1. Global Earthquakes

In this problem set, we will use this file from the USGS Earthquakes Database. The dataset is similar to the one you use in Assignment 02. Use the file provided (usgs_earthquakes.csv) to recreate the following map. Use the mag column for magnitude. [10 points]

In [1]:

```
import pandas as pd
import xarray as xr
import numpy as np
import cmaps
import requests
import cartopy
import cartopy.crs as ccrs
from cartopy.io import shapereader as shpreader
import cartopy.feature as cfeature
from cartopy.mpl.gridliner import LONGITUDE_FORMATTER, LATITUDE_FORMATTER
import matplotlib.pyplot as plt
import matplotlib.ticker as mticker
```

In [2]:

```
Sig_Eqs=pd.read_csv('usgs_earthquakes.csv')
Eqs_index=Sig_Eqs['mag'].sort_values(ascending=False)[0:50].index
Eqs_top50=Sig_Eqs.loc[Eqs_index]
Eqs_top50
```

Out[2]:

	time	latitude	longitude	depth	mag	magType	nst	gap	dmin	rms	net	
37371	2014-04-01 23:46:47.260	-19.6097	-70.7691	25.00	8.2	mww	NaN	23.0	0.60900	0.66	us	usc000r
50562	2014-06-23 20:53:09.700	51.8486	178.7352	109.00	7.9	mww	NaN	22.0	0.13300	0.71	us	usc000
36918	2014-04-03 02:43:13.110	-20.5709	-70.4931	22.40	7.7	mww	NaN	44.0	1.02900	0.82	us	usc000
33808	2014-04-12 20:14:39.300	-11.2701	162.1481	22.56	7.6	mww	NaN	13.0	2.82800	0.71	us	usc000p

In [3]:

```
lon = np.array(Eqs_top50.longitude)#转化为数组格式,方便后续处理
lat = np.array(Eqs_top50.latitude)
mag = np.array(Eqs_top50.mag)

fig,ax=plt.subplots(figsize=(15,10),nrows=1,ncols=1,subplot_kw=dict(projection=ccrs.Robinson(180)))
gl=ax.gridlines(draw_labels=True,linestyle=":",linewidth=0.3,color='k')#绘制网格线
gl.xformatter = LONGITUDE_FORMATTER  #使横坐标转化为经纬度格式
gl.yformatter = LATITUDE_FORMATTER
gl.xlocator=mticker.FixedLocator(np.arange(-180,180,30))
gl.ylocator=mticker.FixedLocator(np.arange(-90,90,30))
ax.set_global()
ax.stock_img()#加地图
ax.coastlines()#加海岸线
ax.set_title('Top 50 Earhquakes of 2014',fontsize =10)#设置标题
geodetic = ccrs.Geodetic()
robinson = ccrs.Robinson()
for i in range(50):
    lon[i],lat[i]=robinson.transform_point(lon[i],lat[i],geodetic)#将经纬度坐标转变为当前投影方式下
cd1 =plt.scatter(lon,lat,c= mag,edgecolors='k',cmap=cmaps.MPL_Reds,transform =ccrs.Robinson())
fig.colorbar(cd1, shrink=0.5,ax=ax)
plt.grid(False)
plt.show()
```

```
C:\Users\admin\anaconda3\lib\site-packages\cartopy\mpl\gridliner.py:531: ShapelyDepr
ecationWarning: __len__ for multi-part geometries is deprecated and will be removed
in Shapely 2.0. Check the length of the `geoms` property instead to get the  number
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```
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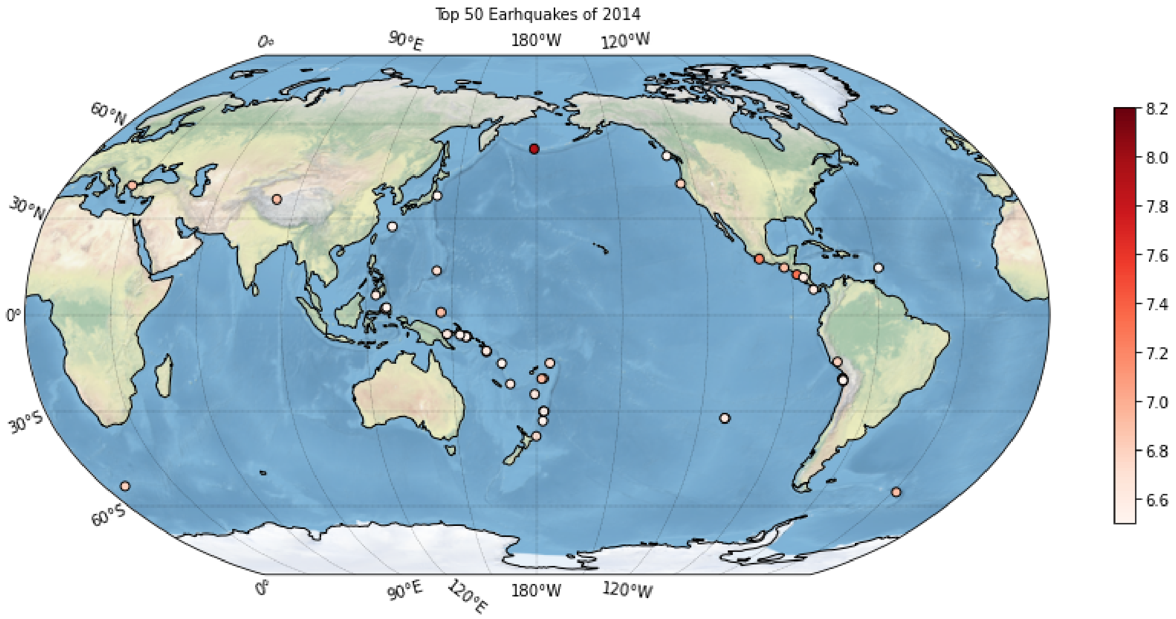

2. Explore a netCDF dataset

2.1 [10 points] Make a global map of a certain variable. Your figure should contain: a project, x label and ticks, y label and ticks, title, gridlines, legend, colorbar, masks or features, annotations, and text box (1 point each).

In [4]:

```
#地面两米的空气温度
ds = xr.open_dataset('air.2m.mon.mean.nc')
```

In [5]:

```
T=ds.air.isel(time=-1)
```

In [6]:

```
# 给两个地点的坐标
hafeng = dict(lon=51.24, lat=10.27)#哈丰角51° 24'E, 10° 27'N
Guangzhou = dict(lon=113.25, lat=23.13)
lons = [hafeng['lon'], Guangzhou['lon']]
lats = [hafeng['lat'], Guangzhou['lat']]

# 创建画布
plt.figure(figsize=(10,6), dpi=100)

# 1.创建ax用。。。投影
proj = ccrs.PlateCarree()
ax = plt.axes(projection=proj)

# 画出地面两米的温度
T.plot(ax=ax, x='lon',y='lat',robust=True,transform=ccrs.PlateCarree(),
         vmin=250, vmax=300, cbar_kwargs={'shrink': 0.4})
#绘制网格线
gl=ax.gridlines(draw_labels=True,linestyle=":",linewidth=0.3,color='k')
#ticks and lables
gl.xformatter = LONGITUDE_FORMATTER  #使横坐标转化为经纬度格式
gl.yformatter = LATITUDE_FORMATTER
gl.xlocator=mticker.FixedLocator(np.arange(-180,180,30))
gl.ylocator=mticker.FixedLocator(np.arange(-90,90,30))
ax.set_xlabel('Month') #为子图设置横轴标题
ax.set_ylabel('Year') #为子图设置纵轴标题
plt.xlabel('X Axis') #设置x轴名称 ax1.set_xlabel
plt.ylabel('Y Axis') #设置Y轴名称 ax1.set_ylabel
#设置标题
ax.set_title('Air temperture of the lasteat time',fontsize =10)

# 画国界线
ax.add_feature(cfeature.NaturalEarthFeature(category='cultural',
                                            name='admin_0_countries',
                                            scale='110m',
                                            facecolor='none',
                                            edgecolor='black',
                                            linewidth=0.5))
# 画海岸线
ax.coastlines(resolution='110m')

#添加文本
ax.text(hafeng['lon'] -12 , hafeng['lat'] - 12, 'hafeng',
         horizontalalignment='left',
         transform=ccrs.Geodetic())
ax.text(Guangzhou['lon'] -12 , Guangzhou['lat'] - 12, 'Guangzhou',
         horizontalalignment='left',
         transform=ccrs.Geodetic())
# 添加两个点
ax.scatter(hafeng['lon'],hafeng['lat'],s=40,c='r',marker='*',label='hafeng',edgecolors='k', linewid
ax.scatter(Guangzhou['lon'],Guangzhou['lat'],s=30,c='green',marker='o',label='Guangzhou',edgecolors=
plt.legend()
plt.show()
```

```
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  return concatenate((arr, values), axis=axis)
```

Air temperture of the lasteat time
180°W 150°W 120°W 90°W 60°W 30°W 0° 30°E 60°E 90°E 120°E 150°E
bafeng

2.2 [10 points] Make a regional map of the same variable. Your figure should contain: a different project, x label and ticks, y label and ticks, title, gridlines, legend, colorbar, masks or features, annotations, and text box (1 point each).

In [7]:

```
# 给两个地点的坐标
hafeng = dict(lon=51.24, lat=10.27)#哈丰角51° 24'E，10° 27'N
Guangzhou = dict(lon=113.25, lat=23.13)
lons = [hafeng['lon'], Guangzhou['lon']]
lats = [hafeng['lat'], Guangzhou['lat']]

# 创建画布
plt.figure(figsize=(10,6), dpi=100)

# 1.创建ax用。。。投影
proj = ccrs.Orthographic()
ax = plt.axes(projection=proj)
# 画出地面两米的温度
T.plot(ax=ax, x='lon',y='lat',robust=True,transform=ccrs.PlateCarree(),
         vmin=250, vmax=300, cbar_kwargs={'shrink': 0.4})

#绘制网格线
gl=ax.gridlines(draw_labels=True,linestyle=":",linewidth=0.3,color='k')

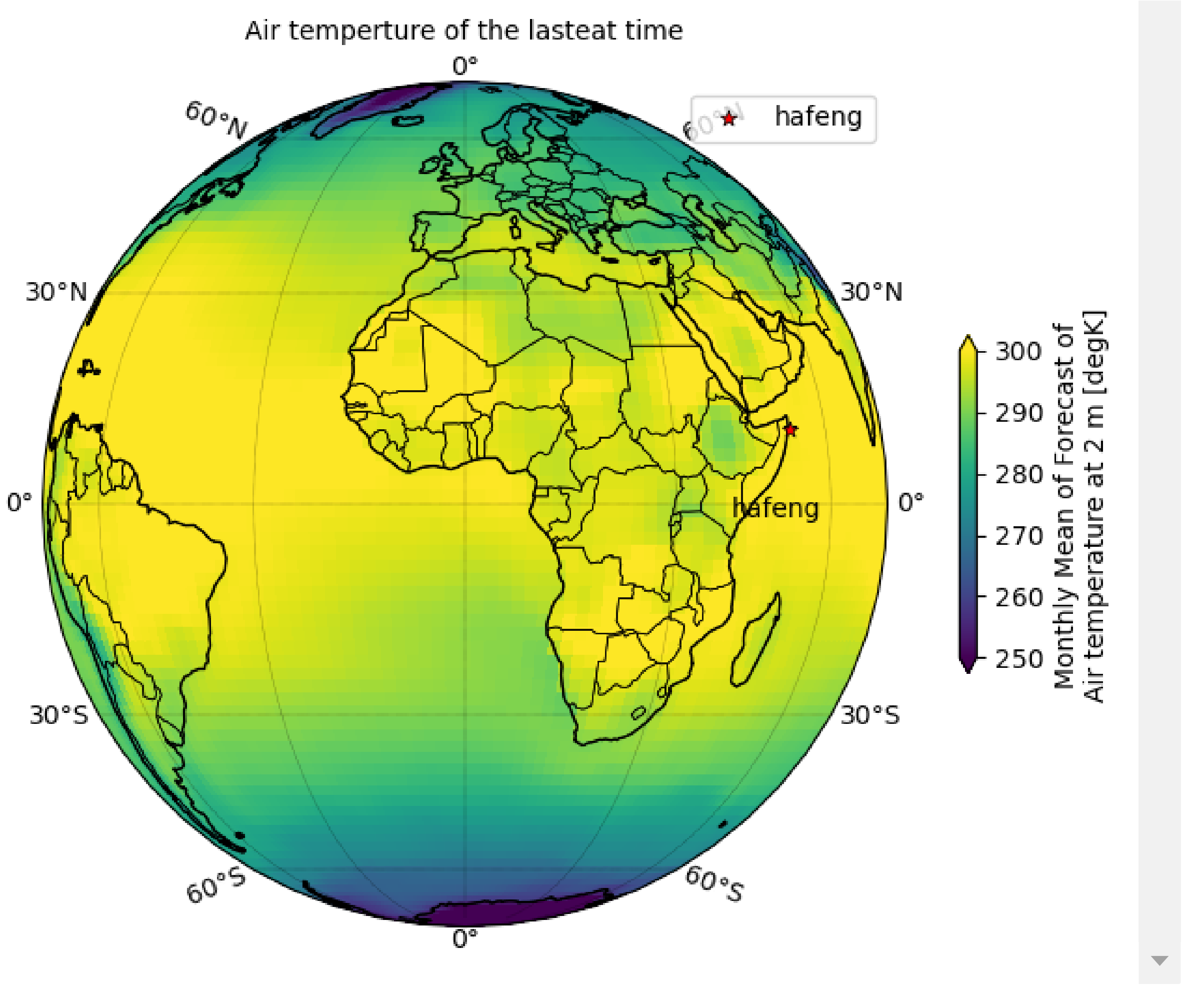
#ticks and lables
gl.xformatter = LONGITUDE_FORMATTER  #使横坐标转化为经纬度格式
gl.yformatter = LATITUDE_FORMATTER
gl.xlocator=mticker.FixedLocator(np.arange(-180,180,30))
gl.ylocator=mticker.FixedLocator(np.arange(-90,90,30))
ax.set_xlabel('Month') #为子图设置横轴标题
ax.set_ylabel('Year') #为子图设置纵轴标题

#设置标题
ax.set_title('Air temperture of the lasteat time',fontsize =10)

# 画国界线
ax.add_feature(cfeature.NaturalEarthFeature(category='cultural',
                                            name='admin_0_countries',
                                            scale='110m',
                                            facecolor='none',
                                            edgecolor='black',
                                            linewidth=0.5))
# 画海岸线
ax.coastlines(resolution='110m')

#添加文本
ax.text(hafeng['lon'] -12 , hafeng['lat'] - 12, 'hafeng',
         horizontalalignment='left',
         transform=ccrs.PlateCarree())

# 添加两个点
ax.scatter(hafeng['lon'],hafeng['lat'],s=40,c='r',marker='*',label='hafeng',edgecolors='k', linewid
plt.legend()
plt.show()
```


Air temperture of the lasteat time
0°
60°N
hafeng
30°N
30°N
0°
0°
hafeng
30°S
30°S
60°S
60°S
0°
300
290
280
270
260
250
Monthly Mean of Forecast of
Air temperature at 2 m [degK]

In [8]:

```
plt.figure(figsize=(5,5), dpi=100)
central_lon, central_lat = 51.24, 10.27 # hafeng
proj = ccrs.Orthographic(central_lon, central_lat)
ax = plt.axes(projection=proj)

extent = [central_lon-50, central_lon+50, central_lat-20, central_lat+20]
ax.set_extent(extent)

ax.add_feature(cfeature.LAKES, edgecolor='blue', facecolor='blue', zorder=2)
ax.add_feature(cfeature.RIVERS, edgecolor='blue', zorder=3)

T.plot(ax=ax, x='lon',y='lat',robust=True,transform=ccrs.PlateCarree(),
         vmin=250, vmax=300, cbar_kwargs={'shrink': 0.4})

#绘制网格线
gl=ax.gridlines(draw_labels=True,linestyle=":",linewidth=0.3,color='k')
#设置标题
ax.set_title('Air temperture of the lasteat time',fontsize =10)
#ticks and lables
gl.xformatter = LONGITUDE_FORMATTER  #使横坐标转化为经纬度格式
gl.yformatter = LATITUDE_FORMATTER
gl.xlocator=mticker.FixedLocator(np.arange(-180,180,30))
gl.ylocator=mticker.FixedLocator(np.arange(-90,90,30))

# Add features to axes using methods
ax.coastlines(resolution='110m', linewidth=0.5)
ax.gridlines()

#添加文本
ax.text(hafeng['lon'] -12 , hafeng['lat'] - 12, 'hafeng',
         horizontalalignment='left',
         transform=ccrs.PlateCarree())

# 添加两个点
ax.scatter(hafeng['lon'],hafeng['lat'],s=40,c='r',marker='*',label='hafeng',edgecolors='k', linewid
plt.legend()
plt.show()
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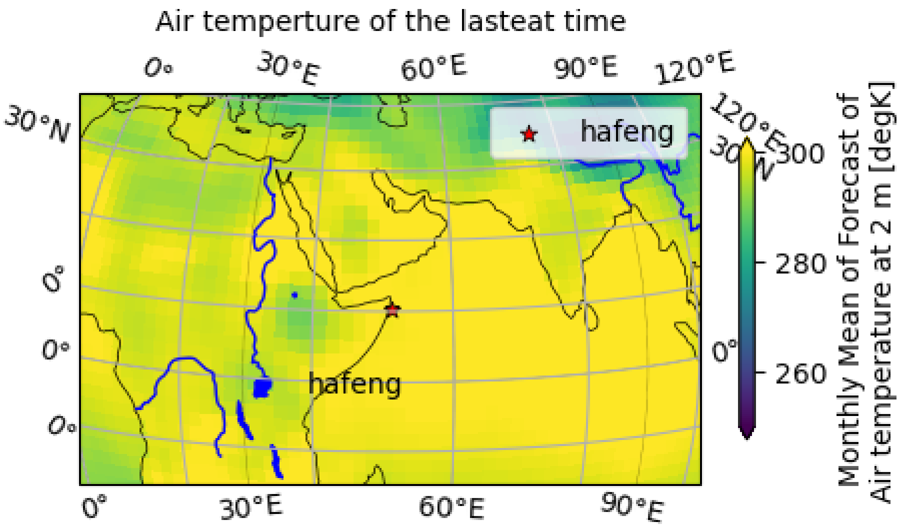
Air temperture of the lasteat time
0°
30°E
60°E
90°E
120°E
30°N
0°
0°
0°
120°E
30°N
0°
★ hafeng
hafeng
300
280
260
Monthly Mean of Forecast of
Air temperature at 2 m [degK]

In [ ]: