EOT11a - a new tide model from Multi-Mission Altimetry

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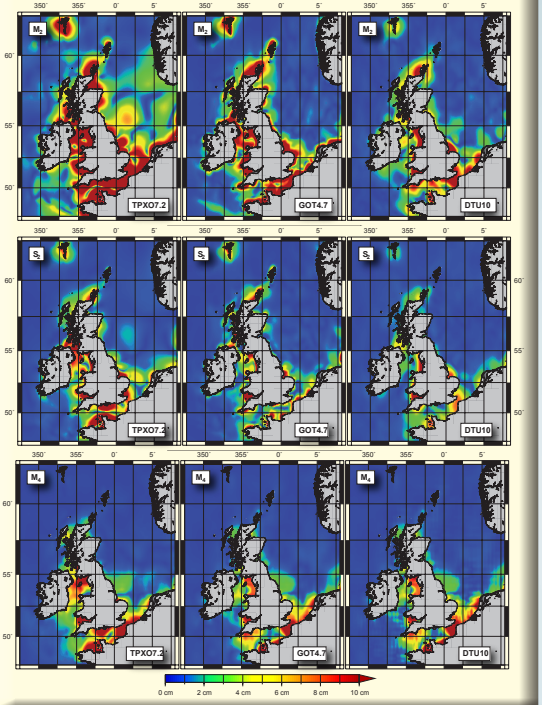
Abstract

EOT11a is another version of empirical ocean tide models. It was obtained by means of residual tidal analysis of multi-mission-altimeter data using data from TOPEX/Poseidon, ERS-2, ENVISAT, and Jason-1/2. The harmonic analysis was customized in order to improve the determination of shallow water tides. FES2004 was again used as reference model in order to mitigate back ground noise caused by minor tidal constituents. The model includes the main astronomical tides M2, S2, N2, K2, 2N2, O1, K1, P1, and Q1, the non-linear constituent M4, the long period tides Mm and Mf, and the radiational tide S1.

Processing steps

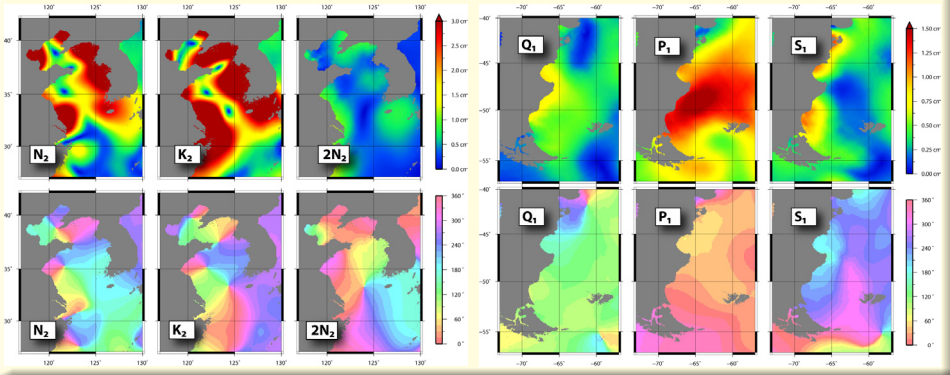
- performing sea level anomalies w.r.t. CLS01 using FES2004 as reference tide model
- residual tide analysis by means of least squares harmonic analysis for the tidal constituents, mission specific mean values as well as annual and semiannual signals
- reconstructing full elastic ocean tides by adding residual tides to the reference model
- computing loading tides from elastic tides
- deriving ocean tides by subtracting loading effects from elastic ocean tides

Comparison with other models at North-West European Shelf



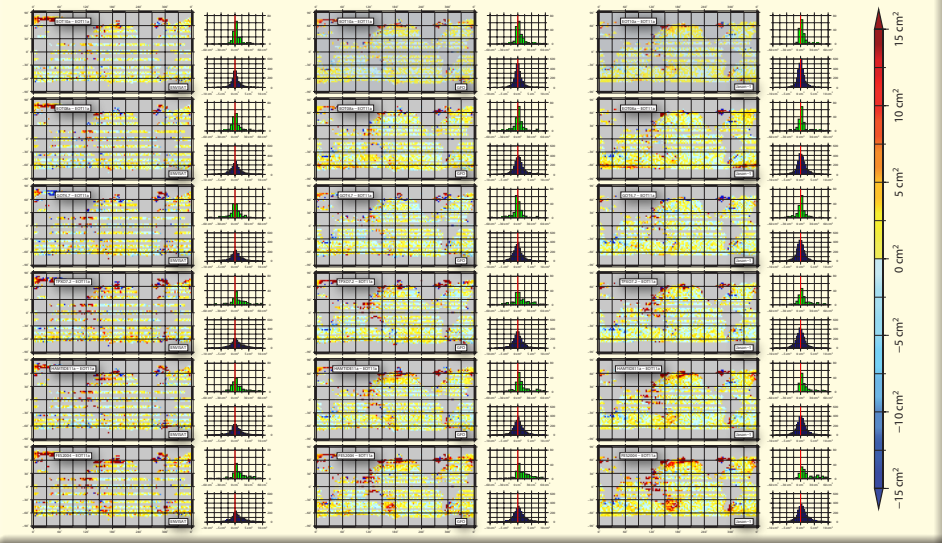
Download EOT11a at ftp://ftp.dgfi.badw.de/pub/EOT11a

Selected residuals for Yellow Sea and Patagonia



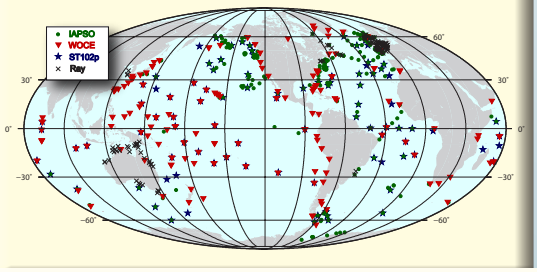
Crossover variance reduction for Envisat, GFO, and Jason-1

Crossover differences within 3° boxes with $\Delta t \leq 3.5$ days were used. No admittance for minor tides applied. Histograms distinguish between global ocean (blue) and shallow water (green).



Comparison with tidal constants

Several compilations with tidal constants of coastal and bottom pressure gauges have been used for comparison with EOT11a (see tables below [unit = cm]).



ST102

	M_2	S_2	N_2	K_2	K_1	O_1	P_1	Q_1	RSS
FES2004	1.45	0.86	0.67	0.49	1.01	0.75	0.41	0.30	2.32
EOT08a	1.43	0.97	0.65	0.45	0.98	0.74	0.42	0.30	2.32
EOT10a	1.41	0.84	**0.64**	0.43	0.97	**0.73**	**0.37**	**0.27**	**2.23**
EOT11a	1.42	0.84	**0.64**	0.46	**0.96**	**0.73**	**0.37**	0.28	2.24
GOT4.7	1.43	0.93	0.65	0.40	1.01	0.76	**0.37**	**0.27**	2.30
TPXO7.2	1.43	**0.82**	**0.64**	**0.37**	1.07	0.86	**0.37**	**0.27**	2.31
HAMTIDE11a	1.48	0.88	0.65	0.49	1.06	0.80	0.42	0.30	2.38
DTU10	**1.38**	0.87	**0.64**	0.45	1.01	0.74	0.42	0.31	2.26
num	101	101	98	97	101	97	97	95	

SW (Ray)

	M_2	S_2	N_2	K_2	K_1	O_1	P_1	Q_1	M_4	RSS
FES2004	7.56	4.85	2.68	2.21	1.87	1.31	1.07	0.94	4.23	10.86
EOT08a	6.82	4.13	2.19	1.55	**1.63**	1.24	0.80	0.87	2.29	9.03
EOT10a	6.80	4.02	2.33	1.56	1.65	1.24	0.90	0.84	2.67	9.12
EOT11a	6.33	3.96	2.09	**1.38**	1.67	1.44	**0.78**	**0.82**	2.61	8.66
GOT4.7	6.09	3.38	**2.06**	1.65	1.67	1.31	0.94	0.85	2.33	8.19
TPXO7.2	6.94	3.81	2.09	1.68	1.77	**1.14**	0.97	1.08	**1.88**	8.94
HAMTIDE11a	6.84	4.77	2.25	2.19	2.04	1.21	2.43	0.86	(3.72)	10.27
DTU10	**5.18**	**2.99**	2.10	1.65	1.73	1.40	1.07	0.87	2.30	**7.42**
num	176	176	173	96	176	176	97	139	129	

IAPSO

	M_2	S_2	N_2	K_2	K_1	O_1	P_1	Q_1	RSS
FES2004	2.56	1.72	0.97	0.91	1.35	1.05	2.80	0.48	4.72
EOT08a	2.46	1.66	0.95	0.80	1.26	1.04	2.66	0.47	4.51
EOT10a	2.47	1.66	0.95	0.86	1.24	**1.03**	2.62	**0.43**	4.49
EOT11a	2.46	1.63	0.97	0.81	**1.21**	**1.03**	**2.56**	**0.43**	**4.42**
GOT4.7	2.46	**1.60**	**0.94**	**0.79**	1.34	1.06	2.65	0.44	4.50
TPXO7.2	2.59	1.62	**0.94**	**0.79**	1.28	1.05	**2.56**	0.44	4.51
HAMTIDE11a	2.56	1.70	**0.94**	0.90	1.40	1.06	2.63	0.46	4.62
DTU10	**2.44**	**1.60**	0.98	0.87	1.31	1.06	2.75	0.47	4.57
num	310	310	304	272	310	309	272	273	

WOCE

	M_2	S_2	N_2	K_2	K_1	O_1	P_1	Q_1	M_4	RSS
FES2004	**11.96**	4.34	2.50	1.63	4.25	3.07	1.37	0.68	1.47	14.24
EOT08a	12.31	4.37	2.64	1.52	4.08	3.02	**1.31**	0.62	1.34	14.48
EOT10a	12.09	4.18	**2.49**	1.51	4.06	3.03	**1.31**	0.68	1.23	14.19
EOT11a	12.09	**4.17**	2.54	1.49	4.00	**2.96**	1.32	0.69	1.27	**14.17**
HAMTIDE11a	12.58	4.72	2.55	1.58	4.54	3.22	1.38	**0.60**	(1.11)	14.97
DTU10	12.47	4.23	2.50	**1.48**	**3.97**	**2.96**	1.32	0.72	**1.14**	14.49
num	151	151	151	150	151	151	150	150	158	

(in brackets) missing constituent replaced by signal RMS

Conclusions

- EOT11a performs significantly better than previous EOT-models.
- The model validation with homogeneously distributed tidal constants (ST102, IAPSO, WOCE) shows that EOT11a is among the best currently available tide models.
- For Ray's compilation of shallow water tidal constants (SW), EOT11a is slightly outperformed by DTU10 and GOT4.7. This holds in particular for the constituents S2 and M4.
- For some shallow water tides the differences between EOT11a and other models exceed the level of ten centimetre (see results at NW-European Shelf). But the validation by means of crossover variance reduction tests shows that each tide models has its own strengths and weaknesses.

Acknowledgement

We greatfully acknowledge R. Ray for providing the comprehensive validation data sets for the shallow water sites.