```python
In [44]: 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
         from cartopy.mpl.gridliner import LONGITUDE_FORMATTER, LATITUDE_FORMATTER
         import math
         %matplotlib inline
```

1

```python
In [18]: ds1 = pd.read_csv(r'D:\Sustech\研究生\课程\Environmental programming\ESE5023_Assignm
         ds1
```

Out[18]:

	time	latitude	longitude	depth	mag	magType	nst	gap	dmin	m
0	2014-01-31 23:53:37.000	60.252000	-152.708100	90.20	1.10	ml	NaN	NaN	NaN	0.290
1	2014-01-31 23:48:35.452	37.070300	-115.130900	0.00	1.33	ml	4.0	171.43	0.342000	0.024
2	2014-01-31 23:47:24.000	64.671700	-149.252800	7.10	1.30	ml	NaN	NaN	NaN	1.000
3	2014-01-31 23:30:54.000	63.188700	-148.957500	96.50	0.80	ml	NaN	NaN	NaN	1.070
4	2014-01-31 23:30:52.210	32.616833	-115.692500	10.59	1.34	ml	6.0	285.00	0.043210	0.200
...	...	...	...	...	...	...	...	...	...	...
120103	2014-12-01 00:10:16.000	60.963900	-146.762900	14.80	3.80	ml	NaN	NaN	NaN	0.690
120104	2014-12-01 00:09:39.000	58.869100	-154.415900	108.40	2.40	ml	NaN	NaN	NaN	0.670
120105	2014-12-01 00:09:25.350	38.843498	-122.825836	2.37	0.43	md	8.0	107.00	0.008991	0.030
120106	2014-12-01 00:05:54.000	65.152100	-148.992000	9.50	0.40	ml	NaN	NaN	NaN	0.690
120107	2014-12-01 00:04:05.000	60.227200	-147.024500	2.50	1.60	ml	NaN	NaN	NaN	0.730

120108 rows × 15 columns

In [34]:
```python
ds2 = ds1.sort_values('mag',ascending=False)
#since some events share the same magnitude, so there are maybe more than 50 earthqu
mag_threshold = ds2.iloc[49,4]
ds2 = ds2[ds2['mag'] >= mag_threshold]
ds2
```

Out[34]:

	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
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
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
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
31496	2014-04-19 13:28:00.810	-6.7547	155.0241	43.37	7.5	mww	NaN	16.0	3.82000	1.25	us
33537	2014-04-13 12:36:19.230	-11.4633	162.0511	39.00	7.4	mww	NaN	17.0	2.88500	1.00	us
95913	2014-10-14 03:51:34.460	12.5262	-88.1225	40.00	7.3	mww	NaN	18.0	1.07800	0.70	us
31850	2014-04-18 14:27:24.920	17.3970	-100.9723	24.00	7.2	mww	NaN	46.0	2.25000	1.20	us
34318	2014-04-11 07:07:23.130	-6.5858	155.0485	60.53	7.1	mww	NaN	21.0	3.72900	0.88	us
106285	2014-11-15 02:31:41.720	1.8929	126.5217	45.00	7.1	mww	NaN	18.0	1.39700	0.71	us
111052	2014-11-01 18:57:22.380	-19.6903	-177.7587	434.00	7.1	mww	NaN	13.0	4.41500	0.84	us
97602	2014-10-09 02:14:31.440	-32.1082	-110.8112	16.54	7.0	mww	NaN	22.0	5.12700	0.43	us
47934	2014-06-29 07:52:55.170	-55.4703	-28.3669	8.00	6.9	mww	NaN	25.0	4.83800	0.76	us
78063	2014-08-03 00:22:03.680	0.8295	146.1688	13.00	6.9	mww	NaN	12.0	6.39300	0.93	us
50609	2014-06-23 19:19:15.940	-29.9772	-177.7247	20.00	6.9	mww	NaN	35.0	0.75100	0.99	us

	time	latitude	longitude	depth	mag	magType	nst	gap	dmin	rms	net
14025	2014-02-12 09:19:49.060	35.9053	82.5864	10.00	6.9	mww	NaN	18.0	7.49600	0.83	us
61294	2014-07-21 14:54:41.000	-19.8015	-178.4001	615.42	6.9	mww	NaN	15.0	3.93400	0.96	us
37367	2014-04-01 23:57:58.790	-19.8927	-70.9455	28.42	6.9	mww	NaN	119.0	0.82800	0.93	us
39915	2014-05-24 09:25:02.440	40.2893	25.3889	6.43	6.9	mww	NaN	25.0	0.40200	0.67	us
66278	2014-07-07 11:23:54.780	14.7240	-92.4614	53.00	6.9	mww	NaN	51.0	0.26300	1.38	us
24887	2014-03-10 05:18:13.400	40.8287	-125.1338	16.60	6.8	Mw	NaN	230.4	0.65577	0.15	nc
32964	2014-04-15 03:57:01.370	-53.4967	8.7220	11.18	6.8	mww	NaN	27.0	18.87700	0.74	us
101767	2014-11-26 14:33:43.640	1.9604	126.5751	39.00	6.8	mww	NaN	19.0	1.42100	1.19	us
71135	2014-08-24 23:21:45.520	-14.5980	-73.5714	101.00	6.8	mww	NaN	18.0	4.10700	0.90	us
22968	2014-03-16 21:16:29.600	-19.9807	-70.7022	20.00	6.7	mww	NaN	44.0	1.00800	0.83	us
84421	2014-09-17 06:14:45.410	13.7641	144.4294	130.00	6.7	mww	NaN	11.0	0.46000	0.84	us
105466	2014-11-16 22:33:20.450	-37.6478	179.6621	22.00	6.7	mww	NaN	25.0	1.07900	0.49	us
50587	2014-06-23 20:06:20.710	-29.9414	-177.6073	26.59	6.7	mwc	NaN	43.0	0.74800	0.76	us
47776	2014-06-29 17:15:09.340	-14.9831	-175.5096	18.00	6.7	mww	NaN	45.0	6.71300	1.39	us
46333	2014-05-04 09:15:52.880	-24.6108	179.0856	527.00	6.6	mww	NaN	19.0	5.32900	1.05	us
33523	2014-04-13 13:24:59.710	-11.1284	162.0520	10.00	6.6	mww	NaN	22.0	2.66600	0.84	us

	time	latitude	longitude	depth	mag	magType	nst	gap	dmin	rms	net
117886	2014-12-08 08:54:52.520	7.9401	-82.6865	20.00	6.6	mww	NaN	43.0	2.48500	1.01	us
47320	2014-05-01 06:36:35.550	-21.4542	170.3546	106.00	6.6	mww	NaN	10.0	3.34000	0.89	us
119708	2014-12-02 05:11:31.000	6.1572	123.1261	614.00	6.6	mww	NaN	9.0	2.60000	1.32	us
97597	2014-10-09 02:32:05.140	-32.0953	-110.8647	10.00	6.6	mww	NaN	32.0	5.12700	0.43	us
109305	2014-11-07 03:33:55.280	-5.9873	148.2315	53.19	6.6	mww	NaN	13.0	3.55700	0.91	us
118288	2014-12-07 01:22:02.180	-6.5108	154.4603	23.00	6.6	mww	NaN	12.0	3.24600	0.72	us
34096	2014-04-11 20:29:12.970	11.6420	-85.8779	135.00	6.6	mww	NaN	20.0	0.76100	1.35	us
31670	2014-04-19 01:04:03.820	-6.6558	155.0869	29.00	6.6	mww	NaN	11.0	3.80300	0.94	us
15979	2014-02-07 08:40:13.550	-15.0691	167.3721	122.00	6.5	mww	NaN	20.0	0.40900	1.15	us
103919	2014-11-21 10:10:19.630	2.2999	127.0562	35.00	6.5	mww	NaN	9.0	1.54900	1.16	us
17606	2014-02-02 09:26:37.820	-32.9076	-177.8806	44.26	6.5	mww	NaN	22.0	3.65100	1.28	us
26972	2014-03-02 20:11:23.430	27.4312	127.3674	119.00	6.5	mww	NaN	17.0	1.00100	0.97	us
36929	2014-04-03 01:58:30.530	-20.3113	-70.5756	24.07	6.5	mww	NaN	82.0	0.82800	0.62	us
34302	2014-04-11 08:16:45.660	-6.7878	154.9502	20.00	6.5	mww	NaN	16.0	3.78700	1.37	us

	time	latitude	longitude	depth	mag	magType	nst	gap	dmin	rms	net
50608	2014-06-23 19:21:45.990	-29.9379	-177.5159	10.00	6.5	mwc	NaN	30.0	0.77800	0.97	us
64647	2014-07-11 19:22:00.820	37.0052	142.4525	20.00	6.5	mww	NaN	9.0	2.42100	0.75	us
12142	2014-02-18 09:27:13.120	14.6682	-58.9272	14.83	6.5	mww	NaN	30.0	1.63500	0.94	us
29890	2014-04-24 03:10:10.150	49.6388	-127.7316	10.00	6.5	mww	NaN	NaN	NaN	0.85	us
67518	2014-07-04 15:00:27.860	-6.2304	152.8075	20.00	6.5	mww	NaN	15.0	2.12400	1.06	us
9062	2014-01-01 16:03:29.000	-13.8633	167.2490	187.00	6.5	mww	NaN	14.0	3.99700	0.76	us
43290	2014-05-13 06:35:24.240	7.2096	-82.3045	10.00	6.5	mww	NaN	33.0	3.12100	1.33	us
53132	2014-06-14 11:10:59.850	-10.1229	91.0921	4.00	6.5	mww	NaN	23.0	5.99800	0.85	us
43450	2014-05-12 19:28:26.700	-49.9403	-114.7995	10.47	6.5	mww	NaN	35.0	23.16400	1.16	us

In [36]:
```python
plt.figure(figsize=(5,5), dpi=300)
ax = plt.axes(projection=ccrs.Robinson(central_longitude=180))
ax.stock_img()
p1 = ax.scatter(ds2['longitude'], ds2['latitude'], c=ds2['mag'], s=10, ec='k',transf
ax.set_title('Top 50 Earthquakes of 2014',fontsize=10)
cb1 = plt.colorbar(p1,fraction=0.02)
cb1.ax.tick_params(labelsize=6, length=1.5,width=1)
cb1.set_label('magnitude', fontdict={'family':'Arial', 'size': 6})
```


Top 50 Earthquakes of 2014
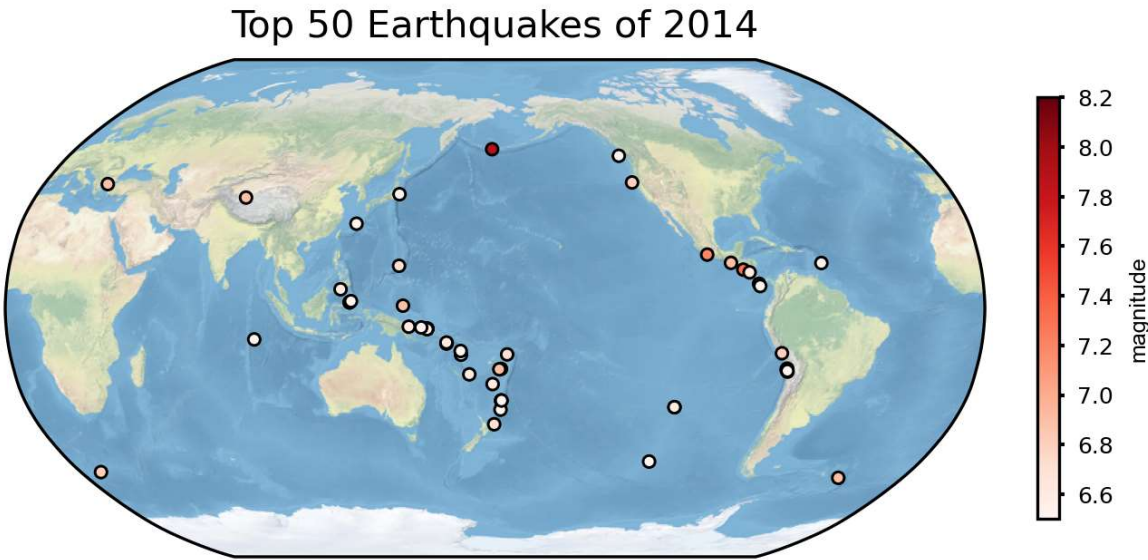
2

Dataset: CRU TS v4.07 temperature 2011-2020

```
In [37]:  ds2 = xr.open_dataset('D:\ESE5023data\cru_ts4.07.2011.2020.tmp.dat.nc')
          ds2
```

Out[37]: xarray.Dataset

► Dimensions:　　　　　　　(**lon**: 720, **lat**: 360, **time**: 120)

▼ Coordinates:

lon	(lon)	float32	-179.8 -179.2 ... 179.2 179.8	📄 🗄
lat	(lat)	float32	-89.75 -89.25 ... 89.25 89.75	📄 🗄
time	(time)	datetime64[ns]	2011-01-16 ... 2020-12-16	📄 🗄

▼ Data variables:

| tmp | (time, lat, lon) | float32 | ... | 📄 🗄 |
| stn | (time, lat, lon) | float64 | ... | 📄 🗄 |

► Indexes:　(3)

▼ Attributes:

Conventions :	CF-1.4
title :	CRU TS4.07 Mean Temperature
institution :	Data held at British Atmospheric Data Centre, RAL, UK.
source :	Run ID = 2304141047. Data generated from:tmp.2304141039.dtb
history :	Fri 14 Apr 11:30:51 BST 2023 : User f098 : Program makegridsauto.for called by update.for
references :	Information on the data is available at http://badc.nerc.ac.uk/data/cru/
comment :	Access to these data is available to any registered CEDA user.
contact :	support@ceda.ac.uk

```
In [79]:  def gridline(ax, data, str1, str2, fontsize, lw, sp):
          # --设置网格点属性
              gl = ax.gridlines(crs=ccrs.PlateCarree(), draw_labels=True,
                  linewidth=lw, color='k', alpha=0.5, linestyle='--')
              gl.top_labels = False   # 关闭顶端的经纬度标签
              gl.right_labels = False   # 关闭右侧的经纬度标签
              gl.xformatter = LONGITUDE_FORMATTER   # x轴设为经度的格式
              gl.yformatter = LATITUDE_FORMATTER   # y轴设为纬度的格式

              maxlong = math.ceil(max(np.unique(data.coords[str1].values)))
              minlong = int(min(np.unique(data.coords[str1].values)))
              maxlat = math.ceil(max(np.unique(data.coords[str2].values)))
              minlat = int(min(np.unique(data.coords[str2].values)))
              gl.xlocator = mticker.FixedLocator(np.arange(-180, 181, sp))
              gl.ylocator = mticker.FixedLocator(np.arange(-90, 91, sp))
              gl.xlabel_style = {'size': fontsize, 'family':'Arial'}
              gl.ylabel_style = {'size': fontsize, 'family': 'Arial'}
```
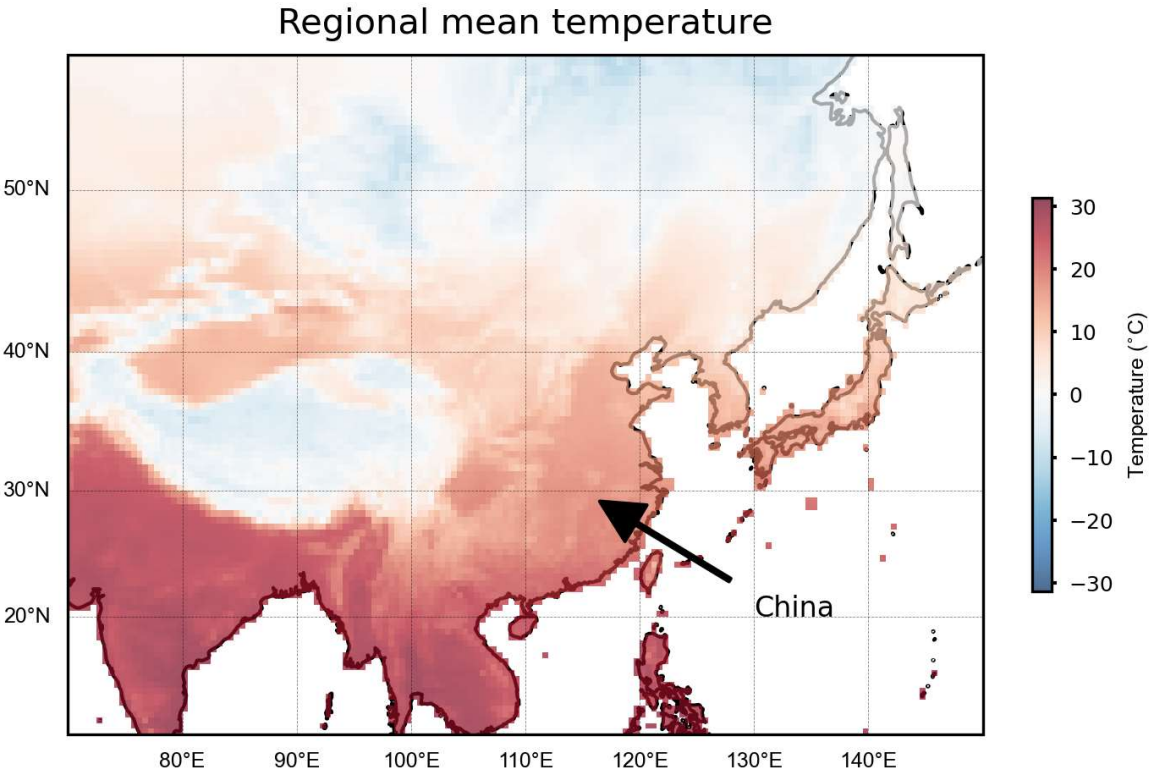
In [94]:
```python
tmpmean = ds2['tmp'].mean(axis=0)
plt.figure(figsize=(5,5), dpi=300)
ax = plt.axes(projection=ccrs.Robinson())
ax.add_feature(cfeature.LAND,ec='k',fc='none',zorder=0)
p1 = tmpmean.plot(x='lon', y='lat', transform=ccrs.PlateCarree(),cmap='RdBu_r',alpha
ax.set_title('Mean temperature',fontsize=10)
ax.set_xlabel('Longitude',fontsize=8)
ax.set_ylabel('Latitude',fontsize=8)
plt.annotate('No data in CRU', (0,-85),xytext=(85,-55),transform=ccrs.PlateCarree(),
gridline(ax, tmpmean, 'lon', 'lat', 4, 0.2,30)
cb1 = plt.colorbar(p1,fraction=0.02)
cb1.ax.tick_params(labelsize=6, length=1.5,width=1)
cb1.set_label('Temperature ($^{\circ}$C)', fontdict={'family':'Arial', 'size': 6})
```

Mean temperature
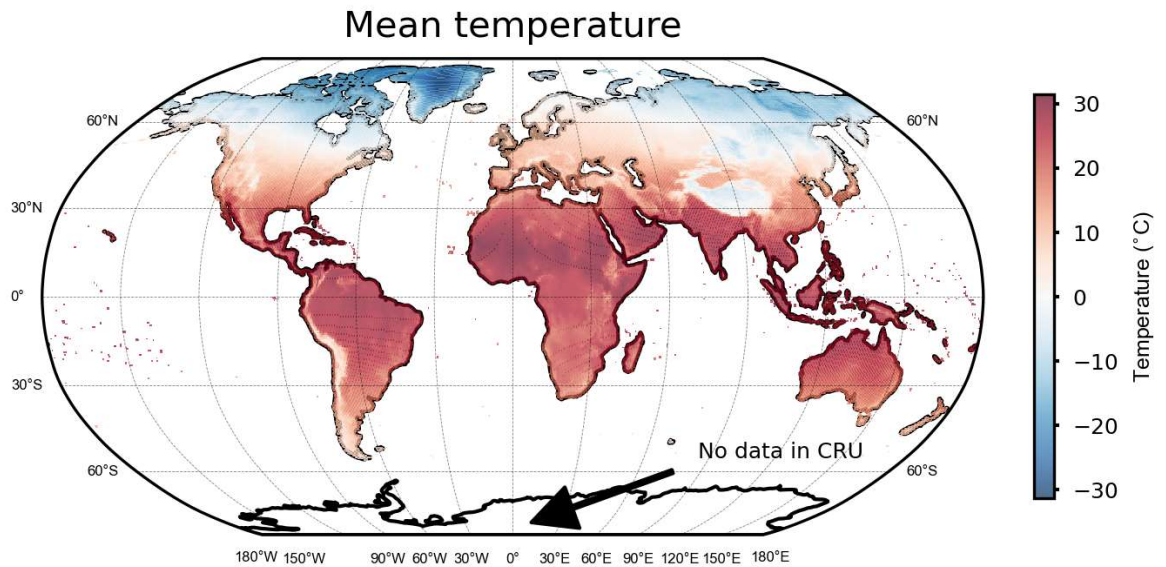
In [90]:
```python
tmpmean = ds2['tmp'].mean(axis=0)
plt.figure(figsize=(5,5), dpi=300)
ax = plt.axes(projection=ccrs.Mercator())
ax.set_extent([70,150,10,50])
ax.add_feature(cfeature.LAND,ec='k',fc='none',zorder=0)
p1 = tmpmean.plot(x='lon', y='lat', transform=ccrs.PlateCarree(),cmap='RdBu_r',alpha
ax.set_title('Regional mean temperature',fontsize=10)
ax.set_xlabel('Longitude',fontsize=8)
ax.set_ylabel('Latitude',fontsize=8)
ax.annotate('China', (115,30),xytext=(130,20),transform=ccrs.PlateCarree(),fontsize=8
gridline(ax, tmpmean, 'lon', 'lat', 6, 0.2,10)
cb1 = plt.colorbar(p1,fraction=0.02)
cb1.ax.tick_params(labelsize=6, length=1.5,width=1)
cb1.set_label('Temperature ($^{\circ}$C)', fontdict={'family':'Arial', 'size': 6})
```

Regional mean temperature