U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Weather Service

NOAA Technical Memorandum NWS TM SR-52

# A STUDY OF FUNNEL CLOUD OCCURRENCES IN THE BEAUMONT-PORT ARTHUR-ORANGE AREA IN TEXAS

SOUTHERN REGION HEADQUARTERS
SCIENTIFIC SERVICES DIVISION
FORT WORTH, TEXAS
January 1971

## ABSTRACT

Statistical information on funnels aloft in the Beaumont-Port Arthur-Orange, Texas area was gathered for the 20 year period from 1950 to 1969. The majority of the funnel cloud activity was found to occur during the late spring, summer, and early autumn months with the peak occurring during July. Most funnels occurred during the day and 83% never touched ground. Synoptic conditions were examined and a rough "rule of thumb" stated for funnel cloud study in the Port Arthur area.

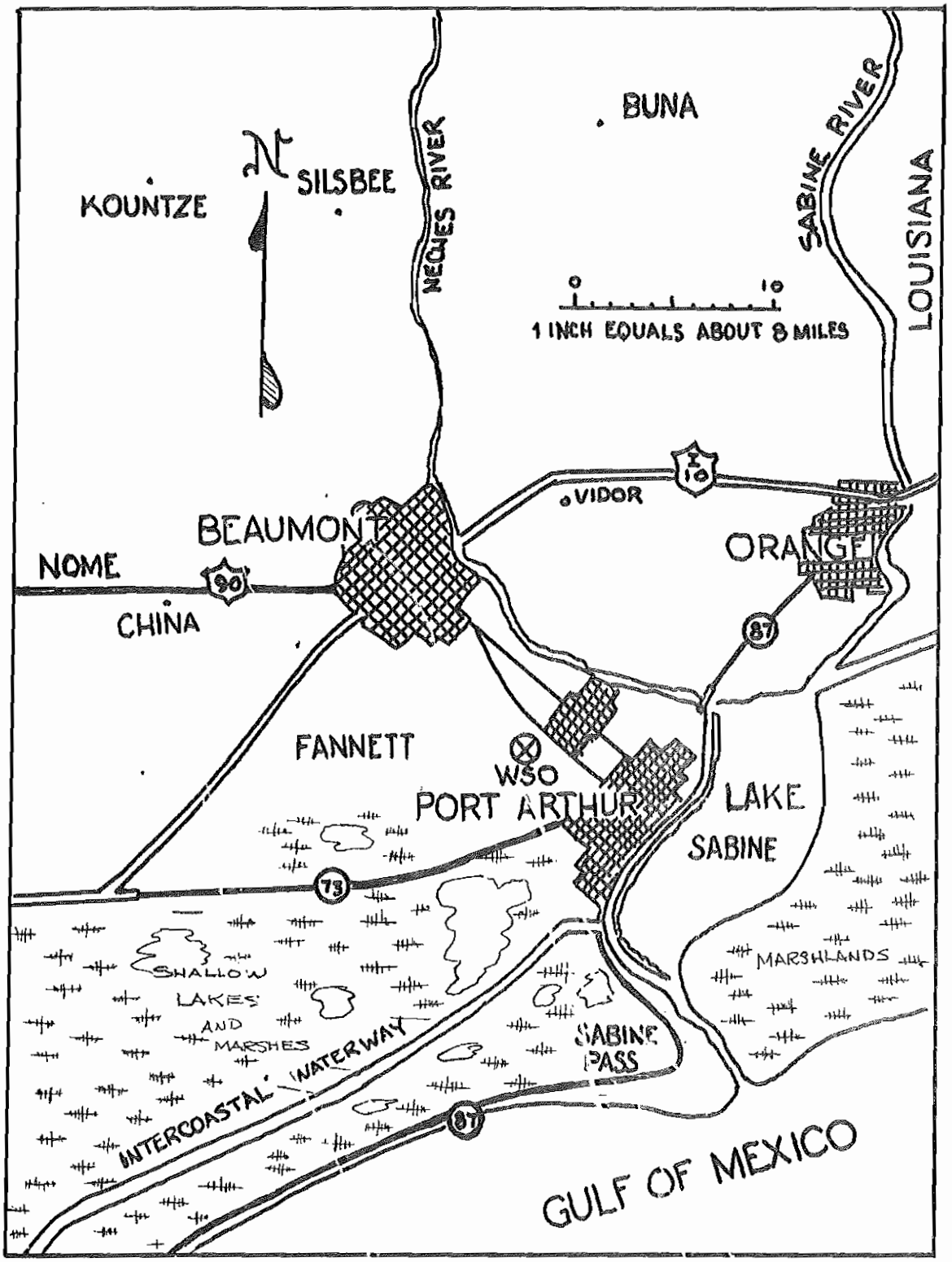

BUNA
SILSBEE
KOUNTZE
NECHES RIVER
SABINE RIVER
LOUISIANA
0 10
1 INCH EQUALS ABOUT 8 MILES
I 10
VIDOR
BEAUMONT
ORANGE
NOME
90
CHINA
87
FANNETT
WSO
PORT ARTHUR
LAKE
SABINE
73
MARSHLANDS
SHALLOW
LAKES
AND
MARSHES
INTERCOASTAL WATERWAY
SABINE
PASS
87
GULF OF MEXICO

FIG. 1

# A STUDY OF FUNNEL CLOUD OCCURRENCES IN THE BEAUMONT-PORT ARTHUR-ORANGE AREA IN TEXAS

Carlos Garza, Jr., WSO, Port Arthur

## INTRODUCTION

In the extreme southeastern corner of Texas lies an oil-rich area bounded by Beaumont, Port Arthur, and Orange, which includes many smaller communities surrounding and within the immediate vicinity (Fig. 1). During the past few years there has been considerable interest in this area in the subject of funnel clouds (Fig. 2). While numerous studies have been conducted in the field of tornadoes, violent storms, and even waterspouts, it is unfortunate that very little information exists concerning funnels aloft resulting from seemingly stable, fair weather conditions.

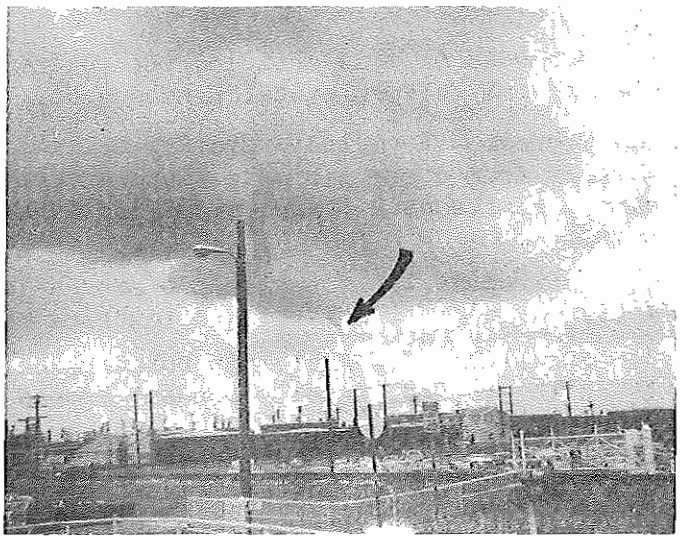


Figure 2. Funnel sighted in the vicinity of Gulf Refineries in Port Arthur (1970). (Photograph courtesy of Mr. D. W. Landry)

The closest related studies that have been conducted are those on the Florida Keys' waterspouts by Gerald H. Clemons (1968) and Joseph H. Golden (1968, 1969). It appears that waterspout activity to the people of the Keys is just as common as funnel cloud activity is to the people of the Beaumont-Port Arthur-Orange area. The author does not mean to imply that these funnels aloft are limited to this area, because they are not. However, they do vary in frequency of occurrence along the coastal sections of the Gulf of Mexico from a rare appearance in the vicinity of Brownsville, Texas to the fairly common occurrence in the Port Arthur area and the common occurrence in the Florida region. Waterspouts vary from the fairly common occurrence in the Texas coastal sections to the very common occurrence in the Florida Keys area.

In this article the more physical and statistical aspects of the subject will be presented and the theoretical studies will be left for future and more intensive research. The data used for this study were obtained from the records of the Weather Service Office, located at Jefferson County Airport, which is in the heart of the Beaumont-Port Arthur-Orange area. The material was gathered from the 20-year period from 1950 to 1969. A longer period of research data would have been impractical not only because of the sparsity of population before 1950

but also because observing and recording techniques have varied greatly before and after 1950. It should be noted here that it was not until late 1954 that the SELS (Severe Local Storms) Unit of the National Severe Storms Forecast Center began collecting and maintaining an operational log of severe storm occurrences, which includes funnel cloud sightings, within the continental United States.

Before proceeding any further, an attempt will be made to remove the confusion caused by the terms describing the basically similar weather phenomena, namely, tornadoes, waterspouts, and funnel clouds, by defining the terminology in the following section.

TERMINOLOGY

For purposes of this article, the following definitions, taken from the Federal Meteorological Handbook No. 1, will be used:

1. Tornado - A violent rotating column of air, forming a pendant, usually from a cumulonimbus cloud and touching the ground. It nearly always starts as a funnel cloud and is accompanied by a loud roaring noise.

2. Waterspout - A funnel cloud over a large body of water, such as a bay, a gulf, or a lake, and touching the water surface.

3. Funnel Cloud - A violent rotating column of air which does not touch the ground, usually pendant from a cumulonimbus cloud.

In other words, a tornado is a violent funnel-shaped disturbance of the atmosphere normally associated with frontal passages, squall lines or any severe thunderstorm conducive to its formation. On the other hand, a funnel cloud normally extends only a few hundred feet below the parent cloud and is generally not destructive since it does not touch the ground. While the above definition of funnels implies that the cloud with which a funnel is associated is usually a cumulonimbus, it has been determined, in this area at least, that the majority of funnel clouds developed under a cumulus congestus cloud. However, if conditions were such as to favor a rapid and extensive development of the parent cloud into a cumulonimbus, a few of the funnels became better organized and some developed into "baby" tornadoes.

Before continuing, attention is called again to the fact that in this article, whenever reference is made to funnels or funnel clouds, it will always mean that they are aloft unless otherwise stated. With this in mind, the number of occurrences between the years 1950 to 1969,inclusive, will be analyzed.

STATISTICS

In the early 1950's little or no significance was attached to funnel clouds unless they were of tornadic proportions. It was not until the mid 1950's that people became more aware and alert to the funnel

type clouds that protruded beneath a seemingly fair weather cumulus parent cloud. The reason for this dramatic change in awareness was that a few of these seemingly harmless looking funnels did develop into small twisters or "baby" tornadoes causing minor and sometimes moderate damage as the convective activity increased and moderate to severe thundershowers developed. Thus the feeling also developed that any funnel extending down from any cloud was destructive. This is not so. In actuality, out of all funnels sighted (tornadoes and waterspouts are also included) in the 20-year period, 83% never touched ground. And out of 184 funnels aloft sighted during a stable condition, only 4 became tornadoes; and these protruded from a cumulonimbus type cloud that reached between 40,000 and 50,000 feet in height upon full development. In other words, these 4 were "severe thunderstorm" induced and could properly be classified as tornadoes. One such twister occurred on July 30, 1969, in Nederland, Texas at about 5:30 pm CST (Fig. 3). As can be seen, here the tornado was ropelike with a radius of about 20 feet near the base of the parent cloud tapering off to less than 5 feet at the tornado's tip. This particular tornado developed in connection with the only thundershower within a 30-mile radius from Jefferson County Airport. The thundershower itself continued to move in a west to southwesterly direction (the tornado withdrew into the cloud within 20 minutes) until it dissipated at around 6:45 pm CST.

Figure 3. Nederland tornado

In order to visualize the statistical data more readily, several graphs have been constructed. In Fig. 4, the yearly values of all the funnel cloud sightings, along with the tornado and waterspout sightings, have been logged. As in many studies requiring visual observations, the statistics compiled here are highly dependent not only on human observation but also on experience and the method of recording the data. Therefore, careful and patient screening was done to include only the most reliable and accurate reports. The dashed line on Fig. 4 reduces the data to funnel cloud sightings only and excludes all "severe weather" induced activity. It may be noted that after the sharp increase of activity from the early 1950's to the mid 1950's, the funnel cloud sightings tapered off to a more or less constant number of occurrences. With the exception of the "saturated" years of 1958 and 1959, there have been an average of 10 funnel clouds per year between 1956 and 1969.

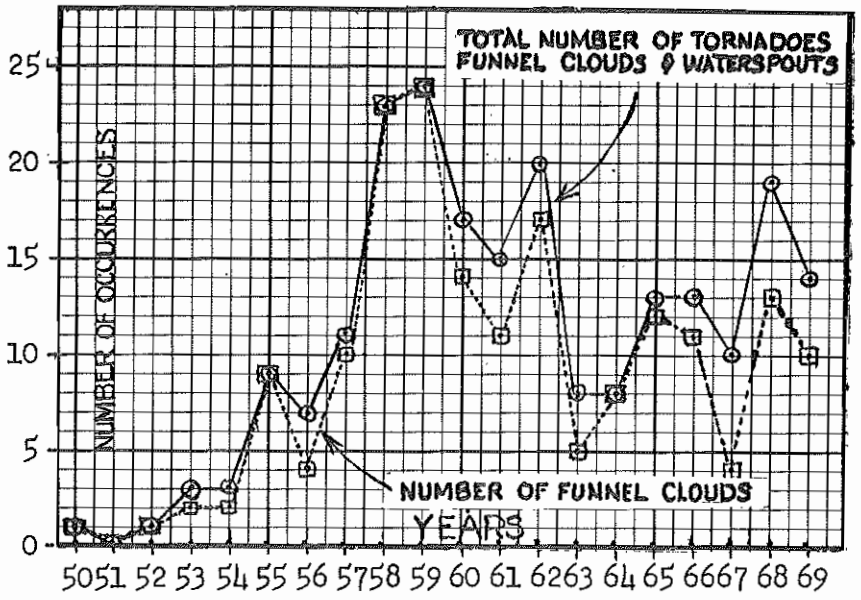



Figure 4.

As do other weather phenomena, funnels have their own special season. To better picture this, in Fig. 5 the number of funnel cloud occurrences have been broken up into monthly values. Most of the funnel clouds have occurred during the late spring, summer, and early autumn months with July and August being the most active months, although June and September do not fall far behind. This is to be expected since a certain amount of convective instability is needed for the formation of funnel clouds.

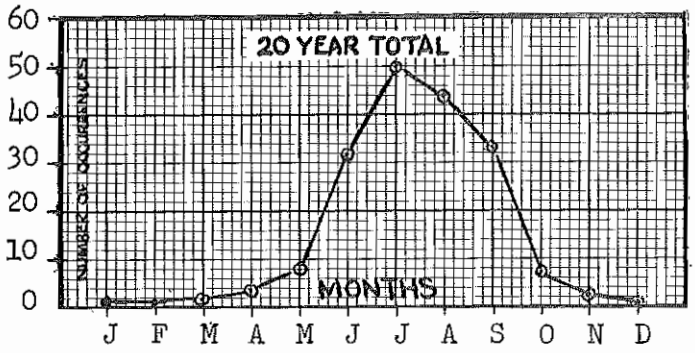



Figure 5.

Thermal conditions necessary for convective action are also very important. Since the more heat a parcel of air possesses the stronger the convective lifting experienced, it can easily be seen that the majority of funnels would occur during the day. Fig. 6 examines the hourly occurrences. Few or no funnel clouds were sighted between the hours of 8 pm CST and 7 am CST. Although this may be due in part to the difficulty of observing funnel clouds at night, it can be established that the major factor contributing to it would be the absence of cloud cover. Most of the funnel cloud activity is during the

summer when the sun rises between 5 and 6 am CST. The "active" hours are between 8 am and 1 pm with the peak being reached at 10 to 11 am. As the day progresses, the activity decreases to a minimum during the hours of 1 to 3 pm followed by a secondary maximum between 3 and 4 pm.

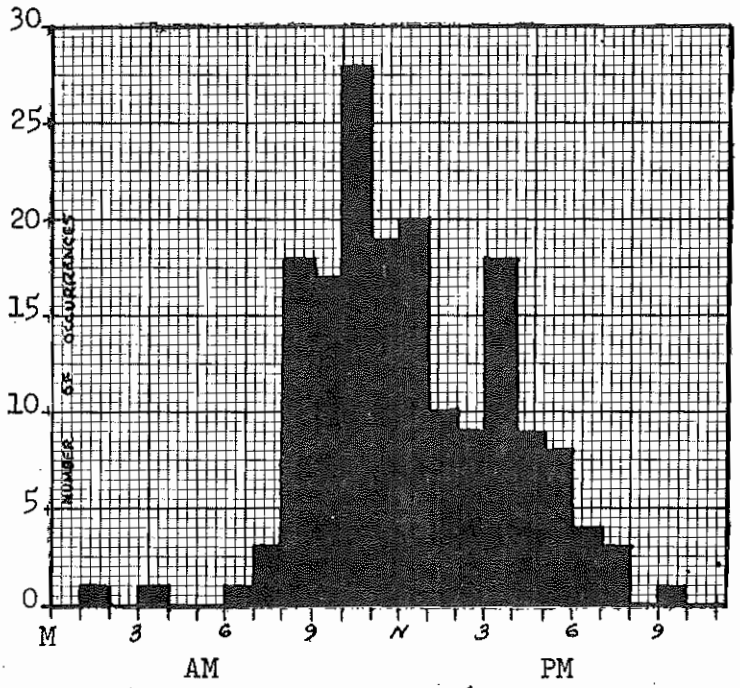



Figure 6.

Funnel clouds never last very long. Out of 107 funnel cloud cases where duration was noted, 98% of the funnels lasted less than 20 minutes. In fact, 90 funnels, or 84%, lasted less than 10 minutes. In one extreme case, on June 11, 1968, the funnel lasted 35 minutes before withdrawing into the parent cloud.

As has been frequently stated, funnels normally extend only a few hundred feet below the base of the clouds and do not touch ground. For a better indication of the extent downward from the clouds, it may be helpful to start with the height of the parent clouds themselves. In Fig. 7 the relation between parent cloud base height and funnel cloud occurrence was examined for 136 cases. Although there were sightings when the ceilings were as low as 500 ft. the majority of funnels occurred when the ceilings were between 2500 and 3000 feet.

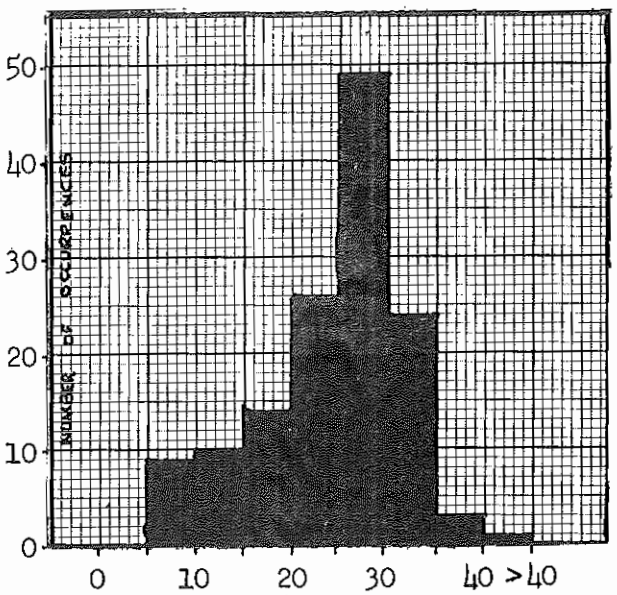



Figure 7.

From two very descriptive reports from a qualified observer, a few funnel lengths can now be estimated. On July 31 and again on August 29, 1955, funnels were sighted when the bases of the clouds were 2500 feet. On July 31 the observer reported the funnel to be 2/3 of the way to the ground while on August 29 he reported the funnel to vary from 1/3 to ½ of the distance between cloud base and ground. As Fig. 8 shows, the funnels would then be as low as 800 feet above the ground or as much as 1700 feet above the surface.

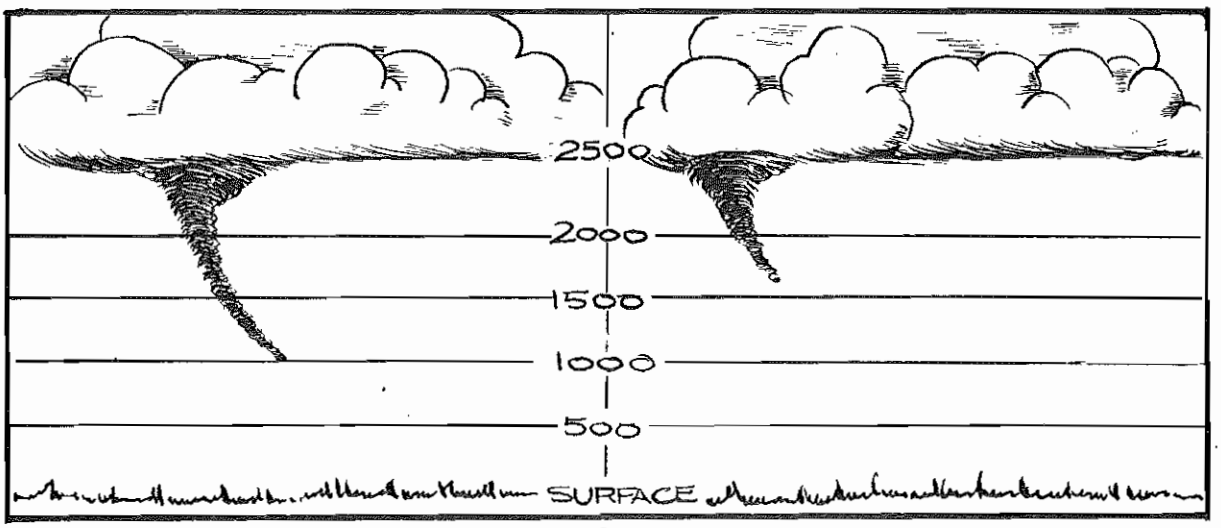


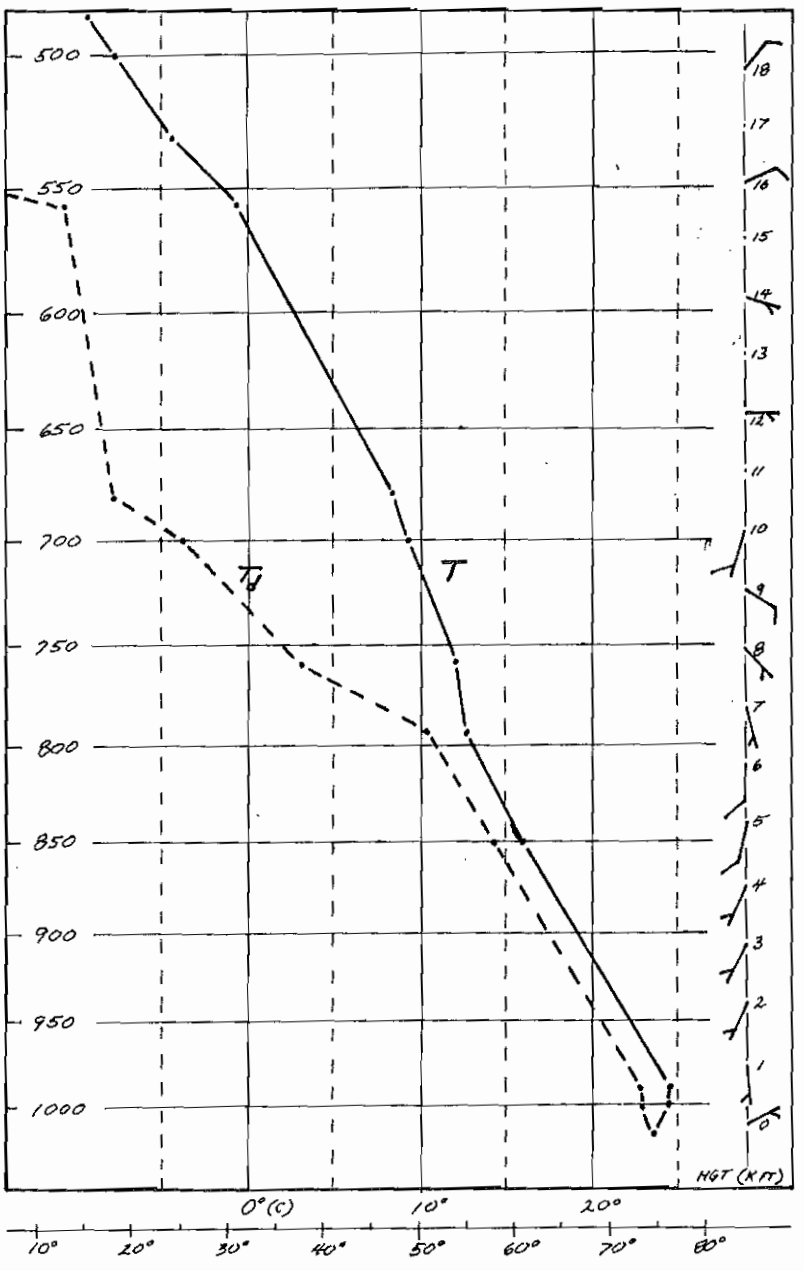

Figure 8.

SYNOPTIC CONDITIONS

As indicated previously, the majority of funnel clouds have occurred during the summer months. Generally the surface conditions would indicate a fairly stable situation. Winds are mostly south to southeasterly with wind speeds varying between 5 to 15 miles per hour. The only variance from the Gulf flow comes from the coastal effect which creates a northerly or land breeze in the early morning hours of the day. For an analysis of the upper atmosphere during a typical funnel cloud day, a radiosonde morning sounding from Lake Charles was used (Fig. 9). Assuming an identical air mass during normal situations, the Lake Charles sounding is used at Port Arthur for forecasting purposes since the distance between Lake Charles and Port Arthur is only about 60 miles. As is normally true for the coastal sections of the Gulf, the atmosphere is fairly moist for the first 200 millibars or 6500 feet above the surface. In a typical funnel cloud day case, the difference between temperature and dewpoint for the lower 6500 feet is rarely more than 5 degrees. A night inversion is apparent although it may be slight or quite pronounced. In contrast, from about 800 millibars up, it is normally dry, with the temperature and dewpoint difference being 10 to 20 degrees. As far as winds are concerned, they are light, less than 15 miles per hour up to 400 millibars (23,000 feet). Winds in the first 10,000 feet above the surface are southeast, south, or southwesterly while above 10,000 feet the winds may be from any direction

(although the most favorable winds seem to be from the northeast to south to southwest quadrant) and the wind speeds are less than the lower portion, being less than 10 miles per hour. While the majority of funnel clouds have occurred during times when the above described conditions have prevailed, there have been occurrences during variations from these conditions.

Summer or convective type showers are normally forecast with the typical atmosphere described and no severe weather conditions are visualized. In fact, showers did occur (immediately before, during, or immediately after) in 125 out of 145 cases when funnels were sighted. But, although this constituted 86% of the cases, thunder was heard in only 41%.




Lake Charles Raob
7/17/68 1200Z

Figure 9.

## CONCLUSION

While the author has compiled all the statistical information available in this area on funnel clouds, much more data is needed from other areas to formulate a good foundation for theoretical research. Preliminary indications are that 1970 was a very productive year for funnel clouds with 22 funnels aloft sighted during the year. This "saturated" year, along with the years 1958 and 1959 clearly indicate the need for a better understanding of this phenomena. A station equipped with raob and radar facilities could possibly provide not only critical surface data but also vital upper air information that could be used. At present it would be quite impractical to attempt to forecast when or where these funnels would occur, but in time some "rules of thumb" might be formulated to prepare the forecaster for these occurrences. Personnel at the WSO, Port Arthur, Texas have developed a very rough, but still helpful, rule of thumb utilizing the morning sounding at Lake Charles. If conditions approximate the typical funnel cloud sounding, special notice is given to the presence of smoke in the area. The exact relationship has not been fully investigated at the present time, but it appears that most of the funnels occur under the additional condition of marginal visibility - say, between 6 and 10 miles. This visibility condition appears to offer a fruitful area for further investigation.

While these guidelines are helpful in anticipating funnel cloud occurrences in the area, present skill in forecasting this phenomena is limited and highly subjective.

## ACKNOWLEDGEMENTS

Thanks are due Mr. Stanley McGrail, MIC at WSO, Port Arthur, Texas for his technical advice and discussions on the material and for his artistic assistance on all graphs and figures used. Comments from the Port Arthur WSO staff and information contributed by Mr. Joseph Golden on the subject of waterspouts are also appreciated.

REFERENCES

Alderman, Dorus D., 1965: Radar Echoes Associated With Waterspout Activity. ESSA Technical Memorandum WBTM SR-5.

Clemons, Gerald H., 1968: Detailed Radar Observations and Recent Climatology of Waterspouts in The Key West Area. Unpublished manuscript, NOAA, National Weather Service Office, Key West, Fla.

Golden, Joseph H., 1969: The Dinner Key "Tornadic-Waterspout" of June 7, 1968. Mariner's Weather Log, 13.

------, 1969: Waterspouts and Tornadoes Over South Florida. Unpublished Manuscript, NOAA, National Hurricane Center, Miami, Florida.

Staff, Severe Local Storms (SELS) Unit, 1969: Severe Local Storm Occurrences, 1955-67. ESSA WBTM FCST 12.

Wolford, Laura V., 1960: Tornado Occurrences in The United States. NOAA, National Weather Service, Office of Climatology, Technical Paper No. 20.