Comparison of recent ocean tide models with gravimetric and GPS observations

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Introduction:

Ocean tide models play nowadays a vital role in space and terrestrial data processing. We investigate the possible impact of the latest publicly available ocean tide models EOT11a (Savcenko and Bosch, 2010) and FES2012 (Carrère et al., 2012) and indicate the benefit of switching existing processing schemes to these latest ocean tide models. Specifically in this poster, we focus on the analysis of aliased residual ocean tide signal in daily GPS time series and on the gravity field recovery from a GRACE-like satellite observation. For both, ocean tides are considered one of the major culprits in deriving better estimates.

Ocean tide models:

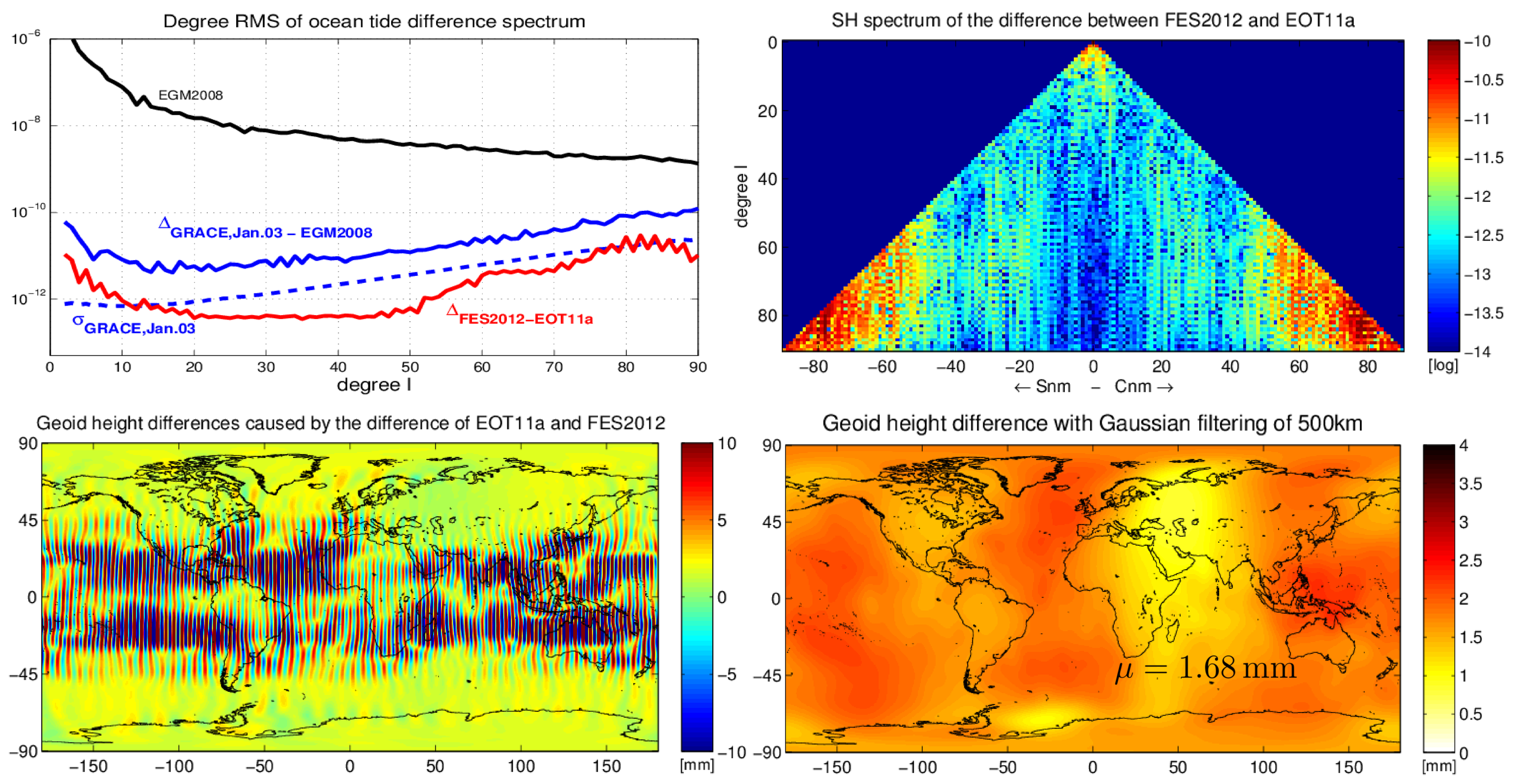
The IERS conventions 2010 (Petit and Luzum, 2010) state the FES2004 model as the standard ocean tide model. Since then the EOT11a and the FES2012 model have become available and are used here.

Overview about the model content:

Model	No.	Waves	
FES 2004:	15	waves; grid step size: 0.125°	
	4	long-period waves:	$M_m, M_f, M_{tm}, M_{sqm}$
	5	diurnal waves:	K_1, O_1, P_1, Q_1, S_1
	5	semi-diurnal waves:	$2N_2, K_2, M_2, N_2, S_2$
	1	quarter-diurnal wave:	M_4
EOT 11a:	13	waves; grid step size: 0.125°	
	2	long-period waves:	M_m, M_f
	5	diurnal waves:	K_1, O_1, P_1, Q_1, S_1
	5	semi-diurnal waves:	$2N_2, K_2, M_2, N_2, S_2$
	1	quarter-diurnal wave:	M_4
FES 2012:	33	waves; grid step size: 0.0625°	
	5	long-period waves:	$M_m, M_f, M_{tm}, M_{sqm}, S_{sa}$
	6	diurnal waves:	$K_1, O_1, P_1, Q_1, S_1, J_1$
	13	semi-diurnal waves:	$2N_2, K_2, M_2, N_2, S_2, L_2, R_2$ $\epsilon_2, \lambda_2, \mu_2, \nu_2, T_2, MKS_2$
	1	third-diurnal wave:	M_3
	5	quarter-diurnal waves:	$M_4, MN_4, MS_4, N_4, S_4$
	1	sixth-diurnal wave:	M_6
	1	eighth-diurnal wave:	M_8

Impact on space gravimetry:

Current GRACE solutions are based on EOT11a. It has been already shown that EOT11a posses an improvement compared to FES2004. Assuming FES2012 outperforms EOT11a, a spherical harmonic analysis of the residual signal for one month of data (January 2003) reveals the affected coefficients and possible improvements in the space domain. Admittance has been included for both models.

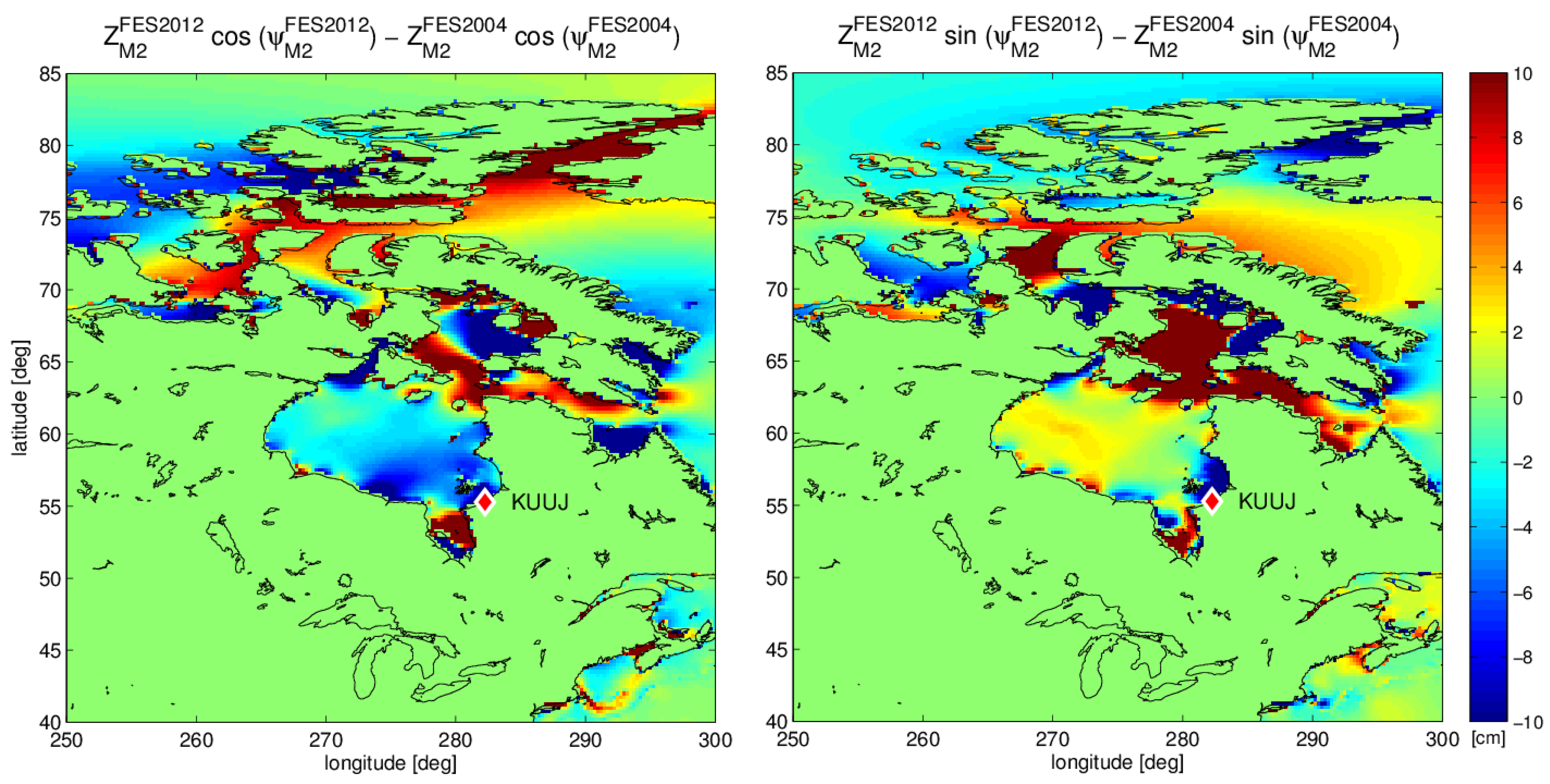


An improvement for the low degrees of the monthly gravity field recovery may be expected as the difference level is higher than the noise level till approximately degree 10. Especially the oceanic areas seem to be affected. Besides, striping pattern occur which are inherent to the observable and reflect the general error behaviour of the GRACE observation. Coefficients of degree and order higher than 40 are primarily affected. However, this effect is normally damped by spatial filtering. Possible accumulation effects may also be reduced as the mean value (of the filtered signal) is not zero. A full scale gravity field recovery is necessary in order to quantify conclusively the impact on the gravity field solution.

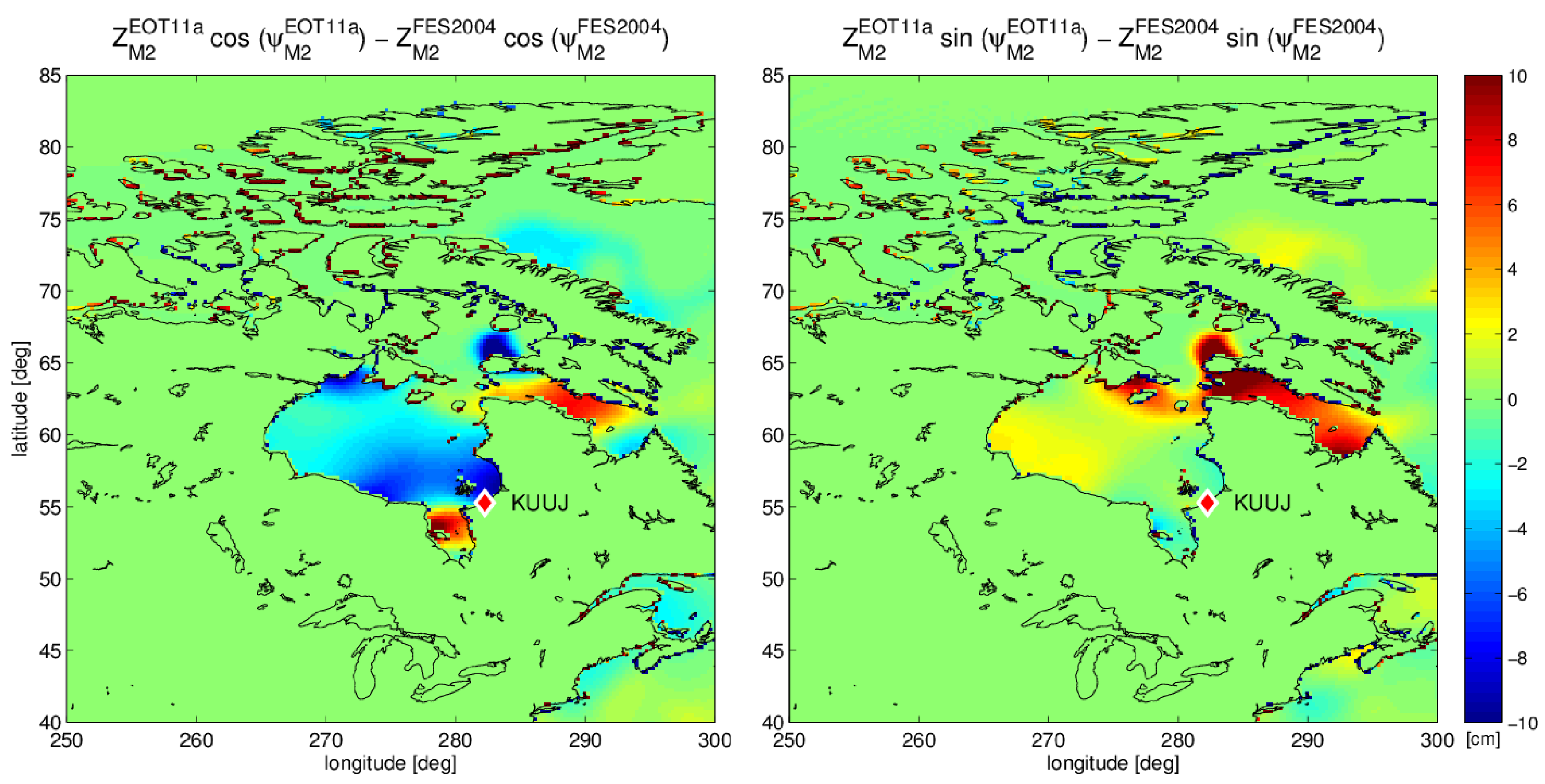
Aliasing analysis in GPS time series:

Daily GPS observations suffer from a non-zero residual ocean tide signal which aliases to longer frequencies. Exemplary, we investigate the M_2 wave at the station KUUJ in the South-East area of Hudson Bay. The M_2 tide has aliasing frequencies around 14 days. We identify the spectral content in the GPS time series and compare it to the displacement time series of the difference spectrum of FES2012/EOT11a minus FES2004.

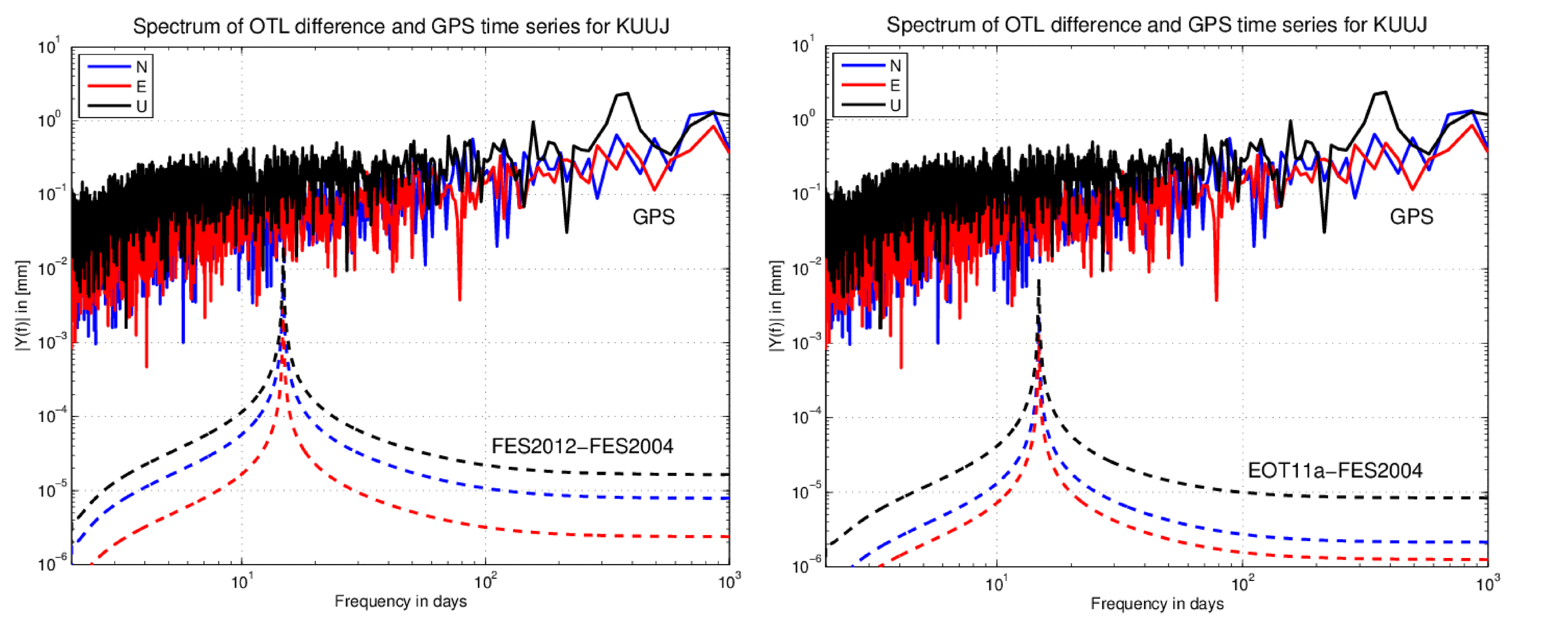
Tidal height map of M_2 wave: FES2012 – FES2004:



Tidal height map of M_2 wave: EOT11a – FES2004:



Spectrum at aliasing frequency:



Despite the significant difference in the tidal maps, the displacement caused by the aliased residual M_2 wave signal is below the noise level of the GPS time series. Thus, no significant improvement is expected for a reprocessed daily time series. However, more stations and other waves need to be tested. Especially, the newly delivered waves in FES2012 like e.g. L_2 may reduce noise in the GPS time series as currently their signal can fully alias into the solution.

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