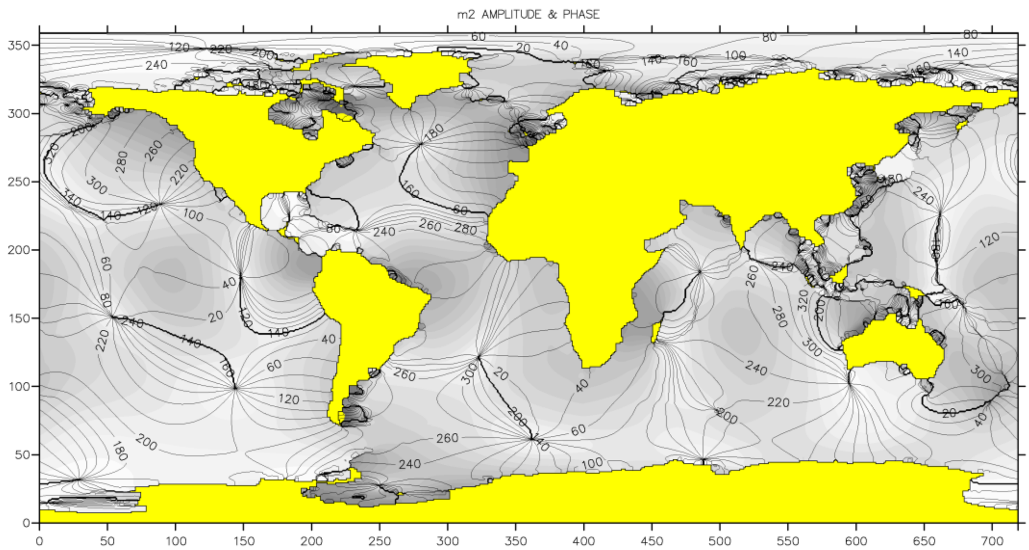

MIKE 21 Toolbox

Global Tide Model – Tidal prediction

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1 The Global Tide Model

The Global Tide Model is developed by DTU Space (DTU10). The Global Tide model is available on a 0.125 x 0.125 degree resolution grid for the major 10 constituent in the tidal spectra. The model is utilising the latest 17 years' multi-mission measurements from TOPEX/Poseidon (phase A and phase B), Jason-1 (phase A and phase B) and Jason-2 satellite altimetry for sea level residuals analysis. Based on these measurements, harmonic coefficients have been calculated. The provided constituents consider the semidiurnal M2, S2, K2, N2, the diurnal S1, K1, O1, P1, Q1, and the shallow water constituent M4.

The following figures (Figure 1.1 - Figure 1.8) show the Co-Tidal charts for the 8 major constituents depicting the phase and amplitude on the same chart.

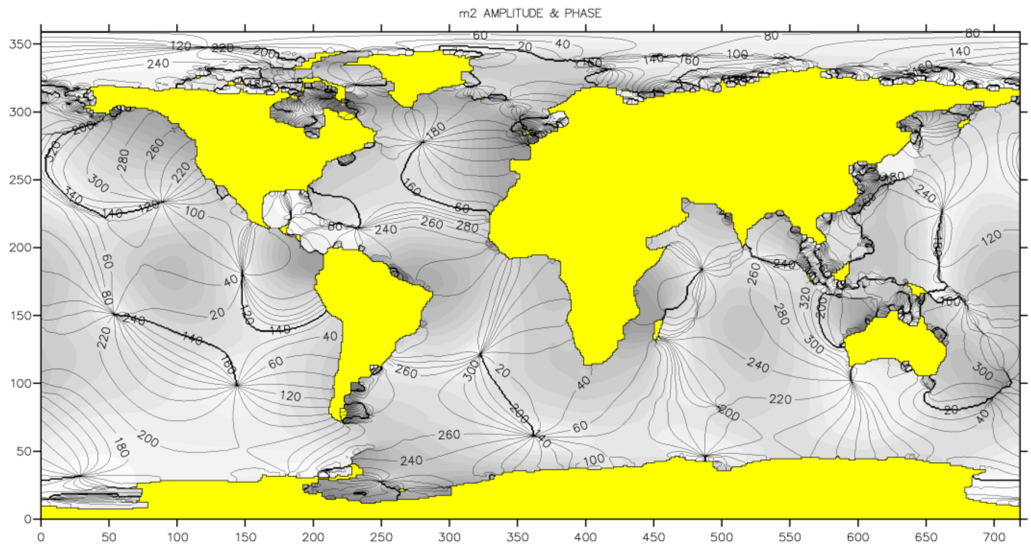

Figure 1.1 Co-Tidal chart of M2

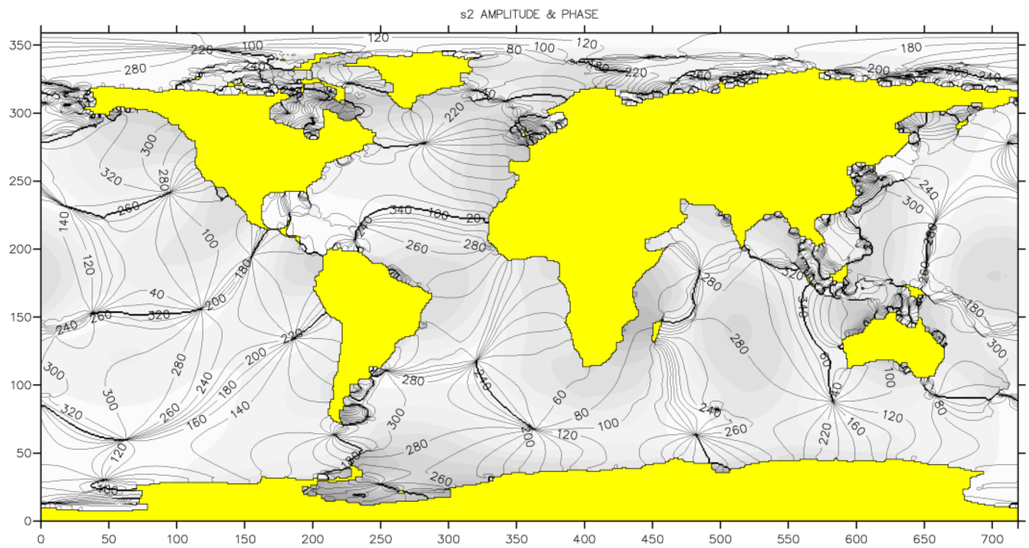

Figure 1.2 Co-Tidal chart of S2

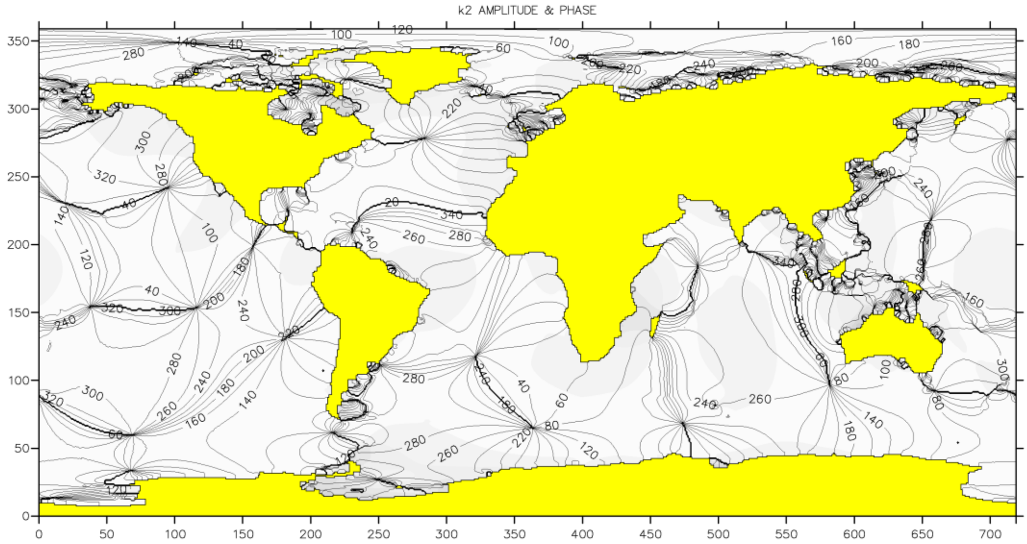

Figure 1.3 Co-Tidal chart of K2

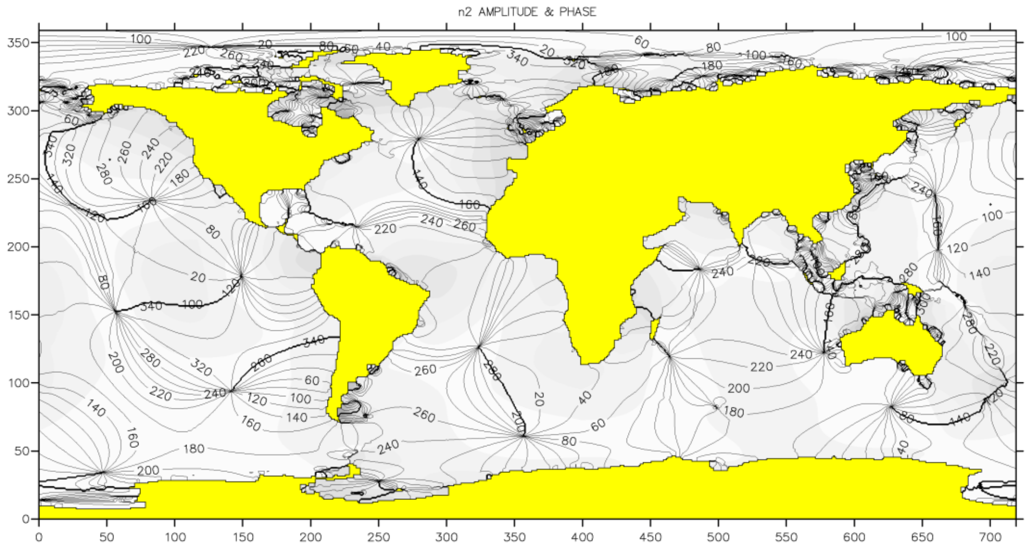

Figure 1.4 Co-Tidal chart of N2

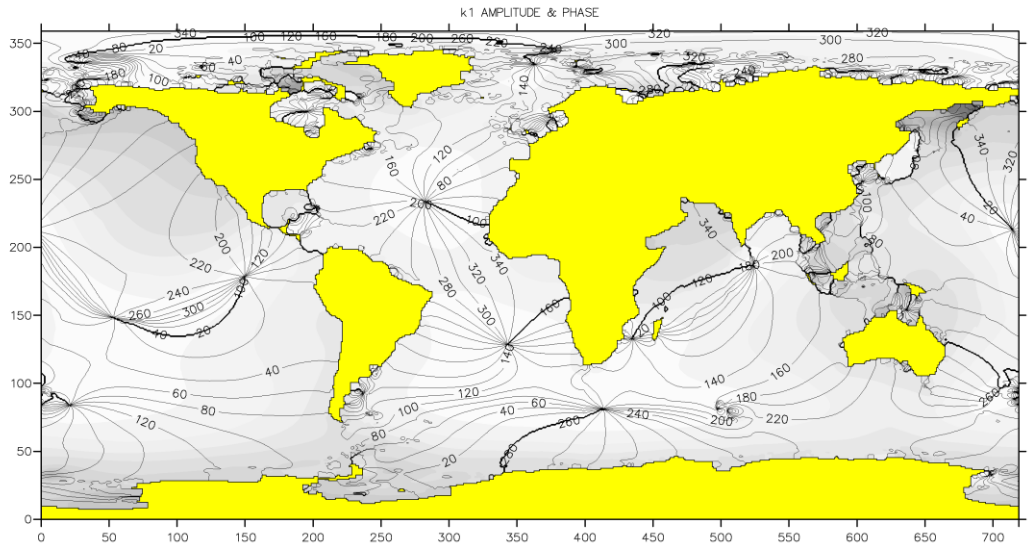

Figure 1.5 Co-Tidal chart of K1

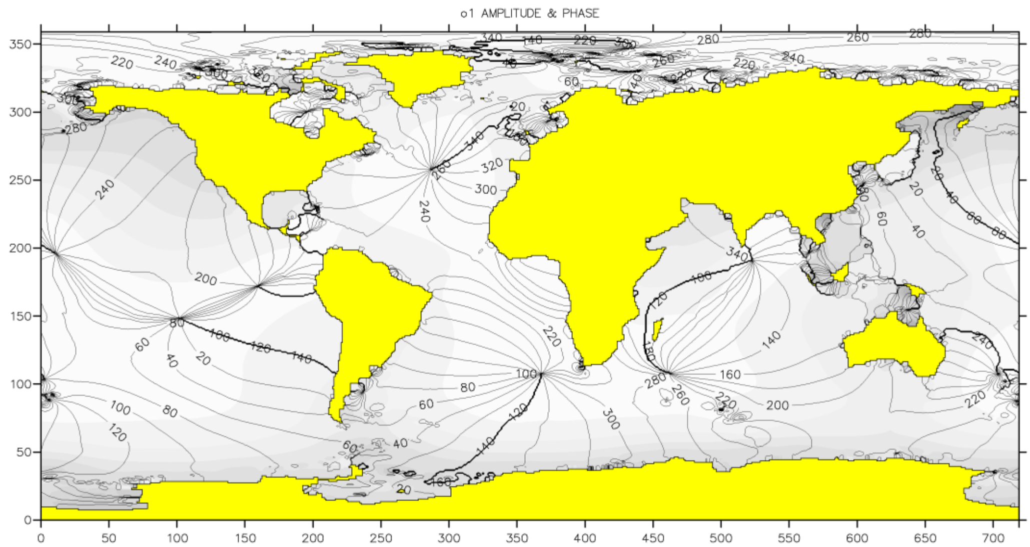

Figure 1.6 Co-Tidal chart of O1

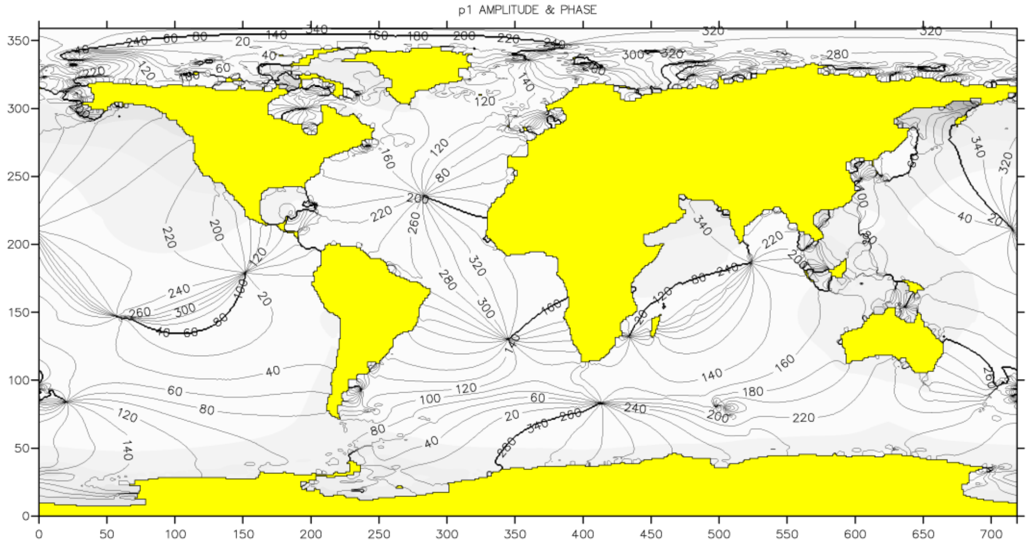

Figure 1.7 Co-Tidal chart of P1

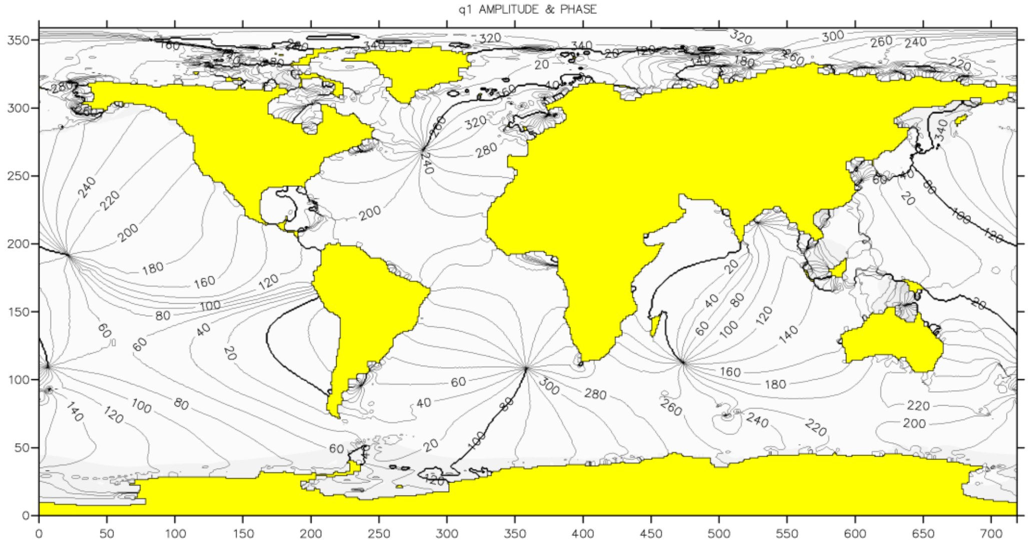

Figure 1.8 Co-Tidal chart of Q1

1.1 Satellite Data used for the Global Tide Model

The satellite data for the Global Tide Model are based on data from four altimetric satellites. These are satellites, which observe the distance between the satellite and the sea surface averaged over a region of 5 km along pre-selected ground tracks, and have done such for years at regular intervals.

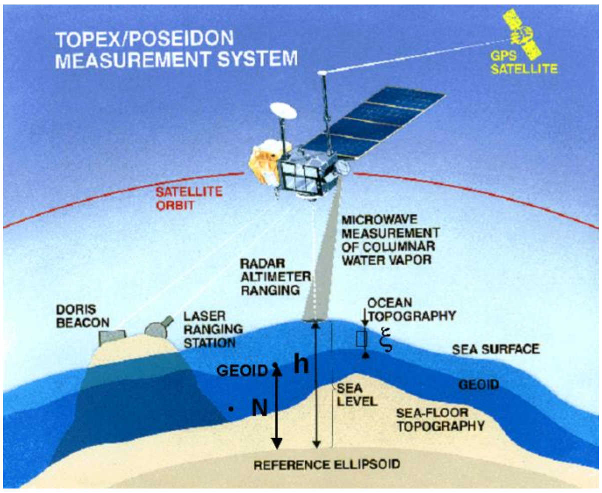

Figure 1.9 TOPEX/Poseidon measurement system

The TOPEX/Poseidon satellite from 1992-2002 is the main satellite. Furthermore, data from its interlaced orbit from 2002-2004 have been used. Data from ERS-2 and data from the GFO satellites were used to supplement the satellite data at high latitude where the TOPEX/Poseidon does not cover (outside the 65 parallel).

The far best satellite to use is the TOPEX/Poseidon satellite as this satellite initially was designed to map the ocean tides of the world globally at its launch in 1992.

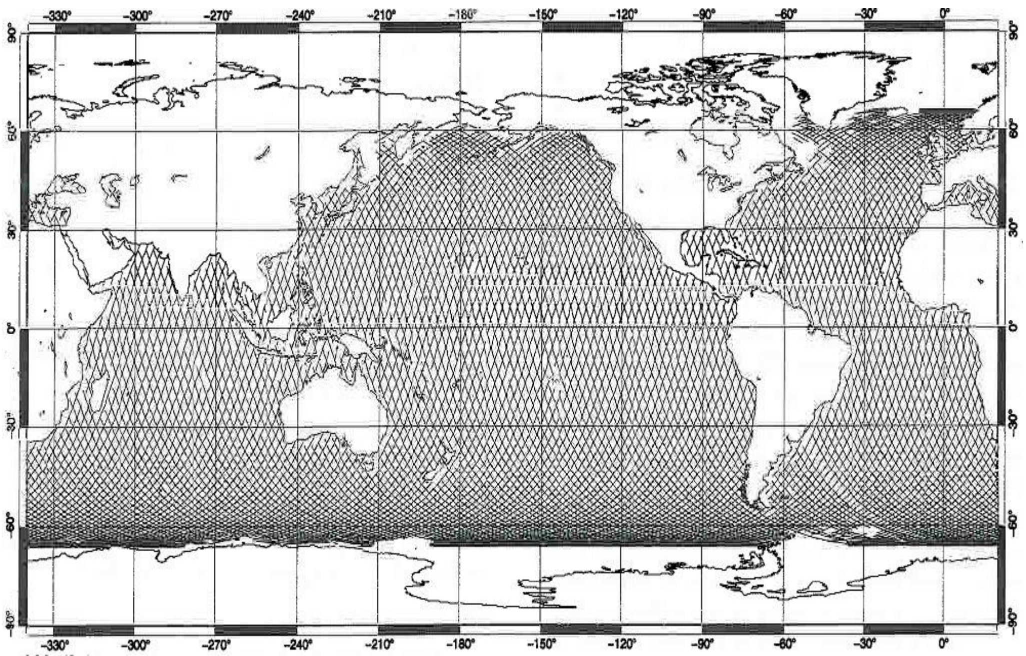

Figure 1.10 TOPEX/Poseidon Track coverage

Due to the relatively coarse track spacing of the TOPEX/Poseidon satellite (2.9° ≈ 315 km at equator), empirical models from TOPEX/Poseidon are primarily useful for open ocean tides. On the shelves surrounding the ocean the horizontal extension of the tidal signal is highly reduced, and the track spacing of the TOPEX/Poseidon satellite becomes critically to resolve especially the high frequency parts of the ocean tide signal properly. Fortunately, it was decided to put the TOPEX/Poseidon in an interlaced mission with ground tracks in between the original ground tracks for 2.5 years during the period from 2002-2004 where the TOPEX/Poseidon follow on called 'JASON-1' was safely launched and calibrated in identical orbits to Topex. With these data the track distance is 140 km

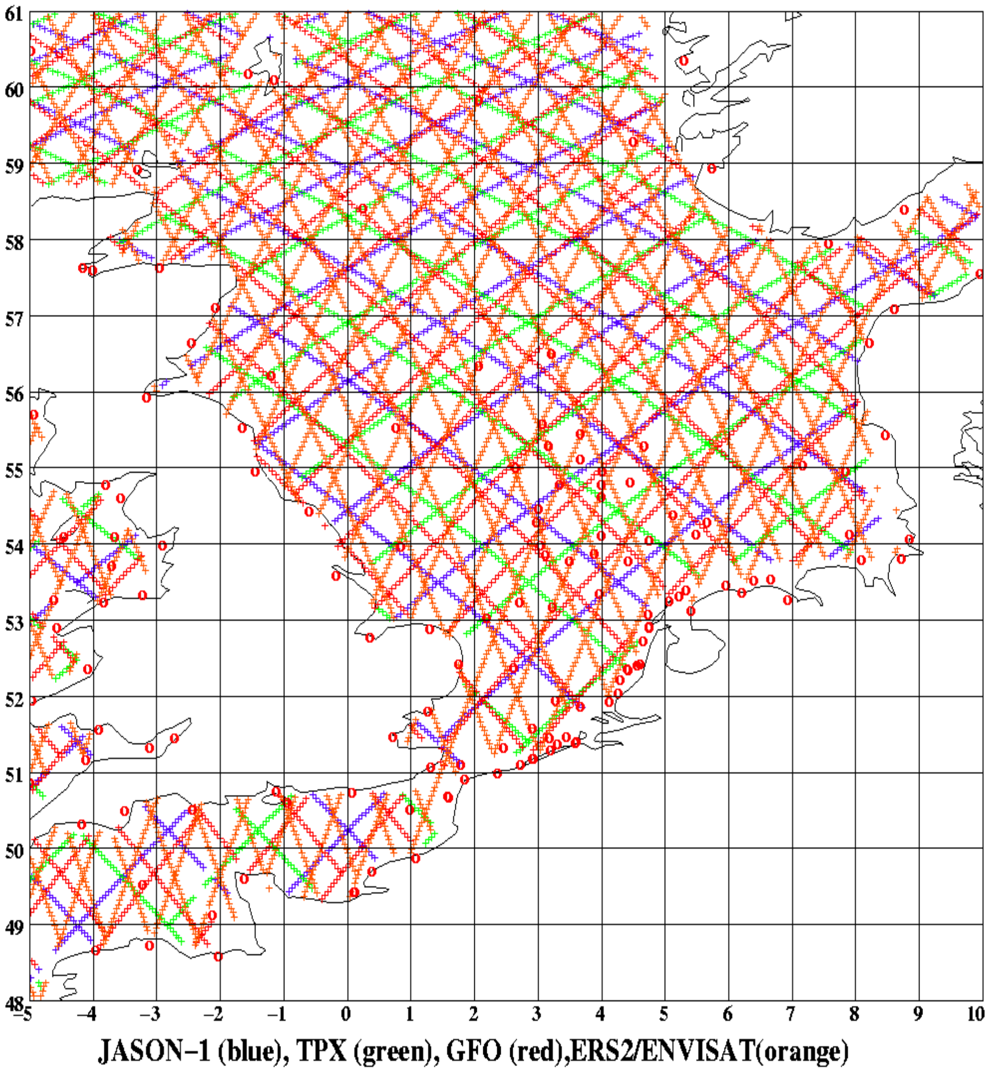

Figure 1.11 TOPEX/Poseidon Tracks and Tide Gauges on the NW European Shelf

The track spacing of ERS5 1 satellite in the 35-day repeat mission is around 3.6 times better than that of TOPEX/Poseidon (0.71° ≈ 80 km at the Equator). Similarly, the data from the Geosat Follow On (GFO) mission also provide a valuable supplement to the TOPEX/Poseidon data when investigating ocean tides in coastal regions (140 km track distance at the Equator).

The empirical TOPEX/Poseidon derived Global Tide Models are limited by the 6° parallel, while ERS 1 provides altimetry all the way up to 82°. Therefore, the ERS 1 satellite provides observations in roughly all ice free ocean areas of the world. However, there are several drawbacks to the use of ERS 1 altimetry for tidal analysis. The major drawback is the fact that ERS 1 is placed in a sun-synchronous orbit (exactly 35 days) so only non-solar constituents can be resolved. Solar constituents are consequently delivered by the apriori hydrodynamic model in this region.

The following data were used:

- TOPEX/Poseidon + JASON-1 X-over data within +/- 65 N (465 repeats)
- TOPEX/Poseidon Along track data (Depth < 1 km) (371 repeats)
- TOPEX/Poseidon -2 Interlaced mission - Crossover data (Max 90 repeats)
- GFO (various constituents 65N-72N)
- ERS-2/ENVISAT (various non-solar constituents 65N-82N)

All data selection and editing closely follows standard procedures as i.e. documented in Shum et al. 1997 or Andersen, 1995, 1999.

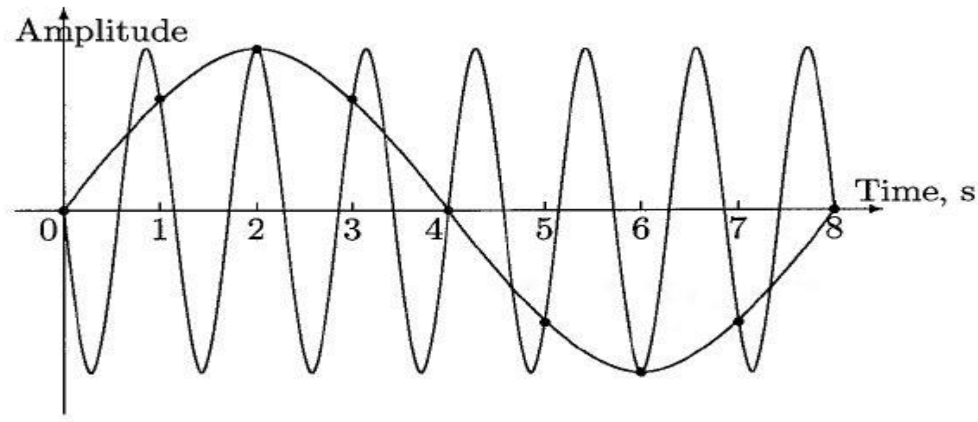

Figure 1.12 TOPEX/Poseidon measurement frequency

1.2 Computation of the Global Tide Model

The method used to compute the DTU10 Global Tide Model is identical to the methodology described in Andersen, (1995, 1999) and the interested user can reference these publications.

The model is computed as a long-wavelength adjustment of the FES94.1 pure hydrodynamic model [Le Provost et al., 1994] for all constituents using the altimetry data described above. In the deep ocean only the long wavelength are adjusted as the tidal signal is very long wavelength. Close to the coast the short wavelength part of the tidal signal is also being modelled using satellite data.

1.3 Validation against Tide Gauges

The derived amplitudes and phase lags for the major tidal constituents were compared with tide gauges readings by means of bi-linear interpolation within the altimetry derived models using the cosine and sine grids for each constituent. In this comparison the vector difference between the two complex signals are computed and displayed as the values in Table 1.1.

A global set of tide gauge readings was defined by C. Le Provost and other members of the TOPEX/Poseidon ocean tide subcommittee for the investigation of ocean tide models on a common basis. This new set has been constructed from the original 80 tide gauge set selected by Cartwright & Ray [1990, 1991] by various additions, corrections and updates. The new set should have 102 gauges with a more reasonable spatial distribution with 42 tide gauges in the Atlantic Ocean, 18 readings in the Indian Ocean and 42 in the Pacific Ocean. This set of totally 102 tide gauges are shown in Figure 1.13.

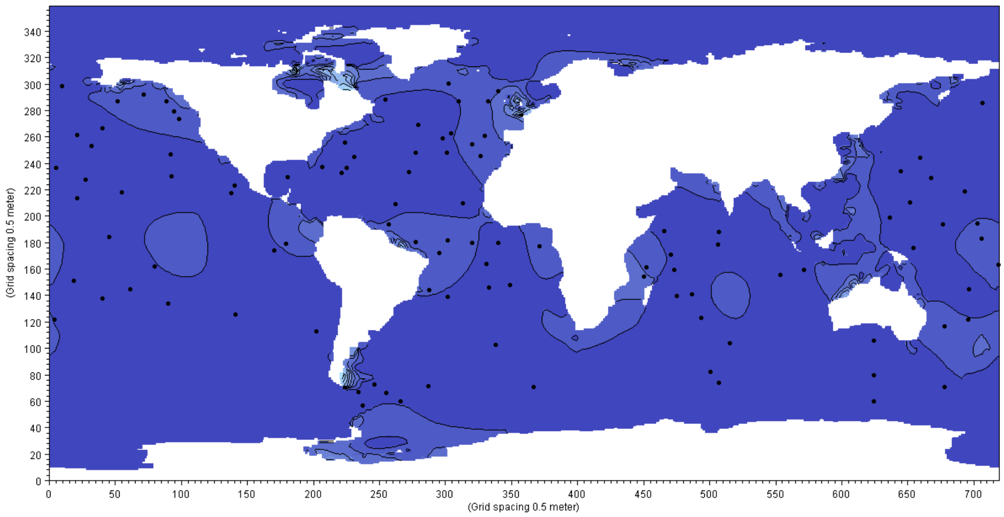

Figure 1.13 Location of 102 high quality global tide gauge stations

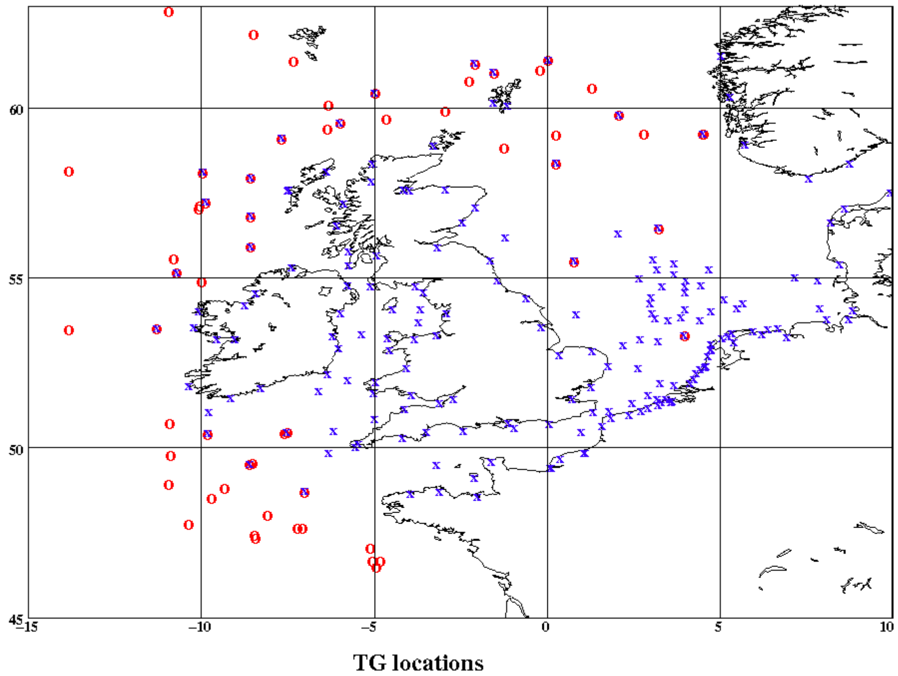

Figure 1.14 Location of Tide gauges on the NW European shelf. The red circles are high quality pelagic tide gauge stations. The blue crosses are 199 coastal stations gathered from various local sources in the region

Table 1.1 Comparison and RMS differences between the tide gauges and interpolated amplitude and phase values from the Global Tide models based on both Global data and European data

DTU10	M2	S2	K1	O1
Global	2.26	1.49	1.59	1.32
European	2.55	1.90	1.23	0.88

2 Extraction from the Global Tide Model

Based on the Global Tide Model users of MIKE 21 software can extract time series of water level for any period and any positions on the globe. Furthermore, it is possible to extract line series based on either a bathymetry or a mesh file in order to create boundary conditions for local or regional models automatically. It is important to remember that the time zone for the extracted time series is given in UTC or GMT. Normally, the user should then adjust the timing to the local time used in the area, where the data is extracted.

3 Updated Global Tide Model

An improved version of the Global Tide Model is available in 0.125º x 0.125º resolution. The model is updated with additional 4 years of radar satellite measurement and 2 additional constituents has been added providing better predictions in shallow water. The updated model includes the following 10 constituents:
Semidiurnal: M2, S2, K2, N2
Diurnal: S1, K1, O1, P1, Q1
Shallow water: M4

The data can conveniently be copied to the default folder for tidal constituents (e.g. C:\Program Files (x86)\DHI\2017\MIKE Zero\Application Data\Tide Constituents).

Due to space requirements, the model is not included on the official DVD but can be downloaded here:

Global Tide Model

The Global Tide Model is developed by DTU Space. Go to the DTU10 global ocean tide model for more information:

DTU global ocean tide model

4 References

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