CCRIF SPC
The Caribbean Catastrophe Risk Insurance Facility

On behalf of
Caribbean XSR SP

Covered Area Rainfall Event (29/09/2019 to 30/09/2019)

Excess Rainfall

Event Briefing

Turks and Caicos Islands

9 October 2019

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1 INTRODUCTION

A tropical wave and upper level low pressure system produced periods of rain/showers and thunderstorm activity over the Turks and Caicos Islands on 29 September 2019, generating adverse weather mainly over the northwest of the Turks and Caicos Islands.

This event briefing describes the impact of the precipitation on the Turks and Caicos Islands during the period of 27-30 September 2019. The Rainfall Index Loss (RIL) calculated for this Covered Area Rainfall Event (CARE), which occurred in the Turks and Caicos Islands, starting on 29 September and ending on 30 September 2019, was below the attachment point of the Turks and Caicos Islands' Excess Rainfall policy and therefore no payout is due.

2 EVENT DESCRIPTION

On 29 September 2019 at 1800UTC, a tropical wave passed over the central Caribbean Sea, originating from latitude 20N and along longitude 70W (Figure 1), moving towards the west with a velocity of 11 to 17 mph (19 to 28 km/h). The combination of the instability associated with the tropical wave and the presence of an upper level low pressure system NE of the Dominican Republic (Figure 2) led to scattered strong rain showers over the region from 18N to 21N between 67W and 74W. Of significance was the development at 1700UTC of a multi-cell storm extended from the waters to the north of the Dominican Republic (20N, 70W) to the northwest of the Turks and Caicos Islands (23N, 74W), as reported in Figure 3. Individual cells lasted for 30-60 minutes but the multi-cell system persisted for over 6 hours and affected the Turks and Caicos Islands with intense precipitation.

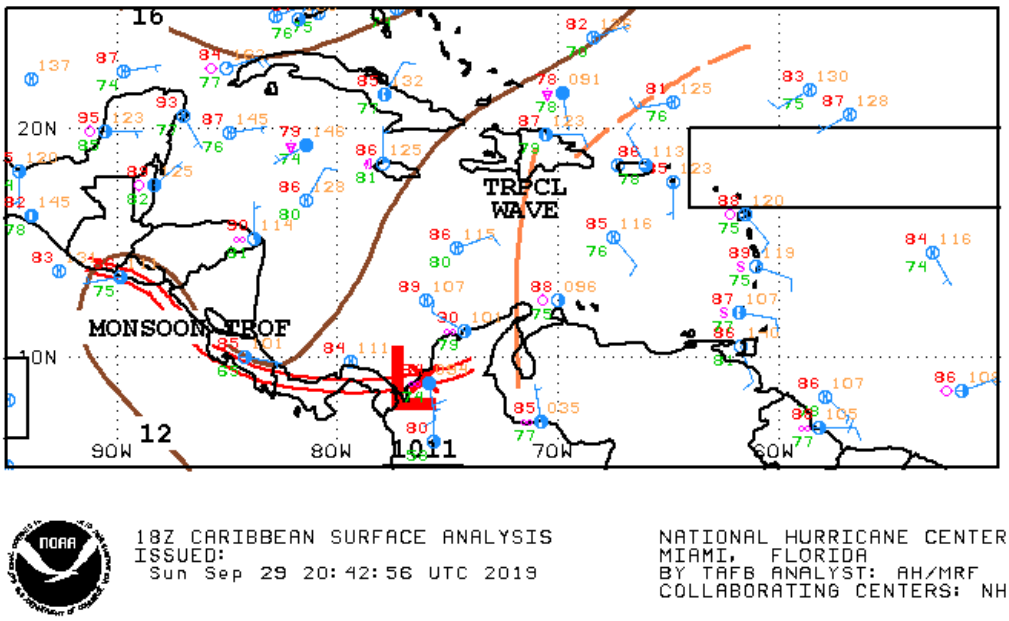


Figure 1 Surface analysis over the Caribbean area on 29 September at 1800UTC. The tropical wave is visible over the central Caribbean Sea. Source: US National Hurricane Center (NHC)

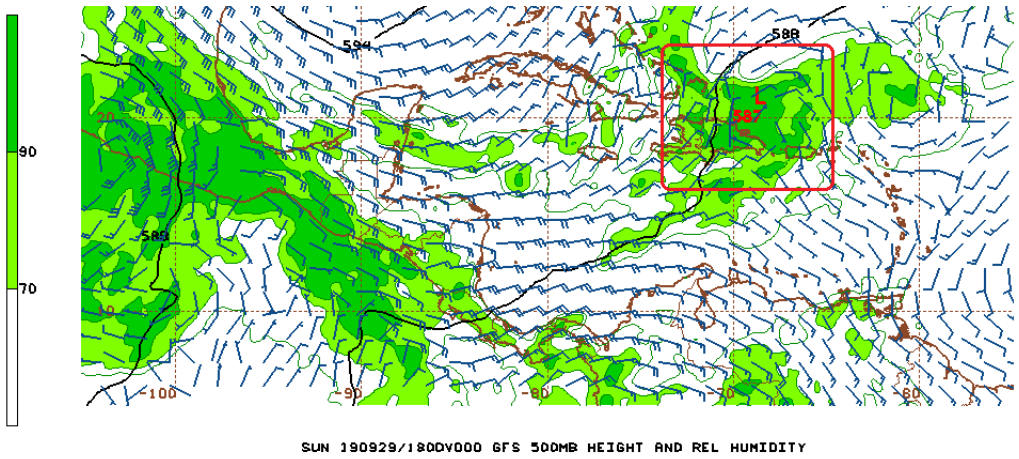
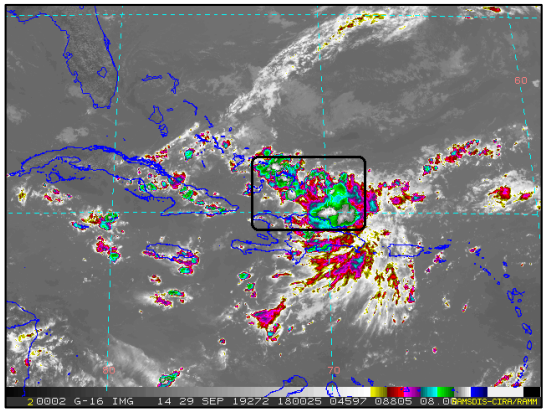
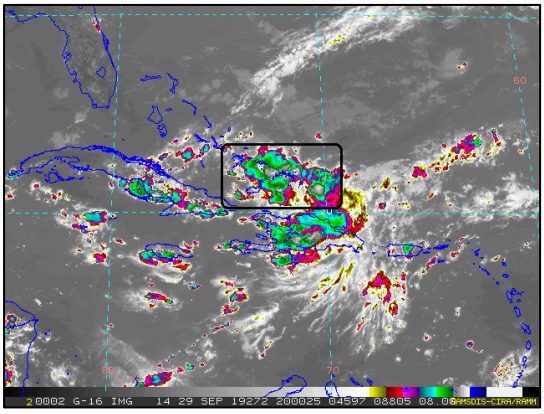


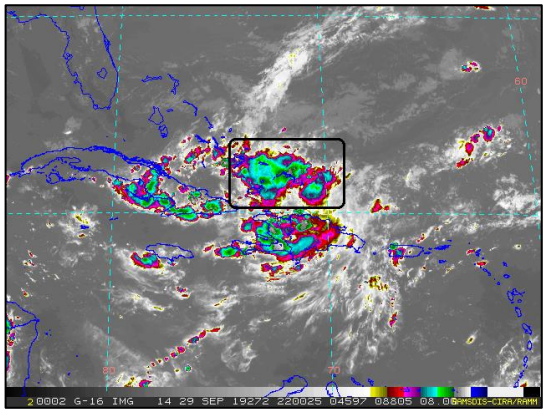
Figure 2 Upper level analysis produced by the GFS global model (NOAA) of geopotential height and relative humidity at 500 mb on 29 September 2019 at 1800UTC. The red square indicates the low pressure system NE of the Dominican Republic embedded in a humid air mass. Source: US National Hurricane Center (NHC)



