Pironaut_Analysis

June 27, 2021

1 Import necessary libraries

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

2 Load dataset

[2]:
```
data = pd.read_csv('data.csv', index_col='Date/Time')
data
```

[2]:

Date/Time	ISS Latitude	ISS Longitude	MI_X (µT)	MI_Y (µT)	MI_Z (µT)	Temperature (°C)
2021-04-22 13:57:09.543388	-47.212235	76.437753	4.624717	8.101723	7.200235	30.7821
2021-04-22 13:57:20.028311	-47.496254	77.350902	8.608018	14.286917	12.647129	30.8182
2021-04-22 13:57:30.488157	-47.747431	78.189963	11.523164	19.480419	17.299894	30.8182
2021-04-22 13:57:40.978215	-47.991795	79.037446	13.994987	23.589293	20.642420	30.8182
2021-04-22 13:57:51.457418	-48.252575	79.979309	15.953756	26.988495	23.597565	30.8362
…	…	…	…	…	…	…
2021-04-22 16:52:53.760041	-23.361424	-7.034313	6.736912	28.151909	39.960793	30.2592
2021-04-22 16:53:04.297911	-23.883611	-6.555795	6.644437	28.037600	40.073650	30.3314
2021-04-22 16:53:14.768474	-24.356762	-6.117104	6.773014	28.061943	40.039501	30.1511
2021-04-22 16:53:25.270123	-24.875453	-5.630385	6.850633	27.772247	39.879162	30.1511
2021-04-22 16:53:35.729491	-25.345326	-5.184030	7.037113	27.691031		

```
2021-04-22 16:53:35.729491  39.690861           30.2412

[1010 rows x 6 columns]
```

[3]:
```
data.columns
```

[3]:
```
Index(['ISS Latitude', 'ISS Longitude', 'MI_X (µT)', 'MI_Y (µT)', 'MI_Z (µT)',
       'Temperature (°C)'],
      dtype='object')
```

3 Index recorded date/time values

[4]:
```
data.index = pd.to_datetime(data.index)
data.index
```

[4]:
```
DatetimeIndex(['2021-04-22 13:57:09.543388', '2021-04-22 13:57:20.028311',
               '2021-04-22 13:57:30.488157', '2021-04-22 13:57:40.978215',
               '2021-04-22 13:57:51.457418', '2021-04-22 13:58:01.958980',
               '2021-04-22 13:58:12.487666', '2021-04-22 13:58:22.968106',
               '2021-04-22 13:58:33.447997', '2021-04-22 13:58:43.918014',
               …
               '2021-04-22 16:52:01.400417', '2021-04-22 16:52:11.898228',
               '2021-04-22 16:52:22.378068', '2021-04-22 16:52:32.840353',
               '2021-04-22 16:52:43.298669', '2021-04-22 16:52:53.760041',
               '2021-04-22 16:53:04.297911', '2021-04-22 16:53:14.768474',
               '2021-04-22 16:53:25.270123', '2021-04-22 16:53:35.729491'],
              dtype='datetime64[ns]', name='Date/Time', length=1010, freq=None)
```

[5]:
```
data.iloc[0]
```

[5]:
```
ISS Latitude       -47.212235
ISS Longitude       76.437753
MI_X (µT)            4.624717
MI_Y (µT)            8.101723
MI_Z (µT)            7.200235
Temperature (°C)    30.782100
Name: 2021-04-22 13:57:09.543388, dtype: float64
```

[6]:
```
data.shape
```

[6]:
```
(1010, 6)
```

4 Calculate the total magnetic field from its vector components

[7]:
```
data['MI_TOT'] = (data['MI_X (μT)']**2 + data['MI_Y (μT)']**2 + data['MI_Z␣
↪(μT)']**2)**0.5
```

[8]:
```
data.shape
```

[8]:
```
(1010, 7)
```

[9]:
```
data
```

[9]:

Date/Time	ISS Latitude	ISS Longitude	MI_X (μT)	MI_Y (μT)	\
2021-04-22 13:57:09.543388	-47.212235	76.437753	4.624717	8.101723	
2021-04-22 13:57:20.028311	-47.496254	77.350902	8.608018	14.286917	
2021-04-22 13:57:30.488157	-47.747431	78.189963	11.523164	19.480419	
2021-04-22 13:57:40.978215	-47.991795	79.037446	13.994987	23.589293	
2021-04-22 13:57:51.457418	-48.252575	79.979309	15.953756	26.988495	
…	…	…	…	…	
2021-04-22 16:52:53.760041	-23.361424	-7.034313	6.736912	28.151909	
2021-04-22 16:53:04.297911	-23.883611	-6.555795	6.644437	28.037600	
2021-04-22 16:53:14.768474	-24.356762	-6.117104	6.773014	28.061943	
2021-04-22 16:53:25.270123	-24.875453	-5.630385	6.850633	27.772247	
2021-04-22 16:53:35.729491	-25.345326	-5.184030	7.037113	27.691031	

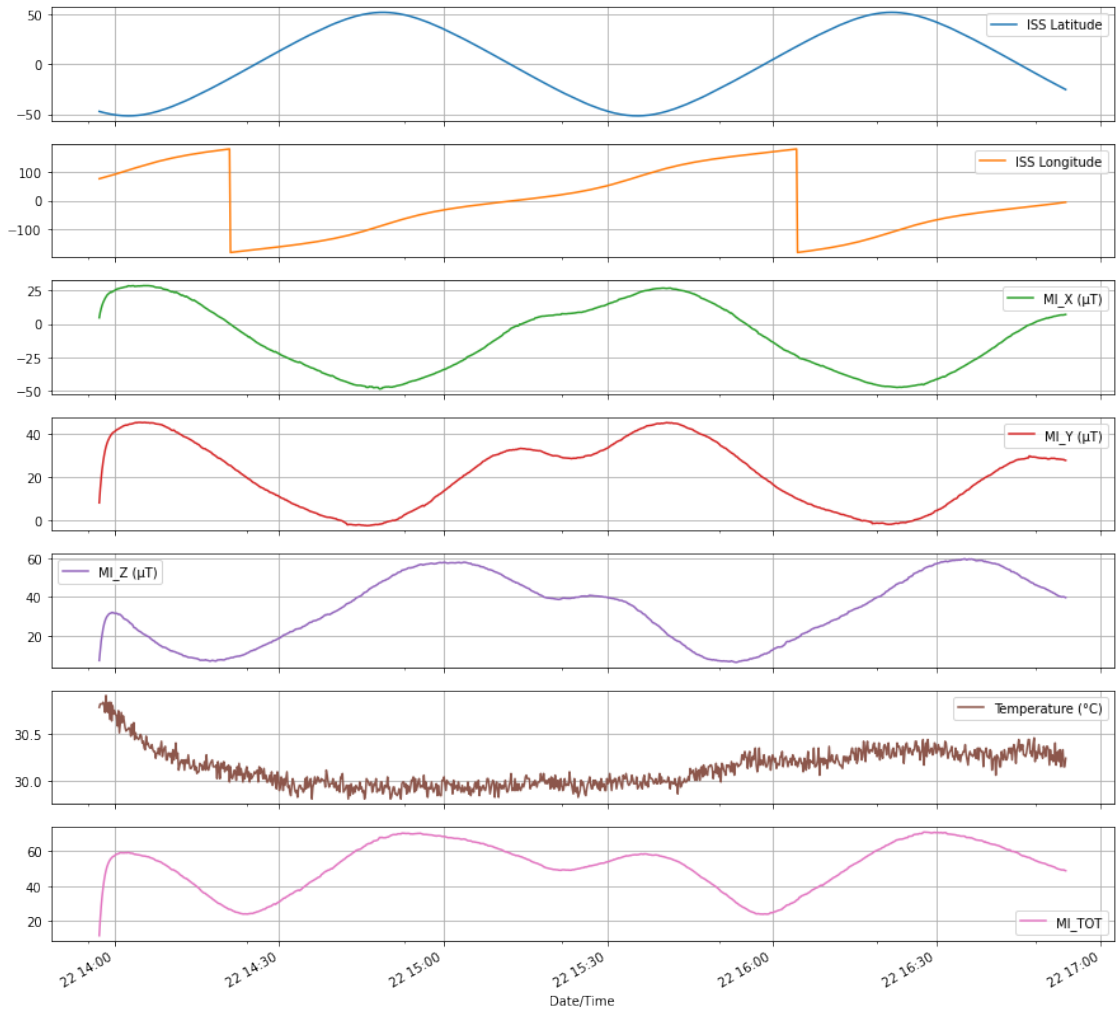
Date/Time	MI_Z (μT)	Temperature (°C)	MI_TOT
2021-04-22 13:57:09.543388	7.200235	30.7821	11.784282
2021-04-22 13:57:20.028311	12.647129	30.8182	20.932363
2021-04-22 13:57:30.488157	17.299894	30.8182	28.487829
2021-04-22 13:57:40.978215	20.642420	30.8182	34.328179
2021-04-22 13:57:51.457418	23.597565	30.8362	39.239601
…	…	…	…
2021-04-22 16:52:53.760041	39.960793	30.2592	49.343499
2021-04-22 16:53:04.297911	40.073650	30.3314	49.357400
2021-04-22 16:53:14.768474	40.039501	30.1511	49.360997
2021-04-22 16:53:25.270123	39.879162	30.1511	49.077250
2021-04-22 16:53:35.729491	39.690861	30.2412	48.904791

[1010 rows x 7 columns]

5 Plot the recorded data against time

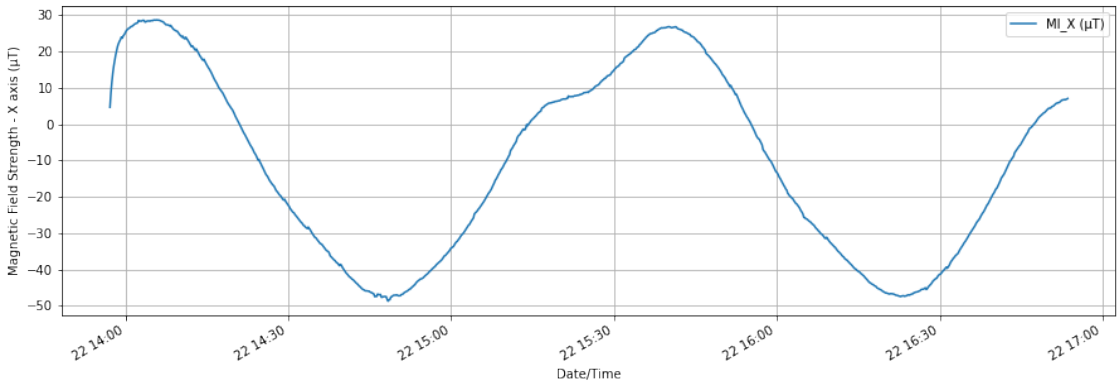
[10]:
```
data[['ISS Latitude','ISS Longitude', 'MI_X (μT)','MI_Y (μT)','MI_Z (μT)',
      'Temperature (°C)', 'MI_TOT']].plot(figsize=(15,15), subplots=True,␣
↪grid=True)
```

[10]:
```
array([<AxesSubplot:xlabel='Date/Time'>, <AxesSubplot:xlabel='Date/Time'>,
       <AxesSubplot:xlabel='Date/Time'>, <AxesSubplot:xlabel='Date/Time'>,
       <AxesSubplot:xlabel='Date/Time'>, <AxesSubplot:xlabel='Date/Time'>,
       <AxesSubplot:xlabel='Date/Time'>], dtype=object)
```



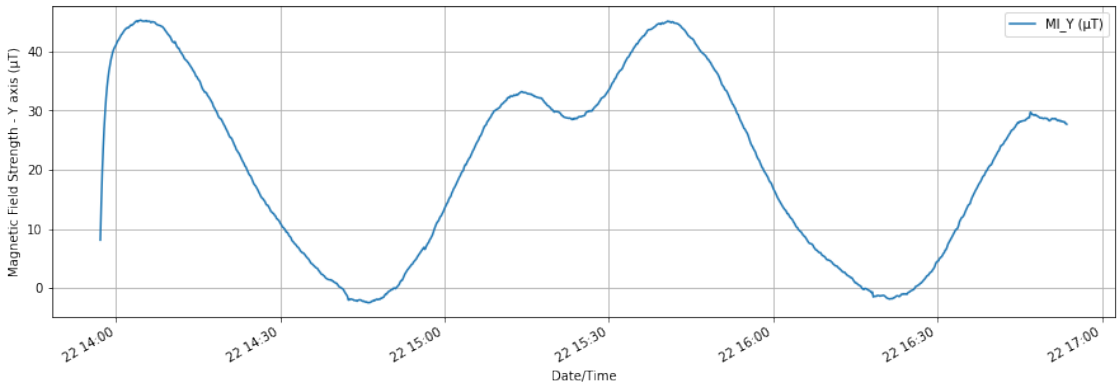
[11]:
```
ax_magX = data[['MI_X (µT)']].plot(figsize=(15,5), subplots=True, grid=True)[0]
ax_magX.set_ylabel('Magnetic Field Strength - X axis (µT)')
```

[11]:
```
Text(0, 0.5, 'Magnetic Field Strength - X axis (µT)')
```



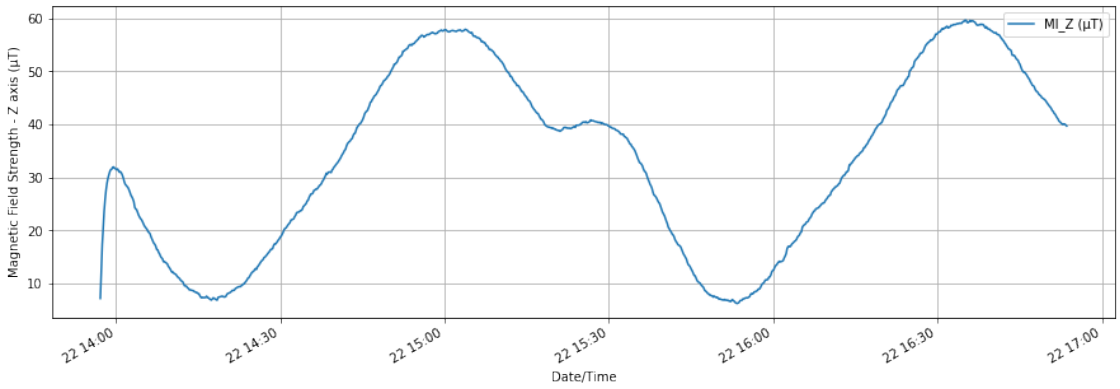
[12]:
```
ax_magY = data[['MI_Y (µT)']].plot(figsize=(15,5), subplots=True, grid=True)[0]
ax_magY.set_ylabel('Magnetic Field Strength - Y axis (µT)')
```

[12]: Text(0, 0.5, 'Magnetic Field Strength - Y axis (µT)')



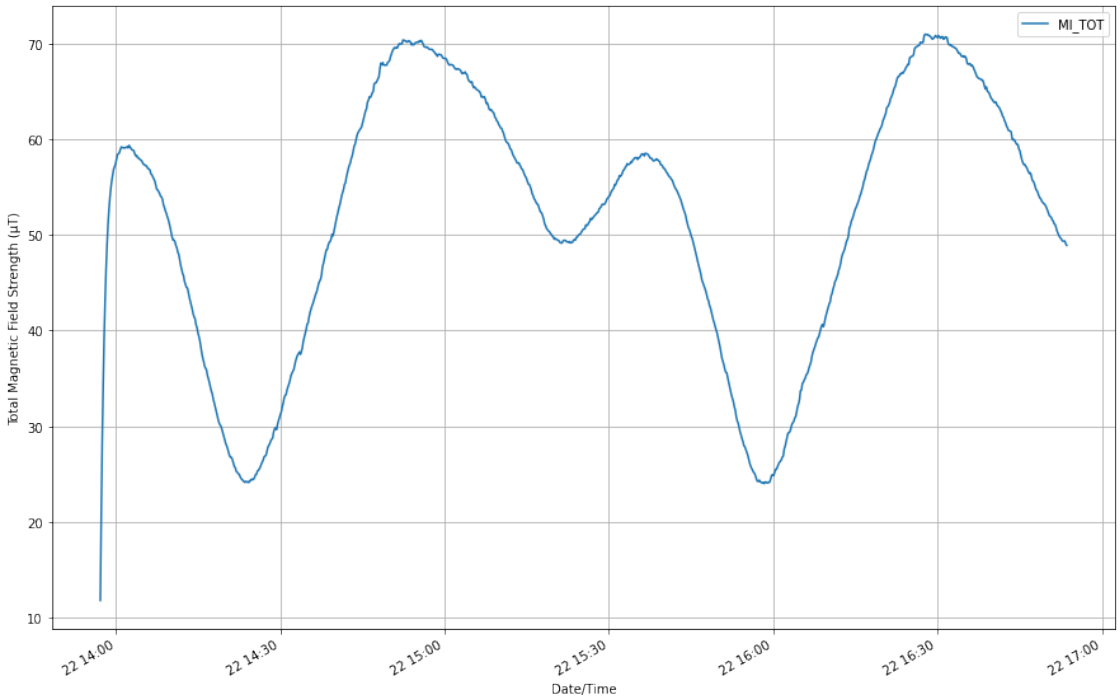
[13]:
```
ax_magZ = data[['MI_Z (µT)']].plot(figsize=(15,5), subplots=True, grid=True)[0]
ax_magZ.set_ylabel('Magnetic Field Strength - Z axis (µT)')
```

[13]: Text(0, 0.5, 'Magnetic Field Strength - Z axis (µT)')



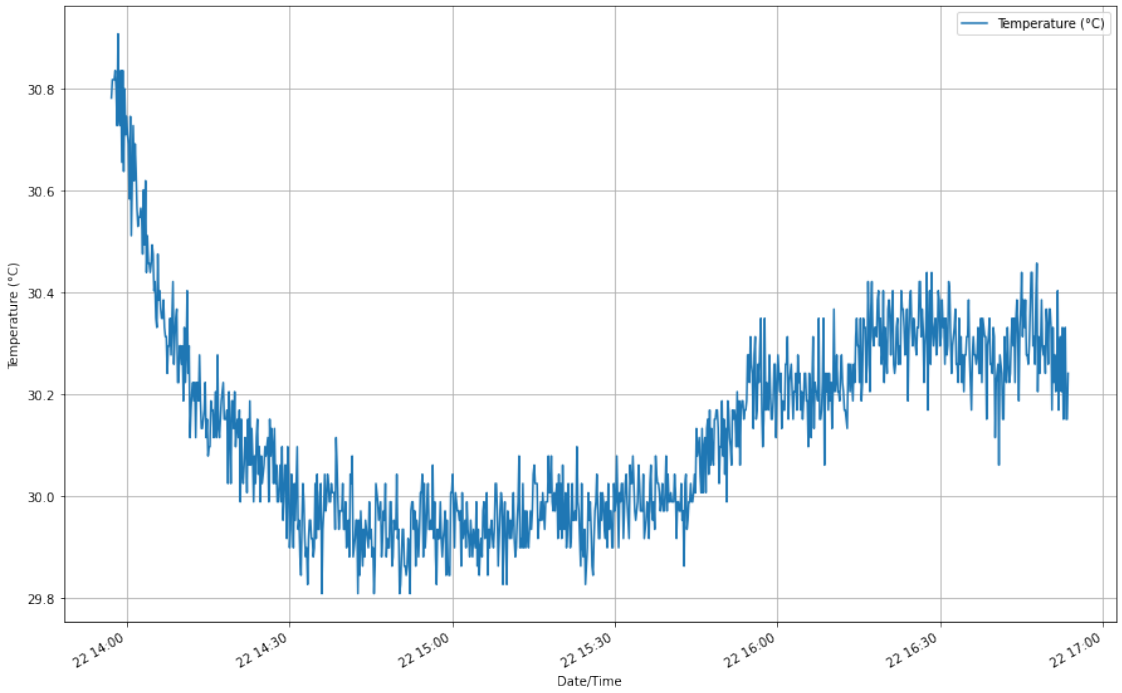
[14]:
```
ax_magTot = data[['MI_TOT']].plot(figsize=(15,10), subplots=True, grid=True)[0]
ax_magTot.set_ylabel('Total Magnetic Field Strength (µT)')
```

[14]: Text(0, 0.5, 'Total Magnetic Field Strength (µT)')



[15]:
```
ax_temp = data[['Temperature (°C)']].plot(figsize=(15,10), subplots=True,␣
↪grid=True)[0]
ax_temp.set_ylabel('Temperature (°C)')
```

[15]: Text(0, 0.5, 'Temperature (°C)')



6 Find location values with strongest and weakest magnetic fields

[16]:
```
'''
To find the minimum and maximum MFI, we checked data from the fifth data point␣
 ↪onwards.

We noticed that the lowest recorded MFI was at the very beginning of the␣
 ↪experiment.
This could be due to the fact that the sensors were being initialised, which␣
 ↪could have resulted in some error in the beginning.

With us noticing that the MFI variations appear to be periodic, we only␣
 ↪considered maximum and minimum points once all the sensors on-board the␣
 ↪AstroPi were fully initialised.
'''

new_data = data.iloc[5:]

mag_max = new_data['MI_TOT'].max()

mag_min = new_data['MI_TOT'].min()

mag_dif = mag_max - mag_min
```

```
lat_max = new_data.loc[data['MI_TOT'] == mag_max, 'ISS Latitude']
lon_max = new_data.loc[data['MI_TOT'] == mag_max, 'ISS Longitude']

lat_min = new_data.loc[data['MI_TOT'] == mag_min, 'ISS Latitude']
lon_min = new_data.loc[data['MI_TOT'] == mag_min, 'ISS Longitude']
```

[17]:
```
print("Maximum magnetic field strength inside ISS: " + str(round(mag_max, 2)) +␣
↪"µT")
print(" ")
print("Mimumun magnetic field strength inside ISS: " + str(round(mag_min, 2)) +␣
↪"µT")
print(" ")
print("The range of magnetic field strength experienced inside ISS: " +␣
↪str(round(mag_dif, 2)) + "µT")
```

```
Maximum magnetic field strength inside ISS: 70.98µT

Mimumun magnetic field strength inside ISS: 23.99µT

The range of magnetic field strength experienced inside ISS: 46.99µT
```

[18]:
```
print(lat_max)
print(" ")
print(lon_max)
```

```
Date/Time
2021-04-22 16:27:43.657640    46.268818
Name: ISS Latitude, dtype: float64

Date/Time
2021-04-22 16:27:43.657640   -76.507585
Name: ISS Longitude, dtype: float64
```

[19]:
```
print(lat_min)
print(" ")
print(lon_min)
```

```
Date/Time
2021-04-22 15:58:20.377744   -0.882304
Name: ISS Latitude, dtype: float64

Date/Time
2021-04-22 15:58:20.377744    166.128014
Name: ISS Longitude, dtype: float64
```

[ ]:
```

```