

Tropical Cyclone Report
Hurricane Stan
1-5 October 2005

Richard J. Pasch and David P. Roberts
National Hurricane Center
14 February 2006

Stan was associated with disastrous inland flooding across portions of Central America and Mexico, and some estimates of the death toll are as high as 2000. However, not all of these deaths can be directly attributed to Stan.

a. Synoptic History

A tropical wave that moved off the coast of Africa on 17 September was the likely precursor to Stan. This wave showed little distinction as it moved over the eastern and central tropical Atlantic for several days. Cloudiness and showers associated with the system began to increase the wave neared 50°W longitude on 22 September, but north-northeasterly shear created an environment that was not favorable for tropical cyclone formation. The wave moved into the eastern Caribbean Sea on 25 September, while shear over the system diminished. By 27 September, deep convection associated with the wave became more consolidated over the central Caribbean Sea. Over the next several days, organization of the system waxed and waned as it moved into the western Caribbean Sea. It was not until early on 1 October, when the system neared the eastern coast of the Yucatan peninsula, that development began in earnest. Based on the extent and organization of deep convection as well as surface observations, it is estimated that a tropical depression formed around 1200 UTC 1 October centered about 115 n mi southeast of Cozumel. Figure 1 is a “best track” chart of the tropical cyclone’s path. Wind and pressure histories are shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1.

Lower- to middle-tropospheric ridging to the north and northeast of the tropical cyclone resulted in a west-northwestward steering current, and an upper-tropospheric anticyclone became established over the area. The depression strengthened into a tropical storm shortly before its center made landfall on the east coast of the Yucatan peninsula, just south of Tulum, around 1000 UTC 2 October. Stan crossed the peninsula in about 18 h while weakening back to a depression; it quickly regained tropical storm strength, however, after it moved back over water. Deep layer high pressure over the western Gulf of Mexico forced the system to turn toward the west-southwest and southwest over the Bay of Campeche. This turn may also have been due to the interaction with a broad, deep-layer cyclonic circulation that covered eastern Mexico and most of Central America. As Stan approached the southern Gulf coast of Mexico, it rapidly intensified into a hurricane around 0600 UTC 4 October. It made its second landfall shortly thereafter, as a category 1 hurricane on the Saffir-Simpson Hurricane Scale, around 1200 UTC about 80 n mi east-southeast of Veracruz. Once inland, the cyclone weakened rapidly, and it

dissipated over the very mountainous terrain of the Mexican state of Oaxaca just after 0600 UTC 5 October.

b. Meteorological Statistics

Observations in Stan (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 (AFRES). Microwave satellite 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 Stan. An AFRES mission just prior to landfall on 4 October measured a peak 700 mb flight-level wind of 79 kt around 1000 UTC. A little earlier, a dropsonde from this mission yielded surface wind estimates of 69 to 72 kt. These data are the primary bases for setting the peak (and landfall) intensity of Stan at 70 kt.

Ship and buoy reports of winds of tropical storm force associated with Stan are given in Table 2, and rainfall observations from stations in Mexico are given in Table 3. Several locations reported rainfall totals in excess of 10 in.

c. Casualty and Damage Statistics

It is impossible to determine how many people were killed by Stan. According to the government of Mexico, there were 80 deaths in the Mexican states of Veracruz, Oaxaca, and Chiapas. Since the actual surface circulation of the tropical cyclone seems to have been confined to Mexico, the direct death toll is therefore set at 80. However, the tropical cyclone appeared to be embedded within the western portion of a broader-scale low-level cyclonic circulation. This larger system produced extensive very heavy rains over portions of extreme eastern Mexico and Central America that resulted in disastrous floods. Estimates of the total number of lives lost in Mexico and Central America are mostly in the range of 1000 to 2000, some even higher. Guatemala was particularly hard hit; over 1000 persons may have perished in that country.

d. Forecast and Warning Critique

Although there were not many forecasts to verify, the official track predictions for Stan were mediocre at best. Table 4 lists the mean track forecast errors for various numerical guidance techniques and for the official forecasts. It can be seen that the average official track errors through 72 h were comparable to, or a little larger than, the average official track errors for the 10-yr period 1995-2004¹. These errors are largely associated with Stan's unexpected acceleration toward the Gulf coast of Mexico. There were no forecasts to verify at 96 and 120 h. Overall, the interpolated version of the GFDL Hurricane Model (GFDI) was the best track prediction model for Stan; it had lower mean errors than the official forecasts at 12 through 72 h.

¹ Errors given for the 96 and 120 h periods are averages over the four-year period 2001-4.

Average official intensity errors were 6, 11, 16, 16, and 28 kt for the 12, 24, 36, 48, and 72 h forecasts, respectively. For comparison, the average official intensity errors over the 10-yr period 1995-2004 are 6, 10, 12, 15, and 18 kt, respectively. In the official forecasts, Stan was predicted to strengthen into a tropical storm prior to striking the Yucatan peninsula, and it was predicted to become a hurricane before hitting the Gulf coast of Mexico. However, it was not predicted to become a hurricane as quickly as it did.

Table 5 lists the watches and warnings issued for Stan. The tropical storm warning for the east coast of the Yucatan peninsula was issued about 19 h before landfall of the center in that area. Stan's second landfall in Mexico was not predicted very well by the official forecasts. The system turned rather unexpectedly to the left, and as a result the center reached the coast sooner and farther to the east than anticipated. In fact, Stan's center made its second landfall near the eastern end of the area covered by a hurricane warning. This warning was issued about 21 h before the center crossed the coast, but was extended eastward from the vicinity of the landfall location only about 6 h prior to the arrival of the center on the coast.

Four days prior to Stan's genesis, the Tropical Weather Outlooks from the National Hurricane Center indicated the potential for tropical cyclone formation. However, the system was slower to develop than was suggested by some of the Outlooks.

Table 1. Best track for Hurricane Stan, 1-5 October 2005.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
01 / 1200	18.9	85.6	1007	25	tropical depression
01 / 1800	19.1	86.2	1005	30	"
02 / 0000	19.3	86.7	1004	30	"
02 / 0600	19.5	87.2	1003	40	tropical storm
02 / 1200	19.8	87.9	1003	35	"
02 / 1800	20.3	88.8	1004	35	"
03 / 0000	20.5	89.8	1003	30	tropical depression
03 / 0600	20.5	91.0	1003	35	tropical storm
03 / 1200	20.3	91.7	1000	40	"
03 / 1800	20.1	92.2	997	50	"
04 / 0000	19.8	93.2	990	55	"
04 / 0600	19.2	94.1	987	65	hurricane
04 / 1200	18.6	94.9	977	70	"
04 / 1800	17.9	95.6	988	45	tropical storm
05 / 0000	17.2	96.4	1000	30	tropical depression
05 / 0600	16.9	97.0	1004	25	"
05 / 1200					dissipated
04 / 1200	18.6	94.9	977	70	minimum pressure
02 / 1000	19.6	87.5	1003	35	Landfall near Punta Hualaxtoc, about 35 n mi south of Tulum, Mexico
04 / 1200	18.6	94.9	977	70	Landfall near Punta Roca Partida, about 80 n mi east-southeast of Veracruz, Mexico

Table 2. Selected ship and buoy reports with winds of at least 34 kt for Hurricane Stan, 1-5 October 2005.

Date/Time (UTC)	Ship call sign or buoy ID	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
1 / 1600	42056	19.9	85.1	105 / 31	1006.3
02 / 1200	ZCAM4	21.1	86.3	130 / 37	1008.0
05 / 0000	DGTX	13.9	95.0	240 / 35	1003.5
05 / 0600	C6NL6	13.7	92.6	220 / 40	1011.4

Table 3. Selected surface observations for Hurricane Stan, 1-5 October 2005.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)	Storm tide (ft)	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC)	Sustained (kt)	Gust (kt)			
Mexico								
Cancun								11.61
Peto								5.62
Motul								4.21
Conkal								3.51
Suchiate								8.53
Huehuetan								7.63
Cuetzalan								6.55
Huixtla								6.18
Libertad								6.06
El Raudal								5.65
La Cangrejera								5.50
Angel R Cabada								5.38
El Novillero								12.08
Tapachula								10.74
Despoblado								11.27
Cacaluta								9.38
Tapanatepec								4.23
Mapastepec								5.39
Arriaga Meteo Office								3.81
Tonala								9.14
Tres Picos								9.51
Nil Tepec								3.99
Zanatepec								4.58
Tapachula Observation								4.58
Oaxaca OBS Airport								4.11
Rio Verde								6.43
Oaxaca Centro								4.60
Oyameles								6.29
Chignahuapan								3.90

