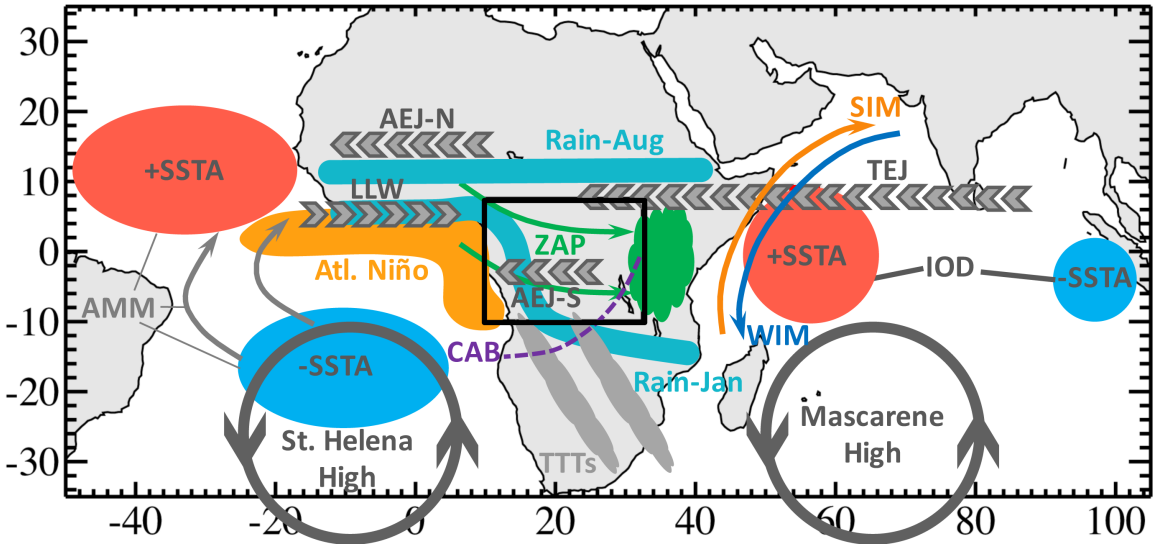
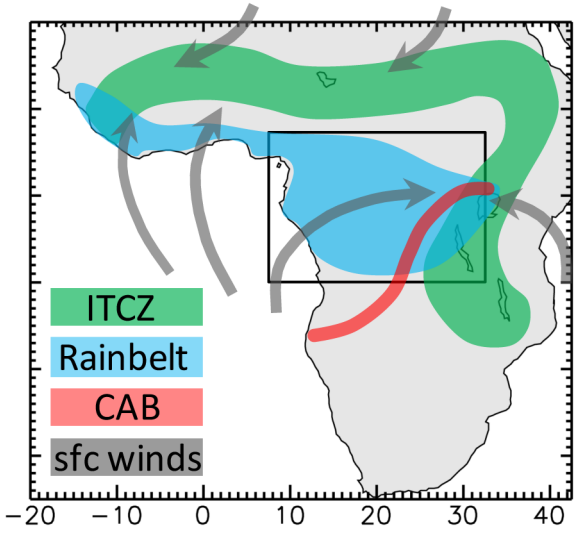
Precipitation characteristics in tropical Africa using satellite and in situ observations

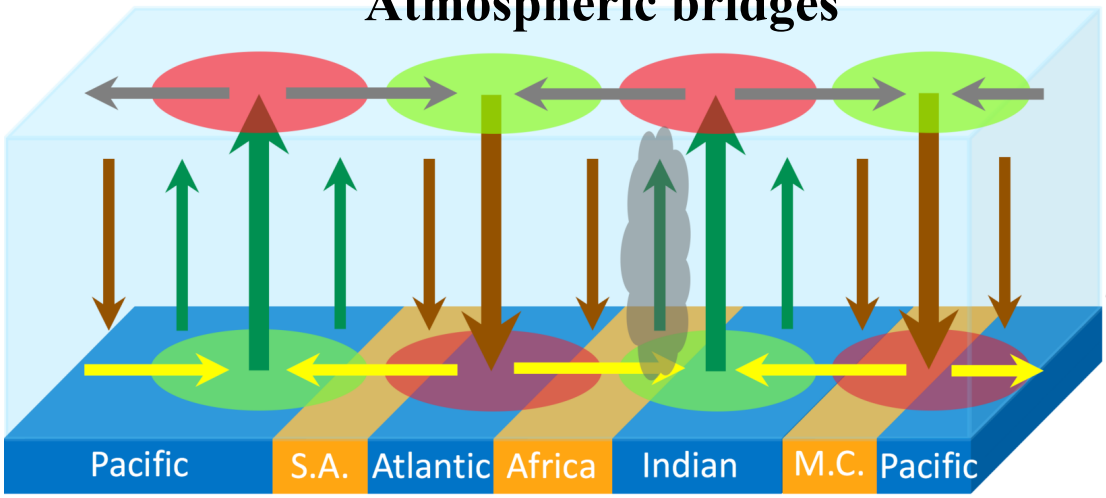
Amin Dezfuli, Charles Ichoku, George Huffman, Karen Mohr and TAHMO team

