Covered Area Rainfall Event (02/06/2023 to 04/06/2023)

Excess Rainfall

Event Briefing

The Bahamas - South East

13 June 2023

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1 INTRODUCTION

The Bahamas was affected by a newly formed Tropical Depression Two, resulting in adverse weather conditions from 2 to 4 June 2023. During this period, the heaviest rainfall occurred particularly over the southeast area.

This event briefing describes the impact of rainfall covered by The Bahamas' Excess Rainfall policy for the South East[1], which was associated with a Covered Area Rainfall Event (CARE), starting on 2 June and ending on 4 June 2023. The Rainfall Index Loss (RIL) was below the attachment point of The Bahamas - South East excess rainfall policy and therefore no payout is due.

2 EVENT DESCRIPTION

On 31 May at 1800 UTC a surface trough was analyzed E of Florida and extended from 31N72W across the NW Bahamas to near 25N80W. Multi-layer clouds with embedded showers and thunderstorms were related to the trough covering most of the waters N of 20N W of 70W, including the Bahamas. A diffluent pattern aloft, ahead of the upper-level trough located over the eastern Gulf of Mexico, was helping to induce this convective activity.

On 1 June at 1200 UTC a surface trough extended from near Miami, FL northeastward to 31N74W. Scattered to numerous moderate with isolated strong convection spanned across the Atlantic from the Greater Antilles to north of 31N, and between 67W and the east coast of Florida, including the Bahamas. This area of convection was supported by atmospheric instability on the east side of an upper-level trough located over the east-central Gulf of Mexico. GOES Total Precipitable Water imagery showed a large area of atmospheric moisture across the area.

On 1 June at 1800 UTC a complex weather pattern over the western Caribbean due to the disturbance in the Gulf, surface trough in the Bahamas and divergence aloft resulted in scattered moderate to isolated strong convection from Central America to eastern Cuba and western Hispaniola, especially between 70W and 85W.

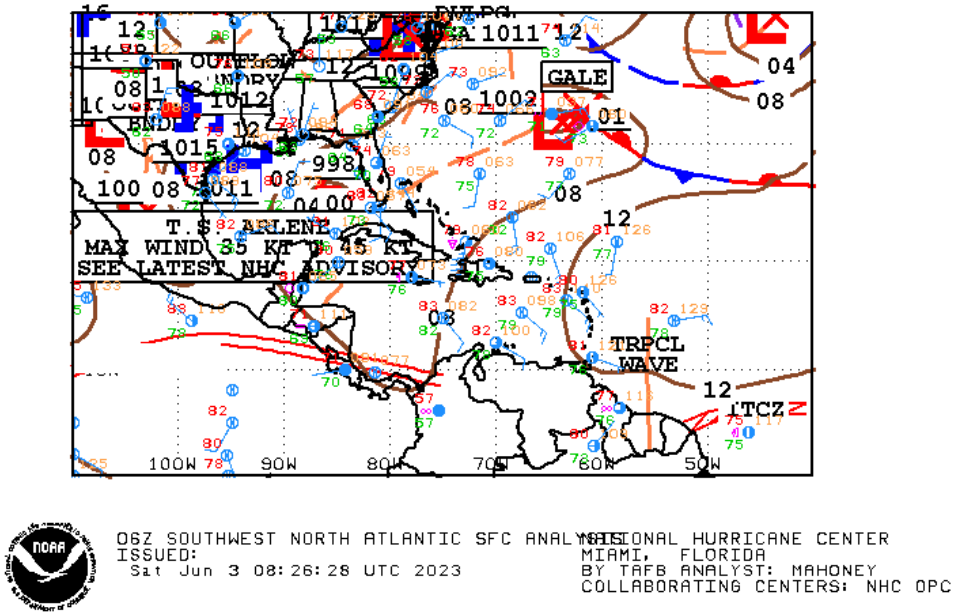
On 2 June at 0000 UTC a complex weather pattern over the western Caribbean due to newly formed Tropical Depression Two in the Gulf of Mexico, surface troughing in the Bahamas, and divergence aloft resulted in scattered moderate to isolated strong convection from Central America to eastern Cuba and across Hispaniola, especially between 69W and 81W.

On 3 June at 1800 UTC another surface trough extended southwestward from a 1003 mb low near Bermuda across 31N68W to just northeast of the Bahamas. Convergent southerly winds feeding toward these features were coupling with divergent winds aloft to generate scattered

[1] The Government of Bahamas has four excess rainfall policies: one for The Bahamas Central; one for The Bahamas Extreme North; one for The North and one for The Bahamas South East. This heavy rainfall, did not affect the Central, Extreme North and North areas and their respective XSR policies.

showers and thunderstorms from Great Bahama Bank across southeast Bahamas to south of Bermuda.

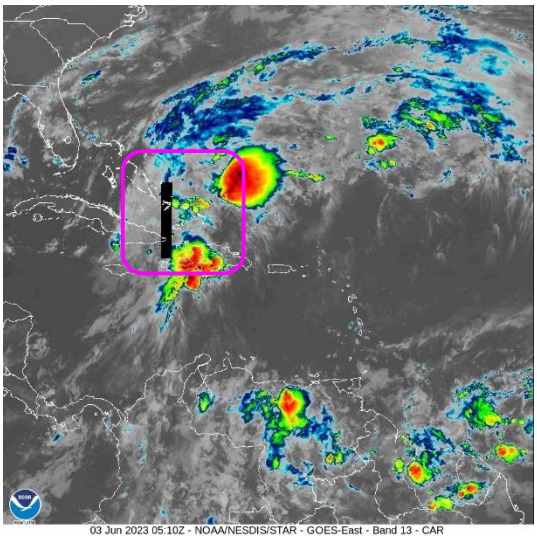
On 4 June at 1800 UTC a mid to upper level trough extended from the central Florida Panhandle to the northwest Caribbean south of western Cuba. The atmosphere had been very moist ahead of this trough with a deep layer of southerly flow. The moist pattern along with divergent flow aloft on the eastern side of the trough had been supporting clusters of showers and thunderstorms over parts of south Florida, Cuba, the Bahamas and Hispaniola over the past days.



03 June at 0600UTC

Figure 1 Surface analysis over the Caribbean Sea on 03 June 2023 at 0600 as indicated in the label. Source: US National Hurricane Center[2]

[2] National Oceanic and Atmospheric Administration - FTP, National Hurricane Center, available on 06 June 2023 at: https://www.nhc.noaa.gov/tafb/CAR_06Z.gif



03 June at 0500UTC

Figure 2 Satellite imagery at different times as indicated by the labels, from 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, GOES Image View[3]

3 IMPACTS

At the time of writing this event briefing, they were only flood warnings by The Bahamas Department of Meteorology[4] There was no further information for damages or loss in the Bahamas South East due to this rainfall event.

[3] NESDIS Online Archive, NOAA National Environmental Satellite, GOES Image View, available at: *https://www.star.nesdis.noaa.gov/GOES/sector_band.php?sat=G16&sector=car&band=13&length=12*

[4] Flood Warning by The Bahamas Department of Meteorology

4 RAINFALL MODEL OUTPUTS

Three of the six data sources used by the XSR 3.0 model, CMORPH[5], IMERG[6] and WRF11[7], detected the occurrence of precipitation over the Bahamas South East and the surrounding waters during the period of 31 May to 4 June 2023. However, each data source reported a specific distribution and accumulation of rainfall, as discussed below. The CARE for the Bahamas South East was activated on 2 June and lasted for the period 2 - 4 June. The CARE was activated due to the use of the 12-hour and the 48-hour aggregation intervals for precipitation[8] and thus the period considered by the XSR 3.0 model for the loss estimate based on the accumulated precipitation in the Bahamas South East was 31 May – 4 June.

CMORPH reported total accumulated amounts of precipitation below than 220 mm over all the region of the Bahamas South East. The maximum values, between 200 mm and 220 mm, were shown in the north area of the Acklins Island and in the east area of the Crooked Island.

IMERG reported total accumulated amounts of precipitation higher than 80 mm over all the region of the Bahamas South East. The maximum values, between 280 mm and 300 mm, were shown in the north east area of the Acklins Island.

WRF5 showed total accumulated values of precipitation below 160 mm over all the region of the Bahamas South East, with the maximum value between 140 mm and 160 mm in a small area in Acklins Islands, and in the central area of Inagua Islands. Lower values were reported over the rest of the region.

WRF7 simulated total accumulated values of rainfall below 160 mm over all the region of the Bahamas South East, with maximum amounts, between 140 mm and 160 mm, in the central area of Acklins Islands. Lower values were reported over the rest of the region.

WRF11 showed total accumulated values of precipitation until 400 mm over the eastern portion of the Inagua Islands. Over the rest of the Inagua Islands, the accumulated rainfall amount ranged between 80 mm and 380 mm, and over the rest of the region, the total accumulated amounts of precipitation were higher than 20 mm.

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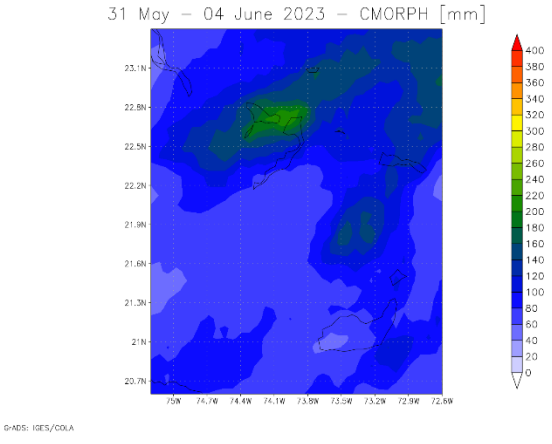
[5] CMORPH Model: the satellite-based rainfall precipitation estimates provided by the NOAA Climate Prediction Center (CPC) using the so-called Morphing Technique *http://www.cpc.ncep.noaa.gov/products/janowiak/cmorph_description.html*. Further details in the Definitions section of this report.

[4] 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*.

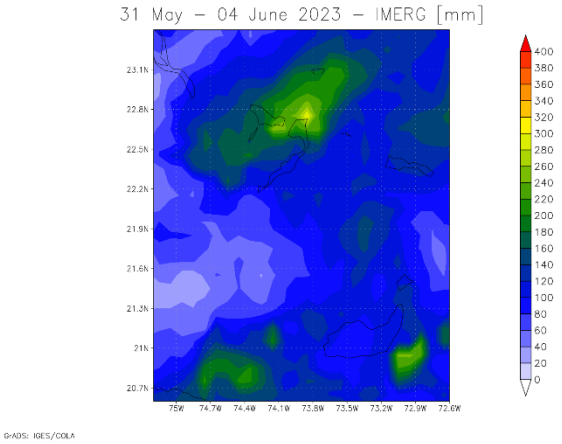
[5] WRF5, WRF7, WRF11 and WRF15 Models: the Weather Research and Forecasting Model weather model-based Configuration #1 and #2 data *https://www.mmm.ucar.edu/weather-research-and-forecasting-model*. These data are initialised by the NCEP FNL dataset. (NCEP FNL Operational Model Global Tropospheric Analyses [*http://rda.ucar.edu/datasets/ds083.2/*]). Further details 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.

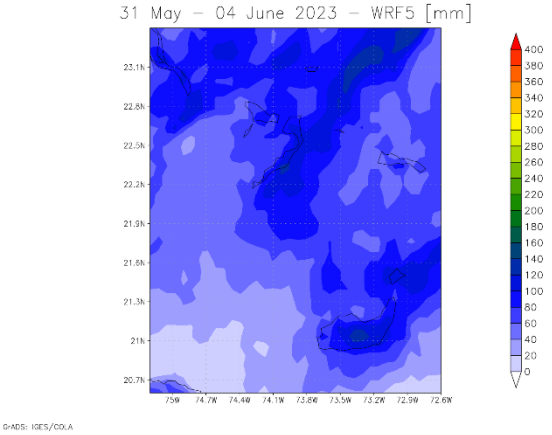
WRF15 simulated total accumulated values of rainfall higher than 80 mm over the Inagua Islands, with maximum amounts, between 240 mm and 260 mm, in the western portion of the Inagua Islands. Lower values were reported over the rest of the region.



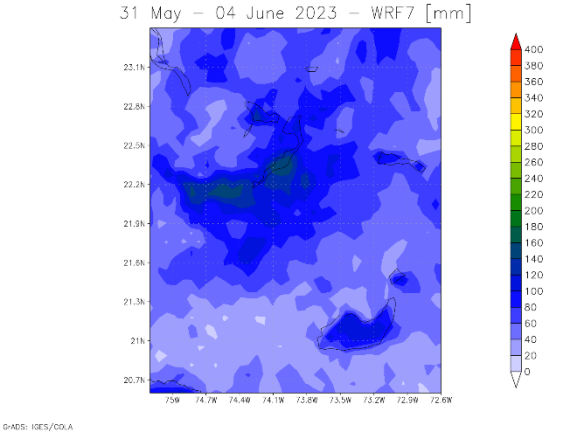
a) CMORPH



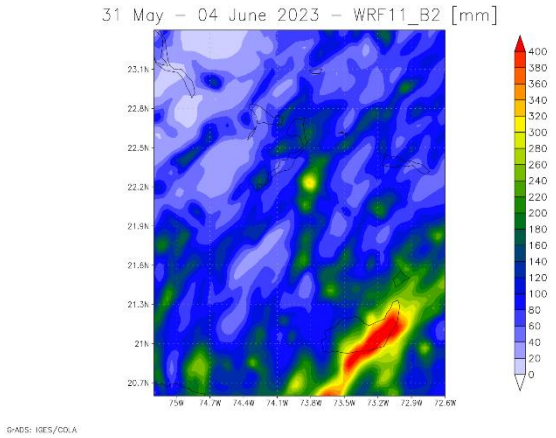
b) IMERG



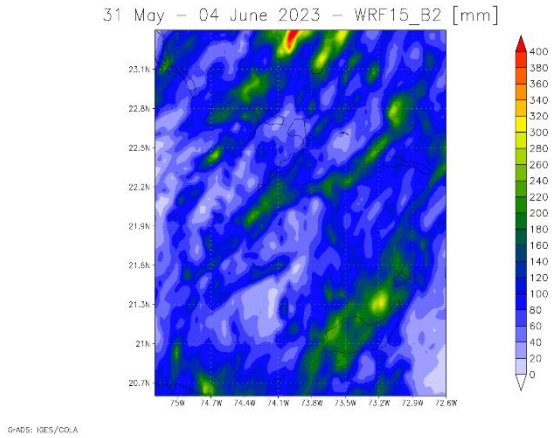
c) WRF5



d) WRF7



e) WRF11



f) WRF15

Figure 3 Total accumulated precipitation during the period 31 May - 04 June, 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/BHS/BHS_SE/CARE_1_2023/daily_prec_short.mp4
https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/BHS/BHS_SE/CARE_1_2023/daily_prec_long.mp4

The Rainfall Index Loss (RIL) was above the loss threshold for the Bahamas South East for three data sources used by XSR3.0: CMORPH, IMERG and WRF11. The RIL was the highest for IMERG, due to the larger value of accumulated precipitation estimated over the Acklins and Crooked Islands, the areas characterized by the highest exposure for the South East area of the Bahamas.

The final RIL (RIL_{FINAL}) was calculated as the average of the three RILs from CMORPH, IMERG and WRF11. The RIL_{FINAL} was greater than zero and therefore this CARE qualified as a loss event. However, the RIL_{FINAL} was below the attachment point of the excess rainfall policy for the Bahamas South East and therefore it did not trigger a policy payout.

5 TRIGGER POTENTIAL

The Rainfall Index Loss calculated for this Covered Area Rainfall Event (CARE) was below the attachment point of The Bahamas – South East Excess Rainfall policy and therefore no payout 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.