

Zenith angle and sunlight

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Set up

```
library(photobiology)
```

```
## Loading required package: lubridate
## Loading required package: data.table
##
## Attaching package: 'data.table'
##
## The following objects are masked from 'package:lubridate':
##
##     hour, mday, month, quarter, wday, week, yday, year
```

```
library(photobiologyInOut)
library(photobiologygg)
```

```
## Loading required package: photobiologyWavebands
## Loading required package: proto
## Loading required package: ggplot2
## Loading required package: scales
```

```
options(photobiology.radiation.unit = "photon")
```

Data from TUV

The TUV model (Version 5.0) was run in batch mode and without summary calculations.

TUV inputs:

```
=====
inpfil =      usrinp   outfil =      usrout   nstr =          16
lat =         0.000   lon =          0.000   tmzone =         0.0
iyear =        2014   imonth =          3   iday =          21
zstart =        0.000   zstop =         80.000   nz =           81
wstart =       290.000   wstop =        760.000   nwint =         940
tstart =        12.000   tstop =         18.000   nt =           13
lzenit =         F   alsurf =         0.100   psurf =        -999.0
o3col =       300.000   so2col =         0.000   no2col =         0.000
taucld =         0.000   zbase =         4.000   ztop =          5.000
tauaer =         0.235   ssaaer =         0.990   alpha =          1.000
dirsun =         1.000   difdn =         1.000   difup =          0.000
zout =          0.000   zaird =    -9.990E+02   ztemp =        -999.000
lirrad =         T   laflux =         F   lmmech =         F
lrates =         T   isfix =          0   nms =           0
```

```

ljvals =          F   ijfix =          0   nmj =          0
iwfix =          0   itfix =          0   izfix =          0
=====
==== Spectral weighting functions used:
==== Photolysis reactions used:
=====
Discrete ordinates          16 -stream radiative transfer
air temperature: USSA, 1976
air concentrations: USSA, 1976
ozone profile: USSA, 1976
DATAE1/SUN/susim_hi.flx
DATAE1/SUN/atlas3_1994_317_a.dat
DATAE1/SUN/neckel.flx
DATAE1/SUN/sao2010.solref.converted
aerosols: Elterman (1968) continental profile
step =    1  sza =    1.827 Earth-sun factor = 1.0077450
step =    2  sza =    5.711 Earth-sun factor = 1.0077339
step =    3  sza =   13.207 Earth-sun factor = 1.0077206
step =    4  sza =   20.707 Earth-sun factor = 1.0077095
step =    5  sza =   28.208 Earth-sun factor = 1.0076983
step =    6  sza =   35.710 Earth-sun factor = 1.0076849
step =    7  sza =   43.211 Earth-sun factor = 1.0076739
step =    8  sza =   50.712 Earth-sun factor = 1.0076628
step =    9  sza =   58.213 Earth-sun factor = 1.0076495
step =   10  sza =   65.715 Earth-sun factor = 1.0076385
step =   11  sza =   73.216 Earth-sun factor = 1.0076274
step =   12  sza =   80.718 Earth-sun factor = 1.0076140
step =   13  sza =   88.219 Earth-sun factor = 1.0076028