African rainfall: global & regional implications

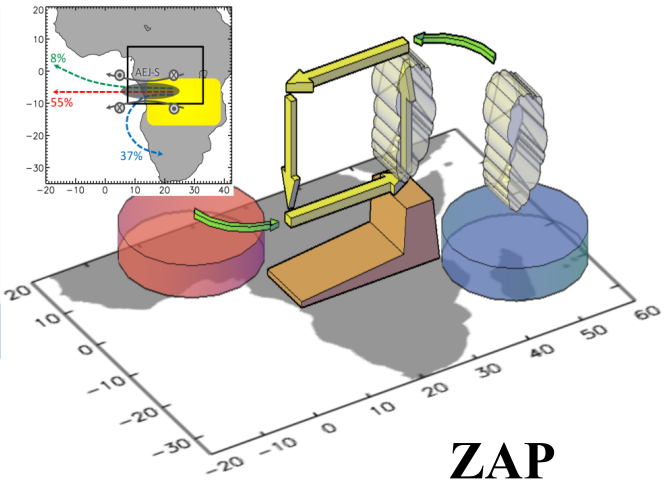




Atmospheric bridges

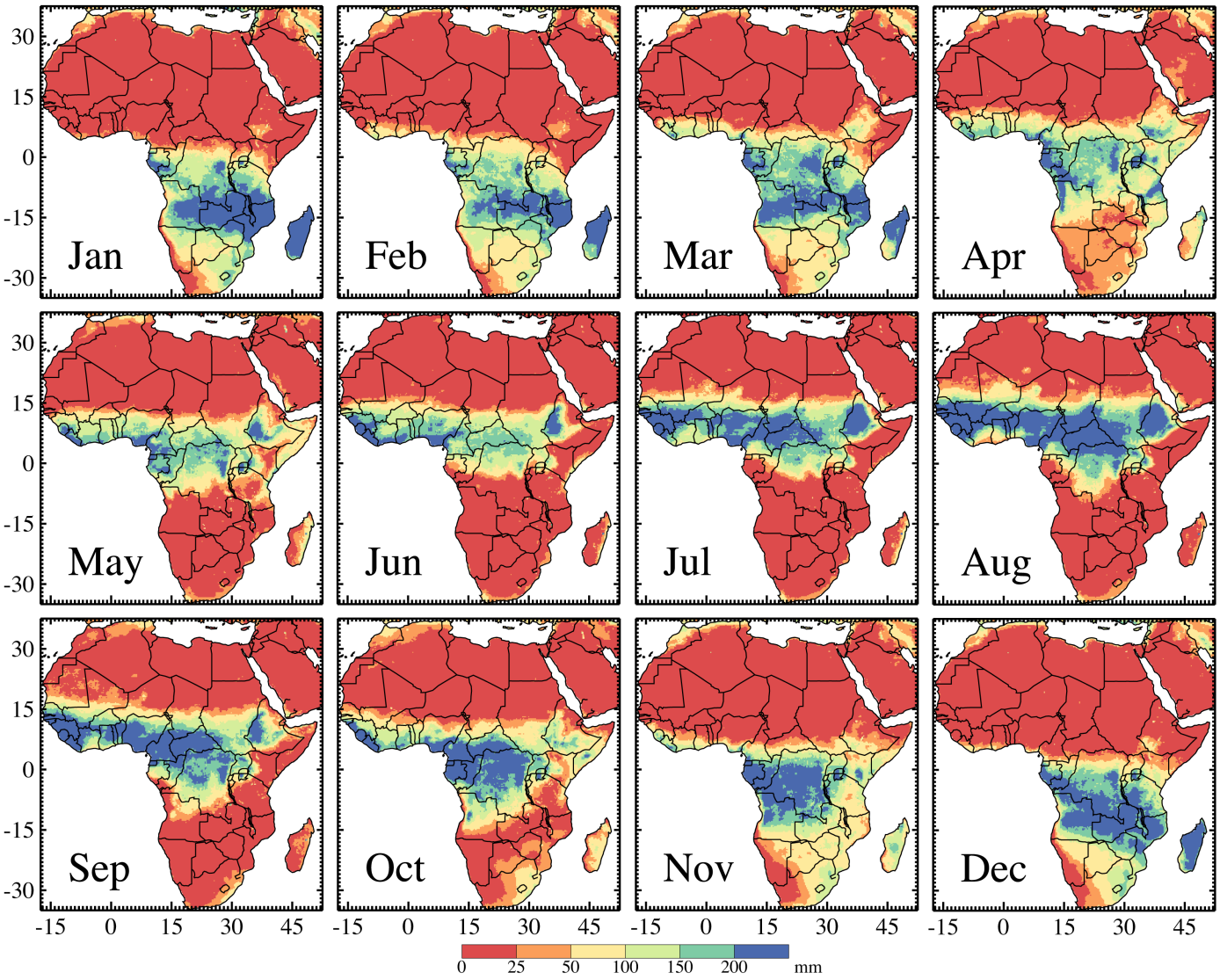


(Dezfuli, 2017)

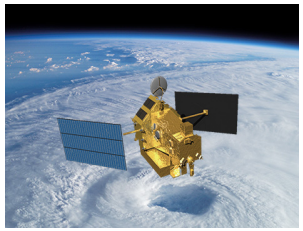


ZAP

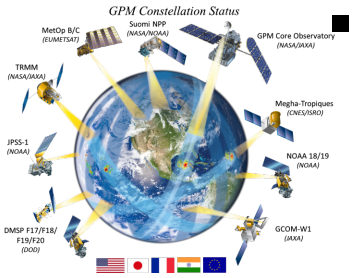
Annual cycle of precipitation



Precipitation data sets

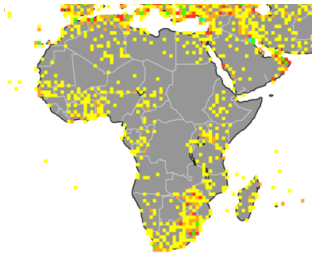


- **TMPA**: TRMM Multi-Satellite Precipitation Analysis, 3B42 v7



- **IMERG**: Integrated Multi-satellitE Retrievals for GPM, V04A

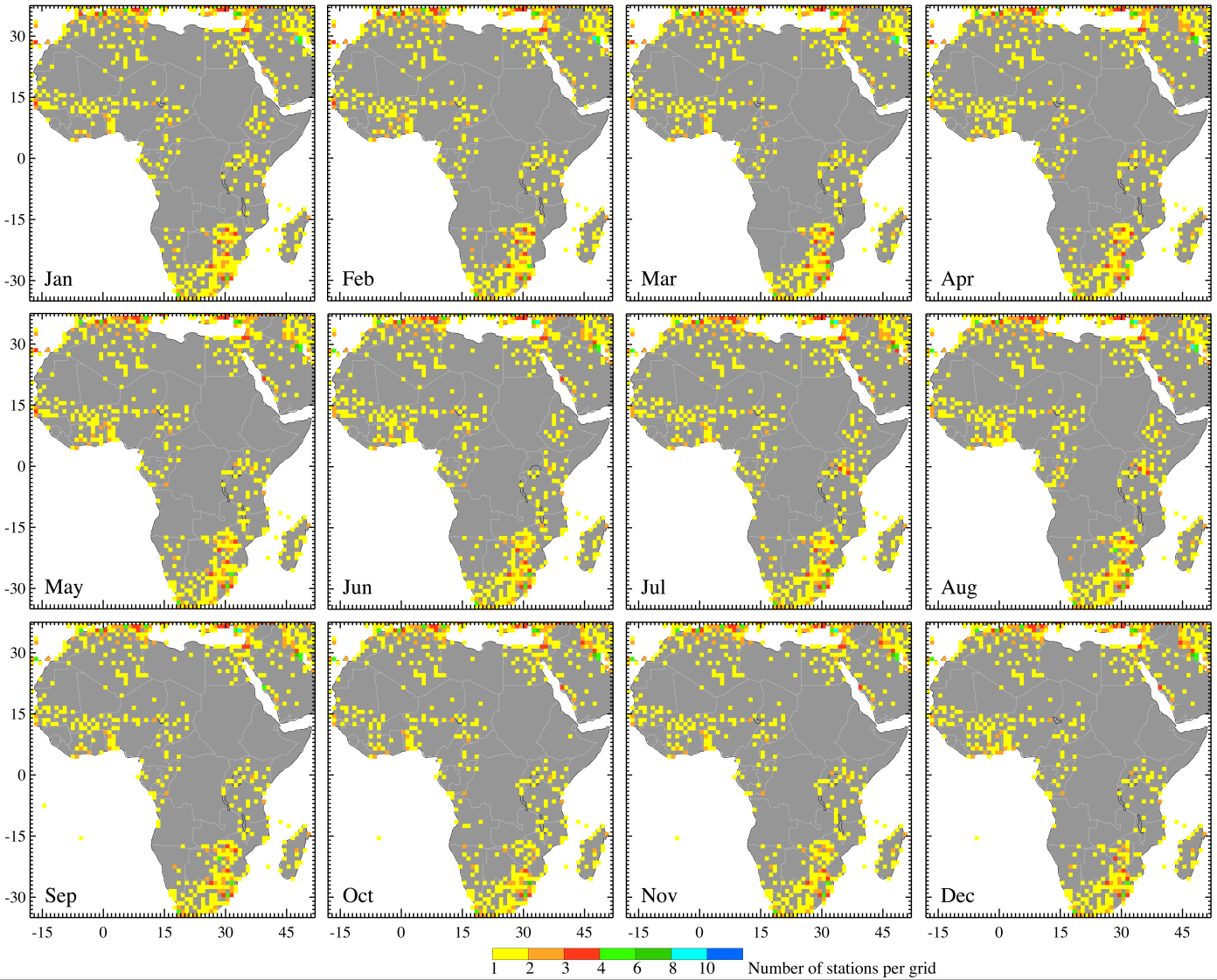
- **TAHMO**: Trans-African Hydro-Meteorological Observatory



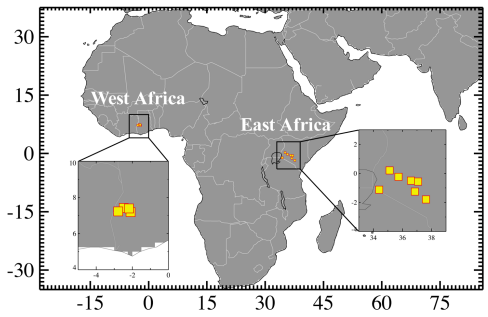
- **GPCC**: Global Precipitation Climatology Centre, 1st Guess Daily

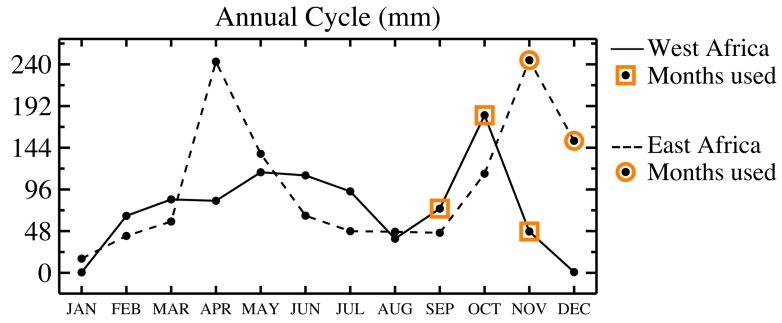
- **CHIRPS**: Climate Hazards Group InfraRed Precipitation with Station

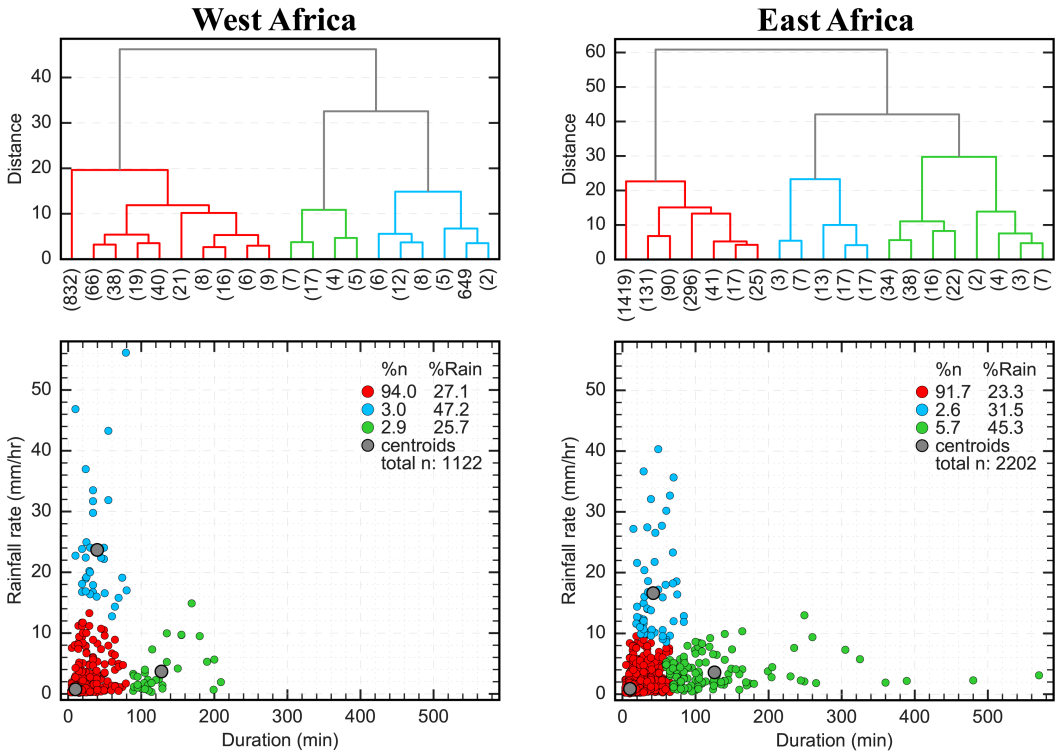
Number of stations/grid used in GPCC



Classifying rainfall events based on duration & intensity



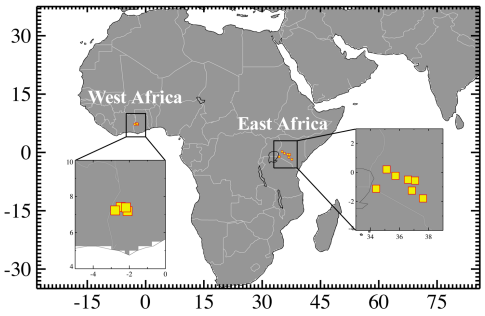


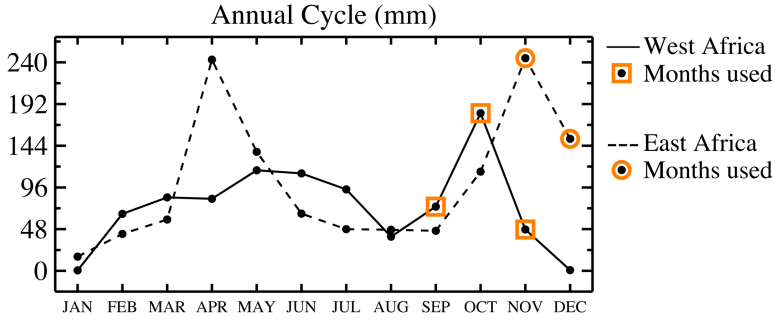


Three rainfall classes:

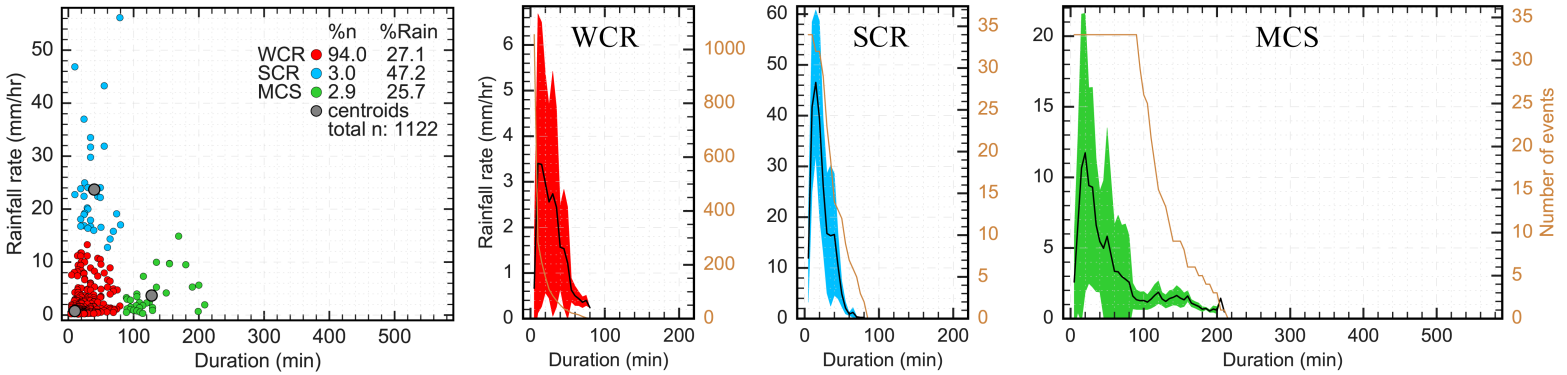
- **Weak Convective Rainfall (WCR)**
- **Strong Convective Rainfall (SCR)**
- **Mesoscale Convective System (MCS)**

Characteristics of three rainfall types

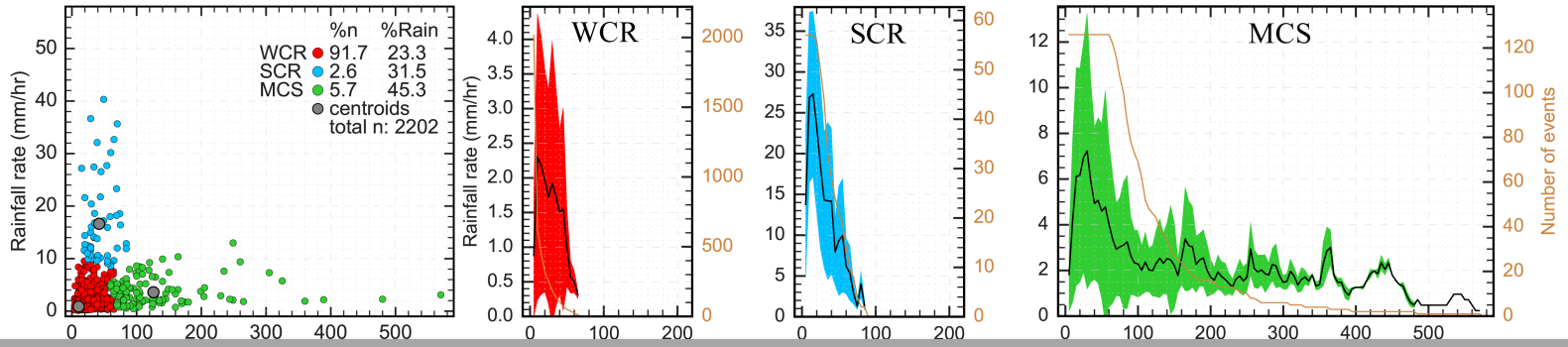




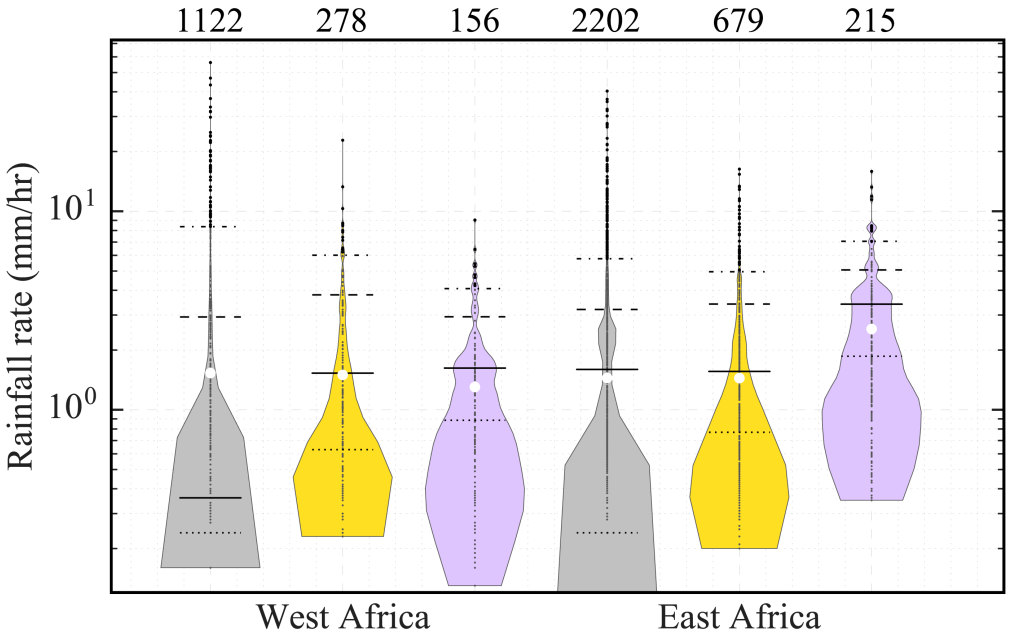
West Africa (Sep-Oct-Nov)

