HYDRODYNAMIC BEHAVIOR OF A SUBMARINE

TP Fluid Dynamics

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1. *Goals*

The primary goal of this study is to utilize the Star CCM+ tool for modeling the hydrodynamic behaviour of the 'Agosta' submarine at a depth of 300 meters and a speed of 38 km/h. The report aims to comprehensively detail the simulation process and analyse the resulting hydrodynamic effects.

2. *Geometry*

Figure 1: Geometry and Domain

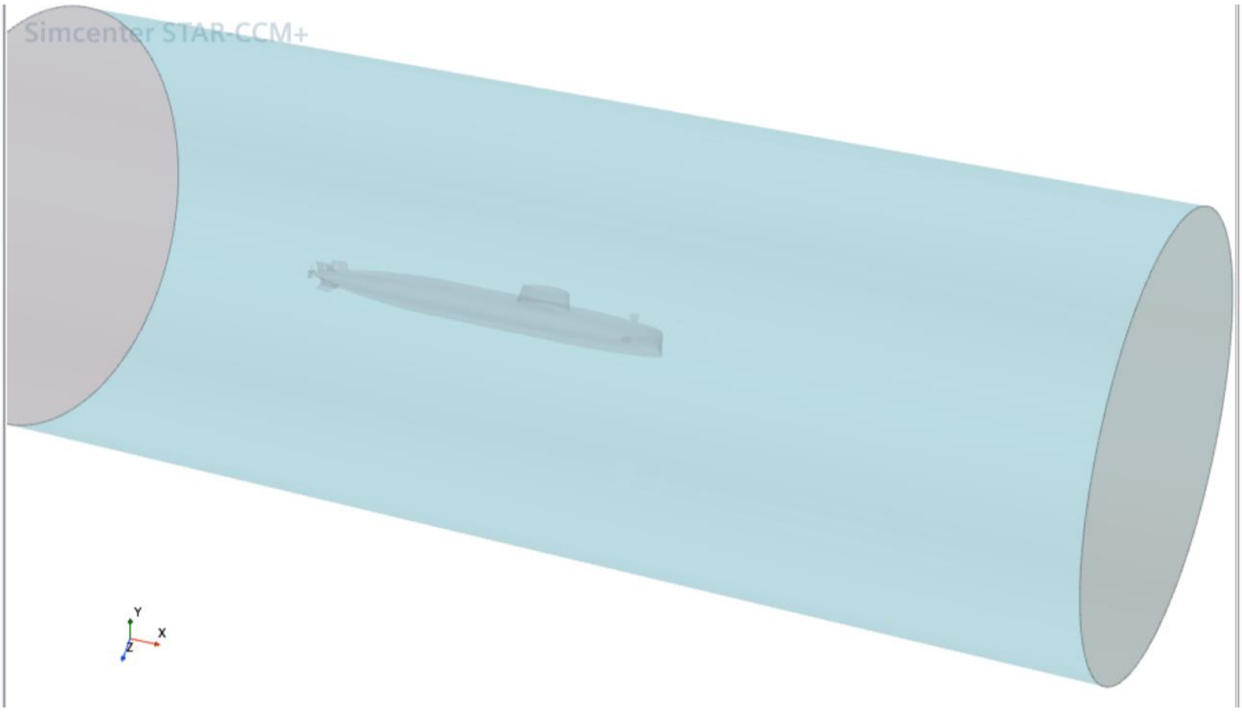


Figure 2: Mesh, Submarine and Domain

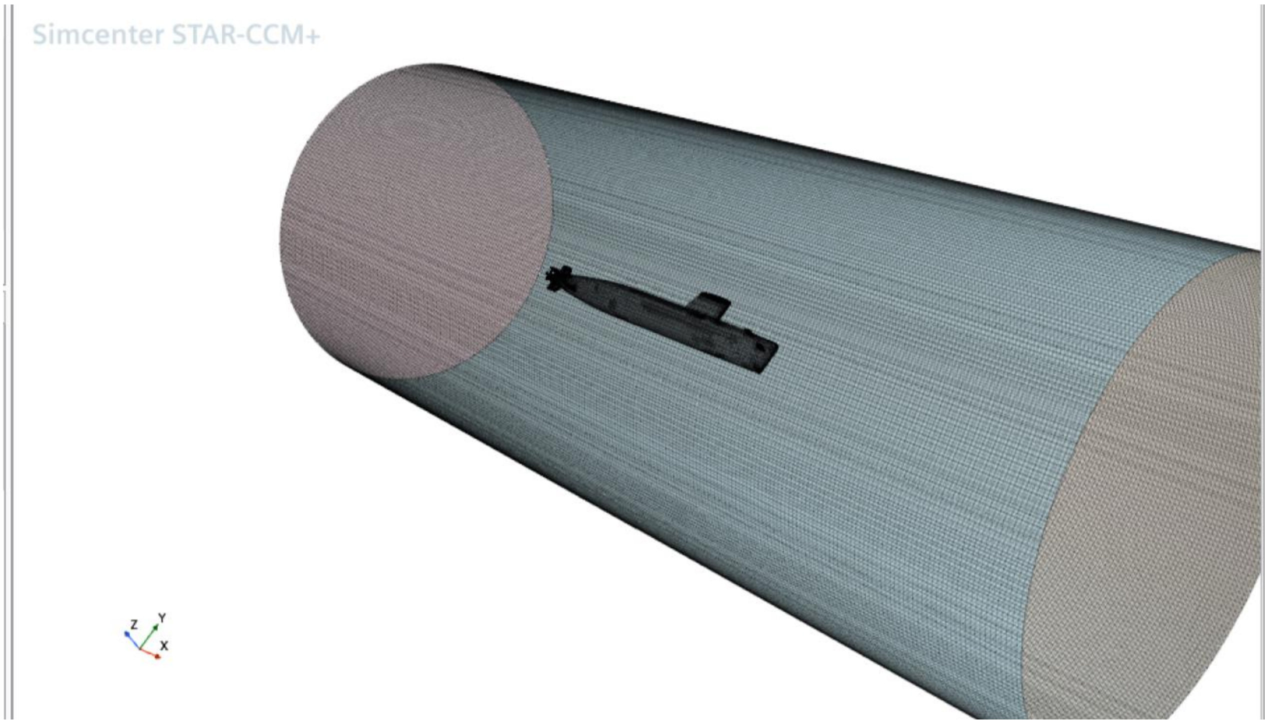
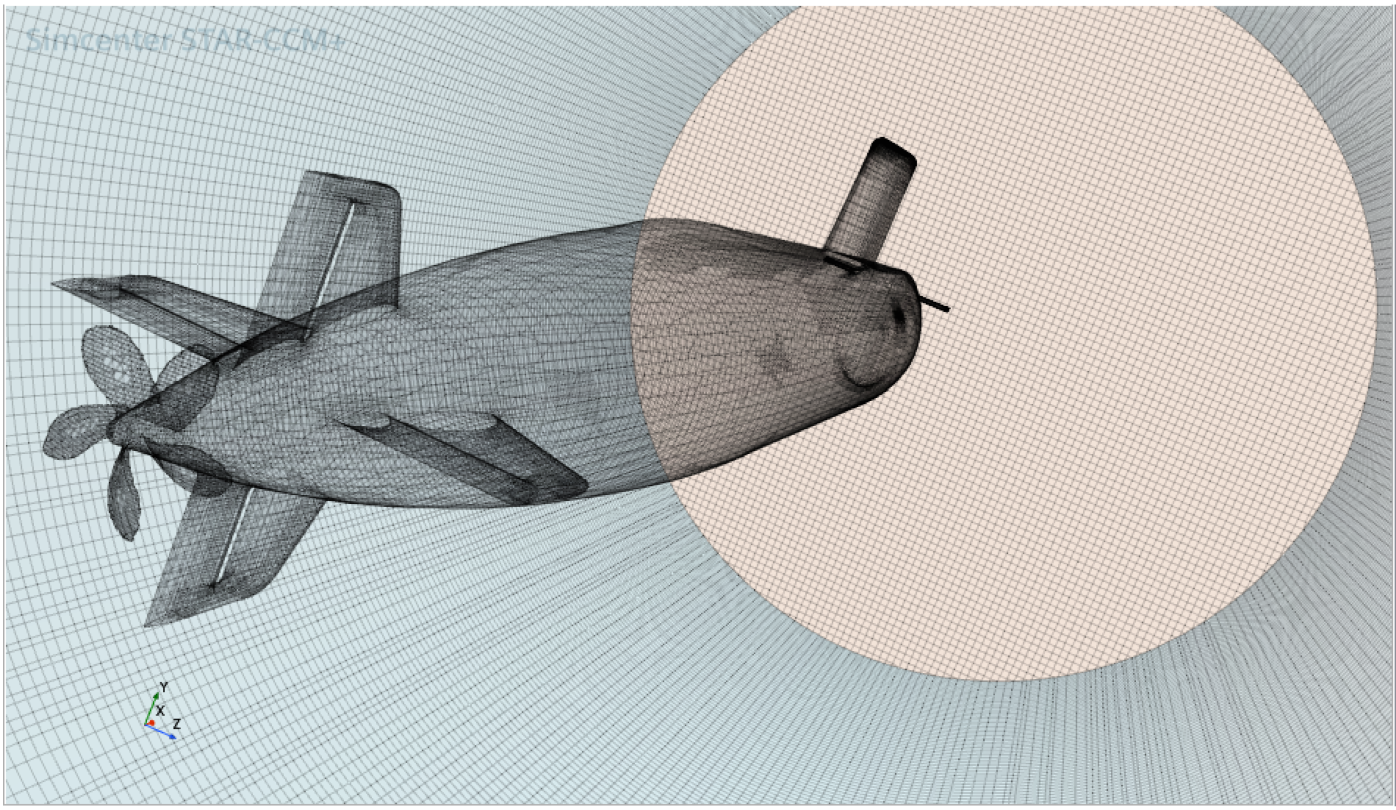


Figure 3: Mesh zoom, Submarine



3. *Results and Interpretations*

   a. *Pressure, velocity, turbulent viscosity ration in a horizontal plane*

Figure 4:Pressure, vertical Plane

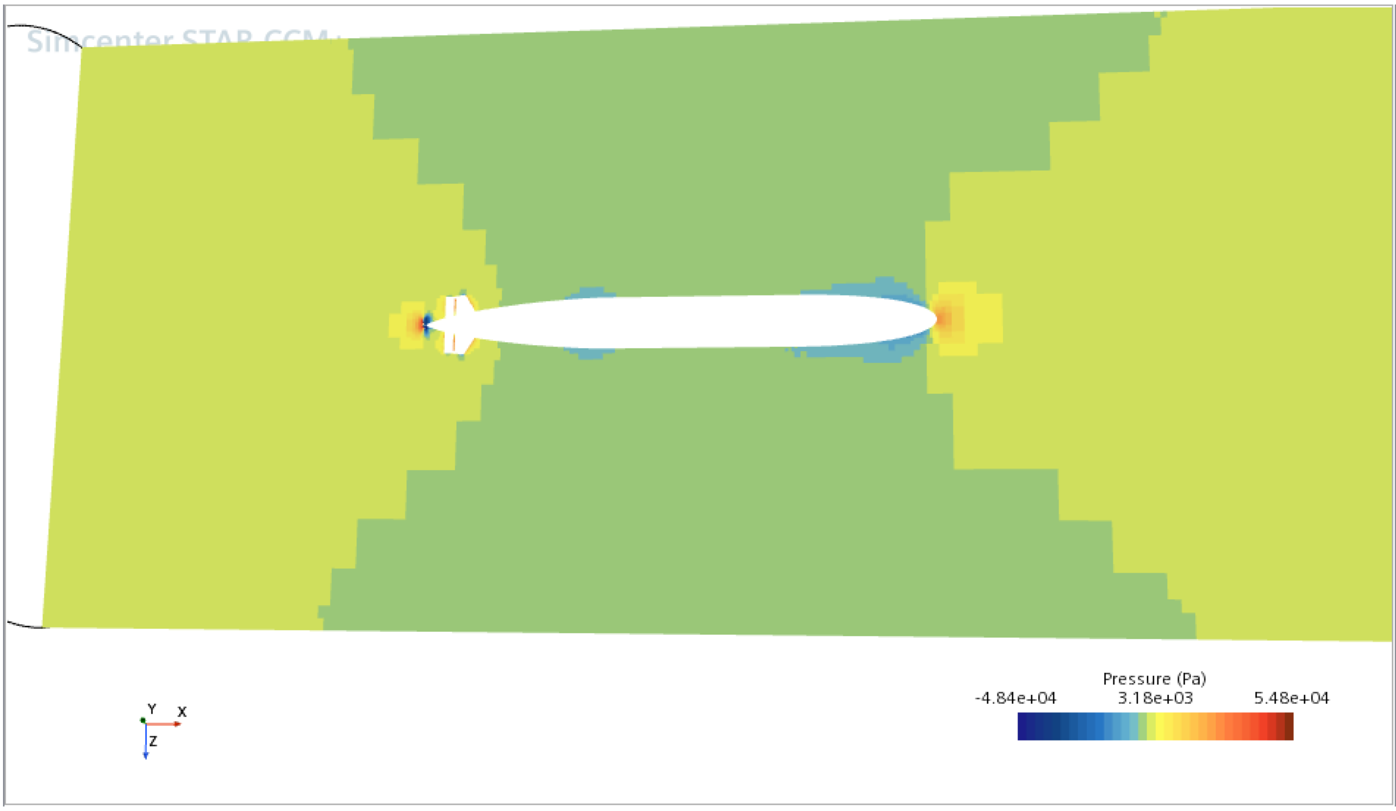


Figure 5:Velocity, vertical plane

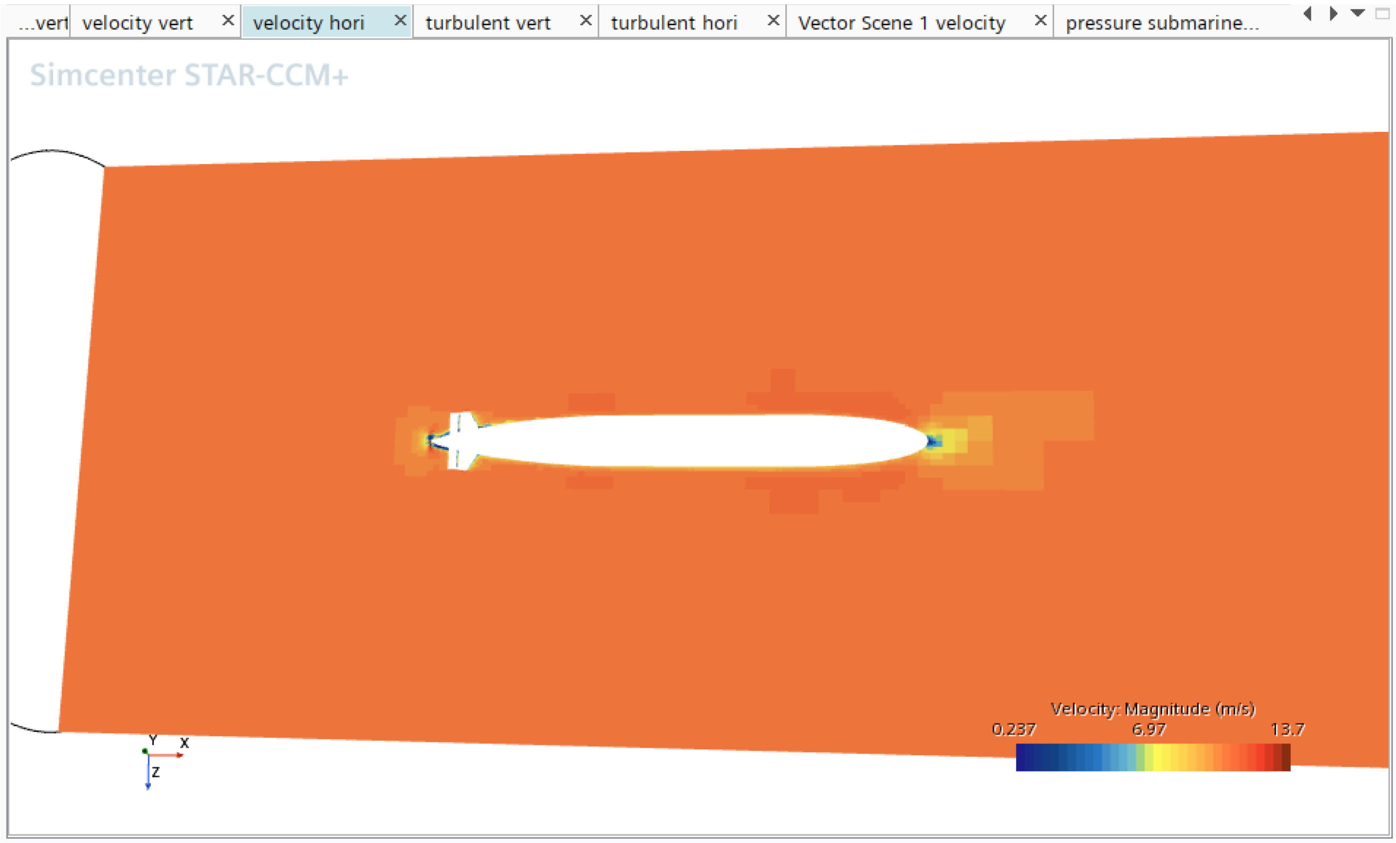
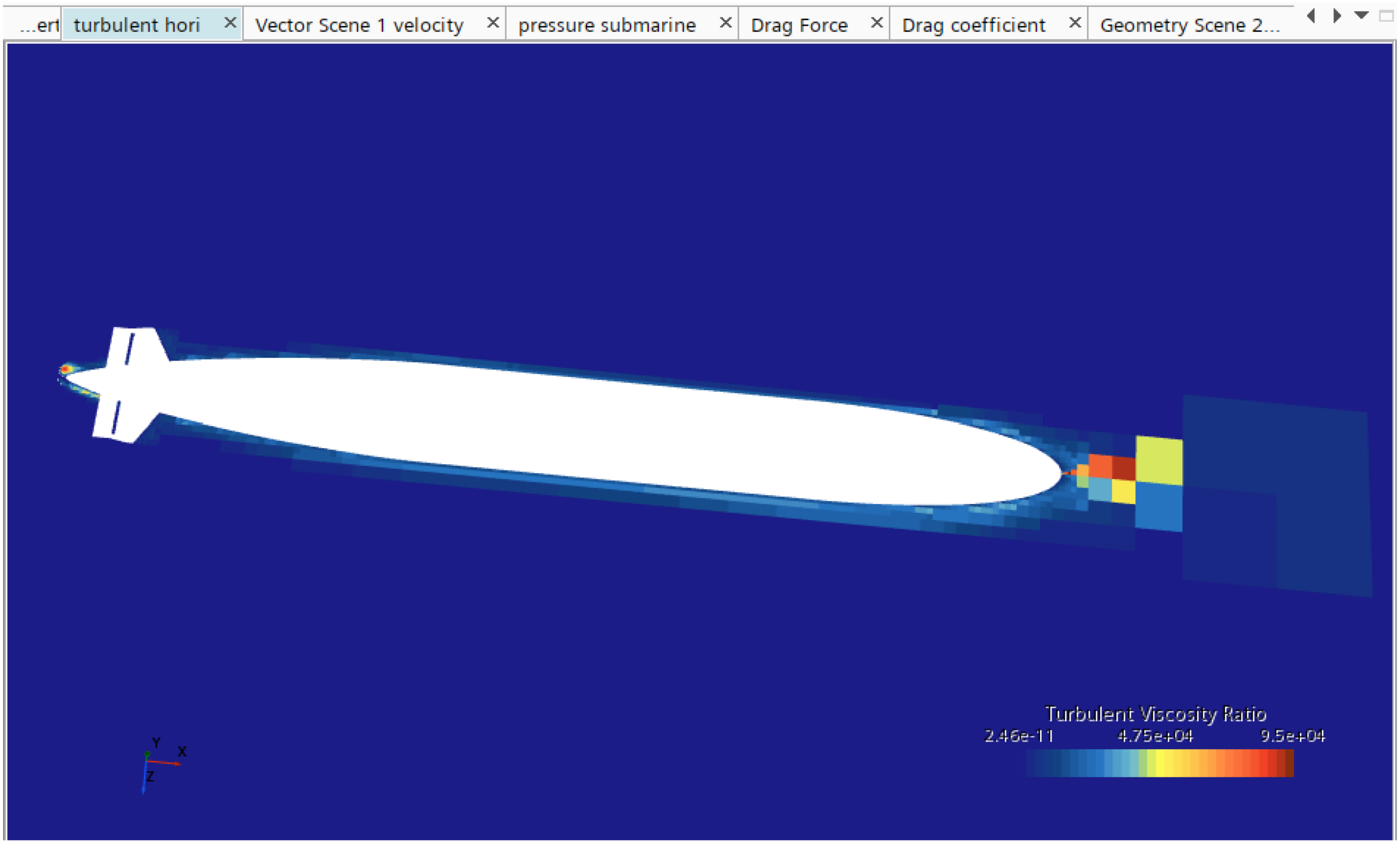


Figure 6: Turbulent viscosity ratio, vertical plane



I noticed that the pressure is higher at the bottom of the submarine and the front of the submarine, and this is the opposite of the velocity, this phenomenon is called the Bernoulli's effect. For the Turbulent viscosity ration its somehow higher in the front of the submarine we can say that it depends on a lot of the pressure I think these two are proportional. Generally, we can say that no one of these parameters has a homogeneous variation their values change a lot along the submarine.

b. *Pressure, velocity, turbulent viscosity ration in a vertical plane*

Vertically along the submarine the pressure is very high, we observe the opposite for the velocity this is due to Bernoulli's effect this difference is also a factor that makes the submarine floating. For the Turbulent viscosity, approximately his average show that its low, this doesn't surprise me because I expected more turbulence at the front of the submarine due to the compression of the water as the submarine advances.

Figure 7:Pressure, vertical plane

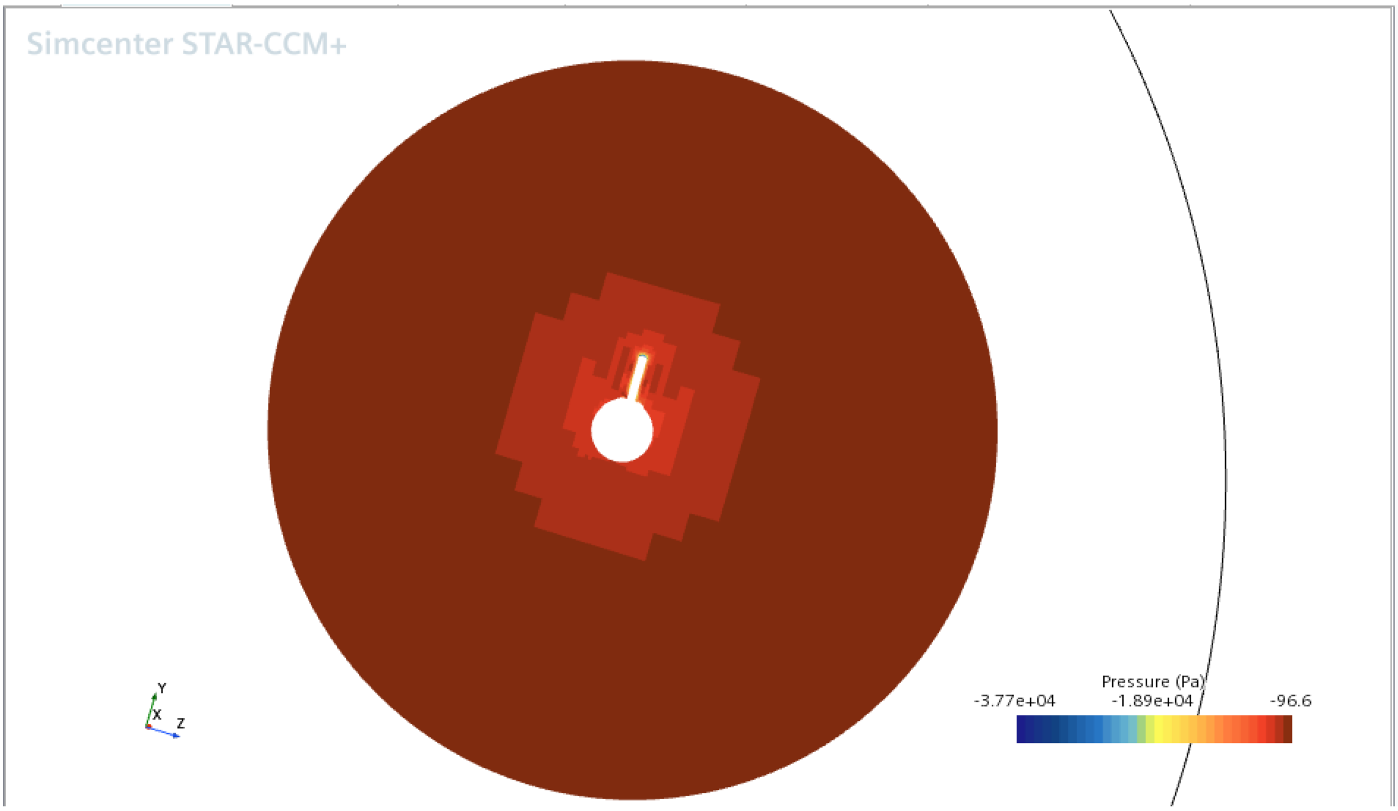


Figure 8:Velocity, vertical plane

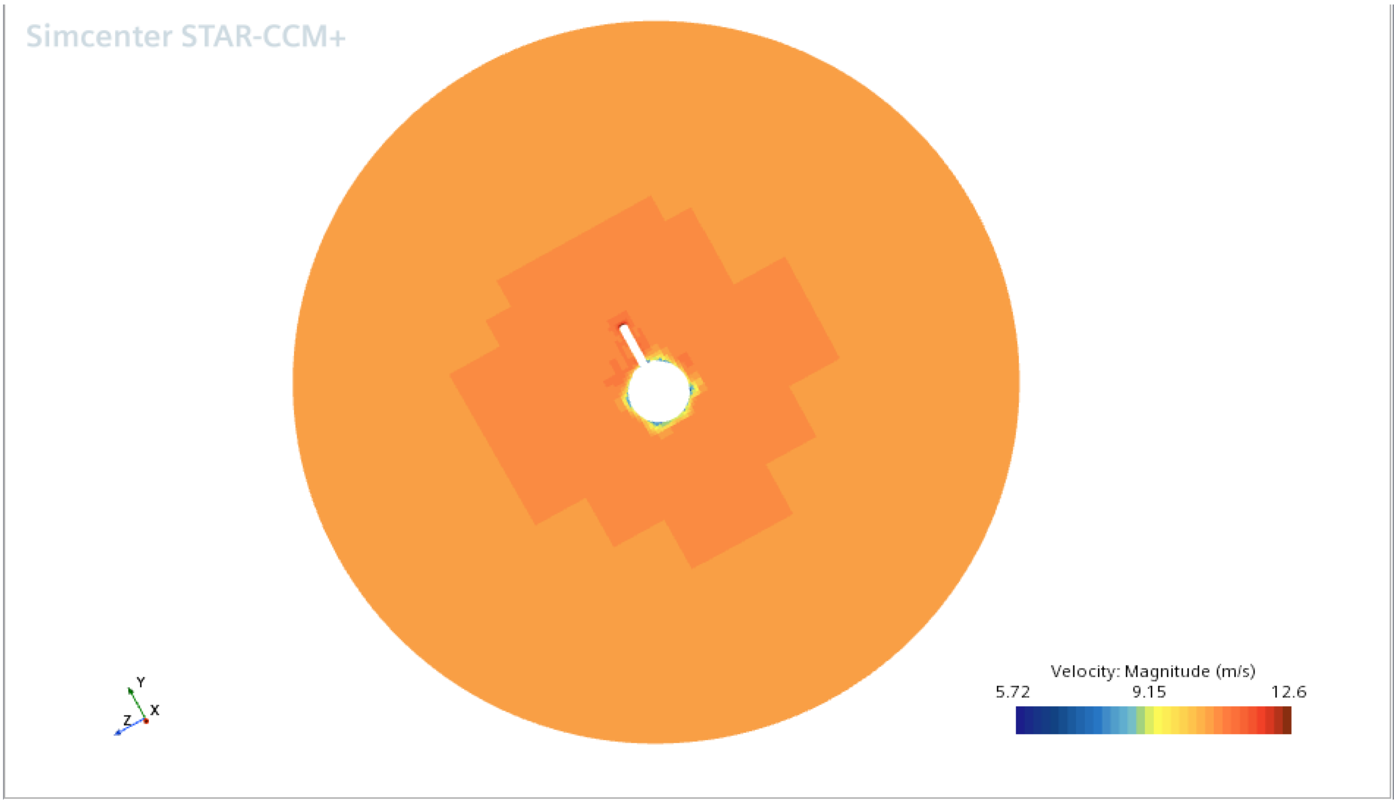
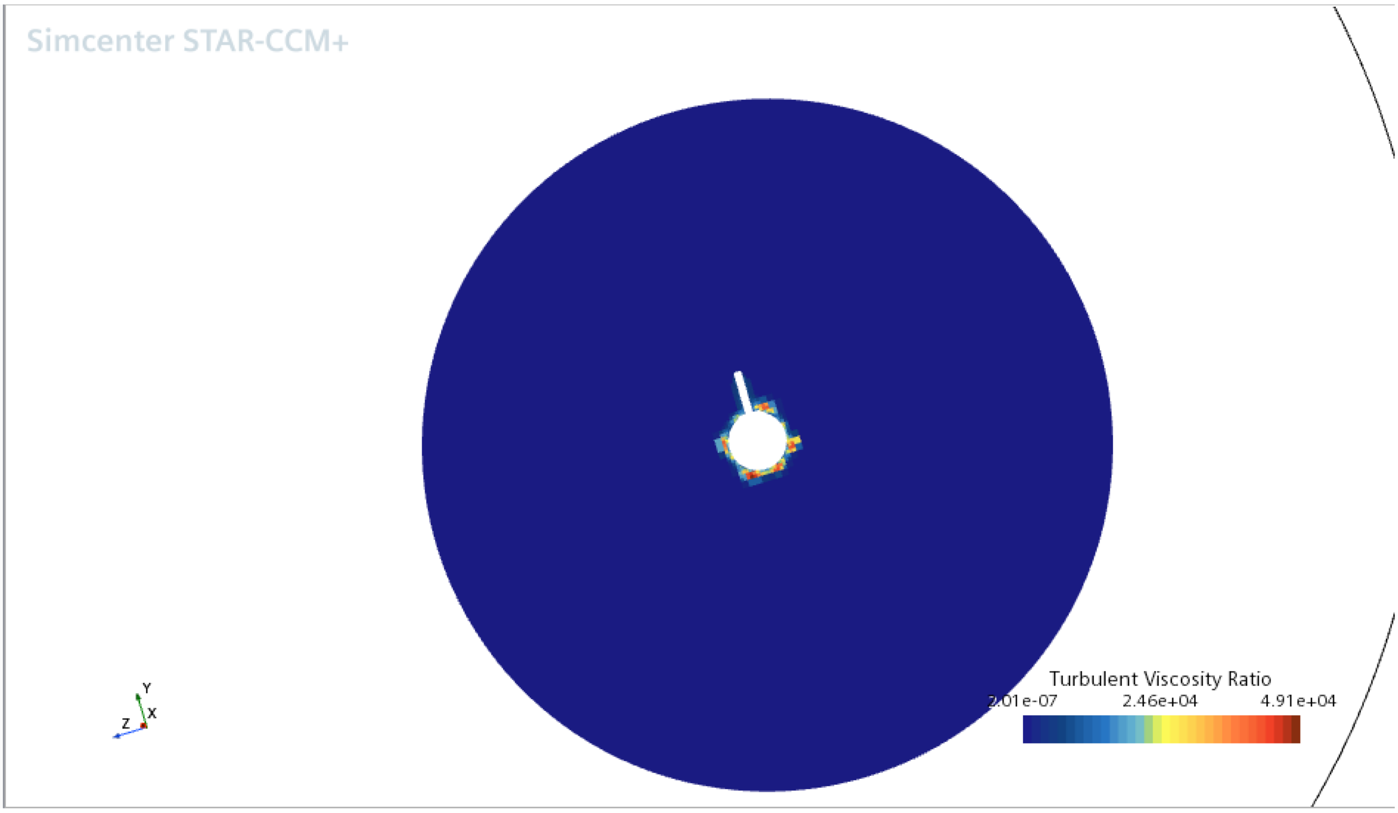


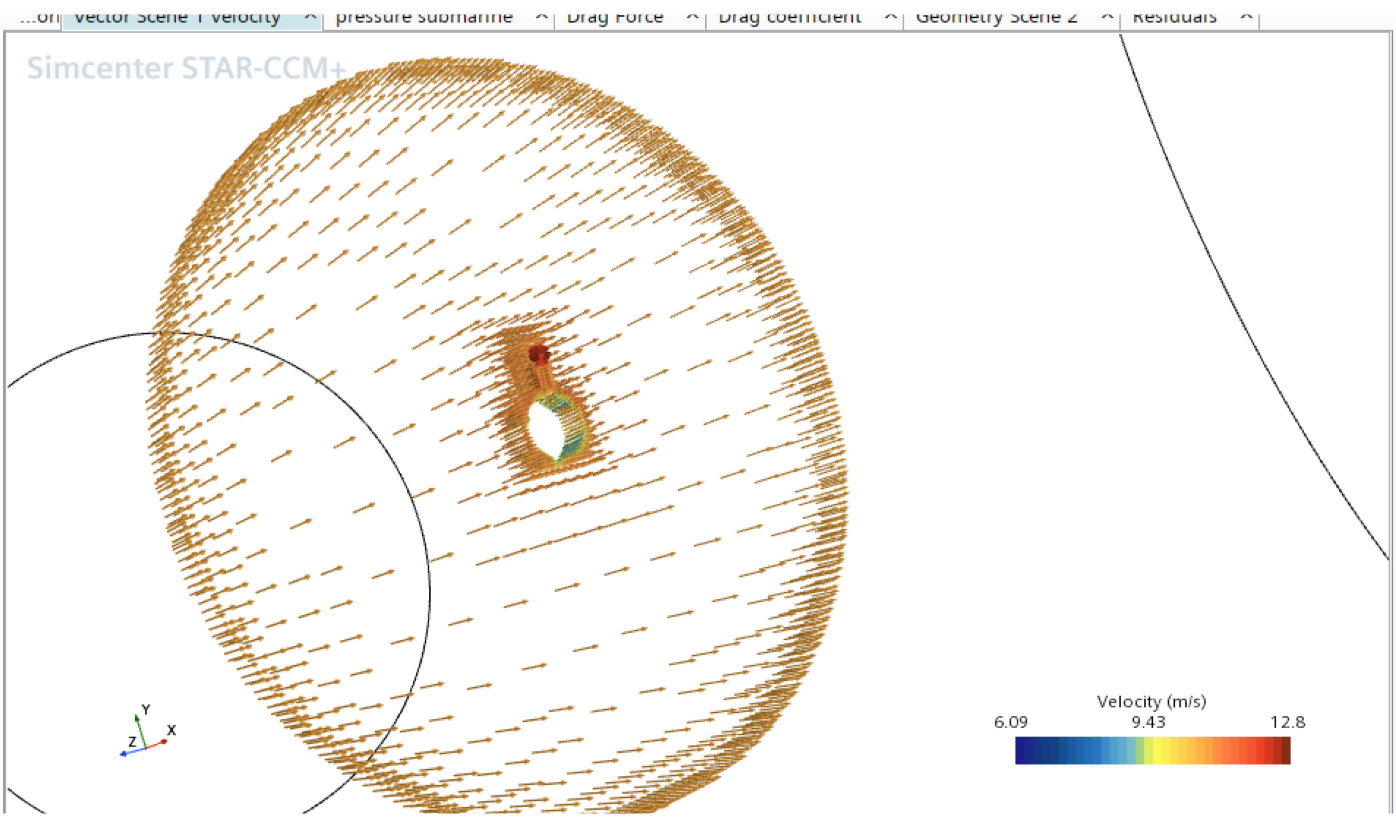
Figure 9:Turbulent Viscosity Ratio, vertical plane



c. *Velocity vector fields on a vertical plane*

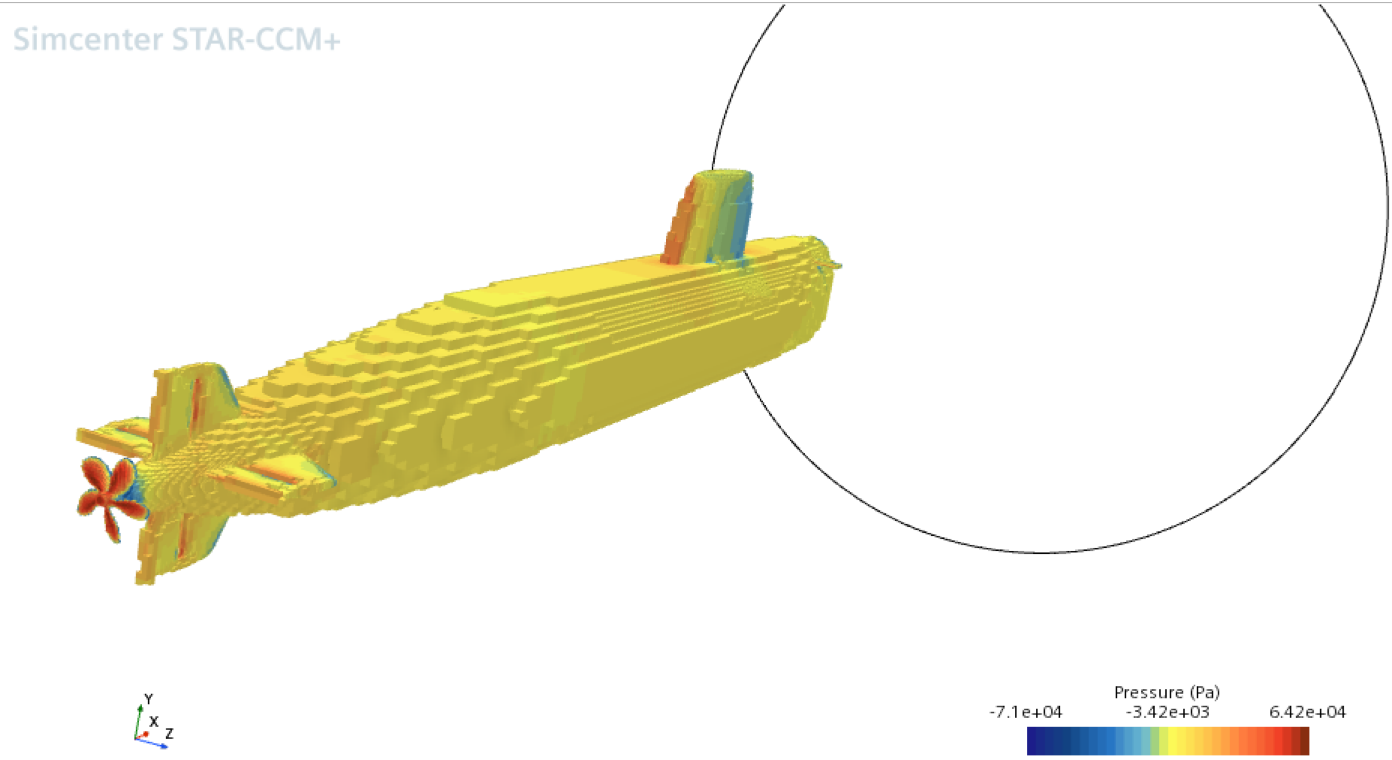
We have a consistent flow around the submarine this was predictable because we have a steady flow and since the velocity is not so high the lengths of the vectors are short. This will bring stability to the moving submarine. Indeed, at the top of the hump the velocity is very high but all around we get what we expected.

Figure 10: velocity vector fields on a vertical plane



d. The pressure contour on the wall of the submarine

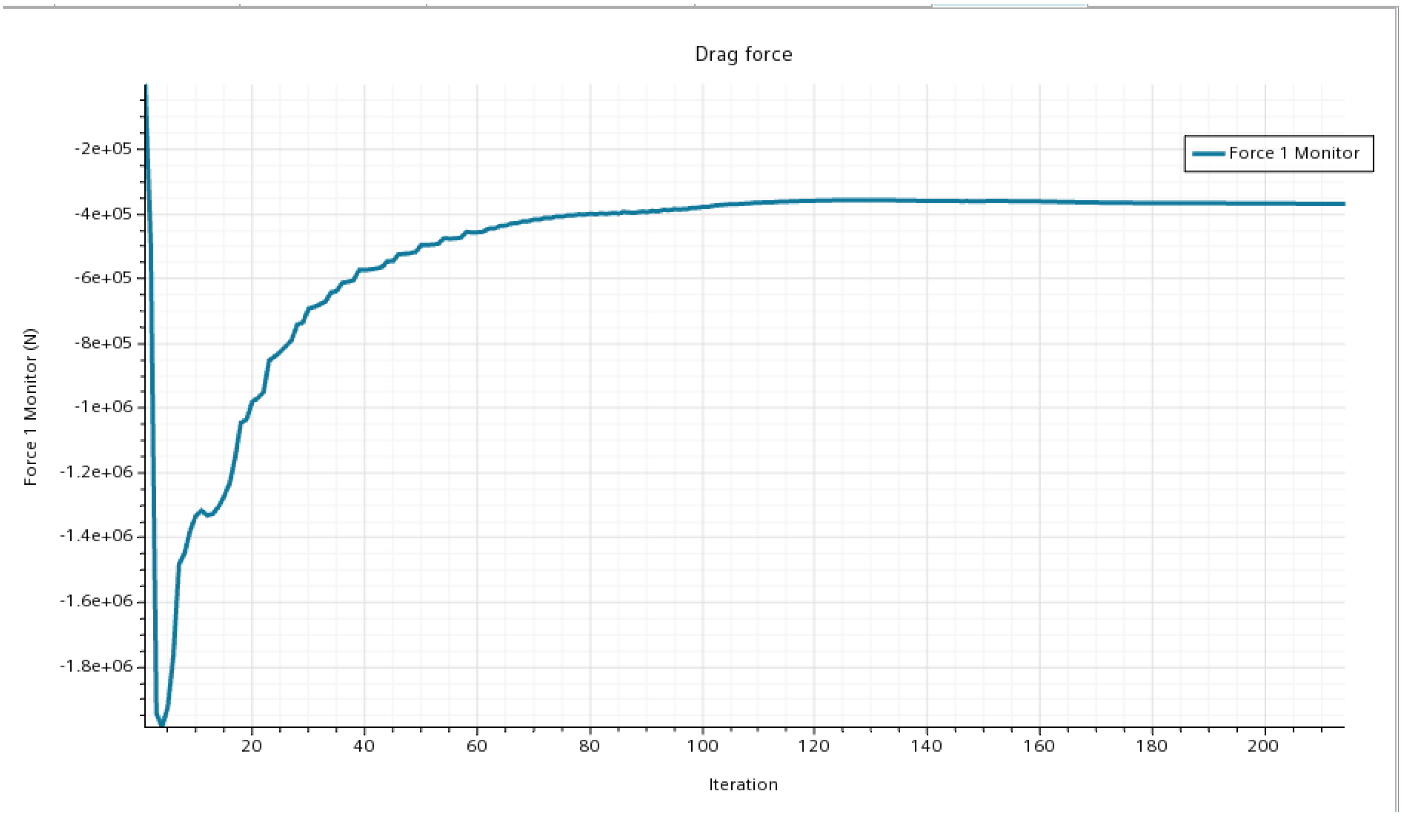
Figure 11:the pressure contour on the wall of the submarine



Behind the hump and at the back of the propeller the pressure is very high this is due to water compression as the submarine move, this contributes to stability and speed because hump and propeller help to reduce the drag force. The pressure all around the submarine is adequate.

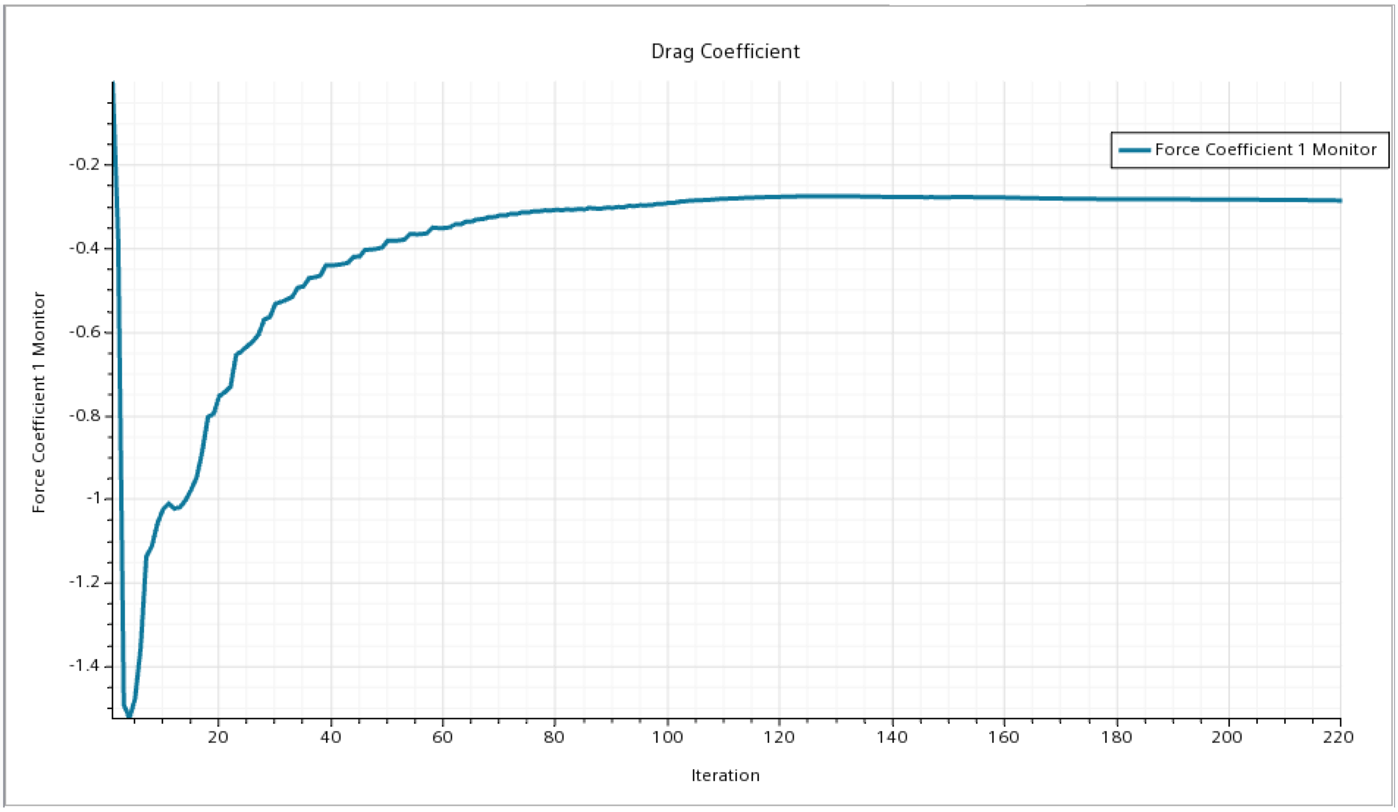
e. *The drag force as a function of the iterations*

Figure 12: The drag force as a function of the iterations



f. The drag coefficient force as a function of the iterations

Figure 13:The drag coefficient force as a function of the iterations



The iterations of the drag force and its coefficients Converge. This Convergence is a positive outcome in simulations because it signifies that the calculated values have reached a steady state and are no longer changing significantly. The negative sign associated with the drag force or coefficient convergence could be a result of the chosen coordinate system or simulation setup.

g. Values (converged) of the drag coefficient

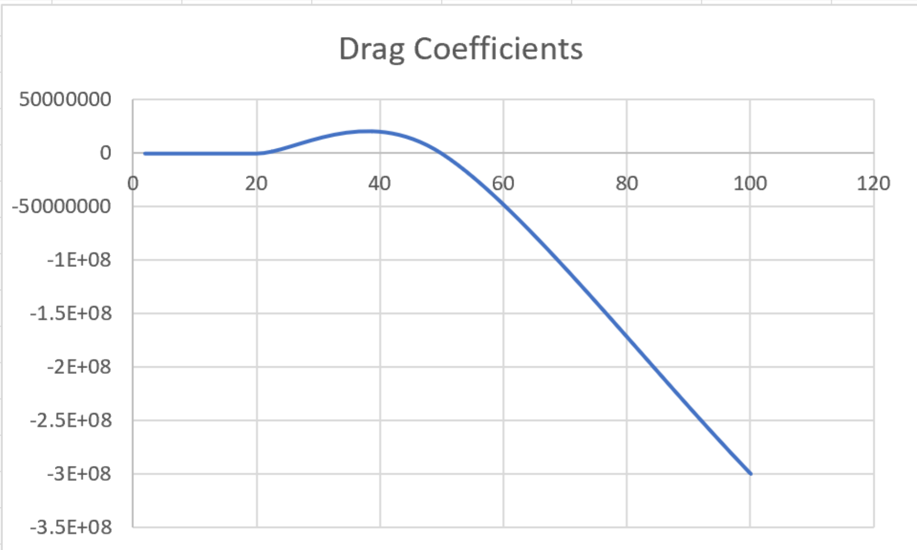
Drag coefficient(converged): -0,28.

Drag force (converged): -3.7 e+0,5. N

h. Study the evolution of the drag coefficient as a function of velocity.

Velocities	Coefficients
2	-0.003
5	-0.0193
10.55	-0.28
20	-0.275
50	-1.805
100	-3.00E+08

Figure 14: Drag Coefficients depending on velocity.



When the velocity of the submarine increases the drag coefficient decreases due to the proportionality between them by definition of the drag force.