datos_temporales

October 17, 2025

0.0.1 Datos temporales con Xarray

Manejo y representación de datos temporales en Python.

Librerías principales

1. Pandas
2. Xarray

Usamos `Xarray` para datos visualizar datos espaciotemporales (en 3 o más dimensiones).

Como se menciona en el `README.md` podemos instalar las librerías necesarias (`pandas` y `xarray`, entre otras) utilizando el archivo `environment.yml`:

```
conda env create -f environment.yml -n geospatial
```

0.0.2 Importar librerías

[ ]:
```
import numpy as np
import pandas as pd
import xarray as xr
import matplotlib.pyplot as plt
from matplotlib.dates import date2num, num2date, datetime
import cmocean as cmo
import subprocess
import scipy.stats as sstat
from scipy.interpolate import UnivariateSpline
import seaborn as sns
```

0.0.3 Abrir archivo NetCDF con `Xarray`

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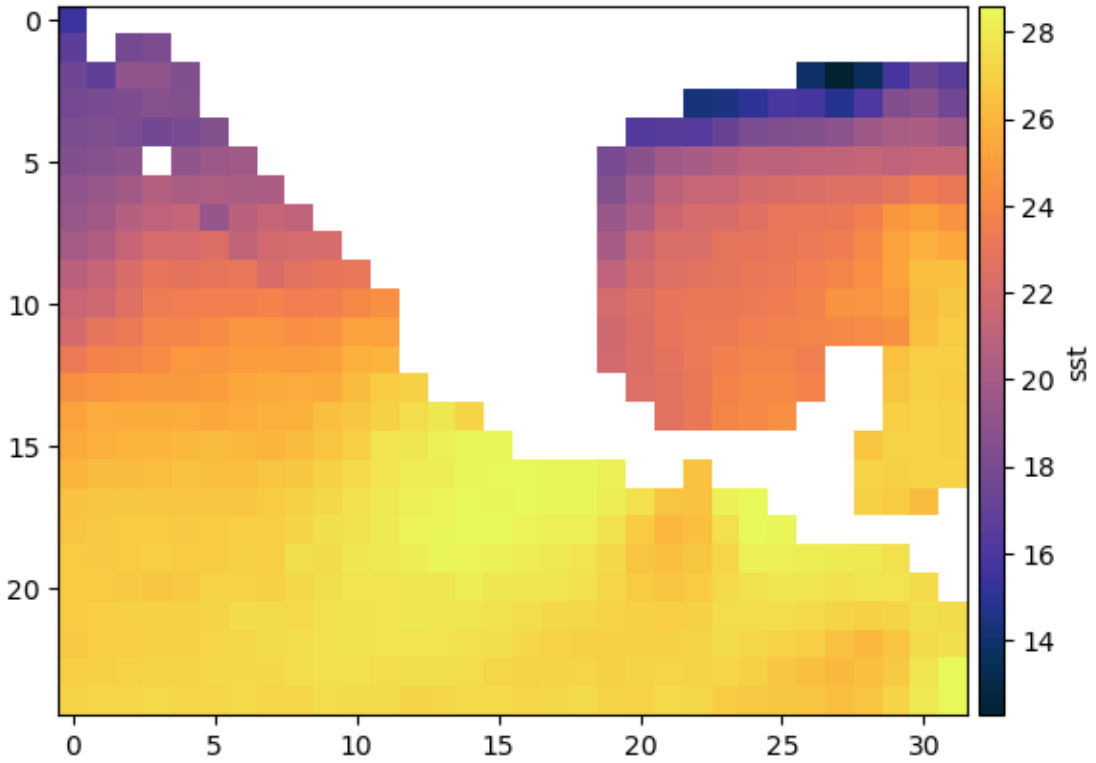
[59]:
```
roi = [8,33,-117+360,-85+360] # region de interés
ds = xr.open_dataset('data/ERA5_Coarse.nc')
sst = ds.sst
sst = sst - 273.15 # convertiendo a Celsius de Kelvin
sst = sst.sel(latitude=slice(roi[1],roi[0]), longitude=slice(roi[2],roi[3]))
#sst = sst.squeeze()
#sst.plot()
```

0.0.4 Mapa de TSM global de la primera capa temporal del NetCDF (1959-01-01)

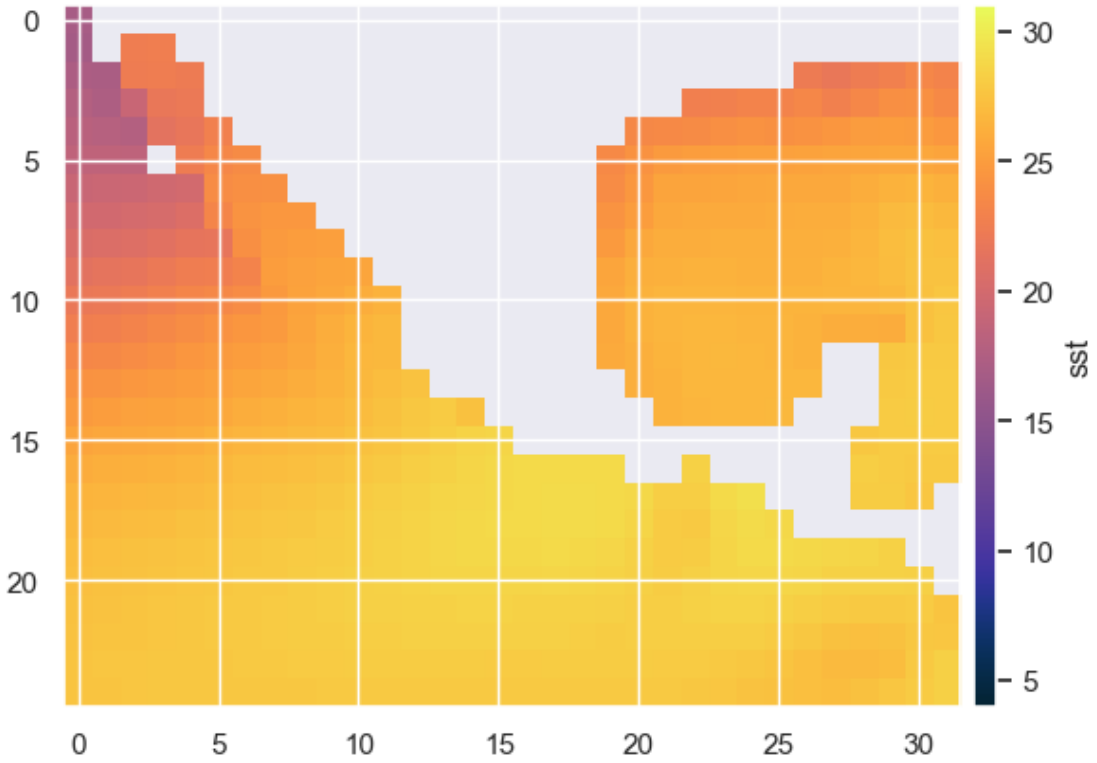
[60]:
```
cmap = cmo.cm.thermal
fig, ax = plt.subplots()
image = plt.imshow(sst[0],cmap=cmap)

cax = fig.add_axes([ax.get_position().x1+0.01, ax.get_position().y0,0.02, ax.
 ↪get_position().height])
cbar= plt.colorbar(image, cax=cax)
cbar.set_label('sst')
plt.show()
```



Mapa de TSM media

[101]:
```
sst_mean = sst.mean(dim='time')
fig, ax = plt.subplots()
image = plt.imshow(sst_mean,cmap=cmap,vmin=4,vmax=31)
```

```
cax = fig.add_axes([ax.get_position().x1+0.01,ax.get_position().y0,0.02,ax.
 ↪get_position().height])
cbar= plt.colorbar(image, cax=cax)
cbar.set_label('sst')
plt.show()
```



0.0.5 Seleccionar datos para años específicos

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[63]:
```
# Seleccionar un año concreto
print(sst.sel(time='1965').squeeze().time.values)
# Seleccionar un periodo concreto
print(sst.sel(time=slice('1965','1995')).time.values)
# Seleccionar un mes concreto
print(sst.isel(time=(sst.time.dt.month == 1)).time.values)
```

