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# An Operational Drought Monitoring System for the Caribbean and Central America

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## 1. Introduction

The recent 2015 El Nino drought devastated the economy of many Small Island Developing States of the Caribbean and Central America. Reports indicated several nations suffered a production loss of up to 50 percent. The Caribbean was impacted by a comparable drought in 2009-2010, which prompted regional meteorological organizations and institutions to establish a drought and precipitation monitoring network. However, effective monitoring and early warning information systems still remain a challenge due to the smallness of the scale of the Caribbean land relative to surrounding waters and ensuing limited availability of useful data.

To enhance capabilities of regional meteorological and hydrological services in drought monitoring and provide decision support tools to policymakers in the region, the Climate Prediction Center's International Desk has expanded its monitoring areas to the Caribbean and is developing tools to help detect and classify drought and track near real-time rainfall season characteristics, a critical determinant of drought development.

## 2. Tools

Using a consolidation of evidence-approach, similar to that used in the United States Drought Monitor, Standardized Precipitation Index (SPI) and soil moisture percentile rankings at multiple time scales are used. Additionally, rainfall season characteristics, including onset, evolution, and demise of the season are also tracked to provide an assessment of near real-time seasonal performance.

### 2.1 Rainfall season characteristics

Information on rainfall season characteristics is highly important for monitoring applications. The onset, mid-season dry spells, and early cessation of the season are all determinants of drought development. Figure 1a exhibits a bimodal distribution of rainfall, with the first rainfall season from May-August and second rainfall season from August-November over the "Dry Corridor" of Central America, delimited by 92°W-83°W, 10°N-16°N. The two seasons are divided by a period of reduced rainfall, also referred to as "Mid-Summer Drought". The onset and demise of the first and second rainfall seasons are determined using anomalous rainfall accumulation as in Coelho *et al.* (2015). First, daily rainfall anomaly is computed. Cumulative rainfall anomaly is then calculated from a few months earlier than the typical start of the rainfall season. The onset is defined as the relative minimum of the smoothed, 21-day centered moving averaged accumulated rainfall anomaly. Conversely, the demise is defined as the relative maximum of the smoothed curve.

The 2015 first rainfall season began in early June and the season was very short, while the second season started in early October and was relatively long (Fig. 1b). The onset of the 2015 first rainfall season occurred in early June and was late by two weeks relative to the climatological onset in early to mid-May (Fig. 1c). The 2015 second rainfall season started in early to mid- October and was delayed by six weeks relative to the climatological onset in early September (Fig. 1d). The demise of the 2015 first rainfall season occurred in late June and was ahead of the climatology, which is in mid to late August, by nine weeks (Fig. 1e). The demise of the 2015 second rainfall season took place in early December and was prolonged by two weeks compared to the climatology in mid to late November (Fig. 1f).

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## 2.2 Drought monitor

Drought monitoring, specifically tailored for the Caribbean requires high to medium-resolution data. SPI at 1, 3, 6, and 12 month time scales is computed using the $0.25^0$ x $0.25^0$ near real-time Tropical Measuring Mission Multi-Satellite Precipitation Analysis (Huffman *et al.* 2007). Soil moisture percentile rankings are calculated from the $0.5^0$x $0.5^0$ soil moisture output of the Climate Prediction Center's Leaky Bucket Model (Fan and van den Dool 2004).

Figure 2a shows SPI over portions of northeastern Tropical Pacific, Caribbean Sea, to western Atlantic during March-May 2015. Drought conditions were detected in May 2015 as indicated by large negative values of SPI along the Gulf of Fonseca of Central America, Hispaniola, Puerto Rico, and the northern portions of the Lesser Antilles. Abnormal dryness is observed across the southern parts of the Lesser Antilles. While wet soil is observed over Central America, neutral to dry soil is depicted over the Caribbean (Fig. 2b). Time series of SPI shows long-term drought developed over Roseau, Dominica as early as early spring 2015 (Fig. 2c). However, soil moisture did not dry out until late spring to early summer 2015 (Fig. 2d).

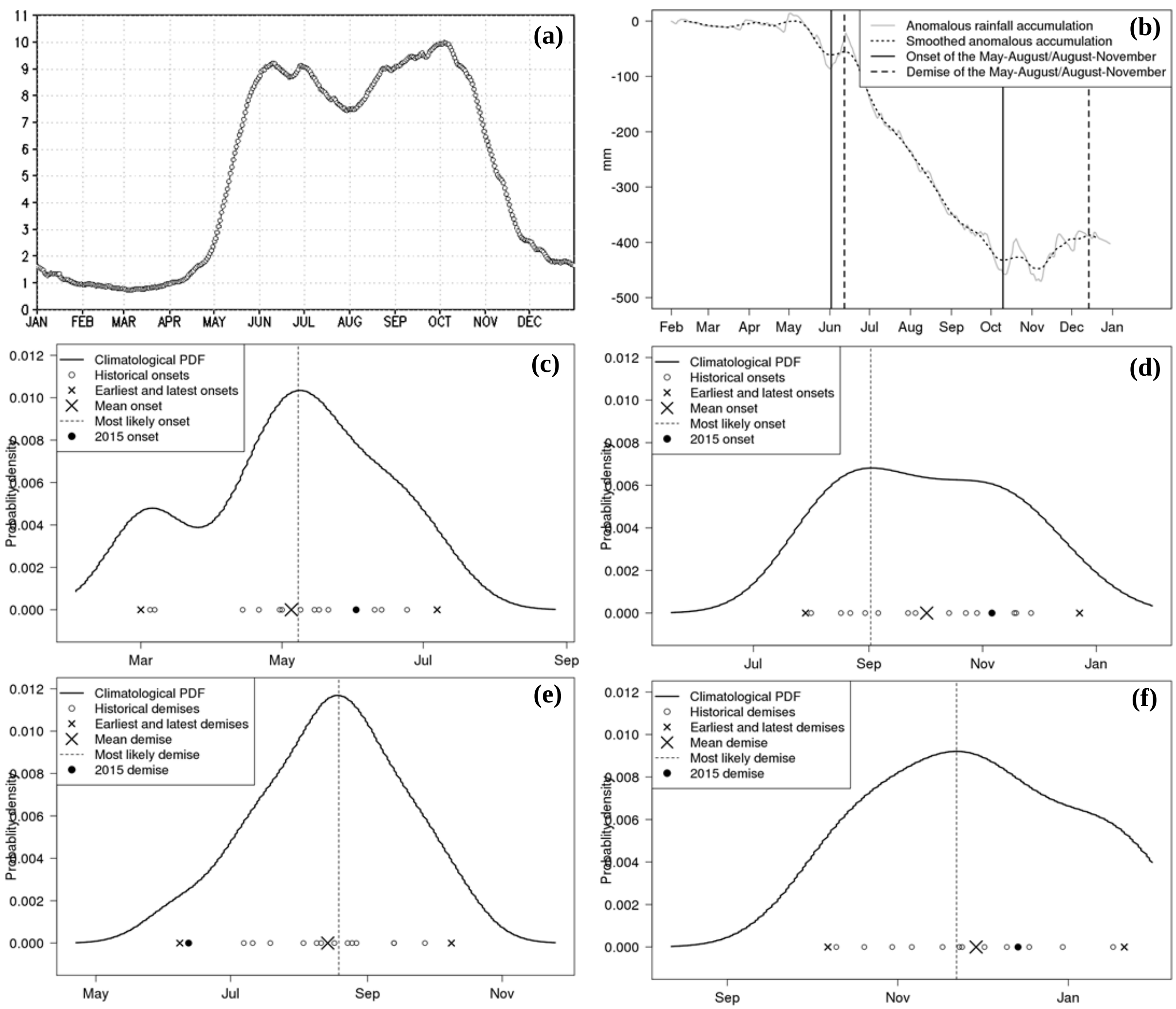


**Fig. 1** Daily rainfall climatology over the "Dry Corridor" of Central America, delimited by 92°-83°W; 10°-16°N (a); anomalous rainfall accumulation and onset and demise of the 2015 first and second rainfall seasons (b); probability distribution function for the onset of the first (c) and second (d) rainfall season; probability distribution function for the demise of the first (e) and second (f) rainfall season.

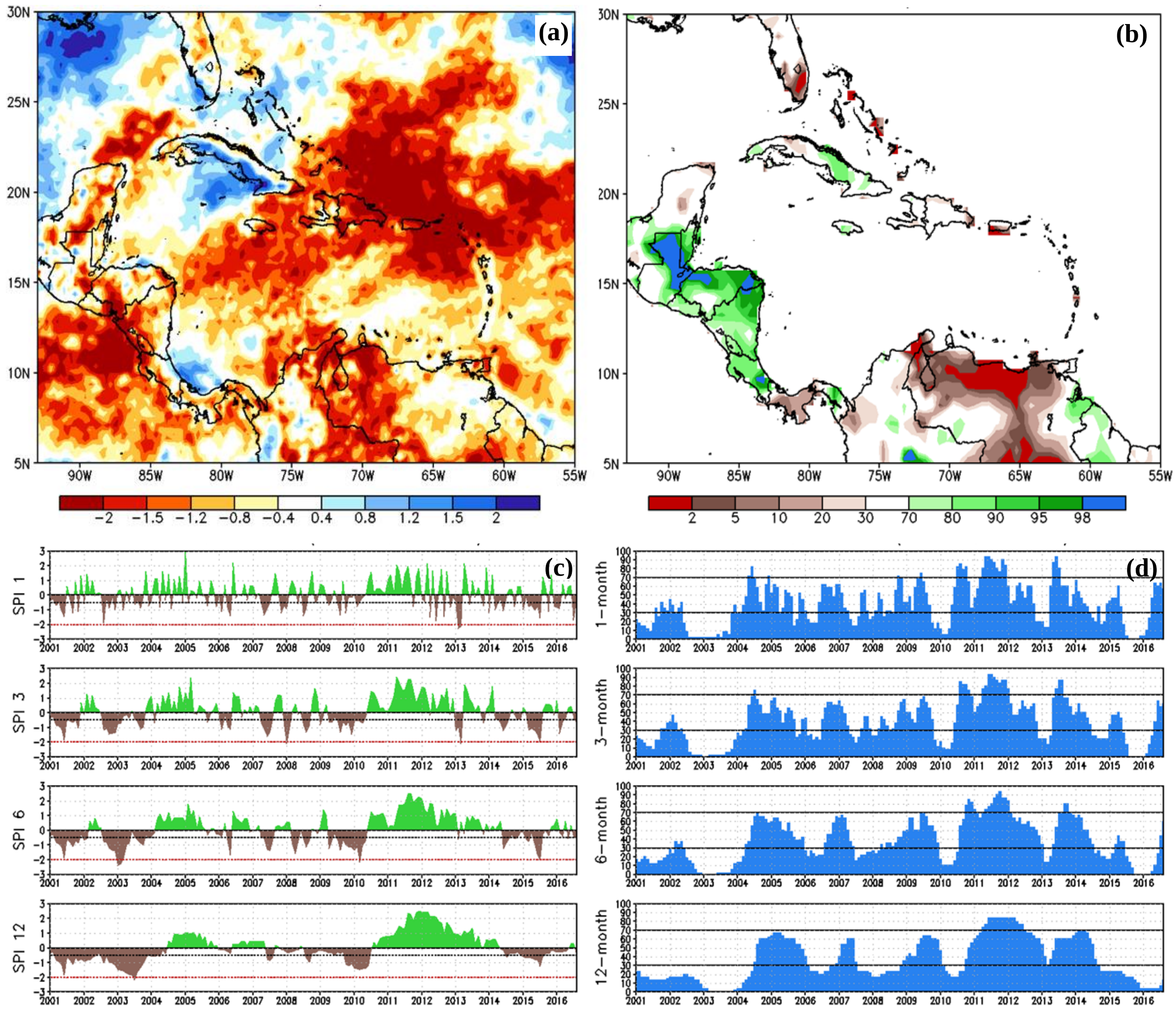

**Fig. 2** Basin-wide Standardized Precipitation Index at 3-month time scale, ending in May 2015 (a); soil moisture percentile during March-May 2015 (b); time series of Standardized Precipitation Index at 1, 3, 6, and 12-month time scale over the nearest grid point (15.309°N, 61.379°W) to Roseau, Dominica (c); same as (c) but for soil moisture percentile (d).

## 3. Summary and future works

Near real-time monitoring of drought indices enabled the timely detection of short and long-term drought over the Caribbean and Central America in 2015. Basin-wide and grid point Standardized Precipitation Index and soil moisture percentile at 1, 3, 6, and 12-month time scales showed developing drought over Roseau, Dominica as early as spring 2015. However, the soil did not dry out until late spring to early summer 2015. Over the “Dry Corridor” of Central America, both the first and second rainfall seasons were delayed relative to the climatological onset. However, the first rainfall season was very short due to a precocious cessation of rainfall, while the second season was relatively long, with a slightly delayed demise of the season.

Future work include development of drought indices using the Climate Prediction Center Morphing technique precipitation data, implementation of rainfall characteristics analysis over grid points or sub-regions, and exploration of potentials toward drought outlook using the National Multi-Model Ensemble prediction.

## References

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