

Tropical Cyclone Report
Hurricane Lane
(EP132006)
13-17 September 2006

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Lane made landfall on the Pacific coast of Mexico as a relatively small but strong category 3 hurricane (on the Saffir-Simpson Hurricane Scale). Since it spent its entire life span near the coast of Mexico, Lane dumped heavy rains and flooded many communities in western portions of that country. The hurricane was directly responsible for four fatalities.

a. Synoptic History

Lane developed in association with a tropical wave that departed the west coast of Africa on 31 August and entered the eastern North Pacific basin on 10 September. The system gradually gained organization during the next three days, leading to the formation of a tropical depression by 1800 UTC 13 September centered about 100 n mi southwest of Acapulco, Mexico. 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 1.

Weak wind shear and warm waters aided the cyclone in reaching tropical storm intensity early on 14 September. Steered west-northwestward and roughly parallel to the Pacific coast of Mexico by a mid-level ridge centered to its north, Lane continued to gradually strengthen that day. Intensification was more rapid on 15 September, and Lane became a hurricane by 1200 UTC that day while centered about 80 n mi west of Manzanillo, Mexico. Turning toward the north-northwest around the southwestern periphery of the ridge, the center of Lane passed about 30 n mi west of Cabo Corrientes, Mexico (just west of Puerto Vallarta) later that day. The hurricane continued to strengthen and its eastern eyewall impacted the Islas Marias very early on 16 September while Lane was at category 2 intensity; the center of Lane passed just west of the Islas Marias.

As a large middle latitude trough deepened over the western United States, Lane was drawn northward that day near the mouth of the Gulf of California. A distinct eye appeared on satellite and radar imagery as Lane strengthened some more, and the hurricane reached its peak intensity of 110 kt by 1200 UTC 16 September. Little change in the intensity of Lane occurred before it made landfall at 1915 UTC that day on the Pacific coast of mainland Mexico, in the state of Sinaloa along the Peninsula de Guevedo about 15 n mi southeast of El Dorado, as a category 3 hurricane with winds of 110 kt. The relatively small cyclone weakened quickly after moving inland over the rugged terrain of western Mexico. Lane weakened to a tropical storm

early on 17 September, and the circulation dissipated later that day. Some of the remaining moisture contributed to enhanced rainfall over portions of northern Mexico and southern Texas.

b. Meteorological Statistics

Observations in Lane (Figs. 2 and 3) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB) and the U. S. Air Force Weather Agency (AFWA), as well as flight-level and dropwindsonde observations from flights of the 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command. Microwave satellite data and imagery from NOAA polar-orbiting satellites, the NASA Tropical Rainfall Measuring Mission (TRMM), the NASA QuikSCAT, and Defense Meteorological Satellite Program (DMSP) satellites were also useful in tracking Lane, as was imagery from radars along the coast of Mexico.

The estimated peak intensity for Lane of 110 kt on 16 September is based on a blend of subjective Dvorak estimates at 1200 UTC ranging from 102 kt to 115 kt. Just prior to landfall at 1915 UTC, a reconnaissance aircraft made one penetration of the center at about 1800 UTC and measured via dropsonde a central pressure of 955 mb. The actual central pressure at that time, however, was probably slightly lower (estimated to be 954 mb) since the center dropsonde also measured a surface wind of 23 kt. Wind data from only one pass through the center are inconclusive about the intensity of Lane at landfall. The aircraft measured a maximum flight-level wind of 110 kt at 700 mb, corresponding to about 100 kt at the surface. A dropsonde in the eyewall measured a surface wind of 108 kt, but surface estimates based on low-layer profile averages were not available. Even though these limited data do not confirm that Lane had maximum sustained surface winds of 110 kt at landfall, the landfall intensity is kept at 110 kt based on the satellite estimates and the low central pressure reported by the aircraft.

