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The Coverages of the MF and VHF Maritime Distress Communication Systems

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THE COVERAGES OF THE MF AND THE VHF MARITIME DISTRESS COMMUNICATION SYSTEMS

William A. Kissick*

The radio coverage for two maritime distress communication systems are calculated for those U.S. Coast Guard stations in the contiguous United States. The two systems are: the international MF distress channel and the international VHF distress channel. The predicted coverage for each station is shown as a contour drawn on a map background.

Key Words: coverage; distress; maritime; MF; predictions; radio; VHF

1. BACKGROUND AND OBJECTIVES

The coverages given herein are for the two most important maritime communication systems operated in this country. The MF distress channel is the international calling and distress channel; the frequency is 2182 kHz. The VHF distress channel is another international calling and distress channel; its frequency is 156.8 MHz. These systems are operated by the U.S. Coast Guard.

The purpose of the 2182 kHz distress channel is to provide for medium range coverage along all coastlines. In order to provide this coverage, the shore stations are located at intervals along the coasts of the United States.** The VHF distress channel is the short range calling and distress frequency. This channel provides for distress, safety, and command and control communications in all boating areas where the Coast Guard has search-and-rescue responsibilities. These areas include the inland waters and coastal areas to at least 20 n mi (≈37 km) offshore, including adjacent tidal waters. Coverage of all large bodies of inland waters (e.g. Puget Sound,

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** Only the contiguous United States are considered in this work; Alaska and Hawaii are excluded.

Chesapeake Bay, and the U.S. waters of the Great Lakes) and the navigable waterways (e.g. the Mississippi River) must be complete.

The purpose of this report, then, is to describe the techniques and the resulting coverages calculated using radio propagation models developed by and available at the Institute for Telecommunication Sciences. This work was requested and sponsored by the U.S. Coast Guard because a comprehensive view of the coverage for the contiguous U.S. was needed.

2. PREDICTION METHODS AND ASSUMPTIONS

Coverage calculations are basiced on radio propagation predictions that have the following two embellishments: First, we must make predictions for a number of directions (radials) around the fixed, shore station. Second, the factor we wish to calculate for each direction is not a signal level at some distance, but the distance at which some particular minimum signal level occurs. The "coverage" is then denoted as the area contained within the locus of the minimum signal level points. In the following subsections, we will describe the techniques used to calculate the signal level versus distance relationship and how the minimum signal point is found for the MF and VHF systems, respectively.

2.1 The MF System

At 2182 kHz there are two important modes of propagation. The surface wave, or more generally, the ground wave is always present. The other mode is the ionospheric waveguide mode, or more generally, the sky wave. The sky wave is usually present at night for distances greater than 200-400 km. For this work, we wish to make conservative estimates of the coverage--in other words, coverage for worst case conditions. For this reason, the sky wave will not be considered; only the ground wave will be calculated. Therefore, with regard to the mode of propagation, what we calculate is the minimum coverage. For calculation purposes, the actual frequency used is 2183.4 kHz, because the emission type is single-sideband using the upper sideband. 2183.4 kHz represents the approximate center of the radiated signal.

Either the atmospheric or the external man-made noise is the dominant noise source at the receiver for MF, so system performance is limited by the received signal-to-noise ratio. The modulation type used is suppressed-

carrier single-sideband (SSB) voice, so a 49 dB signal-to-noise power density is the minimum required for 90% sentence intelligibility (Akima et al., 1969). The shore stations are assumed to be the receive end of the circuit, so the noise level at each station must be known. Since there is some geographic dependence, the median atmospheric noise at 2183.4 kHz (CCIR, 1963) was found for six locations along the coasts, for two times of day (local midnight and noon), and for each season of the year. The noise locations are shown on the map of Figure 1. For each (receive) station location, then, the

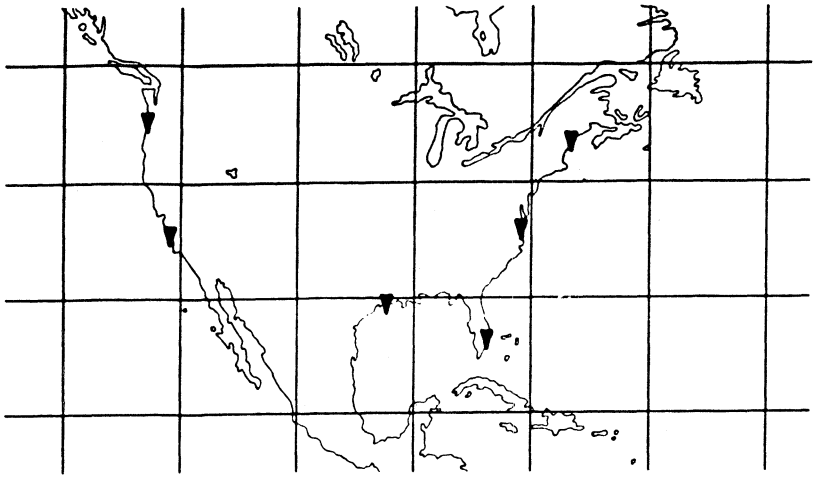

Figure 1. The locations at which the MF atmospheric noise was found for use in the MF coverage calculations.

nearest noise location was used to determine the maximum and minimum (as a function of time and month) atmospheric noise. Those values were used to represent the received noise level unless the assumed average man-made noise level was higher, in which case the latter was used. Now that we know the minimum signal-to-noise ratio and the noise level, we thereby know the required minimum signal level.

There are automated techniques available at the Institute for Telecommunication Sciences for predicting the ground wave field strength

versus distance over a homogeneous earth*. The reader may find more detailed information on this propagation mechanism in Wait (1964), Norton, (1941), or Fock (1965). There is a special feature of the predictions we need, however, because the propagation paths are inhomogeneous. The inhomogeneity was handled by using predictions for homogeneous paths over land and over sea water, then combining the results using Millington's method (Millington, 1949). Tables of field strength versus distance were developed for a set of sea-then-land paths with the distance to the transition as the parameter. Using other assumptions, described below, the tables were used to determine the distance at which the field strength reached the minimum value for a number of radials for each shore station. There were cases where the path involved three or sometimes four sections of alternating land and sea. For these cases, manual calculations of Millington's method were applied. The path inhomogeneity is the most important factor in the coverage the way we are modeling it; the manual procedure allowed for the judicious choice of radials for each station.

The remaining assumptions not already mentioned are the following: the surface conductivity and relative permittivity are 0.005 S/m and 15.0 for the (average) land, respectively, and 5.0 S/m and 81.0 for the sea water, respectively. The transmit end of the circuit, the boat or ship, is assumed to have 150 W of power fed into a 10% efficient, short vertical whip mounted 4.6 m (15 ft) above the sea. The remaining data needed to make the predictions and the resulting coverage maps are given in data Tables 1 through 8 referred to Section 3. The height of the shore station antenna above the ground is an important input to the predictions, however, the actual length of the antenna is not. In all cases, the gain of the receive antenna was assumed to be 1.76 dBi, the gain of a very short (relative to one wavelength) antenna.

2.2 The VHF System

The Longley-Rice propagation model is the best general purpose model available at the Institute for Telecommunication Sciences for predicting long term (hourly median) radio transmission loss at VHF and higher frequencies over irregular terrain. The Longley-Rice model is based on well-established propagation theories and empirical techniques. It has been documented in

* Berry, L.A. (1978), User's guide to low-frequency radio coverage programs, unpublished report, OT Technical Memorandum 78-247.

detail (Rice et al., 1967; Longley and Rice, 1968; and Longley, 1976). The model has been tested against a large number of propagation measurements and has been used extensively to provide information for line-of-sight, diffraction, or tropospheric scatter types of communication systems.

For the application to the marine mobile systems of this work, we used the Longley-Rice model in the "area" prediction mode. This means that the terrain is described by statistical parameters, such as "roughness," which is defined as the interdecile elevation along the path. This approach provides realistic and consistent predictions.

For those stations that are on the sea coasts, the coverage predictions will be invalid over land. The reason is that the surface conductivity and relative permittivity used in those predictions are for sea water (conductivity = 5.0 S/m, relative permittivity = 81.0). For those stations that serve the Great Lakes and are on their shores, the same limitation applies; the surface conductivity and relative permittivity are those for fresh water, 0.01 S/m and 81.0, respectively. And, for those stations serving inland waterways, the surface conductivity and relative permittivity are 0.005 S/m and 15.0, respectively, the values that represent average ground.

Time and location variabilities and prediction confidence are accounted for by adjustments are made to the predicted hourly median signal level. The particular assumptions for this work are that the actual received signal level will be greater than the predicted value 50% of the time for 90% of the locations and with a 50% confidence level.

For this VHF distress channel we wish to calculate the receive coverage for each shore station for two types of vessels, a small boat and a larger one. The former will be represented by a radiated power of 1 W from a 0 dBi gain omnidirectional antenna at 6 ft (1.83 m) above the water, and the latter by a radiated power of 25 W from a 6 dBi gain omnidirectional antenna at 15 ft (4.57 m) above the water. To show these two cases on the coverage maps, two contours are plotted, the smaller one will represent the coverage for the first case described above.

The remaining information needed to make the predictions concerns the shore station. The typical receiver sensitivity was determined to be 0.5μV into 50 Ω. For the cases involving directional antennas, one of three

patterns was used. For the yagi antennas, a typical pattern for a 2-bay/4-element yagi was used. For the remaining directional antennas, two offset antenna patterns were used depending on whether the main-beam gain was 9 dB or less, or greater than 9 dB.

3. THE MF STATIONS AND COVERAGE MAPS

The Tables and Figures found on pages 7 to 32 give the station location and antenna data, and the coverage results, respectively, for the MF system. These Tables and Figures have been separated by Coast Guard District. The map projection used in the coverage maps is the Lambert conformal conic projection. Note that for Districts 1, 11, and 12 all or some of the antenna lengths are missing. These values were not needed for the predictions.

4. THE VHF STATIONS AND COVERAGE MAPS

The Tables and Figures found on pages 33 to 138 give the station location and antenna data, and the coverage results, respectively, for the VHF system. These Tables and Figures have been separated by Coast Guard District. The map projection used in the coverage maps is an osculatory fit to Clarke's spheroid of 1860. The center point of each map is either a station location (marked with a + sign) or it is marked with an asterisk. The latitude and longitude of each center point is noted in the figure caption. The scale of these maps is such that each frame is a 500 x 500 km square.

5. ACKNOWLEDGMENTS

I wish to acknowledge the following people for their assistance with the work, and their contributions to the success, of this project:

Lt. Richard Carlson of U.S. Coast Guard Headquarters for the project concept and support, and for assistance in obtaining the basic station location data. The communication staff at each of the Coast Guard district offices for providing and verifying the data; in many cases this required physical inspection of the radio sites. Jeanne Major and Margo Vaughan of ITS for their help in collecting and checking the data, and their work on the tedious MF coverage calculations. Eric Rehm of ITS for his programming assistance with the VHF coverage calculations.

Table 1. MF Station Location and Antenna Data for District 1.

LOCATION	LATITUDE (N)	LONGITUDE (W)	ANTENNA VERTICAL LENGTH (ft)*	ANTENNA BASE HEIGHT (ft)*
Bass Harbor, ME	44°13'30"	68°20'30"		3
Brant Pt., MA	41°17'13"	70°05'22"		36
Cape Elizabeth, ME	43°33'51"	70°12'11"		1
Castle Hill, RI	41°27'46"	71°21'42"		3
Eastern Pt., MA	42°34'48"	70°39'54"		12
Jonesport, ME	44°29'24"	67°35'48"		3
Otis AFB, MA	41°42'30"	70°30'00"		1
Owls Head, ME	44°05'30"	69°02'42"		15
Plum Island, MA	42°48'53"	70°48'48"		34
Pt. Allerton, MA	42°18'10"	70°55'03"		1
Race Pt., MA	42°04'44"	70°13'15"		39
S. Portland, ME	43°38'43"	70°14'52"		30
Southwest Harbor, ME	44°16'30"	68°18'45"		26
West Quoddy Head, ME	44°48'54"	66°57'48"		50
Woods Hole, MA	41°31'12"	70°40'07"		42

*1 ft = 0.3048 m

Table 2. MF Station Location and Antenna Data for District 3

LOCATION	LATITUDE (N)	LONGITUDE (W)	ANTENNA	
			VERTICAL LENGTH (ft)*	BASE HEIGHT (ft)*
Atlantic City, NJ	39°22'42"	74°25'18"	50	0
Barnegat, NJ	39°45'30"	74°06'24"	50	0
Camp Hero, NY	41°04'18"	71°48'17"	40	0
Cape May, NJ	38°56'24"	74°53'00"	50	0
Indian River Inlet, DE	38°36'21"	75°04'42"	50	0
New Haven, CT	41°16'18"	72°17'24"	90	0
Sandy Hook, NJ	40°28'01"	74°00'28"	50	0
Shark River, NJ	40°11'42"	74°00'36"	35	0
Shinnecock Hills, NY	40°51'00"	72°30'09"	40	0
Short Beach, NY	40°35'24"	73°33'24"	50	0

* 1 ft = 0.3048 m

Table 3. MF Station Location and Antenna Data for District 5

LOCATION	LATITUDE (N)	LONGITUDE (W)	ANTENNA	
			VERTICAL LENGTH (ft)*	BASE HEIGHT (ft)*
Baltimore, MD	39°12'02"	76°34'10"	50	0
Cape Hatteras, NC	35°14'37"	75°32'01"	100	0
Cape Henry, VA	36°55'36"	76°00'29"	70	0
Chincoteague, VA	37°55'54"	75°23'04"	50	0
Elizabeth City, NC	36°15'53"	76°10'32"	50	0
Ft. Macon, NC	34°41'49"	76°40'54"	20	0
Oak Island, NC	33°53'34"	78°02'06"	80	0
Oregon Inlet, NC	35°46'01"	75°31'27"	100	0

* 1 ft = 0.3048 m

Table 4. MF Station Location and Antenna Data for District 7

LOCATION	LATITUDE (N)	LONGITUDE (W)	ANTENNA	
			VERTICAL LENGTH (ft)*	BASE HEIGHT (ft) *
Cape Canaveral, FL	28°27'30"	80°31'50"	35	11
Card Sound, FL	25°25'48"	80°28'07"	35	12
Chokoloskee, FL	25°48'00"	81°21'00"	35	5
Ft. Lauderdale, FL	26°05'20"	80°07'00"	80	7
Ft. Meyers Beach, FL	26°26'00"	81°55'00"	35	4
Ft. Pierce, FL	27°27'30"	80°18'20"	35	10
Ft. Worth Inlet, FL	26°33'00"	80°03'00"	35	10
Georgetown, SC	33°18'26"	79°17'29"	35	10
Islamorada, FL	24°56'00"	80°32'00"	35	5
Jacksonville Beach, FL	30°18'00"	81°24'00"	80	10
Key West, FL	24°33'00"	81°48'00"	80	6
Marathon, FL	24°42'00"	81°05'00"	35	4
Miami Beach, FL	25°46'40"	80°08'00"	35	30
Mullet Key, FL	27°38'00"	82°44'00"	80	4
Ponce de Leon, FL	29°03'50"	80°55'01"	35	8
St. Petersburg, FL	27°52'00"	82°57'00"	35	10
St. Simons Island, GA	31°08'45"	81°22'28"	35	10
Sullivan Island, SC	32°45'40"	79°50'29"	35	8
Tybee Roads, GA	32°01'00"	80°51'00"	35	10
Venice, FL	27°04'00"	82°27'00"	35	8
Yankeetown, FL	29°01'51"	82°43'39"	35	32

* 1 ft = 0.3048 m

Table 5. MF Station Location and Antenna Data for District 8

LOCATION	LATITUDE (N)	LONGITUDE (W)	ANTENNA	
			VERTICAL LENGTH (ft)*	BASE HEIGHT (ft)*
Belle Chasse, LA	29°53'05"	89°56'47"		0
Carrabelle, FL	29°50'07"	84°38'08"	50	0
Freeport, TX	28°56'05"	95°18'01"	40	0
Galveston, TX	29°19'58"	94°46'17"	65	0
Grand Isle, LA	29°15'06"	89°57'04"	35	0
Mobile, AL	30°39'01"	88°03'05"	40	0
Mobile Pt., AL	30°14'06"	88°01'04"	6.5	0
Panama City, FL	30°10'02"	85°45'04"	80	0
Pecan Island, LA	29°38'48"	92°26'04"	40	0
Port Isabel, TX	26°04'00"	97°10'00"	100	0
Port O'Connor, TX	28°26'01"	96°25'07"	52	0
Sabine, TX	29°43'00"	93°52'00"	40	0
Santa Rosa Island, FL	30°19'01"	87°15'03"	60	0
Santa Rosa Island, FL	30°19'01"	87°15'03"	6.5	0

* 1 ft = 0.3048 m

Table 6. MF Station Location and Antenna Data for District 11

LOCATION	LATITUDE (N)	LONGITUDE (W)	ANTENNA	
			VERTICAL LENGTH (ft)*	BASE HEIGHT (ft)*
Channel Islands Harbor Radio Beacon, CA	34°09'42"	119°13'19"	35	0
Long Beach, CA	33°44'30"	118°24'36"		0
Pt. Conception, CA	34°27'00"	120°28'18"	35	0
Santa Catalina, CA	33°20'56"	118°19'29"		0
San Clementi, CA	32°52'12"	118°25'35"		0
San Diego, CA	32°43'33"	117°10'50"	35	60

* 1 ft = 0.3048 m

Table 7. MF Station Location and Antenna Data for District 12

LOCATION	LATITUDE (N)	LONGITUDE (W)	ANTENNA	
			VERTICAL LENGTH (ft)*	BASE HEIGHT (ft) *
Arcata, CA	40°58'34"	124°06'50"		5
Bolinas, CA	38°05'25"	122°57'00"		117
Cambria, CA	35°30'53"	121°03'30"		5
Humboldt Bay, CA	40°46'10"	124°13'00"		4
Pt. Arena, CA	38°57'18"	123°44'24"	60	5
Pt. Pinos, CA	36°38'00"	121°56'00"	30	5
Pt. St. George, CA	41°47'05"	124°15'13"	75	5
Pt. Sur, CA	36°18'24"	121°54'00"	80	4

* 1 ft = 0.3048 m

Table 8. MF Station Location and Antenna Data for District 13

LOCATION	LATITUDE (N)	LONGITUDE (W)	ANTENNA	
			VERTICAL LENGTH (ft)*	BASE HEIGHT (ft)*
Bahokus Peak, WA	48°21'54"	124°39'18"	75	0
Cape Arago, OR	43°20'30"	124°22'30"	80	6
Cape Disappointment, WA	46°16'30"	124°03'12"	35	3
Ft. Stevens, OR	46°12'12"	123°57'30"	75	0
Gray's Harbor, WA	46°54'24"	124°06'36"	35	3
North Bend, OR	43°25'00"	124°14'54"	35	45
Port Angeles, WA	48°08'24"	123°24'36"	35	3
Pt. Grenville, WA	47°18'18"	124°16'36"	35	3
Port Orford, OR	42°44'12"	124°30'42"	90	0
Quillayute, WA	47°54'18"	124°38'06"	35	3
Yaquina Bay, OR	44°37'18"	124°03'42"	35	50

* 1 ft = 0.3048 m

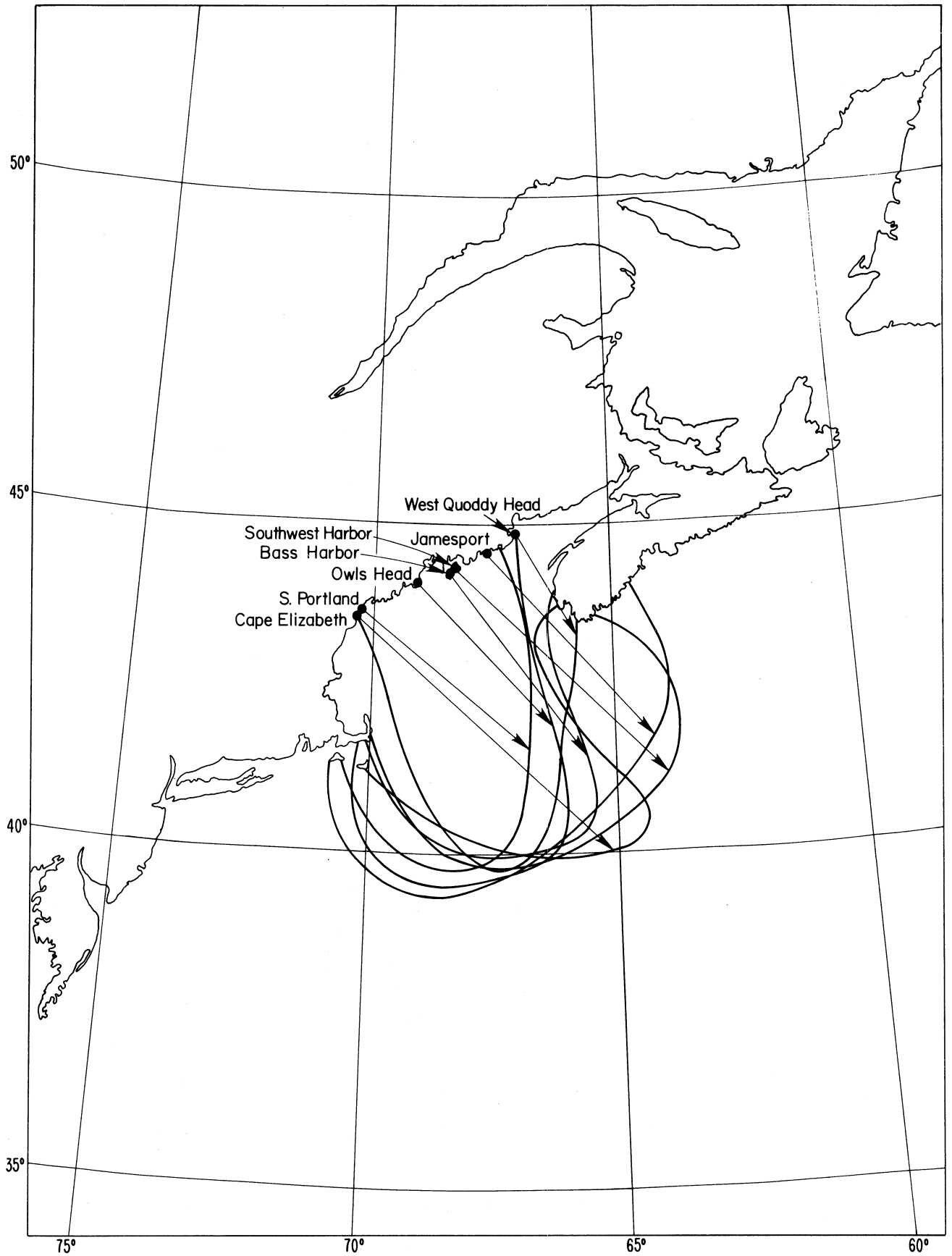

Figure 2. 2182 kHz coverage for the northern portion of District 1, maximum noise.

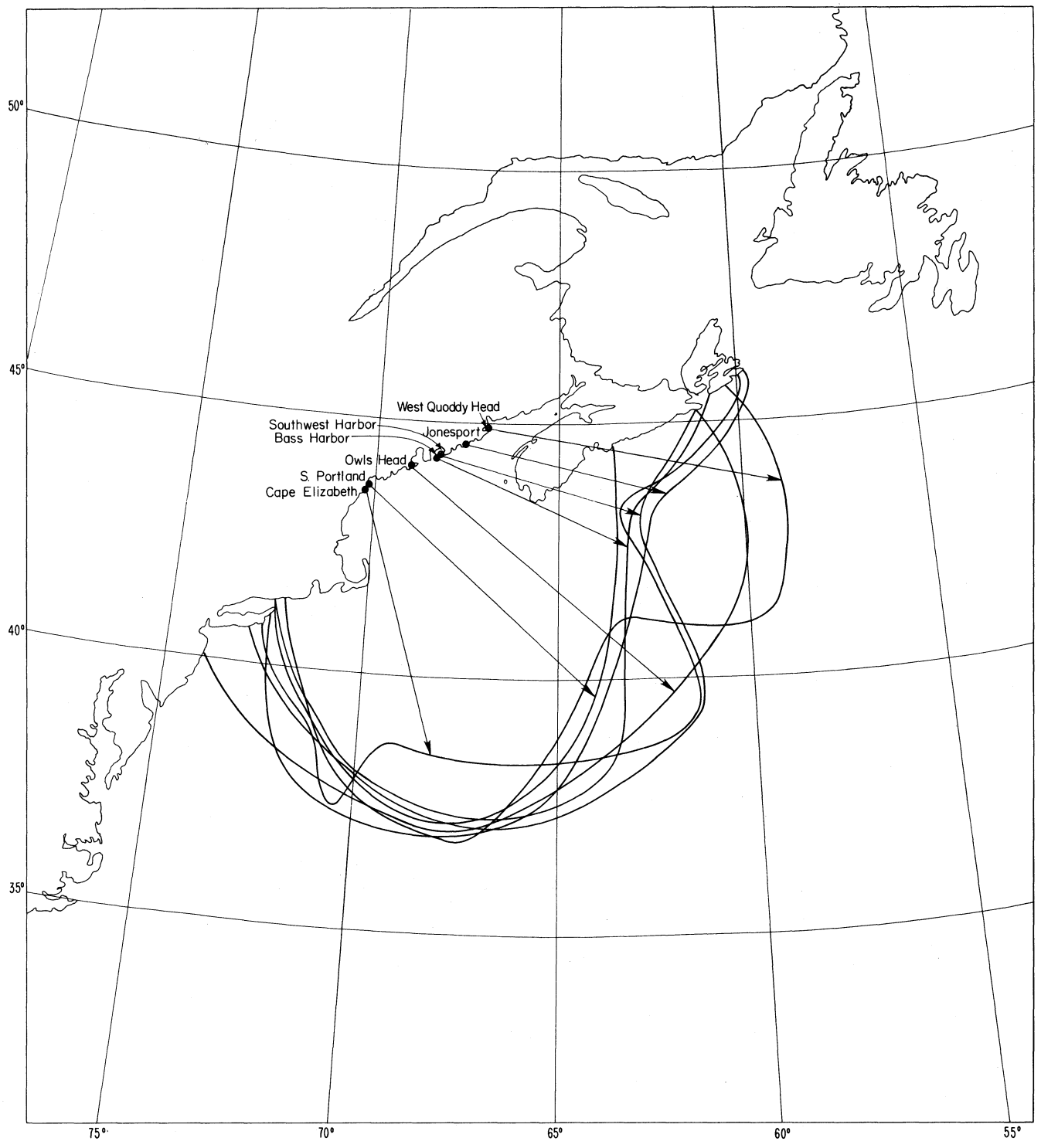

Figure 3. 2182 kHz coverage for the northern portion of District 1, minimum noise.

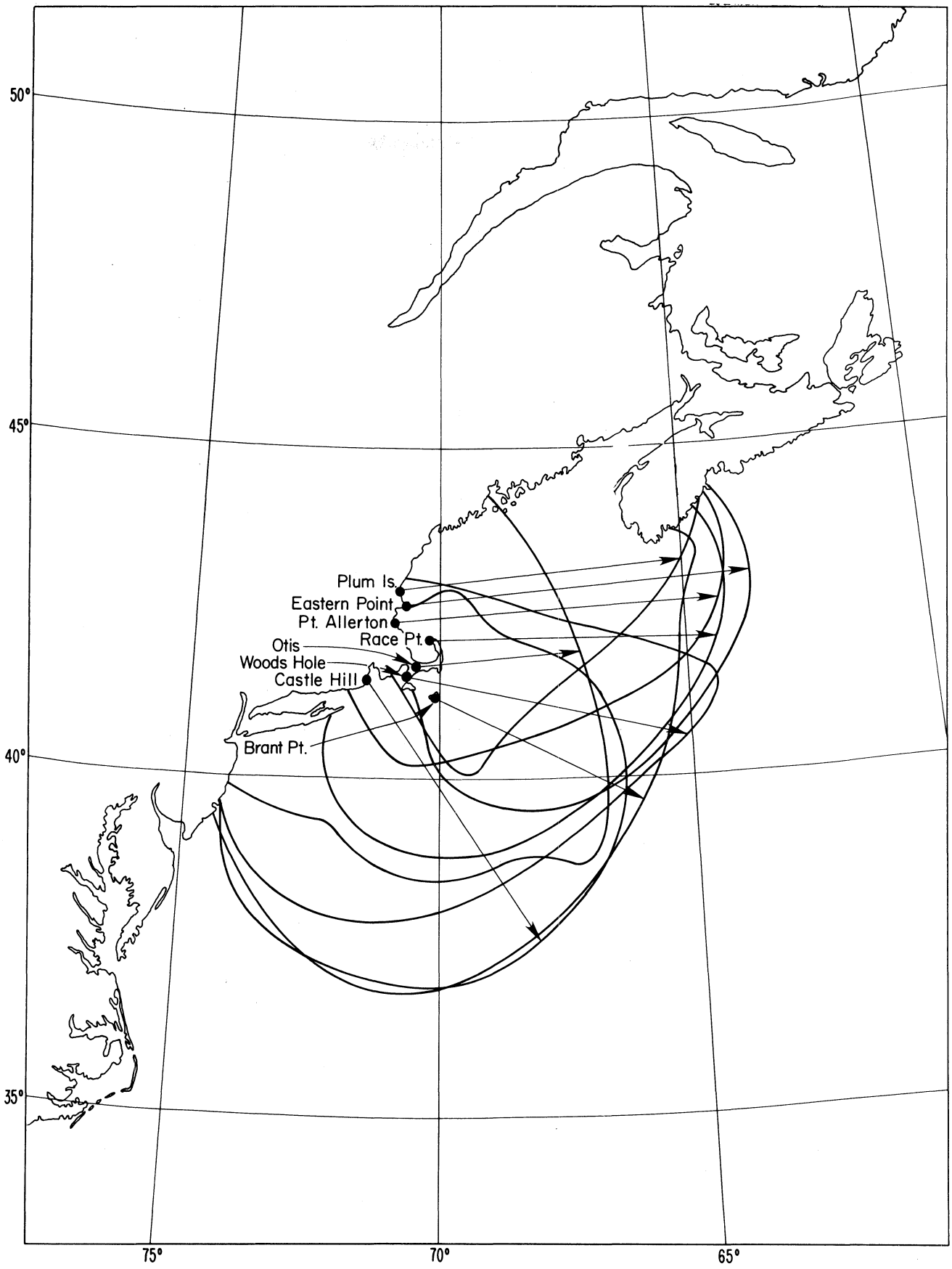

Figure 4. 2182 kHz coverage for the southern portion of District 1, maximum noise.

Figure 5. 2182 kHz coverage for the southern portion of District 1, minimum noise.

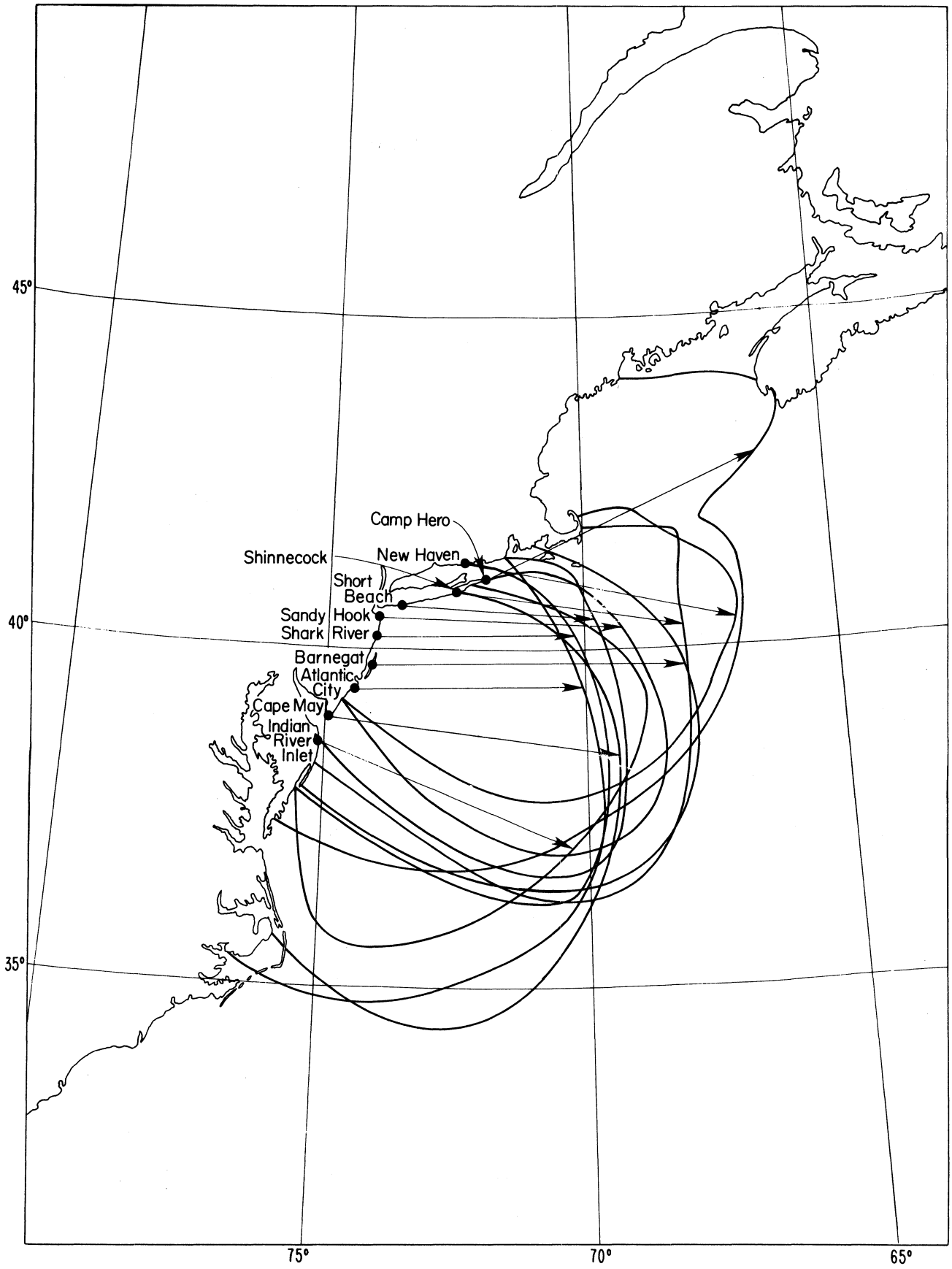

Figure 6. 2182 kHz coverage for District 3, maximum noise.

Figure 7. 2182 kHz coverage for District 3, minimum noise.

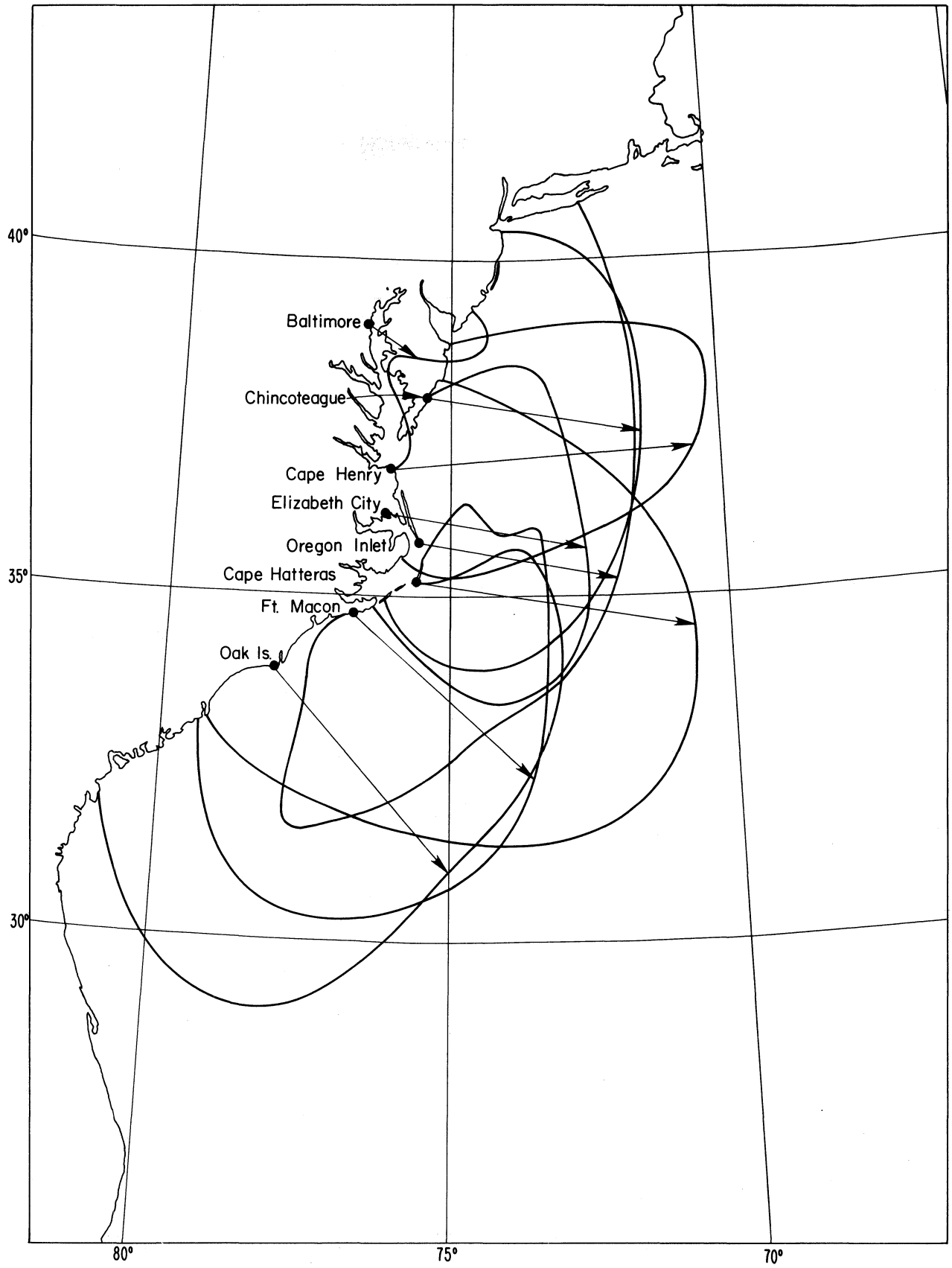

Figure 8. 2182 kHz coverage for District 5, maximum noise.

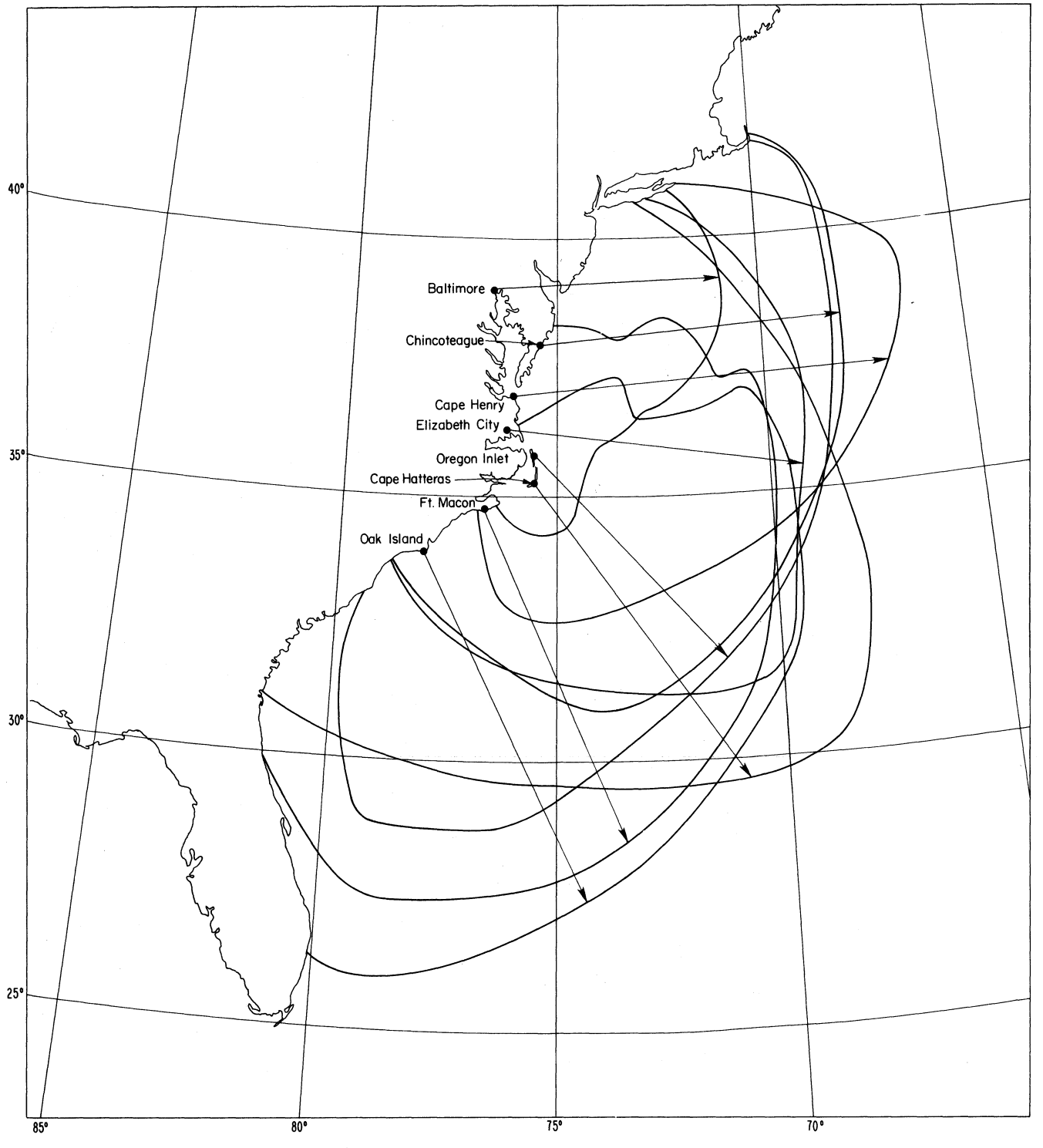

Figure 9. 2182 kHz coverage for District 5, minimum noise.

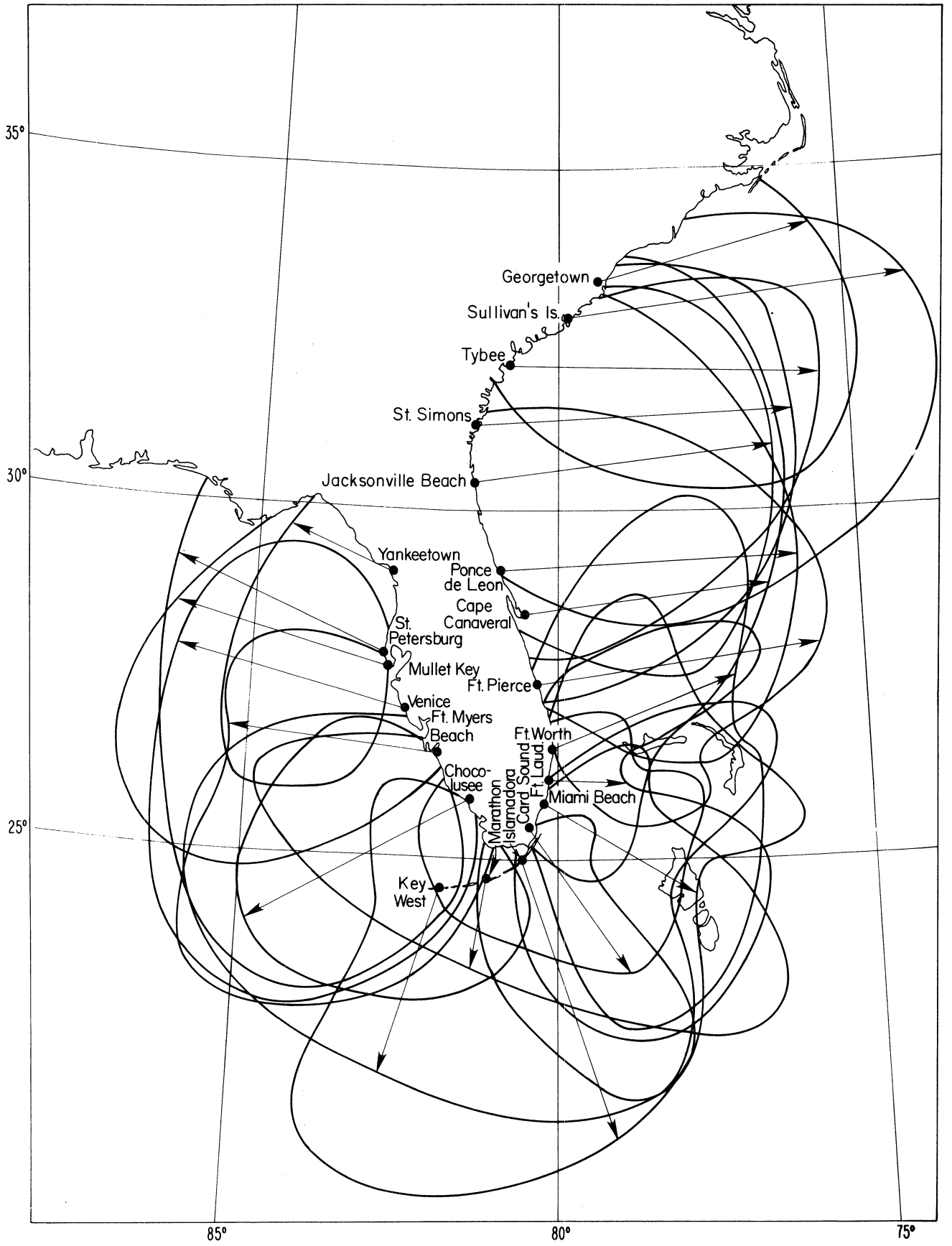

Figure 10. 2182 kHz coverage for District 7, maximum noise.

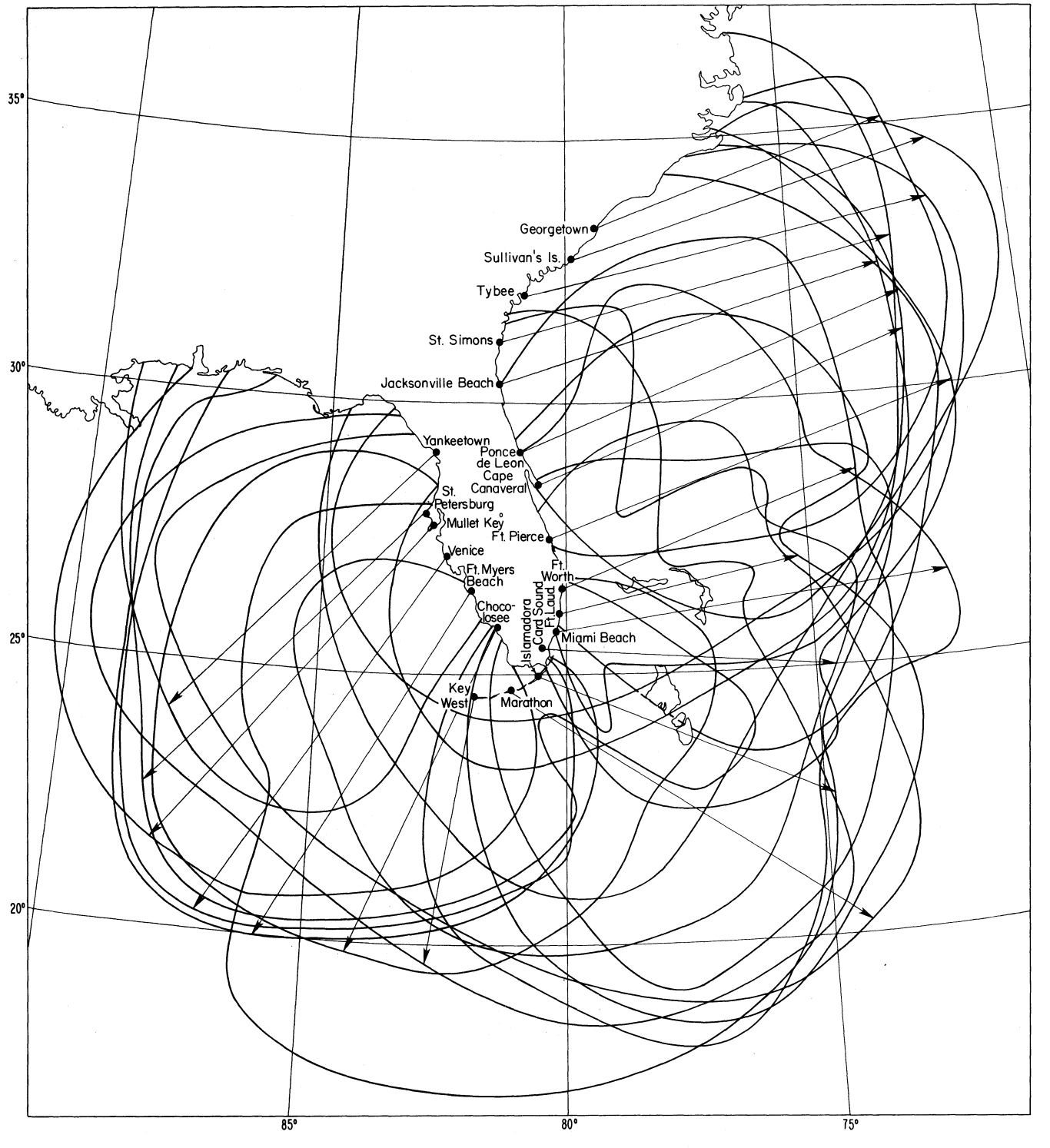

Figure 11. 2182 kHz coverage for District 7, minimum noise.

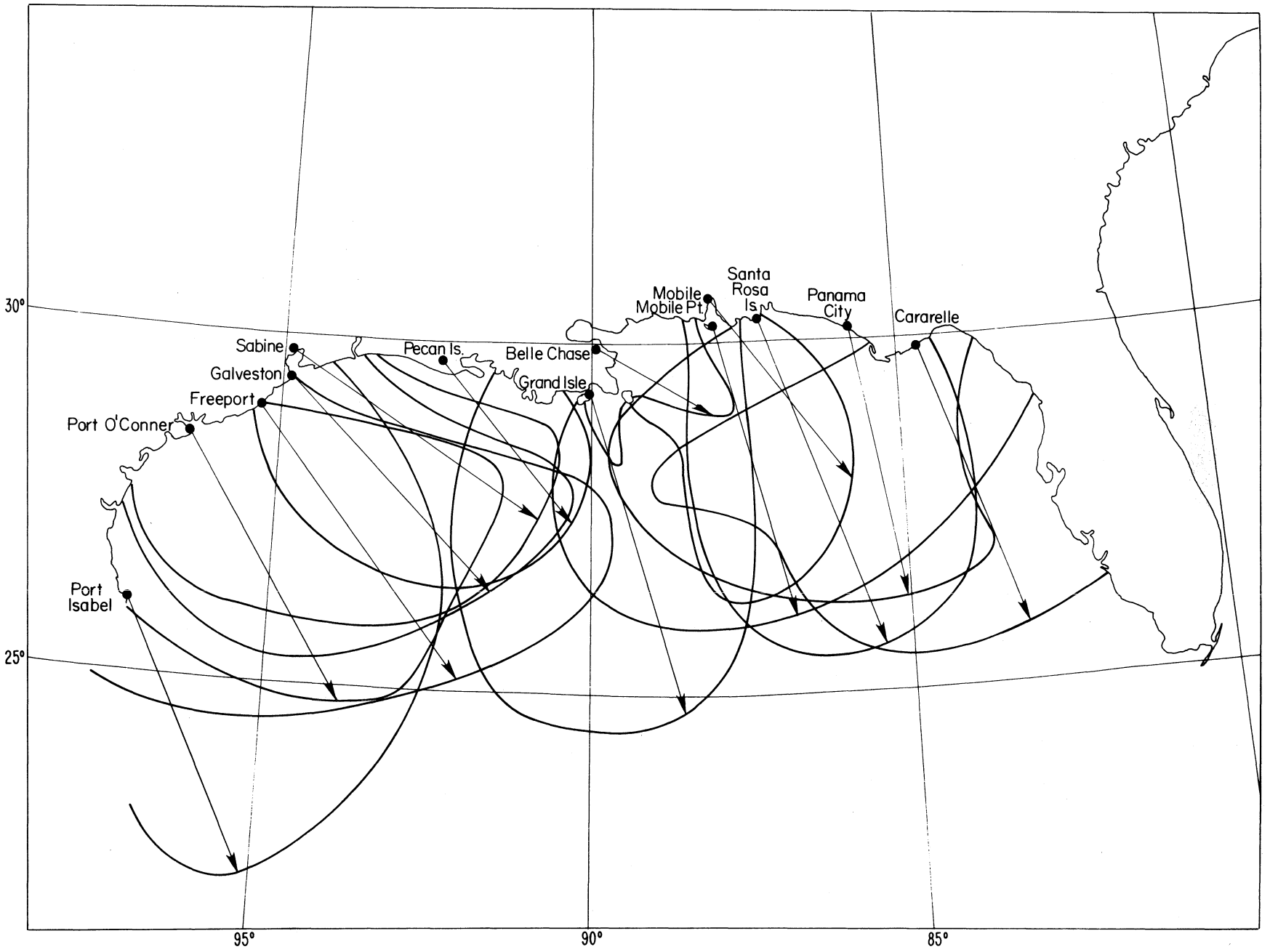

Figure 12. 2182 kHz coverage for District 8, maximum noise.

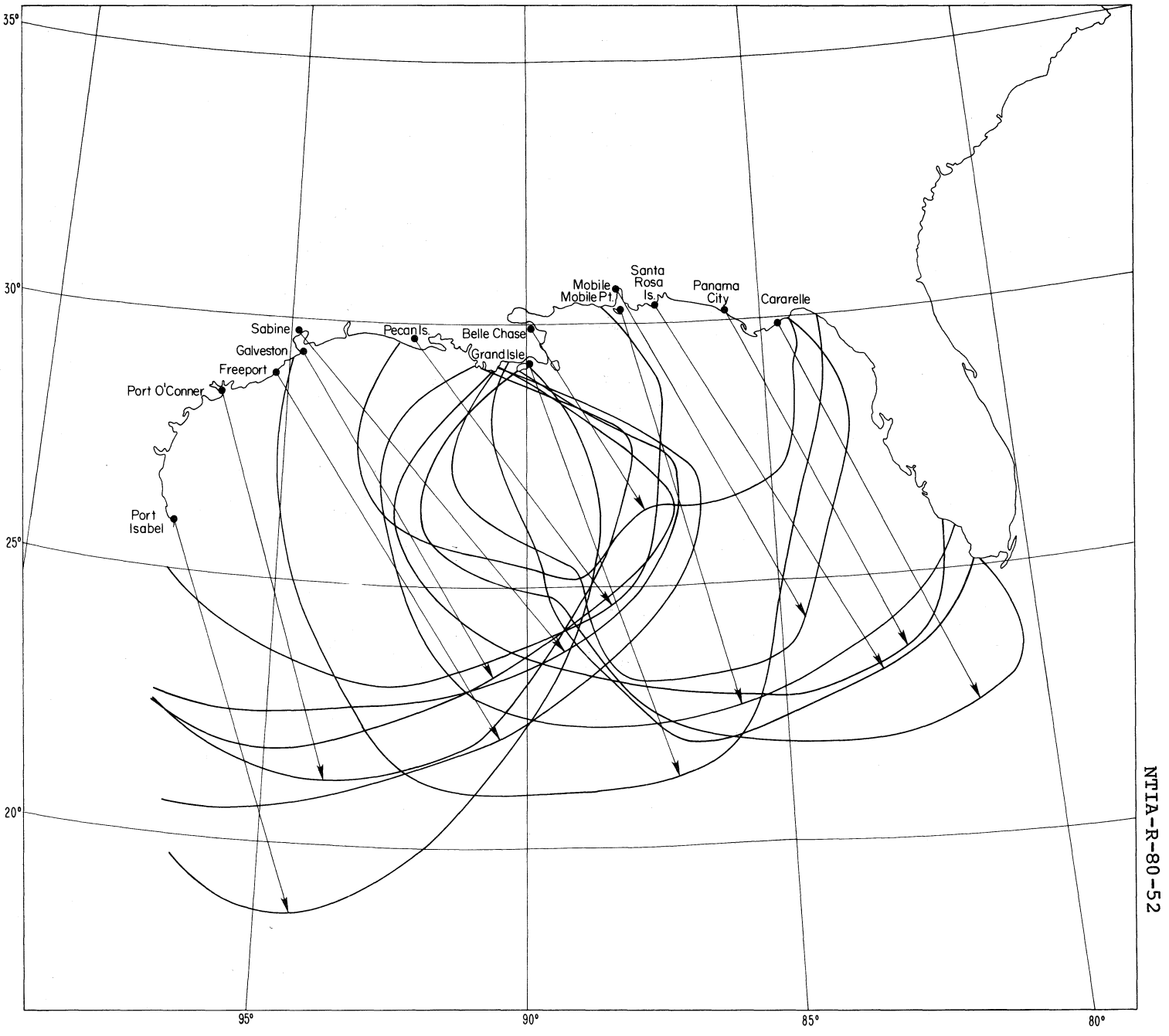

Figure 13. 2182 kHz coverage for District 8, minimum noise.

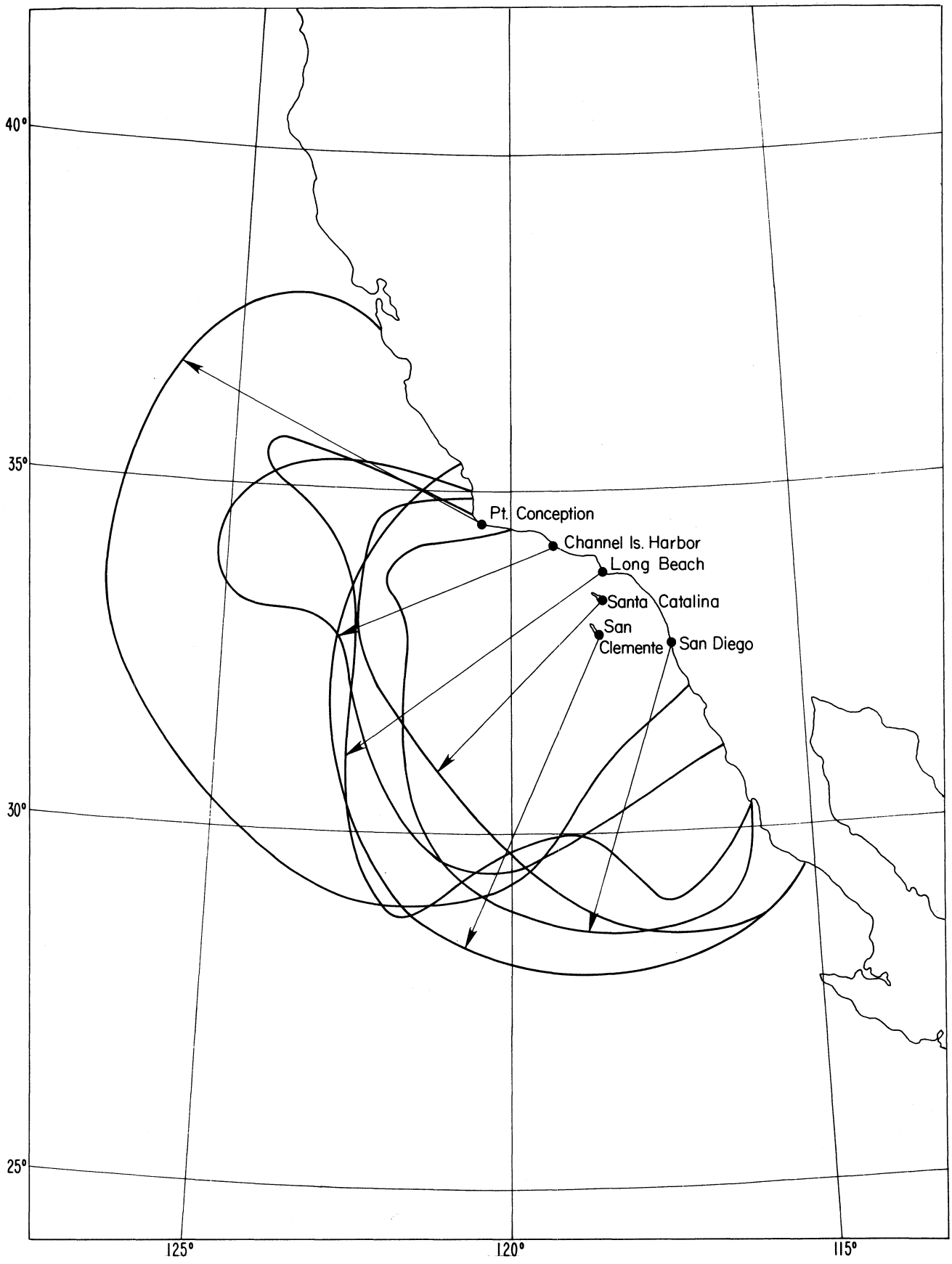

Figure 14. 2182 kHz coverage for District 11, maximum noise.

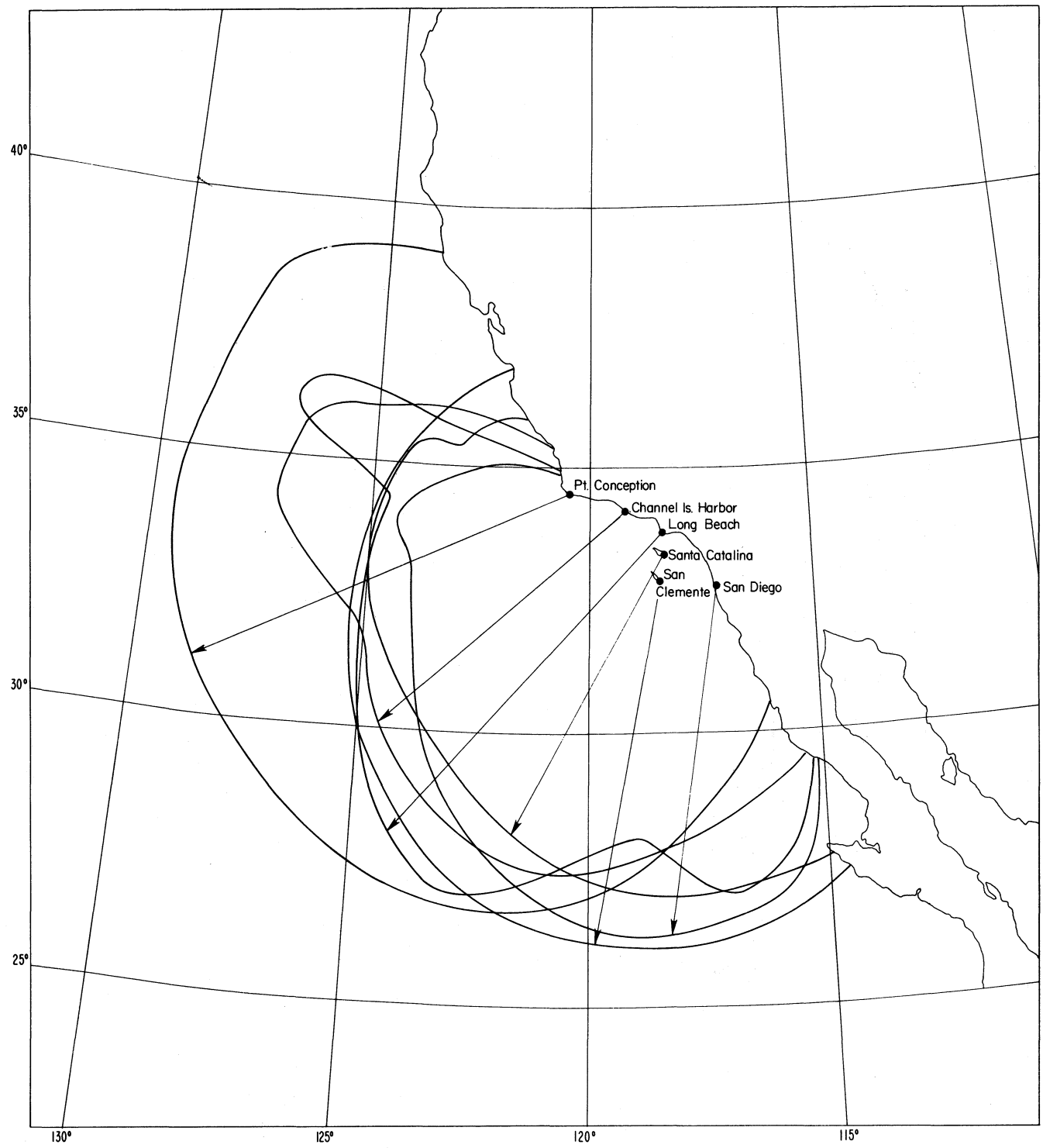

Figure 15. 2182 kHz coverage for District 11, minimum noise.

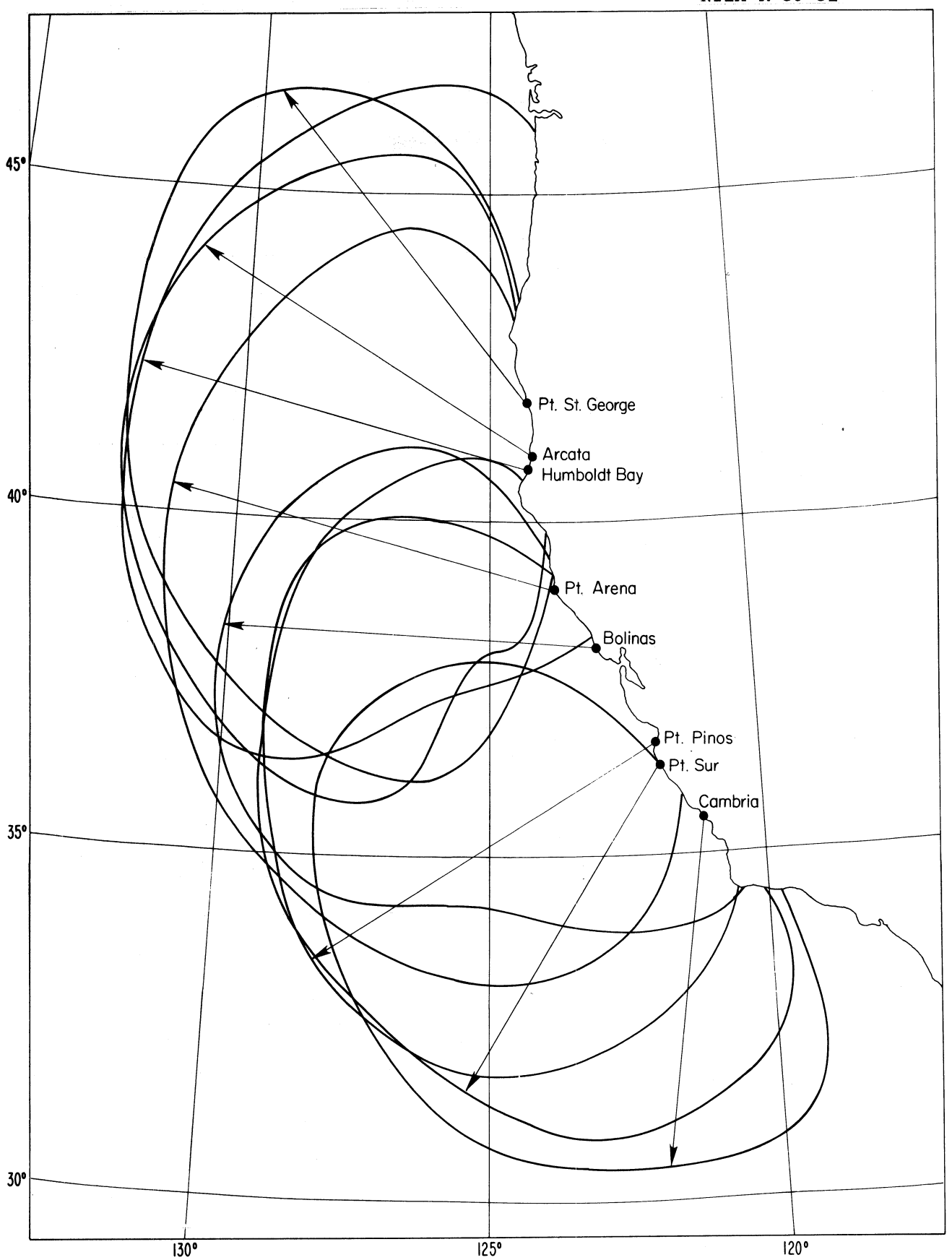

Figure 16. 2182 kHz coverage for District 12, maximum noise.

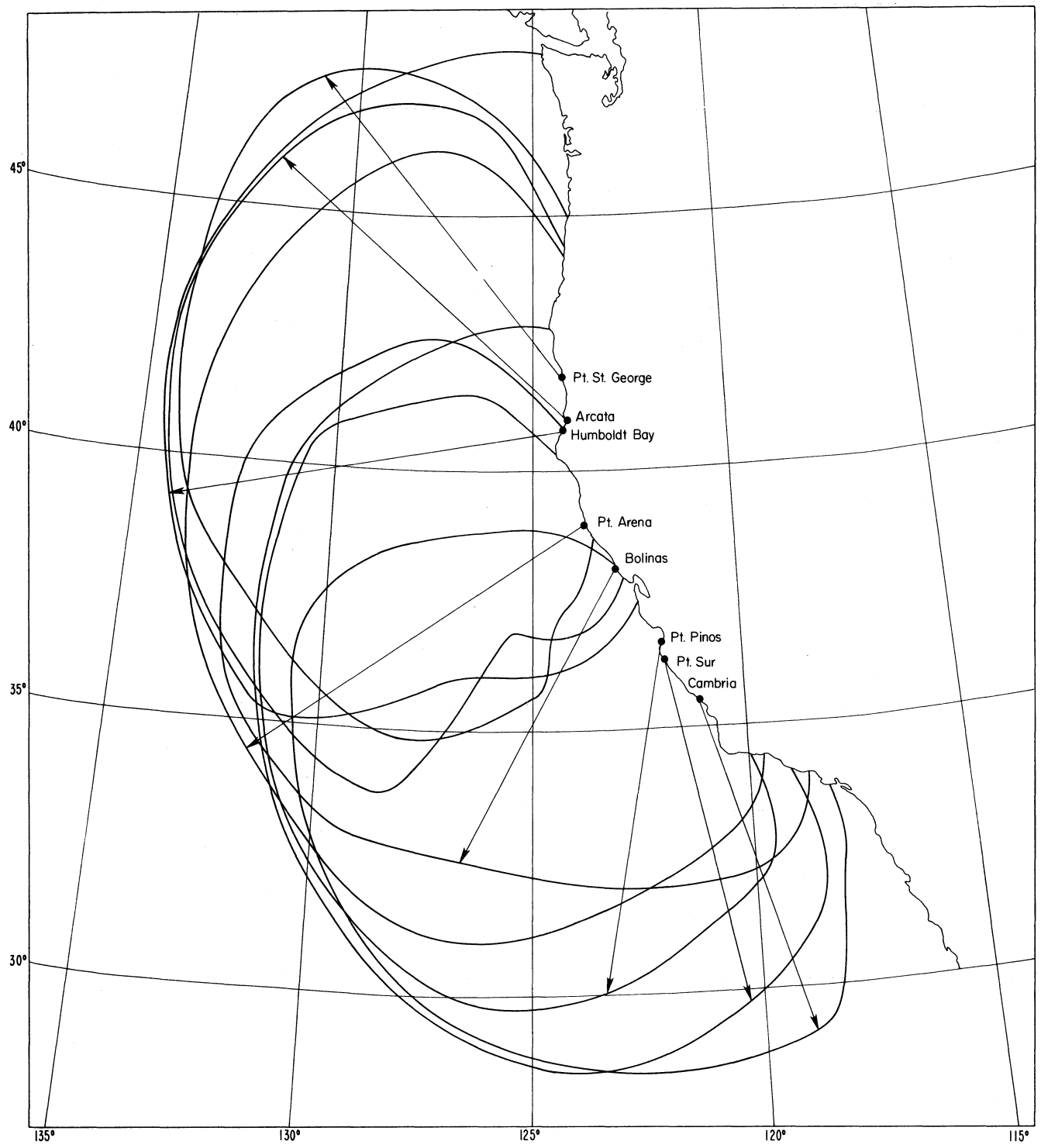

Figure 17. 2182 kHz coverage for District 12, minimum noise.

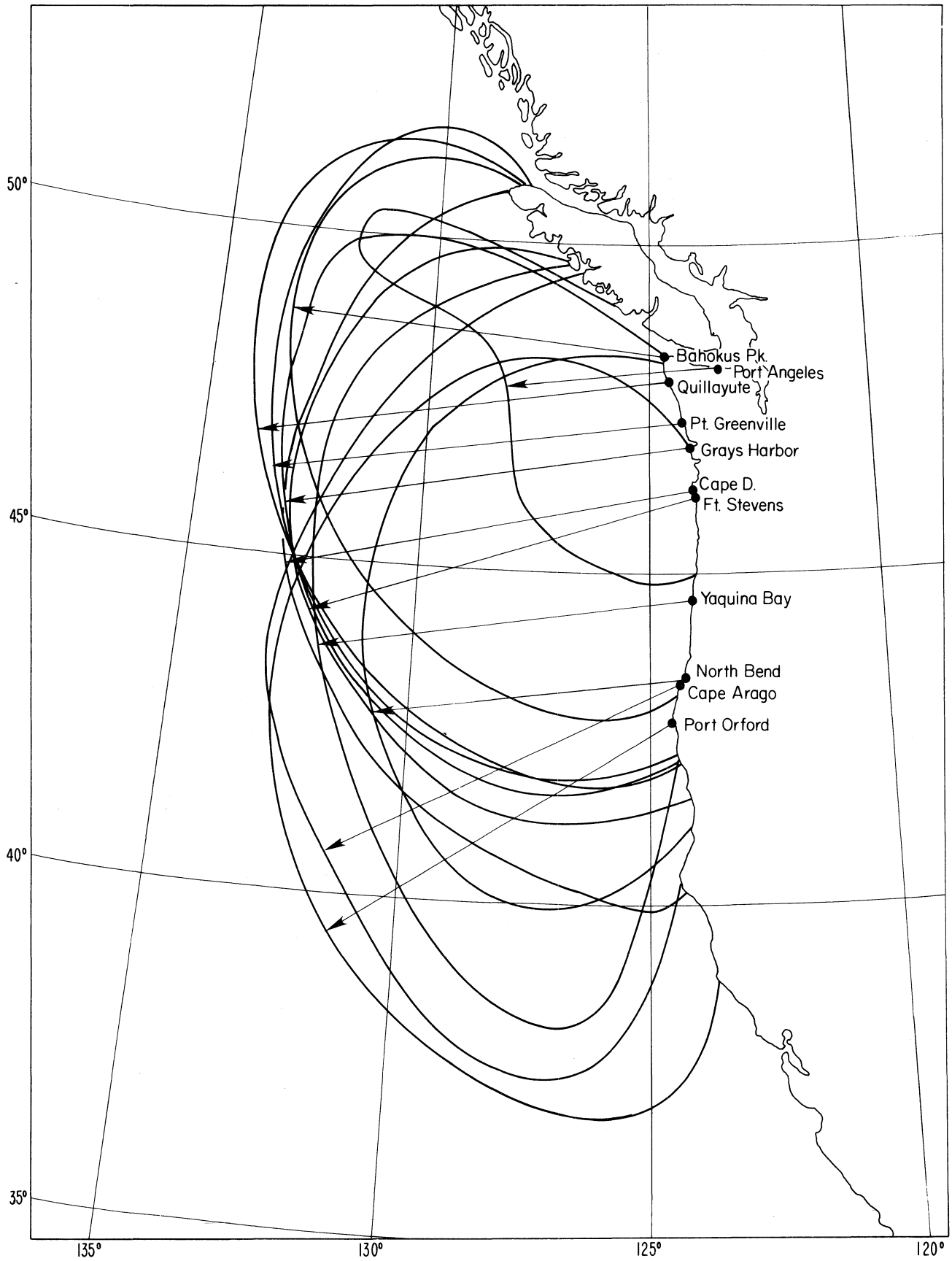

Figure 18. 2182 kHz coverage for District 13, maximum noise.

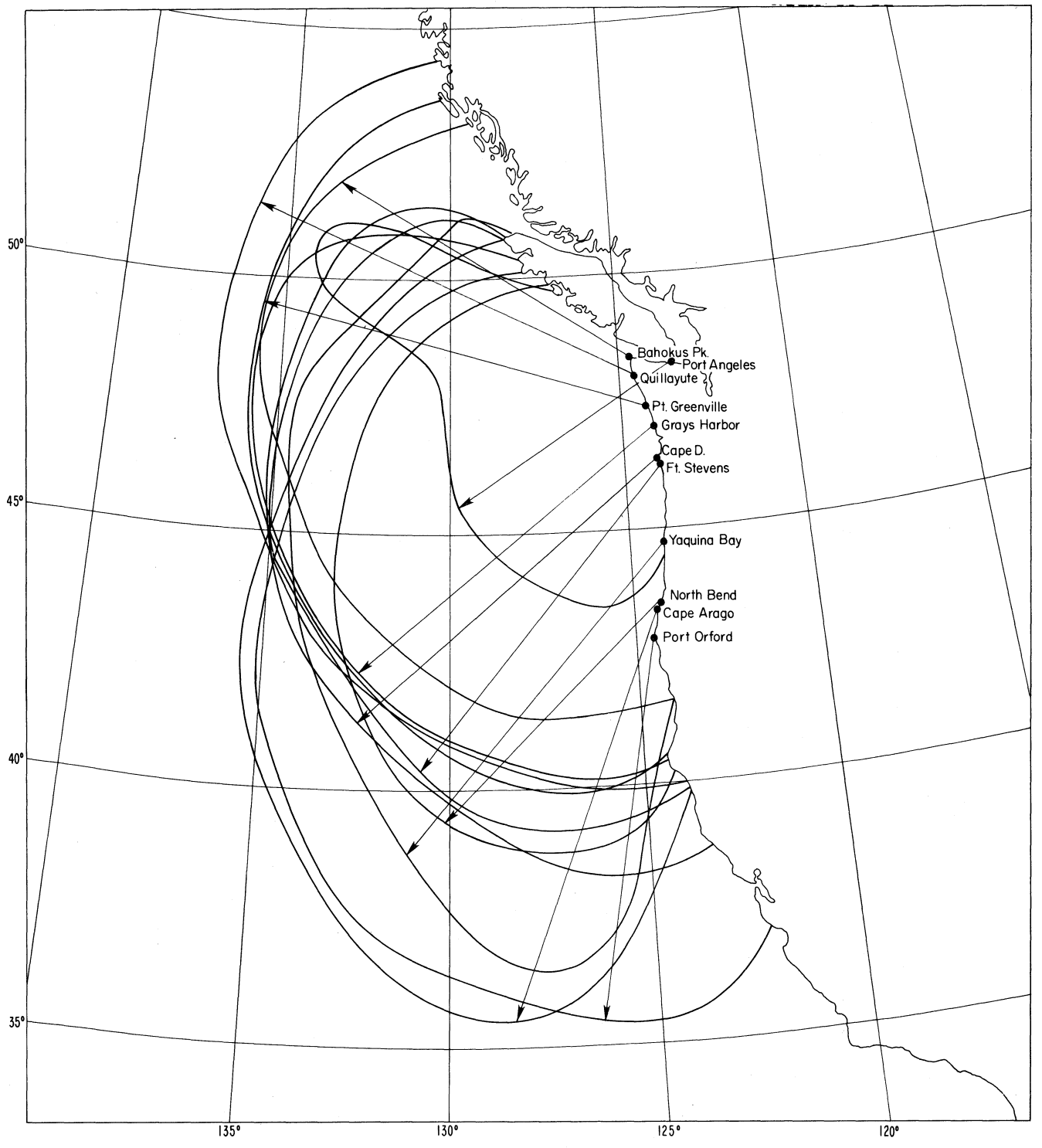

Figure 19. 2182 kHz coverage for District 13, minimum noise.

Table 9. VHF Station Location and Antenna Data for District 1

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	ANTENNA TYPE[1]	ANTENNA HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	ANTENNA DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Boston, MA	42°21'18"	71°03'36"	200	CL	625	5.8	90	23
Brunswick, ME	43°57'00"	69°58'00"	552	SD	360	6	170	21
Eastern Point, MA	42°34'48"	70°39'54"	25	CL	125	5.8	ND[3]	23
Independence, ME	43°45'45"	70°19'30"	420	SD	300	9	120	22
Merrimack River, MA	42°48'53"	70°48'48"	17	CL	134	9	90	22
Mt. Agamenticus, ME	43°13'00"	70°42'00"	656	SD	35	9	56	22
Mt. Cadillac, ME	44°21'00"	68°13'36"	1582	CL	8	5.8	ND	21
Nantucket, MA	41°16'06"	70°10'48"	50	CL	300	5.8	ND	24
Newport Bridge, RI	41°30'12"	71°20'30"	0	SD	400	9	ND	24
Nobska Pt., MA	41°30'54"	70°39'24"	36	CL	125	9	170	24
Owls Head, ME	44°05'30"	69°02'42"	84	CL	15	5.8	ND	21
Provincetown, MA	42°03'06"	70°11'18"	90	CL	90	5.25	ND	23
West Quoddy Head, ME	44°48'54"	66°57'48"	60	CL	75	5.25	ND	20

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 10. VHF Station Location and Antenna Data for District 2

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	TYPE[1]	HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Athens, AL	34°49'51"	86°56'42"	1186	SD	480	6	210	47
Baldknob, IL	37°33'30"	89°20'58"	635	SD	225	6	225	38
Carthage, TN	36°18'43"	87°57'08"	594	VD	90	6	180	44
Caruthersville, MO	36°19'43"	89°17'29"	465	SD	270	5	270	39
Charlestown, IN	38°16'00"	85°45'00"	301	SD	100	6	045	28
Cincinnati, OH	39°06'20"	84°33'24"	395	SD	220	6	ND[3]	27
Coal Mountain, WV	38°24'04"	81°54'06"	1050	SD	100	6	304,124	26
Dubuque, IA	42°24'22"	90°34'09"	814	SD	355	6	090,270	34
Gasconade, MO	38°39'51"	91°32'21"	662	SD	240	6	300	37
Greenville, MS	33°23'06"	91°04'38"	473	SD	370	6	261	41
Hastings, MN	44°43'38"	92°50'18"	223	SD	88	6	ND	33
Helena, AR	34°31'30"	90°35'45"	300	SD	150	6	030,210	40
Henderson, KY	37°51'56"	87°34'04"	709	SD	596	6	ND	29
Knoxville, TN	36°00'13"	83°56'35"	1355	VD	130	6	330	45
La Crosse, MN	43°51'27"	91°10'00"	647	SD	60	6	ND	33
Lockport, IL	41°34'43"	88°01'36"	998	Y	350	8	250	36
Madison, IN	38°44'54"	85°24'17"	438	SD	112	6	005	28
Marshall, MO	39°07'18"	93°15'09"	1109	SD	309	6	055,115,255,285	32
Memphis, TN	35°08'50"	90°03'20"	514	SD	325	6	ND	39
Model, TN	36°36'50"	87°58'40"	572	SY	309	6	010,190,130,310	43
Morgantown, WV	39°37'00"	79°57'00"	1023	Y	80	8	005	25
Mt. Nebo, AR	35°13'29"	93°15'20"	1794	SY	40	10	140,285	48
Natchez, MS	31°29'12"	91°21'42"	585	SD	400	6	280	42
Niota, IL	40°36'30"	91°16'20"	509	SD	400	6	270	35
Omaha, NE	41°19'10"	95°58'53"	485	SY	285	10	180,360	30
Orion, IL	41°18'44"	90°22'47"	605	SD	500	6	090	35
Parkersburg, WV	39°20'59"	81°33'56"	743	SD	350	6	215	26
Peoria, IL	40°39'11"	89°31'11"	825	SD	325	6	180,000	35
Pere Marquette, IL	38°59'55"	90°30'59"	624	SD	190	6	010	37
Pittsburgh, PA	40°27'25"	79°57'28"	630	SD	177	6	ND	25
Poteau, OK	35°04'19"	94°40'46"	2056	SD	135	6	310	48
Signal Mountain, TN	35°08'06"	85°19'25"	1715	SD	400	6	010,190	45
St. Joseph, MO	39°46'12"	94°47'53"	1038	SD	510	6	170,350	31
St. Louis, MO	38°34'15"	90°15'00"	419	SD	140	9	ND	37
Vicksburg, MS	32°23'02"	90°52'45"	154	SD	109	6	ND	41
West Portsmouth, OH	38°43'00"	83°04'00"	1695	SD	600	6	180	27
Wheeling, WV	40°05'30"	80°42'30"	1375	SD	75	6	ND	25
Yellow Creek, MS	34°57'45"	88°13'25"	557	CL	330	6	ND	46

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 11. VHF Station Location and Antenna Data for District 3

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	ANTENNA TYPE[1]	ANTENNA HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Albany, NY	42°37'00"	73°45'48"	600	SD	50	6	ND[3]	50
Atlantic City, NJ	39°22'29"	74°25'17"	5	SD	200	9	100	55
Barnegat, NJ	39°35'20"	74°04'19"	10	SD	175	9	100	55
Bristol Bridge, NJ	40°07'01"	74°49'30"	100	SD	95	6	ND	57
Cape May, NJ	38°56'25"	74°54'13"	10	SD	189	6	ND	56
Delaware Memorial Bridge, DE	39°41'10"	75°31'02"	400	SD	75	6	ND	57
Eatons Neck, NY	40°57'12"	73°23'42"	71	SD	75	9	045	53
Fire Island, NY	40°37'18"	73°15'36"	10	SD	175	9	180	53
Fortescue, NJ	39°14'20"	75°10'18"	70	SD	10	6	ND	57
Governor's Island, NY	40°41'15"	74°01'28"	0		130	9	ND	54
Manasquan Inlet, NJ	40°06'06"	74°02'18"	10	SD	165	6	ND	54
Manhattan Island, NY	40°42'09"	74°00'20"	25	SD	575	6	ND	53
Milford, CT	41°13'00"	72°01'00"	147	SD	100	9	135	51
Montauk, NY	41°04'09"	71°48'17"	40	SD	120	6	ND	52
Mt. Beacon, NY	41°25'00"	73°55'00"	1500	SD	120	6	ND	50
Mt. Mansfield, VT	44°40'00"	73°05'00"	4000	SD	100	6	ND	49
Rehoboth Beach, DE	38°37'35"	75°04'35"	17	CL	100	6	ND	56
Sandy Hook, NJ	40°28'11"	74°00'25"	10	SD	160	6	340	54
Saugerties, NY	42°08'12"	74°02'06"	650	SD	50	6	ND	50
Shinnecock, NY	40°51'00"	72°30'09"	5	SD	200	9	180	52
South Glastonbury, CT	41°45'00"	72°50'00"	25	SD	150	9	ND	51
Waterford, CT	41°19'00"	72°10'00"	105	SD	275	9	205	51

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 12. VHF Station Location and Antenna Data for District 5

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	ANTENNA TYPE[1]	ANTENNA HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	ANTENNA DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Alexandria, VA	38°45'15"	77°07'43"	75	SD	255	12	180	60
Annapolis, MD	39°01'59"	76°29'29"	25	SD	275	12	170	59
Annapolis Bay, MD	38°59'42"	76°23'05"	0	SD	380	9	ND[3]	59
Buxton, NC	35°14'39"	75°32'04"	5	SD	320	12	090	65
Cape Henry, VA	36°55'36"	76°00'30"	2	SD	180	9	ND	63
Carolina Beach, NC	34°03'29"	77°55'00"	2	SD	502	12	190	67
Catonsville, MD	39°13'02"	76°57'59"	300	SD	200	12	070	59
Cedar Island, NC	34°57'44"	76°16'58"	10	SD	220	12	152	66
Chincoteague, VA	37°55'53"	75°23'07"	5	SD	254	12	130	61
Cobbs Creek, VA	37°31'02"	76°24'04"	30	SD	270	9	102	62
Crisfield, MD	37°58'29"	75°49'55"	2	SD	250	12	225, 315	61
Croatan, NC	34°47'50"	76°56'30"	25	SD	280	12	135	66
Elizabeth City, NC	36°18'24"	76°16'00"	7	SD	280	12	120	64
Engelhard, NC	35°36'46"	76°02'30"	6	SD	260	12	120	65
Hobucken, NC	35°14'47"	76°36'02"	20	SD	180	9	090	65
Hollyridge, NC	34°31'10"	77°31'30"	60	SD	180	12	140	66
Midway, NC	36°05'12"	76°45'42"	50	SD	250	9	180	64
Newport News, VA	37°13'00"	76°33'00"	25	SD	325	12	305	63
North East, MD	39°34'01"	75°55'25"	280	SD	150	9	ND	58
Oakgrove, VA	38°08'42"	76°54'12"	175	SD	425	12	105	60
Ocean City, MD	38°19'00"	75°05'00"	100	SD	105	12	130	61
Oregon Inlet, NC	35°46'02"	75°31'29"	5	SD	200	12	065	64
Parramore Beach, VA	37°33'34"	75°37'30"	5	SD	105	12	130	62
Portsmouth, VA	36°50'12"	76°18'15"	5	SD	100	6	ND	63
Richmond, VA	37°31'00"	77°32'19"	250	SD	260	12	135	62

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 13. VHF Station Location and Antenna Data for District 7

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	TYPE[1]	HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Cape Kennedy, FL	28°30'05"	80°34'54"	9	CL	400	5.25	90	71
Crystal River, FL	28°57'27"	82°42'05"	4	SD	450	12	270	77
Delray Beach, FL	26°25'58"	80°05'30"	15	SD	285	12	90	72
Flagler Beach, FL	29°28'03"	81°08'38"	14	SD	237	9	ND[3]	70
Ft. Pierce, FL	27°32'46"	80°22'08"	30	SD	400	12	90	71
Islamorada, FL	24°57'30"	80°34'30"	4	CL	300	5.25	90	73
Jacksonville Beach, FL	30°20'00"	81°25'00"	11	SD	257	9	ND	70
Jekyll Island, FL	31°01'08"	81°25'54"	15	SD	300	12	90	69
Jupiter, FL	26°56'22"	80°07'04"	10	SD	300	6	75	71
Key West, FL	24°33'22"	81°48'21"	6	CL	200	5.25	270	74
Marathon, FL	24°42'43"	81°05'46"	8	SD	200	6	135	74
Miami Beach, FL	25°49'23"	80°07'19"	5	CL	225	5.25	ND	72
Mt. Pleasant, SC	32°47'31"	79°50'40"	5	SD	450	12	90	68
Myrtle Beach, SC	33°42'58"	78°52'32"	25	SD	230	12	90	68
Naples, FL	26°03'20"	81°42'30"	3	SD	500	12	220	75
Parris Island, SC	32°18'57"	80°41'55"	7	SD	300	12	90	69
Pine Island, FL	26°36'35"	82°07'00"	8	CL	200	5.25	ND	75
Princeton, FL	25°37'19"	80°23'23"	12	SD	298	12	90	72
Seminole, FL	27°50'54"	82°45'49"	10	SD	300	12	270	76
South Island, SC	33°09'13"	79°12'20"	10	CL	145°	5.25	ND	68
Steinhatchee, FL	29°40'20"	83°22'40"	12	SD	150	12	220	77
Sugarloaf Key, FL	24°39'39"	81°32'18"	4	SD	330	12	270	74
Tarpon Springs, FL	28°11'04"	82°45'39"	5	SD	425	12	270	76
Tybee Island, GA	32°01'18"	80°50'45"	8	CL	145	5.25	ND	69
Venice, FL	27°06'00"	82°22'15"	13	SD	450	12	270	76

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 14. VHF Station Location and Antenna Data for District 8

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	ANTENNA TYPE[1]	ANTENNA HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Cameron, LA	29°47'34"	93°18'00"	8		400	9	180	86
Cameron, LA	29°47'34"	93°18'00"	8		400	9	000	86
Cape San Blas, FL	29°40'31"	85°20'48"	0		220	12	150	78
Chalmette, LA	29°57'13"	89°57'32"	0		600	9	060	81
Chalmette, LA	29°57'13"	89°57'32"	0		600	9	240	81
Ft. Walton, FL	30°23'14"	86°48'12"	8		280	12	190	79
Freeport, TX	28°58'42"	95°18'42"	10		380	12	175	87
Galveston, TX	29°20'02"	94°46'05"	10		211	12	125	87
Gulfport, MS	30°23'17"	89°07'53"	14		360	12	160	80
Leeville, LA	29°13'16"	90°12'51"	0		560	9	040	82
Leeville, LA	29°13'16"	90°12'51"	0		560	9	220	82
Morgan Pt., TX	29°41'23"	94°59'17"	0		170	6	ND[3]	87
Panama City, FL	30°11'01"	85°46'34"	10		300	12	225	79
Pascagoula, MS	30°21'55"	88°32'39"	0		160	5.25	ND	80
Pecan Island, LA	29°41'33"	92°30'12"	6		400	9	005	85
Pecan Island, LA	29°41'33"	92°30'12"	6		400	9	185	85
Plaquemine Pt. LA	30°17'49"	91°11'40"	25		800	12	150	83
Plaquemine Pt. LA	30°17'49"	91°11'40"	22	Y	778	9.3	330	83
Pt. Isabel, TX	26°04'22"	97°09'55"	10		140	12	110	89
Pt. Mansfield, TX	26°32'16"	97°26'38"	10		270	12	075	89
Pt. O'Connor, TX	28°26'17"	96°25'49"	12		300	9	330	88
Pt. O'Connor, TX	28°26'17"	96°25'49"	12		300	9	150	88
Robstown, TX	27°39'12"	97°33'55"	59		840	12	080	88
Sabine, TX	29°42'49"	93°51'45"	6		415	9	180	86
Sabine, TX	29°42'49"	93°51'45"	6		415	9	000	86
St. Marks, FL	30°09'42"	84°12'21"	5		228	12	220	78
South Bend, LA	29°37'31"	91°32'06"	8		460	9	000	84
South Bend, LA	29°37'31"	91°32'06"	8		460	9	180	84
Spanish Fort, AL	30°39'33"	87°53'33"	160		500	12	180	80
Venice, LA	29°16'56"	89°21'47"	10		350	9	090	82

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 15. VHF Station Location and Antenna Data for District 9

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	ANTENNA TYPE[1]	ANTENNA HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Alexandria Bay, NY	44°18'12"	75°59'03"	245		205	9	ND[3]	90
Alpena, MI	44°51'24"	83°25'36"	900		200	12	090	94
Ashtabula, OH	41°54'08"	80°47'56"	580		140	9	000	92
Bayfield, WI	46°49'33"	90°50'27"	1110		200	12	045	100
Beaver Island, MI	45°34'34"	85°34'24"	610		300	12	225	96
Belle Island, MI	42°21'00"	83°00'18"	583		290	9	040	93
Calumet, MI	47°22'18"	88°10'12"	1510		100	12	090	99
Chicago, IL	41°53'00"	87°37'00"	583		525	12	ND	98
Cleveland, OH	41°30'17"	81°41'30"	620		550	9	350	93
Duluth, MN	46°47'36"	92°07'48"	1246		130	16	060	100
Dunkirk, NY	42°25'30"	79°15'00"	1500		100	9	000	92
Frankfort, MI	44°38'16"	86°14'30"	780		140	9	275	96
Goetzville, MI	46°03'36"	84°05'57"	750		900	12	134	95
Grand Marais, MI	46°32'48"	86°02'20"	1150		200	12	000	99
Holland, MI	42°54'10"	86°12'20"	598		375	12	270	98
Ludington, MI	44°01'00"	86°30'00"	850		85	12	225	97
Milwaukee, WI	43°06'06"	87°53'18"	583		540	9	090	98
Munising, MI	46°24'30"	86°39'00"	1060		100	12	000	99
North Superior, MN	47°46'00"	90°20'48"	1100		125	12	122	100
Oswego, NY	43°27'34"	76°31'55"	260		563	12	000	90
Pt. Austin, MI	44°01'50"	83°00'04	569		250	12	020	94
Pt. Huron, MI	43°00'00"	82°25'00"	579		175	9	180	93
Rochester, NY	43°17'05"	77°37'09"	255		180	12	000	91
Sault Ste. Marie, MI	46°26'30"	84°23'40"	759		125	4.5	310	95
Sault Ste. Marie, MI	46°26'30"	84°23'40"	759		125	4.5	145	95
Sturgeon Bay, WI	44°54'06"	87°22'05"	869		460	12	035	96
Toledo, OH	41°40'00"	83°22'00"	590		550	12	080	93
Two Rivers, WI	44°08'08"	87°33'05"	583		85	12	090	97
30 Mile Pt.	43°20'30"	78°29'20"	560		200	12	000	91

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 16. VHF Station Location and Antenna Data for District 11

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	TYPE[1]	HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Laguna Peak, CA	34°06'36"	119°03'54"	1450	SD	70	12	300	102
Point Loma, CA	32°42'03"	117°14'30"	435	SD	100	12	180	101
San Clemente, CA	32°53'06"	118°27'01"	2065	SD	100	12	050	101
San Pedro Channel, CA	33°44'46"	118°20'07"	1593	CL	143	6	ND[3]	101
Tranquillon Mtn., CA	34°34'48"	120°33'30"	2170	SD	50	12	150	102

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 17. VHF Station Location and Antenna Data for District 12

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	TYPE[1]	HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Cahto Peak, CA	39°41'14"	123°34'45"	4233	CR	35	6	315, 270	106
Cambria, CA	35°30'53"	121°03'30"	640	SD	50	12	ND[3]	103
Jenner, CA	38°29'54"	123°11'03"	1350	SD	60	12	ND	105
Mt. Diablo, CA	37°55'00"	121°55'00"	3685	W	50	6	ND	104
Mt. Tamalpias, CA	37°55'26"	122°35'43"	2578	W	30	6	ND	104
Mt. Umunhum, CA	37°09'37"	121°54'24"	3380	SD	16	8	ND	104
Pt. Cabrillo, CA	39°20'55"	123°49'30"	52	W	32	6	ND	105
Pt. Sur, CA	36°18'24"	121°54'00"	270	SD	100	12	ND	103
Trinidad, CA	40°03'16"	124°09'16"	358	SD	50	12	ND	106

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

Table 18. VHF Station Location and Antenna Data for District 13

LOCATION	LATITUDE (N)	LONGITUDE (W)	ELEVATION (ft/MSL)	TYPE[1]	HEIGHT (ft)[2]	ANTENNA GAIN (dBi)	DIRECTION (DEG/TRUE N)	FIGURE NUMBER
Bahokus Peak, WA	48°21'54"	124°39'18"	1350	CL	50	5.6	ND[3]	109
Browns Pt., WA	48°18'24"	122°26'36"	9	CL	31	5.6	ND	108
Cape Disappointment, WA	46°16'30"	124°03'12"	167	CL	35	5.6	ND	110
Cape Mears, OR	45°29'12"	123°58'36"	215	CL	17	5.6	ND	110
Cape Sebastian, OR	42°19'24"	124°23'36"	423	CL	30	5.6	ND	112
Gold Mountain, WA	47°37'54"	122°21'12"	1731	CL	45	5.6	ND	108
Gray's Harbor, WA	46°53'18"	124°06'54"	18	W	107	5.6	270	110
Heceta Head, OR	44°08'12"	124°07'36"	149	CL	56	5.6	ND	111
Jump-Off-Joe Mtn., WA	46°06'12"	119°08'12"	2000	CL	45	5.6	ND	115
Kalaloch, WA	47°39'42"	124°17'30"	1298	CL	25	5.6	ND	109
King TV Tower, WA	47°37'54"	122°21'12"	850	CL	125	5.6	ND	108
Lyle (DLS), OR	45°06'12"	121°06'06"	3210	CL	8	5.6	ND	114
Mt. Constitution, WA	47°32'48"	122°47'24"	2300	CL	50	5.6	ND	107
Port Angeles, WA	48°08'24"	123°24'48"	10	CL	50	5.6	ND	109
Port Orford, OR	42°44'12"	124°30'42"	225	CL	90	5.6	ND	112
Rainier, OR	46°02'30"	122°55'12"	750	CL	45	5.6	ND	113
Seattle Pier, WA	48°35'24"	122°20'30"	20	CL	50	5.6	ND	107
Shannon Pt., WA	48°30'30"	122°40'54"	10	CL	50	5.6	ND	107
Skyline, OR	45°32'24"	122°39'12"	1100	CL	60	5.6	ND	113
Sun Devils, OR	43°17'36"	124°22'12"	719	CL	35	5.6	ND	112
West Point, WA	47°39'42"	122°26'06"	10	CL	23	5.6	ND	108
Yaquina Head, OR	44°40'36"	124°03'30"	426	CL	25	5.6	ND	111

[1] CL COLLINEAR
CR CORNER REFLECTOR
SD STACKED DIPOLE
W WHIP OR VERTICAL WIRE
Y YAGI

[2] 1 ft = 0.3048 m

[3] ND non-directional

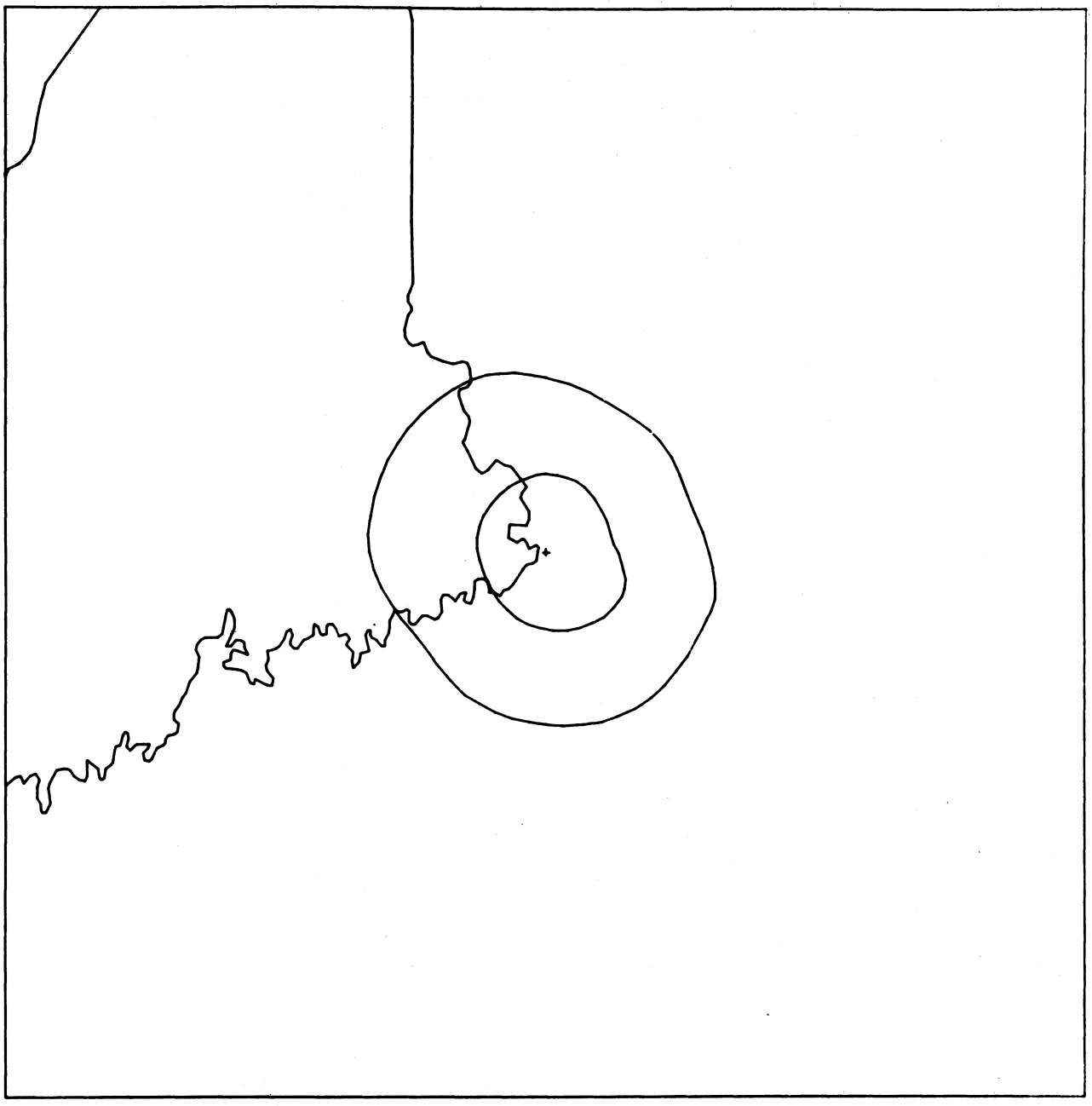

Figure 20. VHF coverage for the District 1 station at West Quoddy Head (solid).
Center: 44°48'54"N, 66°57'48"W.

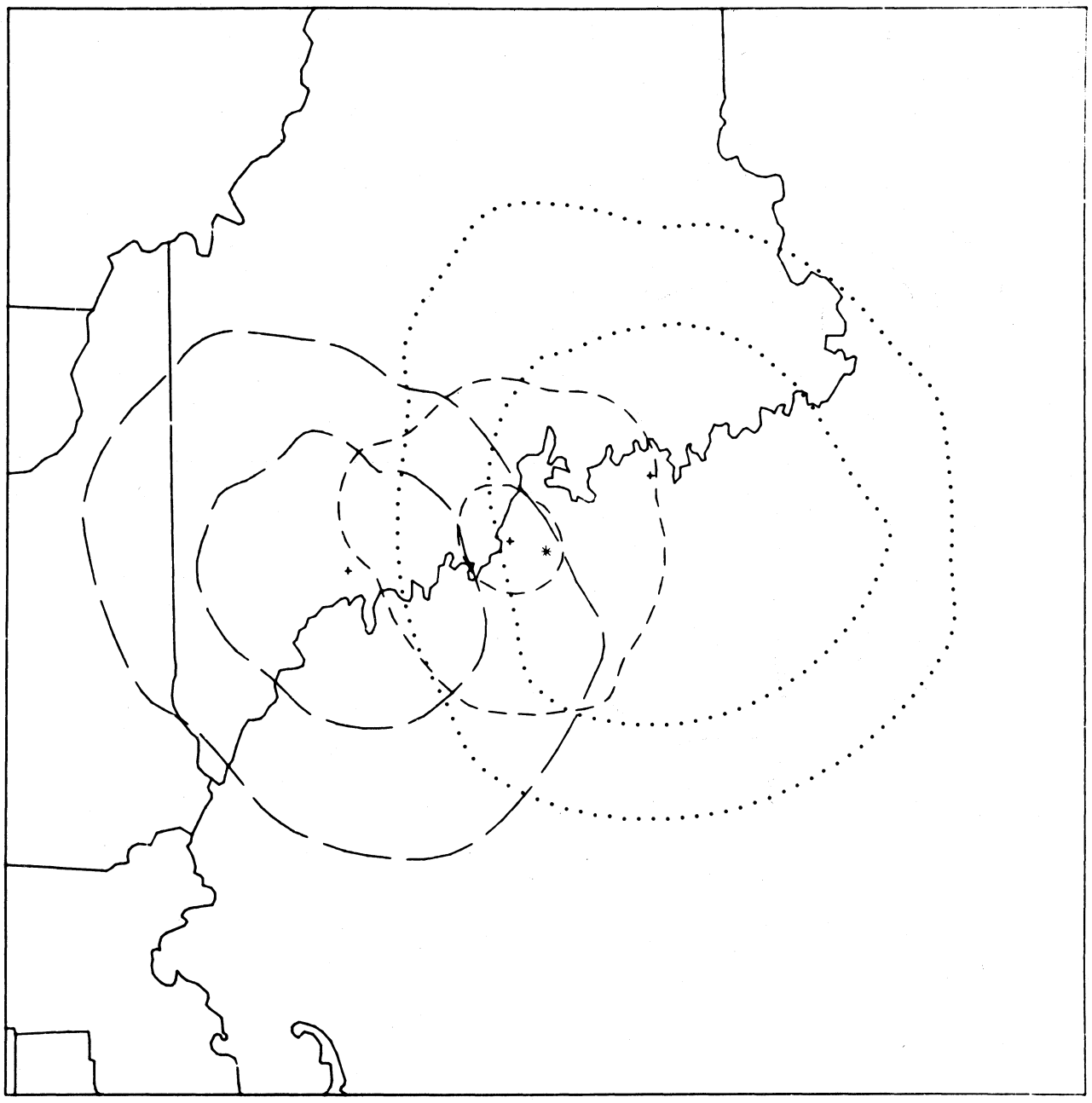

Figure 21. VHF coverage for the District 1 stations at Mt. Cadillac (dots), Owls Head (short dashes), and Brunswick (long dashes).
Center: 44°2'54"N, 68°49'48"W.

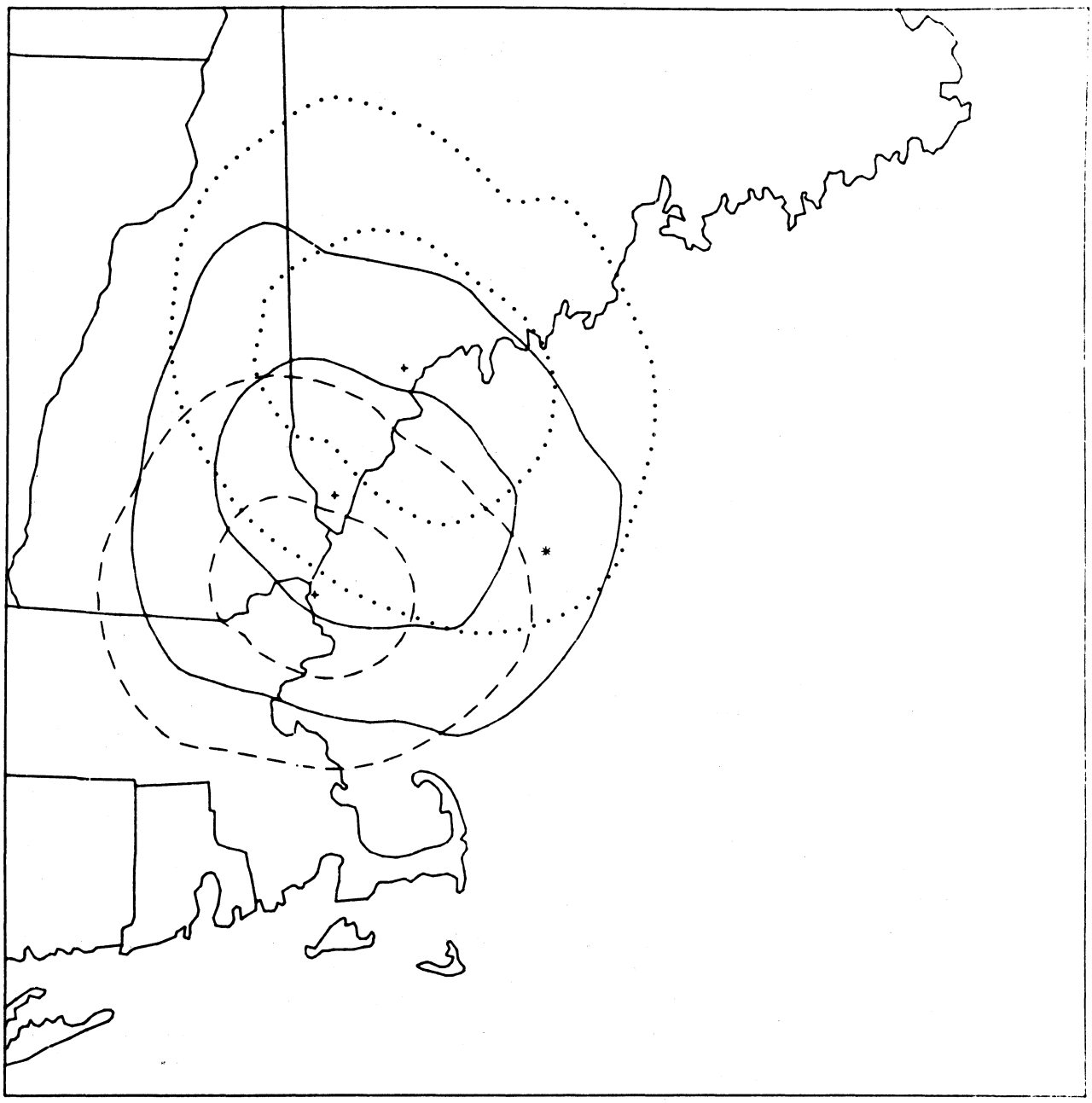

Figure 22. VHF coverage for the District 1 stations at Mt. Agamenticus (solid), Merrimac River (short dashes), and Independence (dots). Center: 43°0'0"N, 69°30'0"W.

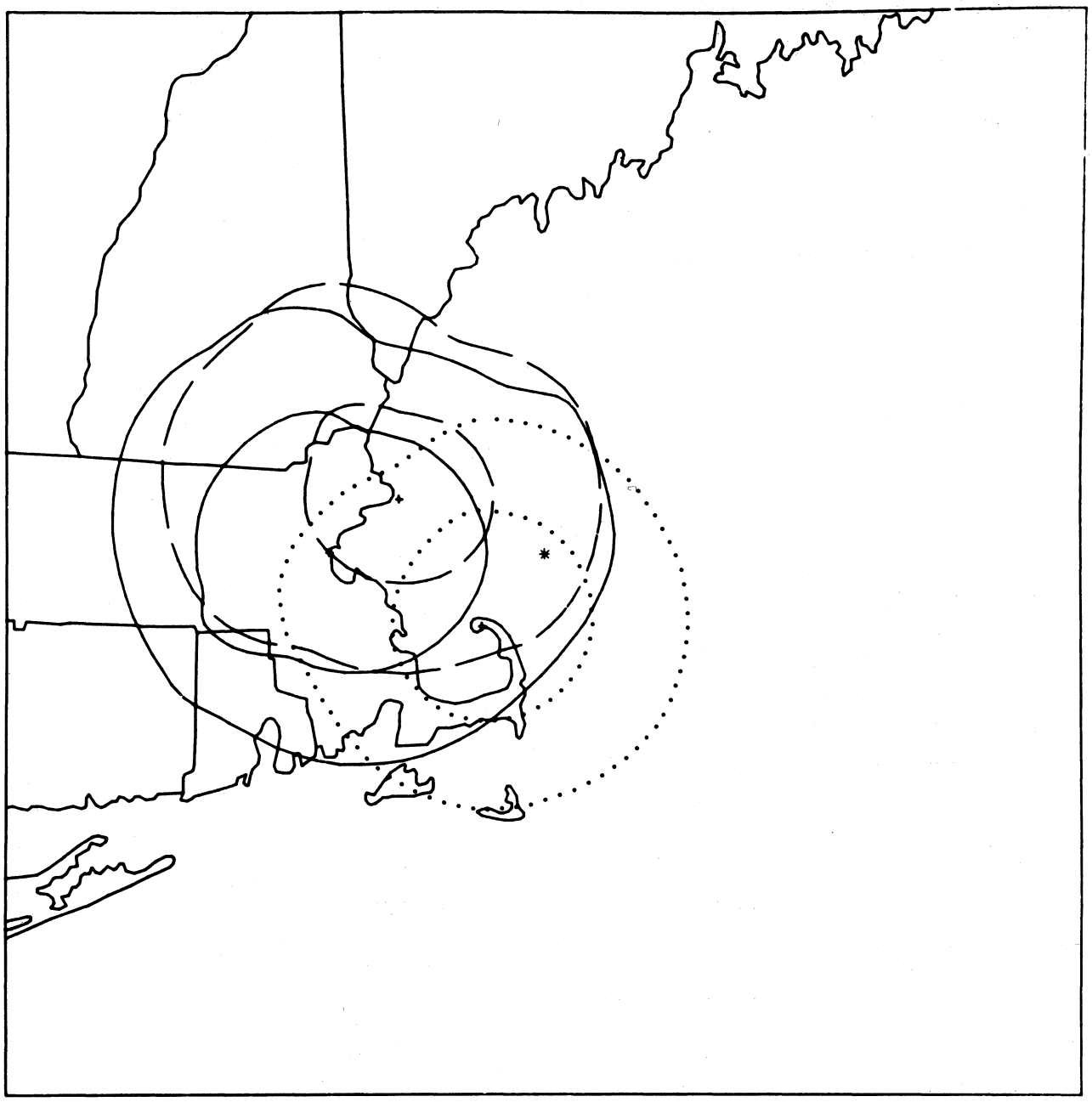

Figure 23. VHF coverage for the District 1 station at Boston (solid), Provincetown (dots), and Eastern Point (long dashes).
Center: 42°21'18"N, 69°50'0"W.

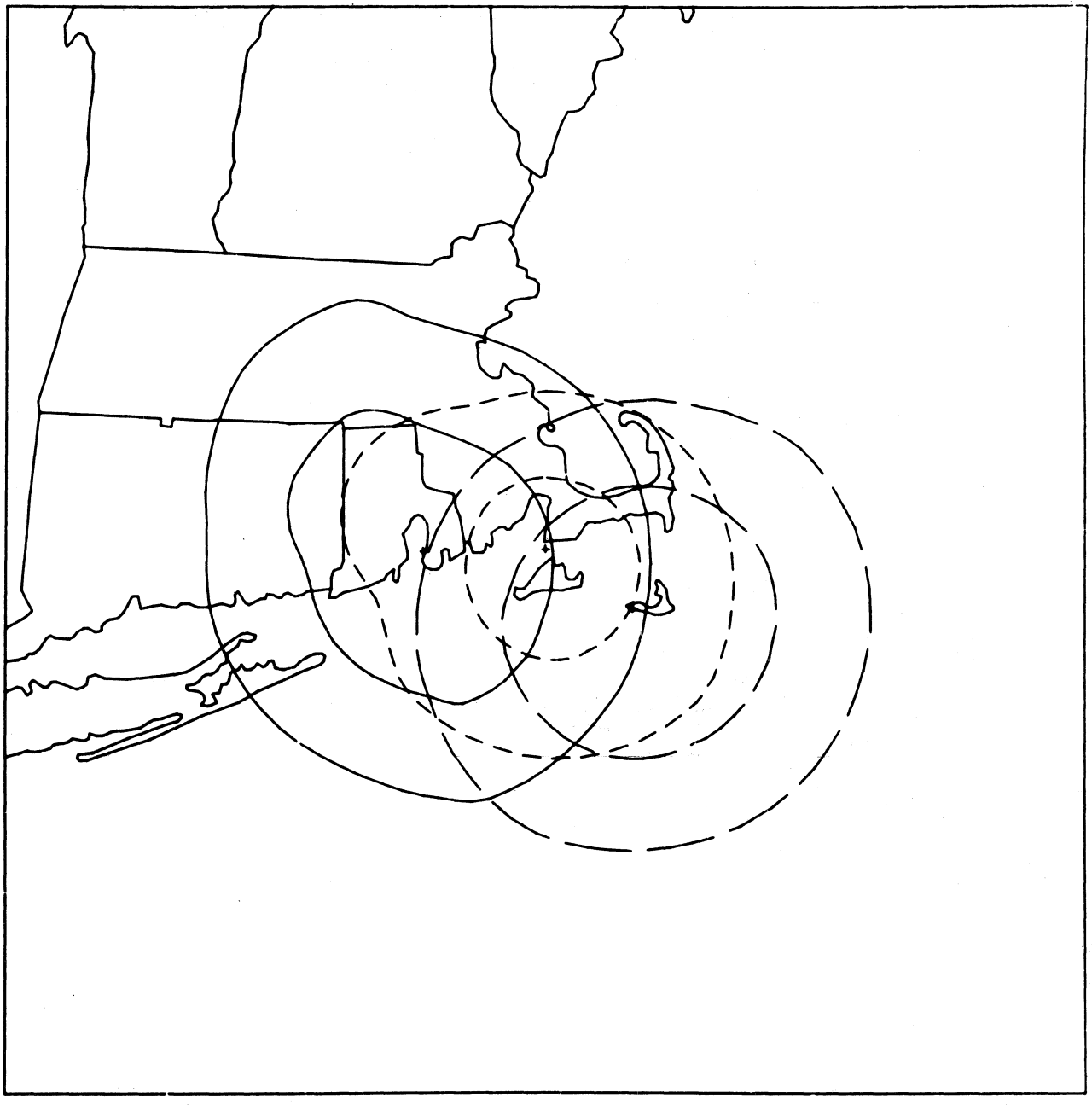

Figure 24. VHF coverage for the District 1 station at Nantucket (long dashes), Nobska Point (short dashes) and Newport Building (solid).
Center: 41°30'54"N, 70°39'24"W.

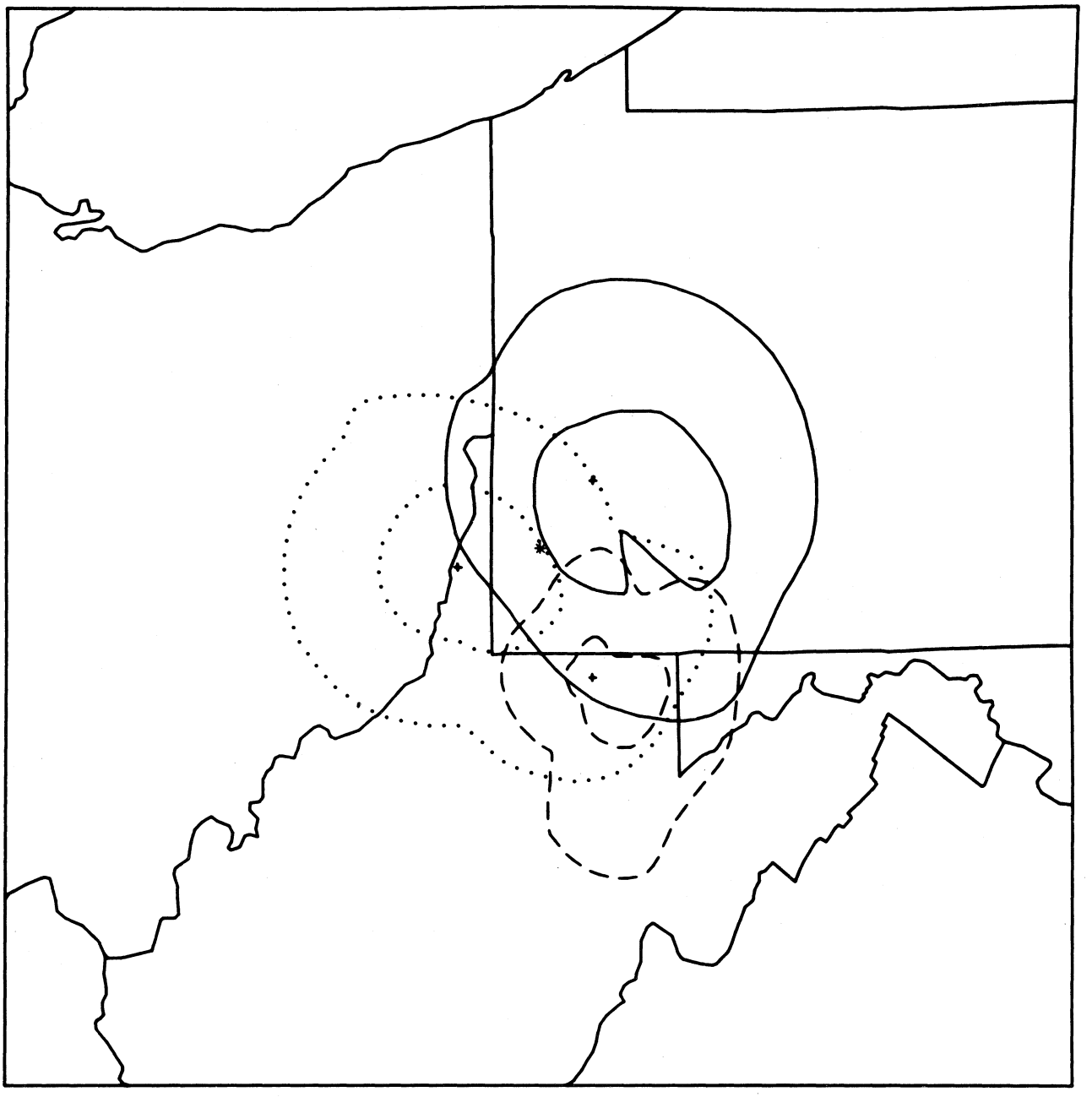

Figure 25. VHF coverage for the District 2 station at Pittsburgh (solid), Morgantown (short dashes), and Wheeling (dots).
Center: 40°10'12"N, 80°14'54"W.

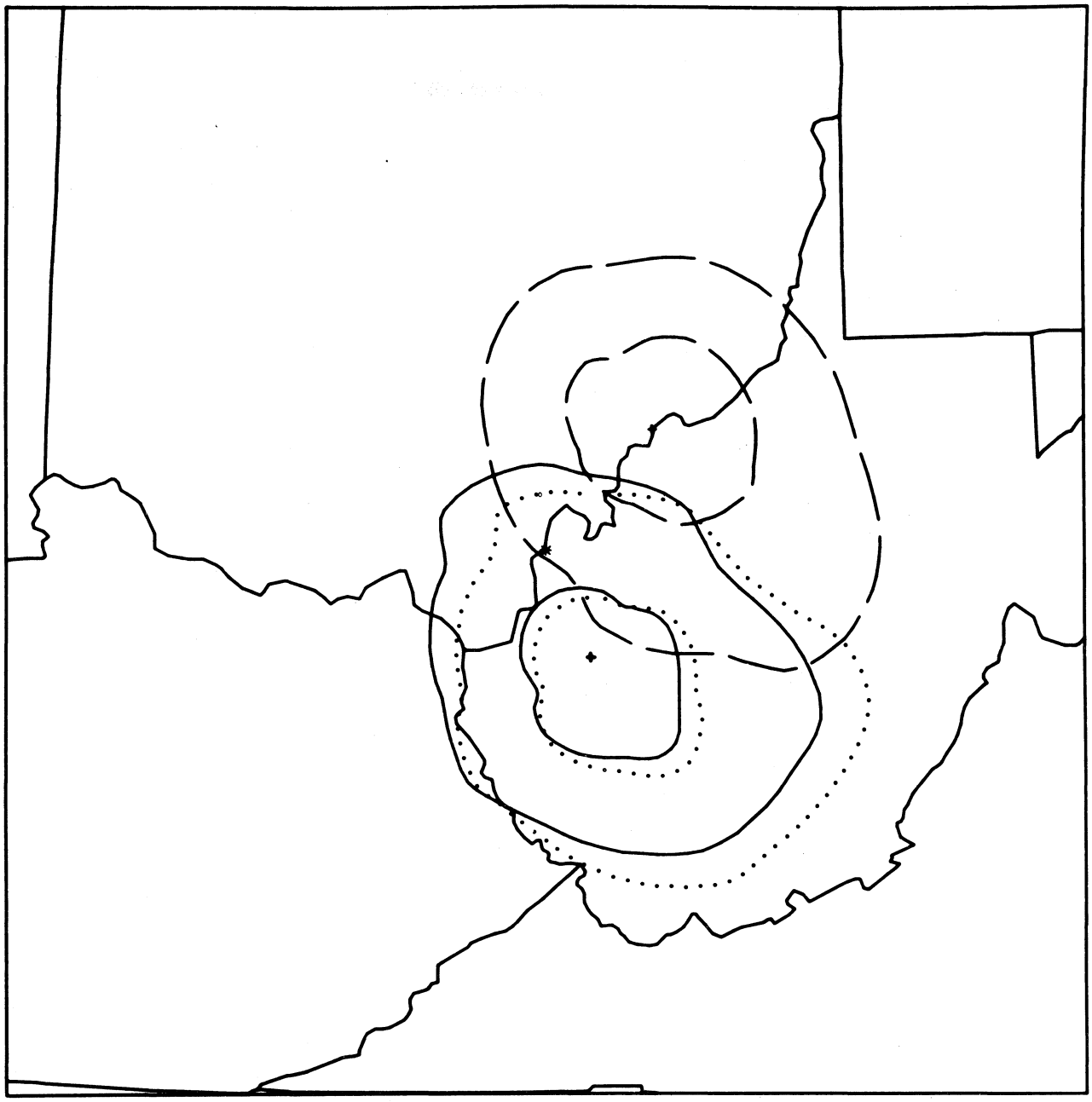

Figure 26. VHF coverage for the District 2 station at Parkersburg (long dashes), Coal Mountain (124°, dots; 304°, solid). Center: 38°50'42"N, 82°8'18"W.

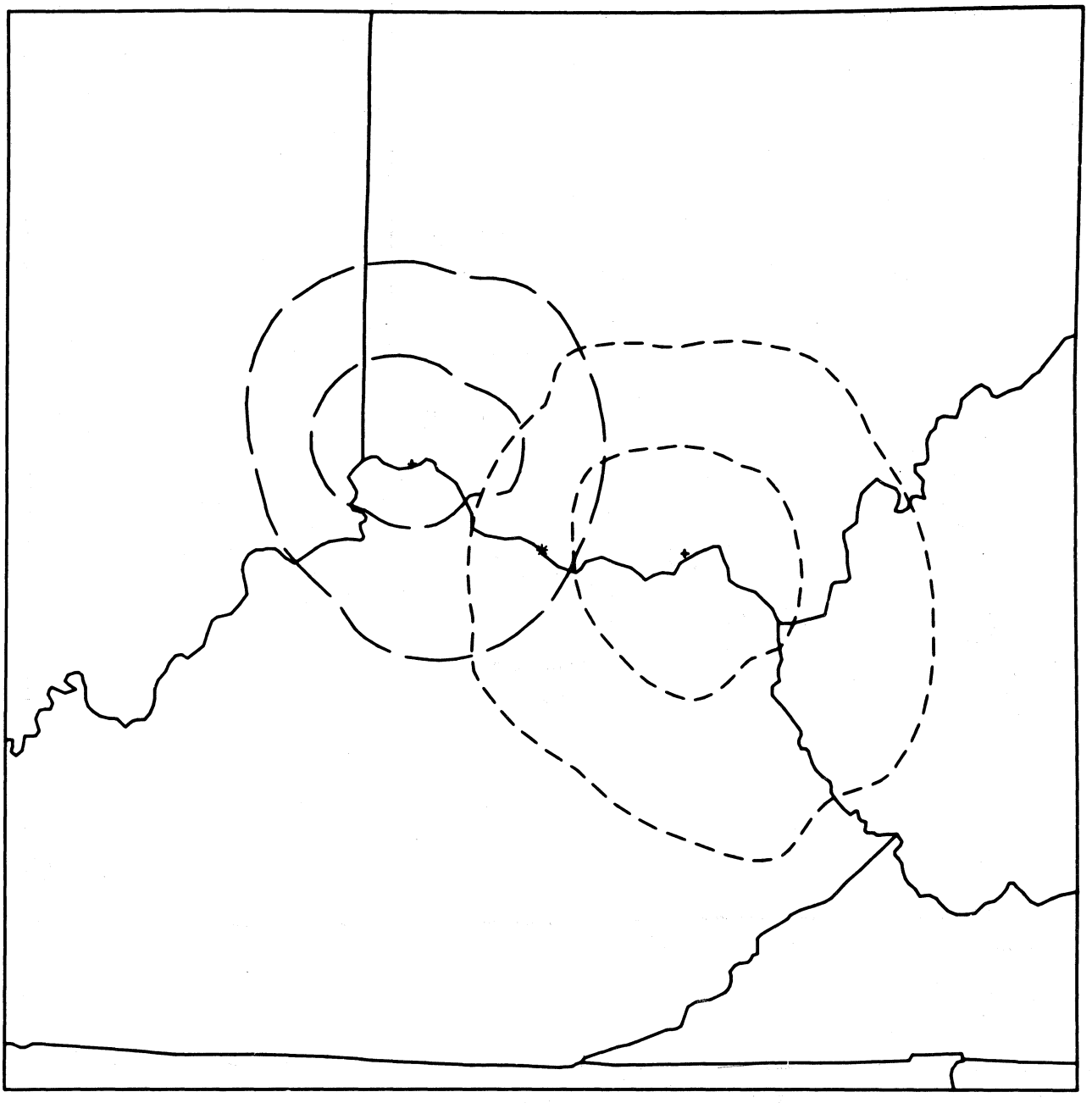

Figure 27. VHF coverage for the District 2 station at West Portsmouth (short dashes) and Cincinnati (long dashes). Center: 38°44'42"N, 83°50'42"W.

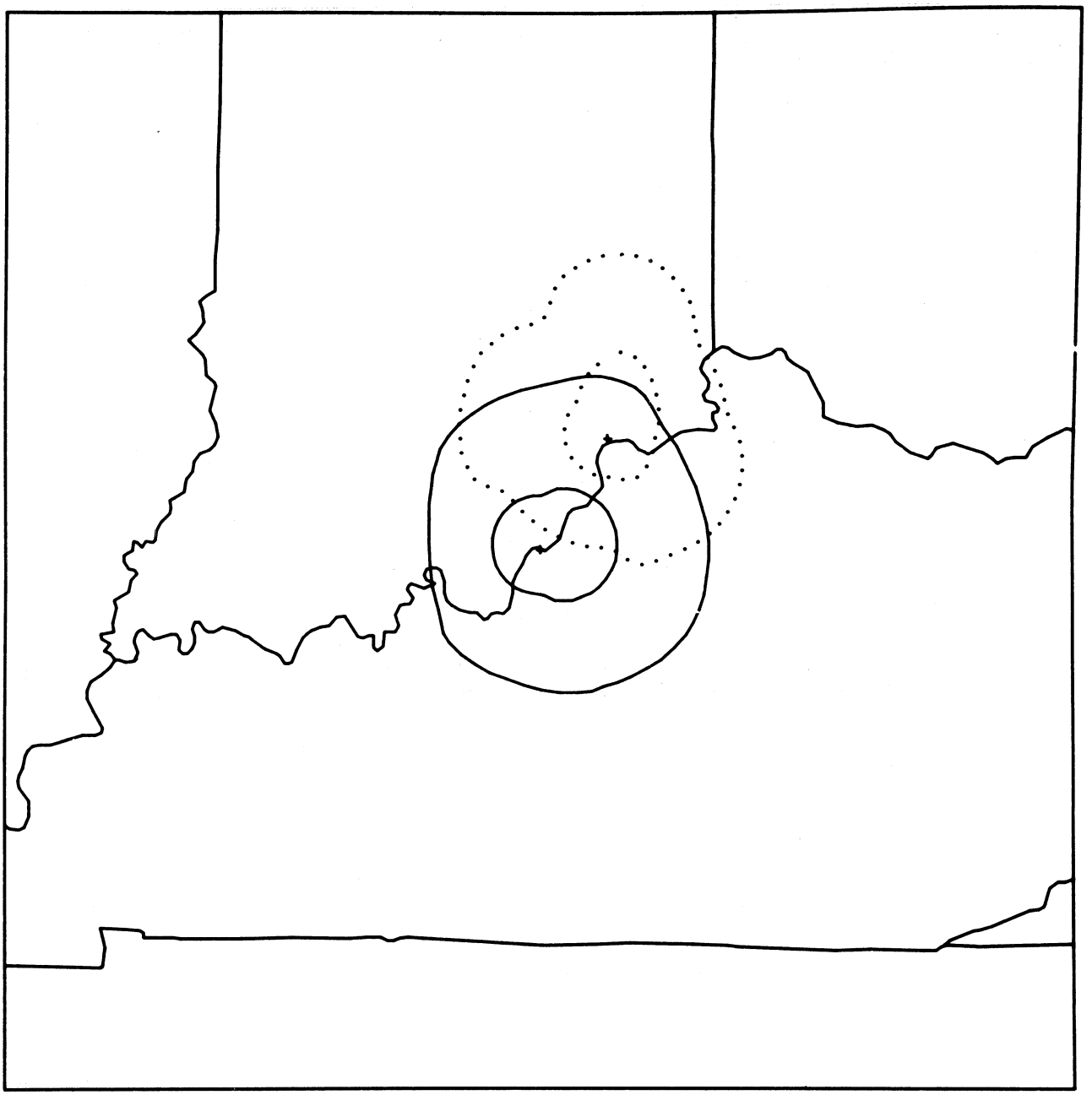

Figure 28. VHF coverage for the District 2 station at Madison (dots) and Charlestown (solid). Center: 38°16'40"N, 85°45'40"W.

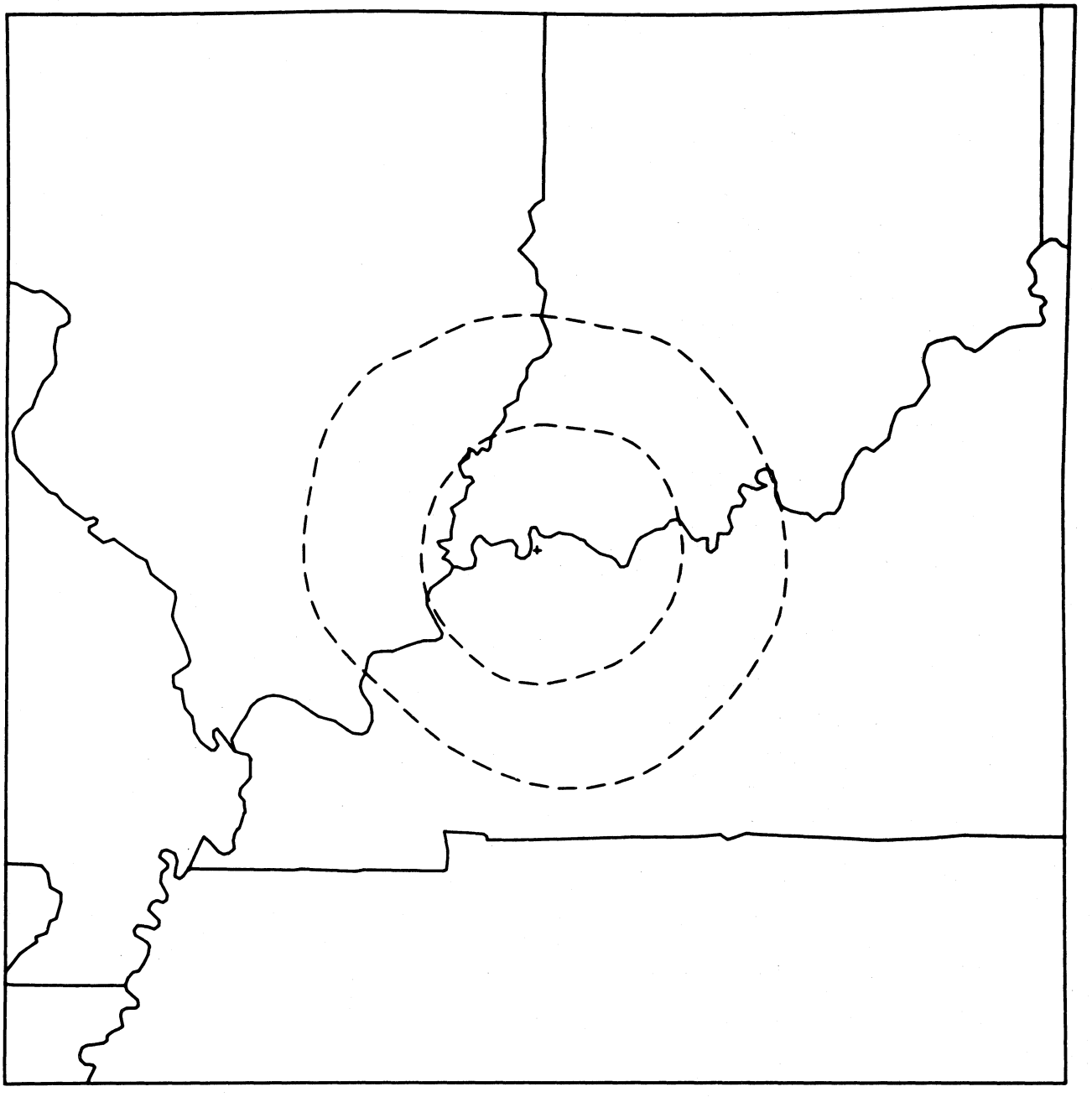

Figure 29. VHF coverage for the District 2 station at Henderson (short dashes).

Center: 37°51'56"N, 87°34'4"W.

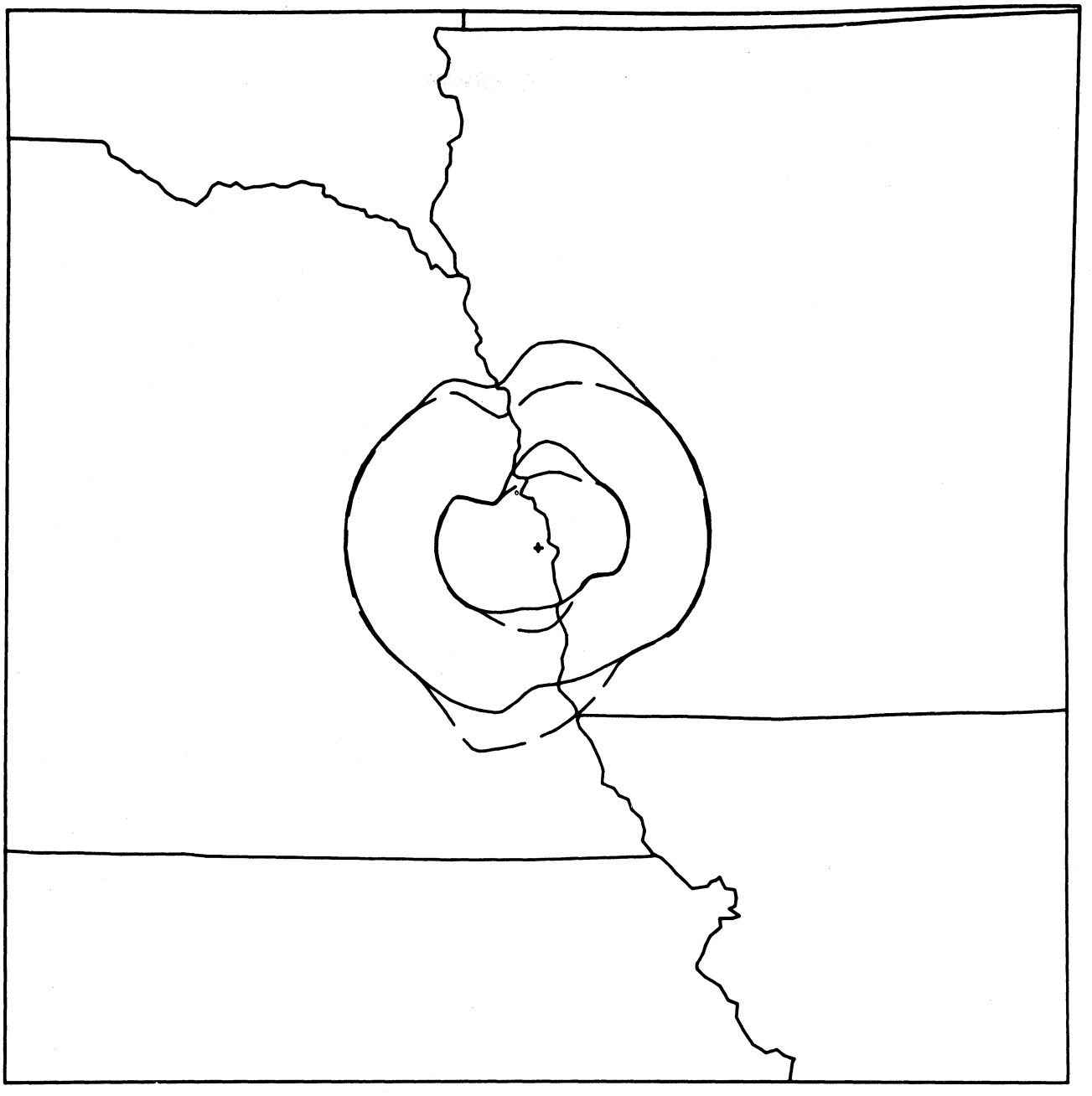

Figure 30. VHF coverage for the District 2 station at Omaha (180°, long dashes; 0°, solid). Center: 41°19'10"N, 95°58'53"W.

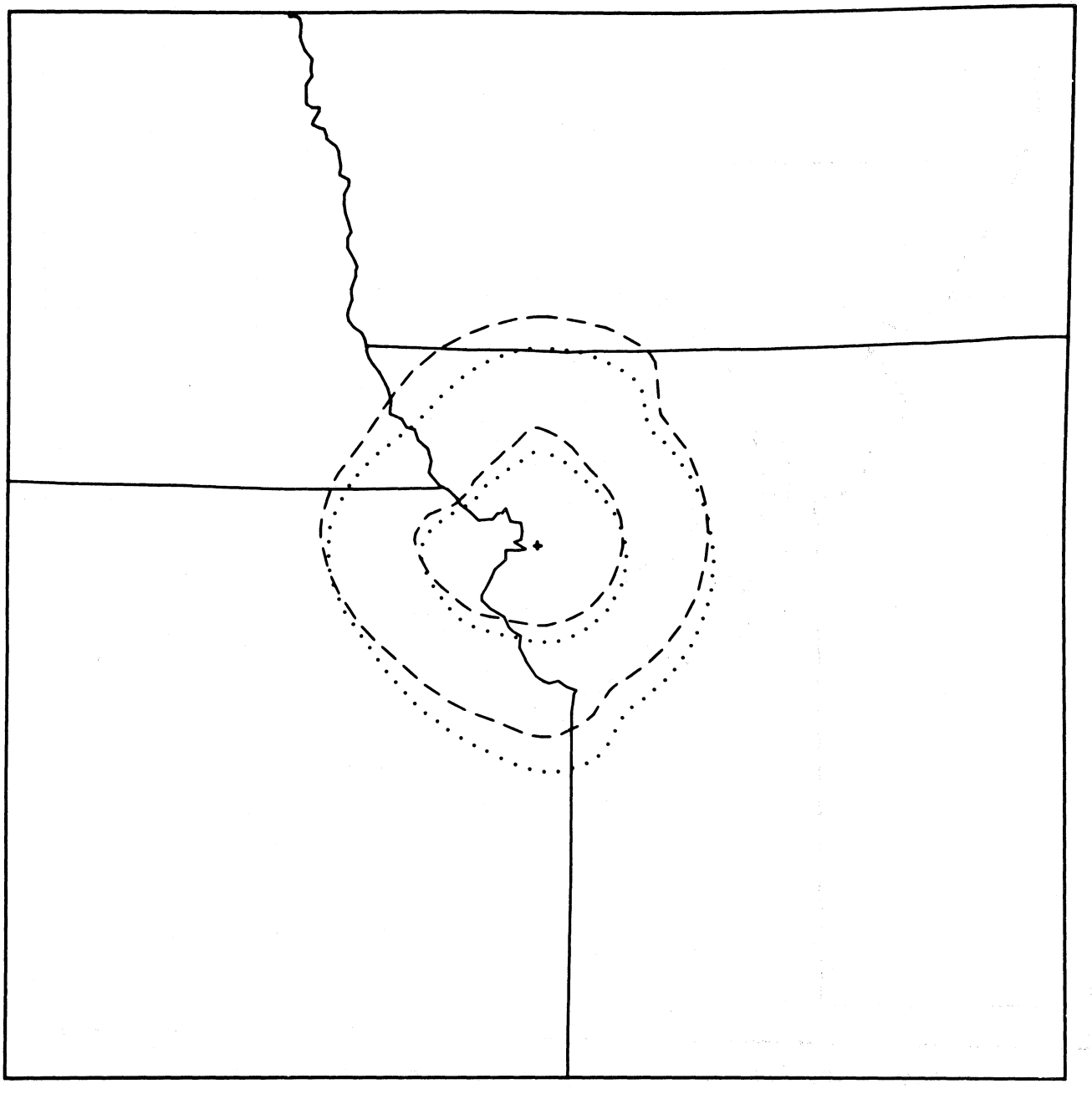

Figure 31. VHF coverage for the District 2 station at St. Joseph (170°, dots; 350°, short dashes). Center: 39°46'12"N, 94°47'53"W.

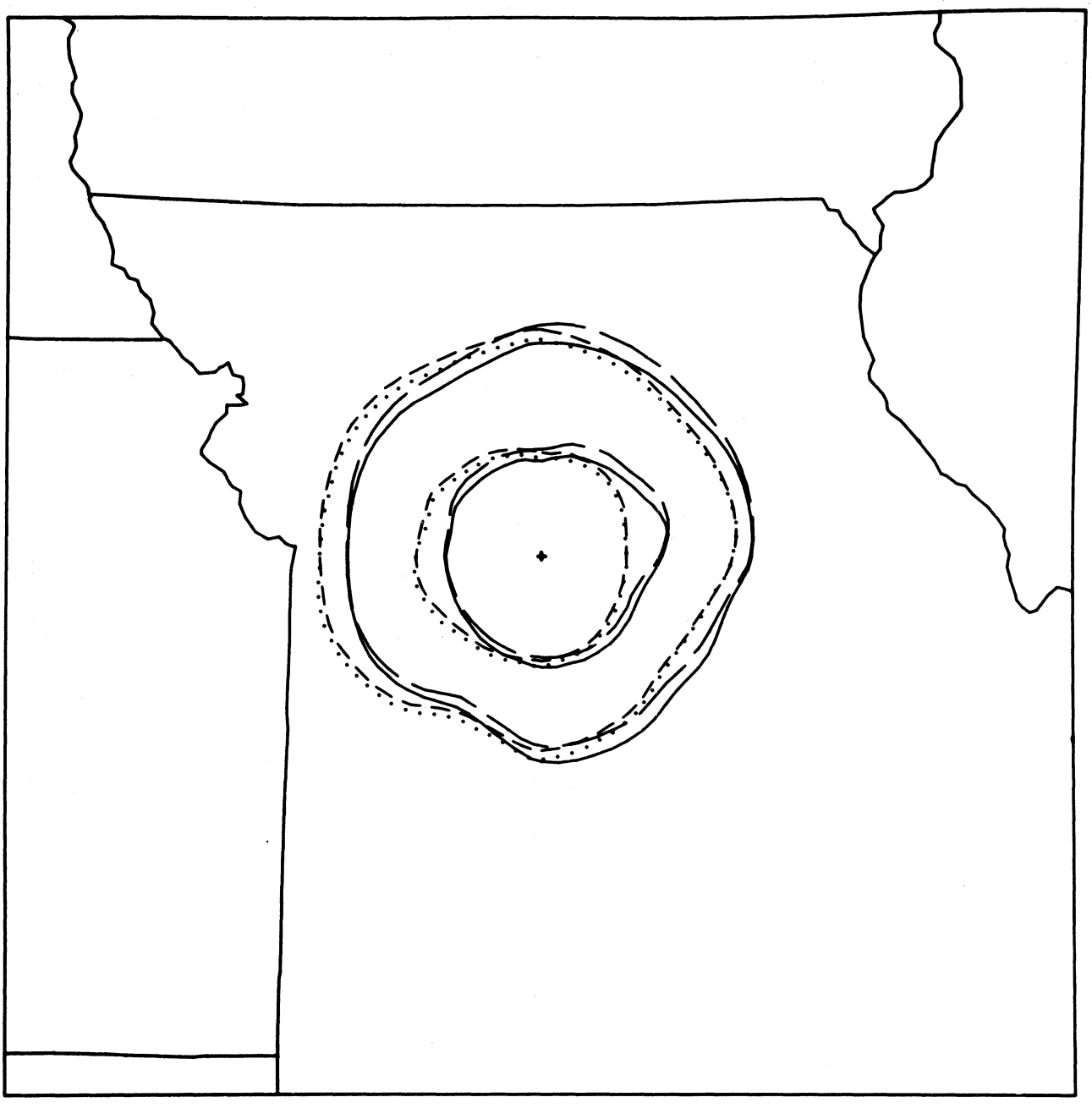

Figure 32. VHF coverage for the District 2 station at Marshall (55°, long dashes; 115°, solid; 255°, dots; 285°, short dashes). Center: 39°7'18"N, 93°15'9"W.

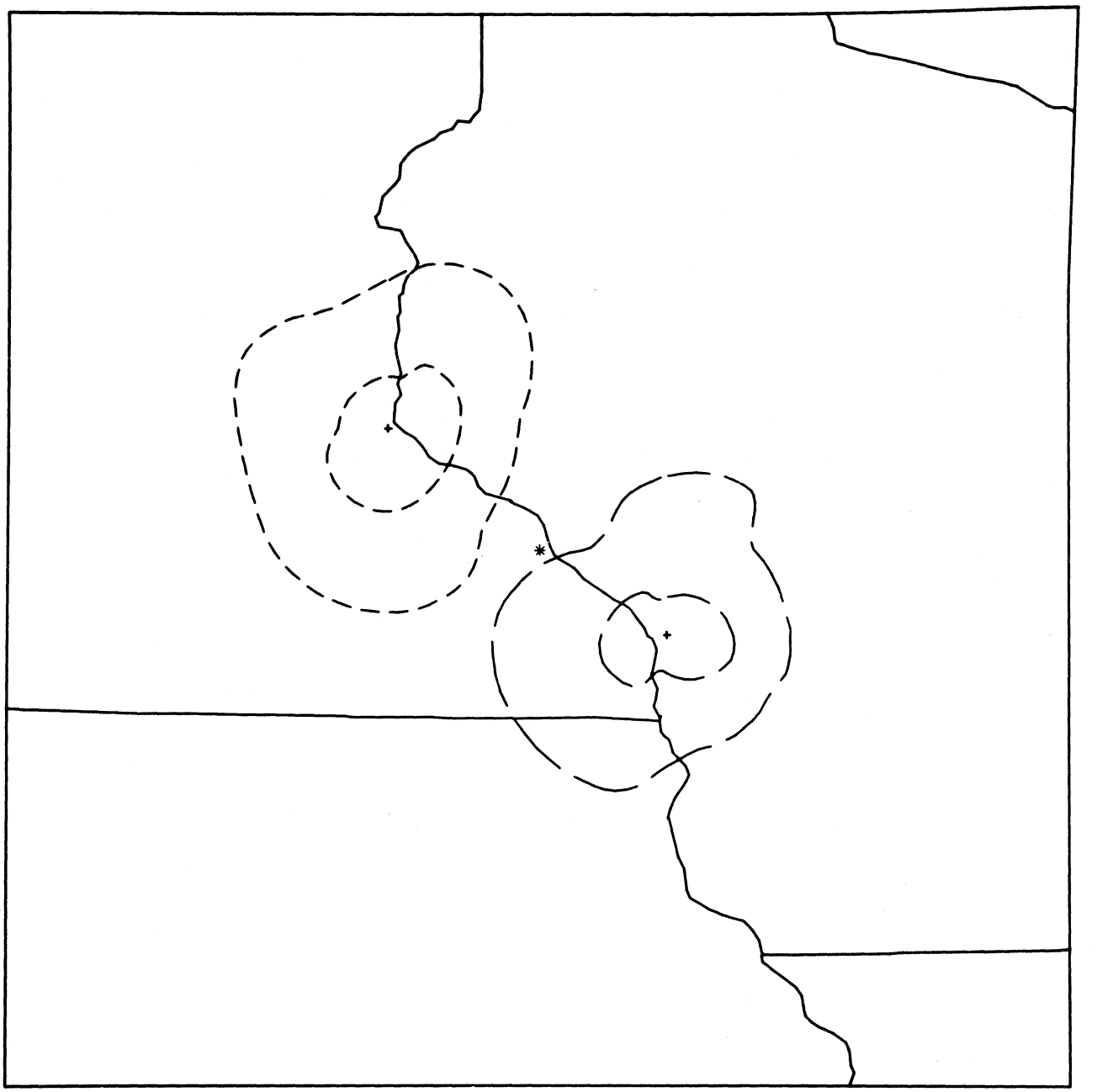

Figure 33. VHF coverage for the District 2 station at Hastings (short dashes) and La Crosse (long dashes). Center: 44°13'6"N, 91°55'30"W.

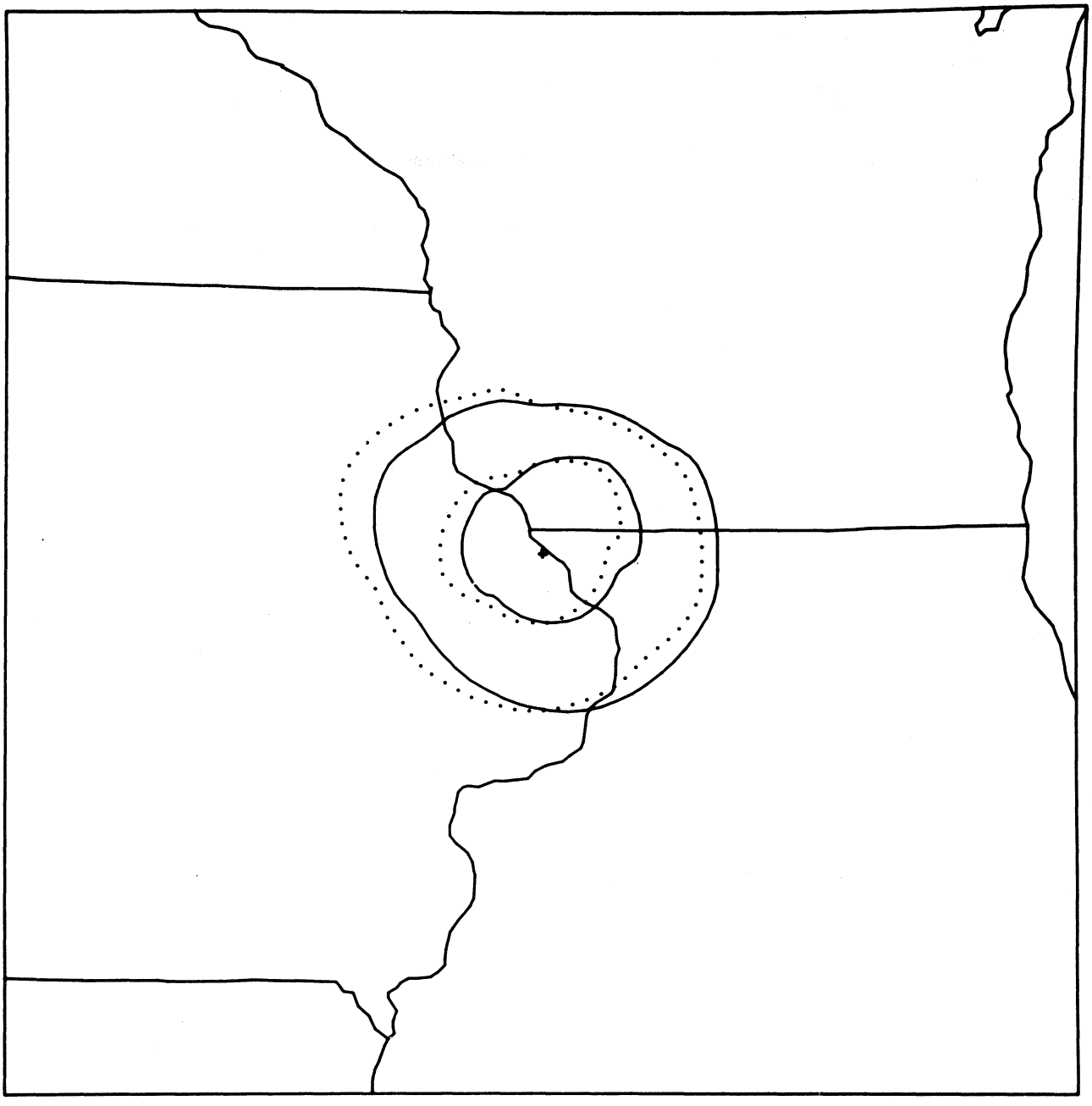

Figure 34. VHF coverage for the District 2 station at Dubuque (90°, solid; 270°, dots).
Center: 42°24'22"N, 90°34'9"W.

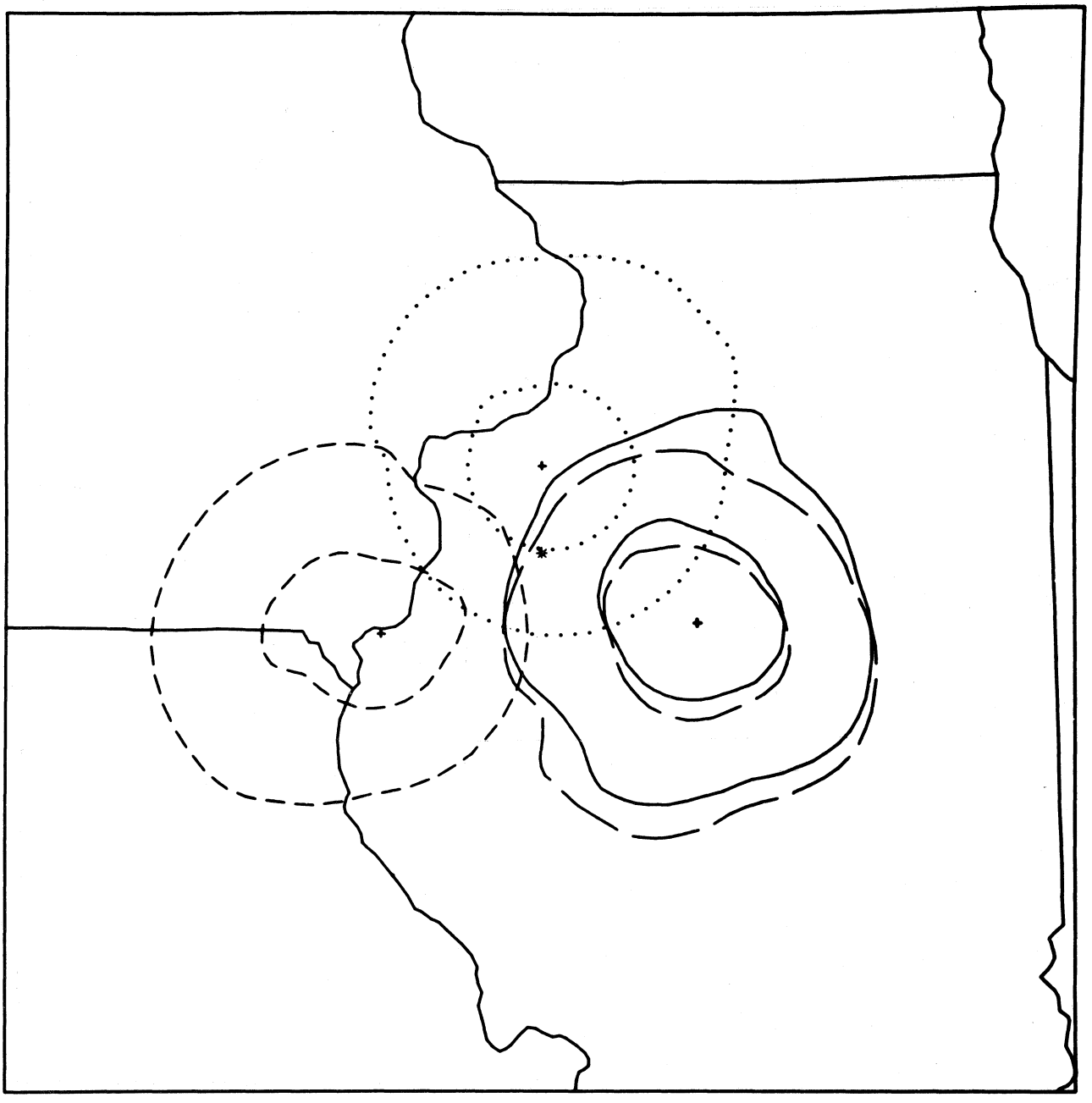

Figure 35. VHF coverage for the District 2 station at Peoria (180°, long dashes; 0°, solid), Orion (dots), and Niota (short dashes). Center: 40°56'54"N, 90°22'40"W.

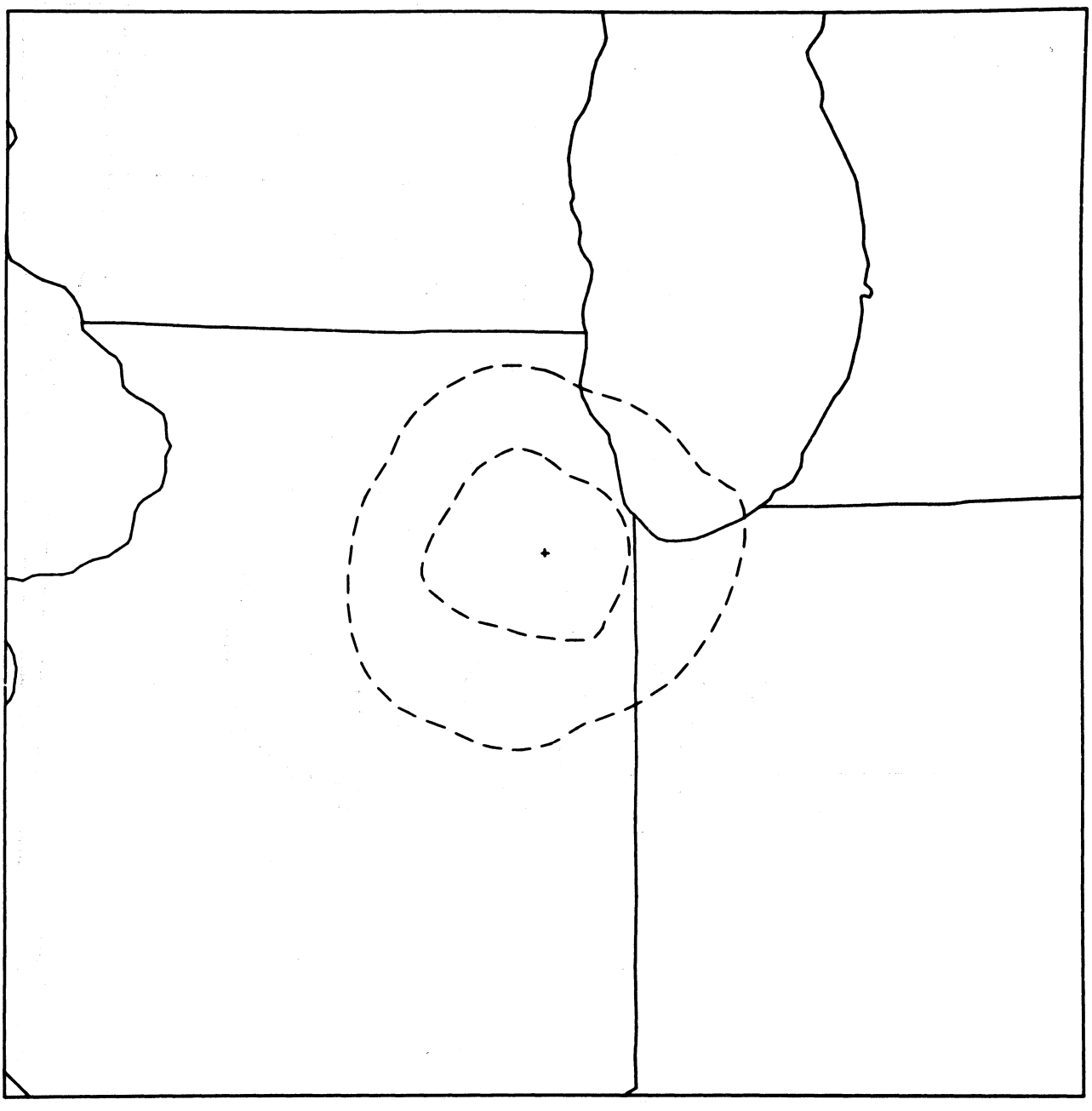

Figure 36. VHF coverage for the District 2 station at Lockport (short dashes).
Center: 41°34'43"N, 88°1'36"W.

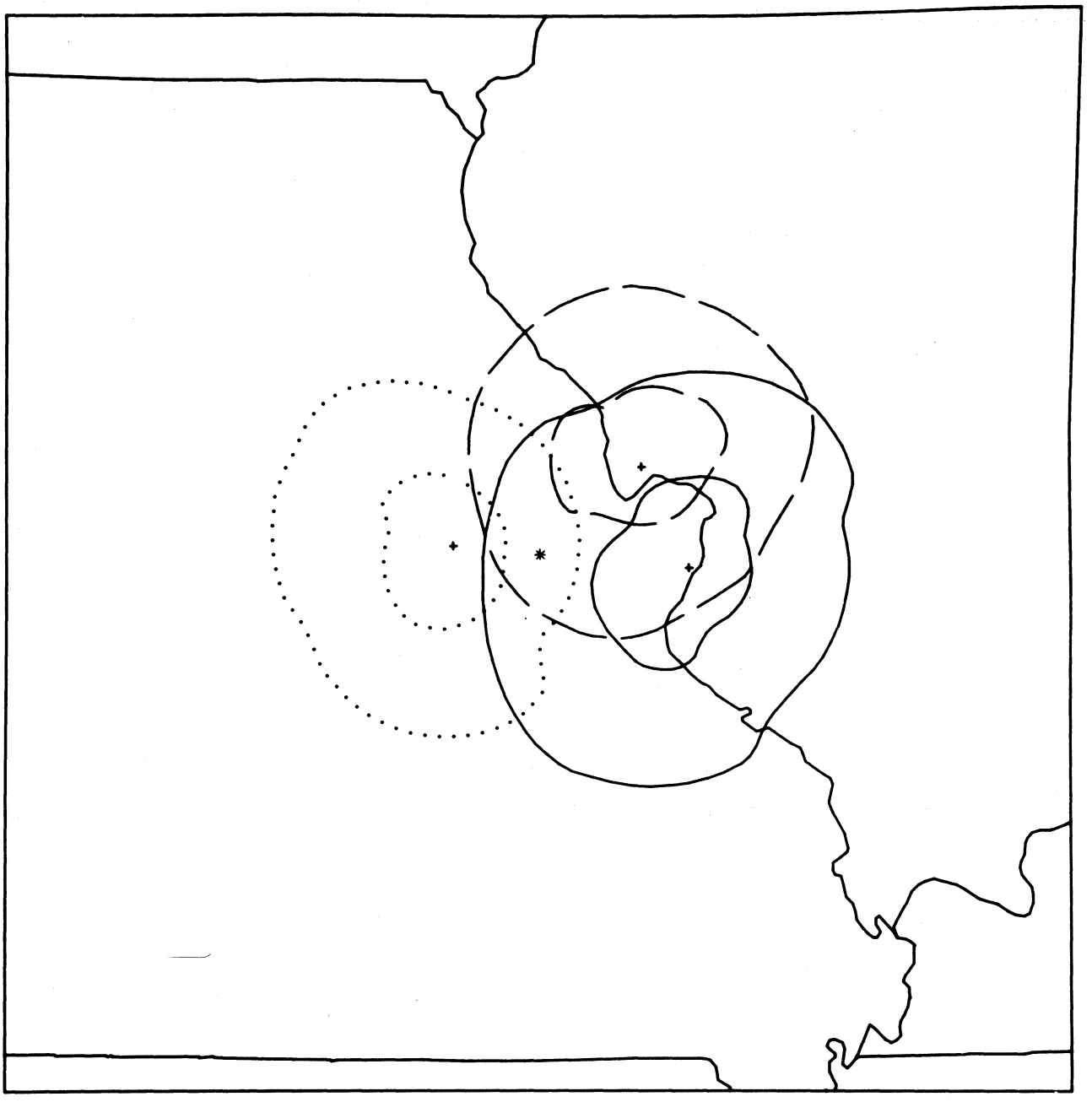

Figure 37. VHF coverage for the District 2 station at Pere Marquette (long dashes), St. Louis (solid), and Gasconde (dots).
Center: 38°37'42"N, 91°3'54"W.

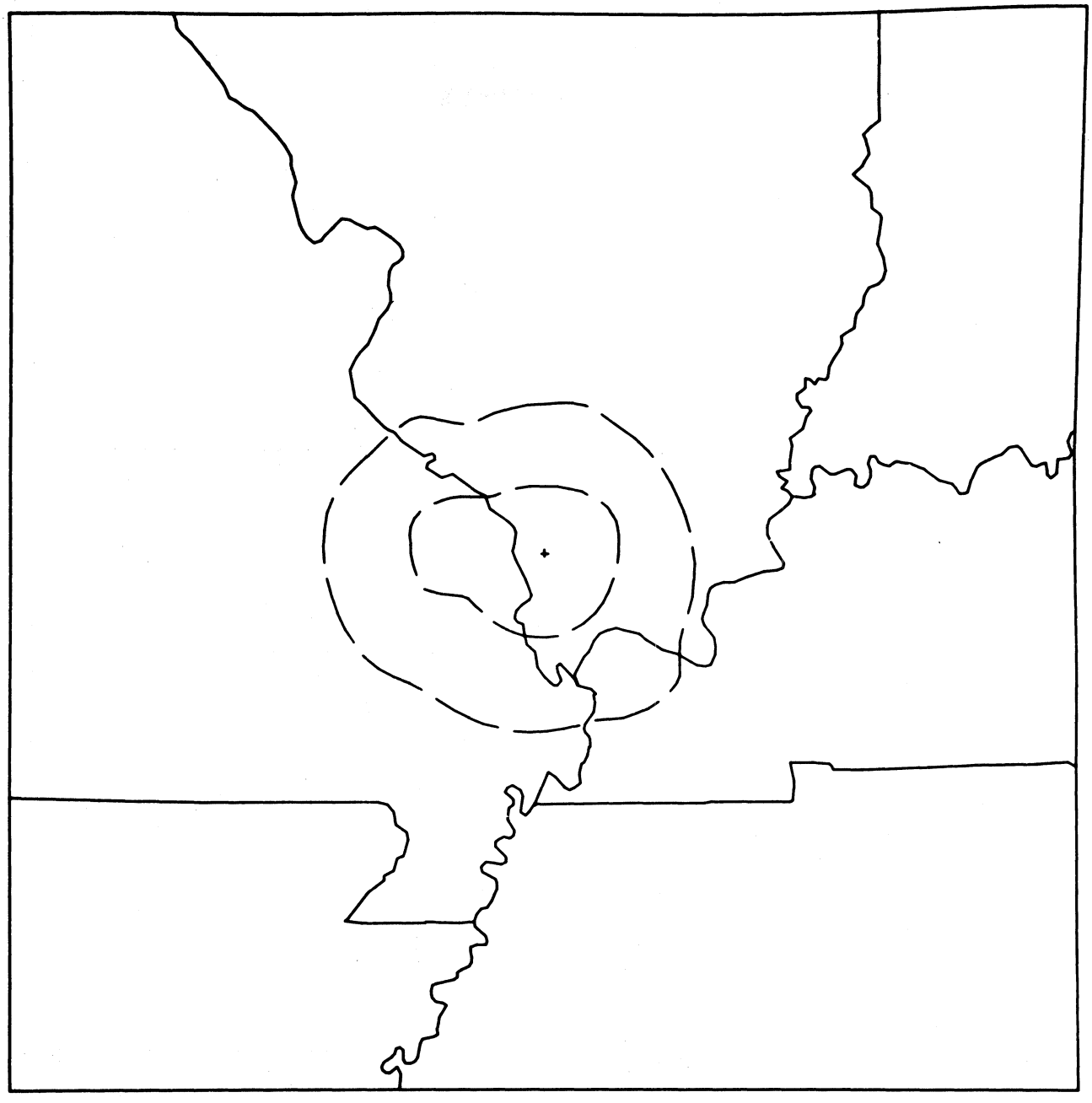

Figure 38. VHF coverage for the District 2 station at Bald Knob (long dashes).
Center: 37°33'30"N, 89°20'58"W.

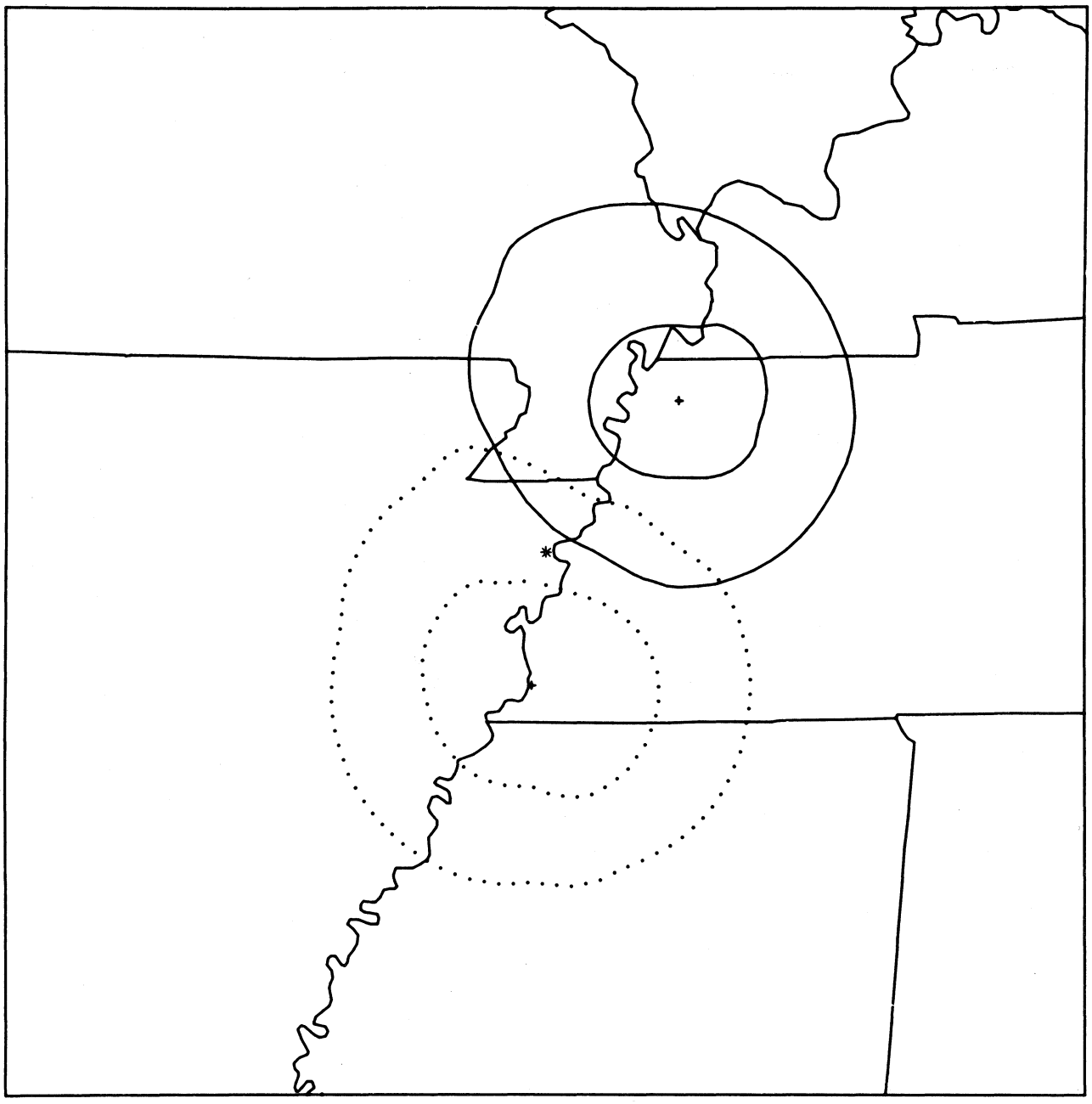

Figure 39. VHF coverage for the District 2 station at Caruthersville (solid) and Memphis (dots). Center: 35°42'12"N, 89°58'40"W.

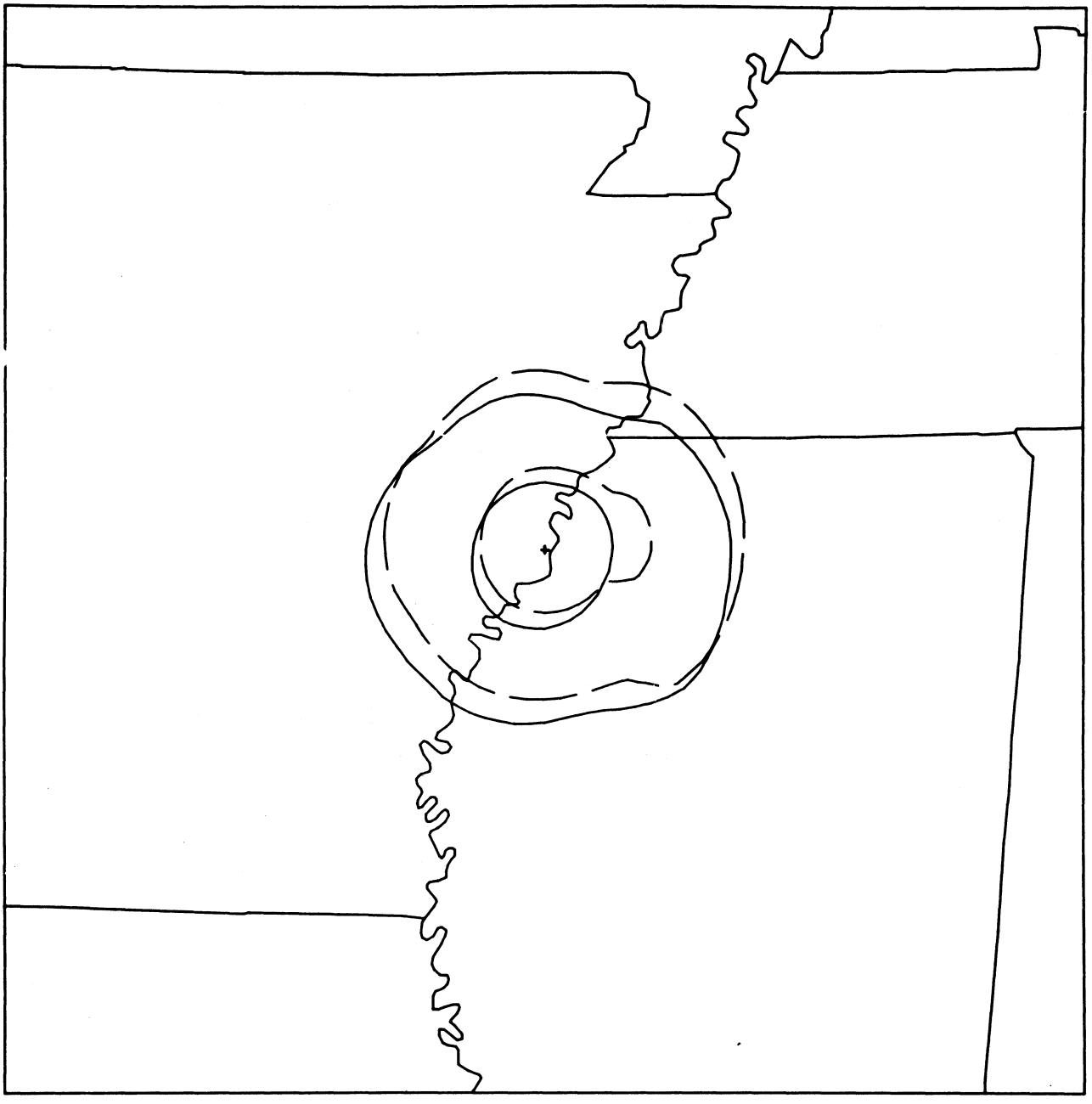

Figure 40. VHF coverage for the District 2 station at Helena (30°, long dashes; 210°, solid). Center: 34°31'30"N, 90°35'45"W.

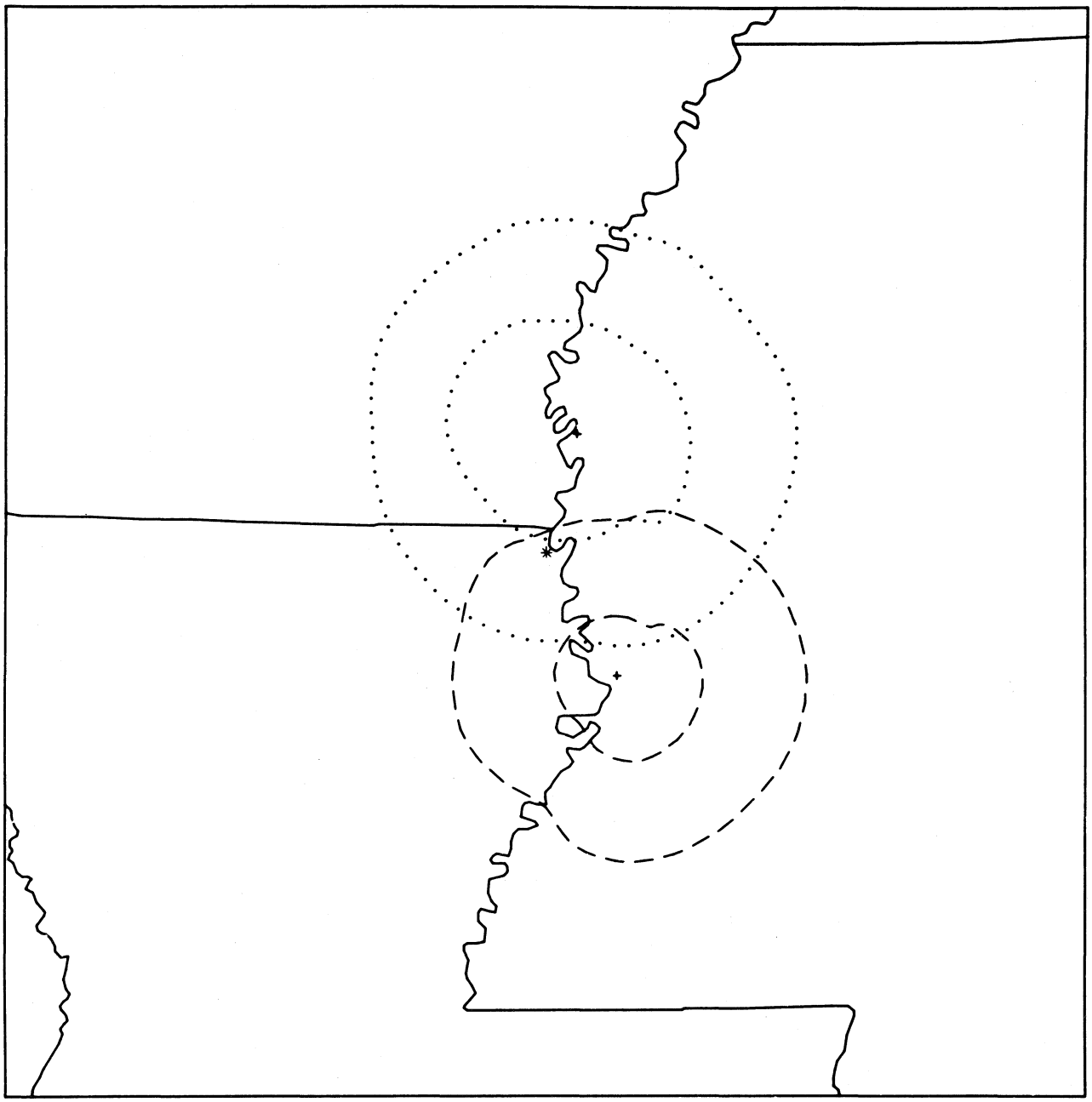

Figure 41. VHF coverage for the District 2 station at Greenville (dots) and Vicksburg (short dashes). Center: 32°53'40"N, 91°13'30"W.

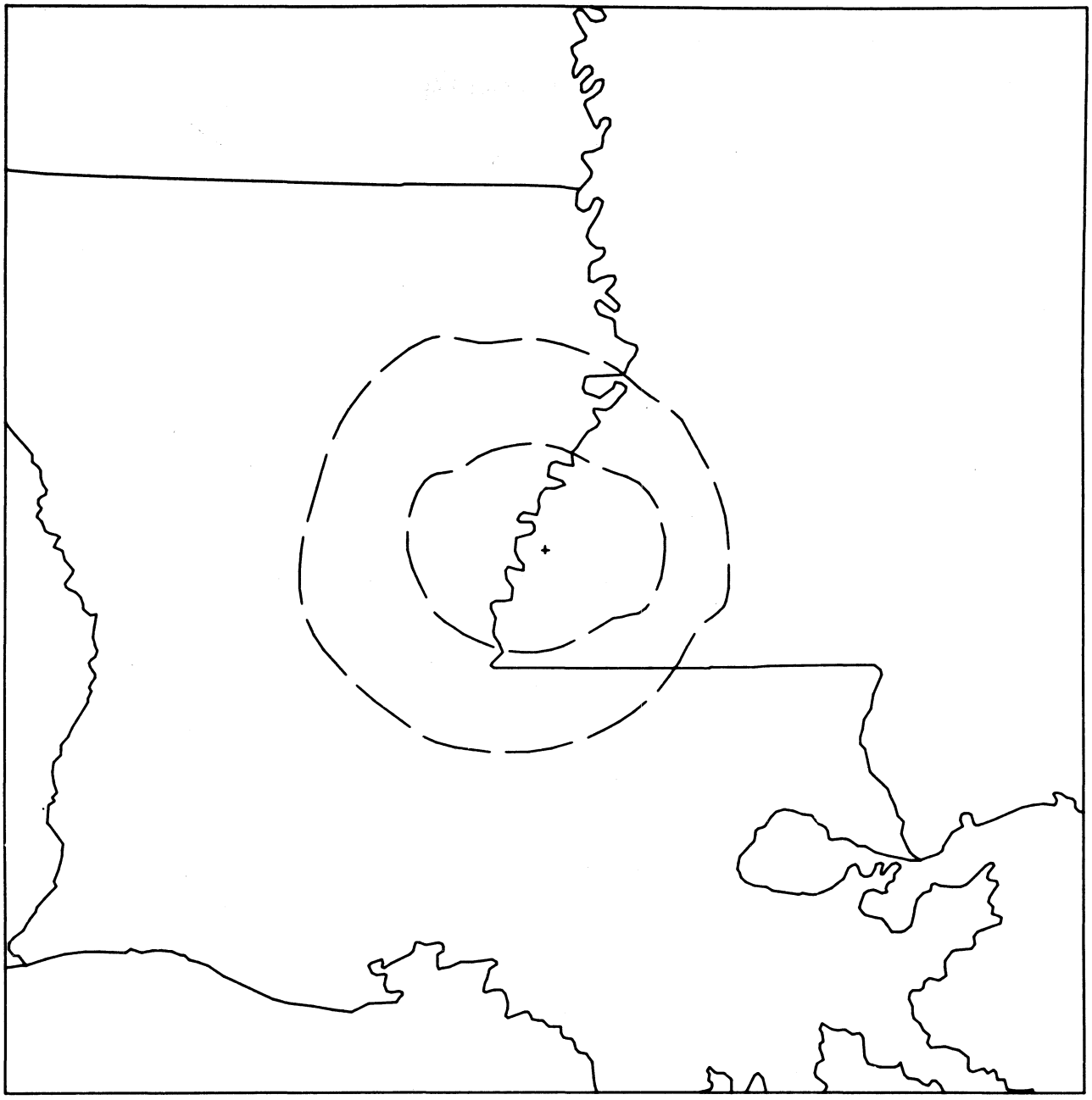

Figure 42. VHF coverage for the District 2 station at Natchez (long dashes).
Center: 31°29'12"N, 91°21'42"W.

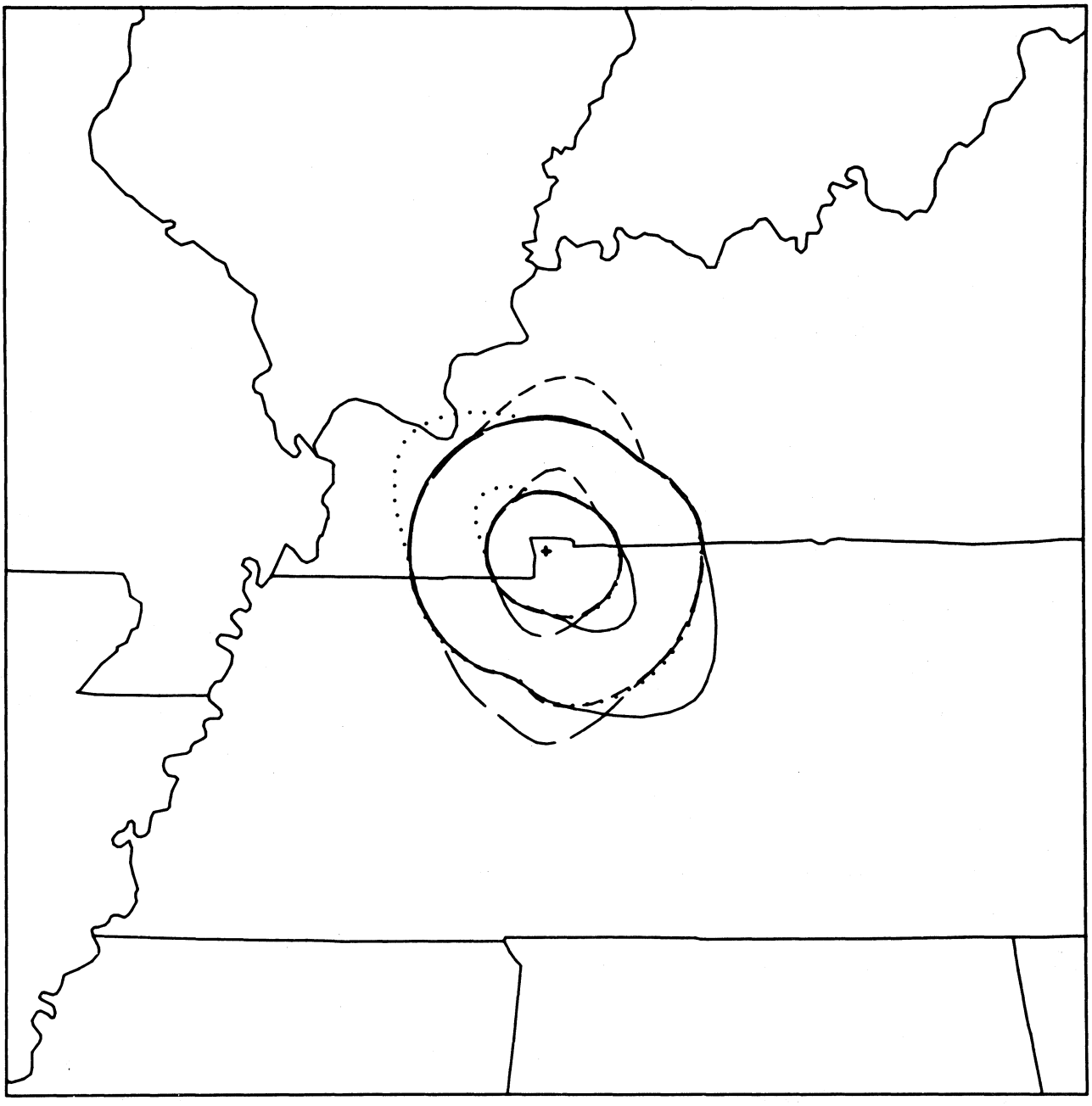

Figure 43. VHF coverage for the District 2 station at Model (10°, short dashes; 190°, long dashes; 130°, solid; 310°, dots).

Center: 36°36'50"N, 87°58'40"W.

Figure 44. VHF coverage for the District 2 station at Carthage (short dashes).
Center: 36°18'43"N, 87°57'8"W.

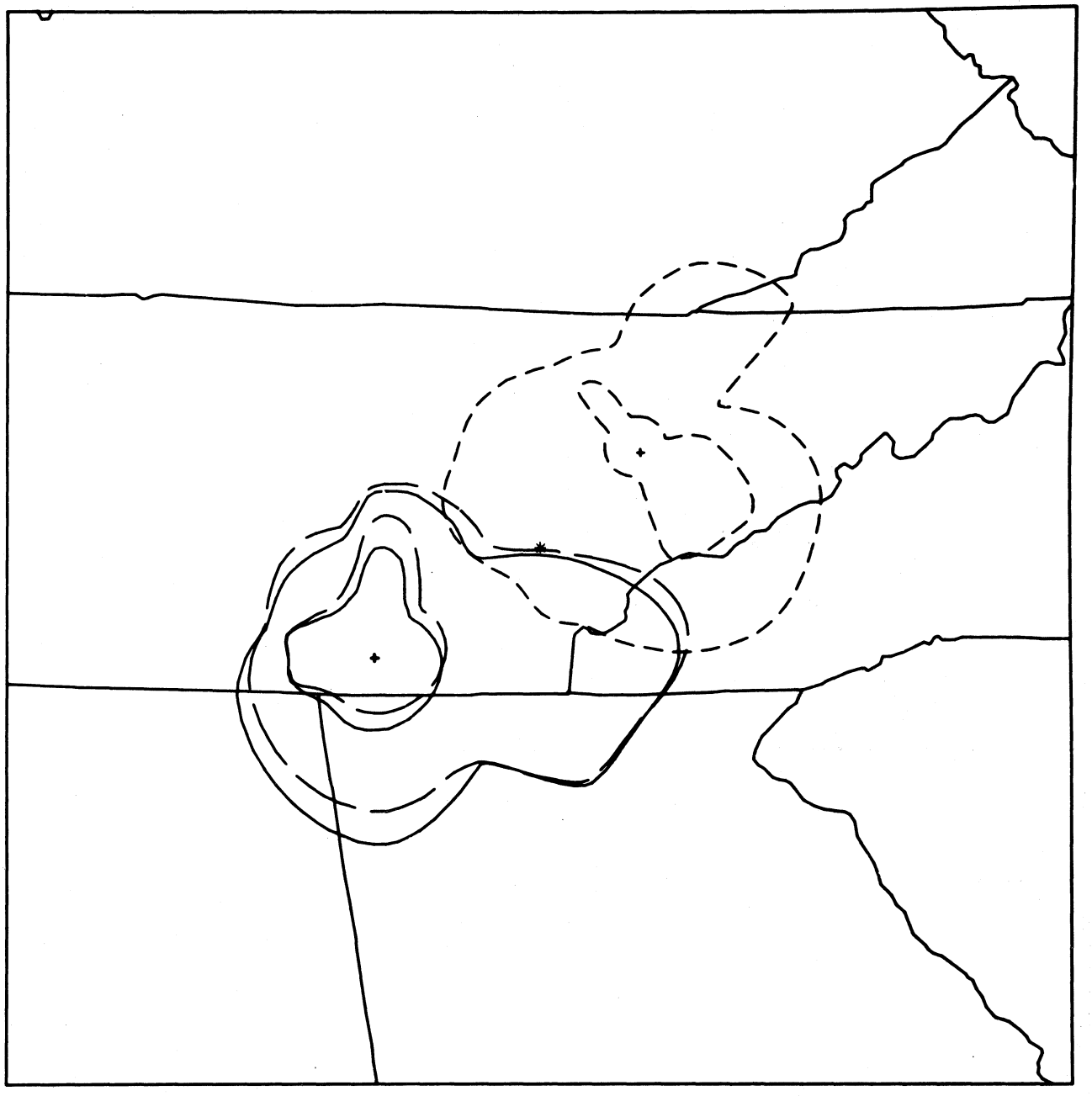

Figure 45. VHF coverage for the District 2 station at Knoxville (short dashes), Signal Mountain (10°, long dashes; 190°, solid).
Center: 35°36'6"N, 84°27'48"W.

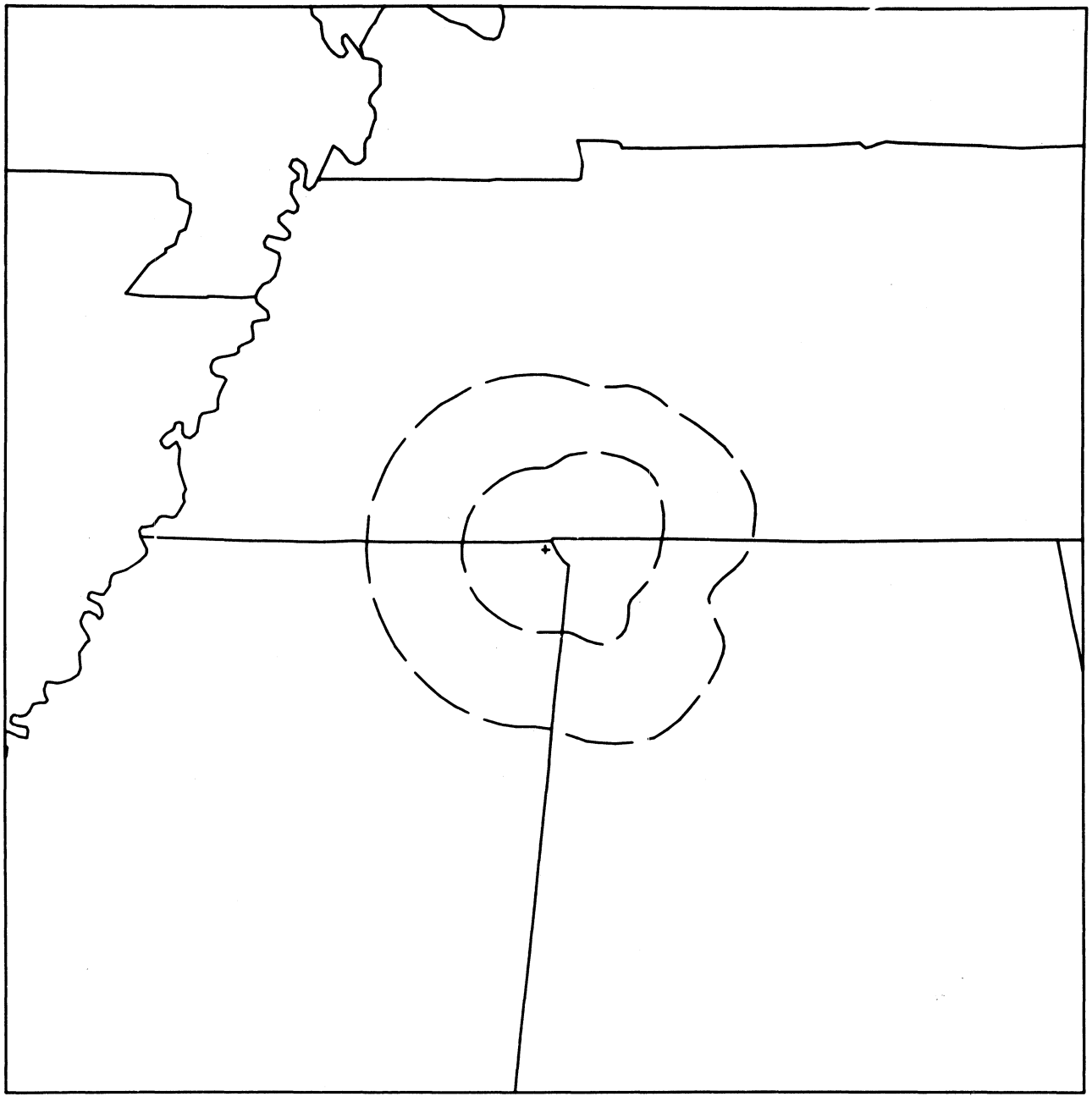

Figure 46. VHF coverage for the District 2 station at Yellow Creek (long dashes).
Center: 34°57'45"N, 88°13'25"W.

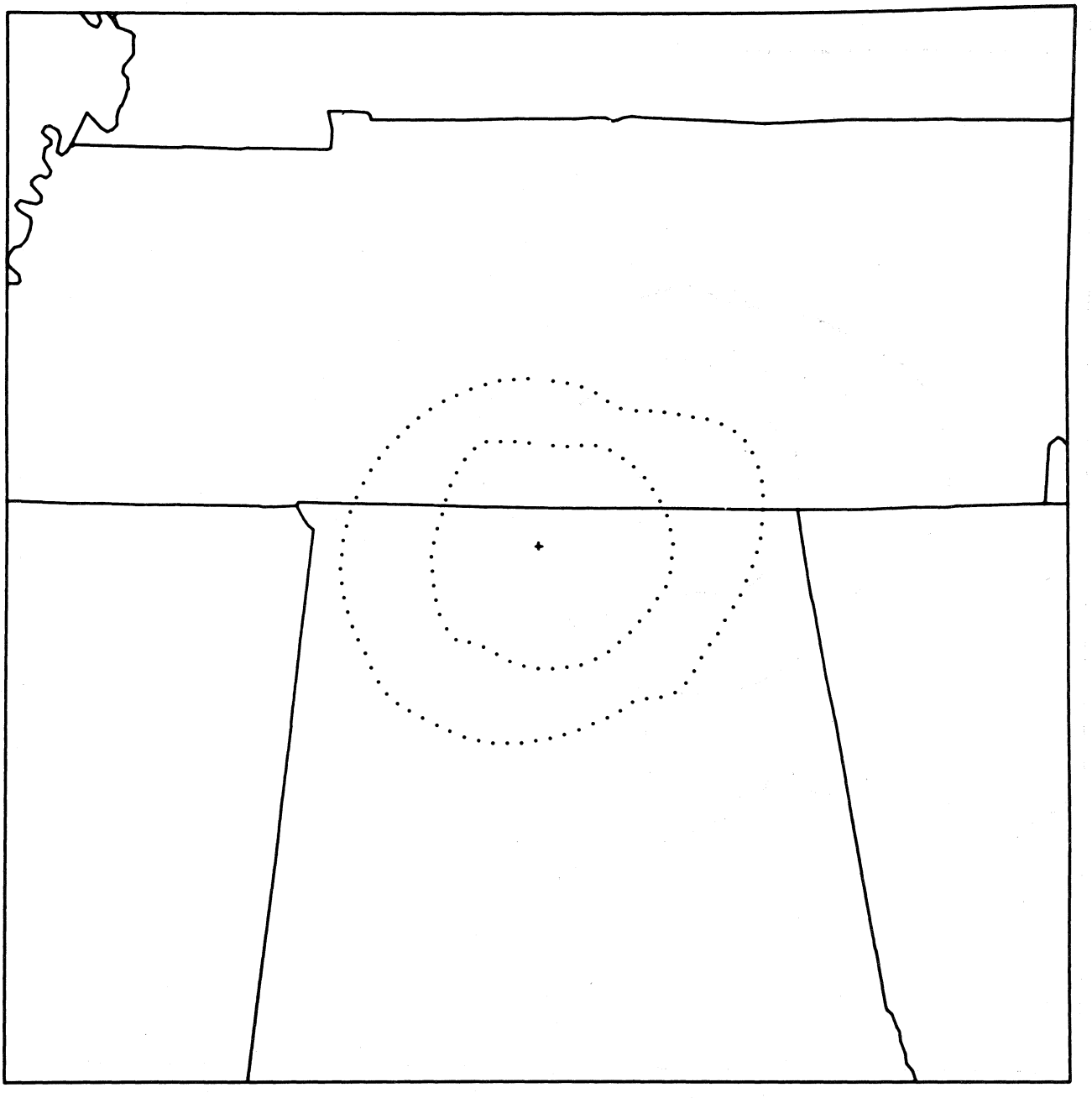

Figure 47. VHF coverage for the District 2 station at Athens (dots).
Center: 34°49'51"N, 86°56'42"W.

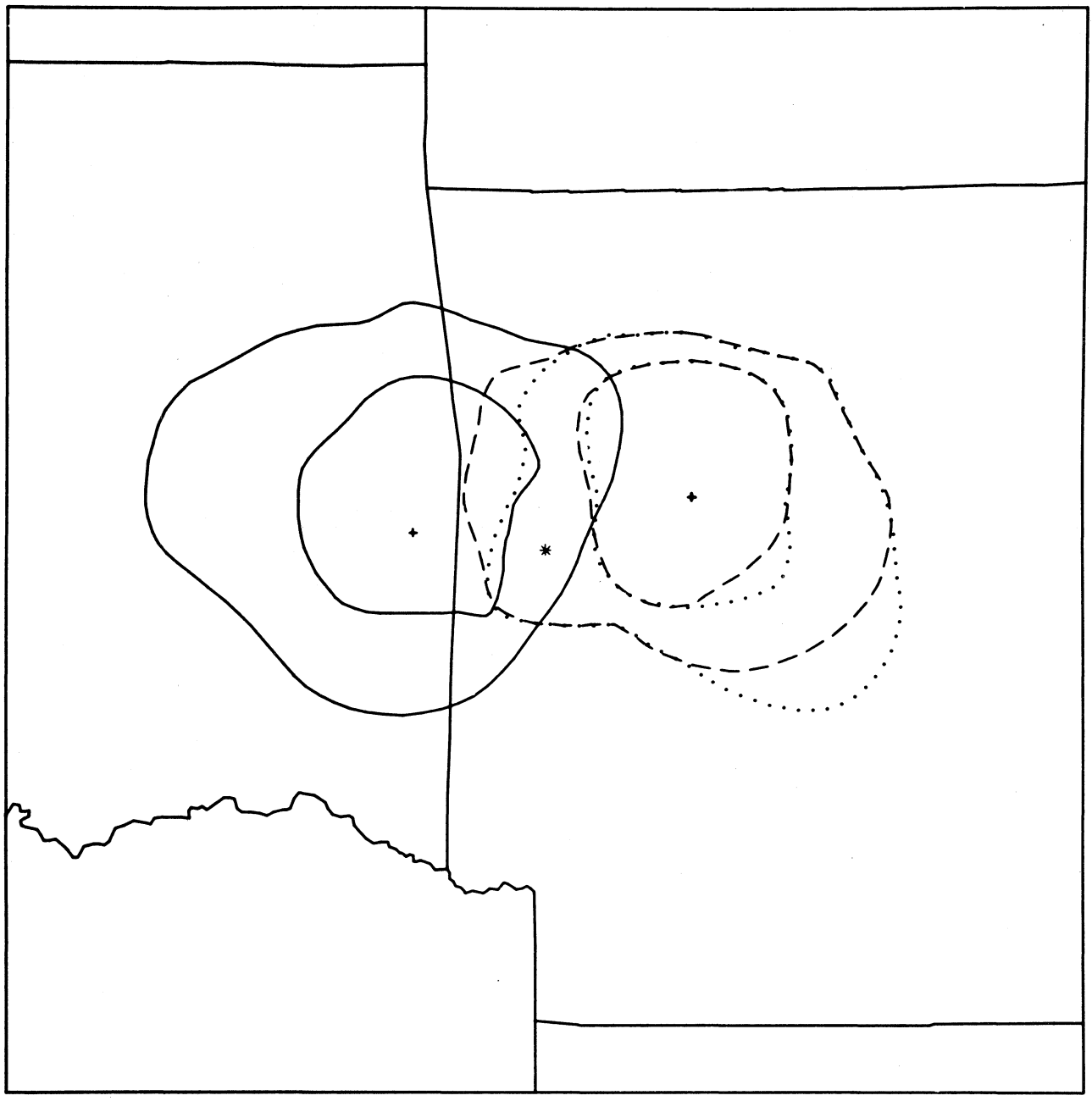

Figure 48. VHF coverage for the District 2 station at Poteau (solid) and Mt. Nebo (140°, dots; 285°, short dashes).
Center: 35°0'0"N, 94°0'0"W.

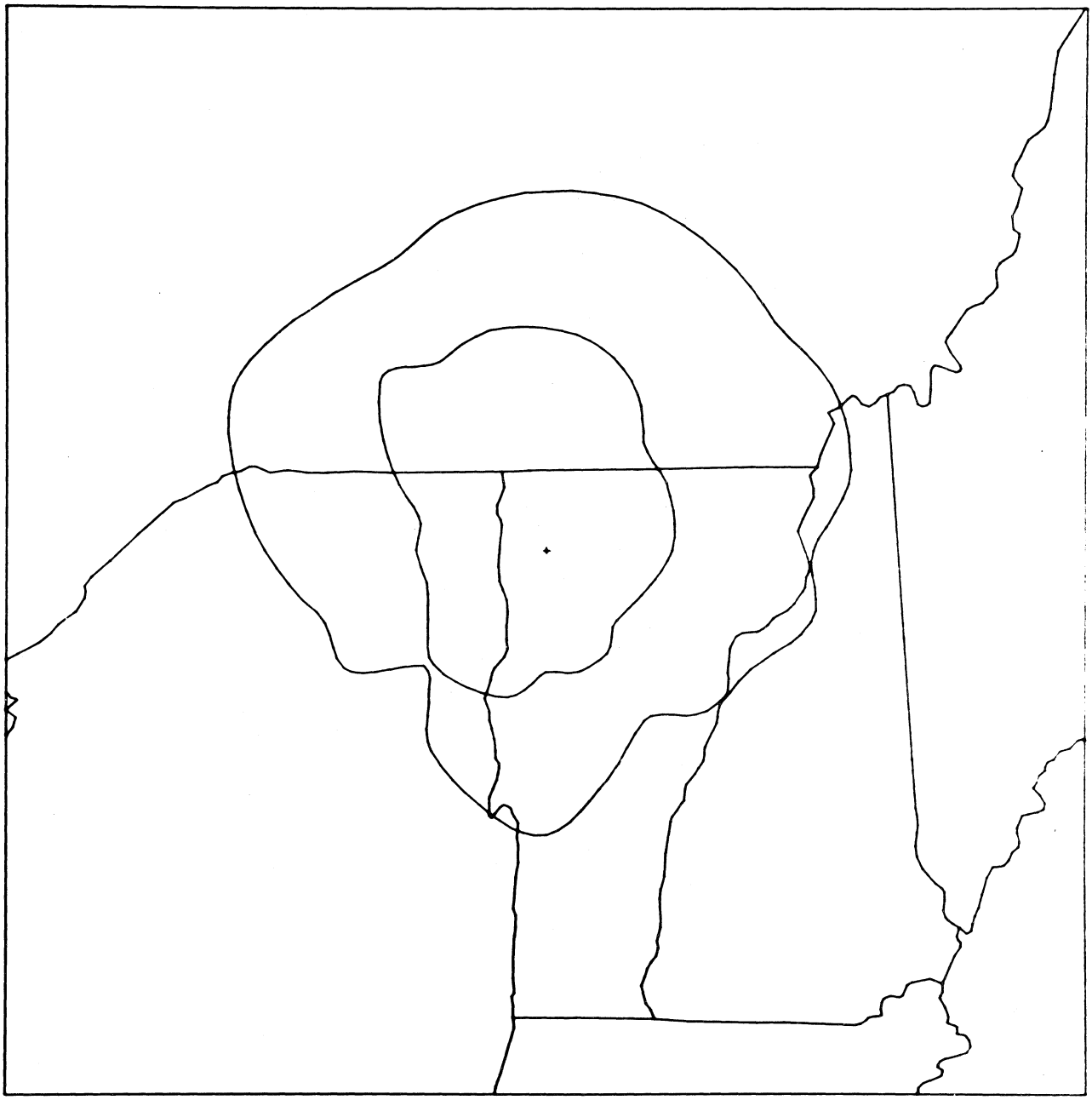

Figure 49. VHF coverage for the District 3 station at Mt. Mansfield (solid).
Center: 44°40'40"N, 73°5'40"W.

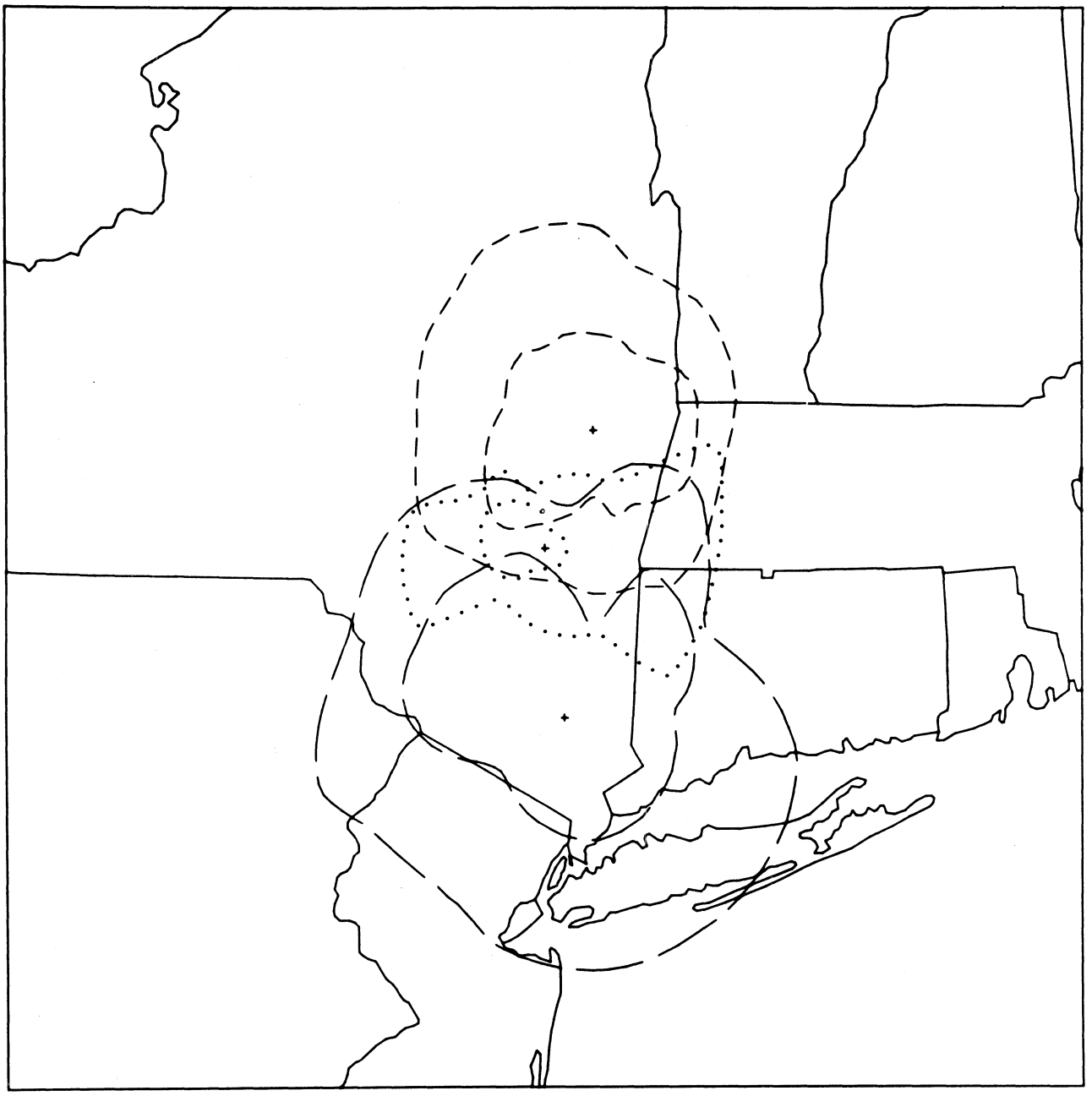

Figure 50. VHF coverage for the District 3 station at Saugerties (dots), Albany (short dashes), and Mt. Beacon (long dashes).
Center: 42°8'12"N, 74°2'6"W.

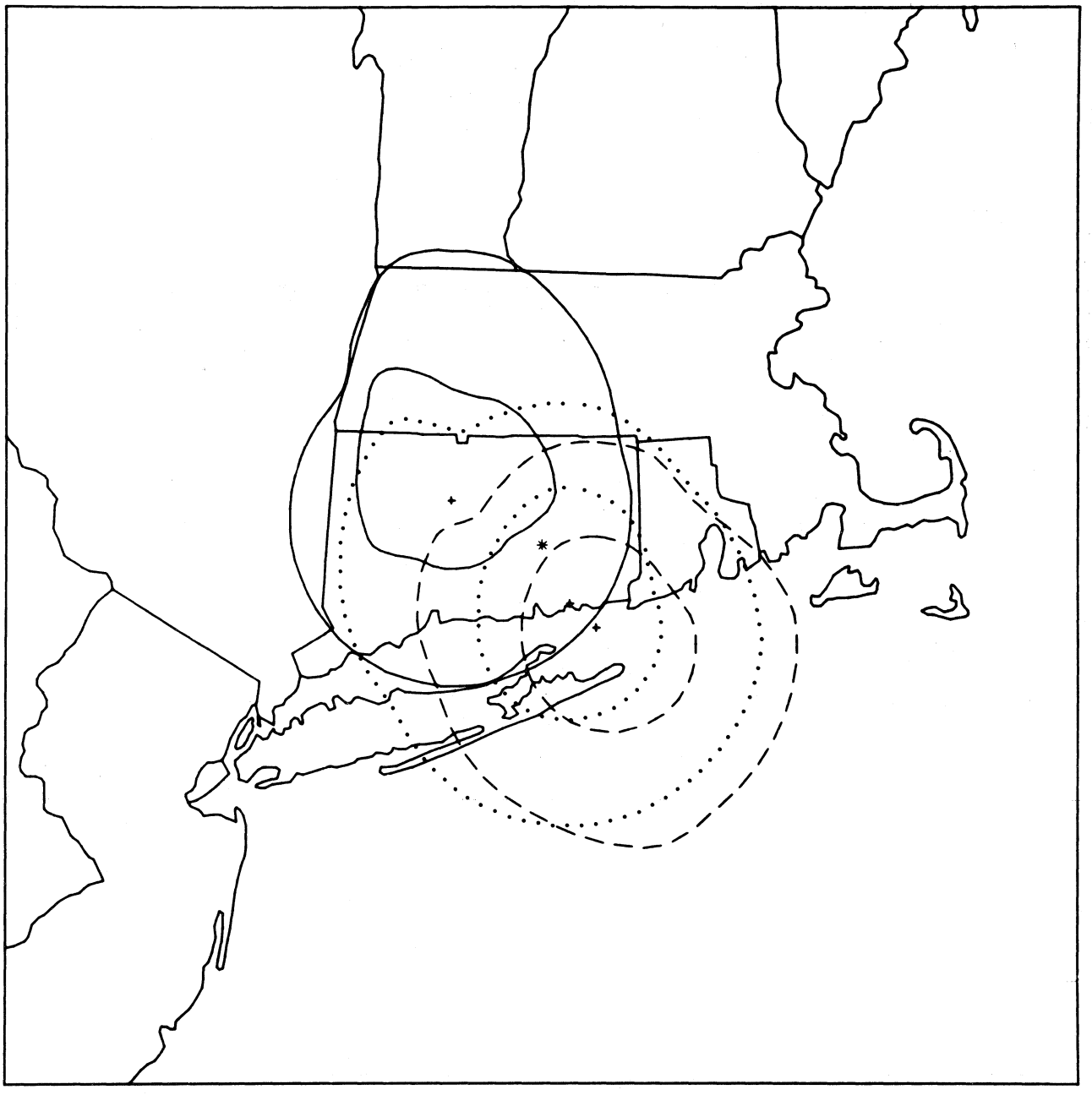

Figure 51. VHF coverage for the District 3 station at South Glastonbury (solid), Waterford (dots), Milford (short dashes).
Center: 41°34'30"N, 72°19'42"W.

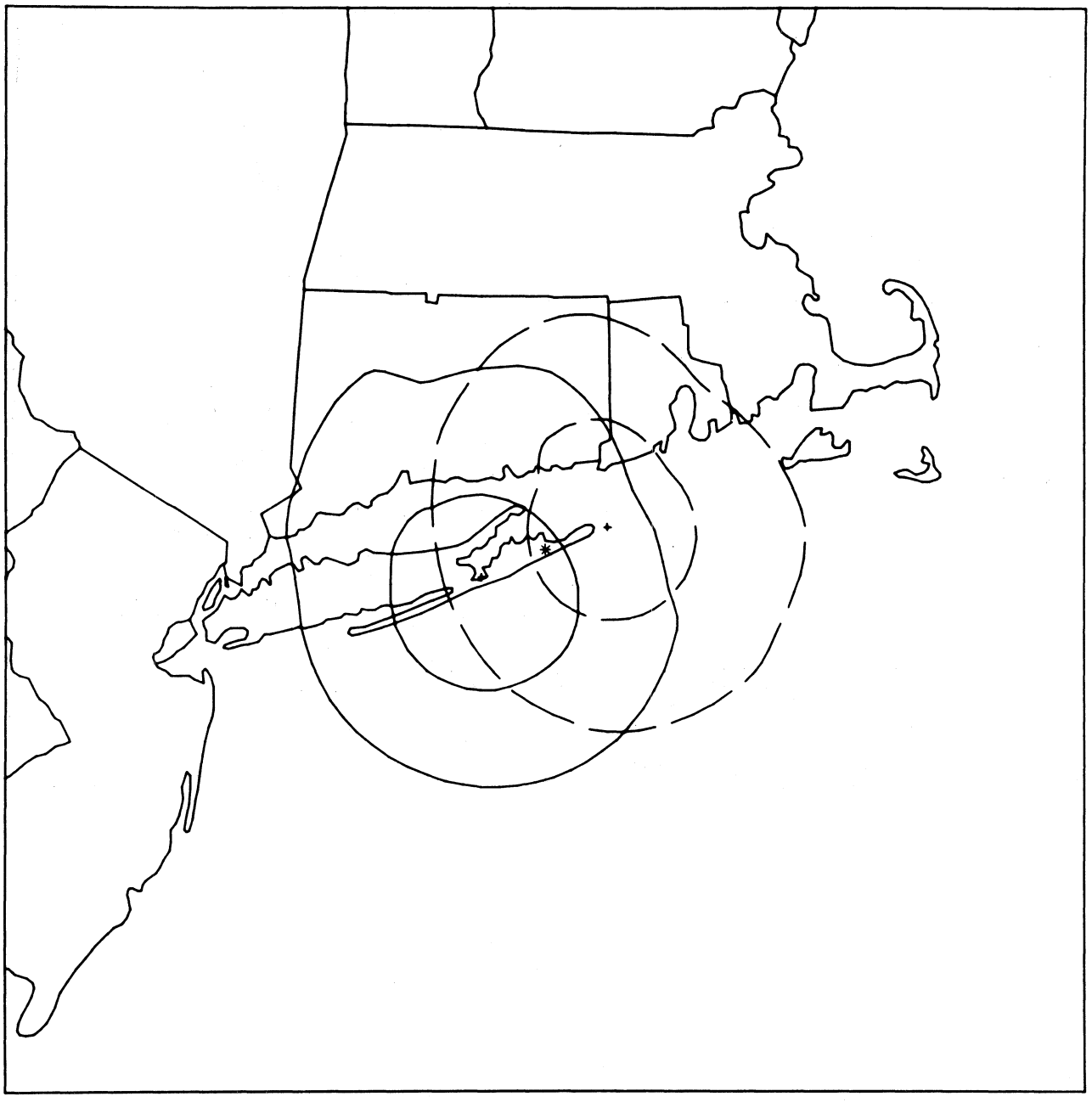

Figure 52. VHF coverage for the District 3 station at Montauk (long dashes) and Shinnecock (solid). Center: 40°58'30"N, 72°8'36"W.

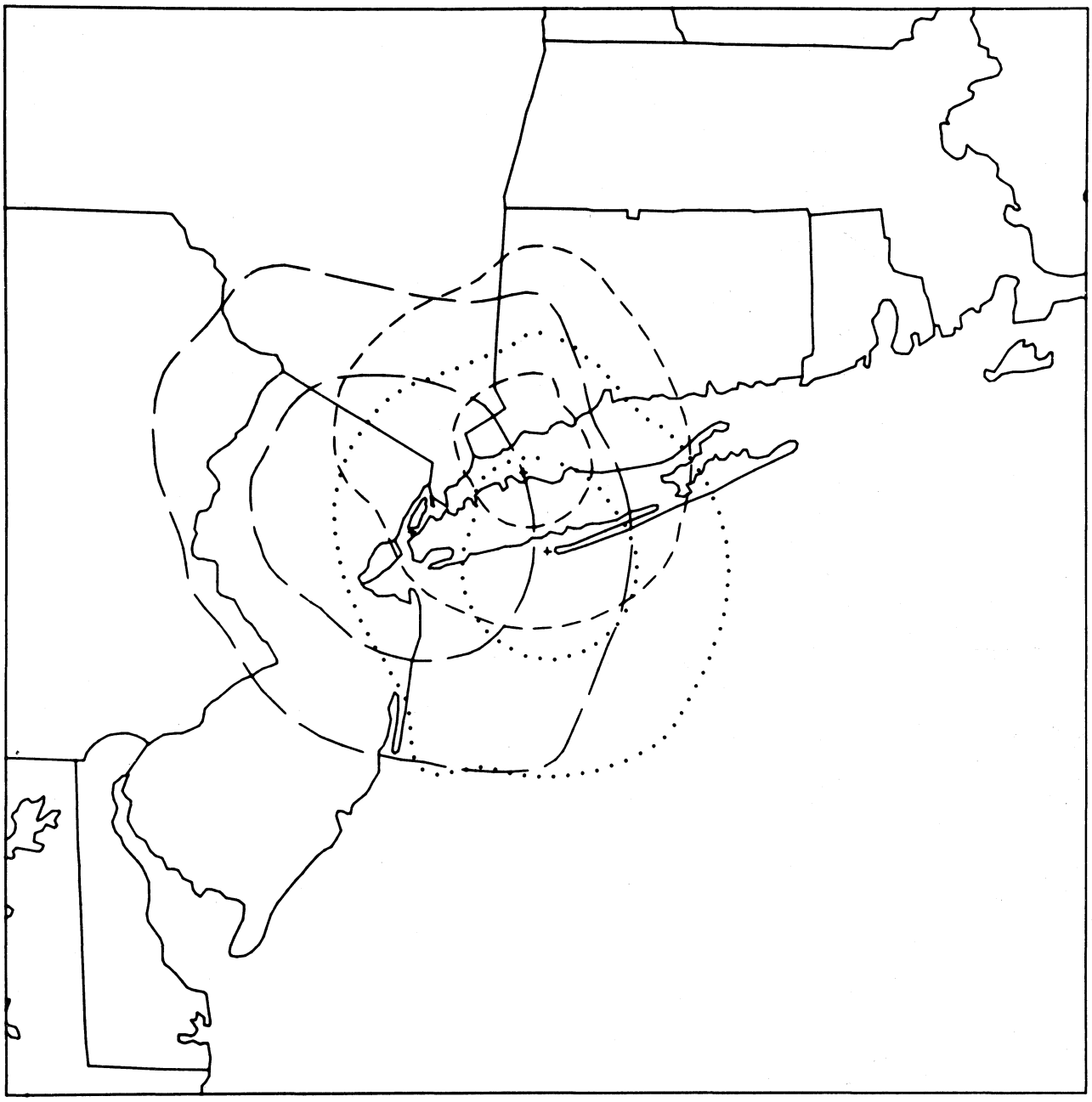

Figure 53. VHF coverage for the District 3 station at Fire Island (dots), Eatons Neck (short dashes), and Manhattan (long dashes).
Center: 40°37'18"N, 73°15'36"W.

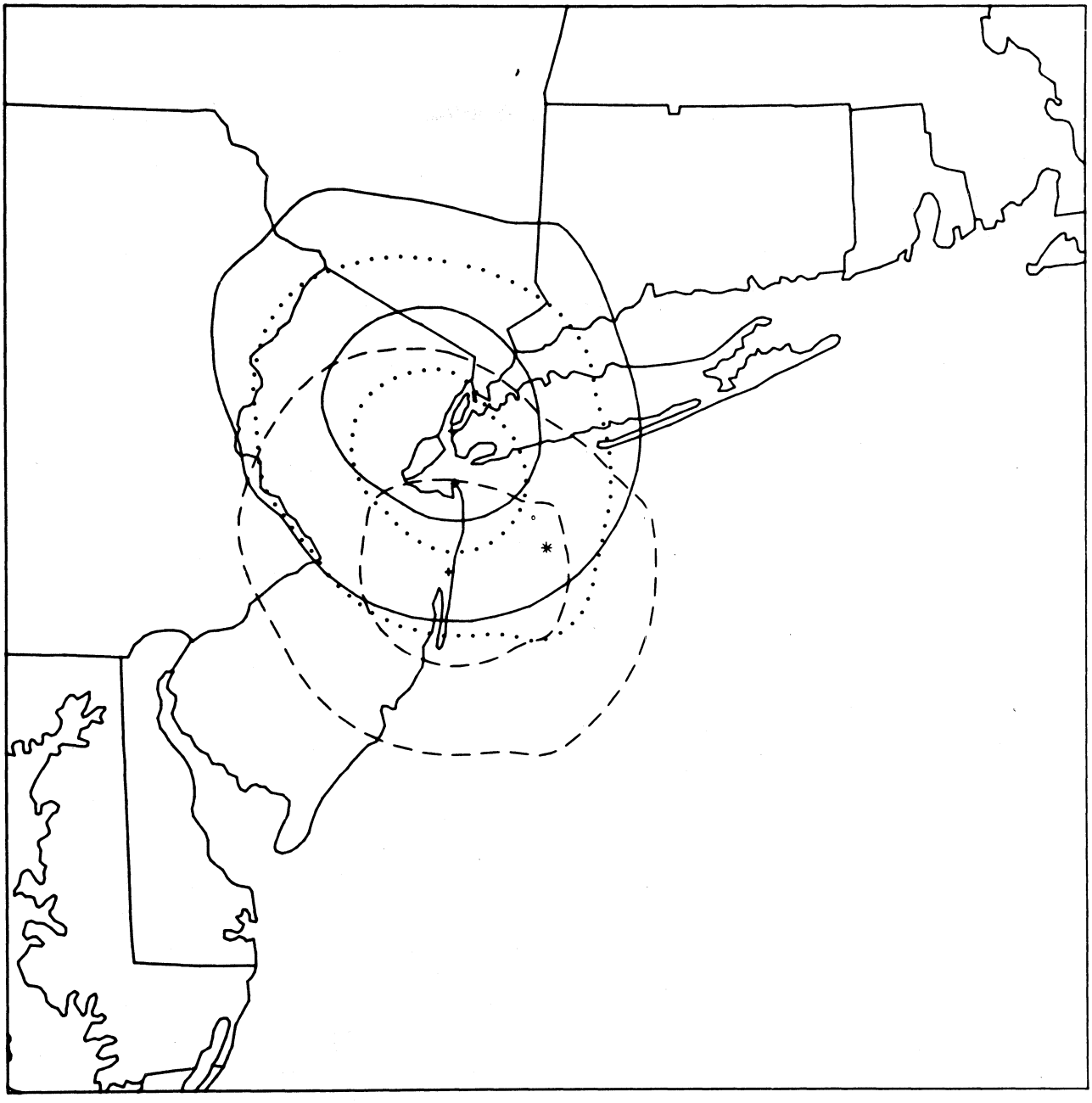

Figure 54. VHF coverage for the District 3 station at Governor's Island (solid), Sandy Hook (dots), Manasquan Inlet (short dashes).
Center: 40°12'0"N, 73°30'0"W.

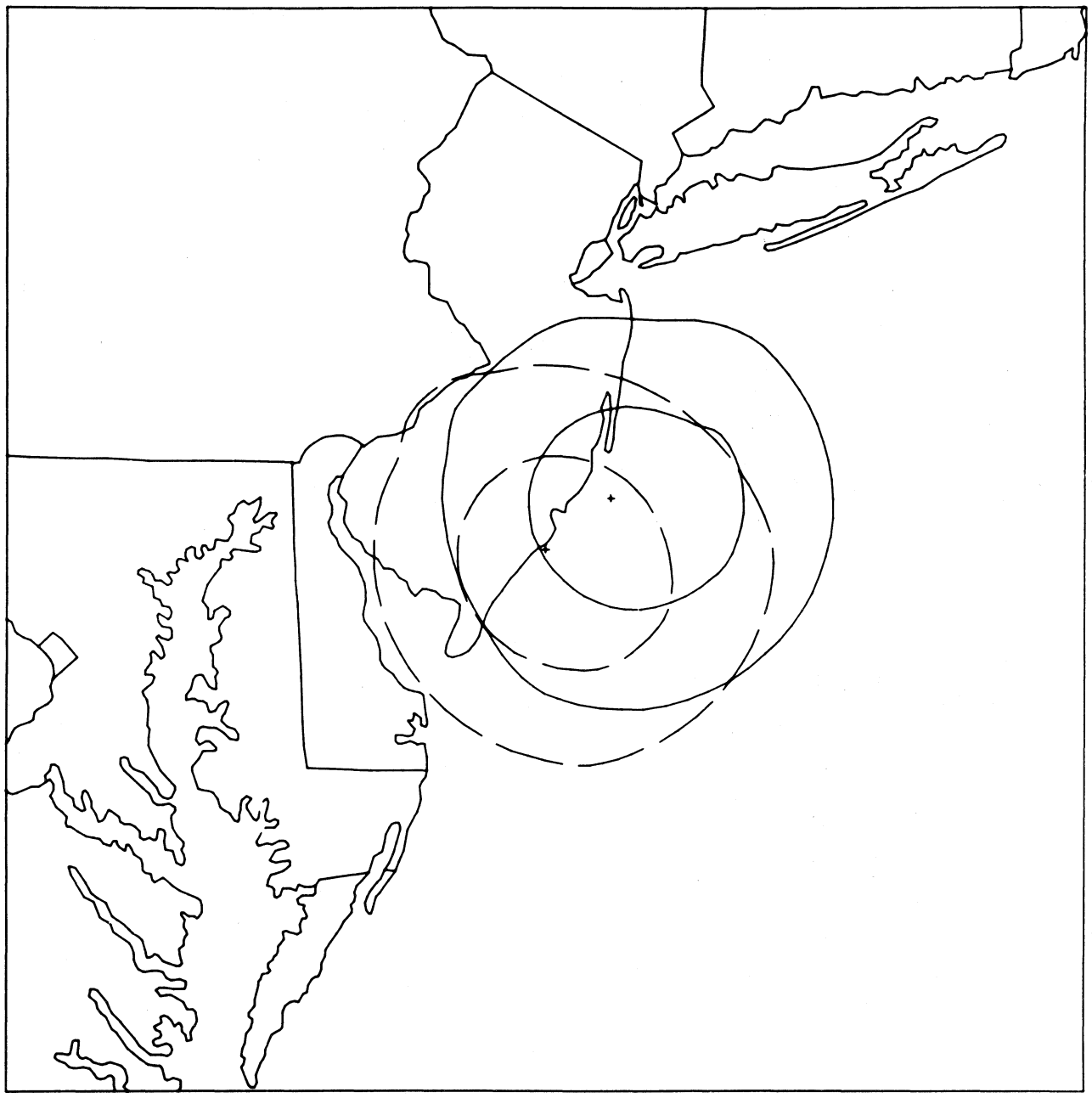

Figure 55. VHF coverage for the District 3 station at Atlantic City (long dashes) and Barnegat Light (solid). Center: 39°22'29"N, 74°25'17"W.

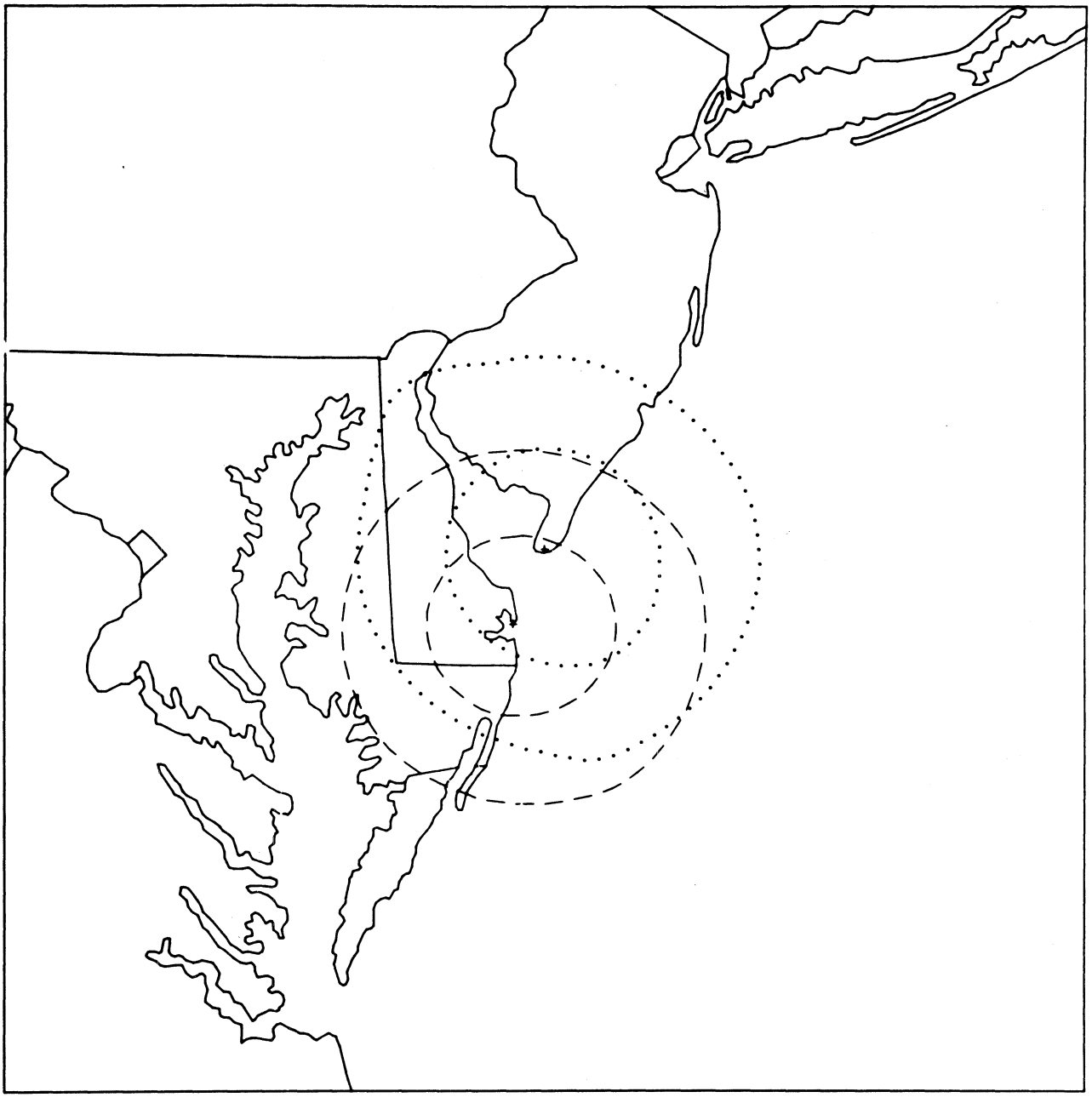

Figure 56. VHF coverage for the District 3 station at Cape May (dots) and Rehoboth Beach (short dashes). Center: 38°56'25"N, 74°54'13"W.

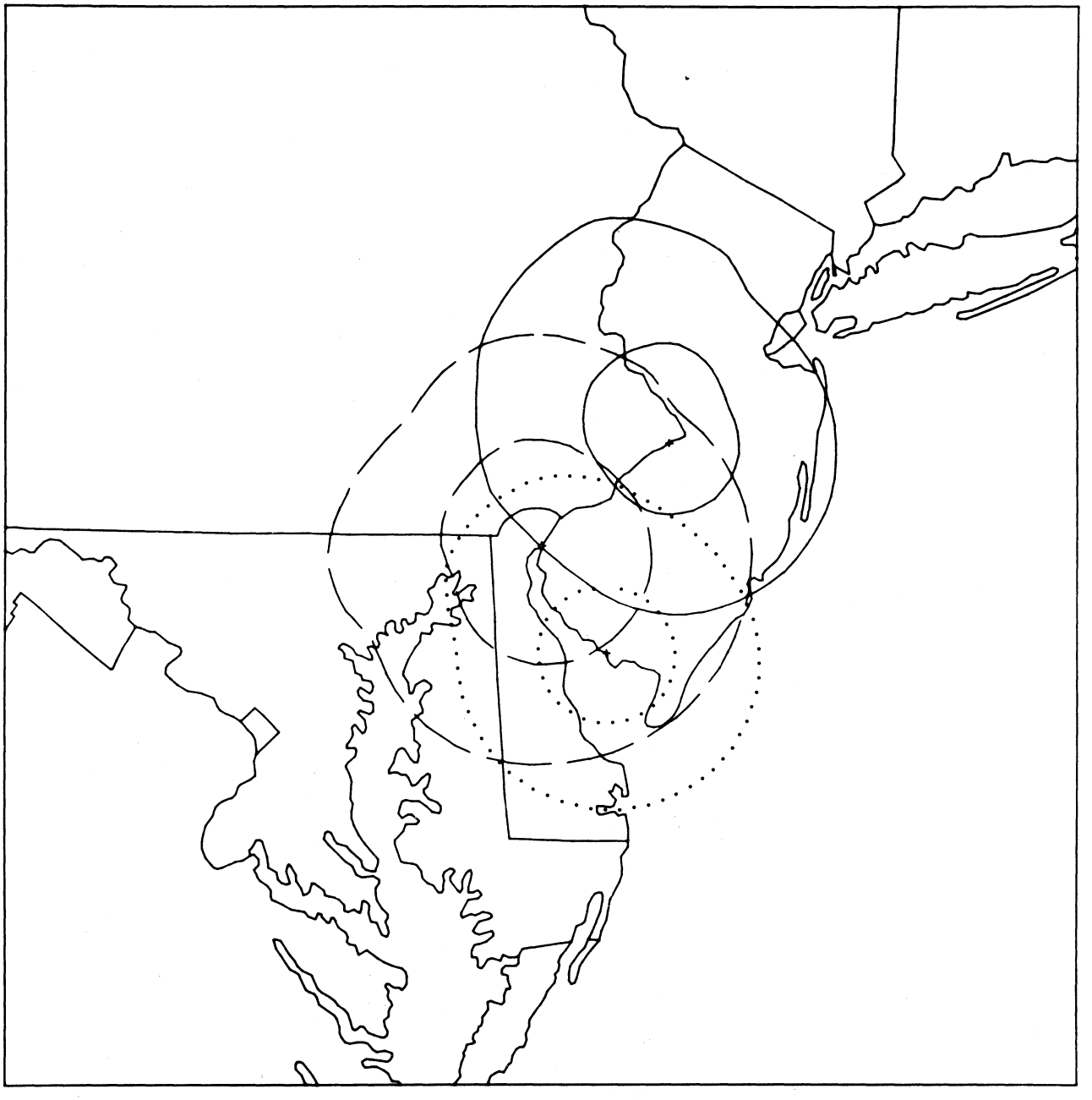

Figure 57. VHF coverage for the District 3 station at Delaware Memorial Bridge (long dashes), Bristol Bridge (solid), and Fortescue (dots). Center: 39°41'10"N, 75°31'2"W.

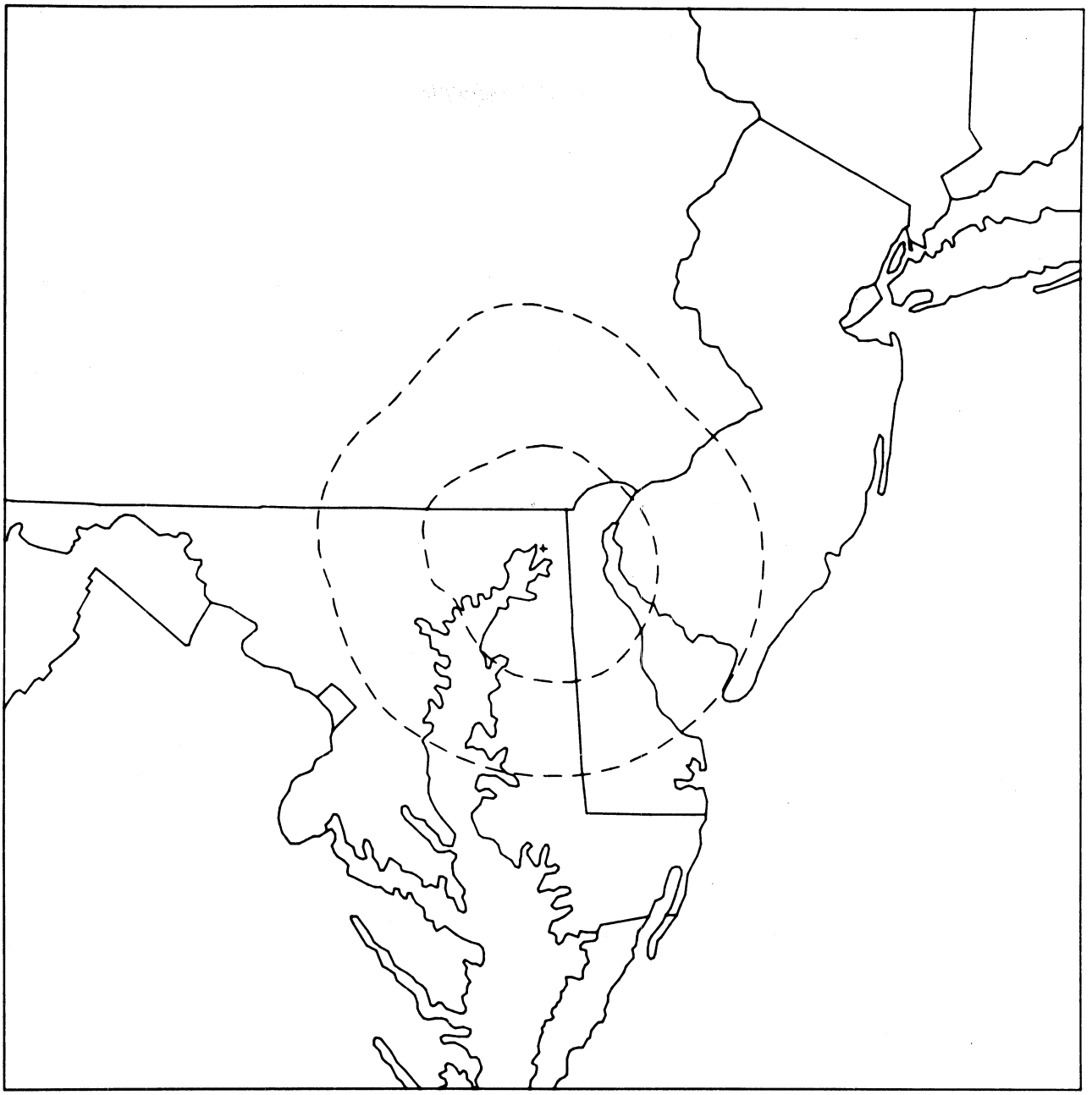

Figure 58. VHF coverage for the District 5 station at North East (short dashes).
Center: 39°34'1"N, 75°55'25"W.

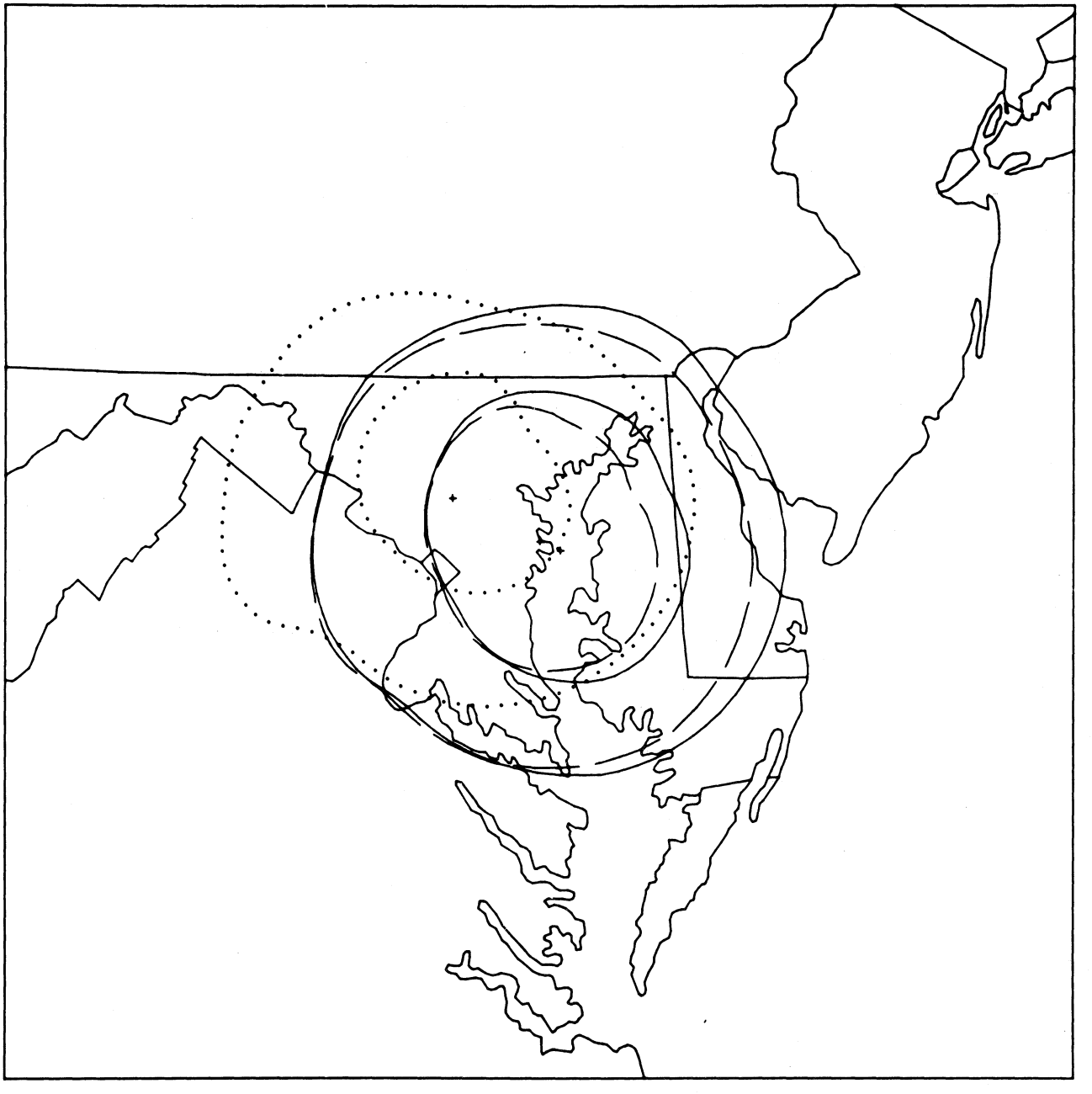

Figure 59. VHF coverage for the District 5 station at Annapolis (long dashes), Annapolis Bay (solid), and Catonsville (dots).
Center: 39°1'59"N, 76°29'29"W.

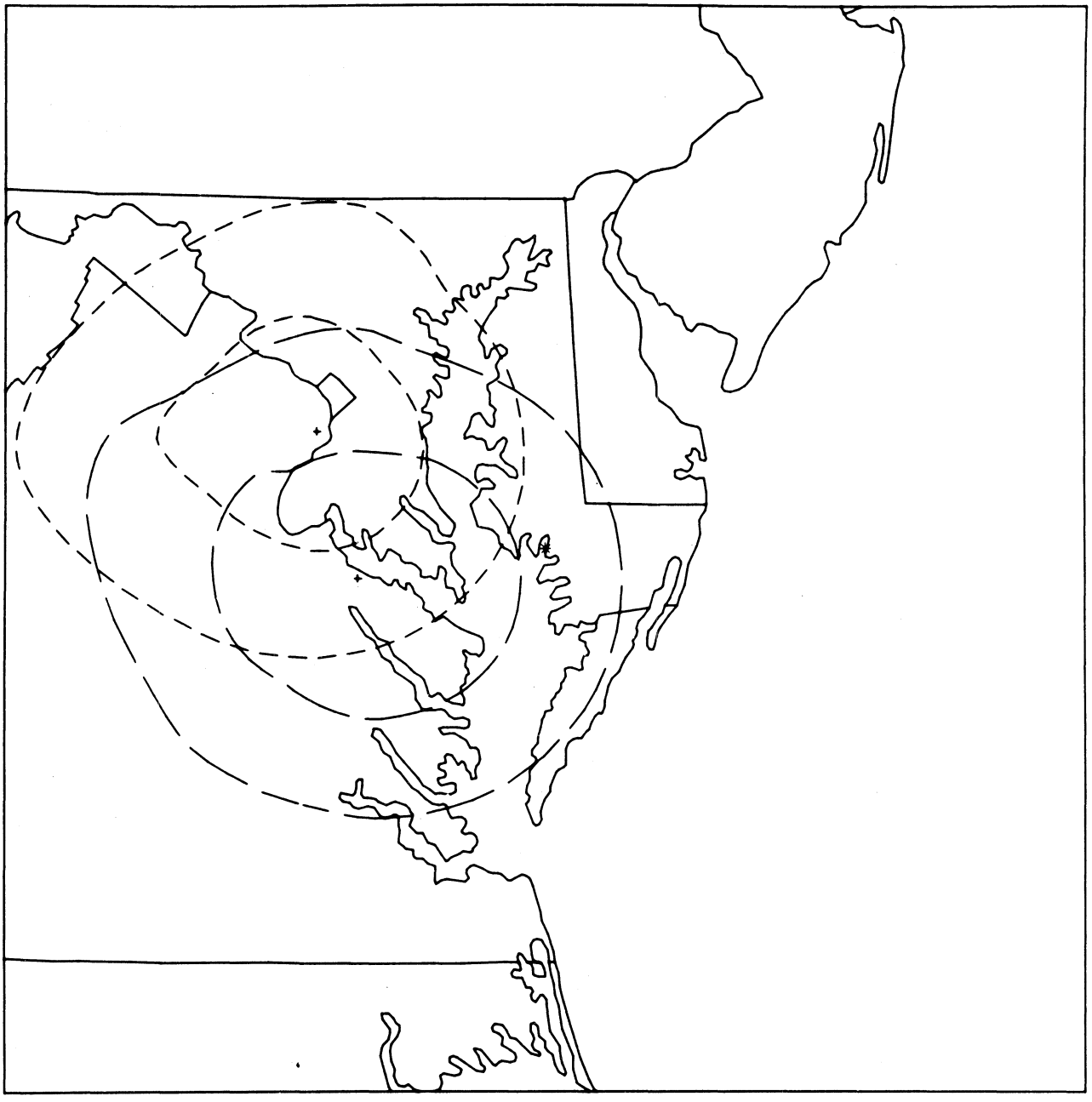

Figure 60. VHF coverage for the District 5 station at Alexandria (short dashes) and Oak Grove (long dashes). Center: 38°16'24"N, 75°54'24"W.

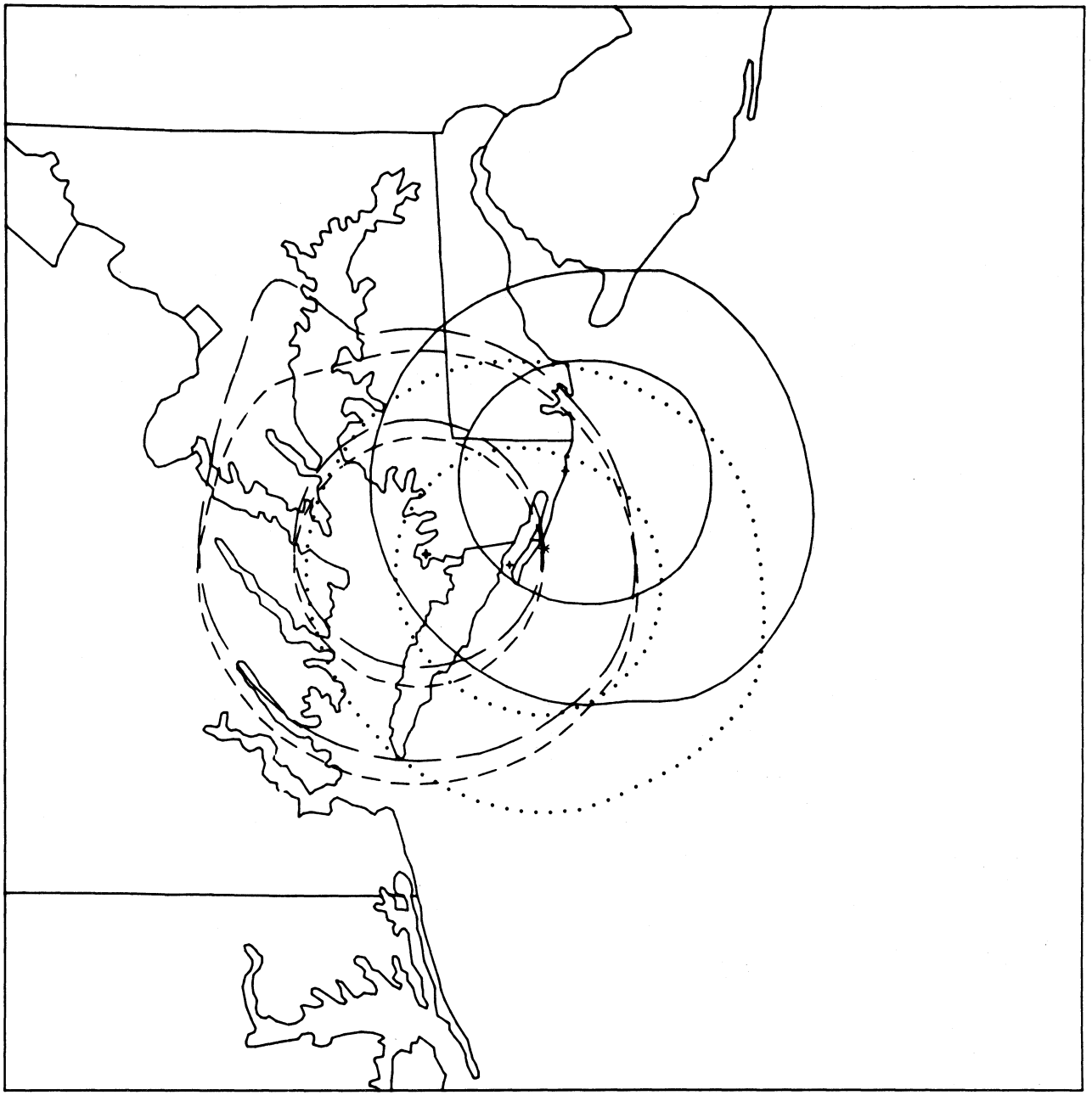

Figure 61. VHF coverage for the District 5 station at Ocean City (solid), Chincoteague (dots), and Crisfield (225°, short dashes; 315°, long dashes). Center: 38°0'0"N, 75°12'0"W.

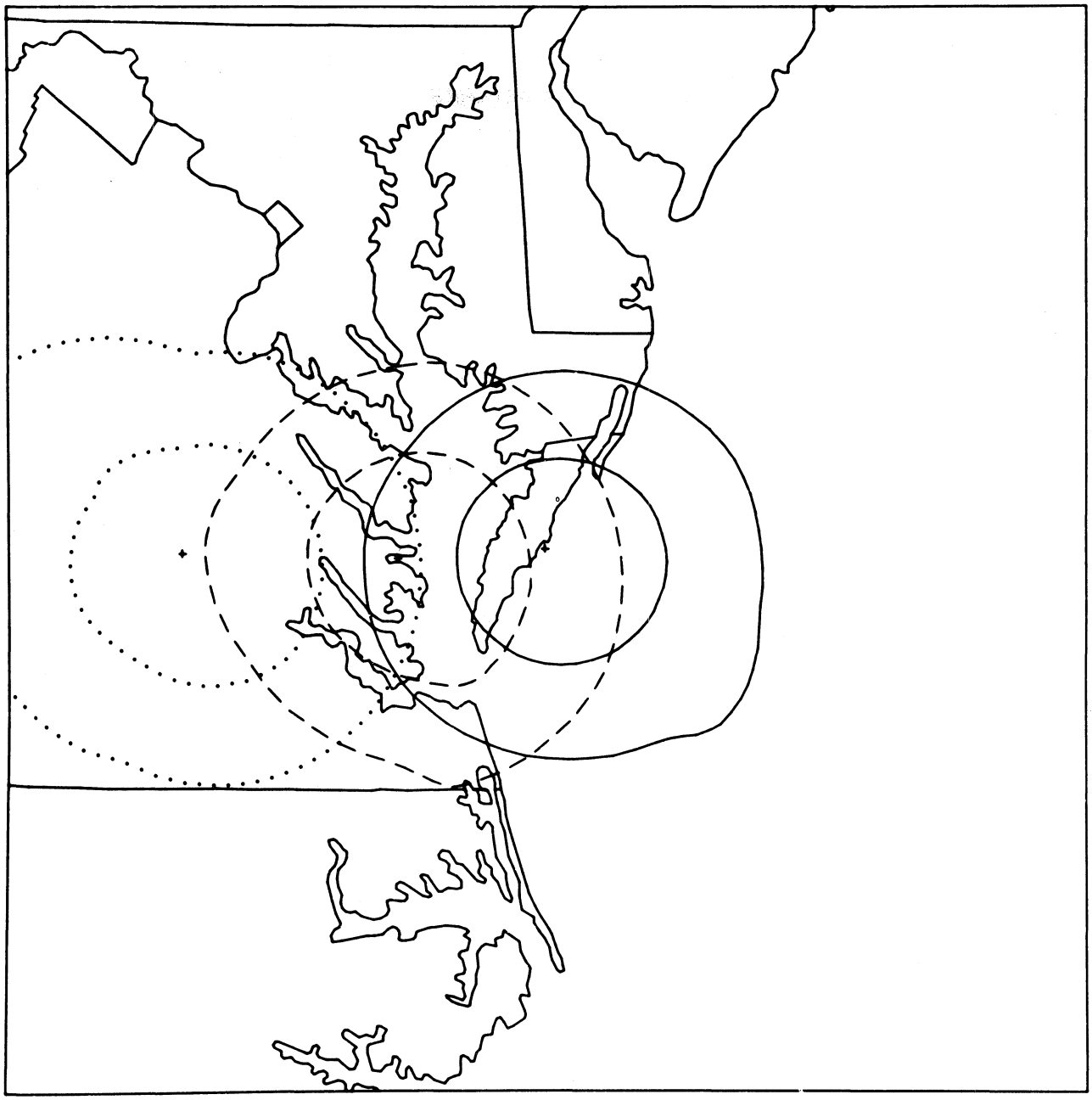

Figure 62. VHF coverage for the District 5 station at Parramore Beach (solid), Richmond (dots), and Cobbs Creek (short dashes).
Center: 37°33'34"N, 75°37'30"W.

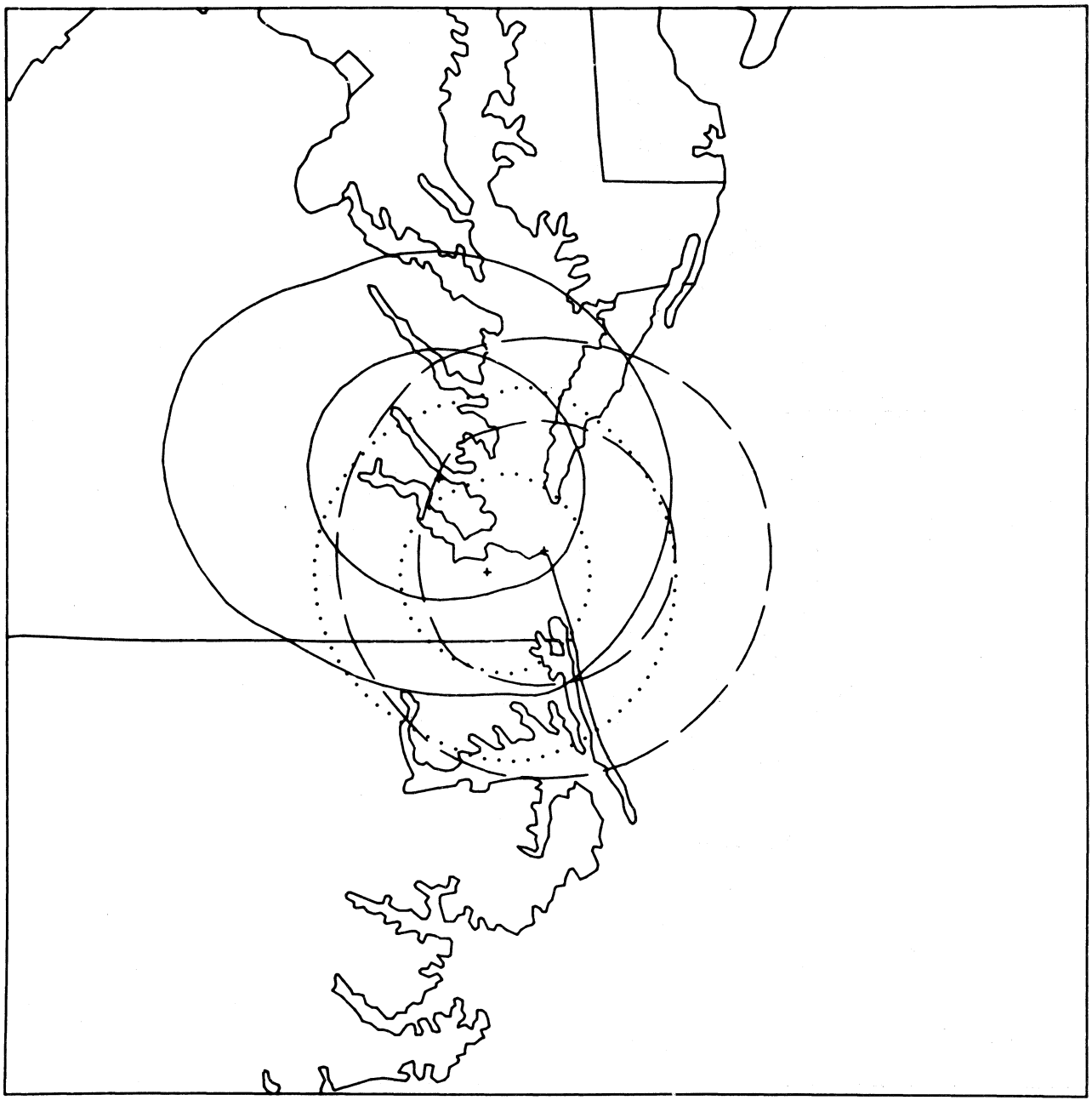

Figure 63. VHF coverage for the District 5 station at Cape Henry (long dashes), Newport News (solid), and Portsmouth (dots).
Center: 36°55'36"N, 76°0'30"W.

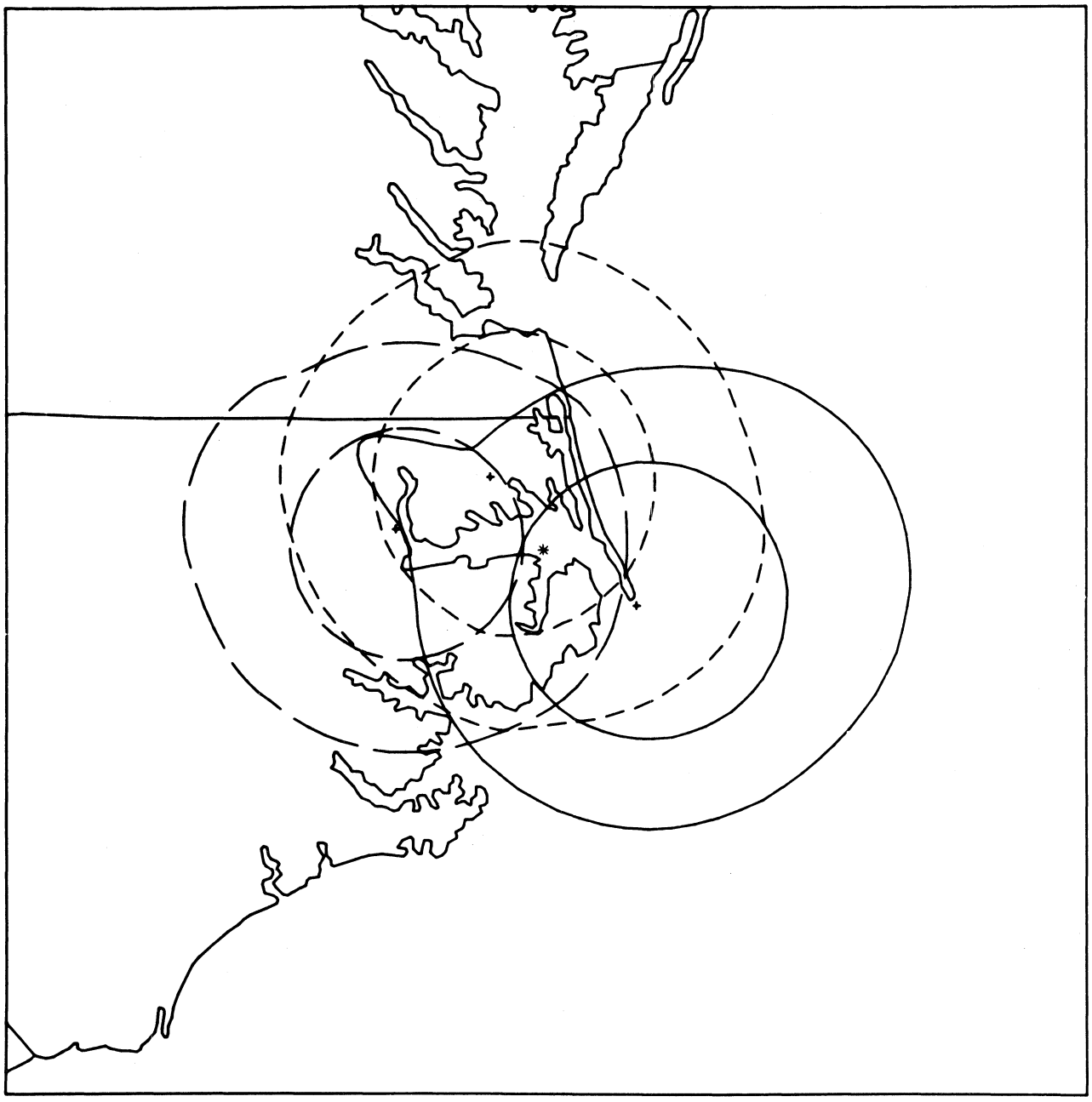

Figure 64. VHF coverage for the District 5 station at Elizabeth City (short dashes), Midway (long dashes), and Oregon Inlet (solid).
Center: 36°0'0"N, 76°0'0"W.

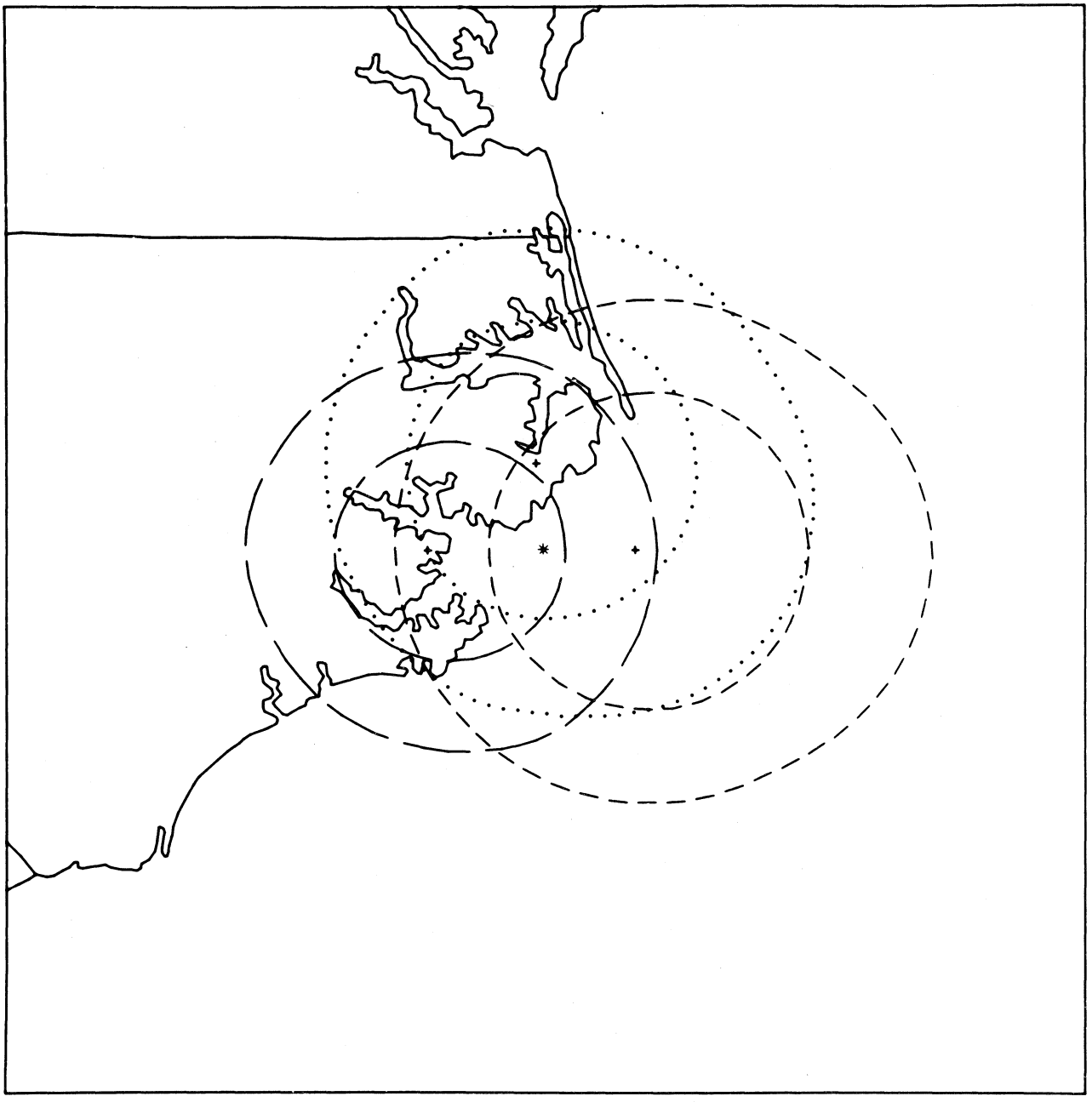

Figure 65. VHF coverage for the District 5 station at Engelhard (dots), Buxton (short dashes), and Hobucken (long dashes).
Center: 35°15'0"N, 76°0'0"W.

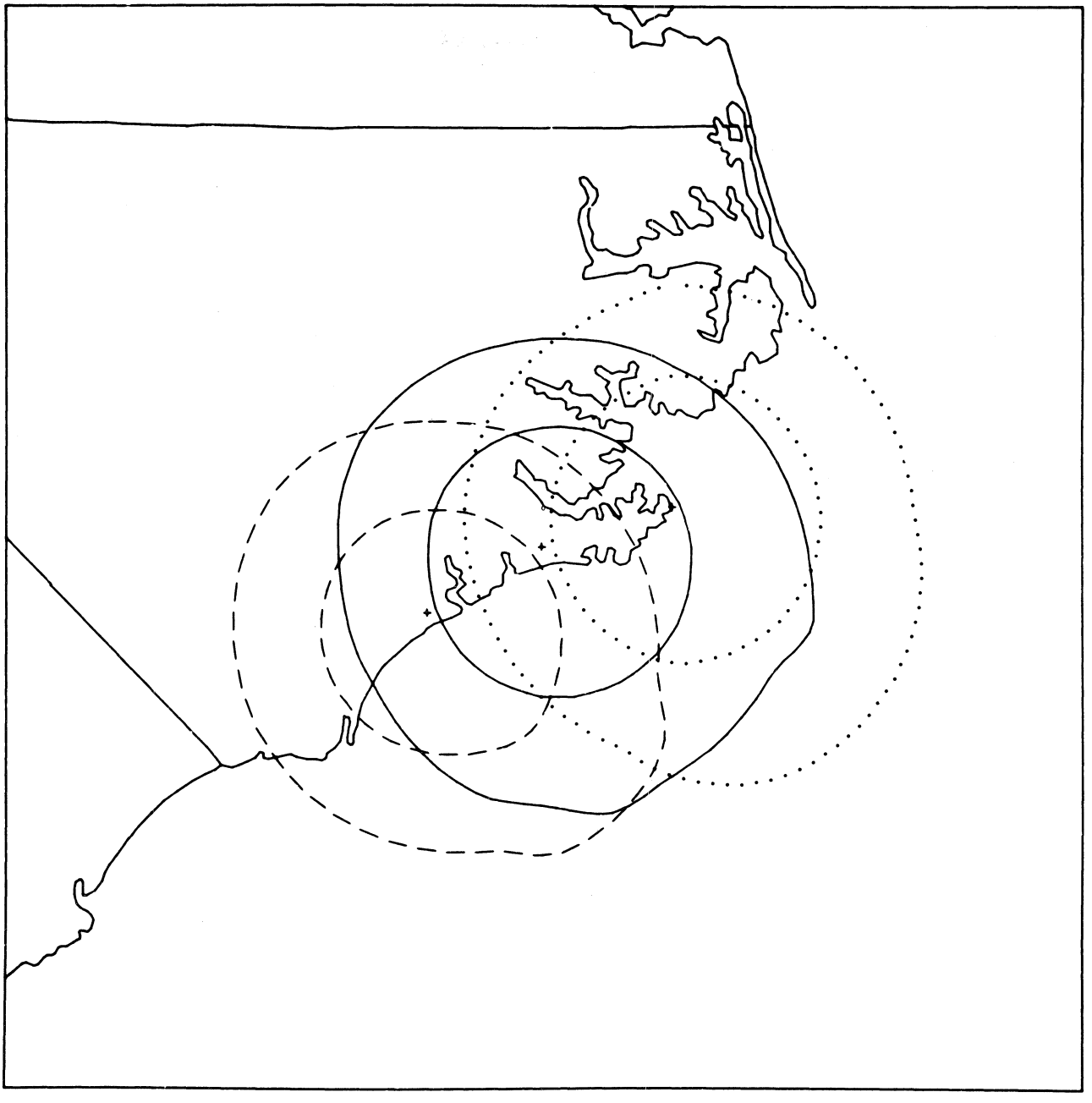

Figure 66. VHF coverage for the District 5 station at Croatan (solid), Cedar Island (dots), and Hollyridge (short dashes).
Center: 34°47'50"N, 76°56'30"W.

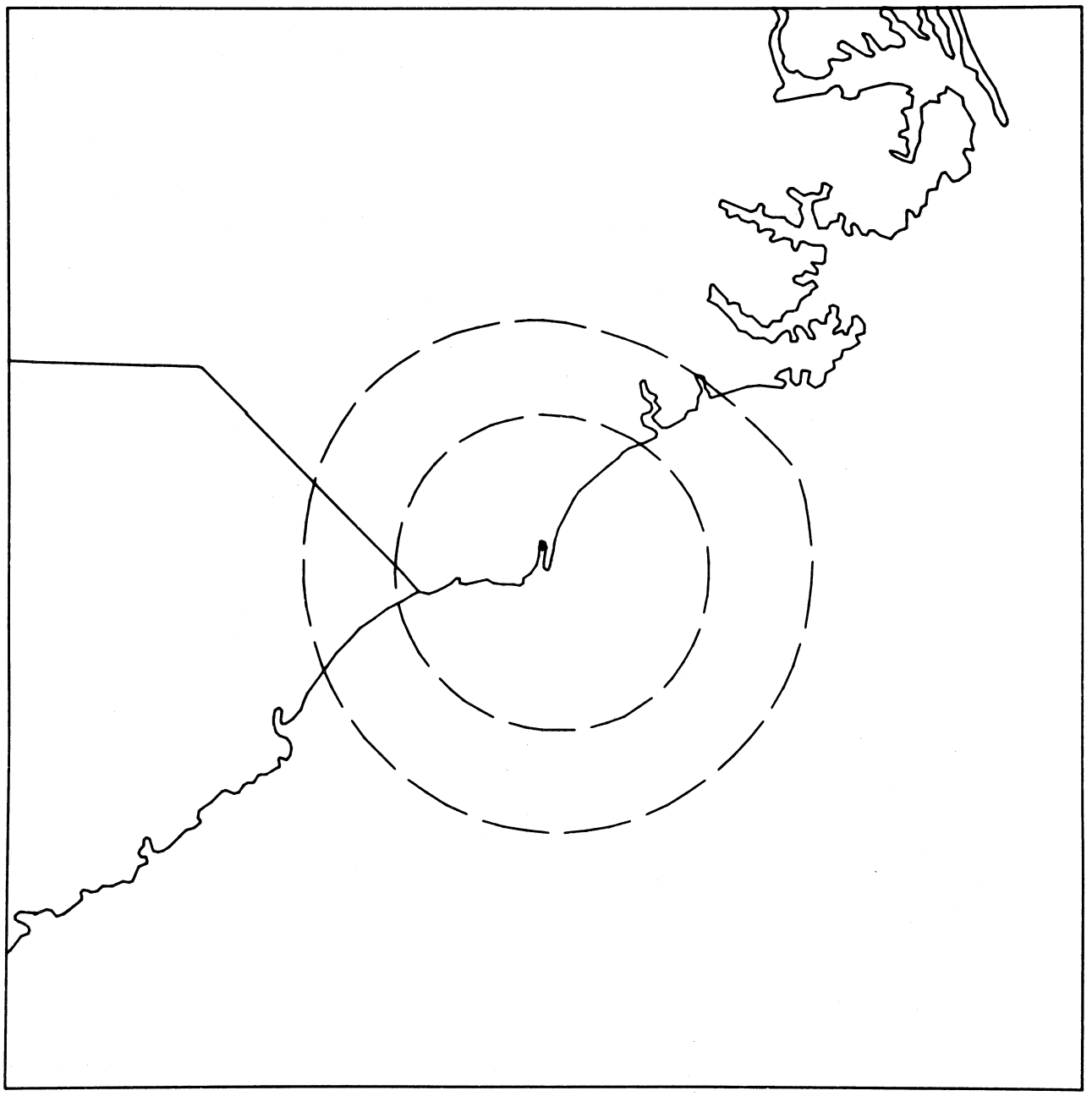

Figure 67. VHF coverage for the District 5 station at Carolina Beach (long dashes).
Center: 34°3'29"N, 77°55'40"W.

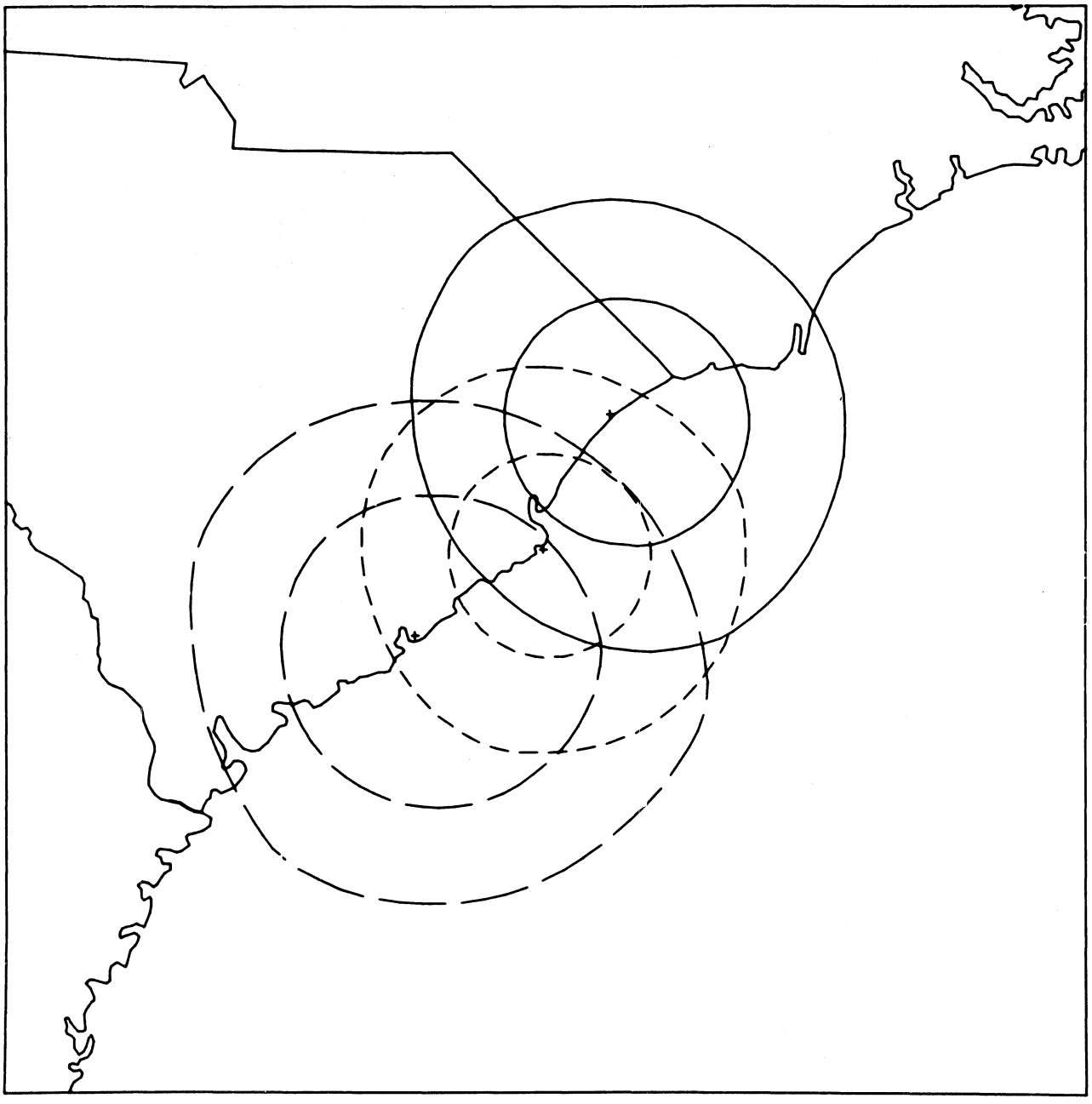

Figure 68. VHF coverage for the District 7 station at South Island (short dashes), Mt. Pleasant (long dashes), and Myrtle Beach (solid).
Center: 33°9'13"N, 79°12'20"W.

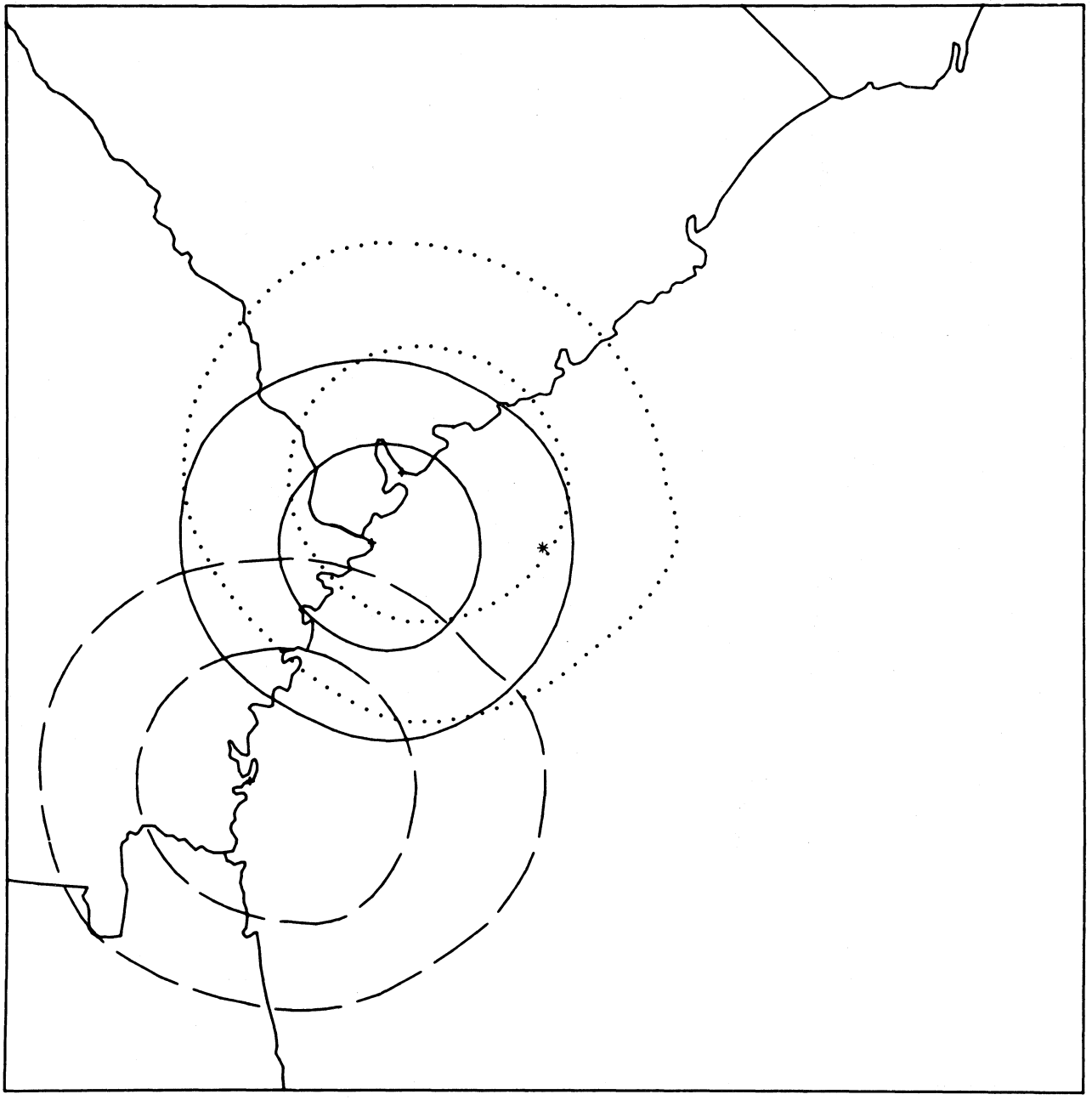

Figure 69. VHF coverage for the District 7 station at Jekyll Island (long dashes), Tybee Island (solid), and Parris Island (dots).
Center: 32°0'0"N, 80°0'0"W.

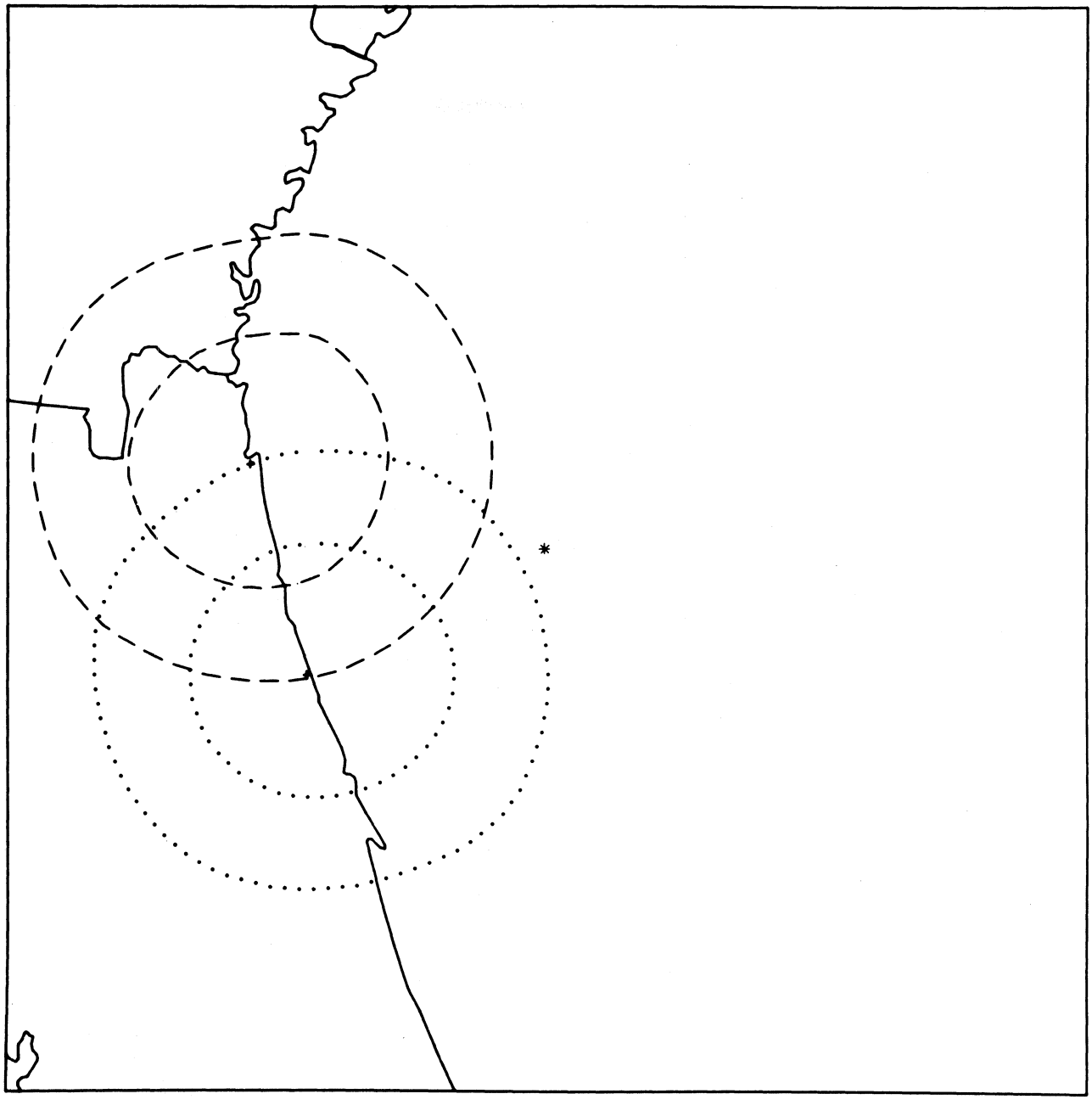

Figure 70. VHF coverage for the District 7 station at Flagler Beach (dots) and Jacksonville (short dashes). Center: 30°0'0"N, 80°0'0"W.

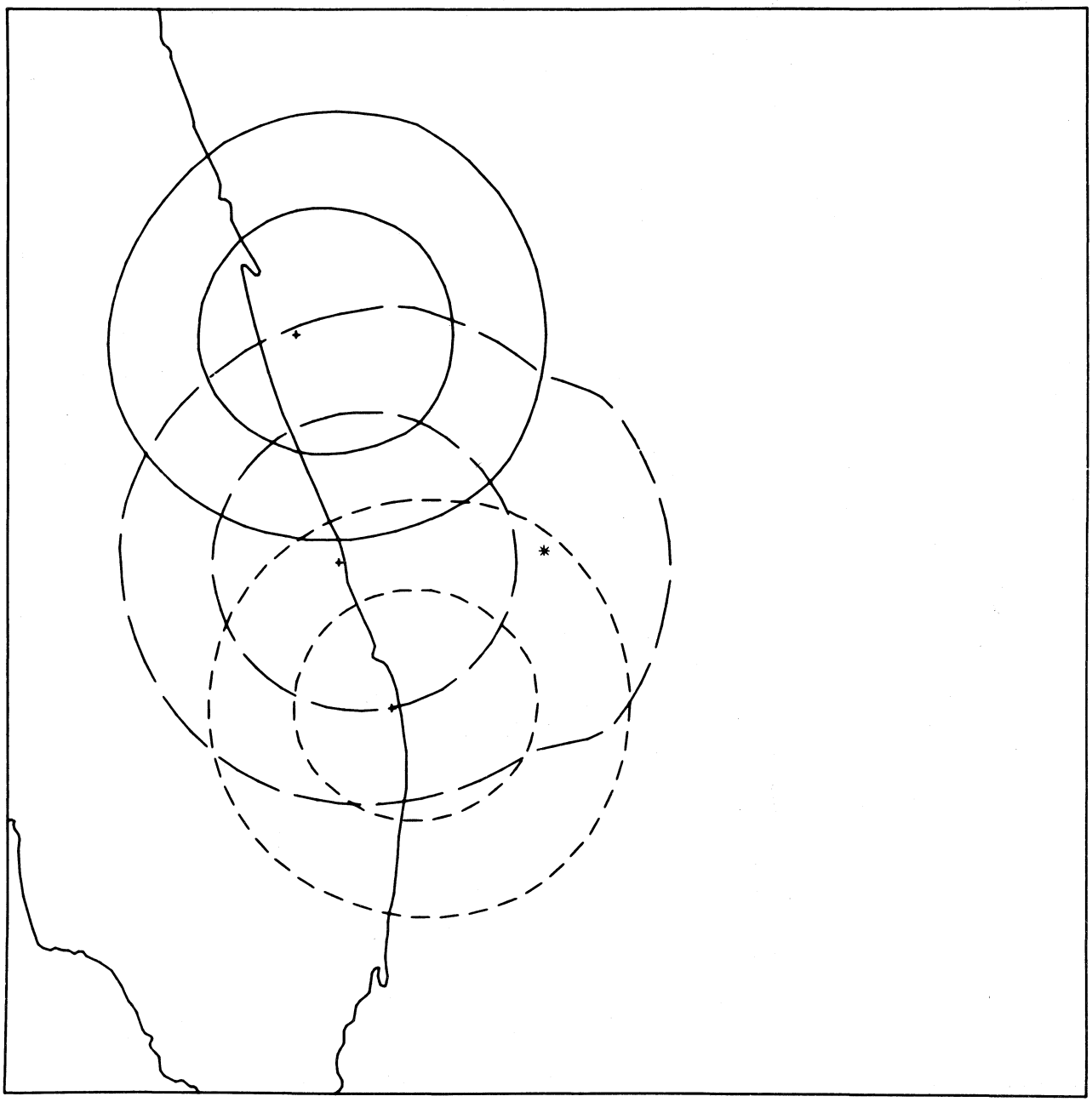

Figure 71. VHF coverage for the District 7 station at Jupiter (short dashes), Ft. Pierce (long dashes), and Cape Kennedy (solid).
Center: 27°36'0"N, 79°24'0"W.

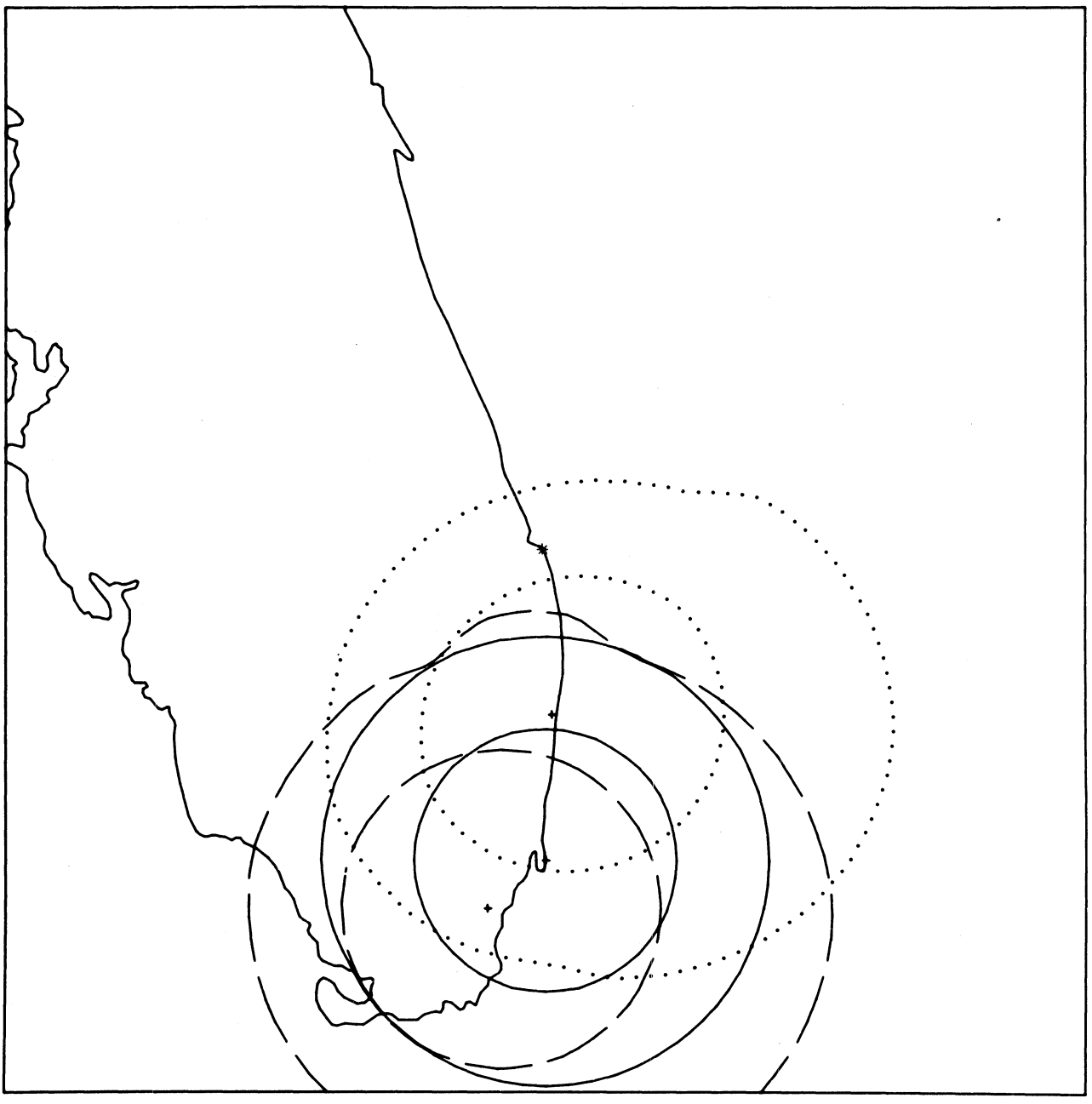

Figure 72. VHF coverage for the District 7 station at Princeton (long dashes), Miami Beach (solid), and Delray Beach (dots).
Center: 27°7'12"N, 80°8'12"W.

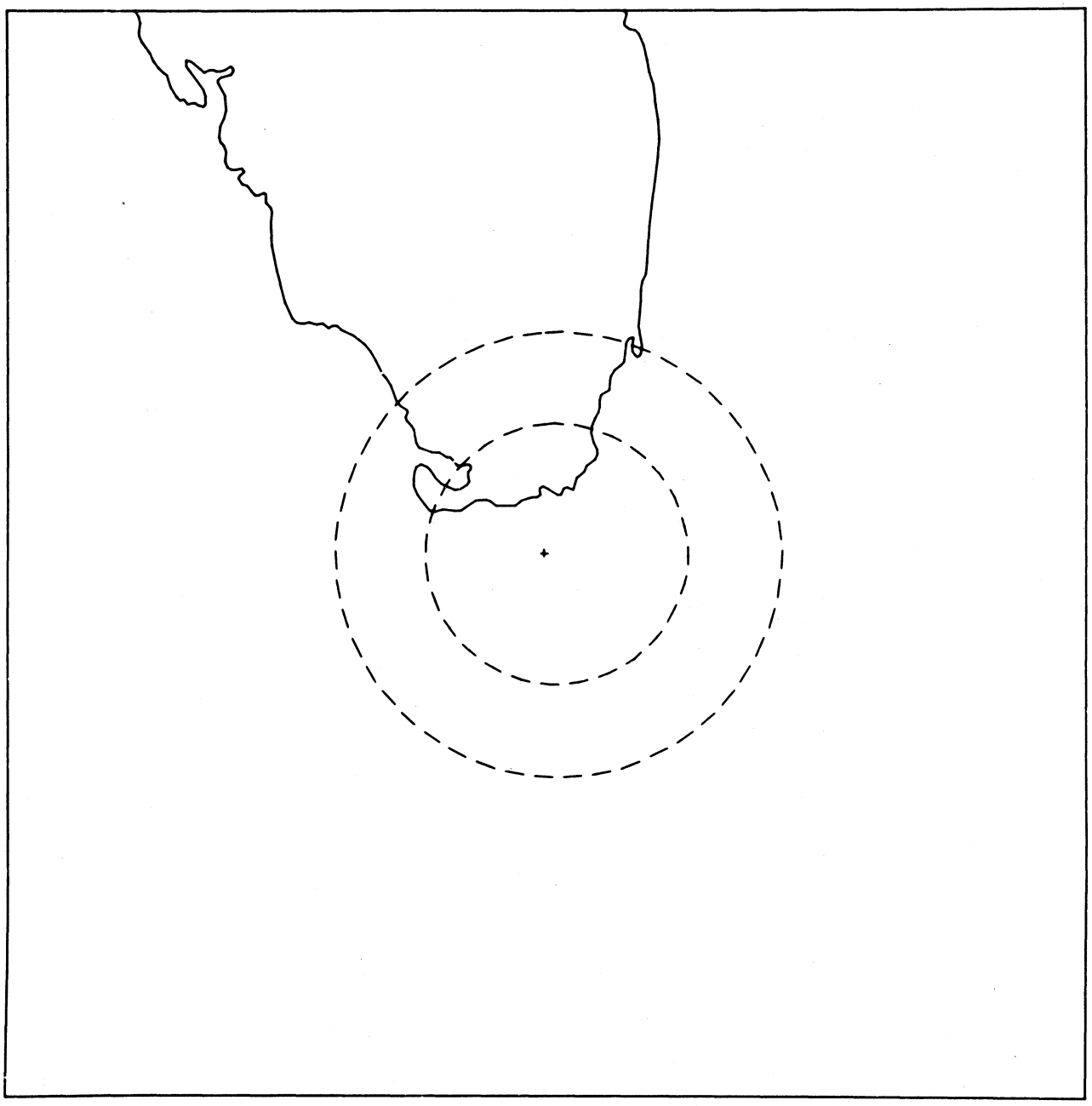

Figure 73. VHF coverage for the District 7 station at Islamorada (short dashes).
Center: 24°57'30"N, 80°34'30"W.

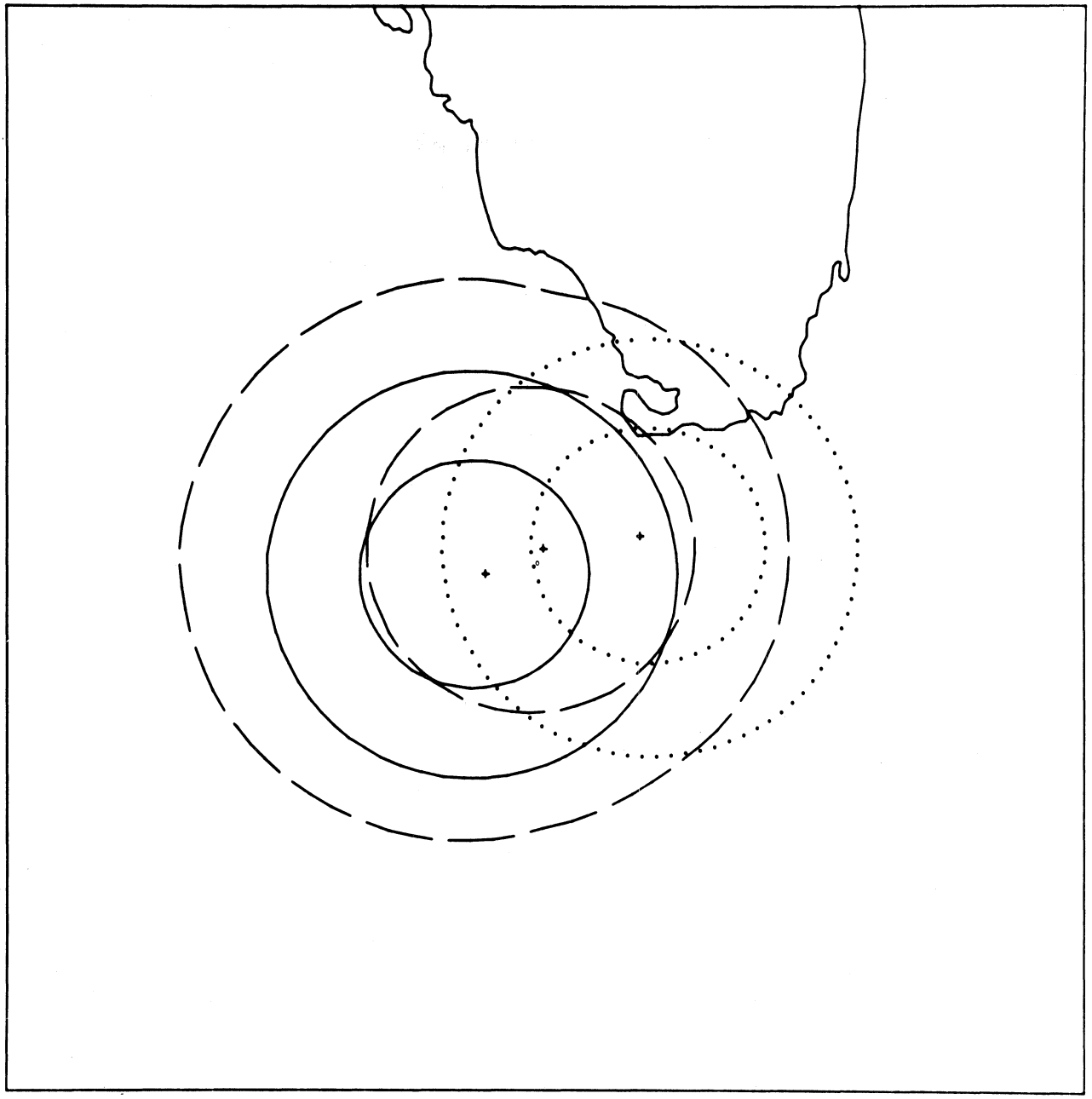

Figure 74. VHF coverage for the District 7 station at Sugarloaf Key (long dashes), Key West (solid), Marathon (dots).
Center: 24°39'39"N, 81°32'18"W.

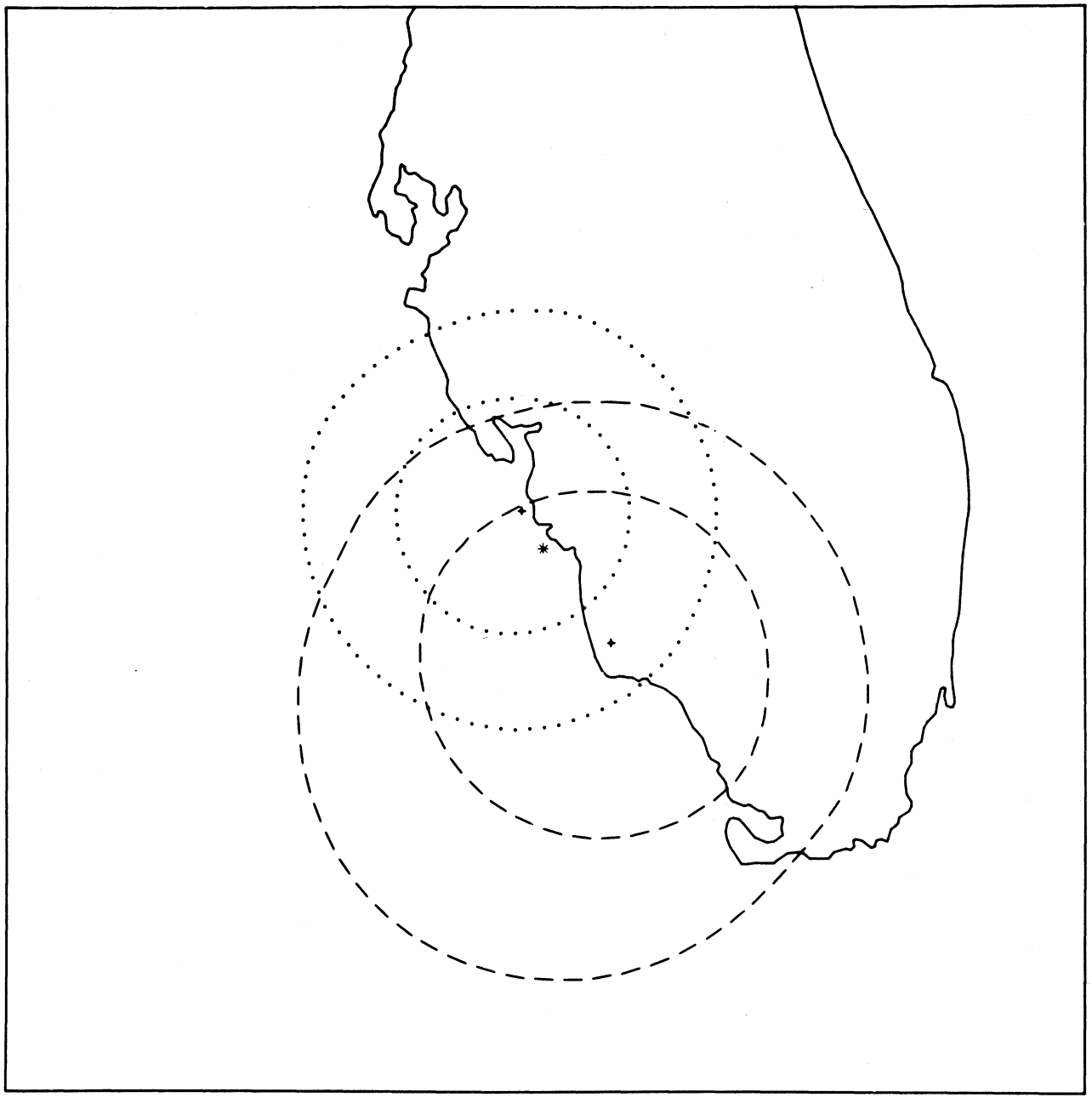

Figure 75. VHF coverage for the District 7 station at Pine Island (dots) and Naples (short dashes). Center: 26°26'54"N, 82°1'18"W.

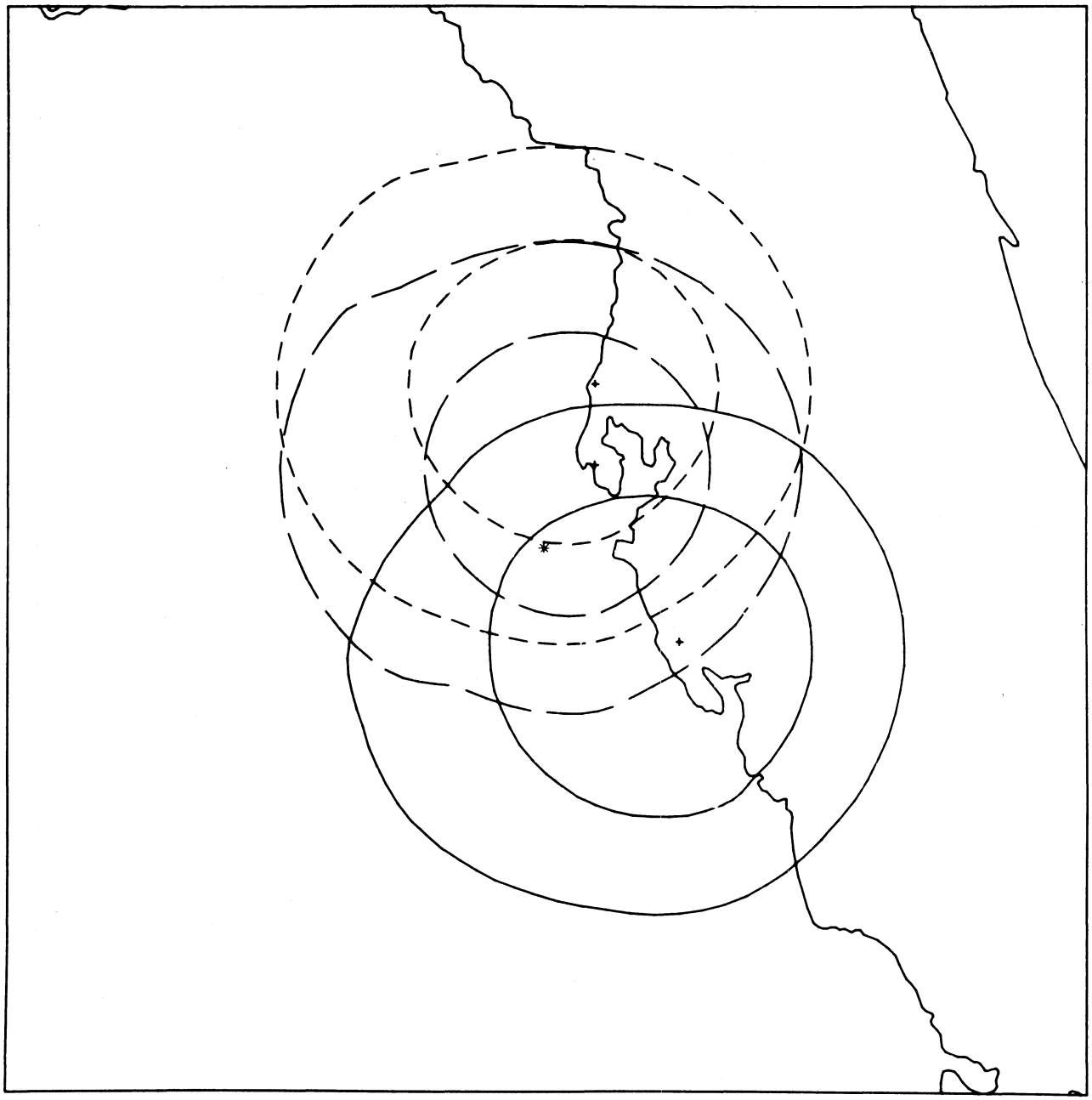

Figure 76. VHF coverage for the District 7 station at Tarpon Springs (short dashes), Seminole (long dashes), Venice (solid).
Center: 27°30'0"N, 83°0'0"W.

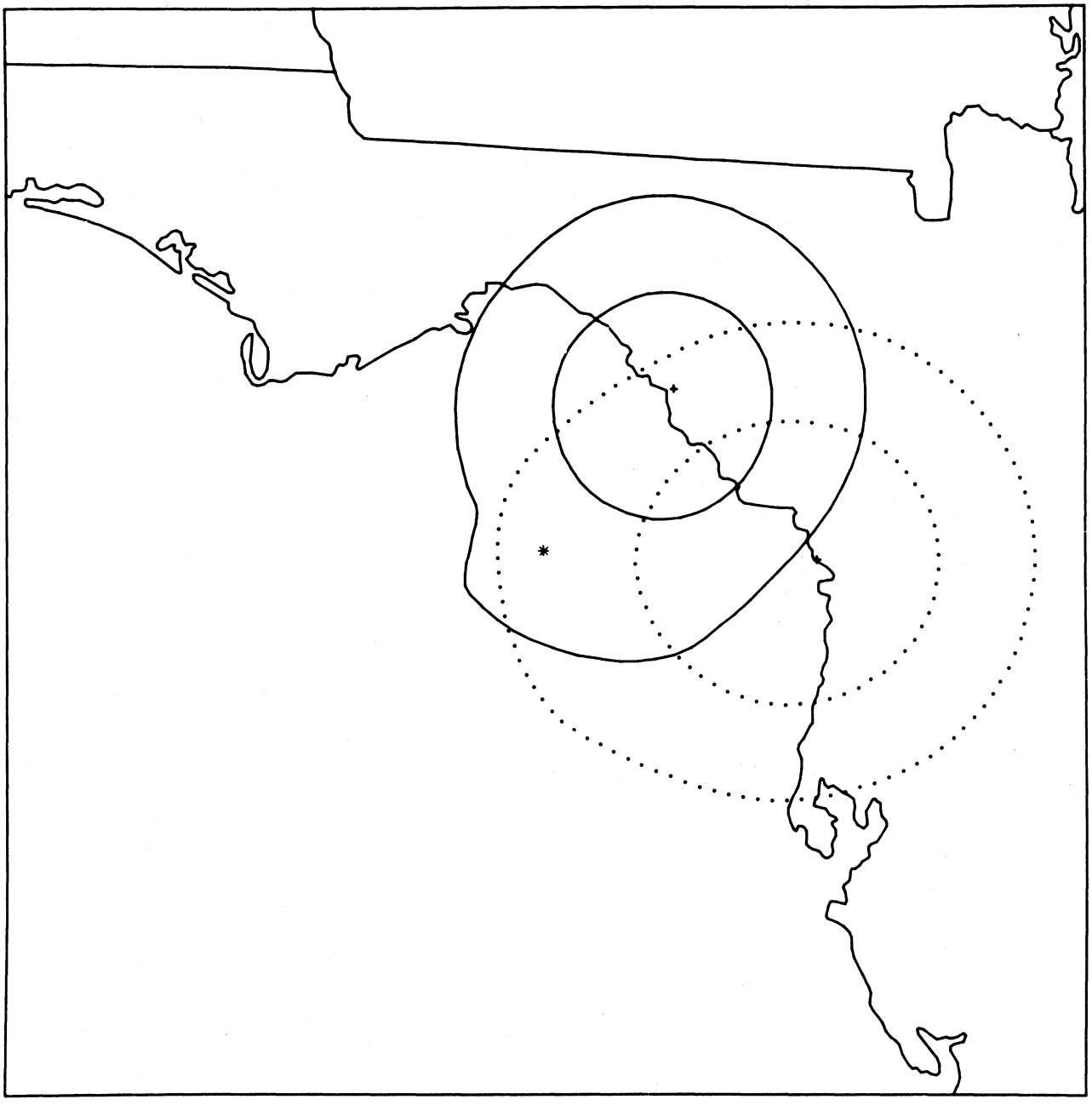

Figure 77. VHF coverage for the District 7 station at Steinhatchee (solid) and Crystal River (dots). Center: 29°0'0"N, 84°0'0"W.

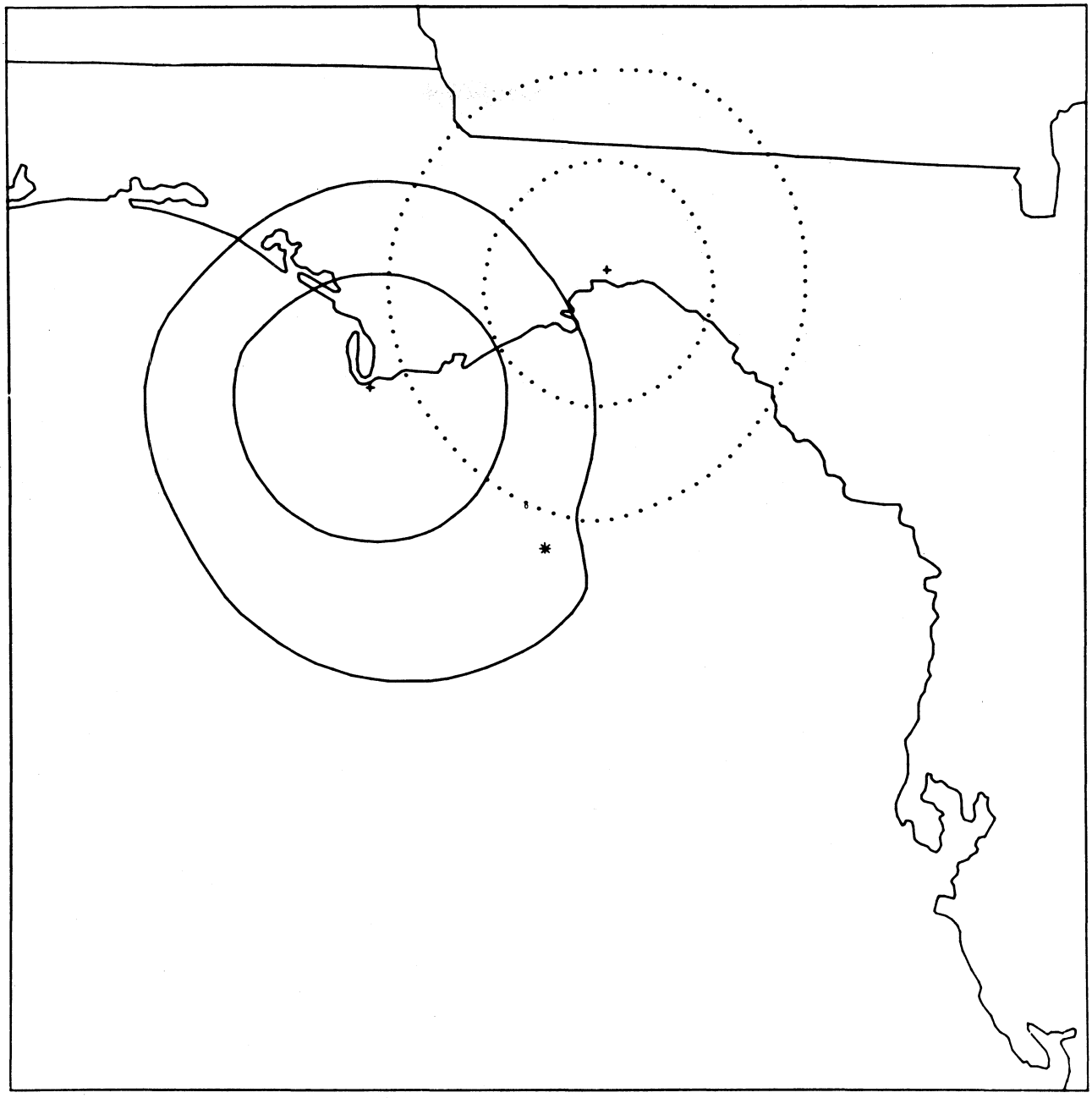

Figure 78. VHF coverage for the District 8 station at Cape San Blas (solid) and St. Marks (dots). Center: 29°0'0"N, 84°30'0"W.

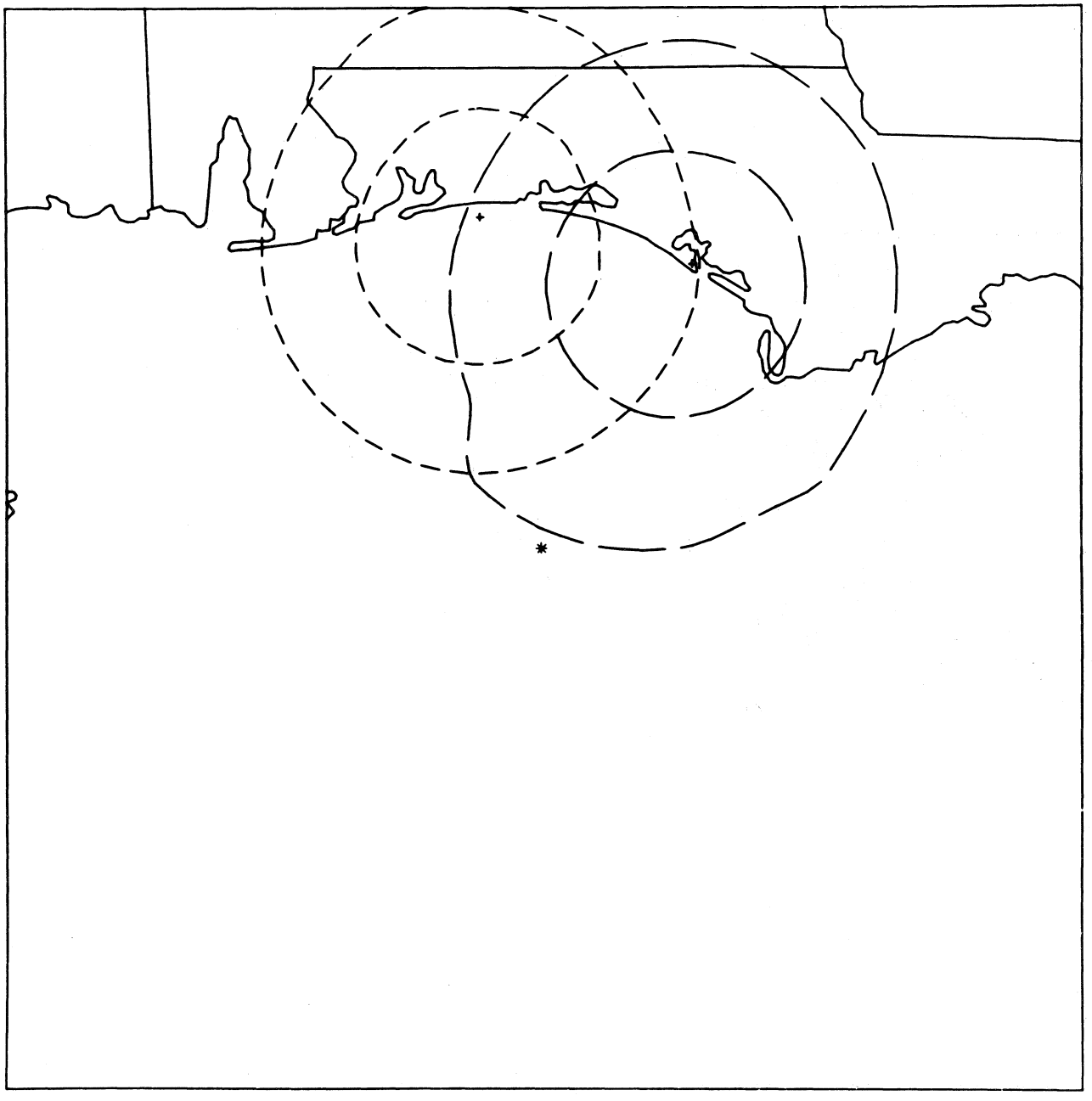

Figure 79. VHF coverage for the District 8 station at Fort Walton (short dashes) and Panama City (long dashes). Center: 29°0'0"N, 86°30'0"W.

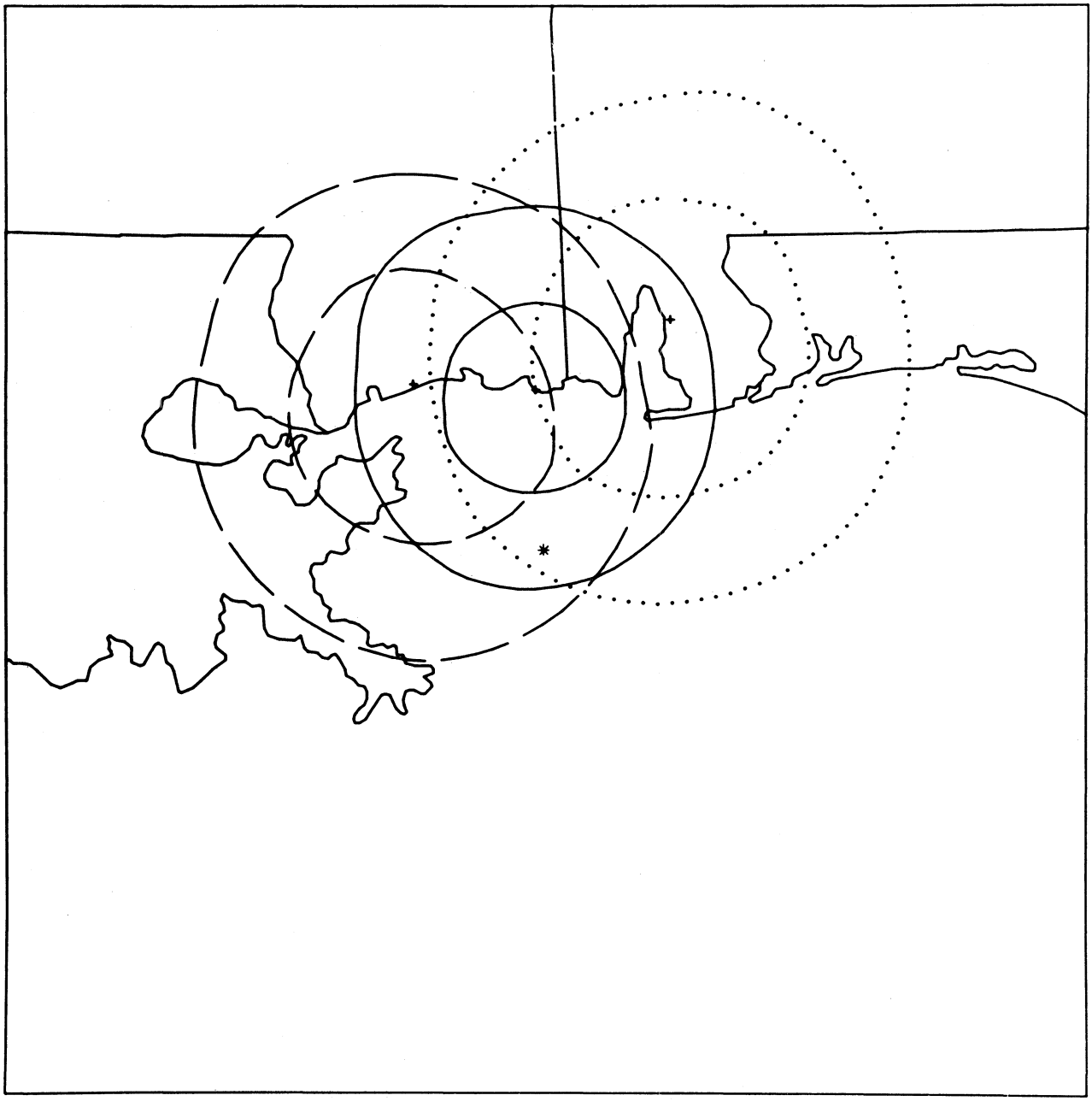

Figure 80. VHF coverage for the District 8 station at Gulfport (long dashes), Pascagoula (solid), and Spanish Fort (dots).
Center: 29°42'0"N, 88°30'0"W.

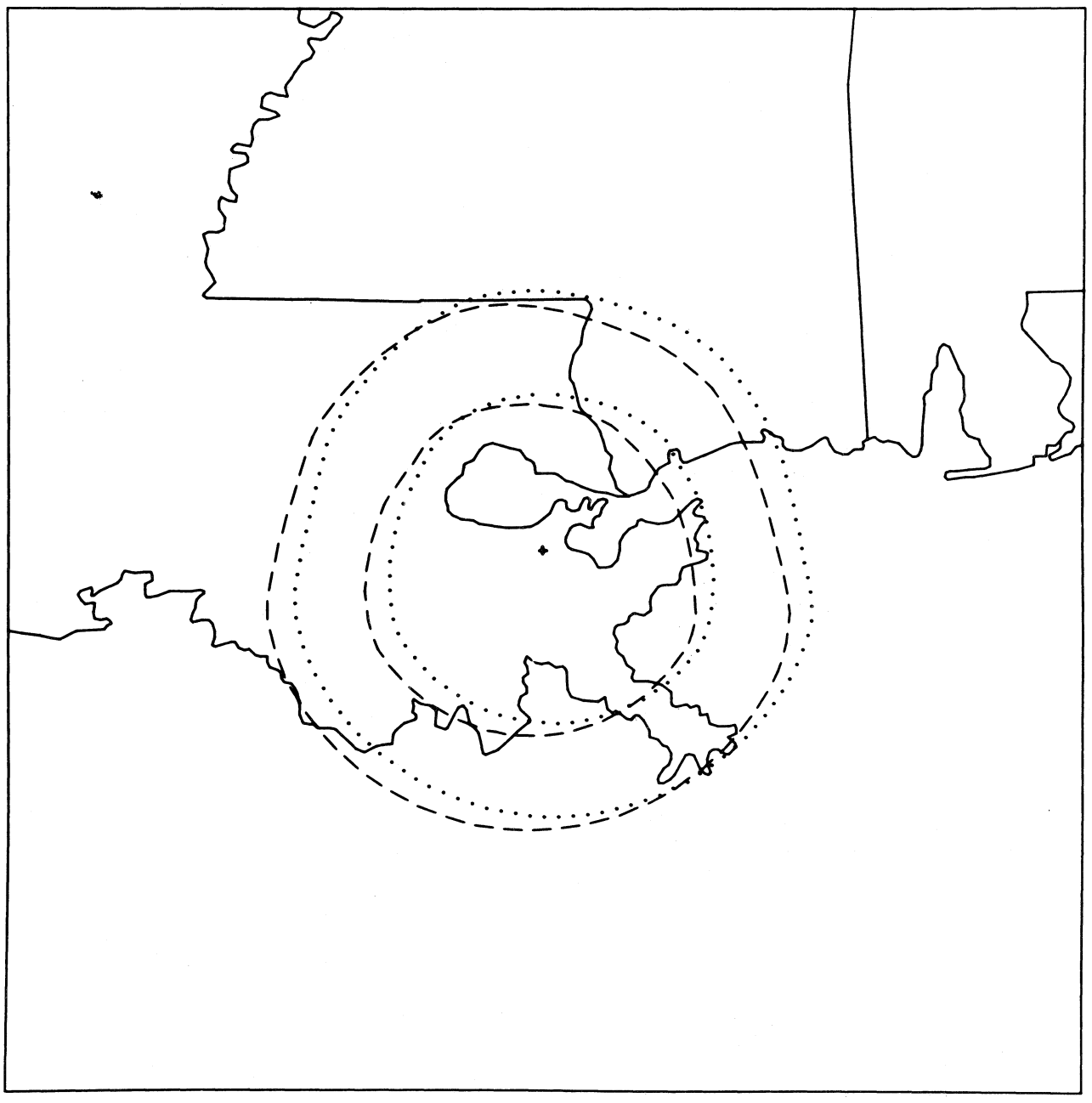

Figure 81. VHF coverage for the District 8 station at Chalmette (60°, dots; 240°, short dashes). Center: 29°57'13"N, 89°57'32"W.

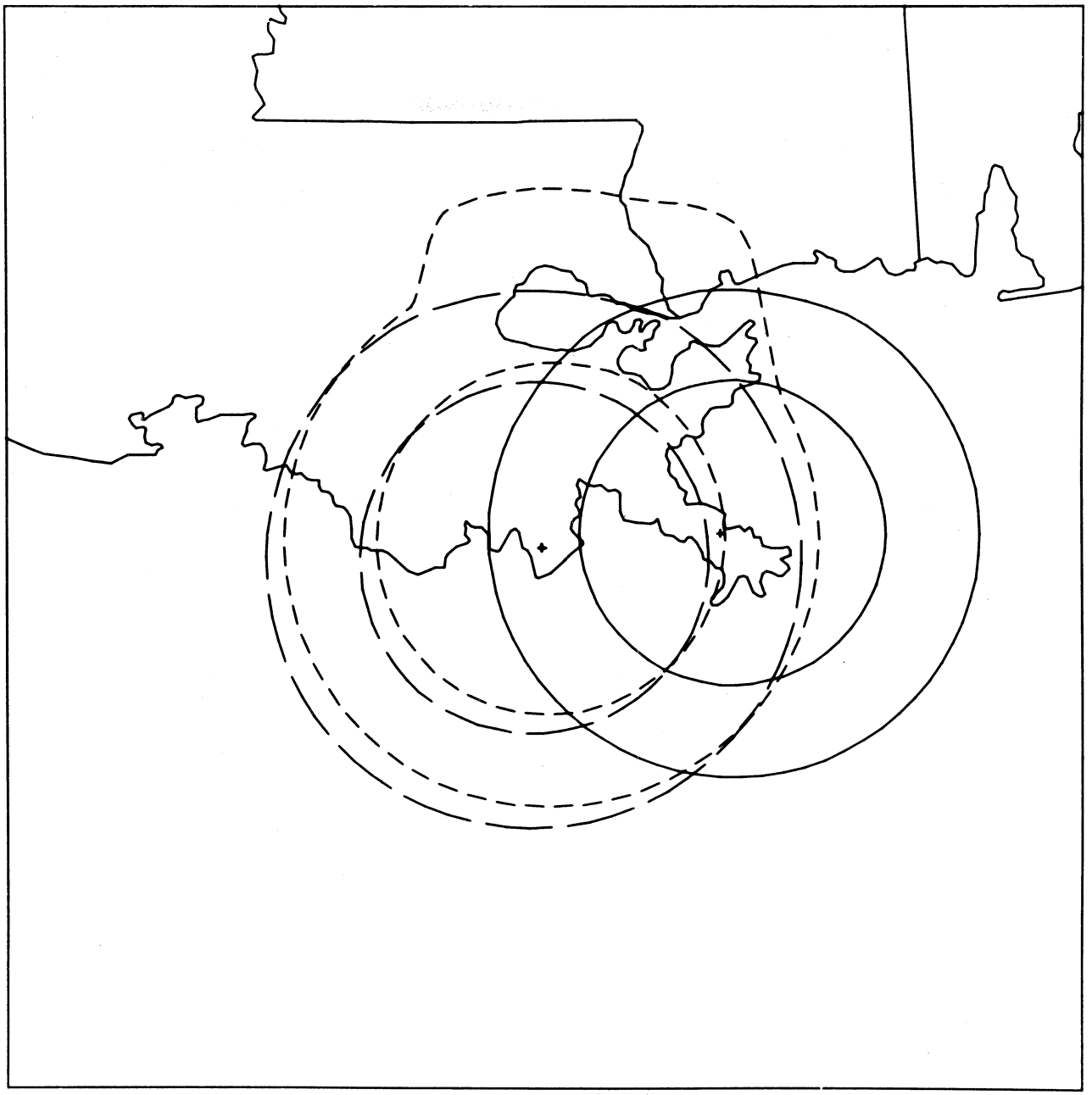

Figure 82. VHF coverage for the District 8 station at Leeville (40°, short dashes; 220°, long dashes), and Venice (solid).
Center: 29°13'16"N, 90°12'51"W.

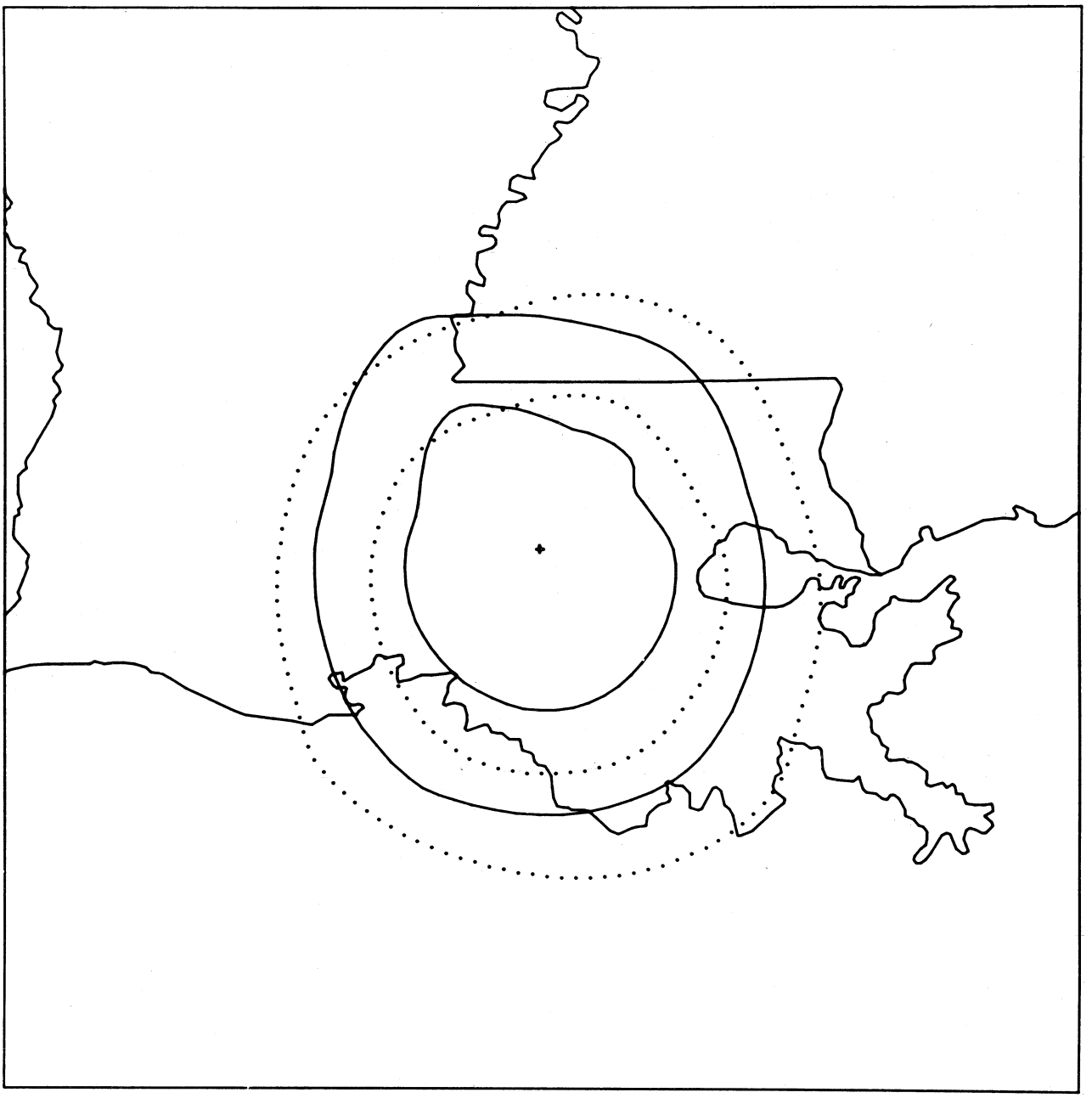

Figure 83. VHF coverage for the District 8 station at Plaquemine Pt. (330°, solid; 150°, dots). Center: 30°17'49"N, 91°11'40"W.

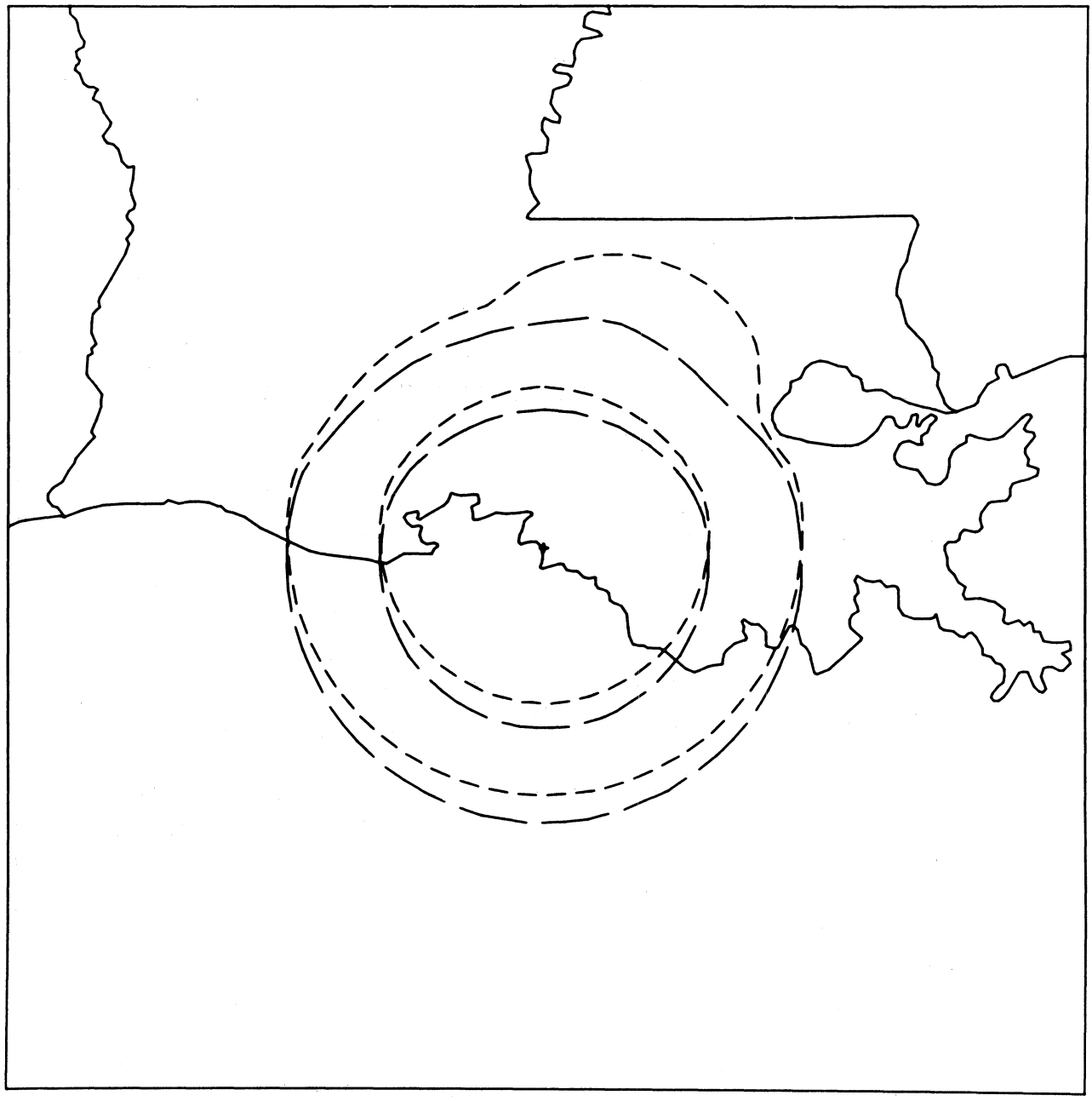

Figure 84. VHF coverage for the District 8 station at South Bend (0°, short dashes; 180°, long dashes). Center: 29°37'31"N, 91°32'6"W.

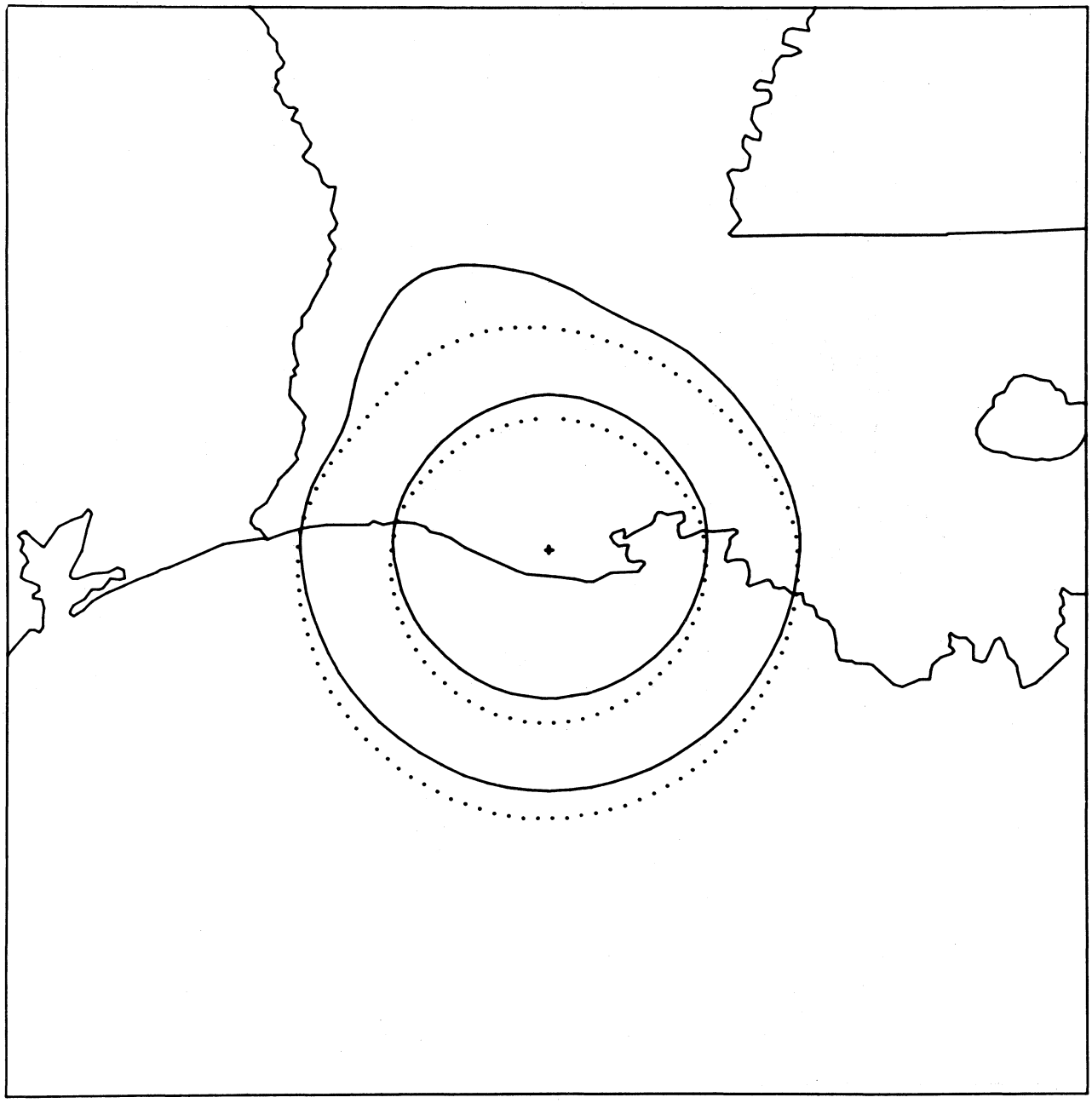

Figure 85. VHF coverage for the District 8 station at Pecan Island (5°, solid; 185°, dots). Center: 29°41'33"N, 92°30'12"W.

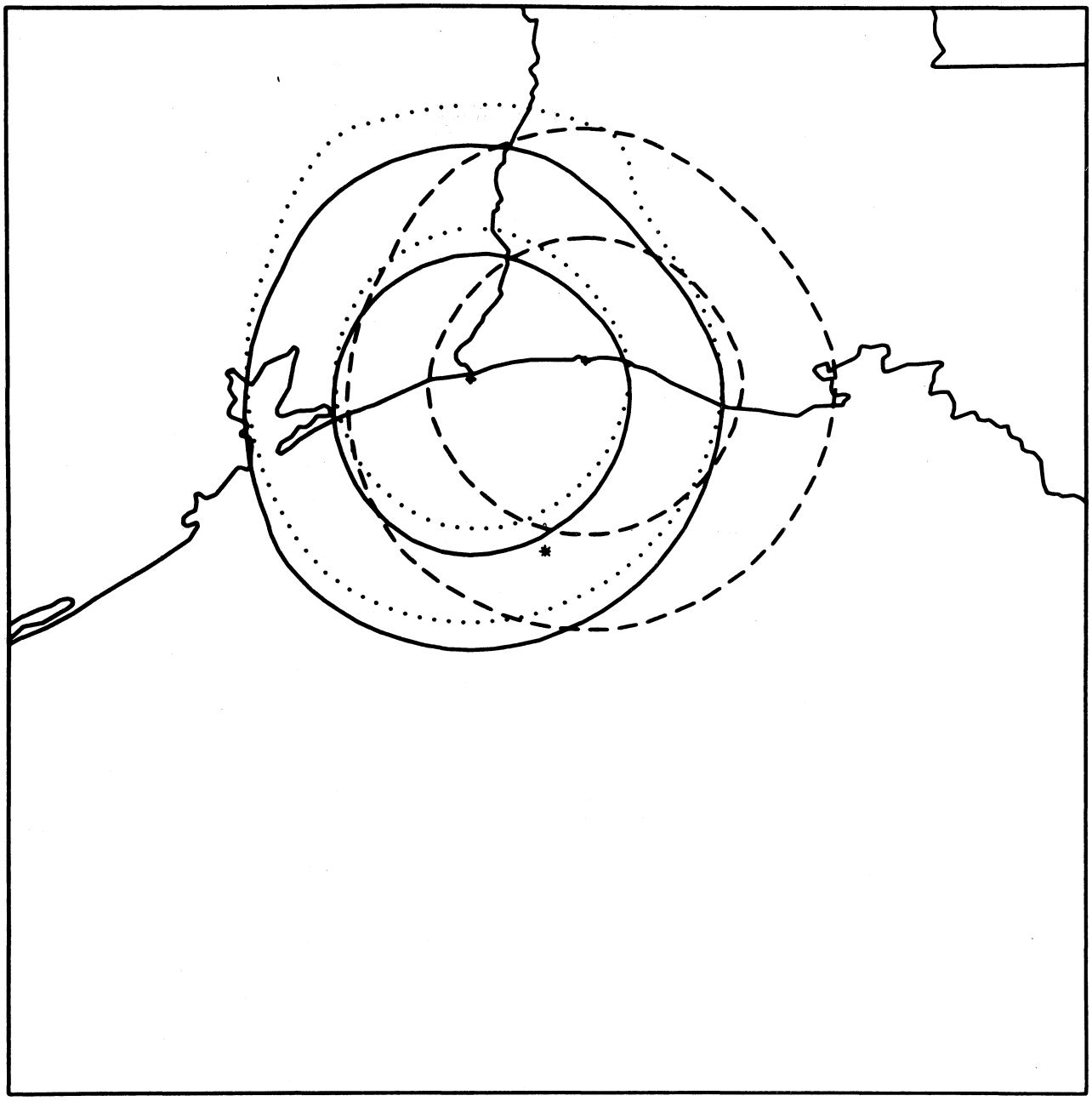

Figure 86. VHF coverage for the District 8 station at Sabine (180°, solid; 0°, dots) and Cameron (180°, short dashes; 0°, long dashes). Center: 29°0'0"N, 93°30'0"W.

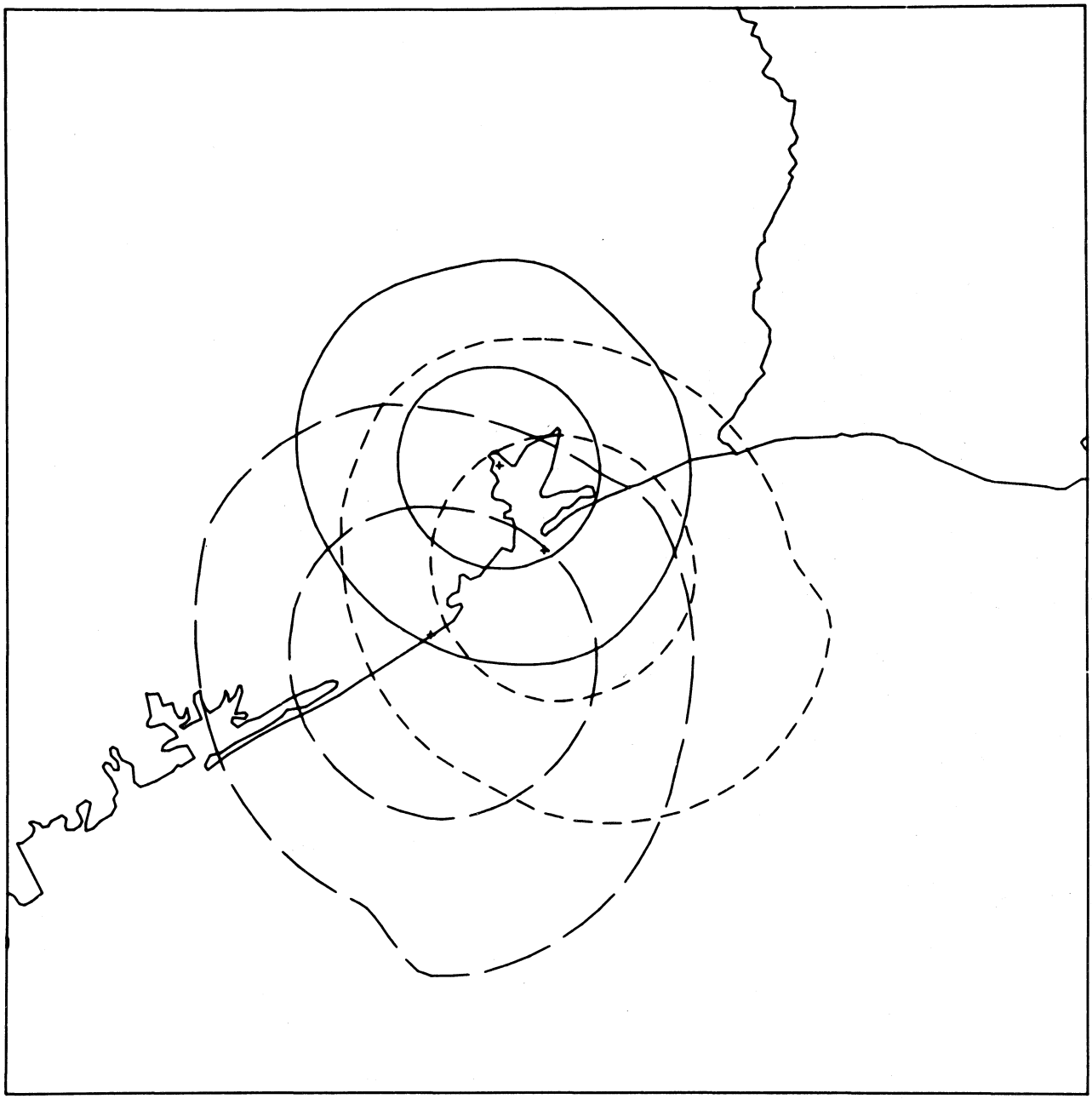

Figure 87. VHF coverage for the District 8 station at Galveston (short dashes), Freeport (long dashes), and Morgan Pt. (solid).
Center: 29°20'2"N, 94°46'5"W.

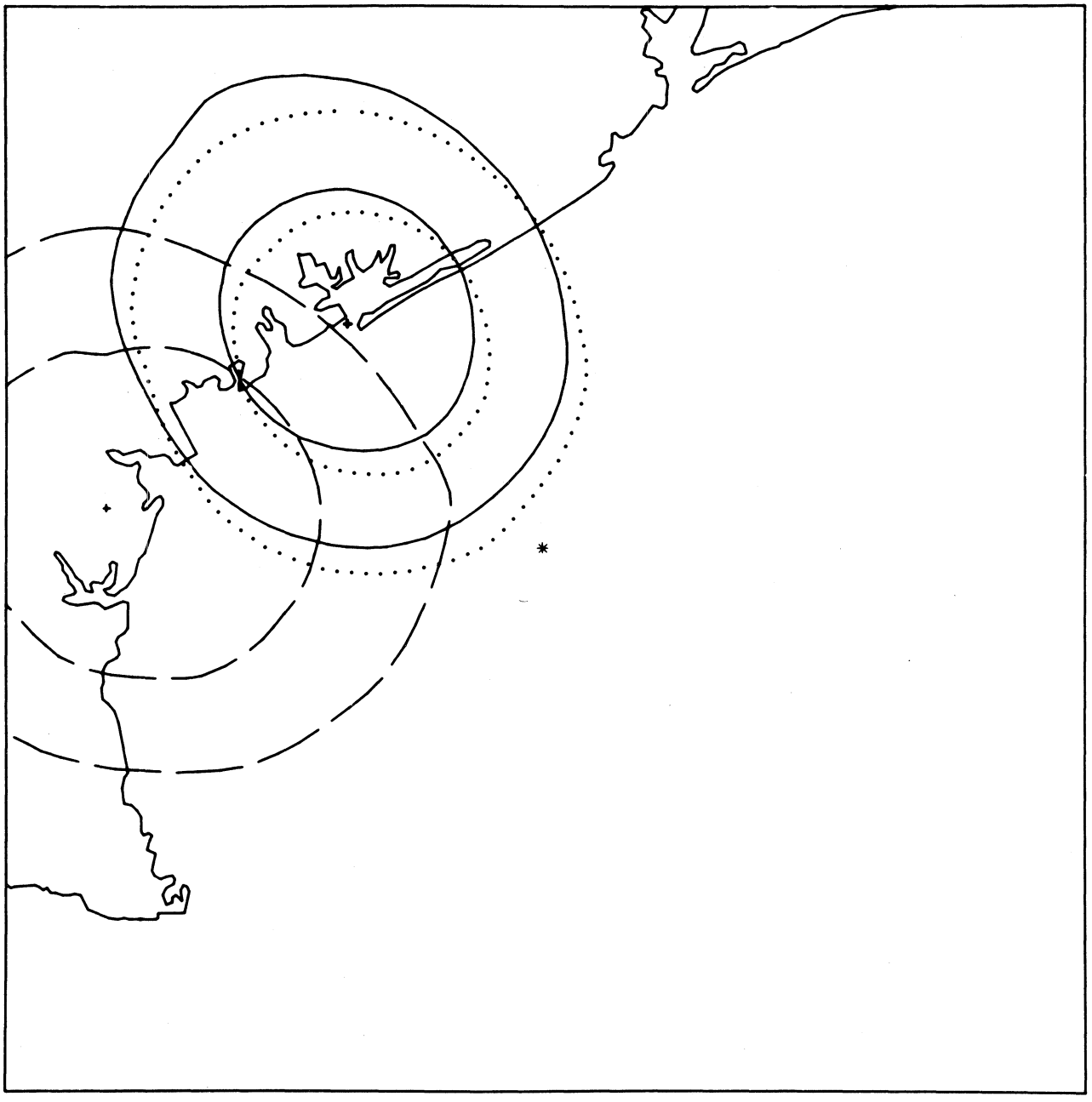

Figure 88. VHF coverage for the District 8 station at Robstown (long dashes), Port O'Connor (330°, solid; 150°, dots).
Center: 27°30'0"N, 95°30'0"W.

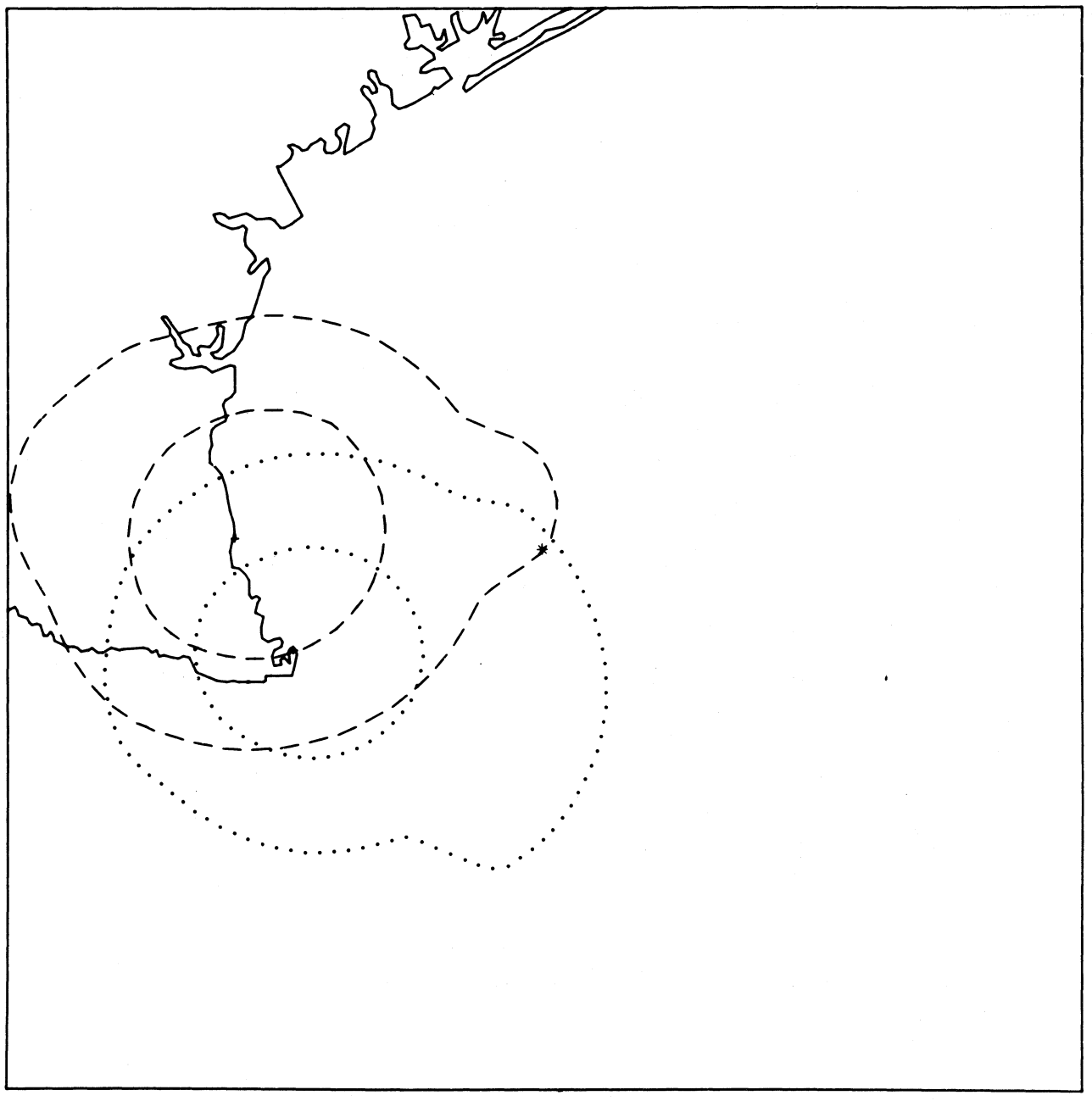

Figure 89. VHF coverage for the District 8 station at Pt. Isabel (dots) and Pt. Mansfield (short dashes). Center: 26°30'0"N, 96°0'0"W.

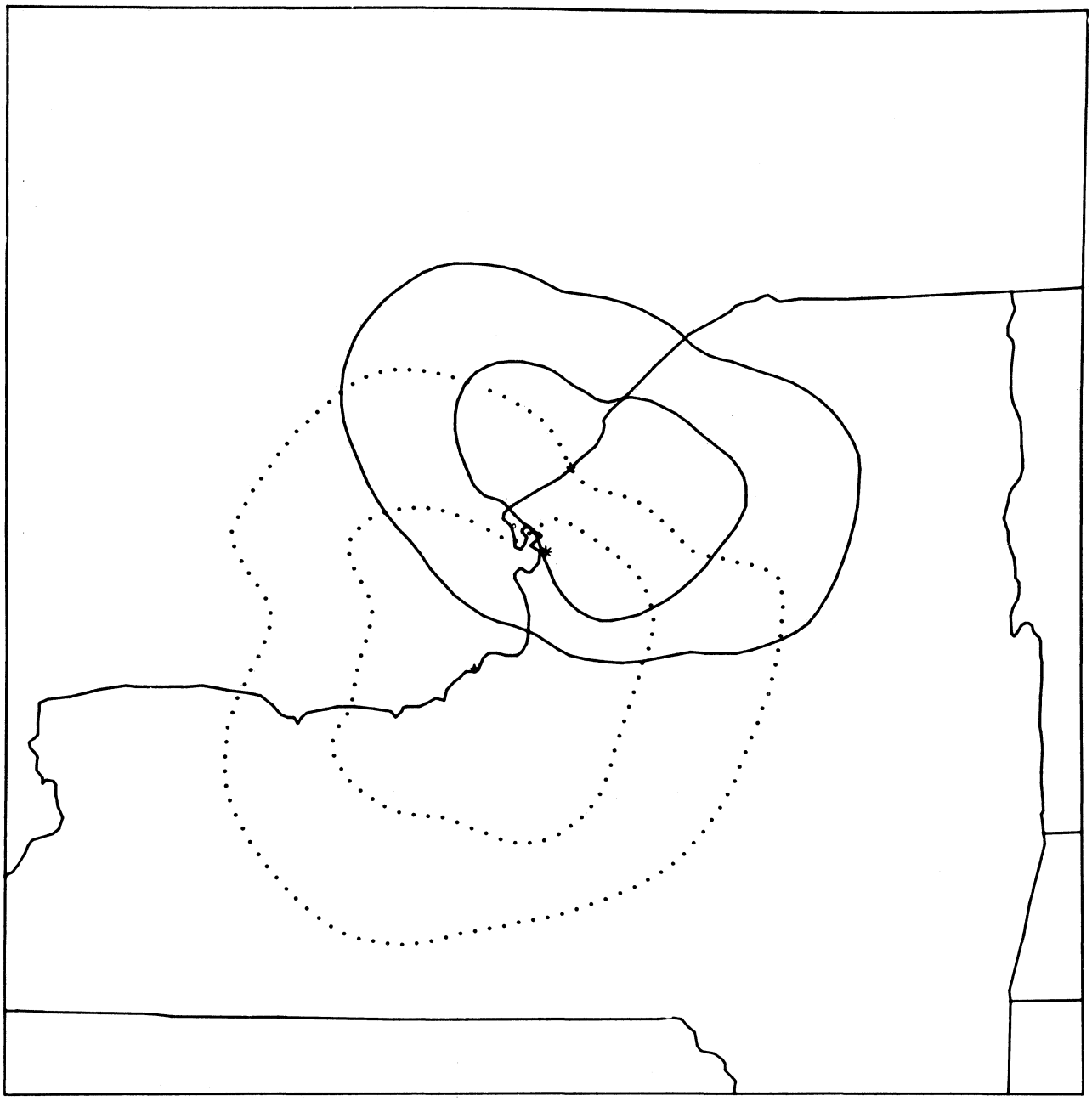

Figure 90. VHF coverage for the District 9 station at Alexandria Bay (solid) and Oswego (dots). Center: 43°56'48"N, 76°7'6"W.

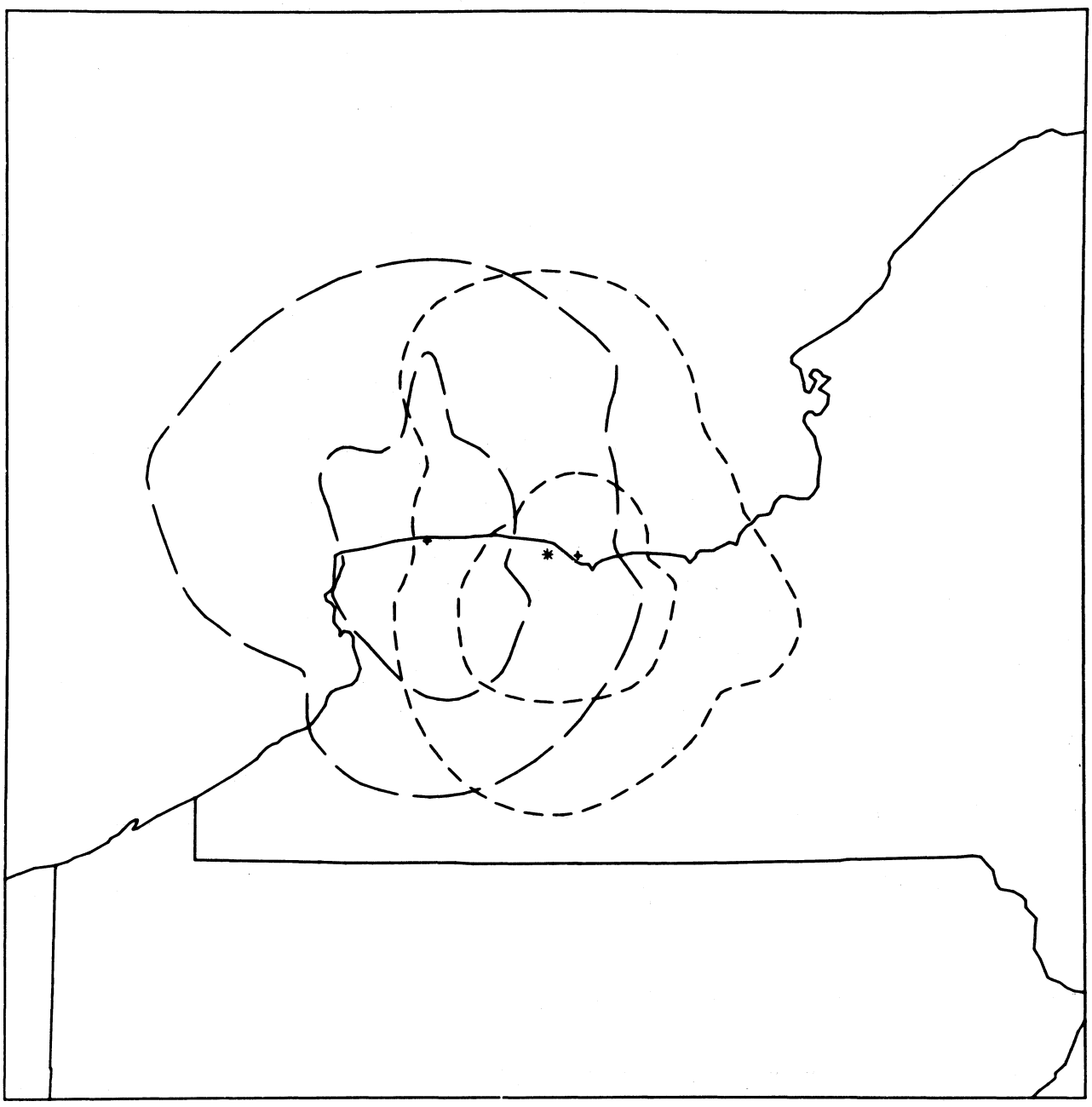

Figure 91. VHF coverage for the District 9 station at Rochester (short dashes) and 30 Mile Pt. (long dashes). Center: 43°17'18"N, 77°47'30"W.

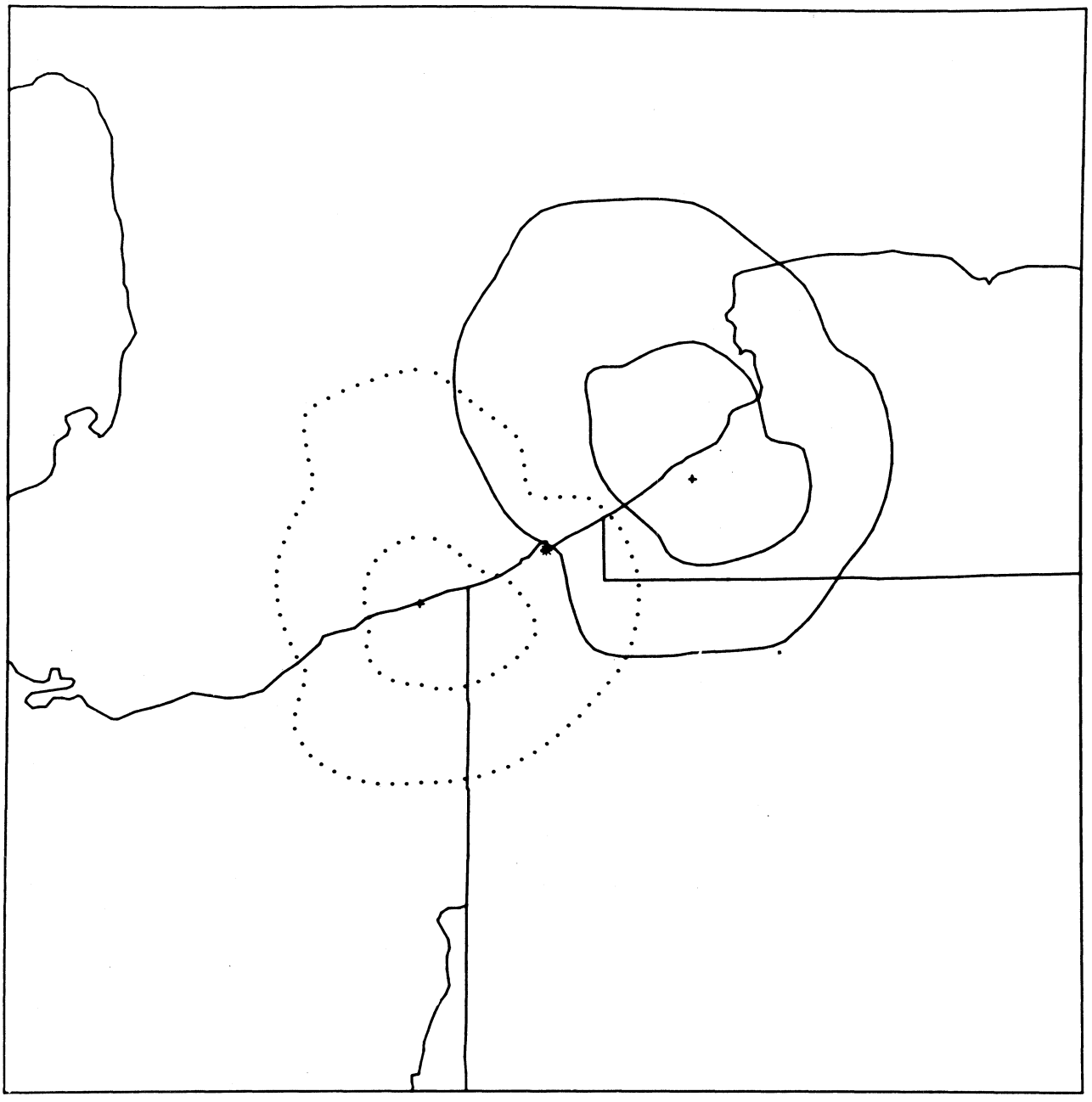

Figure 92. VHF coverage for the District 9 station at Dunkirk (solid) and Ashtabula (dots).
Center: 42°7'42"N, 80°5'12"W.

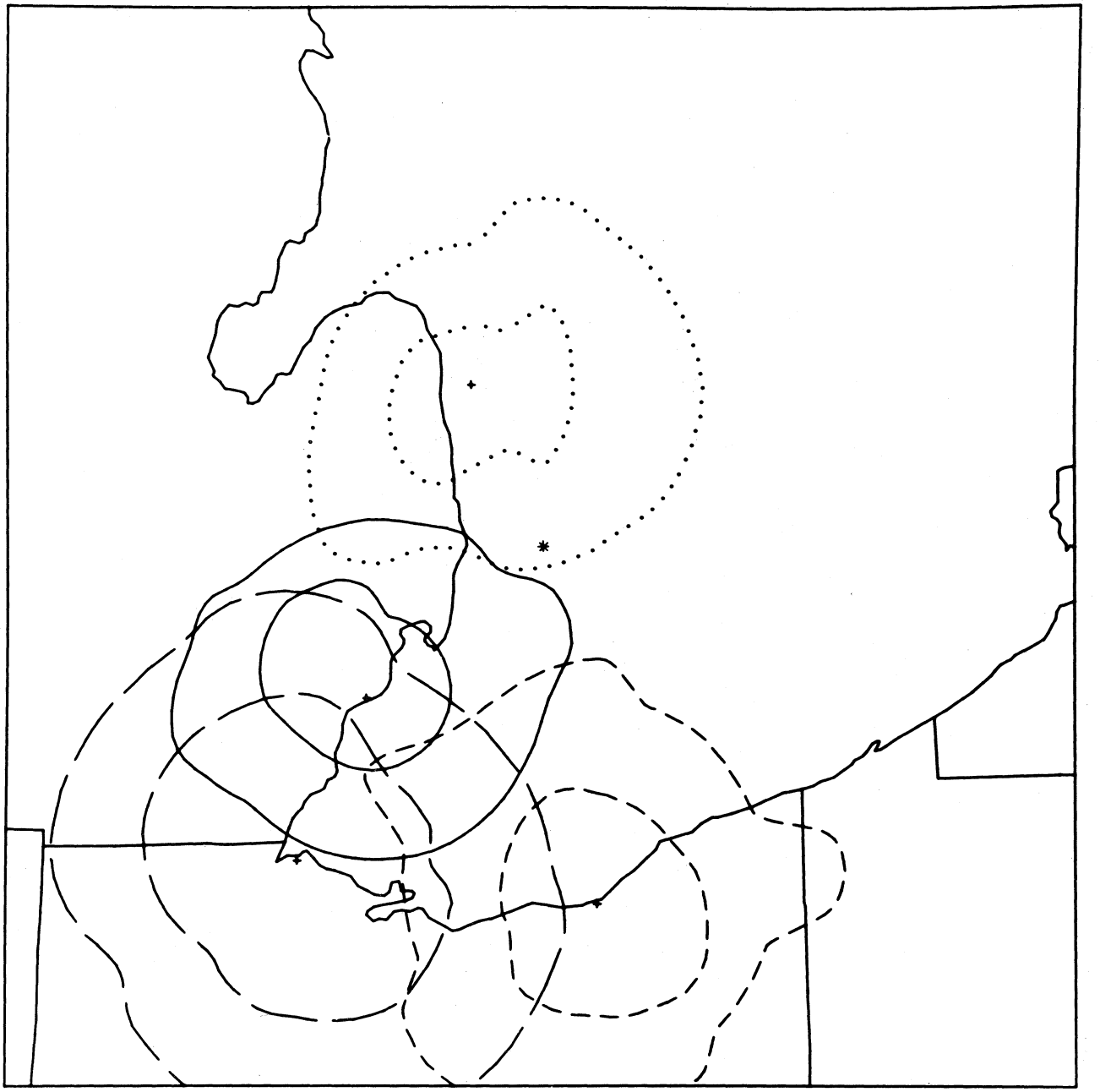

Figure 93. VHF coverage for the District 9 station at Cleveland (short dashes), Toledo (long dashes), Belle Island (solid), and Pt. Huron (dots).
Center: 43°0'0"N, 82°0'0"W.

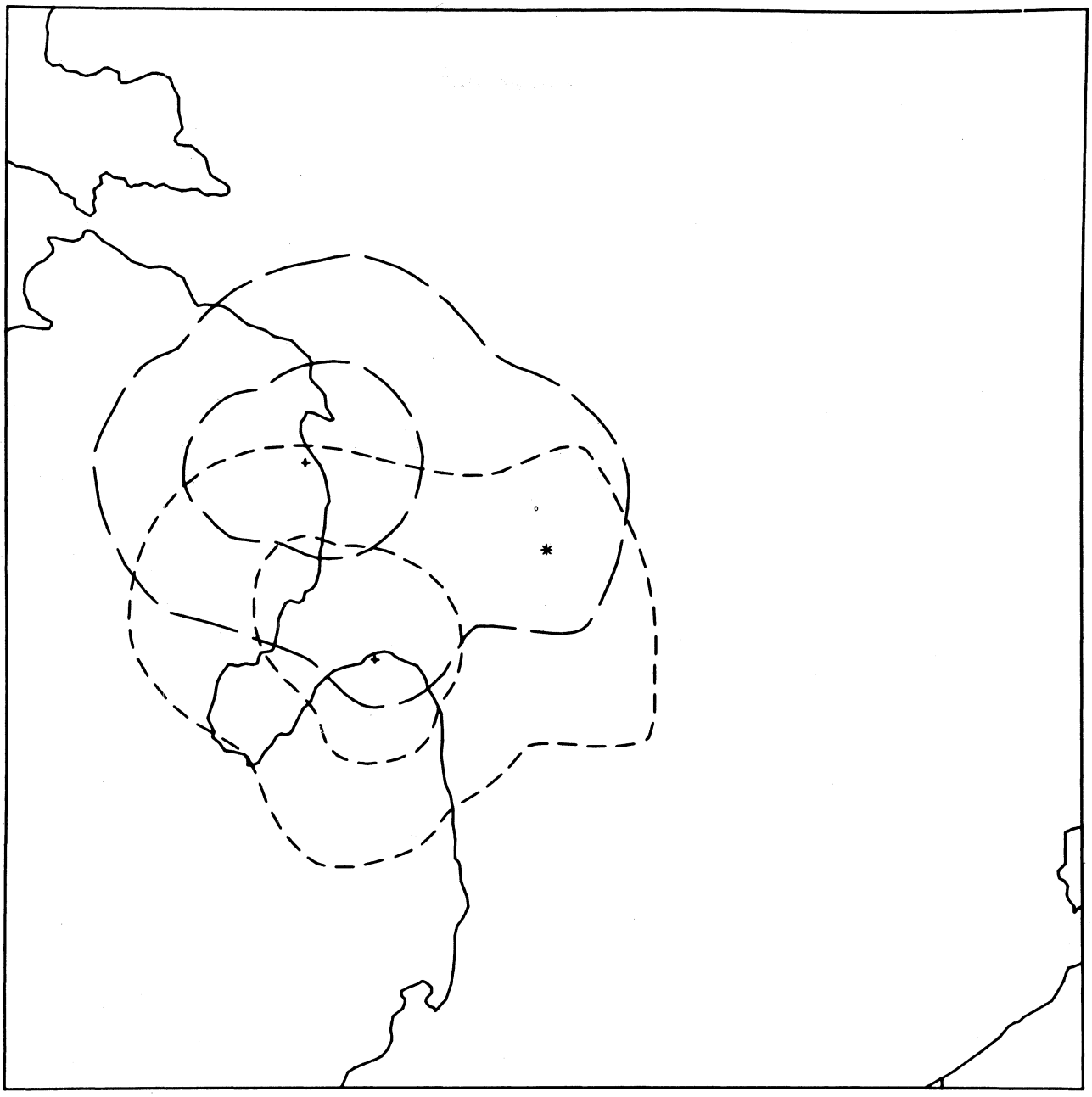

Figure 94. VHF coverage for the District 9 station at Pt. Austin (short dashes) and Alpena (long dashes). Center: 44°30'0"N, 82°0'0"W.

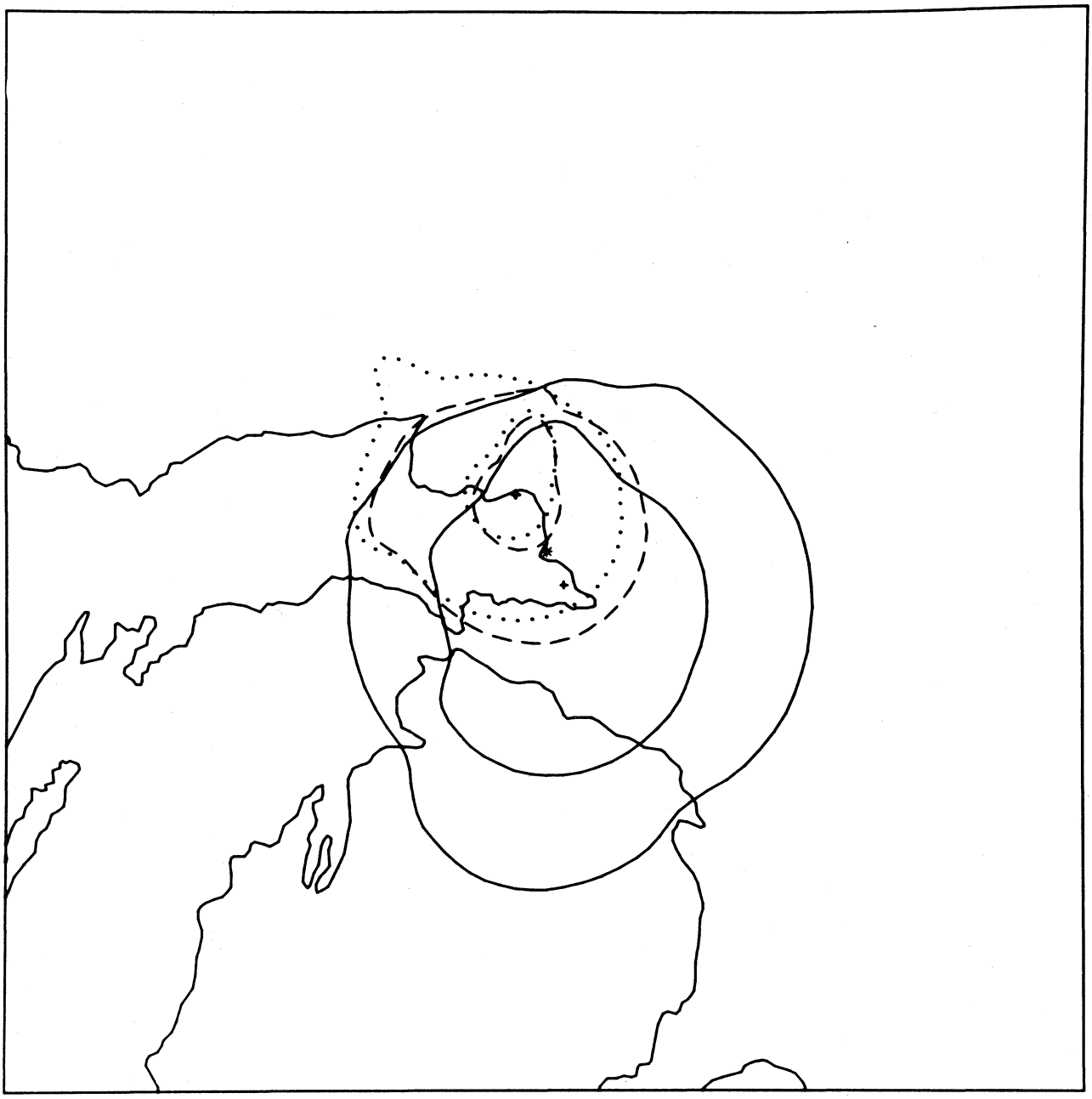

Figure 95. VHF coverage for the District 9 station at Goetzville (solid), Sault Ste. Marie (310°, dots; 145°, short dashes).
Center: 46°12'0"N, 84°12'0"W

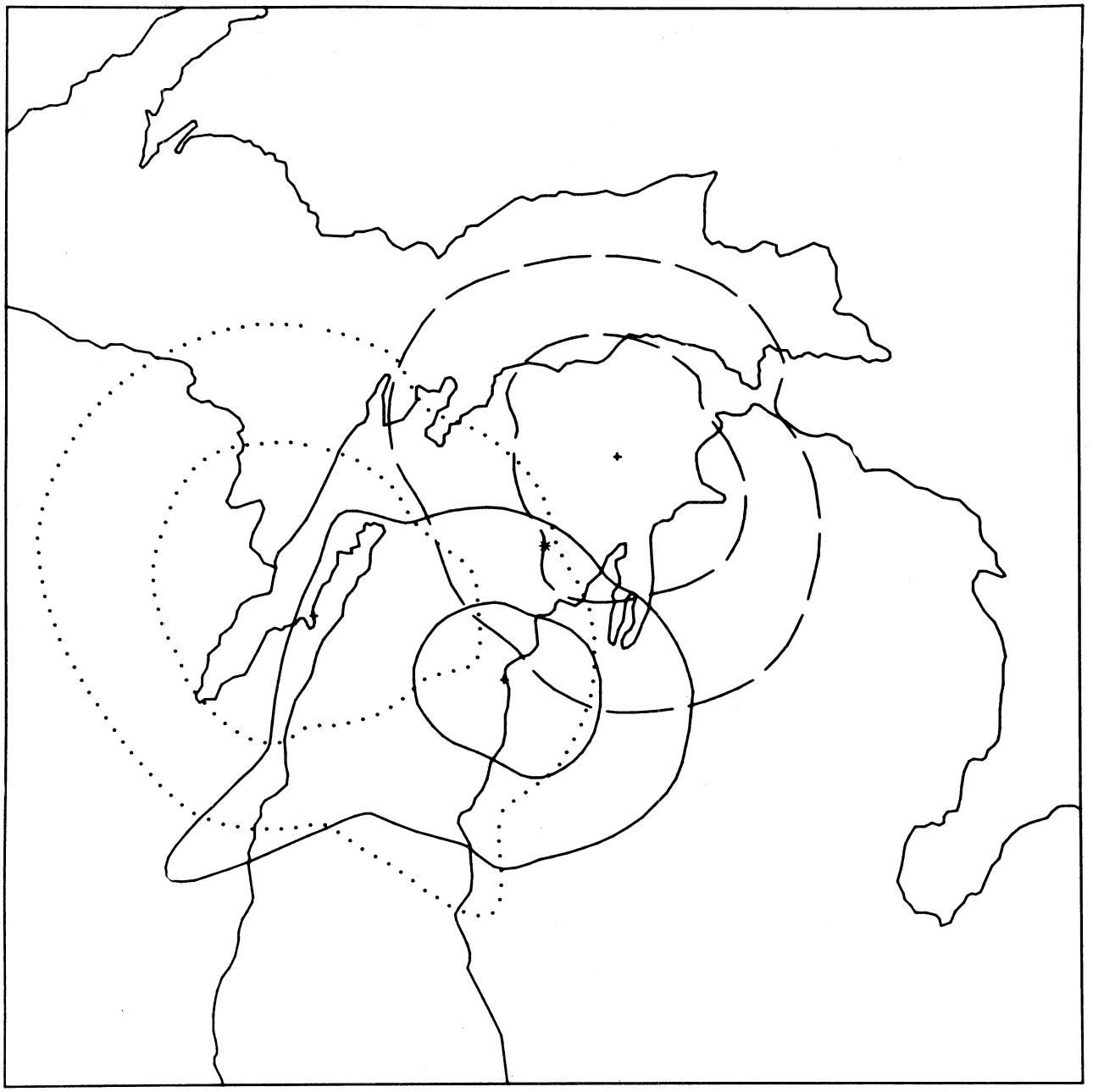

Figure 96. VHF coverage for the District 9 station at Beaver Island (long dashes), Frankfort (solid), and Sturgeon Bay (dots).
Center: 45°12'0"N, 86°0'0"W.

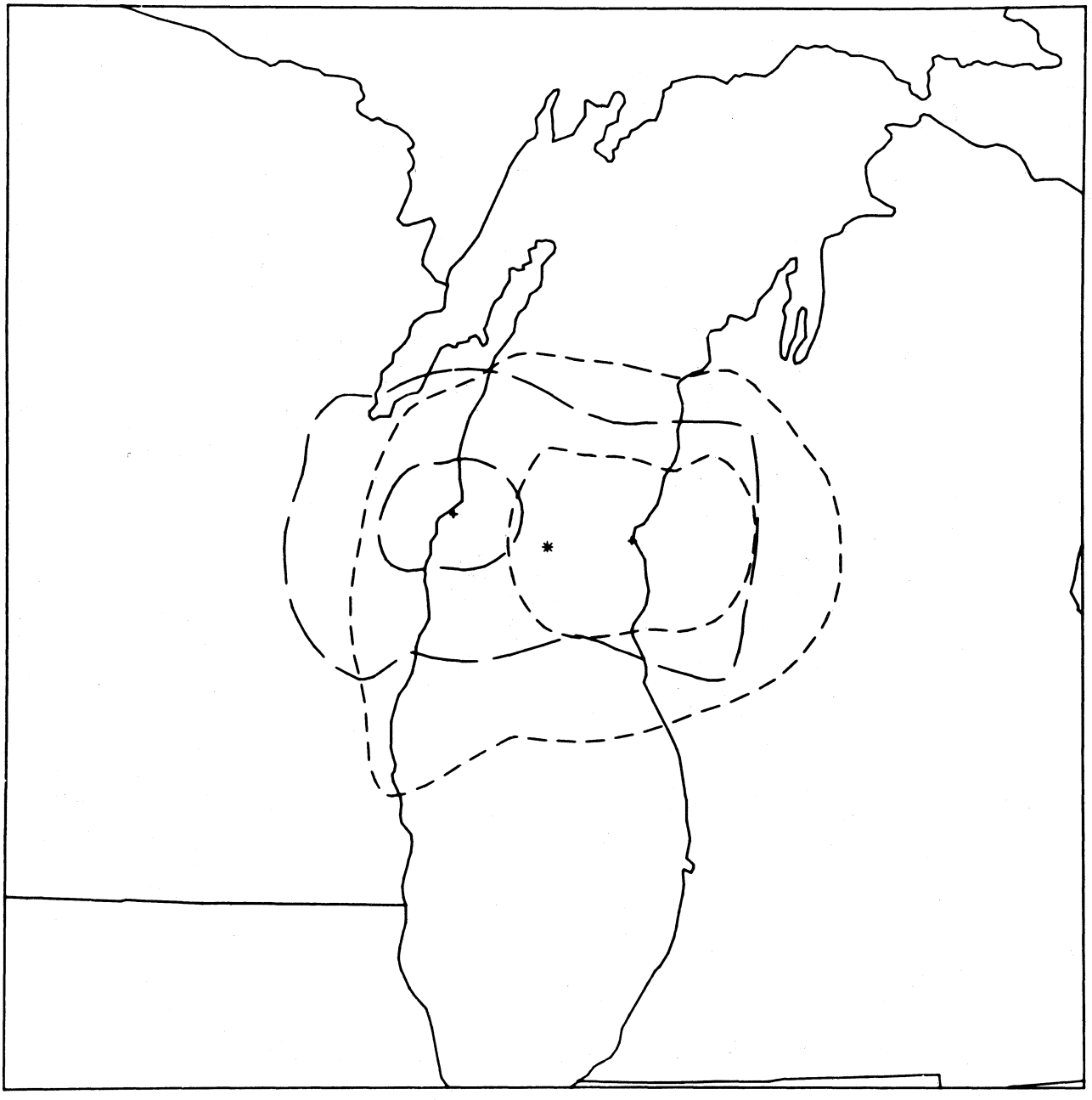

Figure 97. VHF coverage for the District 9 station at Ludington (short dashes) and Two Rivers (long dashes). Center: 44°0'0"N, 87°0'0"W.

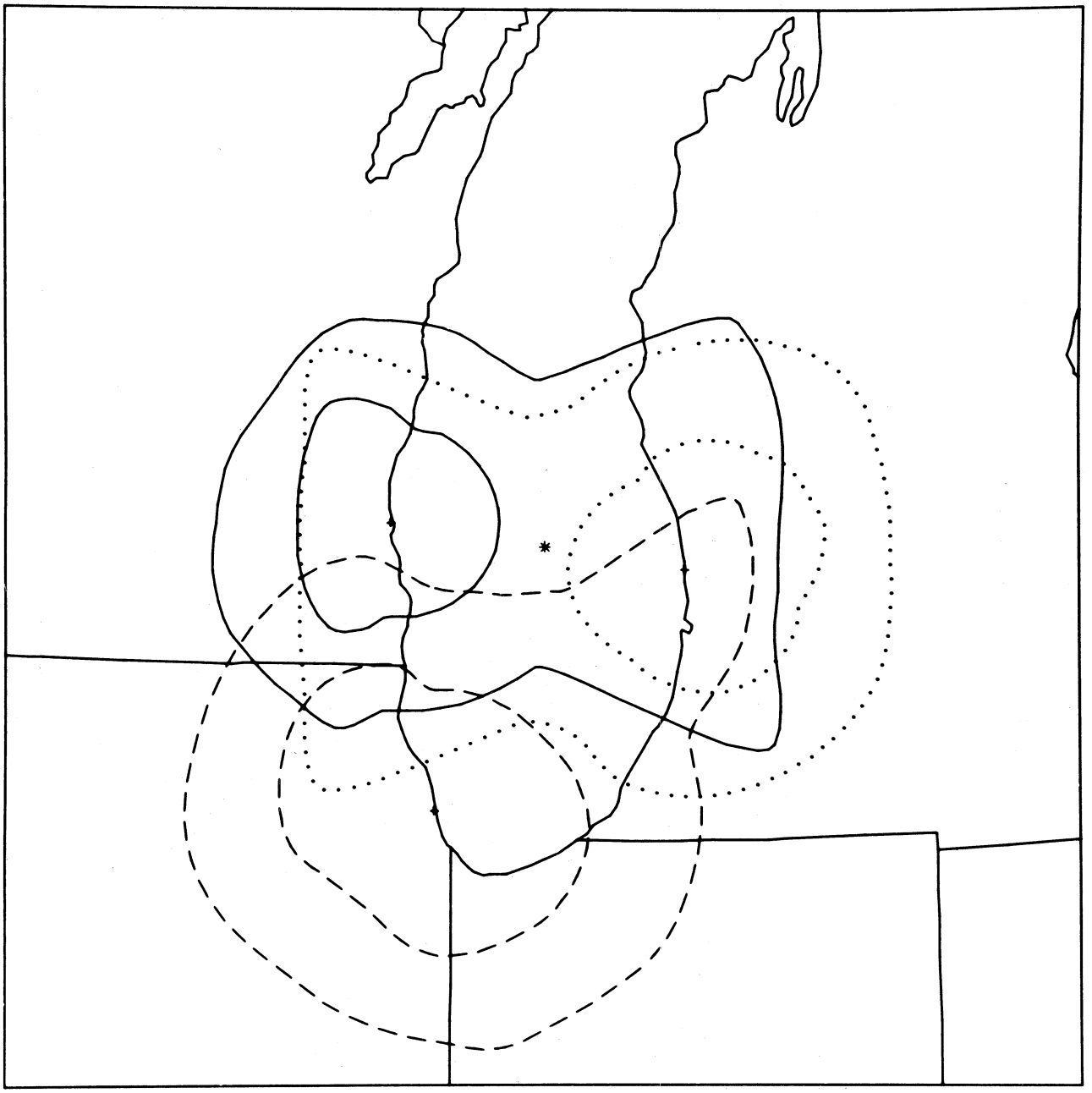

Figure 98. VHF coverage for the District 9 station at Milwaukee (solid), Holland (dots), and Chicago (short dashes).
Center: 43°0'0"N, 87°0'0"W.

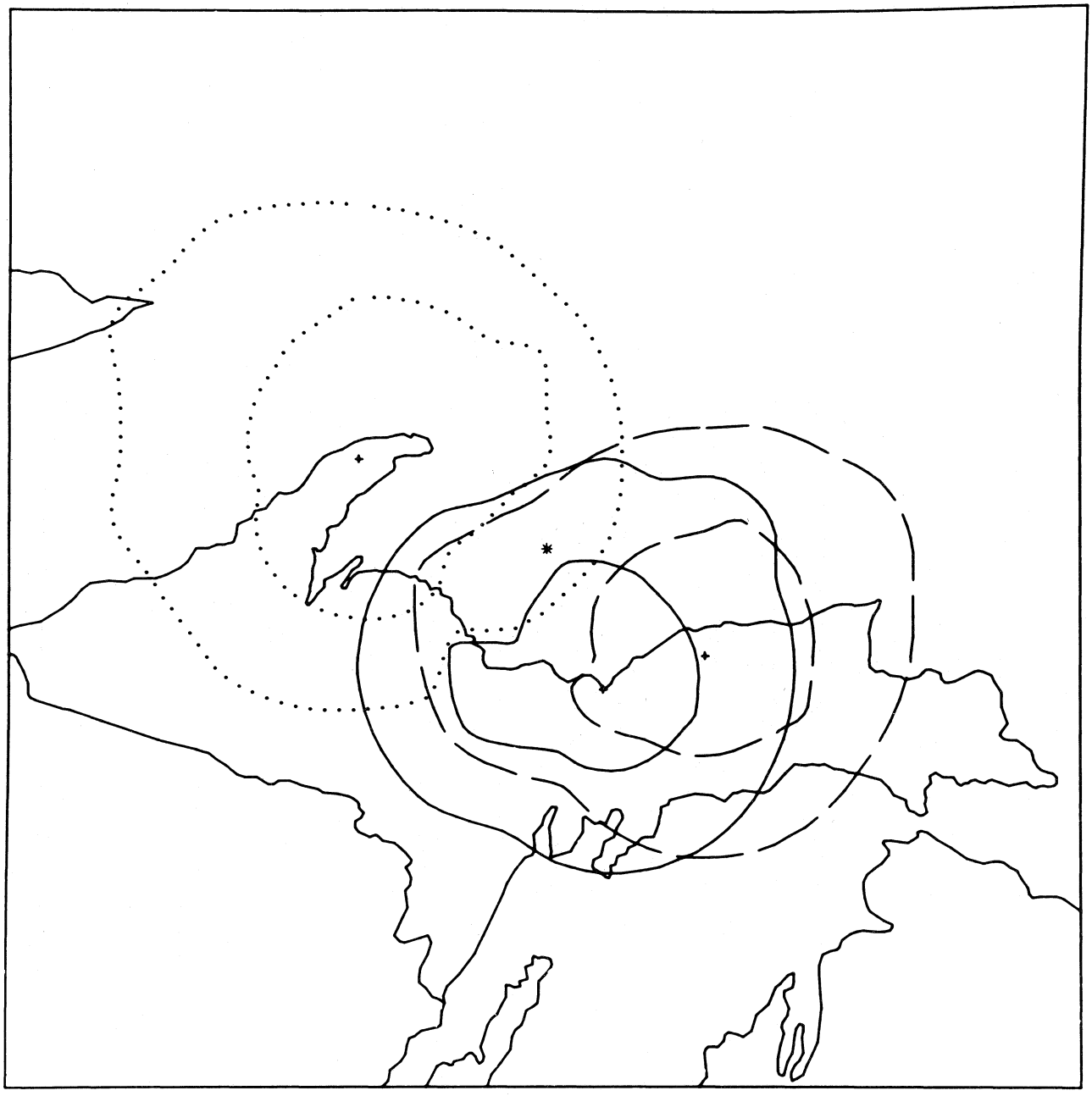

Figure 99. VHF coverage for the District 9 station at Grand Marais (long dashes), Munising (solid), and Calumet (dots).

Center: 47°0'0"N, 87°0'0"W.

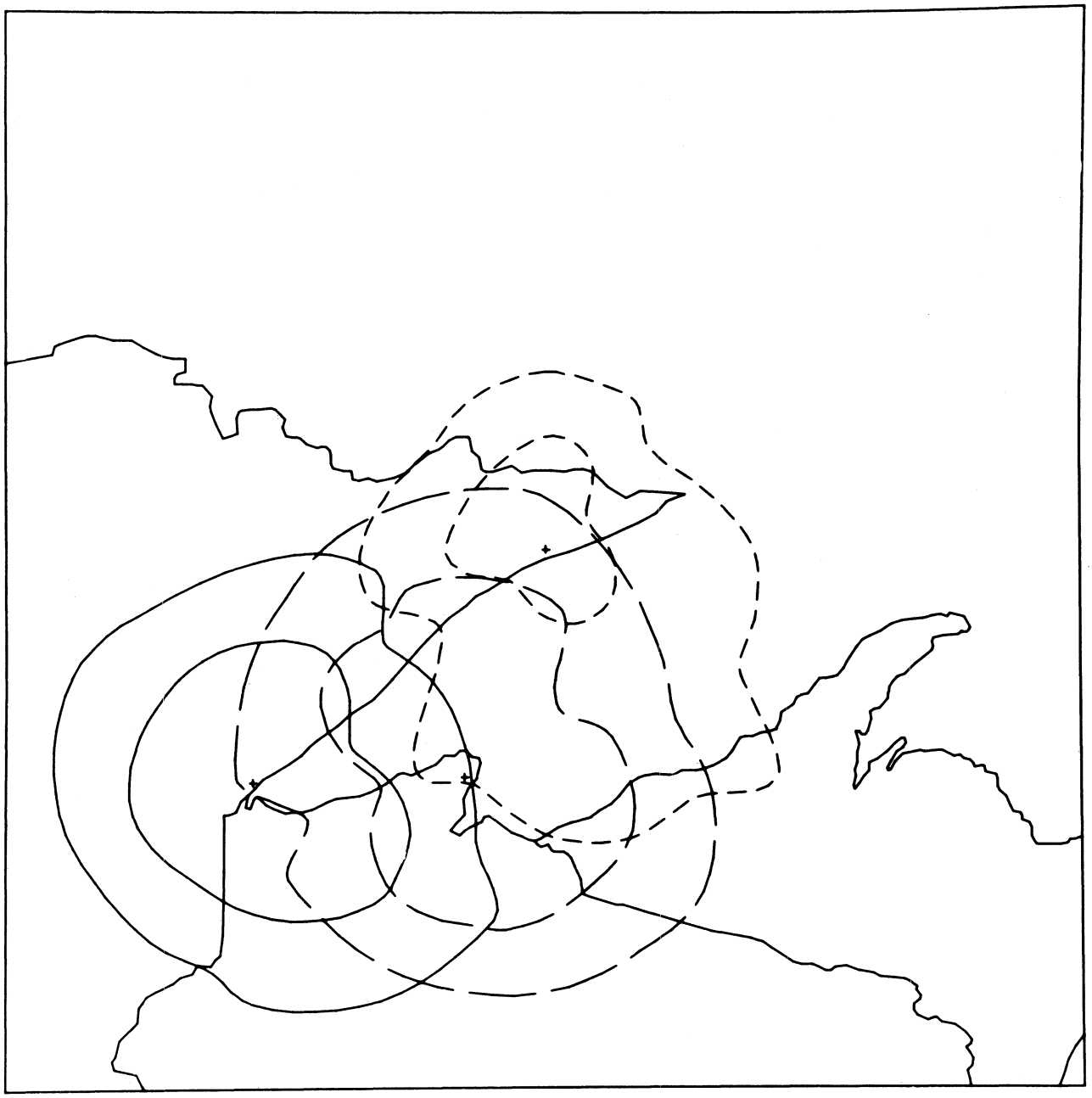

Figure 100. VHF coverage for the District 9 station at North Superior (short dashes), Bayfield (long dashes), and Duluth (solid).
Center: 47°46'40"N, 90°20'48"W.

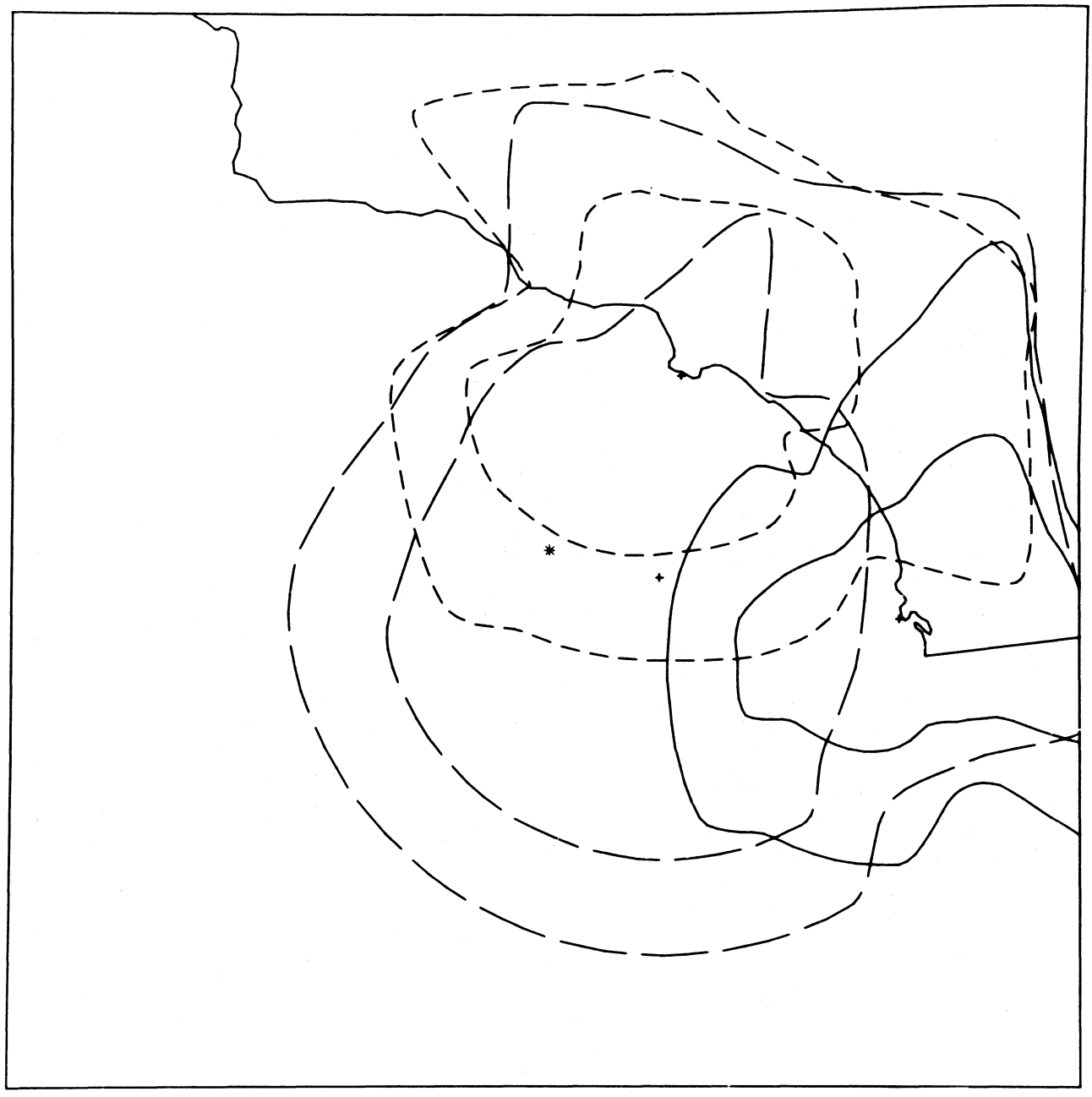

Figure 101. VHF coverage for the District 11 station at San Pedro Channel (short dashes), San Clemente (long dashes), Point Loma (solid).
Center: 33°0'0"N, 119°0'0"W.

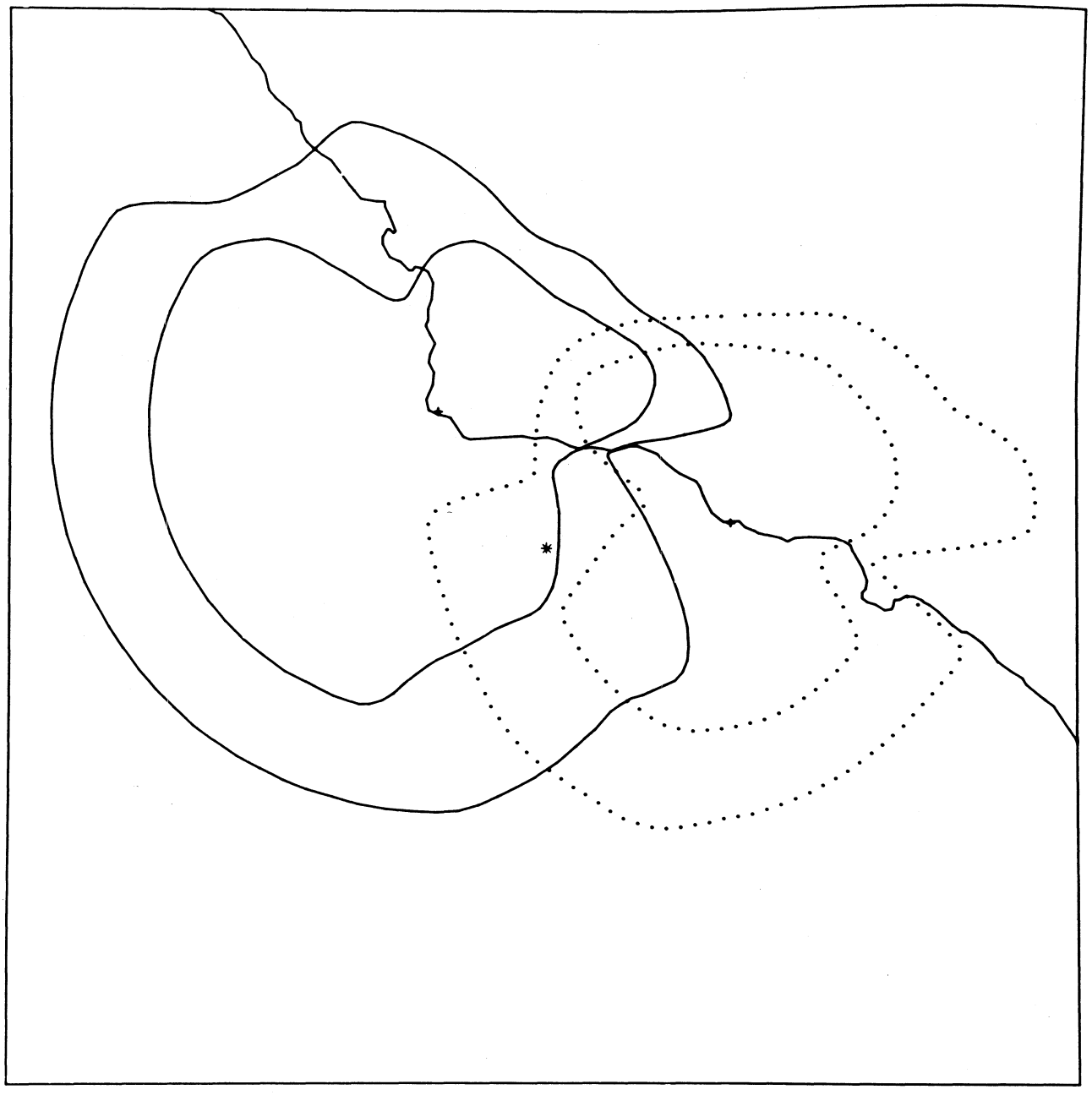

Figure 102. VHF coverage for the District 11 station at Tranquillon Mountain (solid) and Laguna Peak (dots). Center: 34°0'0"N, 120°0'0"W.

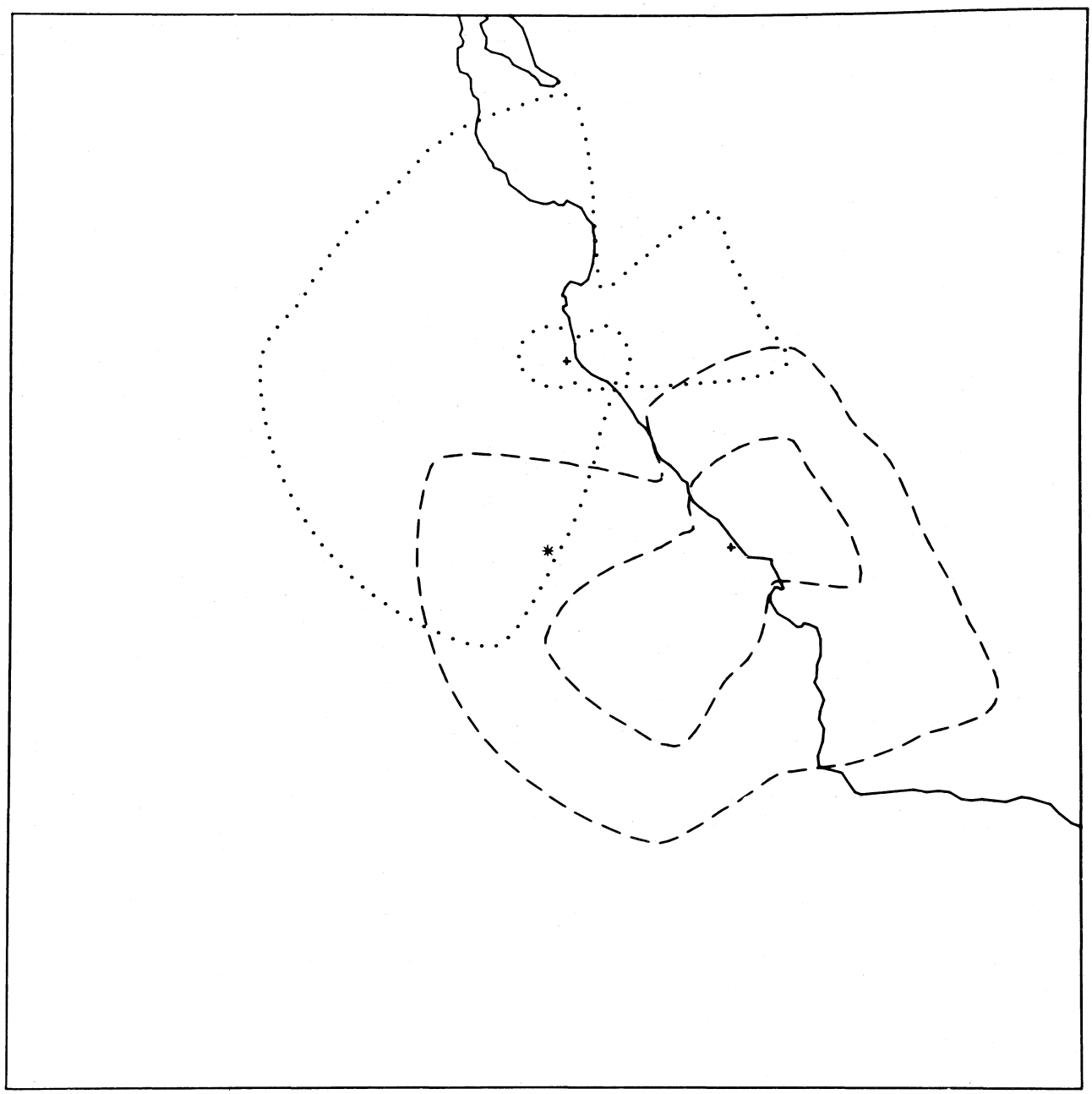

Figure 103. VHF coverage for the District 12 station at Pt. Sur (dots) and Cambria (short dashes). Center: 35°30'0"N, 122°0'0"W.

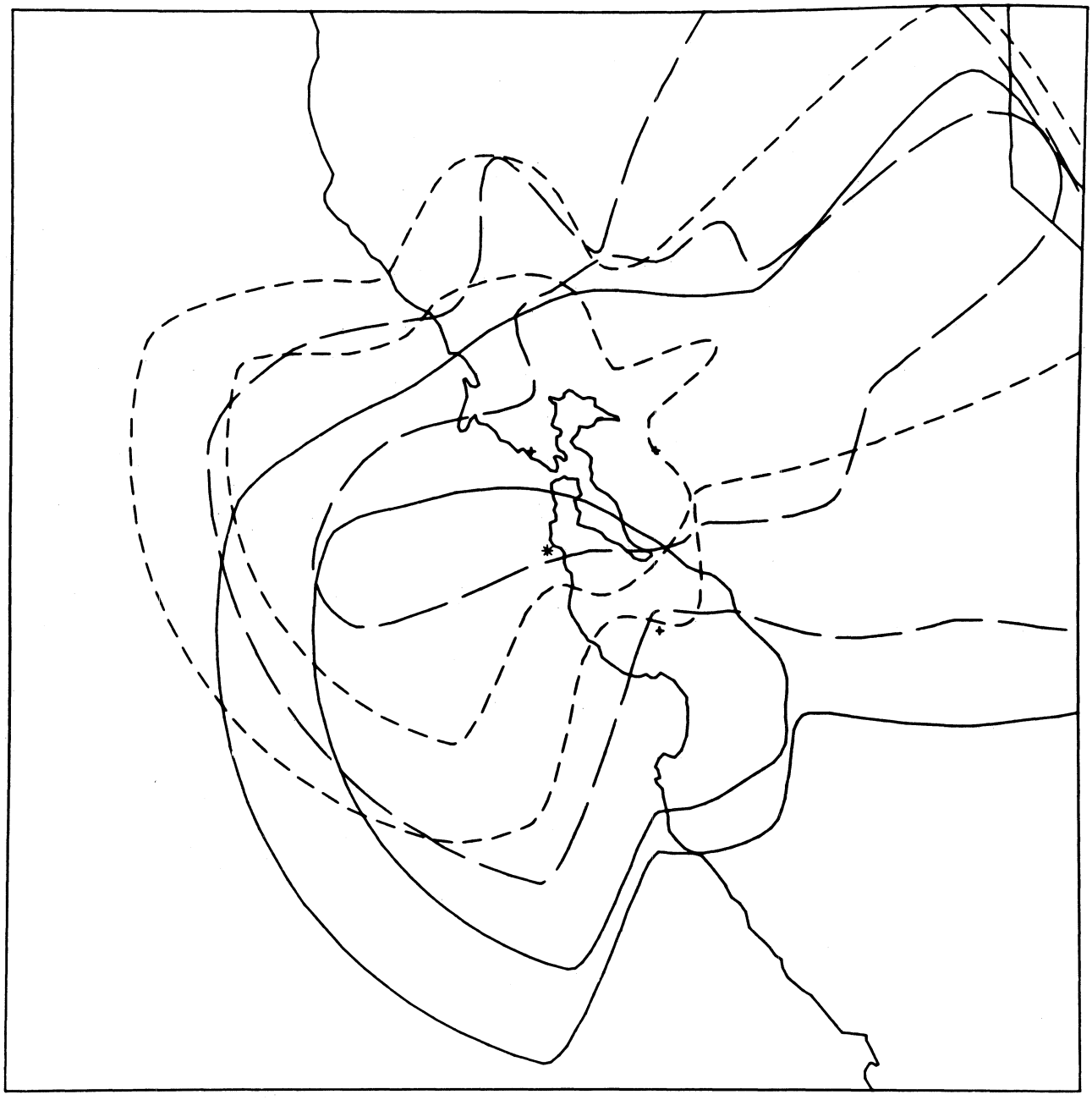

Figure 104. VHF coverage for the District 12 station at Mt. Tamalpias (short dashes), Mt. Diablo (long dashes), and Mt. Umumhum (solid).
Center: 37°30'0"N, 122°30'0"W.

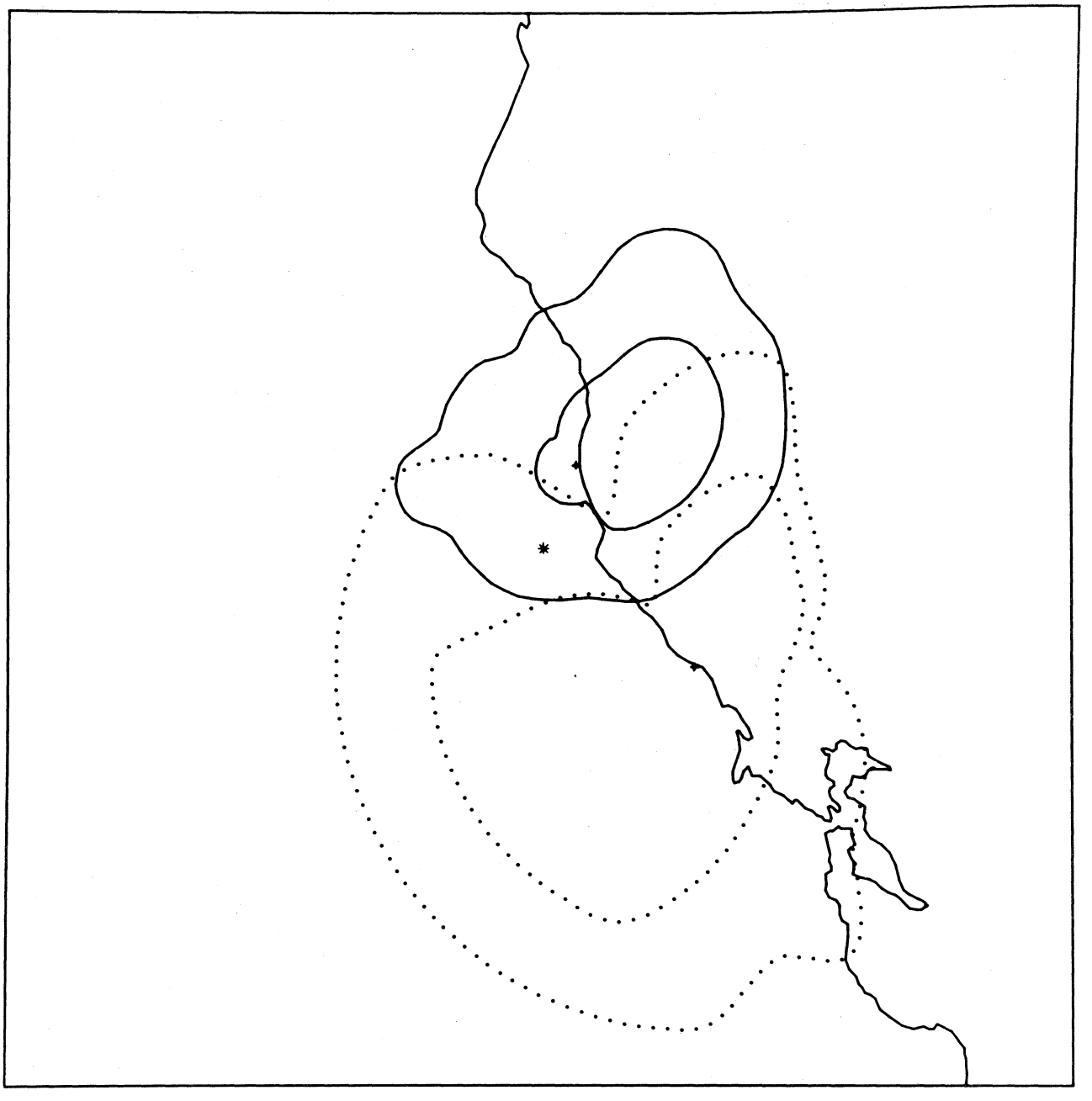

Figure 105. VHF coverage for the District 12 station at Pt. Cabrillo (solid) and Jenner (dots). Center: 39°0'0"N, 124°0'0"W.

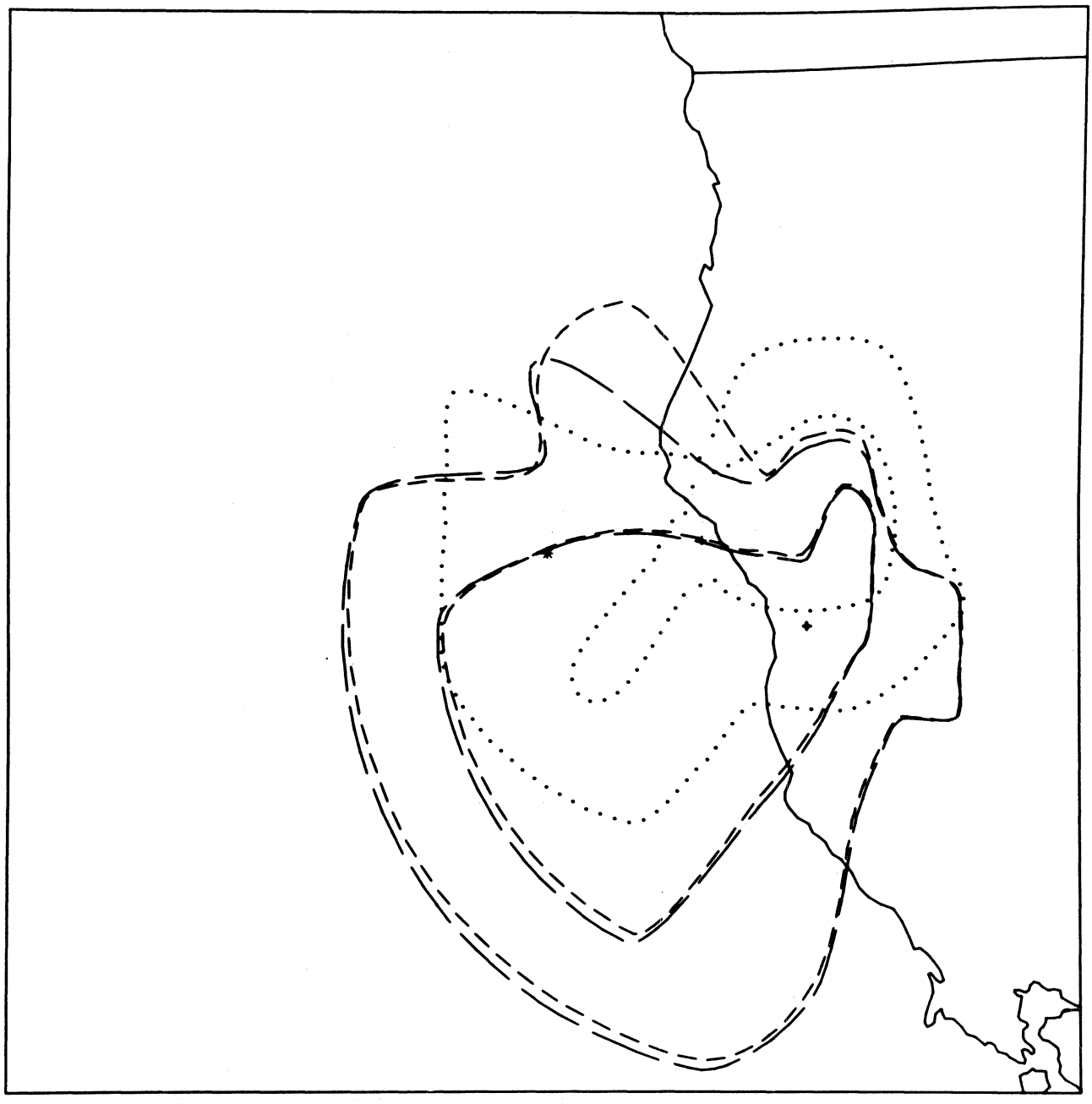

Figure 106. VHF coverage for the District 12 station at Trinidad (dots), and Cahto Peak (315°, short dashes; 270°, long dashes).
Center: 40°0'0"N, 125°0'0"W.

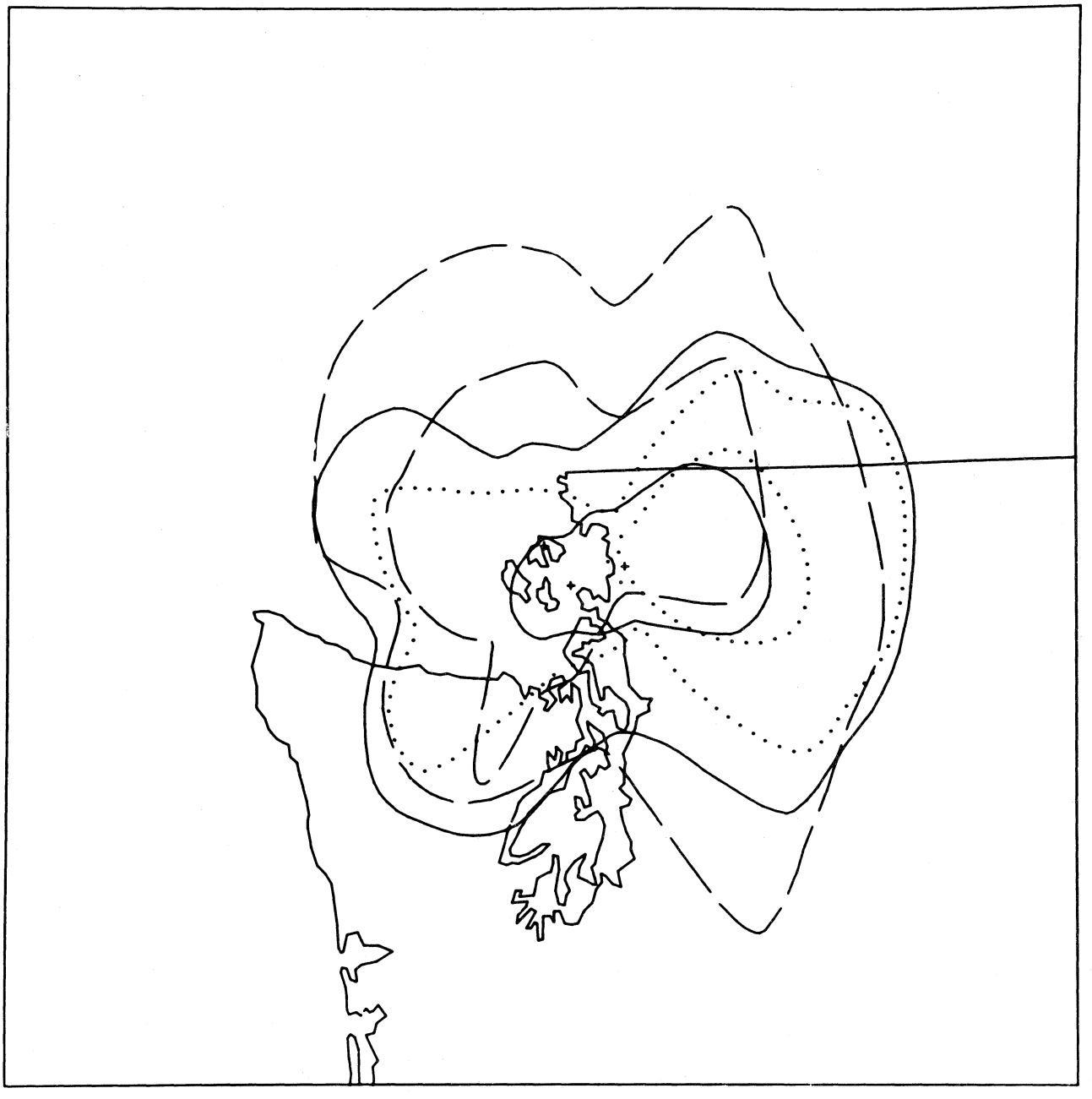

Figure 107. VHF coverage for the District 13 station at Mt. Constitution (long dashes), Shannon Pt. (solid), and Seattle Pier (dots).
Center: 48°40'30"N, 122°50'40"W.

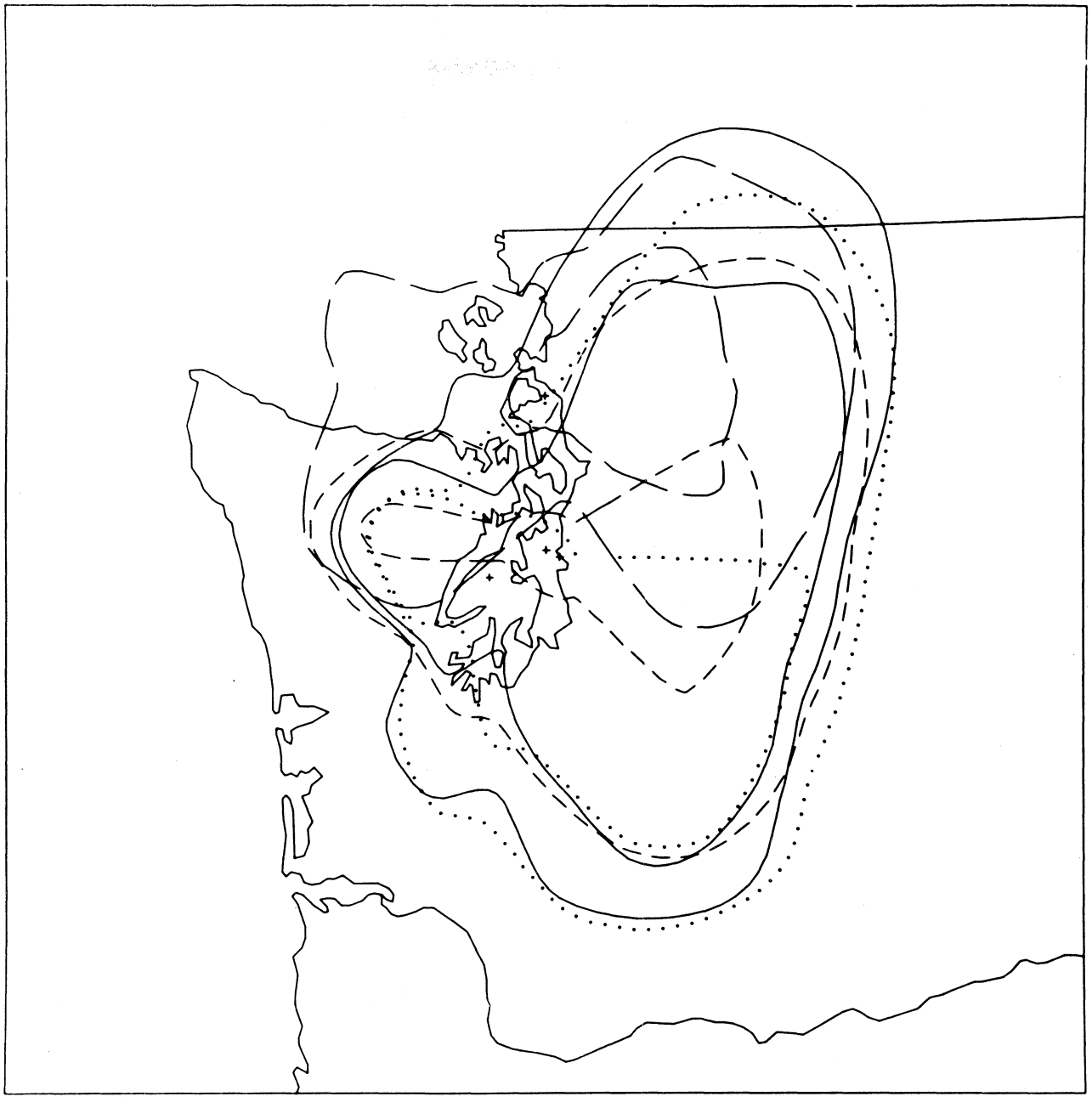

Figure 108. VHF coverage for the District 13 station at West Point (short dashes), Browns Point (long dashes), King TV Tower (solid), and Gold Mountain (dots). Center: 47°39'42"N, 122°26'6"W.

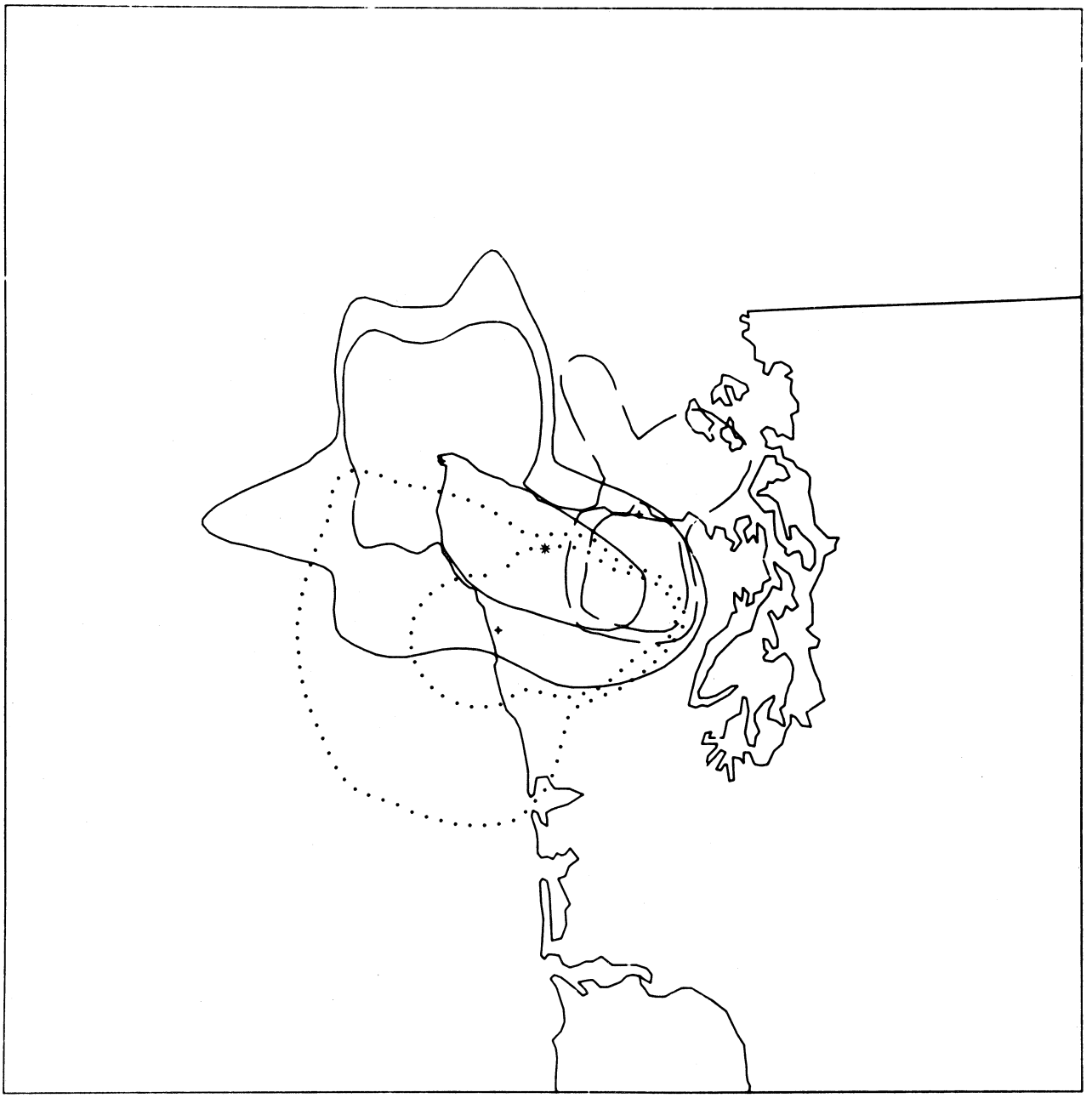

Figure 109. VHF coverage for the District 13 station at Port Angeles (long dashes), Bahokus Peak (solid), and Kalaloch (dots).
Center: 48°0'0"N, 124°0'0"W.

Figure 110. VHF coverage for the District 13 station at Grays Harbor (short dashes), Cape Disappointment (long dashes), and Cape Mears (solid). Center: 46°0'0"N, 125°0'0"W.

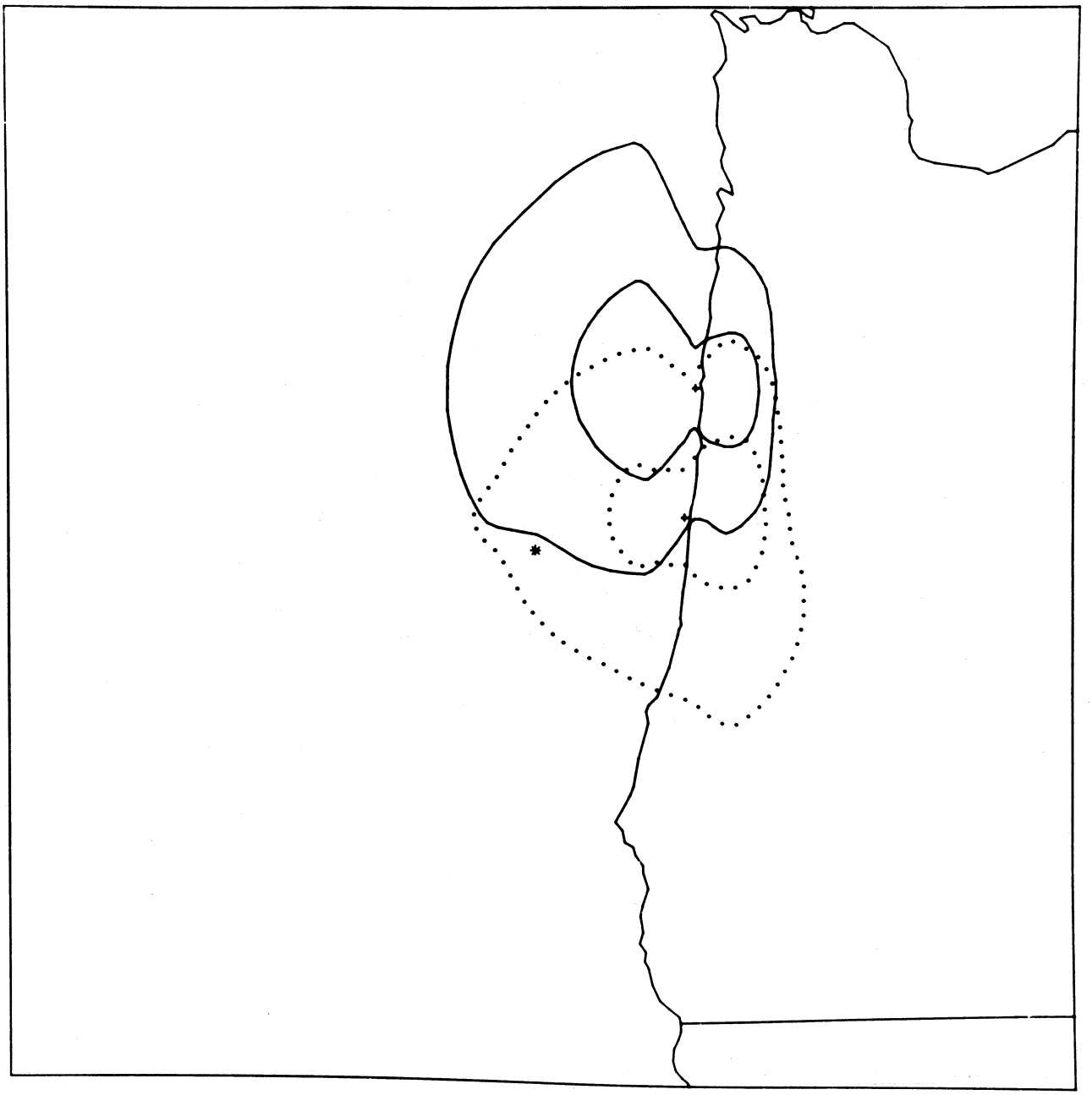

Figure 111. VHF coverage for the District 13 station at Yaquina Head (solid) and Heceta Head (dots). Center: 44°0'0"N, 125°0'0"W.

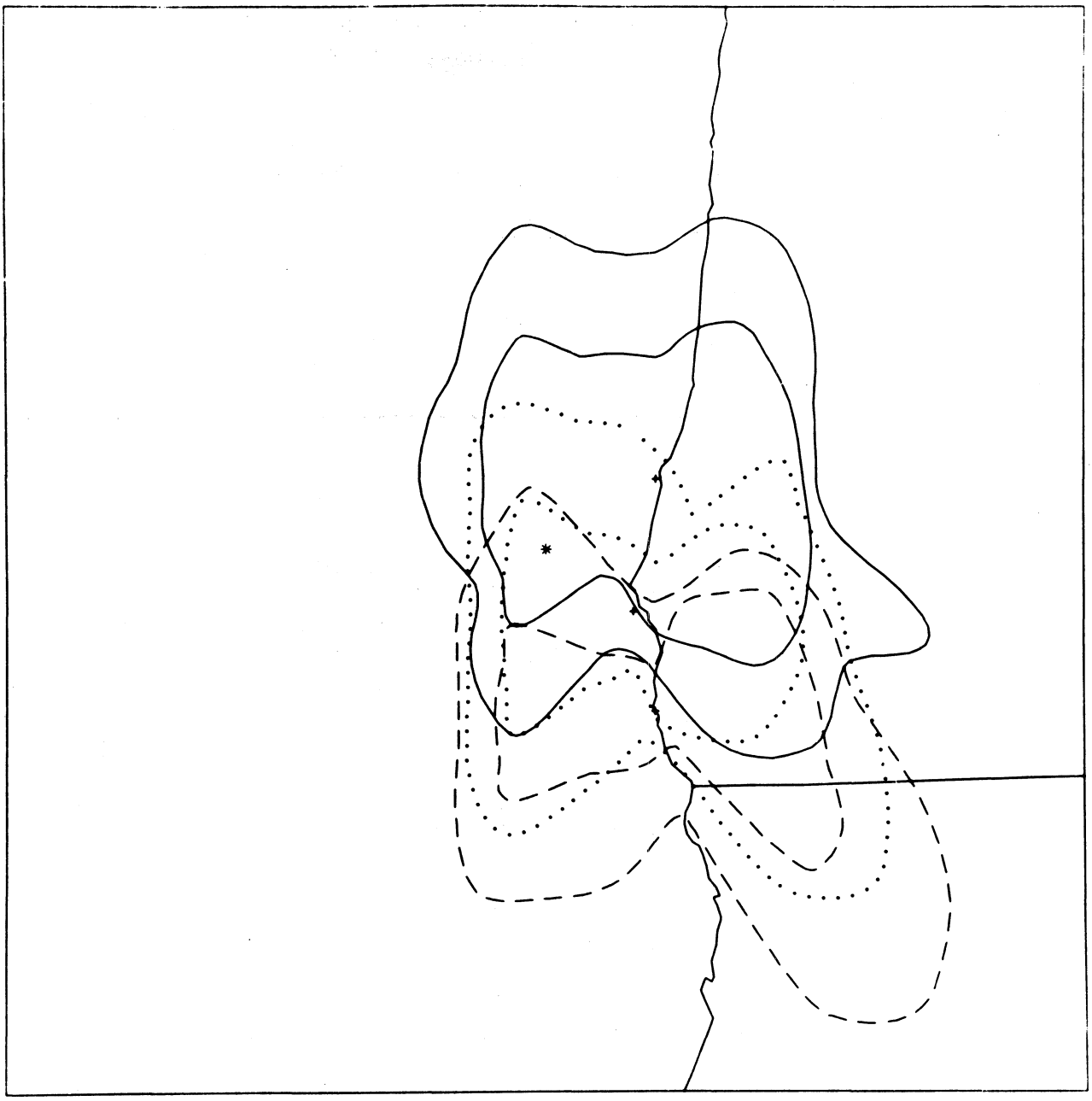

Figure 112. VHF coverage for the District 13 station at Sun Devils (solid), Port Orford (dots), and Cape Sebastian (short dashes).
Center: 43°0'0"N, 125°0'0"W.

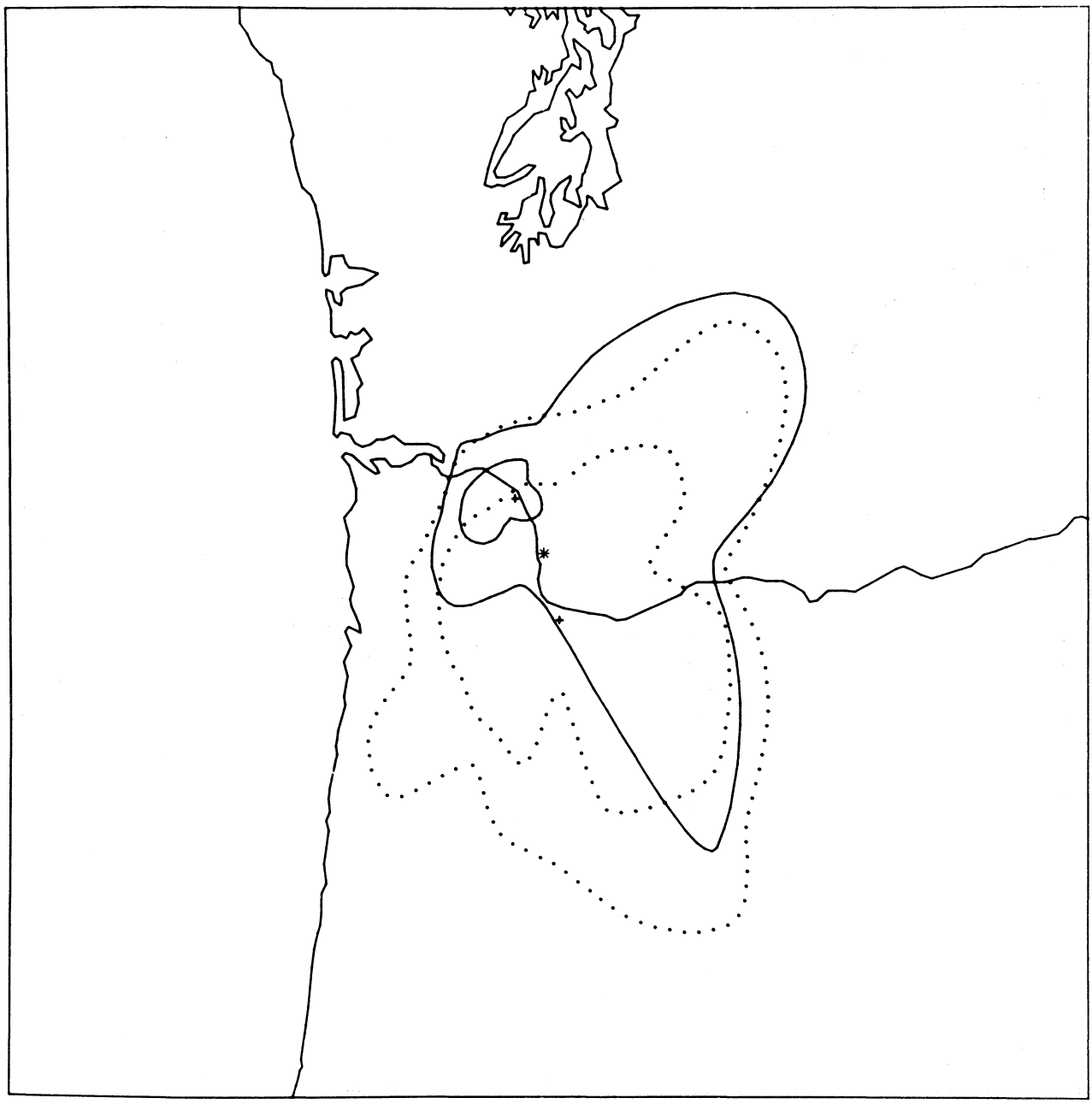

Figure 113. VHF coverage for the District 13 station at Rainer (solid) and Skyline (dots). Center: 45°48'54"N, 122°44'42"W.

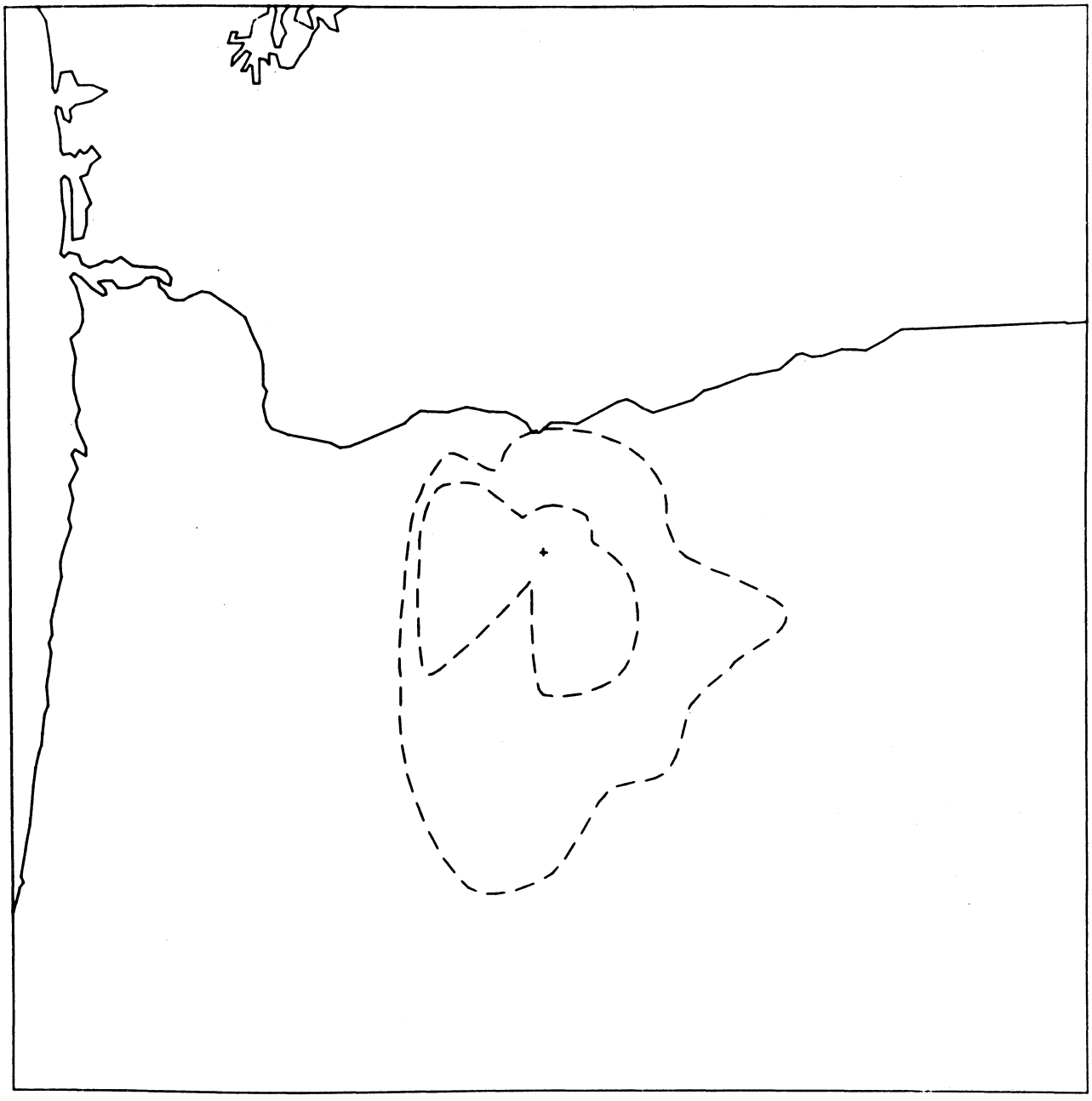

Figure 114. VHF coverage for the District 13 station at Lyle (DLS) (short dashes).

Center: 45°6'12"N, 121°6'6"W.

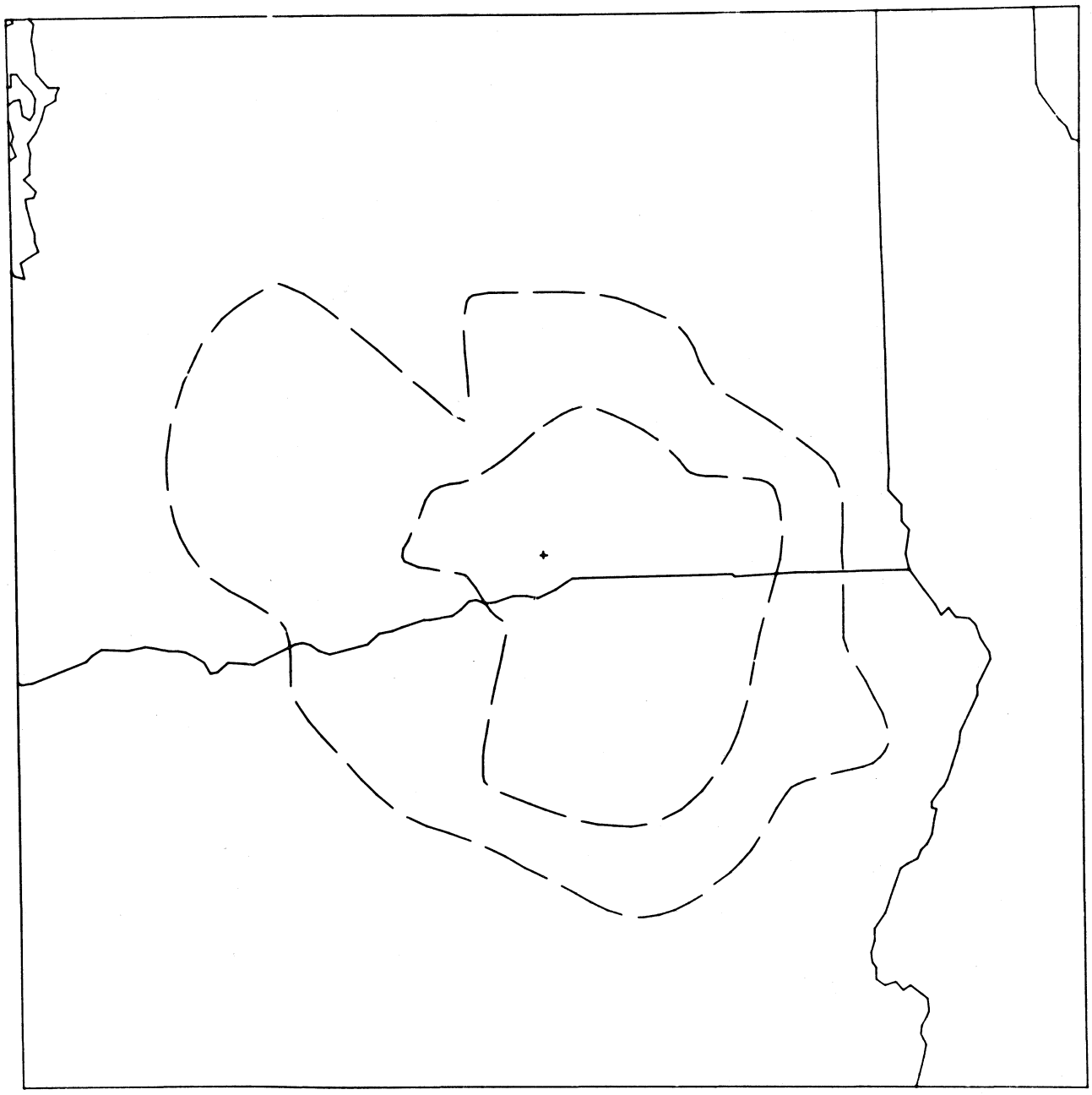

Figure 115. VHF coverage for the District 13 station at Jump-Off-Joe Mountain (long dashes).
Center: 46°6'12"N, 119°8'12"W.

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15 ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The radio coverage for two maritime distress communication systems are calculated for those U.S. Coast Guard stations in the contiguous United States. The two systems are: the international MF distress channel and the international VHF distress channel. The predicted coverage for each station is shown as a contour drawn on a map background.

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coverage; distress; maritime; MF; predictions; radio; VHF

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