

In [1]:

```
# 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 [137]:

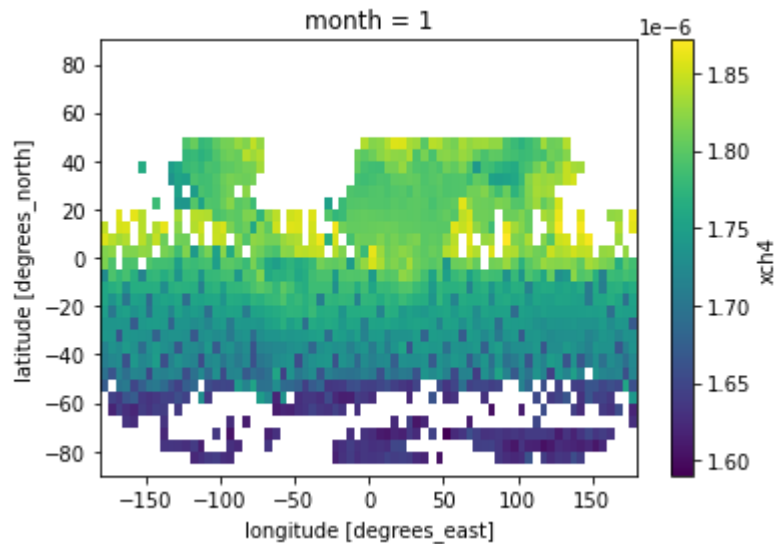
```
#第一题
ds = xr.open_dataset("200301_202006-C3S-L3_GHG-PRODUCTS-OBS4MIPS-MERGED-v4.3.nc", engine="netcdf4")
```

In [12]:

```
#第一问：一月的
monthly_xch4=ds.xch4.groupby('time.month').mean()
monthly_xch4.isel(month=0).plot()
```

Out[12]:

<matplotlib.collections.QuadMesh at 0x1e5f606a2e0>



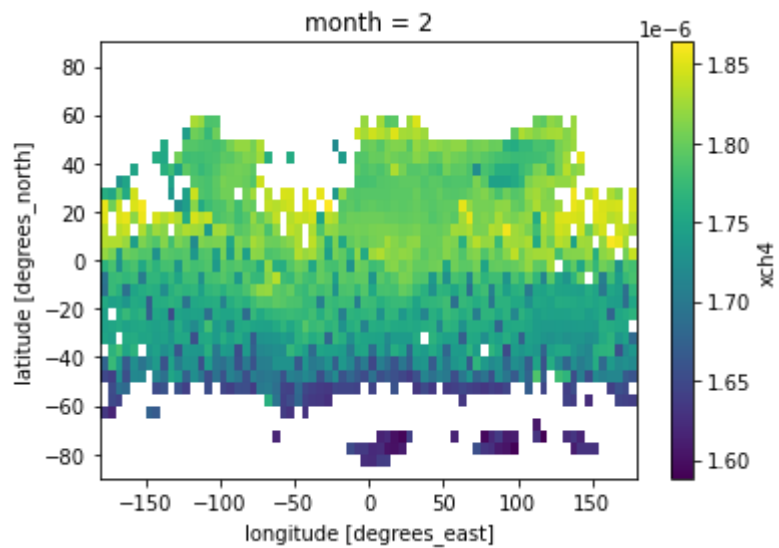
In [13]:

```
#第一问：2月的
```

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=1).plot()
```

Out[13]:

<matplotlib.collections.QuadMesh at 0x1e5f68a4a30>



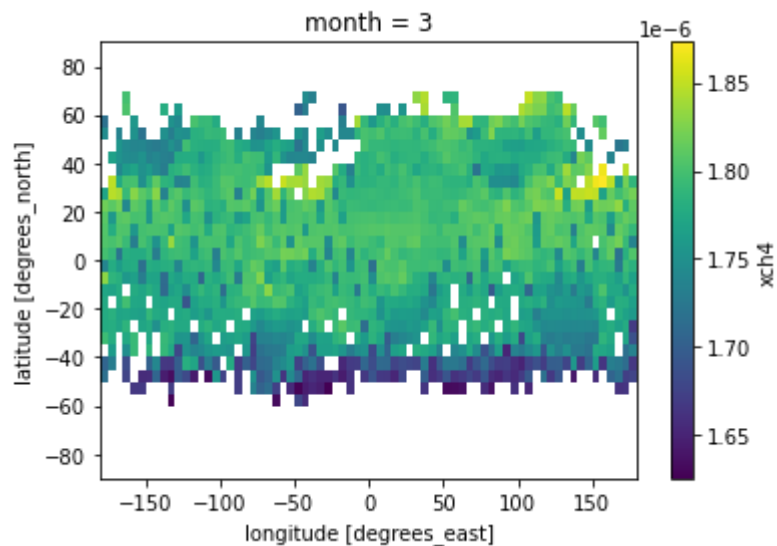
In [14]:

#第一问: 3月的

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=2).plot()
```

Out[14]:

<matplotlib.collections.QuadMesh at 0x1e5f6961df0>



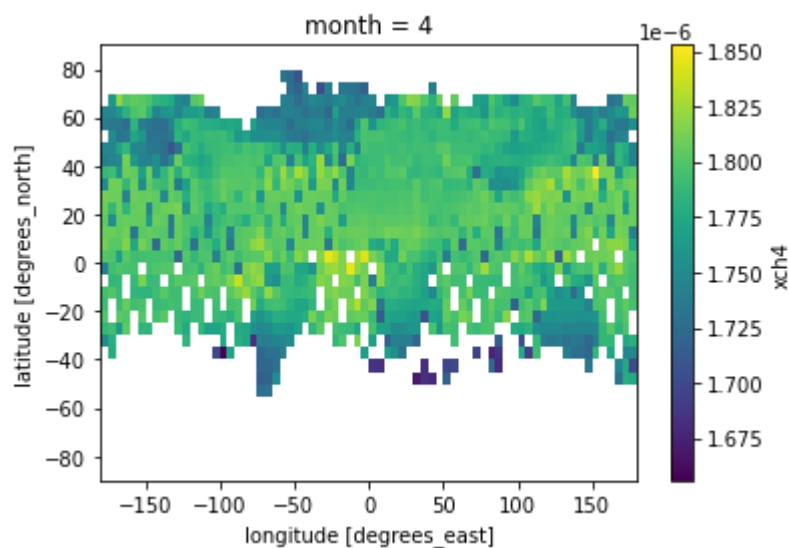
In [15]:

#第一问: 4月的

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=3).plot()
```

Out[15]:

<matplotlib.collections.QuadMesh at 0x1e5f6a20c10>



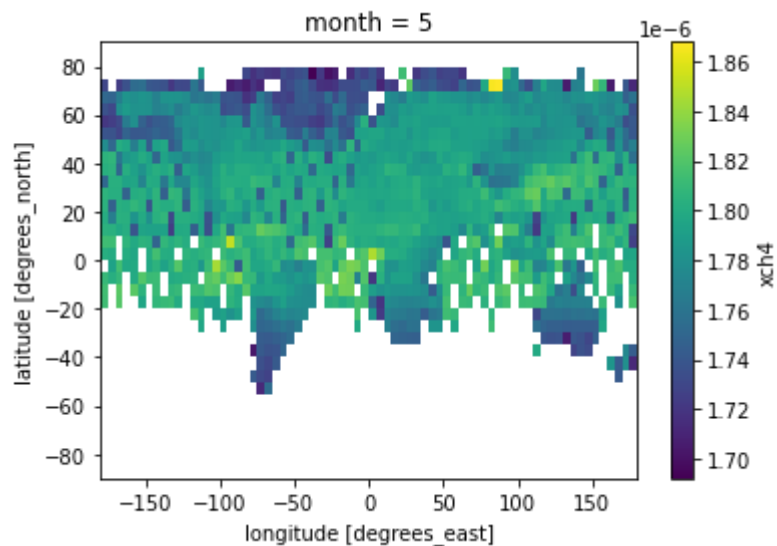
In [16]:

#第一问: 5月的

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=4).plot()
```

Out[16]:

<matplotlib.collections.QuadMesh at 0x1e5f6ae69d0>



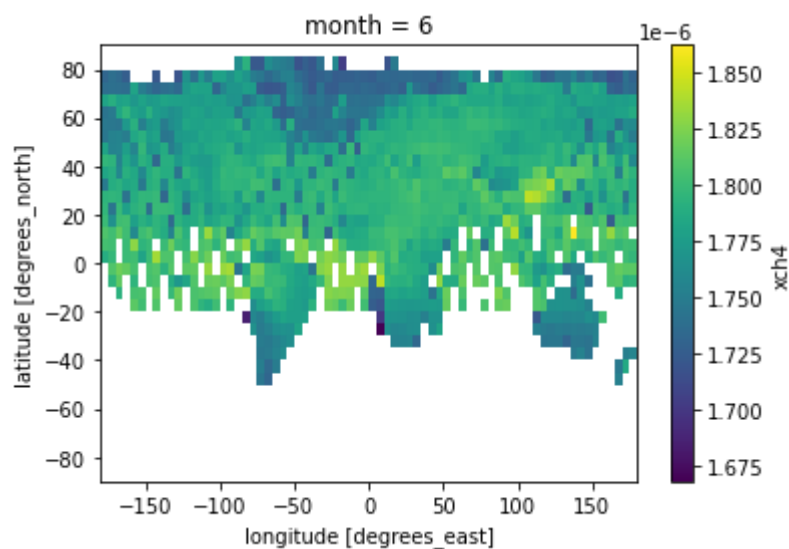
In [17]:

#第一问: 6月的

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=5).plot()
```

Out[17]:

<matplotlib.collections.QuadMesh at 0x1e5f6bb6610>



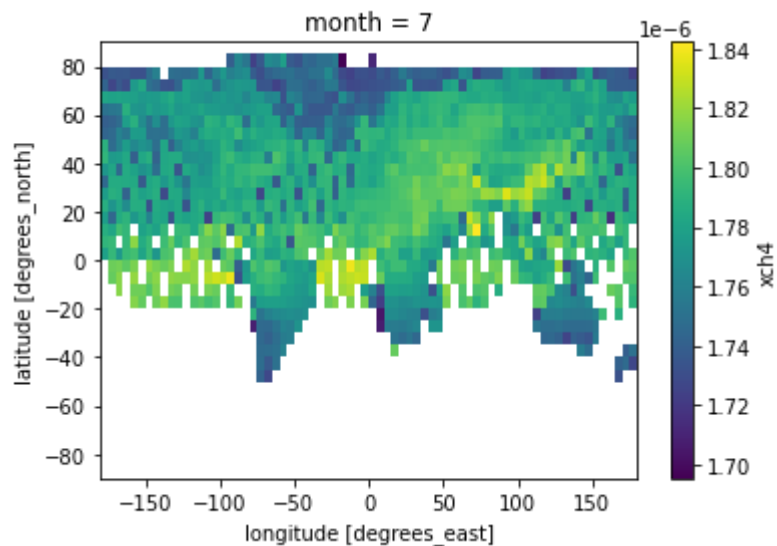
In [18]:

#第一问: 7月的

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=6).plot()
```

Out[18]:

<matplotlib.collections.QuadMesh at 0x1e5f6c7f310>



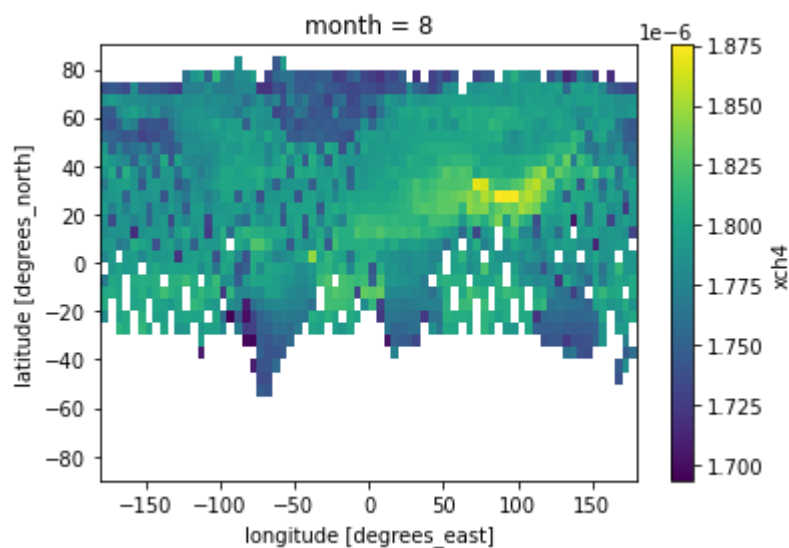
In [19]:

#第一问: 8月的

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=7).plot()
```

Out[19]:

<matplotlib.collections.QuadMesh at 0x1e5f6d4c040>



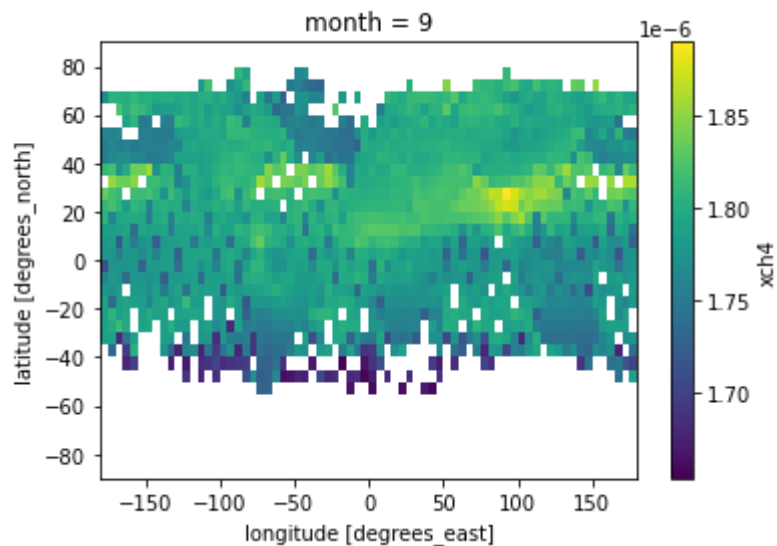
In [20]:

#第一问: 9月的

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=8).plot()
```

Out[20]:

<matplotlib.collections.QuadMesh at 0x1e5f6e0bd60>



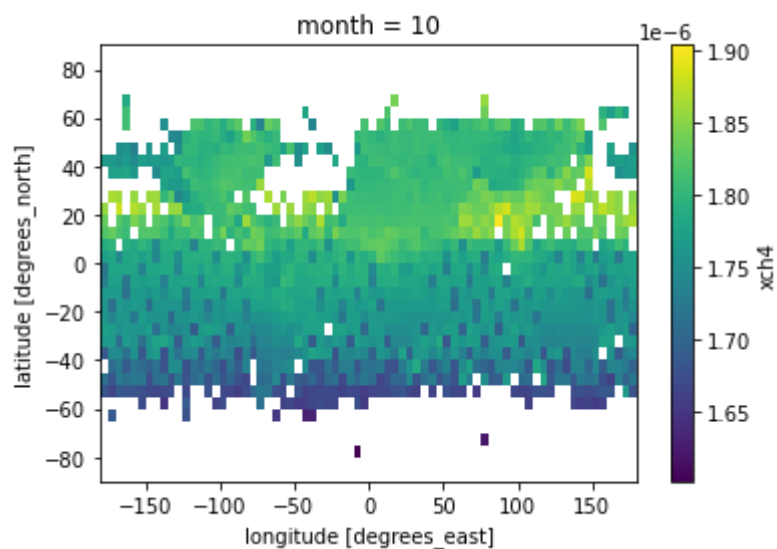
In [21]:

#第一问: 10月的

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=9).plot()
```

Out[21]:

<matplotlib.collections.QuadMesh at 0x1e5f6eb80d0>



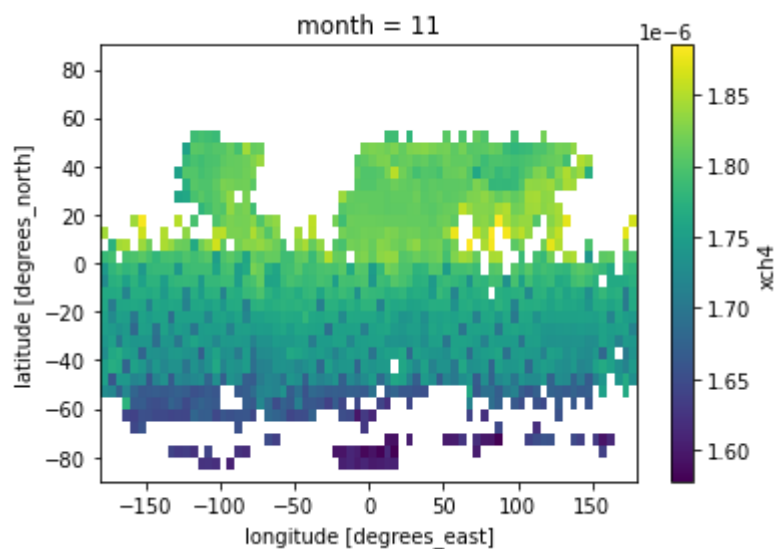
In [22]:

```
#第一问：11月的
```

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=10).plot()
```

Out[22]:

<matplotlib.collections.QuadMesh at 0x1e5f6f54370>



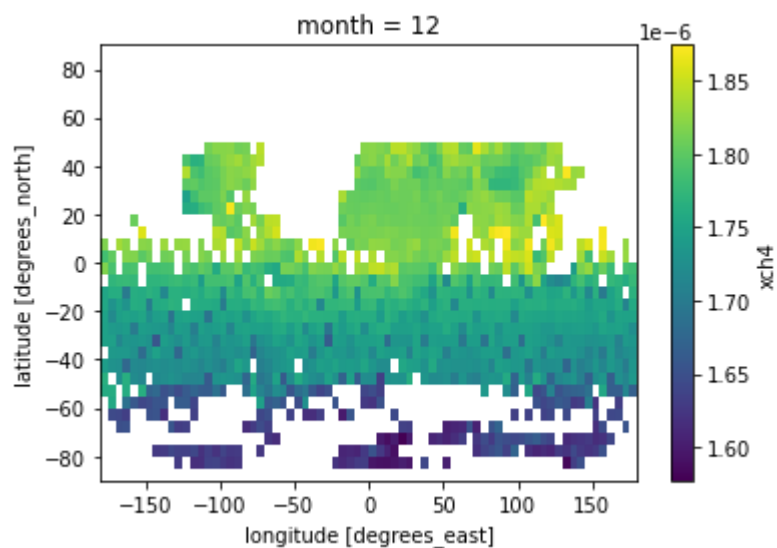
In [23]:

```
#第一问：12月的
```

```
monthly_xch4=ds.xch4.groupby('time.month').mean()  
monthly_xch4.isel(month=11).plot()
```

Out[23]:

<matplotlib.collections.QuadMesh at 0x1e5f7fe0550>



In [25]:

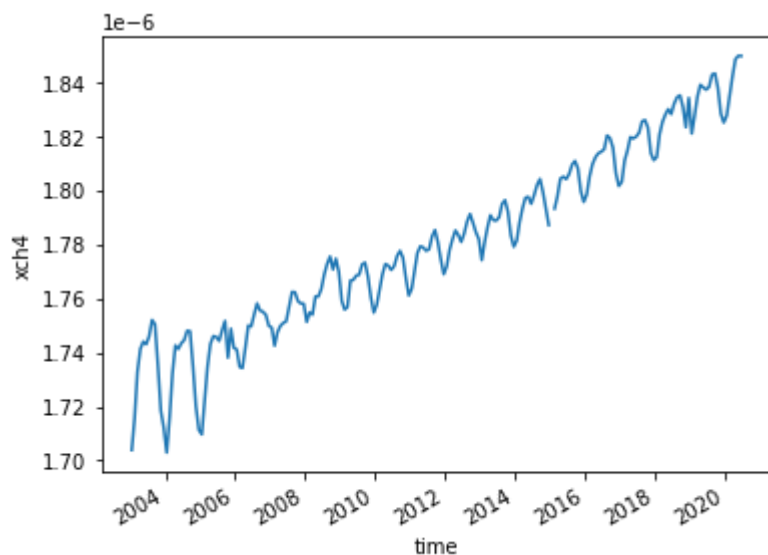
#第一题第二问

```
ds.xch4.mean(dim=('lon', 'lat')).sel(  
    time=slice("2003-1", "2020-6")  
).plot()
```

#在2003年到2020年的时间序列上，全球平均甲烷浓度总体呈现上升趋势，且在每一年中可能由于温度等因素的影响  
#但在总体尺度上，从2003年到2020年，全球甲烷平均浓度呈现明显的上升态势

Out[25]:

[<matplotlib.lines.Line2D at 0x1e5f8441370>]





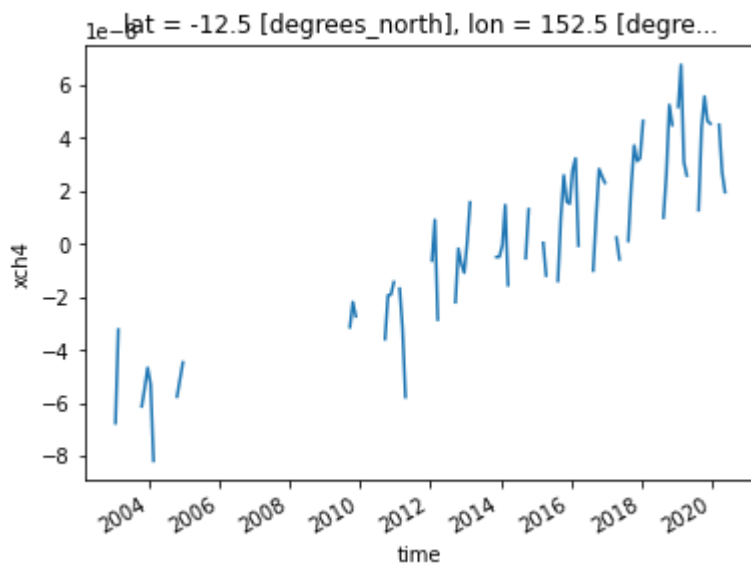
In [27]:

```
#第一题第三问
#发现题目要求的时间尺度和数据的时间尺度是一致的，不需要调整，沿用课堂做过的思路直接处理
# 数据按月分组
group_data = ds.xch4.groupby('time.month')
# Apply mean to grouped data, and then compute the anomaly
xch4_anom = group_data - group_data.mean(dim='time')
xch4_anom
# Plot anomalies
xch4_anom.sel(lon=150, lat=-15,
               method='nearest').plot()
# (1) 发现画出来的图断断续续的，结合第一题的结果，分析认为在下载的数据集中，可能存在坐标点时间序列不
# (2) 尽管图像断断续续的，但在整体的时间尺度上，仍然可以看出，在该坐标系下，从2003年到2020年间，非季
```

```
C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning:
g: Passing method to Float64Index.get_loc is deprecated and will raise in a future v
ersion. Use index.get_indexer([item], method=...) instead.
    indexer = self.index.get_loc(
C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning:
g: Passing method to Float64Index.get_loc is deprecated and will raise in a future v
ersion. Use index.get_indexer([item], method=...) instead.
    indexer = self.index.get_loc(
```

Out[27]:

[<matplotlib.lines.Line2D at 0x1e5f84c6940>]



In [136]:

```
#第二题
ds2 = xr.open_dataset("NOAA_NCDC_ERSST_v3b_SST.nc", engine="netcdf4")
```

In [121]:

```
#第二题
#如果没理解错，这个题是要用rolling函数画图，且设定周期为3个月
# Group data by month
group_data = ds2.sst.groupby('time.month')
# Apply mean to grouped data, and then compute the anomalies
sst_anom = group_data - group_data.mean(dim='time')
sst_anom

ds_anom_rolling = sst_anom.rolling(time=3, center=True).mean()

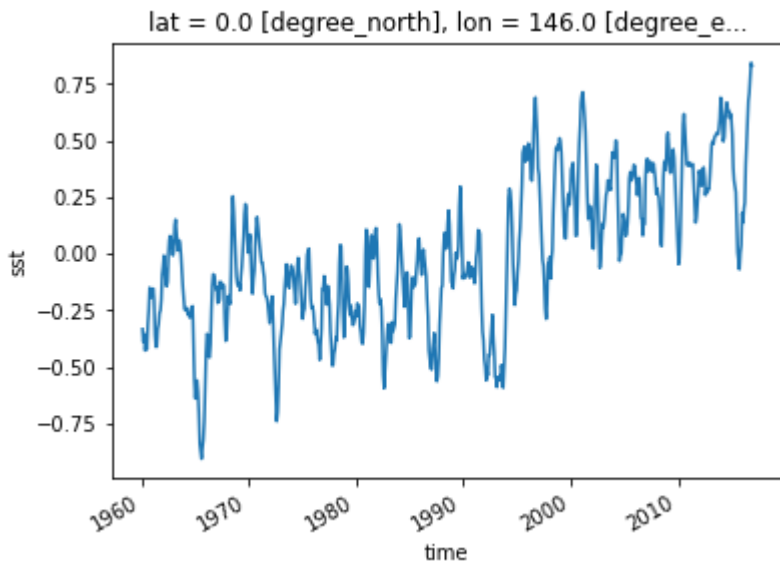
# Show rolling means
ds_anom_rolling

# Plot 3-month rolling mean(最终选择了中心点坐标进行绘画，发现如果lon和lat是个范围，做出来的是个柱状
#题跟这个要求很像，然而没给参考答案)
ds_anom_rolling.sel(lon=145, lat=0, method='nearest').plot(
    label="3-month rolling mean")
```

```
C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning:
g: Passing method to Float64Index.get_loc is deprecated and will raise in a future v
ersion. Use index.get_indexer([item], method=...) instead.
    indexer = self.index.get_loc(
C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning:
g: Passing method to Float64Index.get_loc is deprecated and will raise in a future v
ersion. Use index.get_indexer([item], method=...) instead.
    indexer = self.index.get_loc(
```

Out[121]:

[<matplotlib.lines.Line2D at 0x1e5948336a0>]



In [126]:

```
#第三题使用的数据是全球月均近地面温度
ds3 = xr.open_dataset("CESM2_200001-201412.nc", engine="netcdf4")
#第一问：跟第一题第三问思路一样
group_data = ds3.tas.groupby('time.month')
# Apply mean to grouped data, and then compute the anomaly
tas_anom = group_data - group_data.mean(dim='time')
tas_anom
# Plot anomalies(随便选个坐标120E, 40N)
tas_anom.sel(lon=120+180, lat=40,
              method='nearest').plot()
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

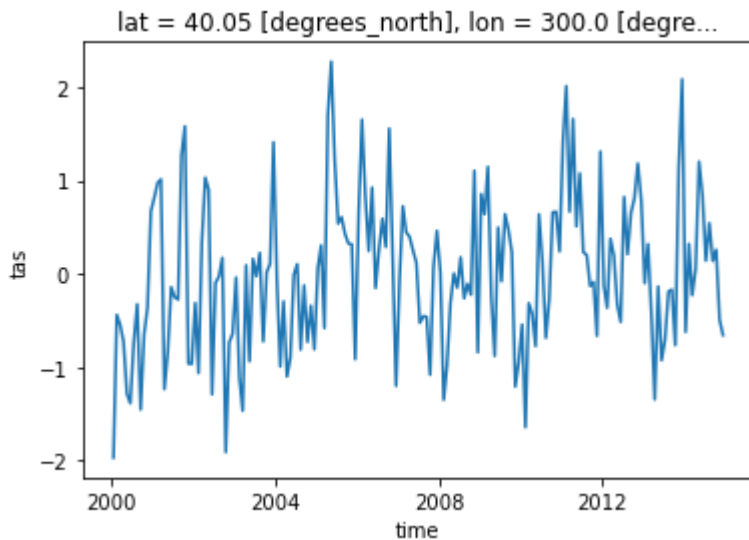
```
indexer = self.index.get_loc(
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

```
indexer = self.index.get_loc(
```

Out[126]:

[<matplotlib.lines.Line2D at 0x1e59491f220>]



In [129]:

#第二问:

#1用resample画一个图, 还是选120E, 40N

```
group_data1 = ds3.tas.groupby('time.month')

# Apply mean to grouped data, and then compute the anomalies
tas_anom = group_data1 - group_data1.mean(dim='time')

# Use resample() function at a frequency of 3 years
resample_obj1 = tas_anom.resample(time="3Y")

# Apply mean() function to the resample object and get results
ds3_anom_resample = resample_obj1.mean(dim="time")
# Plot anomalies
tas_anom.sel(lon=120+180, lat=40,
              method='nearest').plot()

# Plot 3-year resampled anomalies
ds3_anom_resample.sel(lon=120+180, lat=40,
                     method='nearest').plot()
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

indexer = self.index.get\_loc(

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

indexer = self.index.get\_loc(

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

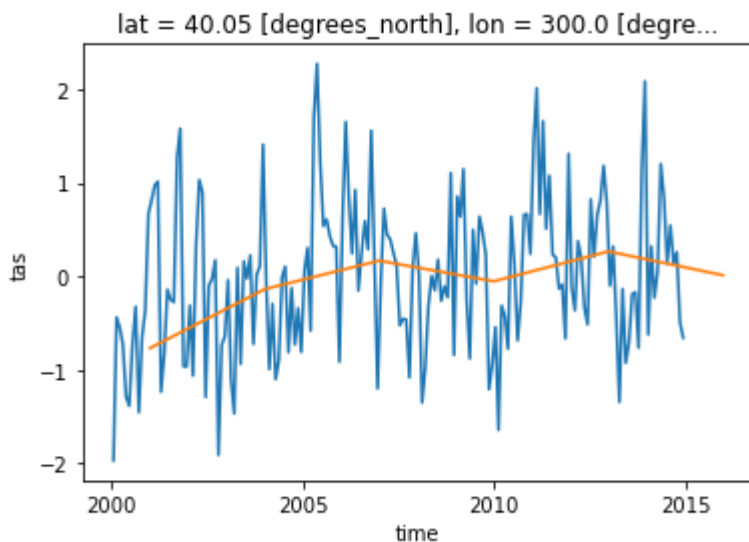
indexer = self.index.get\_loc(

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

indexer = self.index.get\_loc(

Out[129]:

[<matplotlib.lines.Line2D at 0x1e594b05610>]



In [131]:

```
#第二问:
#2用rolling画一个图, 还是选120E, 40N
ds3_anom_rolling = tas_anom.rolling(time=12, center=True).mean()

# Plot anomalies
tas_anom.sel(lon=120+180, lat=40,
              method='nearest').plot()
# Plot 12-month rolling mean
ds3_anom_rolling.sel(lon=120+180, lat=40, method='nearest').plot(
    label="12-month rolling mean")
plt.legend()
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

```
indexer = self.index.get_loc(
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

```
indexer = self.index.get_loc(
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

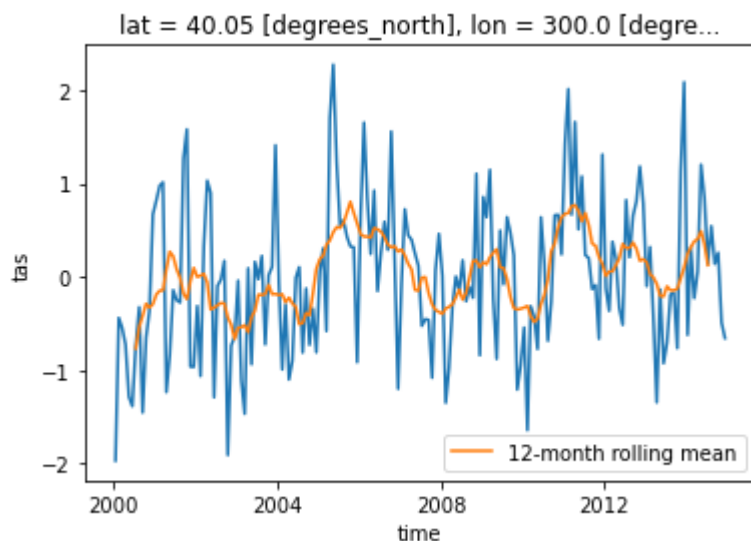
```
indexer = self.index.get_loc(
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

```
indexer = self.index.get_loc(
```

Out[131]:

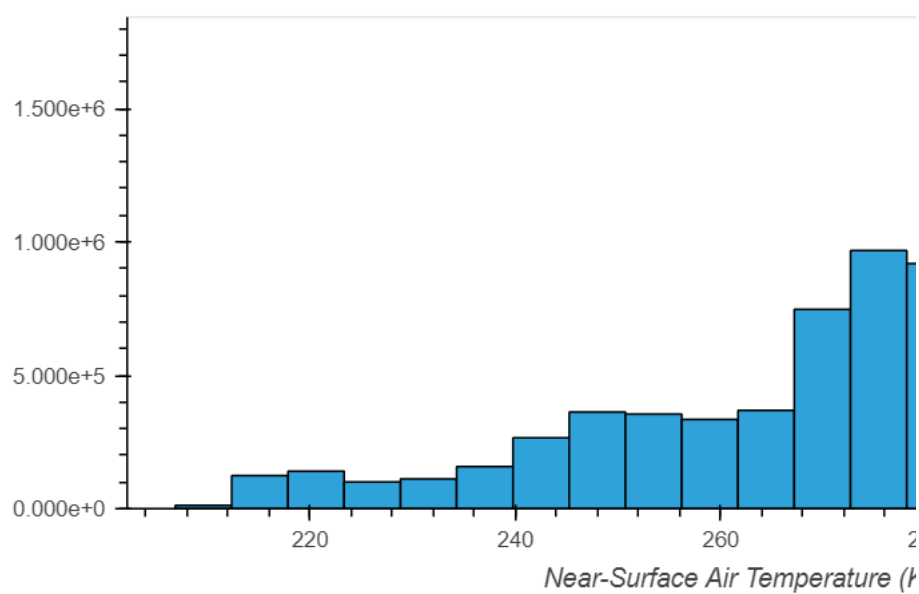
<matplotlib.legend.Legend at 0x1e59497e130>



In [132]:

```
#3. 用hvplot画图
import hvplot.xarray
ds3.tas.hvplot()
```

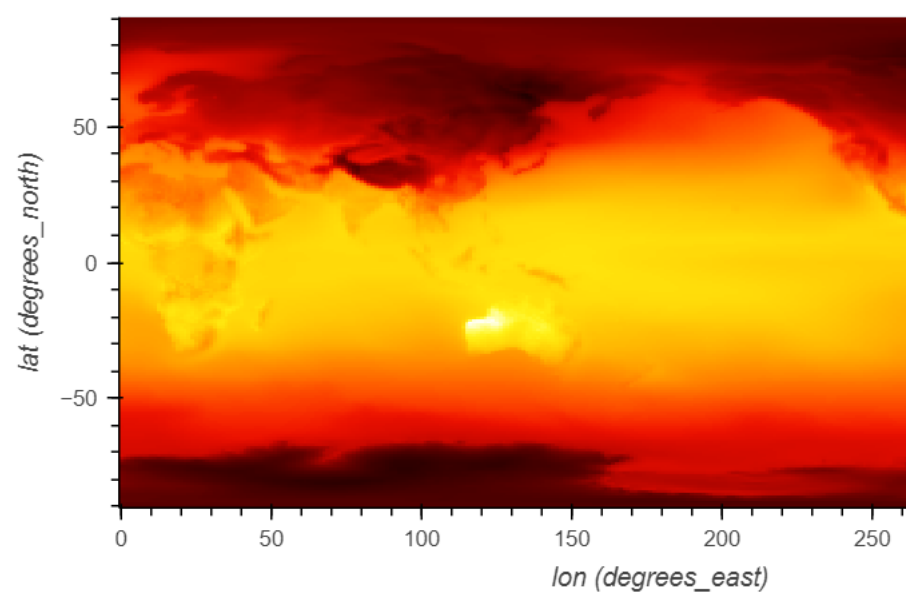
Out[132]:



In [133]:

```
#4展示2-D图像
ds3.tas.isel(time=-1).hvplot(cmap="fire")
```

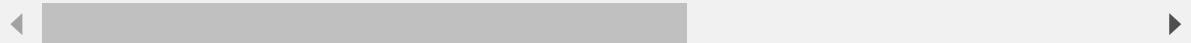
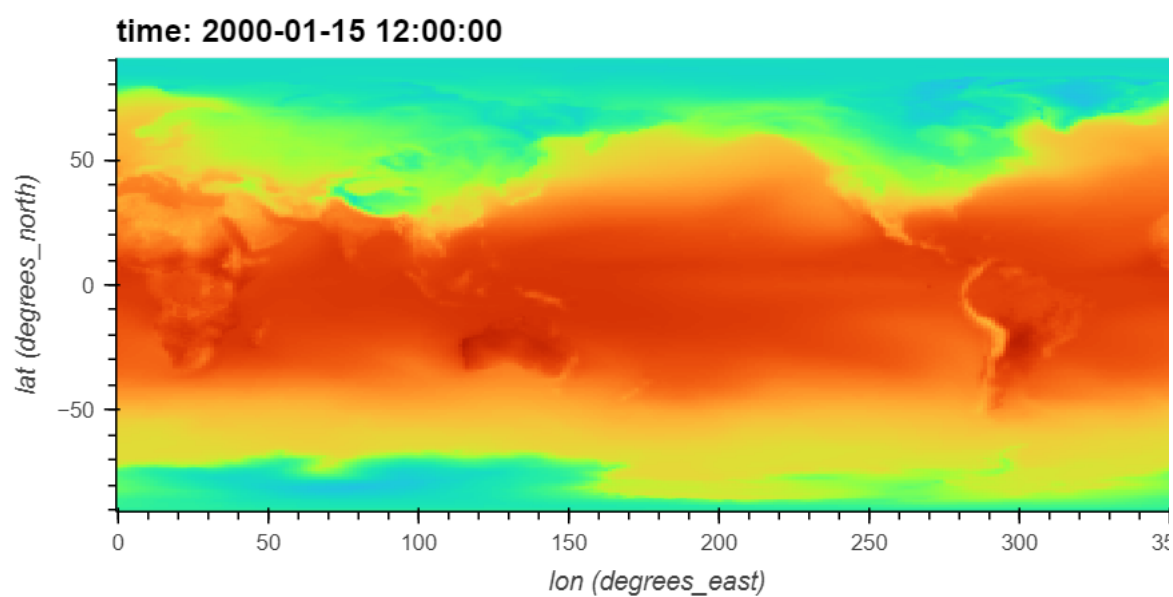
Out[133]:



In [134]:

```
# 5Show widgets  
ds3.tas.hvplot(groupby="time", clim=(ds3.tas.min(), ds3.tas.max()), cmap='turbo')
```

Out[134]:



In [135]:

```
# 6Show 1-D line
ds3.tas.sel(lon=120+180, lat=40, method='nearest').hvplot()
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

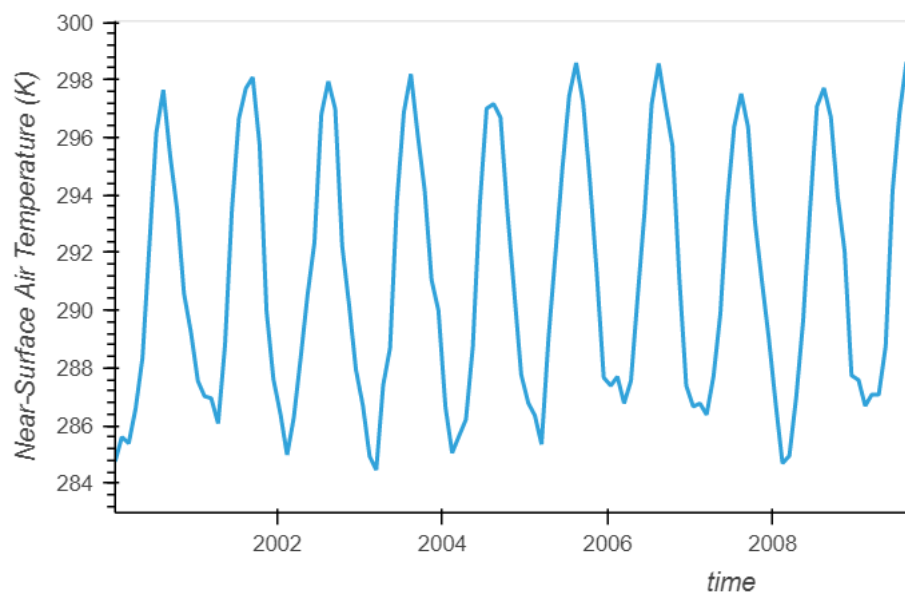
```
indexer = self.index.get_loc(
```

C:\Users\86135\anaconda3\lib\site-packages\xarray\core\indexes.py:234: FutureWarning: Passing method to Float64Index.get\_loc is deprecated and will raise in a future version. Use index.get\_indexer([item], method=...) instead.

```
indexer = self.index.get_loc(
```

WARNING:param.CurvePlot02422: Converting cftime.datetime from a non-standard calendar (noleap) to a standard calendar for plotting. This may lead to subtle errors in formatting dates, for accurate tick formatting switch to the matplotlib backend.

Out[135]:



In [ ]: