

Sub-Seasonal to seasonal forecasting at CIMH

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Caribbean Institute for Meteorology and Hydrology



First WMO Regional Climate Center – Washington Training Workshop
30 September – October 4, 2019, College Park, Maryland, USA

Functions of the Caribbean Institute for Meteorology & Hydrology

- **WMO Regional Training Centre** - Train various categories of meteorological and hydrological personnel
- Operate as a **centre of research** in meteorology, hydrology and associated sciences
- **Regional Climate Data Centre** - Data collection, storage, & dissemination
- **Regional Instrument Centre** – Develop, maintain, repair, and calibrate meteorological & hydrological instruments
- Regional **Centre of Excellence for Training in Satellite Meteorology**
- **WMO Regional Climate Centre** (Designated in May 2017)
- Caribbean **Centre for Climate and Environmental Simulations**



- **WMO Pan American Centre for Sand & Dust Storm Warning Alerting & Advisory System;**
- **Advisor to regional governments** on matters related to meteorology, climate & hydrology
- Provide specialized services to industry

Developing the Caribbean's capacity to provide S2S prediction services

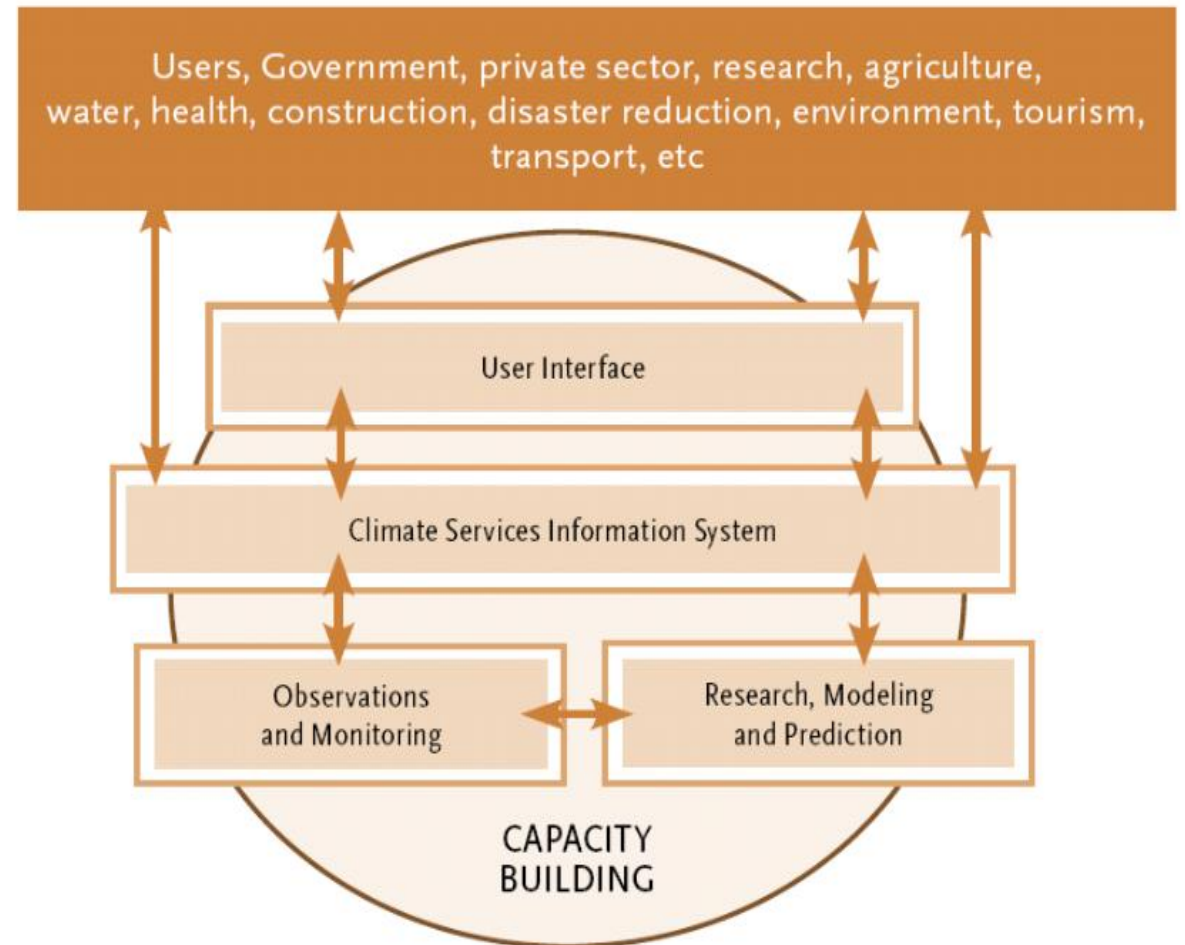
The Caribbean Embrace of the GFCS

Caribbean Roll Out in May 2013 in Trinidad and Tobago

REGIONAL WORKSHOP ON CLIMATE SERVICES AT THE NATIONAL LEVEL FOR THE CARIBBEAN

Since then national road map exercises in Belize, Trinidad and Tobago, Suriname, Guyana.

Endorsed at the 53rd Special Meeting of COTED (Environment and Sustainable Development).



Recent and Current activity of the Caribbean RCC in Climate Services

Observations and Monitoring

The essential infrastructure for generating the necessary climate data.

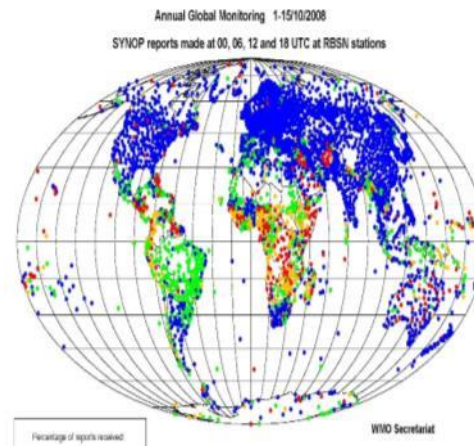
- Provision of **observation equipment**, raingauges, water level sensors, AWS; retrofitting already existing instruments
- Enhancing database and monitoring through **remote sensing** and **GIS technology** and techniques
- **Data rescue** exercises, and digitising
- **Database release** and launch of “light” **synchronising version** for Met Services; training
- **Non- meteorological data and surveillance** - CID/DEWETRA



The screenshot shows the CID website interface. At the top, there are navigation tabs: Home, About Us, Submit Impact, Reported Incidents, Related Links, and Contact Us. Below this is a 'SEARCH IMPACTS' section with fields for 'START DATE', 'END DATE', 'COUNTRY', and 'IMPACT'. A 'Submit' button is located below these fields. To the left, there are two images showing flood damage. Below the search section, there is a 'Benefits of the CID' section with four columns of text:

- PROVIDES EVIDENCE-BASED INFORMATION TO DETERMINE APPROPRIATE CLIMATE RISK MANAGEMENT OPTIONS**
- IMPROVES THE EFFECTIVENESS OF SUSTAINABLE PLANNING**
- REDUCES VULNERABILITY TO CLIMATE RELATED HAZARDS**
- SUPPORTS REGIONAL GROWTH RESILIENT TO CLIMATE RISKS**

A 'LEARN MORE' button is located at the bottom of this section.

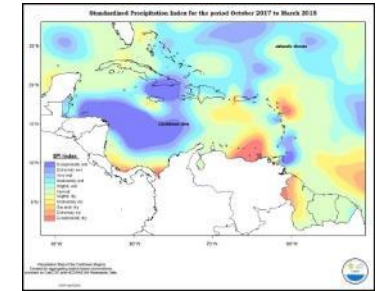
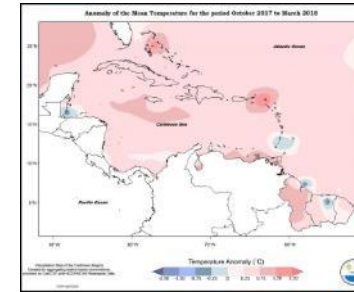
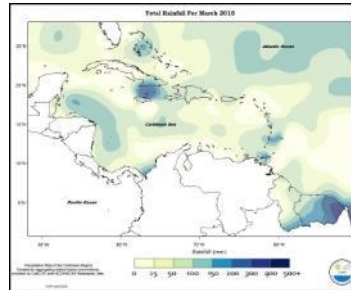
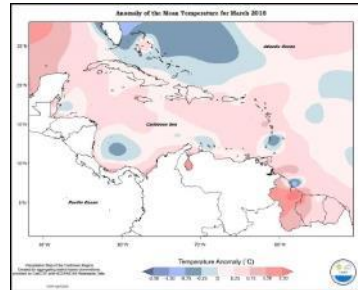
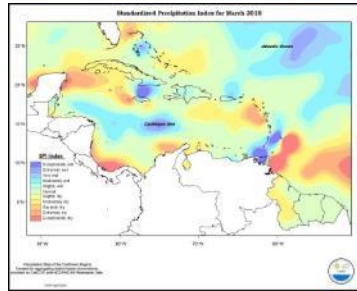


The screenshot shows a data management interface with a table of elements. The table has columns for 'Elements', 'Name', 'Definition', 'Data Value Units', 'Scale Factor', 'Element group', and 'Note'. The table lists various meteorological parameters such as temperature, precipitation, and relative humidity.

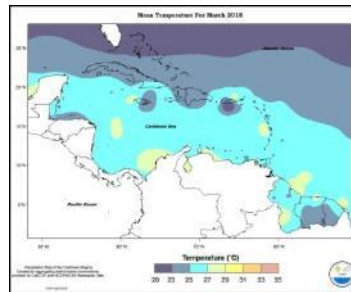
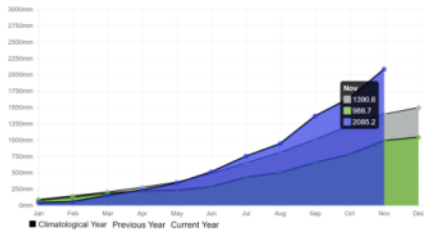
Elements	Name	Definition	Data Value Units	Scale Factor	Element group	Note
TMPOBS	Temp. daily obs	Rainfall	Degrees C	0.1	Monthly	
TMPMAX	Temp. daily max	Temperature, daily maximum	Degrees C	0.1	Daily/Monthly	
TMPMIN	Temp. daily min	Temperature, daily minimum	Degrees C	0.1	Daily/Monthly	
TMPMEAN	Temp. daily mean	Temperature, daily mean	Degrees C	0.1		
PRECP	Prcep. daily	Precipitation, daily total	Millimeters	0.1	Monthly/Daily	
PRM05	PRCP: max 5 min	Prcep. greatest amount in 5 minutes	Millimeters	0.1		
PRM15	PRCP: max 15 min	Prcep. greatest amount in 15 minutes	Millimeters	0.1		
PRM30	PRCP: max 30 min	Prcep. greatest amount in 30 minutes	Millimeters	0.1		
PRM60	PRCP: max 60 min	Prcep. greatest amount in 60 minutes	Millimeters	0.1		
PRM2H	PRCP: max 2 hour	Prcep. greatest amount in 2 hours	Millimeters	0.1		
DPTMAX	Temp. dew pt max	Temperature, dew point, daily maximum	Degrees C	0.1		
DPTMIN	Temp. dew pt min	Temperature, dew point, daily minimum	Degrees C	0.1		
DPTMEAN	Temp. dew pt mean	Temperature, dew point, daily mean	Degrees C	0.1		
RHMAX	RH: daily max	Relative humidity, daily maximum	Percent	1.0	Daily	

CSIS - Climate Monitoring – drought and rainfall, temperature

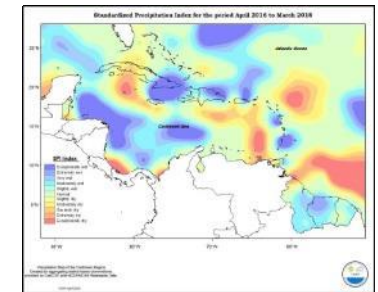
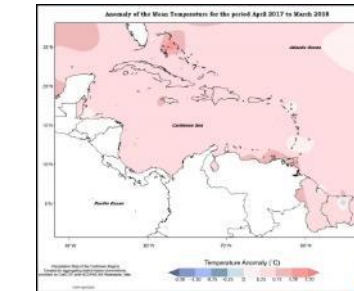
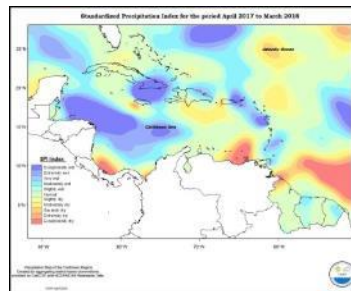
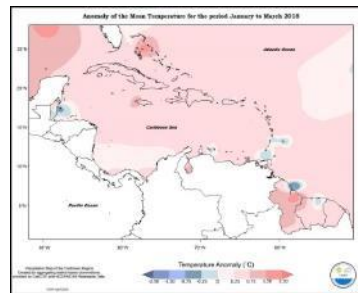
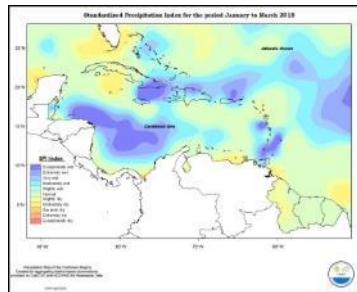
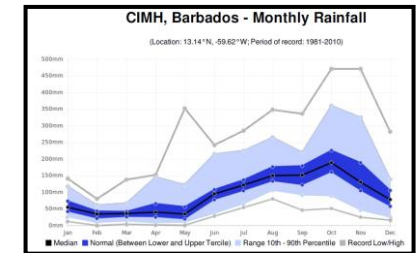
Supports our regional Climate Watch



Hewanorra, St-Lucia - Accum. Rainfall Calendar Year
(Location: 13.737°N, 60.952°W)



Piarco, Trinidad - Max. Temperature
(Location: 10.597°N, 61.34°W)

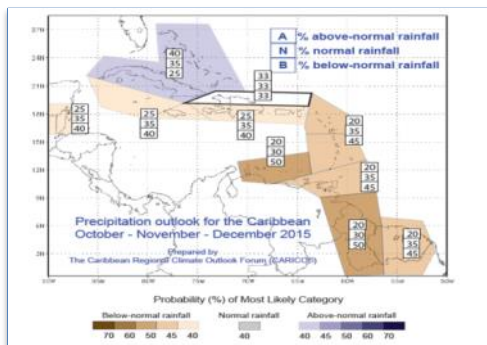


Produced through two in-house-built tools

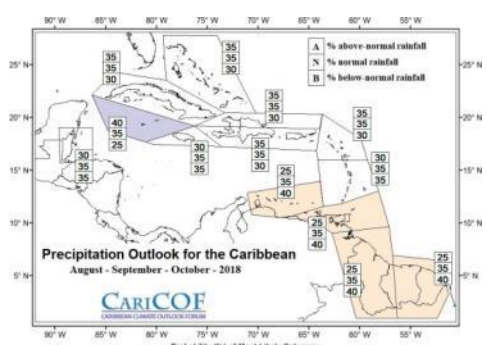
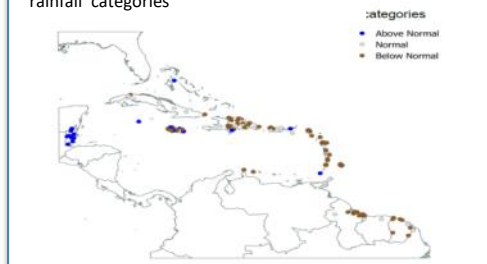
Reference Climatologies

<https://rcc.cimh.edu.bb/caribbean-climatology/1981-2010/>

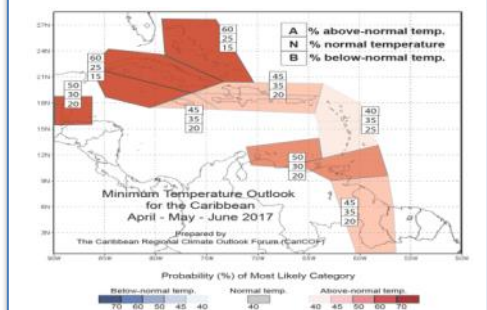
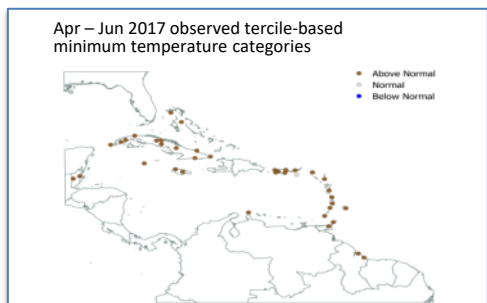
CSIS - Long-Range Forecasts – Consensus-based



Oct - Dec 2015 observed tercile-based rainfall categories



0-3-ml Tercile-based precip. and temp. outlooks + verification



Climate Products Partnering with the NMHSs

Seasonal forecasts up to 3-6 month ahead

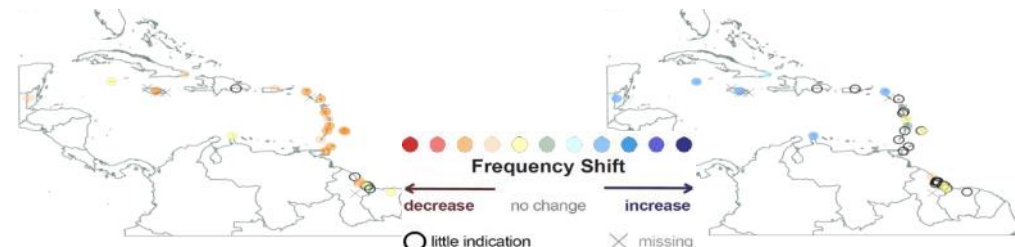
Rainfall totals
Mean, maximum and minimum temperatures

