Supplementary file to referee comment by K. Rypdal to " Effects of cosmic ray decreases on cloud microphysics" by Svensmark et al.

Import the array of 7 data series (columns) from the MODIS data. The 1. column is time measured in Julian days. The 6 others are various cloud parameters. The time series runs from Julian day 2451642 to 2454041 and contains 2400 days, although there are a few gaps of missing data, the longest gap is 13 days. The variable "modis" below is a list of all the 7 x 2400 numbers in the data array as read from top left to the right as in a book page.

```
modis = Flatten[Import["modis.txt", "Table"]];
```

The algorithm to convert from a given date in the Gregorian calendar to Julian day is:
(here an example converting the date April 12, 2001, to Julian day.

```
day = 12;
month = 4;
year = 2001;

a = Floor[(14 – month) / 12];
y = year + 4800 – a;
m = month + 12 * a – 3;
Julday =
 day + Floor[(153 * m + 2) / 5] + 365 * y + Floor[y / 4] – Floor[y / 100] + Floor[y / 400] – 32 045
```

```
2 452 012
```

The command below reads the 4th column in the data array, which is the ocean cloud optical depth. The result is a single list of 2400 numbers, including the data gaps given by a text string which appear as empty spaces in a plot.

```
rawmodislist = Flatten[Table[modis[[4 + 7 * (i – 1)]], {i, 1, 2400}]];
```

Make a list with Julian day as time coordinate:

```
Modislist = Table[{2 451 641 + i, rawmodislist[[i]]}, {i, 1, 2400}];
```

Use the Julian day algorithm above to convert the dates of the 5 strongest Forbush depressions (FDs) in Table 1 of J. Svensmark et al. (2012) to Julday:

```
FD1day = 2 452 944;
FD2day = 2 453 390;
FD3day = 2 453 627;
FD4day = 2 451 742;
FD5day = 2 452 012;
```

Plot the dates of these FDs as vertical red lines along with the plot of the optical thickness time series. It is not possible observe anything particular about these times from looking at the plot of the time series on these time scales. We obviously need to zoom in on the individual events.

```
ListPlot[Modislist, Joined → True, Frame → True, GridLines →
  {{{FD1day, Red}, {FD2day, Red}, {FD3day, Red}, {FD4day, Red}, {FD5day, Red}}, {}},
 FrameLabel → {"Julian day", "Ocean cloud optical thickness"}, PlotLabel →
  Style[Framed["Ocean cloud optical thickness. Red vertical lines: FD 1-5"],
   12, Black, Background → Lighter[Yellow]]]
```
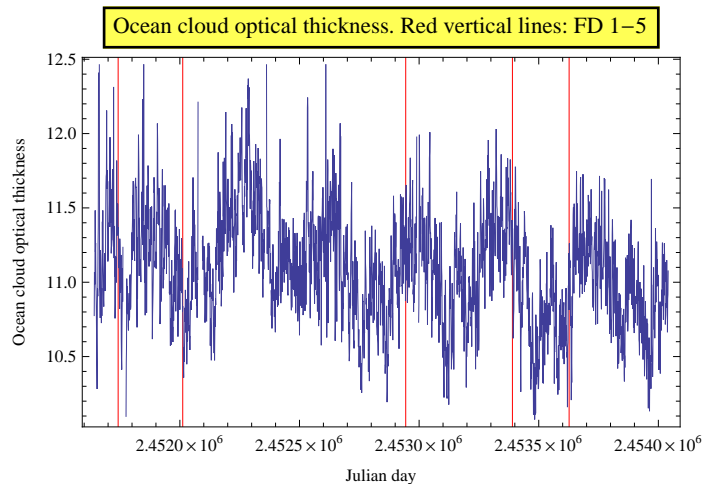

