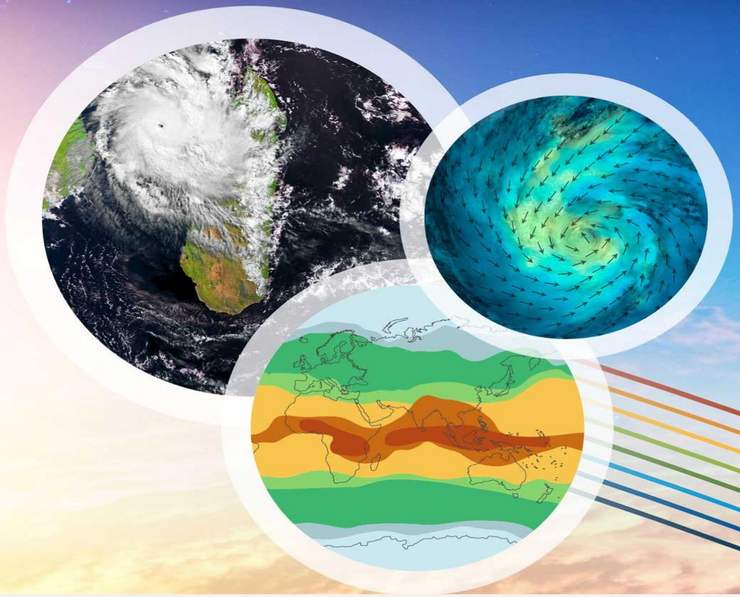
Reviewing and Exploring Products Supporting Improvements on the Annual State of Climate Report for Africa

Accra, GHANA

July 11-13, 2023



Essential Climate Variables and Observed Trends

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

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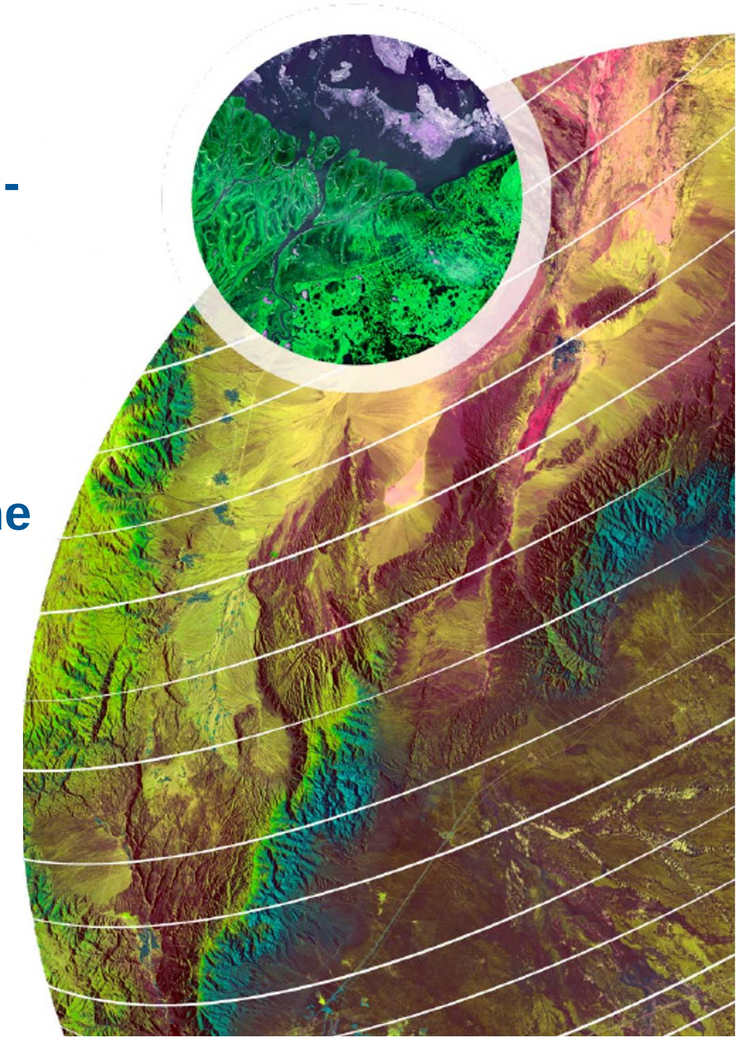
OUTLINE OF CONTENT

01 **Essential Climate Variable - Overview**

02 **The major ECVs used in the SoC Report – Observed Trends**

03 **Actionable Indicators for the Majors ECVs in 2022**



01

Essential Climate Variables - Overview

Essential Climate Variables (ECVs)

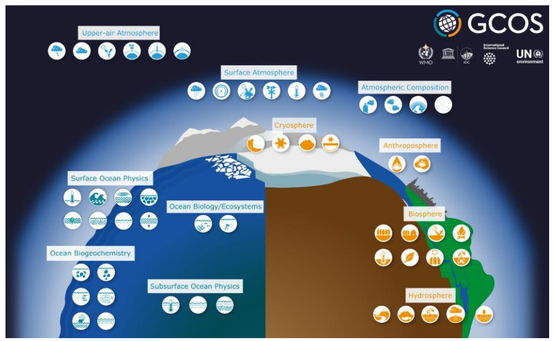
Background Summary

- In order to coordinate and facilitate the development and improvement of global climate observations, the **Global Climate Observing System** (GCOS) was **established, in 1992**, jointly by **WMO**, the **Intergovernmental Oceanographic Commission (IOC) of UNESCO**, **the United Nations Environment Programme** (UNEP) and the **International Science Council** (ISC).

- GCOS has identified a set of Essential Climate Variables (ECVs) that together provide the information necessary to understand, model and predict the trajectory of the climate as well as plan mitigation and adaptation strategies

Essential Climate Variables (ECVs)

Who is in charge?



https://public.wmo.int/en/programmes/global-climate-observing-system/essential-climate-variables

https://gcos.wmo.int/en/essential-climate-variables

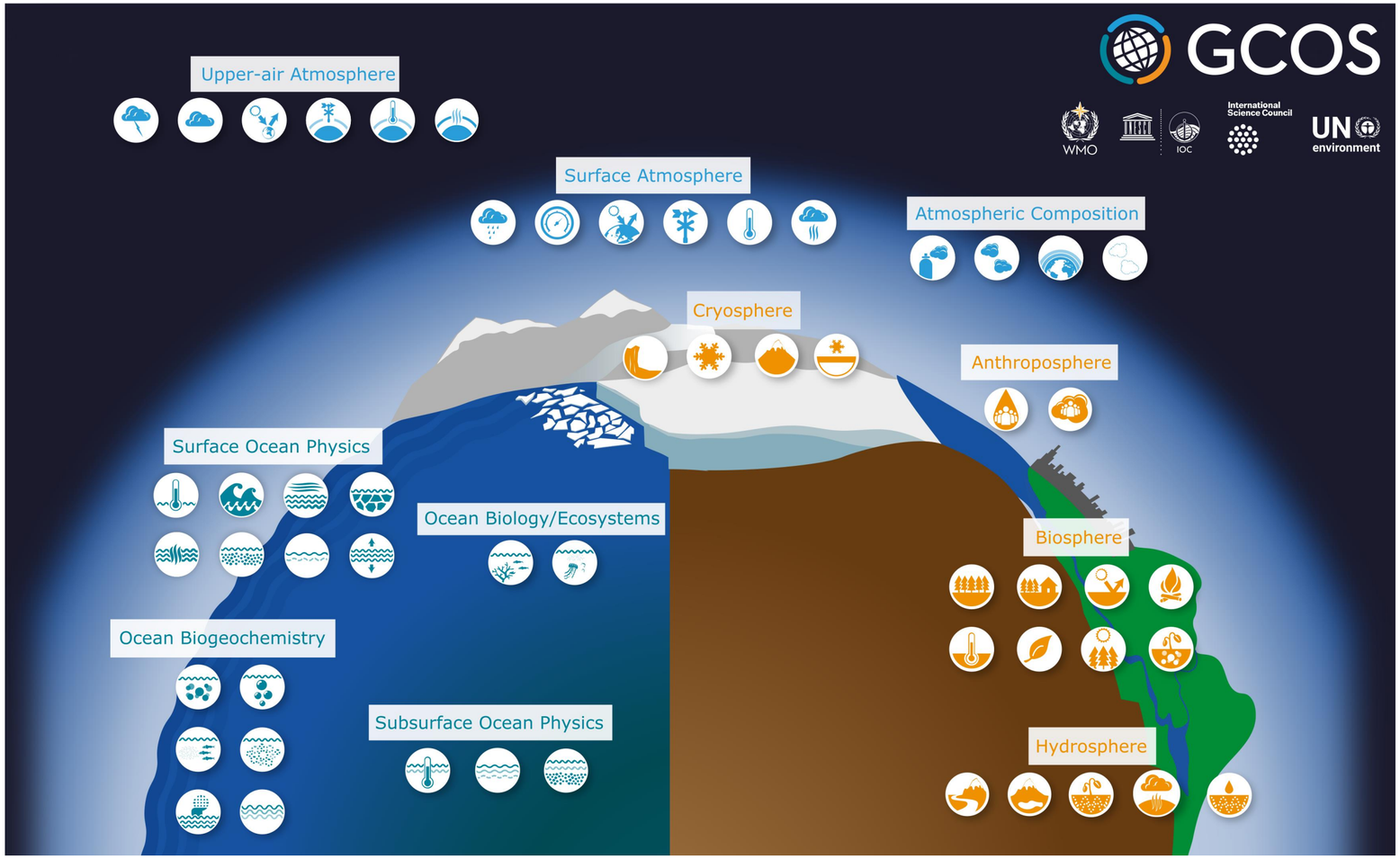
- The **Global Observing Systems Information Center** (GOSIC) provides background, definitions, requirements, network information and data sources for the ECVs.

- It is **maintained** by the National Centers for Environmental Information (NCEI) of the U.S. National Oceanic and Atmospheric Administration (NOAA) and the **U.S. GCOS Program at NCEI on behalf of the global observing community**.

The GCOS Science Panels are tasked to check whether the datasets are compliant with the GCOS Monitoring Principles and the observation requirements.

Essential Climate Variables (ECVs)

What is it all About?

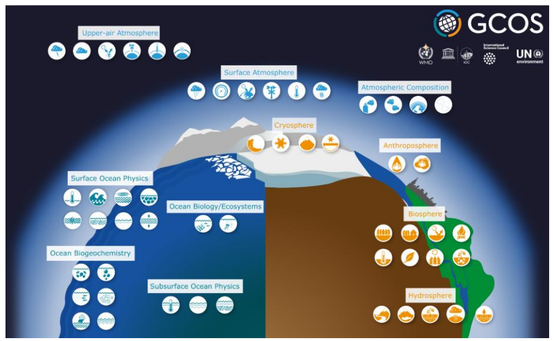


An Essential Climate Variables (ECVs) is a physical, chemical or biological variable or a group of linked variables that critically contributes to the characterization of Earth’ s climate.

https://public.wmo.int/en/programmes/global-climate-observing-system/essential-climate-variables

Essential Climate Variables (ECVs)

For what purposes?



https://public.wmo.int/en/programmes/global-climate-observing-system/essential-climate-variables

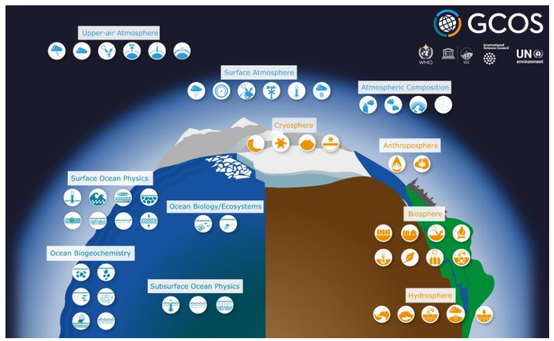
https://gcos.wmo.int/en/essential-climate-variables

- ECV datasets provide the empirical evidence needed to:
  - understand and predict the evolution of climate,
  - guide mitigation and adaptation measures,
  - assess risks and enable attribution of climate events to underlying causes,
  - underpin climate services.

- They are required to support the work of the UNFCCC and the IPCC.

Essential Climate Variables (ECVs)

How are they selected?



https://public.wmo.int/en/programmes/global-climate-observing-system/essential-climate-variables

https://gcos.wmo.int/en/essential-climate-variables

ECVs are identified based on the following criteria:

- **Relevance:** The variable is critical for characterizing the climate system and its changes.
- **Feasibility:** Observing or deriving the variable on a global scale is technically feasible using proven, scientifically understood methods.
- **Cost effectiveness:** Generating and archiving data on the variable is affordable, mainly relying on coordinated observing systems using proven technology, taking advantage where possible of historical datasets.

01

Essential Climate Variables (ECVs)

Observed as per the GCOS Monitoring Principles

1. The impact of new **systems** or changes to existing systems **should be assessed prior to implementation**.
2. A suitable period of overlap for new and old observing systems is required.
3. The **details** and **history** of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e., metadata**) should be documented and treated with the same care as the data themselves**.
4. The **quality** and **homogeneity** of data should be regularly **assessed as a part of routine operations**.
5. Consideration of the **needs for environmental and climate-monitoring products and assessments**, such as IPCC assessments, **should be integrated** into national, regional and global **observing priorities**.
6. Operation of historically-uninterrupted stations and observing systems should be maintained.
7. **High priority** for additional observations should be **focused on data-poor regions**, poorly observed parameters, **regions sensitive to change**, and key measurements with inadequate temporal resolution.
8. **Long-term requirements**, including appropriate sampling frequencies, should be **specified to network designers, operators and instrument engineers** at the outset of system design and implementation.
9. The **conversion of research observing systems** to long-term **operations in a carefully-planned manner** should be promoted.
10. **Data management systems** that facilitate access, use and interpretation of data and products should be **included as essential elements of climate monitoring systems**.

The Identified 57 Essential Climate Variables

Atmosphere

Surface

- Precipitation
- Pressure
- Radiation budget
- Temperature
- Water vapour
- Wind speed and direction

Upper-air

- Earth radiation budget
- Lightning
- Temperature
- Water vapor
- Wind speed and direction
- Clouds

Atmospheric Composition

- Aerosols
- Carbon dioxide, methane and other greenhouse gases
- Ozone
- Precursors for aerosols and ozone

Land

Hydrosphere

- Groundwater
- Lakes
- River discharge
- Terrestrial water storage

Cryosphere

- Glaciers
- Ice sheets and ice shelves
- Permafrost
- Snow

Biosphere

- Above-ground biomass
- Albedo
- Evaporation from land
- Fire
- Fraction of absorbed photosynthetically active radiation (FAPAR)
- Land cover
- Land surface temperature
- Leaf area index
- Soil carbon
- Soil moisture

Anthroposphere

- Anthropogenic Greenhouse gas fluxes
- Anthropogenic water use

Ocean

Physical

- Ocean surface heat flux
- Sea ice
- Sea level
- Sea state
- Sea surface currents
- Sea surface salinity
- Sea surface stress
- Sea surface temperature
- Subsurface currents
- Subsurface salinity
- Subsurface temperature

Biogeochemical

- Inorganic carbon
- Nitrous oxide
- Nutrients
- Ocean colour
- Oxygen
- Transient tracers

Biological/ecosystems

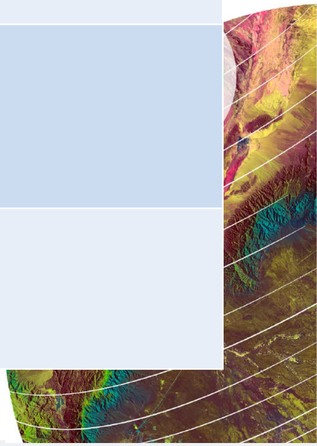
- Marine habitats
- Plankton

02

The majors ECVs used in the SoC Report – Observed Trends

The majors ECVs used in the SoC Report

Variables	Type	Sources
Surface Temperature	Gridded	HADCRUT5 Analysis, NOAA-Global-Temp, GISTEMP V4, Berkeley Earth, ERA5, JRA-55
	In-situ	National Meteorological and Hydrological Services
Precipitation	Gridded	GPCC Monitoring Product, CPC-Unified, CHIRPS, CHIRPS, CMORPH, ERA5
	In-situ	National Meteorological and Hydrological Services
Sea-surface Temperature	Gridded	NOAA-NCEP/Reyn_SmithOIv2
Sea Level	Gridded	LEGOS/C3S altimetry data

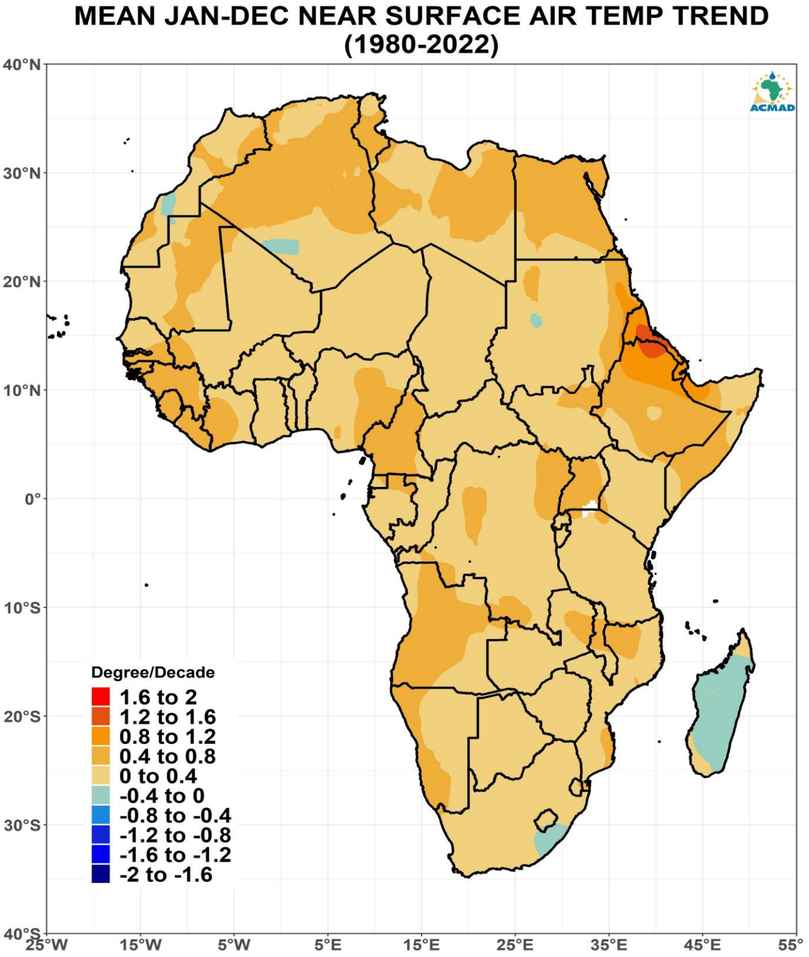


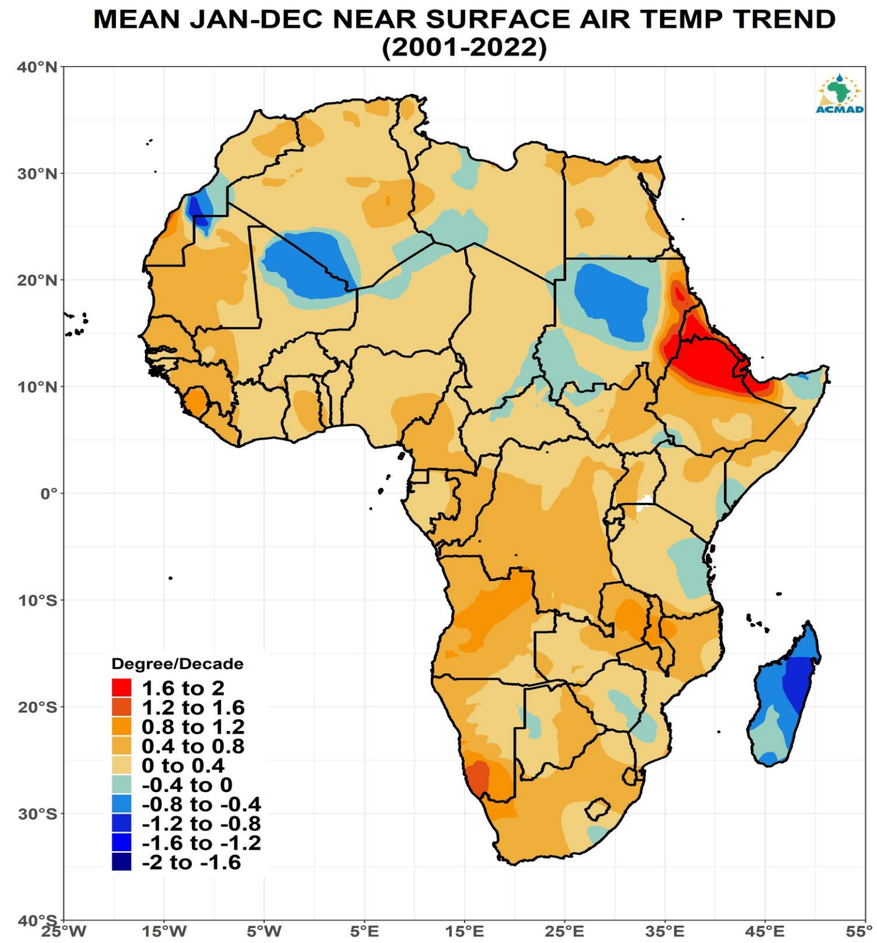
02

The majors ECVs used in the SoC Report

Temperature : Observed Trends (1/2)

Mean temperature trend over African land for each qualifying grid point for 1980-2022 and 2001-2022





Mean Near-Surface Air Temperature trend for the period *1990-2022 (left) and* 2001-2022 (Right).
Data source: https://cds.climate.copernicus.eu/. Calculated using the toolbox-editor

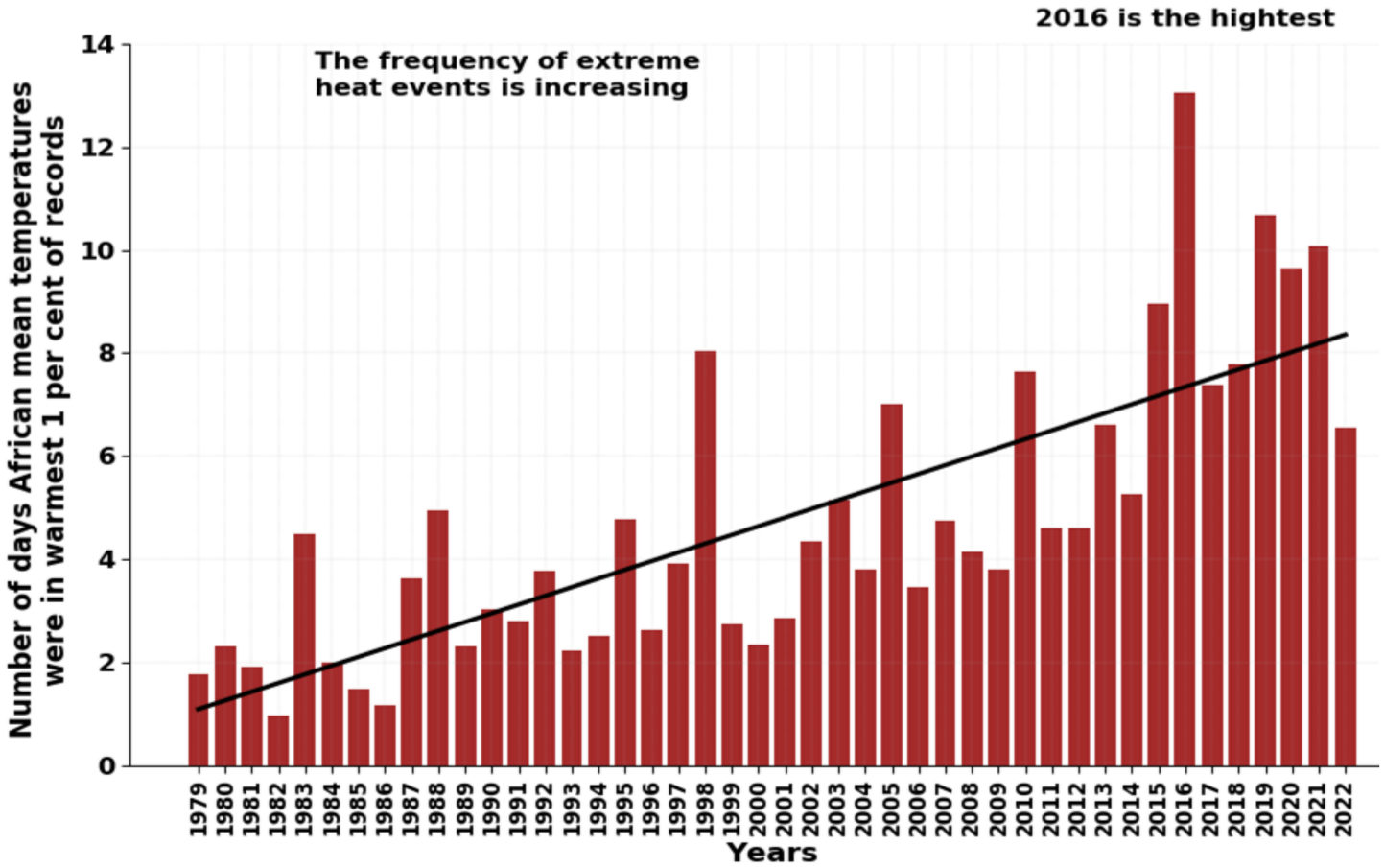
The Mean January to December near-surface air temperature for both periods(1980-2022) and 2001-2022 indicates:

- ✓ positive trends up to <=+2 degree C per decade for the regions of northeast Ethiopia, Eritrea and Djibouti.
- ✓ Central Morocco, north Mali, southern Algeria much of Sudan, north of Somalia, east Tanzania and Madagascar exhibited a cooling tendency(up to -2 degrees c per decade) during the period of 2001-2022.

