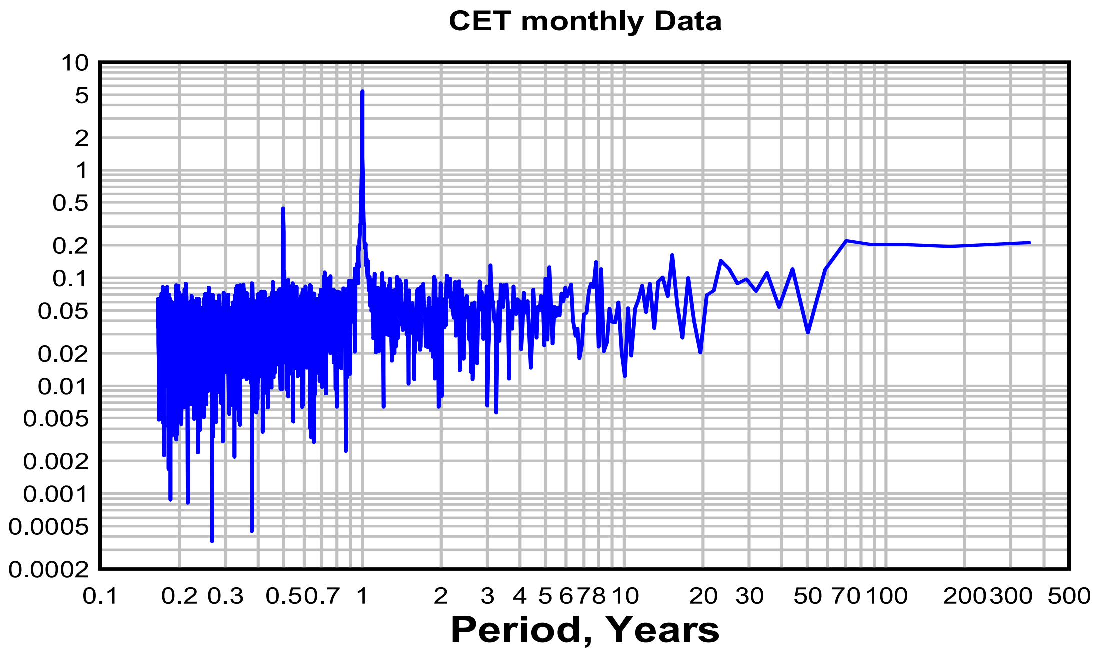
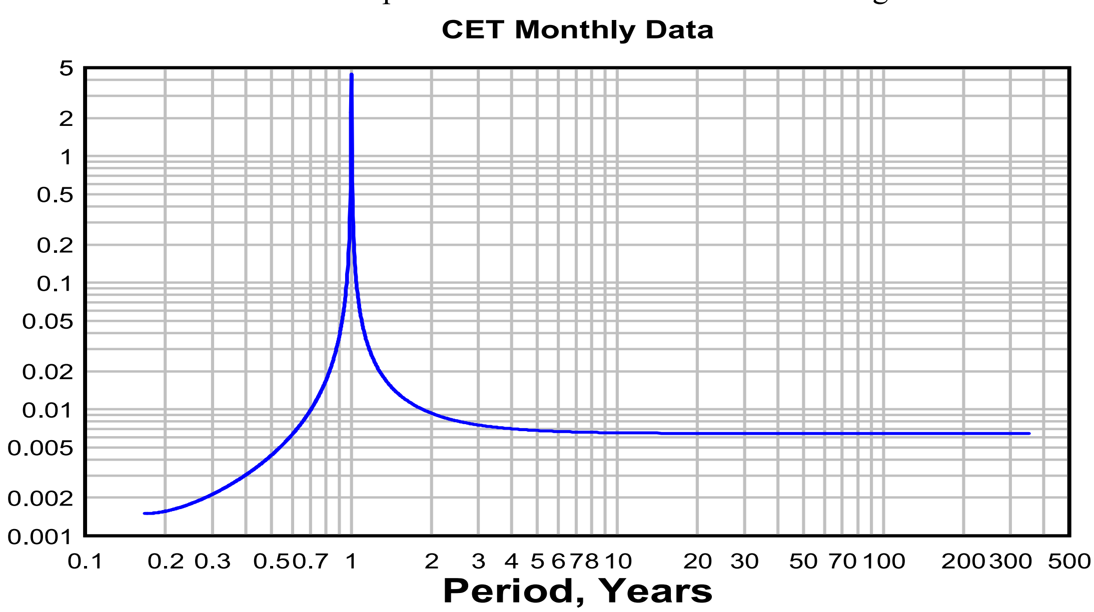
FFT Power Spectrum of Central England Temperature (CET)

First we calculate the FFT power spectrum of CET 1659-2010. It look like this:



