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Nonlinear Processes in Geophysics
Discussions

Interactive comment on "On the nonlinear and Solar-forced nature of the Chandler wobble in the Earth's pole motion" *by* Dmitry M. Sonechkin et al.

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While the paper definitely contains an interesting and fresh idea, this idea had not been mathematically developed by the author to the level at which it is possible to judge on its viability. Accordingly, I am at this point unable to say whether the paper is publishable or not. Below, I offer some guidelines for the further work. If the author provides a development along these, I shall be able to consider a new version of his paper.

1. Referring to Newcomb (1892), the author suggests that the augmented Euler frequency is given by \Omega (C-A-R)/(A+R). I am surprised to see the same addition '-R' both in the numerator and denominator. In the derivations, which I saw, the additions to the numerator and denominator turn out to be different.

For example, in equation (7.127) from the now-classical book https://doi.org/10.1017/CBO9781316136133 the corrections to the numerator and denominator do not coincide.

The theory of the Chandler wobble of the elastic homogeneous Earth is presented, in a remarkably simple language and with sufficient mathematical rigour, in the paper by Kubo: http://adsabs.harvard.edu/abs/1991CeMDA..50..165K From what I see there in eqn (3.11), the augmented Euler frequency of a homogeneous Earth looks as \Omega (C - A - R) / A, with no correction in the denominator. This tells me that the elasticity enters the correction to the numerator, not the correction to the denominator (the latter correction comes from the layered structure solely). So these corrections are not obliged to coincide.

2. The author argues that a solution expressed through the Jacobi functions "is applicable only to the free oscillations in the systems" and that "the respective solution is not known for the forced polar motion". I see no ideological problem here. Some day, someone should start out from the solution in the Jacobi functions, add perturbations, and employ the method of variation of parameters. The resulting system will be cumbersome, but in principle this programme can be accomplished.

3. Based on the said argument, the author suggests to approximate the Euler system with eqns (5).

While I am open-minded enough to consider this approximation, I refuse to accept the author's motivation for it. The motivation came from the complaint that the Jacobi-function solution is inconvenient to be generalised to the perturbed case. However, in eqns (5), I see no perturbation. So the above motivation bears no relevance to the method.

Nonetheless, the method by itself is of interest and may be worth pursuing.

Sadly, the author stops at eqn (7). After that equation, the author states that the sec-

ular term may be excluded by taking into account the dependence of the frequency on amplitude. The idea is sound – but, alas, the author provides no mathematics in support of it.

The author points out that the difference between \Omega_{rig} and the frequency of the semi-annual solar tide can produce a tone present in the measured power spectrum. Combining this tone with the frequency of the 8.85-year (3232-day) eastward precession of the Lunar node, the author obtains another observable tone.

While these observations are intriguing, they can serve only as an addition to a clear mathematical development (a toy model, at least).

So, if the author wants to make this manuscript bona fide and publishable, he absolutely must introduce some perturbation, to model the lunar and solar torques and to demonstrate how to remove the secular terms. Without such a development, the paper will remain a collection of interesting hypotheses.

4. Combining the tone given by eqn (10) with the leading Chandler frequency, the author arrives at the Hale cycle of the heliomagnetic activity. He then suggests that the wonder of the magnetic pole must render a torque influencing the Earth rotation. This is a totally separate (and extremely complex) topic, and I would recommend the author to reserve it for a separate project – lest we get in this paper more hypotheses than proofs.

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