Validation of recent tide models by means of crossover differences and time series of bottom pressure and tide gauges

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Crossover statistics

Satellite altimetry can be used to compare the performance of ocean tide models. The principal is to correct altimeter data using different ocean tide models, to compute single and dual satellite crossover differences \(x\) with a maximum time delay of 3.5 days and to look for those models which exhibit correct altimeter data using different ocean tide models, to compute single and dual satellite crossover statistics.

Introduction

Since the edition of FES2004 a number of new global ocean tide models like GOT4.7, TPXO7.2, EOT10a, DTU10, EOT11a, and HAMTIDE have been issued, all of them claiming to describe the tidal elevation and the short-term water mass variations in the system Earth. The present paper performs a comparative validation of these models by means of altimetric crossover differences (see left) and time series of bottom pressure (right) and tide gauges (below).

A fair comparison is not easy as the models differ by spatial resolution, the number of constituents, the presence of loading tides, and the approach applied to generate the tables (hydrodynamic, empirical, inverse modeling, assimilation). First of all a common format (redsw) was introduced for all models. It is then essential to apply one and the same software to ensure that the model evaluation follows identical conventions. Comparison is performed on the basis of the smallest common set of constituents (\(T2\), \(N2\), shallow-water and long-period tides excluded).

Model characteristics

<table>
<thead>
<tr>
<th>Model</th>
<th>Resolution</th>
<th>Diurnal</th>
<th>Semidiurnal</th>
<th>Non-Linear</th>
<th>Long-Period</th>
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<tbody>
<tr>
<td>FES2004</td>
<td>1/8° x 1/8°</td>
<td>(K1), (O1), (P1), (Q1), (M2), (S2), (N2), (K2), (2N2), (M4), (Mm), (Mf), (Mtm), (Msqm)</td>
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<td>EOT08a</td>
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<td>(K1), (O1), (P1), (Q1), (M2), (S2), (N2), (K2), (M4), (MS4), (MN4), (Mm), (Mf)</td>
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<td>EOT11a</td>
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<td>HAMTIDE11a</td>
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<td>DTU10</td>
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Tide Gauge comparisons

Pelagic ST102

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<th>RMS</th>
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</thead>
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<td>40°N</td>
<td>EOT10a</td>
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<tr>
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<td>40°N</td>
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<td>HAMTIDE11a</td>
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<tr>
<td>40°N</td>
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Pelagic IAPSO

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Shallow water (R-Ray)

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<td>40°N</td>
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</table>

Conclusions

• In general the comparison indicate that all new ocean tide models exhibit a significant improvement over the state-of-the-art represented some seven years ago by FES2004. This is primarily due to a significantly extended time series of satellite altimetry, helping to de-alias and separate more and more tidal constituents. Satellite altimetry is used either empirically, or by assimilation into numerical models. It seems to be difficult for pure hydrodynamic models to keep step with models which use satellite altimetry. This underpins the impact of satellite altimetry.

• The crossover test relative to FES2004 indicate that GOT4.7, TPXO7.2, and EOT11a show the best performance. Comparing these models among each other (see bottom left panel), TPXO7.2 is in a slight inferior position.

• The tide gauge comparison show smallest RMS values for GOT4.7, TPXO7.2, EOT10a, and EOT11a. For WOCE sites (coastal TGs, bottom table) we did not include GOT4.7 and TPXO7.2, as these models have a coarser spatial resolution which requires significant extrapolation.

• For the validation with bottom pressure gauges the most significant variance reduction is show by EOT11a (or EOT10a), followed by GOT4.7.

• DTU10 is another tide model with high performance indicated by TG comparison. Due to format problems with some of its tables it was not validated by crossover statistics.

References:


GOT4.7: Ray, personal communication.

EOT10a: Savcenko, R. and Bosch (2008), EOT08a - empirical ocean tide model from multi-mission satellite altimetry. Report No.13, Deutsches Geodätisches Forschungsinstitut, München, Germany


Acknowledgement

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