More meaningful Drought – alerting system

Wet days
(Extreme) wet spells
Coral bleaching

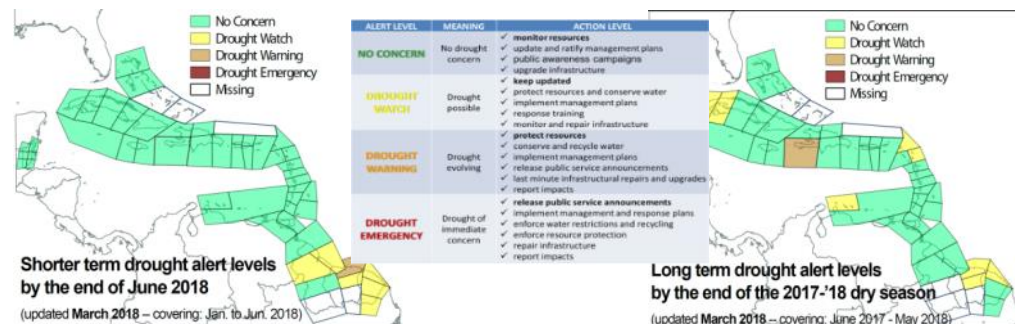
Forecast verifications
Routine analysis of GPC products

MJJ 2018 Frequency of wet days

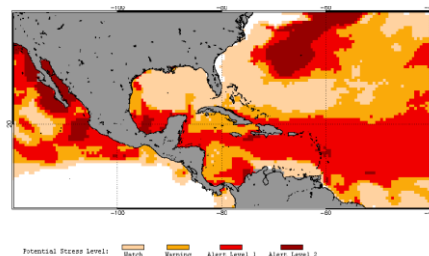


MJJ 2018 frequency of extreme 3-day wet spells

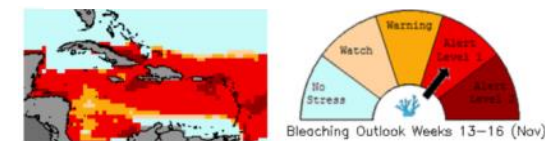
Thematic / hazard-specific outlooks



Coral bleaching thermal stress for Aug. to Nov. 2017



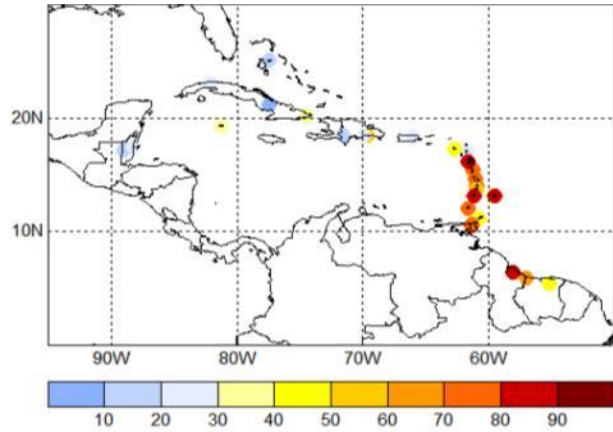
Coral bleaching alert levels (0-4--ml)



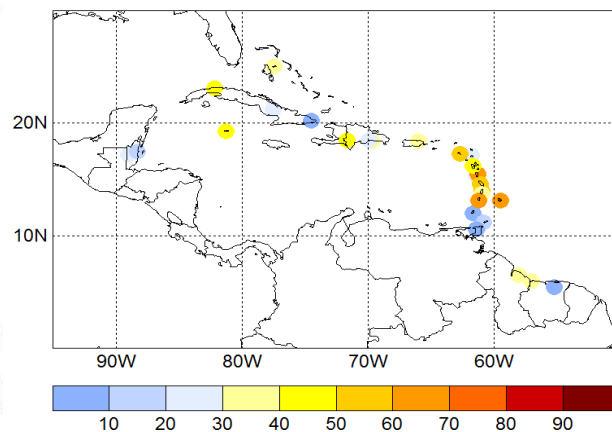
CSIS - Experimental products

Seasonal heatwave frequency outlooks (up to 6 months)

Probability of at least 14 heatwave days between Jun. & Sep.

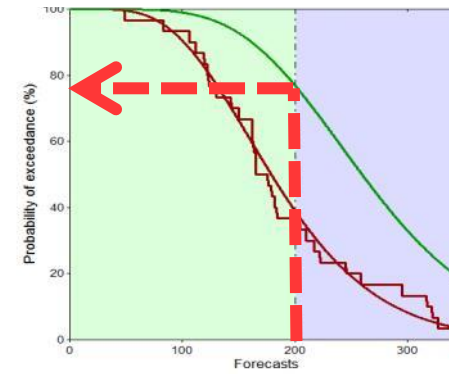


Probability of at least 60 heatwave days between Jun. & Nov.

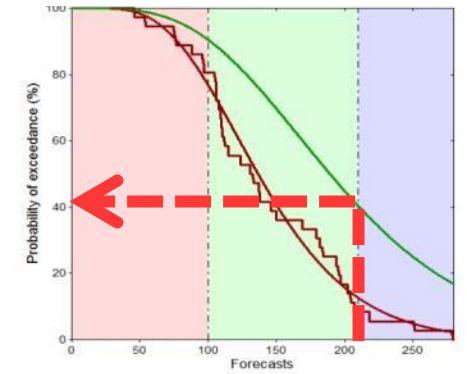


Seasonal rainfall exceedance outlooks for crop water demand (3 months)

Probability of meeting water demand for sweet potato

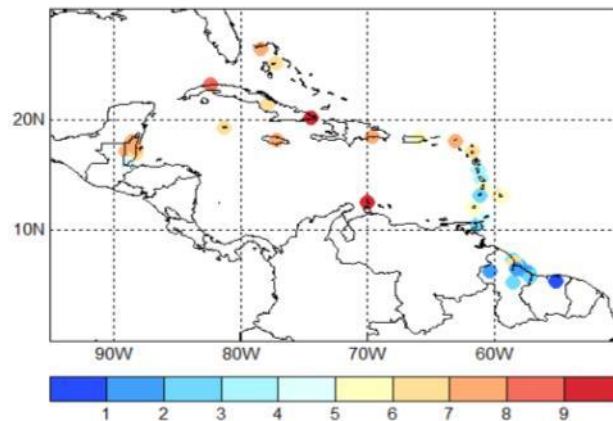


Probability of meeting water demand for sugar cane

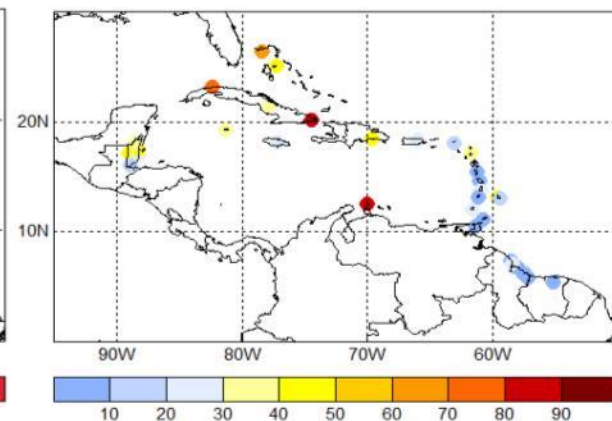


Seasonal dry spells frequency outlooks (3 months)

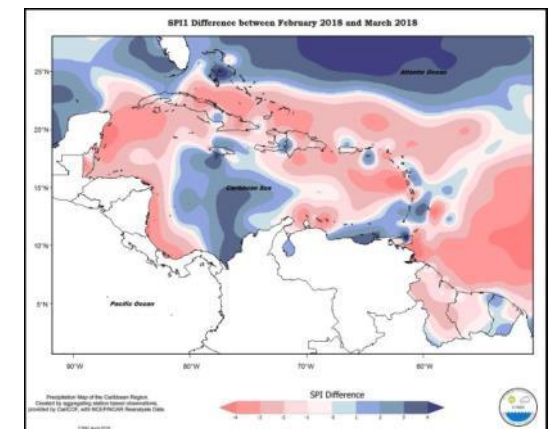
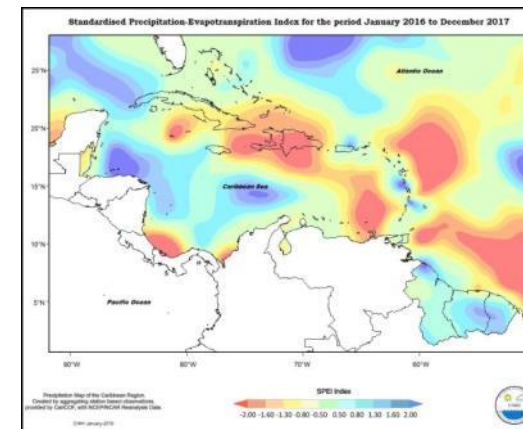
MAX. number of 7-day dry spells between May & Jul.



Probability of at least ONE 15-day dry spell between May & Jul.



Drought monitoring products (SPEI, SPI change)

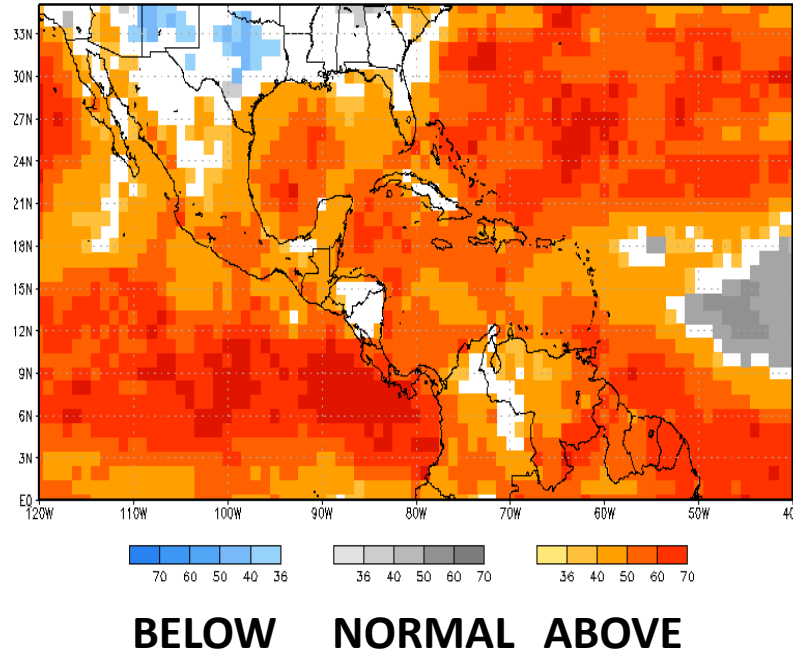
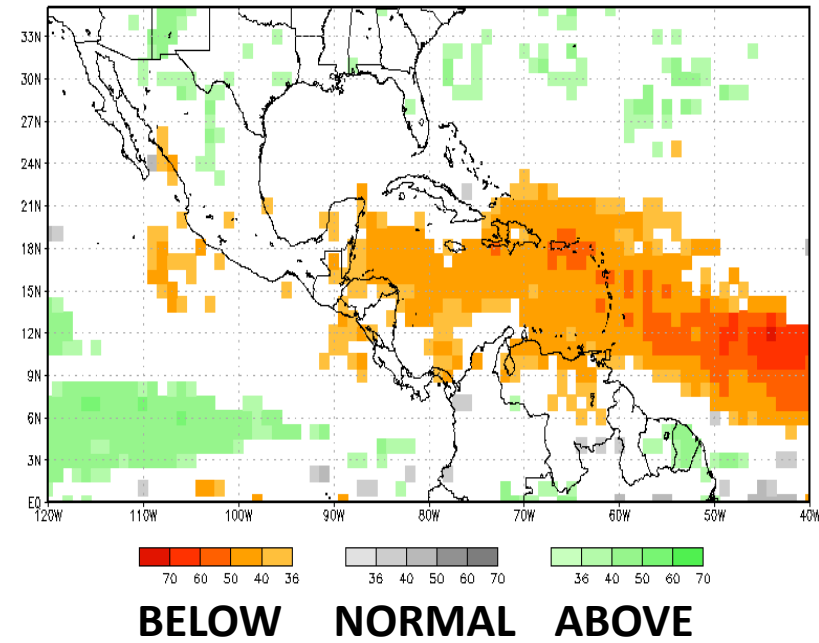


AUGMENTING SEASONAL FORECASTS – PARTNERING WITH RCC-WASHINGTON

Monthly forecasts of rainfall, temperature and heatwave frequency

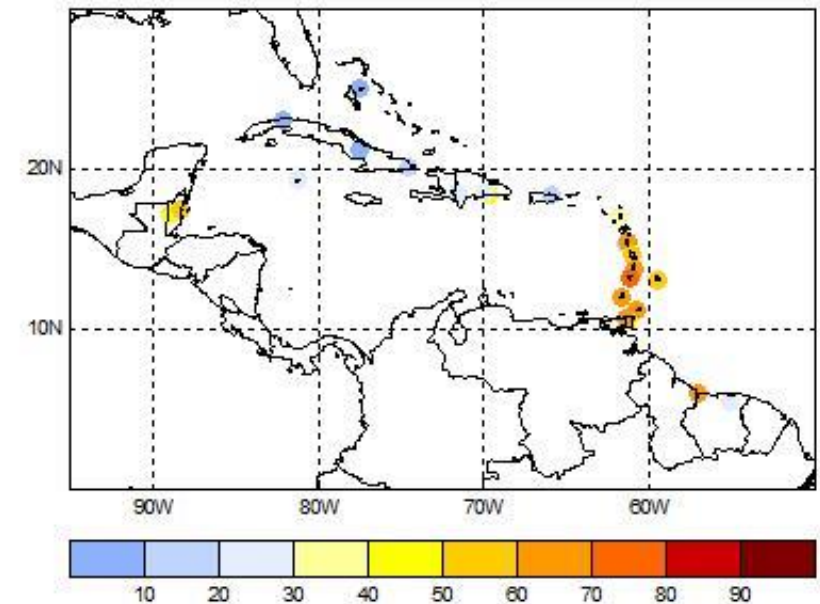
Monthly rainfall and temperature forecasts

June 2019



Forecast probability of at least 14 heatwave days September 2019

Prob. at least 14 heatwave days in September 2019



AUGMENTING SEASONAL FORECASTS – PARTNERING WITH RCC-WASHINGTON

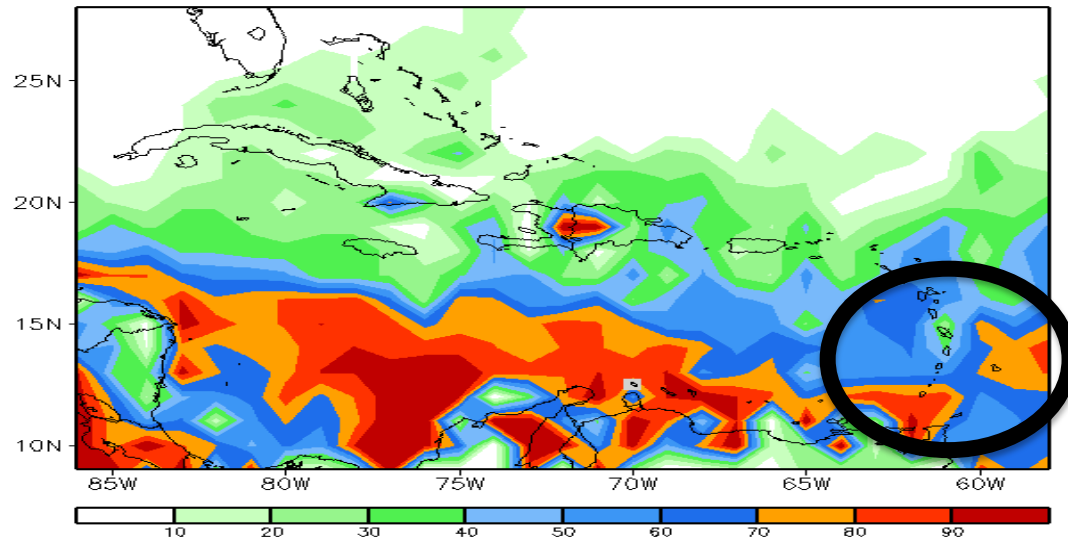
Mid- and short-range forecasts of extreme rainfall – early warning for flash flood potential

Tropical Storm Kirk (27-28 Sept. 2018) led to near-record rainfall in Barbados, triggering widespread flash flooding.



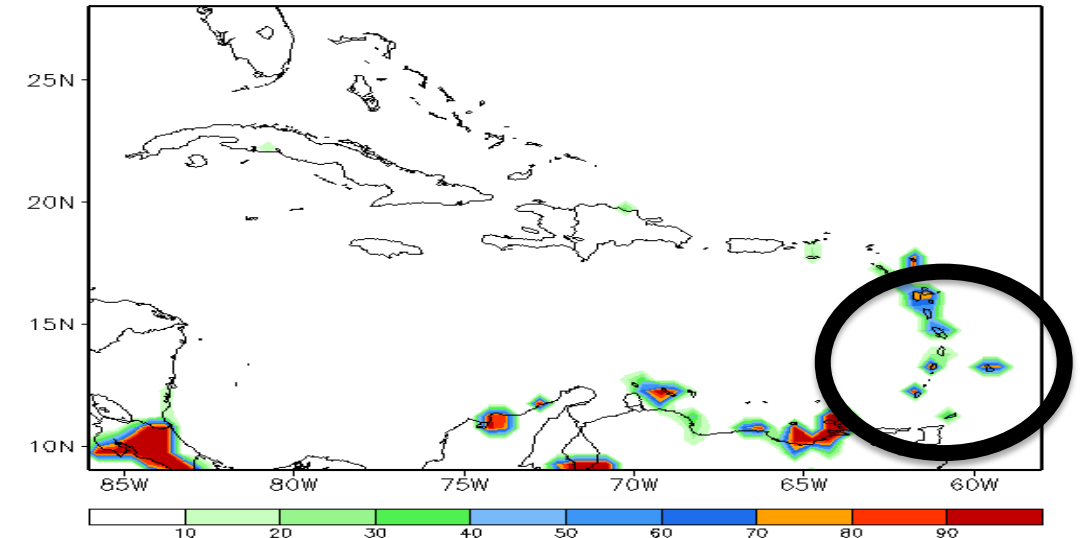
Image credit: NOAA

**MID-RANGE (1 week lead time)
forecast for 24 – 30 Sep. 2018**



Increased chance for extreme rainfall over Barbados in the following week.