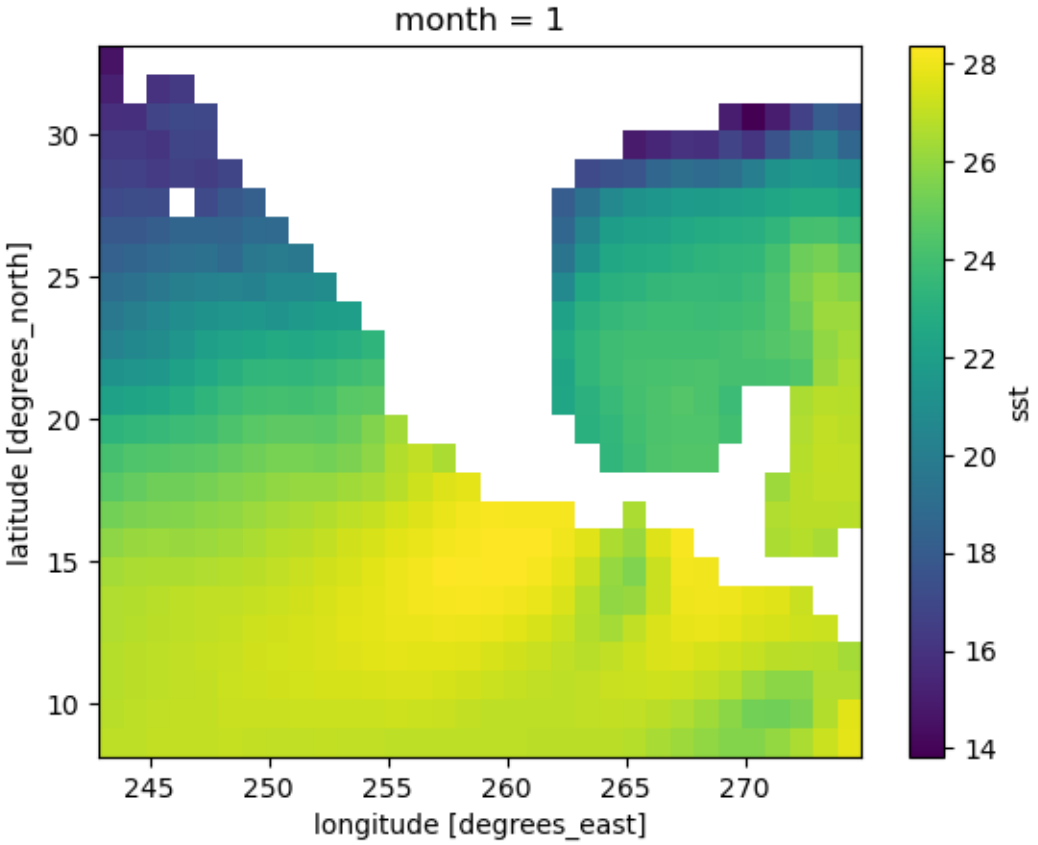
```
1965-09-01T00:00:00.000000000
['1965-09-01T00:00:00.000000000' '1969-01-01T00:00:00.000000000'
 '1972-05-01T00:00:00.000000000' '1975-09-01T00:00:00.000000000'
 '1979-01-01T00:00:00.000000000' '1982-05-01T00:00:00.000000000'
 '1985-09-01T00:00:00.000000000' '1989-01-01T00:00:00.000000000'
 '1992-05-01T00:00:00.000000000' '1995-09-01T00:00:00.000000000']
```

```
['1959-01-01T00:00:00.000000000' '1969-01-01T00:00:00.000000000'
 '1979-01-01T00:00:00.000000000' '1989-01-01T00:00:00.000000000'
 '1999-01-01T00:00:00.000000000' '2009-01-01T00:00:00.000000000'
 '2019-01-01T00:00:00.000000000']
```

0.0.6 Agrupar por mes

---

[72]:
```
sst.groupby("time.month") # Lo que significa es que tenemos datos de los meses␣
 ↪1, 5 y 9
#sst.groupby("time.year")
sst.groupby("time.month").mean().sel(month=1).plot(); # Así graficamos los␣
 ↪datos del mes
```



0.0.7 Agrupar por estación

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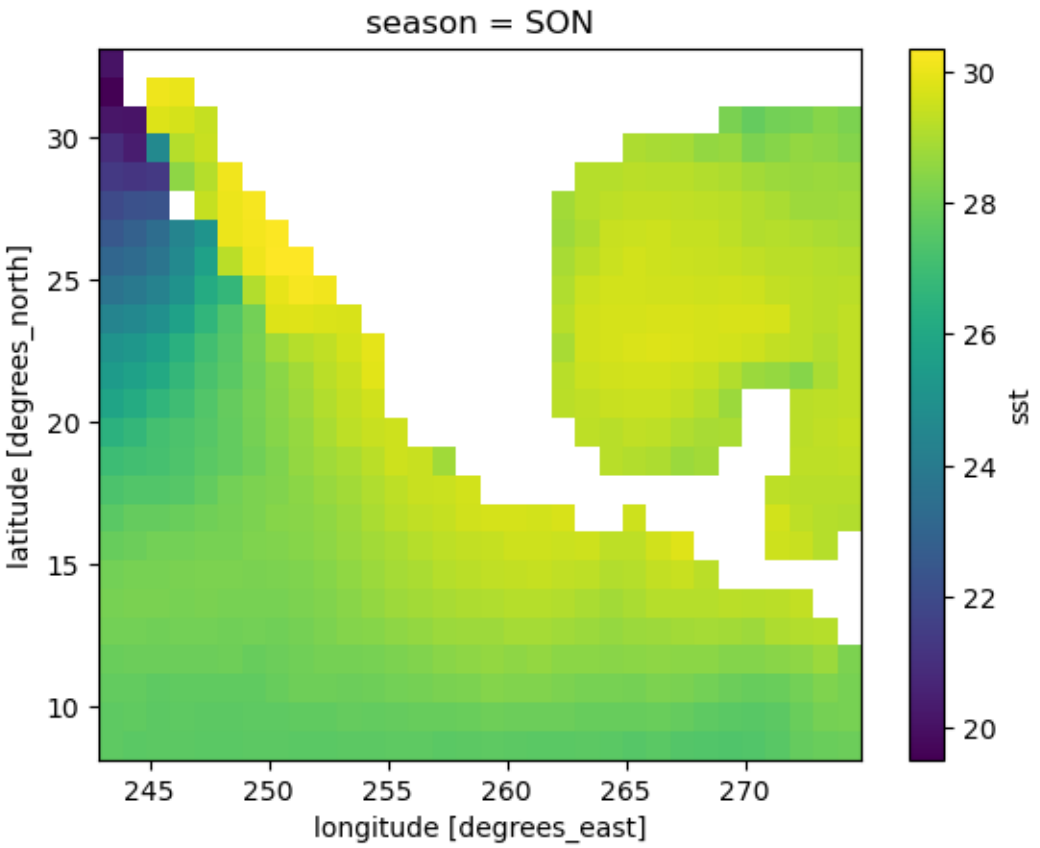
[71]:
```
sst.groupby("time.season").mean().isel(season=2).plot();
```



0.0.8 Función resample

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[73]:
```
sst.resample(time='1YE').mean() # 'S' usa el inicio del año, y 'E' el final
```

[73]:
```
<xarray.DataArray 'sst' (time: 61, latitude: 25, longitude: 32)> Size: 390kB
array([[[15.43694278,         nan,         nan, …,         nan,
                 nan,         nan],
        [16.63696362,         nan, 17.77837162, …,         nan,
                 nan,         nan],
        [17.45384156, 16.81218517, 19.00245457, …, 15.84476477,
         17.32119144, 16.54688494],
        …,
        [26.70294818, 26.91518837, 26.89667905, …, 26.53204547,
         27.42913046, 27.5747371 ],
        [26.93184676, 26.9960124 , 27.08300619, …, 26.69616143,
         27.80116777, 28.51994631],
        [27.18357349, 27.224294  , 27.2458882 , …, 27.18357349,
         27.99983445, 28.528584  ]],
```

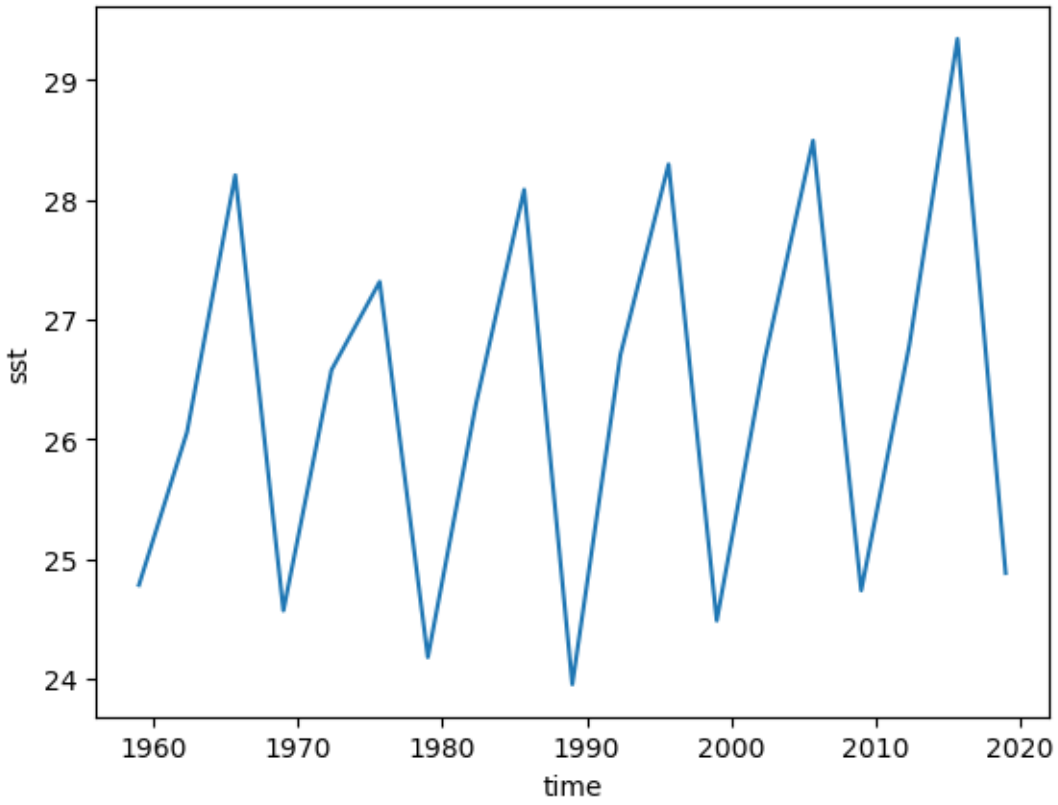
```
        [[        nan,         nan,         nan, …,         nan,
                  nan,         nan],
         [        nan,         nan,         nan, …,         nan,
                  nan,         nan],
         [        nan,         nan,         nan, …,         nan,
                  nan,         nan],
…
         [        nan,         nan,         nan, …,         nan,
                  nan,         nan],
         [        nan,         nan,         nan, …,         nan,
                  nan,         nan],
         [        nan,         nan,         nan, …,         nan,
                  nan,         nan]],

        [[15.08835061,         nan,         nan, …,         nan,
                  nan,         nan],
         [15.74481445,         nan, 16.18471926, …,         nan,
                  nan,         nan],
         [16.62770896, 16.42657436, 17.39893058, …, 16.28898843,
          17.95667805, 17.14103407],
         …,
         [26.97935401, 27.07930433, 27.13236438, …, 26.13471209,
          27.0990476 , 26.6208902 ],
         [27.07128363, 27.15642649, 27.19591304, …, 26.57214899,
          27.68517603, 28.40395458],
         [27.22799586, 27.2594617 , 27.28105591, …, 28.07942453,
          28.47367302, 28.74267512]]], shape=(61, 25, 32))
Coordinates:
  * latitude   (latitude) float32 100B 32.62 31.62 30.62 … 10.62 9.625 8.625
  * longitude  (longitude) float32 128B 243.4 244.4 245.4 … 272.4 273.4 274.4
  * time       (time) datetime64[ns] 488B 1959-12-31 1960-12-31 … 2019-12-31
```

[74]:
```
sst.resample(time='1MS').mean().time # ¿En qué se diferencia de groupby?
```

[74]:
```
<xarray.DataArray 'time' (time: 721)> Size: 6kB
array(['1959-01-01T00:00:00.000000000', '1959-02-01T00:00:00.000000000',
       '1959-03-01T00:00:00.000000000', …, '2018-11-01T00:00:00.000000000',
       '2018-12-01T00:00:00.000000000', '2019-01-01T00:00:00.000000000'],
      shape=(721,), dtype='datetime64[ns]')
Coordinates:
  * time     (time) datetime64[ns] 6kB 1959-01-01 1959-02-01 … 2019-01-01
Attributes:
    long_name:  time
```

0.0.9 Grafica la SST media (anual) en el periodo

[77]:
```
sst_media = sst.mean(dim=['latitude','longitude'])
sst_media.plot();
```



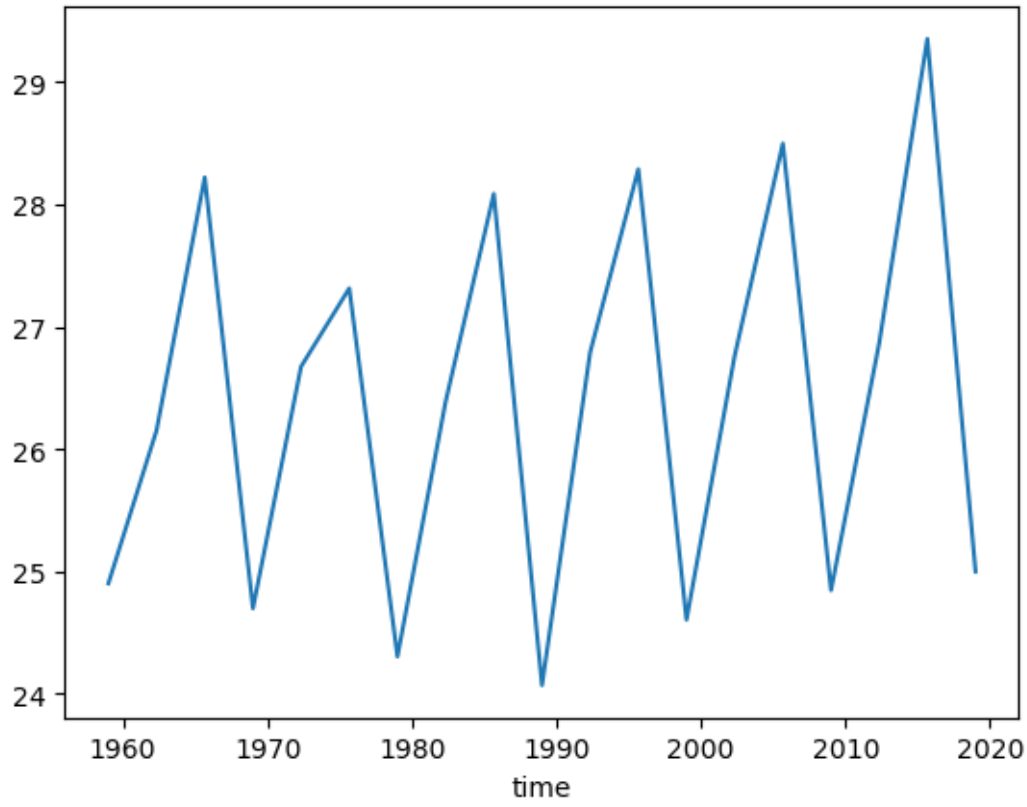
0.0.10 La media ponderada (tiene en cuenta el tamaño de cada pixel)

[ ]:
```
try:
    sst.to_netcdf('data/sst.nc')
    result = subprocess.run(["cdo", "gridarea", 'data/sst.nc', 'data/sst_grid.
 ↪nc'],capture_output=True, text=True, check=True)
    if result.returncode == 0:
        print("CDO ejecutado exitosamente")
except subprocess.CalledProcessError as e:
    print(f"Error en CDO: {e.stderr}")
except Exception as e:
    print(f"Error: {e}")
```

```
CDO ejecutado exitosamente
```

[90]:
```
sst_area = xr.open_dataset("data/sst_grid.nc")
areacello = (sst_area.cell_area * sst[0].notnull())
w = areacello/areacello.sum()
```

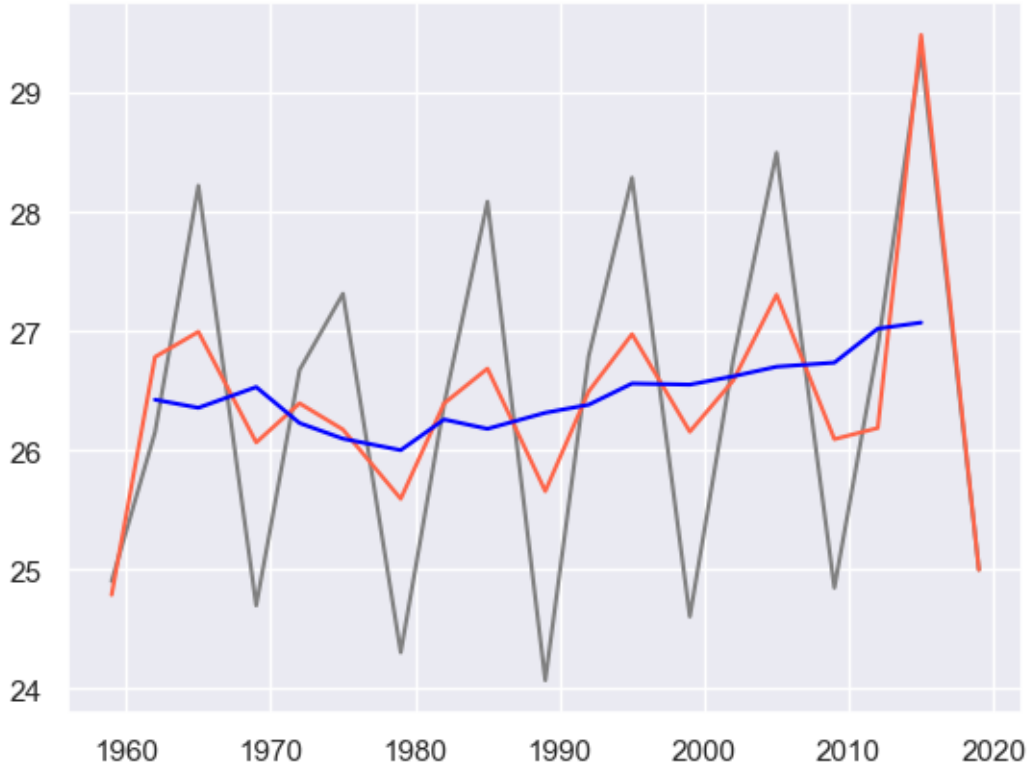
[91]:
```
sst_media_pond = (sst * w).sum(dim=['latitude','longitude'])
sst_media_pond.plot();
```



0.0.11 Suavizar la serie temporal

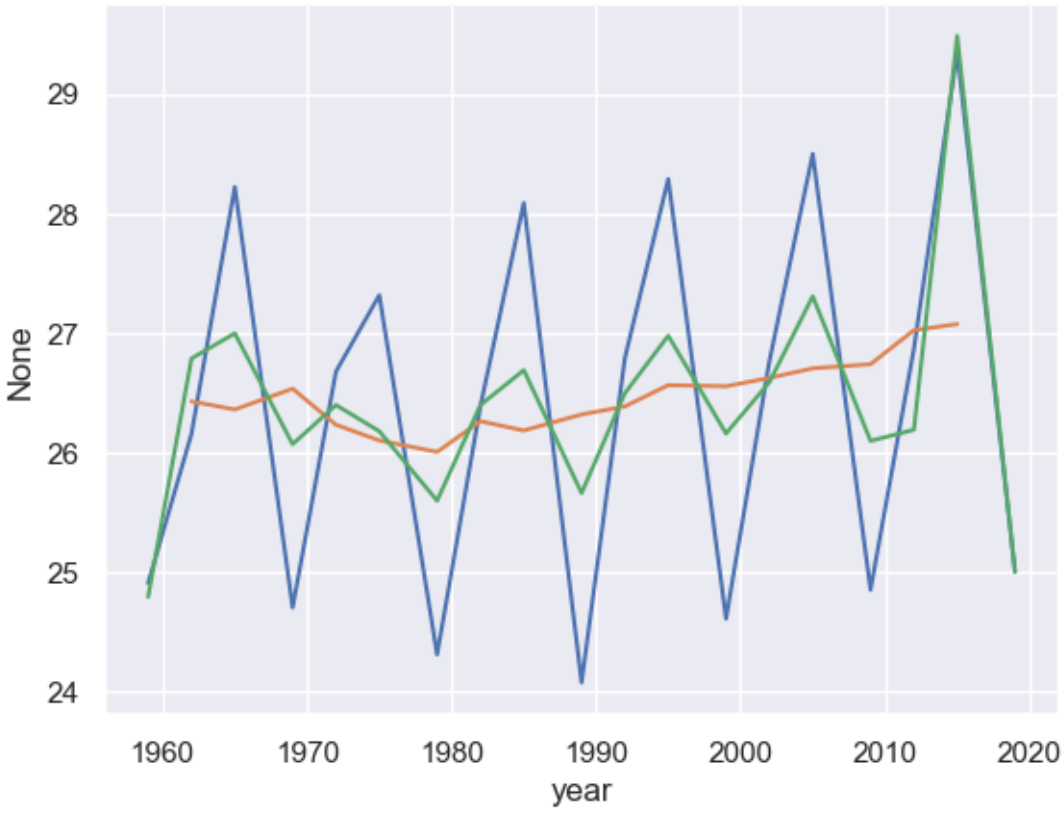
[ ]:
```
xs = sst_media_pond.time.dt.year # vector of time in years
movavg_sst_media_pond = sst_media_pond.rolling(time=3,center=True).mean()␣
 ↪#Elijo 3 ya que cada punto se diferencia unos 3 años
# Otros métodos que exigen interpolación: ejemplo de la Spline
# Creating a spline regression model of current Tmax
spl_sst_media_pond = UnivariateSpline(xs, sst_media_pond.values,k=4)  # 4␣
 ↪Degrees of freedom
fig, ax = plt.subplots()
plt.plot(xs,sst_media_pond,'grey')
plt.plot(xs,spl_sst_media_pond(xs),'tomato')
```

```
plt.plot(xs,movavg_sst_media_pond,'blue')
plt.show()
```



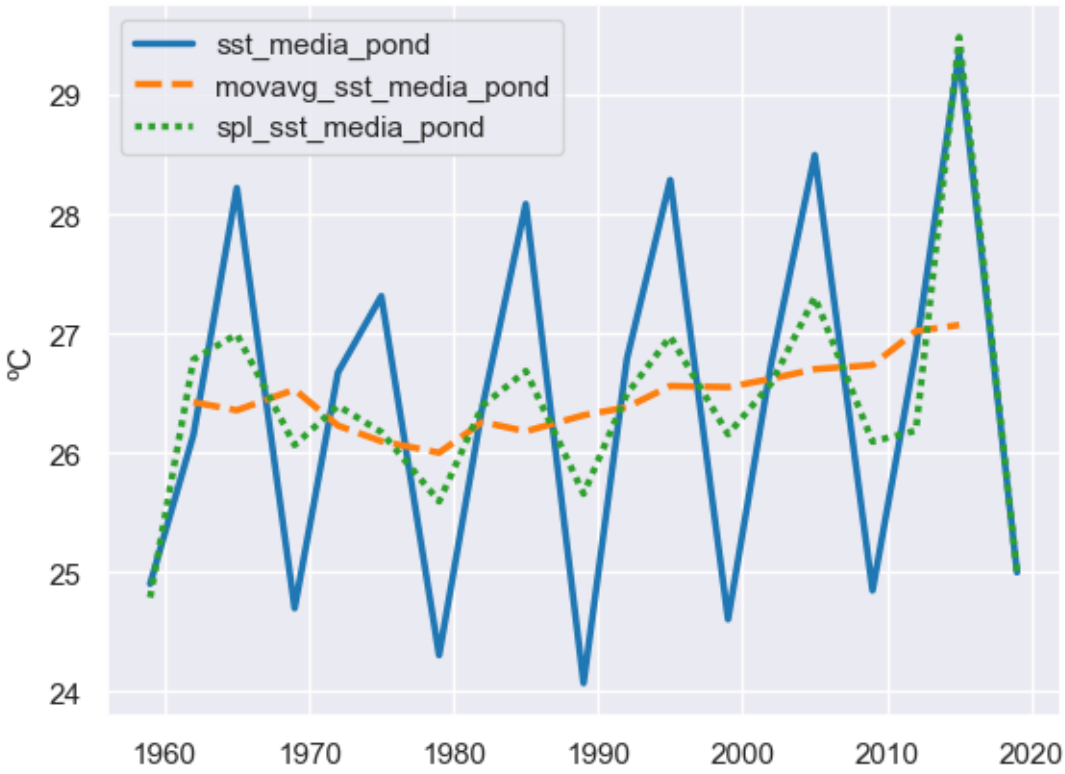
0.0.12 Gráfica con Seaborn

[96]:
```
sns.set_theme(style="darkgrid")
sns.lineplot(y=sst_media_pond,x=xs)
sns.lineplot(y=movavg_sst_media_pond,x=xs)
sns.lineplot(y=spl_sst_media_pond(xs),x=xs);
```



0.0.13 Crear dataframe con pandas y graficar

[100]:
```
values = {'sst_media_pond': sst_media_pond,
          'movavg_sst_media_pond': movavg_sst_media_pond,
          'spl_sst_media_pond': spl_sst_media_pond(xs),
         }
df = pd.DataFrame(values,index=xs)
df.head()
fig, ax = plt.subplots()
sns.set_theme(style="darkgrid")
sns.lineplot(data=df, palette="tab10", linewidth=2.5,)
plt.ylabel('ºC')
plt.show()
```


sst_media_pond
movavg_sst_media_pond
spl_sst_media_pond
°C
29
28
27
26
25
24
1960
1970
1980
1990
2000
2010
2020