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Isobaric Prognostic Charts and the PWC Skill Score Verification

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INTRODUCTION

For several years, the Pacific Weather Centre has verified the isobaric prognostic charts of the PE and Spectral models. An examination of the behaviour of the Skill Score (SS) and the background of its behaviour and its implications are examined.

ANALYSIS PERIOD

Fig. 1 shows the grid area of the prog. charts that we verified. Fig. 2 is a plot of the skill scores for the forecast 36 hour. Spectral and PE surface pressure field. A perfect forecast would give a score 0.0. For practical reasons, a good forecast has an SS say less than .6 while a poor score is anything greater than .6. However, a careful look at the behaviour of the score under various synoptic situations will reveal that such a generality is a rather simplistic and erroneous way of categorizing a model's performance.

The period Oct. 1 to Nov. 15 was segmented into 3 periods. The migratory cyclones of the periods were charted in fig. 3a, 3b, and 3c. Fig. 3a shows a period of relative calm over the B.C. coastal waters as most disturbances moved across Alaska, Northern Yukon, and then southeastward across the Prairies.

Fig. 3b is a period of strong cyclonic activity over the eastern Pacific. It was also during this period that the weathership C7P (due to labour unrest) failed to register its usual weather reports.

Fig. 3c was a mix of the previous 2 periods with some disturbances moving across the eastern Pacific and also across Alaska, Yukon and the east side of the Rockies.

SKILL SCORE

The skill score is defined as the ratio of the root mean square forecast gradient error to the root mean square actual gradient (see Appendix A), the gradients being obtained by taking the pressure difference between a set of defined grid points (fig. 1). Hence, a gradient error under an anticyclonic circulation will result in a poorer skill score than that which would be obtained under a strong cyclonic circulation.

For example, fig. 4 shows the sfc (actual) and corresponding 36 hr. prog. chart. During a period of relative calm, a slight error in forecasting the gradient gave an SS = 1.0. A more crucial example is fig. 5 where a forecast surface ridge failed to materialize. Instead an unexpected low developed off Vancouver Island (SS - 1.02).

These examples clearly show the limitations of the skill score. More than a casual glance of fig. 2 is required to delineate periods of high and low circulation over the verified grid area.

With this in mind, the whole period was broken into 3 groups (fig. 3a, b, c). The SS was calculated for both the PE & Spectral 36 hr. prog. As well, the correlation (ability to match the high and low of the scores in unison) between the PE and Spectral was tabulated.

From fig. 6, it can be seen that the PE outperformed the spectral .67 vs. .74. The PE performed best (skill score wise) during the period of low circulation over the Eastern Pacific but its performance deteriorated at a greater rate as the circulation changed. During period 1, the progs correlated fairly well and they should, as the circulation was weak over the eastern Pacific. However, as the circulation increased and become a mix, the correlation fell, i.e. the progs. were letting the forecasters down during a period of greatest need; and as well, offering a differing view points of what would occur.

Another interesting aspect is the standard deviation SD. In contrast to the other 2 periods, the spectral $\langle SS \rangle$ is best under period 1 (a period of low circulation). However, as previously shown, a slight departure in a forecast gradient can result in a poor SS similar in magnitude to a situation of high circulation. This reflects itself in a large SD = .17 in contrast to the second period where $\langle SS \rangle = .77$ and SD = .14.

CONCLUSION

Overall, the PE outperformed the spectral but the performance of the Spectral approached that of the PE where migratory paths of cyclones were not locked in as in fig. 3a and 3b.

Secondly, the skill score, as designed fails to compensate for the severity of the situation under varying types of circulation. A SS of .4 achieved under strong cyclonic circulation is much more significant than achieved under periods of low circulation. As well, SS = 1 achieved under anticyclonic conditions is rather irrelevant (forecasting wise) compared to say SS = .8 under cyclonic circulations. To put a proper perspective on the SS, some additional consideration should be given to the severity of the situation. That is, the SS should be adjusted to account for the maximum pressure difference over the grid area. As well, the improvements of models over each other and amongst themselves are usually defined over a very large area of the hemisphere.

