In [1]:
```
# Assignment 04 by Yang Yi 12432892
import netCDF4
import numpy as np
import xarray as xr
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 cartopy.mpl.ticker as cticker
%matplotlib inline
```

In [2]:
```
# 1.Global Earthquakes
data = pd.read_csv("usgs_earthquakes.csv")
data.head()
```

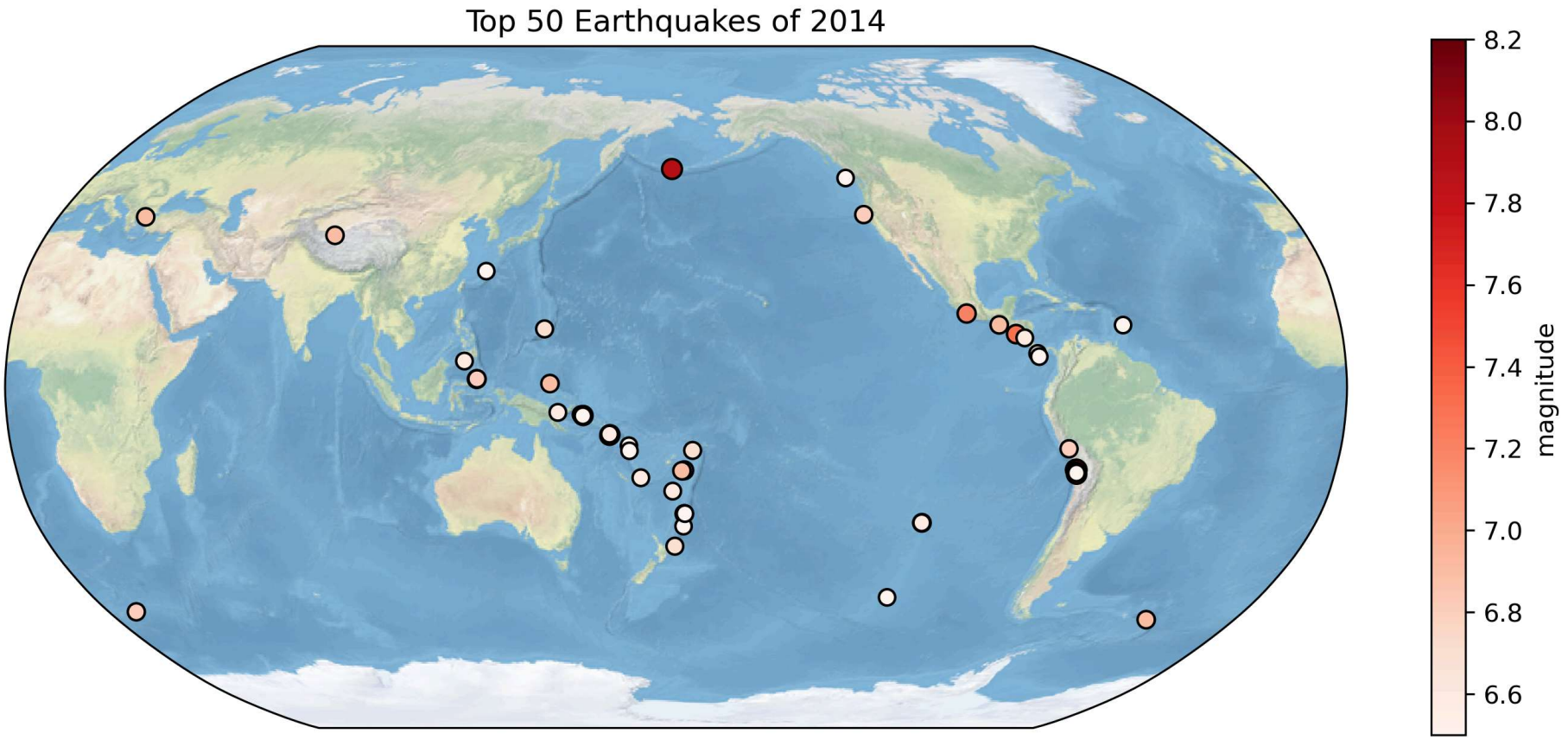
Out[2]:

	time	latitude	longitude	depth	mag	magType	nst	gap	dmin	rms	net	id	updated	
0	2014-01-31 23:53:37.000	60.252000	-152.7081	90.20	1.10	ml	NaN	NaN	NaN	0.2900	ak	ak11155107	2014-02-05T19:34:41.515Z	I
1	2014-01-31 23:48:35.452	37.070300	-115.1309	0.00	1.33	ml	4.0	171.43	0.34200	0.0247	nn	nn00436847	2014-02-01T01:35:09.000Z	
2	2014-01-31 23:47:24.000	64.671700	-149.2528	7.10	1.30	ml	NaN	NaN	NaN	1.0000	ak	ak11151142	2014-02-01T00:03:53.010Z	
3	2014-01-31 23:30:54.000	63.188700	-148.9575	96.50	0.80	ml	NaN	NaN	NaN	1.0700	ak	ak11151135	2014-01-31T23:41:25.007Z	C
4	2014-01-31 23:30:52.210	32.616833	-115.6925	10.59	1.34	ml	6.0	285.00	0.04321	0.2000	ci	ci37171541	2014-02-01T00:13:20.107Z	P

In [4]:

```
# 本题从我的师姐龙师倩处得到启发
# 设置画布大小和分辨率
plt.figure(figsize=(12, 10),dpi=300)
# 创建投影的地图对象
proj = ccrs.Robinson(central_longitude=180, globe=None)
ax = plt.axes(projection=proj)
ax.stock_img()
# 设置地图为全球视图
ax.set_global()

top_50_earthquakes = data.nlargest(50, 'mag')
```

```
lons = top_50_earthquakes['longitude'].values
lats = top_50_earthquakes['latitude'].values
magnitudes = top_50_earthquakes['mag'].values

# 在地图上绘制散点图
sc = ax.scatter(lons, lats, s=magnitudes**2, c=magnitudes, edgecolor='black', cmap='Reds', transform=ccrs.PlateCarree())

plt.colorbar(sc, label='magnitude', shrink=0.5)
plt.title('Top 50 Earthquakes of 2014')
plt.show()
```



In [7]:
```
# 2.Explore a netCDF dataset
# 本题我使用了Assignment 03中的文件
import xarray as xr
```

```
import glob
# 定义文件路径
file='D:\\ESE5023-Assignments-12432892\\output_file\\*.nc4'
# 获取所有文件路径
files=glob.glob(file)
# 合并多个文件
CO2=xr.open_mfdataset(files,combine='by_coords')
# 查看合并后的文档
CO2
```

Out[7]: xarray.Dataset

► Dimensions: (**lat**: 361, **lon**: 576, **time**: 86)

▼ Coordinates:

lat	(lat)	float64	-90.0 -89.5 -89.0 ... 89.5 90.0
lon	(lon)	float64	-180.0 -179.4 ... 178.8 179.4
time	(time)	datetime64[ns]	2015-01-16T12:00:00 ... 2022-02-15

▼ Data variables:

XCO2	(time, lat, lon)	float64	dask.array<chunksize=(1, 361, 576), met...
XCO2PREC	(time, lat, lon)	float64	dask.array<chunksize=(1, 361, 576), met...

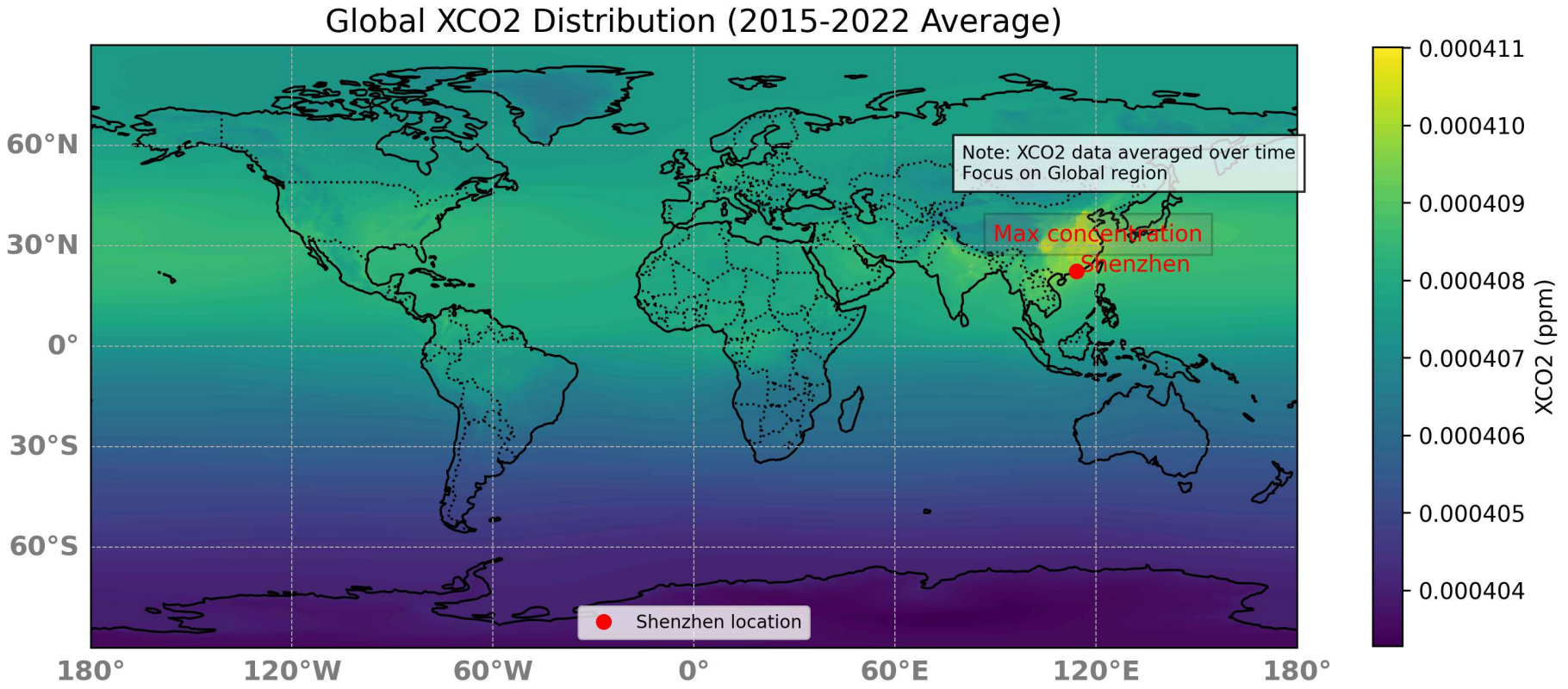
► Indexes: (3)

► Attributes: (25)

In [17]:
```
# 2.1 绘制全局地图
# 加载数据集
file = 'D:\\ESE5023-Assignments-12432892\\output_file\\*.nc4'
CO2 = xr.open_mfdataset(file, combine='by_coords')

# 提取变量
xco2 = CO2['XCO2'].mean(dim='time')  # 对时间维度取平均值
lats = CO2['lat'].values
lons = CO2['lon'].values

# 找到 XCO2 最大值的位置
```

```python
xco2_numpy = xco2.values  # 转换为 NumPy 数组
max_idx = np.unravel_index(np.argmax(xco2_numpy), xco2_numpy.shape)
max_lat = lats[max_idx[0]]
max_lon = lons[max_idx[1]]

# 创建绘图
plt.figure(figsize=(12, 6), dpi=300)
ax = plt.axes(projection=ccrs.PlateCarree())  # PlateCarree 是等矩形投影
ax.set_global()

# 添加地理特征
ax.coastlines()
ax.add_feature(cfeature.BORDERS, linestyle=':')

# 添加网格线和坐标标签
gl = ax.gridlines(draw_labels=True, linestyle="--", linewidth=0.5)
gl.top_labels = False  # 关闭顶部标签
gl.right_labels = False  # 关闭右侧标签
gl.xlabel_style = {'size': 12, 'color': 'gray', 'weight': 'bold'}
gl.ylabel_style = {'size': 12, 'color': 'gray', 'weight': 'bold'}

# 添加 X 和 Y 轴标签
ax.set_xlabel("Longitude (°)", fontsize=12, weight='bold')
ax.set_ylabel("Latitude (°)", fontsize=12, weight='bold')

# 标注深圳的位置 (纬度：22.5°N，经度：114.1°E)
shenzhen_lat, shenzhen_lon = 22.5, 114.1
ax.plot(shenzhen_lon, shenzhen_lat, 'ro', markersize=6, transform=ccrs.PlateCarree())
ax.text(shenzhen_lon + 1, shenzhen_lat, "Shenzhen", color='red', fontsize=10, transform=ccrs.PlateCarree())

# 绘制数据
mesh = ax.pcolormesh(lons, lats, xco2, transform=ccrs.PlateCarree(), cmap='viridis')

# 添加颜色条
cbar = plt.colorbar(mesh, orientation='vertical', pad=0.05, shrink=0.8)
cbar.set_label('XCO2 (ppm)')

# 添加标题
plt.title("Global XCO2 Distribution (2015-2022 Average)", fontsize=14)

# 添加文本框
```

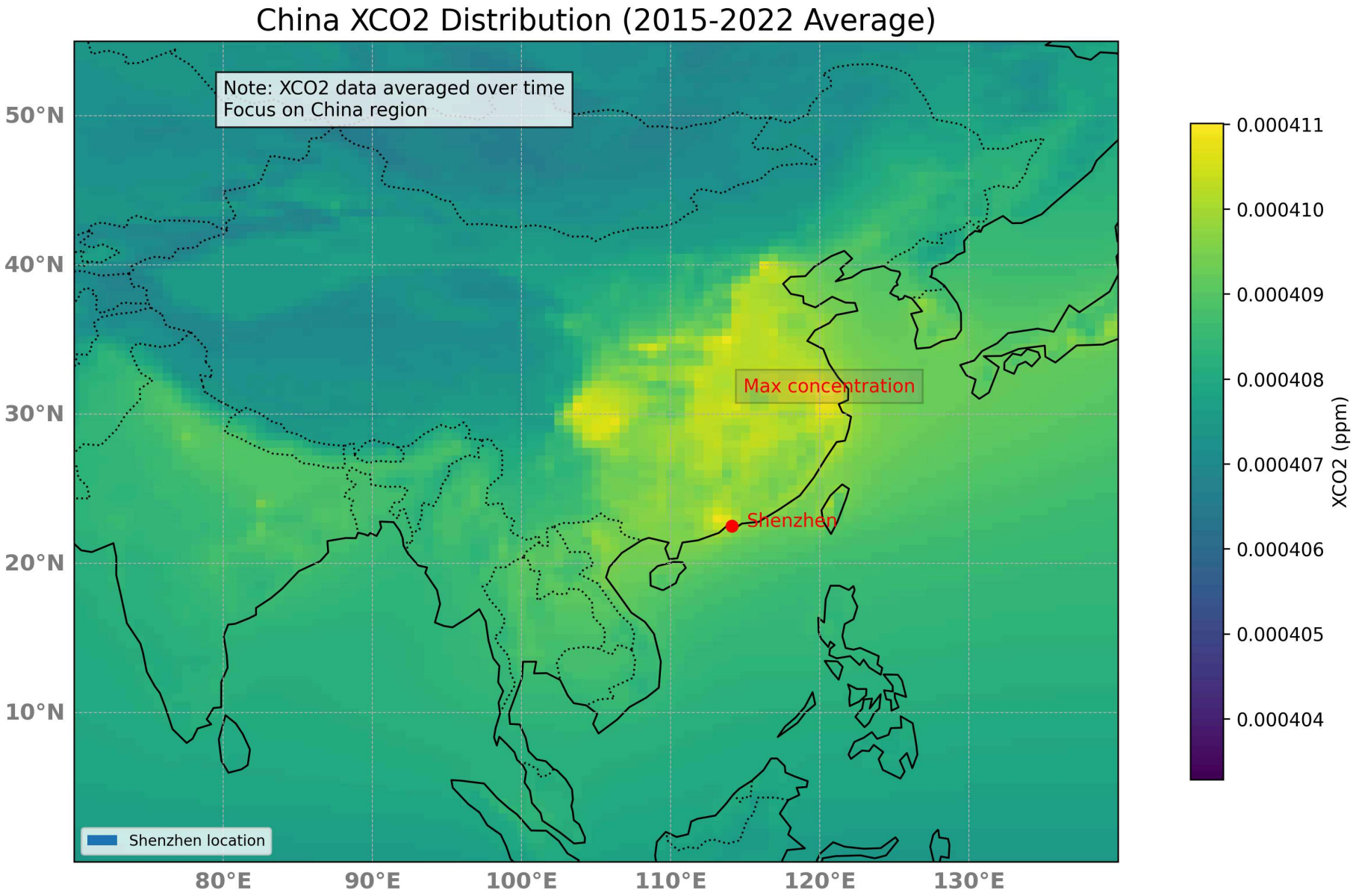
```
plt.text(80, 50, "Note: XCO2 data averaged over time\nFocus on Global region",
         bbox=dict(facecolor='white', alpha=0.8), fontsize=8)

# 在图中 XCO2 浓度最大处添加注释“Max concentration”
ax.text(max_lon, max_lat, 'Max concentration', size=10,
        horizontalalignment='center', color='red',
        bbox=dict(facecolor="grey", alpha=0.2),
        transform=ccrs.PlateCarree())

#添加图例
plt.legend(['Shenzhen location'],loc='best',fontsize=8)

# 显示图像
plt.show()
```



In [11]:

```
# 2.2 绘制聚焦中国的区域地图
# 加载数据集
file = 'D:\\ESE5023-Assignments-12432892\\output_file\\*.nc4'
CO2 = xr.open_mfdataset(file, combine='by_coords')

# 提取变量
xco2 = CO2['XCO2'].mean(dim='time')  # 对时间维度取平均值
lats = CO2['lat'].values
lons = CO2['lon'].values

# 找到 XCO2 最大值的位置
xco2_numpy = xco2.values  # 转换为 NumPy 数组
max_idx = np.unravel_index(np.argmax(xco2_numpy), xco2_numpy.shape)
max_lat = lats[max_idx[0]]
max_lon = lons[max_idx[1]]

# 创建绘图
plt.figure(figsize=(14, 8), dpi=300)
ax = plt.axes(projection=ccrs.PlateCarree())  # 使用 PlateCarree 投影
ax.set_extent([70, 140, 0, 55], crs=ccrs.PlateCarree())  # 聚焦中国地区

# 添加地理特征
ax.coastlines()
ax.add_feature(cfeature.BORDERS, linestyle=':')

# 添加网格线和坐标标签
gl = ax.gridlines(draw_labels=True, linestyle="--", linewidth=0.5)
gl.top_labels = False  # 关闭顶部标签
gl.right_labels = False  # 关闭右侧标签
gl.xlabel_style = {'size': 12, 'color': 'gray', 'weight': 'bold'}
gl.ylabel_style = {'size': 12, 'color': 'gray', 'weight': 'bold'}

# 添加 X 和 Y 轴标签
ax.set_xlabel("Longitude (°)", fontsize=12, weight='bold')
ax.set_ylabel("Latitude (°)", fontsize=12, weight='bold')

# 绘制 XCO2 数据
mesh = ax.pcolormesh(lons, lats, xco2, transform=ccrs.PlateCarree(), cmap='viridis')

# 添加颜色条
```

```
cbar = plt.colorbar(mesh, orientation='vertical', pad=0.05, shrink=0.8)
cbar.set_label('XCO2 (ppm)')  # 替换为实际单位

# 标注深圳的位置 (纬度：22.5°N，经度：114.1°E)
shenzhen_lat, shenzhen_lon = 22.5, 114.1
ax.plot(shenzhen_lon, shenzhen_lat, 'ro', markersize=6, transform=ccrs.PlateCarree())
ax.text(shenzhen_lon + 1, shenzhen_lat, "Shenzhen", color='red', fontsize=10, transform=ccrs.PlateCarree())

# 添加标题
plt.title("China XCO2 Distribution (2015-2022 Average)", fontsize=16)

# 添加文本框
plt.text(80, 50, "Note: XCO2 data averaged over time\nFocus on China region",
         bbox=dict(facecolor='white', alpha=0.8), fontsize=10)

# 在图中 XCO2 浓度最大处添加注释“Max concentration”
ax.text(max_lon, max_lat, 'Max concentration', size=10,
        horizontalalignment='center', color='red',
        bbox=dict(facecolor="grey", alpha=0.2),
        transform=ccrs.PlateCarree())

#添加图例
plt.legend(['Shenzhen location'],loc='best',fontsize=8)

# 显示图像
plt.show()
```



2.1和2.2可能由于cartopy和我的python有些地方不兼容的问题，所以我虽然写了x轴和y轴标签的代码，但是图中并没有显现，希望助教能看到我写了代码,谢谢~ 代码如下：

添加 X 和 Y 轴标签

ax.set_xlabel("Longitude (°)", fontsize=12, weight='bold') ax.set_ylabel("Latitude (°)", fontsize=12, weight='bold')