Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2020-74-AC3, 2021

Earth System Dynamics
Discussions
Open Access

Interactive comment on "ESD Ideas: Long-period tidal forcing in geophysics – application to ENSO, QBO, and Chandler wobble" *by* Paul R. Pukite

Paul Pukite

puk@umn.edu

Received and published: 5 January 2021

Prof. Zotov preceded by »

» To my knowledge, the problem discussed is not so easy, as it could be imagined. Of cause, El Nino oscillation and QBO seems to be reproduced by GCMs, but predictions are still comprehensive, for example strong El Nino 2016 was unexpected. At the same time LOD started to decrease after 2016 and it was also unexpected.

This is at best a 2nd-order effect. The consistent cycles of LOD are thoroughly explained by periodic tidal forcing. Figure 1 below shows how well the tidal factors model the dLOD/dt, where it also clearly reveals the repeating 18.6 year nodal envelope over the 3 panels.

Printer-friendly version

Discussion paper

» Very strong El Nino repeats at the beginning of the declining phase of LOD, what makes us to think about possible connection of these phenomena.

Yes, there may be some 2nd-order effects here, but the 1st-order mechanism must be explained first.

» But simple tides also do not explain what we observe.

I suggest they do, at least in that they may explain the 1st-order observations. It is entirely possible that some other mechanisms can explain the 2nd-order variations.

» Chandler wobble frequency does not present anywhere else in Earth systems, thus we do not see any pike in the excitation spectra at 0.843 cpy, at the same time we know from theory, that Chandler frequency is somewhere near resonance.

Like the QBO, the Chandler wobble is essentially a wavenumber=0 mechanism, which can only occur for behaviors that have no longitudinal dependence. In other words, across longitudes any axial torque applied is invariant to the inertial moment response. Thus, only the draconic/nodal 27.2122 day lunar cycle can provide a 1st-order forcing stimulus. In contrast, the LOD response must include the variation of land relief and tidal bulges which interact strongly with the tropical/synodic 27.3216 day cycle. That is also why the higher wavenumber ENSO (which is confined to the Pacific ocean) is much more sensitive to the tropical cycle than the draconic cycle.

» Amplitude of Chandler wobble is changing with 40 and 80-year modulations. In the combinations of solar and lunar frequencies we can find some close-bye modes.

This is a 2nd-order effect that may be more adequately explained after the 1st-order effects are substantiated.

» The interests of N. Sidorenkov, for sure, are in the field of interrelations of frequencies of El Nino, QBO and Chandler wobble. And in his book and papers this question was risen decades ago.

Yes indeed, I transitively referenced Sidorenkov in a citation and in a previous response to this submission.

» I did not quite understood the author's calculations, why 0.42 – the remainder of the division of solar year by draconic month should be doubled to satisfy 0.84 cpy frequency of Chandler wobble, but I know that in the publications of Sidorenkov it is mentioned, that atmospheric processes and spectra of QBO, if doubled, will remind the spectra of Polar motion at annual and Chandler frequency. So, his works should be referred to.

The 0.42y period is a sample-and-hold behavior of QBO generated by modulating the draconic (or nodal 27.212 day cycle) lunar forcing with an annual impulse generating a lagged response. As described in Mathematical Geoenergy (Wiley/2018), it should have the predicted frequency response peaks as shown in Figure 2.

The 2nd, 3rd, and 4th peaks listed (at 2.423, 1.423, and 0.423) are readily observed in the power spectra of the QBO time-series. When the spectra are averaged over each of the time series, the precisely matched peaks emerge more cleanly above the red noise envelope âĂŤ see the bottom panel in Figure 3.

The inset shows what these harmonics provide âĂŤ essentially the jagged stairstep structure of the semi-annual impulse lag integrated against the draconic modulation. It is important to note that these harmonics are not the traditional harmonics of a high-Q resonance behavior, where the higher orders are integral multiples of the fundamental frequency âĂŤ in this case at 0.423 cycles/year. Instead, these are clear substantiation of a forcing response that maintains the frequency spectrum of an input stimulus, thus excluding the possibility that the QBO behavior is primarily a natural resonance phenomena. This does not preclude an additional natural response that may selectively amplify parts of the frequency spectrum.

» In my opinion, the hypothesis of Chandler wobble, El Nino and QBO teleconnections is not proved, but is interesting.

Thank you for the interest.

» Yu. Avsyuk, in particular, pointed out, that full moon in Perigee happens every 412 days, what is somewhere close to the Chandler frequency. Chandler spectrum pike is splitted and should be forced by something, otherwise it would damp.

This is indeed the case, as when a forced response behavior occurs, the fundamental frequency of the Chandler wobble should precisely match the input forcing period – which is what the model described in this submission accomplishes. The doubling of the frequencies from QBO to Chandler wobble are understood by considering the topologies of the physical mechanisms – the Chandler wobble is largly hemispherically symmetric while the QBO likely shows a topological boundary due to the equatorial waveguide, inducing the reversal of the stratospheric winds. That can also be clearly observed with the semi-annual (SAO) that occurs above the equator. See Figure 4.

» But the frequencies do not match exactly. Tidal effects for LOD are well modeled, but even here we do not know exactly, why long-term, 20 and 80 – year modulations exist.

Perhaps that can be better explained after establishing a firm foundation for the collective behavior across several phenomena.

» The working hypothesis is angular momentum exchange in the Earth interior. Thus, there are unresolved problems in geophysics, including mentioned in the article, and we need ways to solve them.

That is a possibility of course.

» At that, the possible synchronizations of geophysical and astronomical processes look intuitively very beautiful, but need further development.

That will definitely occur.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2020-74, 2020.

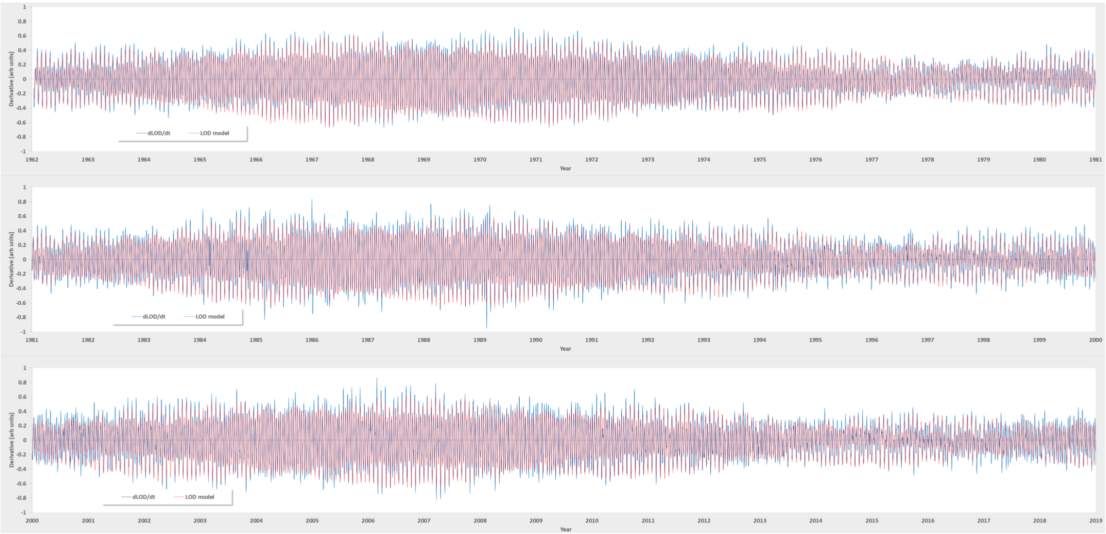

Fig. 1. Measure and model of dLOD/dt showing strong tidal forcing

Printer-friendly version

Discussion paper

Table 11.1 Physically Aliased Frequencies and Periods of the Draconic Lunar Month Against an Annual Cycle.

Aliased Harmonic	Frequency (1/year)	Period (year)
Y/27.212-10	3.423	0.292
Y/27.212-11	2.423	0.413
Y/27.212-12	1.423	0.703
Y/27.212-13	0.423	2.363
Y/27.212-14	−0.577	−1.734
Y/27.212-15	−1.577	−0.634
Y/27.212-16	−2.577	−0.388

Fig. 2. Predicted physically aliased draconic harmonics for QBO, from Mathematical Geoenergy (Wiley, 2018)

Printer-friendly version

Discussion paper

Fig. 3. Identified aliased draconic harmonics in QBO spectra, at 0.42, 1.42, 2.42/yr

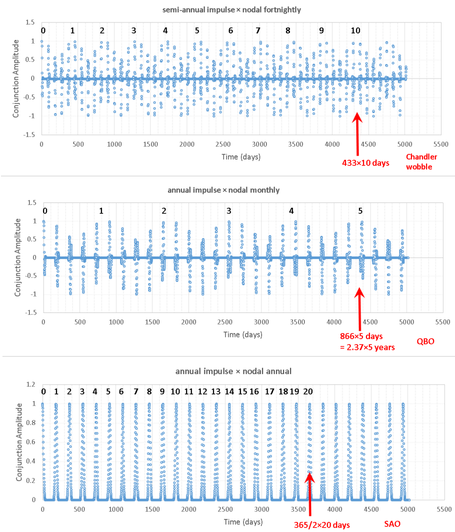

Fig. 4. Generation of forced response dependent on selection of impulse and tidal forcing