

Preliminary Report
Hurricane Luis
28 August - 12 September 1995

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a. Synoptic History

Luis was a Category 4 Cape Verde hurricane that thrashed some of the Leeward Islands of the Caribbean Sea.

Luis was first detected as a circulation of low clouds on 26 August over the far eastern tropical Atlantic between the coast of Africa and the Cape Verde Islands. This was the 39th tropical wave of the 1995 Atlantic hurricane season to be tracked and the 13th tropical cyclone. The low-level cloud circulation moved westward and gradually evolved into a tropical depression by the 28th. The official track of Luis, listed in Table 1 and plotted in Fig. 1, begins at this time.

The depression strengthened to a storm on the 29th, but its deep convection sputtered for the next two days while there was strong vertical shear nearby. The shear diminished on the 30th and Luis became a hurricane on the 31st, midway between Africa and the Lesser Antilles. The intensification process was steady until late on the 3rd when a reconnaissance aircraft reached the hurricane and confirmed the presence of a Category 4 hurricane on the Saffir/Simpson scale. Luis was located about 600 n. mi. east of the Lesser Antilles at this time.

The track heading turned from westward to northwestward on the 5th and the hurricane moved across the northeastern-most Leeward Islands. The center passed directly over Barbuda and close enough to the northeast of Antigua, St. Barthelemy, St. Martin and Anguilla that the southern portion of the eyewall possibly affected these islands. Although there were minor fluctuations in intensity, Luis was a deadly category 4 hurricane at this time.

Nevis, St. Kitts, St. Eustatius and the northernmost British Virgin Islands also experienced hurricane conditions, while tropical storm conditions affected the remainder of the British and U.S. Virgin Islands and the eastern islands of Puerto Rico.

Luis then gradually recurved across the north Atlantic. The center of the hurricane passed about 200 miles west of Bermuda on the 9th of September, causing tropical storm force winds there. Luis became extratropical late on the 10th and 11th, and reintensified as it moved over eastern Newfoundland, where high winds and coastal sea conditions were also reported.

The overall track follows the general outline of the periphery of the Atlantic subtropical surface high pressure ridge. The period of recurvature began on the 5th with a turn from westward to northwestward; this turn brought the hurricane and its destruction to the Leeward Islands. The recurvature continued through the 10th, by which time the motion was northeastward. Luis did not

quite reach 70 degrees west longitude. The weakness in the Atlantic ridge in which the recurvature occurred was a persistent feature and a number of this season's many Cape Verde tropical cyclones recurved at least as far east as Luis.

b. Meteorological Statistics

The reconnaissance pressure and wind speed observations are plotted in Figs. 2 and 3 respectively. Remote satellite wind speed estimates from 22,000 miles away are plotted in Fig. 3 and the corresponding wind speed from the Dvorak pressure-wind relation is plotted in Fig. 2. A small selection of surface observations are also plotted. Table 2 lists some significant surface observations and Table 3 lists ship reports of tropical storm conditions.

The highest reconnaissance wind speed was 146 knots at 1306 UTC on the 4th at a flight level of 700 mb, along with a surface pressure of 945 mb. The surface pressure did not reach its minimum value of 935 mb until late on the 7th, at which time aircraft winds were in the 120-knot range. The ship **TEAL ARROW** was in the center of the hurricane at 1800 UTC on the 6th and measured a sea-level pressure of 942 mb. The ship reported 99 knots sustained at 2100 UTC and again at 0300 UTC and reported a highest gust of 125 knots and wave heights to nearly 50 feet.

Aircraft winds were generally 120 knots or less during the time that the **TEAL ARROW** reported 125 knots. The official highest sustained surface wind attained by Luis is estimated to be 130 knots from 0600-1200 UTC, on the 4th, when aircraft winds reached the 140-knot range. One could go even higher than 130 knots on the 4th if the flight level to surface wind speed ratio indicated from the above ship report was maintained.

