

```
In [1]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.ticker as mticker
import cartopy.crs as ccrs
import cartopy.feature as cfeature
import geopandas
import xarray as xr
import netCDF4
%matplotlib inline
```

```
In [2]: import textwrap
```

1. Global Earthquakes

```
In [3]: # 导入数据
E=pd.read_csv('usgs_earthquakes.csv')
E
```

Out[3]:

	time	latitude	longitude	depth	mag	magType	nst	gap	dmin	r
--	------	----------	-----------	-------	-----	---------	-----	-----	------	---

0	2014-01-31 23:53:37.000	60.252000	-152.708100	90.20	1.10	ml	NaN	NaN	NaN	0.29
1	2014-01-31 23:48:35.452	37.070300	-115.130900	0.00	1.33	ml	4.0	171.43	0.342000	0.02
2	2014-01-31 23:47:24.000	64.671700	-149.252800	7.10	1.30	ml	NaN	NaN	NaN	1.00
3	2014-01-31 23:30:54.000	63.188700	-148.957500	96.50	0.80	ml	NaN	NaN	NaN	1.07
4	2014-01-31 23:30:52.210	32.616833	-115.692500	10.59	1.34	ml	6.0	285.00	0.043210	0.20
...
120103	2014-12-01 00:10:16.000	60.963900	-146.762900	14.80	3.80	ml	NaN	NaN	NaN	0.69
120104	2014-12-01 00:09:39.000	58.869100	-154.415900	108.40	2.40	ml	NaN	NaN	NaN	0.67
120105	2014-12-01 00:09:25.350	38.843498	-122.825836	2.37	0.43	md	8.0	107.00	0.008991	0.03
120106	2014-12-01 00:05:54.000	65.152100	-148.992000	9.50	0.40	ml	NaN	NaN	NaN	0.69
120107	2014-12-01 00:04:05.000	60.227200	-147.024500	2.50	1.60	ml	NaN	NaN	NaN	0.73

120108 rows × 15 columns

```
In [4]: # 筛选出2014年震级最大的50个地震事件
df=df.sort_values('mag',ascending=False).head(50)[['latitude','longitude','mag']]
df
```

Out[4]:

	latitude	longitude	mag
37371	-19.6097	-70.7691	8.2
50562	51.8486	178.7352	7.9
36918	-20.5709	-70.4931	7.7
33808	-11.2701	162.1481	7.6
31496	-6.7547	155.0241	7.5
33537	-11.4633	162.0511	7.4
95913	12.5262	-88.1225	7.3
31850	17.3970	-100.9723	7.2
34318	-6.5858	155.0485	7.1
106285	1.8929	126.5217	7.1
111052	-19.6903	-177.7587	7.1
97602	-32.1082	-110.8112	7.0
47934	-55.4703	-28.3669	6.9
78063	0.8295	146.1688	6.9
50609	-29.9772	-177.7247	6.9
14025	35.9053	82.5864	6.9
61294	-19.8015	-178.4001	6.9
37367	-19.8927	-70.9455	6.9
39915	40.2893	25.3889	6.9
66278	14.7240	-92.4614	6.9
24887	40.8287	-125.1338	6.8
32964	-53.4967	8.7220	6.8
101767	1.9604	126.5751	6.8
71135	-14.5980	-73.5714	6.8
22968	-19.9807	-70.7022	6.7
84421	13.7641	144.4294	6.7
105466	-37.6478	179.6621	6.7
50587	-29.9414	-177.6073	6.7
47776	-14.9831	-175.5096	6.7
46333	-24.6108	179.0856	6.6
33523	-11.1284	162.0520	6.6
117886	7.9401	-82.6865	6.6
47320	-21.4542	170.3546	6.6
119708	6.1572	123.1261	6.6
97597	-32.0953	-110.8647	6.6
109305	-5.9873	148.2315	6.6

	latitude	longitude	mag
118288	-6.5108	154.4603	6.6
34096	11.6420	-85.8779	6.6
31670	-6.6558	155.0869	6.6
15979	-15.0691	167.3721	6.5
103919	2.2999	127.0562	6.5
17606	-32.9076	-177.8806	6.5
26972	27.4312	127.3674	6.5
36929	-20.3113	-70.5756	6.5
34302	-6.7878	154.9502	6.5
50608	-29.9379	-177.5159	6.5
64647	37.0052	142.4525	6.5
12142	14.6682	-58.9272	6.5
29890	49.6388	-127.7316	6.5
67518	-6.2304	152.8075	6.5

```
In [5]: #地图样式参考的代码网站: https://blog.csdn.net/rs_gis/article/details/105754345
#在地图上绘制散点参考的代码网站: https://zhuanlan.zhihu.com/p/360407544

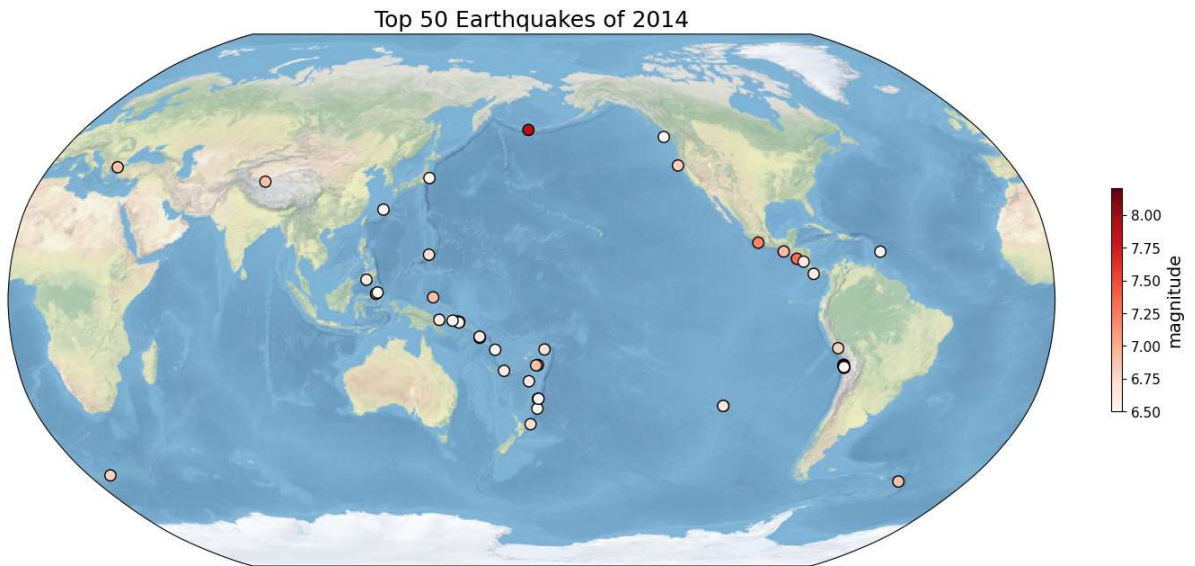
# 导入colormap
cm = plt.cm.get_cmap('Reds')

# 绘制地图
f = plt.figure(figsize=(16,9)) #定义画布大小
ax = plt.axes(projection=ccrs.Robinson(central_longitude=180)) #axes创建坐标系图形
ax.stock_img()

# 在地图上增加地震发生的地点，并用颜色表示震级
color=ax.scatter(df['longitude'],df['latitude'],
                 c=df['mag'],edgecolors='k',cmap=cm,s=80,
                 transform=ccrs.PlateCarree())

# 增加colorbar
cb=plt.colorbar(color,fraction=0.01)
cb.ax.tick_params(labelsize=11)
cb.set_label(label='magnitude',loc='center',size=14)


# 设置图片标题
plt.title('Top 50 Earthquakes of 2014',size=18)
plt.show()
```










2. Explore a netCDF dataset

```
In [6]: # 导入数据,使用的是assignment3 相同的数据
BC=xr.open_dataset("BC-em-anthro_input4MIPs_emissions_CMIP_CEDS-2017-05-18_gn_200001")
BC_emiss=BC.BC_em_anthro.sel(sector=2)
BC_emiss
```

```
Out[6]: xarray.DataArray 'BC_em_anthro' (time: 180, lat: 360, lon: 720)
```

 [46656000 values with dtype=float32]

▼ Coordinates:

lon	(lon)	float64	-179.8 -179.2 ... 179.2 179.8		
lat	(lat)	float64	-89.75 -89.25 ... 89.25 89.75		
sector	()	int32	2		
time	(time)	object	2000-01-16 00:00:00 ... 2014-12-...		

► Indexes: (3)

▼ Attributes:

units : kg m-2 s-1
long_name : BC Anthropogenic Emissions
cell_methods : time: mean

```
In [7]: # 导入经纬度数据
# 参考的网站为: https://cloud.tencent.com/developer/article/1790266
from cartopy.mpl.gridliner import LONGITUDE_FORMATTER, LATITUDE_FORMATTER
```

```
In [8]: # 2.1
# 关闭warning
import warnings
warnings.filterwarnings('ignore')

# 绘制图像
plt.figure(figsize=(16,9), dpi=100)
proj = ccrs.PlateCarree(central_longitude=180)
ax = plt.axes(projection=proj)
```

```

# 导入黑炭排放的数据
# 其中colorbar的参数设置参考了这个网址: https://blog.csdn.net/weixin_42372313/article
bc=np. log(BC_emiss. mean(dim='time')). plot(ax=ax, transform=ccrs. PlateCarree(),
                                             cbar_kwargs={'shrink': 0.8, 'label': 'BC Ant

# 添加国界
ax. add_feature(cfeature. NaturalEarthFeature(category='cultural',
                                              name='admin_0_countries',
                                              scale='110m',
                                              facecolor='none',
                                              edgecolor='black',
                                              linewidth=0.5))

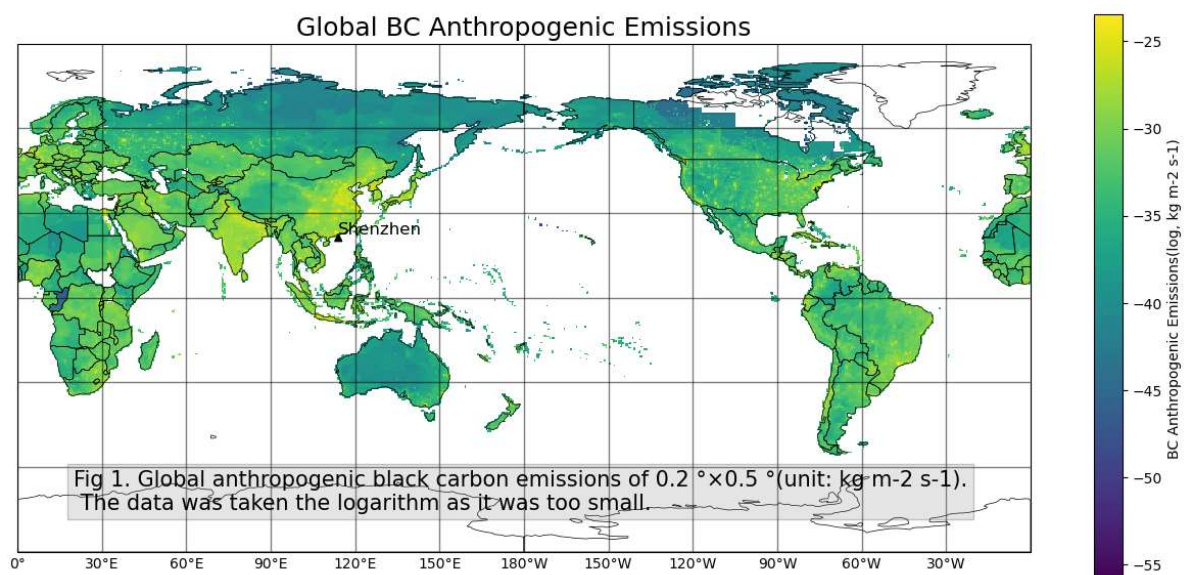
# 添加深圳的经纬度, 并且在图里标记出来
central_lon, central_lat=114.06-180, 22.54
ax. annotate('Shenzhen', (central_lon, central_lat), size=12,
            arrowprops=dict(facecolor='black',
                            headwidth=5, headlength=5,
                            shrink=0.005),
            transform=ccrs. PlateCarree())

# 添加说明文本
tx1="Fig 1. Global anthropogenic black carbon emissions of 0.2 ° × 0.5 ° (unit: kg m
plt. text(20, -75,
         tx1, size = 15, transform=ccrs. PlateCarree(),
         bbox=dict(facecolor="grey", alpha=0.2))

# 画经纬度
gl = ax. gridlines(draw_labels=True,
                  crs=ccrs. PlateCarree(),
                  linewidth=1, color='black', alpha=0.5)
gl. top_labels=False #删除顶部的标记
gl. xformatter=LONGITUDE_FORMATTER
gl. yformatter=LATITUDE_FORMATTER
gl. ylocator = mticker. FixedLocator(np. arange(-90, 90, 30))
gl. xlocator = mticker. FixedLocator(np. arange(-180, 180, 30))

# 添加图像标题
ax. set_title('Global BC Anthropogenic Emissions', fontsize=18)
plt. show()

```



```

In [9]: # 2.2
# 关闭warning
import warnings

```

```
warnings.filterwarnings('ignore')

# 绘制图像
plt.figure(figsize=(16,9),dpi=100)

# 添加北京的经纬度，设置为图像的中心点
central_lon, central_lat = 116.2, 39.56 # Beijing
proj = ccrs.Orthographic(central_lon, central_lat)
ax = plt.axes(projection=proj)
extent = [central_lon-20, central_lon+20, central_lat-20, central_lat+20] #设置区域
ax.set_extent(extent)

# 添加黑炭数据
bc_region=np. log(BC_emiss.mean(dim='time')).plot(ax=ax, transform=ccrs.PlateCarree(
    cbar_kwargs={'shrink': 1,'label':'BC Anthr

# 添加国界
ax.add_feature(cfeature.NaturalEarthFeature(category='cultural',
                                             name='admin_0_countries',
                                             scale='110m',
                                             facecolor='none',
                                             edgecolor='black',
                                             linewidth=2))

# 添加河流
ax.add_feature(cfeature.RIVERS, edgecolor='blue', zorder=2)

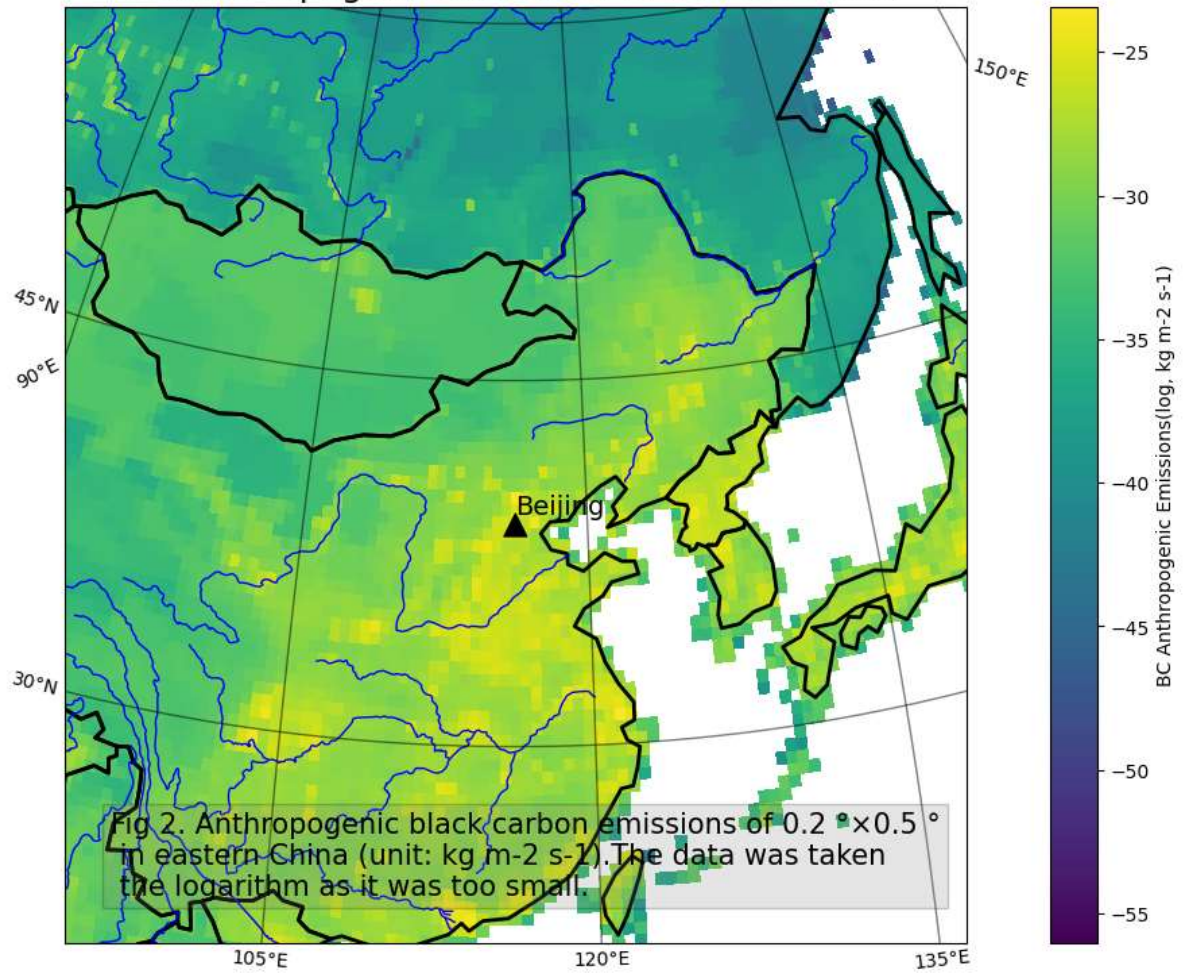
# 添加北京的标记
ax.annotate('Beijing', (central_lon,central_lat),size=14,
            arrowprops=dict(facecolor='black', shrink=0.05))

# 添加图像的说明文本
tx="Fig 2. Anthropogenic black carbon emissions of 0.2 ° ×0.5 ° \n in eastern China
plt.text(98, 22,
        tx, size = 15, transform=ccrs.PlateCarree(),
        bbox=dict(facecolor="grey",alpha=0.2))

# 添加经纬度
gl = ax.gridlines(draw_labels=True,crs=ccrs.PlateCarree(), linewidth=1, color='black')
gl.top_labels=False
gl.right_labels=False
gl.xformatter=LONGITUDE_FORMATTER
gl.yformatter=LATITUDE_FORMATTER
gl.ylocator = mticker.FixedLocator(np.arange(-90,90,15))
gl.xlocator = mticker.FixedLocator(np.arange(-180, 180, 15))

# 添加图像标题
ax.set_title('BC Anthropogenic Emissions of Eastern China',fontsize=18)
plt.show()
```


BC Anthropogenic Emissions of Eastern China



In []: