Marine Engineering and Physics Lab

HF radar datasets to Shear current and Internal waves tasks

- Full library is located inside the synology server and another backup version in our github account "HF_MEPLab_Codes" under branch "giora".

- The code can be downloaded from github or directly run through the Synology path in case the server is mapped on the computer.

- The code was tested on Windows OS only, regarding Mac OS or Linux it has never been tried before - better to use it on Windows stations such as the XBand radar station or any personal computer which has Windows.

- The pipeline has been configured and changed throughout 3 years of collaborative work but it still might have flaws and errors. Any user of this library must approach this library with patience.

- Any additional change and improvements are more than welcomed and can be merge into the "main" branch on github via one of the collaborators

- To open the Python on the WERA lab station:
    - Open the terminal (konsol) and change directory to "/home/wera/Documents/pycharm-community-2021.1.2/bin"
    - Once changed to this directory, insert: ./pycharm
    - Our pycharm projects are located in: /home/wera/PycharmProjects/HandleSortFiles

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Shear current - SORT files

Python operation

Preparing radial files - **working only on the WERA lab station**

Directory: */home/wera/PycharmProjects/HandleSortFiles/WriteAngleFilesFromSort.py*
Outputs (on the synology server): WERA/radials_spectrum/YYYYDDD/fname.asc

```
if __name__ == '__main__':
    station_id = 'is1'  # is1: Ashkelon is2: Ashdod
    year = '2021'
    days_list = ['102']# days to analyze
    angles = np.arange(-3, 6, 1)  # angles to calculate
    basic_sort_path = '/mnt/synology/WERA/data/' + station_id + '/raw/' +

    generate_day_deg(basic_sort_path, days_list, angles)
```

Changeable parameters:

1) Station_id: 'is1' or 'is2'
2) year: 'YYYY'
3) days_list: can be multiple days ['102', '103', '104']
4) angles: np.arange(-3, 6, 1) → -3 -2 -1 0 1 2 3 4 5 degrees.
    a) Maximum angle: 60°, Minimum angle: -60°, Resolution: 1°

Without having the files from this script the following matlab pipeline will be crashed!

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MATLAB operation:

Preparing the matlab matrix to faster post processing.

Directory: */WERA/MEPLab_HF_lib/radials_codes/Create_P_days.m*
Outputs: */WERA/radials_spectrum/folderName*

```
addpath(genpath('..\'));

%% generate full day mat file

Synology_path = 'Z:';
days = string({'2022039'});

%% point of interest

% ADCP implemented in front of
%Ashkelon May-June 2021
%ADCP_shallow = [34.532972 31.670556];
%ADCP_deep = [34.512833 31.681639];

%in_front_ASH = [34.58777539086895 31.854180076569225];
in_situ = [34.4092 31.8135]; % Vector experiment February 8th 2022

%%

HF_station = 'is1'; %is1: Ashkelon, is2: Ashdod
N_range_cells = 1;  % number of range cell to average
N_angs = 1;  % number of angles to average (2*N_ang + 1)
```

Changeable parameters:

1) Synology path: Synology's WERA folder drive as mapped on the computer
2) days: Days to analyze
    a) **The .asc files of these days must be prepared using *WriteAngleFilesFromSort.py* to prevent script to crush**
3) coordinate of interest: for example - In situ coordinate
4) HF_Station: 'is1' or 'is2' to extract the spectrum from one of the stations
5) N_range_cells: number of distances to average (usually 1)
6) N_angs: number of angles to average over the coordinate of interest

- Example: For a target located 3.5 km off Ashkelon at angle 1 degree with 1 range cell average and 4 angles to average in each side the folder name would be: *is1_R_3.5622_Ncells_1_ang_-3_5*

- Inside this folder .mat files with information about the spectrum for every 20 minutes measurement will be stored

- These matrices can be called for any case of post processing without the need to extract all the information from the HF radar

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Analysis of the matrices generated by *create_P_day.m*

Directory: */WERA/MEPLab_HF_lib/radials_codes/Evaluate_U_from_P_day.m*
Outputs: time series plot of currents extracted from first order peaks and the accuracy

```
%% Calculate velocity values with optional averaging (average_every=3 e.g. 00:00-01:00, 01:00-02:00 etc.)

basic_path = 'Z:\radials_spectrum\is1_R_3.5622_Ncells_1_ang_-3_5\';

average_every = 3;
H = 72 / average_every;
dt = 24 / H ;

files = dir(basic_path);
files = files(3:16);

c0_all = -10.*ones(H*length(files), 3);
U_all = -10.*ones(H*length(files), 3); % [negative_peak, positive_peak, resolution]
eval_metric_all = -10.*ones(H*length(files), 4); % [sigma squared neg, sigma squared pos, acc neg, acc pos]
for cur_day = 1 : length(files)

    id_zero = find(U_all == -10);
    id_zero = id_zero(1);

    cur_filename = strcat(basic_path, files(cur_day).name);
    [cur_U_all, sig_metric, acc_metric, cur_c0] = get_U(cur_filename, average_every, '', 'centroid', 0.1);
```

Changeable parameters:

1) basic path - folder generated by *create_P_day.m*
    a) **If the folder wasn't generated before, the script will collapse!**
2) average_every: number of sort files to average
3) files - which days inside the folder wants to be analyzed
4) After this - each section analyze the results (plot, fft, noise reduction)

Helper function: *get_U.m*

Inputs:

1) filename - specific .mat file representing 1 day measurement
2) Averaging parameter
3) Velocity type: 'Cp' to extract absolute velocity from both peaks " to extract current (deviation from undisturbed peak location)
4) Detection type: 'centroid', 'max' or 'WERA'
5) Optional: choose window size around highest peak (for centroid and WERA detection methods)
    a) If empty a default value is used

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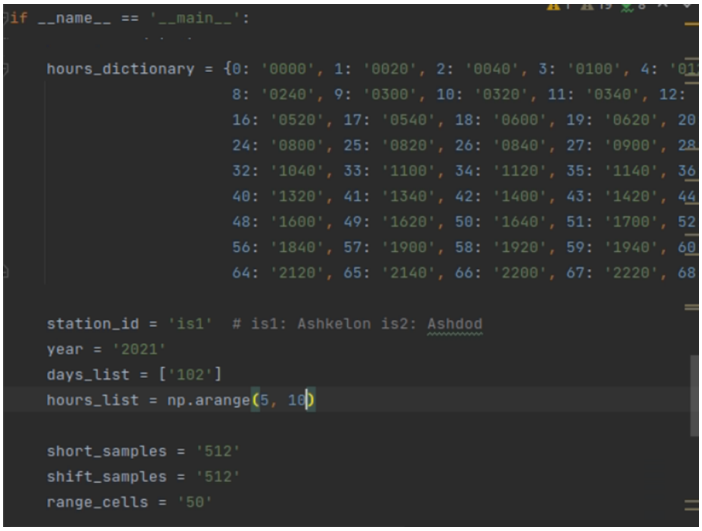
Internal Waves

Python operation - **must be executed serially**

Preparing short sort files - **working only on the WERA lab station**

Directory*: /home/wera/PycharmProjects/HandleSortFiles/generate_ShortSortFromSort.py*
Outputs (Synology)*: /WERA/radials_spectrum_shortSort/ShortParamsFName/station/YYYYDDD*



Changeable parameters:

1) station_id: ‘is1’ or ‘is2’
2) year
3) days_list - can be multiple days [‘102’, ‘103’, ‘104’]
4) Hours_list - sort files to create the short Sort to them
5) Short Sort parameters
    a) short_samples: length of each short sort: N_samples * T_chirp (T_chirp = 0.26s)
    b) shift_smaples: Number of samples to jump between consecutive samples - only same value is applicable for future analysis
    c) range_cells: number of range cells to include (N_cell = 50 ~ 25km)

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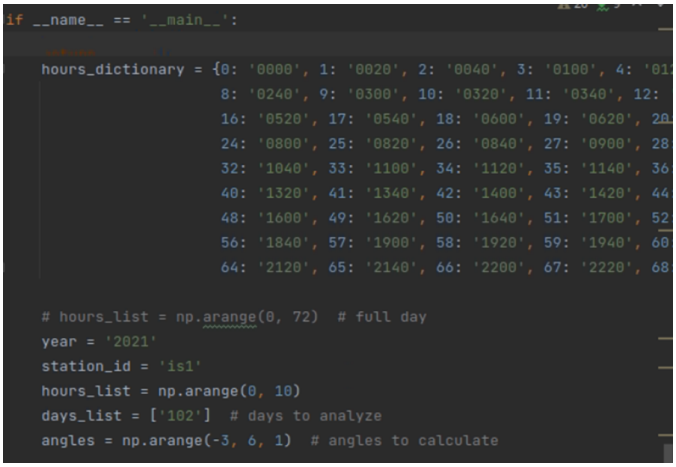
Prepare the radial files from the short sort files - can be done only after the short sort generation

Direction*: /home/wera/PycharmProjects/HandleSortFiles/WriteAnglesFilesFromShortSort.py*
Outputs (Synology): */WERA/radials_spectrum_shortSort/ShortParamsFName/ST/YYYYDDD*



```
if __name__ == '__main__':

    hours_dictionary = {0: '0000', 1: '0020', 2: '0040', 3: '0100', 4: '01
                        8: '0240', 9: '0300', 10: '0320', 11: '0340', 12:
                        16: '0520', 17: '0540', 18: '0600', 19: '0620', 20
                        24: '0800', 25: '0820', 26: '0840', 27: '0900', 28
                        32: '1040', 33: '1100', 34: '1120', 35: '1140', 36
                        40: '1320', 41: '1340', 42: '1400', 43: '1420', 44
                        48: '1600', 49: '1620', 50: '1640', 51: '1700', 52
                        56: '1840', 57: '1900', 58: '1920', 59: '1940', 60
                        64: '2120', 65: '2140', 66: '2200', 67: '2220', 68

    # hours_list = np.arange(0, 72)  # full day
    year = '2021'
    station_id = 'is1'
    hours_list = np.arange(0, 10)
    days_list = ['102']  # days to analyze
    angles = np.arange(-3, 6, 1)  # angles to calculate
```

Changeable parameters - must have the same values generated by *generate_ShortSortFromSort.py*:

1) station_id: ‘is1’ or ‘is2’
2) year
3) days_list - can be multiple days [‘102’, ‘103’, ‘104’]
4) Hours_list - sort files to create the short Sort to them
5) Short Sort parameters

- Inside the YYYYDDD folder the .asc files are stored for later use

- These are the same type of files as the .asc file of the SORT files but representing much shorter periods of time

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MATLAB operation

Prepare .mat files that contain information of peak location for every time, distance and angle for later post processing use.

Directory: /WERA/MEPLab_HF_lib/radials_codes/*operate_generate_internal_waves_mat.m*
Outputs: /WERA/internal_waves/internal_waves_matrices

```
addpath(genpath('..\'));

Synology_path = 'Z:';

ST = 'is1';
cell_size = 512;
step_size = 512;
range = 50;
distance = 40;
angles = 1;
day = '2021084';
hhmm_start = char('0000');
hhmm_end = char('0040');
```

Changeable parameters:

1) Synology path: Synology's WERA folder drive as mapped on the computer
2) ST - ('is1' or 'is2')
3) Cell_size, step_size, range
    a) **All must be chosen according to already prepared .asc files**
4) distance - which distance to insert into the final matrix
    a) Must be lower than range
5) angles - angles to insert into the final matrix
    a) Angles between -angle to +angle are inserted
6) Distance
5) day - the day to analyze
    a) must be chosen according to already prepared .asc files
7) Hhmm start and end: specific hours within the day to analyze
    a) '0000' and '2340' for whole day

- Final .mat file for further analysis is stored in the output folder

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Shear current - Short SORT files

The python operation is the same described for internal waves

MATLAB operation:

Preparing the matlab matrix to faster post processing.

Directory: */WERA/MEPLab_HF_lib/radials_codes/Create_P_shortSort.m*
Outputs: */WERA/radials_spectrum_shortSort/ShortParamsFName/ST/FolderName*

```
addpath(genpath('..\'));
```

```
%% generate short sort mat file

Synology_path = 'Z:';
days = string({'2022039'});
short_params = "short_1024_shift_1024_range_100";
HF_station = 'is1'; %is1: Ashkelon, is2: Ashdod

hhmms = string({...
                '0000', '0020', '0040', '0100', '0120', '0140', '0200',...
                '0220', '0240', '0300', '0320', '0340', '0400', '0420',...
                '0440', '0500', '0520', '0540', '0600', '0620', '0640',...
                '0700', '0720', '0740', '0800', '0820', '0840', '0900',...
                '0920', '0940', '1000', '1020', '1040', '1100', '1120',...
                '1140', '1200', '1220', '1240', '1300', '1320', '1340',...
                '1400', '1420', '1440', '1500', '1520', '1540', '1600',...
                '1620', '1640', '1700', '1720', '1740', '1800', '1820',...
                '1840', '1900', '1920', '1940', '2000', '2020', '2040',...
                '2100', '2120', '2140', '2200', '2220', '2240', '2300',...
                '2320', '2340'});

splits = hhmms(31:33);
```

```
%% coordinate of interest

%ADCP_shallow = [34.532972 31.670556];
%ADCP_deep = [34.512833 31.681639];
%in_front_ASH = [34.58777539086895 31.854180076569225];
in_situ = [34.4092 31.8135];  % February 8th, 2022 Vector, ADCP, Drone measurements
```

```
%%

N_range_cells = 1;  % number of range cell to average
N_angs = 0;  % number of angles to average (2*N_ang + 1)
```

Change to relevant values:

1) Synology path: Synology's WERA folder drive as mapped on the computer
2) days - the days to analyze
    a) .asc files must be created before!
3) short_params - Short Sort parameter in the form of string as follows:
    a) "short_<short_value>_shoft_<shift_value>_range_<range_cells_value>"
    b) A folder with this values must be created from the previous python files
4) HF_station - 'is1' or 'is2'

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5) splits - hours to analyze within each day
6) In situ - coordinate of interest
7) N_range_cells - Radial distances to average
8) N_angs - Azimuthal angles to average, the degree files must be ready from previous python file

Directory*: /WERA/MEPLab_HF_lib/radials_codes/Evaluate_U_from_P_shortSort.m*
Outputs: time series plot of currents extracted from first order peaks and the accuracy

```
%% Calculate current values from short Sort files (below the 20 minutes avg)

basic_path = 'Z:\radials_spectrum_shortSort\short_1024_shift_1024_range_100\is1\R_20.9184_Ncells_1_ang_22_22\';

average_every = 1;

T_chirp = 0.26; % chirp duration [seconds]
T_meas = 17.75; % duration of the full measurements [minutes]
short_samples = 1024; % must be equal to the hsort value of the path

num_splits = round(T_meas / (T_chirp * short_samples / 60));
H = num_splits / average_every;
dt = T_chirp * short_samples / 60;
```

Changeable parameters:

1) basic path - folder generated by *create_P_shortSort.m*
    a) **If the folder wasn't generated before, the script will collapse!**
2) average_every: number of sort files to average
3) files - which days inside the folder wants to be analyzed
4) After this - each section analyze the results

Helper function: *get_U_shortSort.m has the same features as get_U.m*