There is a clear annual variability in the data, along with with a general decreasing trend over the 6.5 year period. To reveal that trend more clearly I run a 120 day moving average. However, this algorithm requires that I fill the missing datagaps. For the present purpose it is sufficient with a primitive routine for this, so I simply fill the n missing points by repeating the n previous points. This "filled" array I denote "modislist1". The smoothed plot looks as follows:

```
movavlist = Table[{2 451 641 + 60 + i, MovingAverage[modislist1, 120][[i]]}, {i, 1, 2281}];
ListPlot[movavlist, Joined → True, Frame → True]
```
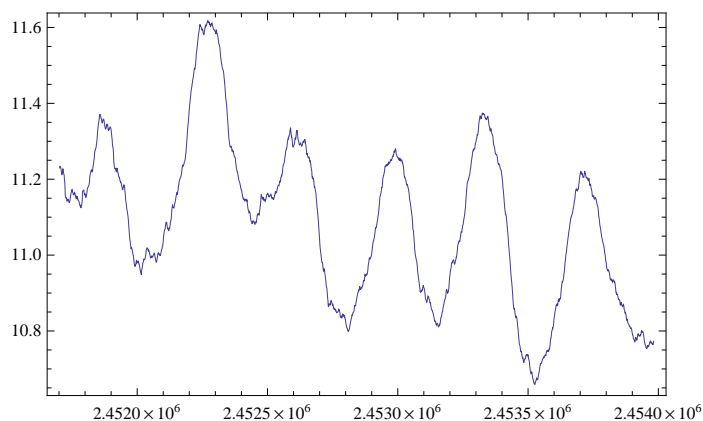
Now I subtract this smooth annual and slower trend from the original signal to obtain a detrended signal:

```
detrendlist = Table[{2 451 641 + 60 + i,
    rawmodislist[[i + 60]] - MovingAverage[modislist1, 120][[i]]}, {i, 1, 2281}];
P0 = ListPlot[detrendlist, Joined → True, Frame → True, PlotRange → {-1, 2}, GridLines →
    {{{FD1day, Red}, {FD2day, Red}, {FD3day, Red}, {FD4day, Red}, {FD5day, Red}}, {}},
  FrameLabel → {"Julian day", "Ocean cloud optical thickness"},
  PlotLabel → Style[Framed["Detrended optical thickness. Red vertical lines: FD 1-5"],
    12, Black, Background → Lighter[Yellow]]]
```
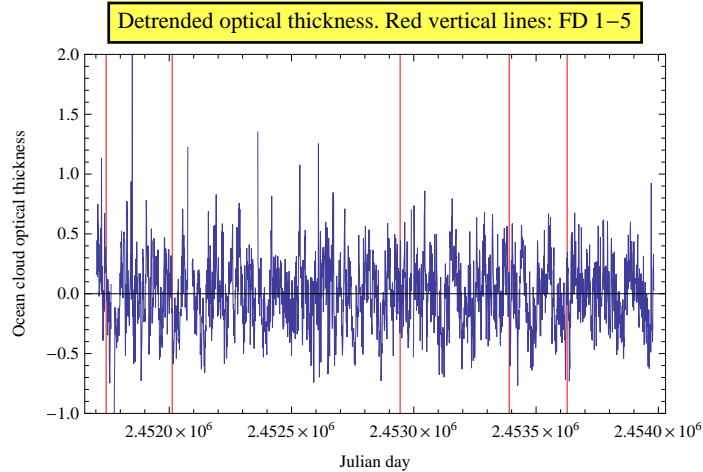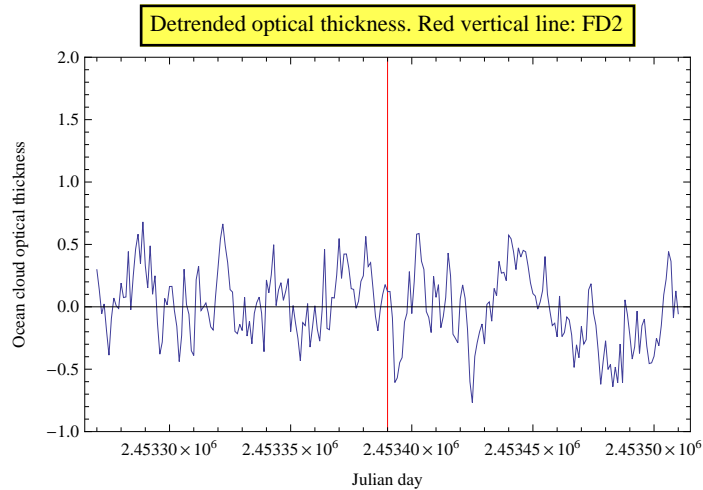


```
FD1detrendlist =
  Table[{2 451 641 + 60 + i, rawmodislist[[i + 60]] - MovingAverage[modislist1, 120][[i]]},
    {i, FD1day - 60 - 2 451 641 - 120, FD1day - 60 - 2 451 641 + 120}];
P1 = ListPlot[FD1detrendlist, Joined → True, Frame → True,
  PlotRange → {-1, 2}, GridLines → {{{FD1day, Red}}, {}},
  FrameLabel → {"Julian day", "Ocean cloud optical thickness"},
  PlotLabel → Style[Framed["Detrended optical thickness. Red vertical line: FD1"],
    12, Black, Background → Lighter[Yellow]]]
```
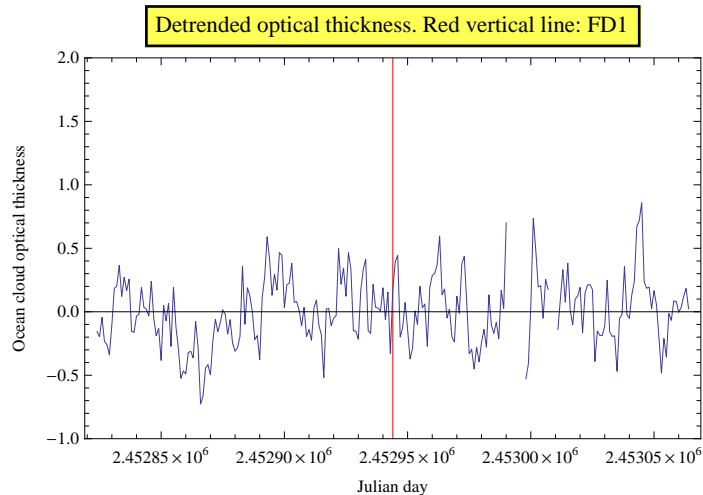
```
FD2detrendlist =
  Table[{2 451 641 + 60 + i, rawmodislist[[i + 60]] - MovingAverage[modislist1, 120][[i]]},
