CCRIF SPC
The Caribbean Catastrophe Risk Insurance Facility

On behalf of
Caribbean XSR SP

Covered Area Rainfall Event (18-20 October 2017)

Excess Rainfall

Event Briefing

Trinidad

29 October 2017

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1 INTRODUCTION

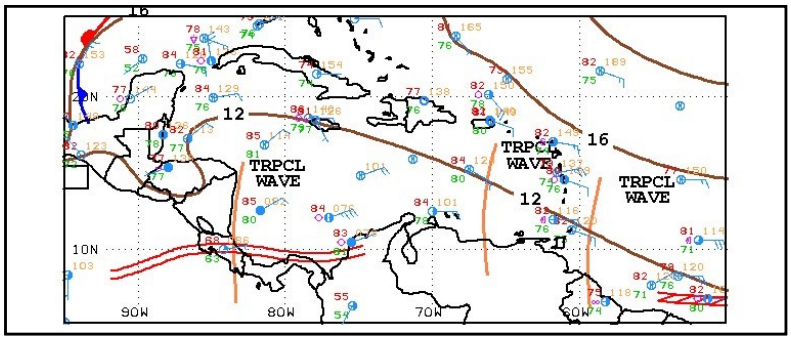
A tropical wave on 18 October at 0600UTC in the eastern Caribbean Sea with significant moisture in the lower and middle levels led to the development of heavy showers and thunderstorms in the Lesser Antilles.

Trinidad was affected by heavy precipitation between 18 October at 0930UTC and 20 October at 1530UTC. The Rainfall Index Loss calculated for this Covered Area Rainfall Event (CARE) that started on 18 October and ended on 20 October 2017, indicated government losses above the attachment point of Trinidad's Excess Rainfall policy. Final calculations show that a payout of US$7,007,886.40 is due.

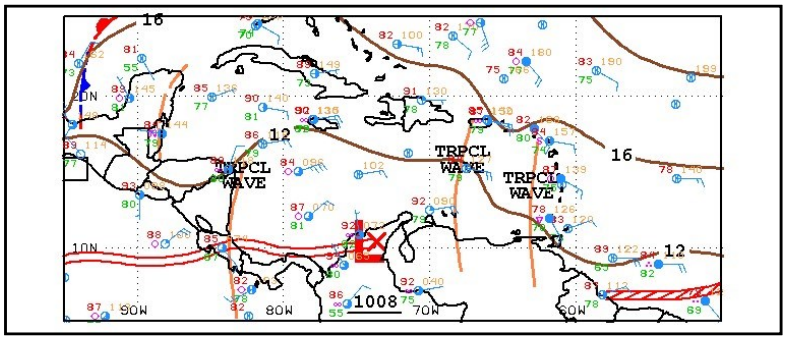
Note that the Government of Trinidad and Tobago purchased two separate Excess Rainfall policies – one for Trinidad and one for Tobago. Tobago's policy was not triggered by this event and therefore no payout is due on Tobago's policy.

2 EVENT DESCRIPTION

On 18 October at 0600UTC in the eastern Caribbean Sea, a tropical wave coming from the Atlantic basin approached the Lesser Antilles and Trinidad and Tobago from the east. Its axis extended from 06N, 59W to 15N, 59W and in the following hours it moved toward the west at 10 to 20 kt (Figure 1).



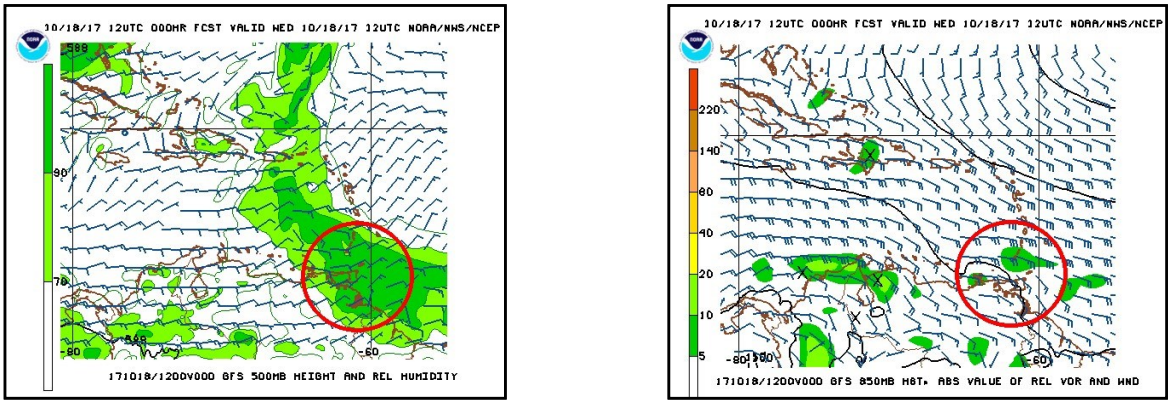
a)