However, how extensive are the improvements over a smaller area such as the eastern Pacific under a period of only cyclonic circulation where the figures are no longer padded by the better scores received under periods of low circulation which post little problem forecasting wise.

Overall, the skill score graphs, to be of practical use, should be accompanied by additional information if the verification scheme is to be of any use in evaluating the behaviour of various models under different regimes of circulation.

ACKNOWLEDGEMENT

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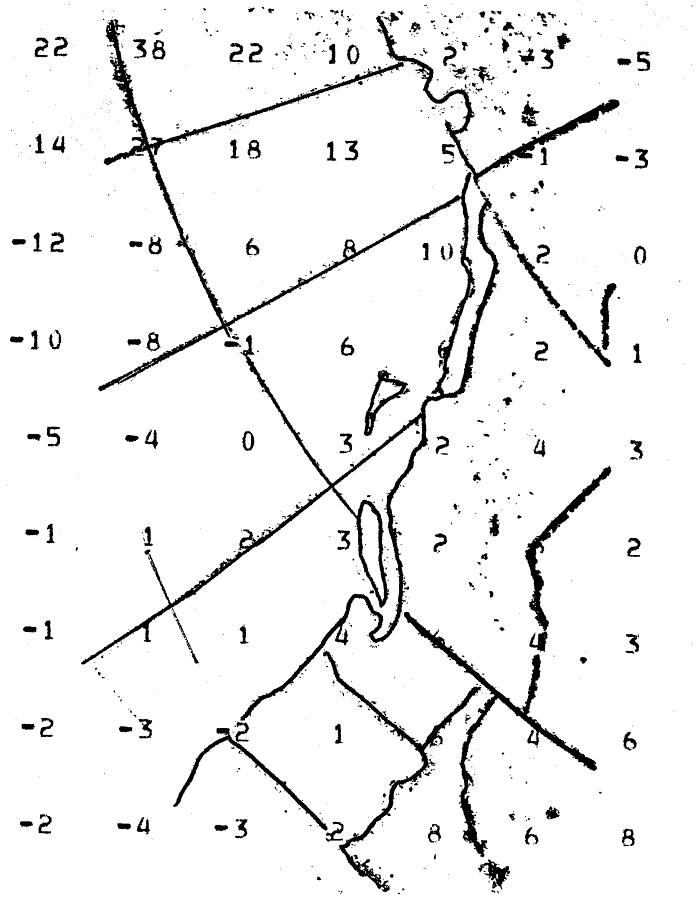
36 HOUR CMC



ROOT MEAN SQUARE ERROR	9.1
ROOT MEAN SQUARE GRADIENT	18.3
ROOT MEAN SQUARE GRADIENT ERROR	11.1
ABSOLUTE ERROR IN MBS/POINT	6.0
SKILL SCORE	.608
B.C.AREA SKILL	.306
B.C. AREA ABSOLUTE ERROR	3.8

Fig. 1. Grid and grid points used to compute the Skill Score(SS).

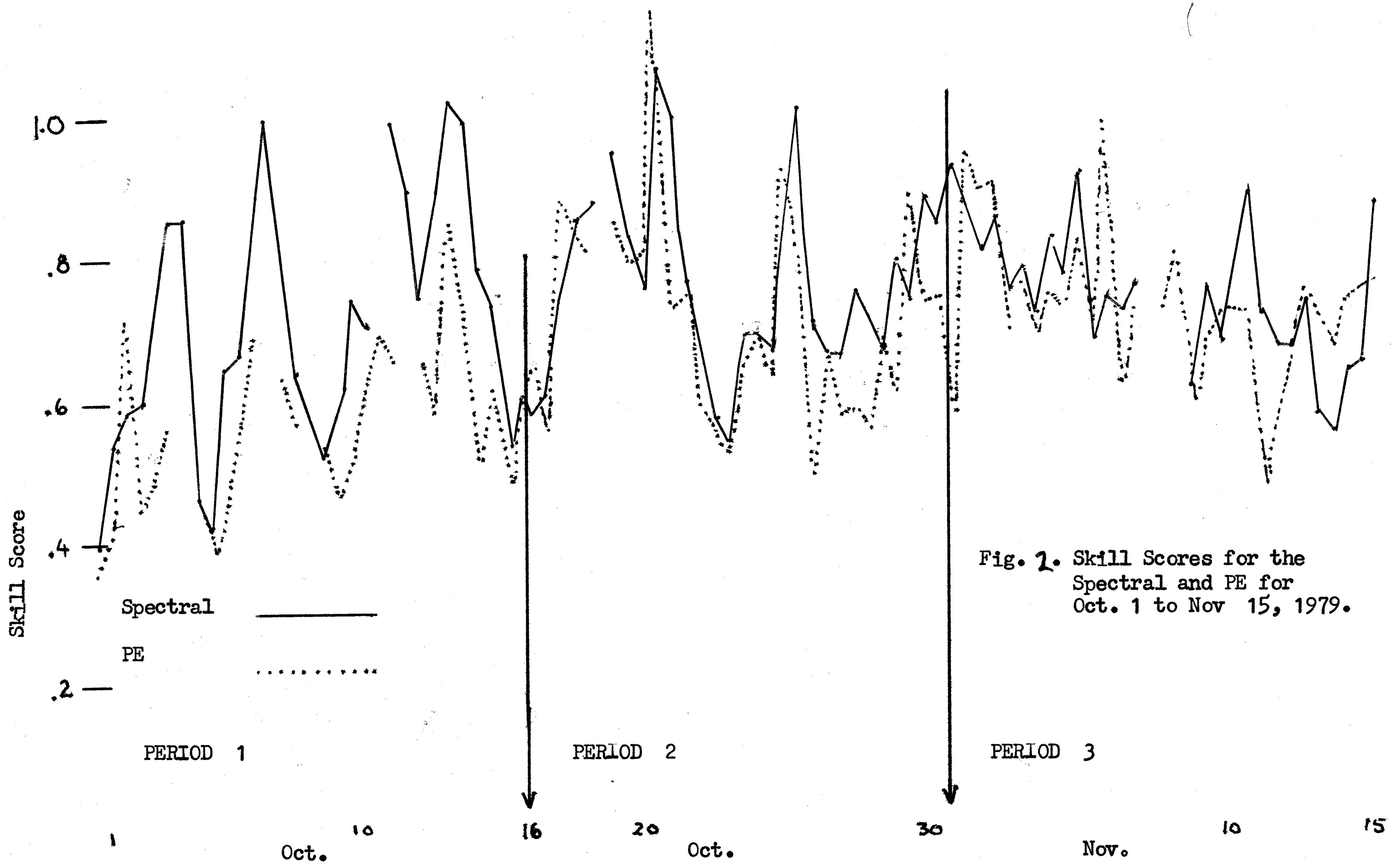


Fig. 2. Skill Scores for the Spectral and PE for Oct. 1 to Nov 15, 1979.

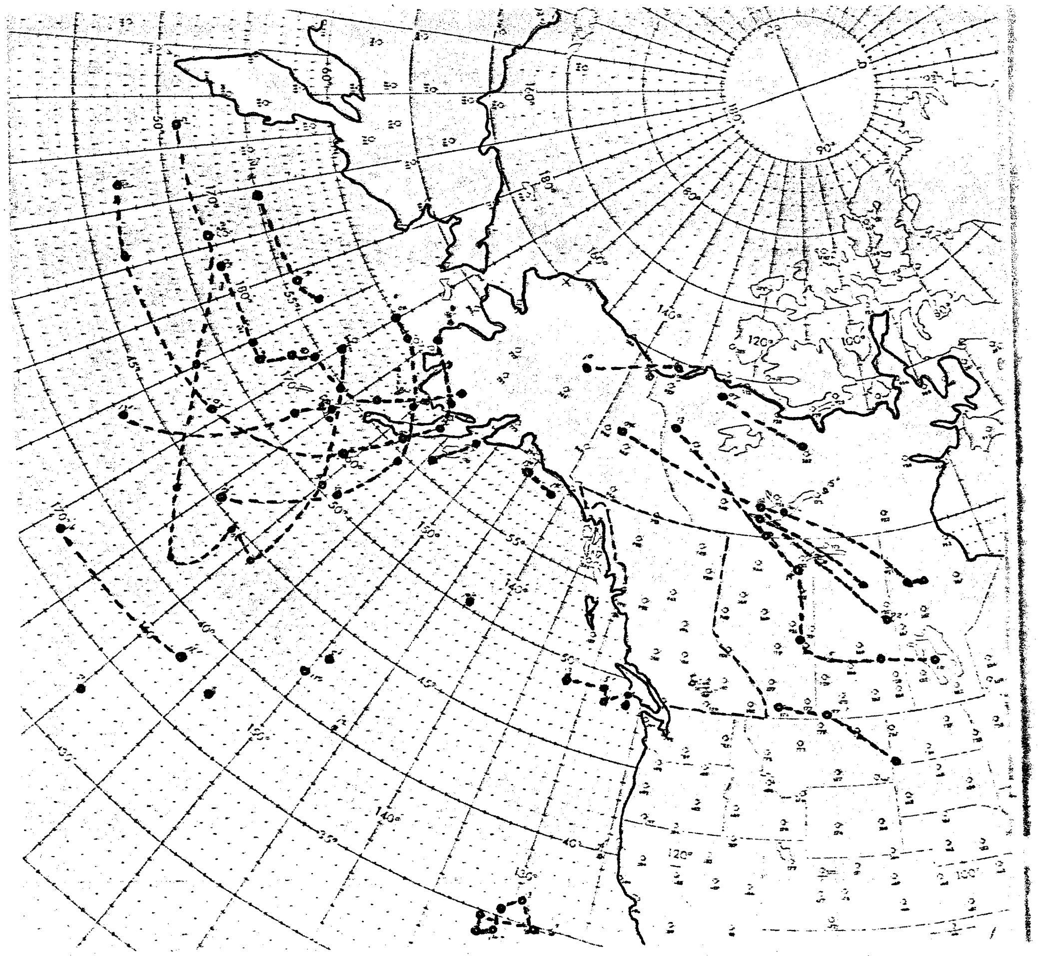


Fig. 3a. Migratory paths of cyclones between Oct. 1 to 16.

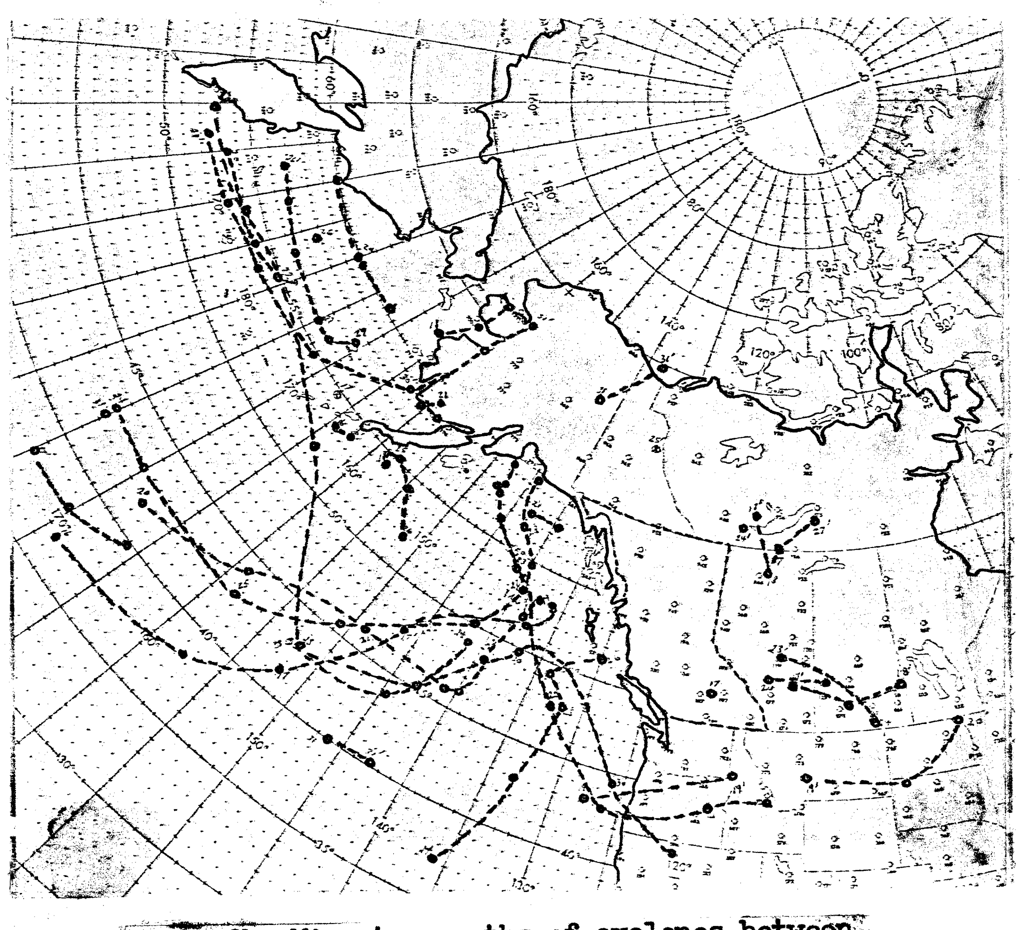


Fig. 3b. Migratory paths of cyclones between Oct. 16 to Oct. 31.

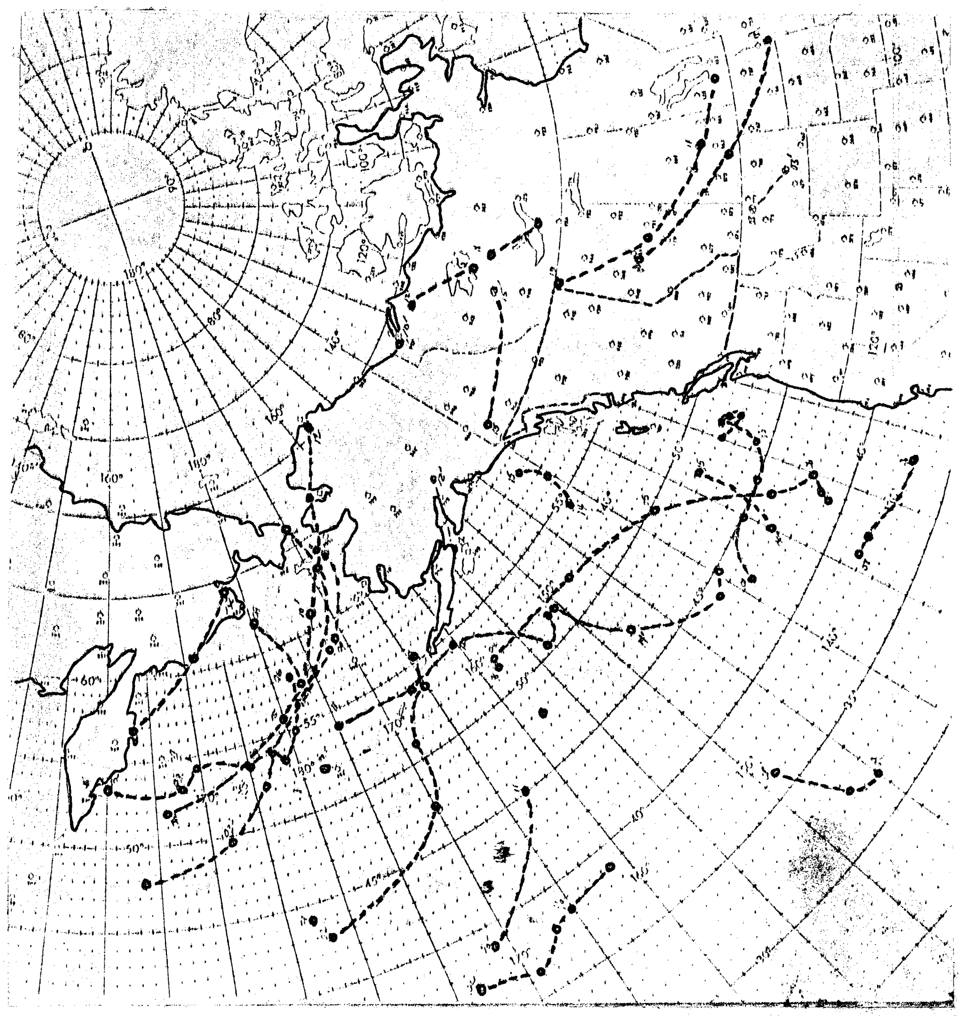


Fig. 3c. Migratory paths of cyclones between Nov. 1 to 15.

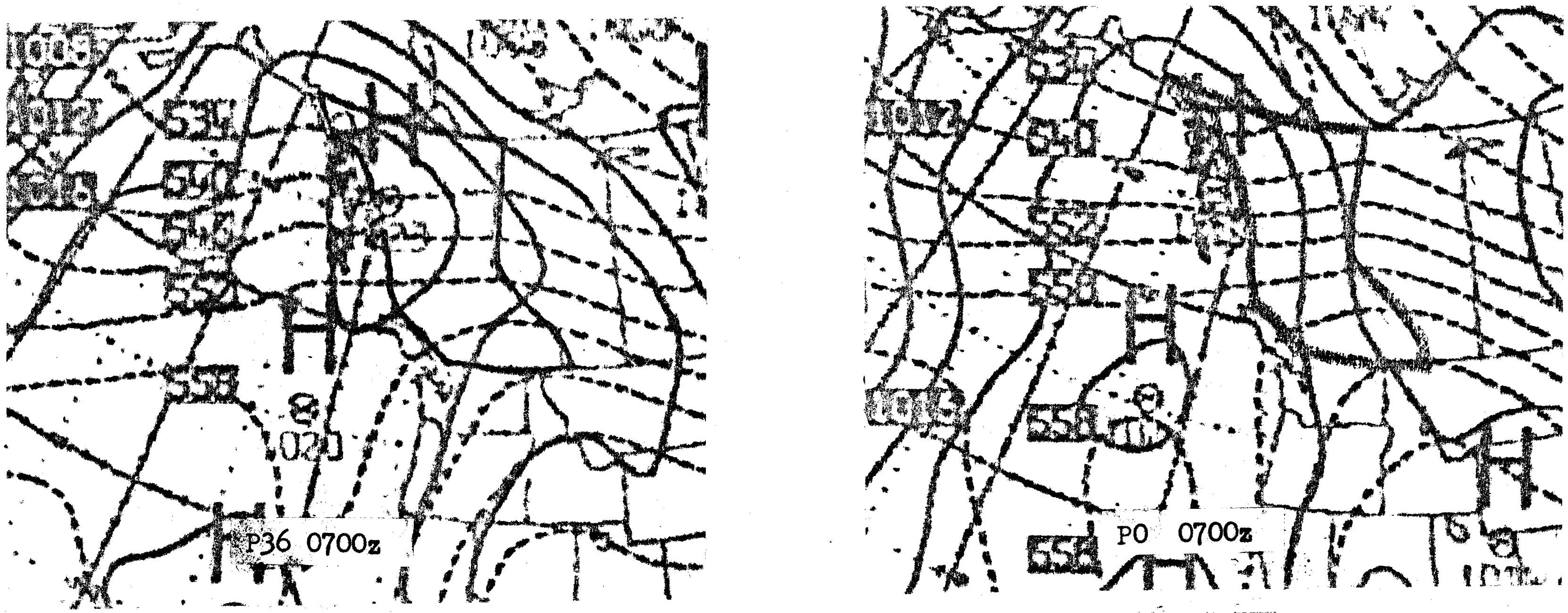


Fig. 4 Spectral 36 hour surface prog(P36) and surface actual(PO).

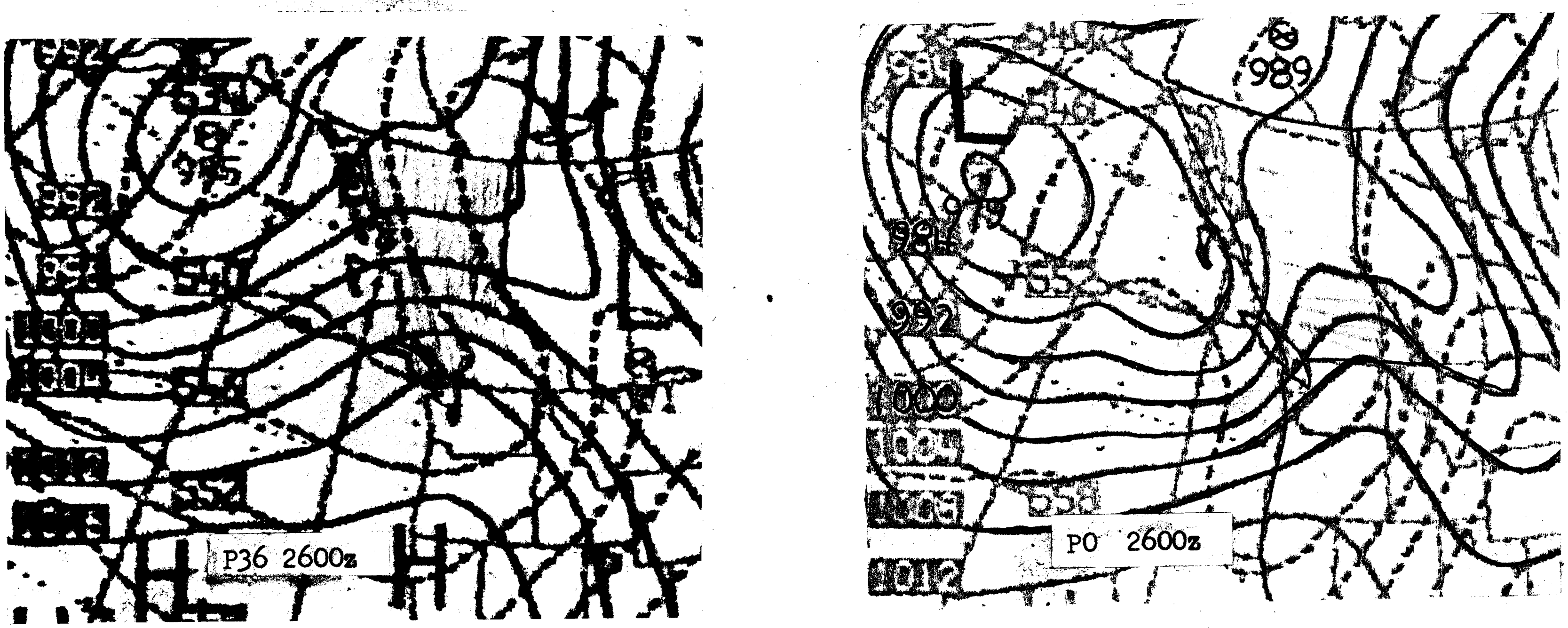


Fig. 5 Spectral 36 hour surface prog(P36) and surface actual(PO).

	Oct. 1-15		Oct. 16-31		Nov. 1-15		Oct-Nov. 1----15	
	SS	SD	SS	SD	SS	SD	SS	SD
Spectral	.70	.17	.77	.14	.74	.10	.74	.14
PE	.58	.15	.70	.15	.71	.12	.67	.15
	CO		CO		CO		CO	
	.72		.65		.50		.65	

Fig. 6. The average Skill Score(SS), the standard deviation(SD) and the correlation of the Spectral and PE for the periods.

<u>APPENDIX A.</u> PACIFIC WEATHER CENTRE

Verification Skill Score for surface prognosos

$$RMSG = \frac{1}{d}\left(\sum_{i=1}^{48} \frac{(G_{xi}^{2} + G_{yi}^{2})}{48}\right)^{\frac{1}{2}}$$

$$RMSGE = \frac{1}{d}\left[\sum_{i=1}^{48} \frac{\left((F_{xi} - G_{xi})^{2} + (F_{yi} - G_{yi})^{2}\right)}{48}\right]^{\frac{1}{2}}$$

$$SS = \frac{RMSGE}{RMSG}$$

P_i = actual pressure

f_i = forecast pressure

$G_{x_i} = (P_i - P_{i+1})\ x$ in x- direction

$G_{y_i} = (P_i - P_{i+1})\ y$ in y- direction

$F_{x_i} = (f_{x_i} - f_{x_{i+1}})\ x$ in x- direction

$F_{y_i} = (f_{y_i} - f_{y_{i+1}})\ y$ in y- direction