2.Earth’s energy budget

In [80]:

```
import numpy as np
import math
import pandas as pd
import xarray as xr
from matplotlib import pyplot as plt
%matplotlib inline
```

In [4]:

```
# 读取文件
ds = xr.open_dataset("CERES_EBAF-TOA_200003-201701.nc")

# 检查文件

ds
```

Out[4]:

xarray.Dataset

▶ Dimensions: (**lat**: 180, **lon**: 360, **time**: 203)

▼ Coordinates:

lon	(lon)	float32	0.5 1.5 2.5 ... 357.5 358.5 35…
time	(time)	datetime64[ns]	2000-03-15 ... 2017-01-15
lat	(lat)	float32	-89.5 -88.5 -87.5 ... 88.5 89.5

▼ Data variables:

toa_sw_all_mon	(time, lat, lon)	float32	...
toa_lw_all_mon	(time, lat, lon)	float32	...
toa_net_all_mon	(time, lat, lon)	float32	...
toa_sw_clr_mon	(time, lat, lon)	float32	...
toa_lw_clr_mon	(time, lat, lon)	float32	...
toa_net_clr_mon	(time, lat, lon)	float32	...
toa_cre_sw_mon	(time, lat, lon)	float32	...
toa_cre_lw_mon	(time, lat, lon)	float32	...
toa_cre_net_mon	(time, lat, lon)	float32	...
solar_mon	(time, lat, lon)	float32	...
cldarea_total_d…	(time, lat, lon)	float32	...
cldpress_total_…	(time, lat, lon)	float32	...
cldtemp_total_d…	(time, lat, lon)	float32	...
cldtau_total_da…	(time, lat, lon)	float32	...

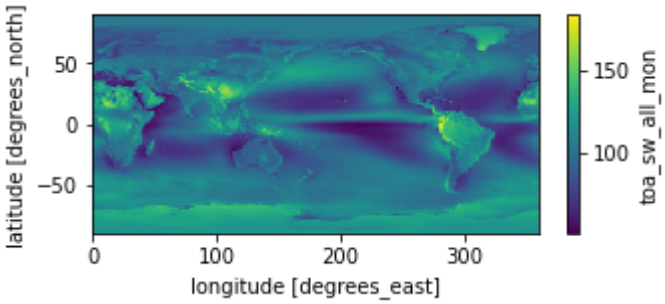
▼ Attributes:

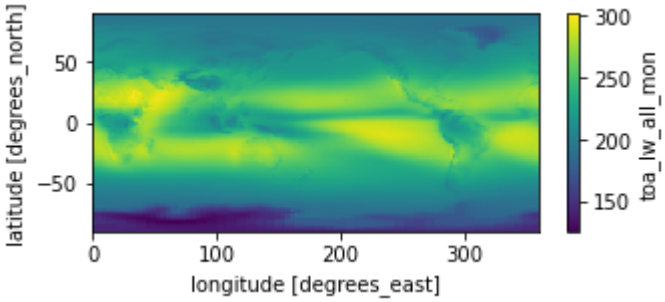
title :	CERES EBAF (Energy Balanced and Filled) TOA Fluxes. Monthly Av erages and 07/2005 to 06/2015 Climatology.
institution :	NASA/LaRC (Langley Research Center) Hampton, Va
Conventions :	CF-1.4
comment :	Data is from East to West and South to North.
Version :	Edition 4.0; Release Date March 7, 2017
Fill_Value :	Fill Value is -999.0
DOI :	10.5067/TERRA+AQUA/CERES/EBAF-TOA_L3B.004.0
Production_Files :	List of files used in creating the present Master netCDF file: /homedir/nloeb/ebaf/monthly_means/adj_fluxes/deliverable/sw*.gz /homedir/nloeb/ebaf/monthly_means/adj_fluxes/deliverable/lw*.gz /homedir/nloeb/ebaf/monthly_means/adj_fluxes/deliverable/net*.gz /homedir/nloeb/ebaf/monthly_means/adj_fluxes/deliverable/solflx*.gz /homedir/nloeb/ebaf/monthly_means/out_glob.dat

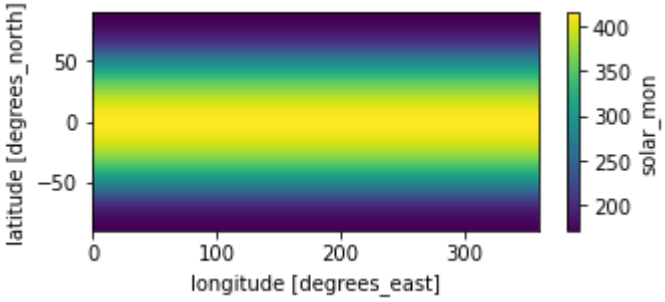
2.1

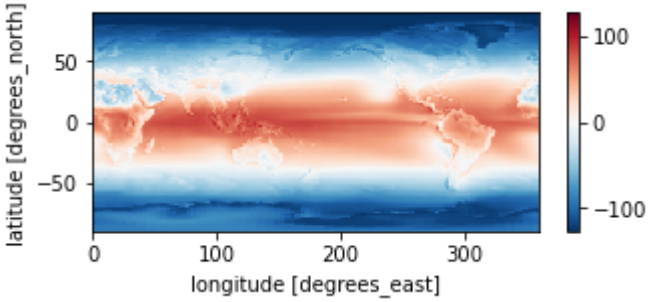
In [70]:

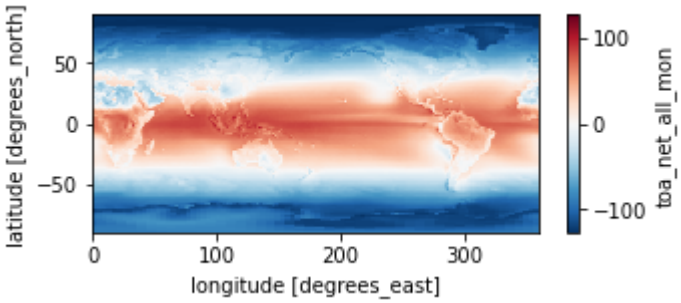
```
#计算时间平均TOA短波，并画图
ds.toa_sw_all_mon.mean(dim="time").plot(figsize=(5,2))
plt.show()
#计算时间平均TOA长波，并画图
ds.toa_lw_all_mon.mean(dim="time").plot(figsize=(5,2))
plt.show()
#计算时间平均TOA太阳辐射，并画图
ds.solar_mon.mean(dim="time").plot(figsize=(5,2))
plt.show()
#计算时间平均TOA净通量，并画图
ds1=ds.solar_mon.mean(dim="time")-ds.toa_lw_all_mon.mean(dim="time")-ds.toa_sw_all_mon.mean(dim="ti
ds1.plot(figsize=(5,2))
plt.show()
#验证时间平均TOA净通量，并画图
ds.toa_net_all_mon.mean(dim="time").plot(figsize=(5,2))
plt.show()
```











2.2

In [73]:

```
#利用weight函数转换经纬度为栅格
weights = np.cos(np.deg2rad(ds.lat))


#计算栅格尺度上的平均Toa短波
sw_weighted = ds.toa_sw_all_mon.weighted(weights).mean()
print(sw_weighted)
#计算栅格尺度上的平均Toa长波
lw_weighted = ds.toa_lw_all_mon.weighted(weights).mean()
print(lw_weighted)
#计算栅格尺度上的平均Toa太阳辐射
solar_weighted = ds.solar_mon.weighted(weights).mean()
print(solar_weighted)
```

```
<xarray.DataArray 'toa_sw_all_mon' ()>
array(99.13805277)
<xarray.DataArray 'toa_lw_all_mon' ()>
array(240.26693375)
<xarray.DataArray 'solar_mon' ()>
array(340.28326598)
```

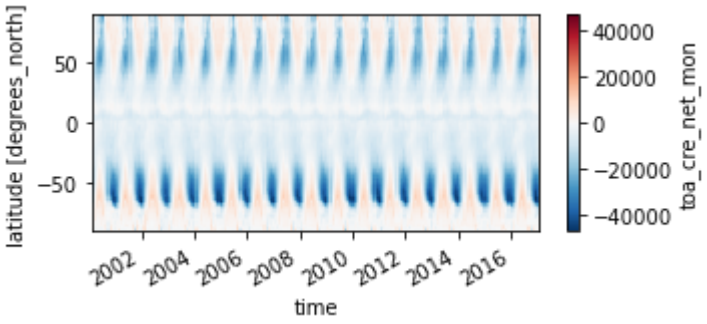
2.3

In [74]:

```
#计算各位置总净辐射量
ra_sum=ds.toa_cre_net_mon.sum(dim='lon')
#画图
ra_sum.transpose().plot(figsize=(5,2))
```

Out[74]:

