AA403- Space Engineering System Assignment 2

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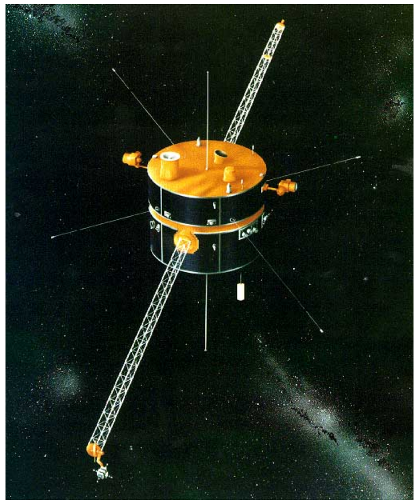
1 Introduction

The Global Geospace Science (GGS) Wind satellite is a NASA science spacecraft launched on 1 November 1994, at 09:31:00 UTC, from launch pad LC-17B at Cape Canaveral Air Force Station (CCAFS) in Merritt Island, Florida, aboard a McDonnell Douglas Delta II 7925-10 rocket. Wind was designed and manufactured by Martin Marietta Astro Space Division in East Windsor Township, New Jersey. The satellite is a spin-stabilized cylindrical satellite with a diameter of 2.4 m (7 ft 10 in) and a height of 1.8 m (5 ft 11 in).

It was deployed to study radio waves and plasma that occur in the solar wind and in the Earth's magnetosphere. The spacecraft's original mission was to orbit the Sun at the L1 Lagrangian point, but this was delayed to study the magnetosphere and near lunar environment when the Solar and Heliospheric Observatory (SOHO) and Advanced Composition Explorer (ACE) spacecraft were sent to the same location. Wind has been at L1 continuously since May 2004, and is still operating as of March 2021.[2] As of March 2021, Wind currently has enough fuel to last over 50 more years at L1, until at least 2070.[3] Wind continues to collect data, and by the end of 2021 had contributed data to over 6290 scientific publications.

Table 1: Details of ACE Spacecraft

Spacecraft	WIND
Launch Date and Time	November 1, 1994, 09:31:00 UTC
Launch Vehicle	McDonnell Douglas Delta II 7925-10 rocket
Launch Site	Merritt Island, Florida
Expected Misson Lifetime	3 years (planned)
Current Status	Themajor,orbital,parameters,extracted,are:27,.22727 years, 9 months, 18 days (in prog
Mass Budget	1. Launch mass : 1,250 kg
	2. Dry mass : 950 kg
	3. Payload mass : 195 kg
	Net: 2,395 kg
Scientific Instruments	1. Wind/WAVES
	2. Wind / 3DP
	3. WIND/Magnetic Field Instrument (MFI)
	4. Wind / SWE
	5. Wind / KONUS and TGRS
	6. Wind / EPACT
	7. Wind / SMS



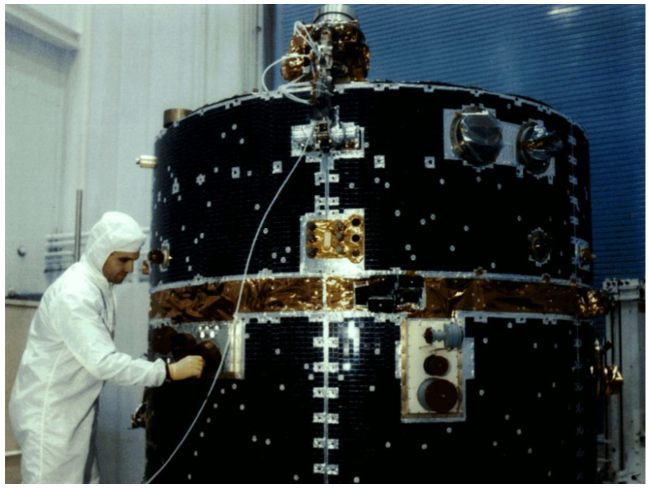
2 What instruments are on board and what types of data have they been gathering?

Wind has an unusually broad range of instrumentation compared to most other NASA missions still operating. Multiple instruments measure the low energy, thermal particles allowing for redundancy to cross-calibrate each instrument. Wind also measures electric and magnetic fields from quasi-static all the way up to radio frequencies. Wind can measure energetic particles up to approximately 50 megaelectron volts per nucleon and distinguish ion species from hydrogen to uranium including carbon, nitrogen, oxygen, neon, silicon, sulfur, iron, argon, etc. Wind also had two gamma ray instruments, one still operating that was provided by Russia. So, Wind can measure particles from a few electron volts to tens of megaelectron volts, electromagnetic fields from about 0 Hz to 13 MHz, and gamma rays with energies up to about 15 megaelectron volts. (For context, a typical blue photon would have an energy of about 3 electron volts, which is about 5 million times less energy per photon.) Note that 1 electron volt is the energy gained by an electron being accelerated by a 1 volt electric potential.

3 Science Objectives

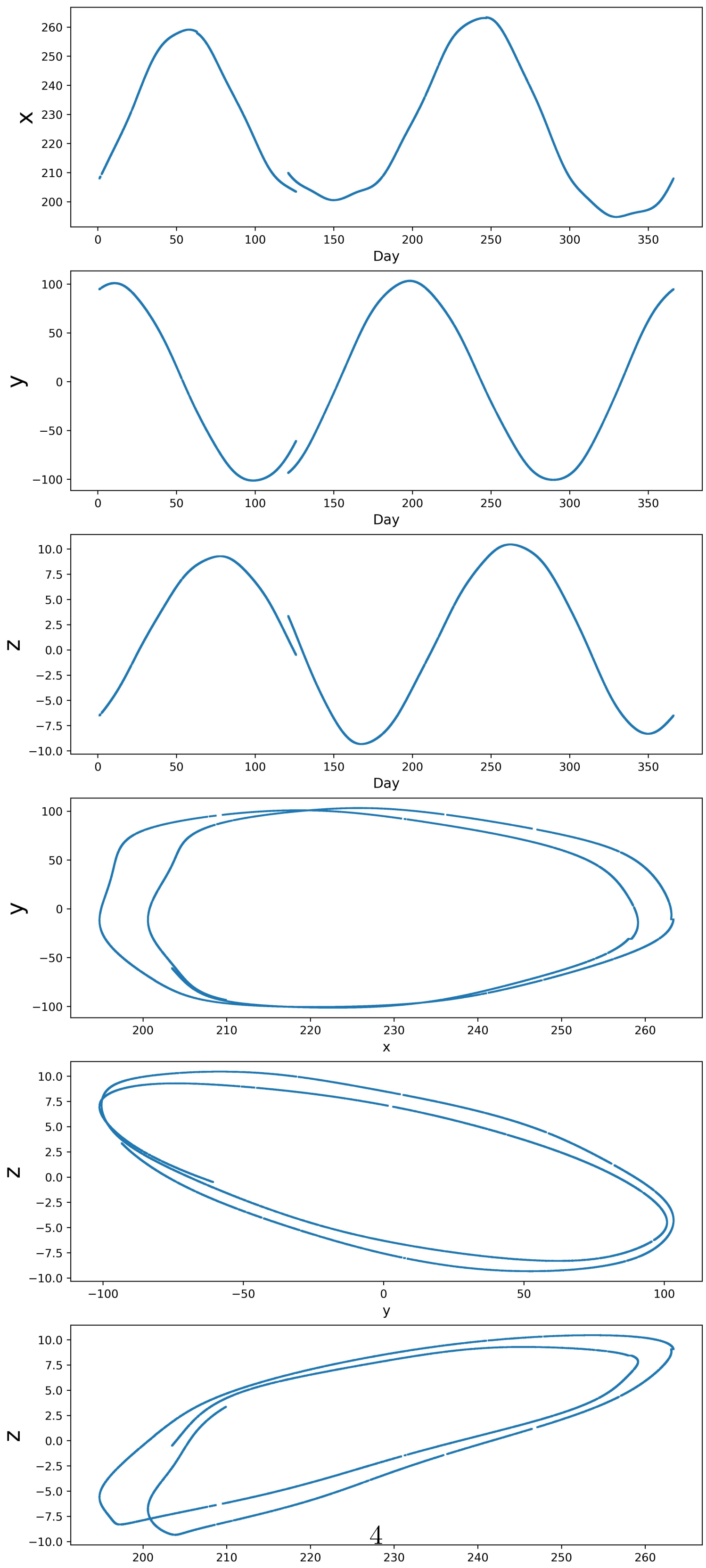
The aim of the International Solar-Terrestrial Physics Science Initiative is to understand the behaviour of the solar-terrestrial plasma environment, in order to predict how the Earth's atmosphere will respond to changes in solar wind conditions. Wind's objective is to measure the properties of the solar wind before it reaches the Earth.

Provide complete plasma, energetic particle, and magnetic field input for magnetospheric and ionospheric studies. Determine the magnetospheric output to interplanetary space in the up-stream region. Investigate basic plasma processes occurring in the near-Earth solar wind. Provide baseline ecliptic plane observations to be used in heliospheric latitudes by the Ulysses mission.



The major orbital parameters extracted are:

- Perigee distance, r_p = 19.99987499 Re
- Apogee distance, r_a = 104.4688130 Re
- Semi major axis, a = 62.2343440 Re
- Semi minor axis, b = 45.709552 Re
- Eccentricity, e = 0.6786360


x
Day
y
Day
z
Day
y
x
z
y
z
x

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In [2]:
```
import matplotlib.pyplot as plt
#import pandas as pd
import numpy as np
```

In [3]:
```
f = np.genfromtxt('2.txt')
f[f==9999.99]=np.nan
print(f)
np.shape(f)
```

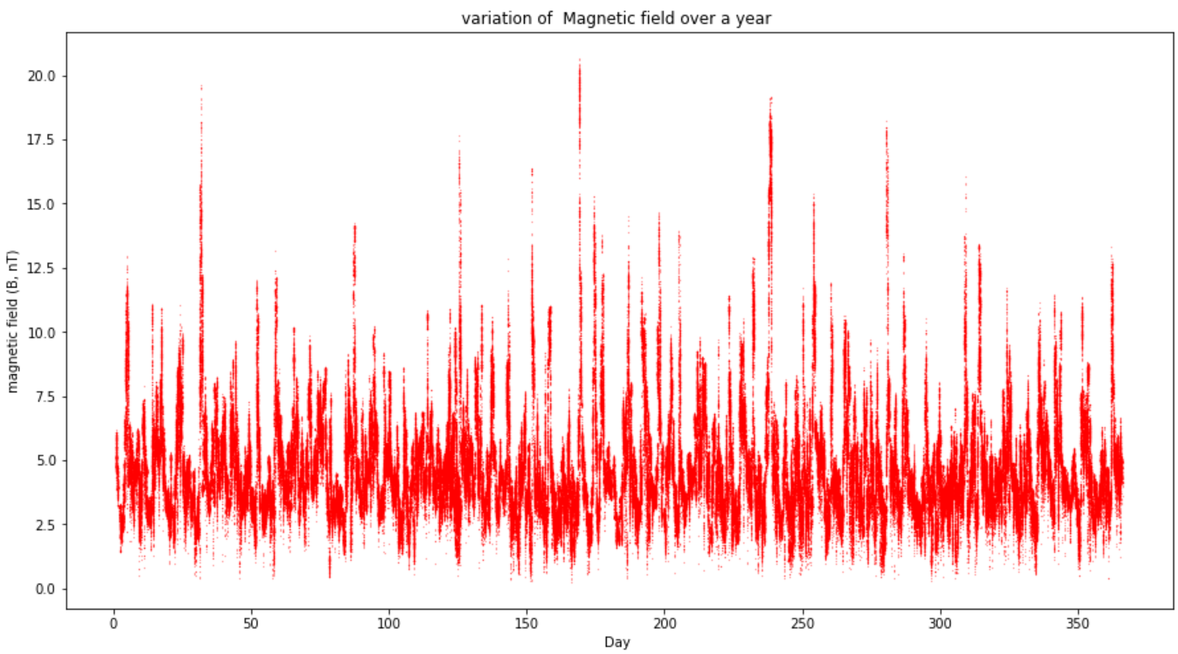
```
[[ 2.0180e+03  1.2100e+02  0.0000e+00 ...  2.0990e+02 -9.3320e+01
   3.3600e+00]
 [ 2.0180e+03  1.2100e+02  0.0000e+00 ...  2.0990e+02 -9.3320e+01
   3.3600e+00]
 [ 2.0180e+03  1.2100e+02  0.0000e+00 ...  2.0990e+02 -9.3320e+01
   3.3600e+00]
 ...
 [ 2.0190e+03  1.2500e+02  2.3000e+01 ...  2.0346e+02 -6.0720e+01
  -4.9000e-01]
 [ 2.0190e+03  1.2500e+02  2.3000e+01 ...  2.0346e+02 -6.0730e+01
  -4.9000e-01]
 [ 2.0190e+03  1.2500e+02  2.3000e+01 ...  2.0346e+02 -6.0760e+01
  -4.9000e-01]]
```

Out[3]: (532800, 8)

In [4]:
```
D=f[:,1]
Hr=f[:,2]
Min=f[:,3]
B=f[:,4]
Day=D+(Hr/24)+(Min/(24*60))
x=f[:,5]
y=f[:,6]
z=f[:,7]
```

In [5]:
```
f=plt.figure()
f.set_figwidth(15)
f.set_figheight(8)

plt.plot(Day,B,".",markersize=0.3,color='r')
plt.title("variation of  Magnetic field over a year ")
plt.xlabel("Day ")
plt.ylabel(" magnetic field (B, nT) " )
#plt.grid(axis = 'x')
plt.savefig('magetic_field.jpg',dpi=500)
plt.show()
```



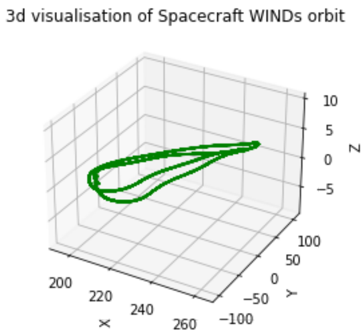
In [ ]:
```
fig, (ax0,ax1, ax2,ax3,ax4,ax5) = plt.subplots(6,figsize=(10,25))
ax0.plot(Day,x)
ax0.set_xlabel( 'Day',fontsize=12)
ax0.set_ylabel( 'x',fontsize=20)

ax1.plot(Day,y)
ax1.set_xlabel( 'Day',fontsize=12)
ax1.set_ylabel( 'y',fontsize=20)
ax2.plot(Day,z)
ax2.set_xlabel( 'Day',fontsize=12)
ax2.set_ylabel( 'z',fontsize=20)
ax3.plot(x,y)
ax3.set_xlabel( 'x',fontsize=12)
ax3.set_ylabel( 'y',fontsize=20)
ax4.plot(y,z)
ax4.set_xlabel( 'y',fontsize=12)
ax4.set_ylabel( 'z',fontsize=20)
ax5.plot(x,z)
ax5.set_xlabel( 'x',fontsize=12)
ax5.set_ylabel( 'z',fontsize=20)
plt.savefig('evolution.jpg',dpi=500)
#ax0.set_title('Evolution of Nthcomp Model parameters ')
```

In [70]:
```
a=plt.figure()
ax = plt.axes(projection ='3d')

ax.plot3D(x, y, z, 'green')
ax.set_title(' 3d visualisation of Spacecraft WINDs orbit')
ax.set_xlabel('X', rotation=90)
ax.set_ylabel('Y', rotation=90)
ax.set_zlabel('Z', rotation=90)

plt.savefig('3dimage.jpg',dpi=500)
plt.show()
```



In [9]:
```
R=np.sqrt(np.square(x-240) + np.square(y) + np.square(z))
len(R)
np.shape(R)
R = R[~np.isnan(R)]
print(np.shape(R))
rp=min(R)
ra=max(R)
print(rp,ra)
a=0.5*(rp+ra)
b=np.sqrt(rp*ra)
print(a,b)
e=(ra-rp)/(ra+rp)
print(e)
#t=(np.pi(6371*a*1000)**1.5)/np.sqrt(4*10**14)
#t/(24*3600)
```

```
(409119,)
19.99987499960935 104.46881304963698
62.23434402462316 45.70955263782722
0.678636043923009
```