1. Collocated buoy/Topex dataset

The buoy data originates from the US National Data Buoy Center (NDBC) who provide one directional buoy spectra for a large number of moored buoys around the coast of the U.S. The buoys used in this study were selected for their location in open water and proximity to Topex tracks. A network of 24 NDBC buoys was used, providing a reasonable representation of the global wave field. Although limitations in the buoy data are clear, the buoy data are used in this study to correct the importance of the wave mean square (the 304) to account for the larger scales of variability of the wave field. The maximum time- separation between Topex and buoy data is 1 hour. With these criteria and standard ice and rain flags (Aviso Topex GDR products), the collocation yielded 6344 data points for the period September 1992-December 1998.

The data consist of Topex-1a/1b burst co-efficient and SWH (m). No attempt was made to correct for up to the gradient in Topex estimates toward the end of 1996, which were shown to have a significant impact on our dataset (Gommenginger et al., 2002). The buoy data include wind speed and direction, SWH, and air temperature, and peak wave period from the NDBC retrieved parameter records, and a series of directional wave spectra from the NDBC spectrums.

Table 1. Collocated buoy/Topex dataset

<table>
<thead>
<tr>
<th>Buoy ID</th>
<th>Latitude</th>
<th>Longitude</th>
<th>SWH (m)</th>
<th>Tz (s)</th>
<th>Tm (s)</th>
<th>Tp (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>30.10</td>
<td>-89.02</td>
<td>2.00</td>
<td>1.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>02</td>
<td>30.10</td>
<td>-89.02</td>
<td>2.00</td>
<td>1.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>03</td>
<td>30.10</td>
<td>-89.02</td>
<td>2.00</td>
<td>1.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

The empirical log-log model for Tz returns an r.m.s. retrieval error of about 1s. While the empirical models empirical log-log model for Tm shows a error under 0.8 s. The empirical models return errors in excess of 2.8 s.

2. Empirical altimeter wave period model

Our empirical model is based on heuristic reasoning and, unlike previous altimeter wave period model, makes no assumptions on, for example, the shape of the ocean wave spectrum. After this, it is related to the Geostrophic Optics approximates to the inverse of the mean square of the long ocean waves (Barrick, 1974).

\[ L \sim T^2 \] and \[ m_{SS} \sim SWH^2 / L^4 \]

The ocean wavelength is related to wave period, T, through the dispersion relationship for deep water, so that

\[ \sigma \sim SWH / L \]

and thus:

\[ SWH = \sigma L \]

The empirical models show improved performance when tested on the Gulf of Mexico data alone, and poorer performance using the Hawaii dataset alone. This suggests that the empirical models are better able to reproduce a wide range of wave period conditions. However, much validation remains to be done, especially with regards to testing the empirical models with conditions. This work suggests that wave period can be retrieved globally from altimeter data with an r.m.s. error of the order of 0.8 s for Tz. Analysis of the altimeter models’ performance in different sea conditions shows that they are better suited to wind-dominated seas than to regions with strong swell.

3. Validation

The performance of all models is evaluated through the root mean square of error defined as \( Tz - T \times 100 \% \).

Based on an independent validation dataset, the Best empirical and the D97 models perform better than the empirical log-log model for Tz return an r.m.s. error of 2s, while the empirical log-log model for Tz return an r.m.s. error of 4s. While the empirical models of display a bias, D97 is characterized by a large, unexplained, 0.5 s bias. 70% of models perform yet worse as well in both terms of bias and r.m.s. error on Table 1.

The empirical log-log model for Tm returns a retrieval error of about 1 s. Models for Tz return errors in excess of 2 s and large biases, explained partly by the noisy nature of the buoy data on Table 2.

4. Geographical variability

To better understand the performance of the different models in different sea conditions, we identified with the validation dataset, the data for the Gulf of Mexico (left) and the Southern Ocean (right) in Table 2.

In Table 3, the empirical models show improved performance when tested on the Gulf of Mexico data alone, and poorer performance using the Southern Ocean dataset. This suggests that empirical models are better suited to wind than to swell conditions.

5. Conclusions & Future work

This work suggests that wave period can be retrieved globally from altimeter data with an r.m.s. error of the order of 0.8 s for Tz. Analysis of the altimeter models’ performance in different sea conditions shows that they are better suited to wind-dominated seas than to regions with strong swell.

Unlike previous wave period models, these simple empirical models are better able to reproduce a wide range of wave period conditions. However, much validation remains to be done, especially with regards to testing the empirical models with data from the Southern Ocean and the coastal zone.

Together with further validation, future work hopes to include comparative studies with numerical wave models, and the compilation of global wave period climatologies (e.g. Figure 3), in order to study the geographical and seasonal/annual variability of the global ocean wave field.

References