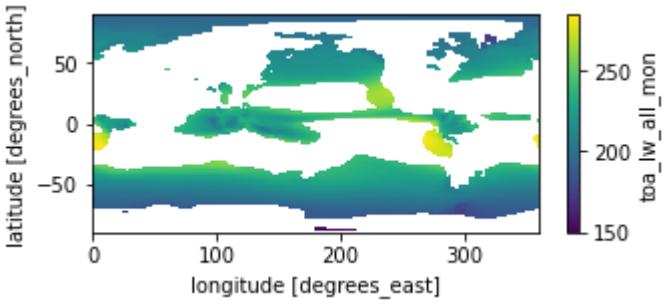
<matplotlib.collections.QuadMesh at 0x1ef2d0be220>

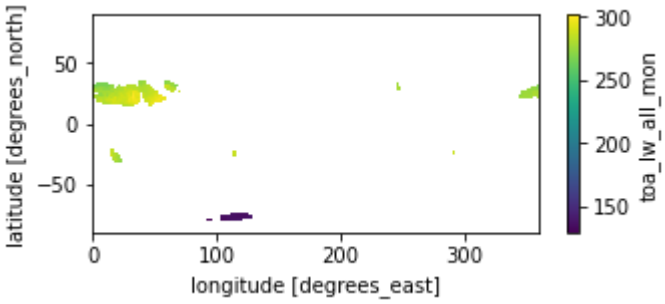


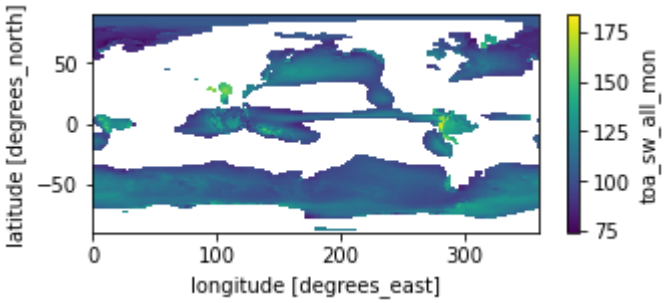
2.4

In [78]:

```
#根据云层面积将其分为高空云和低空云
hig_cld=(ds.cldarea_total_daynight_mon.mean(dim="time")>=75)
low_cld=(ds.cldarea_total_daynight_mon.mean(dim="time")<=25)

#绘制高空云区域时间平均TOA长波2D图
ds.toa_lw_all_mon.mean(dim="time").where(hig_cld).plot(figsize=(5,2))
plt.show()

#绘制低空云区域时间平均TOA长波2D图
ds.toa_lw_all_mon.mean(dim="time").where(low_cld).plot(figsize=(5,2))
plt.show()

#绘制高空云区域时间平均TOA短波2D图
ds.toa_sw_all_mon.mean(dim="time").where(hig_cld).plot(figsize=(5,2))
plt.show()

#绘制低空云区域时间平均TOA短波2D图
ds.toa_sw_all_mon.mean(dim="time").where(low_cld).plot(figsize=(5,2))
plt.show()
```



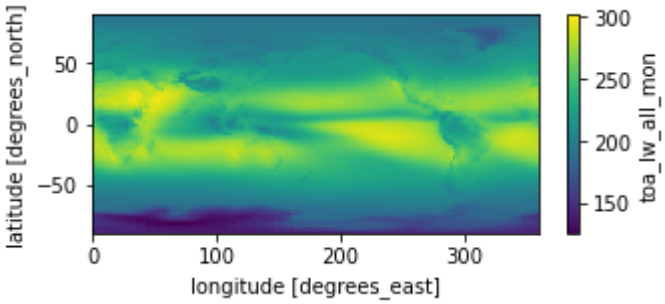


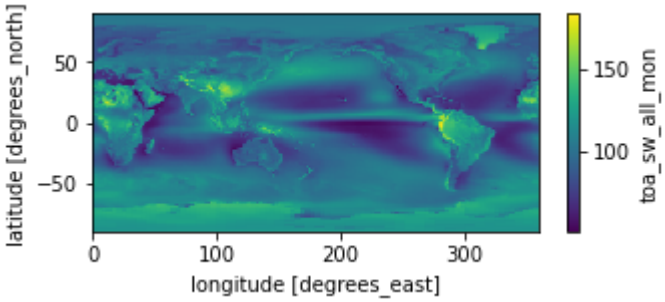


2.5

In [79]:

```
#计算云面积的平均值
cld_a = ds.cldarea_total_daynight_mon.mean(dim='time')

#计算短波和长波辐射的全球平均值 ， 并画图
ds.toa_lw_all_mon.mean(dim='time').where(cld_a).plot(figsize=(5,2))
plt.show()

ds.toa_sw_all_mon.mean(dim='time').where(cld_a).plot(figsize=(5,2))
plt.show()
```





In [ ]: