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An Initial Evaluation of a Latent Instability Index

Peter Jackson

Pacific Weather Centre, Vancouver, B.C.

INTRODUCTION

On May 28, 1982, the Latent Instability Index (LATDEX) proposed in a paper by W.S. Harley was added to the Instability Indices already being computed for the Pacific Weather Centre fire weather program. This note presents the theory behind LATDEX and then gives an initial evaluation of LATDEX by comparing it with the K index (KIDEX). This note is mainly concerned with whether or not the Latent Instability Index, as implemented at PWC, actually functions as an instability index.

THEORY

"Latent instability is the most important type of conditional instability..."[1] The Latent Instability Index proposed by Harley is basically a measure of the difference between the saturated equivalent potential temperature at pressure level p' and the equivalent potential temperature at pressure level p (where $p' < p$). A larger negative difference indicates greater instability.

The index is defined as:

$$L = \frac{-2\ (\theta_S E(p') - \theta_E\ (p))}{(\theta_S E(p^1) + \theta_E(p))(p' - p)}$$

where:

L	= Latent Instability Index	
θ_E	$= \theta + B \frac{p_o}{p} e_w(Td)$	(equivalent potential temperature)
$\theta_S E$	$= \theta + B \frac{p_o}{p} e_w(T)$	(saturated equivalent potential temperature)
θ	= potential temperature	
B	= 1.555 K mb^{-1}	
$e_w(Td)$	= actual vapour pressure	
$e_w(T)$	= saturation vapour pressure	
Td	= dew point temperature	
T	= temperature	
p_o	= 1000 mb	
p	= 700 mb	
p'	= 500 mb	

[1]HARLEY, W.S.: A Probability Method of Severe Storm Forecasting.

Since the index is of the order of 10^{-5} mb $^{-1}$ it has been normalized to be in the range 70 to 100 with increasing index value implying increasing instability. The normalizing function is:

$$L_n = -1 * 10^5 * L + 45$$

L_n = normalized LATDEX
L = non-normalized LATDEX

EVALUATION

The overriding problem in the evaluation of any instability index is the lack of reliable verification of convective activity. In an attempt to nullify this problem, this evaluation is a comparison between the performances of LATDEX and KIDEX. Both indices are verified against surface observations of cloud type; the categories used were: no convection, AC, CU, ACC, TCU, CB, and lightning. The surface observations used and indices computed were from 00Z and 12Z for May 28, 1982 to July 21, 1982 at Vernon, Prince George, and Fort Nelson. Scatter diagrams for each index and station are plotted in Figures 1 to 6. Figures 7, 8, and 9 compare the mean index values for each convective group at each station (the dashed line is for KIDEX, the solid line for LATDEX). Figure 10 summarizes the scatter or error about the mean. In this figure:

Mean Standard Error (MSE) = average of the standard deviations for each convective group

Normalized MSE = MSE/index range (range = 24 for KIDEX, 22 for LATDEX)

RESULTS

Figures 7, 8, and 9 show that, in the mean, both KIDEX and LATDEX increase with increasing convection (as represented by the surface observations of cloud type). However, by looking at the scatter diagrams in Figures 1 to 6, one can see that the scatter about the mean is usually so large that the trend of the mean values is rendered almost meaningless. The reason for this cannot be totally attributed to the indices but lies also with the method of verifying the amount of convection. The use of surface cloud observations at one station and at one time probably underestimates the actual amount of convection. This, however, is not a major concern here, as this note doesn't try to derive any working relationships between the indices and the actual amount of convection.

By looking at the scatter diagrams (Figures 1 to 6), and the standard deviation analysis (Figure 10), it can be seen that KIDEX slightly outperforms LATDEX. The normalized MSE is slightly larger for LATDEX at each of the three stations. The normalized MSE for large amounts of convection is slightly larger for LATDEX at two out of the three stations.

CONCLUSION

The Latent Instability Index does function as an instability index. LATDEX and KIDEX performed in a similar manner with the amount of scatter about the mean index value for each convective category being slightly greater for LATDEX than for KIDEX.

ACKNOWLEDGMENTS

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REFERENCES

Harley, W.S.; A Probability Method of Severe Storm Forecasting, unpublished.

Iribarne, E.W. and Godson, W.L., 1973; Atmospheric Thermodynamics; R. Reidel Publishing Company, Boston, Mass., Chapter 8.

SCATTER DIAGRAM FOR LATDEX AT VERNON
FOR MAY 28 TO JULY 21 1982

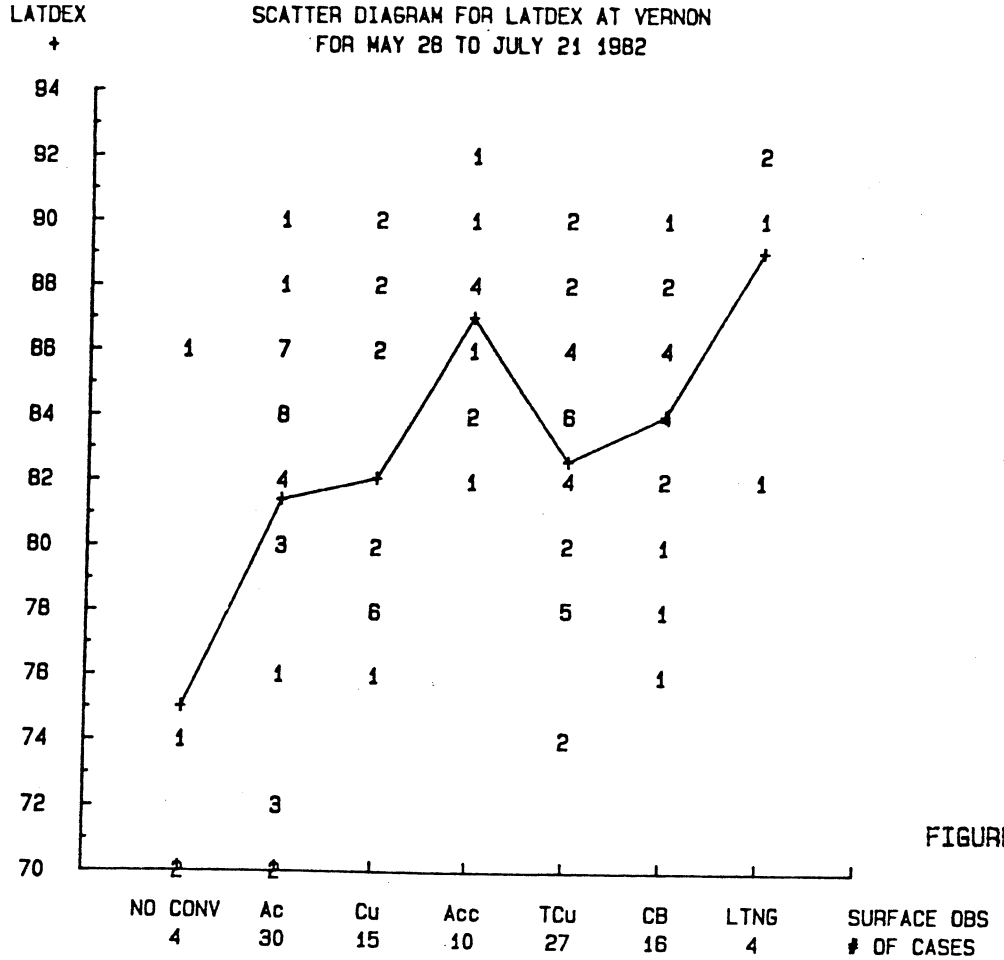

FIGURE 1

SCATTER DIAGRAM FOR KIDEX AT VERNON
FOR MAY 28 TO JULY 21 1982

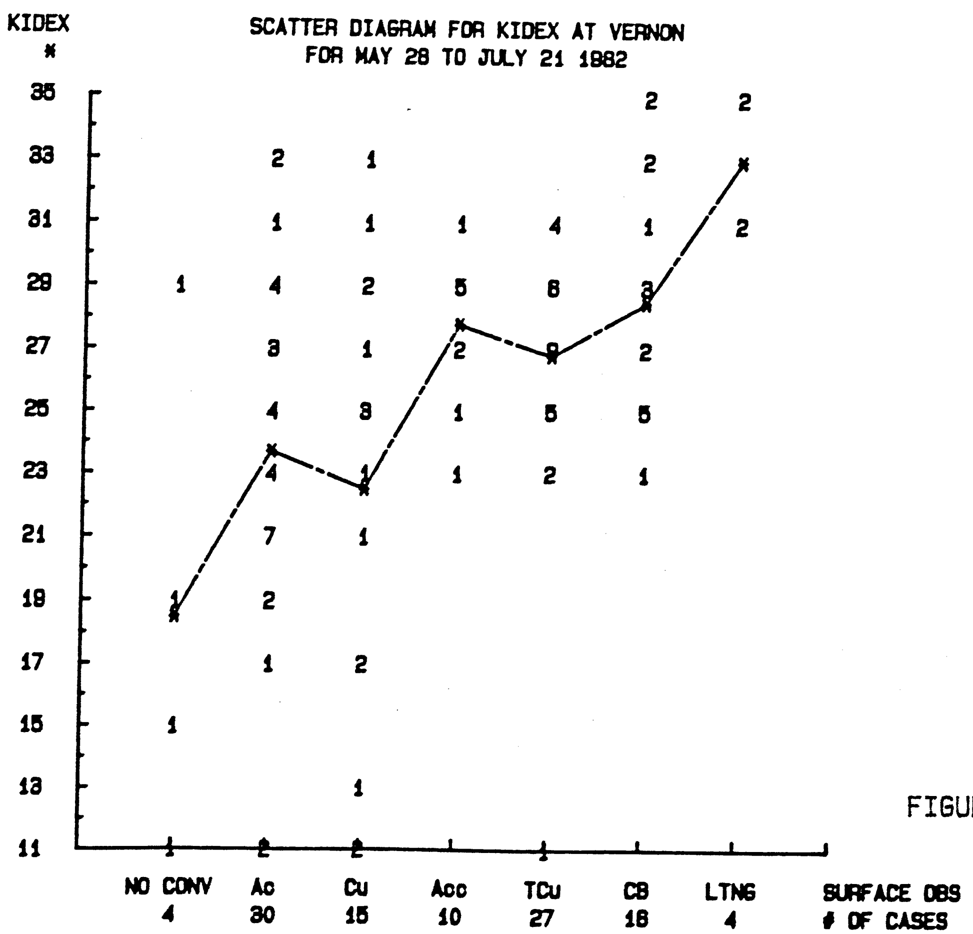

FIGURE 2

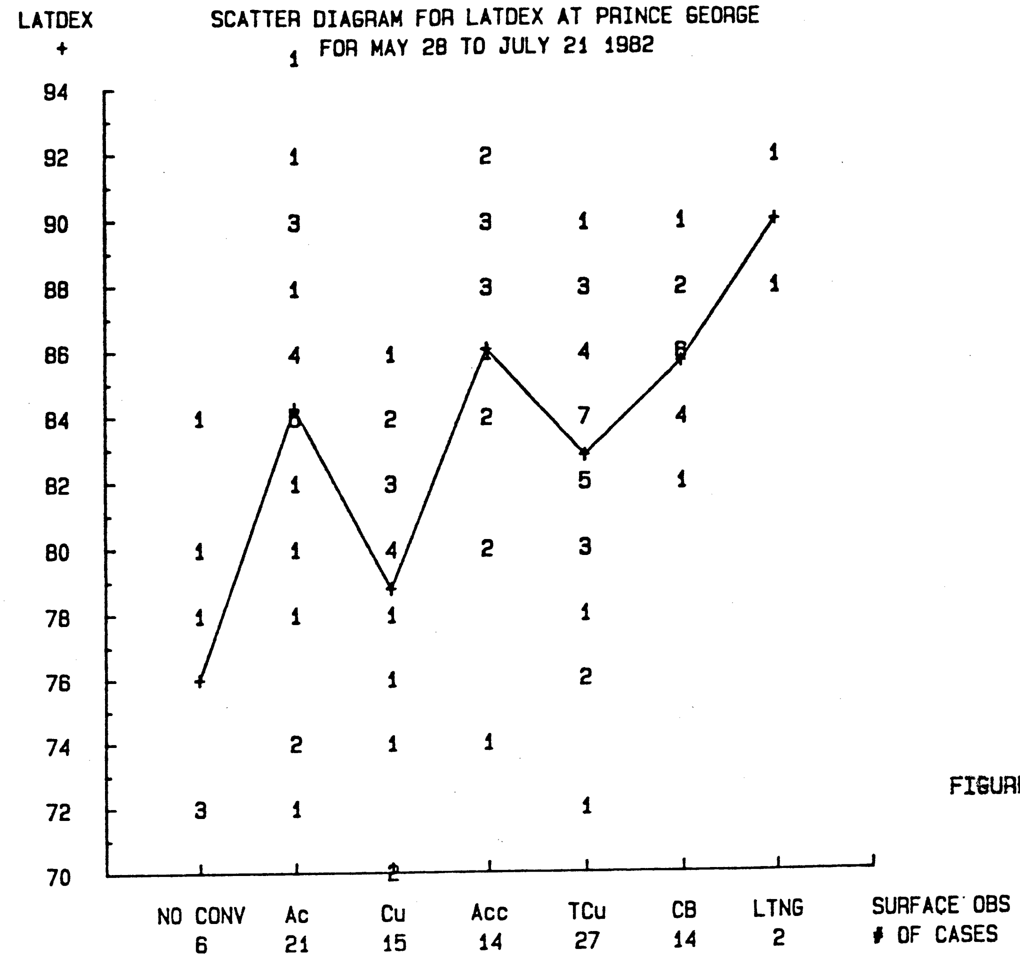

FIGURE 3

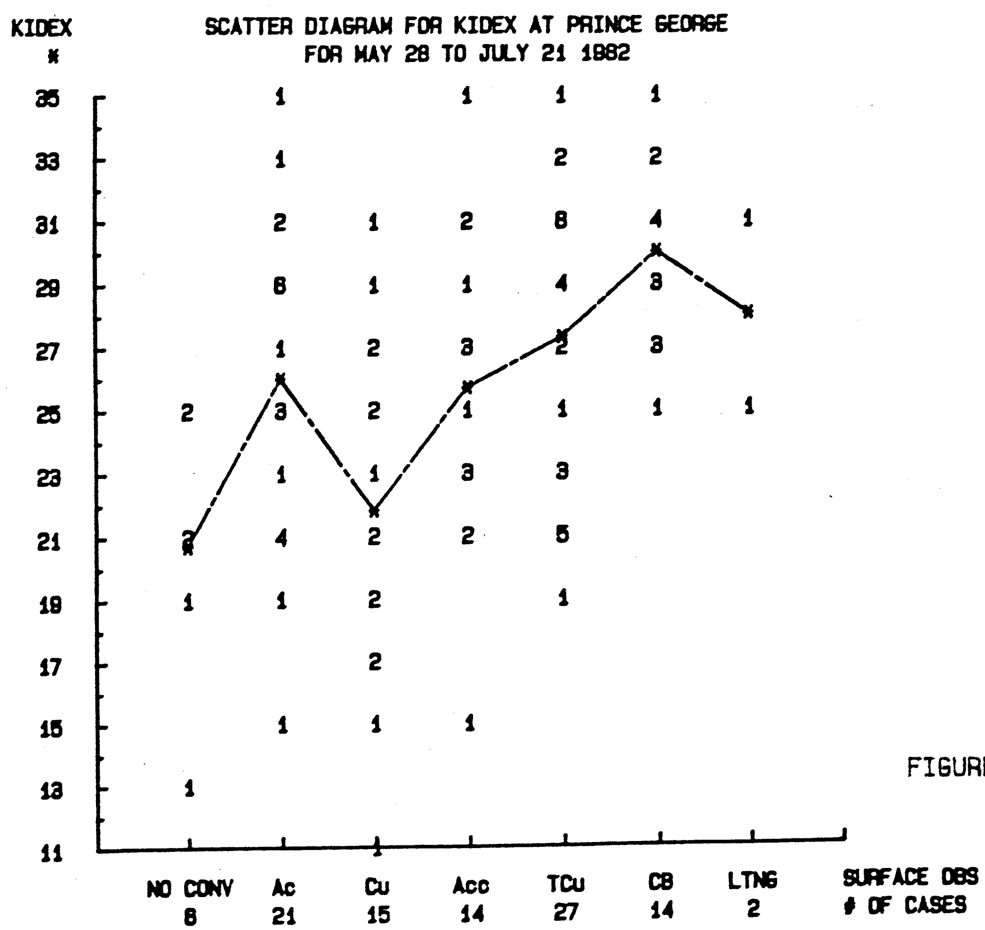

FIGURE 4

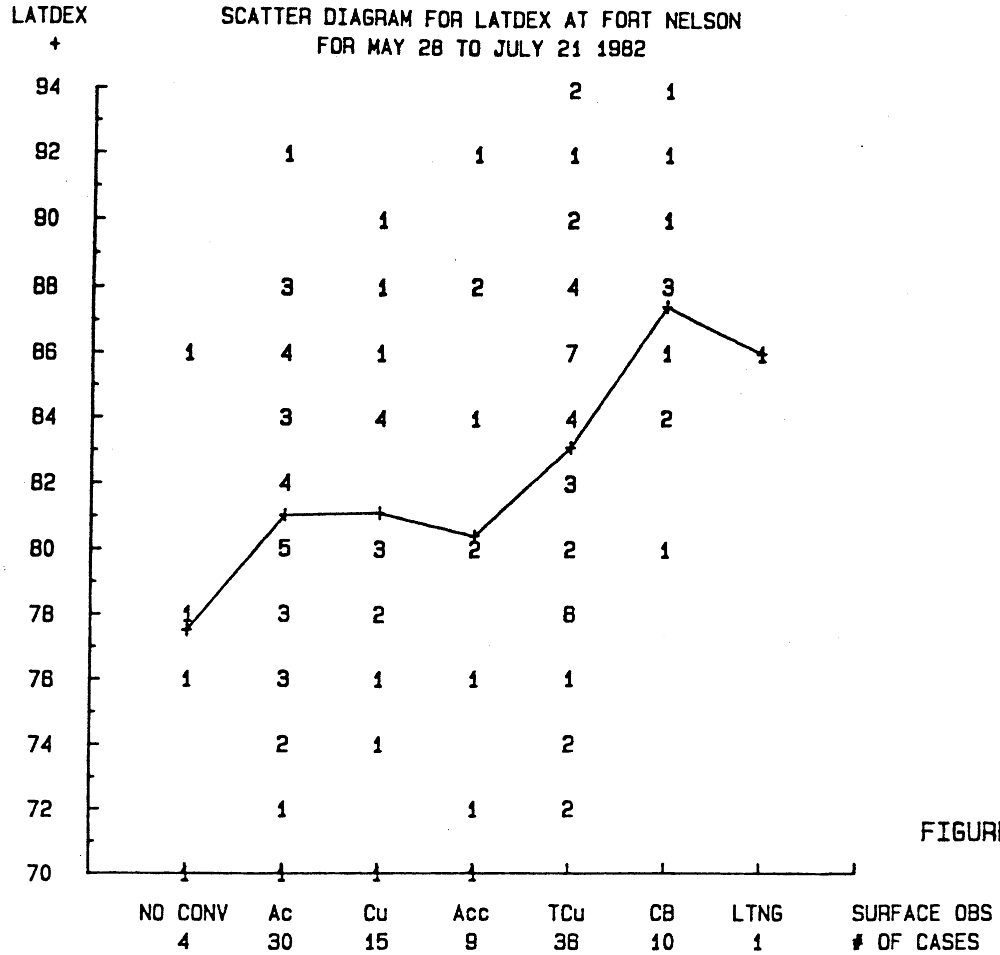

