PACIFIC REGION TECHNICAL NOTES

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Comparison of CMC 36-Hour Prognostic 500 mb Height Before and After Ship PAPA's Removal

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INTRODUCTION

Ocean Weathership PAPA located at 50°N, 145°W was decommissioned on June 22, 1981. One of PWC's main concerns was the effect of the removal of the ship on the numerical analyses and prognostics prepared by the CMC. This technical note presents and compares the performance of the CMC 36-hour prognostic heights at Port Hardy before and after the removal.

METHODOLOGY

A) Data

For both cases, before and after the removal of the ship, data available over a one year period were extracted:

1980-81 DATA:	22/06/80 to 21/06/81
SHIP REMOVAL:	22/06/81
1981-82 DATA:	22/06/81 to 21/06/82 (except 01/05/82 to 15/05/82)

The CMC 36 hour prognostic height values at Port Hardy (YZT) were abstracted from the CMC charts and tabulated against the 500 mb height values recorded by the YZT radiosonde. The errors in the prognostic height (ΔZ) for each valid period, both 00Z and 12Z, were tabulated.

B) Distribution

For both years, 1980-81 and 1981-82, distribution of the errors were plotted versus seasons (Figure I) and versus height tendencies (Figure II). Both curves were smoothed by a method which averages the fluctuations of high frequencies. Finally, each distribution was put in percent. The following describes the method used:

ΔZ	:	Error on height.
$N(j)$	:	Number of cases where $\Delta Z \equiv j, (-15 \leq j \leq 15)$.
N	:	Total number of cases versus seasons/years or versus height tendencies/years.
$N'(j)$	:	$N(j)$ smoothed and in percent.
$\overline{X}$	:	Average error in height derived from the distribution.
σ	:	Standard deviation derived from the distribution.

$$\Delta Z = Z(\text{CMC PROG}) - Z(\text{RADIOSONDE}) \equiv j$$

$$N'(j) = \left\{ [N(j-1) + 2N(j) + N(j+1)] \ /4N \right\} \%$$

$$\bar{X} = \sum_{j=-15}^{15} [N'(j) * j/100]$$

$$\sigma = \left\{ \sum_{j=-15}^{15} \left[N'(j) * (j-\bar{X})^2 \ /100-1 \right] \right\}^{1/2}$$

2. SEASONAL DIFFERENCES

Figure I shows, for both years, the distribution of the prognostic errors in height stratified according to season.

For both years, the average errors are higher during the spring and fall when most of the climatic changes occur. The 81-82 average errors are generally higher by about 1.5 dam than the 80-81 errors. Overall the results show a slightly poorer performance without the ship.

For both years, the standard deviations are larger during fall and winter when the atmosphere is highly baroclinic. The standard deviations don't show significant difference versus years.

3. SYNOPTIC SITUATIONS (based on height tendencies)

Figure II shows for both years, the distributions of the prognostic height errors versus synoptic situations based on height tendencies.

The synoptic situations were classified in terms of the 500 mb height tendencies. These were determined, over a 24 hour period, by the height tendencies 12 hours prior and 12 hours after the valid time of the prognostic. The following defines the tendencies:

/ height has risen by 4 dam or more in 12 hours.
— height hasn't risen or dropped by 4 dam in 12 hours.
\ height has dropped by 4 dam or more in 12 hours.

Nine categories are possible:

/, /—, /\, —/, ——, —\, \, \—, \/

Preliminary evaluation for 80-81 and 81-82 showed that the standard deviations, calculated from each of the distributions based on height tendency, were about the same value (σ = 4.0 dam $\pm$ .5).

A) Situations of significant rising heights in the first 12 hours (/, /—, /\).

In these situations, both years, the average errors are negative and vary from -2 to -3 dam with the ship and from 0 to -1 dam without the ship. Overall, the CMC model had some tendencies to underestimate the height but performed better without the ship.

B) Situations of significant dropping heights in the first 12 hours (↘ , ↘— , ↘/).

In these situations, both years, the average errors are positive and vary from 3 to 4 dam except for falling then rising height tendencies (↘/) where unacceptable variations of the order of 5 to 9 dam are shown. Overall, both years, the CMC model had similar tendencies to overestimate the height except for the falling and rising tendency cases where, without the ship, it showed a rather poor performance of 8.5 dam; 4 dam higher than with the ship.

C) Situations of steady height tendencies in the first 12 hours (—/ , — , —↘).

As expected, the 24 hours steady state cases (-) show, both years, no significant average errors. The steady then dropping height tendency cases show a distibution curve whose parameters are, both years, quite similar to those described in Sub-Section A. The steady then rising height tendency cases are similar to those described in Sub-Section B.

CONCLUSIONS

The standard deviation is conservative, both years, versus synoptic situations.

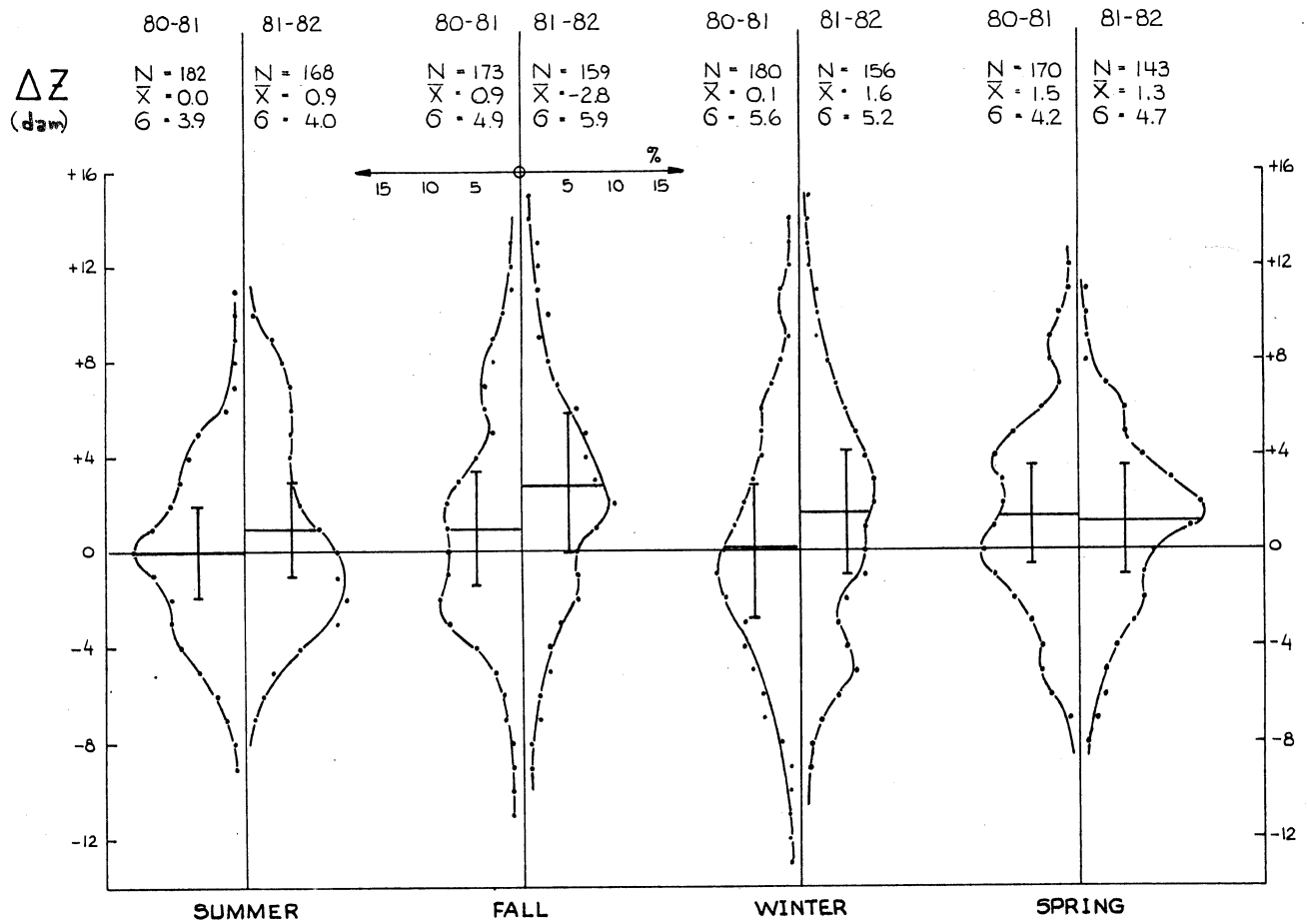
The model performed rather poorly when falling then rising heights (↘/) occurred as would be expected in shortwave and frontal passages. This is more evident without the ship where an average error of the order of 9 dam is present.

On average, the model overestimated the heights when synoptic situations related to height tendencies (—/, ↘/ , ↘ , ↘—) occurred. The errors are generally of the same order with or without the ship except in the cases (↘/).

On average, the model underestimated the height when synoptic situations related to height tendencies (—↘, /↘, / , /—) occurred. The average errors are worse by -2 dam with the ship.

FIGURE 1.

DISTRIBUTION OF PORT HARDY FORECAST HEIGHT ERRORS (ΔZ) IN PERCENT VERSUS SEASONS WITH SHIP PAPA DATA (1980/81) AGAINST DATA WITHOUT SHIP PAPA (1981/82).



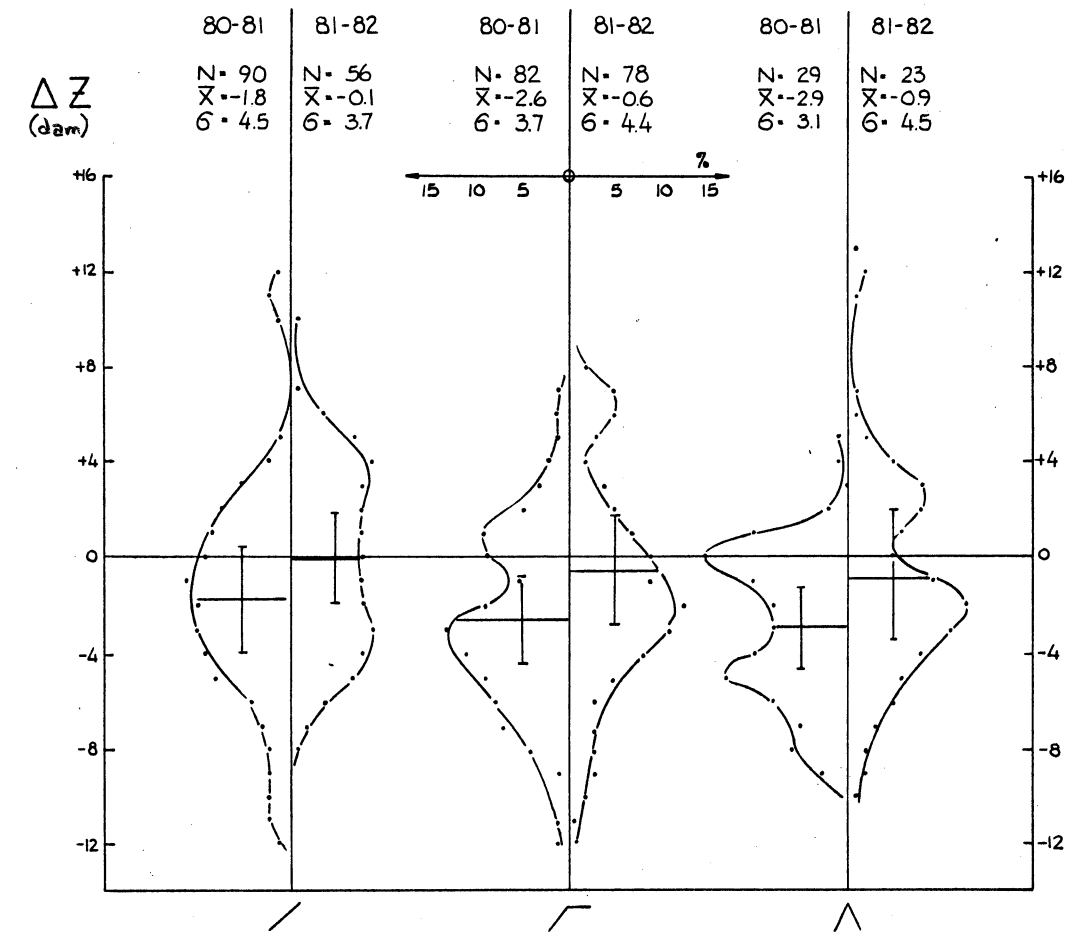
Note: for each frequency distribution:

Vertical bars represent $\sigma/2$.

Horizontal lines represent the average height error.

FIGURE 2a&b

DISTRIBUTION OF PORT HARDY FORECAST HEIGHT ERRORS (ΔZ) IN PERCENT VERSUS SYNOPTIC PATTERN FOR DATA WITH SHIP PAPA (1980/81) AGAINST DATA WITHOUT SHIP PAPA (1981/82). (Synoptic Patterns based on 500mb height tendencies at Port Hardy).



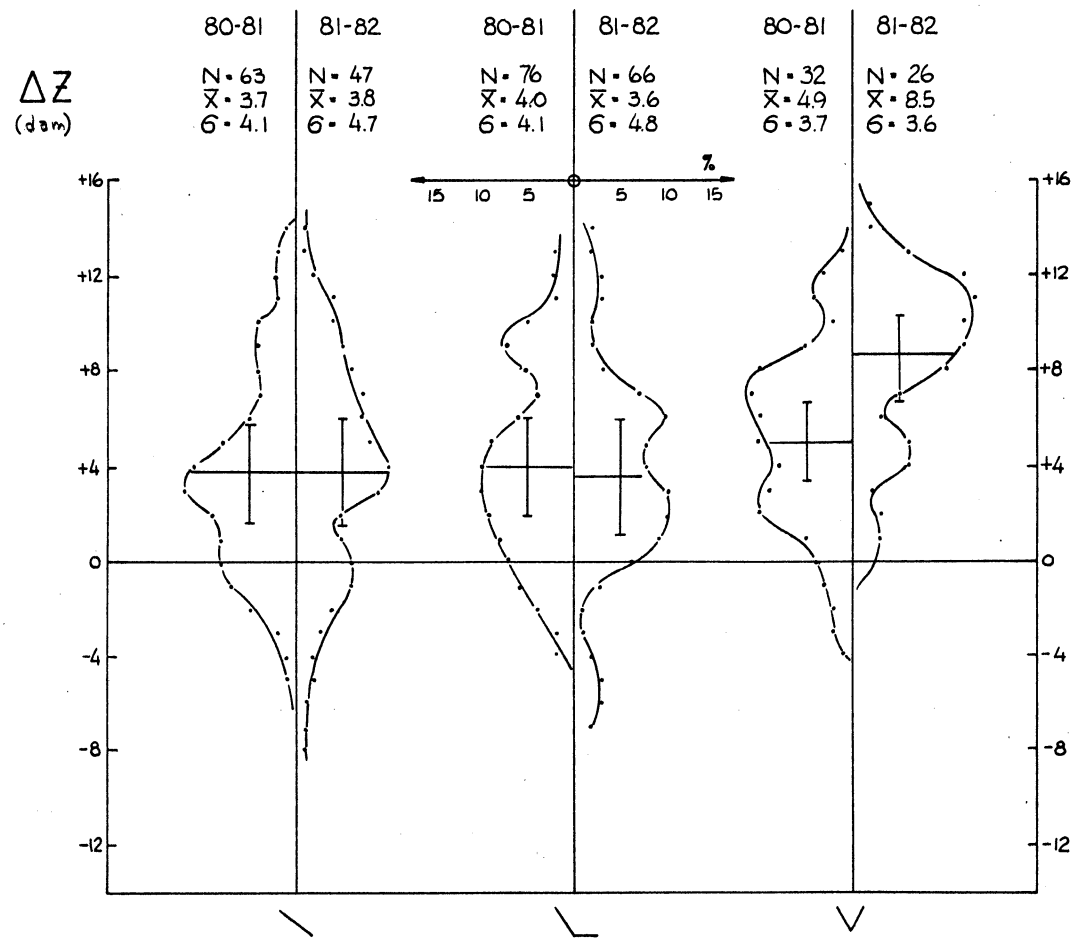
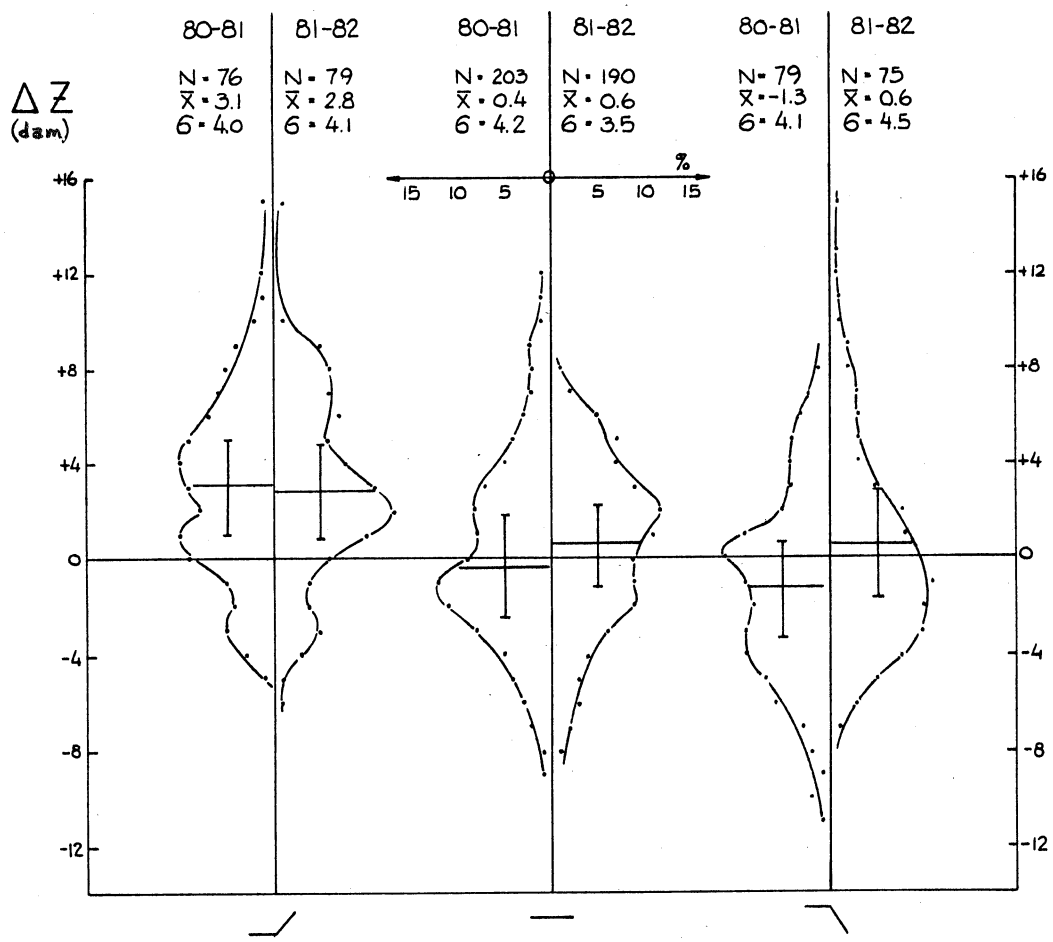


FIGURE 2c

DISTRIBUTION OF PORT HARDY FORECAST HEIGHT ERRORS (ΔZ) IN PERCENT VERSUS SYNOPTIC PATTERN FOR DATA WITH SHIP PAPA (1980/81) AGAINST DATA WITHOUT SHIP PAPA (1981/82). (Synoptic Patterns based on 500mb height tendencies at Port Hardy).



Note: for each frequency distribution:

Vertical bars represent $\sigma/2$.

Horizontal lines represent the average height error.