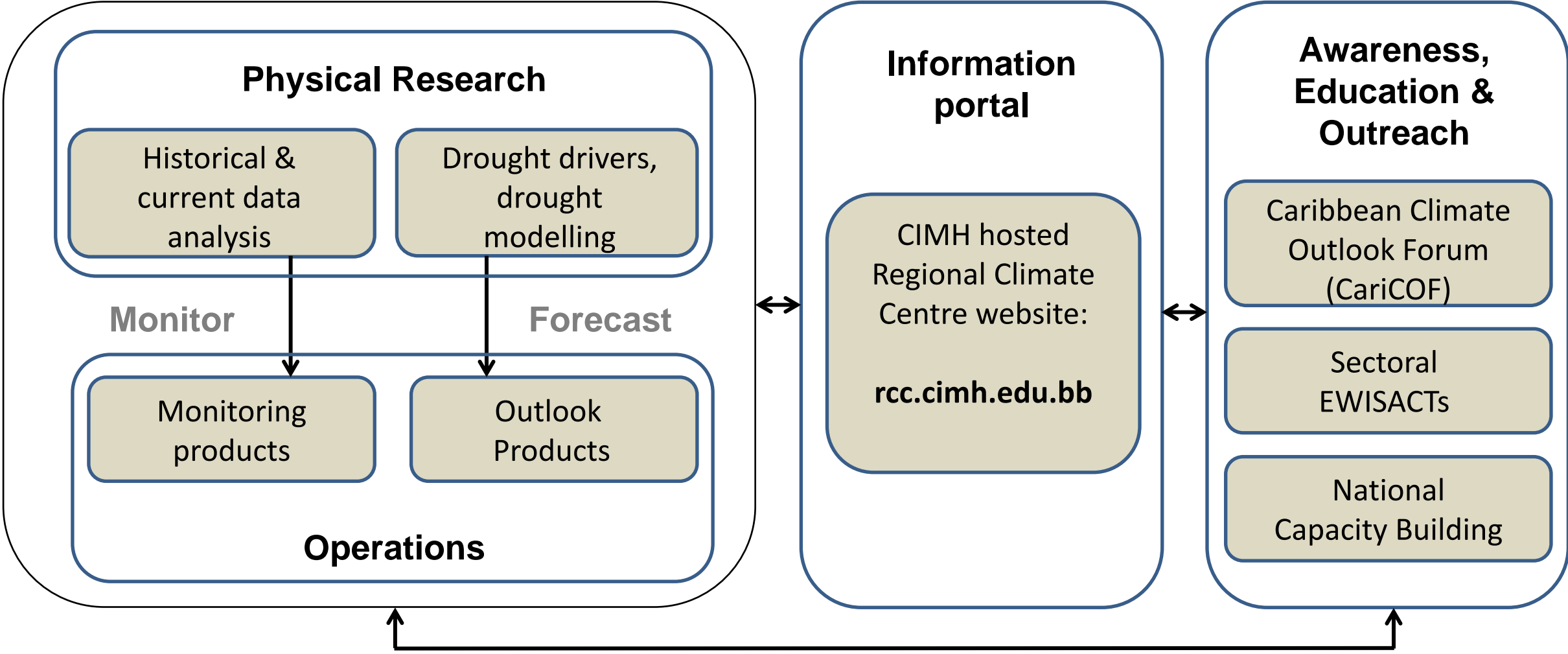
**SHORT-RANGE (1 day lead time)
Forecast for 26 – 28 Sep. 2018**



>70% chance for an extreme wet spell in Barbados over the next 3 days.

DROUGHT EARLY WARNING

CIMH coordinated regional Drought Early Warning Information System



CSIS – Dissemination Newsletters/Bulletins

CARI COF
Caribbean Climate Outlook Newsletter - October to December 2019
 For climate information specific to your country, please consult with your national meteorological service.
 CariCOF outlooks speak to recent and expected climate trends across the Caribbean in general.

BRIEF SUMMARY: June to December 2019
 June to August 2019: Shorter term drought and long term drought have developed in many areas in the Caribbean. Seasonal temperatures were mostly above average, with all-time records broken in June in Cuba and Jamaica, and a build-up of excessive heat, especially during heat waves.
 October to December 2019: The October to December period typically marks the transition between wet and dry seasons, during which many very wet spells occur, as well as, up to 1 or 2 extremely wet spells. Those spells are expected to raise the concern for long-term flooding and flash floods, respectively. In the coastal Guianas specifically, those concerns will arise when their dry season ends in mid- to late-November. Uncomfortable heat is still expected at times during October, the last month of the Caribbean Heat Season, especially during heat waves which still occur in the Guianas and Windwards.

LOOKING BACK:
June - July - August 2019 (JJA)
 Observations
 Exceptionally wet
 Wet
 Normal
 Dry
 Exceptionally dry
 JJA 2019 Rainfall Monitor
 JJA 2019 Temperature Monitor

WHAT NEXT?
Rainfall patterns October-November-December (OND)
 Belize: Oct to Dec - wet season. Frequent heavy showers.
 Caribbean Islands north of 16°N: Oct - wet season. Frequent heavy showers. Nov to Dec - transition to dry season. Decreasing shower frequency & intensity.
 Caribbean Islands south of 16°N (except ABC Islands): Oct to Nov - wet season. Frequent heavy showers. Dec - transition to dry season. Decreasing shower frequency & intensity.
 Guianas: Oct - Dry season with heavy showers at times. Nov to Dec - transition to wet season. Increase in showers.
 ABC Islands: frequent showers, occasionally heavy.

OND 2019 Rainfall Outlook
 Drought continues at severe levels in Antigua. April-June is now the fourth driest period on record and also the driest since 2001. It continues to be the worst drought since 2002/2003. (Antigua Climate)
 The Dominica Meteorological Service has issued an advisory, asking the public and relevant sectors to practice conservation measures and to develop Drought Plans for the island. (Carri FM)
 St. Lucia implements additional water restrictions as drought worsens. The water restrictions imposed, prohibit the use of potable water for non-potable uses and also a strict schedule of water rationing. (Jamaica Observer)

Notable Climate Records:
 WET: JJA: 1 location in Guyana recorded its highest rainfall totals for this period (165% of average).
 DRY: JJA: 1 location in Domin. Republ. recorded its lowest rainfall totals for this period (50% of avg.).
 HOT: JJA: 2 locations in Guyana, 1 in Dominica, 1 in Puerto Rico recorded their highest mean temp., while 1 location in Guyana and 1 in Saint Lucia their highest min. temp.

September 2019
 Find out more by using the clickable images and headings or visit caricof.cimh.edu.bb
 e-mail: caricof@cimh.edu.bb
 Page 1 of 2

CARIBBEAN DROUGHT BULLETIN
 July 2015 | Volume II | ISSUE 2

Announcement
 Below normal rainfall conditions continued in June over most of the eastern Caribbean and across to Jamaica, extending the drought conditions and impacts, particularly over the northern Windward and Leeward Islands. Though rainfall quantities will increase, below normal rainfall will most likely continue during the wet season, causing much concern for water availability later in the year and into the early months of 2016. This situation should be closely monitored.

Month at a Glance
 Apart from Trinidad that was moderate to very wet, the islands of the eastern Caribbean were normal to below normal (and particularly below normal). Tobago, Grenada and Anguilla were slightly dry; Barbados, St. Vincent, St. Lucia, Antigua, St. Maarten and St. Croix were moderately dry. Read more...

Headline Impacts
 Government imposed water restrictions take effect in Jamaica at low levels at water catchments as reported in St. Thomas. (Jamaica Observer)
 Drought continues at severe levels in Antigua. April-June is now the fourth driest period on record and also the driest since 2001. It continues to be the worst drought since 2002/2003. (Antigua Climate)
 The Dominica Meteorological Service has issued an advisory, asking the public and relevant sectors to practice conservation measures and to develop Drought Plans for the island. (Carri FM)
 St. Lucia implements additional water restrictions as drought worsens. The water restrictions imposed, prohibit the use of potable water for non-potable uses and also a strict schedule of water rationing. (Jamaica Observer)

April-May-June Rainfall Summary
 For the three month period, normal to below normal (and particularly below normal) conditions were experienced in the eastern Caribbean islands. Trinidad was normal; Tobago, St. Kitts and Anguilla moderately dry; Grenada, St. Vincent and St. Lucia slightly dry; Barbados severely dry; Dominica extremely dry; and Antigua, St. Maarten and St. Croix extremely dry. Conditions in Guyana ranged from exceptionally wet in the west to moderately wet in the east. Aruba was severely dry and Puerto Rico moderate to severely dry. As one moves outward from the normal east central areas of the Dominican Republic, conditions became relatively drier to become exceptionally dry in the southwest. Western and eastern portions of Jamaica were dry, up to being extremely so, but Grand Cayman was normal to slightly dry.

Alert Level Guide

Alert Level	Interpretation
No stress	No thermal stress
Watch	Low-level thermal stress
Warning	Thermal stress is accumulating
Alert level 1	Bleaching expected
Alert level 2	Widespread bleaching and some mortality expected

Announcement
 BLEACHING POTENTIAL HIGH IN THE COMING MONTHS IN THE BAHAMAS, GREATER ANTILLES AND THE LEeward ISLANDS DUE TO CONTINUED EL NIÑO
 GLOBAL CORAL BLEACHING UPDATE (CLICK HERE)
 CORAL DISEASE SUSCEPTIBILITY (CLICK HERE)
 CORAL BLEACHING RESPONSE PLANS (CLICK HERE)

CARIBBEAN CORAL REEF WATCH

Notable Observations

- El Niño moderate in strength and intensifying.
- Southwestern Caribbean region already unusually warm with early bleaching watches and warnings.
- Bleaching Warning issued for Florida.

Current Global Conditions

- Reports on extensive bleaching have come from the British Indian Ocean Territory, the Maldives, and western Indonesia in the Indian Ocean and from Kiribati in the Central Pacific.
- These observations are consistent with near-record high sea surface temperatures and with a moderate El Niño.

Alert Level Guide

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Monthly CariCOF newsletter

Partnering with NMHSS in CariCOF

Monthly Bulletin of the Caribbean Drought and Precipitation Monitoring Network

Monthly Caribbean Coral Reef Watch (May to December)

Partnering with NOAA, USA

CSIS – Co-developed Sector-specific Bulletins



A CARIBBEAN AGRO-CLIMATIC BULLETIN OF THE CARISAM MARCH 2017

CARIBBEAN AGRO-CLIMATIC BULLETIN OF THE CARISAM

MARCH 2017 • VOLUME 1 • ISSUE 1

A joint bulletin of the Caribbean Agricultural Research and Development Institute (CARDI) and the Caribbean Institute for Meteorology and Hydrology (CIMH). As of April 2017 the previous monthly CAMI bulletin transitions into the Caribbean Agro-Climatic Bulletin of the CARISAM.

KEY MESSAGES

Concerns remain for the western Caribbean for both short and long term drought and in the southern portion of the eastern Caribbean for long term drought. Some models suggest the possibility for the return of El Niño, and drier than normal conditions late in 2017, and into the 2018 dry season. This will be closely monitored.


FEBRUARY IN REVIEW

The Bermuda-Azores High Pressure System along with weak unstable conditions contributed to this month's rainfall patterns.

- Portions of Dominica and Barbados experienced slightly wet conditions, whereas the rest of the Eastern Caribbean region experienced dry to normal conditions.
- Predominantly above normal rainfall across the Guianas.
- Predominantly normal rainfall across the northern Caribbean with mixed conditions across The Bahamas and in the west in Belize.

ABOUT CARISAM

The Caribbean Society for Agricultural Meteorology (CARISAM) is an online platform that hosts forums, provides online weather and climate information for agro-meteorologists, and much more. Agricultural interests can register and access relevant information and be part of future capacity.



Caribbean Health Climatic Bulletin
Test Vol 1 | Issue 4
April 2017

This quarterly bulletin is intended to provide climate information pertinent to Caribbean health professionals.

What are the Key Climate Messages for April to June?

Heat stress will start appearing as of May when the hot part of the year starts. In addition, there is the possibility of heat waves in Belize and Trinidad. Along with the heat, we expect the wet season to start in May or June. There will likely be increased rainfall, resulting in decreased surface dryness and increased water availability and some concern of flash flooding appears after April. Finally, at this time of the year, UV radiation will be very intense on sunny days.

What are the Health Implications?

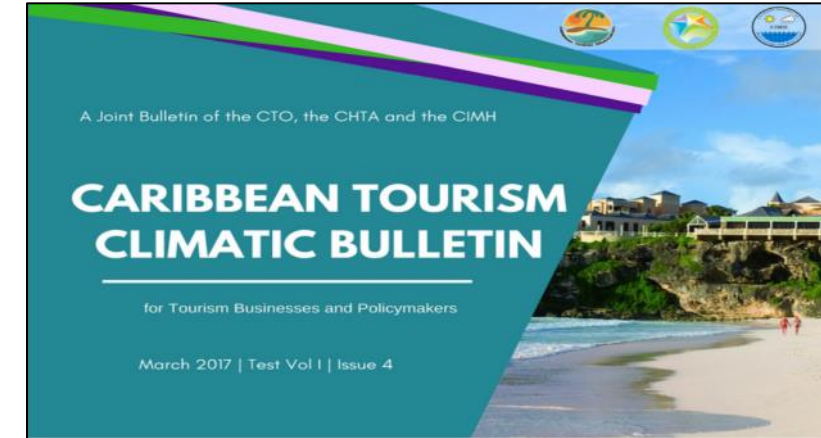
Respiratory Illness
There may be an increase in symptoms in persons with asthma, as well as persons with allergies to dust as episodes of Saharan dust incursions into the Caribbean tend to annually peak between May and July. The surface dryness before the wet season may lead to greater levels of dust in the atmosphere.
There may be an increase in symptoms for persons with allergies to pollen until the dry season comes to an end.
There may be increased risk of Legionella growth in water systems due to warmer temperatures. There may be increased risk of ENT (ear, nose and throat) infections due to contact with flood waters contaminated with faeces.

Gastrointestinal Illness
Beyond April, cases of gastroenteritis may increase in frequency. Increased temperatures may accelerate proliferation of pathogens. In the event of flash floods, contamination of food and water supplies might occur.

Non-communicable Diseases
Morbidity from heat stress is likely to increase beyond April, especially in persons with pre-existing chronic non-communicable disease. There is an increasing risk of dehydration, possibly leading to apathy, general weakness, dizziness, fainting, and kidney failure.
There is an increased risk of skin damage, due to the very intense UV radiation at this time of year on sunny days.

Vector-Borne Illness
With the increasing heat and return of the wet season, there may be an increase in cases of vector borne diseases such as Dengue, Chikungunya, Zika and Yellow Fever. The increased temperatures may shorten the generation time for mosquitoes and the maturation time for pathogens to mature inside the mosquito. In addition, increased rainfall may create more breeding places for mosquitoes. Some mosquito eggs laid last year may still be present in breeding areas and may become activated by settling rain water, thus later contributing to mosquito populations. However, note that in case of flash floods, flood waters may sweep away mosquito eggs, larvae and pupae, potentially reducing the number of cases.
Until the end of the dry season, there will be very limited risk of Leptospirosis due to human contact with flood waters contaminated with the urine of infected animals, as well as food or soil exposed to these contaminated flood waters.

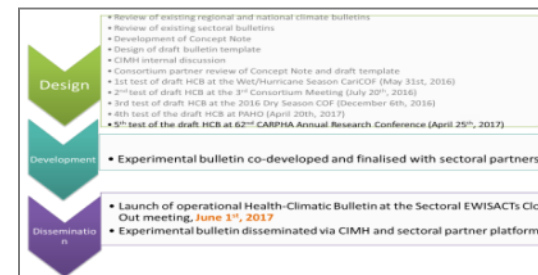
Physical Injury or Death
There is the possibility of persons suffering injury or death. Flash flooding may lead to cases of drowning, persons being swept away by flood waters, physical trauma by debris in the flood water, possible landslides, and electrocution.
There may be increased mental stress, and resulting violence, due to high temperatures.



New Tourism-Climatic Bulletin (since May 2017)

Typical Bulletin development process

New Health-Climatic Bulletin (since May 2017)



Health focus group (2016 Dry Season COF. Photo credit: IRI)

Testing exercises across the 3 bulletins

Regional CAMI Bulletin (since 2011), now the Caribbean Agro-Climatic Bulletin of the CariSAM

USER Interface Mechanisms

Forums with the farming community and agricultural extension agencies to promote a better understanding of the applications of weather and climate information.

Now PICSA.



Webinars and forums also with the health and tourism sectors

On-Line e.g. Portal of the Caribbean Society for Agro-Meteorology (CariSAM)

Also webinars for the health and tourism sectors

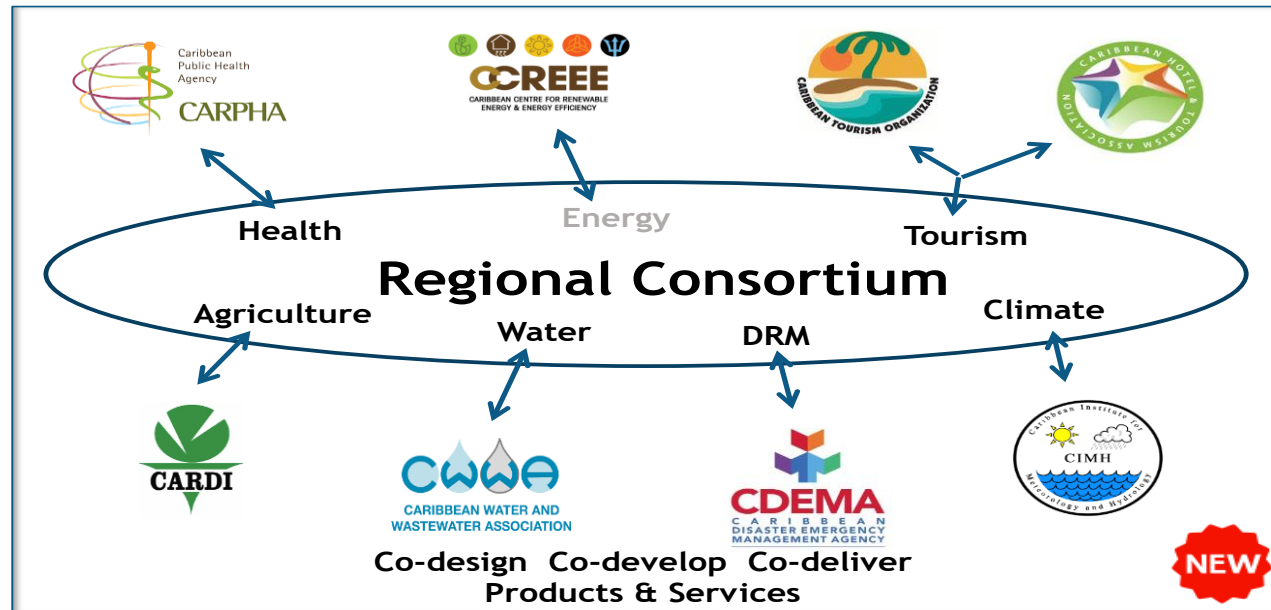
CariCOF – Wet/Hurricane (DRR) and Dry Season (agriculture, water), but participation from all sectors NCOFS in Guyana, Trinidad and Tobago, Belize, Suriname



Stakeholder meetings bring meteorologists and climatologists and the user-community together to discuss climate forecasts and other information; and provide feedback. Builds trust and understanding

Consortium of Sectoral EWISACTs Partners

The Consortium is a key regional mechanism to champion the design, development and delivery of tailored climate products and services in the agriculture and food security, disaster risk management, energy, health, tourism and water sectors.



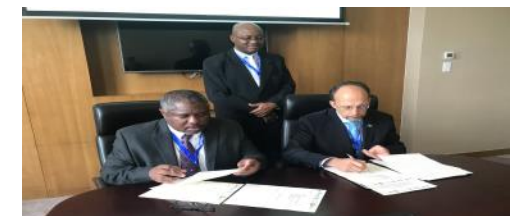
CTO and CHTA sign the LoA, September 16th, 2016



CWWA signs the LoA, October 26th, 2016



CARDI and CDEMA sign the LoA, December 6th, 2016



CARPHA and CIMH sign the LoA, April 26th, 2017

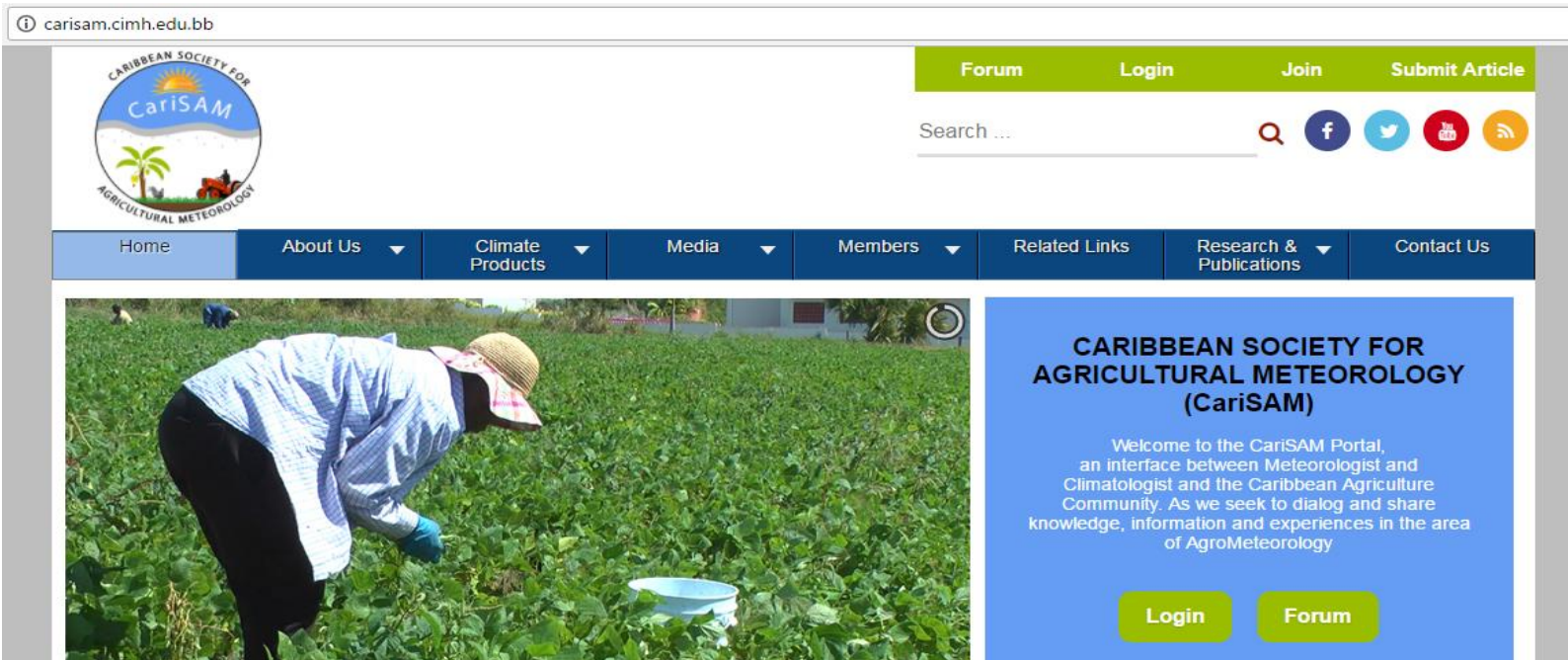
6 Consortium Meetings hosted by CIMH:

May 2015, October 2015, July 2016, May 2018, Nov 2018, May 2019, 7th Consortium Meeting (Nov 2019)

Recognised Observers – 5Cs, UWI CSGM, CCCCC, OECS

New partnerships being brokered – CCREEE

CariSAM Portal



- weather and climate data resource
- tailored climate information products
- publication hub
- discussion forum
- online training

www.carisam.cimh.edu.bb

A professional community supported by an *interactive online portal* which is designed to enhance collaboration and dialogue between the Caribbean agricultural and food security community (including forestry), and meteorologists and climatologists.

Builds the capacity of agricultural practitioners to use climate information and links them to key agencies and specialists at national, regional and international levels

CAPACITY BUILDING FOCUS

Training programme enhanced with upgraded classrooms and video conferencing facility

For Climate Services Provider

- **Pre-CariCOF training**- Since 2012
- Seasonal forecasts, verification, tools, Caribbean climate
- Drought and rainfall monitoring, Caribbean rainfall climate, instruments, remote sensing, statistical methods.
- **National** – Seasonal Forecast training for Guyana (supported by Government of Guyana), Belize
- **Internship programme** for undergraduate and graduates
- **Communications training**

For User Community

- **CariCOF Stakeholder Forum** - Dry Season (agriculture and water); Wet Hurricane Season (DRM); 2016 strong health focus, 2017 Heat products
- **Drought monitoring, management and planning**
- **Agriculture Extension Officers training**, including through the PICSA approach
- Webinars for **health and tourism** sectors
- **Media** – Dry Season CariCOF 2015; Special media event February 2016; Wet Season CariCOF 2017.

Cooperation with South Pacific on RCOFs and other training workshops

RESEARCH, MODELLING AND PREDICTION

- **Climate** extremes, indices, forecasting and early warning (e.g. drought, heat waves, flash floods), forecast verification,
- **Statistical modelling** of climate and associated hazards
- **Heat and human health**; other applications in livestock and poultry health
- **Social Sciences research** to enhance climate services... In progress, research on capacities of NMHS and User Needs Assessments
- Climate and **vector borne diseases**; *Aedes aegypti* proliferation

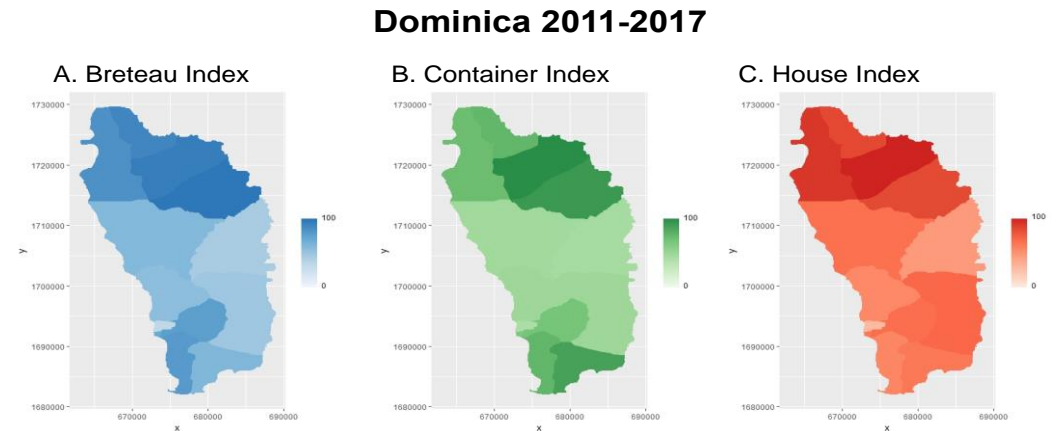
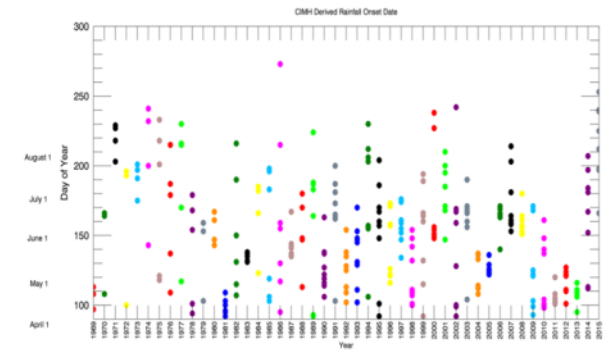


Figure 16. Average *Aedes aegypti* larval indices for Dominica over the study period (2011-2017) per environmental health district.

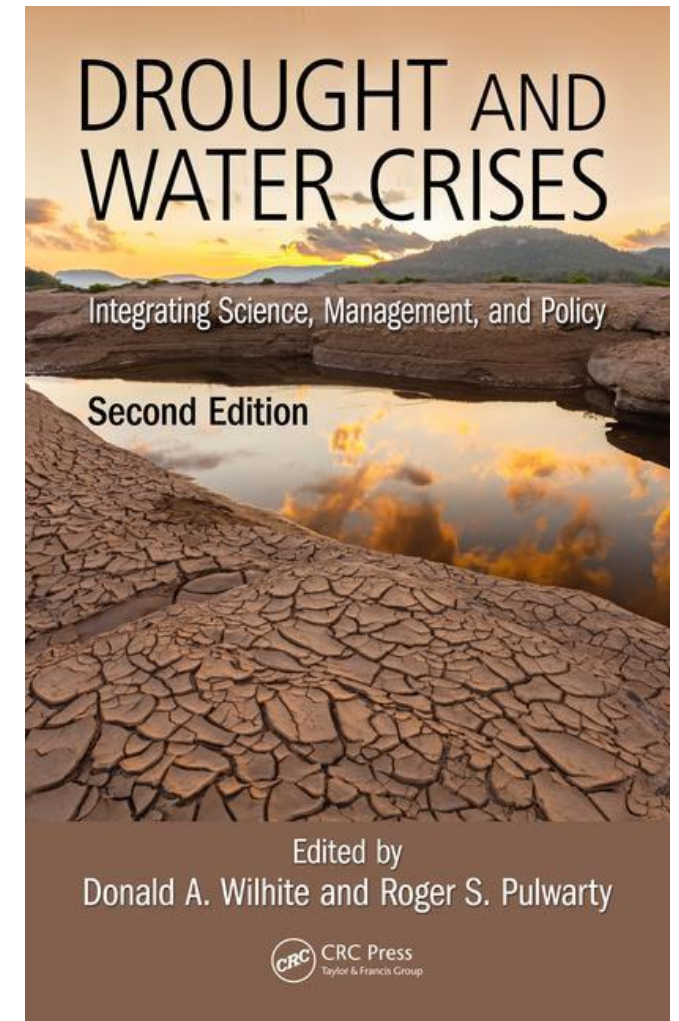
Publishing in 2016-2019

Published:

- Trotman A, Mahon R, Shumake-Guillemot J, Lowe R, Stewart-Ibarra AM. 2018. Strengthening climate services for the health sector in the Caribbean. WMO Bulletin 67 (2)
- Stewart-Ibarra AM, Romero M, Hinds AQJ, Lowe R, Mahon R, Rollock L, St. Ville S, Ryan SJ, Trotman A, Borbor-Cordova MJ. (2019). Co-developing climate services for public health: stakeholder needs and perceptions for the prevention and control of Aedes-transmitted diseases in the Caribbean. Available on: <https://www.biorxiv.org/content/10.1101/587188v1>. Accepted in PLoS NTDs, September 2019.
- T. S. Stephenson, M. A. Taylor, A. R. Trotman, C. J. Van Meerbeeck, J. D. Campbell, A. Brown and J. Spence (2018). Caribbean In: **State of the Climate in 2017**. Bull. Amer. Meteor. Soc., 100(9), (*in press*)
- Lowe R, Gasparrini A, Van Meerbeeck CJ, Lippi CA, Mahon R, Trotman AR, Rollock L, Hinds AQJ, Ryan SJ, Stewart-Ibarra AM. 2018. Nonlinear and delayed impacts of climate on dengue risk in Barbados: A modelling study. PLoS Med 15(7):e1002613. <https://doi.org/10.1371/journal.pmed.1002613>
- T. S. Stephenson, M. A. Taylor, A. R. Trotman, C. J. Van Meerbeeck, V. Marcellin, K. Kerr, J. D. Campbell, J. M. Spence, G. Tamar, M. Hernández Sosa, and K. Stephenson (2018). Caribbean In: **State of the Climate in 2017**. Bull. Amer. Meteor. Soc., 99 (8), S200-203.
- Ryan SJ, Carlson CJ, Stewart-Ibarra AM, Borbor-Cordova MJ, Romero MM, Cox S, Mahon R, Trotman A, St. Ville S, Ahmed S. 2017. Zika Virus Outbreak, Dominica, 2016. Emerging Infectious Diseases. 23(11).
- Ryan SJ, Lippi CA, Carlson CJ, Stewart-Ibarra AM, Borbor-Cordova MJ, Romero MM, Cox S, Mahon R, Trotman A, Rollock L, Gittens-St. Hilaire M, King D, Daniel S. 2018. Zika Virus Outbreak, Barbados, 2015 – 2016. The American Journal of Tropical Medicine and Hygiene 98(6):1857-1859.
- A. Trotman, A. Joyette, C. Van Meerbeeck, R. Mahon, S.-A. Cox, N. Cave and D. Farrell (2017). **Drought Risk Management in the Caribbean Community – Early Warning Information and other Risk Reduction Considerations**. In: Wilhite and Pulwarty (Eds.) Drought and Water Crises - Integrating Science, Management, and Policy. Second Edition. CRC Press. 592 pp. ISBN: 978-1-1380-3564-5.
- T. S. Stephenson, M. A. Taylor, A. R. Trotman, C. J. Van Meerbeeck, A. O. Porter, S. Etienne-LeBlanc, M. Hernández, I. T. Gonzalez, V. Cutié, D. Boudet, C. Fonseca, S. Willie, J. M. Spence, K. Kerr, A. P. Aaron-Morrison, G. Tamar, R. Stennett-Brown, and J. D. Campbell (2017). In: **State of the Climate in 2016**. Bull. Amer. Meteor. Soc., 98 (8), S182–S185.
- Ryan SJ, Carlson CJ, Stewart-Ibarra AM, Borbor-Cordova MJ, Romero MM, Cox SA, Mahon R, Trotman A, St. Ville S, Ahmed S. **Outbreak of Zika virus infections, Dominica, 2016**. Emerg Infect Dis. 2017 Nov [date cited]. <https://doi.org/10.3201/eid2311.171140>
- Gerlak, A.K., Guido, Z., Vaughan, C., Rountree, V., Greene, C., Liverman, D., Trotman, A.R., Mahon, R., Cox, S., Mason, S.J., Jacobs, K.L., James L. Buizer, C.J. Van Meerbeeck (2017). **Building a framework for process-oriented evaluation of Regional Climate Outlook Forums**. Weather, Climate and Society, 9. <https://doi.org/10.1175/WCAS-D-17-0029.1>
- R. Mahon, D. Farrell, S.-A. Cox, A. Trotman, C. Van Meerbeeck and G. Barnwell (2017) **The Growing Importance of Climate Services to the Building of a Climate Resilient Caribbean**. *Social and Economic Studies* 67: 2 & 3: 239–260. ISSN: 0037-7651

Submitted:

- CSGM and CIMH (*final draft*) The State of Caribbean Climate in 2017 – Chapters 6 (Climate Extremes and Early Warning) and 8 (Adding Value to Climate Information through Services).



Thank you!

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