NBS CIRCULAR 546

Effective Radio Ground-Conductivity Measurements in the United States

UNITED STATES DEPARTMENT OF COMMERCE

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Effective Radio Ground-Conductivity Measurements in the United States

R. S. Kirby, J. C. Harman, F. M. Capps, and R. N. Jones

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Contents

Effective Radio Ground-Conductivity Measurements in the United States

R. S. Kirby, J. C. Harman, F. M. Capps, and R. N. Jones

Maps are presented showing the results of effective ground-conductivity measurements made by various broadcasters and consulting engineers throughout the United States. The need for such detailed maps has been indicated by the lack of reliability inherent in the use of general-area conductivity maps and by studies of the correlation of effective ground-conductivity measurements with surface soil conditions. Over 7,000 radials are shown on the maps, and provisions have been made for entering new measurements, as the results become available, for possible future publication. Due to the complexity of ground-wave propagation over an inhomogeneous earth, the determination of effective ground conductivity over a given radial strictly applies only at the frequency at which the measurements were made.

1. Introduction

In 1947 the National Bureau of Standards began a program of cataloging measurements of effective ground conductivity as obtained from the files of the Federal Communications Commission. By 1953, a total of 7,237 such ground-conductivity determinations made at 621 broadcast stations in the 540 to 1,600-kc portion of the spectrum had been collected. A study was made of the relationship between effective ground conductivity and surface soil composition. The study showed some association of ground conductivity with soil type, but so little that its use in predicting future values of ground conductivity for given soil type generally yields too wide a range of values to be sufficiently precise. Previous effective ground-conductivity maps have been prepared on the assumption that the values of effective ground conductivity are fairly highly associated with soil types. However, the use of such maps has shown them to be inaccurate in many cases.

It is the purpose of this circular to present, in map form, a compilation of the accumulated effective ground-conductivity data showing the locations of the radials over which the measurements were made, the frequencies and call letters of the transmitters, and the values of effective ground conductivity associated with each radial.

2. Description of Data

Although both the conductivity and the dielectric constant of the ground are important in ground-wave radio propagation, it is important to note that, at the frequencies involved in these measurements, ground conductivity has, by far, the greater effect upon the received field strength, and the dielectric constant has but little effect. It is only at the higher frequencies that the dielectric constant becomes important and must be considered.

The method employed by the standard broadcasters and consulting engineers to determine effective ground conductivity involves a process of curve fitting, using calculated ground-wave field strength versus distance curves such as those presented by the Federal Communications Commission.[1] It will not be treated in detail here. In general, field-strength measurements are made along at least eight radials from a broadcast transmitter, or sometimes along more radials, depending upon the complexity of the horizontal radiation pattern of the transmitting antennas. At least 18 to 20 field-strength measurements are made along each radial, which when corrected for power are plotted versus distance and compared with the calculated ground-wave field-strength-versus-distance curves. The value of ground conductivity associated with the calculated curves most nearly fitting the measured data is taken as the value of effective ground conductivity for that radial. In some cases, where it appears apparent from the data that there is a rather abrupt change in ground conductivity, two or more values of effective ground conductivity are resolved by a process such as the equivalent-distance method described by Kirke.[2]

[1] Federal Communications Commission, Standards of good engineering practice concerning standard broadcast stations, U. S. Government Printing Office, Washington, D. C. (1938–48).

[2] J. L. Kirke, Calculation of ground-wave field strength over a composite land and sea path, J. Inst. Elec. Engrs. (London) part III, 96 53 (January 1949).

In an inhomogeneous medium, such as the ground, it is important to bear in mind that the depth of penetration varies considerably with frequency as well as with ground constants. The depth of penetration, defined as the depth at which the magnitude of the electric vector in the medium is a given percentage of its magnitude at the surface, is deeper at the lower frequencies and with higher values of the dielectric constant and lower values of conductivity. Because the characteristics of the ground may vary considerably with depth, the values of effective ground conductivity presented herein strictly apply only at the frequencies at which the measurements were made.

3. Maps

Special sectional maps have been prepared employing Albers equal-area projection, in which the linear distance scale is maintained constant. Each map covers 5 degrees of latitude and 5 degrees of longitude. A total of 48 of these sectors cover the entire United States. Figure 1 is an index map showing the location of each of the sectional maps superimposed on a United States map. The number in the corner of each square gives the order in which the sectional maps are arranged. In several cases large numbers of measurements were made in relatively small areas, and, to avoid confusion, several sectional maps of the same area have been prepared in order to accommodate all the measurements. The letters a, b, c, etc., denote cases in which more than one map is used. There are 81 sectional maps presented in this Circular, covering the 48 different sectors shown on the index map.

The maps have been prepared by using a scale such that sufficient detail can be shown, while keeping the number of maps to a practical minimum. One unavoidable consequence of using relatively small area maps for this presentation is that the radials around the edges of the maps frequently run into the next map. Effective ground conductivities are expressed in millimhos per meter, following the practice of the Federal Communications Commission. Where more than one value of conductivity has been assigned to a particular radial, the numbers shown indicate the appropriate value of effective ground conductivity for that portion of the path.

In tabulating, plotting, and drafting such a large amount of data, it seems quite probable that some errors have occurred. It is requested that anyone noting such errors bring them to the attention of the authors. As the results of new measurements become available, these will be incorporated in the master set of maps kept on file at the Central Radio Propagation Laboratory of the National Bureau of Standards in Boulder, Colo., and at the appropriate time, consideration will be given to the method for making the revised maps available.

The assistance of the staff of the Federal Communications Commission in making available from their files the data used in this report is greatly appreciated. Acknowledgment is made to Holmes S. Moore and to Rex B. Simms, former members of the staff of the Central Radio Propagation Laboratory of the National Bureau of Standards, for their assistance in collecting the ground-conductivity data and in preparing the maps.

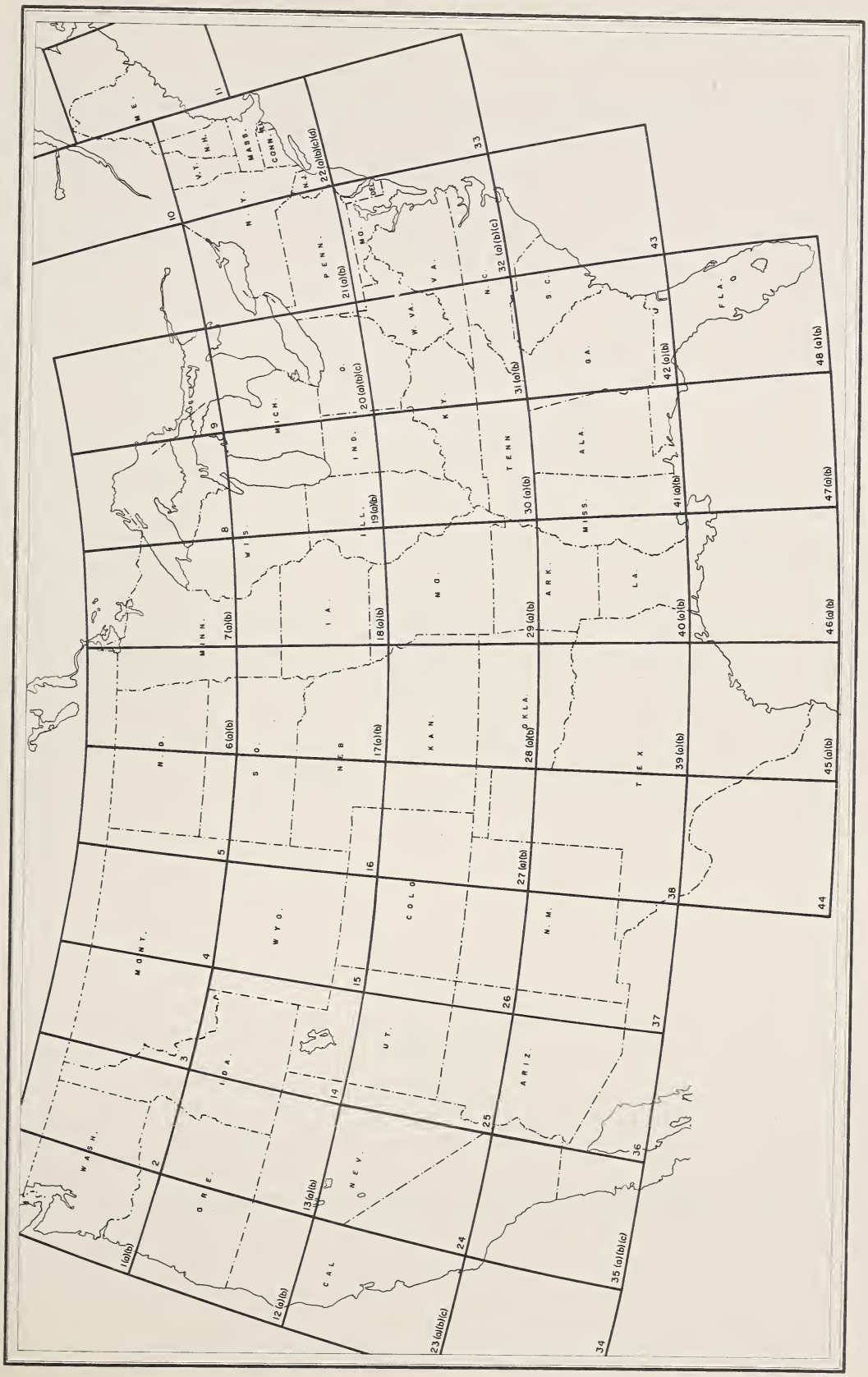
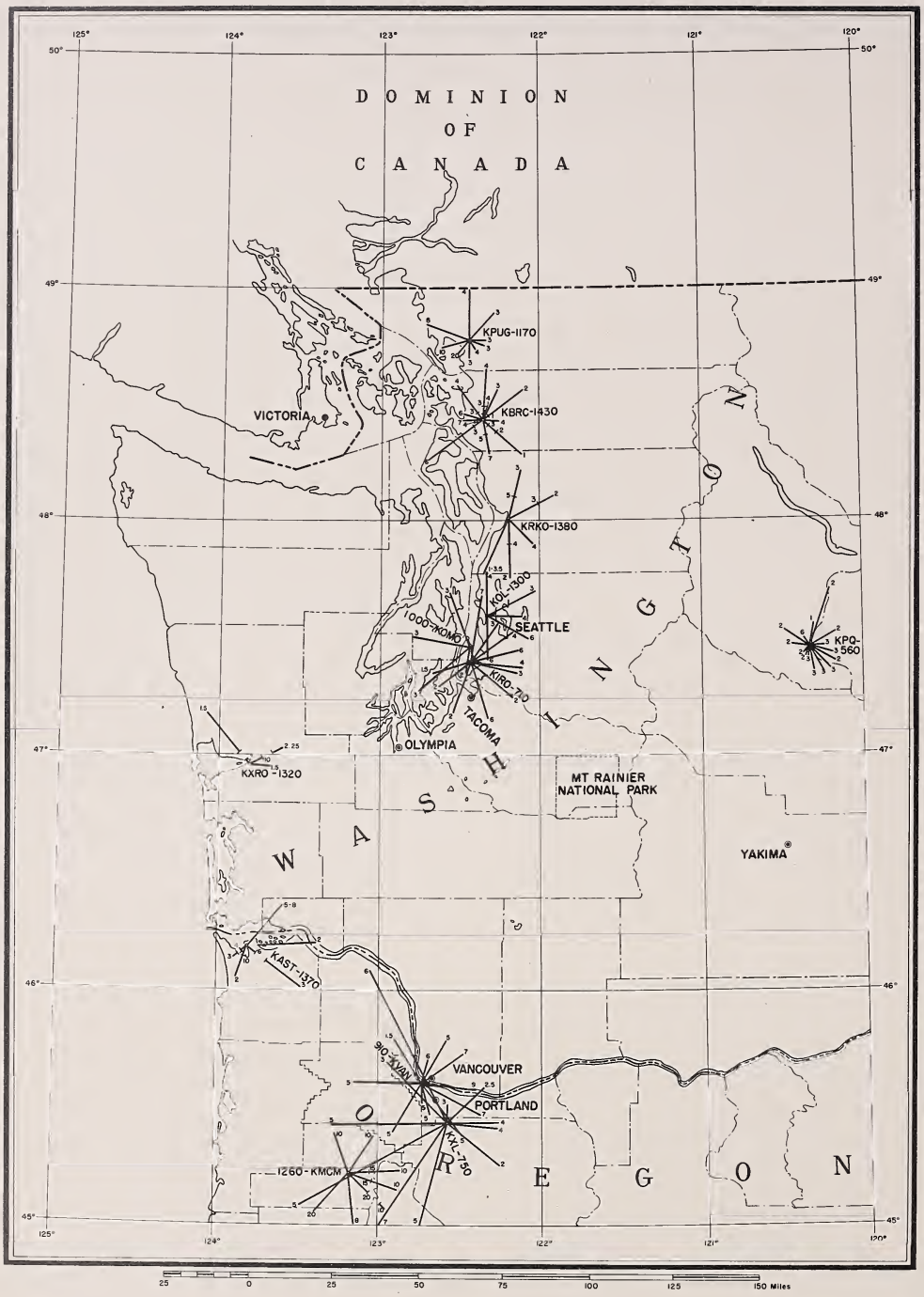


FIGURE 1. *Index to effective radio ground conductivity maps for the United States.*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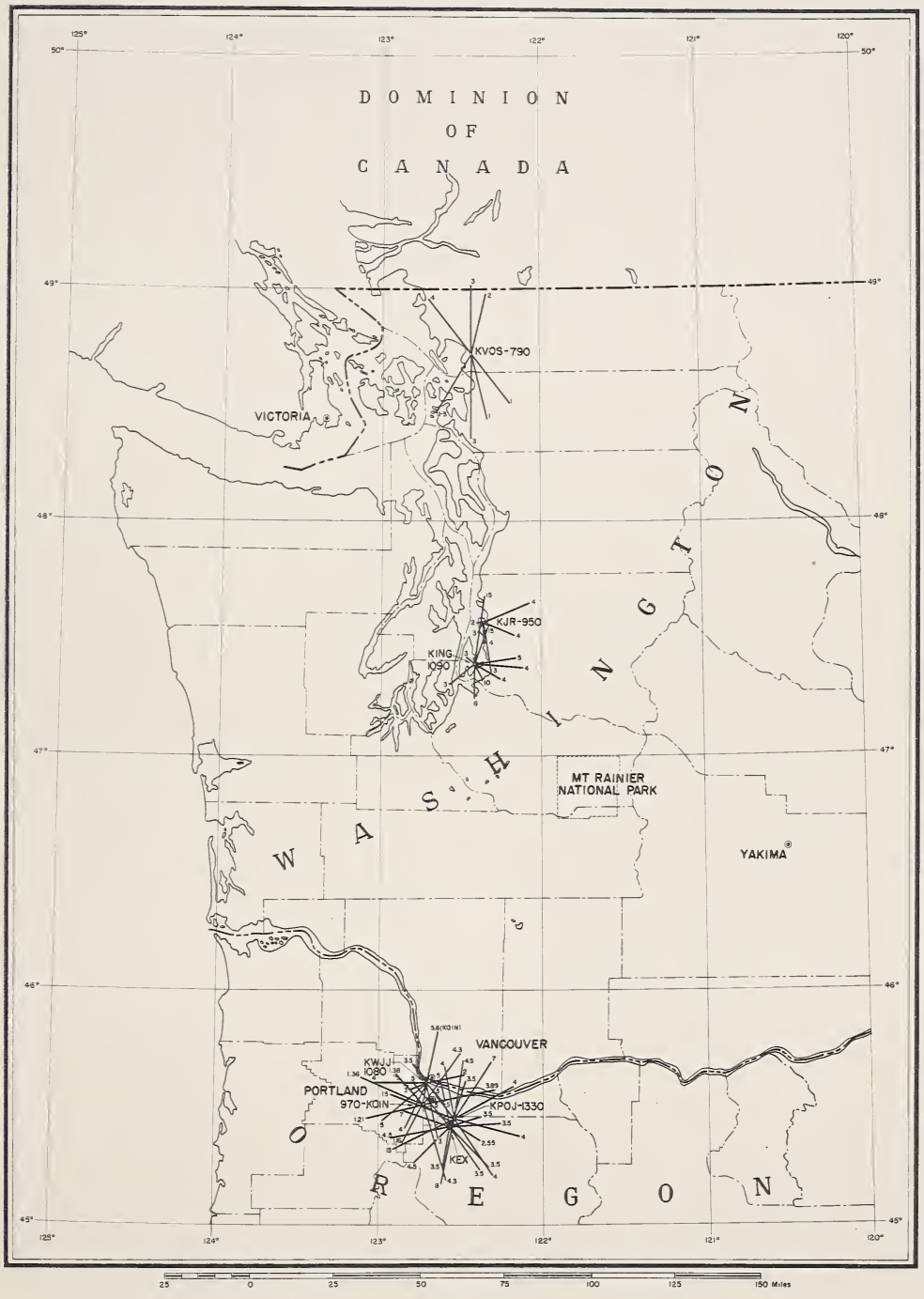
VICTORIA
KPUG-1170
KBRC-1430
KRKO-1380
KOL-1300
1000-KOMO
SEATTLE
KIRO-710
TACOMA
OLYMPIA
KXRO-1320
KPQ-1560
MT RAINIER
NATIONAL PARK
YAKIMA
KAST-1370
910-KVAN
VANCOUVER
PORTLAND
KXL-750
1260-KMCM
WASHINGTON
OREGON
125°
124°
123°
122°
121°
120°
50°
49°
48°
47°
46°
45°
25 0 25 50 75 100 125 150 Miles

Map 1a.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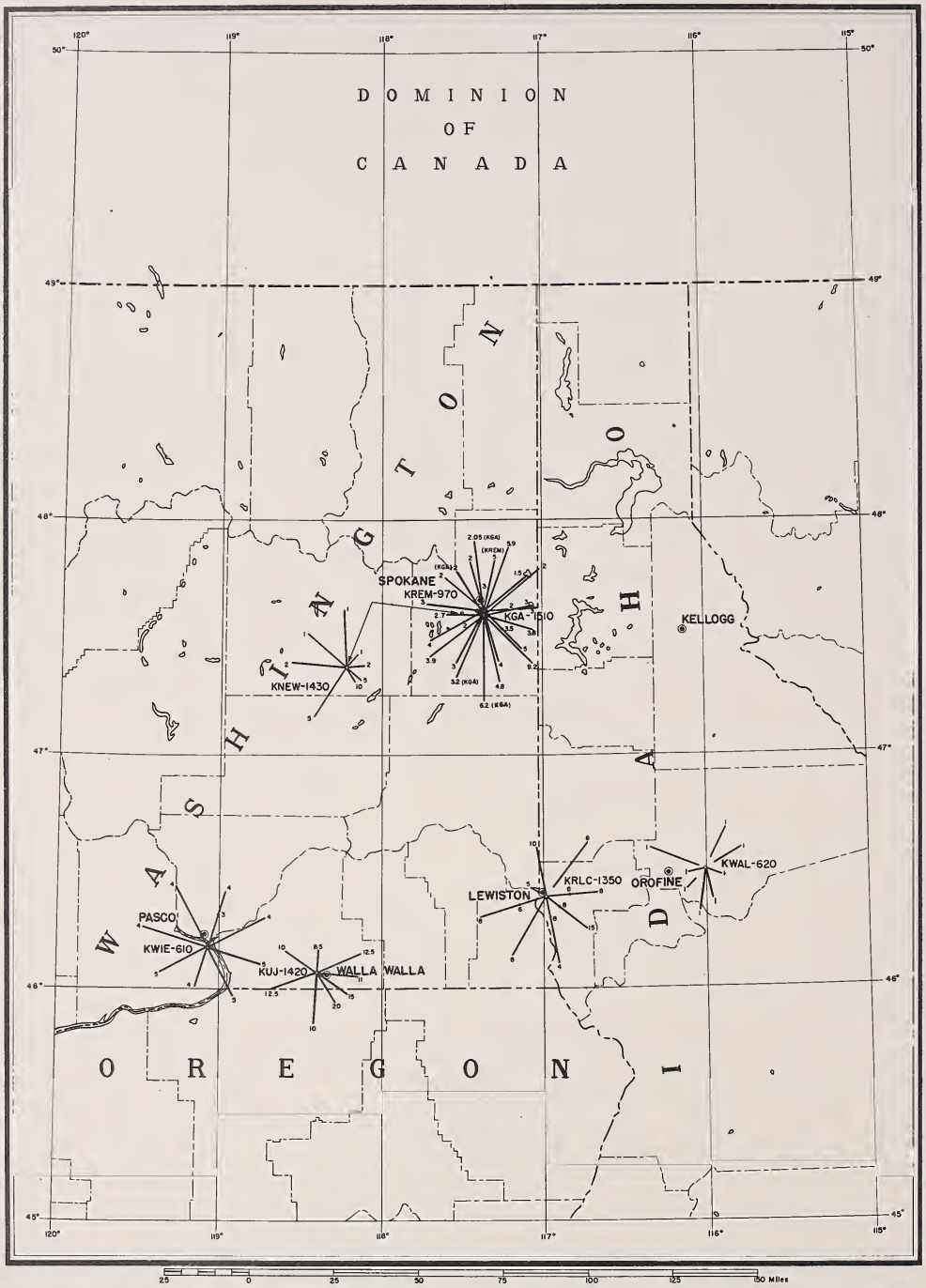
CANADA
KVOS-790
VICTORIA
KJR-950
KING
1090
WASHINGTON
MT RAINIER
NATIONAL PARK
YAKIMA
VANCOUVER
KWJJ
1080
PORTLAND
970-KOIN
KPOJ-1330
KEX
OREGON
125°
124°
123°
122°
121°
120°
50°
49°
48°
47°
46°
45°
25 0 25 50 75 100 125 150 Miles

Map 1b.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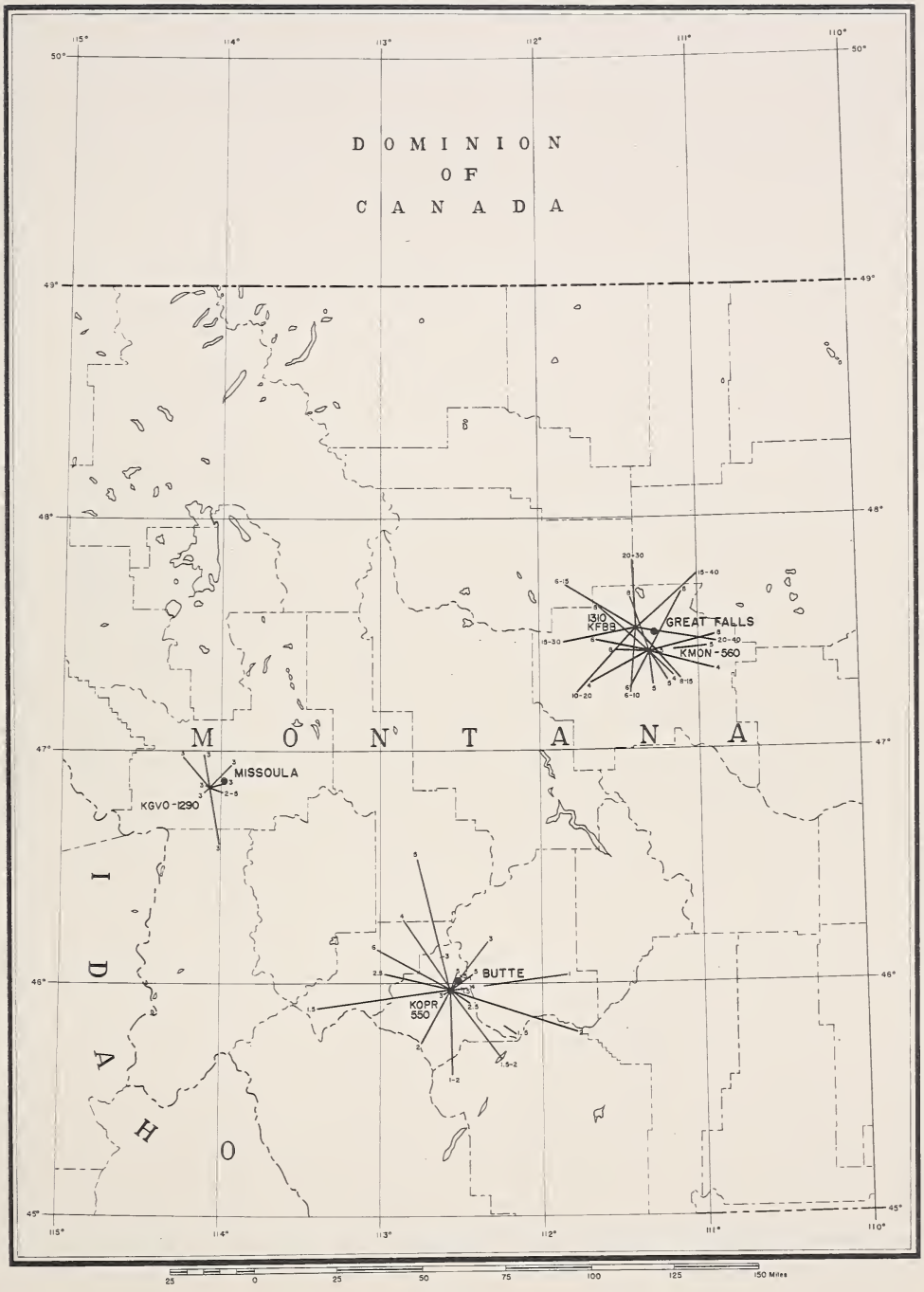
OF
CANADA
WASHINGTON
IDAHO
OREGON
SPOKANE
KREM-970
KGA-1510
KNEW-1430
KELLOGG
KWAL-620
OROFINE
KRLC-1350
LEWISTON
PASCO
KWIE-610
KUJ-1420
WALLA WALLA
120°
119°
118°
117°
116°
115°
50°
49°
48°
47°
46°
45°
25 0 25 50 75 100 125 150 Miles

MAP 2.



Map 3.

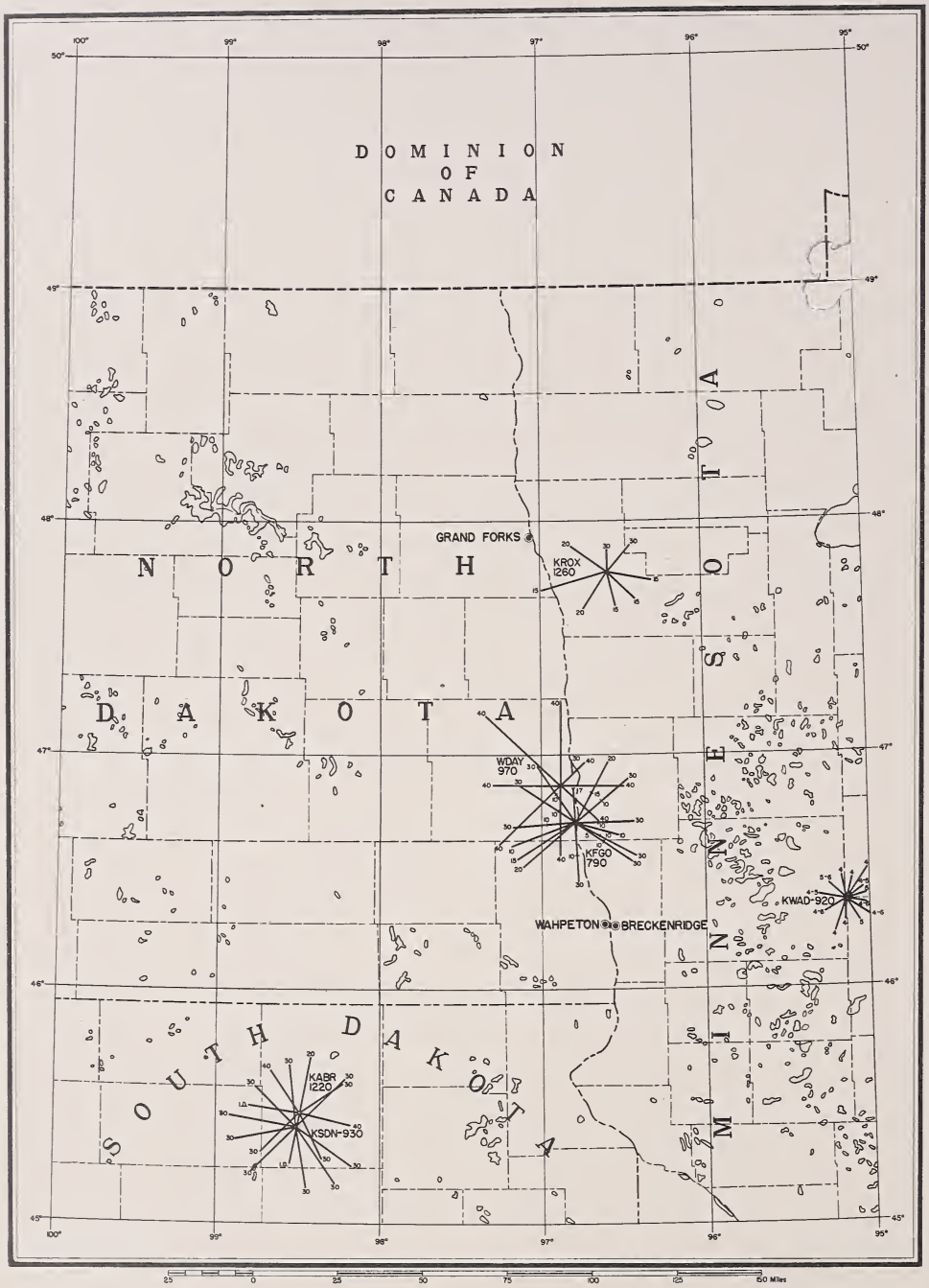
282270 O - 54 - 2


DOMINION
OF
CANADA
MONTANA
CHINOOK
JORDAN
CIRCLE
KGCX
1480
ROUNDUP
MILES CITY
BILLINGS
KGHL-790
KOOK
970
110°
109°
108°
107°
106°
105°
50°
49°
48°
47°
46°
45°
25
0
25
50
75
100
125
150 Miles

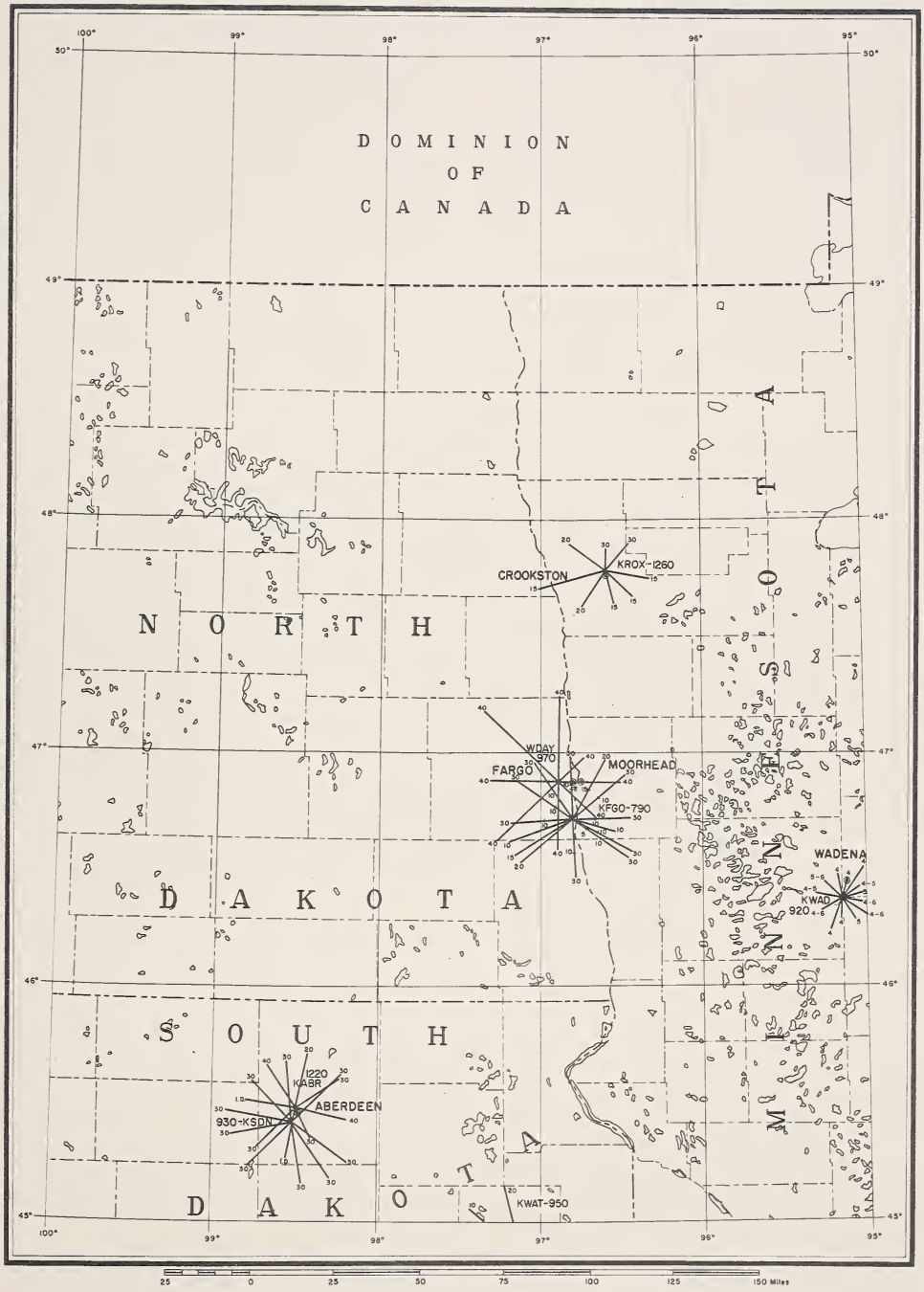
Map 4.


DOMINION
OF
CANADA
MINOT
KCJB
910
KGCX-1480
SIDNEY
BISMARCK
KFYR-550
NORTH
DAKOTA
SOUTH
DAKOTA
MONTANA
105°
104°
103°
102°
101°
100°
50°
49°
48°
47°
46°
45°
25
0
25
50
75
100
125
150 Miles

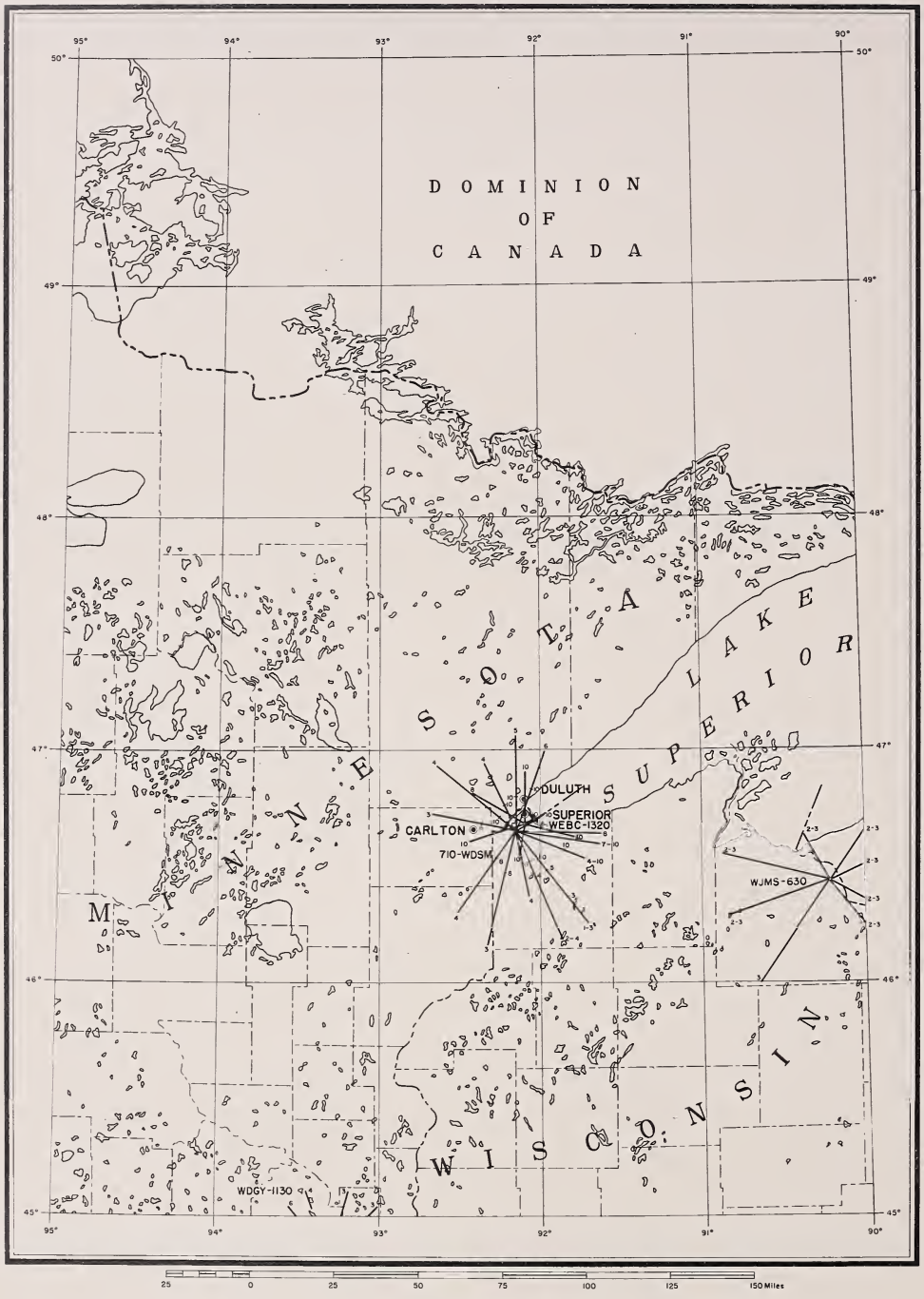
Map 5.


DOMINION
OF
CANADA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
GRAND FORKS
KROX
1260
WDAY
970
KFGO
790
KWAD-920
WAHPETON
BRECKENRIDGE
KABR
1220
KSDN-930
100°
99°
98°
97°
96°
95°
50°
49°
48°
47°
46°
45°
25
0
25
50
75
100
125
150 Miles

Мар 6а.


DOMINION
OF
CANADA
NORTH
DAKOTA
SOUTH
DAKOTA
MINNESOTA
CROOKSTON
KROX-1260
WDAY
970
FARGO
MOORHEAD
KFGO-790
WADENA
KWAD
920
ABERDEEN
1220
KABR
930-KSDN
KWAT-950
100°
99°
98°
97°
96°
95°
50°
49°
48°
47°
46°
45°
25
0
25
50
75
100
125
150 Miles

Map 6b.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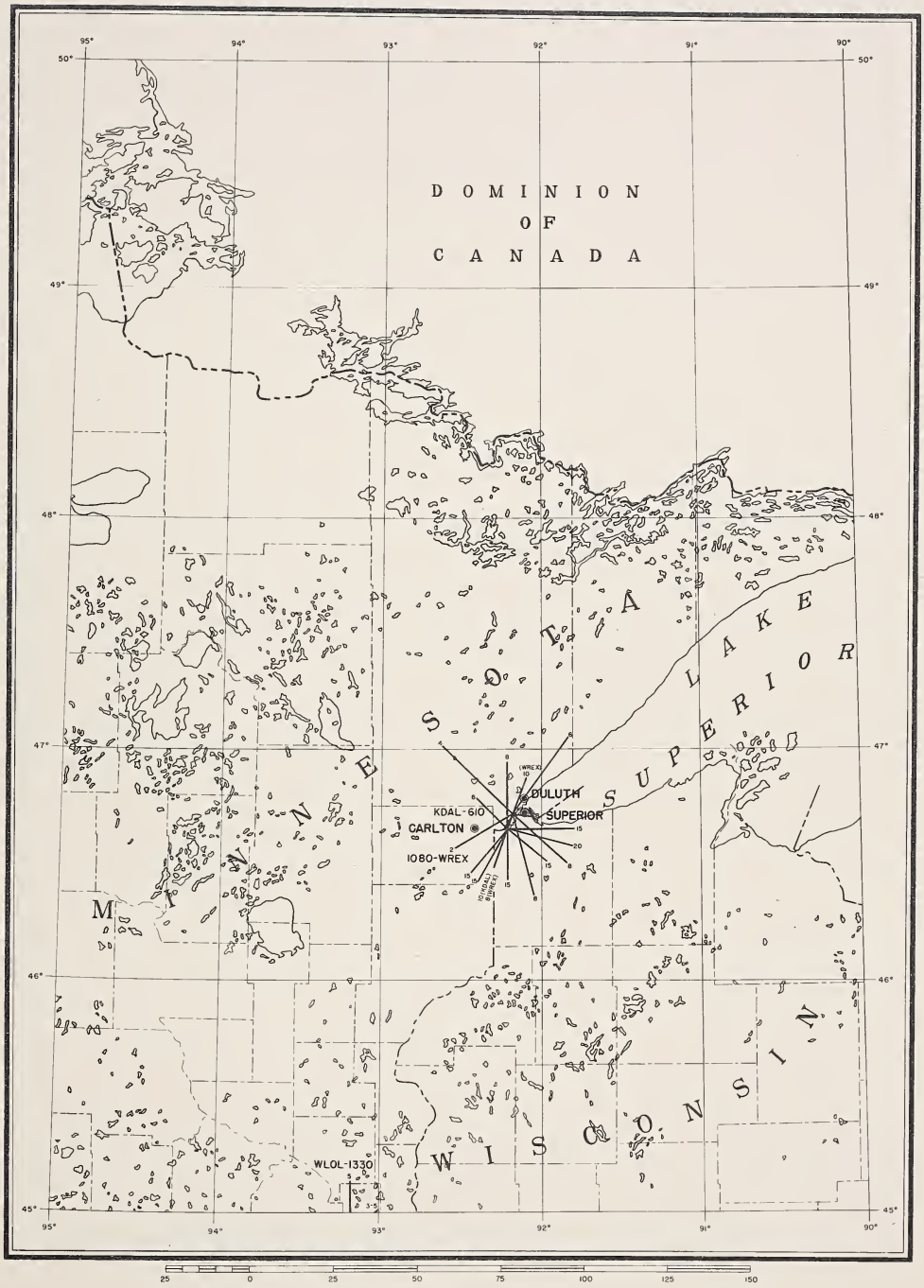
OF
CANADA
MINNESOTA
LAKE SUPERIOR
WISCONSIN
DULUTH
SUPERIOR
WEBC-1320
CARLTON
710-WDSM
WJMS-630
WDGY-1130
95°
94°
93°
92°
91°
90°
50°
49°
48°
47°
46°
45°
25 0 25 50 75 100 125 150 Miles

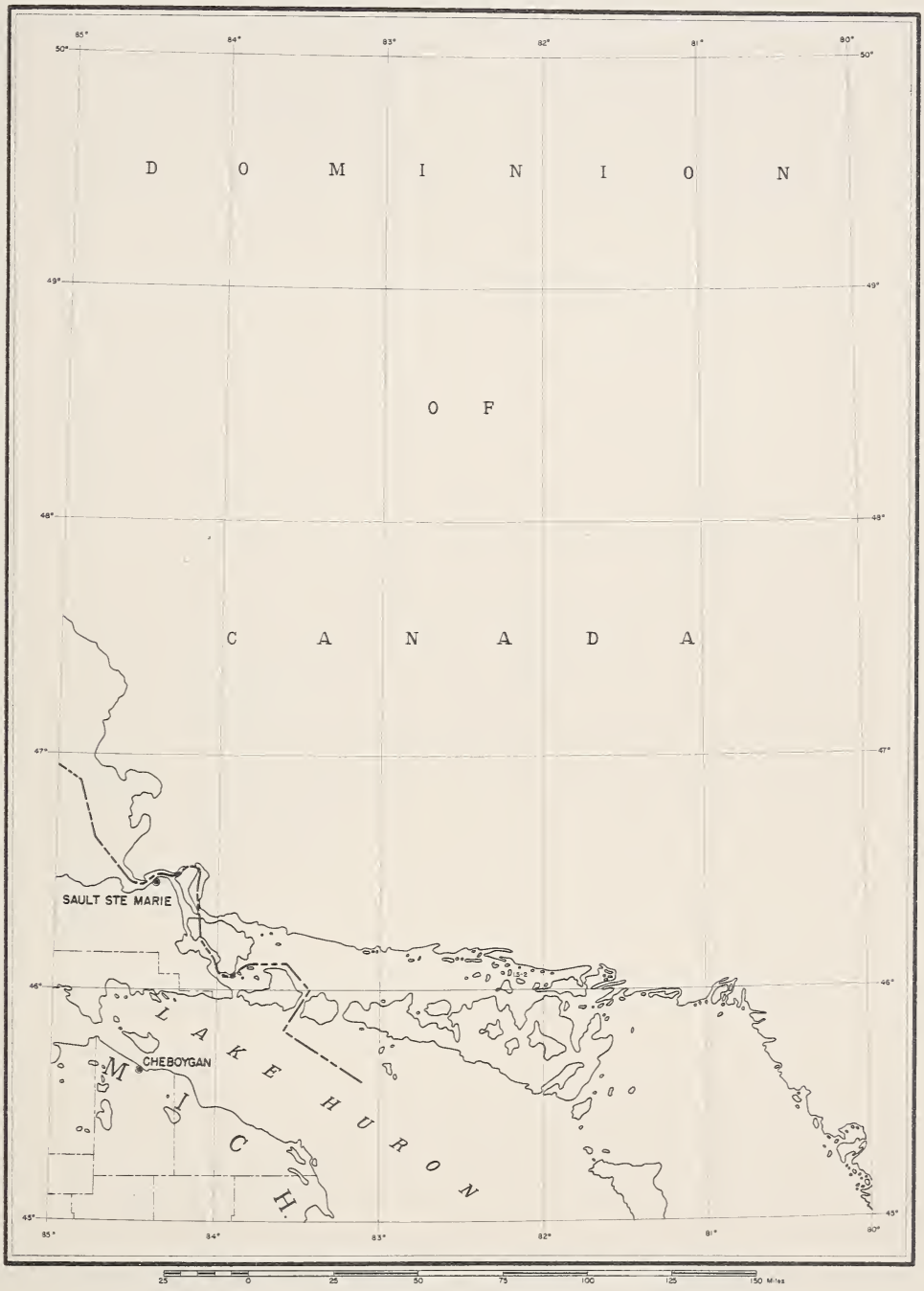
Map 7a.


DOMINION
OF
CANADA
MINNESOTA
LAKE SUPERIOR
WISCONSIN
DULUTH
SUPERIOR
KDAL-610
CARLTON
1080-WREX
WLOL-1330
95°
94°
93°
92°
91°
90°
50°
49°
48°
47°
46°
45°
25
0
25
50
75
100
125
150

Map 7b.

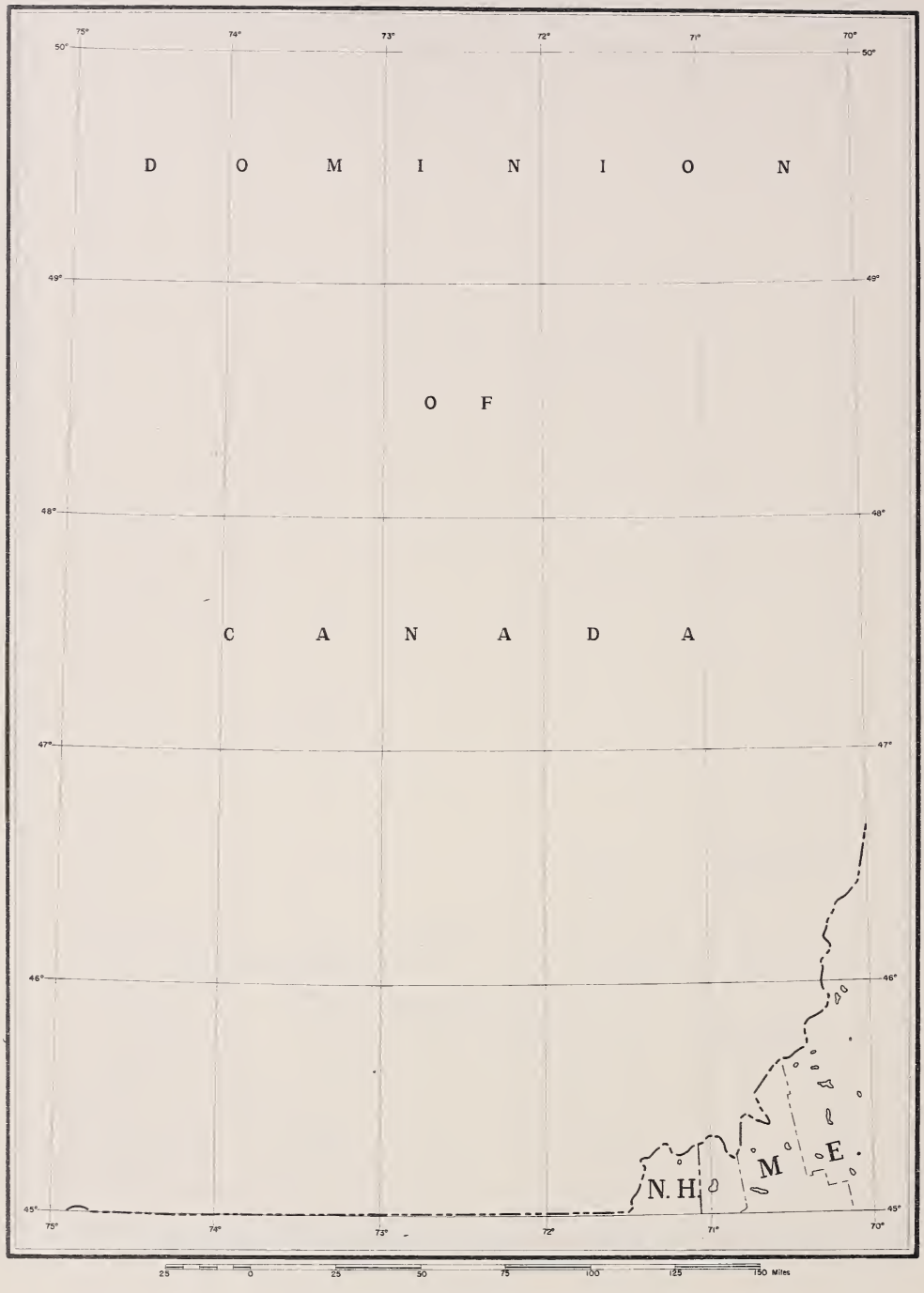

DOMINION
OF
CANADA
LAKE SUPERIOR
MICHIGAN
WISCONSIN
WJMS-630
NEWBERRY
FLORENCE
IRON MOUNTAIN
WDBC-680
RHINELANDER
MERRILL
WLIN-550
90°
89°
88°
87°
86°
85°
50°
49°
48°
47°
46°
45°
25 0 25 50 75 100 125 150 Miles

Map 8.

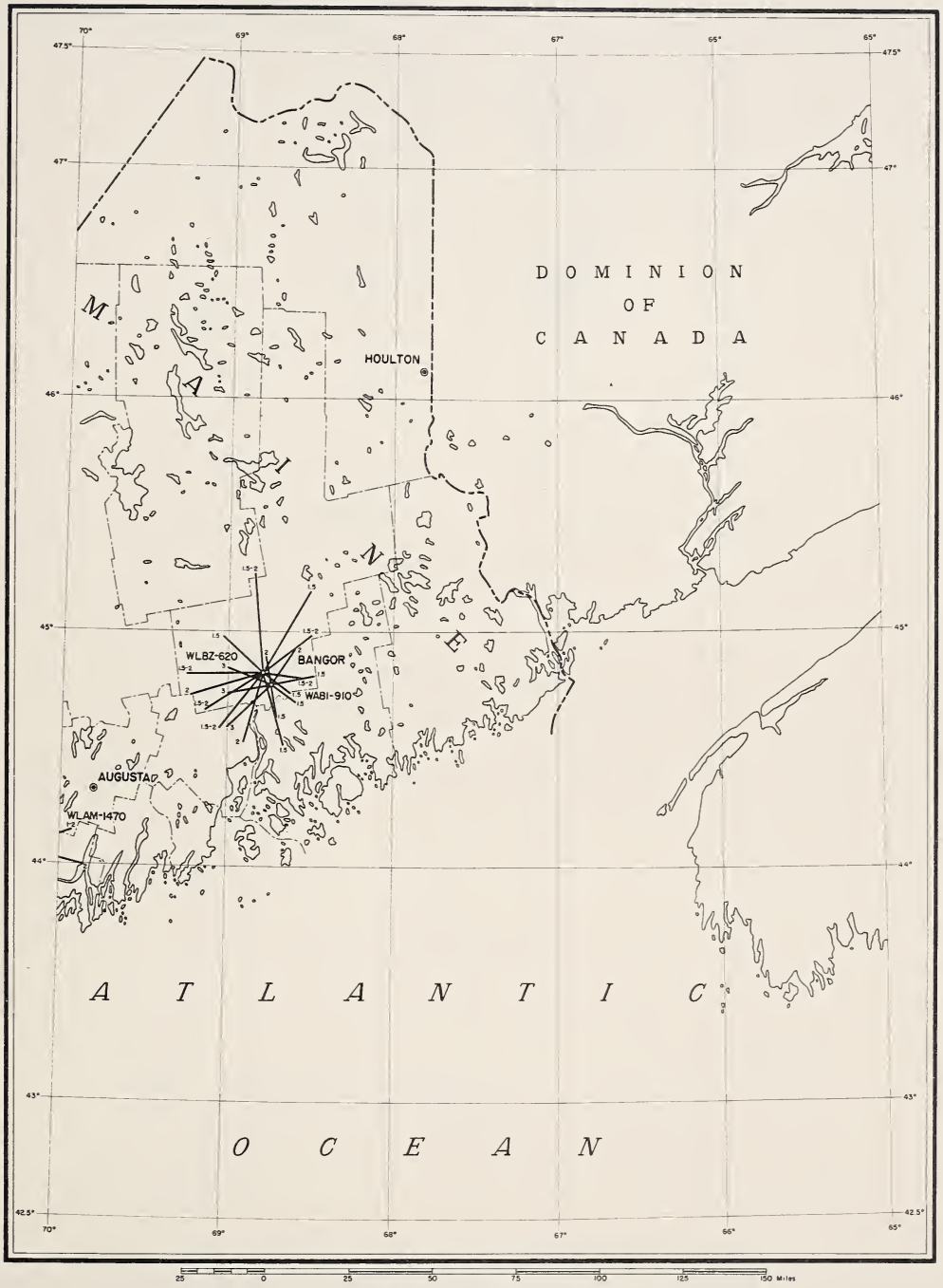


Map 9.

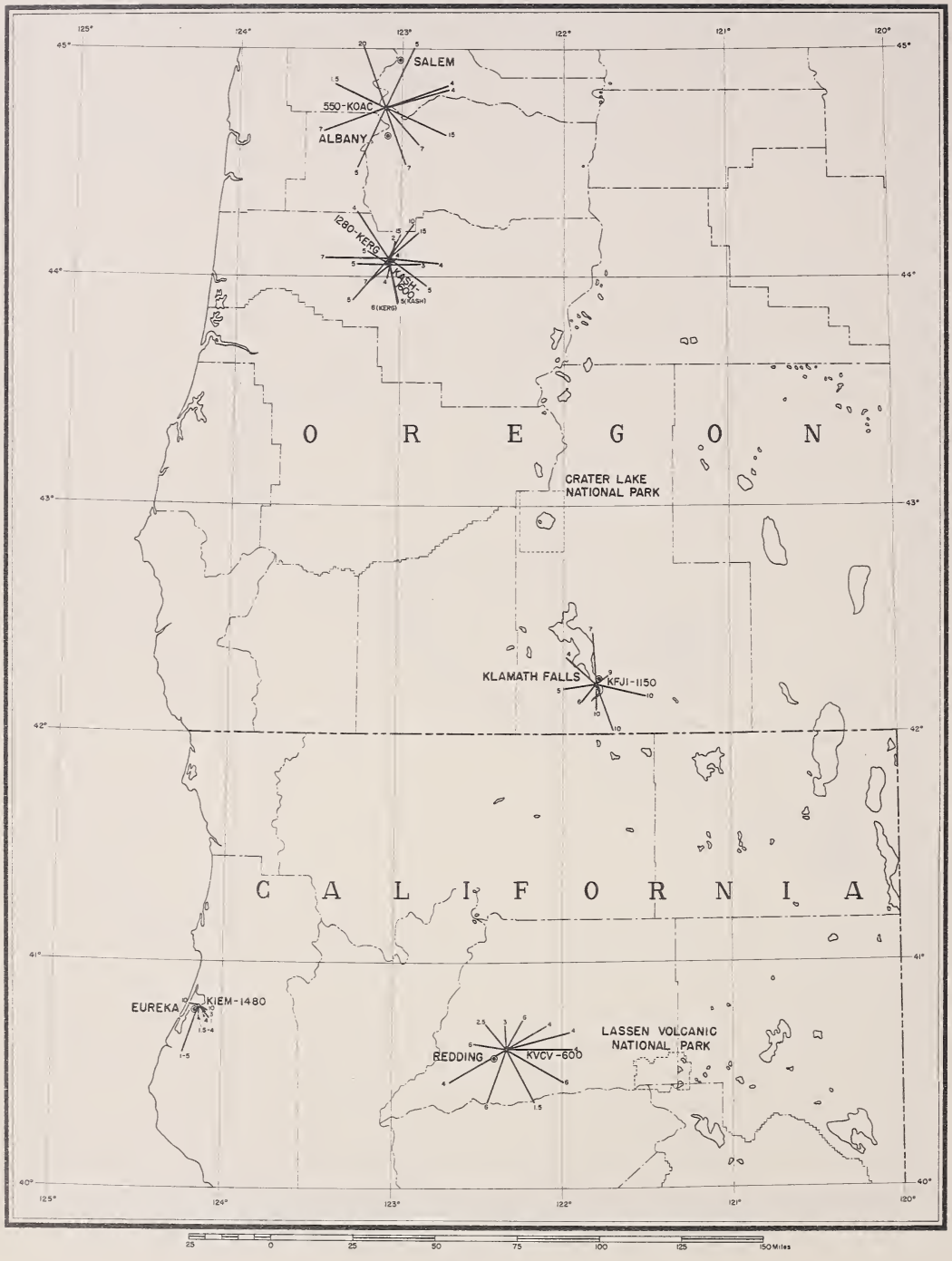
282270 O - 54 - 3


75°
74°
73°
72°
71°
70°
50°
D O M I N I O N
49°
O F
48°
C A N A D A
47°
46°
N. H.
M
E
45°
25 0 25 50 75 100 125 150 Miles

Map 10.


DOMINION
OF
CANADA
HOULTON
MAINE
WLBZ-620
BANGOR
WABI-910
AUGUSTA
WLAM-1470
ATLANTIC
OCEAN
70°
69°
68°
67°
66°
65°
47.5°
47°
46°
45°
44°
43°
42.5°
25 0 25 50 75 100 125 150 Miles

Map 11.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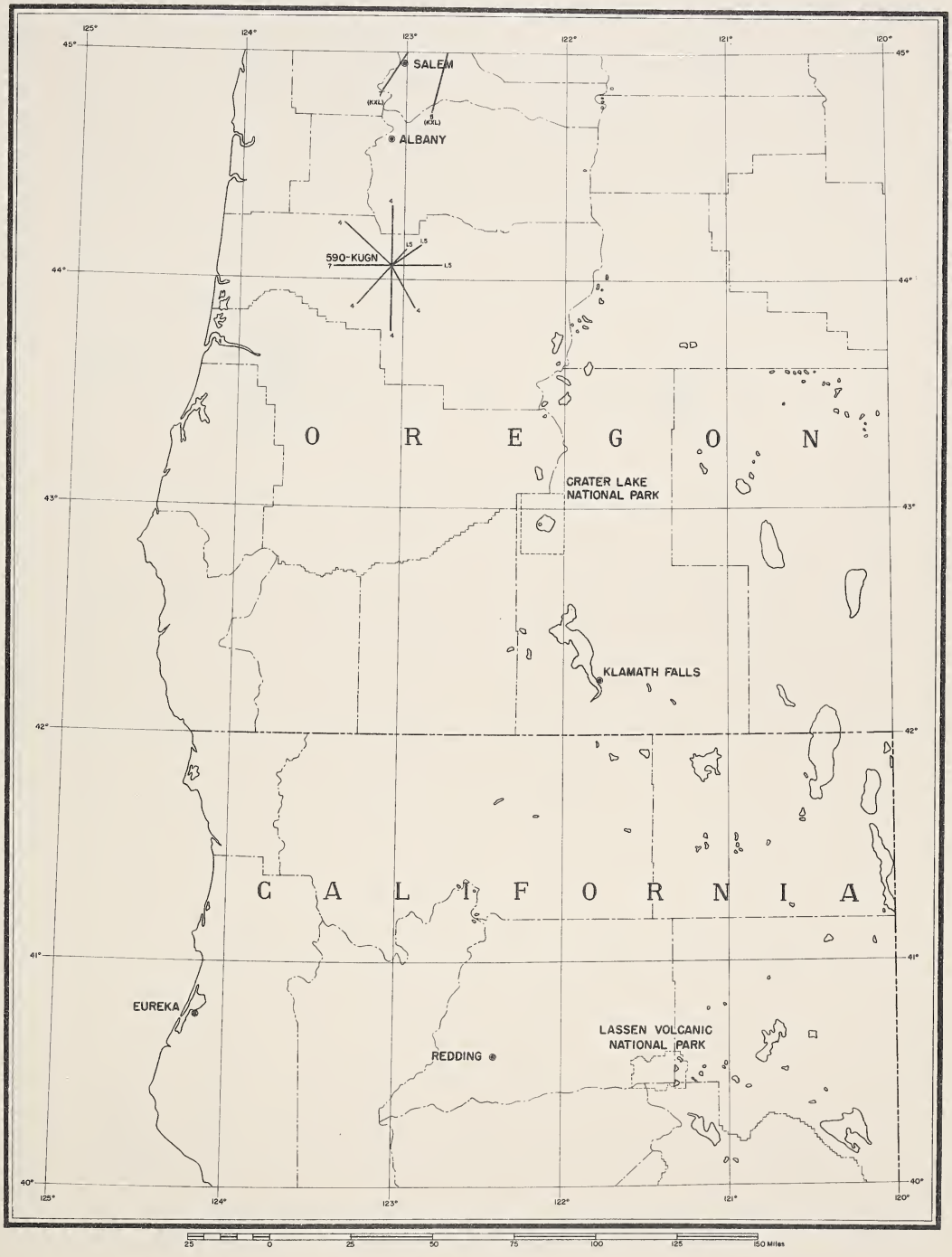
550-KOAC
ALBANY
1280-KERG
KASH-600
5(KASH)
6(KERG)
OREGON
CRATER LAKE
NATIONAL PARK
KLAMATH FALLS
KFJI-1150
CALIFORNIA
EUREKA
KIEM-1480
REDDING
KVCV-60b
LASSEN VOLCANIC
NATIONAL PARK
125°
124°
123°
122°
121°
120°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

Map 12a.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OREGON
CRATER LAKE
NATIONAL PARK
KLAMATH FALLS
CALIFORNIA
EUREKA
REDDING
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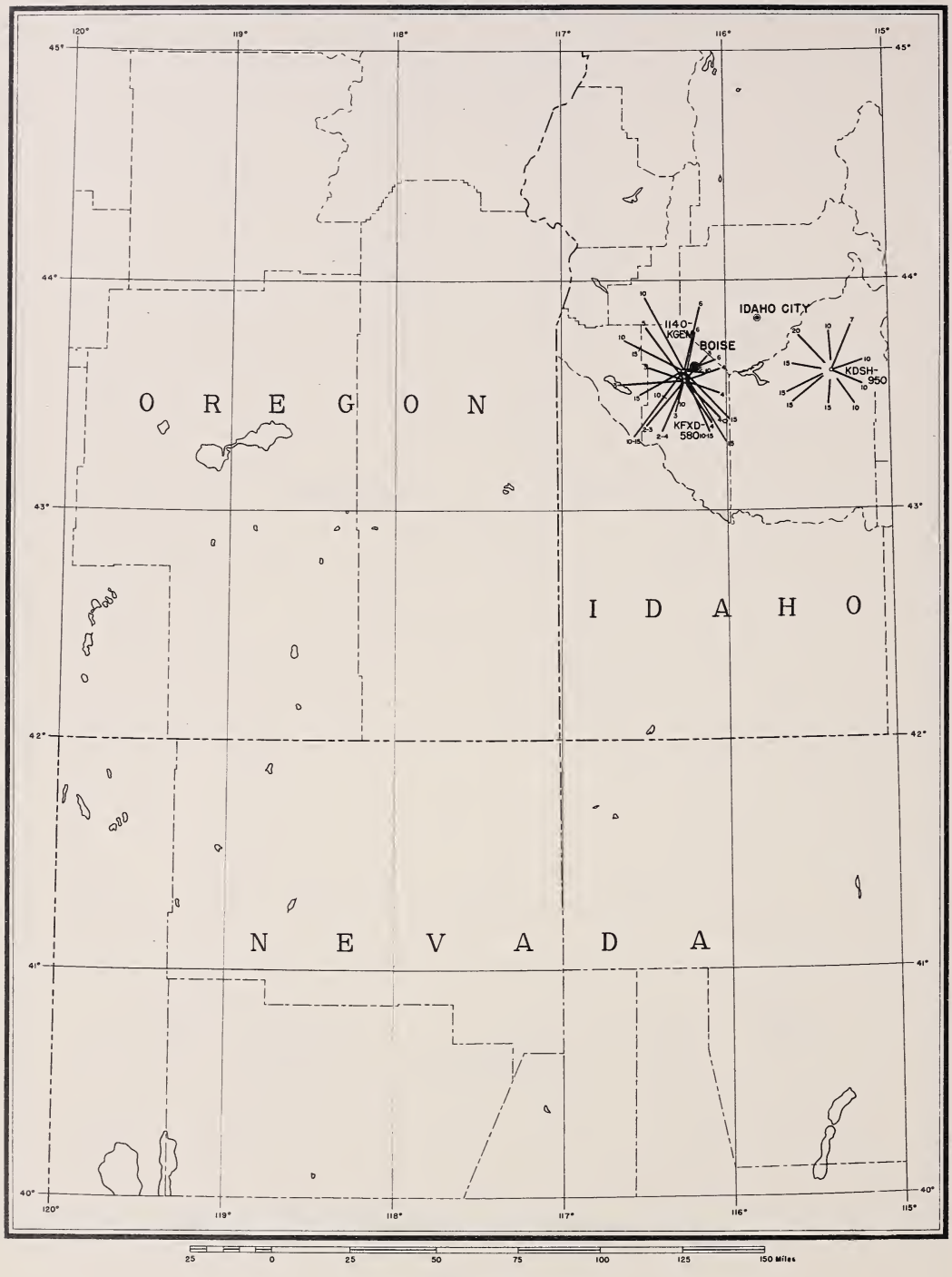
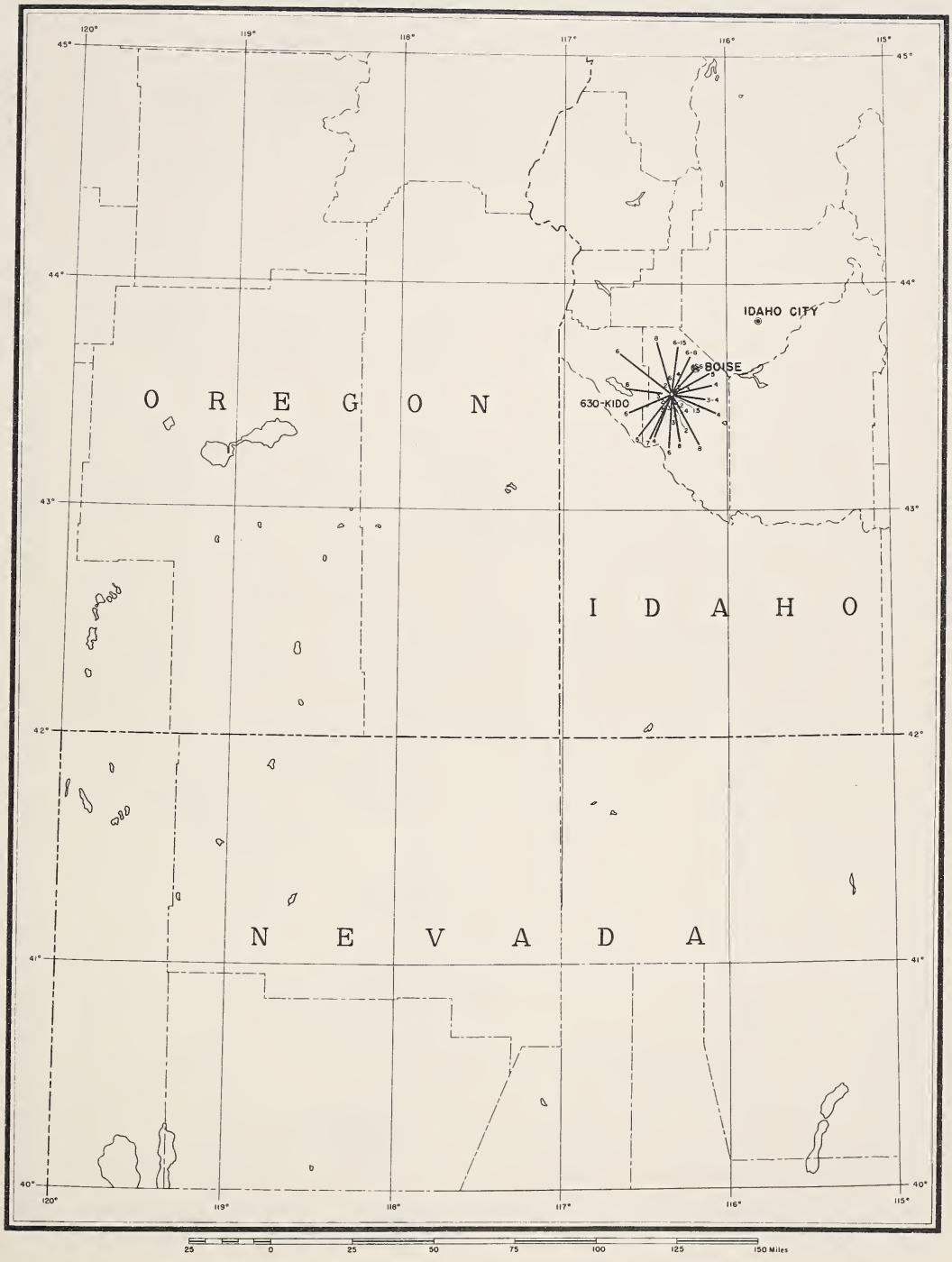
NATIONAL PARK
125°
124°
123°
122°
121°
120°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

Map 12b.


120°
119°
118°
117°
116°
115°
45°
44°
43°
42°
41°
40°
OREGON
IDAHO
NEVADA
1140-
KGEM
BOISE
IDAHO CITY
KDSH-
950
KFXD-
580
25
0
25
50
75
100
125
150 Miles

Map 13a.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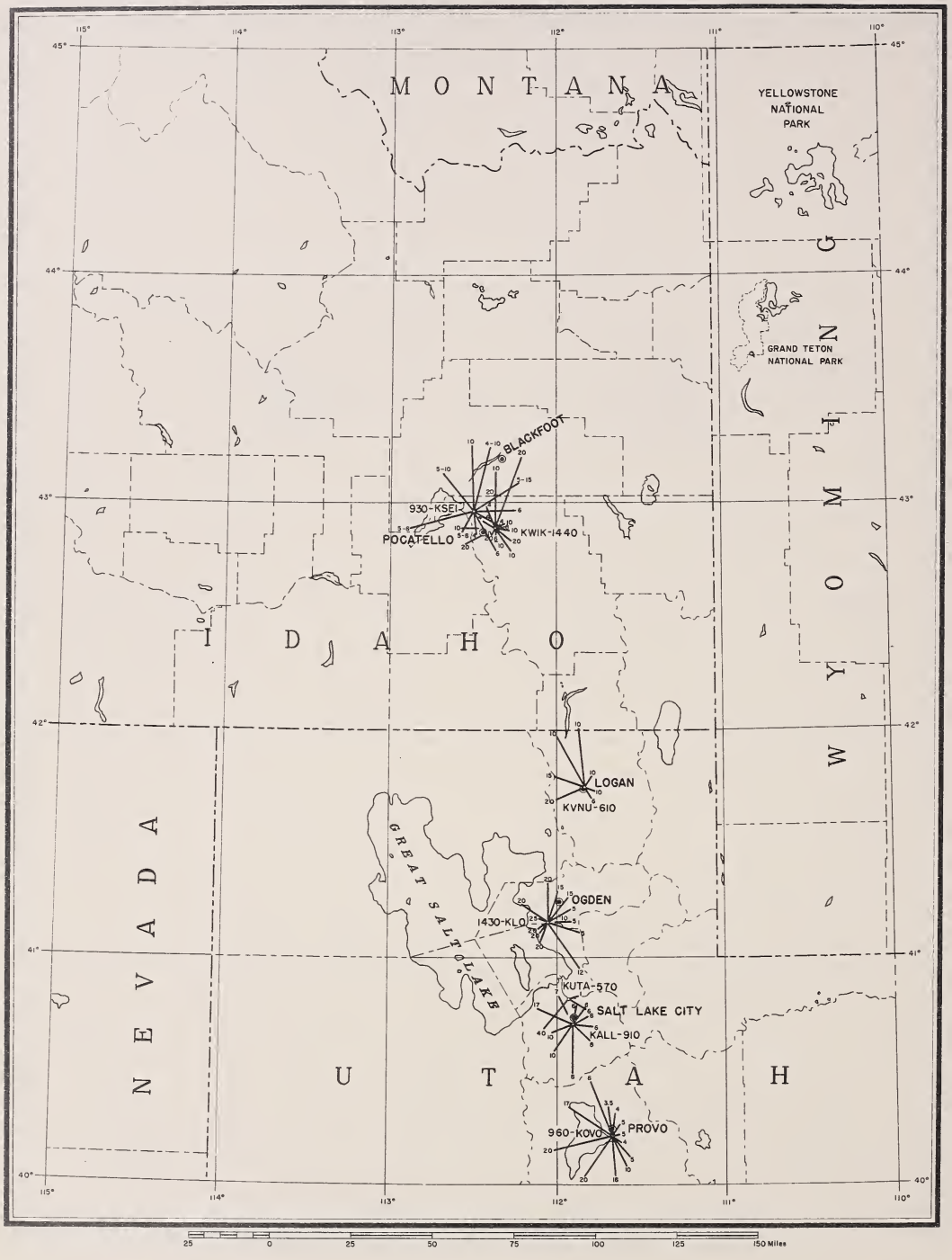
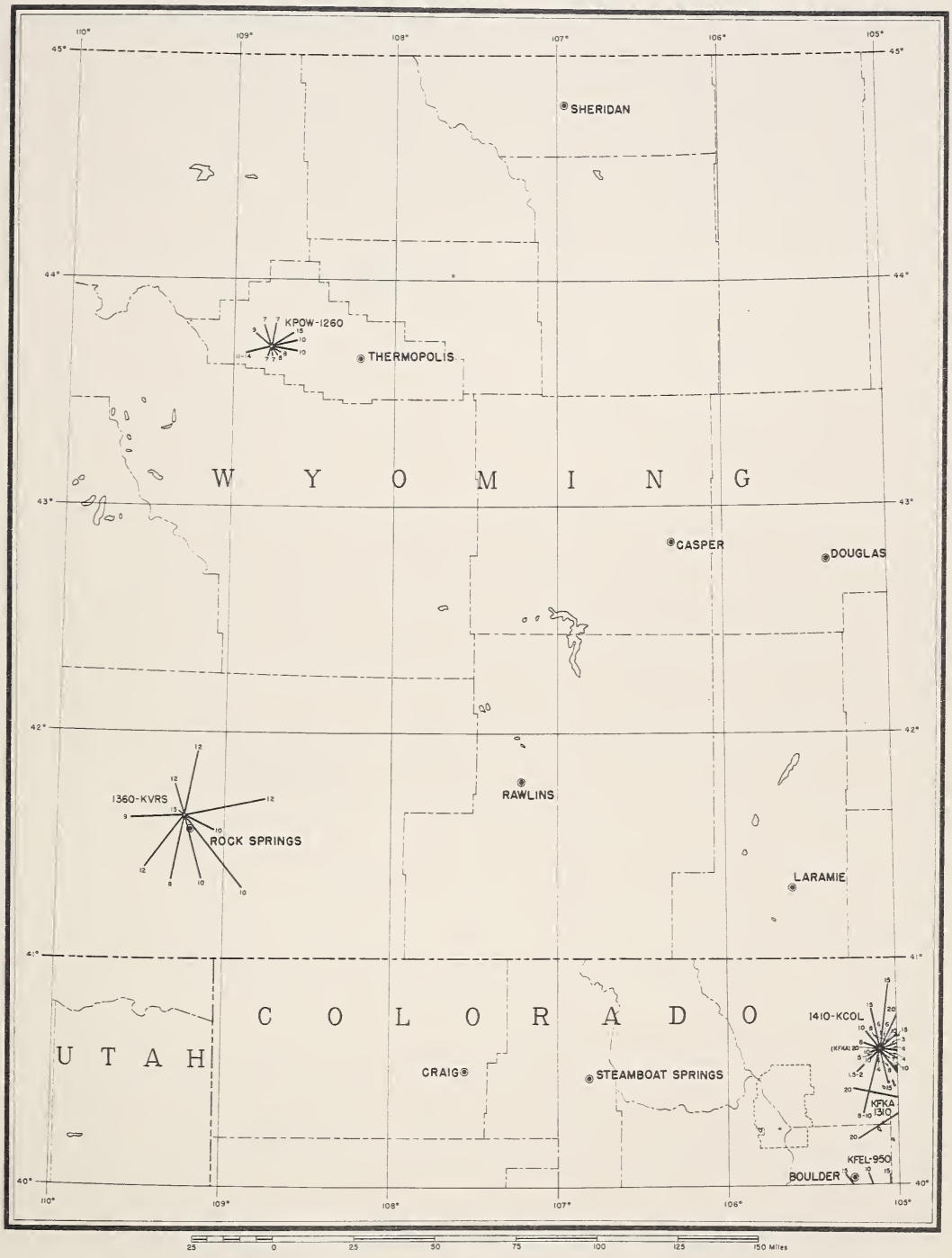
119°
118°
117°
116°
115°
45°
44°
43°
42°
41°
40°
IDAHO CITY
BOISE
630-KIDO
O R E G O N
I D A H O
N E V A D A
25 0 25 50 75 100 125 150 Miles

Map 13b.

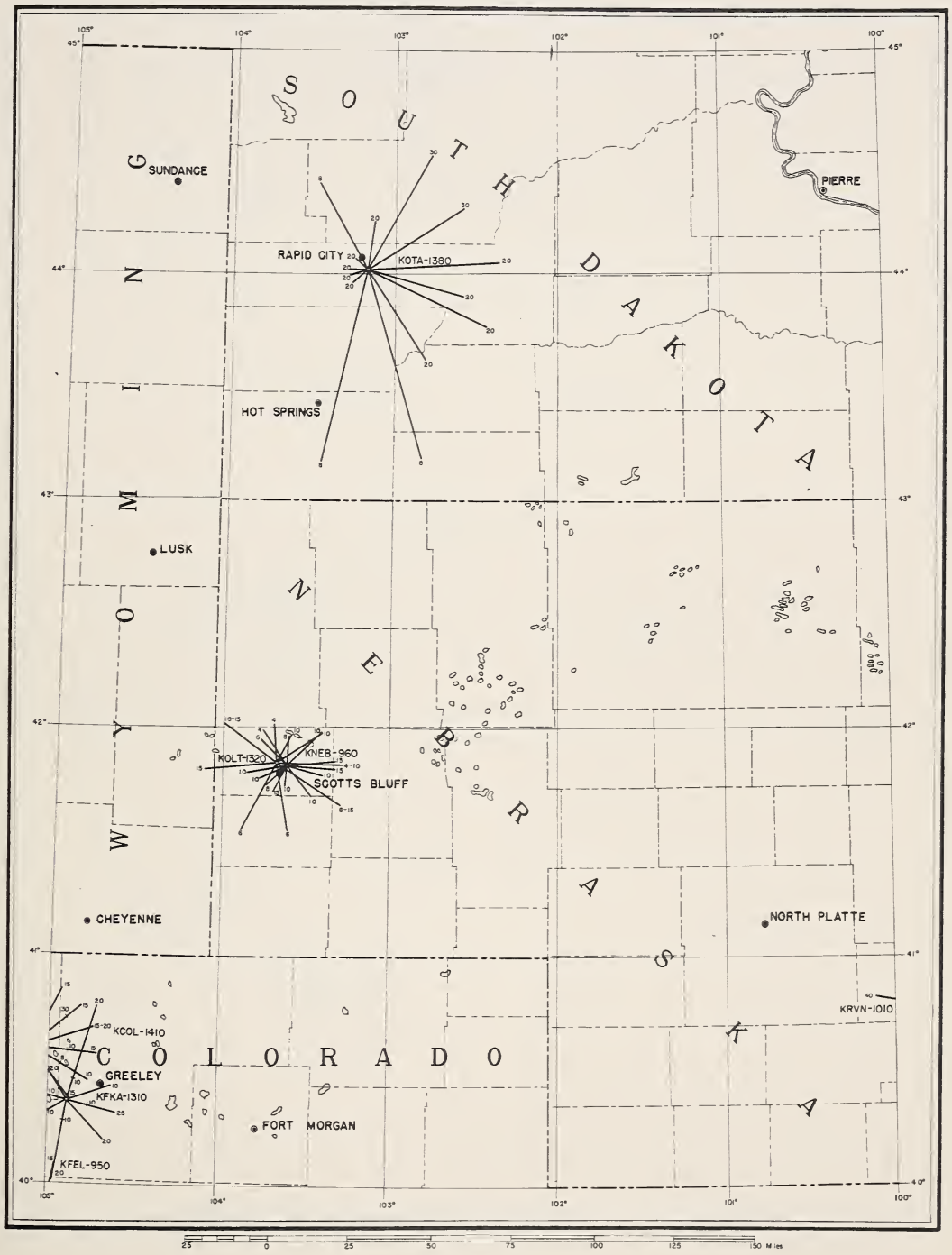

MONTANA
YELLOWSTONE NATIONAL PARK
GRAND TETON NATIONAL PARK
WYOMING
IDAHO
NEVADA
UTAH
BLACKFOOT
930-KSEI
POCATELLO
KWIK-1440
LOGAN
KVNU-610
GREAT SALT LAKE
OGDEN
1430-KLO
KUTA-570
SALT LAKE CITY
KALL-910
960-KOVO
PROVO
115°
114°
113°
112°
111°
110°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

Map 14.



Map 15.

282270 O - 54 - 4


SOUTH DAKOTA
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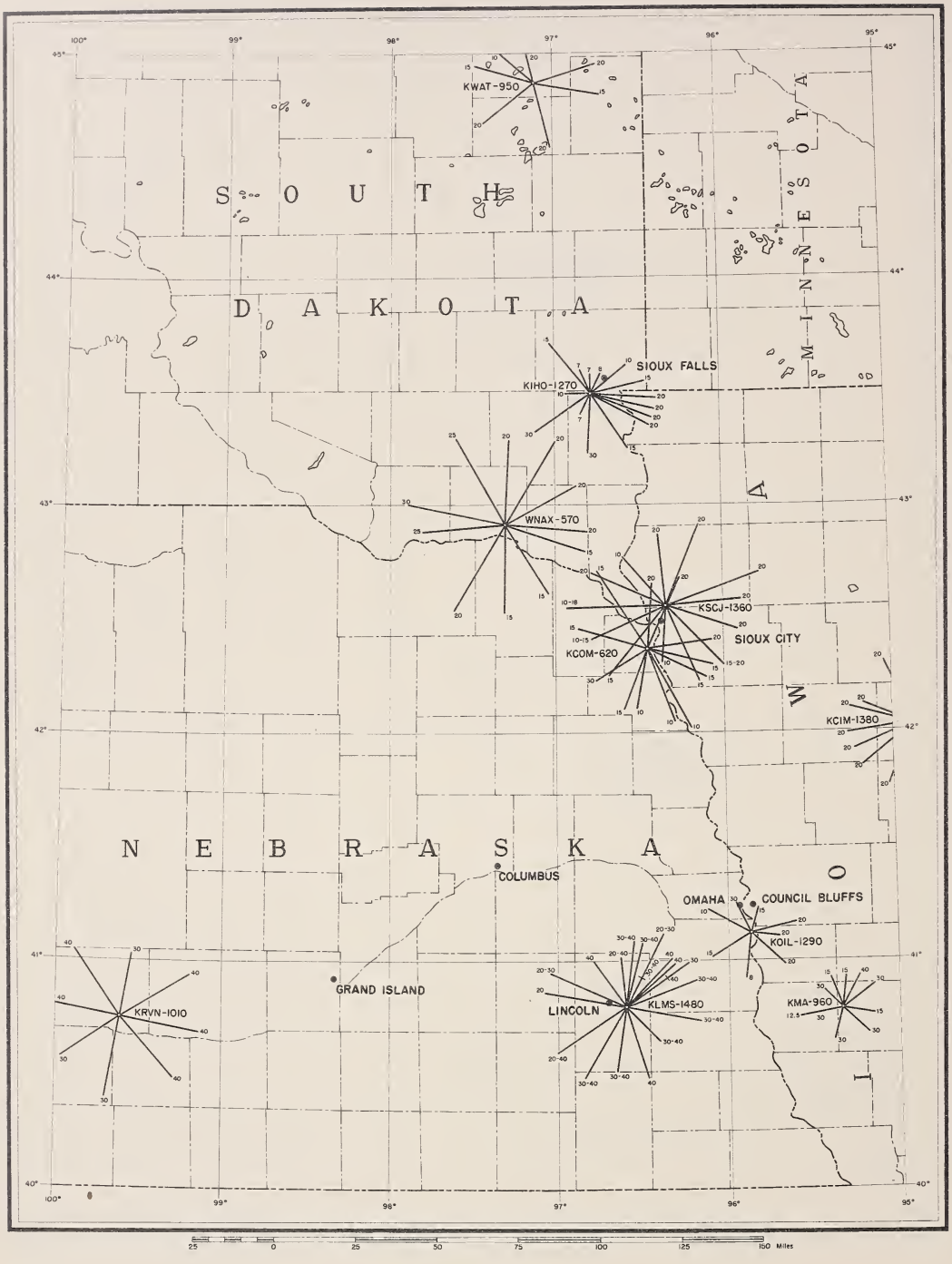
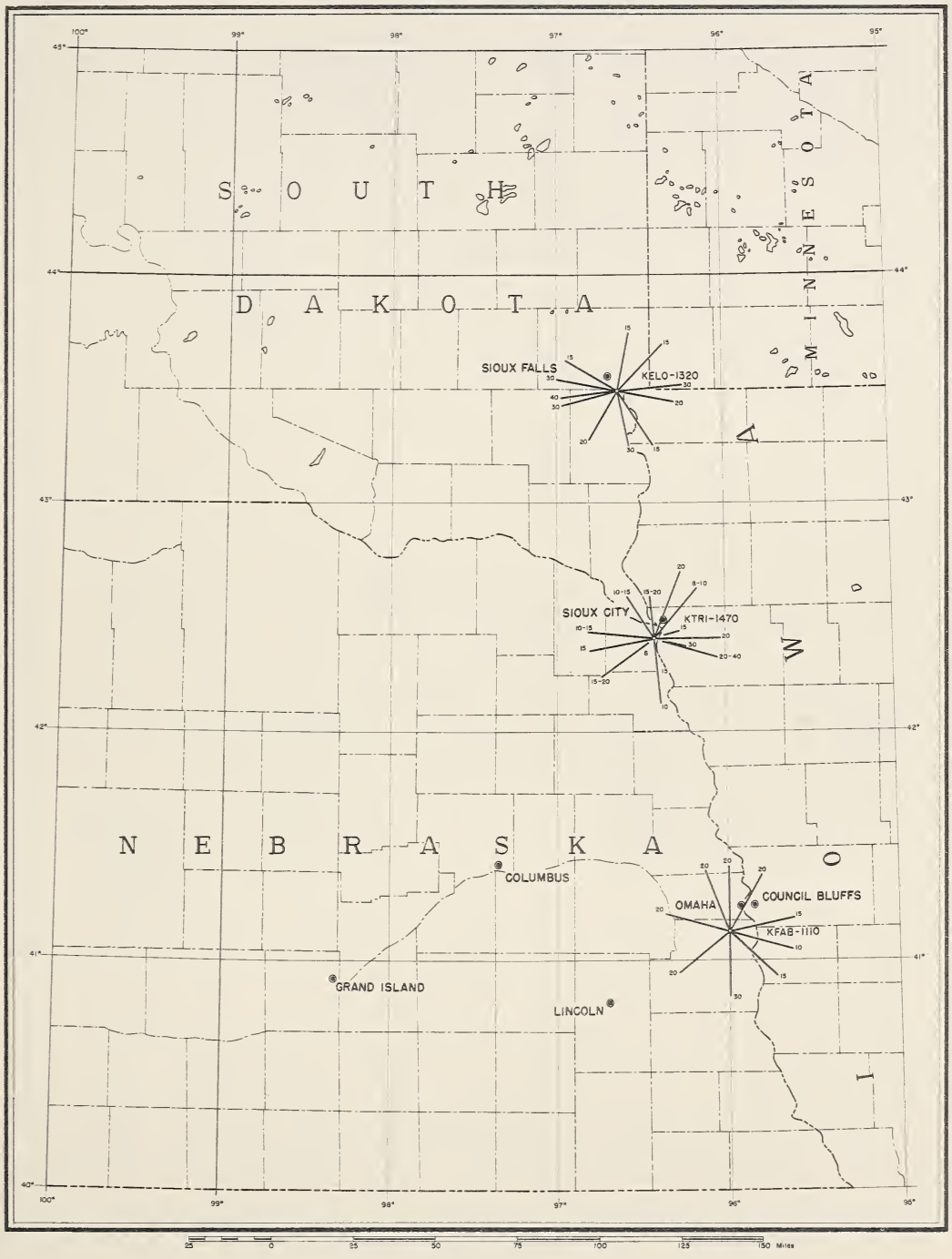
COLORADO
WYOMING
SUNDANCE
PIERRE
RAPID CITY
KOTA-1380
HOT SPRINGS
LUSK
KOLT-1320
KNEB-960
SCOTTS BLUFF
CHEYENNE
NORTH PLATTE
KRVN-1010
KCOL-1410
GREELEY
KFKA-1310
FORT MORGAN
KFEL-950
105°
104°
103°
102°
101°
100°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

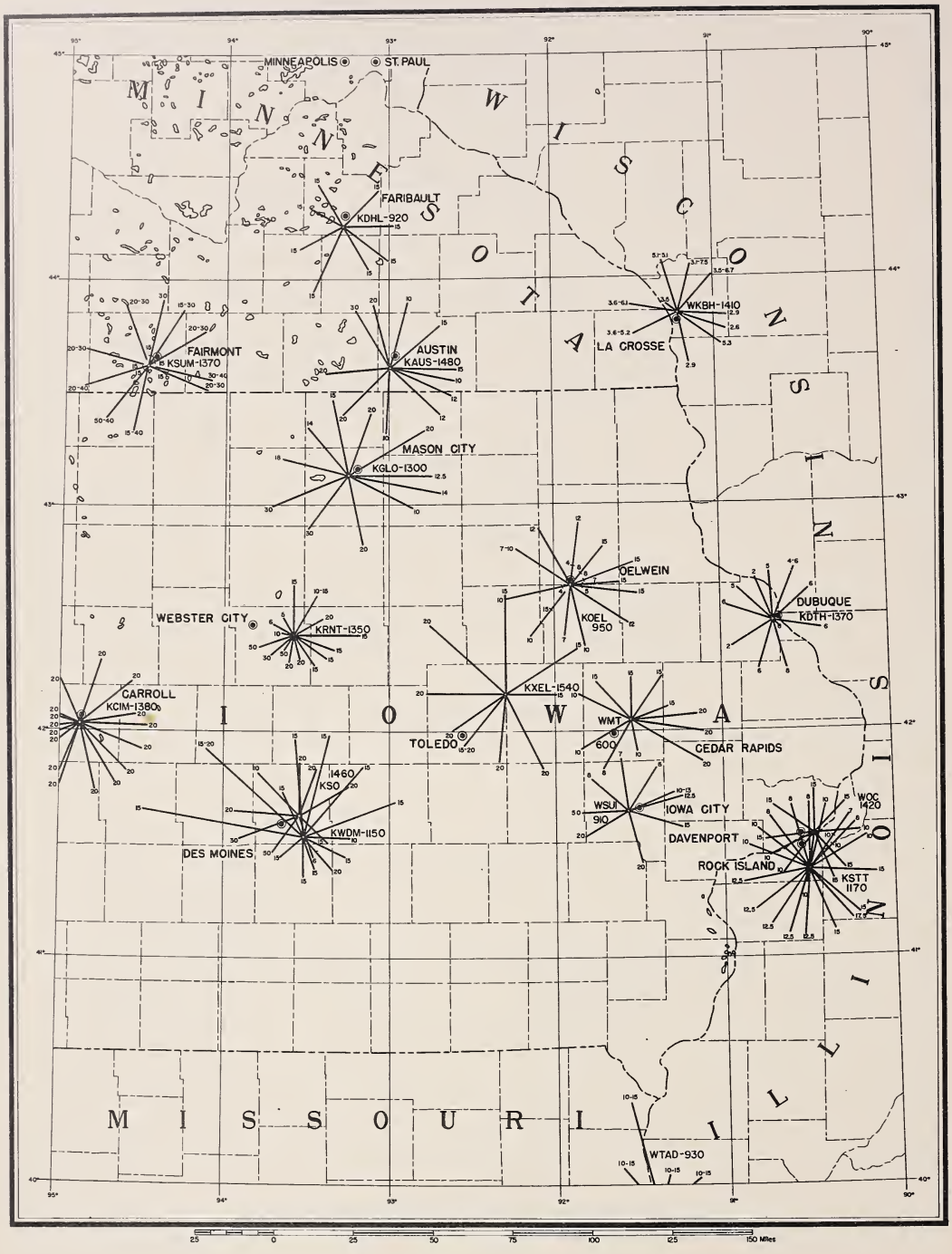
Map 16.


KWAT-950
SOUTH DAKOTA
MINNESOTA
SIOUX FALLS
KIHO-1270
WNAX-570
KSCJ-1360
SIOUX CITY
KCOM-620
KCIM-1380
IOWA
NEBRASKA
COLUMBUS
OMAHA
COUNCIL BLUFFS
KOIL-1290
GRAND ISLAND
KRVN-1010
LINCOLN
KLMS-1480
KMA-960
100°
99°
98°
97°
96°
95°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

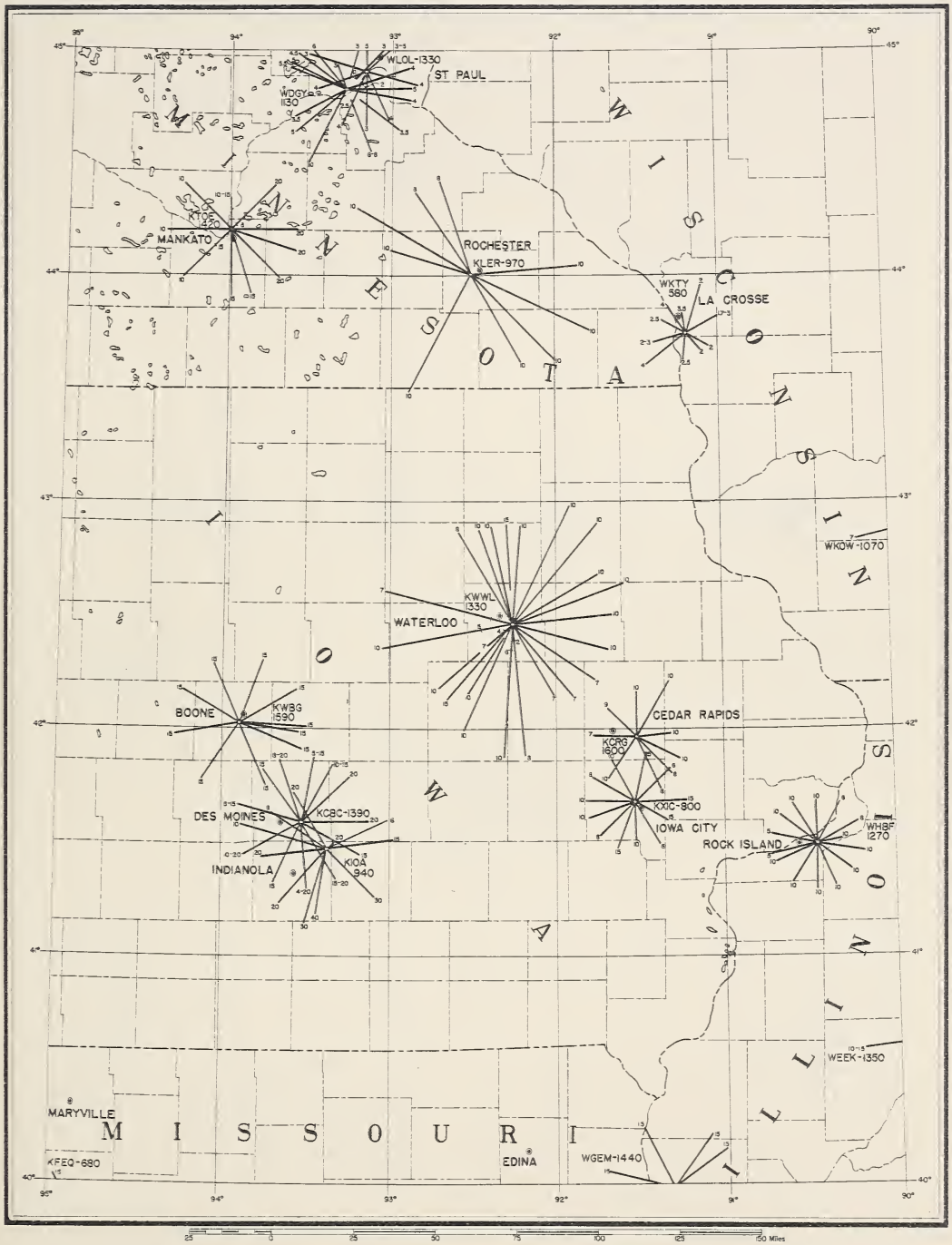
Map 17a.


SOUTH DAKOTA
NEBRASKA
MINNESOTA
IOWA
SIOUX FALLS
KELO-1320
SIOUX CITY
KTRI-1470
COLUMBUS
OMAHA
COUNCIL BLUFFS
KFAB-1110
GRAND ISLAND
LINCOLN
100°
99°
98°
97°
96°
95°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

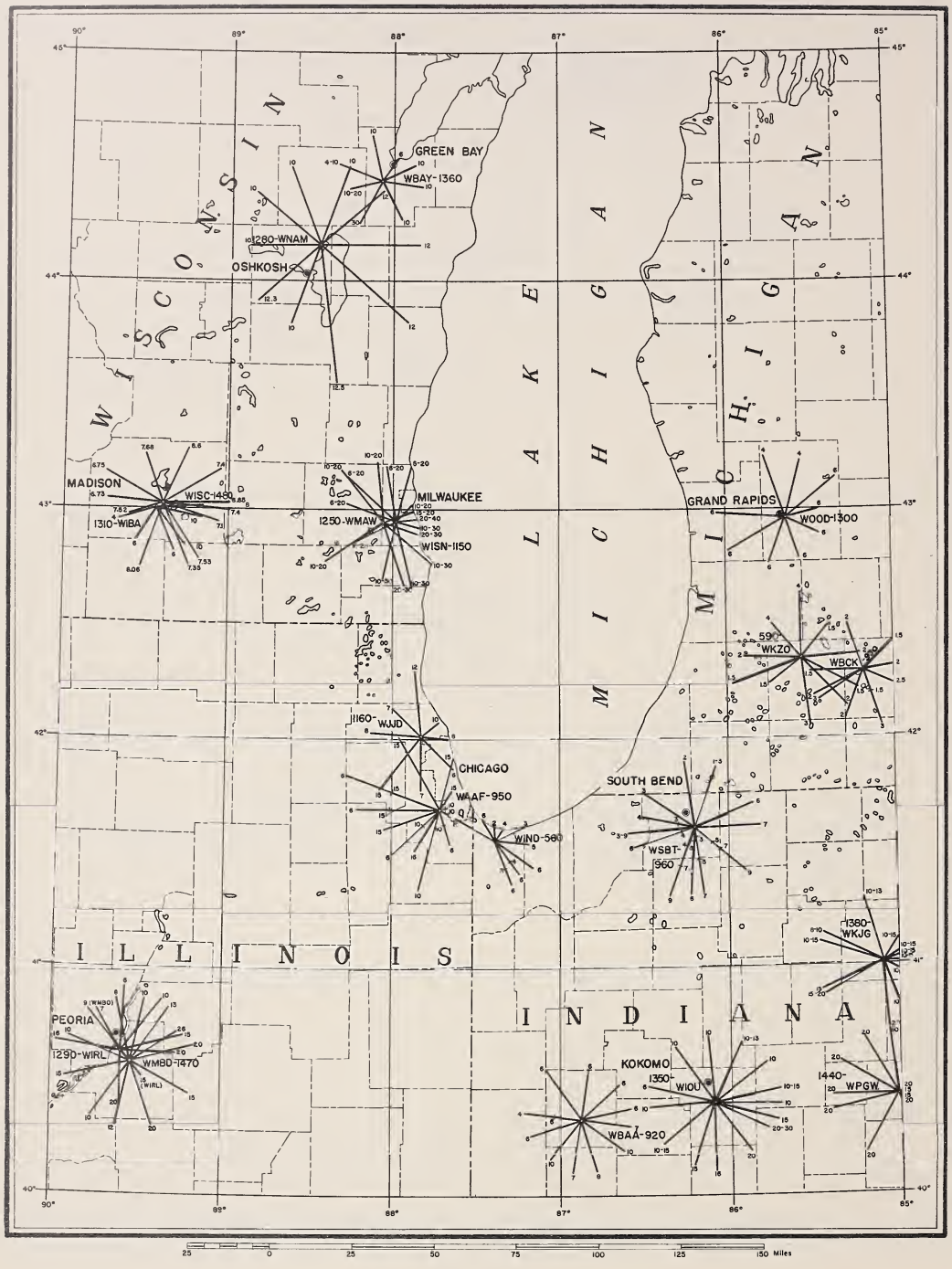
Map 17b.


MINNEAPOLIS
ST. PAUL
MINNESOTA
WISCONSIN
IOWA
ILLINOIS
MISSOURI
FARIBAULT
KDHL-920
FAIRMONT
KSUM-1370
AUSTIN
KAUS-1480
MASON CITY
KGLO-1300
LA CROSSE
WKBH-1410
OELWEIN
KOEL
950
DUBUQUE
KDTH-1370
WEBSTER CITY
KRNT-1350
CARROLL
KCIM-1380
KXEL-1540
TOLEDO
WMT
600
CEDAR RAPIDS
1460
KSO
KWDM-1150
DES MOINES
WSUI
910
IOWA CITY
DAVENPORT
ROCK ISLAND
WOC
1420
KSTT
1170
WTAD-930
25 0 25 50 75 100 25 150 Miles

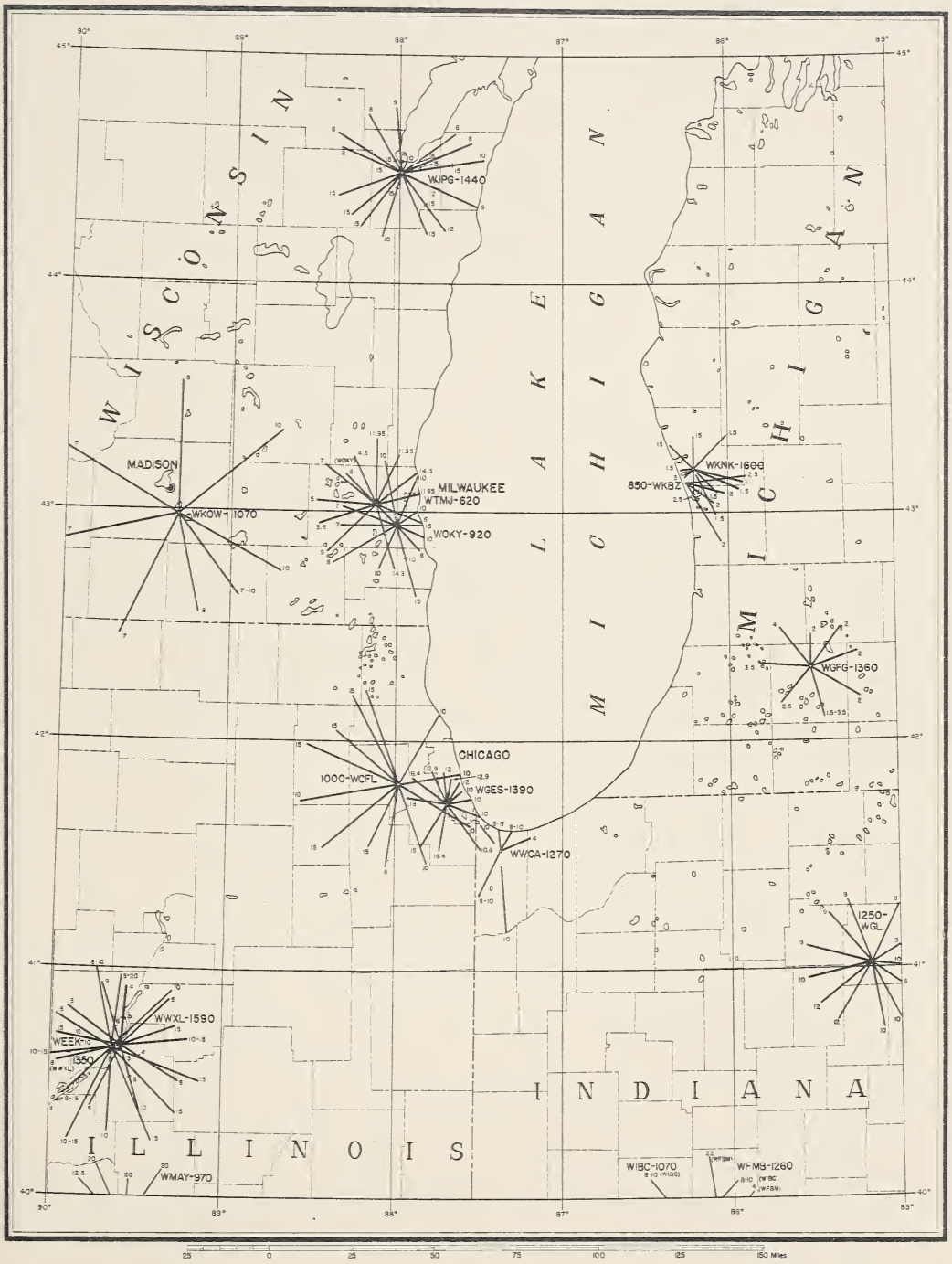
Map 18a.


WLOL-1330
ST PAUL
WDGY
130
KTOE
1320
MANKATO
ROCHESTER
KLER-970
WKTY
580
LA CROSSE
WKOW-1070
KWWL
1330
WATERLOO
BOONE
KWBG
1590
CEDAR RAPIDS
KCRG
1600
KXIC-800
IOWA CITY
DES MOINES
KCBC-1390
KIOA
940
INDIANOLA
ROCK ISLAND
WHBF
1270
WEEK-1350
MARYVILLE
KFEQ-680
EDINA
WGEM-1440
MINNESOTA
WISCONSIN
IOWA
MISSOURI
ILLINOIS
25 0 25 50 75 100 125 150 Miles

Map 18b.

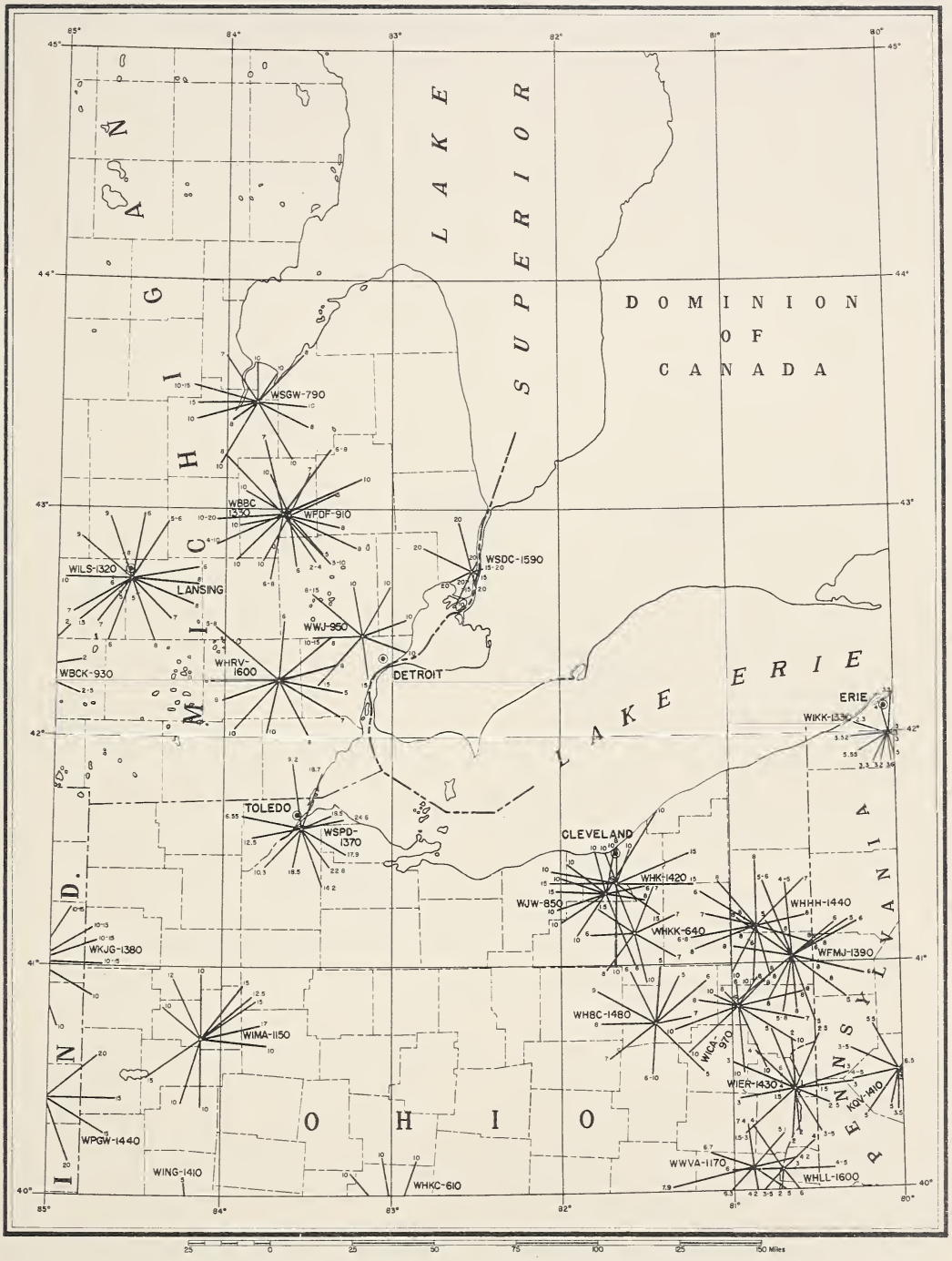

WISCONSIN
LAKE MICHIGAN
ILLINOIS
INDIANA
GREEN BAY
WBAY-1360
1280-WNAM
OSHKOSH
MADISON
WISC-1480
1310-WIBA
MILWAUKEE
1250-WMAW
WISN-1150
GRAND RAPIDS
WOOD-1300
WKZO
WBCK
1160-WJJD
CHICAGO
WAAF-950
WIND-560
SOUTH BEND
WSBT-960
1380-WKJG
PEORIA
1290-WIRL
WMBD-1470
KOKOMO
1350-WIOU
WBAA-920
1440-WPGW
90°
89°
88°
87°
86°
85°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

Map 19a.

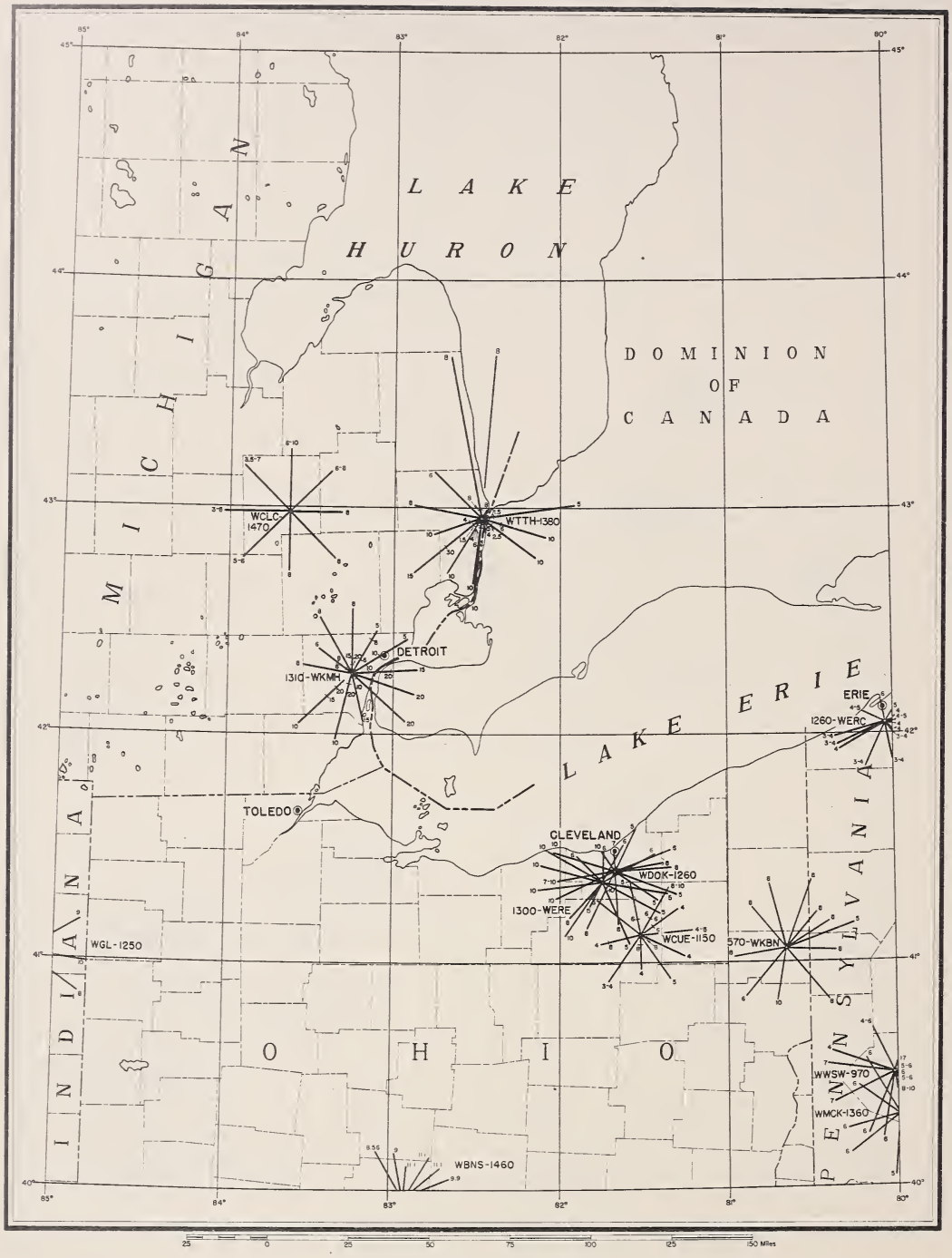


MAP 19b.

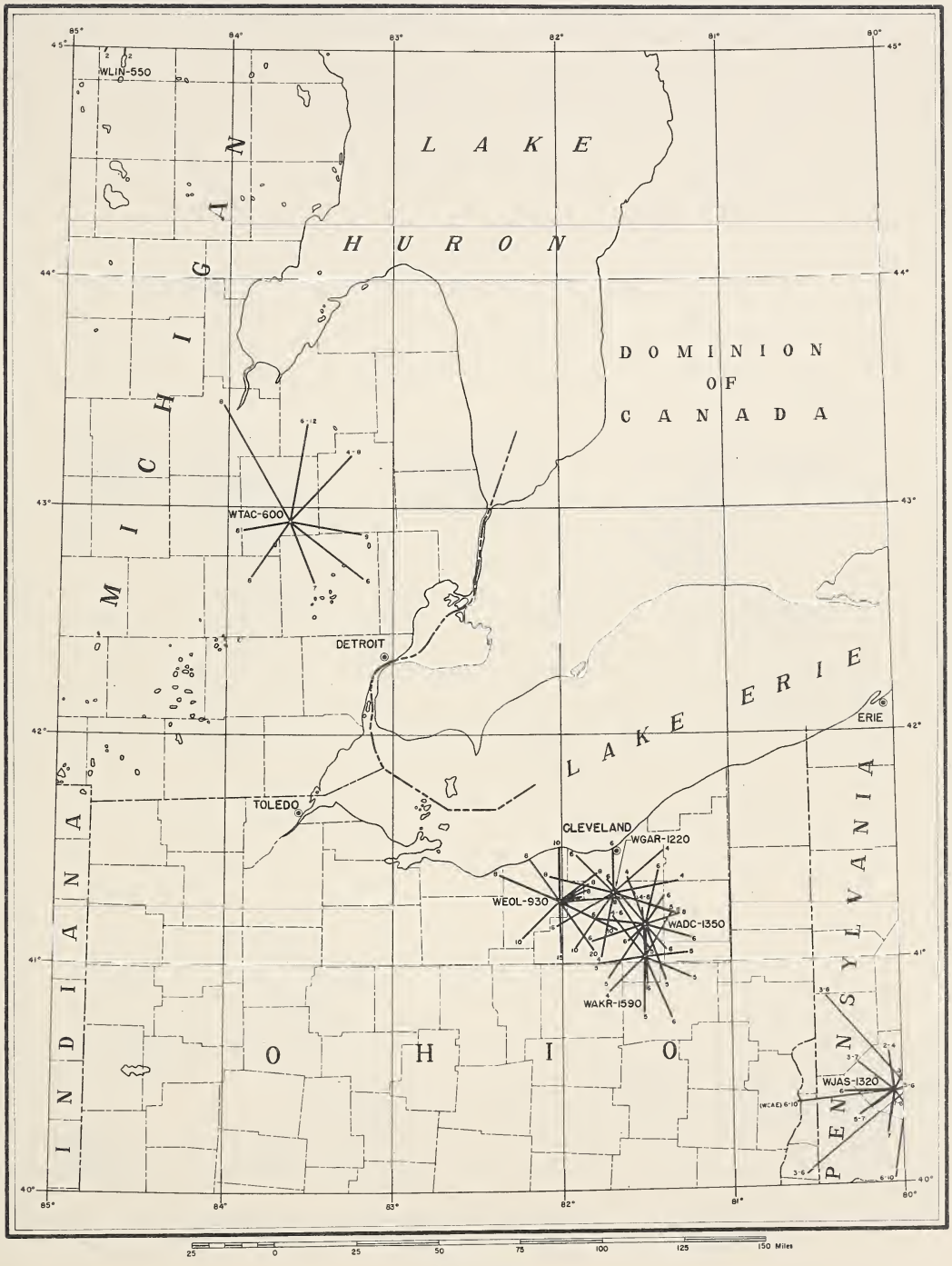
282270 O - 54 - 5


LAKE SUPERIOR
DOMINION OF CANADA
LAKE ERIE
MICHIGAN
OHIO
INDIANA
PENNSYLVANIA
WSGW-790
WBBC 1430
WFDF-910
WILS-1320
LANSING
WJW-950
WHRV-1600
WBCK-930
DETROIT
WSDC-1590
ERIE
WIKK-1330
TOLEDO
WSPD-1370
CLEVELAND
WHK-1420
WJW-850
WHHH-1440
WHKK-640
WFMJ-1390
WHBC-1480
WICA-570
WIER-1430
KQV-1410
WWVA-1170
WHLL-1600
WKJG-1380
WIMA-1150
WPGW-1440
WING-1410
WHKC-610
25 0 25 50 75 100 25 150 Miles

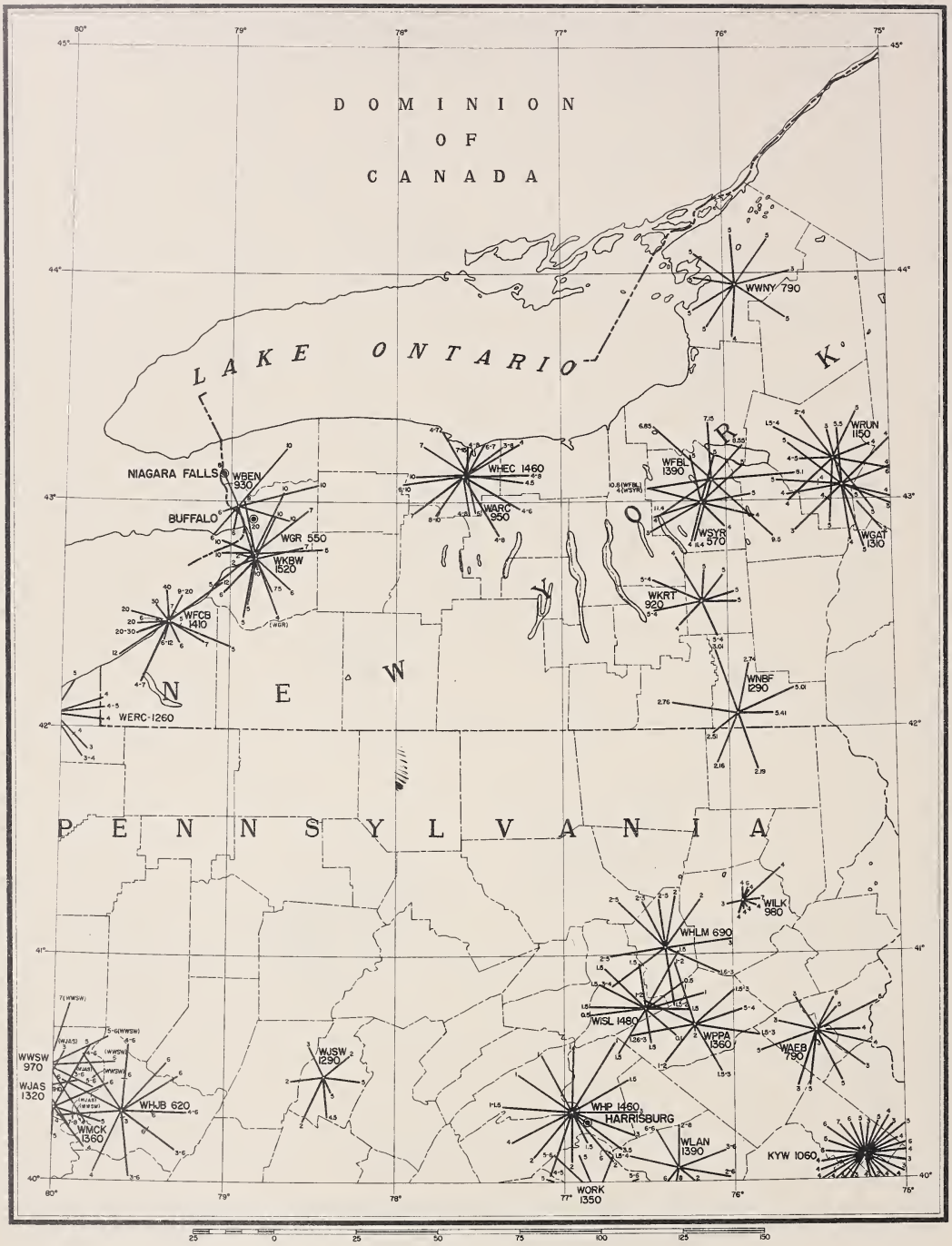
Map 20a.


LAKE HURON
MICHIGAN
DOMINION OF CANADA
LAKE ERIE
INDIANA
OHIO
PENNSYLVANIA
WCLC 1470
WTTH-1380
DETROIT
1310-WKMH
TOLEDO
ERIE
1260-WERC
CLEVELAND
WDOK-1260
1300-WERE
WCUE-1150
570-WKBN
WGL-1250
WWSW-970
WMCK-1360
WBNS-1460
85°
84°
83°
82°
81°
80°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

Map 20b.


WLIN-550
LAKE
HURON
MICHIGAN
DOMINION
OF
CANADA
WTAC-600
DETROIT
LAKE ERIE
ERIE
TOLEDO
CLEVELAND
WGAR-1220
WEOL-930
WADC-1350
WAKR-1590
OHIO
INDIANA
PENNSYLVANIA
WJAS-1320
(WCAE) 6-10
85°
84°
83°
82°
81°
80°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

Map 20c.


DOMINION
OF
CANADA
LAKE ONTARIO
NIAGARA FALLS
WBEN 930
BUFFALO
WGR 550
WKBW 1520
WFCB 1410
WERC-1260
WHEC 1460
WARC 950
WWNY 790
WFBL 1390
WSYR 570
WRUN 1150
WGAT 1310
WKRT 920
WNBF 1290
NEW YORK
PENNSYLVANIA
WILK 980
WHLM 690
WISL 1480
WPPA 1360
WAEB 790
WWSW 970
WJAS 1320
WJSW 1290
WHJB 620
WMCK 1560
WHP 1480
HARRISBURG
WLAN 1390
KYW 1060
WORK 1350
80°
79°
78°
77°
76°
75°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150

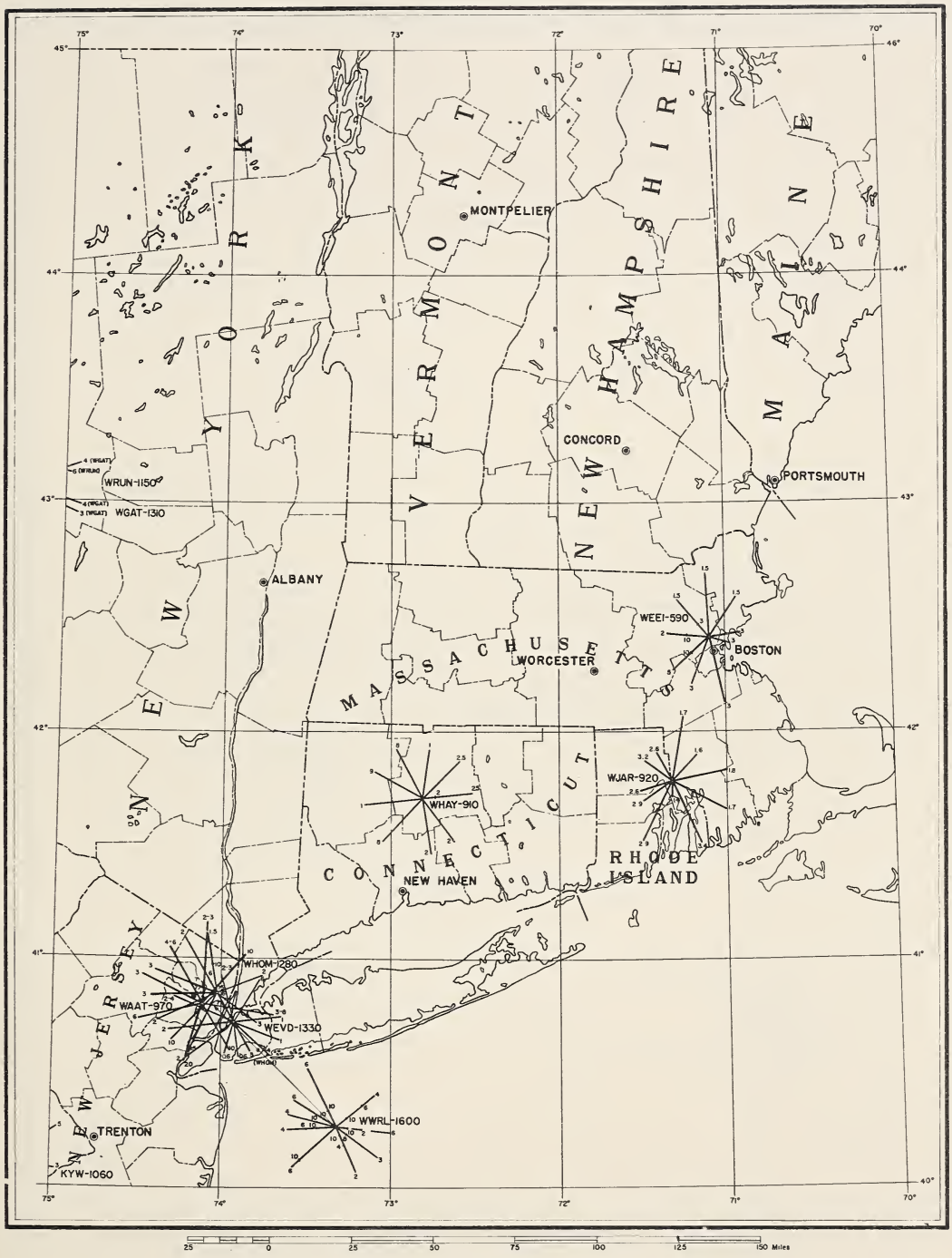
Map 21a.


DOMINION
OF
CANADA
LAKE ONTARIO
NEW YORK
PENNSYLVANIA
NIAGARA FALLS
WHLD-1270
BUFFALO
WEBR-970
WVET-1280
WSAY-1370
WAGE
620
WIBX-950
WNDR-1260
WKOP-1360
WIKK-1330
KQV
1410
PITTSBURGH
WCAE-1250
WVAM-1430
HARRISBURG
WLBR-1270
WSAN-1470
WEEU-850
WIBG-990
WFIL-560
WTTM
920
WPWA
1590
45°
44°
43°
42°
41°
40°
80°
79°
78°
77°
76°
75°
25 0 25 50 75 100 125 150 Miles

Map 21b.


WCAX-620
ELIZABETHTOWN
MONTPELIER
RUTLAND
WGAN-560
PORTLAND
CONCORD
WMUR-610
PORTSMOUTH
WROW-590
ALBANY
WTAG-580
BOSTON
WVOM-1600
SPRINGFIELD
WPJB-1420
WDRC
1360
HARTFORD
WPRO-630
BRISTOL
WATR
1320
NEW LONDON
RHODE
ISLAND
CONNECTICUT
WBMX-1380
WNJR-1430
WNBC-660
NEW YORK
TRENTON
WMCA-570
WPAT-930
NEW JERSEY
NEW YORK
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
MAINE
75°
74°
73°
72°
71°
70°
45°
44°
43°
42°
41°
40°
25
0
25
50
75
100
125
150 Miles

Map 22a.



Map 22b.

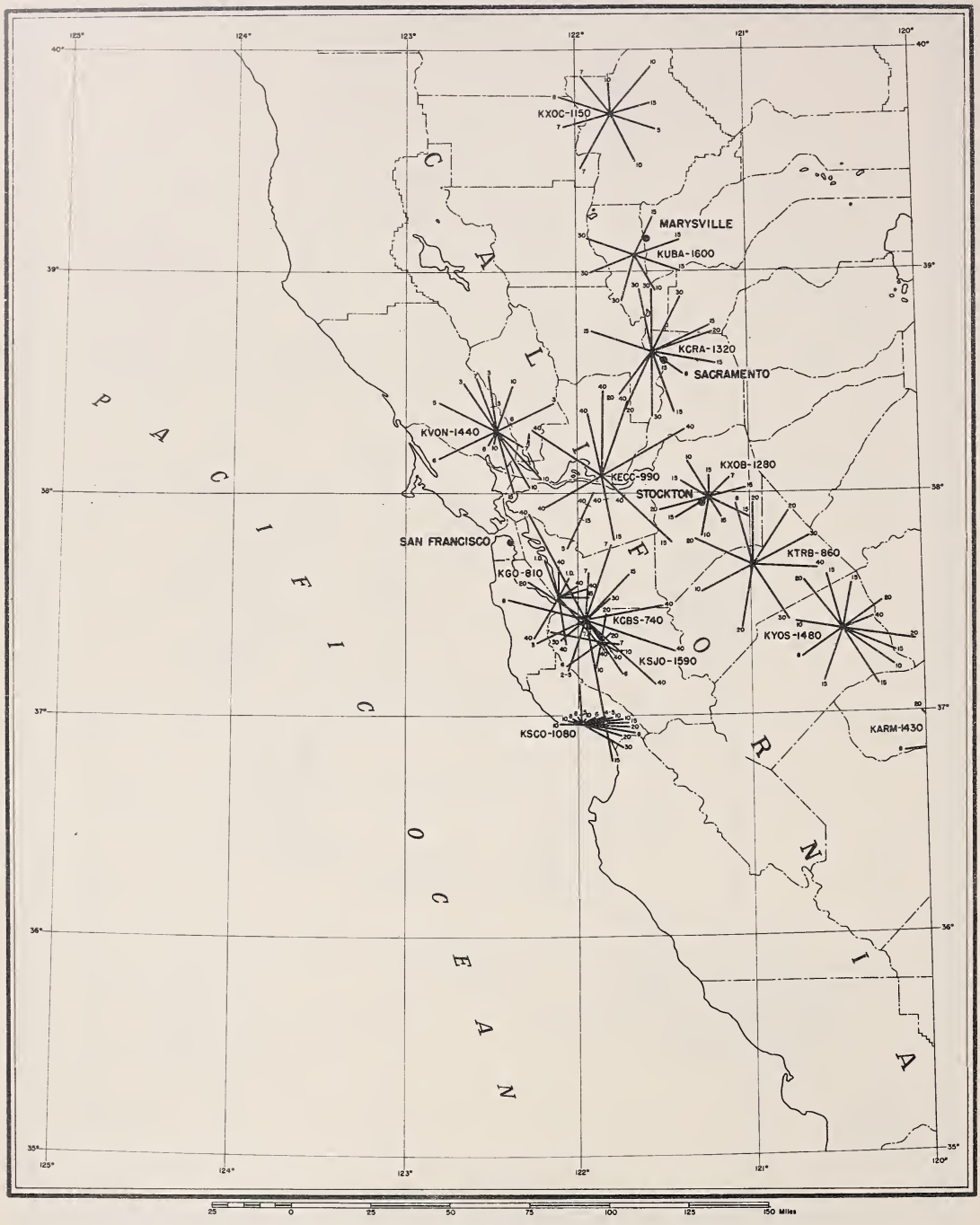
282270 O - 54 - 6


MONTPELIER
CONCORD
PORTSMOUTH
ALBANY
WPTR-1540
WOKO-1460
MASSACHUSETTS
WHDH 850
WCOP-1150
BOSTON
WNAC-1260
WAAB 1440
WJKO-1600
WARA 1320
PROVIDENCE
WEAN-790
HARTFORD
WONS-1410
RHODE ISLAND
CONNECTICUT
NEW HAVEN
NEW LONDON
WMGM 1050
WNEW 1130
WOR 710
NEW YORK
TRENTON
NEW JERSEY
NEW YORK
VERMONT
NEW HAMPSHIRE
MAINE
75°
74°
73°
72°
71°
70°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

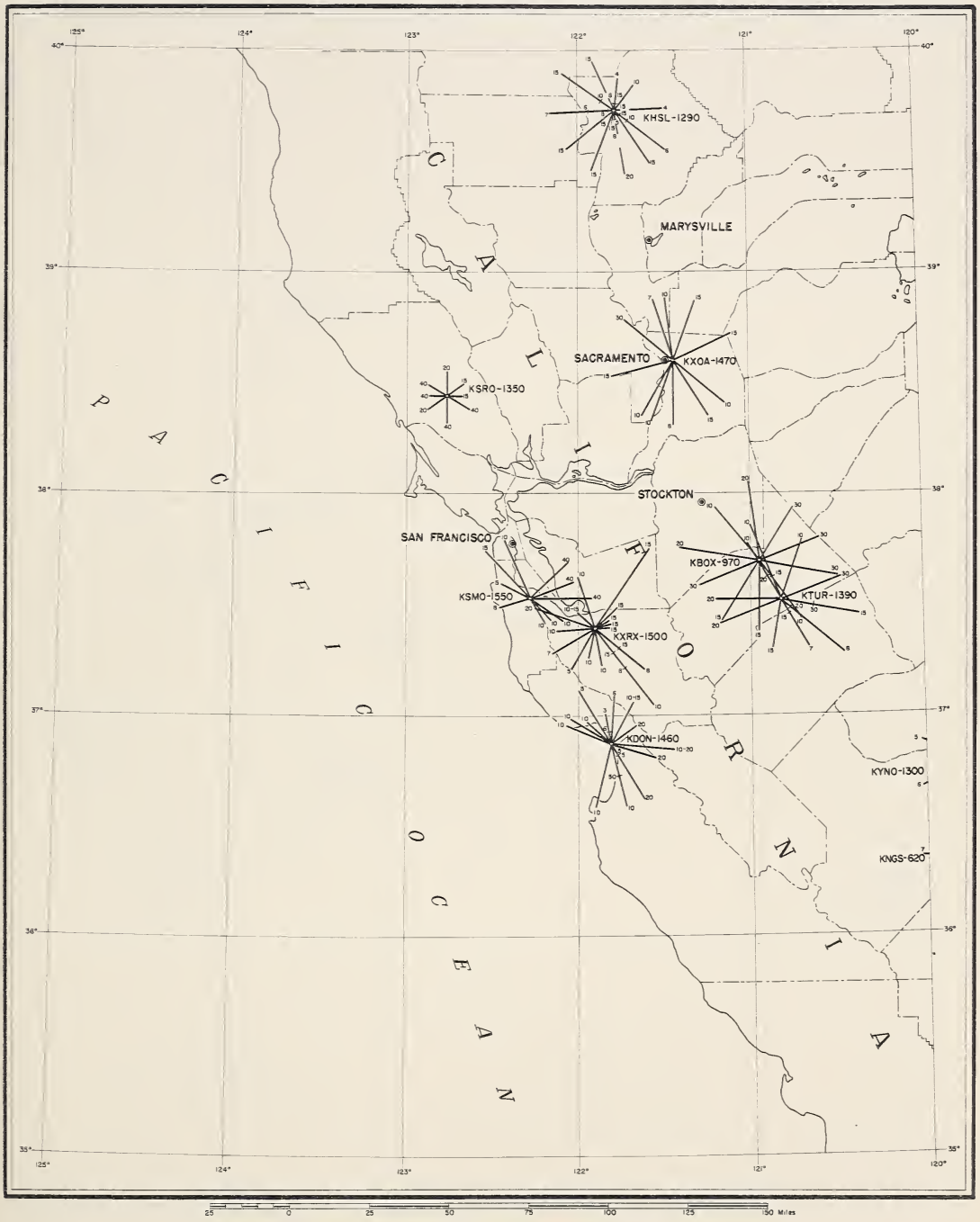
Map 22c.


WEAV-960
MONTPELIER
WDEV 550
WLAM 1470
WCSH 970
WSYB 1380
CONCORD
PORTSMOUTH
WKNE 1290
WFEA 1370
WTRY 980
ALBANY
WXKW 850
WEIM 1280
WLAW 680
BOSTON
WMEX-1510
WORCESTER
WORC 1310
WHYN 560
WSPR-1270
WPJB-1420
WSAR 1480
WTIC 1080
HARTFORD
PROVIDENCE
WBRY 1590
NEW LONDON
WELI-960
RHODE ISLAND
NEW HAVEN
WNLK-1350
WOV 1280
WVNJ-620
WGSM-740
NEW YORK
WBBR 1330
TRENTON
WTTM 920
N.J.
VERMONT
NEW HAMPSHIRE
MAINE
NEW YORK
MASSACHUSETTS
CONNECTICUT
75°
74°
73°
72°
71°
70°
45°
44°
43°
42°
41°
40°
25 0 25 50 75 100 125 150 Miles

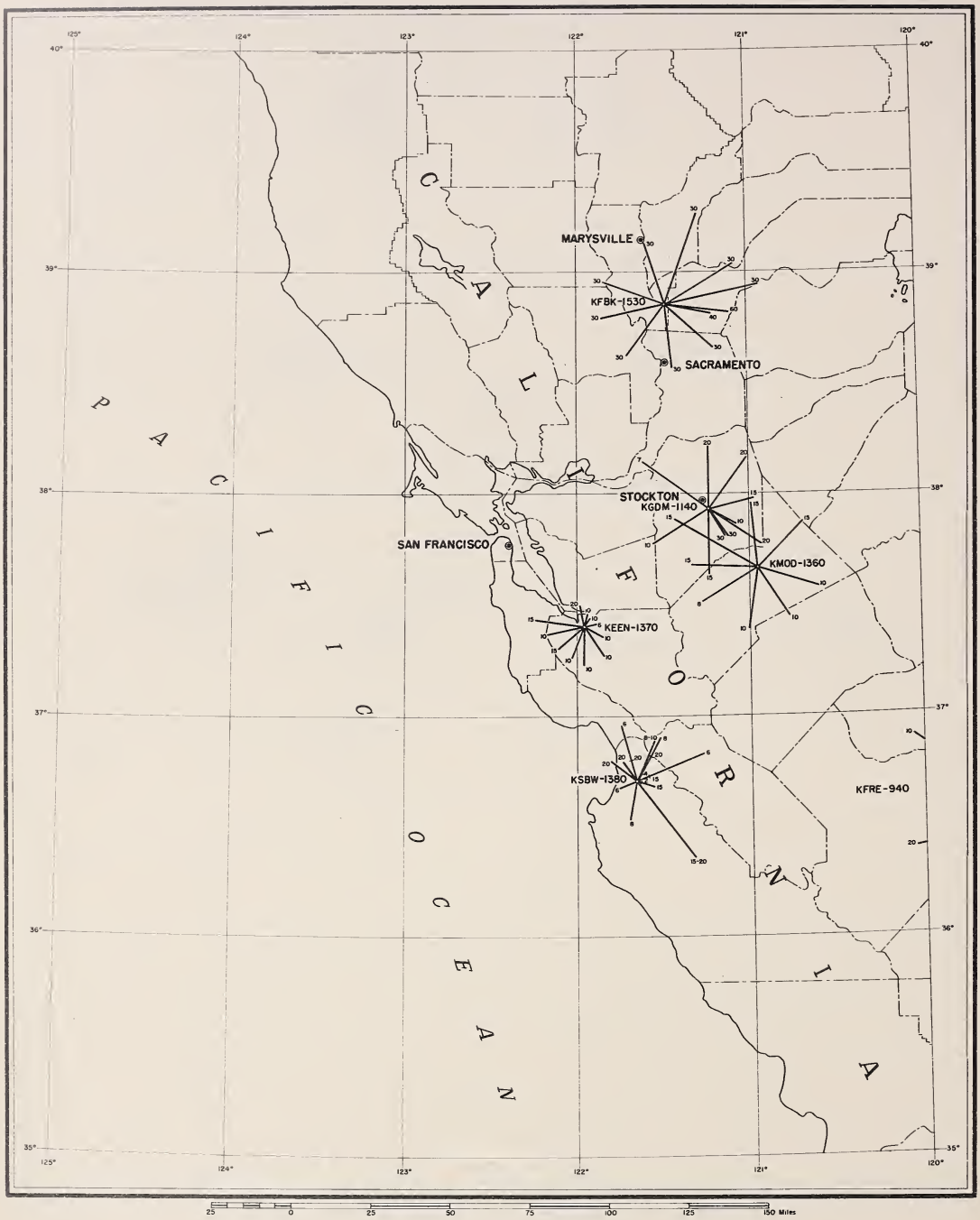
Map 22d.


KXOC-1150
MARYSVILLE
KUBA-1600
KCRA-1320
SACRAMENTO
KVON-1440
KECC-990
KXOB-1280
STOCKTON
SAN FRANCISCO
KTRB-860
KGO-810
KCBS-740
KYOS-1480
KSJO-1590
KSCO-1080
KARM-1430
CALIFORNIA
PACIFIC OCEAN
NEVADA
125°
124°
123°
122°
121°
120°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

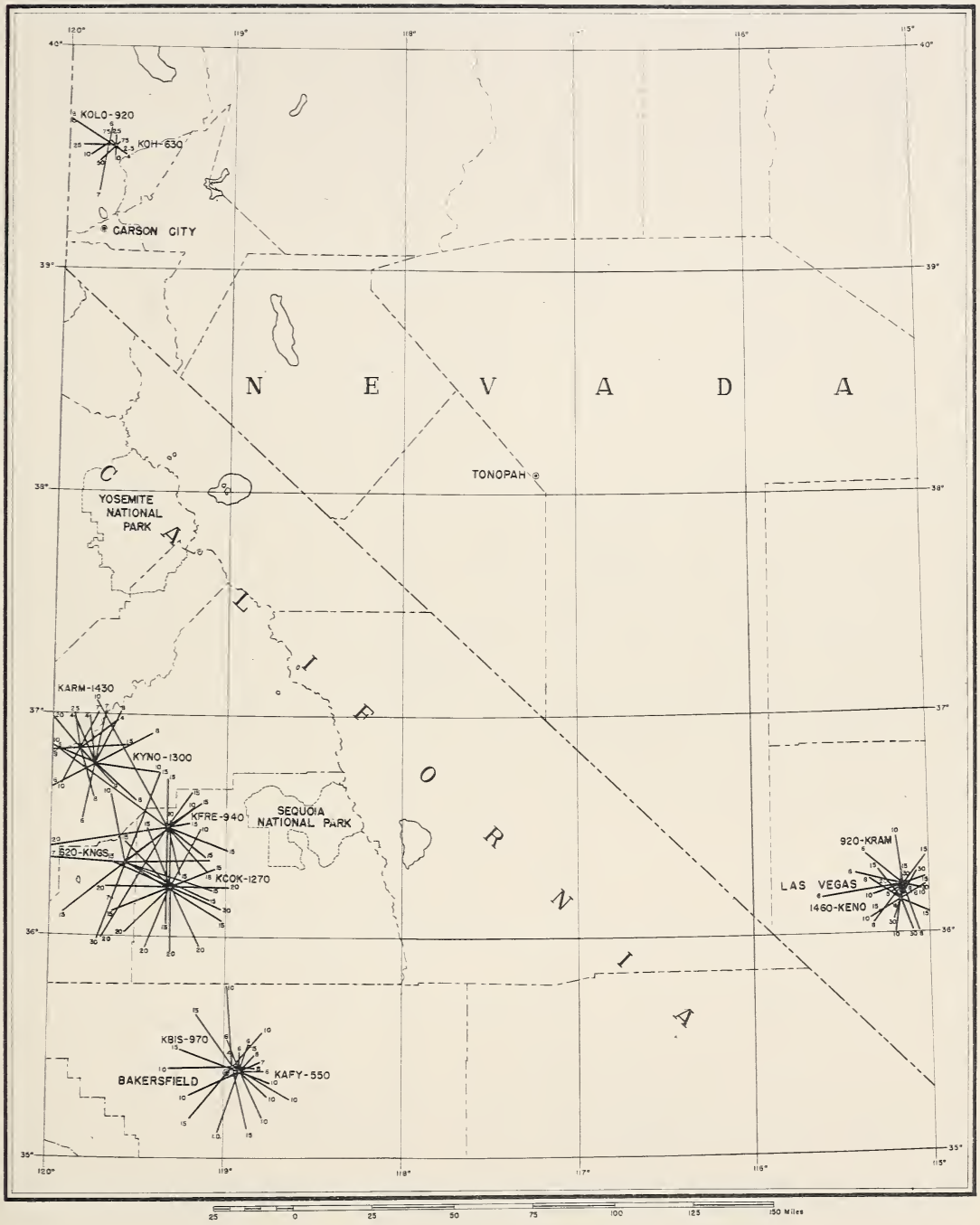
Map 23a.


KHSL-1290
MARYSVILLE
SACRAMENTO
KXOA-1470
KSRO-1350
STOCKTON
SAN FRANCISCO
KBOX-970
KTUR-1390
KSMO-1550
KXRX-1500
KDON-1460
KYNO-1300
KNGS-620
CALIFORNIA
PACIFIC OCEAN
125°
124°
123°
122°
121°
120°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

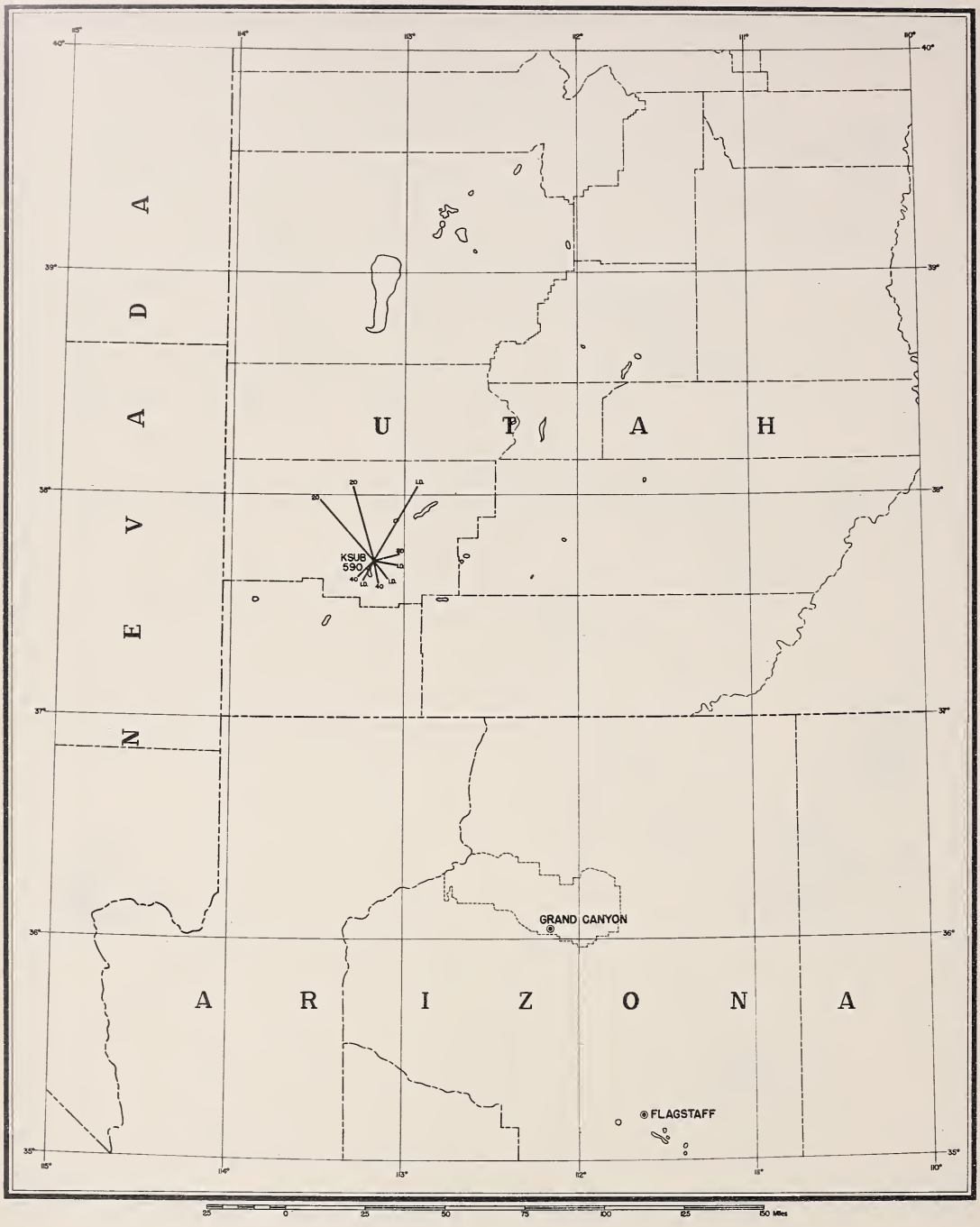
Map 23b.


MARYSVILLE
KFBK-1530
SACRAMENTO
STOCKTON
KGDM-1140
SAN FRANCISCO
KMOD-1360
KEEN-1370
KSBW-1380
KFRE-940
CALIFORNIA
PACIFIC OCEAN
NEVADA
125°
124°
123°
122°
121°
120°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

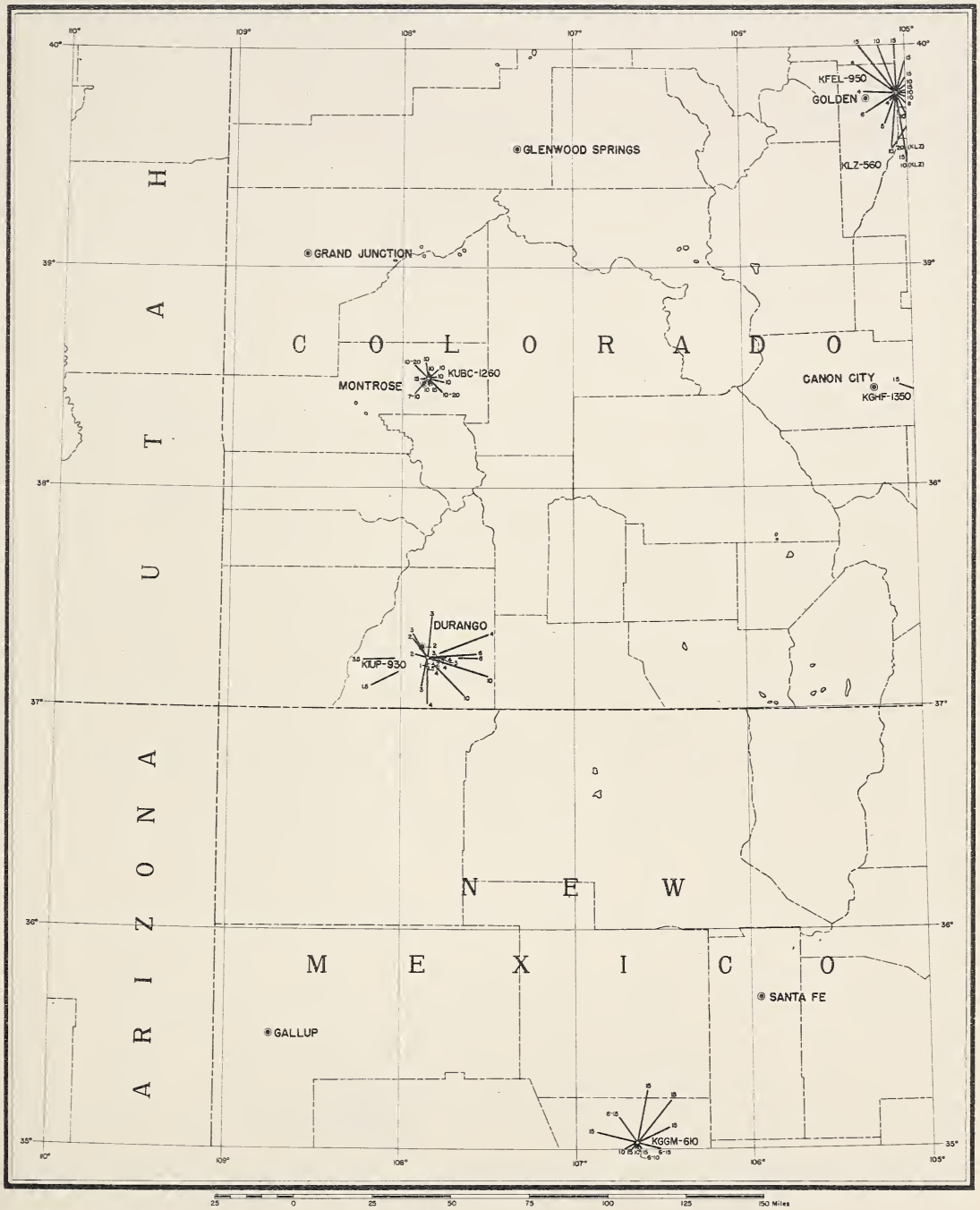
Map 23c.


KOLO-920
KOH-630
CARSON CITY
NEVADA
TONOPAH
YOSEMITE NATIONAL PARK
CALIFORNIA
KARM-1430
KYNO-1300
KFRE-940
SEQUOIA NATIONAL PARK
KBIS-970
KAFY-550
BAKERSFIELD
920-KRAM
LAS VEGAS
1460-KENO
120°
119°
118°
117°
116°
115°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

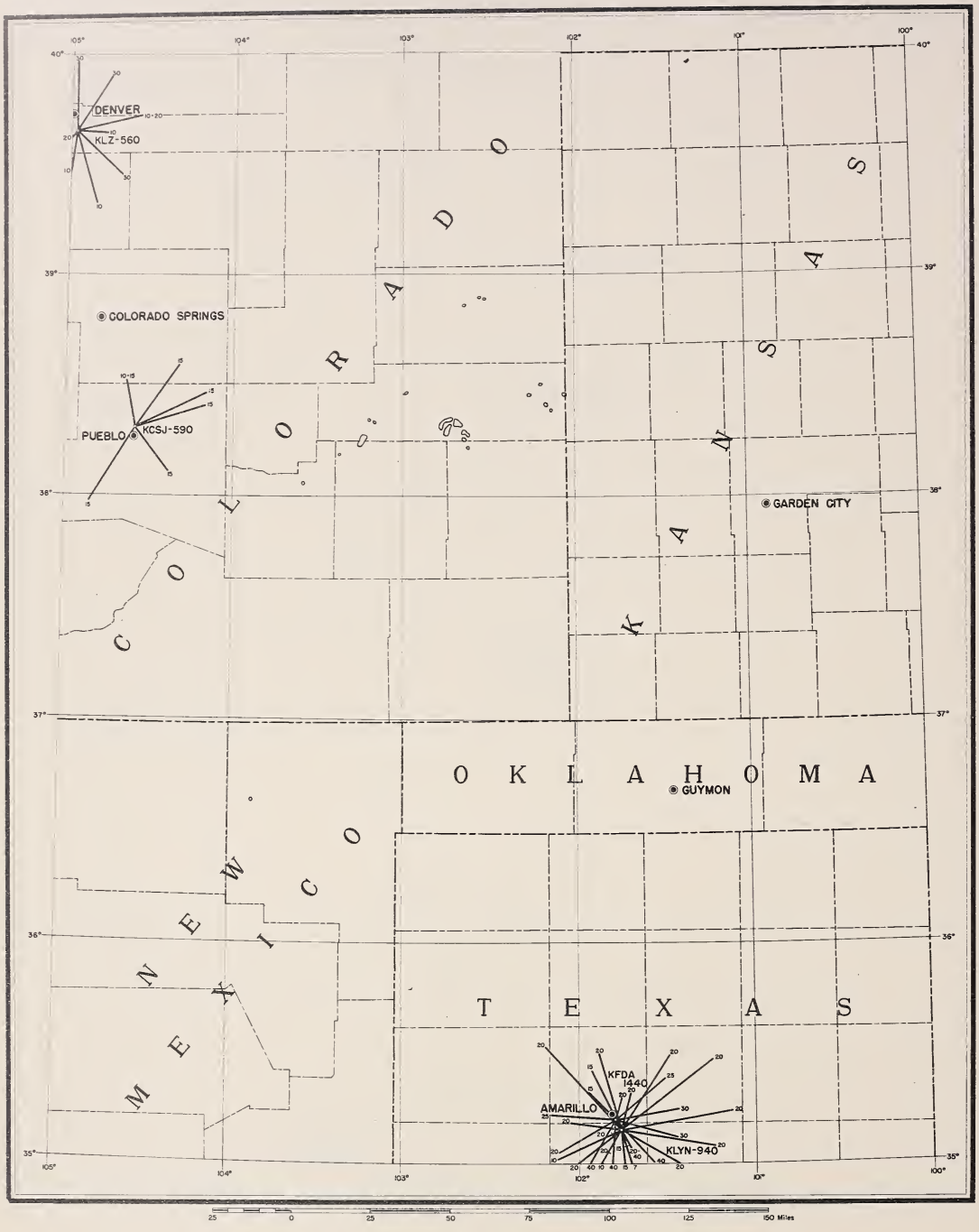
Map 24.


NEVADA
UTAH
ARIZONA
KSUB
590
GRAND CANYON
FLAGSTAFF
25 0 25 50 75 100 125 150 Miles

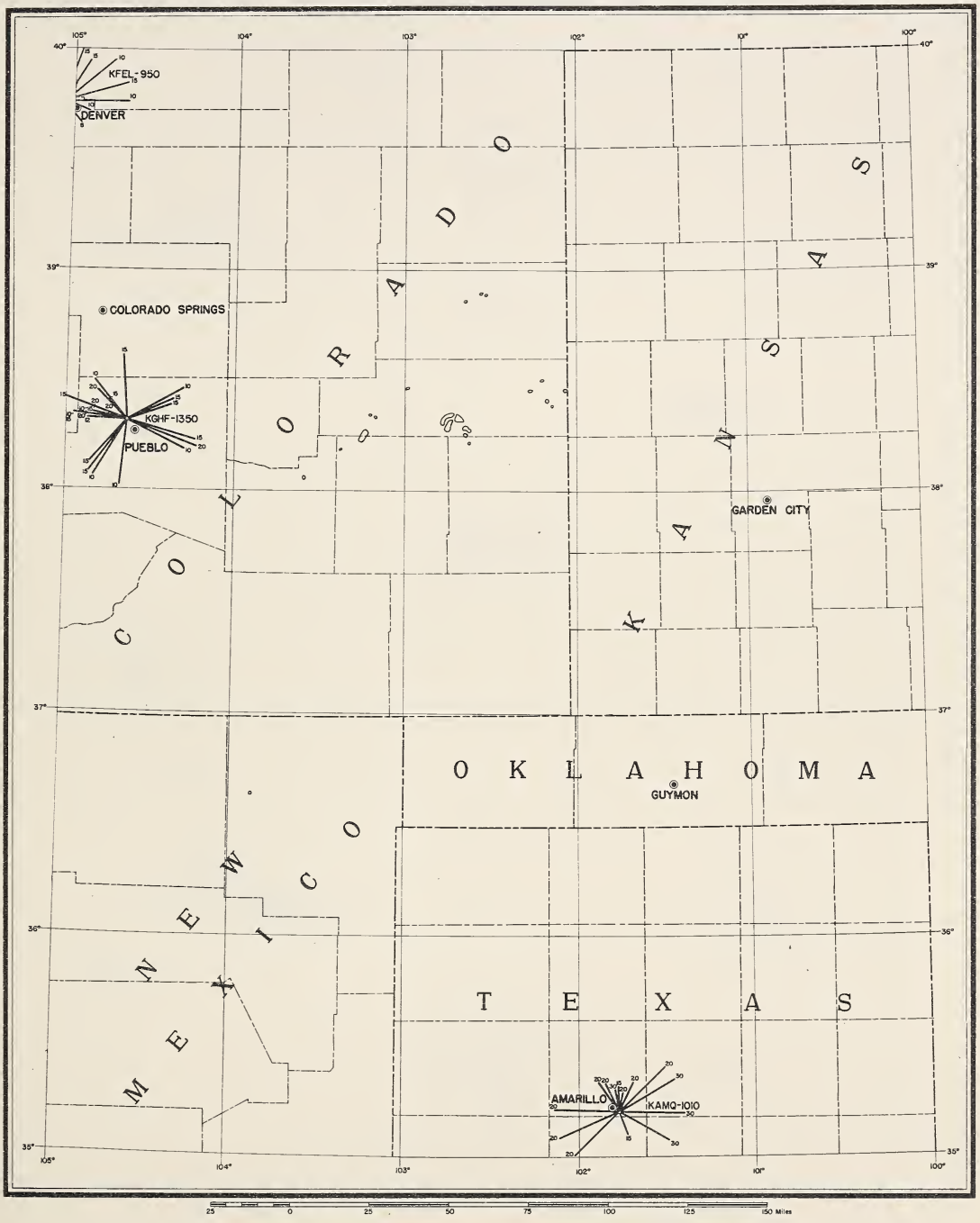
Map 25.


KFEL-950
GOLDEN
GLENWOOD SPRINGS
KLZ-560
GRAND JUNCTION
C O L O R A D O
MONTROSE
KUBC-1260
CANON CITY
KGHF-1350
DURANGO
KIUP-930
N E W
M E X I C O
SANTA FE
GALLUP
KGGM-610
U T A H
A R I Z O N A
110°
109°
108°
107°
106°
105°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

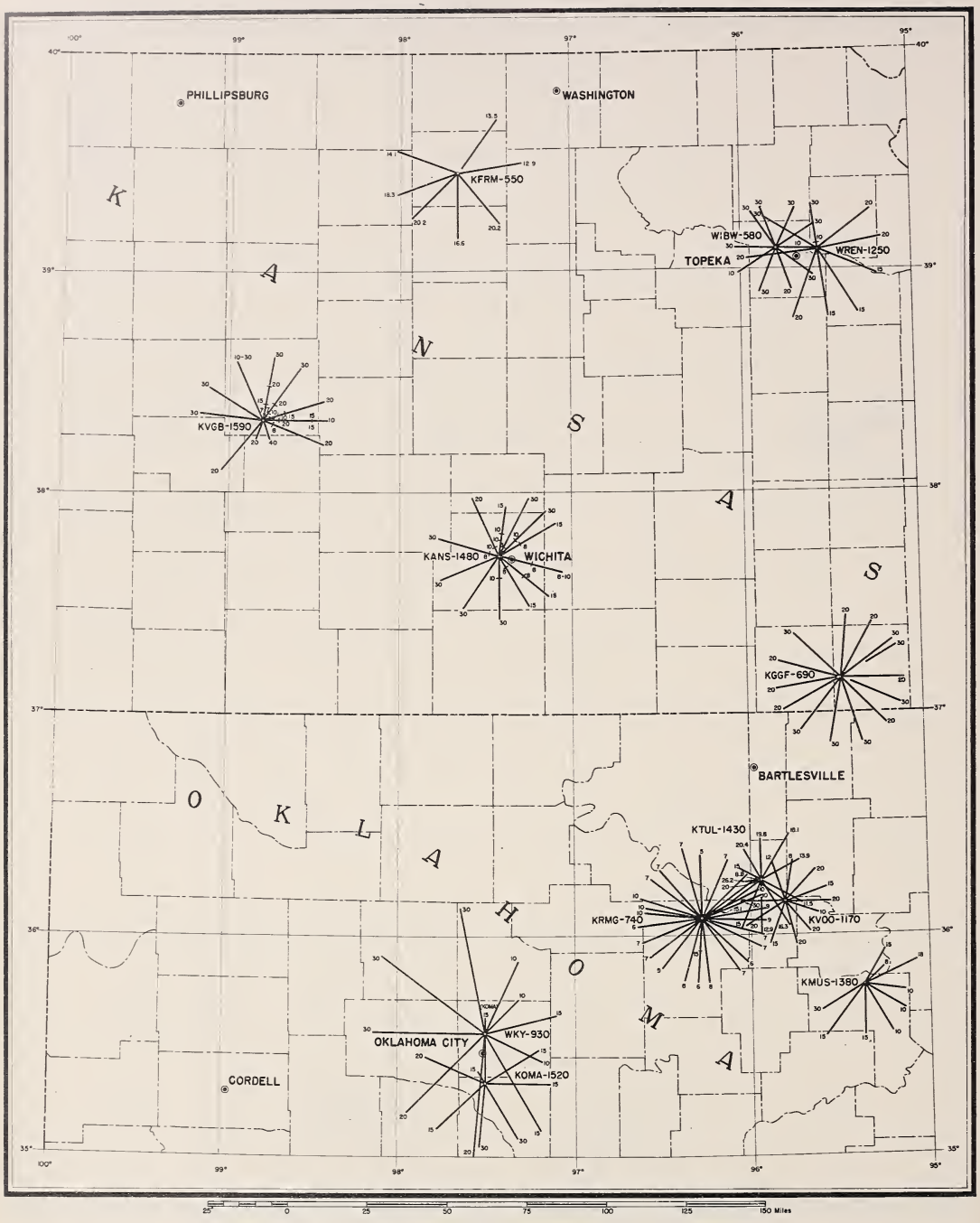
Map 26.


DENVER
KLZ-560
COLORADO SPRINGS
PUEBLO
KCSJ-590
GARDEN CITY
GUYMON
KFDA
1440
AMARILLO
KLYN-940
COLORADO
KANSAS
OKLAHOMA
NEW MEXICO
TEXAS
105°
104°
103°
102°
101°
100°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

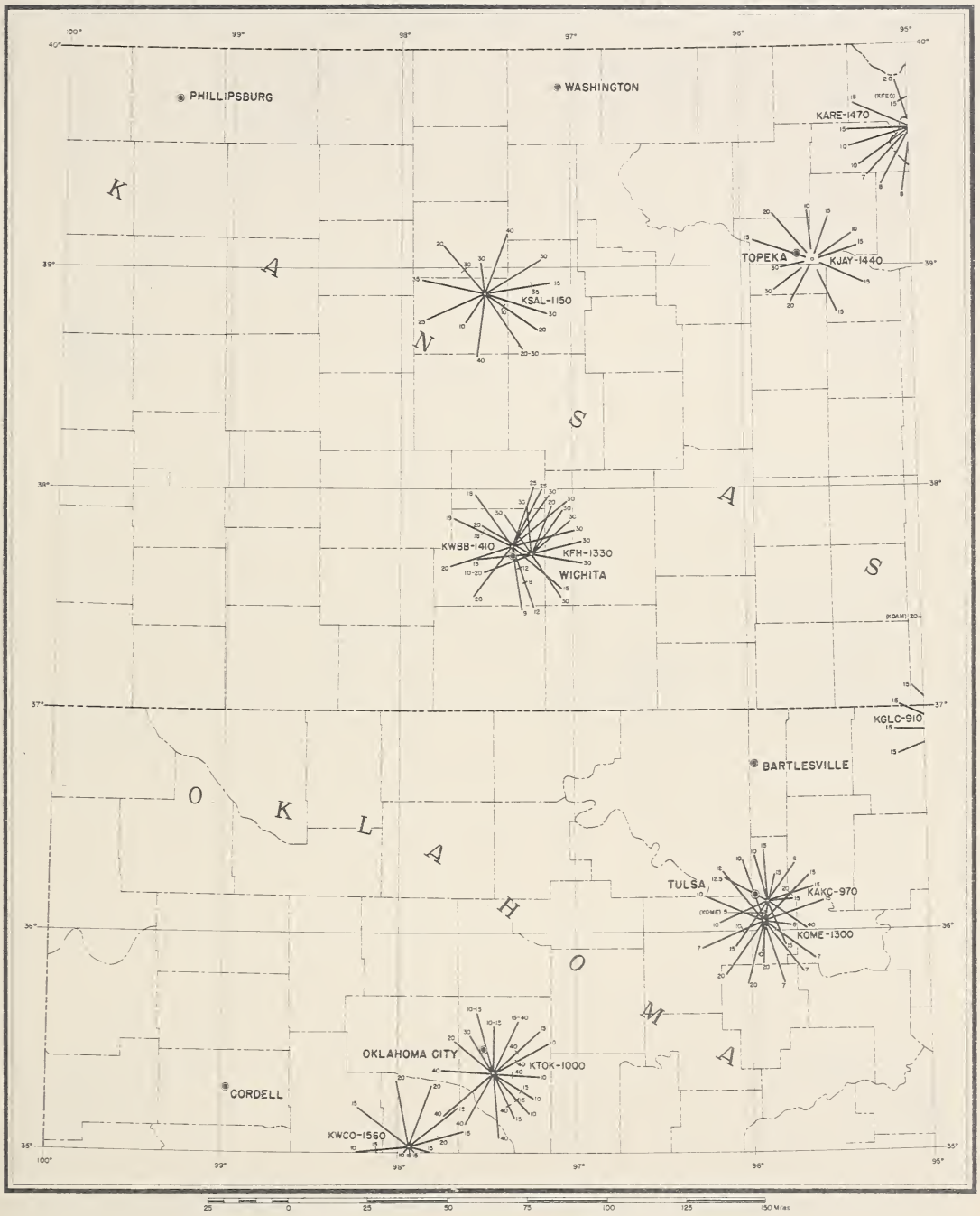
Map 27a.


KFEL-950
DENVER
COLORADO SPRINGS
KGHF-1350
PUEBLO
GARDEN CITY
GUYMON
AMARILLO
KAMQ-1010
COLORADO
KANSAS
OKLAHOMA
NEW MEXICO
TEXAS
105°
104°
103°
102°
101°
100°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

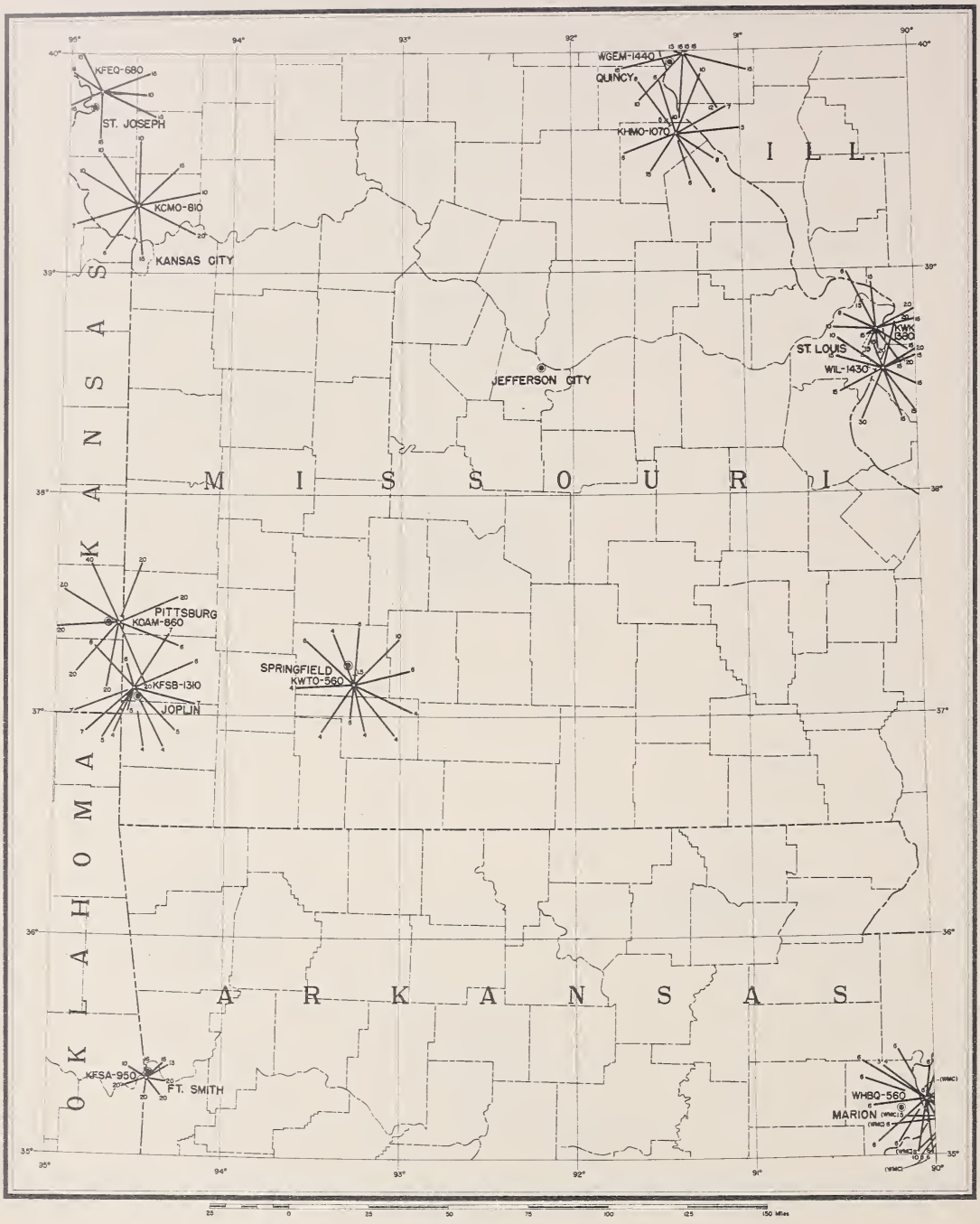
Map 27b.


PHILLIPSBURG
WASHINGTON
KFRM-550
WIBW-580
TOPEKA
WREN-1250
KVGB-1590
KANS-1480
WICHITA
KGGF-690
BARTLESVILLE
KTUL-1430
KRMG-740
KVOO-1170
KMUS-1380
OKLAHOMA CITY
WKY-930
KOMA-1520
CORDELL
KANSAS
OKLAHOMA
100°
99°
98°
97°
96°
95°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

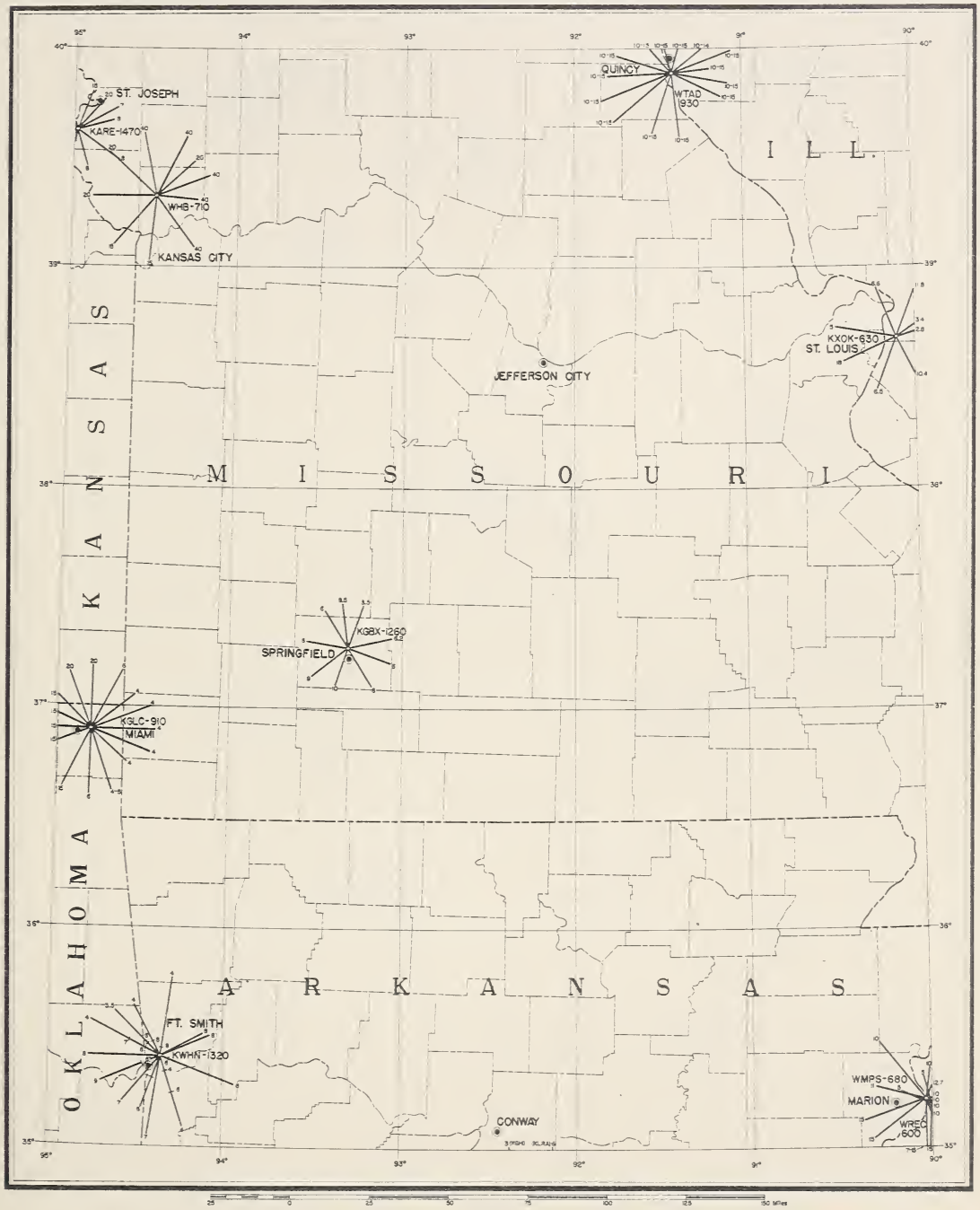
Map 28a.


PHILLIPSBURG
WASHINGTON
KARE-1470
TOPEKA
KJAY-1440
KSAL-1150
KANSAS
KWBB-1410
KFH-1330
WICHITA
KGLC-910
BARTLESVILLE
OKLAHOMA
TULSA
KAKC-970
KOME-1300
OKLAHOMA CITY
KTOK-1000
CORDELL
KWCO-1560
100°
99°
98°
97°
96°
95°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

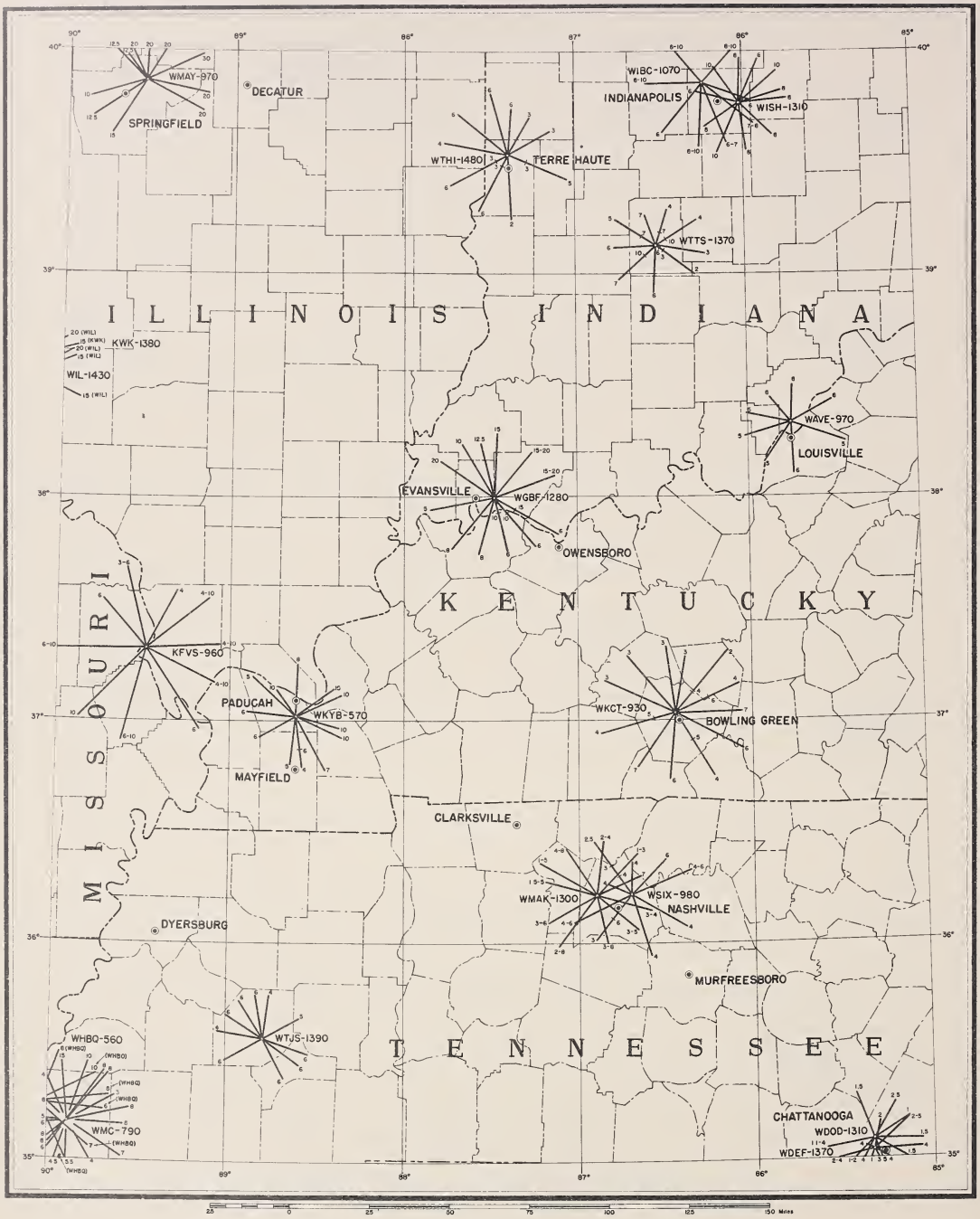
Map 28b.


KFEQ-680
ST. JOSEPH
KCMO-810
KANSAS CITY
WGEM-1440
QUINCY
KHMO-1070
ILL.
KWK 590
ST. LOUIS
WIL-1430
JEFFERSON CITY
MISSOURI
KANSAS
OKLAHOMA
PITTSBURG
KOAM-860
KFSB-1310
JOPLIN
SPRINGFIELD
KWTO-560
ARKANSAS
KFSA-950
FT. SMITH
WHBQ-560
MARION
95°
94°
93°
92°
91°
90°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

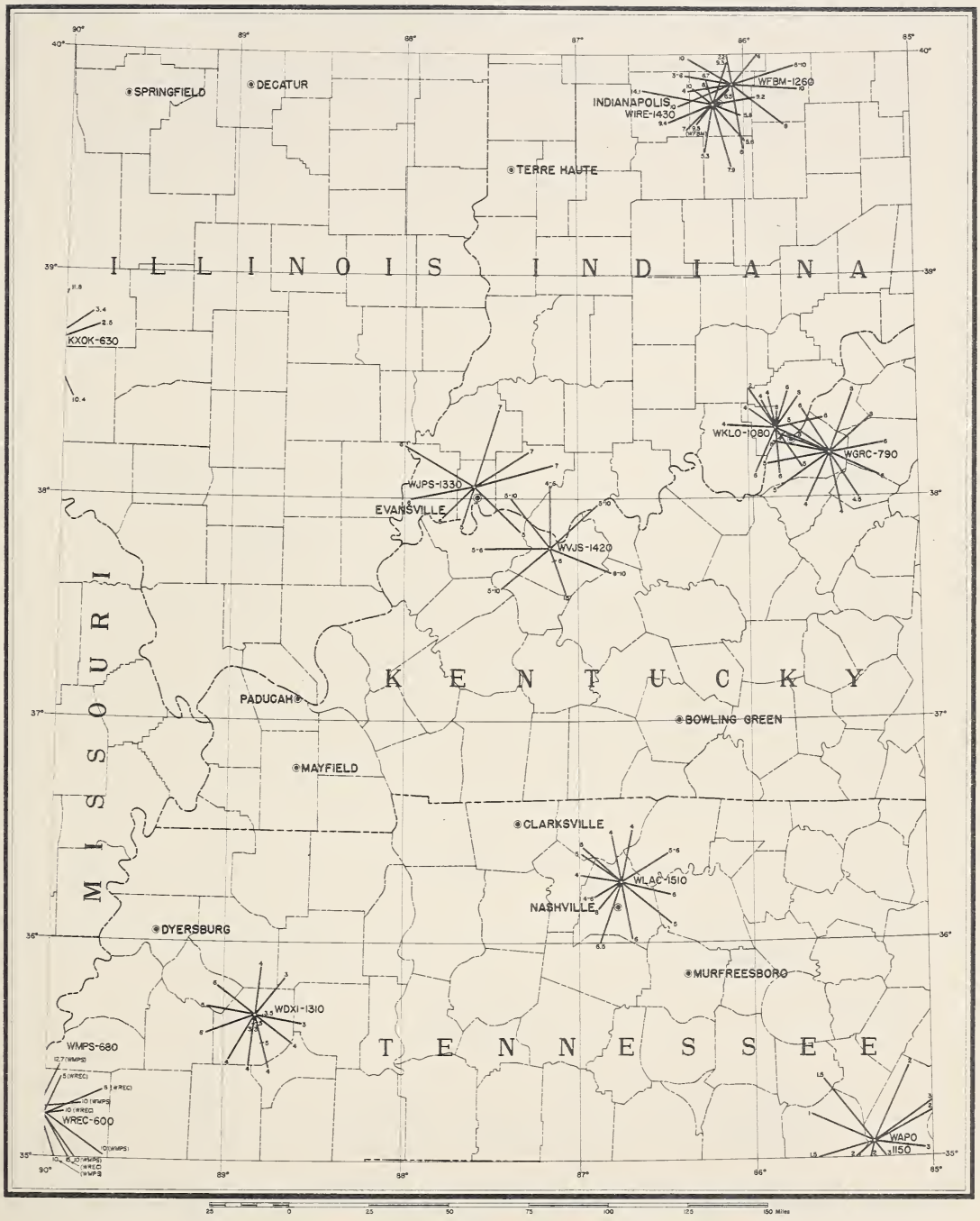
Map 29a.


ST. JOSEPH
KARE-1470
WHB-710
KANSAS CITY
QUINCY
WTAD
1930
ILL.
KXOK-630
ST. LOUS
JEFFERSON CITY
KANSAS
MISSOURI
KGBX-1260
SPRINGFIELD
KSLC-910
MIAMI
OKLAHOMA
ARKANSAS
FT. SMITH
KWHN-1320
CONWAY
WMPS-680
MARION
WREC
600

Map 29b.


WMAY-970
SPRINGFIELD
DECATUR
WIBC-1070
INDIANAPOLIS
WISH-1310
WTHI-1480
TERRE HAUTE
WTTS-1370
ILLINOIS
INDIANA
KWK-1380
WIL-1430
WAVE-970
LOUISVILLE
EVANSVILLE
WGBF-1280
OWENSBORO
KENTUCKY
KFVS-960
PADUCAH
WKYB-570
MAYFIELD
WKCT-930
BOWLING GREEN
CLARKSVILLE
WMAK-1300
WSIX-980
NASHVILLE
DYERSBURG
MURFREESBORO
WHBQ-560
WTJS-1390
TENNESSEE
WMC-790
CHATTANOOGA
WDOD-1310
WDEF-1370
MISSOURI

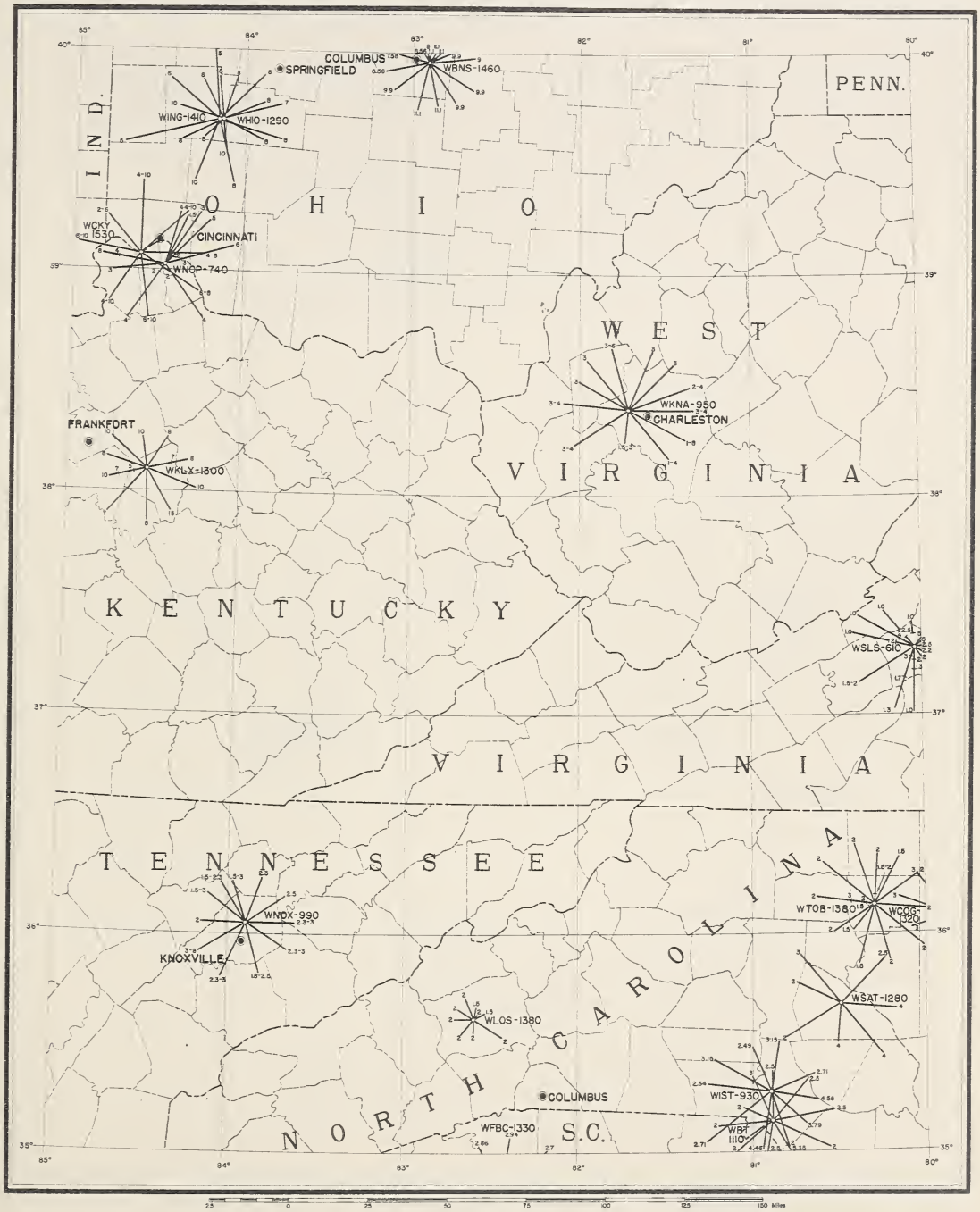
Map 30a.


SPRINGFIELD
DECATUR
TERRE HAUTE
INDIANAPOLIS
WIRE-1430
WFBM-1260
ILLINOIS
INDIANA
KXOK-630
WJPS-1330
EVANSVILLE
WVJS-1420
WKLO-1080
WGRC-790
KENTUCKY
PADUCAH
BOWLING GREEN
MAYFIELD
CLARKSVILLE
WLAC-1510
NASHVILLE
DYERSBURG
MURFREESBORO
WDXI-1310
WMPS-680
WREC-600
WAPO
1150
MISSOURI
TENNESSEE

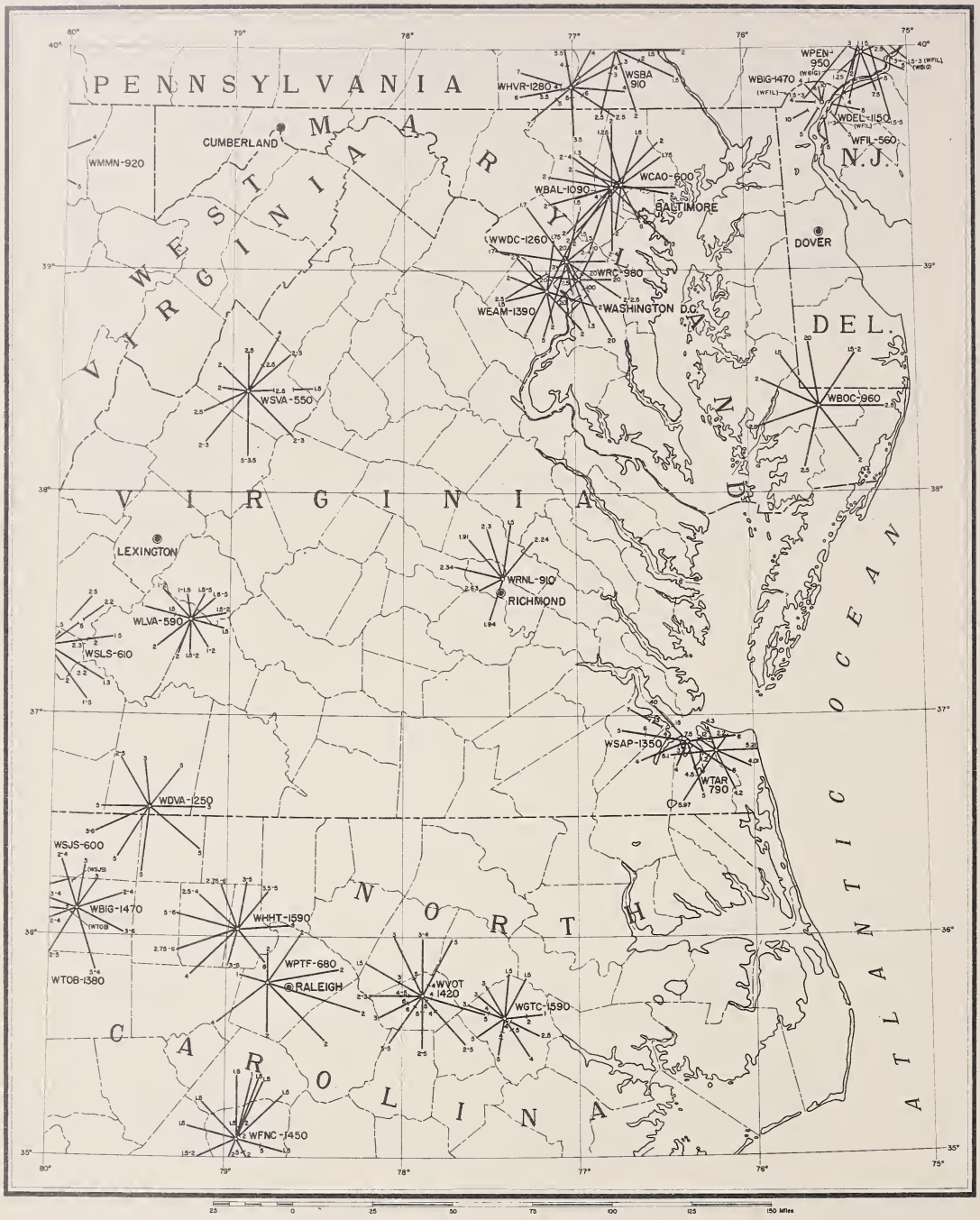
Map 30b.


COLUMBUS
SPRINGFIELD
WHKC-610
WWVA-1170
WHLL-1600
PENN.
WONE-980
WMMN-920
INDIANA
OHIO
CINCINNATI
WSAI-1360
WNXT-1260
WEST
VIRGINIA
WSAZ-930
CHARLESTON
WCHS-580
FRANKFORT
WVLK-590
WLAP-630
WOLS-560
KENTUCKY
VIRGINIA
WJHL-910
TENNESSEE
WFRC-1600
WSJS-600
WBIG-1470
WROL-620
KNOXVILLE
WHKY-1290
NORTH CAROLINA
WWNC-570
WAYS-610
COLUMBUS
S. C.
WAPO-1150
WMRC-1440
WSPA-950
85°
84°
83°
82°
81°
80°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

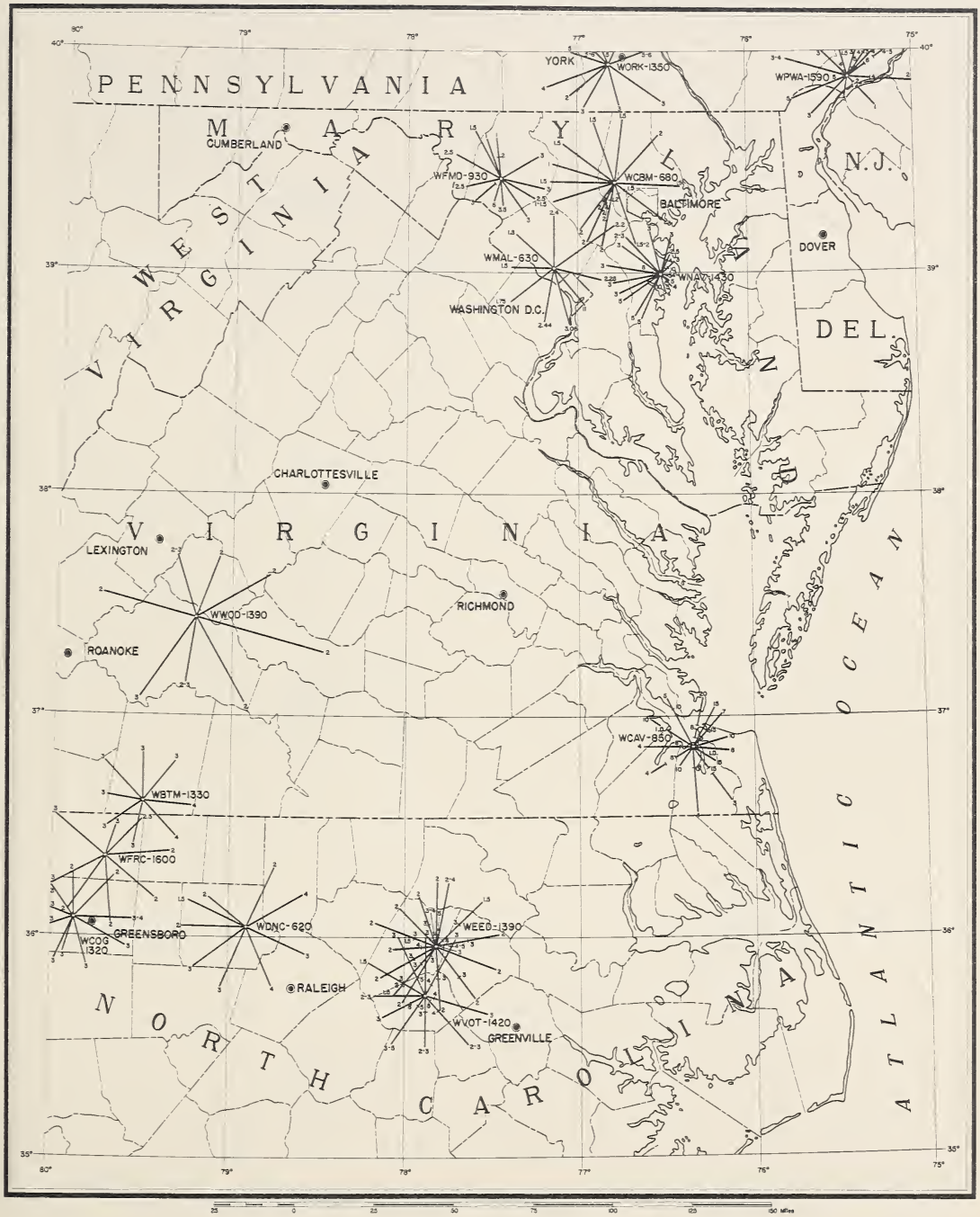
Map 31a.


COLUMBUS
SPRINGFIELD
WBNS-1460
WING-1410
WHIO-1290
PENN.
IND.
OHIO
WCKY 1530
CINCINNATI
WNOP-740
WEST
VIRGINIA
WKNA-950
CHARLESTON
FRANKFORT
WKLX-1300
KENTUCKY
WSLS-610
TENNESSEE
WNOX-990
KNOXVILLE
WTOB-1380
WCOG-1320
NORTH CAROLINA
WSAT-1280
WLOS-1380
COLUMBUS
WIST-930
WFBC-1330
S.C.
85°
84°
83°
82°
81°
80°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

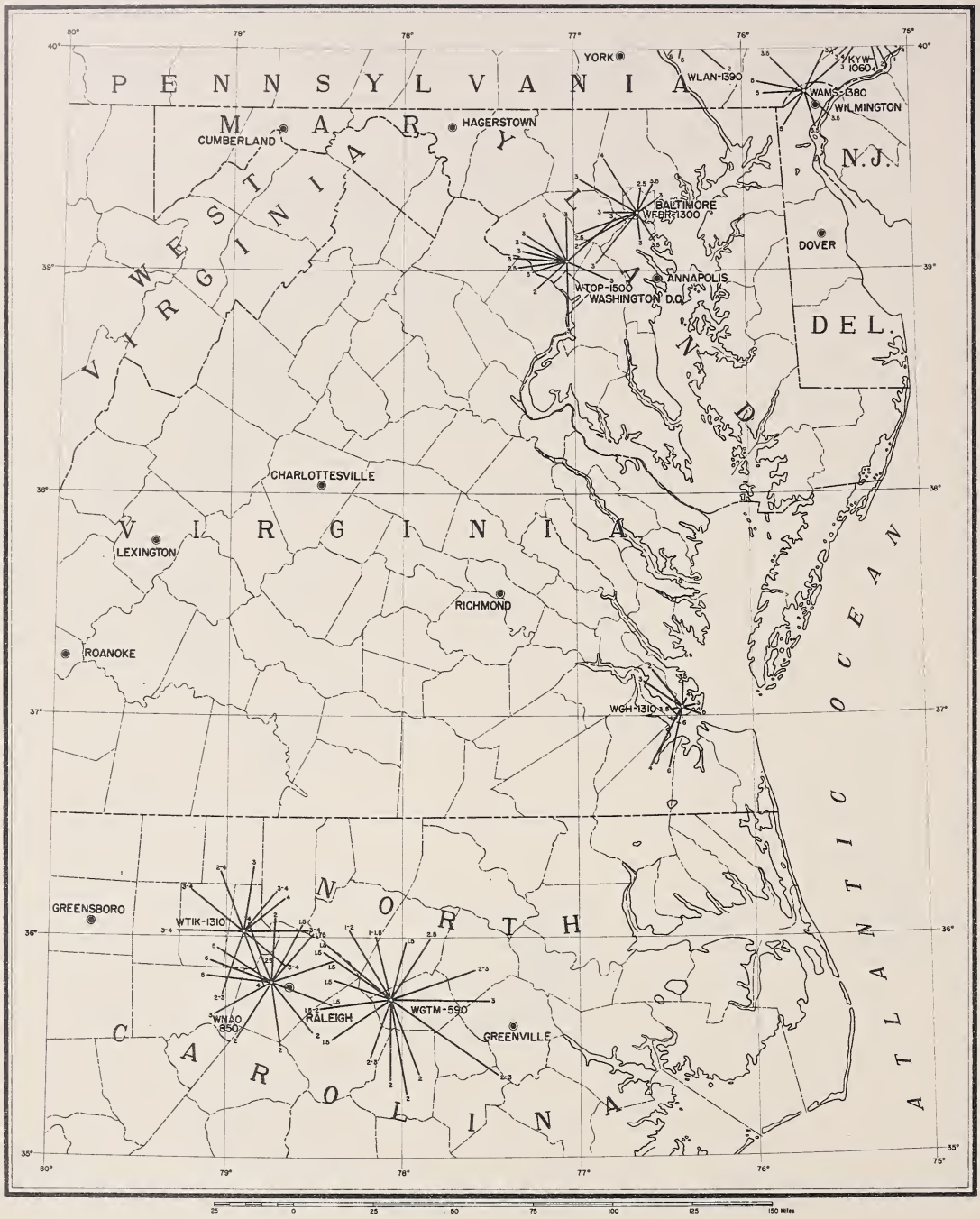
Map 31b.


PENNSYLVANIA
MARYLAND
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
DEL.
N.J.
ATLANTIC OCEAN
CUMBERLAND
WMMN-920
WHVR-1280
WSBA 910
WPEN 950
WBIG-1470
WDEL-1150
WFIL-560
WCAO-600
WBAL-1090
BALTIMORE
DOVER
WWDC-1260
WRC 980
WEAM-1390
WASHINGTON D.C.
WSVA-550
WBOC-960
LEXINGTON
WRNL-910
RICHMOND
WLVA-590
WSLS-610
WSAP-1350
WTAR 790
WDVA-1250
WSJS-600
WBIG-1470
WHHT-1590
WPTF-680
RALEIGH
WVOT 1420
WGTC-1590
WTOB-1380
WFNC-1450
80°
79°
78°
77°
76°
75°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

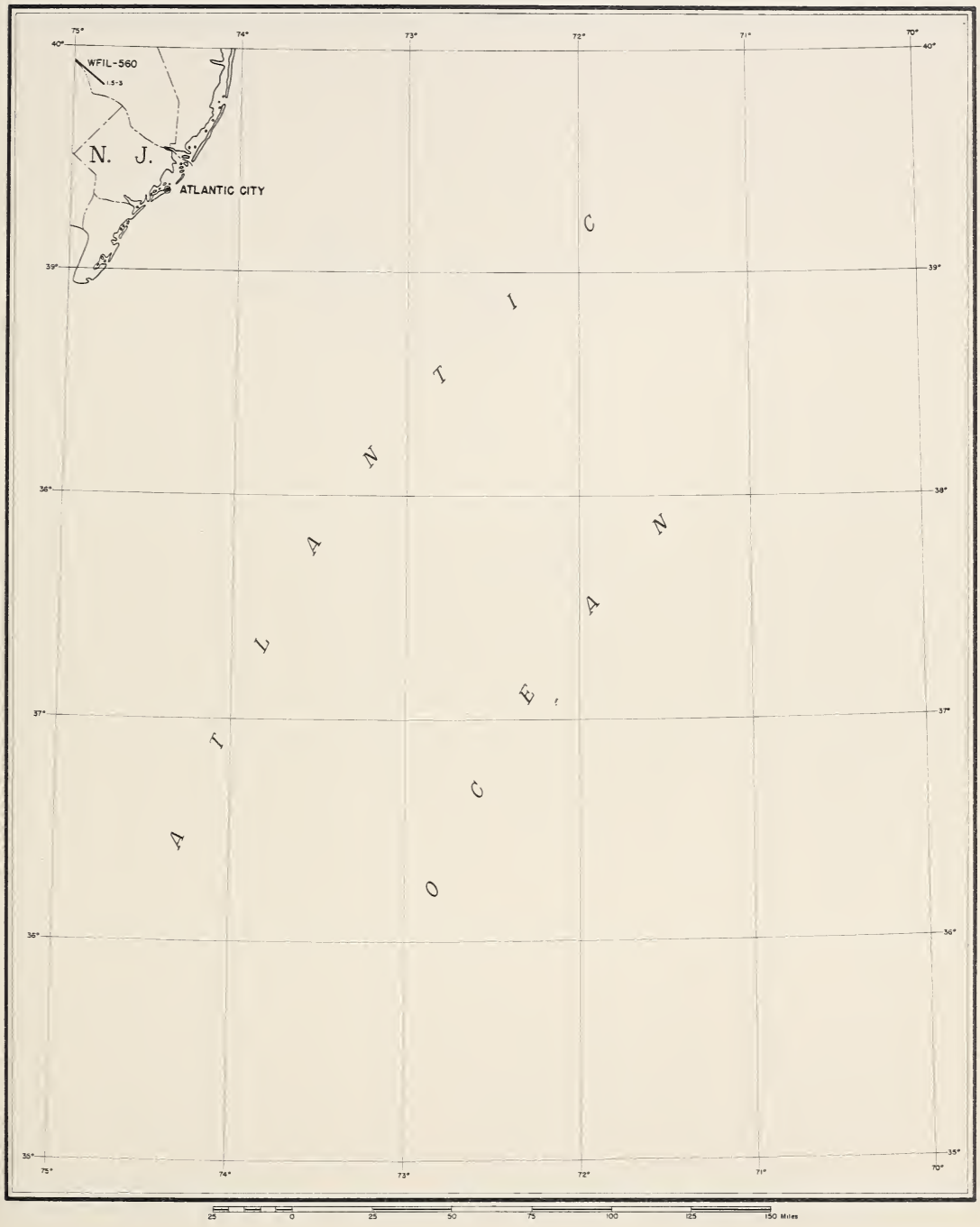
Map 32a.


PENNSYLVANIA
MARYLAND
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
ATLANTIC OCEAN
N.J.
DEL.
CUMBERLAND
YORK
WORK-1350
WPWA-1590
WFMD-930
WCBM-680
BALTIMORE
DOVER
WMAL-630
WASHINGTON D.C.
WNAV-1430
CHARLOTTESVILLE
LEXINGTON
WWOD-1390
RICHMOND
ROANOKE
WCAV-850
WBTM-1330
WFRC-1600
WCOG 1320
GREENSBORO
WDNC-620
WEED-1390
RALEIGH
WVOT-1420
GREENVILLE
80°
79°
78°
77°
76°
75°
40°
39°
38°
37°
36°
35°

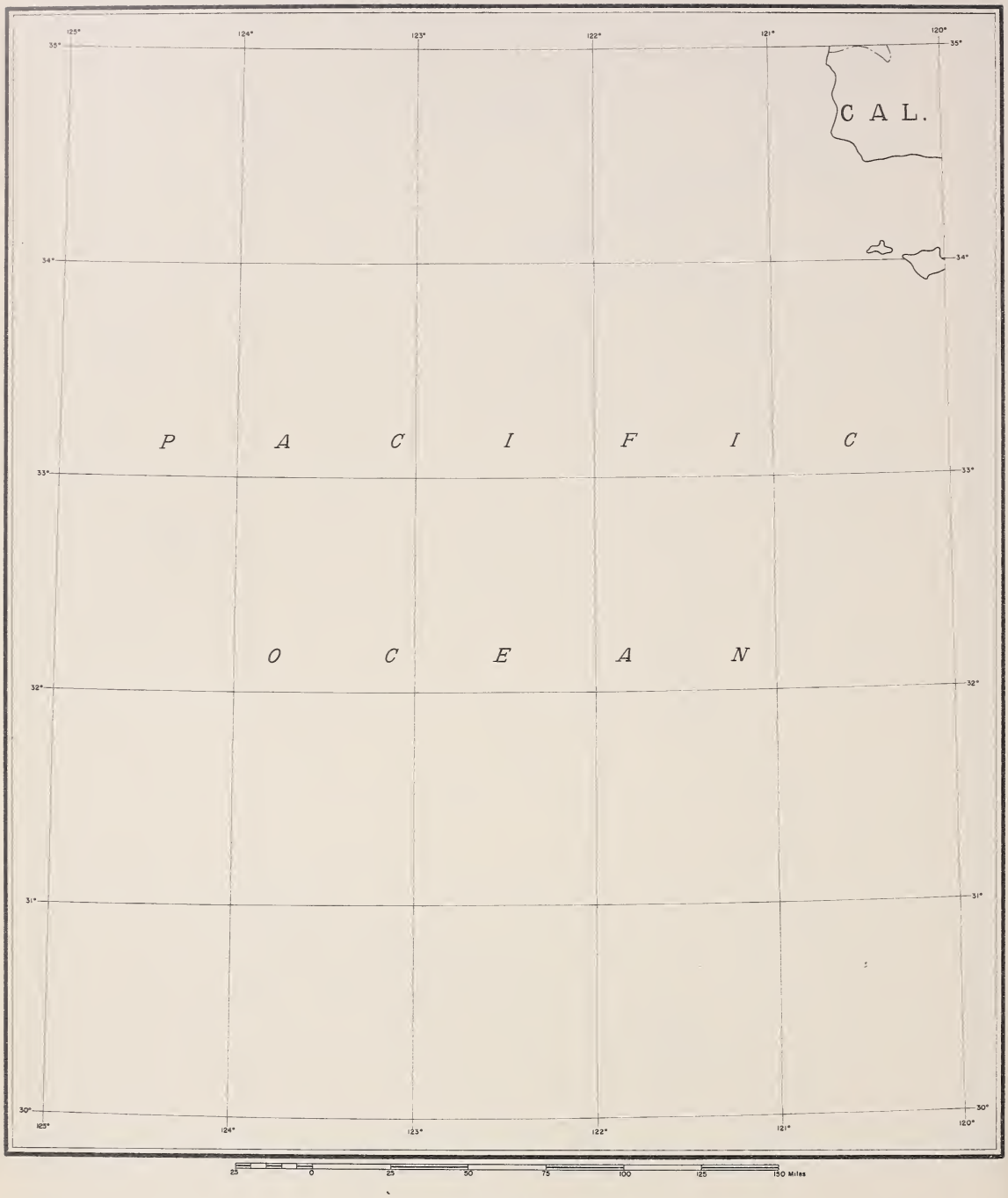
Map 32b.


PENNSYLVANIA
YORK
WLAN-1390
KYW-1060
WAMS-1380
WILMINGTON
N.J.
MARYLAND
HAGERSTOWN
CUMBERLAND
BALTIMORE
WFBR-1300
DOVER
ANNAPOLIS
WTOP-1500
WASHINGTON D.C.
DEL.
WEST VIRGINIA
CHARLOTTESVILLE
VIRGINIA
LEXINGTON
RICHMOND
ROANOKE
WGH-1310
ATLANTIC OCEAN
GREENSBORO
WTIK-1310
NORTH
WNAO 850
RALEIGH
WGTM-590
GREENVILLE
CAROLINA
80°
79°
78°
77°
76°
75°
40°
39°
38°
37°
36°
35°
25
0
25
50
75
100
125
150 Miles

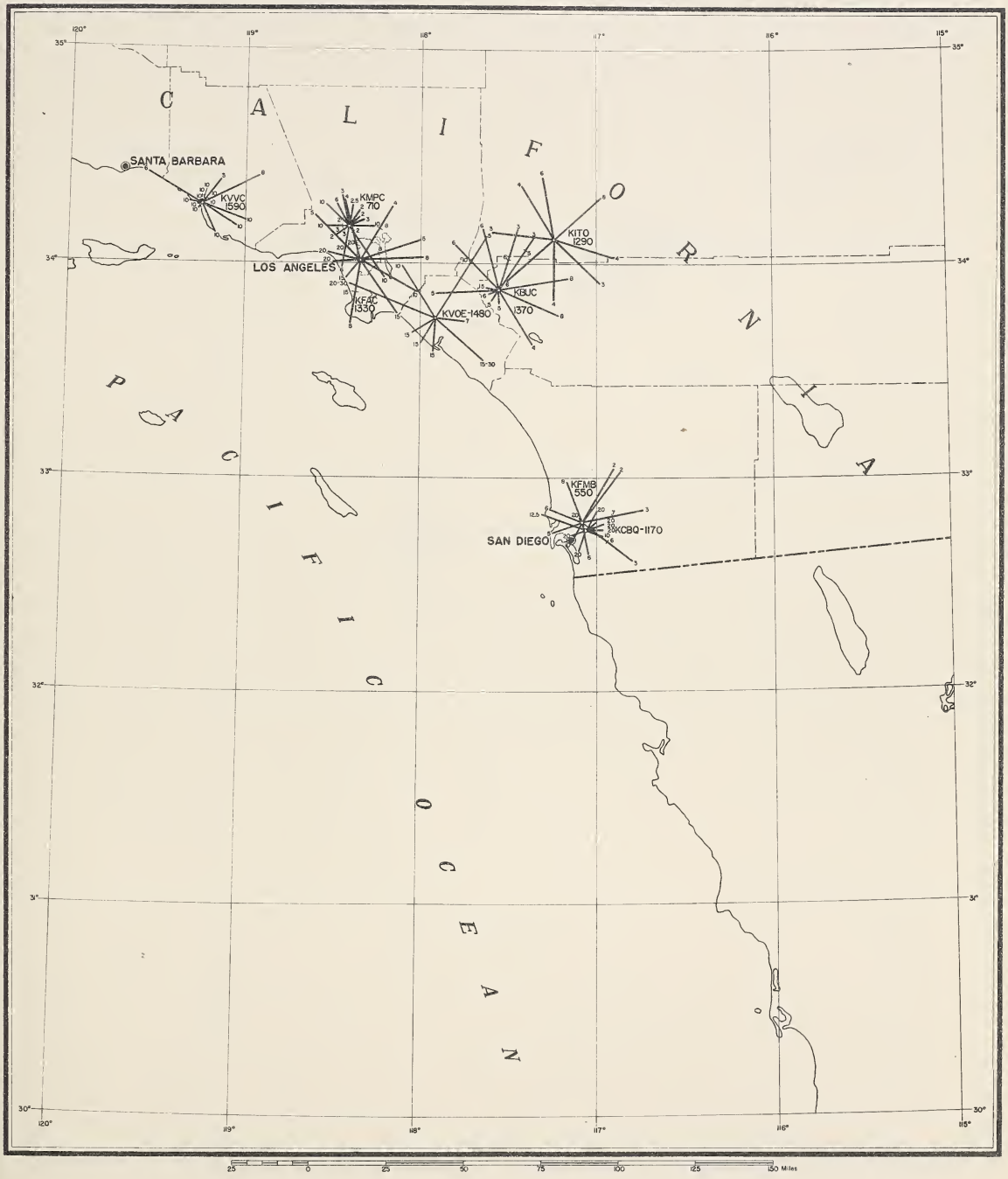
Map 32c.


WFIL-560
1.5-3
N. J.
ATLANTIC CITY
ATLANTIC OCEAN
75°
74°
73°
72°
71°
70°
40°
39°
38°
37°
36°
35°
25 0 25 50 75 100 125 150 Miles

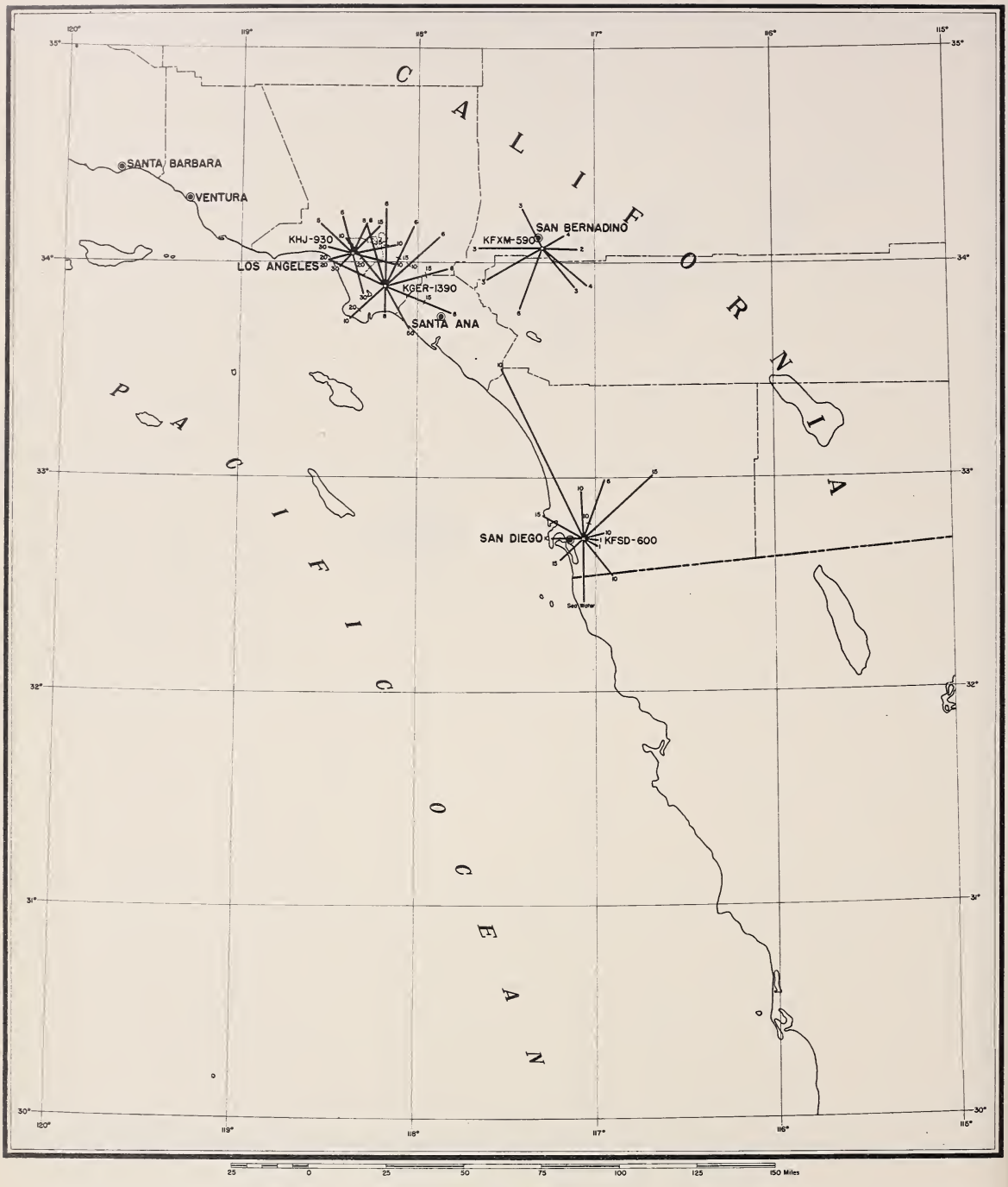
Map 33.


125°
124°
123°
122°
121°
120°
35°
34°
33°
32°
31°
30°
CAL.
PACIFIC
OCEAN
25 0 25 50 75 100 125 150 Miles

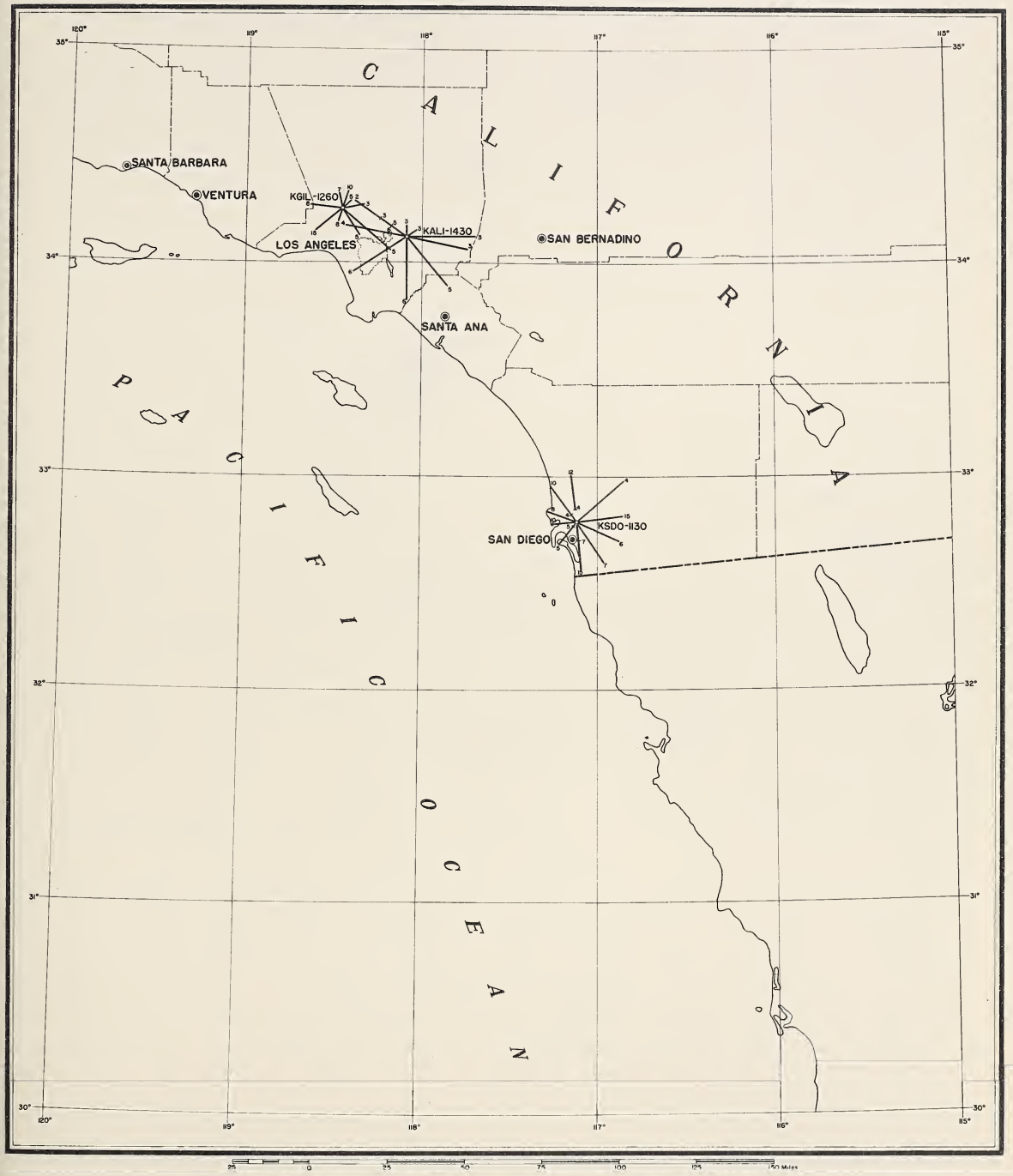
Map 34.


CALIFORNIA
PACIFIC OCEAN
SANTA BARBARA
LOS ANGELES
SAN DIEGO
KVVC 1590
KMPC 710
KFAC 1330
KVOE-1480
KBUC 1370
KITO 1290
KFMB 550
KCBQ-1170
120°
119°
118°
117°
116°
115°
35°
34°
33°
32°
31°
30°
25 0 25 50 75 100 125 150 Miles

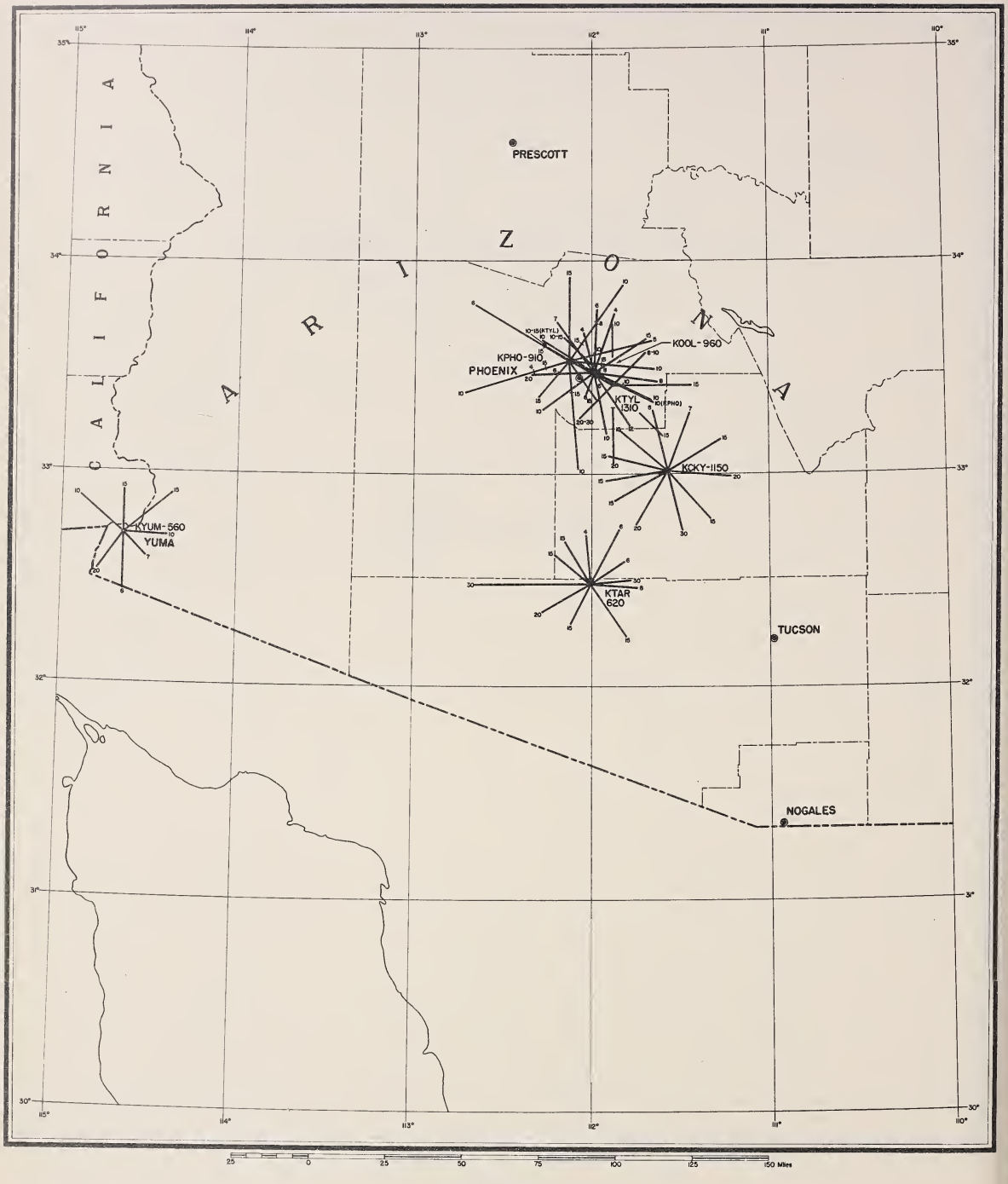
Map 35a.


CALIFORNIA
PACIFIC OCEAN
SANTA BARBARA
VENTURA
LOS ANGELES
KHJ-930
KGER-1390
SANTA ANA
SAN BERNADINO
KFXM-590
SAN DIEGO
KFSD-600
120°
119°
118°
117°
116°
115°
35°
34°
33°
32°
31°
30°
25 0 25 50 75 100 125 150 Miles

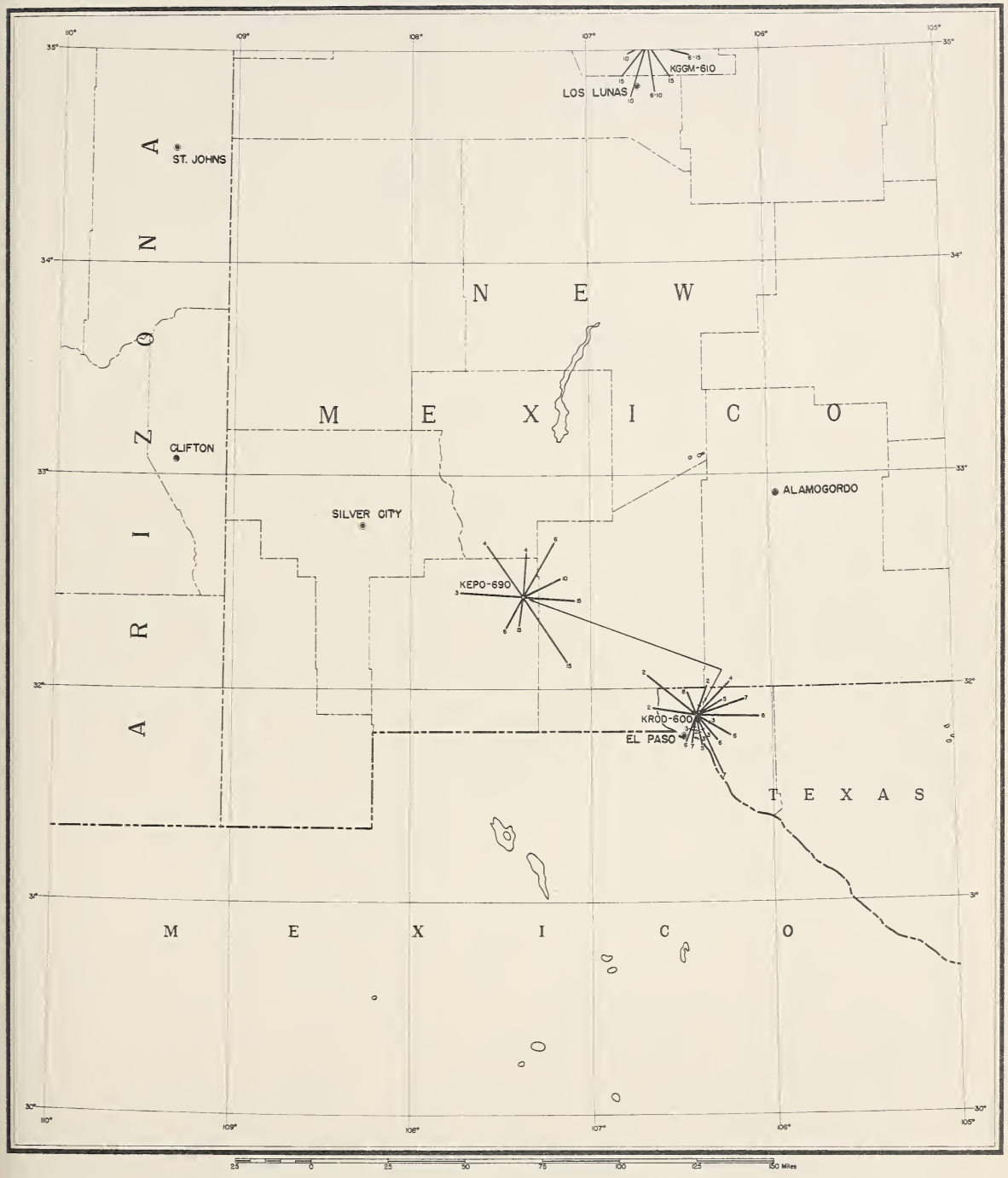
Map 35b.


CALIFORNIA
PACIFIC OCEAN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNADINO
SANTA ANA
SAN DIEGO
KGIL-1260
KALI-1430
KSDO-1130
120°
119°
118°
117°
116°
115°
35°
34°
33°
32°
31°
30°
25
0
25
50
75
100
150
Miles

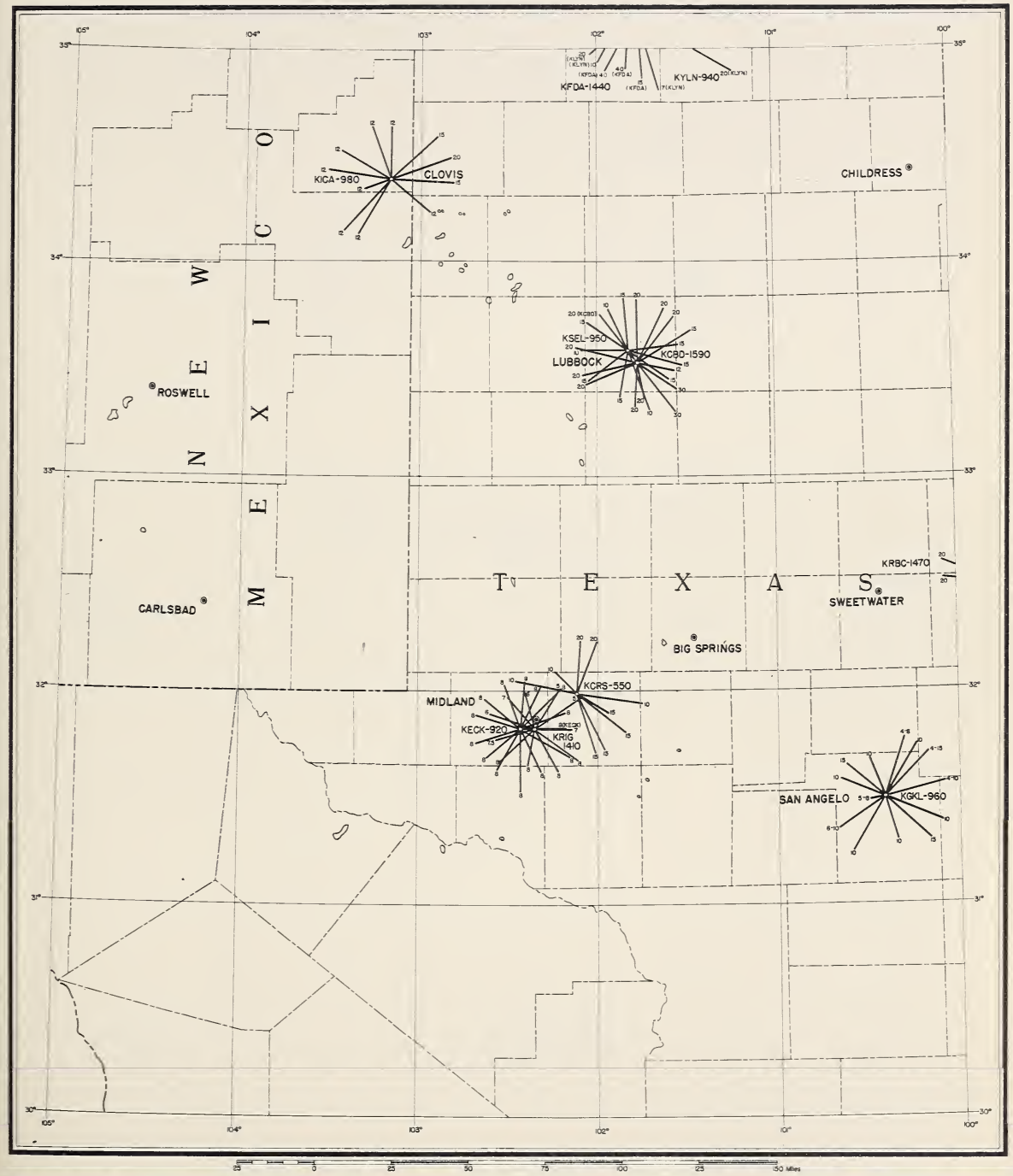
Map 35c.


CALIFORNIA
ARIZONA
PRESCOTT
PHOENIX
KPHO-910
KOOL-960
KTYL-1310
KCKY-1150
KTAR-620
KYUM-560
YUMA
TUCSON
NOGALES
115°
114°
113°
112°
111°
110°
35°
34°
33°
32°
31°
30°
25 0 25 50 75 100 125 150 Miles

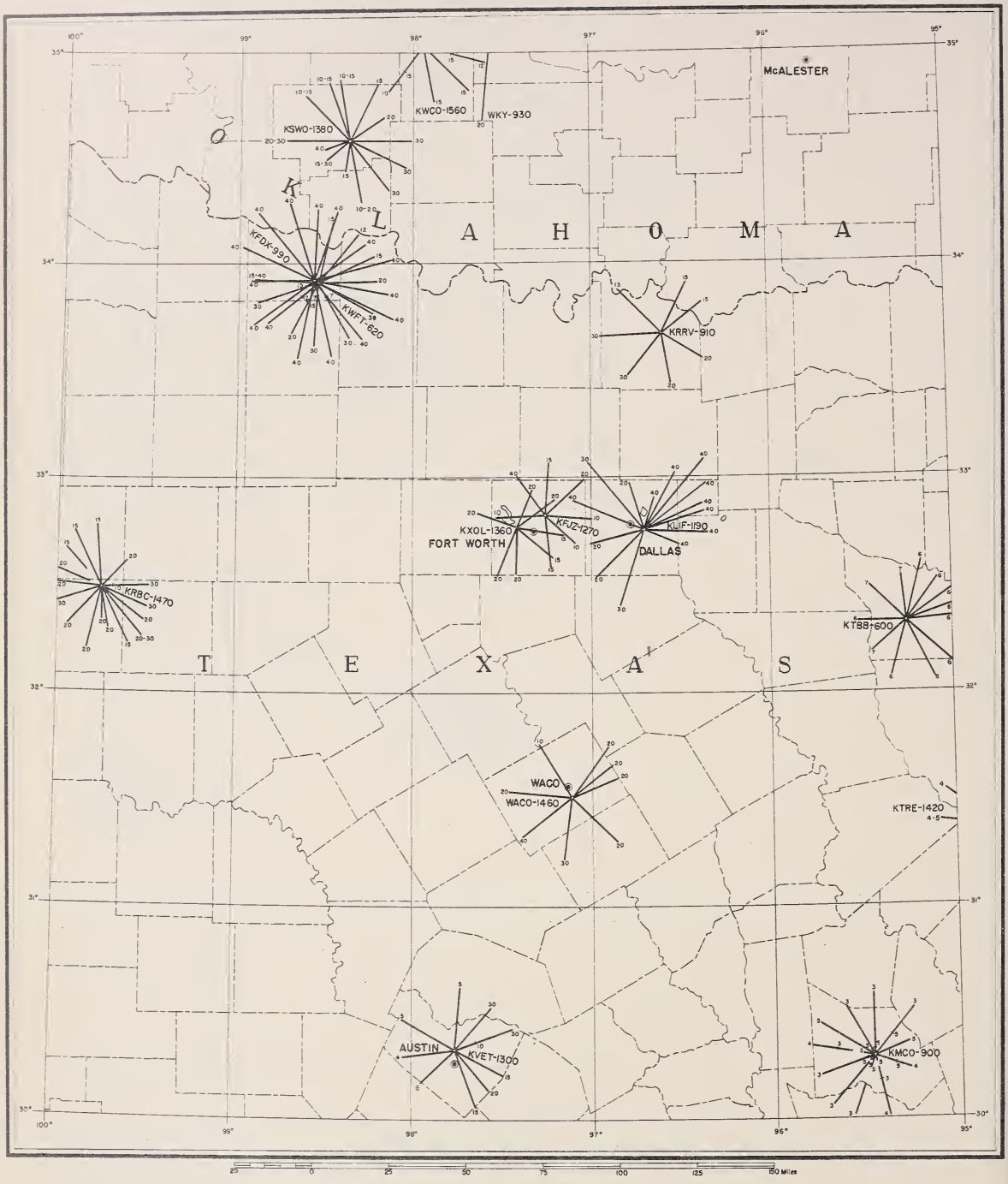
Map 36.


KGGM-610
LOS LUNAS
ST. JOHNS
CLIFTON
SILVER CITY
ALAMOGORDO
KEPO-690
KROD-600
EL PASO
ARIZONA
NEW MEXICO
TEXAS
MEXICO
110°
109°
108°
107°
106°
105°
35°
34°
33°
32°
31°
30°
25 0 25 50 75 100 125 150 Miles

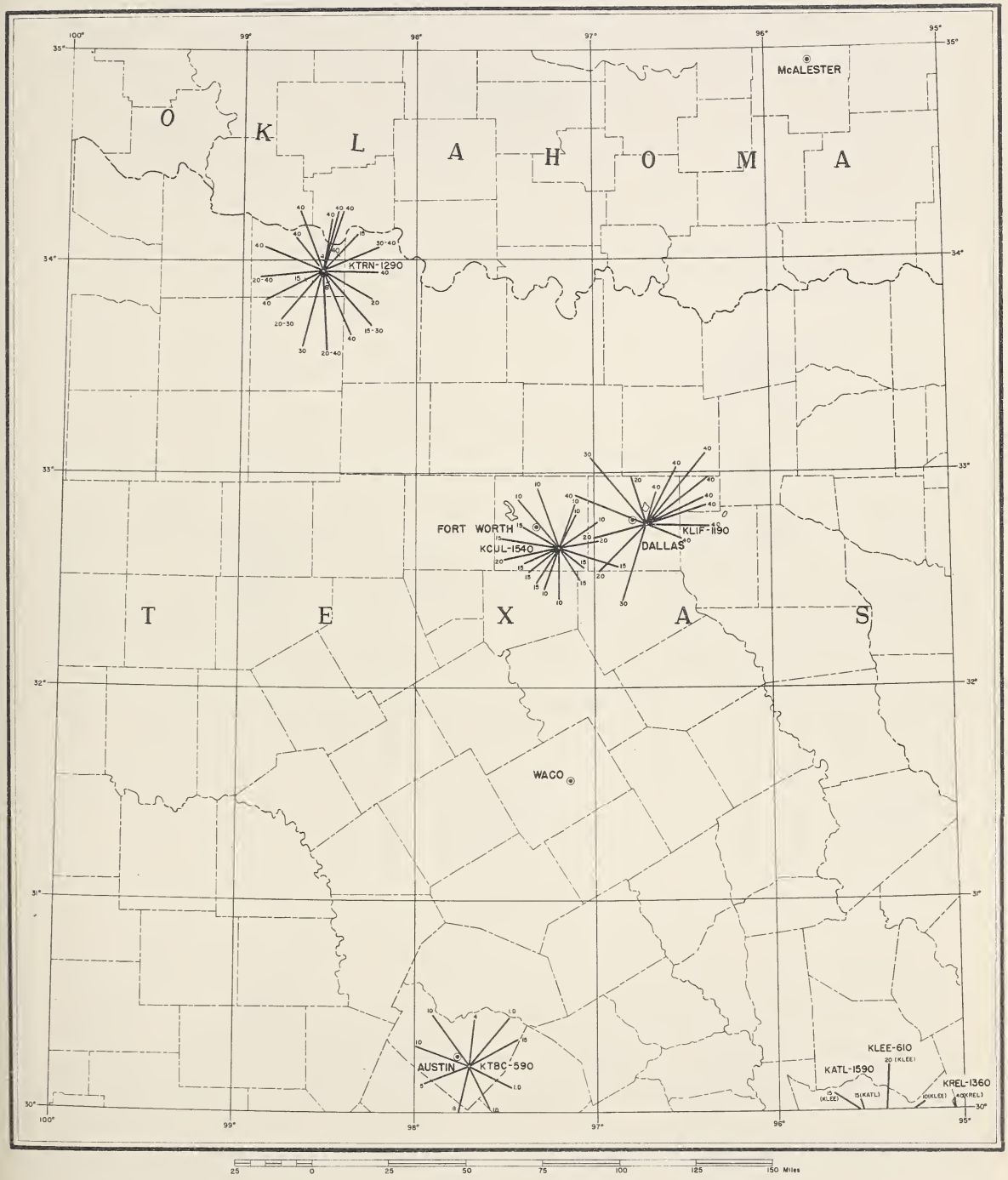
Map 37.


KFDA-1440
KYLN-940
KICA-980
CLOVIS
CHILDRESS
KSEL-950
LUBBOCK
KCBD-1590
ROSWELL
NEW MEXICO
TEXAS
KRBC-1470
SWEETWATER
CARLSBAD
BIG SPRINGS
KCRS-550
MIDLAND
KECK-920
KRIG
1410
SAN ANGELO
KGKL-960
105°
104°
103°
102°
101°
100°
35°
34°
33°
32°
31°
30°
25
0
25
50
75
100
125
150 Miles

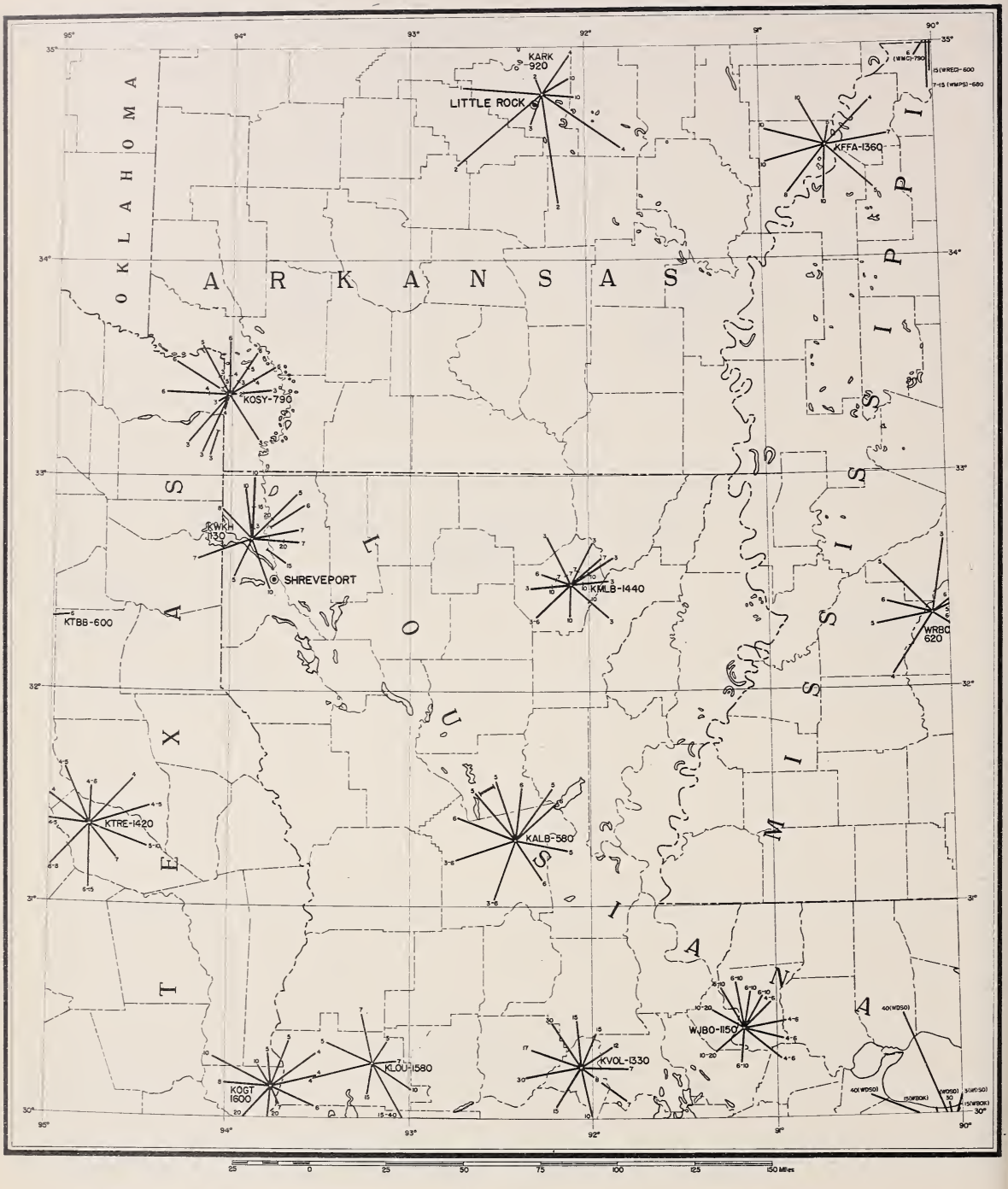
Map 38.


McALESTER
KWCO-1560
WKY-930
KSWO-1380
OKLAHOMA
KFDX-990
KWFT-620
KRRV-910
KXOL-1360
FORT WORTH
KFJZ-1270
KLIF-1190
DALLAS
KRBC-1470
KTBB-600
TEXAS
WACO
WACO-1460
KTRE-1420
AUSTIN
KVET-1300
KMCO-900
100°
99°
98°
97°
96°
95°
35°
34°
33°
32°
31°
30°
25 0 25 50 75 100 125 150 Miles

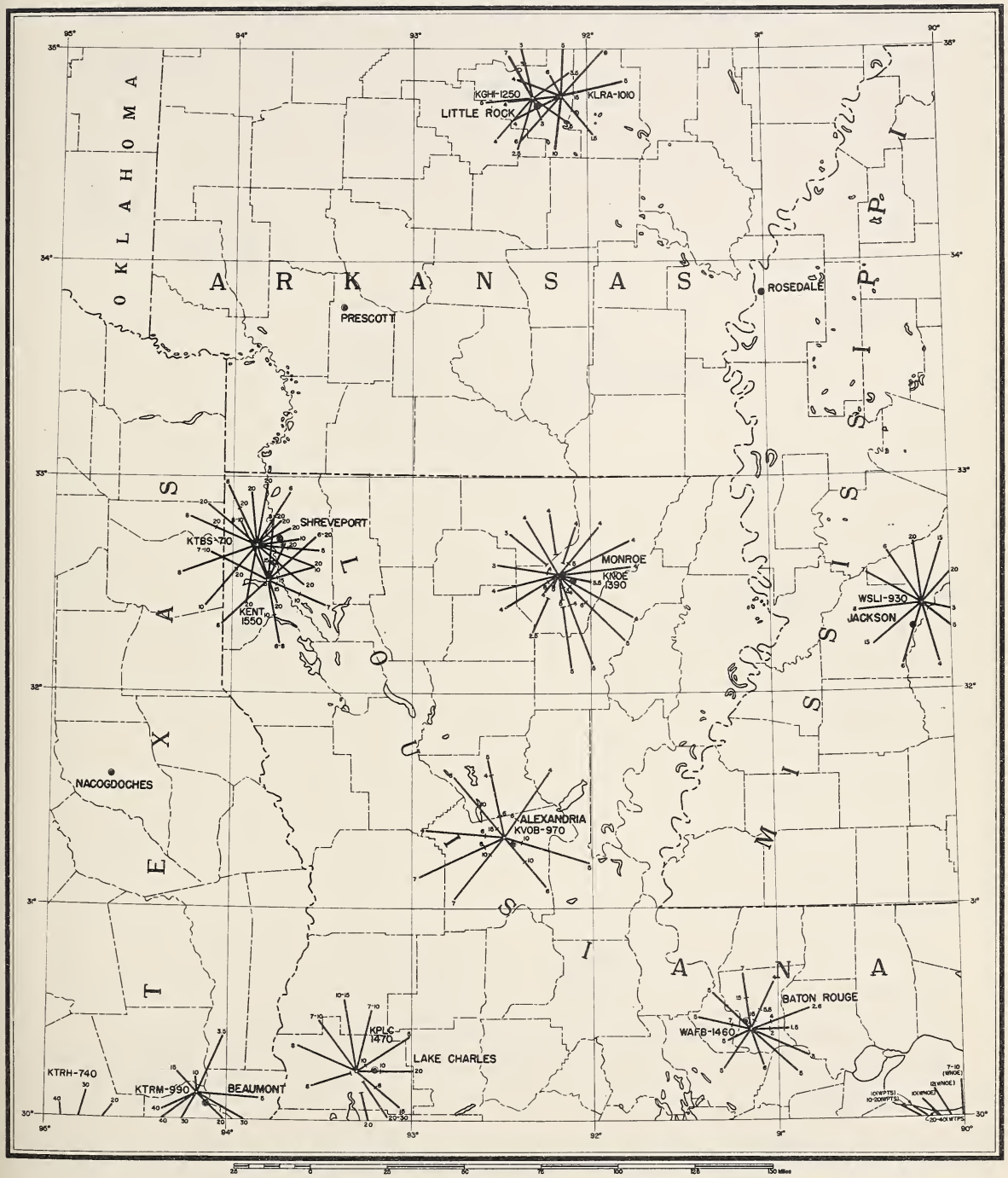
Map 39a.


McALESTER
OKLAHOMA
KTRN-1290
FORT WORTH
KCUL-1540
DALLAS
KLIF-1190
TEXAS
WACO
AUSTIN
KTBC-590
KLEE-610
KATL-1590
KREL-1360
25 0 25 50 75 100 125 150 Miles

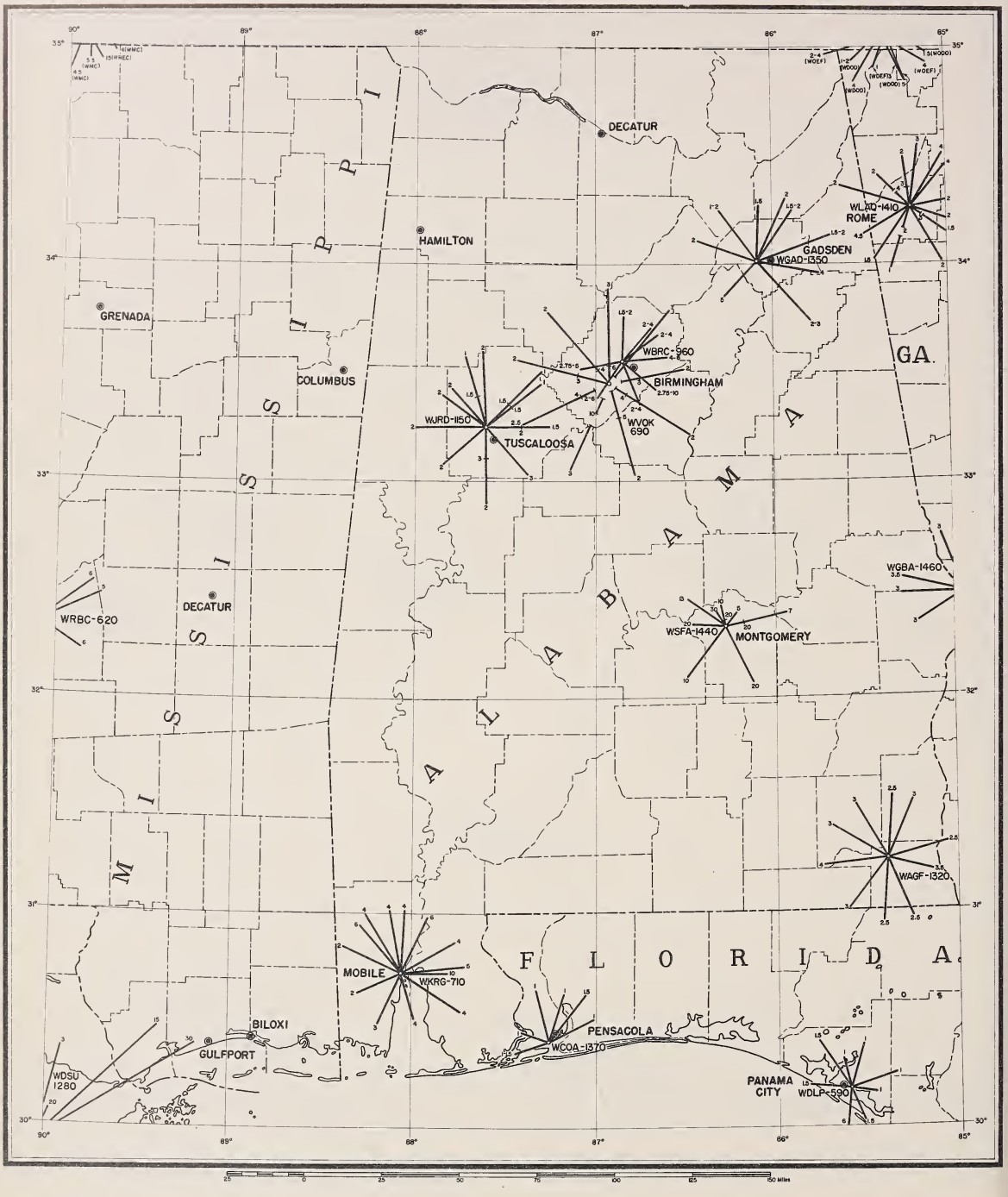
Map 39b.


OKLAHOMA
ARKANSAS
LOUISIANA
MISSISSIPPI
TEXAS
KARK 920
LITTLE ROCK
KFFA-1360
KOSY-790
KWKH 1130
SHREVEPORT
KTBS-600
KMLB-1440
WRBC 620
KTRE-1420
KALB-580
WJBO-1150
KVOL-1330
KLOU-1580
KOGT 1600
25 0 25 50 75 100 125 150 Miles

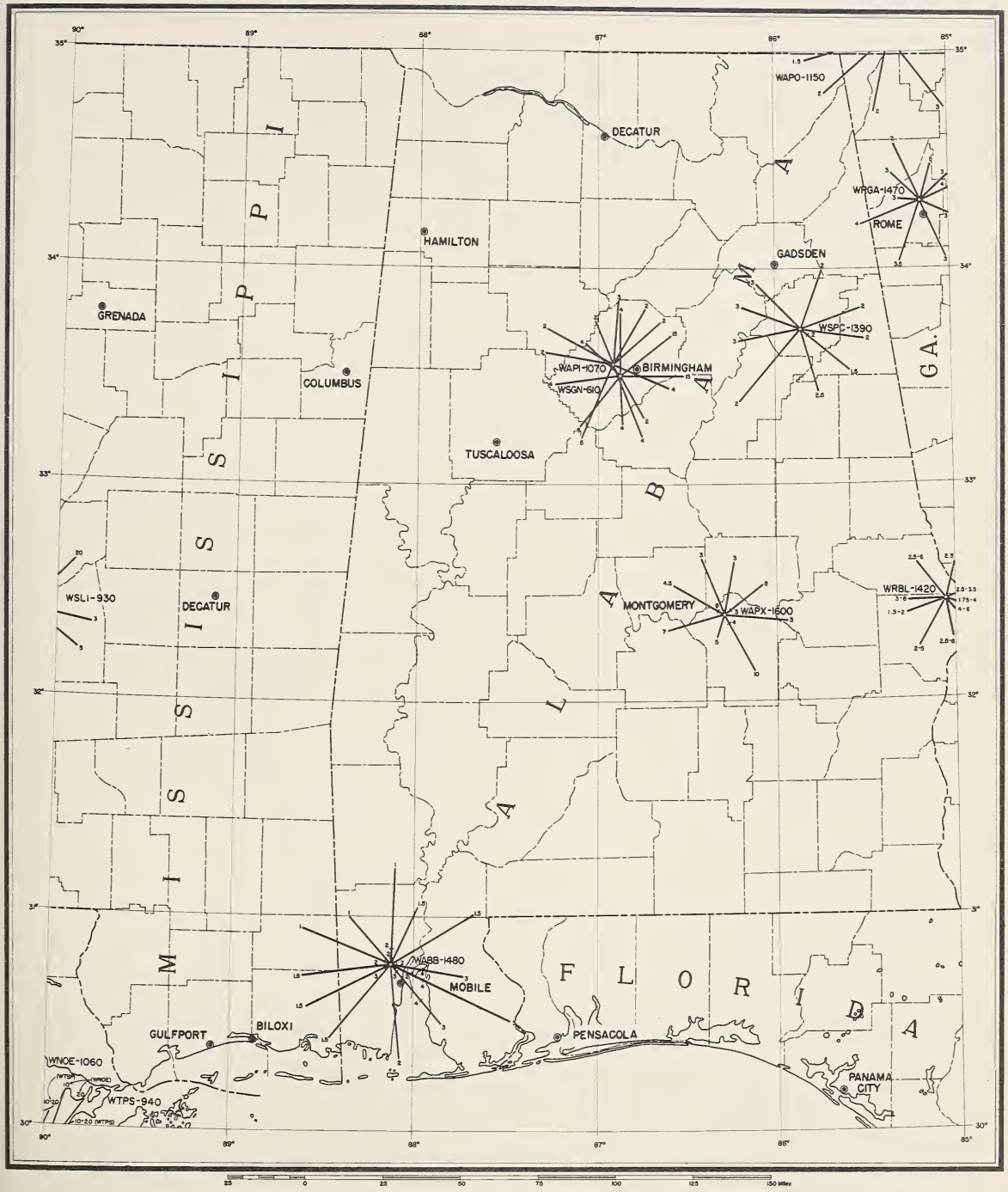
Map 40a.


OKLAHOMA
ARKANSAS
LOUISIANA
MISSISSIPPI
TEXAS
KGH-1250
LITTLE ROCK
KLRA-1010
PRESCOTT
ROSEDALE
KTBS-710
SHREVEPORT
KENT 1550
MONROE
KNOE 1390
WSLI-930
JACKSON
NACOGDOCHES
ALEXANDRIA
KVOB-970
BATON ROUGE
WAFB-1460
KPLC 1470
LAKE CHARLES
KTRH-740
KTRM-990
BEAUMONT

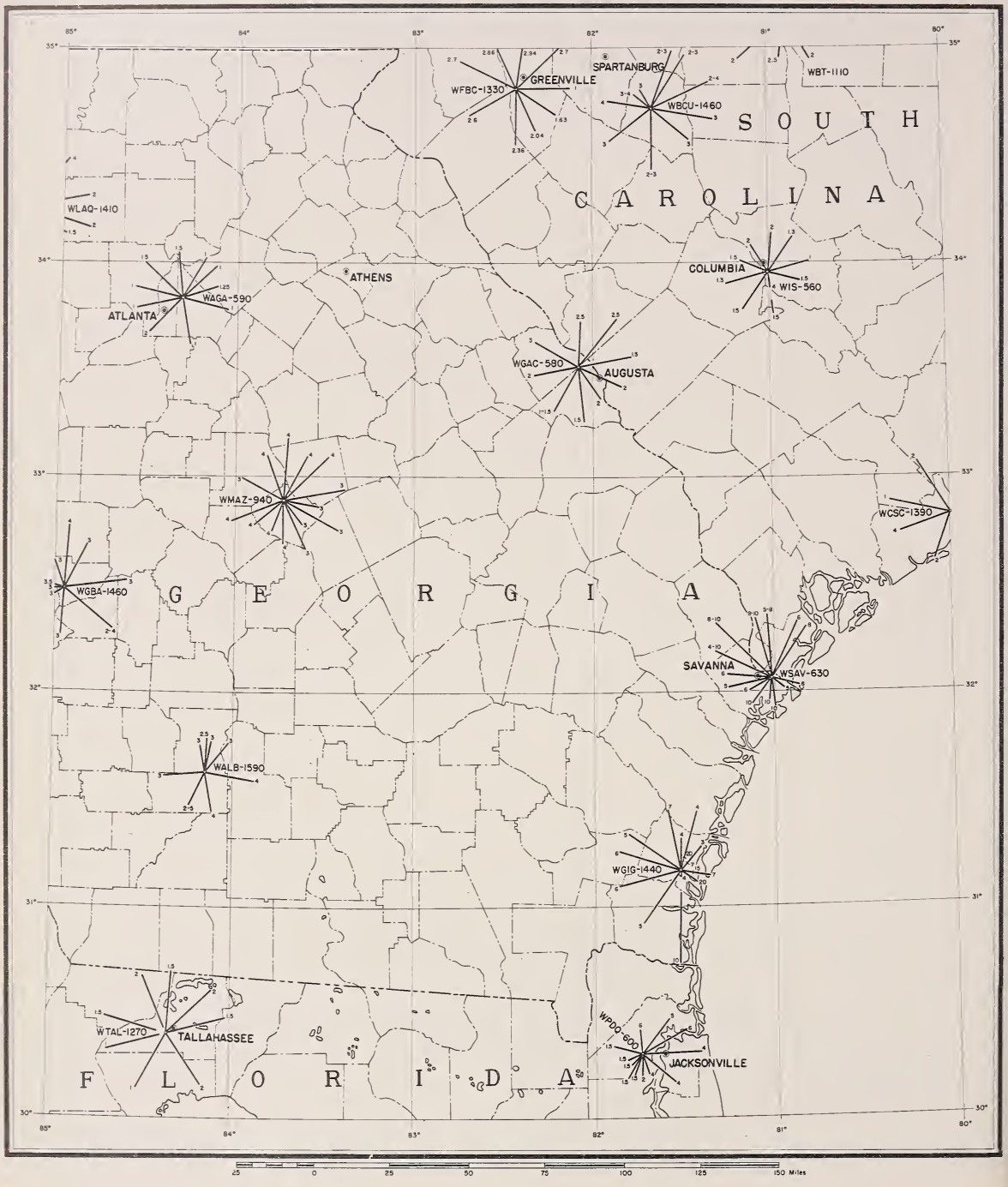
Map 40b.


DECATUR
HAMILTON
GRENADA
COLUMBUS
TUSCALOOSA
WJRD-1150
WBRC-960
BIRMINGHAM
WVOK 690
GADSDEN
WGAD-1350
WLAO-1410
ROME
GA.
WRBC-620
DECATUR
WSFA-1440
MONTGOMERY
WGBA-1460
WAGF-1320
MOBILE
WKRG-710
BILOXI
GULFPORT
WDSU 1280
PENSACOLA
WCOA-1370
PANAMA CITY
WDLP-590
MISSISSIPPI
ALABAMA
FLORIDA
90°
89°
88°
87°
86°
85°
35°
34°
33°
32°
31°
30°
0
25
50
75
100
125
150 Miles

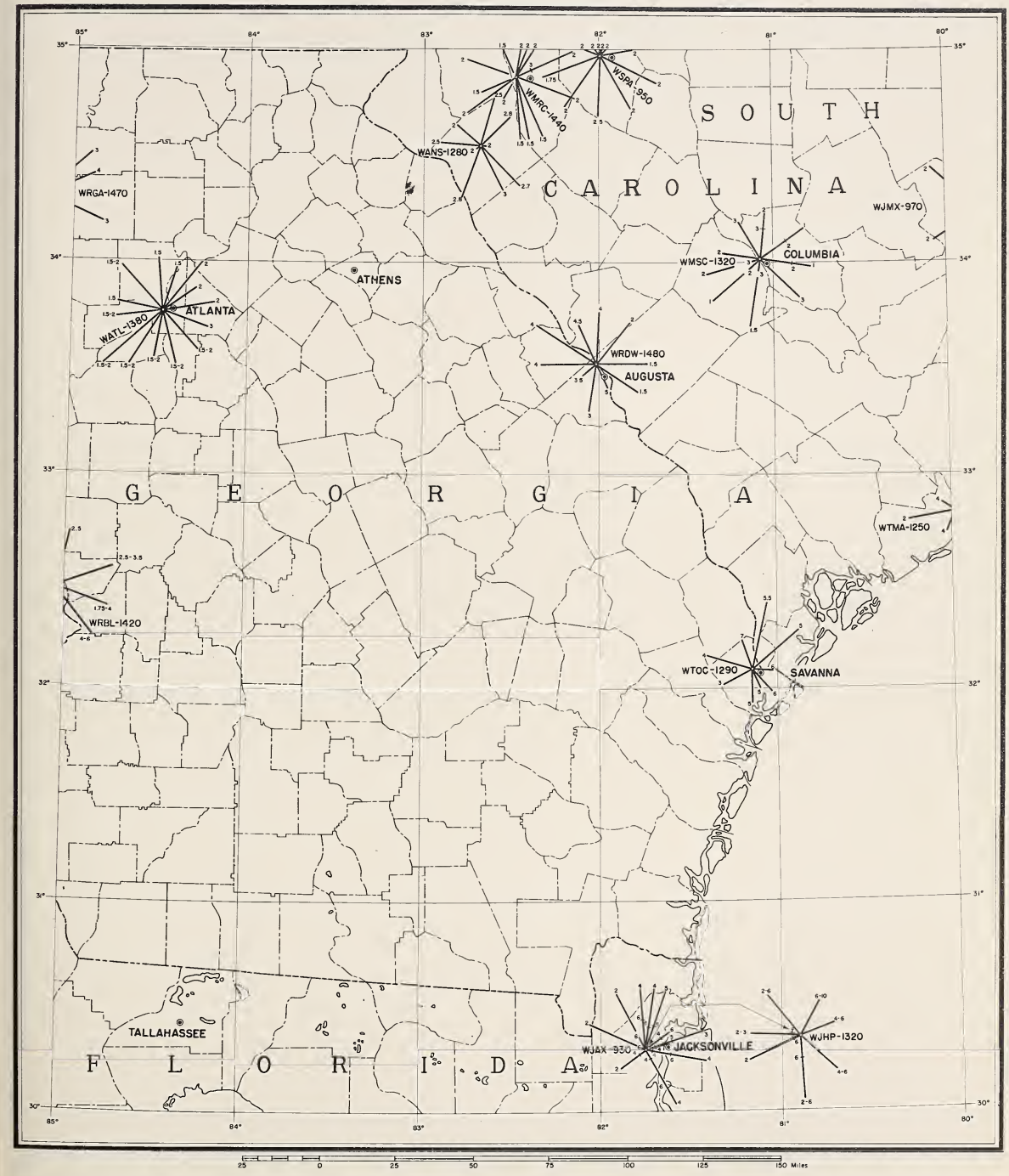
Map 41a.


WAPO-1150
DECATUR
WRGA-1470
ROME
HAMILTON
GADSDEN
GRENADA
WSPC-1390
WAPI-1070
BIRMINGHAM
WSGN-610
COLUMBUS
TUSCALOOSA
WSLI-930
DECATUR
MONTGOMERY
WAPX-1600
WRBL-1420
WABB-1480
MOBILE
GULFPORT
BILOXI
PENSACOLA
WNOE-1060
WTPS-940
PANAMA CITY
MISSISSIPPI
ALABAMA
GA.
FLORIDA
90°
89°
88°
87°
86°
85°
35°
34°
33°
32°
31°
30°
25 0 25 50 75 100 125 150 Miles

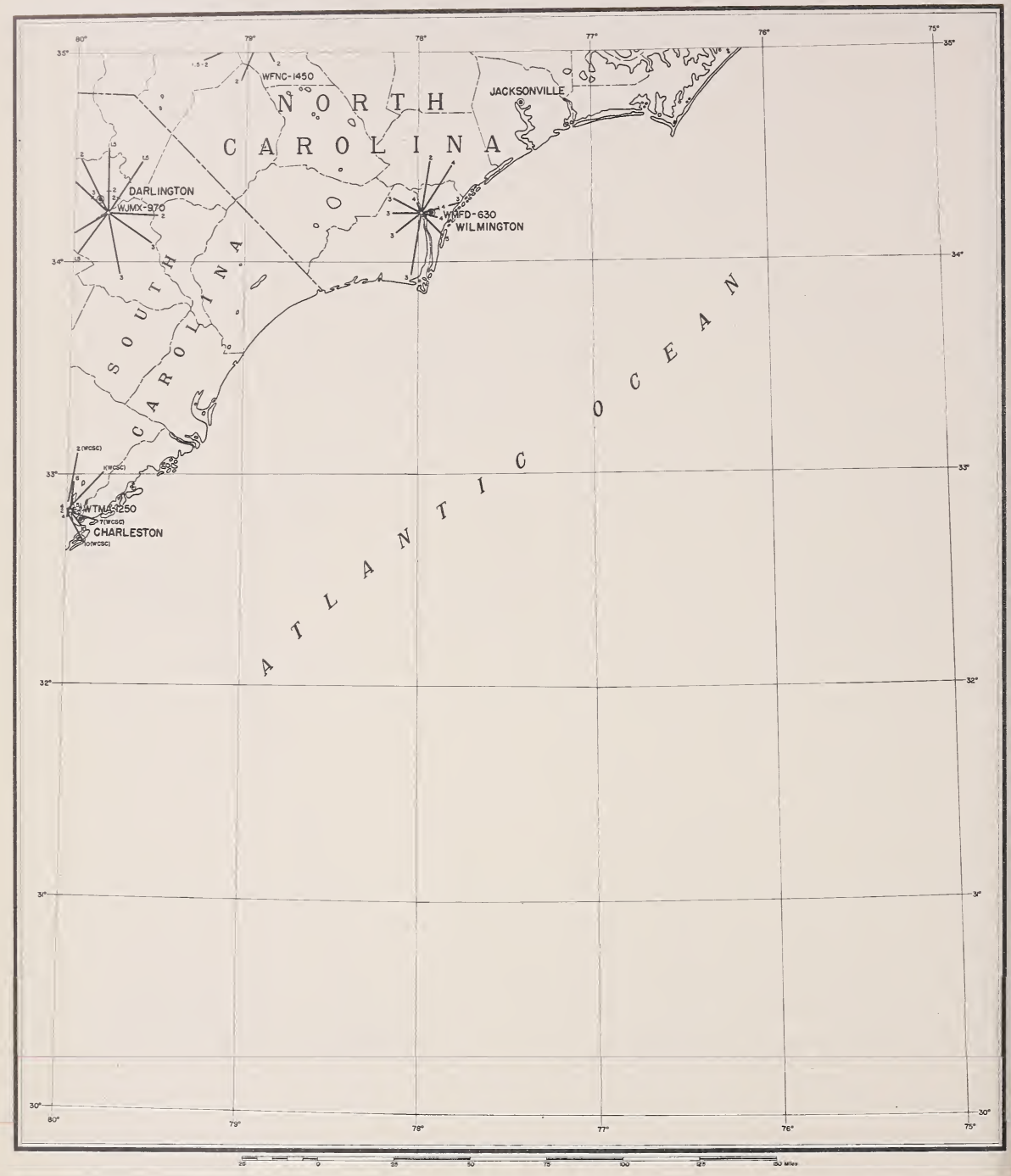
Map 41b.


SOUTH
CAROLINA
GEORGIA
FLORIDA
WFBC-1330
GREENVILLE
SPARTANBURG
WBCU-1460
WBT-1110
WLAQ-1410
ATLANTA
WAGA-590
ATHENS
COLUMBIA
WIS-560
WGAC-580
AUGUSTA
WMAZ-940
WCSC-1390
WGBA-1460
SAVANNA
WSAV-630
WALB-1590
WGIG-1440
WTAL-1270
TALLAHASSEE
WPDQ-600
JACKSONVILLE
85°
84°
83°
82°
81°
80°
35°
34°
33°
32°
31°
30°
25 0 25 50 75 100 125 150 Miles

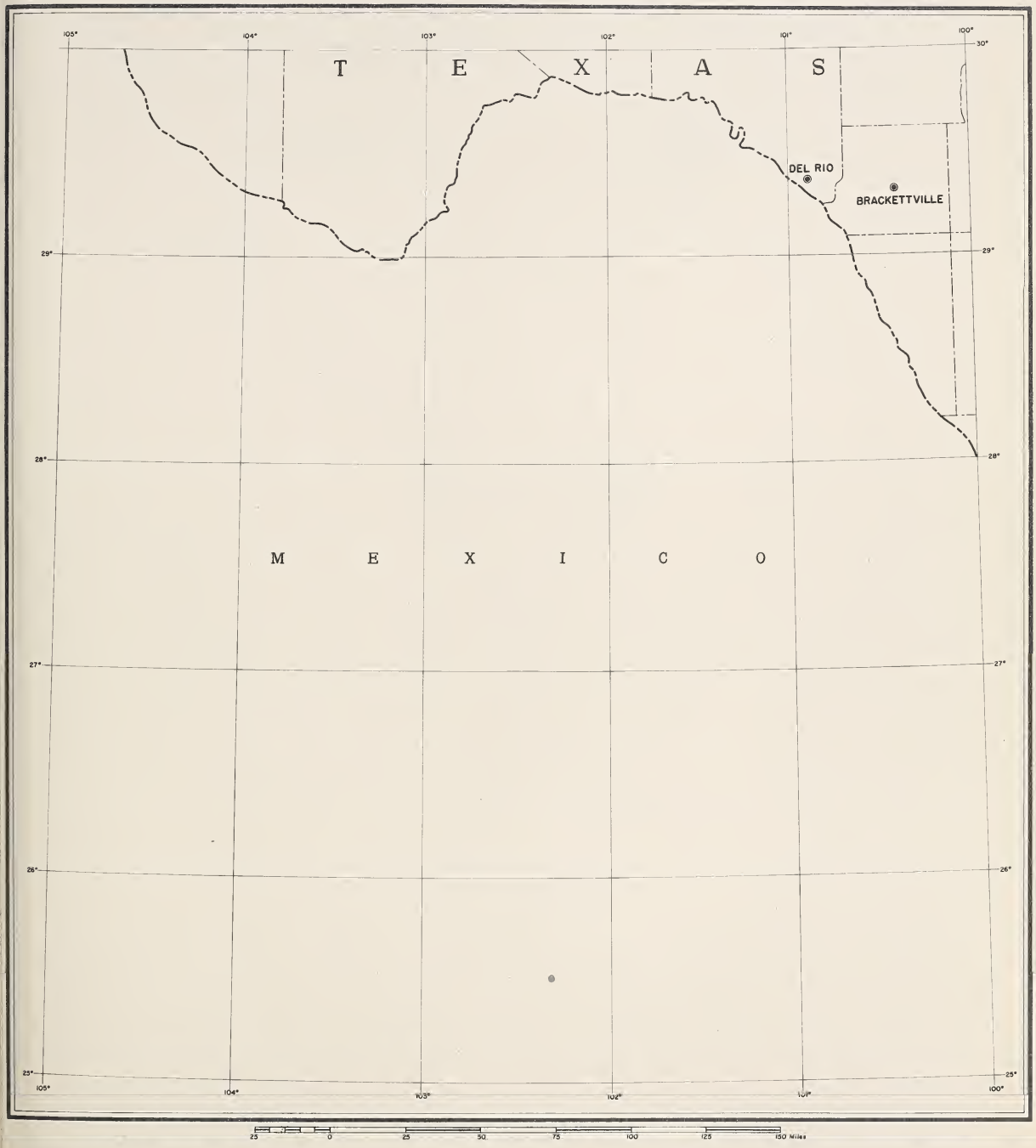
Map 42a.


SOUTH
CAROLINA
GEORGIA
FLORIDA
WSPA-950
WMRC-1440
WANS-1280
WRGA-1470
WJMX-970
WMSC-1320
COLUMBIA
ATHENS
ATLANTA
WATL-1380
WRDW-1480
AUGUSTA
WTMA-1250
WRBL-1420
WTOC-1290
SAVANNA
TALLAHASSEE
WJAX-930
JACKSONVILLE
WJHP-1320
85°
84°
83°
82°
81°
80°
35°
34°
33°
32°
31°
30°
25 0 25 50 75 100 125 150 Miles

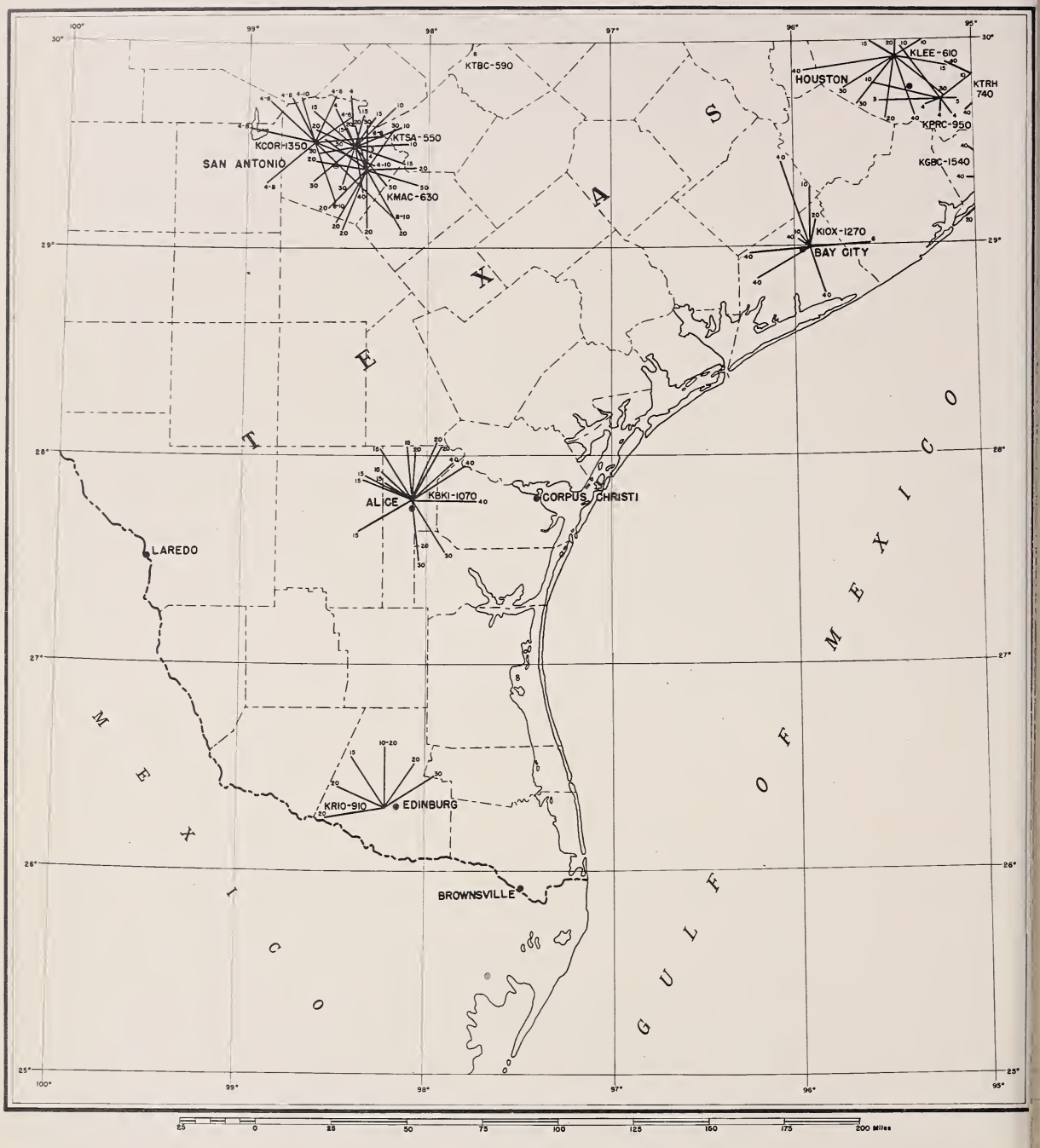
Map 42b.


NORTH
CAROLINA
SOUTH
CAROLINA
ATLANTIC OCEAN
WFNC-1450
JACKSONVILLE
DARLINGTON
WJMX-970
WMFD-630
WILMINGTON
WTMA-1250
CHARLESTON
80°
79°
78°
77°
76°
75°
35°
34°
33°
32°
31°
30°

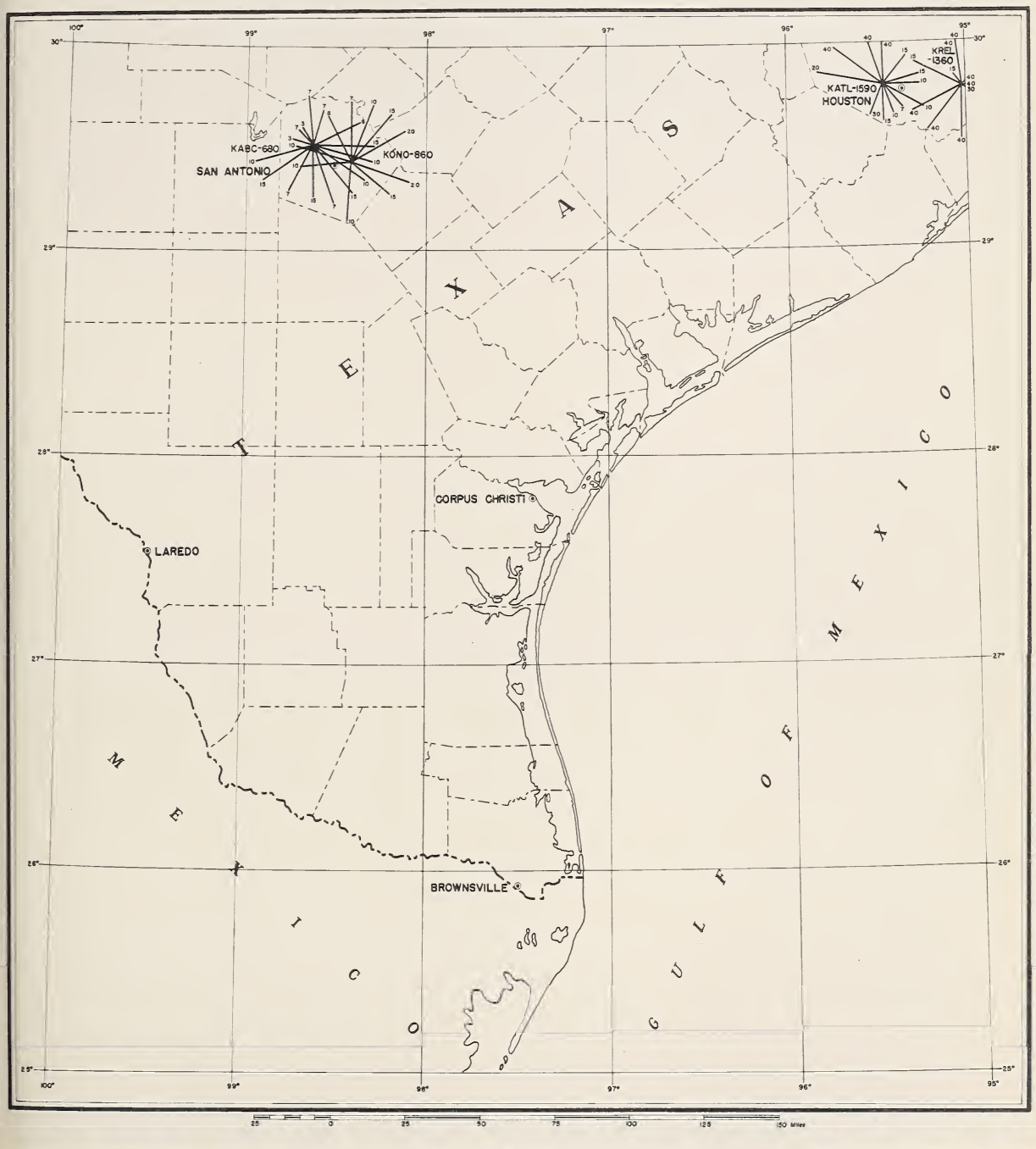
Map 43.


105°
104°
103°
102°
101°
100°
30°
29°
28°
27°
26°
25°
T E X A S
DEL RIO
BRACKETTVILLE
M E X I C O
25 0 25 50 75 100 125 150 Miles

Map 44.


KTBC-590
HOUSTON
KLEE-610
KTRH
740
KPRC-950
KGBC-1540
KCOR-1350
SAN ANTONIO
KTSA-550
KMAC-630
KIOX-1270
BAY CITY
TEXAS
ALICE
KBKI-1070
CORPUS CHRISTI
LAREDO
MEXICO
GULF OF MEXICO
KRIO-910
EDINBURG
BROWNSVILLE
100°
99°
98°
97°
96°
95°
30°
29°
28°
27°
26°
25°
25 0 25 50 75 100 125 150 175 200 Miles

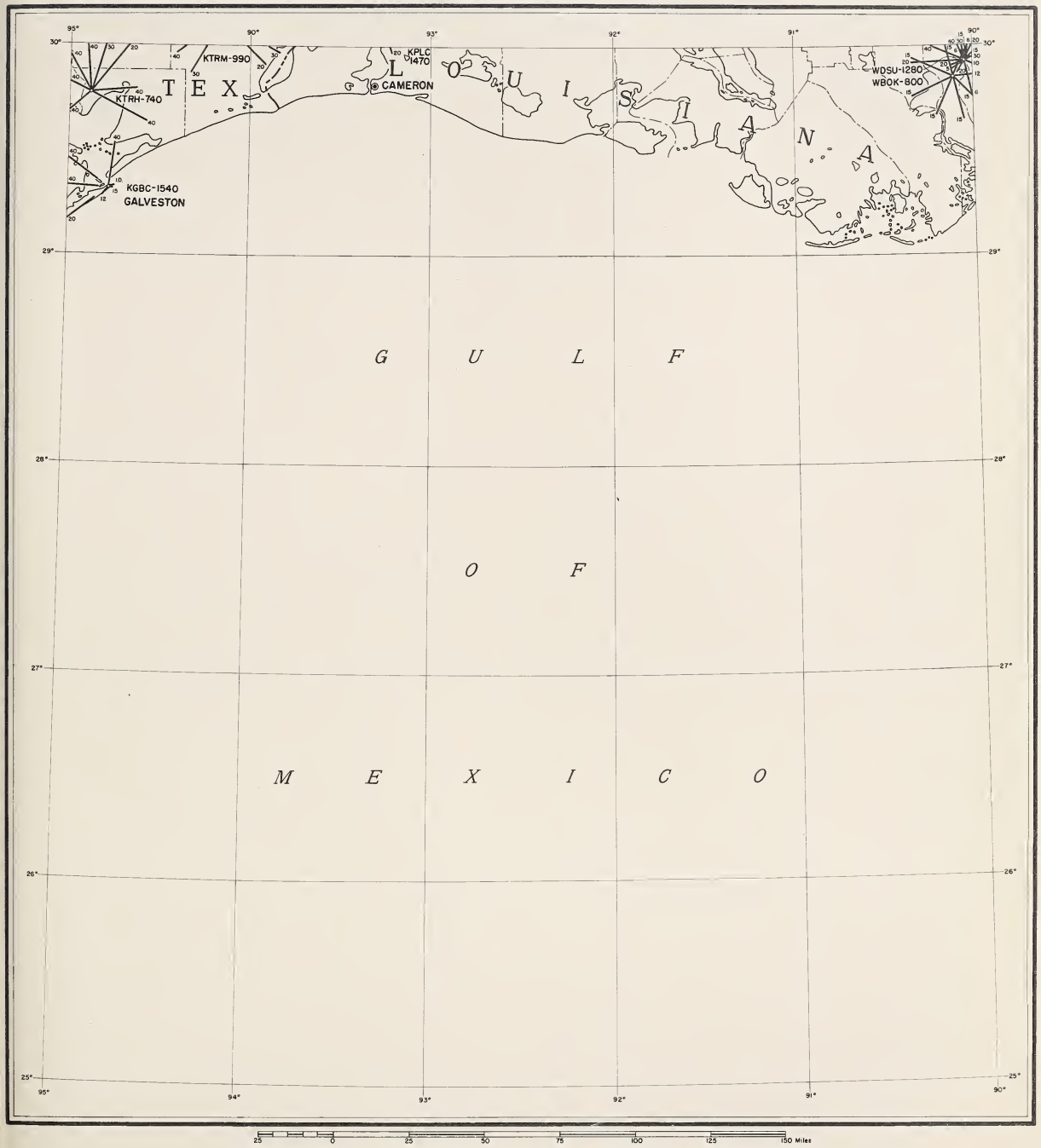
Map 45a.


KABC-680
SAN ANTONIO
KONO-860
KATL-1590
HOUSTON
KREL
1360
CORPUS CHRISTI
LAREDO
BROWNSVILLE
TEXAS
MEXICO
GULF OF MEXICO
100°
99°
98°
97°
96°
95°
30°
29°
28°
27°
26°
25°
25 0 25 50 75 100 125 150 Miles

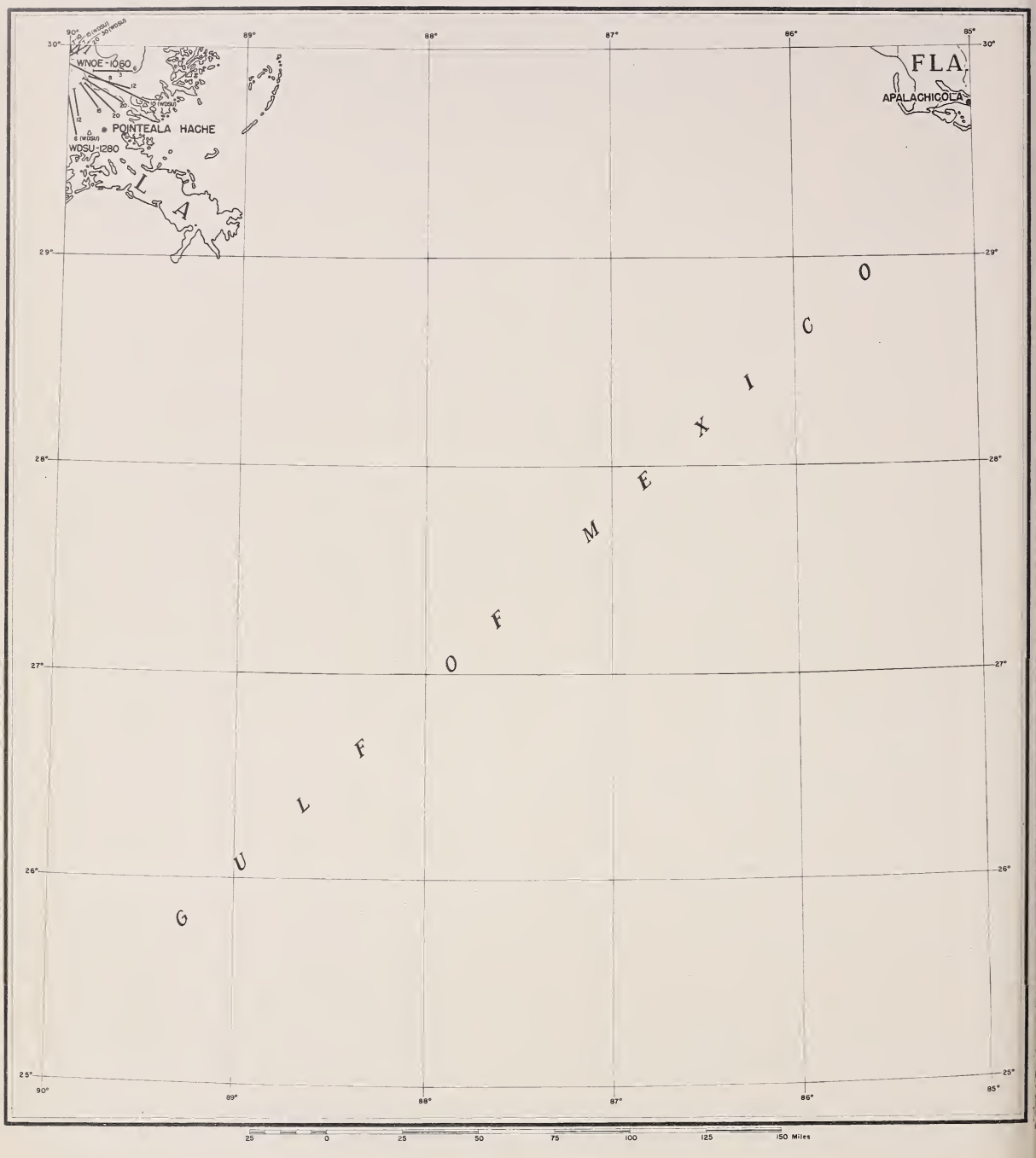
Map 45b.


KREL-1360
KOGT-1600
CAMERON
WTPS-940
GALVESTON
T E X.
L O U I S I A N A
G U L F
O F
M E X I C O
95°
94°
93°
92°
91°
90°
30°
29°
28°
27°
26°
25°
25 0 25 50 75 100 125 150 Miles

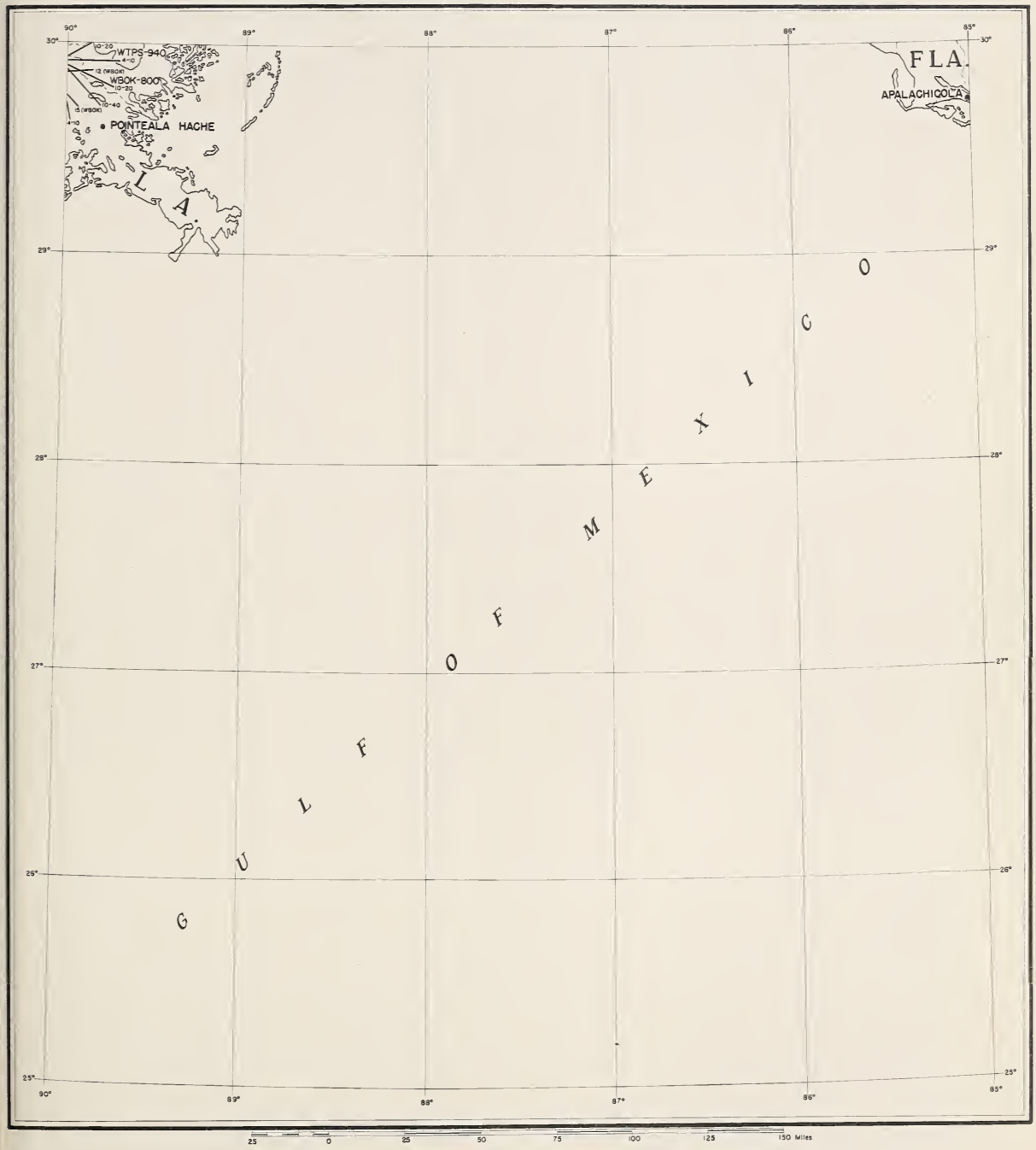
Map 46a.


TEX
KTRM-990
KTRH-740
KPLC
1470
CAMERON
LOUISIANA
WDSU-1280
WBOK-800
KGBC-1540
GALVESTON
GULF
OF
MEXICO
95°
90°
93°
92°
91°
30°
29°
28°
27°
26°
25°
94°
25
0
25
50
75
100
125
150 Miles

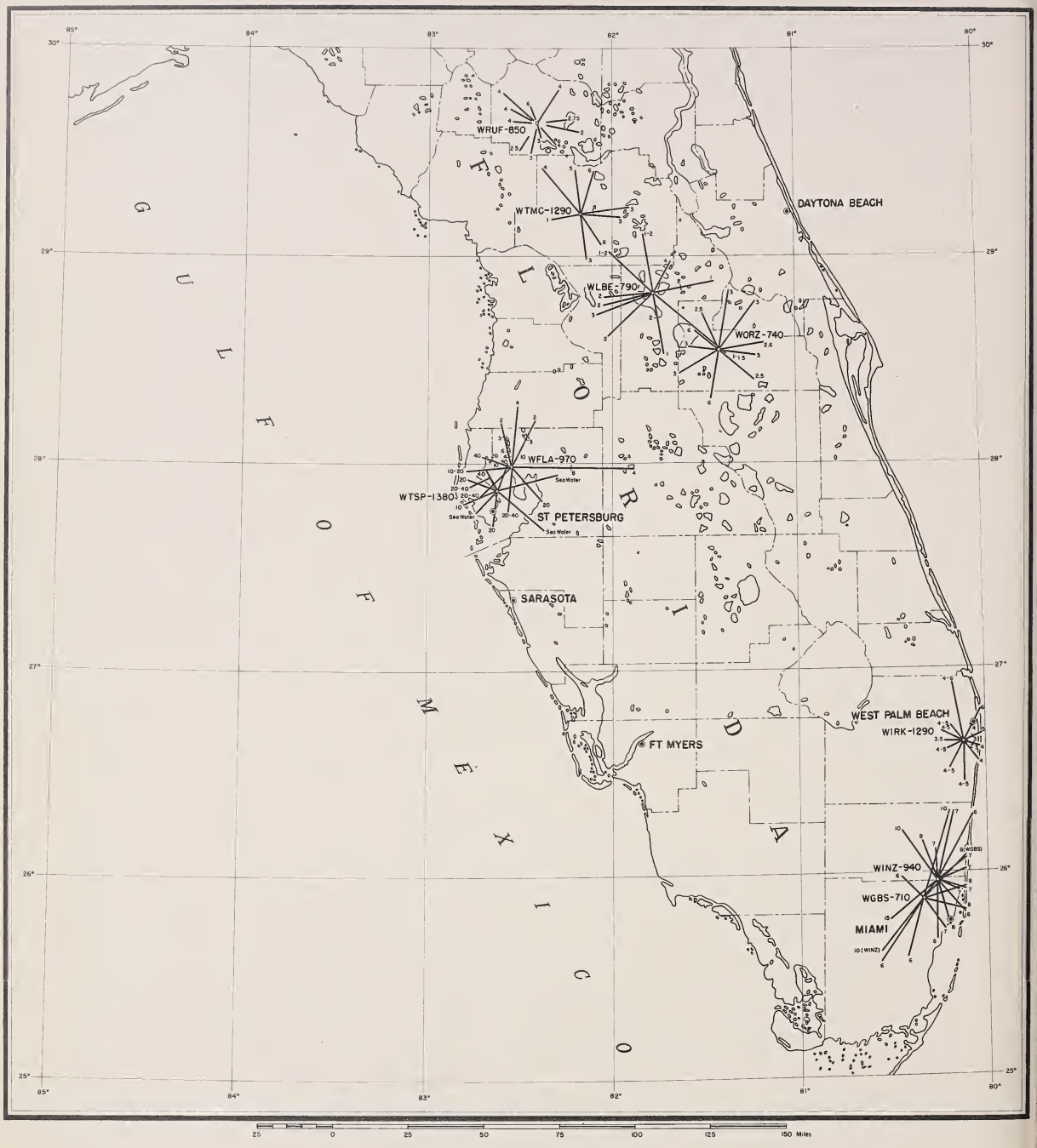
Map 46b.


WNOE-1060
POINTEALA HACHE
WDSU-1280
LA.
FLA.
APALACHICOLA
GULF OF MEXICO
30°
29°
28°
27°
26°
25°
90°
89°
88°
87°
86°
85°
25 0 25 50 75 100 125 150 Miles

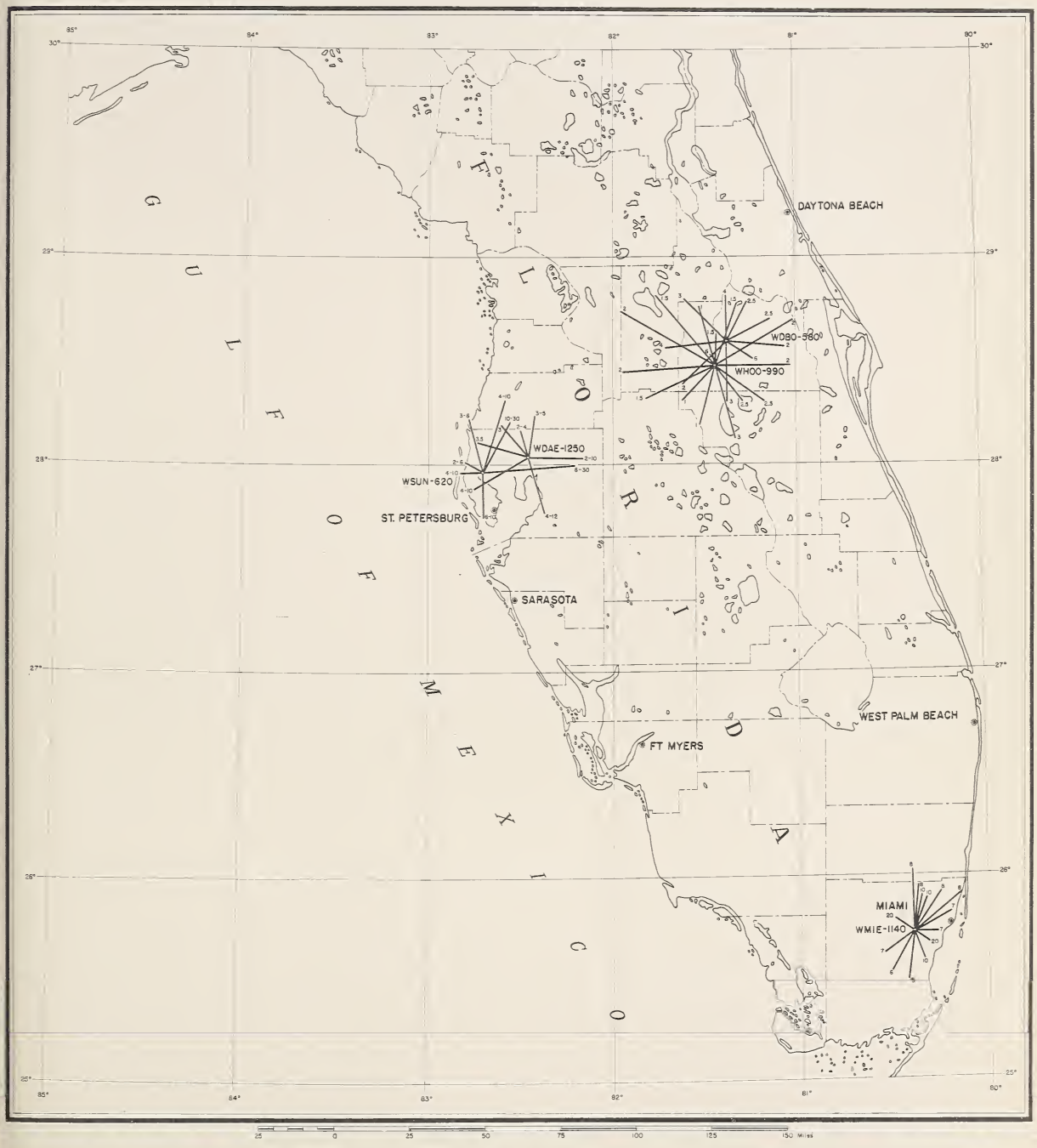
Map 47a.


90°
89°
88°
87°
86°
85°
30°
29°
28°
27°
26°
25°
WTPS-940
WSOK-800
POINTE A LA HACHE
LA.
FLA.
APALACHICOLA
GULF OF MEXICO
25 0 25 50 75 100 125 150 Miles

Map 47b.


WRUF-850
WTMC-1290
DAYTONA BEACH
WLBE-790
WORZ-740
WFLA-970
WTSP-1380
ST PETERSBURG
SARASOTA
WEST PALM BEACH
WIRK-1290
FT MYERS
WINZ-940
WGBS-710
MIAMI
GULF OF MEXICO
FLORIDA
85°
84°
83°
82°
81°
80°
30°
29°
28°
27°
26°
25°
25 0 25 50 75 100 125 150 Miles

Map 48a.



MAP 48b.

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