QUASI-SEMMIDIURNAL NUTATIONS INDUCED BY THE INDIRECT EFFECT OF THE TRIAXIALITY OF THE EARTH: RIGID AND NON-RIGID MODELS

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ABSTRACT. In this work we compute the numerical nutation amplitudes due to the indirect effect of the triaxialy of the Earth (Escapa et al. 2002a, 2002b) for different rigid and non-rigid Earth models. In some cases we found contributions larger than 1 μas that should be incorporated in IERS Conventions.

1. INTRODUCTION

The triaxiality of the Earth is the main source of the high frequency variations in Earth rotation, contributing to the diurnal and subdiurnal nutation series in two ways. First, through a direct effect due to the apparence of the non-zonal harmonics C_{nm}, S_{nm}. This effect is the most studied in rigid and non-rigid models (see, for example, Souchay et al. 1999 and Getino et al. 2001). Second, through an indirect effect due to the fact that the response of the Earth to the external interactions depends on the Earth itself and, therefore, on the triaxiality. As far as we know, this effect has not been studied in a systematic way by other theories different from the Hamiltonian one. In this context, the nature of the indirect effect is clear. It is originated because the solution of the unperturbed problem in the triaxial case is different from the axial-symmetrical case, since the expressions of the kinetic energy are also different in these cases. So, it affects to all the terms of the potential when constructing the generating function. However, the part proportional to the J_2 coefficient provides the most significative contribution.

2. RIGID AND NON-RIGID EARTH MODELS

The indirect effect of the triaxiality on the rigid Earth nutations was recently computed by Escapa et al. 2002a by expressing the disturbing potential in terms of the action-angle variables for the torque free-motion of the triaxial Earth, since this canonical set does not coincide with the canonical Andoyer variables. Numerically, the most remarkable fact is that the indirect effect produces new quasi semidiurnal contributions to the nutation series. Some terms are within the truncation level adopted by REN–2000 (Souchay et al. 1999), that does not consider this effect.

In the case of a two-layer Earth model premiliminary estimations of the indirect effect of the triaxiality were given by Escapa et al. 2002b. The contributions to the nutations, which have also quasi semidiurnal period, are proportional both to the triaxiality of the whole Earth and to the triaxiality of the fluid core, the part relative to the core providing the main of the contribution.

3. NUMERICAL REPRESENTATION

The main difficulty in evaluating the indirect effect arises when considering a non-rigid Earth model because there is a large uncertainty in the values of the equatorial moment of inertia of the core (Brzezinski and Capitaine 2002). Due to this fact, we have computed the contribution of the indirect effect for the quite different models. These are characterized by the value of $2d_c = 1 - A_c/B_c$ that is a measure of the triaxiality of the core. The values are: 0 (symmetrical core, SC), $4.922\,10^{-6}$ (Morelli and Dziewonski 1987, MD), $9.088\,10^{-6}$ (Defraigne et al. 1996, DDW), $11.015\,10^{-6}$ (triaxiality of the core equals to that of the total Earth, TE). The values of MD and DDW models are taken from Brzezinski and Capitaine (2002).

In Table 1 we have displayed the contribution in terms of the polar motion, hence the periods are now quasi diurnal. The contribution is specially important, about 12% of the direct effect, for the term of period .9973 but in the case of Model SC that does not provide any contribution. However, it seems quite improbable that d_c is exactly equal to 0. We believe that the value deduced from DDW is more realistic since this is the most updated model. Therefore, in our opinion it is necessary the inclusion of this effect (Model DDW) in IERS conventions in order to avoid an unnecessary bias.

Table 1: Polar Motion for different Earth models: X-component (μas)

Arguments						Period	Model SC		Model MD		Model DDW		Model TE		Rigid Earth	
Φ	l_M	l_S	F	D	Ω	(days)	sin	cos	sin	cos	sin	cos	sin	cos	sin	cos
1	-1	0	-2	0	-2	1.1196	.018	-.010	.021	-.012	.024	-.014	.025	-.014	.014	-.008
1	0	0	-2	0	-1	1.0760	.016	-.009	.021	-.012	.025	-.014	.026	-.015	.013	-.007
1	0	0	-2	0	-2	1.0758	.084	-.048	.109	-.063	.131	-.075	.141	-.081	.069	-.040
1	-1	0	0	0	0	1.0347	-.006	.003	-.010	.006	-.013	.007	-.014	.008	-.005	.003
1	0	-1	-2	2	-2	1.0055	.002	-.001	.006	-.004	.010	-.006	.012	-.007	.002	-.001
1	0	0	-2	2	-2	1.0028	.025	-.014	.134	-.077	.227	-.130	.270	-.155	.028	-.016
1	0	0	0	0	1	.9974	.000	-.000	.021	-.012	.038	-.022	.047	-.027	.002	-.001
1	0	0	0	0	0	.9973	0	0	-1.113	.639	-2.055	1.180	-2.491	1.430	-.083	.048
1	0	0	0	0	-1	.9971	.001	-.001	-.160	.092	-.297	.170	-.360	.206	-.011	.006
1	0	1	0	0	0	.9946	-.005	.003	.043	-.024	.083	-.048	.102	-.058	-.001	.000
1	0	0	2	-2	2	.9919	-.003	.001	.009	-.005	.019	-.011	.023	-.013	-.001	.001

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