

Extreme wave heights off Holderness

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1 Introduction

This note gives estimates of 100-year return values obtained from analysis of a ‘data set’ synthesised to represent the wave climate at the buoy N3 off Holderness (near 53.83°N 0.15°E) described in a previous JTR (2 September 1999), and derives return values at buoys N1 and N2, from data sets produced by Halcrow Maritime using the N3 ‘data set’ as input to its ‘STORM’ shallow water wave model.

2 N3 ‘data set’

The cumulative probability distribution of H_s of the synthesized data set at N3 is shown in Figure 1 which indicates that neither the FT-1 nor the Generalised Extreme Value (GEV) distribution fit satisfactorily. The 3-parameter GEV fit is statistically a highly significant improvement over the 2-parameter FT-1. However, the data are clearly not from a GEV, but seem to be compounded from two distributions, which considering their origin does not seem unreasonable. As Figure 2 shows, the Weibull distribution fits no better.

Since all very high waves come from an onshore direction, and for these there is no evidence of any change in height between TOPEX and N3, the estimate of extreme wave height at N3 given in the earlier JTR was the value estimated from the TOPEX data at the nearest location to N3 on Track 120.

A range of return values at N3 given in the previous JTR, are shown in Table 1, calculated from the fit to TOPEX data from 1992-1998 with location and scale parameters of $\alpha = 1.053$ m and $\beta = 0.552$ m.

Nyr	1	10	50	100	200	1000
H_s m	5.46	6.73	7.62	8.00	8.38	9.25
s.e. (H_s)	0.26	0.32	0.37	0.39	0.41	0.46

Table 1: Estimates of extreme wave heights at N3

Cumulative distributions of H_s at N3 for different wind directions at Leman are given in Figures 3 & 4. Figure 3 shows data with onshore winds – and it is assumed waves – are reasonably from an FT-1 distribution. (Fitting the 3-parameter GEV does not give a statistically better fit.) There

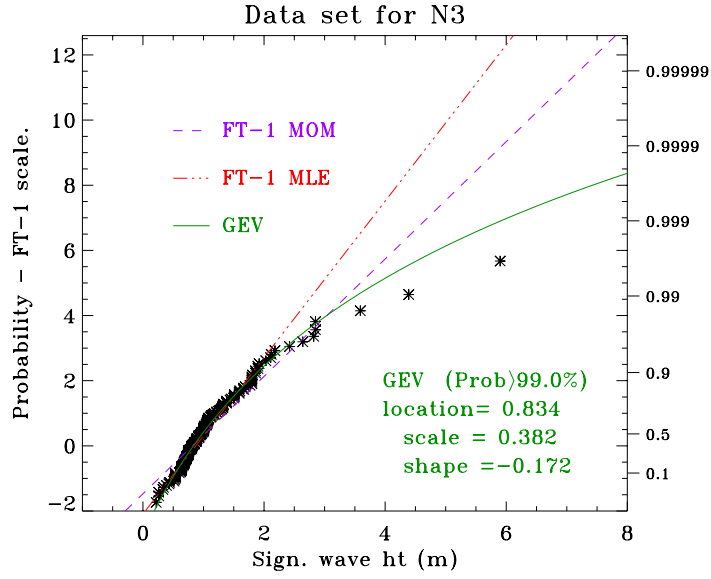


Figure 1: Cumulative probability distribution of estimated H_s at N3, 1992-1997, with fitted GEV distribution.

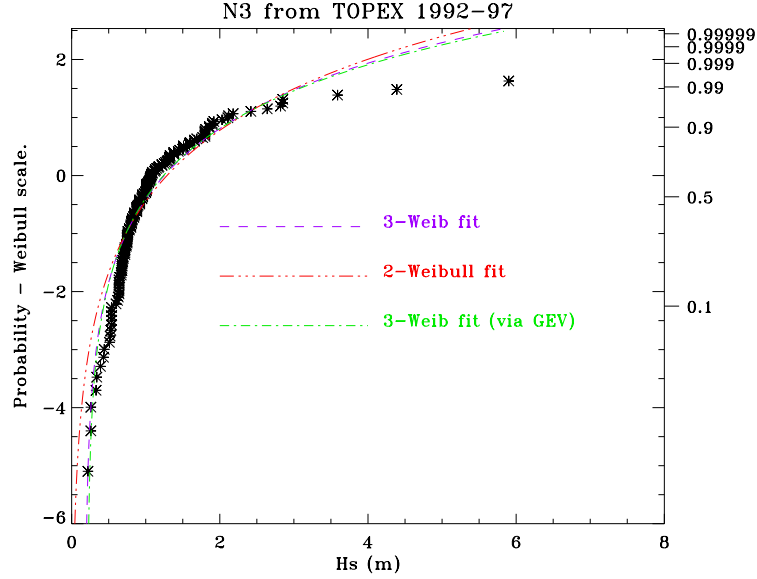


Figure 2: Cumulative probability distribution of estimated H_s at N3, 1992-1997, with fitted 2- & 3- parameter Weibull distributions.

are 73 data values from this direction, from a total of 163. The 100-year return value with onshore winds, assuming these prevail for 45% of the time, is 8.33 m. The wave heights with offshore winds (from 160° to 340° exclusive) are much lower; the FT-1 is not a good fit, but indicates a 100-year return value, during the 55% of the time with such winds, of 3.7 m. These offshore winds would not contribute significantly to the omni-directional 100-year value, which can be taken as the onshore value of 8.3 m, within 1 s.e. of the value in Table 1.

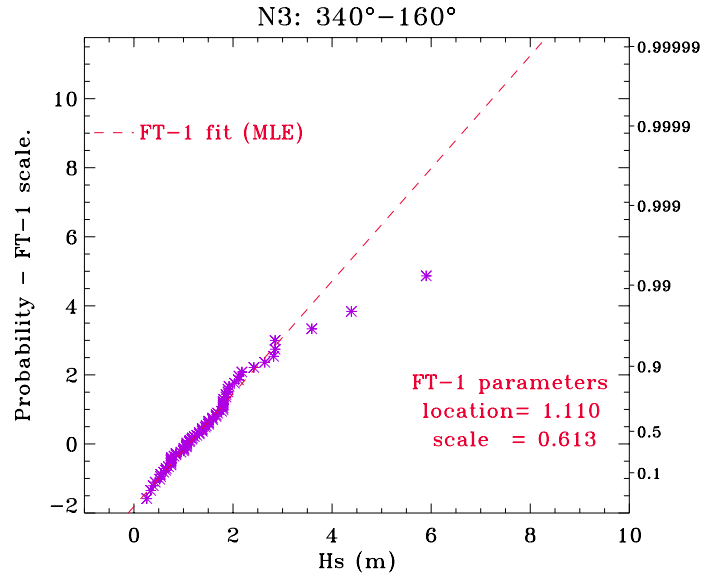


Figure 3: Cumulative probability distribution of estimated H_s at N3, with winds from 340°-160°.

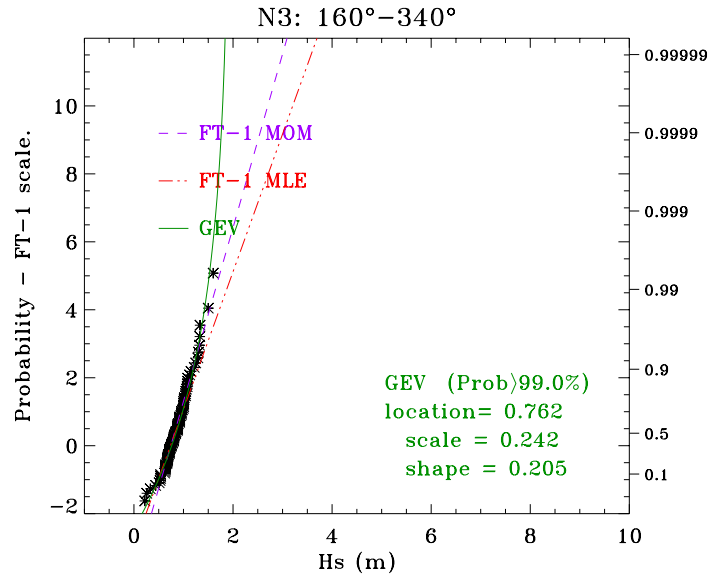


Figure 4: Cumulative probability distribution of estimated H_s at N3, with winds from 160°-340°.

For comparison, Figures 5 & 6 show plots of data from the nearest location on TOPEX Track 120 by wind direction. Both are quite good fits to the FT-1, with 100-year return values of 8.32 and 6.65 m respectively (and s.e. of 0.7 and 0.4).

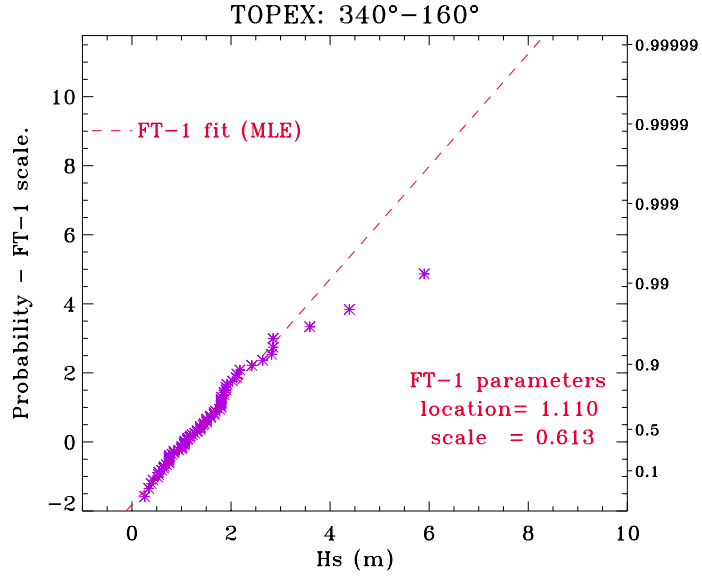


Figure 5: Cumulative probability distribution of estimated H_s at TOPEX Track 120, with winds from 340°-160°.

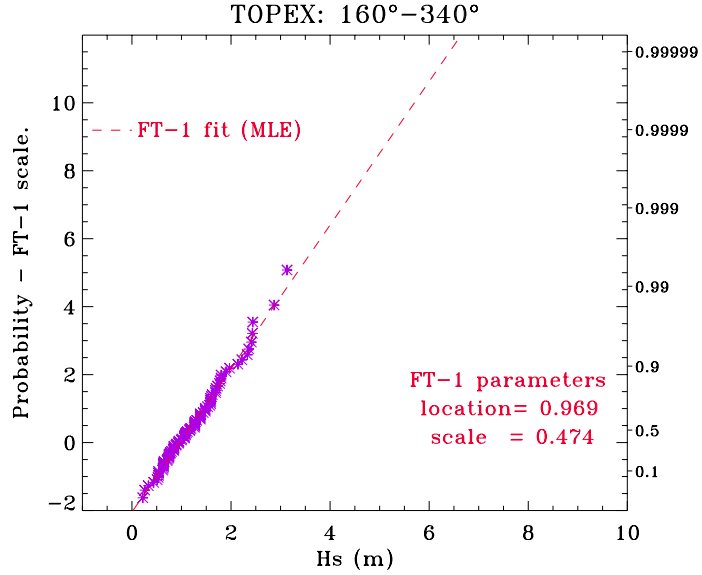


Figure 6: Cumulative probability distribution of estimated H_s at TOPEX Track 120, with winds from 160°-340°.

3 N1 & N2 distributions

Cumulative distributions of H_s values derived from the Halcrow ‘STORM’ model at N1 and N2 are shown in Figures 7 & 8. (Only 162 values were included in the data files sent to SOS.) Clearly the wave model has a lower limit for H_s of 0.2m. The figure shows the FT-1 distributions fitted by maximum likelihood to the data set truncated at 0.2m (excluding values of 0.2m and below). This distribution appears to be a satisfactory fit to data at both sites. Estimates of 100-year return values are 6.22 m at N1 and 6.91 m at N2 (compared to 4.22 and 5.12 if all the

data were ‘fitted’ to an FT-1 distribution). It is not clear why the FT-1 is a poor fit at N3, but satisfactory at N1 and N2; it may be because H_s at N1 and N2 greater than 0.2 m only originate from onshore waves at N3, so the truncation reduces the data set to that from a single distribution.

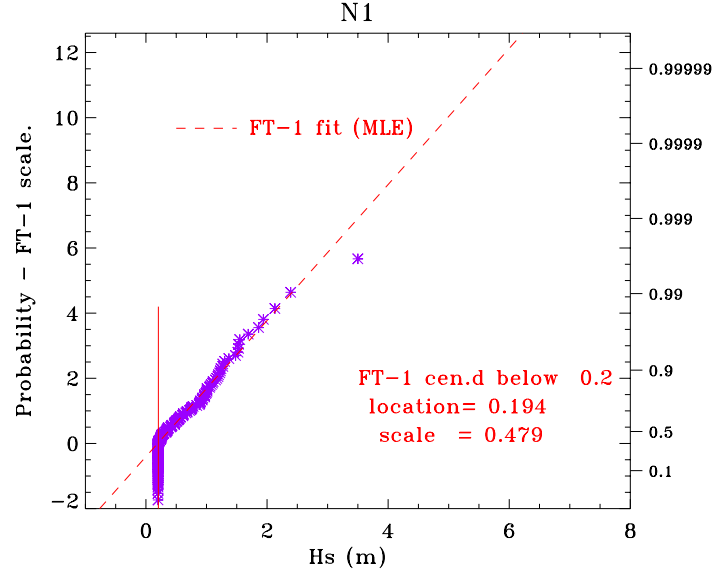


Figure 7: Cumulative probability distribution of estimated H_s at N1, with truncated FT-1 fit.

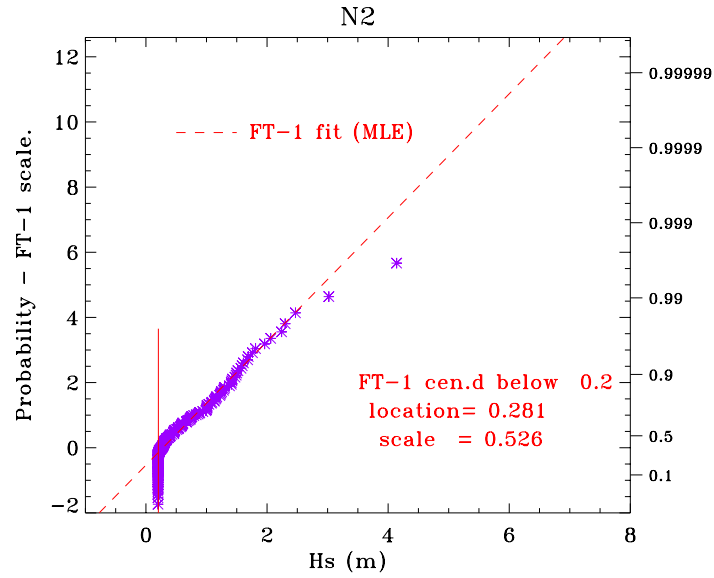


Figure 8: Cumulative probability distribution of estimated H_s at N2, with truncated FT-1 fit.

4 Conclusions

The 100-year return value of H_s at N1, N2, and N3 are estimated to be 6.2, 6.9 and 8.0 m respectively. But note that these values have been derived by extrapolating the fitted FT-1 distributions, which makes no allowance for any physical constraints, such as the limited water depth at N1 and N2.