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)	Storm tide (ft)	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC)	Sustained (kt)	Gust (kt)			
Patla								4.13
Nuevo Necaxa								4.94
Tenango								4.42
La Laguna								5.41
Los Reyes								5.82
Nexapa								4.42
Huachinango								3.89
Xicotepec De Juarez								4.78
Teziutlan								6.14
El Carmen								4.52
P. La Soledad								5.82
Zacapuaxtla								11.25
Cuetzalan								12.01
Venustiano Carranza								4.12
Idolos								2.99
Villa Tejeda								3.52
El Tejar								5.74
Veracruz								9.72
Ixhuatlan Del Café								3.83
Camelpo								6.62
Papaloapan								4.06
Temazcal (Aleman)								2.75
Cerro De Oro (Madrid)								8.11
Huautla								8.49
Cuicatlan								3.01
Maria Lombardo								7.99
Dique Pescaditos								5.18
Santo Domingo								3.26
Cosautlan								2.87
Jalcomulco								2.78
Manlio F. Altamirano								6.77

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)	Storm tide (ft)	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC)	Sustained (kt)	Gust (kt)			
El Naranjillo								5.45
Jacatepec								10.74
Xalapa Observatorio								3.89
Actopan								3.76
Rinconada								3.81
Carrizal								3.01
Cardel								4.78
Las Animas								3.46
Huatusco								3.32
Libertad								4.25
El Raudal								4.36
Misantla								5.78
Altotonga								7.22
Martinez De La Torre								7.51
Oxtlapa								2.87
Poza Rica								6.33
Tuxpan								4.52

Table 4. Preliminary forecast evaluation (heterogeneous sample) for Hurricane Stan, 1-5 October 2005. 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	48 (14)	104 (12)	183 (10)	271 (8)	466 (4)		
GFNI	48 (10)	73 (8)	121 (6)	166 (4)			
GFDI	41 (14)	66 (10)	89 (8)	133 (6)	161 (2)		
GFSI	40 (12)	78 (10)	108 (8)	140 (6)	235 (2)		
AEMI	40 (12)	81 (10)	108 (8)	153 (6)	258 (2)		
NGPI	49 (11)	100 (10)	140 (8)	193 (6)	201 (2)		
UKMI	136 (13)	228 (11)	220 (9)	187 (7)	213 (3)		
A98E	46 (14)	89 (12)	119 (10)	155 (8)	264 (4)		
A9UK	54 (7)	102 (6)	120 (5)	142 (4)	292 (2)		
BAMD	43 (14)	73 (12)	101 (10)	139 (8)	206 (4)		
BAMM	49 (13)	83 (12)	108 (10)	152 (8)	225 (4)		
BAMS	56 (13)	93 (12)	113 (10)	155 (8)	221 (4)		
CONU	53 (14)	80 (11)	98 (9)	121 (7)	155 (3)		
GUNA	44 (9)	63 (8)	83 (6)	157 (4)			
FSSE	38 (8)	69 (8)	101 (6)	173 (4)			
OFCL	43 (14)	74 (12)	105 (10)	142 (8)	234 (4)		
NHC Official (1995-2004 mean)	42 (3400)	75 (3116)	107 (2848)	138 (2575)	202 (2117)	236 (649)	310 (535)

Table5. Watch and warning summary for Hurricane Stan, 1-5 October 2005.

Date/Time (UTC)	Action	Location
01/1500	Tropical Storm Warning issued	Punta Gruesa to Cabo Catoche
01/1500	Tropical Storm Watch issued	Cabo Catoche to Campeche
02/0900	Tropical Storm Warning modified to	Chetumal to Cabo Catoche
02/1800	Tropical Storm Warning discontinued	Chetumal to Cabo Catoche
02/1800	Tropical Storm Watch discontinued	Cabo Catoche to Campeche
03/0900	Hurricane Watch issued	Cabo Rojo to Punta El Lagarto
03/1500	Hurricane Watch changed to Hurricane Warning	Cabo Rojo to Punta El Lagarto
03/2100	Tropical Storm Warning issued	East of Punta El Lagarto to Chilitepec
04/0600	Tropical Storm Warning changed to Hurricane Warning	East of Punta El Lagarto to Chilitepec
04/0900	Hurricane Warning changed to Tropical Storm Warning	North of Palma Sola to Cabo Rojo
04/0900	Hurricane Warning modified to	Palma Sola to Chilitepec
04/1800	Hurricane Warning discontinued	Palma Sola to Chilitepec
04/1800	Tropical Storm Warning modified to	Palma Sola to Coatzacoalos
04/2100	Tropical Storm Warning discontinued	Palma Sola to Coatzacoalos

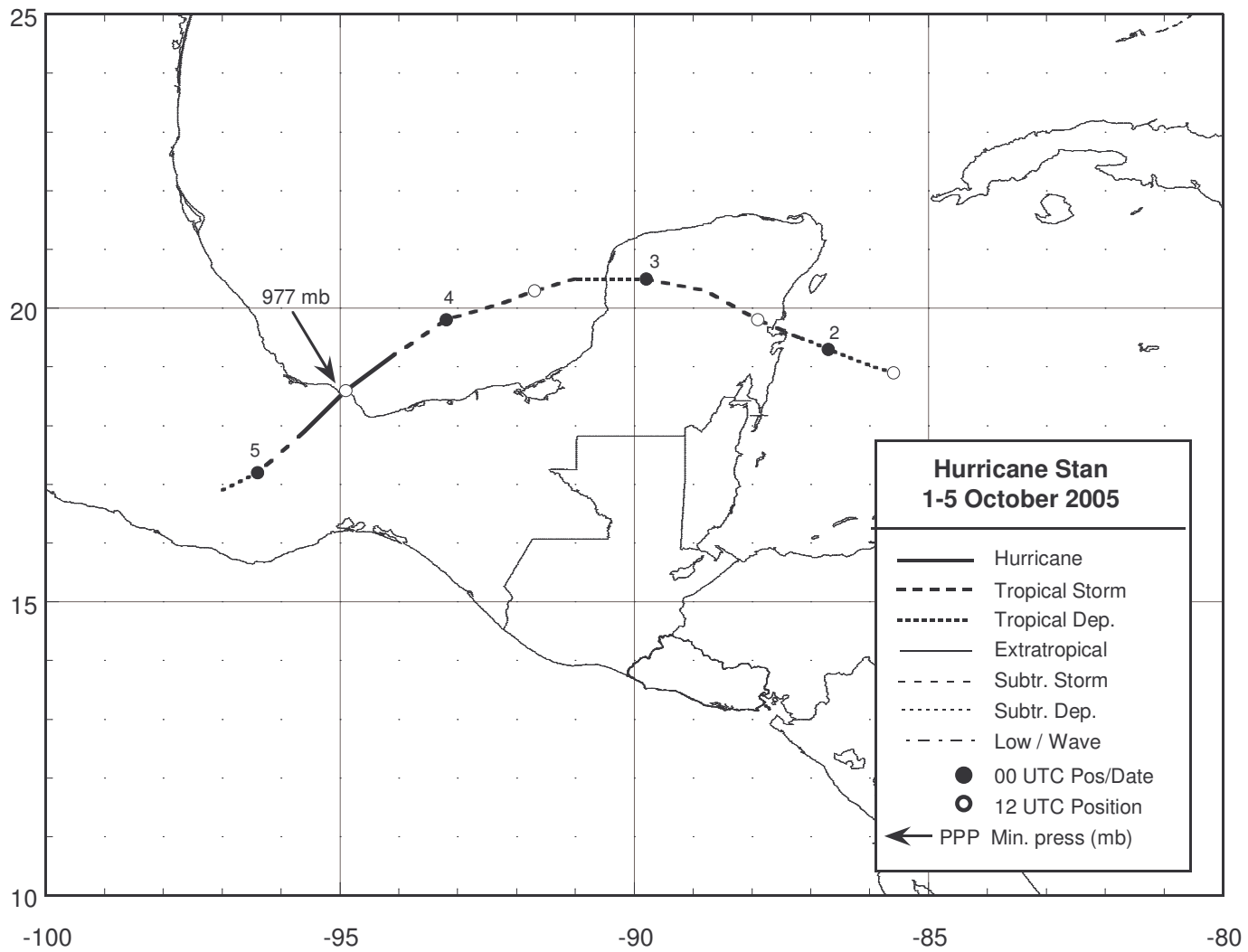


Figure 1. Best track positions for Hurricane Stan, 1-5 October 2005.

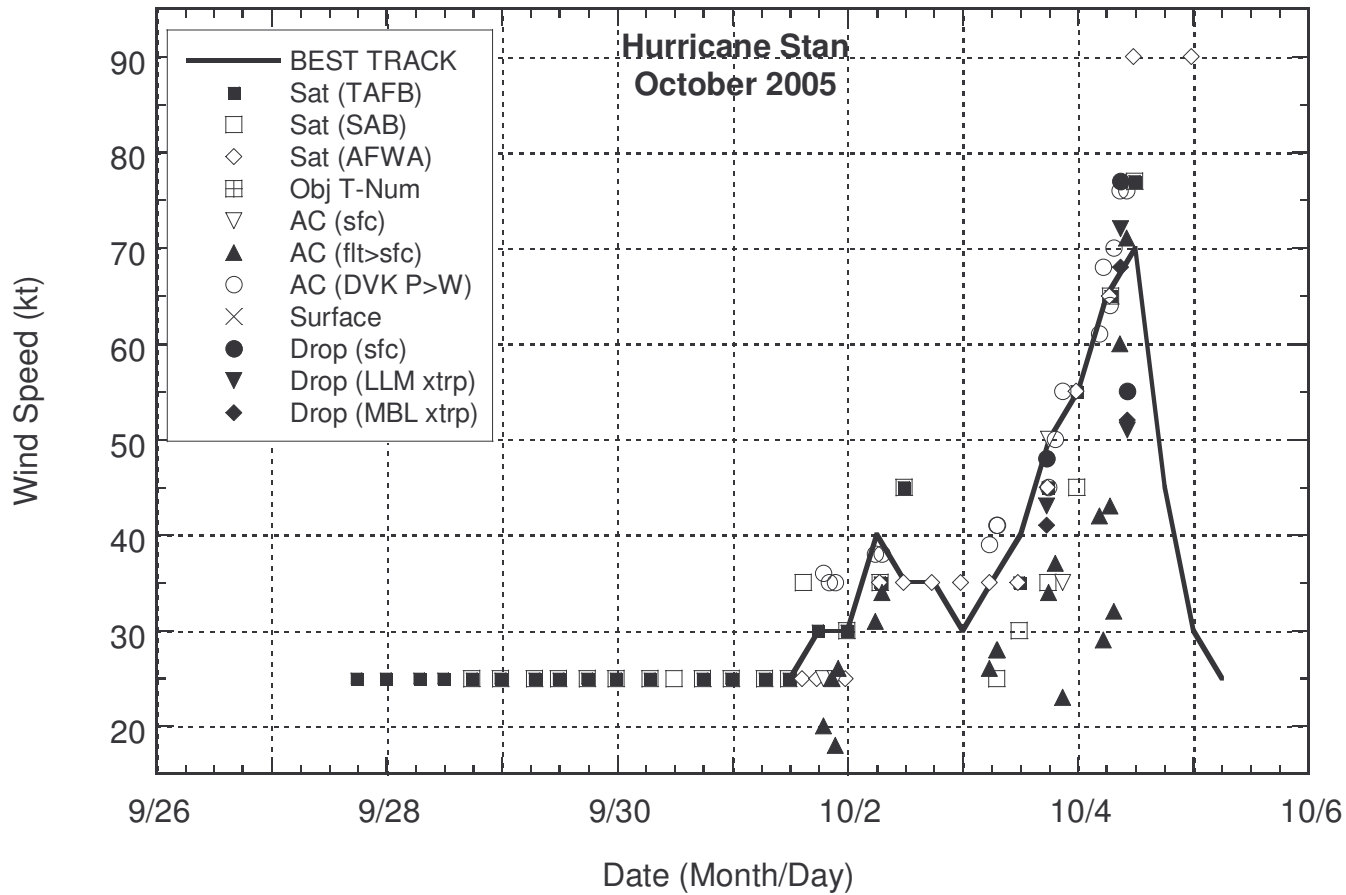


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Stan, 1-5 October 2005. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde 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).

