

Final Report: MAE 575 Project

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Nomenclature

$\bar{u}(x, y)$: Average velocity in the x-direction

$\bar{v}(x, y)$: Average velocity in the y-direction

$\overline{u'^2}(x, y)$: Reynold's stress

$\overline{v'^2}(x, y)$: Reynold's stress

$\overline{u'v'}(x, y)$: Reynold's stress

$k(x, y)$: Turbulence Kinetic energy

$\epsilon(x, y)$: Turbulence Kinetic Energy Dissipation

$k - \epsilon$: $k - \epsilon$ Turbulence Model

$k - \omega$: $k - \omega$ Turbulence Model

RSTM : Reynold's Stress Turbulence Model

H : Step height

U_{ref} : Reference Velocity (44.2 m/s)

LLE : Local, Linear and Equilibrium

LLR : Launder Reece and Rodi

AIAA : American Institute of Aeronautics and Astronautics

1 Introduction

The aim of this project was to utilize Ansys Fluent, a commercial solver, to solve a turbulent flow problem in a backward step geometry using three distinct Turbulence models. The performance of these models was then compared against the experimental data provided by Driver and Seegmiller (1985), as published in the AIAA Journal, Volume 23, pages 163-171. The problem was modeled as a 2D Turbulence model, with zero mean velocity in the z direction and fluctuations only in the x and y directions.

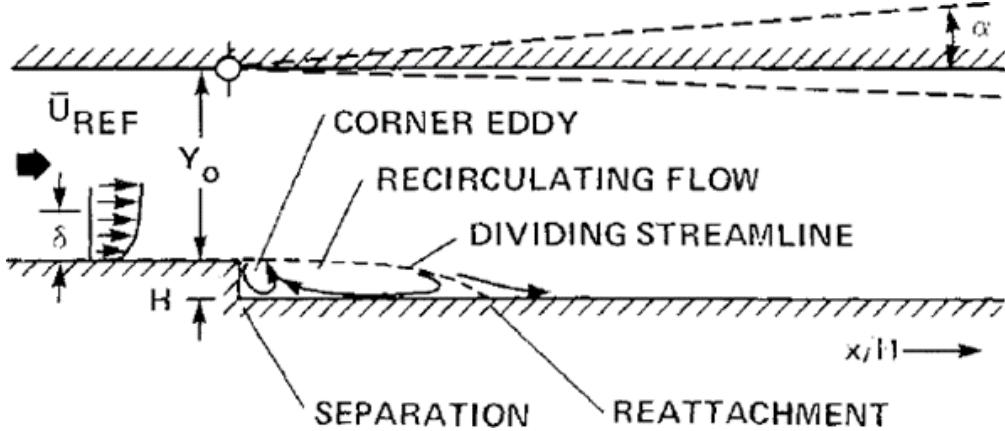


Figure 1: Experimental Setup

The project required the creation of a geometry similar to the experimental case with a height of 1.27 cm and other dimensions as specified. This geometry is shown in Figure 1. Three different meshes were then created with increasing quad size to obtain a Coarse, Medium, and Fine mesh. Three different types of Turbulence models, namely $k - \epsilon$, $k - \omega$, and RSTM, were used to simulate the turbulent flow in the backward step. The inlet velocity was set to 44.2 m/s at the channel inlet, and the outlet was modeled as a pressure outflow boundary condition.

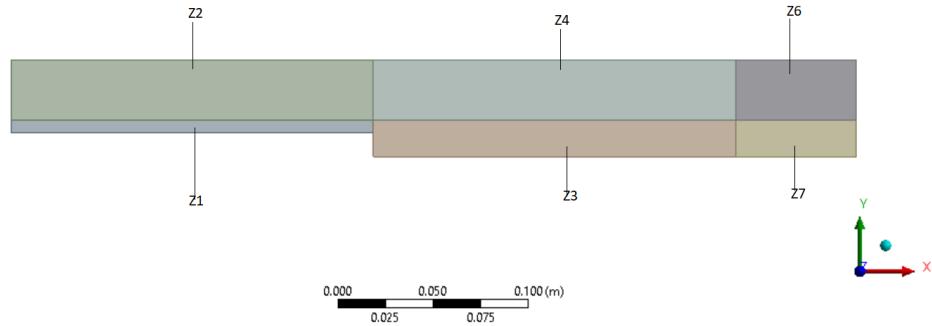
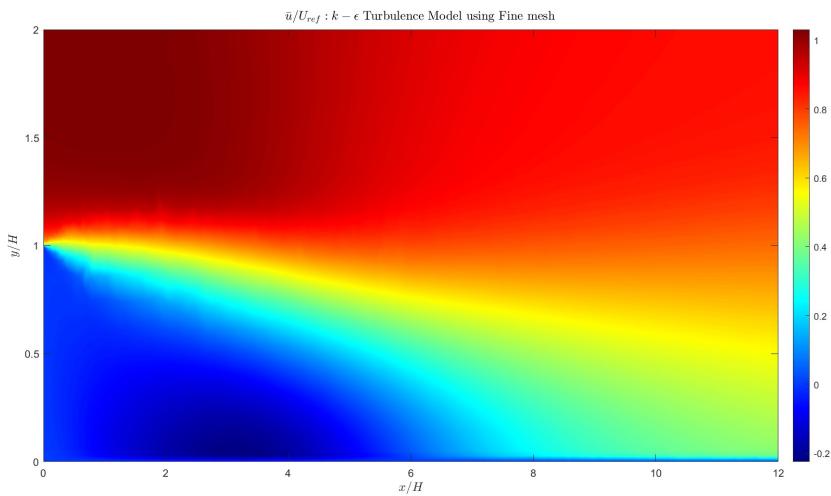
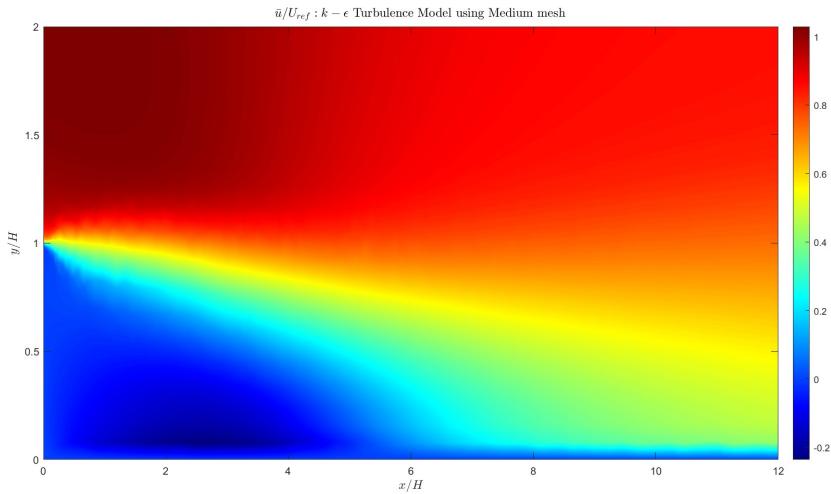
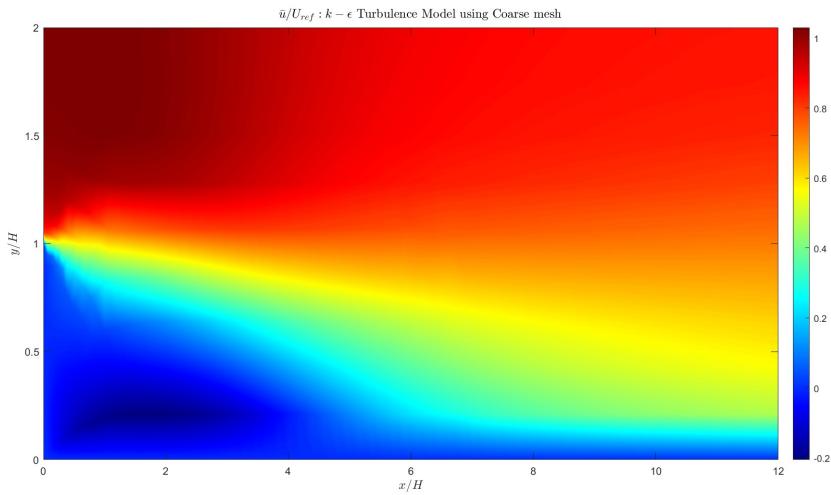


Figure 2: Geometry showing six zones

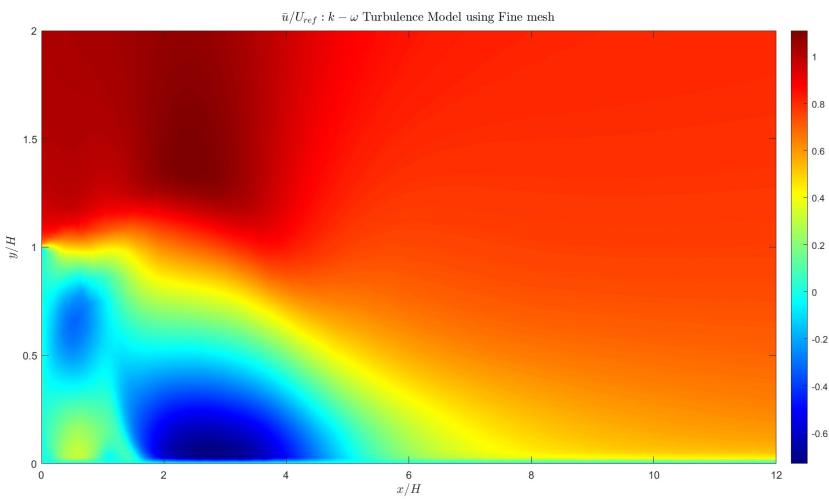
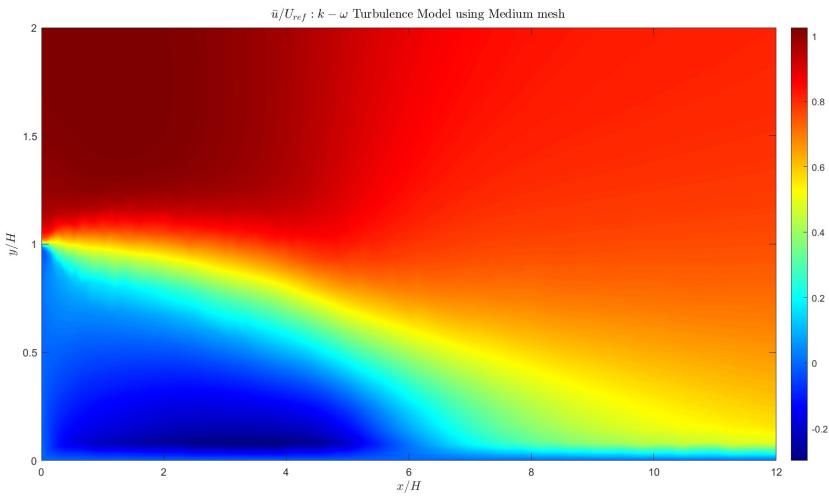
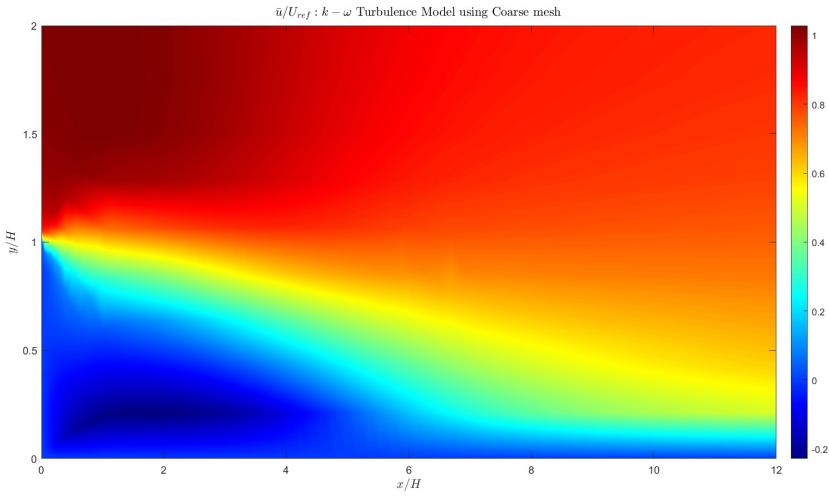
Seven different parameters characterizing the flow, including $\bar{u}(x, y)$, $\bar{v}(x, y)$, $\bar{u'^2}(x, y)$, $\bar{v'^2}(x, y)$, $\bar{u'v'}(x, y)$, $k(x, y)$, and $\epsilon(x, y)$, were measured. The entire geometry was divided into six zones, and the turbulence properties of these parameters were measured at four different locations, namely, $x/H = 1, 4, 6, 10$, which corresponds to the experimental data. The measurements were normalized using the reference velocity $U_{ref} = 44.2\text{m/s}$, as in the experiment.

2 Influence of Mesh: Contour Plots and Discussion

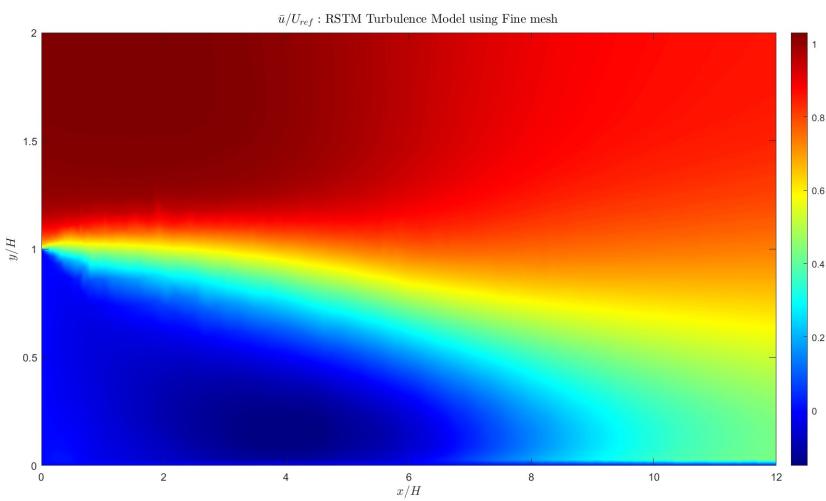
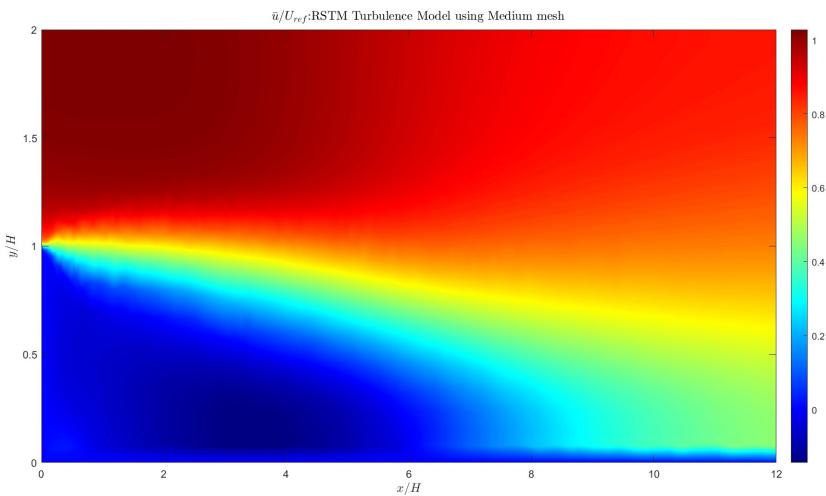
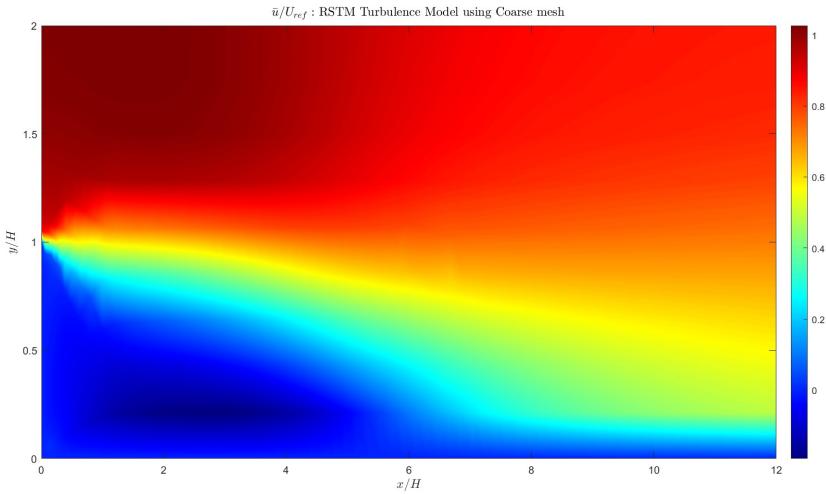
Average Horizontal Velocity \bar{u}/U_{ref}



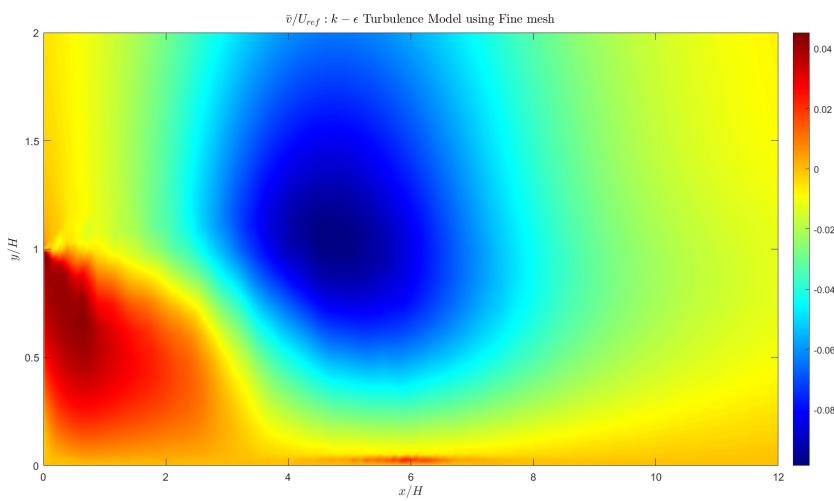
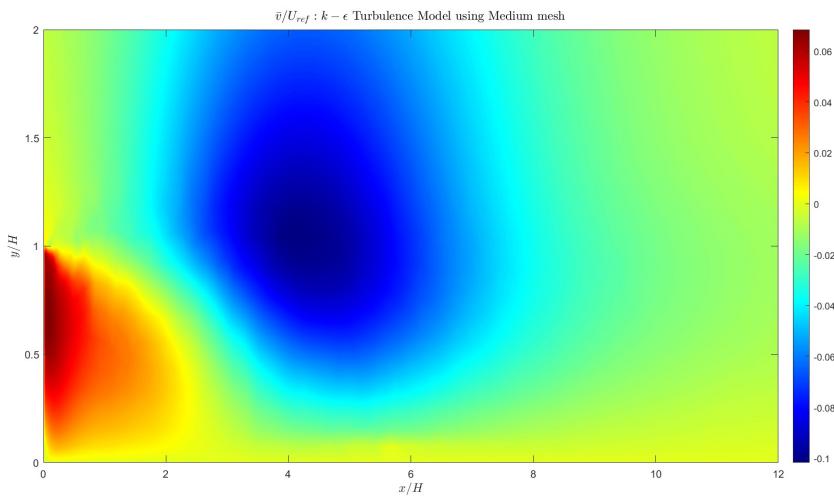
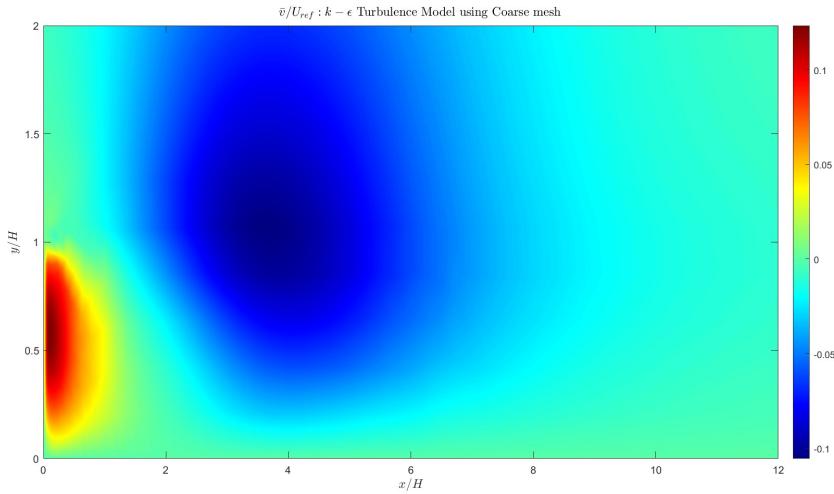
Average Horizontal Velocity \bar{u}/U_{ref}



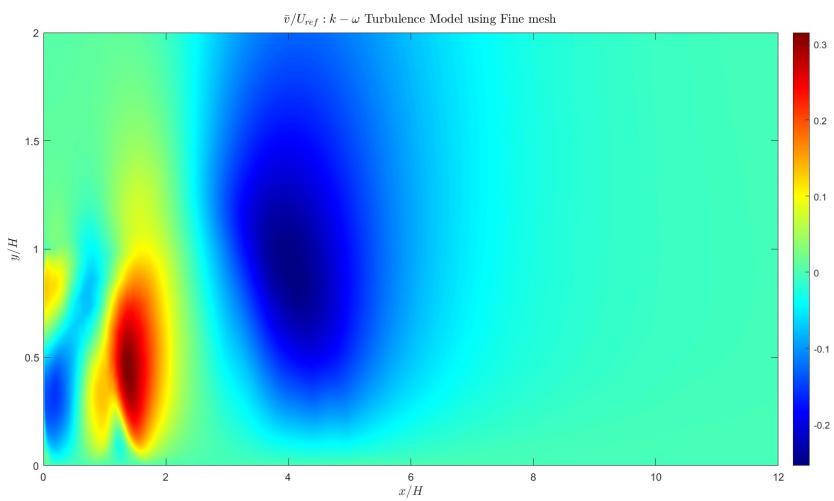
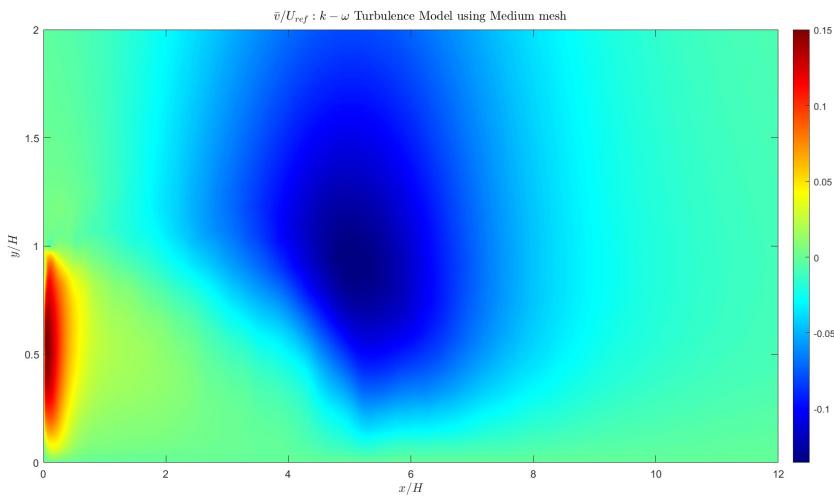
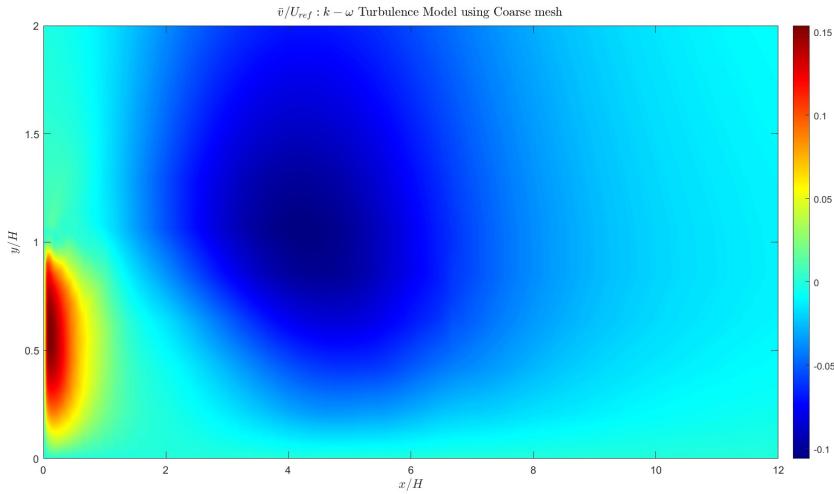
Average Horizontal Velocity \bar{u}/U_{ref}



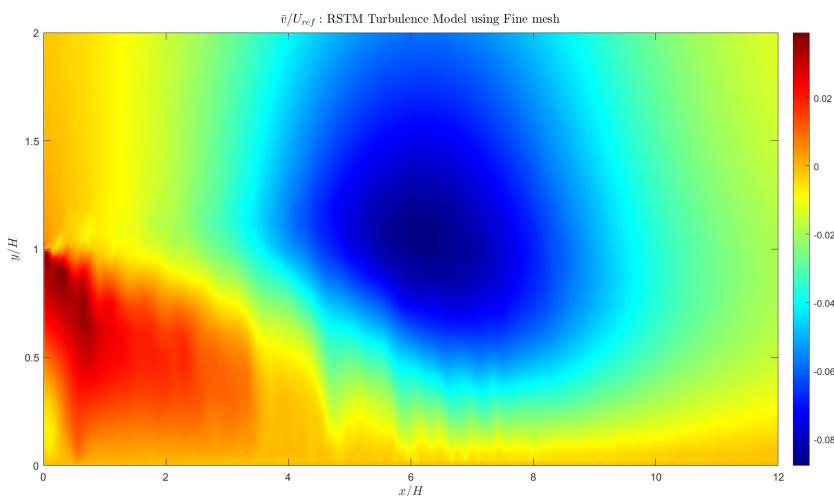
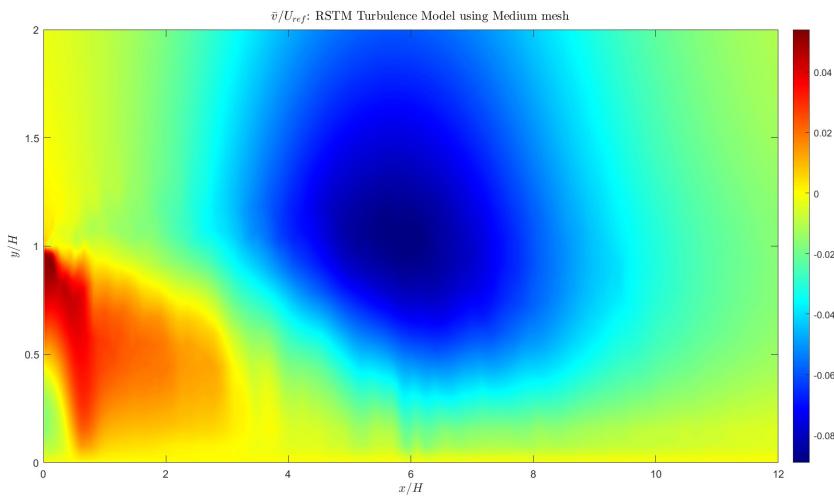
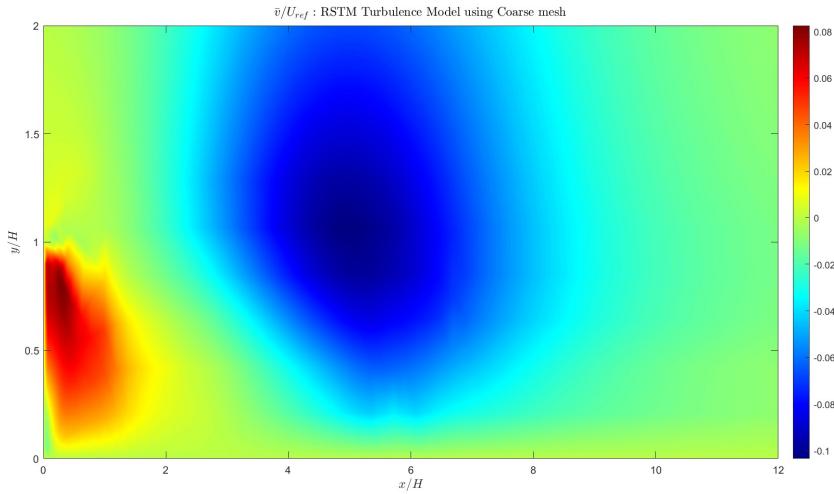
Average Vertical Velocity \bar{v}/U_{ref}



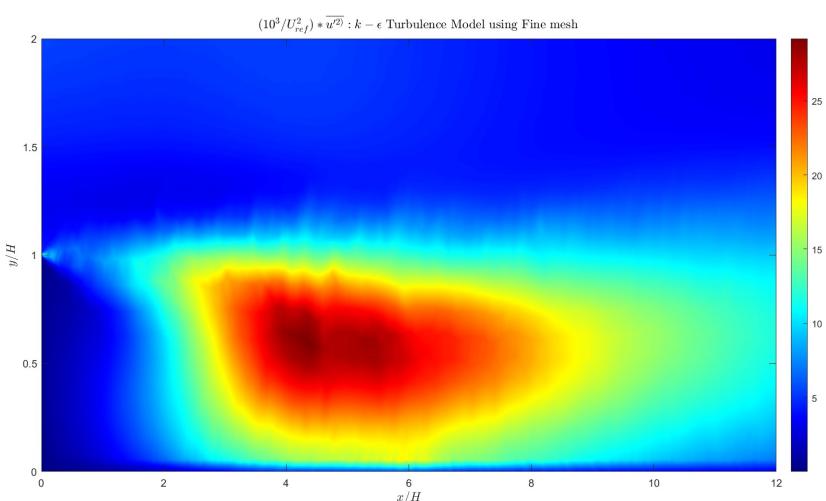
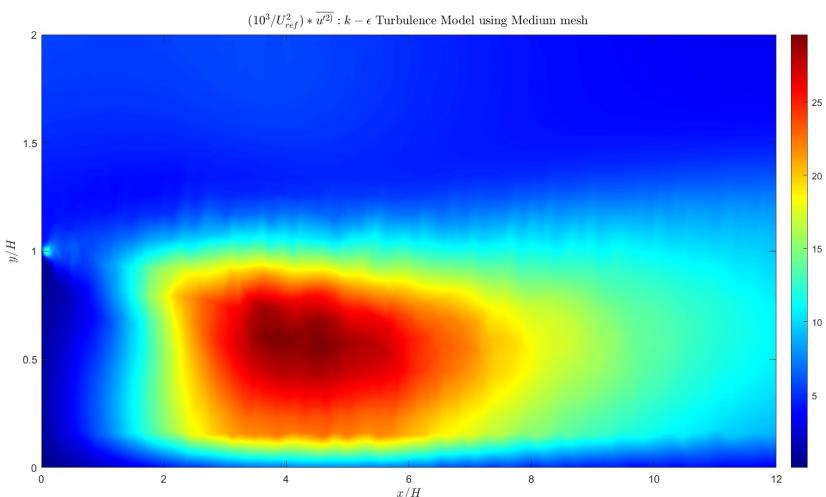
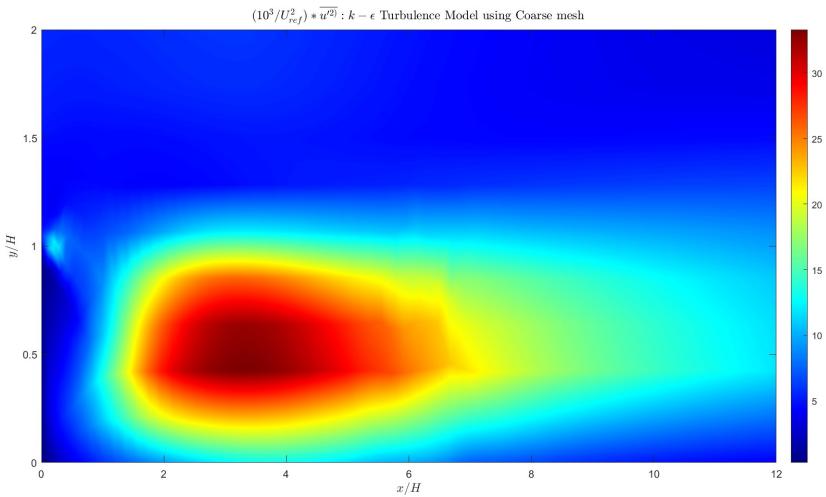
Average Vertical Velocity \bar{v}/U_{ref}



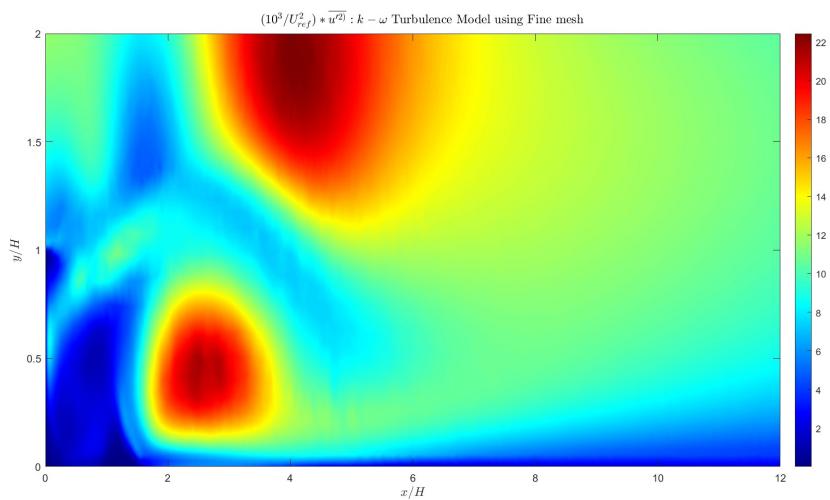
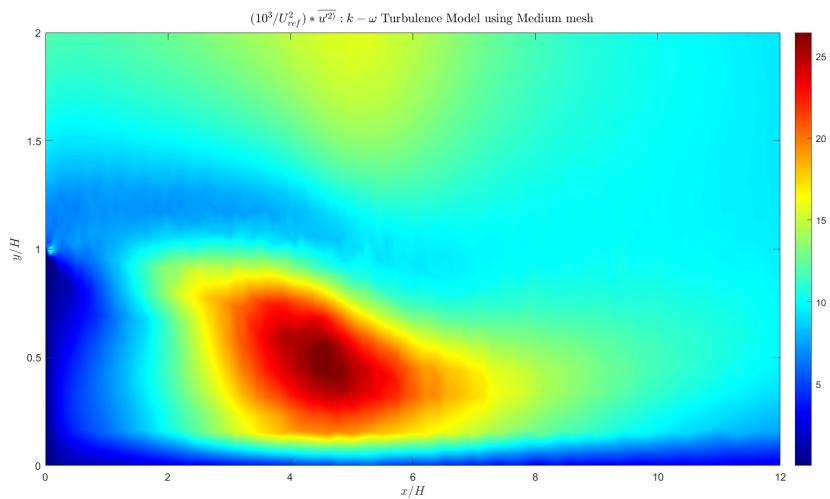
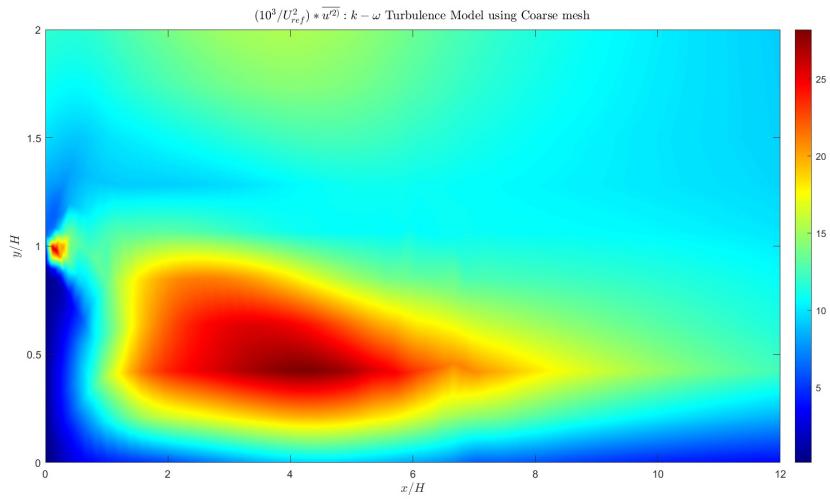
Average Vertical Velocity \bar{v}/U_{ref}



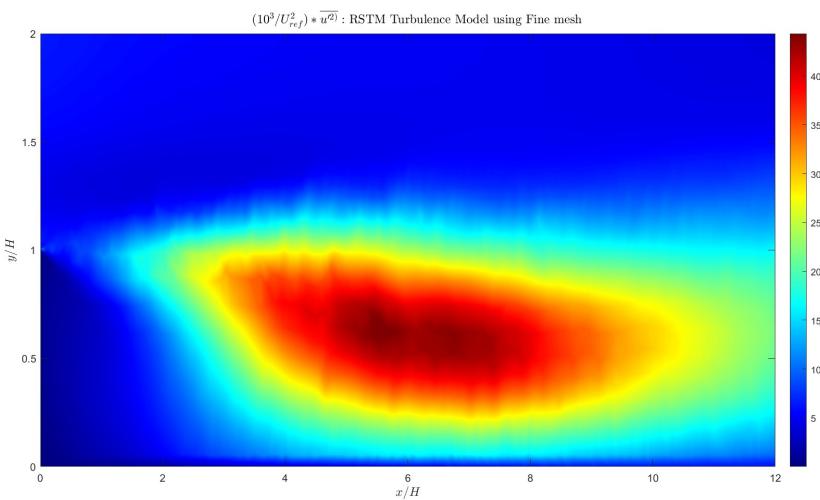
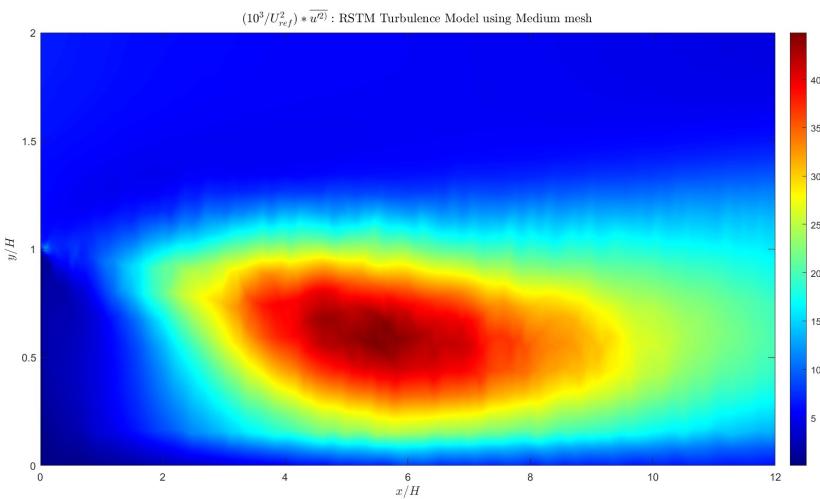
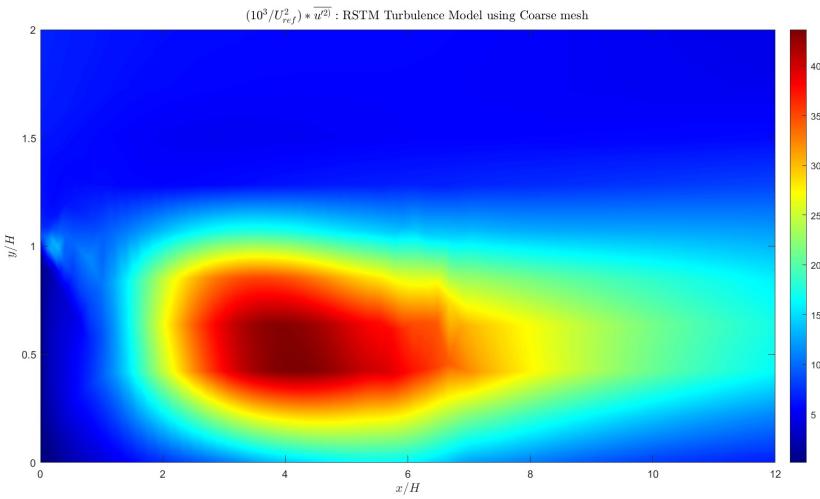
$$(10^3/U_{ref}^2) * \overline{u'^2} \text{ Reynold's Stress}$$



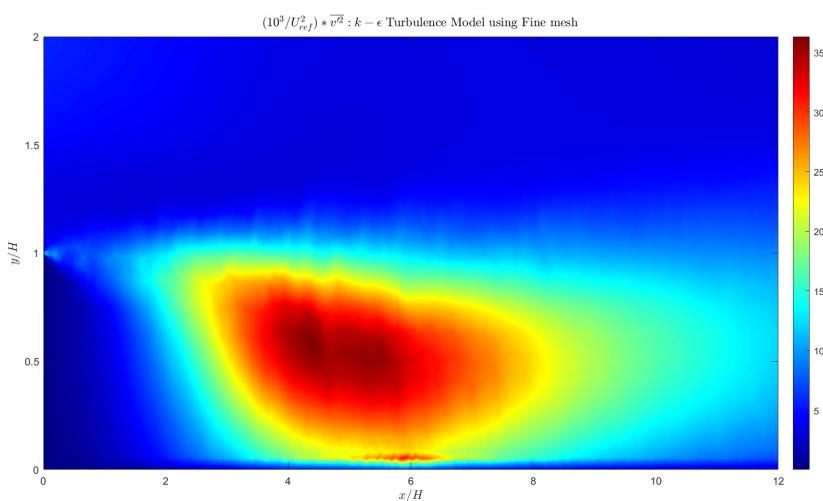
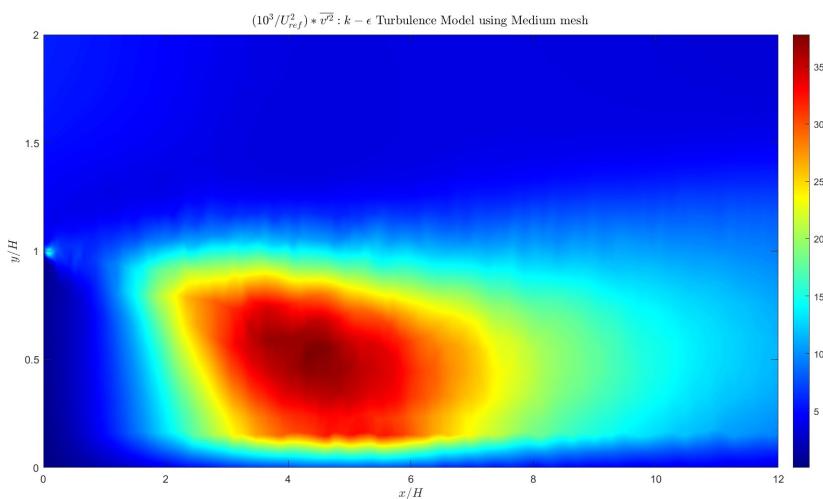
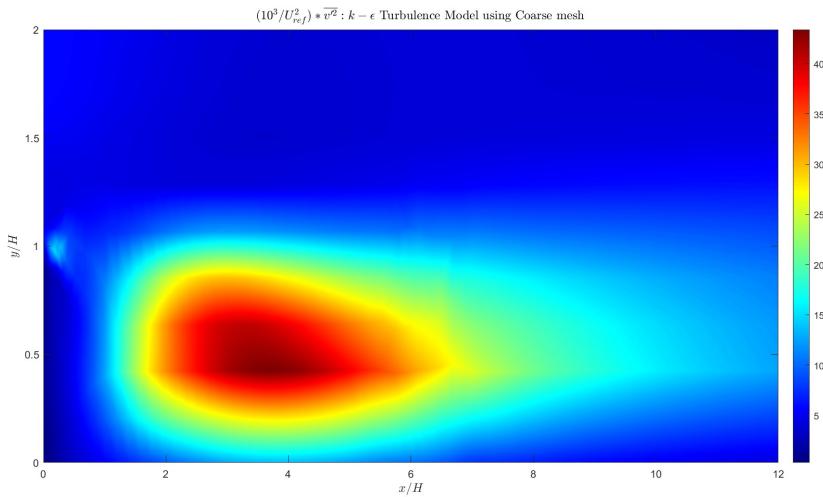
$$(10^3/U_{ref}^2) * \overline{u'^2} \text{ Reynold's Stress}$$



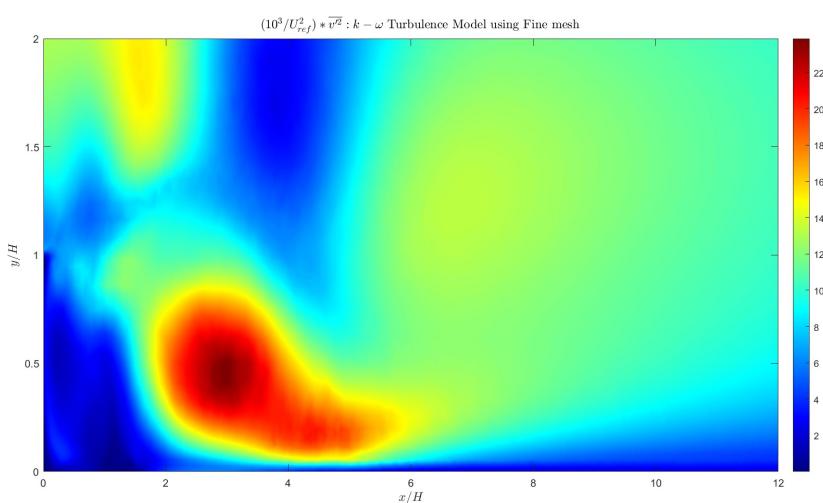
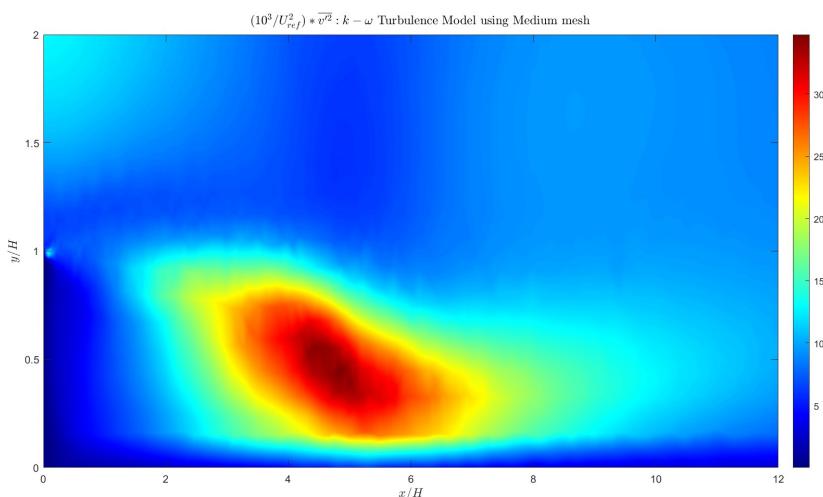
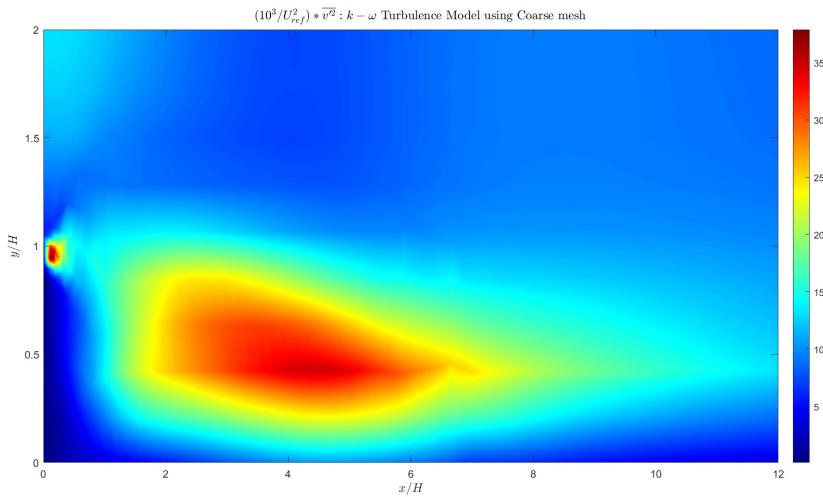
$$(10^3/U_{ref}^2) * \overline{u'^2} \text{ Reynold's Stress}$$



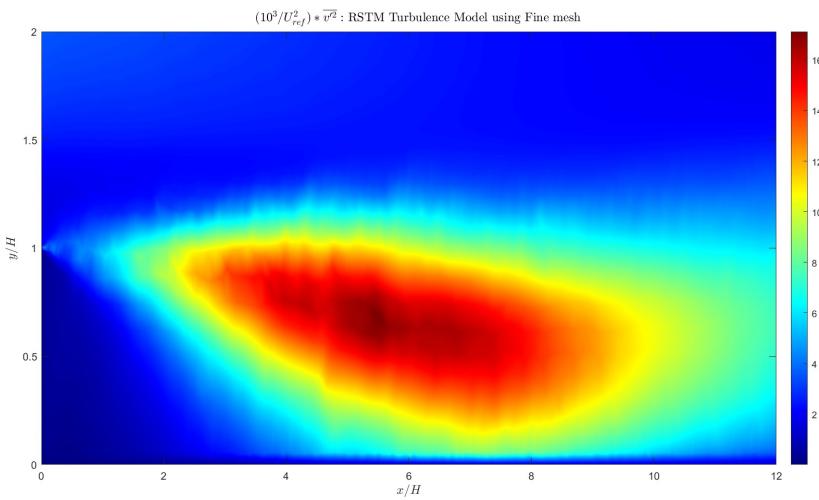
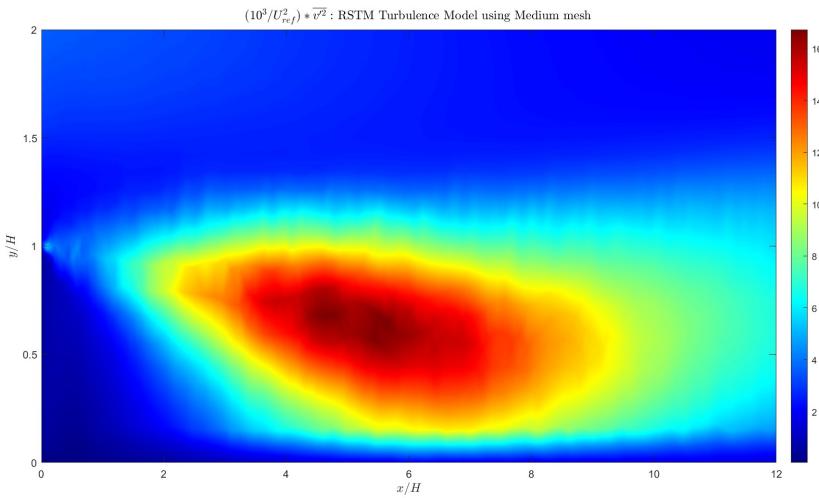
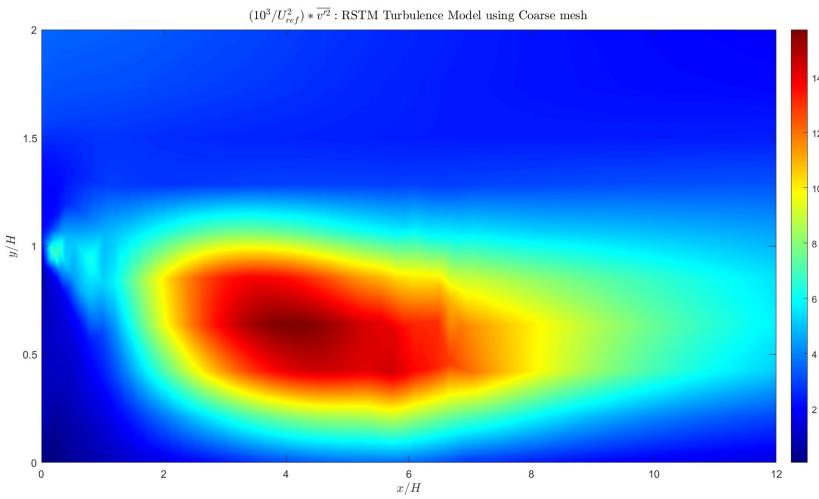
$$(10^3/U_{ref}^2) * \overline{v'^2} \text{ Reynold's Stress}$$



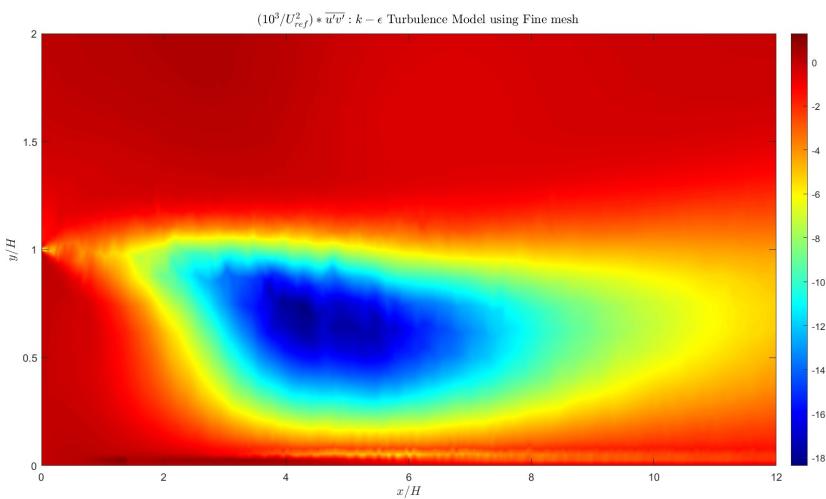
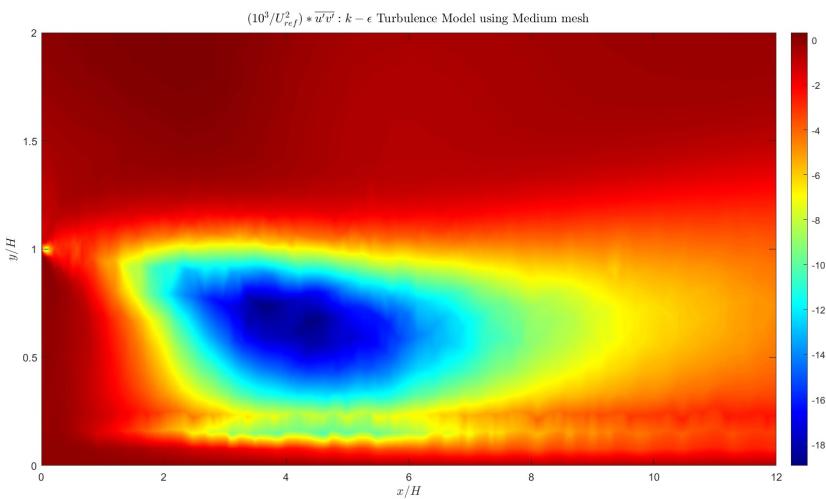
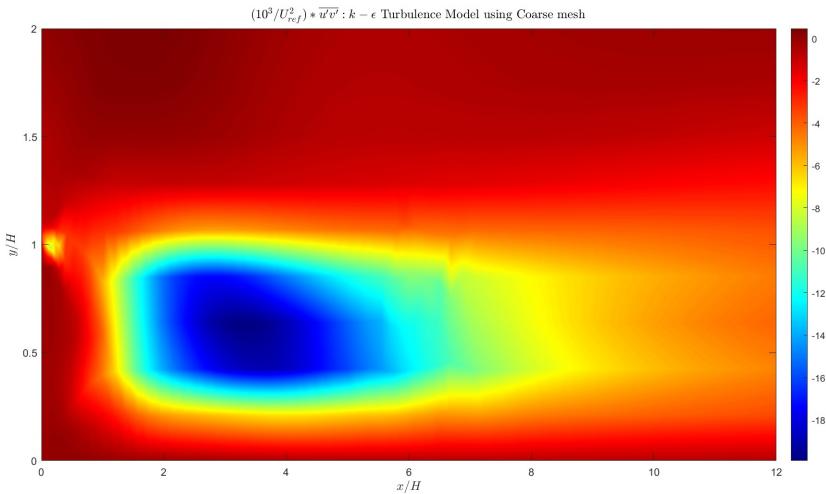
$$(10^3/U_{ref}^2) * \overline{v'^2} \text{ Reynold's Stress}$$



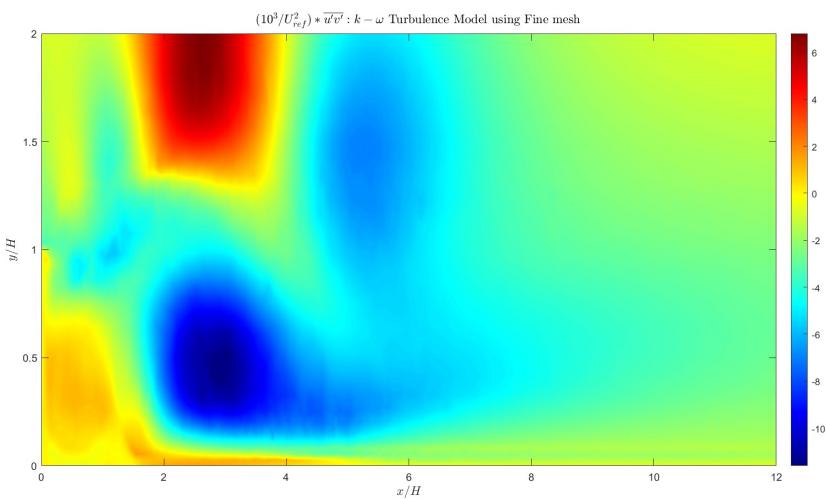
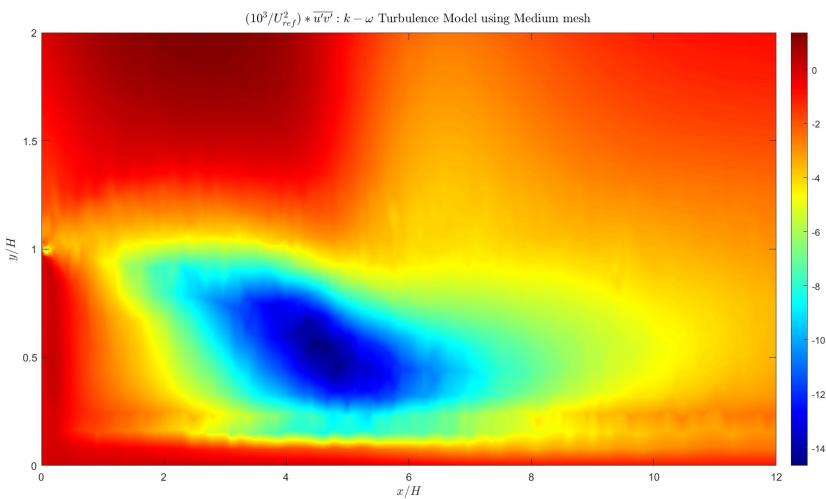
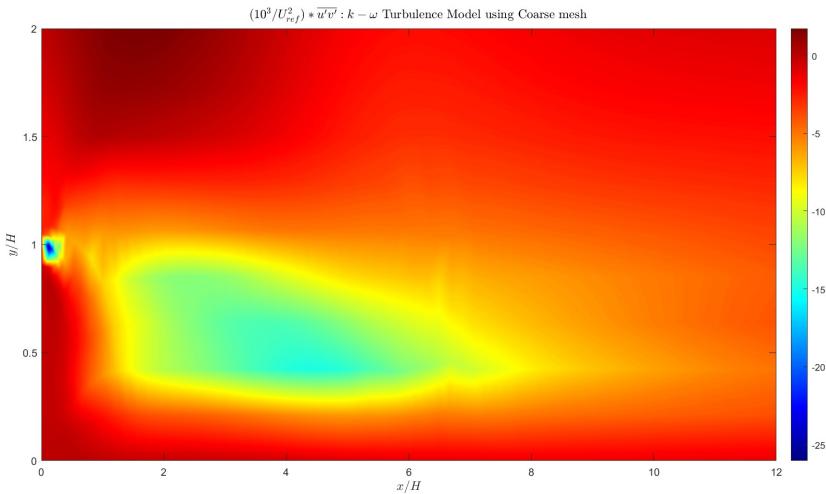
$$(10^3/U_{ref}^2) * \overline{v'^2} \text{ Reynold's Stress}$$



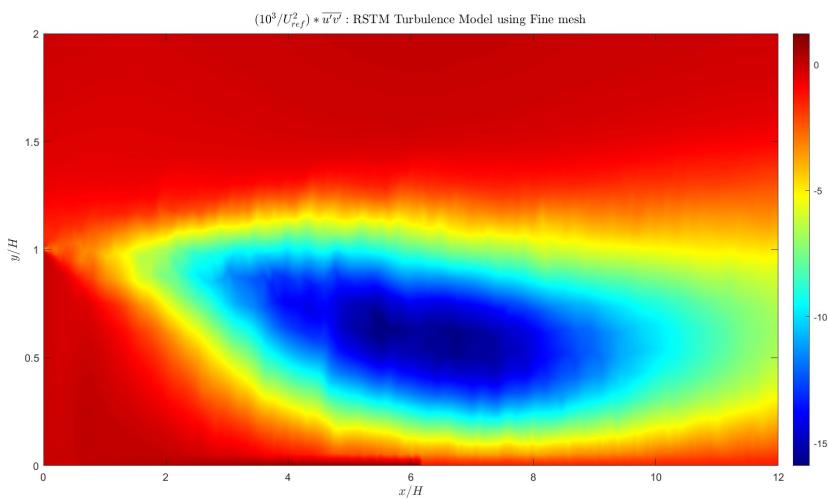
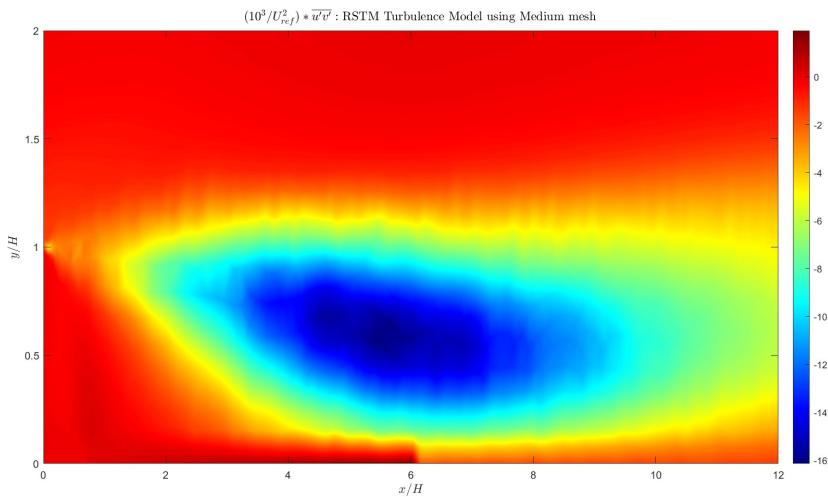
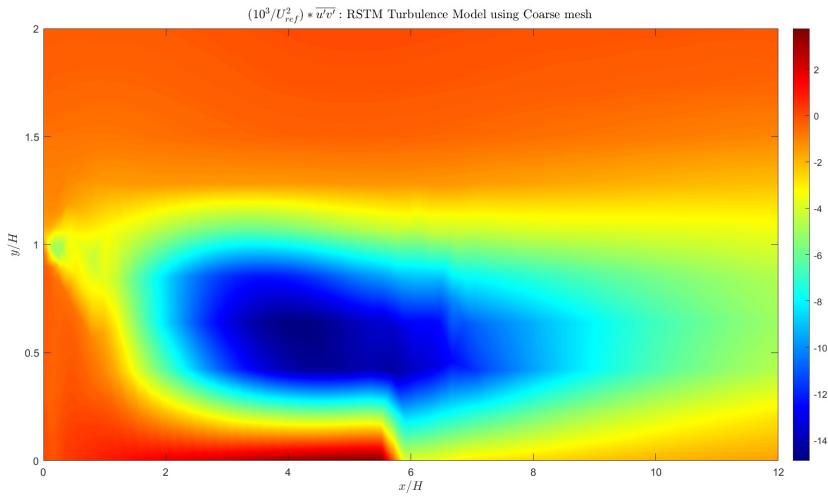
$$(10^3/U_{ref}^2) * \overline{u'v'} \text{ Reynold's Stress}$$



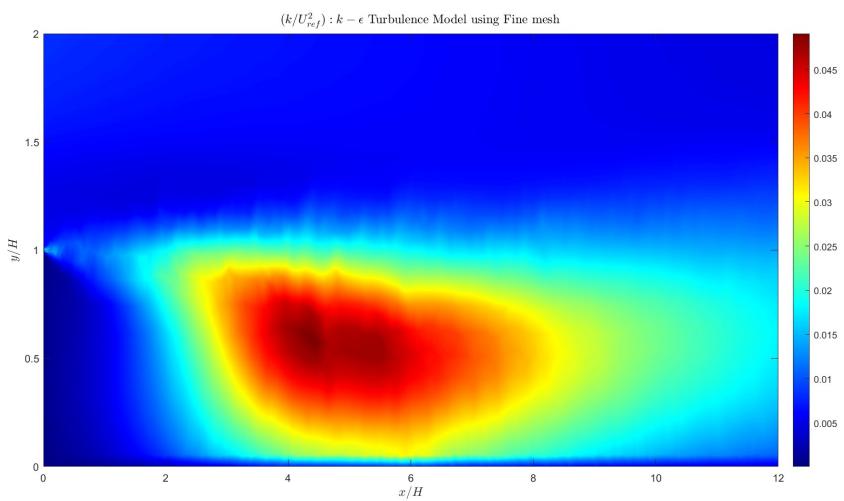
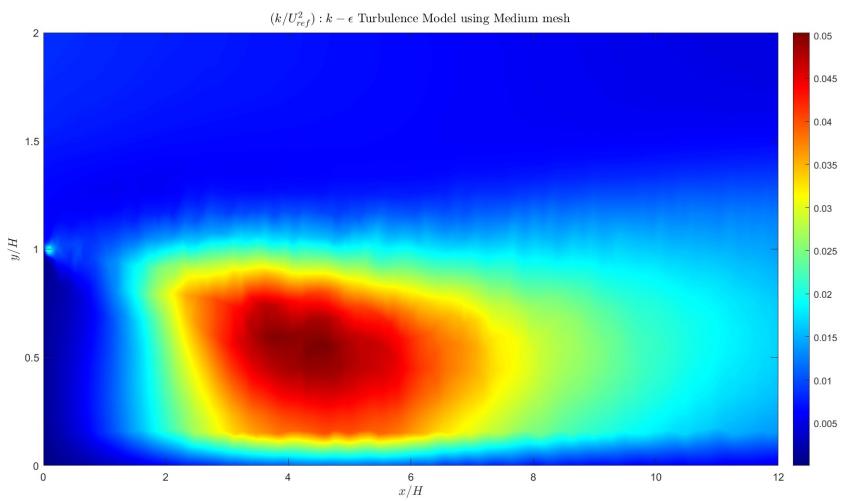
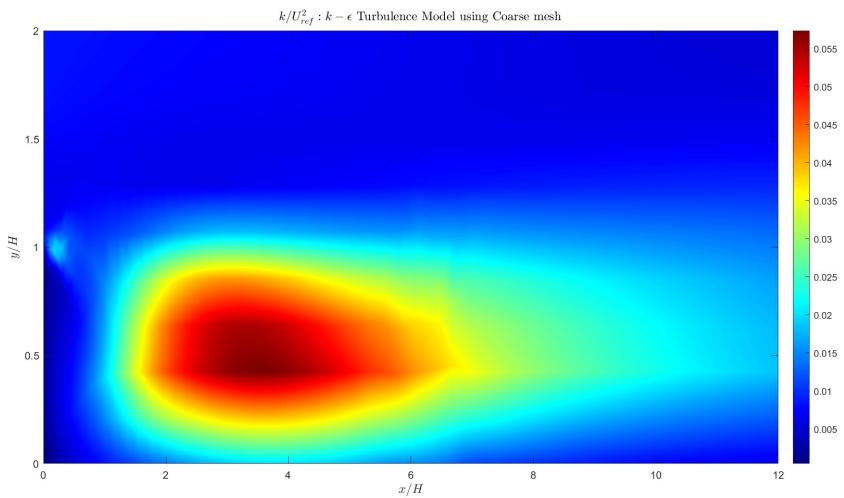
$$(10^3/U_{ref}^2) * \overline{u'v'} \text{ Reynold's Stress}$$



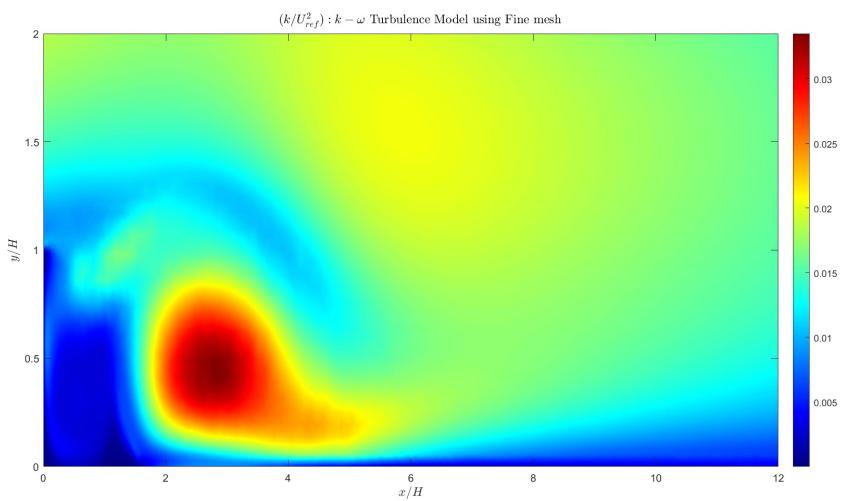
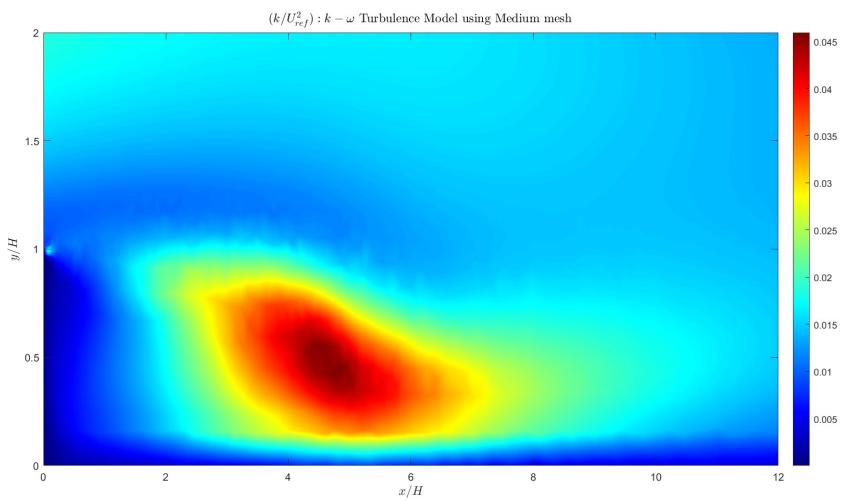
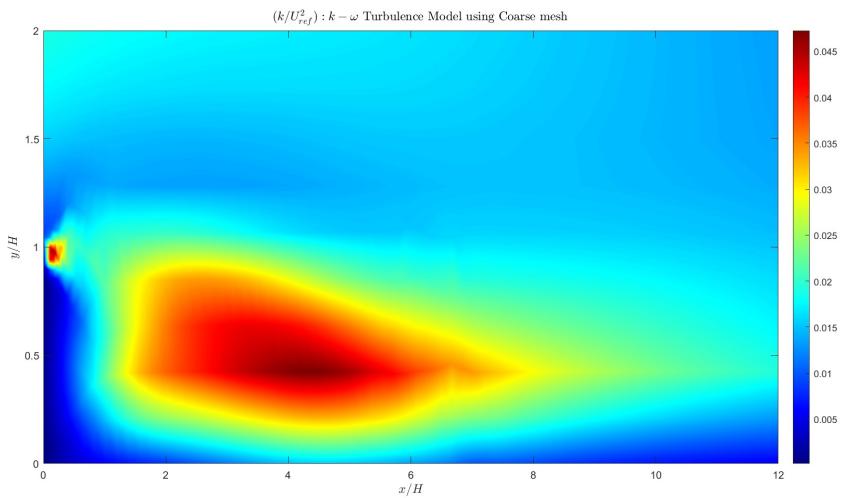
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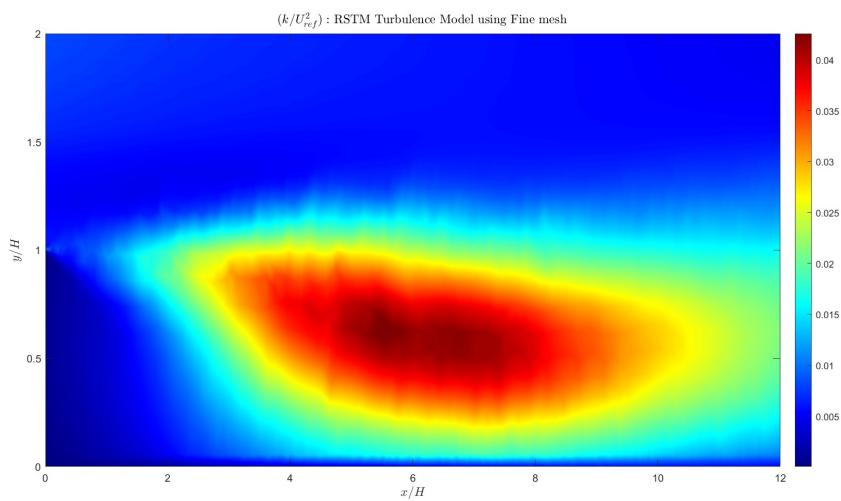
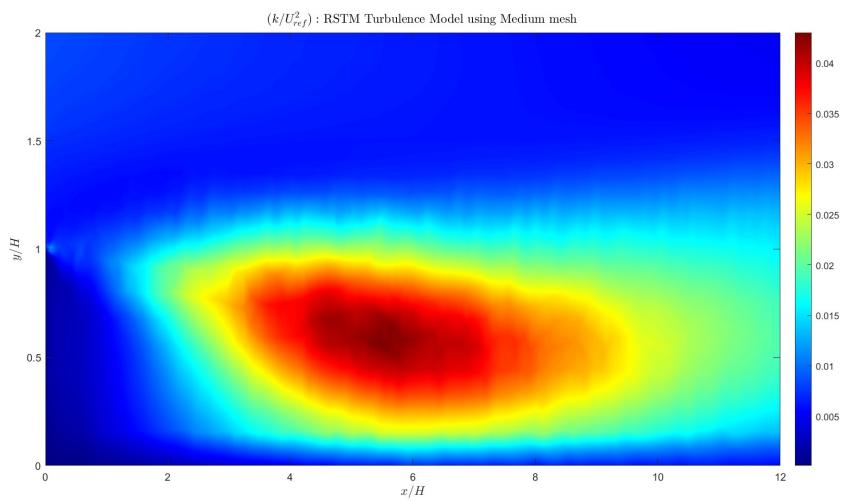
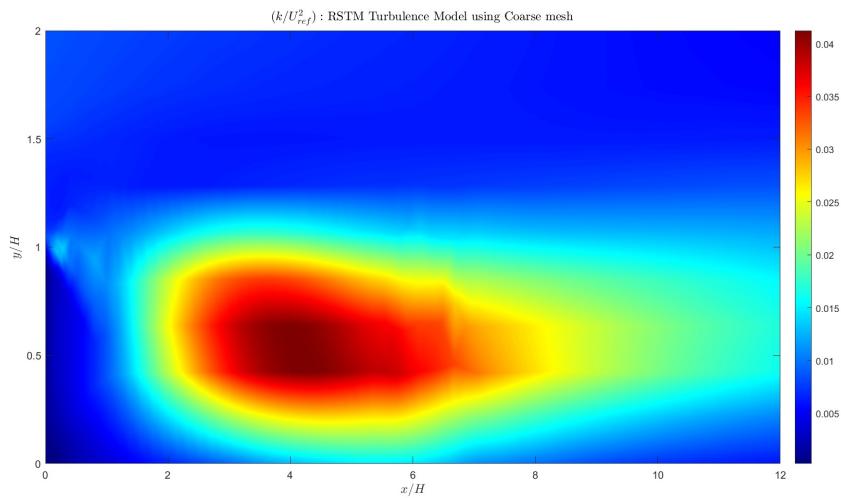
(k/U_{ref}^2) Turbulent Kinetic Energy



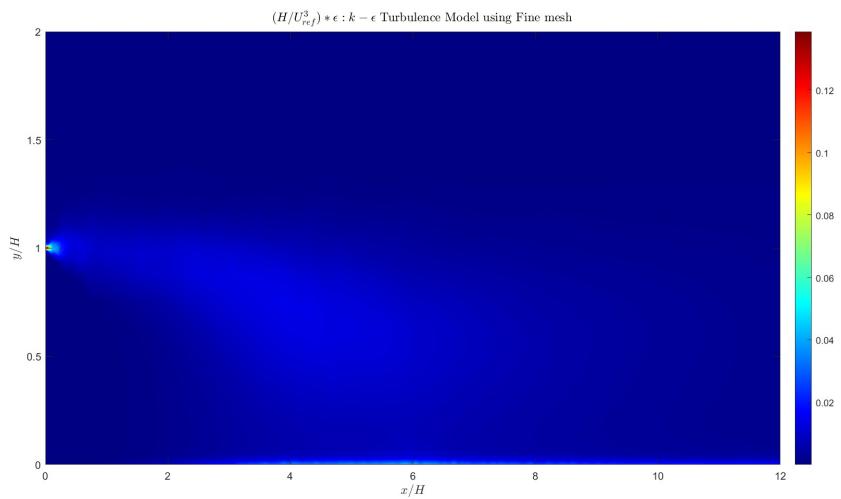
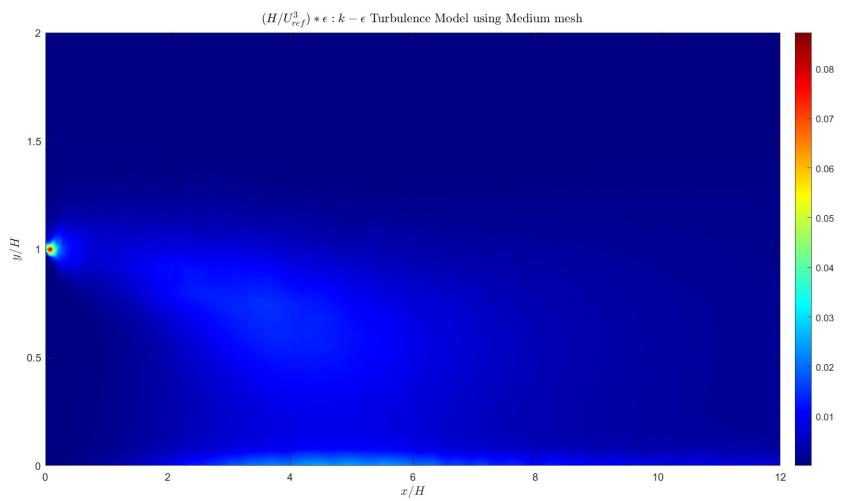
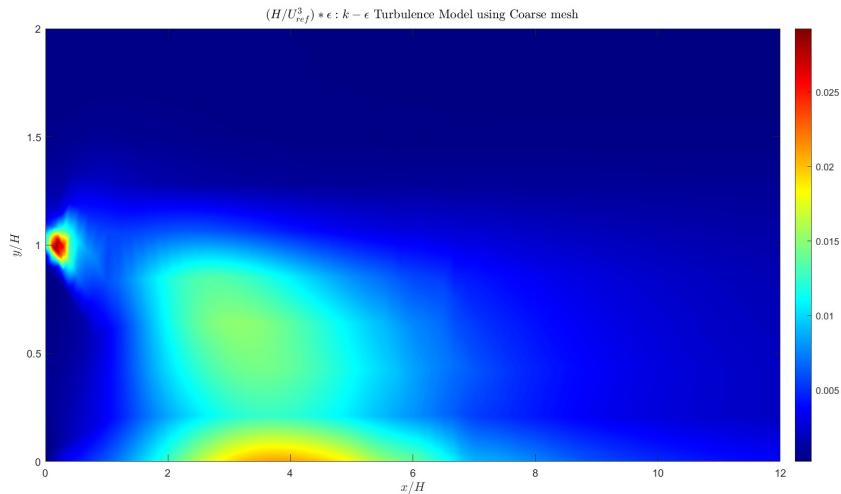
(k/U_{ref}^2) Turbulence Kinetic Energy



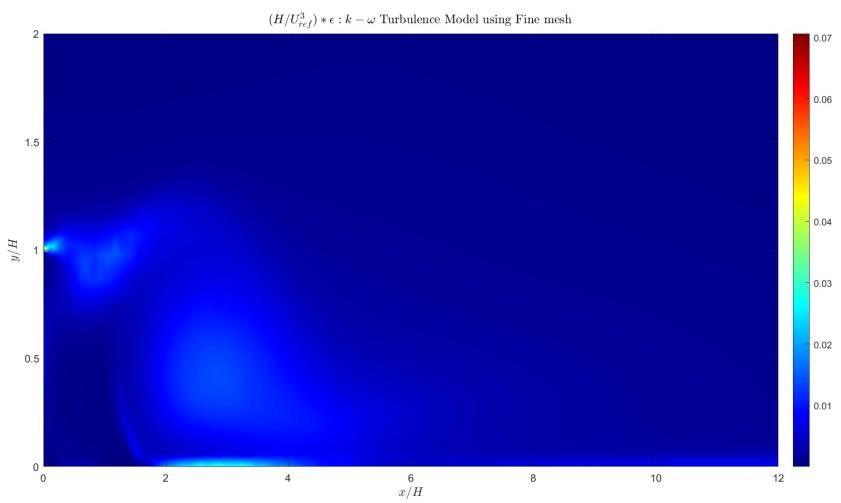
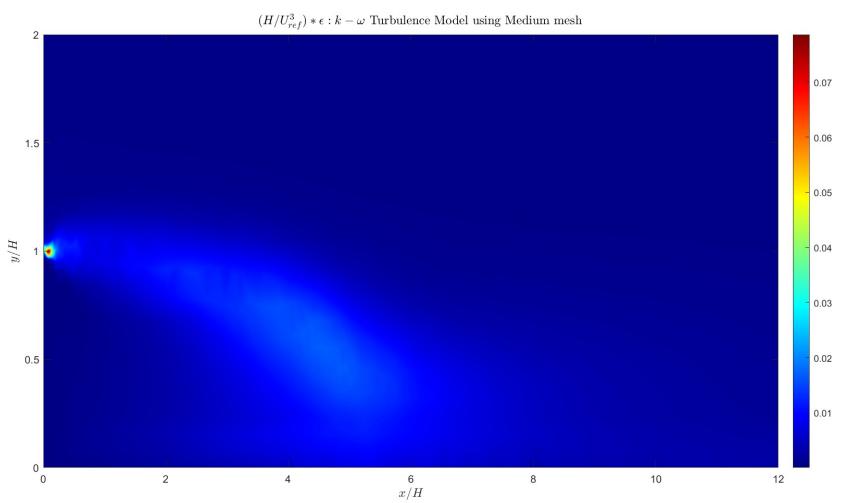
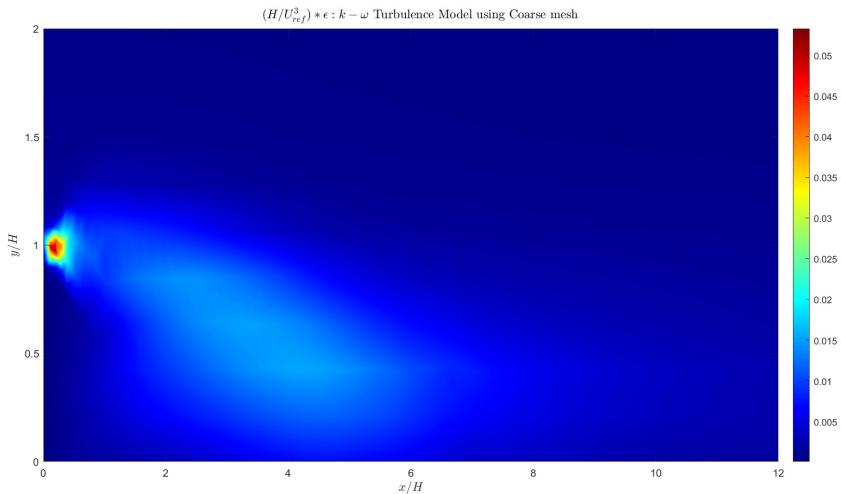
(k/U_{ref}^2) Turbulence Kinetic Energy



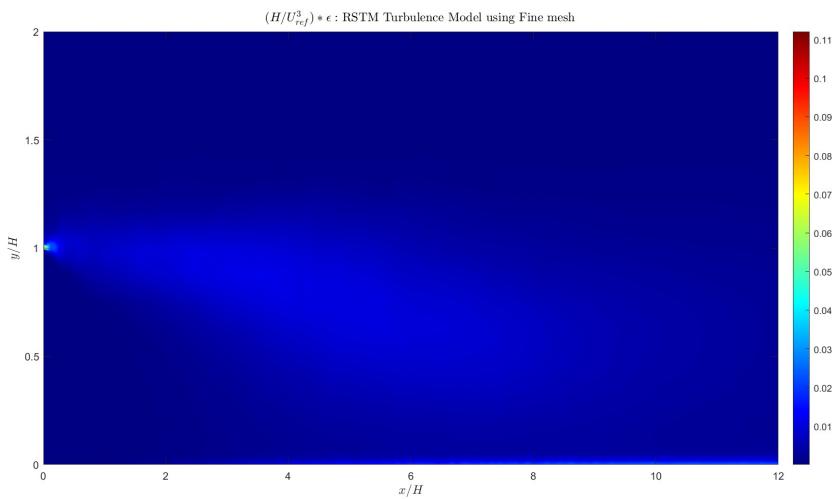
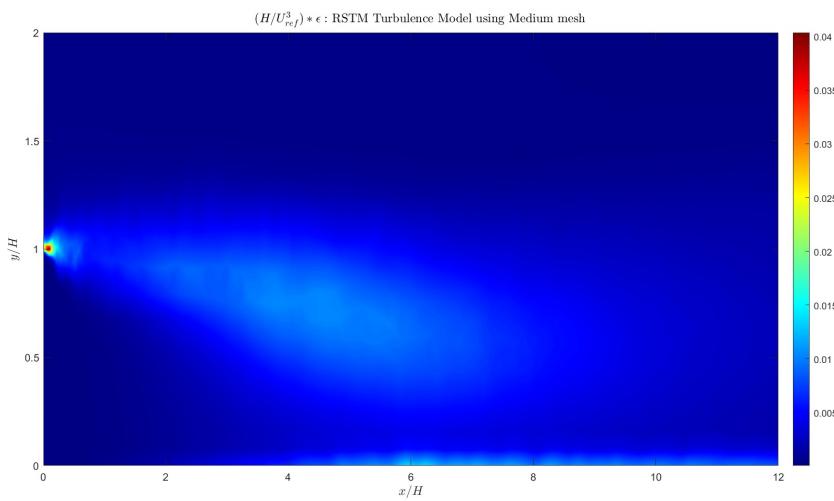
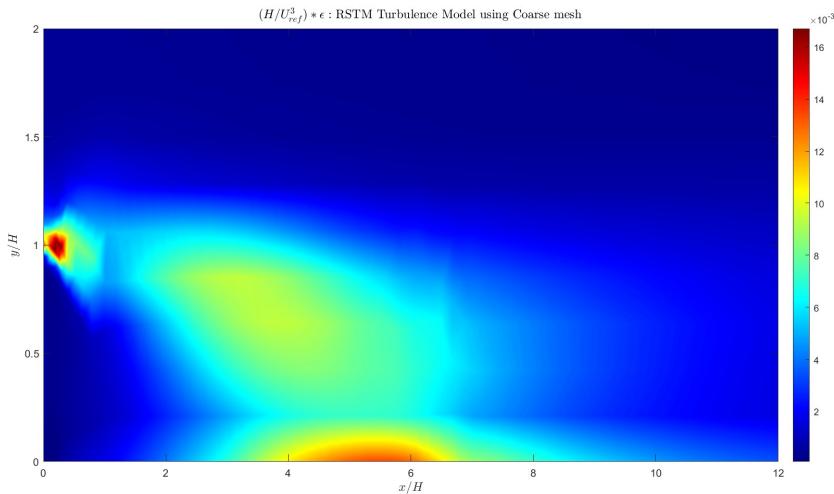
$(H/U_{ref}^3) * \epsilon$ Turbulence Dissipation Rate



$(H/U_{ref}^3) * \epsilon$ Turbulence Dissipation Rate



$(H/U_{ref}^3) * \epsilon$ Turbulence Dissipation Rate



Discussion

Q1: Do you see significant differences in any of these color fields among the three meshes (COARSE, MEDIUM, FINE); if so, discuss what you believe are the most important differences you see.

Answer: There are discernible changes in the results as the mesh size is refined. In the case of $\bar{u}(x, y)$, there is little variation in the plots, but larger circulation zones are noticeable in higher mesh sizes. The RSTM model with a fine mesh exhibits the largest refinement zone, which could indicate that smaller mesh sizes are not as accurate in predicting the circulation and flows near the bottom wall and step. Medium and fine meshes produce similar results, except for the $k - \omega$ case, which seems problematic.

Similarly, for $\bar{v}(x, y)$, flow characteristics around the step become more refined with higher mesh sizes, suggesting that coarse mesh is not sufficient for accurate results, and medium and fine meshes provide better results.

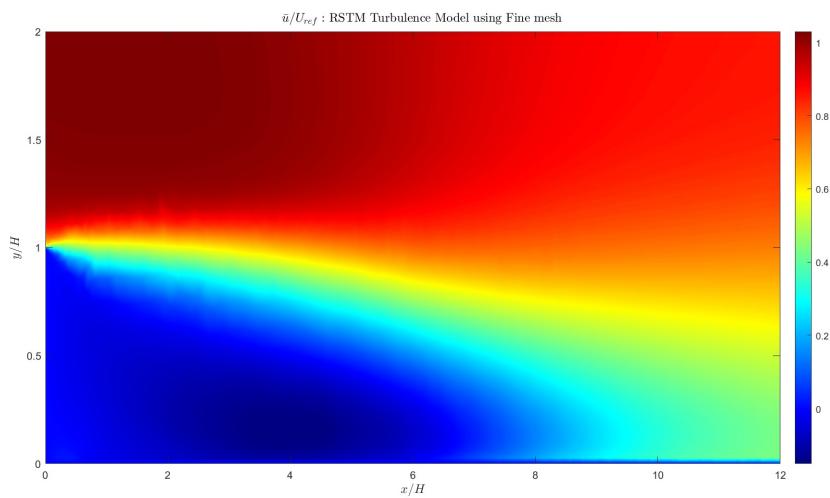
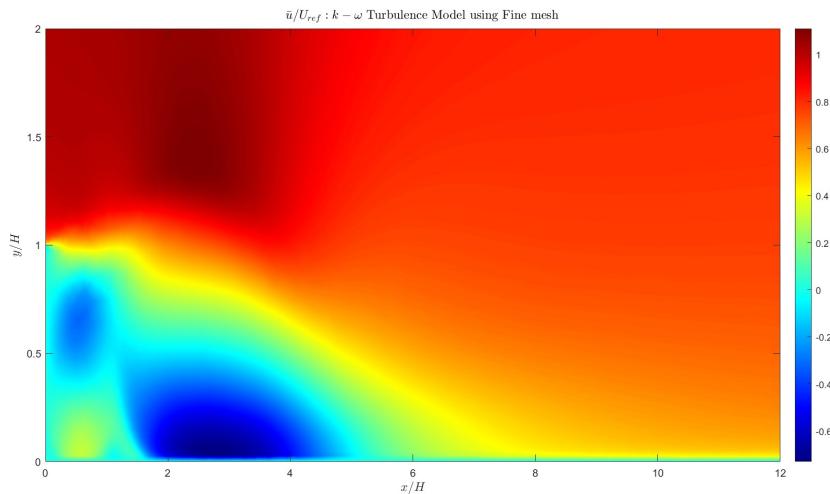
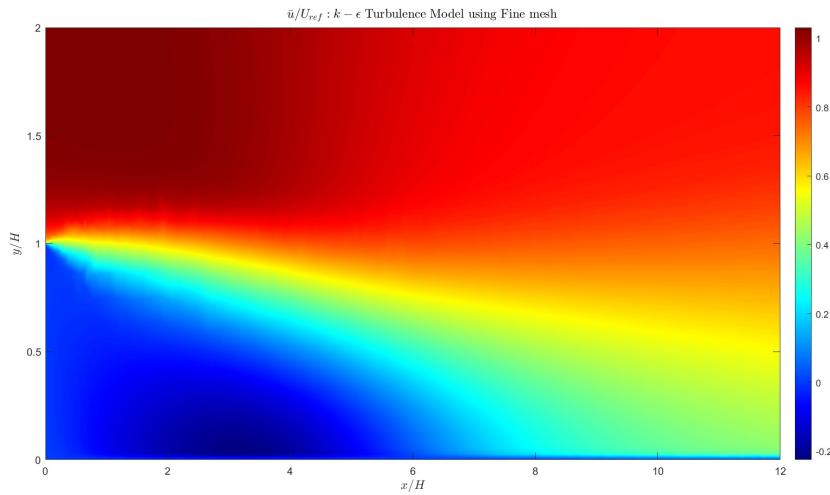
Reynolds stresses and Kinetic Energy plots exhibit differences in results with mesh refinement. Lower mesh sizes tend to average out flow velocities, creating nearly uniform lumps of stress downstream of the step. Fine meshes capture features from the start of the step and extend much further down the channel, indicating that lower mesh sizes are less accurate. Medium and fine meshes exhibit similar results, indicating mesh independence.

Turbulent Dissipation Rate exhibits the most significant change with mesh refinement. The lumps are messier and extend further downstream for lower mesh sizes, while finer meshes start at the step and dissipate slowly and smoothly, with a smaller region of high-energy dissipation. The lump at the step decreases with each mesh refinement, becoming increasingly precise, which aligns with the majority of dissipation occurring near the step.

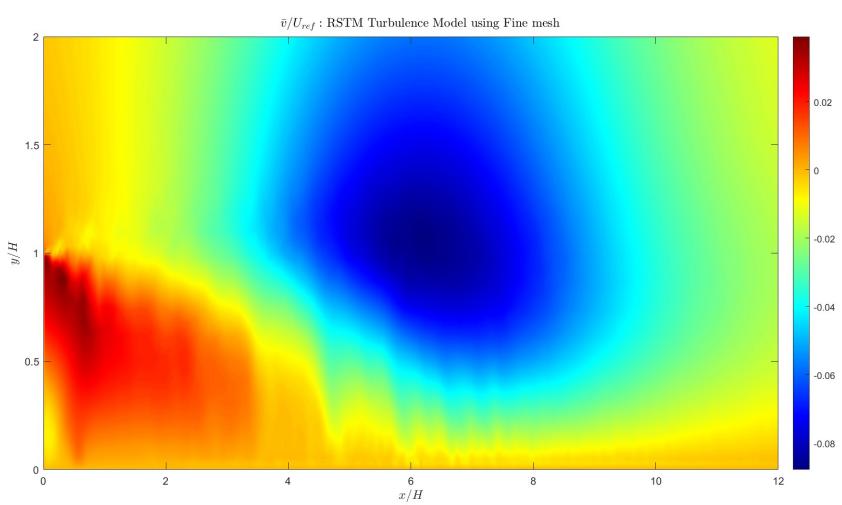
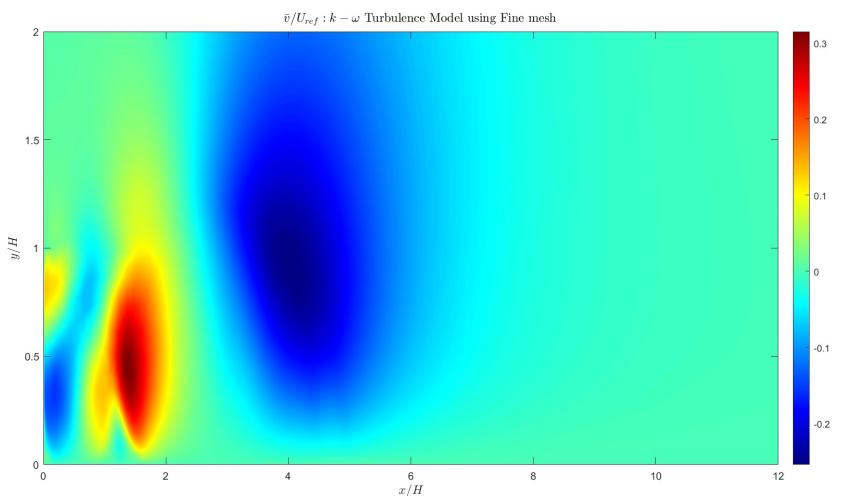
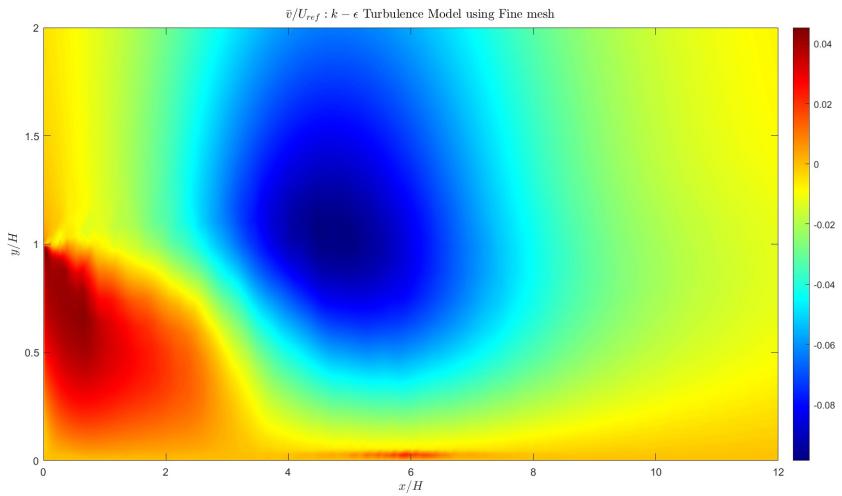
Lastly, the fine mesh for the $k - \omega$ model is markedly different from other models. It exhibits coherent structures resembling vortices, as seen in the Turbulence Dissipation Rate figure. This could be due to differences in how ω is modeled, but it is difficult to determine if this model is more accurate than others. As we have learned in this course, none of the models are entirely accurate.

3 Comparison of Models: Contour Plots and Discussion

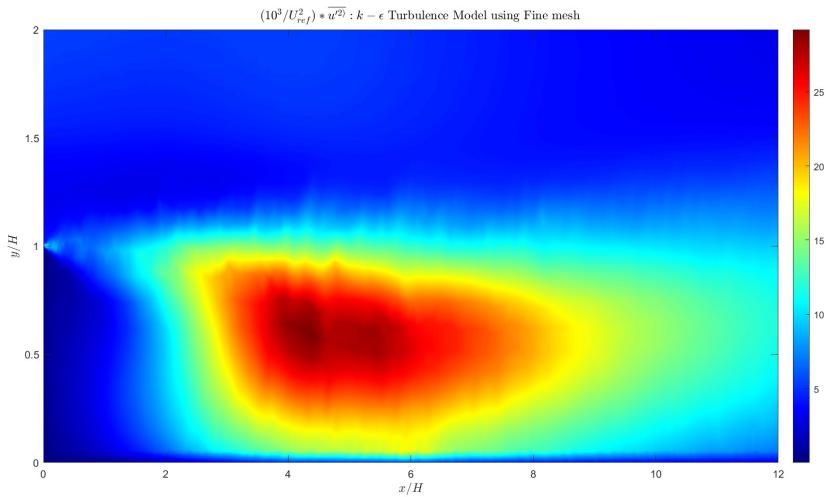
Average Horizontal Velocity \bar{u}/U_{ref}



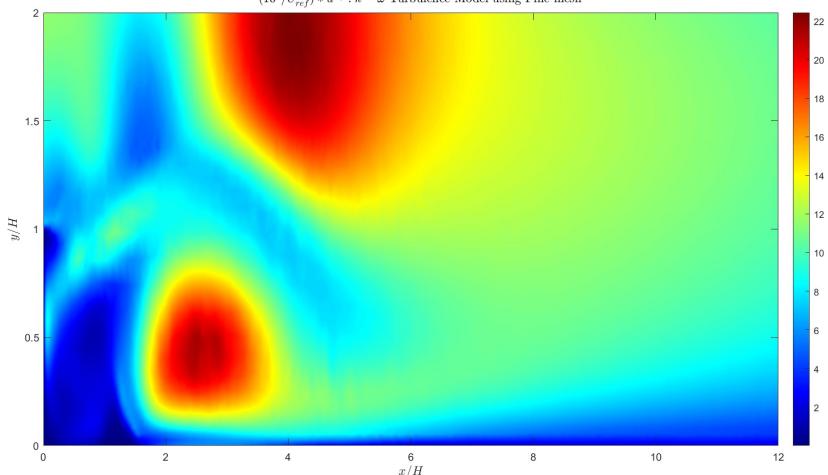
Average Vertical Velocity \bar{v}/U_{ref}



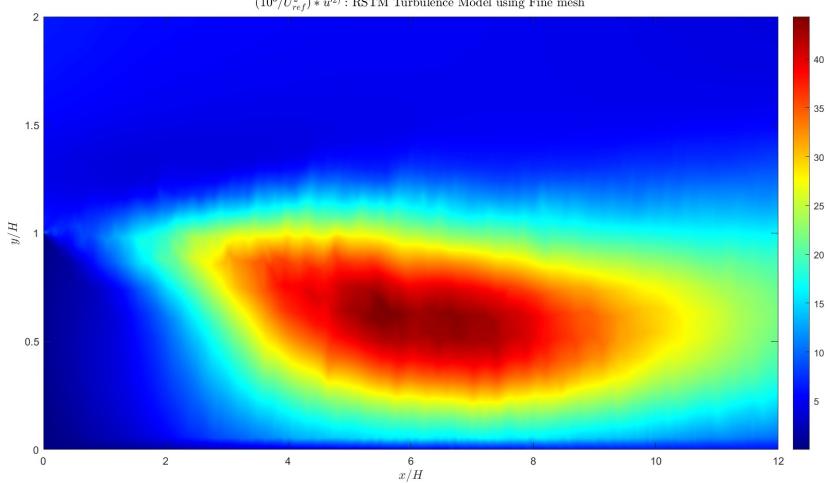
Reynold's Stress $(10^3/U_{ref}^2) * \overline{u'^2}$



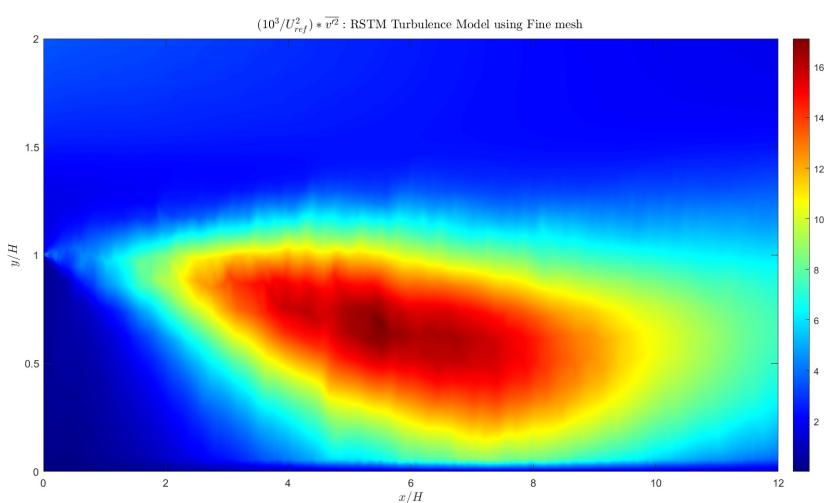
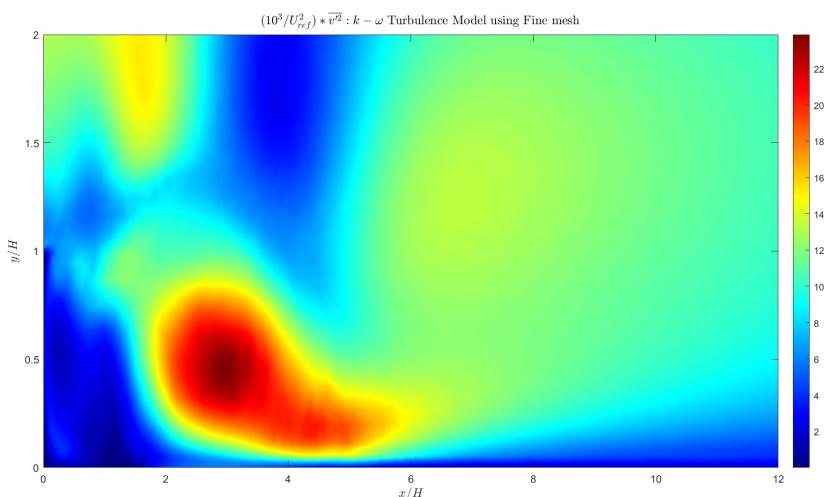
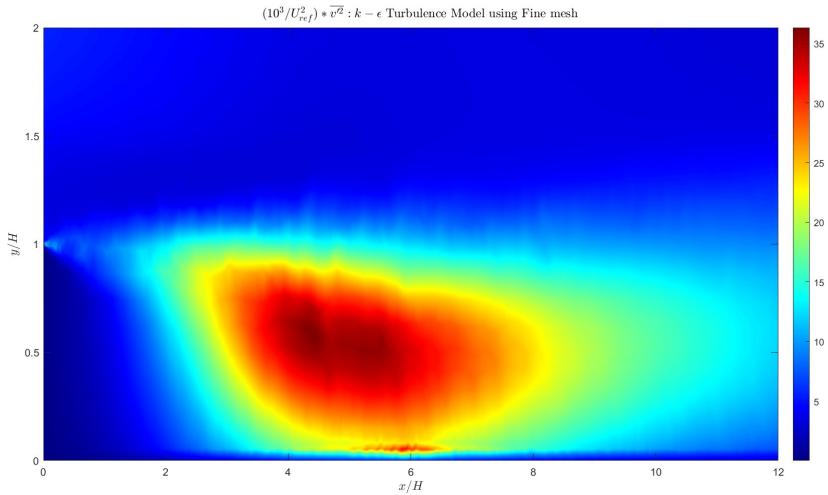
$(10^3/U_{ref}^2) * \overline{u'^2} : k - \omega$ Turbulence Model using Fine mesh



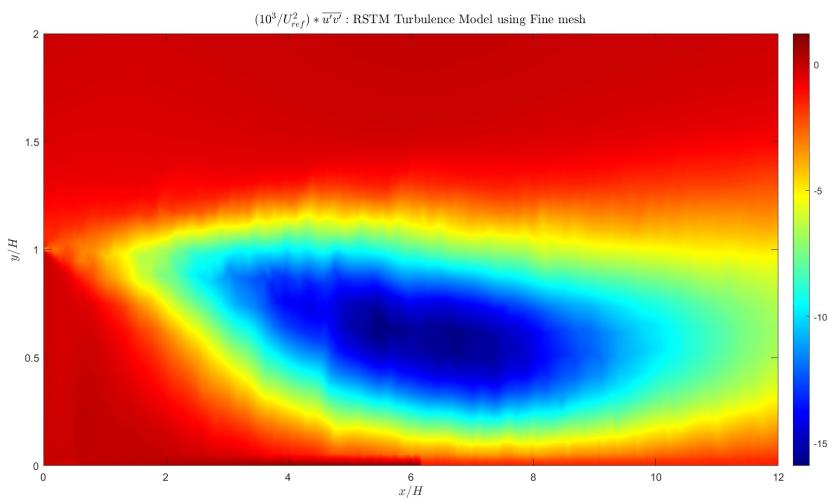
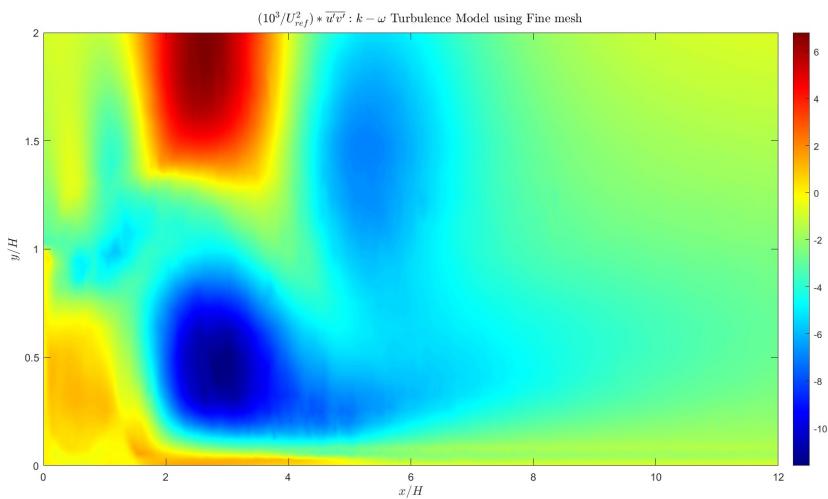
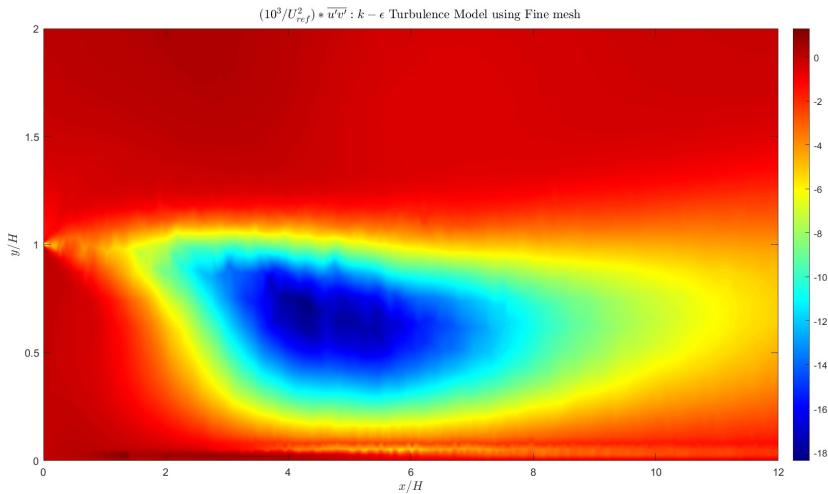
$(10^3/U_{ref}^2) * \overline{u'^2} : \text{RSTM Turbulence Model using Fine mesh}$



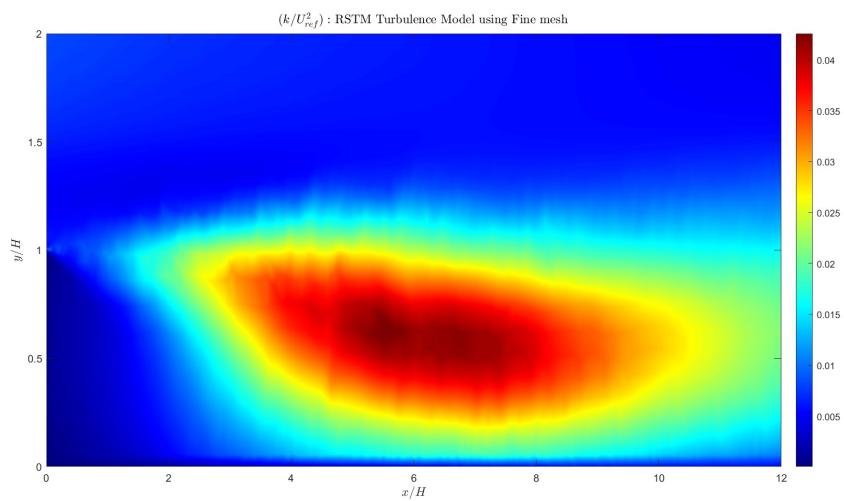
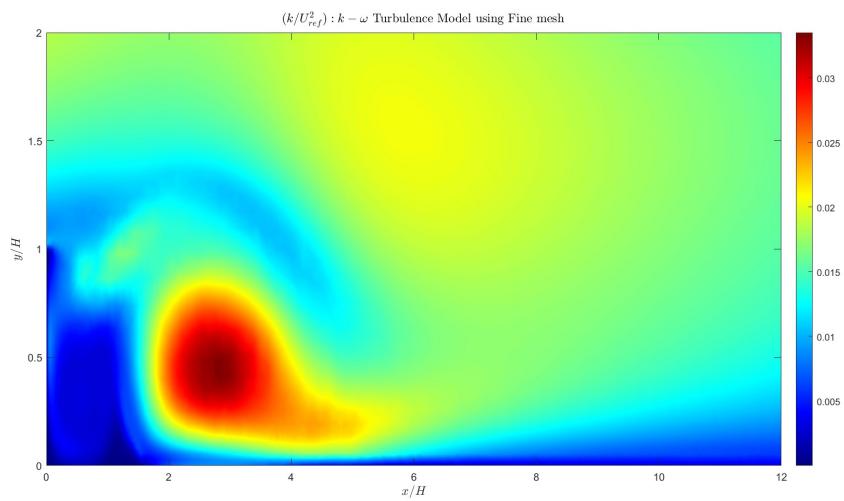
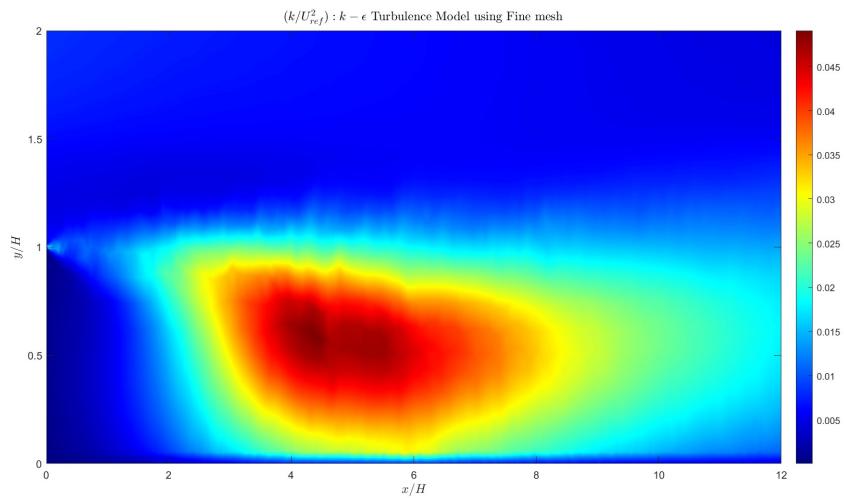
Reynold's Stress $(10^3/U_{ref}^2) * \bar{v'^2}$



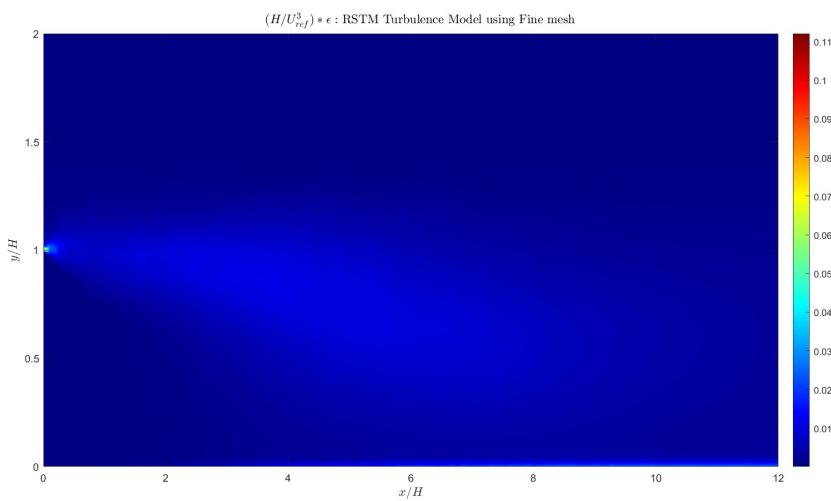
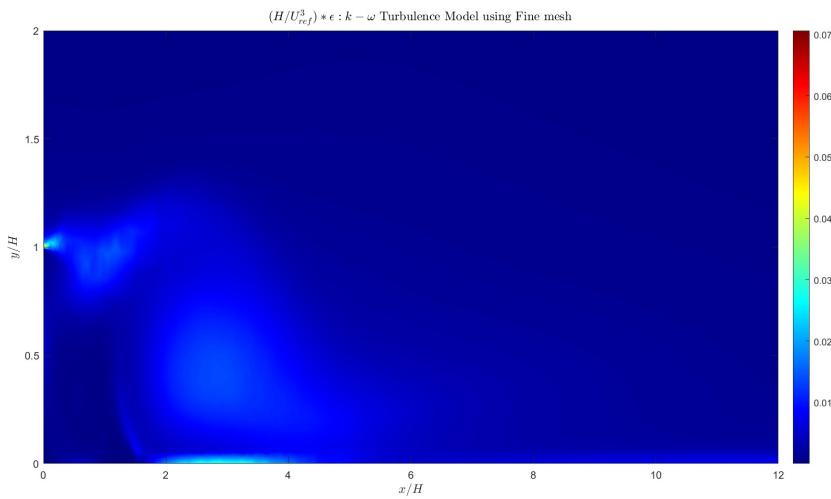
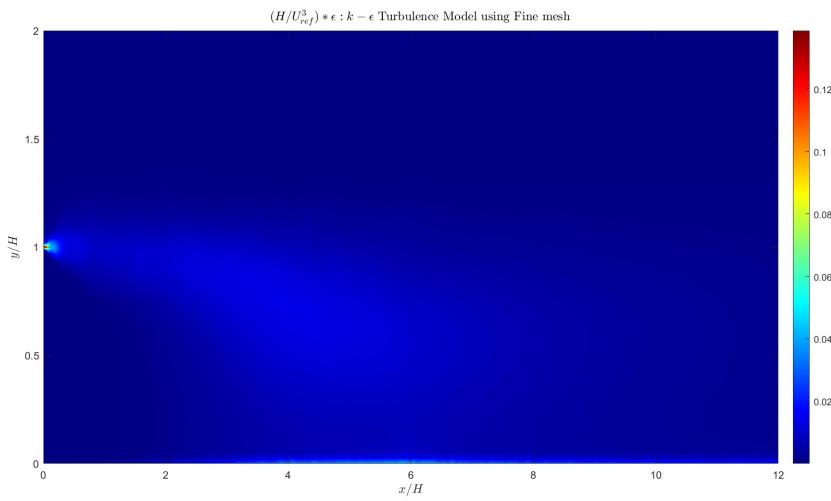
Reynold's Stress $(10^3/U_{ref}^2) * \overline{u'v'}$



(k/U_{ref}^2) Turbulent Kinetic Energy



$(H/U_{ref}^3) * \epsilon$ Turbulence Dissipation Rate



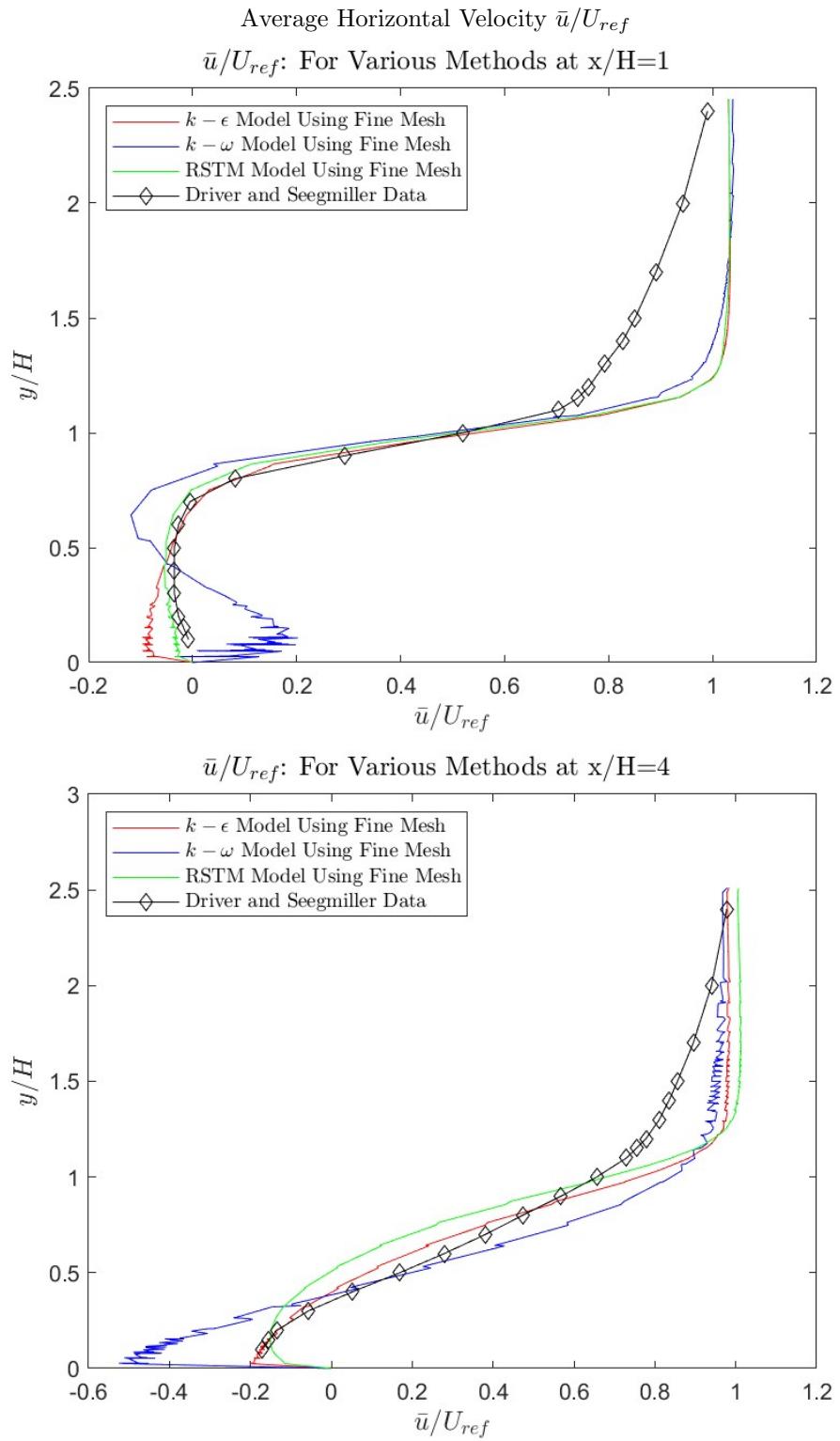
Discussion

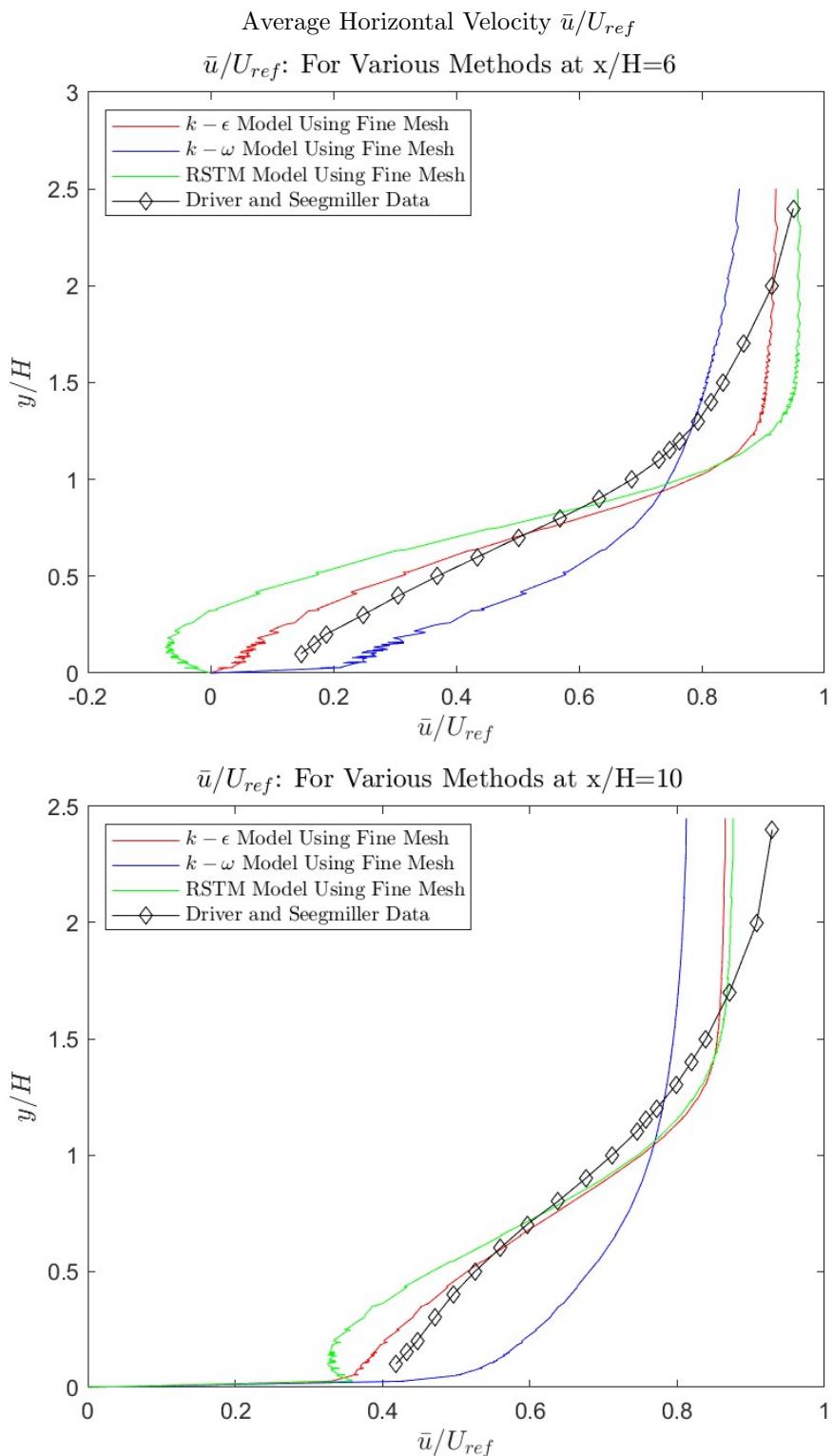
Q2: Do you see significant differences in any of the color fields among the three turbulence models ($k-\epsilon$, $k-\omega$, and RSTM); if so, discuss what you believe are the most important differences you see?

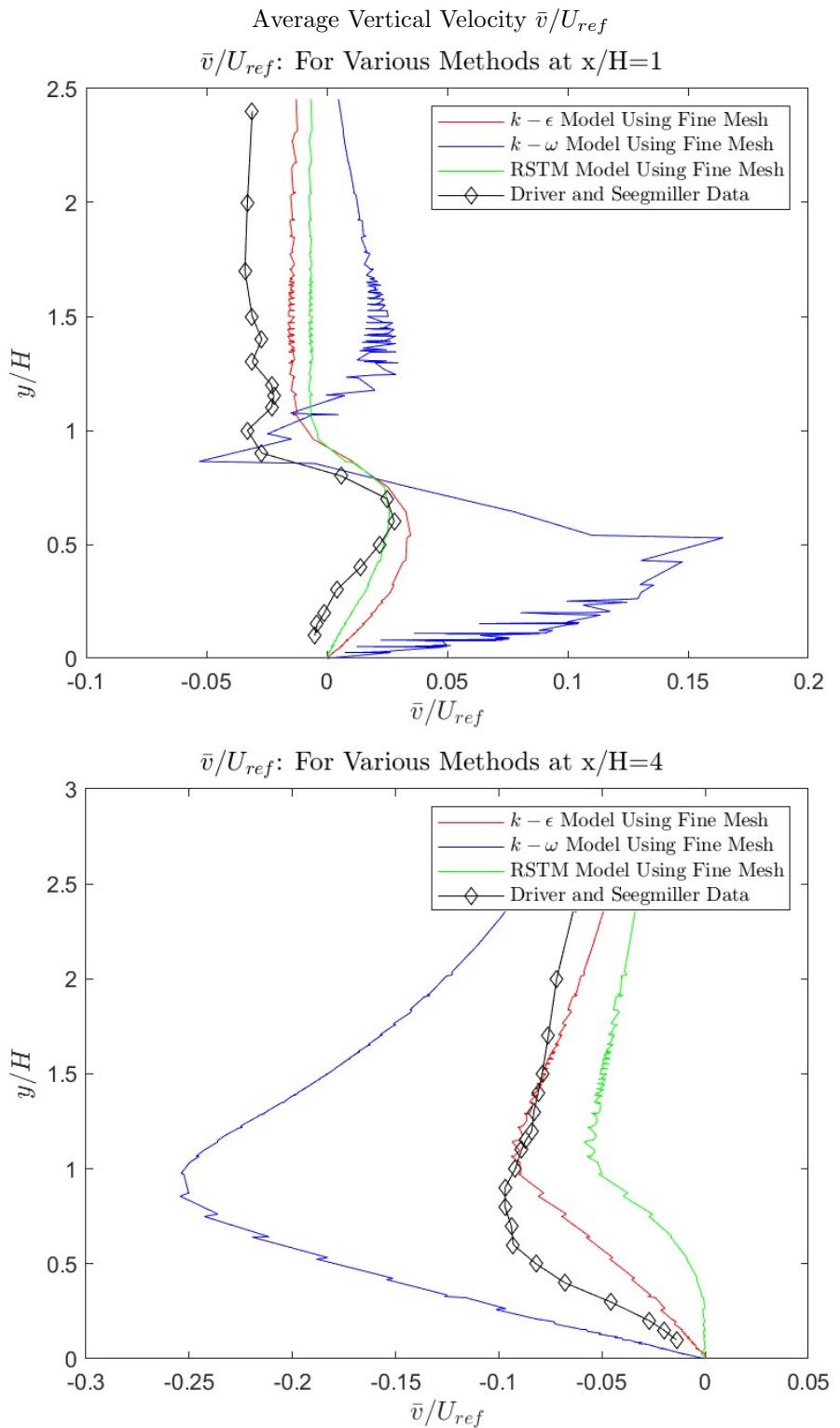
Answer: The turbulence model employed has a significant impact on the outcomes of the study. The $k - \epsilon$ and RSTM models produce comparable results, whereas the $k - \omega$ model displays unique findings. The RSTM model exhibits a larger recirculation zone than the $k - \epsilon$ model in the case of $\bar{u}(x, y)$. However, the $k - \omega$ model uncovers coherent structures right after the step, which may also be valid. The $k - \omega$ model, particularly in the fine mesh, reveals corner eddies near the left bottom of the wall for $\bar{v}(x, y)$, implying that it is more precise in capturing the actual flow characteristics, consistent with Driver and Seegmiller's reference paper on step flow.

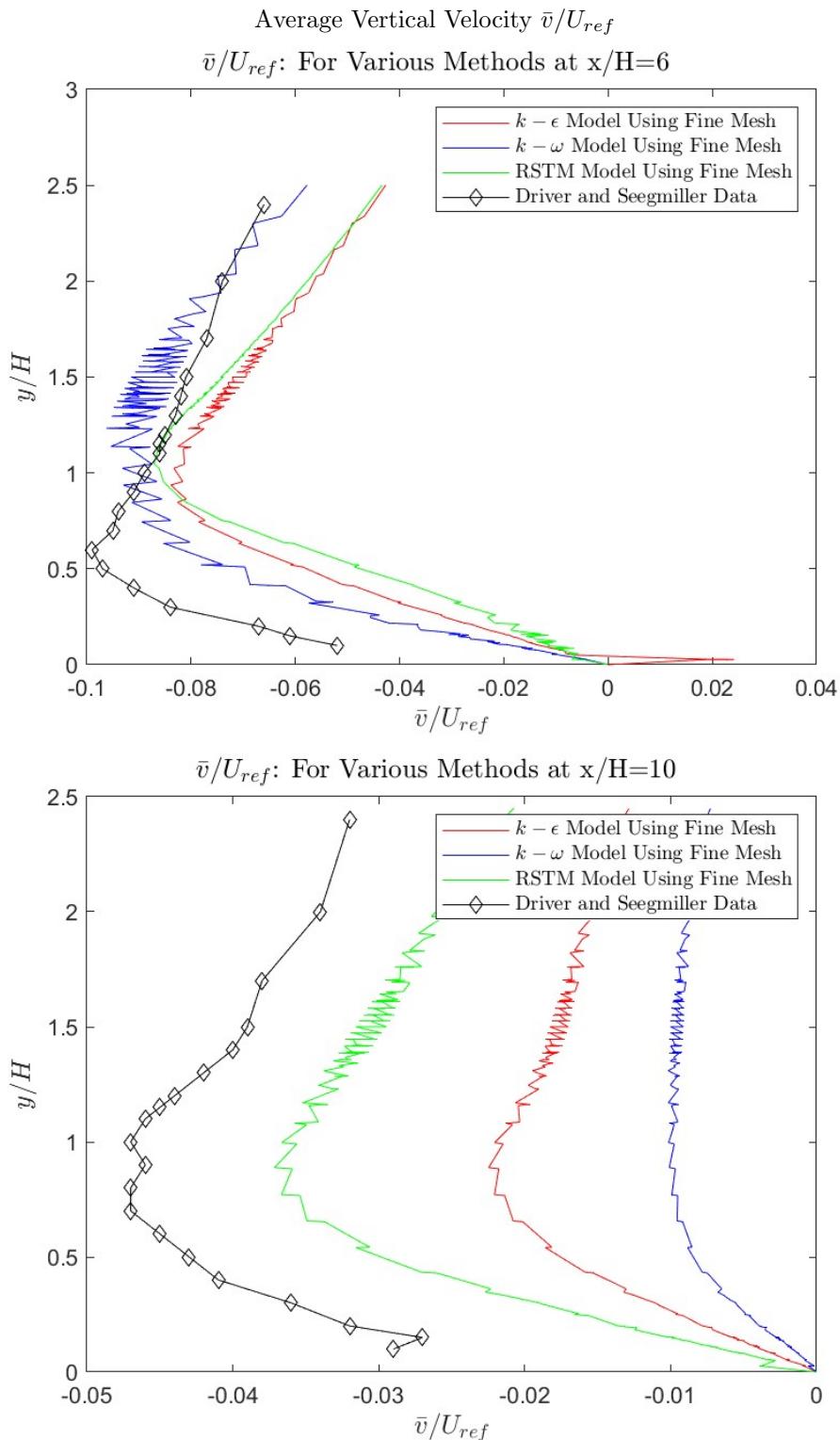
There are minor discrepancies between the Reynolds stress findings of the $k - \epsilon$ and RSTM models. The RSTM model provides a more comprehensive distribution of Reynolds stresses across the channel and near the step, as well as for kinetic energy and kinetic energy dissipation just after the wall. The $k - \omega$ model, on the other hand, displays coherent structures in the Reynolds stresses and turbulent kinetic energy while presenting the most accurate turbulent dissipation rate. While it may be due to the distinct modelling of the $k - \omega$ model, it is difficult to determine which model is the most accurate, as none of them are completely accurate according to our understanding of turbulence models in this course.

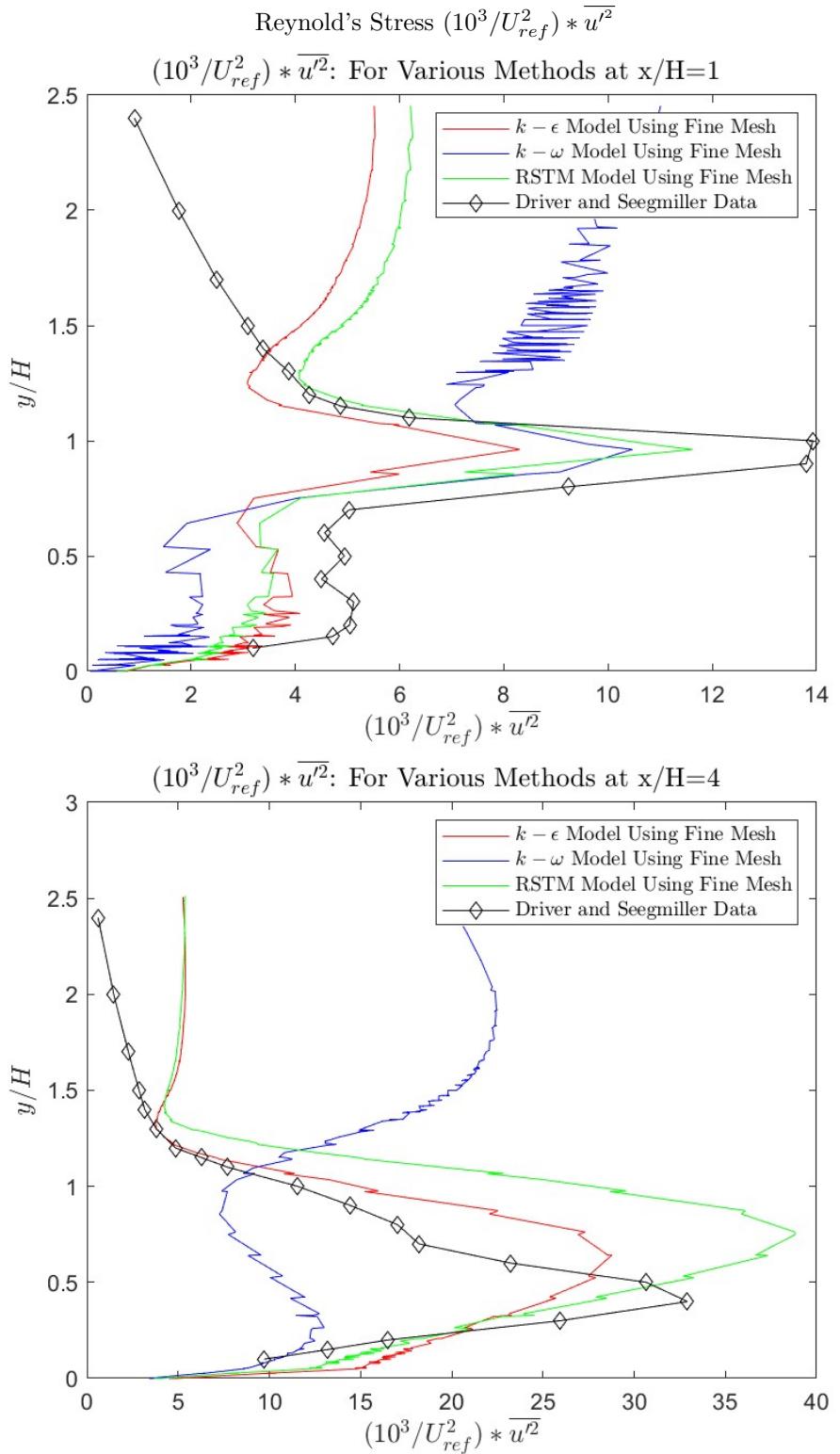
4 Turbulence Models Comparison with Experiment

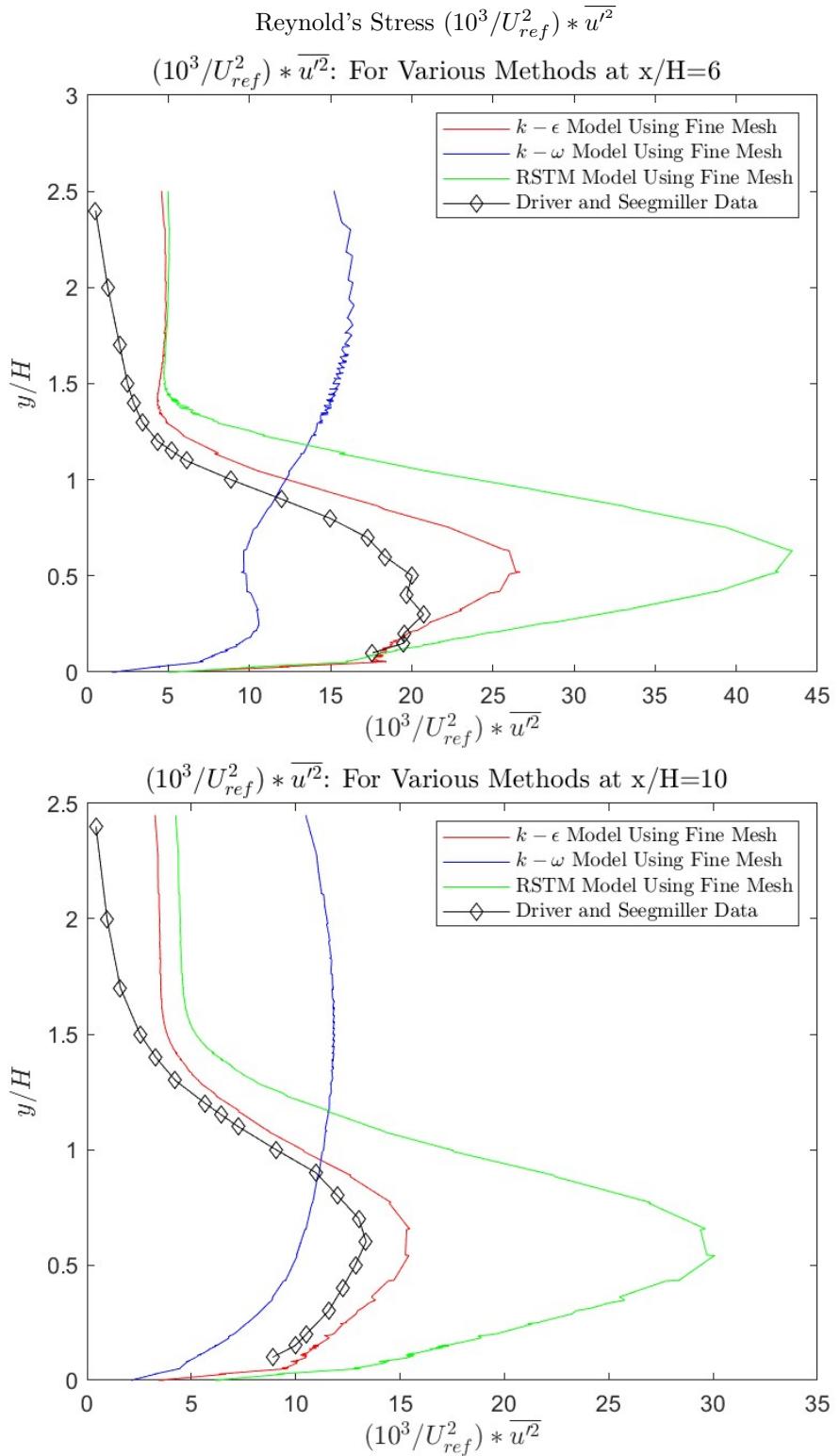


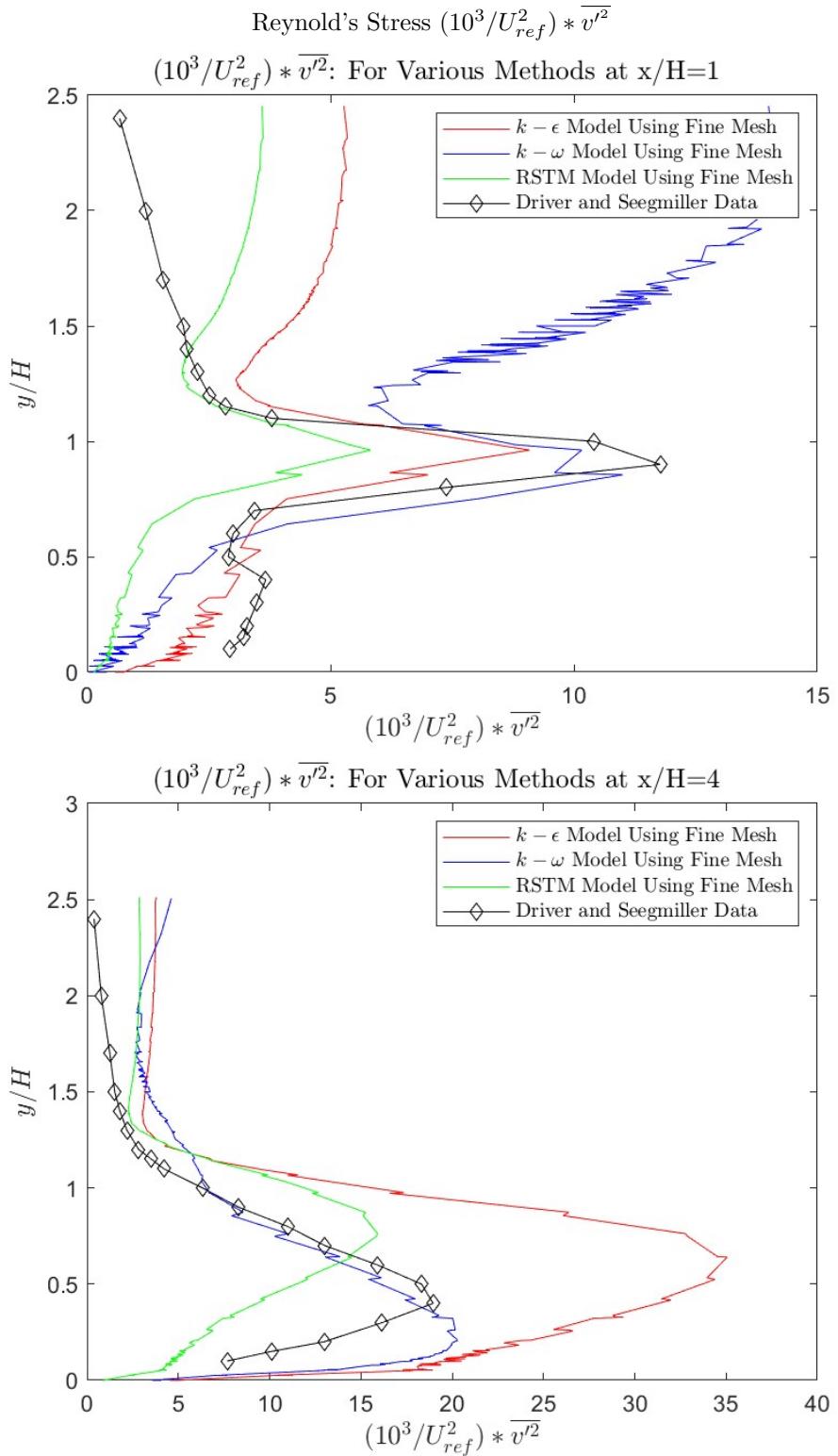


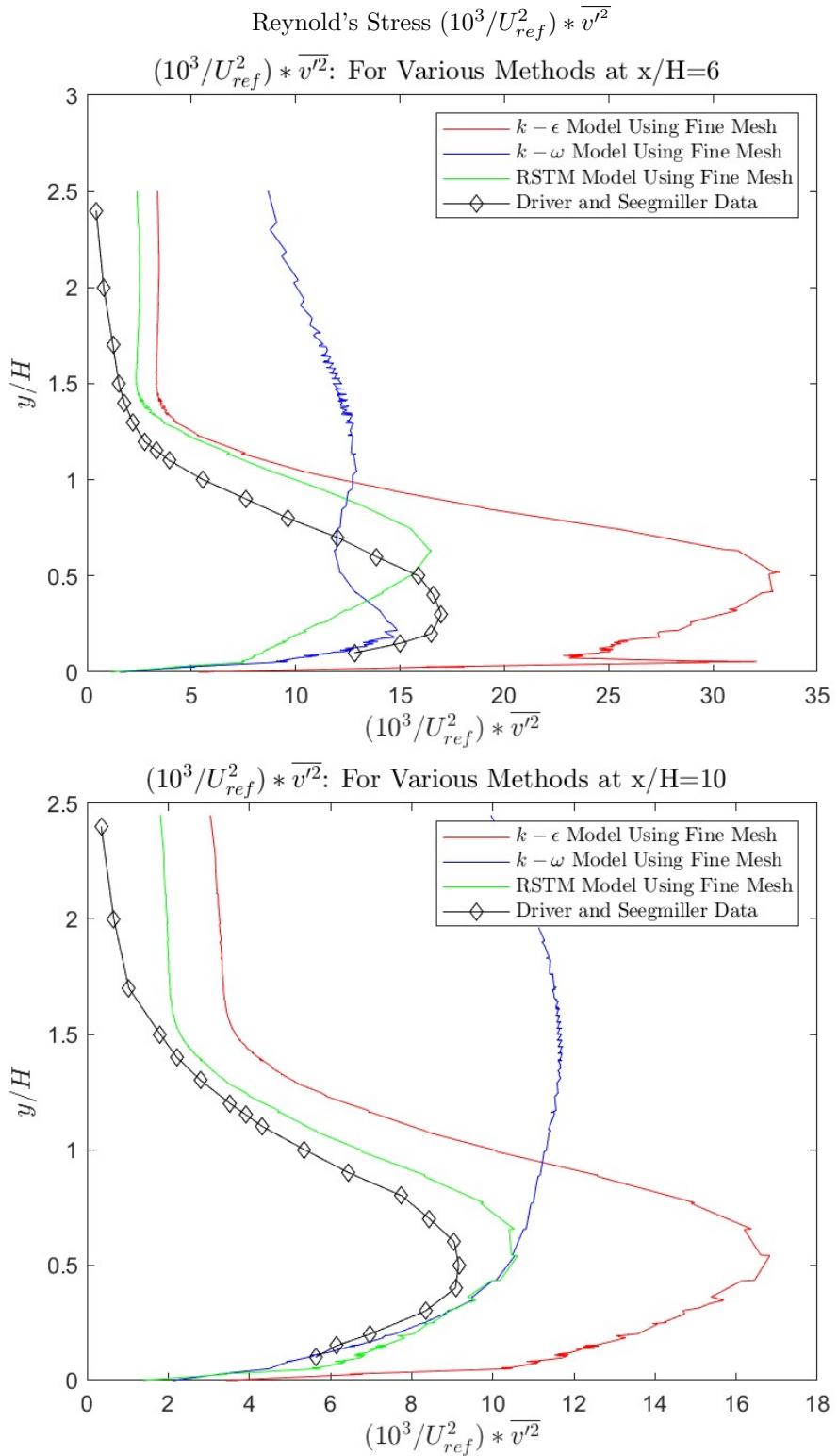


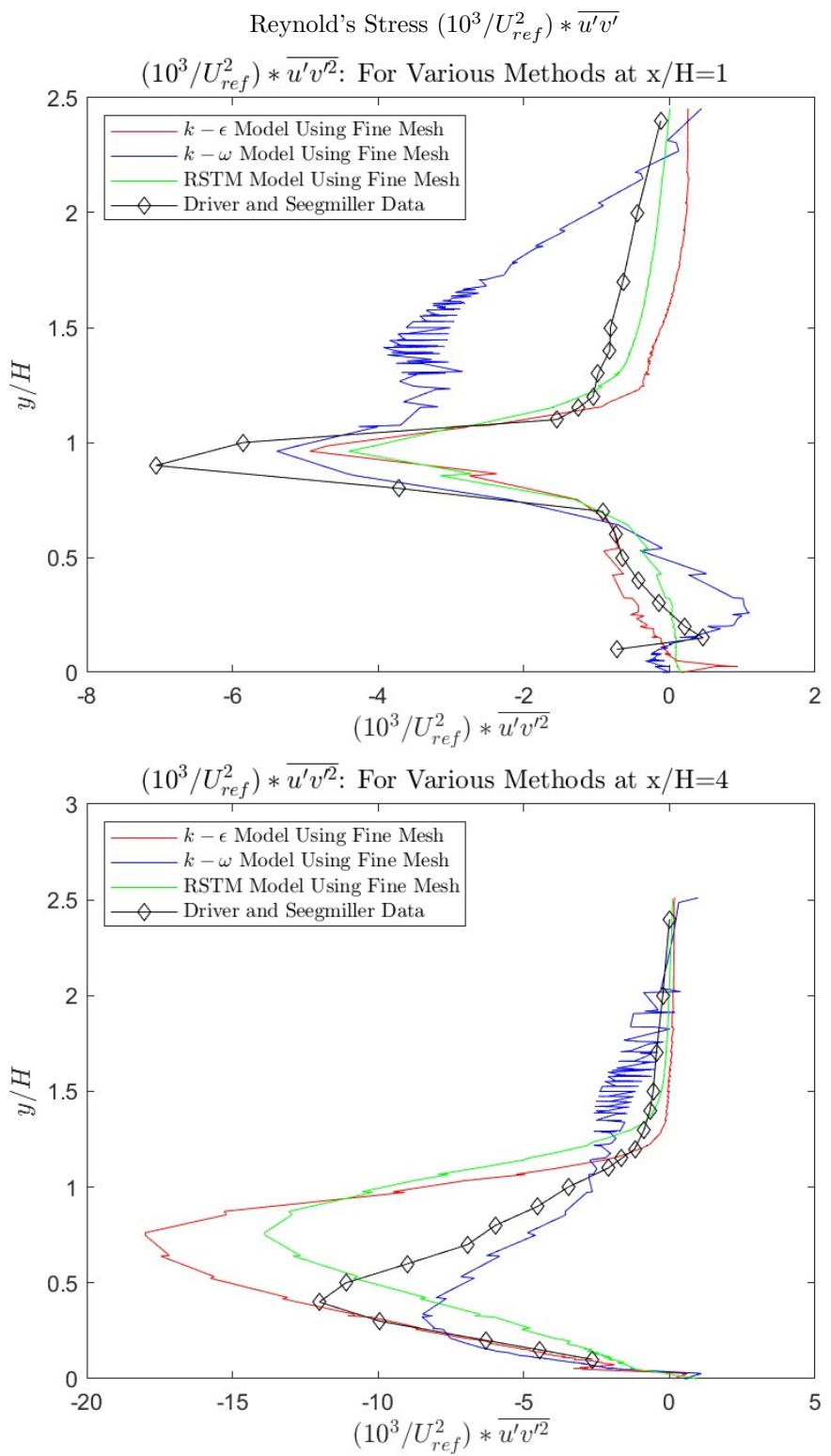


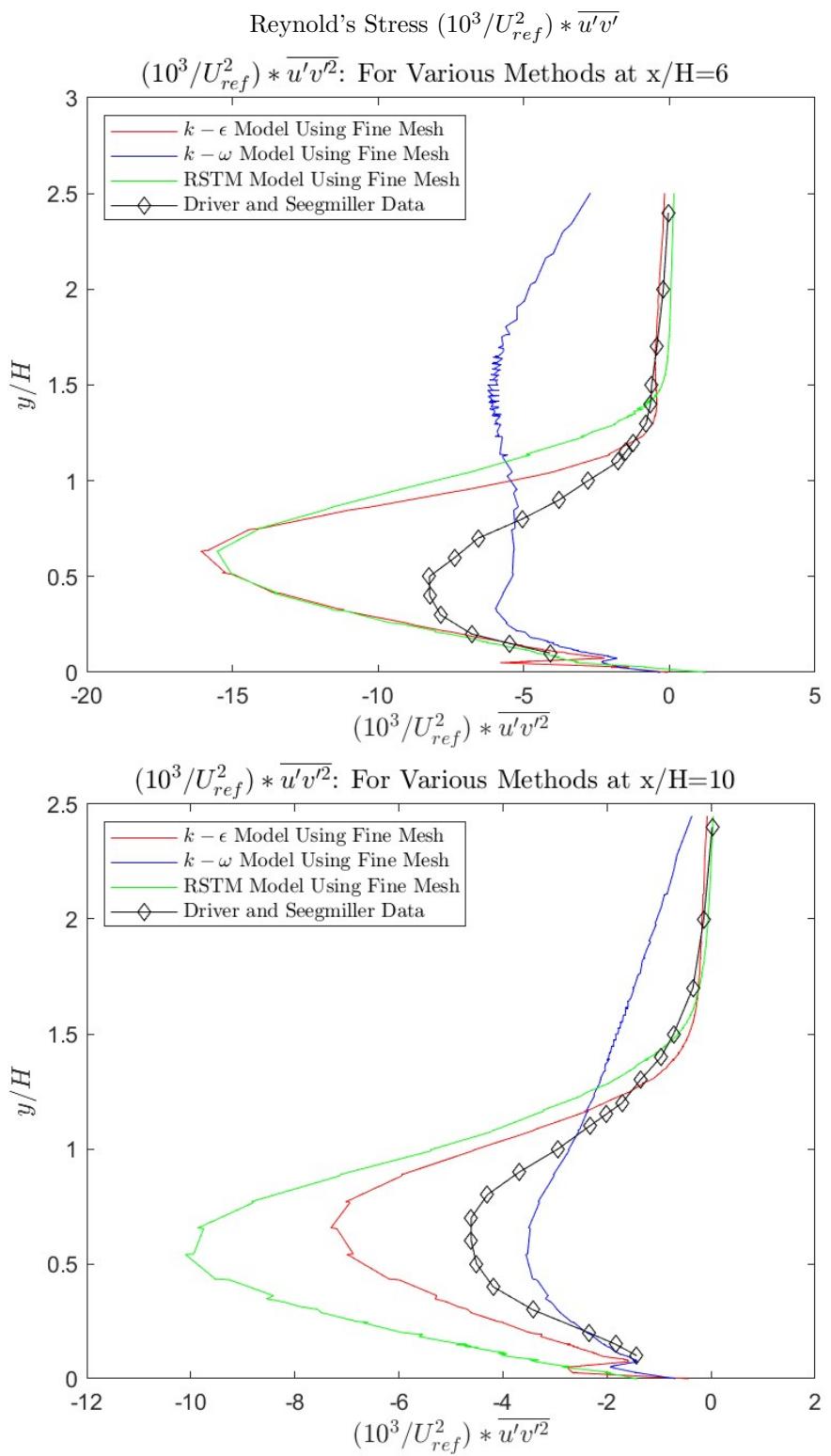


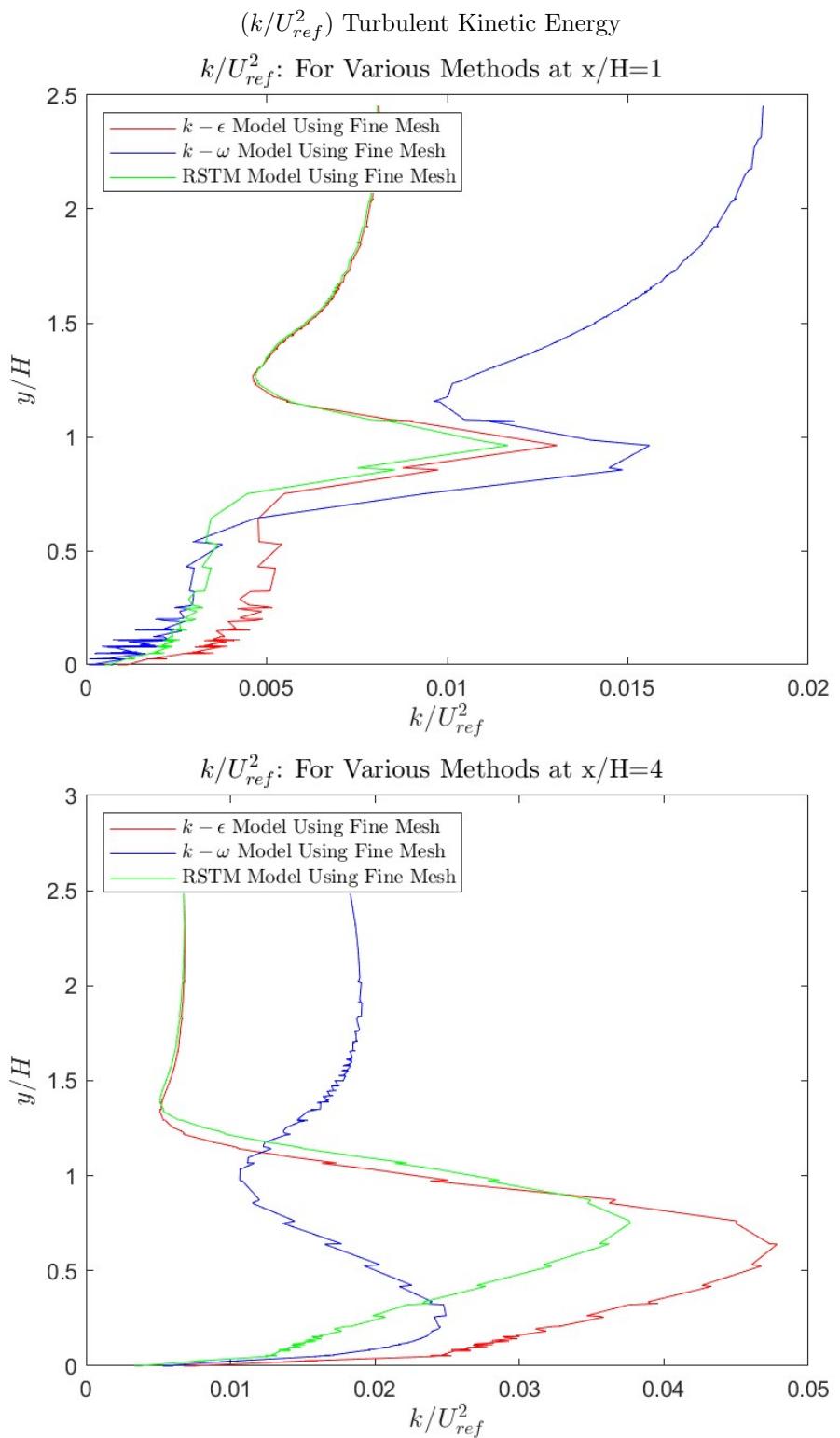


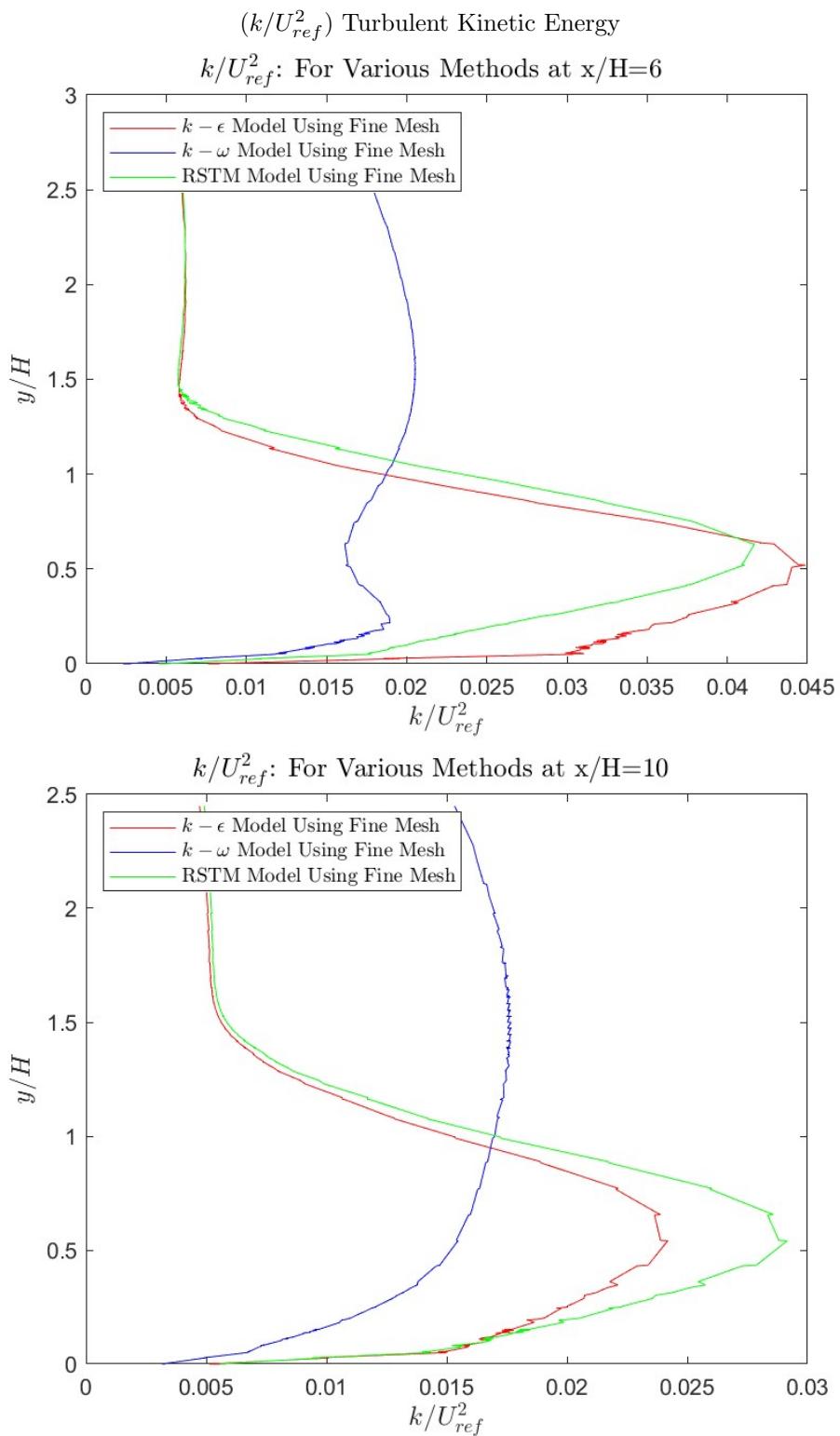


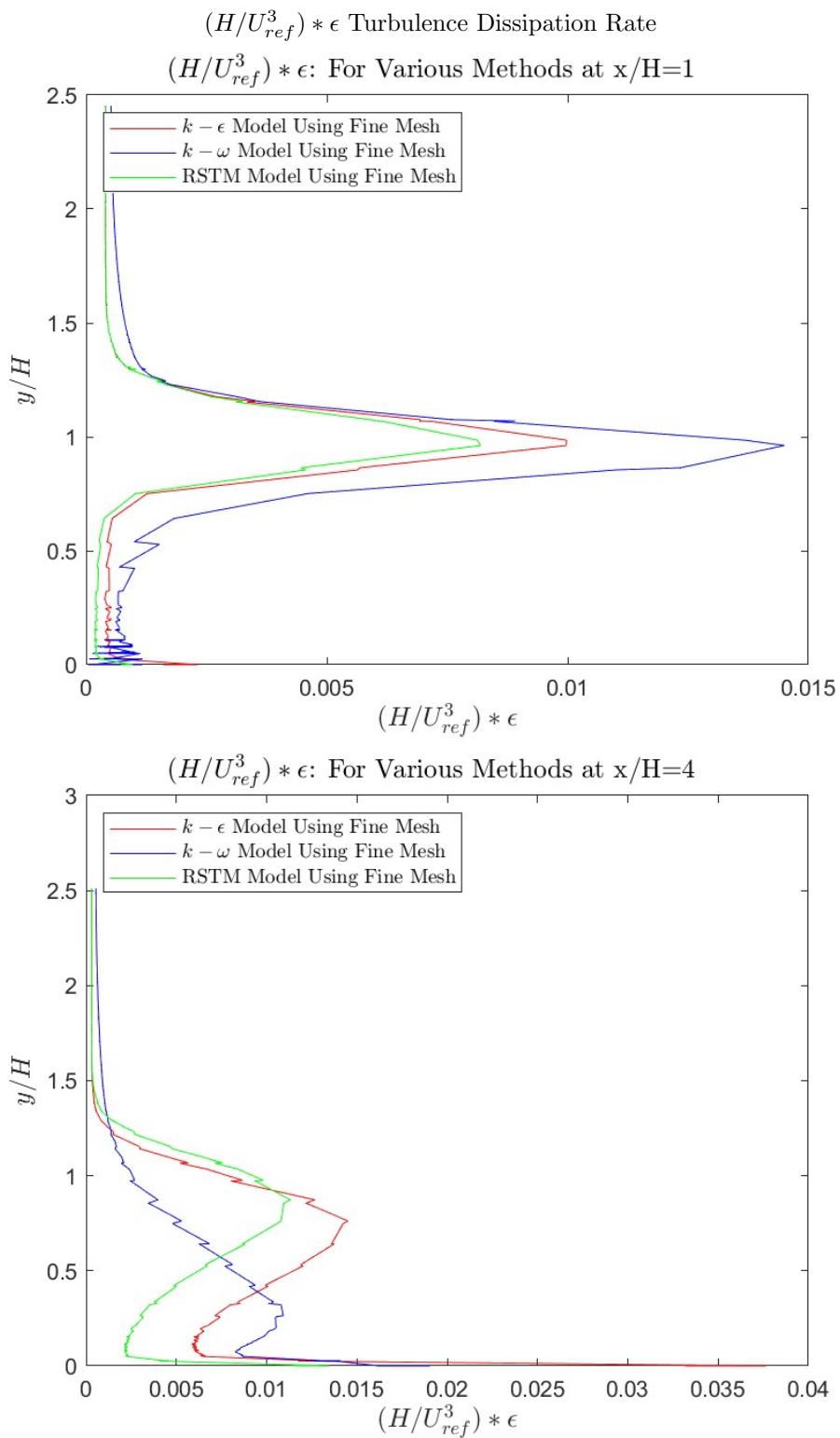


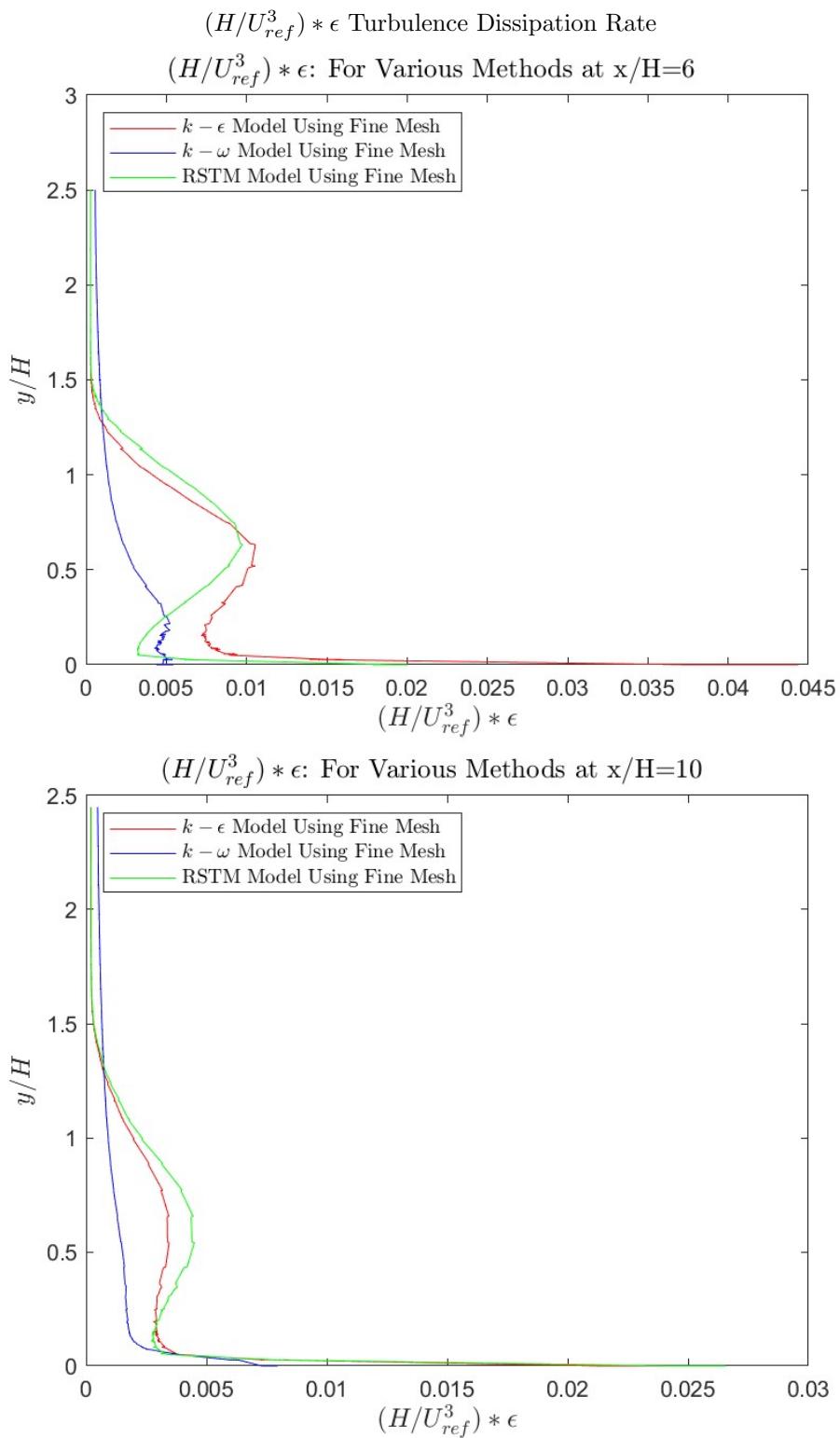












Q3: Discuss briefly what you think is most important in the $\bar{u}(x, y)$ and $\bar{v}(x, y)$ graphs, and comment on how accurately or inaccurately these models predict these quantities.

Answer: In my opinion, the most significant features in the $\bar{u}(x, y)$ and $\bar{v}(x, y)$ graphs are the regions near the step at $y < 0.5$ for $\bar{u}(x, y)$ and the peak at $y/H = 1$ for $\bar{v}(x, y)$. The RSTM model appears to perform better in predicting those regions, although still deviating from the experimental data. In terms of x-velocity, the $k - \epsilon$ and RSTM models exhibit similar results. However, the RSTM model shows more accuracy in predicting $\bar{v}(x, y)$ compared to the other models. The $k - \omega$ model appears to deviate greatly from the experimental results, and it's possible that the fine model for $k - \omega$ is not accurately modeled or that it predicts features that other models cannot. Therefore, it's difficult to conclude which model is the most accurate in predicting these quantities

Q4: Does any of these three turbulence models consistently predict and more accurately than the others, and if so which one?

Answer: The $k - \epsilon$ and RSTM models yield comparable predictions for the x-velocity. However, in terms of predicting $\bar{v}(x, y)$, the RSTM model appears to be significantly more accurate. Therefore, while the difference between the models may not be particularly significant, the RSTM model does seem to provide a more accurate prediction of the experimental results.

Q5: Discuss briefly what you think is most important in the $\overline{u'_i u'_j}(x, y)$ graphs, and comment on how accurately or inaccurately these turbulence models predict these quantities.

Answer: In my opinion, the most significant feature of the $\overline{u'_i u'_j}(x, y)$ graphs is the peak-like structure that occurs at around $y/H = 1$. Based on the available data, it appears that the $k - \epsilon$ model provides the most accurate prediction of $\overline{u'^2}(x, y)$, while the RSTM model yields better predictions for $\overline{v'^2}(x, y)$ and $\overline{u'v'}(x, y)$. On the other hand, the $k - \omega$ model appears to be significantly divergent from the experimental data and the other models, indicating that it is not particularly effective at accurately predicting these quantities. Therefore, it is difficult to conclusively determine which model provides the most accurate predictions.

Q6: Does any of these three turbulence models consistently predict the components more accurately than the others, and if so which one?

Answer: It is evident that no single model is superior at accurately predicting all reference quantities. For example, while the RSTM model excels at predicting $\overline{v'^2}(x, y)$, it struggles with accurately predicting $\overline{u'^2}(x, y)$. On the other hand, the $k - \omega$ model exhibits significant deviation from the experiment and other models, making it difficult to draw any definitive conclusions regarding which model predicts the results most accurately. However, it is clear that the $k - \omega$ model does not perform well compared to the experiment.

Q7: Based on what you have learned in the lectures, what do you think are the greatest sources of error in each of these three turbulence models?

Answer: The major sources of error would be: 1. The need to model the transport equations involved, particularly the ϵ equation. 2. Inaccurate modelling of the ϵ equation, with the $k - \epsilon$ and $k - \omega$ models employing the LLE modelling approach, while the RSTM model utilizes the LRR modelling approach - as covered in our lectures. Given what we have learned in class, it is clear that developing our own non-linear

models is essential to accurately solve turbulence-related problems.

Q8: How certain are you that the Driver and Segmiller data are actually the “right answer”? Discuss some possible sources of error in the experimental data.

Answer: I acknowledge that Driver and Segmiller’s results for this case are impressive. However, it would be unwise to assume that their findings are completely accurate, given that all experiments are subject to a certain degree of error.

Numerous factors can introduce error into their results, including their experimental setup, observations, testing, and data acquisition systems. For instance, it is impossible to create a perfectly smooth wall with a no-slip condition, or a flawless wind tunnel, or an inlet with uniform inlet velocity and a perfect pressure outlet, and these factors can introduce errors into their experimental setup. Additionally, probes and sensors used in the experiment may have sensitivity and calibration errors, and issues may arise when applying filters to the data post-experiment.

Despite these potential sources of error, as long as the results are qualitatively sound, and any errors fall within an acceptable quantitative limit, the experiment can be considered reasonable.

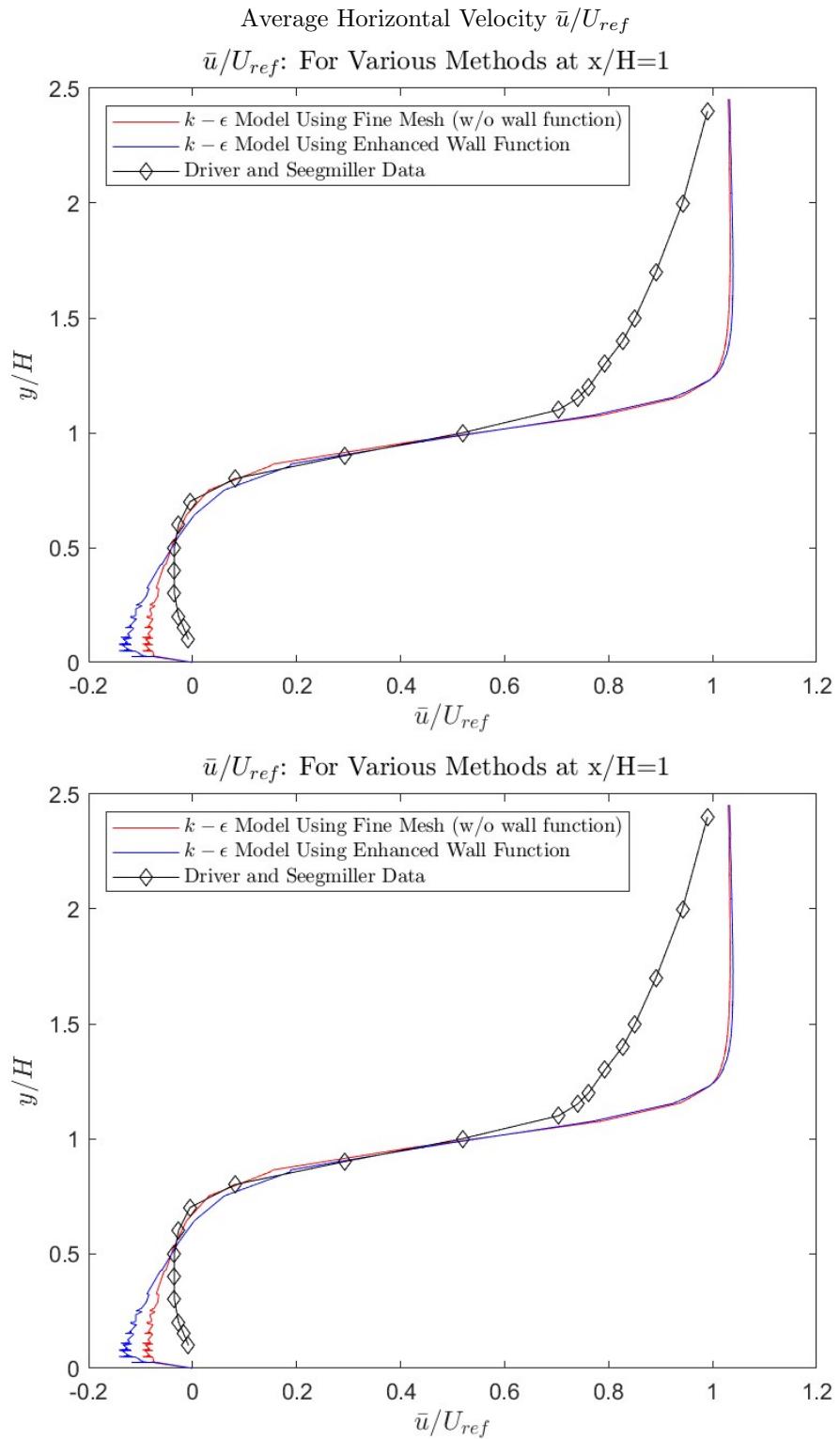
Q9: How does the magnitude of the differences between the results from the three turbulence models compare with the magnitude of the differences between turbulence model results and the experimental data?

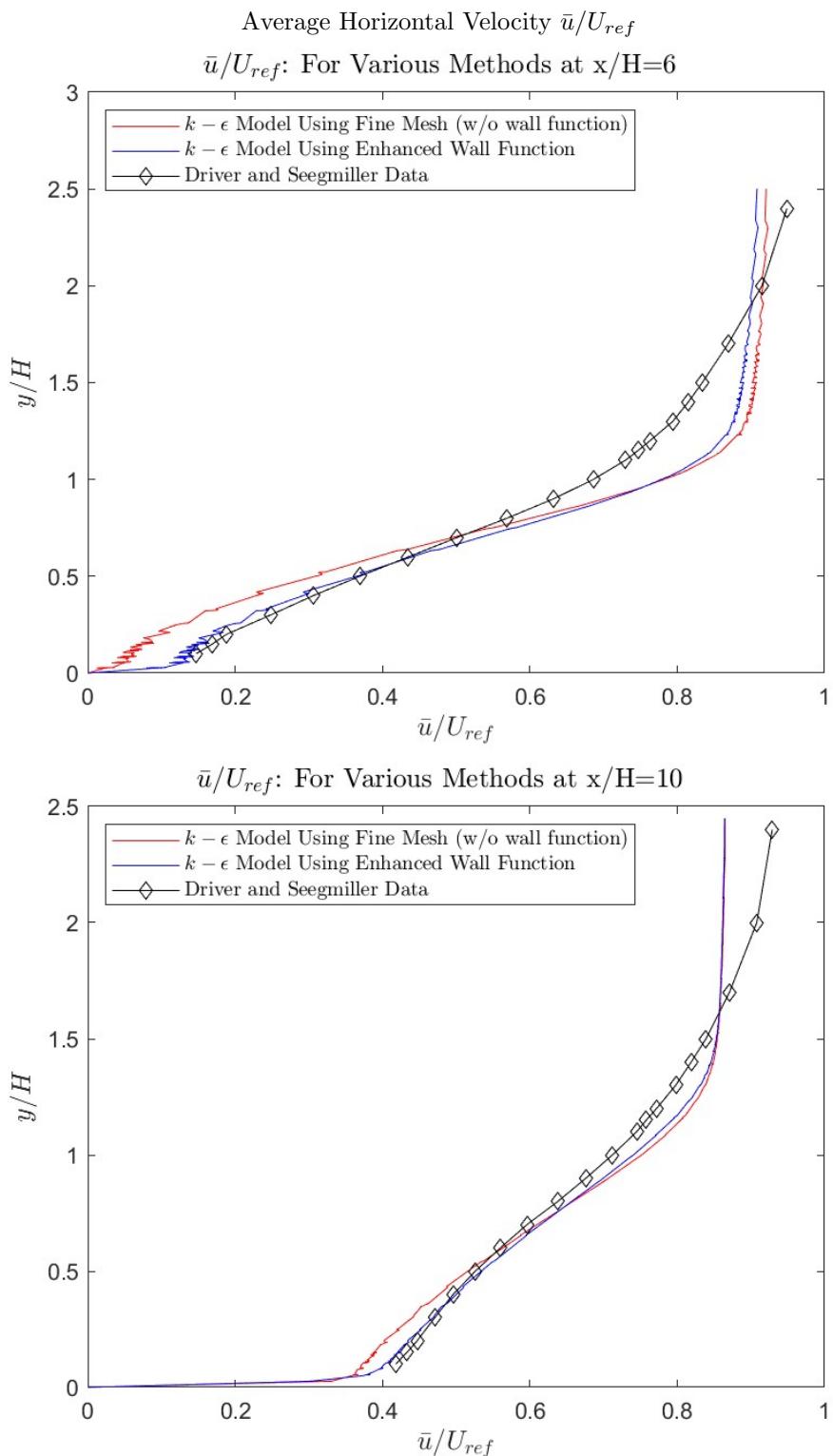
Answer: Both the $k - \epsilon$ and RSTM models tend to overestimate the Reynolds stresses, except in a few isolated cases. This over-prediction leads to higher kinetic energy and, consequently, higher kinetic energy dissipation than what was observed in the experiment (for which no data is available). On the other hand, the $k - \omega$ model appears to underestimate the Reynolds stresses, with a distinct curve shape. While it is difficult to draw definitive conclusions regarding the differences between methods for all cases, it is clear that the fine $k - \omega$ model stands out as fundamentally different from the others.

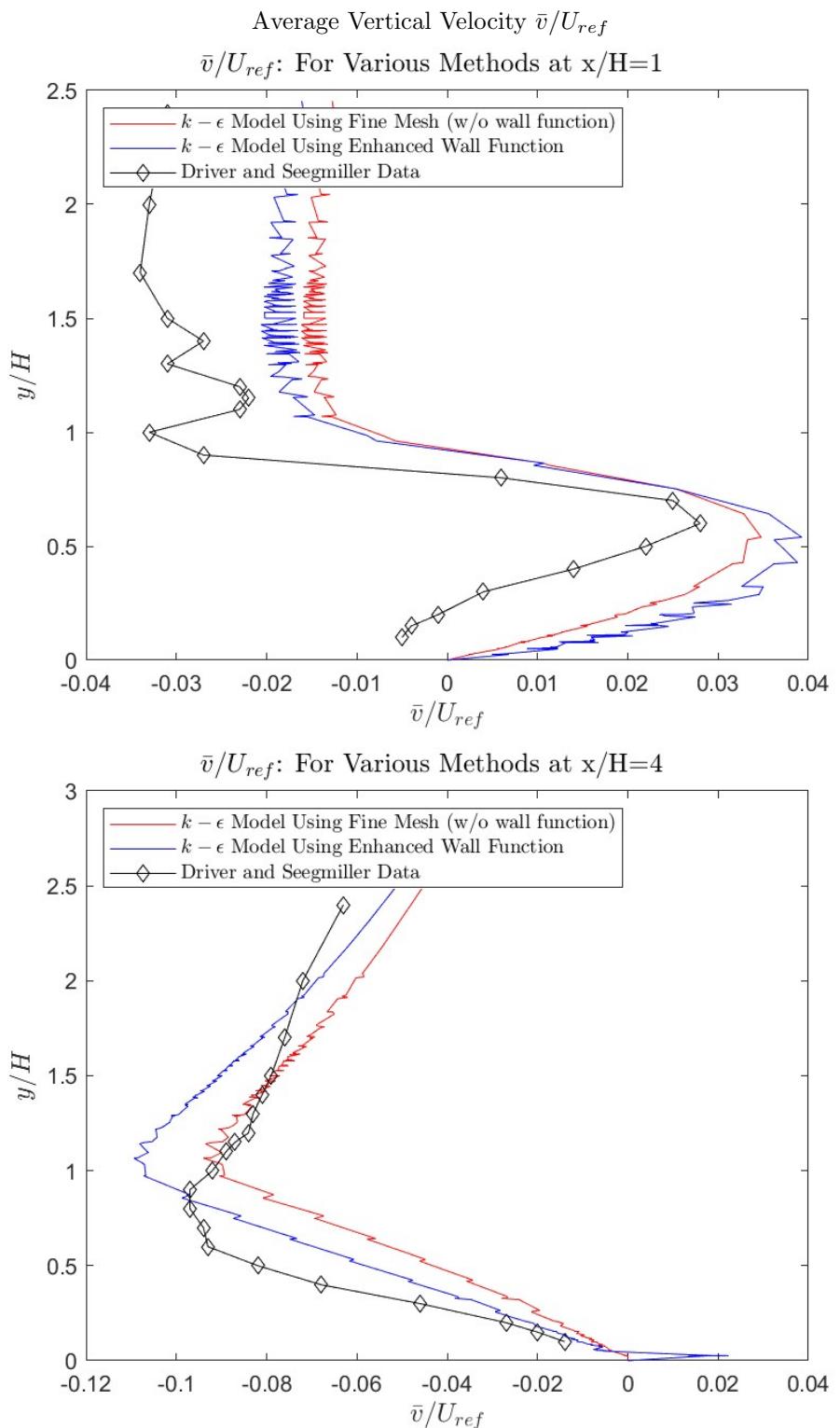
Q10: Based on your answer to Q9, discuss what the implications of this are for choosing a turbulence model for a CFD simulation, at least in this flow but also in general?

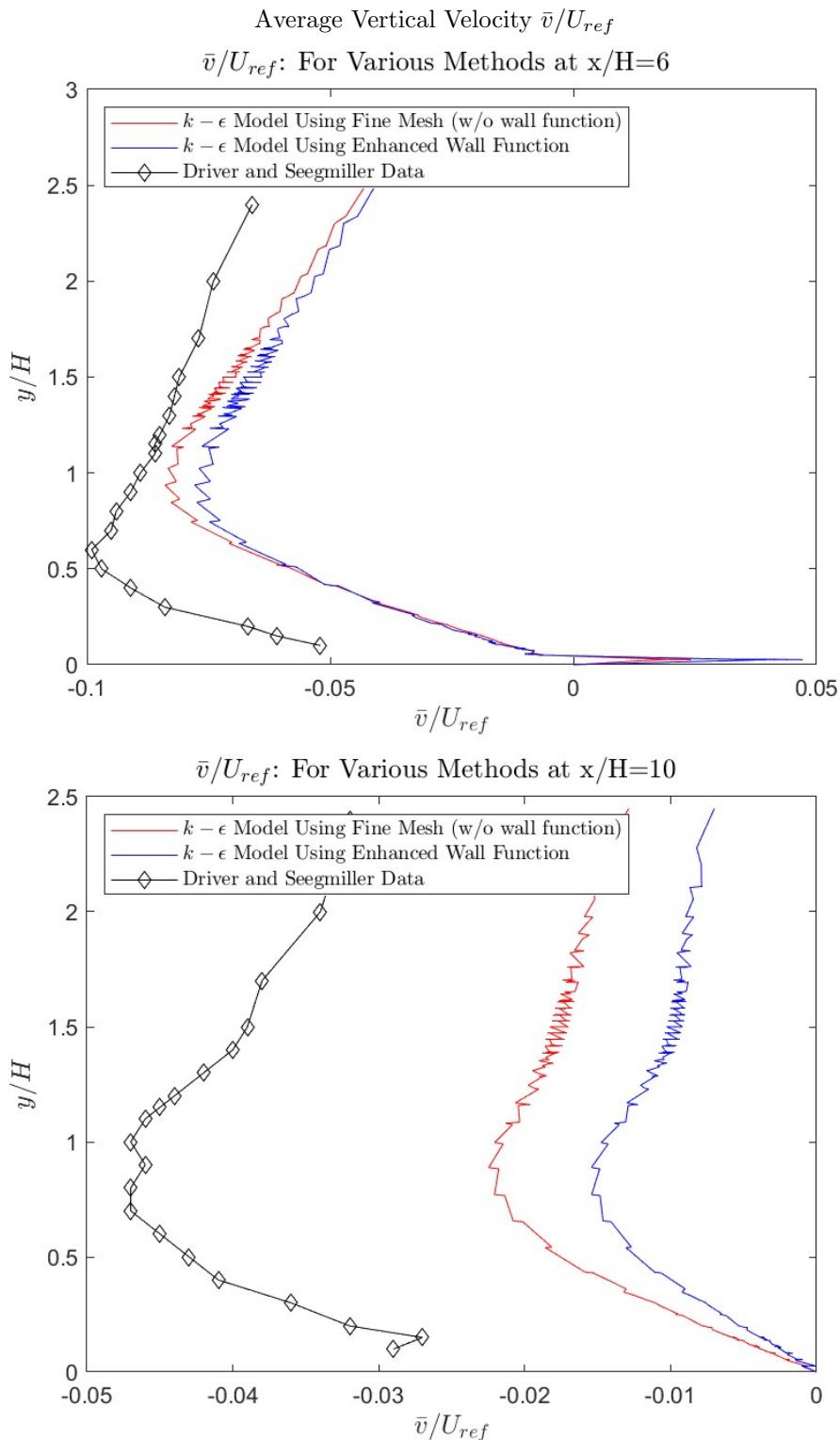
Answer: As discussed earlier, it is evident that no single model demonstrated superior predictive capabilities for all quantities. While some models outperformed others in certain scenarios, these findings cannot be universally applied. Specifically, we observed that the Reynolds stresses did not yield conclusive results. However, when examining Kinetic Energy and Kinetic energy dissipation, we noted that all methods produced nearly identical outcomes, with negligible deviations that balanced out over time. Notably, the fine $k - \omega$ model diverged significantly from all other models tested, which could be indicative of error. Or not. I can’t really say. As a result, no singular method proved significantly advantageous for general use.