The majors ECVs used in the SoC Report

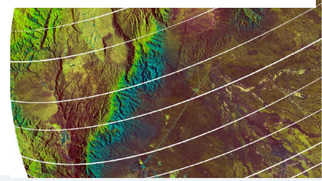
Temperature : Observed Trends (2/2)

Extreme heat events are becoming more frequent in Africa



Warming is observed across Africa and the frequency of extreme heat events is increasing since 1979.

2016 experienced the highest extremely warm days since 1979, 2019 is second followed by 2021.

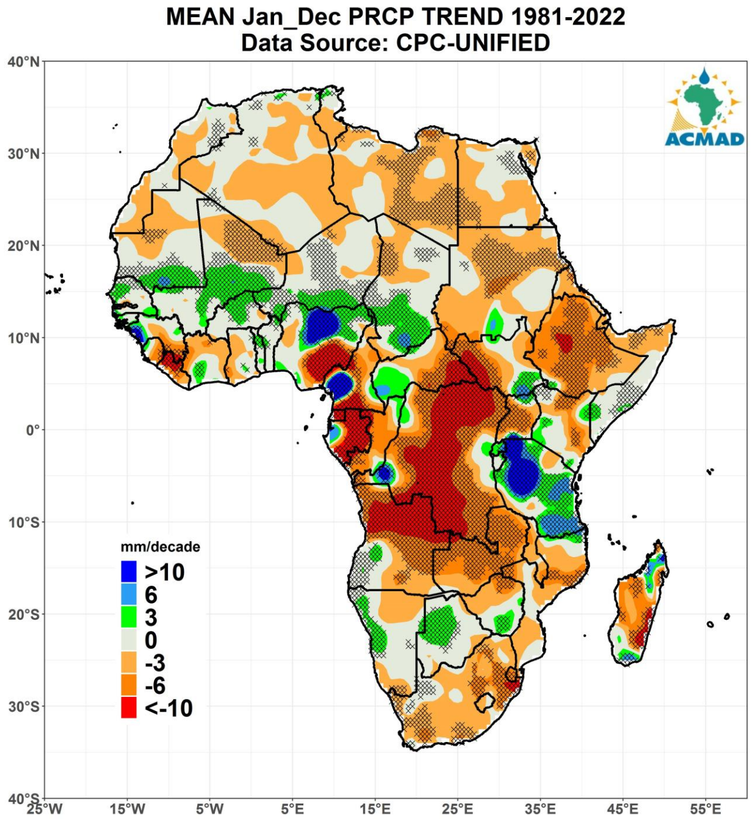


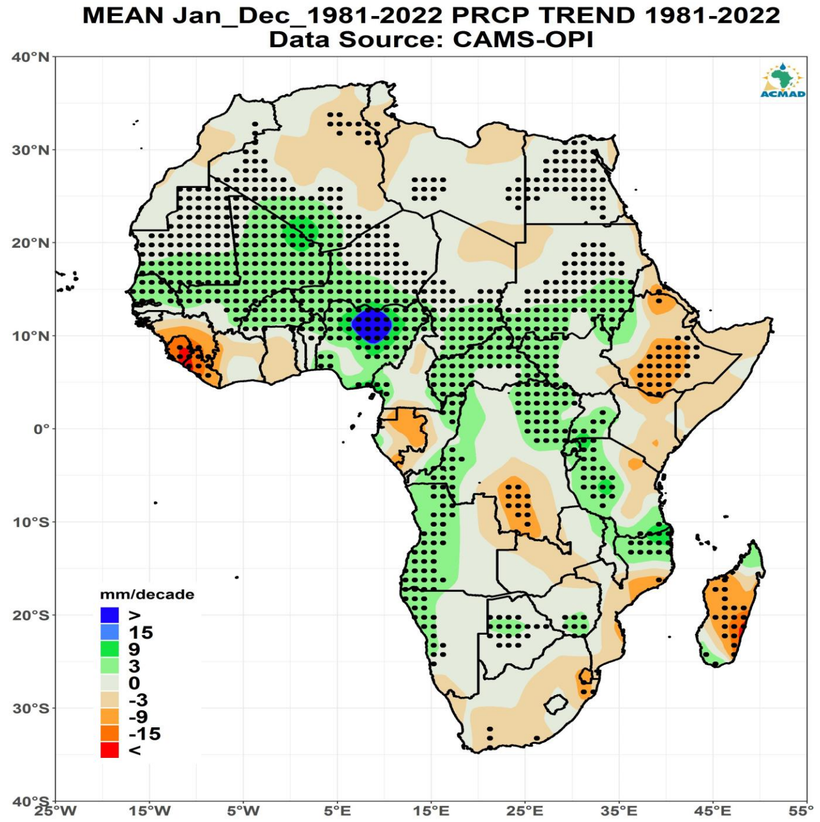
02

The majors ECVs used in the SoC Report

Precipitation : Observed Trends (1/2)

Mean Jan-Dec precipitation trend in Africa over the period 1981-2022



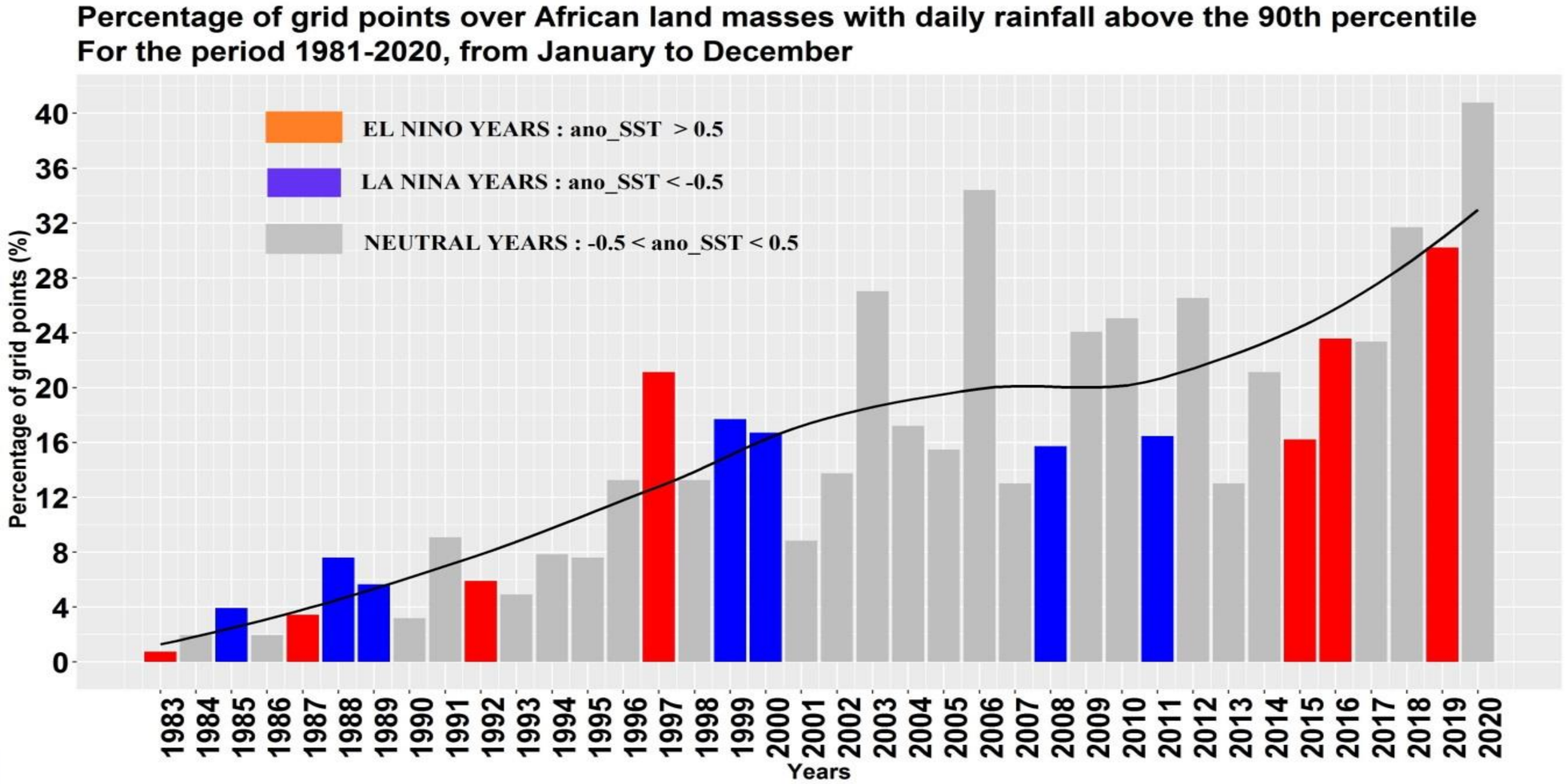


- There is a significantly increasing trend(>=3mm/decade) Mali, Southeast Mauritania, southwest Niger , Burkina Faso, much of Nigeria, Western Tanzania, Burundi, Rwanda, Uganda, Malawi, North Mozambique, western Angola, parts of Botswana, and western Namibia.
- Decreasing trends((>=3mm/decade) are significant over northeast Algeria, Ethiopia, central Madagascar, South Africa, Zambia, Angola, Gabon, south Nigeria , Sierra Leone and Liberia.

Mean Near-Surface Air Temperature trend for the period *1990-2022 (left) and* 2001-2022 (Right).
Data source: https://cds.climate.copernicus.eu/. Calculated using the toolbox-editor

The majors ECVs used in the SoC Report

Precipitation : Observed Trends (1/2)

