In [61]:
```python
# 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
```

In [62]:
```python
# 1. Global methane levels from 2002
# Open the dataset
ds = xr.open_dataset("200301_202006-C3S-L3_GHG-PRODUCTS-OBS4MIPS-MERGED-v4.3.nc", engine="netcdf4"
ds
```

Out[62]:

xarray.Dataset

▶ Dimensions: (**time**: 210, bnds: 2, **lat**: 36, **lon**: 72, pressure: 10)

▼ Coordinates:

time	(time)	datetime64[ns]	2003-01-16T12:00:00 ... 2020-...
lat	(lat)	float64	-87.5 -82.5 -77.5 ... 82.5 87.5
lon	(lon)	float64	-177.5 -172.5 ... 172.5 177.5

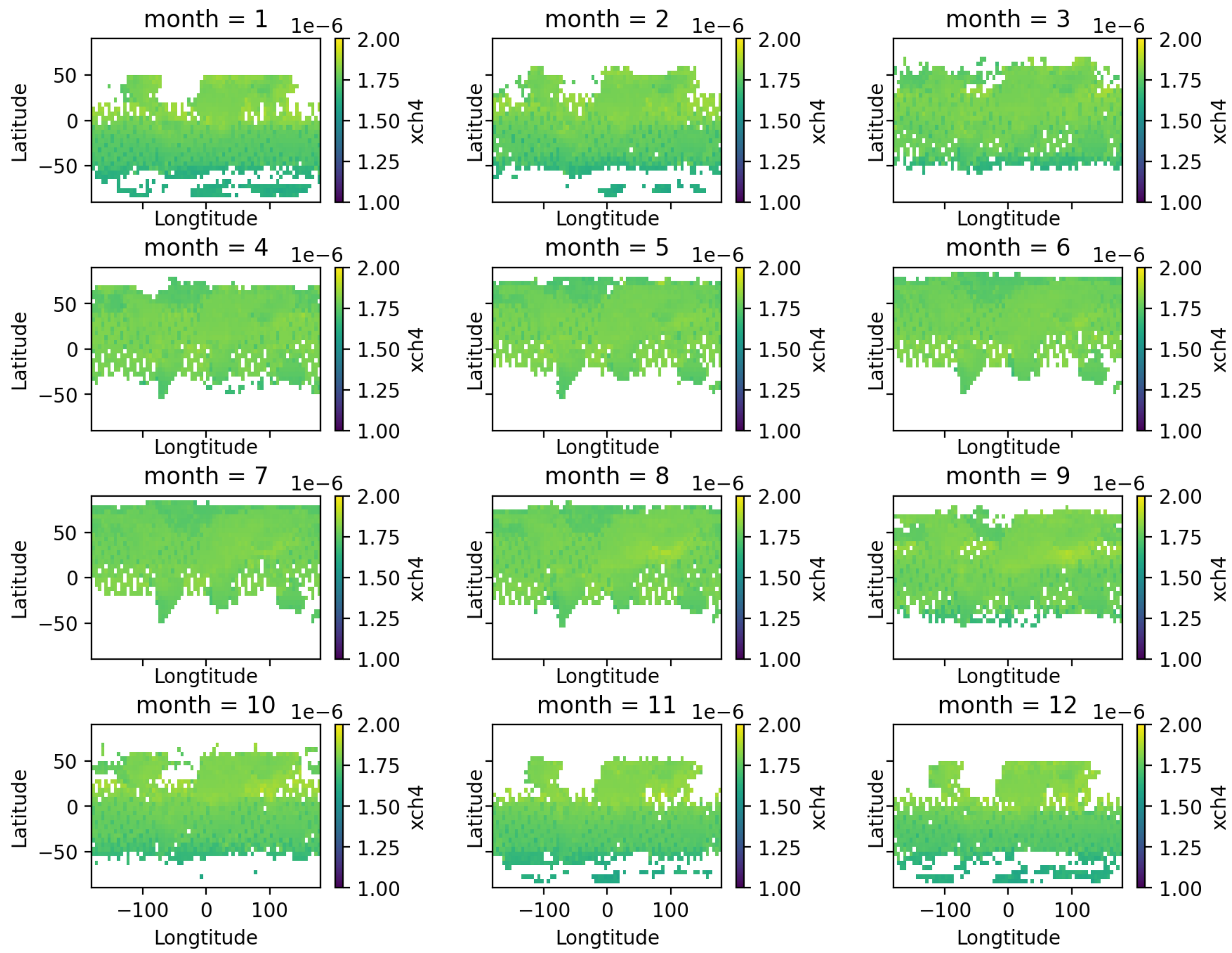
▼ Data variables:

time_bnds	(time, bnds)	datetime64[ns]	...
lat_bnds	(lat, bnds)	float64	...
lon_bnds	(lon, bnds)	float64	...
pre	(pressure)	float64	...
pre_bnds	(pressure, bnds)	float64	...
land_fraction	(lat, lon)	float64	...
xch4	(time, lat, lon)	float32	...
xch4_nobs	(time, lat, lon)	float64	...
xch4_stderr	(time, lat, lon)	float32	...
xch4_stddev	(time, lat, lon)	float32	...
column_averagi...	(time, pressure, lat, lon)	float32	...
vmr_profile_ch4...	(time, pressure, lat, lon)	float32	...

▶ Attributes: (28)

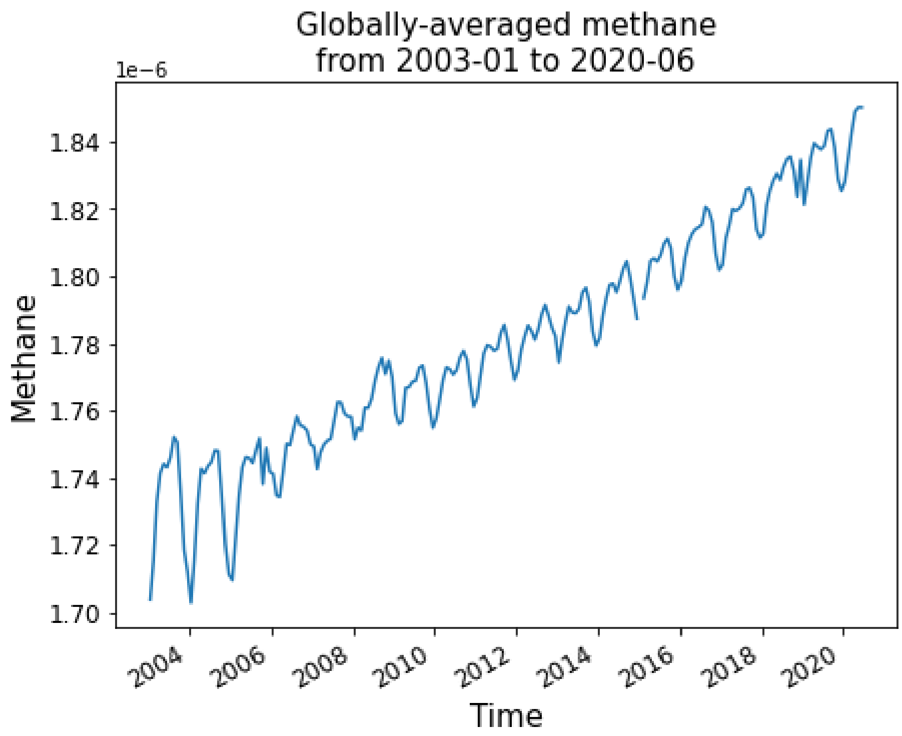
In [63]:

```python
# 1.1 Compute methane climatology for each month, and plot your results in 12 panels.
# Compute the global average methane climatology groupby "Month"
xch4_month_mean = ds.xch4.groupby("time.month").mean()
# Subplot the figures in 4 rows and 3 columns
fig,ax=plt.subplots(4,3, figsize=(10,8),sharex="all",sharey="all",dpi=200)
ax=ax.flatten()
# Use a "for" loop to subplot the panels month by month
for i in range(12):
    ax[i]=plt.subplot(4,3,i+1)
    xch4_month_mean[i,:,:].plot(vmin=0.000001, vmax=0.000002)
    plt.xlabel("Longtitude",fontsize=10)
    plt.ylabel("Latitude",fontsize=10)
plt.subplots_adjust(wspace=0.4,hspace=0.4)
```



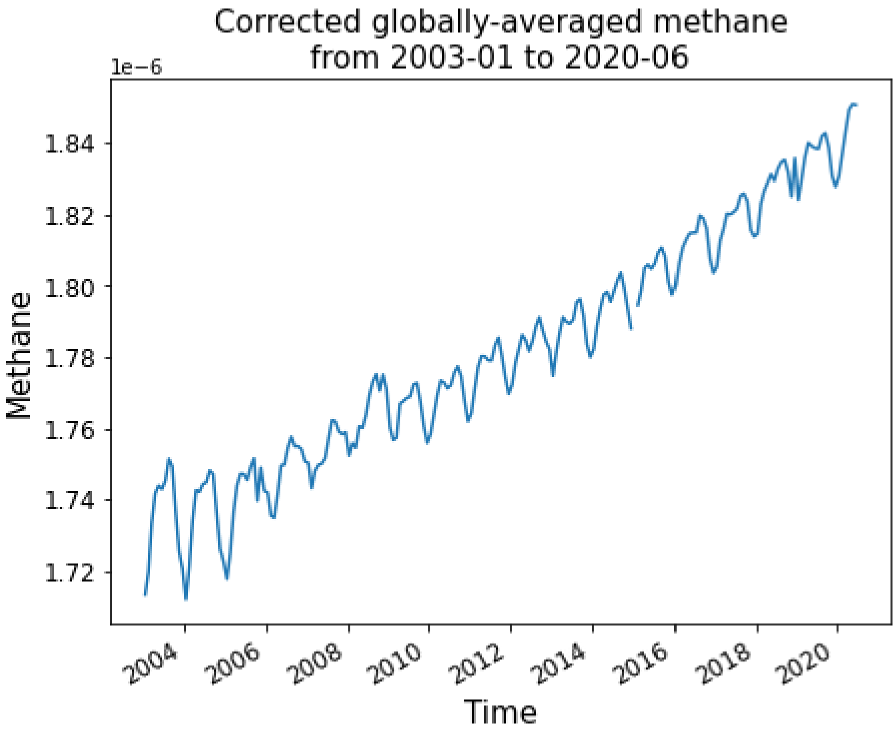
In [64]:

```python
# 1.2 Plot globally-averaged methane from 2003-01 to 2020-06 as a time series.
# Compute the globally averaged methane and plot the data from 2003-01 to 2020-06,
# without considering the cosine of latitude weights
ds.xch4.mean(dim=('lon', 'lat')).sel(time=slice("2003-01", "2020-06")).plot(figsize=(7,5))
plt.title("Globally-averaged methane\nfrom 2003-01 to 2020-06",fontsize=15)
plt.xlabel("Time",fontsize=15)
plt.ylabel("Methane",fontsize=15)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```



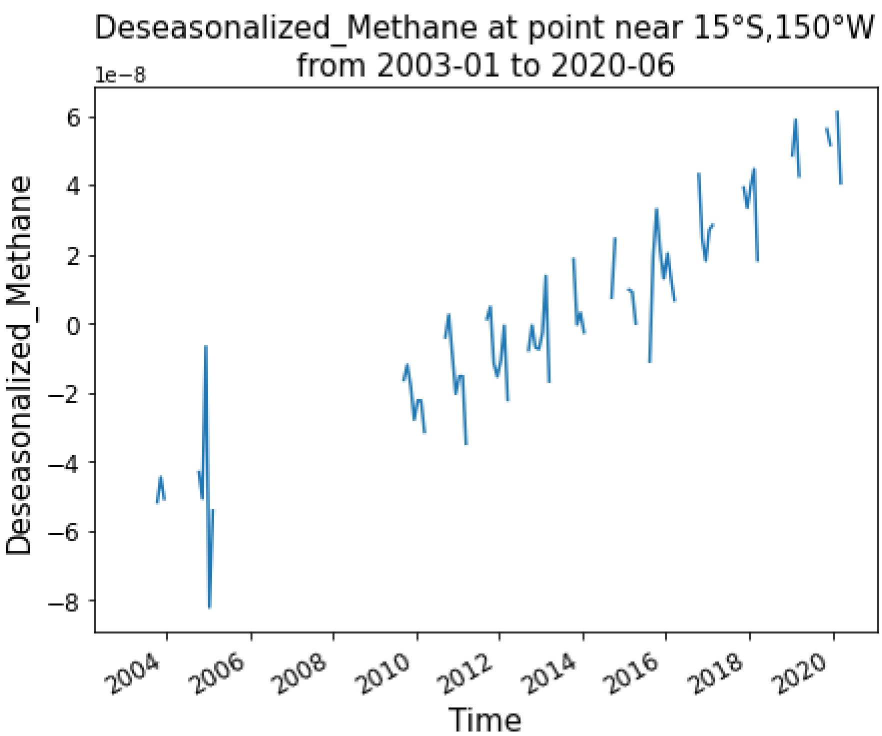
In [65]:

```
# 1.2 connected above
# Take the cosine of latitude weights into consideration and create a parameter "weights"
weights = np.cos(np.deg2rad(ds.lat))
# Use the function weighted() to recalculate xch4 distribution globally
xch4_weighted = ds.xch4.weighted(weights)
# Compute the globally averaged weighted methane and plot it
xch4_weighted.mean(dim=('lon', 'lat')).plot(figsize=(7,5))
plt.title("Corrected globally-averaged methane\nfrom 2003-01 to 2020-06",fontsize=15)
plt.xlabel("Time",fontsize=15)
plt.ylabel("Methane",fontsize=15)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
### From the figure above and below, it is obvious to find out an increasing trend of methane from
```



In [66]:
```python
# 1.3 Plot deseasonalized methane levels at point [15° S, 150° W] from 2003-01 to 2020-06 as a tim
# Select the xch4 data for the given point
S15_W150=ds.xch4.sel(lon=-150,lat=-15,method="nearest")
# Create a parameter of "group_data" to group the xch4 by "month"
group_data=S15_W150.sel(time=slice("2003-01","2020-06")).groupby("time.month")
# Apply function mean() to group_data, and subtract the mean value of each month to calculate Dese
Deseasonalized_Methane = group_data - group_data.mean(dim="time")
# Plot the Deseasonalized_Methane
Deseasonalized_Methane.plot(figsize=(7,5))
plt.title("Deseasonalized_Methane at point near 15° S,150° W\nfrom 2003-01 to 2020-06",fontsize=15
plt.xlabel("Time",fontsize=15)
plt.ylabel("Deseasonalized_Methane",fontsize=15)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
### From the figure below, the variation trend of Deseasonalized_Methane at point near 15° S,150°
### to globally-averaged methane, with a noteworthy increasing tendancy.
```

```
D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
ethod to Float64Index.get_loc is deprecated and will raise in a future version. Use index.get_i
ndexer([item], method=...) instead.
  indexer = self.index.get_loc(
D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
ethod to Float64Index.get_loc is deprecated and will raise in a future version. Use index.get_i
ndexer([item], method=...) instead.
  indexer = self.index.get_loc(
```



In [67]:
```
# 2. Niño 3.4 index
# Open the dataset
ds2 = xr.open_dataset("NOAA_NCDC_ERSST_v3b_SST.nc", engine="netcdf4")
ds2
```

Out[67]:

xarray.Dataset

► Dimensions: (**lat**: 89, **lon**: 180, **time**: 684)

▼ Coordinates:

lat	(lat)	float32	-88.0 -86.0 -84.0 ... 86.0 88.0
lon	(lon)	float32	0.0 2.0 4.0 ... 354.0 356.0 358.0
time	(time)	datetime64[ns]	1960-01-15 ... 2016-12-15

▼ Data variables:

sst	(time, lat, lon)	float32	...

▼ Attributes:

Conventions :	IRIDL
source :	https://iridl.ldeo.columbia.edu/SOURCES/.NOAA/.NCDC/.ERSST/.version3b/.sst/
history :	extracted and cleaned by Ryan Abernathey for Research Computing in Earth Scie nce

In [68]:
```python
# 2.1 Compute monthly climatology for SST and the anomalies from Niño 3.4 region
# Select the data of region 5N-5S, 170W-120W
Nino3_4=ds2.sst.sel(lat=slice(-5,5), lon=slice(190,240))
# Group the data by month
group_data = Nino3_4.groupby('time.month')

# Apply function mean() to group_data, and subtract the mean value of each month to calculate anom
sst_anomalies = group_data - group_data.mean(dim='time')
sst_anomalies
```

Out[68]:

xarray.DataArray 'sst' (**time**: 684, **lat**: 5, **lon**: 26)

```
array([[[-0.43157768, -0.41846275, -0.39795303, ..., -0.2116642 ,
         -0.23776245, -0.24401474],
        [-0.41259003, -0.4067192 , -0.3875141 , ..., -0.52064896,
         -0.5346451 , -0.51997185],
        [-0.40932274, -0.39743805, -0.36237717, ..., -0.6373882 ,
         -0.6171951 , -0.583725  ],
        [-0.4140854 , -0.37909317, -0.3215618 , ..., -0.43292618,
         -0.38404274, -0.3352623 ],
        [-0.5043678 , -0.43894005, -0.3710251 , ..., -0.17453575,
         -0.11044502, -0.06918144]],

       [[-0.5374584 , -0.52739716, -0.50823593, ..., -0.40254593,
         -0.44382668, -0.45287704],
        [-0.55093956, -0.539135  , -0.51673317, ..., -0.6660595 ,
         -0.7127285 , -0.710968  ],
        [-0.61242104, -0.5959244 , -0.5572338 , ..., -0.7235069 ,
         -0.7326374 , -0.73106194],
        [-0.6798363 , -0.6483364 , -0.5889931 , ..., -0.5397434 ,
         -0.50793266, -0.49977684],
        [-0.7830448 , -0.7286701 , -0.6683655 , ..., -0.33967972,
...
         -0.2555828 , -0.13972664],
        [-0.989378  , -1.0497723 , -1.0954857 , ..., -0.86087227,
         -0.7690697 , -0.65498734],
        [-1.1887245 , -1.252285  , -1.3029232 , ..., -1.0460625 ,
         -0.9661274 , -0.8785801 ],
        [-1.002367  , -1.0756893 , -1.1325111 , ..., -0.7207298 ,
         -0.6597252 , -0.5900669 ],
        [-0.5770798 , -0.65514374, -0.72174263, ..., -0.4353485 ,
         -0.36265945, -0.28103828]],

       [[-0.3578701 , -0.41542053, -0.47110367, ..., -0.2400589 ,
         -0.1464405 , -0.03788376],
        [-0.7678585 , -0.83501625, -0.9024124 , ..., -0.727829  ,
         -0.61603355, -0.48027992],
        [-0.96187973, -1.0445309 , -1.1224213 , ..., -0.9327831 ,
         -0.81235695, -0.6655674 ],
        [-0.82112694, -0.9206734 , -1.0085506 , ..., -0.6531601 ,
         -0.5626869 , -0.4374504 ],
        [-0.4864292 , -0.5823746 , -0.6702862 , ..., -0.36221695,
         -0.30041504, -0.1987915 ]]], dtype=float32)
```

▼ Coordinates:

lat	(lat)	float32	-4.0 -2.0 0.0 2.0 4.0
lon	(lon)	float32	190.0 192.0 194.0 ... 238.0 240.0
time	(time)	datetime64[ns]	1960-01-15 ... 2016-12-15
month	(time)	int64	1 2 3 4 5 6 7 ... 6 7 8 9 10 11 12

► Attributes: (0)

In [69]:
```python
# 2.1 Connected above
# Compute rolling means of anomalies for 3 months (moving averages)
Anomalies_rolling_3month = sst_anomalies.rolling(time=3, center=True).mean()
Anomalies_rolling_3month
```

Out[69]:

xarray.DataArray 'sst' (**time**: 684, **lat**: 5, **lon**: 26)

```
array([[[        nan,         nan,         nan, ...,         nan,
                 nan,         nan],
        [        nan,         nan,         nan, ...,         nan,
                 nan,         nan],
        [        nan,         nan,         nan, ...,         nan,
                 nan,         nan],
        [        nan,         nan,         nan, ...,         nan,
                 nan,         nan],
        [        nan,         nan,         nan, ...,         nan,
                 nan,         nan]],

       [[-0.47460747, -0.45974922, -0.43648148, ..., -0.27058157,
         -0.30415025, -0.31023726],
        [-0.46876016, -0.44866624, -0.41753197, ..., -0.5630188 ,
         -0.59371823, -0.5862376 ],
        [-0.47883353, -0.44749323, -0.39656577, ..., -0.6553109 ,
         -0.64915466, -0.63602704],
        [-0.50033313, -0.45391592, -0.3848133 , ..., -0.4699656 ,
         -0.4336287 , -0.4124813 ],
        [-0.59417087, -0.53199005, -0.46596208, ..., -0.2483565 ,
...
         -0.28286046, -0.17690596],
        [-0.90275574, -0.96958417, -1.0264289 , ..., -0.81837213,
         -0.7308731 , -0.622153  ],
        [-1.1050434 , -1.1707128 , -1.226497  , ..., -0.9666475 ,
         -0.88591766, -0.7975814 ],
        [-0.9271374 , -0.99966496, -1.0538692 , ..., -0.64857996,
         -0.59212875, -0.5278715 ],
        [-0.5174097 , -0.59214914, -0.65140855, ..., -0.37964886,
         -0.3267015 , -0.2595253 ]],

       [[        nan,         nan,         nan, ...,         nan,
                 nan,         nan],
        [        nan,         nan,         nan, ...,         nan,
                 nan,         nan],
        [        nan,         nan,         nan, ...,         nan,
                 nan,         nan],
        [        nan,         nan,         nan, ...,         nan,
                 nan,         nan],
        [        nan,         nan,         nan, ...,         nan,
                 nan,         nan]]], dtype=float32)
```

▼ Coordinates:

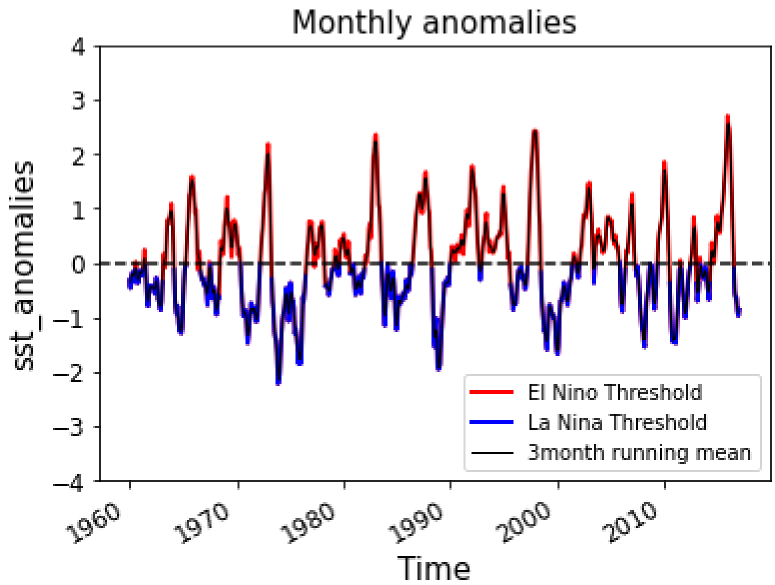
lat	(lat)	float32	-4.0 -2.0 0.0 2.0 4.0
lon	(lon)	float32	190.0 192.0 194.0 ... 238.0 240.0
time	(time)	datetime64[ns]	1960-01-15 ... 2016-12-15

month (time) int64 1 2 3 4 5 6 7 ... 6 7 8 9 10 11 12

▶ Attributes: (0)

In [71]:

```
# 2.2 Visualize the computed Niño 3.4.
# Calculate the averaged anomalies by (dim="lon","lat")
Monthly_anomalies=sst_anomalies.mean(dim=("lon","lat"))
# Plot the sst_anomalies.mean(dim=("lon","lat"))
line1=Monthly_anomalies.plot(color="red",linewidth=2,linestyle="-")
# Detect those sst_anomalies lower than "0", and create a new layer "masked_sample"
masked_sample = Monthly_anomalies.where(Monthly_anomalies < 0)
# Plot the "masked_sample" to get the "La Nina Threshold"
line2=masked_sample.plot(color="blue",linewidth=2,linestyle="-")
# Plot the Anomalies_rolling_3month.mean(dim="lon","lat")
line3=Anomalies_rolling_3month.mean(dim=("lon","lat")).plot(color="black",linewidth=1,linestyle="
plt.legend(labels=["El Nino Threshold","La Nina Threshold","3month running mean"])
# Add a auxiliary line "y=0"
plt.axhline(y=0,color="black",linestyle="--",linewidth=1.5)
plt.title("Monthly anomalies",fontsize=15)
plt.xlabel("Time",fontsize=15)
plt.ylabel("sst_anomalies",fontsize=15)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.ylim(-4,4)
plt.show()
```



In [72]:
```python
# 3. Explore a netCDF dataset
# Open a dataset
ds3 = xr.open_dataset("CESM2_200001-201412.nc", engine="netcdf4")
ds3
```

```
D:\Users\60918\anaconda3\lib\site-packages\xarray\conventions.py:512: SerializationWarning: var
iable 'tas' has multiple fill values {1e+20, 1e+20}, decoding all values to NaN.
  new_vars[k] = decode_cf_variable(
```

Out[72]:

xarray.Dataset

► Dimensions: (**time**: 180, **lat**: 192, **lon**: 288, nbnd: 2)

▼ Coordinates:

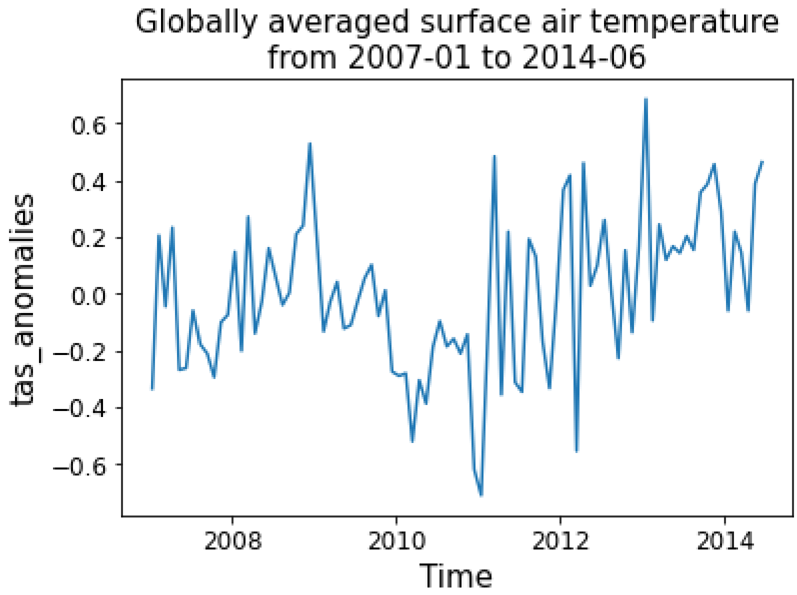
lat	(lat)	float64	-90.0 -89.06 -88.12 ... 89.06 90.0
lon	(lon)	float64	0.0 1.25 2.5 ... 356.2 357.5 358.8
time	(time)	object	2000-01-15 12:00:00 ... 2014-12-...

▼ Data variables:

tas	(time, lat, lon)	float32	...
time_bnds	(time, nbnd)	object	...
lat_bnds	(lat, nbnd)	float64	...
lon_bnds	(lon, nbnd)	float64	...

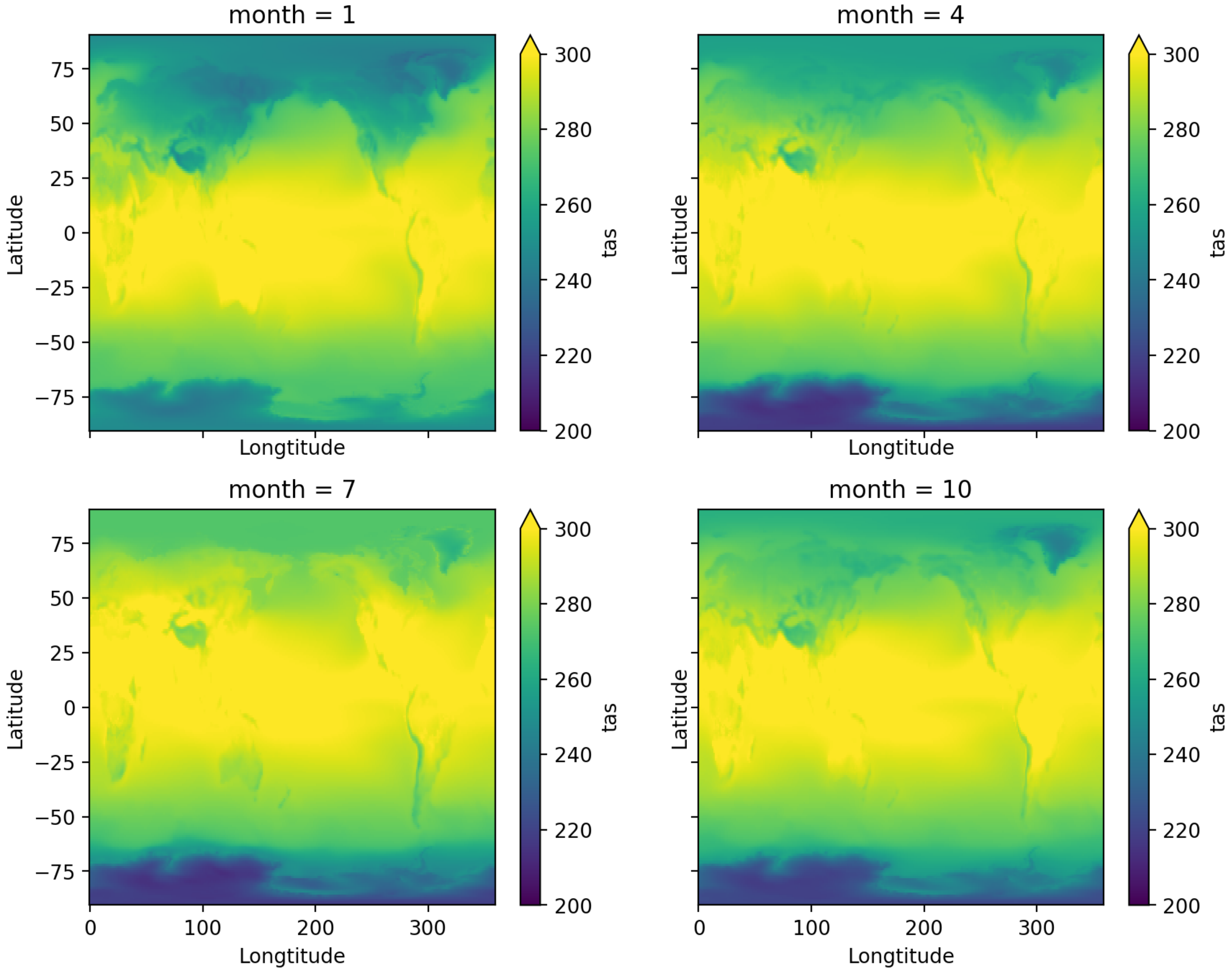
► Attributes: (45)

In [73]:
```python
# 3.1 Plot a time series of a certain variable with monthly seasonal cycle removed.
# Choose a time range for the data and calculate the global "tas" means
New_ds3=ds3.tas.mean(dim=("lon", "lat")).sel(time=slice("2007-01", "2014-06"))
# Group data by "Month"
group_data = New_ds3.groupby('time.month')

# Apply mean to grouped data, and then compute "tas_anomalies" with monthly seasonal cycle removed
tas_anomalies = group_data - group_data.mean(dim="time")
# Plot "tas_anomalies"
tas_anomalies.plot()
plt.title("Globally averaged surface air temperature\nfrom 2007-01 to 2014-06",fontsize=15)
plt.xlabel("Time",fontsize=15)
plt.ylabel("tas_anomalies",fontsize=15)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```



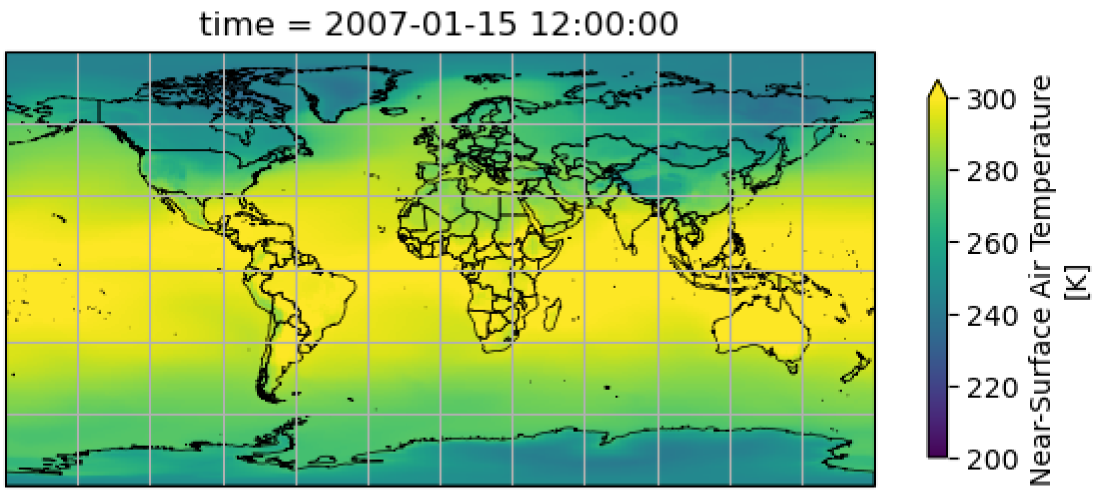
In [77]:

```
# 3.2.1 Figure Global tas in Month 1,4,7 and 10
# Group tas data by month and compute the means for each month
tas_month_mean = ds3.tas.sel(time=slice("2007-01", "2014-06")).groupby("time.month").mean()

# Use a "for" loop to subplot Month 1,4,7,10 in 4 panels
fig,ax=plt.subplots(2,2, figsize=(10,8),sharex="all",sharey="all",dpi=200)
ax=ax.flatten()
for i in range(4):
    ax[i]=plt.subplot(2,2,i+1)
    tas_month_mean[i*3,:,:].plot(vmin=200, vmax=300)
    plt.xlabel("Longtitude",fontsize=10)
    plt.ylabel("Latitude",fontsize=10)
plt.subplots_adjust(wspace=0.2,hspace=0.2)
```



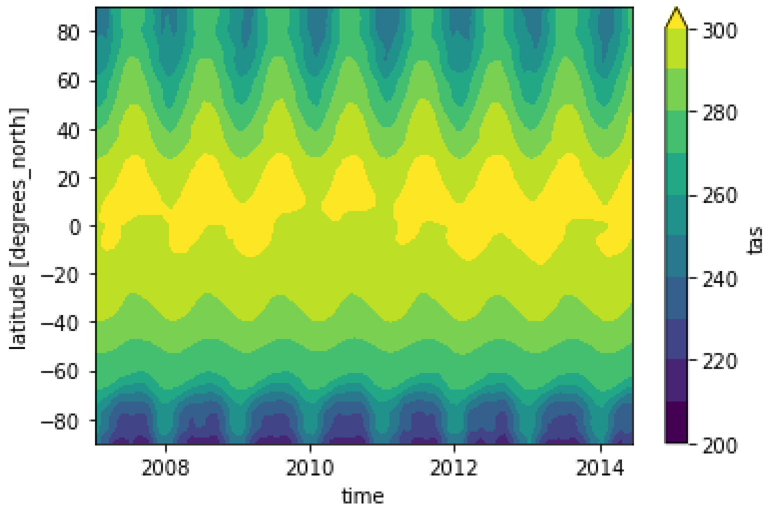
In [78]:
```python
# 3.2.2 Figure Global tas in 2007-01
# Rechoose data in time="2007-01"
surface_T= ds3.tas.sel(time="2007-01")
# Create a figure object
plt.figure(figsize=(7,5), dpi=100)
# Create an axes with Orthographic projection style
proj = ccrs.PlateCarree()
ax = plt.axes(projection=proj)
# Plot the global tas in 2007-01
surface_T.plot(ax=ax, transform=ccrs.PlateCarree(),
         vmin=200, vmax=300, cbar_kwargs={"shrink": 0.5})

# Add border lines over countries
ax.add_feature(cfeature.NaturalEarthFeature(category="cultural",
                                            name="admin_0_countries",
                                            scale="50m",
                                            facecolor="none",
                                            edgecolor="black",
                                            linewidth=0.5))

# Add gridlines
gridline = ax.gridlines(crs=ccrs.PlateCarree())
# Manipulate latitude and longitude gridline numbers and spacing
gridline.ylocator = mticker.FixedLocator(np.arange(-90,91,30))
gridline.xlocator = mticker.FixedLocator(np.arange(-180, 181,30))
```

```
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:245: ShapelyDeprecationWarning: __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 of parts of a multi-part geometry.
  if len(multi_line_string) > 1:
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:297: ShapelyDeprecationWarning: Iteration over multi-part geometries is deprecated and will be removed in Shapely 2.0. Use the `geoms` property to access the constituent parts of a multi-part geometry.
  for line in multi_line_string:
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:364: ShapelyDeprecationWarning: __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 of parts of a multi-part geometry.
  if len(p_mline) > 0:
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:402: ShapelyDeprecationWarning: Iteration over multi-part geometries is deprecated and will be removed in Shapely 2.0. Use the `geoms` property to access the constituent parts of a multi-part geometry.
  line_strings.extend(multi_line_string)
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:402: ShapelyDeprecationWarning: __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 of parts of a multi-part geometry.
  line_strings.extend(multi_line_string)
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:256: ShapelyDeprecationWarning: __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 of parts of a multi-part geometry.
  line_strings = list(multi_line_string)
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:256: ShapelyDeprecationWarning: Iteration over multi-part geometries is deprecated and will be removed in Shapely 2.0. Use the `geoms` property to access the constituent parts of a multi-part geometry.
  line_strings = list(multi_line_string)
```



In [79]:
```python
# 3.2.3 Figure a tas contourf for different latitudes from 2007-01 to 2014-06
ds3.tas.mean(dim="lon").sel(time=slice("2007-01", "2014-06")).plot.contourf(x="time",
                                                                            levels=11, vmin=200, vmax=300)
```

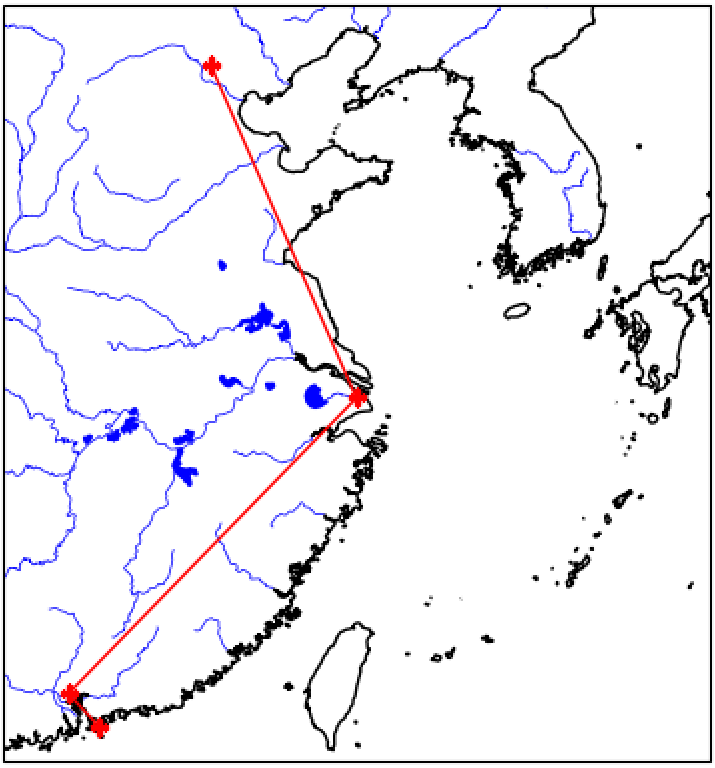
Out[79]: <matplotlib.contour.QuadContourSet at 0x1641c6fb160>



In [80]:
```python
# 3.2.4 Find out the location of Beijing, Shanghai, HongKong and Guangzhou in the map
# Beijing=116.5E, 39.9N
# Shanghai=121.5E,31.2N
# HongKong=114.2E,22.3N
# Guangzhou=113.25E,23.13N
# Create 4 dictionaries to contain the latitudes and longtitudes of the 4 cities.
HongKong = dict(lon=114.2, lat=22.3)
Guangzhou = dict(lon=113.25, lat=23.13)
Shanghai=dict(lon=121.5, lat=31.2)
Beijing=dict(lon=116.5, lat=39.9)
lons = [HongKong["lon"], Guangzhou["lon"],Shanghai["lon"],Beijing["lon"]]
lats = [HongKong["lat"], Guangzhou["lat"],Shanghai["lat"],Beijing["lat"]]

# Make a layer to add some river messages
rivers= cfeature.NaturalEarthFeature("physical", "rivers_lake_centerlines", "10m")

# Create a figure object and choose Shanghai as the figure center
plt.figure(figsize=(7,5), dpi=100)
central_lon, central_lat = 121.5, 31.2

# Set Orthographic projection style and create an axes
proj = ccrs.Orthographic(central_lon, central_lat)
ax = plt.axes(projection=proj)

# Set a plotting range
Range = [central_lon-10, central_lon+10, central_lat-10, central_lat+10]
ax.set_extent(Range)

# Add some features for lakes and rivers, using function add_feature()
ax.add_feature(cfeature.LAKES, edgecolor="blue", facecolor="blue",zorder=1)
ax.add_feature(rivers, facecolor="None", edgecolor="blue", linewidth=0.5)

# Add coastlines, using function coastlines()
ax.coastlines(resolution="10m")

# Add 4 points to show the locations of 4 cities
ax.plot(lons, lats, "rP-", linewidth=1,transform=ccrs.PlateCarree())
```

Out[80]:
```
[<matplotlib.lines.Line2D at 0x164199931f0>]
```

```
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:245: ShapelyDeprecationWarning: __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 of parts of a multi-part geometry.
  if len(multi_line_string) > 1:
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:297: ShapelyDeprecationWarning: Itera
tion over multi-part geometries is deprecated and will be removed in Shapely 2.0. Use the `geom
s` property to access the constituent parts of a multi-part geometry.
  for line in multi_line_string:
D:\Users\60918\anaconda3\lib\site-packages\cartopy\crs.py:364: ShapelyDeprecationWarning: __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 of parts of a multi-part geometry.
  if len(p_mline) > 0:
```



In [81]:
```
# 3.2.5 Draw Monthly tas in Beijing, Shanghai, Guangzhou and HongKong from 2007-01 to 2014-06
# Choose tas data of different cities, based on the latitudes and longtitudes
Beijing=ds3.tas.sel(time=slice("2007-01", "2014-06")).sel(lon=116.5,lat=39.9,method="nearest")
Shanghai=ds3.tas.sel(time=slice("2007-01", "2014-06")).sel(lon=121.5,lat=31.2,method="nearest")
HongKong=ds3.tas.sel(time=slice("2007-01", "2014-06")).sel(lon=114.2,lat=22.3,method="nearest")
Guangzhou=ds3.tas.sel(time=slice("2007-01", "2014-06")).sel(lon=113.25,lat=23.13,method="nearest"
# Plot tas data
Beijing.plot(color="blue",linewidth=1.0,linestyle="-")
Shanghai.plot(color="red",linewidth=1.0,linestyle="-")
Guangzhou.plot(color="grey",linewidth=1.0,linestyle="-")
HongKong.plot(color="black",linewidth=1.0,linestyle="-")
plt.legend(labels=["Beijing","Shanghai","Guangzhou","HongKong"],loc="lower right")
plt.title("Monthly Surface Air Temperature in different cities",fontsize=12)
plt.xlabel("Time",fontsize=12)
plt.ylabel("Surface air temperature[K]",fontsize=12)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.ylim(240,310)
plt.show()
```

```
D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
ethod to Float64Index.get_loc is deprecated and will raise in a future version. Use index.get_i
ndexer([item], method=...) instead.
  indexer = self.index.get_loc(
D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
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D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
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D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
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D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
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D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
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D:\Users\60918\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing m
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  indexer = self.index.get_loc(
```

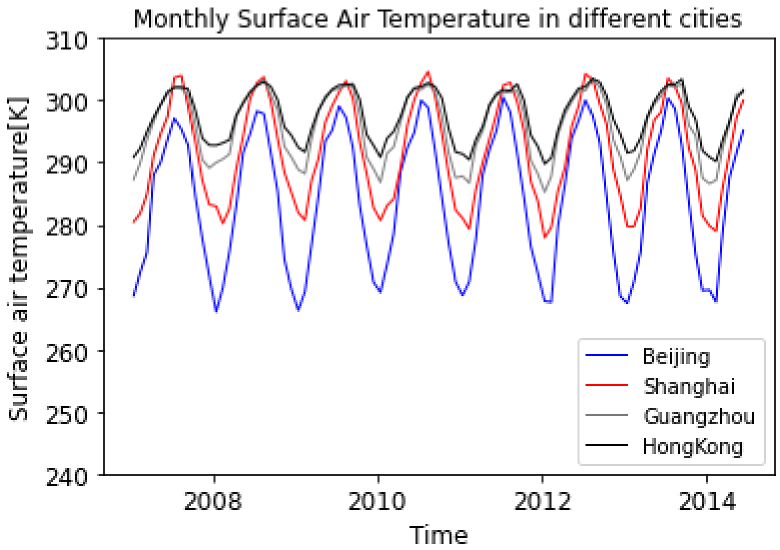

Monthly Surface Air Temperature in different cities
Surface air temperature[K]
310
300
290
280
270
260
250
240
2008
2010
2012
2014
Time
Beijing
Shanghai
Guangzhou
HongKong