Assignment 1:

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Homework 1

1/19/2022 - 1/23/2022

Part 1: Data Scraping and Preparation:

Task 1: Scrape your Competitor's Data:

In [ ]:
```
#Installing Necessary Packages:
pip install bs4
pip install matplotlib
pip install requests
pip install pandas
pip install numpy
```

In [ ]:
```
#Code added to convert Jupyter Notebook to pdf
python -m pip install notebook-as-pdf
pyppeteer-install
```

In [2]:
```
pip install requests
```

```
Requirement already satisfied: requests in c:\users\aruna\desktop\lib\site-packages (2.24.0)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\aruna\desktop\lib\site-packages (from requests)
(2020.6.20)
Requirement already satisfied: idna<3,>=2.5 in c:\users\aruna\desktop\lib\site-packages (from requests) (2.10)
Requirement already satisfied: chardet<4,>=3.0.2 in c:\users\aruna\desktop\lib\site-packages (from requests)
(3.0.4)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in c:\users\aruna\desktop\lib\site-packa
ges (from requests) (1.25.11)
Note: you may need to restart the kernel to use updated packages.
```

In [1]:
```
#Making the necessary imports, as requested in the instructions:
from bs4 import BeautifulSoup as bs
import requests as rq
import pandas as pd
import numpy as np
import matplotlib as mp #For Visualization
```

In [2]:
```
#Using requests to get page content (as in, HTTP GET)
#I use the requests package get method to get this page content
#We need to add the headers argument to be able to get the data
r = rq.get('https://www.spaceweatherlive.com/en/solar-activity/top-50-solar-flares.html', headers = {
            'User-Agent': 'Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chr
#I extract the text from the page using the text function
ourText = r.text
```

In [3]:
```
#Now, I use the BeautifulSoup package to read and parse the data as html
#There are multiple options to place as the second parametere for bs, such as 'html5lib',
#but I chose to use 'html.parser'
theSoup = bs(ourText, 'html.parser')
```

In [4]:
```
#I use prettify() function of BeautifulSoup to view the content and find the appropiate table
theSoup.prettify()
```

```
            }\n                       }\n                              warnings_requestData();\n                          setInterval(function(){warnings
_requestData()}, 300000);\n                  });\n   </script>\n  <link href="/manifest.json" rel="manifest"/>\n  <scr
ipt async="" src="https://cdn.onesignal.com/sdks/OneSignalSDK.js">\n  </script>\n  <script>\n    var OneSignal =
 window.OneSignal || [];\n                        OneSignal.push(function() {\n                        OneSignal.init({\n
          appId: "f7e23cab-977f-419b-ab27-268baafb97c2",\n                              safari_web_id: \'web.onesignal.au
to.548f76b5-1495-4e31-bc8e-b1b76d8ec8fd\',\n                            autoRegister: false,\n                              autoR
esubscribe: true,\n                           notifyButton: {\n                          enable: true,\n
       showCredit: false,\n                        prenotify: true,\n                               text: {\n
                    \'dialog.main.title\': \'Manage SpaceWeatherLive Browser Notifications\',\n
              \'tip.state.unsubscribed\': \'Subscribe to SpaceWeatherLive notifications\',\n
          \'tip.state.subscribed\': \'You're subscribed to SpaceWeatherLive notifications\'\n
   }\n                       },\n                              welcomeNotification: {\n                              "title": \'Sp
aceWeatherLive alerts\',\n                          "message": \'Thanks for subscribing to our service!\'\n
               },\n                        promptOptions: {\n                          showCredit: false\n
        }\n                 });\n                  });\n  </script>\n </body>\n</html>'
```

In [5]:

```python
#I get table data by using the find function, which saves the aforementioned table as a variable,
#called here as table
table = theSoup.find('table')
```

In [6]:

```python
#I use the preexisting pandas function, read_html, to read in the HTML file/table
#As mentioned in the project instructions, I made sure to type cast the data as a string
myTable = pd.read_html(str(table))[0]
#Changing the names of the columns to be as requested
myTable.columns = ['rank', 'x_classification', 'date', 'region', 'start_time', 'maximum_time', 'end_time', 'mov
myTable
```

Out[6]:

	rank	x_classification	date	region	start_time	maximum_time	end_time	movie
0	1	X28+	2003/11/04	486	19:29	19:53	20:06	MovieView archive
1	2	X20+	2001/04/02	9393	21:32	21:51	22:03	MovieView archive
2	3	X17.2+	2003/10/28	486	09:51	11:10	11:24	MovieView archive
3	4	X17+	2005/09/07	808	17:17	17:40	18:03	MovieView archive
4	5	X14.4	2001/04/15	9415	13:19	13:50	13:55	MovieView archive
5	6	X10	2003/10/29	486	20:37	20:49	21:01	MovieView archive
6	7	X9.4	1997/11/06	8100	11:49	11:55	12:01	MovieView archive
7	8	X9.3	2017/09/06	2673	11:53	12:02	12:10	MovieView archive
8	9	X9	2006/12/05	930	10:18	10:35	10:45	MovieView archive
9	10	X8.3	2003/11/02	486	17:03	17:25	17:39	MovieView archive
10	11	X8.2	2017/09/10	2673	15:35	16:06	16:31	MovieView archive
11	12	X7.1	2005/01/20	720	06:36	07:01	07:26	MovieView archive
12	13	X6.9	2011/08/09	1263	07:48	08:05	08:08	MovieView archive
13	14	X6.5	2006/12/06	930	18:29	18:47	19:00	MovieView archive
14	15	X6.2	2005/09/09	808	19:13	20:04	20:36	MovieView archive
15	16	X6.2	2001/12/13	9733	14:20	14:30	14:35	MovieView archive
16	17	X5.7	2000/07/14	9077	10:03	10:24	10:43	MovieView archive
17	18	X5.6	2001/04/06	9415	19:10	19:21	19:31	MovieView archive
18	19	X5.4	2012/03/07	1429	00:02	00:24	00:40	MovieView archive
19	20	X5.4	2005/09/08	808	20:52	21:06	21:17	MovieView archive
20	21	X5.4	2003/10/23	486	08:19	08:35	08:49	MovieView archive
21	22	X5.3	2001/08/25	9591	16:23	16:45	17:04	MovieView archive
22	23	X4.9	2014/02/25	1990	00:39	00:49	01:03	MovieView archive
23	24	X4.9	1998/08/18	8307	22:10	22:19	22:28	View archive
24	25	X4.8	2002/07/23	39	00:18	00:35	00:47	MovieView archive
25	26	X4	2000/11/26	9236	16:34	16:48	16:56	MovieView archive
26	27	X3.9	2003/11/03	488	09:43	09:55	10:19	MovieView archive
27	28	X3.9	1998/08/19	8307	21:35	21:45	21:50	View archive
28	29	X3.8	2005/01/17	720	06:59	09:52	10:07	MovieView archive
29	30	X3.7	1998/11/22	8384	06:30	06:42	06:49	MovieView archive
30	31	X3.6	2005/09/09	808	09:42	09:59	10:08	MovieView archive
31	32	X3.6	2004/07/16	649	13:49	13:55	14:01	MovieView archive
32	33	X3.6	2003/05/28	365	00:17	00:27	00:39	MovieView archive
33	34	X3.4	2006/12/13	930	02:14	02:40	02:57	MovieView archive
34	35	X3.4	2001/12/28	9767	20:02	20:45	21:32	MovieView archive
35	36	X3.3	2013/11/05	1890	22:07	22:12	22:15	MovieView archive
36	37	X3.3	2002/07/20	39	21:04	21:30	21:54	MovieView archive
37	38	X3.3	1998/11/28	8395	04:54	05:52	06:13	MovieView archive
38	39	X3.2	2013/05/14	1748	00:00	01:11	01:20	MovieView archive
39	40	X3.1	2014/10/24	2192	21:07	21:41	22:13	MovieView archive
40	41	X3.1	2002/08/24	69	00:49	01:12	01:31	MovieView archive
41	42	X3	2002/07/15	30	19:59	20:08	20:14	MovieView archive
42	43	X2.8	2013/05/13	1748	15:48	16:05	16:16	MovieView archive
43	44	X2.8	2001/12/11	9733	07:58	08:08	08:14	MovieView archive
44	45	X2.8	1998/08/18	8307	08:14	08:24	08:32	View archive
45	46	X2.7	2015/05/05	2339	22:05	22:11	22:15	MovieView archive
46	47	X2.7	2003/11/03	488	01:09	01:30	01:45	MovieView archive
47	48	X2.7	1998/05/06	8210	07:58	08:09	08:20	MovieView archive
48	49	X2.6	2005/01/15	720	22:25	23:02	23:31	MovieView archive
49	50	X2.6	2001/09/24	9632	09:32	10:38	11:09	MovieView archive

In [7]:

```python
#This is a second function I wrote to read the dataset in (in the case that the read_html method did not work,
#and I was running into some issues at first)

# table = theSoup.find('table')
# table_rows = table.find_all('tr')

# res = []
# for tr in table_rows:
#     td = tr.find_all('td')
#     row = [tr.text.strip() for tr in td if tr.text.strip()]
#     if row:
#         res.append(row)
# df = pd.DataFrame(columns=['rank', 'x_classification', 'date', 'region', 'start_time', 'maximum_time', 'end_t
# print(df)
```

Task 2: Tidy the Top 50 Solar Flare Data:

In [8]:

```python
# Dropping the last column of the table, since we will not use it moving forward
myTable = myTable.drop(columns = 'movie')
myTable
```

Out[8]:

	rank	x_classification	date	region	start_time	maximum_time	end_time
0	1	X28+	2003/11/04	486	19:29	19:53	20:06
1	2	X20+	2001/04/02	9393	21:32	21:51	22:03
2	3	X17.2+	2003/10/28	486	09:51	11:10	11:24
3	4	X17+	2005/09/07	808	17:17	17:40	18:03
4	5	X14.4	2001/04/15	9415	13:19	13:50	13:55
5	6	X10	2003/10/29	486	20:37	20:49	21:01
6	7	X9.4	1997/11/06	8100	11:49	11:55	12:01
7	8	X9.3	2017/09/06	2673	11:53	12:02	12:10
8	9	X9	2006/12/05	930	10:18	10:35	10:45
9	10	X8.3	2003/11/02	486	17:03	17:25	17:39
10	11	X8.2	2017/09/10	2673	15:35	16:06	16:31
11	12	X7.1	2005/01/20	720	06:36	07:01	07:26
12	13	X6.9	2011/08/09	1263	07:48	08:05	08:08
13	14	X6.5	2006/12/06	930	18:29	18:47	19:00
14	15	X6.2	2005/09/09	808	19:13	20:04	20:36
15	16	X6.2	2001/12/13	9733	14:20	14:30	14:35
16	17	X5.7	2000/07/14	9077	10:03	10:24	10:43
17	18	X5.6	2001/04/06	9415	19:10	19:21	19:31
18	19	X5.4	2012/03/07	1429	00:02	00:24	00:40
19	20	X5.4	2005/09/08	808	20:52	21:06	21:17
20	21	X5.4	2003/10/23	486	08:19	08:35	08:49
21	22	X5.3	2001/08/25	9591	16:23	16:45	17:04
22	23	X4.9	2014/02/25	1990	00:39	00:49	01:03
23	24	X4.9	1998/08/18	8307	22:10	22:19	22:28
24	25	X4.8	2002/07/23	39	00:18	00:35	00:47
25	26	X4	2000/11/26	9236	16:34	16:48	16:56
26	27	X3.9	2003/11/03	488	09:43	09:55	10:19
27	28	X3.9	1998/08/19	8307	21:35	21:45	21:50
28	29	X3.8	2005/01/17	720	06:59	09:52	10:07
29	30	X3.7	1998/11/22	8384	06:30	06:42	06:49
30	31	X3.6	2005/09/09	808	09:42	09:59	10:08
31	32	X3.6	2004/07/16	649	13:49	13:55	14:01
32	33	X3.6	2003/05/28	365	00:17	00:27	00:39
33	34	X3.4	2006/12/13	930	02:14	02:40	02:57
34	35	X3.4	2001/12/28	9767	20:02	20:45	21:32
35	36	X3.3	2013/11/05	1890	22:07	22:12	22:15
36	37	X3.3	2002/07/20	39	21:04	21:30	21:54
37	38	X3.3	1998/11/28	8395	04:54	05:52	06:13
38	39	X3.2	2013/05/14	1748	00:00	01:11	01:20
39	40	X3.1	2014/10/24	2192	21:07	21:41	22:13
40	41	X3.1	2002/08/24	69	00:49	01:12	01:31
41	42	X3	2002/07/15	30	19:59	20:08	20:14
42	43	X2.8	2013/05/13	1748	15:48	16:05	16:16
43	44	X2.8	2001/12/11	9733	07:58	08:08	08:14
44	45	X2.8	1998/08/18	8307	08:14	08:24	08:32
45	46	X2.7	2015/05/05	2339	22:05	22:11	22:15
46	47	X2.7	2003/11/03	488	01:09	01:30	01:45
47	48	X2.7	1998/05/06	8210	07:58	08:09	08:20
48	49	X2.6	2005/01/15	720	22:25	23:02	23:31
49	50	X2.6	2001/09/24	9632	09:32	10:38	11:09

In [9]:

```python
import datetime as dt
# Combining the date column with the time columns to convert to a datetime format
myTable_st = pd.to_datetime(myTable['date'] + ' ' + myTable['start_time'])
myTable_mt = pd.to_datetime(myTable['date'] + ' ' + myTable['maximum_time'])
myTable_et = pd.to_datetime(myTable['date'] + ' ' + myTable['end_time'])

# Adding the new columns of the datetimes to myTable
myTable['start_datetime'] = myTable_st
myTable['max_datetime'] = myTable_mt
myTable['end_datetime'] = myTable_et

# Droping the old columns
myTable = myTable.drop('date', 1)
myTable = myTable.drop('start_time', 1)
myTable = myTable.drop('maximum_time', 1)
myTable = myTable.drop('end_time', 1)

# Changing the order of the columns
myTable = myTable[['rank', 'x_classification', 'start_datetime', 'max_datetime', 'end_datetime', 'region']]

# Replace all instances of '-' with '<NA>' as stated by the prompt. It should be noted that there doesn't actua
#appear to be any missing regions in this dataset.
myTable = myTable.replace('-', np.nan)

print("Dataframe at end of Task 2 Size: ", myTable.shape)
myTable
```

Dataframe at end of Task 2 Size: (50, 6)

Out[9]:

	rank	x_classification	start_datetime	max_datetime	end_datetime	region
0	1	X28+	2003-11-04 19:29:00	2003-11-04 19:53:00	2003-11-04 20:06:00	486
1	2	X20+	2001-04-02 21:32:00	2001-04-02 21:51:00	2001-04-02 22:03:00	9393
2	3	X17.2+	2003-10-28 09:51:00	2003-10-28 11:10:00	2003-10-28 11:24:00	486
3	4	X17+	2005-09-07 17:17:00	2005-09-07 17:40:00	2005-09-07 18:03:00	808
4	5	X14.4	2001-04-15 13:19:00	2001-04-15 13:50:00	2001-04-15 13:55:00	9415
5	6	X10	2003-10-29 20:37:00	2003-10-29 20:49:00	2003-10-29 21:01:00	486
6	7	X9.4	1997-11-06 11:49:00	1997-11-06 11:55:00	1997-11-06 12:01:00	8100
7	8	X9.3	2017-09-06 11:53:00	2017-09-06 12:02:00	2017-09-06 12:10:00	2673
8	9	X9	2006-12-05 10:18:00	2006-12-05 10:35:00	2006-12-05 10:45:00	930
9	10	X8.3	2003-11-02 17:03:00	2003-11-02 17:25:00	2003-11-02 17:39:00	486
10	11	X8.2	2017-09-10 15:35:00	2017-09-10 16:06:00	2017-09-10 16:31:00	2673
11	12	X7.1	2005-01-20 06:36:00	2005-01-20 07:01:00	2005-01-20 07:26:00	720
12	13	X6.9	2011-08-09 07:48:00	2011-08-09 08:05:00	2011-08-09 08:08:00	1263
13	14	X6.5	2006-12-06 18:29:00	2006-12-06 18:47:00	2006-12-06 19:00:00	930
14	15	X6.2	2005-09-09 19:13:00	2005-09-09 20:04:00	2005-09-09 20:36:00	808
15	16	X6.2	2001-12-13 14:20:00	2001-12-13 14:30:00	2001-12-13 14:35:00	9733
16	17	X5.7	2000-07-14 10:03:00	2000-07-14 10:24:00	2000-07-14 10:43:00	9077
17	18	X5.6	2001-04-06 19:10:00	2001-04-06 19:21:00	2001-04-06 19:31:00	9415
18	19	X5.4	2012-03-07 00:02:00	2012-03-07 00:24:00	2012-03-07 00:40:00	1429
19	20	X5.4	2005-09-08 20:52:00	2005-09-08 21:06:00	2005-09-08 21:17:00	808
20	21	X5.4	2003-10-23 08:19:00	2003-10-23 08:35:00	2003-10-23 08:49:00	486
21	22	X5.3	2001-08-25 16:23:00	2001-08-25 16:45:00	2001-08-25 17:04:00	9591
22	23	X4.9	2014-02-25 00:39:00	2014-02-25 00:49:00	2014-02-25 01:03:00	1990
23	24	X4.9	1998-08-18 22:10:00	1998-08-18 22:19:00	1998-08-18 22:28:00	8307
24	25	X4.8	2002-07-23 00:18:00	2002-07-23 00:35:00	2002-07-23 00:47:00	39
25	26	X4	2000-11-26 16:34:00	2000-11-26 16:48:00	2000-11-26 16:56:00	9236
26	27	X3.9	2003-11-03 09:43:00	2003-11-03 09:55:00	2003-11-03 10:19:00	488
27	28	X3.9	1998-08-19 21:35:00	1998-08-19 21:45:00	1998-08-19 21:50:00	8307
28	29	X3.8	2005-01-17 06:59:00	2005-01-17 09:52:00	2005-01-17 10:07:00	720
29	30	X3.7	1998-11-22 06:30:00	1998-11-22 06:42:00	1998-11-22 06:49:00	8384
30	31	X3.6	2005-09-09 09:42:00	2005-09-09 09:59:00	2005-09-09 10:08:00	808
31	32	X3.6	2004-07-16 13:49:00	2004-07-16 13:55:00	2004-07-16 14:01:00	649
32	33	X3.6	2003-05-28 00:17:00	2003-05-28 00:27:00	2003-05-28 00:39:00	365
33	34	X3.4	2006-12-13 02:14:00	2006-12-13 02:40:00	2006-12-13 02:57:00	930
34	35	X3.4	2001-12-28 20:02:00	2001-12-28 20:45:00	2001-12-28 21:32:00	9767
35	36	X3.3	2013-11-05 22:07:00	2013-11-05 22:12:00	2013-11-05 22:15:00	1890
36	37	X3.3	2002-07-20 21:04:00	2002-07-20 21:30:00	2002-07-20 21:54:00	39
37	38	X3.3	1998-11-28 04:54:00	1998-11-28 05:52:00	1998-11-28 06:13:00	8395
38	39	X3.2	2013-05-14 00:00:00	2013-05-14 01:11:00	2013-05-14 01:20:00	1748
39	40	X3.1	2014-10-24 21:07:00	2014-10-24 21:41:00	2014-10-24 22:13:00	2192
40	41	X3.1	2002-08-24 00:49:00	2002-08-24 01:12:00	2002-08-24 01:31:00	69
41	42	X3	2002-07-15 19:59:00	2002-07-15 20:08:00	2002-07-15 20:14:00	30
42	43	X2.8	2013-05-13 15:48:00	2013-05-13 16:05:00	2013-05-13 16:16:00	1748
43	44	X2.8	2001-12-11 07:58:00	2001-12-11 08:08:00	2001-12-11 08:14:00	9733
44	45	X2.8	1998-08-18 08:14:00	1998-08-18 08:24:00	1998-08-18 08:32:00	8307
45	46	X2.7	2015-05-05 22:05:00	2015-05-05 22:11:00	2015-05-05 22:15:00	2339
46	47	X2.7	2003-11-03 01:09:00	2003-11-03 01:30:00	2003-11-03 01:45:00	488
47	48	X2.7	1998-05-06 07:58:00	1998-05-06 08:09:00	1998-05-06 08:20:00	8210
48	49	X2.6	2005-01-15 22:25:00	2005-01-15 23:02:00	2005-01-15 23:31:00	720
49	50	X2.6	2001-09-24 09:32:00	2001-09-24 10:38:00	2001-09-24 11:09:00	9632

Task 3: Scrape the NASA Data:

In [10]:

```python
#We now scrape the NASA data (http://cdaw.gsfc.nasa.gov/CME_list/radio/waves_type2.html) to get additional
#features/information about these solar flares

#Using requests to get page content, similar to Task 1:
r2 = rq.get('http://cdaw.gsfc.nasa.gov/CME_list/radio/waves_type2.html')
#Extracting the text from the page:
theText = r2.text
#Using BeautifulSoup to read and parse the data as html:
mySoup = bs(theText, 'html.parser')
#Using prettify to view the content and find the appropiate table
mySoup.prettify()
```

```
Out[12]: ['',
 'NOTE: List includes DH type II bursts observed by Wind spacecraft, ',
 'but after STEREO launch on Oct 2006 the start and end times and ',
 'frequencies of bursts are determined using both Wind and STEREO ',
 'observations',
 '',
 '==============================================================================================================',
 '                 DH Type II                              Flare                       CME                        ',
 '--------------------------------------------  -----------------  ---------------------------  Plots',
 'Start              End          Frequency      Loc    NOAA  Imp   Date  Time  CPA  Width  Spd         ',
 '(1)          (2)   (3)   (4)   (5)    (6)      (7)    (8)   (9)   (10)  (11)  (12)  (13)  (14)   (15) ',
 '==============================================================================================================',
 '1997/04/01 14:00 04/01 14:15  8000  4000   S25E16  8026 M1.3   04/01 15:18   74   79  312   PHTX',
 '1997/04/07 14:30 04/07 17:30 11000  1000   S28E19  8027 C6.8   04/07 14:27 Halo  360  878   PHTX',
 '1997/05/12 05:15 05/14 16:00 12000    80   N21W08  8038 C1.3   05/12 05:30 Halo  360  464   PHTX',
 '1997/05/21 20:20 05/21 22:00  5000   500   N05W12  8040 M1.3   05/21 21:00  263  165  296   PHTX',
 '1997/09/23 21:53 09/23 22:16  6000  2000   S29E25  8088 C1.4   09/23 22:02  133  155  712   PHTX',
 '1997/11/03 05:15 11/03 12:00 14000   250   S20W13  8100 C8.6   11/03 05:28  240  109  227   PHTX',
 '1997/11/03 10:30 11/03 11:30 14000  5000   S16W21  8100 M4.2   11/03 11:11  233  122  352   PHTX',
 '1997/11/04 06:00 11/05 04:30 14000   100   S14W33  8100 X2.1   11/04 06:10 Halo  360  785   PHTX',
 '1997/11/06 12:20 11/07 08:30 14000   100   S18W63  8100 X9.4   11/06 12:10 Halo  360 1556   PHTX',
 '1997/11/27 13:30 11/27 14:00 14000  7000   N17E63  8113 X2.6   11/27 13:56   98   91  441   PHTX',
 '1997/12/12 22:45 12/12 23:20 14000  8000   N25W52  8116 B9.4   12/13 00:26  278   73  191   PHTX',
 '1998/01/25 15:03 01/25 15:18 14000 10000   N21E25  8141 C1.1   01/25 15:26 Halo  360  693   PHTX',
 '1998/03/29 03:40 03/29 03:52 14000  7000     SW90 ----- ----   03/29 03:48 Halo  360 1397   PHTX',
 '1998/04/20 10:25 04/22 06:00 10000    35   S22W90  8194 M1.4   04/20 10:07  284  165 1863   PHTX',
 '1998/04/23 06:00 04/23 15:30 14000   200   S17E90  8210 X1.2   04/23 05:55 Halo  360 1691   PHTX',
 '1998/04/24 09:17 04/24 09:25  4700  2600   S20E90  8210 C8.9   04/24 08:55  100   84 1184   PHTX  uncertain',
 '1998/04/27 09:20 04/27 10:00 10000  1000   S16E50  8210 X1.0   04/27 08:56 Halo  360 1385   PHTX',
 '1998/04/29 16:30 04/29 17:00 10000  2000   S18E20  8210 M6.8   04/29 16:58 Halo  360 1374   PHTX',
 '1998/05/02 14:25 05/02 14:50  5000  3000   S15W15  8210 X1.1   05/02 14:06 Halo  360  938   PHTX',
 '1998/05/06 08:25 05/06 08:35 14000  5000   S11W65  8210 X2.7   05/06 08:29  309  190 1099   PHTX',
 '1998/05/09 03:35 05/09 10:00  9000   400   S14W89  8210 M7.7   05/09 03:35  262  178 2331   PHTX',
 '1998/05/11 21:40 05/11 22:00 10000  1000   N32W90  8214 B6.6   05/11 21:55  208 >301  830   PHTX',
 '1998/05/19 10:00 05/19 11:30 14000  3000   N23W43  8222 B5.7   05/19 10:27  268  139  801   PHTX',
 '1998/05/27 13:30 05/27 14:20  4000  1000   N19W62  8226 C7.5   05/27 13:45  175  268  878   PHTX',
 '1998/06/11 10:15 06/11 10:20  8000  4000   N16E86  8243 M1.4   06/11 10:28  123  177 1223   PHTX',
 '1998/06/16 18:20 06/17 21:00 12000    50   S22W90  8232 M1.0   06/16 18:27  341  281 1484   PHTX',
 '1998/06/20 19:39 06/20 20:00  2600  1800     BACK ----- ----   06/20 18:20 Halo  360  964   PHTX  uncertain',
 '1998/06/22 07:15 06/22 09:20  6000  2000   N16W46  8243 C2.9   06/22 05:01  265   59  206   PHTX',
 '1998/11/02 14:00 11/02 14:40 14000  4000   S25E44  8373 C4.4   11/02 14:18  116  169  661   PHTX',
 '1998/11/05 22:00 11/07 08:00  5000    50   N22W18  8375 M8.4   11/05 20:44 Halo  360 1118   PHTX',
 '1998/11/06 03:00 11/06 05:30  5000  1000     BACK ----- ----   11/06 02:18  159 >160  405   PHTX',
 '1998/11/07 00:20 11/07 00:50 14000  6000     BACK ----- ----   11/07 01:54  296   19  381   PHTX',
 '1998/11/08 11:20 11/08 11:30 10000  8000   S21W37 ----- C5.9   11/08 11:54  264  196  559   PHTX',
 '1998/12/18 17:50 12/18 18:15 14000  5000   N19E64  8415 M8.0   12/18 18:09 Halo  360 1749   PHTX',
 '1999/04/24 13:50 04/25 00:00  3700   100    NW90b ----- ----   04/24 13:31 Halo  360 1495   PHTX',
 '1999/05/03 05:50 05/03 08:45  8000   200   N15E32  8525 M4.4   05/03 06:06 Halo  360 1584   PHTX',
 '1999/05/27 10:55 05/28 10:00 14000    70     W90b ----- ----   05/27 11:06 Halo  360 1691   PHTX',
 '1999/06/01 18:50 06/02 09:00 14000   400    NW90b ----- ----   06/01 19:37 Halo  360 1772   PHTX',
 '1999/06/04 07:05 06/05 01:00 14000    60   N17W69  8552 M3.9   06/04 07:26  289  150 2230   PHTX',
 '1999/06/11 11:45 06/11 17:00 14000   400   N38E90 ----- C8.8   06/11 11:26   35 >181 1569   PHTX',
 '1999/06/22 18:25 06/22 18:40  3000  2000   N22E37  8592 M1.7   06/22 18:54 Halo  360 1133   PHTX',
 '1999/06/23 05:50 06/23 07:10 12000  2000     BACK ----- ----   06/23 06:06  264 >154  450   PHTX',
 '1999/06/23 07:07 06/23 07:14 14000  2000   N23E42  8596 M1.7   06/23 07:31 Halo  360 1006   PHTX  uncertain',
 '1999/06/28 21:03 06/28 21:10  3500  1500   N22W44  8592 C3.5   06/28 21:30  336 >184  903   PHTX',
 '1999/06/29 19:20 06/29 19:55 14000  2000   S14E01  8603 M1.6   06/29 19:54 Halo  360  560   PHTX',
 '1999/07/05 03:10 07/05 04:05  2000  1000    SW90b  8603 C7.6   07/05 02:54  284  190  670   PHTX',
 '1999/08/28 18:25 08/28 18:33 16000 12000   S26W14  8674 X1.1   08/28 18:26  120  245  462   PHTX',
 '1999/09/03 03:00 09/03 04:10  2000  1000   S36W24  8679 C2.1   09/03 00:06  184  175  512   PHTX',
 '1999/09/10 07:30 09/10 07:35  5500  2000    NW90b ----- ----   09/10 07:54   18  125 1467   PHTX',
 '1999/10/14 09:10 10/14 10:00 14000  4000   N11E32  8731 X1.8   10/14 09:26 Halo  360 1250   PHTX',
 '1999/10/17 23:27 10/17 23:33 11500 10000   N03E38 ----- ----   10/18 00:06   40   87  247   PHTX',
 '1999/11/16 03:27 11/16 03:48  7000  4000   N17E38  8766 M3.8   11/16 03:06   81   98  636   PHTX',
 '1999/11/16 05:17 11/16 05:34 14000  7000   N08W39  8759 M1.8   11/16 05:30  285  129  712   PHTX',
 '2000/01/18 17:31 01/18 22:00 14000   500   S19E11  8831 M3.9   01/18 17:54 Halo  360  739   PHTX',
 '2000/01/28 20:20 01/28 20:24  2200  1100   S31W17  8841 C4.7   01/28 20:12 Halo  360 1177   PHTX',
 '2000/02/05 19:34 02/05 19:38  5800  2900   N26E52  8858 X1.2   02/05 19:54   60   76  632   PHTX',
 '2000/02/08 09:05 02/11 02:20 12000    20   N25E26  8858 M1.3   02/08 09:30 Halo  360 1079   PHTX',
 '2000/02/10 01:55 02/10 02:00 14000  8000   N31E04  8858 C7.3   02/10 02:30 Halo  360  944   PHTX',
 '2000/02/12 03:55 02/12 09:20  4000   400   N26W23  8858 M1.7   02/12 04:31 Halo  360 1107   PHTX',
 '2000/02/17 20:42 02/18 22:12 14000   100   S29E07  8872 M1.3   02/17 21:30 Halo  360  728   PHTX',
 '2000/02/18 09:44 02/18 09:54  2000  1200    NW90b ----- C1.1   02/18 09:54  286  118  890   PHTX',
 '2000/03/02 13:50 03/02 14:03 14000  6000   S20W58  8882 M6.5   03/02 13:54  235   76  835   PHTX',
 '2000/03/07 16:24 03/07 16:48 14000  4500   S22E77  8906 M1.2   03/07 16:30  120  108  644   PHTX',
 '2000/03/27 06:56 03/27 06:58 14000 10000   S00E90  8932 C2.3   03/27 07:31  129   90  487   PHTX',
 '2000/04/04 15:45 04/04 16:00 14000  9000   N16W66  8933 C9.7   04/04 16:32 Halo  360 1188   PHTX',
 '2000/04/09 23:15 04/09 23:45  4500  1000   S14W01  8948 M3.1   04/10 00:30 Halo  360  409   PHTX',
 '2000/04/18 15:00 04/18 16:00 14000  6000   S50W30  altr FILA   04/18 14:54  195  105  668   PHTX',
 '2000/05/04 11:10 05/04 13:00  6500  1000   S17W87  8970 M6.8   05/04 11:26  235 >170 1404   PHTX',
 '2000/05/05 16:35 05/05 17:30 14000  2500   S17W87  8970 M1.5   05/05 15:50 Halo  360 1594   PHTX',
 '2000/05/07 21:15 05/07 24:00 14000   500     W90b ----- ----   05/07 20:50 Halo  360 1781   PHTX',
 '2000/05/12 23:34 05/12 23:42 14000  7000     E90b ----- ----   05/12 23:26 Halo  360 2604   PHTX',
 '2000/05/15 16:47 05/16 14:00  4800    40   S24W67  8993 C7.8   05/15 16:26  257 >165 1212   PHTX',
 '2000/06/02 22:00 06/02 22:15 14000  8000   N16E60  9026 M7.6   06/02 21:30   69  104  547   PHTX',
 '2000/06/06 15:20 06/08 09:00 14000    40   N20E18  9026 X2.3   06/06 15:54 Halo  360 1119   PHTX',
 '2000/06/10 17:15 06/10 18:45 10000  1000   N22W38  9026 M5.2   06/10 17:08 Halo  360 1108   PHTX',
 '2000/06/15 19:52 06/15 19:56  5000  2500   N20W65  9041 M1.8   06/15 20:06  298  116 1081   PHTX',
 '2000/06/17 03:00 06/17 04:15 14000  1000   N22W72  9041 M3.5   06/17 03:28  298  133  857   PHTX',
 '2000/06/23 14:40 06/23 15:05 14000  2000   N26W72  9042 M3.0   06/23 14:54  282 >198  847   PHTX',
 '2000/06/25 08:10 06/25 09:00 12000  2500   N16W55  9046 M1.9   06/25 07:54  262  165 1617   PHTX',
 '2000/07/10 22:00 07/10 23:30 14000  1000   N18E49  9077 M5.7   07/10 21:50   67 >289 1352   PHTX',
 '2000/07/11 13:00 07/11 13:30 12000  1000   N18E27  9077 X1.0   07/11 13:27 Halo  360 1078   PHTX',
 '2000/07/12 20:05 07/12 20:35  6000  1000   N19W61  9070 M1.5   07/12 20:30  281  101  820   PHTX',
 '2000/07/14 10:30 07/15 14:30 14000    80   N22W07  9077 X5.7   07/14 10:54 Halo  360 1674   PHTX',
 '2000/07/22 11:45 07/22 12:45 14000  2000   N14W56  9085 M3.7   07/22 11:54  259 >229 1230   PHTX',
 '2000/08/11 11:35 08/11 11:59  2800  2000    NW90b ----- ----   08/11 07:31  273   70 1071   PHTX  uncertain',
 '2000/09/12 12:00 09/13 12:20 14000    60   S19W06   DSF M1.0   09/12 11:54 Halo  360 1550   PHTX',
 '2000/09/12 18:15 09/12 19:00  2000  1000    NE90b ----- ----   09/12 17:30 Halo  360 1053   PHTX',
 '2000/09/16 04:30 09/16 10:30 14000   400   N14W07  9165 M5.9   09/16 05:18 Halo  360 1215   PHTX',
 '2000/09/19 08:45 09/19 10:20 12000  1500   N14W46  9165 M5.1   09/19 08:50  283   76  766   PHTX',
 '2000/09/25 02:20 09/25 03:00 14000  1000   N09W18  9169 M1.8   09/25 02:50 Halo  360  587   PHTX',
 '2000/10/16 07:10 10/16 08:00 14000  1000   N03W90  9182 M2.5   10/16 07:27 Halo  360 1336   PHTX',
 '2000/10/25 09:30 10/25 24:00 10000   300   N09W63  9199 C4.0   10/25 08:26 Halo  360  770   PHTX',
 '2000/11/03 18:35 11/03 18:45  4000  2500   N02W02  9213 C3.2   11/03 18:26 Halo  360  291   PHTX',
 '2000/11/08 23:20 11/09 12:00  4000   200   N10W77  9213 M7.4   11/08 23:06  271 >170 1738   PHTX',
 '2000/11/09 16:15 11/11 04:00 10000    40   S11E10  9221 M1.0   --/-- --:-- ---- ---- ----   PHTX  CME_not_mea
surable_due_to_the_Snow_Storm',
 '2000/11/12 14:25 11/12 14:40  3000  2000   S14E05  9227 C4.4   11/12 14:50  257   50  581   PHTX',
 '2000/11/23 08:16 11/23 08:35 14000  9000   S26W40  9238 C5.4   11/23 06:06 Halo  360  492   PHTX',
 '2000/11/23 21:00 11/23 21:06  3500  3000   S20E60  9239 C7.9   11/23 21:30  124  148 1198   PHTX',
 '2000/11/24 05:10 11/24 15:00 14000   100   N20W05  9236 X2.0   11/24 05:30 Halo  360 1289   PHTX',
 '2000/11/24 15:25 11/24 22:00 14000   200   N22W07  9236 X2.3   11/24 15:30 Halo  360 1245   PHTX',
 '2000/11/24 22:24 11/24 22:36  4000  3000   N21W14  9236 X1.8   11/24 22:06 Halo  360 1005   PHTX',
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 '2000/11/25 19:00 11/25 19:35  6000  2000   N20W23  9236 X1.9   11/25 19:31 Halo  360  671   PHTX',
 '2000/11/25 19:55 11/25 20:25 13000  4000   N20W27  9236 ----   11/25 21:30  345   59  388   PHTX',
 '2000/11/26 17:00 11/26 17:15 14000  7000   N18W38  9236 X4.0   11/26 17:06 Halo  360  980   PHTX',
 '2000/12/28 12:40 12/28 13:38 14000  1900     Back ----- ----   12/28 12:06 Halo  360  930   PHTX',
 '2001/01/20 19:12 01/20 19:16 14000  6000   S07E40  9313 M1.2   01/20 19:31 Halo  360  839   PHTX',
 '2001/01/20 21:30 01/20 24:00 14000   500   S07E46  9313 M7.7   01/20 21:30 Halo  360 1507   PHTX',
 '2001/01/26 12:06 01/26 14:20 14000   400   S23W57  9320 C1.6   01/26 12:06  276  176  928   PHTX',
 '2001/01/28 15:45 01/28 17:00 14000   200   S04W59  9313 M1.5   01/28 15:54 Halo  360  916   PHTX',
 '2001/02/11 01:40 02/11 01:55 12000  5500   N24W57  9346 C6.5   02/11 01:31 Halo  360 1183   PHTX',
 '2001/03/10 04:18 03/10 04:32 14000  4000   N27W42  9368 M6.7   03/10 04:26  297   81  819   PHTX',
 '2001/03/12 05:35 03/12 05:45  3000  1500     BACK ----- ----   03/12 05:50  233   48  829   PHTX',
 '2001/03/27 02:35 03/27 03:15  6000  1000   N14E17  9393 C7.3   03/27 02:06  154   60  300   PHTX',
 '2001/03/27 15:00 03/27 15:20  4000  1500   N15E14  9393 C5.6   03/27 17:06   46   66  340   PHTX',
 '2001/03/29 10:12 03/30 06:00  4000    60   N20W19  9393 X1.7   03/29 10:26 Halo  360  942   PHTX',
 '2001/04/02 11:30 04/02 12:00 14000  5000   N20W70  9393 X1.1   04/02 11:26  270   80  992   PHTX',
 '2001/04/02 22:05 04/03 02:30 14000   250   N19W72  9393 X20.   04/02 22:06  261  244 2505   PHTX',
 '2001/04/03 03:40 04/03 07:25 14000   400   S21E83  9415 X1.2   04/03 03:26  108  292 1613   PHTX',
 '2001/04/04 09:50 04/04 10:10 13000  3000   S21E68  9415 M1.6   04/04 09:50   86   89 1065   PHTX',
 '2001/04/05 09:14 04/05 09:34 14000  7500   N14W85  9393 M8.4   04/05 09:06  283  205 1750   PHTX  uncertain',
 '2001/04/06 19:35 04/07 01:50 14000   230   S21E31  9415 X5.6   04/06 19:30 Halo  360 1270   PHTX  Double type
II, CME-CME interaction?',
 '2001/04/09 15:53 04/10 01:00 12000   100   S21W04  9415 M7.9   04/09 15:54 Halo  360 1192   PHTX',
 '2001/04/10 05:24 04/10 24:00 14000   100   S23W09  9415 X2.3   04/10 05:30 Halo  360 2411   PHTX',
 '2001/04/11 13:15 04/11 14:15 14000  1500   S22W27  9415 M2.3   04/11 13:31 Halo  360 1103   PHTX',
 '2001/04/12 10:20 04/12 10:40 14000  7000   S19W43  9415 X2.0   04/12 10:31 Halo  360 1184   PHTX',
 '2001/04/15 14:05 04/16 13:00 14000    40   S20W85  9415 X14.   04/15 14:06  245  167 1199   PHTX',
 '2001/04/18 02:55 04/18 14:00  1000   100    SW90b ----- C2.2   04/18 02:30 Halo  360 2465   PHTX',
 '2001/04/26 12:40 04/28 05:00  5000    20   N20W05  9433 M1.5   04/26 12:30 Halo  360 1006   PHTX',
 '2001/05/07 12:00 05/07 13:50  2000   280    NW90b ----- ----   05/07 12:06  286  205 1223   PHTX',
 '2001/05/12 23:52 05/13 00:12  3000  1000   S17E00  9455 M3.0   05/13 02:21  190  132  527   PHTX',
 '2001/05/30 00:25 05/30 01:38 14000  1000     E90b  9481 ----   05/30 00:06   70  216 2087   PHTX',
 '2001/06/15 10:50 06/15 11:15  7000  3000   S26E41  9502 M6.3   06/15 10:31  185  119 1090   PHTX',
 '2001/06/15 16:05 06/15 16:20 14000  3500     W90b ----- ----   06/15 15:56 Halo  360 1701   PHTX',
 '2001/08/16 00:10 08/16 16:10  5400   150     Back ----- ----   08/15 23:54 Halo  360 1575   PHTX',
 '2001/08/25 16:50 08/25 23:00  8000   170   S17E34  9591 X5.3   08/25 16:50 Halo  360 1433   PHTX',
 '2001/08/30 20:43 08/30 20:47 12000 10000   N15E44  9601 M3.0   08/30 21:26   82   76  351   PHTX',
 '2001/09/03 18:48 09/03 19:00 12000  7500   S23E90  9607 M2.5   09/03 18:35  127  207 1352   PHTX',
 '2001/09/15 11:50 09/15 12:05 14000  6000   S21W49  9608 M1.5   09/15 11:54  263  130  478   PHTX',
 '2001/09/16 13:50 09/16 14:10  3000  2000   S13E15  9616 C8.9   09/16 14:30  131   68  584   PHTX',
 '2001/09/17 08:35 09/17 08:47 14000  5400   S14E04  9616 M1.5   09/17 08:54  198  166 1009   PHTX',
 '2001/09/20 18:43 09/20 18:57 14000 10000   N09W11  9631 M1.5   09/20 19:31  306  207  446   PHTX',
 '2001/09/24 10:45 09/25 20:00  7000    30   S16E23  9632 X2.6   09/24 10:30 Halo  360 2402   PHTX',
 '2001/09/27 08:15 09/28 07:00  4000    80   S15W40    EP C9.5   09/27 08:06  224  138  669   PHTX',
 '2001/10/01 07:00 10/01 18:30  1000   150   S24W81  9628 M9.1   10/01 05:30 Halo  360 1405   PHTX',
 '2001/10/05 11:35 10/05 12:55  1400   500    SW90b ----- ----   10/05 10:30 Halo  360 1537   PHTX',
 '2001/10/09 11:15 10/09 16:00  8000   200   S28E08  9653 M1.4   10/09 11:30 Halo  360  973   PHTX',
 '2001/10/09 11:20 10/09 11:55 14000  2000   S28E08  9653 ----   --/-- --:-- ---- ---- ----   PHTX  ------',
 '2001/10/09 13:10 10/09 23:00  5000    50     BACK ----- ----   --/-- --:-- ---- ---- ----   PHTX  Possible HA
LO',
 '2001/10/19 01:15 10/19 02:25 14000  1300   N16W18  9661 X1.6   10/19 01:27 Halo  360  558   PHTX',
 '2001/10/19 16:45 10/21 16:40 14000    30   N15W29  9661 X1.6   10/19 16:50 Halo  360  901   PHTX',
 '2001/10/22 15:15 10/22 17:40  8000  1200   S21E18  9672 M6.7   10/22 15:06 Halo  360 1336   PHTX',
 '2001/10/25 15:30 10/27 23:00 14000    30   S16W21  9672 X1.3   10/25 15:26 Halo  360 1092   PHTX',
 '2001/11/04 16:30 11/06 11:00 14000    70   N06W18  9684 X1.0   11/04 16:35 Halo  360 1810   PHTX',
 '2001/11/17 05:35 11/17 06:40 11000  1700   S13E42  9704 M2.8   11/17 05:30 Halo  360 1379   PHTX  uncertain',
 '2001/11/22 20:50 11/22 22:23  8000  1000   S25W67  9698 M3.8   11/22 20:30 Halo  360 1443   PHTX',
 '2001/11/22 22:40 11/24 02:30 14000    40   S17W36  9704 M9.9   11/22 23:30 Halo  360 1437   PHTX',
 '2001/12/11 12:45 12/11 17:00  4500   750    SW90b ----- ----   12/11 09:54  263  121  891   PHTX',
 '2001/12/25 11:25 12/25 12:40 14000  1000    SE90b ----- ----   12/25 11:30 Halo  360 1773   PHTX',
 '2001/12/26 05:20 12/27 05:00 14000   150   N08W54  9742 M7.1   12/26 05:30  281 >212 1446   PHTX',
 '2001/12/28 20:35 12/29 03:00 14000   350   S26E90  9756 X3.4   12/28 20:30 Halo  360 2216   PHTX',
 '2001/12/29 20:45 12/29 21:05  3000  1500     BACK ----- ----   12/29 20:30  297 >211  819   PHTX',
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 '2002/01/14 06:25 01/14 21:30 12000   100   S28W83  9772 M4.4   01/14 05:35 Halo  360 1492   PHTX',
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re',
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d feature',
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GAP',
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CO_DATA_GAP',
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GAP',
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GAP',
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ot_measurable',
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eraction',
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GAP',
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Gap. Lower f may be 500 kHz.',
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 '2015/06/22 18:20 06/22 21:55 14000   300   N12W08 12371 M6.5   06/22 18:36 Halo  360 1209   PHTX',
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 '2015/08/22 07:07 08/22 07:18 14000  7300   S15E13 12403 M1.2   08/22 07:12 Halo  360  547   PHTX',
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 '2017/04/23 06:00 04/23 06:13 15000  8300   N16E41 ----- ----   04/23 06:00   85   77  955   PHTX',
 '2017/07/14 01:18 07/14 21:30 14000    70   S06W29 12665 M2.4   07/14 01:25 Halo  360 1200   PHTX',
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 '2017/09/10 16:02 09/11 06:50 16000   150   S09W92 ----- X8.3   09/10 16:00 Halo  360 3163   PHTX  onset has W
AVES Data Gap',
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 '2017/09/17 11:45 09/17 12:35 16000   900  S08E170 ----- ----   09/17 12:00 Halo  360 1385   PHTX  STEREO A da
ta',
 '2017/10/18 05:48 10/18 12:40 16000   400  S06E123 ----- ----   10/18 08:00   85  146 1001   PHTX  STEREO A da
ta, faint in WIND',
 '2019/05/03 23:52 05/04 00:16 13000  2300   N12E82 12740 C1.0   05/03 23:24   90  113  692   PHTX',
 '2020/11/29 13:07 11/29 15:23 14000   850   S23E89 ----- M4.4   11/29 13:25 Halo  360 2077   ----',
 '2020/12/07 16:18 12/08 02:00 14000   160   S25W08 12790 C7.4   12/07 16:24 Halo  360 1407   ----',
 '==============================================================================================================',
 '']
```

As can be seen, we need to remove the unnecessary first 12 rows as well as the last 2 rows.

```
In [13]: #Removing the first 12 unnecessary lines
         for i in range(0,12):
             dataRows.pop(0)
         #Remove the last two useless lines
         dataRows.pop(len(dataRows)-1)
         dataRows.pop(len(dataRows)-1)

         dataRows
```

```
Out[13]: ['1997/04/01 14:00 04/01 14:15  8000  4000    S25E16  8026 M1.3    04/01 15:18   74   79  312    PHTX',
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 '1997/09/23 21:53 09/23 22:16  6000  2000    S29E25  8088 C1.4    09/23 22:02  133  155  712    PHTX',
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 '1998/04/29 16:30 04/29 17:00 10000  2000    S18E20  8210 M6.8    04/29 16:58 Halo  360 1374    PHTX',
 '1998/05/02 14:25 05/02 14:50  5000  3000    S15W15  8210 X1.1    05/02 14:06 Halo  360  938    PHTX',
 '1998/05/06 08:25 05/06 08:35 14000  5000    S11W65  8210 X2.7    05/06 08:29  309  190 1099    PHTX',
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 '1998/05/19 10:00 05/19 11:30 14000  3000    N23W43  8222 B5.7    05/19 10:27  268  139  801    PHTX',
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 '1999/06/22 18:25 06/22 18:40  3000  2000    N22E37  8592 M1.7    06/22 18:54 Halo  360 1133    PHTX',
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 '2001/04/02 22:05 04/03 02:30 14000   250    N19W72  9393 X20.    04/02 22:06  261  244 2505    PHTX',
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II, CME-CME interaction?',
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d feature',
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 '2014/06/10 12:58 06/10 15:00 16000  1000    S17E82 12087 X1.5    06/10 13:30 Halo  360 1469    PHTX',
 '2014/06/12 22:14 06/12 22:35 14000  6000    S20W55 12085 M3.1    06/12 22:12  233  186  684    PHTX',
 '2014/07/30 07:44 07/30 08:00  6300  4500    N10E30   EP? C1.5    07/30 07:00   13  254  700    PHTX',
 '2014/08/01 18:58 08/02 05:00  1000   150    S10E11 12127 M1.5    08/01 18:36 Halo 360h  789    PHTX',
 '2014/08/22 10:37 08/22 11:18 14000  6000    N12E01 12146 C2.2    08/22 11:12 Halo  360  600    PHTX',
 '2014/08/25 15:20 08/25 16:02 14000  4000    N05W36 12146 M2.0    08/25 15:36 Halo  360  555    PHTX',
 '2014/08/25 20:43 08/25 21:00 14000  7200    N07W43 12146 M3.9    08/25 20:48  273  177  711    PHTX',
 '2014/08/28 17:05 08/28 22:08 16000   600   S19E162 12157 ----    08/28 17:24 Halo  360  766    PHTX',
 '2014/09/01 11:12 09/01 20:05 16000   150   N14E127 12158 ----    09/01 11:12 Halo  360 1901    PHTX  WAVES Data
Gap. STEREO B data',
 '2014/09/09 00:05 09/09 13:00 11000   100    N12E29 12158 M4.5    09/09 00:06 Halo  360  920    PHTX',
 '2014/09/10 17:45 09/11 12:00 14000   100    N14E02 12158 X1.6    09/10 18:00 Halo  360 1267    PHTX',
 '2014/09/20 05:10 09/20 05:30 14000  9700    S11W89 12164 ----    09/20 05:24  292   87  426    PHTX',
 '2014/09/22 06:13 09/22 06:50 16000  4900   N14W142 12158 ----    09/22 06:12  342  252  618    PHTX',
 '2014/09/23 23:41 09/23 23:47 14000 12000    S13E33 12172 M2.3    09/23 23:36  109  134  331    PHTX',
 '2014/09/24 20:54 09/24 23:48 16000   500   N13E179    EP ----    09/24 21:30 Halo  360 1350    PHTX',
 '2014/10/02 21:34 10/02 21:56  3300  1900    S17W82 12173 M7.3    10/02 19:12  264  159  513    PHTX  faint',
 '2014/10/10 18:11 10/10 18:33  2500  1500    S20W51    EP C3.0    10/10 16:12  309 >210  782    PHTX',
 '2014/10/21 12:33 10/21 13:01  8900  1300    S18E46 12192 C4.4    10/21 12:12  152  142  260    PHTX',
 '2014/11/08 16:57 11/08 17:18 14000  7800      W90b 12203 ----    11/08 16:36  305  121  426    PHTX',
 '2014/12/13 14:27 12/13 14:51 14000  4800      W90b ----- ----    12/13 14:24 Halo  360 2222    PHTX',
 '2014/12/17 04:09 12/17 04:19  2900  2100    S11E33 12241 M1.1    12/17 02:00  107  108  869    PHTX',
 '2014/12/17 05:00 12/17 05:09 14000 11500    S20E09 12242 M8.7    12/17 05:00 Halo  360  587    PHTX',
 '2014/12/18 22:31 12/18 22:54  5100  1300    S11E15 12241 M6.9    12/19 01:04 Halo  360 1195    PHTX  PARTIAL LAS
CO_DATA_GAP',
 '2014/12/21 12:05 12/21 12:28 14000  7400    S14W25 12241 M1.0    12/21 12:12 Halo  360  669    PHTX',
 '2015/03/03 02:33 03/03 02:37  8100  3600      W90b 12290 M8.2    03/03 01:48 Halo  329  213  764    PHTX',
 '2015/03/06 08:00 03/06 11:30  4700   200    S20E87 12297 M1.5    03/06 07:12   83  155  880    PHTX',
 '2015/03/10 00:10 03/10 00:27 14000  6200    S18E45 12297 M5.8    03/10 00:00 Halo  360  995    PHTX',
 '2015/03/11 10:30 03/11 14:50  1000   250    S15E23 12297 M2.6    03/11 08:24   62   93  530    PHTX',
 '2015/03/24 09:00 03/24 11:47 14000   400      SW90b ----- ----    03/24 08:24 Halo  360 1794    PHTX',
 '2015/04/26 03:21 04/26 03:33  8000  4600      W90b ----- ----    04/26 03:24 Halo  360  820    PHTX',
 '2015/05/05 22:24 05/05 23:14 14000   500    N15E79 12339 X2.7    05/05 22:24 Halo  360  715    PHTX',
 '2015/05/12 03:00 05/12 03:04 14000  6400      W90b ----- ----    05/12 02:48  286  250  772    PHTX  uncertain',
 '2015/06/09 20:23 06/09 22:35  2300   200    S03E25 12364 C2.8    06/09 20:12   77  262 1036    PHTX',
 '2015/06/14 05:26 06/14 05:41  3000  1250    S12W34 12365 C5.9    06/14 04:12  199  195 1228    PHTX',
 '2015/06/18 17:42 06/18 19:40  3700   500    N15E50 12371 M3.0    06/18 17:24 Halo  360 1305    PHTX',
 '2015/06/21 02:33 06/21 21:20  5500   150    N12E16 12371 M2.0    06/21 02:36 Halo  360 1366    PHTX',
 '2015/06/22 18:20 06/22 21:55 14000   300    N12W08 12371 M6.5    06/22 18:36 Halo  360 1209    PHTX',
 '2015/06/25 08:35 06/25 16:30 14000   150    N09W42 12371 M7.9    06/25 08:36 Halo  360 1627    PHTX',
 '2015/07/01 16:08 07/01 20:47  1000   150      W90b ----- ----    07/01 14:36 Halo  360 1435    PHTX',
 '2015/08/22 07:07 08/22 07:18 14000  7300    S15E13 12403 M1.2    08/22 07:12 Halo  360  547    PHTX',
 '2015/09/18 04:54 09/18 09:52 14000   400    S21W10 12415 C2.6    09/18 05:00  201  131  823    PHTX',
 '2015/09/20 18:23 09/21 01:46 14000   300    S20W24 12415 M2.1    09/20 18:12 Halo  360 1239    PHTX',
 '2015/11/04 14:07 11/04 15:14 14000   440    N09W04 12443 M3.7    11/04 14:48 Halo  360  578    PHTX',
 '2015/11/09 13:21 11/09 13:27 14000  9000    S11E41 12449 M3.9    11/09 13:25  142  273 1041    PHTX',
 '2015/12/16 08:45 12/16 08:57  5300  3800    S13W04 12468 C6.6    12/16 09:36 Halo  360  579    PHTX',
 '2015/12/23 01:18 12/23 01:23 12000  6700    S22E63 12473 M4.7    12/23 01:25   98   89  520    PHTX',
 '2015/12/28 11:50 12/28 21:45 14000   180    S23W11 12473 M1.8    12/28 12:12 Halo  360 1212    PHTX',
 '2016/01/02 00:55 01/02 03:08  1100   300    S25W82 12473 M2.3    01/01 23:24 Halo  360 1730    PHTX',
 '2016/02/05 20:28 02/05 23:31  1650   500     ------ ----- ----    --/-- --:-- ---- ---- ----    PHTX  uncertain',
 '2016/02/05 22:35 02/05 22:55  5200  1900    S17W29 ----- ----    02/05 21:24  193  155  445    PHTX',
 '2016/05/04 14:20 05/04 14:34 14000 10500    N06W61 12535 C1.3    05/04 14:12  255  134  390    PHTX',
 '2016/05/24 17:00 05/24 20:50  1500   700     ------ ----- ----    --/-- --:-- ---- ---- ----    PHTX  uncertain',
 '2016/08/15 18:21 08/15 18:28 11000  3400      E90b ----- ----    08/15 17:24   75   98  633    PHTX',
 '2017/04/23 06:00 04/23 06:13 15000  8300    N16E41 ----- ----    04/23 06:00   85   77  955    PHTX',
 '2017/07/14 01:18 07/14 21:30 14000    70    S06W29 12665 M2.4    07/14 01:25 Halo  360 1200    PHTX',
 '2017/07/23 05:27 07/23 06:12  4400   900      BACK ----- ----    07/23 04:48 Halo  360 1848    PHTX  faint',
 '2017/09/04 20:27 09/05 04:54 14000   210    S10W12 12673 M5.5    09/04 20:12 Halo  360 1418    PHTX',
 '2017/09/06 12:05 09/07 08:00 16000    70    S08W33 12673 X9.3    09/06 12:24 Halo  360 1571    PHTX',
 '2017/09/10 16:02 09/11 06:50 16000   150    S09W92 ----- X8.3    09/10 16:00 Halo  360 3163    PHTX  onset has W
AVES Data Gap',
 '2017/09/12 07:38 09/12 07:43 16000 13000    N08E48 12680 C3.0    09/12 08:03  124   96  252    PHTX  uncertain',
 '2017/09/17 11:45 09/17 12:35 16000   900   S08E170 ----- ----    09/17 12:00 Halo  360 1385    PHTX  STEREO A da
ta',
 '2017/10/18 05:48 10/18 12:40 16000   400   S06E123 ----- ----    10/18 08:00   85  146 1001    PHTX  STEREO A da
ta, faint in WIND',
 '2019/05/03 23:52 05/04 00:16 13000  2300    N12E82 12740 C1.0    05/03 23:24   90  113  692    PHTX',
 '2020/11/29 13:07 11/29 15:23 14000   850    S23E89 ----- M4.4    11/29 13:25 Halo  360 2077    ----',
 '2020/12/07 16:18 12/08 02:00 14000   160    S25W08 12790 C7.4    12/07 16:24 Halo  360 1407    ----']
```

```
In [14]:
# Creating the Dataframe with the data in dataRows array. Names are chosen for the columns as suggested in the
#example in the instructions:

# Making an empty table:
tableNASAdf = pd.DataFrame(columns = ['start_date', 'start_time', 'end_date', 'end_time', 'start_frequency', 'e

#Filling the table by iterating through each line in dataRows:
#Creating a row counter, which is helpful for accurately inputting the data into the table, 'tableNASAdf'
rowNum = 0
for line in dataRows:
    #Split the data wherever there is a space for that 'line':
    features = line.split(' ')
    #After running the code once, I realized that there was extra spacing adding in certain areas to line
    #the data up evenly.Thus, we remove any spaces being treated as extra 'features' that were created by
    #the line.split(' ') above.
    while '' in features:
        features.remove('')
    #Adding the data to the DataFrame, tableNASAdf:
    columnNum = 0
    while (columnNum < 14):
        #After examining the dataset, it appears that column 15, the plots, were added after this assignment
        #was written.Therefore, to adhere to the guidelines of the assignment, we ignore this last column
        #(and any other extra information that appears after it), which does not seem to be important for our
        #purposes anyways. We see later in task 4 that the example dataset preview includes the plot column,
        #but I still believe this column will not help us with the rest of our assignment; therefore,
        #I will keep this column out still.
        if (columnNum == 15):
            break
        tableNASAdf.iat[rowNum, columnNum] = features[columnNum]
        columnNum += 1
    rowNum += 1
tableNASAdf
```

Out[14]:

	start_date	start_time	end_date	end_time	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_date	cm
0	1997/04/01	14:00	04/01	14:15	8000	4000	S25E16	8026	M1.3	04/01	
1	1997/04/07	14:30	04/07	17:30	11000	1000	S28E19	8027	C6.8	04/07	
2	1997/05/12	05:15	05/14	16:00	12000	80	N21W08	8038	C1.3	05/12	
3	1997/05/21	20:20	05/21	22:00	5000	500	N05W12	8040	M1.3	05/21	
4	1997/09/23	21:53	09/23	22:16	6000	2000	S29E25	8088	C1.4	09/23	
...	...	...	...	...	...	...	...	...	...	...	
517	2017/09/17	11:45	09/17	12:35	16000	900	S08E170	-----	----	09/17	
518	2017/10/18	05:48	10/18	12:40	16000	400	S06E123	-----	----	10/18	
519	2019/05/03	23:52	05/04	00:16	13000	2300	N12E82	12740	C1.0	05/03	
520	2020/11/29	13:07	11/29	15:23	14000	850	S23E89	-----	M4.4	11/29	
521	2020/12/07	16:18	12/08	02:00	14000	160	S25W08	12790	C7.4	12/07	

522 rows × 14 columns

We note that our table has more data than the example table in the assignment because the assignment's table only includes data up to 2014, while ours includes data up to 2020 (as the website was updated).

Task 4: Tidy the NASA Table:

```
In [15]:
#First, we recode any missing entries at NaN. After looking carefully at the NASA data and the data descriptio
#I have found that:
#---- and ----- are missing data entries that can exist in multiple columns (for Flare and CME data),
#???? is a missing data entry that can appear in the frequency columns and indicates that the starting
#and ending frequencies are not determined,
# --/-- is a missing data entry that can appear in the date column for CME,
# and --:-- is a missing data entry that can appear in the time column for CME.
#Replacing these missing entries:
tableNASAdf = tableNASAdf.replace('----', np.nan)
tableNASAdf = tableNASAdf.replace('---', np.nan)
tableNASAdf = tableNASAdf.replace('-----', np.nan)
tableNASAdf = tableNASAdf.replace('????', np.nan)
tableNASAdf = tableNASAdf.replace('--/--', np.nan)
tableNASAdf = tableNASAdf.replace('--:--', np.nan)
tableNASAdf = tableNASAdf.replace(to_replace = '360h', value = '360') #There was a typo in the table in which a

tableNASAdf
```

Out[15]:

	start_date	start_time	end_date	end_time	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_date	cm
0	1997/04/01	14:00	04/01	14:15	8000	4000	S25E16	8026	M1.3	04/01	
1	1997/04/07	14:30	04/07	17:30	11000	1000	S28E19	8027	C6.8	04/07	
2	1997/05/12	05:15	05/14	16:00	12000	80	N21W08	8038	C1.3	05/12	
3	1997/05/21	20:20	05/21	22:00	5000	500	N05W12	8040	M1.3	05/21	
4	1997/09/23	21:53	09/23	22:16	6000	2000	S29E25	8088	C1.4	09/23	
...	...	...	...	...	...	...	...	...	...	...	
517	2017/09/17	11:45	09/17	12:35	16000	900	S08E170	NaN	NaN	09/17	
518	2017/10/18	05:48	10/18	12:40	16000	400	S06E123	NaN	NaN	10/18	
519	2019/05/03	23:52	05/04	00:16	13000	2300	N12E82	12740	C1.0	05/03	
520	2020/11/29	13:07	11/29	15:23	14000	850	S23E89	NaN	M4.4	11/29	
521	2020/12/07	16:18	12/08	02:00	14000	160	S25W08	12790	C7.4	12/07	

522 rows × 14 columns

```
In [16]:
#The CPA column (cme_angle) contains angles in degrees for most rows, except for halo flares,
#which are coded as Halo.
#I create a new column that indicates if a row corresponds to a halo flare or not,
#and then replace Halo entries in the cme_angle column with NaN:

#Creating and filling new 'is_halo' column as indicated:
tableNASAdf['is_halo'] = tableNASAdf['cme_angle'].map(lambda x: x == 'Halo')

#Replacing "Halo" with 'NaN'
tableNASAdf = tableNASAdf.replace('Halo', np.nan)

tableNASAdf
```

Out[16]:

	start_date	start_time	end_date	end_time	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_date	cm
0	1997/04/01	14:00	04/01	14:15	8000	4000	S25E16	8026	M1.3	04/01	
1	1997/04/07	14:30	04/07	17:30	11000	1000	S28E19	8027	C6.8	04/07	
2	1997/05/12	05:15	05/14	16:00	12000	80	N21W08	8038	C1.3	05/12	
3	1997/05/21	20:20	05/21	22:00	5000	500	N05W12	8040	M1.3	05/21	
4	1997/09/23	21:53	09/23	22:16	6000	2000	S29E25	8088	C1.4	09/23	
...	...	...	...	...	...	...	...	...	...	...	
517	2017/09/17	11:45	09/17	12:35	16000	900	S08E170	NaN	NaN	09/17	
518	2017/10/18	05:48	10/18	12:40	16000	400	S06E123	NaN	NaN	10/18	
519	2019/05/03	23:52	05/04	00:16	13000	2300	N12E82	12740	C1.0	05/03	
520	2020/11/29	13:07	11/29	15:23	14000	850	S23E89	NaN	M4.4	11/29	
521	2020/12/07	16:18	12/08	02:00	14000	160	S25W08	12790	C7.4	12/07	

522 rows × 15 columns

```
In [17]:
#A helper function to use in map function below to determine if a given string is an integer/number:
def isInteger(string):
    try:
        #Check if the string is a float because NaN values are floats; integers will work here as well
        float(string)
        return True
    except ValueError:
        return False
```

```
In [18]:
#The width column indicates if the given value is a lower bound.
# I create a new column that indicates if width is given as a lower bound, and remove any non-numeric part
#of the width column:

#Creating and filling new 'width_lower_bound' column as indicated:
tableNASAdf['width_lower_bound'] = tableNASAdf['cme_width'].map(lambda x: str(x)[0] == '>')

#Removing any non-numeric part of the width column:
tableNASAdf['cme_width'] = tableNASAdf['cme_width'].map(lambda x: x if isInteger(x) else x[1:])

#Here, I display the first 50 columns to clearly demonstrate that we have completed the task as requested.
tableNASAdf.head(50)
```

Out[18]:

	start_date	start_time	end_date	end_time	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_date	cme_
0	1997/04/01	14:00	04/01	14:15	8000	4000	S25E16	8026	M1.3	04/01	
1	1997/04/07	14:30	04/07	17:30	11000	1000	S28E19	8027	C6.8	04/07	
2	1997/05/12	05:15	05/14	16:00	12000	80	N21W08	8038	C1.3	05/12	
3	1997/05/21	20:20	05/21	22:00	5000	500	N05W12	8040	M1.3	05/21	
4	1997/09/23	21:53	09/23	22:16	6000	2000	S29E25	8088	C1.4	09/23	
5	1997/11/03	05:15	11/03	12:00	14000	250	S20W13	8100	C8.6	11/03	
6	1997/11/03	10:30	11/03	11:30	14000	5000	S16W21	8100	M4.2	11/03	
7	1997/11/04	06:00	11/05	04:30	14000	100	S14W33	8100	X2.1	11/04	
8	1997/11/06	12:20	11/07	08:30	14000	100	S18W63	8100	X9.4	11/06	
9	1997/11/27	13:30	11/27	14:00	14000	7000	N17E63	8113	X2.6	11/27	
10	1997/12/12	22:45	12/12	23:20	14000	8000	N25W52	8116	B9.4	12/13	
11	1998/01/25	15:03	01/25	15:18	14000	10000	N21E25	8141	C1.1	01/25	
12	1998/03/29	03:40	03/29	03:52	14000	7000	SW90	NaN	NaN	03/29	
13	1998/04/20	10:25	04/22	06:00	10000	35	S22W90	8194	M1.4	04/20	
14	1998/04/23	06:00	04/23	15:30	14000	200	S17E90	8210	X1.2	04/23	
15	1998/04/24	09:17	04/24	09:25	4700	2600	S20E90	8210	C8.9	04/24	
16	1998/04/27	09:20	04/27	10:00	10000	1000	S16E50	8210	X1.0	04/27	
17	1998/04/29	16:30	04/29	17:00	10000	2000	S18E20	8210	M6.8	04/29	
18	1998/05/02	14:25	05/02	14:50	5000	3000	S15W15	8210	X1.1	05/02	
19	1998/05/06	08:25	05/06	08:35	14000	5000	S11W65	8210	X2.7	05/06	
20	1998/05/09	03:35	05/09	10:00	9000	400	S14W89	8210	M7.7	05/09	
21	1998/05/11	21:40	05/11	22:00	10000	1000	N32W90	8214	B6.6	05/11	
22	1998/05/19	10:00	05/19	11:30	14000	3000	N23W43	8222	B5.7	05/19	
23	1998/05/27	13:30	05/27	14:20	4000	1000	N19W62	8226	C7.5	05/27	
24	1998/06/11	10:15	06/11	10:20	8000	4000	N16E86	8243	M1.4	06/11	
25	1998/06/16	18:20	06/17	21:00	12000	50	S22W90	8232	M1.0	06/16	
26	1998/06/20	19:39	06/20	20:00	2600	1800	BACK	NaN	NaN	06/20	
27	1998/06/22	07:15	06/22	09:20	6000	2000	N16W46	8243	C2.9	06/22	
28	1998/11/02	14:00	11/02	14:40	14000	4000	S25E44	8373	C4.4	11/02	
29	1998/11/05	22:00	11/07	08:00	5000	50	N22W18	8375	M8.4	11/05	
30	1998/11/06	03:00	11/06	05:30	5000	1000	BACK	NaN	NaN	11/06	
31	1998/11/07	00:20	11/07	00:50	14000	6000	BACK	NaN	NaN	11/07	
32	1998/11/08	11:20	11/08	11:30	10000	8000	S21W37	NaN	C5.9	11/08	
33	1998/12/18	17:50	12/18	18:15	14000	5000	N19E64	8415	M8.0	12/18	
34	1999/04/24	13:50	04/25	00:00	3700	100	NW90b	NaN	NaN	04/24	
35	1999/05/03	05:50	05/03	08:45	8000	200	N15E32	8525	M4.4	05/03	
36	1999/05/27	10:55	05/28	10:00	14000	70	W90b	NaN	NaN	05/27	
37	1999/06/01	18:50	06/02	09:00	14000	400	NW90b	NaN	NaN	06/01	
38	1999/06/04	07:05	06/05	01:00	14000	60	N17W69	8552	M3.9	06/04	
39	1999/06/11	11:45	06/11	17:00	14000	400	N38E90	NaN	C8.8	06/11	
40	1999/06/22	18:25	06/22	18:40	3000	2000	N22E37	8592	M1.7	06/22	
41	1999/06/23	05:50	06/23	07:10	12000	2000	BACK	NaN	NaN	06/23	
42	1999/06/23	07:07	06/23	07:14	14000	2000	N23E42	8596	M1.7	06/23	
43	1999/06/28	21:03	06/28	21:10	3500	1500	N22W44	8592	C3.5	06/28	
44	1999/06/29	19:20	06/29	19:55	14000	2000	S14E01	8603	M1.6	06/29	
45	1999/07/05	03:10	07/05	04:05	2000	1000	SW90b	8603	C7.6	07/05	
46	1999/08/28	18:25	08/28	18:33	16000	12000	S26W14	8674	X1.1	08/28	
47	1999/09/03	03:00	09/03	04:10	2000	1000	S36W24	8679	C2.1	09/03	
48	1999/09/10	07:30	09/10	07:35	5500	2000	NW90b	NaN	NaN	09/10	
49	1999/10/14	09:10	10/14	10:00	14000	4000	N11E32	8731	X1.8	10/14	

```
In [19]:
#Finally, we combine the data and time columns for start, end, and cme so they can be encoded as datetime objec

#The to_datetime method runs into issues with the times that say 24:00 in the NASA dataset
#(as the interval should only be between 0:00 and 23:59, and 24:00 should be 0:00 of the next day),
#so rather than deal with all the various cases before converting the time to a date time format
#(for example, the day being incremented by one may lead to a new month with some months and not others
#because some months have 30 days and others have 31), I change the 24:00 times in the dataset to 23:59,
#and will increment the time by 1 second once it is in a to_datetime format.
#It can be noted that, after looking closely at the dataset, all 24:00 times exist in the 'end_time' column,
#but it will make no diffrence to do the replace across the entire dataset, as done below:
tableNASAdf = tableNASAdf.replace(to_replace = '24:00', value = '23:59')
tableNASAdf.head(70)

# Combining the date column with the time columns to convert to a datetime format
tableNASAdf_st = pd.to_datetime(tableNASAdf['start_date'] + ' ' + tableNASAdf['start_time'])
tableNASAdf_et = pd.to_datetime(tableNASAdf['start_date'].str[:5] + tableNASAdf['end_date'] + ' ' + tableNASAdf
tableNASAdf_cmet = pd.to_datetime(tableNASAdf['start_date'].str[:5] + tableNASAdf['cme_date'] + ' ' + tableNASA
```

```
In [20]:
#Converting 23:59 times back to 24:00 times for each of our 3 lists.
#We note that the dataset did not consists of any 23:59 times before we set the 24:00 values to 23:59,
#so we are not falsifying any data
for dateTime in range(len(tableNASAdf_st)):
    if (str(dt.datetime.strptime(str(tableNASAdf_st[dateTime]), "%Y-%m-%d %H:%M:%S").time()) == "23:59:00"):
        #print(tableNASAdf_st[dateTime])
        tableNASAdf_st[dateTime] = tableNASAdf_st[dateTime] + dt.timedelta(0,60)
        #print(tableNASAdf_st[dateTime])
for dateTime in range(len(tableNASAdf_et)):
    if (str(dt.datetime.strptime(str(tableNASAdf_et[dateTime]), "%Y-%m-%d %H:%M:%S").time()) == "23:59:00"):
        #print(tableNASAdf_et[dateTime])
        tableNASAdf_et[dateTime] = tableNASAdf_et[dateTime] + dt.timedelta(0,60)
        #print(tableNASAdf_et[dateTime])
for dateTime in range(len(tableNASAdf_cmet)):
    if ((str(tableNASAdf_cmet[dateTime]) != 'NaT') and str(dt.datetime.strptime(str(tableNASAdf_cmet[dateTime])
        #print(tableNASAdf_cmet[dateTime])
        tableNASAdf_cmet[dateTime] = tableNASAdf_cmet[dateTime] + dt.timedelta(0,60)
        #print(tableNASAdf_cmet[dateTime])
```

```
In [21]:
# Adding the new columns of the datetimes to tableNASAdf
tableNASAdf['start_datetime'] = tableNASAdf_st
tableNASAdf['end_datetime'] = tableNASAdf_et
tableNASAdf['cme_datetime'] = tableNASAdf_cmet

# Droping the old columns
tableNASAdf = tableNASAdf.drop('start_date', 1)
tableNASAdf = tableNASAdf.drop('start_time', 1)
tableNASAdf = tableNASAdf.drop('end_date', 1)
tableNASAdf = tableNASAdf.drop('end_time', 1)
tableNASAdf = tableNASAdf.drop('cme_date', 1)
tableNASAdf = tableNASAdf.drop('cme_time', 1)

tableNASAdf
```

Out[21]:

	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_angle	cme_width	cme_speed	is_halo	width_lower_bo
0	8000	4000	S25E16	8026	M1.3	74	79	312	False	
1	11000	1000	S28E19	8027	C6.8	NaN	360	878	True	
2	12000	80	N21W08	8038	C1.3	NaN	360	464	True	
3	5000	500	N05W12	8040	M1.3	263	165	296	False	
4	6000	2000	S29E25	8088	C1.4	133	155	712	False	
...	...	...	...	...	...	...	...	...	...	
517	16000	900	S08E170	NaN	NaN	NaN	360	1385	True	
518	16000	400	S06E123	NaN	NaN	85	146	1001	False	
519	13000	2300	N12E82	12740	C1.0	90	113	692	False	
520	14000	850	S23E89	NaN	M4.4	NaN	360	2077	True	
521	14000	160	S25W08	12790	C7.4	NaN	360	1407	True	

522 rows × 13 columns

```
In [22]:
#Rearranging the columns to match the order seen in the example
#(NOTE: we use different names for some of them for consistency with our past code,
#and we do not include the plot attribute for the reason stated earlier):
tableNASAdf = tableNASAdf[['start_datetime', 'end_datetime', 'start_frequency',
                    'end_frequency', 'flare_location', 'flare_region','flare_classification',
                    'cme_datetime', 'cme_angle', 'cme_width', 'cme_speed', 'is_halo',
                    'width_lower_bound']]
tableNASAdf
```

Out[22]:

	start_datetime	end_datetime	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_datetime	cme_angle
0	1997-04-01 14:00:00	1997-04-01 14:15:00	8000	4000	S25E16	8026	M1.3	1997-04-01 15:18:00	74
1	1997-04-07 14:30:00	1997-04-07 17:30:00	11000	1000	S28E19	8027	C6.8	1997-04-07 14:27:00	NaN
2	1997-05-12 05:15:00	1997-05-14 16:00:00	12000	80	N21W08	8038	C1.3	1997-05-12 05:30:00	NaN
3	1997-05-21 20:20:00	1997-05-21 22:00:00	5000	500	N05W12	8040	M1.3	1997-05-21 21:00:00	263
4	1997-09-23 21:53:00	1997-09-23 22:16:00	6000	2000	S29E25	8088	C1.4	1997-09-23 22:02:00	133
...	...	...	...	...	...	...	...	...	...
517	2017-09-17 11:45:00	2017-09-17 12:35:00	16000	900	S08E170	NaN	NaN	2017-09-17 12:00:00	NaN
518	2017-10-18 05:48:00	2017-10-18 12:40:00	16000	400	S06E123	NaN	NaN	2017-10-18 08:00:00	85
519	2019-05-03 23:52:00	2019-05-04 00:16:00	13000	2300	N12E82	12740	C1.0	2019-05-03 23:24:00	90
520	2020-11-29 13:07:00	2020-11-29 15:23:00	14000	850	S23E89	NaN	M4.4	2020-11-29 13:25:00	NaN
521	2020-12-07 16:18:00	2020-12-08 02:00:00	14000	160	S25W08	12790	C7.4	2020-12-07 16:24:00	NaN

522 rows × 13 columns

Part 2: Analysis:

Task 5: Replication:

In [23]:

```python
#We need to get JUST the top 50 solar flares from the NASA table based on their classification
#(with X28 being the highest).Thus, we will create a copy of our tableNASAdf for temporary use
#(mainly to remove rows that had nan values for their flare_classification)
tableNASAdfCopy = tableNASAdf.copy()
tableNASAdfCopy = tableNASAdfCopy.dropna(subset = ['flare_classification'])
tableNASAdfCopy
```

Out[23]:

	start_datetime	end_datetime	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_datetime	cme_angle
0	1997-04-01 14:00:00	1997-04-01 14:15:00	8000	4000	S25E16	8026	M1.3	1997-04-01 15:18:00	74
1	1997-04-07 14:30:00	1997-04-07 17:30:00	11000	1000	S28E19	8027	C6.8	1997-04-07 14:27:00	NaN
2	1997-05-12 05:15:00	1997-05-14 16:00:00	12000	80	N21W08	8038	C1.3	1997-05-12 05:30:00	NaN
3	1997-05-21 20:20:00	1997-05-21 22:00:00	5000	500	N05W12	8040	M1.3	1997-05-21 21:00:00	263
4	1997-09-23 21:53:00	1997-09-23 22:16:00	6000	2000	S29E25	8088	C1.4	1997-09-23 22:02:00	133
...	...	...	...	...	...	...	...	...	...
515	2017-09-10 16:02:00	2017-09-11 06:50:00	16000	150	S09W92	NaN	X8.3	2017-09-10 16:00:00	NaN
516	2017-09-12 07:38:00	2017-09-12 07:43:00	16000	13000	N08E48	12680	C3.0	2017-09-12 08:03:00	124
519	2019-05-03 23:52:00	2019-05-04 00:16:00	13000	2300	N12E82	12740	C1.0	2019-05-03 23:24:00	90
520	2020-11-29 13:07:00	2020-11-29 15:23:00	14000	850	S23E89	NaN	M4.4	2020-11-29 13:25:00	NaN
521	2020-12-07 16:18:00	2020-12-08 02:00:00	14000	160	S25W08	12790	C7.4	2020-12-07 16:24:00	NaN

407 rows × 13 columns

In [24]:

```python
#Now we will grab just the rows that have a flare classification with X (and store it in a new dataframe):
topFlaresdf = tableNASAdfCopy.loc[tableNASAdfCopy['flare_classification'].str.contains('X')]
#For ease of use, I will get rid of the X character at the beginning and add it back after sorting:
topFlaresdf['flare_classification'] = topFlaresdf['flare_classification'].str.lstrip('X').astype(float)
#Now, sorting the rows:
topFlaresdf = topFlaresdf.sort_values('flare_classification', ascending = False)
#Taking just the top 50:
topFlaresdf = topFlaresdf.head(50)
#Placing back the 'X' character for the flare_classficiation:
topFlaresdf['flare_classification'] = topFlaresdf.flare_classification.astype(str)
topFlaresdf['flare_classification'] = "X" + topFlaresdf['flare_classification']
topFlaresdf
```

```
<ipython-input-24-6ed48779540b>:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ret
urning-a-view-versus-a-copy
  topFlaresdf['flare_classification'] = topFlaresdf['flare_classification'].str.lstrip('X').astype(float)
```

Out[24]:

	start_datetime	end_datetime	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_datetime	cme_angle
240	2003-11-04 20:00:00	2003-11-05 00:00:00	10000	200	S19W83	10486	X28.0	2003-11-04 19:54:00	NaN
117	2001-04-02 22:05:00	2001-04-03 02:30:00	14000	250	N19W72	9393	X20.0	2001-04-02 22:06:00	261
233	2003-10-28 11:10:00	2003-10-30 00:00:00	14000	40	S16E08	10486	X17.0	2003-10-28 11:30:00	NaN
126	2001-04-15 14:05:00	2001-04-16 13:00:00	14000	40	S20W85	9415	X14.0	2001-04-15 14:06:00	245
234	2003-10-29 20:55:00	2003-10-30 00:00:00	11000	500	S15W02	10486	X10.0	2003-10-29 20:54:00	NaN
8	1997-11-06 12:20:00	1997-11-07 08:30:00	14000	100	S18W63	8100	X9.4	1997-11-06 12:10:00	NaN
514	2017-09-06 12:05:00	2017-09-07 08:00:00	16000	70	S08W33	12673	X9.3	2017-09-06 12:24:00	NaN
328	2006-12-05 10:50:00	2006-12-05 20:00:00	14000	250	S07E68	10930	X9.0	NaT	NaN
237	2003-11-02 17:30:00	2003-11-03 01:00:00	12000	250	S14W56	10486	X8.3	2003-11-02 17:30:00	NaN
515	2017-09-10 16:02:00	2017-09-11 06:50:00	16000	150	S09W92	NaN	X8.3	2017-09-10 16:00:00	NaN
288	2005-01-20 07:15:00	2005-01-20 16:30:00	14000	25	N14W61	10720	X7.1	2005-01-20 06:54:00	NaN
359	2011-08-09 08:20:00	2011-08-09 08:35:00	16000	4000	N17W69	11263	X6.9	2011-08-09 08:12:00	NaN
331	2006-12-06 19:00:00	2006-12-09 00:00:00	16000	30	S05E64	10930	X6.5	NaT	NaN
317	2005-09-09 19:45:00	2005-09-09 22:00:00	10000	50	S12E67	10808	X6.2	2005-09-09 19:48:00	NaN
82	2000-07-14 10:30:00	2000-07-15 14:30:00	14000	80	N22W07	9077	X5.7	2000-07-14 10:54:00	NaN
121	2001-04-06 19:35:00	2001-04-07 01:50:00	14000	230	S21E31	9415	X5.6	2001-04-06 19:30:00	NaN
375	2012-03-07 01:00:00	2012-03-08 19:00:00	16000	30	N17E27	11429	X5.4	2012-03-07 00:24:00	NaN
135	2001-08-25 16:50:00	2001-08-25 23:00:00	8000	170	S17E34	9591	X5.3	2001-08-25 16:50:00	NaN
443	2014-02-25 00:56:00	2014-02-25 11:28:00	14000	100	S12E82	11990	X4.9	2014-02-25 01:25:00	NaN
193	2002-07-23 00:50:00	2002-07-23 04:00:00	11000	400	S13E72	10039	X4.8	2002-07-23 00:42:00	NaN
104	2000-11-26 17:00:00	2000-11-26 17:15:00	14000	7000	N18W38	9236	X4.0	2000-11-26 17:06:00	NaN
239	2003-11-03 10:00:00	2003-11-03 12:30:00	6000	400	N08W77	10488	X3.9	2003-11-03 10:06:00	293
286	2005-01-17 10:00:00	2005-01-17 10:35:00	6100	1500	N15W25	10720	X3.8	2005-01-17 09:54:00	NaN
222	2003-05-28 01:00:00	2003-05-29 00:30:00	1000	200	S07W20	10365	X3.6	2003-05-28 00:50:00	NaN
332	2006-12-13 02:45:00	2006-12-13 10:40:00	12000	150	S06W23	10930	X3.4	2006-12-13 02:54:00	NaN
160	2001-12-28 20:35:00	2001-12-29 03:00:00	14000	350	S26E90	9756	X3.4	2001-12-28 20:30:00	NaN
192	2002-07-20 21:30:00	2002-07-20 22:20:00	10000	2000	S13E90	10039	X3.3	2002-07-20 22:06:00	NaN
404	2013-05-14 01:16:00	2013-05-14 08:20:00	16000	240	N08E77	11748	X3.2	2013-05-14 01:25:00	NaN
201	2002-08-24 01:45:00	2002-08-24 03:25:00	5000	400	S02W81	10069	X3.1	2002-08-24 01:27:00	NaN
403	2013-05-13 16:15:00	2013-05-13 19:10:00	16000	300	N11E85	11748	X2.8	2013-05-13 16:07:00	NaN
487	2015-05-05 22:24:00	2015-05-05 23:14:00	14000	500	N15E79	12339	X2.7	2015-05-05 22:24:00	NaN
19	1998-05-06 08:25:00	1998-05-06 08:35:00	14000	5000	S11W65	8210	X2.7	1998-05-06 08:29:00	309
238	2003-11-03 01:15:00	2003-11-03 01:25:00	3000	1500	N10W83	10488	X2.7	2003-11-03 01:59:00	304
284	2005-01-15 23:00:00	2005-01-17 00:00:00	3000	40	N15W05	10720	X2.6	2005-01-15 23:06:00	NaN
142	2001-09-24 10:45:00	2001-09-25 20:00:00	7000	30	S16E23	9632	X2.6	2001-09-24 10:30:00	NaN
9	1997-11-27 13:30:00	1997-11-27 14:00:00	14000	7000	N17E63	8113	X2.6	1997-11-27 13:56:00	98
276	2004-11-10 02:25:00	2004-11-10 03:40:00	14000	1000	N09W49	10696	X2.5	2004-11-10 02:26:00	NaN
123	2001-04-10 05:24:00	2001-04-11 00:00:00	14000	100	S23W09	9415	X2.3	2001-04-10 05:30:00	NaN
99	2000-11-24 15:25:00	2000-11-24 22:00:00	14000	200	N22W07	9236	X2.3	2000-11-24 15:30:00	NaN
73	2000-06-06 15:20:00	2000-06-08 09:00:00	14000	40	N20E18	9026	X2.3	2000-06-06 15:54:00	NaN
345	2011-02-15 02:10:00	2011-02-15 07:00:00	16000	400	S20W12	11158	X2.2	2011-02-15 02:24:00	NaN
318	2005-09-10 21:45:00	2005-09-11 01:00:00	14000	200	S13E47	10808	X2.1	2005-09-10 21:52:00	NaN
361	2011-09-06 22:30:00	2011-09-07 15:40:00	16000	150	N14W18	11283	X2.1	2011-09-06 23:05:00	NaN
420	2013-10-25 15:08:00	2013-10-25 22:32:00	16000	200	S06E69	11882	X2.1	2013-10-25 15:12:00	NaN
7	1997-11-04 06:00:00	1997-11-05 04:30:00	14000	100	S14W33	8100	X2.1	1997-11-04 06:10:00	NaN
98	2000-11-24 05:10:00	2000-11-24 15:00:00	14000	100	N20W05	9236	X2.0	2000-11-24 05:30:00	NaN
125	2001-04-12 10:20:00	2001-04-12 10:40:00	14000	7000	S19W43	9415	X2.0	2001-04-12 10:31:00	NaN
274	2004-11-07 16:25:00	2004-11-08 20:00:00	14000	60	N09W17	10696	X2.0	2004-11-07 16:54:00	NaN
285	2005-01-17 09:25:00	2005-01-17 16:00:00	14000	30	N15W25	10720	X2.0	2005-01-17 09:30:00	NaN
102	2000-11-25 19:00:00	2000-11-25 19:35:00	6000	2000	N20W23	9236	X1.9	2000-11-25 19:31:00	NaN

In [25]:

```python
#To get a table that is directly comparable to the SpaceWeatherLive table (myTable),
#we will just look at the flare_classificiation, start_datetime, cme_datetime, end_datetime, and flare_region
topFlaresdf = topFlaresdf.reset_index()
topFlaresdf = topFlaresdf[['flare_classification', 'start_datetime', 'cme_datetime', 'end_datetime', 'flare_reg
#Renaming some of the columns to match the names seen in the SWL data
topFlaresdf = topFlaresdf.rename(columns={'flare_classification': 'x_classification', 'cme_datetime': 'max_date
#We do not really need the rank column in the SpaceWeatherLive table because they are already sorted
#in decreasing order, so we will drop that column in a copy of the dataframe.
tableSWL = myTable.drop(columns = 'rank')

#Comparing the two tables side by side (in a concatenated table):
dfCompare = pd.concat([tableSWL, topFlaresdf], axis = 1, keys=['SWL Data', 'NASA Data'])
dfCompare
```

Out[25]:

	SWL Data					NASA Data				
	x_classification	start_datetime	max_datetime	end_datetime	region	x_classification	start_datetime	max_datetime	end_datetime	region
0	X28+	2003-11-04 19:29:00	2003-11-04 19:53:00	2003-11-04 20:06:00	486	X28.0	2003-11-04 20:00:00	2003-11-04 19:54:00	2003-11-05 00:00:00	10486
1	X20+	2001-04-02 21:32:00	2001-04-02 21:51:00	2001-04-02 22:03:00	9393	X20.0	2001-04-02 22:05:00	2001-04-02 22:06:00	2001-04-03 02:30:00	9393
2	X17.2+	2003-10-28 09:51:00	2003-10-28 11:10:00	2003-10-28 11:24:00	486	X17.0	2003-10-28 11:10:00	2003-10-28 11:30:00	2003-10-30 00:00:00	10486
3	X17+	2005-09-07 17:17:00	2005-09-07 17:40:00	2005-09-07 18:03:00	808	X14.0	2001-04-15 14:05:00	2001-04-15 14:06:00	2001-04-16 13:00:00	9415
4	X14.4	2001-04-15 13:19:00	2001-04-15 13:50:00	2001-04-15 13:55:00	9415	X10.0	2003-10-29 20:55:00	2003-10-29 20:54:00	2003-10-30 00:00:00	10486
5	X10	2003-10-29 20:37:00	2003-10-29 20:49:00	2003-10-29 21:01:00	486	X9.4	1997-11-06 12:20:00	1997-11-06 12:10:00	1997-11-07 08:30:00	8100
6	X9.4	1997-11-06 11:49:00	1997-11-06 11:55:00	1997-11-06 12:01:00	8100	X9.3	2017-09-06 12:05:00	2017-09-06 12:24:00	2017-09-07 08:00:00	12673
7	X9.3	2017-09-06 11:53:00	2017-09-06 12:02:00	2017-09-06 12:10:00	2673	X9.0	2006-12-05 10:50:00	NaT	2006-12-05 20:00:00	10930
8	X9	2006-12-05 10:18:00	2006-12-05 10:35:00	2006-12-05 10:45:00	930	X8.3	2003-11-02 17:30:00	2003-11-02 17:30:00	2003-11-03 01:00:00	10486
9	X8.3	2003-11-02 17:03:00	2003-11-02 17:25:00	2003-11-02 17:39:00	486	X8.3	2017-09-10 16:02:00	2017-09-10 16:00:00	2017-09-11 06:50:00	NaN
10	X8.2	2017-09-10 15:35:00	2017-09-10 16:06:00	2017-09-10 16:31:00	2673	X7.1	2005-01-20 07:15:00	2005-01-20 06:54:00	2005-01-20 16:30:00	10720
11	X7.1	2005-01-20 06:36:00	2005-01-20 07:01:00	2005-01-20 07:26:00	720	X6.9	2011-08-09 08:20:00	2011-08-09 08:12:00	2011-08-09 08:35:00	11263
12	X6.9	2011-08-09 07:48:00	2011-08-09 08:05:00	2011-08-09 08:08:00	1263	X6.5	2006-12-06 19:00:00	NaT	2006-12-09 00:00:00	10930
13	X6.5	2006-12-06 18:29:00	2006-12-06 18:47:00	2006-12-06 19:00:00	930	X6.2	2005-09-09 19:45:00	2005-09-09 19:48:00	2005-09-09 22:00:00	10808
14	X6.2	2005-09-09 19:13:00	2005-09-09 20:04:00	2005-09-09 20:36:00	808	X5.7	2000-07-14 10:30:00	2000-07-14 10:54:00	2000-07-15 14:30:00	9077
15	X6.2	2001-12-13 14:20:00	2001-12-13 14:30:00	2001-12-13 14:35:00	9733	X5.6	2001-04-06 19:35:00	2001-04-06 19:30:00	2001-04-07 01:50:00	9415
16	X5.7	2000-07-14 10:03:00	2000-07-14 10:24:00	2000-07-14 10:43:00	9077	X5.4	2012-03-07 01:00:00	2012-03-07 00:24:00	2012-03-08 19:00:00	11429
17	X5.6	2001-04-06 19:10:00	2001-04-06 19:21:00	2001-04-06 19:31:00	9415	X5.3	2001-08-25 16:50:00	2001-08-25 16:50:00	2001-08-25 23:00:00	9591
18	X5.4	2012-03-07 00:02:00	2012-03-07 00:24:00	2012-03-07 00:40:00	1429	X4.9	2014-02-25 00:56:00	2014-02-25 01:25:00	2014-02-25 11:28:00	11990
19	X5.4	2005-09-08 20:52:00	2005-09-08 21:06:00	2005-09-08 21:17:00	808	X4.8	2002-07-23 00:50:00	2002-07-23 00:42:00	2002-07-23 04:00:00	10039
20	X5.4	2003-10-23 08:19:00	2003-10-23 08:35:00	2003-10-23 08:49:00	486	X4.0	2000-11-26 17:00:00	2000-11-26 17:06:00	2000-11-26 17:15:00	9236
21	X5.3	2001-08-25 16:23:00	2001-08-25 16:45:00	2001-08-25 17:04:00	9591	X3.9	2003-11-03 10:00:00	2003-11-03 10:06:00	2003-11-03 12:30:00	10488
22	X4.9	2014-02-25 00:39:00	2014-02-25 00:49:00	2014-02-25 01:03:00	1990	X3.8	2005-01-17 10:00:00	2005-01-17 09:54:00	2005-01-17 10:35:00	10720
23	X4.9	1998-08-18 22:10:00	1998-08-18 22:19:00	1998-08-18 22:28:00	8307	X3.6	2003-05-28 01:00:00	2003-05-28 00:50:00	2003-05-29 00:30:00	10365
24	X4.8	2002-07-23 00:18:00	2002-07-23 00:35:00	2002-07-23 00:47:00	39	X3.4	2006-12-13 02:45:00	2006-12-13 02:54:00	2006-12-13 10:40:00	10930
25	X4	2000-11-26 16:34:00	2000-11-26 16:48:00	2000-11-26 16:56:00	9236	X3.4	2001-12-28 20:35:00	2001-12-28 20:30:00	2001-12-29 03:00:00	9756
26	X3.9	2003-11-03 09:43:00	2003-11-03 09:55:00	2003-11-03 10:19:00	488	X3.3	2002-07-20 21:30:00	2002-07-20 22:06:00	2002-07-20 22:20:00	10039
27	X3.9	1998-08-19 21:35:00	1998-08-19 21:45:00	1998-08-19 21:50:00	8307	X3.2	2013-05-14 01:16:00	2013-05-14 01:25:00	2013-05-14 08:20:00	11748
28	X3.8	2005-01-17 06:59:00	2005-01-17 09:52:00	2005-01-17 10:07:00	720	X3.1	2002-08-24 01:45:00	2002-08-24 01:27:00	2002-08-24 03:25:00	10069
29	X3.7	1998-11-22 06:30:00	1998-11-22 06:42:00	1998-11-22 06:49:00	8384	X2.8	2013-05-13 16:15:00	2013-05-13 16:07:00	2013-05-13 19:10:00	11748
30	X3.6	2005-09-09 09:42:00	2005-09-09 09:59:00	2005-09-09 10:08:00	808	X2.7	2015-05-05 22:24:00	2015-05-05 22:24:00	2015-05-05 23:14:00	12339
31	X3.6	2004-07-16 13:49:00	2004-07-16 13:55:00	2004-07-16 14:01:00	649	X2.7	1998-05-06 08:25:00	1998-05-06 08:29:00	1998-05-06 08:35:00	8210
32	X3.6	2003-05-28 00:17:00	2003-05-28 00:27:00	2003-05-28 00:39:00	365	X2.7	2003-11-03 01:15:00	2003-11-03 01:59:00	2003-11-03 01:25:00	10488
33	X3.4	2006-12-13 02:14:00	2006-12-13 02:40:00	2006-12-13 02:57:00	930	X2.6	2005-01-15 23:00:00	2005-01-15 23:06:00	2005-01-17 00:00:00	10720
34	X3.4	2001-12-28 20:02:00	2001-12-28 20:45:00	2001-12-28 21:32:00	9767	X2.6	2001-09-24 10:45:00	2001-09-24 10:30:00	2001-09-25 20:00:00	9632
35	X3.3	2013-11-05 22:07:00	2013-11-05 22:12:00	2013-11-05 22:15:00	1890	X2.6	1997-11-27 13:30:00	1997-11-27 13:56:00	1997-11-27 14:00:00	8113
36	X3.3	2002-07-20 21:04:00	2002-07-20 21:30:00	2002-07-20 21:54:00	39	X2.5	2004-11-10 02:25:00	2004-11-10 02:26:00	2004-11-10 03:40:00	10696
37	X3.3	1998-11-28 04:54:00	1998-11-28 05:52:00	1998-11-28 06:13:00	8395	X2.3	2001-04-10 05:24:00	2001-04-10 05:30:00	2001-04-11 00:00:00	9415
38	X3.2	2013-05-14 00:00:00	2013-05-14 01:11:00	2013-05-14 01:20:00	1748	X2.3	2000-11-24 15:25:00	2000-11-24 15:30:00	2000-11-24 22:00:00	9236
39	X3.1	2014-10-24 21:07:00	2014-10-24 21:41:00	2014-10-24 22:13:00	2192	X2.3	2000-06-06 15:20:00	2000-06-06 15:54:00	2000-06-08 09:00:00	9026
40	X3.1	2002-08-24 00:49:00	2002-08-24 01:12:00	2002-08-24 01:31:00	69	X2.2	2011-02-15 02:10:00	2011-02-15 02:24:00	2011-02-15 07:00:00	11158
41	X3	2002-07-15 19:59:00	2002-07-15 20:08:00	2002-07-15 20:14:00	30	X2.1	2005-09-10 21:45:00	2005-09-10 21:52:00	2005-09-11 01:00:00	10808
42	X2.8	2013-05-13 15:48:00	2013-05-13 16:05:00	2013-05-13 16:16:00	1748	X2.1	2011-09-06 22:30:00	2011-09-06 23:05:00	2011-09-07 15:40:00	11283
43	X2.8	2001-12-11 07:58:00	2001-12-11 08:08:00	2001-12-11 08:14:00	9733	X2.1	2013-10-25 15:08:00	2013-10-25 15:12:00	2013-10-25 22:32:00	11882
44	X2.8	1998-08-18 08:14:00	1998-08-18 08:24:00	1998-08-18 08:32:00	8307	X2.1	1997-11-04 06:00:00	1997-11-04 06:10:00	1997-11-05 04:30:00	8100
45	X2.7	2015-05-05 22:05:00	2015-05-05 22:11:00	2015-05-05 22:15:00	2339	X2.0	2000-11-24 05:10:00	2000-11-24 05:30:00	2000-11-24 15:00:00	9236
46	X2.7	2003-11-03 01:09:00	2003-11-03 01:30:00	2003-11-03 01:45:00	488	X2.0	2001-04-12 10:20:00	2001-04-12 10:31:00	2001-04-12 10:40:00	9415
47	X2.7	1998-05-06 07:58:00	1998-05-06 08:09:00	1998-05-06 08:20:00	8210	X2.0	2004-11-07 16:25:00	2004-11-07 16:54:00	2004-11-08 20:00:00	10696
48	X2.6	2005-01-15 22:25:00	2005-01-15 23:02:00	2005-01-15 23:31:00	720	X2.0	2005-01-17 09:25:00	2005-01-17 09:30:00	2005-01-17 16:00:00	10720
49	X2.6	2001-09-24 09:32:00	2001-09-24 10:38:00	2001-09-24 11:09:00	9632	X1.9	2000-11-25 19:00:00	2000-11-25 19:31:00	2000-11-25 19:35:00	9236

In [26]:

```python
#Reorganizing Columns to make it easier to compare SWL Data to NASA Data
dfFinal = dfCompare.swaplevel(axis=1)[tableSWL.columns[0:]]
dfFinal
```

Out[26]:

	x_classification		start_datetime		max_datetime		end_datetime		region	
	SWL Data	NASA Data	SWL Data	NASA Data	SWL Data	NASA Data	SWL Data	NASA Data	SWL Data	NASA Data
0	X28+	X28.0	2003-11-04 19:29:00	2003-11-04 20:00:00	2003-11-04 19:53:00	2003-11-04 19:54:00	2003-11-04 20:06:00	2003-11-05 00:00:00	486	10486
1	X20+	X20.0	2001-04-02 21:32:00	2001-04-02 22:05:00	2001-04-02 21:51:00	2001-04-02 22:06:00	2001-04-02 22:03:00	2001-04-03 02:30:00	9393	9393
2	X17.2+	X17.0	2003-10-28 09:51:00	2003-10-28 11:10:00	2003-10-28 11:10:00	2003-10-28 11:30:00	2003-10-28 11:24:00	2003-10-30 00:00:00	486	10486
3	X17+	X14.0	2005-09-07 17:17:00	2001-04-15 14:05:00	2005-09-07 17:40:00	2001-04-15 14:06:00	2005-09-07 18:03:00	2001-04-16 13:00:00	808	9415
4	X14.4	X10.0	2001-04-15 13:19:00	2003-10-29 20:55:00	2001-04-15 13:50:00	2003-10-29 20:54:00	2001-04-15 13:55:00	2003-10-30 00:00:00	9415	10486
5	X10	X9.4	2003-10-29 20:37:00	1997-11-06 12:20:00	2003-10-29 20:49:00	1997-11-06 12:10:00	2003-10-29 21:01:00	1997-11-07 08:30:00	486	8100
6	X9.4	X9.3	1997-11-06 11:49:00	2017-09-06 12:05:00	1997-11-06 11:55:00	2017-09-06 12:24:00	1997-11-06 12:01:00	2017-09-07 08:00:00	8100	12673
7	X9.3	X9.0	2017-09-06 11:53:00	2006-12-05 10:50:00	2017-09-06 12:02:00	NaT	2017-09-06 12:10:00	2006-12-05 20:00:00	2673	10930
8	X9	X8.3	2006-12-05 10:18:00	2003-11-02 17:30:00	2006-12-05 10:35:00	2003-11-02 17:30:00	2006-12-05 10:45:00	2003-11-03 01:00:00	930	10486
9	X8.3	X8.3	2003-11-02 17:03:00	2017-09-10 16:02:00	2003-11-02 17:25:00	2017-09-10 16:00:00	2003-11-02 17:39:00	2017-09-11 06:50:00	486	NaN
10	X8.2	X7.1	2017-09-10 15:35:00	2005-01-20 07:15:00	2017-09-10 16:06:00	2005-01-20 06:54:00	2017-09-10 16:31:00	2005-01-20 16:30:00	2673	10720
11	X7.1	X6.9	2005-01-20 06:36:00	2011-08-09 08:20:00	2005-01-20 07:01:00	2011-08-09 08:12:00	2005-01-20 07:26:00	2011-08-09 08:35:00	720	11263
12	X6.9	X6.5	2011-08-09 07:48:00	2006-12-06 19:00:00	2011-08-09 08:05:00	NaT	2011-08-09 08:08:00	2006-12-09 00:00:00	1263	10930
13	X6.5	X6.2	2006-12-06 18:29:00	2005-09-09 19:45:00	2006-12-06 18:47:00	2005-09-09 19:48:00	2006-12-06 19:00:00	2005-09-09 22:00:00	930	10808
14	X6.2	X5.7	2005-09-09 19:13:00	2000-07-14 10:30:00	2005-09-09 20:04:00	2000-07-14 10:54:00	2005-09-09 20:36:00	2000-07-15 14:30:00	808	9077
15	X6.2	X5.6	2001-12-13 14:20:00	2001-04-06 19:35:00	2001-12-13 14:30:00	2001-04-06 19:30:00	2001-12-13 14:35:00	2001-04-07 01:50:00	9733	9415
16	X5.7	X5.4	2000-07-14 10:03:00	2012-03-07 01:00:00	2000-07-14 10:24:00	2012-03-07 00:24:00	2000-07-14 10:43:00	2012-03-08 19:00:00	9077	11429
17	X5.6	X5.3	2001-04-06 19:10:00	2001-08-25 16:50:00	2001-04-06 19:21:00	2001-08-25 16:50:00	2001-04-06 19:31:00	2001-08-25 23:00:00	9415	9591
18	X5.4	X4.9	2012-03-07 00:02:00	2014-02-25 00:56:00	2012-03-07 00:24:00	2014-02-25 01:25:00	2012-03-07 00:40:00	2014-02-25 11:28:00	1429	11990
19	X5.4	X4.8	2005-09-08 20:52:00	2002-07-23 00:50:00	2005-09-08 21:06:00	2002-07-23 00:42:00	2005-09-08 21:17:00	2002-07-23 04:00:00	808	10039
20	X5.4	X4.0	2003-10-23 08:19:00	2000-11-26 17:00:00	2003-10-23 08:35:00	2000-11-26 17:06:00	2003-10-23 08:49:00	2000-11-26 17:15:00	486	9236
21	X5.3	X3.9	2001-08-25 16:23:00	2003-11-03 10:00:00	2001-08-25 16:45:00	2003-11-03 10:06:00	2001-08-25 17:04:00	2003-11-03 12:30:00	9591	10488
22	X4.9	X3.8	2014-02-25 00:39:00	2005-01-17 10:00:00	2014-02-25 00:49:00	2005-01-17 09:54:00	2014-02-25 01:03:00	2005-01-17 10:35:00	1990	10720
23	X4.9	X3.6	1998-08-18 22:10:00	2003-05-28 01:00:00	1998-08-18 22:19:00	2003-05-28 00:50:00	1998-08-18 22:28:00	2003-05-29 00:30:00	8307	10365
24	X4.8	X3.4	2002-07-23 00:18:00	2006-12-13 02:45:00	2002-07-23 00:35:00	2006-12-13 02:54:00	2002-07-23 00:47:00	2006-12-13 10:40:00	39	10930
25	X4	X3.4	2000-11-26 16:34:00	2001-12-28 20:35:00	2000-11-26 16:48:00	2001-12-28 20:30:00	2000-11-26 16:56:00	2001-12-29 03:00:00	9236	9756
26	X3.9	X3.3	2003-11-03 09:43:00	2002-07-20 21:30:00	2003-11-03 09:55:00	2002-07-20 22:06:00	2003-11-03 10:19:00	2002-07-20 22:20:00	488	10039
27	X3.9	X3.2	1998-08-19 21:35:00	2013-05-14 01:16:00	1998-08-19 21:45:00	2013-05-14 01:25:00	1998-08-19 21:50:00	2013-05-14 08:20:00	8307	11748
28	X3.8	X3.1	2005-01-17 06:59:00	2002-08-24 01:45:00	2005-01-17 09:52:00	2002-08-24 01:27:00	2005-01-17 10:07:00	2002-08-24 03:25:00	720	10069
29	X3.7	X2.8	1998-11-22 06:30:00	2013-05-13 16:15:00	1998-11-22 06:42:00	2013-05-13 16:07:00	1998-11-22 06:49:00	2013-05-13 19:10:00	8384	11748
30	X3.6	X2.7	2005-09-09 09:42:00	2015-05-05 22:24:00	2005-09-09 09:59:00	2015-05-05 22:24:00	2005-09-09 10:08:00	2015-05-05 23:14:00	808	12339
31	X3.6	X2.7	2004-07-16 13:49:00	1998-05-06 08:25:00	2004-07-16 13:55:00	1998-05-06 08:29:00	2004-07-16 14:01:00	1998-05-06 08:35:00	649	8210
32	X3.6	X2.7	2003-05-28 00:17:00	2003-11-03 01:15:00	2003-05-28 00:27:00	2003-11-03 01:59:00	2003-05-28 00:39:00	2003-11-03 01:25:00	365	10488
33	X3.4	X2.6	2006-12-13 02:14:00	2005-01-15 23:00:00	2006-12-13 02:40:00	2005-01-15 23:06:00	2006-12-13 02:57:00	2005-01-17 00:00:00	930	10720
34	X3.4	X2.6	2001-12-28 20:02:00	2001-09-24 10:45:00	2001-12-28 20:45:00	2001-09-24 10:30:00	2001-12-28 21:32:00	2001-09-25 20:00:00	9767	9632
35	X3.3	X2.6	2013-11-05 22:07:00	1997-11-27 13:30:00	2013-11-05 22:12:00	1997-11-27 13:56:00	2013-11-05 22:15:00	1997-11-27 14:00:00	1890	8113
36	X3.3	X2.5	2002-07-20 21:04:00	2004-11-10 02:25:00	2002-07-20 21:30:00	2004-11-10 02:26:00	2002-07-20 21:54:00	2004-11-10 03:40:00	39	10696
37	X3.3	X2.3	1998-11-28 04:54:00	2001-04-10 05:24:00	1998-11-28 05:52:00	2001-04-10 05:30:00	1998-11-28 06:13:00	2001-04-11 00:00:00	8395	9415
38	X3.2	X2.3	2013-05-14 00:00:00	2000-11-24 15:25:00	2013-05-14 01:11:00	2000-11-24 15:30:00	2013-05-14 01:20:00	2000-11-24 22:00:00	1748	9236
39	X3.1	X2.3	2014-10-24 21:07:00	2000-06-06 15:20:00	2014-10-24 21:41:00	2000-06-06 15:54:00	2014-10-24 22:13:00	2000-06-08 09:00:00	2192	9026
40	X3.1	X2.2	2002-08-24 00:49:00	2011-02-15 02:10:00	2002-08-24 01:12:00	2011-02-15 02:24:00	2002-08-24 01:31:00	2011-02-15 07:00:00	69	11158
41	X3	X2.1	2002-07-15 19:59:00	2005-09-10 21:45:00	2002-07-15 20:08:00	2005-09-10 21:52:00	2002-07-15 20:14:00	2005-09-11 01:00:00	30	10808
42	X2.8	X2.1	2013-05-13 15:48:00	2011-09-06 22:30:00	2013-05-13 16:05:00	2011-09-06 23:05:00	2013-05-13 16:16:00	2011-09-07 15:40:00	1748	11283
43	X2.8	X2.1	2001-12-11 07:58:00	2013-10-25 15:08:00	2001-12-11 08:08:00	2013-10-25 15:12:00	2001-12-11 08:14:00	2013-10-25 22:32:00	9733	11882
44	X2.8	X2.1	1998-08-18 08:14:00	1997-11-04 06:00:00	1998-08-18 08:24:00	1997-11-04 06:10:00	1998-08-18 08:32:00	1997-11-05 04:30:00	8307	8100
45	X2.7	X2.0	2015-05-05 22:05:00	2000-11-24 05:10:00	2015-05-05 22:11:00	2000-11-24 05:30:00	2015-05-05 22:15:00	2000-11-24 15:00:00	2339	9236
46	X2.7	X2.0	2003-11-03 01:09:00	2001-04-12 10:20:00	2003-11-03 01:30:00	2001-04-12 10:31:00	2003-11-03 01:45:00	2001-04-12 10:40:00	488	9415
47	X2.7	X2.0	1998-05-06 07:58:00	2004-11-07 16:25:00	1998-05-06 08:09:00	2004-11-07 16:54:00	1998-05-06 08:20:00	2004-11-08 20:00:00	8210	10696
48	X2.6	X2.0	2005-01-15 22:25:00	2005-01-17 09:25:00	2005-01-15 23:02:00	2005-01-17 09:30:00	2005-01-15 23:31:00	2005-01-17 16:00:00	720	10720
49	X2.6	X1.9	2001-09-24 09:32:00	2000-11-25 19:00:00	2001-09-24 10:38:00	2000-11-25 19:31:00	2001-09-24 11:09:00	2000-11-25 19:35:00	9632	9236

In [27]:

```python
#Creating a function that highlights a value in the NASA data if it differs from the respective value for the
def highlight_diff(data, color='yellow'):
    attr = 'background-color: {}'.format(color)
    other = data.xs('SWL Data', axis='columns', level=-1)
    return pd.DataFrame(np.where(data.ne(other, level=0), attr, ''),
                        index=data.index, columns=data.columns)

dfFinal.style.apply(highlight_diff, axis=None)
```

Out[27]:

	x_classification		start_datetime		max_datetime		end_datetime		region	
	SWL Data	NASA Data	SWL Data	NASA Data	SWL Data	NASA Data	SWL Data	NASA Data	SWL Data	NASA Data
0	X28+	X28.0	2003-11-04 19:29:00	2003-11-04 20:00:00	2003-11-04 19:53:00	2003-11-04 19:54:00	2003-11-04 20:06:00	2003-11-05 00:00:00	486	10486
1	X20+	X20.0	2001-04-02 21:32:00	2001-04-02 22:05:00	2001-04-02 21:51:00	2001-04-02 22:06:00	2001-04-02 22:03:00	2001-04-03 02:30:00	9393	9393
2	X17.2+	X17.0	2003-10-28 09:51:00	2003-10-28 11:10:00	2003-10-28 11:10:00	2003-10-28 11:30:00	2003-10-28 11:24:00	2003-10-30 00:00:00	486	10486
3	X17+	X14.0	2005-09-07 17:17:00	2001-04-15 14:05:00	2005-09-07 17:40:00	2001-04-15 14:06:00	2005-09-07 18:03:00	2001-04-16 13:00:00	808	9415
4	X14.4	X10.0	2001-04-15 13:19:00	2003-10-29 20:55:00	2001-04-15 13:50:00	2003-10-29 20:54:00	2001-04-15 13:55:00	2003-10-30 00:00:00	9415	10486
5	X10	X9.4	2003-10-29 20:37:00	1997-11-06 12:20:00	2003-10-29 20:49:00	1997-11-06 12:10:00	2003-10-29 21:01:00	1997-11-07 08:30:00	486	8100
6	X9.4	X9.3	1997-11-06 11:49:00	2017-09-06 12:05:00	1997-11-06 11:55:00	2017-09-06 12:24:00	1997-11-06 12:01:00	2017-09-07 08:00:00	8100	12673
7	X9.3	X9.0	2017-09-06 11:53:00	2006-12-05 10:50:00	2017-09-06 12:02:00	NaT	2017-09-06 12:10:00	2006-12-05 20:00:00	2673	10930
8	X9	X8.3	2006-12-05 10:18:00	2003-11-02 17:30:00	2006-12-05 10:35:00	2003-11-02 17:30:00	2006-12-05 10:45:00	2003-11-03 01:00:00	930	10486
9	X8.3	X8.3	2003-11-02 17:03:00	2017-09-10 16:02:00	2003-11-02 17:25:00	2017-09-10 16:00:00	2003-11-02 17:39:00	2017-09-11 06:50:00	486	nan
10	X8.2	X7.1	2017-09-10 15:35:00	2005-01-20 07:15:00	2017-09-10 16:06:00	2005-01-20 06:54:00	2017-09-10 16:31:00	2005-01-20 16:30:00	2673	10720
11	X7.1	X6.9	2005-01-20 06:36:00	2011-08-09 08:20:00	2005-01-20 07:01:00	2011-08-09 08:12:00	2005-01-20 07:26:00	2011-08-09 08:35:00	720	11263
12	X6.9	X6.5	2011-08-09 07:48:00	2006-12-06 19:00:00	2011-08-09 08:05:00	NaT	2011-08-09 08:08:00	2006-12-09 00:00:00	1263	10930
13	X6.5	X6.2	2006-12-06 18:29:00	2005-09-09 19:45:00	2006-12-06 18:47:00	2005-09-09 19:48:00	2006-12-06 19:00:00	2005-09-09 22:00:00	930	10808
14	X6.2	X5.7	2005-09-09 19:13:00	2000-07-14 10:30:00	2005-09-09 20:04:00	2000-07-14 10:54:00	2005-09-09 20:36:00	2000-07-15 14:30:00	808	9077
15	X6.2	X5.6	2001-12-13 14:20:00	2001-04-06 19:35:00	2001-12-13 14:30:00	2001-04-06 19:30:00	2001-12-13 14:35:00	2001-04-07 01:50:00	9733	9415
16	X5.7	X5.4	2000-07-14 10:03:00	2012-03-07 01:00:00	2000-07-14 10:24:00	2012-03-07 00:24:00	2000-07-14 10:43:00	2012-03-08 19:00:00	9077	11429
17	X5.6	X5.3	2001-04-06 19:10:00	2001-08-25 16:50:00	2001-04-06 19:21:00	2001-08-25 16:50:00	2001-04-06 19:31:00	2001-08-25 23:00:00	9415	9591
18	X5.4	X4.9	2012-03-07 00:02:00	2014-02-25 00:56:00	2012-03-07 00:24:00	2014-02-25 01:25:00	2012-03-07 00:40:00	2014-02-25 11:28:00	1429	11990
19	X5.4	X4.8	2005-09-08 20:52:00	2002-07-23 00:50:00	2005-09-08 21:06:00	2002-07-23 00:42:00	2005-09-08 21:17:00	2002-07-23 04:00:00	808	10039
20	X5.4	X4.0	2003-10-23 08:19:00	2000-11-26 17:00:00	2003-10-23 08:35:00	2000-11-26 17:06:00	2003-10-23 08:49:00	2000-11-26 17:15:00	486	9236
21	X5.3	X3.9	2001-08-25 16:23:00	2003-11-03 10:00:00	2001-08-25 16:45:00	2003-11-03 10:06:00	2001-08-25 17:04:00	2003-11-03 12:30:00	9591	10488
22	X4.9	X3.8	2014-02-25 00:39:00	2005-01-17 10:00:00	2014-02-25 00:49:00	2005-01-17 09:54:00	2014-02-25 01:03:00	2005-01-17 10:35:00	1990	10720
23	X4.9	X3.6	1998-08-18 22:10:00	2003-05-28 01:00:00	1998-08-18 22:19:00	2003-05-28 00:50:00	1998-08-18 22:28:00	2003-05-29 00:30:00	8307	10365
24	X4.8	X3.4	2002-07-23 00:18:00	2006-12-13 02:45:00	2002-07-23 00:35:00	2006-12-13 02:54:00	2002-07-23 00:47:00	2006-12-13 10:40:00	39	10930
25	X4	X3.4	2000-11-26 16:34:00	2001-12-28 20:35:00	2000-11-26 16:48:00	2001-12-28 20:30:00	2000-11-26 16:56:00	2001-12-29 03:00:00	9236	9756
26	X3.9	X3.3	2003-11-03 09:43:00	2002-07-20 21:30:00	2003-11-03 09:55:00	2002-07-20 22:06:00	2003-11-03 10:19:00	2002-07-20 22:20:00	488	10039
27	X3.9	X3.2	1998-08-19 21:35:00	2013-05-14 01:16:00	1998-08-19 21:45:00	2013-05-14 01:25:00	1998-08-19 21:50:00	2013-05-14 08:20:00	8307	11748
28	X3.8	X3.1	2005-01-17 06:59:00	2002-08-24 01:45:00	2005-01-17 09:52:00	2002-08-24 01:27:00	2005-01-17 10:07:00	2002-08-24 03:25:00	720	10069
29	X3.7	X2.8	1998-11-22 06:30:00	2013-05-13 16:15:00	1998-11-22 06:42:00	2013-05-13 16:07:00	1998-11-22 06:49:00	2013-05-13 19:10:00	8384	11748
30	X3.6	X2.7	2005-09-09 09:42:00	2015-05-05 22:24:00	2005-09-09 09:59:00	2015-05-05 22:24:00	2005-09-09 10:08:00	2015-05-05 23:14:00	808	12339
31	X3.6	X2.7	2004-07-16 13:49:00	1998-05-06 08:25:00	2004-07-16 13:55:00	1998-05-06 08:29:00	2004-07-16 14:01:00	1998-05-06 08:35:00	649	8210
32	X3.6	X2.7	2003-05-28 00:17:00	2003-11-03 01:15:00	2003-05-28 00:27:00	2003-11-03 01:59:00	2003-05-28 00:39:00	2003-11-03 01:25:00	365	10488
33	X3.4	X2.6	2006-12-13 02:14:00	2005-01-15 23:00:00	2006-12-13 02:40:00	2005-01-15 23:06:00	2006-12-13 02:57:00	2005-01-17 00:00:00	930	10720
34	X3.4	X2.6	2001-12-28 20:02:00	2001-09-24 10:45:00	2001-12-28 20:45:00	2001-09-24 10:30:00	2001-12-28 21:32:00	2001-09-25 20:00:00	9767	9632
35	X3.3	X2.6	2013-11-05 22:07:00	1997-11-27 13:30:00	2013-11-05 22:12:00	1997-11-27 13:56:00	2013-11-05 22:15:00	1997-11-27 14:00:00	1890	8113
36	X3.3	X2.5	2002-07-20 21:04:00	2004-11-10 02:25:00	2002-07-20 21:30:00	2004-11-10 02:26:00	2002-07-20 21:54:00	2004-11-10 03:40:00	39	10696
37	X3.3	X2.3	1998-11-28 04:54:00	2001-04-10 05:24:00	1998-11-28 05:52:00	2001-04-10 05:30:00	1998-11-28 06:13:00	2001-04-11 00:00:00	8395	9415
38	X3.2	X2.3	2013-05-14 00:00:00	2000-11-24 15:25:00	2013-05-14 01:11:00	2000-11-24 15:30:00	2013-05-14 01:20:00	2000-11-24 22:00:00	1748	9236
39	X3.1	X2.3	2014-10-24 21:07:00	2000-06-06 15:20:00	2014-10-24 21:41:00	2000-06-06 15:54:00	2014-10-24 22:13:00	2000-06-08 09:00:00	2192	9026
40	X3.1	X2.2	2002-08-24 00:49:00	2011-02-15 02:10:00	2002-08-24 01:12:00	2011-02-15 02:24:00	2002-08-24 01:31:00	2011-02-15 07:00:00	69	11158
41	X3	X2.1	2002-07-15 19:59:00	2005-09-10 21:45:00	2002-07-15 20:08:00	2005-09-10 21:52:00	2002-07-15 20:14:00	2005-09-11 01:00:00	30	10808
42	X2.8	X2.1	2013-05-13 15:48:00	2011-09-06 22:30:00	2013-05-13 16:05:00	2011-09-06 23:05:00	2013-05-13 16:16:00	2011-09-07 15:40:00	1748	11283
43	X2.8	X2.1	2001-12-11 07:58:00	2013-10-25 15:08:00	2001-12-11 08:08:00	2013-10-25 15:12:00	2001-12-11 08:14:00	2013-10-25 22:32:00	9733	11882
44	X2.8	X2.1	1998-08-18 08:14:00	1997-11-04 06:00:00	1998-08-18 08:24:00	1997-11-04 06:10:00	1998-08-18 08:32:00	1997-11-05 04:30:00	8307	8100
45	X2.7	X2.0	2015-05-05 22:05:00	2000-11-24 05:10:00	2015-05-05 22:11:00	2000-11-24 05:30:00	2015-05-05 22:15:00	2000-11-24 15:00:00	2339	9236
46	X2.7	X2.0	2003-11-03 01:09:00	2001-04-12 10:20:00	2003-11-03 01:30:00	2001-04-12 10:31:00	2003-11-03 01:45:00	2001-04-12 10:40:00	488	9415
47	X2.7	X2.0	1998-05-06 07:58:00	2004-11-07 16:25:00	1998-05-06 08:09:00	2004-11-07 16:54:00	1998-05-06 08:20:00	2004-11-08 20:00:00	8210	10696
48	X2.6	X2.0	2005-01-15 22:25:00	2005-01-17 09:25:00	2005-01-15 23:02:00	2005-01-17 09:30:00	2005-01-15 23:31:00	2005-01-17 16:00:00	720	10720
49	X2.6	X1.9	2001-09-24 09:32:00	2000-11-25 19:00:00	2001-09-24 10:38:00	2000-11-25 19:31:00	2001-09-24 11:09:00	2000-11-25 19:35:00	9632	9236

As can be clearly seen from the table above, we CANNOT replicate the top 50 solar flare table in SpaceWeatherLive.com exactly using the data pbtained from NASA. In fact, every value in the NASA data differs from the SWL data except one (Row 9: Both data tables have a X8.6 Classification). For certain rows, such as the first one, they seem to be talking about the same solar flare event--considering the equivalence in classification as well as date (not time)--but these rows still have inconsistencies, verifying we cannot replicate the data exactly. It is also interesting to note that, for the NASA data, some of the region numbers would have matched to the regions seen for the SWL data for that respective solar flare if the NASA data did not have a '10' at the beginning of their numbers. This suggests to me that NASA classifies their regions slightly differently than SWL. It should also be noted that I relabled the cme_datetime as max_datetime to match up with the SWL data, but I wasn't sure if these columns were in fact comparable. Either way, however, the data is not exactly replicable.

Task 6: Integration:

In [28]:

```python
#For Task 6, we write a function that finds the best matching row in the NASA data for each of the top 50
#solar flares in the SpaceWeatherLive data.
# As stated in the instructions, I must decide for myself what is the best matching entry in the NASA data
#for each of the top 50 solar flares.
#I am defining the best matching rows across the two datasets based on the flare_classification, start_datetime
#and end_datetime.
#We first note that we can only use attributes that exist in both datasets, which are flare classfication,
#start datetime, end datetime, and region (we are not confident cme_datetime = max_datetime).
#Since some of the region codes for the NASA dataset seem to be similar to ones in the SWL dataset but just
#add a '10' at the beginning, I believe NASA uses a different system to write their region codes.
#Since we do not know how the NASA region code system works, we cannot transform them to be usable with the
#SWL dataset. Thus, region codes are not good determiners for the best match.
#Now, we use flare_classification because it can be transformed into an integer value (which is easier to work
#and it is pretty unique (it is rare that two rows in the SWL data have the same classification).
#We will store multiple close flare_classification values for a given row in the SWL dataset, and then choose
#the best matching one by looking at that start_datetime and end_datetime.
#Thus, we use start_datetime and end_datetime to shorten our choices to just 1, which will be the best match
#in the NASA data for the respective row in the SWL data.

#Making a copy of NASA data table. We add a column to the table, called SWLRank to indicate the rank according
#to SpaceWeatherLive, if it appeared in that dataset.
#We set these values to NaN to start, but we will update them to the appropiate rank in the functions below.
out_NASA = tableNASAdf.copy()
out_NASA['SWLRank'] = pd.Series(np.nan, index=out_NASA.index)

#Making a copy of the SWL table. We edit the 'x_classification' column to have floats by stripping the
#'X' and '+' and casting.
#Since this table is just a copy, the original is left unchanged, and there is no problem in doing this.
out_SWL = myTable.copy()
out_SWL['x_classification'] = out_SWL['x_classification'].str.lstrip('X')
out_SWL['x_classification'] = out_SWL['x_classification'].str.rstrip('+').astype(float)

#In task 5, we obtained the rows that had a flare classification with X and stored it in a new dataframe
#using the below line:
topFlaresdf2 = tableNASAdfCopy.loc[tableNASAdfCopy['flare_classification'].str.contains('X')]
#Since SWL only has flare classification's with X, when doing our comparisons for the best match, we can
#just look at the rows from the NASA dataset with the 'X', which are all in totalFlaresdf2

#Similar to above, we get rid of the 'X' character and cast the column to float type so that we can compare
#this column to the respective column for the SWL data.
topFlaresdf2['flare_classification'] = topFlaresdf2['flare_classification'].str.lstrip('X').astype(float)


#A helper list that will store the indicies of the rows from the NASA dataset that we no longer want to use in
#comparison for the rest of the SWL data rows because they were already chosen as best matches for other SWL da
listToDrop = []

#A helper function to find the nearest time
def nearestTime(items, pivot):
    return min(items, key=lambda x: abs(x - pivot))

#My function to find the best match. It takes a row from the SWL dataset as an argument.
def bestMatch(row):
    tolerance = 10 #Tolerance is continuously updated value that is used to shorten down our choices for the
    #closest classification scores (and their respective rows)

    #If listToDrop has indicies in it, there are rows that need to be dropped from our evaluation dataset,
    #which we do in the if block.
    #Otherwise, we are still at the first iteration, so we do not have any values in listToDrop.
    #Thus, we just take a copy of topFlaresdf2
    if (len(listToDrop) > 0):
        topFlaresdf2Temp = topFlaresdf2.copy()
        topFlaresdf2Temp = topFlaresdf2Temp.drop(listToDrop, axis = 0)
    else:
        topFlaresdf2Temp = topFlaresdf2.copy()
    #While our temp NASA dataset still has more than 5 rows in it, we try to remove rows that are not close
    #to the inputted SWL row, based on the flare classification.
    #We chose 5 arbitrarily, but it seems to be a good amount to keep before we shorten down the list further
    #when comparing the start_datetime and end_datetime.
    while (len(topFlaresdf2Temp.index) > 5):
        #for each row in the temp NASA dataset, if the absolute difference of the flare classifications from
        #the SWL and NASA data rows is greater than the given tolerance,
        #then that NASA dataset row is too far from the SWL data row to be the best match, so remove it from
        #the temp NASA dataset.
        for j, val in topFlaresdf2Temp.iterrows():
            if (abs(val['flare_classification'] - row['x_classification']) >= tolerance):
                topFlaresdf2Temp = topFlaresdf2Temp.drop(j, axis = 0)
        tolerance -= .1 #The tolerance value starts off large to make sure we get at least 5 rows for the best
        #We decrement the tolerance by .1 to slowly get rid of more NASA data rows that are not close enough.

    #Printing the current flare class value from SWL data for demonstration/understanding
    print("Current Flare Class Value from SWL: ", row['x_classification'])
    #Printing the closest row matches found, based on the flare value
    print("Closest Matches Found: \n", topFlaresdf2Temp['flare_classification'])

    #Now, we shorten the list of 5 potential best match rows from the NASA dataset using the
    #start_datetime and end_datetime.
    SWLrowStartTime = row['start_datetime'] #Storing the current SWL data row start_time in a variable
    #Finding the nearest time to the SWL start time using the helper function 'nearestTime', and storing it in
    closestStartTime = nearestTime(topFlaresdf2Temp['start_datetime'], SWLrowStartTime)
    #Printing the current start datetime value from SWL data for demonstration/understanding
    print("Current Start DateTime from SWL: ", SWLrowStartTime)
    #Printing the closest start datetime to the SWL datetime
    print("Closest Start DateTime from NASA: ", closestStartTime)

    SWLrowEndTime = row['end_datetime'] #Storing the current SWL data row end_time in a variable
    #Finding the nearest time to the SWL end time using the helper function 'nearestTime', and storing it in a
    closestEndTime = nearestTime(topFlaresdf2Temp['end_datetime'], SWLrowEndTime)
    #Printing the current end datetime value from SWL data for demonstration/understanding
    print("Current Start DateTime from SWL: ", SWLrowEndTime)
    #Printing the closest end datetime to the SWL datetime
    print("Closest End DateTime from NASA:  ", closestEndTime)

    #With the closest start and end time options, we iterate through our short list of potential best match row
    #from the NASA dataset, and drop the ones that do not match these times.
    for k, value in topFlaresdf2Temp.iterrows():
        if (value['start_datetime'] != closestStartTime or value['end_datetime'] != closestEndTime):
            topFlaresdf2Temp = topFlaresdf2Temp.drop(k, axis = 0)
    print("The Best Match: \n", topFlaresdf2Temp) #Printing the best match, based on my method of finding the b

    index = np.nan #Creating an index variable to use for the below for-loop
    #I needed the index for the best match, and I could not seem to access it without looping
    #through the 1-row NASA dataset
    for l, val in topFlaresdf2Temp.iterrows():
        index = l
    #The index for the best match is used to find the matching row in the full NASA (cleaned) dataset.
    #This row's SWLRank value is then updated to be the rank value for the SWL data row we are currently workin
    out_NASA.at[index, 'SWLRank'] = row['rank']
    #We add the index to list to drop because this index represents the row from the NASA dataset we
    #identified as a best match for a row in the SWL dataset, so it needs to be removed from further evaluatio
    listToDrop.append(index)

#The for loop to iterrate through the 50 rows of the SWL dataset and find the respective best match in the NASA
for i, row in out_SWL.iterrows():
    bestMatch(row)
```

```
    flare_location flare_region  flare_classification         cme_datetime  \
274         N09W17        10696                   2.0 2004-11-07 16:54:00

    cme_angle cme_width cme_speed  is_halo  width_lower_bound
274       NaN       360      1759     True              False
Current Flare Class Value from SWL:  2.7
Closest Matches Found:
 102    1.9
125    2.0
285    2.0
Name: flare_classification, dtype: float64
Current Start DateTime from SWL:  1998-05-06 07:58:00
Closest Start DateTime from NASA:  2000-11-25 19:00:00
Current Start DateTime from SWL:  1998-05-06 08:20:00
Closest End DateTime from NASA:   2000-11-25 19:35:00
The Best Match:
          start_datetime        end_datetime start_frequency end_frequency  \
102 2000-11-25 19:00:00 2000-11-25 19:35:00            6000          2000

    flare_location flare_region  flare_classification         cme_datetime  \
102         N20W23         9236                   1.9 2000-11-25 19:31:00

    cme_angle cme_width cme_speed  is_halo  width_lower_bound
102       NaN       360       671     True              False
Current Flare Class Value from SWL:  2.6
Closest Matches Found:
 49     1.8
100    1.8
125    2.0
189    1.8
285    2.0
Name: flare_classification, dtype: float64
Current Start DateTime from SWL:  2005-01-15 22:25:00
Closest Start DateTime from NASA:  2005-01-17 09:25:00
Current Start DateTime from SWL:  2005-01-15 23:31:00
Closest End DateTime from NASA:   2005-01-17 16:00:00
The Best Match:
          start_datetime        end_datetime start_frequency end_frequency  \
285 2005-01-17 09:25:00 2005-01-17 16:00:00           14000            30

    flare_location flare_region  flare_classification         cme_datetime  \
285         N15W25        10720                   2.0 2005-01-17 09:30:00

    cme_angle cme_width cme_speed  is_halo  width_lower_bound
285       NaN       360      2094     True              False
Current Flare Class Value from SWL:  2.6
Closest Matches Found:
 49     1.8
100    1.8
125    2.0
189    1.8
Name: flare_classification, dtype: float64
Current Start DateTime from SWL:  2001-09-24 09:32:00
Closest Start DateTime from NASA:  2001-04-12 10:20:00
Current Start DateTime from SWL:  2001-09-24 11:09:00
Closest End DateTime from NASA:   2001-04-12 10:40:00
The Best Match:
          start_datetime        end_datetime start_frequency end_frequency  \
125 2001-04-12 10:20:00 2001-04-12 10:40:00           14000          7000

    flare_location flare_region  flare_classification         cme_datetime  \
125         S19W43         9415                   2.0 2001-04-12 10:31:00

    cme_angle cme_width cme_speed  is_halo  width_lower_bound
125       NaN       360      1184     True              False
```

In [29]:

```python
#Final dataset/output for Task 6 (with SWLRank as the last column):
out_NASA
```

Out[29]:

	start_datetime	end_datetime	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_datetime	cme_angle
0	1997-04-01 14:00:00	1997-04-01 14:15:00	8000	4000	S25E16	8026	M1.3	1997-04-01 15:18:00	74
1	1997-04-07 14:30:00	1997-04-07 17:30:00	11000	1000	S28E19	8027	C6.8	1997-04-07 14:27:00	NaN
2	1997-05-12 05:15:00	1997-05-14 16:00:00	12000	80	N21W08	8038	C1.3	1997-05-12 05:30:00	NaN
3	1997-05-21 20:20:00	1997-05-21 22:00:00	5000	500	N05W12	8040	M1.3	1997-05-21 21:00:00	263
4	1997-09-23 21:53:00	1997-09-23 22:16:00	6000	2000	S29E25	8088	C1.4	1997-09-23 22:02:00	133
...	...	...	...	...	...	...	...	...	...
517	2017-09-17 11:45:00	2017-09-17 12:35:00	16000	900	S08E170	NaN	NaN	2017-09-17 12:00:00	NaN
518	2017-10-18 05:48:00	2017-10-18 12:40:00	16000	400	S06E123	NaN	NaN	2017-10-18 08:00:00	85
519	2019-05-03 23:52:00	2019-05-04 00:16:00	13000	2300	N12E82	12740	C1.0	2019-05-03 23:24:00	90
520	2020-11-29 13:07:00	2020-11-29 15:23:00	14000	850	S23E89	NaN	M4.4	2020-11-29 13:25:00	NaN
521	2020-12-07 16:18:00	2020-12-08 02:00:00	14000	160	S25W08	12790	C7.4	2020-12-07 16:24:00	NaN

522 rows × 14 columns

In [30]:

```python
#To more clearly see the matches, I am outputting a shortened out_NASA dataset with just the matching rows
import math

out_NASA_matches = out_NASA.loc[out_NASA['SWLRank'] >= 0]
#We notice that the SWLRank values are floats in out_NASA, which needs to be the case because NaN values
#must be floats. Since this dataset only have non-null values, we can show the ranks as ints.
out_NASA_matches = out_NASA_matches.astype({'SWLRank': 'int32'})
print("The Size of this dataset is 50, as it should be: ", out_NASA_matches.shape)
out_NASA_matches
```

```
The Size of this dataset is 50, as it should be:  (50, 14)
```

Out[30]:

	start_datetime	end_datetime	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_datetime	cme_angle
7	1997-11-04 06:00:00	1997-11-05 04:30:00	14000	100	S14W33	8100	X2.1	1997-11-04 06:10:00	NaN
8	1997-11-06 12:20:00	1997-11-07 08:30:00	14000	100	S18W63	8100	X9.4	1997-11-06 12:10:00	NaN
9	1997-11-27 13:30:00	1997-11-27 14:00:00	14000	7000	N17E63	8113	X2.6	1997-11-27 13:56:00	98
19	1998-05-06 08:25:00	1998-05-06 08:35:00	14000	5000	S11W65	8210	X2.7	1998-05-06 08:29:00	309
73	2000-06-06 15:20:00	2000-06-08 09:00:00	14000	40	N20E18	9026	X2.3	2000-06-06 15:54:00	NaN
82	2000-07-14 10:30:00	2000-07-15 14:30:00	14000	80	N22W07	9077	X5.7	2000-07-14 10:54:00	NaN
98	2000-11-24 05:10:00	2000-11-24 15:00:00	14000	100	N20W05	9236	X2.0	2000-11-24 05:30:00	NaN
99	2000-11-24 15:25:00	2000-11-24 22:00:00	14000	200	N22W07	9236	X2.3	2000-11-24 15:30:00	NaN
102	2000-11-25 19:00:00	2000-11-25 19:35:00	6000	2000	N20W23	9236	X1.9	2000-11-25 19:31:00	NaN
104	2000-11-26 17:00:00	2000-11-26 17:15:00	14000	7000	N18W38	9236	X4.0	2000-11-26 17:06:00	NaN
117	2001-04-02 22:05:00	2001-04-03 02:30:00	14000	250	N19W72	9393	X20.	2001-04-02 22:06:00	261
121	2001-04-06 19:35:00	2001-04-07 01:50:00	14000	230	S21E31	9415	X5.6	2001-04-06 19:30:00	NaN
123	2001-04-10 05:24:00	2001-04-11 00:00:00	14000	100	S23W09	9415	X2.3	2001-04-10 05:30:00	NaN
125	2001-04-12 10:20:00	2001-04-12 10:40:00	14000	7000	S19W43	9415	X2.0	2001-04-12 10:31:00	NaN
126	2001-04-15 14:05:00	2001-04-16 13:00:00	14000	40	S20W85	9415	X14.	2001-04-15 14:06:00	245
135	2001-08-25 16:50:00	2001-08-25 23:00:00	8000	170	S17E34	9591	X5.3	2001-08-25 16:50:00	NaN
142	2001-09-24 10:45:00	2001-09-25 20:00:00	7000	30	S16E23	9632	X2.6	2001-09-24 10:30:00	NaN
160	2001-12-28 20:35:00	2001-12-29 03:00:00	14000	350	S26E90	9756	X3.4	2001-12-28 20:30:00	NaN
192	2002-07-20 21:30:00	2002-07-20 22:20:00	10000	2000	S13E90	10039	X3.3	2002-07-20 22:06:00	NaN
193	2002-07-23 00:50:00	2002-07-23 04:00:00	11000	400	S13E72	10039	X4.8	2002-07-23 00:42:00	NaN
201	2002-08-24 01:45:00	2002-08-24 03:25:00	5000	400	S02W81	10069	X3.1	2002-08-24 01:27:00	NaN
222	2003-05-28 01:00:00	2003-05-29 00:30:00	1000	200	S07W20	10365	X3.6	2003-05-28 00:50:00	NaN
233	2003-10-28 11:10:00	2003-10-30 00:00:00	14000	40	S16E08	10486	X17.	2003-10-28 11:30:00	NaN
234	2003-10-29 20:55:00	2003-10-30 00:00:00	11000	500	S15W02	10486	X10.	2003-10-29 20:54:00	NaN
237	2003-11-02 17:30:00	2003-11-03 01:00:00	12000	250	S14W56	10486	X8.3	2003-11-02 17:30:00	NaN
238	2003-11-03 01:15:00	2003-11-03 01:25:00	3000	1500	N10W83	10488	X2.7	2003-11-03 01:59:00	304
239	2003-11-03 10:00:00	2003-11-03 12:30:00	6000	400	N08W77	10488	X3.9	2003-11-03 10:06:00	293
240	2003-11-04 20:00:00	2003-11-05 00:00:00	10000	200	S19W83	10486	X28.	2003-11-04 19:54:00	NaN
274	2004-11-07 16:25:00	2004-11-08 20:00:00	14000	60	N09W17	10696	X2.0	2004-11-07 16:54:00	NaN
276	2004-11-10 02:25:00	2004-11-10 03:40:00	14000	1000	N09W49	10696	X2.5	2004-11-10 02:26:00	NaN
284	2005-01-15 23:00:00	2005-01-17 00:00:00	3000	40	N15W05	10720	X2.6	2005-01-15 23:06:00	NaN
285	2005-01-17 09:25:00	2005-01-17 16:00:00	14000	30	N15W25	10720	X2.0	2005-01-17 09:30:00	NaN
286	2005-01-17 10:00:00	2005-01-17 10:35:00	6100	1500	N15W25	10720	X3.8	2005-01-17 09:54:00	NaN
288	2005-01-20 07:15:00	2005-01-20 16:30:00	14000	25	N14W61	10720	X7.1	2005-01-20 06:54:00	NaN
317	2005-09-09 19:45:00	2005-09-09 22:00:00	10000	50	S12E67	10808	X6.2	2005-09-09 19:48:00	NaN
318	2005-09-10 21:45:00	2005-09-11 01:00:00	14000	200	S13E47	10808	X2.1	2005-09-10 21:52:00	NaN
328	2006-12-05 10:50:00	2006-12-05 20:00:00	14000	250	S07E68	10930	X9.0	NaT	NaN
331	2006-12-06 19:00:00	2006-12-09 00:00:00	16000	30	S05E64	10930	X6.5	NaT	NaN
332	2006-12-13 02:45:00	2006-12-13 10:40:00	12000	150	S06W23	10930	X3.4	2006-12-13 02:54:00	NaN
345	2011-02-15 02:10:00	2011-02-15 07:00:00	16000	400	S20W12	11158	X2.2	2011-02-15 02:24:00	NaN
359	2011-08-09 08:20:00	2011-08-09 08:35:00	16000	4000	N17W69	11263	X6.9	2011-08-09 08:12:00	NaN
361	2011-09-06 22:30:00	2011-09-07 15:40:00	16000	150	N14W18	11283	X2.1	2011-09-06 23:05:00	NaN
375	2012-03-07 01:00:00	2012-03-08 19:00:00	16000	30	N17E27	11429	X5.4	2012-03-07 00:24:00	NaN
403	2013-05-13 16:15:00	2013-05-13 19:10:00	16000	300	N11E85	11748	X2.8	2013-05-13 16:07:00	NaN
404	2013-05-14 01:16:00	2013-05-14 08:20:00	16000	240	N08E77	11748	X3.2	2013-05-14 01:25:00	NaN
420	2013-10-25 15:08:00	2013-10-25 22:32:00	16000	200	S06E69	11882	X2.1	2013-10-25 15:12:00	NaN
443	2014-02-25 00:56:00	2014-02-25 11:28:00	14000	100	S12E82	11990	X4.9	2014-02-25 01:25:00	NaN
487	2015-05-05 22:24:00	2015-05-05 23:14:00	14000	500	N15E79	12339	X2.7	2015-05-05 22:24:00	NaN
514	2017-09-06 12:05:00	2017-09-07 08:00:00	16000	70	S08W33	12673	X9.3	2017-09-06 12:24:00	NaN
515	2017-09-10 16:02:00	2017-09-11 06:50:00	16000	150	S09W92	NaN	X8.3	2017-09-10 16:00:00	NaN

Task 7: Atributes Visualization:

In [31]:

```python
%matplotlib inline
```

In [32]:

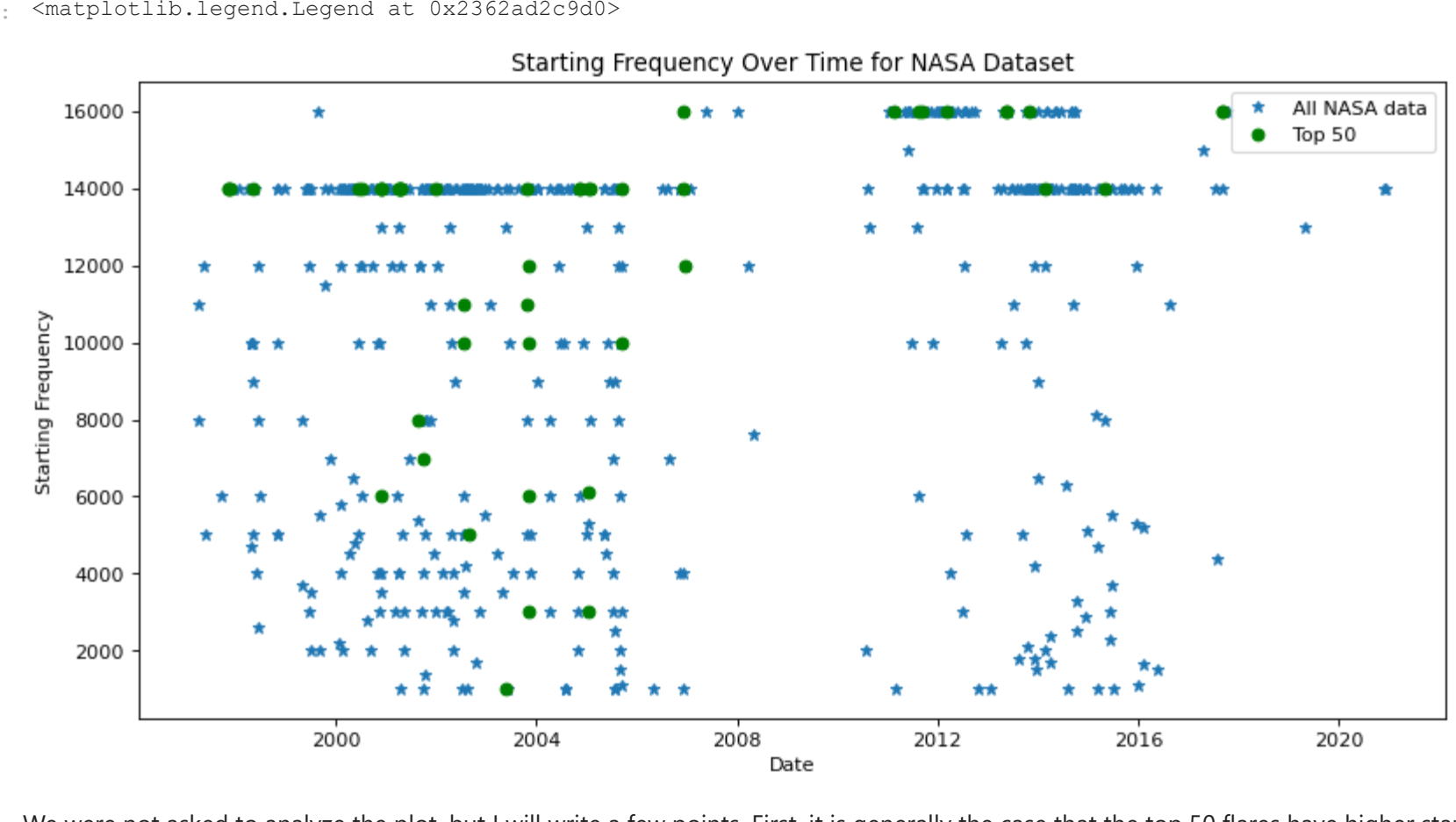
```python
#Getting the top 50 flares from NASA dataset (again):
topFlaresdf = tableNASAdfCopy.loc[tableNASAdfCopy['flare_classification'].str.contains('X')]
topFlaresdf['flare_classification'] = topFlaresdf['flare_classification'].str.lstrip('X').astype(float)
topFlaresdf = topFlaresdf.sort_values('flare_classification', ascending = False)
topFlaresdf = topFlaresdf.head(50)
topFlaresdf['flare_classification'] = topFlaresdf.flare_classification.astype(str)
topFlaresdf['flare_classification'] = "X" + topFlaresdf['flare_classification']
```

```
<ipython-input-32-ef7f3ff2bf8d>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ret
urning-a-view-versus-a-copy
  topFlaresdf['flare_classification'] = topFlaresdf['flare_classification'].str.lstrip('X').astype(float)
```

In [33]:

```python
#Plotting start frequency over time for NASA Dataset:

#Since we cannot plot nan values anyways, we will remove them from a copy of the dataset, and this copy will be
out_NASA_noNan = out_NASA.copy().dropna(axis = 0, subset = ['start_datetime', 'start_frequency'])

#Converting frequency columns in top 50 flare dataset and all NASA dataset to ints, so that values are sorted
#when plotted appropiately
out_NASA_noNan = out_NASA_noNan.astype({'start_frequency': 'int32'})
topFlaresdf = topFlaresdf.astype({'start_frequency': 'int32'})

#Creating the plot
mp.pyplot.figure(figsize = (12,6), dpi = 80)
mp.pyplot.title('Starting Frequency Over Time for NASA Dataset')
mp.pyplot.xlabel('Date')
mp.pyplot.ylabel('Starting Frequency')
mp.pyplot.plot(out_NASA_noNan['start_datetime'], out_NASA_noNan['start_frequency'], '*', label = 'All NASA data
mp.pyplot.plot(topFlaresdf['start_datetime'], topFlaresdf['start_frequency'], 'go', label = 'Top 50')
mp.pyplot.legend(loc = 'upper right')
```

Out[33]: `<matplotlib.legend.Legend at 0x2362ad2c9d0>`

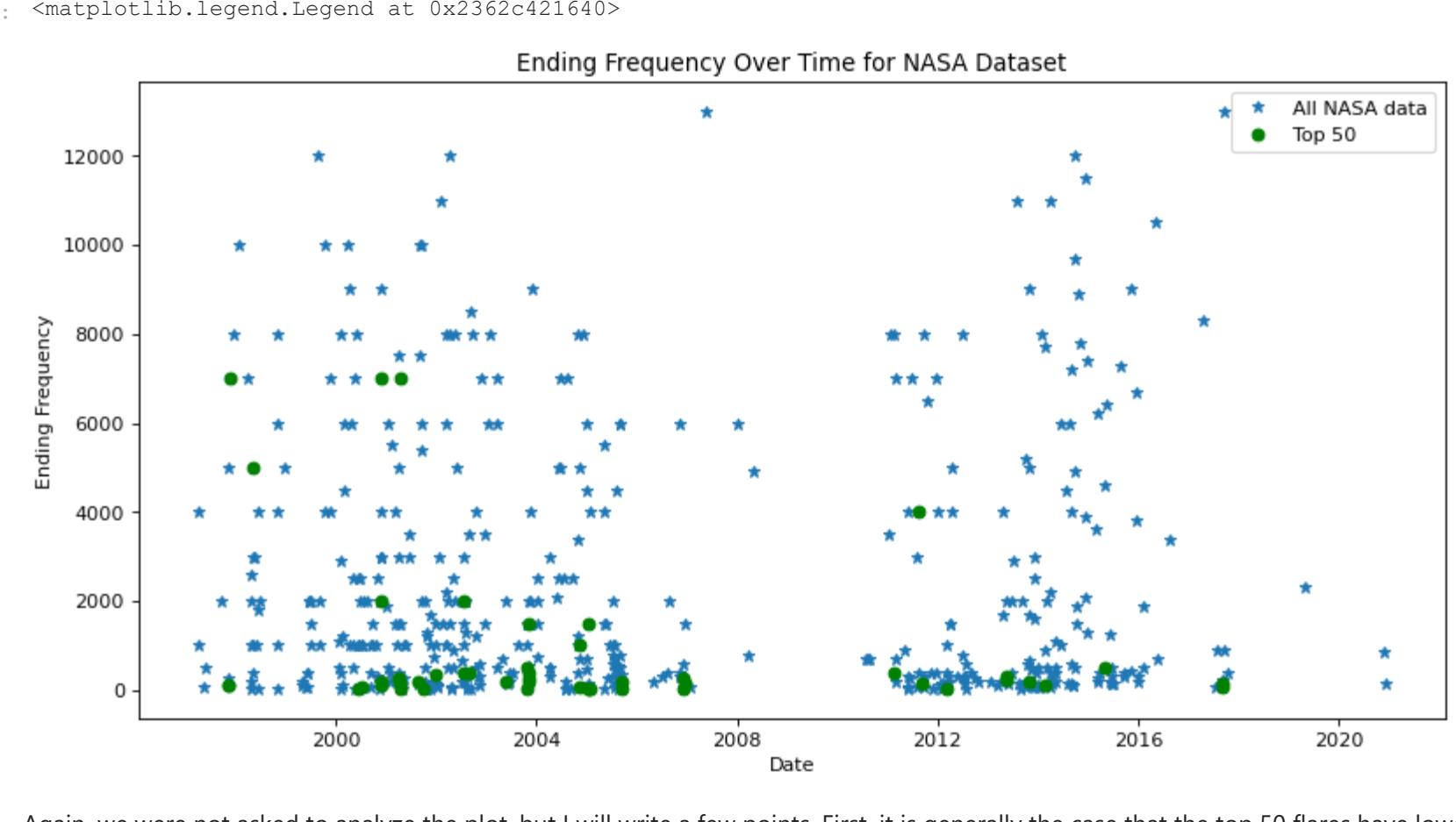


We were not asked to analyze the plot, but I will write a few points. First, it is generally the case that the top 50 flares have higher starting frequencies than those points not in the top 50. They also seem to be more clustered towards time before 2008. One also notices a huge gap in time with no data (around 2009-2011), which is also represented via the table.

In [34]:

```python
#Plotting end frequency over time for NASA Dataset:

#Since we cannot plot nan values anyways, we will remove them from a copy of the dataset, and this copy will be
out_NASA_noNan = out_NASA.copy().dropna(axis = 0, subset = ['start_datetime', 'end_frequency'])

#Converting frequency columns in top 50 flare dataset and all NASA dataset to ints,
#so that values are sorted when plotted appropiately
out_NASA_noNan = out_NASA_noNan.astype({'end_frequency': 'int32'})
topFlaresdf = topFlaresdf.astype({'end_frequency': 'int32'})

#Creating the plot
mp.pyplot.figure(figsize = (12,6), dpi = 80)
mp.pyplot.title('Ending Frequency Over Time for NASA Dataset')
mp.pyplot.xlabel('Date')
mp.pyplot.ylabel('Ending Frequency')
mp.pyplot.plot(out_NASA_noNan['start_datetime'], out_NASA_noNan['end_frequency'], '*', label = 'All NASA data')
mp.pyplot.plot(topFlaresdf['start_datetime'], topFlaresdf['end_frequency'], 'go', label = 'Top 50')
mp.pyplot.legend(loc = 'upper right')
```

Out[34]: `<matplotlib.legend.Legend at 0x2362c421640>`

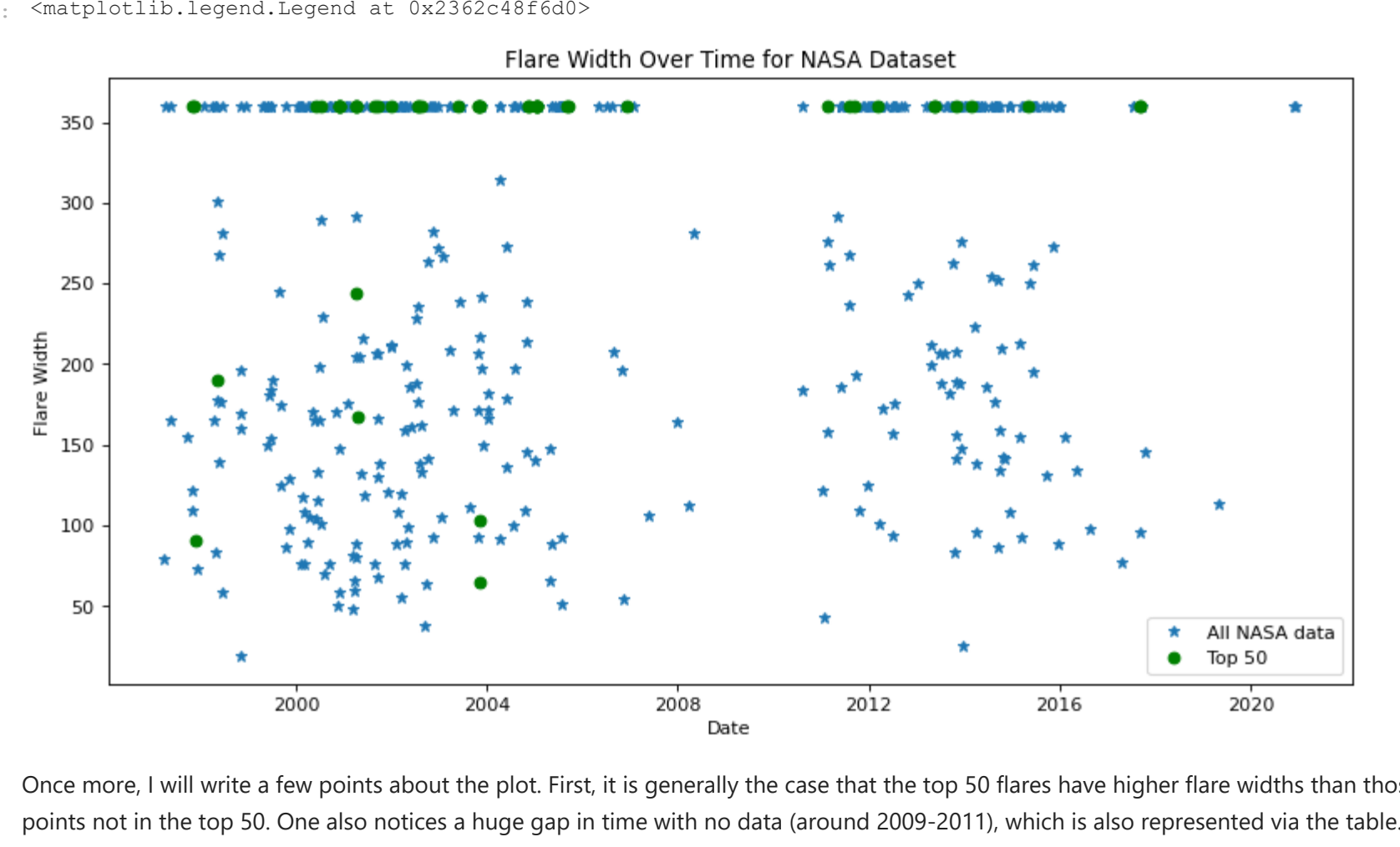


Again, we were not asked to analyze the plot, but I will write a few points. First, it is generally the case that the top 50 flares have lower ending frequencies than those points not in the top 50, opposite of their starting frequencies. One again notices a huge gap in time with no data (around 2009-2011), which is also represented via the table. The top 50 flares appear to show a general negative correlation (as time increases, the ending frequency decreases).

In [35]:

```python
#Plotting flare width over time for NASA Dataset:
#out_NASA = out_NASA.replace(to_replace = '60h', value = '360')


#Since we cannot plot nan values anyways, we will remove them from a copy of the dataset, and this copy will be
out_NASA_noNan = out_NASA.copy().dropna(axis = 0, subset = ['start_datetime', 'cme_width'])
topFlaresdf_noNan = topFlaresdf.copy().dropna(axis = 0, subset = ['start_datetime', 'cme_width'])

#Converting width columns in top 50 flare dataset and all NASA dataset to ints,
#so that values are sorted when plotted appropiately
out_NASA_noNan = out_NASA_noNan.astype({'cme_width': 'int32'})
topFlaresdf_noNan = topFlaresdf_noNan.astype({'cme_width': 'int32'})

#Creating the plot
mp.pyplot.figure(figsize = (12,6), dpi = 80)
mp.pyplot.title('Flare Width Over Time for NASA Dataset')
mp.pyplot.xlabel('Date')
mp.pyplot.ylabel('Flare Width')
mp.pyplot.plot(out_NASA_noNan['start_datetime'], out_NASA_noNan['cme_width'], '*', label = 'All NASA data')
mp.pyplot.plot(topFlaresdf_noNan['start_datetime'], topFlaresdf_noNan['cme_width'], 'go', label = 'Top 50')
mp.pyplot.legend(loc = 'lower right')
```

Out[35]: `<matplotlib.legend.Legend at 0x2362c48f6d0>`



Once more, I will write a few points about the plot. First, it is generally the case that the top 50 flares have higher flare widths than those points not in the top 50. One also notices a huge gap in time with no data (around 2009-2011), which is also represented via the table. There appears to be a correlation between the starting frequency and the flare width (when the starting frequency is high, the width is also high).

In [36]:

```python
out_NASA
```

Out[36]:

	start_datetime	end_datetime	start_frequency	end_frequency	flare_location	flare_region	flare_classification	cme_datetime	cme_angle
0	1997-04-01 14:00:00	1997-04-01 14:15:00	8000	4000	S25E16	8026	M1.3	1997-04-01 15:18:00	74
1	1997-04-07 14:30:00	1997-04-07 17:30:00	11000	1000	S28E19	8027	C6.8	1997-04-07 14:27:00	NaN
2	1997-05-12 05:15:00	1997-05-14 16:00:00	12000	80	N21W08	8038	C1.3	1997-05-12 05:30:00	NaN
3	1997-05-21 20:20:00	1997-05-21 22:00:00	5000	500	N05W12	8040	M1.3	1997-05-21 21:00:00	263
4	1997-09-23 21:53:00	1997-09-23 22:16:00	6000	2000	S29E25	8088	C1.4	1997-09-23 22:02:00	133
...	...	...	...	...	...	...	...	...	...
517	2017-09-17 11:45:00	2017-09-17 12:35:00	16000	900	S08E170	NaN	NaN	2017-09-17 12:00:00	NaN
518	2017-10-18 05:48:00	2017-10-18 12:40:00	16000	400	S06E123	NaN	NaN	2017-10-18 08:00:00	85
519	2019-05-03 23:52:00	2019-05-04 00:16:00	13000	2300	N12E82	12740	C1.0	2019-05-03 23:24:00	90
520	2020-11-29 13:07:00	2020-11-29 15:23:00	14000	850	S23E89	NaN	M4.4	2020-11-29 13:25:00	NaN
521	2020-12-07 16:18:00	2020-12-08 02:00:00	14000	160	S25W08	12790	C7.4	2020-12-07 16:24:00	NaN

522 rows × 14 columns

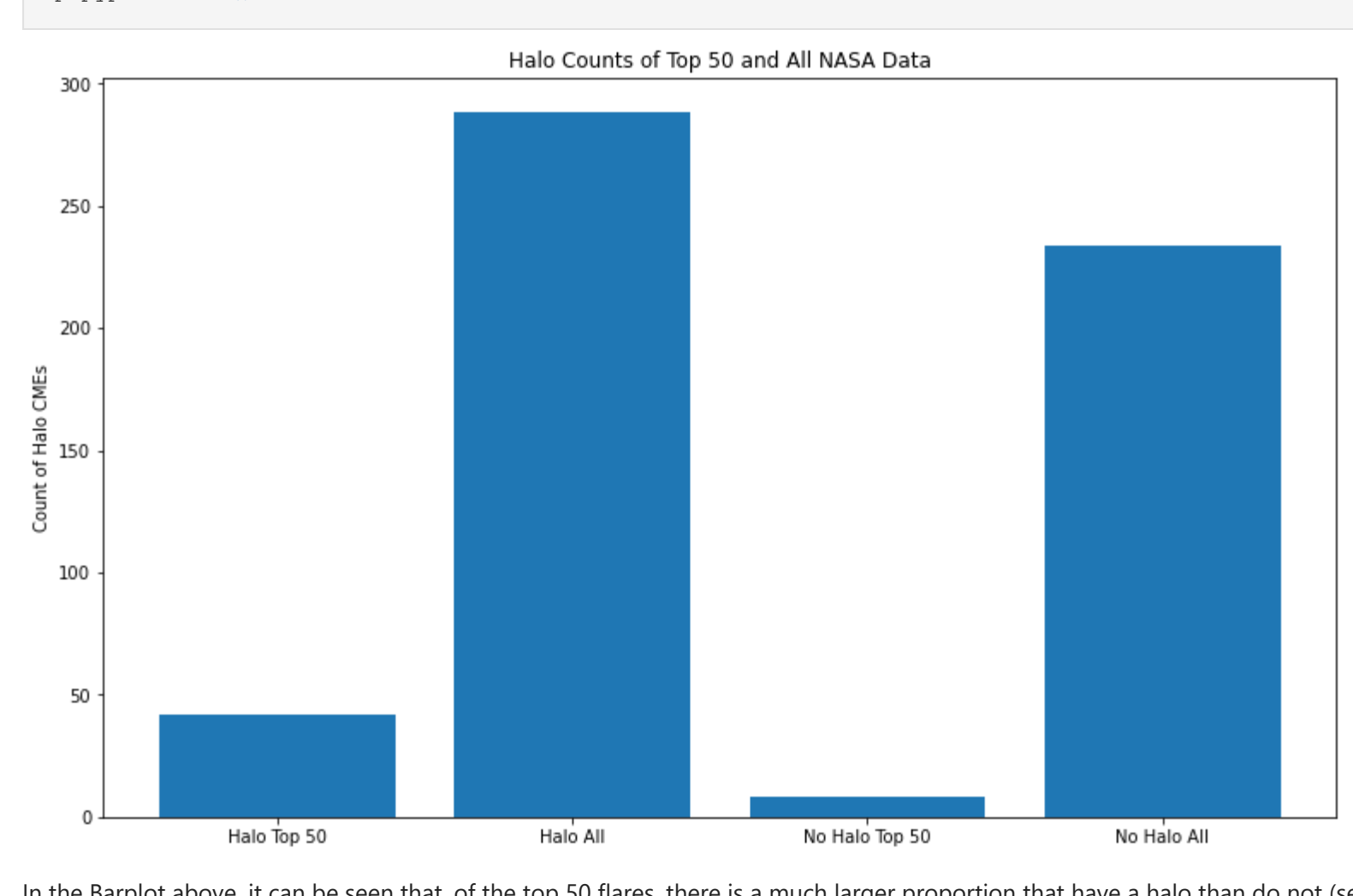
Task 8: Attributes Comparison:

In [37]:

```python
# Iterating through the rows to get a count of the halos in the dataframes of all flares and the top 50 flares

import numpy as np
halo_countTop = 0
no_countTop = 0
halo_countAll = 0
no_countAll = 0

for index, row in topFlaresdf.iterrows():
    if row['is_halo']:
        halo_countTop += 1
    else:
        no_countTop += 1

for index, row in out_NASA.iterrows():
    if row['is_halo']:
        halo_countAll += 1
    else:
        no_countAll += 1
```

In [38]:

```python
#Making the Barplot:
fig = mp.pyplot.figure(figsize = (10,6))
ax = fig.add_axes([0,0,1,1])
cases = ['Halo Top 50', 'Halo All', 'No Halo Top 50', 'No Halo All']
amounts = [halo_countTop,halo_countAll,no_countTop,no_countAll]

#I tried to add labels but I could not get it to work
#labels = [round(halo_countTop/(no_countTop + halo_countTop), 3), round(halo_countAll/(halo_countAll + no_count
#ind = np.arrange(len(labels))
ax.bar(cases, amounts)
mp.pyplot.title('Halo Counts of Top 50 and All NASA Data')
mp.pyplot.ylabel('Count of Halo CMEs')

# for index, value in enumerate(amounts):
#     mp.pyplot.text(value, index, str(value))
mp.pyplot.show()
```



In the Barplot above, it can be seen that, of the top 50 flares, there is a much larger proportion that have a halo than do not (seen by comparing 'Halo Top 50' to 'No Halo Top 50'). It is also seen that, when looking at the entire NASA dataset, there are more flares with halos than without, but not my as large of a difference as is seen in the top 50.

Task 9: Events Distribution:

In [39]:

```python
#Making a new dataframe with the count of strong flares (top 50) per month
#(based on start_datetime; I could have chosen end_datetime but either is fine).
top50Month = topFlaresdf['start_datetime'].groupby(topFlaresdf['start_datetime'].dt.to_period("M")).agg('count'
top50Monthdf = top50Month.to_frame()
top50Monthdf = top50Monthdf.rename(columns = {'start_datetime': 'count'})
top50Monthdf = top50Monthdf.reset_index()
top50Monthdf['start_datetime'] = top50Monthdf['start_datetime'].dt.to_timestamp()
top50Monthdf
```

Out[39]:

	start_datetime	count
0	1997-11-01	3
1	1998-05-01	1
2	2000-06-01	1
3	2000-07-01	1
4	2000-11-01	4
5	2001-04-01	5
6	2001-08-01	1
7	2001-09-01	1
8	2001-12-01	1
9	2002-07-01	2
10	2002-08-01	1
11	2003-05-01	1
12	2003-10-01	2
13	2003-11-01	4
14	2004-11-01	2
15	2005-01-01	4
16	2005-09-01	2
17	2006-12-01	3
18	2011-02-01	1
19	2011-08-01	1
20	2011-09-01	1
21	2012-03-01	1
22	2013-05-01	2
23	2013-10-01	1
24	2014-02-01	1
25	2015-05-01	1
26	2017-09-01	2

In [40]:

```python
#Making a new dataframe with the count of all flares (all NASA data) per month
#(based on start_datetime; I could have chosen end_datetime but either is fine).
AllMonth = out_NASA['start_datetime'].groupby(out_NASA['start_datetime'].dt.to_period("M")).agg('count')
AllMonthdf = AllMonth.to_frame()
AllMonthdf = AllMonthdf.rename(columns = {'start_datetime': 'count'})
AllMonthdf = AllMonthdf.reset_index()
AllMonthdf['start_datetime'] = AllMonthdf['start_datetime'].dt.to_timestamp()
AllMonthdf
```

Out[40]:

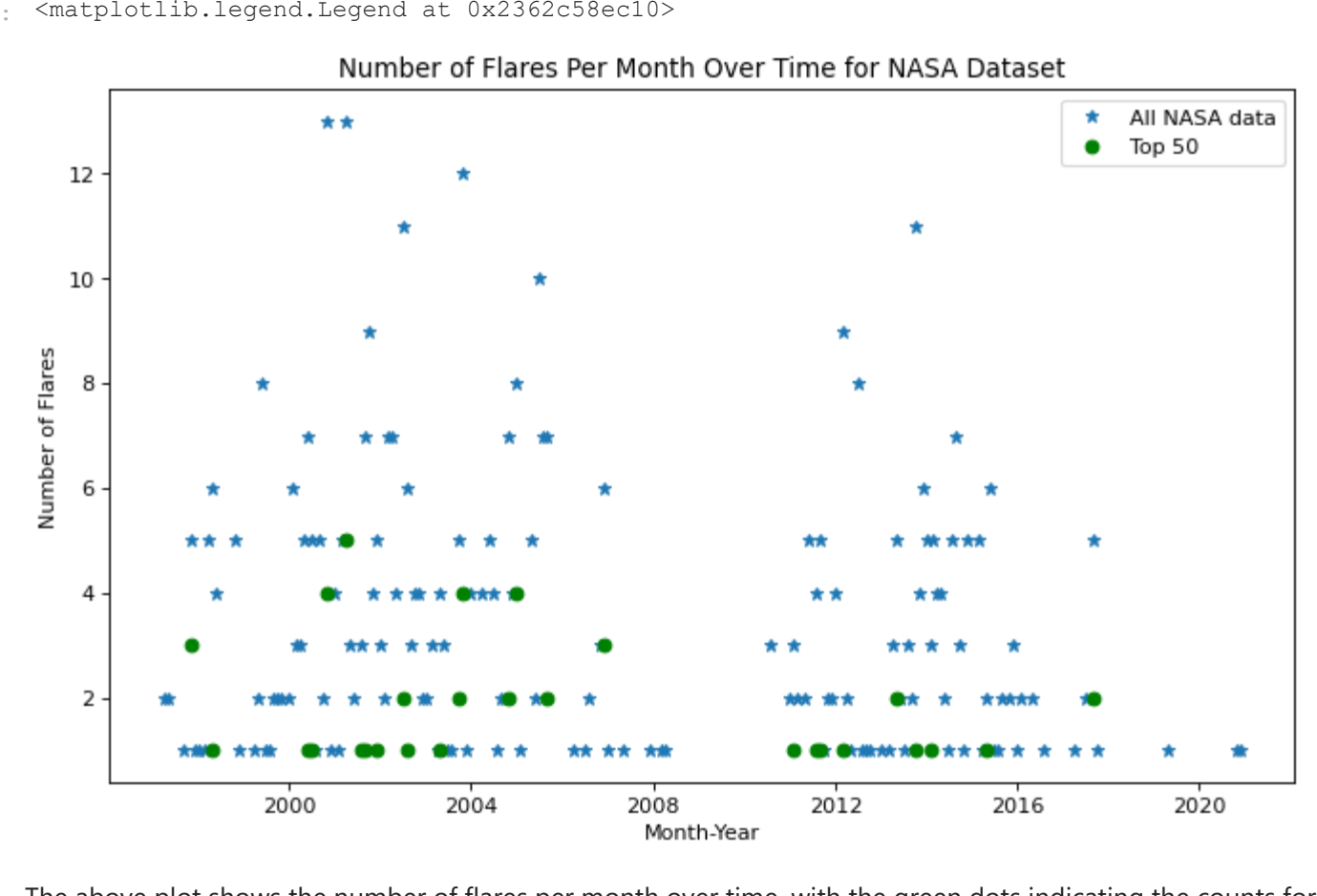
	start_datetime	count
0	1997-04-01	2
1	1997-05-01	2
2	1997-09-01	1
3	1997-11-01	5
4	1997-12-01	1
...	...	...
147	2017-09-01	5
148	2017-10-01	1
149	2019-05-01	1
150	2020-11-01	1
151	2020-12-01	1

152 rows × 2 columns

In [41]:

```python
#Creating the plot
mp.pyplot.figure(figsize = (10,6), dpi = 80)
mp.pyplot.title('Number of Flares Per Month Over Time for NASA Dataset')
mp.pyplot.xlabel('Month-Year')
mp.pyplot.ylabel('Number of Flares')
mp.pyplot.plot(AllMonthdf['start_datetime'], AllMonthdf['count'], '*', label = 'All NASA data')
mp.pyplot.plot(top50Monthdf['start_datetime'], top50Monthdf['count'], 'go', label = 'Top 50')
mp.pyplot.legend(loc = 'upper right')
```

Out[41]: `<matplotlib.legend.Legend at 0x2362c58ec10>`



The above plot shows the number of flares per month over time, with the green dots indicating the counts for the strong flares (top 50). In general, it appears that the strong flare counts are smaller than counts seen when looking at the entire dataset. This makes sense considering there is a larger number of points being counted for the entire dataset, so the counts per month should be higher. The strong flares are also more clustered towards the time periods of about 1997-2007 as well as 2011-2017. The larger of these two clusters is between 1997-2007. Unfortunately, this pattern does not seem to be unique to the strong flares as those time-period clusters are basically seen for the entire dataset as well (clusters of about 1997-2008 and 2011-2020).

NOTE: FOR THIS ENTIRE DOCUMENT, I HAD TO REWORK MY COMMENTS SO THAT THE WHOLE COMMENT COULD BE READ ONCE THE JUPYTER NOTEBOOK GETS CONVERTED INTO A PDF; THUS, I APOLOGIZE IF THE COMMENTS ARE POORLY FORMATTED (MY COMMENTS READ MUCH NICER BEFORE I HAD TO REFORMAT THEM)