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THE FLORIDA EAST COAST THANKSGIVING HOLIDAY STORM OF 1984

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UNITED STATES
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Service
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by

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1. Introduction

During the period November 21 through 24, 1984, a low pressure system formed over the Atlantic Ocean near the southeast Florida coast and developed into an intense storm, unusually strong and well defined for this area and season. The storm produced extensive damage, widespread coastal flooding and severe beach erosion along the Florida Atlantic coast from West Palm Beach northward to Fernandina Beach. A strong high pressure area over the northeast U.S. enhanced the severity of the storm.

2. Synoptic Analysis

Surface Features

At 7 PM EST on November 19, 1984, a northeast/southwest oriented cold front extended from north Florida across the east Gulf of Mexico to the Yucatan Peninsula (Fig. 1). The front then moved southeast over Florida, and by 7 PM EST, November 20, it extended from the Grand Bahama Island across the Straits of Florida to the northern tip of Yucatan (Fig. 2). From this time through 7 AM EST November 22, the front became quasi-stationary with several minor low pressure systems or waves developing and moving east along the frontal boundary (Figs. 3 & 4). It was not until 1 PM EST November 22 that the main low pressure system developed near the Grand Bahama Island (Fig. 5). The initial central pressure of the low was 1012 millibars (mb) (29.89 inches).

During this period, 7 PM on the 19th to 1 PM on the 22nd, a large high pressure system, 1037 mb (30.62 inches), moved southward from Canada into the north central U.S. The large high reached its highest central pressure value of 1042 mb (30.77 inches) when it was located over Michigan at 7 AM on the 21st (Fig. 6). Thereafter the system began to weaken slowly.

By 7 PM on Thursday the 22nd, the center of the high pressure, 1035 mb (30.56 inches), was situated over West Virginia with the storm center, 1010 mb (29.82 inches), remaining near the Grand Bahama Island (Fig. 7). For the next 36 hours, both systems remained stationary with the high pressure continuing to weaken slowly but the storm intensifying so that by 1 AM November 24, the central pressure of the storm was 1000 mb (29.53 inches) (Figs. 8 & 9). The storm finally began to move east and weaken early the afternoon of the 24th. By 7 AM on the 25th, the storm center had moved to near latitude 27N and longitude 66W, 850 miles east of the Florida coast. By that time it had weakened to 1008 mb (29.77 inches).

As shown by the surface analyses for the four day period of November 21 through 24, a strong pressure gradient persisted across southeast Georgia and most of the Florida Peninsula. At the beginning the gradient was strong due to the large high pressure system over the north central U.S. which was building southeastward. Later the combination of the high center and the developing storm center maintained the persistent strong easterly winds.

Upper Level (500 mb) Features

A 500 mb short wave trough was located over northern old Mexico at 7 PM November 20. The trough moved east so that by 7 AM on the 21st it had reached extreme eastern Texas and Louisiana (Fig.12). Intense deepening then took place as the 500 mb trough moved to extreme north Florida by 7 PM on the 22nd and then southeast to near Grand Bahama Island 24 hours later (Fig. 13). After this time period, the trough moved east and began to weaken.

Associating 500 mb and Surface Analyses

It was during the period that the trough was moving eastward through the Florida panhandle that the first sign of a closed surface low pressure system was observed. Furthermore, as the 500 mb trough moved southeast toward the Grand Bahama Island, both the upper level and surface systems intensified. A 500 mb ridge from southern California to the Dakotas and northward at 7 PM on the 19th gradually moved eastward and strengthened. By 7 AM November 21, the associated surface high pressure system reached its highest pressure of 1042 mb (30.77 inches). Thereafter, both the upper ridge and surface high center moved little and weakened.

3. Computer Forecast Guidance

Limited Fine Mesh (LFM) Computer Forecasts

The upper level (500 mb) forecasts in general were good while the surface forecasts were considered to be fair overall. The 7 PM November 19 LFM package gave the first indication that a significant weather event would take place over Florida and adjacent waters within the next 48 hours. The 500 mb trough was forecast to move over the Florida panhandle by 7 PM November 21. For this same period, the surface prognosis (Fig. 14) implied a quasi-stationary front with small waves over the northern Bahamas across extreme south Florida to the southeast Gulf of Mexico. However, the main forecast predictor for the impending weather disaster was the tight pressure gradient shown on the computer forecast between the strong high over the northeast U.S. and the implied frontal system across extreme south Florida.

The 7 PM November 20 LFM forecast again moved the 500 mb trough to the Florida panhandle by 7 AM on the 22nd then to near Key West with intensification by 7 PM on the 22nd. Also, during this period, the surface prog indicated the formation of two weak low centers, one near the northern Bahamas and the second just south of the central Cuban coast (Fig. 15). As shown by this prog, a strong pressure gradient was still forecast across eastern

Florida and the adjacent waters.

Finally the 7 AM November 22 forecast package put the weather systems on a more accurate track. The 12 hour forecast which placed the 500 mb trough from north Florida to the Carolina coast at 7 PM on the 22nd moved the trough southeast to near Palm Beach during the next 12 hours and to the Bahamas by 7 PM on the 23rd (Fig. 16). The surface progs developed a 1013 mb (29.91 inches) low center near the northern Bahamas by 7 PM on the 23rd (Fig. 17). Later LFM forecasts incorrectly showed eastward movement with weakening of both the 500 mb trough and surface low center. Actual movement of the storm was practically nil for the 48-hour period from 7 AM on the 22nd to 7 AM on the 24th.

Evaluation of the LFM Forecasts

The LFM forecast packages were good in the sense that they showed as early as Tuesday, the 20th, an indication of a significant weather event occurring over Florida within the next two days. The overall handling of the individual system movements was forecast with good accuracy especially at the beginning of the period of development. The LFM forecast of the central pressure value for the low was 13 millibars high, a rather significant amount when considering storm intensities at the latitude where the storm developed. However the forecast strength of the high center was only 2 millibars low, not that significant of an error. The most important factor shown by the LFM forecast was the definite indication of the strong pressure gradient over most of Florida and the adjacent waters for an extended period of time. This would indicate a period of high winds along the Florida east coast.

Upper air events as depicted by the LFM provided the single most outstanding clue to the forecast of cyclogenesis or storm development on what would have otherwise been a strong but fairly typical autumn cold front. A very strong 500 mb short wave trough developed rapidly and swept southeast over the eastern Gulf of Mexico and Florida, triggering cyclogenesis on the front as it lay across the Gulf Stream just off Palm Beach.

4. Impact of the Thanksgiving Holiday Storm

The meteorological conditions just described produced one of the most damaging storms to affect the eastern coastal sections of Florida during the past several decades. Much of the damage from Fernandina Beach southward to North Miami Beach, nearly 400 miles, was caused by the easterly winds of gale force with gusts as high as 60 miles an hour blowing for nearly four days. This action of the wind over the ocean produced shoreward moving swells of around 20 feet which pounded the Florida east coast and produced the most severe beach erosion in recent years in many areas. An example of the destruction was the reduction of the newly completed 1,100-foot pier at St. Augustine to 300 feet. Sand dunes were obliterated leaving barrier islands void of any natural protection against the next onslaught of a coastal storm in the future.

To add to the destructiveness, the highest monthly astronomical tide period coincided with the highest period of storm tides which occurred on the mornings of Thursday and Friday, the 22nd and 23rd. All of this produced tides 4 to 6 feet above mean sea level (MSL) at times of high tide. In some places, this was the highest tide in the last 30 years. At Mayport, Florida, just north of Jacksonville, the tide of 5.2 feet above MSL was the third highest tide of record. Much of state road A1A, the famous coastal highway, was closed in Indian River County between Vero Beach and Sebastian Inlet because of high water. In this area several beach front buildings collapsed, and 800 to 1,000 people were ordered to evacuate their homes. In Palm Beach County, five blocks of A1A were seriously damaged by the high tides and heavy surf. Bridges were closed because of flooded approaches which caused some barrier islands including the large Hutchinson Island to become isolated for periods of time around the time of high tide. In the storm's aftermath, severe coastal beach erosion stretched from Jacksonville to Palm Beach. Several counties were declared emergency areas by the Governor of Florida. The storm tides and high surf alone combined to produce property damage at first estimate of over 8 million dollars along the coast. Figures 18 and 19 show this damage assessment to both public and private property in the individual counties along the coast. (Later post-storm reports from the Florida Department of Natural Resources indicate a much greater property damage total of 38 million dollars.) The damage to beaches due to sand removal was estimated near 50 million dollars based on a 6 dollar per cubic yard of sand replenishment figure.

Rainfall from the storm was widespread with the heaviest amounts along the immediate Atlantic coastline from Vero Beach to Palm Beach. At the West Palm Beach weather office, a new station rainfall record was set on Thanksgiving Day for the greatest amount in a calendar day, 7.41 inches. A deluge of 4.87 inches of rain fell between midnight and 3 AM on the 22nd. The weather office at West Palm Beach also measured an event total of 11.29 inches for the period of November 21 through 24. Due to the heavy rains, significant freshwater flooding occurred over the eastern parts of Palm Beach, Martin, St. Lucie and Indian River counties. Over 100 residents in low-lying areas of Palm Beach county were evacuated due to the flooding on Thanksgiving morning.

5. Conclusion

The Thanksgiving Holiday Storm was a very disruptive weather event over a large portion of coastal eastern Florida. This points out the vulnerability of coastal inhabitants to severe beach erosion and flooding produced by strong onshore winds and much above normal high tides. This is definitely a serious problem along the east coast of Florida which poses a threat to life and property.

The weather service forecast office (WSFO) in Miami recognized the problem in their state forecast discussions issued at 4 PM

Tuesday and Wednesday, November 20 and 21. It was emphasized that the synoptic weather pattern indicated a significant weather event was probably going to happen within 36 hours in Florida. It was recognized that the upper level trough would strengthen significantly as it moved southeastward over Florida, and this would cause the development of a surface low pressure system that would cause a strong pressure gradient over Florida resulting in gale force winds. This could then result in some degree of coastal flooding and beach erosion along the coast.

The WSFO in Miami and the other affected weather service offices (WSO) in Florida handled the warnings and statements issued to the public in the usual manner for extratropical winter storms. An extratropical storm being a storm that does not exhibit tropical characteristics. The WSFO Miami put gale warnings into effect from Savannah to Cape Canaveral Wednesday morning the 21st. Small craft advisories were already in effect for the entire coast of Florida and Georgia. A coastal flood warning was issued by the WSFO Friday morning, the 23rd, from Flagler Beach to Boca Raton. Follow-up statements about the progress of the storm including emphasis on the warnings and appropriate safety actions to be taken were issued by the WSOs of Jacksonville, Daytona Beach, West Palm Beach and the WSFO at Miami.

This storm did produce more coastal damage to buildings, parking lots, piers, dune walkovers, highways, seawalls, revetments, and bulkheads, not to mention the greatest loss in the form of sand removal from beaches, dune lines and even sections of barrier islands, than any recent storm, hurricane or extratropical storm, to affect the entire east coast of Florida. Why did this storm cause so much damage? The following factors contributed to the severity of the Thanksgiving Holiday Storm.