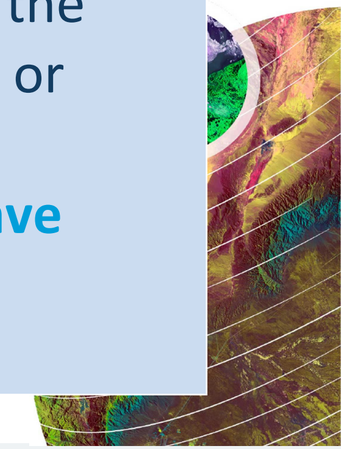


More extreme rainfall events are observed across Africa

03 The Majors ECVs in 2022 - Actionable Indicators

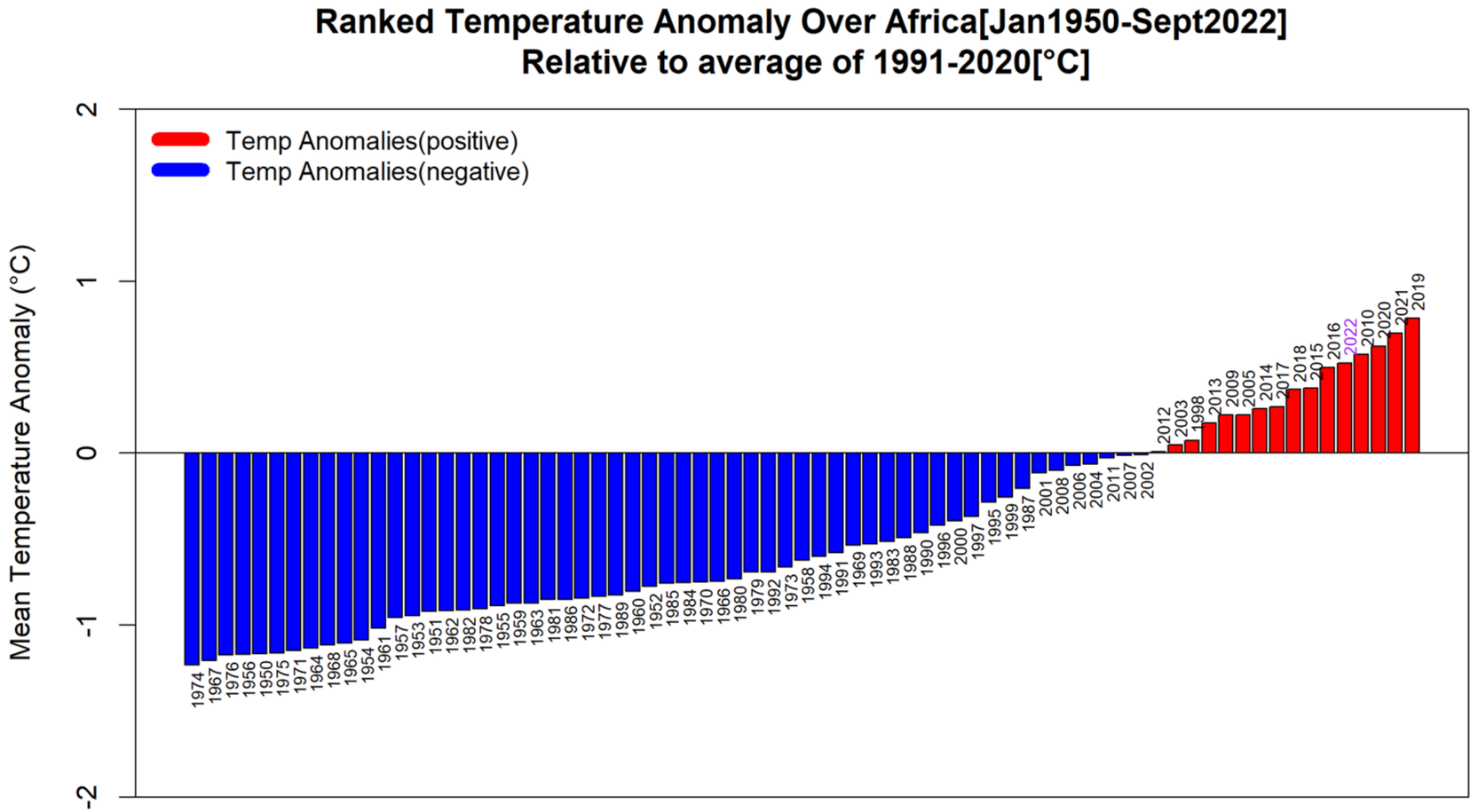
The majors ECVs in 2022 - Actionable Indicators

Variables	Analysis type	Underlying Questions
Surface Temperature	• Ranking Percentile • Observed Quintile and Percentile • Number days for which a region face extreme event • % of land mass for and percentage of land mass occupied by a define max/min threshold	❑ Categorizing of the observed anomalies ❑ Compare the observed conditions with long-term records ❑ What is frequency of extreme events? ❑ What is the percentage of landmass occupied by extreme events? Are they expanding or shrinking? What are the likely effects of the expansion and or shrinking? ❑ **How many people are likely to have been affected by extreme event?** ❑ **….**
Precipitation		



The majors ECVs in 2022 - Actionable Indicators

Ranked Temperature



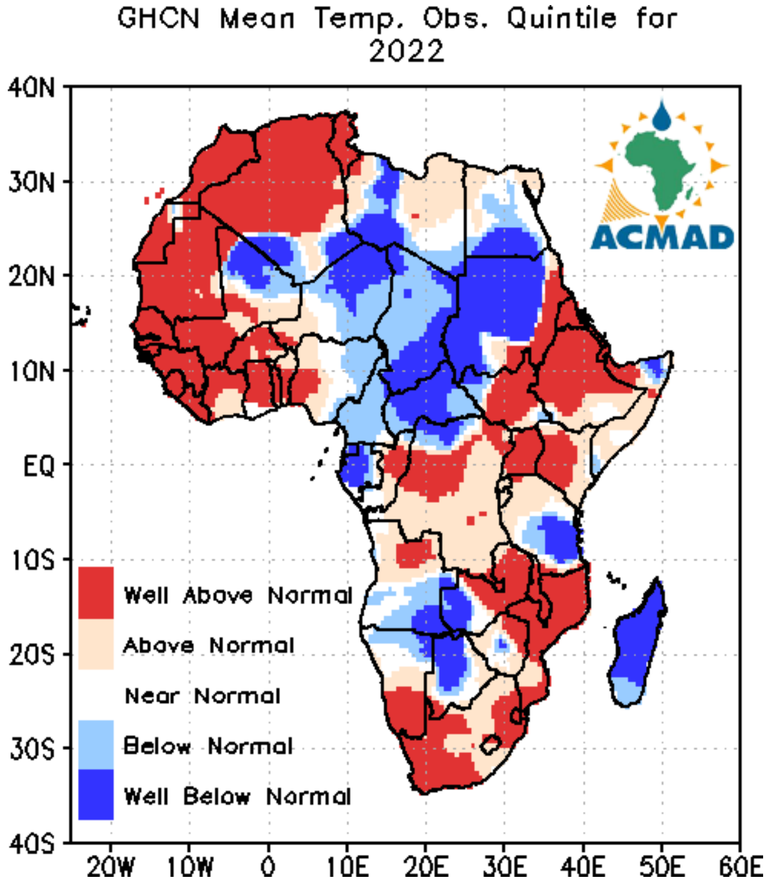
The year 2019 is the warmest year on record since 1950 relative to the average of 1991-2020. And year 2022 is the 5th warmest year on record since 1950.

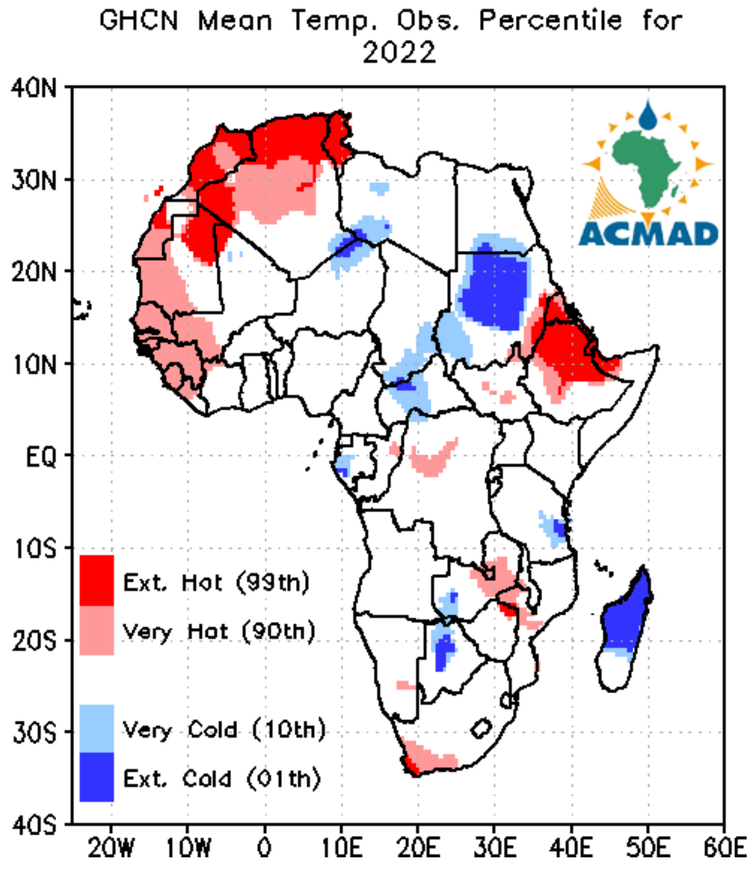
Figure 1: *Ranked mean Jan-Sept temperature anomalies (°C) over Africa for 1950- 2022 period, relative to 1991-2020. Data source:* ***http://iridl.ldeo.columbia.edu/SOURCES/.NOAA/.NCEP/.CPC/.GHCN_CAMS/.gridded/.deg0p5/.temp/***

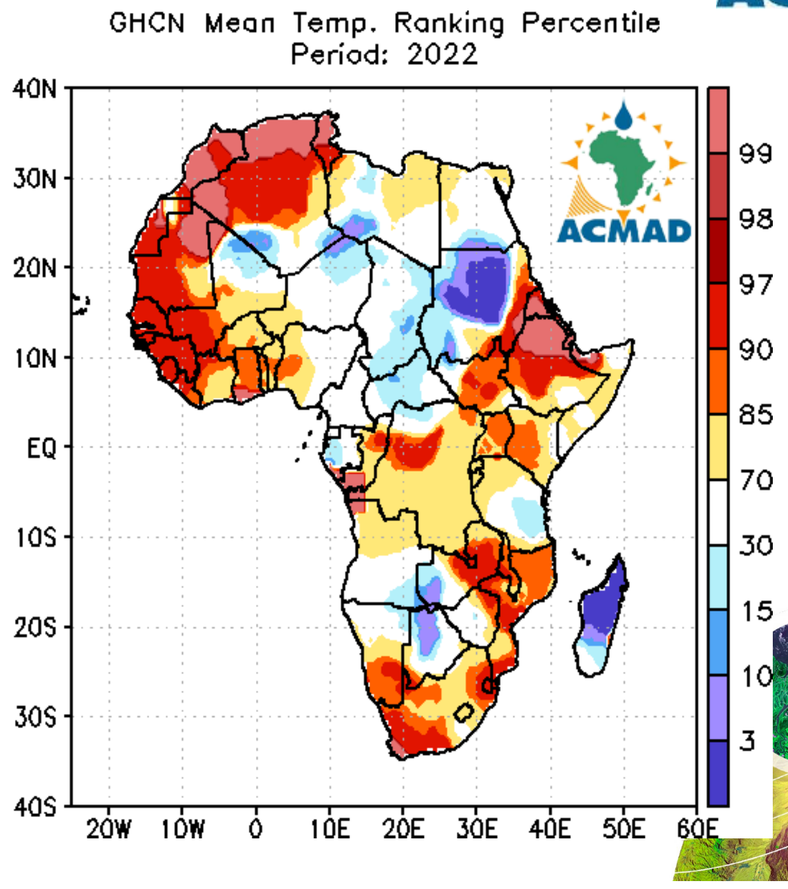
03

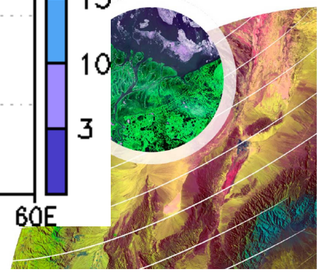
The majors ECVs in 2022 - Actionable Indicators

Temperature – Characterizing the observed anomalies







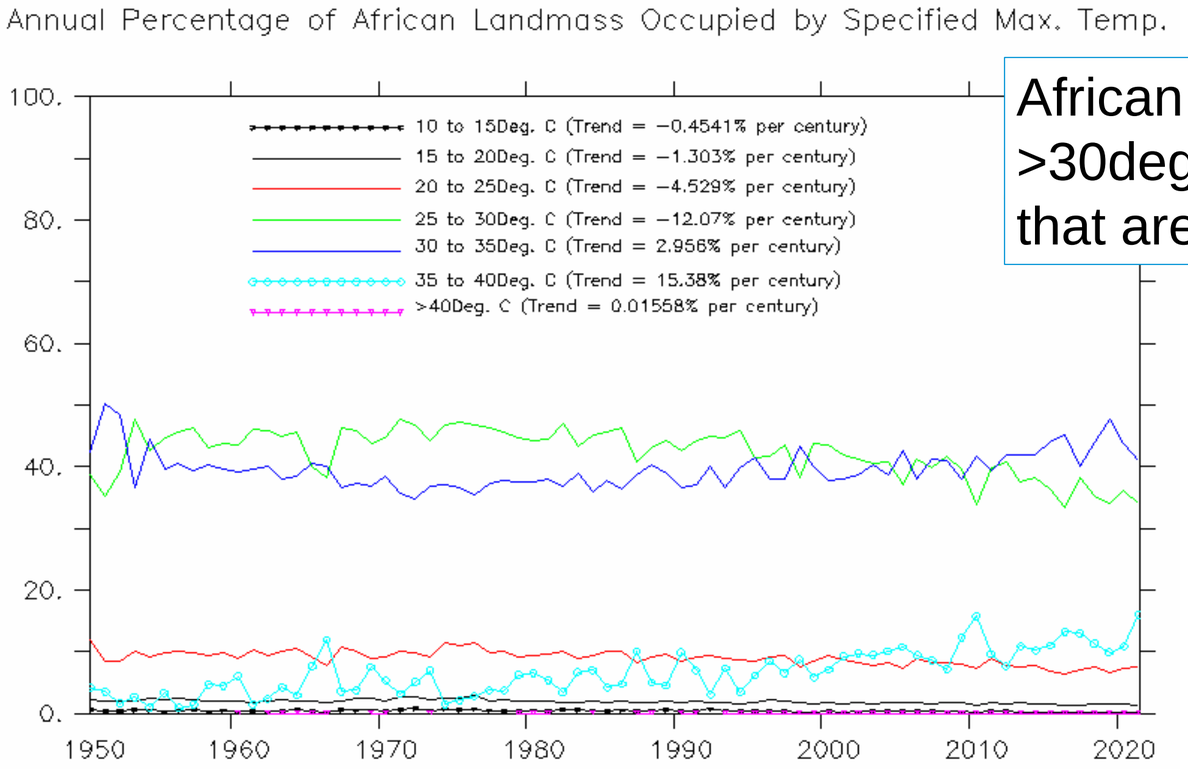


Parts of West Africa including Senegal, Gambia, Sierra Leone, west Mauritania, Guinea, south Mali; Liberia, and much of Morocco, north Algeria Tunisia much of Ethiopia, Malawi, west Zambia, north Congo Republique toward west DRC have experienced very hot (90th) to extremely hot(99th) temperatures during January to December 2022.

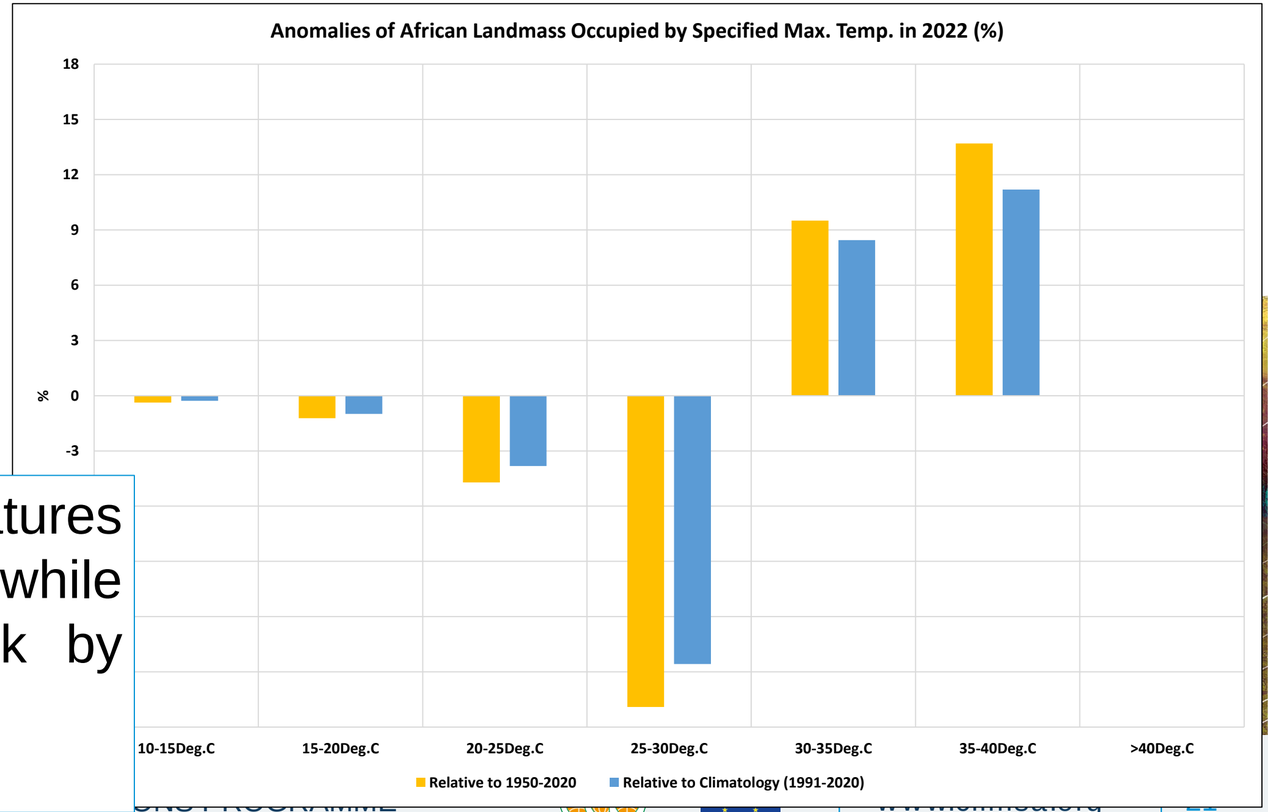
Centre Africa Republic, southeast Tchad, north and southeast Sudan, north Botswana and north Madagascar have recorded very cold(10th) to extreme cold(99th) temperatures from January to December 2022.

The majors ECVs in 2022 - Actionable Indicators

Temperature – % of landmass occupied by extreme event



African Landmass occupied by max. temp >30deg.C are expanding while those of max. temp that are <30deg.C are shrinking.

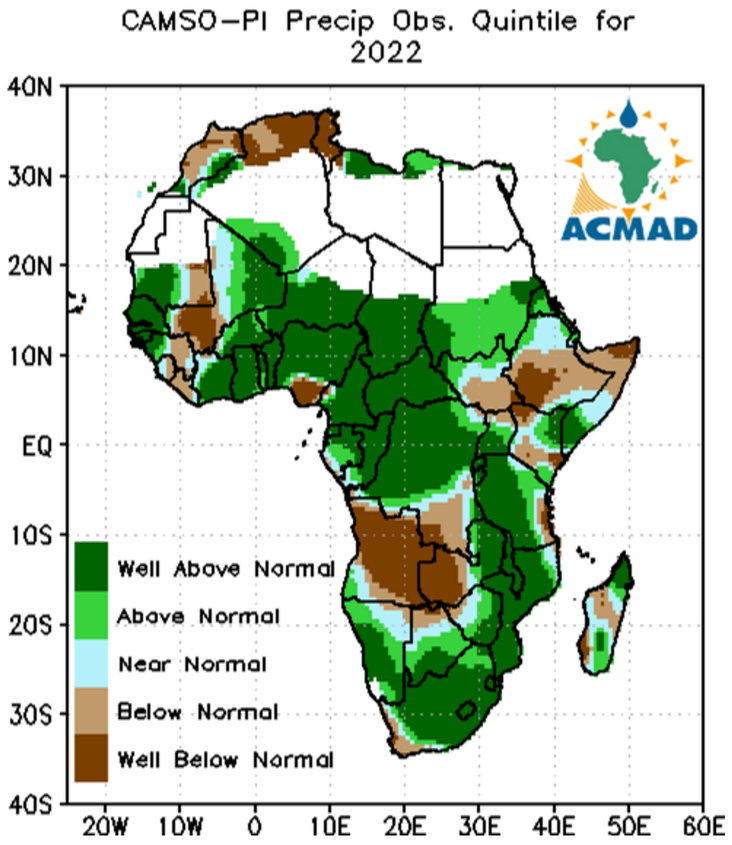


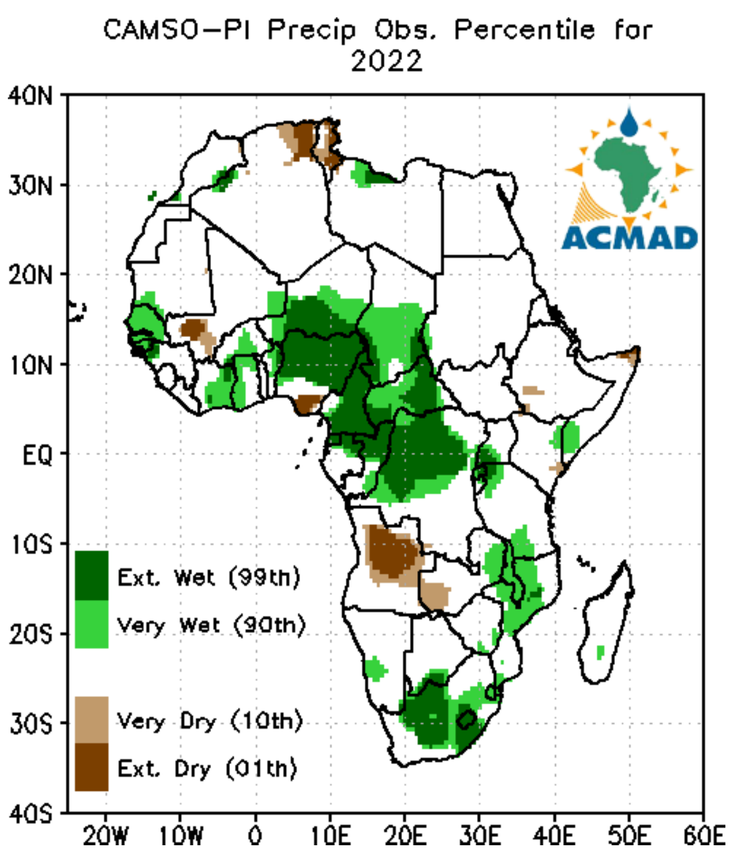
In 2022 – Landmass occupied by max. temperatures >30deg.C expanded by 9 – 14% above normal while max. temperatures that are <30deg.C shrank by almost 16% below normal.

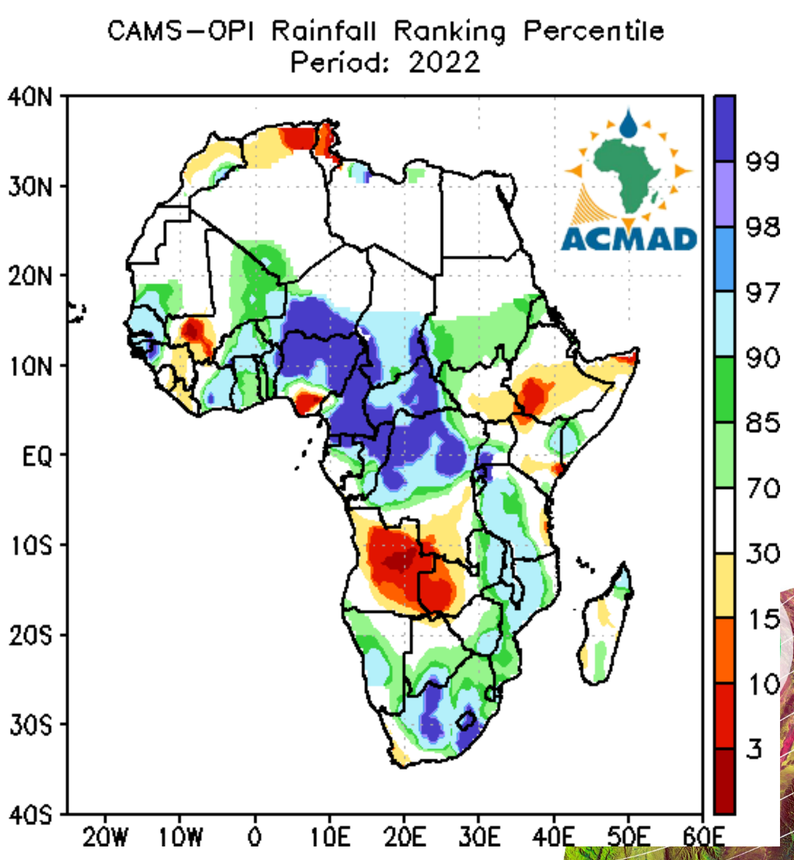
More places got warmer in 2022.

The majors ECVs in 2022 - Actionable Indicators

Precipitation – Characterizing the observed anomalies

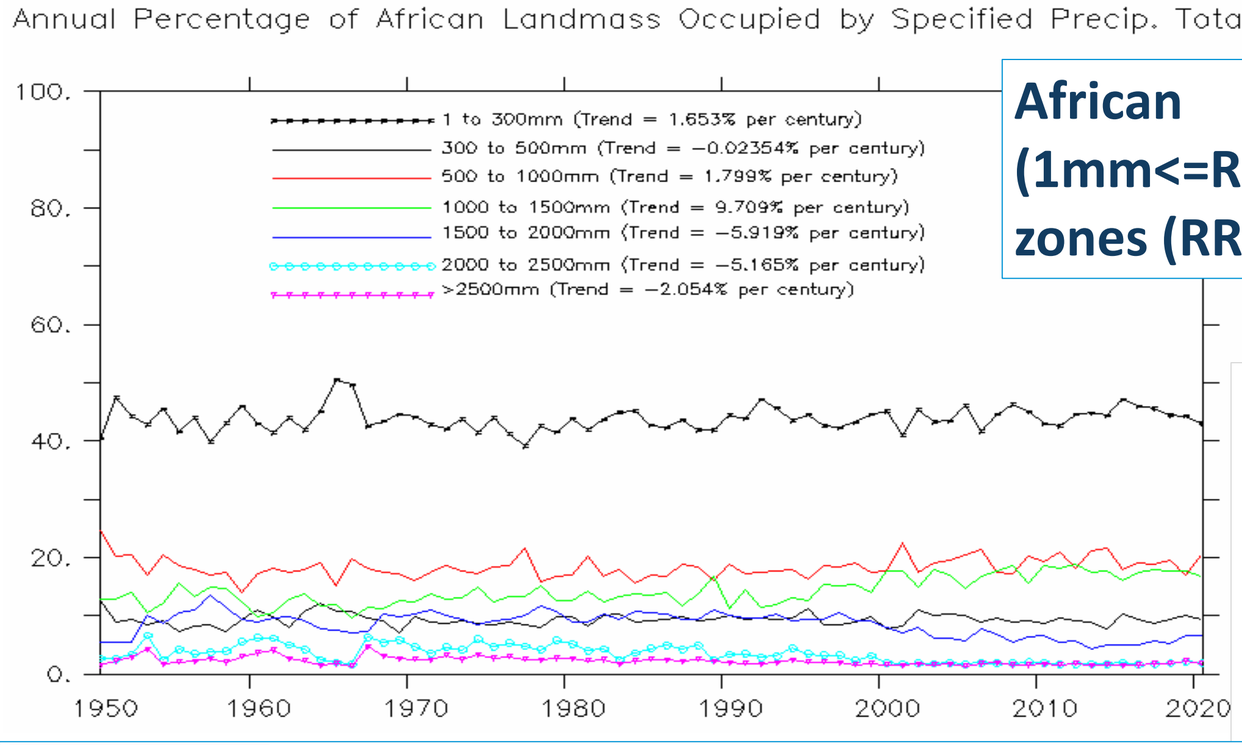




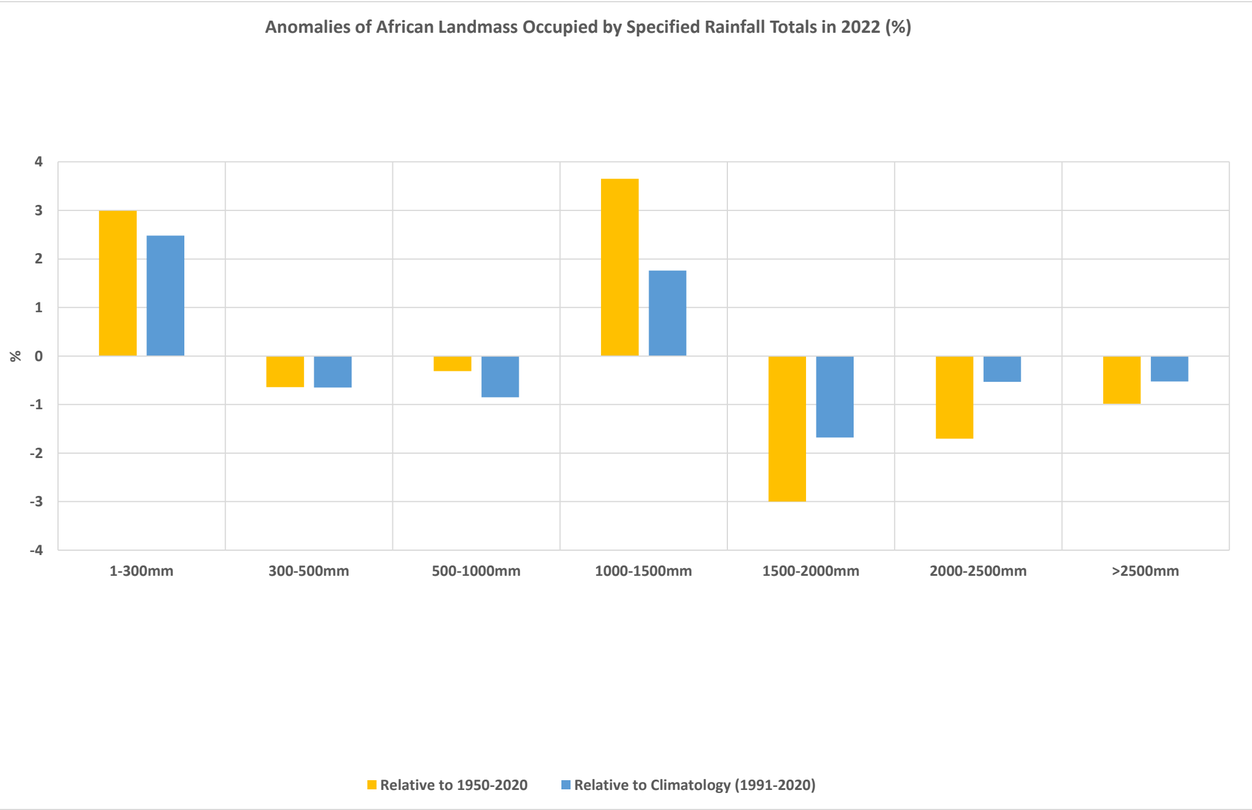


03 The majors ECVs in 2022 - Actionable Indicators

Rainfall – % of landmass occupied by extreme event



African Landmass occupied by arid zones (1mm<=RR<1500mm) are expanding, while those of humid zones (RR>=1500mm) are shrinking.



In 2022 – Landmass occupied by arid zones (1mm<=RR<1500mm) expanded by almost 4% above normal while humid zones (RR>=1500mm) shrank by about 3% below normal.

More places got lesser rainfall in 2022

THANK YOU

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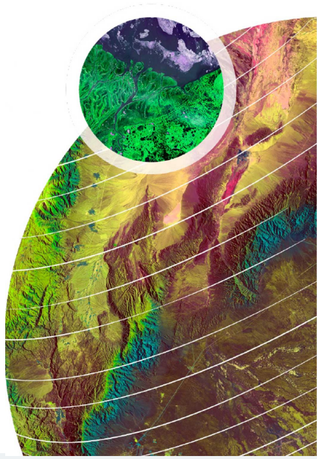
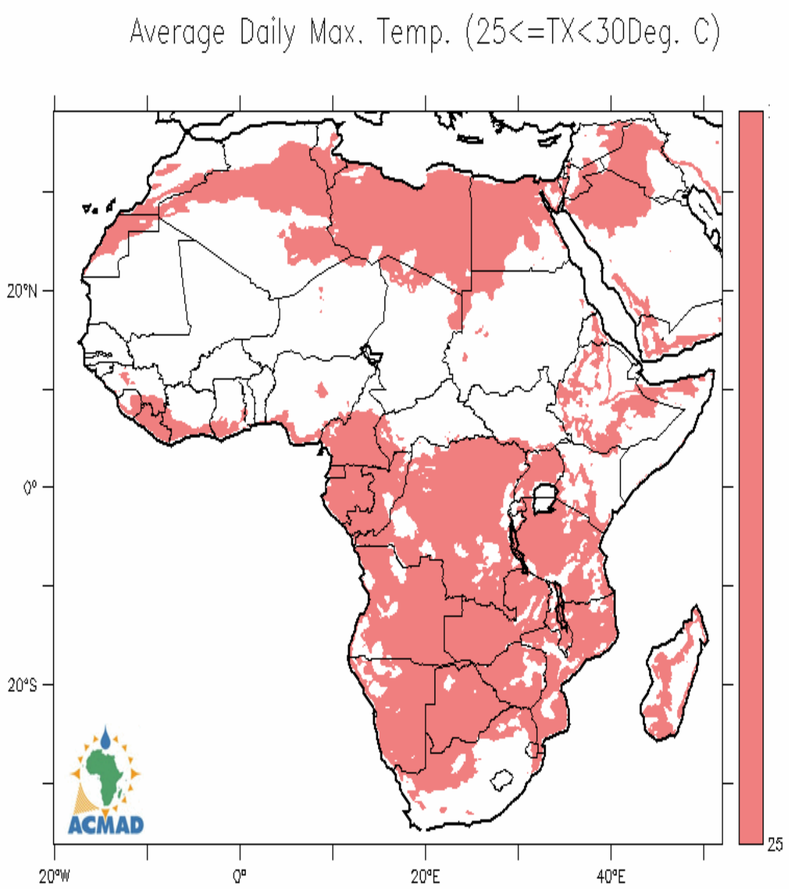
Discussion Points

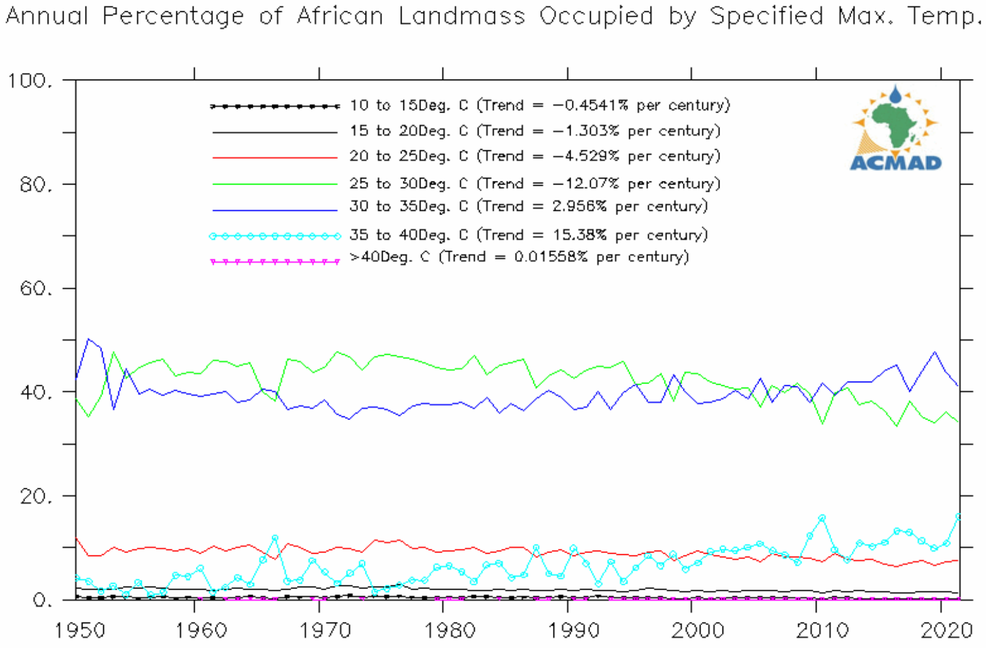
- Identify additional ECVs and actionable indicators for future SoC report.

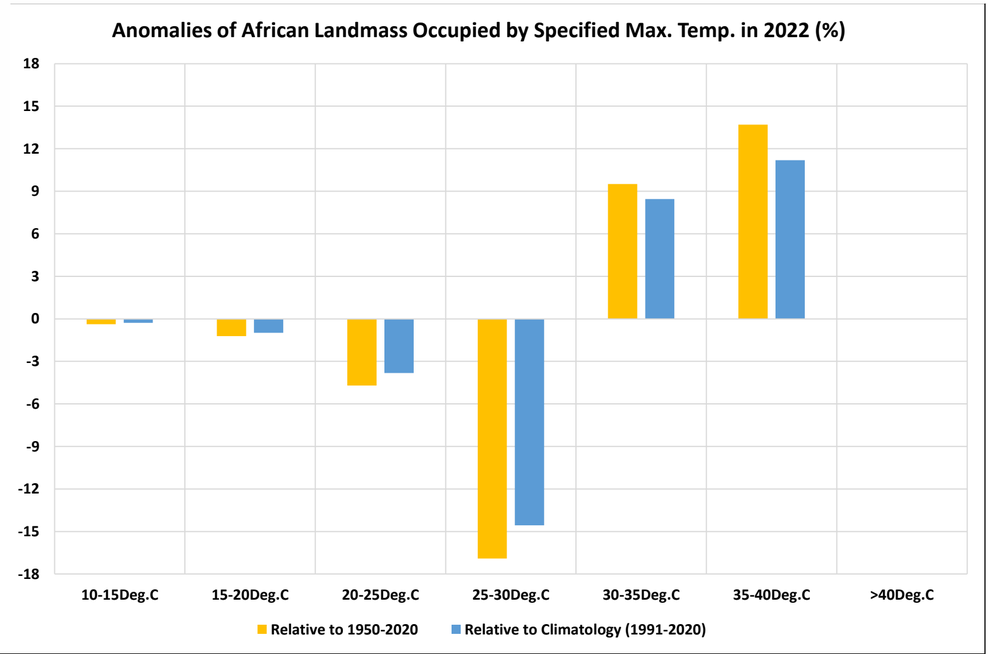
- Introduce projected trends and extremes information for long-term resilient development planning.



Anomalies of African Landmass Occupied by Specified Max.







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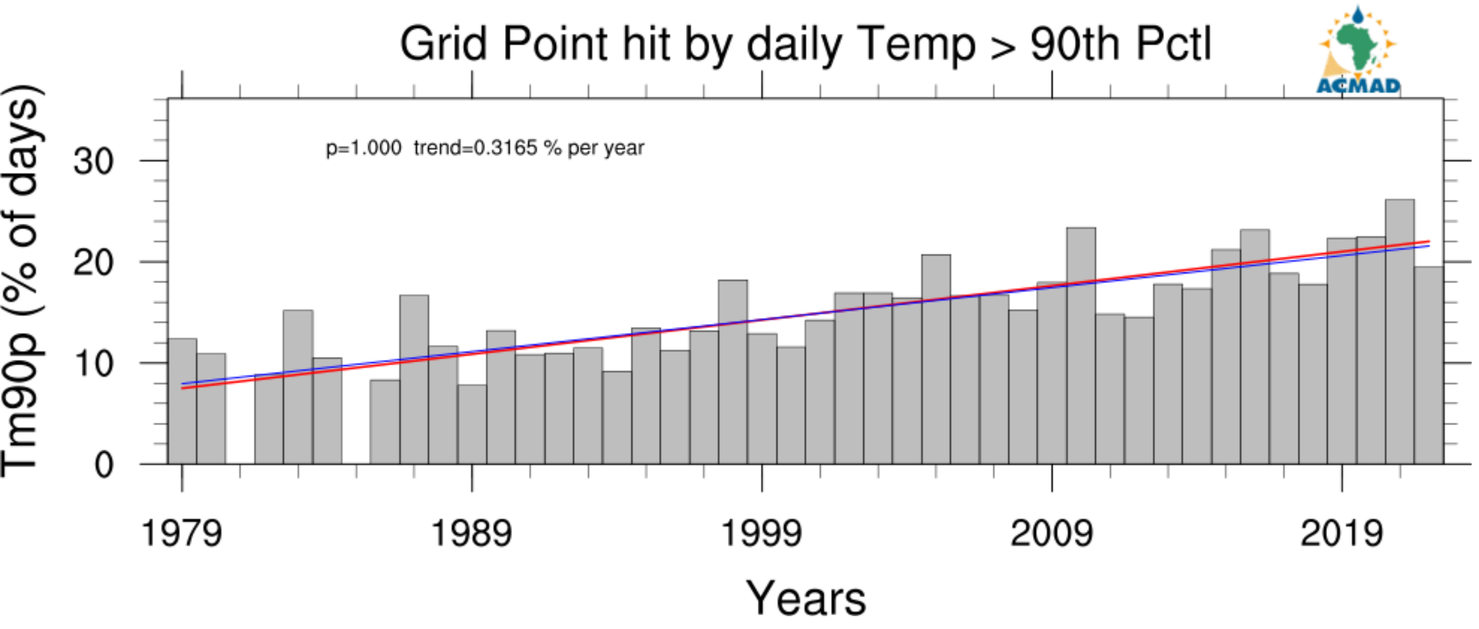
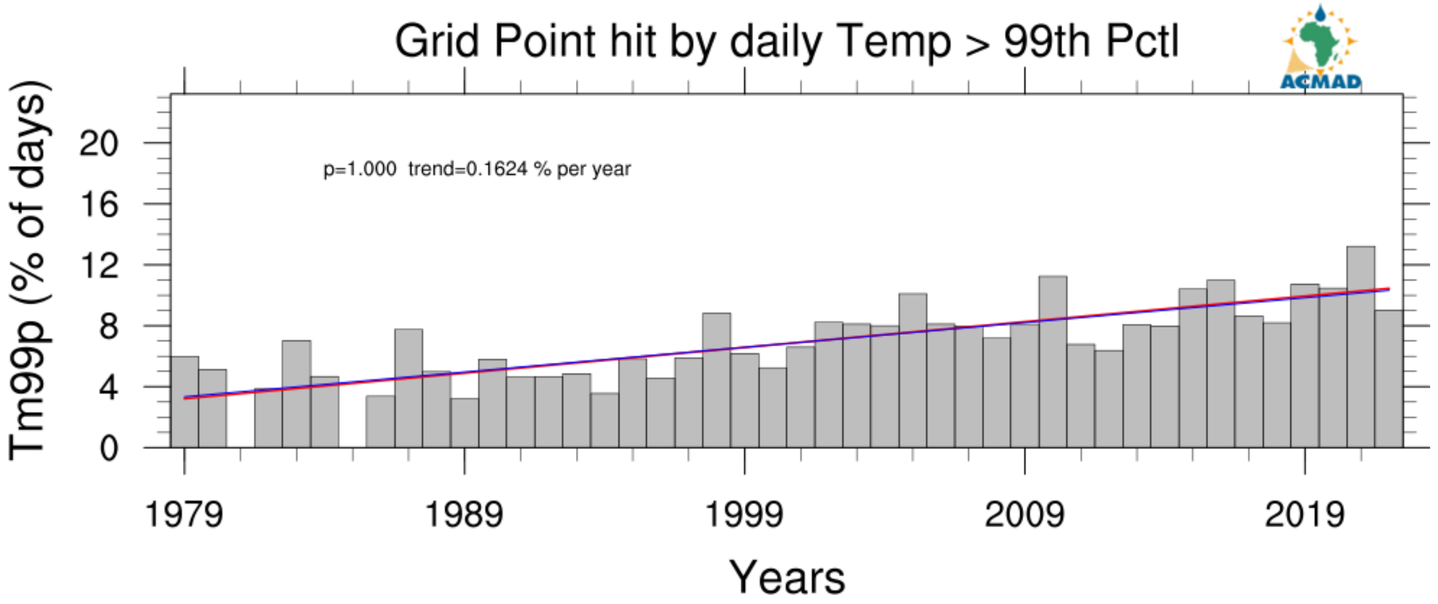
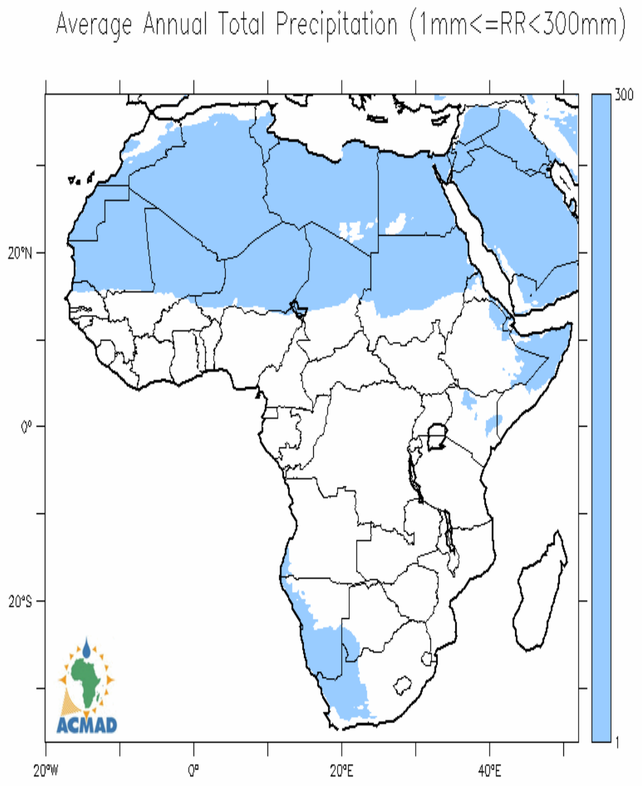
More places got warmer in 2022.

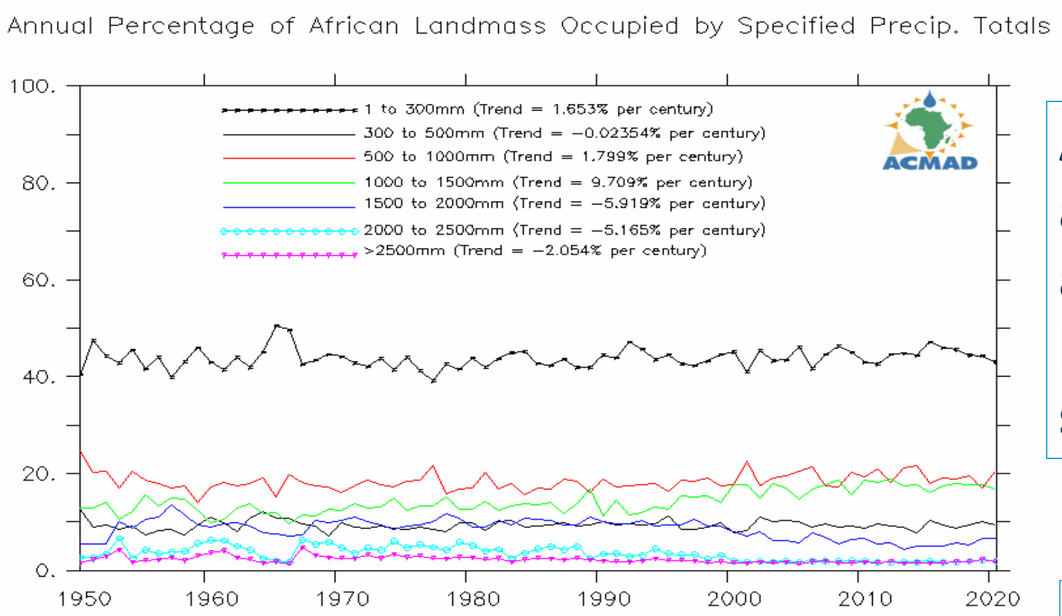


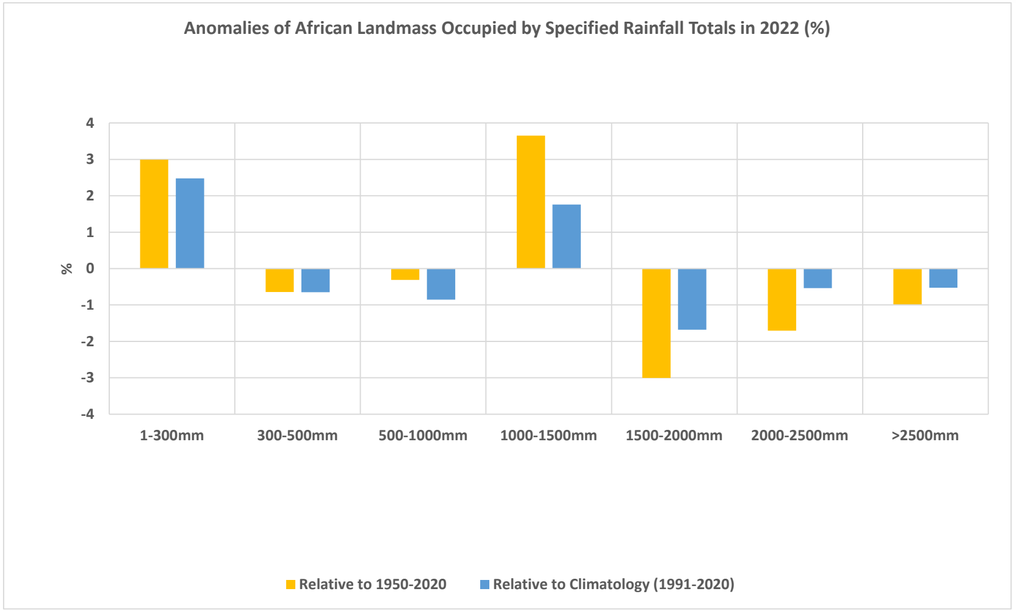
There is an increase in the Grid points hit by daily Temp > 90th and 99th Pctl over Africa.



