Regular Wave Case

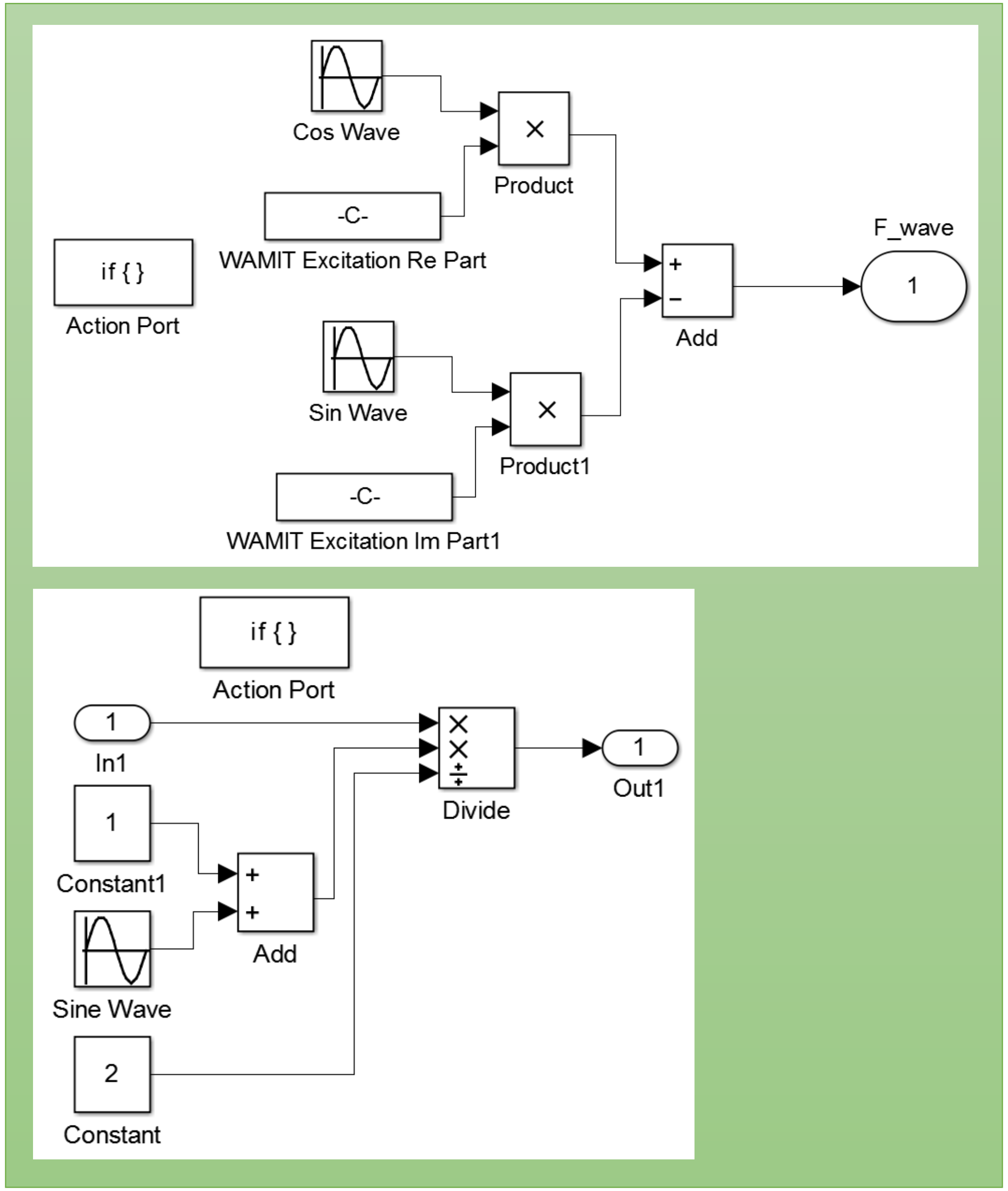
$$F_{ext} = \Re\left[R_f \frac{H}{2} F_x(\omega_r) e^{i(\omega_r t)}\right] = R_f \frac{H}{2} \Re\left[F_x(\omega_r) e^{i(\omega_r t)}\right]$$
$$F_x(\omega_r) e^{i(\omega_r t)} = (\Re F_x(\omega_r) + iImF_x(\omega_r))(\cos(\omega_r t) + isin(\omega_r t))$$
$$\Re\left[F_x(\omega_r) e^{i(\omega_r t)}\right] = \Re F_x(\omega_r)\cos(\omega_r t) - ImF_x(\omega_r) sin(\omega_r t)$$

$\Re F_x(\omega_r)$: WAMIT Excitation Real Part
$ImF_x(\omega_r)$: WAMIT Excitation Imaginary Part

$$F_{ext} = R_f \frac{H}{2}[\Re F_x(\omega_r)\cos(\omega_r t) - ImF_x(\omega_r) sin(\omega_r t)]$$

$$R_f = \begin{cases} \frac{1}{2}\left(1 + \cos\left(\pi + \frac{\pi t}{t_r}\right)\right), & \frac{t}{t_r} < 1 \\ 1, & \frac{t}{t_r} \geq 1 \end{cases}$$

$$R_f = \begin{cases} \frac{1}{2}\left(1 + \sin\left(\pi + \frac{\pi t}{t_r} + \frac{\pi}{2}\right)\right), & \frac{t}{t_r} < 1 \\ 1, & \frac{t}{t_r} \geq 1 \end{cases}$$



Questions/Comments

- You named ‘Cos Wave’ and ‘Sin Wave’ blocks. I think it is less confusing if you named ‘Sin Wave’ for all of your blocks and set up appropriate phases.
- On the other hand, if you want to name your block ‘Cos Wave’, then it should be like this case below:
  - $\sin\left(\pi + \frac{\pi t}{t_r} + \frac{\pi}{2}\right) = \cos\left(\pi + \frac{\pi t}{t_r}\right)$

Irregular Wave Case

$$F_{ext} = \Re\left[R_f \int_0^\infty \sqrt{2S(\omega_r)}\, F_x(\omega_r) e^{i(\omega_r t + \emptyset)} d\omega_r\right]$$

$$F_{ext} = R_f \Re\left[\int_0^\infty \sqrt{2S(\omega_r)}\,\big(\Re F_x(\omega_r) + iImF_x(\omega_r)\big)\big(\cos(\omega_r t + \emptyset) + isin(\omega_r t + \emptyset)\big) d\omega_r\right]$$

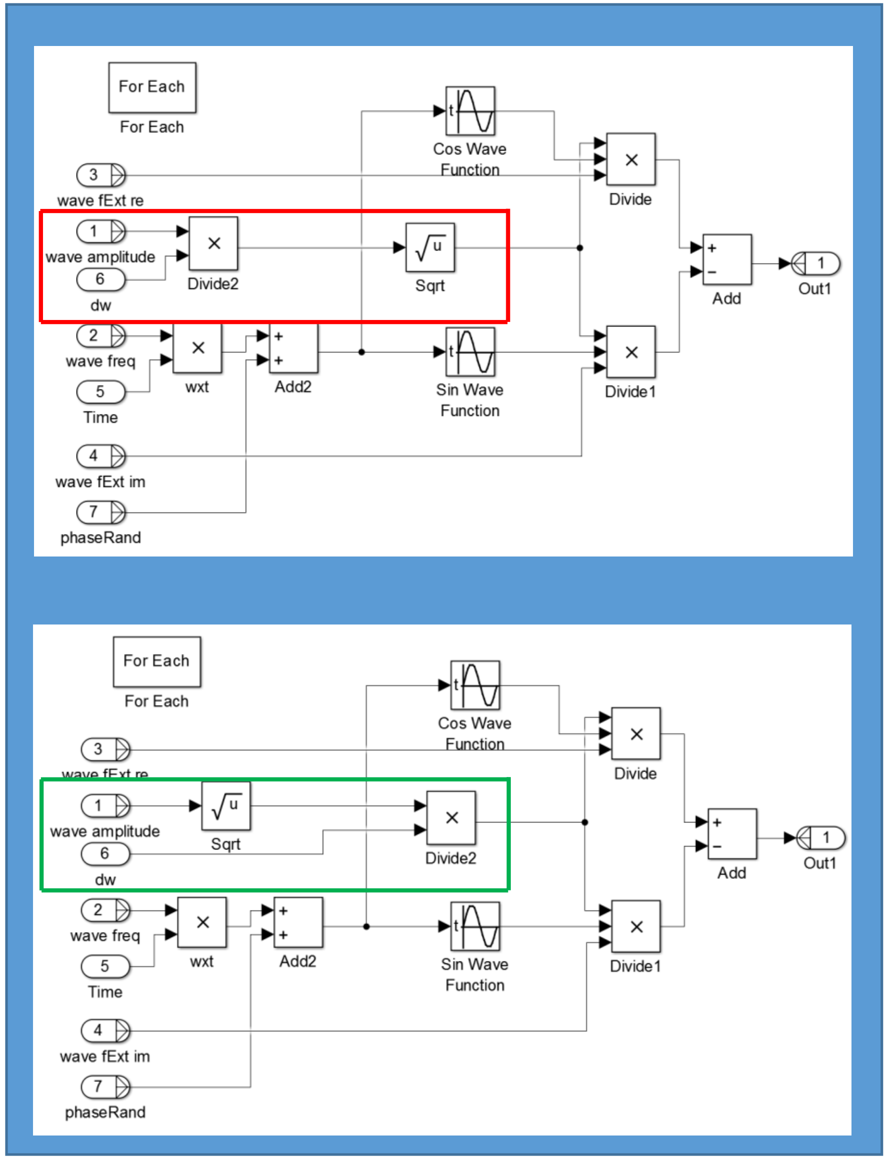
$$F_{ext} = R_f \left[\int_0^\infty \sqrt{2S(\omega_r)}\,\big(\Re F_x(\omega_r)\cos(\omega_r t + \emptyset) - ImF_x(\omega_r) sin(\omega_r t + \emptyset)\big) d\omega_r\right]$$

$$F_{ext} = R_f \left[\int_0^\infty \sqrt{2S(\omega_r)}\, \Re F_x(\omega_r)\cos(\omega_r t + \emptyset) d\omega_r - \int_0^\infty \sqrt{2S(\omega_r)}\, ImF_x(\omega_r) sin(\omega_r t + \emptyset) d\omega_r\right]$$

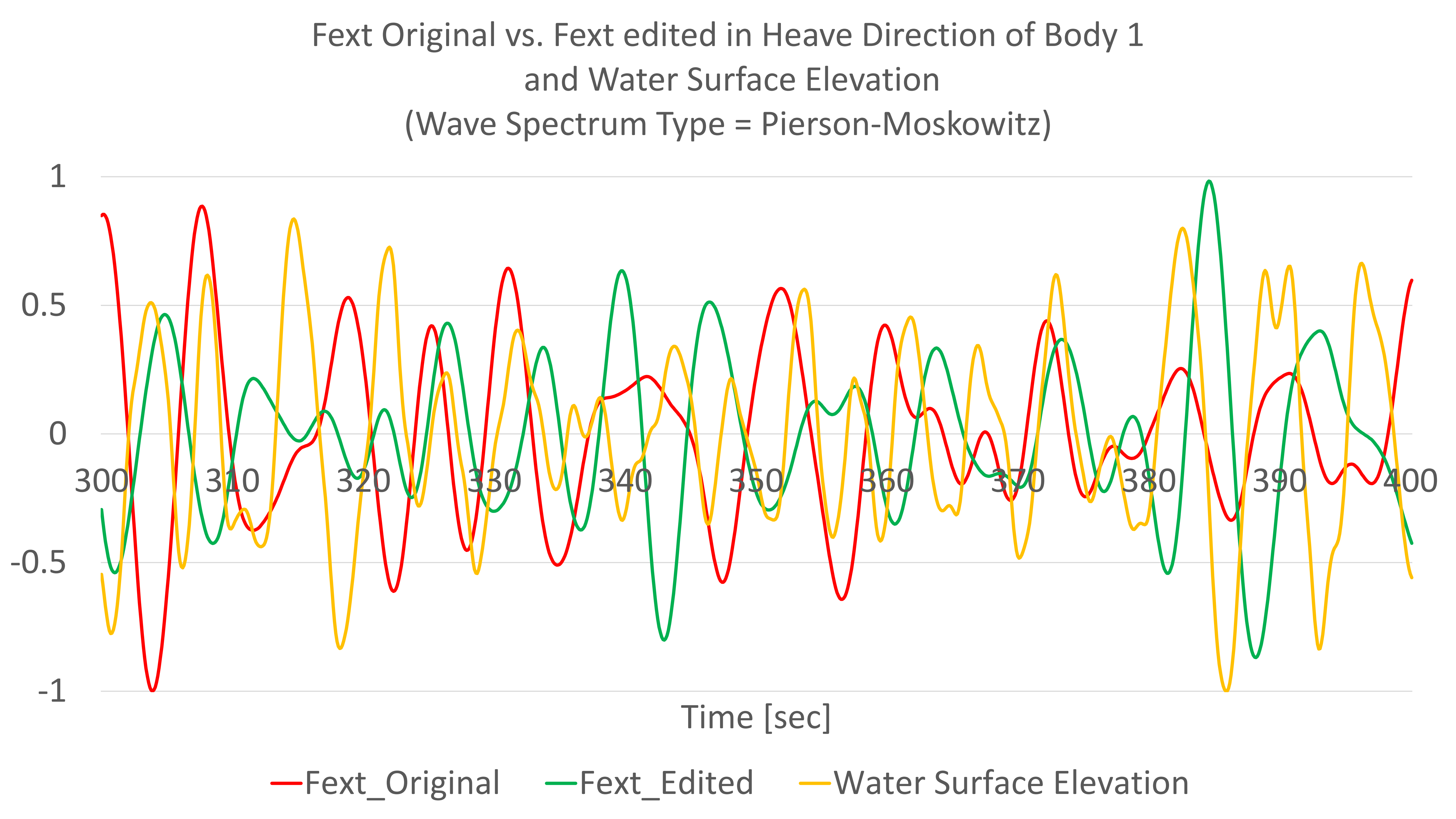
$\Re F_x(\omega_r)$: WAMIT Excitation Real Part
$ImF_x(\omega_r)$: WAMIT Excitation Imaginary Part

$$R_f = \begin{cases} \frac{1}{2}\left(1 + \cos\left(\pi + \frac{\pi t}{t_r}\right)\right), & \frac{t}{t_r} < 1 \\ 1, & \frac{t}{t_r} \geq 1 \end{cases}$$

$$R_f = \begin{cases} \frac{1}{2}\left(1 + \sin\left(\pi + \frac{\pi t}{t_r} + \frac{\pi}{2}\right)\right), & \frac{t}{t_r} < 1 \\ 1, & \frac{t}{t_r} \geq 1 \end{cases}$$




Fext Original vs. Fext Edited in Heave Direction of Body 1
(Wave Spectrum Type = Pierson-Moskowitz)
Force [N]
2500000
2000000
1500000
1000000
500000
0
-500000
-1000000
-1500000
-2000000
-2500000
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Time [sec]
Fext_original
Fext_edited


Fext Original vs. Fext edited in Heave Direction of Body 1
and Water Surface Elevation
(Wave Spectrum Type = Pierson-Moskowitz)
1
0.5
0
-0.5
-1
300
310
320
330
340
350
360
370
380
390
400
Time [sec]
Fext_Original
Fext_Edited
Water Surface Elevation

Questions/Comments

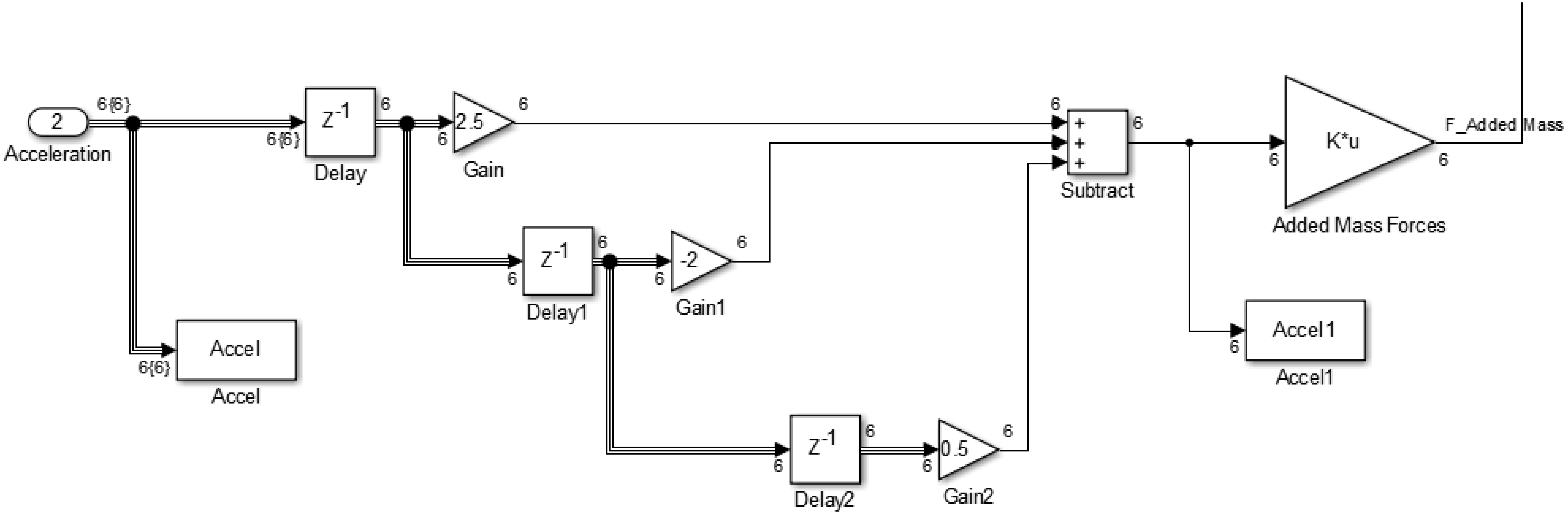
- The red box is the original blocks and the green box is my blocks. I think because you only ran a regular wave case that is why you didn't see the error. However, if you run an irregular wave, I think you will not get the correct results. Correct me if I am wrong. My assumption based on the mathematical formulation above (slide 3).
- According to slide 4, the red graph shows that the excitation force has a maximum magnitude of 2,291,958 N. Isn't this number is way too big?

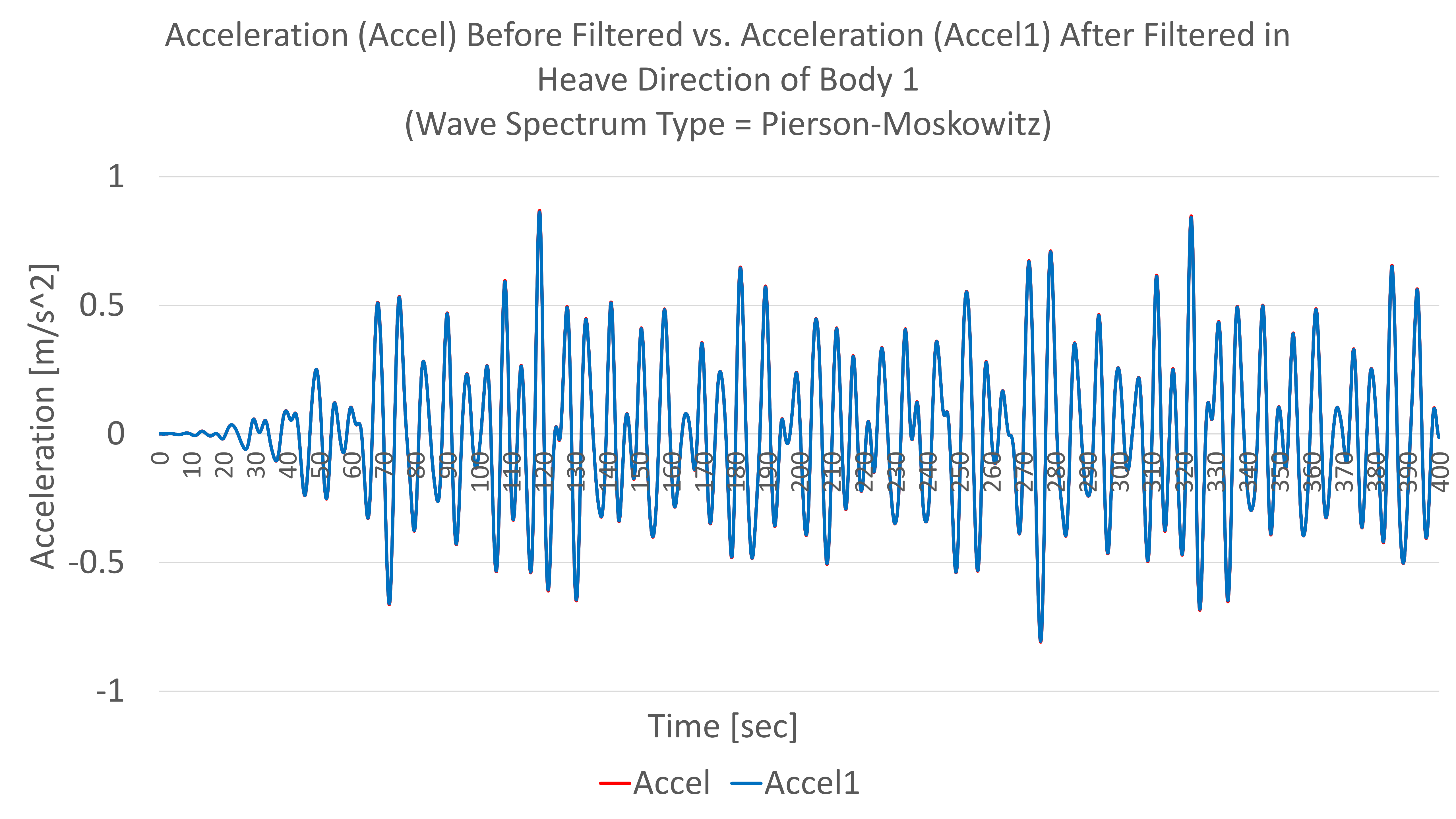
Mode and Coordinate System in WEC-Sim

- 1 means surge (X-axis)
- 2 means sway (y-axis)
- 3 means heave (z-axis)
- 4 means roll (moment about x-axis)
- 5 means pitch (moment about y-axis)
- 6 means yaw (moment about z-axis)

Correct?

Frad (Irregular wave)




Acceleration (Accel) Before Filtered vs. Acceleration (Accel1) After Filtered in Heave Direction of Body 1
(Wave Spectrum Type = Pierson-Moskowitz)
Acceleration [m/s^2]
1
0.5
0
-0.5
-1
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Time [sec]
Accel
Accel1

Questions/Comments

- What is the purpose of the block in slide 8?
- Gain 1=2.5, Gain 2=-2, and Gain 3=0.5? I think because they have to add up to 1 (2.5-2+0.5=1). Otherwise, the magnitude before and after filtered will not be the same.
- Each Z^{-1} means the signal is delayed by one sample time. In this case, it is delayed by 0.1 second.
- Because the sample time (0.1 second) is very small compared to wave period (8 seconds), acceleration before and after filtered is basically the same.
- I think this filter block is designed to catch high frequency content.

Correct?

Hydrostatic Restoring Force

$$F_B = (mg - \rho g V) + k(z_b - cg), \qquad where$$

m: $dry\ mass\ [kg/s^2]$

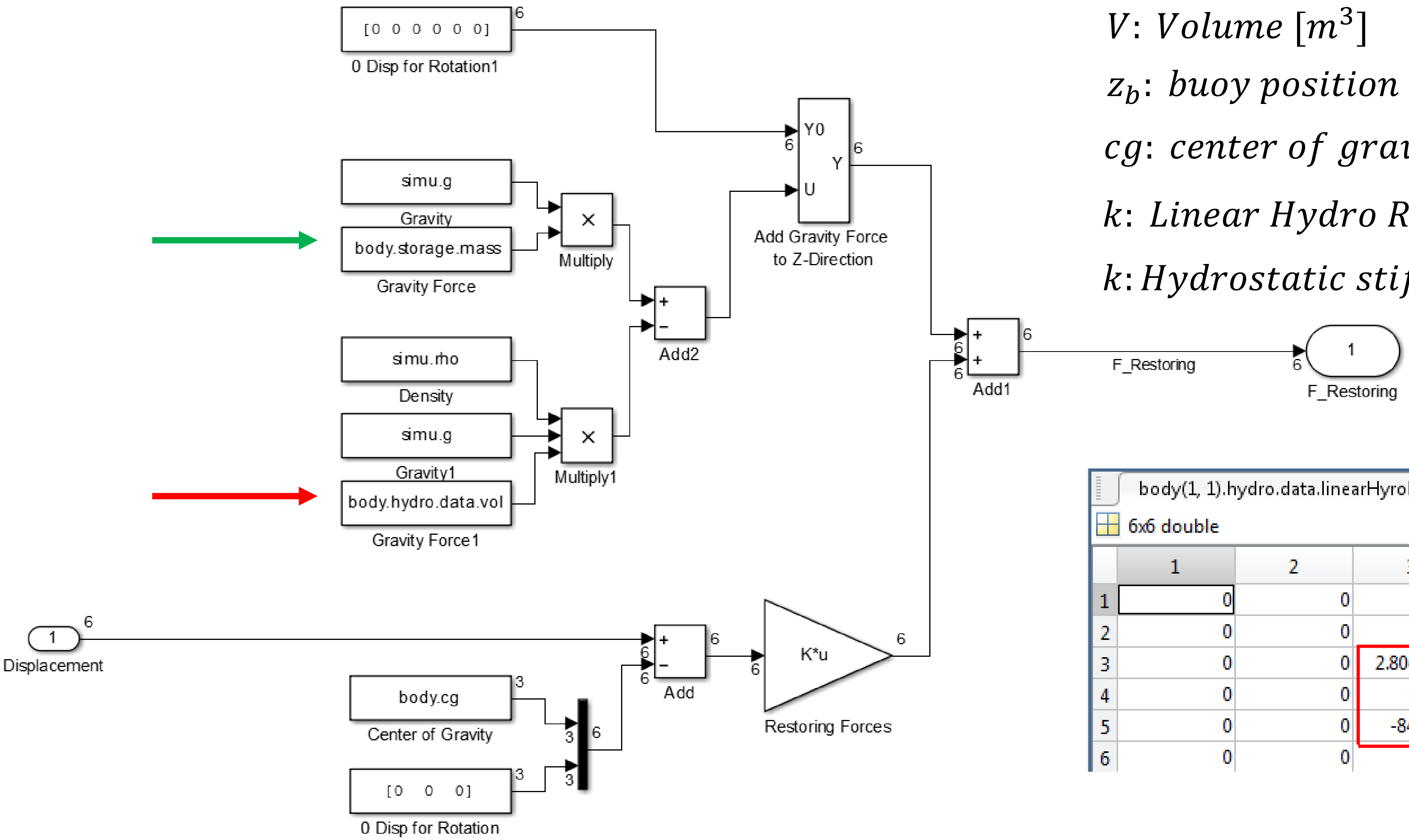
V: $Volume\ [m^3]$

z_b: $buoy\ position\ [m]$

cg: $center\ of\ gravity\ [m]$

k: $Linear\ Hydro\ Restoring\ Coefficient\ [N/m]$

k: $Hydrostatic\ stiffness\ [N/m]$



body(1, 1).hydro.data.linearHyroRestCoef

6x6 double

	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	2.8049e+06	-2.2560	-848.9378	0
4	0	0	-2.2560	71948502	0.9668	0
5	0	0	-848.9378	0.9668	71931825	0
6	0	0	0	0	0	0

Questions/Comments

- Green and red arrows: Names are not labeled correctly.
- Is it the correct equation?
- Linear hydro restoring coefficient = hydrostatic stiffness?