# Preliminary Report
# Hurricane Mitch
# 22 October - 05 November 1998

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Mitch is responsible for over nine thousand deaths predominately from rain-induced flooding in portions of Central America, mainly in Honduras and Nicaragua. This makes Mitch one of the deadliest Atlantic tropical cyclones in history, ranking only below the 1780 "Great Hurricane" in the Lesser Antilles, and comparable to the Galveston hurricane of 1900, and Hurricane Fifi of 1974, which primarily affected Honduras.

The 905 mb minimum central pressure and estimated maximum sustained wind speed of 155 knots over the western Caribbean make Mitch the strongest October hurricane (records began in 1886). Mitch moved across the Yucatan Peninsula and southern Florida as a tropical storm.

## a. Synoptic History

The origins of Mitch can be traced back to a tropical wave that moved across the southern portion of west Africa on 8/9 October. Rawinsonde data from Abidjan, Cote D' Ivorie, located about 980 n mi southeast of Dakar, suggests that the wave had passed through the region around 8 October. The wave crossed the west coast of Africa, generally south of 15 North, on 10 October. The wave progressed across the tropical Atlantic for the next seven days with west-southwesterly upper-level winds preventing significant development.

After moving through the eastern Caribbean Sea on the 18th and 19th, satellite pictures showed an organizing cloud pattern over the south-central Caribbean Sea on the 20th. Shower and thunderstorm activity continued to become better organized in the southwest Caribbean Sea early on the 21st. Subsequently, a U.S. Air Force Reserve (USAFR) reconnaissance aircraft was dispatched to investigate the disturbance that afternoon and found winds of 39 knots at the 1500-foot flight level , and a central pressure of 1001 mb. On this basis, the system became a tropical depression at 0000 UTC 22 October, about 360 n mi south of Kingston, Jamaica – see Figs. 1a and 1b, and Table 1 for the "best track". The depression moved slowly westward and strengthened to a tropical storm later that day, about 225 n mi east-southeast of San Andres Island, while moving in a cyclonic loop. By the 23rd, the intensification of Mitch was disrupted by westerly vertical wind shear associated with an upper-level low north-northwest of the tropical cyclone. Later on the 23th, the upper low weakened, the shear diminished, and Mitch began to strengthen while moving slowly northward.

Mitch became a hurricane at 0600 UTC 24 October while located about 255 n mi south-southwest of Kingston, Jamaica. Later that day, as it turned toward the west, Mitch began a period of rapid intensification. During a 24 hour period beginning on the afternoon of the 24th, its central pressure dropped 52 mb, to 924 mb. With a symmetric, well-established upper-tropospheric outflow pattern evident on satellite imagery, the hurricane continued to strengthen. On the afternoon of the 26th, the central pressure reached a minimum of 905 mb, while the cyclone was centered about 50 n mi southeast of Swan Island. This pressure is the fourth lowest ever measured in an Atlantic hurricane, tied with Hurricane Camille in 1969. This is also the lowest pressure ever observed in an October hurricane in the Atlantic basin. Prior to Mitch, the strongest measured hurricane in the northwest Caribbean was Hurricane Hattie in 1961 with a central pressure of 924 mb. At its peak on the 26th, Mitch's maximum sustained 1-minute surface winds were estimated to be 155 knots, a category five hurricane on the Saffir/Simpson Hurricane Scale.

After passing over Swan Island on 27 October, Mitch began to gradually weaken while moving slowly westward. It then turned southwestward and southward toward the Bay Islands off the coast of Honduras. The center passed very near the island of Guanaja as a category five hurricane, although it is unlikely that winds of that strength were experienced on the island. Mitch slowly weakened as its circulation interacted with the land mass of Honduras. From mid-day on the 27th, to early on the 29th,the central pressure rose 59 mb. The center of the hurricane meandered near the north coast of Honduras from late on the 27th through the 28th, before making landfall during the morning of the 29th about 70 n mi east of la Ceiba with estimated surface winds of 70 knots and a minimum central pressure of 987 mb.

After making landfall, Mitch moved slowly southward, then southwestward and westward, over Honduras, weakening to a tropical storm by 1800 UTC 29 October, and to a tropical depression by 1800 UTC 31 October.

The overall motion was slow, less than 4 knots, for a week. This resulted in a tremendous amount of rainfall, estimated at up to 35 inches, primarily over Honduras and Nicaragua -- see Table 2. The heavy rainfall resulted in flash floods and mudslides that killed thousands of people. It is noted that a large east-west mountain range, with peaks approaching 10,000 feet, covers this part of Central America and this terrain likely contributed to the large rainfall totals. Some heavy rains also occurred in other portions of Central America.

Although Mitch's surface circulation center dissipated near the Guatemala/Mexico border on 1 November, the remnant circulation aloft continued to produce locally heavy rainfall over portions of Central America and eastern Mexico for the next couple of days.

By the afternoon of 2 November, meteorologists at the Tropical Prediction Center/National Hurricane Center (NHC) Tropical Analysis and Forecast Branch (TAFB), and the Satellite Analysis Branch (SAB) of the National Environmental Satellite, Data, and Information Service began to follow a cloud-system center,

the remnants of Mitch, in satellite imagery over the Bay of Campeche. Shower and thunderstorm activity began to increase later on the 2nd. On 3 November, a low-level circulation became evident in the eastern Bay of Campeche. A USAFR aircraft sent to investigate the system later that afternoon found 45 knot winds at 1500 feet and a minimum central pressure of 997 mb. Thus, advisories were re-initiated on Tropical Storm Mitch located about 130 n mi southwest of Merida, Mexico. Mitch moved northeastward and weakened to a depression early on the 4th after it made landfall over the northwestern Yucatan peninsula. The center re-emerged over the south-central Gulf of Mexico by mid-morning on the 4th, and Mitch regained tropical storm strength. The storm began to accelerate northeastward as it became involved with a frontal zone moving through the eastern Gulf of Mexico. Mitch made landfall on the morning of 5 November in southwest Florida near Naples, with estimated maximum sustained winds of 55 knots. Mitch continued to move rapidly northeastward and by mid-afternoon of the 5th, moved offshore of southeastern Florida and became extratropical. The extratropical cyclone accelerated northeastward across the North Atlantic Ocean from the 6th through the 9th.

b. Meteorological Statistics

The best-track intensities in Table 1 were obtained from the data in Figures 2 and 3 which depict the curves of minimum central sea-level pressure and maximum sustained one-minute average "surface" (10 meters above ground level) wind speed, respectively, as a function of time. The data these curves are based on, also plotted in the figures, include USAFR and NOAA aircraft reconnaissance data, Dvorak-based intensity estimates from TAFB, SAB, and the U.S. Air Force Weather Agency (AFGWC in figures).

Most of the aerial reconnaissance flights into Mitch were by the USAFR "Hurricane Hunters". The Hurricane Hunters flew 19 missions, and made 41 center fixes while NOAA aircraft performed 2 missions contributing 9 center fixes. The highest 700-mb flight-level wind report was 168 knots at 1900 UTC 26 October by the USAFR. This wind speed was observed 14 n mi northeast of the center near the time of a 905 mb GPS dropsonde-measured pressure. A dropsonde in the northeast eyewall showed winds to near 160 knots at 900 mb, but lower speeds below that altitude. The highest satellite-based intensity estimate, obtained by both objective and subjective methods, was 155 knots on the 26th and the 27th.

Table 2 lists rainfall observations from Honduras, with a maximum of 35.89 inches from Choluteca. Even higher values may have gone unobserved. Table 3 lists selected surface observations from Florida, where the highest observed sustained wind speed was 52 knots, at an elevation of 43.9 meters, from the Fowey Rock C-MAN station just offshore of Miami. Significant ship reports are listed in Table 4.

Five tornadoes were spawned by Mitch in South Florida: two in the Florida Keys, one each in Broward, Palm Beach, and Collier Counties. The most significant of these (F2 intensity) occurred in the upper Florida Keys, Islamorada to North Key Largo.

c. Casualty and Damage Statistics

The estimated death toll from Mitch currently stands at 9,086. Fact Sheet #21 from the U.S. Agency for International Development, as of December 1998, compiled the following death totals: Honduras, 5677; Nicaragua, 2,863; Guatemala, 258; El Salvador; 239; Mexico, 9 and 7 in Costa Rica. The death toll also includes 31 fatalities associated with the schooner *Fantome.* In addition, another 9191 persons were listed as missing. The exact death toll will probably never be known. However, this was one of the deadliest Atlantic tropical cyclones in history, ranking below only the 1780 "Great Hurricane" in the lesser Antilles, and comparable to the Galveston hurricane of 1900, and Hurricane Fifi of 1974, the latter also striking Honduras.

Mitch also claimed two lives in Monroe County, Florida. Both deaths were drowning-related incidents resulting from a fishing boat capsizing.

It has been estimated that there was a 50 percent loss to Honduras' agricultural crops. At least 70,000 houses were damaged and more than 92 bridges were damaged or destroyed. There was severe damage to the infrastructure of Honduras and entire communities were isolated from outside assistance. To a lesser extent, damage was similar in Nicaragua, where a large mudslide inundated ten communities situated at the base of La Casitas Volcano. Guatemala and El Salvador also suffered from flash floods which destroyed thousands of homes, along with bridges and roads.

The Florida tornadoes injured 65 people and damaged or destroyed 645 homes.

Insured property damage supplied by the Florida insurance Council puts the insured damage estimate for Florida at $20 million. These estimates exclude storm surge damage. To determine the total *estimated* damage, a ratio of 2:1 is applied to the insured property damage; this is based on comparisons done in historical hurricanes. Thus, the U.S. total estimated damage from Mitch is $40 million.

d. Forecast and Warning Critique

Table 5 lists the various watches and warnings issued. Hurricane warnings were issued for Jamaica, Honduras, Guatemala, Belize, and the Caribbean coast of the Yucatan Peninsula, Mexico. A tropical storm warning was issued for the Cayman Islands, the Gulf of Mexico coast of the Yucatan Peninsula, Cuba, and South Florida and the Florida Keys. As the effects of Mitch on Nicaragua were confined to rainfall flooding, there were no hurricane warnings there.

The average official track forecast errors for Mitch were 39, 80, 125, 167, and 237 n mi for the 12-, 24-, 36-, 48-, and 72-hr forecast periods, respectively - see Table 7. The number of forecasts ranged from 41 at the 12-hr period to 28 at the 72-hr period. The average track errors are quite similar to the average official forecast for the previous ten years. The official forecasts

are plotted in Fig. 4(a) and this shows that there was a persistent northwest bias to these forecasts. The official track forecast was for a slow mostly northwestward motion for the many days that the hurricane was in the northwestern Caribbean, as suggested by the models. Mitch actually moved westward and then southward and the forecast turn toward the northwest did not take place until the hurricane had moved over Honduras and Nicaragua. Some of the most reliable guidance models also had this track bias, as shown in Fig. 4(b) which shows the GFDL model track forecasts. In retrospect, the slow southward, then southwestward, motion which began early on the 27th, was likely due to a weak mid-level anticyclone over the western Gulf of Mexico. However, the absence of rawinsonde data from Mexico and Central America likely hindered the track prediction models and forecasters from resolving this feature during the event.

The average absolute official wind speed forecast errors were 8, 15, 27, 30, and 39 kt at 12, 24, 36, 48, and 72 h, respectively. These are somewhat larger than the previous ten-year averages. There was an under-forecast of 80 knots for the 72-hr forecast verifying at 0000 UTC on the 27th, at the time of the estimated peak surface wind of 155 knots. Overall, the official intensity forecasts indicated a general strengthening trend between the 24th and the 26th.

Acknowledgments:

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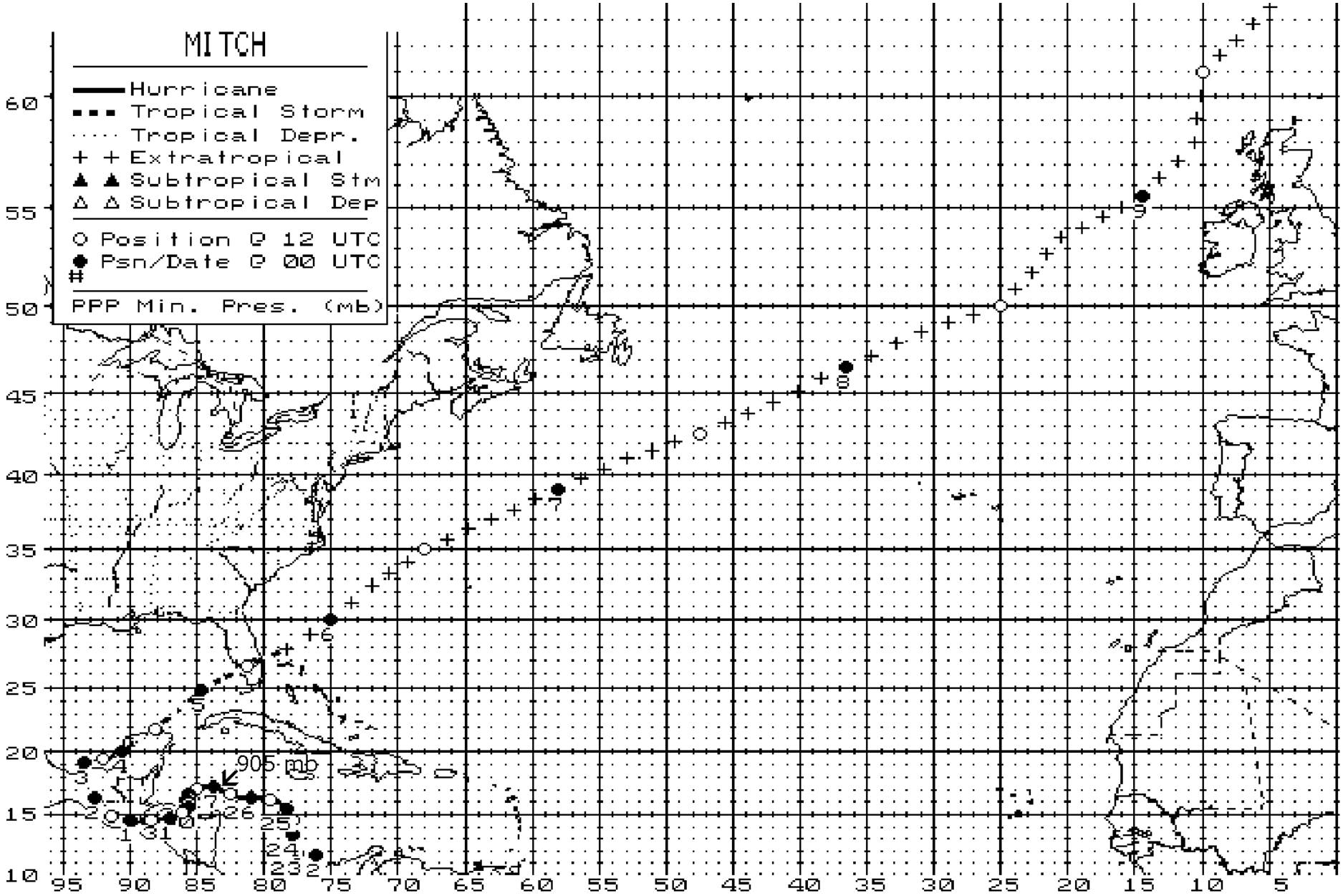



Figure 1a. Best Track of Hurricane Mitch, 22 October - 9 November 1998.

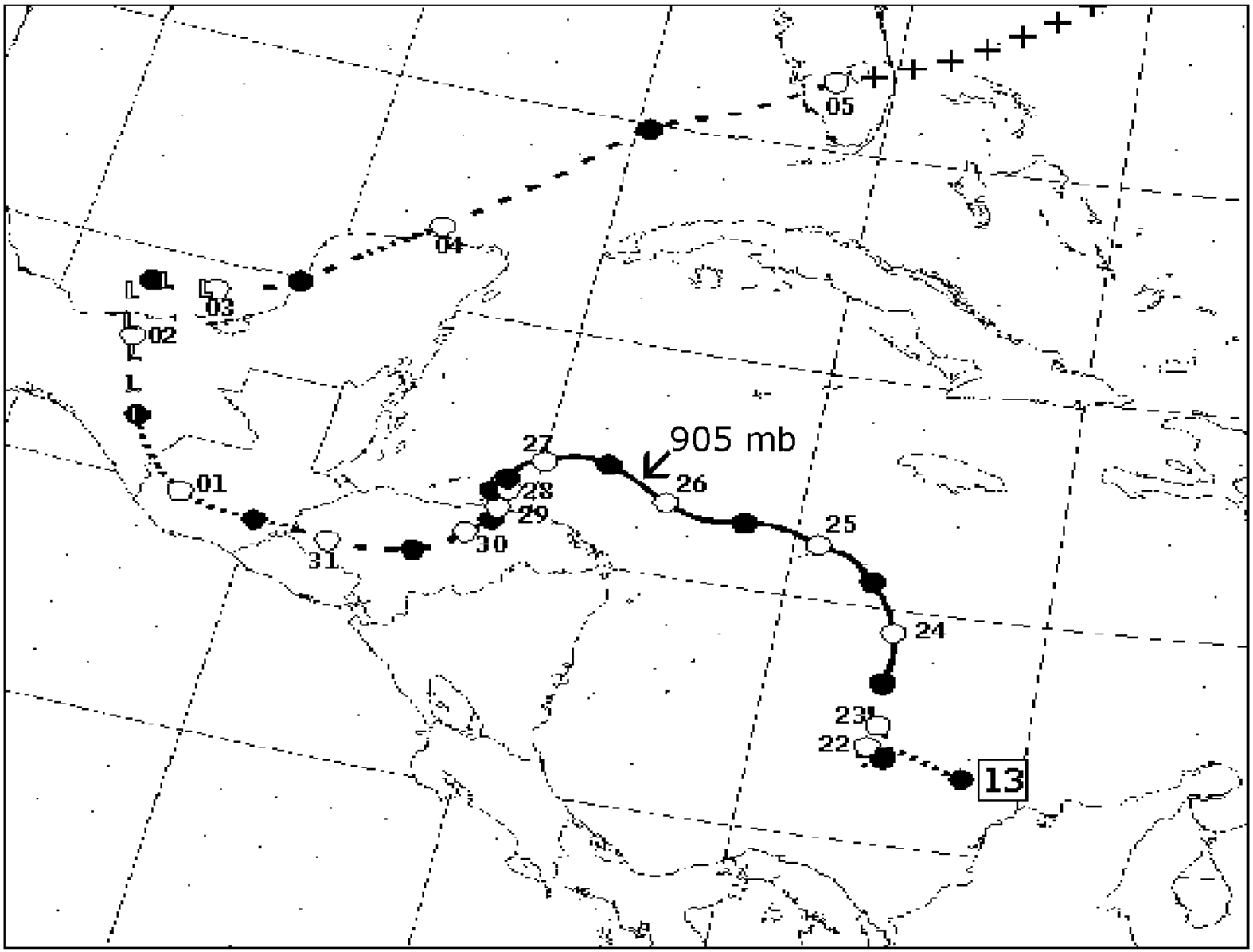



Figure 1b. Best Track of Hurricane Mitch, 22 October - 5 November 1998. All symbols are as shown in Figure 1a, with "L" indicating the period when the system was below tropical depression status.

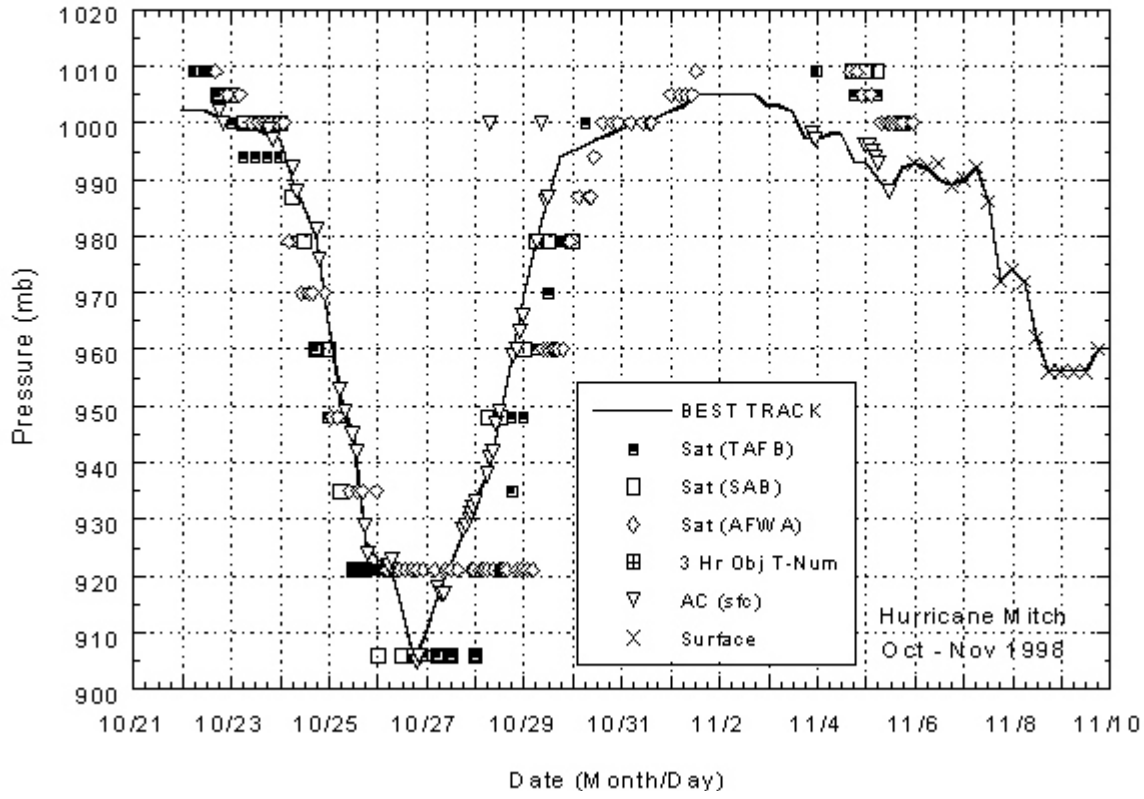



Figure 2. Best track minimum central pressure curve and central pressure observations for Hurricane Mitch.

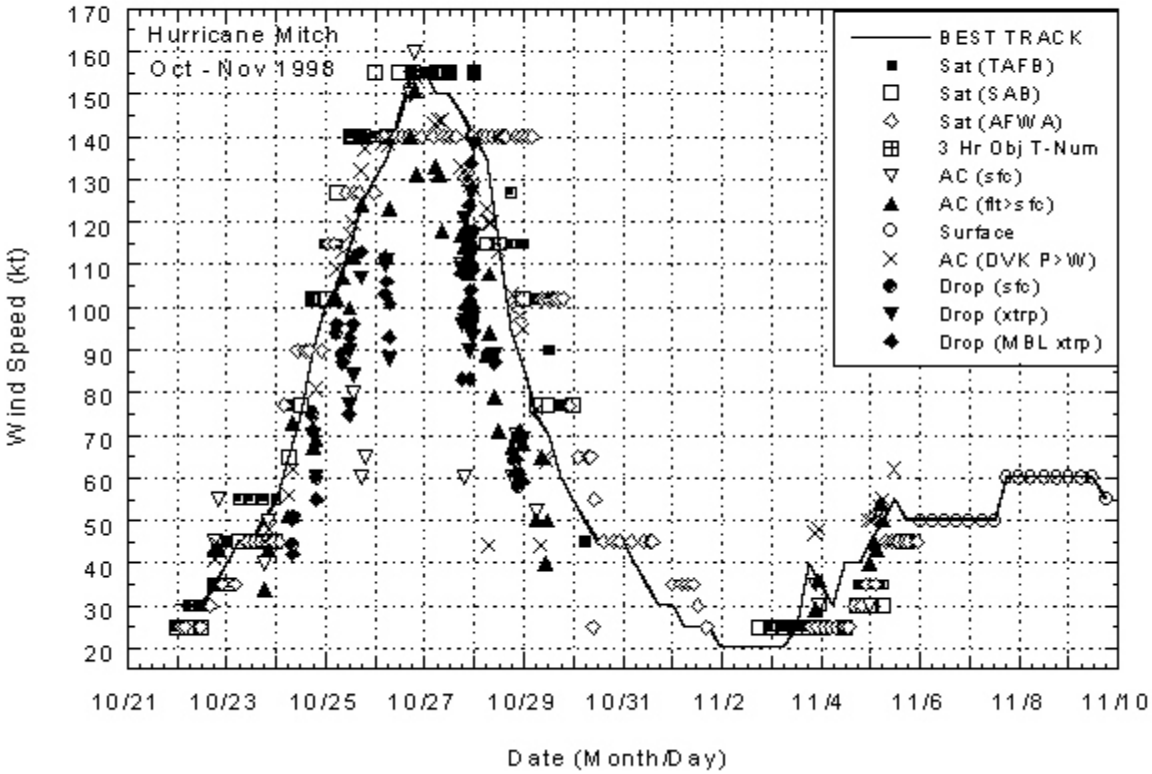
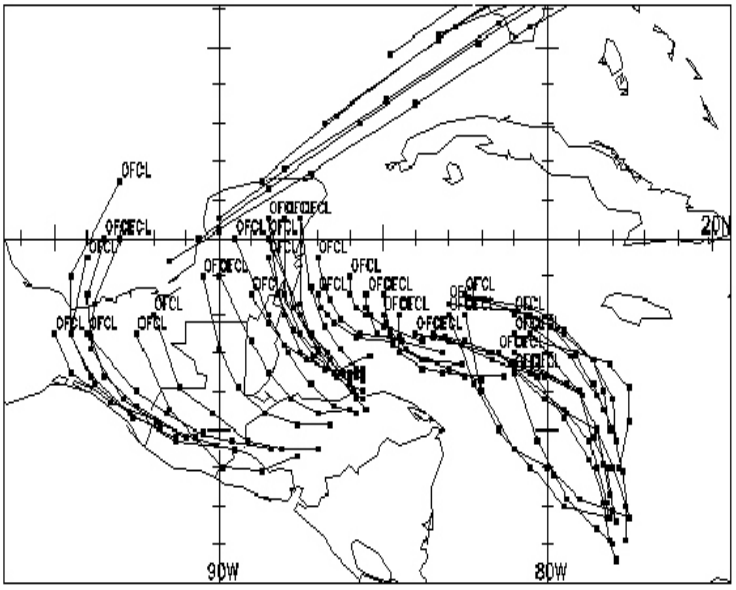



Figure 3. Best track maximum sustained wind speed curve for Hurricane Mitch, with all available intensity estimates and wind observations. *In situ* observations have been adjusted for elevation (90% of 700 mb wind speeds, 80% of 850 mb speeds, and 85% of 1500 ft speeds).

(a)




(b)

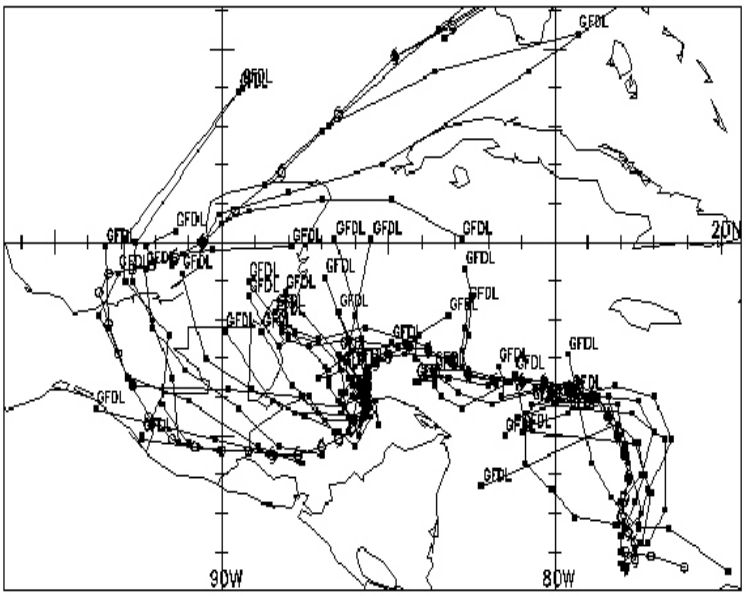



**Fig. 4. Track forecasts for hurricane Mitch, (a) Official, (b) GFDL model.**

Table 1.
Preliminary Best Track - Hurricane Mitch, 22 October - 09 November 1998.

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|---|---|---|---|---|---|
| 22/0000 | 11.6 | 76.1 | 1002 | 30 | Tropical Depression |
| 0600 | 11.9 | 77.1 | 1002 | 30 | " " |
| 1200 | 12.0 | 77.9 | 1002 | 30 | " " |
| 1800 | 11.6 | 77.9 | 1001 | 35 | Tropical Storm |
| 23/0000 | 11.8 | 77.6 | 1000 | 40 | " " |
| 0600 | 12.2 | 77.6 | 999 | 45 | " " |
| 1200 | 12.5 | 77.8 | 999 | 45 | " " |
| 1800 | 12.9 | 78.0 | 998 | 50 | " " |
| 24/0000 | 13.4 | 77.9 | 997 | 55 | " " |
| 0600 | 13.9 | 77.8 | 990 | 65 | Hurricane |
| 1200 | 14.5 | 77.9 | 985 | 75 | " " |
| 1800 | 15.0 | 78.1 | 980 | 90 | " " |
| 25/0000 | 15.5 | 78.4 | 965 | 100 | " " |
| 0600 | 16.0 | 78.9 | 951 | 105 | " " |
| 1200 | 16.2 | 79.6 | 945 | 115 | " " |
| 1800 | 16.4 | 80.3 | 926 | 125 | " " |
| 26/0000 | 16.4 | 81.0 | 923 | 130 | " " |
| 0600 | 16.4 | 81.8 | 922 | 135 | " " |
| 1200 | 16.6 | 82.6 | 914 | 145 | " " |
| 1800 | 16.9 | 83.1 | 905 | 155 | " " |
| 27/0000 | 17.2 | 83.8 | 910 | 155 | " " |
| 0600 | 17.3 | 84.4 | 917 | 150 | " " |
| 1200 | 17.1 | 85.0 | 922 | 150 | " " |
| 1800 | 16.9 | 85.4 | 928 | 145 | " " |
| 28/0000 | 16.6 | 85.6 | 933 | 140 | " " |
| 0600 | 16.3 | 85.6 | 938 | 130 | " " |
| 1200 | 16.3 | 85.6 | 948 | 115 | " " |
| 1800 | 16.3 | 85.7 | 959 | 95 | " " |
| 29/0000 | 16.2 | 85.8 | 970 | 85 | " " |
| 0600 | 16.1 | 85.8 | 979 | 75 | " " |
| 1200 | 15.9 | 85.7 | 987 | 70 | " " |
| 1800 | 15.8 | 85.6 | 994 | 60 | Tropical Storm |
| 30/0000 | 15.6 | 85.7 | 995 | 55 | " " |
| 0600 | 15.4 | 85.9 | 996 | 50 | " " |

Table 1 (continued).
Preliminary Best Track - Hurricane Mitch, 22 October - 05 November 1998.

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|---|---|---|---|---|---|
| 30/1200 | 15.2 | 86.1 | 997 | 45 | Tropical Storm |
| 1800 | 14.9 | 86.5 | 998 | 45 | " " |
| 31/0000 | 14.7 | 87.0 | 999 | 45 | " " |
| 0600 | 14.5 | 87.7 | 1000 | 40 | " " |
| 1200 | 14.5 | 88.5 | 1000 | 35 | " " |
| 1800 | 14.6 | 89.2 | 1001 | 30 | Tropical Depression |
| 01/0000 | 14.6 | 90.0 | 1002 | 30 | " " |
| 0600 | 14.7 | 90.8 | 1003 | 25 | " " |
| 1200 | 14.9 | 91.5 | 1005 | 25 | " " |
| 1800 | 15.5 | 92.2 | 1005 | 25 | Tropical Depression |
| 02/0000 | 16.3 | 92.7 | 1005 | 20 | Low |
| 0600 | 17.1 | 93.1 | 1005 | 20 | Low |
| 1200 | 17.9 | 93.4 | 1005 | 20 | Low |
| 1800 | 18.7 | 93.7 | 1005 | 20 | Low |
| 03/0000 | 19.2 | 93.4 | 1003 | 20 | Low |
| 0600 | 19.3 | 92.7 | 1003 | 20 | Low |
| 1200 | 19.4 | 92.1 | 1002 | 25 | Low |
| 1800 | 19.6 | 91.4 | 997 | 40 | Tropical Storm |
| 04/0000 | 20.0 | 90.6 | 997 | 35 | " " |
| 0600 | 20.8 | 89.6 | 998 | 30 | Tropical Depression |
| 1200 | 21.8 | 88.2 | 998 | 40 | Tropical Storm |
| 1800 | 23.3 | 86.5 | 993 | 40 | " " |
| 05/0000 | 24.8 | 84.8 | 993 | 45 | " " |
| 0600 | 25.6 | 83.1 | 990 | 50 | " " |
| 1200 | 26.6 | 81.3 | 987 | 55 | " " |
| 1800 | 27.5 | 78.3 | 992 | 50 | Extratropical |
| 06/0000 | 30.0 | 75.0 | 993 | 50 | " " |
| 0600 | 32.5 | 72.0 | 992 | 50 | " " |
| 1200 | 35.0 | 68.0 | 990 | 50 | " " |
| 1800 | 37.0 | 63.0 | 989 | 50 | " " |
| 07/0000 | 39.0 | 58.0 | 990 | 50 | " " |
| 0600 | 41.0 | 53.0 | 992 | 50 | " " |
| 1200 | 42.5 | 47.5 | 986 | 50 | " " |

Table 1 (continued).
Preliminary Best Track - Hurricane Mitch, 22 October - 05 November 1998.

| Date/Time (UTC) | Latitude (°N) | Longitude (°W) | Pressure (mb) | Wind Speed (kt) | Stage |
|---|---|---|---|---|---|
| 07/1800 | 44.5 | 42.0 | 972 | 60 | " " |
| 08/0000 | 46.5 | 36.5 | 974 | 60 | " " |
| 0600 | 48.5 | 31.0 | 972 | 60 | " " |
| 1200 | 50.0 | 25.0 | 962 | 60 | " " |
| 1800 | 53.5 | 20.5 | 956 | 60 | " " |
| 09/0000 | 55.5 | 14.5 | 956 | 60 | " " |
| 0600 | 58.0 | 10.5 | 956 | 60 | " " |
| 1200 | 61.0 | 10.0 | 956 | 60 | Extratropical |
| 1800 | 63.5 | 5.0 | 960 | 55 | " " |
| 26/1800 | 16.9 | 83.1 | 905 | 155 | Minimum Pressure |
| LANDFALLS | | | | | |
| 29/1200 | 15.9 | 85.7 | 987 | 70 | HONDURAS<br>72 n mi E of La Ceiba |
| 04/0200 | 20.1 | 90.5 | 998 | 35 | MEXICO<br>15 n mi NNE of Campeche |
| 05/1100 | 26.2 | 81.9 | 989 | 55 | USA<br>5 n mi W of Naples, Florida |

Table 2.

Hurricane Mitch selected Honduras rainfall totals,
25-31 October 1998.

| L o c a t i o n | Rainfall Total (in) | Maximum 1-Day Total | Date |
|---|---|---|---|
| Choluteca | 35.89 | 18.37 | 10/31 |
| La Ceiba | 34.52 | 11.19 | 10/27 |
| Balfate | 26.43 | 10.24 | 10/26 |
| Tela | 22.26 | 6.73 | 10/28 |
| Yoro | 20.49 | 9.28 | 10/28 |
| Orica | 17.89 | 4.35 | 10/30 |
| Santa Lucia | 15.18 | 5.48 | 10/30 |
| Sabana Grande | 14.53 | 7.33 | 10/30 |
| Lepaguare | 13.19 | 3.55 | 10/26 |
| Amapala | 12.38 | 10.24 | 10/31 |
| Colonia 21 De Octubre | 11.85 | 6.31 | 10/31 |
| Santa Barbara | 11.81 | 3.96 | 10/30 |
| Unah (Tegucigalpa) | 11.58 | 5.09 | 10/30 |
| Moroceli | 10.65 | 7.48 | 10/31 |
| Roatan | 10.65 | 3.68 | 10/27 |
| La Mesa | 10.55* | 5.87 | 10/28 |
| Catacamas | 10.13 | 3.95 | 10/30 |
| Gracias | 10.05 | 3.23 | 10/25 |

* - No data available 10/30-31; a higher amount could have occurred.

Table 3.
Hurricane Mitch selected surface observations, November 1998.

| LOCATION | Press. (mb) | Date/Time (UTC) | Sust. Wind (kts)[a] | Peak gust (kts) | Date/Time (UTC)[b] | Storm Surge (ft)[c] | Storm Tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| ***Florida*** | | | | | | | | |
| Key West Airport | 995.7 | 05/0853 | 35 | 48 | 05/0653 | | | 2.11 |
| Boca Chica NAS | 996.6 | 05/0855 | 25 | 38 | 05/0855 | | | |
| Marathon | 997.2 | 05/1053 | 18 | 30 | 05/1104 | | | |
| Homestead | | | | | | | | 3.12 |
| Homestead AFB | 995.9 | 05/1158 | 20 | 35 | 05/1229 | | | |
| Tamiami Airport | 995.1 | 05/1153 | 20 | 33 | 05/1153 | | | 3.58 |
| Miami Int. Airport | 994.1 | 05/1356 | 20 | 38 | 05/1042 | | | 5.88 |
| Opa Locka Airport | 993.9 | 05/1353 | 28 | 38 | 05/1153 | | | |
| Hollywood | | | | | | | | 3.29 |
| Ft. Lauderdale | | | | | | | | 6.62 |
| Ft. Lauderdale Beach | | | | | | | | 3.88 |
| Ft. Lauderdale Int. | 993.8 | 05/1353 | 29 | 36 | 05/1120 | | | |
| Ft. Lauderdale Exec. | 993.8 | 05/1353 | 25 | 34 | 05/1830 | | | |
| Pompano Beach Airport | 993.7 | 05/1353 | 28 | 39 | 05/0408 | | | |
| West Palm Beach | | | | | | | | 6.70 |
| West Palm Beach | 994.7 | 05/1153 | 25 | 34 | 05/1658 | | | |
| Naples | | | | | | | | 1.42 |
| Naples Airport | 991.2 | 05/1115 | 18 | 27 | 05/1246 | | | |
| Miami Beach | | | 26 | 40 | 05/1248 | | | 3.15 |
| Flamingo | | | 33 | 39 | 05/0948 | | | |
| Virginia Key | 995.0 | 05/1352 | 26 | 37 | 05/1252 | | | |
| Lower Keys | | | | | | | 2-4 [e] | |
| Collier County | | | | | | | <1[e] | |
| Miami-Dade County | | | | | | | <1[e] | |
| Broward County | | | | | | | 1-2[e] | |
| | | | | | | | | |
| Vero Beach | 996.6 | 05/1321 | 25 | 42 | 05/13219 | | | 4.14 |
| Vero Beach FAA tower | | | | | | | | 5.45 |
| Cape Canaveral(KTTS) | 1000.7 | 05/1358 | 22 | 39 | 05/1705 | 3 [e] | | |
| Patrick AFB(KCOF) | 999.0 | 05/1355 | 27 | 37 | 05/1735 | | | |
| Melbourne Airport(KMLB | 998.3 | 05/1350 | 20 | 30 | 05/1150 | | | 4.54 |
| Melbourne NWS | | | | | | | | 4.95 |
| Titusville(KTIX) | 1002.0 | 05/1358 | 25 | 35 | 05/1758 | | | |
| Fort Pierce | 994.6 | 05/1255 | 20 | 29 | 05/1400 | | | 5.36 |
| Orlando Int. | 1001.5 | 05/1253 | 23 | 29 | 05/1714 | | | 1.58 |
| Stuart(KSUA) | 995.3 | 05/1230 | | | | | | |
| Jupiter/Tequesta | 1003.2 | | | | | | | 7.00 |
| Port Myaca | 997.9 | | | | | | | 6.48 |
| Stuart | 995.2 | | | | | | | 6.10 |
| Fort Pierce | 996.2 | | | | | | | 5.33 |
| Okeechobee | 998.9 | | | | | | | 4.17 |
| | | | | | | | | |
| St Petersburg (KPIE) | 1001.8 | 05/0953 | 20 | 25 | 05/0953 | | | 1.22 |
| St Petersburg(KSPG) | 1000.9 | 05/1053 | 21 | 27 | 05/0945 | | | |
| St Petersburg Pier | | | 30 | 35 | 05/1300 | | | |
| Tampa Airport(KTPA) | 1001.5 | 05/1056 | 14 | 23 | 05/1156 | | | 0.47 |
| MacDill AFB(KMCF) | 1001.5 | 05/1059 | 12 | 22 | 05/1331 | | | 1.34 |
| Tampa Old Port | | | 24 | 29 | 05/1254 | | | |
| Ruskin(KTBW) | | | | | | | | 1.94 |
| Sunshine Skyway | | | 29 | 34 | 05/1054 | | | |
| Winter Haven(KGIF) | 1001.2 | 05/1053 | 16 | 23 | 05/1153 | | | 0.84 |

| LOCATION | Press. (mb) | Date/Time (UTC) | Sust. Wind (kts)[a] | Peak gust (kts) | Date/Time (UTC)[b] | Storm Surge (ft)[c] | Storm Tide (ft)[d] | Total rain (in) |
|---|---|---|---|---|---|---|---|---|
| ***Florida*** | | | | | | | | |
| Lakeland(KLAL) | 1001.4 | 05/1054 | 13 | 20 | 05/1152 | | | 1.94 |
| Sarasota Airport(KSRQ) | 1000.0 | 05/1050 | 15 | 25 | 05/1350 | | | 1.75 |
| Arcadia | | | | | | | | 4.76 |
| Punta Gorda(KPGD) | 997.3 | 05/0944 | 25 | 33 | 05/0944 | | | 3.88 |
| Fort Myers(KFMY) | 994.6 | 05/1017 | 21 | 31 | 05/1238 | | | 6.05 |
| Fort Myers Reg. S.W. | 993.6 | 05/1018 | 27 | 33 | 05/1018 | | | |

**[a] Standard NWS ASOS and C-MAN on-hour averaging periods are 2 min; buoys are 8 min.**
**[b] Date/time is for sustained wind when both sustained and gust are listed.**
**[c] Storm surge is water height above normal astronomical tide level.**
**[d] Storm tide is water height above NGVD.**
**[e] Estimated.**

Table 4.
Hurricane Mitch selected National Buoy Data Center (NDBC) and Ship observations, 21 September - 05 November 1998.

| LOCATION | Press (mb) | Date/ Time (UTC) | Sust. wind (kts)[a] | Peak Gust (kts) | Date/ Time (UTC)[b] | Max Sgnft. Wave Ht. (FT) |
|---|---|---|---|---|---|---|
| CMAN Stations | | | | | | |
| Lake Worth, FL (LKWF1) | 994.1 | 05/1300 | 36 | 42 | 05/1200 | |
| Fowey Rocks, FL (FWYF1) | 995.9 | 05/1400 | 52 | 63 | 05/1300 | |
| Molasses Reef, FL (MLRF1) | 997.1 | 05/1200 | 41 | 45 | 05/1100 | |
| Long Key, FL (LONF1) | 996.9 | 05/1100 | 32 | 39 | 05/0900 | |
| Sombrero Key, FL (SMKF1) | 997.2 | 05/1100 | 41 | 46 | 05/0800 | |
| Sand Key, FL (SANF1) | 995.9 | 05/0700 | 39 | 43 | 05/0700 | |
| Dry Tortugas, FL (DRYF1) | 993.4 | 05/0500 | 41 | 47 | 05/0500 | |
| | | | | | | |
| NOAA/ NDBC Buoys | | | | | | |
| 42003 (25.9N / 85.9W) | 1001.4 | 05/0500 | 37 | 44 | 04/2350 | 14.6 |
| 41010 (25.9N / 78.5W) | 995.4 | 05/2000 | 37 | 45 | 05/1800 | 13.7 |
| | | | | | | |
| Ship Reports of ≥34-Knot Winds | | | | | | |
| PFRO (14.4N 77.0W) | 1010.2 | 22/1200 | 37 | | 22/1200 | 2.0 |
| ZCBN5 (11.8N 78.3W) | 1006.0 | 23/2100 | 38 | | 23/2100 | 2.0 |
| ZCBN5 (12.5N 77.6W) | 1005.2 | 24/0000 | 37 | | 24/0000 | 2.0 |
| ZCBN5 (13.4N 77.1W) | 1005.3 | 24/0300 | 40 | | 24/0300 | MM |
| ZCBN5 (14.2N 76.7W) | 1006.1 | 24/0600 | 39 | | 24/0600 | MM |
| PEXV (19.7N 81.3W) | 1009.1 | 25/2100 | 43 | | 25/2100 | 2.0 |
| PDWT (20.2N 84.3W) | 1008.0 | 27/0000 | 37 | | 27/0000 | 3.0 |
| KGDF (21.5N 76.5W) | 1012.0 | 27/0000 | 35 | | 27/0000 | 3.0 |
| 3FKZ3 (22.1N 73.1W) | 1016.0 | 27/0000 | 36 | | 27/0000 | 3.0 |
| PDWT (20.4N 83.9W) | 1009.5 | 27/0300 | 39 | | 27/0300 | 7.0 |
| PDWT (20.6N 83.5W) | 1009.5 | 27/0600 | 39 | | 27/0600 | MM |
| PDWT (20.7N 83.0W) | 1009.0 | 27/0900 | 45 | | 27/0900 | MM |
| PJAG (9.6N 85.5W) | 1011.0 | 27/1200 | 39 | | 27/1200 | 2.0 |
| PDWT (20.8N 82.5W) | 1012.0 | 27/1200 | 37 | | 27/1200 | 4.0 |
| ELRU3 (21.1N 85.5W) | 1010.0 | 27/1200 | 37 | | 27/1200 | MM |
| C6YC (21.3N 83.2W) | 1010.0 | 27/1800 | 40 | | 27/1800 | 2.0 |
| C6YC (20.9N 82.6W) | 1009.5 | 27/2100 | 45 | | 27/2100 | 3.0 |

[a] Standard NWS C-MAN averaging period is 2 min; buoys are 8 min.
[b] Date/time is for sustained wind when both sustained and gust are listed.
[C] Buoy failed shortly after this observation; a lower pressure and a higher wind and wave height may have occurred.
MM - missing data.

Table 4 (continued).
Hurricane Mitch selected National Buoy Data Center (NDBC) and Ship observations, 21 September - 05 November 1998.

| LOCATION | Press (mb) | Date/ Time (UTC) | Sust. wind (kts)[a] | Peak Gust (kts) | Date/ Time (UTC)[b] | Max Sgnft. Wave Ht. (FT) |
|---|---|---|---|---|---|---|
| Ship Reports of ≥34-knot Winds | | | | | | |
| C6KU7 (18.6N 86.6W) | 1005.1 | 28/1200 | 40 | | 28/1200 | 3.0 |
| PJAG (14.4N 77.3W) | 1010.0 | 31/1200 | 35 | | 31/1200 | 2.0 |
| C6YE (17.7N 87.2W) | 1008.0 | 31/1200 | 38 | | 31/1200 | 3.0 |
| C6HH3 (16.2N 87.6W) | 1007.8 | 31/1500 | 54 | | 31/1500 | MM |
| WLDF (23.9N 86.9W) | 1003.7 | 04/0600 | 40 | | 04/0600 | 4.0 |
| 3FKZ3 (20.3N 85.4W) | 999.0 | 04/1200 | 48 | | 04/1200 | MM |
| WLDF (24.7N 84.9W) | 1003.0 | 04/1200 | 39 | | 04/1200 | 2.0 |
| 3FKZ3 (20.0N 84.9W) | 1000.0 | 04/1500 | 48 | | 04/1500 | 5.0 |
| 3FKZ3 (19.5N 82.8W) | 1001.0 | 05/0000 | 36 | | 05/0000 | 4.0 |
| ELFT8 (23.2N 86.6W) | 998.0 | 05/0000 | 38 | | 05/0000 | 2.0 |
| C6KY3 (22.7N 86.3W) | 997.0 | 05/0300 | 40 | | 05/0300 | 3.0 |
| SHIP (25.1N 85.2W) | 1000.5 | 05/0600 | 36 | | 05/0600 | 6.0 |
| KXDB (24.9N 80.3W) | 996.1 | 05/1200 | 45 | | 05/1200 | 3.0 |
| C6KU7 (25.9N 77.5W) | 1000.0 | 05/1500 | 35 | | 05/1500 | 3.0 |
| 3EZK9 (25.1N 75.6W) | 1001.0 | 05/1800 | 37 | | 05/1800 | 10.0 |
| ELUA5 (26.0N 75.4W) | 1000.0 | 05/1800 | 38 | | 05/1800 | 4.0 |

[a] Standard NWS C-MAN averaging period is 2 min; buoys are 8 min.
[b] Date/time is for sustained wind when both sustained and gust are listed.
[C] Buoy failed shortly after this observation; a lower pressure and a higher wind and wave height may have occurred.
MM - missing data

Table 5.
Watch and warning summary, Hurricane Mitch, 22 October-05 November 1998.

| Date/Time (UTC) | Action | Location |
|---|---|---|
| 24/1500 | Hurricane Watch Issued | Jamaica |
| 24/2100 | Hurricane Warning Issued | Jamaica |
| 24/2100 | Hurricane Watch Issued | Eastern Cuba from Camaguey to Guantanamo |
| 25/1200 | Hurricane Watch Issued | Cayman Is. |
| 25/2100 | Hurricane Warning Discontinued | Jamaica |
| 26/0000 | Hurricane Watch Discontinued | Eastern Cuba from Camaguey to Guantanamo |
| 26/0300 | Hurricane Warning Issued | Honduras from Limon eastward to the Nicaragua border...and Swan Island. |
| 26/2100 | Hurricane Warning Issued | Honduras from Limon to the Guatemala border |
| 27/0000 | Hurricane Watch Issued | Belize |
| 27/0430 | Hurricane Watch Issued | East coast of the Yucatan peninsula from Cabo Catoche southward |
| 27/0900 | Hurricane Warning Issued | East coast of the Yucatan peninsula from Cabo Catoche southward and the coast of Guatemala |
| 27/1200 | Hurricane Warning Issued | Belize |
| 27/1800 | Hurricane Watch Discontinued, Tropical Storm Warning changed to Tropical Storm Watch | Cayman Is. |
| 29/0300 | Tropical Storm Watch Discontinued | Cayman Is. |
| 29/2100 | Hurricane Warning changed to Tropical Storm Warning | Caribbean coast of Honduras, Guatemala, Belize, and the Yucatan peninsula from Cabo Catoche southward including offshore islands |
| 29/2100 | Hurricane Watch Issued | Belize |
| 30/1500 | Hurricane Watch Discontinued | Belize |
| 31/1500 | Tropical Storm Warning Discontinued | Caribbean coast of Honduras, Guatemala, Belize, and the Yucatan peninsula from Cabo Catoche southward including offshore islands. |
| 03/2100 | Tropical Storm Warning Issued | West coast of Yucatan peninsula from Progreso southward to Carmen |
| 04/0900 | Tropical Storm Warning Discontinued | West coast of Yucatan peninsula from Progreso southward to Carmen |

Table 5 (continued).
Watch and warning summary, Hurricane Mitch 22 October - 5 November 1998.

| Date/Time (UTC) | Action | Location |
|---|---|---|
| 04/1500 | Tropical Storm Warning Issued | Florida Keys, Florida peninsula southward from Tarpon Springs on the west coast and southward from New Smyrna Beach on the east coast. |
| 04/1800 | Tropical Storm Warning Issued | Western Cuba from the province of Matanzas westward including the Isle of Youth |
| 05/1500 | Tropical Storm Warning Discontinued | Florida Keys west of Craig Key, and Florida west coast from west of Flamingo to Tarpon Springs |
| 05/1800 | Tropical Storm Warning Discontinued | Western Cuba from the province of Matanzas westward including the Isle of Youth |
| 05/2100 | Tropical Storm Warning Discontinued | Florida Keys east of Craig Key, and Florida east coast southward from New Smyrna Beach |

Table 6.

Deaths estimates associated with Hurricane Mitch. Death figures based on Fact Sheet #21 from the U.S. Agency for International Development.

| LOCATION | DEATHS* |
|---|---|
| ***Honduras*** | **5677** |
| ***Nicaragua*** | **2863** |
| ***Guatemala*** | **258** |
| ***El Salavador*** | **239** |
| ***Mexico*** | **9** |
| ***Costa Rica*** | **7** |
| ***United States*** | **2** |
| ***Offshore - Crew from Ship Fantome*** | **31** |
| **Storm Total** | **9086** |

* - These are the best estimates received to-date; subject to revision at a later time.

Table 7.

Preliminary track forecast evaluation of Hurricane Mitch - heterogeneous sample. Errors in nautical miles for tropical storm and hurricane stages with number of forecasts in parenthesis. Bold italized numbers represent average errors which were smaller than the Official forecast error.

| Forecast Technique | Period (hours) | | | | |
|---|---|---|---|---|---|
| | 12 | 24 | 36 | 48 | 72 |
| CLIP | 49 (41) | 115 (40) | 208 (38) | 323 (36) | 604 (32) |
| GFDI | 44 (39) | 96 (38) | 146 (35) | 181 (31) | 230 (26) |
| GFDL** | 39 (38) | 71 (36) | 116 (34) | 140 (30) | 228 (26) |
| LBAR | 42 (41) | 88 (40) | 138 (38) | 179 (33) | 246 (25) |
| AVNI | 59 (41) | 113 (40) | 166 (38) | 217 (36) | 300 (32) |
| AVNO** | 57 (39) | 103 (38) | 153 (36) | 198 (34) | 277 (30) |
| BAMD | 51 (41) | 104 (40) | 162 (38) | 219 (36) | 345 (32) |
| BAMM | 60 (41) | 106 (40) | 157 (38) | 202 (36) | 297 (32) |
| BAMS | 83 (41) | 156 (40) | 232 (38) | 308 (36) | 460 (32) |
| NGPI | 46 (40) | 67 (38) | 98 (32) | 134 (28) | 170 (24) |
| NGPS** | 47 (21) | 70 (20) | 98 (17) | 130 (15) | 191 (13) |
| UKMI | 52 (40) | 88 (38) | 118 (36) | 153 (34) | 230 (30) |
| UKM** | 52 (21) | 87 (20) | 116 (19) | 144 (18) | 200 (16) |
| A90E | 46 (41) | 96 (40) | 141 (38) | 188 (36) | 385 (32) |
| A98E | 46 (41) | 95 (40) | 140 (38) | 197 (36) | 424 (32) |
| A9UK | 52 (19) | 104 (18) | 157 (18) | 213 (18) | 449 (16) |
| EMX | | 61 (9) | | 122 (7) | 150 (6) |
| | | | | | |
| NHC Official | 39 (41) | 80 (40) | 125 (38) | 167 (35) | 237 (28) |
| NHC Official 10-Year Average (1988-1997) | 47 (1838) | 88 (1633) | 127 (1449) | 165 (1284) | 248 (1006) |

** - Output from these models was unavailable at time of forecast issuance.