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

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In [2]: #1. Global Earthquakes
df = pd.read_csv('usgs_earthquakes.csv')
#选取震级最大的50次地震
top_50_earthquakes = df.nlargest(50, 'mag')
```

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In [3]: # 创建图形和轴对象，使用PlateCarree投影
fig = plt.figure(figsize=(12, 6))
ax = fig.add_subplot(1, 1, 1, projection=ccrs.Robinson(central_longitude=-180))

# 添加地理特征
ax.add_feature(cfeature.LAND,color='lightyellow')
ax.add_feature(cfeature.OCEAN,color='lightblue')
ax.set_extent([0.1, 359.9, -90, 90])

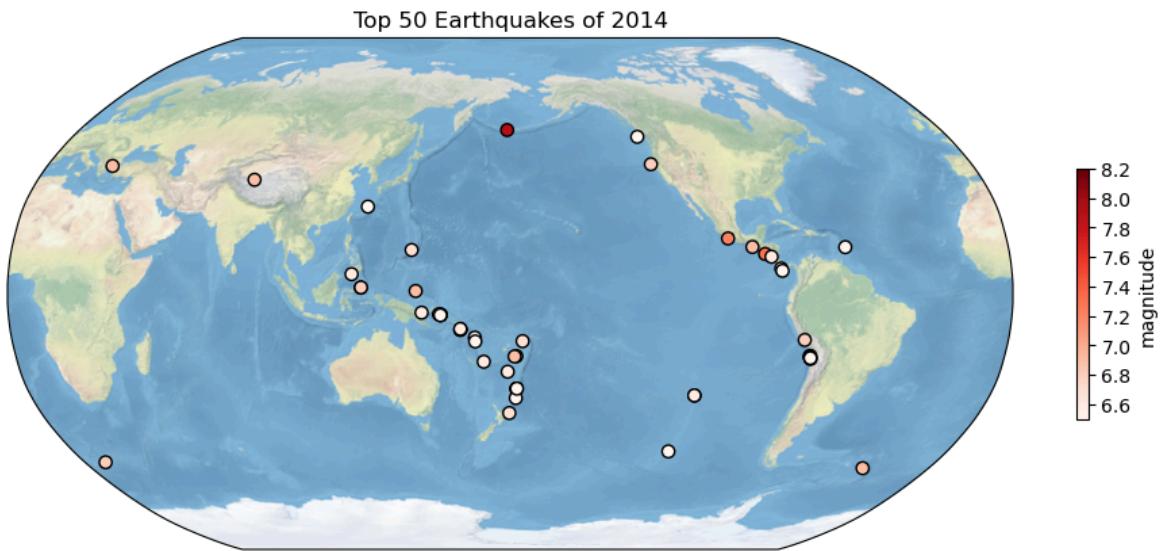
# 设置标题
ax.set_title('Top 50 Earthquakes of 2014')

# 绘制地震点，颜色根据震级大小
sc = ax.scatter(
    top_50_earthquakes['longitude'],
    top_50_earthquakes['latitude'],
    c=top_50_earthquakes['mag'],
    cmap='Reds',
    s=45,
    edgecolor='k',
    transform=ccrs.PlateCarree()
)

#加一个背景
ax.stock_img()

# 添加颜色条
cbar = fig.colorbar(sc, ax=ax, orientation='vertical', ticks=np.arange(6.6, 8.3,
cbar.set_label('magnitude'))

# 显示图形
plt.show()
```



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In [4]: #2. Explore a netCDF dataset
#从nasa网站中获取数据，为2025年10月的降水量多于20mm的天数，网站如下：https://disc.gsfc.nasa.gov
# Import modules
import numpy as np
import xarray as xr
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.ticker as mticker
%matplotlib inline
import cartopy.crs as ccrs
import cartopy.feature as cfeature
from cartopy.mpl.gridliner import LONGITUDE_FORMATTER, LATITUDE_FORMATTER
from matplotlib.lines import Line2D

#读取文件
ds = xr.open_dataset("MERRA2.statM_2d_edi_Nx.v2_1.202510.nc4.nc4",
                     engine="netcdf4")
print(ds.data_vars)
print(ds["R20mm"].shape)
```

Data variables:

R20mm	(time, lat, lon) float64 2MB ...
WSDI	(time, lat, lon) float64 2MB ...
	(1, 361, 576)

```
In [5]: #提取变量：降水量大于20mm的天数 (R20mm)
heavy_rain_days = ds["R20mm"].squeeze() # 移除单维度

# 创建图形
fig = plt.figure(figsize=(14, 7))
ax = fig.add_subplot(1, 1, 1, projection=ccrs.PlateCarree())

# 绘制数据
im = ax.pcolormesh(
    ds["lon"],
    ds["lat"],
    heavy_rain_days,
    cmap="YlOrRd",
    transform=ccrs.PlateCarree(),
    shading="auto"
)

# 添加地理特征
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ax.add_feature(cfeature.LAND, facecolor="lightgray")
ax.add_feature(cfeature.OCEAN, facecolor="lightblue")
ax.add_feature(cfeature.COASTLINE, linewidth=0.5)
ax.add_feature(cfeature.BORDERS, linestyle=":", linewidth=0.5)

# 设置网格线
gl = ax.gridlines(
    crs=ccrs.PlateCarree(),
    draw_labels=True,
    linewidth=1,
    color="gray",
    alpha=0.5,
    linestyle="--"
)
gl.top_labels = False
gl.right_labels = False
gl.xlocator = mticker.FixedLocator(np.arange(-180, 181, 30))
gl.ylocator = mticker.FixedLocator(np.arange(-90, 91, 30))
gl.xformatter = LONGITUDE_FORMATTER
gl.yformatter = LATITUDE_FORMATTER

# 设置标题和标签
plt.title("Global Distribution of Days with Precipitation > 20mm (October 2025)")

# 添加颜色条
cbar = plt.colorbar(im, ax=ax, orientation="vertical", pad=0.05, shrink=0.6, aspect=1)
cbar.set_label("Number of Days", fontsize=12)

# 添加文本框
ax.annotate(
    "Data Source: MERRA-2\nVariable: R20mm",
    xy=(0.02, 0.02),
    xycoords="axes fraction",
    fontsize=10,
    bbox=dict(boxstyle="round", facecolor="white", alpha=0.8)
)

# 注释
ax.annotate("China",
            xy=(100, 32),
            xytext=(120, 40),
            arrowprops=dict(arrowstyle="->", color="black"),
            fontsize=10,
            transform=ccrs.PlateCarree())

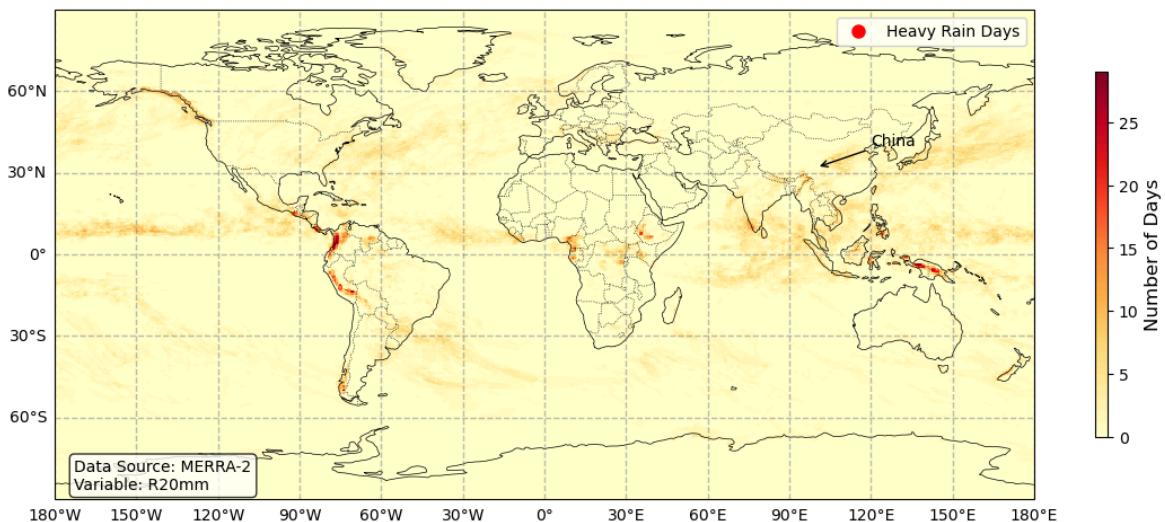
#设置图例
legend_elements = [Line2D([0], [0], marker='o', color='w', label='Heavy Rain Day',
                         markerfacecolor='red', markersize=10)]
ax.legend(handles=legend_elements, loc='upper right')

# 设置地图范围 (全球)
ax.set_extent([-180, 180, -90, 90], crs=ccrs.PlateCarree())

# 保存图形
plt.show()

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Global Distribution of Days with Precipitation > 20mm (October 2025)



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In [6]: #2.2 [10 points] Make a regional map of the same variable. Your figure should co
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import cartopy.crs as ccrs
import cartopy.feature as cfeature
import matplotlib.pyplot as plt
import matplotlib.ticker as mticker
from cartopy.mpl.ticker import LongitudeFormatter, LatitudeFormatter
from matplotlib.lines import Line2D

# 提取变量并筛选区域 (70°E-140°E, 15°N-55°N)
heavy_rain_days = ds["R20mm"].sel(lon=slice(70, 140), lat=slice(15, 55)).squeeze()

# 创建图形、投影
fig = plt.figure(figsize=(12, 8))
ax = fig.add_subplot(1, 1, 1, projection=ccrs.LambertConformal(central_longitude=100))

# 绘制数据
im = ax.pcolormesh(
    heavy_rain_days.lon,
    heavy_rain_days.lat,
    heavy_rain_days,
    cmap="YlOrRd",
    transform=ccrs.PlateCarree(),
    shading="auto"
)

# 添加地理特征
ax.add_feature(cfeature.LAND, facecolor="lightgray")
ax.add_feature(cfeature.OCEAN, facecolor="lightblue")
ax.add_feature(cfeature.COASTLINE, linewidth=0.8)
ax.add_feature(cfeature.BORDERS, linestyle="-", linewidth=0.8)
ax.add_feature(cfeature.STATES, linestyle=":", linewidth=0.5)

# 设置坐标轴标签和刻度
gl = ax.gridlines(crs=ccrs.PlateCarree(), draw_labels=True, linewidth=1, color='black')
gl.top_labels = False
gl.right_labels = False
gl.xlocator = mticker.FixedLocator([70, 90, 110, 130]) # 设置经度刻度
gl.ylocator = mticker.FixedLocator([20, 30, 40, 50]) # 设置纬度刻度
gl.top_labels = False
gl.right_labels = False

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# 标题
plt.title("Days with Precipitation > 20mm (October 2025)", fontsize=14, pad=20)

# 色条
cbar = plt.colorbar(im, ax=ax, orientation="vertical", pad=0.05, shrink=0.7)
cbar.set_label("Number of Days", fontsize=12)

# 图例
legend_elements = [
    Line2D([0], [0], marker='o', color='w', label='Heavy Rain Days',
           markerfacecolor='red', markersize=10)
]
ax.legend(handles=legend_elements, loc='upper right', fontsize=10)

# 注释
ax.annotate("Tibetan Plateau",
            xy=(90, 32),
            xytext=(100, 40),
            arrowprops=dict(arrowstyle="->", color="black"),
            fontsize=10,
            transform=ccrs.PlateCarree())

#文本框
ax.text(0.02, 0.02, "Data: MERRA-2\nProjection: Lambert Conformal",
        transform=ax.transAxes, bbox=dict(boxstyle="round", facecolor="white", alpha=0.8))

plt.show()

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Days with Precipitation > 20mm (October 2025)

