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Atmospheric Chemistry and Physics Discussions

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

**J. Svensmark et al.**

enghoff@space.dtu.dk

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Dear Kristoffer Rypdal,

Thank you for these additional comments. The question here seems to be if and how to take seasonal variations into account when making the autocorrelation function, which we agree is not a trivial matter.

In your analysis you look at the complete time series of one of the investigated parameters. However, this is not the approach we have used, since – as we mentioned in our previous response – the signal is too noisy to extract meaningful data when looking at single events. For this reason we have made the average of the five strongest events and these events occur in October, January, September, July, and April, which is (by



lucky chance) spread out nicely throughout the year. Seasonal variations will therefore be less of an issue in this mean than for individual events. Furthermore, when creating the PC the linear trend was removed from each of the parameters (page 8, line 17 of the Discussion paper). For these reasons there should not be much of a long time trend in the data. If we anyways apply a 21-day running mean filter to the PC from day -60 to day 60 and subtract this from the original PC, like in your analysis, we find *kc* to be 3 and the effective sample size *Nc* to be 33.6 giving a probability for finding a 3.1 sigma signal at random in the 121 day interval of 6.3% compared to the 4.0% we found earlier.

However, as we mentioned in our previous response, for the signal to be interpreted as a FD-induced reduction of clouds there are a number of requirements that must be met.

1) The signal must be found such that it occurs within a reasonable timeframe after the actual FD event. We set this timeframe to 16 days giving the factor of 16/121=0.13.

2) The signal must also have the correct sign, as expected from the cloud microphysical theory. Four of the investigated parameters seem to behave as expected (2 of them have no significant signal in either direction), so this will give an additional factor between $\frac{1}{2}$ and $\frac{1}{2}^4$ depending on intercorrelation.

In summary this gives a conditional probability of finding the 3.1 sigma signal in the 121 day PC at random of maximum 0.063·0.13·0.5 = 0.4%, making it very unlikely that the signal is random.

Finally you use your Fig. 3 to look at fluctuation levels around the mean. In our opinion this is not an optimal analysis since the plot relies on a single point in each 120 day window, which could be due to an anomaly that does not represent the actual level of fluctuation. Instead we've produced a graph showing the standard deviation of a 21-day box detrended optical thickness in a 121 day rolling window (see below) normalized by the standard deviation of the entire time series. Also shown is the timing of our 13 FD events. As can be seen the relative standard deviation has a maximum of 1.35 and a minimum of 0.7 and the vast majority of the time it is within 20% of the mean. Of the top 5 FDs no. 1, 2, and 3 has relative standard deviations very close to 1, no. 4 is at 1.15 and no. 5 is around 0.85, which does not point to a strong systematic behavior and certainly not one that can explain that the response goes from 2 to 6% in the optical thickness between the weakest and strongest events.

We hope that this answers your concerns.

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



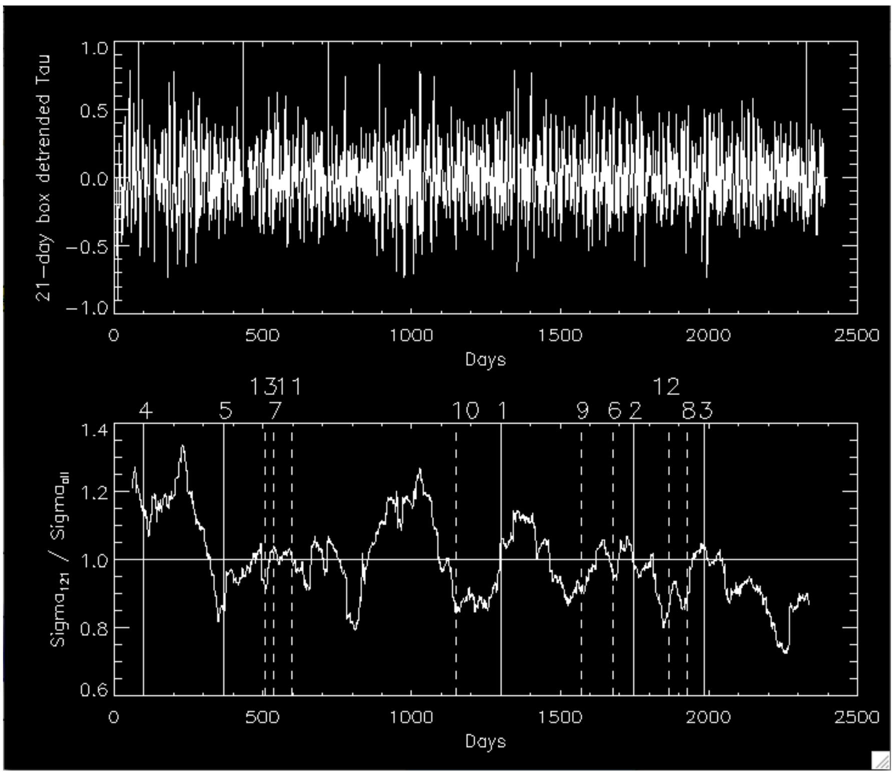


**Fig. 1.**