Comment on the Planetary Influences Paper by Abreu et al. (2012)

Leif Svalgaard, February, 2013

Examination of Abreu et al.'s Figure 1 shows power around 1000 years, perhaps also 2000 or even ~7000 years, even though the latter ones may not be significant:

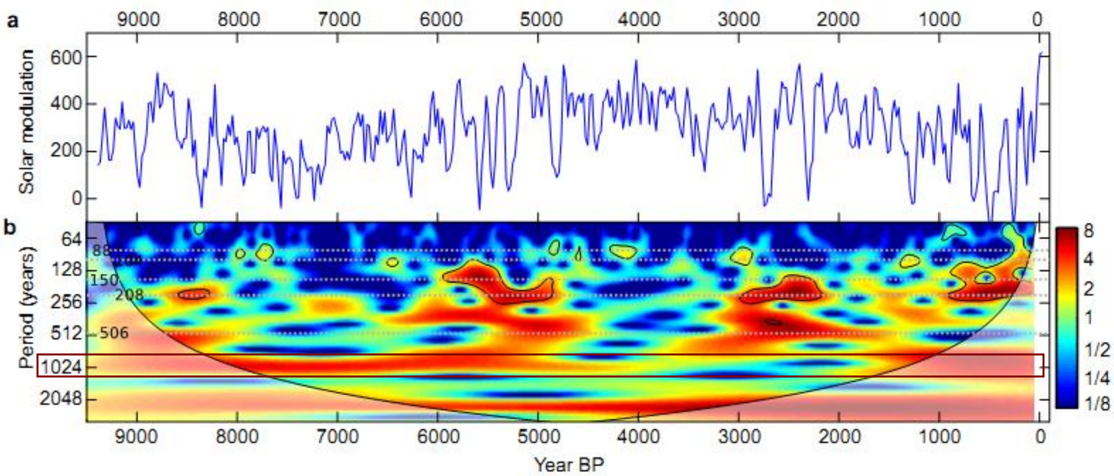

Fig. 1: Properties of solar activity reconstructed from cosmogenic radionuclides. (a) Solar activity for the past 9 400 years, as specified by the solar modulation potential determined using the cosmogenic radionuclides 10Be and 14C (Steinhilber et al. 2012). (b) Corresponding wavelet analysis of solar activity showing the temporal evolution of the amplitudes of the various periodicities. The box around 1024 years shows the power at that period.

Other people [e.g. Scafetta, 2012] also claim to find a ~1000-yr period, sometimes called the Bond cycle period. Such long periods are difficult to investigate because many of the assumptions we usually adhere to may not apply over such long periods and the meaning, calibration, and stability of our datasets become increasingly uncertain as we go back in time. Let us for the moment take at face value that there is a ~1000-yr 'period' or fluctuation in the Cosmic Ray data. Such a variation may be solar or not, as we have to correct for [poorly known] climate and geomagnetic field variations which could have long cycles too.

But for the sake of the argument let us consider some influence with a 1024-yr period on the cosmic rays record in addition to the 10.81-yr solar cycle [both values are somewhat arbitrary, but good enough for the argument to follow]. Let us also assume that there are no other periodic forces at work so that the data record is just a convolution of 1024-yr and 10.81-yr cycles.

Although there are much more sophisticated methods to tease cycles out of data, if the cycles are real and strong the Fast Fourier Transform [FFT] is sufficient to show such cycles.

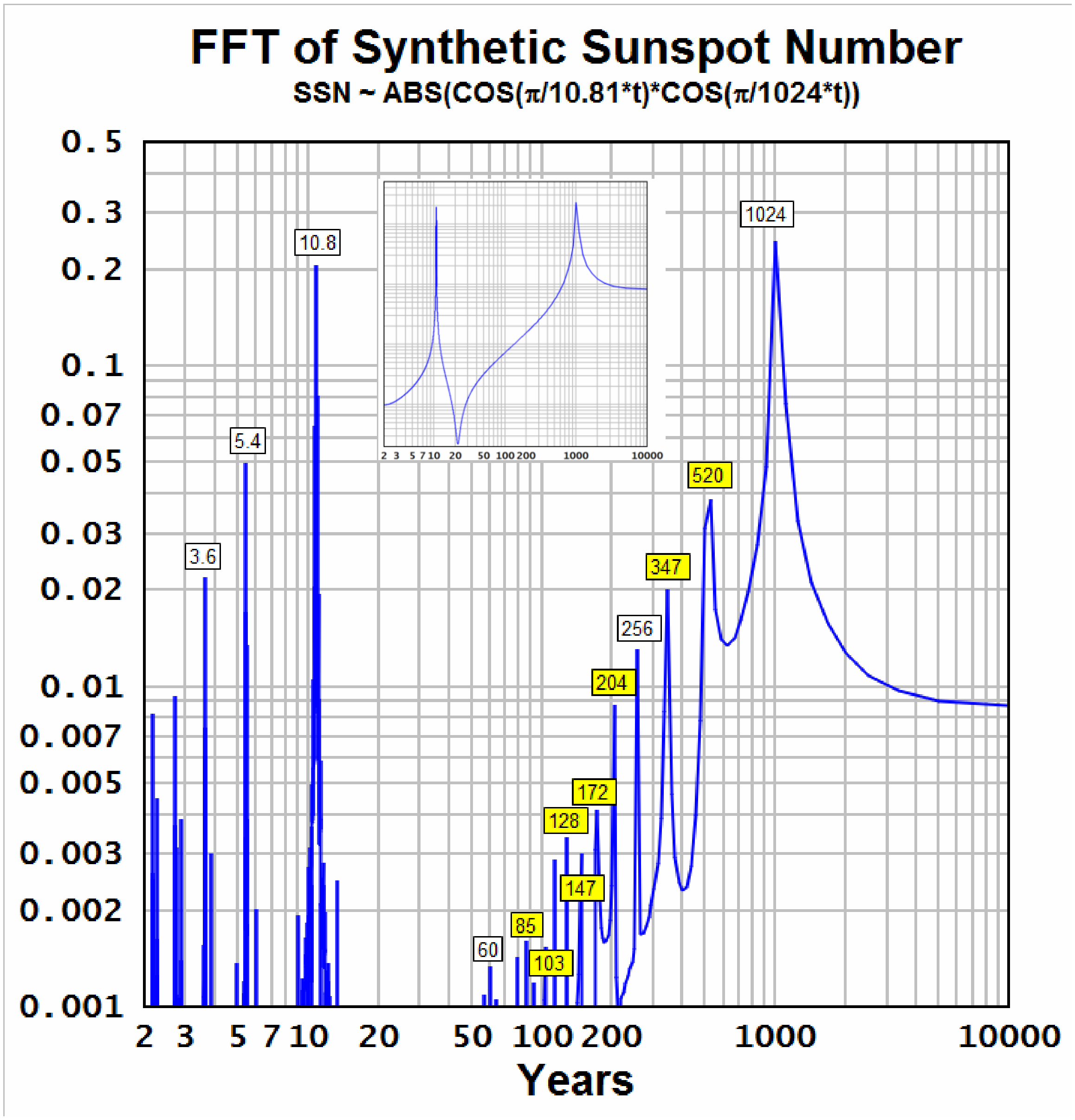

Figure 2. Computed FFT for synthetic 'sunspot number' using eq.(1). Boxes show the period for several of the peaks. The insert shows the result if both COS-factors are squared [no harmonics…].

For simplicity we generate a synthetic 'solar activity' number as follows:

$$\text{Syn. } SSN = \text{ABS}(\text{COS}(\pi/10.81*t)*\text{COS}(\pi/1024*t)) \qquad (1)$$

Where t is time in years and only π instead of 2π is used because we take the absolute value of the product of the two wave forms. The result is a reasonable 11-yr modulation 'cycle' riding on a slowly varying background. We generate 10,000 years of data and compute the FFT as shown in Figure 2. Since the data are not pure cosine curves there are a number of harmonics [which by the way disappear if the cosines are squared].

The peaks marked with yellow boxes have to very good approximation the very same periods as the peaks identified by Abreu et al., casting some doubt on their claimed high statistical significance with probability of the order of 10^{-11} compared to random occurrence at those frequencies. All it takes, is ***one*** underlying long period of 1024 years of a variation that is not quite sinusoidal, and that may not be solar, to generate the 'planetary peaks'.

The peaks in Figure 2 are harmonics of the 'main' peak at 1024 years:

Period *P*	Harmonic *n*	*n * P*
60	17	1020
85	12	1020
103	10	1030
128	8	1024
147	7	1029
172	6	1032
204	5	1020
256	4	1024
347	3	1041
520	2	1040
1024	1	**1024**

It doesn't really matter what the period of the 'solar' modulation is. The 1024-yr harmonics stay firmly in place [as they should as long as the modulation cycle is much shorter than 1024 years]. There are claims of a 'Halstatt' cycle with a period of about 2300 years. If the Halstatt cycle were 2048 years long [and I don't think the data excludes that] then the same peaks would be produced, except they would only be the even harmonics and there would also be odd harmonics which do not match any of the Abreu periods. So, no 2048 year cycle.

The periods are [as expected] really just fractions of the 1024 year main period:
1024/1, 1024/2, 1024/3, 1024/4, 1024/5, 1024/6, 1024/7, 1024/8, 1024/10, 1024/12,…
Somewhat reminiscent of a Balmer Formula for lines in the Hydrogen spectrum.

We can dispense with the 'modulation' cycle as it does not alter the peaks. In a next exercise we take the square root [to 'flatten' the series a bit] of the absolute value of the cosines and add some random noise [10%]. Thus

Syn SSN = SQRT(ABS(COS(π/1024*t) + 0.1*RAND()   (2)

The result is shown in Figure 3, generating data for 20,000 years. Increasing the noise (e.g. to 100%) 'drowns' some of the weaker lines, but has otherwise negligible impact on the periods.

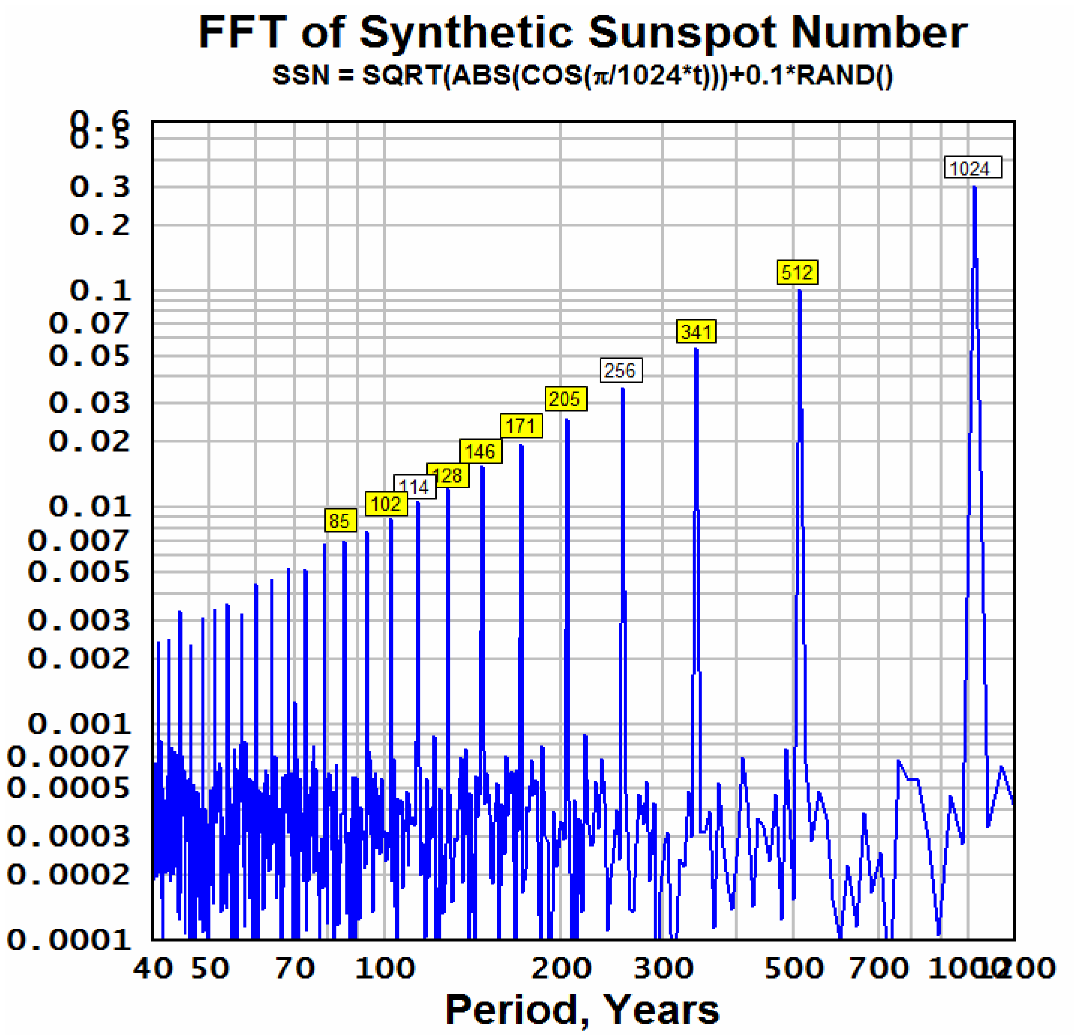

Figure 3. Computed FFT for synthetic 'sunspot number' using eq.(2). Boxes show the period for several of the peaks. The random noise is set to 10%.

References:

Abreu, J. A.; Beer, J.; Ferriz-Mas, A.; McCracken, K. G.; Steinhilber, F., Is there a planetary influence on solar activity? Astronomy & Astrophysics, Volume 548, id.A88 (2012), doi:10.1051/0004-6361/201219997

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