CRH-SSD
MAY 1986

CENTRAL REGION TECHNICAL ATTACHMENT 86-12

ON THE EXPLOITATION OF RADAR AND THE CSI

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Since about 80 percent of Central Region warnings are radar based,[1] stratifying verification statistics for radar versus non-radar offices should shed some light on the efficacy of on-site weather radar for severe weather services. Such stratification also obliquely tells us something about the quality of radar services, including remoting, that our offices provide to non-radar offices.

If warning statistics for radar and non-radar offices turn out to be substantially the same, one must conclude that:

a) Radar provides no help at all; or

b) Radar potential is not being exploited; or

c) Remoting and advisory services flowing from radar to non-radar offices are of such superior quality as to cancel the expected advantages of an on-site radar; or

d) Non-radar offices "compensate" by supporting vigorous spotter training, post-storm activity, better networks, etc.

By extension, if verification statistics were to be stratified for WSFO and WSO, the four possibilities above remain much the same if the word "meteorologist" is substituted for "radar" and "meteorological technician" for "non-radar."

We are all well aware of the basic limitations of our severe local storm verification procedures. However, these procedures (warts and all) remain the only quantitative game in town, so it is useful to try to interpret their message.

Central Region numbers for the years 1982-84 have been reworked into four categories: radar; non-radar; WSFO; and WSO. Averages are obtained for FAR, POD, and CSI in each category. Figures 1-3 depict FAR, POD, and CSI graphically.

As may be seen readily from the figures, verification statistics generally show favorable year-to-year trends for all categories of offices. Further, it is seen that radar offices always slightly out-perform their non-radar counterparts, and that for the last 2 years, the WSO group improved its numbers faster than the WSFO's. Whether differences shown are statistically significant or not can be worked out by formula or decided on faith.

In the original paper describing the CSI,[2] the ratio (k) between the cost of a failure to detect to that of a false alarm was used. A "warn-on-everything" philosophy (CYA) should be verified using a large value for k, while a do not warn "until you see the whites of their eyes," philosophy would use a fractional k. Present National Weather Service policy and procedures use k=1, i.e., failures to detect and false alarms are considered equally undesirable.

The same paper also discusses the potential of various warning criteria when applied in a research (non-real time) mode to research data sets. Figure 4 shows these results. It is seen that as k increases, the CSI levels off. Remembering that National Weather Service uses a k of one (1), we see that there are essentialy three quality levels possible. The Central Region, in general, is performing at the "50 dbz + 13.5 km top" level. That is, if all offices were to issue warnings based only on echoes of 50 dbz (=VIP5) whose VIP1 tops reach 13.5 km, the required CSI would be about where it is now.[3]

Figure 4 also implies that the next rung of the CSI performance ladder lies around the 0.32 - 0.38 CSI level, which may be close to optimal for conventional radar and present staffing. Only Doppler capability allows for a leap above the 0.5 CSI level and the JDOP effort (See Table 1), and others since then have basically confirmed Donaldson's data for both conventional and Doppler Radar.[4] (There are some individual National Weather Service Offices that have reached rarefied CSI levels over 0.5 at least partially through extremely effective verification activities. These activities are highly dependent upon staffing and population density considerations.)

Putting everything together, the perspective that emerges is one of average regional CSI's capped at around 0.4 for positive lead times. This means that recent CSI progress is not nearly as modest as it would seem. Furthermore, an increase in follow-up statements should enhance emphasis on gathering severe weather reports, which will result in a significant increase in the Central Region CSI. Central Region, on average, is just one surge away from optimal CSI performance, given present radar hardware and staffing levels.

Acknowledgement

The author thanks Mike Manker, Scientific Services Division, for the needed number crunching and Pamela Goldsmith, Meteorological Services Division, for putting this into a civilized format.

References

[1]Kelly, D.L., and J.T. Schaefer, 1982: Implications of severe local storm warning verification. Preprints, Twelfth Conference on Severe Local Storms (San Antonio, TX), Amer. Meteor. Soc., Boston, MA, 459-462.

[2]Donaldson, R.J., R.M. Dyer and M.J. Kraus, 1975: An objective evaluator of techniques for predicting severe weather events. Preprints, Ninth Conference on Severe Local Storms (Norman, OK), Amer. Meteor. Soc., Boston, MA, 395-402.

[3]Strictly speaking, this statement applies only to 5 cm radars.

[4]NOAA Technical Memorandum ERL NSSL-86. Final Report on the Joint Doppler Operational Project (JDOP) 1976-78, NSSL, March 1979.

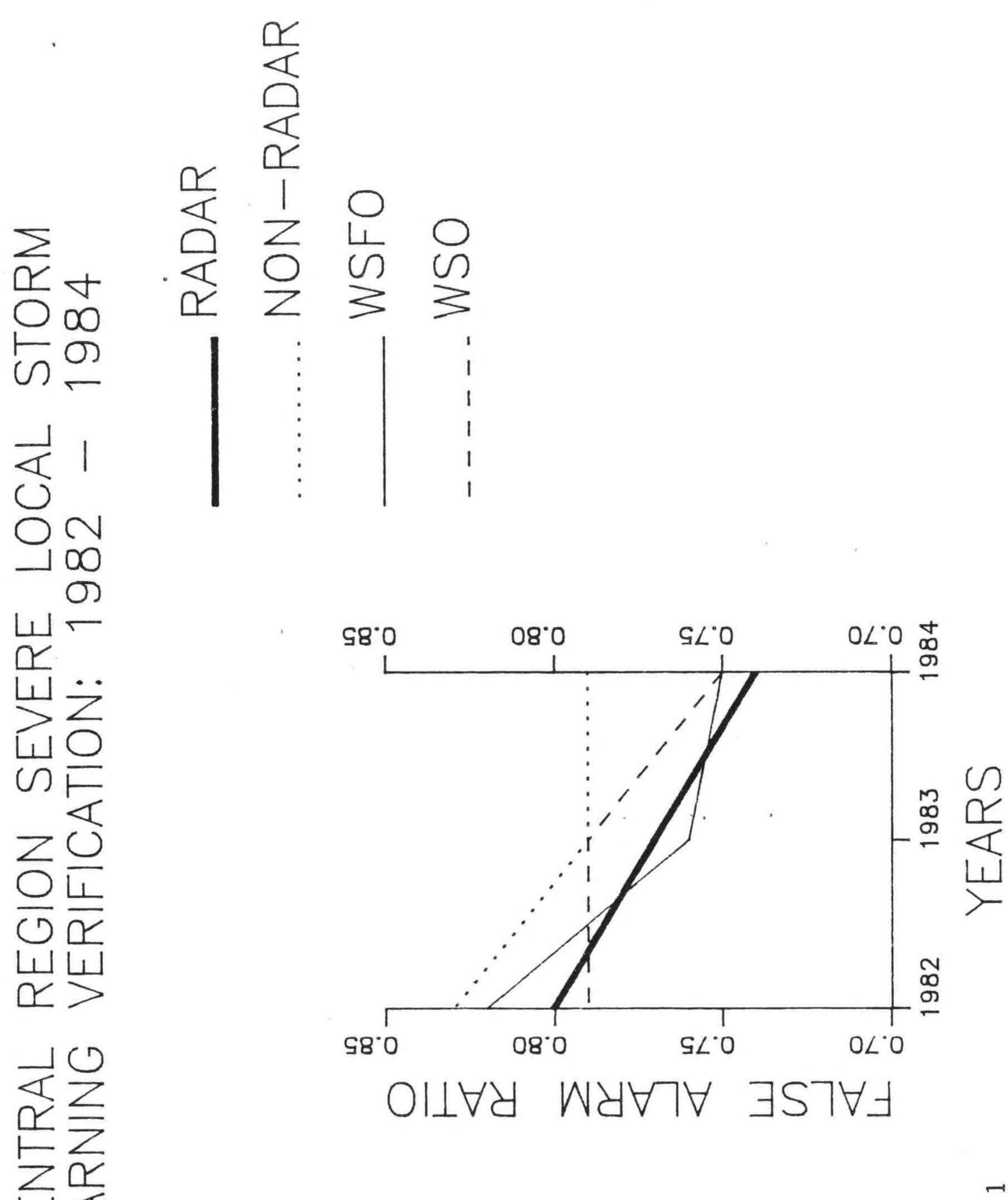
CENTRAL REGION SEVERE LOCAL STORM
WARNING VERIFICATION: 1982 - 1984
RADAR
NON-RADAR
WSFO
WSO
FALSE ALARM RATIO
0.70
0.75
0.80
0.85
1982
1983
1984
YEARS

