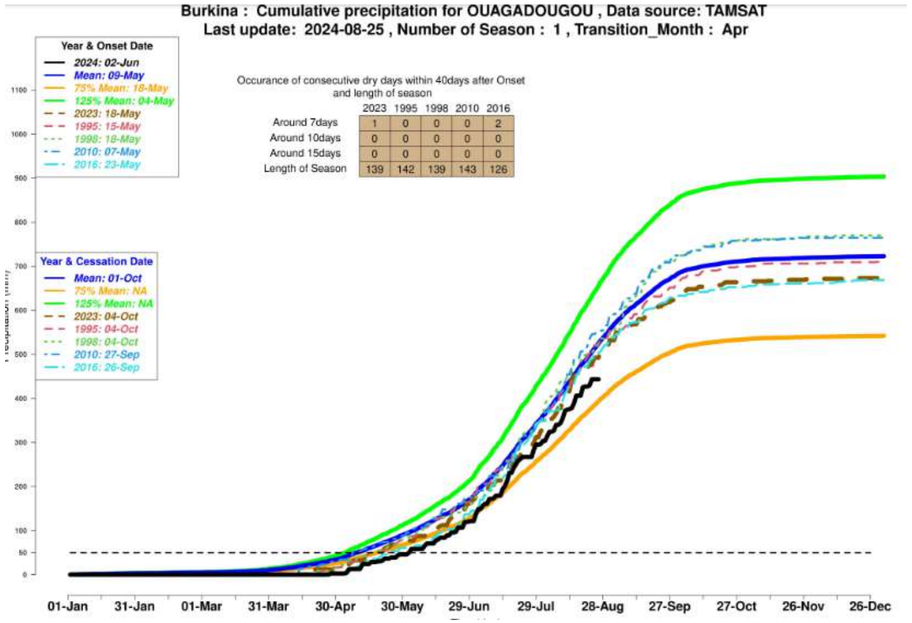
IDENTIFICATION OF ANALOGUE YEARS USING HISTORICAL EL NIÑO AND LA NIÑA EPISODES

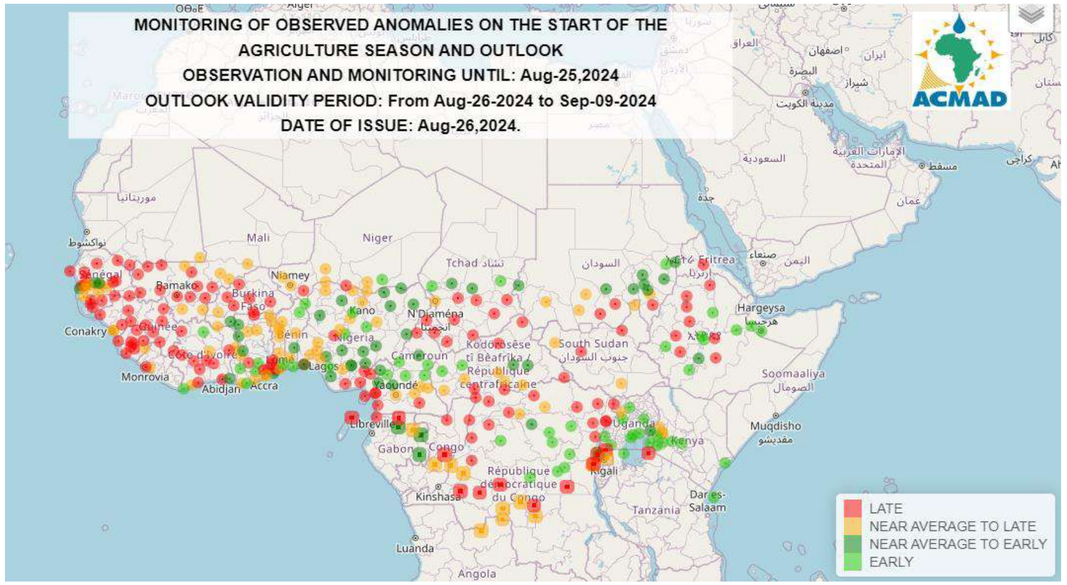
Analysis of Historical El Niño and La Niña Episodes

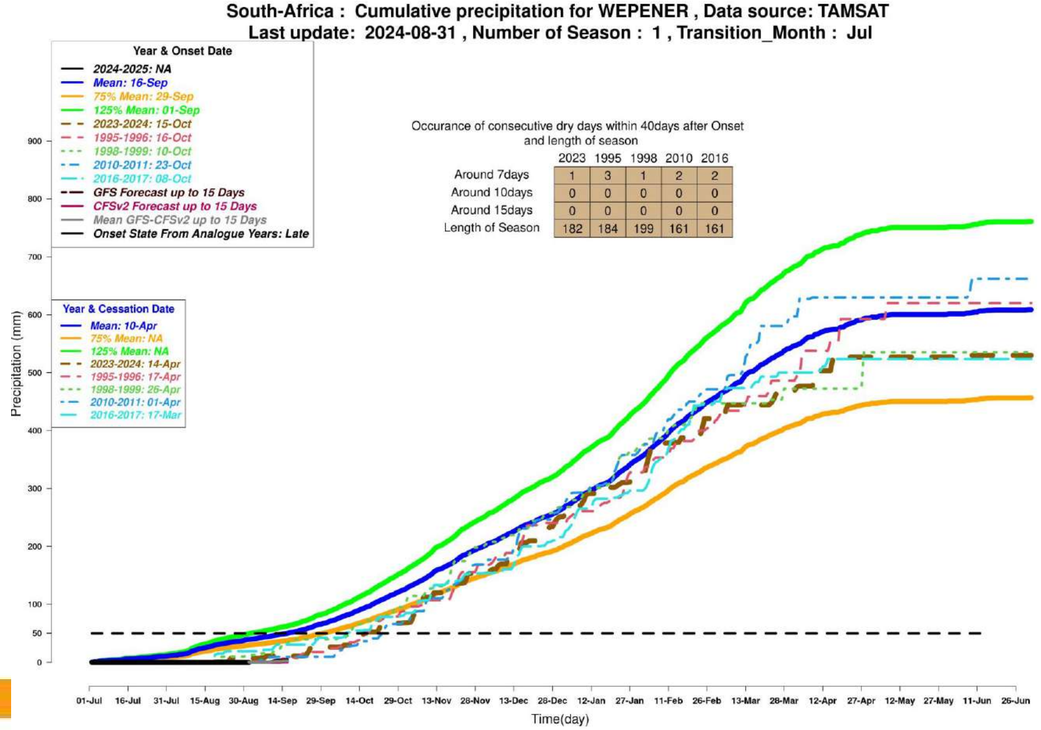
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.7	-1.4	-1.1	-0.8	-0.7	-0.6	-0.6	-0.5	-0.5	-0.6	-0.7	-0.7
2001	-0.7	-0.5	-0.4	-0.3	-0.3	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3	-0.3
2002	-0.1	0.0	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.2	1.3	1.1
2003	0.9	0.6	0.4	0.0	-0.3	-0.2	0.1	0.2	0.3	0.3	0.4	0.4
2004	0.4	0.3	0.2	0.2	0.2	0.3	0.5	0.6	0.7	0.7	0.7	0.7
2005	0.6	0.6	0.4	0.4	0.3	0.1	-0.1	-0.1	-0.1	-0.3	-0.6	-0.8
2006	-0.9	-0.8	-0.6	-0.4	-0.1	0.0	0.1	0.3	0.5	0.8	0.9	0.9
2007	0.7	0.2	-0.1	-0.3	-0.4	-0.5	-0.6	-0.8	-1.1	-1.3	-1.5	-1.6
2008	-1.6	-1.5	-1.3	-1.0	-0.8	-0.6	-0.4	-0.2	-0.2	-0.4	-0.6	-0.7
2009	-0.8	-0.8	-0.6	-0.3	0.0	0.3	0.5	0.6	0.7	1.0	1.4	1.6
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2010	1.5	1.2	0.8	0.4	-0.2	-0.7	-1.0	-1.3	-1.6	-1.6	-1.6	-1.6
2011	-1.4	-1.2	-0.9	-0.7	-0.6	-0.4	-0.5	-0.6	-0.8	-1.0	-1.1	-1.0
2012	-0.9	-0.7	-0.6	-0.5	-0.3	0.0	0.2	0.4	0.4	0.3	0.1	-0.2
2013	-0.4	-0.4	-0.3	-0.3	-0.4	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.3
2014	-0.4	-0.5	-0.3	0.0	0.2	0.2	0.0	0.1	0.2	0.5	0.6	0.7
2015	0.5	0.5	0.5	0.7	0.9	1.2	1.5	1.9	2.2	2.4	2.6	2.6
2016	2.5	2.1	1.6	0.9	0.4	-0.1	-0.4	-0.5	-0.6	-0.7	-0.7	-0.6
2017	-0.3	-0.2	0.1	0.2	0.3	0.3	0.1	-0.1	-0.4	-0.7	-0.8	-1.0
2018	-0.9	-0.9	-0.7	-0.5	-0.2	0.0	0.1	0.2	0.5	0.8	0.9	0.8
2019	0.7	0.7	0.7	0.7	0.5	0.5	0.3	0.1	0.2	0.3	0.5	0.5
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2020	0.5	0.5	0.4	0.2	-0.1	-0.3	-0.4	-0.6	-0.9	-1.2	-1.3	-1.2
2021	-1.0	-0.9	-0.8	-0.7	-0.5	-0.4	-0.4	-0.5	-0.7	-0.66	-0.87	-0.91
2022	-0.84	-0.67	-0.46	-0.25	-0.08	0.10	0.19	-0.5	-0.7	-0.8	-1.0	-1.0

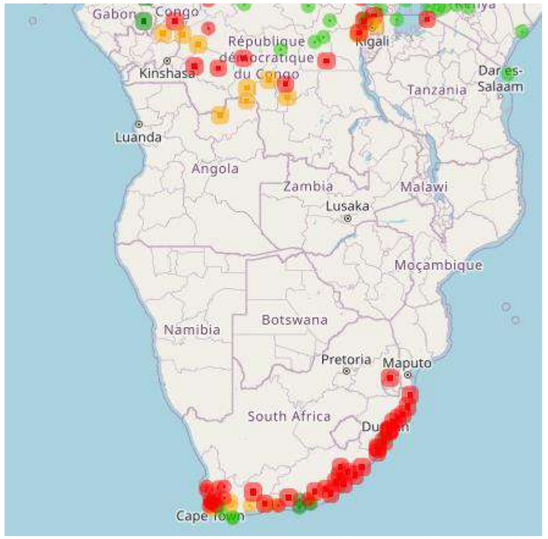
IDENTIFIED ANALOGUE YEARS: 2001, 2009, 2012, 2018 and 2021

Monitoring and forecasting at ACMAD


Burkina : Cumulative precipitation for OUAGADOUGOU , Data source: TAMSAT
Last update: 2024-08-25 , Number of Season : 1 , Transition_Month : Apr
Year & Onset Date
2024: 02-Jun
Mean: 09-May
75% Mean: 18-May
125% Mean: 04-May
2023: 18-May
1995: 15-May
1998: 18-May
2010: 07-May
2016: 23-May
Occurance of consecutive dry days within 40days after Onset and length of season
2023 1995 1998 2010 2016
Around 7days 1 0 0 0 2
Around 10days 0 0 0 0 0
Around 15days 0 0 0 0 0
Length of Season 139 142 139 143 126
Year & Cessation Date
Mean: 01-Oct
75% Mean: NA
125% Mean: NA
2023: 04-Oct
1995: 04-Oct
1998: 04-Oct
2010: 27-Sep
2016: 26-Sep
01-Jan 31-Jan 01-Mar 31-Mar 30-Apr 30-May 29-Jun 29-Jul 28-Aug 27-Sep 27-Oct 26-Nov 26-Dec


MONITORING OF OBSERVED ANOMALIES ON THE START OF THE AGRICULTURE SEASON AND OUTLOOK
OBSERVATION AND MONITORING UNTIL: Aug-25,2024
OUTLOOK VALIDITY PERIOD: From Aug-26-2024 to Sep-09-2024
DATE OF ISSUE: Aug-26,2024.
ACMAD
LATE
NEAR AVERAGE TO LATE
NEAR AVERAGE TO EARLY
EARLY

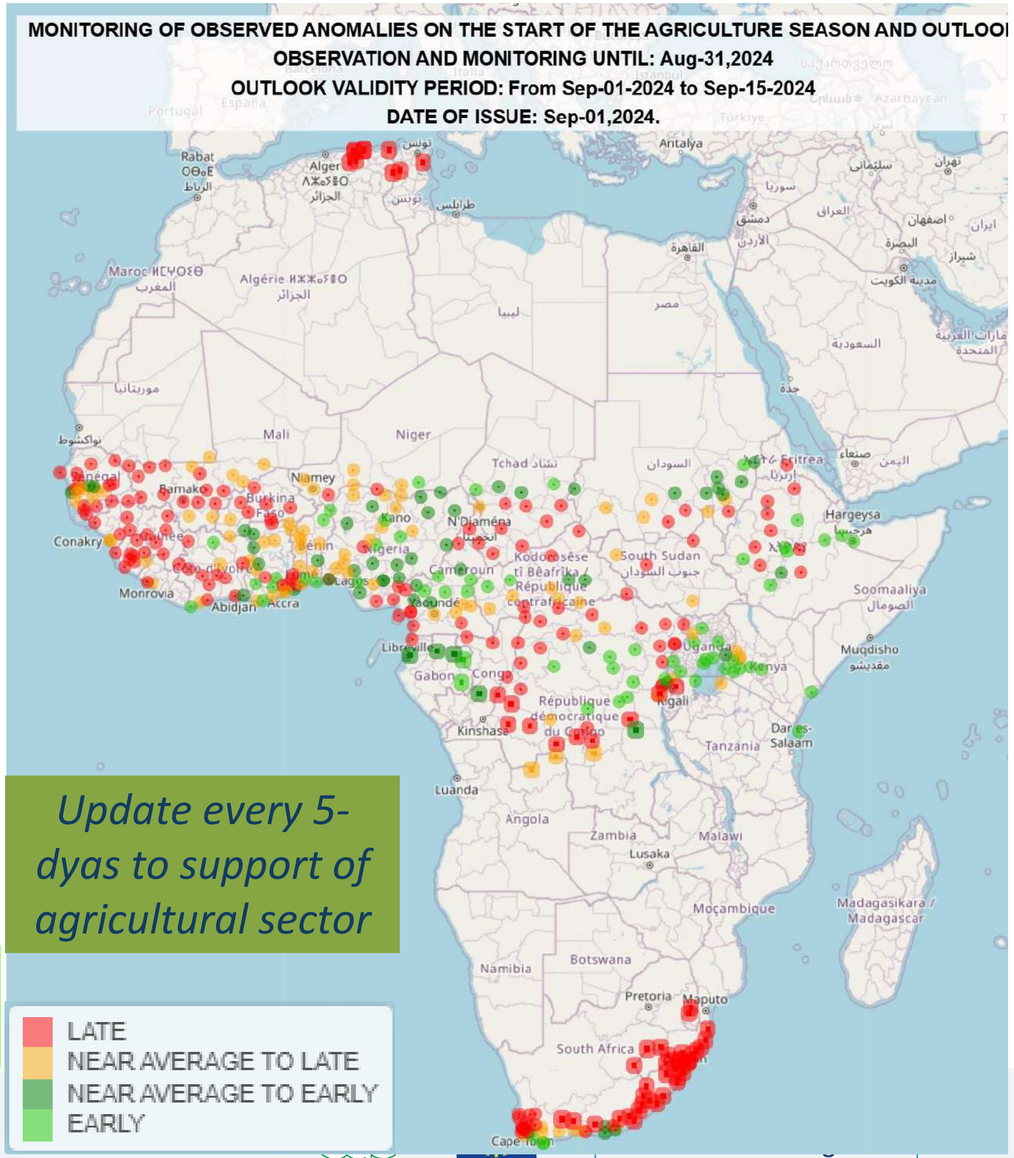

South-Africa : Cumulative precipitation for WEPENER , Data source: TAMSAT
Last update: 2024-08-31 , Number of Season : 1 , Transition_Month : Jul
Year & Onset Date
2024-2025: NA
Mean: 16-Sep
75% Mean: 29-Sep
125% Mean: 01-Sep
2023-2024: 15-Oct
1995-1996: 16-Oct
1998-1999: 10-Oct
2010-2011: 23-Oct
2016-2017: 08-Oct
GFS Forecast up to 15 Days
CFSv2 Forecast up to 15 Days
Mean GFS-CFSv2 up to 15 Days
Onset State From Analogue Years: Late
Occurance of consecutive dry days within 40days after Onset and length of season
2023 1995 1998 2010 2016
Around 7days 1 3 1 2 2
Around 10days 0 0 0 0 0
Around 15days 0 0 0 0 0
Length of Season 182 184 199 161 161
Year & Cessation Date
Mean: 10-Apr
75% Mean: NA
125% Mean: NA
2023-2024: 14-Apr
1995-1996: 17-Apr
1998-1999: 26-Apr
2010-2011: 01-Apr
2016-2017: 17-Mar
Precipitation (mm)
01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov 28-Nov 13-Dec 28-Dec 12-Jan 27-Jan 11-Feb 26-Feb 13-Mar 28-Mar 12-Apr 27-Apr 12-May 27-May 11-Jun 26-Jun
Time(day)


Gabon
Congo
Kinshasa
République démocratique du Congo
Rwanda
Dar es-Salaam
Tanzania
Luanda
Angola
Zambia
Malawi
Lusaka
Moçambique
Namibia
Botswana
Pretoria
Maputo
South Africa
Cape Town

Contribution to the Food Security Value Chain – Monitoring and forecasting of the start of the agricultural season

http://sgbd.acmad.org:8080/thredds/fileServer/ACMAD/CDD/climatemonitoringservice/season_onset_monitoring.html

Prediction of the start of the agricultural season, dry and wet periods to support farmers in planning their activities



Update every 5-dyas to support of agricultural sector

Future development projects should integrate the production and dissemination of this information in real time to rural areas.

THANK YOU

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On the ONSET Detection Methods

Local indicator : **"Threshold based" or Isochrone Method** of pentad time series

Vellinga, Michael, Alberto Arribas, and Richard Graham. "Seasonal forecasts for regional onset of the West African monsoon." Climate Dynamics 40.11-12 (2013): 3047-3070.

The mean onset date:

Using the Climatological fields, at each grid point, ***for a selected period*** *consider the* ***rainfall accumulation.***

Scaled *by the* ***total rainfall amount*** *(at the end of the selected period).*

The ***onset date*** *is the* ***calendar day*** *for which a specific* ***fraction*** *(here 20%) of the average* ***total*** *rainfall* ***amount*** *has* ***fallen****.*

Onset date for individual year

Same (based on the observations of the year) but scaled by the same average (see above) season-total rainfall

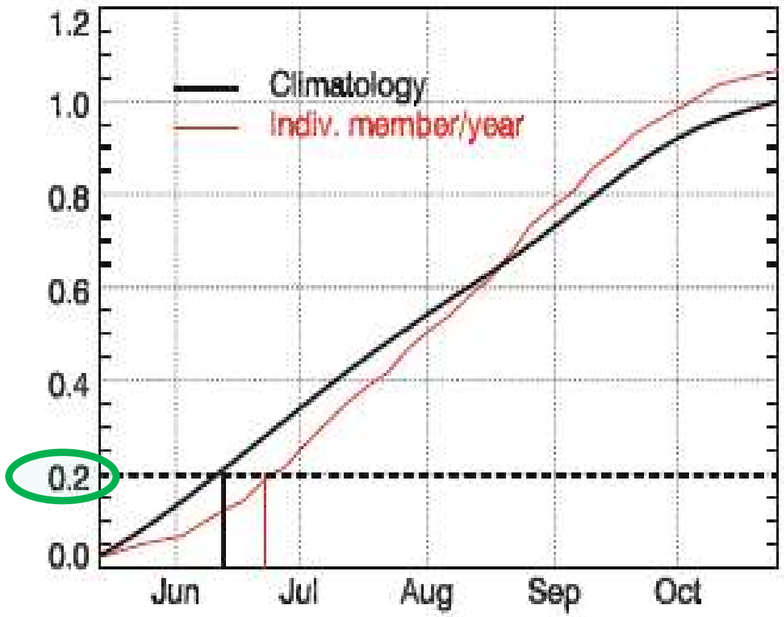

Fig. 16 Isochrone method: in each gridpoint timing of the occurrence of the 20 % value (*dashed line*) of the normalised rainfall accumulation is determined for the long-term average (*heavy black line*) and an individual ensemble member or year of observations (*thin red*)

For the displayed case, onset date of the individual year is late but as a whole the season is wetter than climatology.