FIGURE 5

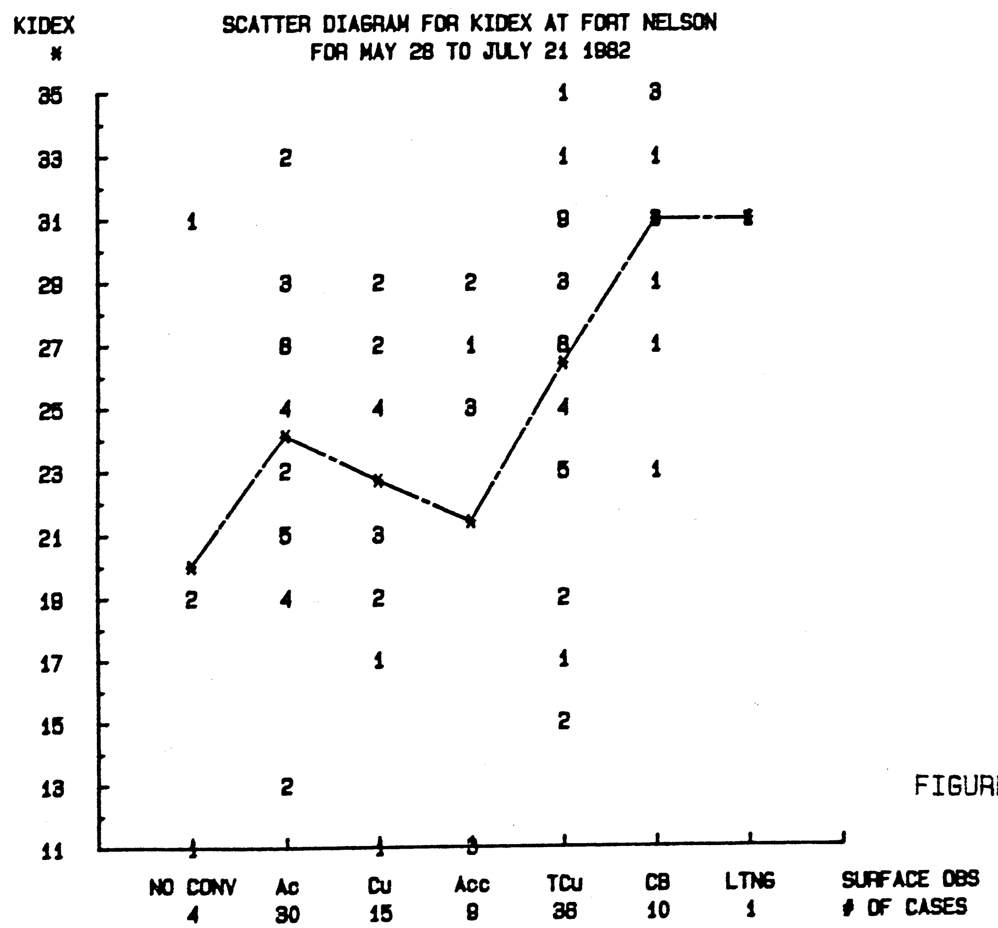

FIGURE 6

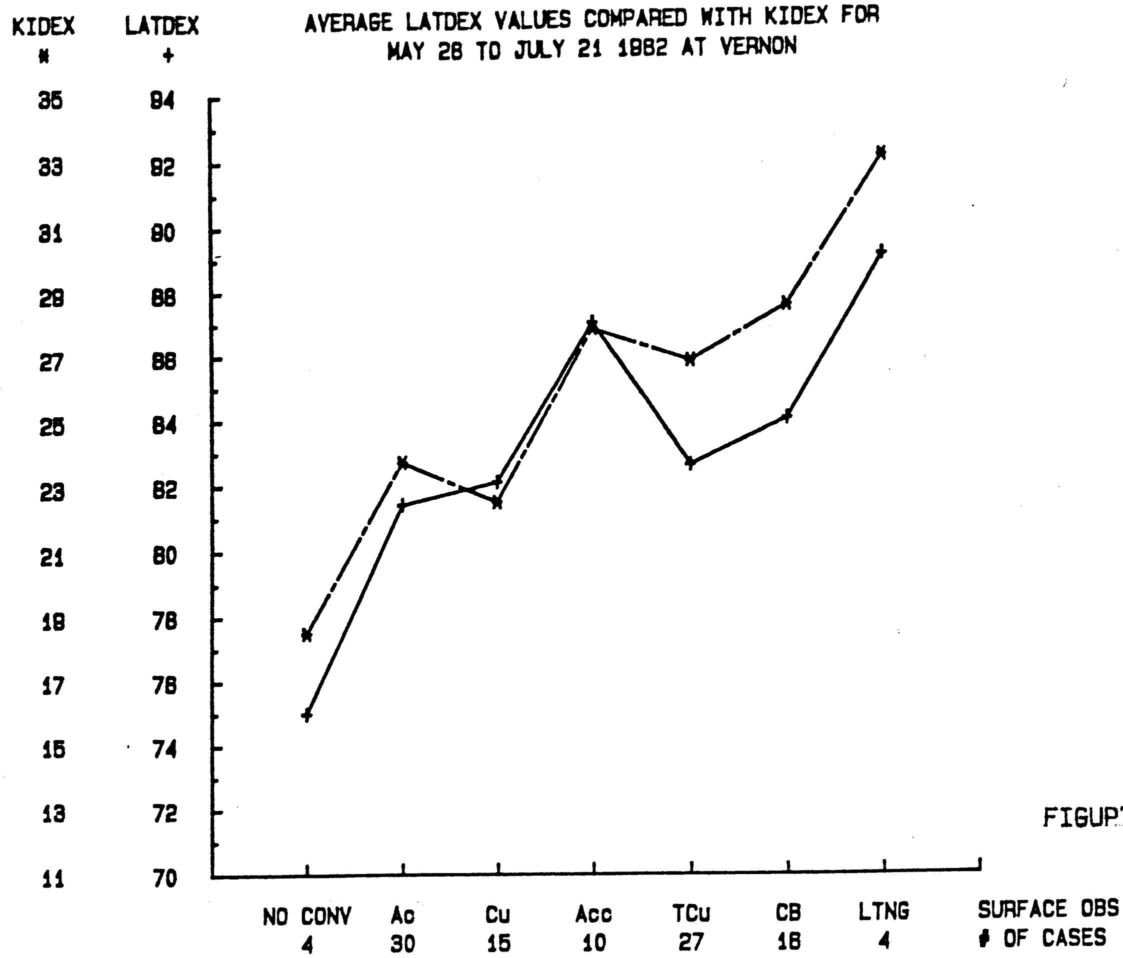

FIGURE 7

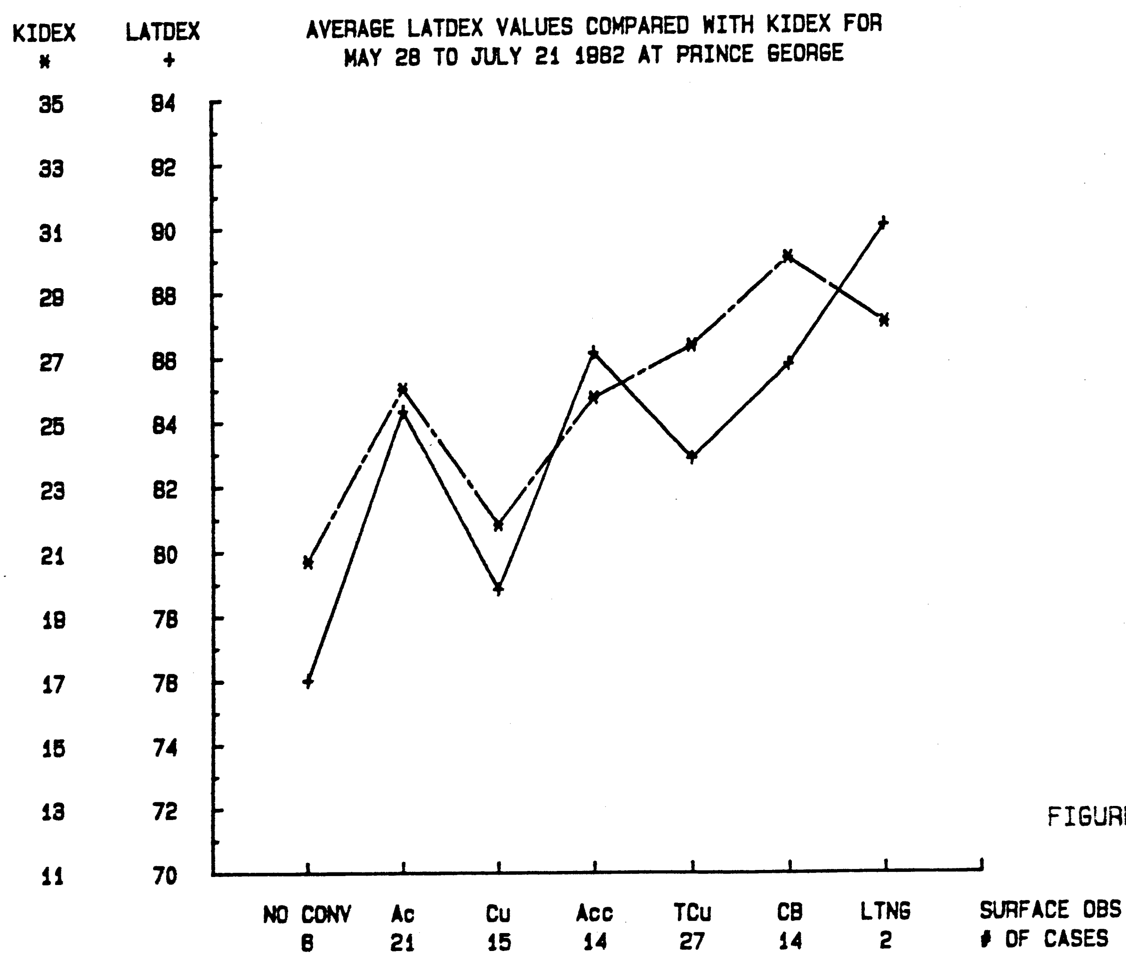

FIGURE 8

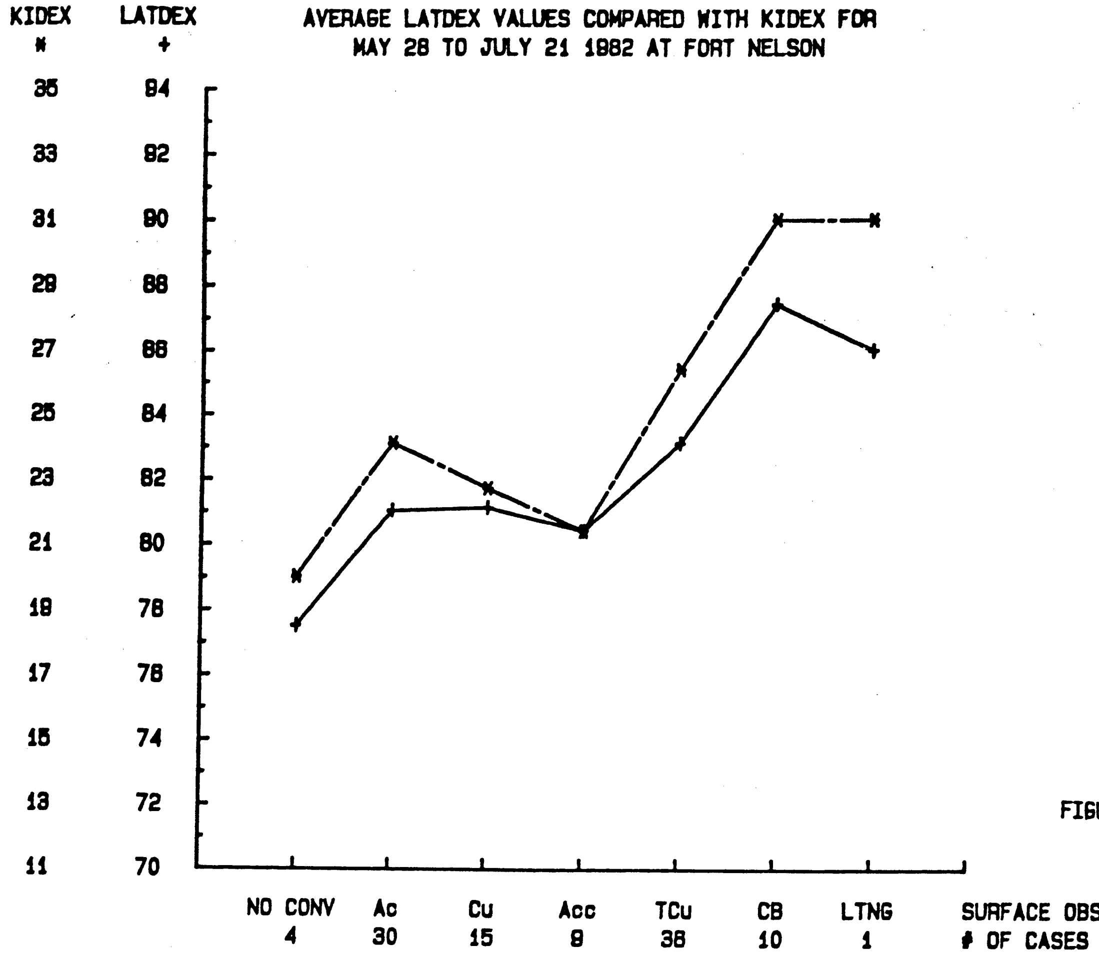

FIGURE 9

	MEAN STANDARD ERROR	NORMALIZED MSE	NORM MSE FOR CB OR LTNG
VERNON LATDEX	4.7	.214	.177
KIDEX	4.4	.183	.121
PRINCE GEORGE LATDEX	4.1	.186	.091
KIDEX	4.3	.179	.125
FORT NELSON LATDEX	4.9	.223	.177
KIDEX	5.1	.213	.154

FIGURE 10

STANDARD DEVIATION ANALYSIS