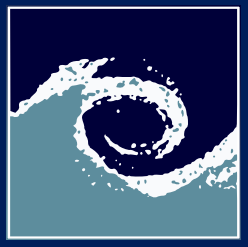
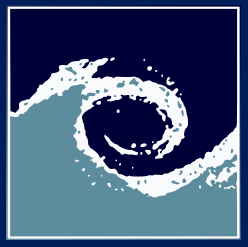


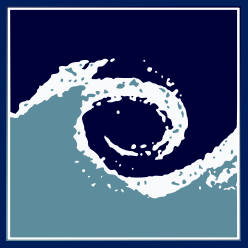
Laboratory Session 7

Open-Source CFD Course 2021

Miklós BALOGH and Josh DAVIDSON

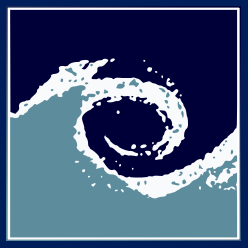
2021





Floating object tutorial

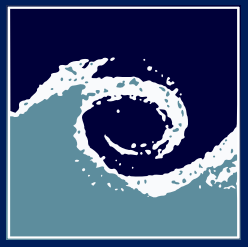
- During this week's lecture we had a brief look at the floatingObject tutorial
- Your first task for today's lab is to run the floatingObject tutorial and view the outputs in paraView



