



NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

TROPICAL STORM BILL (AL022015)

16 – 18 June 2015

Robbie Berg
National Hurricane Center
9 September 2015



GOES-EAST VISIBLE SATELLITE IMAGE OF TROPICAL STORM BILL AT 1645 UTC 16 JUNE 2015 AT THE TIME OF ITS
LANDFALL ALONG THE TEXAS COAST ON MATAGORDA ISLAND

Tropical Storm Bill formed over the far northwestern Gulf of Mexico and made landfall along the Texas coast on Matagorda Island. Bill produced heavy rains and flooding while it moved across eastern Texas and Oklahoma.

Tropical Storm Bill

16 – 18 JUNE 2015

SYNOPTIC HISTORY

Tropical Storm Bill formed from the interaction of an upper-level trough over the Gulf of Mexico and a broad area of low pressure near the Yucatan Peninsula and Belize. A weak, low-latitude tropical wave that moved off the west coast of Africa on 31 May could have fostered the development of the broad low, but the wave was difficult to track due to dry air across the tropical Atlantic, which inhibited deep convection. By 11 June, a zone of low-level shear vorticity developed over the western Caribbean Sea and Central America between the subtropical high over the western Atlantic Ocean and Hurricane Carlos off the southern coast of Mexico. Carlos' circulation, combined with the upper-level trough, advected deep moisture and the vorticity northward over the next couple of days, and a broad, elongated area of low pressure formed over northern Belize and the Yucatan Peninsula on 13 June. Blocked by a mid-tropospheric high near the southeastern U.S. coast, the disturbance was steered northwestward over the western Gulf of Mexico on 14 and 15 June. The low developed a well-defined center of circulation by 0000 UTC 16 June, and since it was already producing tropical-storm-force winds, it was designated as a tropical storm at that time while centered about 175 n mi east-southeast of Corpus Christi, Texas. The “best track” chart of the tropical cyclone's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1¹.

Bill continued northwestward early on 16 June but slowed down and turned west-northwestward as it approached the Texas coast. Bill made landfall on Matagorda Island at 1645 UTC 16 June with maximum winds of 50 kt, and was then nearly stationary along the coast for a couple of hours. Later that evening, the center turned northward and accelerated inland over eastern Texas, and surface observations indicated that Bill weakened to a tropical depression by 0600 UTC 17 June when centered about 30 n mi east of Austin, Texas. The depression continued northward on 17 June and early on 18 June, producing heavy rainfall and flooding while it moved through the Dallas/Ft. Worth metro area and into southern Oklahoma. Bill turned northeastward after moving into Oklahoma, and although it was still producing heavy rains, its associated convection was not very deep and had begun to lose organization. Thus, Bill is deemed to have become a remnant low by 1800 UTC 18 June while centered about 65 n mi south-southeast of Tulsa, Oklahoma.

Bill's remnant low moved east-northeastward for the next few days, producing heavy rain, flooding, and tornadoes across southern Missouri, northern Arkansas, and portions of the

¹ A digital record of the complete best track, including wind radii, can be found on line at <ftp://ftp.nhc.noaa.gov/atcf>. Data for the current year's storms are located in the *btk* directory, while previous years' data are located in the *archive* directory.

Ohio River Valley. The low ultimately dissipated just after 0000 UTC 21 June over the mountainous terrain of central West Virginia.

METEOROLOGICAL STATISTICS

Observations in Bill (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), and objective Advanced Dvorak Technique (ADT) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Observations also include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from flights of the 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), the European Space Agency's Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Bill.

Winds and Pressure

Aircraft data indicated that Bill was producing tropical-storm-force winds over the Gulf of Mexico before it had a well-defined center of circulation. During the morning of 15 June, a Hurricane Hunter aircraft measured a peak 1000-ft flight-level wind of 54 kt at 1320 UTC, suggestive of peak surface winds of 40-45 kt, and SFMR values were generally within that range as well. Similar flight-level and SFMR winds were observed on the evening Air Force flight, supporting Bill's intensity of 45 kt when it was designated a tropical cyclone at 0000 UTC 16 June.

Bill's estimated peak intensity of 50 kt from 1200 UTC 16 June up until landfall is based on a peak 850-mb flight-level wind of 61 kt at 1150 UTC and two dropsondes that measured average winds of 58 kt and 62 kt in the lowest 150 m of the profile at 1054 UTC and 1311 UTC, respectively. The estimated minimum central pressure of 997 mb is based on surface pressure data from several dropsondes between 1057 UTC and 1548 UTC 16 June.

Selected surface observations from land stations, data buoys, and offshore oil platforms are given in Table 2. Sustained tropical-storm-force winds were limited to coastal areas between the landfall location on Matagorda Island, Texas, and extreme southwestern Louisiana. The highest sustained winds measured on land were 45 kt from a Weatherflow station located on the barrier island across from Matagorda, Texas, at 2322 UTC 16 June, and 43 kt from another Weatherflow station located at Crab Lake on the Bolivar Peninsula at 1739 UTC. These stations also had the highest measured wind gusts of 52 kt and 54 kt, respectively. Figures 4 and 5 show sustained winds and wind gusts of at least tropical storm force associated with Bill.

The only ship that provided reliable wind and pressure data was the *Maersk Memphis* (WMMK), which reported sustained winds of 36 kt at 1800 UTC 16 June and 35 kt at 2300 UTC.

Storm Surge²

The highest measured storm surge was 3.50 ft at a Texas Coastal Ocean Observing Network (TCOON) gauge in Port Lavaca. A storm surge of 3.42 ft was measured by a TCOON gauge at the Galveston Bay entrance, while National Ocean Service (NOS) gauges measured 3.22 ft and 3.04 ft at Eagle Point and United States Coast Guard (USCG) Freeport, respectively. Storm surge occurred as far north as southwestern Louisiana, where 2.79 ft was measured by an NOS gauge at the Freshwater Canal Locks.

Bill produced moderate storm surge flooding along portions of the Texas coast north of its landfall. Combined with the normal tide, Bill's surge produced inundation of 1 to 3 ft above ground level for parts of the Texas and southwestern Louisiana coasts. The TCOON gauge at Port Lavaca measured a storm tide of 3.7 ft above Mean Higher High Water (MHHW), suggesting that localized inundation of up to 4 ft may have occurred along parts of Matagorda Bay and Lavaca Bay just north of Bill's landfall. Elsewhere, measurements around 3.0 ft above MHHW were reported at the entrance to Galveston Bay, Eagle Point, and USCG Freeport. Figure 6 shows inundation estimates along the Texas and Louisiana coasts in terms of storm tide above MHHW.

Rainfall and Flooding

Bill produced a swath of heavy rainfall extending from the central Texas coast northward across eastern Texas, western Louisiana, and southern and eastern Oklahoma. Many locations reported storm-total amounts in excess of 10 inches. The highest rainfall report available from the storm was 13.78 inches in Ganado, Texas, located north of Port Lavaca in Jackson County. A report of 13.50 inches was also received near El Campo, Texas, not too far to the northeast of Ganado. In Oklahoma, the highest rainfall report received was 9.72 inches in Lone Grove in the southern part of the state just west of Ardmore. The maximum reported rainfall in western Louisiana was 7.88 inches at Bayou Toro. Figure 7 shows daily rainfall amounts from 1200 UTC 16 June through 1200 UTC 19 June.

The heavy rainfall from Bill caused flash flooding and major river flooding across portions of Texas and Oklahoma. In many areas, the flooding was exacerbated by already-saturated grounds resulting from heavy rainfall and flooding which had occurred in May. The Red River at Interstate 35 along the Texas/Oklahoma border reached a record crest of 42.05 ft, 17 ft above flood stage and about 2 ft above the previous record crest set in 1987. West Mustang Creek near Ganado, Texas, reached a record crest of 27.45 ft, which was over 7 ft above flood stage.

