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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.

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Dear Kristoffer Rypdal, Thank you for these final comments.

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.

We agree that as the time interval gets more narrow the level of natural fluctuations become more spiky, which also is a feature of Gaussian data. This gives a hen-egg type problem where it is hard to tell if the high level of fluctuation is due to an FD response or if an FD response is detected due to high levels of fluctuation – especially since the FD response is so close to the fluctuation levels. We agree that the 20 day timescale

is more appropriate for the FD events than 120 days and we acknowledge that the spiky fluctuation levels could be an issue for the slope analysis. In order to investigate further we remade the slope analysis (Fig. 2 in the Discussion paper) but changed the sign of the extrema we looked for (ie we looked for maxima for CCN, optical thickness, cloud fraction, liquid water path, and emissivity and minima for effective radius). If the slope was simply created by increased levels of fluctuation then we should find slopes going in the opposite direction when looking for extrema of opposite signs, e.g. positive slopes when looking for maxima. Figure 1 in this response shows the result. In none of the four (five) parameters showing a significant slope in the Discussion paper do we see a slope of any significance with the reverse analysis. If anything the maxima gets smaller with increasing FD strength which would make sense if there was an overall decrease in the mean of the parameter. This shows that while there are changing levels of fluctuations it does not change the result of the slope analysis.

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.

We're not able to change the original manuscript while the discussion is still open – any changes we make are going to come after the discussion has closed. And we are of course open to making changes, based on the discussion. For instance it would make sense to include a paragraph discussing the issues with varying levels of fluctuations, to underline that more events would be preferable and to make the difficulty of extracting useful information from the existing data more clear. Also we are happy to change any sentences that make claims that are too strong for the data to support.

We are curious which sentences you feel are too strong though. You say that “the original manuscript. . .claims that an FD-cloud response is rigorously proven within a high degree of statistical certainty” but the conclusion of the discussion paper (page 3605, line 13-15) reads “In combination the observed responses make an actual FD-induced change in cloud microphysics more probable. . .”, which we still think is true. But we are open to specific suggestions.

In summary we find that the discussion has been useful in highlighting the difficulties of extracting information from the noisy data, when a limited number of events are available, and we think that the paper could be improved by including some of this discussion.

With this in mind we still find that

- there is a signal above 2-3 sigma in four out of six investigated parameters, when looking at the five strongest events found from the described ranking method based on lower atmosphere ionisation.

- the strength of the signal is of a magnitude which corresponds to derived values, for all six parameters.

- the signal occurs within a timeframe that makes physical sense

- the signal has the right sign to make physical sense

- combining the signal from the six parameters strengthens the significance of the signal to the 3.1 sigma level in the PCA

- the probability to find such a 3.1 sigma level fluctuation at random is 0.4% or less

- there appears to be a correlation between the strength of the FD and the level of response which is not caused by seasonal/random variations in the levels of fluctuation but by an actual change in the mean of the parameter

Based on the above points we conclude that the paper adds significantly to the inves-

tigation of the effect of Forbush decreases on cloud cover.

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

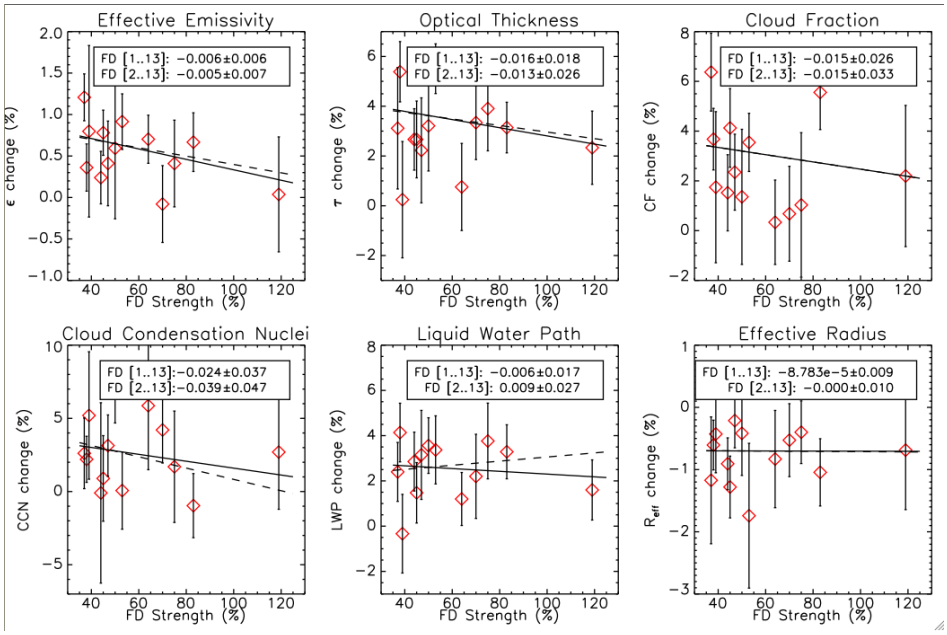
Effective Emissivity
FD [1..13]: −0.006±0.006
FD [2..13]: −0.005±0.007
ϵ change (%)
Optical Thickness
FD [1..13]: −0.016±0.018
FD [2..13]: −0.013±0.026
τ change (%)
Cloud Fraction
FD [1..13]: −0.015±0.026
FD [2..13]: −0.015±0.033
CF change (%)
Cloud Condensation Nuclei
FD [1..13]:−0.024±0.037
FD [2..13]:−0.039±0.047
CCN change (%)
Liquid Water Path
FD [1..13]: −0.006±0.017
FD [2..13]: 0.009±0.027
LWP change (%)
Effective Radius
FD [1..13]: −8.783e−5±0.009
FD [2..13]: −0.000±0.010
R_{eff} change (%)
FD Strength (%)

Fig. 1.