b)

Figure 1 Caribbean surface analysis on 18 October at 0600UTC (a) and at 1800UTC (b). Source: NOAA Ocean Prediction Center.

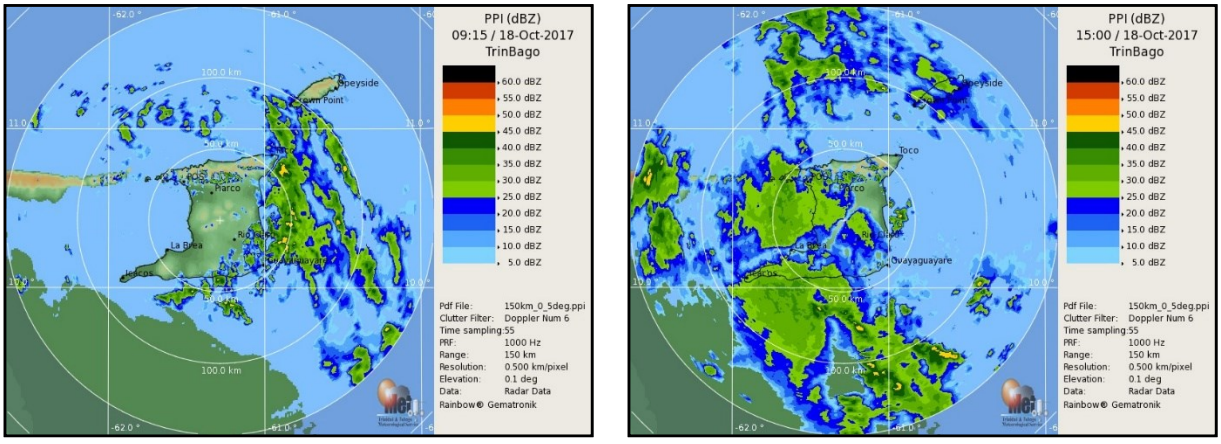
Even though the wave was embedded in a region of moderate to strong vertical wind shear, deep convection was supported by the upper level diffluent flow (Figure 2a). Significant moisture in the lower and middle levels (Figure 2a) led to the development of heavy showers and thunderstorms. At the lower level, this tropical wave coincided with a shortwave 700 mb trough and a maximum of 850 mb relative vorticity along the wave axis near 11N (Figure 2b).



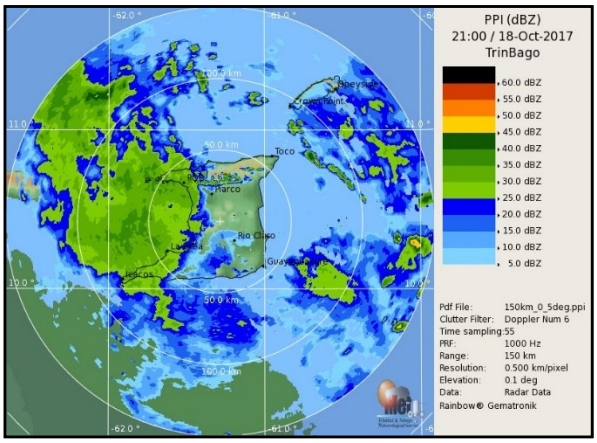
a) b)

Figure 2 Upper level analysis of the tropical Atlantic Ocean on 18 October at 1200UTC. a) Wind and relative humidity at 500 mb; b) Wind and absolute and relative vorticity at 850 mb. Source: NOAA Ocean Prediction Center

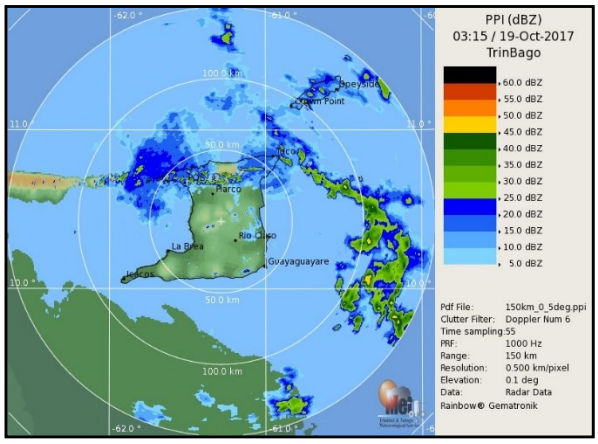
Moderate to locally precipitation affected Trinidad and Tobago starting on 18 October at 0930UTC with the approach of the tropical wave and continued after its passage, until 20 October (Figure 3). The weather radar located in Trinidad showed that diffuse precipitation occurred over the full island of Trinidad within the first hours of the event (18 October at 0930UTC - 19 October at 0315UTC). In a second phase (19 October at 0315UTC - 1445UTC), the precipitation became more scattered (maintaining a moderate to high intensity), mainly in the southern-central portion of the island. The radar maps were not available between 19 October at 1445UTC and 20 October at 1300UTC. At the latter time, scattered moderate to heavy rainfall was still experienced at the north-central sector of Trinidad. The radar showed sparse precipitation continuing until 20 October at 1530UTC. On 20 October at 1900UTC, rainfall was no longer observed on the island.



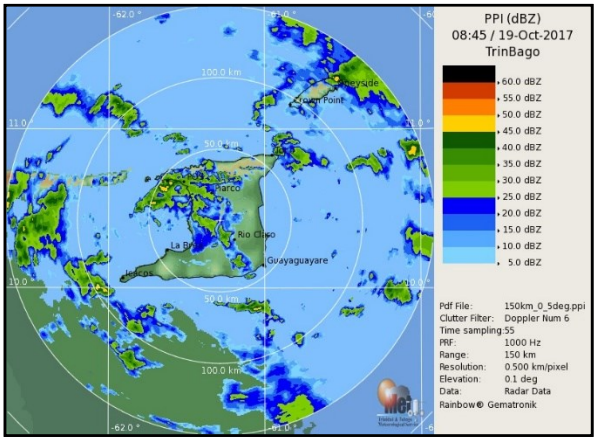
a) 18 October 0915UTC b) 18 October 1500UTC



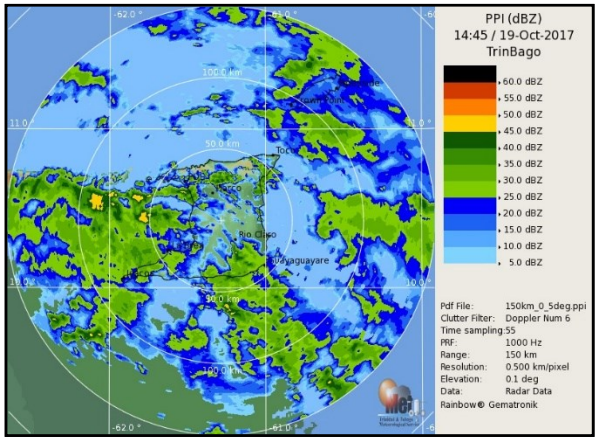
c) 18 October 2100UTC



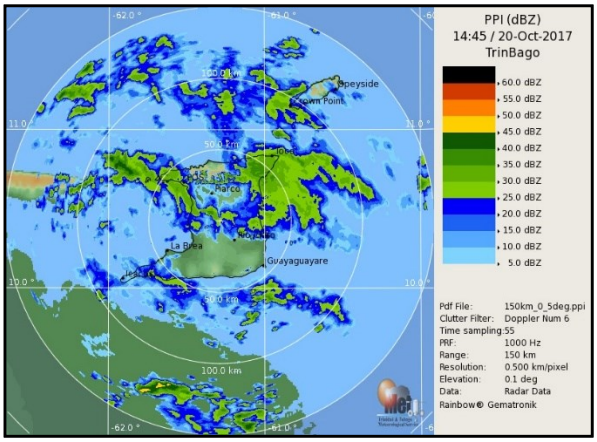
d) 19 October 0315UTC



e) 19 October 0845UTC



f) 19 October 1445UTC



g) 20 October 1445UTC

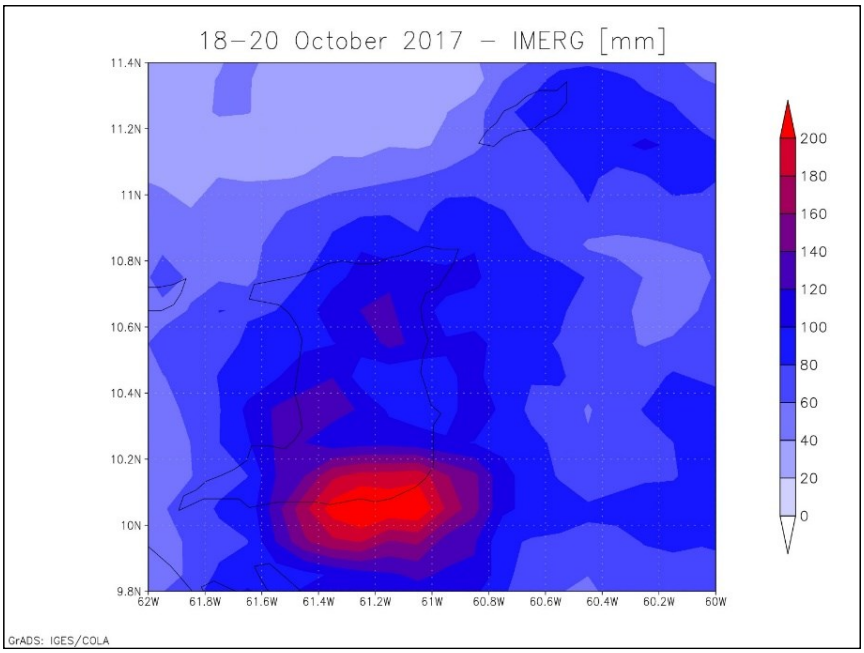
Figure 3 Reflectivity maps (PPI[1]) collected by the weather radar located over Trinidad during the event at different times (Source: http://www.metoffice.gov.tt/Radar)

[1] plan position indicator

On Trinidad and Tobago, the surface rain gauges published by NOAA (NNDC Climate data online, source: https://www7.ncdc.noaa.gov/CDO/cdodata.cmd) reported the following accumulated measurements during the event:

Piarco, Trinidad (10.58N, 61.35W)	117.6 mm
Arthur Napoleon Raymond Robinson Airport, Tobago (11.15N, 60.83W)	22.3 mm

Satellite precipitation estimates were available also through the IMERG (Integrated Multi-satellitE Retrievals for GPM) dataset (Figure 4). During the event the maximum accumulated precipitation (228 mm) was estimated along the southern coast but secondary maxima (120140 mm) also were estimated in the interior of the island. According to IMERG, the greatest precipitation occurred on 18 October (maximum 120-160 mm along the southeast coast), while on 19 and 20 October, the daily accumulated rainfall was above 20-35 mm, only in few spots (i.e. southeast coast, northeast coast, central west inland).



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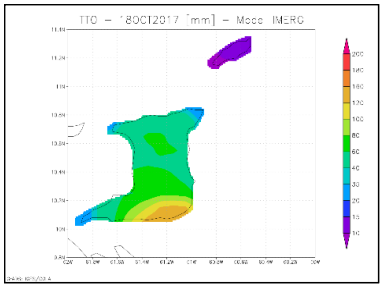

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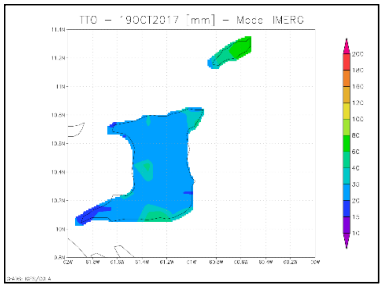

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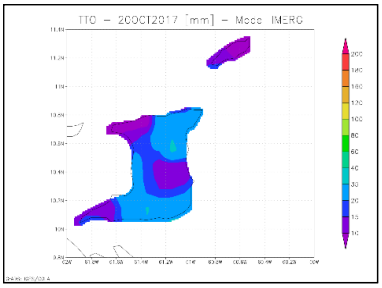


d)

Figure 4 IMERG accumulated precipitation (rainfall) at 10 km (a) and 1 km (b-c-d) resolutions on 18-20 October 2017. Source: XSR Web

3 IMPACTS

According to the Government of Trinidad and Tobago the worst hit areas were in the Penal/Debe, Sangre Grande, Couva/Tabaquite/Talparo, Siparia and Mayaro/Rio Claro regions of Trinidad. The majority of the reports pertained to major floods, while other reports were as a result of fallen trees, landslides which blocked roads complicating transportation and transit. Thousands of people were affected. Power and water supply services were disrupted.

At the time of this writing the impact was widespread and covered the East and South of Trinidad from coast to coast and there are no reports of damage for this event in Tobago. The Trinidad and Tobago Meteorological Service activated the riverine flood alert. Also, the national response mechanism was activated on Wednesday 18th October 2017.

Figure 5 shows the flood damage caused by Inter-Tropical Convergence Zone in Trinidad.

Figure 5 Damage caused by heavy rainfall in Trinidad – October 2017.
Sources: *The Watchers* and *Trinidad Express*

4 RAINFALL MODEL OUTPUTS

All the models CMORPH[2], WRF1 and WRF2 [3] simulated intense precipitation in the region during the period 18-20 October 2017. However, they widely differed in the spatial representation.

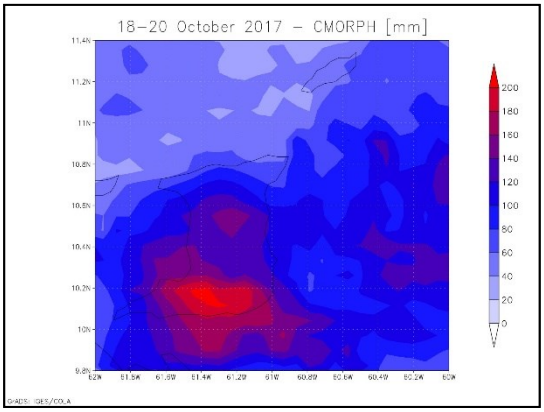
CMORPH estimated rainfall greater than 80 mm over a great part of Trinidad, with a maximum in the southern sector of the island (208.9 mm).

WRF1 simulated more intense precipitation (maximum 336.7 mm) but located along the eastern margin of the island of Trinidad and offshore, while accumulated rainfall of less than 40 mm was estimated over the greater part of the island.

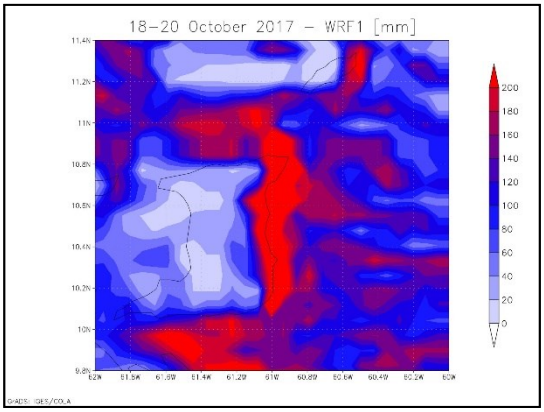
WRF2 simulated a similar pattern to WRF1, but with a lower rainfall value (maximum 149.2 mm offshore to the east coast).

[2] CMORPH Model: the satellite-based rainfall precipitation estimates provided by the NOAA Climate Prediction Center (CPC) using the so-called Morphing Technique *http://www.cpc.ncep.noaa.gov/products/janowiak/cmorph_description.html*. Further details in the Definitions section of this report.

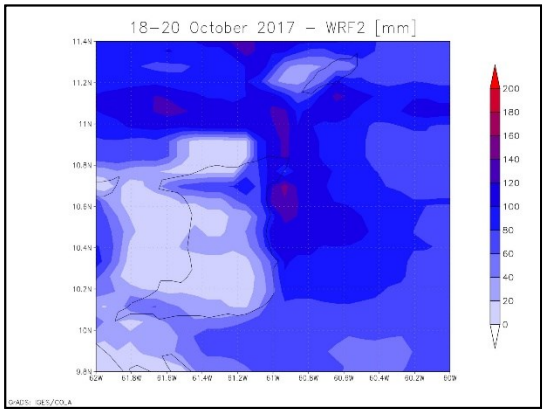
[3] WRF1 and WRF2 Models: the Weather Research and Forecasting Model [*https://www.mmm.ucar.edu/weather-research-and-forecasting-model*] weather model-based Configuration #1 and #2 data. These data is initialised by the NCEP FNL dataset. (NCEP FNL Operational Model Global Tropospheric Analyses [*http://rda.ucar.edu/datasets/ds083.2/*]). Further details in the Definitions section of this report.



a) CMORPH



b) WRF1



c) WRF2

Figure 6 Rainfall accumulated precipitation at 8km resolution during 18-20 October 2017. Source: XSR Web

All three models simulated the greatest precipitation occurring on 18 October (Figure **7**). However, as previously described, the location of precipitation was very different among them. On the first day of this CARE, CMORPH presented two maxima inland over Trinidad (120-160 mm), while WRF1 showed a similar value affecting only the eastern coast, and WRF2 presented a lower value (60-80 mm) in the south-eastern region.

On 19 October, CMORPH reported diffuse rainfall over Trinidad with accumulated rainfall ranging between 10 and 60 mm. WRF1 and WRF2 simulated accumulated values in the same interval but with more localized maxima (WRF1: east coast, WRF2: east coast and over the northern sector).

On 20 October, CMORPH showed daily accumulated rainfall larger than 10 mm in the southeastern sector of the island, with a maximum of 40-60 mm. WRF1 simulated quite high precipitation (100-120 mm) occurring along the east coast between 10.3 and10.5N and lower values mainly along the east and south coasts. WRF2 estimated rainfall ranging between 10 mm and 40 mm over the northern sector and the south-western portion of Trinidad.

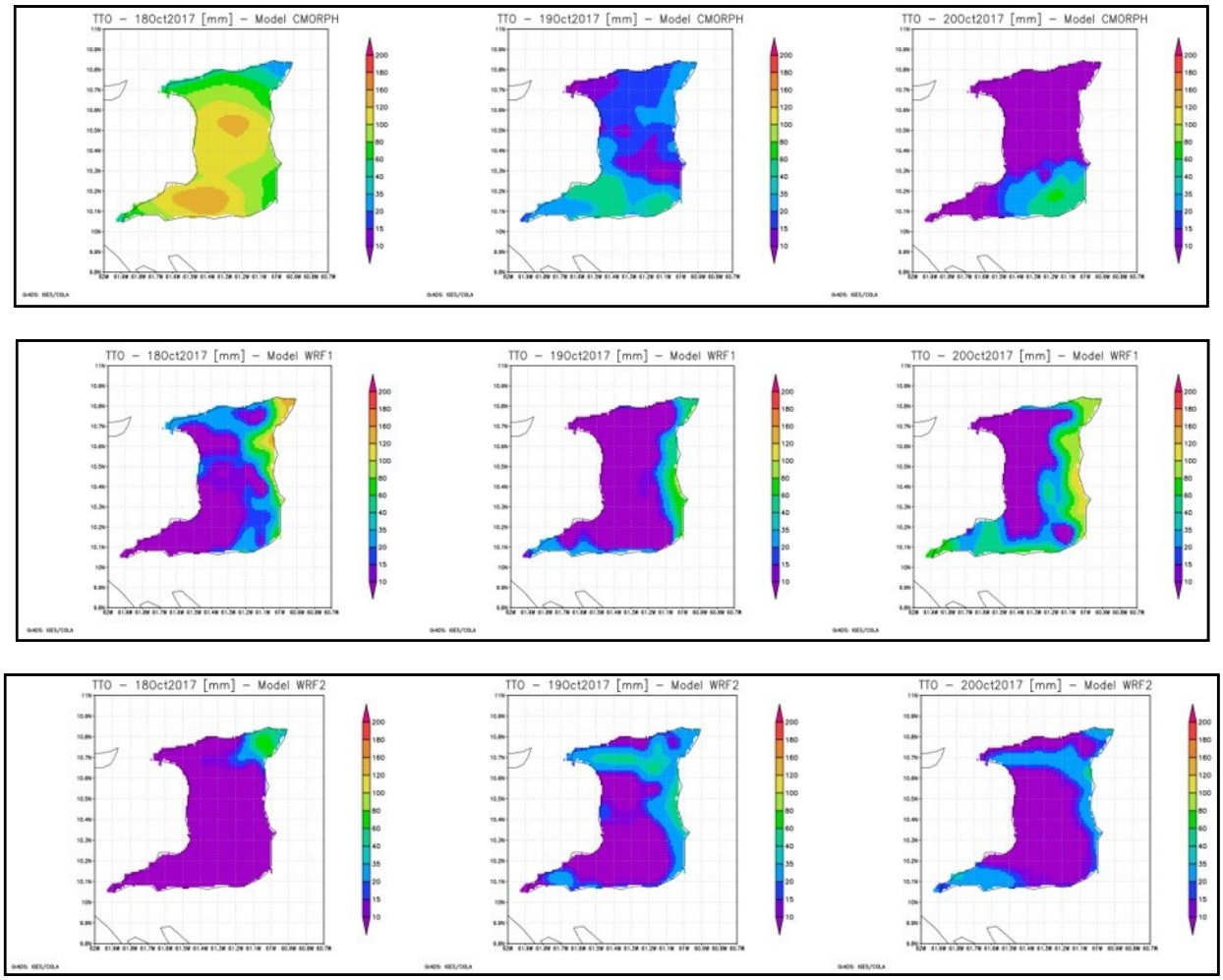


Figure 7 Accumulated precipitation (rainfall) at 1km resolution on 18 (left), 19 (centre) and 20 (right) October 2017 by CMORPH (top), WRF1 (middle) and WRF2 (bottom). Source: XSR Web.

The largest Rainfall Index Loss (RIL) was produced by CMORPH (RIL_{CMORPH} = US$45,300,553.61) due to the fact that it simulated the rainfall maxima occurring more inland over Trinidad and affecting the area with larger exposure (western sector) compared with that from both WRF configurations. WRF1 also produced an RIL larger than the Country Loss Threshold (RIL_{WRF1} = US$4,924,948.77), but much smaller than that from CMORPH, since the maximum rainfall was simulated over the eastern sector along the coast. Finally, the RIL from WRF2 (RIL_{WRF2}=US$525,781.25) was much lower than the Country Loss Threshold, since the simulated precipitation maxima affected only the waters on the eastern part of the island.

Therefore, the final RIL for this event was equal to the average of the RIL of CMORPH and WRF1, which were above the Country Loss Threshold. The final RIL was US$25,112,751.20.

5 TRIGGER POTENTIAL

The Rainfall Index Loss calculated for this Covered Area Rainfall Event (CARE) that started on 18 October and ended on 20 October 2017, produced government losses which were above the attachment point of Trinidad's Excess Rainfall policy. Final calculations show that a payout of US$7,007,886.40 is due.

CCRIF expresses empathy with the Government of Trinidad and Tobago and the many people and communities affected by this event.

For further information, please contact ERN-RED, the CCRIF SPC Risk Management Specialist.

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DEFINITIONS

Active Exposure Cell Percentage Threshold	The percentage of the total number of XSR Exposure Grid Cells as defined in the Schedule, with in the covered Area of the Insured, which when exceeded triggers a Covered Area Rainfall Event.
Active Exposure Grid Cells	The XSR Exposure Grid Cells for which in the same single day the Average Aggregate Rainfall value computed using the CMORPH-based Rainfall Estimate equals or exceeds the Rainfall Event Threshold.
Average Aggregate Rainfall	The Average Aggregate Rainfall amount (where the number of days in the Rainfall Aggregation Period is defined in the Schedule) as measured in millimeters per day (mm/day) in any of the XSR Exposure Grid Cells in the Covered Area of the Insured. For a given number of days n, the n-day aggregation period is the average of rainfall on the day itself and on the previous n-1 days.
Calculation Agent	Entity charged with undertaking the primary calculation of the Rainfall Index Loss as described in the Calculation Agency Agreement.
CMORPH-based Maximum Average Aggregate Rainfall	The maximum value during the Covered Area Rainfall Event of the Average Aggregate Rainfall computed using the CMORPH-based Daily Rainfall Estimates in any given XSR Exposure Grid Cell over the Covered Area of the Insured.
CMORPH-based Covered Area Rainfall Parameters	The CMORPH Model information provided on a continuous basis by the XSR Model Data Reporting Agency used by the Calculation Agent to obtain the CMORPH-based Daily Rainfall Estimates using the XSR Rainfall Model. Parameters are drawn from XSR Exposure Grid Cells within the Covered Area of the Insured as identified in the Cell Identification and Rainfall Exposure Value Table in the Schedule, by their respective latitude and longitude. Measurement units and precision of data ingested by the XSR Rainfall Model are identical to those provided by the XSR Model Data Reporting Agency and are further elaborated in the Attachment entitled 'Calculation of Rainfall Index Loss and Policy Payment'.
CMORPH Model	The satellite-based rainfall estimation model provided by NOAA CPC as described in the Rainfall Estimation Models section of the Policy.

Covered Area	The territory of the Insured as represented in the XSR Rainfall Model.
Covered Area Rainfall Event	Any period of days, with an interruption less than or equals to the Event Tolerance Period, during which the number of Active Exposure Grid Cells is greater than or equal to the product of (a) Active Exposure Cell Percentage Threshold multiplied by (b) the total number of XSR Exposure Grid Cells within the Covered Area.
Country Disaster Alert	An official disaster alert issued by ReliefWeb (http://reliefweb.int/) for the country in question for one of the following types of events: tropical cyclone, flood, flash flood and severe local storm. Any disaster alert issued later than seven (7) days after the completion of the Covered Area Rainfall Event event will not be considered.
Maximum Average Aggregate Rainfall	The highest value during a Covered Area Rainfall Event of the Average Aggregate Rainfall amount in any of the XSR Exposure Grid Cells in the Covered Area of the Insured computed.
Rainfall Event Threshold	Average Aggregate Rainfall level as defined in the Schedule which should be exceeded to trigger an Active Exposure Cell.
Rainfall Aggregation Period	The number of days over which the Average Aggregate Rainfall is computed for all XSR Exposure Grid Cells during a Covered Area Rainfall Event.
Rainfall Index Loss	For any Covered Area Rainfall Event affecting the Insured, the US Dollar loss calculated by the Calculation Agent using the XSR Rainfall Model, as described in the Attachment entitled 'Calculation of Rainfall Index Loss and Policy Payment'. The Rainfall Index Loss can only be calculated once the Covered Area Rainfall Event is completed.
WRF1 Model	The weather research and forecasting rainfall model by NOAA with Configuration #1 data initialized by the National Center for Environmental Prediction as described in the Rainfall Estimation Models and in the Input Data to the Rainfall Estimation Models sections of the Policy.
WRF2 Model	The weather research and forecasting rainfall model by NOAA with Configuration #2 data initialized by the National Center for Environmental Prediction as described in the Rainfall Estimation

	Models and in the Input Data to the Rainfall Estimation Models sections of this Attachment.
XSR Rainfall Model	The computer model used to calculate the Rainfall Index Loss, as described in the Attachment entitled 'Calculation of Rainfall Index Loss and Policy Payment'.
XSR Exposure Grid Cells	The 30 arc-second by 30 arc-second grid of cells each of which is attributed with an XSR Grid Cell Exposure Value greater than zero, as provided in the Schedule.
XSR Grid Cell Exposure Value	The value, as shown in the Cell Identification and Rainfall Exposure Value Table in the Schedule, used to calculate the CMORPH-based Exposure Grid Cell Loss, the WRF1-based Exposure Grid Cell Loss, and the WRF2-based Exposure Grid Cell Loss.