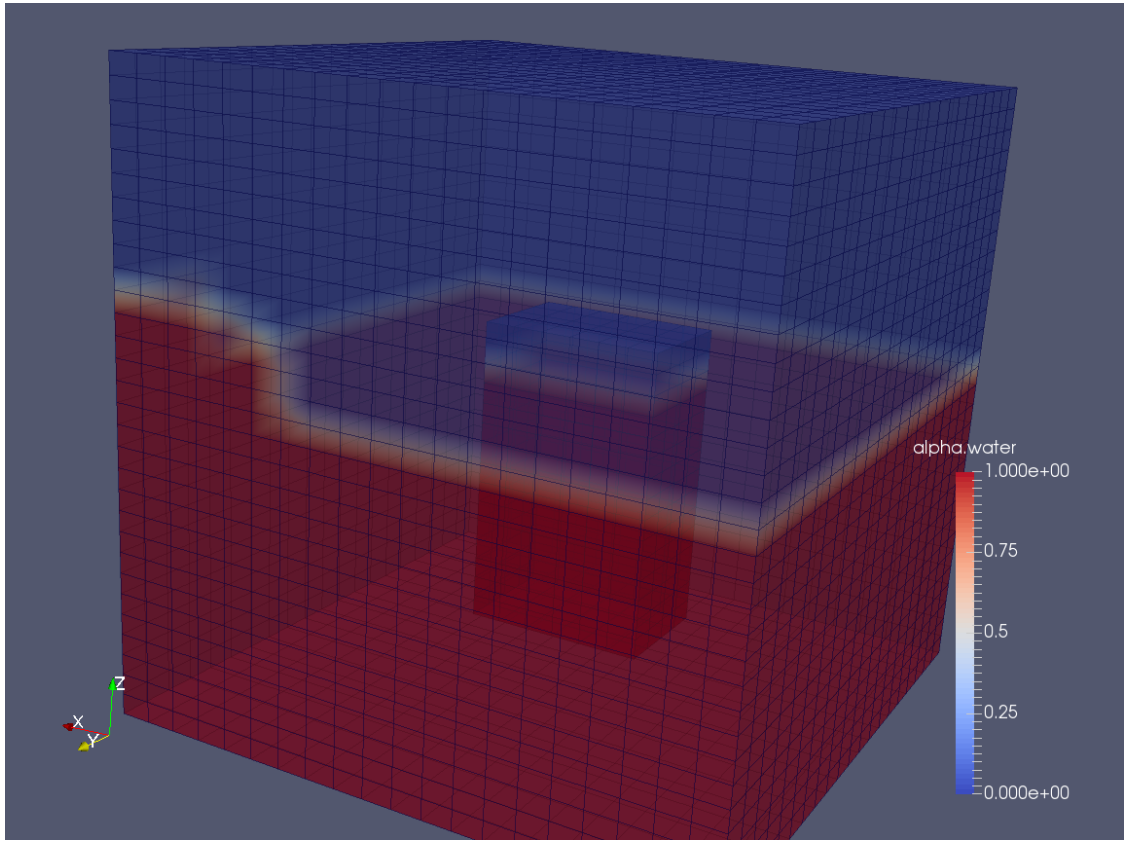
Floating object tutorial

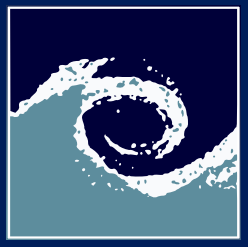
Steps

1. Find the floatingObject tutorial case and make a second copy of it
2. Run the *Allrun* script
3. Once the simulation has finished open paraView by typing "paraFoam"
4. Create the figures in the next three slides
   - Email them to me by Friday for a bonus mark
   - Hint : In the first figure I have changed the "opacity" so I can see the floating object inside the domain
   - Hint : In the second figure I have used the "slice"
   - Hint : In the third figure I deselect all "Mesh parts" excpet for "floatingObject - wall"

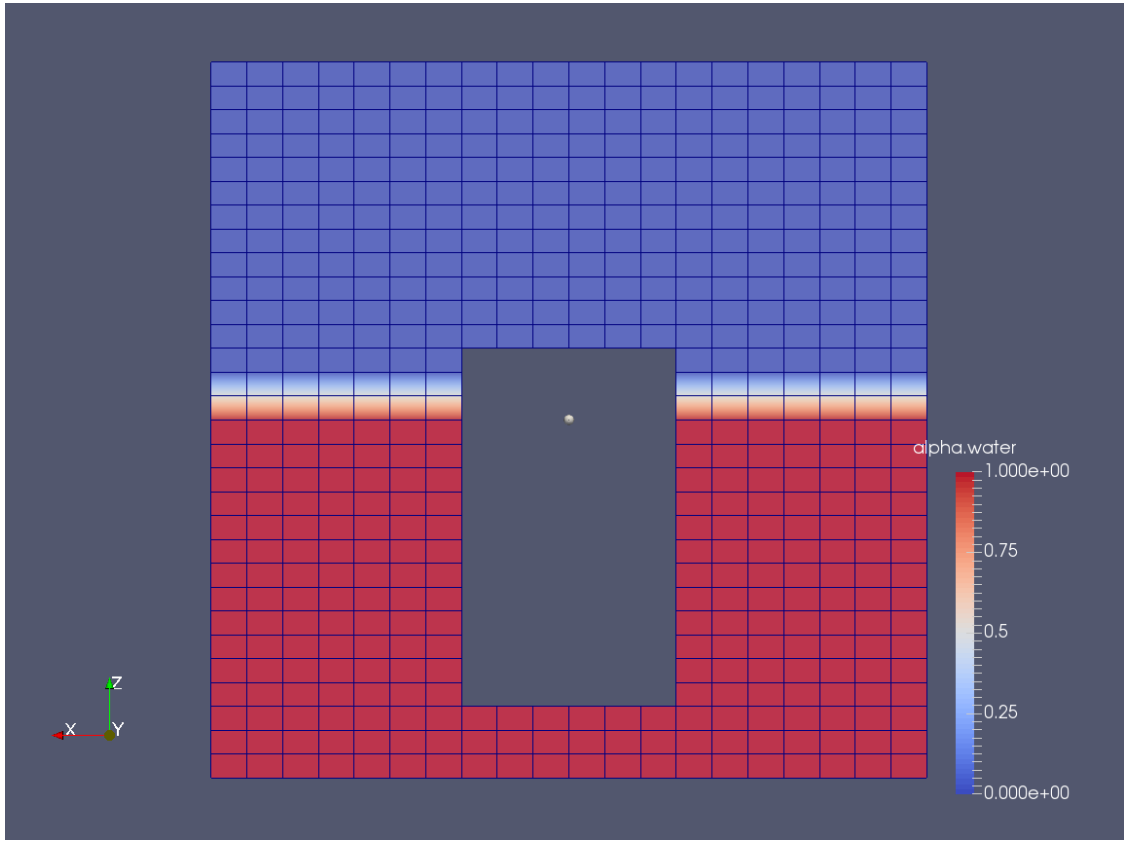


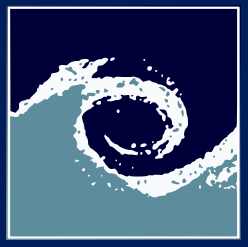
alpha.water at time = 0s



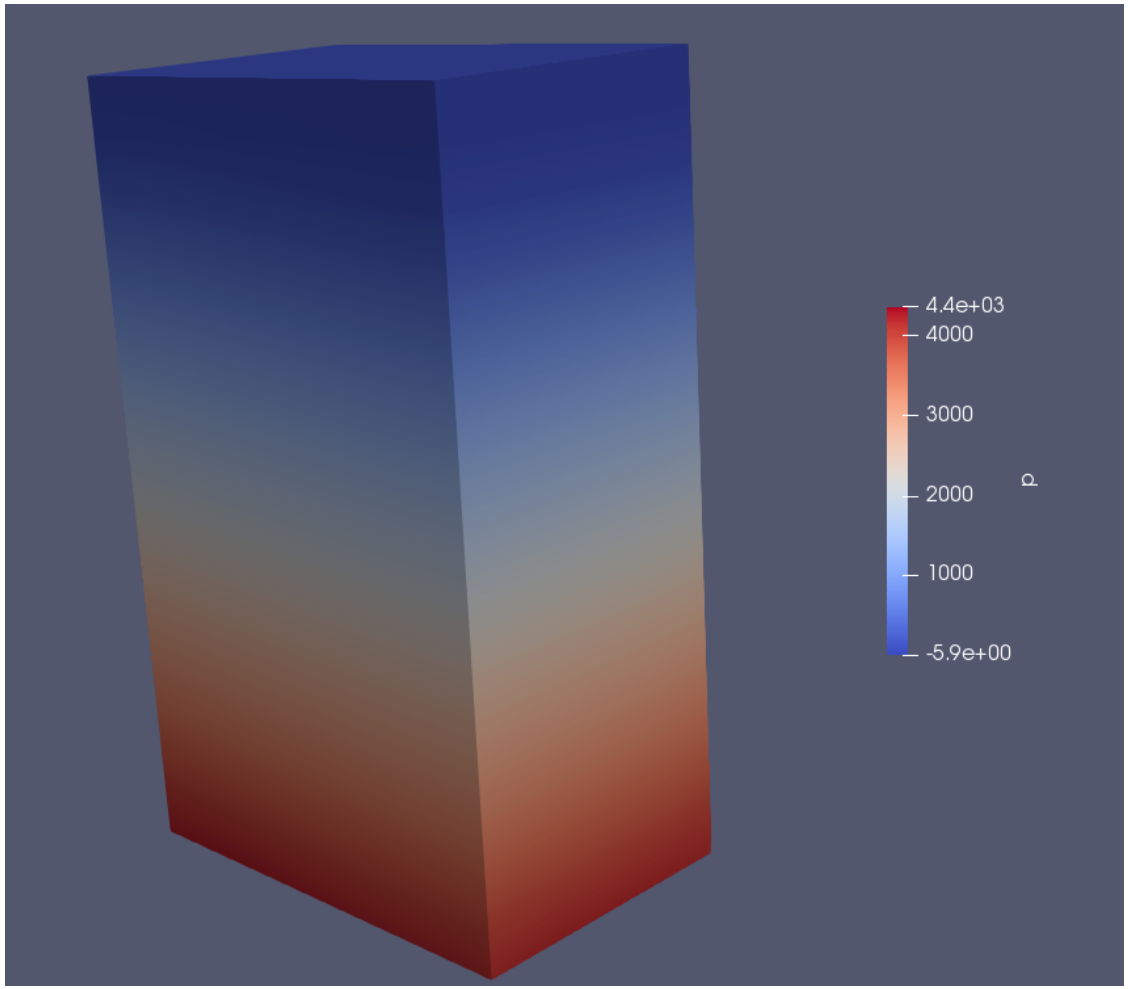


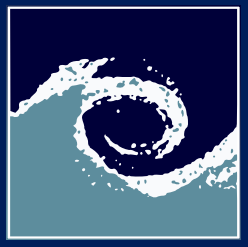
alpha.water at time = 0s





Pressure at time = 3s

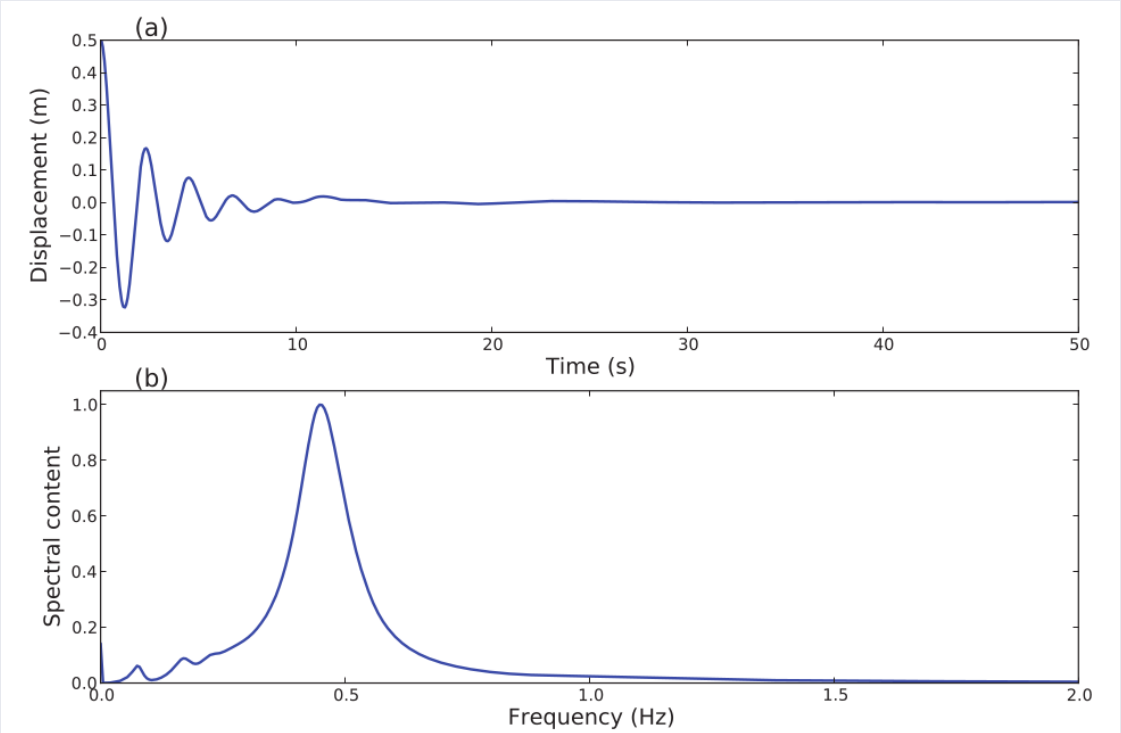




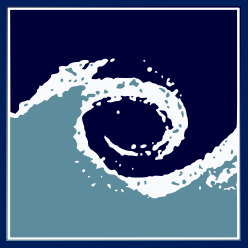
Free decay experiment

A free decay experiment involves starting a body displaced from its equilibrium and then running the simulation so that it oscillates back to rest (see Figure (a) below). The frequency of the oscillation corresponds to the natural frequency of the body, so it is a useful experiment to identify the body dynamics (see the Fourier transform in Figure(b) below).

Example result

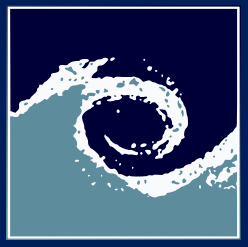


[0] Davidson, Giorgi and Ringwood, *Identification of Wave Energy Device Models From Numerical Wave Tank Data – Part 1: Numerical Wave Tank Idenitication Tests*, IEEE Transactions on Sustainable Energy, 2016



Free decay experiment

1. Make another copy of the floatingObject tutorial, then modify the case to simulate heave/vertical motion free decay tests
   - 1.1 Remove the extra block of water above the mean surface level, which casues external excitation to the floating object (*system/setFieldsDict*)
   - 1.2 Change the simulation length to 20s (*system/controlDict*)
   - 1.3 Change the mass of the object (*constant/dynamicMeshDict*)
   - 1.4 Change the motion constaints to heave [z-axis] (*constant/dynamicMeshDict*)



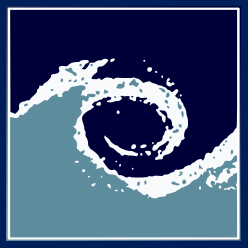
1.1 *system/setFieldsDict*

(a) Original

```
10     version     2.0;
11     format      ascii;
12     class       dictionary;
13     location    "system";
14     object      setFieldsDict;
15 }
16 // * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
17
18 defaultFieldValues
19 (
20     volScalarFieldValue alpha.water 0
21 );
22
23 regions
24 (
25     boxToCell
26     {
27         box (-100 -100 -100) (100 100 0.5368);
28         fieldValues ( volScalarFieldValue alpha.water 1 );
29     }
30
31     boxToCell
32     {
33         box (0.7 0.8 -100) (100 100 0.65);
34         fieldValues ( volScalarFieldValue alpha.water 1 );
35     }
36 );
37
```

(b) Modified

```
10     version     2.0;
11     format      ascii;
12     class       dictionary;
13     location    "system";
14     object      setFieldsDict;
15 }
16 // * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
17
18 defaultFieldValues
19 (
20     volScalarFieldValue alpha.water 0
21 );
22
23 regions
24 (
25     boxToCell
26     {
27         box (-100 -100 -100) (100 100 0.5368);
28         fieldValues ( volScalarFieldValue alpha.water 1 );
29     }
30
31  /* boxToCell
32   {
33       box (0.7 0.8 -100) (100 100 0.65);
34       fieldValues ( volScalarFieldValue alpha.water 1 );
35   }
36  */
37 );
```



1.1 *system/controlDict*

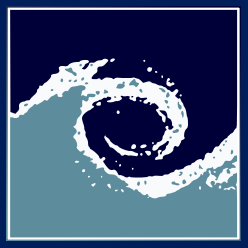
(a) Original

```
10     version     2.0;
11     format      ascii;
12     class       dictionary;
13     location    "system";
14     object      controlDict;
15 }
16 // * * * * * * * * * * * * * * * * * *
17
18 application     interFoam;
19
20 startFrom      startTime;
21
22 startTime      0;
23
24 stopAt         endTime;
25
26 endTime        6;
27
28 deltaT         0.01;
29
```

(b) Modified

```
10     version     2.0;
11     format      ascii;
12     class       dictionary;
13     location    "system";
14     object      controlDict;
15 }
16 // * * * * * * * * * * * * * * * * * *
17
18 application     interFoam;
19
20 startFrom      startTime;
21
22 startTime      0;
23
24 stopAt         endTime;
25
26 endTime        20;
27
28 deltaT         0.01;
29
30 writeControl   adjustableRunTime;
31
32 writeInterval  5;
```

[0] Note : If you do not have much free space on your harddrive, then change the output write interval to a bigger value (as shown in the blue box)



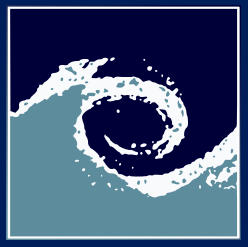
1.3 and 1.4 *constant/dynamicMeshDict*

(a) Original

```
41          // Cuboid dimensions
42          Lx              0.3;
43          Ly              0.2;
44          Lz              0.5;
45
46          // Density of the cuboid
47          rho             500;
48
49          // Cuboid mass
50          mass            #calc "$rho*$Lx*$Ly*$Lz";
51          L               ($Lx $Ly $Lz);
52          centreOfMass    (0 0 0.25);
53          transform       (1 0 0 0 1 0 0 0 1) (0.5 0.45 0.1);
54
55          joint
56          {
57              type            composite;
58              joints
59              (
60                  {
61                      type Py;
62                  }
63                  {
64                      type Ry;
65                  }
66              );
67          }
68
69          patches         (floatingObject);
```

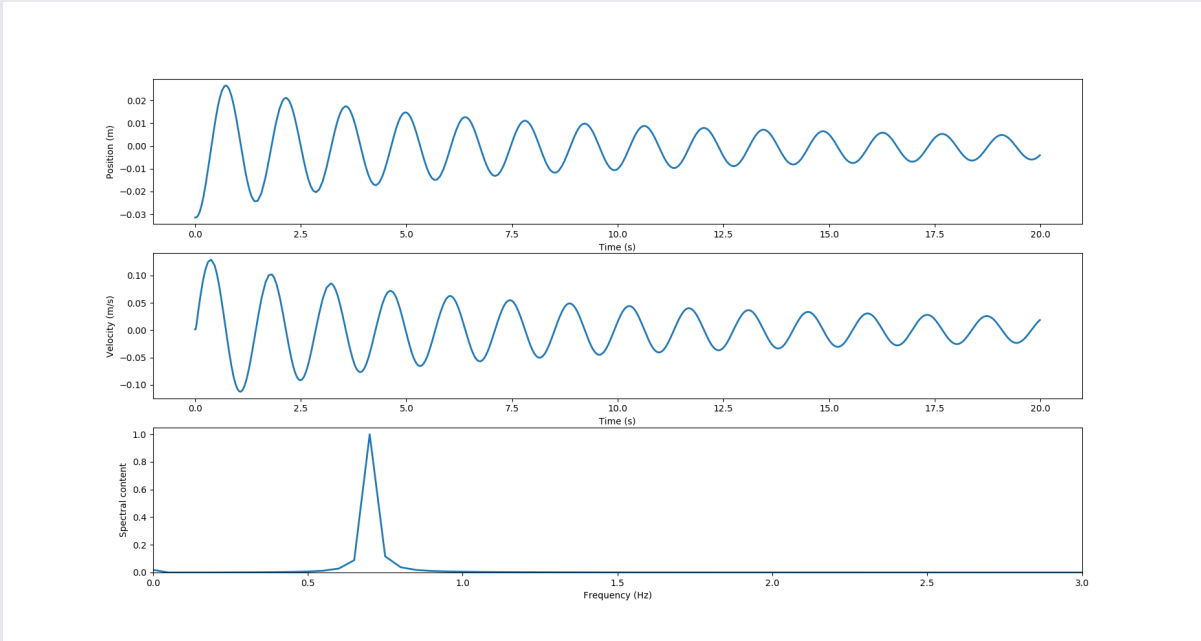
(b) Modified

```
41          // Cuboid dimensions
42          Lx              0.3;
43          Ly              0.2;
44          Lz              0.5;
45
46          // Density of the cuboid
47          rho             800;
48
49          // Cuboid mass
50          mass            #calc "$rho*$Lx*$Ly*$Lz";
51          L               ($Lx $Ly $Lz);
52          centreOfMass    (0 0 0.25);
53          transform       (1 0 0 0 1 0 0 0 1) (0.5 0.45 0.1);
54
55          joint
56          {
57              type            composite;
58              joints
59              (
60                  {
61                      type Pz;
62                  }
63              );
64          }
65
66          patches         (floatingObject);
```

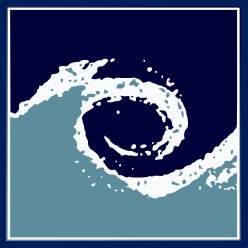


Plot results

2. Once the simulation has finished, use the python scripts provided to plot the results like in the graph below [1].
   - 1.1 Copy the *extractData.py* and *plotter.py* files into the case folder
   - 1.2 In the command line, type "python extractData.py", to extract the position and velocity of the floating object at each time step and save as a text file in the created "Results" folder
   - 1.3 In the command line, type "python plotter.py", to read the data, perform a Fourier transform and then plot the results



[1] Advanced post processing methods such as this will be taught in Lecture 5



Assignments

1. What does *topoSet* do in the floating object tutorial?
2. How many cells are used in the floating object tutorial?
3. For the free decay experiment, if you change the density of the floating object from 800 to 700 kg/m^3, what does the natural heave frequency change to?
4. What could you modify in the free decay case setup so that there is zero motion from the floating object's initial position?
5. Modify the floatingObject tutorial so that it crashes!!!