² Several terms are used to describe water levels due to a storm. **Storm surge** is defined as the abnormal rise of water generated by a storm, over and above the predicted astronomical tide, and is expressed in terms of height above normal tide levels. Because storm surge represents the deviation from normal water levels, it is not referenced to a vertical datum. **Storm tide** is defined as the water level due to the combination of storm surge and the astronomical tide, and is expressed in terms of height above a vertical datum, i.e. the North American Vertical Datum of 1988 (NAVD88) or Mean Lower Low Water (MLLW). **Inundation** is the total water level that occurs on normally dry ground as a result of the storm tide, and is expressed in terms of height above ground level. At the coast, normally dry land is roughly defined as areas higher than the normal high tide line, or Mean Higher High Water (MHHW).

The Lavaca River near Edna, Texas, reached 29.72 ft, its fourth-highest crest and more than 8 ft above flood stage. Farther north, the Washita River near Dickson, Oklahoma, reached a record crest of 48.70 ft, which was more than 21 ft above flood stage. Flash flooding was reported in the Austin and San Antonio metro areas.

Tornadoes

Bill produced four tornadoes while it was a tropical cyclone. On 17 June, an EF-0 (on the Enhanced Fujita Scale) tornado occurred near Haworth in extreme southeastern Oklahoma, damaging or destroying ten chicken houses. That same day, another tornado of unknown intensity touched down near Ben Bolt in southern Texas, causing some tree damage and moving a propane tank from one property to another. In the early morning of 18 June, two EF-1 tornadoes touched down in De Soto Parish in northwestern Louisiana near Mansfield and Keachi.

After Bill became post-tropical, numerous tornadoes occurred in southern Illinois and southern Indiana on 19 June. A few others touched down in Ohio, Maryland, and northern Virginia on 20 June.

CASUALTY AND DAMAGE STATISTICS

By far, Bill's most significant impacts resulted from heavy rainfall. Bill caused two direct deaths³ as a result of heavy rain and flooding in Oklahoma during its tropical depression stage. An 80-year-old woman died near Macomb in Pottawatomie County after she reportedly ignored barricades and drove through a flooded roadway. A 2-year-old boy drowned in Ardmore, Oklahoma, after he was swept from his father's arms while the two were trying to escape floodwaters. Flooding caused by Bill in Texas and Oklahoma was exacerbated by record rainfall and widespread flooding that occurred in the two states in late May. Numerous roads were closed due to flooding, and high water rescues were conducted in cities such as San Antonio and Alice, Texas. A rockslide in the Arbuckle Mountains near Turner Falls, Oklahoma, forced the closure of Interstate 35, the major route between Dallas/Ft. Worth and Oklahoma City. The interstate was also closed near Ardmore, Oklahoma, due to high water. Closed roads snarled traffic in the Houston and Dallas metro areas, and about 500 flights were canceled at both cities' airports.

Some coastal flooding occurred along portions of the Texas coast due to storm surge, but there was little to no significant damage. On Matagorda Bay, the pier in Port Lavaca suffered moderate damage, and residents in Indianola were cut off from their homes due to the

³ 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.

rising water. Farther north, the road from Sargeant to the beach was flooded and closed, and rising water surrounded homes in the city of Matagorda. In Galveston County, minor coastal flooding occurred on the Bolivar Peninsula with some debris removal required off of State Highway 87. A few homes had minor damage in their downstairs garage areas, and surf caused beach erosion on Galveston beaches.

No major wind damage was reported from Bill. In Lavaca County, Texas, powerlines were blown down in several locations in the county, and a roof was blown off a barn. Most damage was limited to limbs breaking off trees across southeastern Texas.

The majority of the damage caused by Bill resulted from freshwater and storm surge flooding, but an insured loss total from the National Flood Insurance Program is not available at this time.

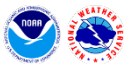
Moisture associated with Bill's precursor disturbance and Hurricane Carlos over the eastern North Pacific Ocean produced heavy rains, flooding, and landslides over portions of Central America and the Yucatan Peninsula of Mexico. In Honduras, two people died in floodwaters near Tegucigalpa, while two other people were reported missing. The Permanent Contingency Commission of Honduras (COPECO) reported that more than 500 people were affected by floods and landslides in Honduras. Two people died in a landslides in Guatemala, and the National Coordination for Disaster Reduction (CONRED) reported that 516,000 people across the country were affected by flooding and landslides. Flooding and damage to trees and vehicles occurred in Cancun, Mexico, with about 13 inches of rain occurring in the city over a 48-h period.

FORECAST AND WARNING CRITIQUE

Bill's genesis was well forecast in the short term, but not particularly well forecast in NHC's five-day Tropical Weather Outlook (TWO). The possibility of formation was first noted in the TWO 78 h before genesis occurred, when the incipient disturbance was located over the northwestern Caribbean Sea and the Yucatan Peninsula. Soon thereafter, the disturbance was given a low (<40%) chance of genesis over the next two days 72 h before formation. The two-day probability was raised to a medium (40-60%) chance 54 h before genesis and to a high (>60%) chance 30 h before genesis. Table 3 provides the number of hours in advance of formation associated with the first NHC TWO forecast in each likelihood category.

A verification of NHC official track forecasts for Bill is given in Table 4a. Since Bill moved inland and weakened within a day of its formation, NHC did not make many forecasts for the cyclone. Still, official forecast track errors were lower than the mean official errors for the previous 5-yr period between 24 and 48 h. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. The official forecasts had lower errors than all of the track models between 24 and 48 h.

A verification of NHC official intensity forecasts for Bill is given in Table 5a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period at all forecast times. A homogeneous comparison of the official intensity errors with selected



guidance models is given in Table 5b. With one minor exception (GFNI at 36 h), the official forecasts had lower errors than all of the intensity models at all forecast times.

Tropical storm warnings associated with Bill are given in Table 6. Because Bill formed so close to land, tropical-storm-force winds first reached the coast within about 12 h of the issuance of the initial tropical storm warning. The NHC's Tropical Weather Outlook did, however, state that tropical storm conditions were possible along portions of the middle and upper Texas coasts and the western Louisiana coast about 36 h before tropical-storm-force winds first reached the coast.

NHC issued a storm surge forecast of 2 to 4 ft above ground level along the upper Texas coast and 1 to 2 ft above ground level along the western Louisiana coast with the first advisory at 0300 UTC 16 June. These forecasts verified well, with a maximum of 3.7 ft above MHHW observed along the Texas coast at Port Lavaca, and a maximum of 2.1 ft above MHHW observed in Louisiana at the Freshwater Canal Locks.

ACKNOWLEDGMENTS

National Weather Service Forecast Offices (WFOs) in Corpus Christi, TX; Houston/Galveston, TX; and Austin/San Antonio, TX, Dallas/Ft. Worth, TX; Norman, OK; and Tulsa, OK; as well as the Weather Prediction Center, National Data Buoy Center, and the National Ocean Service Center for Operational Oceanographic Products and Services, provided extensive post-storm reports that were included as observations in Table 2. Data were also provided by Weatherflow and the Texas Tech University Hurricane Research Team (TTUHRT).



Table 1. Best track for Tropical Storm Bill, 16-18 June 2015.

