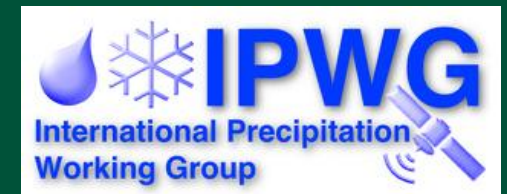
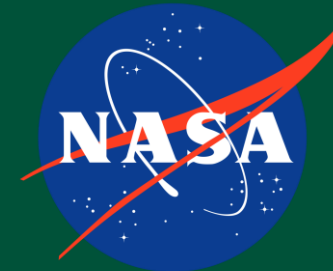


Can Satellite Products Be Used to Study Extreme Precipitation Trends across West Africa?

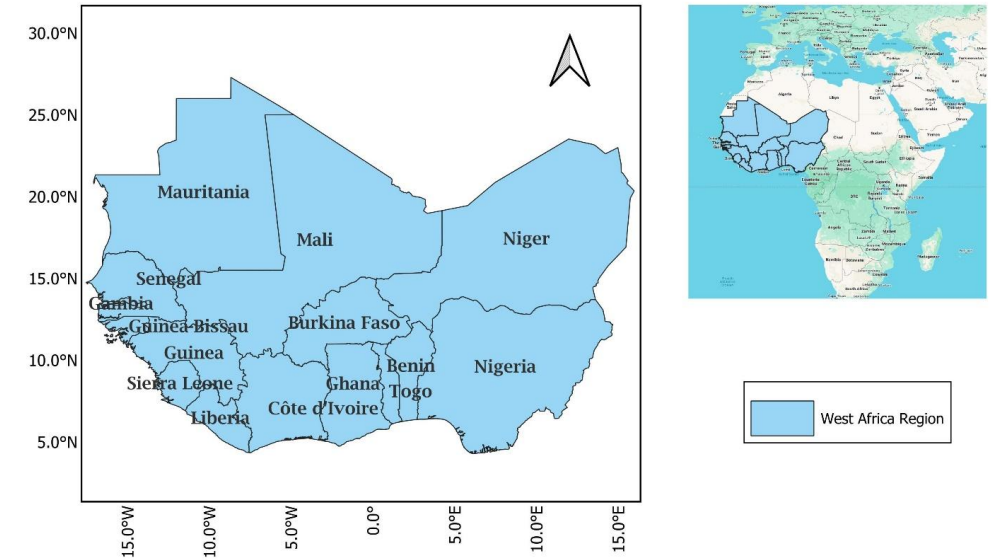
Malihe Nasibi, Efthymios I. Nikolopoulos, William Amponsah, Humberto Vergara Arrieta, Georgios C. Anagnostopoulos, Ishrat Jahan Dollan, Abdou Ali, Francisca Martey, Viviana Maggioni



West Africa



Torrential rains in Niger killed 15 people and submerged National Road 25 in western Niger, August 20, 2024.
(Photo: AFP / The Standard)



Bioclimatic Regions across West Africa (CILSS 2016)



Climate Data Records vs. High-Resolution Precipitation Products

Climate Data Records (CDRs)

- Prioritize temporal homogeneity
- Provide longer temporal coverage
- Appropriate for climate-scale trend analysis
- Generally lower spatial or temporal resolution than HRPPs

High-Resolution Precipitation Products (HRPPs)

- Provide the best possible instantaneous precipitation estimates
- Offer fine spatial and temporal resolution
- Appropriate for real-time and localized weather monitoring
- Prone to being affected by changes in PMW sensor availability

Can IMERG reliably capture changes in extreme precipitation across West Africa while providing higher spatial resolution than GPCP?

Datasets

Global Precipitation Climatology Project (GPCP) Version 3.3

The GPCP daily product uses IMERG Final Run at low and middle latitudes and is adjusted to match the GPCP monthly product, which is supported by a consistent series of SSMI/SSMIS sensors.

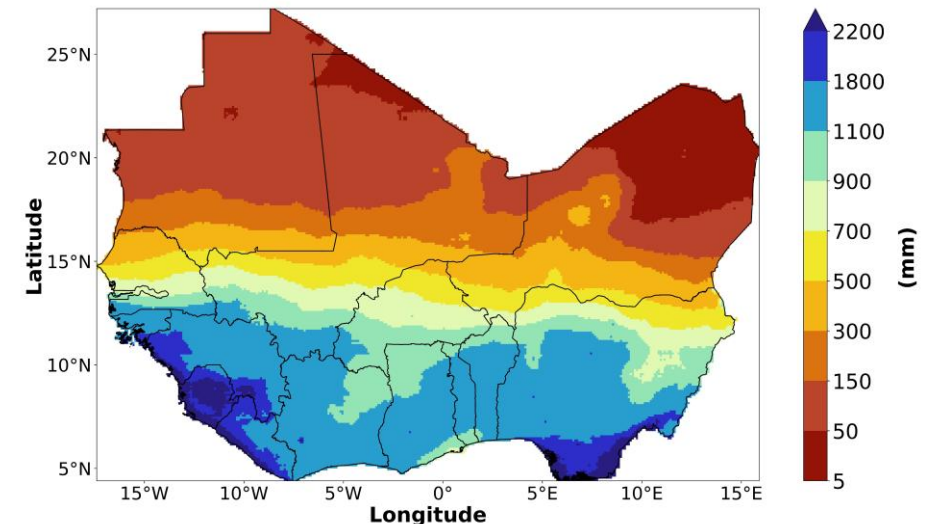
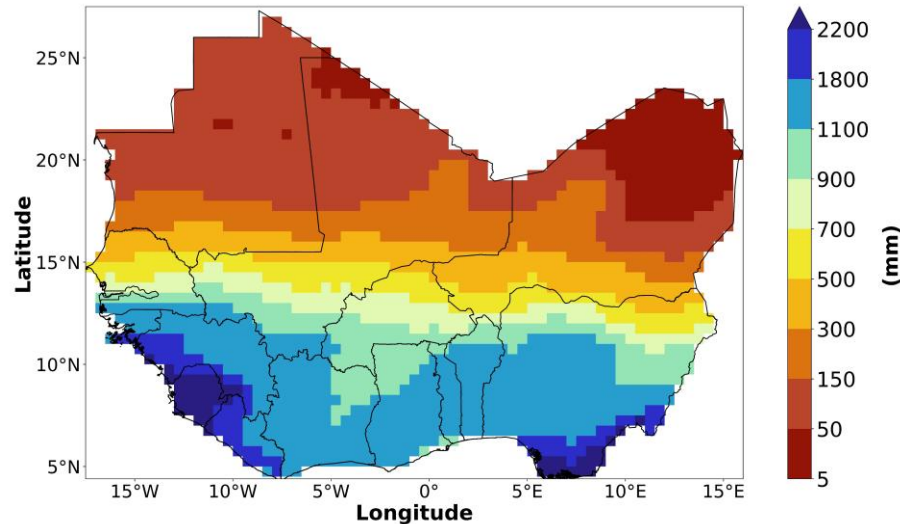
- 0.5° spatial resolution
- Available from 1998 to near-present

Integrated Multi-satellite Retrievals for GPM (IMERG) V07B Final Run

Combines microwave estimates, microwave-calibrated infrared observations, and gauge information to provide half-hourly precipitation estimates.

- 0.1° spatial resolution
- Available from 1998 to near-present

Average Annual Precipitation over 1998–2024



Extreme Precipitation Indices

- **Trend Magnitude**

Non-parametric **Theil-Sen (TS) slope estimator** to quantify changes in the frequency and intensity of extreme precipitation indices.

- **Trend Significance**

Non-parametric statistical **Mann-Kendall (MK) test**, applied at each grid point to test the alternative hypothesis of either an increasing or decreasing trend in the time series at three significance levels (0.1, 0.05, and 0.01).



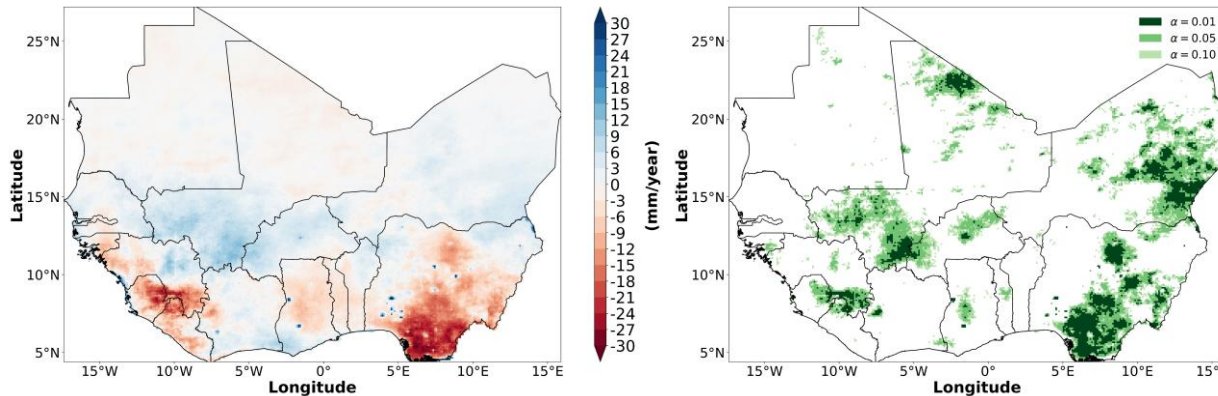
Annual series 1998-2024

Extreme precipitation indices introduced by the Expert Team on Climate Change Detection and Indices (ETCCDI)

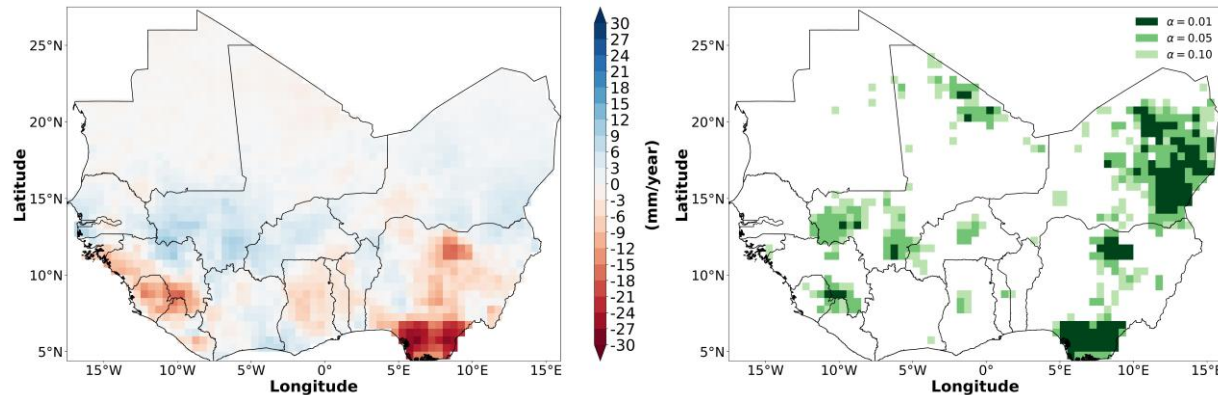
Index	Definition
RX1day	Annual maximum 1-day precipitation
RX5day	Annual maximum consecutive 5-day precipitation
D95p	Number of days above 95 th threshold in each year
D99p	Number of days above 99 th threshold in each year
R95pTOT	Contribution of annual precipitation from very wet days
R99pTOT	Contribution of annual precipitation from extremely wet days

Annual Total Precipitation

IMERG



GPCP

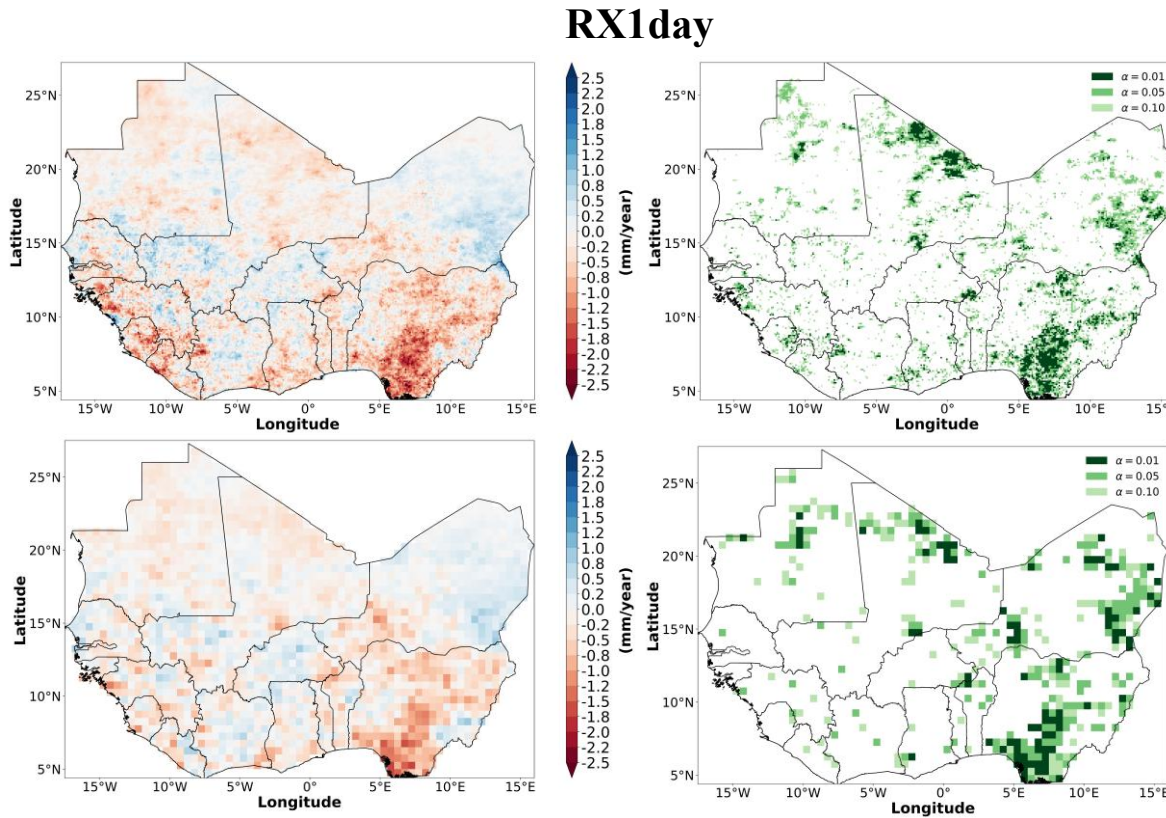


- Significant decreasing trends occur along the eastern coast of Nigeria, parts of the western Guineo-Congolian region, central Ghana, and northern Mali.
- Significant increasing trends are observed in parts of the Sudanian and Sahelian regions, particularly from southern Mali into Burkina Faso and southeastern Niger.

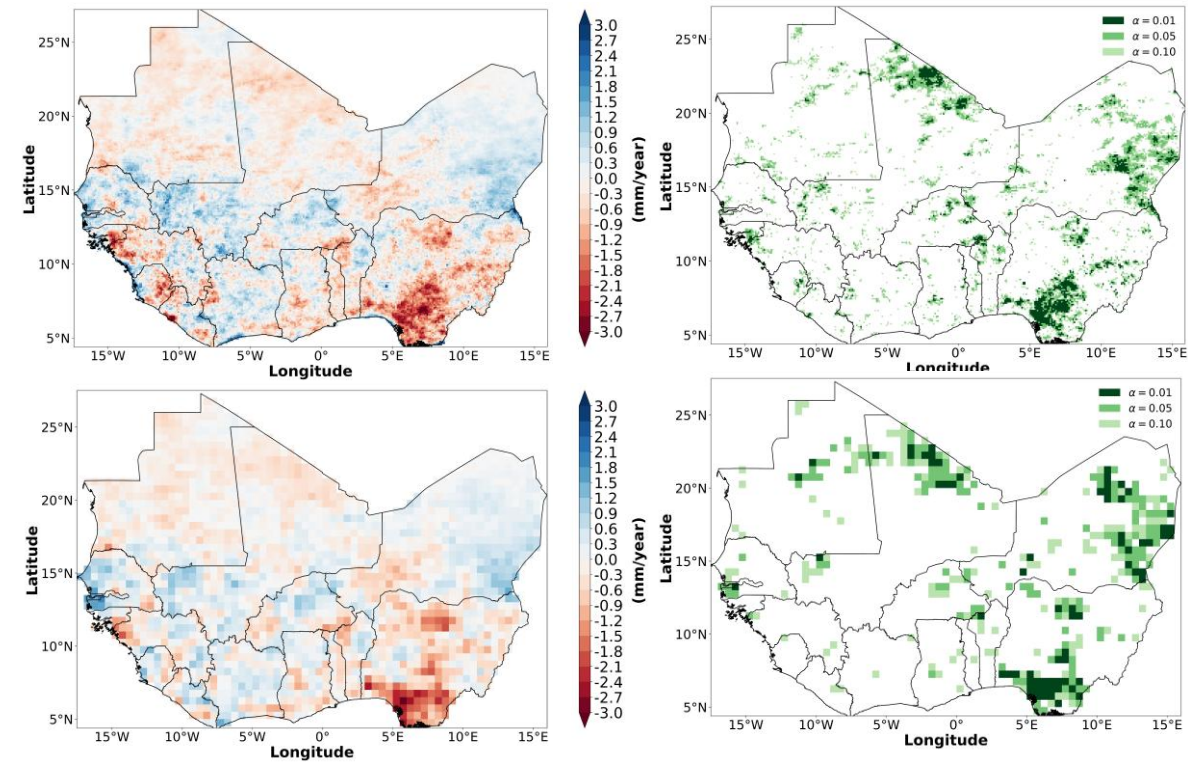
($\alpha=0.05$)	IMERG	GPCP
Increasing Trend	7.7%	9%
Decreasing Trend	6.8%	5.2%

Absolute Precipitation Indices

IMERG



RX5day



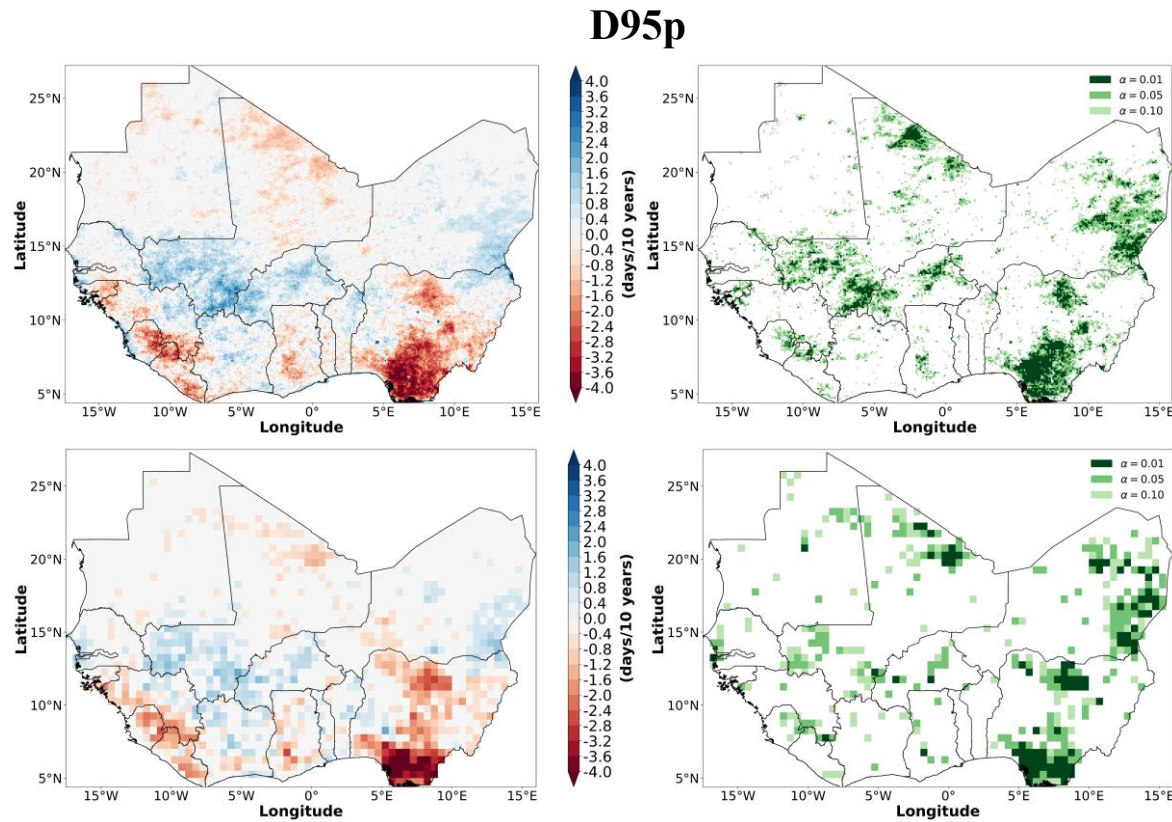
GPCP

$(\alpha=0.05)$	IMERG	GPCP
Increasing Trend	2.2%	3.4%
Decreasing Trend	8%	8%

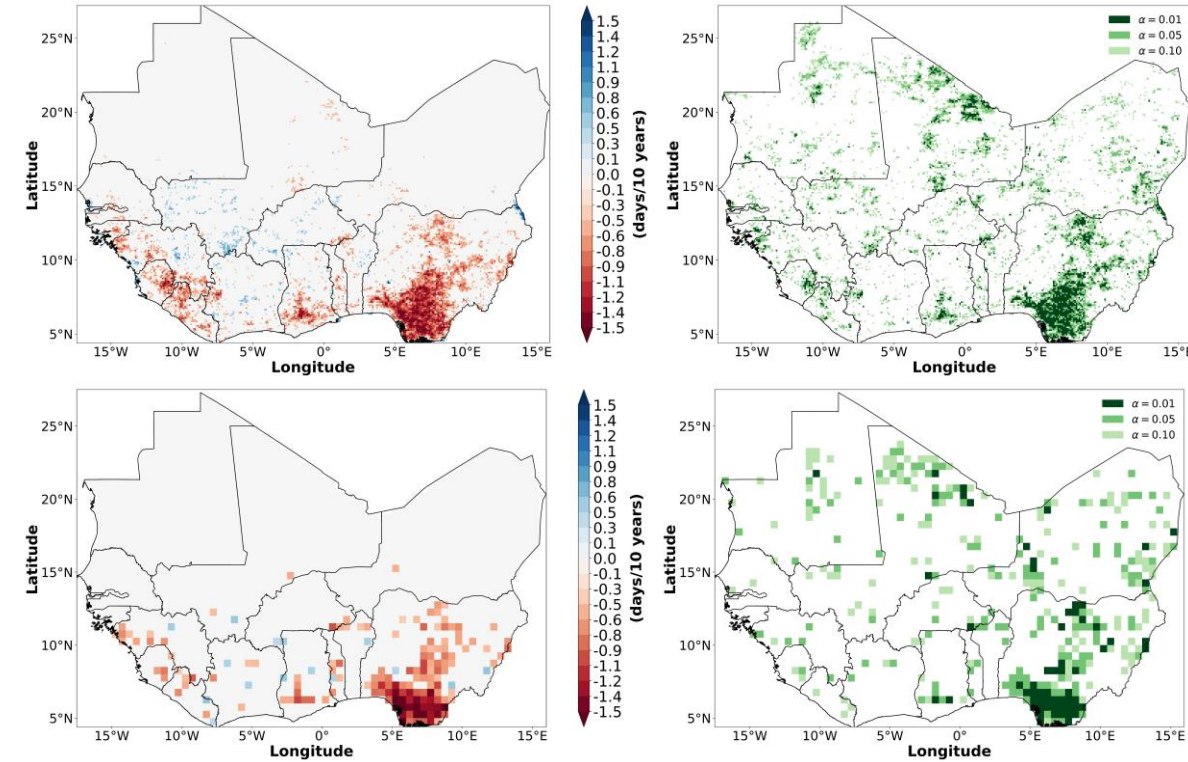
$(\alpha=0.05)$	IMERG	GPCP
Increasing Trend	3.2%	4%
Decreasing Trend	5.3%	6.1%

Number of Very Wet and Extremely Wet Days

IMERG



D99p



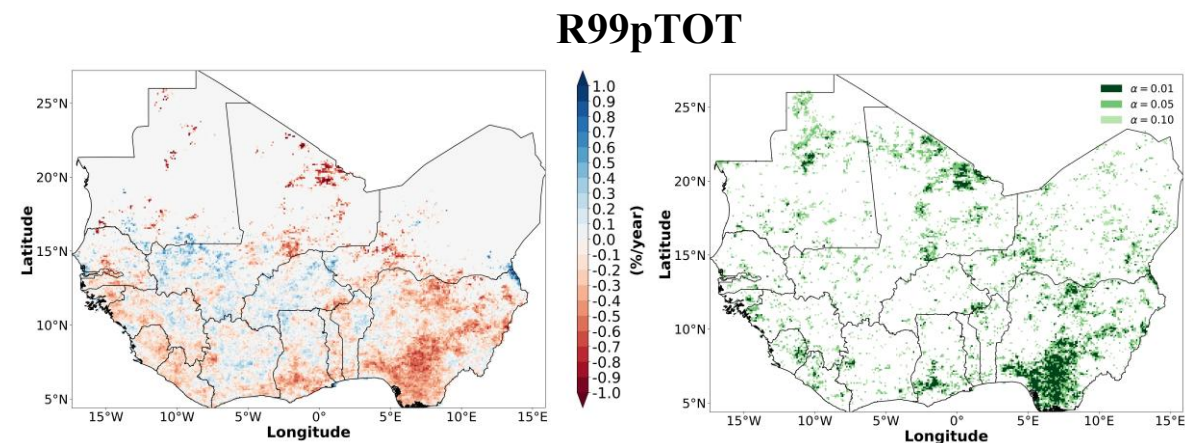
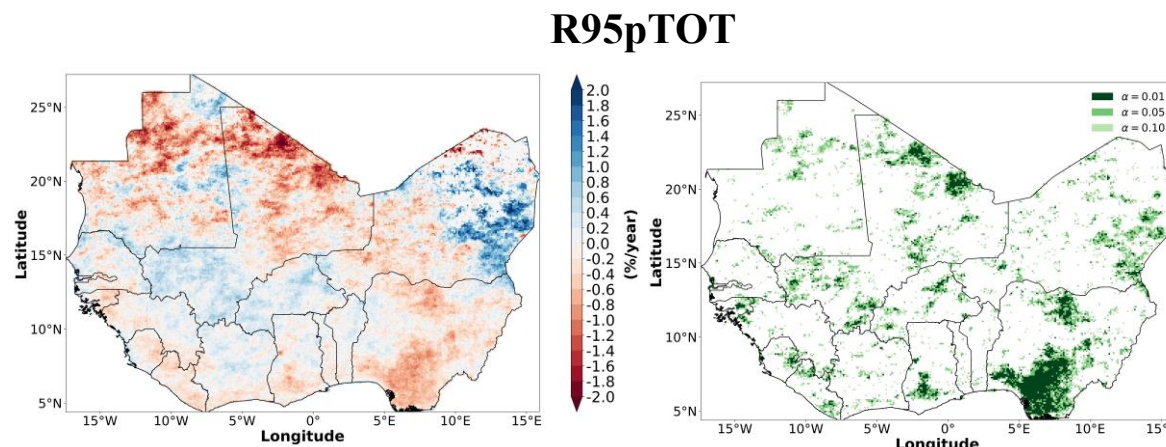
GPCP

$(\alpha=0.05)$	IMERG	GPCP
Increasing Trend	6.3%	4.1%
Decreasing Trend	6.1%	6.9%

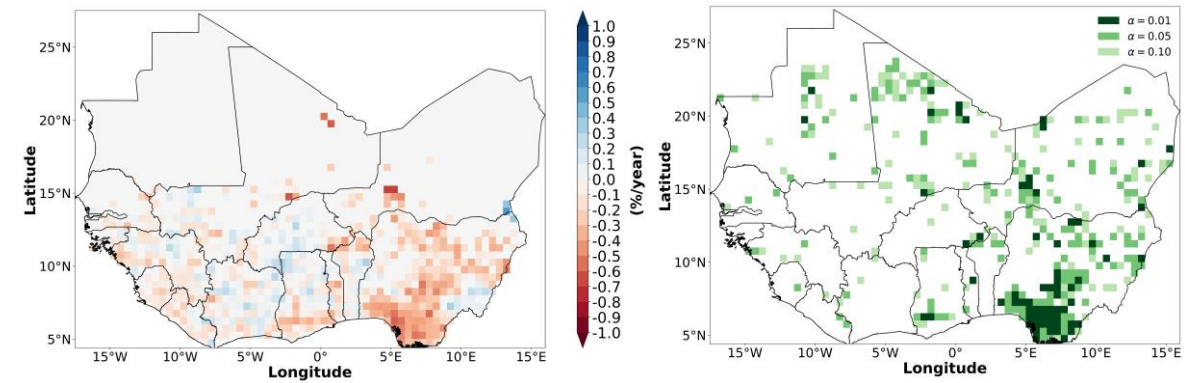
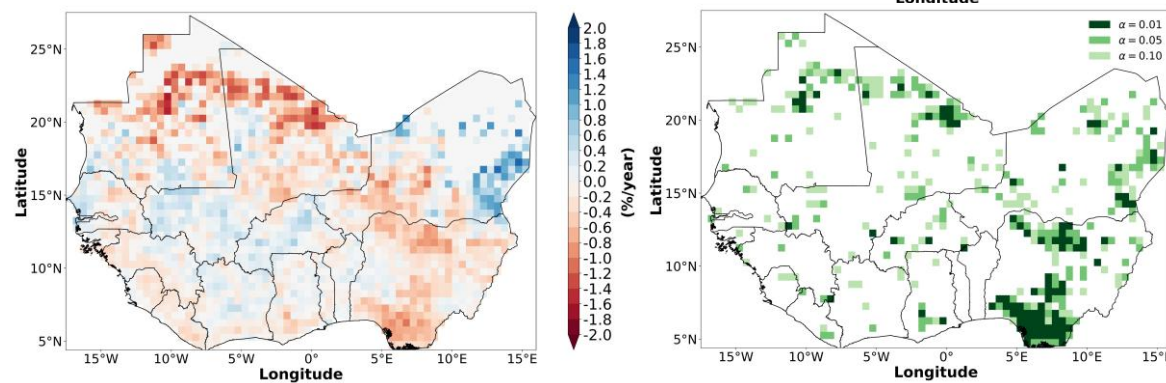
$(\alpha=0.05)$	IMERG	GPCP
Increasing Trend	5.4%	5.3%
Decreasing Trend	0.8%	0.2%

Contribution of Extreme Days to Annual Precipitation

IMERG



GPCP



($\alpha=0.05$)	IMERG	GPCP
Increasing Trend	3.2%	8.7%
Decreasing Trend	8%	2.3%

($\alpha=0.05$)	IMERG	GPCP
Increasing Trend	7.1%	6.8%
Decreasing Trend	0.7%	0.3%

Take Home Messages

- Despite their different spatial resolutions and inconsistencies in the satellite constellation, IMERG and GPCP show consistent spatial patterns, trend directions, and areas of statistically significant change in annual total precipitation and in the frequency and intensity of extreme precipitation.
- Parts of the western Guineo-Congolian region and eastern coastal Nigeria show drying and weakening of extreme rainfall, with declines in annual precipitation as well as in the frequency, intensity, and contribution of extreme days.
- Annual precipitation is increasing across southern Mali toward Burkina Faso and southeastern Niger, accompanied by increases in the frequency, intensity, and contribution of extreme rainfall.
- In southwestern Ghana, the frequency and intensity of extreme precipitation events have decreased.

THANK YOU!

mnasibi@gmu.edu

