gps-correction

June 22, 2023

```python
%pip install pandas
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: pandas in
/home/ubuntu/.local/lib/python3.10/site-packages (2.0.2)
Requirement already satisfied: pytz>=2020.1 in /usr/lib/python3/dist-packages
(from pandas) (2022.1)
Requirement already satisfied: python-dateutil>=2.8.2 in
/home/ubuntu/.local/lib/python3.10/site-packages (from pandas) (2.8.2)
Requirement already satisfied: tzdata>=2022.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from pandas) (2023.3)
Requirement already satisfied: numpy>=1.21.0 in /usr/lib/python3/dist-packages
(from pandas) (1.21.5)
Requirement already satisfied: six>=1.5 in
/home/ubuntu/.local/lib/python3.10/site-packages (from python-
dateutil>=2.8.2->pandas) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
```

```python
import pandas as pd
import numpy as np

df = pd.read_csv('leniwce_run2/data.csv', usecols=range(8), encoding='utf-8')

print(df.head(5))
```

```
   Counter                   Date/time  Latitude  Longitude Image file  \
0        1  2023-05-05 12:54:05.688582  6.682633 -62.045643        day
1        2  2023-05-05 12:54:43.503046  4.612380 -60.567484        day
2        3  2023-05-05 12:55:21.735159  2.686210 -59.203338        day
3        4  2023-05-05 12:55:59.467610  0.736819 -57.828976        day
4        5  2023-05-05 12:56:37.207741 -1.187191 -56.474213        day

   Image type Prediction score  sunlight
0    0.996094              Yes       NaN
1    0.996094              Yes       NaN
2    0.996094              Yes       NaN
3    0.996094              Yes       NaN
4    0.996094              Yes       NaN
```

```
[ ]: %pip install orbit
     %pip install skyfield
```

Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: orbit in /home/ubuntu/.local/lib/python3.10/site-
packages (0.2)
Requirement already satisfied: lxml in /home/ubuntu/.local/lib/python3.10/site-
packages (from orbit) (4.9.2)
Requirement already satisfied: requests-cache in
/home/ubuntu/.local/lib/python3.10/site-packages (from orbit) (1.0.1)
Requirement already satisfied: requests in /usr/lib/python3/dist-packages (from
orbit) (2.25.1)
Requirement already satisfied: pyephem in
/home/ubuntu/.local/lib/python3.10/site-packages (from orbit) (9.99)
Requirement already satisfied: ephem in /home/ubuntu/.local/lib/python3.10/site-
packages (from pyephem->orbit) (4.1.4)
Requirement already satisfied: platformdirs>=2.5 in
/home/ubuntu/.local/lib/python3.10/site-packages (from requests-cache->orbit)
(3.6.0)
Requirement already satisfied: urllib3>=1.25.5 in /usr/lib/python3/dist-packages
(from requests-cache->orbit) (1.26.5)
Requirement already satisfied: url-normalize>=1.4 in
/home/ubuntu/.local/lib/python3.10/site-packages (from requests-cache->orbit)
(1.4.3)
Requirement already satisfied: cattrs>=22.2 in
/home/ubuntu/.local/lib/python3.10/site-packages (from requests-cache->orbit)
(23.1.2)
Requirement already satisfied: attrs>=21.2 in /usr/lib/python3/dist-packages
(from requests-cache->orbit) (21.2.0)
Requirement already satisfied: exceptiongroup in
/home/ubuntu/.local/lib/python3.10/site-packages (from cattrs>=22.2->requests-
cache->orbit) (1.1.1)
Requirement already satisfied: typing_extensions>=4.1.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from cattrs>=22.2->requests-
cache->orbit) (4.6.3)
Requirement already satisfied: six in /home/ubuntu/.local/lib/python3.10/site-
packages (from url-normalize>=1.4->requests-cache->orbit) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: skyfield in
/home/ubuntu/.local/lib/python3.10/site-packages (1.46)
Requirement already satisfied: numpy in /usr/lib/python3/dist-packages (from
skyfield) (1.21.5)
Requirement already satisfied: sgp4>=2.2 in
/home/ubuntu/.local/lib/python3.10/site-packages (from skyfield) (2.22)
Requirement already satisfied: jplephem>=2.13 in
/home/ubuntu/.local/lib/python3.10/site-packages (from skyfield) (2.18)