Damage reports indicate that Lane produced strong winds and flooding over many areas along and near the Pacific coast of Mexico, including locations well removed from the landfall location, even as far southeast as Acapulco. Very few surface observations are available, however. A 24-h total of 10.24 in of rain was reported in association with Lane at San Lorenzo in the state of Sinaloa. A temporary tower, operated by the National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory (ESRL), was placed at Estacion Obispo about 10 n mi inland from the landfall location of the center, where the elevation is 27 m. Prior to being blown down in the eyewall, the tower measured a 1-minute sustained surface wind of 81 kt with a gust to 105 kt at 1930 UTC 16 September; a sea level pressure of 966 mb was measured at the same location at 1945 UTC. Storm surge observations in the landfall area are not available.

c. Casualty and Damage Statistics

Media reports indicate that Lane was directly responsible for four fatalities due to floods and mud slides and that damages were heaviest in the landfall area in the Mexican state of Sinaloa. Many streets and homes were flooded in El Dorado and Culiacan, to the north of where

the center made landfall, and in Mazatlan, southeast of where the center came ashore. Large rural areas were also flooded, severely impacting the agricultural industry. Numerous roads were washed out, isolating several communities, and a bridge between Culiacan and Mazatlan was destroyed. Impacts were also significant much farther south and east along the coast of Mexico, even though the center of Lane remained just offshore. Hundreds of homes were evacuated, many crops were destroyed, and some roads were damaged due to floods and mud slides in the coastal states of Michoacan, Colima, and Jalisco. The combination of high waves and heavy rains left more than a foot of water in some streets of Acapulco (even farther southeast in the state of Guerrero), where about 200 homes were flooded and a mud slide caused one of the fatalities. Just offshore from Acapulco a boat capsized, leaving one person reported missing.

d. Forecast and Warning Critique

The tropical wave that led to the genesis of Lane was first mentioned in the NHC's Tropical Weather Outlook late on 11 September, about two days prior to the formation of a tropical depression. Only slow development was anticipated initially, but the potential that the system could become a tropical depression was conveyed beginning about 19 h prior to genesis.

A verification of official and guidance model track forecasts is given in Table 2. Lane was a tropical cyclone for less than four days and there are very few forecasts to verify through 72 h and no forecasts to verify at 96 and 120 h. Average official track errors for Lane were 19, 40, 87, 137, and 260 n mi for the 12, 24, 36, 48, and 72-h forecasts, respectively. The number of forecasts range from 14 at 12 h to only four at 72 h. The errors for the 12 and 24-h forecasts are less than the average long-term official track errors, but the errors at 36-72 h are larger than the long-term averages (Table 2). The official forecasts generally performed better on average than most of the available guidance, with a notable exception being the GFDI (interpolated GFDL) model. While most of the models had a westward bias in forecasting Lane to pass over or very near the Baja California peninsula, most runs of the GFDL model correctly forecast that Lane would move farther east and remain close to the coast of mainland Mexico.

Average official intensity errors for Lane were 12, 19, 29, 29, and 34 kt for the 12, 24, 36, 48, and 72-h forecasts, respectively. For comparison, the average long-term official intensity errors are 6, 11, 14, 17, and 19 kt, respectively (Table 3). Official forecasts of Lane's strengthening phase had a severe low bias, providing yet another example of our inability to accurately forecast rapid intensification. Later official intensity forecasts were biased very high since the hurricane made landfall sooner than the official track forecast had been indicating. Despite these large biases, the official intensity errors were comparable to those of the DSHP (SHIPS model with inland decay component), slightly less than the errors of the consensus models (ICON, FSSE), and much less than the errors of the GFDI (interpolated GFDL) model.

Coastal tropical cyclone watches and warnings issued by the Government of Mexico for Hurricane Lane are listed in Table 4. A hurricane watch was issued for the Islas Marias about 29 hours in advance of Lane's eastern eyewall impacting those islands early on 16 September, and a hurricane warning was issued about 17 hours in advance. The area of Lane's final landfall on the

west coast of mainland Mexico was placed under a hurricane watch about 28 hours in advance and under a hurricane warning about 22 hours in advance of landfall.

Table 1. Best track for Hurricane Lane, 13-17 September 2006.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
13 / 1800	15.7	101.0	1006	30	tropical depression
14 / 0000	16.2	101.7	1005	30	"
14 / 0600	16.7	102.6	1000	35	tropical storm
14 / 1200	17.2	103.6	999	40	"
14 / 1800	17.6	104.4	997	45	"
15 / 0000	18.0	105.0	997	50	"
15 / 0600	18.5	105.6	994	55	"
15 / 1200	19.3	106.0	987	65	hurricane
15 / 1800	20.3	106.3	985	75	"
16 / 0000	21.3	106.6	975	90	"
16 / 0600	22.2	106.9	960	100	"
16 / 1200	23.1	107.1	952	110	"
16 / 1800	24.0	107.2	954	110	"
17 / 0000	24.7	107.3	978	65	"
17 / 0600	25.4	107.4	990	35	tropical storm
17 / 1200	26.0	107.5	1005	25	tropical depression
17 / 1800					dissipated
16 / 1200	23.1	107.1	952	110	minimum pressure
16 / 1915	24.1	107.2	954	110	landfall along Peninsula de Guevedo, Mexico

Table 2. Preliminary track forecast evaluation (heterogeneous sample) for Hurricane Lane, 13-17 September 2006. 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.

Forecast Technique	Forecast Period (h)						
	12	24	36	48	72	96	120
CLP5	31 (14)	63 (12)	115 (10)	196 (8)	288 (4)		
GFNI	52 (11)	93 (9)	101 (7)	126 (5)			
GFDI	50 (14)	53 (10)	71 (10)	85 (8)	173 (4)		
GFSI	43 (12)	61 (9)	109 (9)	161 (8)	340 (4)		
AEMI	36 (14)	66 (11)	113 (10)	185 (8)	346 (4)		
NGPI	65 (13)	109 (11)	153 (10)	204 (7)	318 (3)		
UKMI	29 (12)	65 (10)	118 (8)	169 (6)	204 (2)		
BAMD	29 (14)	63 (12)	108 (10)	174 (8)	363 (4)		
BAMM	22 (14)	50 (12)	89 (10)	152 (8)	362 (4)		
BAMS	27 (14)	46 (12)	66 (10)	121 (8)	312 (4)		
CONU	34 (14)	54 (12)	97 (10)	142 (8)	249 (4)		
GUNA	27 (10)	53 (7)	96 (7)	136 (5)	194 (1)		
FSSE	29 (12)	44 (10)	93 (8)	129 (6)	186 (2)		
OFCL	19 (14)	40 (12)	87 (10)	137 (8)	260 (4)		
NHC Official (2001-2005 mean)	35 (1300)	60 (1152)	83 (1009)	103 (877)	145 (652)	192 (465)	231 (313)

Table 3. Preliminary intensity forecast evaluation (heterogeneous sample) for Hurricane Lane, 13-17 September 2006. 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.

Forecast Technique	Forecast Period (h)						
	12	24	36	48	72	96	120
SHF5	20.6 (14)	29.7 (12)	28.1 (10)	33.4 (8)	29.5 (4)		
GFDI	19.2 (14)	33.6 (10)	47.6 (9)	60.5 (6)	34.3 (4)		
SHIP	18.3 (14)	28.0 (12)	28.1 (10)	28.0 (8)	31.3 (4)		
DSHP	11.8 (14)	23.4 (12)	28.1 (10)	26.5 (8)	31.3 (4)		
FSSE	18.3 (12)	29.8 (10)	33.8 (8)	35.0 (6)	28.5 (2)		
ICON	14.2 (14)	19.4 (10)	28.7 (9)	33.3 (8)	21.5 (4)		
OFCL	11.8 (14)	18.8 (12)	28.5 (10)	29.4 (8)	33.8 (4)		
NHC Official (2001-2005 mean)	6.2 (1300)	10.8 (1152)	14.3 (1009)	16.5 (876)	18.7 (652)	18.3 (465)	19.3 (313)

Table 4. Watch and warning summary for Hurricane Lane, 13-17 September 2006.

Date/Time (UTC)	Action	Location
13 / 2100	Tropical Storm Watch issued	Manzanillo to Cabo Corrientes
13 / 2100	Tropical Storm Warning issued	Tecpan de Galeana to Manzanillo
14 / 1200	Tropical Storm Watch changed to Hurricane Watch	Manzanillo to Cabo Corrientes
14 / 1200	Tropical Storm Warning modified to	Tecpan de Galeana to Cabo Corrientes
14 / 2100	Tropical Storm Warning discontinued	Tecpan de Galeana to Cabo Corrientes
14 / 2100	Tropical Storm Warning issued	Lazaro Cardenas to El Roblito
14 / 2100	Tropical Storm Warning issued	Islas Marias
14 / 2100	Hurricane Watch issued	Islas Marias
15 / 0300	Tropical Storm Warning issued	Buena Vista to Agua Blanca
15 / 0300	Hurricane Watch issued	Buena Vista to Agua Blanca
15 / 0900	Tropical Storm Warning changed to Hurricane Warning	Islas Marias
15 / 0900	Tropical Storm Watch issued	La Cruz to Altata
15 / 0900	Tropical Storm Warning discontinued	Lazaro Cardenas to El Roblito
15 / 0900	Tropical Storm Warning issued	Punta San Telmo to La Cruz
15 / 0900	Hurricane Watch discontinued	Islas Marias
15 / 1500	Tropical Storm Warning changed to Hurricane Warning	Buena Vista to Agua Blanca
15 / 1500	Tropical Storm Watch discontinued	All
15 / 1500	Tropical Storm Warning modified to	Manzanillo to La Cruz
15 / 1500	Hurricane Watch modified to	Manzanillo to Huatabampito
15 / 1500	Hurricane Watch modified to	Buena Vista to Loreto
15 / 2100	Tropical Storm Warning modified to	Manzanillo to El Roblito
15 / 2100	Hurricane Watch modified to	Altata to Huatabampito
15 / 2100	Hurricane Warning issued	El Roblito to Altata
16 / 0300	Tropical Storm Warning modified to	Cabo Corrientes to El Roblito
16 / 0300	Hurricane Watch modified to	Cabo Corrientes to El Roblito
16 / 0600	Tropical Storm Warning issued	Altata to Huatabampito

16 / 1000	Tropical Storm Warning modified to	Topolobampo to Huatabampito
16 / 1000	Hurricane Watch modified to	Topolobampo to Huatabampito
16 / 1000	Hurricane Warning modified to	El Roblito to Topolobampo
16 / 1500	Tropical Storm Warning discontinued	Cabo Corrientes to El Roblito
16 / 1500	Tropical Storm Warning issued	San Evaristo to Cabo San Lucas
16 / 1500	Hurricane Watch discontinued	Cabo Corrientes to El Roblito
16 / 1500	Hurricane Watch discontinued	Buena Vista to Loreto
16 / 1500	Hurricane Warning discontinued	Islas Marias
16 / 1500	Hurricane Warning discontinued	Buena Vista to Agua Blanca
16 / 2100	Tropical Storm Warning discontinued	San Evaristo to Cabo San Lucas
17 / 0000	Tropical Storm Warning discontinued	All
17 / 0000	Hurricane Watch discontinued	All
17 / 0000	Hurricane Warning discontinued	El Roblito to Topolobampo
17 / 0000	Hurricane Warning issued	Mazatlan to Altata
17 / 0900	Hurricane Warning changed to Tropical Storm Warning	Mazatlan to Altata
17 / 1200	Tropical Storm Warning discontinued	All

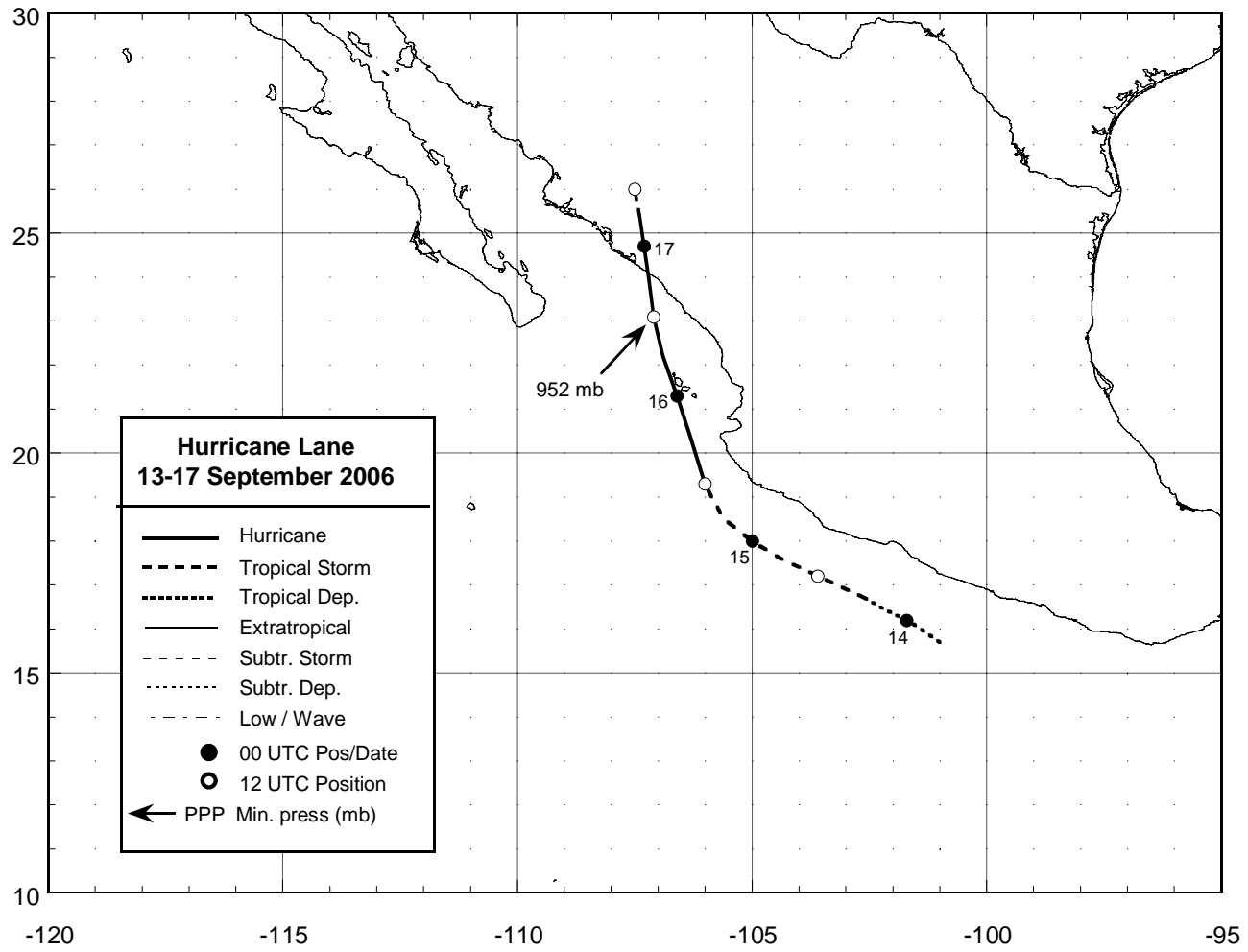


Figure 1. Best track positions for Hurricane Lane, 13-17 September 2006.

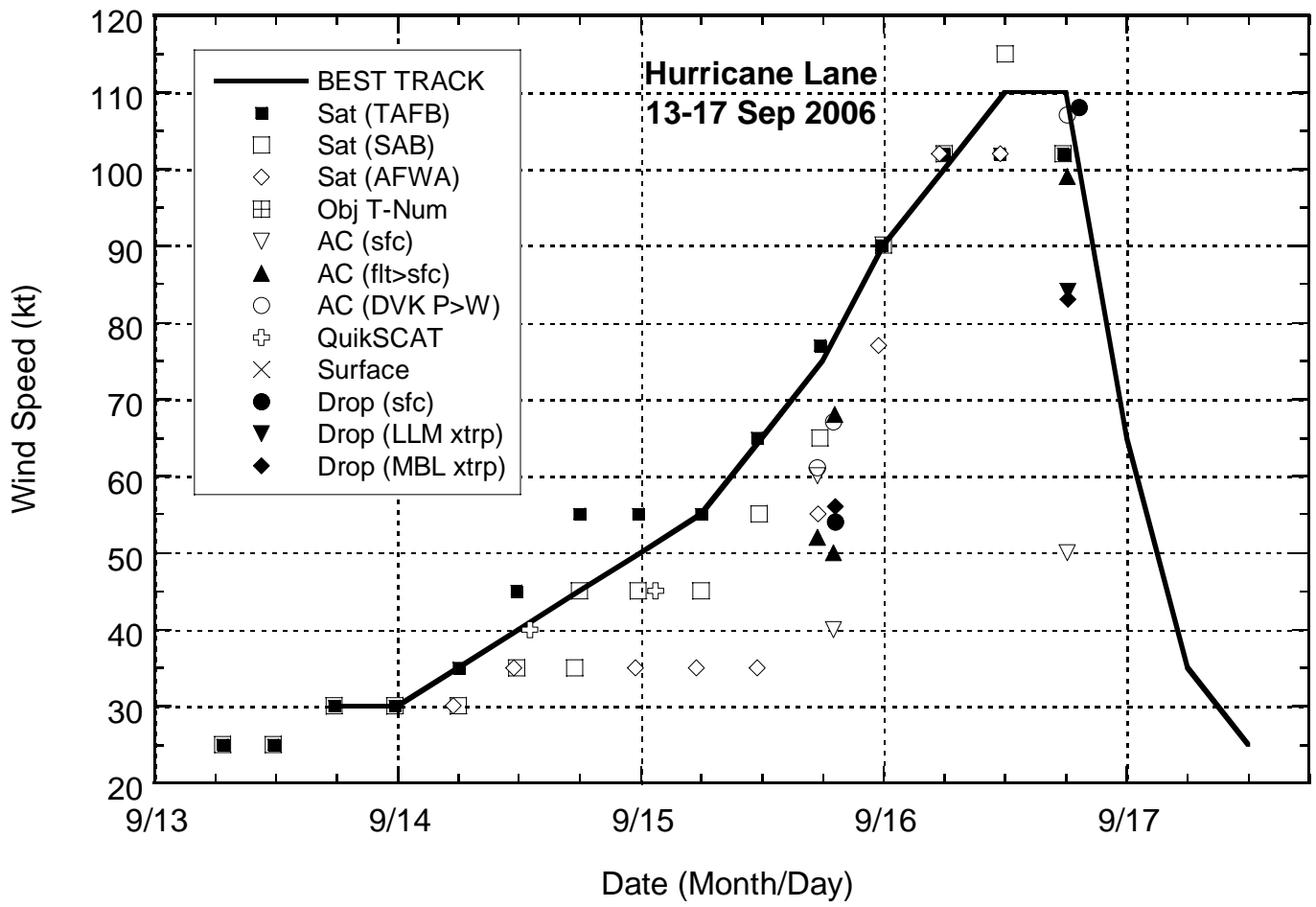


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Lane, 13-17 September 2006. Aircraft observations have been adjusted for elevation using the 90% reduction factor for observations from 700 mb. Dropwindsonde observations include actual 10 m winds (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).