Figure 1

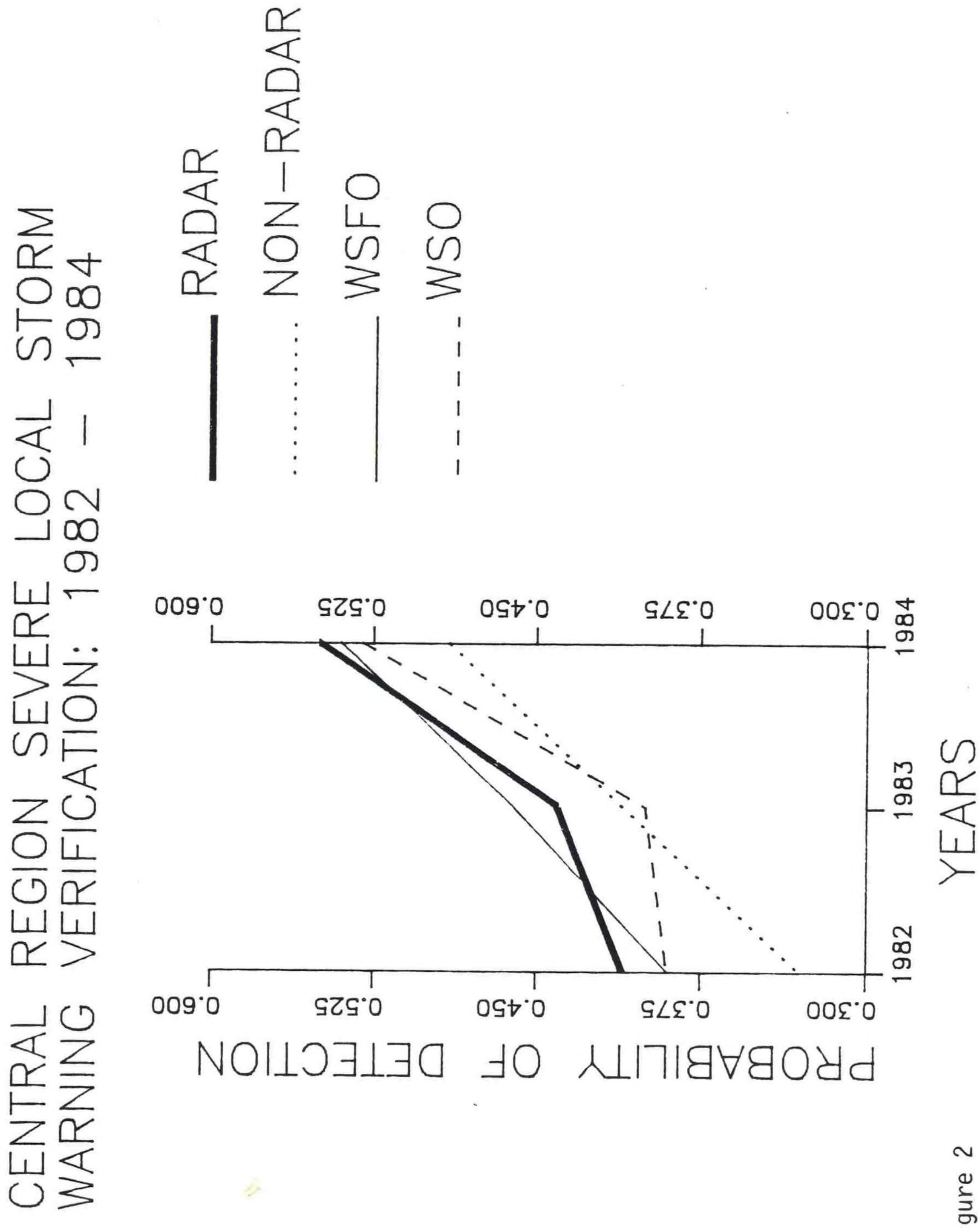
CENTRAL REGION SEVERE LOCAL STORM
WARNING VERIFICATION: 1982 – 1984
RADAR
NON-RADAR
WSFO
WSO
PROBABILITY OF DETECTION
0.300
0.375
0.450
0.525
0.600
1982
1983
1984
YEARS

Figure 2

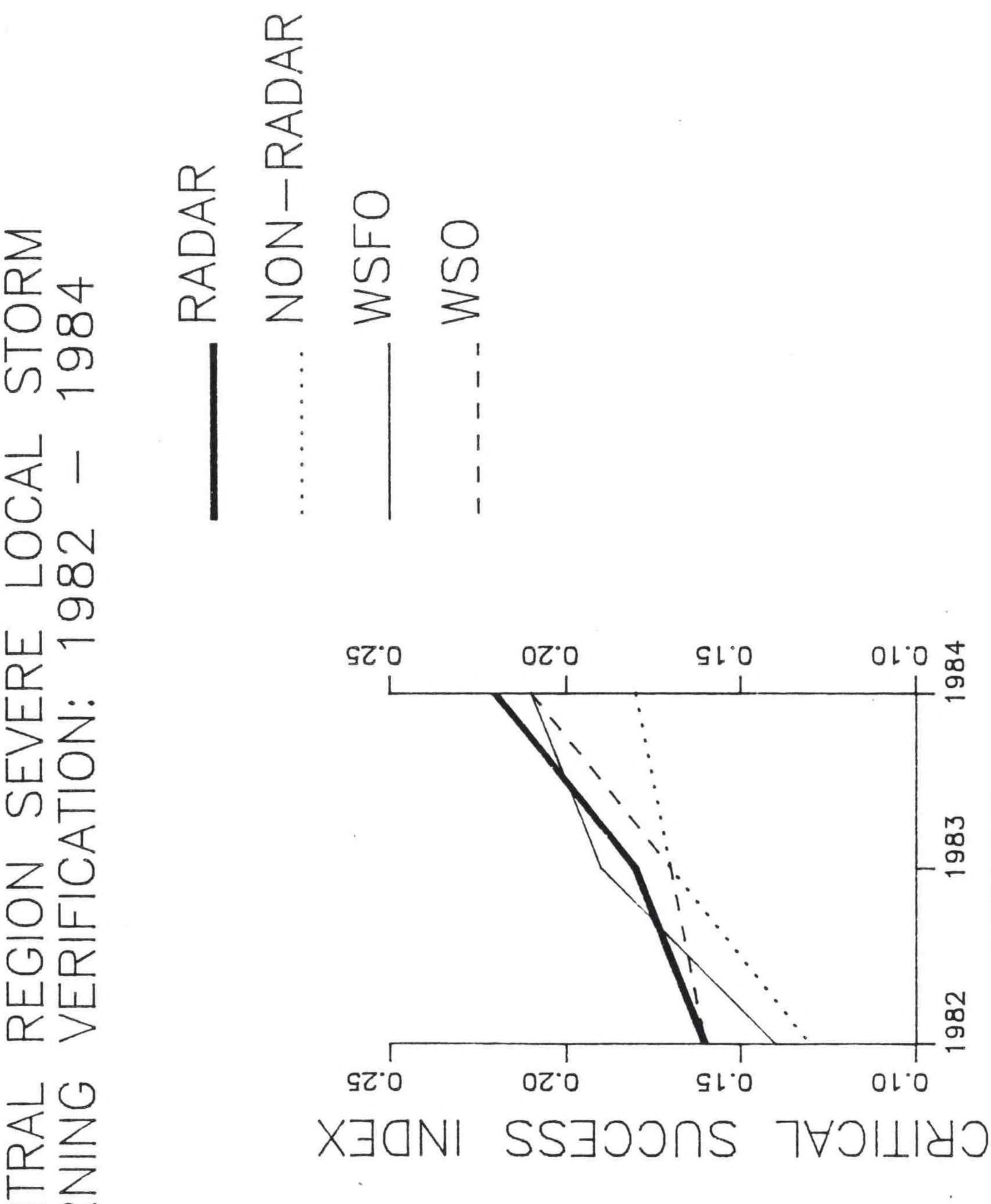
CENTRAL REGION SEVERE LOCAL STORM
WARNING VERIFICATION: 1982 - 1984
RADAR
NON-RADAR
WSFO
WSO
CRITICAL SUCCESS INDEX
0.10
0.15
0.20
0.25
1982
1983
1984
YEARS

Figure 3

FIGURE 4

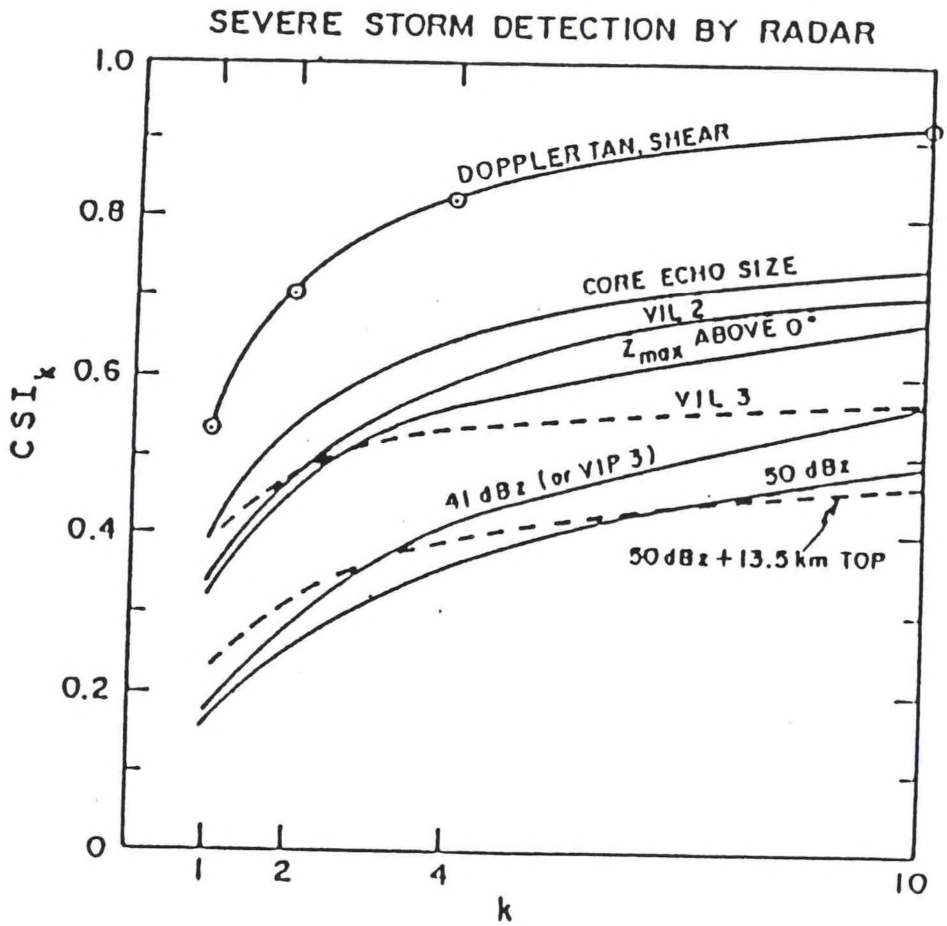

Fig. 4 The success of various radar techniques for severe thunderstorm detection. Note from Eq. (4) that the values of CSI_k will increase with increasing k for non-zero z. (After Donaldson et al.)

TABLE 1 *JDOP Critical Success Index*

X = Forecast severe event which occurs.
Y = Forecast severe event which doesn't occur.
Z = Forecast non-severe event which occurs severe.
LT = Lead time between advisory/warning issuance and event occurrence (min).

$$\text{Probability of Detection (POD)} = \frac{X}{X+Z}$$

$$\text{False Alarm Ratio (FAR)} = \frac{Y}{X+Y}$$

$$\text{Critical Success Index (CSI)} = \frac{X}{X+Y+Z}$$

1977 Severe Storm + Tornado

OKC WSFO	NSSL Doppler
POD = .58	POD = .75
FAR = .54	FAR = .22
CSI = .34	CSI = .62
LT = 0.7[1] min	LT = 23.0[1] min

1978 Severe Storm

OKC WSFO	NSSL Doppler
POD = .47	POD = .70
FAR = .40	FAR = .16
CSI = .36	CSI = .62
LT = 13.6 min	LT = 15.4 min

1978 Tornado

OKC WSFO	NSSL Doppler
POD = .75	POD = .56
FAR = .79	FAR = .38
CSI = .20	CSI = .42
LT = -2.3 min	LT = 19.8 min

[1] Tornado only