

## Eastern North Pacific Hurricane Season of 1989

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### ABSTRACT

The 1989 eastern Pacific hurricane season is summarized. Seventeen tropical storms were tracked, of which nine became hurricanes. Cosme, Kiko and Raymond made landfall in Mexico and ten deaths were attributed to Cosme from inland flash flooding.

### 1. General

Seventeen tropical storms were tracked in the eastern Pacific Ocean during 1989 and nine of these reached hurricane force. In addition, seven tropical depressions were tracked which did not develop into tropical storms. The 17 named tropical storms and hurricanes, along with their dates, highest sustained wind, minimum sea-level pressure, U.S. damage, and deaths are listed in Table 1.

The season's first tropical cyclone was Tropical Storm Adolph, first detected as a closed low-level circulation on 31 May. The last named storm of the season terminated on 5 October when Raymond moved inland over Mexico and the last tropical cyclone of the season to be tracked was Tropical Depression Number 24-E, which dissipated on 19 October, some 1400 km southwest of the southern tip of Baja California, Mexico.

The eight tropical storms and nine hurricanes during 1989 compare with averages of 7.4 tropical storms and 8.2 hurricanes during the period of 1966–88. Figure 1 shows a bar graph of the monthly distribution of the sum of tropical storms and hurricanes for 1989 and also of the 1966–88 monthly averages. In this figure, the storm or hurricane was assigned to the month in which it first became a depression. During 1989, there were slightly more tropical storms and hurricanes in August and September than normal and none in October or November.

### 2. Best tracks

Best tracks for all tropical storms and hurricanes are based on a post-analysis of all available data. A best

track consists of six-hour center positions, maximum one-minute wind speed and minimum sea-level pressure and includes tropical depression stages.

The GOES-7 geostationary visible and infrared satellite imagery is the primary data source for tracking tropical cyclones in the eastern Pacific, supplemented by polar-orbiting satellites and a few ship reports. Intensity parameters are estimated from satellite images using the Dvorak (1984) method.

Figure 2 shows the best-track center positions of this season's 17 tropical storms and hurricanes. Fourteen of these developed their initial circulation within a five-degree latitude belt between 10° and 15°N latitude and within a 30° longitude belt between 95° and 125°W longitude. Tropical storms Juliette and Priscilla developed just north of this zone and Hurricane Kiko developed near the Gulf of California. Except for Kiko, the development of all of this season's named tropical cyclones are associated with Atlantic tropical waves (Avila 1990).

Most eastern Pacific tropical cyclones move on a west through northwestward heading and dissipate over cold water without affecting land. Cosme and Kiko made hurricane landfalls in Mexico and Raymond made landfall as a tropical storm, although Raymond was earlier estimated to be a 64 m s<sup>-1</sup> hurricane. The remnants of Octave were tracked over southern California. Dalilia remained far enough south over warm water to move west of 140°W longitude, into the area of responsibility of the Central Pacific Hurricane Center in Honolulu where it subsequently threatened Hawaii.

### 3. Verification

The National Hurricane Center (NHC) issues official forecasts, from zero through 72 hours, of the center position and maximum one-minute wind speed for all tropical cyclones in the eastern Pacific Ocean east of 140°W longitude. These forecasts are updated every

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TABLE 1. 1989 eastern Pacific hurricane season statistics.

Number	Name	Class <sup>a</sup>	Dates <sup>b</sup>	Maximum 1-min wind (m s <sup>-1</sup> )	Minimum sea-level pressure (mb)	U.S damage (\$ millions)	Deaths
1	Adolph	T	31 May-5 Jun	28	994		
2	Barbara	H	15-21 Jun	36	984		
3	Cosme	H	18-23 Jun	39	979		10
4	Dalilia	H	12-21 Jul	41	977		
5	Erick	T	19-21 Jul	18	1005		
6	Flossie	T	23-28 Jul	18	1004		
7	Gil	H	30 Jul-5 Aug	39	979		
8	Henriette	T	14-18 Aug	23	1000		
9	Ismael	H	14-25 Aug	54	955		3 <sup>c</sup>
10	Juliette	T	21-25 Aug	33	992		
11	Kiko	H	24-29 Aug	54	955		
12	Lorena	H	27 Aug-6 Sep	33	989		
13	Manuel	T	28-31 Aug	21	1002		
14	Narda	T	3-8 Sep	23	1000		
15	Octave	H	8-16 Sep	59	948		
16	Priscilla	T	21-26 Sep	28	993		
17	Raymond	H	26 Sep-5 Oct	64	935	1.5	

<sup>a</sup> T: tropical storm, wind speed 17-32 m s<sup>-1</sup>. H: hurricane, wind speed 33 m s<sup>-1</sup> or higher.

