1. Global Earthquakes

```python
import numpy as np
import pandas as pd
import xarray as xr
import matplotlib.pyplot as plt
import matplotlib.ticker as mticker
%matplotlib inline
from matplotlib.ticker import (MultipleLocator, FormatStrFormatter, AutoMinorLocator)
import cartopy.crs as ccrs
import cartopy.feature as cfeature
import warnings
warnings.filterwarnings("ignore")

equs = pd.read_csv(r"C:\\Users\\yuanwenting\\Documents\\ESE5023\\assignment\\usgs_earthquakes.csv")
equs
```

	time	latitude	longitude	depth	mag	magType	nst	gap	dmin	rms	net	id	updated	place	type
0	2014-01-31 23:53:37.000	60.252000	-152.708100	90.20	1.10	ml	NaN	NaN	NaN	0.2900	ak	ak11155107	2014-02-05T19:34:41.515Z	26km S of Redoubt Volcano, Alaska	earthquake
1	2014-01-31 23:48:35.452	37.070300	-115.130900	0.00	1.33	ml	4.0	171.43	0.342000	0.0247	nn	nn00436847	2014-02-01T01:35:09.000Z	32km S of Alamo, Nevada	earthquake
2	2014-01-31 23:47:24.000	64.671700	-149.252800	7.10	1.30	ml	NaN	NaN	NaN	1.0000	ak	ak11151142	2014-02-01T00:03:53.010Z	12km NNW of North Nenana, Alaska	earthquake
3	2014-01-31 23:30:54.000	63.188700	-148.957500	96.50	0.80	ml	NaN	NaN	NaN	1.0700	ak	ak11151135	2014-01-31T23:41:25.007Z	22km S of Cantwell, Alaska	earthquake
4	2014-01-31 23:30:52.210	32.616833	-115.692500	10.59	1.34	ml	6.0	285.00	0.043210	0.2000	ci	ci37171541	2014-02-01T00:13:20.107Z	10km WNW of Progreso, Mexico	earthquake
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
120103	2014-12-01 00:10:16.000	60.963900	-146.762900	14.80	3.80	ml	NaN	NaN	NaN	0.6900	ak	ak11453391	2015-03-24T18:25:07.628Z	29km SW of Valdez, Alaska	earthquake
120104	2014-12-01 00:09:39.000	58.869100	-154.415900	108.40	2.40	ml	NaN	NaN	NaN	0.6700	ak	ak11453395	2014-12-10T01:04:25.209Z	102km SSE of Old Iliamna, Alaska	earthquake
120105	2014-12-01 00:09:25.350	38.843498	-122.825836	2.37	0.43	md	8.0	107.00	0.008991	0.0300	nc	nc72358451	2014-12-01T01:15:02.814Z	9km WNW of Cobb, California	earthquake
120106	2014-12-01 00:05:54.000	65.152100	-148.992000	9.50	0.40	ml	NaN	NaN	NaN	0.6900	ak	ak11453390	2014-12-10T01:03:01.225Z	57km NW of Ester, Alaska	earthquake
120107	2014-12-01 00:04:05.000	60.227200	-147.024500	2.50	1.60	ml	NaN	NaN	NaN	0.7300	ak	ak11453389	2014-12-09T02:04:46.894Z	78km WSW of Cordova, Alaska	earthquake

120108 rows × 15 columns
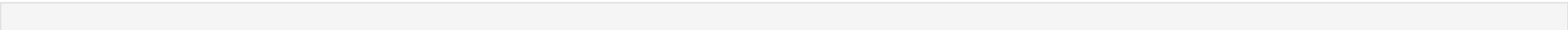
In [4]:
```python
plt.figure(figsize=(8,5), dpi=150)
#中央经线设置参照：https://blog.csdn.net/qq_44955314/article/details/119933373
proj=ccrs.Robinson(central_longitude=180,globe=None)
ax = plt.axes(projection=proj)

#绘制地球阴影浮雕图参照：https://www.cnblogs.com/youxiaogang/p/14262751.html
ax.stock_img()

#筛选mag前50次地震
equs_50=equs.sort_values("mag", ascending=False).head(50)

#画散点图。x、y、c分别为equs_50中'longitude'、'latitude'和'mag'列
plt.scatter('longitude', 'latitude', c='mag', data=equs_50,
            cmap='Reds', edgecolors='black', linewidths=0.5,
            transform=ccrs.PlateCarree())

#colorbar刻度设置参照：https://blog.csdn.net/x_and_y/article/details/107370761
plt.colorbar(shrink=0.4,label='magnitude').ax.yaxis.set_major_locator(MultipleLocator(0.2))
plt.title('Top 50 earthquakes of 2014',fontsize=8)
```
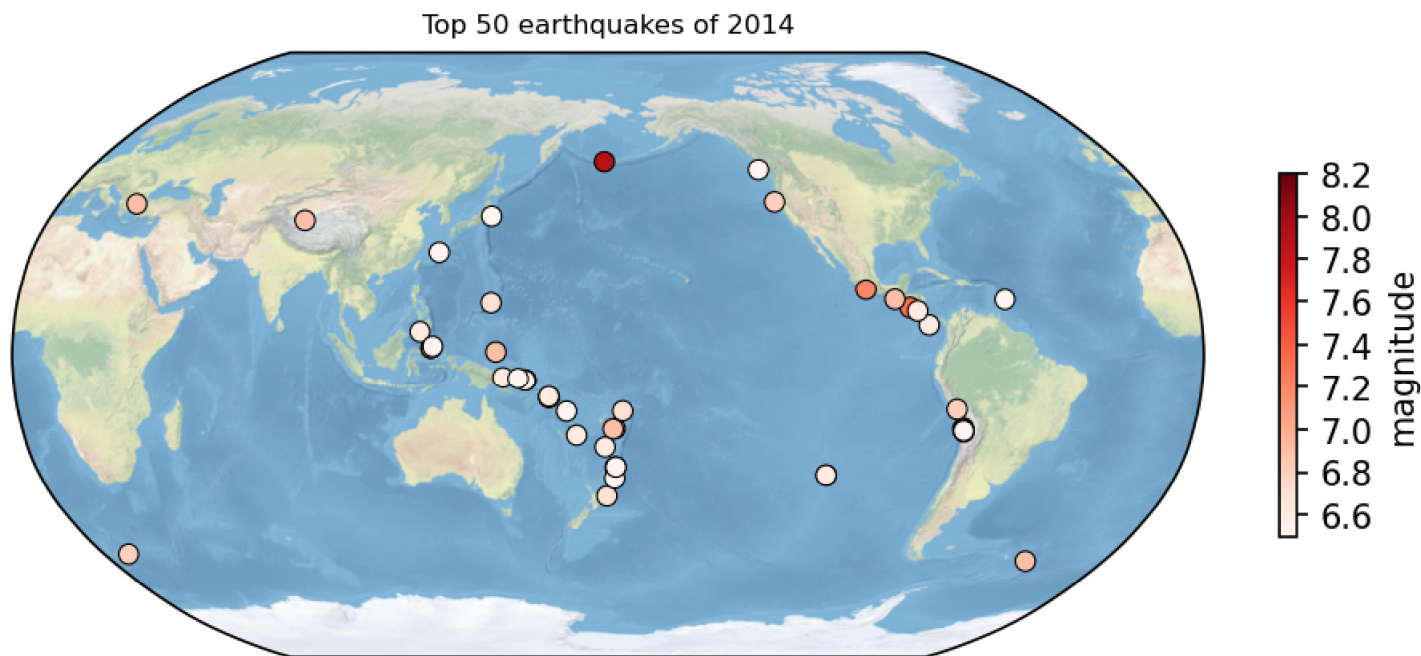
Out[4]: Text(0.5, 1.0, 'Top 50 earthquakes of 2014')

2.Explore a netCDF dataset

In [5]:
```python
#2.1
ds= xr.open_dataset("CESM2_200001-201412.nc", engine="netcdf4")
```

```
surface_T= ds.tas.isel(time=1)
surface_T
```

Out[5]: xarray.DataArray 'tas' (**lat**: 192, **lon**: 288)

```
array([[236.51689, 236.51689, 236.51689, ..., 236.51689, 236.51689, 236.51689],
       [236.9432 , 236.89592, 236.73224, ..., 236.99376, 236.97823, 236.96432],
       [237.28722, 237.2335 , 237.1985 , ..., 237.55449, 237.49416, 237.40793],
       ...,
       [241.329  , 241.3181 , 241.30516, ..., 241.35661, 241.34663, 241.33691],
       [241.3106 , 241.30481, 241.29861, ..., 241.32701, 241.32219, 241.31647],
       [241.32259, 241.32254, 241.32248, ..., 241.32278, 241.32271, 241.32265]],
      dtype=float32)
```

▼Coordinates:

lat	(lat)	float64	-90.0 -89.06 -88.12 ... 89.06 90.0	📄	🗄
lon	(lon)	float64	0.0 1.25 2.5 ... 356.2 357.5 358.8	📄	🗄
time	()	object	2000-02-14 00:00:00	📄	🗄

►Attributes: (19)

In [6]:
```python
#2.1（续）
from cartopy.mpl.gridliner import LONGITUDE_FORMATTER, LATITUDE_FORMATTER

plt.figure(figsize=(10,5), dpi=150)
proj = ccrs.PlateCarree()
ax = plt.axes(projection=proj)

#画温度图，设置colorbar
surface_T.plot(ax=ax, transform=ccrs.PlateCarree(),cbar_kwargs={'shrink': 0.4})

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

#设置网格线gridlines
gl=ax.gridlines(draw_labels=True,crs=ccrs.PlateCarree(),linestyle=":",linewidth=0.3,color='k',alpha=0.5)

#Cartopy经纬度添加参照：https://cloud.tencent.com/developer/article/1790266
gl.top_labels=False    #关闭上部/右侧经纬度标签
gl.right_labels=False
gl.xformatter = LONGITUDE_FORMATTER   #使横纵坐标转化为经纬度格式
gl.yformatter = LATITUDE_FORMATTER
gl.xlocator=mticker.FixedLocator(np.arange(-180,181,30))   #设置横纵坐标范围及刻度
gl.ylocator=mticker.FixedLocator(np.arange(-90,91,30))
gl.xlabel_style={'size':5} #修改经纬度字体大小
gl.ylabel_style={'size':5}
```

```python
#设置图像标题title
ax.set_title('Global near surface temperature on 14 February 2000',fontsize=8)
ax.spines['geo'].set_linewidth(1) #调节边框粗细

#设置注释annotate
ax.annotate('Shenzhen',xy=(114.06,22.54),xytext=(130,20),  # 深圳
            bbox=dict(boxstyle='square', fc='grey',linewidth=0.1),
            arrowprops=dict(facecolor='black', width=0.01,headwidth=5, headlength=5,shrink=0.005),
            fontsize=7, color='white', horizontalalignment='left',
            transform=ccrs.PlateCarree())

#设置点标签text
plt.text(0, 0, 'Temperatures are hottest along the equator', size = 10,
         horizontalalignment='center', color='red',
         bbox=dict(facecolor="grey",alpha=0.2),
         transform=ccrs.PlateCarree())

#设置图列legend
plt.legend(['Near surface temperature'],loc='best',fontsize=6)
```

Out[6]: <matplotlib.legend.Legend at 0x24d01202880>

Global near surface temperature on 14 February 2000

Near surface temperature

Shenzhen

Temperatures are hottest along the equator

Near-Surface Air Temperature [K]

In [16]:

```
#2.2
plt.figure(figsize=(10,4), dpi=150)

#设置正投影样式
central_lon, central_lat = 114.06, 22.54  #深圳
proj = ccrs.Orthographic(central_lon, central_lat)
ax = plt.axes(projection=proj)

#设置显示范围（114.06-40~114.06+30，22.54-10，22.54+30）
extent = [central_lon-40, central_lon+30, central_lat-10, central_lat+30]
ax.set_extent(extent)

#画温度图，设置colorbar
surface_T.plot(ax=ax, transform=ccrs.PlateCarree(),cbar_kwargs={'shrink': 0.5})

#画国界线features
ax.add_feature(cfeature.NaturalEarthFeature(category='cultural',
                                            name='admin_0_countries',
                                            scale='110m',
                                            facecolor='none',
                                            edgecolor='black',
```

```python
                                                linewidth=0.5))
#设置注释annotate
ax.annotate('Shenzhen',xy=(114.06,22.54),xytext=(120,20),  # 深圳
            bbox=dict(boxstyle='square', fc='grey',linewidth=0.1),
            arrowprops=dict(facecolor='black', width=0.01,headwidth=5, headlength=5,shrink=0.005),
            fontsize=7, color='white', horizontalalignment='left',
            transform=ccrs.PlateCarree())

#设置点标签text
ax.text(108.47,24.38, 'hunan', size = 10,
        horizontalalignment='center', color='k',
        bbox=dict(facecolor="red",alpha=0.01),
        transform=ccrs.PlateCarree())

#加河流、湖泊的features
rivers_10m = cfeature.NaturalEarthFeature('physical', 'rivers_lake_centerlines', '10m')
ax.add_feature(cfeature.LAKES, edgecolor='c', facecolor='c', zorder=2)
ax.add_feature(rivers_10m, facecolor='None', edgecolor='b', linewidth=0.5)

#设置网格线gridlines
gl=ax.gridlines(draw_labels=True,crs=ccrs.PlateCarree(),linestyle=":",linewidth=0.3,color='k',alpha=1)

#设置Cartopy经纬度（x、y轴）
gl.top_labels=False  #关闭上部/右侧经纬度标签
gl.right_labels=False
gl.xformatter = LONGITUDE_FORMATTER  #使横纵坐标转化为经纬度格式
gl.yformatter = LATITUDE_FORMATTER
gl.xlocator=mticker.FixedLocator(np.arange(-180,181,10))  #设置横纵坐标范围及刻度
gl.ylocator=mticker.FixedLocator(np.arange(-90,91,30))
gl.xlabel_style={'size':6} #修改经纬度字体大小
gl.ylabel_style={'size':6}

#设置图像标题title
ax.set_title('China near surface temperature on 14 February 2000',fontsize=8)
ax.spines['geo'].set_linewidth(1) #调节边框粗细
```

China near surface temperature on 14 February 2000