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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "Effects of cosmic ray decreases on cloud microphysics" *by* J. Svensmark et al.

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By proper smoothing to highlight trends, or by just looking at the raw signal in Fig.1 in my very first comment, one observes that the seasonal trend is not sinusoidal, but a complex quasiperiodic pattern including more than one frequency. Spread of the FDs over the year is therefore not a guarantee that they do not take place at times of larger natural fluctuation levels. The argument that the linear detrending removes seasonal trends is only true for the means. It does nothing to the trends in fluctuation level, which is what is important here.

Moreover, as I will show below (see Fig.2 below) the authors' estimation of the natural fluctuation level in the figure in their comment is flawed. The natural fluctuation level on the time scale of the contended FD response (∼20 days) is highly variable and has a spiky structure in time. This makes it virtually impossible to decide whether a large fluctuation is ”natural” or a response to an FD.

In my Fig. 3 in my previous comment I used a 120 day running window and computed extreme values in these windows, because this window size and those extreme values are what the authors have based their statistical arguments on so far. Now they claim that those extreme values ”could be due to an anomaly that does not represent the actual level of fluctuation.” In their previous comment they argued that averaging over 5 windows corresponding to the 5 strongest FDs would reduce the influence of such anomalies. I acknowledge that while I looked at the statistics of the extremes in single windows, the authors in the paper look at the extremes of a signal which is averaged over 5 windows , so what I should have done is to average the 20-day moving-average-detrended signal over 5 successive 120 day windows and then compute the extreme of this averaged signal. Then to repeat this procedure in a 5x120=600 day running window. The result is shown in my Fig.1 below. The structure is is the same as Fig. 3 in my previous comment. Extreme values are reduced by about 1/sqrt[5], but we also have the same reduction in the standard deviation. Hence, I find that 36% of the extrema are beyond the 2.5 sigma value, which is essentially the same as found in my previous comment.

Before I proceed, let me stress that the detrending by subtracting a 20-day moving average is essentially equivalent to the 20-day box linear detrending used by the authors. I use it because it is easier to implement numerically.

In their comment the authors introduce the idea of looking at the standard deviation of the fluctuations around the 20-day linear trend instead of evaluating extremes. I think that is legitimate. But then they proceed to evaluate this standard deviation in a 120-day running window, which is toally unjustifiable, and has the effect of a further moving-average smoothing, which of course reduces the fluctuation level.

The authors’ method is essentially equivalent to the following steps:

1. Produce a 20-days-detrended signal.

2. Evaluate the standard deviation in a 20-day running window. This gives the fluctuation level sigma_20(t) on the 20-day time scale as a function of time, and is a relevant quantity for assessing FD responses.

3. Evaluate the mean standard deviation <sigma_20> on this time scale, which is the mean of the time series in point 2.

4. What the authors should have done is to compute the time series of the ratio sigma_20(t)/<sigma_20>, which gives an impression of the magnitude of the natural fluctuation level as a function of time relative to the mean fluctuation level on the 20-day time scale.

5. What they actually do is to produce a 120-day moving average of the signal in point 4, which will reduce the fluctuation ratio. This smoothing is not physically relevant, since the contended duration of an FD response is about 20 days.

The result of these procedures is shown in Fig.2 below. The red curve is produced according to point 5 above, and is identical to the one produced in the authors' comment, the blue curve is the proper one described in point 4 above. The actual fluctuation levels are much more variable and deviate much more from the fluctuation level mean than contended by the authors. Note, for instance that FD 2 and 3 occur at positive spikes in the fluctuation level, while many other similar spikes occur without any FDs.

I would also like to lead the authors' attention to the autocorrelation function for the 20-day detrended signal which I presented in Fig.2 in my previous comment. This curve has a structure very similar to the conditionally averaged "response" for the principal component presented in the paper (a minimum after 7 days and a recovery after 15 days followed by an overshoot). This is the correlation function for a strongly damped oscillatory response, and since it is so strong it obviously occurs all the time whether there are FDs or not. Hence there is nothing in the correlation structure either that can

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help us to separate an FD response from an natural fluctuation.

In my opinion this has been an interesting and useful dicussion. Unfortunately other obligations in the coming week will prevent me from contributing more to it up to the deadline on March 28th. My recommendation to the editors in my first referee report was not to publish the discussion paper as a regular paper. The reason I did not suggest the option of submission of a substantial revision was that I could not see a way that statistical significance could be demonstrated beyond reasonable doubt from these data. The discussion has not changed my position on that, and since what is still submitted for review is the original manuscript which claims that an FD-cloud response is rigorously proven within a high degree of statistical certainty, my recommendation must be rejection. Recommendation of publication from my side would require resubmission of a paper either with milder claims, or with more convincing data and/or analysis, preferably both.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 3595, 2012.

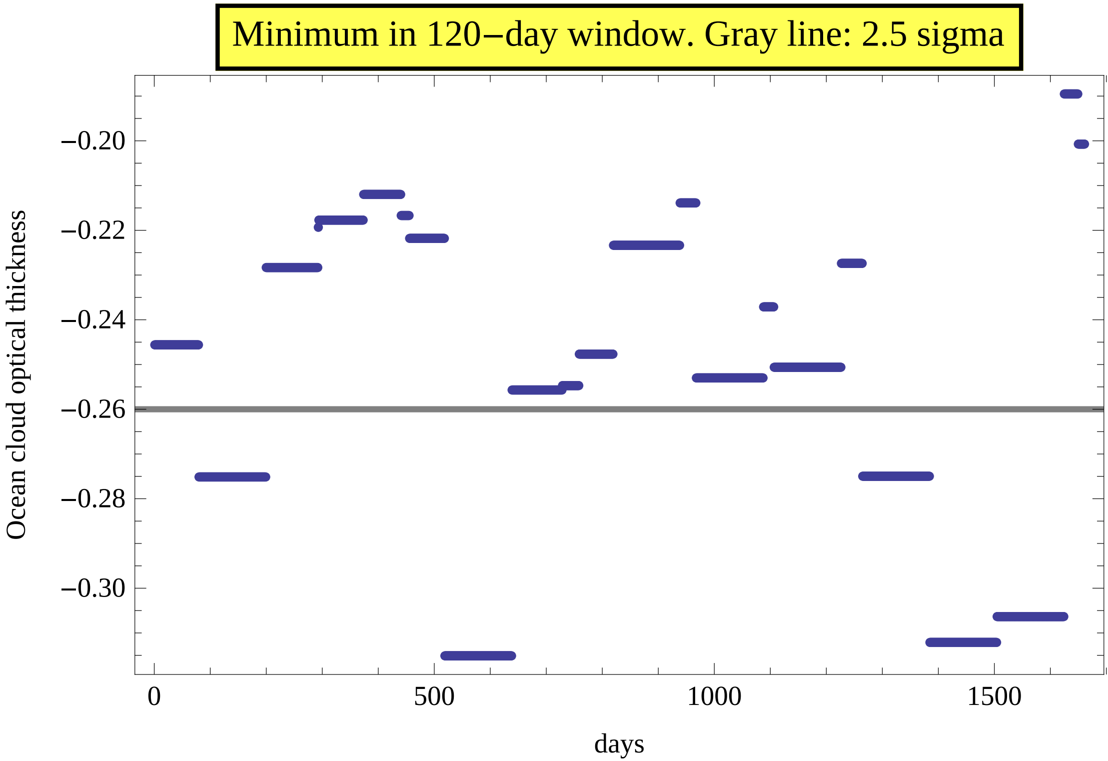

Fig. 1. Extrema in 120-day windows of the signal obtained by averaging over a sucession of 5 such windows.

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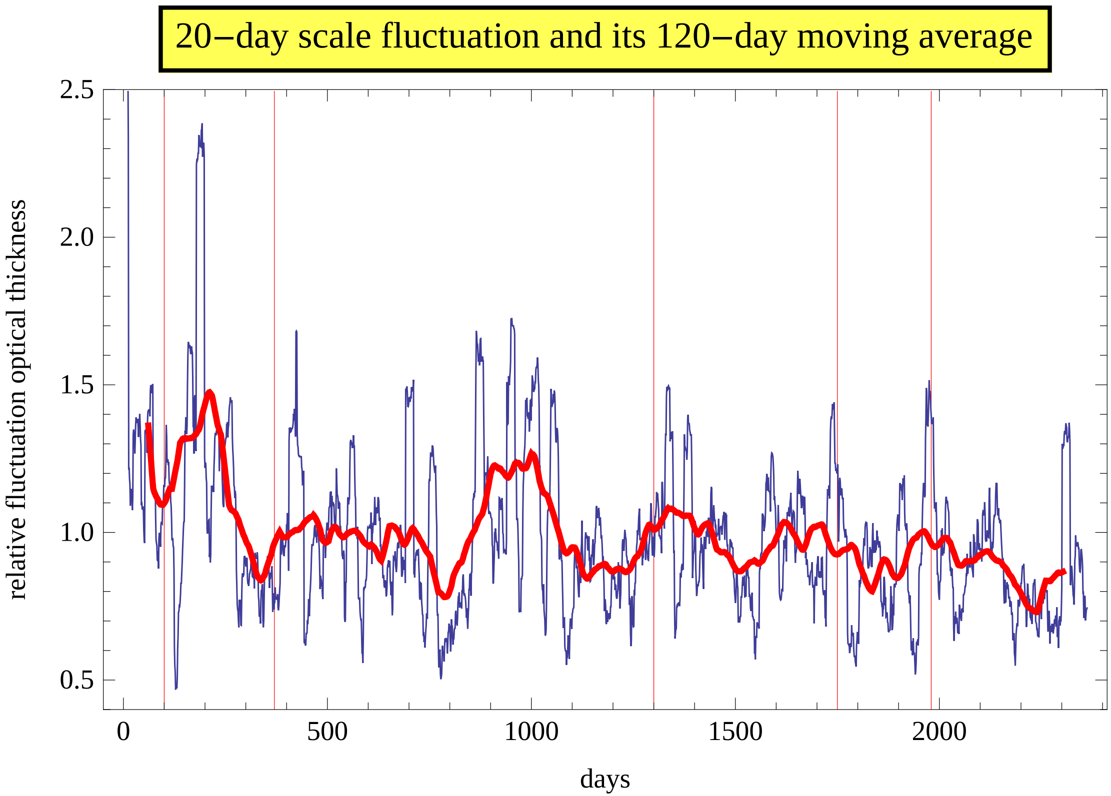

Fig. 2. Blue curve: Relative fluctuation levels on the 20-day time scale (see text). Red curve: 120-day moving average of the blue curve.

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