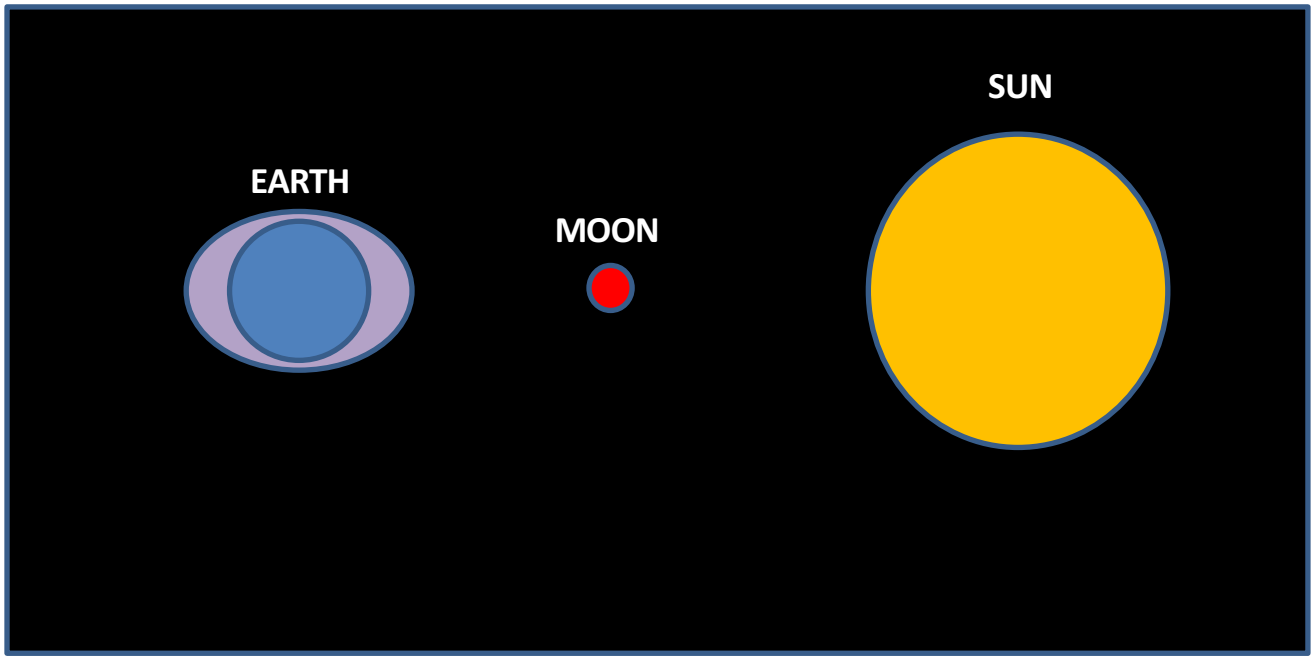
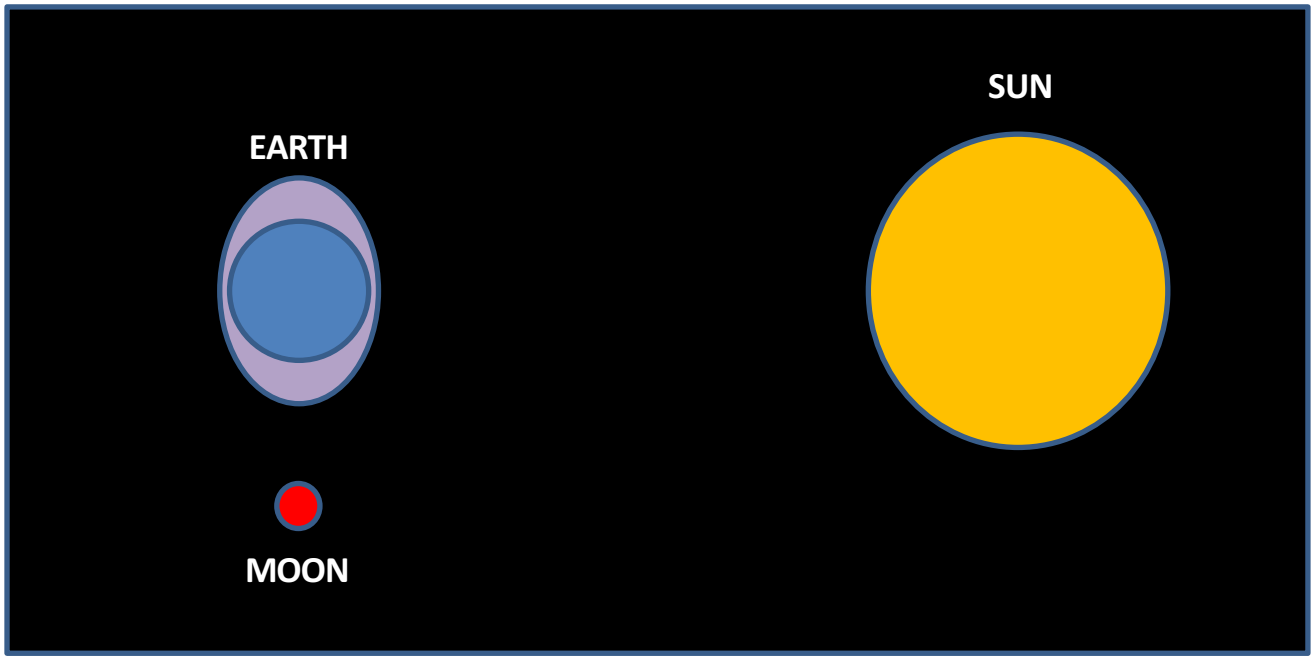
TIDAL GROUP COESSING, 2018

- Group members
  - Jonathan Fafa
  - Alabi Benjamin O.
  - Oladipo, Mumin O.
- **Instructors:**
  - Professor Brain Arbic
  - Paige Martin
  - Maddie Foster-Martinez
  - Christian Buckingham

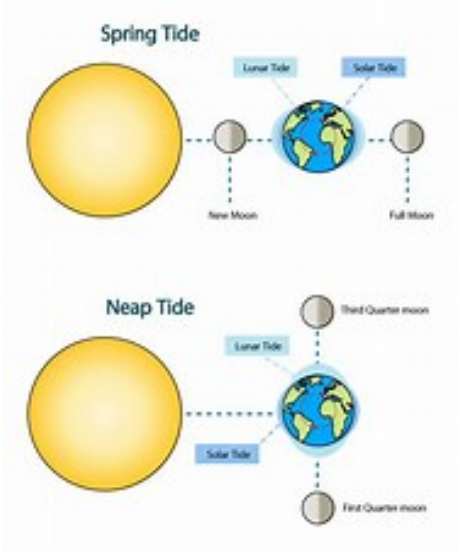
SPRING TIDE



NEAP TIDE



Both SPRING AND NEAP TIDES



In [46]:
```
from netCDF4 import Dataset
import matplotlib.pyplot as plt
%matplotlib inline
import csv
import numpy as np
from utide import solve, reconstruct
```

import data

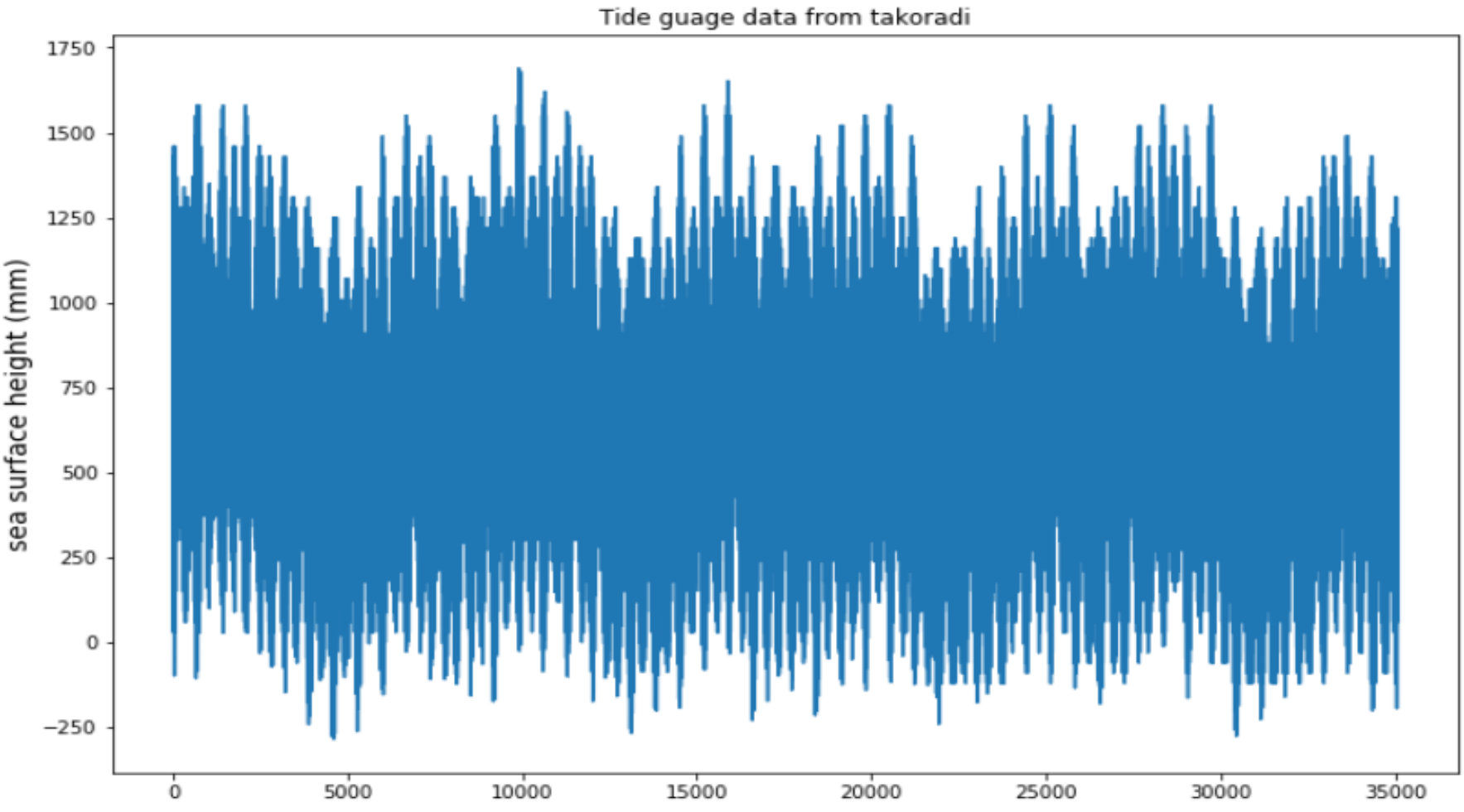
In [13]:
```
datadir = r"C:\Users\Jojo\Desktop\pendrive\Takoradi_data_from_Stephan/"
reader = csv.reader(open(datadir+"h231a.csv","r"), delimiter=",")
data_list = list(reader)
data = np.array(data_list).astype("int")
print(data.shape)
print(data[:30,:])
```

```
(35064, 5)
[[1983    1    1    0  270]
 [1983    1    1    1  520]
 [1983    1    1    2  790]
 [1983    1    1    3 1070]
 [1983    1    1    4 1310]
 [1983    1    1    5 1430]
 [1983    1    1    6 1430]
 [1983    1    1    7 1190]
 [1983    1    1    8  730]
 [1983    1    1    9  240]
 [1983    1    1   10   30]
 [1983    1    1   11   30]
 [1983    1    1   12   30]
```

Plot the data

In [15]:
```
ssh = data[:,4]
plt.figure(figsize=(12,8))
plt.plot(ssh)
plt.ylabel("sea surface height (mm)",fontsize=14)
plt.title("Tide guage data from takoradi")
```

Out[15]:
```
Text(0.5,1,'Tide guage data from takoradi')
```

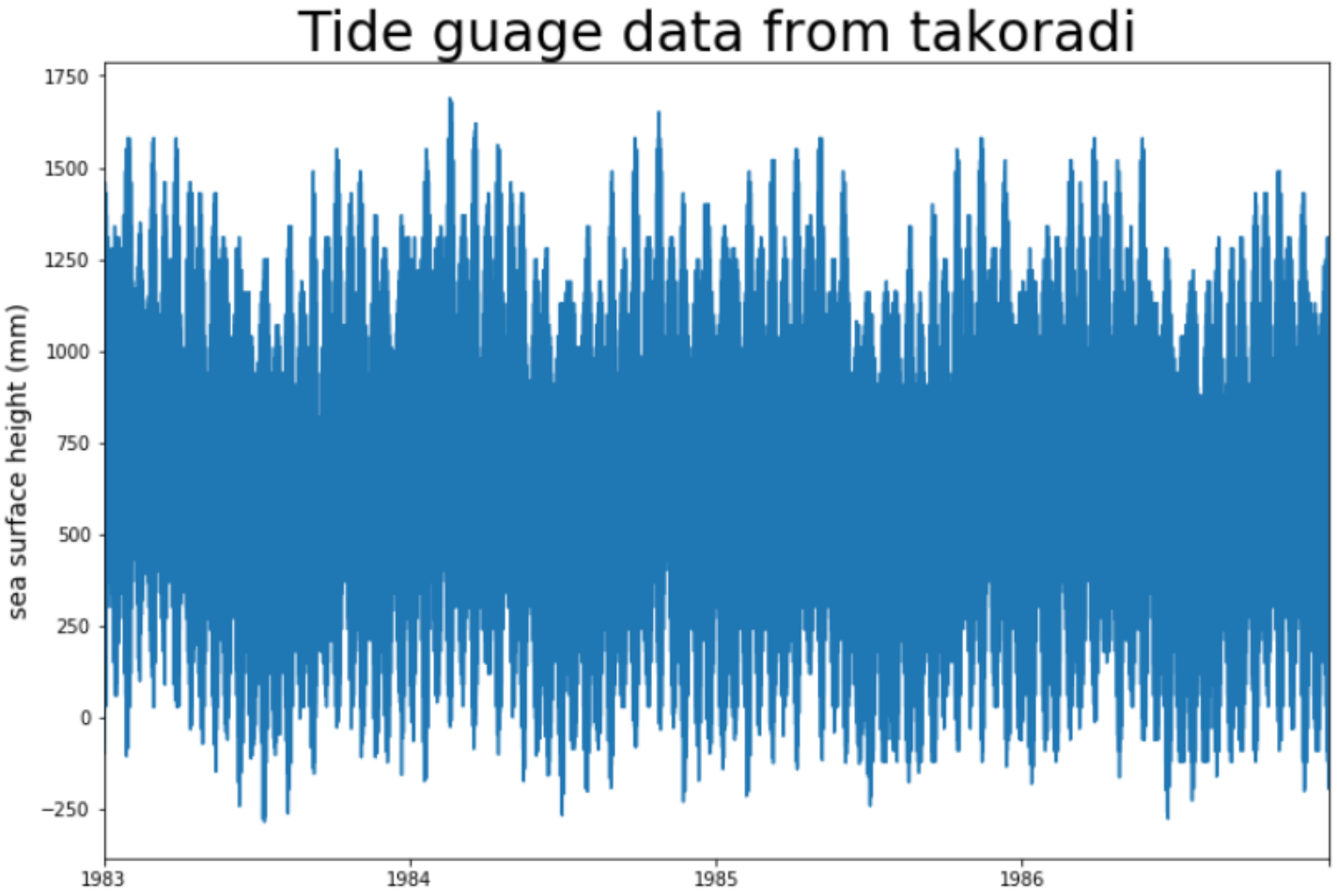

Tide guage data from takoradi
sea surface height (mm)
1750
1500
1250
1000
750
500
250
0
−250
0
5000
10000
15000
20000
25000
30000
35000

In [18]:

```
ssh = data[:,4]
years = np.arange(0,data.shape[0],(365*24))
years_labels = ["1983","1984","1985","1986"]

plt.figure(figsize=(12,8))
plt.plot(ssh)
plt.ylabel("sea surface height (mm)",fontsize=14)
plt.title("Tide guage data from takoradi",fontsize=30)
plt.xticks(years,years_labels)
plt.xlim(0,ssh.shape[0])
```

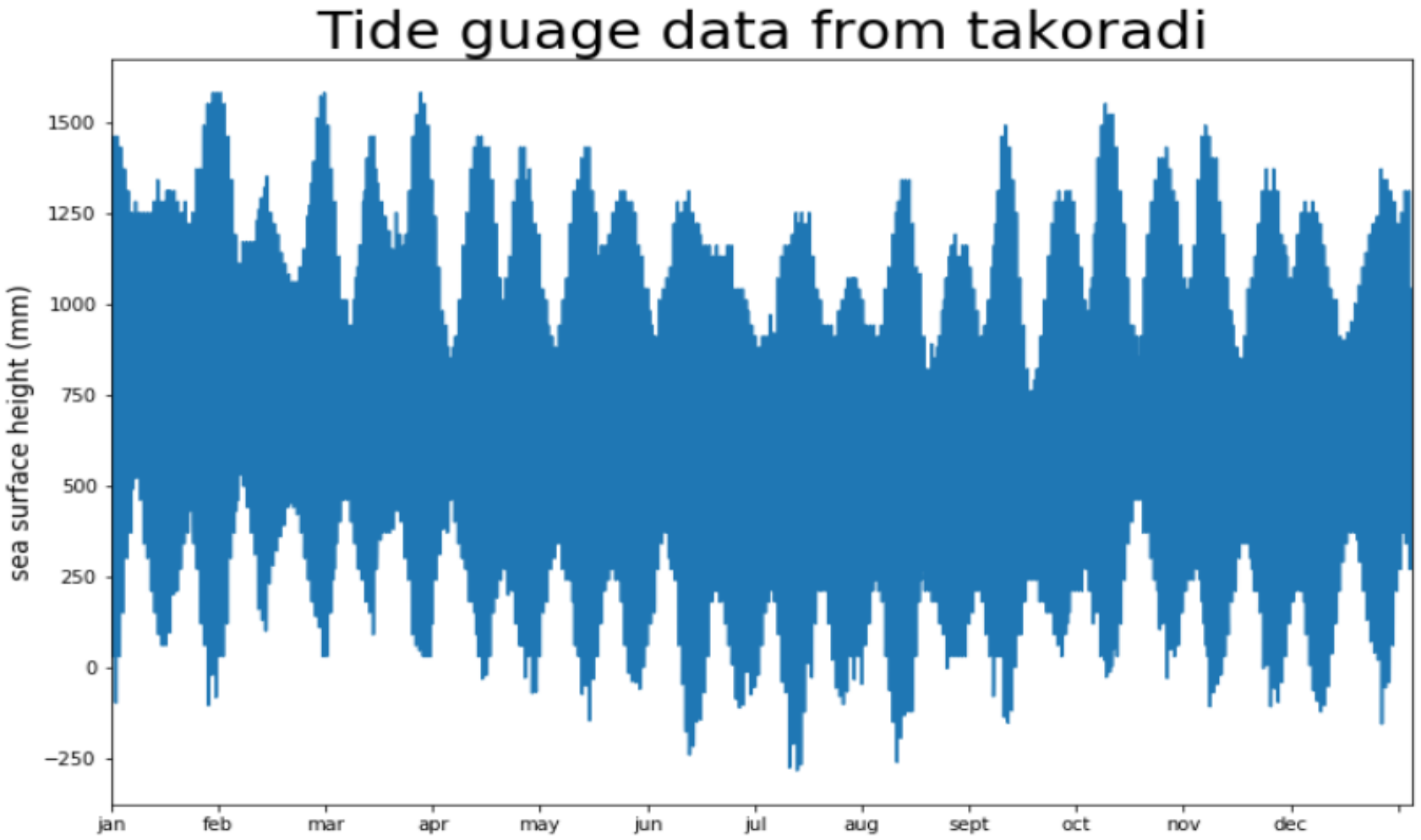
Out[18]: (0, 35064)



In [42]:
```
###### ssh = data[:(364*24),4]
months = np.arange(0,data.shape[0],(30*24))
months_labels = ["jan","feb","mar","apr","may","jun","jul","aug","sept","oct","nov","dec"]

plt.figure(figsize=(12,8))
plt.plot(ssh)
plt.ylabel("sea surface height (mm)",fontsize=14)
plt.title("Tide guage data from takoradi",fontsize=30)
plt.xticks(months,months_labels)
plt.xlim(0,ssh.shape[0])
```

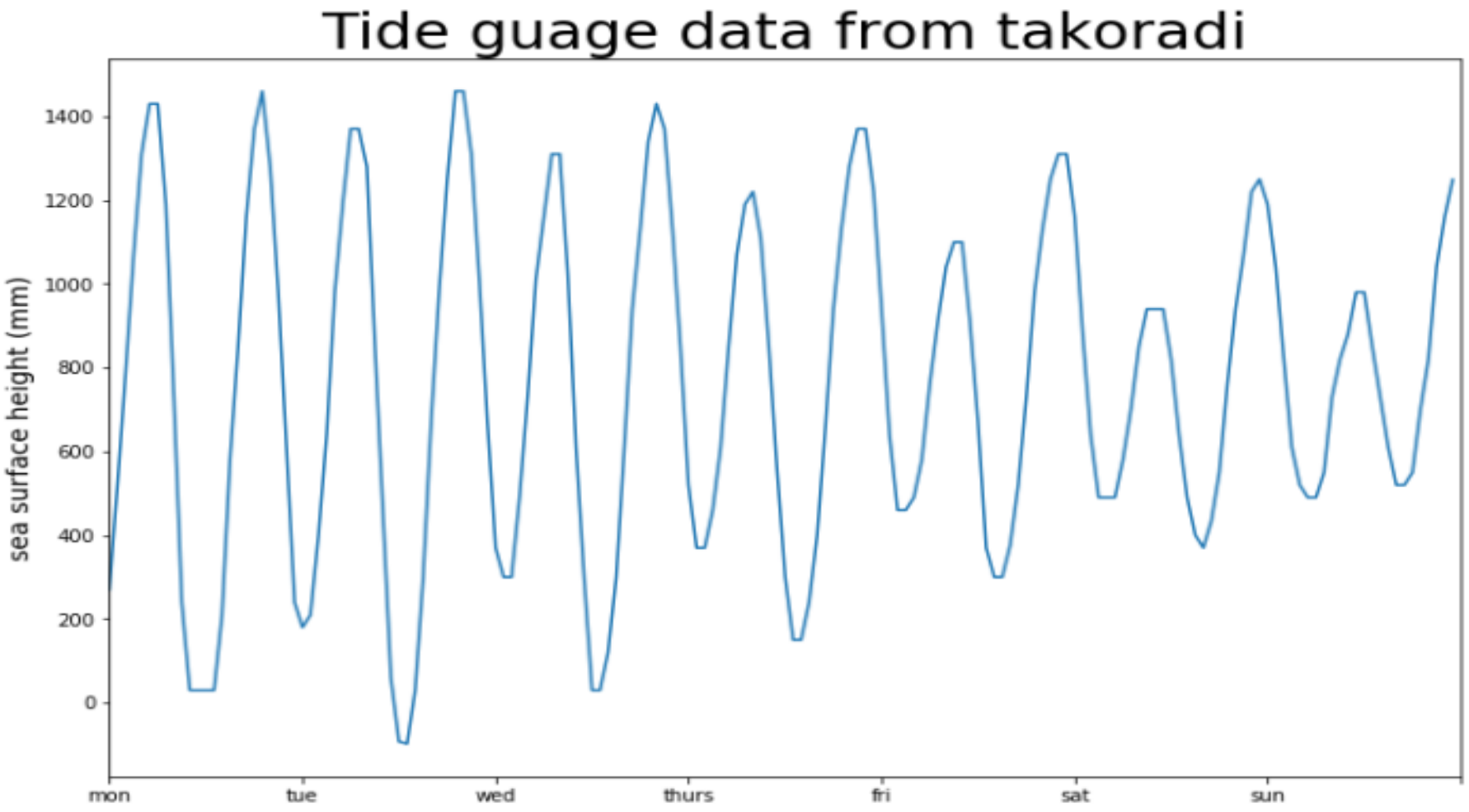
Out[42]:
```
(0, 8736)
```


Tide guage data from takoradi
sea surface height (mm)
1500
1250
1000
750
500
250
0
−250
jan
feb
mar
apr
may
jun
jul
aug
sept
oct
nov
dec

In [54]:
```
ssh = data[:(7*24),4]
days = np.arange(0,data.shape[0],(1*24))
days_labels = ["mon","tue","wed","thurs","fri","sat","sun"]

plt.figure(figsize=(12,8))
plt.plot(ssh)
plt.ylabel("sea surface height (mm)",fontsize=14)
plt.title("Tide guage data from takoradi",fontsize=30)
plt.xticks(days,days_labels)
plt.xlim(0,ssh.shape[0])
```

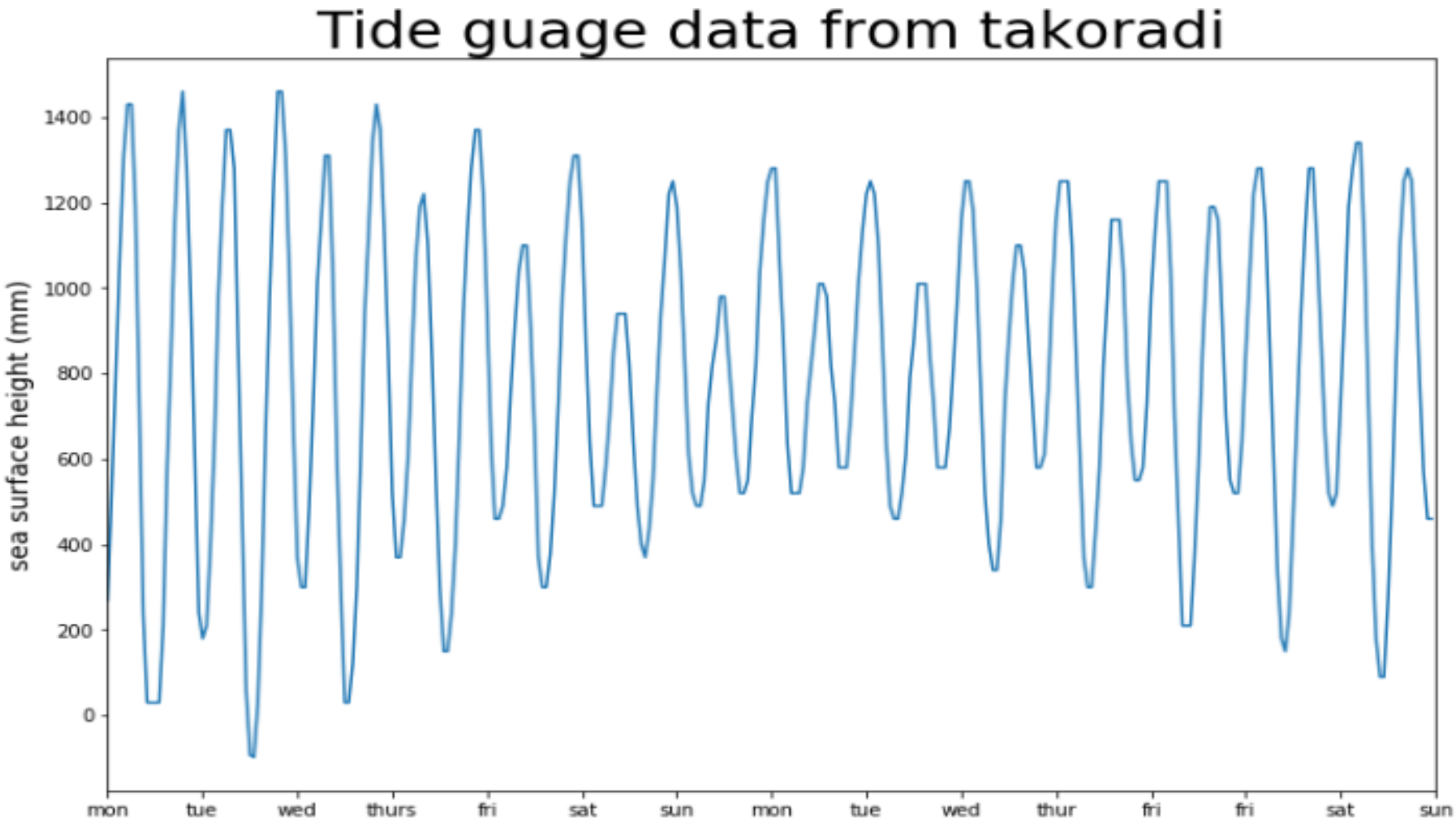
Out[54]:
```
(0, 168)
```


Tide guage data from takoradi
sea surface height (mm)
1400
1200
1000
800
600
400
200
0
mon
tue
wed
thurs
fri
sat
sun

In [55]:
```
ssh = data[:(14*24),4]
days = np.arange(0,data.shape[0],(1*24))
days_labels = ["mon","tue","wed","thurs","fri","sat","sun","mon","tue","wed","thur","fri","fri","sat","sun"]


plt.figure(figsize=(12,8))
plt.plot(ssh)
plt.ylabel("sea surface height (mm)",fontsize=14)
plt.title("Tide guage data from takoradi",fontsize=30)
plt.xticks(days,days_labels)
plt.xlim(0,ssh.shape[0])
```

Out[55]:
```
(0, 336)
```


Tide guage data from takoradi
sea surface height (mm)
1400
1200
1000
800
600
400
200
0
mon
tue
wed
thurs
fri
sat
sun
mon
tue
wed
thur
fri
fri
sat
sun

TIDE FORECAST

ALABI BENJAMIN O.

NIGERIAN METEOROLOGICAL AGENCY, ABUJA

alabibenjamin2@gmail.com

INTRODUCTION

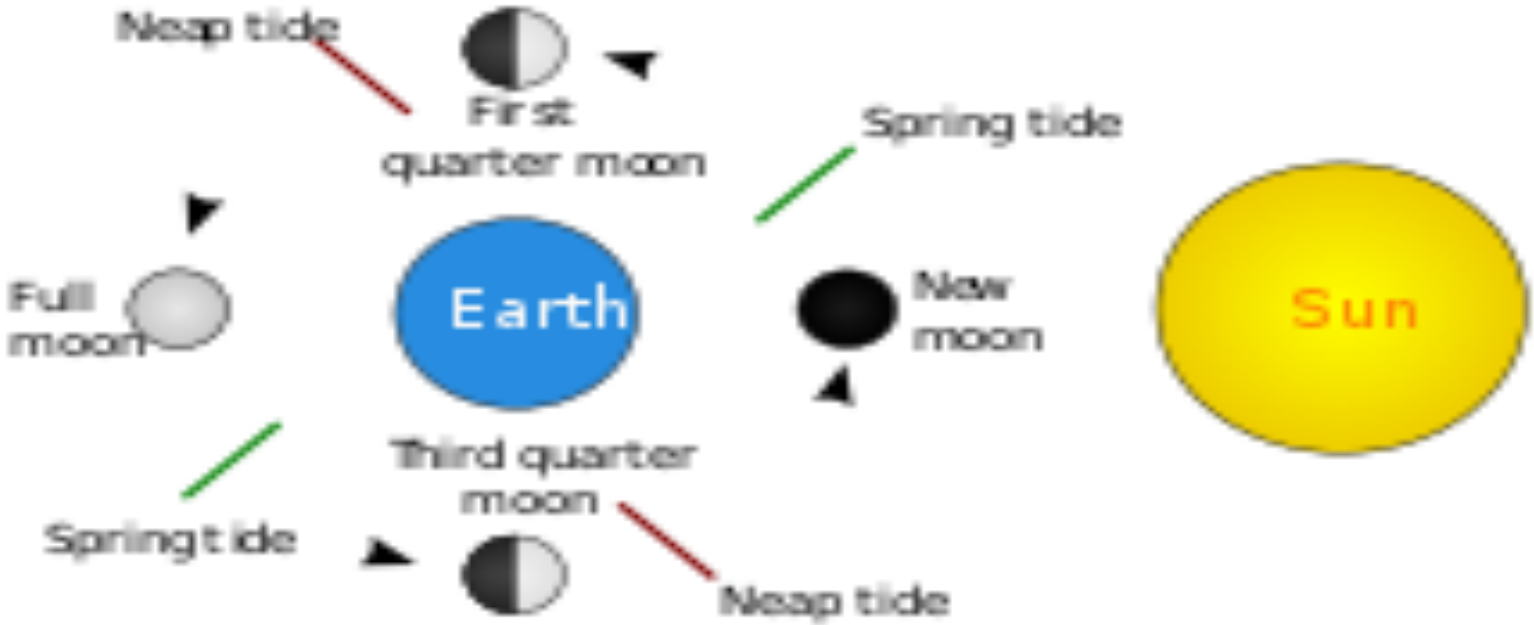
- Tides are the rise and fall of sea levels caused by the combined effects of the gravitational forces exerted by the Moon and the Sun and the rotation of Earth.
- Primary constituents include the Earth's rotation, the position of the Moon and Sun relative to the Earth, the Moon's altitude (elevation) above the Earth's equator, and bathymetry.
- To make accurate records, tide gauges at fixed stations measure water level over time. Gauges ignore variations caused by waves with periods shorter than minutes.
- Utide is the tidal analysis toolbox which uses harmonic analysis to predict tides.
- Tidal phenomena are not limited to the oceans, but can occur in other systems whenever a gravitational field that varies in time and space is present.

AREAS OF TIDES

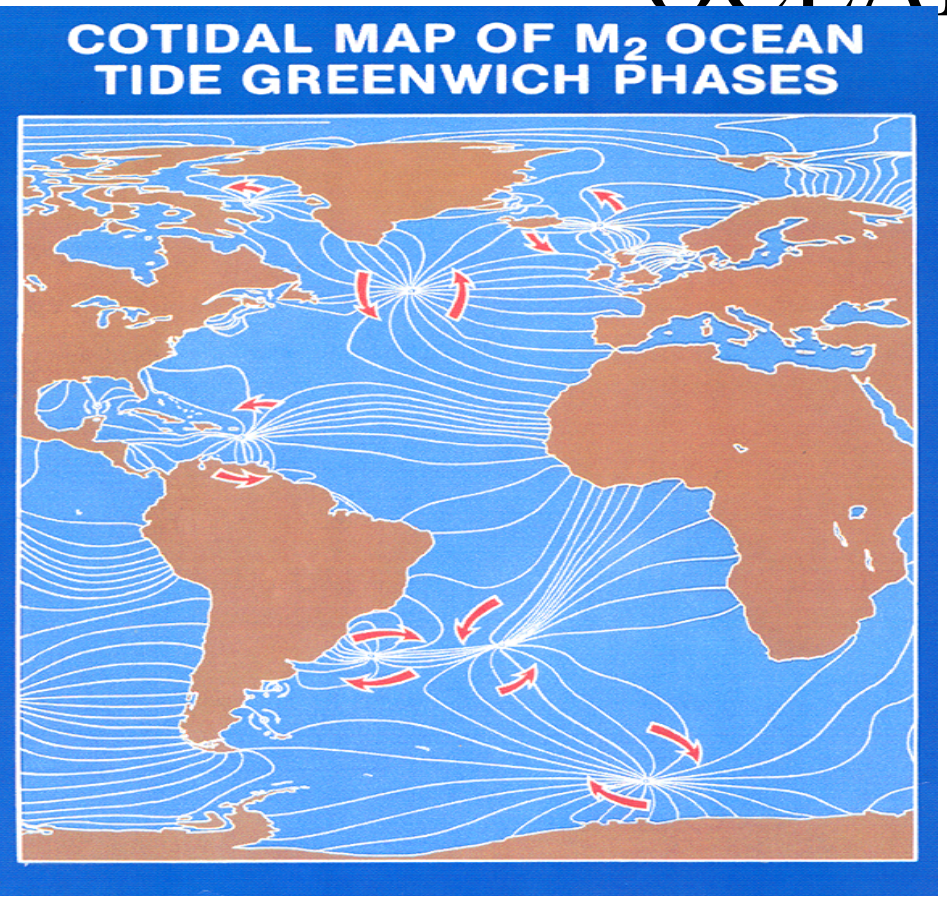
High tide, Alma, New Brunswick in the Bay of Fundy, 1972

Low tide at the same fishing port in Bay of Fundy, 1972

VARIATION OF TIDES



PHASES AND AMPLITUDES OF OCEAN TIDE



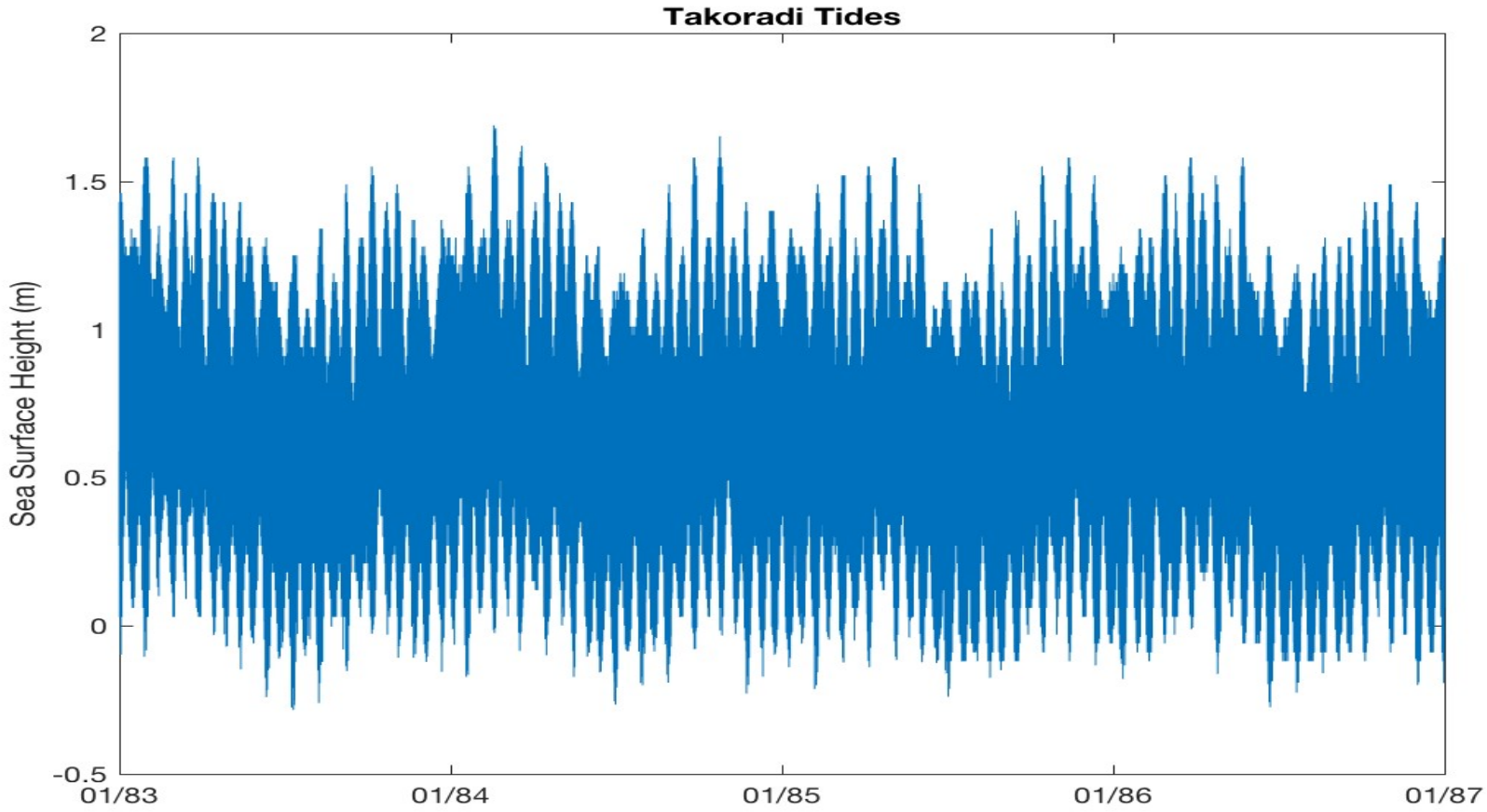


Fig. 2: Time Series of Takoradi Tides

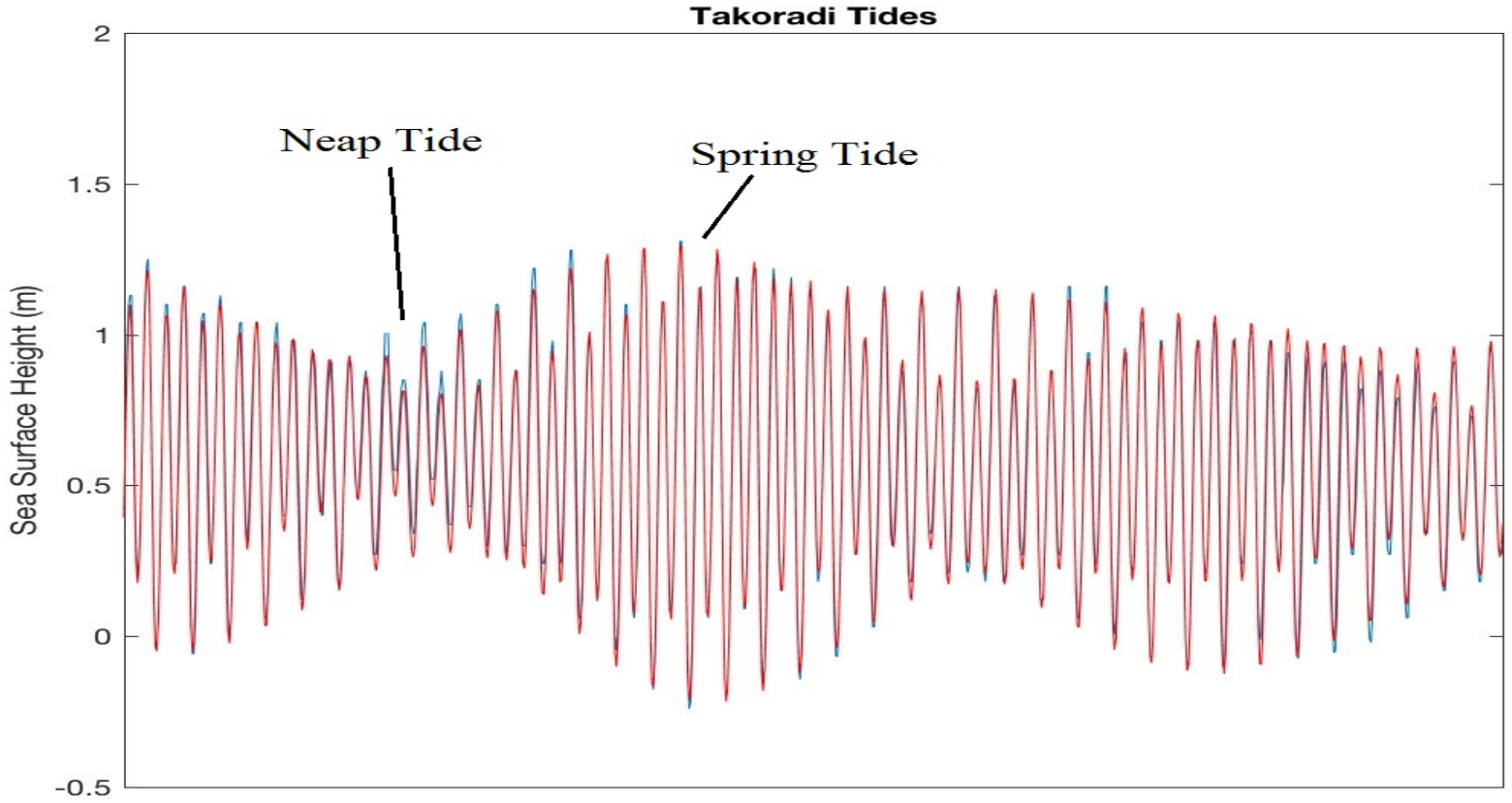


Fig. 3: Tides Variation

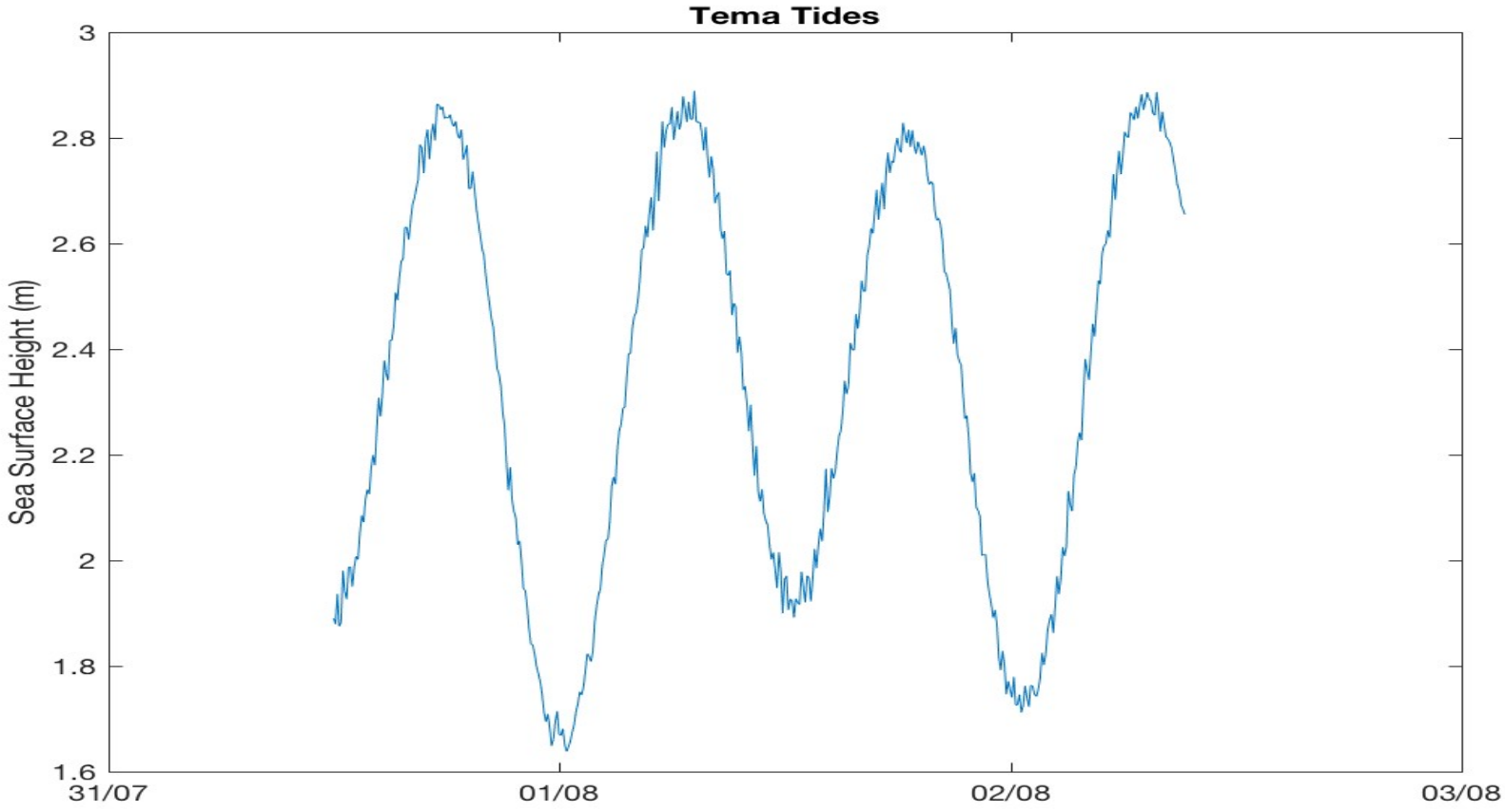


Fig. 3: Time Series of Tema Tides

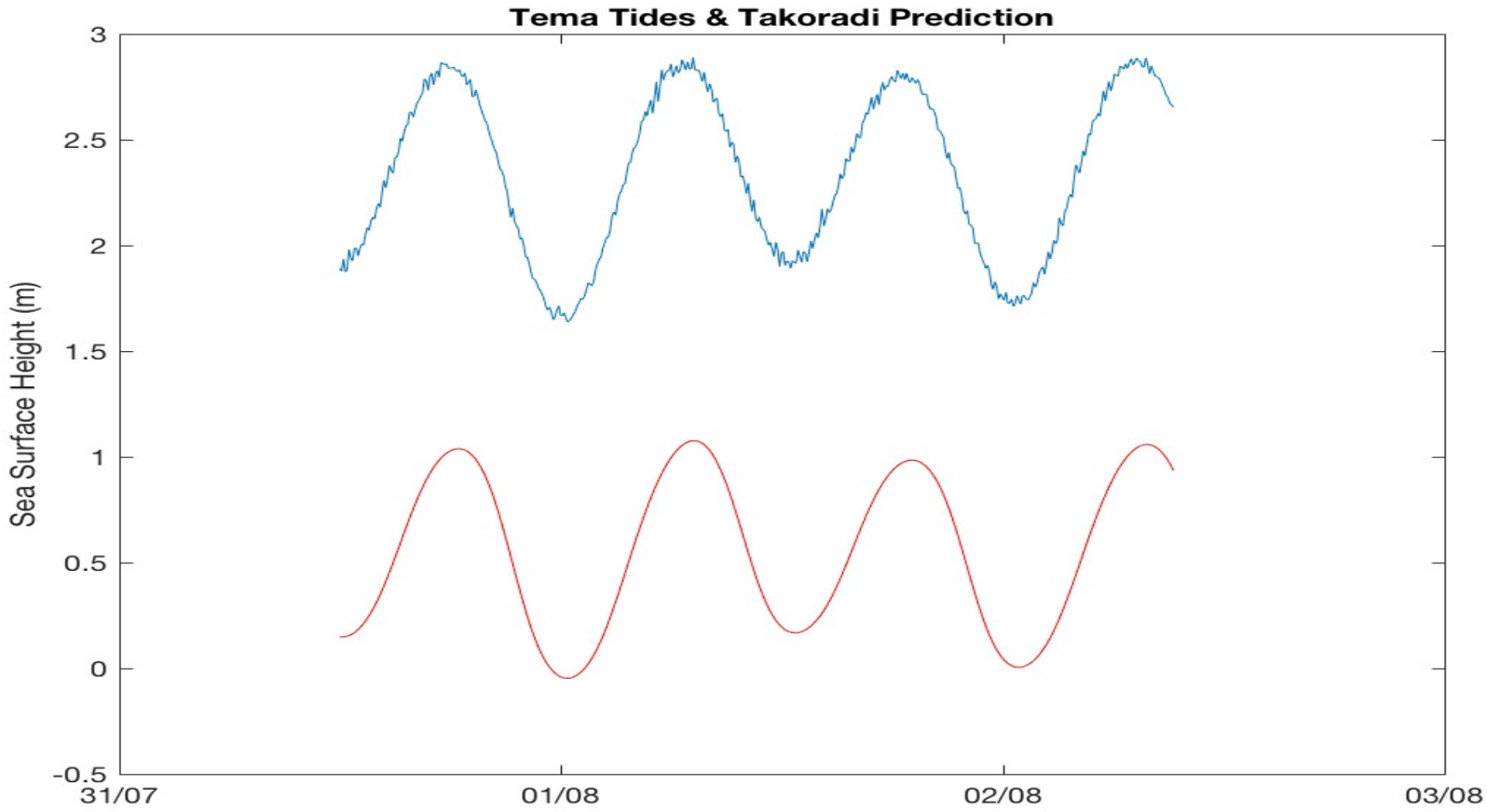


Fig. 3: Time Series of Tema Tides and Takoradi Forecast

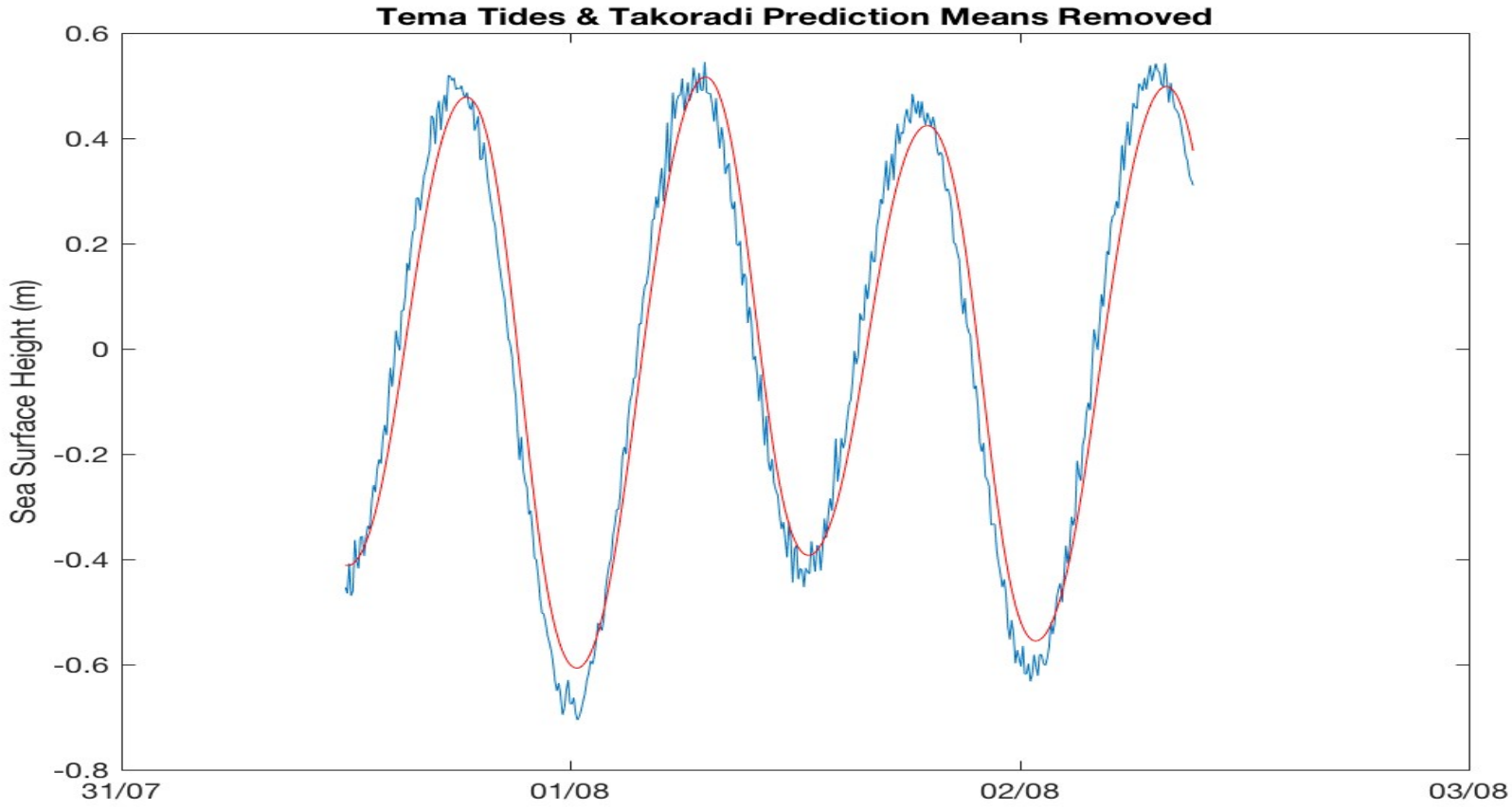


Fig. 3: Tema Tides and Takoradi Forecast Profiles

PLOTTING CSV FILE USING PYTHON: Sudden Ionospheric Disturbance Data

By

OLADIPO, Mumin Olatunji
PhD Physics (in view)
University of Ilorin, Ilorin, Nigeria
muminoladipo@gmail.com

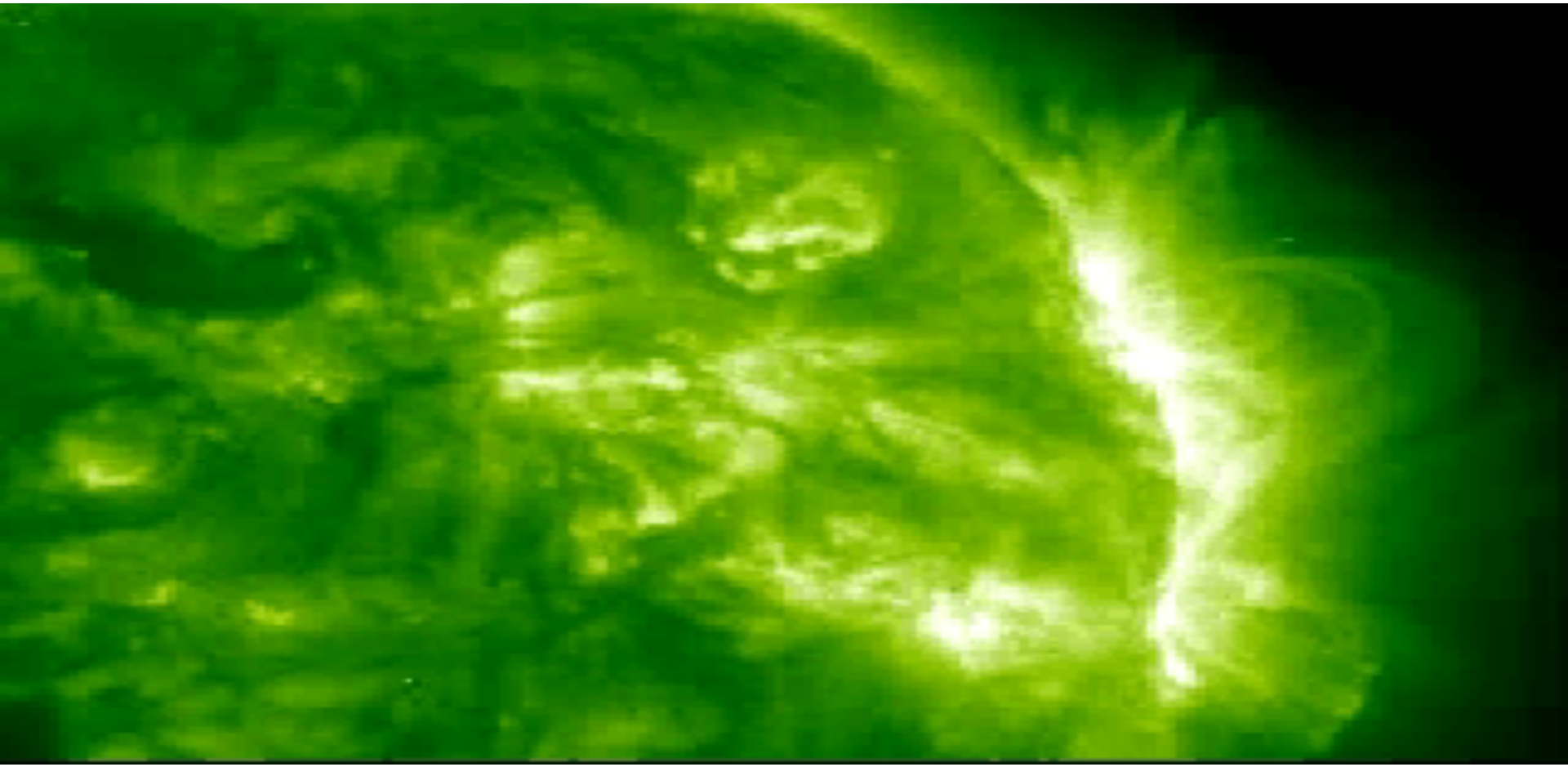
at

COESSING, 2018

Introduction

- Tools needed
  - Python
  - Anaconda , Jupyter
  - SID data
- SID(Sudden Ionospheric Disturbance): This is a rapid change in the ionization level of the ionosphere due to eruption from the sun (solar flare).
- Why does SID matter?
  - Because oceanography is a multi-disciplinary field.
  - Navigation is an important part of oceanography and communication is vital for navigation.
  - SID study helps to improve communication.

Solar Flare



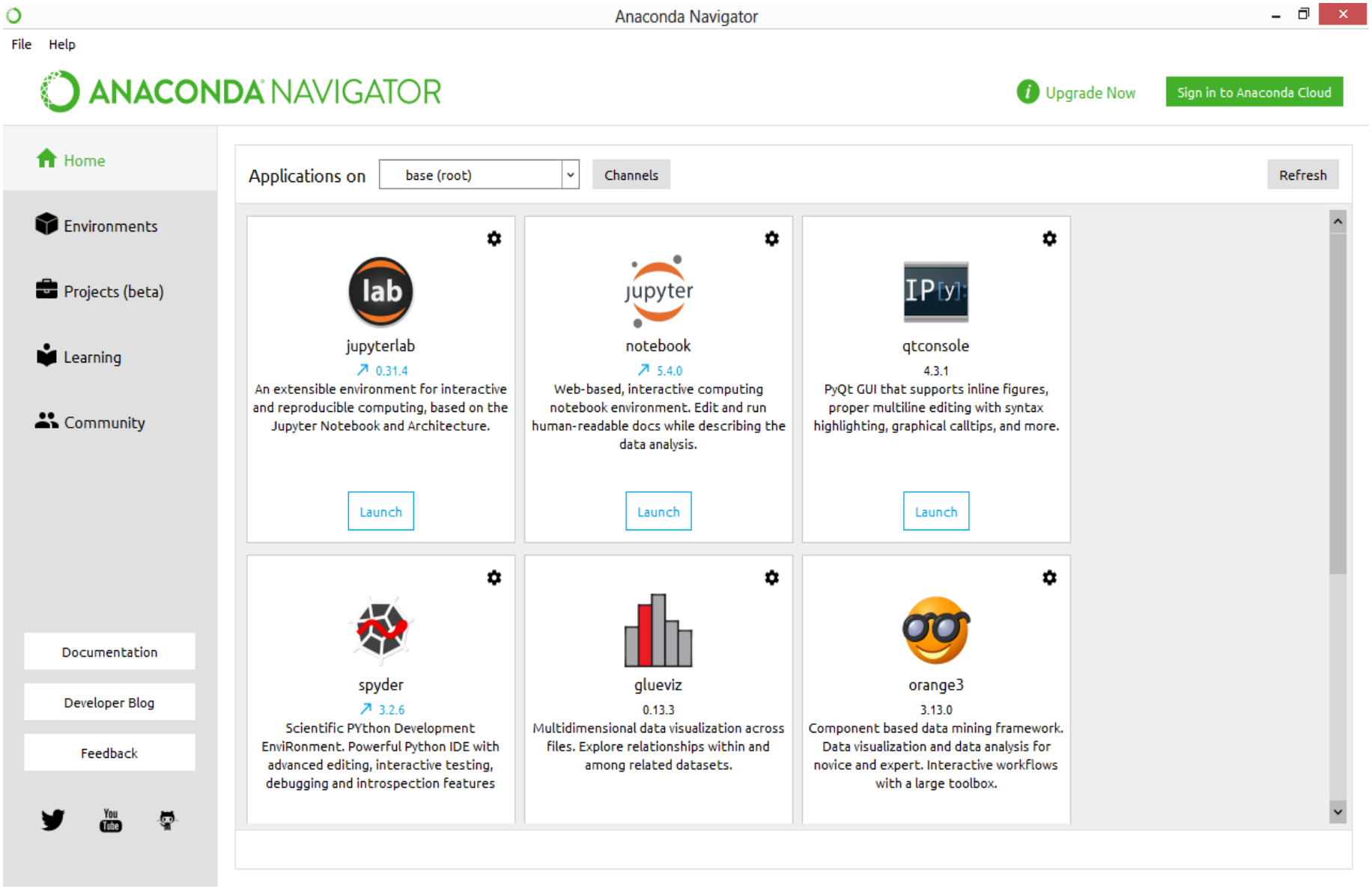
- Media 1.0: Solar eruption

Aims and Objectives

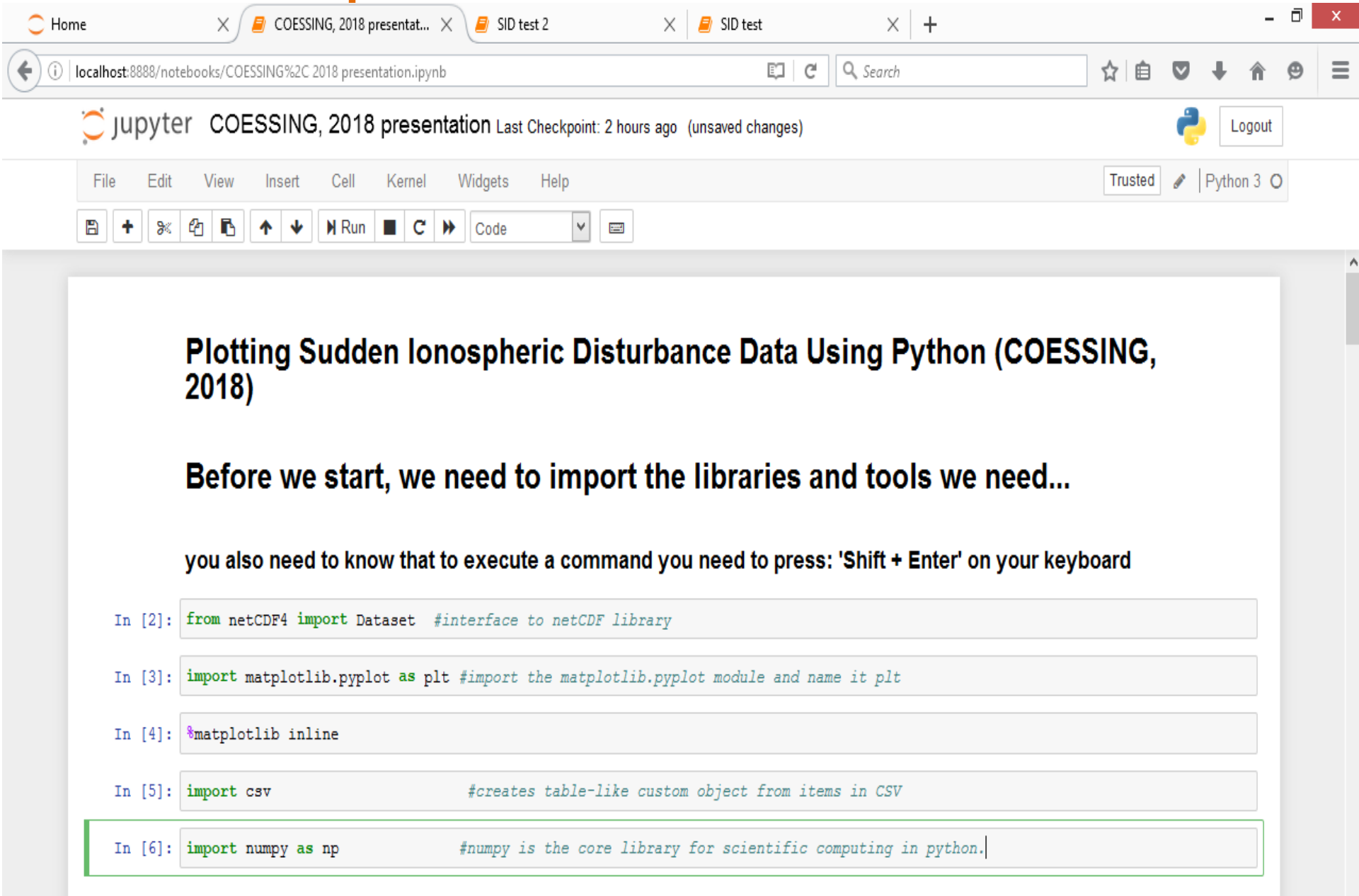
- Aim
  - Learn how to use Python
- Objectives
  - To Download Python and anaconda
  - To Install Python and anaconda
  - To Learn to plot graph using Python
  - To plot 24hr SID data collected at University of Ilorin, Ilorin-Nigeria, using PYTHON
  - To identify solar flare signature (SID) on the data

Note: VLF signal is enhanced during SID occurrence, thus we are looking for an enhancement on our plot.

Anaconda Navigator



Import Relevant Libraries



Import Data

Now let's import the data. The file is in CSV format...

In [31]:
```
datadir = r"C:\Users\Mumee\Documents\Documents\project\READYTOCOPY\aa/"
with open(datadir+'ILORIN_UIK_2016-01-27.csv', 'r') as csvfile:
        spamreader = csv.reader(csvfile) #, delimiter=',', quotechar='|')
        for row in spamreader:
        print(', '.join(row))
```

```
  File "<ipython-input-31-49dae31fd90a>", line 5
    print(', '.join(row))
        ^
IndentationError: expected an indented block
```

Do you get this error!!! don't panic, just rearrange...adjust the indent of the line (line 5 in our case) and you are good.

In the interim, NOTE: you can add comment to your code by typing '#' follow by comment

In [32]:
```
datadir = r"C:\Users\Mumee\Documents\Documents\project\READYTOCOPY\aa/" #this is the data path...'r' means read
with open(datadir+'ILORIN_UIK_2016-01-27.csv', 'r') as csvfile:         #specify the particular file to open
        spamreader = csv.reader(csvfile)                                #you are telling python to read the csv file
        for row in spamreader:
            print(', '.join(row))                       #display the file you read and use comma to separate each column
```

```
time, data
1/27/2016 0:00, 2820.996359
1/27/2016 0:00, 2820.996359
1/27/2016 0:00, 2821.78191
1/27/2016 0:00, 2822.567461
1/27/2016 0:00, 2823.353012
1/27/2016 0:00, 2824.138563
1/27/2016 0:00, 2824.924114
1/27/2016 0:00, 2825.709665
1/27/2016 0:00, 2826.495217
1/27/2016 0:00, 2827.280768
1/27/2016 0:00, 2828.066319
1/27/2016 0:00, 2832.278802
1/27/2016 0:01, 2836.491285
1/27/2016 0:01, 2840.703768
1/27/2016 0:01, 2844.91625
1/27/2016 0:01, 2856.360546
1/27/2016 0:01, 2867.804842
```

Extract Data

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Run Code

Now we need to extract the useful data. In this case, it is the signal strength in column two (delimiter is comma)

In [33]:
```
datadir = r"C:\Users\Mumee\Documents\Documents\project\READYTOCOPY\aa/"  #this is the data path...
import pandas as pd                                                      #we will need pandas library so import it
df = pd.read_csv(datadir+'ILORIN_UIK_2016-01-27.csv')                    #convert csv to python object, rows and column...
saved_column = df.data                                                  #save it to save_column
print(saved_column)                                                     #let me see how it looks now
```

```
0        2820.996359
1        2820.996359
2        2821.781910
3        2822.567461
4        2823.353012
5        2824.138563
6        2824.924114
7        2825.709665
8        2826.495217
9        2827.280768
```

```
17267    2485.052193
17268    2290.661369
17269    2096.270545
17270    1901.879721
17271    1706.825187
17272    1511.770653
17273    1316.716120
17274    1121.661586
17275     932.614422
17276     743.567259
17277     554.520095
17278     365.472931
17279     182.736466
Name: data, Length: 17280, dtype: float64
```

Plot (Cont.)

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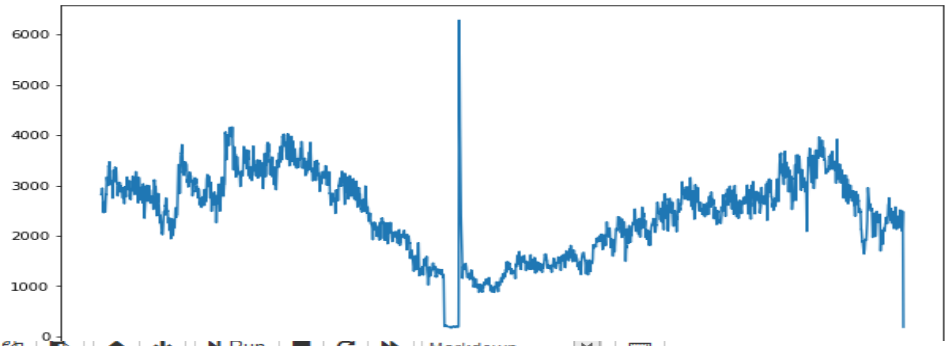
Time to plot... ¶

In [42]:
```
m = np.arange(0,86400,5)                    #the data is taken every 5s interval, so this is the variable for time
plt.figure(figsize=(10,6))                  #this instrution specify the size of our plot
plt.plot(m,saved_column)                    #Mr Python, Kindly plot signal strength(saved_column)  against time (m)
```

Out[42]:
```
[<matplotlib.lines.Line2D at 0xeb768f6780>]
```

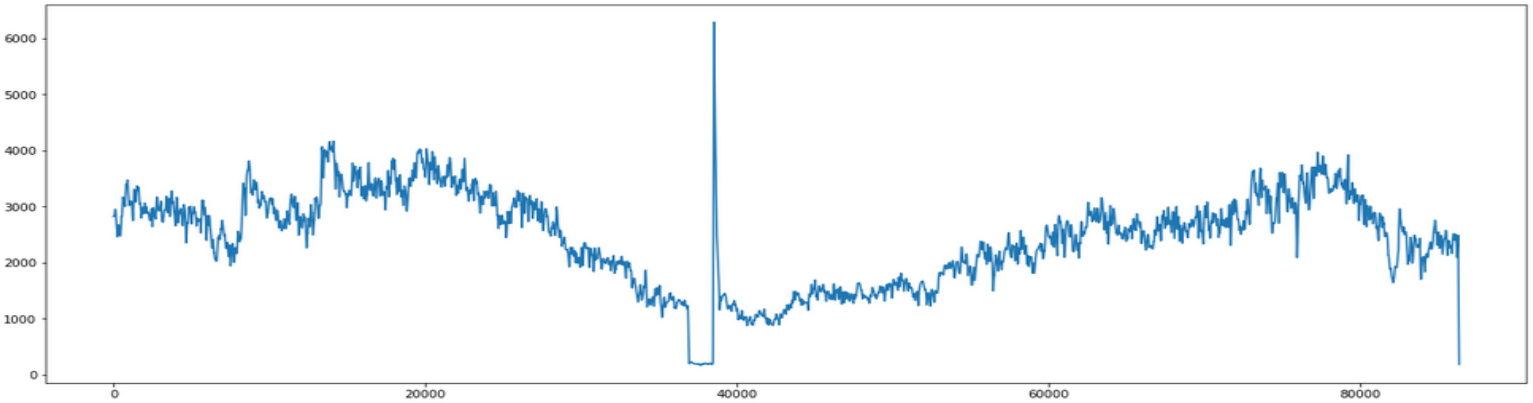


Run Markdown

Too small?!! Let's make it bigger

In [44]:
```
m = np.arange(0,86400,5)                    #the data is taken every 5s interval, so this is the variable for time
plt.figure(figsize=(20,7))                  #this instrution specify the size of our plot
plt.plot(m,saved_column)                    #Mr Python, Kindly plot signal strength(saved_column)  against time (m)
```

Out[44]:
```
[<matplotlib.lines.Line2D at 0xeb769bc278>]
```



Graph Label

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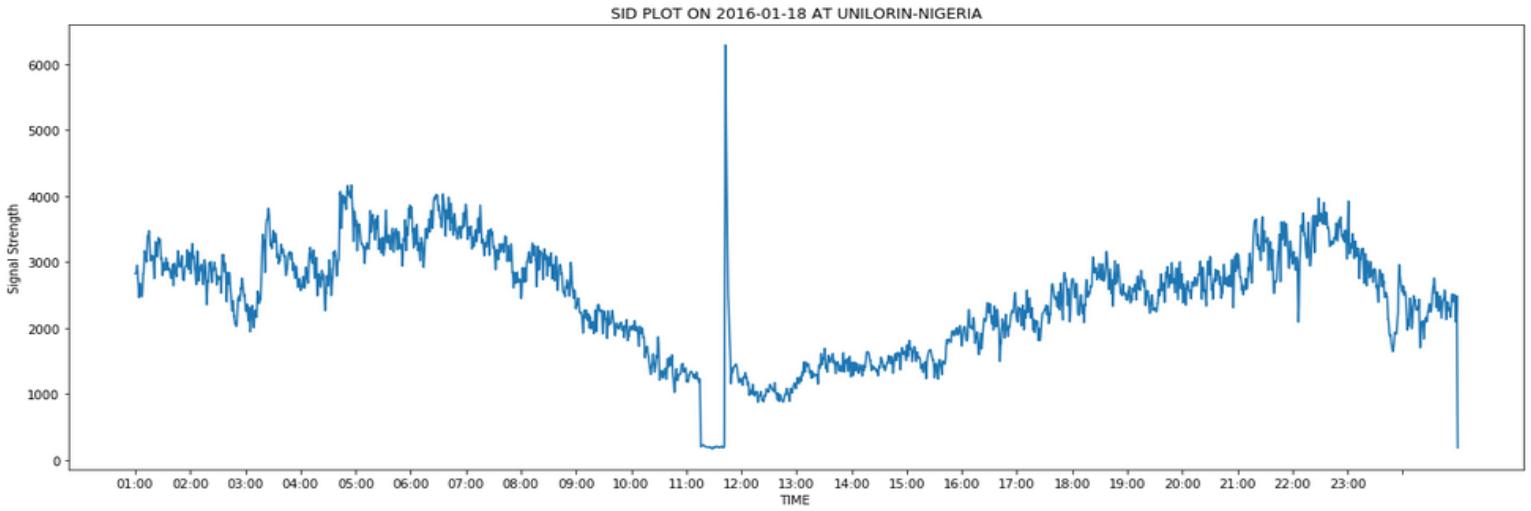
Run Markdown

let's give it more details...

In [47]:
```
m = np.arange(0,86400,5)                    #the data is taken every 5s interval, so this is the variable for time
plt.figure(figsize=(20,7))                  #this instrution specify the size of our plot
plt.plot(m,saved_column)                    #Mr Python, Kindly plot signal strength(saved_column)  against time (m)
plt.ylabel('Signal Strength')                                   #to label Y axis
plt.xlabel('TIME ')                                             #label X axis
plt.title('SID PLOT ON 2016-01-18 AT UNILORIN-NIGERIA')         #graph title
hour = np.arange(0,86400,3600)                                  #to label in hour we divide by 3600s
hour_label = ['01:00','02:00' , '03:00', '04:00','05:00' ,'06:00','07:00','08:00','09:00','10:00','11:00','12:00','13:00','14:
plt.xticks(hour,hour_label)                                     #to excute the time label
```

Out[47]:
```
([<matplotlib.axis.XTick at 0xeb76dbaf98>,
  <matplotlib.axis.XTick at 0xeb7714ed68>,
  <matplotlib.axis.XTick at 0xeb76df0518>,
  <matplotlib.axis.XTick at 0xeb771ac240>,

   <matplotlib.axis.XTick at 0xeb771d6400>,
   <matplotlib.axis.XTick at 0xeb771d6a90>,
   <matplotlib.axis.XTick at 0xeb771dd160>,
   <matplotlib.axis.XTick at 0xeb771dd7f0>],
 <a list of 23 Text xticklabel objects>)
```



Graph Label (Cont.)

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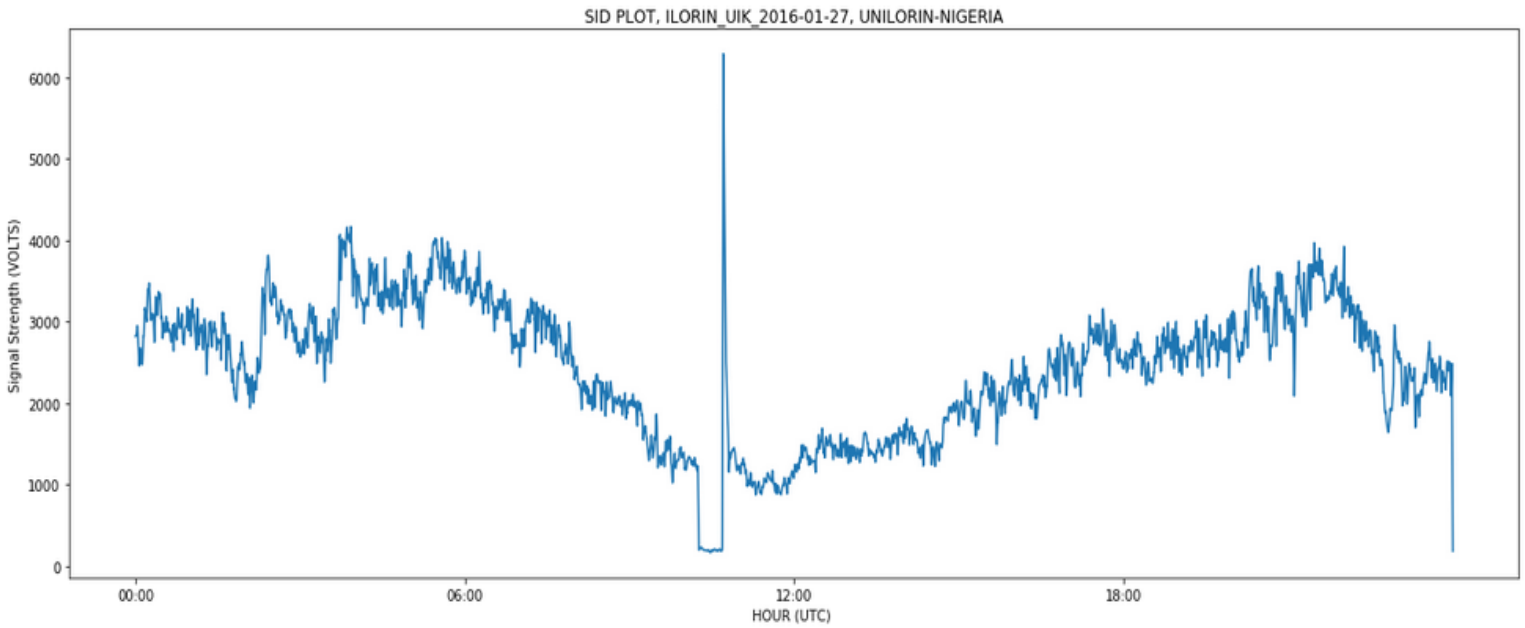
Run Code

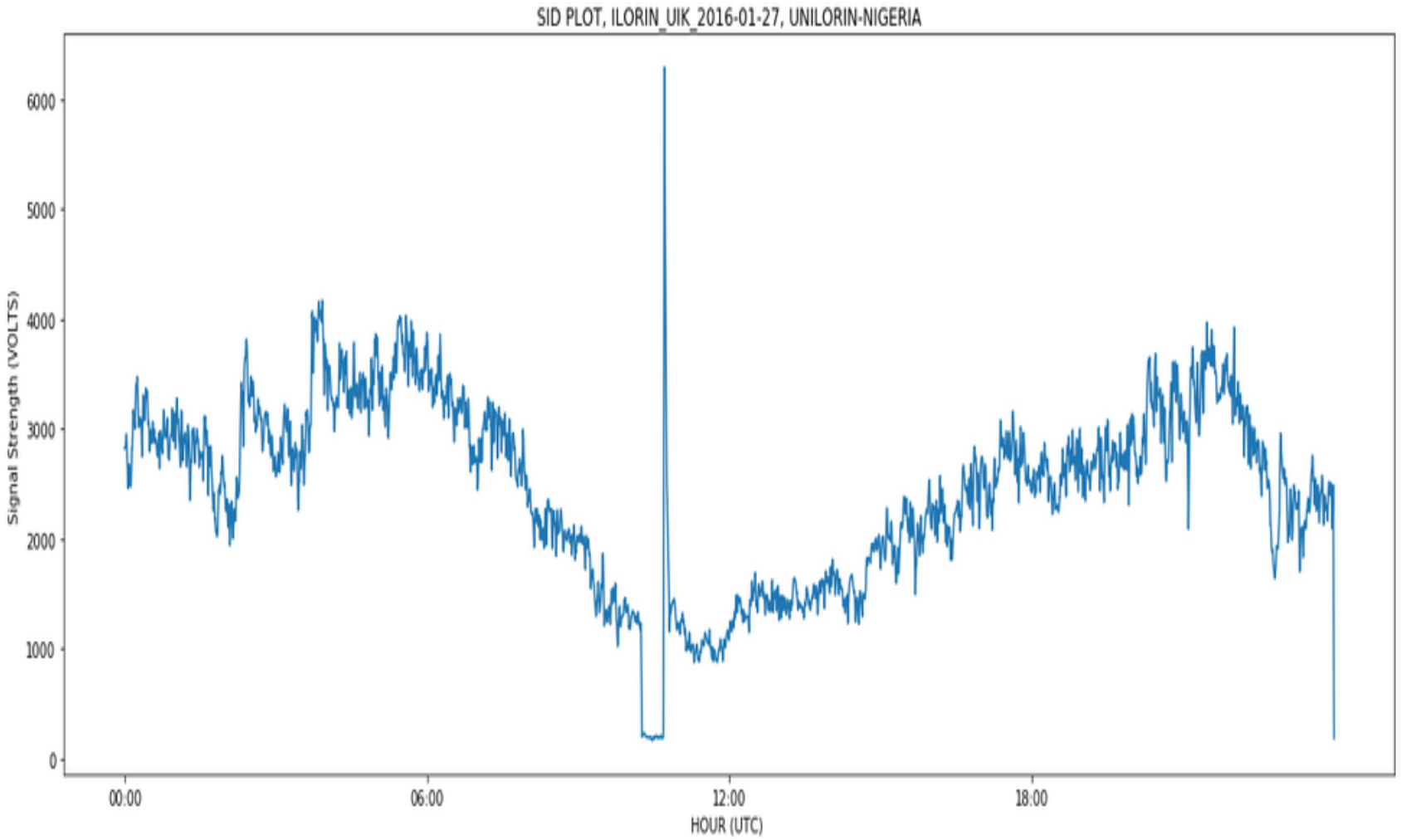
Let's Make it a 6 Hourly plot...

In [48]:
```
plt.figure(figsize=(20,7))
plt.plot(m,saved_column)
plt.ylabel('Signal Strength (VOLTS)')
plt.xlabel('HOUR (UTC) ')
plt.title('SID PLOT, ILORIN_UIK_2016-01-27, UNILORIN-NIGERIA')
hour = np.arange(0,86400,21600) #to label in 6 hours we divide by 21600s
hour_label = ['00:00','06:00','12:00','18:00','19:00','20:00','21:00','22:00','23:00']
plt.xticks(hour,hour_label) #to excute the labelling
```

Out[48]:
```
([<matplotlib.axis.XTick at 0xeb771a57f0>,
  <matplotlib.axis.XTick at 0xeb77235860>],
 <a list of 4 Text xticklabel objects>)
```



Result: Discussion



- The hike on the graph indicates Sudden Ionospheric Disturbance caused by C- class solar flare. The plot can be compared with GOES-15 satellite plot for 2016-01-27 on http://www.tesis.lebedev.ru/en/sun_flares.html

Conclusions

- I had learned to plot SID data using PYTHON tools
- Python is an excellent scientific tool
- COESSING, 2018 is a success for me!!!

Acknowledgment

- My sincere appreciation goes to almighty God for the favor.
- Special thanks to
  - Professor Brain Arbic
  - Paige Martin
  - Maddie Foster-Martinez
  - Christian Buckingham
  - And the organizer of COESSING, 2018
- My appreciations also goes to my family, fiancée and friends.

Your support gives me the stance to strive.

THANK YOU
THANK YOU
THANK YOU