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May 10, 1973
(Revision of May 1, 1973 letter)

To: National Weather Service Offices

In re: F P P Classification of all tornadoes

Since January 1971, we have been classifying all U. S. tornadoes into the "Fujita-Pearson tornado scale" (F PP scale), based on storms' intensity, path length, and mean path width. The purpose of the F P P classification is to distinguish violent tornadoes from weak ones, long ones from short ones, etc. In fact, the smallest tornado in the "1972 Storm Data" was 10 x 15 ft in the damage area, thus necessitating numerical expressions of all U. S. tornadoes for better statistics and assessment.

Originally, the F P P tornado scale was designed to express tornadoes in 0 to 5 numbers of F P P. Because of the occurrence of rather large number of scale-zero tornadoes in 1972, an experimental breakdown of the scale zero was suggested in various occasions. Of 740 tornadoes in 1972, the frequency distribution was 169 (23%) F 0, 389 (52%) P 0 length, and 201 (27%) P 0 width.

The F P P table to be used experimentally in 1973 includes negative values as expressed by "-" . Specific negative values for path-length scale are to be assigned whenever possible (see Page 5).

Maximum Windspeed		Path Length		Path Width (average)	
F -	less than 40 mph	P -	less than 0.3 mile	P -	less than 6 yds.
F 0	40-72	P 0	0.3-0.9	P 0	6-17
F 1	73-112	P 1	1.0-3.1	P 1	18-55
F 2	113-157	P 2	3.2-9.9	P 2	56-175
F 3	158-206	P 3	10-31	P 3	176-556
F 4	207-260	P 4	32-99	P 4	0.3-0.9 mile
F 5	261-318	P 5	100-315	P 5	1.0-3.1

*Family tornadoes, please indicate F P P for each member. **Path length excludes the sections without surface disturbances. ***Path width is the width averaged over the entire path length.

Columns	Information
1-6	Blank. Reserved for line numbers in DATADISK
7-8	Contain the final two digits of the year in which the tornado occured.
9-10	For years 1916 through 1974, always contains "00". For 1975 and all future years, these contain the state ID number as follow:

Handwritten	Code	State
30	~~01~~	Alabama
	~~02~~	Alaska
5	~~03~~	Arizona
28	~~04~~	Arkansas
6	~~05~~	California
42	~~06~~	Colorado
1	~~07~~	Connecticutt
2	~~08~~	Delaware
67	~~09~~	Florida
20	~~10~~	Georgia
	~~11~~	Hawaii
	12	Idaho
27	~~13~~	Illinois
37	~~14~~	Indiana
18	~~15~~	Iowa
14	~~16~~	Kansas
5	~~17~~	Kentucky
14	~~18~~	Louisiana
2	~~19~~	Maine
4	~~20~~	Maryland, D.C.
1	~~21~~	Massachusetts
33	~~22~~	Michigan
11	~~23~~	Minnesota
34	~~24~~	Mississippi
12	~~25~~	Missouri
2	~~26~~	Montana
26	~~27~~	Nebraska
	28	Nevada
2	~~29~~	New Hampshire
1	~~30~~	New Jersey
1	~~31~~	New Mexico
7	~~32~~	New York
23	~~33~~	North Carolina
51	~~34~~	North Dakota
10	~~35~~	Ohio
28	~~36~~	Oklahoma
	37	Oregon
18	~~38~~	Pennsylvania
	39	Puerto Rico
	40	Rhode Island
14	~~41~~	South Carolina
4	~~42~~	South Dakota
9	~~43~~	Tennessee
178	~~44~~	Texas
	45	Utah
	46	Vermont
10	~~47~~	Virginia
	48	Washington
1	~~49~~	West Virginia
12	~~50~~	Wisconsin
24	~~51~~	Wyoming

TABLE 3. Hour in Central Standard Time (CST)

CODE	TIME	CODE	TIME	CODE	TIME
00	0000-0059	13	1300-1359	35	Late morning
01	0100-0159	14	1400-1459	40	Early afternoon
02	0200-0259	15	1500-1559	45	Afternoon
03	0300-0359	16	1600-1659	50	Late afternoon
04	0400-0459	17	1700-1759	55	Early evening
05	0500-0559	18	1800-1859	60	Evening
06	0600-0659	19	1900-1959	65	Late evening
07	0700-0759	20	2000-2059	70	Early night
08	0800-0859	21	2100-2159	75	Night
09	0900-0959	22	2200-2259	80	Late night
10	1000-1059	23	2300-2359	85	AM
11	1100-1159	25	Early morning	90	PM
12	1200-1259	30	Morning	99	Unknown

TABLE 4. F-intensity Scale (Col. 22)

CODE	DESCRIPTION OF DAMAGE (see SMRP #98)
0	Light damage
1	Moderate damage
2	Considerable damage
3	Severe damage
4	Devastating damage
5	Incredible damage

TABLE 5. Path Width (Col. 30)

CODE	DESCRIPTION
0	0-17 yds or narrower
1	18-55 yds
2	56-175 yds
3	176-556 yds
4	0.3-0.9 miles
5	1.0-3.1 miles
9	Unknown

QUARTERLY REPORT

TORNADO STATISTICS

NUMBER OF TORNADOES PLOTTED IN STORM DATA :

JUNE	195			
JULY	95			
AUG	34			
SEPT	38	NOV	0	REPORTS NOT YET RECEIVED
OCT	8	DEC	0	
	370			

NUMBER OF TORNADOES PLOTTED ON 1-DEGREE GRIDS : 193 (JULY - OCT), 911 (TOTAL)

NUMBER OF TORNADOES CODED IN KEYPUNCH FORMAT : 193 (JULY - OCT), 911 (TOTAL)

NUMBER OF TORNADOES KEYPUNCHED : 182 (JULY - OCT), 900 (TOTAL)

NUMBER OF TORNADOES VERIFIED FOR CORRECTNESS : 182 (JULY - OCT), 900 (TOTAL)

EXPERIMENTAL CLASSIFICATION OF TORNADOES IN F P P SCALE

by T. Theodore Fujita

CONTENTS

INTRODUCTION

In order to assist the F P P classification of tornadoes by the National Weather Service Offices, a short text and figures were prepared. As listed in the Contents, this text includes the method of the F P P determination which can be performed based on the tornado data available at each forecast office.

F P P statistics of 1972 tornadoes are also included to see how U.S. tornadoes behaved during the past years.

Three tornado cases investigated during the 1973 tornado season are presented for your assessment information. These examples by no means represent the expected tornado survey applicable to most storms. Nonetheless, they will serve as background information of tornado damage patterns which are likely to occur in various parts of the country.

(A) EXPLANATION OF THE F P P SCALE

During the entire year of 1971, all U.S. tornadoes were classified experimentally into F scale intensity by the NOAA climatologists. The result tabulated below indicates that the total frequencies of F 0 and F 1 tornadoes were more than 60%. F 3 and stronger tornadoes were minorities, only about 10% of the total.

TABLE I. F-scale frequency of 1971 tornadoes

Scale	F 0	F 1	F 2	F 3	F 4	F 5	Total
Frequencies	183	379	232	70	22	2	888
In %	20.6	42.7	26.1	7.9	2.5	0.2	100

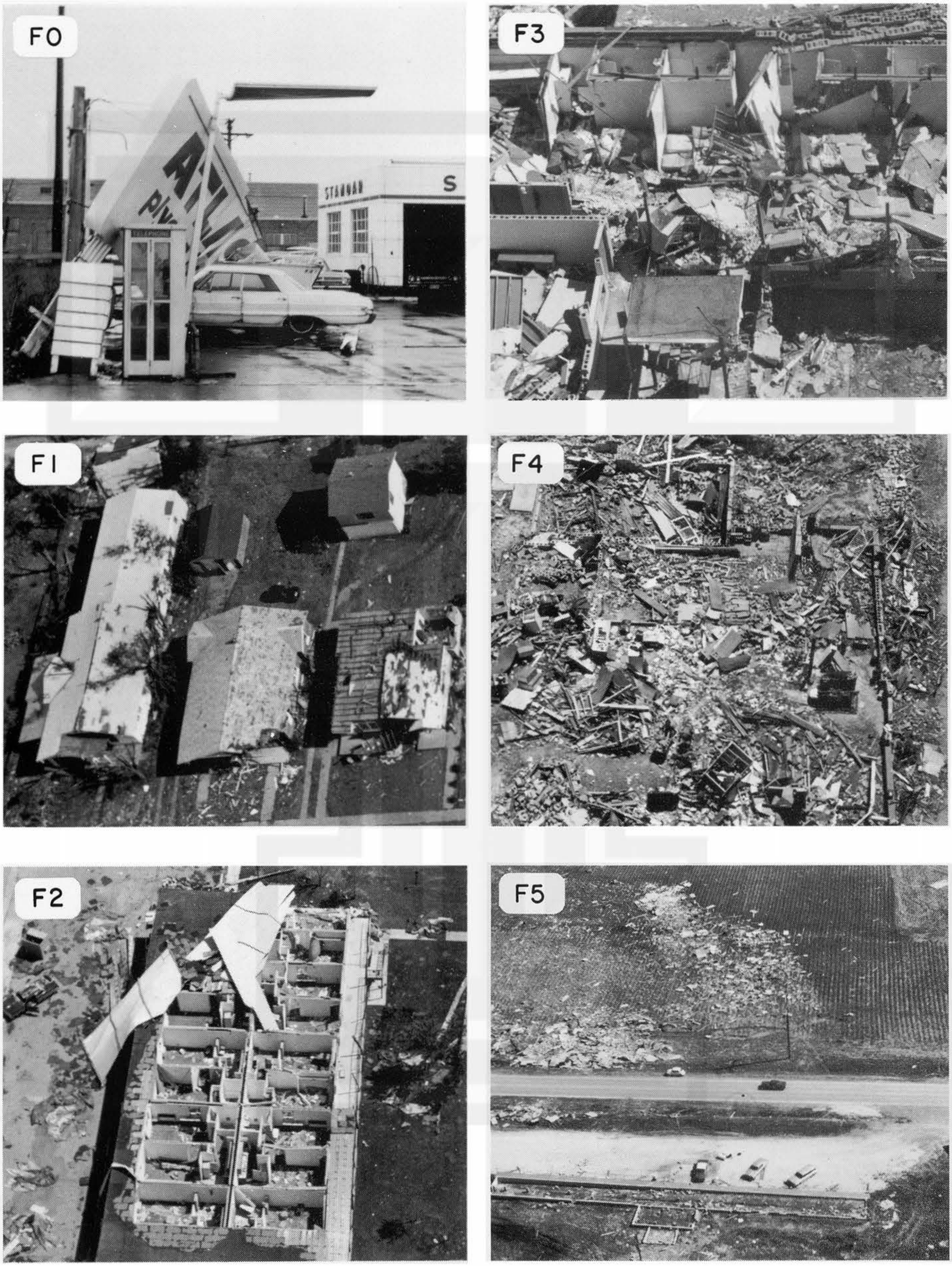


Fig. 1. Typical damage expected to occur under F 0 through F 5 winds.

FUJITA-SCALE INTENSITY was constructed initially by connecting Beaufort force 12 (73 mph) with Mach 1, the speed of sound in 12 steps. F-scale windspeed can be computed from the formula

$$V_F = 14.1 \; (F + 2)^{\frac{3}{2}} \text{ in mph.}$$

Technically, V_F is defined as being the "fastest ¼ mile speed" rather than the "fastest mile", because the period of the fastest mile is too long for tornado winds. The peak gust speed is naturally faster than the fastest ¼ mile speed. The period of the F-scale wind is the time required for a specific F-scale wind to travel through the distance of ¼ mile. Shown in the following table is the F-scale windspeed and the period.

TABLE II. F-scale wind speed

Scale	negative	0	1	2	3	4	5	6 or higher
Speed (mph)	less than 40	40-72	73-112	113-157	158-206	207-260	261-318	319 and higher
Period (sec)	more than 22	22-12	12-8	8-6	5-4	4-3	3-2	2 or shorter

Figure 1 was prepared for easy assessment of the F-scale wind based on the extent of damage, which varies from location to location. For instance, one house may receive severe damage while the neighbors' could escape damage.

THE LARGEST F SCALE WITHIN THE ENTIRE AREA OF A TORNADO IS REGARDED AS BEING THE F SCALE FOR THE STORM.

Damage specification for each F scale is presented in an attempt to clarify the nature of the damage to be expected.

(F -) LITTLE OR NO DAMAGE 40 mph or less

40 mph speed corresponds to Beaufort 8 or "Fresh Gale". Beaufort specification for use on land is "Breaks twigs off trees". Little damage is expected.

(F 0) LIGHT DAMAGE 40-72 mph

This speed range corresponds to Beaufort 9 through 11. Some damage to chimneys or TV antennae; breaks branches off trees; pushes over shallow-rooted trees; old trees with hollow inside break or fall; sign boards damaged.

(F 1) MODERATE DAMAGE 73-112 mph

73 mph is the beginning of hurricane windspeed or Beaufort 12. Peels surface off roofs; windows broken; trailer houses pushed or overturned; trees on soft ground uprooted; some trees snapped; moving autos pushed off the road.

(F 2) CONSIDERABLE DAMAGE 113-157 mph

Roof torn off frame houses leaving strong upright walls standing; weak structure or outbuildings demolished; trailer houses demolished; railroad boxcars pushed over, large trees snapped or uprooted; light-object missiles generated; cars blown off highway; block structures and walls badly damaged.

(F 3) SEVERE DAMAGE 158-206 mph

Roofs and some walls torn off well-constructed frame houses; some rural buildings completely demolished or flattened; trains overturned; steel framed hangar-warehouse type structures torn; cars lifted off the ground and may roll some distance; most trees in a forest uprooted, snapped, or leveled; block structures often leveled.

(F 4) DEVASTATING DAMAGE 207-260 mph

Well-constructed frame houses leveled, leaving piles of debris; structure with weak foundation lifted, torn, and blown off some distance; trees debarked by small flying debris; sandy soil eroded and gravels fly in high winds; cars thrown some distances or rolled considerable distance finally to disintegrate; large missiles generated.

(F 5) INCREDIBLE DAMAGE 261-318 mph

Strong frame houses lifted clear off foundation and carried considerable distance to disintegrate; steel-reinforced concrete structures badly damaged; automobile-sized missiles fly through the distance of 100 yds. or more; trees debarked completely; incredible phenomena can occur.

(F6-12) INCONCEIVABLE DAMAGE 319 mph to sonic speed

Should a tornado with the maximum windspeed in excess of F 6 occur, the extent and types of damage may not be conceived. A number of missiles such as ice boxes, water heaters, storage tanks, automobiles, etc. will fly through a long distance, creating serious secondary damage on structures. Assessment of tornadoes in these categories is feasible only through detailed survey involving engineering and aerodynamical calculations as well as meteorological models of tornadoes.

After the F-scale classification of a tornado, the storm may be identified by

F- Doubtful tornado (little or no damage)
F0 Very weak tornado (light damage)
F1 Weak tornado (moderate damage)
F2 Strong tornado (considerable damage)
F3 Severe tornado (severe damage)
F4 Devastating tornado (devestating damage)
F5 Incredible tornado (incredible damage)
F6 Inconceivable tornado (inconceivable damage)

PEARSON-SCALE PATH LENGTH corresponding to P scale is computed from

$$L = 10^{\frac{1}{2}(P_L - 1)} \text{ in miles .}$$

When P = 1, the path length is 1.0 mile. An increment of one scale increases the path length by the factor of square root of 10 or 3.162 .... Namely, the increment of 2 scales results in a path 10 times longer.

TABLE III. P-scale path length, P 1 or longer

Scale	1	2	3	4	5	6
Length (mile)	1.0-3.1	3.2-9.9	10-31	32-99	100-315	316-999

TABLE IV. P-scale path length, P 0 or shorter

Scale	0	-1	-2	-3	-4	-5
Length (yds)	1760-557	556-176	175-56	55-18	17-6	6-2

Tables II and IV present ranges of the P-scale applicable to all possible tornadoes, which may extend between several yards to 1000 miles. During the 1972 experiment, all negative scales were combined into P 0 without distinguishing storms with 1.0 mile or shorter path length.

In the 1973 experiment, P 0 and P - are used for the purpose of learning more about the distribution of short-track tornadoes. Whenever possible, please select a proper negative scale such as -1, -3, etc. If not, simply assign "-" without a specific negative number.

Between the initial touch-down and the final lifting points there may be some sections where no surface disturbances existed. Such sections must be excluded from the path length because the definition of the path length is the total distance travelled by tornadic disturbances on the surface, not in the air.

Family tornadoes often spawn from a single echo. In most cases, a new tornado forms after the dissipation of the old one. Some times, however, the old one is still visible when a new one starts forming, thus the observation, two disturbances on the ground simultaneously. A F P P scale should be assigned to each member of such a family.

PEARSON-SCALE PATH WIDTH is the width of the tornado damage averaged over the entire path length. The equation for computing the path width as a function of the width scale is

$$\overline{w} = 10^{\frac{1}{2}(P_W - 5)} \quad \text{in miles .}$$

The P-scale path width computed from this equation is tabulated below.

TABLE V. P-scale path width (*in miles)

Scale	negative	0	1	2	3	4	5	6
Width (yds)	less than 6	6-17	18-55	56-175	176-556	*0.3-0.9	*1.0-3.1	*3.2-9.9

The damage area can be obtained simply by multiplying L by $\overline{w}$, thus

$$L \times \overline{w} = 10^{\frac{P_L + P_W}{2} - 3} \quad \text{in sq. miles .}$$

A serious problem is the definition of damage areas. How can one define the area of tornado damage, the extent of which varies from location to location? From the practical point of view, nobody can add up the individual areas of damage to structures, trees, crops etc. to obtain the total area of damage produced by a tornado.

It would be reasonable and practical to define the damage area as being that surrounded by a smoothed boundary including the damage of specific intensity. If we choose the F scale as the measure of the intensity, damage areas can be described by the F-scale contour lines drawn over the tornado-affected areas. The contours will appear like elongated onion rings with the strongest F-scale contours surrounded by weak ones. The outermost contour is likely to be that of F 1 or F 0 because the areas weaker than F 0 cannot be mapped due mainly to the lack of well-defined damage.

Presented in Fig. 2 is an example showing the variation of the widths of F 0 and F 2 damage along the Conyers tornado which occurred near Atlanta, Ga.

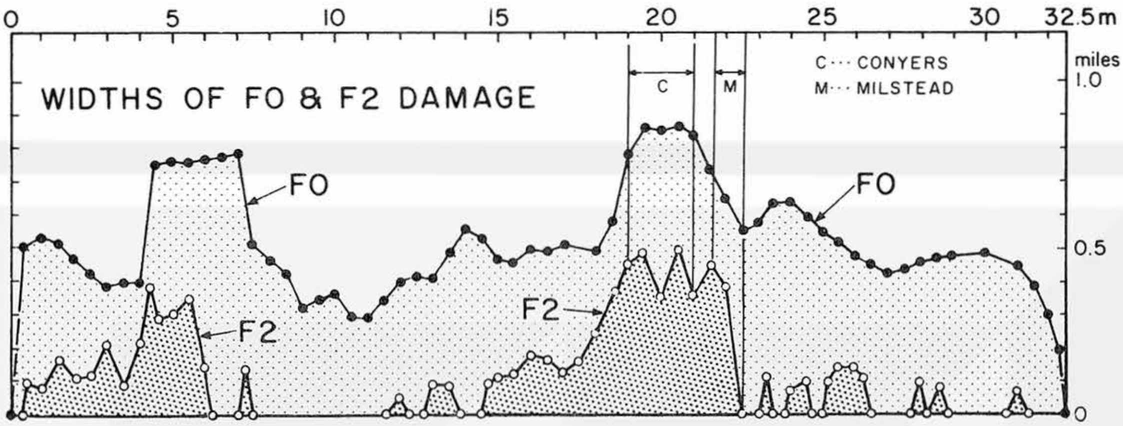


Fig. 2. Width of F 0 and F 2 damage by Conyers Tornado of March 31, 1973.

As seen in the figure, F 0 damage is confirmed along the entire path length of 32.5 miles. The maximum width of the F 0 damage is 0.8 mile while the minimum width was 0.3 mile, resulting in an average width of about 0.5 mile.

It is not possible to obtain such damage widths without going through aerial mapping or detailed ground survey. This example merely shows the variations of the width of F-scale damage, for possible use as the background information of the P-scale assessment.

When the mean damage width is determined based on local police reports, newspaper clippings, etc., an expected accuracy of the P scale estimate is likely to be "plus-minus one". The range of this error is 1 to 10 or one order of magnitude.

(B) F P P STATISTICS OF 1972 TORNADOES

1972 was a year of relatively weak tornado activities. There was no tornado with F 5 intensity nor P 5 path length. Shown in Table VI is the F P P distribution of 740 tornadoes confirmed during the year.

TABLE VI. F P P distribution of 1972 tornadoes

Tornado intensity			Path Length			Path Width		
F 0	169	(23%)	P 0	389	(52%)	P 0	201	(27%)
F 1	344	(46%)	P 1	186	(25%)	P 1	301	(41%)
F 2	174	(24%)	P 2	97	(13%)	P 2	148	(20%)
F 3	43	(6%)	P 3	58	(8%)	P 3	79	(11%)
F 4	11	(0.8%)	P 4	10	(1.4%)	P 4	9	(1.2%)
F 5	0	(0%)	P 5	0	(0%)	P 5	2	(0.3%)
Total	740	(100%)	Total	740	(100%)	Total	740	(100%)

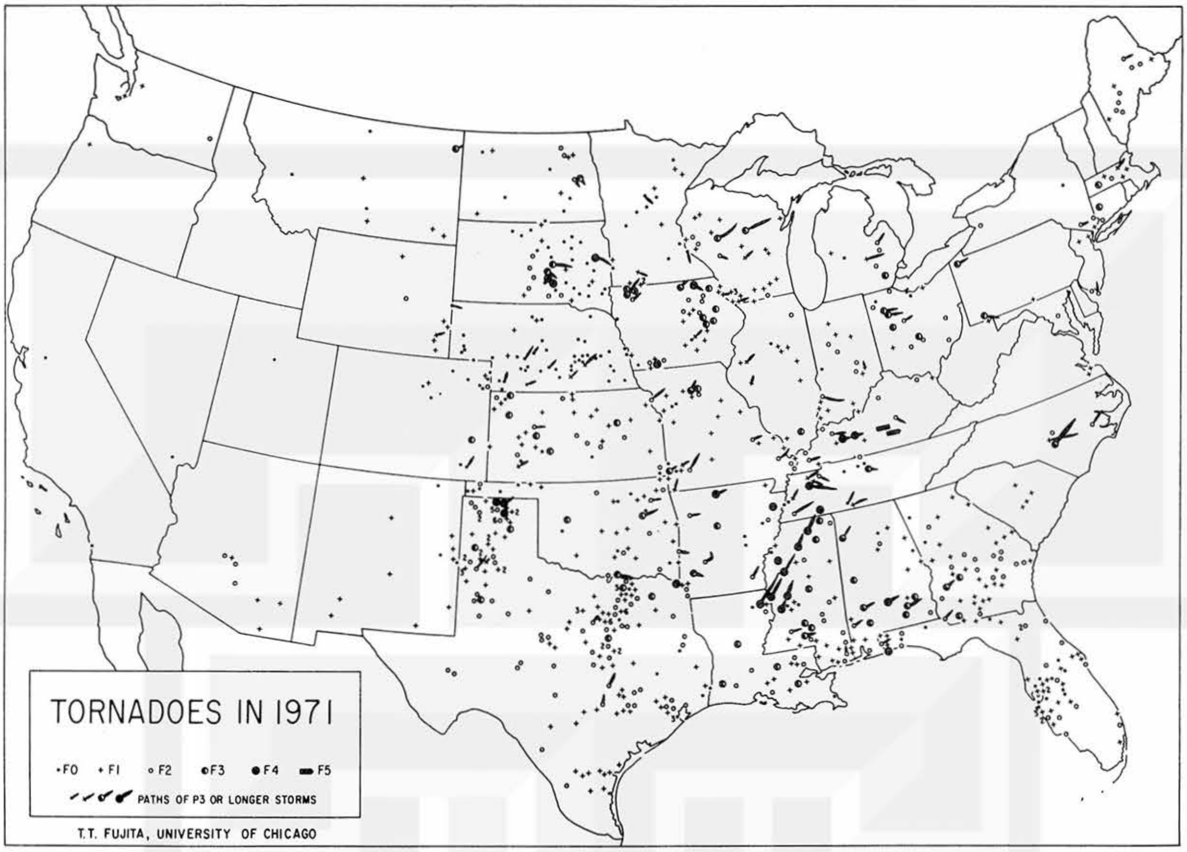


Fig. 3. Distribution of 1971 tornadoes.

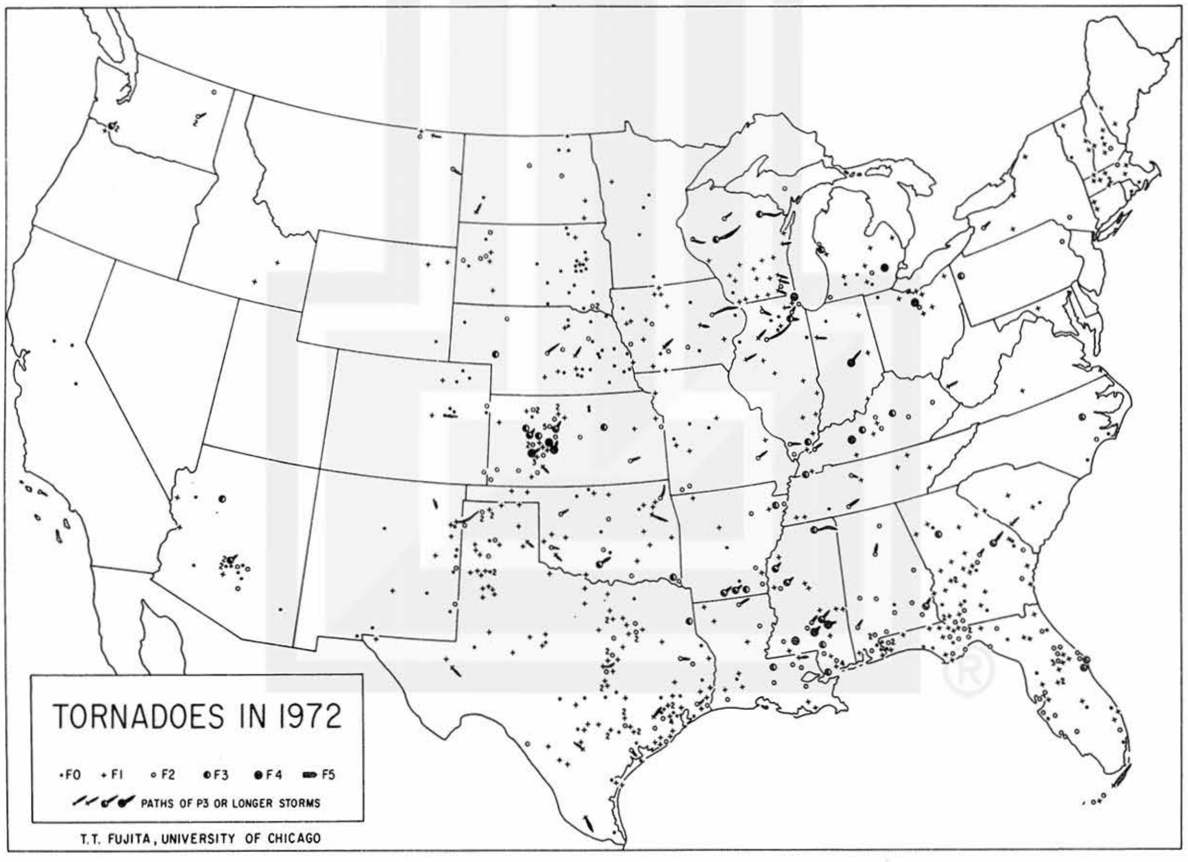


Fig. 4. Distribution of 1972 tornadoes.

Above statistics show that just about 90% of the 1972 tornadoes were F 2 or weaker, P 2 or shorter, or P 3 or narrower. Namely, the majority of the storms confirmed as tornadoes are relatively weak, short, or narrow.

Distributions of 1971 and 1972 tornadoes were shown in Figs. 3 and 4, respectively. Two distribution maps were made by distinguishing the F-scale tornado intensities in 6 symbols. Meanwhile, those storms with P 3 or longer tracks were identified by an earthworm-like symbol extending from the touch-down position of each storm.

Tornadoes in 1971 reveal four or possibly five tornado zones extending from SSW to NNE. Occurrence of these zones may be accidental. Nevertheless, distinct zones are visible from Texas Panhandle to eastern Dakotas, southern Texas to Wisconsin, Mississippi to Ohio, Georgia to Maine, and in central Florida. Two F 5 tornadoes occurred in central Kentucky where the topography is rather hilly.

1972 was the year of weak tornadoes. Similar but diffused zones of tornado occurrences are also seen in this year. Especially is the Texas Panhandle to eastern Dakota zone distinct, while the occurrence of strong storms along the Mississippi to Ohio Valley is rather significant. Occurrences of three F 3 tornadoes in Arizona is noteworthy.

(C) SPECIFIC EXAMPLES OF 1973 TORNADOES

To obtain meteorological significance of damage patterns caused by tor-ıadoes and related phenomena three tornadoes listed in the Contents were urveyed.

*GEORGIA - SOUTH CAROLINA TORNADOES OF MARCH 31, 1973

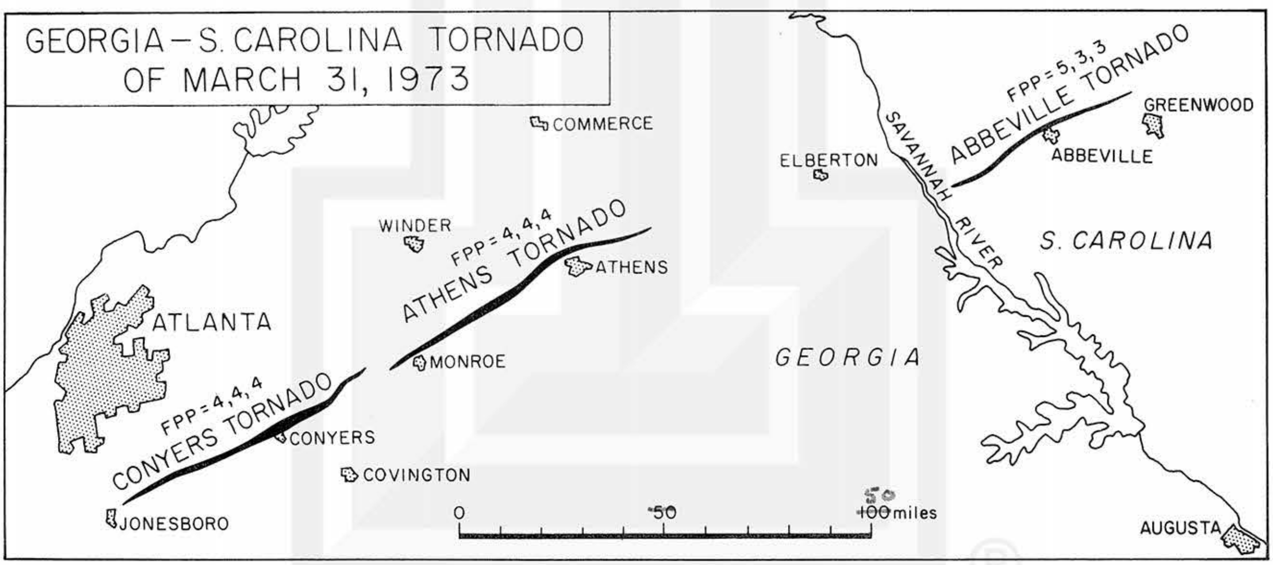


Fig. 5. Three tornadoes on March 31, 1973.

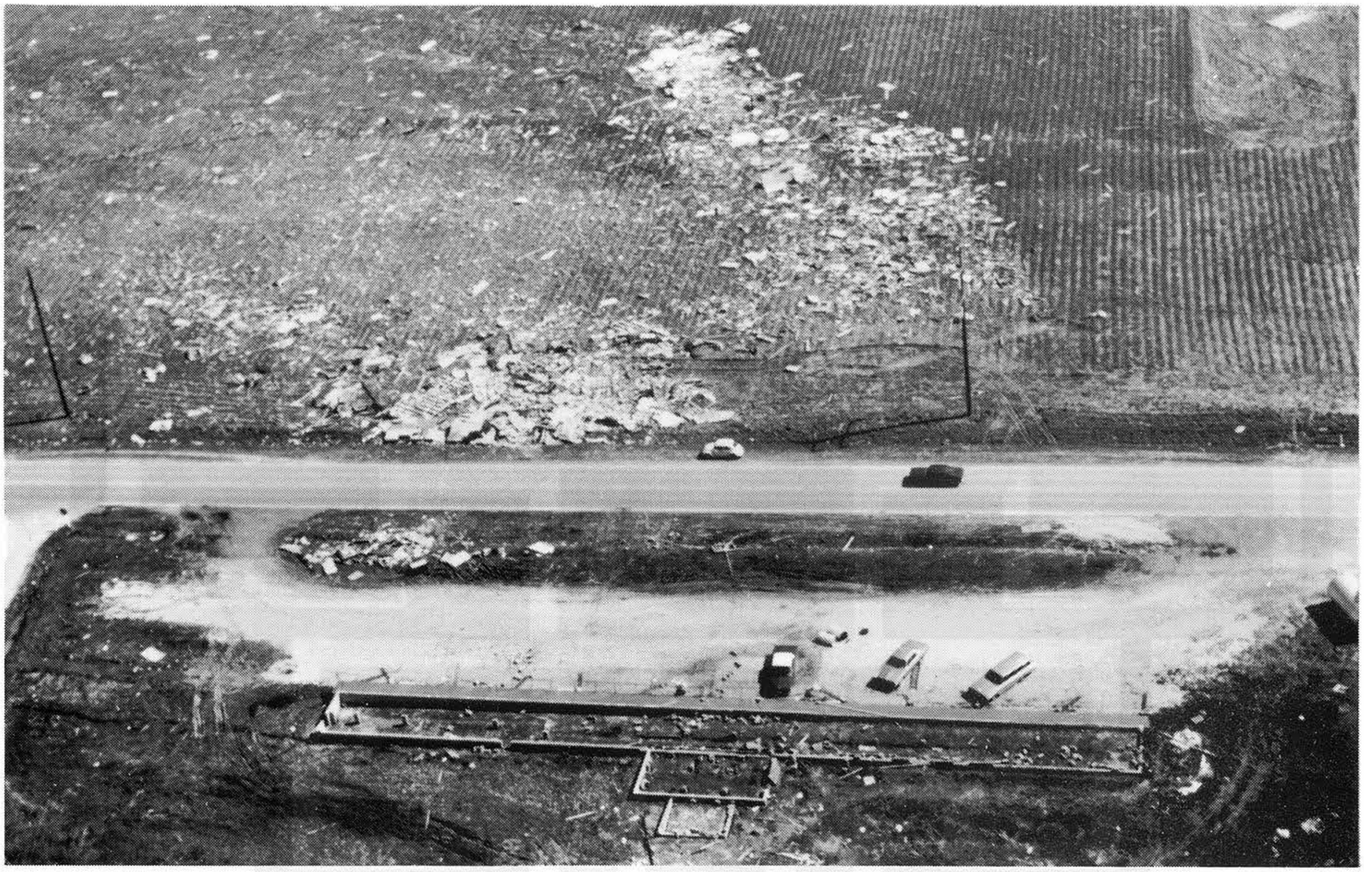


Fig. 6. A blown-off motel on S. C. -72

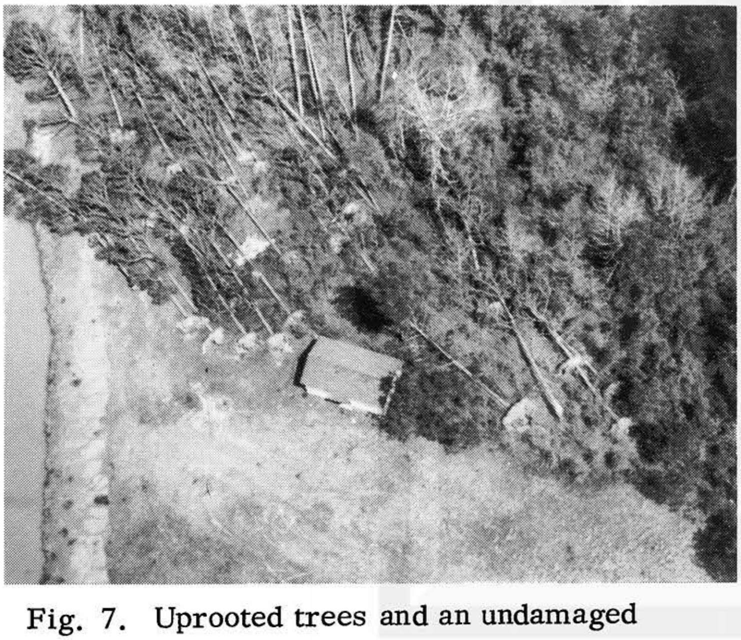


Fig. 7. Uprooted trees and an undamaged frame house.

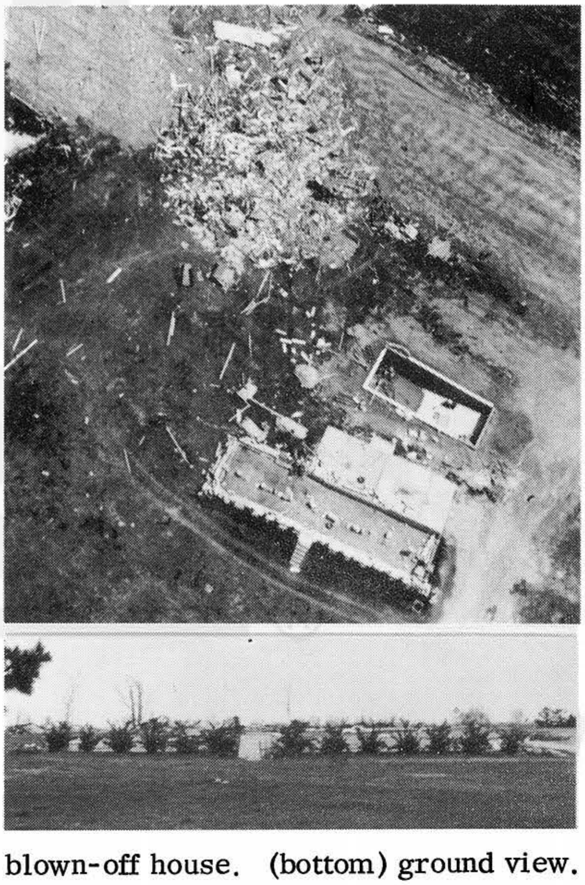


Fig. 8. (top) aerial view of a blown-off house. (bottom) ground view.

The paths of three tornadoes in Georgia and South Carolina were surveyed. Two of these tornadoes, identified in Fig. 5 as Conyers tornado (F P P = 4,4,4) and Athens tornado (F P P = 4,4,4), were family tornadoes. They spawned from a hook-echo cell detected and photographed by Athens radar.

The Abbeville tornado (F P P = 5,3,3) in South Carolina formed later from a different cell. This violent tornado lifted a motel clean off the foundation and transported the structure in two sections into a cotton field across N.C. Highway 72. As shown in Fig. 6, the western section was carried as far as 200 ft to disintegrate into pieces.

Figure 7 shows a number of uprooted trees lying flat in a parallel direction. A wooden house is seen undamaged. Did the trees protect the weak house before they finally fell? (F 1 or F 2).

When I took the aerial picture in Fig. 8, Mr. Pearl, a staff meteorologist, was on the ground to take a front picture of the house. He could not see the tons of debris in the low elevation spots, thus assuming that the house was under construction. (F 4).

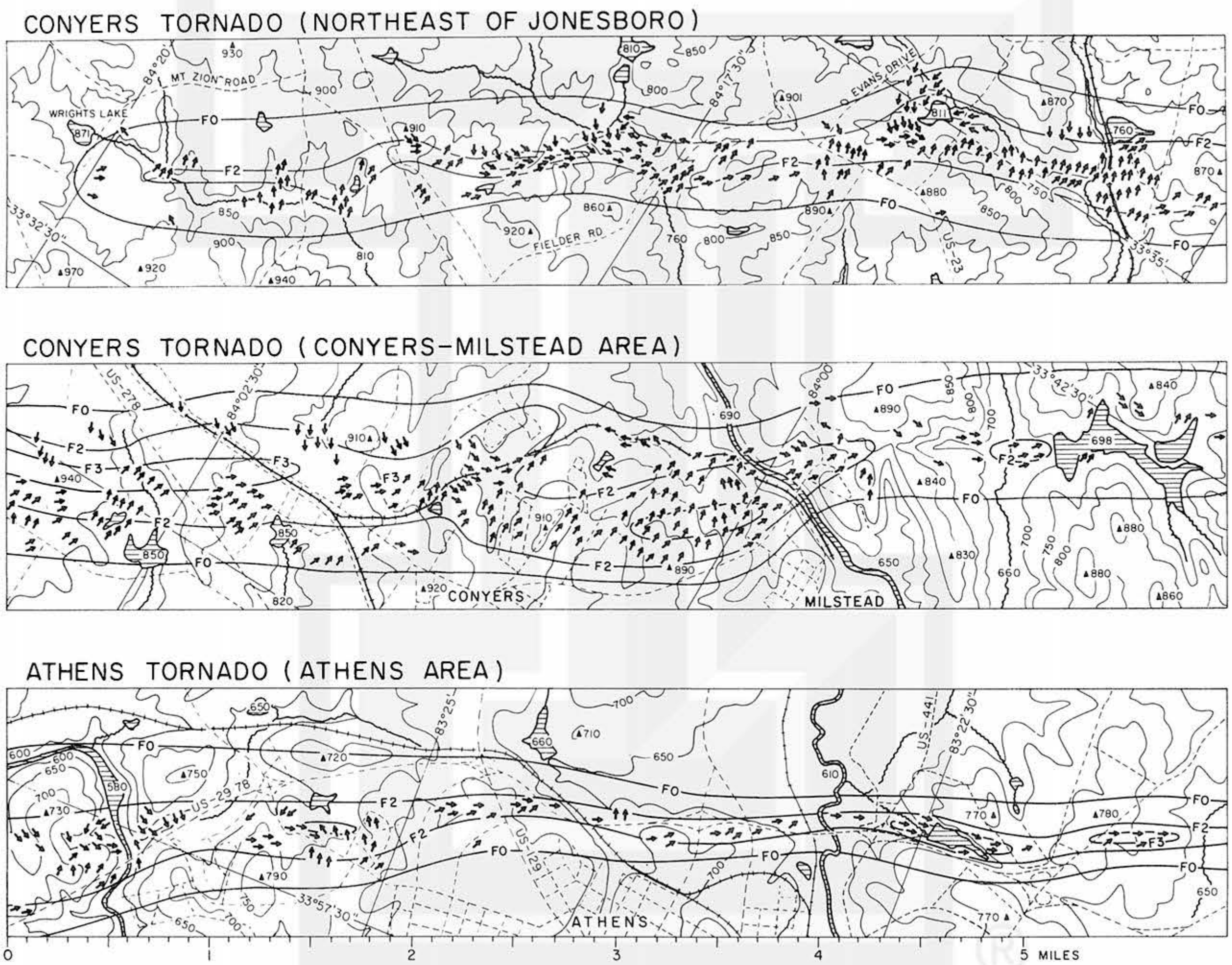


Fig. 9. Patterns of trees uprooted by the Georgia tornadoes of March 31, 1973.

Distinction between tornado and straight-wind damage is often very difficult. Shown in the top chart of Fig. 9 are the damage patterns to the northeast of Jonesboro where the Conyers tornado touched down. Directions of tree fall are predominantly from right to left of the path. As the tornado intensified, while travelling northeast, trees were apparently uprooted toward the translational direction of the tornado. A beautiful cyclonic pattern of trees is seen around a lake, 811 ft MSL. Such a pattern appears to be exceptional.

The middle chart shows the directions of widespread tree damage. In some areas, trees were uprooted by strong winds and apparently blown down into valleys. It is not unusual to observe severe damage on structures and trees in the low spots on the storm's track.

The tail end of the Athens tornado, shown in the bottom chart, is rather narrow. Trees fell mostly in the direction of the storm's movement, showing a characteristic convergence pattern of tree-fall directions.

The results of the mapping presented in Fig. 9 present rather complicated and difficult problems of tornado identification based on the directions of damage. Their overall patterns often imply damage by straight wind A very narrow path as well as the characteristic of explosive structural damage often plays an important role in determining the nature of the storm.

*PEARSALL TORNADO (50 SW of San Antonio) OF APRIL 15, 1973

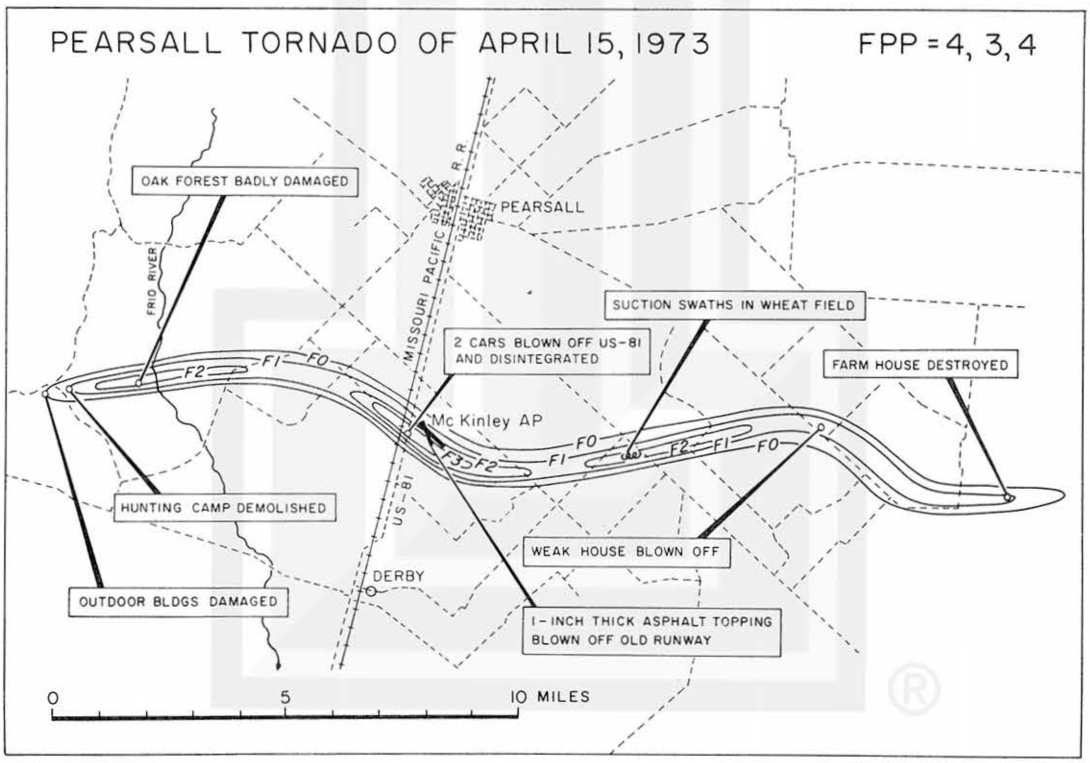


Fig. 10. F-scale contour lines of Pearsall tornado.

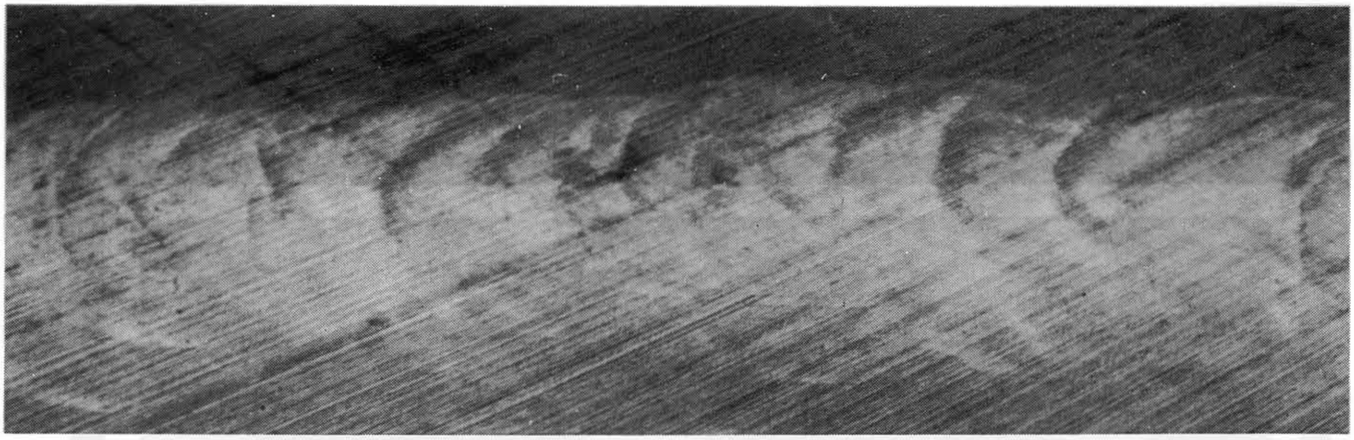


Fig. 11. Suction Swaths in wheat field (F 3).

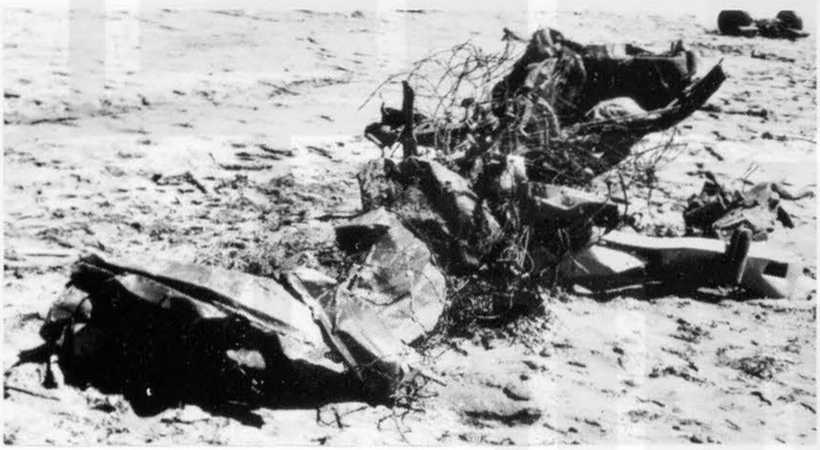


Fig. 12. Disintegrated car (F 4).

Fig. 13. Asphalt of 8-year old runway blown off by tornado (F 3).

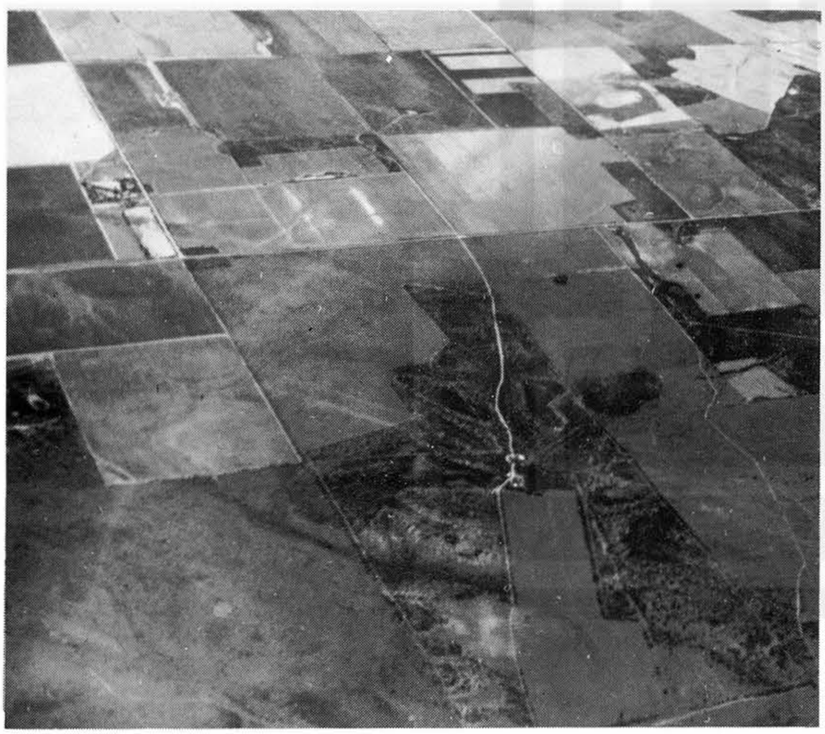


Fig. 14. Path of tornado still visible 3 weeks later. Photographed on May 7 from 10,000 ft (F 3).

A devastating tornado was spawned from a well-defined hook echo which appeared somewhat like a giant doughnut. The tornado left a devastating damage swath across McKinley Airport, 5-miles southwest of Pearsall.

F-scale contour lines were determined while flying over the entire area in an Army helicopter based at San Antonio. Meanwhile, an extensive field survey was performed in cooperation with the San Antonio WSFO and the Frio County Sheriff at Pearsall.

Very distinct suction swaths were spotted in a wheat field. They were photographed both from the ground and the helicopter (see Fig. 11). The tornado windspeed causing these swaths was estimated to be F 3.

Two cars travelling on US-81 were blown off the road. After leaving several bounce holes in the nearby field, both cars disintegrated beyond recognition (see Fig. 12). Five of the occupants were found dead in the field, stripped of all clothing except a bra on one of the dead females. Pieces of these automobiles were found scattered in peanut and wheat fields as far as one mile from the highway.

About a one-inch thick pavement of an 8-year old runway at McKinley Air Field was blown off. A 2000 ft section of the runway lost most of the pavement. Pieces of the asphalt, some one foot in horizontal dimensions, were found several hundred feet away (see Fig. 13).

On May 7, about 3 weeks after the tornado, aerial photographs of the tornado area were taken from 10,000 ft altitude. As shown in Fig. 14, a picture taken with an orange filter depicted the tornado swath. The F 4 tornado eroded the top soil, thus preventing the rapid growth of new grass. The tornado area experienced repeated rainfall and a damaging hailstorm during the 3-week period.

*CHICAGO TORNADO CYCLONE OF APRIL 19, 1973

During the early evening of April 19, the Chicago area experienced wide-spread wind damage. The areas of the wind damage reported by newspapers were so large that various questions regarding the nature of the wind storm came out in our staff meeting the next morning.

By mid-day, 7 cars driven by Project members were on the road to map the F-scale intensity and the direction of individual damage.

The results of the survey presented in Fig. 15 are of extreme interest. First of all, the damage length turned out to be in excess of 50 miles, while the damage width exceeded 10 miles. The most intense damage, occurring in Coal City was F 2. If we try to assign an F P P scale to this storm, the scale will be 2, 4, 7 --- too large in area for a possible tornado.

At Coal City, there were clear evidences of tornadic circulation within a small area, permitting us to assign F P P = 2, 1, 3 for the Coal City tornado. There was a sighting of a small funnel cloud from near Joliet. No corresponding damage was confirmed beneath the funnel.

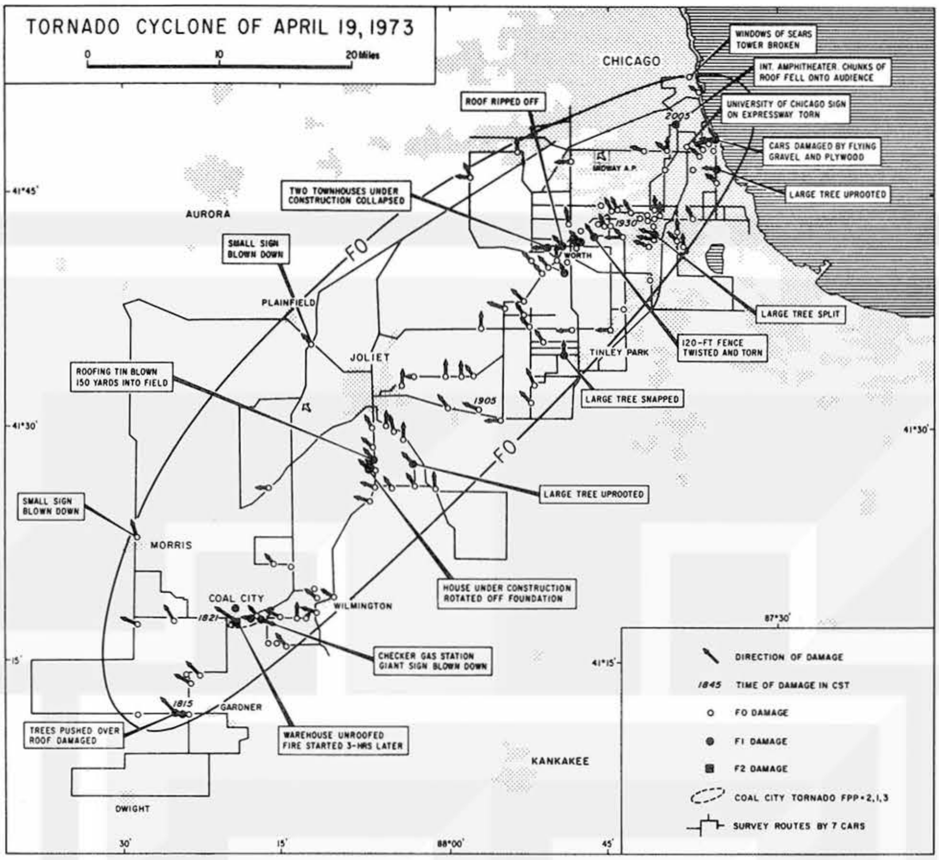


Fig. 15. Pattern of damage by a tornado cyclone.

When all of these evidences were put together, it was concluded that the large elliptic area including F 1 or weaker damage was disturbed by a tornado cyclone, rather than a weak giant-sized tornado. The damage directions do not imply typical straight-line wind because they were perpendicular to the storm's motion. Moreover, no thunderstorm was accompanied by the damaging wind.

This example will suggest that wide spread damage with the P-scale width, 6 or larger, is likely to be caused by straight wind or a tornado cyclone. In most cases a tornado cyclone is defined as a mesocyclone which spawns one or more tornadoes during its life time.

CONCLUSIONS

Atmospheric vortices which were confirmed in storm data as "tornadoes" display tremendous variations; some are incredibly strong but others are weak. Since there is no clear-cut definition of genuine tornadoes, a passing funnel is called a tornado whenever a surface disturbance is witnessed or confirmed.

We would very much like to know the spectrum of tornadoes in terms of intensity, path length, path width, area etc. Although the F P P classification is still experimental in nature, we have learned a lot during the past two years as to the variations of tornadoes.

The continuation of the classification into 1973 and beyond will be very useful for improving the prediction of tornadoes in various scales.

2WD173
STOROS
NRCGRANT

LAT	LONG

(lat, long)

11	12	13	14
21	22	23	24
31	32	33	34
41	42	43	44

(bx)

#'s of boxes crossed

```
        8
    7   |   1
  6 --- 0 --- 2
    5   |   3
        4
```

(d)

continuous - 0
skipping - 1 (p)
BOTH 2

CONTINUOUS X2
SKIPPING x 1/2

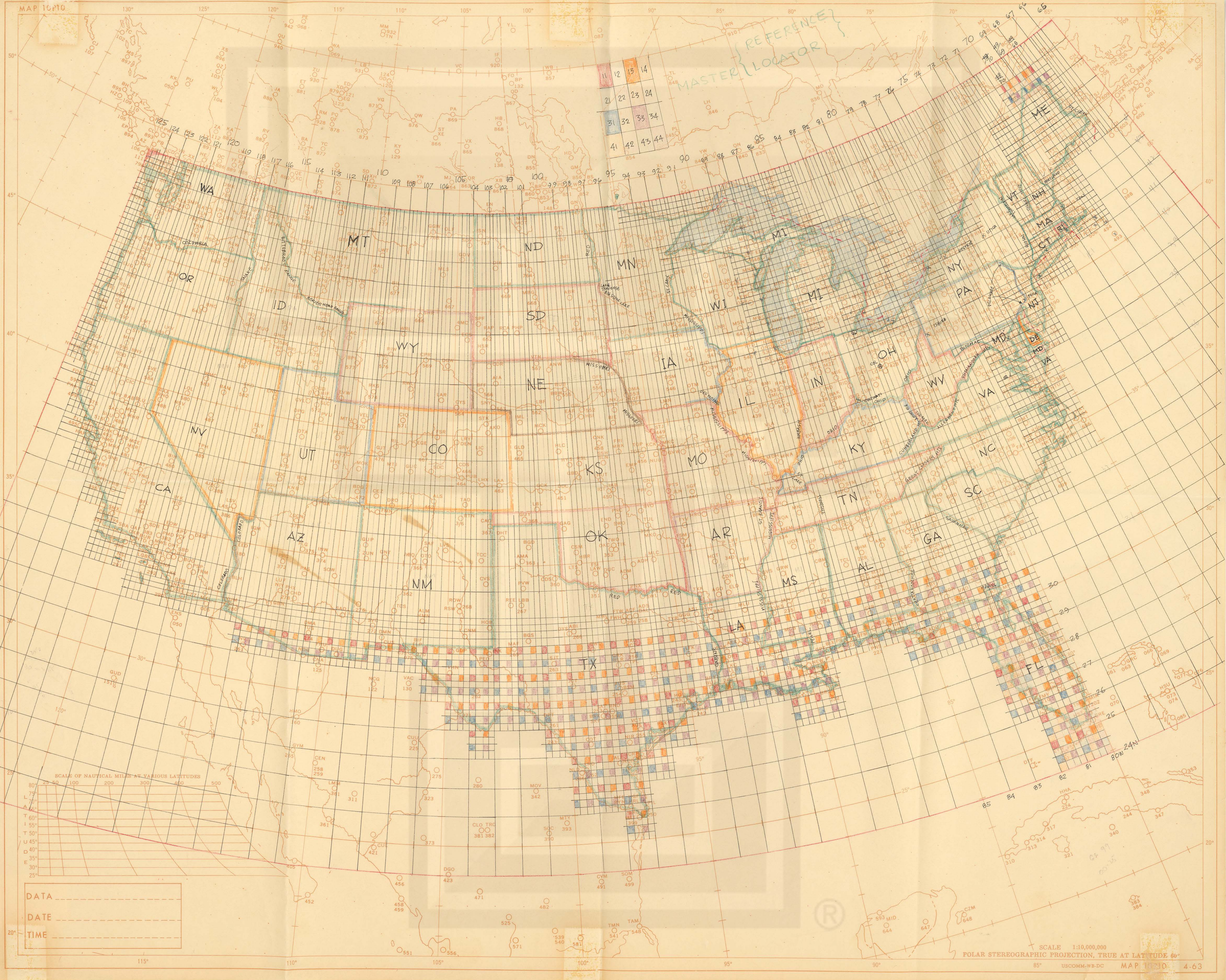
PATH LENGTH TO BE GIVEN AS SKIPPING ONLY

page ______

map by ______ date ______
book by ______ date ______
punched by ______ date ______
checked by ______ date ______

BLANK Th BLANK Pw BLANK GRID inner box

final number						year		id					O	mo		day		cst			F	deaths			injuries					boxes			lat		long		bx		miles		p	d		lat		long		bx		miles		p	d		lat		long		bx		miles		p	d		lat		long		bx		miles		p	d				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80


MASTER {REFERENCE LOCATOR}
SCALE OF NAUTICAL MILES AT VARIOUS LATITUDES
LATITUDE
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MI
IN
KY
TN
MS
AL
GA
FL
OH
WV
VA
NC
SC
PA
NY
MD
DE
NJ
VT
NH
MA
CT
RI
ME
DATA
DATE
TIME
SCALE 1:10,000,000
POLAR STEREOGRAPHIC PROJECTION, TRUE AT LATITUDE 60°
USCOMM-WB-DC
4-63