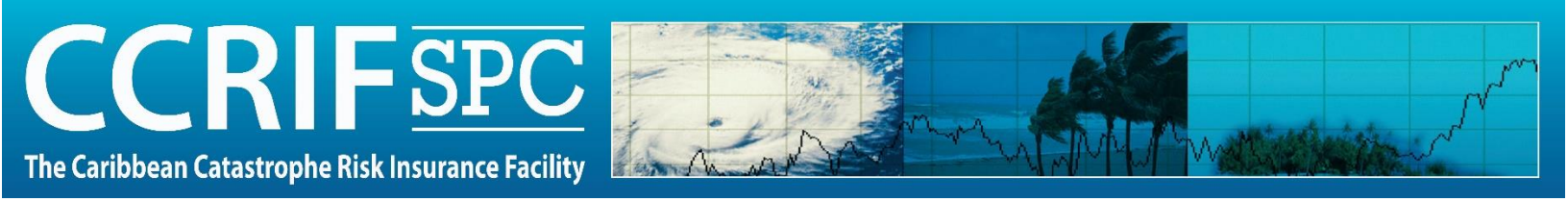

Covered Area Rainfall Event

(3/10/2023 to 4/10/2023)

Antigua and Barbuda

Excess Rainfall

Event Briefing

10 October 2023

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1 INTRODUCTION

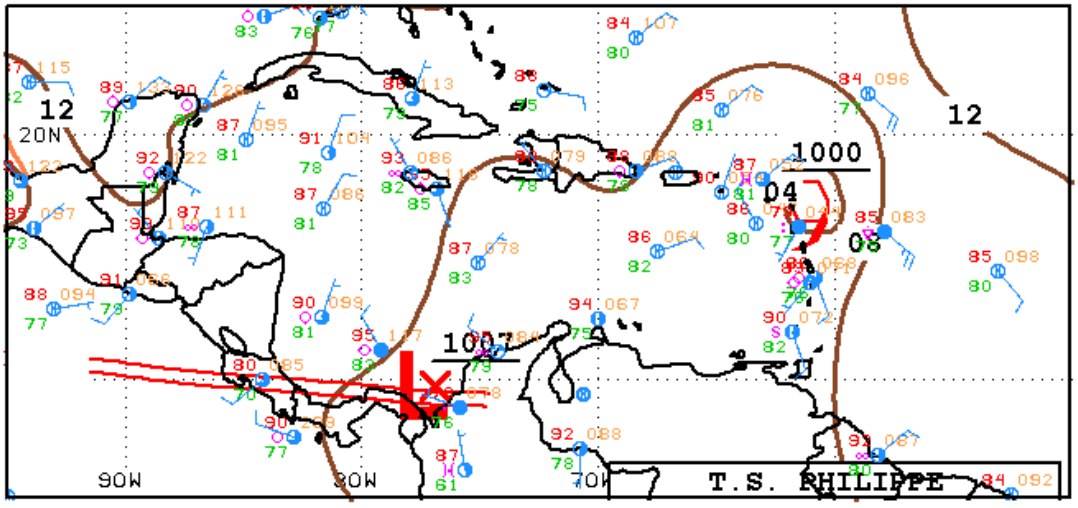
This event briefing describes the impact of rainfall in Antigua and Barbuda, which was associated with a Covered Area Rainfall Event (CARE), starting on 3 October and ending on 4 October 2023. The Rainfall Index Loss (RIL) for the CARE in Antigua and Barbuda was above the attachment point of Antigua and Barbuda's excess rainfall policy and a payout of US$2,880,424.06 is due.

2 EVENT DESCRIPTION

On 23 September at 2100UTC, the US National Hurricane Center (NHC) reported that a tropical storm (TS) formed in the central tropical Atlantic Ocean, and it was named Philippe. Its centre was sited near latitude 15.6° North, longitude 39.7° West, about 1400 mi (2300 km) E of the Leeward Islands. The system proceeded with estimated forward velocity of 14 mph (22 km/h) towards the west. The minimum central pressure was 1005 mb and the maximum sustained winds were estimated at 40 mph (65 km/h).

During the next three days, the tropical storm proceeded with the same forward velocity and direction over the tropical Atlantic Ocean. The strong environmental wind shear and the entrainment of dry air hindered the intensification of the system, and the maximum sustained winds remained constant at about 50 mph (85 km/h). Moreover, the shear caused a marked asymmetry of the storm, with the convective bursts shifted well to the east of the system centre. From 27 September to 2 October, the intensity of the storm remained unvaried, but its forward velocity decreased and the storm started to meander to the east of the northern Leeward Islands.

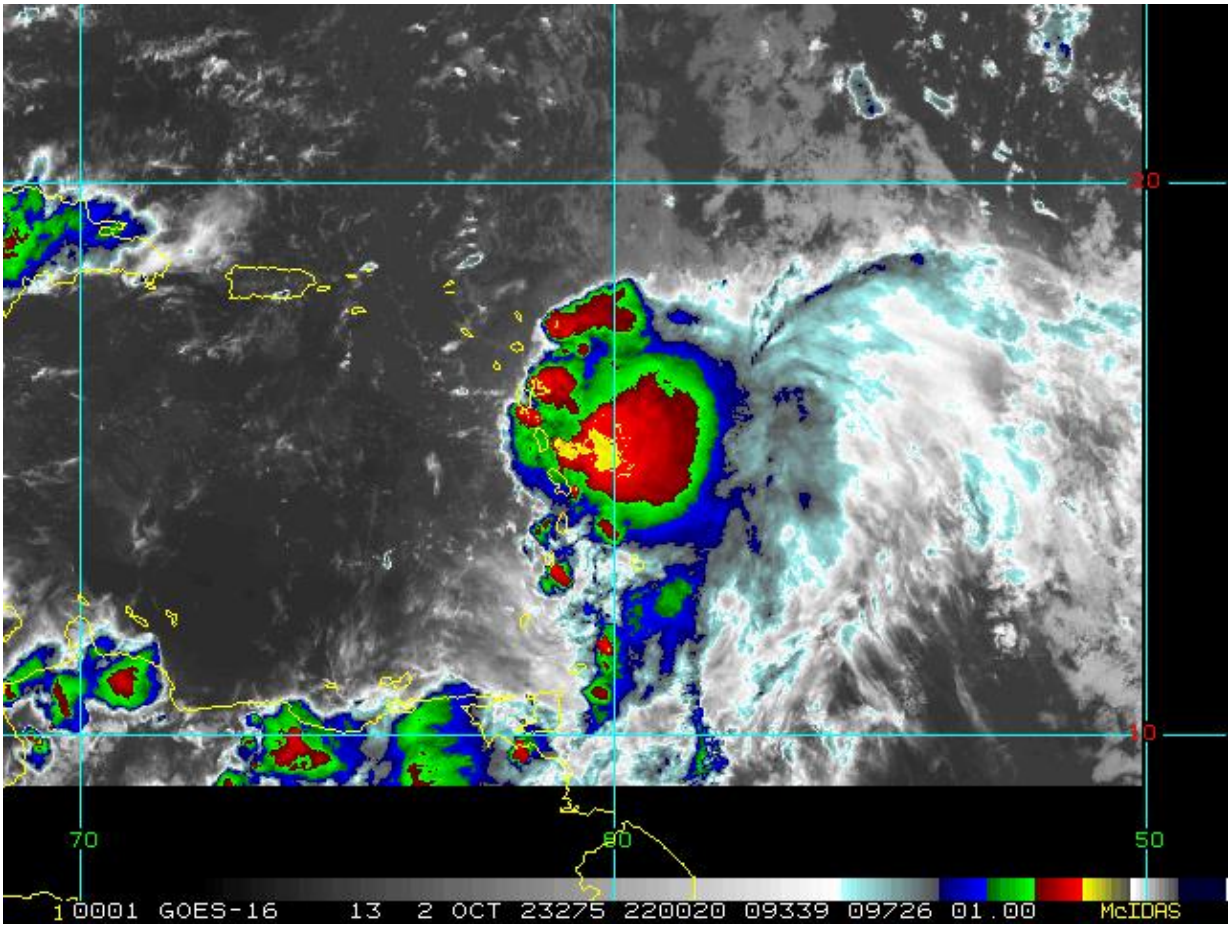
On 2 October at 2200UTC, the centre of Philippe made landfall on the island of Barbuda (Antigua and Barbuda), with maximum sustained winds estimated at 50 mph (85 km/h) and minimum central pressure of 999 mb (Figure 1). TS Philippe presented a high asymmetry and a poorly defined circulation centre, sited near the northwestern edge of the large convective mass (Figure 2a). Therefore, the heavy rainfall associated with Philippe started to affect the Leeward Islands a few hours later from 3 October at 0300UTC. In particular, over Antigua and Barbuda the precipitation was very intense at this time, as seen from the satellite and radar images (Figure 2b and 3). The centre of Philippe was located near latitude 17.8° North, longitude 62.1° West, about 24 mi (40 km) NW of Barbuda and about 70 mi (110 km) ESE of Sint Maarten. The intensity and sheared shape of the tropical storm were unchanged, while it increased its forward velocity, moving west-northwest at 7 mph (11 km/h) along the western periphery of a mid-level high pressure area over the central Atlantic Ocean.



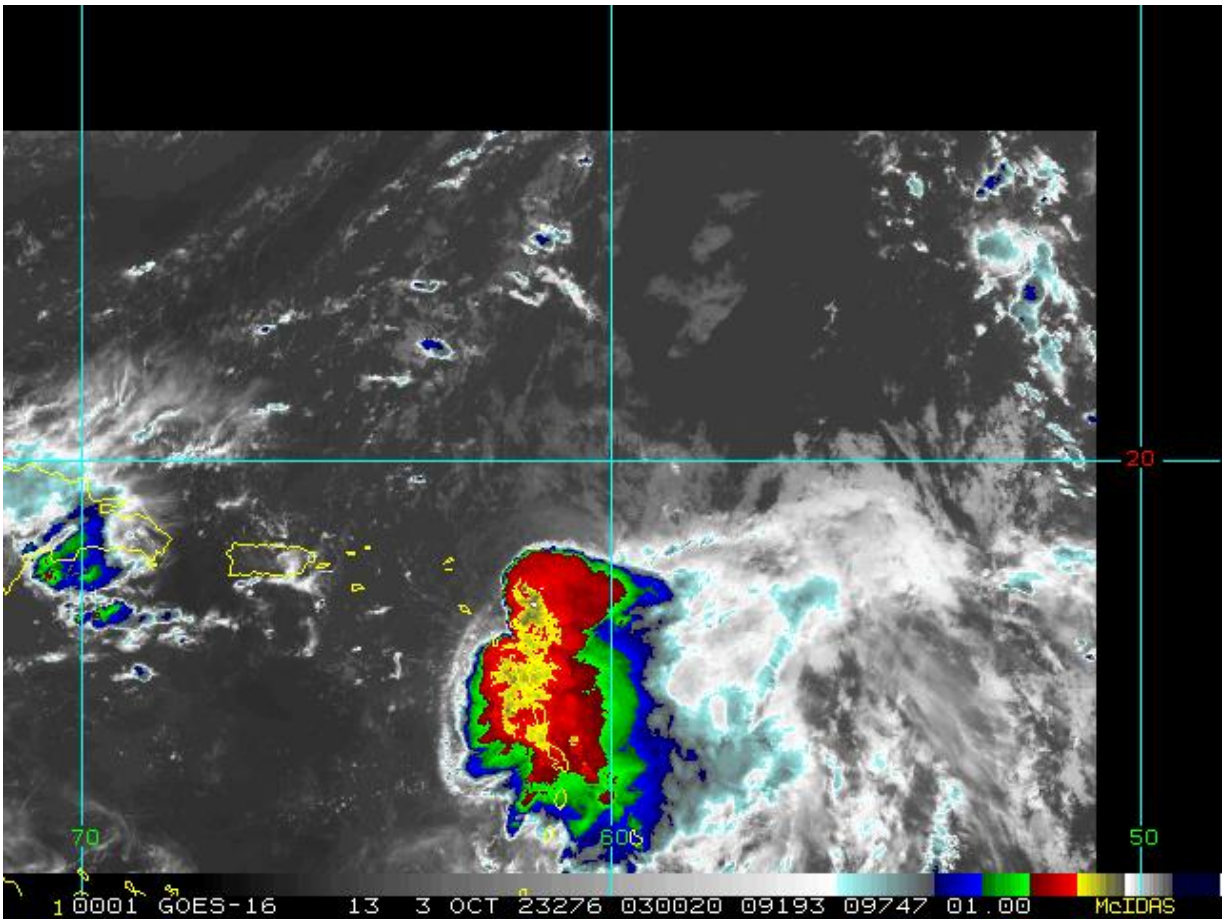
02 October at 1800UTC

Figure 1 Surface analysis over the Caribbean area on 2 October, 2023 at 1800UTC. Source: US National Hurricane Center[1]

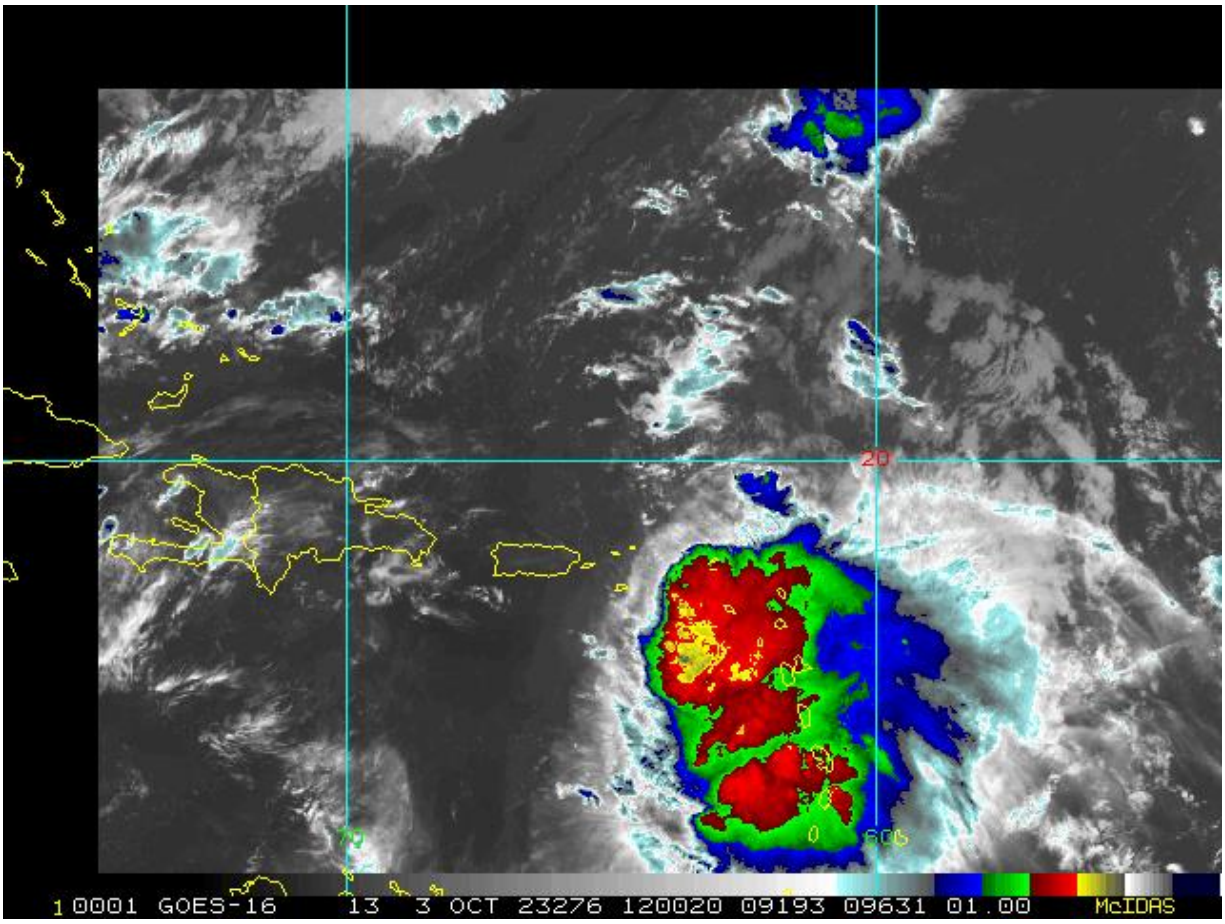
1 National Oceanic and Atmospheric Administration - FTP, National Hurricane Center, review date: 2 October 2023, available at: *https://www.nhc.noaa.gov/tafb/CAR_18Z.gif*



a) 02 October at 2200UTC



b) 3 October at 0300UTC



c) 3 October at 1200UTC

Figure 2 Satellite imagery on 2 and 3October, 2023 at different times as indicated by the labels from the thermal infrared channel enhanced with colour. Blue/green colours represent high altitude clouds (top cloud temperature between -50°C and -70°C), while the red/yellow colours represent very high altitude clouds (top cloud lower than -70°C). High altitude clouds indicate strong convection associated with intense precipitation. Source: NOAA, National Environmental Satellite, Data and Information Service[2].

2 RAMSDIS Online Archive, NOAA Satellite and Information Service, available at: https://rammb-data.cira.colostate.edu/tc_realtime/storm.asp?storm_identifier=al172023

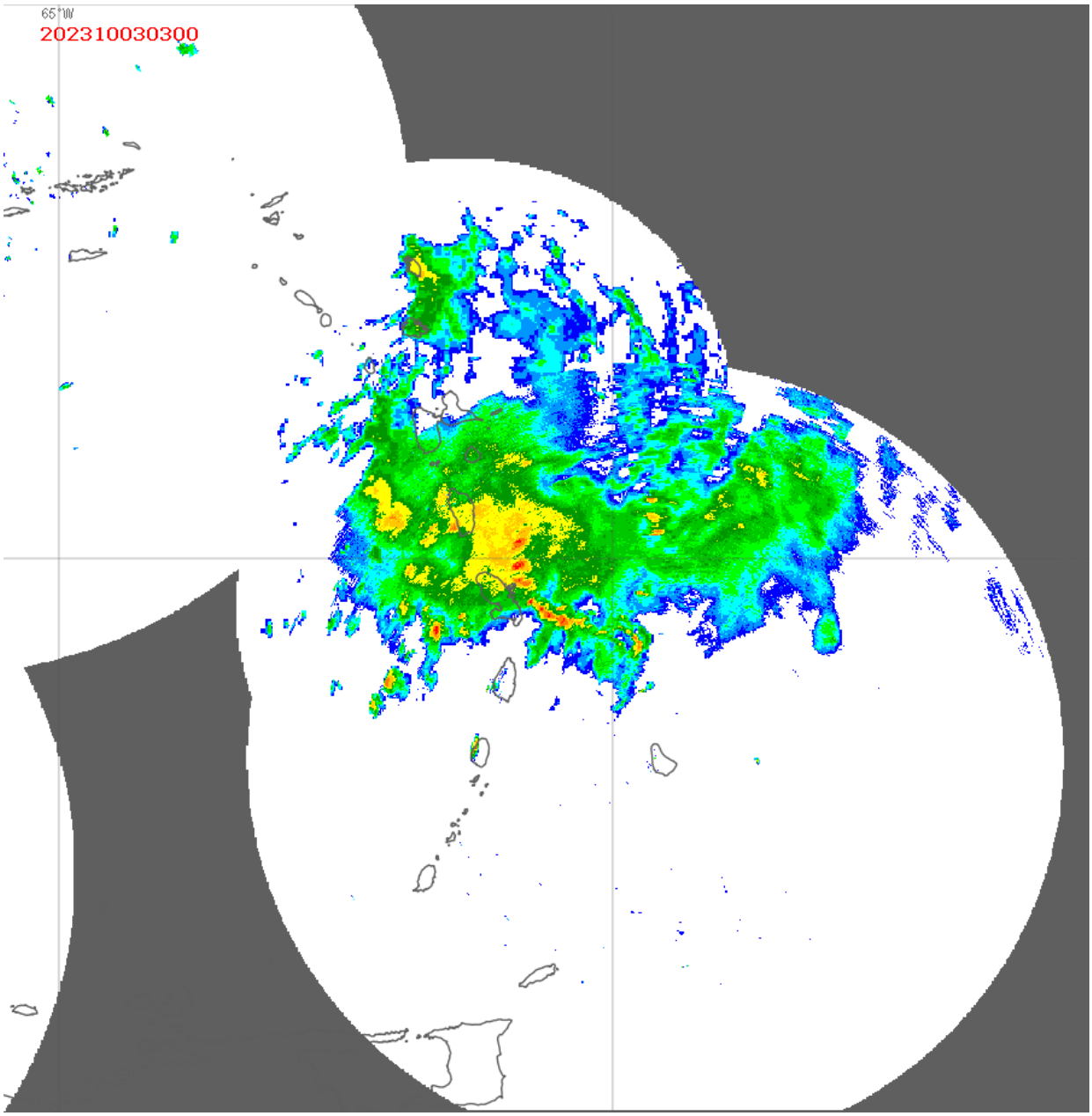


Figure 3 Radar imagery on 3 October at 0300UTC from the radar composite over the Caribbean and Central America region. Blue/green colours represent low to moderate rainfall, while the yellow/red colours represent intense and very intense precipitation. Source: Barbados Radar Composite[3].

At 1200UTC, the centre of Philippe was sited near latitude 18.6° North, longitude 63.5° West,

3 Barbados Radar Composite, available on 3 October 2023 at: *https://www.barbadosweather.org/BMS_Radar_Composite_Resp.php#*

about 40 mi (60 km) NW of Anguilla. As in the previous hours, most of the stronger convection was over the southern and eastern portions of the storm, and the Leeward Islands continued to experience strong winds and heavy rains even when the centre of the storm moved north of those islands. At this time, Antigua and Barbuda was still affected by moderate to intense rainfall (Figure 2c).

The tropical storm proceeded toward the northwest at 10 mph (17 km/h) and at 1800UTC its centre was located near latitude 19.0° North, longitude 64.4° West, about 17 mi (27 km) N of Anegada Island, British Virgin Islands. At this time, the precipitation associated with TS Philippe ceased over the other northern Leeward Islands.

In the next six hours, TS Philippe lost organization and moved away from the British Virgin Islands, proceeding north-northwest toward the north Atlantic Ocean.

3 IMPACTS

At the time of writing this report, information available on the effects of excess rainfall in Antigua and Barbuda, due to the passage of Tropical Storm Philippe, indicated that homes in low-lying areas were affected and there was significant damage to numerous businesses. During the storm, power outages occurred, and many residents were forced to evacuate their homes due to severe flooding. The widespread flooding led to a busy period for emergency personnel who conducted numerous search and rescue operations, responding to approximately 33 requests made to E911 for assistance.[4]

Floods

Downed power lines

Figure 4 Damages in Antigua during the passage of Tropical Storm Philippe

[4] Caribbean Loop News: WATCH: Aftermath of Philippe in Antigua | Loop Caribbean News (loopnews.com)

4 RAINFALL MODEL OUTPUTS

All data sources used by the XSR 3.0 model, CMORPH, IMERG, WRF5, WRF7, WRF11 and WRF15[5], detected the occurrence of precipitation over Antigua and Barbuda and the surrounding waters during the period 1 to 4 October 2023. However, each data source reported a specific distribution and accumulation of rainfall, as discussed below and shown in Figure 4. The CARE for Antigua and Barbuda was activated on 3 October and lasted until 4 October. The CARE was activated due to the use of the 12-hour and the 48-hour aggregation intervals for precipitation[6] and thus the period considered by the XSR 3.0 model for the loss estimate based on the accumulated precipitation in Antigua and Barbuda was 1 – 4 October.

CMORPH reported total accumulated amounts of precipitation higher than 60 mm over Antigua, with the maximum values between 90 mm and 120 mm over the southern portion. Lower accumulated values were shown over Barbuda.

Similarly to CMORPH, IMERG reported total accumulated amounts of precipitation higher over Antigua than over Barbuda. In particular, the values were greater than 120 mm over Antigua, with the maximum values between 150 mm and 180 mm over the southeastern part of the island, while lower accumulated amounts, between 60 mm and 90 mm, were shown over Barbuda.

WRF5 showed total accumulated values of precipitation higher than 90 mm over the entire country, with maximum amounts between 120 and 150 mm over southeastern Antigua and over northwestern and central Barbuda.

WRF7 showed total accumulated values of precipitation greater than 150 mm over most of the country. Over Antigua, the highest values, between 180 mm and 210 mm, were reported over the western portion of the island, while over Barbuda the maximum amounts, between 240 mm and 270 were shown over the southern and western edges.

WRF11 showed total accumulated values of precipitation higher than 60 mm over Barbuda, with the maximum values between 90 mm and 120 mm over the southeastern portion. Lower accumulated amounts were shown over Antigua.

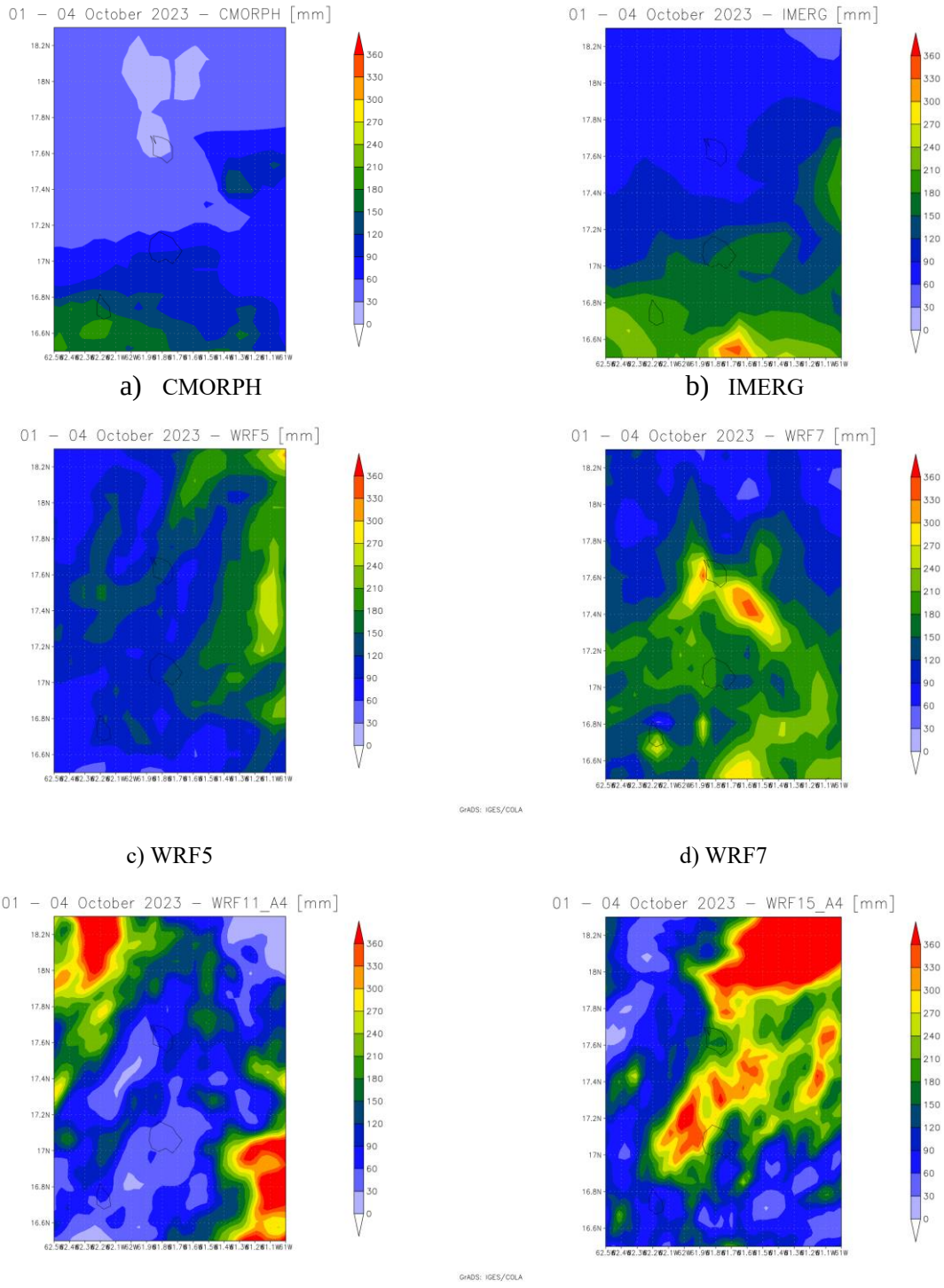
WRF15 simulated total accumulated values of rainfall greater than 150 mm over Barbuda and the west side of Antigua. The maximum values, between 300 mm and 330 mm, were shown along the western coast of Antigua.

5 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 are provided in the Definitions section of this report

IMERG Model: The satellite-based rainfall estimation model developed by NASA, expressed in mm, derived by aggregating the IMERG 30-minute Rainfall Data at 10km spatial resolution and available at *https://jsimpsonhttps.pps.eosdis.nasa.gov/imerg/late*. Further details in the Definitions section of this reportWRF5,

WRF7, WRF11 and WRF15 Models: the Weather Research and Forecasting Model weather model-based Configuration #1 and #2 data *https://www.mmm.ucar.edu/weather-research-and-forecasting-model*. These data are initialised by the NCEP FNL dataset. (NCEP FNL Operational Model Global Tropospheric Analyses [*http://rda.ucar.edu/datasets/ds083.2/*]). Further details are provided in the Definitions section of this report.

6 The two aggregation periods correspond to the Rainfall Aggregation Period #1 and Rainfall Aggregation Period #2, as indicated in the Schedule. Further details in the Definitions section of this report.



a) CMORPH

b) IMERG

c) WRF5

d) WRF7

e) WRF11

f) WRF15

Figure 5 Total accumulated precipitation during the period 01-04 October, 2023 estimated by CMORPH (a), IMERG (b), WRF5 (c), WRF7 (d), WRF11 (e), WRF15 (f). Source: CCRIF SPC

Daily rainfall maps by CMORPH, IMERG, WRF5, WRF7, WRF11 and WRF15 over the exposure map of XSR 3.0 are not included here and they can be downloaded at the following links for 12-hour aggregation and 48-hour aggregation respectively:

https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/ATG/CARE_1_2023/daily_prec_short.mp4

https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/ATG/CARE_1_2023/daily_prec_long.mp4

The Rainfall Index Loss (RIL) was above the loss threshold for Antigua and Barbuda for CMORPH, IMERG, WRF5, WRF7 and WRF15. The RIL was the highest for WRF15, due to the very high total accumulated amount of precipitation over Saint John Parish, the area characterized by the highest exposure for Antigua and Barbuda .

The final RIL (RIL_{FINAL}) was calculated as the average of the RILs from CMORPH, IMERG, WRF5, WRF7 and WRF15. The RIL_{FINAL} was greater than the attachment point of the Excess Rainfall policy for Antigua and Barbuda and therefore the policy was triggered. Therefore, a payout of US$2,880,424.06 is due to the Government of Antigua and Barbuda under the Excess Rainfall policy.

5 TRIGGER POTENTIAL

The Rainfall Index Loss calculated for the CARE that started on 3 October and ended on 4 October 2023, produced government losses which were above the attachment point of Antigua and Barbuda's Excess Rainfall policy. Final calculations show that a payout of US$2,880,424.06 is due.

For additional information, please contact CCRIF SPC at: pr@ccrif.org

DEFINITIONS

Active Exposure Cell Percentage Threshold	The percentage of the total number of XSR Exposure Grid Cells within the Covered Area of the Insured, that must be exceeded to trigger a Covered Area Rainfall Event.
Active Exposure Grid Cells	The XSR Exposure Grid Cells for which in the same single day the Aggregate Rainfall #1 value computed using the CMORPH-based Rainfall Estimate equals or exceeds the Rainfall Event Threshold #1 or the Aggregate Rainfall #2 value computed using the CMORPH-based Rainfall Estimate equals or exceeds the Rainfall Event Threshold #2.
Aggregate Rainfall #1	The rainfall amount accumulated over the Rainfall Aggregation Period #1 (as defined in the Schedule) measured in millimeters (mm) in any of the XSR Exposure Grid Cells in the Covered Area of the Insured. For a given day and a Rainfall Aggregation Period #1 of n hours, the Aggregate Rainfall #1 is the maximum amount of rainfall accumulated over any of the n-hour windows that intersect the day itself considering a time interval of 3 hours.
Aggregate Rainfall #2	The rainfall amount accumulated over the Rainfall Aggregation Period #2 (as defined in the Schedule) measured in millimeters (mm) in any of the XSR Exposure Grid Cells in the Covered Area of the Insured. For a given day and a Rainfall Aggregation Period #2 of n hours, the Aggregate Rainfall #2 is the maximum amount of rainfall accumulated over any of the n-hour windows that intersect the day itself considering a time interval of 3 hours.
Calculation Agent	Entity charged with undertaking the primary calculation of the Rainfall Index Loss.
CMORPH-based Maximum Aggregate Rainfall #1	The maximum value during the Covered Area Rainfall Event of the Aggregate Rainfall #1 computed using the CMORPH-based Rainfall Estimates in any given XSR Exposure Grid Cell over the Covered Area of the Insured.
CMORPH-based Maximum Aggregate Rainfall #2	The maximum value during the Covered Area Rainfall Event of the Aggregate Rainfall #2 computed using the CMORPH-based 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 Rainfall

	Estimates using the XSR Rainfall Model. Parameters are drawn from XSR Exposure Grid Cells within the Covered Area of the Insured, 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 (CARE) event will not be considered. The Disaster Alert description issued by ReliefWeb and/or its attached documentation must include specific reference to the CARE dates with a tolerance period of 2 calendar days.
Maximum Aggregate Rainfall #1	The highest value during a Covered Area Rainfall Event of the Aggregate Rainfall #1 amount in any of the XSR Exposure Grid Cells in the Covered Area of the Insured computed.
Maximum Aggregate Rainfall #2	The highest value during a Covered Area Rainfall Event of the Aggregate Rainfall #2 amount in any of the XSR Exposure Grid Cells in the Covered Area of the Insured computed.
Rainfall Event Threshold #1	Aggregate Rainfall #1 level as defined in the Schedule which should be exceeded to trigger an Active Exposure Cell.
Rainfall Event Threshold #2	Aggregate Rainfall #2 level as defined in the Schedule which should be exceeded to trigger an Active Exposure Cell.

Rainfall Aggregation Period #1	The number of hours over which the Aggregate Rainfall #1 is computed for all XSR Exposure Grid Cells during a Covered Area Rainfall Event.
Rainfall Aggregation Period #2	The number of hours over which the Aggregate Rainfall #2 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.
WRF5 Model	The weather research and forecasting rainfall model by NOAA with Configuration #5 data initialized with and assimilating the data provided 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.
WRF7 Model	The weather research and forecasting rainfall model by NOAA with Configuration #7 data initialized with and assimilating the data provided 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.
XSR Grid Cell Exposure Value	The value, used to calculate the CMORPH-based Exposure Grid Cell Loss, the WRF5-based Exposure Grid Cell Loss, and the WRF7-based Exposure Grid Cell Loss.