**Application of Open-source Tools**

*SST variability using satellite-derived data*

Sea surface temperature (SST) plays an important role in the hydrological cycle, density and water mass formation, ocean circulation, air-sea interactions, and marine productivity. For marine productivity, SST is one of the proxies used to study and track upwelling. Coastal upwelling is an important oceanographic and biological occurrence for the West Africa, Gulf of Guinea (GoG) subregion. It enhances biological productivity as nutrient-rich subsurface waters are brought to the surface ocean. As the water becomes more productive, abundance of fish, mainly *Sardinella aurita*, increases. Upwelling of subsurface waters has surface signatures such as cold waters, low sea surface heights, high chlorophyll, and high sea surface salinity.

This exercise examines the variability of SST in the NW GoG. In this lab exercise, we will be plotting SST in the Equatorial Atlantic Ocean and the GoG during the winter season (January) and summer season (August) using the Python program. The SST data is from the OSTIA product. The Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA) analysis uses satellite data from sensors that include the Advanced Very High-Resolution Radiometer (AVHRR), the Advanced Along Track Scanning Radiometer (AATSR), the Spinning Enhanced Visible and Infrared Imager (SEVIRI), the Advanced Microwave Scanning Radiometer-EOS (AMSRE), the Tropical Rainfall Measuring Mission Microwave Imager (TMI), and in situ data from drifting and moored buoys. We will then discuss the possible causes of the differences in SSS during the seasons.

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1. Open your python program
2. Change the first line to point to your directory where the data is stored on your computer.

datadir=r'PASTE YOUR DIRECTORY PATH ON THIS LINE/'

1. The first set of command lines identifies your data directory and import your python tool packages.

The second set of command lines load the data.

The third set of command lines plots the January SST.

The fourth set of command lines plots the August SST.

The fifth set of command lines plots the time series of the seasonal anomalies in the Gulf of Guinea.

Seasonal anomalies are gotten by removing the annual mean from the monthly values. We do this to see how the monthly values differ with respect to the annual mean. A positive number means the value for that month is higher than the annual mean. A negative number means the value for that month is lower than the annual mean. A zero means the value for that month is the same as the annual mean.

1. The last line in the set of commands saves the figure you just made in your directory.

i.e. Fig\_SST\_JanAug\_SeasAnom\_TimeSeries.tif

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datadir = r'C:\Users\ebenezer\Documents\MyRes\Meetings\GeoBluePlanet2022\ppt\Lab/'

%**matplotlib** inline

**import numpy as np**

**import matplotlib.pyplot as plt**

**import pandas as pd**

lon = pd.read\_csv(datadir+'ostia.atl.sst.lon.dat',header=None)

lat = pd.read\_csv(datadir+'ostia.atl.sst.lat.dat',header=**None**)

tjan = pd.read\_csv(datadir+'ostia.atl.sst.mean.Jan.dat',header=**None**)

taug = pd.read\_csv(datadir+'ostia.atl.sst.mean.Aug.dat',header=**None**)

data = pd.read\_csv(datadir+'ostia.atl.sst.Jan93Dec15.TimeSeries.SeasAnom.dat',header=**None**)

ctime = np.arange(12)

plt.figure(figsize=(12,8))

plt.subplot(221)

X,Y = np.meshgrid(lon,lat)

plt.pcolor(X,Y,tjan,cmap='jet',vmin=10,vmax=30)

plt.yticks(FontSize=12)

plt.xticks(FontSize=12)

plt.text(-55,-15,'(a)',FontSize=22,FontWeight='bold',FontName='Times New Roman')

plt.text(5,15,'Jan',FontSize=22,FontWeight='bold',FontName='Times New Roman')

rectangle = plt.Rectangle((-10,3), 14, 7, fc='none',ec="black", LineStyle='dashed', LineWidth=4)

plt.gca().add\_patch(rectangle)

plt.subplot(222)

plt.pcolor(X,Y,taug,cmap='jet',vmin=10,vmax=30)

plt.yticks(FontSize=12)

plt.xticks(FontSize=12)

plt.text(-55,-15,'(b)',FontSize=22,FontWeight='bold',FontName='Times New Roman')

plt.text(5,15,'Aug',FontSize=22,FontWeight='bold',FontName='Times New Roman')

plt.colorbar()

plt.subplot(2,2,(3,4))

plt.plot(ctime,data,LineWidth=4,color='k')

plt.axhline(0,LineStyle='dashed',color='grey')

plt.grid()

plt.ylim(-2.5,2.5)

xlabels = ['Jan','Feb','Mar','Apr','May','Jun','Jul','Aug','Sep','Oct','Nov','Dec']

plt.xticks(np.arange(12),xlabels,FontSize=14)

plt.xlim(0,11)

plt.yticks(FontSize=12)

plt.ylabel('SST (oC)',FontSize=14)

plt.text(0.5,2.0,'Seas Anom',FontSize=22,FontWeight='bold',FontName='Times New Roman')

plt.text(0.3,-2.5,'(c)',FontSize=22,FontWeight='bold',FontName='Times New Roman')

plt.savefig(datadir+'Fig\_SST\_JanAug\_SeasAnom\_TimeSeries.tif')