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Interactive Comment

Interactive comment on "Technical Note: Long-term memory effect in the atmospheric CO_2 concentration at Mauna Loa" *by* C. Varotsos et al.

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This comment is to demonstrate that the "obvious technical flaws" identified in Janosi (2006) are just an artifact due to superficial application of detrended fluctuation analysis (DFA, Peng et al. 1994,1995). Upon following the procedure suggested by Hu et al.(2001) and hence applying DFA correctly, one identifies the existence of long-

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range correlated noise with α-values close to unity, even in the simple (first) method of removing seasonality suggested in Janosi (2006). The α-values obtained, in such a way, actually coincide, within experimental error, to those reported by Varotsos, Assimakopoulos and Efstathiou (2006). In other words, when following the method of Janosi (2006) to remove seasonality, the results of DFA strengthen the existence of long-range correlated noise in the time-series of the monthly atmospheric CO_2 concentration time-series at Mauna Loa.

FIGURE 1 available online at

`http://www.cc.uoa.gr/~nsarlis/DFACO2/FIGUREandCAPTION.pdf`

Following Janosi (2006), from the monthly CO_2 data available at http:/cdiac.esd.ornl.gov/ftp/trends/co2/maunaloa.co2, we disregarded the first year (1958) because there were 4 months missing. The data for 1964, for which 3 months were also missing, were filled, in our case, with the following values [CO_2](Feb64) = 319.96 ppm, [CO_2](Mar64) = 320.77 ppm, [CO_2](Apr64) = 322.01 ppm; these values were obtained by a fourth order polynomial fit to the 45 years data for each month. The resulting time-series was then subjected to the first "simplest" method to remove seasonality suggested in Janosi (2006), i.e., one computes the 46 years average of each month and subtracts these averages from the raw data. This way we obtained the time-series of Fig.1(a) in which we also added an appropriate constant so that the time-series starts from zero in January 1959. The latter point, which of course does not modify the results of the DFA, helps us identify in Fig.1(b) the existence of a power law trend u(i)=$A_p i^\lambda$, with λ =1.35, in the "deseasonalized" time-series (we followed here the notation of Hu et al.(2001)). The analysis of correlated noise superimposed on a power-law trend by means of the DFA has been studied in detail by Hu et al. (2001) who suggested (verbatim) "Thus, for all values of λ the minimal order l that can be used in the DFA method is $l > \lambda + 0.5$, e.g., for $\lambda = 1.6$ the minimal order of the DFA that can be used is l=3". In the present case, $\lambda = 1.35$, thus the minimal

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order of the DFA is l=2, shown in Fig.1(c). The results for l =3,4,5 are also shown in Figs. 1(d), 1(e), 1(f), respectively. The corresponding α-values are 1.03(3), 1.00(3), 1.01(4), 0.91(3) starting from l=2 to l=5. The behaviour suggested as "kink" in Janosi (2006) at intermediate $\log \Delta\tau$ comes from un-eliminated periodicity, which does not appear in Varotsos, Assimakopoulos and Efstathiou (2006) because they performed more effective removal of the seasonality. This should not hinder the identification of the existence of long-range correlated noise in the data for the following reason: When Hu et al. (2001) studied the influence of periodic trends superimposed on long-range correlated data, they obtained their Fig.6(a), which is strikingly similar to our Figs.1(c) to (f). In other words, the un-eliminated periodic trend results in the presence of a "kink" that disappears in smaller as well as in larger time-scales; the fact that the slope does not markedly differ in the low and the high parts of the DFA (see Figs.1(c) to (f)) suggests that this slope corresponds to the actual α-value of the long-range correlated noise.

The fact that the (first) simple method suggested in Janosi (2006) leads (through the aforementioned correct application of DFA) to apparently the same scaling exponents as those suggested by Varotsos, Assimakopoulos and Efstathiou (2006), who used a different method to remove seasonality, strengthens the existence of 1/f noise in the atmospheric CO_2 concentration in Mauna Loa. The latter result does not come from the resurrection "of the golden age of box counting" but from the careful application of modern techniques of statistical physics to time-series of complex dynamics(Varotsos 2005, Varotsos, Ondov and Efstathiou 2005, Varotsos and Kirk-Davidoff 2006) .

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