CLIMATE STUDIES IN THE CARIBBEAN

Climate Studies Group, Mona (CSGM)
Department of Physics
University of the West Indies, Mona
ABOUT THE CSGM

Mandate: Climate Science Research for the Caribbean

- To investigate and understand the mechanisms responsible for a) the mean climate and b) extremes in climate in the Caribbean.
- To investigate climate change and its historical, current and future manifestations in the Caribbean.
- To promote climate data capture and sound data management principles.
- To investigate and promote the advantageous uses of climate information for the development of the Caribbean region.
- To build capacity (data, human and technical) to do climate science within the Caribbean region and respond to climate science demands within the region.
‘Rainfall is King’

“There is an overwhelming dependence on surface and groundwater which means a very strong dependence on rainfall.”

“The size, topography (steep hilly interiors and narrow coastal zones) and economic activities force consideration of climate as an issue for the Caribbean, especially rainfall...”
CLIMATE RESEARCH + DROUGHT

4 Areas of concentration
CARIBBEAN RAINFALL CLIMATOLOGY
CARIBBEAN RAINFALL CLIMATOLOGY

1. Dry Season
   December - April

2. Rainfall Season
   May - November
   Peaks in September/October

3. Bimodal - MSD
   Early season - May-July
   Late Season - Aug – Nov

Interest:
What dives this pattern...
**Caribbean Rainfall Climatology**

- **High Pressure**
- **Trade Wind Strength**
- **Vertical Shear**
- **SSTs**

**Climatology**

- **Bar graph**: Precipitation
- **Line graph**: Temperature

**Nah moves closer to equator**
- Stronger trades
- Low SST
- Mid-latitude fronts

**Nah starts Northward migration**
- Weaker trades
- SST begins to increase

**Nah temporarily retreats Southward**
- ‘Mid-Summer Drought’

**Nah return Northward**
- High SST
- Easterly waves
- ITCZ North

**Air Temp follows the sun**

**Jamaica**

**Easterly Waves**

**Trade Wind Strength + vertical shear**
Drivers of Variability
1. Late wet season drier in most of the Caribbean

2. Dry season drier in south Caribbean

3. Early Wet season drier in most of the Caribbean
DRIVERS OF VARIABILITY

1. Late wet season drier in most of the Caribbean
   Increases shear

2. Dry season drier in south Caribbean
   Changes large scale circulations

3. Early Wet season drier in most of the Caribbean
   Warms Caribbean Sea

El Niño

160W 120W 80W 40W
20S 0 20N 40N
90W 80W 70W
10N 15N 20N
200W 160W 120W 80W 40W
20S 0 20N 40N
-100 -75 -50 -25 0 25 50 75 100
90W 80W 70W
10N 15N 20N

(a) (b) (c) (d)

MJJ
ASO

Dry season drier in south Caribbean

Late wet season drier in most of the Caribbean

Changes large scale circulations

Early Wet season drier in most of the Caribbean

Warms Caribbean Sea
Drivers of Variability

NAO+ ENSO

- +50% a 3-5 yrs
- +15-30% a 5-10 yrs
- 20% a >10 yrs

- +60% a 3-5 yrs
- 15-30% a 5-10 yrs

- <50% a 3-5 yrs
- 15-30% a 5-10 yrs
- 16-33% a >10 yrs

Combinations of Patterns of variability

Gouirand et al. (2011)
DRIVERS OF VARIABILITY

Gradient Indices

Gradients in SSTs between Equatorial Pacific and Tropical Atlantic

Drier than normal Caribbean basin during midsummer drought
Caribbean Rain/Drought Models

MJJ RAIN =
  - 0.0610 + 0.3111 NINO3(FMA)
  - 0.0675 SLP2(FMA)
  - 0.0299 SLP4(FMA)
  + 0.1187 VSH4(FMA)

ASON RAIN =
  - 0.0280 + 1.5822 CSST(MJJ)
  - 0.7227 PACEq(MJJ)
  - 0.5739 PACTNA(MJJ)

\[ R^2 = 0.76 \]

\[ R^2 = 0.70 \]
HISTORICAL DROUGHT

Indices of Drought

3 month SPI Jamaica

6 month SPI Jamaica
HISTORICAL DROUGHT

Drought Influences

12 month SPI Jamaica
HISTORICAL DROUGHT

Significant Drought and Drought Influences

SST composite:
Flood minus Drought
**HISTORICAL DROUGHT**

Other Indices of Rainfall/Drought

![Total rainfall](image1.png)

![Intense rainfall](image2.png)

1961-2010 1986-2010

Stephenson et al (2002)
FUTURE DROUGHT

Regional Climate Model
- PRECIS, UK
- Caribbean
- Scale ~50 km
Mean changes in the annual rainfall for 2071-2099 with respect to 1961-1989, as simulated by PRECIS_ECH and PRECIS_Had for SRESA2 and SRESB2.

General tendency for drying (main Caribbean basin) by end of the century.

- Drying between 25% and 30%
- Possibly wetter far north Caribbean NDJ and FMA.
- Drying exceeds natural variability June-October – wet season dryer!
Mean changes in the annual mean surface temperature for 2071-2099 with respect to 1961-1989, as simulated by PRECIS_ECH and PRECIS_Had for SRESA2 and SRESB2.

Irrespective of scenario the Caribbean expected to warm.

Warming between 1 and 5°C

Warming greater under A2 scenario.

Warming consistent with projections for other parts of globe.

Warming far exceeds natural variability
FUTURE DROUGHT

1961-2099 SPI and SPEI estimates from 17 AR4 GCMs (dot lines). Multimodel mean (black line) is included.

INSMET (2011)
FUTURE DROUGHT

Why?

Taylor et al. (2011)
SUMMARY OF CLIMATE RESEARCH + DROUGHT

1. Caribbean Rainfall Climatology
2. Drivers of Variability
3. Historical Drought
4. Future Drought
Thank You