# Tropical Cyclone Report <br> Hurricane Noel <br> (AL162007) 

28 October-2 November 2007

Daniel P. Brown
National Hurricane Center
17 December 2007

Noel took an erratic track across Hispaniola and Cuba as a tropical storm before becoming a hurricane as it exited the northwestern Bahamas. Torrential rainfall from Noel produced devastating floods and loss of life in the Dominican Republic, Haiti, Jamaica, eastern Cuba and the Bahamas. Noel then evolved into a large and powerful extratropical cyclone that brought hurricane force wind gusts to portions of the northeastern United States and eastern Canada.

## a. Synoptic History

The tropical wave that played a role in the development of Noel departed the west coast of Africa early on 16 October. During the next several days, the wave moved westward across the eastern Atlantic without showing any signs of organization. As the tropical wave approached the Lesser Antilles late on 22 October, it began to interact with a surface trough lying just north of the Leeward Islands and an upper-level trough that extended southwestward from the Atlantic into the eastern Caribbean Sea. As the wave interacted with these two features, a broad surface low pressure area formed about 150 n mi east-northeast of the northern Leeward Islands late on 23 October. The new surface low then moved slowly westward and produced disorganized thunderstorm activity during the next couple of days, while strong upper-level westerly winds inhibited further development. The low turned west-southwestward on 25 October, moving over the Virgin Islands and passing near the southeastern coast of Puerto Rico early the next day. On 27 October, the strong upper-level winds began to decrease, allowing convection to develop and remain closer to the low center. An increase in organization that afternoon led to the formation of a tropical depression about 185 n mi south-southeast of Port-Au-Prince, Haiti by 0000 UTC 28 October. The "best track" chart of the tropical cyclone's path is given in Fig. 1, with a closeup of the tropical cyclone portion of the track shown in Fig. 2. Wind and pressure histories are provided in Figs. 3 and 4, respectively. The best track positions and intensities are listed in Table 1.

After genesis, the depression turned northwestward, around the eastern side of a mid-to upper-level low located to the northwest of the tropical cyclone. Convection continued to increase and banding features became better defined during the early morning hours of 28 October. A ship observation taken to the northeast of the center at 1200 UTC that day suggests that the depression reached tropical storm strength by that time. Thereafter, Noel continued to strengthen, reaching an intensity of 50 kt six hours later. As Noel continued moving northwestward toward the southern coast of Haiti on 29 October, interaction with the mountainous terrain along the southern coast of the island resulted in the disruption of the lowlevel circulation. Noel's maximum winds decreased to 45 kt before the center made landfall
along the southern coast of Haiti around 0700 UTC near the town of Jacmel, about 25 miles south-southwest of Port-Au-Prince.

During its passage along the west coast of Haiti, the low-level circulation became very difficult to track. Satellite imagery during this time suggests that a mid-level circulation continued moving northward and exited the northern coast of Hispaniola just before 1200 UTC. Shortly thereafter, visible satellite imagery suggests that a new low-level center formed near the northwestern coast of Haiti, southwest of the apparent mid-level center. A reconnaissance mission later that afternoon was unable to fly directly through the low-level center seen in satellite imagery because it was located too close to the complex terrain of eastern Cuba. Wind and pressure data from this mission, however, were consistent with the position estimated from satellite imagery.

The mid-to upper-level low that had been steering Noel northwestward weakened late on 29 October. After this occurred, the tropical storm turned westward to the south of a mid-level ridge over the western Atlantic. During this time, Noel hugged the northern coast of eastern Cuba and regained an intensity of 50 kt . Surface data and radar observations from Holguin, Cuba indicate the center of Noel passed near or just north of Cabo Lucrecia and made landfall around 0600 UTC near Guardalavaca, Cuba. A few hours later, the center passed near La Jiquima, where a minimum pressure of 997.9 mb was recorded. Noel's center spent a little more than 30 hours over Cuba. While over the island, the maximum winds decreased, but ship and surface observations show that Noel remained a minimal tropical storm. For the first 18 h over Cuba, Noel moved a little south of due west. Thereafter, the tropical storm turned northwestward, then north-northwestward and re-emerged over the Atlantic waters along the north-central coast of Cuba near Cayo Coco, shortly after 1200 UTC 31 October.

Once over water, the tropical storm regained strength and meandered just off the north coast of Cuba. During this time, the low-level center was displaced to the southwest of the convective activity due to southwesterly wind shear. Early on 1 November, Noel turned northnortheastward ahead of a mid-latitude trough that was moving across the Gulf of Mexico. At this time, a very strong burst of deep convection developed just northeast of the center. Aircraft data indicate that the minimum pressure began to fall but that the maximum winds did not initially increase. The center of Noel moved across Andros Island in the northwest Bahamas shortly after 1200 UTC 1 November with maximum winds of 50 kt , and six hours later passed very near Nassau with winds of 55 kt . Despite the southwesterly shear, Noel continued to intensify over the northwestern Bahamas and shortly after passing between Eleuthera and Abaco Islands, it attained hurricane strength. Noel reached a peak intensity of 70 kt and accelerated northeastward ahead of the mid-latitude trough. Shortly thereafter, the satellite appearance of Noel began to deteriorate as the inner-core convection weakened. By 0000 UTC 3 November, Noel lacked the deep convection required to consider it a tropical cyclone and the system became extratropical, while centered about 240 n mi southeast of Cape Hatteras, North Carolina.

The extratropical low grew into a very large and powerful cyclone as it moved northnortheastward off the east coast of the United States. The cyclone intensified a little, reaching a peak intensity of 75 kt at 1200 UTC 3 November. Late that day, the low weakened slightly as it passed about 75 n mi east-southeast of Nantucket Island, Massachusetts. Shortly after 0600 UTC

4 November, the center of the low made landfall near Chebogue Point, Nova Scotia, just south of Yarmouth with maximum winds of 65 kt . The cyclone weakened after landfall in eastern Canada and exited the coast of Labrador about 18 h later. The low continued northeastward and merged with another extratropical cyclone over Greenland by 0600 UTC 6 November.
b. Meteorological Statistics

Observations in Noel (Figs. 3 and 4) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB). Microwave satellite imagery from NOAA polar-orbiting satellites, the NASA Tropical Rainfall Measuring Mission (TRMM), the NASA Aqua, the NASA QuikSCAT, the Department of Defense WindSat, and Defense Meteorological Satellite Program (DMSP) satellites were also useful in tracking Noel. Ten reconnaissance missions by the U.S. Air Force Reserve and one by the NOAA WP-3D aircraft were flown into Noel. The NOAA G-IV aircraft conducted two synoptic surveillance missions. Observations from these missions include flightlevel winds, dropwindsonde observations, and surface wind estimates from the SteppedFrequency Microwave Radiometer (SFMR). Radar imagery and surface observations from Cuba were extremely useful in tracking Noel's passage over that country. One NOAA WP-3D flight was flown after Noel was no longer a tropical cyclone. This flight was flown in support of an experimental unmanned Aerosonde mission that was conducted on 3 November.