<sup>b</sup> Dates begin at 0000 UTC and include tropical depression stage.

<sup>c</sup> Ismael remained offshore, but associated rainfall caused three deaths.

six hours and are verified by comparison with the best tracks described above.

Table 2 lists the official track error averages for 1989. These errors range from 28 km at the 0-hour forecast period (initial position error) to 439 km at 72 hours. The 1989 track errors are slightly less than the previous ten-year averages at 24, 48 and 72 hours.

The average 1989 official wind speed errors are listed in Table 3. The mean errors show that there is a negative bias at all forecast periods, while the mean absolute errors peak at 48 hours.

#### 4. Tropical cyclones affecting land

##### a. Hurricane Cosme, 18-23 June

A tropical depression formed to the south of Acapulco, Mexico on 18 June. It was associated with a tropical wave that emerged from the northwest coast of Africa approximately two weeks prior to that date. During 17-18 June, several different centers of circulation were observed on satellite pictures before a single center organized. The depression was designated

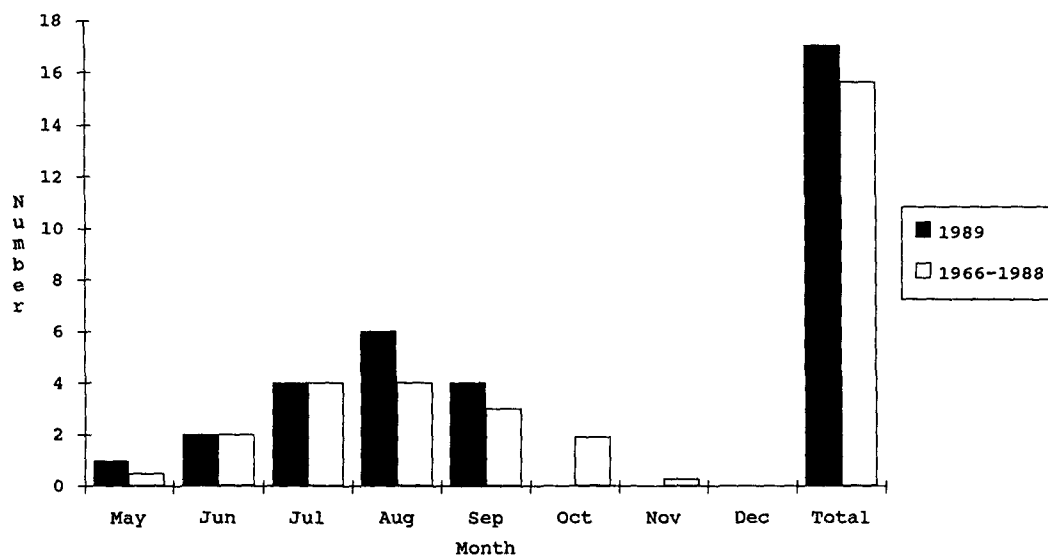


FIG. 1. Monthly distribution of the number of tropical storms and hurricanes, assigned to the month in which they first developed into a tropical depression.

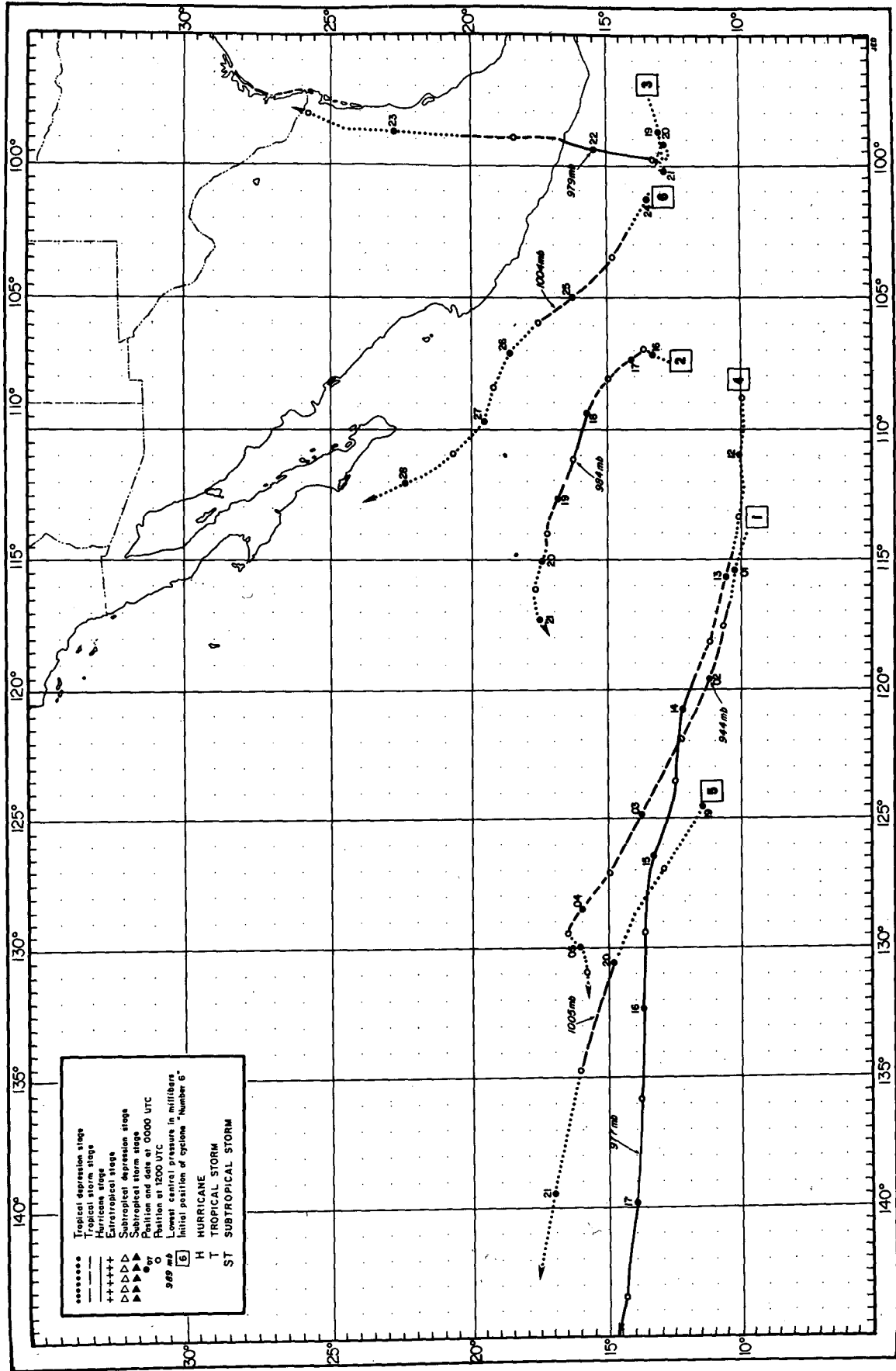


FIG. 2a. Tropical storm and hurricane tracks for the eastern Pacific, 1989, storms 1 through 6. Storms are identified by number in Table 1.

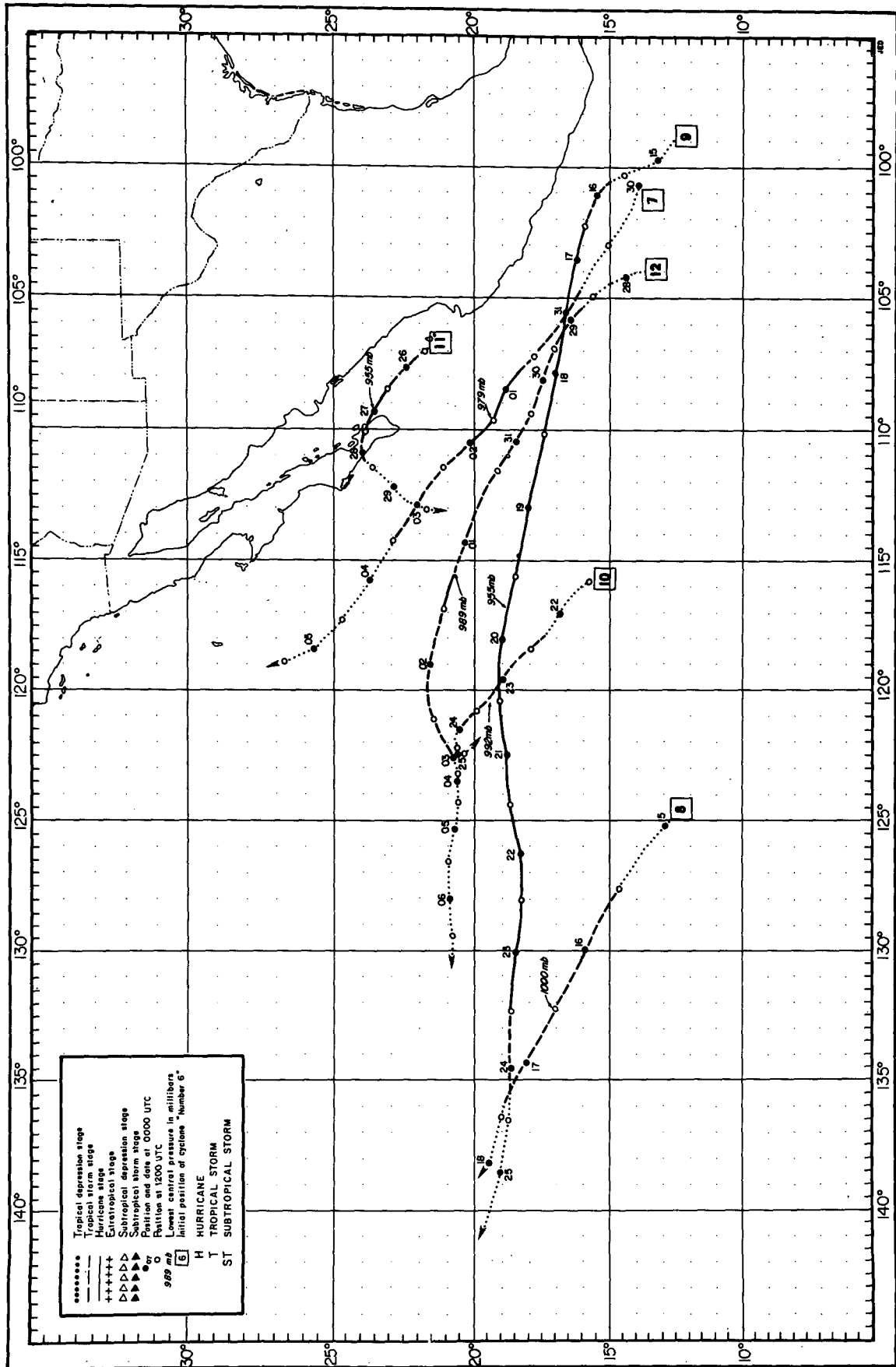


FIG. 2b. Same as Fig. 2a, storms 7 through 12.

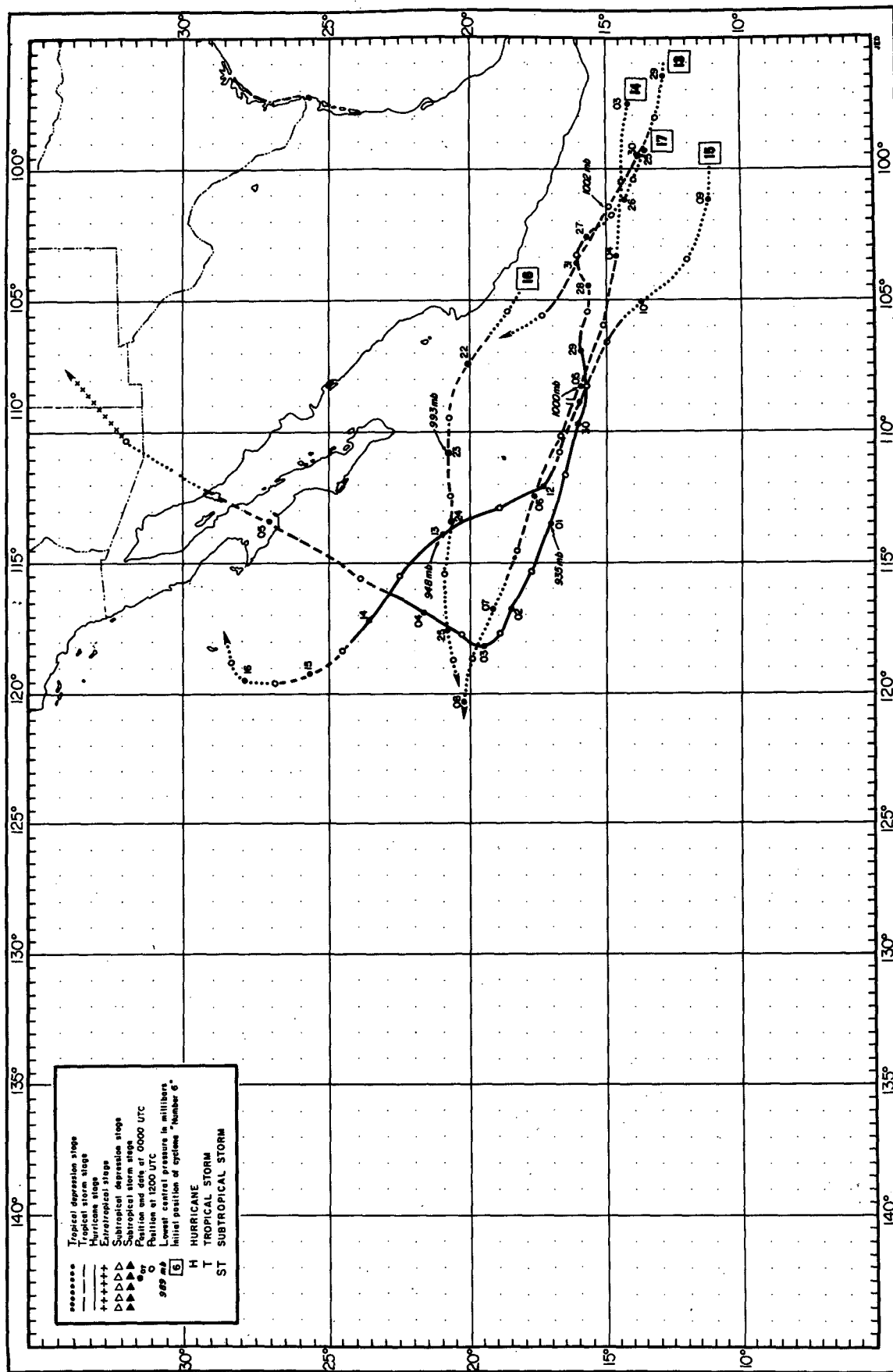


FIG. 2c. Same as Fig. 2a, storms 13 through 17.

TABLE 2. Official track forecast errors in km, eastern Pacific.

	Forecast period (hours)					
	0	12	24	36	48	72
1989 (number of cases)	28 (215)	80 (215)	152 (182)	232 (150)	304 (119)	439 (77)
1979-88 average			163		317	460
1989 departure from 1979-87 average			-7%		-4%	-5%
1989 range	0-267	0-587	19-673	9-767	24-888	61-1255

Tropical Storm Cosme on the morning of 20 June and Cosme attained hurricane strength on the morning of 21 June.

During 19-20 June, Cosme remained nearly stationary as the circulation gradually organized. After attaining hurricane status, it turned toward the north with increasing forward speed. The center moved onshore just east of Acapulco on the night of 21 June. After going inland and rapidly weakening, the remnants of Cosme accelerated northward through eastern Mexico. The circulation was last identified as a cloud swirl south of Brownsville, Texas on 23 June. The development of Tropical Storm Allison in the northwest Gulf of Mexico can be associated with the remnants of Cosme's pressure and wind patterns.

Maximum sustained winds of  $39 \text{ m s}^{-1}$  and a lowest sea-level pressure of 979 mb are estimated to have occurred just prior to landfall. The highest recorded winds in Acapulco were  $15 \text{ m s}^{-1}$  with gusts to  $21 \text{ m s}^{-1}$ . Winds gusting to  $26 \text{ m s}^{-1}$  were reported at Puerto Escondido, Mexico, located about 275 km east of where Cosme made landfall. The maximum wind observed by a ship was  $28 \text{ m s}^{-1}$ , reported by the ship KIGR just east of the center at 2200 UTC 21 June.

Heavy rains accompanied the hurricane over southern Mexico with reports of flash floods and mud slides over the coastal mountains. Rainfall amounts in excess of 125 mm during a 12-hour period were recorded along the coast of Acapulco during the night of 21 June.

The Mexican government reported ten deaths due to drowning. Many adobe houses were destroyed by floods. No estimate of dollar damage is available.

#### b. Hurricane Kiko, 25-29 August

On 23 August satellite imagery revealed a large mesoscale convective system developing over northwest Mexico. The coldest convective tops moved southward from the vicinity of the state of Sinaloa, Mexico to a location near the Islas Marias by 24 August. While meteorological reports are insufficient to document the process of transformation which occurred over the next 12 to 24 hours, Dvorak satellite classifications indicated that a tropical depression formed on 25 August and the best track begins at 1200 UTC 25 August just west of the Islas Marias.

The depression drifted toward the northwest and rapidly developed into a tropical storm by 1800 UTC 25 August. Kiko reached hurricane status by 0600 UTC 26 August when an eye embedded within a small central dense overcast appeared in satellite imagery. The rapid rate of development continued and the maximum intensity of  $54 \text{ m s}^{-1}$  was estimated at 0000 UTC 27 August while Kiko was centered just east of the southern tip of Baja California. Kiko made landfall on the Baja peninsula near Punta Arena about six hours later.

Figure 3 shows a visible satellite picture of Kiko centered just east of Baja California shortly prior to the time of its maximum intensity estimate. Kiko was a rather small storm and the accuracy of satellite intensity estimates are highly uncertain in this situation.

Because the hurricane was small and moved slowly, it weakened rapidly over the mountainous terrain of Baja. It turned toward the west as it weakened, in response to height rises and a change in the steering current to the north of the hurricane. Kiko was downgraded to a tropical storm by 1800 UTC 27 August while centered just southwest of La Paz, and was downgraded to a tropical depression by 0600 UTC 28 August just as the center emerged off the west coast of Baja. Kiko turned to the southwest, as it began to interact with Tropical Storm Lorena, centered about 1200 km to the southeast. The depression diminished to a weak swirl in the stratocumulus and was eventually absorbed within the circulation of Tropical Storm Lorena.

The first surface observation of sustained tropical storm force wind was  $24 \text{ m s}^{-1}$  reported at 1800 UTC 25 August on Isla Maria. This was early in the life of Kiko and was determined to be unrepresentative since

TABLE 3. Official maximum one-minute wind speed forecast errors in  $\text{m s}^{-1}$ , eastern Pacific, 1989.

	Forecast period (hours)					
	0	12	24	36	48	72
Mean	-0.4	-0.9	-1.4	-2.1	-4.5	-6.0
Mean absolute	2.3	4.1	6.5	8.7	10.9	10.8
Number of cases	215	215	182	150	118	77

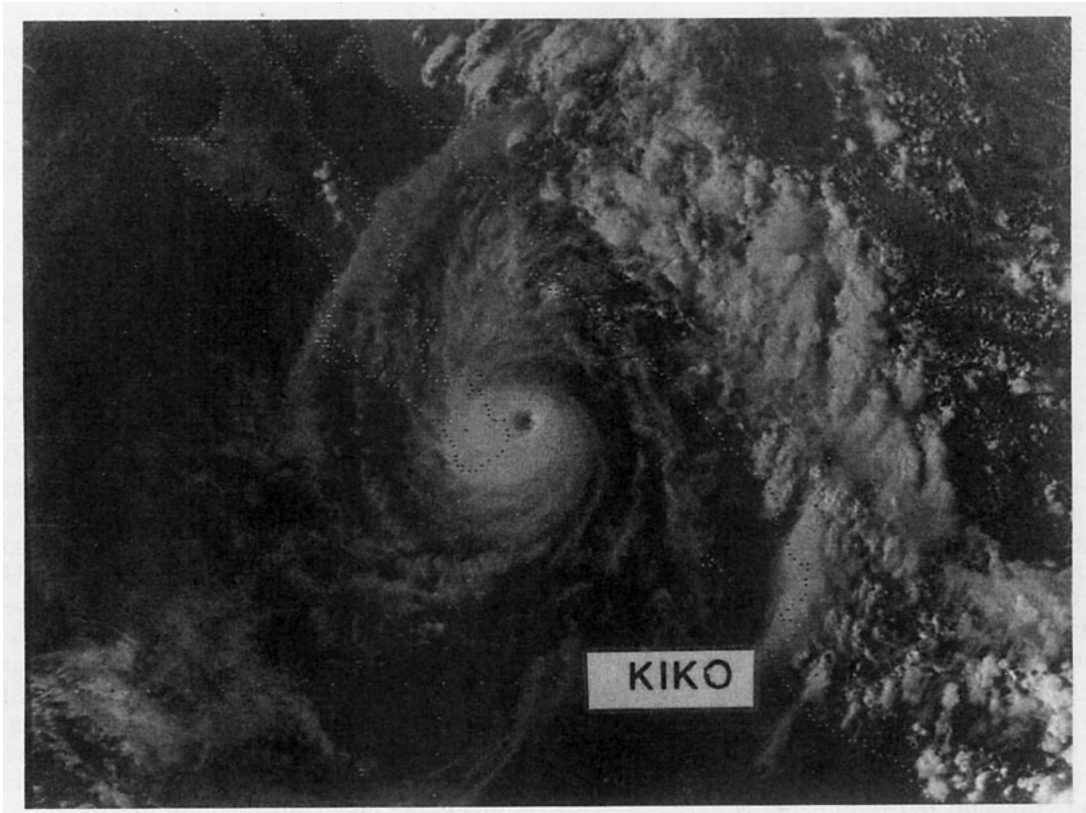


FIG. 3. A visible satellite image of Hurricane Kiko at 2231 UTC 26 August 1989, near the southern tip of Baja California.

the 2100 UTC report from the same station was only  $3 \text{ m s}^{-1}$ .

A hotel owner on Cabo San Lucas relayed ship reports from outside the Cabo San Lucas harbor of northwest winds of  $15 \text{ m s}^{-1}$  at 1900 UTC on the 26th. A ham radio report from near Punta Arena at 0130 UTC on the 27th listed northerly winds of  $21 \text{ m s}^{-1}$  with gusts to  $28 \text{ m s}^{-1}$  while Kiko was just offshore. The hurricane made landfall during the night in an area with limited observations, although torrential rains were reported from Cabo San Lucas and Todos Santos during the day of 27 August.

No casualty or damage reports have been obtained.

#### c. Hurricane Octave, 8–16 September

Although Octave did not make landfall as a tropical cyclone, its remnants were tracked across southern and central California on 17 and 18 September. These remnants consisted of an area of light rain, which was reported to cause minor damage to the California raisin crop.

#### d. Hurricane Raymond, 26 September–5 October

The southern extension of the tropical wave that spawned Hurricane Hugo in the Atlantic continued

moving westward through the Caribbean Sea with no significant convective activity. However, as the wave moved across Central America on 21 and 22 September, satellite imagery showed an increase in cloudiness and thunderstorms associated with the wave. This activity continued to increase as the wave centered into the Pacific Ocean, and, by 24 September, the most prominent convective clusters associated with the tropical wave were located to the southeast of Acapulco. The best track begins on 25 September at 0000 UTC when a tropical depression formed from the wave to the south of Acapulco. The tropical depression initially moved slowly toward the west northwest but, within 24 hours, began turning toward the northwest in response to the flow around a southward moving upper-level trough over central Mexico.

The depression became Tropical Storm Raymond at 1800 UTC 26 September. Raymond continued moving toward the northwest until 1200 UTC 27 September when high pressure developed to the north and the cyclone resumed a westward track.

Raymond continued strengthening over warm sea-surface temperatures and was upgraded to a hurricane at 1800 UTC 28 September. Satellite images eventually showed a distinct eye and a well-defined outflow pattern and its maximum wind speed is estimated to have been

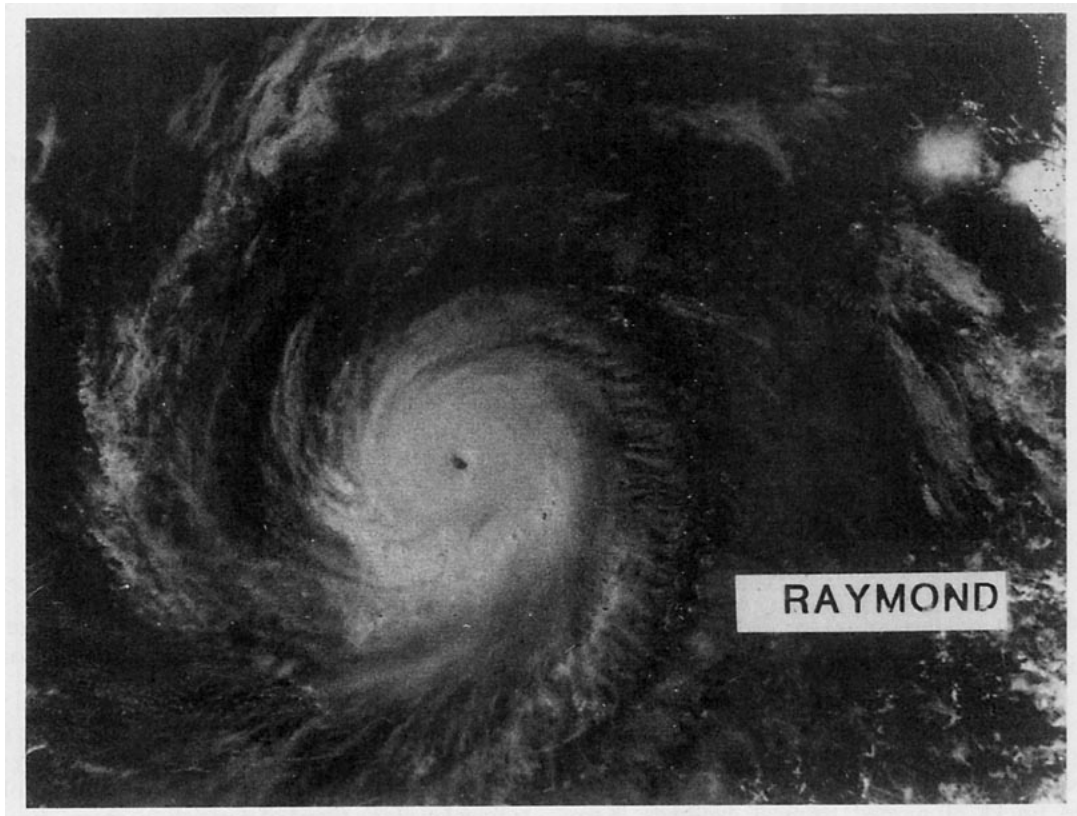


FIG. 4. A visible satellite image of Hurricane Raymond at 2201 UTC 30 September 1989, near the time of maximum surface winds of  $64 \text{ m s}^{-1}$ .

$64 \text{ m s}^{-1}$  at 0000 UTC 1 October. This makes Raymond the strongest hurricane of the 1989 eastern Pacific season. Figure 4 is a visible satellite image of Raymond near the time of its maximum intensity.

Raymond headed toward the west northwest and, on 2 October, the slowly weakening hurricane showed a distinct decrease in forward motion and a turn toward the northwest in response to a downstream longwave trough. By 3 October, Raymond recurved to the northeast and headed toward Mexico with increasing forward speed.

While Raymond accelerated to the northeast over cooler waters, the vertical shear also increased over the cyclone, resulting in weakening. Raymond was downgraded to a tropical storm by 1200 UTC 4 October, and within the next 24 hours moved rapidly across Baja California, the Gulf of California, and into the mainland Mexican state of Sonora as a weakening tropical storm.

The mountainous terrain of Mexico further weakened Raymond, resulting in a tropical depression being tracked across southeastern Arizona into western New Mexico.

The strongest wind reported by a ship was  $31 \text{ m s}^{-1}$  early on 27 September, but, in post analysis, did not appear representative and most likely occurred in a squall. A pressure of 998.0 mb and wind of  $21 \text{ m s}^{-1}$

was reported by a ship at 1800 UTC 4 October while Raymond was approaching the Baja peninsula. A wind of  $18 \text{ m s}^{-1}$  was reported at Guaymas on the coast of the Mexican state of Sonora at 0000 UTC 5 October while Raymond was centered over the Baja peninsula.

Rainfall over the Baja peninsula and the state of Sonora is believed to be small because of the storm's rapid forward motion and shearing conditions. Flash floods were reported over portions of southeast Arizona where maximum rainfall amounts ranged from 50 to 125 mm. The most extensive damage reports came from Nogales and Wilcox. Rainfall amounts of up to 25 mm were also reported over portions of southwest and central New Mexico.

No casualty or damage reports have been obtained from Mexico. No casualties were reported in the United States and the damage estimate in southeast Arizona is placed at 1.5 million dollars.

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