Anomalies of African Landmass Occupied by Specified Rainfall Totals in 2022



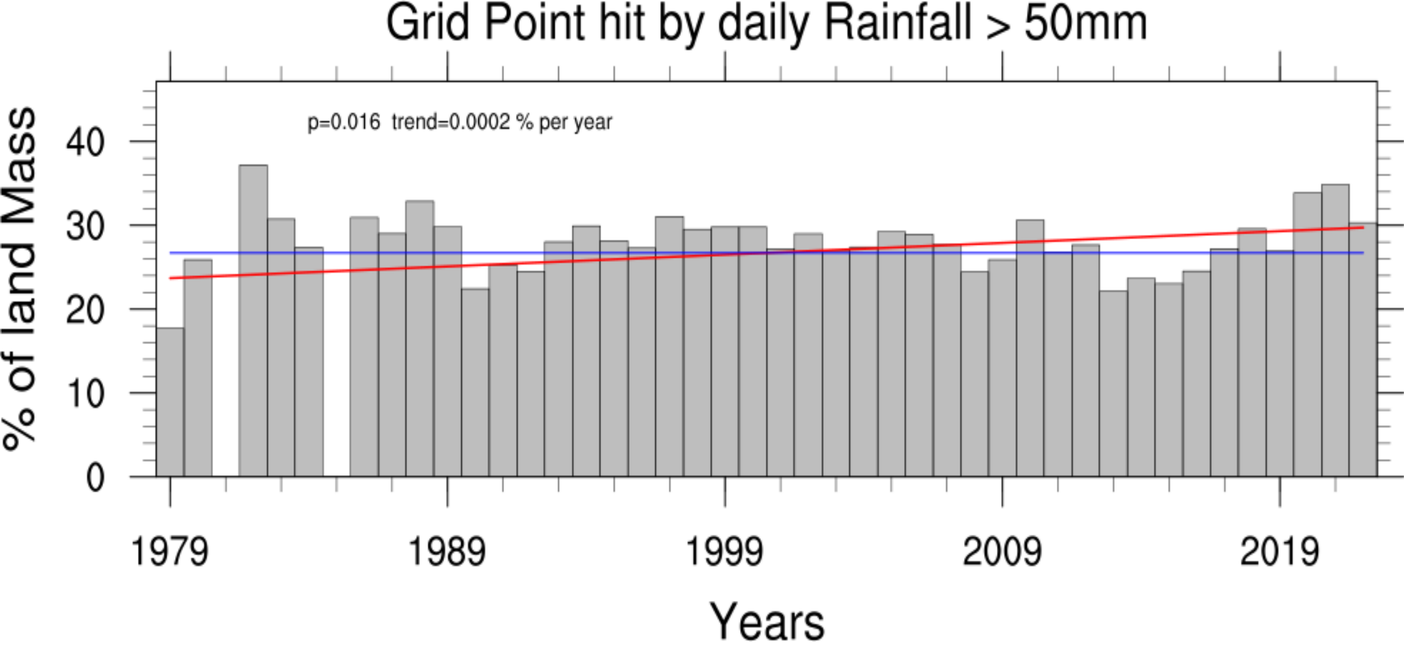




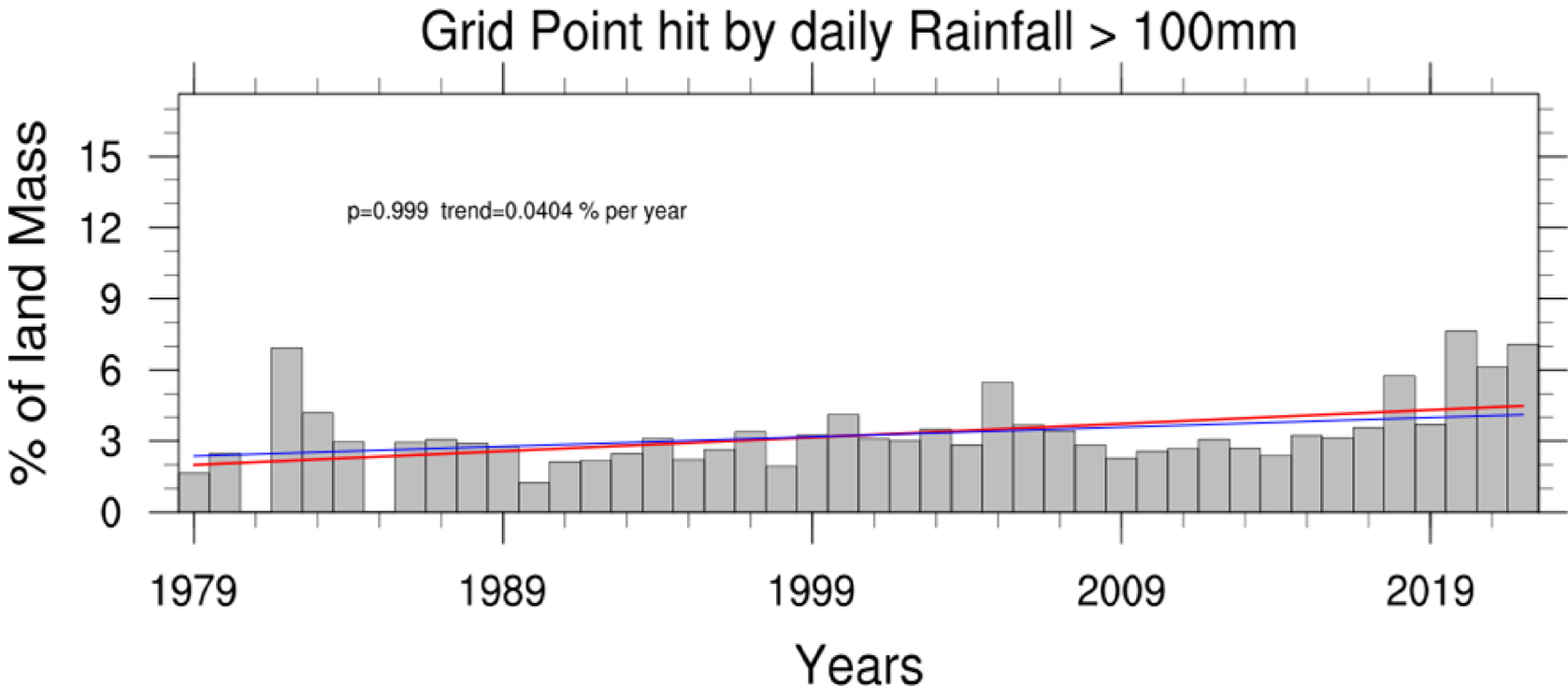
African Landmass occupied by arid zones (1mm<=RR<1500mm) are expanding while those of humid zones (RR>=1500mm) are shrinking.

In 2022 – Landmass occupied by arid zones (1mm<=RR<1500mm) expanded by almost 4% above normal while humid zones (RR>=1500mm) shrank by about 3% below normal.

More places got lesser rainfall in 2022

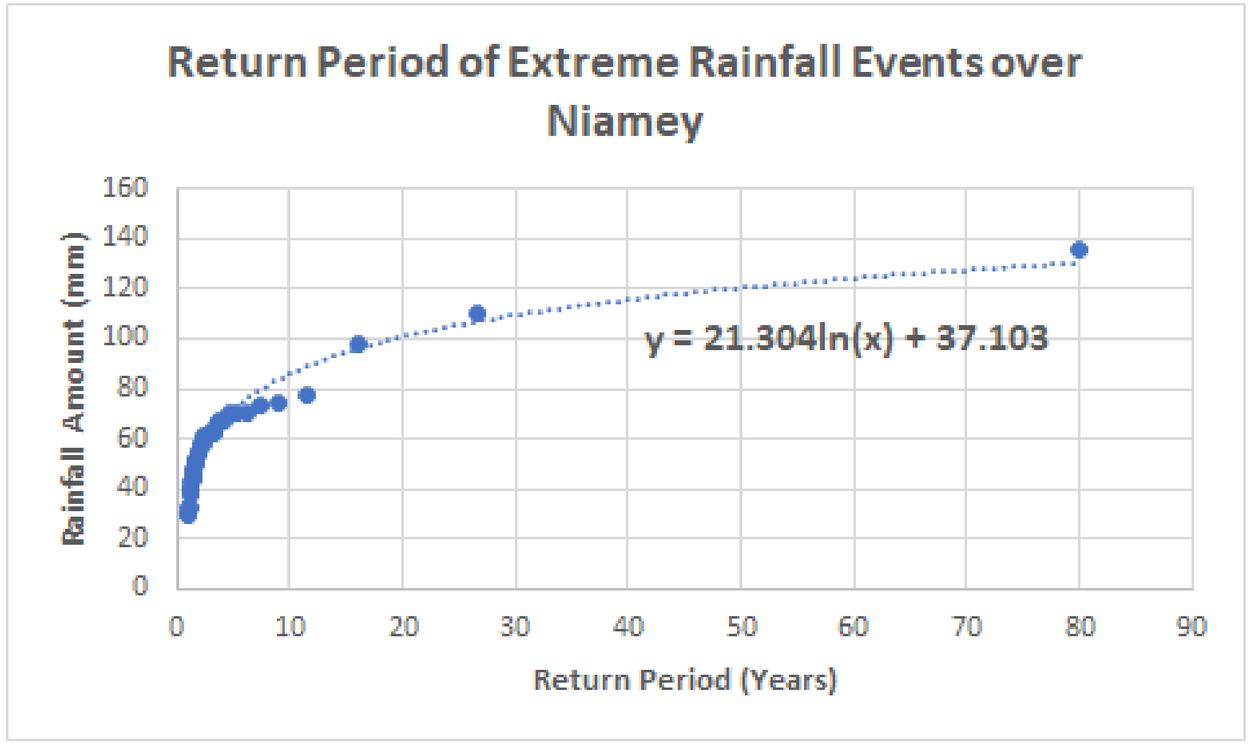


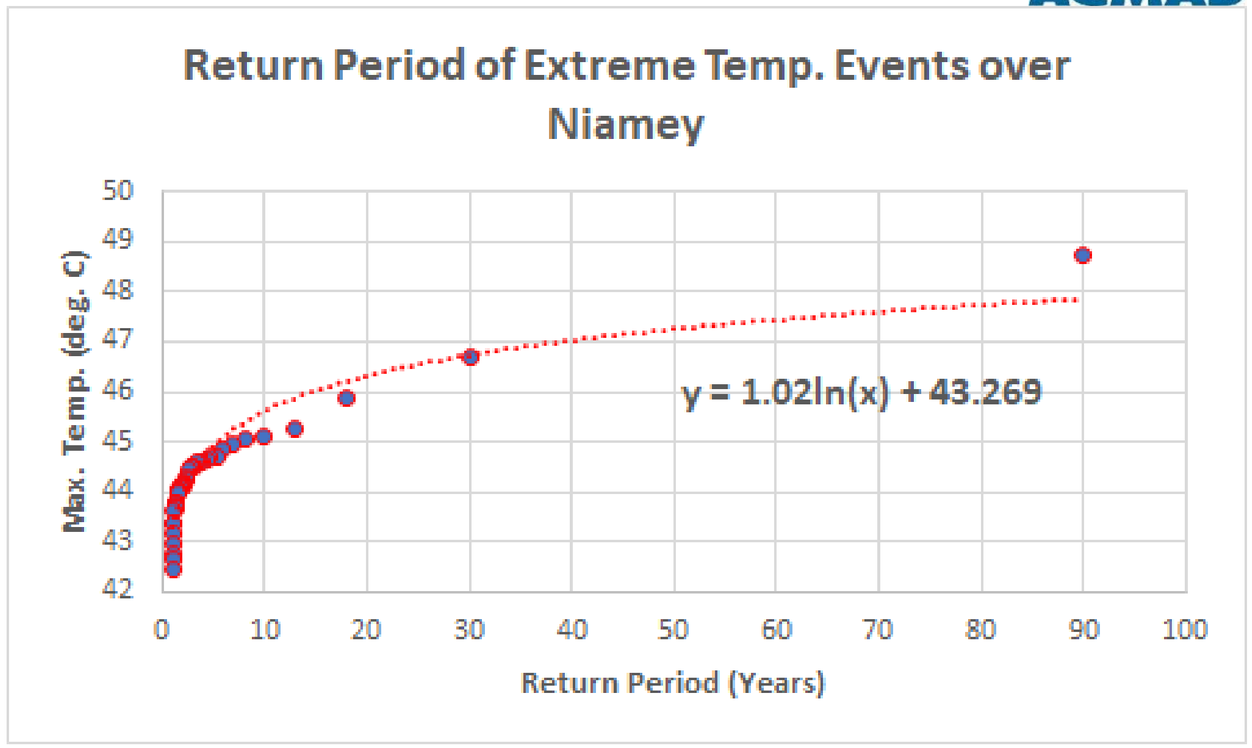
% of grid points hit by daily rainfall above 50mm and 100mm is increasing



Goals

- Share and review products available in Africa's State of Climate report
- Identify additional ECVs and actionable indicators for future SoC.
- Introduce projected trends and extremes information for long-term resilient development planning.





30 - 60mm daily rainfalls may likely become annual events.

60 - 80mm daily rainfalls may likely be reoccurring every 2 - 12years.

Daily temperatures of 42 – 44 deg. C are fast becoming annual events.

44 – 46 deg. C daily temperatures may likely be reoccurring every 2 - 18years.