The 50 kt estimated intensity of Noel when it was centered south of Hispaniola is based on a blend of an SFMR surface wind estimate of 53 kt and peak flight-level wind of 58 kt adjusted to the surface using a standard adjustment factor. The highest wind gust recorded on the island of Hispaniola was 60 kt at Barahona, Dominican Republic at 0815 UTC 29 October (Table 2). Noel's re-strengthening to 50 kt prior to landfall in eastern Cuba is supported by an SFMR surface wind estimate of 52 kt . A wind gust to 113 kt was reported at Gran Piedra, Cuba. This observing site, however, is at an elevation of about 4000 ft and this wind measurement is clearly not representative of conditions near sea level. Table 2 shows that most of the official observing sites in eastern Cuba reported maximum wind gusts between 30 and 40 kt .

The 70 kt peak intensity of Noel is based on several peak SFMR surface wind estimates of around 70 kt on 2 November. A maximum flight-level wind of 89 kt was observed at 0216 UTC 2 November, which would typically correspond to an 80 kt maximum surface wind using a standard $90 \%$ adjustment of the 700 mb wind. SFMR and dropwindsonde data, however, during this flight suggest that the standard $90 \%$ adjustment was likely not valid for Noel at this time. The highest SFMR wind during the mission was 70 kt and a dropwindsonde at 0520 UTC provided a surface wind estimate of 70 kt (derived from the mean wind over the lowest 150 m of the sounding). A subsequent reconnaissance mission between 1200 and 1800 UTC 2 November recorded a maximum flight-level wind of 90 kt at 700 mb , but again the highest surface wind estimate from the SFMR during this flight was 70 kt .

Reconnaissance data from a NOAA WP-3D mission early on 3 November suggest that Noel maintained a shallow warm core at the time the cyclone is analyzed as extratropical in the best track. While the presence of the warm core is noted, this does not mean that Noel remained
a tropical cyclone during this time. Inner-core convection significantly decreased after 1200 UTC 2 November, and Noel no longer met the convective requirement of a tropical cyclone by 0000 UTC 3 November (Fig. 5). The shallow warm core associated with Noel at this time was likely the residual warm core of the tropical cyclone. The 75 kt peak intensity of the extratropical cyclone is based on QuikSCAT data from 1024 UTC 3 November.

Ship reports of winds of tropical storm force directly associated with Noel are given in Table 3.

Noel produced several days of torrential rainfall across Hispaniola and Cuba. In Haiti, 15.98 in of rainfall was recorded between 28-30 October at Foret des Pins. Rainfall reports received from the Dominican Republic include accumulations between 25-31 October, a period that includes the effects of the precursor low of Noel. The reports indicate that the heaviest rains fell between 28-31 October. Several locations in the Dominican Republic reported total accumulations between 15 and 25 in with a maximum of 35.63 in ( 905 mm ) at Angelina. The rainfall totals, however, from several of the locations that received greater than 20 in, including Angelina, are incomplete. These sites received rainfall that was not recorded because the gauges reached their maximum capacity during some of the 24 h periods between measurements. In some cases, this occurred on several consecutive days during Noel's passage. For example, at Angelina the rain gauge reached its capacity of 300 mm ( 11.81 in ) on two consecutive days. At Rancho Arriba (total rainfall 31.98 in ), the rain gauge reached its capacity of 170 mm ( 6.69 in ) on 4 consecutive days ( $28-31$ October). It is possible that the maximum rainfall in the Dominican Republic from Noel and its incipient low may have approached 40 in.

Reports show that rainfall accumulations of 5 to 12 in were common across eastern Cuba. In the Provence of Holguin, 12.20 in fell at Loynaz Hechavarria during the 24-h period ending at 1200 UTC 31 October. In the Bahamas, 29.43 in was recorded on Long Island during the 79 h period between 0200 UTC 30 October and 0900 UTC 2 November. The precursor low also produced significant rainfall across Puerto Rico and the Virgin Islands, with a maximum amount of 17.23 in at Gate Tower, Puerto Rico.

The combination of Noel over the northern Caribbean and strong high pressure over the eastern United States produced a tight pressure gradient over the western Atlantic and Florida between 29-31 October. This pressure gradient resulted in an extended period of gale force winds along the east coast of the Florida Peninsula that were not directly associated with the circulation of Noel. The highest sustained wind measured over land in south Florida during this period was 37 kt , with a gust to 47 kt at Miami Beach

The post-Noel extratropical cyclone produced very strong winds along coastal sections of the United States from the Carolinas northward as it passed offshore. The strongest winds were observed in eastern Massachusetts, where a sustained wind of 51 kt with a gust to 63 kt was measured on Nantucket Island. The highest wind gust reported in mainland Massachusetts was 77 kt at Barnstable. In eastern Maine, wind gusts as high as 57 kt were recorded. In eastern Canada, the low brought hurricane force wind gusts to portions of Nova Scotia and Newfoundland. The highest sustained wind in Canada was 61 kt at McNab’s Island in Halifax Harbor. Maximum wind gusts were 97 kt at Wreckhouse, Newfoundland and 79 kt at Grand

Etang, Nova Scotia. A wind gust to 73 kt was also experienced near Halifax. The extratropical cyclone produced a wide-swath of 2 to 4 inches of precipitation that extended from coastal sections of Massachusetts northward across Maine, Nova Scotia, New Brunswick and eastern Quebec. The highest precipitation total in the United States was 5.03 in at Cutler Rainwise, Maine and the highest in Canada was 5.28 in at Cap D’Espoir, in southeastern Quebec. The extratropical cyclone also produced significant snowfall across northern Maine, northwestern New Brunswick, southeastern Quebec and Labrador.

## c. Casualty and Damage Statistics

Torrential rains from Noel produced widespread damage and loss of life in the Dominican Republic, Haiti, Jamaica, eastern Cuba, and the Bahamas. As of this writing, Noel is estimated to have caused a total of 163 deaths, while 59 remained missing. On 16 November, the United Nations Office for the Coordination of Humanitarian Affairs listed the death toll in the Dominican Republic at 87 , while 42 people remained missing. The exact number of deaths in Haiti has been somewhat difficult to determine, as counts have ranged from 57 to 103. Media reports from Reuters on 8 November stated that authorities have confirmed 57 fatalities. A report from the USAID Fact Sheet \#3 on 8 November lists 103 casualties in Haiti with 20 persons missing. This report, however, appears to include deaths that may have occurred during "continuous rains over the past six weeks" before Noel's passage. A report from the International Federation of Red Cross and Red Crescent Societies on 14 December states that the Haitian Direction of the Civil Protection (Direction de las Protection Civile- DPC) confirmed 73 deaths, while 17 people remained missing. For the purpose of establishing a final death toll in Haiti for Noel, this report uses the count of 73 fatalities, since that count is from a Haitian governmental agency and it appears to only include the deaths directly attributed to the tropical cyclone. Reports indicate that Noel was responsible for one death in the Bahamas, one death in Jamaica, and one death in Cuba. The reports show that nearly all of the fatalities were the result of floods and mudslides. In the Dominican Republic and Haiti, there were several reports of villages being swept away by flood waters. In Cuba, a man died attempting to cross a swollen river, and in Jamaica the death was the consequence of a tree falling on a house due to a landslide.

Reports show that 78,000 people in the Dominican Republic remained in emergency shelters over two weeks after the passage of Noel. The cyclone is estimated to have damaged nearly 15,000 homes with a little more than 6,000 homes destroyed. Mudslides and floods also washed away several bridges that left numerous towns and villages isolated for many days. The government of the Dominican Republic reported that crop losses totaled $\$ 77.7$ million (United States dollars) in that country. In Haiti, government reports note that nearly 18,000 homes were damaged and almost 4,000 homes were destroyed, while countless crops were ruined due to floods.

Reuters reported that 80,000 residents in Cuba were evacuated from flooding produced by Noel. Twenty-two thousand houses were damaged or destroyed and over 8,000 miles (13,000 km ) of roads were damaged. Other infrastructures including railroad lines, drainage systems, bridges and power lines were also damaged. Agricultural losses accounted for $\$ 305$ million of
the $\$ 500$ million (United States dollars) in financial losses in Cuba as reported by the Granma International Newspaper on 8 November. Officials reported that Cuba lost 10\% of its coffee crop and that nearly 125,000 acres of sugar cane fields were flooded or damaged, which accounts for about half of the Cuban sugar output. Damage to homes amounted to $\$ 128$ million, and $\$ 33$ million in damages were estimated for the collapse of power and communication lines. The Cuban Meteorological Service stated that rains from Noel produced the worst flooding in Cuba since Hurricane Flora in 1963.

Media reports from the Bahamas show that severe flooding occurred on Cat Island, Exuma, and Long Island with water inundating several homes. The one death reported in the Bahamas was a drowning that was blamed on the flooding in Exuma.

As a tropical cyclone, Noel was not directly responsible for any damage in the United States. The extratropical cyclone produced strong winds that downed trees and power lines in the northeastern United States and eastern Canada. Media reports indicate 190,000 homes and businesses in eastern Canada and about 80,000 homes in the northeastern United States lost electricity. Coastal floods and significant wave action washed out sections of coastal roads in Nova Scotia and many roads were littered with large rocks and boulders that washed ashore during the storm. Several waterfront buildings also suffered damage and some docks were destroyed.

The gale force winds created by the combination of Noel and a strong high over the eastern United States generated very large waves that pounded the east coast of Florida for several days. This wave action produced significant beach erosion along the Atlantic Coast of Florida prior to Noel's center passing offshore. It is difficult to determine the monetary impact of the beach erosion in Florida, but media reports estimate the cost at $\$ 3-4$ million for the Palm Beach area beaches alone. Additional beach erosion was reported along the Atlantic coast from the Carolinas northward as Noel passed east of the United States.

## d. Forecast and Warning Critique

The tropical wave that played a role in the development of Noel was introduced into the Tropical Weather Outlook (TWO) at 0930 UTC 23 October. Subsequent Outlooks issued over the next couple of days correctly predicted that upper-level winds would remain unfavorable for significant development during that time. The Outlook issued at 1530 UTC 25 October was the first to indicate that upper-level winds "could become more favorable" for development. The Outlook issued six hours later was the first to explicitly mention the possibility of tropical depression formation, which was a little more than 48 hours prior to genesis.

Verification of official and guidance model track forecasts is given in Table 4. Average official track errors for Noel (with the number of cases in parenthesis) were 51 (22), 78 (20), 97 (18), 120 (16), 180 (12), 97 (8), and 184 (4) n mi for the $12,24,36,48,72,96$, and 120 h forecasts, respectively. Noel's erratic track across the northern Caribbean proved to be difficult to predict. Despite official track errors through 72 h that were larger than the $5-\mathrm{yr}$ (2002-2006) mean, the official forecasts beat most of the individual track models for this period. The only
track models that consistently beat the official forecast for this period were the deep-layer Beta and Advection model (BAMD), the CONU and GUNA model consensuses, and the Florida State Super Ensemble (FSSE). The official track errors at 96 and 120 were much lower than the 5 -yr means and were only bettered by the CONU and GUNA model consensuses at 120 h .

Average official intensity errors (Table 5) were $8,10,12,12,14,16,20 \mathrm{kt}$ for the 12,24 , $36,48,72,96$, and 120 h forecasts, respectively. The official intensity errors are close to the $5-\mathrm{yr}$ means through 36 h and are slightly below the $5-\mathrm{yr}$ means at 48 h and beyond. The NHC intensity forecasts were out-performed by the consensus of the DSHP, GHMI, HWFI models (ICON) at all forecast times, except 48 and 72 h . Most of the intensity guidance had errors lower than the official forecasts at 96 and 120 h . Because of expected strong wind shear, the official intensity forecasts issued on 31 October and 1 November, did not predict that Noel would strengthen into a hurricane before becoming an extratropical cyclone, which Noel did despite the strong shear.

Table 6 is a summary of coastal watches and warnings issued in association with Noel.

## e. Acknowledgements

The Meteorological Services of the Dominican Republic, Cuba, and the Bahamas provided most of the surface and rainfall data shown in the report. Chris Fogarty of the Canadian Hurricane Center furnished surface data for the extratropical portion of Noel. The National Data Buoy Center and National Weather Service Offices in Miami, Florida; Taunton, Massachusetts; and Caribou, Maine also supplied surface data and storm summaries. David Roth of the Hydrometeorological Prediction Center contributed additional rainfall information.

Table 1. Best track for Hurricane Noel, 28 October- 2 November 2007.

| Date/Time <br> (UTC) | Latitude <br> $\left({ }^{\circ} \mathrm{N}\right)$ | Longitude <br> ( ${ }^{\circ} \mathrm{W}$ ) | Pressure (mb) | Wind Speed <br> (kt) | Stage |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $24 / 0000$ | 18.0 | 60.2 | 1010 | 20 | low |
| $24 / 0600$ | 18.0 | 60.7 | 1009 | 25 | " |
| $24 / 1200$ | 18.1 | 61.2 | 1009 | 25 | " |
| $24 / 1800$ | 18.4 | 61.7 | 1009 | 25 | " |
| $25 / 0000$ | 18.8 | 62.3 | 1009 | 25 | " |
| 25/0600 | 19.1 | 62.9 | 1007 | 25 | " |
| 25/1200 | 19.2 | 63.5 | 1007 | 25 | " |
| $25 / 1800$ | 19.1 | 64.1 | 1006 | 25 | " |
| $26 / 0000$ | 18.8 | 64.8 | 1005 | 25 | " |
| 26 / 0600 | 18.0 | 65.7 | 1005 | 25 | " |
| 26 / 1200 | 17.2 | 66.7 | 1004 | 25 | " |
| 26/1800 | 16.5 | 67.7 | 1004 | 25 | " |
| 27/0000 | 16.1 | 68.5 | 1004 | 25 | " |
| 27/0600 | 15.7 | 69.3 | 1004 | 25 | " |
| 27/1200 | 15.3 | 70.1 | 1004 | 25 | " |
| 27/1800 | 15.4 | 71.0 | 1004 | 25 | " |
| 28/0000 | 15.7 | 71.2 | 1003 | 30 | tropical depression |
| 28/0600 | 16.0 | 71.4 | 1002 | 30 | " |
| $28 / 1200$ | 16.3 | 71.6 | 999 | 40 | tropical storm |
| $28 / 1800$ | 16.6 | 71.8 | 996 | 50 | * |
| 29 / 0000 | 17.1 | 72.1 | 999 | 50 | " |
| 29 / 0600 | 18.0 | 72.4 | 1002 | 45 | " |
| 29/1200 | 19.2 | 72.9 | 1002 | 40 |  |
| 29/1800 | 20.2 | 73.6 | 1001 | 45 |  |
| 30/0000 | 21.0 | 74.6 | 999 | 45 | , |
| 30/0600 | 21.1 | 75.8 | 997 | 50 | " |
| $30 / 1200$ | 20.8 | 76.8 | 999 | 40 | " |
| $30 / 1800$ | 20.8 | 77.4 | 1000 | 35 | " |
| $31 / 0000$ | 21.2 | 77.8 | 1000 | 35 | " |
| $31 / 0600$ | 21.8 | 78.1 | 1000 | 35 |  |
| $31 / 1200$ | 22.5 | 78.3 | 995 | 45 |  |
| $31 / 1800$ | 22.6 | 78.8 | 995 | 45 | " |
| 01/0000 | 22.9 | 78.6 | 995 | 50 | " |
| $01 / 0600$ | 23.4 | 78.3 | 993 | 50 | " |
| $01 / 1200$ | 23.9 | 78.0 | 993 | 50 | " |
| $01 / 1800$ | 25.1 | 77.3 | 992 | 55 | " |
| $02 / 0000$ | 26.4 | 76.5 | 981 | 70 | hurricane |
| $02 / 0600$ | 27.7 | 75.6 | 981 | 70 | " |
| $02 / 1200$ | 28.7 | 74.4 | 981 | 70 | " |
| $02 / 1800$ | 30.3 | 73.3 | 980 | 70 | " |


| $03 / 0000$ | 32.3 | 72.4 | 980 | 70 | extratropical |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 03 / 0600 | 34.3 | 71.7 | 980 | 70 | " |
| $03 / 1200$ | 36.4 | 70.9 | 974 | 75 | " |
| $03 / 1800$ | 38.8 | 69.7 | 970 | 75 | " |
| $04 / 0000$ | 41.1 | 68.2 | 968 | 70 | " |
| $04 / 0600$ | 43.6 | 66.2 | 965 | 65 | " |
| 04 / 1200 | 47.5 | 64.3 | 966 | 60 | " |
| 04 / 1800 | 51.2 | 62.2 | 966 | 60 | " |
| $05 / 0000$ | 54.8 | 59.6 | 967 | 60 | " |
| $05 / 0600$ | 57.9 | 57.6 | 967 | 55 | " |
| $05 / 1200$ | 60.4 | 55.4 | 968 | 55 | " |
| $05 / 1800$ | 62.3 | 53.3 | 974 | 55 | " |
| $06 / 0000$ | 64.2 | 50.4 | 983 | 45 | " |
| 06 / 0600 |  |  |  |  | dissipated |
| 02 / 1800 | 30.3 | 73.3 | 980 | 70 | Maximum wind and minimum pressure |
| 29 / 0700 | 18.1 | 72.5 | 1002 | 45 | Landfall near Jacmel, Haiti |
| $30 / 0600$ | 21.1 | 75.8 | 997 | 50 | Landfall near Guardalavaca, Cuba |
| $01 / 1315$ | 24.1 | 77.9 | 993 | 50 | Landfall Andros Island, Bahamas |
| $01 / 1745$ | 25.0 | 77.4 | 992 | 55 | Landfall, New Providence Island, Nassau Bahamas |

Table 2. Selected surface observations for Hurricane Noel, 28 October-2 November 2007.

| Location | Minimum Sea Level Pressure |  | Maximum Surface Wind Speed |  |  | Storm <br> surge <br> $(f t)^{c}$ | Storm tide $(f t)^{\text {d }}$ | Total rain (in) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Date/ time (UTC) | Press. <br> (mb) | $\begin{aligned} & \text { Date/ } \\ & \text { time } \\ & (\text { UTC })^{\mathrm{a}} \end{aligned}$ | Sustained $(\mathrm{kt})^{\mathrm{b}}$ | Gust <br> (kt) |  |  |  |
| Dominican Republic ${ }^{\text {e }}$ |  |  |  |  |  |  |  |  |
| Punta Cana | 28/2200 | 1006.0 | 28/2300 |  | 35 |  |  |  |
| Las Americas |  |  | 29/1700 |  | 35 |  |  | $9.83{ }^{\text {f }}$ |
| Santiago | 29/0600 | 1006.0 | 29/1300 |  | 35 |  |  | 9.07 |
| Barhona (78482) |  |  | 29/0815 |  | 60 |  |  |  |
| Jarabacoa |  |  |  |  |  |  |  | 7.44 |
| Altamira |  |  |  |  |  |  |  | 5.61 |
| Luperon |  |  |  |  |  |  |  | 6.77 |
| La Union (Airport) |  |  |  |  |  |  |  | 8.93 |
| Gaspar Hdez |  |  |  |  |  |  |  | $11.46{ }^{\text {f }}$ |
| Rio San Juan |  |  |  |  |  |  |  | 11.59 |
| Cabrera |  |  |  |  |  |  |  | 8.85 |
| Nagua |  |  |  |  |  |  |  | 7.99 |
| Joaquin Balaguer Airport |  |  |  |  |  |  |  | 22.63 |
| Yamasa |  |  |  |  |  |  |  | 11.35 |
| Monte Plata |  |  |  |  |  |  |  | 10.71 |
| Bayaguana |  |  |  |  |  |  |  | 7.76 |
| Santo Domingo |  |  |  |  |  |  |  | 14.60 |
| S.G. Boya |  |  |  |  |  |  |  | 10.59 |
| Hato Mayor |  |  |  |  |  |  |  | 4.82 |
| Los Llanos |  |  |  |  |  |  |  | 8.67 |
| La Romana |  |  |  |  |  |  |  | 7.45 |
| Higuey |  |  |  |  |  |  |  | 7.93 |
| San Rafael Del Yuma |  |  |  |  |  |  |  | 4.87 |
| Моса |  |  |  |  |  |  |  | 14.41 |
| Salcedo |  |  |  |  |  |  |  | 11.37 |
| La Vega |  |  |  |  |  |  |  | 14.70 |
| Pimentel |  |  |  |  |  |  |  | $13.19{ }^{\text {f }}$ |
| Angelina |  |  |  |  |  |  |  | $35.63{ }^{\text {f }}$ |
| Villa Riva |  |  |  |  |  |  |  | 10.83 |


| Location | Minimum Sea Level Pressure |  | Maximum Surface Wind Speed |  |  | Storm surge <br> $(f t)^{c}$ | Storm tide <br> $(\mathrm{ft})^{\mathrm{d}}$ | Total rain (in) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { Date/ } \\ & \text { time } \\ & \text { (UTC) } \end{aligned}$ | Press. <br> (mb) | $\begin{gathered} \text { Date/ } \\ \text { time } \\ (\text { UTC })^{\mathrm{a}} \end{gathered}$ | Sustained $(\mathrm{kt})^{\mathrm{b}}$ | Gust <br> (kt) |  |  |  |
| Cotui |  |  |  |  |  |  |  | $28.23{ }^{\text {f }}$ |
| Bonao |  |  |  |  |  |  |  | $16.46{ }^{\text {f }}$ |
| Juma Bonao |  |  |  |  |  |  |  | 18.60 |
| Limon del Yuna |  |  |  |  |  |  |  | 9.29 |
| Sabana Mar |  |  |  |  |  |  |  | 5.57 |
| San Cristobal |  |  |  |  |  |  |  | $13.28{ }^{\text {f }}$ |
| Azua |  |  |  |  |  |  |  | $21.22{ }^{\text {f }}$ |
| Rancho Arriba |  |  |  |  |  |  |  | $31.98{ }^{\text {f }}$ |
| Villa Altagracia |  |  |  |  |  |  |  | 20.32 |
| Bani |  |  |  |  |  |  |  | $17.91{ }^{\text {f }}$ |
| San Jose Ocoa |  |  |  |  |  |  |  | 19.53 |
| Bohechio |  |  |  |  |  |  |  | $14.21{ }^{\text {f }}$ |
| Constanza |  |  |  |  |  |  |  | 12.46 |
| Padre Las Casas |  |  |  |  |  |  |  | $16.54{ }^{\text {f }}$ |
| San Juan de la Maguana |  |  |  |  |  |  |  | 11.85 |
| Barahona |  |  |  |  |  |  |  | 25.57 |
| Polo |  |  |  |  |  |  |  | $27.85{ }^{\text {f }}$ |
| Oviedo |  |  |  |  |  |  |  | 13.41 |
| Neyba |  |  |  |  |  |  |  | 12.82 |
| Duverge |  |  |  |  |  |  |  | 7.49 |
| Las Matas de Farfan |  |  |  |  |  |  |  | 4.62 |
| El Cercado |  |  |  |  |  |  |  | 7.04 |
| Sanchez |  |  |  |  |  |  |  | 6.20 |
| Arroyo Barril |  |  |  |  |  |  |  | 6.03 |
| Samana |  |  |  |  |  |  |  | 4.15 |
| Catey Airport |  |  |  |  |  |  |  | 8.64 |
| Haiti ${ }^{\text {g }}$ |  |  |  |  |  |  |  |  |
| Cayes |  |  |  |  |  |  |  | 11.61 |
| Foret des Pins |  |  |  |  |  |  |  | 15.98 |
| Nazon, Centreville |  |  |  |  |  |  |  | 5.63 |
| Port-Au-Prince (Airport) |  |  |  |  |  |  |  | 3.94 |