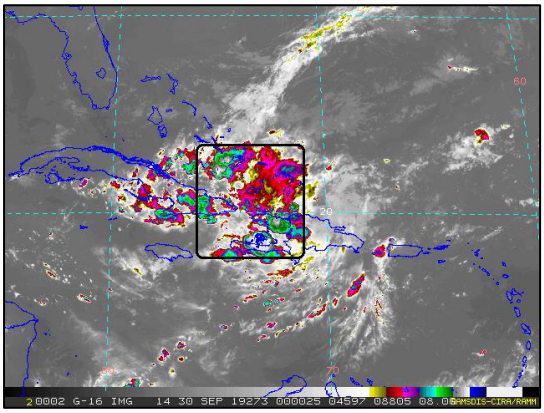
a) 29 September 1800UTC



b) 29 September 2000UTC



c) 29 September 2200UTC



d) 29 September 0000UTC

Figure 3 Satellite imagery at different times (indicated in the labels) from thermal infrared channel enhanced with color (red/violet colours are for medium height clouds while blue/green/grey colours are for high altitude clouds). High altitude clouds indicate strong convection associated with intense precipitation. The multi-cell storm over the Turks and Caicos Islands is highlighted by a black box in the images)

The surface measurements from the GSOD dataset (Global Surface Summary of the Day - *https://www1.ncdc.noaa.gov*) reported data from two rain gauges in the Turks and Caicos Islands, respectively located in Turks Island (21.450N, 71.15W) and Providenciales (21.77N, 72.26W) in the northwestern edge of the country. On 27, 28 and 30 September, both rain gauges reported zero precipitation, while on 29 September both instruments reported error readings. The incomplete data series is an indication of missing or anomalous instrument sampling due to instrument failure on the day of thunderstorm activity. Therefore, these surface measurements cannot be used to better characterize the multi-cell storm event in the Turks and Caicos Islands.

The satellite-derived estimate of precipitation by IMERG (Integrated Multi-satellitE Retrievals for GPM) dataset for this event is reported in Figure 4. During the period 27 -30 September, the accumulated precipitation over great part of the Turks and Caicos Islands was estimated in the interval between 60 and 100 mm, with the largest values over Middle Caicos and North Caicos.

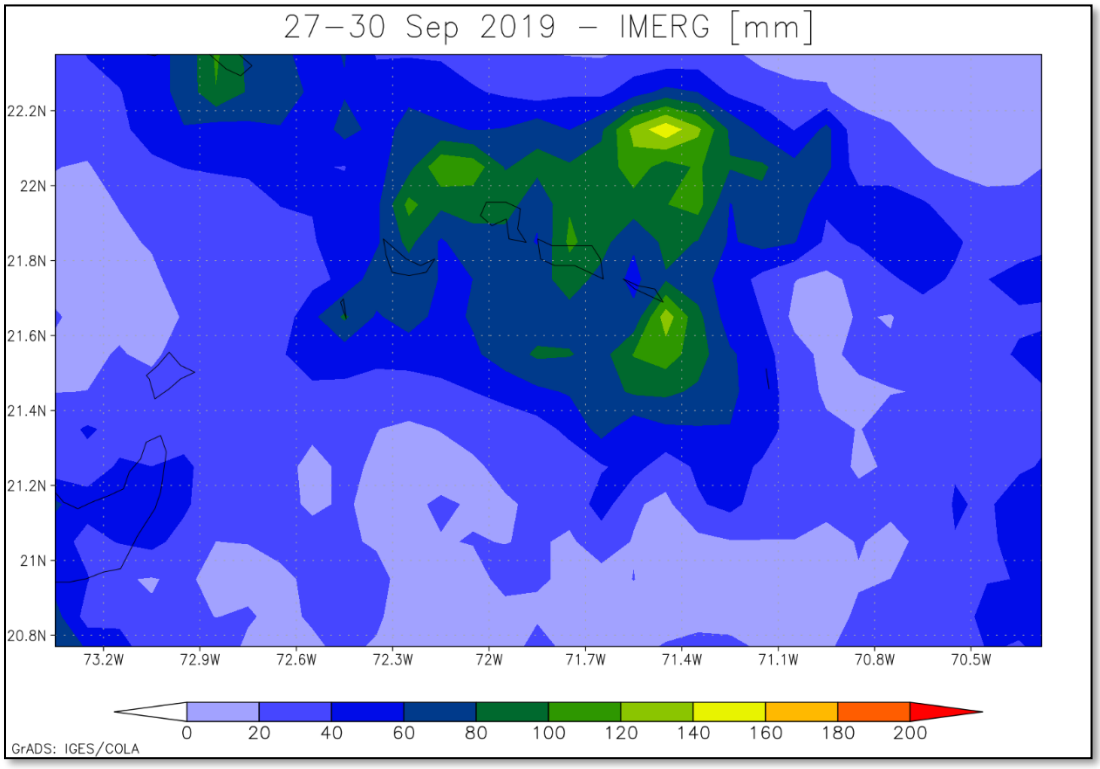


Figure 4 IMERG accumulated precipitation (rainfall) at 10 km resolution over the Turks and Caicos Islands in the period 27 to 30 September 2019. Source: XSR Web

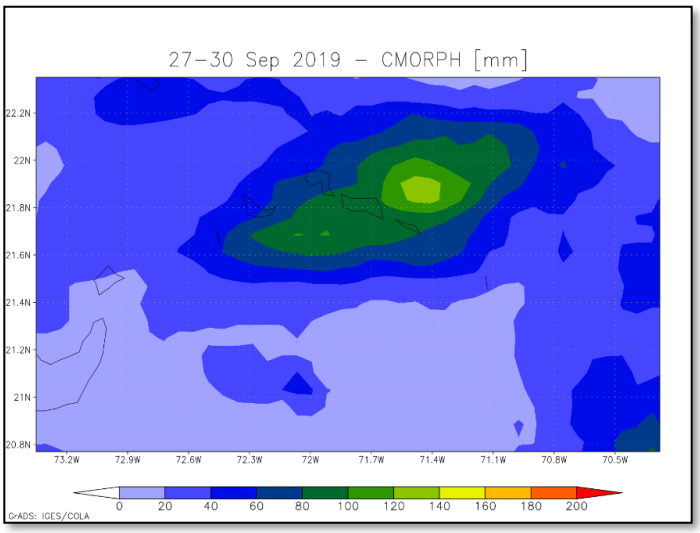
3 IMPACTS

At the time of this event brief, no information was available related to damage or loss in the Turks and Caicos Islands due to this CARE. However, a subsequent version of this report may be updated with information contained in official reports or communications that may be issued by the Government of the Turks and Caicos Islands.

4 RAINFALL MODEL OUTPUTS

All three models, CMORPH[1], WRF5 and WRF7[2], simulated the occurrence of showers over the Turks and Caicos Islands and the surrounding waters during the period 27-30 September 2019.

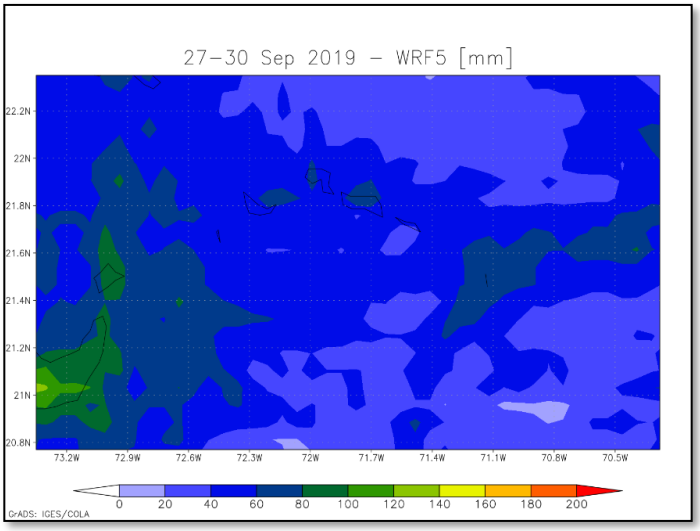
CMORPH reported total accumulated amounts of precipitation comparable with those of IMERG over the Turks and Caicos Islands, between 40 mm and 100 mm, with the maximum over Middle Caicos and East Caicos. Both WRF simulations produced lower amounts of precipitation than CMORPH over the Turks and Caicos Islands, as the storm system was reported to affect the Inagua Islands more intensively. Over the Turks and Caicos Islands, WRF5 indicated total amounts of precipitation between 40 mm and 80 mm, while WRF7 reported values in the same range as CMORPH (between 40 mm and 100mm), but with less extended areas affected by the maximum precipitation.



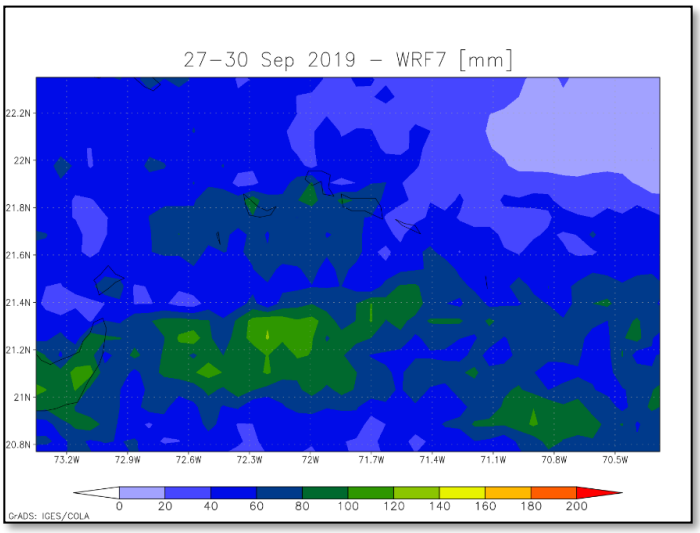
a) CMORPH

[1] 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.

[2] WRF5 and WRF7 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.



b) WRF5



c) WRF7

Figure 5 Total accumulated precipitation during the period 20-24 September 2019 estimated by CMORPH(a), WRF5(b) and WRF7(c)

Daily rainfall maps by CMORPH, WRF5 and WRF7 over the exposure map of XSR 2.5 are not included here; 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/TCA/CARE_2_2019/daily_prec_short.mp4

https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/TCA/CARE_2_2019/daily_prec_long.mp4

The standardized precipitation index (SPI) was greater than 1 in several active grid cells during this event, as shown in Figure 6. Large positive values of the standardized precipitation index indicate conditions that are unusually wet compared to the climatological average. The XSR model considers that this condition increases the flood losses when precipitation occurs. The SPI was

greater than 1 in several grid cells in the Turks and Caicos Islands due to the precipitation which had fallen during the previous 30 days. The largest contribution was from the precipitation that occurred during the CARE on 10-12 September related to Tropical Storm Humberto, which was identified by the XSR model, and classified as a non-reportable event.

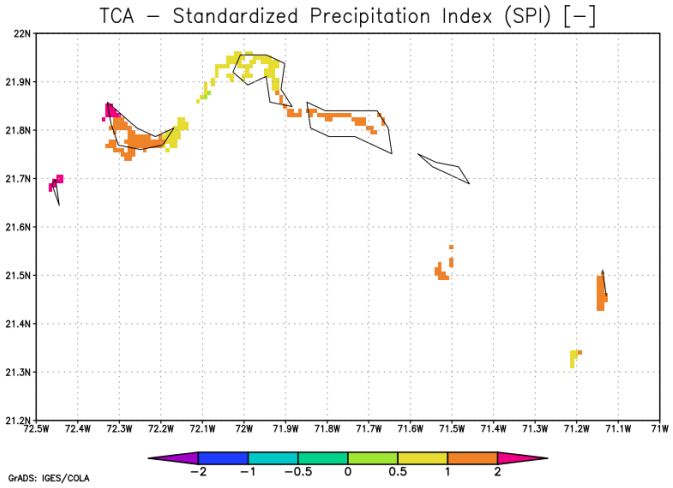


Figure 6 Standardized precipitation index (SPI) for the Turks and Caicos Islands during this the CARE on 27-30 September 2019. Source: XSR Web

The Rainfall Index Loss (RIL) was above the loss threshold for the Turks and Caicos Islands for two of the data sources used by XSR2.5, i.e. for CMORPH and WRF7. The largest RIL was associated with CMORPH, given that it reported higher amounts of rainfall over areas characterized by large exposure. The final RIL (RIL_{FINAL}) was calculated as the average of the RILs from these two data sources. 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 Turks and Caicos Islands' Excess Rainfall policy and thus did not trigger a policy payout.

5 TRIGGER POTENTIAL

The Rainfall Index Loss calculated for this Covered Area Rainfall Event was below the attachment point of the Turks and Caicos Islands' Excess Rainfall policy and therefore no payout is due.

For further information, please contact ERN-RED, the CCRIF SPC Risk Management Specialist at the official email: monitor.xsr2@ccrif.org

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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.