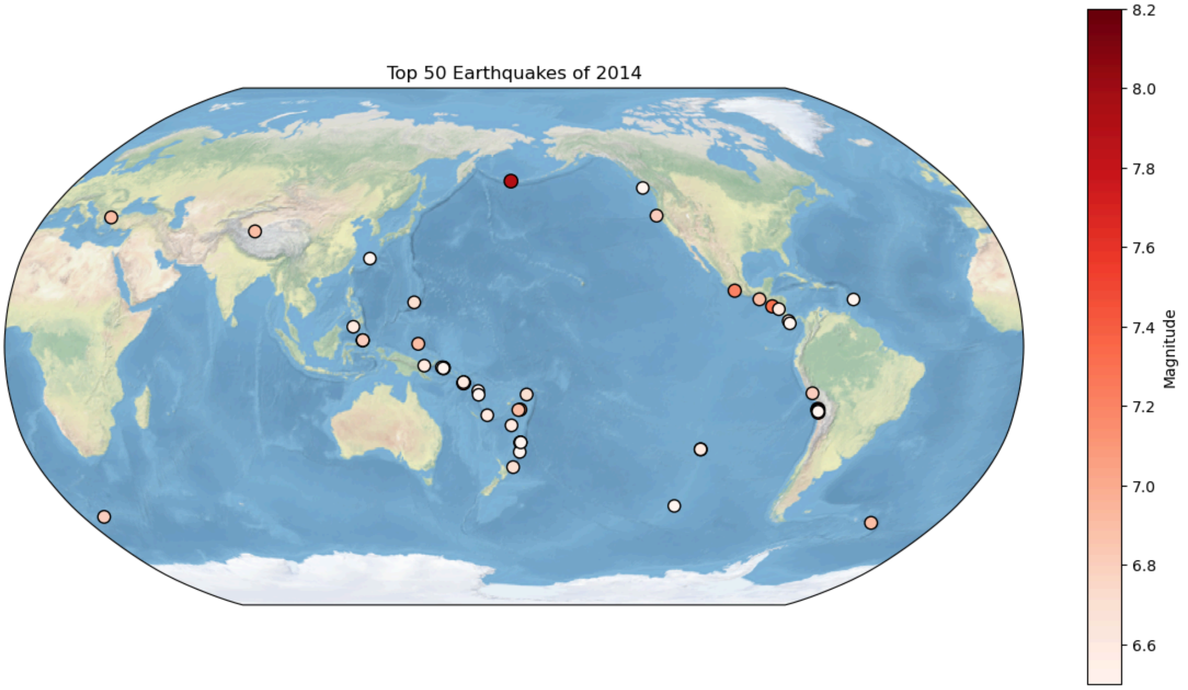
In [17]:
```
import numpy as np
import pandas as pd
import xarray as xr
from matplotlib import pyplot as plt
import matplotlib.ticker as mticker
import cartopy.crs as ccrs
import cartopy.feature as cfeature
```

1. Global Earthquakes

In [67]:
```
earthquakes = pd.read_csv("usgs_earthquakes.csv")
#largest
earthquakes_max = earthquakes.nlargest(50, 'mag')
#map
plt.figure(figsize=(15, 8))
ax = plt.axes(projection=ccrs.Robinson(central_longitude=180))#rotation
ax.set_global()
#add background
ax.stock_img()
#earthquake location
scatter = plt.scatter(
    earthquakes_max['longitude'],
    earthquakes_max['latitude'],
    c=earthquakes_max['mag'],
    cmap='Reds',
    s=earthquakes_max['mag'] * 10,
    edgecolor='black',
    transform=ccrs.PlateCarree()
)
#intensity-colorbar
cbar = plt.colorbar(scatter, orientation='vertical', pad=0.05)
cbar.set_label('Magnitude')
plt.title('Top 50 Earthquakes of 2014', fontsize=12)

plt.show()
```



2.Explore a netCDF dataset

In [56]:
```
#dataset same as Assignment03
CH4=xr.open_dataset("200301_202006-C3S-L3_GHG-PRODUCTS-OBS4MIPS-MERGED-v4.3.
#methane=CH4['xch4']
#methane
methane = CH4['xch4'].mean(dim='time')
```

In [57]:
```
methane
```

Out[57]: xarray.DataArray 'xch4' (**lat**: 36, **lon**: 72)

```
array([[           nan,            nan,            nan, ...,
nan,
                   nan,            nan],
       [           nan,            nan,            nan, ...,
nan,
                   nan,            nan],
       [           nan,            nan,            nan, ...,
nan,
                   nan,            nan],
       ...,
       [1.7319782e-06, 1.7372315e-06, 1.7349937e-06, ..., 1.7301
534e-06,
        1.7371364e-06, 1.7258259e-06],
       [           nan,            nan,            nan, ...,
nan,
                   nan,            nan],
       [           nan,            nan,            nan, ...,
nan,
                   nan,            nan]], dtype=float32)
```

▼ Coordinates:

```
lat    (lat)  float64  -87.5 -82.5 -77.5 ... 82.5 87.5
lon    (lon)  float64  -177.5 -172.5 ... 172.5 177.5
```

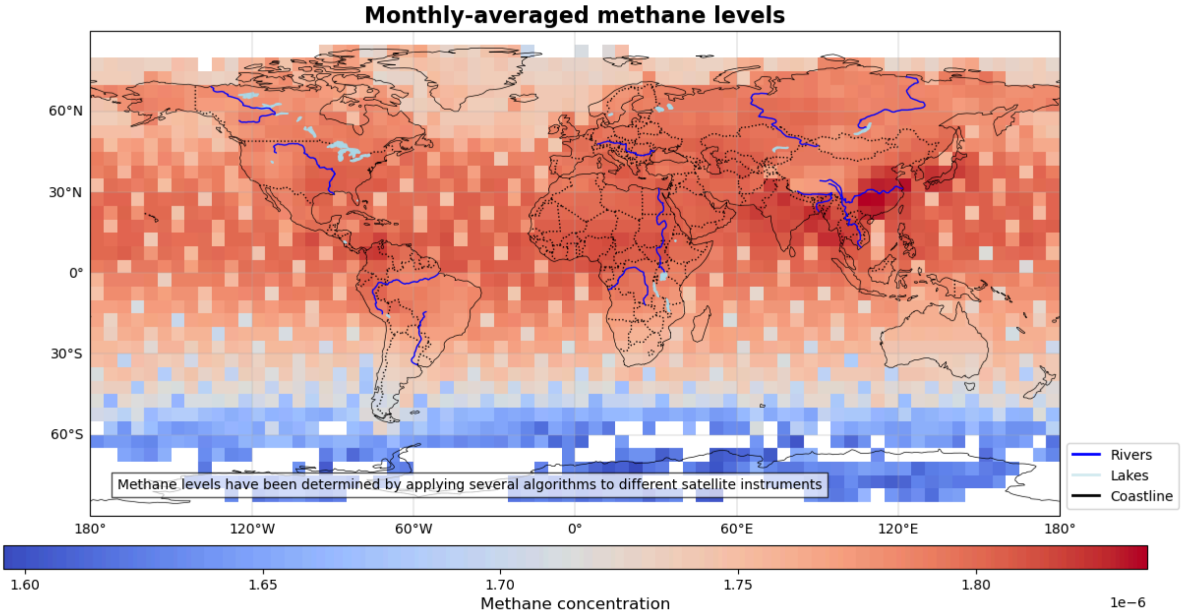
▶ Indexes: (2)

▶ Attributes: (0)

In [78]:
```
#2.1 global map
#map
plt.figure(figsize=(15, 8))
ax = plt.axes(projection=ccrs.PlateCarree())
ax.set_global()
# add background and boundary
ax.add_feature(cfeature.BORDERS, linestyle=':', linewidth=1.0)
ax.add_feature(cfeature.COASTLINE, linewidth=0.5)
lakes = ax.add_feature(cfeature.LAKES, edgecolor='lightblue', facecolor='li
rivers = ax.add_feature(cfeature.RIVERS, edgecolor='blue', zorder=3)
#add CH4 information
CH4_plot = plt.pcolormesh(
    methane['lon'], methane['lat'], methane,
    transform=ccrs.PlateCarree(), cmap='coolwarm',shading='auto')
#color bar
cbar = plt.colorbar(CH4_plot, orientation='horizontal', pad=0.05, aspect=50
cbar.set_label('Methane concentration', fontsize=12)

#gridlines
gl = ax.gridlines(draw_labels=True, dms=True, x_inline=False, y_inline=False
gl.top_labels = False
gl.right_labels = False
#title and axis label and ticks
plt.title('Monthly-averaged methane levels', fontsize=16, weight='bold')
ax.set_xlabel('Longitude', fontsize=12)
ax.set_ylabel('Latitude', fontsize=12)
#legend
legend_elements = [
    plt.Line2D([0], [0], color='blue', lw=2, label='Rivers'),
    plt.Line2D([0], [0], color='lightblue', lw=2, label='Lakes', alpha=0.5),
    plt.Line2D([0], [0], color='black', lw=2, label='Coastline')
]
ax.legend(handles=legend_elements, loc='lower left', bbox_to_anchor=(1, 0),
# annotations and textbox
plt.text(-170, -80, 'Methane levels have been determined by applying several

plt.show()
```


Monthly-averaged methane levels
60°N
30°N
0°
30°S
60°S
Methane levels have been determined by applying several algorithms to different satellite instruments
Rivers
Lakes
Coastline
180°
120°W
60°W
0°
60°E
120°E
180°
1.60
1.65
1.70
1.75
1.80
Methane concentration
1e−6

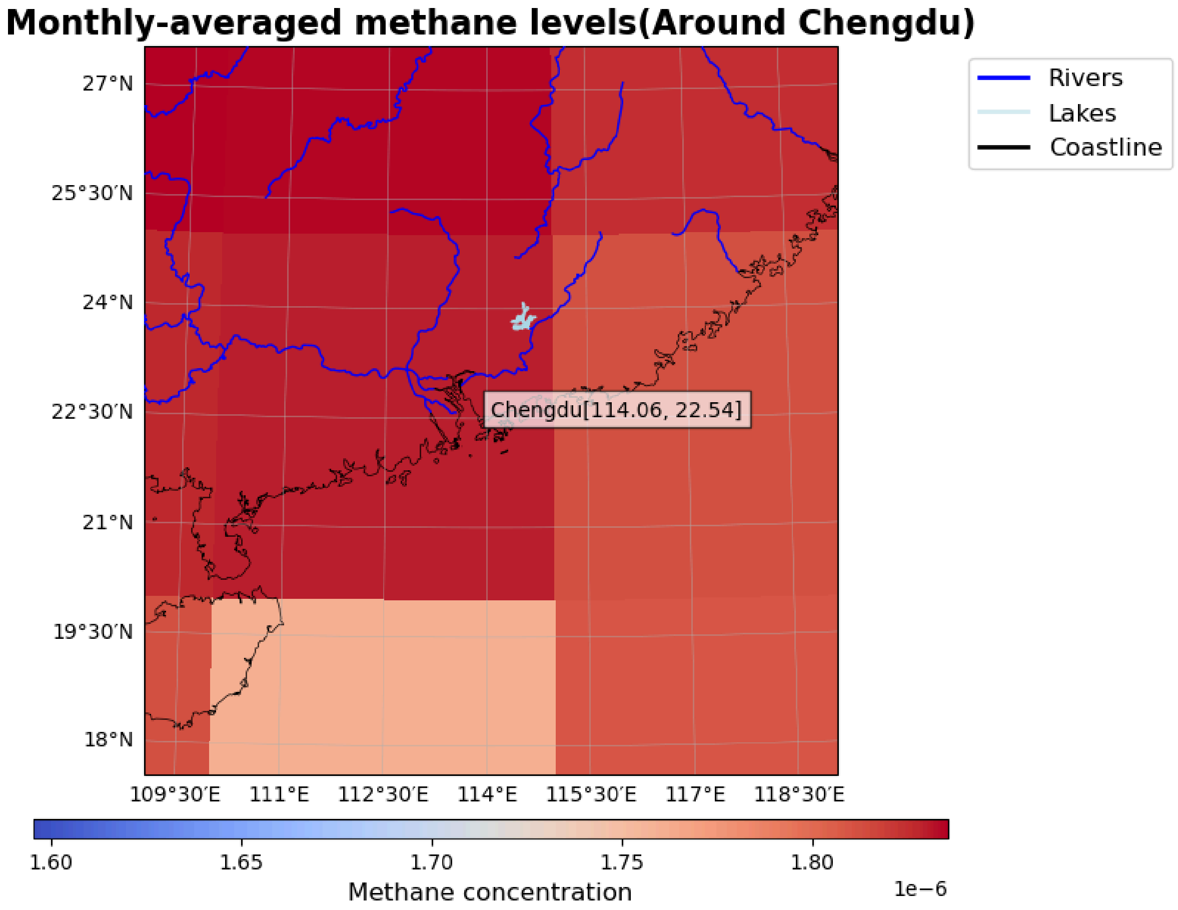
In [77]:

```
#2.1 regional map around Chengdu,China
central_lon, central_lat = 114.06, 22.54
extent = [central_lon - 5, central_lon + 5, central_lat - 5, central_lat + 5
#map with different projection
plt.figure(figsize=(8, 8), dpi=100)
proj = ccrs.Orthographic(central_lon, central_lat)
ax = plt.axes(projection=proj)
ax.set_extent(extent, crs=ccrs.PlateCarree())

###same as above
# add background and boundary
ax.add_feature(cfeature.BORDERS, linestyle=':', linewidth=1.0)
ax.add_feature(cfeature.COASTLINE, linewidth=0.5)
lakes = ax.add_feature(cfeature.LAKES, edgecolor='lightblue', facecolor='lig
rivers = ax.add_feature(cfeature.RIVERS, edgecolor='blue', zorder=3)
#add CH4 information
CH4_plot = plt.pcolormesh(
    methane['lon'], methane['lat'], methane,
    transform=ccrs.PlateCarree(), cmap='coolwarm',shading='auto')
#color bar
cbar = plt.colorbar(CH4_plot, orientation='horizontal', pad=0.05, aspect=50)
cbar.set_label('Methane concentration', fontsize=12)
```

```
#gridlines
gl = ax.gridlines(draw_labels=True, dms=True, x_inline=False, y_inline=Fals
gl.top_labels = False
gl.right_labels = False
#title and axis label and ticks
plt.title('Monthly-averaged methane levels(Around Chengdu)', fontsize=16, we
ax.set_xlabel('Longitude', fontsize=12)
ax.set_ylabel('Latitude', fontsize=12)
#legend
legend_elements = [
    plt.Line2D([0], [0], color='blue', lw=2, label='Rivers'),
    plt.Line2D([0], [0], color='lightblue', lw=2, label='Lakes', alpha=0.5),
    plt.Line2D([0], [0], color='black', lw=2, label='Coastline')
]
ax.legend(handles=legend_elements, loc='upper right', bbox_to_anchor=(1.5, 1
# annotations and textbox
plt.text(114.06, 22.54,'Chengdu[114.06, 22.54]', fontsize=10, bbox=dict(face

plt.show()
```


Monthly-averaged methane levels(Around Chengdu)
27°N
25°30′N
24°N
22°30′N
21°N
19°30′N
18°N
109°30′E
111°E
112°30′E
114°E
115°30′E
117°E
118°30′E
Chengdu[114.06, 22.54]
Rivers
Lakes
Coastline
1.60
1.65
1.70
1.75
1.80
Methane concentration
1e−6