Requirement already satisfied: certifi>=2017.4.17 in /usr/lib/python3/dist-packages (from skyfield) (2020.6.20)
Note: you may need to restart the kernel to use updated packages.

```python
from skyfield.api import load, wgs84
```

```python
ts = load.timescale()
t = ts.tt(2023, 5, 5)
t.tdb
```

```
2460069.5000000168
```

```python
n = 25544
# Legacy format: https://celestrak.org/NORAD/elements/gp.php?
  ↪CATNR=25544&FORMAT=TLE
# url = 'https://celestrak.org/NORAD/elements/gp.php?CATNR={}&FORMAT=TLE'.
  ↪format(n)
filename = 'tle-CATNR-{}.txt'.format(n)
satellites = load.tle_file(filename)
satellite = satellites[0]
print( satellite )
```

```
ISS (ZARYA) catalog #25544 epoch 2023-05-05 12:50:51 UTC
```

```python
ts = load.timescale()
t = ts.now( )

geocentric = satellite.at(t)
print(geocentric.position.km)

lat, lon = wgs84.latlon_of(geocentric)
print('Latitude:', lat)
print('Longitude:', lon)
```

```
[ 4497.74696034 -4905.9657547   1352.71600173]
Latitude: 11deg 38' 45.9"
Longitude: -30deg 48' 05.7"
```

```python
t = ts.utc(2023, 5, 5)

days = t - satellite.epoch
print('{:.3f} days away from epoch'.format(days))

if abs(days) > 14:
    print("To old")
```

```
-0.535 days away from epoch
```

```python
from datetime import datetime

for i, row in df.iterrows():
    date = datetime.strptime(df.at[i, "Date/time"], '%Y-%m-%d %H:%M:%S.%f')
    # t = ts.utc(date.year, date.month, date.day,date.hour, date.minute,
    →float("{}.{}".format(date.second, date.microsecond)))
    t = ts.utc(date.year, date.month, date.day,date.hour, date.minute, date.
    →second)

    geocentric = satellite.at(t)

    lat, lon = wgs84.latlon_of(geocentric)

    df.at[i, "Latitude"] = lat.degrees
    df.at[i, "Longitude"] = lon.degrees
```

1 Correct sunlight

```python
eph = load('de421.bsp')

for i, row in df.iterrows():
    date = datetime.strptime(df.at[i, "Date/time"], '%Y-%m-%d %H:%M:%S.%f')
    t = ts.utc(date.year, date.month, date.day,date.hour, date.minute,
    →float("{}.{}".format(date.second, date.microsecond)))

    sunlit_flag = satellite.at(t).is_sunlit(eph)
    state = ('in shadow', 'in sunlight')[sunlit_flag]

    df.at[i, "sunlight"] = state
```

```
/tmp/ipykernel_60078/705775834.py:8: DeprecationWarning: In future, it will be
an error for 'np.bool_' scalars to be interpreted as an index
  state = ('in shadow', 'in sunlight')[sunlit_flag]
```

```python
print(df.head(5))
```

```
   Counter                Date/time   Latitude  Longitude Image file  \
0        1  2023-05-05 12:54:05.688582  17.155422 -70.811687        day
1        2  2023-05-05 12:54:43.503046  15.272209 -69.321093        day
2        3  2023-05-05 12:55:21.735159  13.376787 -67.859699        day
3        4  2023-05-05 12:55:59.467610  11.470901 -66.423468        day
4        5  2023-05-05 12:56:37.207741   9.556213 -65.008510        day

   Image type Prediction score      sunlight
0    0.996094              Yes  in sunlight
1    0.996094              Yes  in sunlight
```

```
2    0.996094         Yes  in sunlight
3    0.996094         Yes  in sunlight
4    0.996094         Yes  in sunlight
```

```
[ ]: df.to_csv('corrected.csv', index=False)
```

```
[ ]: %pip install mobilechelonian
     %pip install jupyter
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: mobilechelonian in
/home/ubuntu/.local/lib/python3.10/site-packages (0.5)
Requirement already satisfied: IPython in
/home/ubuntu/.local/lib/python3.10/site-packages (from mobilechelonian) (8.14.0)
Requirement already satisfied: ipywidgets>=7.0.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from mobilechelonian) (8.0.6)
Requirement already satisfied: widgetsnbextension~=4.0.7 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipywidgets>=7.0.0->mobilechelonian) (4.0.7)
Requirement already satisfied: ipykernel>=4.5.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipywidgets>=7.0.0->mobilechelonian) (6.23.2)
Requirement already satisfied: jupyterlab-widgets~=3.0.7 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipywidgets>=7.0.0->mobilechelonian) (3.0.7)
Requirement already satisfied: traitlets>=4.3.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipywidgets>=7.0.0->mobilechelonian) (5.9.0)
Requirement already satisfied: prompt-toolkit!=3.0.37,<3.1.0,>=3.0.30 in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
(3.0.38)
Requirement already satisfied: stack-data in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
(0.6.2)
Requirement already satisfied: jedi>=0.16 in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
(0.18.2)
Requirement already satisfied: matplotlib-inline in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
(0.1.6)
Requirement already satisfied: pexpect>4.3 in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
(4.8.0)
Requirement already satisfied: pygments>=2.4.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
(2.15.1)
Requirement already satisfied: decorator in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
```

(5.1.1)
Requirement already satisfied: backcall in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
(0.2.0)
Requirement already satisfied: pickleshare in
/home/ubuntu/.local/lib/python3.10/site-packages (from IPython->mobilechelonian)
(0.7.5)
Requirement already satisfied: tornado>=6.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (6.3.2)
Requirement already satisfied: debugpy>=1.6.5 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (1.6.7)
Requirement already satisfied: psutil in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (5.9.5)
Requirement already satisfied: jupyter-client>=6.1.12 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (8.2.0)
Requirement already satisfied: comm>=0.1.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (0.1.3)
Requirement already satisfied: nest-asyncio in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (1.5.6)
Requirement already satisfied: packaging in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (23.1)
Requirement already satisfied: jupyter-core!=5.0.*,>=4.12 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (5.3.1)
Requirement already satisfied: pyzmq>=20 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (25.1.0)
Requirement already satisfied: parso<0.9.0,>=0.8.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
jedi>=0.16->IPython->mobilechelonian) (0.8.3)
Requirement already satisfied: ptyprocess>=0.5 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
pexpect>4.3->IPython->mobilechelonian) (0.7.0)
Requirement already satisfied: wcwidth in
/home/ubuntu/.local/lib/python3.10/site-packages (from prompt-
toolkit!=3.0.37,<3.1.0,>=3.0.30->IPython->mobilechelonian) (0.2.6)
Requirement already satisfied: pure-eval in
/home/ubuntu/.local/lib/python3.10/site-packages (from stack-
data->IPython->mobilechelonian) (0.2.2)
Requirement already satisfied: executing>=1.2.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from stack-

data->IPython->mobilechelonian) (1.2.0)
Requirement already satisfied: asttokens>=2.1.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from stack-
data->IPython->mobilechelonian) (2.2.1)
Requirement already satisfied: six in /home/ubuntu/.local/lib/python3.10/site-
packages (from asttokens>=2.1.0->stack-data->IPython->mobilechelonian) (1.16.0)
Requirement already satisfied: python-dateutil>=2.8.2 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
client>=6.1.12->ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian) (2.8.2)
Requirement already satisfied: platformdirs>=2.5 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
core!=5.0.*,>=4.12->ipykernel>=4.5.1->ipywidgets>=7.0.0->mobilechelonian)
(3.6.0)
Note: you may need to restart the kernel to use updated packages.
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: jupyter in
/home/ubuntu/.local/lib/python3.10/site-packages (1.0.0)
Requirement already satisfied: jupyter-console in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter) (6.6.3)
Requirement already satisfied: ipykernel in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter) (6.23.2)
Requirement already satisfied: notebook in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter) (6.5.4)
Requirement already satisfied: nbconvert in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter) (7.6.0)
Requirement already satisfied: qtconsole in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter) (5.4.3)
Requirement already satisfied: ipywidgets in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter) (8.0.6)
Requirement already satisfied: ipython>=7.23.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(8.14.0)
Requirement already satisfied: debugpy>=1.6.5 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(1.6.7)
Requirement already satisfied: packaging in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(23.1)
Requirement already satisfied: pyzmq>=20 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(25.1.0)
Requirement already satisfied: tornado>=6.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(6.3.2)
Requirement already satisfied: jupyter-client>=6.1.12 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(8.2.0)
Requirement already satisfied: psutil in

```
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(5.9.5)
Requirement already satisfied: traitlets>=5.4.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(5.9.0)
Requirement already satisfied: jupyter-core!=5.0.*,>=4.12 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(5.3.1)
Requirement already satisfied: comm>=0.1.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(0.1.3)
Requirement already satisfied: matplotlib-inline>=0.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(0.1.6)
Requirement already satisfied: nest-asyncio in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipykernel->jupyter)
(1.5.6)
Requirement already satisfied: widgetsnbextension~=4.0.7 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipywidgets->jupyter)
(4.0.7)
Requirement already satisfied: jupyterlab-widgets~=3.0.7 in
/home/ubuntu/.local/lib/python3.10/site-packages (from ipywidgets->jupyter)
(3.0.7)
Requirement already satisfied: prompt-toolkit>=3.0.30 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-console->jupyter)
(3.0.38)
Requirement already satisfied: pygments in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-console->jupyter)
(2.15.1)
Requirement already satisfied: pandocfilters>=1.4.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(1.5.0)
Requirement already satisfied: jupyterlab-pygments in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(0.2.2)
Requirement already satisfied: tinycss2 in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(1.2.1)
Requirement already satisfied: nbclient>=0.5.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(0.8.0)
Requirement already satisfied: nbformat>=5.7 in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(5.9.0)
Requirement already satisfied: mistune<4,>=2.0.3 in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(3.0.1)
Requirement already satisfied: markupsafe>=2.0 in /usr/lib/python3/dist-packages
```

