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National Weather Service

Precipitation Detection Probabilities by Los Angeles ARTC Radars

DENNIS E. RONNE

Western Region

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NOAA TECHNICAL MEMORANDA

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U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

NOAA Technical Memorandum NWSTM WR-67

PRECIPITATION DETECTION PROBABILITIES BY LOS ANGELES ARTC RADARS

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WESTERN REGION
TECHNICAL MEMORANDUM NO. 67

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PREFACE

The detection of precipitation by radar is dependent on a number of factors including the design parameters of the radar system itself and the manner in which it is sited. These factors combine to produce a variability in radar detection capability, season to season, day to day, and radar site to radar site. While it is possible to determine these variations with a fair degree of accuracy from the theoretical approach, it is an extremely complex procedure. A more direct approach was taken by Mr. Ronne, where he allowed nature to integrate (albeit coarsely) these factors for him. This resulted in an operationally useful set of detection probabilities.

Because of the variability of detection capability among radars, it is essential that the user have a guide, such as is presented here, to make maximum and proper interpretation of radar data.

Since this study was made, two significant improvements have been made in the radar network monitored by Palmdale: (1) installation of a long-range ARSR-type radar to replace the Edwards, California ASR radar and (2) the removal of an obstruction which blocked radar propagation to the ENE of Las Vegas, Nevada. The improvements will increase the detection probabilities over the interior of southern California and southern Nevada. However, at least two years of data collection will be required to determine the new probabilities in these areas. Nonetheless, because of the importance of this study, we elected to publish it now and to consider it as an interim report.

PRECIPITATION DETECTION PROBABILITIES BY LOS ANGELES ARTC RADARS

I. INTRODUCTION

With the closure of the Weather Service radar site on Santa Catalina Island on April 1, 1968, and the establishment of the joint use radar program in April of 1968 at FAA's Los Angeles ARTC Center, located at Palmdale, California, the area of radar coverage over the Pacific Southwest was increased by some 400%.

Radars microwaved into the Los Angeles Center cover parts of four states, the northern end of the Baja California Peninsula, and extreme northwestern part of Sonora, Mexico. The five radars utilized (Table I) are of similar design (1) and, with one exception, have a maximum range of 200 nautical miles (225 statute miles), Figure 1. The one exception is the ASR-5 at Edwards AFB, a 10-CM wavelength radar with a 65 nautical mile range.

However, the range to which precipitation targets may be detected varies considerably due to local topography around each site and vertical tilt of the antenna.

The purpose of the study is:

1. To delineate areas of "high" to "low" detection capabilities for all precipitation echoes for all radars for:

   a. Summer storms, April to September.

   b. Winter storms, October to March.

2. To determine capabilities to detect moderate or heavier precipitation, even while weather suppression circuits are in use during (a) and (b) mentioned above.

II. DATA COLLECTION

This project was undertaken in September 1968 and includes 24 months of data, two winters and two summers. All aviation weather sequence surface reports of precipitation, other than drizzle, were logged during hours of operation and correlated with the radar maps. Due to the time lag between surface and radar observations, an echo at a distance of 10 miles or less from reported surface precipitation was considered as "verified". Overall verification included only those radar observations made when the radar was operating in optimum weather detection mode (*). For verification of moderate or greater intensities, all radar observations were used, since theoretically ARTC radars should display moderate or greater intensity precipitation, despite weather suppression circuits (2).

III. ANALYSIS OF DATA

Data was analyzed in two categories:

1. Overall verification of all precipitation, other than drizzle, by season, summer and winter.

2. Moderate or greater intensity precipitation by season.

Unlike the Salt Lake City study (1), this study deals with all types of precipitation with no distinction between precipitation type or character; frozen, liquid, showery, or steady. Differentiation between showery or steady precipitation as reported in surface observations was deemed impractical, since individual reports are only as reliable as each observer's judgment. Nor did the author feel the need to differentiate between thundershowers and rain since the predominate weather patterns for the Pacific Southwest are thundershowers in summer and rain and rainshowers in winter. Even though thundershowers may develop in winter with the invasion of moist tropical air from the south, the tops will not normally extend any higher than those of some heavier rainshowers.

As might be expected, probability of detection of summer precipitation is much greater overall than winter precipitation. This is mainly due to greater heights to which summer precipitation extends. Each season was analyzed separately, as shown in Figures 2 through 5. Figure 6 is a combination of two winters and Figure 7 includes two summers, except as noted later in text.

Verification percentages for the first winter, Figure 2, are lower at most stations than for the second winter, Figure 3. (One exception occurs in the vicinity of Paso Robles--some radar data collected during the second winter appears doubtful and the percentages may be too low.) There are several apparent reasons for this: (1) inexperience of the observers in radar meteorology; (2) lack of familiarization with individual radar characteristics; (3) a persistent problem with poor sensitivity on the Paso Robles Monitor Scope for the first nine months of operation (subsequently corrected).

*All weather suppression circuits turned off.

In comparing Figures 2 and 3, it will be noticed that the greatest area of improvement for the second winter (Figure 3) is indicated between Sandberg (SDB) and Daggett (DAG), California. This is due to the addition of the 65 nautical mile range radar at Edwards AFB in December 1969. Contours drawn around the Edwards 65-mile radar in Figures 6, 7, and 8 were based on information collected and analyzed after implementation of the radar in December 1969. This was done so that users could have a better idea of the extended coverage in that area. Figures 3 through 7 show a marked similarity in all other areas for both summer and winter storms; however, it can be noted that summer patterns show higher percentage values in most areas.

Figure 8 contours were based on correlation of surface reports of moderate or heavier precipitation with the nearest radar observation. As expected, Figure 8 reveals the radar's capabilities of detecting precipitation of moderate or greater intensity at greater ranges than light precipitation. Note the higher percentage values for Figure 8 as compared to Figures 2, 3, and 6 for the same winter periods. Of the 45 stations reviewed, all but 10 showed a higher percentage of verification of moderate or greater intensity precipitation than light intensity; some as much as 50% higher, others as little as 2%. Figure 8 is the result of winter storms. Surface reports of heavier precipitation from summer storms were too widespread to be of much use; however, statistics are given in Table 2.

In reviewing Table 2, careful attention should be given to the number of cases of precipitation reported (Column 1). Reliability of the percentages is in direct relation to the number of reports. As examples, Visalia (VIS), California, had one surface report of summer precipitation which was verified by the Paso Robles radar for 100% verification. Burbank (BUR), California, had 3 reports with 2 verified by the San Pedro radar for only 67% verification. However, small samples such as these can hardly be representative of a 2-year period. There are also some large areas for which no surface reports were available due to the sparsity of reporting stations. In areas affected by terrain blocking, a subjective evaluation has been made based on the analyst's experience. One such area is southwest through northwest of Las Vegas, Nevada, and another includes most of western Arizona.

IV. SUMMARY

Radar is not meant simply to "verify" surface reported precipitation as was the practice in this study, where much depended on the accuracy and actual time the surface observation was taken in relation to the radar observation. Stations which fall in an area of low percentage of verification, Figure 6 or 7, should not discount radar as a valuable forecasting tool. The radars may still see frontal systems, lines or heavier precipitation patterns, advancing towards the station, which can be valuable for the short-range forecast.

This study adds support to claims that ARTC radars, though designed primarily for Air Traffic Control, are capable of detecting significant precipitation over large areas. Precipitation undetected by one radar due to existing terrain blockage or overshooting of the tops can frequently be seen by another overlapping radar system.

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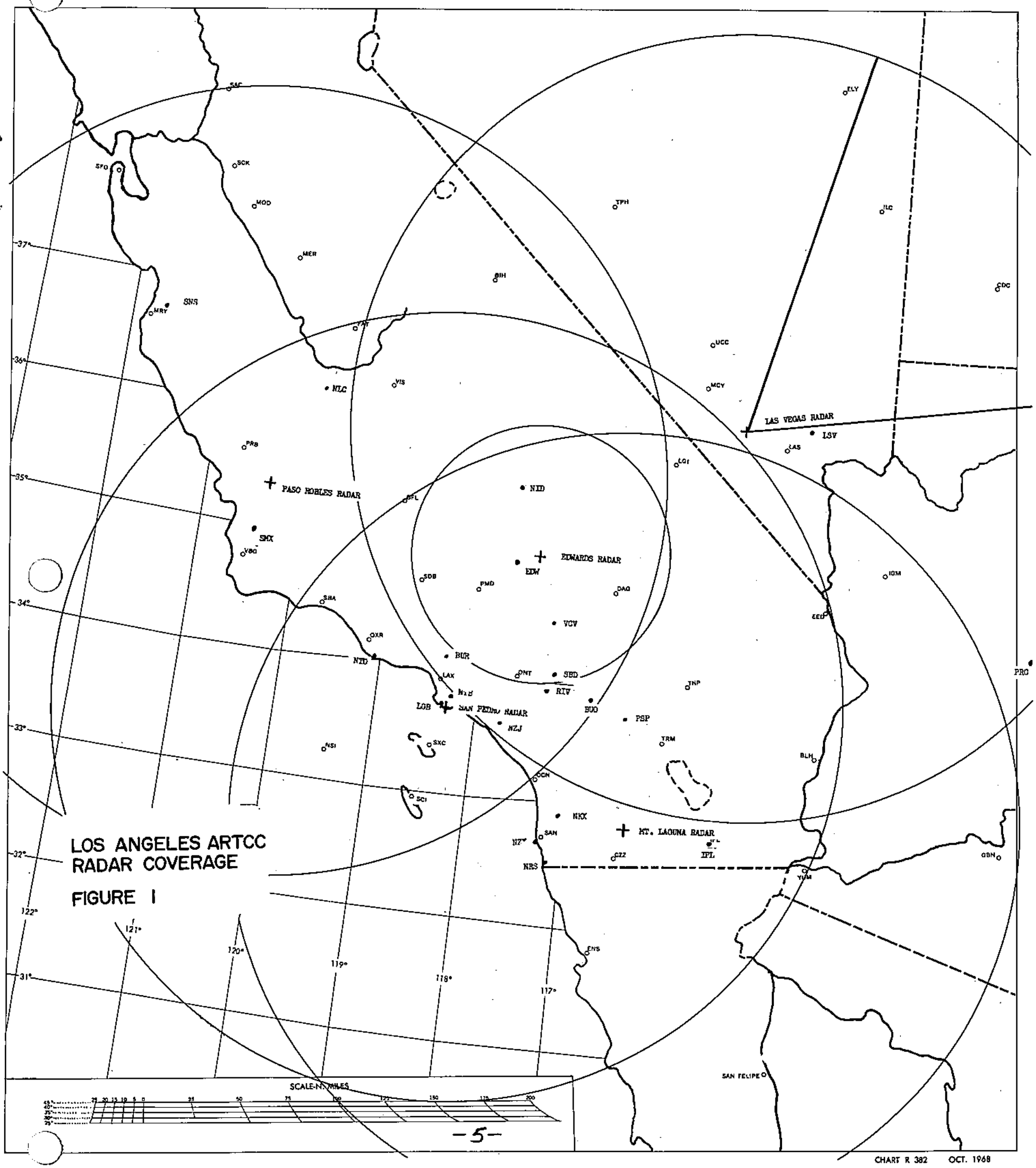
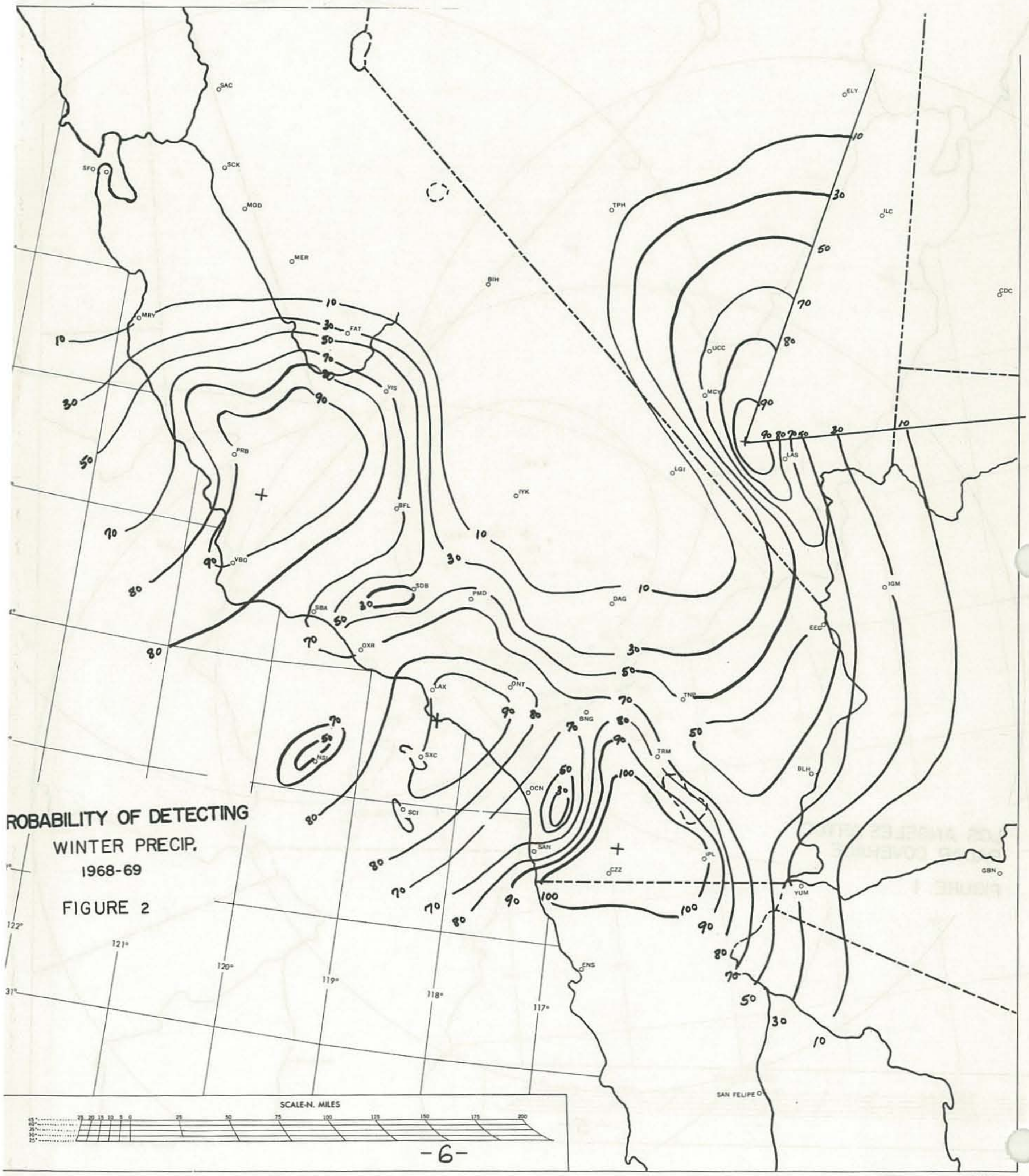
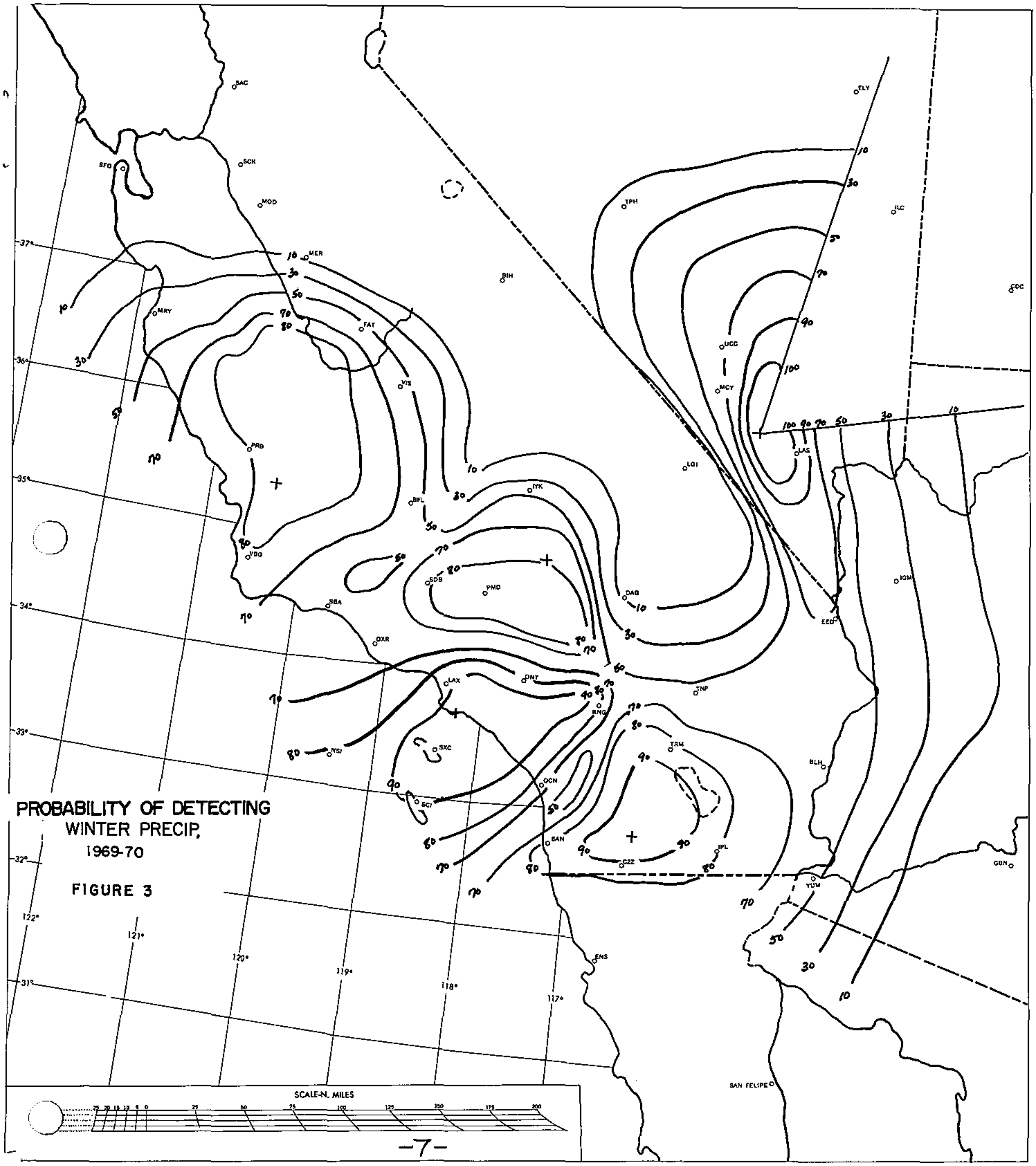


LOS ANGELES ARTCC
RADAR COVERAGE
FIGURE I

CHART R 382 OCT. 1968

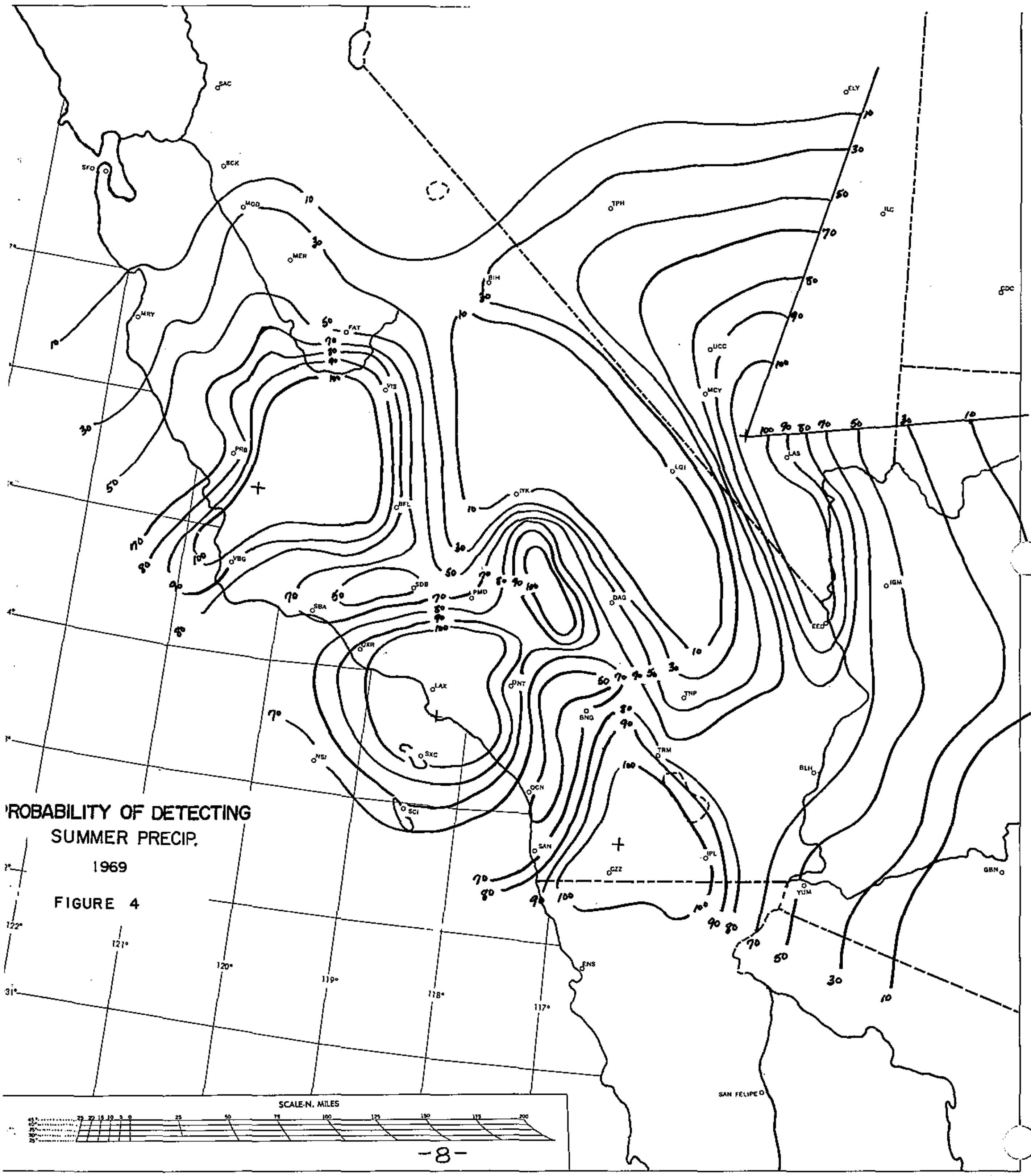

PROBABILITY OF DETECTING
WINTER PRECIP.
1968-69
FIGURE 2
SAC
SFO
SCK
MOD
MER
MRY
FAT
VIS
PRB
BFL
VBG
SBA
SDB
PMD
OXR
LAX
ONT
SXC
NSI
SCI
OCN
SAN
BNG
TRM
CZZ
IPL
YUM
BLH
TNP
DAG
IYK
LGI
MCY
UCC
LAS
EED
IGM
BIH
TPH
ELY
ILC
CDC
GBN
ENS
SAN FELIPE
SCALE-N. MILES
122°
121°
120°
119°
118°
117°
31°
CHART R 382 OCT. 1968



PROBABILITY OF DETECTING WINTER PRECIP, 1969-70

FIGURE 3

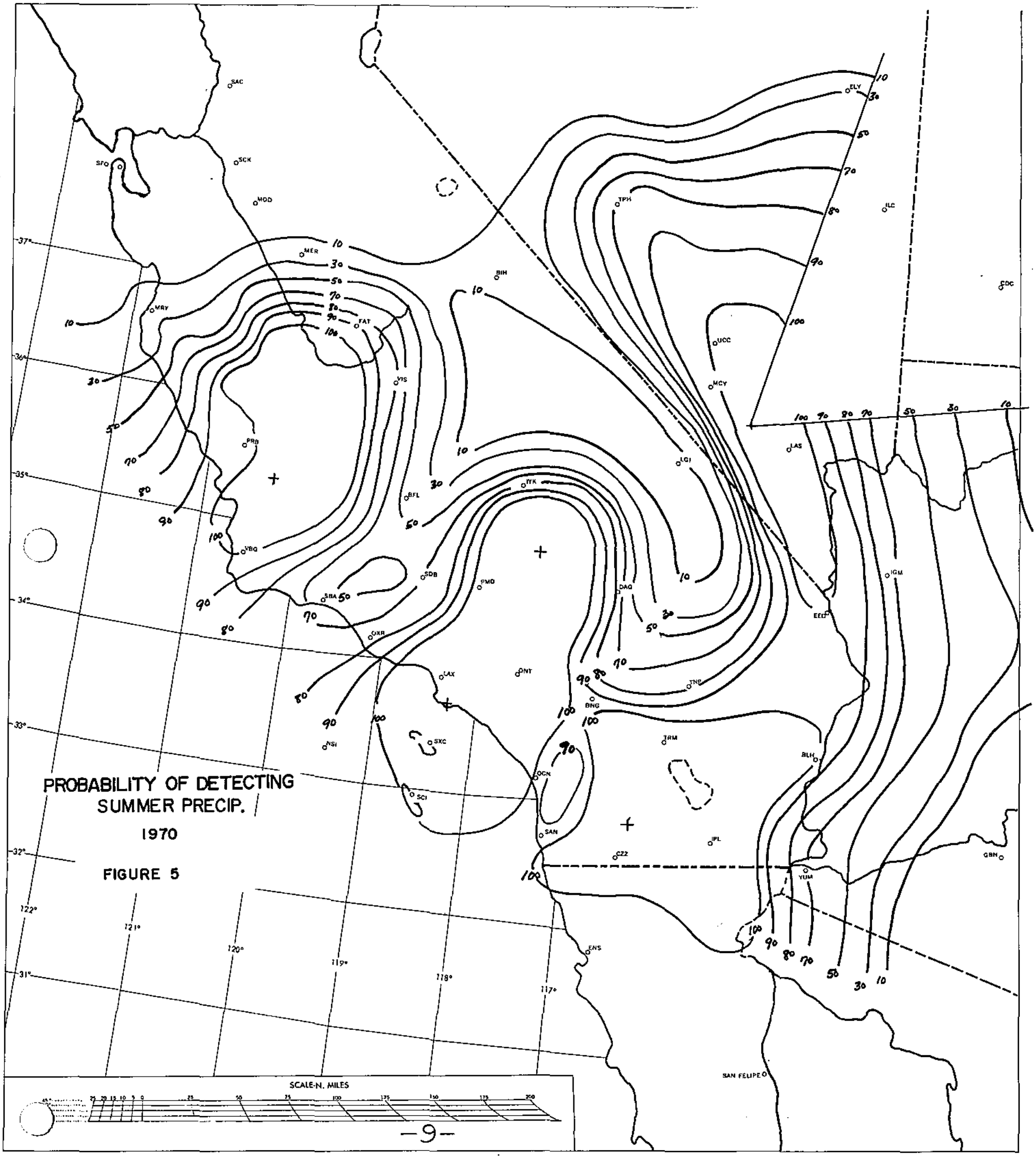
CHART R 382 OCT. 1968



PROBABILITY OF DETECTING SUMMER PRECIP.
1969

FIGURE 4

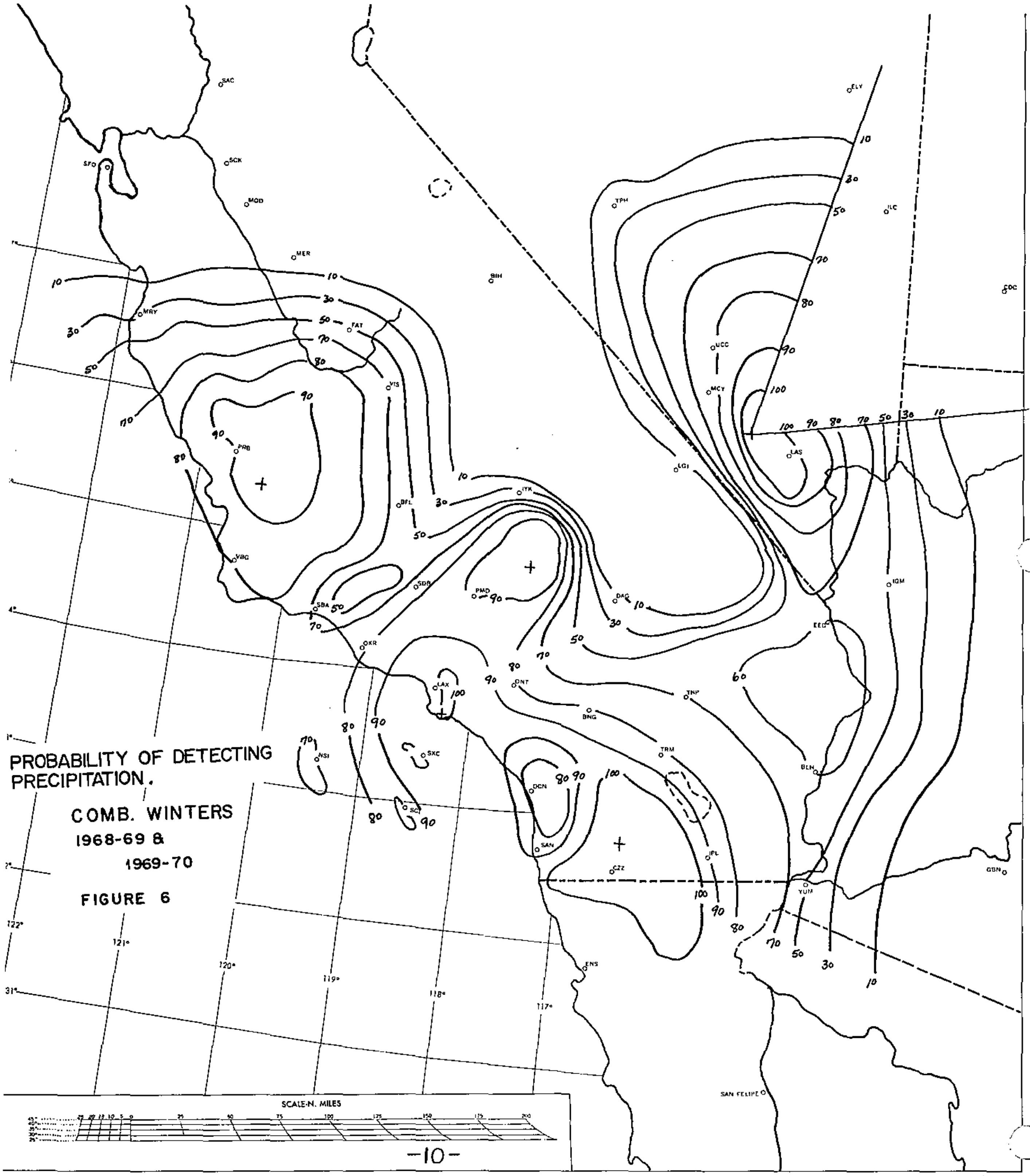
CHART R 382 OCT. 1968



PROBABILITY OF DETECTING SUMMER PRECIP.
1970

FIGURE 5

CHART R 382 OCT. 1968

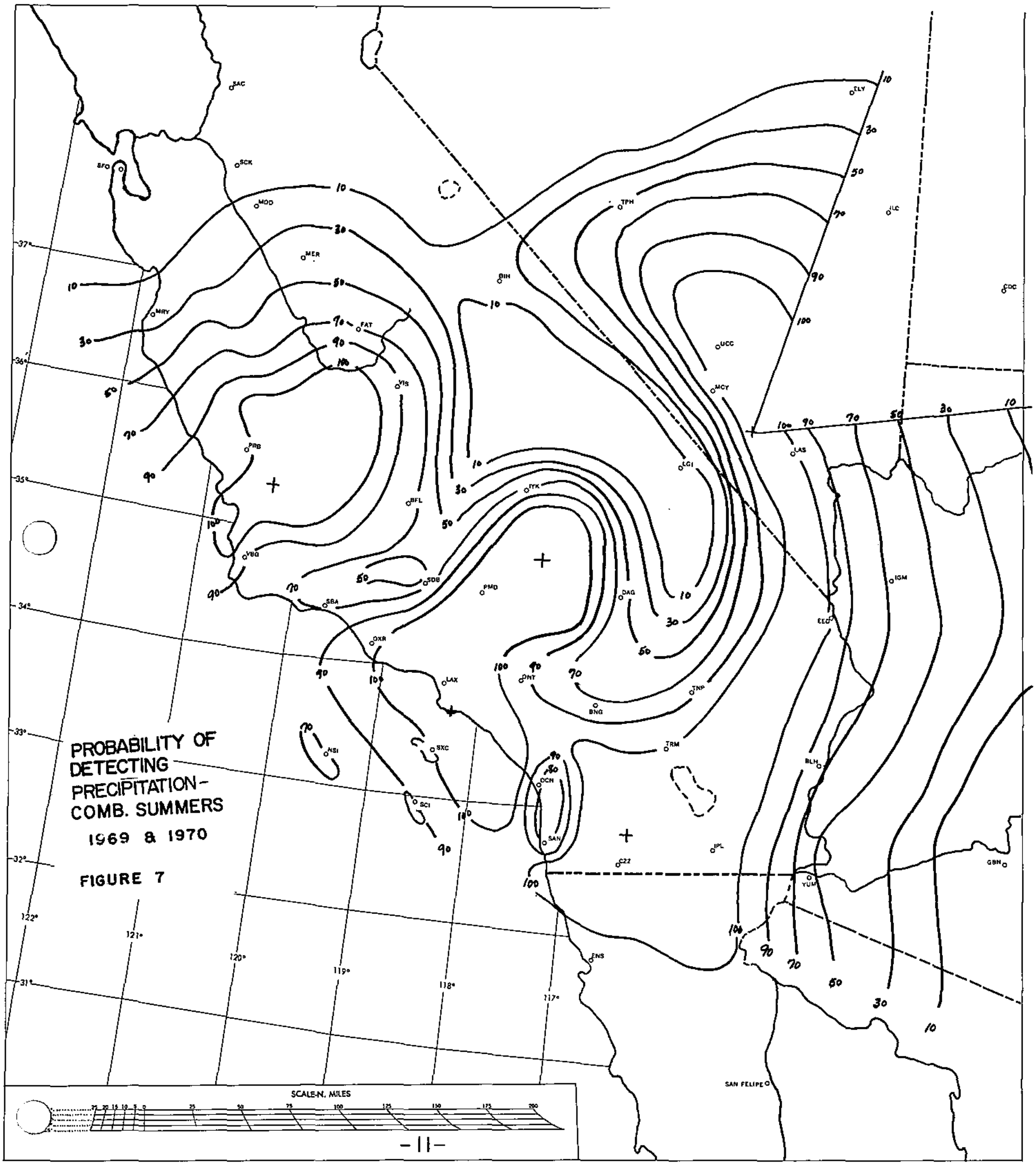


PROBABILITY OF DETECTING PRECIPITATION.

COMB. WINTERS 1968-69 & 1969-70

FIGURE 6

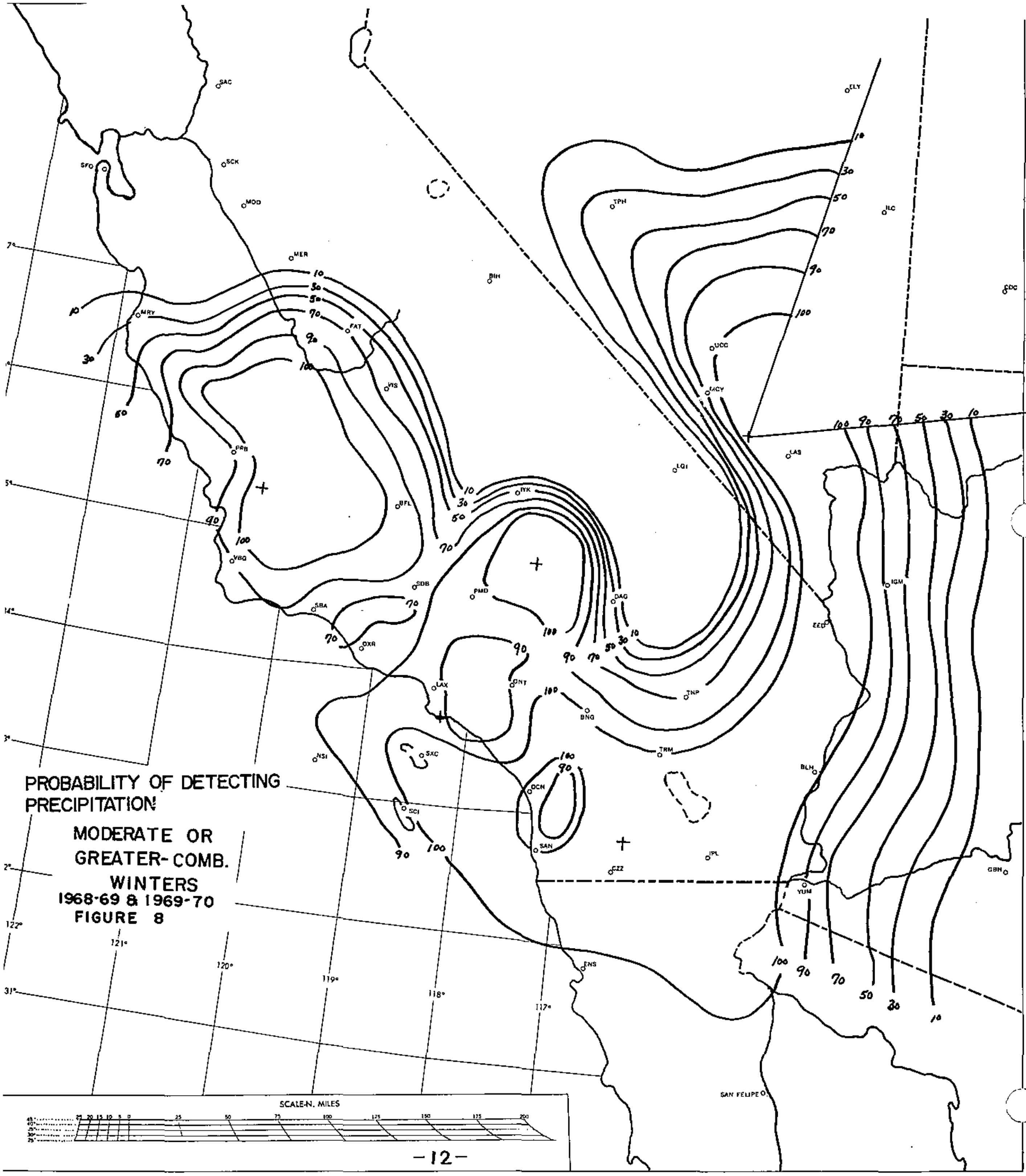
CHART R 382 OCT. 1968



PROBABILITY OF DETECTING PRECIPITATION - COMB. SUMMERS 1969 & 1970

FIGURE 7

CHART R 382 OCT. 1968



PROBABILITY OF DETECTING PRECIPITATION

MODERATE OR GREATER- COMB.

WINTERS 1968-69 & 1969-70

FIGURE 8

CHART R 382 OCT. 1968

TABLE I

RADAR LOCATIONS AND TYPE

LOCATION	TYPE	ELEVATION MSL
Edwards, California	ASR-5	3050 Ft.
Las Vegas, Nevada	FPS-20	8924 Ft.
Mt. Laguna, California	FPS-7	6246 Ft.
Paso Robles, California	ARSR-2	3665 Ft.
San Pedro, California	ARSR-1	1546 Ft.

TABLE 2

VERIFICATION OF SUMMER (1969-70) AND WINTER (1968-69, 1969-70) PRECIPITATION

SUMMER

1. Summer (All Precip) Cases Reported
2. Percent Verified
3. SFC Reported as MDT or Greater
4. Percent Verified

WINTER

1. Winter (All Precip) Cases Reported
2. Percent Verified
3. SFC Reported as MDT or Greater
4. Percent Verified

STATION	Summer (1)	Summer (2)	Summer (3)	Summer (4)	Winter (1)	Winter (2)	Winter (3)	Winter (4)
SNS	15	26	0	-	146	29	16	25
MRY	15	20	2	50	150	24	55	33
PRB	11	72	0	-	162	87	21	89
SMX	13	92	1	100	154	80	20	100
SBA	10	70	1	100	151	71	37	89
PMD	16	91	0	-	99	81	19	71
ONT	14	92	4	100	167	86	30	94
LAX	5	100	1	100	173	88	18	96
BUR	3	67	0	-	147	90	59	79
LGB	3	100	1	100	154	94	11	90
BUO	8	84	0	-	53	81	4	100
SAN	8	78	1	100	145	83	2	100
FAT	24	71	0	-	196	46	30	63
BFL	6	75	0	-	127	71	2	100
SDB	9	44	0	-	116	75	19	86
BIH	26	24	0	-	68	0	3	0
TPH	40	64	2	100	98	9	9	37
DAG	33	72	4	100	50	10	0	-
TRM	17	90	1	100	66	78	3	100
PSP	14	95	3	100	73	81	7	88
IPL	6	100	2	100	62	90	6	100
YUM	19	54	4	75	63	35	6	88
LAS	43	96	7	100	97	93	1	100
ELY	53	26	1	0	0	-	0	-
EED	34	100	2	100	48	60	2	100
PRC	47	27	0	-	53	7	0	-
BLH	16	85	1	100	52	60	4	100
NTD	3	100	0	-	117	72	32	79
NSI	3	67	0	-	87	67	9	80
NID	0	-	0	-	17	35	2	50
VBG	8	100	0	-	119	84	20	84
EDW	12	100	1	100	34	77	5	100
LSV	15	92	0	-	46	56	0	-
NTB	0	-	0	-	43	95	6	83
NZJ	3	100	1	100	111	92	31	90
NKX	0	-	-	-	58	79	7	84
NZY	1	100	0	-	62	93	9	93
VCV	12	100	1	100	55	53	4	100
SBD	12	75	0	-	102	69	11	94
RIV	6	75	0	-	91	84	11	100
MER	8	23	0	-	70	6	5	0
NLC	6	100	0	-	48	82	7	100
SXC	1	100	0	-	18	100	2	100
VIS	1	100	1	100	30	76	11	75
NRS	1	100	0	-	21	85	2	100
SCI	0	-	0	-	24	100	2	100
AVERAGES		79%		91%		67%		76%

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