| Location | Minimum Sea Level Pressure |  | Maximum Surface Wind Speed |  |  | Storm surge $(f t)^{c}$ | Storm tide (ft) ${ }^{\text {d }}$ | Total rain (in) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Date/ time (UTC) | Press. (mb) | $\begin{gathered} \text { Date/ } \\ \text { time } \\ (\text { UTC) } \end{gathered}$ | Sustained $(\mathrm{kt})^{\mathrm{b}}$ | Gust <br> (kt) |  |  |  |
| Saint-Louis du Nord |  |  |  |  |  |  |  | 6.69 |
| Cuba |  |  |  |  |  |  |  |  |
| La Jiquima (78362) | 30/0900 | 997.9 | 29/1633 |  | 31 |  |  | 5.71 |
| Cabo Lucrecia (78365) | 30/0600 | 1000.3 | 29/2130 |  | 38 |  |  | 3.82 |
| Guaro (78370) | 30/0900 | 1001.5 | 29/1145 |  | 27 |  |  | 2.39 |
| Pinares de Mayari (78371) | 30/0600 | 1002.7 | 30/1430 |  | 17 |  |  | 6.00 |
| Holguin (78372) | 30/0900 | 1001.3 | 30/2058 |  | 25 |  |  | 3.46 |
| Velasco (78378) | 30/0900 | 999.9 | 30/0610 |  | 30 |  |  | 3.30 |
| Las Tunas (78357) | 30/1300 | 1001.9 | 1/1840 |  | 32 |  |  | 4.75 |
| Puerto Padre (78358) | 30/0920 | 1000.8 | 30/1002 |  | 37 |  |  | 8.76 |
| Florida (78350) | 31/0015 | 1000.5 | 29/1710 |  | 40 |  |  | 0.54 |
| Santa Cruz del Sur (78351) | 30/2115 | 1001.7 | 29/1915 |  | 34 |  |  | 0.85 |
| Esmeralda (78352) | 31/0130 | 1000.4 | 30/1515 |  | 31 |  |  | 0.78 |
| Nuevitas (78353) | 30/1700 | 1002.6 | 31/1915 |  | 40 |  |  | 9.49 |
| Guaimaro (78354) | 30/1900 | 1001.0 | 31/0315 |  | 42 |  |  | 9.02 |
| Camaguey (78355) | 30/2230 | 1001.7 | 31/2020 |  | 28 |  |  | 3.14 |
| Cayo Coco (78339) | 31/2058 | 997.8 | 31/2144 |  | 34 |  |  | 1.64 |
| Jucaro (78345) | 31/2000 | 1000.0 | 31/1758 |  | 24 |  |  | 0.19 |
| Ciego de Avila (78346) | 31/0900 | 1000.4 | 31/1850 |  | 25 |  |  | 0.78 |
| Falla (78347) | 31/0900 | 999.8 | 31/1900 |  | 26 |  |  | 1.22 |
| Gran Piedra (78366) |  |  | 30/0010 |  | $113^{\text {h }}$ |  |  | 6.74 |
| Universidad (78364) |  |  | 30/1648 |  | 54 |  |  | 3.32 |
| Mansanillo (78359) |  |  |  |  |  |  |  | 3.21 |
| Cabo Cruz (78360) |  |  |  |  |  |  |  | 9.08 |
| Contramaestre (78363) |  |  |  |  |  |  |  | 4.19 |
| Artemisa (78319) |  |  |  |  |  |  |  | 11.41 |
| Guantanamo (78334) |  |  |  |  |  |  |  | 9.30 |
| Guantanamo (78356) |  |  |  |  |  |  |  | 10.15 |
| Guantanamo (78368) |  |  |  |  |  |  |  | 7.77 |
| Punta de Maisi (78369) |  |  |  |  |  |  |  | 3.69 |
| Guantanamo (MUGM) | 30/0855 | 1004.4 | 31/2155 |  | 46 |  |  |  |


| Location | Minimum Sea Level Pressure |  | Maximum Surface Wind Speed |  |  | Storm surge $(\mathrm{ft})^{\mathrm{c}}$ | Storm tide <br> (ft) ${ }^{\text {d }}$ | Total rain (in) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Date/ time (UTC) | Press. <br> (mb) |  | Sustained $(\mathrm{kt})^{\mathrm{b}}$ | Gust <br> (kt) |  |  |  |
| Santiago De Cuba (MUCU) |  |  | 30/2355 |  | 40 |  |  |  |
| Bahamas |  |  |  |  |  |  |  |  |
| Georgetown (MYEG) | 01/1716 | 998.6 | 01/1601 | 31 | 42 |  |  |  |
| Nassau (MYNN) | 01/1700 | 993.0 | 01/0100 | 30 | 36 |  |  | 4.60 |
| Exuma |  |  |  |  |  |  |  | 13.62 |
| Long Island |  |  |  |  |  |  |  | 29.43 |
| Freeport (MYGF) | 01/2200 | 1001.4 |  |  |  |  |  |  |
| Congo Town (78084) (Andros Island) | 01/2100 | 993.6 |  |  |  |  |  |  |
| Rock Sound (78080) (Eleuthera) | 01/2000 | 994.3 | 01/1900 | 35 |  |  |  |  |
| Deadman’s Cay (78094) <br> (Long Island) | 012004 | 1000.6 |  |  |  |  |  |  |
| Moss Town (78091) (Exuma) | 01/1904 | 998.6 | 01/1404 | 31 |  |  |  |  |
| South Bimini (78069) (Bimini) | 01/2000 | 1000.0 |  |  |  |  |  |  |
| Nassau <br> (Weather Underground) | 01/1914 | 989.7 | 01/0030 | 30 | 40 |  |  |  |
| Buoy/CMAN |  |  |  |  |  |  |  |  |
| 41046- E. of Bahamas $\left(24.0^{\circ} \mathrm{N} 71.0^{\circ} \mathrm{W}\right)$ | 02/0642 | 1007.0 | 02/0616 | 31i | 35 |  |  |  |
| 41047- NE. of Bahamas ( $27.5^{\circ} \mathrm{N} 71.5^{\circ} \mathrm{W}$ ) | 02/1211 | 1001.0 | 02/1353 | 54i | 62 |  |  |  |

${ }^{\text {a }}$ Date/time is for sustained wind when both sustained and gust are listed.
${ }^{\mathrm{b}}$ Except as noted, sustained wind averaging periods for C-MAN and land-based ASOS reports are 2 min ; buoy averaging periods are 8 min .
${ }^{\text {c }}$ Storm surge is water height above normal astronomical tide level.
${ }^{\text {d }}$ Storm tide is water height above National Geodetic Vertical Datum (1929 mean sea level).
${ }^{\text {e }}$ Rainfall totals from the Dominican Republic are accumulations between 25-31 October. The totals include rainfall from Noel and its incipient low.
${ }^{\mathrm{f}}$ Incomplete.
${ }^{\mathrm{g}}$ Rainfall totals from Haiti are accumulations between 28-30 October.
${ }^{\mathrm{h}}$ Elevated location.
i 1-min average.

Table 3. Selected ship reports with winds of at least 34 kt that are directly associated with Noel, 28 October-2 November 2007.

| Date/Time <br> (UTC) | Ship call sign | Latitude <br> $\left({ }^{\circ} \mathbf{N}\right)$ | Longitude <br> $\left({ }^{\circ} \mathbf{W}\right)$ | Wind <br> dir/speed (kt) | Pressure <br> $(\mathbf{m b})$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $29 / 0600$ | PDKK | 17.4 | 69.5 | $170 / 37$ | 1005.5 |
| $29 / 1500$ | KS004 | 21.6 | 70.6 | $160 / 35$ | 1011.6 |
| $29 / 1500$ | ZCDP8 | 21.4 | 70.4 | $120 / 38$ | 1009.0 |
| $29 / 1800$ | VQHO7 | 17.7 | 70.1 | $140 / 35$ | 1009.6 |
| $29 / 1800$ | ZCDP8 | 21.0 | 69.6 | $150 / 40$ | 1010.1 |
| $29 / 1800$ | C6FN5 | 21.1 | 69.6 | $130 / 37$ | 1007.0 |
| $29 / 2100$ | WDB3258 | 21.0 | 75.3 | $040 / 34$ | 1008.0 |
| $30 / 0000$ | WDB3258 | 21.0 | 74.8 |  | 1002.0 |
| $30 / 1000$ | WZJC | 21.3 | 75.1 | $120 / 37$ | 1003.5 |
| $01 / 0600$ | H3GQ | 25.5 | 79.5 | $050 / 37$ | 1004.0 |
| $02 / 0000$ | A8MH9 | 25.8 | 72.2 | $130 / 39$ | 1005.7 |
| $02 / 0600$ | A8MH9 | 24.3 | 72.4 | $150 / 37$ | 1004.0 |
| $02 / 1800$ | DEDI | 30.2 | 76.1 | $020 / 35$ | 1001.0 |
| $02 / 1900$ | P3ZY6 | 31.0 | 75.9 | $030 / 41$ | 1001.0 |

Table 4. Track forecast evaluation (heterogeneous sample) for Hurricane Noel, 28 October-2 November. Forecast errors ( n mi ) are followed by the number of forecasts in parentheses. Errors smaller than the NHC official forecast are shown in bold-face type. Verification includes the depression stage, but does not include the extratropical stage.

| Forecast <br> Technique | Forecast Period (h) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 12 | 24 | 36 | 48 | 72 | 96 | 120 |
| CLP5 | 64 (22) | 132 (20) | 187 (18) | 233 (16) | 293 (12) | 160 ( 8) | 255 ( 4) |
| GFNI | 55 (19) | 88 (17) | 98 (15) | 98 (12) | 176 (7) | 220 ( 5) |  |
| GFDI | 46 (22) | 86 (20) | 115 (18) | 169 (16) | 326 (12) | 455 ( 8) | 494 ( 4) |
| HWFI | 45 (21) | 74 (19) | 103 (17) | 144 (15) | 233 (11) | 198 ( 7) | 281 ( 3) |
| GFSI | 55 (21) | 90 (18) | 130 (16) | 126 (12) | 229 (7) | 178 ( 4) | 416 ( 1) |
| AEMI | 61 (21) | 85 (17) | 112 (15) | 164 (13) | 263 (9) | 403 ( 4) | 704 ( 3) |
| NGPI | 59 (20) | 95 (18) | 127 (16) | 179 (14) | 288 (8) | 351 ( 5) | 253 ( 2) |
| UKMI | 56 (21) | 87 (19) | 101 (17) | 100 (15) | 101 (11) | 202 (7) | 322 ( 3) |
| BAMD | 45 (22) | 64 (20) | 85 (18) | 106 (16) | 161 (12) | 221 (8) | 215 ( 4) |
| BAMM | 57 (22) | 96 (20) | 126 (18) | 147 (16) | 172 (12) | 147 ( 8) | 323 ( 4) |
| BAMS | 81 (22) | 143 (20) | 195 (18) | 237 (16) | 296 (12) | 318 ( 8) | 490 ( 4) |
| CONU | 48 (22) | 74 (20) | 87 (18) | 93 (16) | 154 (12) | 140 ( 8) | 139 ( 4) |
| GUNA | 44 (19) | 63 (17) | 74 (15) | 98 (12) | 156 ( 6) | 132 ( 4) | 127 ( 1) |
| FSSE | 42 (19) | 56 (17) | 76 (15) | 97 (13) | 188 ( 9) | 128 ( 5) | 272 ( 1) |
| OFCL | 51 (22) | 78 (20) | 97 (18) | 120 (16) | 180 (12) | 97 ( 8) | 184 ( 4) |
| NHC Official (2002-2006 mean) | 35 (1852) | 61 (1686) | 86 (1519) | 112 (1362) | 162 (1100) | 221 (885) | 290 (723) |

Table 5. Intensity forecast evaluation (heterogeneous sample) for Hurricane Noel, 28 October-2 November 2007. Forecast errors (kt) are followed by the number of forecasts in parentheses. Errors smaller than the NHC official forecast are shown in bold-face type. Verification includes the depression stage, but does not include the extratropical stage.

| Forecast <br> Technique | Forecast Period (h) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 12 | 24 | 36 | 48 | 72 | 96 | 120 |
| SHF5 | 9.1 (22) | 10.6 (20) | 10.9 (18) | 13.8 (16) | 10.8 (12) | 10.3 ( 8) | 12.3 ( 4) |
| GHMI | 8.0 (22) | 10.6 (20) | 15.9 (18) | 19.8 (16) | 20.8 (12) | 13.3 ( 8) | 8.0 ( 4) |
| HWFI | 8.3 (21) | 9.1 (19) | 12.2 (17) | 15.3 (15) | 12.8 (11) | 19.4 (7) | 8.3 (3) |
| SHIP | 8.2 (22) | 10.3 (20) | 13.2 (18) | 18.4 (16) | 20.4 (12) | 19.4 ( 8) | 8.8 ( 4) |
| DSHP | 7.5 (22) | 9.6 (20) | 10.5 (18) | 14.1 (16) | 16.1 (12) | 13.1 ( 8) | 26.5 ( 4) |
| FSSE | 8.4 (19) | 10.9 (17) | 13.3 (15) | 11.5 (13) | 14.9 ( 9) | 24.2 (5) | 34.0 ( 1) |
| ICON | 7.1 (22) | 8.5 (20) | 11.2 (18) | 15.1 (16) | 15.0 (12) | 12.1 ( 8) | 9.3 ( 4) |
| OFCL | 8.0 (22) | 10.3 (20) | 11.7 (18) | 12.2 (16) | 13.8 (12) | 15.6 ( 8) | 20.0 ( 4) |
| NHC Official (2002-2006 mean) | $\begin{gathered} 6.4 \\ (1852) \end{gathered}$ | $\begin{gathered} 9.8 \\ (1686) \end{gathered}$ | $\begin{gathered} 12.0 \\ (1519) \end{gathered}$ | $\begin{gathered} 14.1 \\ (1362) \end{gathered}$ | $\begin{gathered} 18.3 \\ (1100) \end{gathered}$ | $\begin{gathered} 19.8 \\ (885) \end{gathered}$ | $\begin{gathered} 21.8 \\ (723) \end{gathered}$ |

Table 6. Tropical Cyclone watch and warning summary for Hurricane Noel, 28 October-2 November 2007.

| Date/Time <br> (UTC) | Action | Location |
| :---: | :---: | :---: |
| 28/ 0300 | Tropical Storm Warning issued | Southwestern peninsula of Haiti from Haiti-Dominican Republic border to Port-Au-Prince |
| 28/ 0300 | Tropical Storm Watch issued | Cuban Provinces of Granma... Santiago De Cuba...and Guantanamo. |
| 28/1200 | Tropical Storm Watch issued | Jamaica |
| 28/ 2100 | Tropical Storm Warning extended | extended northward to include entire coast of Haiti |
| 28/ 2100 | Tropical Storm Watch replaced with Tropical Storm Warning and a Hurricane Watch | Cuban Provinces of Granma...Santiago De Cuba...Guantanamo...and Holguin |
| 29/ 0900 | Tropical Storm Warning issued | Southeastern Bahamas...including the Turks and Caicos Islands |
| 29/ 0900 | Tropical Storm Watch issued | Central Bahamas |
| 29/1500 | Tropical Storm Watch replaced with Tropical Storm Warning | Central Bahamas |
| 29/1500 | Hurricane Watch discontinued | all |
| 29/1500 | Tropical Storm Warning discontinued | Jamaica and the Cuban Provinces of Granma and Santiago |
| 29/1800 | Tropical Storm Warning discontinued | South of Gonaives, Haiti |
| 29/2100 | Tropical Storm Warning extended | Cuban Provinces of Camaguey and Las Tunas |
| 29/2100 | Tropical Storm Watch issued | Northwestern Bahamas |
| 30/0300 | Tropical Storm Warning extended | Cuban Province of Ciego de Avila |
| 30/ 0300 | Tropical Storm Warning discontinued | Remainder of Haiti |
| 30/ 0600 | Tropical Storm Warning discontinued | Turks and Caicos |
| 30/ 0900 | Tropical Storm Warning and Hurricane Watch issued | Northwestern Bahamas |
| 30/ 1200 | Tropical Storm Warning discontinued | Southeastern Bahamas |
| 30/1500 | Hurricane Watch discontinued | Northwestern Bahamas |
| 30/2100 | Tropical Storm Warning extended | Cuban Province of Sancti Spiritus |


| $31 / 1500$ | Tropical Storm Warning <br> discontinued | Cuban Province of Sancti Spiritus <br> and Guantanamo |
| :---: | :---: | :---: |
| $31 / 2100$ | Tropical Storm Watch issued | Florida east coast from Ocean Reef <br> to Jupiter Inlet |
| $01 / 0300$ | Hurricane Watch issued | Northwestern Bahamas |
| $01 / 0900$ | Tropical Storm Watch replaced with <br> Tropical Storm Warning | Ocean Reef to Deerfield Beach |
| $01 / 0900$ | Tropical Storm Warning <br> discontinued | Remainder of Cuba |
| $01 / 1500$ | Tropical Storm Watch discontinued | Deerfield Beach to Jupiter Inlet |
| $01 / 1800$ | Tropical Storm Warning <br> discontinued | Ocean Reef to Deerfield Beach |
| $02 / 0300$ | Tropical Storm Warning <br> discontinued | Central and Northwest Bahamas |
| $02 / 0300$ | Hurricane Watch discontinued | Northwest Bahamas |



Figure 1. Best track positions for Hurricane Noel, 28 October-2 November 2007. Track during the extratropical stage is partially based on analyses from the Canadian Hurricane Center and the Ocean Prediction Center. The 965 mb minimum pressure shown on the map represents the lowest minimum pressure during the extratropical phase.


Figure 2. Close-up of the best track positions for Hurricane Noel, 28 October-2 November 2007.


Figure 3. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Noel, 28 October-2 November 2007. Aircraft observations have been adjusted for elevation using $90 \%, 80 \%$, and $80 \%$ reduction factors for observations from $700 \mathrm{mb}, 850 \mathrm{mb}$, and 1500 ft , respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM), and from the sounding boundary layer mean (MBL). Estimates during the extratropical stage are partially based on analyses from the Canadian Hurricane Center and the Ocean Prediction Center. Dashed vertical lines indicated 0000 UTC. Thin solid vertical lines denote landfalls.


Figure 4. Selected pressure observations and best track minimum central pressure curve for Hurricane Noel, 28 October-2 November 2007. Estimates during the extratropical stage are primarily based on analyses from the Canadian Hurricane Center and the NOAA Ocean Prediction Center. Dashed vertical lines indicated 0000 UTC. Thin solid vertical lines denote landfalls.


Figure 5. Geostationary (A and B) and microwave ( C and D ) satellite images of the approximate times that Noel obtained hurricane strength (A and C) and when Noel became extratropical (B and D). Note the dramatic decrease in inner-core convection during this 24-h period. Images are courtesy of the Naval Research Laboratory.

