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AGENDA ITEM NO.3: REVIEW OF THE 2018 CYCLONE SEASON

AGENDA ITEM NO.3.2: COUNTRY REPORT

AGENDA ITEM NO.3.2(18): USA

The 2018 Atlantic hurricane season was again a devastating one for the U.S., primarily due to the effects of intense hurricanes Florence and Michael. These two cyclones produced nearly 50 billion dollars in damage due to record-setting rainfall in the Carolinas from Florence and catastrophic wind and storm surge damage in the Florida panhandle from Hurricane Michael. Michael was the most intense landfalling hurricane in the United States since Andrew in 1992. In addition, the United States was impacted by two tropical storms. Alberto and Gordon struck the northern Gulf coast in May and September, respectively.

Tropical Storm Alberto

Sub-tropical storm Alberto moved northward over the eastern Gulf of Mexico, and it transformed into a tropical storm with an estimated peak intensity of 55 kt on 27 May about 125 mi south-southwest of Apalachicola, Florida. Alberto weakened on 28 May, and it made landfall near the Bay County/Walton County Line in the Florida Panhandle in the afternoon of May 28 with estimated maximum winds of 40 kt. Alberto or its remnants moved north-northwestward across Alabama and Tennessee on the 29th, and over western Kentucky and Indiana on 30 May. It then became a remnant low early on 31 May while centered about 30 mi west of Saginaw, Michigan and dissipated over southern Ontario.

Heavy rainfall fell over the Florida peninsula over a multi-day period as Alberto moved northward across the eastern Gulf of Mexico, with a maximum six-day total of 11.80 inches reported at Taylor Creek on the northern shore of Lake Okeechobee from 25–30 May. Copious moisture surged northward on the east side of Alberto across Georgia, the Carolinas, and Virginia, where flooding rains occurred on the southeast-facing side of the southern and central Appalachian Mountains. Alberto produced four tornadoes, all of EF-0 intensity (on the Enhanced Fujita Scale).

Eight direct deaths¹ occurred from Alberto in the United States—five in North Carolina and three in Virginia. A reporter and a photojournalist from WYFF News 4,

¹ Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as “direct” deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater

the NBC affiliate in Greenville, South Carolina, died when a tree fell on their SUV in Polk County, North Carolina. A woman in Polk County also died due to a mudslide at her home near Tryon, and two people died when a landslide caused a gas leak and explosion at their home near Boone, North Carolina. In Virginia, two people were swept away and died in floodwaters near Charlottesville in Albemarle County, and a third person died from flooding in Madison County.

The NOAA National Centers for Environmental Information (NCEI) estimates that wind and water damages from Alberto totaled around \$125 million. Winds knocked down trees and caused some power outages across portions of the Florida Panhandle, but otherwise there was no significant wind damage where Alberto made landfall. Coastal flooding from storm surge was reported in Taylor, Wakulla, and Franklin Counties in Florida, with up to 2.5 ft of inundation occurring along Apalachee Bay near the fort in St. Marks and near Mashers Sands Beach. Alligator Point Road was overwashed due to surge, and flooding in Eastpoint affected the eastern end of the causeway to Apalachicola. The boat ramp at Mandalay Bay on the Aucilla River was washed off its pilings onto dry land, and the Steinhatchee Boat Ramp flooded with overwash into the adjacent parking lot. In North Carolina, flooding and mudslides closed more than 40 roads in the western part of the state, including portions of the Blue Ridge Parkway. About 2,000 people were evacuated for several hours in McDowell County due to fears that the Lake Tahoma Dam faced imminent failure, however the dam was later inspected and deemed safe.

Hurricane Florence

After a period of weakening over the eastern Atlantic, Florence began moving toward the west-northwest and then it went under a second rapid strengthening period of 50 kt in 24 hours. Florence reached its peak intensity of 125 kt around 1800 UTC 11 September when the hurricane was located about 725 n mi east-southeast of Cape Fear, North Carolina. Florence, however, weakened below major hurricane strength before it reached the southeastern coast of North Carolina as an 80-kt hurricane near Wrightsville Beach, around 1115 UTC 14 September. Prior to and after landfall, the hurricane slowed down considerably, which resulted in excessive rainfall of more than 20 inches (500 mm) occurring over much of northeastern South Carolina and southeastern North Carolina, with some areas receiving more than 30 inches of rain. The torrential rains caused extensive inland freshwater flooding that damaged numerous homes, businesses, and public infrastructure, and also resulted in at least 28 river flood stage records being broken that had been set just two years prior during Hurricane Matthew (2016). Florence was responsible for at least 25 direct deaths [preliminary estimate] in the United States."

Florence eventually weakened to tropical storm status by 0000 UTC 15 September when the cyclone was located over eastern South Carolina just north of Myrtle Beach. The tropical storm turned westward and moved slowly across central and northwestern South Carolina, degenerating into a tropical depression by 1800 UTC 16 September when the cyclone was located about 35 n mi south of Florence,

floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered "indirect" deaths.

South Carolina. The depression moved quickly northward around the western periphery of a narrow high pressure system centered just east of the North Carolina Outer Banks on 17 September, passing over western North Carolina, eastern Tennessee, and western Virginia, before reaching western West Virginia by 1200 UTC where Florence became an extratropical low pressure system. The low turned northeastward ahead of an approaching frontal system and steadily weakened and dissipated over Massachusetts shortly after 1200 UTC 18 September.

Florence produced maximum storm surge inundation heights of 8 to 11 ft above ground level in North Carolina along the shores of the Neuse River and its tributaries, where they empty into Pamlico Sound. Pamlico Sound has very little tidal influence, but easterly winds from Florence raised water levels on the western side of the sound and backed up the normal flow of the Neuse River, causing significant shoreline inundation in Craven, Pamlico, and Carteret Counties. A United States Geological Survey (USGS) storm tide pressure sensor deployed across the Neuse River from Downtown New Bern recorded a storm tide water elevation of 10.08 ft above the North American Vertical Datum of 1988 (NAVD88) (Fig. 8), which converts to about 10.4 ft above Mean Higher High Water (MHHW). A post-storm simulation of Florence's surge (Fig. 9b) suggests that the highest inundations—up to 11 ft above ground level—occurred just upstream of Downtown New Bern along the Neuse and Trent Rivers.

A total of 49 tornadoes were spawned by Florence across three states in the southeastern United States: North Carolina – 33, South Carolina – 6, and Virginia – 10.

Florence produced significant damage, mainly due to storm surge and inland freshwater flooding across the Carolina and extending northward into Virginia due to the slow motion of the storm. The NOAA National Centers for Environmental Information (NCEI) estimates that wind and water damages in the United States from Florence totaled 24 billion dollars. The final number of fatalities in the United States from the hurricane is still being assessed as of this writing.

Tropical Storm Gordon

Gordon formed just southeast of the Florida Keys and made landfall around 1115 UTC 3 September with an estimated intensity of 45 kt near Tavernier in the Florida Keys. After crossing Florida Bay, Gordon made a second landfall near Flamingo on the southern tip of the Florida peninsula around 1315 UTC that day. The center of Gordon emerged over the extreme eastern Gulf of Mexico, and strengthened into a 50-kt tropical storm as an eye-like feature became apparent in NWS radar imagery when it was centered just off the coast of Marco Island, Florida. The small eye feature only persisted an hour or two, but the tropical storm slowly strengthened while it continued to move west-northwestward to northwestward over the eastern Gulf of Mexico.

Gordon reached its peak intensity of 60 kt the next day while centered over the north-central Gulf of Mexico about 140 mi south-southeast of Pascagoula, Mississippi, and then it made landfall between the Alabama/Mississippi border and Pascagoula around 0315 UTC 5 September. It weakened after it moved inland and

became a remnant low near Pine Bluff, Arkansas. The remnants of Gordon merged with a developing extratropical low late on 8 September, and the new low moved slowly east-northeastward across western Kentucky and the Ohio Valley.

According to media reports, Gordon was responsible for one direct death while it was a tropical cyclone. A 2-year-old girl perished when strong winds caused a tree to fall on a mobile home that she was in near Pensacola, Florida. Heavy rainfall in Missouri and Kentucky produced by an extratropical low that included the remnant moisture from Gordon caused flash flooding that was responsible for three deaths. A 40-year-old man drowned when his vehicle stalled in flood waters beneath a railroad overpass in Louisville, Kentucky, and a 9-year-old boy drowned after he was swept away by floodwaters in Morehead, Kentucky. In Greene County, Missouri, a Sheriff's deputy died after his patrol car was washed off a road into a nearby river.

Gordon produced moderate damage across portions of the northern Gulf coast. In Alabama, some homes on Dauphin Island experienced roof and siding damage. In Pensacola, Florida, a pier sustained minor damage, and numerous trees were downed across portions of southern Mississippi, Alabama, and the western Florida panhandle. Some of these falling trees caused damage to homes and other property. Beach erosion was reported in the Fort Pickens area in Escambia County, Florida. At one point 27,000 customers were without power, mainly in southern Alabama and the western portion of the Florida Panhandle. Flooding from heavy rainfall resulted in two high-water rescues in a neighborhood in the town of Cantonment, Florida. In South Florida and the Keys, only minor damage was reported. There were a few downed power lines in Broward and Miami-Dade counties, which resulted in the loss of power to about 8,000 customers in those counties.

There were no reports of damage associated with the tornado that occurred while Gordon was a tropical cyclone. However, there was damage associated with the tornadoes that occurred in Kentucky and in Indiana in association with the remnants of the tropical cyclone. The two EF-1 tornadoes both caused roof and tree damage, including roofs that were torn off a few homes and a home that experienced a wall collapse in the Stanley, Kentucky, tornado. Gordon's remnants also produced flash flooding in parts of Missouri and Kentucky, with low-lying roads reported underwater in portions of those areas. There were some water rescues in Kentucky due to vehicles that became stranded in floodwaters. Minor flooding was also reported in portions of Arkansas, Ohio, Indiana, Illinois, and Pennsylvania.

Preliminary monetary damage associated with Gordon is estimated by NOAA to be 200 to 250 million dollars.

Hurricane Michael

Michael moved into the southeastern Gulf of Mexico late on 8 October and rapid intensification continued until landfall. The hurricane moved between the north-northwest and north as Michael moved between the ridge and a mid-latitude shortwave trough moving through the west Gulf Coast states. Michael recurved to the northeast, which led to the eye making landfall over Tyndall Air Force base in the Florida Panhandle (southeast of Panama City) near 1730 UTC 9 October with the maximum sustained winds estimated at 135 kt, making Michael a strong category 4

hurricane on the Saffir-Simpson Hurricane Wind Scale. (The final reanalysis of Michael has not been complete as of this writing.)

Michael accelerated northeastward and weakened after landfall as the center moved across the central Florida Panhandle into southwestern Georgia by 0000 UTC 11 October. Weakening to a tropical storm, the center passed just west of Albany, just east of Macon, and just west of Augusta before the center crossed into South Carolina near 1100 UTC that day. By this time, the winds in the central core of the cyclone had weakened to below tropical-storm force. However, tropical-storm force winds continued over the coasts and coastal waters of Georgia and South Carolina. The storm continued northeastward and moved into North Carolina by 1500 UTC, and three hours later it was centered to the south of Greensboro.

Near this time, the system began extratropical transition, with the center becoming elongated and the winds increasing to the west and northwest of the center. This was accompanied by a turn toward the east-northeast, which took the center north of Raleigh, then across the Norfolk, Virginia metropolitan area and into the western Atlantic by 0600 UTC 12 October.

The number of casualties² associated with Hurricane Michael is still uncertain as of this writing due to incomplete reports. However, a compilation by Wayne Blanchard of US Deadly Events includes the following estimates:

There are 20 deaths directly caused by the winds, tides, and rains of the hurricane, with 11 in Florida, 5 in Virginia, 3 in North Carolina, and 1 in Georgia. In Florida, six people drowned in the storm surge in the Mexico Beach/Panama City area, while four people died due to falling trees during the storm. There was one other drowning death in Florida, but it is unclear whether this was due to storm surge or freshwater flooding. In Virginia, five people died due to freshwater flooding. The deaths in North Carolina and Georgia were due to falling trees.

The range of deaths indirectly caused by Michael is currently 37-39. All but one of these occurred in Florida, with the other indirect death occurring in Virginia. The causes of the indirect deaths included falls during the post-storm clean up, traffic accidents, and medical issues compounded by the hurricane. It should be noted that five of the deaths currently have no reported cause, and thus the casualty figures could be revised as new information becomes available.

Michael's winds and storm surge caused catastrophic damage to property in the vicinity of Mexico Beach and Tyndall Air Force Base, with numerous structures destroyed or heavily damaged. The winds and tides also caused damage elsewhere in the eastern portion of the Panama City metropolitan area, and along the coast of the Florida Panhandle east of Panama City through Apalachee Bay. A swath of wind damage occurred near the track of the center elsewhere across the Florida Panhandle into southwestern and central Georgia. Farther to the northeast, a combination of wind and freshwater flooding caused minor damage from eastern

² Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered indirect" deaths.

Georgia through southeastern Virginia. The National Center for Environmental Information estimates the total damage from Michael in the United States at \$25 billion. An exact breakdown of this total is not currently available. However, various agricultural and forestry reports indicate that around \$6.5 billion of this total was to agriculture and forest interests.

Acknowledgements:

The cyclone summaries are based on Tropical Cyclone Reports prepared by the Specialists from the RSMC Miami Hurricane Specialist Unit. These reports are available on the Internet at www.nhc.noaa.gov

Table 1. 2018 Atlantic and eastern North Pacific tropical cyclones that affected the United States.

Name	Class^a	Dates^b	Landfall Winds (kt)	Landfall Pressure (mb)	Deaths^c
Alberto	TS	May 25 – 31	40	992	8
Gordon	TS	September 3 – 6	60	996	1
Florence	H	August 31 – September 17	80	958	25
Michael	MH	October 7 – 12	135	919	15

^a Tropical depression (TD), maximum sustained winds 33 kt or less; tropical storm (TS), winds 34-63 kt; hurricane (H), winds 64-95 kt; major hurricane (MH), winds 96 kt or higher.

^b Dates begin at 0000 UTC and include all tropical and subtropical cyclone stages; non-tropical stages are excluded.

^c Deaths in the USA during the tropical cyclone phase. Additional deaths may have occurred during other portions of the cyclone’s life cycle.

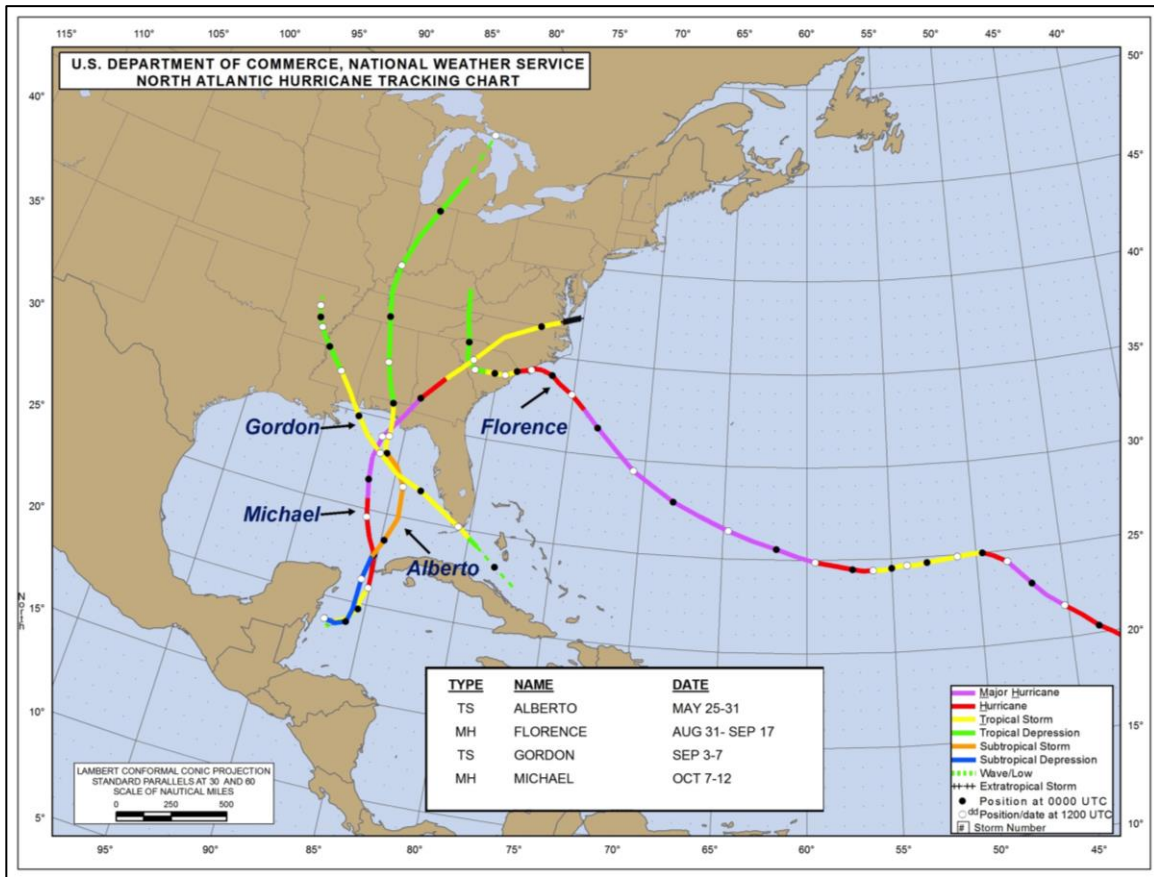


Figure 1. Tracks of Atlantic and eastern North Pacific tropical storms and hurricanes that affected the United States during the 2018 season.