The storm formed at an extremely low latitude. Few extratropical low pressure systems ever reach the intensity that this storm reached at the latitude of 27N. Usually low pressure systems of this type that form off the southeast coast of Florida move out into the Atlantic Ocean before they intensify. This particualr system formed over the Straits of Florida between Florida and Grand Bahama Island early on the 22nd as a wave on the front. The storm reached its maximum intensity about 30 hours later, the afternoon of the 23rd, still in about the same location. It was not until 24 hours after the peak of the storm that the system began to move away from the coast.

The intensity to which the low pressure system reached was very unusual for that low latitude for an extratropical system. Rarely do nontropical low pressure systems reach a pressure of 1000 mb (29.53 inches) off the southeast coast of Florida. At the same time that the low was developing near Grand Bahama Island, the high pressure system over the eastern U.S. was moving southeast, causing the large pressure gradient between the low center and the high center. It is this difference in pressure or the pressure gradient that causes the strength of the wind. At the height of the storm, the pressure gradient between Jacksonville

and the center of the storm over Grand Bahama Island was 19 millibars. Winds computed from this pressure gradient are about 75 miles an hour, which reduced for friction would be 60 miles an hour. As noted earlier, wind gusts were reported at 60 miles an hour.

Another factor was that these strong onshore winds continued for many days. Winds of near gale force (about 40 miles an hour) began blowing along the north Florida coast the evening of the 20th. They did not subside until late on the 24th. Therefore, much of Florida experienced strong onshore winds for about 4 whole days. These winds were frequently between 30 and 40 miles an hour. The direction of the winds was from the north northeast which is probably the best angle of incidence for beach erosion along the coast from Fernandina Beach to Palm Beach. The coastline south of Palm Beach was spared from most of the adverse effects of the storm because the wind was actually blowing offshore throughout much of the storm. However, this northwest wind caused significant damage to the coastlines of the western Bahama Islands Friday and Saturday. This was all due to the position of the storm center remaining over Grand Bahama Island from early Thursday morning through early Saturday.

As noted earlier, the time of the month that the storm occurred was coincident with the highest astronomical tides of the month and nearly the highst spring tide of the year. Tide tables indicated that the highest predicted tides for the month of November fell on the mornings of the 22nd and the 23rd, exactly during the time of the highest storm tide. Reports from the storm survey teams of the Florida Department of Natural Resources indicate that the storm tide was over 6 feet above low mean water. Tide gage readings at Mayport were 7.5 feet above mean low water or 5.2 feet above mean sea level.

The one factor of the storm episode which magnified the entire situation was the nearly stationary nature of the storm for 3 days. This lack of movement produced the prolonged onshore winds which resulted in at least 4 days of heavy surf pounding the shore. Portions of the coastline experienced 9 high tides during this period, with each succeeding high tide higher than the previous one, thus making the erosion of sand greater with each tide. These are the reasons for the extensive damage that resulted from this particular storm.

Post-storm investigation indicated that even through the Weather Service had gale warnings in effect for the marine community prior to the event, and that the possibility of beach erosion and coastal flooding was headlined in public forecasts, state and local officials as well as local residents were not made aware of the seriousness of the situation. There are several reasons for this. Number one, a storm of this magnitude had not affected the state of Florida in recent history, maybe never before. Number two, gale warnings, beach erosion and coastal flooding forecasts have occurred in recent years when no significant damage has

occurred. Number three, residents of Florida are attuned to the hurricane problem during the hurricane season, but are not aware of the problems that extratropical storms in the winter can cause to the coastal areas. In future events, the National Weather Service should attempt to make the officials aware of the potential threat to coastal areas from extratropical storms. This can be accomplished to some degree by increased efforts with preparedness talks and other educational presentations. Particular attention should be given to issuing appropriate gale warnings and even storm warnings during the winter storm situations. Extra care should be given to attempt to provide early warnings of coastal flooding or erosion by the use of coastal flood watches followed by coastal flood warnings as the situations develop. However, one of the most important things besides early recognition of the coastal problem, is the close working relationships between state and county civil defense officials and the National Weather Service.

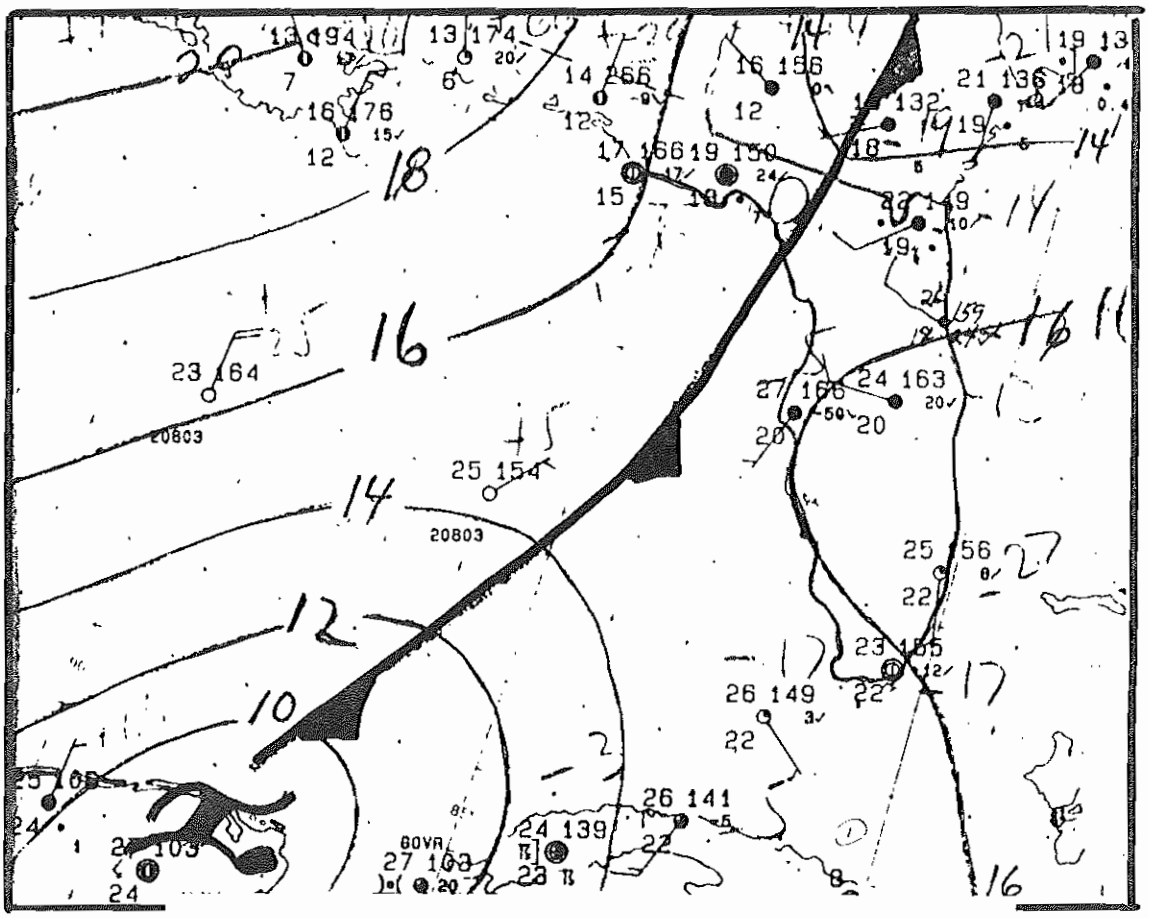

Figure 1. Surface Anaylsis.
7:00 PM EST, November 19, 1984.

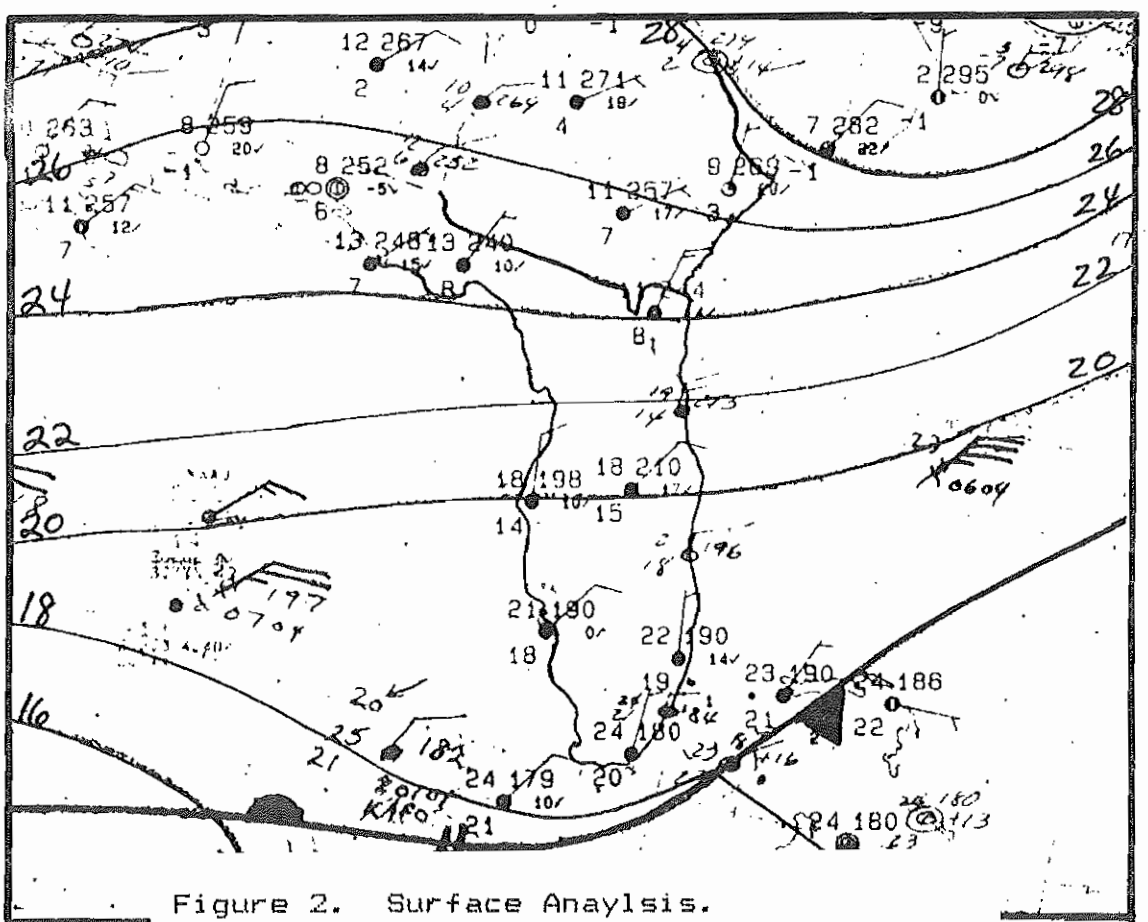

Figure 2. Surface Anaylsis.
7:00 PM EST, November 20, 1984.

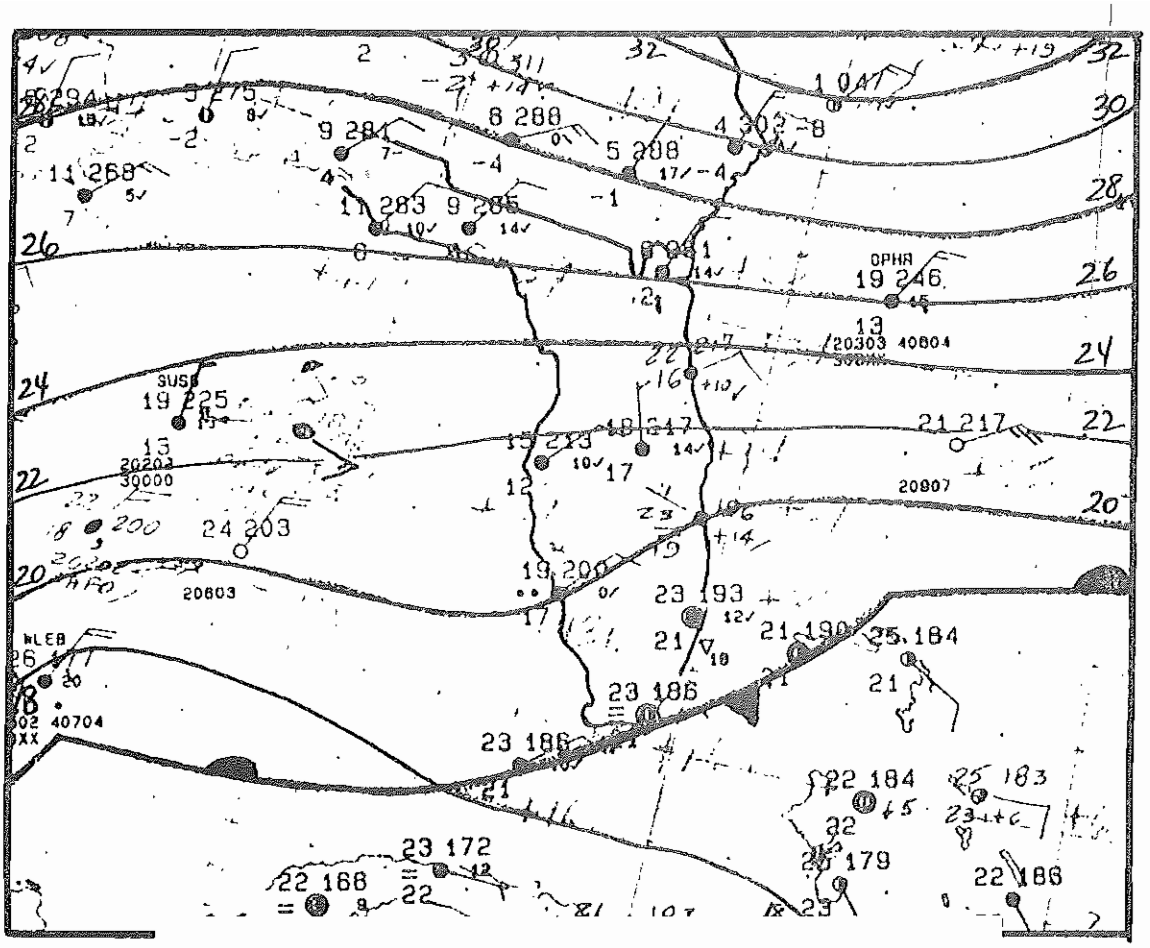

Figure 3. Surface Analysis.
7:00 AM EST, November 21, 1984.

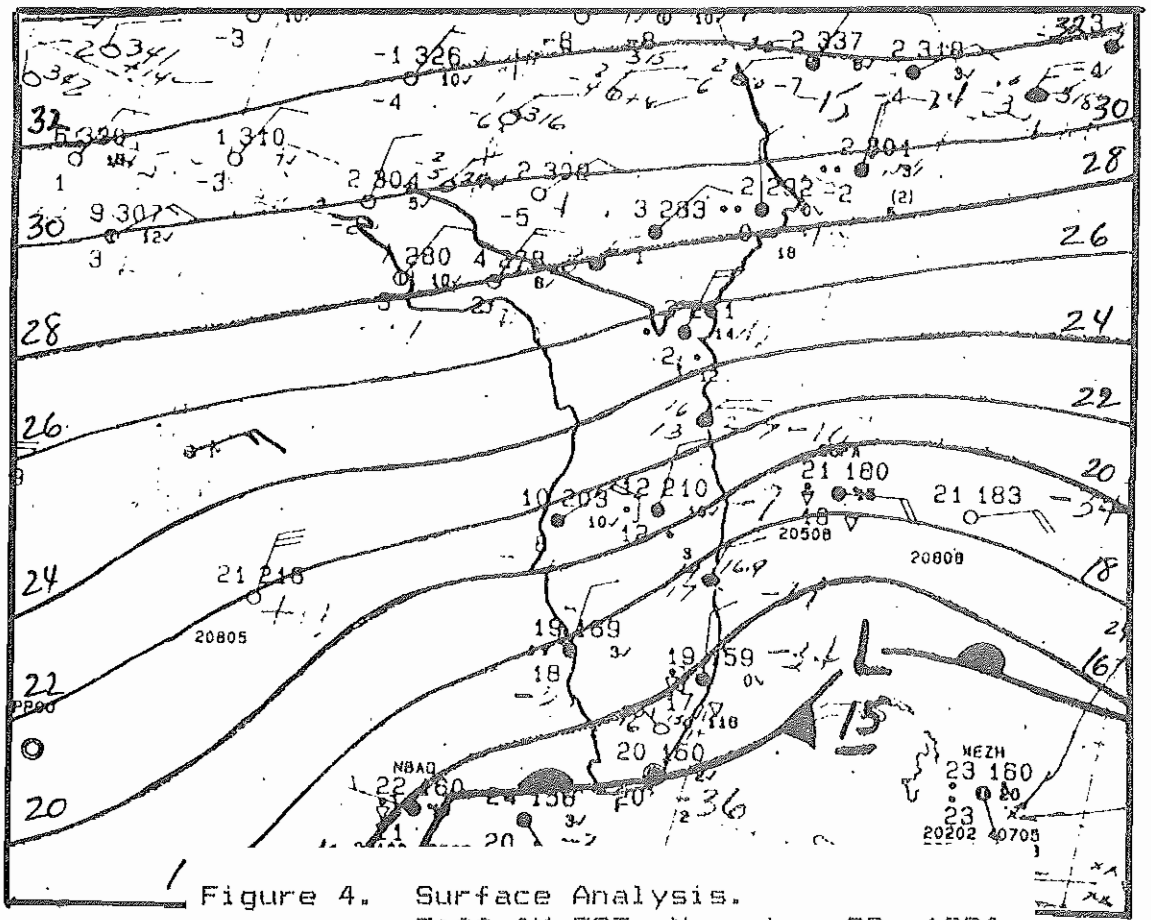

Figure 4. Surface Analysis.
7:00 AM EST, November 22, 1984.

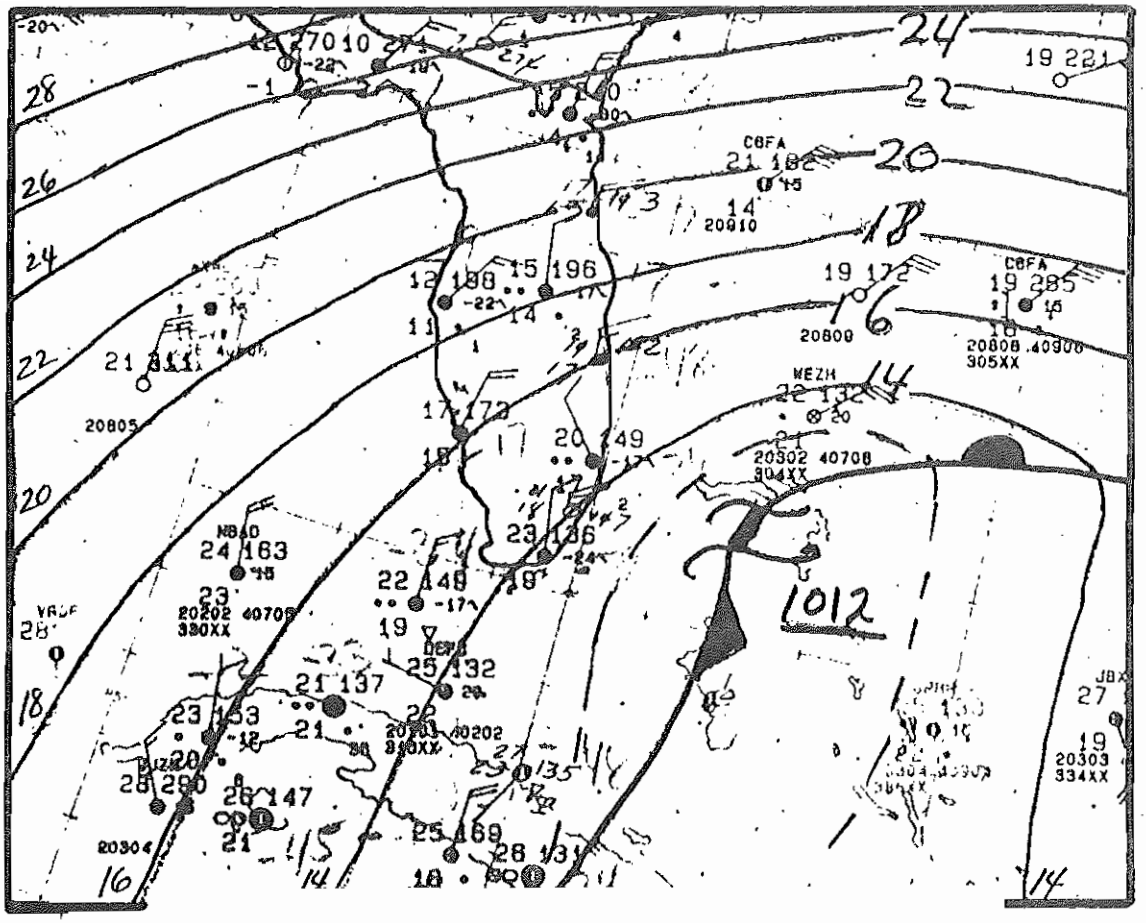

Figure 5. Surface Analysis.
1:00 PM EST, November 22, 1984.

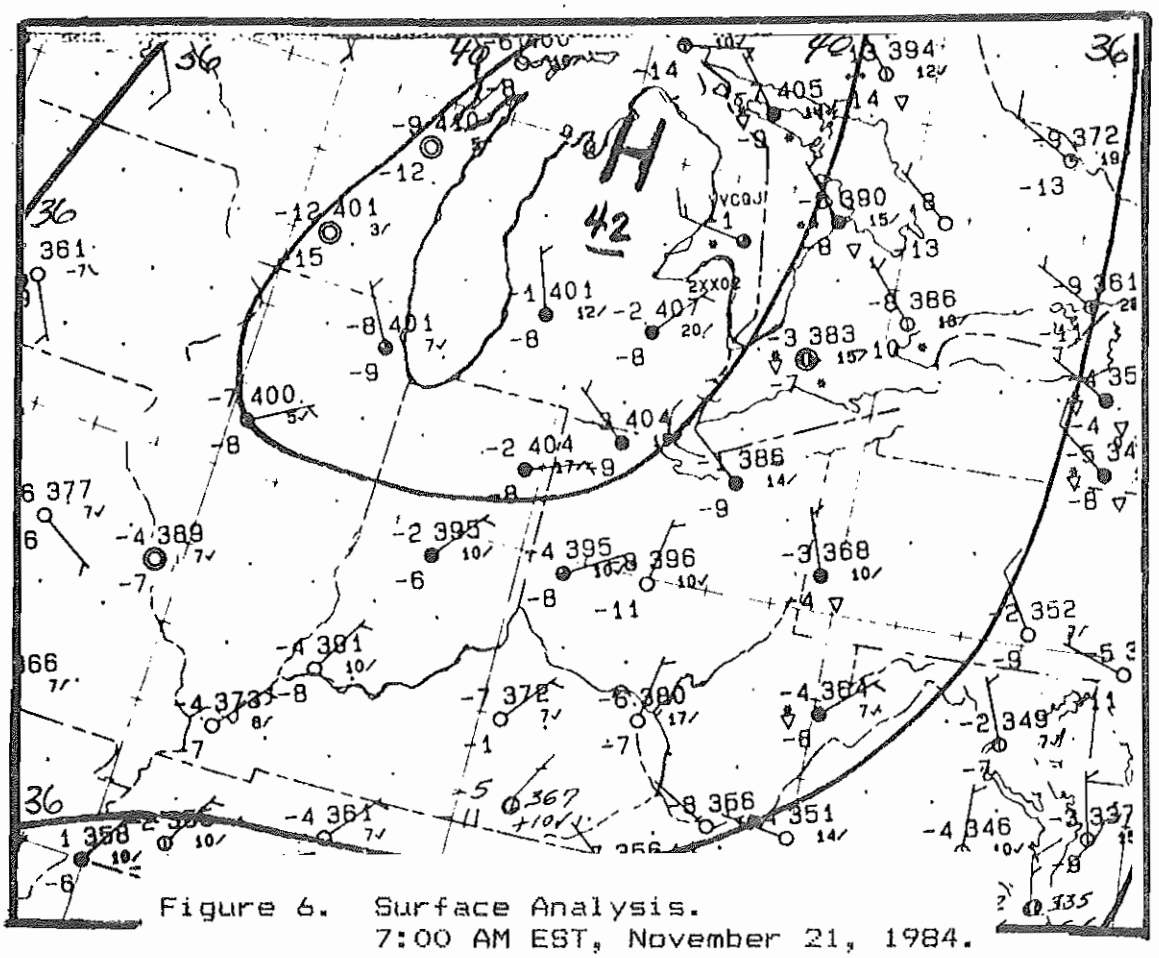

Figure 6. Surface Analysis.
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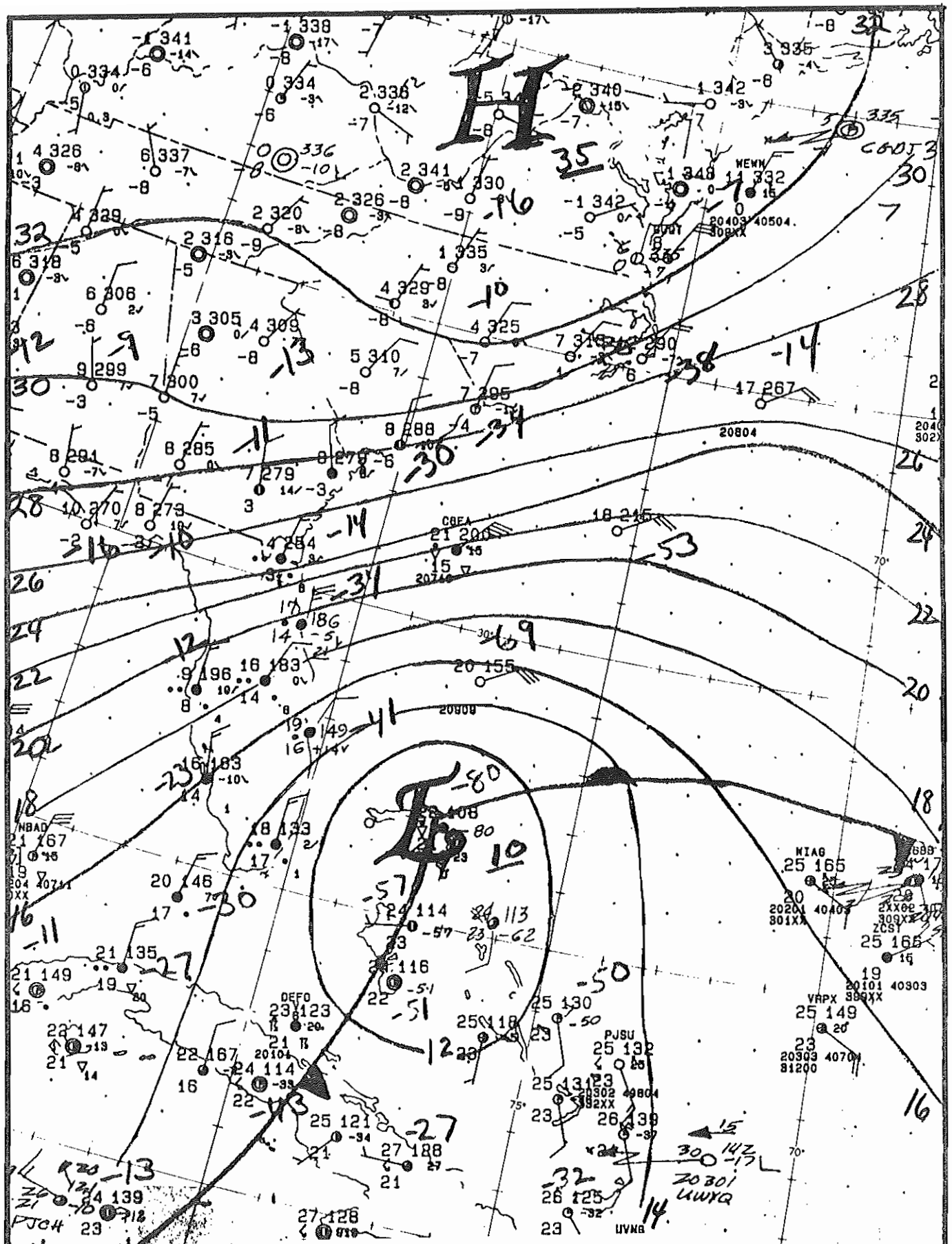

Figure 7. Surface Analysis.
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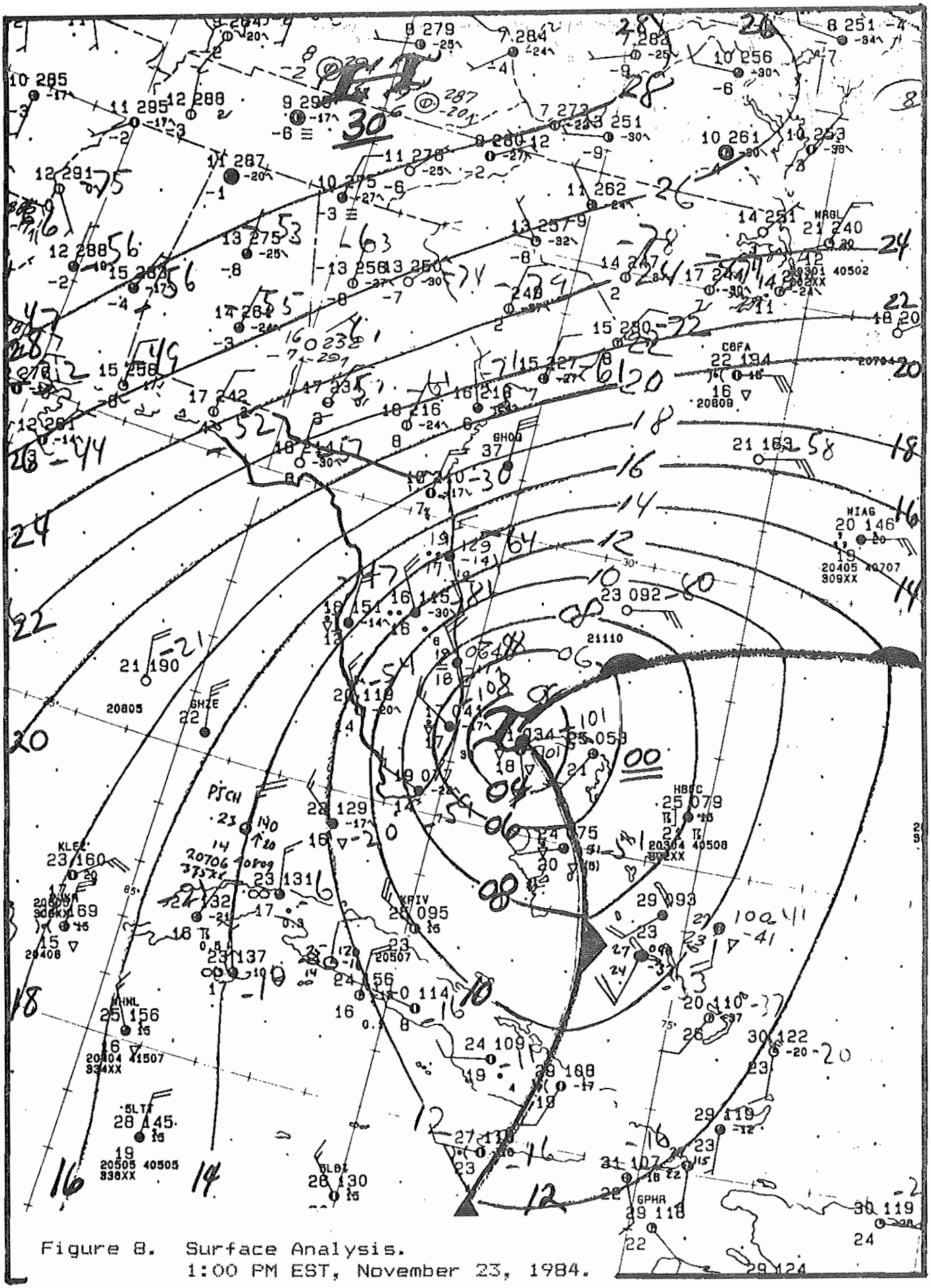

Figure 8. Surface Analysis.
1:00 PM EST, November 23, 1984.

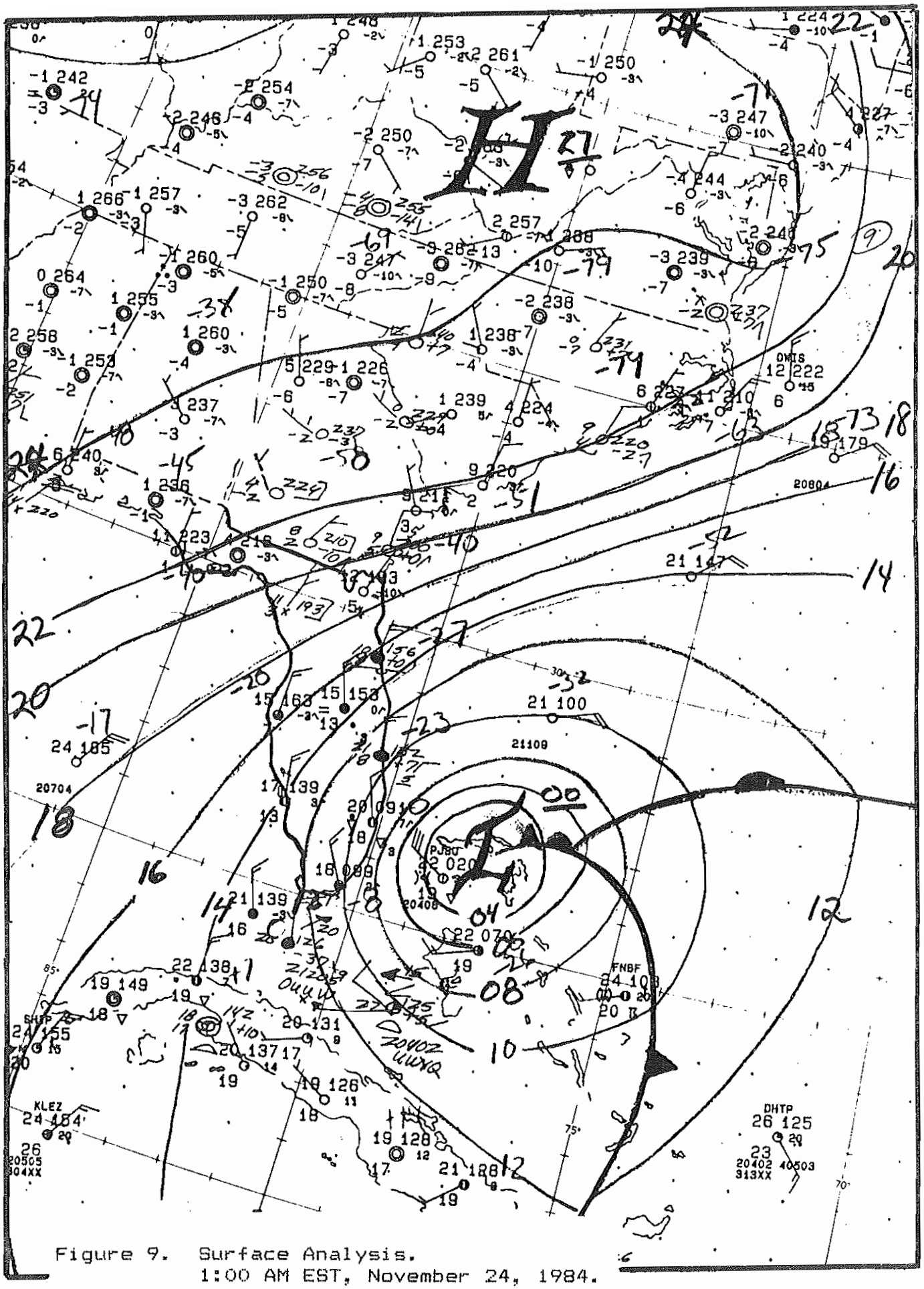

Figure 9. Surface Analysis.
1:00 AM EST, November 24, 1984.

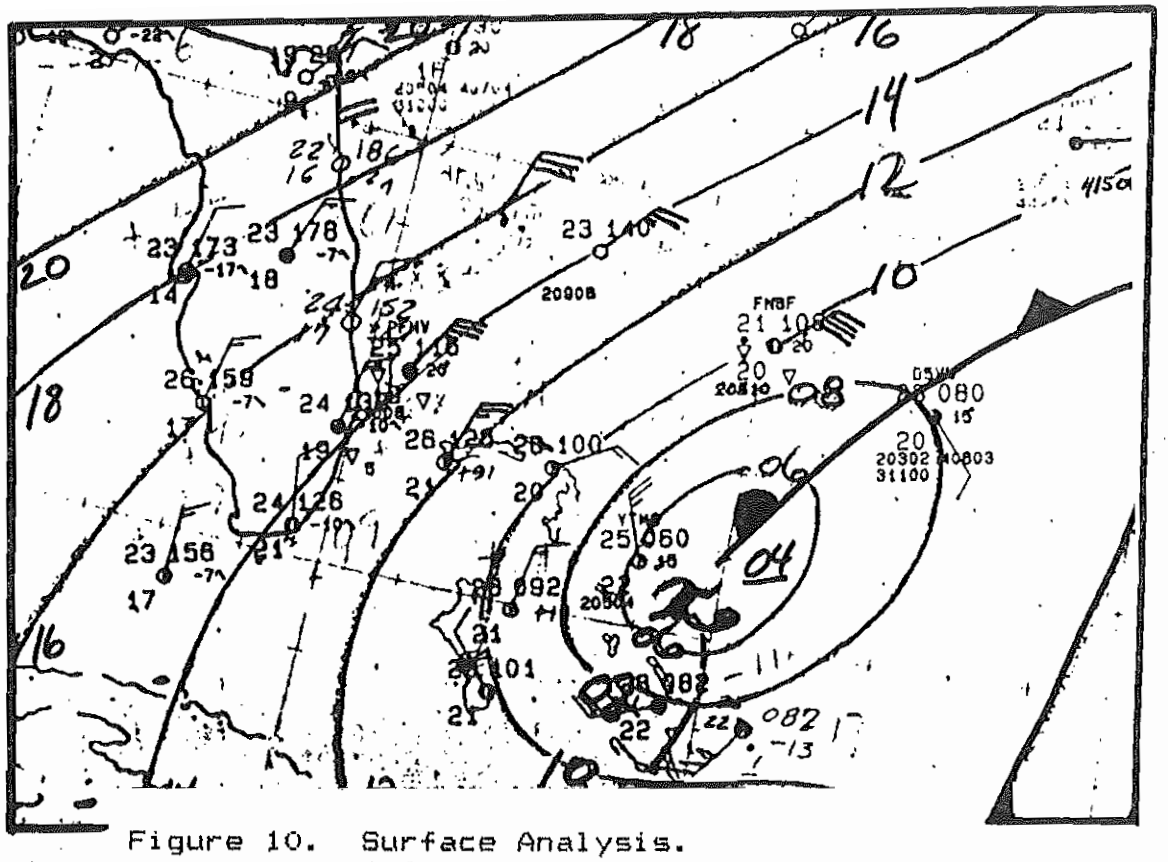

Figure 10. Surface Analysis.
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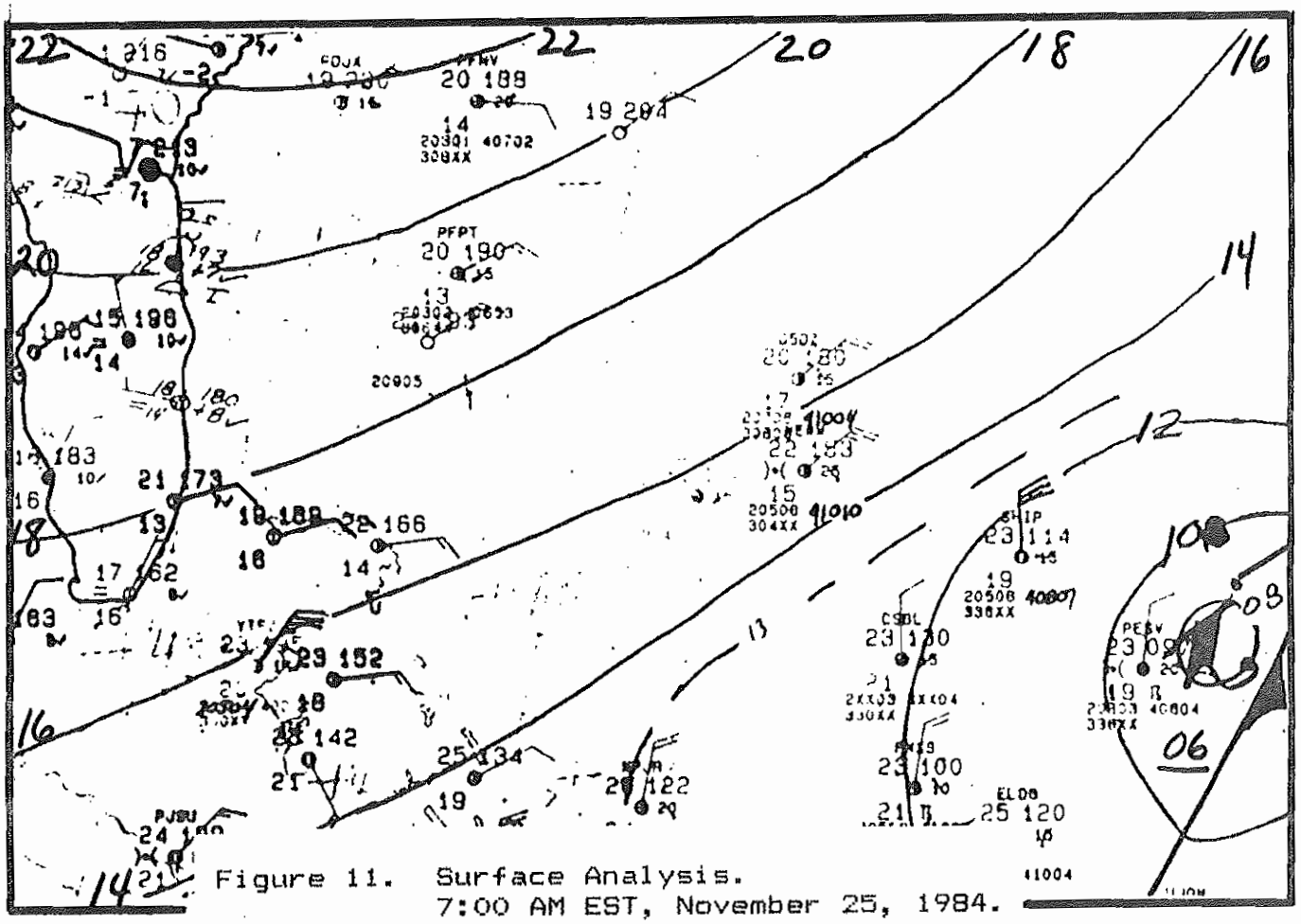

Figure 11. Surface Analysis.
7:00 AM EST, November 25, 1984.

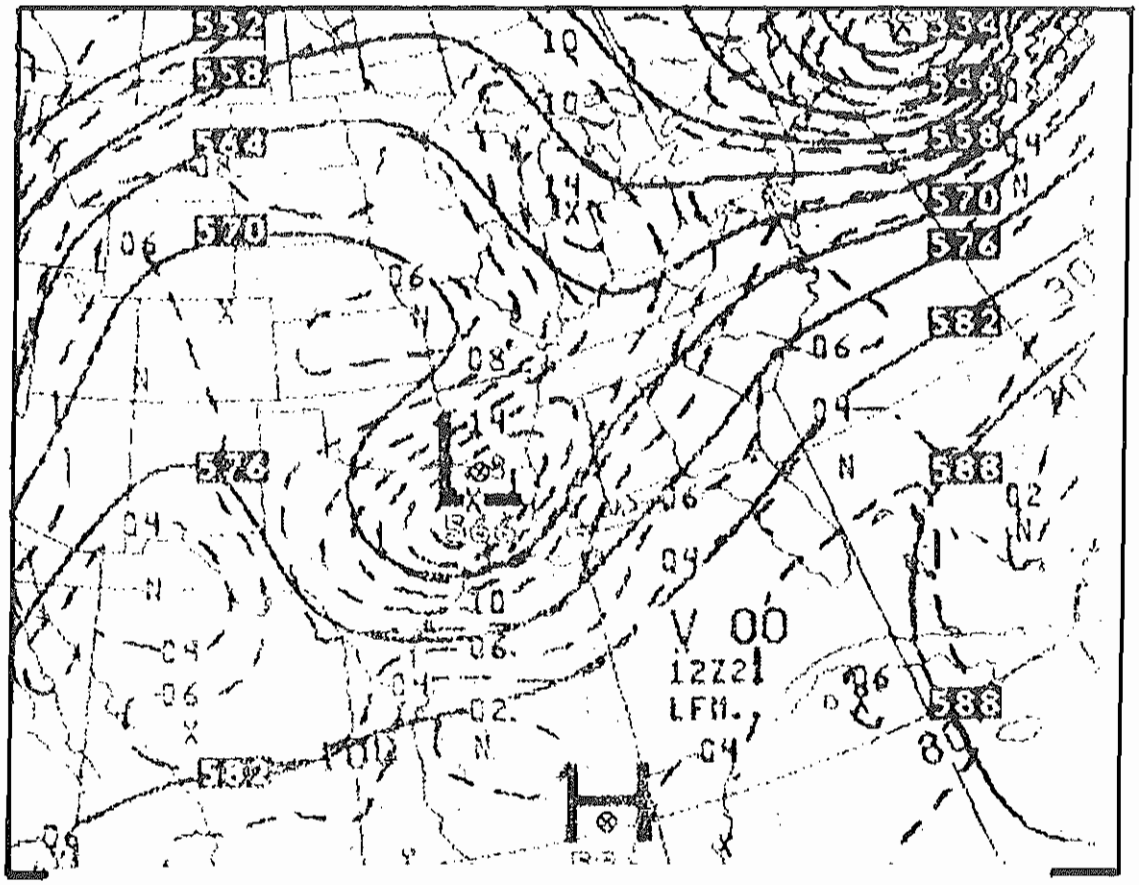

Figure 12. LFM 500 mb Heights/Vorticity Analysis.
7:00 AM EST, November 21, 1984.

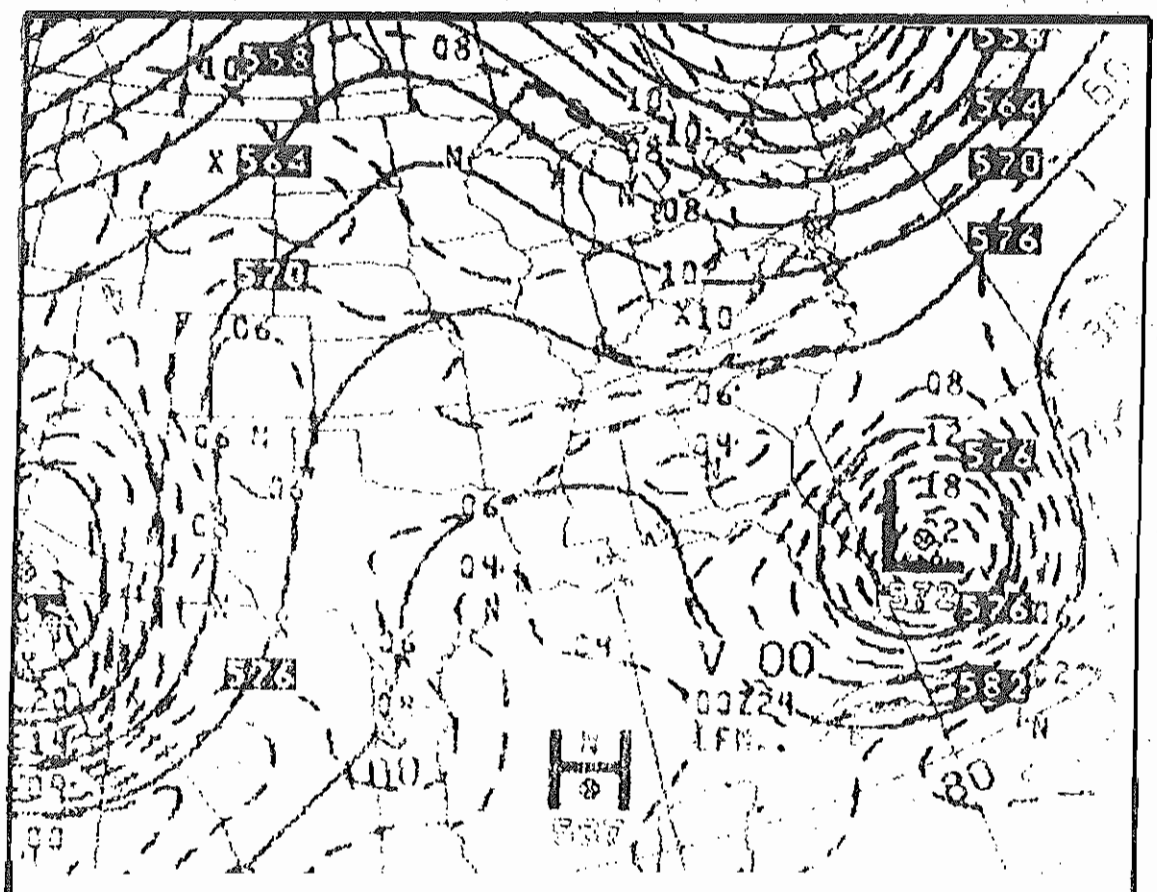

Figure 13. LFM 500 mb Heights/Vorticity Analysis.
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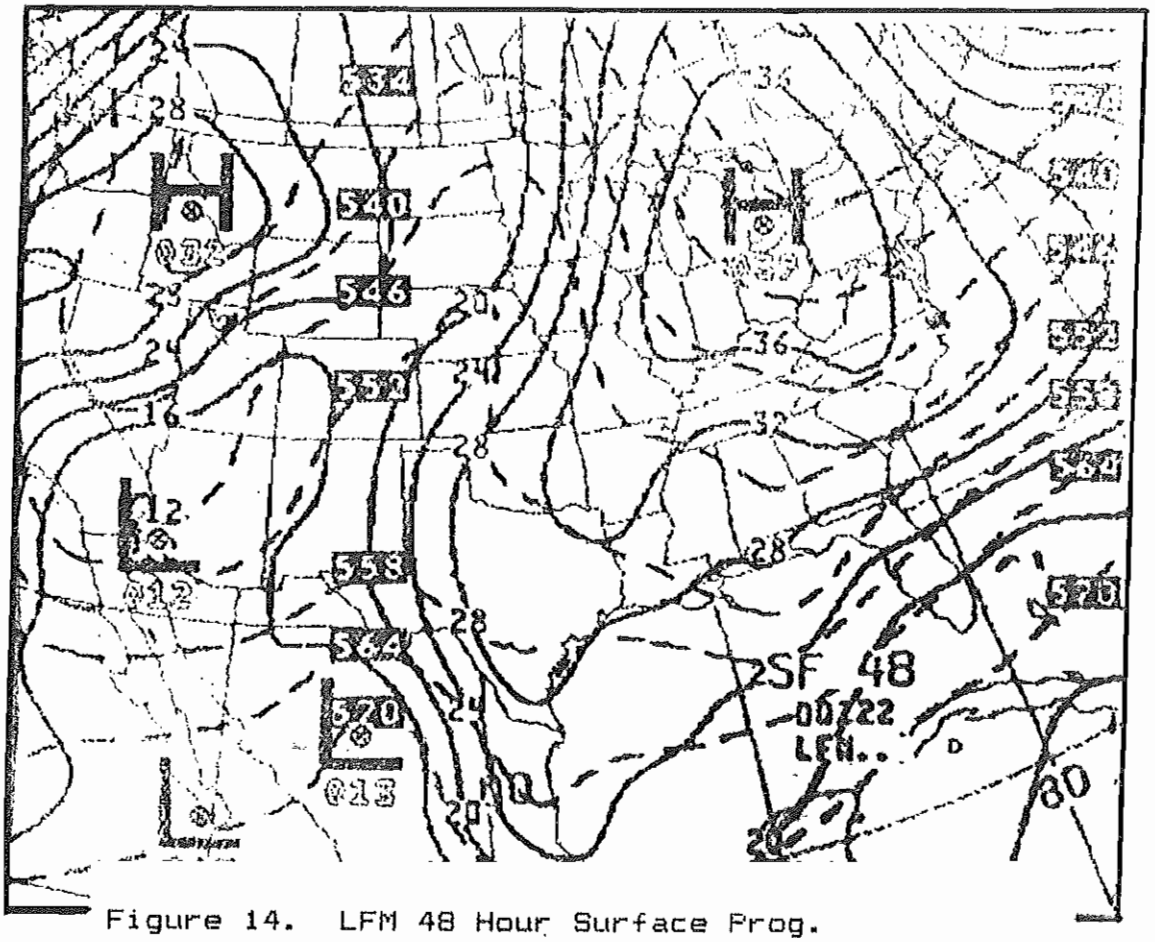

Figure 14. LFM 48 Hour Surface Prog.
Valid 7:00 PM EST, November 21, 1984.

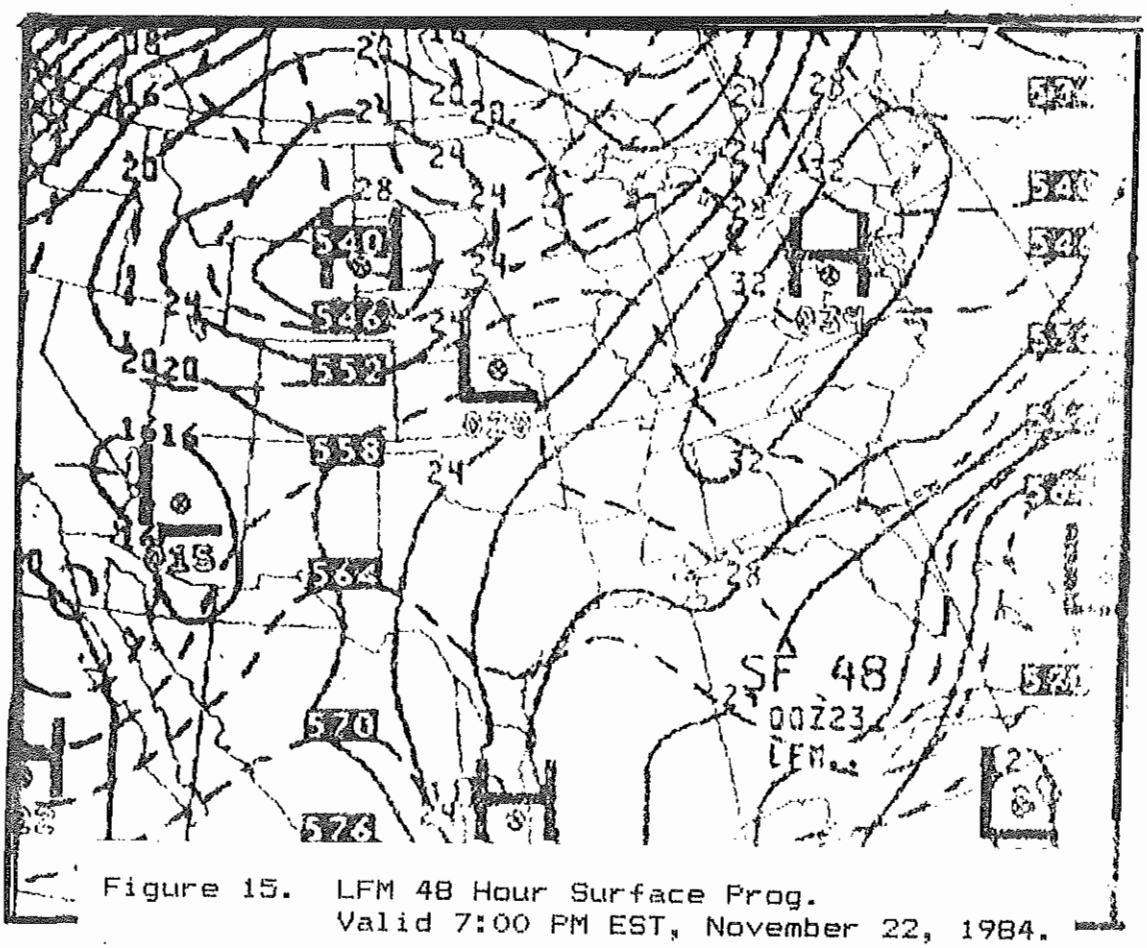

Figure 15. LFM 48 Hour Surface Prog.
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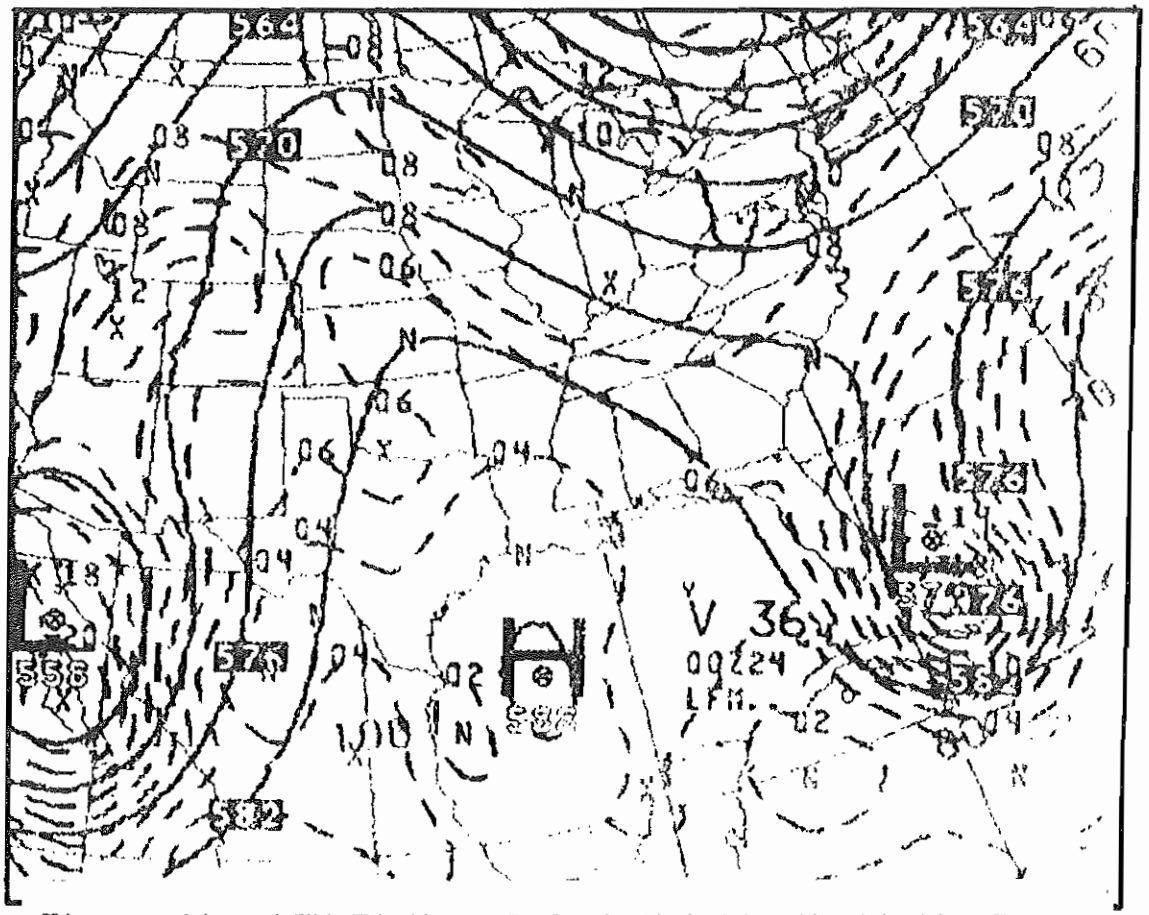


Figure 16. LFM 36 Hour 500 mb Heights/Vorticity Prog.
Valid 7:00 PM EST, November 23, 1984.

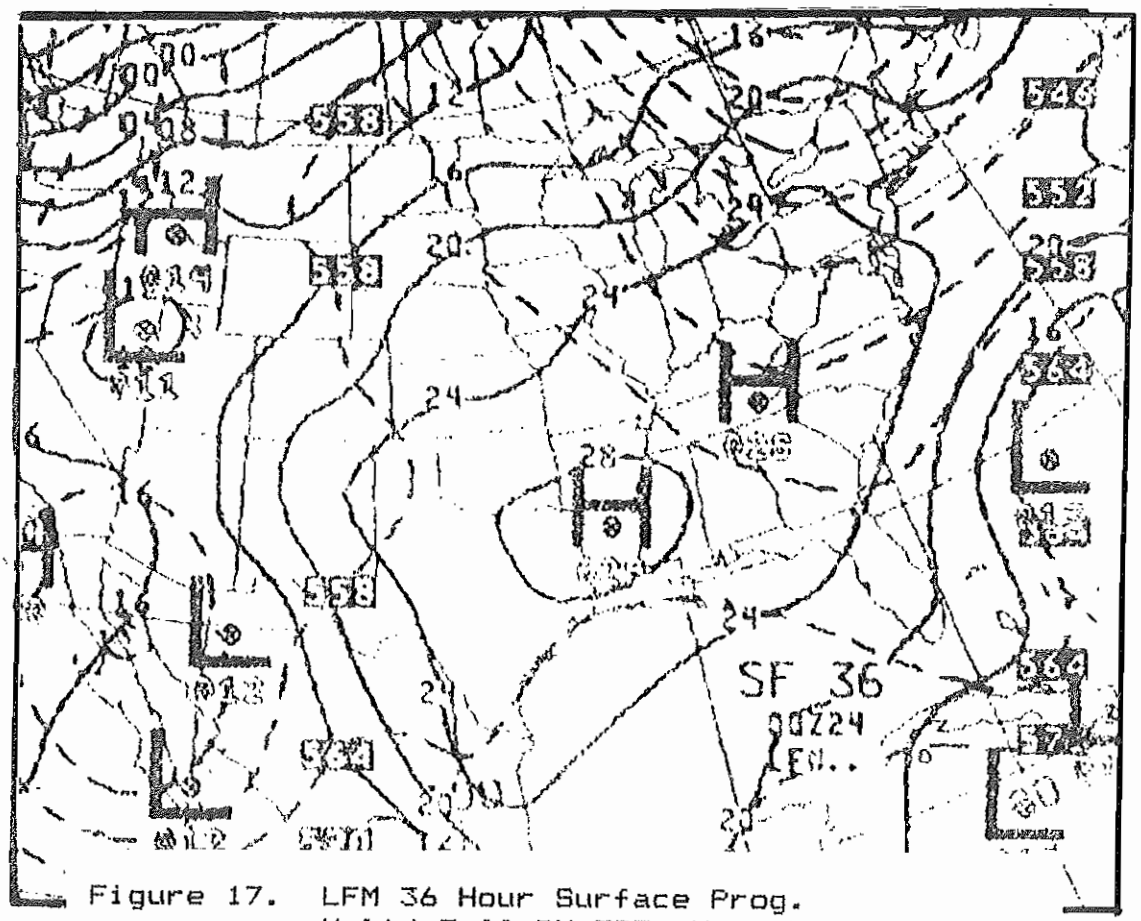


Figure 17. LFM 36 Hour Surface Prog.
Valid 7:00 PM EST, November 23, 1984.

DAMAGE ASSESSMENTS*
THANKSGIVING STORM
NOVEMBER 21-24, 1984

COUNTY	TOTAL	PUBLIC	PRIVATE
NASSAU	0		
DUVAL	0		
ST. JOHNS	619,319	357,319	262,000
FLAGLER	302,000	302,000	(UNKNOWN)
VOLUSIA	1,546,266	773,199	773,067
BREVARD	1,667,432	1,177,432	490,000
INDIAN RIVER	2,628,527	196,827	2,431,700
ST. LUCIE	5,000	5,000	(UNKNOWN)
MARTIN	56,500	56,500	(UNKNOWN)
PALM BEACH	1,031,695	682,250	349,445
BROWARD	0		
DADE	0		
STATE PROPERTY	291,500	291,500	
TOTAL	8,148,239	3,842,027	4,306,212

* DAMAGE ASSESSMENT DOES NOT INCLUDE EROSION ESTIMATES

Figure 18. Damage assessments for individual counties. .

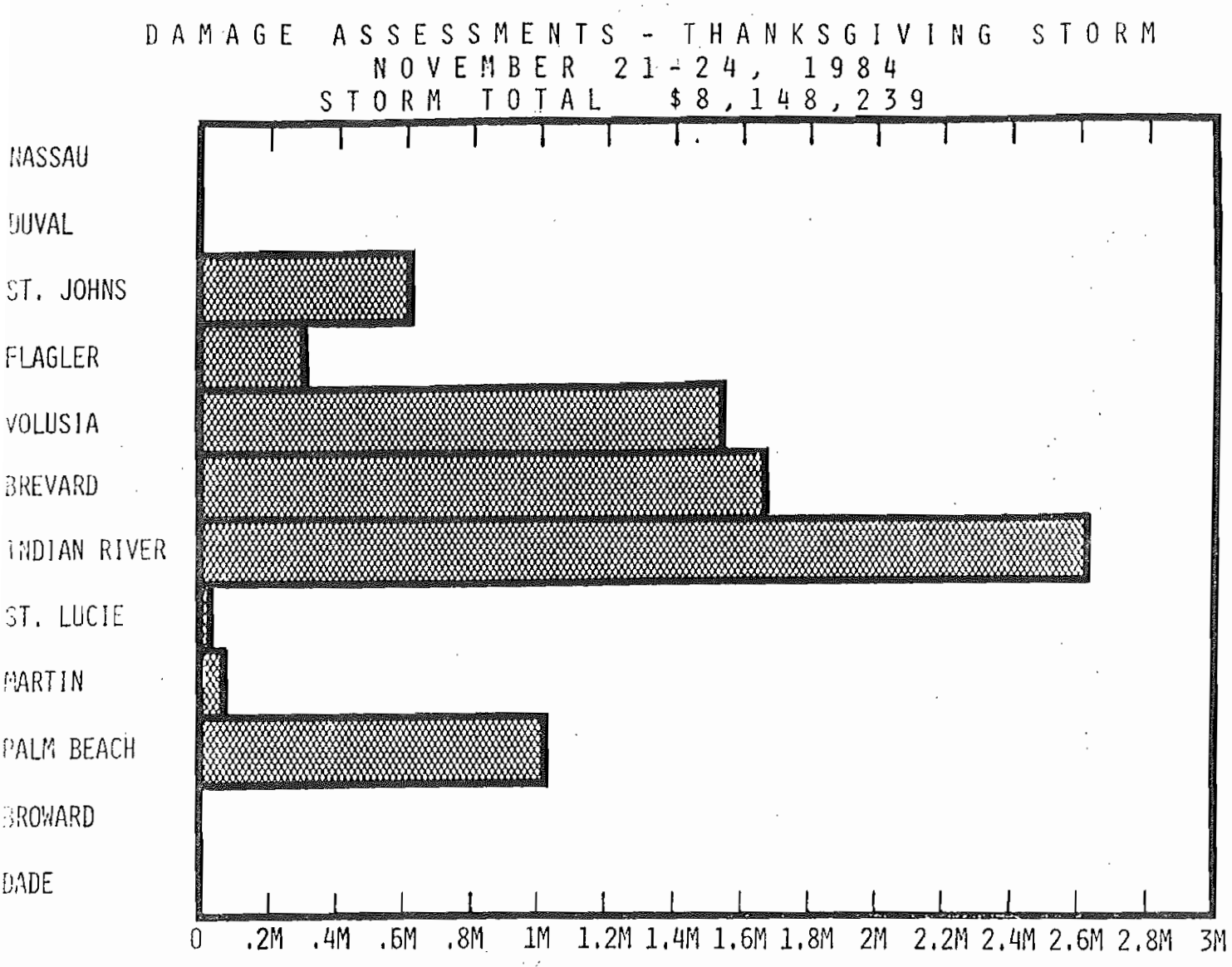
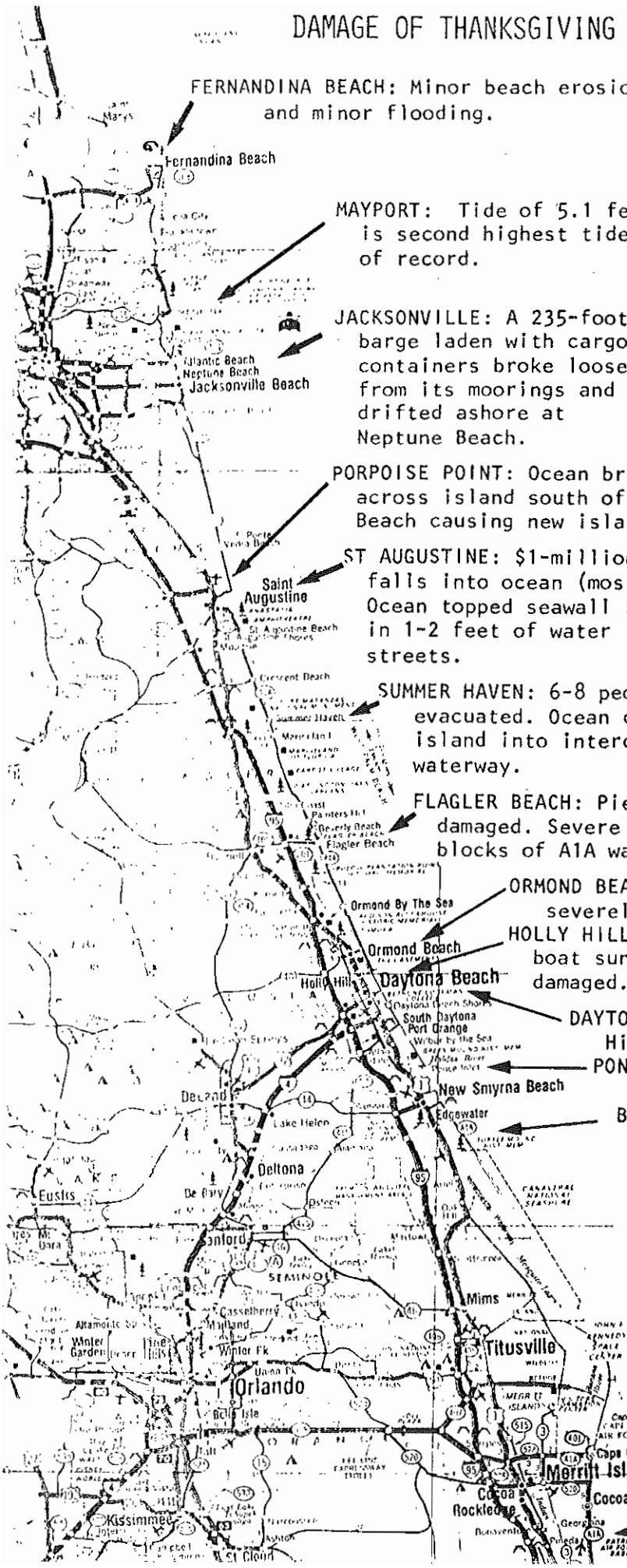


Figure 19. Graphical depiction of damage assessments by county.

DAMAGE OF THANKSGIVING 1984 COASTAL "STORM"



FERNANDINA BEACH: Minor beach erosion and minor flooding.

MAYPORT: Tide of 5.1 feet MSL is second highest tide of record.

JACKSONVILLE: A 235-foot barge laden with cargo containers broke loose from its moorings and drifted ashore at Neptune Beach.

PORPOISE POINT: Ocean breeched across island south of Vilano Beach causing new island.

ST AUGUSTINE: $1-million pier falls into ocean (most of it) Ocean topped seawall resulting in 1-2 feet of water in streets.

SUMMER HAVEN: 6-8 people evacuated. Ocean crossed island into intercoastal waterway.

FLAGLER BEACH: Pier severely damaged. Severe erosion, 8 blocks of A1A washed out.

ORMOND BEACH: Pier severely damaged.

HOLLY HILL: Flooding boat sunk, docks damaged.

DAYTONA BEACH: Tide estimated at 6 feet MSL. Highest in last 30 years.

PONCE DE LEON INLET: Jetty light washed out. Channel unidentifiable.

BETHUME BEACH: Flooding, severe erosion, beach road closed, 30 homes damaged.

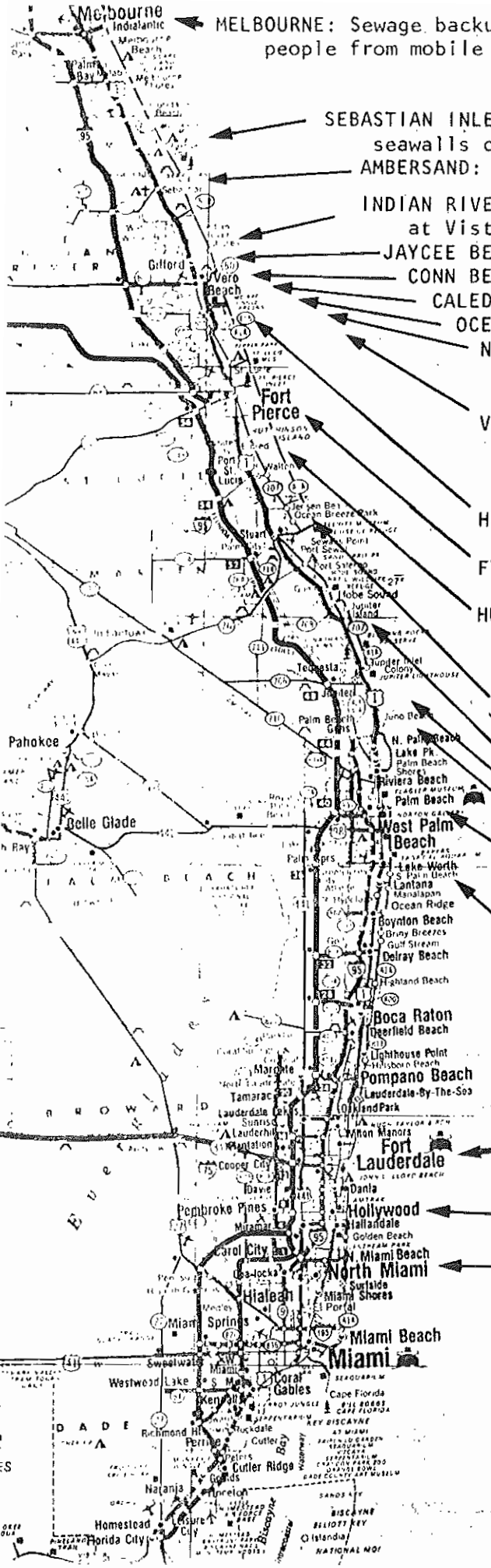
COCOA BEACH: Two-story apartment building at Pelican Landing severely damaged.

PATRICK AFB: A1A closed due to water on northbound lane.

GENERAL DETAILS

* Between St Augustine and Boca Raton, 20-50 feet of beach eroded in many sections.
* Tides 4-6 ft above MSL and 20-foot waves pounded the coast.
* Many marinas and yacht clubs received extensive damage.
* Waves topped sand dunes, cutting through the dunes with Atlantic waters flowing into Intercoastal Waterway.
* Dune walk-overs damaged or destroyed, or dunes washed away from under the walk-overs.
* Seawalls topped and undermined; many sections destroyed.
* Tons of debris desposited on what remained of the beaches.
* Boardwalks in many areas undermined and many section destroyed.
* Heavy rains and high tides caused flooding of streets, canals, homes and businesses.
* Numerous power and telephone outages.

Figure 20. Detailed listing of the damage reports along upper Florida coast.



MELBOURNE: Sewage backup causes evacuation of 200 people from mobile home park.

SEBASTIAN INLET: $1.2-million damage to inlet. Jetty damaged, seawalls collapsed.

AMBERSAND: Revegetated dune destroyed.

INDIAN RIVER SHORES: Patio and steps collapsed into the ocean at Vista Del Mar.

JAYCEE BEACH: Recent renovation work of beach destroyed.

CONN BEACH: Boardwalk damaged, severe erosion, beach closed.

CALEDON SHORES: Severe erosion.

OCEAN GATE: Flooding of buildings.

NORTH VERO BEACH: House partially collapsed. Seawalls collapsed. Erosion 10-15 feet behind seawall. Aquarius Motel: portions of building collapsed

VERO BEACH: 1000 coastal residents told to evacuate. Floor of Ocean Grill restaurant collapses into ocean. Holiday Inn: seawall collapsed. Sexton Plaza: parking lot caved in.

HUMISTON BEACH: Shoreline crumbled, boardwalk separated from pake. Pattric's Pizza Palor badly undermined.

FT PIERCE SOUTH BEACH: Ocean Village Condo project under water for three days.

HUTCHINSON ISLAND: Holiday Inn Oceanside severely damaged: patio and pool area. Erosion right up to building walls Widespread flooding with up to 3 feet of water in buildings.

JENSEN BEACH: 1000-gallon propane tank moved 2 miles from original location on dune line on Hutchinson Island.

JUPITER ISLAND: Several homes damaged. Boulder revetments moved by waves.

JUPITER INLET: Parking lot caves in.

JUNO BEACH: 34-year old pier destroyed. Man electrocuted by downed power line.

PALM BEACH: About 70 homes flooded. Freighter washes up to mansion. Part of A1A washed away. Seawall damaged.

LAKE WORTH: Tide of 4.7 feet MSL highest in recent history. Two-story house boat capsized.

FORT LAUDERDALE: A1A flooded over at least a 5 block area.

HOLLYWOOD: Only minor beach erosion.

NORTH MIAMI BEACH: Flooding of Collins Ave. in Golden Beach area.

Figure 21. Detailed listing of the damage reports along lower Florida coast.

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