# PACIFIC REGION TECHNICAL NOTES

No. 79-003

February 5, 1979


## THE WAVE HEIGHT FORECASTING PROGRAMME OF THE METOC CENTRE, ESQUIMALT, B.C.


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About twelve years ago this office initiated a wave height analysis programme to meet a requirement for sea state information to support maritime defence operations and marine search and rescue coordination. At first the programme was limited to preparation of a daily 1800Z wave height analysis but in 1972 an 0600Z analysis was added.

In 1973 it was decided to try out the production of wave height forecast charts valid for 24 hours. The method used, a manual one based on the techniques outlined by Morgan (TEC763 Aug71) consisted essentially in maintaining continuity of wave energy in successive analyses and, using Bretschneider and Suthons nomograms for wave build up and wave decay respectively ( the inputs to these nomograms being fetch, wind speed, duration of blow, duration of wave travel ) along with the Pacific Weather Centre isobaric progs, in extrapolating to obtain a 24 hour wave height prog.

Thus:

06Z Anal Wv Ht + 18Z Anal Wv Ht + 06Z VR Prog + 18Z VR Prog → 24 Hr Wv Ht Prog Valid 1800Z

A sample of a wave height forecast chart appears as Fig 1

Verification of the wave height progs presented difficulties. The final prog error is the resultant of deficiencies in the wave

height forecasting technique itself, of inaccuracies in the wave reports, wave analysis charts, and surface isobaric analyses used in the procedure, and, very important, of errors in the surface isobaric progs used in the final steps.

The wave forecasting technique could be tested by studying historical situations and basing the wave prog on the actual surface pressure field at the wave prog valid time. We chose however to evaluate the actual product. The results are therefore heavily weighted by the accuracy of the PAWC surface progs used.

A fundamental source of uncertainty arises from the scarcity of accurate, objective wave reports. Initially the weatherships were the only source of these. Now the situation is better with regular wave reports from some of the NOAA buoys and the wave rider buoy off Tofino providing a base for an objective verification programme.

Figure 2 shows the buoy, C7P, etc positions.

Using September 1976 to April 1977 as the test period, a set of scatter diagrams was prepared ( one for each buoy position ) pairing daily 1800Z buoy wave height and forecast wave height for that point. Graphs were then drawn of forecast and observed distribution, these appear in Fig 3. Additional charts showing mean forecast and mean observed wave heights ( Fig 4 ), and isopleths of Coefficients of correlation between observed wave height and forecast wave height, along with the Standard Error of Estimate* of wave height forecasts ( Fig 5 ) were also produced.

* Standard Error of Estimate being the average of the deviations about the line of regression

$$S_y = \sqrt{\frac{\Sigma(d^2)}{N}}$$

Sy = standard error of estimate

d = deviation of actual values(Y) from theoretical (Yc)

Figures 3 and 4 show that in general the wave height forecasts tended to overestimate mean conditions at the expense of the extremes. This was also evident in the diagrams of the slopes of the regression equations ( Fig 6 ).

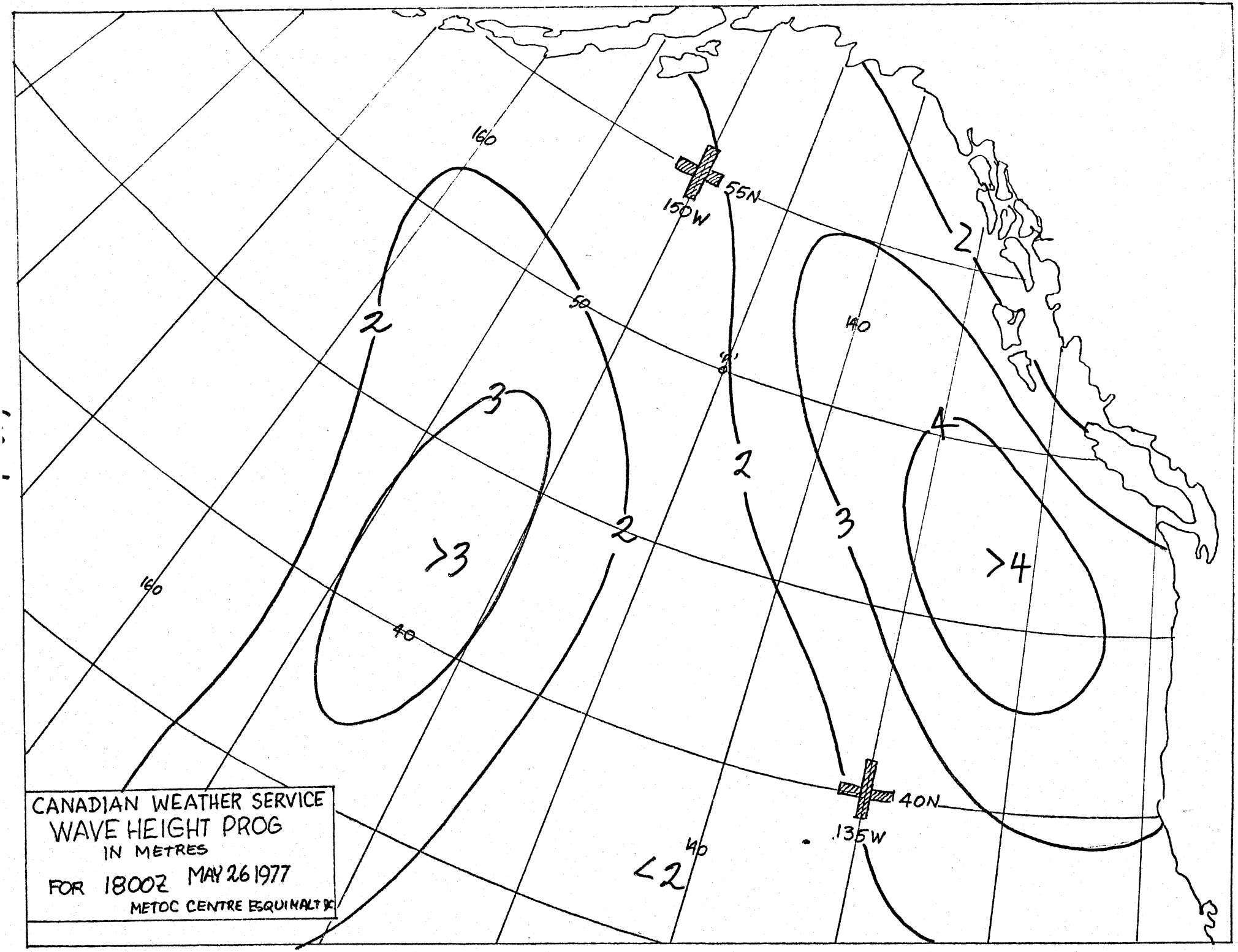
Figure 5 shows increasing standard error of estimate of the wave height forecast with increasing latitude, and a decreasing coefficient of correlation between forecast and observed wave height with increasing distance from the coast. In the case of the former it could well be that the effect of isobaric curvature, upstream boundary problems and the effect of the Alaska coastline on fetch was not adequately being taken into account. In the case of the latter it is undeniable that the lack of data ( upper air as well as surface ) west of weathership position Papa makes progging in this area difficult.

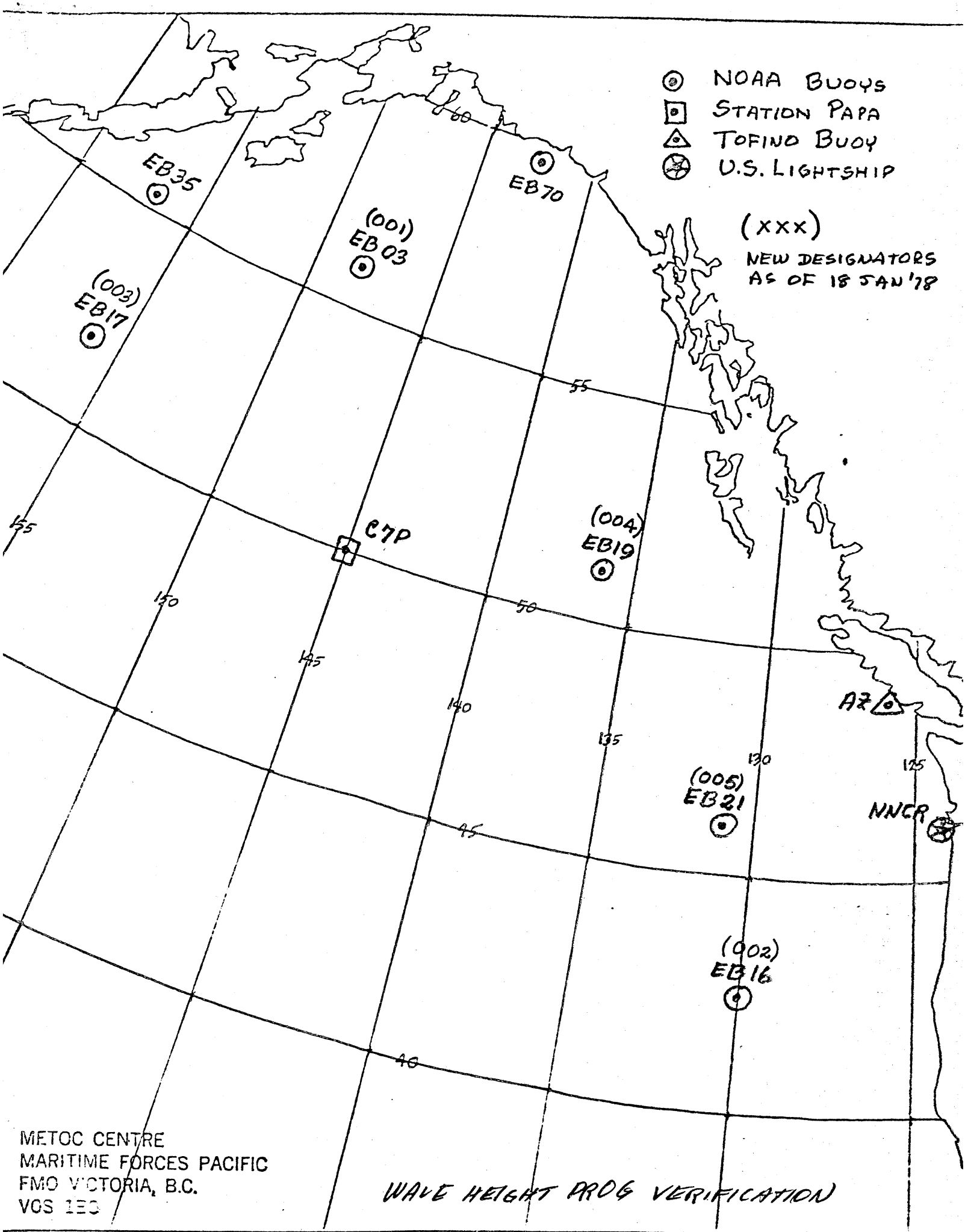
With the recent availability of real time, many times a day satellite photographs, the question of how these might affect the accuracy of analyses and progs comes to mind since clearly improvements in synoptic weather charts and progs would be reflected in the wave height analyses and progs.

In the meantime, with the knowledge gained from the current verification study and in anticipation of further improvements in analyses and progs it is hoped that a verification up-date can be undertaken, possibly for the 1979-1980 season.

Acknowledgement

The author wishes to express his appreciation for the support and advice given by METOC OIC M. Blake.


160
55N
150W
50
140
2
2
3
2
2
3
4
>3
>4
160
40
40
135W
40N
<2
CANADIAN WEATHER SERVICE
WAVE HEIGHT PROG
IN METRES
FOR 1800Z MAY 26 1977
METOC CENTRE ESQUIMALT BC


NOAA BUOYS
STATION PAPA
TOFINO BUOY
U.S. LIGHTSHIP
(XXX)
NEW DESIGNATORS
AS OF 18 JAN '78
EB35
(001)
EB03
EB70
(003)
EB17
C7P
(004)
EB19
AZ
(005)
EB21
NNCR
(002)
EB16
60
55
50
45
40
155
150
145
140
135
130
125
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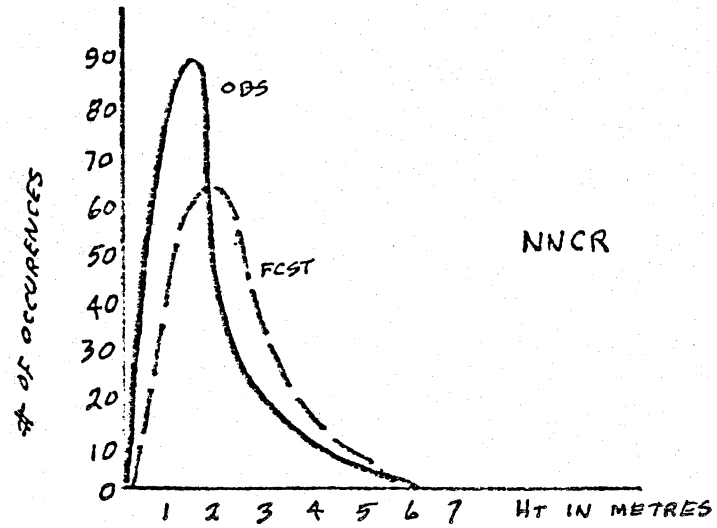
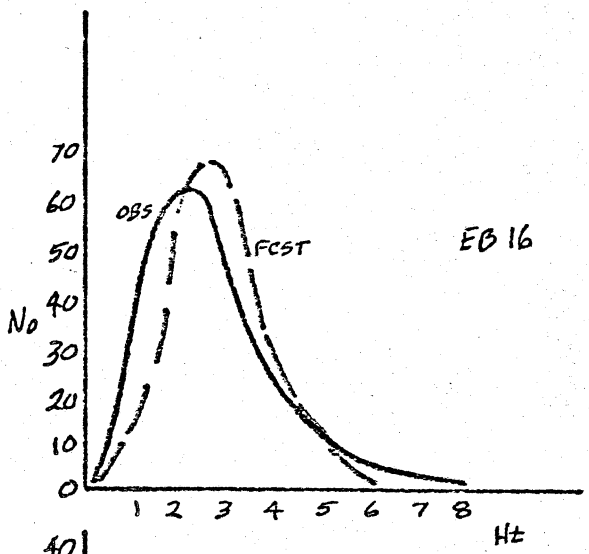
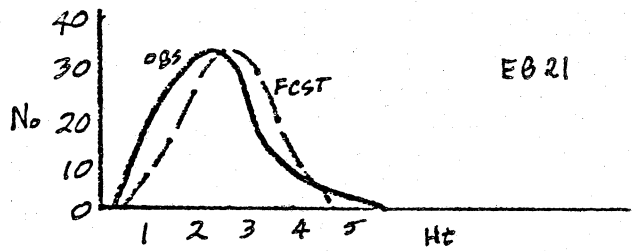
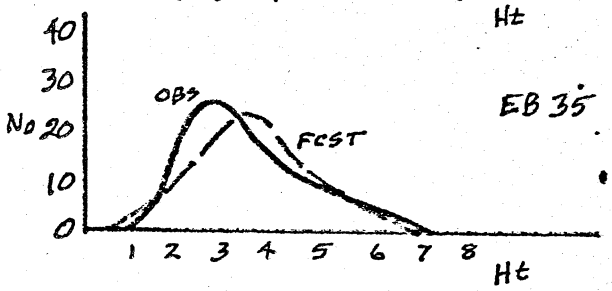
WAVE HEIGHT PROG VERIFICATION

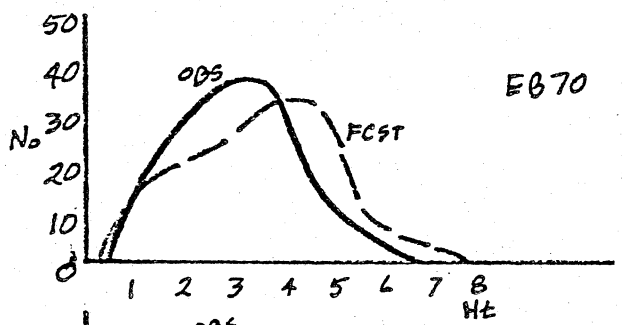
Observed vs Forecast wave height.

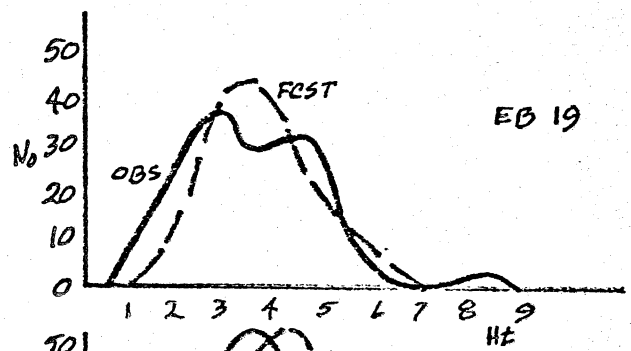


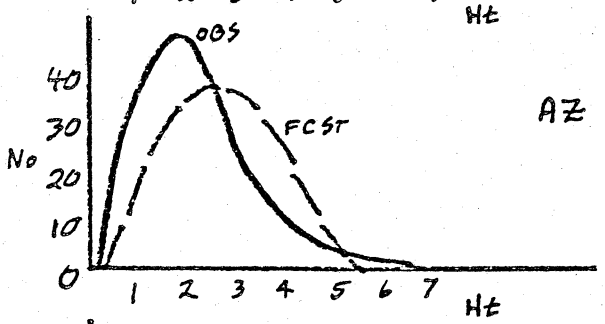



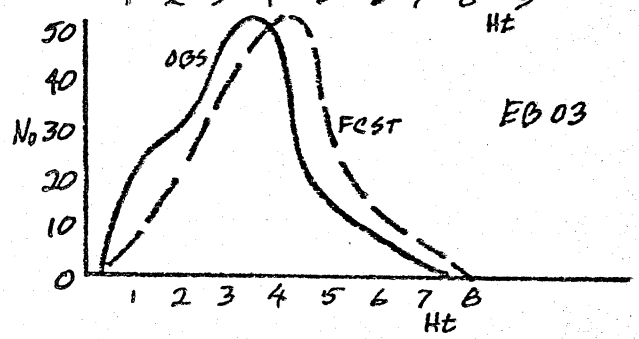



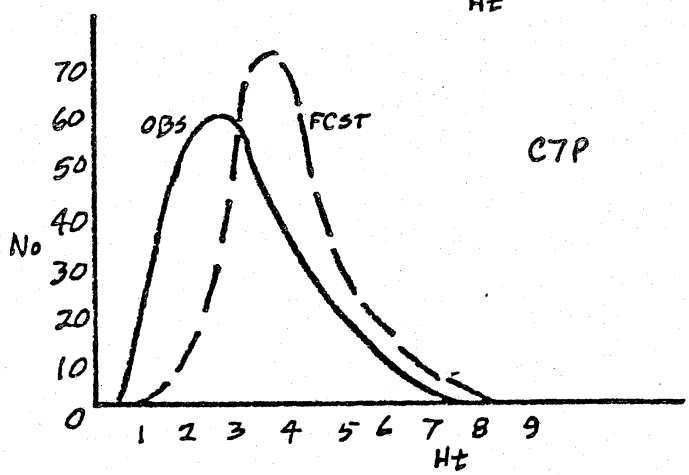



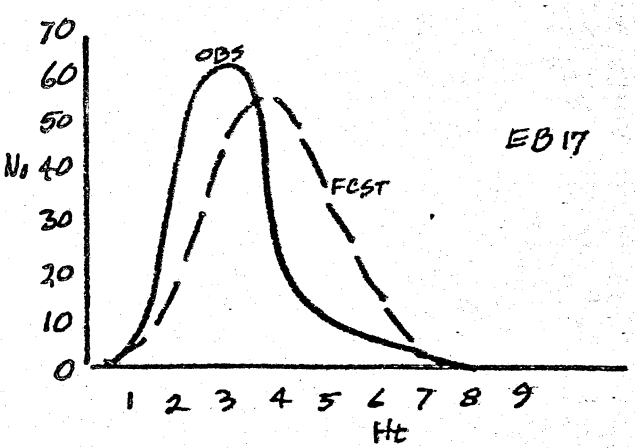




data: Sept 76-Apr 77.

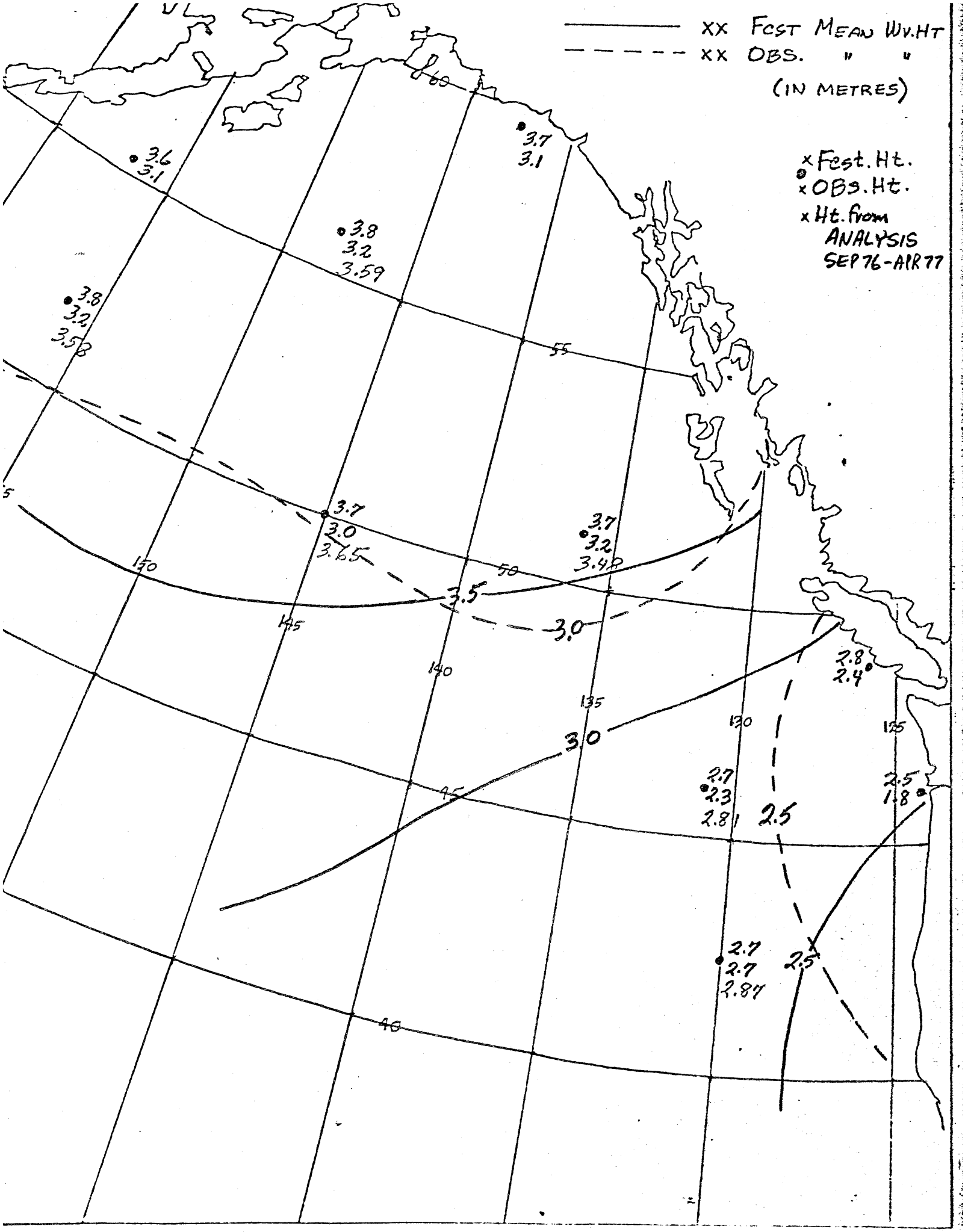
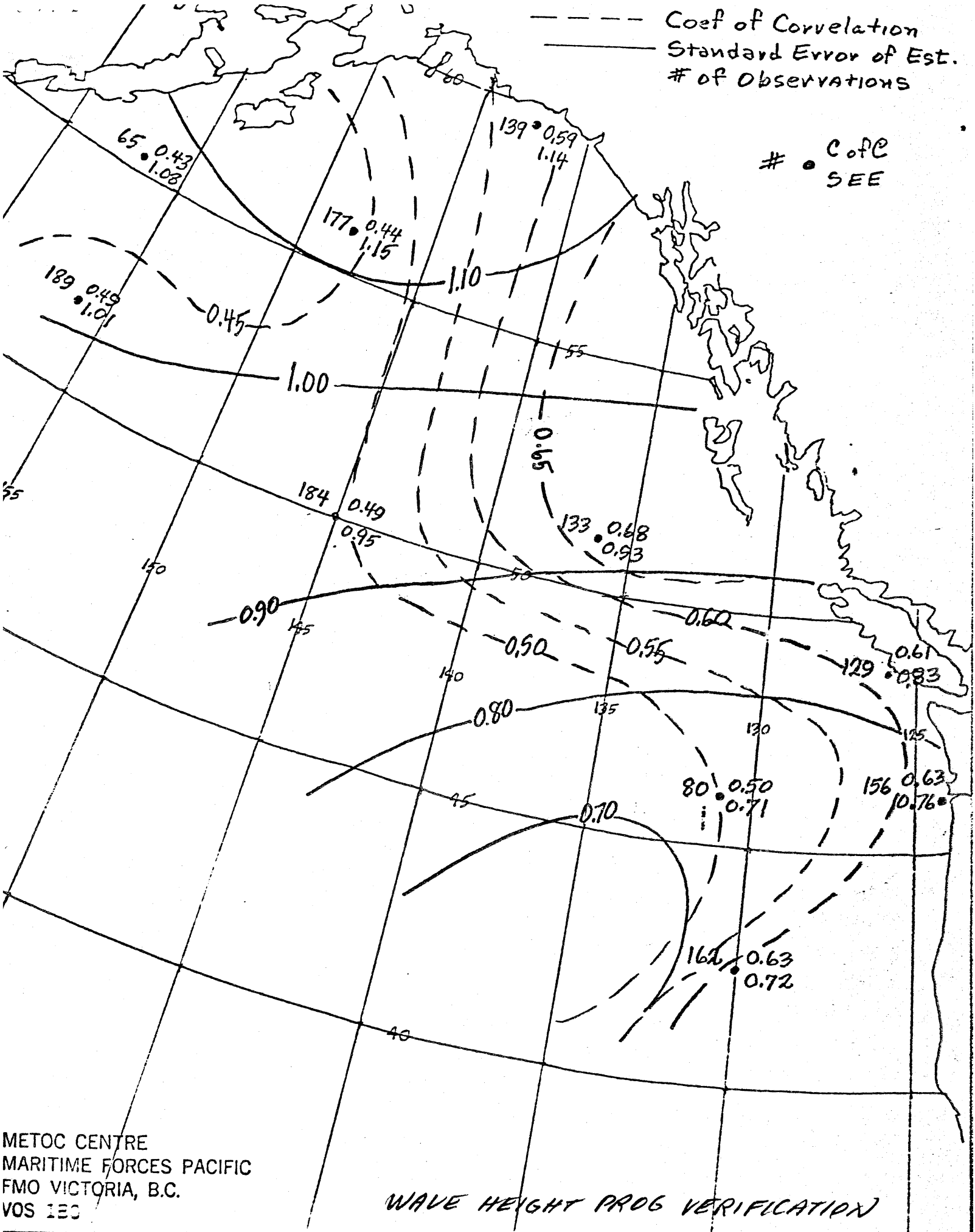

xx Fcst Mean Wv.Ht
xx Obs. " "
(in metres)
x Fcst. Ht.
x Obs. Ht.
x Ht. from Analysis Sep 76-Apr 77
60
55
50
145
140
135
130
125
45
40
3.7
3.1
3.6
3.1
3.8
3.2
3.59
3.8
3.2
3.58
3.7
3.0
3.65
3.7
3.2
3.48
3.5
3.0
2.8
2.4
3.0
2.7
2.3
2.81
2.5
2.5
1.8
2.7
2.7
2.84
2.5

fig 4


Coef of Correlation
Standard Error of Est.
# of Observations
# • C of C
SEE
65 • 0.43 1.08
139 • 0.59 1.14
177 • 0.44 1.15
189 • 0.49 1.01
184 • 0.49 0.95
133 • 0.68 0.93
129 • 0.61 0.83
80 • 0.50 0.71
156 • 0.63 0.76
162 • 0.63 0.72
1.10
0.45
1.00
0.95
0.90
0.60
0.50
0.55
0.80
0.70
60
55
50
45
40
135
130
125
140
145
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VOS IEC
WAVE HEIGHT PROG VERIFICATION

Fig. 5

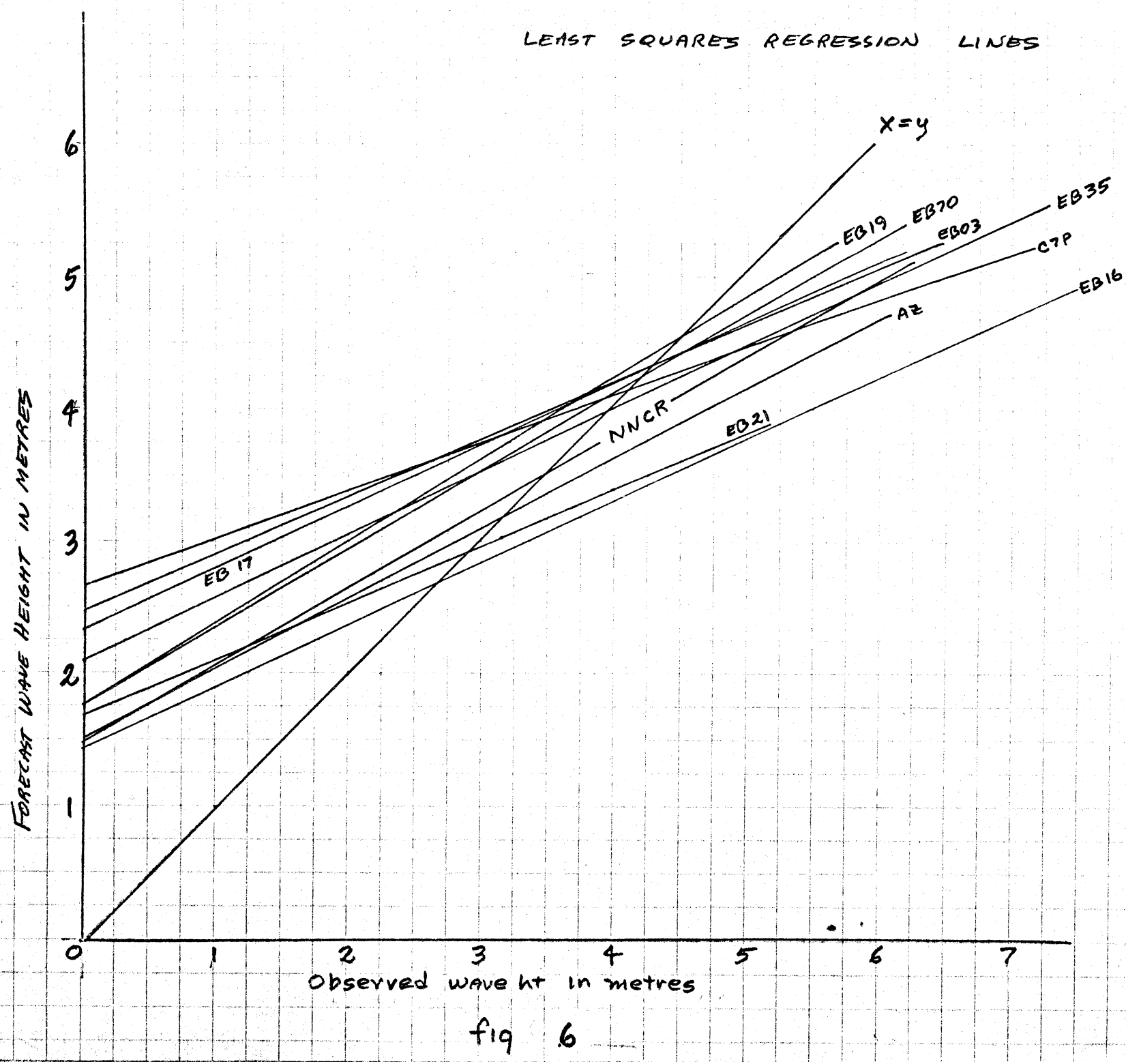
LEAST SQUARES REGRESSION LINES
X=y
EB19
EB70
EB03
EB35
C7P
EB16
AZ
NNCR
EB21
EB17
FORECAST WAVE HEIGHT IN METRES
0
1
2
3
4
5
6
7
Observed wave ht in metres

fig 6