The **QUEEN ELIZABETH 2** encountered a rogue wave of 95 feet early on the 11th while located 200 n. mi. south of eastern Newfoundland and 120 n. mi. southeast of the center of the tropical cyclone. A nearby Canadian data buoy reported a peak wave height of 98 feet at about the same time. Based on wind reports of 120 knots from this ship, the best track wind speeds were increased to 105 knots at 0600 UTC on the 11th, when Luis was passing over southeastern Newfoundland. The high winds, however remained offshore. The Philadelphia Inquirer reported that scientists have interpreted several recent events of 100-foot waves as evidence of global warming and more intense storms in the Atlantic.

c. Casualty and Damage Statistics

The hurricane killed at least 15 people and caused extensive damage when it moved across the northeastern edge of the Leeward Islands of the Caribbean. Nine died in St. Martin, two in Antigua, two in Puerto Rico, one in Guadeloupe, and one in Dominica.

Dollar damage totals are unknown. At Barbuda, where a full Category 4 hurricane was experienced, the damage to structures was estimated at 70 percent along with severe flooding and erosion. The estimate for St. Maartin and St. Martin is 60 percent damage from a Category 2 or 3 hurricane. The prime minister of Antigua was quoted as saying that nearly half the homes on that

island were destroyed. A dollar damage estimate for St. Maartin, alone, is 1.8 billion dollars and this was the part of the island farthest from the hurricane. With great uncertainty, the total damage estimate for Hurricane Luis is temporarily set at 3 billion U.S. dollars.

d. Forecast and Warning Critique

Official average track forecast errors were small ranging from 52 n mi at 24 hours to 173 n mi at 72 hours.

Luis became and remained a Category 4 hurricane several days before hitting the islands. This persistence provided ample time for officials to prepare.

Table 4 lists the sequence of watches and warnings. There was a lead time of 29 hours for Antigua from the time of issuing warnings to the onset of gale-force winds. Lead times for the other nearby islands were similar.