```

```

zangles.spct <-
  read_tuv_file(file = "usrout2.txt",
                unit.out = "photon",
                date = ymd("2014-03-21"))

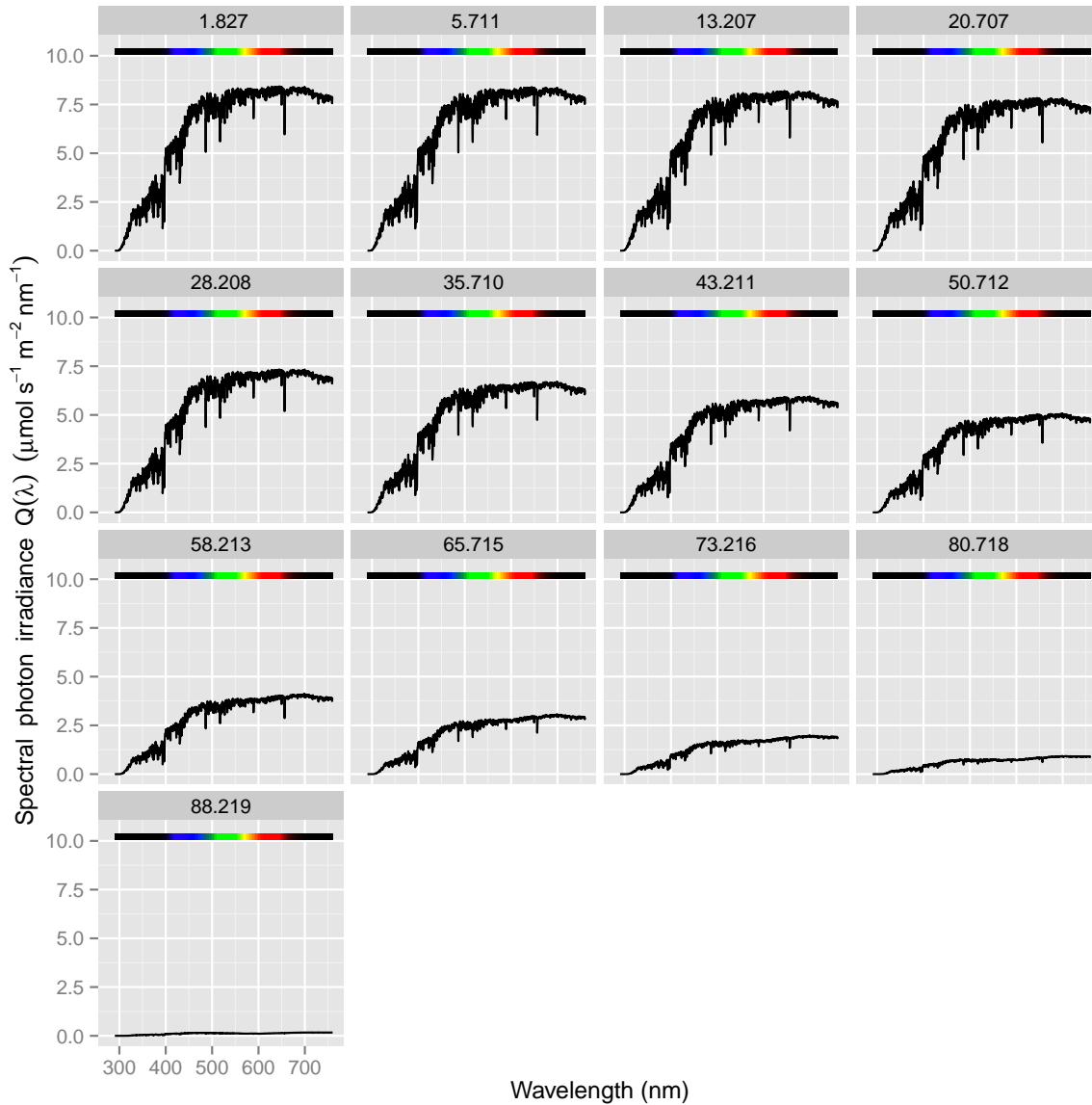
```

Spectra

```

plot(zangles.spct, annotations = "colour_guide") +
  facet_wrap(~angle)

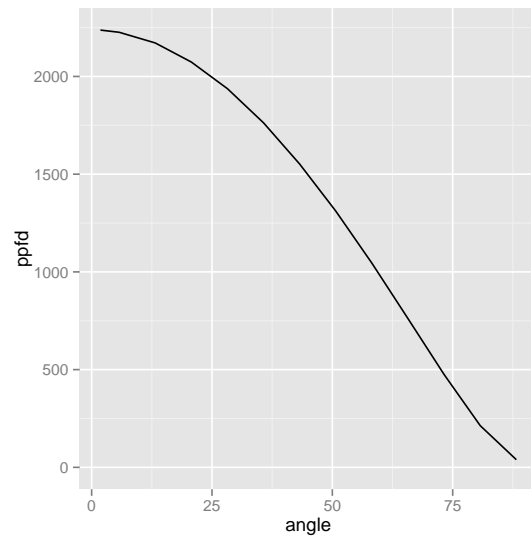
```



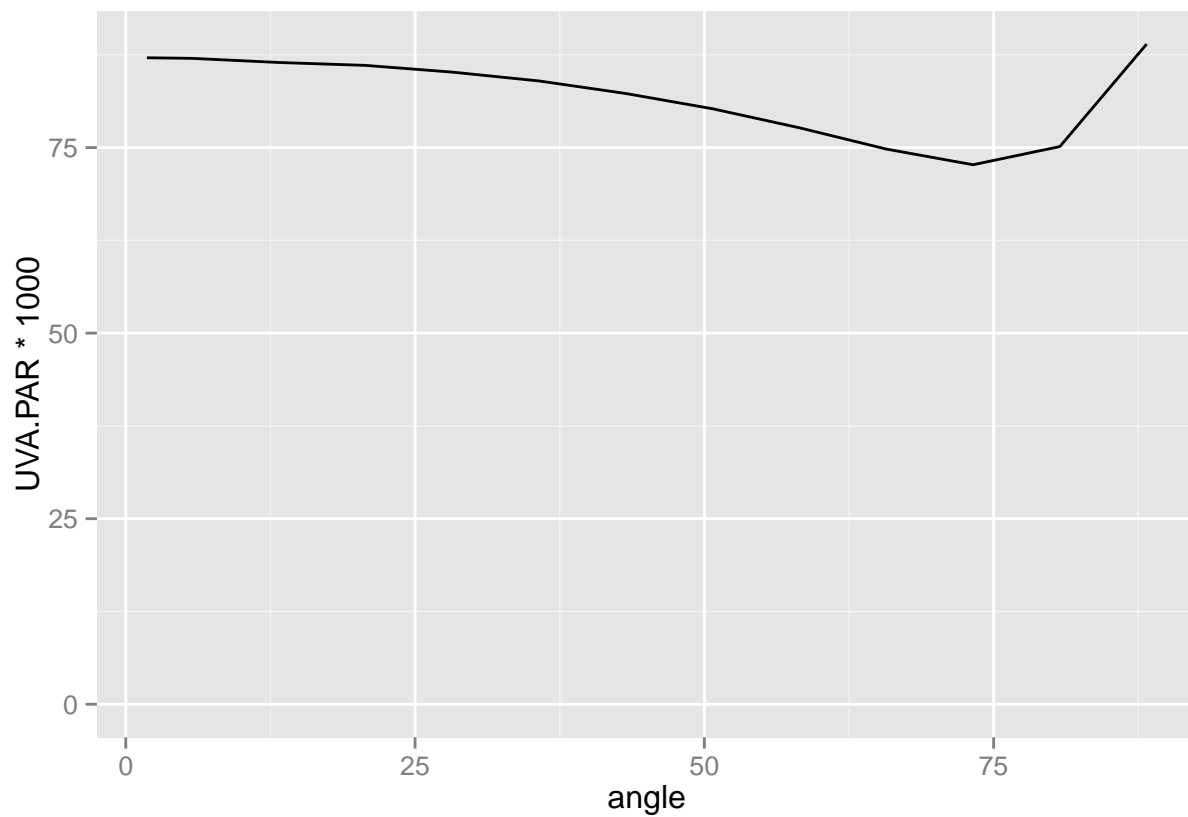
Summaries

```
zangles.summaries <-
  zangles.spct[ , .(ppfd =    q_irrad(.SD, PAR()) * 1e6,
                      UVA.PAR = q_ratio(.SD, UVA(), PAR()),
                      UVB.PAR = q_ratio(.SD, UVB(), PAR()),
                      B.G =     q_ratio(.SD, Blue("Sellaro"), Green("Sellaro")),
                      R.FR =     q_ratio(.SD, Red("Smith"), Far_red("Smith")),
                      angle =    .SD$angle[1],
                      date =     .SD$date[1]
                    ),
    by = spectrum]
```

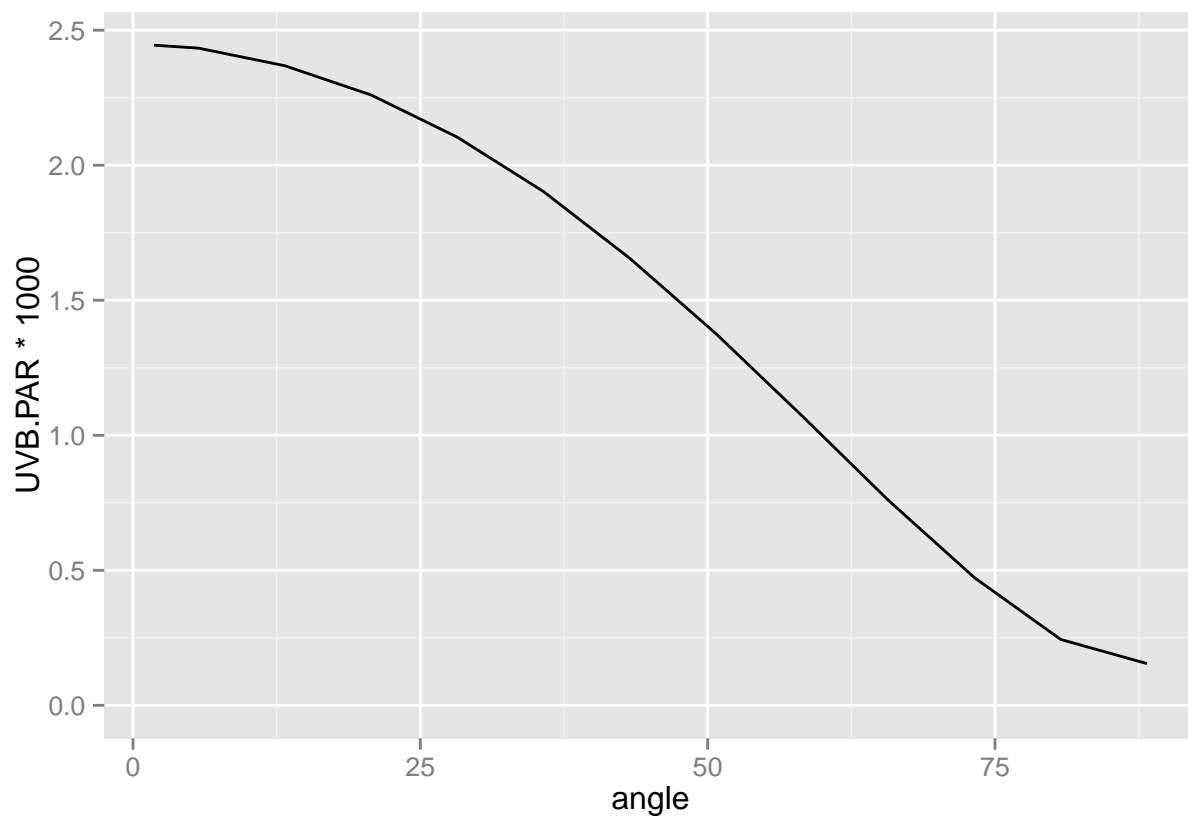
```
ggplot(zangles.summaries, aes(x = angle, y = ppfd)) + geom_line() + ylim(0, NA)
```