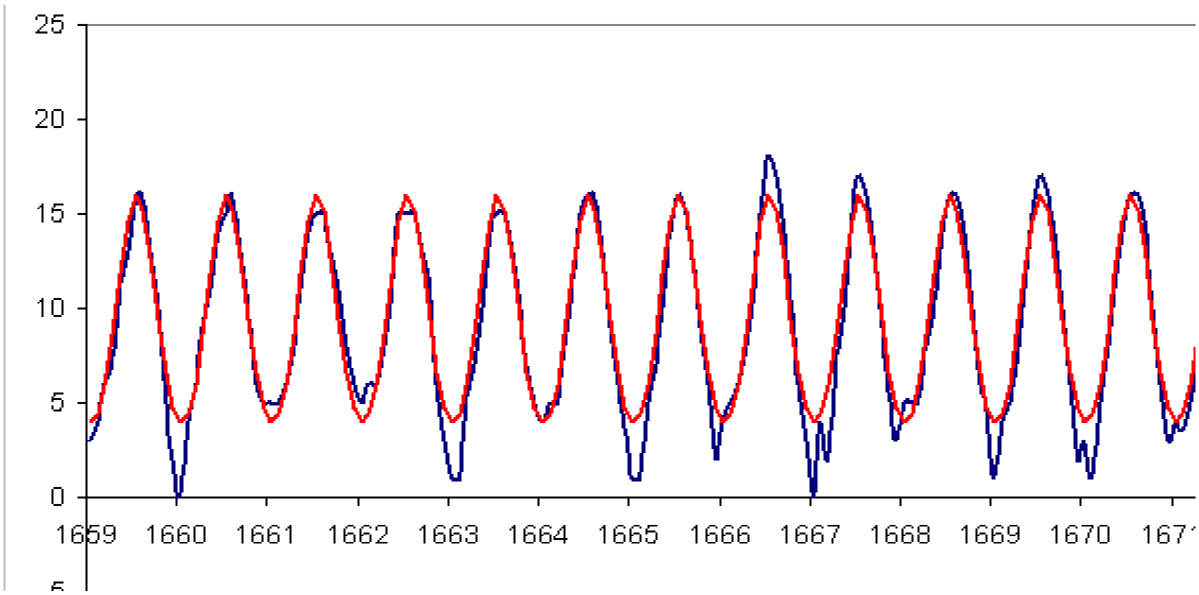
Note that there is a strong yearly variation [no surprise], i.e. a spike at 1 year. Because there are slight variations from year to year, the 1-yr line is broadened a bit. Also note that there is no 11-yr line, if anything a lack of power at that period. There is a very sharp line at half a year.

The variation of CET through the year is roughly sinusoidal, but not quite. Let us first see what the FFT would look like for a perfect sine curve with the same average variation as CET:

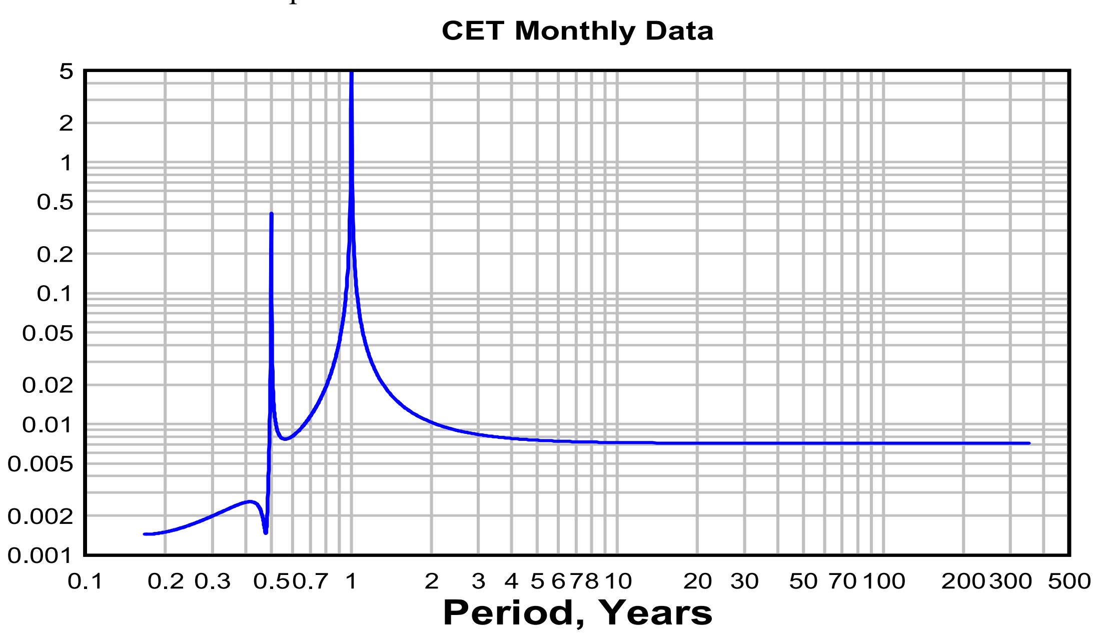


You see a sharp spike at 1 year [as expected]. But no ½-yr spike [this is also expected]. Now, inspection of the data shows that the yearly variation is not quite a sine curve but is a bit 'skinnier'

We can model that by not using the perfect sine curve but an analytical curve that has the same degree of skinniness. I have here used CET[model] = $[3+1*\text{COS}(2\pi*\{\text{time}-1659.0\}+2.81)]^2$. Many other functions could have been chosen. What matters is that the model has the same skinniness as the data. Here you can compare the model [red] with the CET data [blue]:



Sometimes the maxima or minima 'overshoot the model. This is noise that shows up on the first FFT as the 'forest' of spikes.



Now you see a very sharp line at exactly ½ year. This is caused by the actual CET not being a perfect sine wave. The ½-yr spike is in both FFTs very small, just about 1/10 of the yearly variation or about half a degree. We cannot conclude that there is an additional cause of the ½ year wave by just looking at the data without assuming that the yearly variation is a perfect sine curve, which would be somewhat of a miracle as the seasons have different lengths and the months as well. .