   {i, FD2day - 60 - 2 451 641 - 120, FD2day - 60 - 2 451 641 + 120}];
P2 = ListPlot[FD2detrendlist, Joined → True, Frame → True,
  PlotRange → {-1, 2}, GridLines → {{{FD2day, Red}}, {}},
  FrameLabel → {"Julian day", "Ocean cloud optical thickness"},
  PlotLabel → Style[Framed["Detrended optical thickness. Red vertical line: FD2"],
    12, Black, Background → Lighter[Yellow]]]
```
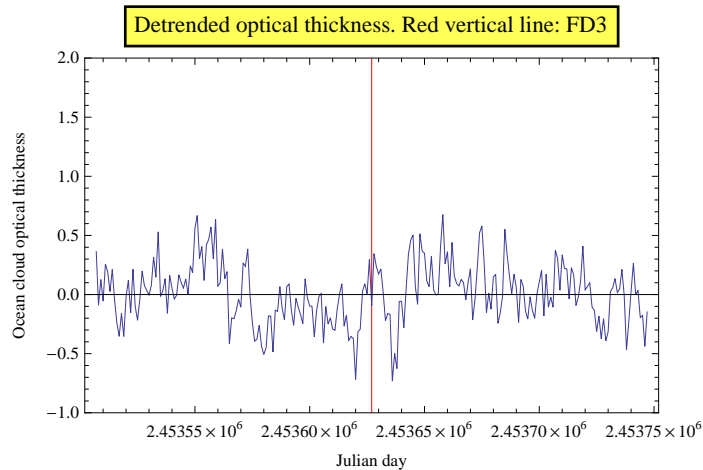


```
FD3detrendlist =
  Table[{2 451 641 + 60 + i, rawmodislist[[i + 60]] - MovingAverage[modislist1, 120][[i]]},
   {i, FD3day - 60 - 2 451 641 - 120, FD3day - 60 - 2 451 641 + 120}];
P3 = ListPlot[FD3detrendlist, Joined → True, Frame → True,
  PlotRange → {-1, 2}, GridLines → {{{FD3day, Red}}, {}},
  FrameLabel → {"Julian day", "Ocean cloud optical thickness"},
  PlotLabel → Style[Framed["Detrended optical thickness. Red vertical line: FD3"],
    12, Black, Background → Lighter[Yellow]]]
```
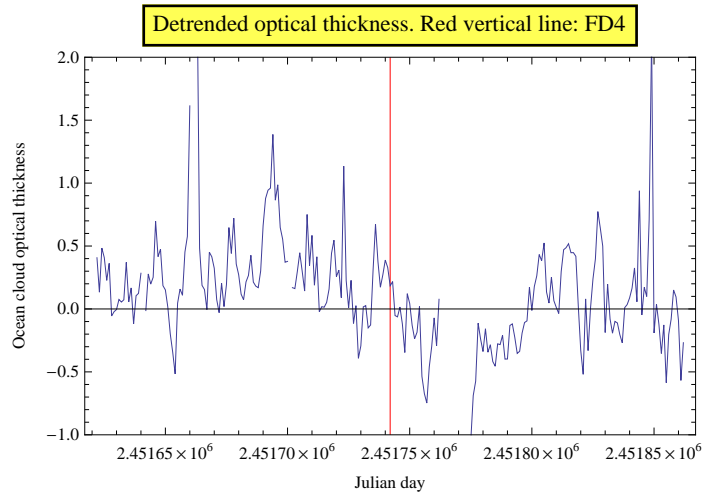
```
FD4detrendlist =
  Table[{2 451 641 + 60 + i, rawmodislist[[i + 60]] - MovingAverage[modislist1, 120][[i]]},
   {i, FD4day - 60 - 2 451 641 - 120, FD4day - 60 - 2 451 641 + 120}];
P4 = ListPlot[FD4detrendlist, Joined → True, Frame → True,
  PlotRange → {-1, 2}, GridLines → {{{FD4day, Red}}, {}},
  FrameLabel → {"Julian day", "Ocean cloud optical thickness"},
  PlotLabel → Style[Framed["Detrended optical thickness. Red vertical line: FD4"],
    12, Black, Background → Lighter[Yellow]]]
```



```
FD5detrendlist =
  Table[{2 451 641 + 60 + i, modislist1[[i + 60]] - MovingAverage[modislist1, 120][[i]]},
   {i, FD5day - 60 - 2 451 641 - 120, FD5day - 60 - 2 451 641 + 120}];
P5 = ListPlot[FD5detrendlist, Joined → True, Frame → True,
  PlotRange → {-1, 2}, GridLines → {{{FD5day, Red}}, {}},
  FrameLabel → {"Julian day", "Ocean cloud optical thickness"},
  PlotLabel → Style[Framed["Detrended optical thickness. Red vertical line: FD5"],
    12, Black, Background → Lighter[Yellow]]]
```