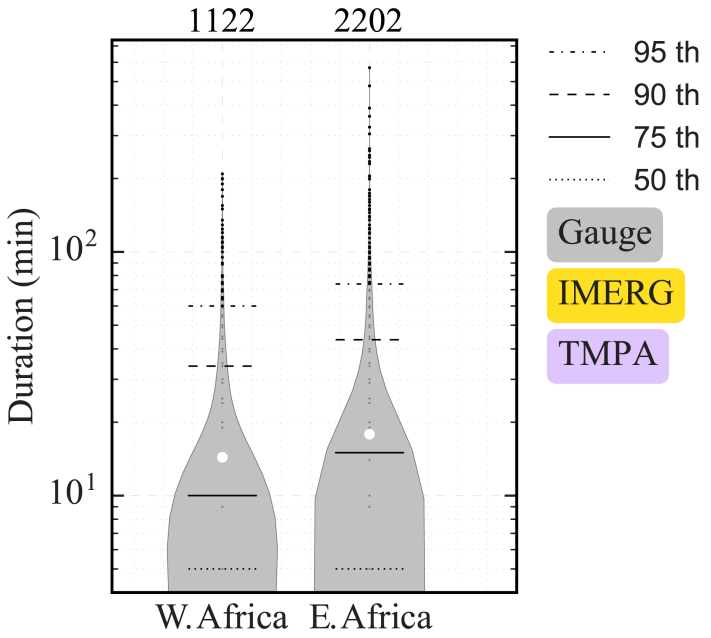


East Africa (Nov-Dec)



Rainfall rate & duration of all rainy events

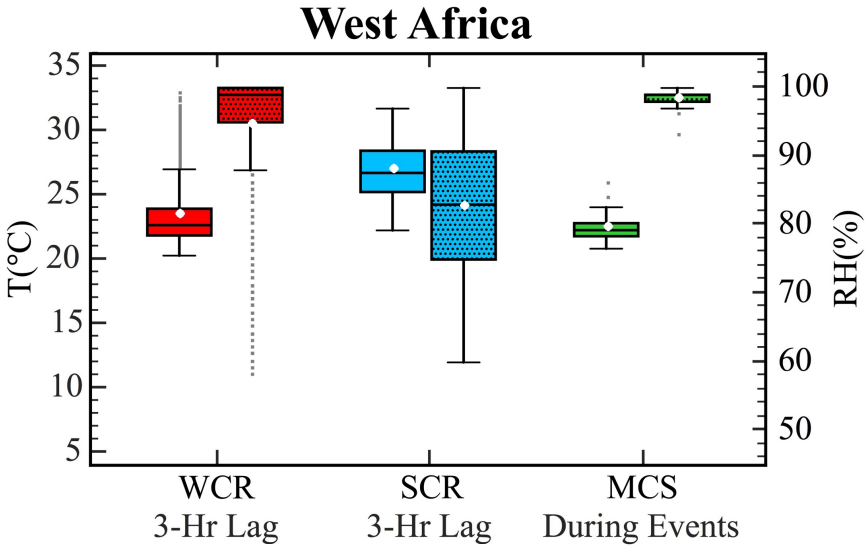


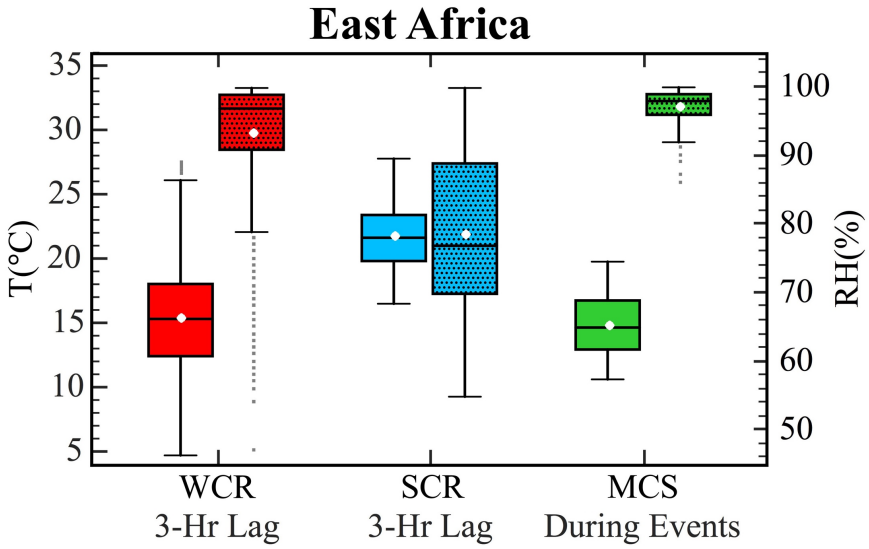


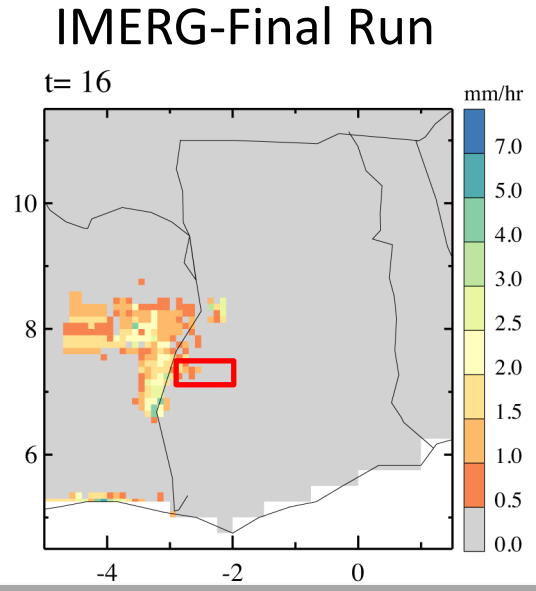
- West vs. East Africa: Comparable means, but different percentiles
- IMERG offers advantages over TMPA in capturing the PDF of rainfall intensity for both regions

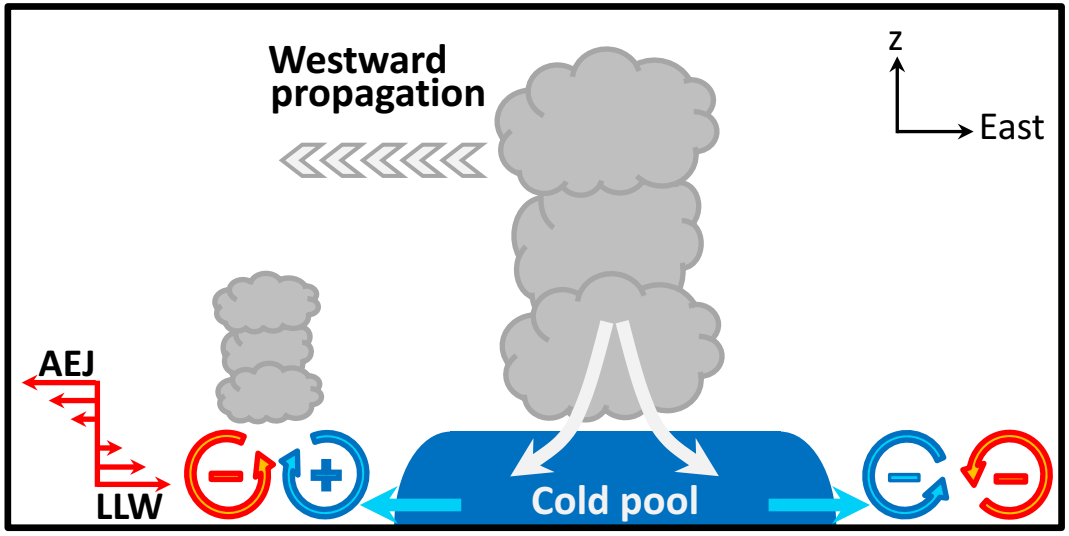
- Relatively longer duration in East Africa

Surface conditions for different rainfall types

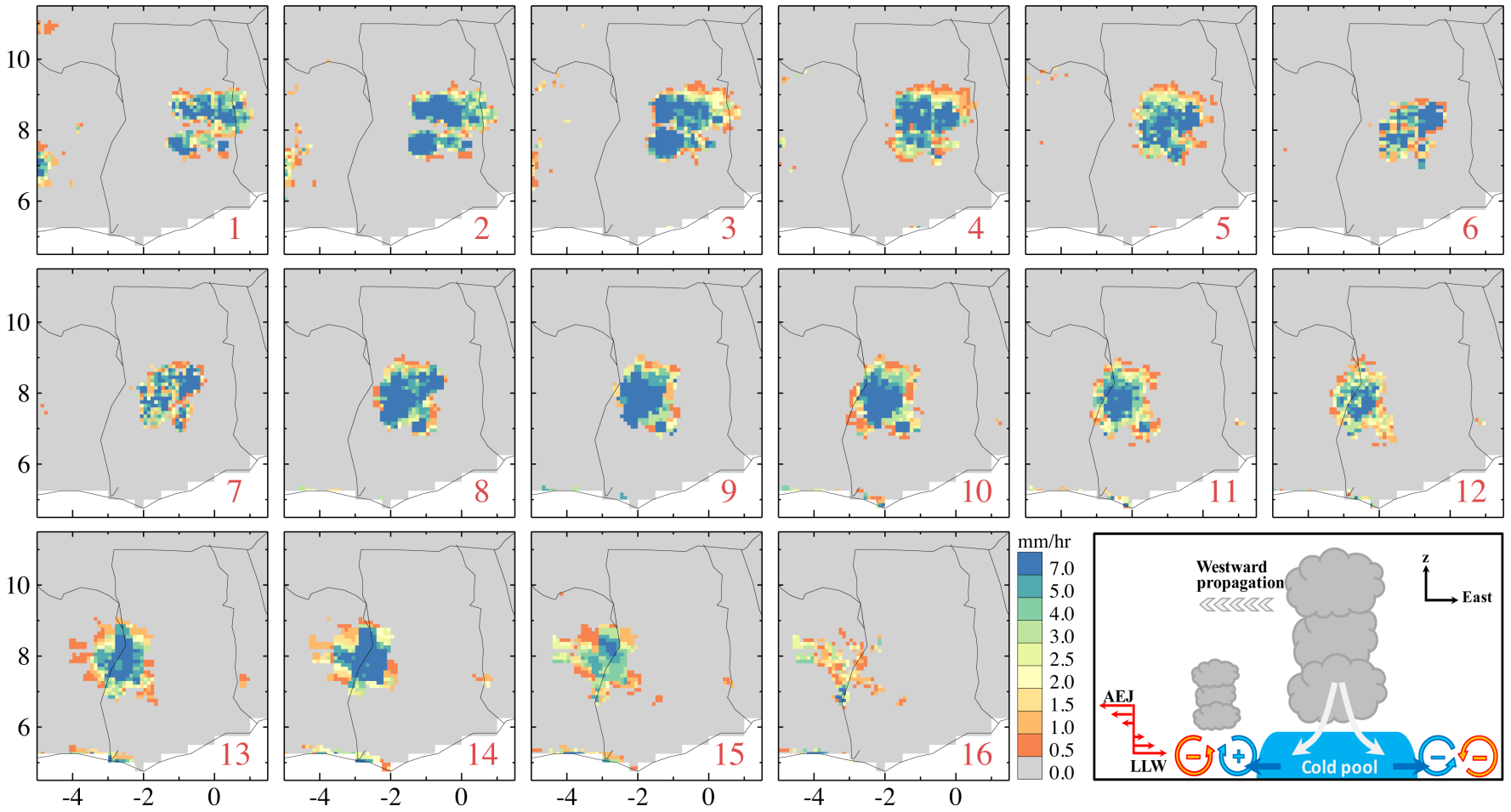




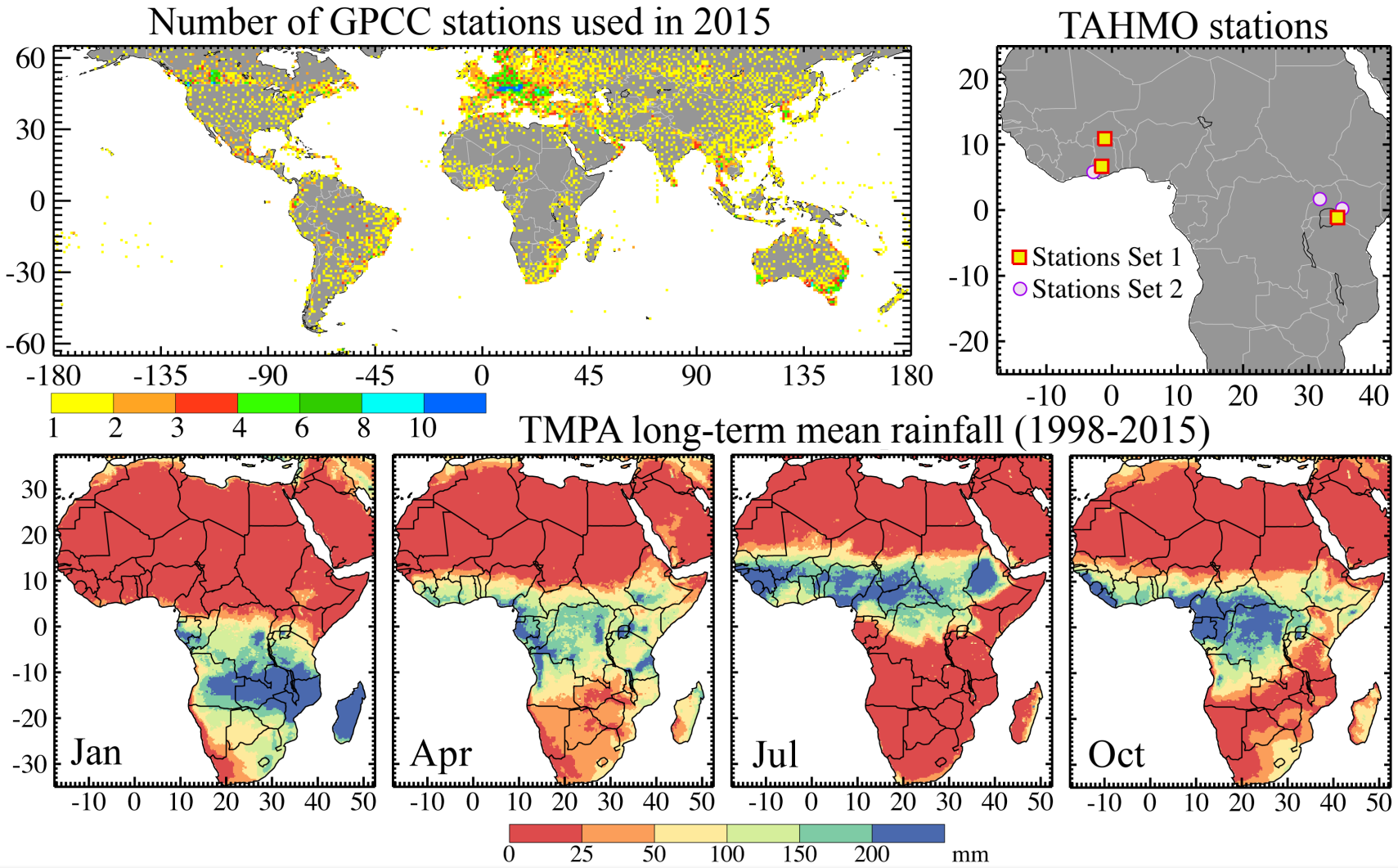




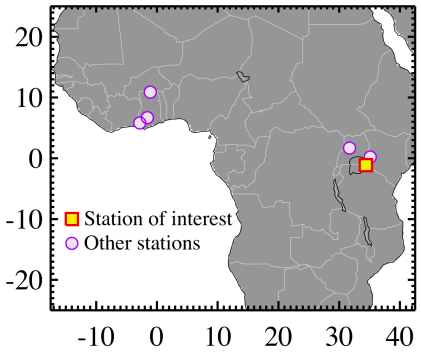
Westward propagating MCS in West Africa



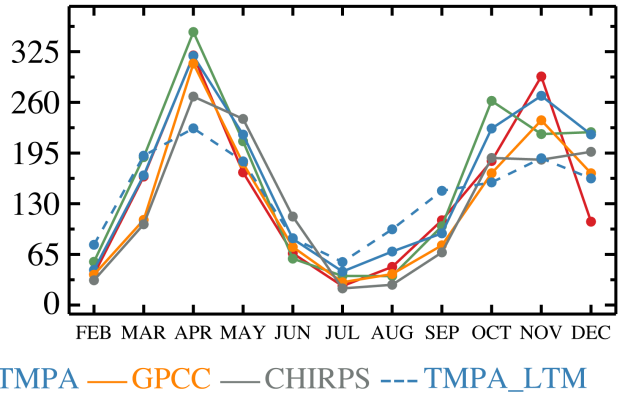
Location of stations & rainfall climatology

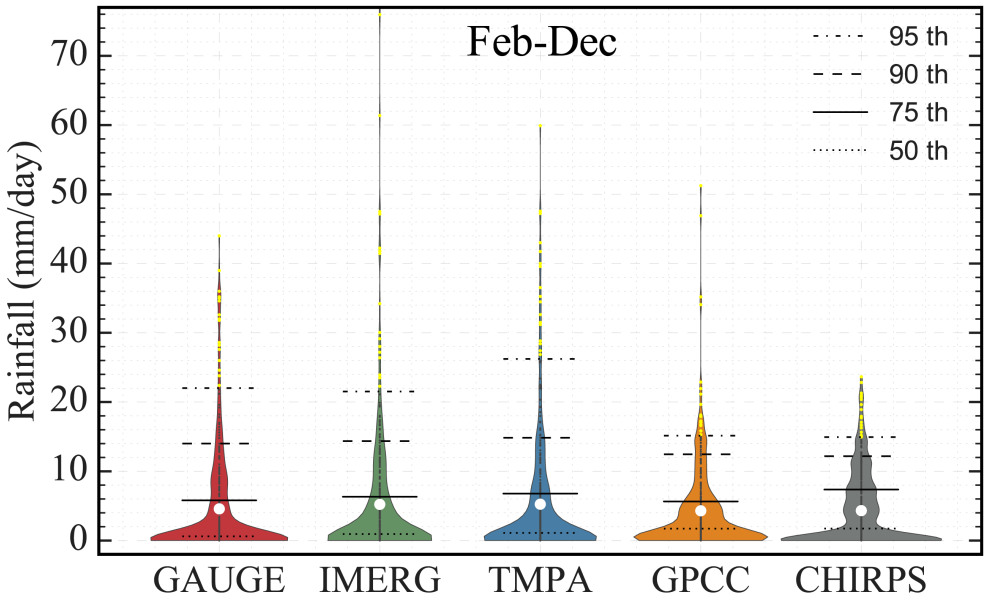


Station 1: Lela Primary School, Kenya

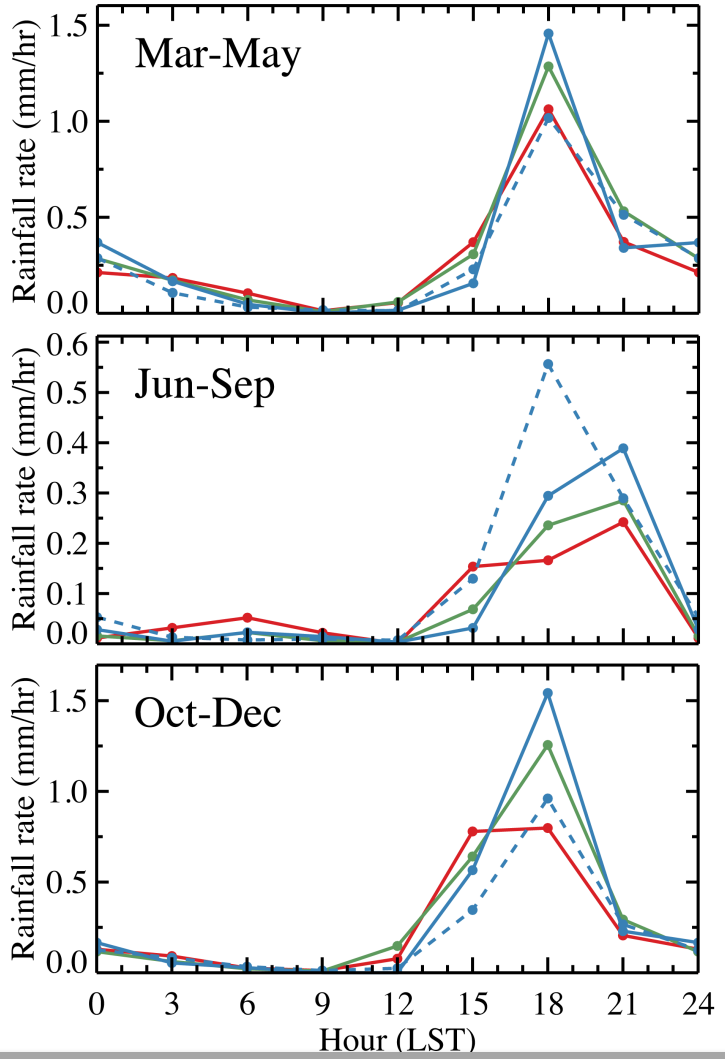


Annual cycle (2015)

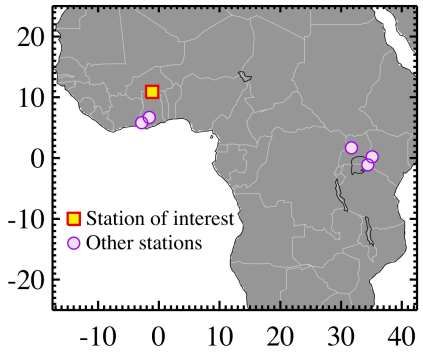




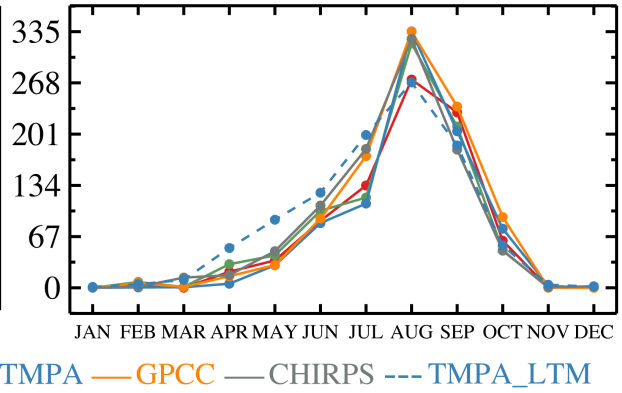
Diurnal cycle



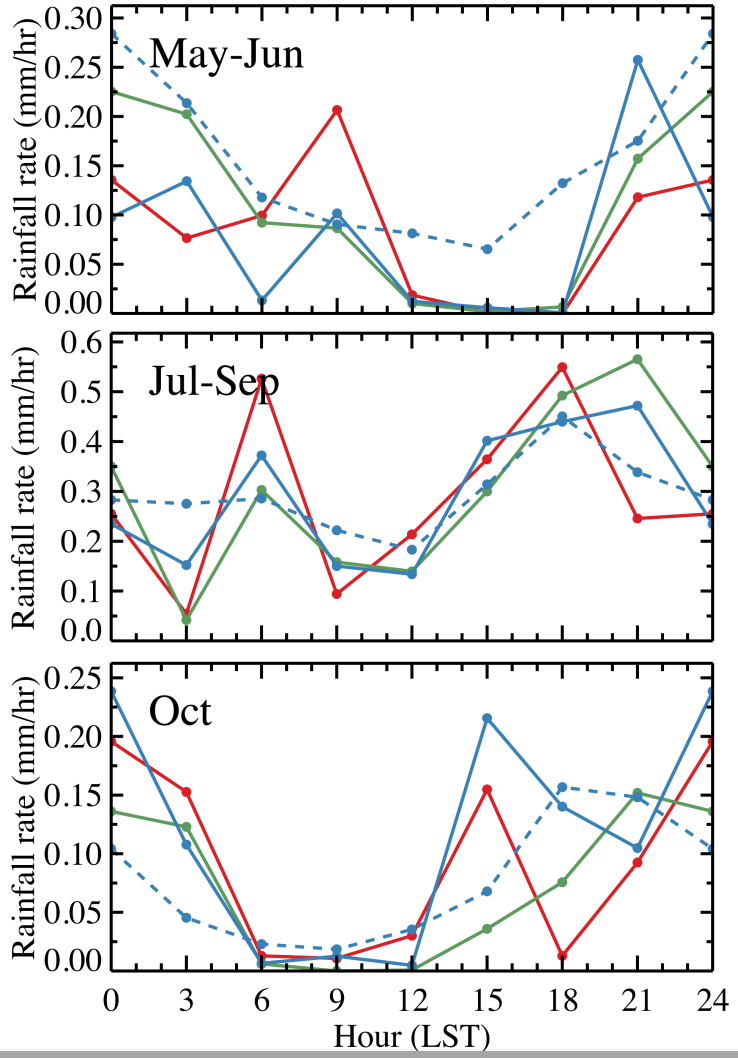
Station 2: Navrongo, Ghana

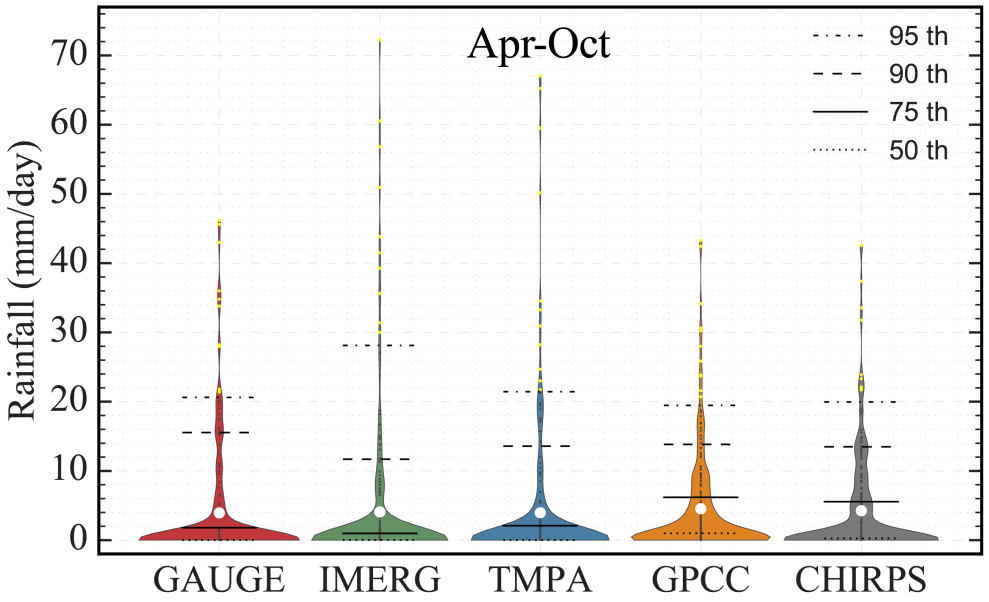


Annual cycle (2015)

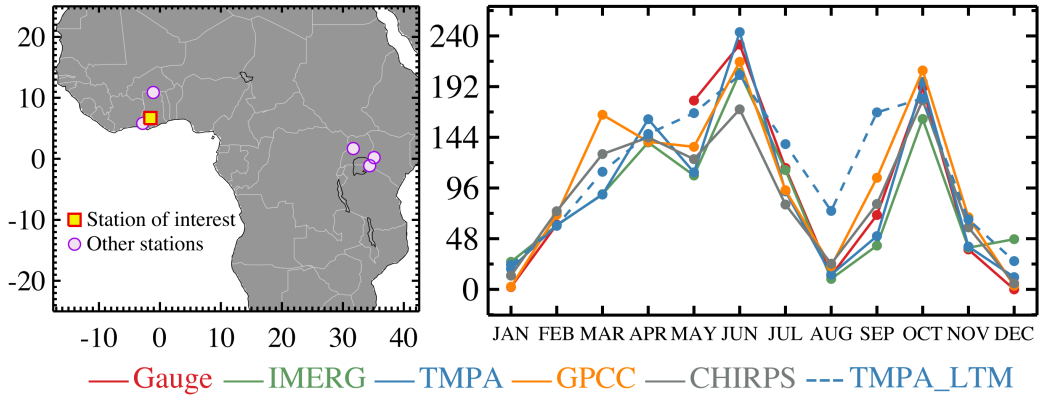


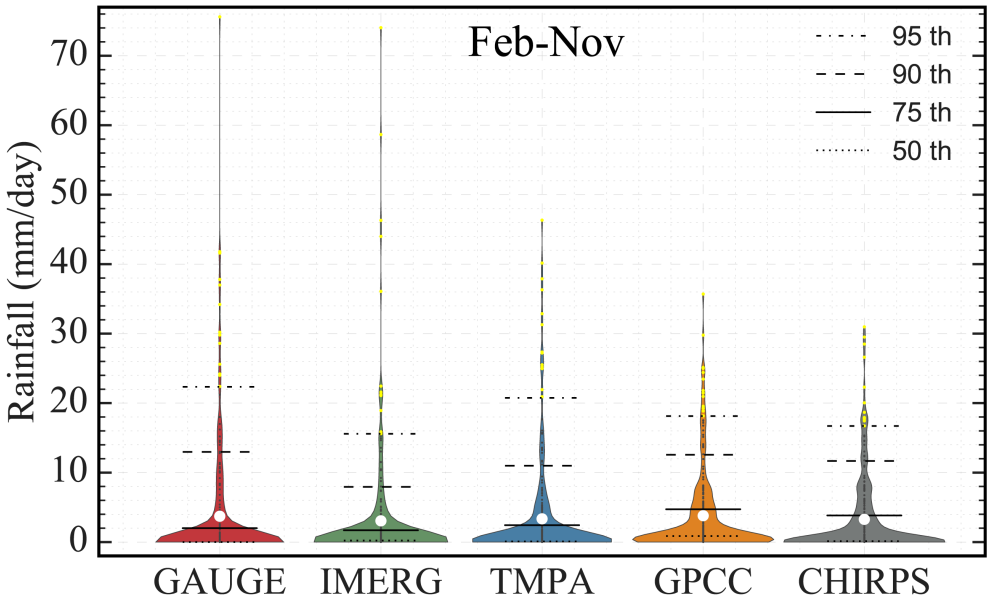
Diurnal cycle

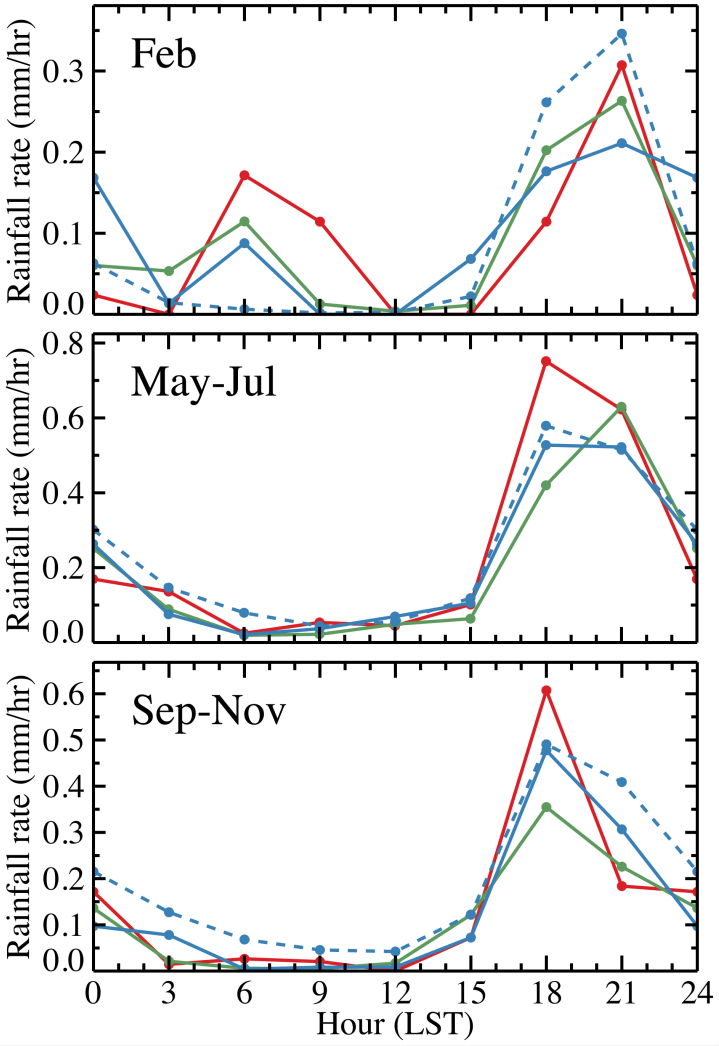




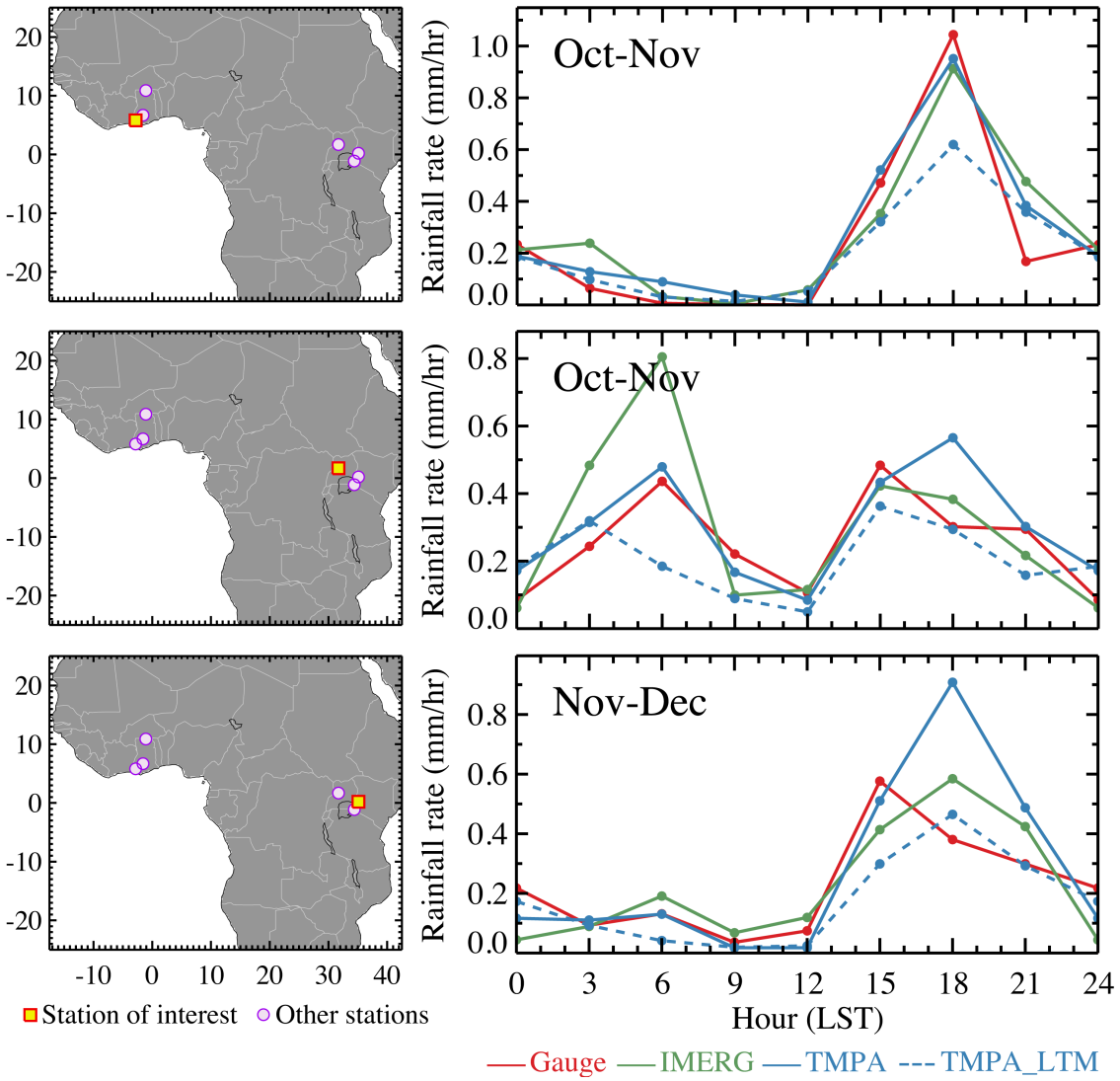
Station 3: Kumasi, Ghana







Diurnal cycle for additional stations



Evaluation measures: IMERG vs TMPA

A: hit
B: false alarm
C: miss
D: correct rejection

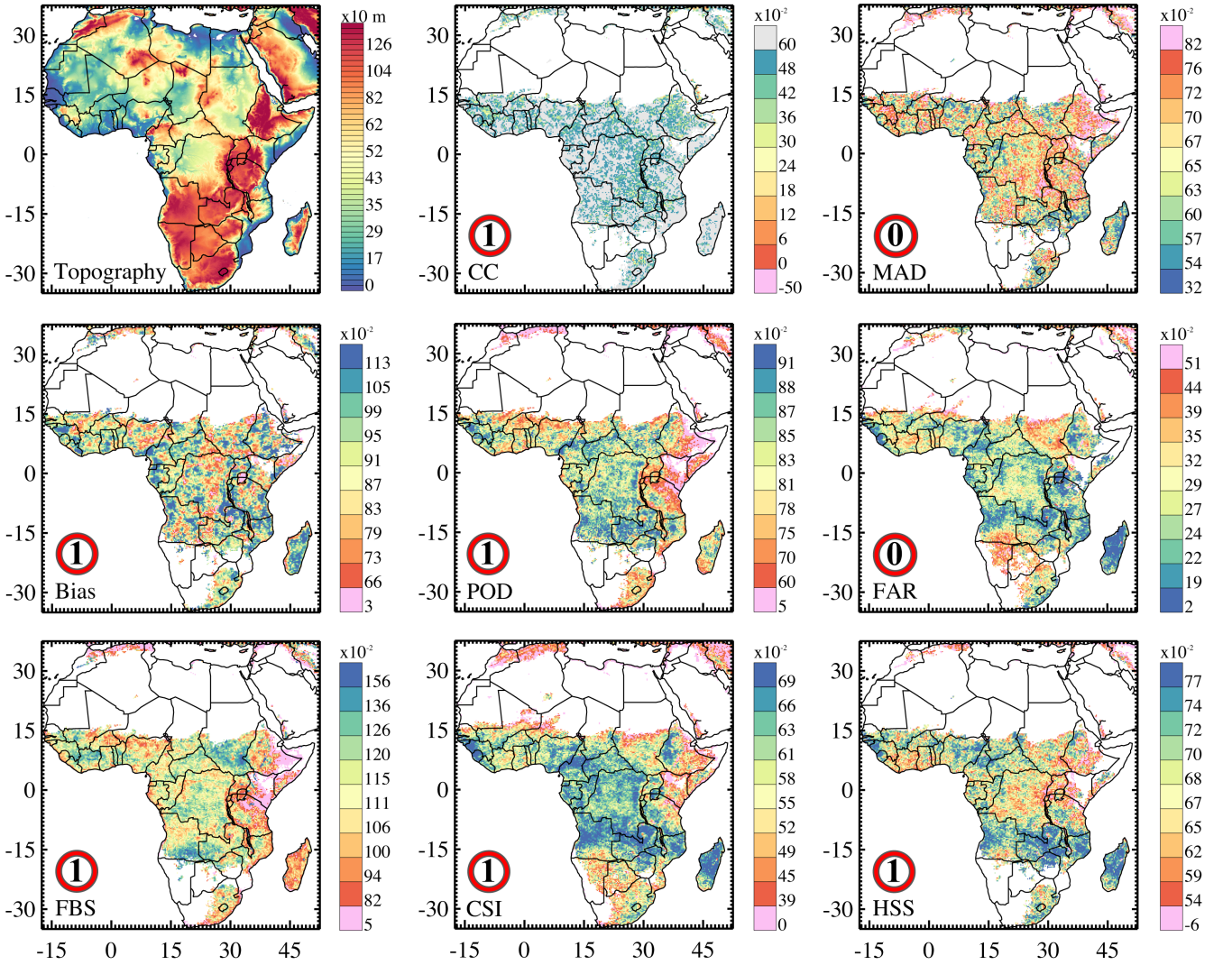
Prob. of Detection:
$$\frac{A}{A+C}$$

False Alarm Ratio:
$$\frac{B}{A+B}$$

Fractions Brier Score:
$$\frac{A+B}{A+C}$$

Critical Success Index:
$$\frac{A}{A+B+C}$$

Heidke Skill Score:
$$\frac{2(AD-BC)}{(A+C)(C+D)+(A+B)(B+D)}$$



Perfect value: 1 or 0

Conclusions

- Three classes of rainfall identified using in-situ observations:
  - WCR: Duration < 40 minutes and Intensity < 10 mm/hr
  - SCR: Duration < 80 minutes and Intensity > 10 mm/hr
  - MCS: Duration > 80 minutes and Intensity < 10 mm/hr
- SCR + MCS: 75% of total rainfall from 8% of rain events
- Which data to use: depends on region/season/objective
- IMERG-V04 has some advantages due to its half-hourly resolution, but not a clear victory over TMPA!

Articles:

- Dezfuli, A.K., Ichoku, C.M., Mohr, K. and Huffman, G.J., 2017. Precipitation characteristics in West and East Africa, from satellite and in-situ observations. *Journal of Hydrometeorology*, (2017).
- Dezfuli, A.K., et al., 2017. Validation of IMERG Precipitation in Africa. *Journal of Hydrometeorology*, *18*(10), pp.2817-2825.