Solar radiation during the solar eclipse of March 20, 2015, Jena, Germany

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The diurnal cycle of solar radiation during the eclipse of March 20, 2015 is presented here with a comparison with the diurnal cycle of two previous days. Radiation was measured as shortwave incoming radiation (SW), and as photosynthetically active radiation (PAR).

Incoming short wave solar radiation and photosynthetically active solar radiation are continuoslly measured at the roof of the Max Planck Institute for Biogeochemistry in Jena, Germany. A description of the measurement station can be found here http://www.bgc-jena.mpg.de/wetter/Weatherstation.pdf.

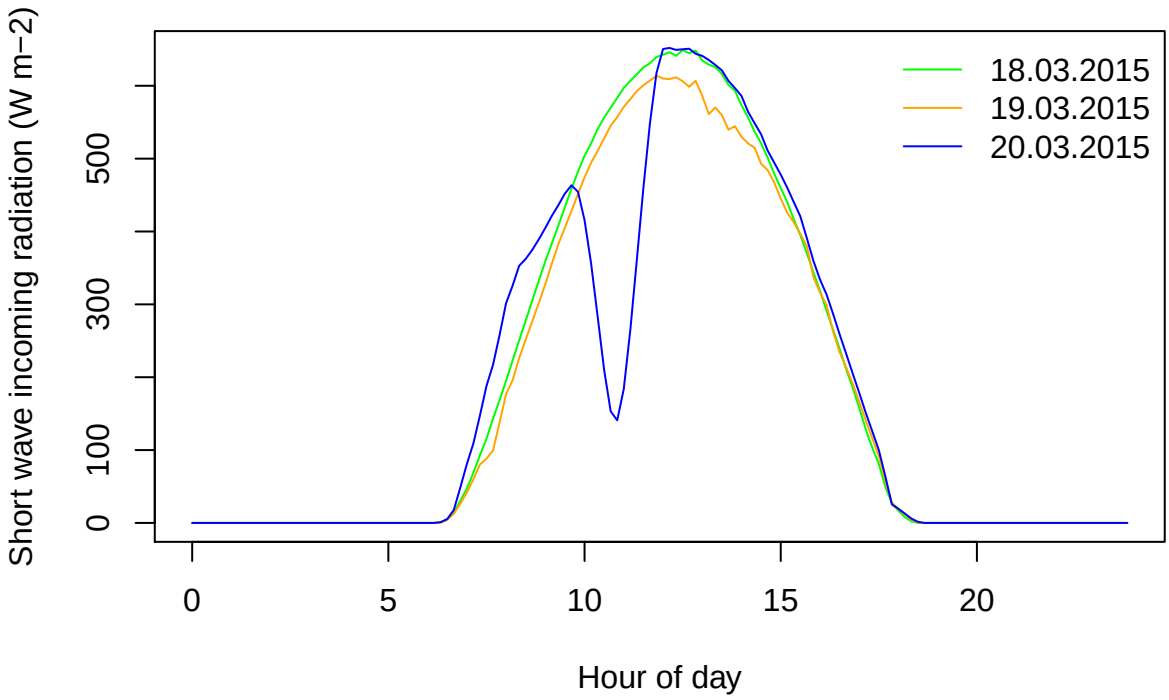
Data for this comparison was downloaded from http://www.bgc-jena.mpg.de/wetter/ for the Weather Station Beutenberg.

Code for pre-processing the data

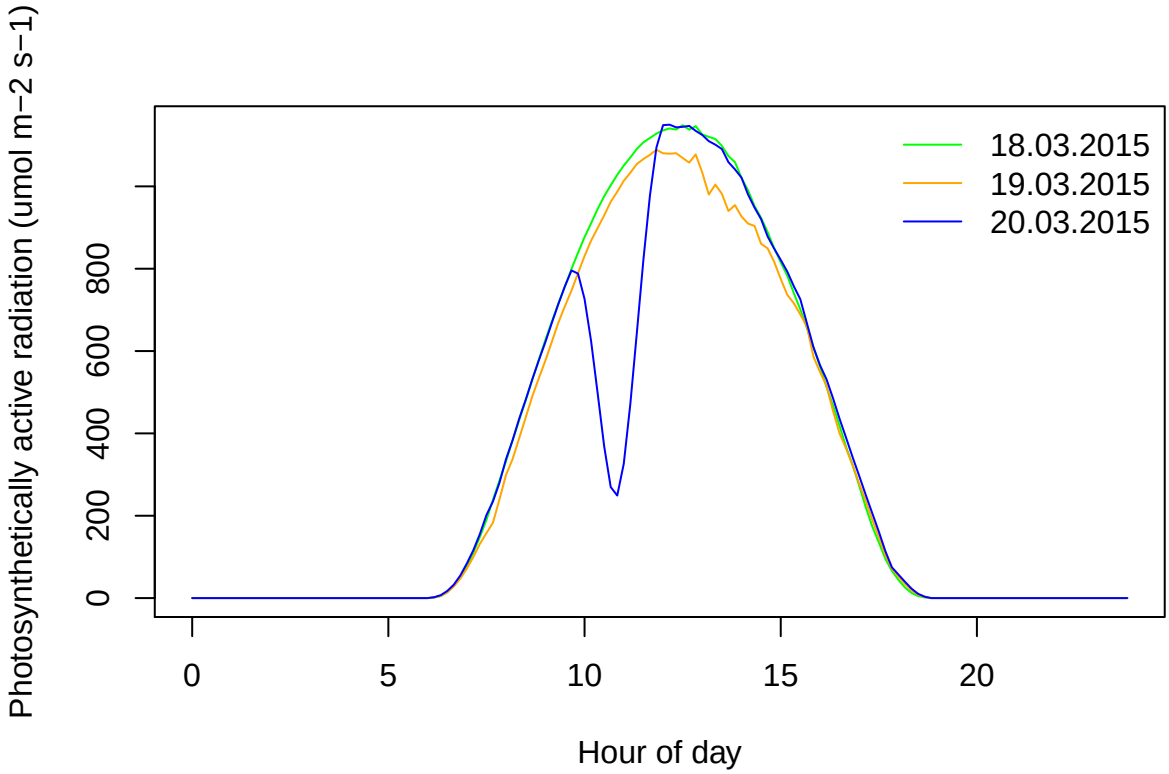
```
all=read.csv("~/Eclipse/mpi_roof.csv")

date=strptime(as.character(all[,1]),format="%d.%m.%Y %H:%M:%S") #Convert dates and times to POSIX
all=cbind(date,all[,-1]) #Replaces dates and times for POSIX dates

#Start of the day, used for subsetting
Wed=strptime("2015-03-18 00:00:00", "%Y-%m-%d %H:%M:%S")
Thr=strptime("2015-03-19 00:00:00", "%Y-%m-%d %H:%M:%S")
Fri=strptime("2015-03-20 00:00:00", "%Y-%m-%d %H:%M:%S")
Sat=strptime("2015-03-21 00:00:00", "%Y-%m-%d %H:%M:%S")

Wedset=all[all[,1]>=Wed & all[,1]<Thr,c(1,18,19)] #data only for 18.03.2015
Thrset=all[all[,1]>=Thr & all[,1]<Fri,c(1,18,19)] #data only for 19.03.2015
Friset=all[all[,1]>=Fri & all[,1]<Sat,c(1,18,19)] #data only for 20.03.2015

hr=seq(0,(23+5/6),1/6)
```

Diurnal radiation cycle

A comparison of the diurnal cycle of SW clearly shows a dramatic decrease for the hours of the eclipse in comparison with the two previous days.



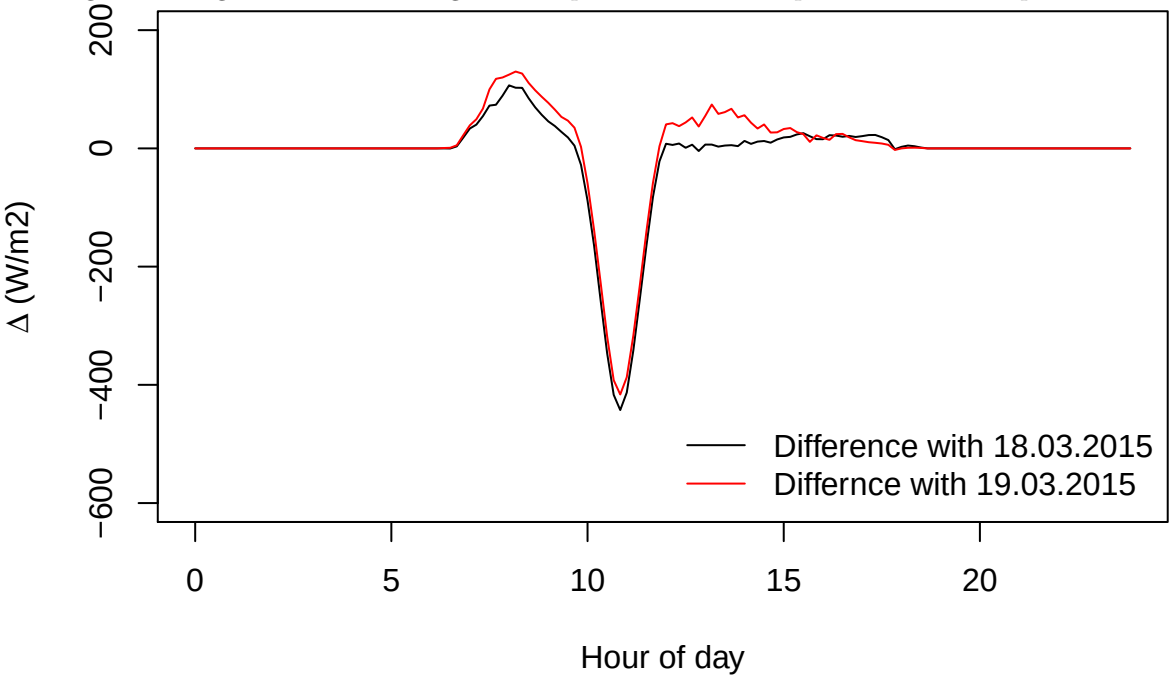
Similarly, PAR showed a dramatic decrease during the eclipse hours in comparison to the two previous days.



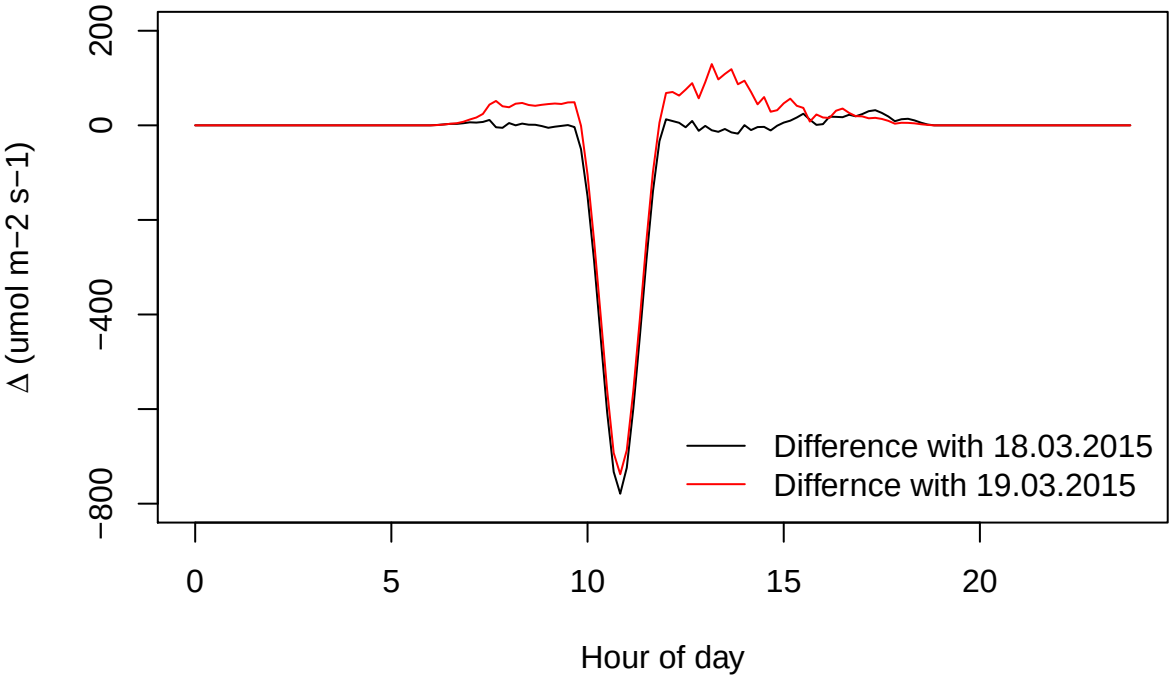
Radiation differences

Differences in radiation between days can be calculated as $\Delta = y_t - y_{t-n}$, where y_t is the observed radiation during the ecplise, and $t - n$ with $n \in \{1, 2\}$ are days previous the eclipse.

For short wave incoming radiation, reductions were larger during the eclipse in comparison with 18.03.2015 than with the previous day. Larger positive differences indicate that incoming radiation was higher during 20.03.2015 during non-eclipse hours in comparison with the previous two days.



A similar pattern was observed for the photisynthetically active radiation flux.



Diurnal reduction in solar radiation

The integral of the curves can be used to compared the total and percent differences between days. To calculate the integrals numerically, we need first a to create a function; this function is a spline cubic

interpolation. The code to calculate these functions is given by

```
splineSWWed=splinefun(hr,Wedset[,2])
splineSWThr=splinefun(hr,Thrset[,2])
splineSWFri=splinefun(hr,Friset[,2])

splinePARWed=splinefun(hr,Wedset[,3])
splinePARThr=splinefun(hr,Thrset[,3])
splinePARFri=splinefun(hr,Friset[,3])
```

The definite integrals in the interval $h \in \{0, 23\}$ are then calculated as

```
intSWWed=integrate(splineSWWed,lower=0,upper=23)$value
intSWThr=integrate(splineSWThr,lower=0,upper=23)$value
intSWFri=integrate(splineSWFri,lower=0,upper=23)$value

intPARWed=integrate(splinePARWed,lower=0,upper=23)$value
intPARThr=integrate(splinePARThr,lower=0,upper=23)$value
intPARFri=integrate(splinePARFri,lower=0,upper=23)$value
```

The percent differences in total radiation are then

```
pR.SW=c(100*(1-(intSWFri/intSWWed)), 100*(1-(intSWFri/intSWThr)))
pR.PAR=c(100*(1-(intPARFri/intPARWed)), 100*(1-(intPARFri/intPARThr)))

data.frame(WRT=c("Wednesday", "Thursday"),pR.SW,pR.PAR)
```

```
##         WRT     pR.SW    pR.PAR
## 1 Wednesday 5.5599679 10.423339
## 2  Thursday 0.1520969  4.902201
```

where WRT abbreviates *with respect to* and pR *percent reduction*.

These differences were larger in terms of PAR than SW. These small differences are due to the fact that during 20.03.2015 a higher amount of radiation was observed during non-eclipse times.

The percent reduction in radiation during the time of the eclipse can be calculated by integrating only in the interval $h \in \{9\,12\}$

```
intSWWed=integrate(splineSWWed,lower=9,upper=12)$value
intSWThr=integrate(splineSWThr,lower=9,upper=12)$value
intSWFri=integrate(splineSWFri,lower=9,upper=12)$value

intPARWed=integrate(splinePARWed,lower=9,upper=12)$value
intPARThr=integrate(splinePARThr,lower=9,upper=12)$value
intPARFri=integrate(splinePARFri,lower=9,upper=12)$value
```

The differences in total radiation are then

```
pR.SW=c(100*(1-(intSWFri/intSWWed)), 100*(1-(intSWFri/intSWThr)))
pR.PAR=c(100*(1-(intPARFri/intPARWed)), 100*(1-(intPARFri/intPARThr)))

data.frame(WRT=c("Wednesday", "Thursday"),pR.SW,pR.PAR)
```

```
##         WRT    pR.SW   pR.PAR
## 1 Wednesday 30.11190 31.13979
## 2  Thursday 26.39855 27.77679
```