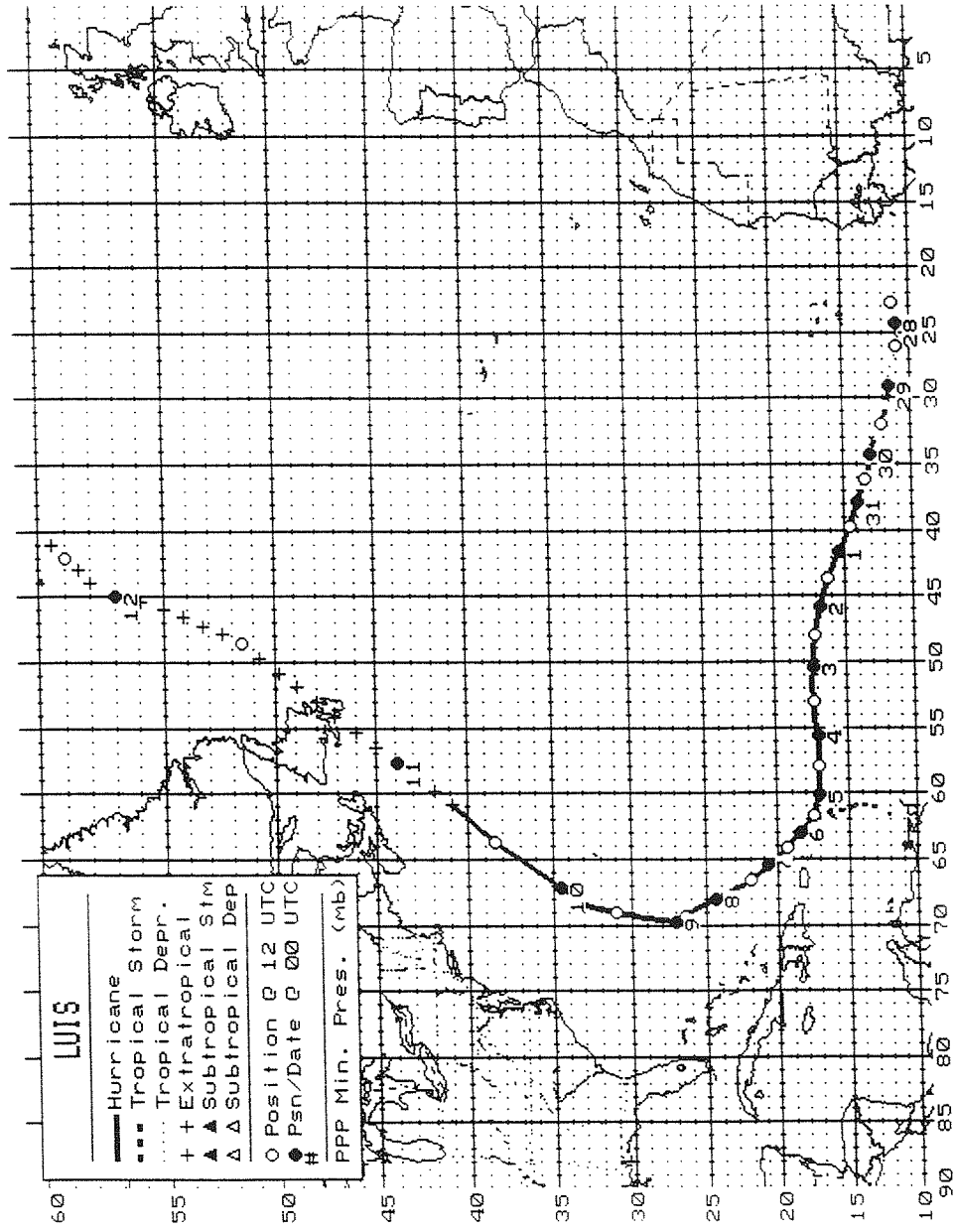


Fig. 1. Track of Hurricane Luis, 28 August - 12 September 1995

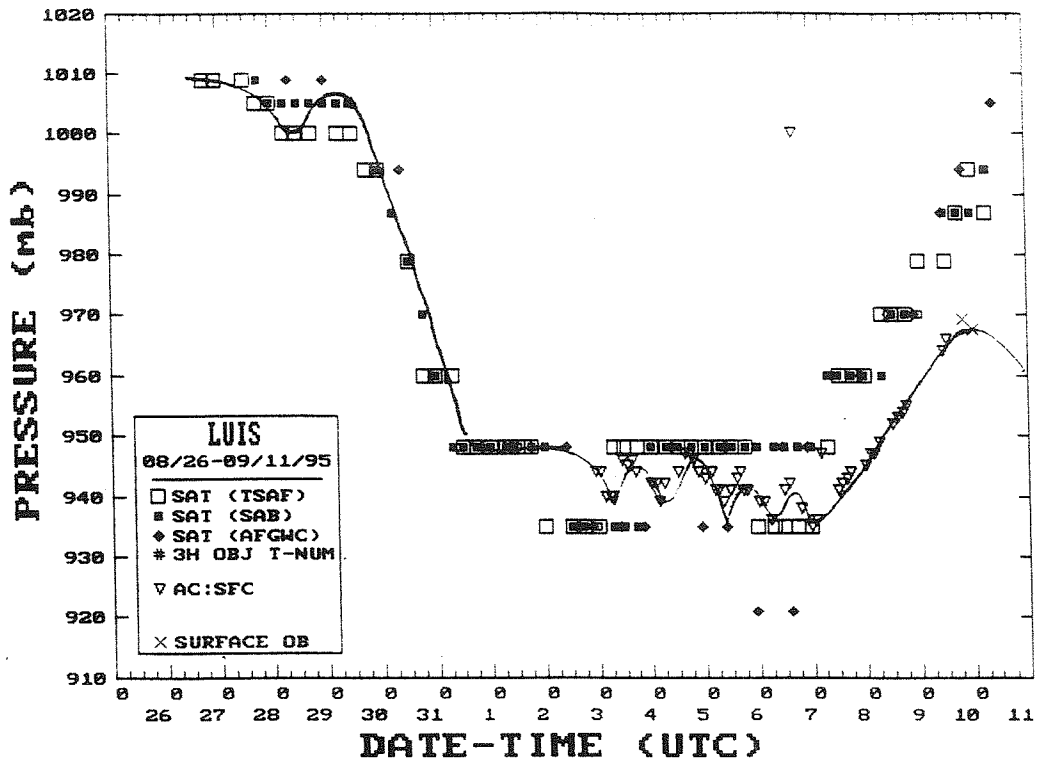


Fig. 2. Minimum central sea-level pressure-versus-time curve.

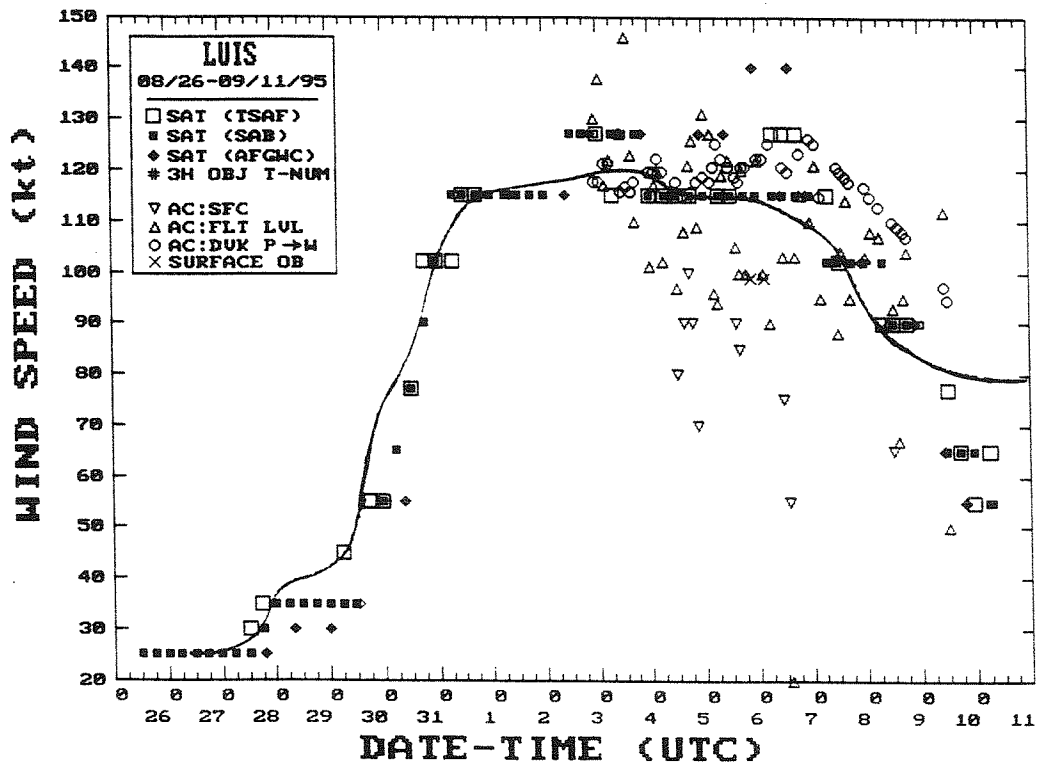


Fig. 3. Maximum one-minute surface wind speed-versus-time curve.

Table 1. Preliminary best track, Hurricane Luis,
28 August - 12 September 1995.

Date/Time <u>(UTC)</u>	Position		Pressure <u>(mb)</u>	Wind Speed <u>(Kt)</u>	Stage
	<u>Lat.(°N)</u>	<u>Lon.(°W)</u>			
28/1800	11.4	27.5	1008	30	Trop. dep.
29/0000	11.6	29.0	1005	35	Trop. storm
0600	11.8	30.5	1000	40	"
1200	12.2	31.9	1000	40	"
1800	12.7	33.1	1003	35	"
30/0000	13.0	34.2	1005	35	"
0600	13.2	35.3	1005	35	"
1200	13.4	36.2	1005	35	"
1800	13.7	37.0	1002	45	"
31/0000	14.0	37.9	998	55	"
0600	14.3	38.8	992	75	Hurricane
1200	14.6	39.7	979	80	"
1800	15.0	40.7	971	90	"
01/0000	15.4	41.7	965	100	"
0600	15.8	42.6	958	105	"
1200	16.2	43.6	950	115	"
1800	16.5	44.7	948	115	"
02/0000	16.8	45.8	948	115	"
0600	17.0	46.9	948	115	"
1200	17.2	48.0	948	120	"
1800	17.3	49.2	948	120	"
03/0000	17.3	50.5	948	120	"
0600	17.4	51.8	948	120	"
1200	17.3	53.1	948	120	"
1800	17.3	54.3	945	125	"
04/0000	17.1	55.6	942	125	"
0600	17.0	56.8	940	130	"
1200	17.0	58.0	945	130	"
1800	17.0	59.1	943	125	"
05/0000	17.1	60.1	940	125	"
0600	17.3	61.0	939	120	"
1200	17.5	61.7	945	115	"
1800	18.0	62.4	944	115	"
06/0000	18.4	63.0	942	115	"
0600	18.9	63.6	939	120	"
1200	19.4	64.2	943	120	"
1800	20.1	64.9	940	125	"
07/0000	20.7	65.4	938	125	"
0600	21.3	66.0	936	120	"

Table 1(continued). Preliminary best track, Hurricane Luis,
28 August - 12 September 1995.

Date/Time <u>(UTC)</u>	Position		Pressure <u>(mb)</u>	Wind Speed <u>(Kt)</u>	Stage
	<u>Lat.(°N)</u>	<u>Lon.(°W)</u>			
1200	22.0	66.6	941	115	Hurricane
1800	22.8	67.2	938	115	"
08/0000	24.3	68.0	935	115	"
0600	25.8	68.8	939	115	"
1200	26.4	69.3	941	110	"
1800	26.5	69.5	944	105	"
09/0000	27.1	69.8	945	100	"
0600	29.1	69.5	949	95	"
1200	31.0	69.1	952	90	"
1800	32.7	68.6	955	85	"
10/0000	34.5	67.2	959	85	"
0600	36.5	65.4	963	85	"
1200	38.4	63.7	961	85	"
1800	40.9	60.9	966	85	Extratropical
11/0000	43.9	57.7	965	95	"
0600	47.1	54.2	963	105	"
1200	51.5	48.5	960	90	"
1800	55.0	46.0	958	75	"
12/0000	57.0	45.0	955	60	"
0600	58.0	44.0	950	60	"
1200	59.0	42.0	955	60	"
1800	60.0	40.0	960	50	"
04/1200	17.0	58.0	945	130	Maximum wind

Table 2. Hurricane Luis selected surface observations, September 1995.

Location	Minimum sea-level pressure		Maximum surface wind speed (kt)		Rain (in) (storm total)
	Pressure (mb)	Date/time (UTC)	1-minute average	Peak gust (UTC)*	
Antigua	971	05/1030	105	127	10
Guadeloupe					
Basse-Terre mountains			65	73	20
Desirade			42	57	
Raizet	994	05/0800			7
Gustavia, St. Barthelemy	948	05/1951	108	135	
St. Maartin (Dutch)	964	05/2300	75	99	6.50
Bermuda			40	49	

* Time of 1-minute wind speed unless only gust is given.

Table 3. Ship reports of 34 knots or higher wind speed, associated with Hurricane Luis, September 1995.

date/time (UTC)	ship name	lat. (°)	lon. (°W)	wind dir & speed(kt)	Press. (mb)
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06/0000	Teal Arrow	20.1	64.9	060/36	1006.5
06/0600	Teal Arrow	20.2	64.6	040/43	1000.0
06/1200	Teal Arrow	20.3	64.6	040/58	987.0
06/1500	Teal Arrow	20.1	64.8	040/64	969.5
06/1800	Teal Arrow	20.1	64.9	160/11	942.0
06/2100	Teal Arrow	20.4	64.8	130/99	944.0
07/0000	Teal Arrow	20.4	65.0	130/85	960.0
07/0300	Teal Arrow	21.0	65.1	130/99	971.0
07/0600	Teal Arrow	21.2	65.1	130/85	979.0
07/1200	Teal Arrow	21.5	65.0	170/48	995.5
07/1200	WZJB	20.1	62.8	170/40	1010.1
07/1200	WVFZ	20.6	68.6	320/55	1001.9
08/0600		22.1	68.7	260/37	1002.0
08/1200		22.8	67.2	200/45	1005.8
08/1800		23.7	65.8	170/40	1008.0
08/1800		25.2	77.5	020/39	1011.5
09/0600		25.5	76.4	020/40	1011.1
09/1800		24.6	73.5	020/50	1014.8
10/0600	DPUF	37.0	61.0	170/35	1009.1
10/1200	DPUF	36.4	61.2	180/52	1003.5
10/1800	DPUF	36.4	61.8	230/40	1007.0
11/0600	C6HE2	44.6	61.5	300/34	1010.0
11/0600	KRPD	44.8	60.8	290/35	1008.0
11/0600	DEDD	44.9	48.1	190/62	1001.1
11/1200	ICBA	39.7	55.3	270/40	1020.0
11/1200	PENG	46.3	41.0	180/41	1010.0
11/1800	OWEB2	44.9	40.2	230/34	1010.0

Table 4. Summary of watches and warnings, Hurricane Luis, September 1995.

Date/time (UTC)	Action	Location
03/0900	Hurricane watch	Antigua, Barbuda, Monserrat, Nevis, St. Kitts
03/1800	Hurricane watch	St. Martin, Saba, St. Eustatius
03/2100	Hurricane watch	Dominica, Guadeloupe, St. Barthelémy
04/0000	Hurricane warning	Antigua to St. Martin
04/0600	T.S. warning	Dominica, Guadeloupe
04/1200	Hurricane watch	British and U.S. Virgin Is., Puerto Rico
04/1200	Hurricane warning	Guadeloupe
04/1500	T.S. warning	St. Barthelémy
04/2100	Hurricane warning	St. Barthelémy, St. Martin, Dominica
05/1200	Hurricane warning	St. Lucia, Martinique
05/2100	T.S. warning	British and U.S. virgin Is., Puerto Rico
06/0900	All warnings discontinued	St. Lucia
06/1200	T.S. warning	Dominica (changed from hurricane warning)
06/1500	All warnings discontinued	Guadeloupe and Dominica
07/0300	T.S. warning	U.S. Virgin Is. and Puerto Rico
07/2100	T.S. watch	(changed from hurricane warning)
08/0300	T.S. warning	Anguilla southward
08/1500	T.S. warning	British Virgin Is. (changed from hurricane warning)
10/0900	T.S. warning	All warnings discontinued
07/0300	T.S. warning	British and U.S. Virgin Is. and Puerto Rico
07/2100	T.S. warning	Turks and Caicos Is.
08/0300	T.S. watch	Bermuda
08/1500	T.S. warning	Turks and Caicos Is.
10/0900	T.S. warning	Bermuda