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Earth System Dynamics
Discussions

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

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Definitely can include reference to Siderenkov, as his book "The Interaction Between Earth's Rotation and Geophysical Processes" published in 2009 is quite comprehensive.

» "I would also recommend the references to I. Serykh and D. Sonechkin, who are trying to connect Chandler wobble, QBO and El Nino for a long period of time already. But it is not obvious, how 1.2-year period of the first one can be doubled in QBO and in El Nino further"

Given that it is straightforward Newtonian 3rd-law physics to attach the nodal cycle of the moon to the 433 day Chandler wobble cycle, the doubling of that period for the

QBO does seem counter-intuitive. But one must also consider how non-intuitive the semi-annual cycle of the stratospheric winds (SAO) that occurs in altitudes above the QBO must also seem. The SAO having a semi-annual cycle means that the equatorial winds reverse for every nodal crossing of the sun over the equatorial plane, so that it will reverse on a South-to-North crossing and then the next North-to-South crossing. So when this is applied to the aliased draconic lunar nodal crossings, the math works out that the synchronization period doubles to 2*433 days or $\sim$28 months. This may seem additionally counter-intuitive that it is *the period* and not *the frequency* that doubles, but that is just due to the precise aliasing of the faster lunar cycles against that of the slower annual cycle. In other words, where the aliasing occurs is in a sense arbitrary – it could be faster OR slower. I supplied the charts for this on a previous response.

For El Nino and ENSO, the explanation becomes more complex, as the non-linearity of the solution to Laplace's Tidal Equation will generate many harmonics that will populate the frequency spectrum, as frequency doubling and Double-Sideband Suppressed-Carrier Modulation (DSCM) of the annual impulse will densely populate the power spectrum. For example, with ENSO, the aliasing of the strong 9-day Mt tide against the annual cycle will lead to modulation at periods upwards of 100 years, and the closeness of the aliasing of the strongest fortnightly Mf tide (producing 3.8 year cycle) and the second strongest monthly Mm tide to the annual cycle (producing a 3.9 year cycle), will also produce long-term variations. See attached Figures 1 and 2.

Thank you for the review, and certainly agree that Siderenkov, Serykh, and Sonechkin along with Zotov have been working this angle for years, but the additional novel mathematical analysis is needed to make it a quantitative instead of a qualitative hand-waving model of the geophysics and geophysical fluid dynamics.

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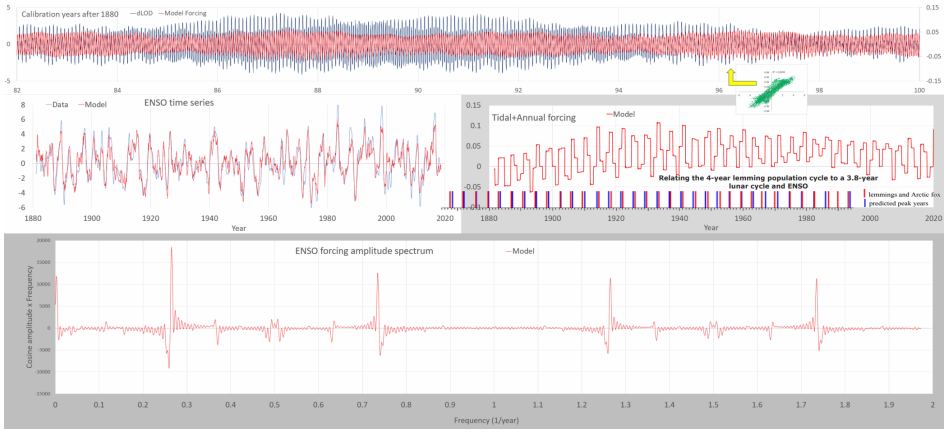

Fig. 1. A 3.8 year cycle agrees with the ENSO model driven by the fortnightly tropical cycle (13.66 days) interacting with an annual cycle, which is indicated in the middle right pane in the figur

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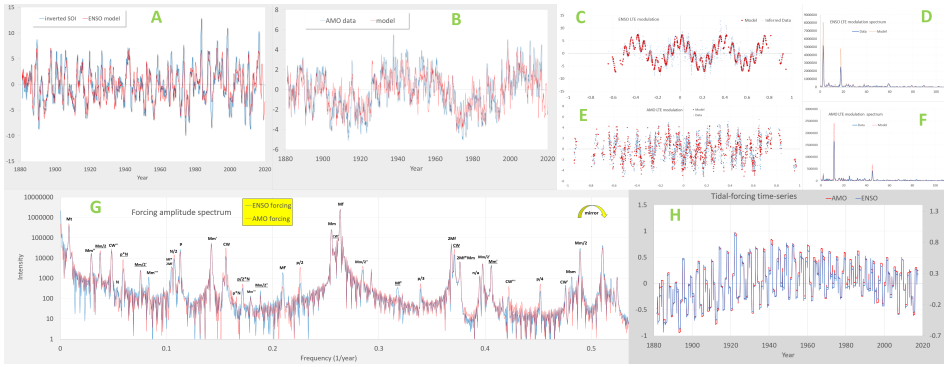

Fig. 2. Slight difference in the Mf, Mm, and Mm tidal forcing strength can explain differences between ENSO/SOI and AMO