(from nbconvert->jupyter) (2.0.1)
Requirement already satisfied: beautifulsoup4 in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(4.12.2)
Requirement already satisfied: bleach!=5.0.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(6.0.0)
Requirement already satisfied: jinja2>=3.0 in /usr/lib/python3/dist-packages
(from nbconvert->jupyter) (3.0.3)
Requirement already satisfied: defusedxml in
/home/ubuntu/.local/lib/python3.10/site-packages (from nbconvert->jupyter)
(0.7.1)
Requirement already satisfied: terminado>=0.8.3 in
/home/ubuntu/.local/lib/python3.10/site-packages (from notebook->jupyter)
(0.17.1)
Requirement already satisfied: Send2Trash>=1.8.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from notebook->jupyter)
(1.8.2)
Requirement already satisfied: argon2-cffi in
/home/ubuntu/.local/lib/python3.10/site-packages (from notebook->jupyter)
(21.3.0)
Requirement already satisfied: nbclassic>=0.4.7 in
/home/ubuntu/.local/lib/python3.10/site-packages (from notebook->jupyter)
(1.0.0)
Requirement already satisfied: prometheus-client in
/home/ubuntu/.local/lib/python3.10/site-packages (from notebook->jupyter)
(0.17.0)
Requirement already satisfied: ipython-genutils in
/home/ubuntu/.local/lib/python3.10/site-packages (from notebook->jupyter)
(0.2.0)
Requirement already satisfied: qtpy>=2.0.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from qtconsole->jupyter)
(2.3.1)
Requirement already satisfied: webencodings in
/home/ubuntu/.local/lib/python3.10/site-packages (from
bleach!=5.0.0->nbconvert->jupyter) (0.5.1)
Requirement already satisfied: six>=1.9.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
bleach!=5.0.0->nbconvert->jupyter) (1.16.0)
Requirement already satisfied: stack-data in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipython>=7.23.1->ipykernel->jupyter) (0.6.2)
Requirement already satisfied: jedi>=0.16 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipython>=7.23.1->ipykernel->jupyter) (0.18.2)
Requirement already satisfied: pickleshare in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipython>=7.23.1->ipykernel->jupyter) (0.7.5)

```
Requirement already satisfied: pexpect>4.3 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipython>=7.23.1->ipykernel->jupyter) (4.8.0)
Requirement already satisfied: decorator in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipython>=7.23.1->ipykernel->jupyter) (5.1.1)
Requirement already satisfied: backcall in
/home/ubuntu/.local/lib/python3.10/site-packages (from
ipython>=7.23.1->ipykernel->jupyter) (0.2.0)
Requirement already satisfied: python-dateutil>=2.8.2 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
client>=6.1.12->ipykernel->jupyter) (2.8.2)
Requirement already satisfied: platformdirs>=2.5 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
core!=5.0.*,>=4.12->ipykernel->jupyter) (3.6.0)
Requirement already satisfied: notebook-shim>=0.2.3 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
nbclassic>=0.4.7->notebook->jupyter) (0.2.3)
Requirement already satisfied: jupyter-server>=1.8 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
nbclassic>=0.4.7->notebook->jupyter) (2.6.0)
Requirement already satisfied: jsonschema>=2.6 in /usr/lib/python3/dist-packages
(from nbformat>=5.7->nbconvert->jupyter) (3.2.0)
Requirement already satisfied: fastjsonschema in
/home/ubuntu/.local/lib/python3.10/site-packages (from
nbformat>=5.7->nbconvert->jupyter) (2.17.1)
Requirement already satisfied: wcwidth in
/home/ubuntu/.local/lib/python3.10/site-packages (from prompt-
toolkit>=3.0.30->jupyter-console->jupyter) (0.2.6)
Requirement already satisfied: ptyprocess in
/home/ubuntu/.local/lib/python3.10/site-packages (from
terminado>=0.8.3->notebook->jupyter) (0.7.0)
Requirement already satisfied: argon2-cffi-bindings in
/home/ubuntu/.local/lib/python3.10/site-packages (from
argon2-cffi->notebook->jupyter) (21.2.0)
Requirement already satisfied: soupsieve>1.2 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
beautifulsoup4->nbconvert->jupyter) (2.4.1)
Requirement already satisfied: parso<0.9.0,>=0.8.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from
jedi>=0.16->ipython>=7.23.1->ipykernel->jupyter) (0.8.3)
Requirement already satisfied: overrides in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (7.3.1)
Requirement already satisfied: jupyter-server-terminals in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (0.4.4)
Requirement already satisfied: websocket-client in
```

/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (1.6.0)
Requirement already satisfied: jupyter-events>=0.6.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (0.6.3)
Requirement already satisfied: anyio>=3.1.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (3.7.0)
Requirement already satisfied: cffi>=1.0.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from argon2-cffi-
bindings->argon2-cffi->notebook->jupyter) (1.15.1)
Requirement already satisfied: pure-eval in
/home/ubuntu/.local/lib/python3.10/site-packages (from stack-
data->ipython>=7.23.1->ipykernel->jupyter) (0.2.2)
Requirement already satisfied: asttokens>=2.1.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from stack-
data->ipython>=7.23.1->ipykernel->jupyter) (2.2.1)
Requirement already satisfied: executing>=1.2.0 in
/home/ubuntu/.local/lib/python3.10/site-packages (from stack-
data->ipython>=7.23.1->ipykernel->jupyter) (1.2.0)
Requirement already satisfied: idna>=2.8 in /usr/lib/python3/dist-packages (from
anyio>=3.1.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (3.3)
Requirement already satisfied: sniffio>=1.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from anyio>=3.1.0->jupyter-
server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (1.3.0)
Requirement already satisfied: exceptiongroup in
/home/ubuntu/.local/lib/python3.10/site-packages (from anyio>=3.1.0->jupyter-
server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (1.1.1)
Requirement already satisfied: pycparser in
/home/ubuntu/.local/lib/python3.10/site-packages (from cffi>=1.0.1->argon2-cffi-
bindings->argon2-cffi->notebook->jupyter) (2.21)
Requirement already satisfied: rfc3986-validator>=0.1.1 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
events>=0.6.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (0.1.1)
Requirement already satisfied: pyyaml>=5.3 in /usr/lib/python3/dist-packages
(from jupyter-events>=0.6.0->jupyter-
server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (5.4.1)
Requirement already satisfied: rfc3339-validator in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
events>=0.6.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (0.1.4)
Requirement already satisfied: python-json-logger>=2.0.4 in
/home/ubuntu/.local/lib/python3.10/site-packages (from jupyter-
events>=0.6.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook->jupyter) (2.0.7)
WARNING: jsonschema 3.2.0 does not provide the extra 'format-
nongpl'

Note: you may need to restart the kernel to use updated packages.

```
[ ]: !wget https://eoimages.gsfc.nasa.gov/images/imagerecords/57000/57752/
     ↪land_shallow_topo_2048.jpg -O map.jpg
```

```
--2023-06-22 04:53:58--  https://eoimages.gsfc.nasa.gov/images/imagerecords/5700
0/57752/land_shallow_topo_2048.jpg
Resolving eoimages.gsfc.nasa.gov (eoimages.gsfc.nasa.gov)… 129.164.142.12,
2001:4d0:2310:170::12
Connecting to eoimages.gsfc.nasa.gov
(eoimages.gsfc.nasa.gov)|129.164.142.12|:443… connected.
HTTP request sent, awaiting response… 200 OK
Length: 238676 (233K) [image/jpeg]
Saving to: 'map.jpg'

map.jpg             100%[===================>] 233.08K   480KB/s    in 0.5s

2023-06-22 04:53:59 (480 KB/s) - 'map.jpg' saved [238676/238676]
```

```python
[ ]: import matplotlib.pyplot as plt
     import numpy as np
     from PIL import Image
```

```python
[ ]: plt.imshow(Image.open("map.jpg"))

     for i, row in df.iterrows():
         lat = df.at[i, "Latitude"]
         lon = df.at[i, "Longitude"]

         plt.plot(
             (lon + 180) / 360 * 2048, # x
             (lat + 90) / 180 * 1024, # y
             marker='.',
             color="red",
             markersize=1)

     plt.show()
```