Visualizing FIRMS Fire Detection Data

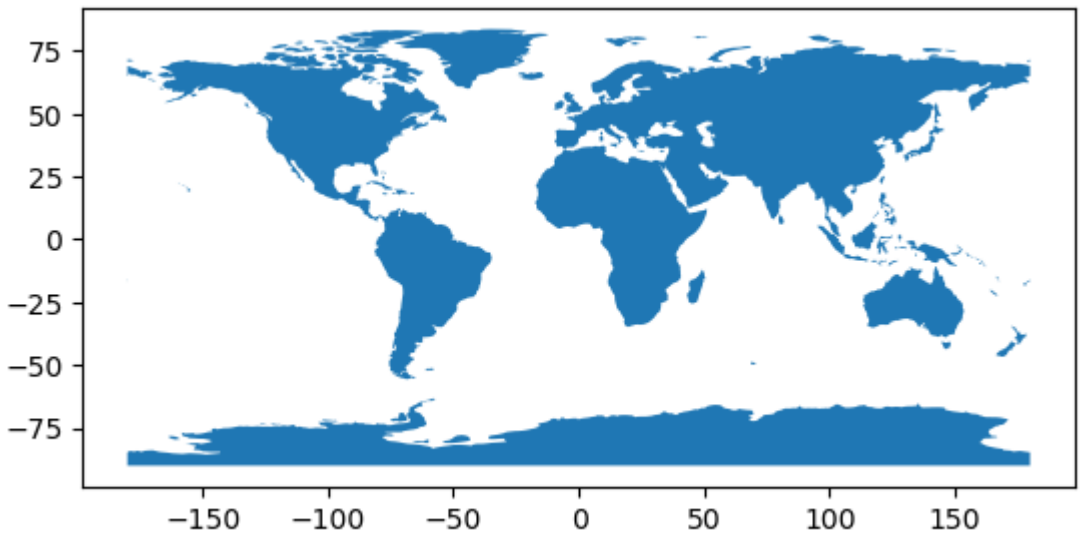
Visible Infrared Imaging Radiometer Suite or VIIRS is an instrument that collects high-resolution, including visible and infrared images of hurricanes and detection of fires, smoke, and particles in the atmosphere.

In downloading a sample dataset, VIIRS SNPP from July 12, 2023, fires can be detected in and around Canada.

First - basic earth data is to be obtained.

In [2]:
```
path = get_path("naturalearth.land")
world = geopandas.read_file(path)

# and test our libraries loaded
```

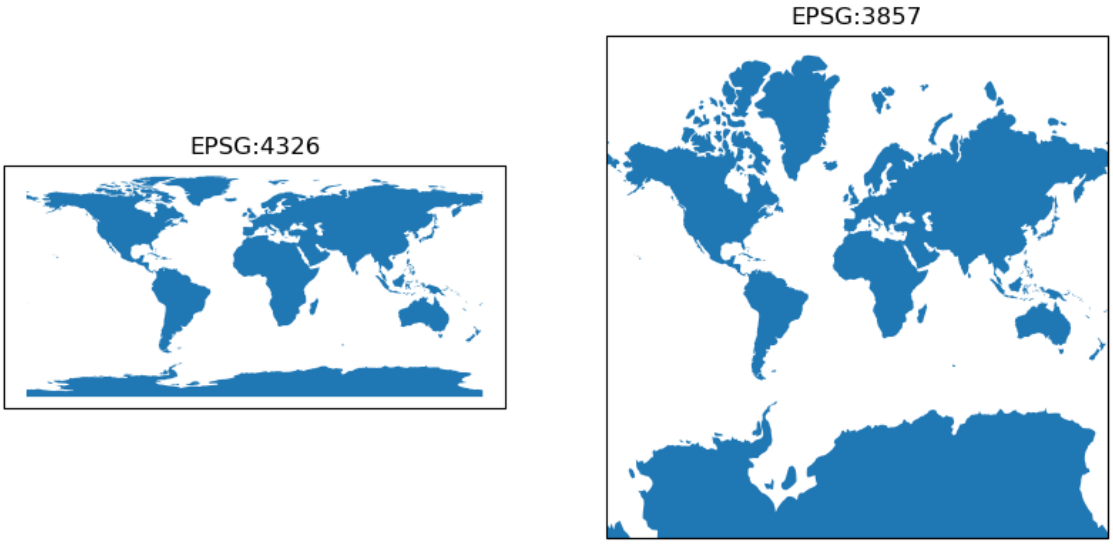
Out[2]: <Axes: >



Then - a common map projection can be chosen.

In [3]:
```
crs = ccrs.epsg("3857")
world_epsg = world.to_crs(epsg="3857")

fig, axs = plt.subplots(1, 2, subplot_kw={"projection": crs}, figsize=(10,
axs[0].set(title='EPSG:4326')
axs[1].set(title='EPSG:3857')
world.plot(ax=axs[0])
```

Out[3]: <GeoAxes: title={'center': 'EPSG:3857'}>



Map projection EPSG:4326 will be map of choice due to its popularity.

Here are the some of the records from the NASA VIIRS SNPP dataset with longtitude and latitude values of fire detection imagery.

In [5]:
```
import pandas as pd
df = pd.read_csv('https://firms.modaps.eosdis.nasa.gov/content/notebooks/s

# show top 5 records
```

Out[5]:

	latitude	longitude	bright_ti4	scan	track	acq_date	acq_time	satellite	instrument	cc
0	0.05836	29.59085	295.64	0.38	0.59	2023-07-12	3	N	VIIRS	
1	0.48765	31.50760	296.73	0.51	0.66	2023-07-12	3	N	VIIRS	
2	2.15227	13.94524	305.26	0.51	0.49	2023-07-12	3	N	VIIRS	
3	2.15681	13.94618	319.05	0.51	0.49	2023-07-12	3	N	VIIRS	
4	2.15754	13.94131	301.13	0.51	0.50	2023-07-12	3	N	VIIRS	

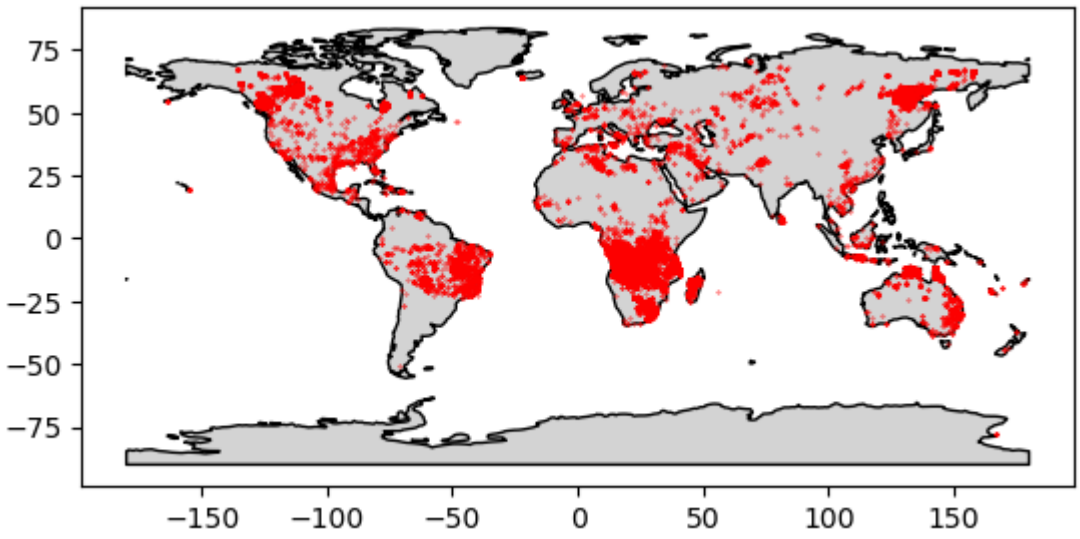
Next is a conversion of longitude, latitude values into point geometry.

In [6]:
```
gdf = geopandas.GeoDataFrame(
    df, geometry=geopandas.points_from_xy(df.longitude, df.latitude), crs=
)

# show top 3 records
```

Out[6]:

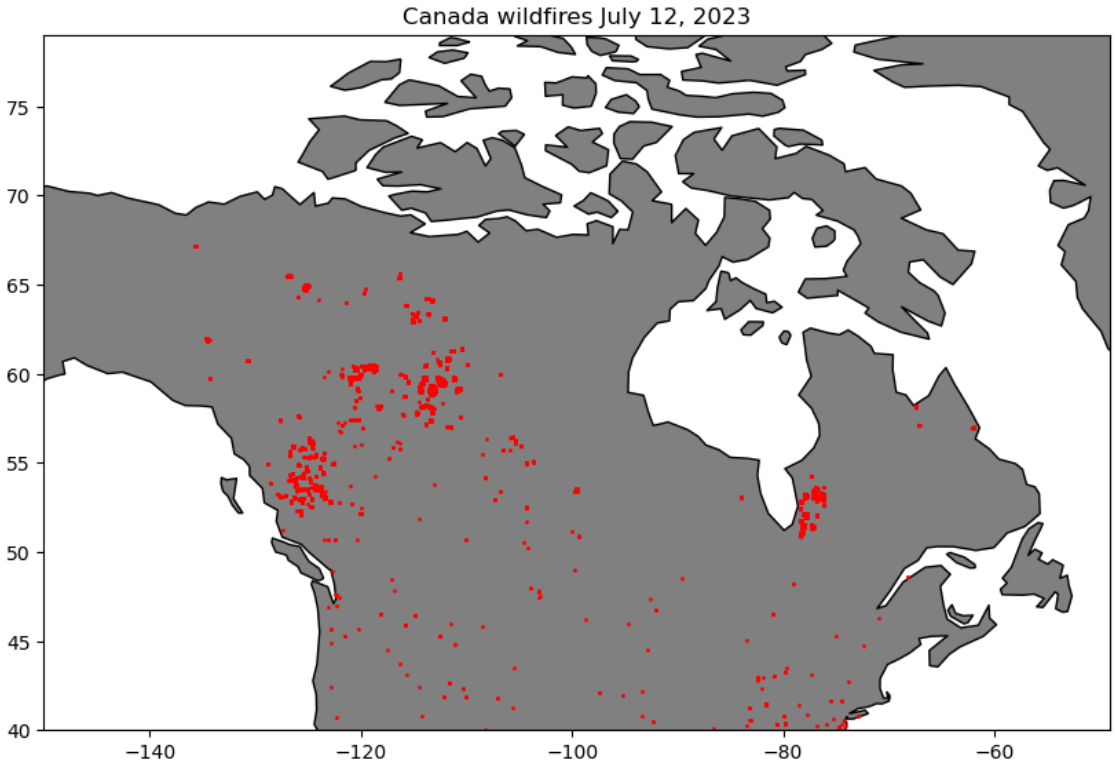
	latitude	longitude	bright_ti4	scan	track	acq_date	acq_time	satellite	instrument	cc
0	0.05836	29.59085	295.64	0.38	0.59	2023-07-12	3	N	VIIRS	
1	0.48765	31.50760	296.73	0.51	0.66	2023-07-12	3	N	VIIRS	
2	2.15227	13.94524	305.26	0.51	0.49	2023-07-12	3	N	VIIRS	

In [7]:
```
ax = world.plot(color="lightgrey", edgecolor="black")

# We can now plot our ``GeoDataFrame``.
gdf.plot(ax=ax, color="red", markersize=0.1)
```



Now to show fire detections in or around Canada using FIRMS Regional Coordinates.

In [8]:
```
df_canada = df[(df['longitude'] >= -150) & (df['latitude'] >= 40) & (df['l

# create geometry for points using latitude and longitude and specifying pr

gdf = geopandas.GeoDataFrame(
    df_canada, geometry=geopandas.points_from_xy(df_canada.longitude, df_ca
)

# set our extent
extent = [-150, 40, -49, 79]
ax = world.plot(figsize=(10, 10), color="grey", edgecolor="black")
ax.set_xlim([extent[0],  extent[2]])
ax.set_ylim([extent[1],  extent[3]])

ax.set(title='Canada wildfires July 12, 2023')

# We can now plot our ``GeoDataFrame``.
gdf.plot(ax=ax, color="red", markersize=1)

plt.show()
```



To visualize data based on time it was detected, newer data will different colors.

With a current data and time of 2023 July 12, 19:50 (7:50pm) GMT, the color coding will be:

dark red; detections <= 1 hour

red; detections > 1 hour but less than or equal to 4 hours

orange; detections > 4hours and less than or equal to 12 hours

yellow; detections older than 12 hours

In [13]:

```
# convert aqc_date and aqc_time to acq_datetime as datetime object
df_canada['acq_datetime'] = pd.to_datetime(df_canada['acq_date'] + ' ' + d
gdf = geopandas.GeoDataFrame(
    df_canada, geometry=geopandas.points_from_xy(df_canada.longitude, df_c
)
# find maximum time from our dataset since we are pretending current date
# if the data were recent, we would set dt_max = pd.Timestamp.now();
dt_max = gdf['acq_datetime'].max()

# create our subsets for 4 color classes

# less than or equal to 1 hour; gdf1 <= 1hour
gdf1 = gdf[gdf['acq_datetime'] >= (dt_max - pd.Timedelta(hours=1))]

# greater than 1 hour but less than or equal to 4 hours; gdf2 > 1 hour and
gdf2 = gdf[(gdf['acq_datetime'] >= (dt_max - pd.Timedelta(hours=4))) & (gd

# greater than 4 hours but less than or equal to 12 hours; gdf3 > 4 hours
gdf3 = gdf[(gdf['acq_datetime'] >= (dt_max - pd.Timedelta(hours=12))) & (g

# greater than 12 hours; gdf4 > 12 hours
gdf4 = gdf[gdf['acq_datetime'] < (dt_max - pd.Timedelta(hours=12))]

# now let's make sure the sizes are correct. They should all add up to 140
print ('Sizes %i, %i, %i, %i from total of %i' % (gdf1.count()[0],gdf2.cou
```

```
Sizes 3792, 913, 8449, 891 from total of 14045
```

We will set the map to view fire detection images in Canada with current data/time set to 2023 July 12, 1950 (7:50pm) GMT with color coding as follows:

dark red; detections <= 1 hour

red; detections > 1 hour but less than or equal to 4 hours

orange; detections > 4hours and less than or equal to 12 hours

yellow; detections older than 12 hours

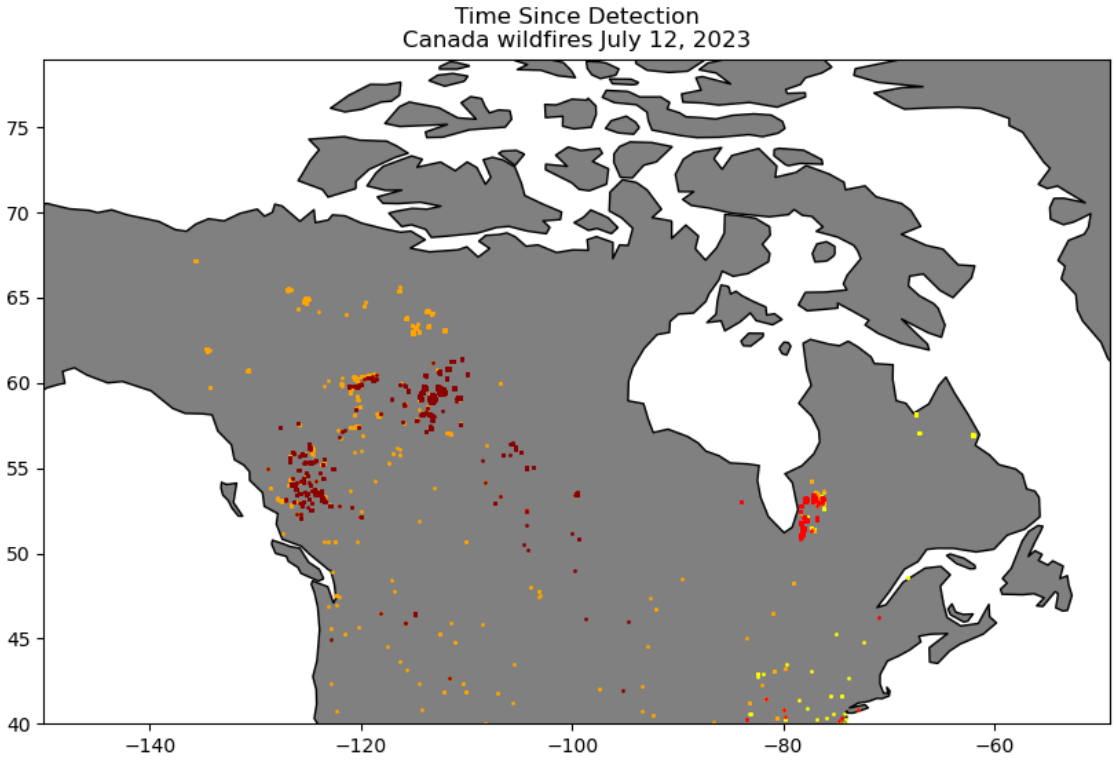
In [14]:

```
# convert aqc_date and aqc_time to acq_datetime as datetime object
df_canada['acq_datetime'] = pd.to_datetime(df_canada['acq_date'] + ' ' + d
gdf = geopandas.GeoDataFrame(
    df_canada, geometry=geopandas.points_from_xy(df_canada.longitude, df_c
)
# find maximum time from our dataset since we are pretending current date
# if the data were recent, we would set dt_max = pd.Timestamp.now();
dt_max = gdf['acq_datetime'].max()

# create our subsets for 4 color classes

# less than or equal to 1 hour; gdf1 <= 1hour
gdf1 = gdf[gdf['acq_datetime'] >= (dt_max - pd.Timedelta(hours=1))]

# greater than 1 hour but less than or equal to 4 hours; gdf2 > 1 hour and
gdf2 = gdf[(gdf['acq_datetime'] >= (dt_max - pd.Timedelta(hours=4))) & (gd

# greater than 4 hours but less than or equal to 12 hours; gdf3 > 4 hours
gdf3 = gdf[(gdf['acq_datetime'] >= (dt_max - pd.Timedelta(hours=12))) & (g

# greater than 12 hours; gdf4 > 12 hours
gdf4 = gdf[gdf['acq_datetime'] < (dt_max - pd.Timedelta(hours=12))]

# now let's make sure the sizes are correct. They should all add up to 140
print ('Sizes %i, %i, %i, %i from total of %i' % (gdf1.count()[0],gdf2.cou
```

```
Sizes 3792, 913, 8449, 891 from total of 14045
```

In [16]:

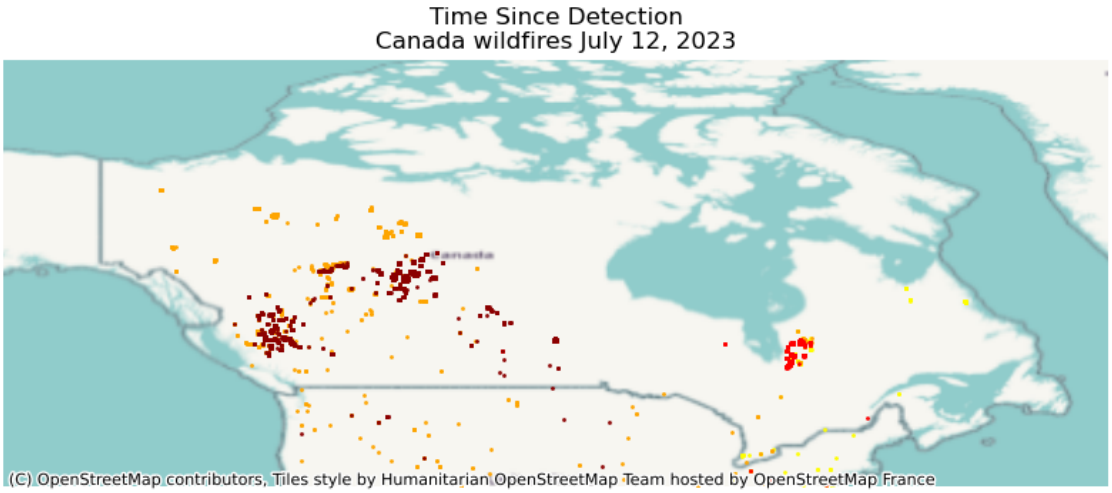
```
# set our extent to Canada
extent = [-150, 40, -49, 79]
ax = world.plot(figsize=(10, 10), color="grey", edgecolor="black")

# set map extent
ax.set_xlim([extent[0],  extent[2]])
ax.set_ylim([extent[1],  extent[3]])

# add graph title
ax.set(title='Time Since Detection\nCanada wildfires July 12, 2023')

# Color code each set; also we are drawing in opposite order, so the older
gdf4.plot(ax=ax, color="yellow", markersize=1)
gdf3.plot(ax=ax, color="orange", markersize=1)
gdf2.plot(ax=ax, color="red", markersize=1)
gdf1.plot(ax=ax, color="darkred", markersize=1)

plt.show()
```



For our final map, more map detail can enhance the imagery of where fires are detected.

In [17]:

```
extent = [-150, 40, -49, 79]
ax = world.plot(figsize=(10, 10), alpha=0)

# set our map extent
ax.set_xlim([extent[0],  extent[2]])
ax.set_ylim([extent[1],  extent[3]])

# set title
ax.set(title='Time Since Detection\nCanada wildfires July 12, 2023')
# turn off axis labels
ax.set_axis_off()

# Color code each set; also we are drawing in opposite order, so the older
if gdf4.count()[0] > 0 :
  gdf4.plot(ax=ax, color="yellow", markersize=1)
if gdf3.count()[0] > 0 :
  gdf3.plot(ax=ax, color="orange", markersize=1)
if gdf2.count()[0] > 0 :
  gdf2.plot(ax=ax, color="red", markersize=1)
if gdf1.count()[0] > 0 :
  gdf1.plot(ax=ax, color="darkred", markersize=1)

# add basemap
cx.add_basemap(ax, crs=gdf1.crs)

# show our map plot
plt.show()
```



Page References

NOAA National Environmental Satellite, Data, and Information Science. Visible Infrared Imaging Radiometer Suite (VIIRS). Retrieved from https:// www.nesdis.noaa.gov/our-satellites/currently-flying/joint-polar- satellite-system/visible-infrared-imaging-radiometer-suite-viirs#:~:text=VIIRS%20features%20daily%20imaging%20capabilities,the%20atmosphere%2 (https://www.nesdis.noaa.gov/our-satellites/currently-flying/joint-polar-satellite-system/visible-infrared-imaging-radiometer-suite-viirs#:~:text=VIIRS%20features%20daily%20imaging%20capabilities,the%20atmosphere%2

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