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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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» "Power spectra of ENSO reveal numerous spectral density peaks at the periods, which are sub- and superharmonics of three different external climate system forcings with seemingly incommensurate periods (Serykh and Sonechkin, 2019). These forces are: Chandler wobble in the Earth's pole motion (âĹij1.2 year period), the Luni-Solar nutation of the Earth's rotation axis (âĹij18.6 year period), and the âĹij11.5-year Sunspot cycle."

The Fourier series of strongly modulated cyclic behavior is not always straightforward. Consider that ENSO is well-known to be reinforced by a strong annual impulse – the so-called spring barrier. This annual impulse when modulated by another function (such

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as tidal forcing) will create a completely different set of incommensurate periods which are not sub- or superharmonics of a fundamental frequency, but as satellite peaks of the harmonics of the annual frequency. One can verify that this is occurring by applying a mirror-symmetry pattern matching of ENSO frequencies from 0 to 0.5 cycles/year to the reversed 1 to 0.5 cycles/year – see FIGURE 1 and FIGURE 2. This satellite pairing is referred to as double-sideband suppressed carrier modulation, and one of the "appropriate signal processing techniques" I refer to in the abstract, well-known by DSP/Fourier analysts.

It is crucial that any analysis of ENSO considers this pattern, as otherwise the conventional harmonic analysis will lead one to incorrect fundamental forcing periods. Unfortunately, there are no references in the literature to any ENSO studies that apply the double-sideband suppressed carrier modulation analysis. The idea suggested here is to continue along this track and further apply the nonlinear Laplace's Tidal Equation solutions that I described in Mathematical Geoenergy (Wiley,2020) which will accurately identify each of the lunisolar factors that are involved in the geophysical fluid dynamics forcing.

Thanks to Serykh, Sonechkin and others for pointing to lunisolar factors as a mechanism, but they fall short in providing the complete picture that I am suggesting should be applied, which is the motivation for submitting a more comprehensive approach (i.e. as from the abstract : "simplifying the math of fluid dynamics and applying the appropriate signal processing techniques") as an ESD Idea.

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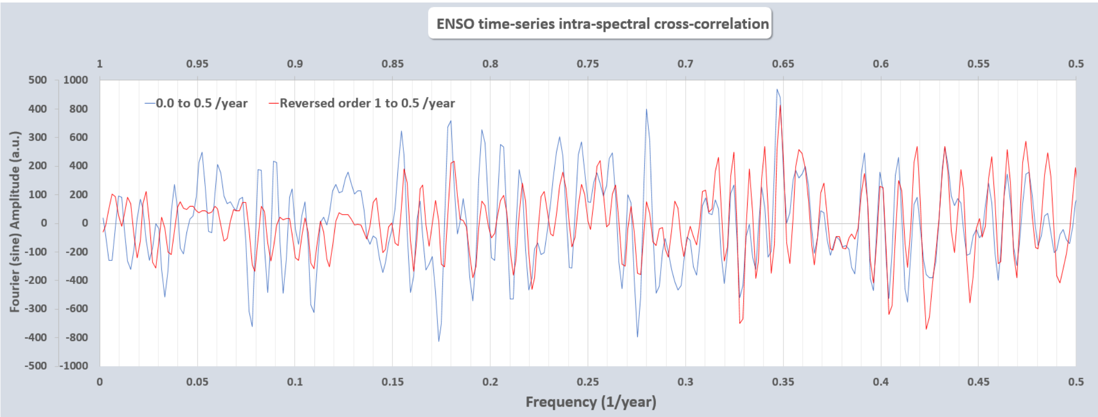

Fig. 1. Lower x-axis is the lower sideband interval (blue) and upper x-axis is the symmetric upper sideband interval (red) shown in reverse

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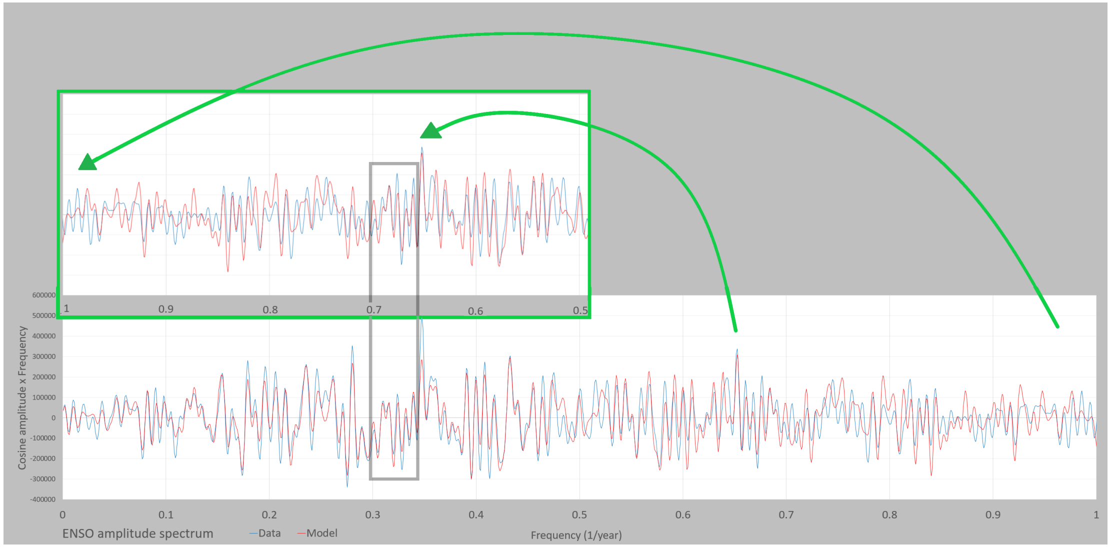

Fig. 2. Mirror folding of the frequency axis, from P. Pukite. "Nonlinear Differential Equations with external forcing." ICLR 2020 Workshop on Integration of Deep Neural Models and Differential Equations. 2020