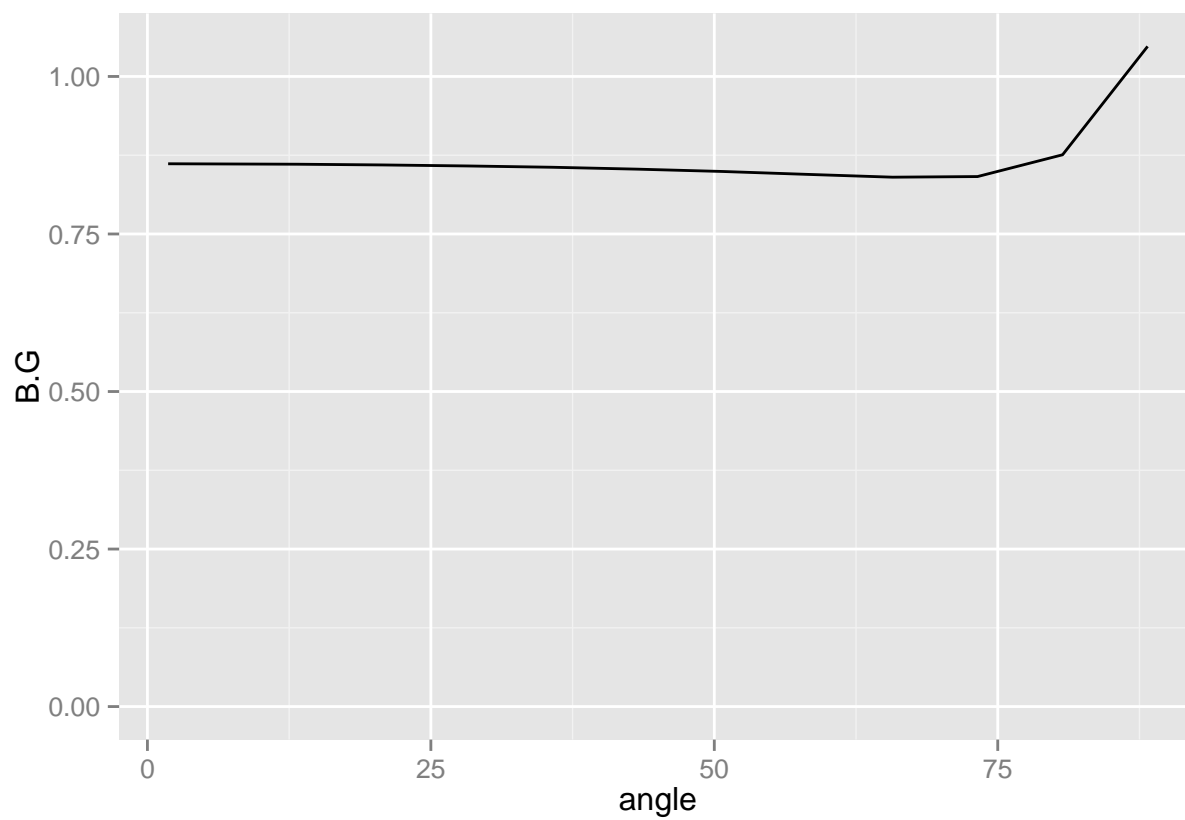
```
ggplot(zangles.summaries, aes(x = angle, y = UVA.PAR * 1e3)) + geom_line() + ylim(0, NA)
```



```
ggplot(zangles.summaries, aes(x = angle, y = UVB.PAR * 1e3)) + geom_line() + ylim(0, NA)
```



```
ggplot(zangles.summaries, aes(x = angle, y = B.G)) + geom_line() + ylim(0, NA)
```



```
ggplot(zangles.summaries, aes(x = angle, y = R.FR)) + geom_line() + ylim(0, NA)
```