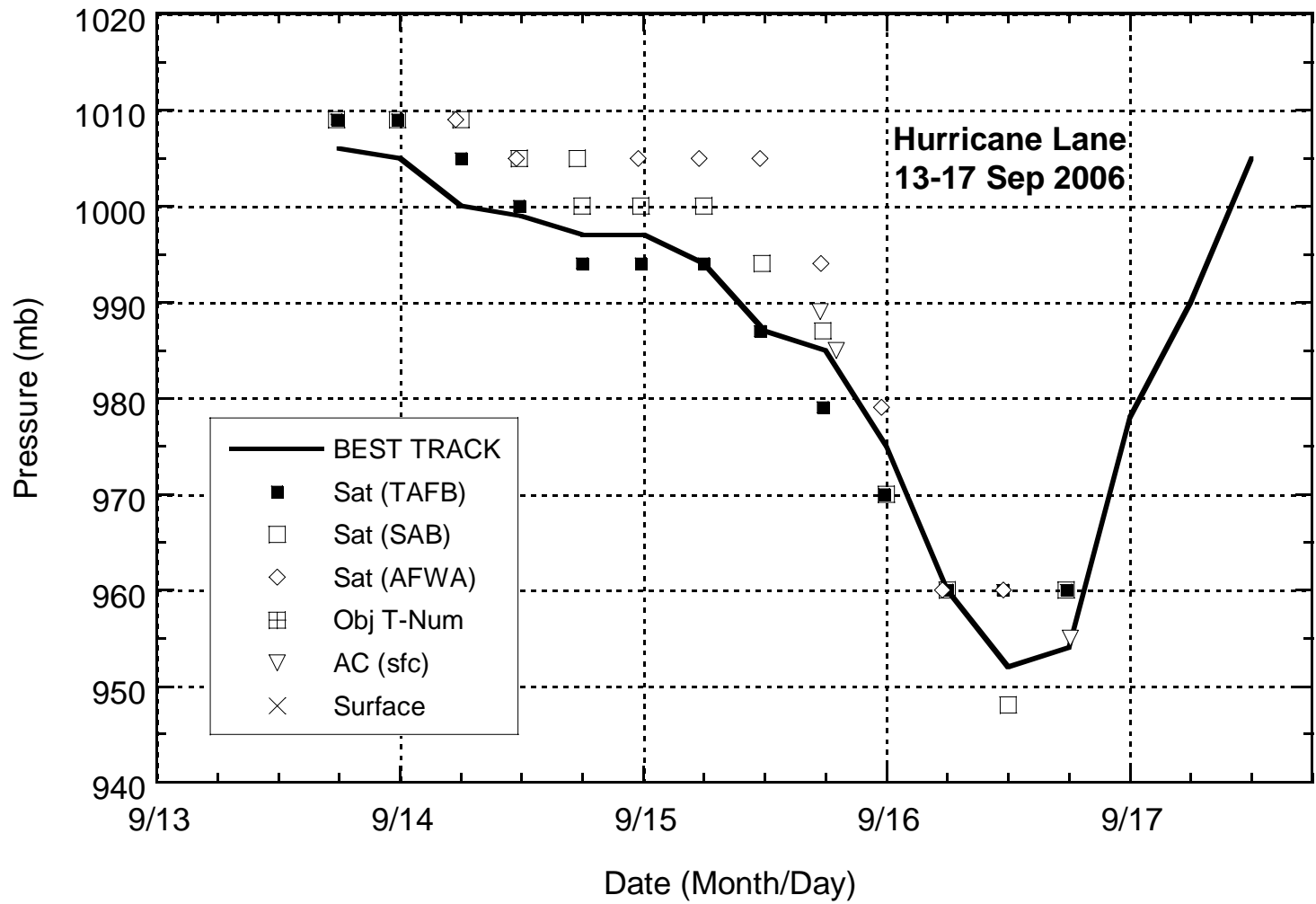


Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Lane, 13-17 September 2006.