How to Normalise Data, Plot and Calculate New Metric

Identifying Suitable Data

Search through study and identify power performance curves (example in fig. 1). They will appear as some unit of power vs some unit of frequency, wavelength, or period (explained later). If power plots are available, then discard study.

Search for the Submerged Surface Area of the device, or make an estimation using a dimensioned schematic diagram and a MATLAB script (if scale model was used then work with model scale dimensions). Example shown in fig. 2. Save SSA codes for future reference. Discard study if there is insufficient information to calculate the submerged surface area.

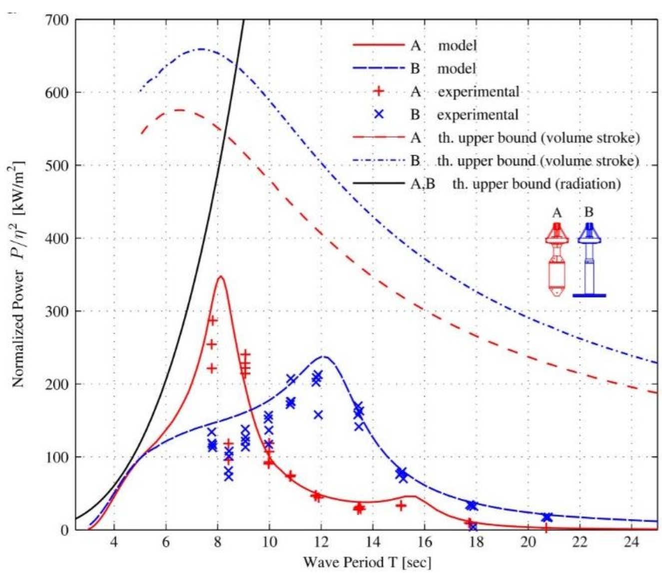

Figure 1 – Example power performance plot

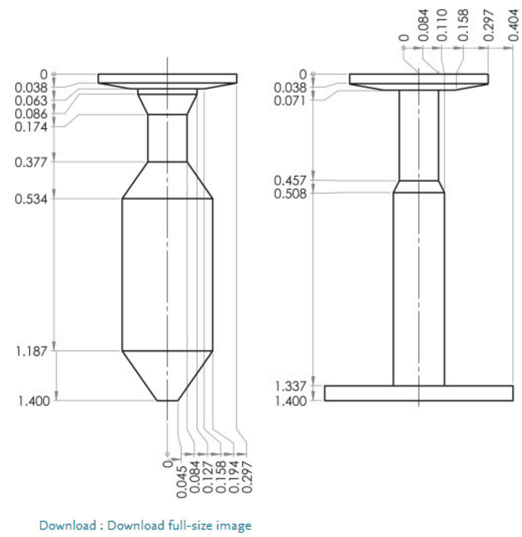

Figure 2 – example schematic diagram

Record on excel spreadsheet: Author, year of publication, url address link, device classification, submerged surface area, full-scale submerged surface area (if applicable), Characteristic dimension (Usually frontal width however check to see how this is defined), and water depth.

Also record details about the testing methodology such as: experimental/numerical study, PTO damping, wave heights, WEC geometry, regular/irregular waves, losses included/excluded, etc.

If many figures and lines with different damping settings are given, just choose the 'best' performing, or the one that appears to be the most representative of real-world performance. Always record the figure number and note which line was used (if there are multiple on one figure). Create a new row on the spreadsheet for each curve used.

If there are multiple lines or figures for different device geometries or sizes it may be worth recording the new metric value obtained for each different configuration.

Digitizing Data

Once Suitable data has been identified, use snipping tool to capture and save the power performance figure. Name each figure such that they can be distinguished from each other. Upload the captured figure to WebPLotDigitiser: https://apps.automeris.io/wpd/. Run the extraction (for the chosen line) and save the digitized matrix to a .txt or .csv file with an appropriate name (fig. 3).

```
Beatty A Num - Notepad
File  Edit  Format  View  Help
3.04528763769890e+000    8.70646766169154e-001
3.09424724602203e+000    1.74129353233831e+000
3.16768665850673e+000    3.48258706467662e+000
3.24112607099143e+000    5.22388059701492e+000
3.31456548347613e+000    7.83582089552239e+000
3.46144430844553e+000    1.39303482587065e+001
3.65728274173807e+000    2.35074626865672e+001
3.80416156670747e+000    3.30845771144279e+001
3.87760097919217e+000    3.74378109452736e+001
3.95104039167687e+000    4.17910447761194e+001
4.04895960832313e+000    4.70149253731343e+001
4.17135862913097e+000    5.39800995024876e+001
4.26927784577723e+000    6.00746268656716e+001
4.39167686658507e+000    6.70398009950249e+001
4.53855569155447e+000    7.57462686567164e+001
4.70991432068544e+000    8.44527363184080e+001
4.85679314565483e+000    9.14179104477612e+001
5.00367197062424e+000    9.75124378109453e+001
5.10159118727050e+000    1.00995024875622e+002
5.29742962056304e+000    1.08830845771144e+002
5.44430844553244e+000    1.14054726368159e+002
5.64014687882497e+000    1.21019900497512e+002
5.81150550795594e+000    1.27985074626866e+002
5.98286413708690e+000    1.35820895522388e+002
6.10526315789474e+000    1.41044776119403e+002
6.22766217870257e+000    1.46268656716418e+002
Ln 1, Col 1    100%    Windows (CRLF)    UTF-8
```

Figure 3 - Digitised data

Normalizing, Plotting, and Calculating New metric

Entering Parameters

Run “Normalise_data_calc_NM” MATLAB code and select “No” when asked if standard data has already been calculated.

Select the desired .csv or .txt file. where the digitized data was saved to. Make sure file types is set to “all files”.

A plot of the digitized data will appear. Check plot matches the one from the paper.

The user will be prompted to enter the characteristic dimension. If the power performance curves were presented with “capture width ratio” or “efficiency” on the y axis, then ensure to check how the characteristic dimensions is defined (not always equal to device width). Next, the user will be prompted to enter the submerged surface area, followed by the water depth. If water is deep, enter any negative number. Refer figure 4 for example. All parameters should be entered in metres or square metres.

```
>> Normalise_data_calc_NM
has standard data already been calculated?
Please choose csv or text file to read from
Enter the characteristic dimension in metres:  4.85
Enter the Submerged Surface Area in square metres:  1191.7
fx Enter water depth in metres. If water is deep then enter any negative number:  50
```

Figure 4 - Entering data into script

If the device was scaled, always enter in the model scale dimensions. However, if dimensions are entered consistently in one scale this should not affect results.

x axis units

The user will be prompted to select the given x axis units (fig. 5) of the power performance figure. The first three options (Period, frequency and rotational frequency) are the most commonly used x-axis dimensions and require no further input from the user.

"k*x" – wavenumber multiplied by some other parameter "x". In this case the user will be prompted to enter the value of x (find in study).

"T/To" - is selected the user will be prompted to enter the characteristic wavelength (find in study)

"Lambda/L" – the user will be prompted to enter the value of L (find in study).

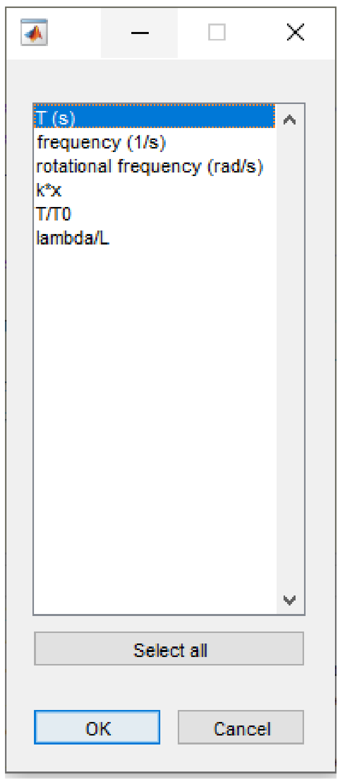

Figure 5 - x axis unit choices

y axis units

Next the user will be prompted to select the given y axis units (fig. 6) of the power performance plot. Again, the first three options are the most common. Selecting "da" (capture width) will require no further prompts from the user.

"capture width ratio"- the user will be prompted to define whether the ratio is given as a decimal or as a percent.

"Power per square metre" - the user will be asked to define whether power is given in kW or W.

“Power” – the user will be asked to select between kW or W, and to enter the incident wave amplitude (search through study).

“da*k” – Select this if capture width has been multiplied by wavenumber.

“da/Lambda” – Select if capture width has been divided by wavelength. Note sometimes “Capture Width Ratio” is defined this way in studies.

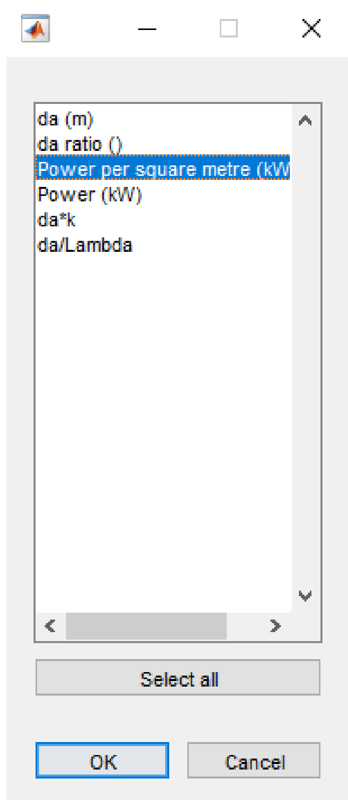

Figure 6 - y axis unit choices

Saving

The user will be prompted to select an output folder for the standard data i.e. a MATLAB data file and figure containing the plots converted to capture width vs Period, Capture width vs lambda, Surface area (SA), characteristic dimension (B), water depth (d).

The user will be prompted to select an output folder for the normalized data i.e. a MATLAB data file and figure containing the normalized capture width vs normalized period (with appropriate limits), normalized capture width vs normalized wavelength, six different New Metric values, and d scaled (square root of scaled surface area).

Plots of the normalized data will appear on screen (fig. 7).

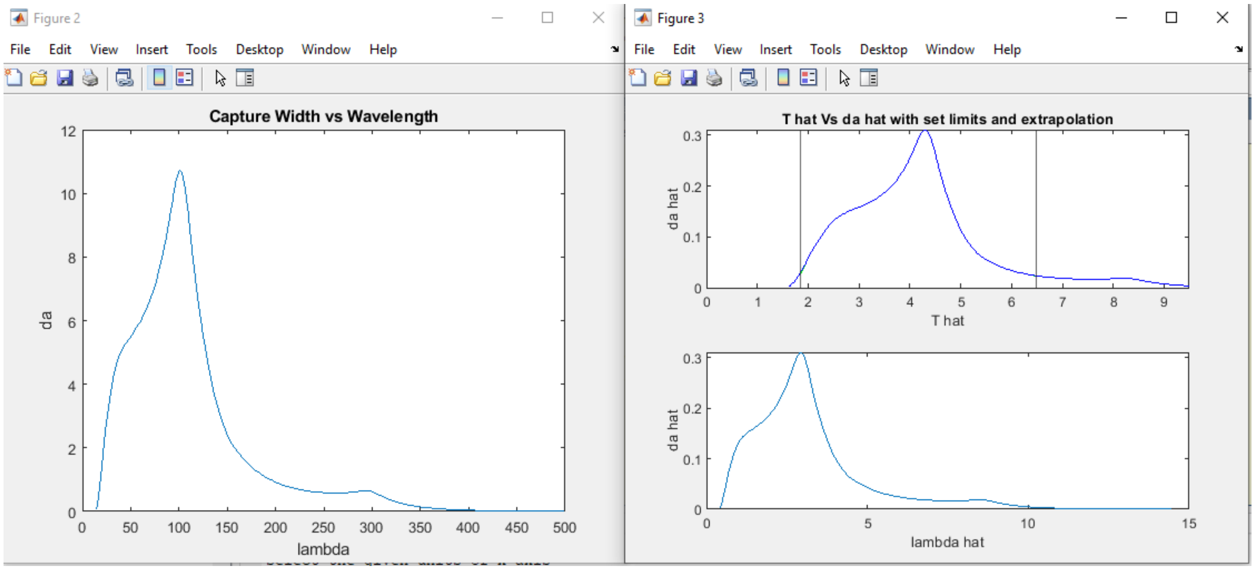

Figure 7 - Saved plots

Transfer the six new metric values to the excel spread sheet (fig. 8 and 9).

Variables in C:\Users\Jactn\Documents\GitHub\best-wec\Jack\new script\Normalised with T_hat limits\Beatty A N

Import	Name	Size	Bytes	Class
☑	NM_T_hat	1x1	8	double
☑	NM_T_hat2	1x1	8	double
☑	NM_T_hat_withlimit	1x1	8	double
☑	NM_T_hat_withlimit2	1x1	8	double
☑	NM_lam_hat2	1x1	8	double
☑	NM_lambda_hat	1x1	8	double
☑	NM_sigma	1x1	8	double
☑	NM_sigma2	1x1	8	double
☑	T_hat	186x1	1488	double
☑	T_hat_new	153x1	1224	double
☑	d_scaled	1x1	8	double
☑	d_scaled2	1x1	8	double
☑	da_hat	186x1	1488	double
☑	da_hat_new	153x1	1224	double
☑	lambda_hat	186x1	1488	double

	1
1	2.4649

Figure 8 - MATLAB data file containing normalised data

O	P	Q	R	S	T	U	V	
T_hat set limits	T_hat set limits2	NM lam_hat	NM_lam_hat2	NM T_hat	NM T_hat2	NM sig	NM sig2	
3.53		6.34						A
3.55	38.86	3.97	143.6	3.69	40.41	0.59	6.43	f
4.51	64.43	5.15	277.74	4.61	65.88	0.73	10.49	f
2.06	217.8	12.08	1314.8	2.06	217.1	0.33	34.66	c
3.11	15.7	3.51	42.85	3.09	16.38	0.49	2.61	c
3.02	16	3.54	43.18	3.07	16.28	0.49	2.6	c
2.59	61.98	1.52	177.6	2.3	55.05	0.37	8.76	c
1.32	19.42	1.15	65.18	1.62	23.86	0.26	3.8	c
1.75	12.45	3.9	73.7	1.73	12.32	0.28	1.96	c
9	27.04	2.97	15.47	10.44	31.46	0.59	1.78	c
5.91	17.74	1.96	10.21	6.91	20.76	0.43	1.28	c
2.97	25.86	10.39	266.68	2.94	25.56	0.47	4.07	c
3.15	27.45	15.44	396.22	3.52	30.58	0.6	4.87	c
7.62	22.16	11.35	56.23	8.43	24.51	1.03	3	c
80.63		47.67	876.79	108.67	703.01	3.7013	23.94	
2.46	124.92	2.59	932.69	2.8525	144.5	0.4075	20.6456	

Figure 9 - Spreadsheet

New metric calculated!

Potting curves on the same graph

Once New metric values have been calculated, organize the Matlab data files into folders however desired. For example, data could be sorted by classification (fig. 10):

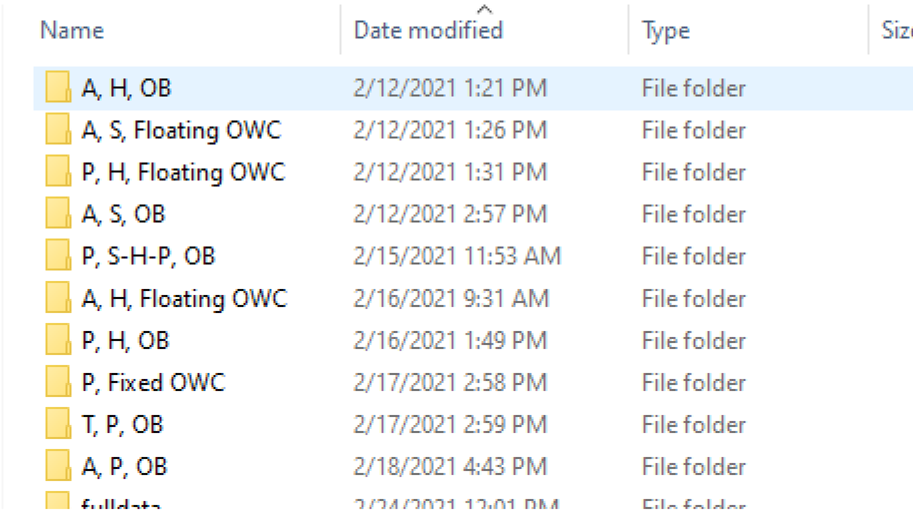

Figure 10 - Data organised to folders based on classification

Run “plotdataV2”. Select a folder to read from. Select a folder to save plot to. The code will plot the data from the chosen folder on the same set of axes (fig. 11):

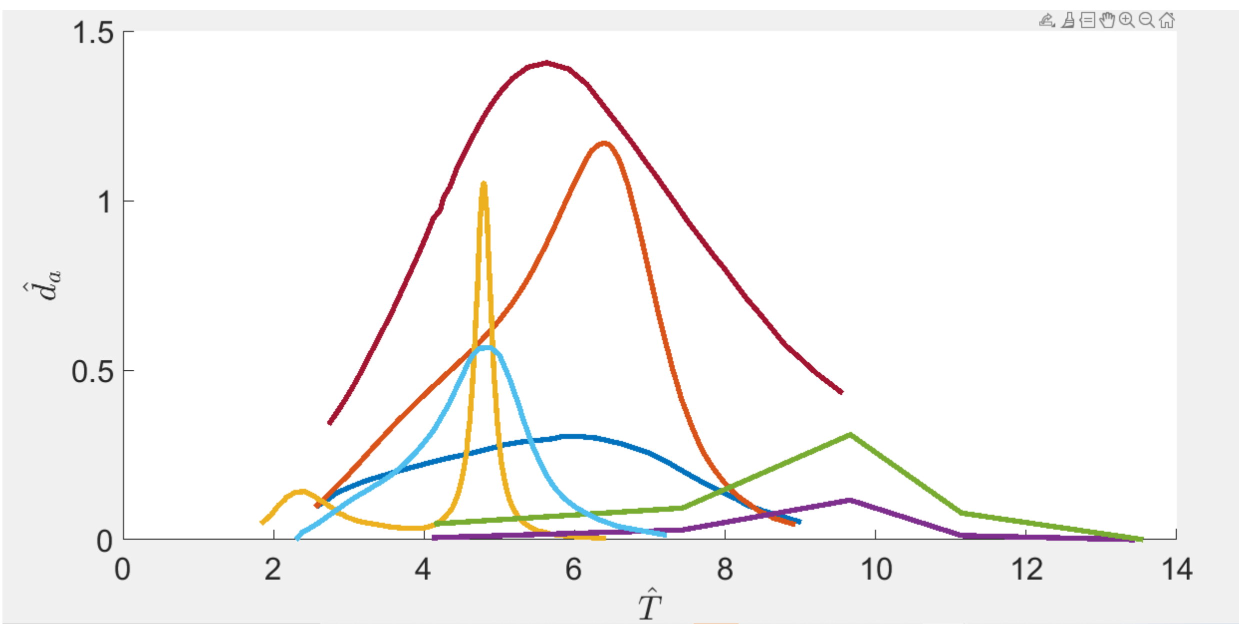

Figure 2 - Data plotted on same set of axes

All done!