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Free Core Nutation period inferred from tidal gravity measurements at Józefosław, Poland

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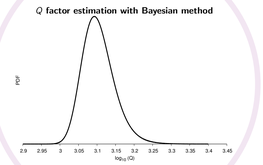
Quality factor

Q factor estimation with Bayesian method



Gravity Measurements

Table: Tidal analysis results (diurnal band)

	NC				PC				PC+OTLC	
	$\Gamma[\cdot]$	$A_m[\frac{nm}{s^2}]$	δ	κ_0	$\kappa\Gamma[\cdot]$	$\kappa_m\Gamma[\cdot]$	δ	κ_0	$\kappa_m\Gamma[\cdot]$	δ	κ
Q_1	13.396	57.7	1.1477	0.0017	0.0070	0.0940	1.1401	0.0008	-0.0660	0.0413	1.1546	0.0065
O_1	13.943	301.3	1.1504	0.0003	0.0720	0.0160	1.1504	0.0002	0.0606	0.0080	1.1541	-0.0498
M_1	14.497	23.7	1.1423	0.0042	0.1280	0.2120	1.1519	0.0023	0.1120	0.1040	1.1531	-0.0803
ν_1	14.918	8.2	1.1436	0.0116	0.3290	0.5800	1.1632	0.0056	-0.0420	0.2860	1.1628	-0.1637
P_1	14.955	146.2	1.1487	0.0007	0.2250	0.0340	1.1463	0.0003	0.1330	0.0370	1.1479	0.0066
S_1	15.000	3.3	1.0835	0.0364	11.8850	1.9270	1.1767	0.0231	-6.4250	0.9750	1.1763	-6.5248
K_1	15.041	423.6	1.1360	0.0002	0.1150	0.0100	1.1359	0.0001	0.0960	0.0050	1.1352	-0.0001
ψ_1	15.082	3.3	1.2799	0.0258	2.1760	1.1550	1.2662	0.0134	2.2900	0.6060	1.2673	2.2255
φ_1	15.123	6.0	1.1746	0.0159	-0.4040	0.7780	1.1704	0.0080	-0.9310	0.3940	1.1694	-0.9899
J_1	15.585	23.7	1.1564	0.0029	0.0040	0.1450	1.1573	0.0014	0.0330	0.0720	1.1550	0.2339
OO_1	16.139	13.0	1.1531	0.0039	-0.3870	0.1960	1.1520	0.0020	0.0110	0.0980	1.1485	0.6568

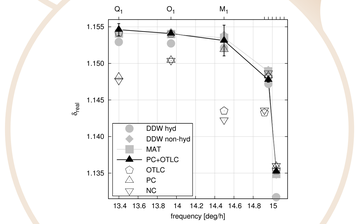


Figure: Comparison of gravimetric factors for diurnal tidal waves. The results when no correction (NC), pressure correction (PC) and ocean tidal loading correction (OTLC) was applied are shown along with theoretical models of Dehant, Defraigne, Wahr (DDW) and Matthews (MAT).

Pressure correction (PC) with empirical admittance factor of $-3.5\,\mathrm{nm}\cdot\mathrm{s}^{-2}\cdot\mathrm{hPa}^{-1}$ and ocean tidal loading (OTLC) was performed using most recent ocean models

Józefosław Observatory is located in suburb area of Warsaw

3.5 years (2007-2010) of continuous gravity measurements with LaCoste&Romberg spring gravimeter

FCN period

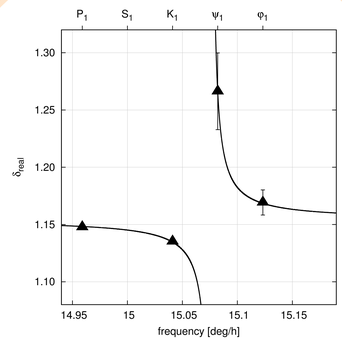


Figure: Resonance curve fitted to gravimetric factors

Table: Comparison of FCN period determination using different strategies

Solution	T [SD]	A_c [10^4 h·deg^{-1}]	T [SD]	A_c [10^4 h·deg^{-1}]
	M_1, τ_1, K_1,ψ_1, φ_1, J_1		M_1, τ_1, P_1, K_1,ψ_1, φ_1, J_1	
NC	408.3 (396.5 – 420.9)	5.47 (±0.20)	412.0 (391.5 – 434.7)	5.40 (±0.32)
PC	413.2 (402.0 – 425.0)	5.45 (±0.17)	418.0 (397.1 – 441.3)	5.37 (±0.31)
OTLC	423.2 (407.0 – 440.7)	6.87 (±0.30)	421.4 (407.0 – 436.8)	6.90 (±0.27)
PC+OTLC	430.2 (421.4 – 439.5)	6.80 (±0.15)	426.0 (414.1 – 438.6)	6.88 (±0.21)
Solution	K_1,ψ_1, φ_1		P_1, K_1,ψ_1, φ_1	
NC	408.5 (401.7 – 415.5)	5.47 (±0.11)	412.3 (385.8 – 442.6)	5.39 (±0.42)
PC	413.2 (407.9 – 418.7)	5.45 (±0.08)	418.1 (390.8 – 449.6)	5.37 (±0.41)
OTLC	423.4 (419.9 – 426.9)	6.86 (±0.06)	421.5 (412.9 – 430.5)	6.90 (±0.16)
PC+OTLC	430.0 (429.8 – 430.2)	6.80 (±0.00)	425.8 (410.6 – 442.2)	6.88 (±0.27)

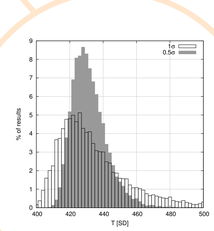


Figure: Monte Carlo simulation of results

Resonance model

$$\tilde{\delta}(\sigma) = \delta_0 + \frac{\tilde{A}}{\sigma - \tilde{\sigma}_{NDFW}},$$

$$\tilde{\delta}(\sigma) - \tilde{\delta}(\sigma_{O_1}) = \frac{\tilde{A}}{\sigma - \tilde{\sigma}_{NDFW}} + \frac{\tilde{A}}{\sigma_{O_1} - \tilde{\sigma}_{NDFW}},$$

$$\sum_{j=1}^{n} p_j \left[\tilde{\delta}(\sigma_j) - \tilde{\delta}(\sigma_{O_1}) - \frac{\tilde{A}}{\sigma_j - \tilde{\sigma}_{NDFW}} + \frac{\tilde{A}}{\sigma_{O_1} - \tilde{\sigma}_{NDFW}} \right]^2 .$$

$$\tilde{\sigma}_{NDFW} = f(\sigma_1, \sigma_2, \sigma_3, \tilde{\delta}_1, \tilde{\delta}_2, \tilde{\delta}_3)$$

$$\frac{1}{T_{FCN}} = \frac{1}{T_{NDFW}} - 1; \; Q = \frac{\sigma_{NDFW}}{2\sigma'_{NDFW}}$$

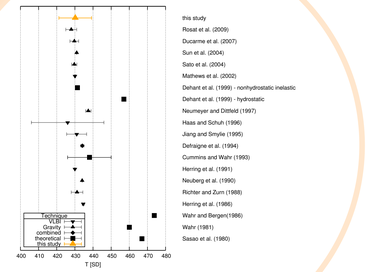


Figure: Comparison of FCN period determination from different studies

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