Python Scripts to Download Tsunami Data

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This code package downloads, processes and displays tsunami data generated by an earthquake. The main purpose is to check if any tsunami waves are generated and recorded after a large earthquake. The basic procedure is: obtain earthquake catalogs from USGS, download tsunami data in the deep ocean from NOAA DART website (https://nctr.pmel.noaa.gov/Dart/), download tide gauge data from IOC website (http://www.ioc-sealevelmonitoring.org/), filter the tsunami data to remove tides, make plots and display figures in html format.

The codes were initially developed by Chao An, and then improved by two undergraduate students Junwei Deng and Runqing Zhou at Shanghai Jiao Tong University, and then modified by Chao An.

1 Environment Setup

Codes are written in Python. Additional modules are required to run this program, including:

numpy (https://numpy.org/)
scipy (https://www.scipy.org/)
matplotlib (https://matplotlib.org/)
basemap (https://matplotlib.org/basemap/).

These packages can be installed on different platforms as follows:

MAC: Install macports (https://www.macports.org/)
Use macports to install packages numpy, scipy, matplotlib, basemap
Example: sudo port install py38-matplotlib-basemap
[conda probably also works, but I didn't test]

WIN: Install miniconda (https://docs.conda.io/en/latest/miniconda.html)
Use conda to install packages (example: conda install numpy)
[May need to use *conda install -c conda-forge basemap* to install basemap]
Change Line 8 in main.py to the correct path.

```
6 ThisOS = platform.system()
7 if(ThisOS == 'Windows'): # WINDOWS
8         os.environ['PROJ_LIB'] = r'C:\ProgramData\Miniconda3\pkgs\proj-7.2.0-h3e70539_0\Library\share\proj'
9
```

CentOS: Install miniconda; Use conda to install packages.

1 Configure Parameters

Parameters are provided in file **config.dat**. The parameters are self-explanatory. If there is not a file of **config.dat**, the program will use default values. At lines 5 and 7, if you wish to download data from particular stations, use -1 to indicate and use commas to separate the station names in the next lines, i.e., "21414, 32405". Last-used parameters will be saved in file **config.dat**.

```
 1 Start Time                                          :  2010-01-01
 2 End Time                                            :  now
 3 Min EQ Magnitude                                    :  7.5
 4 Max EQ Depth (km)                                   :  50
 5 Update DART Stations List                           :  yes
 6 Auto Choose n DART Stations (n nearest; -1 manual)  :  5
 7 Manually Chosen DART Stations                       :
 8 Update IOC Stations List                            :  yes
 9 Auto Choose n IOC Stations  (n nearest; -1 manual)  :  5
10 Manually Chosen IOC Stations                        :
11 Use (1/Filter) or (2/Polynomial) to Remove Tides    :  2
12 Filter Maximum Period (min)                         :  120
13 Polynomial Order                                    :  20
14 Tsunami Data Lasting Time (min)                     :  200
```

2 Select an Earthquake

Start the program by running **main.py**. The program first downloads an earthquake catalog from USGS, and you can choose an earthquake to continue.

```
--> Read parameters from file config.dat ...

    Start Time                                          :   2018-01-01
    End Time                                            :   2021-03-23
    Min EQ Magnitude                                    :   7.5
    Max EQ Depth (km)                                   :   50.0
    Update DART Stations List                           :   no
    Auto Choose n DART Stations (n nearest; -1 manual)  :   5
    Manually Chosen DART Stations                       :   ['']
    Update IOC Stations List                            :   no
    Auto Choose n IOC Stations  (n nearest; -1 manual)  :   5
    Manually Chosen IOC Stations                        :   ['']
    Use (1/Filter) or (2/Polynomial) to Remove Tides    :   2
    Filter Maximum Period (min)                         :   120.0
    Polynomial Order                                    :   20
    Tsunami Data Lasting Time (min)                     :   200.0

Press Enter or input Yes/yes/Y/y to continue; other to exit ...

--> Download USGS earthquake catalog ...

    id    Time                 Mag    Depth(km)     Place
    -------------------------------------------------------------------------
     1    2021-03-04 19:28:33    8.1    28.3          Kermadec Islands
     2    2021-02-10 13:19:55    7.7    10.0          southeast of the Loyalty Islands
     3    2020-10-19 20:54:38    7.6    28.4          99 km SE of Sand Point
     4    2020-07-22 06:12:44    7.8    28.0          99 km SSE of Perryville
     5    2020-01-28 19:10:24    7.7    14.9          123km NNW of Lucea
     6    2019-05-14 12:58:25    7.6    10.0          46km SSE of Namatanai
     7    2018-12-05 04:18:08    7.5    10.0          165km ESE of Tadine
     8    2018-09-28 10:02:45    7.5    20.0          70km N of Palu
     9    2018-02-25 17:44:44    7.5    25.2          83km SW of Porgera
    10    2018-01-23 09:31:40    7.9    14.1          280km SE of Kodiak
    11    2018-01-10 02:51:33    7.5    19.0          44km E of Great Swan Island

--> Choose an earthquake ID to study, q to abort (default: 1) ...
```

In version 2.0, you can input 0 to manually input source information. This option is designed to download tsunami data generated by other sources, such as volcano eruptions.

```
--> Choose an earthquake ID to continue (0: manual input; 1: default; q: abort) ... 0

--> Manually input source information (separated by comma, q to abort) ...

    Year, Month, Day, Hour, Minute, Second, Latitude, Longigude, Description
    2022,1,15,5,0,0,-20.536,-175.382,Tonga Volcano
```

3 Download DART Tsunami Data in Deep Ocean

The program determines the nearest *n* DART stations to the earthquake epicenter, downloads the data from NOAA DART website and saves the data. Then the program filters the data and makes plots. All the files are located in folder cache.

```
--> Choose an earthquake ID to study, q to abort (default: 1) ...

--> Select and download DART data ...


    54401 (NO_DATA)     51426 (NO_DATA)     51425               55042 (NO_DATA)     55015

    55012               52406               55023

--> Process DART data and make plots ...
```

4 Download Tide Gauge Data

Similarly, the program determines the nearest *n* IOC tide stations to the earthquake epicenter, downloads the data from IOC website and saves the data. Then the program filters the data and makes plots. All the files are located in folder cache.

```
--> Select and download IOC data ...


    rbct (prs)          rfrt (prs)          dnew  (NO_DATA)     dfij  (NO_DATA)     lott (prs)

    nkfa (aqu)          gbit (prs)

--> Process IOC data and make plots ...
/Users/ac/work/CodesTest/TsunamiDataDownload-master-final-Source/TsunamiData.py:365: RankWarning: Polyfit may be poorly conditioned
  removeStationTidesPolynomial(fn, self.AllParams.PolynomialOrder)
/Users/ac/work/CodesTest/TsunamiDataDownload-master-final-Source/TsunamiData.py:365: RankWarning: Polyfit may be poorly conditioned
  removeStationTidesPolynomial(fn, self.AllParams.PolynomialOrder)

--> Generate HTML image viewer ...

--> END.
```

5 Create HTML File and Display Results

Finally, the program crates an html file and opens it with the system's default viewer. For example, on my computer HTML files are opened in Google Chrome. Placing mouse on the box with color background will display the figures of the tsunami data.