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UPPER-AIR WIND ROSES AND RESULTANT WINDS FOR THE EASTERN SECTION OF THE UNITED STATES

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UPPER-AIR WIND ROSES AND RESULTANT WINDS FOR THE EASTERN SECTION OF THE UNITED STATES

By LOYD A. STEVENS

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INTRODUCTION

The United States now has a fairly complete network of pilot-balloon stations and it is therefore believed that a summary of upper-air winds, showing average conditions for individual stations, will be of value not only to aviation interests but also to meteorologists and students who are interested in studying the general circulation of the atmosphere. This summary differs from part II of "An Aerological Survey of the United States" [1] in that, in the latter publication, observations from several stations were grouped for areas of geographical and climatic similarity and most of the data given for levels above the "surface" rather than above sea level, as is done in this summary.

The summary is based on pilot-balloon observations from 14 Weather Bureau stations located in the eastern section of the United States. It will be noted that the stations are quite evenly distributed over the area, except for a rather large gap over southern Ohio, southwestern Pennsylvania, West Virginia, and eastern Kentucky. Summaries similar to this are being made for the remainder of the country, and these will be published as soon as the computations are completed.

TABLE 1.—*List of stations, showing elevation above sea level, period of record, and number of observations*

Station	Elevation (meters)	Period of record	Average number observations daily
Atlanta, Ga	309	Oct. 1926–Dec. 1930	2
Boston, Mass	15	Nov. 1926–Oct. 1931	2
Burlington, Vt	132	Jan. 1924–Dec. 1931	2
Cleveland, Ohio	245	Sept. 1926–May 1931	3
Detroit, Mich	2 7	Oct. 1926–June 1931	2
Due West, S.C	217	Jan. 1924–Dec. 1930	2
Greensboro, N.C	271	May 1928–Dec. 1931	3
Ithaca, N.Y	291	Jan. 1924–Sept. 1929	1
Jacksonville, Fla	14	Oct. 1926–Dec. 1931	2
Key West, Fla	11	July 1920–Dec. 1931	2
Knoxville, Tenn	318	Aug. 1927–Dec. 1931	2
Newark, N.J	14	Jan. 1927–Dec. 1931	3
Sault Ste. Marie, Mich	198	Jan. 1927–June 1931	2
Washington, D.C	10	Jan. 1921–Dec. 1931	3

In conformity with the recommendations of the International Commission for Air Navigation and the International Commission for the Exploration of the Upper Air, the data presented herein are given in metric units.

The data used in this summary are computed for heights above sea level. This has been the standard practice in the Weather Bureau since January 1, 1924. The levels used are 750 meters (2,461 feet), 1,500 meters (4,921 feet), 3,000 meters (9,842 feet), and 4,000 meters (13,123 feet). Surface winds are not included, as a comparison between surface winds and winds aloft is given in part II of "An Aerological Survey of the United States", and, furthermore, more satisfactory data for showing average surface wind conditions are available in the hourly wind records kept by all Weather Bureau stations.

[1] Gregg, W. R., Supplement No. 26, Monthly Weather Review, 1926.

TABLE 2.—*Number of observations upon which wind roses and resultants are based*

750 METERS

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Atlanta, Ga	248	221	252	269	277	266	286	283	239	273	271	292	3,177
Boston, Mass	262	229	288	289	288	277	308	302	294	321	252	237	3,347
Burlington, Vt	314	282	348	341	355	364	384	380	325	369	339	331	4,132
Cleveland, Ohio	361	333	403	442	489	395	414	421	419	446	400	328	4,851
Detroit, Mich	239	225	263	278	315	317	249	261	238	267	248	219	3,119
Due West, S.C	342	319	374	368	392	373	391	397	357	390	356	352	4,411
Greensboro, N.C	201	196	247	253	332	322	344	317	308	340	296	300	3,456
Ithaca, N.Y	152	131	155	145	168	160	170	179	159	136	125	119	1,799
Jacksonville, Fla	283	250	289	302	300	296	320	316	300	334	326	315	3,631
Key West, Fla	592	558	613	603	611	606	666	696	645	607	657	630	7,484
Knoxville, Tenn	201	188	207	216	216	223	233	285	270	283	249	241	2,812
Newark, N.J	404	358	411	430	464	445	481	471	453	496	418	448	5,279
Sault Ste. Marie, Mich	192	182	224	245	252	255	222	214	186	174	151	116	2,413
Washington, D.C	698	641	716	716	759	735	774	769	748	782	707	758	8,803

1,500 METERS

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Atlanta, Ga	228	204	227	259	265	246	273	274	228	259	244	256	2,963
Boston, Mass	209	178	242	255	271	256	288	273	268	298	189	188	2,915
Burlington, Vt	202	206	271	276	303	330	337	344	284	298	235	191	3,277
Cleveland, Ohio	233	188	284	358	452	349	385	382	412	335	262	159	3,799
Detroit, Mich	148	131	183	216	257	272	208	222	202	208	160	110	2,317
Due West, S.C	307	293	337	345	378	356	373	375	327	369	305	312	4,077
Greensboro, N.C	177	181	227	238	308	306	332	295	290	323	264	272	3,213
Ithaca, N.Y	80	77	105	128	148	141	151	153	133	110	89	68	1,383
Jacksonville, Fla	261	235	261	272	273	272	295	287	262	290	294	278	3,280
Key West, Fla	513	507	529	527	545	561	590	608	564	535	555	565	6,599
Knoxville, Tenn	171	160	184	199	198	206	219	272	259	270	205	201	2,544
Newark, N.J	335	306	336	373	406	395	396	417	393	444	341	332	4,474
Sault Ste. Marie, Mich	119	129	189	223	223	228	197	196	157	134	80	67	1,942
Washington, D.C	592	542	612	640	706	656	711	689	654	695	593	621	7,711

3,000 METERS

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Atlanta, Ga	143	142	133	200	197	205	233	214	170	180	122	145	2,084
Boston, Mass	49	61	88	117	130	158	167	166	158	165	76	72	1,407
Burlington, Vt	86	95	128	148	154	197	213	213	131	153	94	59	1,671
Cleveland, Ohio	64	65	120	183	243	201	223	229	219	160	87	33	1,827
Detroit, Mich	45	42	70	102	110	150	113	120	77	76	44	30	979
Due West, S.C	236	195	222	247	287	275	303	317	273	292	228	228	3,103
Greensboro, N.C	48	79	115	144	192	216	252	195	183	193	112	124	1,853
Ithaca, N.Y	23	34	48	55	77	74	91	92	77	60	32	30	693
Jacksonville, Fla	166	147	170	201	213	220	250	231	197	188	195	164	2,342
Key West, Fla	329	343	335	370	385	422	442	460	425	400	326	376	4,613
Knoxville, Tenn	47	71	91	110	128	159	155	170	179	161	84	81	1,436
Newark, N.J	95	124	113	167	189	224	210	199	157	195	82	76	1,831
Sault Ste. Marie, Mich	45	76	102	155	140	152	138	121	81	59	31	24	1,124
Washington, D.C	208	217	261	329	417	432	489	418	419	404	268	253	4,115

4,000 METERS

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Atlanta, Ga	80	89	82	155	145	166	199	174	136	110	67	73	1,476
Boston, Mass	17	21	49	66	60	82	104	99	88	75	26	28	715
Burlington, Vt	44	48	85	93	89	112	127	140	86	101	42	24	991
Cleveland, Ohio	23	26	53	80	142	95	128	128	108	74	36	11	904
Detroit, Mich	15	19	34	58	51	89	66	75	33	38	21	15	514
Due West, S.C	155	153	151	174	205	202	241	252	216	234	172	161	2,316
Greensboro, N.C	15	36	57	102	125	154	177	121	128	97	51	43	1,106
Ithaca, N.Y	11	18	26	29	41	51	61	67	65	43	16	13	441
Jacksonville, Fla	115	108	118	168	177	183	227	196	173	149	142	112	1,868
Key West, Fla	266	277	257	303	310	343	359	370	365	309	235	287	3,681
Knoxville, Tenn	11	29	43	64	80	109	120	104	131	98	39	38	866
Newark, N.J	33	48	45	71	100	124	106	104	94	90	25	24	864
Sault Ste. Marie, Mich	19	46	77	100	91	94	98	66	45	25	18	8	687
Washington, D.C	86	84	122	169	226	285	308	272	276	261	130	94	2,313

No record of less than 3 years in length is included. Consequently, the results are believed to give an accurate indication of average conditions prevailing at each station, except at the 4,000-meter level for certain stations during the winter months where the number of observations is probably too small to give reliable averages. It

should be borne in mind in this connection that pilot-balloon observations are not made when precipitation is occurring and that the maximum height reached in many cases is limited by cloud layers. The number of observations on which the data are based are given in table 2.

All the observations made at each station, regardless of the time of day, are combined in this summary. Previous to 1926 two observations were made daily at all these stations except Ithaca, N.Y., at about 8 a.m. and 3 p.m., E.S.T. At Ithaca only one observation was made daily, at 3 p.m., throughout the entire period covered by this summary. At the other stations the time of the 8 a.m. observations was changed to 6:30 a.m. and that of the 3 p.m. observations to 6:30 p.m. during 1926 and 1927, and intermediate observations approximately midway between these two times were begun by certain stations. Early in 1930 the times of 6:30 and 12:30 a.m. and p.m., E.S.T., were standardized for all stations, and this schedule has been followed rather closely since that time. The average number of observations made daily at each station is given in table 1.

WIND ROSES

In figures 1–52, wind roses are presented for each month and for the year.

As these charts are essentially self-explanatory, only the outstanding characteristics will be pointed out. It is desired to call attention, first of all, to the fact that the average velocities from directions having low percentage frequencies are much less uniform than those from directions having high percentage frequencies. This is, of course, due to the smaller number of observations upon which the former are based. Lack of sufficient number of observations appears, also, to account for the high percentage of west winds at Ithaca at 3,000 and 4,000 meters during January and December. The effects of local topography are apparent in the lower levels at certain stations; the most noteworthy case being that of the high percentage of southwest winds throughout the year at 750 meters at Knoxville. This is obviously due to the SW.–NE. direction of the valley in which the station is situated.

In table 3 the annual percentage frequencies of winds for each direction are combined into two figures showing the total frequency of westerly and easterly winds, respectively. In arriving at these figures the total frequencies of NNW. to SSW. plus ½ (N. plus S.) are considered as "westerly" winds and the total frequencies of NNE. to SSE. plus ½ (N. plus S.) are considered as "easterly" winds.

The inclusion of north and south winds in these tables is believed justified by the fact that, in the great majority of cases, winds so recorded are actually one or more degrees east or west of true north or true south. Assigning one half to westerly and one half to easterly directions is, of course, arbitrary and is done as a convenience to avoid reference to many thousands of individual records. Since the percentage frequencies of north and south winds are in most cases relatively small, as will be seen in figures 49 to 52, from which this table was compiled; the errors introduced by this method cannot be large.

The gradual increase in percentage of "westerly" winds and the corresponding decrease in "easterly" winds between 750 meters and 3,000 meters ranges from 8 percent at Ithaca to 29 percent at Key West. From 3,000 meters to 4,000 meters the change is small, however, except at Key West and Jacksonville, where it amounts to 8 percent and 5 percent, respectively.

TABLE 3.—*Total annual percentage frequency of westerly and easterly winds. Westerly winds are, NNW. to SSW. plus ½ (N. plus S.); easterly winds are, NNE. to SSE. plus ½ (N. plus S.)*

Stations	750 meters		1,500 meters		3,000 meters		4,000 meters	
	Total W.	Total E.	Total W.	Total E.	Total W.	Total E.	Total W.	Total E.
Atlanta, Ga.	65	35	73	27	80	20	82	18
Boston, Mass.	82	18	89	11	92	8	92	8
Burlington, Vt.	79	21	86	14	90	10	90	10
Cleveland, Ohio	74	26	82	18	88	12	91	9
Detroit, Mich.	73	27	82	18	89	11	89	11
Due West, S.C.	64	36	76	24	85	15	86	14
Greensboro, N.C.	69	31	78	22	82	18	82	18
Ithaca, N.Y.	82	18	87	13	90	10	92	8
Jacksonville, Fla.	53	47	66	34	74	26	79	21
Key West, Fla.	25	75	35	65	54	46	62	38
Knoxville, Tenn.	68	32	78	22	81	19	79	21
Newark, N.J.	79	21	87	13	89	11	88	12
Sault Ste. Marie, Mich.	69	31	74	26	85	15	86	14
Washington, D.C.	75	25	86	14	91	9	91	9

At most stations velocities are higher in winter than in summer and higher from westerly directions than from easterly directions. At Key West, however, at 750 meters, velocities are higher from easterly directions than from westerly directions. As a rule, velocities increase with latitude, being higher, for instance, at Sault Ste. Marie, Burlington, and Boston than at Key West, Jacksonville, and Atlanta. Velocities also increase with altitude at all stations except Key West where there is a decrease from 750 meters to 3,000 meters and then an increase to 4,000 meters. This is due, of course, to the fact that the easterly trade winds predominate at Key West throughout the year in the lower levels, with the maximum velocity occurring at about 500 meters. It has been found, by computing these data for additional levels for Key West, that the velocity decreases above 500 meters to about 2,500 meters where the antitrades or westerly winds begin to predominate. A gradual increase in velocity then occurs above 2,500 meters.

In table 4 average velocities are given for all observed winds, regardless of direction.

TABLE 4.—*Average velocities in m.p.s. (obtained by dividing the total of all velocities by the total number of observations). One m.p.s.=2.24 m.p.h.*

ATLANTA, GA.

Altitude (meters)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
750	9.7	8.7	9.6	9.0	8.2	7.5	5.8	5.6	5.9	8.8	9.6	9.4	8.1
1,500	11.6	9.3	11.5	8.7	7.5	7.3	5.0	5.0	5.3	8.4	9.9	10.4	8.2
3,000	15.9	13.4	14.0	10.8	8.2	8.2	5.5	6.1	6.4	9.6	12.0	13.1	9.7
4,000	16.3	15.8	15.7	11.9	8.8	9.0	5.9	6.5	6.2	9.0	13.5	14.9	10.0

BOSTON, MASS.

750	11.9	10.1	10.7	10.5	9.3	8.4	7.8	7.5	8.6	9.6	10.6	10.6	9.5
1,500	13.6	12.3	12.0	11.3	9.8	9.3	9.0	8.2	9.5	10.9	11.5	11.6	10.6
3,000	17.0	14.2	13.1	12.4	12.1	11.9	11.4	10.3	12.0	14.2	14.7	15.6	12.5
4,000	18.0	14.2	14.6	12.8	13.3	13.7	11.2	10.9	13.6	14.7	16.3	15.8	13.3

BURLINGTON, VT.

750	9.3	8.4	9.1	9.1	8.6	7.9	7.4	6.9	8.0	9.0	9.8	9.7	8.5
1,500	13.0	11.2	10.4	11.6	8.8	9.2	8.0	8.0	9.8	10.4	11.3	12.3	10.0
3,000	17.2	14.9	12.8	14.1	12.1	10.9	9.7	9.4	12.9	12.6	14.9	16.0	12.4
4,000	19.8	15.8	13.4	13.0	13.1	12.5	11.7	10.5	13.0	13.2	15.8	14.3	12.9

CLEVELAND, OHIO

750	10.9	10.0	10.5	10.1	8.7	8.7	7.6	6.9	8.2	9.7	11.6	10.7	9.4
1,500	12.4	11.5	10.7	10.3	9.2	9.0	8.1	6.8	8.6	9.6	11.8	11.6	9.6
3,000	13.9	13.4	12.5	12.6	10.5	9.5	8.6	7.6	9.3	11.1	12.3	11.1	10.4
4,000	14.1	15.5	12.8	12.7	10.9	11.1	9.3	8.6	9.6	12.4	13.8	12.2	10.9

TABLE 4.—*Average velocities in m.p.s. (obtained by dividing the total of all velocities by the total number of observations). One m.p.s.=2.24 m.p.h.*—Continued

DETROIT, MICH.

Altitude (meters)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
750	12.1	9.8	9.8	10.2	8.7	8.0	7.2	6.8	8.5	10.1	11.5	10.0	9.3
1,500	12.5	11.1	10.1	9.8	9.0	8.1	7.9	6.7	8.7	10.2	12.2	11.1	9.5
3,000	14.6	13.2	11.9	11.3	11.3	9.9	9.3	8.4	9.5	11.7	11.2	13.1	10.7
4,000	19.5	13.8	12.1	11.8	11.3	10.8	9.5	9.8	9.2	13.4	15.1	13.2	11.4

DUE WEST, S.C.

750	8.4	8.3	8.7	8.1	7.7	6.7	5.4	5.5	5.6	7.0	7.9	8.3	7.3
1,500	10.9	10.4	9.7	8.2	7.3	6.7	5.2	4.9	5.6	7.1	8.9	10.3	7.8
3,000	16.6	15.9	14.0	12.4	9.7	7.8	6.4	6.4	6.5	9.8	14.2	15.2	10.8
4,000	19.0	17.4	17.4	13.6	10.2	7.9	7.8	6.9	7.1	10.5	15.9	18.8	12.0

GREENSBORO, N.C.

750	10.3	9.5	10.4	10.1	8.9	8.4	7.4	6.6	7.9	8.0	9.0	9.3	8.7
1,500	11.2	9.9	11.3	10.1	8.6	6.8	5.9	6.0	6.5	7.4	8.9	10.8	8.3
3,000	15.7	12.7	13.3	10.7	9.7	8.0	6.3	6.8	6.1	8.1	10.6	13.3	9.1
4,000	18.3	10.3	14.8	12.5	9.8	8.9	7.0	7.3	6.9	8.5	11.9	15.2	9.5

ITHACA, N.Y.

750	9.4	7.9	8.1	8.6	7.1	6.5	6.2	5.9	6.3	7.3	9.2	9.0	7.5
1,500	13.9	10.6	10.9	9.8	8.1	7.8	7.3	6.7	7.9	9.3	11.9	12.0	9.2
3,000	14.1	14.0	14.1	13.8	11.9	10.2	9.3	8.8	9.5	12.4	14.8	13.7	11.4
4,000	11.8	13.6	13.8	15.1	12.5	12.1	10.7	10.0	10.8	14.2	14.9	11.5	12.1

JACKSONVILLE, FLA.

750	8.2	7.9	9.0	7.9	6.6	5.8	5.8	6.1	6.8	7.7	7.8	8.4	7.3
1,500	8.7	8.2	9.9	7.9	6.8	5.6	4.9	5.8	5.9	7.1	7.9	8.9	7.2
3,000	12.2	12.1	13.5	8.8	7.8	6.5	5.2	5.6	5.7	7.5	9.6	12.3	8.5
4,000	14.4	13.9	14.7	9.6	8.5	7.0	5.3	5.9	5.8	7.8	11.0	14.3	9.1

KEY WEST, FLA.

750	8.5	8.0	8.2	7.1	6.4	5.7	5.5	5.4	6.3	7.7	9.3	8.3	7.2
1,500	6.8	7.0	7.2	5.7	6.1	5.3	5.2	5.1	5.9	6.1	7.6	6.5	6.2
3,000	7.0	7.0	8.3	6.2	5.9	4.9	4.9	4.8	5.3	5.1	6.6	6.4	5.9
4,000	8.4	8.3	9.9	7.4	5.6	4.8	4.4	4.8	5.1	5.6	6.9	7.4	6.3

KNOXVILLE, TENN.

750	6.7	6.3	7.6	7.7	7.0	6.0	5.0	5.1	5.3	5.4	6.8	6.7	6.2
1,500	10.8	8.5	9.3	8.7	8.1	6.3	5.0	5.4	5.3	6.8	9.0	10.1	7.6
3,000	16.0	14.6	13.1	10.7	9.2	8.0	6.0	6.6	7.2	8.5	14.2	12.1	9.4
4,000	16.0	15.7	12.7	11.8	9.0	8.0	6.3	6.9	7.1	9.3	16.3	13.6	9.2

NEWARK, N.J.

750	12.5	10.4	11.1	10.4	9.4	8.2	7.4	7.2	8.2	10.0	11.7	11.7	9.8
1,500	14.7	12.5	12.7	11.3	9.5	8.4	7.9	7.5	8.8	10.2	12.4	12.7	10.5
3,000	15.9	14.5	14.0	13.8	11.7	10.9	9.3	8.6	9.7	11.4	13.2	13.8	11.7
4,000	16.1	14.2	11.9	14.3	12.2	12.2	9.3	8.7	11.2	11.0	11.7	13.7	11.7

SAULT STE. MARIE, MICH.

750	9.3	7.8	9.4	9.1	9.1	9.0	8.5	7.8	9.1	8.6	8.8	9.1	8.8
1,500	11.3	9.6	10.0	9.2	9.3	9.0	9.0	8.1	9.7	10.5	10.5	9.5	9.5
3,000	14.8	14.1	11.9	11.1	10.5	10.8	11.4	9.6	11.5	13.1	12.9	12.7	11.5
4,000	11.9	15.4	13.4	13.1	11.5	11.9	13.2	12.4	11.7	14.7	16.1	13.9	12.7

WASHINGTON, D.C.

750	11.1	10.2	10.4	9.4	8.0	7.4	6.5	6.0	6.7	8.4	9.8	10.5	8.6
1,500	13.1	12.7	11.7	11.3	8.7	7.8	6.7	6.8	7.1	9.3	11.1	12.9	9.8
3,000	17.2	16.0	14.7	13.7	11.2	10.3	8.9	8.6	9.2	11.3	14.2	16.8	11.9
4,000	19.2	17.1	15.1	14.4	10.7	11.1	9.2	8.8	9.2	12.0	15.0	18.5	11.9

RESULTANT WINDS

Resultant winds are of considerable value, both for study purposes and for practical use, in that they show the mass movement of air. In computing these data, each individual wind observation is considered as a force vector, and in arriving at the final results these forces are combined into one force, or value, representing the resultant or mass movement of air. For example, a north wind of 10 m.p.s. combined with a south wind of 12 m.p.s. will give a resultant wind of 2 m.p.s. from the south, which is, of course, the mass movement of the air as measured by these two observations. Resultant winds can be used to advantage in planning air-line schedules,[2] and also in the study of the general circulation of the atmosphere.

In the following figures, 53 to 65, the resultant winds are shown by arrows flying with the wind. The lengths of the arrows indicate velocities in meters per second.

It will be noted that at most stations the resultant directions range from SW. to NW. throughout the year. At the more southerly stations, however, these directions are affected by the easterly trade winds, as follows:

At Atlanta, at 750 meters, the resultant direction is S. during September and NNE. during October; also at Due West, at 750 meters, it is ENE. during September and N. during October. At Jacksonville, at 750 meters, the resultant direction is E. during September and November and NE. during October, and at 1,500 and 3,000 meters during September it is ESE. and SE., respectively. At Key West, at 750 meters, the resultant directions range from ENE. to SE.; at 1,500 meters from E. to S. during the months of April to January, inclusive; at 3,000 meters from ESE. to SSE., during the months June to October, inclusive; and at 4,000 meters from the SE. or ESE., during July, August, and September.

With a few exceptions, the annual resultant directions for all stations and all levels are concentrated between the directions WSW. to WNW., inclusive. The only exceptions are: SW. at 750 meters at Jacksonville, NW. at 4,000 meters at Sault Ste. Marie, and ESE., SE., and SW. at 750, 1,500, and 3,000 meters, respectively, at Key West.

It is interesting to note, in this connection, that, for the year as a whole, the shift from easterly to westerly resultant winds at Key West occurs at about 2,500 meters, whereas at San Juan, Puerto Rico,[3] this shift does not occur until a level between 5,000 and 6,000 meters is reached, thus indicating the amount of increase in the depth of the trade winds southward from Key West.

Resultant velocities are, in general, highest during the winter months and lowest during the summer months. A gradual increase in these velocities with altitude is apparent at all stations except Key West, where a decrease occurs between 750 and 3,000 meters and then an increase to 4,000 meters.

[2] Gregg, W. R., Aeronautical Meteorology, Revised Edition, p. 108.
[3] Ray, C. L., Monthly Weather Review, November 1931, p. 414.

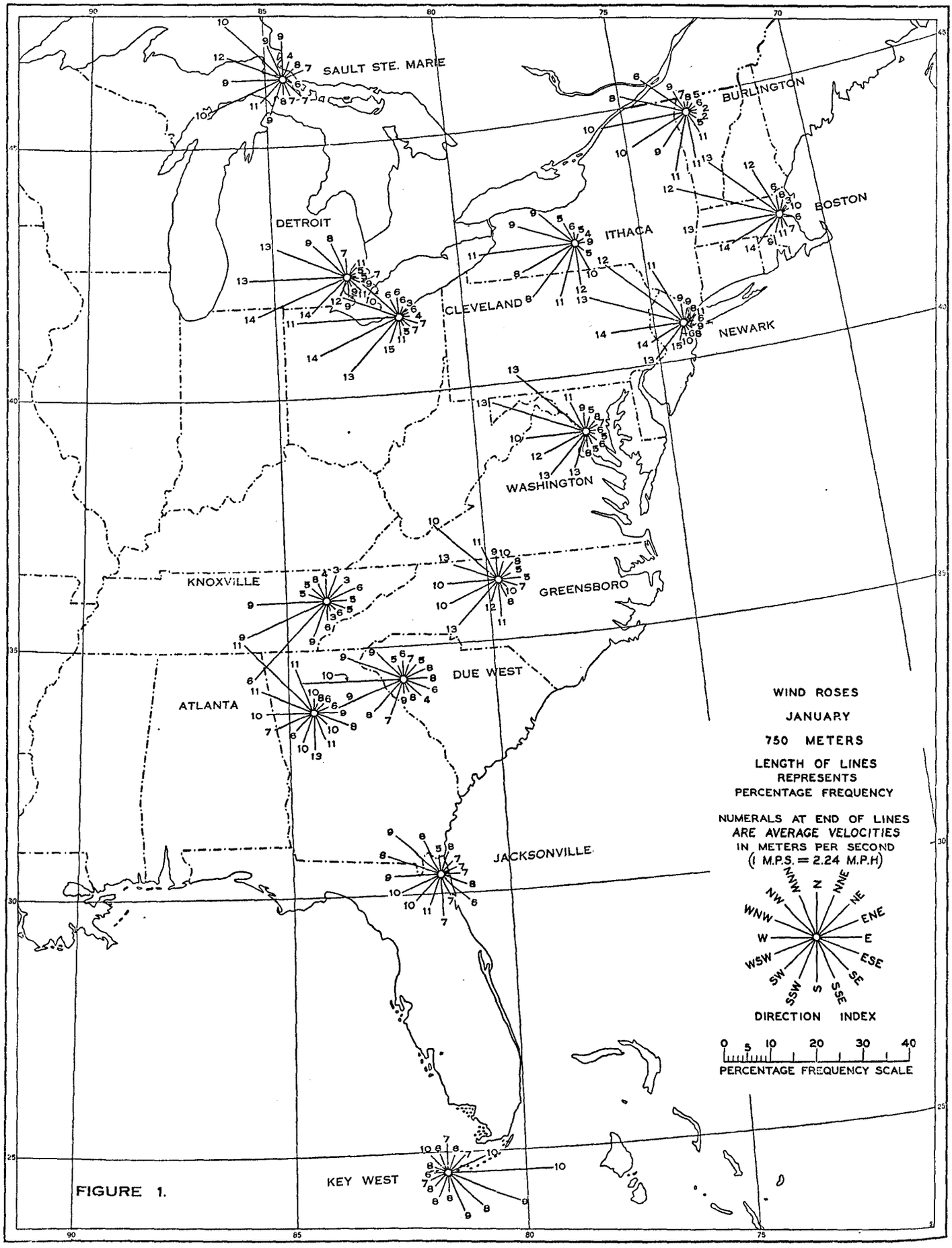
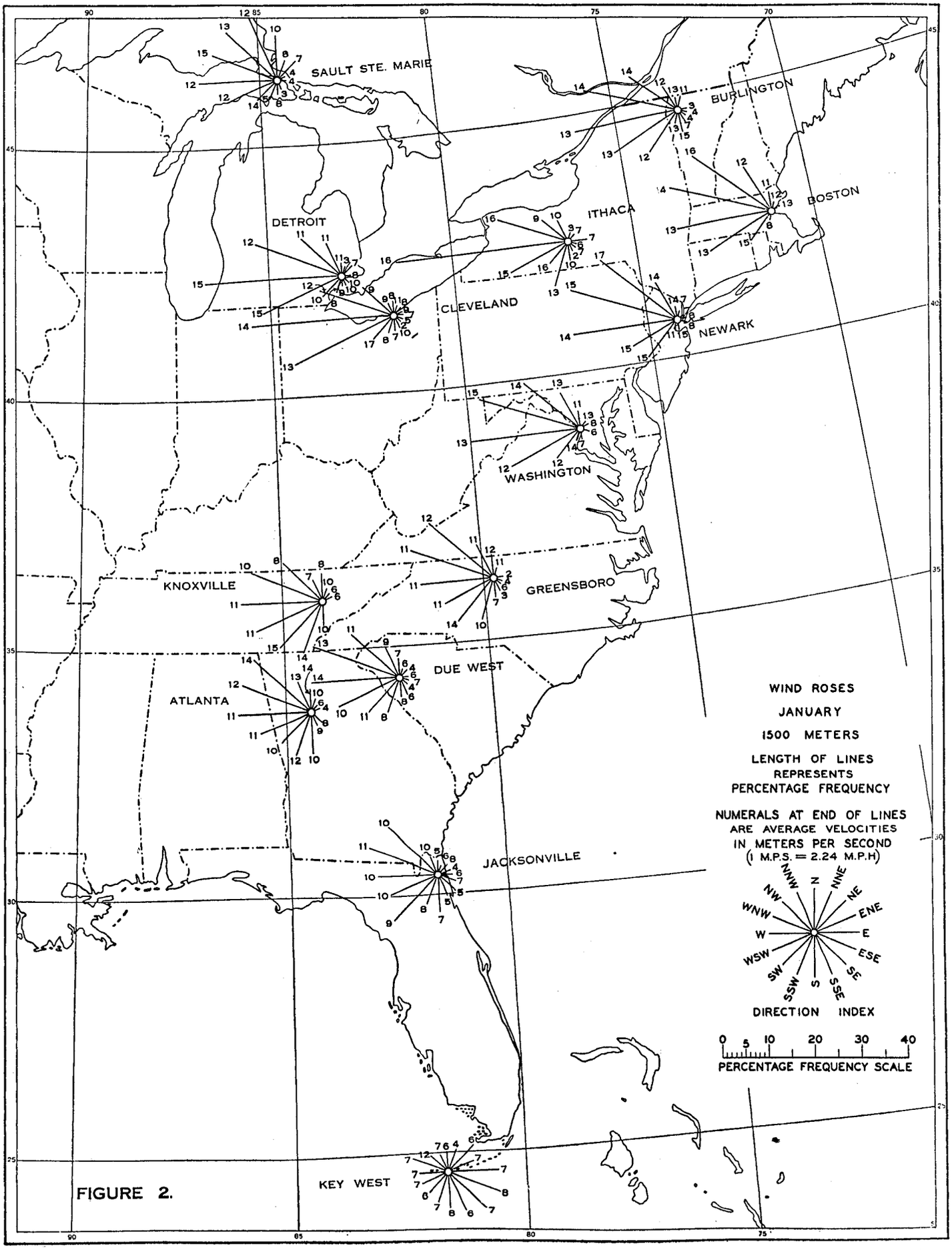

SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JANUARY
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 1.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WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JANUARY
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
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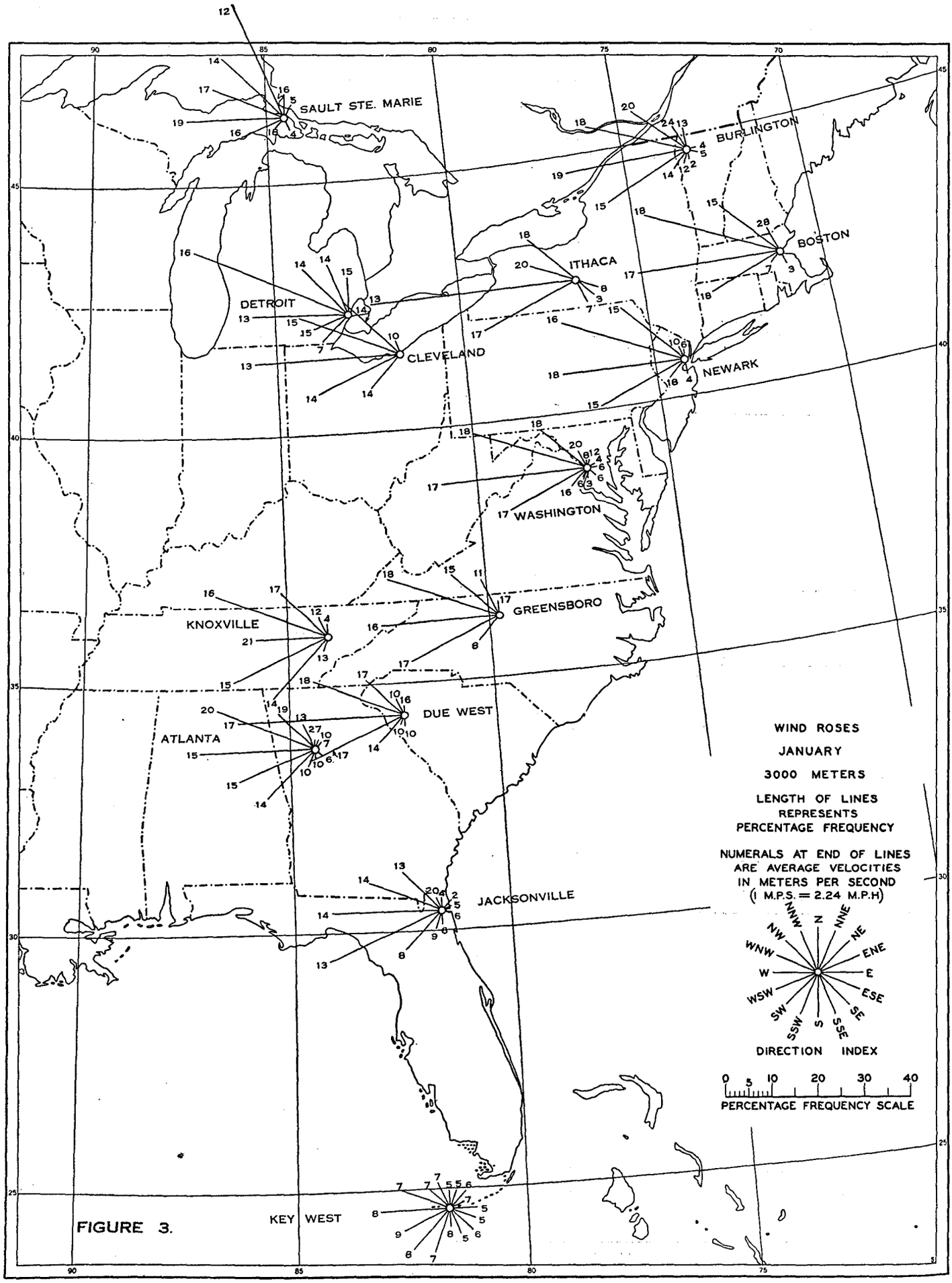
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 2.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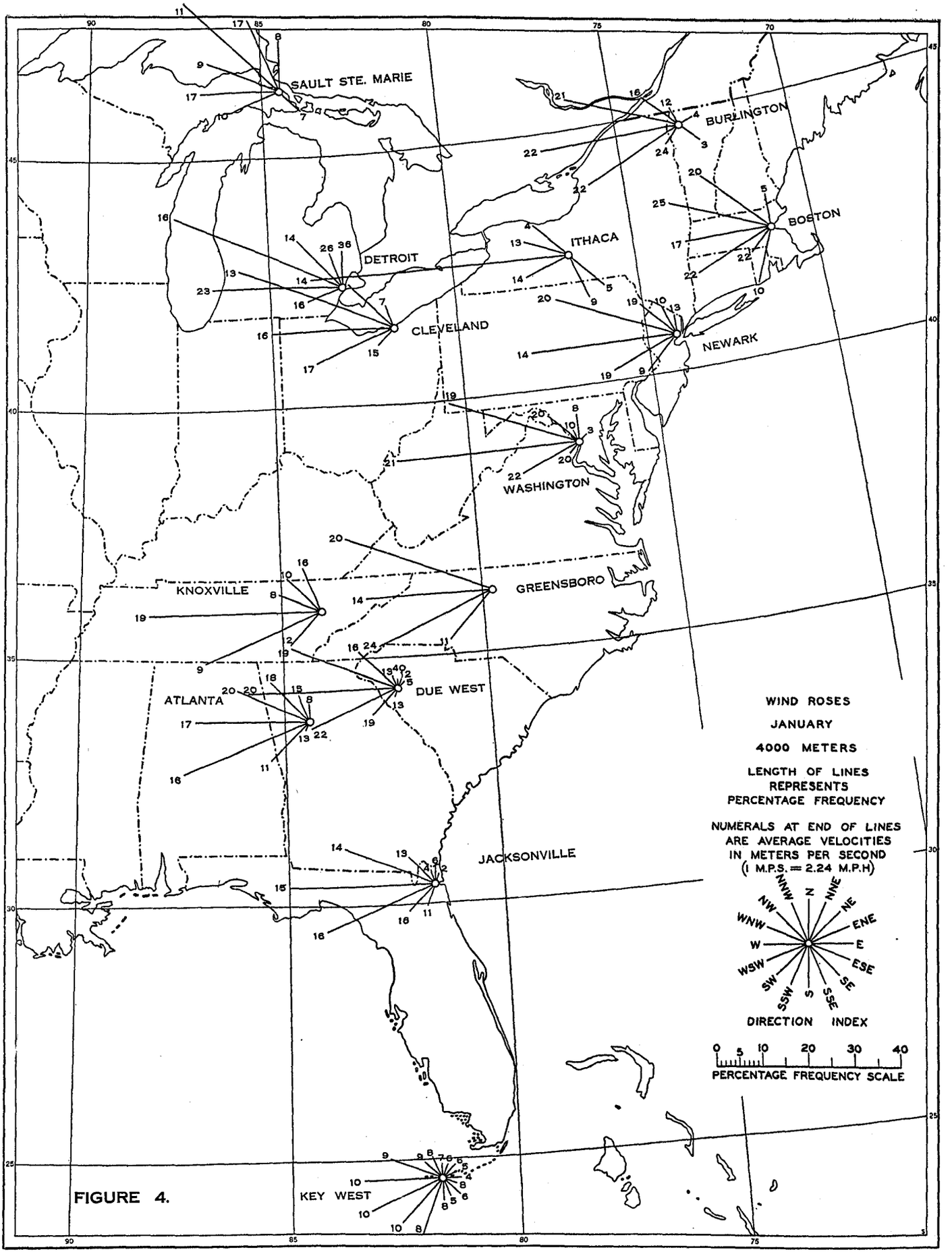
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JANUARY
3000 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 3.


SAULT STE. MARIE
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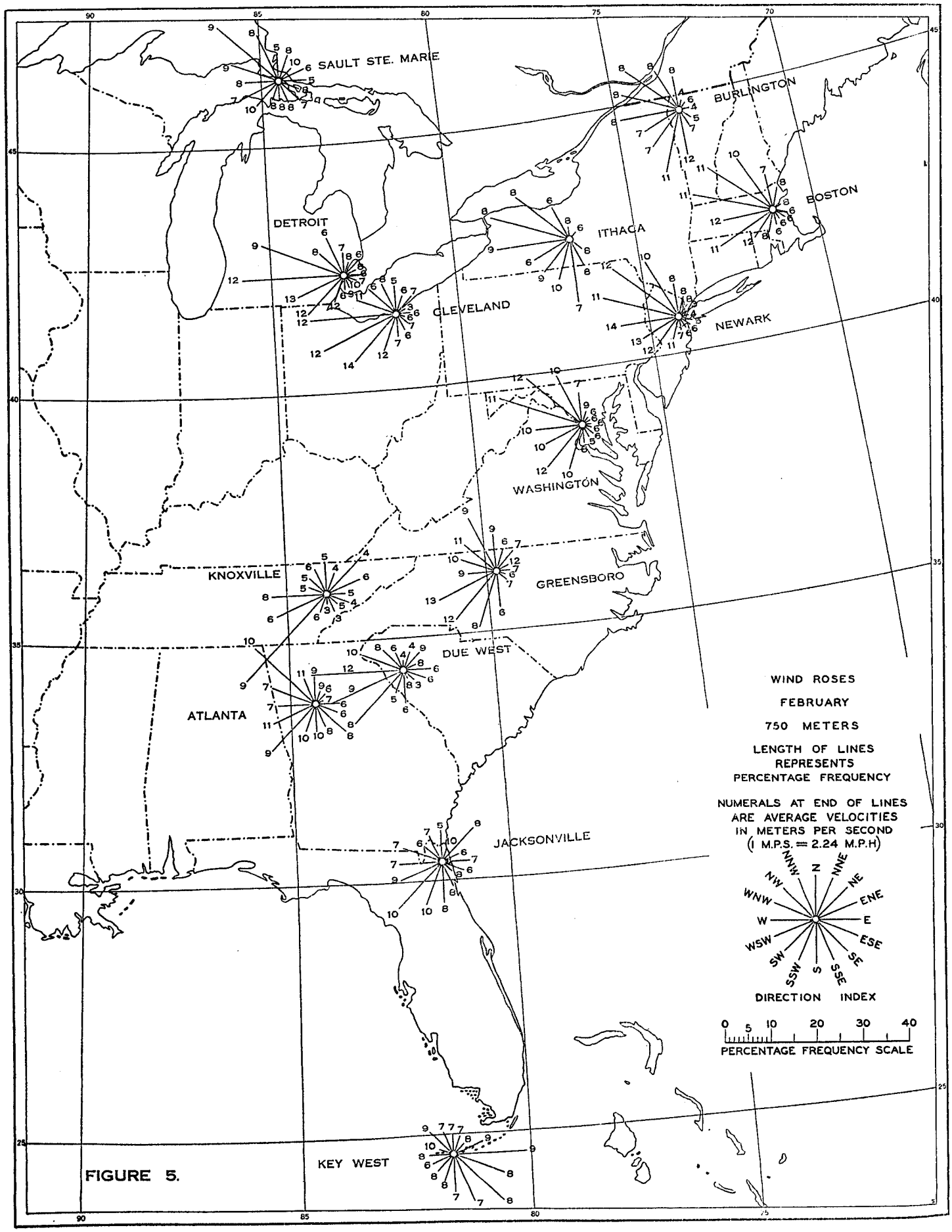
DETROIT
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JANUARY
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 4.


SAULT STE. MARIE
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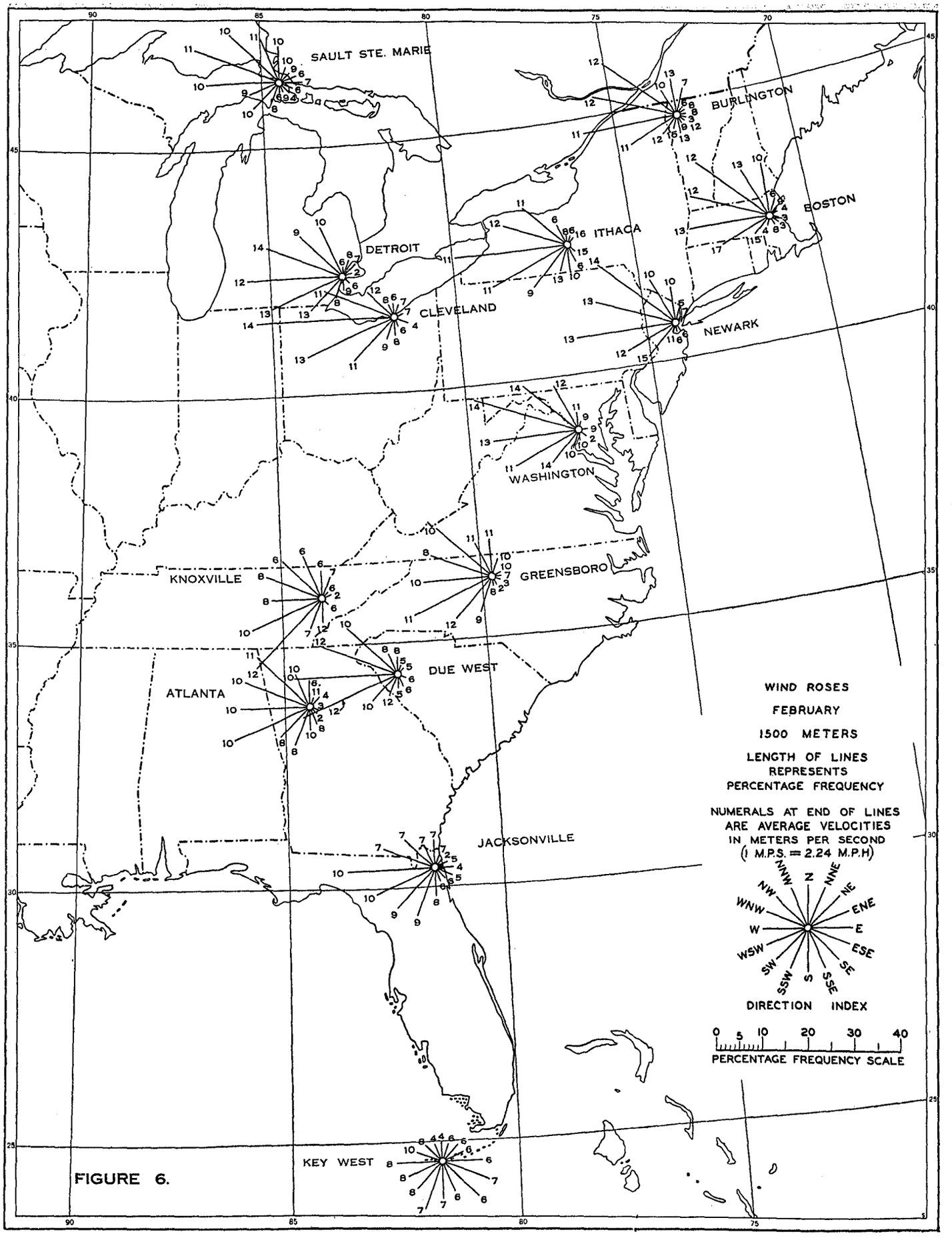
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
FEBRUARY
750 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
Z
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 5.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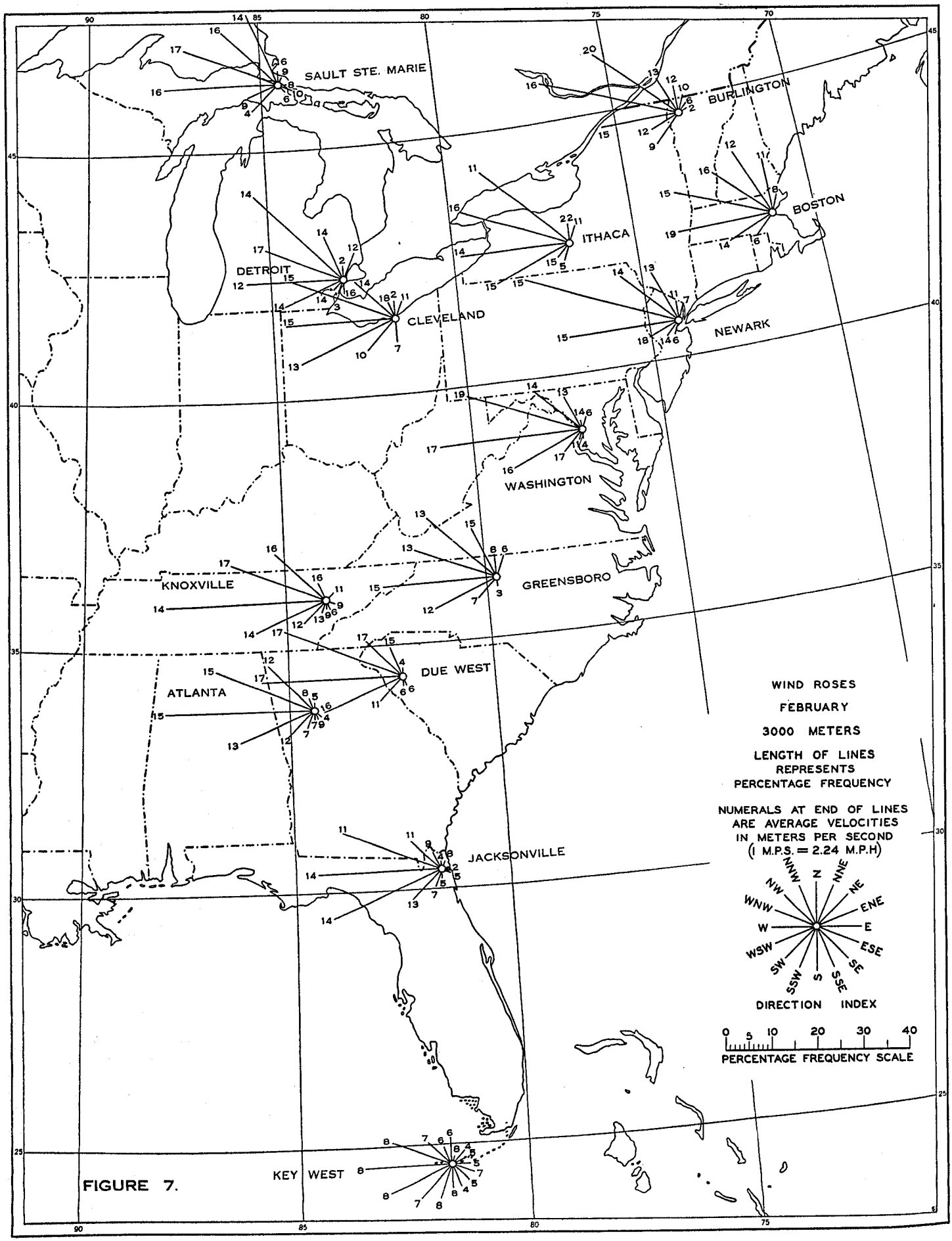
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
FEBRUARY
1500 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 6.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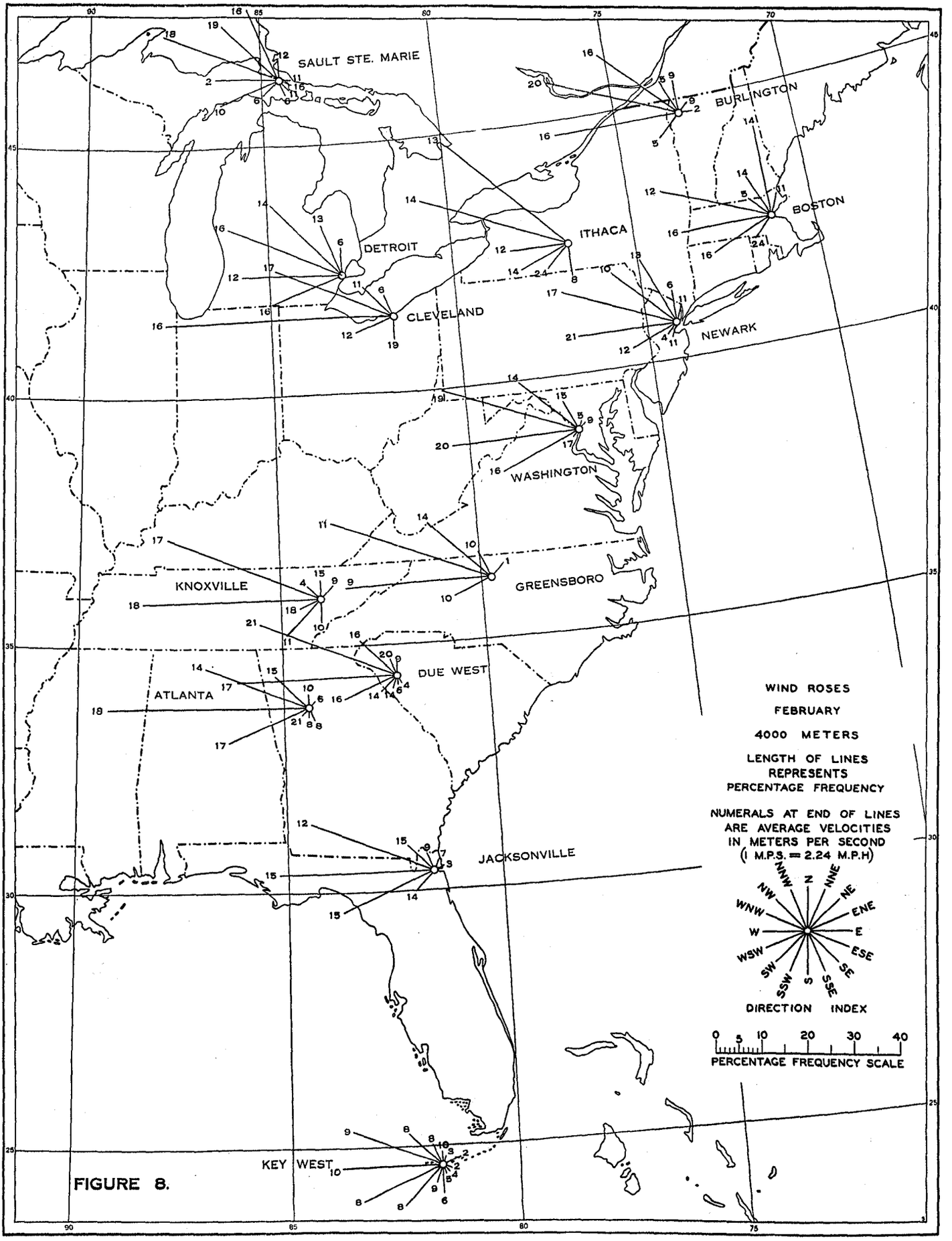
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
FEBRUARY
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 7.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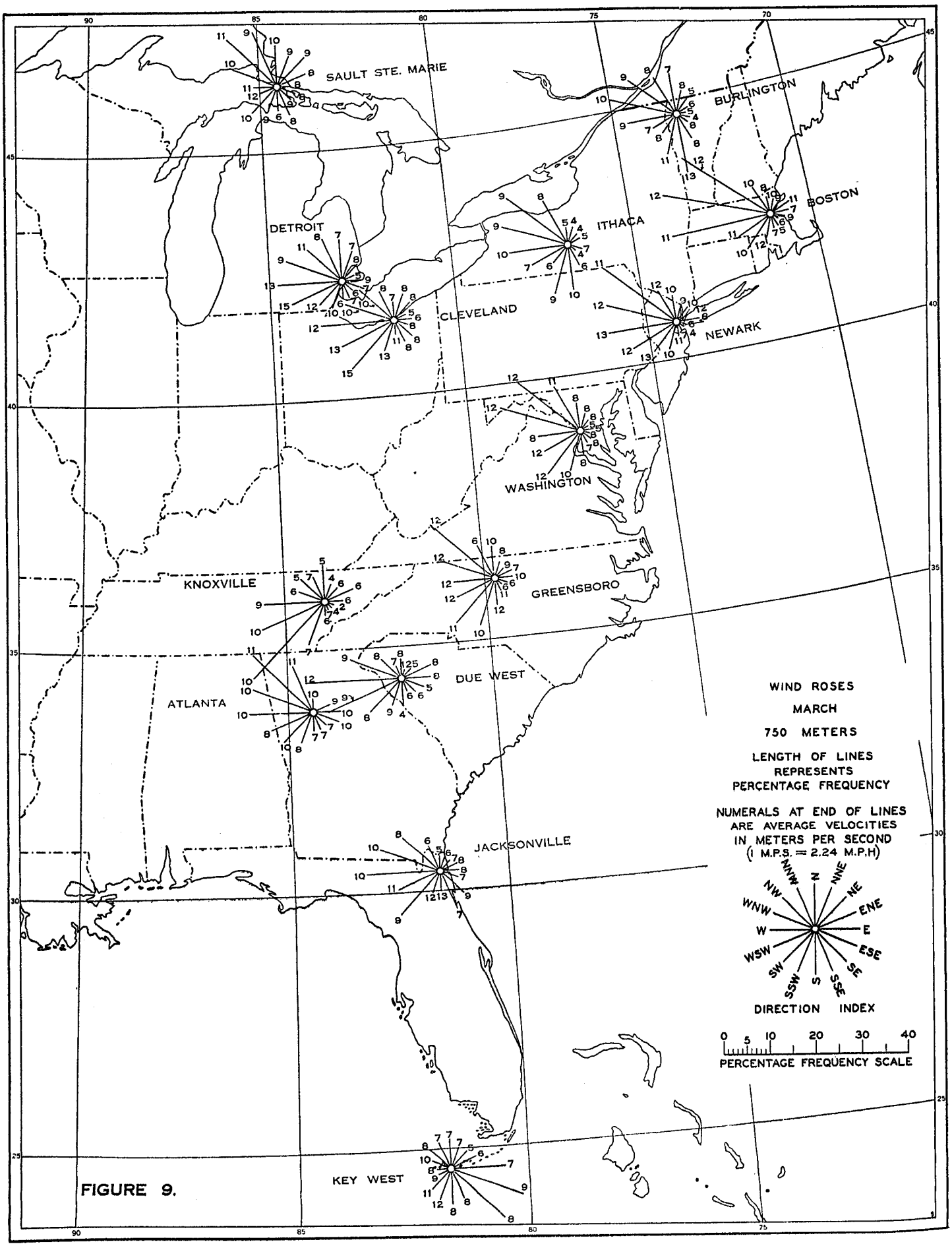
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
FEBRUARY
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 8.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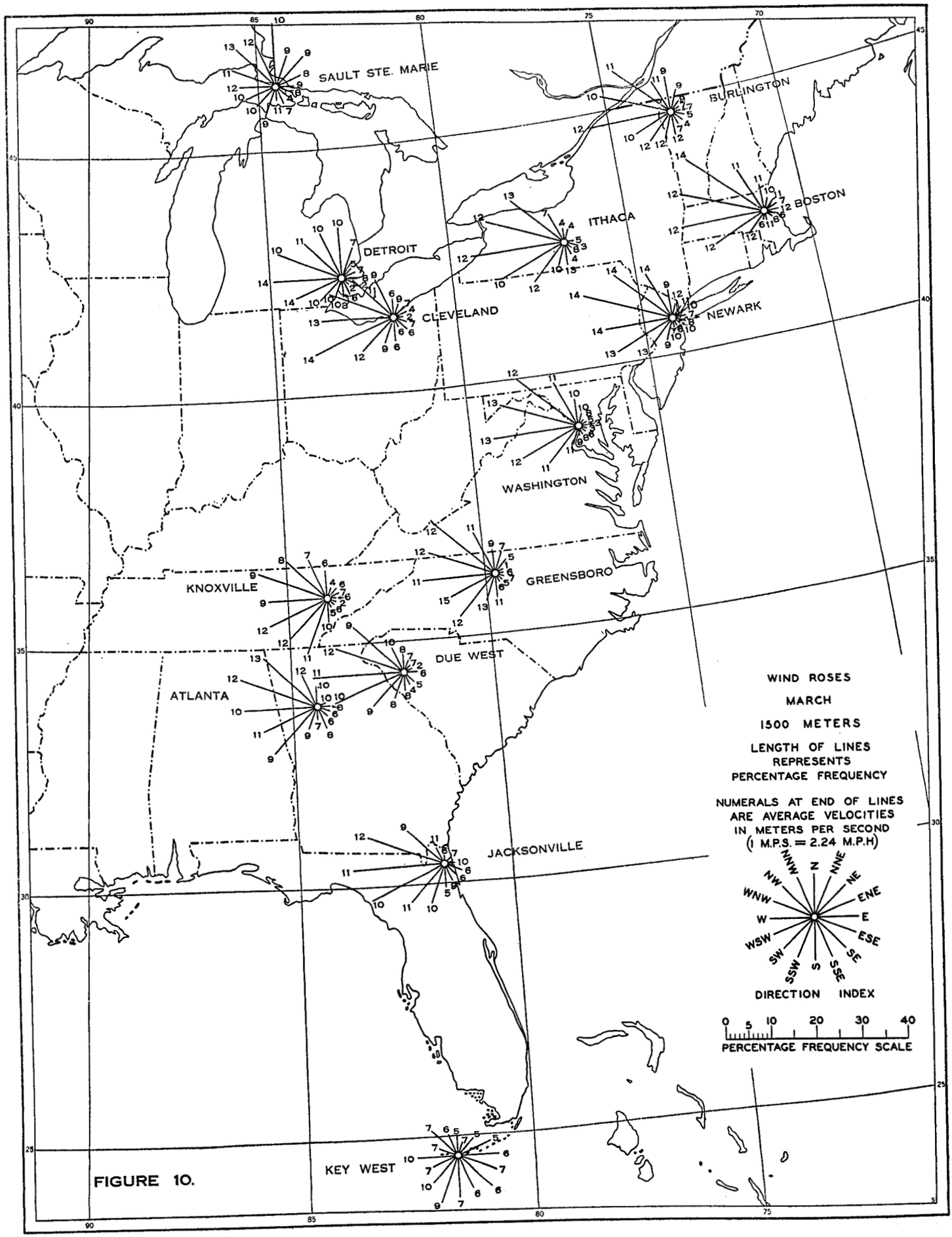
GREENSBORO
ATLANTA
DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
MARCH
750 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 9.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ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
MARCH
1500 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
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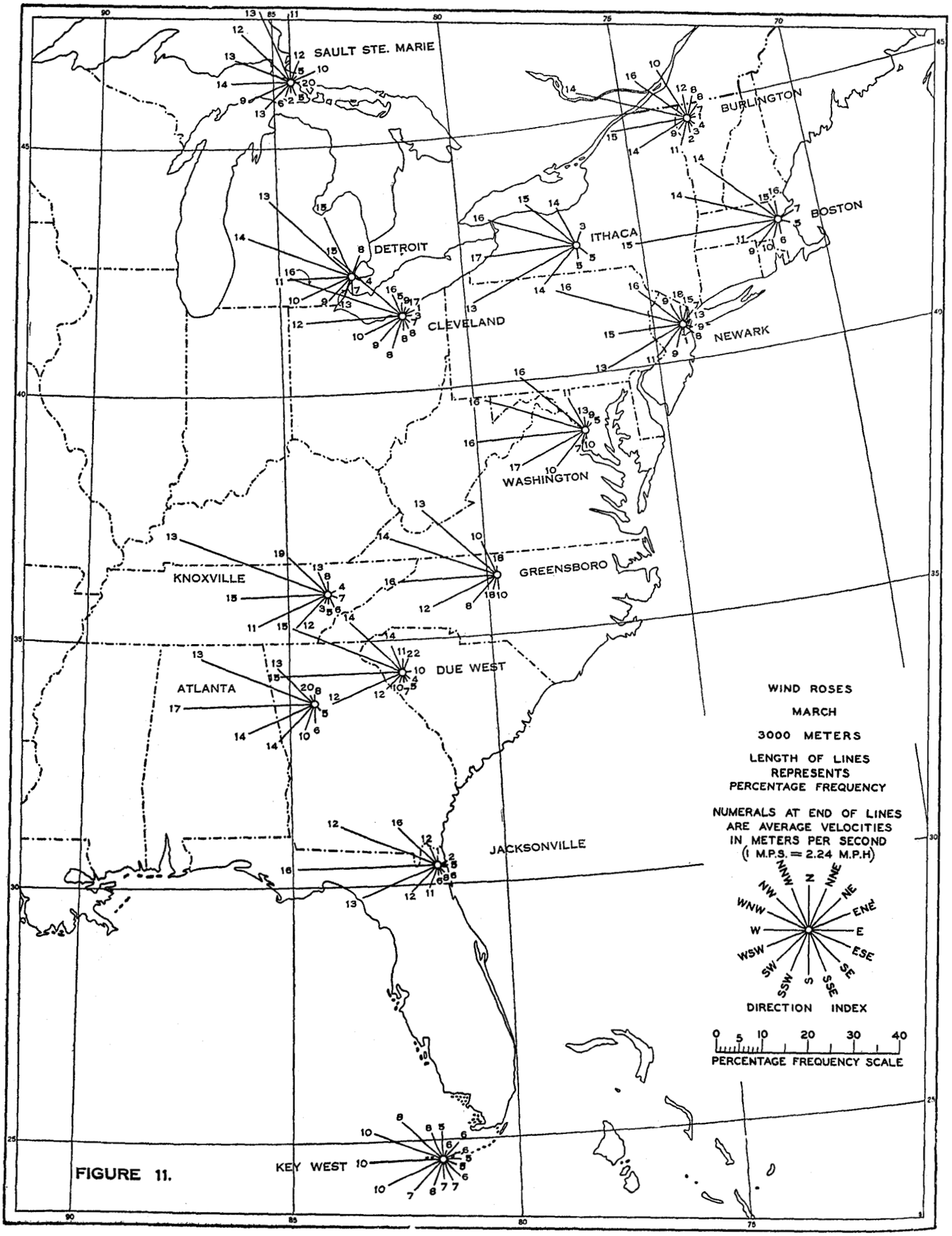
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 10.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DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
MARCH
3000 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
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SE
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S
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WSW
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WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 11.

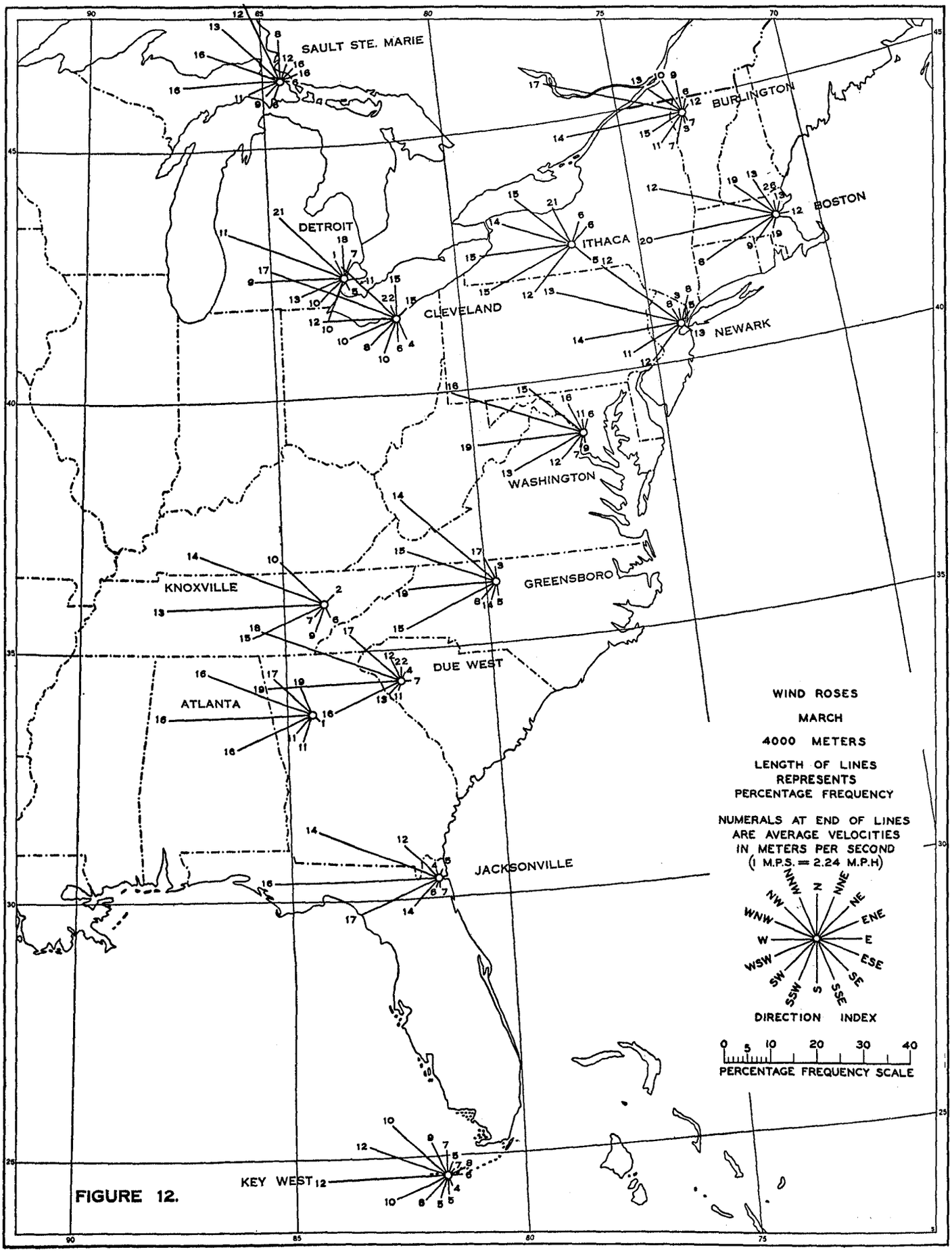
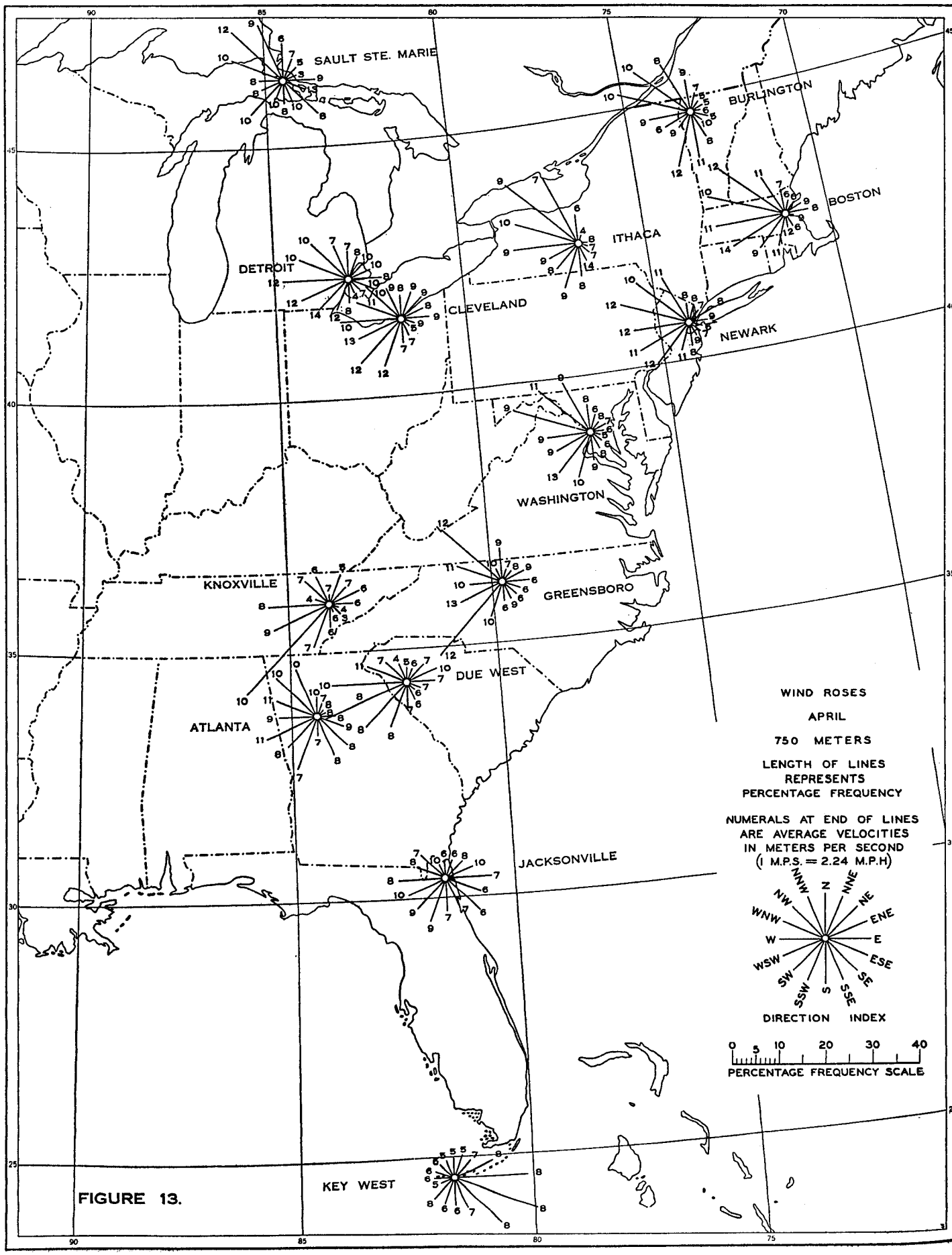


FIGURE 12.

9554—33——3


SAULT STE. MARIE
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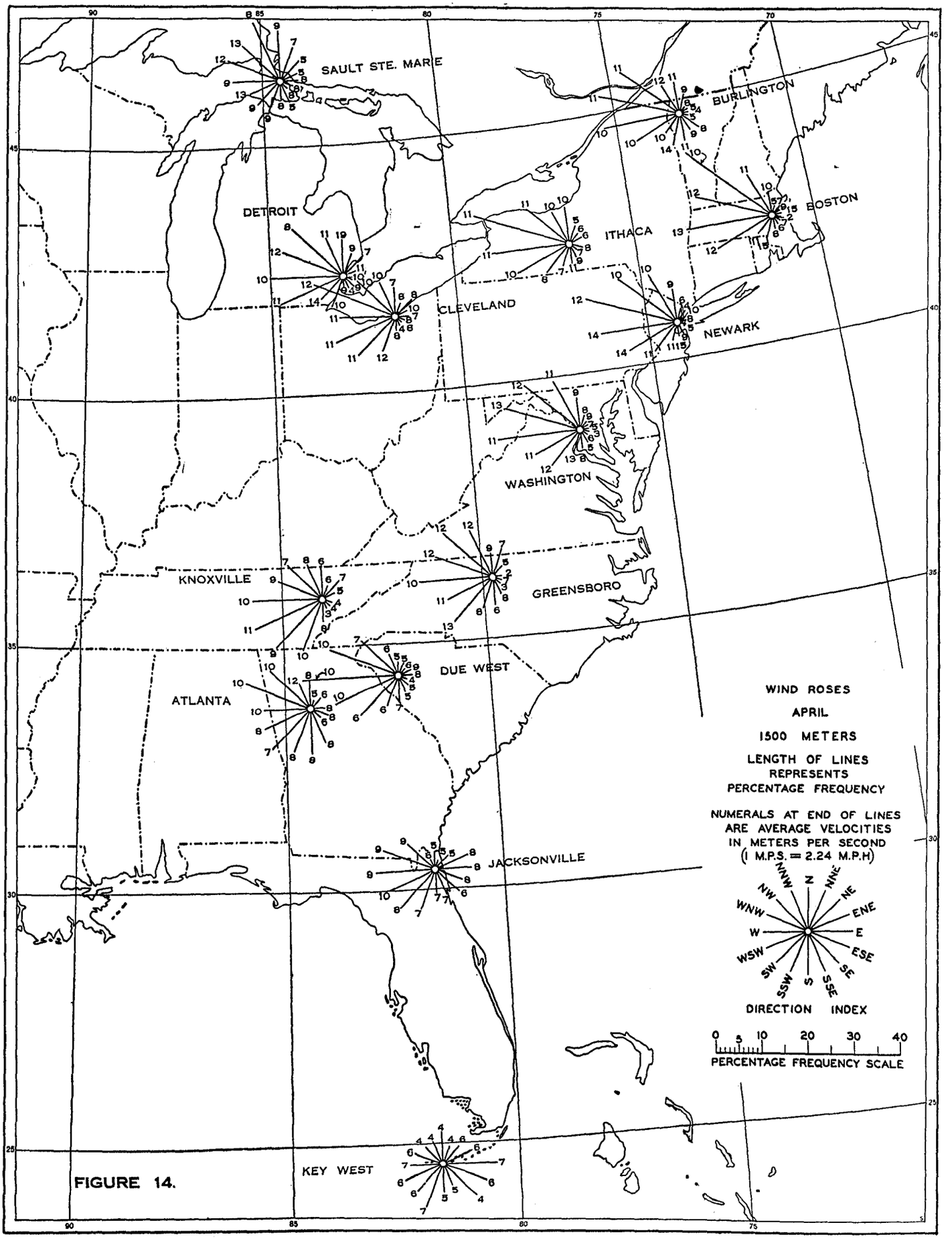
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
APRIL
750 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND (1 M.P.S. = 2.24 M.P.H)
N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 13.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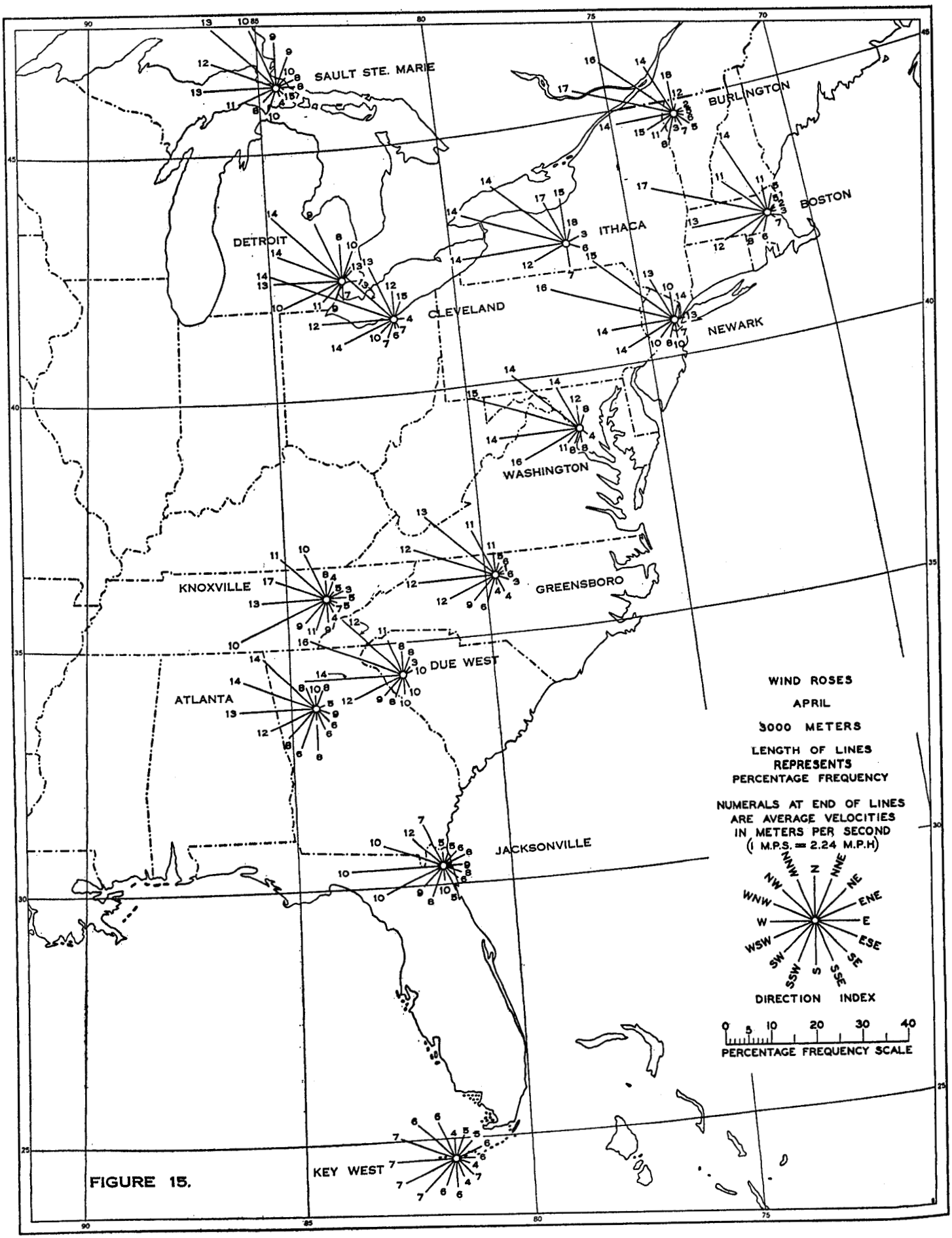
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
APRIL
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 14.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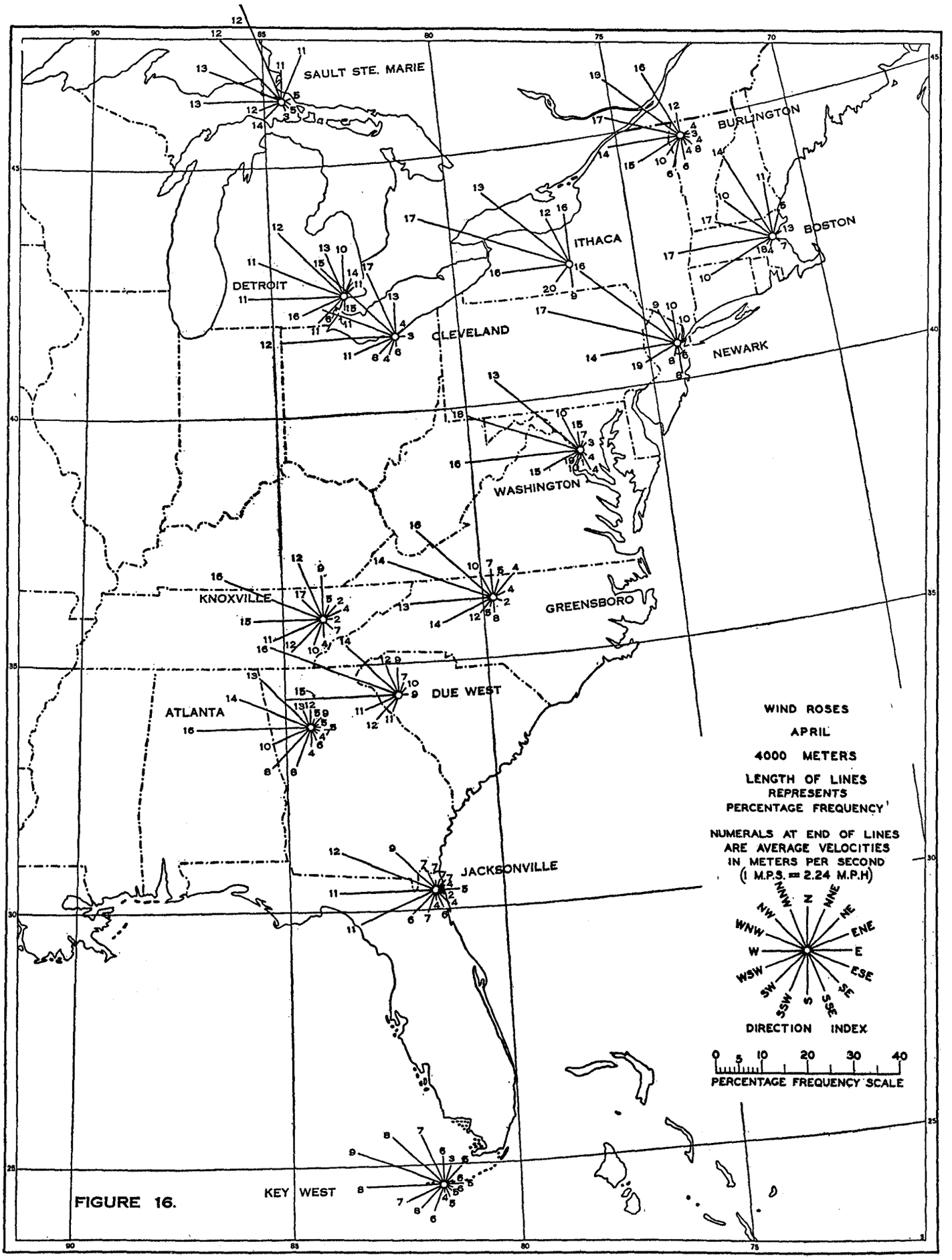
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
APRIL
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 15.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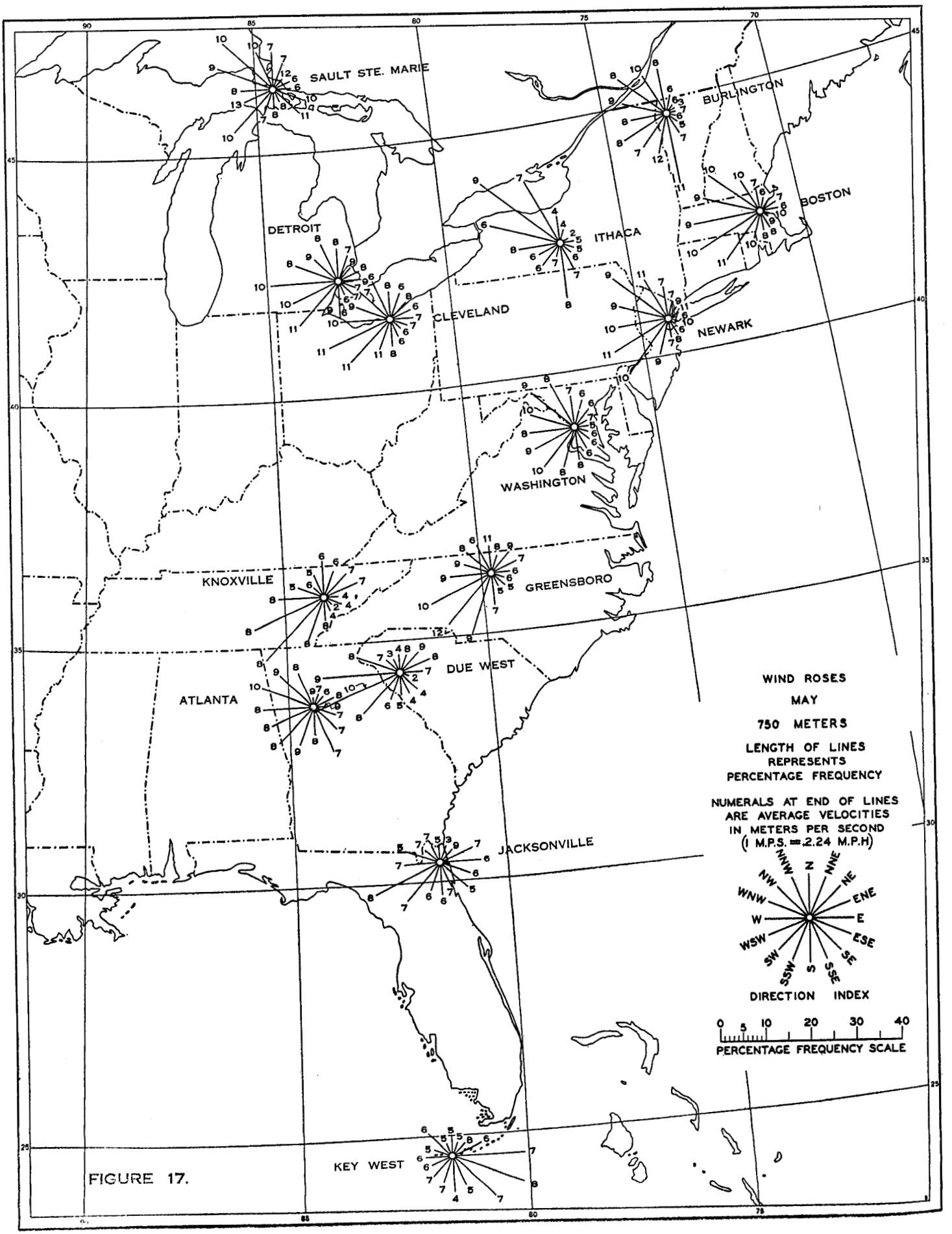
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
APRIL
4000 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND (1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 16.


SAULT STE. MARIE
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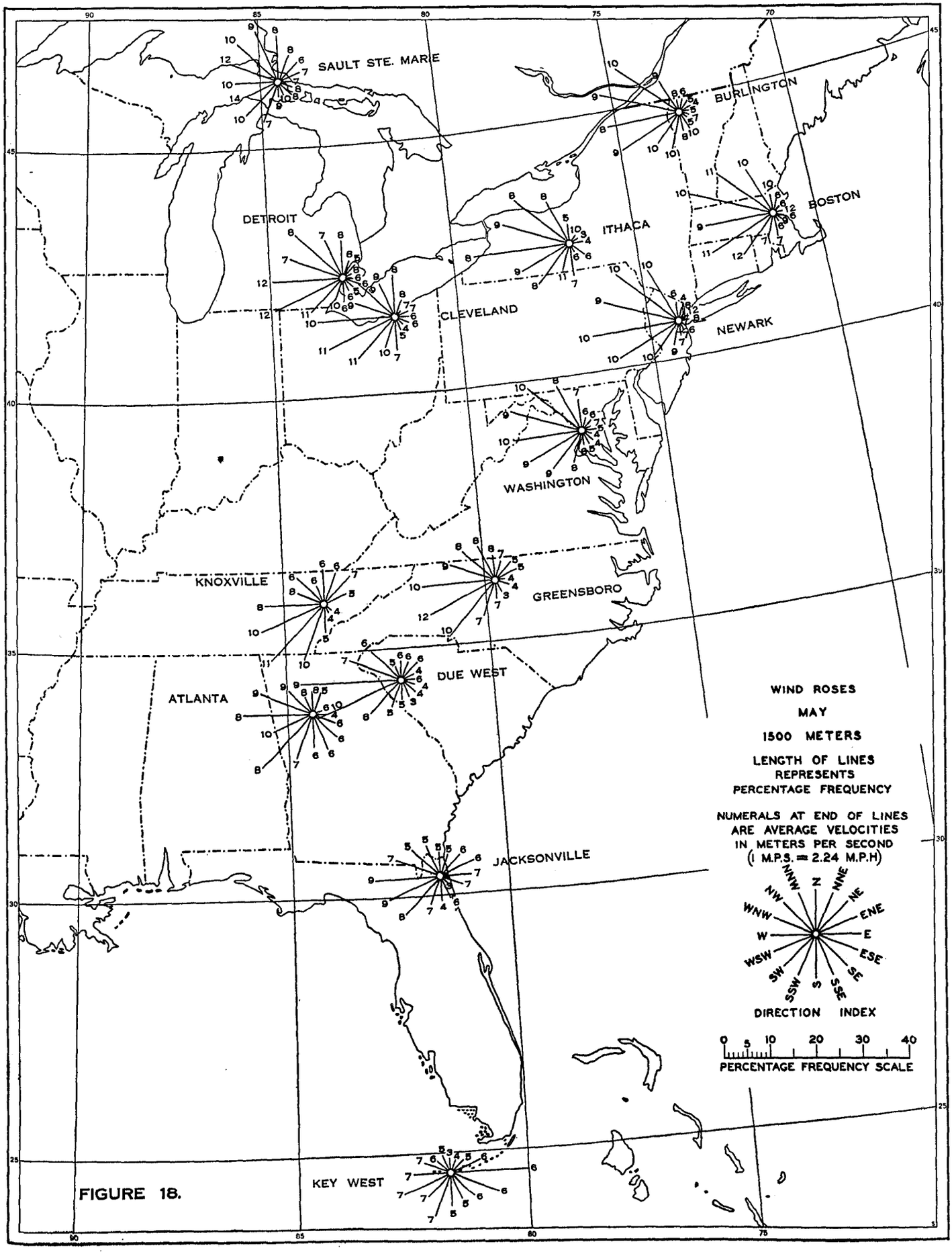
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
MAY
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 17.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KNOXVILLE
GREENSBORO
ATLANTA
DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
MAY
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
Z
NNE
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ENE
E
ESE
SE
SSE
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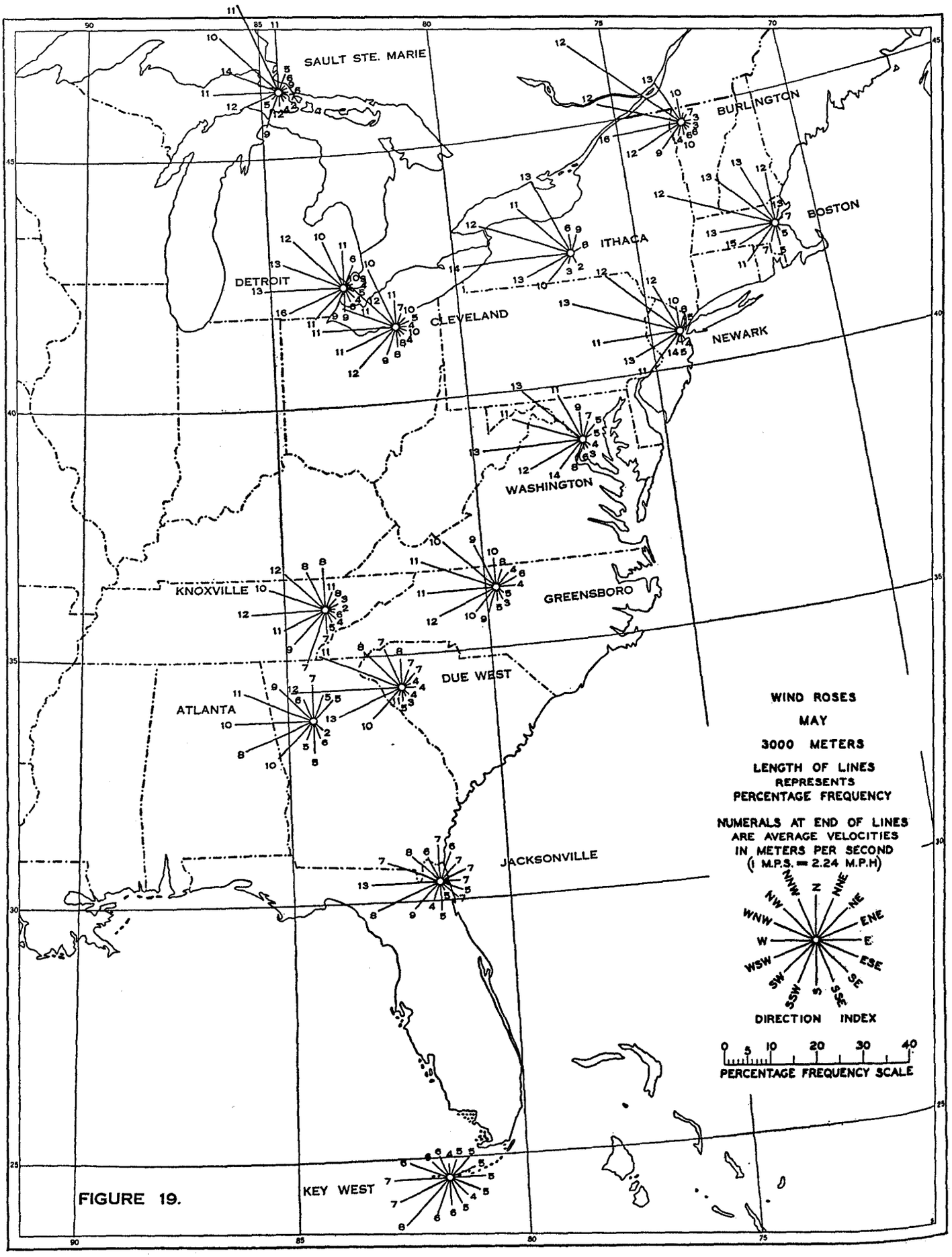
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 18.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KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
MAY
3000 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
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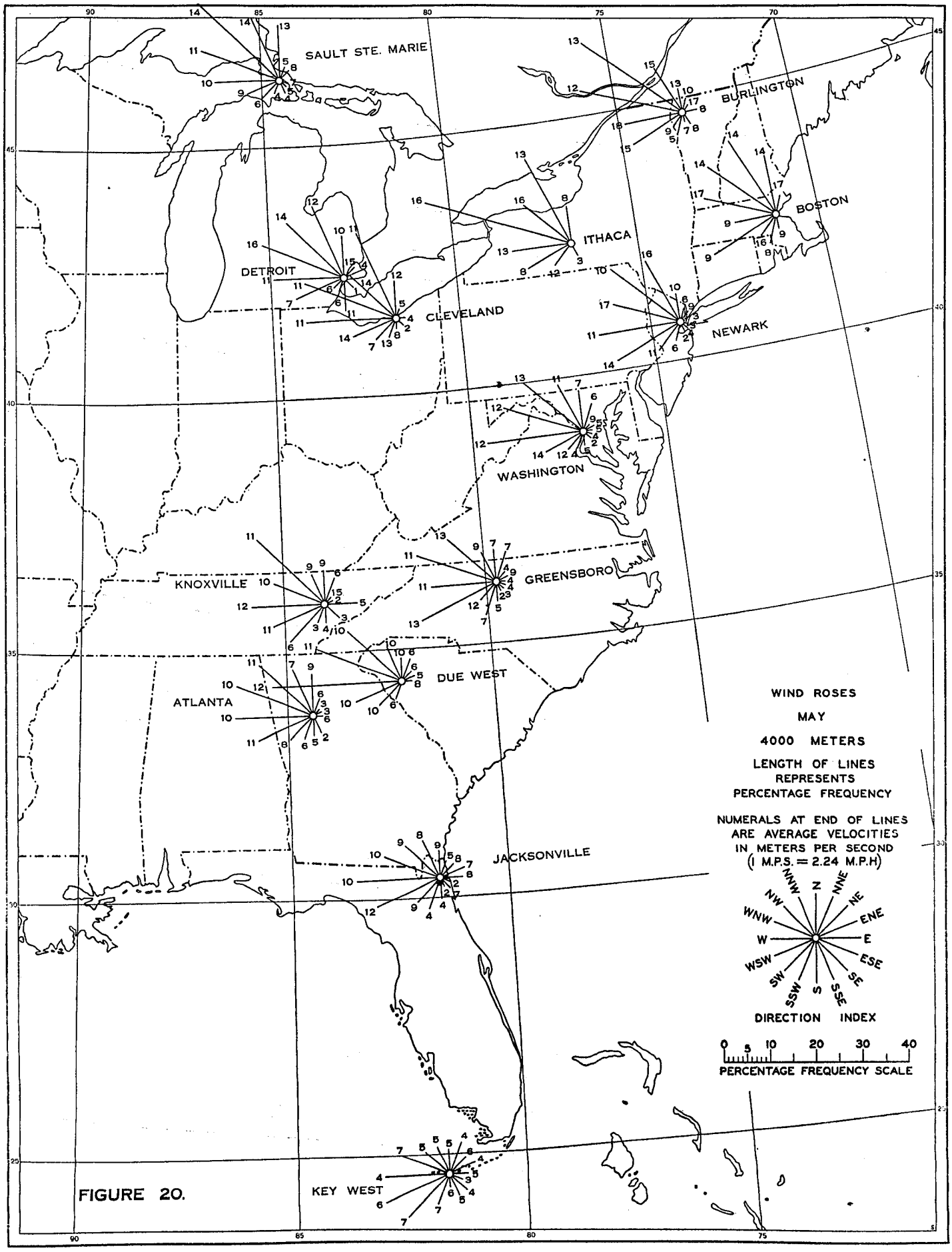
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 19.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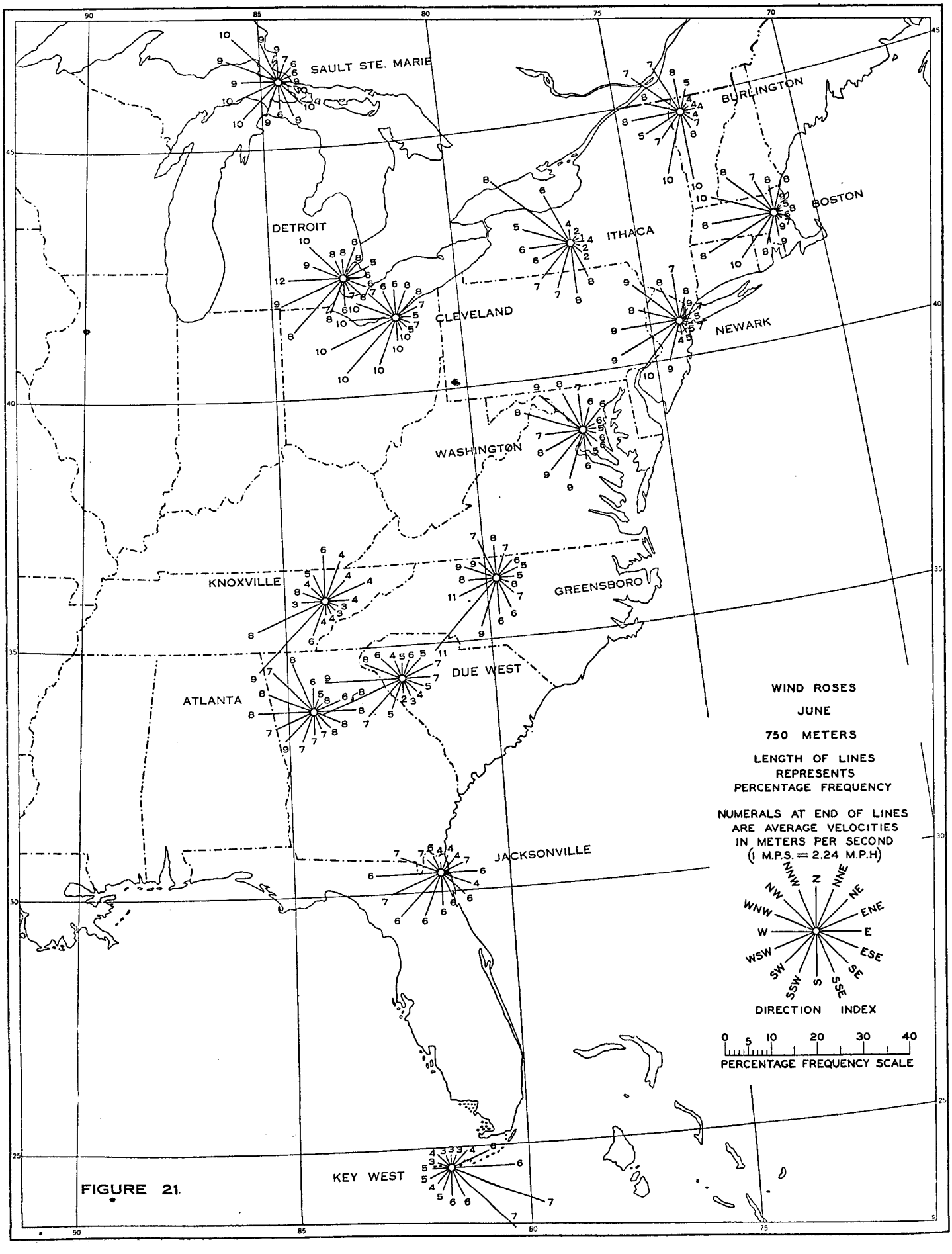
JACKSONVILLE
KEY WEST
WIND ROSES
MAY
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 20.


SAULT STE. MARIE
BURLINGTON
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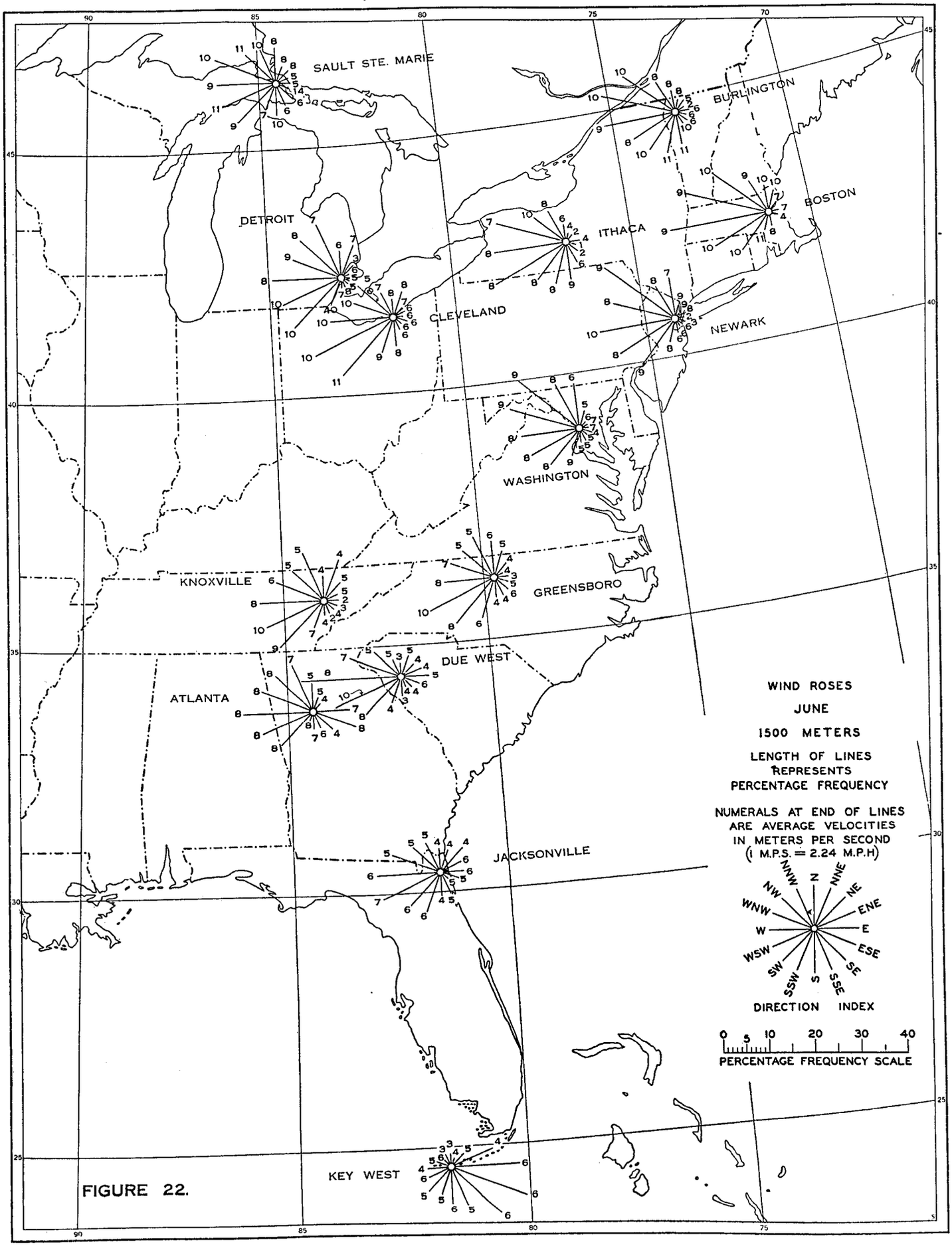
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JUNE
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 21.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WASHINGTON
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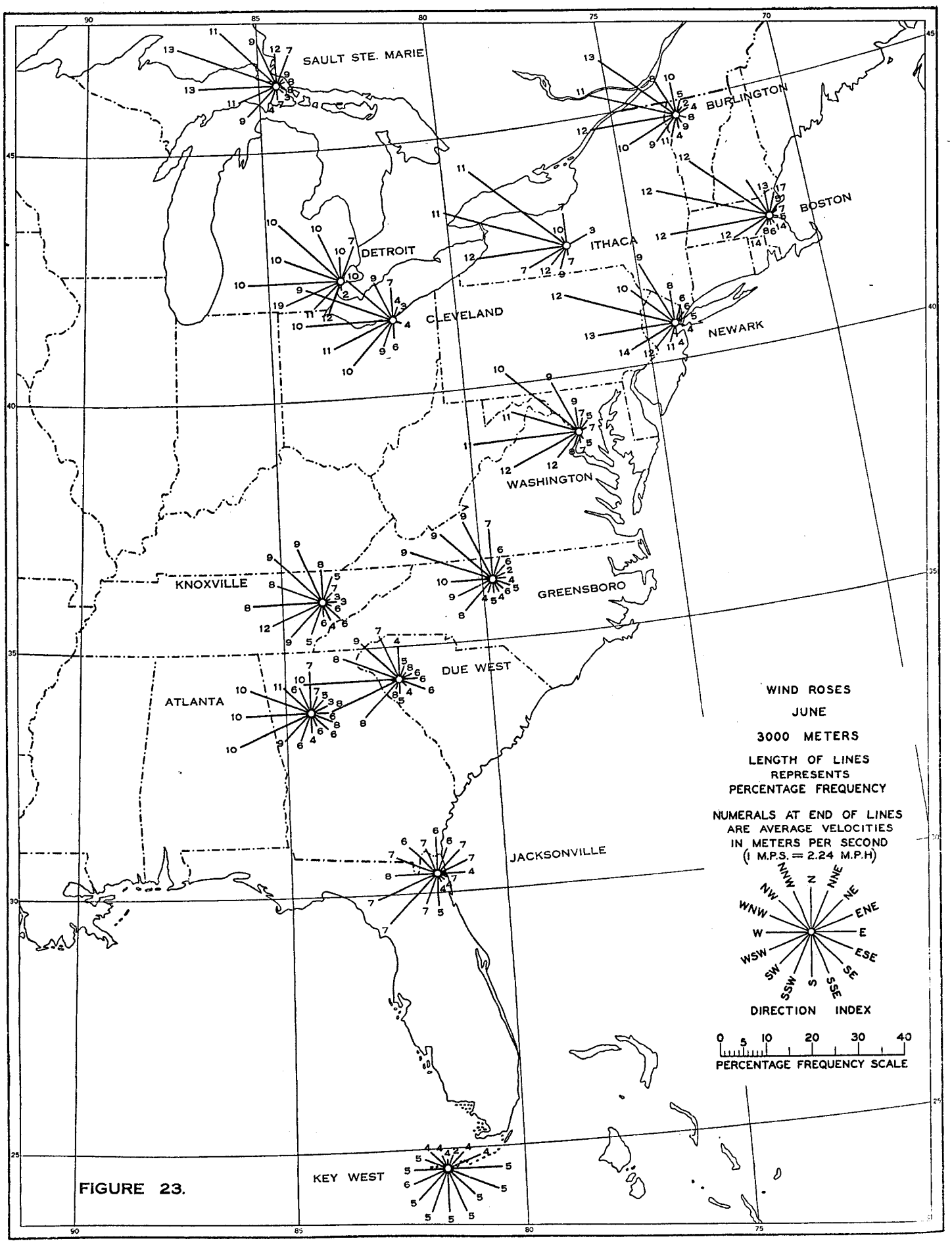
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JUNE
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 22.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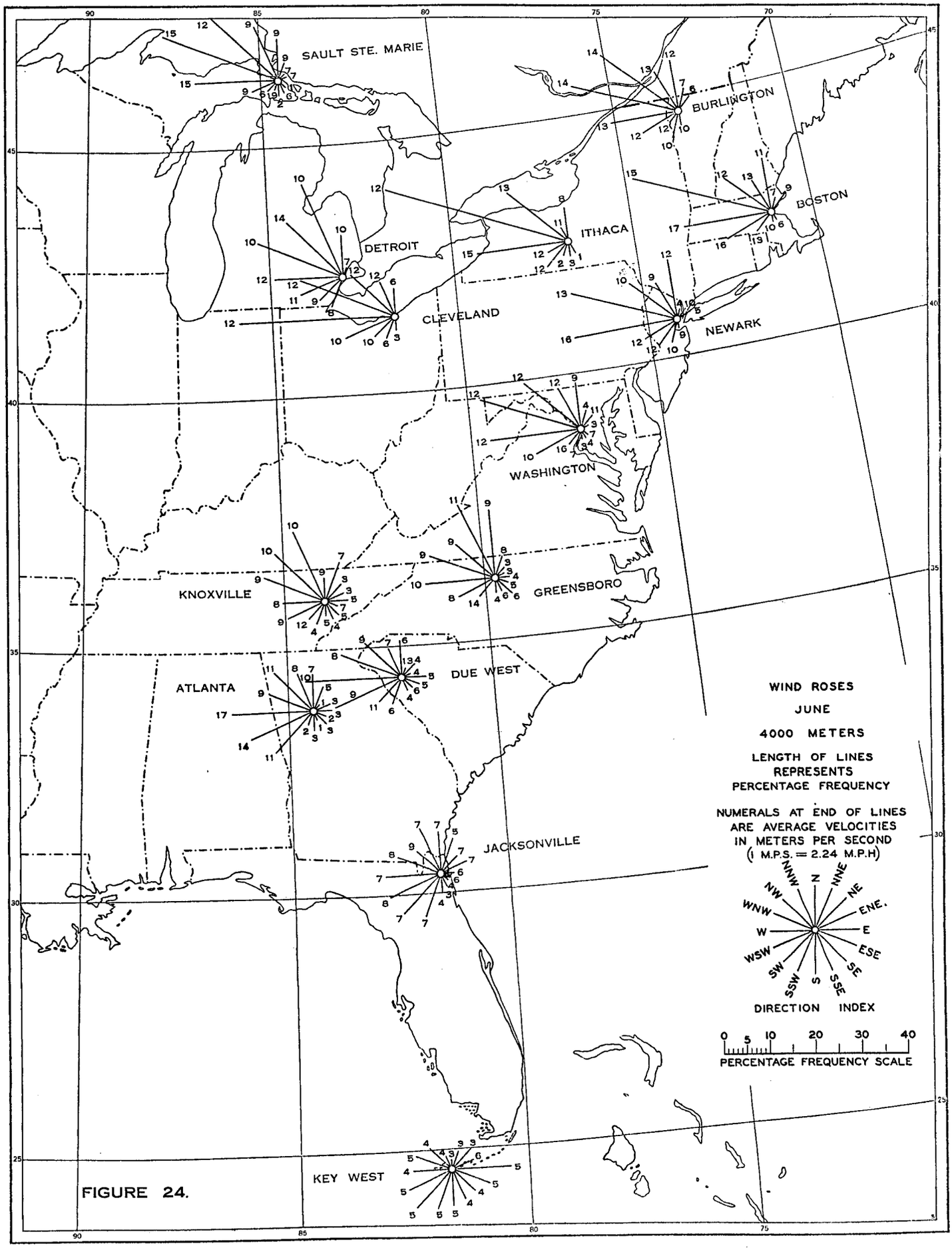
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JUNE
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 23.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WASHINGTON
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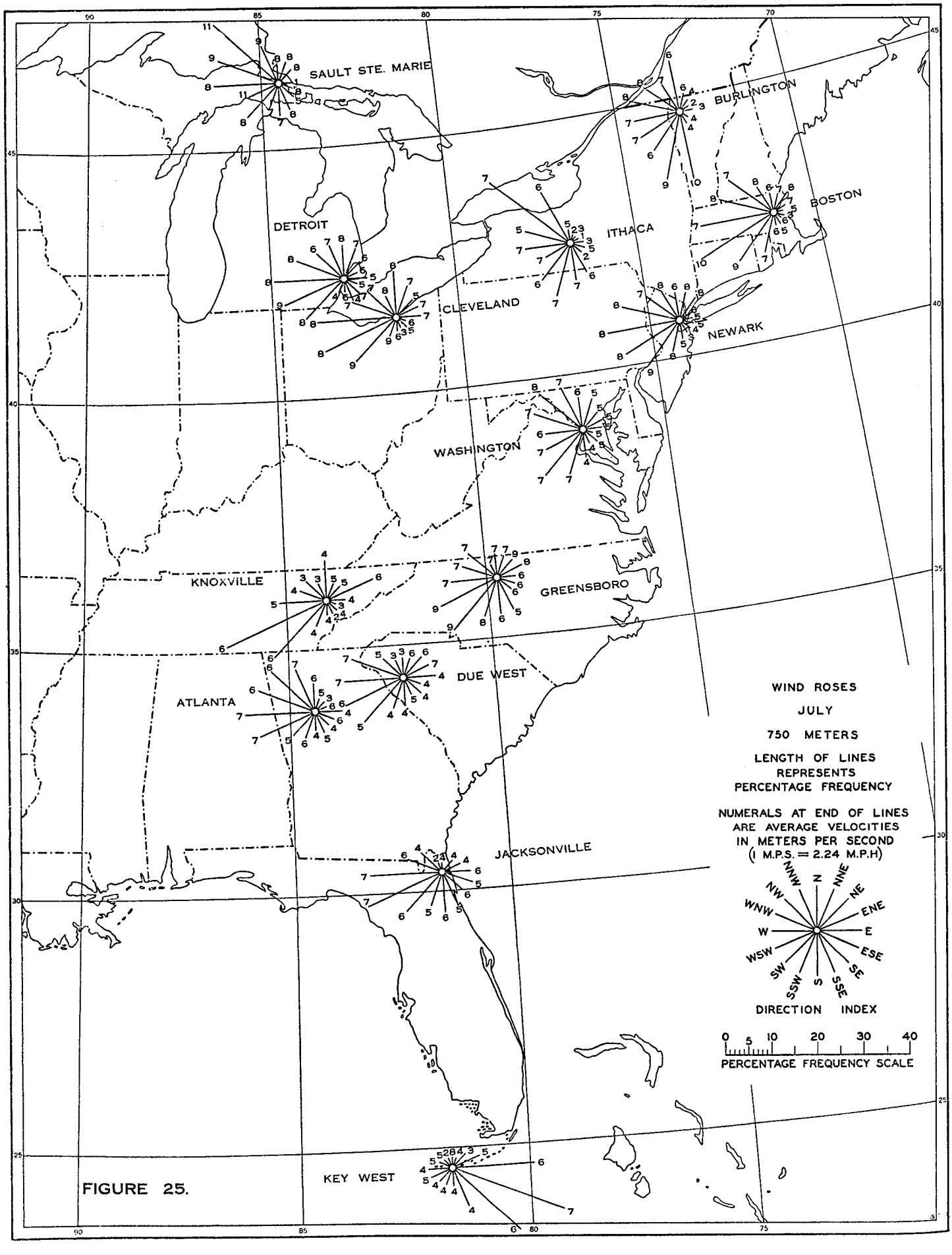
ATLANTA
DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
JUNE
4000 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 24.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DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JULY
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
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ESE
SE
SSE
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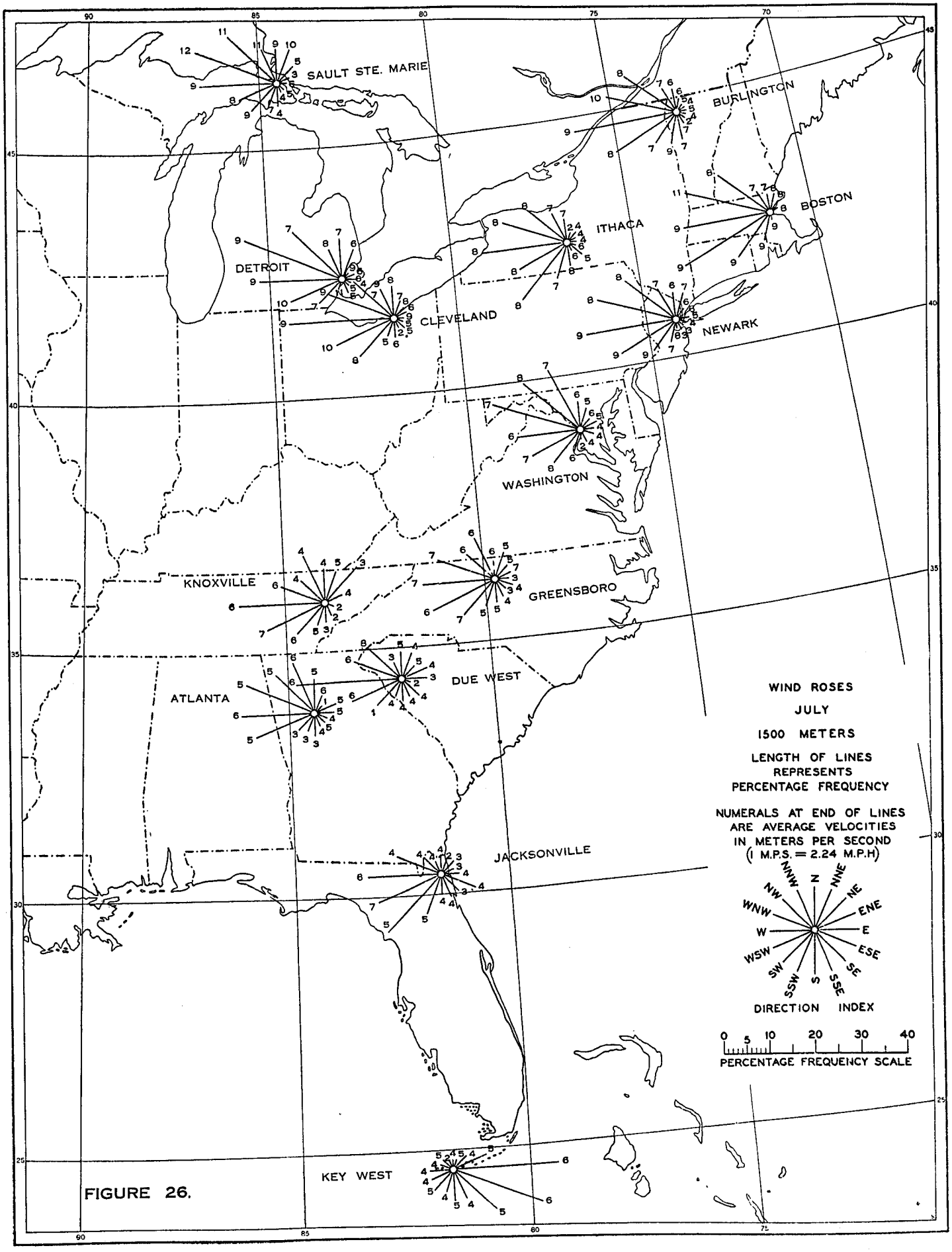
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 25.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ATLANTA
DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
JULY
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
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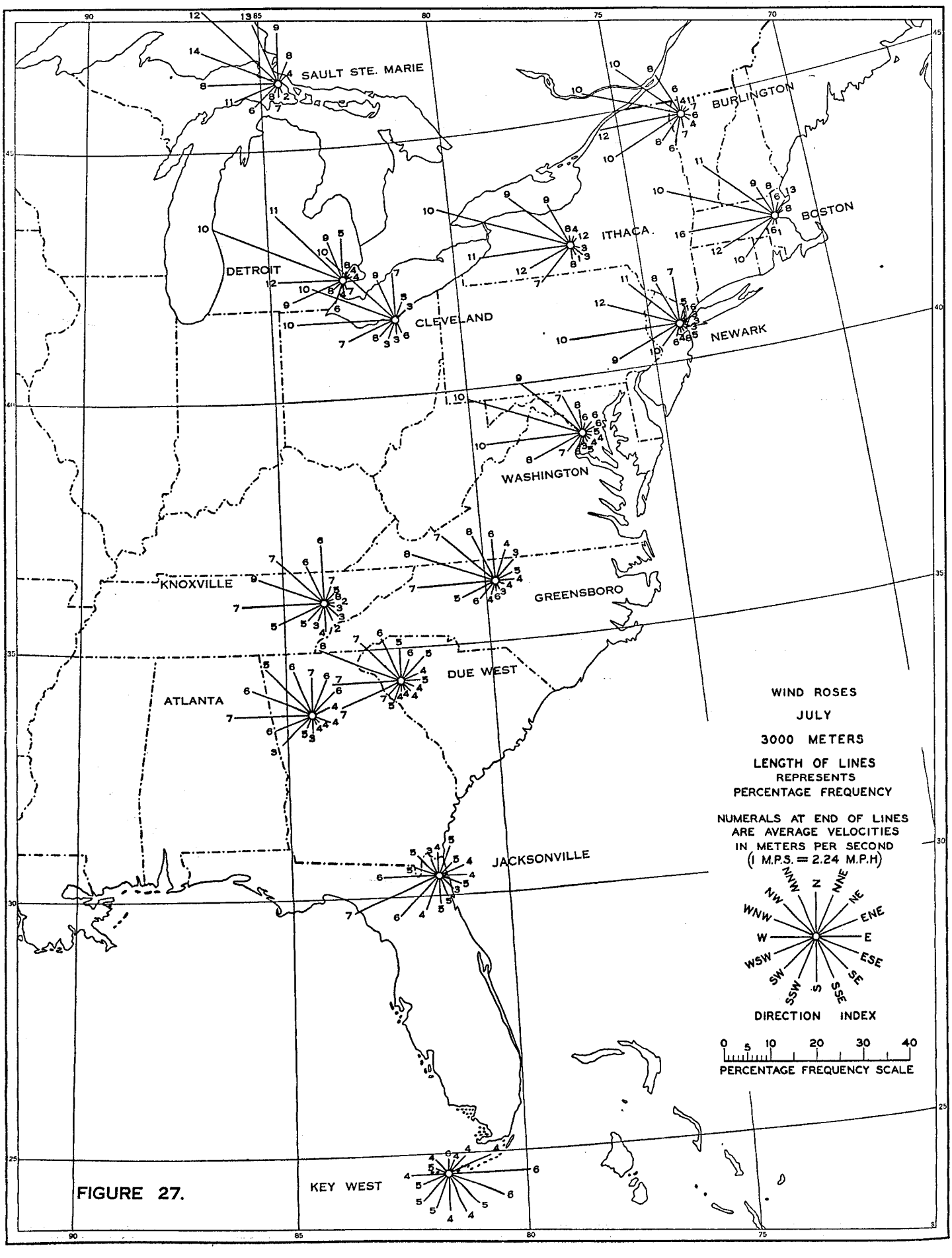
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 26.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ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
JULY
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
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WSW
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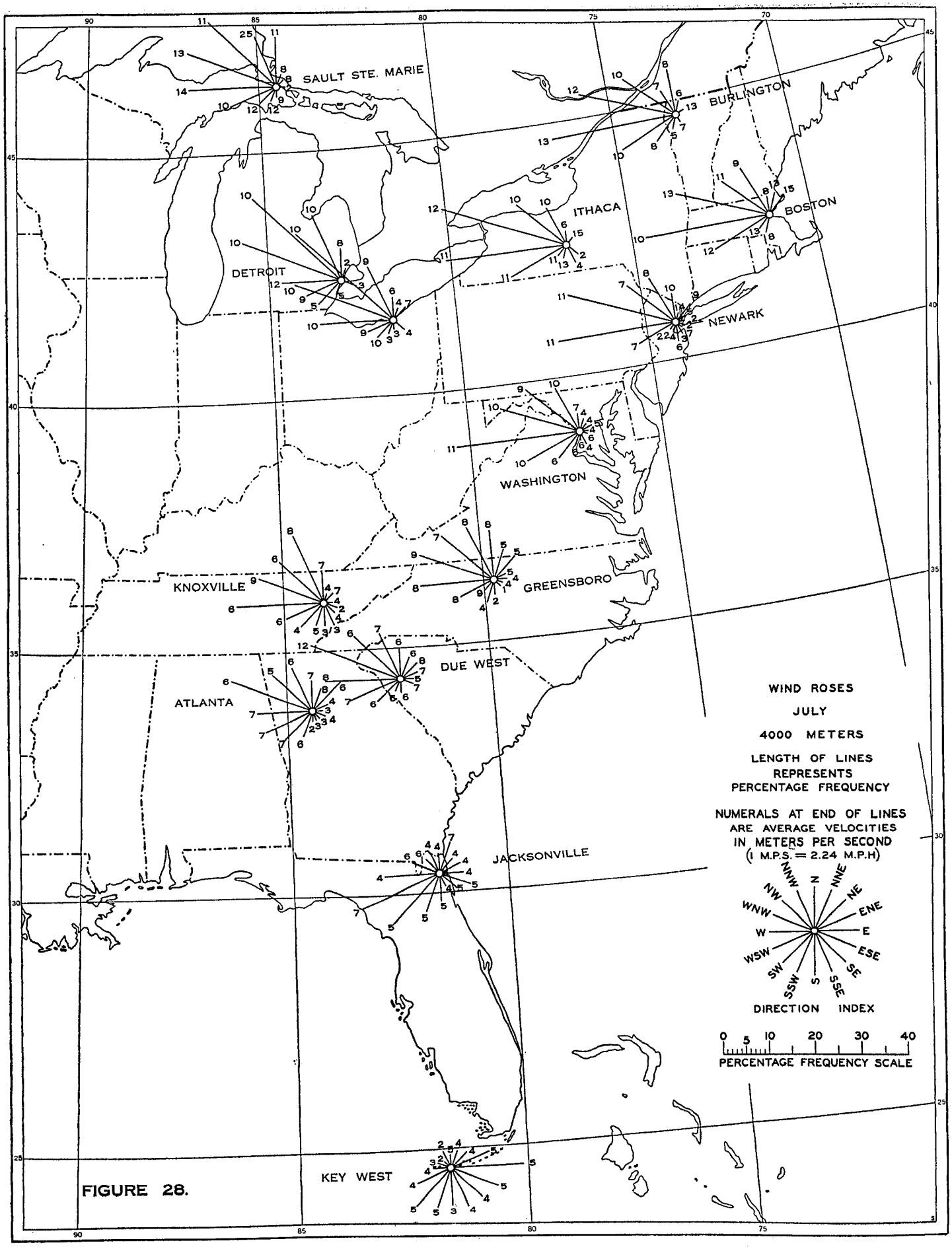
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 27.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JACKSONVILLE
KEY WEST
WIND ROSES
JULY
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
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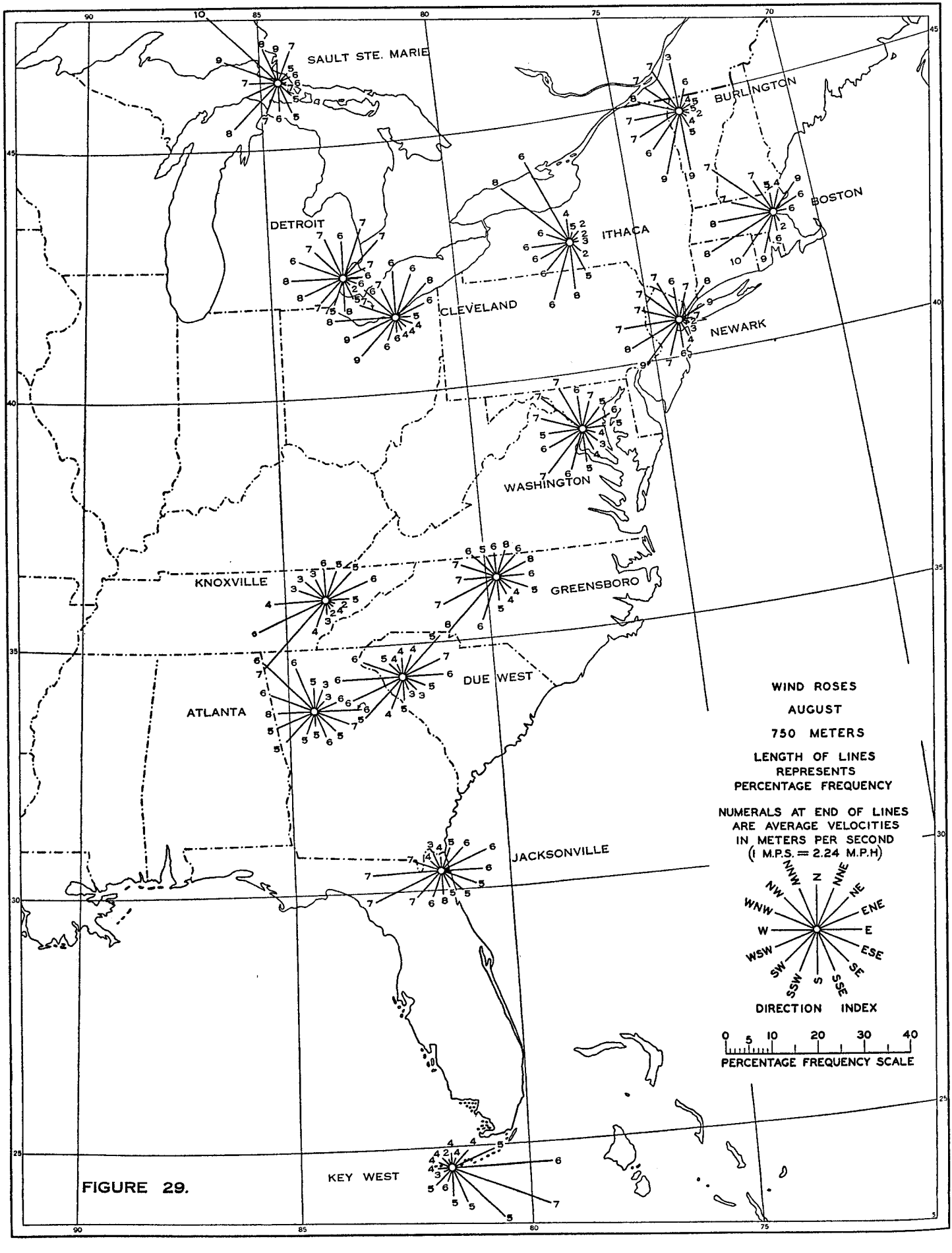
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 28.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WASHINGTON
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DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
AUGUST
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
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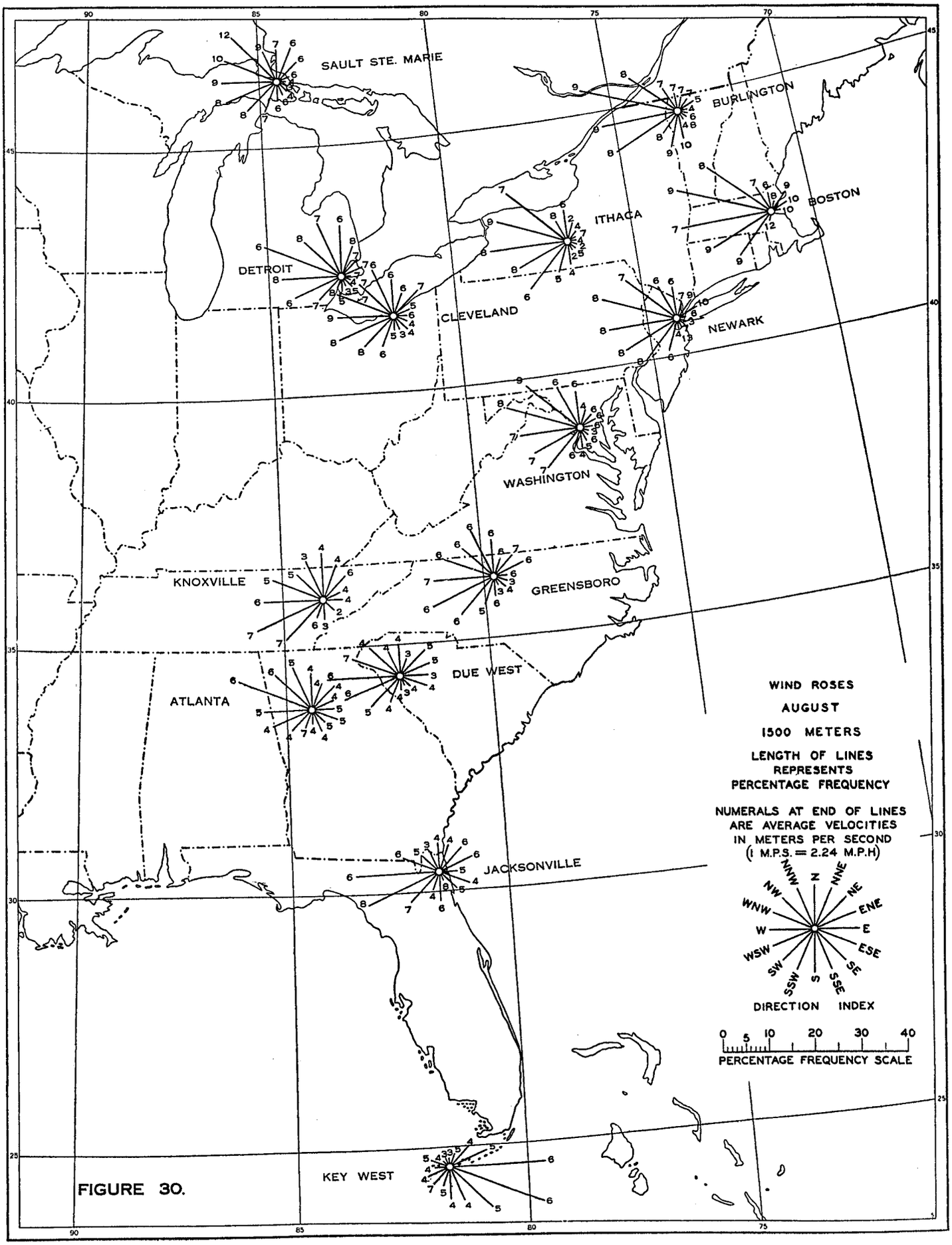
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 29.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ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
AUGUST
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
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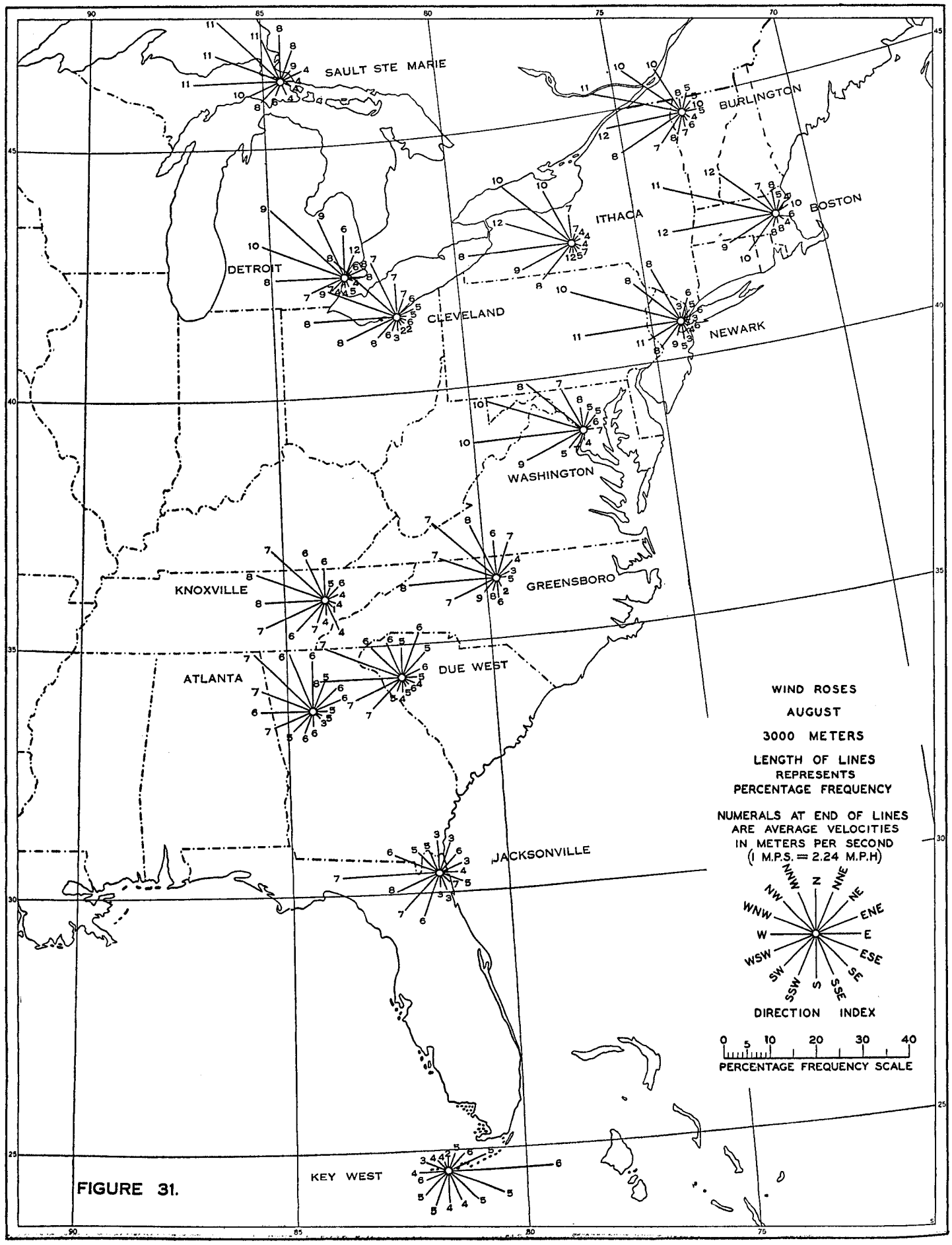
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 30.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DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
AUGUST
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
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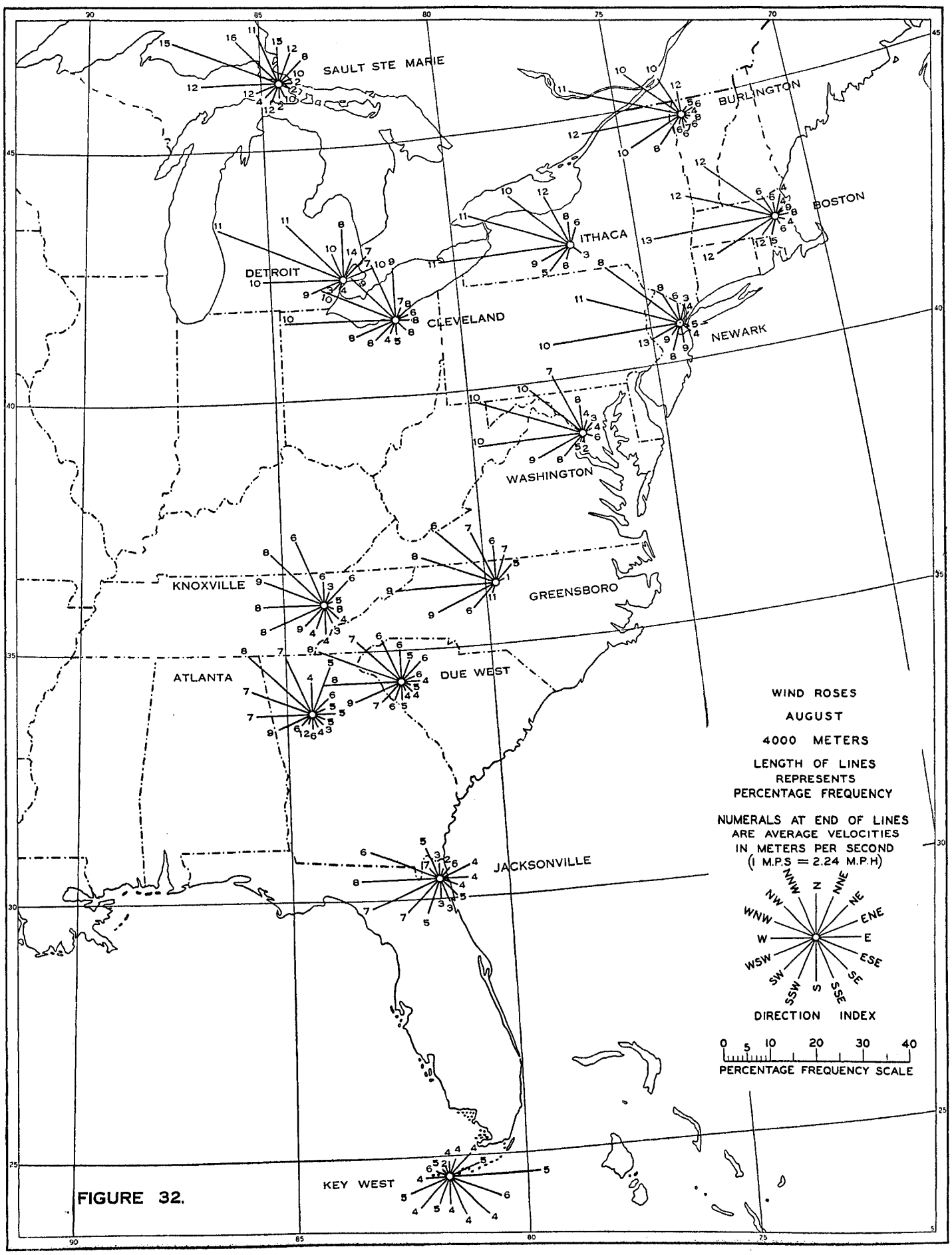
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 31.


SAULT STE MARIE
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ATLANTA
DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
AUGUST
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S = 2.24 M.P.H)
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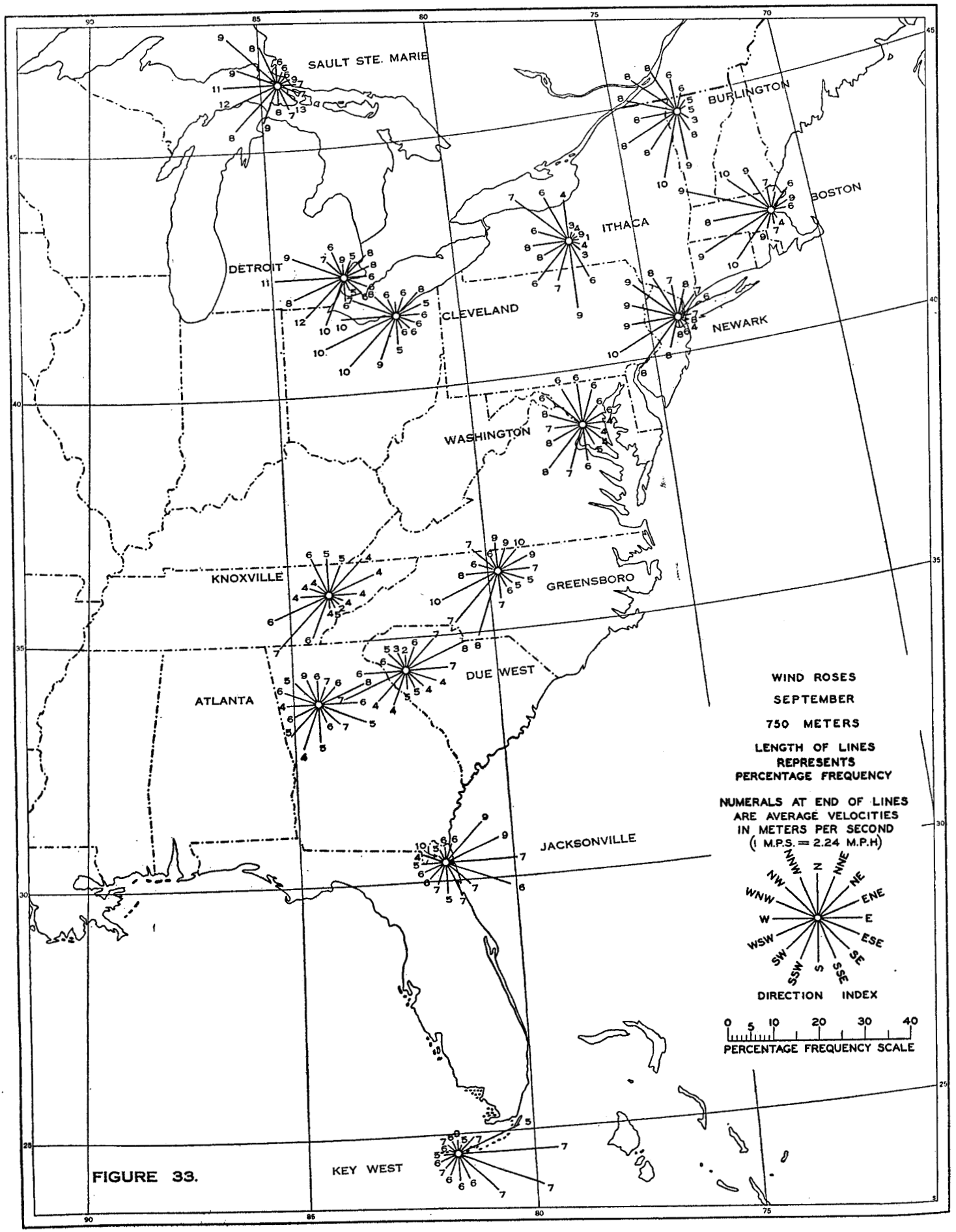
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 32.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WASHINGTON
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GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
SEPTEMBER
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
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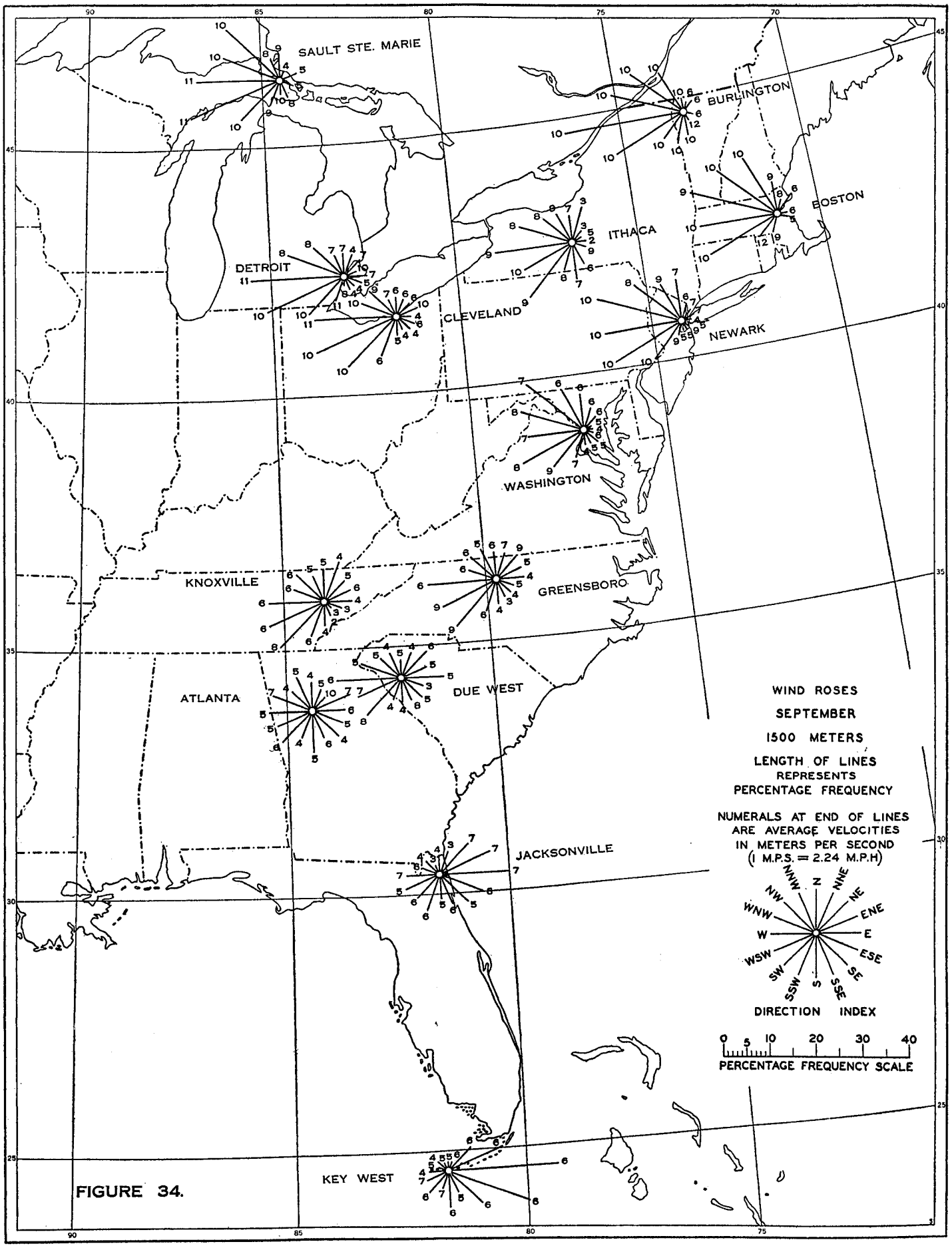
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 33.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DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
SEPTEMBER
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
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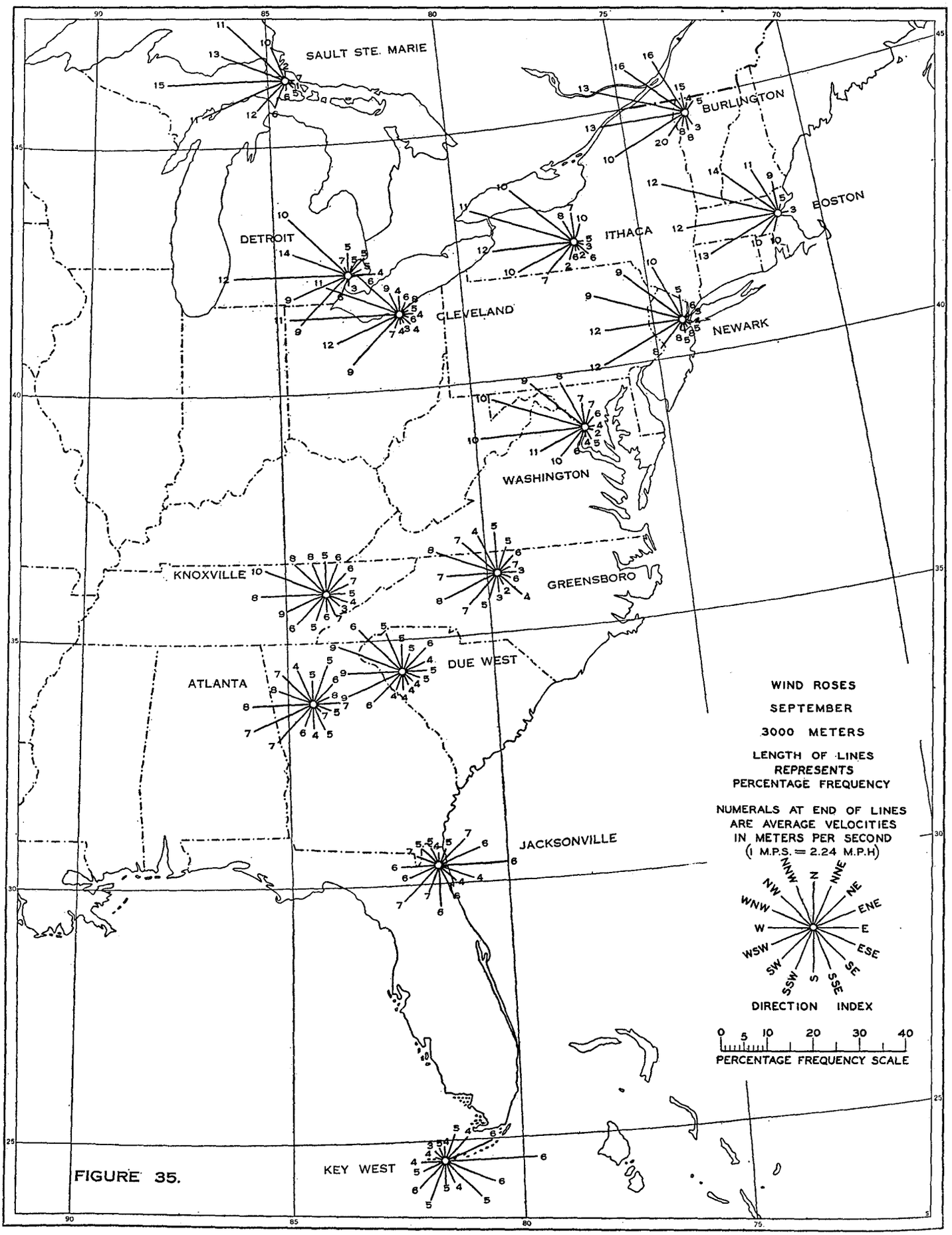
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 34.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ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
SEPTEMBER
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
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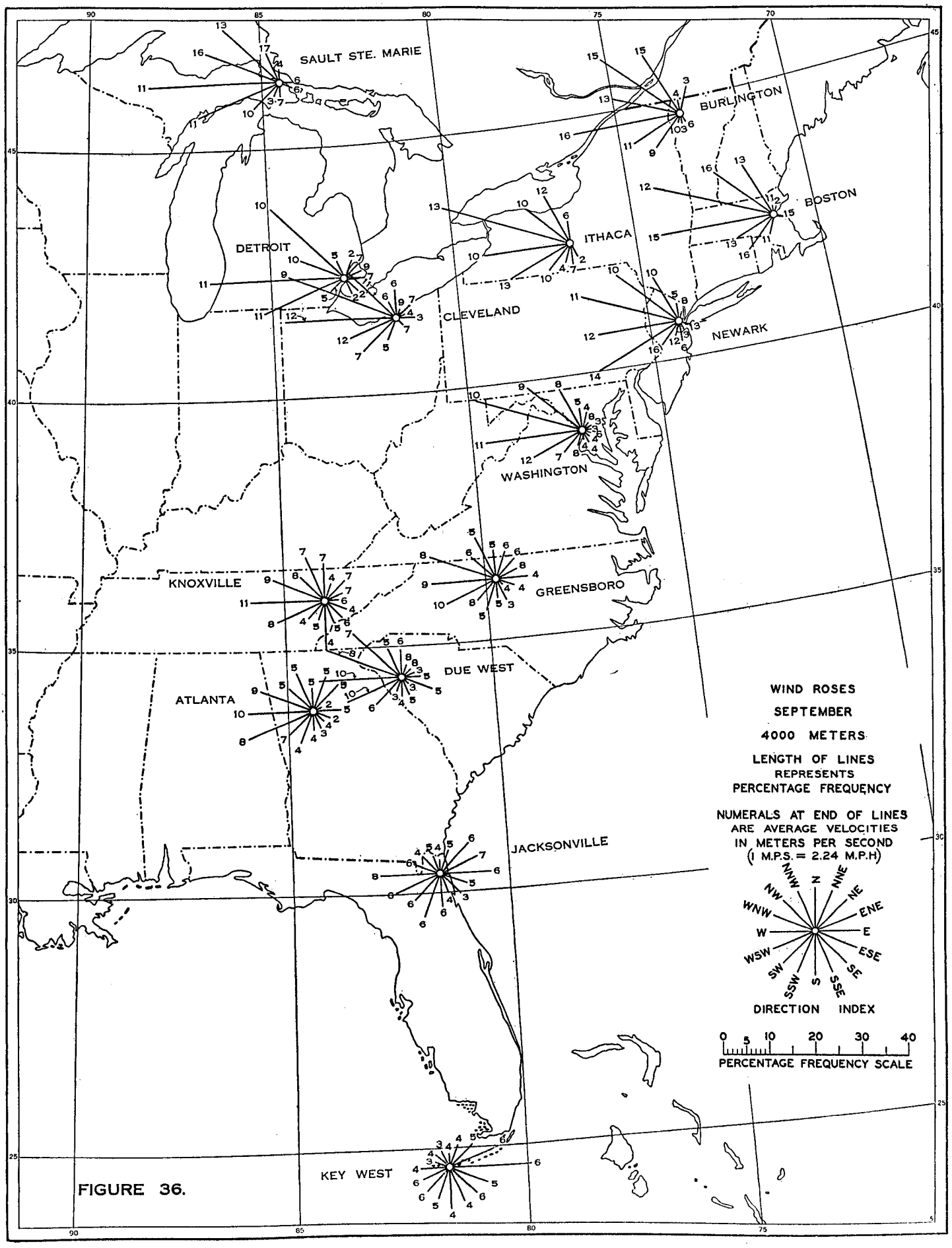
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 35.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ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
SEPTEMBER
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
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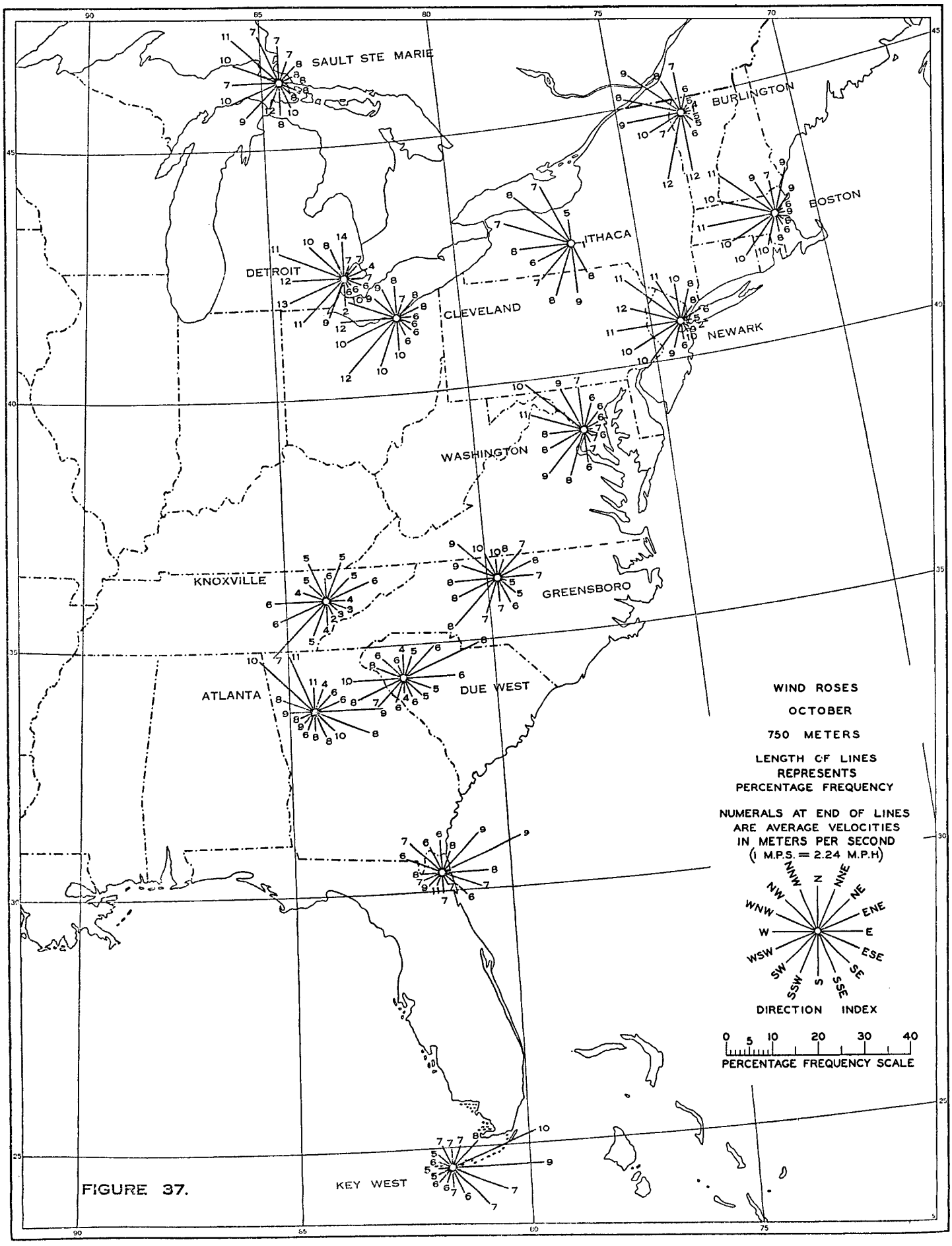
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 36.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ATLANTA
DUE WEST
KEY WEST
WIND ROSES
OCTOBER
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
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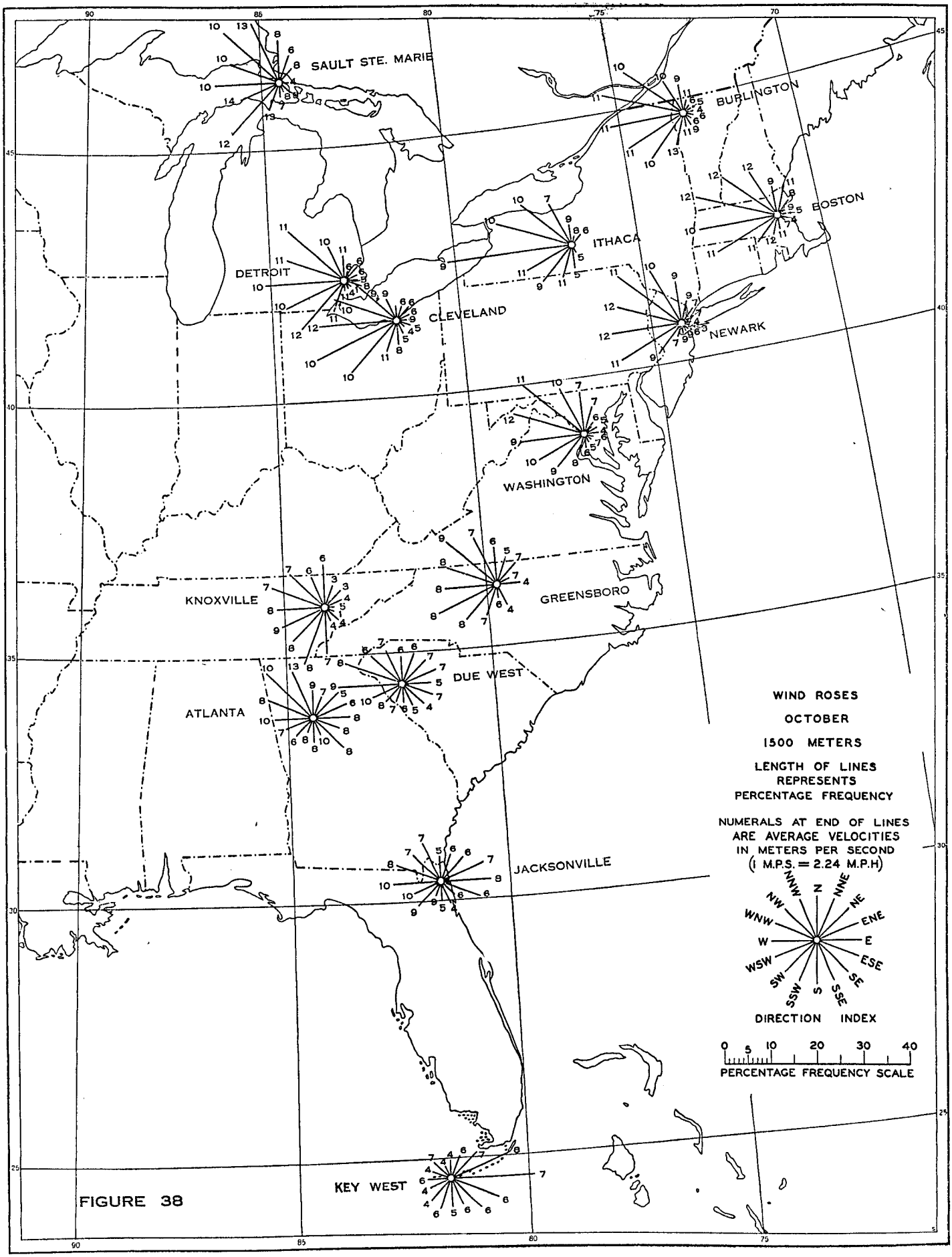
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 37.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ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
OCTOBER
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
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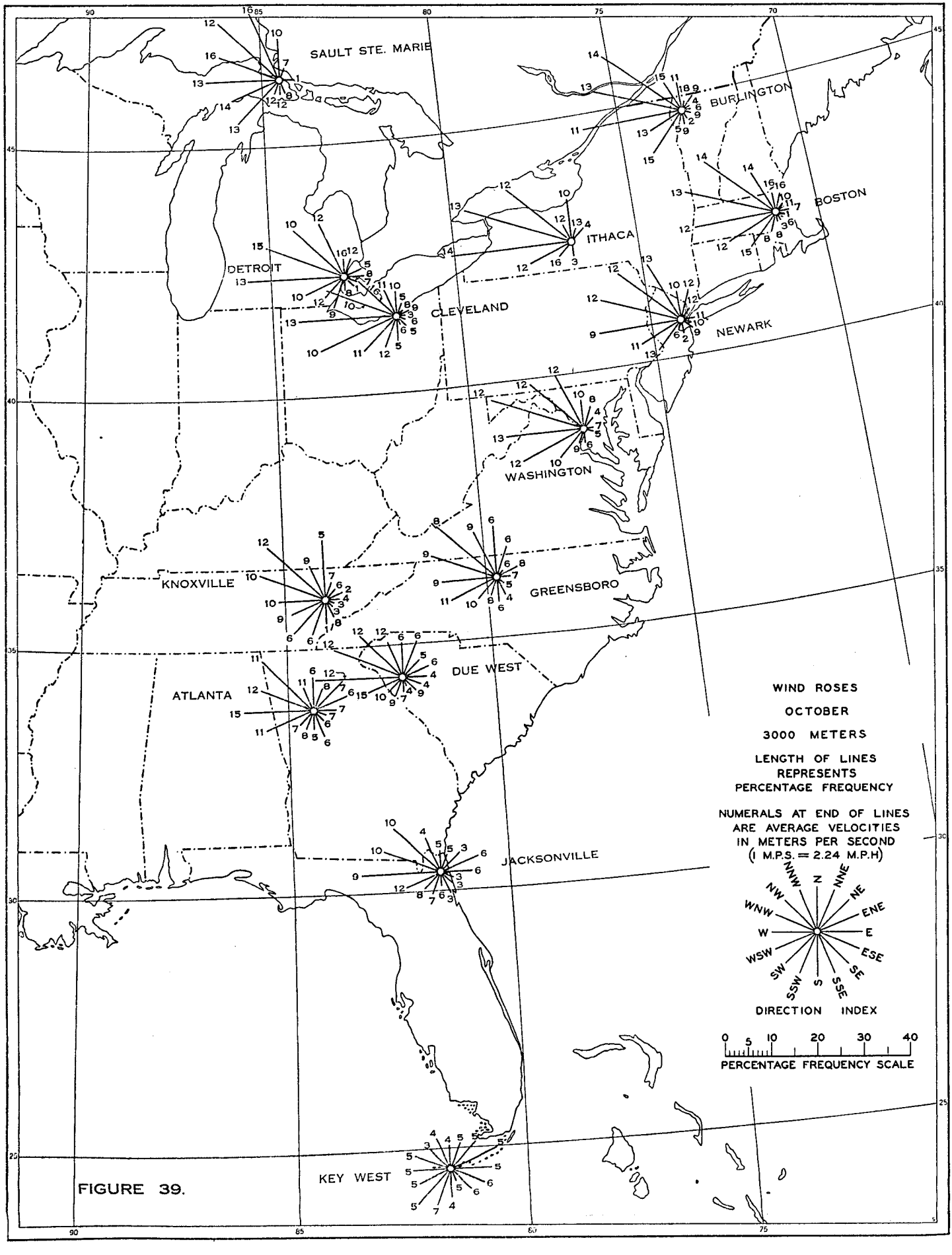
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 38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JACKSONVILLE
KEY WEST
WIND ROSES
OCTOBER
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
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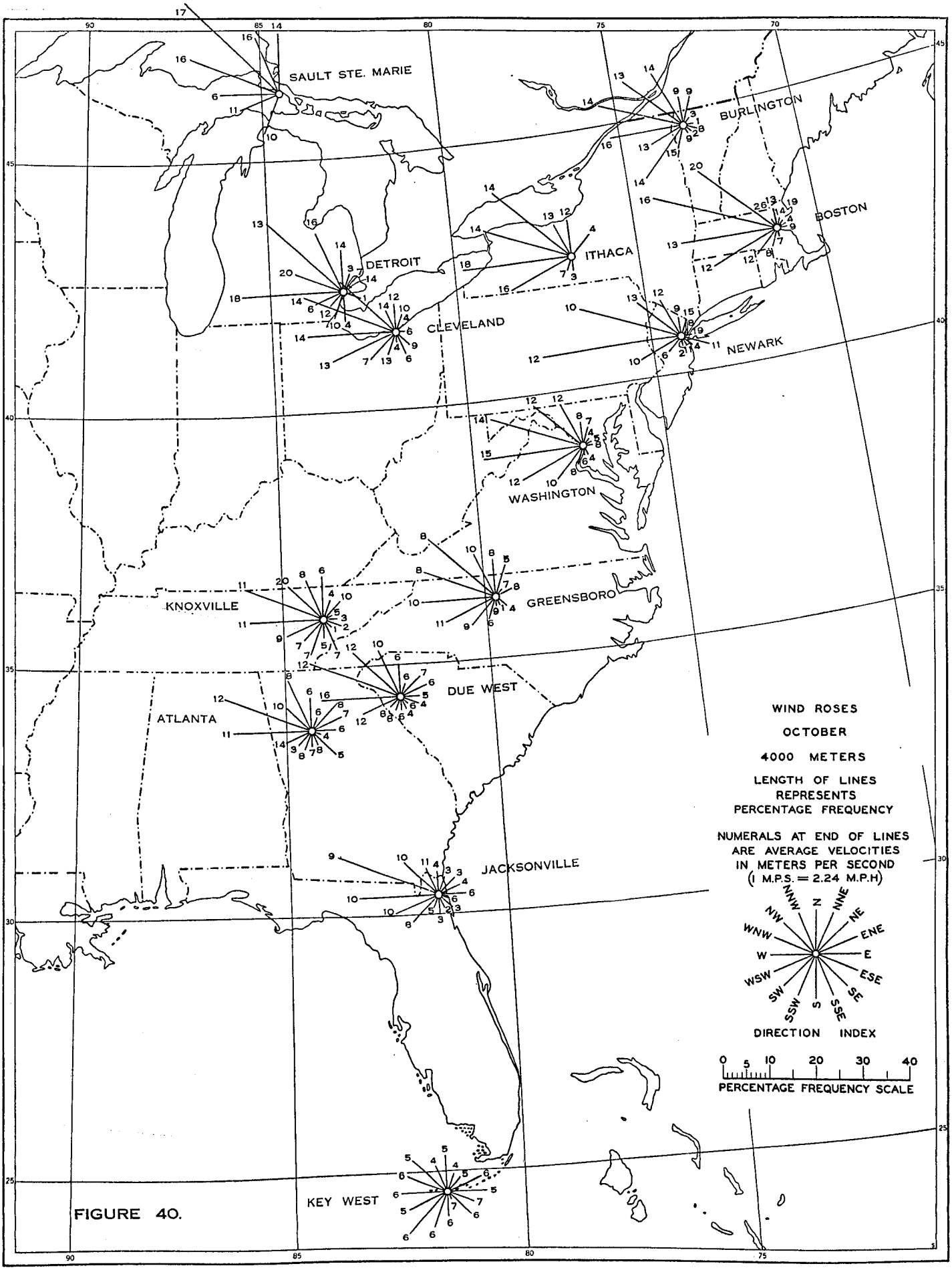
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 39.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ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
OCTOBER
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
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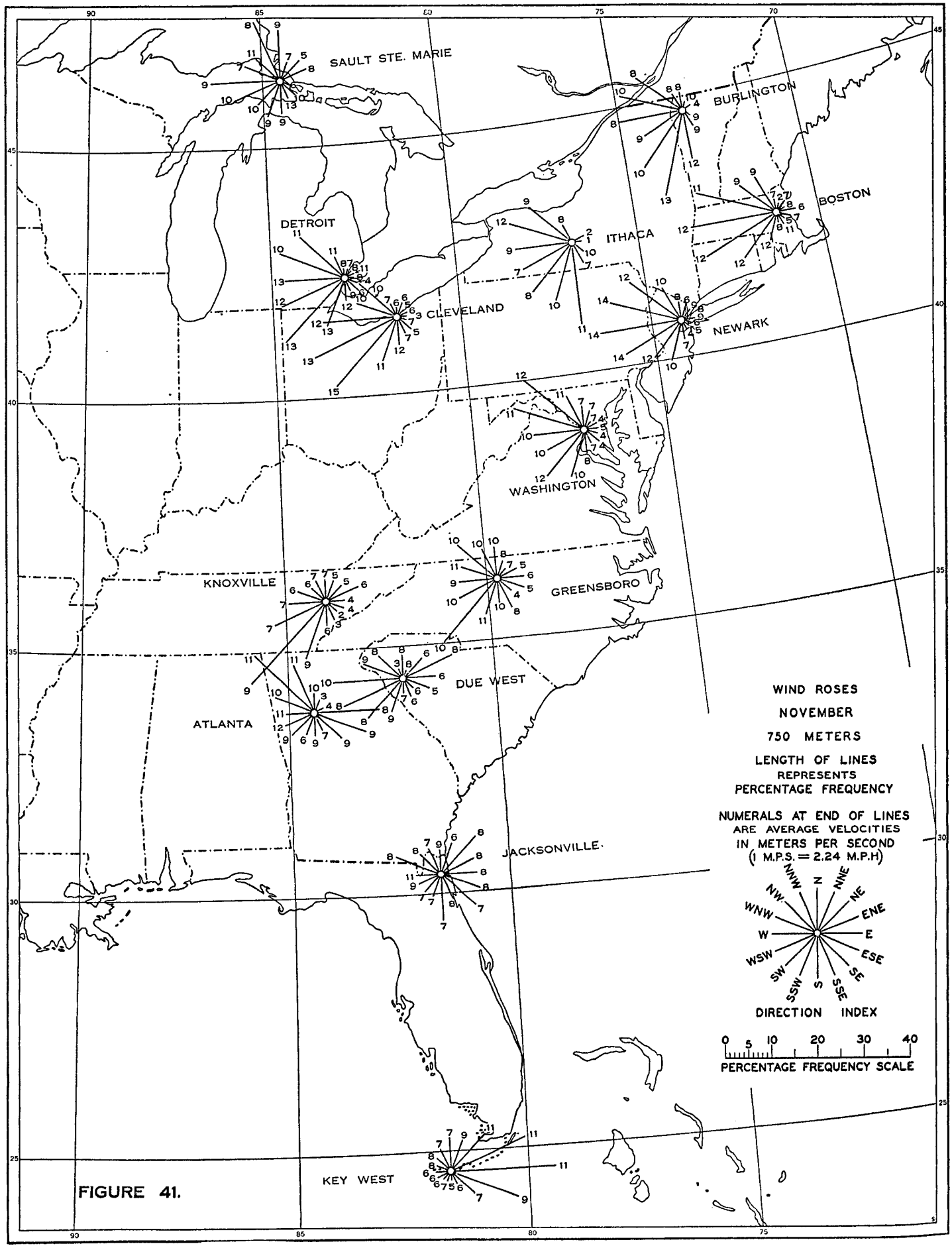
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 40.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GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
NOVEMBER
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
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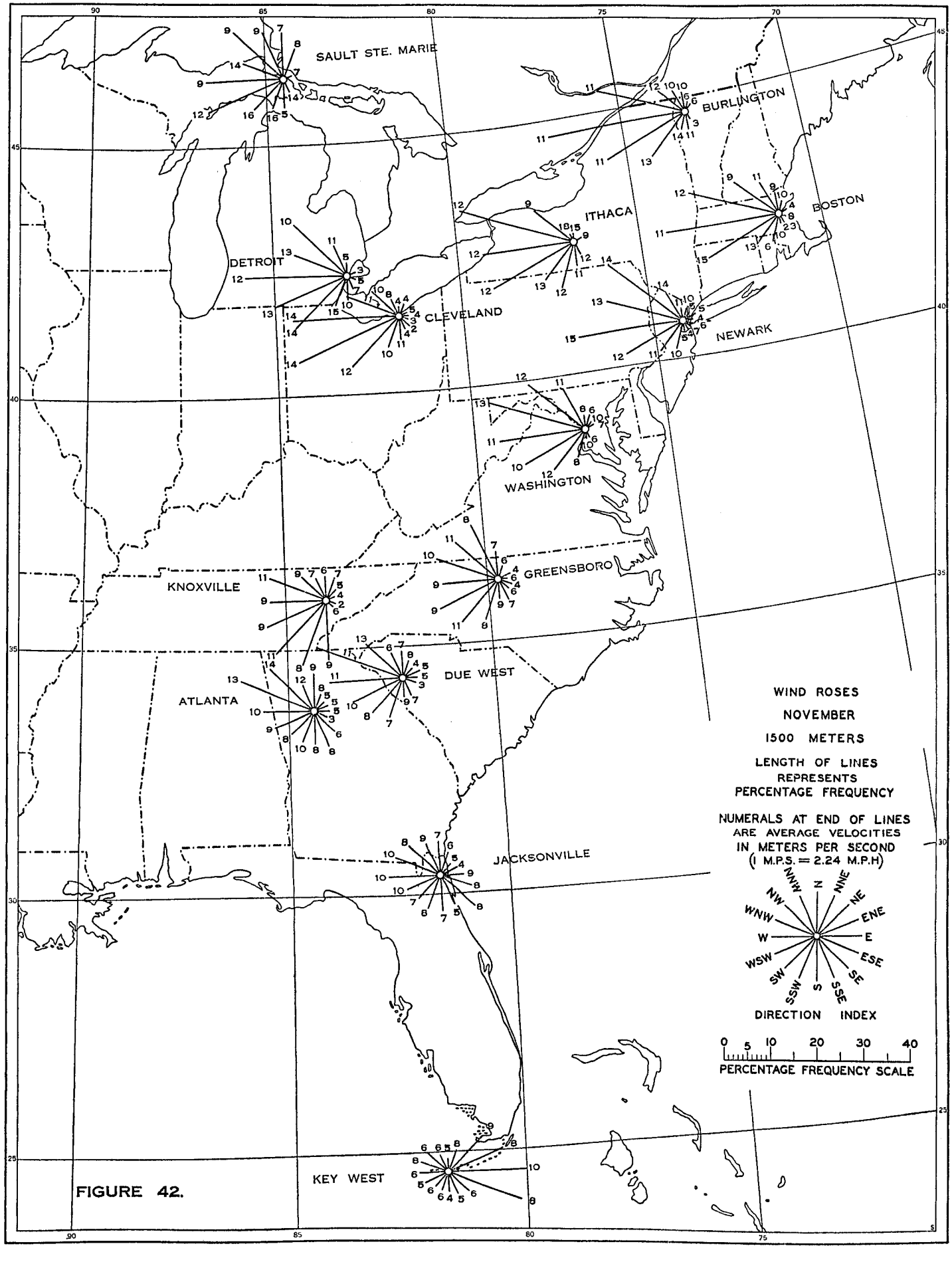
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 41.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BOSTON
ITHACA
DETROIT
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
NOVEMBER
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 42.

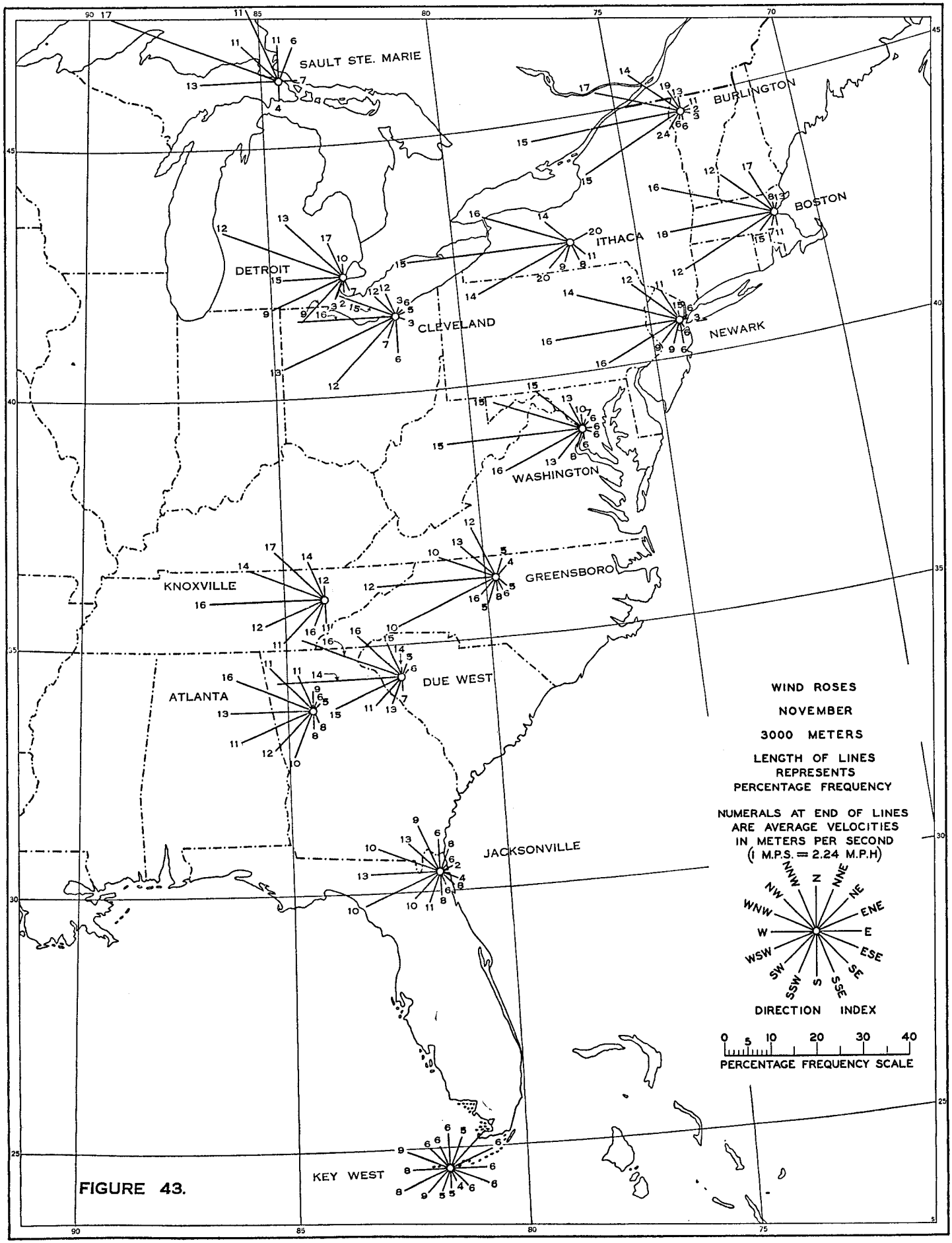
SAULT STE. MARIE
BURLINGTON
BOSTON
ITHACA
DETROIT
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
NOVEMBER
3000 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND (1 M.P.S. = 2.24 M.P.H)
N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 43.

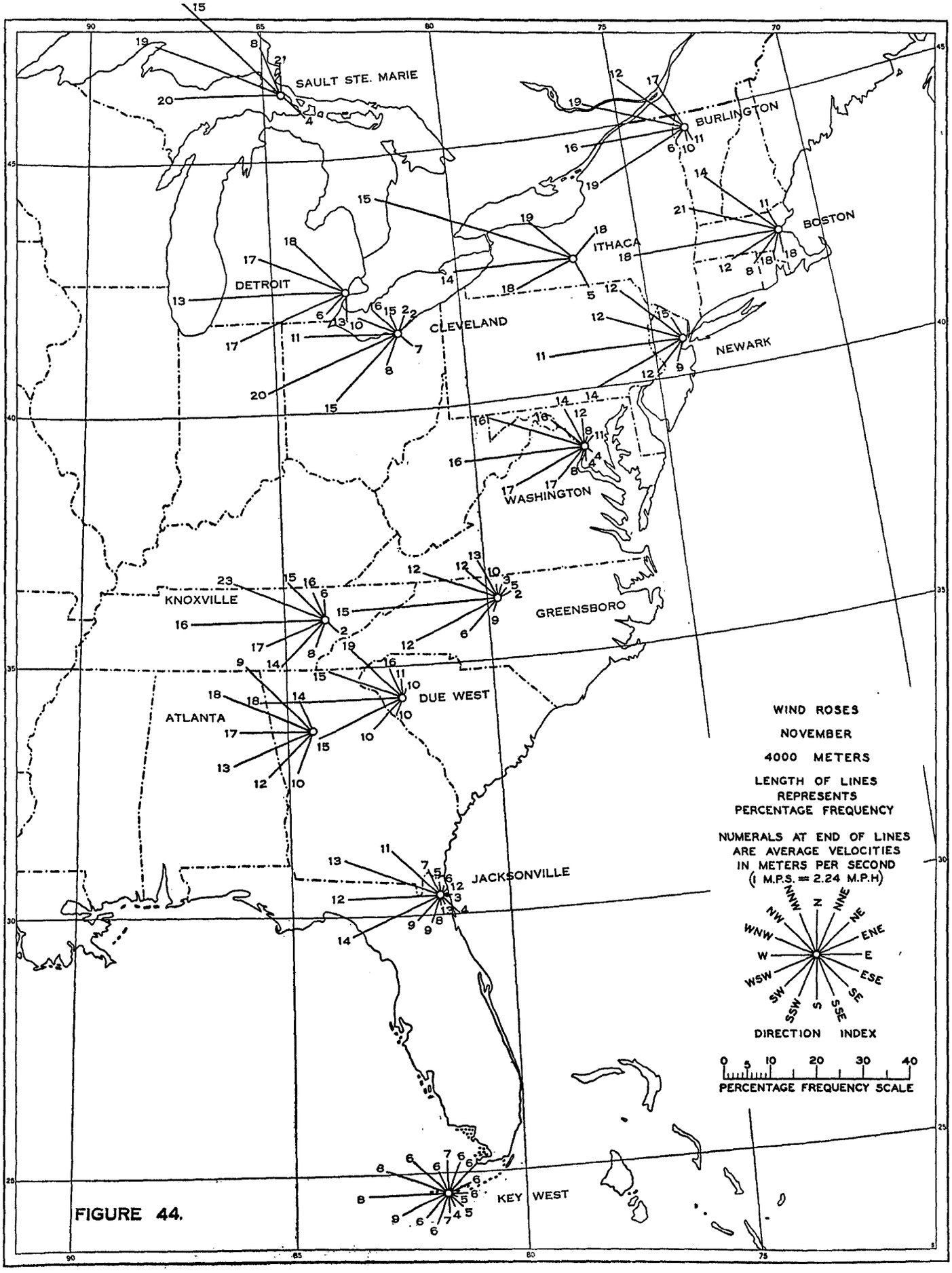
SAULT STE. MARIE
BURLINGTON
BOSTON
ITHACA
DETROIT
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
NOVEMBER
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 44.

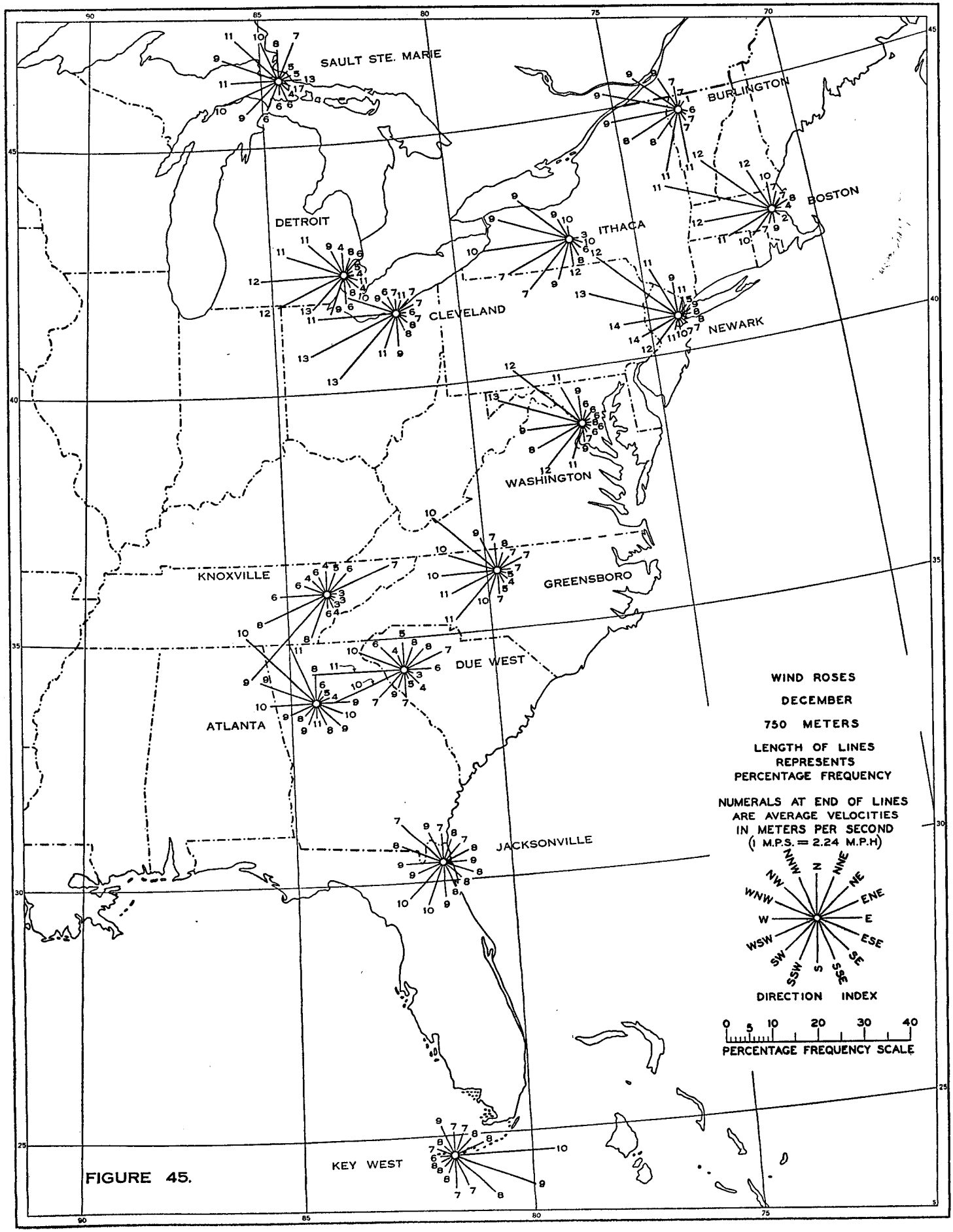
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
DECEMBER
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 45.

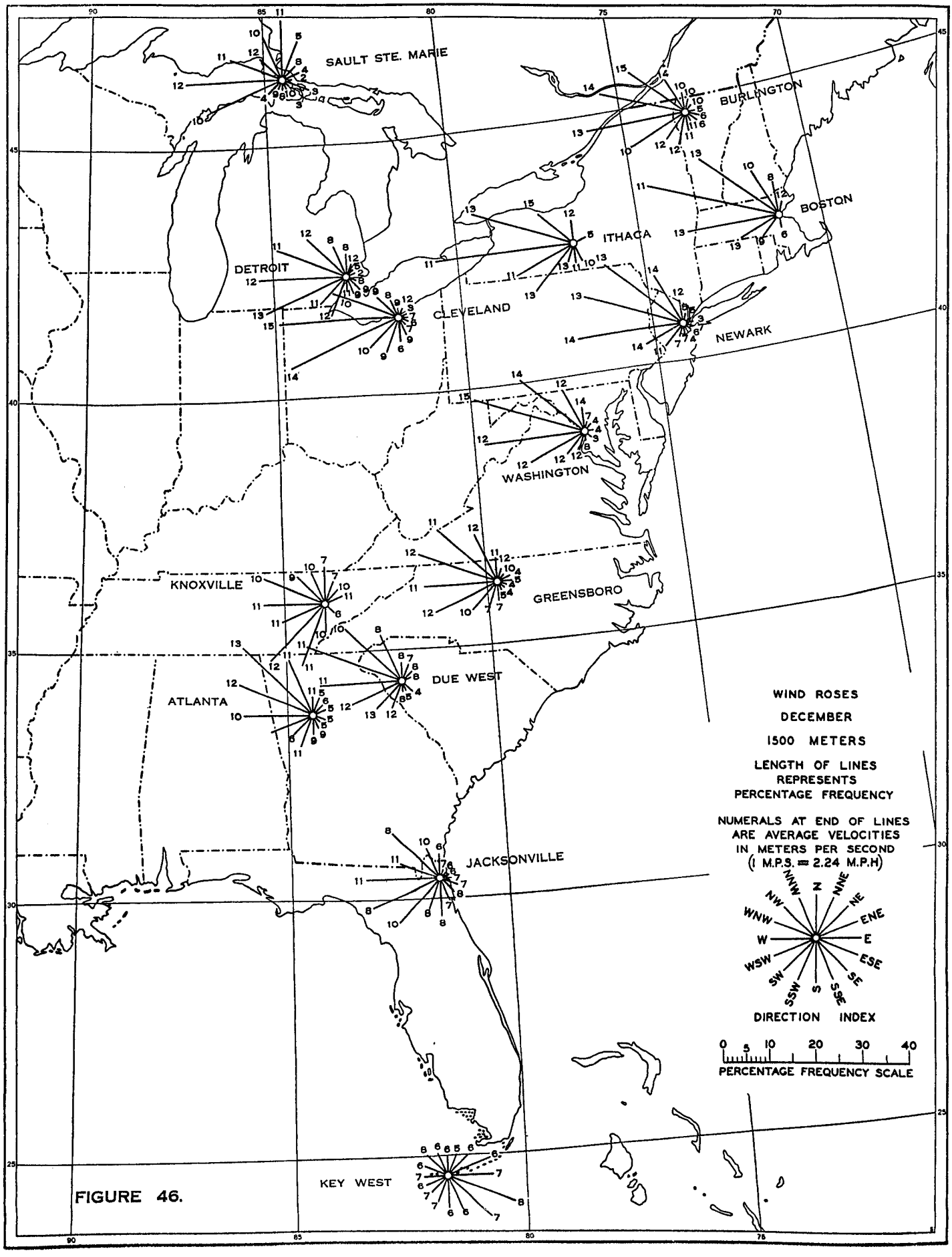
SAULT STE. MARIE
BURLINGTON
BOSTON
ITHACA
DETROIT
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
DECEMBER
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 46.

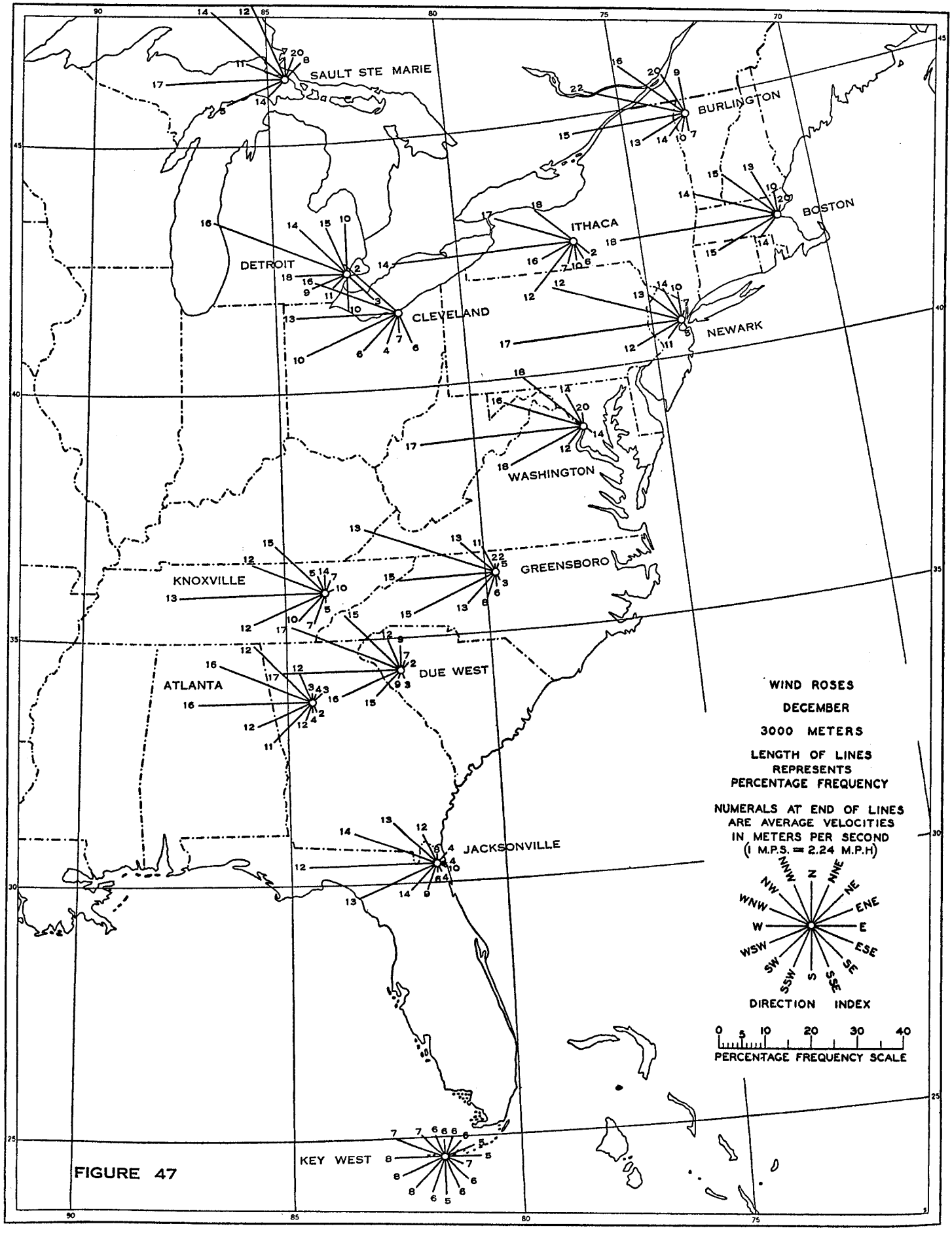
SAULT STE MARIE
BURLINGTON
BOSTON
ITHACA
DETROIT
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
DECEMBER
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 47

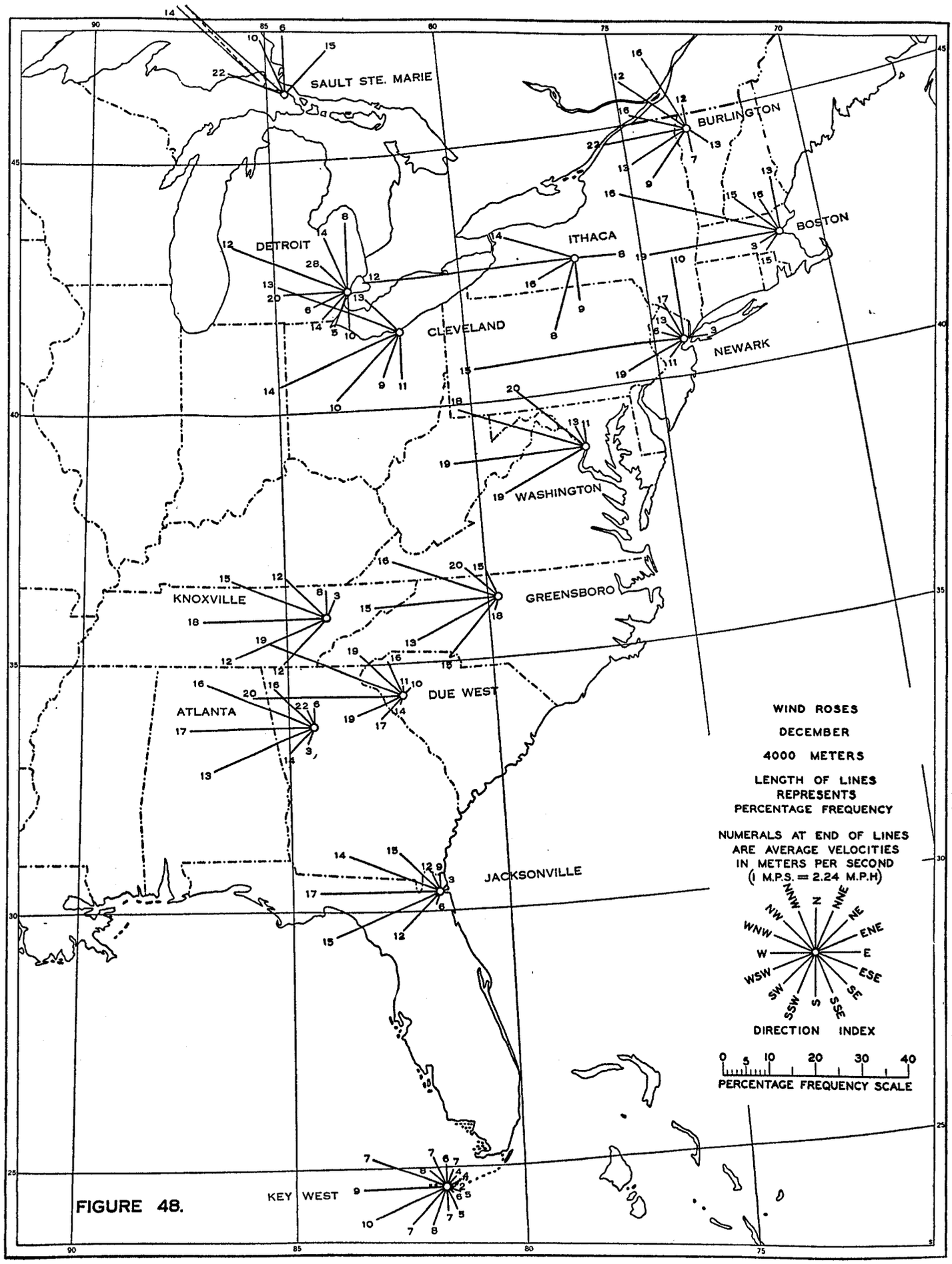
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
DECEMBER
4000 METERS
LENGTH OF LINES REPRESENTS PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES ARE AVERAGE VELOCITIES IN METERS PER SECOND (1 M.P.S. = 2.24 M.P.H)
N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 48.

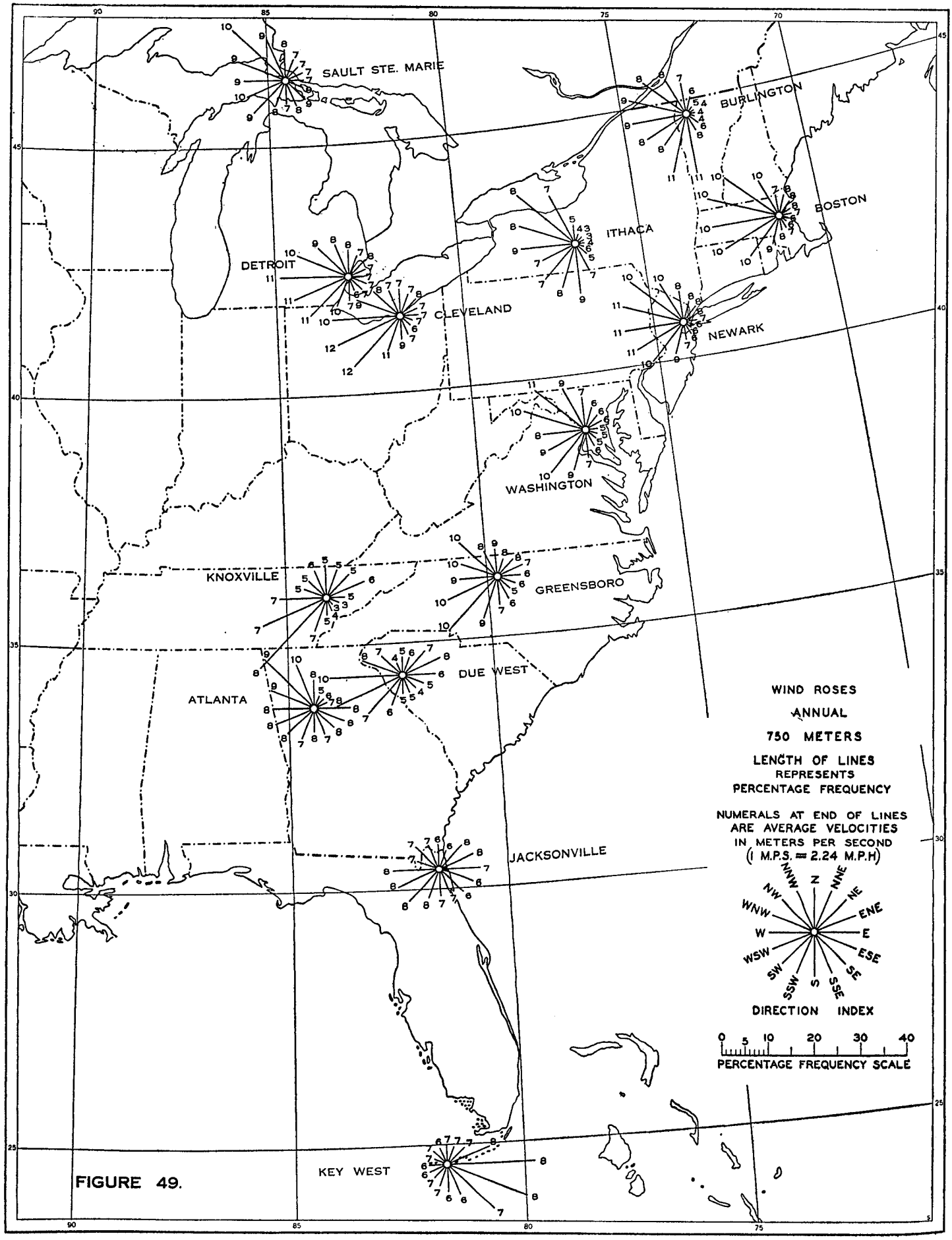
SAULT STE. MARIE
BURLINGTON
BOSTON
ITHACA
DETROIT
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
ATLANTA
DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
ANNUAL
750 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 49.

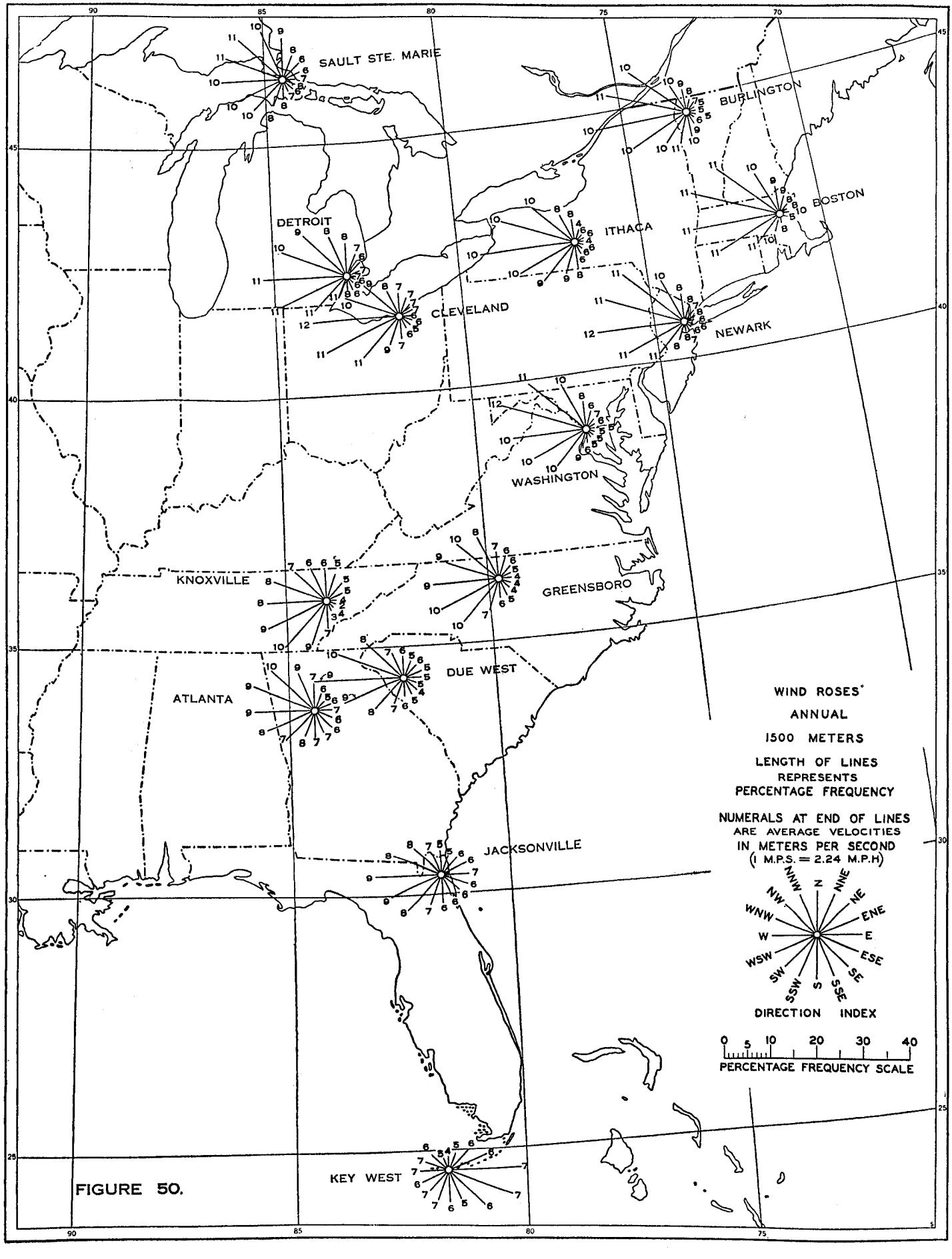
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
ATLANTA
DUE WEST
JACKSONVILLE
KEY WEST
WIND ROSES
ANNUAL
1500 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 50.

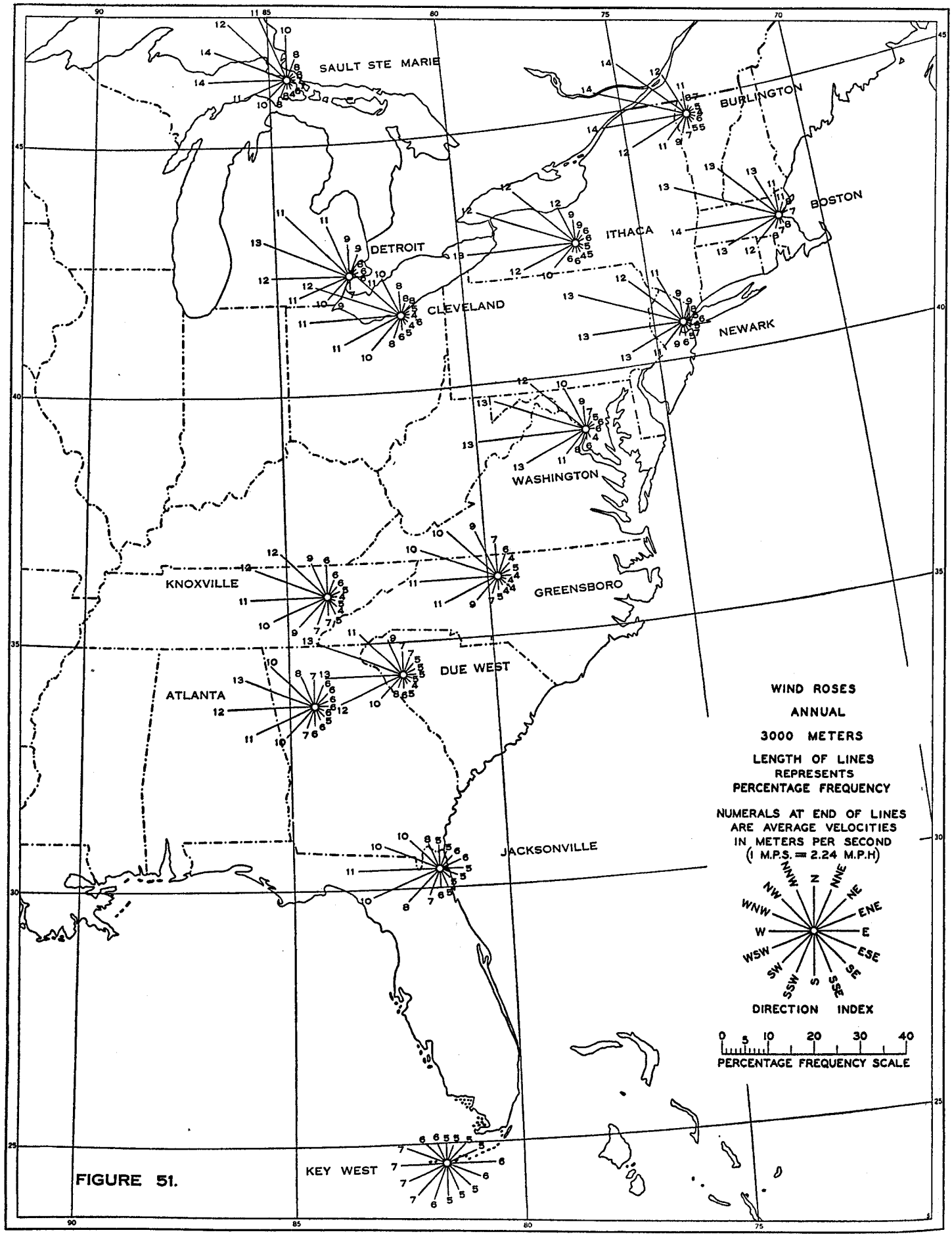
SAULT STE MARIE
BURLINGTON
BOSTON
ITHACA
DETROIT
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
ANNUAL
3000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 51.

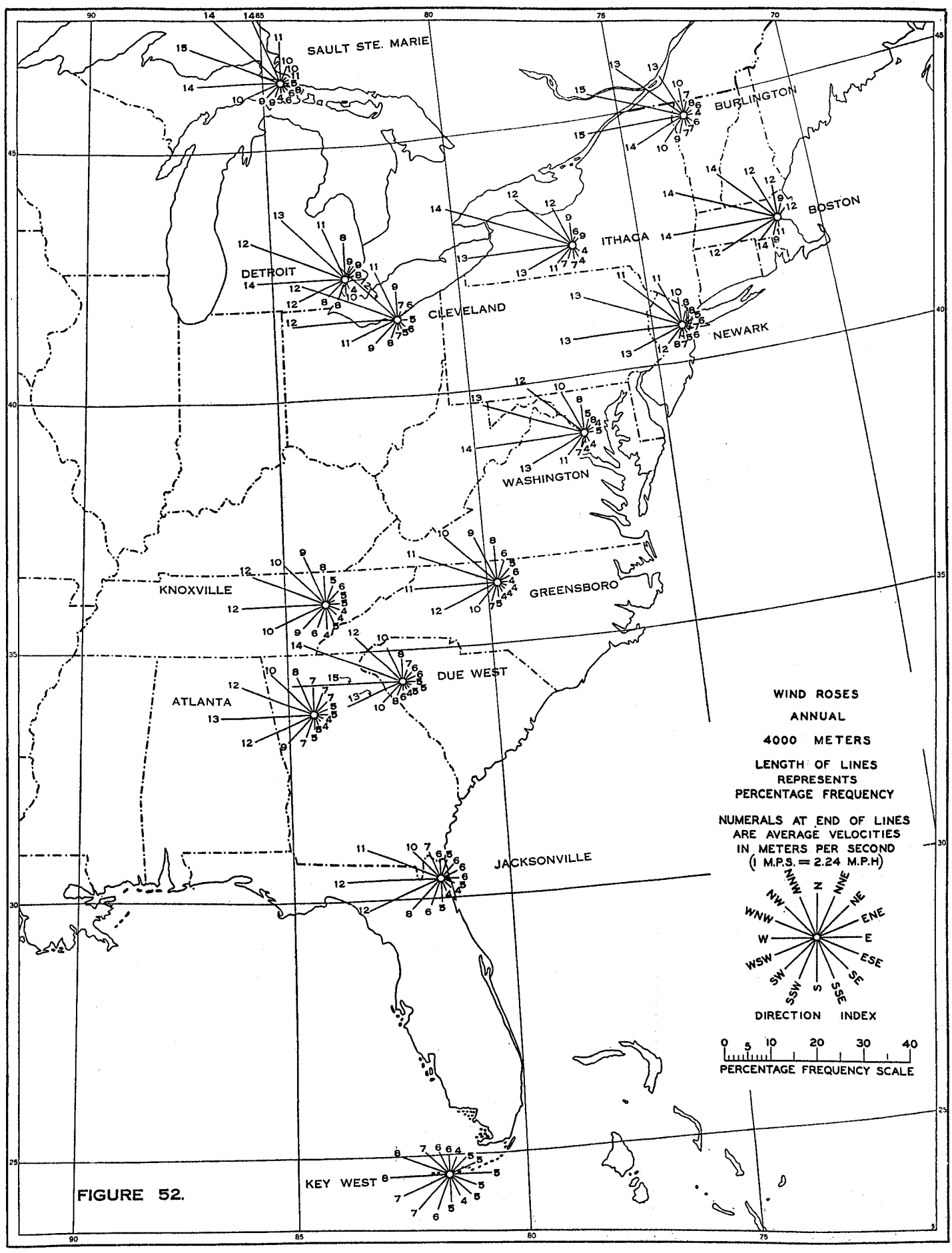
SAULT STE. MARIE
BURLINGTON
BOSTON
ITHACA
DETROIT
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
WIND ROSES
ANNUAL
4000 METERS
LENGTH OF LINES
REPRESENTS
PERCENTAGE FREQUENCY
NUMERALS AT END OF LINES
ARE AVERAGE VELOCITIES
IN METERS PER SECOND
(1 M.P.S. = 2.24 M.P.H)
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
DIRECTION INDEX
0 5 10 20 30 40
PERCENTAGE FREQUENCY SCALE

FIGURE 52.

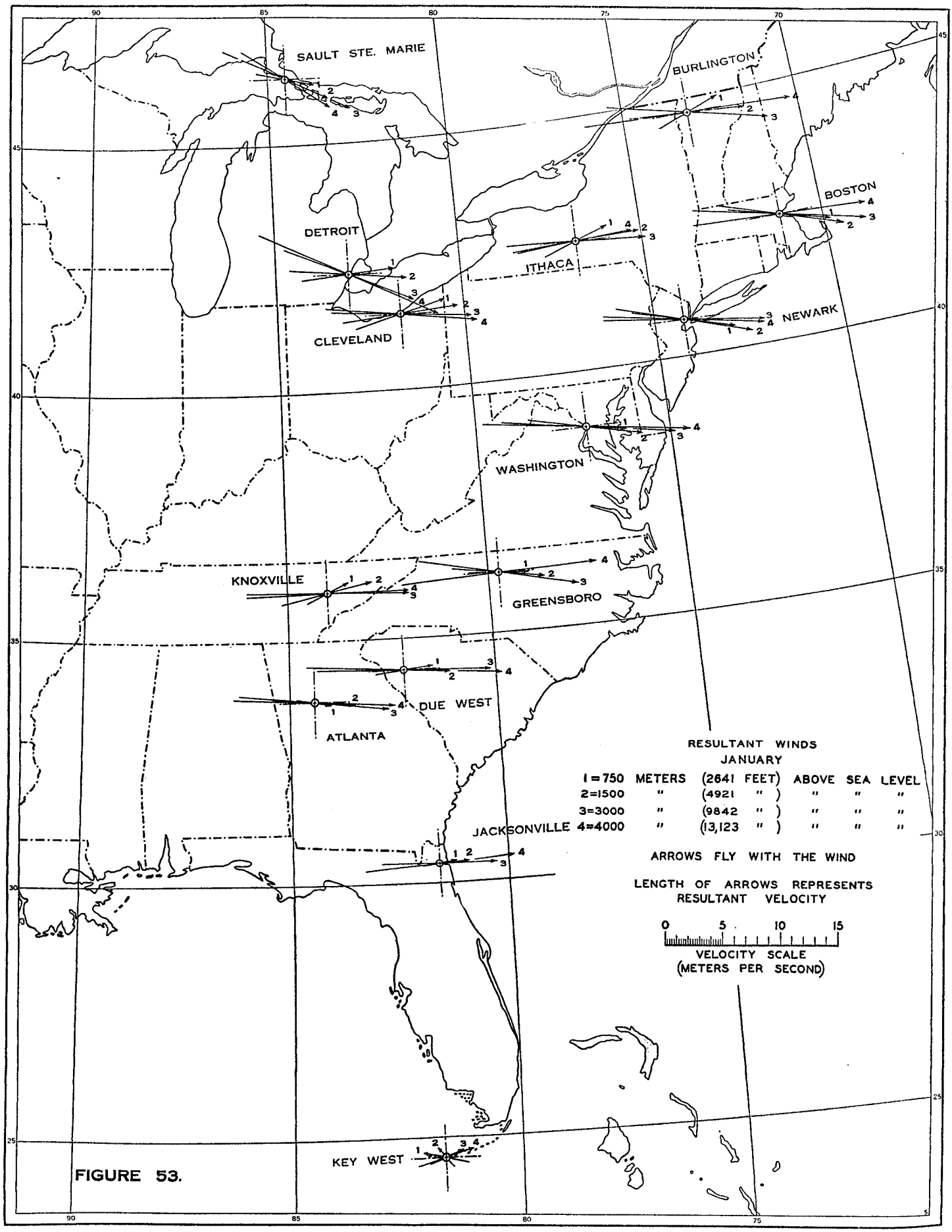
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
JANUARY
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 53.

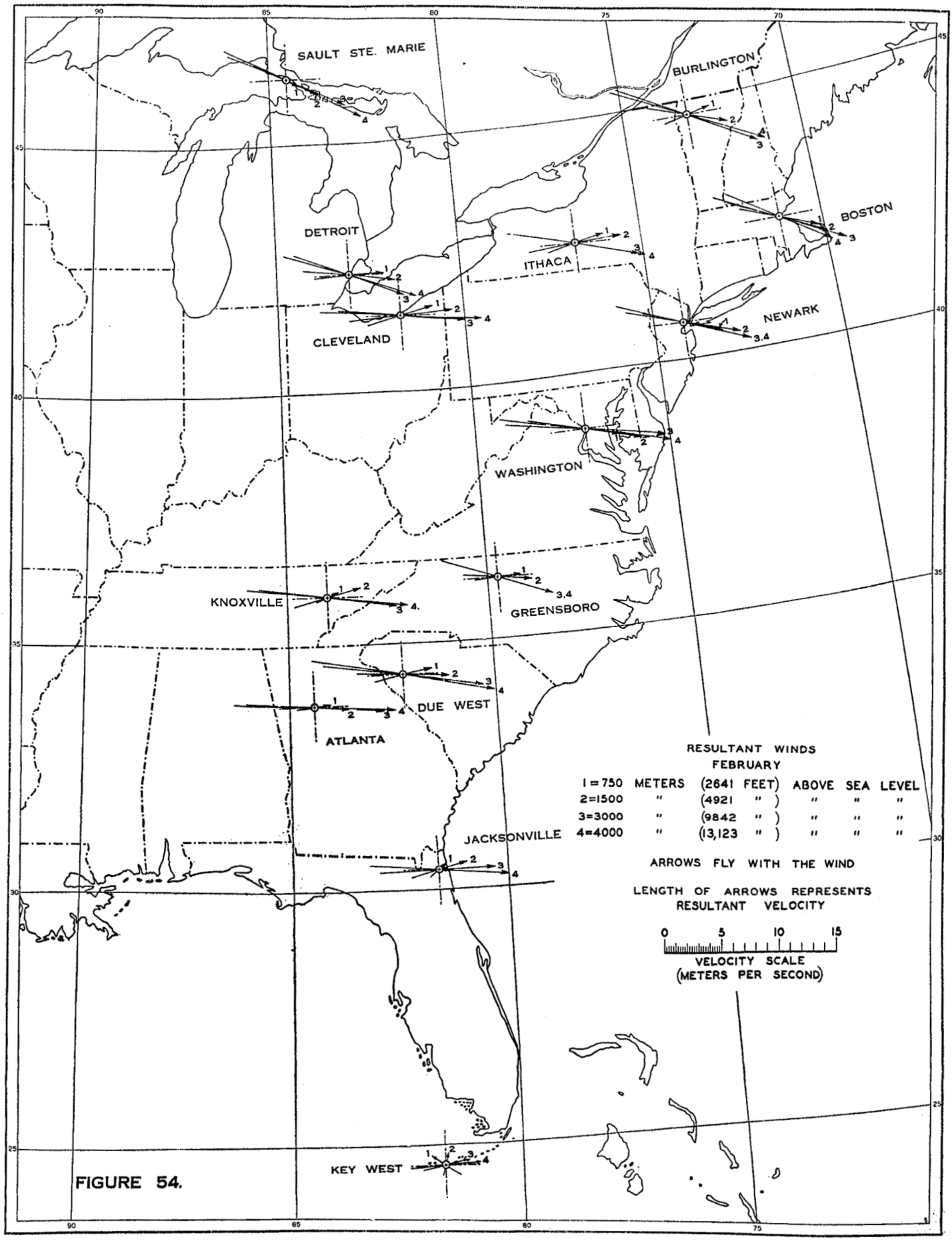
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
NEWARK
CLEVELAND
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
FEBRUARY
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 54.

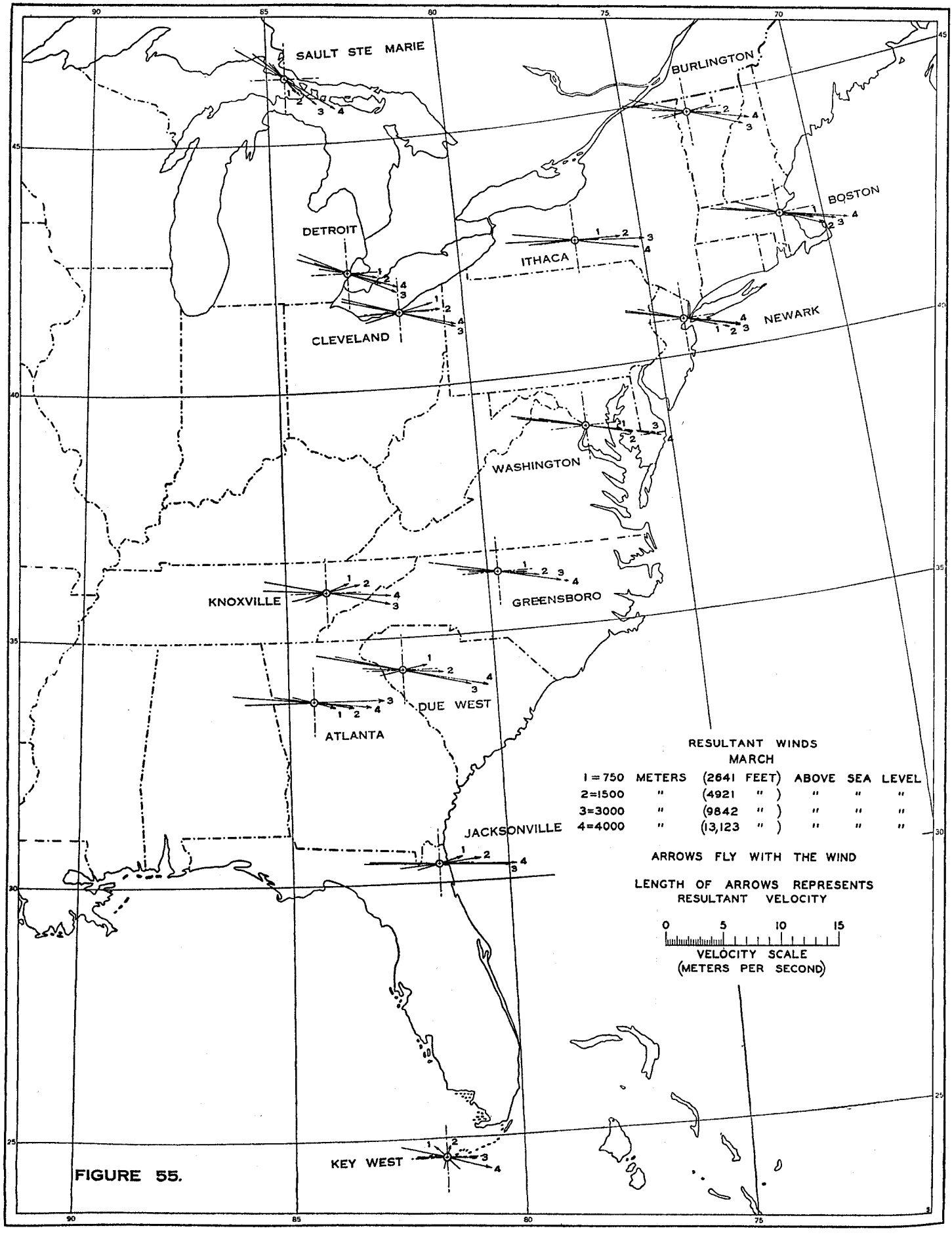
SAULT STE MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
MARCH
1 = 750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 55.

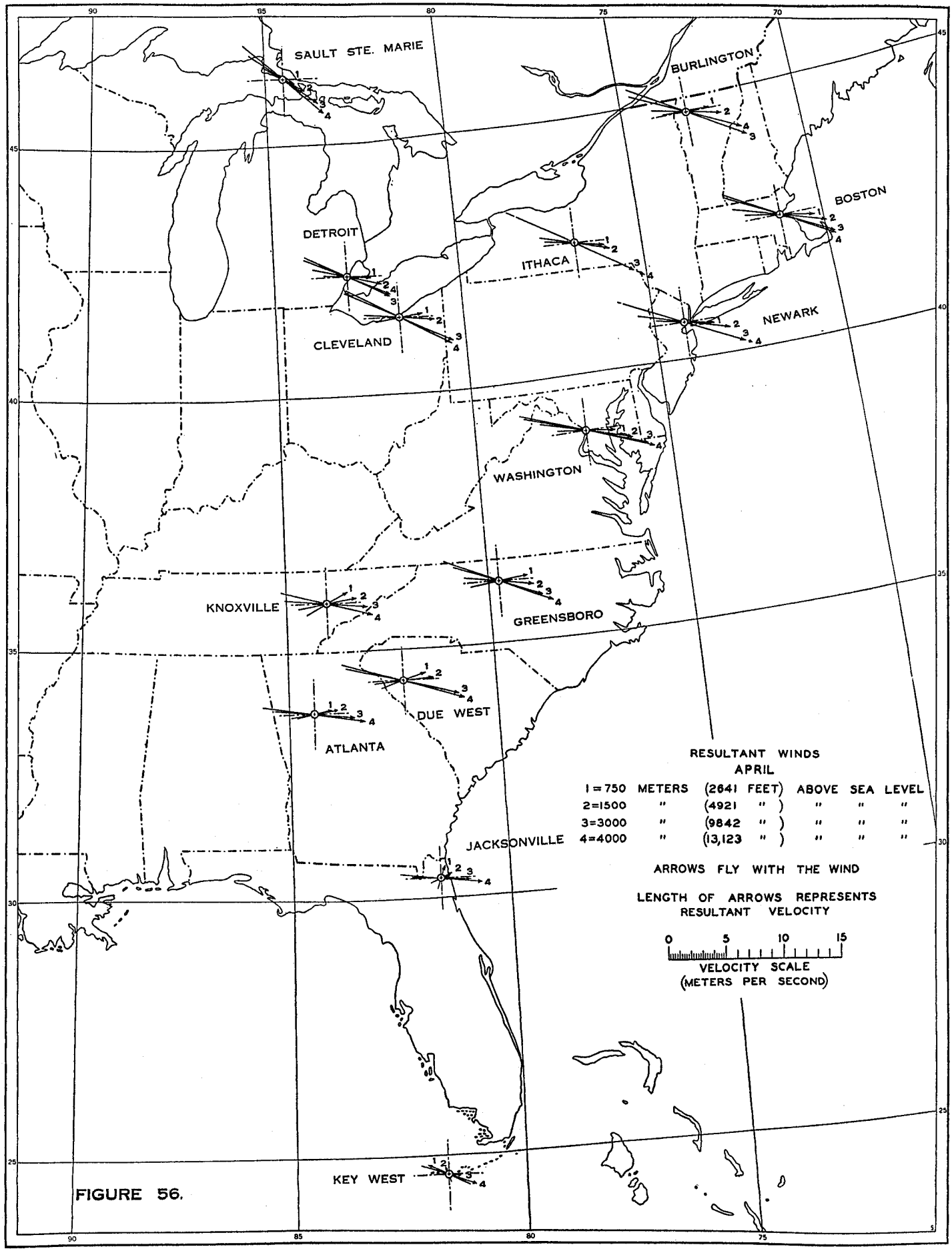
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
NEWARK
CLEVELAND
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
APRIL
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 56.

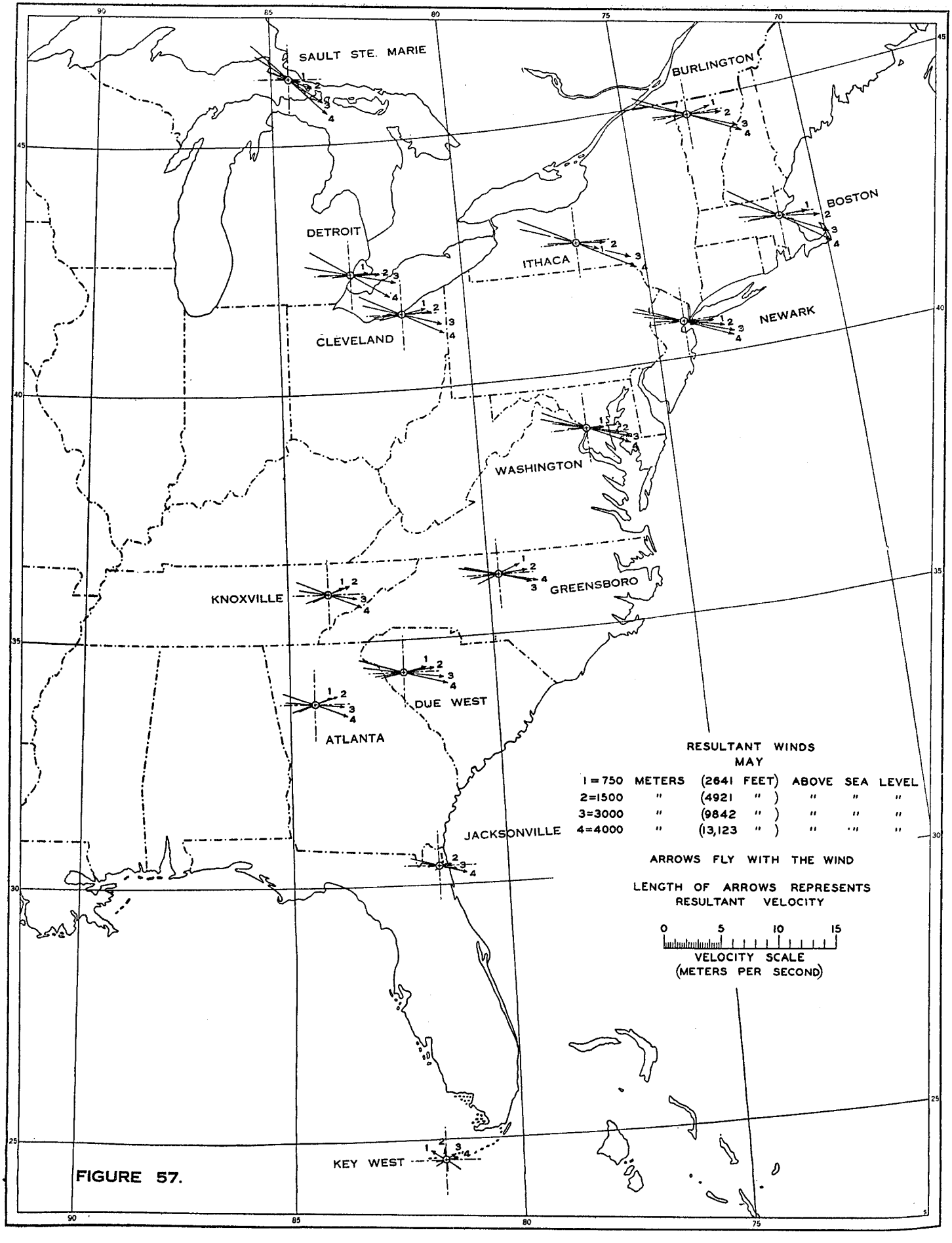
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
NEWARK
CLEVELAND
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
MAY
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 57.

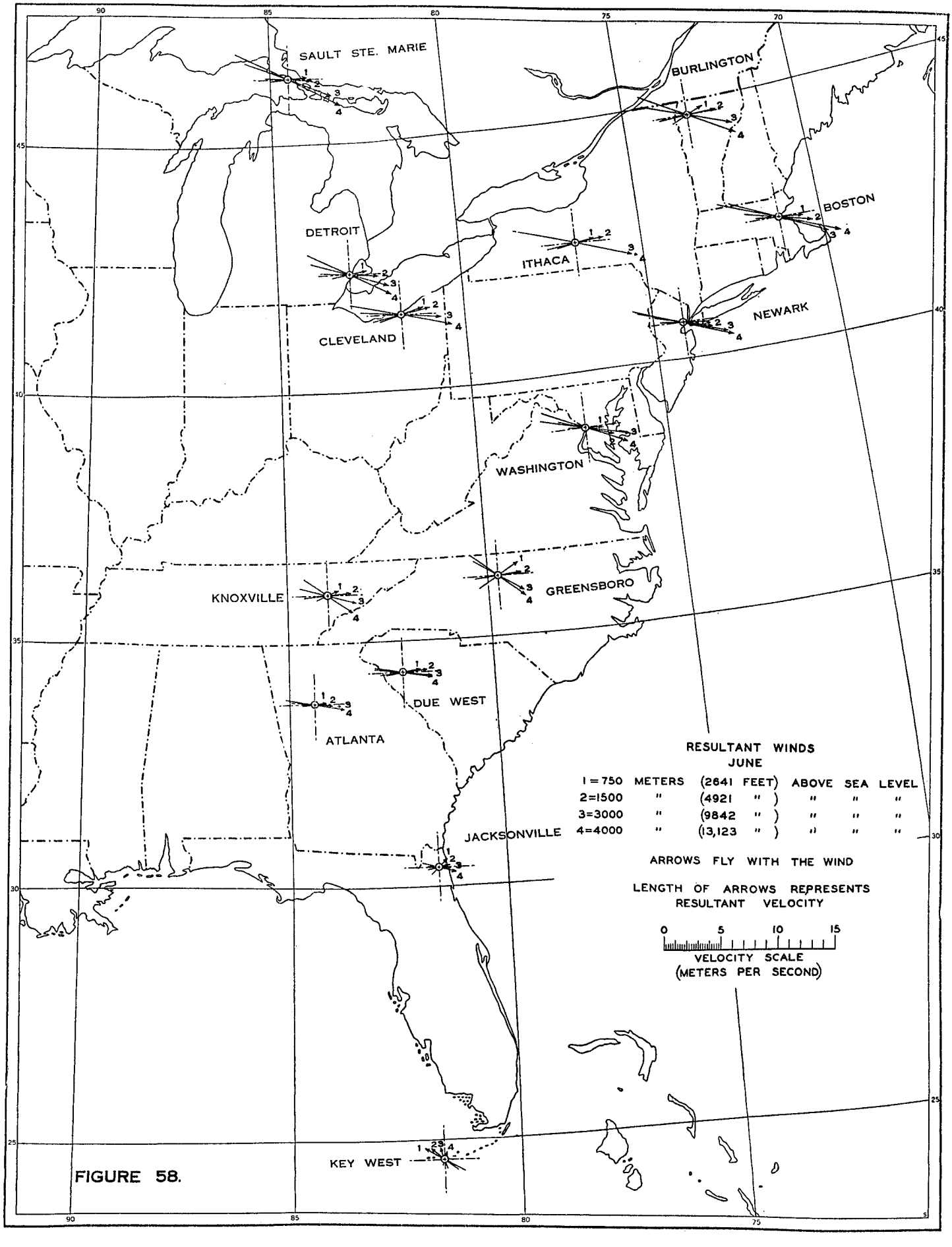
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
NEWARK
CLEVELAND
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
JUNE
1 = 750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS
RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 58.

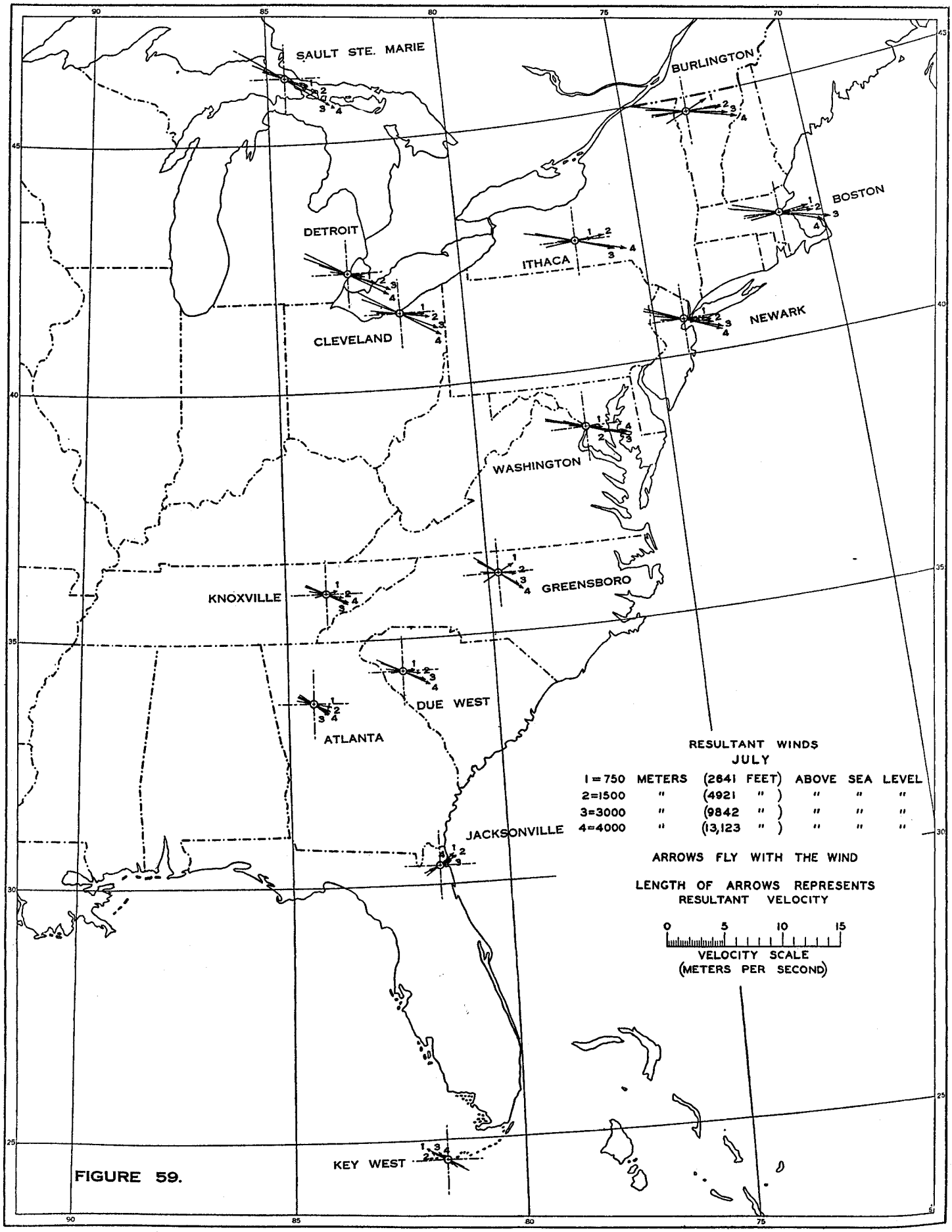
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
JULY
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS
RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 59.

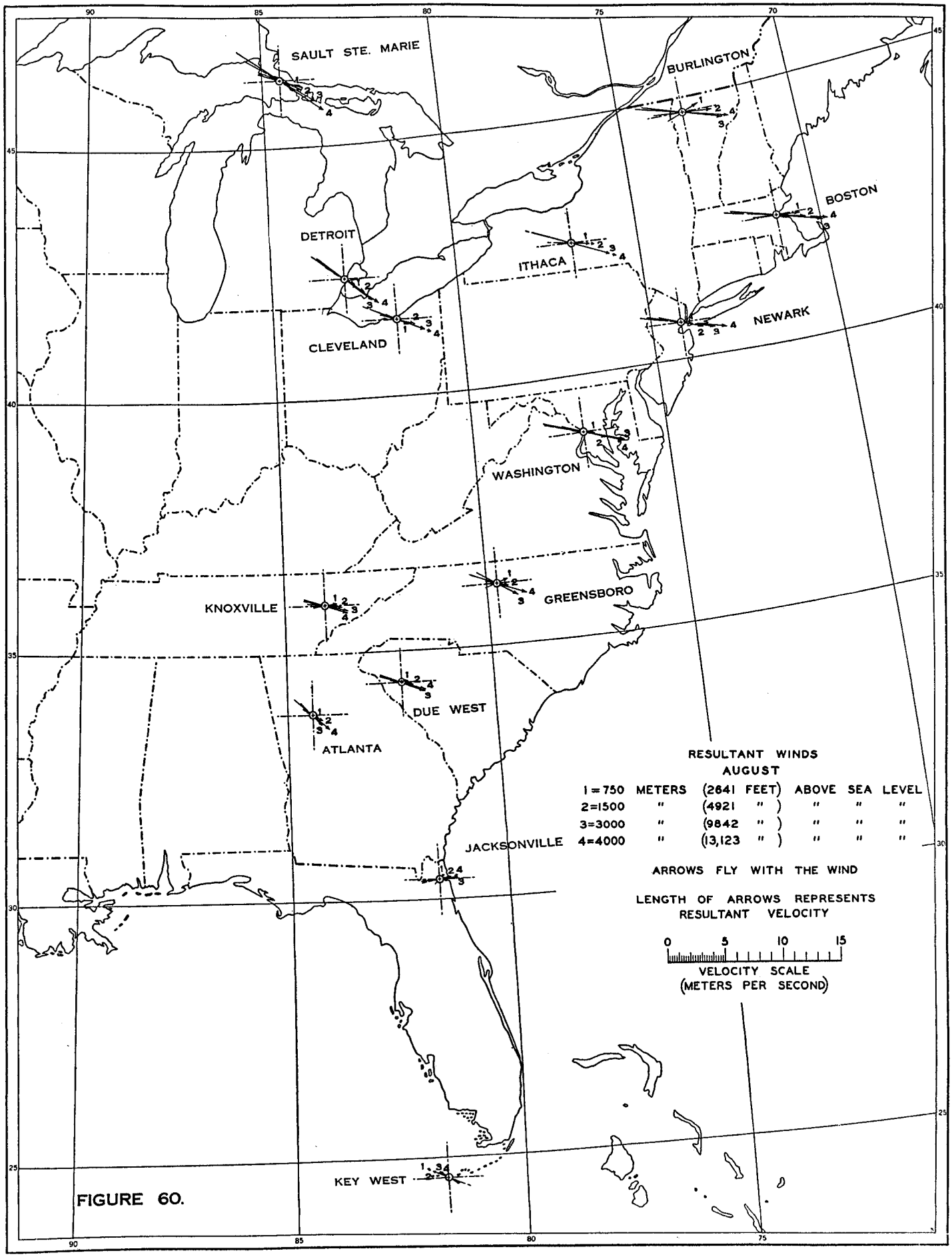
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
NEWARK
CLEVELAND
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
AUGUST
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 60.

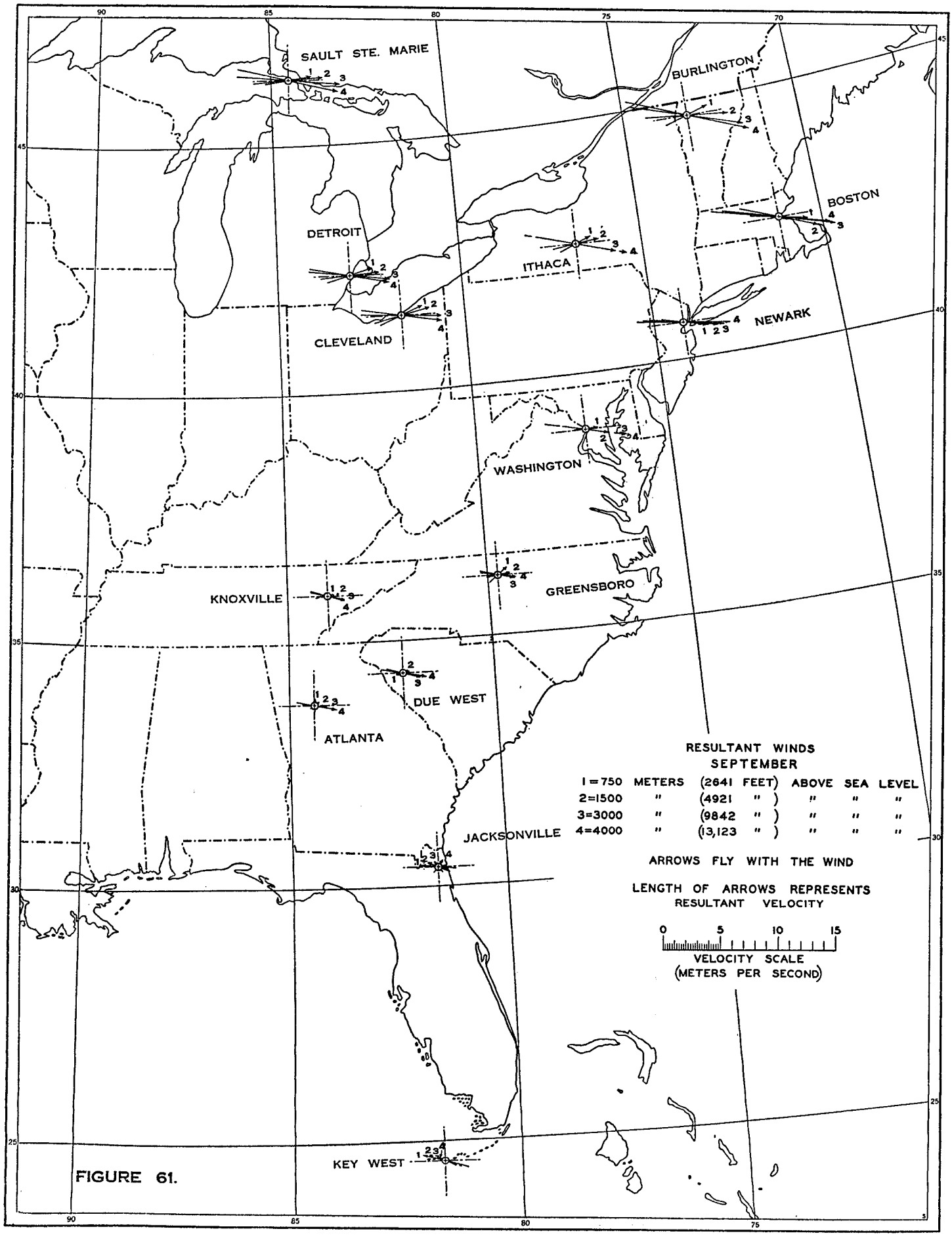
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
SEPTEMBER
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS
RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 61.

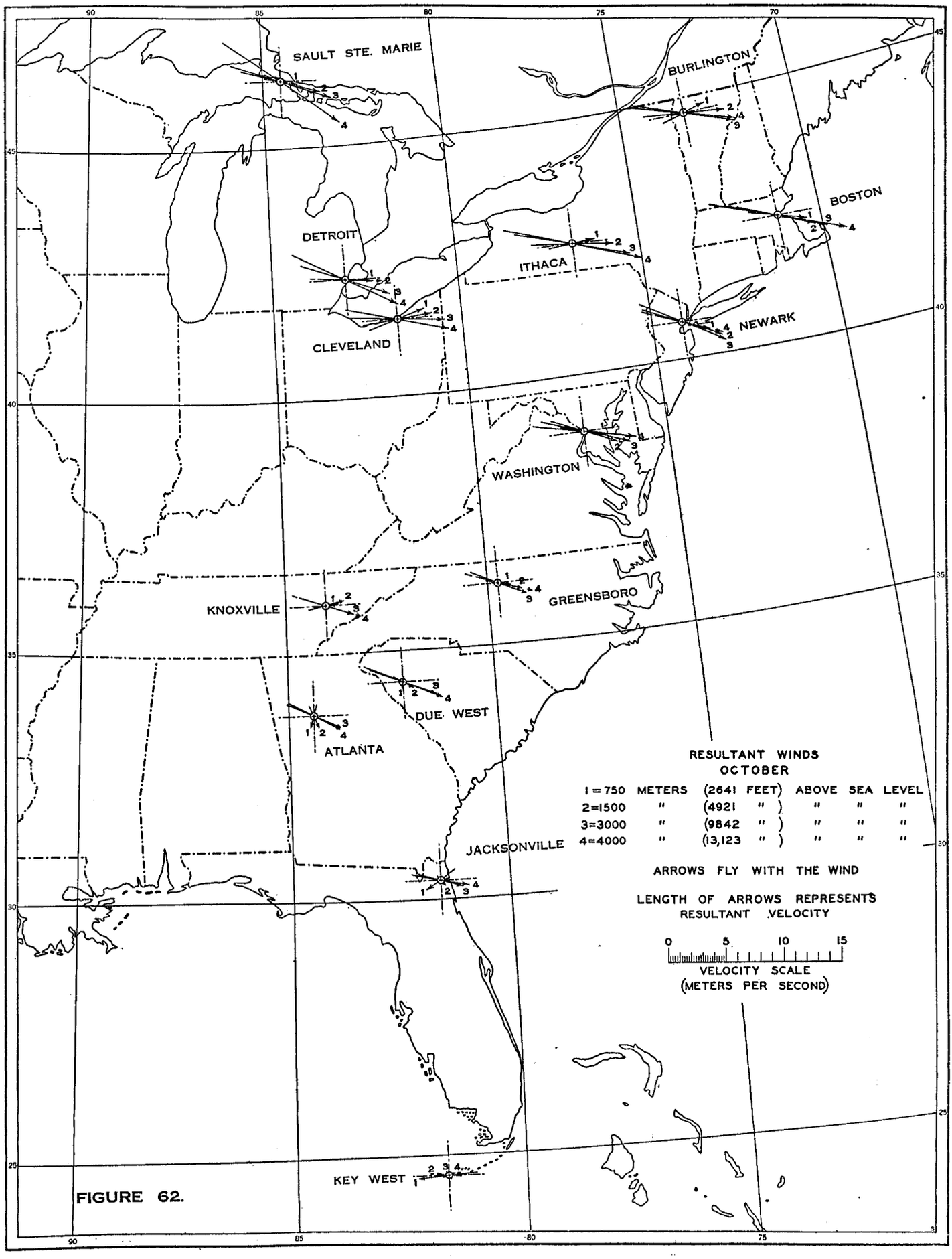
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
OCTOBER
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS
RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 62.

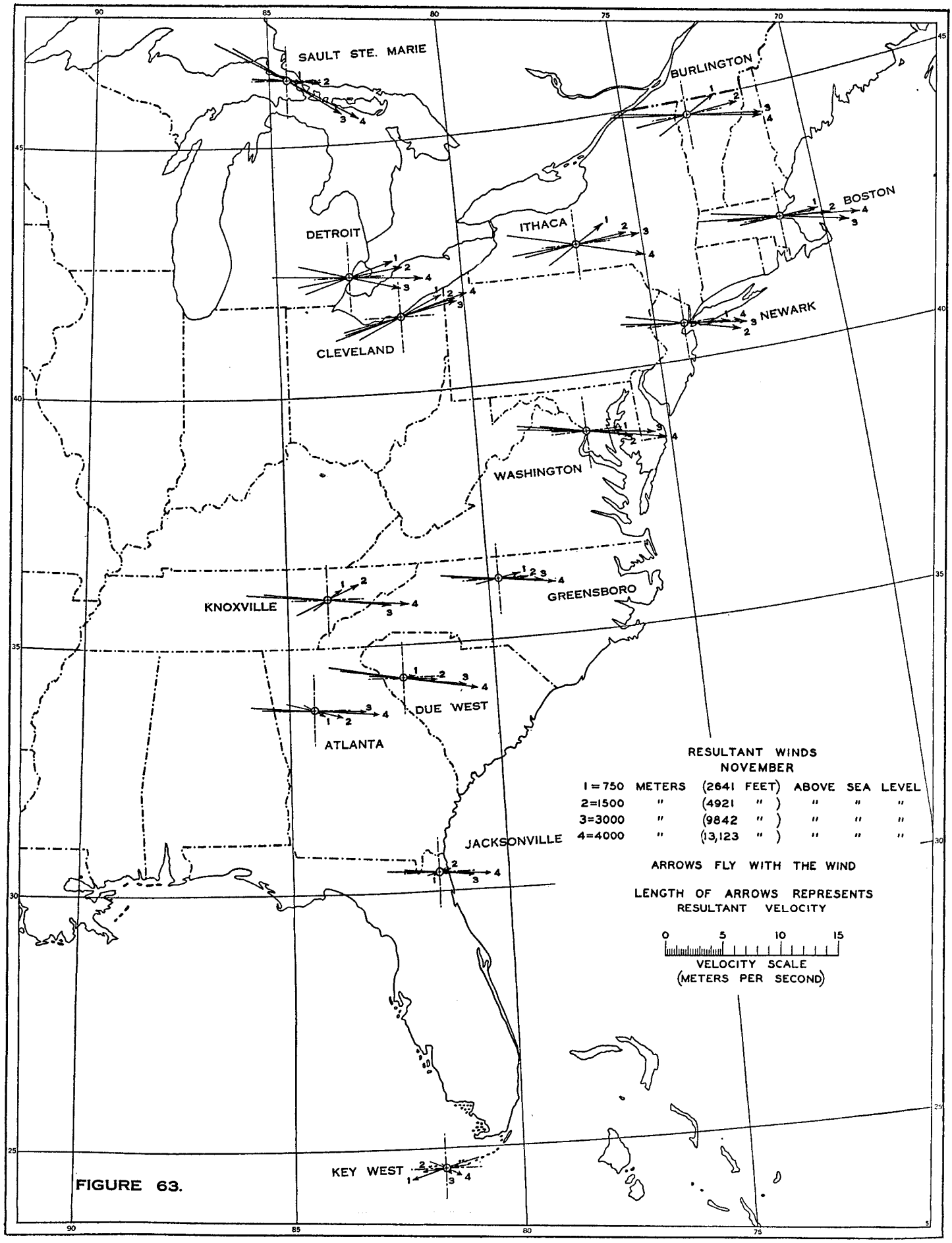
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
NOVEMBER
1 = 750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS
RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 63.

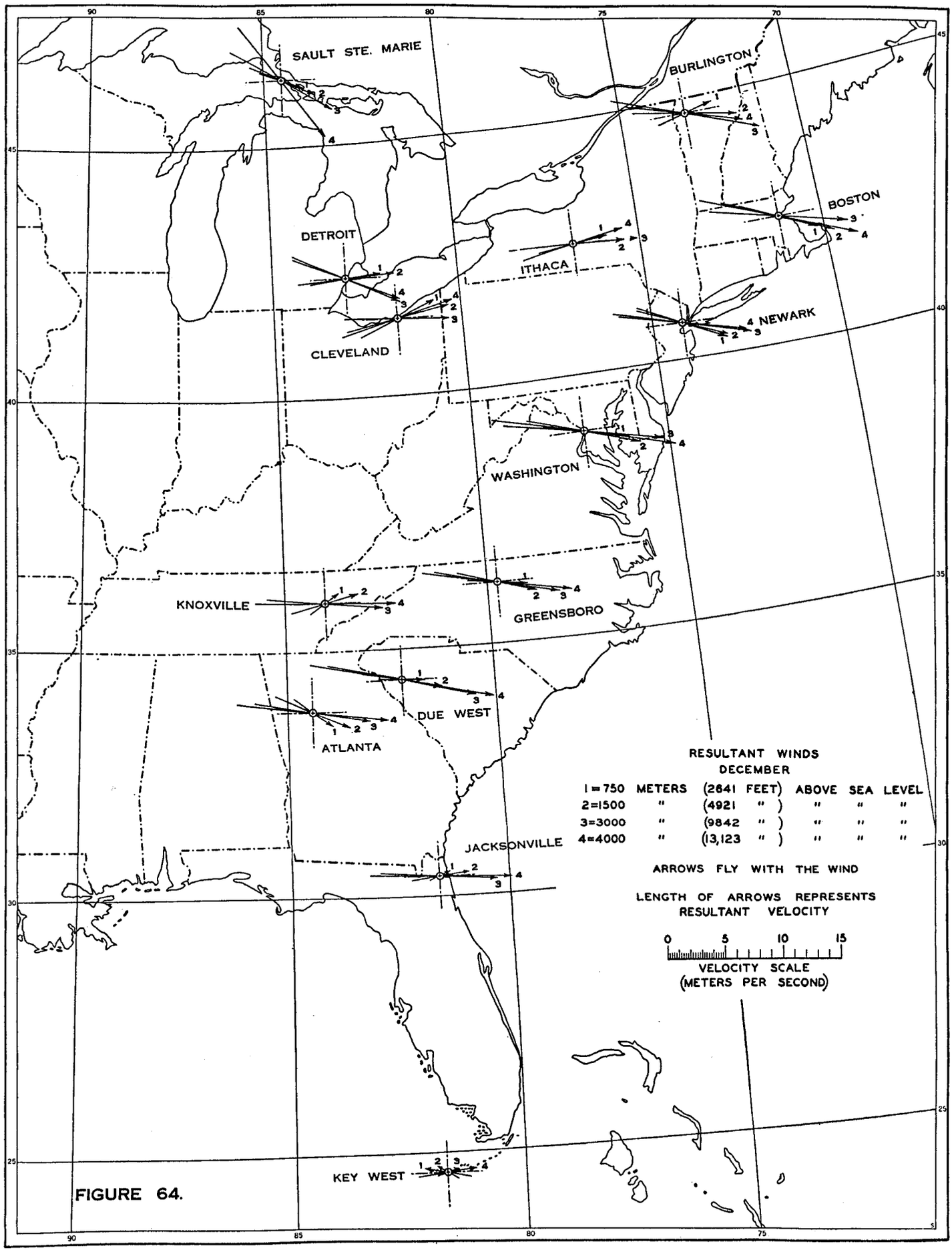
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
NEWARK
CLEVELAND
WASHINGTON
KNOXVILLE
GREENSBORO
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
DECEMBER
1=750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 64.

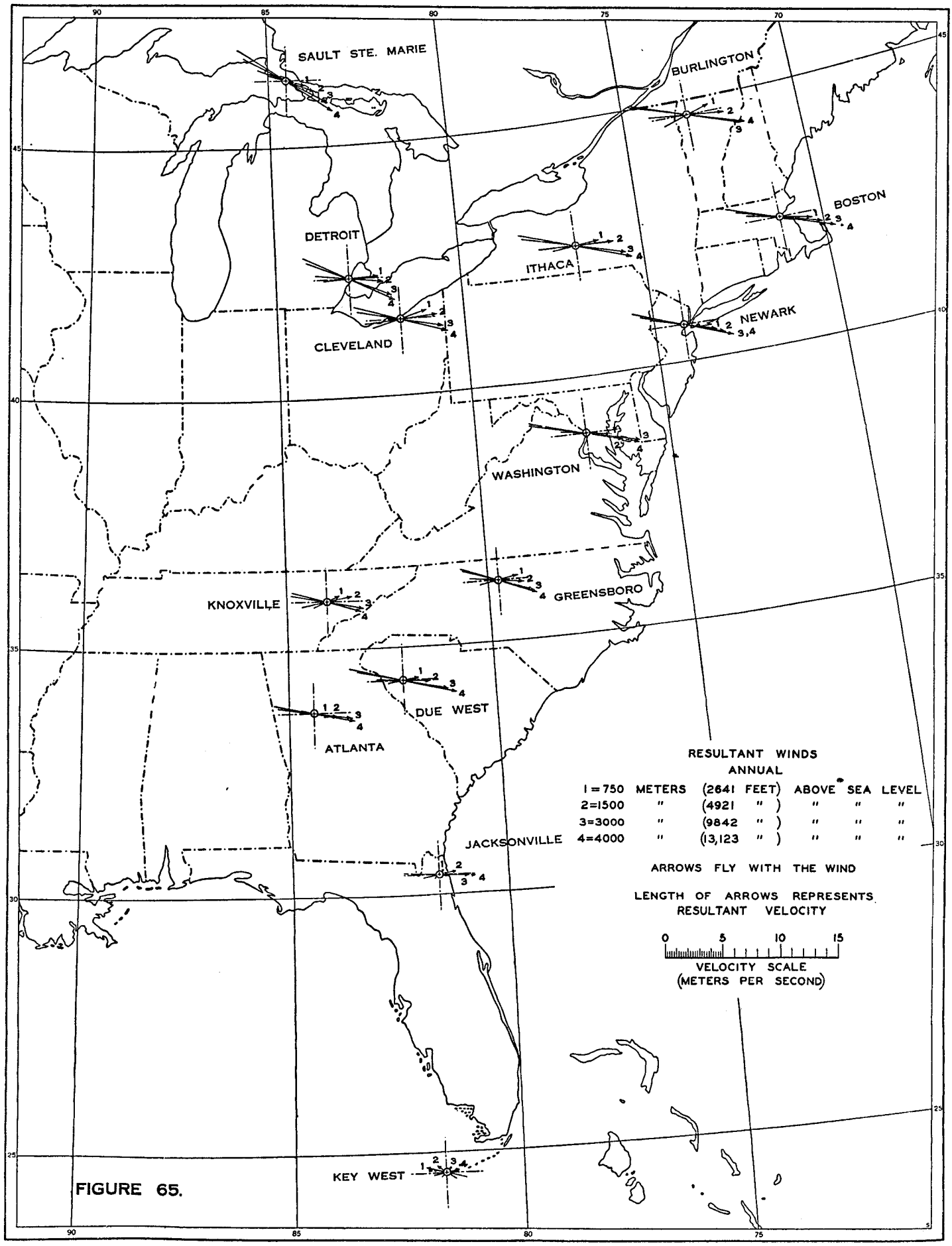
SAULT STE. MARIE
BURLINGTON
BOSTON
DETROIT
ITHACA
CLEVELAND
NEWARK
WASHINGTON
GREENSBORO
KNOXVILLE
DUE WEST
ATLANTA
JACKSONVILLE
KEY WEST
RESULTANT WINDS
ANNUAL
1 = 750 METERS (2641 FEET) ABOVE SEA LEVEL
2=1500 " (4921 ") " " "
3=3000 " (9842 ") " " "
4=4000 " (13,123 ") " " "
ARROWS FLY WITH THE WIND
LENGTH OF ARROWS REPRESENTS RESULTANT VELOCITY
0 5 10 15
VELOCITY SCALE
(METERS PER SECOND)

FIGURE 65.