JERICHO TECHNICAL REPORT-15

Model boundary wave heights

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Satellite Observing Systems

1. Introduction

This note considers how *in situ* and satellite data might be best used together to provide estimates of wave data at the deep-water, open boundary of coastal wave models to be run to determine wave climate at the coast.

The three sites selected for analysis in Jericho were chosen because of their differences, so one simple methodology for estimating wave heights at the outer boundary of wave models is not to be expected. Off Holderness, waves from the South-West are fetch-limited, whilst the other two sites are more exposed. On the other hand, data from the buoy off Holderness, N3, gives some measurements close to the outer boundary (from October 1994 to February 1995) which are not available at the other sites.

2. Off Holderness

Comparing TOPEX data from tracks off Holderness (see Figure 1) with N3 measurements within 15 minutes of the TOPEX pass indicates that significant wave height at N3 is about 75% of that from the altimeter passes further offshore. However, a comparison taking into account the wave direction (as measured by N3) shows that Hs values at N3 of waves coming from 340°- 160° are about the same as measured by TOPEX, whilst Hs values at N3 of waves coming from 160°- 340° are generally much lower - except at low Hs values. This reduction in Hs at N3 when waves are coming offshore is to be expected because they will be fetch-limited - except when the wind speed is low.

This analysis suggests that the dominant direction is offshore about 25% of the time; but this comes from a rather small data set at N3 during one winter, a better estimate should be obtainable from Leman. Leman wind directions will be used to establish the direction for each pass of TOPEX along Track 120. Then when the wind direction is from 340°- 160°, Hs at N3 will be taken to be the same as the altimeter value closest to N3, and when the wind direction is from 160°- 340°, that at N3 will be reduced by a factor to be deduced from the correlation of TOPEX and N3 data and consideration of formulae for fetch-limited wave heights (Carter, 1982).

Zero-upcross wave periods will be estimated from the TOPEX data, and will be adjusted for N3 when the wind is offshore, again using Carter (1982) checked against the few occasions with simultaneous measurements by TOPEX and N3.

Analysis of TOPEX data from Tracks 61 and 239 reveal problems in the data as the altimeter footprint moves off the land. This problem extends to about 50 km from the coast; so these TOPEX tracks cannot be used to investigate changes in wave height in the coastal strip.

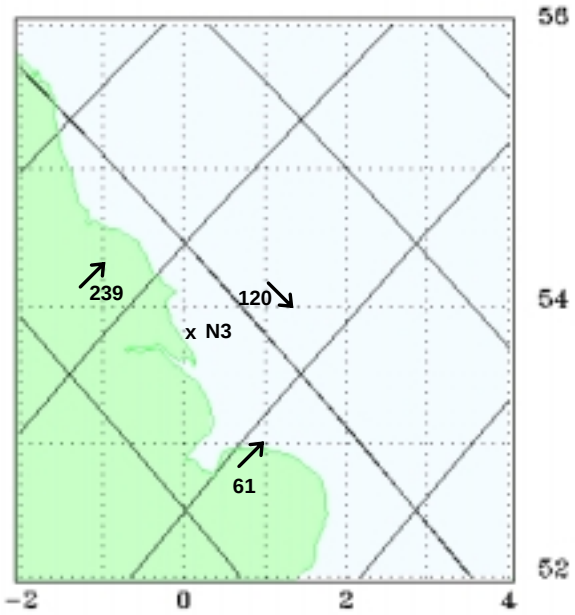

Figure 1 **Location of buoy N3 and TOPEX tracks, off Holderness including Tracks 61,120 & 239.**

3. Lyme Bay

TOPEX tracks 61 and 146 across Lyme Bay (Figure 2) intersect close to the offshore edge of the wave model boundary, so data from both tracks will provide Hs and Tz values for input into model climate studies.

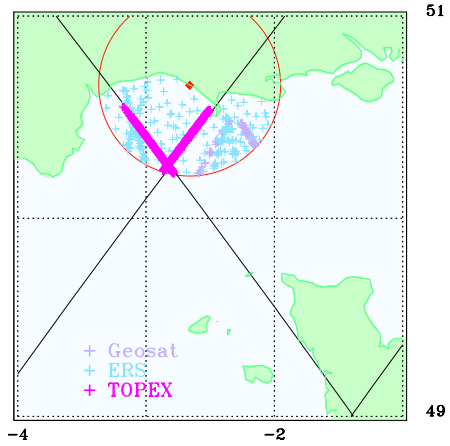

Figure 2 **TOPEX tracks in Lyme Bay.**

The altimeter is approaching the shore along Track 61, so gives good data close to the coast. Figure 2 shows the path of these tracks, and the location of data within 50 km of

a near-shore pressure sensor together with the very limited data from other satellites; note the gap in TOPEX data along the off-shore track as it leaves the coast. There is a consistent decrease in mean Hs values along Track 61 towards the shore (Figure 3). There has been a UK Met. Office buoy at 50.6°N 2.7°W since July 1983, but inspection of the records indicate that wave heighs were usually missing or corrupted; so there are no buoy wave height data from which to check the direction of wave propagation, but reduction in individual passes towards the shore would indicate offshore winds and fetch limited seas, and constant high Hs values indicates onshore propagation. This will provide an estimate of direction of propagation of high waves. Constant low Hs values could be from either direction, but these waves are of less importance to coastal defences. The wind velocity records from the Met. Office buoy appear satisfactory, and these will provide a check on the direction of wind wave propagation.

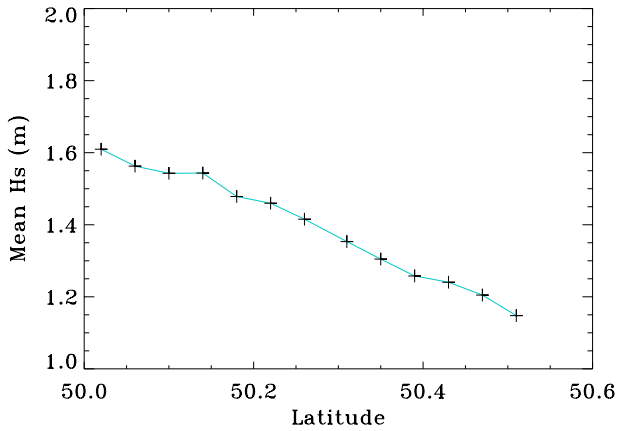

Figure 3 Mean wave height from 200 passes of TOPEX into Lyme Bay.

4. St Gowan

The third site is the most exposed to the open ocean. There are very few near altimeter data; tracks are too far away or coming off land (see Figure 4). However, comparisons of monthly means from St Gowan LV and the TOPEX track 50 km away towards the Cornish coast (Figure 5) show good agreement. So altimeter data from this track might be used as input to the wave model. On the other hand, because the comparison suggests that the Met. Office buoy data from September 1994 to December 1997 are satisfactory, it would seem preferable to use these as input to the model; they also supply wave period and wind direction, which can be taken for the wind sea direction - swell can only come from the Southwest.

5. Conclusion

This study, resulting in proposals for the extraction of data at the outer boundary of the wave models to be run in Jericho to estimate coastal wave climate, has shown how the satellite and buoy data can be used together, taking into account their availability at each location, and comparing results from both, to provide the best estimate of data for a climate study.

However, it is not possible to specify any simple rule for deriving this data set; it varies according to location and circumstances. The quantity and quality of buoy data is variable - the latter can be checked by altimeter data; the altimeter data tracks may be too far from the location of interest, measurements from the altimeter as it comes off the land are unreliable for about 50 km, the altimeter does not measure wave direction.

Reference

Carter D J T 1982
Prediction of wave height and period for a constant wind velocity using the JONSWAP results.
Ocean Engng. 9, 17-33.

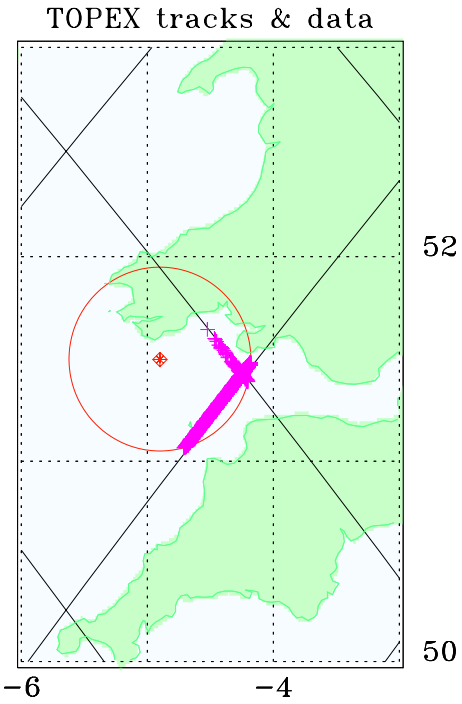

Figure 4 **TOPEX tracks with location of data within 50 km of St Gowan.**

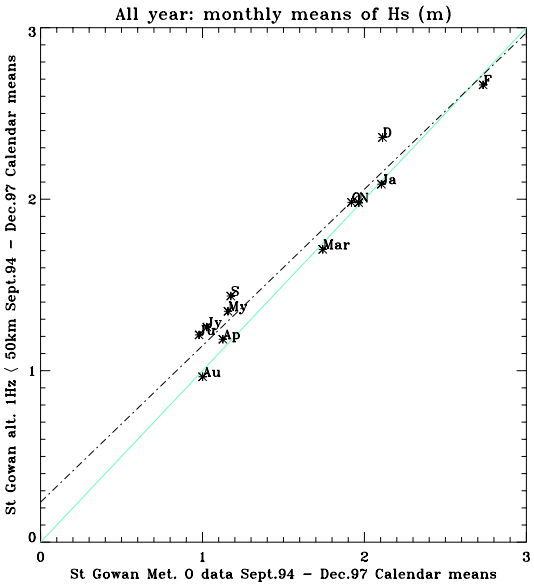

Figure 5 **Comparison of monthly mean wave heights from TOPEX and from UK Met.Office buoy near St Gowan.**