Precipitation characteristics in tropical Africa using satellite and in situ observations

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African rainfall: global & regional implications

Atmospheric bridges

(Dezfuli, 2017)
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

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

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

West Africa

- T°C: Temperature in °C
- RH(%): Relative Humidity in %
- WCR: 3-Hr Lag
- SCR: 3-Hr Lag
- MCS: During Events

East Africa

- T°C: Temperature in °C
- RH(%): Relative Humidity in %
- WCR: 3-Hr Lag
- SCR: 3-Hr Lag
- MCS: During Events

IMERG-Final Run

Westward propagation

Cold pool

AEJ

LLW
Westward propagating MCS in West Africa
Location of stations & rainfall climatology

Number of GPCC stations used in 2015

TAHMO stations

TMPA long-term mean rainfall (1998-2015)

Jan Apr Jul Oct

0 25 50 100 150 200 mm
Station 1: Lela Primary School, Kenya

Annual cycle (2015)

Diurnal cycle

Station 2: Navrongo, Ghana

Annual cycle (2015)

Diurnal cycle

May-Jun

Jul-Sep

Oct

GMAO
Global Modeling and Assimilation Office
gmao.gsfc.nasa.gov

National Aeronautics and Space Administration

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Station 3: Kumasi, Ghana

Annual cycle (2015)

Diurnal cycle

Feb

May-Jul

Sep-Nov
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: