COESSING 2020
Satellite Oceanography Lab

To count this lab exercise towards your COESSING certificate, please take a screenshot of the plot completed (or the saved figure : Fig_SSS_JanAug_SeasAnom_TimeSeries.tif) and send it via direct message to Eben Nyadjro.

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Ocean salinity plays an important role in the hydrological cycle, density and water mass formation, ocean circulation and air-sea interactions.

Changes in sea surface salinity (SSS) are caused by variations in evaporation (E), precipitation (P) and river runoff (R) into the ocean. When E is greater than P+R, SSS goes higher. Likewise, when P+R is greater than E, the SSS becomes lower.

In this lab exercise, we will be plotting SSS in the Equatorial Atlantic Ocean and the Gulf of Guinea (GoG) during the winter season (January) and summer season (August) using the Python program. The SSS data is from the Soil Moisture Active Passive (SMAP) satellite. We will then discuss the possible causes of the differences in SSS during the seasons.

An extensive lesson on salinity in the GoG is available in #proj-remote-sensing-salt folder on the Slack platform.
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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/'
3. The first set of command lines load the data.
    The second set of command lines plots the January SSS.
    The third set of command lines plots the August SSS.
    The fourth 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.
4. The last line in the set of commands saves the figure you just made in your directory.
    i.e. Fig_SSS_JanAug_SeasAnom_TimeSeries.tif

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Please answer the following questions.
In the figure you just plotted, the redder the color, the saltier the water is. The bluer the color, the fresher the water is.

1. What are the differences between the SSS in January and August, especially in the region between latitude 10N and 10S? The latitude is the vertical (x-axis) and the longitude is the horizontal (y-axis).
2. What could be the possible reasons for the lower SSS in the Congo region during January?
3. Plot (c) shows the seasonal anomalies. This is a box average of SSS anomalies in the region bordering from approximately Ivory Coast to Benin. What are the possible causes for the low salinity during the summer months of June-September? (Hint- upwelling).
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```python
datadir = r'C:\Users\enyad\Documents\MyEdu\SummerSch\UG2020\lab\SatLabEx_Py/'
%matplotlib inline
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
lon = pd.read_csv(datadir+'smap.atl.lon.dat',header=None)
lat = pd.read_csv(datadir+'smap.atl.lat.dat',header=None)
tjan = pd.read_csv(datadir+'smap.atl.sss.Jan2017.dat',header=None)
taug = pd.read_csv(datadir+'smap.atl.sss.Aug2017.dat',header=None)
data = pd.read_csv(datadir+'smap.nwgog.sss.Jan16Dec18.TimeSeries.SeasAnom.dat',header=None)
data = data.drop(columns=0)
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=32,vmax=38)
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')
plt.colorbar()


plt.subplot(222)
plt.pcolor(X,Y,taug,cmap='jet',vmin=32,vmax=38)
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(-0.8,0.8)
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('SSS (psu)',FontSize=14)
plt.text(0.5,.6,'Seas Anom',FontSize=22,FontWeight='bold',FontName='Times New Roman')
plt.text(0.3,-.75,'(c)',FontSize=22,FontWeight='bold',FontName='Times New Roman')
plt.savefig(datadir+'Fig_SSS_JanAug_SeasAnom_TimeSeries.tif')
```