6.2. FLUCTUATIONS IN THE MOTION OF THE MEAN POLE AND THE ROTATION OF THE EARTH

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ABSTRACT

Explanations of the progressive and librational motions of the pole are attempted.

RÉSUMÉ

On essaye une explication du mouvement progressif et périodique du pôle.

The observed secular motion of the mean pole shows a progressive component and periodic librations, either real or apparent. Evidence is given that real librations should occur.

The total deformation excitation Ψ due to yielding of the Earth should be proportional to kd, where k is the Love number and d is the distance of the pole of rotation from the pole of figure. Furthermore, the change in τ, the free nutation period, if due only to yielding of the Earth, should be a simple function of k. However, τ varies with d and therefore Ψ may include a function of d^2. The value of d is given by the free nutation term $m_0 \exp(i\sigma_0 t)$ plus the forced nutation terms $m \exp(i\sigma t)$ and $n \exp(-i\sigma t)$. Then it can be shown that these lead to mean excitations which vary as $\cos(\sigma_0 \pm \sigma)\, t/2$, and that one of these produces an excitation that varies as $\cos(\sigma - \sigma_0)\, t/4$. The frequencies $(\sigma - \sigma_0)/2$ and $(\sigma - \sigma_0)/4$ correspond to the observed libration periods of about 12 and 24 years.

The calculated meridian of the librations is in satisfactory agreement with the observed meridian, λ_L. The angle between λ_L and λ_p, the meridian of the progressive motion, is given by $\lambda = \cot^{-1}(k/k_f \cot\theta)$, where k_f is the value of k for hydrostatic equilibrium, and θ is the angle between λ_p and the major axis of the seasonal excitation.

The amplitude of the librations, and apparent fluctuations in the progressive motion, both vary with σ_0 in a manner to be expected. When the natural frequency σ_0 approaches the forced frequency σ the excitations are enhanced, amplitudes become greater, and the mean pole is advanced in the direction of the progressive motion.

Changes in T, the length of the day, show an effective value of k apparently varying with d. The observed value of T and the amplitude of the polar motion since 1955 show

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similar '6-yearly' variations proportional to $|\cos(\sigma-\sigma_0)\, t/2|$. The range of these variations in T relative to atomic time was 3×10^{-9}.

The effective value of k (and hence of τ) depends inversely on the mean excitation. When the librational excitation grows larger the values of τ grow smaller than otherwise. Moreover λ then grows larger, as it should because effectively k grows smaller. The '6-yearly' excitation which is caused by the resultant of the free and forced nutations shows a similar effect; when the resultant is greatest the excitations which it causes are greatest and the values of τ are least.

These relationships point to periodic excitations that connect the nutations with the librations and with changes in T.

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