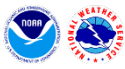
Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
16 / 0000	27.0	94.3	1005	45	tropical storm
16 / 0600	27.6	95.2	1001	45	"
16 / 1200	28.0	96.0	997	50	"
16 / 1645	28.2	96.7	997	50	"
16 / 1800	28.2	96.7	997	50	"
17 / 0000	29.1	96.9	998	40	"
17 / 0600	30.3	97.1	999	30	tropical depression
17 / 1200	31.7	97.4	999	30	"
17 / 1800	32.6	97.5	999	25	"
18 / 0000	33.5	97.3	1000	25	"
18 / 0600	34.2	96.9	1002	25	"
18 / 1200	34.8	96.3	1003	20	"
18 / 1800	35.2	95.5	1004	15	low
19 / 0000	35.6	94.5	1005	15	"
19 / 0600	35.9	93.5	1006	15	"
19 / 1200	36.3	92.3	1006	15	"
19 / 1800	36.9	90.9	1005	20	"
20 / 0000	37.4	89.4	1004	20	"
20 / 0600	37.8	87.8	1002	15	"
20 / 1200	38.2	85.8	1001	15	"
20 / 1800	38.5	83.7	1003	15	"
21 / 0000	38.9	81.3	1006	15	"
21 / 0600					dissipated
16 / 1200	28.0	96.0	997	50	maximum winds and minimum pressure
16 / 1645	28.2	96.7	997	50	landfall on Matagorda Island, Texas

Table 2. Selected surface observations for Tropical Storm Bill, 16-18 June 2015.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Estimated Inundation (ft) ^e	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)				
Texas									
International Civil Aviation Organization (ICAO) Sites									
Palacios (KPSX) (28.72N 96.25W)	16/2253	1004.1	16/2251	34	50				2.05
Rockport / Aransas County Airport (KRKP) (28.09N 97.04W)	16/1938	1003.0	16/1449	31	39				4.40
Angleton / Brazoria County Airport (KLBX) (29.12N 95.47W)	16/1053	1009.3	16/2027	28	40				1.69
Galveston (KGLS) (29.27N 94.87W)	15/2352	1009.9	17/0152	27	40				1.66
Wharton (KARM) (29.25N 96.15W)	17/0055	1005.8	16/2355	27	37				6.26
Port Lavaca / Calhoun County Airport (KPKV) (28.65N 96.68W)	16/2304	1001.7	16/1750	26	37				2.59
Eagle Lake (KELA) (29.60N 96.32W)	17/0115	1005.4	17/0115	25	41				4.06
Victoria (KVCT) (28.85N 96.92W)	16/2304	999.3	16/2152	25	34				4.65
Naval Air Station Corpus Christi (KNGP) (27.69N 97.29W)	16/1927	1006.1	16/1722	25	30				4.62
Corpus Christi (KCRP) (27.77N 97.50W)	16/2253	1006.8	16/1937	24	31				0.67
Bay City (KBYY) (28.97N 95.86W)	16/2315	1007.1	16/2315	23	35				2.53
Houston Executive Airport (KTME) (29.81N 95.90W)	17/0115	1009.5	17/0315	23	34				
Port Aransas / Mustang Beach Airport (KRAS) (27.81N 97.09W)	16/1915	1005.4	16/1455	23	33				2.60
Houston / Pearland – Clover Field (KLVJ) (29.52N 95.24W)	15/2353	1010.5	16/2028	22	38				3.41
Brenham (K11R) (30.21N 96.37W)	17/0355	1007.5	17/0355	22	32				0.42
Gonzalez (KT20) (29.52N 97.46W)	17/0255	1004.4	17/0335	21	30				0.16
Austin / Bergstrom International Airport (KAUS) (30.18N 97.68W)	17/0553	1006.1	17/0408	21	28				0.81



Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Estimated Inundation (ft) ^e	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)				
Giddings / Lee County Airport (KGYB) (30.16N 96.98W)	17/0355	1006.1	17/0355	20	26				1.40
Houston Hobby Airport (KHOU) (29.65N 95.28W)	15/2353	1010.8	17/1415	19	31				2.09
La Grange / Fayette Regional Airport (K3T5) (29.90N 96.95W)	17/0355	1000.7	17/0215	19	31				3.10
Houston Ellington Field (KEFD) (29.62N 95.17W)	16/2250	1011.5	17/1230	19	26				
Naval Air Station Kingsville (KNQI) (27.51N 97.81W)	17/0044	1007.1	16/1937	19	24				1.59
Houston / Bush Intercontinental Airport (KIAH) (29.97N 95.35W)	15/2353	1011.1	17/0353	18	29				3.30
College Station (KCLL) (30.58N 96.37W)	17/1053	1009.9	17/1018	18	29				1.09
Houston / D.W. Hooks Airport (KDWH) (30.07N 95.55W)	17/0153	1010.8	17/1335	18	27				2.11
Bryan (KCFD) (30.71N 96.33W)	17/0915	1009.1	17/0915	17	27				2.24
Caldwell (KRWV) (30.52N 96.70W)	17/0930	1009.4	17/0930	16	27				0.55
Houston Southwest Airport (KAXH) (29.51N 95.48W)	16/2255	1010.5	17/0055	15	27				1.78
Alice (KALI) (27.74N 98.02W)									9.06
Bowie (K0F2) (33.60N 97.78W)									6.86
Orange Grove Naval Auxiliary Landing Field (KNOG) (27.89N 98.04W)									5.46
Weatherflow									
Matagorda (XMGB) (28.59N 95.98W)			16/2322	45 (6 m, 1 min)	52				
Bolivar Peninsula / Crab Lake (XCRB) (29.47N 94.62W)			16/1739	43 (20 m, 1 min)	54				
Surfside Beach (XSRF) (28.93N 95.29W)			16/2249	32 (8 m, 5 min)	42				
Kemah (XGAL) (29.54N 94.91W)			16/2101	30 (5 m, 1 min)	34				



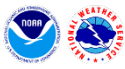
Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Estimated Inundation (ft) ^e	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)				
Seabrook (XSBK) (29.56N 95.02W)			16/1330	27 (9 m, 5 min)	36				
La Marque (XTEX) (29.37N 94.95W)			15/2104	27 (20 m, 1 min)	34				
Texas City (KLEV) (29.42N 94.89W)			16/1210	27 (8 m, 5 min)	33				
Corpus Christi / Poenisch Park (XPOE) (27.72N 97.34W)			16/1645	24 (5 m, 5 min)	29				
South Padre Island (XPAD) (26.08N 97.17W)			17/0315	23 (12 m, 5 min)	27				
Corpus Christi (XCRP) (27.60N 97.30W)			16/1709	21 (10 m, 1 min)	26				
South Padre Island (XSPP) (26.16N 97.18W)			17/0055	20 (5 m, 5 min)	26				
Portland / Wildcat (XWLD) (27.87N 97.32W)			17/0845	20 (5 m, 5 min)	29				
Corpus Christi / Laguna Shores (XLAG) (27.64N 97.29W)			16/0239	19 (10 m, 5 min)	24				
Texas Tech University Hurricane Research Team (TTUHRT)									
Bay City (TT0221A) (28.73N 95.95W)			16/2301	30 (2 m)	41				
Palacios (TT0222A) (28.72N 96.24W)			16/2321	28 (2 m)	39				
Freeport (TT0215A) (29.06N 95.13W)			16/2209	28 (2 m)	33				
Bay City (TT0218A) (28.82N 95.66W)			16/2312	26 (2 m)	34				
Quintana (TT0220A) (28.91N 95.34W)			16/1400	25 (2 m)	33				
Freeport (TT0216A) (29.00N 95.22W)			16/2207	25 (2 m)	33				
Danbury (TT0214A) (29.16N 95.26W)			16/2206	25 (2 m)	32				
Brazoria (TT0217A) (28.92N 95.56W)			16/2303	24 (2 m)	32				
Port Lavaca (TT0224A) (28.73N 96.55W)			16/2250	24 (2 m)	31				
Angleton (TT0213A) (29.12N 95.40W)			16/1934	20 (2 m)	28				
Coastal-Marine Automated Network (C-MAN) Sites									
Port Aransas (PTAT2) (27.82N 97.05W)	16/1900	1005.8	17/1750	29 (15 m)	48				
Sabine Pass (SRST2) (29.68N 94.03W)	15/2300	1111.6	16/2040	23 (9 m)	38				



Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Estimated Inundation (ft) ^e	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)				
National Ocean Service (NOS) Sites									
Galveston Bay (North Jetty) (GNJT2) (29.35N 94.72W)	15/2306	1008.3	16/1142	35 (10 m)	44				
USCG Freeport (FCGT2) (28.94N 95.30W)	16/0954	1009.1	16/2254	32 (10 m)	39	3.04		2.9	
Rockport (RCPT2) (28.02N 97.05W)	16/1900	1003.3	17/1806	29 (6 m)	39	2.05	3.31	2.0	
Sabine Pass North (SBPT2) (29.73N 93.87W)	15/2248	1011.0	15/2230	29 (6 m)		2.63		2.2	
Eagle Point (EPTT2) (29.48N 94.92W)	15/2330	1010.0	17/2200	28 (10 m)	34	3.22		3.0	
Bob Hall Pier / Corpus Christi (MQTT2) (27.58N 97.22W)	16/1906	1006.7	17/1942	26 (8 m)	31	2.05	3.23	2.0	
Morgans Point (MGPT2) (29.68N 94.98W)	15/2330	1010.4	15/2212	24 (10 m)	31	2.89	4.10	2.9	
Port Isabel (PTIT2) (26.06N 97.22W)	16/0012	1008.4	17/0054	22 (8 m)	28	1.34	1.55	1.0	
Galveston Pier 21 (GTOT2) (29.31N 94.79W)	15/2242	1010.5				2.87	3.75	2.5	
Texas Coastal Ocean Observing Network (TCOON)									
Matagorda Bay / Port O'Connor (PCNT2) (28.45N 96.40W)			16/1554	39 (9 m)	48	2.34		2.3	
Galveston Bay Entrance, North Jetty (8771341) (29.36N 94.72W)	15/2236	1008.3	16/1212	36 (12 m)	45	3.42		3.0	
Port Lavaca (VCAT2) (28.64N 96.61W)	16/2212	1000.3	16/1530	36	44	3.50		3.7	
Rollover Pass (RLOT2) (29.51N 94.51W)	15/2236	1010.1	15/2236	29 (10 m)	38	2.09		2.2	
Port Aransas (RTAT2) (27.84N 97.07W)	16/1806	1004.9	16/1900	26	31	1.75		1.7	
Lynchburg Landing (LYBT2) (29.76N 95.08W)	15/2318	1009.8	16/2124	25 (10 m)	32	3.00		2.9	
Packery Channel (PACT2) (27.63N 97.24W)	16/1936	1006.5	16/1648	25 (11 m)	30	1.48		1.5	
High Island (HIST2) (29.59N 94.39W)	15/2300	1010.6	15/2154	23 (10 m)	30	2.28		2.0	



Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Estimated Inundation (ft) ^e	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)				
KI5LU Washington (AU881) (30.34N 96.18W)									6.62
K5BV Aransas Pass (AR105) (27.90N 97.14W)									6.61
Vanderbilt (EW4090) (28.82N 96.62W)									6.32
Lolita (EW3902) (28.79N 96.55W)									6.24
WD5M Rhome (AT109) (33.08N 97.42W)									6.23
Azle (EW2026) (32.91N 97.59W)									6.19
Greenwood (CW7364) (33.39N 97.49W)									6.02
Inez (EW5736) (28.90N 96.78W)									5.84
3 SSW Mont Belvieu (E0401) (29.81N 94.90W)									5.82
K5HAS Edna (AU281) (28.94N 96.52W)									5.78
KB5PRZ Austin (AU323) (30.32N 97.72W)									5.59
Cat Spring (EW4739) (29.50N 96.22W)									5.10
Baytown (EW0401) (29.80N 94.91W)									5.08
NWS Cooperative Observer Program (COOP) Sites									
Madisonville (MSVT2) (30.95N 95.91W)									5.43
Louisiana									
Weatherflow									
Cameron (XCAM) (29.78N 93.29W)			16/1935	32 (10 m, 1 min)	45				
NOS Sites									
Calcasieu Pass (CAPL1) (29.77N 93.34W)	15/2330	1010.7	16/1936	34 (12 m)	42	2.45		1.9	
Freshwater Canal Locks (FRWL1) (29.56N 92.31W)	15/2318	1012.6	15/2118	22 (17 m)	33	2.79		2.1	



Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Estimated Inundation (ft) ^e	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)				
Washita River near Pauls Valley (PLVO2) (34.75N 95.25W)									5.15
Red River at I-35 Bridge near Gainesville (GSVT2) (33.73N 97.16W)									5.02
RAWS Sites									
Clearview (CVWO2) (35.43N 96.20W)									5.23
CWOP Sites									
Lone Grove (EW0547) (34.17N 97.28W)									9.72
Ardmore (DW8325) (34.17N 97.13W)									7.96
Ardmore (DW6599) (34.15N 97.11W)									7.58
Haskell (EW7382) (35.78N 95.72W)									7.09
Lone Grove (EW7376) (34.27N 97.32W)									7.03
Gene Autry (EW6954) (34.30N 97.03W)									7.00
Ratliff City (EW0548) (34.45N 97.51W)									6.11
Springer (EW0546) (34.30N 97.14W)									5.16
Offshore									
NOAA Buoys									
Freeport, TX (42019) (27.91N 95.35W)	16/0850	1003.7	16/0750	33 ^l (5 m, 10 min)	37				
Mid Gulf (42001) (25.89N 89.66W)	15/0850	1010.4	14/1540	29 (5 m)	39				
Galveston (42035) (29.23N 94.41W)	15/2250	1009.0	16/1720	28 (5 m, 10 min)	37				
Corpus Christi (42020) (26.97N 96.69W)	16/0950	1006.5	17/0140	27 (5 m, 10 min)	35				
West Gulf (42002) (26.09N 93.76W)	15/2150	1006.9	16/0640	27 (5 m)	35				
Texas Automated Buoy System (TABS)									
HI-A389 TABS V (42047) (27.90N 93.60W)	15/2300	1007.2	16/1730	30 (3 m)	38				



Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft) ^c	Storm tide (ft) ^d	Estimated Inundation (ft) ^e	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) ^a	Sustained (kt) ^b	Gust (kt)				
GA-252 TABS B (42043) (28.98N 94.90W)	16/0000	1008.9	16/2200	26 (3 m)	36				
PI-745 TABS K (42045) (26.22N 96.50W)	16/0830	1008.1	17/0130	21 (3 m)	26				
PS-1126 TABS J (42044) (26.19N 97.05W)	16/0030	1008.2	17/0300	19 (3 m)	24				
Oil Platforms									
Auger – Garden Banks 426 (42361) (27.55N 92.44W)	16/0030	1010.5	16/0030	39 (122 m)					

- ^a Date/time is for sustained wind when both sustained and gust are listed.
- ^b Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; buoy averaging periods are 8 min.
- ^c Storm surge is water height above normal astronomical tide level.
- ^d For most locations, storm tide is water height above the North American Vertical Datum of 1988 (NAVD88).
- ^e Estimated inundation is the maximum height of water above ground. For NOS tide gauges, the height of the water above Mean Higher High Water (MHHW) is used as a proxy for inundation.
- I Incomplete data

Table 3. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the “Low” category do not include forecasts of a 0% chance of genesis.

	Hours Before Genesis	
	48-Hour Outlook	120-Hour Outlook
Low (<40%)	72	78
Medium (40%-60%)	54	54
High (>60%)	30	30

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Bill, 16-18 June 2015. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	32.6	25.5	19.6	15.6			
OCD5	64.6	114.2	195.8	235.9			
Forecasts	6	6	5	2			
OFCL (2010-14)	28.4	45.0	60.4	77.1	113.1	157.8	210.0
OCD5 (2010-14)	48.3	101.5	161.5	222.6	329.8	412.6	483.9



Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Bill, 16-18 June 2015. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 4a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	40.0	25.8	12.6	15.6			
OCD5	81.0	156.3	232.7	238.9			
GFSI	39.1	31.9	28.8	23.6			
GHMI	46.2	43.3	58.2	139.2			
HWFI	36.7	26.4	18.9	43.2			
EGRI	30.9	28.6	51.4	85.7			
EMXI	38.1	33.8	41.0	22.7			
NVGI	43.5	40.6	62.6	173.2			
GFNI	43.9	52.0	104.4	286.1			
CMCI	53.2	51.1	46.9	45.3			
NAMI	46.0	33.9	45.4	85.9			
TCON	36.3	26.5	27.3	65.2			
TVCA	38.7	27.1	18.1	50.4			
FSSE	37.3	28.6	15.4	31.9			
AEMI	35.2	33.3	34.0	45.2			
BAMS	70.5	124.8	192.7	237.0			
BAMM	58.2	96.8	156.9	198.3			
BAMD	44.4	48.6	57.7	67.2			
Forecasts	4	4	4	2			



Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Bill, 16-18 June 2015. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	3.3	0.8	3.0	5.0			
OCD5	4.3	2.3	3.2	4.5			
Forecasts	6	6	5	2			
OFCL (2010-14)	6.2	9.4	11.5	13.3	14.6	14.6	15.8
OCD5 (2010-14)	7.3	10.8	13.3	15.3	17.7	17.8	17.6

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Bill, 16-18 June 2015. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	3.8	0.0	2.5	0.0			
OCD5	5.8	2.0	4.0	7.0			
HWFI	5.5	6.0	7.0	14.0			
GHMI	5.5	7.3	9.8	10.0			
DSHP	5.8	2.0	4.0	7.0			
LGEM	5.0	2.0	3.8	7.0			
ICON	4.5	4.3	6.5	10.0			
IVCN	4.5	4.3	6.5	10.0			
GFNI	6.0	2.5	2.0	1.0			
GFSI	8.0	10.8	15.3	23.0			
EMXI	6.8	9.5	10.3	15.0			
FSSE	6.0	3.3	2.8	5.0			
Forecasts	4	4	4	1			

Table 6. Watch and warning summary for Tropical Storm Bill.

Date/Time (UTC)	Action	Location
16 / 0300	Tropical Storm Warning issued	Baffin Bay to High Island, Texas
16 / 2100	Tropical Storm Warning modified to	Port Aransas to San Luis Pass, Texas
17 / 0300	Tropical Storm Warning modified to	Port O'Connor to San Luis Pass, Texas
17 / 0600	Tropical Storm Warning discontinued	All

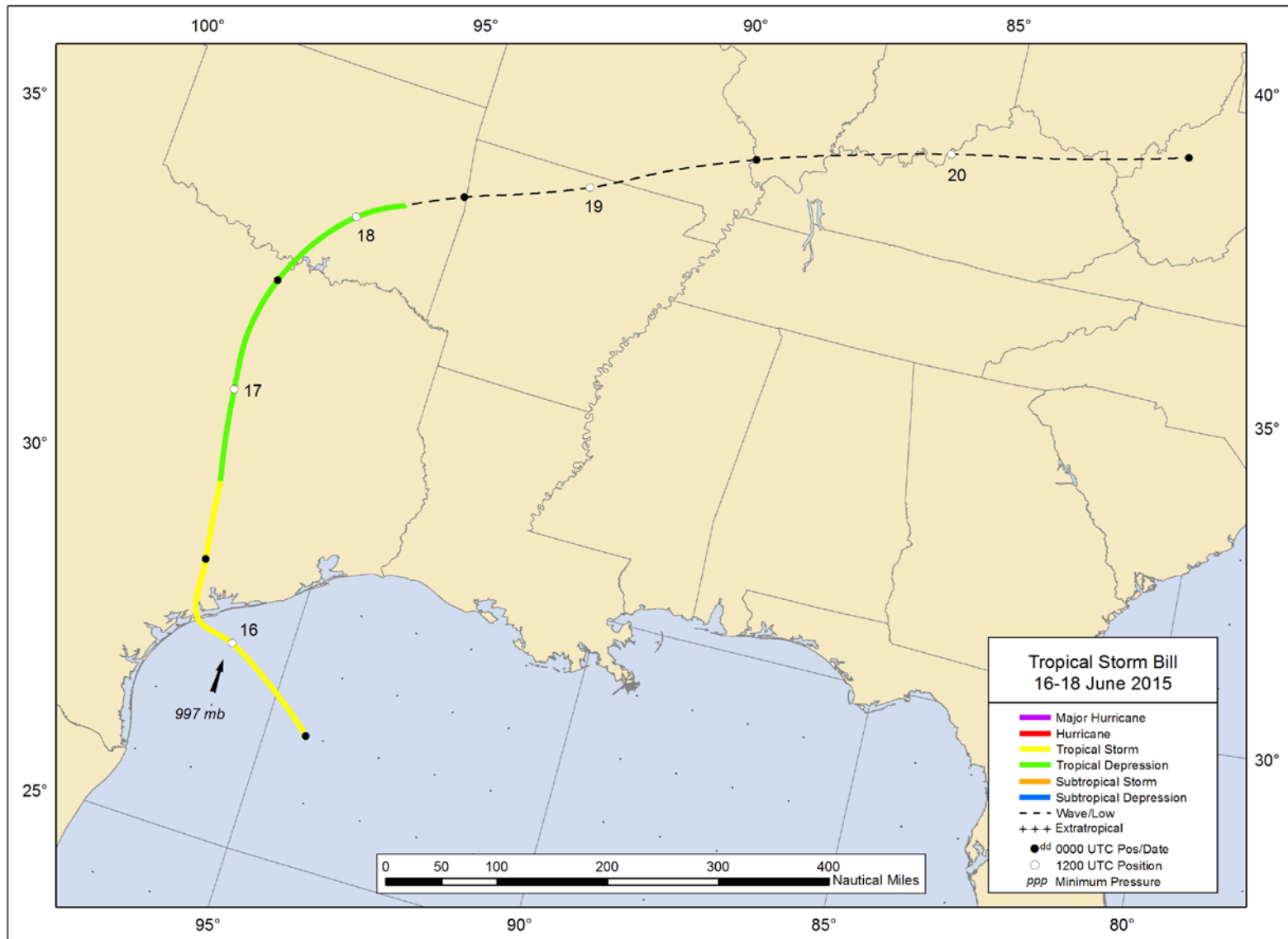


Figure 1. Best track positions for Tropical Storm Bill, 16-18 June 2015. Tracks over the United States and during the remnant low stage are partially based on analyses from the NOAA Weather Prediction Center.

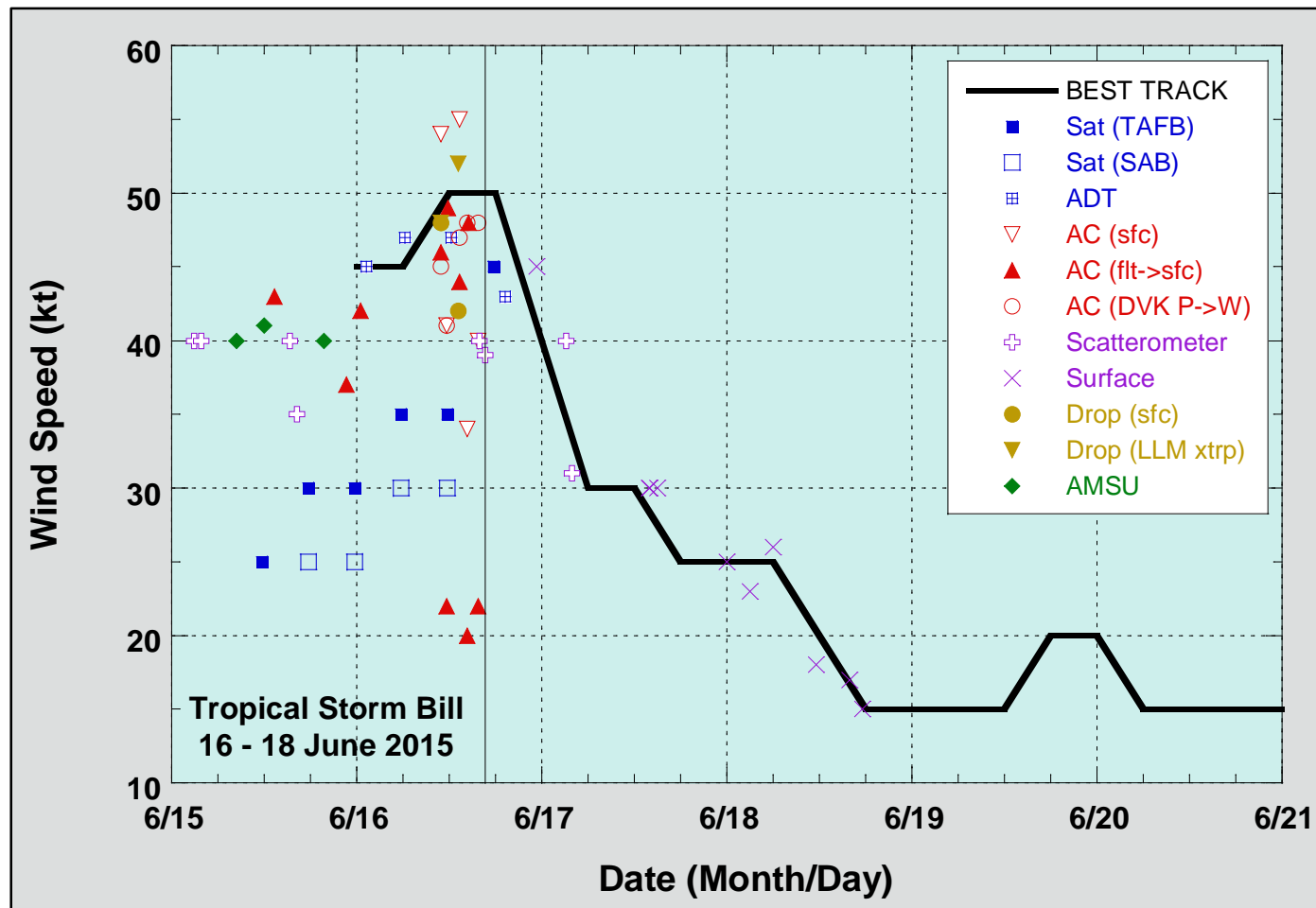


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Bill, 16-18 June 2015. Aircraft observations have been adjusted for elevation using an 80% adjustment factor for observations from 850 mb and 1500 ft. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM). Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.

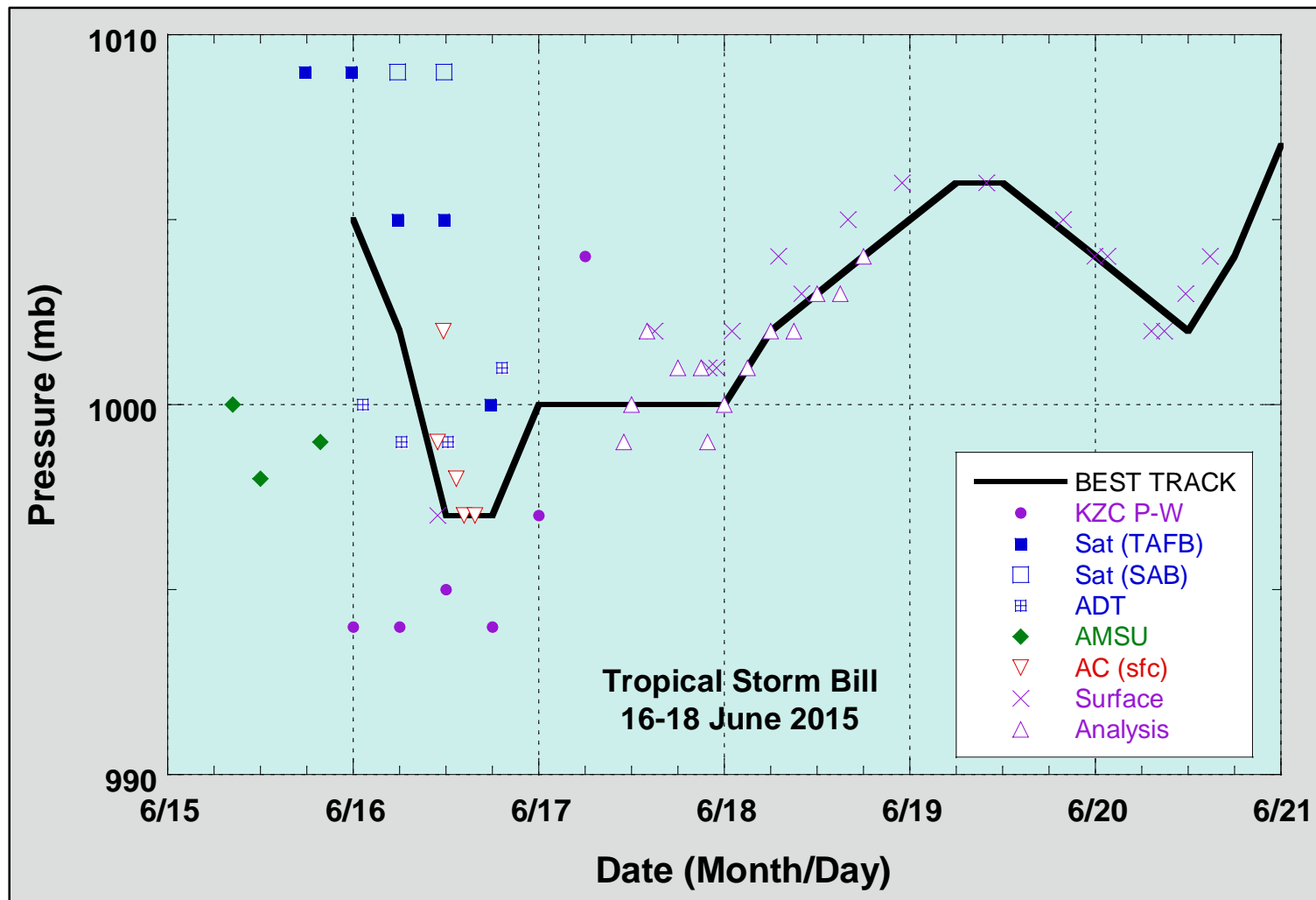


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Bill, 16-18 June 2015. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.

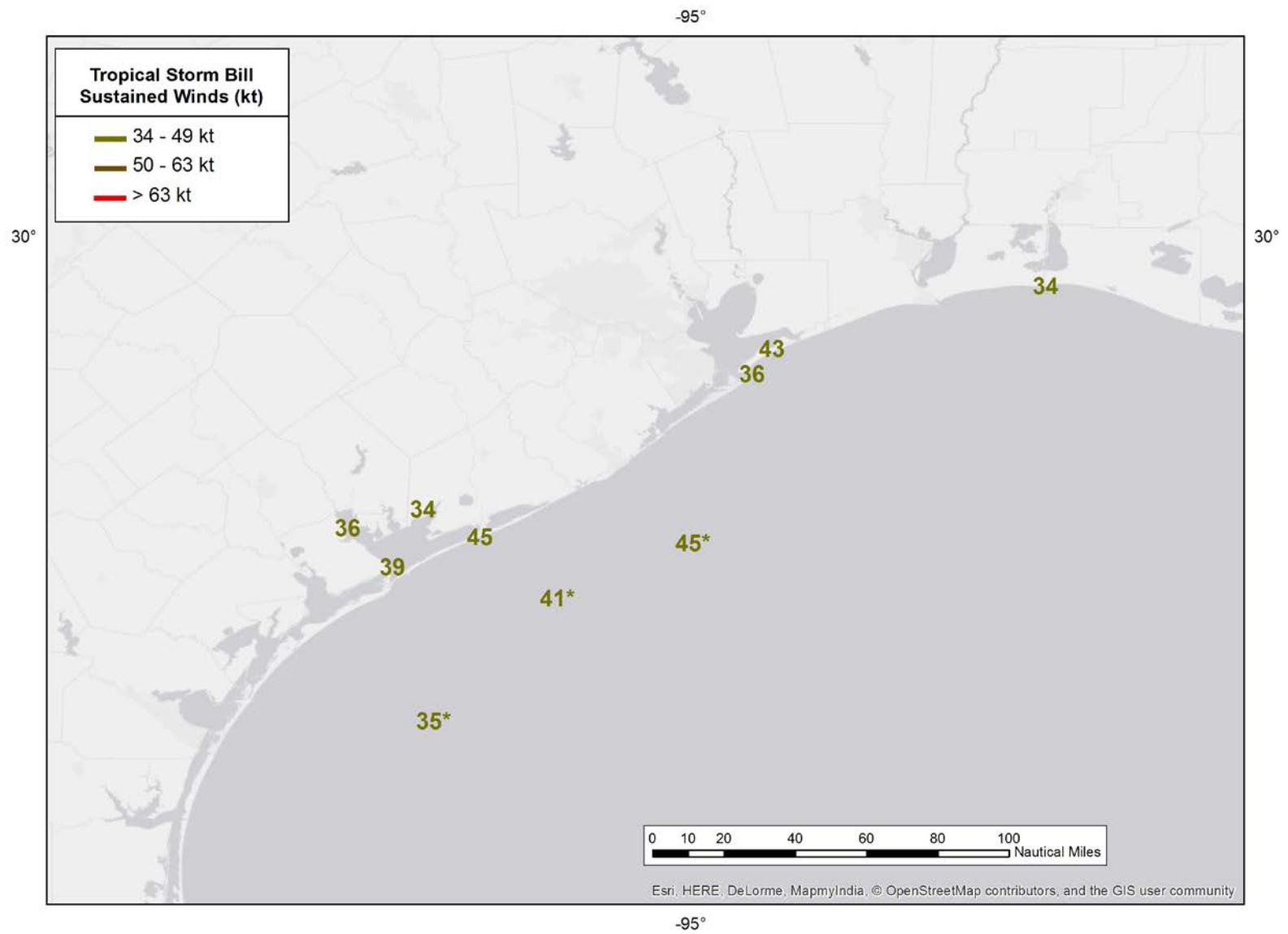


Figure 4. Sustained winds (kt) reported during Tropical Storm Bill, 16-18 June 2015. An asterisk denotes observations from oil rigs that were elevated around 25 m above the ocean surface.

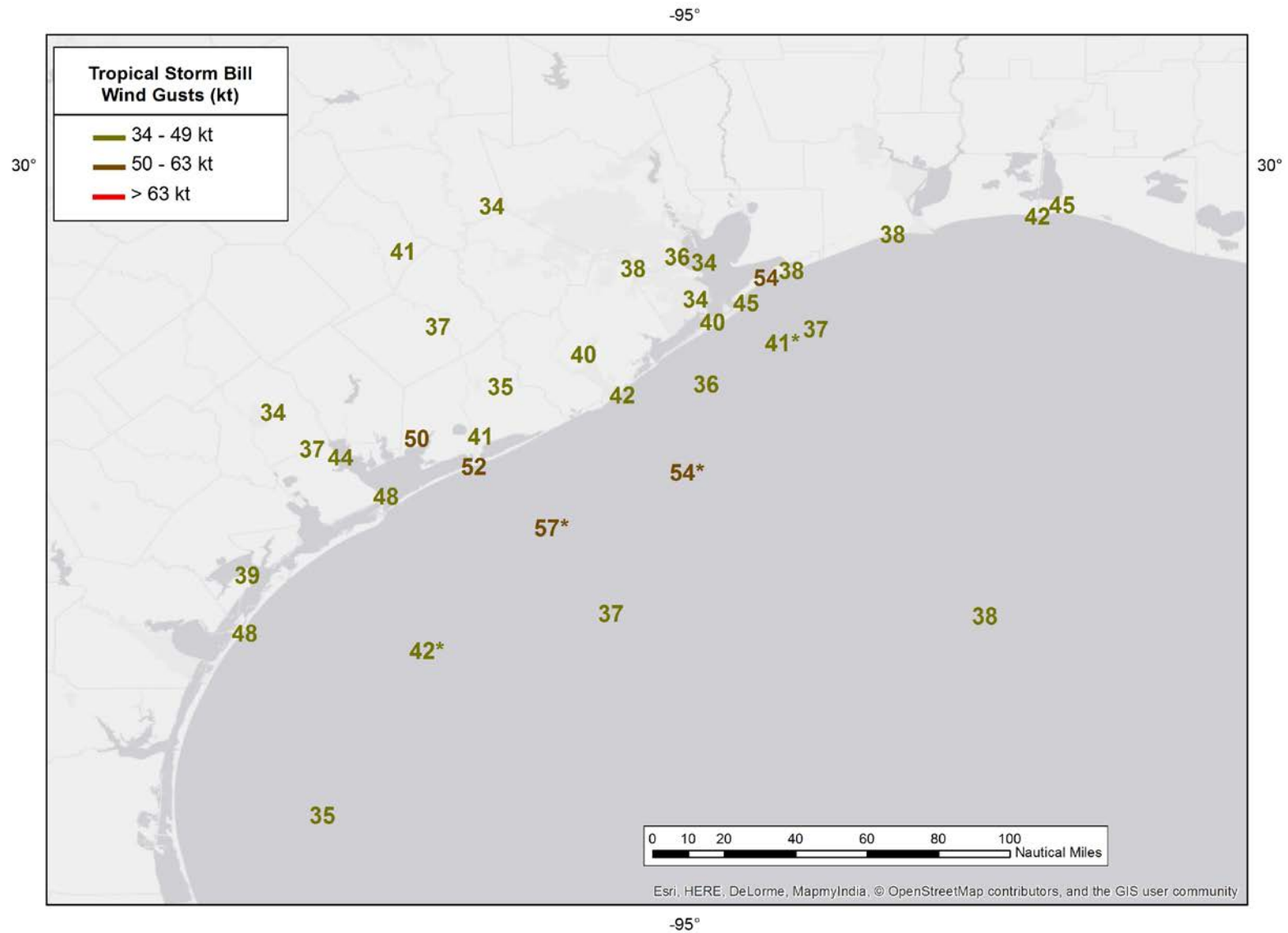


Figure 5. Wind gusts (kt) reported during Tropical Storm Bill, 16-18 June 2015. An asterisk denotes observations from oil rigs that were elevated around 25 m above the ocean surface.

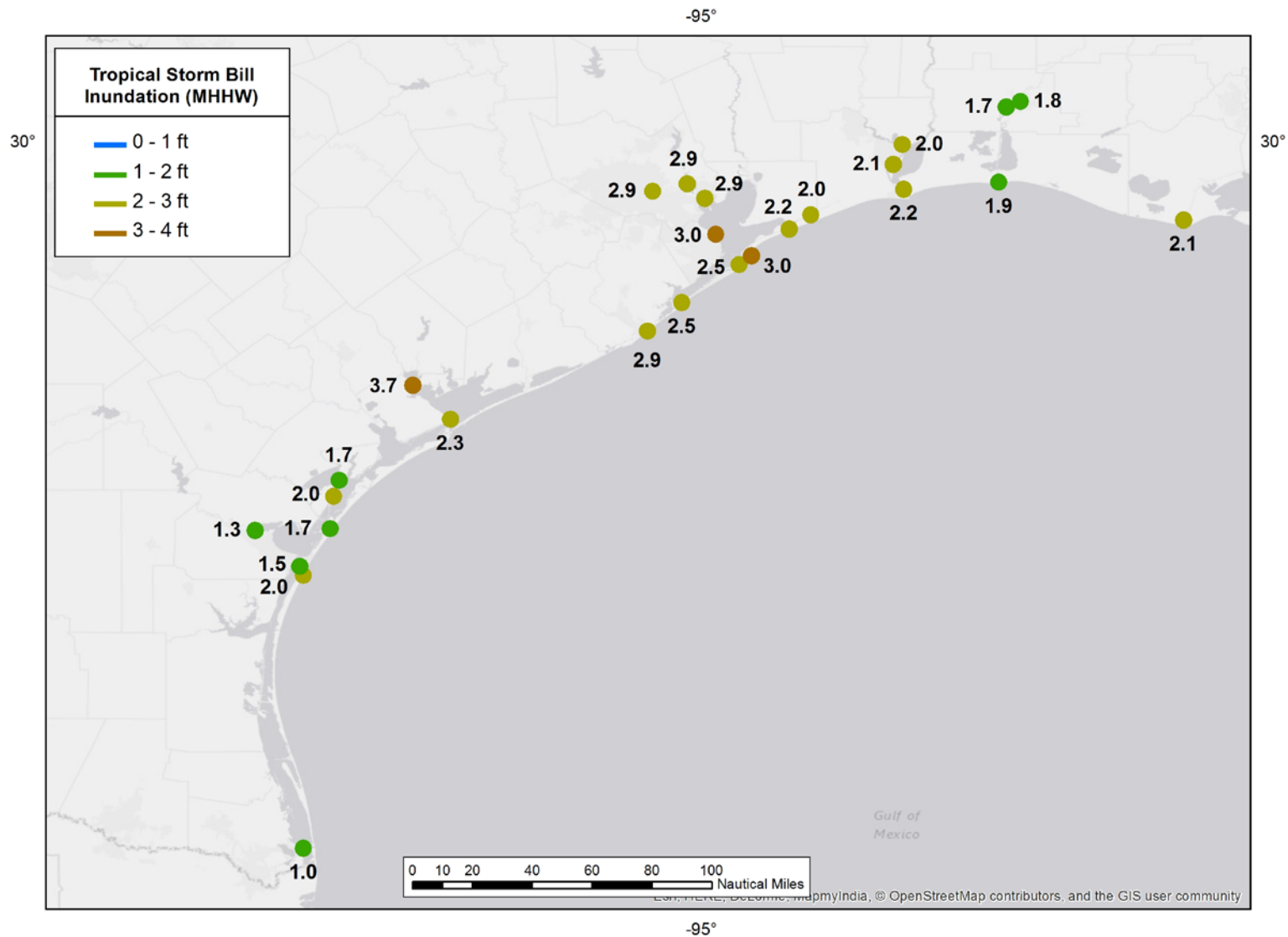


Figure 6. Storm tide measurements above Mean Higher High Water (MHHW) from NOS and TCOON gauges along the Texas and Louisiana coasts. MHHW is used as a proxy for inundation, or storm surge covering normally dry ground.

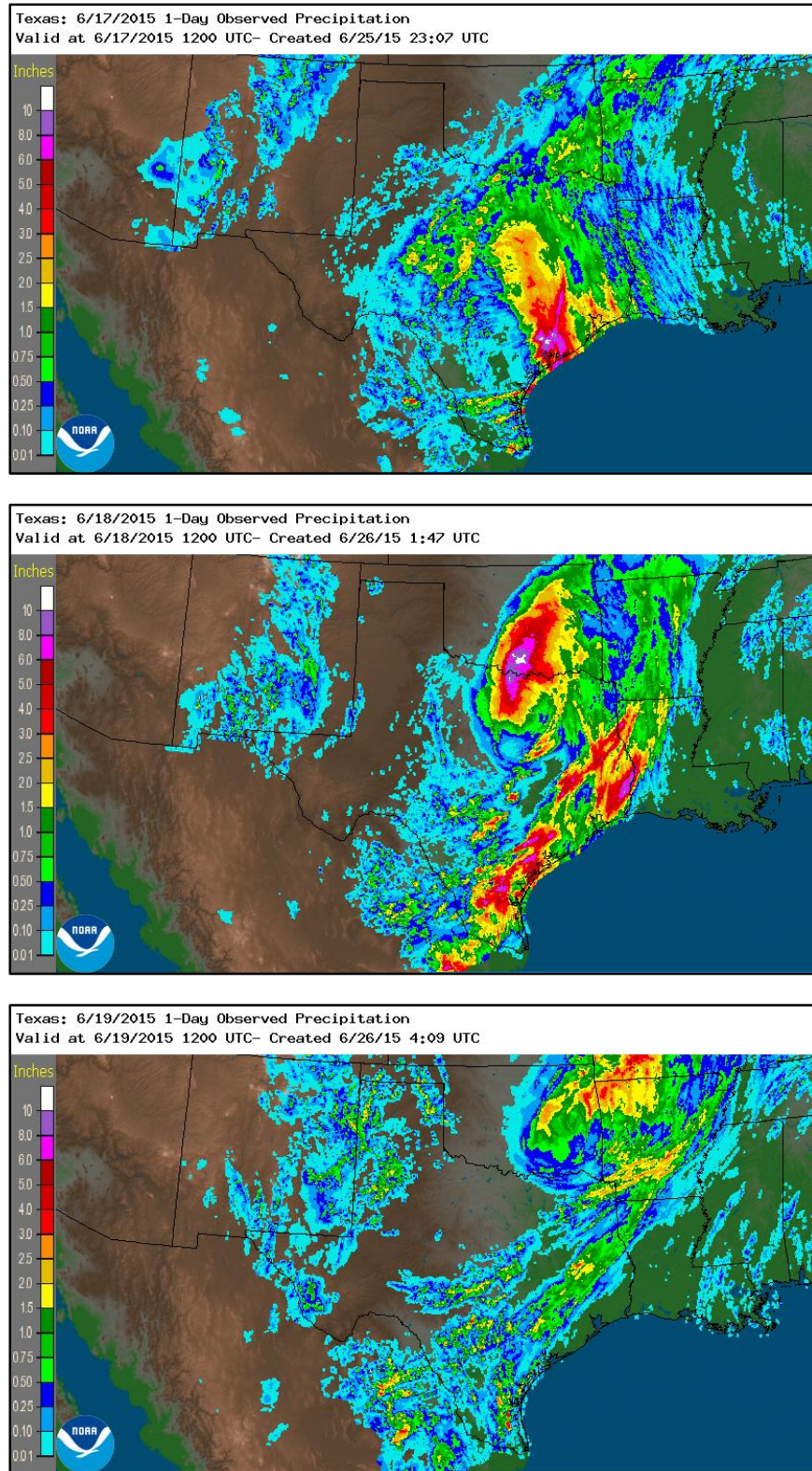


Figure 7. NWS daily precipitation analyses using WSR-88D radar data and gauge reports for the 24-h period ending at (a) 1200 UTC 17 June 2015, (b) 1200 UTC 18 June 2015, and (c) 1200 UTC 19 June 2015.