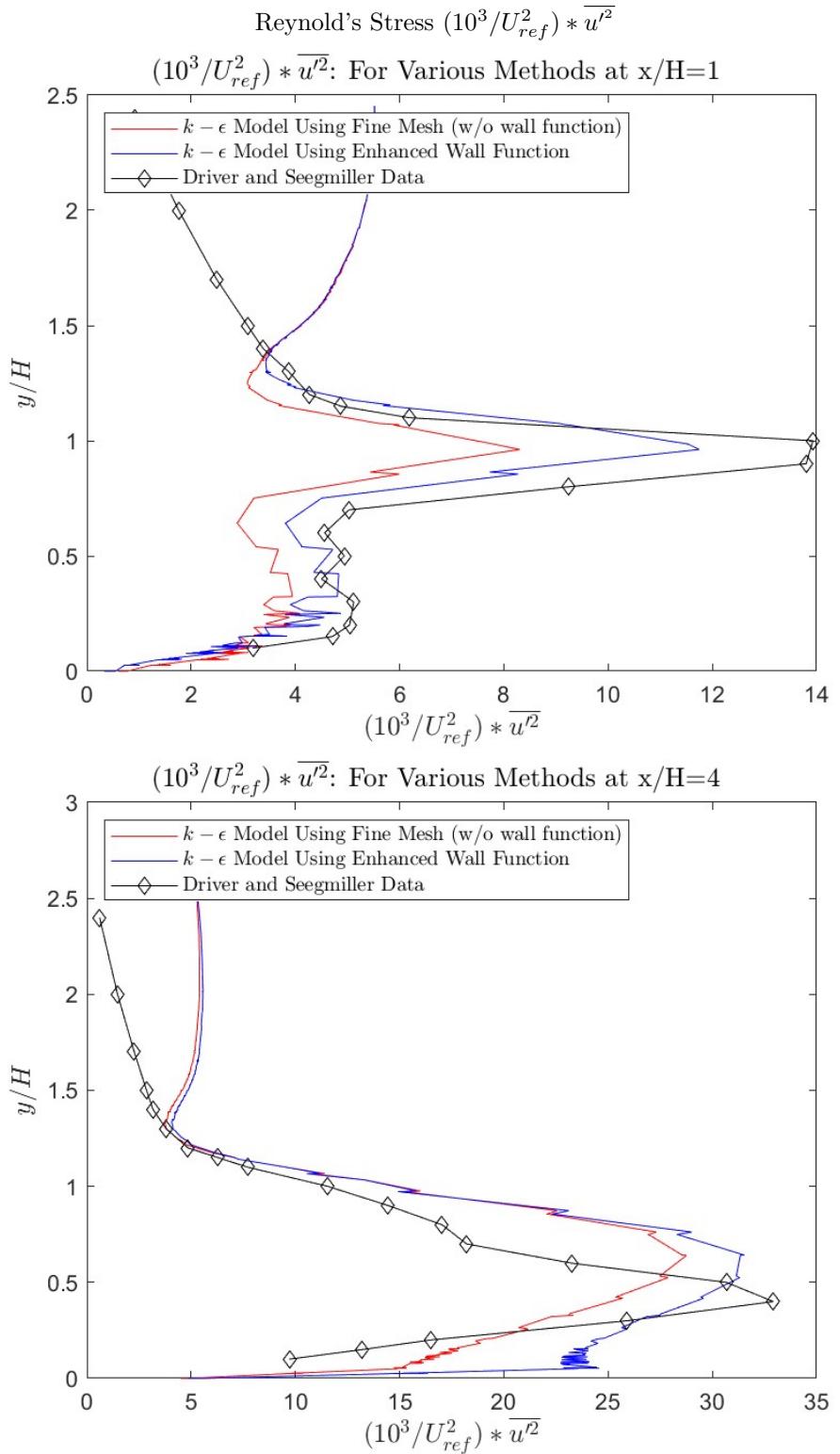
5 Influence of Wall Enhancement

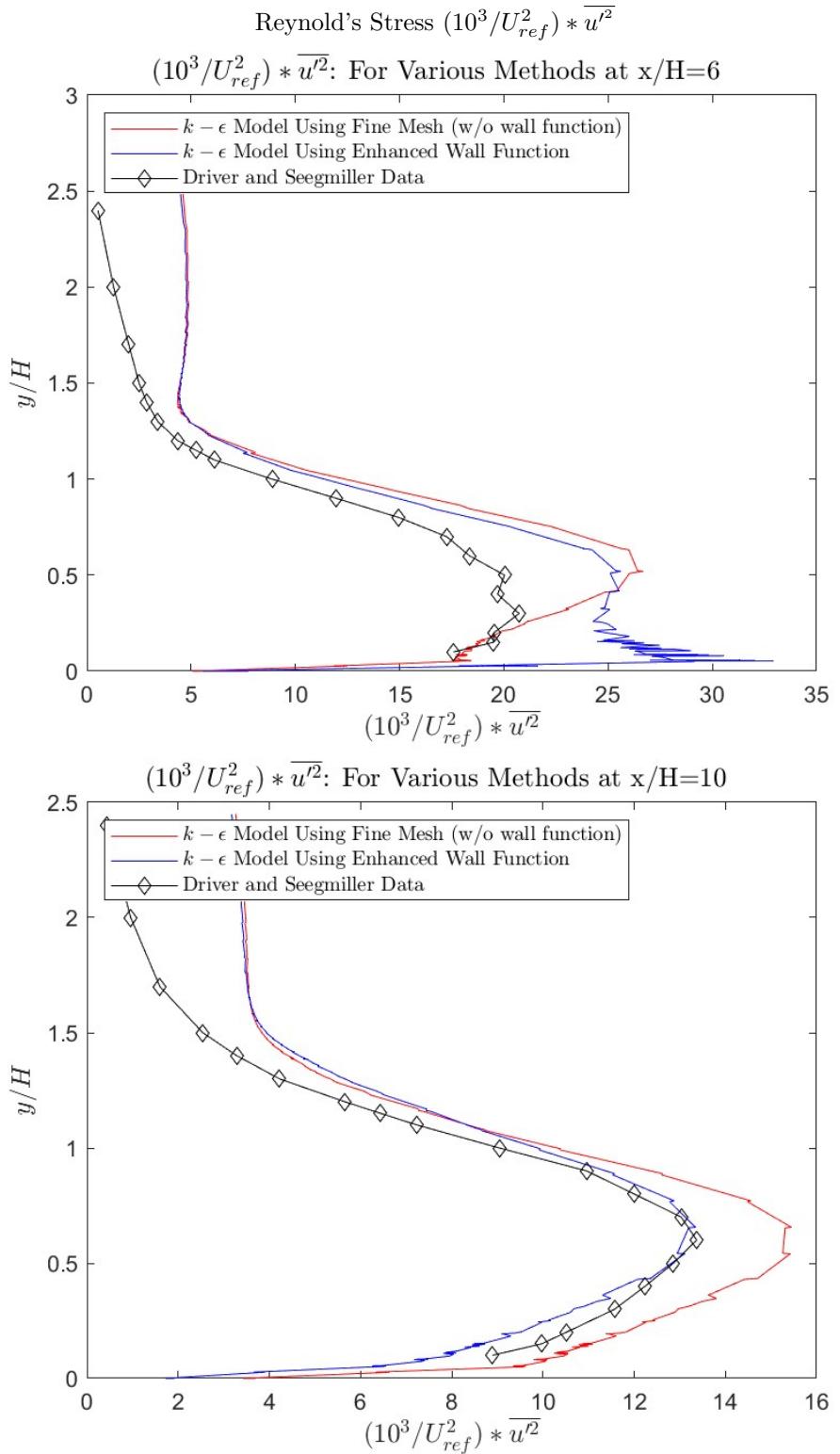


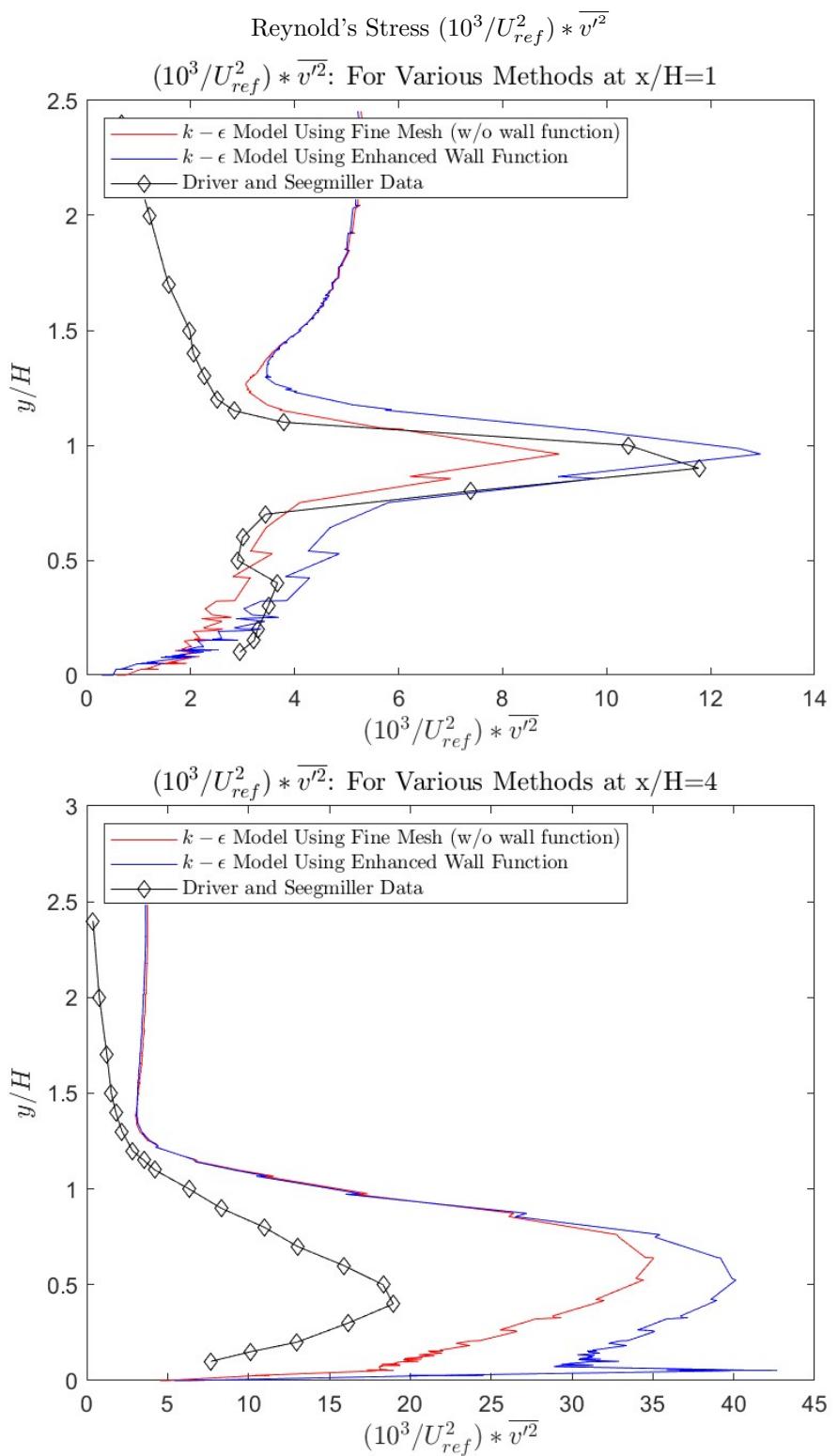


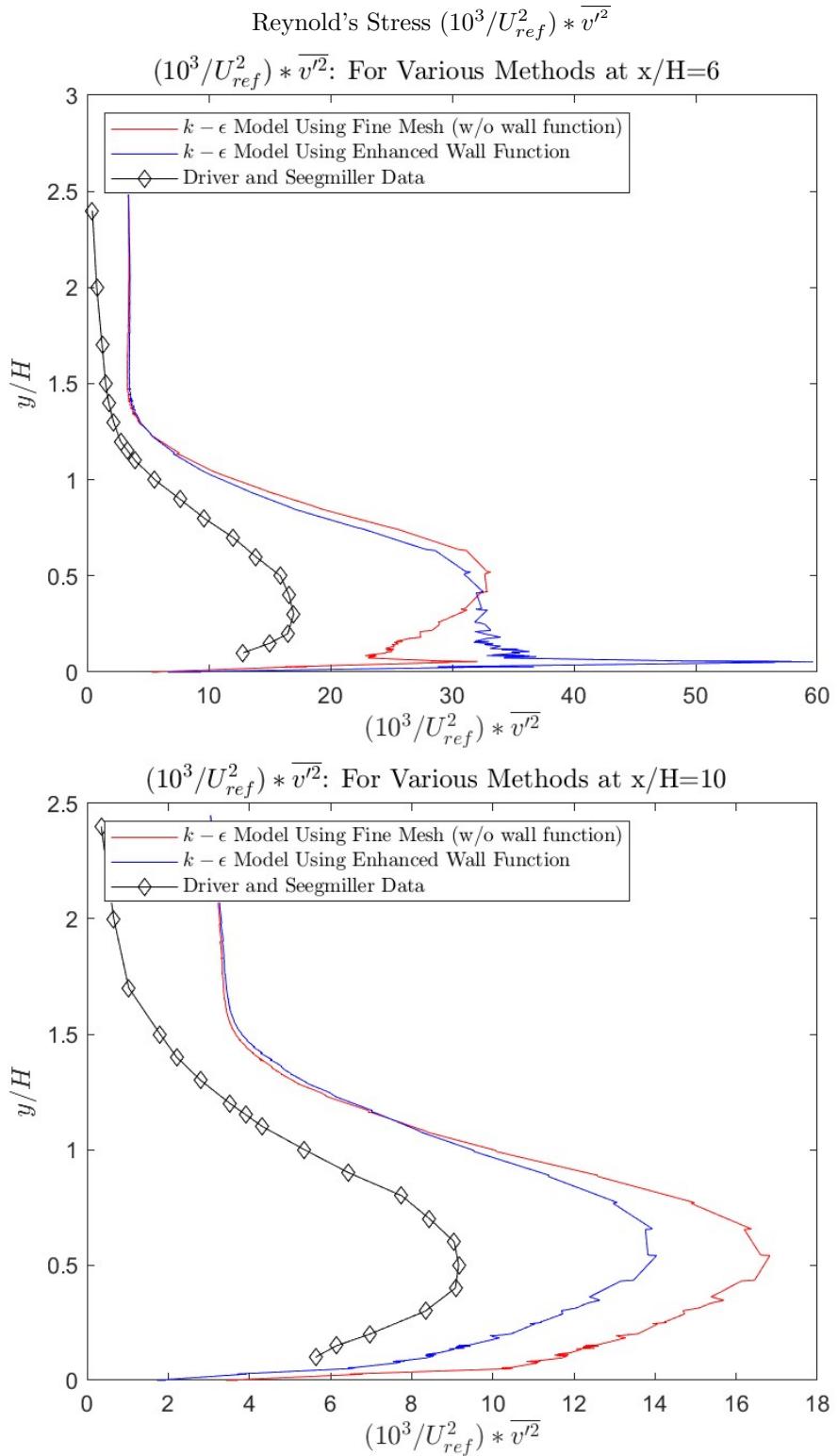


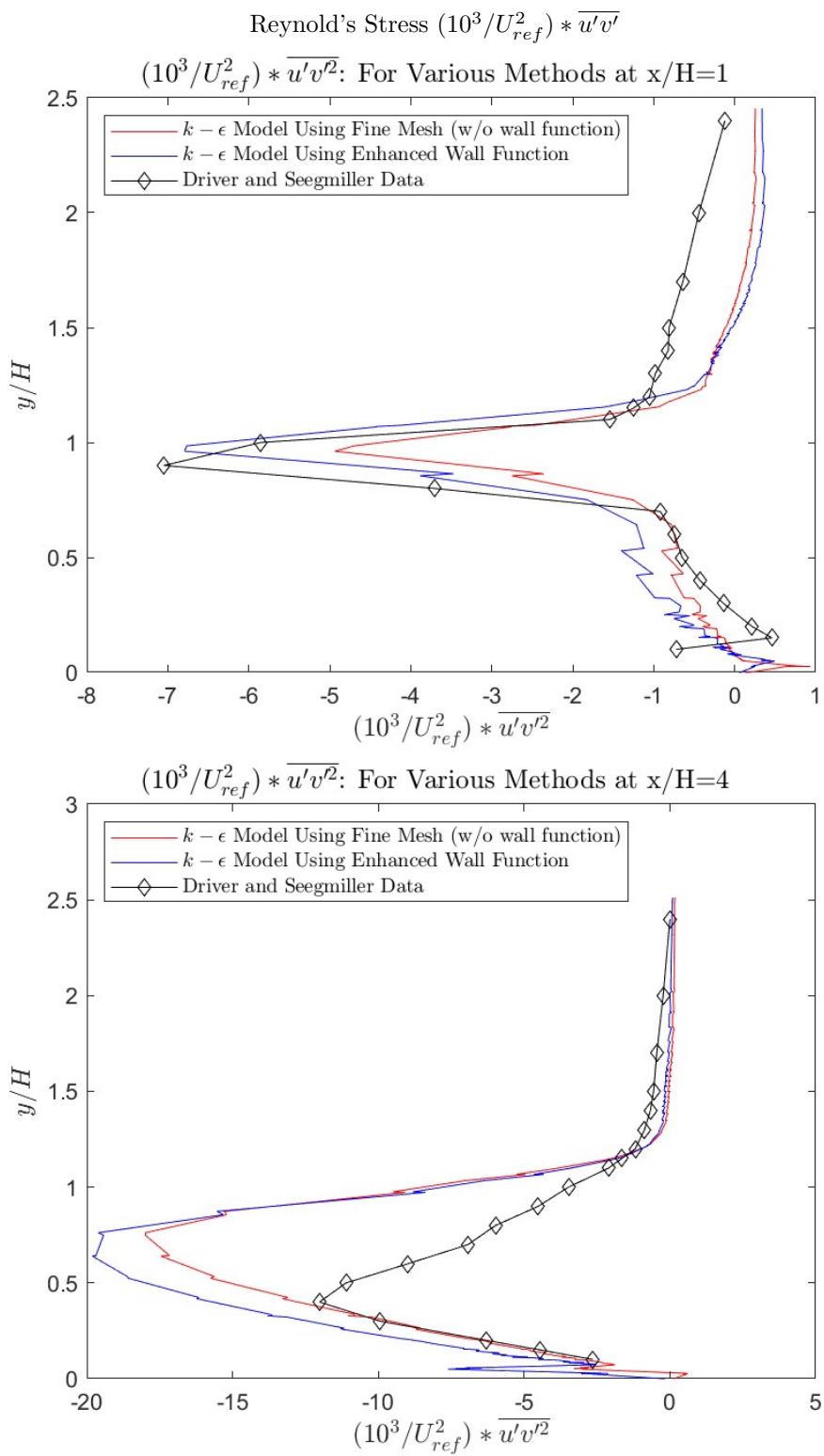


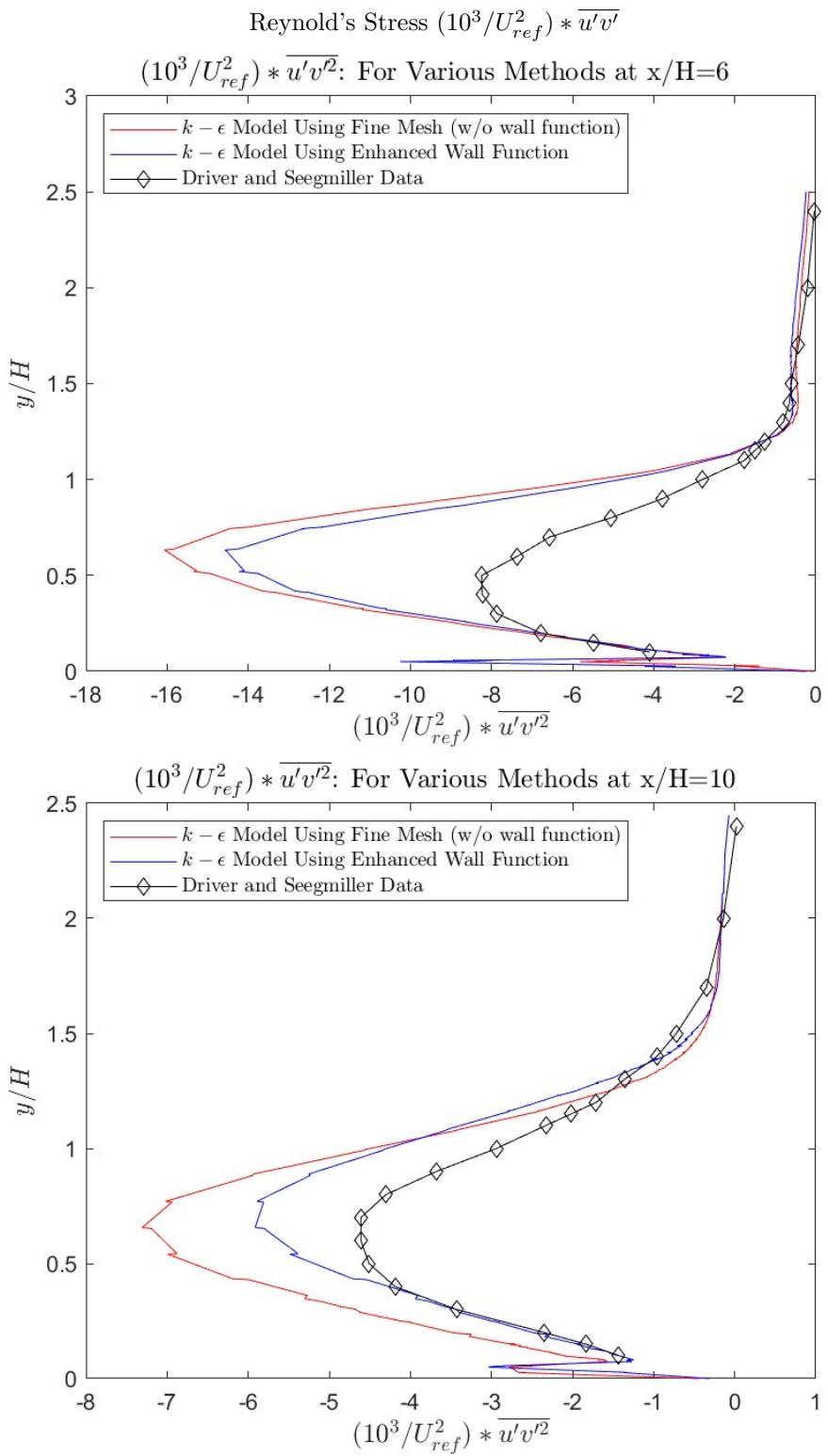


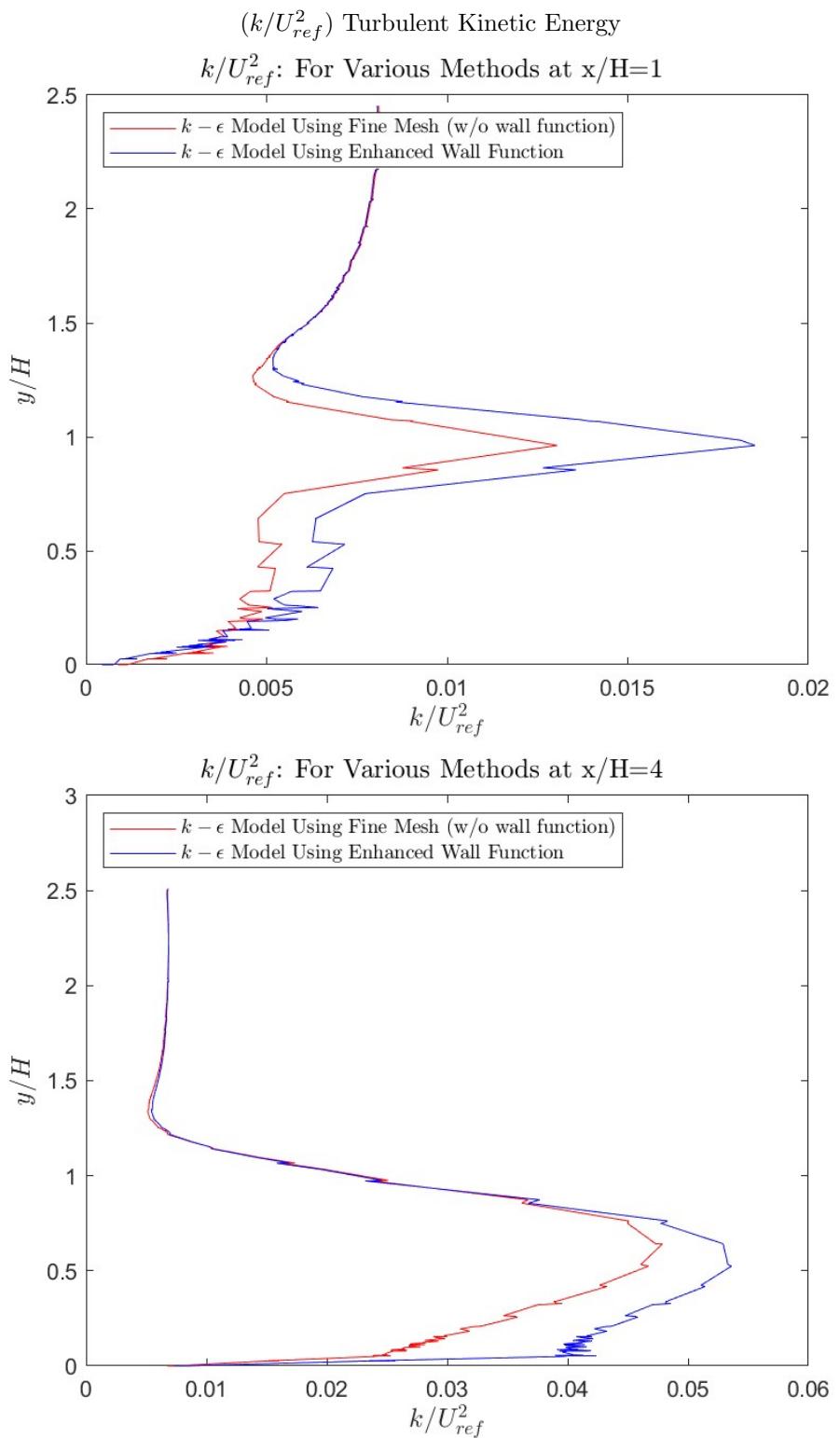


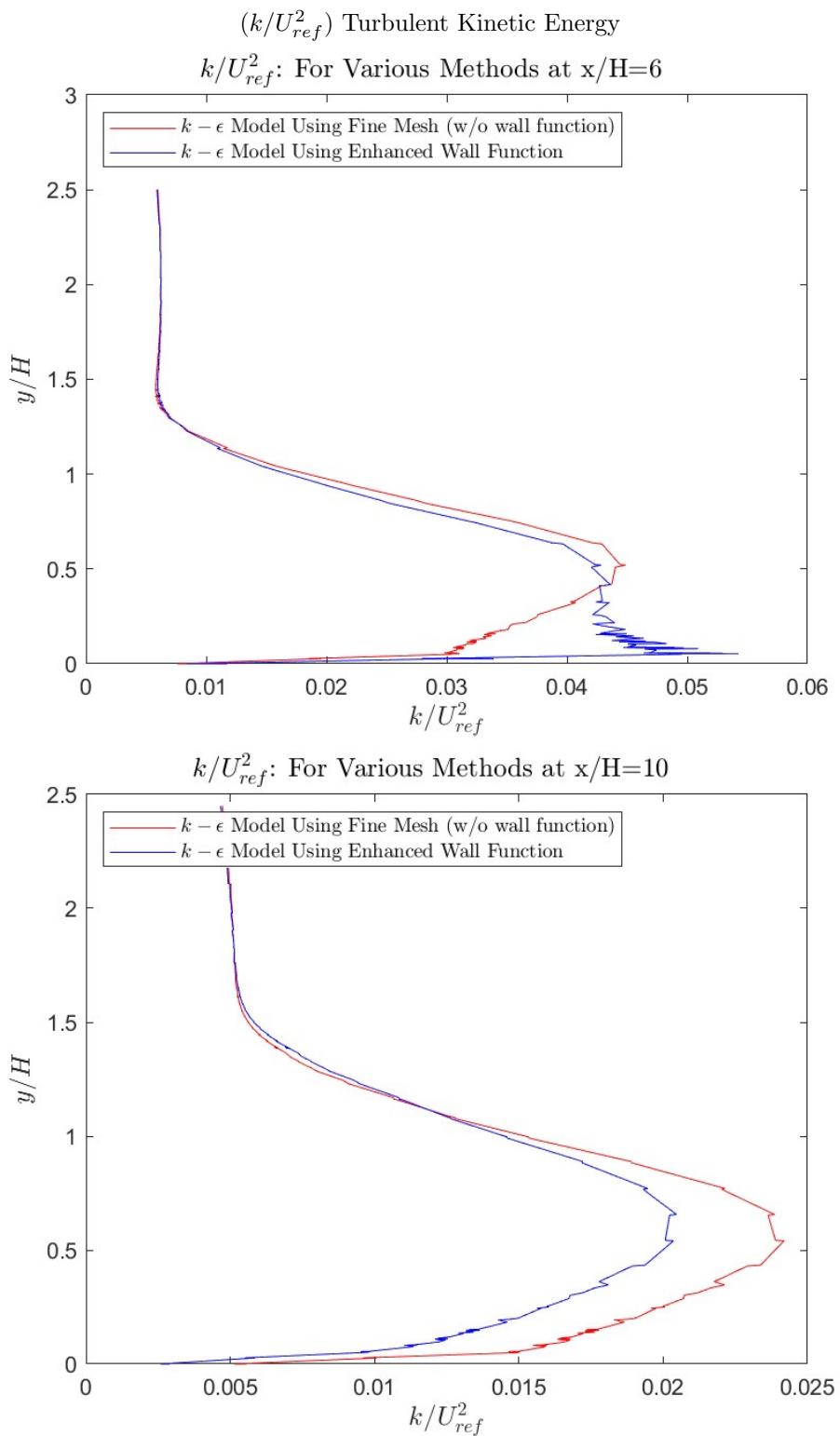


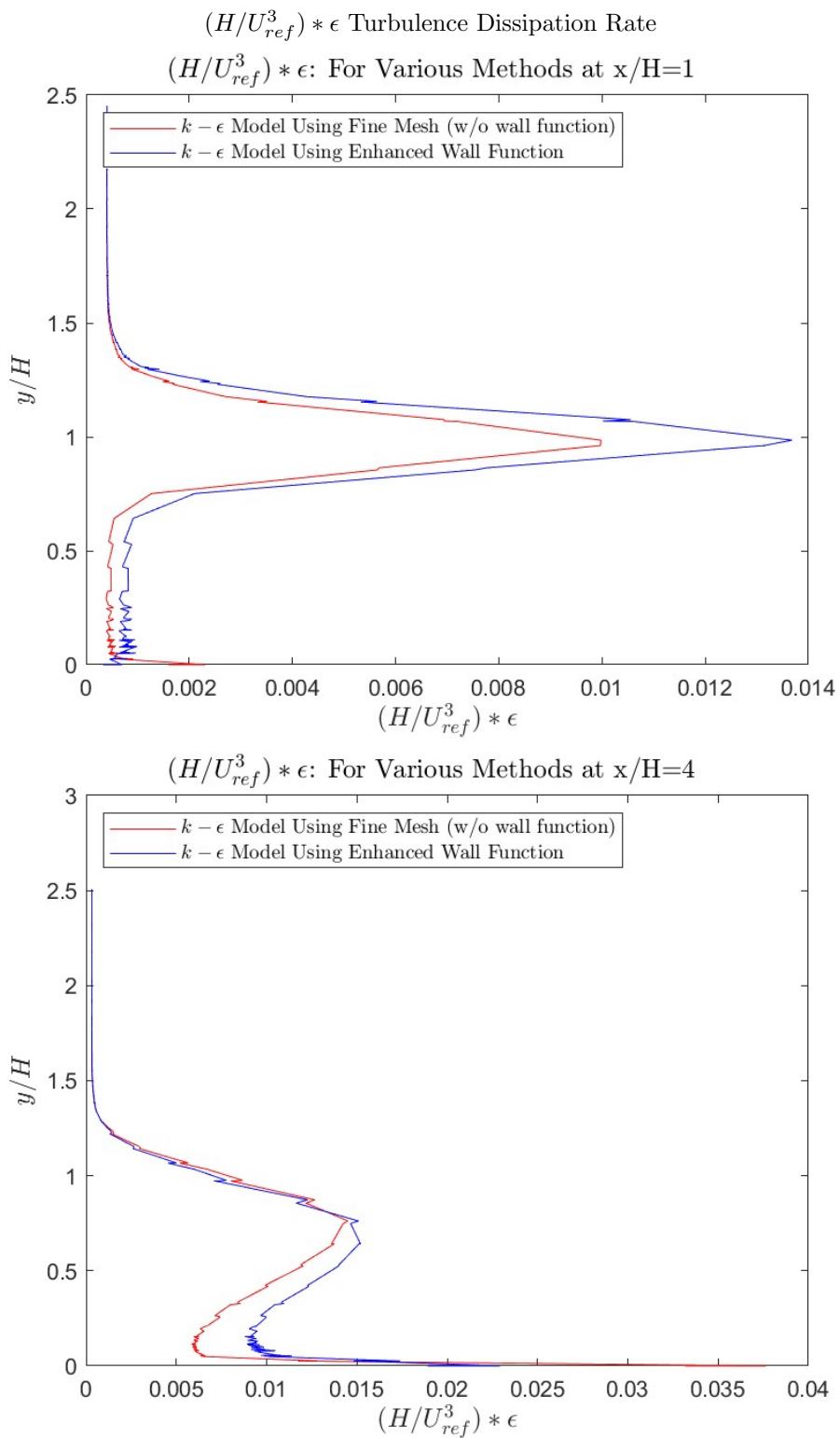


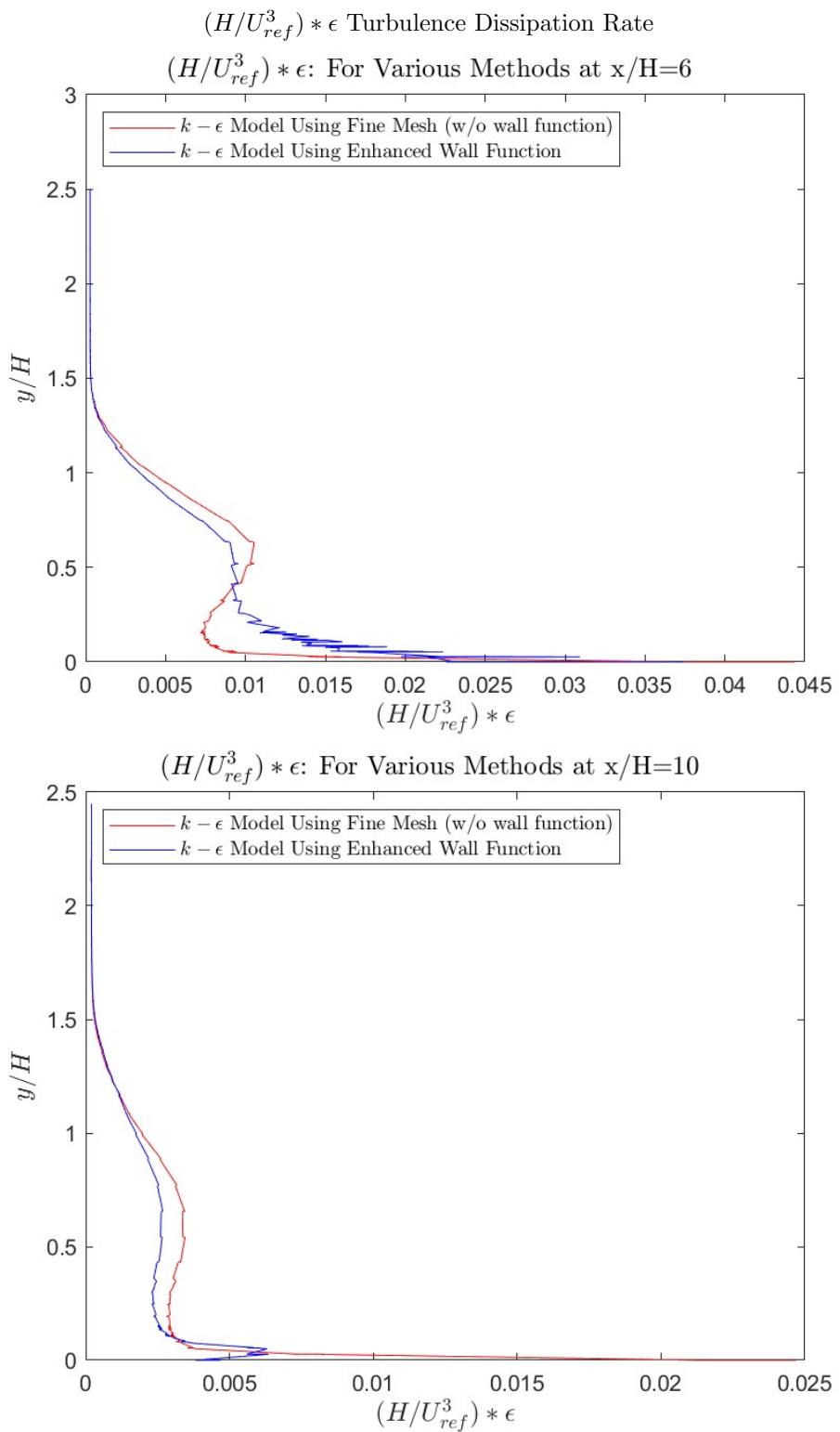












Q11: Does the choice of these the wall functions have any significant effect on the results from these three turbulence models for this problem?

Answer: The results for both the standard and the enhanced wall function look essentially the same for all the turbulent quantities. No clear distinction between the effects of these two wall functions can be made from the results. There is a slight deviation between the two wall functions for all the quantities, but these deviations seem to be very minuscule.

Q12: Do your results show that the “enhanced wall treatment” improves the accuracy of the model results when compared to the experimental data?

Answer: Upon comparison with the reference data from Driver and Seegmiller, it is observed that the enhanced wall functions provide more accurate results for Reynolds stress, with deviations from the reference data being smaller than those from the standard wall function. However, the x-velocities appear to be similar for both wall functions, while the y-velocities show inferior performance for the enhanced wall function. Nevertheless, the observed differences between the two wall treatments are so minimal that we cannot ascertain whether the enhanced wall treatment leads to an improvement in the accuracy of the predictions.

Q13: How does the magnitude of the differences in the model results for these two wall treatments compare with the magnitude of the overall differences between the model results and the experimental data?

Answer: As previously mentioned in Q11 and Q12, the results obtained using both the standard and enhanced wall functions exhibit minimal differences. As a result, it is difficult to distinguish any notable distinctions between the results of these two wall functions and their deviation from the Driver and Seegmiller data.

6 Conclusion

The project aimed to predict the fluid flow characteristics inside a channel with a backward step using three different turbulence models: $k - \epsilon$, $k - \omega$, and RSTM. The predicted results were compared with the reference experimental data from Driver and Seegmiller, and all three models produced good approximations of the actual flow characteristics. The RSTM model was observed to be the best overall in predicting the flow characteristics, including the extended fluid re-circulation zone, detailed Reynolds stresses, and kinetic energy and dissipation. However, the $k - \omega$ fine case predicted the corner eddies formed in the y-velocity contours, but it seemed to be off by a considerable margin, and it is unclear whether it is too wrong or too correct. Therefore, the RSTM model can be preferred over the $k - \epsilon$, $k - \omega$, and RSTM models.

The models were found to over predict the Reynolds stress, except for the $k - \omega$ model, which was slightly off. Different wall functions were also tested, but they did not yield any significant differences in the results, making it difficult to draw conclusive results.

The project also discussed various error sources, including those related to the experimental data from Driver and Seegmiller and the modelled equations used by ANSYS to solve the three turbulence models.

Appendix

Code for all $k - \epsilon$ Coarse

```

1 H=0.0127;
2 coarseke=xlsread("coarseke.csv");
3 x=(coarseke(:,2)/H)-15;
4 y=(coarseke(:,3)/H);
5 u=coarseke(:,7)/44.2;
6 v=coarseke(:,8)/44.2;
7 uu=(coarseke(:,4)*1000)/(44.2*44.2);
8 vv=(coarseke(:,5)*1000)/(44.2*44.2);
9 uv=(coarseke(:,6)*1000)/(44.2*44.2);
10 k=coarseke(:,9)/(44.2*44.2);
11 ep=(coarseke(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);
13
14 %u
15 figure(1);
16 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
17 F=scatteredInterpolant(x,y,u);
18 Z=F(X, Y);
19 contourf(X,Y,Z,400,'edgecolor','none')
20 colormap('jet')
21 shading interp
22 colorbar()
23 ylim([0,2]); xlim([0,12]);
24 t1=sprintf('$\bar{u}/U_{ref}:k-\epsilon$ Turbulence Model using Coarse mesh');
25 set(t1,'Interpreter','latex')
26 set(t1,'FontSize',12)
27 x2=xlabel('$x/H$');
28 set(x2,'Interpreter','latex')
29 set(x2,'FontSize',12)
30 y2=ylabel('$y/H$');
31 set(y2,'Interpreter','latex')
32 set(y2,'FontSize',12)
33 set(gca,'ytick',0:0.5:2)
34 set(gca,'xtick',0:2:12)
35 set(gcf,'position',[10,10,1050,300])
36
37 %v
38 figure(2);
39 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
40 F=scatteredInterpolant(x,y,v);
41 Z=F(X, Y);
42 contourf(X,Y,Z,400,'edgecolor','none')
43 colormap('jet')
44 shading interp
45 colorbar()
46 ylim([0,2]); xlim([0,12]);
47 t1=sprintf('$\bar{v}/U_{ref}:k-\epsilon$ Turbulence Model using Coarse mesh');
48 set(t1,'Interpreter','latex')
49 set(t1,'FontSize',12)
50 x2=xlabel('$x/H$');

```

```

51 set(x2,'Interpreter','latex')
52 set(x2,'FontSize',12)
53 y2=ylabel('$y/H$');
54 set(y2,'Interpreter','latex')
55 set(y2,'FontSize',12)
56 set(gca,'ytick',0:0.5:2)
57 set(gca,'xtick',0:2:12)
58 set(gcf,'position',[10,10,1050,300])
59 %uu
60 figure(3);
61 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
62 F=scatteredInterpolant(x,y,uu);
63 Z=F(X, Y);
64 contourf(X,Y,Z,400,'edgecolor','none')
65 colormap('jet')
66 shading interp
67 colorbar()
68 ylim([0,2]); xlim([0,12]);
69 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{u^{\prime\prime}}:k-\epsilon$ Turbulence
    Model using Coarse mesh');
70 set(t1,'Interpreter','latex')
71 set(t1,'FontSize',12)
72 x2=xlabel('$x/H$');
73 set(x2,'Interpreter','latex')
74 set(x2,'FontSize',12)
75 y2=ylabel('$y/H$');
76 set(y2,'Interpreter','latex')
77 set(y2,'FontSize',12)
78 set(gca,'ytick',0:0.5:2)
79 set(gca,'xtick',0:2:12)
80 set(gcf,'position',[10,10,1050,300])
81
82 %vv
83 figure(4);
84 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
85 F=scatteredInterpolant(x,y,vv);
86 Z=F(X, Y);
87 contourf(X,Y,Z,400,'edgecolor','none')
88 colormap('jet')
89 shading interp
90 colorbar()
91 ylim([0,2]); xlim([0,12]);
92 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{v^{\prime\prime}}:k-\epsilon$ Turbulence
    Model using Coarse mesh');
93 set(t1,'Interpreter','latex')
94 set(t1,'FontSize',12)
95 x2=xlabel('$x/H$');
96 set(x2,'Interpreter','latex')
97 set(x2,'FontSize',12)
98 y2=ylabel('$y/H$');
99 set(y2,'Interpreter','latex')
100 set(y2,'FontSize',12)
101 set(gca,'ytick',0:0.5:2)

```

```

103 set(gca, 'xtick',0:2:12)
104 set(gcf, 'position',[10,10,1050,300])
105
106 %uv
107 figure(5);
108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);
110 Z=F(X, Y);
111 contourf(X,Y,Z,400,'edgecolor','none')
112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$({10^3}/{U_{ref}})^2)*\overline{u^{\prime }}\overline{v^{\prime }}:k-\epsilon$ Turbulence Model using Coarse mesh');
117 set(t1, 'Interpreter', 'latex')
118 set(t1, 'FontSize', 12)
119 x2=xlabel('$x/H$');
120 set(x2, 'Interpreter', 'latex')
121 set(x2, 'FontSize', 12)
122 y2=ylabel('$y/H$');
123 set(y2, 'Interpreter', 'latex')
124 set(y2, 'FontSize', 12)
125 set(gca, 'ytick',0:0.5:2)
126 set(gca, 'xtick',0:2:12)
127 set(gcf, 'position',[10,10,1050,300])
128
129 %k
130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);
133 Z=F(X, Y);
134 contourf(X,Y,Z,400,'edgecolor','none')
135 colormap('jet')
136 shading interp
137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('${(k/U_{ref})^2}:k-\epsilon$ Turbulence Model using Coarse mesh');
140 set(t1, 'Interpreter', 'latex')
141 set(t1, 'FontSize', 12)
142 x2=xlabel('$x/H$');
143 set(x2, 'Interpreter', 'latex')
144 set(x2, 'FontSize', 12)
145 y2=ylabel('$y/H$');
146 set(y2, 'Interpreter', 'latex')
147 set(y2, 'FontSize', 12)
148 set(gca, 'ytick',0:0.5:2)
149 set(gca, 'xtick',0:2:12)
150 set(gcf, 'position',[10,10,1050,300])
151
152 %
153 %e
154 figure(7);
155 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));

```

```

156 F=scatteredInterpolant(x,y,ep);
157 Z=F(X, Y);
158 contourf(X,Y,Z,400, 'edgecolor', 'none')
159 colormap('jet')
160 shading interp
161 colorbar()
162 ylim([0,2]); xlim([0,12]);
163 t1=sgtitle('$H/U_{ref}^3)*\epsilon$ Turbulence Model using Coarse
    mesh');
164 set(t1, 'Interpreter', 'latex')
165 set(t1, 'FontSize', 12)
166 x2=xlabel('$x/H$');
167 set(x2, 'Interpreter', 'latex')
168 set(x2, 'FontSize', 12)
169 y2=ylabel('$y/H$');
170 set(y2, 'Interpreter', 'latex')
171 set(y2, 'FontSize', 12)
172 set(gca, 'ytick', 0:0.5:2)
173 set(gca, 'xtick', 0:2:12)
174 set(gcf, 'position', [10, 10, 1050, 300])
175
176 saveas(figure(1), 'u', 'jpg')
177 saveas(figure(2), 'v', 'jpg')
178 saveas(figure(3), 'k', 'jpg')
179 saveas(figure(4), 'ep', 'jpg')
180 saveas(figure(5), 'uu', 'jpg')
181 saveas(figure(6), 'vv', 'jpg')
182 saveas(figure(7), 'uv', 'jpg',

```

Code for all $k - \epsilon$ Medium

```

1 H=0.0127;
2 mediumke=xlsread("mediumke.csv");
3 x=(mediumke(:,2)/H)-15;
4 y=(mediumke(:,3)/H);
5 u=mediumke(:,7)/44.2;
6 v=mediumke(:,8)/44.2;
7 uu=(mediumke(:,4)*1000)/(44.2*44.2);
8 vv=(mediumke(:,5)*1000)/(44.2*44.2);
9 uv=(mediumke(:,6)*1000)/(44.2*44.2);
10 k=mediumke(:,9)/(44.2*44.2);
11 ep=(mediumke(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);
13
14 %u
15 figure(1);
16 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
17 F=scatteredInterpolant(x,y,u);
18 Z=F(X, Y);
19 contourf(X,Y,Z,400, 'edgecolor', 'none')
20 colormap('jet')
21 shading interp
22 colorbar()
23 ylim([0,2]); xlim([0,12]);
24 t1=sgtitle('$\bar{u}/U_{ref}:k-\epsilon$ Turbulence Model using Medium mesh');

```

```

25 set(t1,'Interpreter','latex')
26 set(t1,'FontSize',12)
27 x2=xlabel('$x/H$');
28 set(x2,'Interpreter','latex')
29 set(x2,'FontSize',12)
30 y2=ylabel('$y/H$');
31 set(y2,'Interpreter','latex')
32 set(y2,'FontSize',12)
33 set(gca,'ytick',0:0.5:2)
34 set(gca,'xtick',0:2:12)
35 set(gcf,'position',[10,10,1050,300])
36
37 %v
38 figure(2);
39 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
40 F=scatteredInterpolant(x,y,v);
41 Z=F(X, Y);
42 contourf(X,Y,Z,400,'edgecolor','none')
43 colormap('jet')
44 shading interp
45 colorbar()
46 ylim([0,2]); xlim([0,12]);
47 t1=sprintf('$\bar{v}/U_{ref}:k-\epsilon$ Turbulence Model using Medium mesh');
48 set(t1,'Interpreter','latex')
49 set(t1,'FontSize',12)
50 x2=xlabel('$x/H$');
51 set(x2,'Interpreter','latex')
52 set(x2,'FontSize',12)
53 y2=ylabel('$y/H$');
54 set(y2,'Interpreter','latex')
55 set(y2,'FontSize',12)
56 set(gca,'ytick',0:0.5:2)
57 set(gca,'xtick',0:2:12)
58 set(gcf,'position',[10,10,1050,300])
59
60 %uu
61 figure(3);
62 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
63 F=scatteredInterpolant(x,y,uu);
64 Z=F(X, Y);
65 contourf(X,Y,Z,400,'edgecolor','none')
66 colormap('jet')
67 shading interp
68 colorbar()
69 ylim([0,2]); xlim([0,12]);
70 t1=sprintf('${(10^3/U_{ref})^2}*\overline{u'^2}:k-\epsilon$ Turbulence
    Model using Medium mesh');
71 set(t1,'Interpreter','latex')
72 set(t1,'FontSize',12)
73 x2=xlabel('$x/H$');
74 set(x2,'Interpreter','latex')
75 set(x2,'FontSize',12)
76 y2=ylabel('$y/H$');
77 set(y2,'Interpreter','latex')

```

```

78 set(y2, 'Fontsize',12)
79 set(gca, 'ytick',0:0.5:2)
80 set(gca, 'xtick',0:2:12)
81 set(gcf, 'position',[10,10,1050,300])
82
83 %vv
84 figure(4);
85 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
86 F=scatteredInterpolant(x,y,vv);
87 Z=F(X, Y);
88 contourf(X,Y,Z,400,'edgecolor','none')
89 colormap('jet')
90 shading interp
91 colorbar()
92 ylim([0,2]); xlim([0,12]);
93 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{v^{\prime\prime}}:k-\epsilon$ Turbulence
    Model using Medium mesh');
94 set(t1, 'Interpreter','latex')
95 set(t1, 'FontSize',12)
96 x2=xlabel('$x/H$');
97 set(x2, 'Interpreter','latex')
98 set(x2, 'FontSize',12)
99 y2=ylabel('$y/H$');
100 set(y2, 'Interpreter','latex')
101 set(y2, 'FontSize',12)
102 set(gca, 'ytick',0:0.5:2)
103 set(gca, 'xtick',0:2:12)
104 set(gcf, 'position',[10,10,1050,300])
105
106 %uv
107 figure(5);
108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);
110 Z=F(X, Y);
111 contourf(X,Y,Z,400,'edgecolor','none')
112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{u^{\prime\prime}}\overline{v^{\prime\prime}}:k-\epsilon$ Turbulence Model using Medium mesh');
117 set(t1, 'Interpreter','latex')
118 set(t1, 'FontSize',12)
119 x2=xlabel('$x/H$');
120 set(x2, 'Interpreter','latex')
121 set(x2, 'FontSize',12)
122 y2=ylabel('$y/H$');
123 set(y2, 'Interpreter','latex')
124 set(y2, 'FontSize',12)
125 set(gca, 'ytick',0:0.5:2)
126 set(gca, 'xtick',0:2:12)
127 set(gcf, 'position',[10,10,1050,300])
128
129 %k

```

```

130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);
133 Z=F(X, Y);
134 contourf(X,Y,Z,400, 'edgecolor', 'none')
135 colormap('jet')
136 shading interp
137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('$(k/U_{ref})^2:k-\epsilon$ Turbulence Model using Medium mesh');
140 set(t1, 'Interpreter', 'latex')
141 set(t1, 'FontSize', 12)
142 x2=xlabel('$x/H$');
143 set(x2, 'Interpreter', 'latex')
144 set(x2, 'FontSize', 12)
145 y2=ylabel('$y/H$');
146 set(y2, 'Interpreter', 'latex')
147 set(y2, 'FontSize', 12)
148 set(gca, 'ytick', 0:0.5:2)
149 set(gca, 'xtick', 0:2:12)
150 set(gcf, 'position',[10,10,1050,300])
151
152 %e
153 figure(7);
154 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
155 F=scatteredInterpolant(x,y,ep);
156 Z=F(X, Y);
157 contourf(X,Y,Z,400, 'edgecolor', 'none')
158 colormap('jet')
159 shading interp
160 colorbar()
161 ylim([0,2]); xlim([0,12]);
162 t1=sgtitle('$(H/U_{ref})^3:\epsilon:k-\epsilon$ Turbulence Model using Medium
163 mesh');
164 set(t1, 'Interpreter', 'latex')
165 set(t1, 'FontSize', 12)
166 x2=xlabel('$x/H$');
167 set(x2, 'Interpreter', 'latex')
168 set(x2, 'FontSize', 12)
169 y2=ylabel('$y/H$');
170 set(y2, 'Interpreter', 'latex')
171 set(y2, 'FontSize', 12)
172 set(gca, 'ytick', 0:0.5:2)
173 set(gca, 'xtick', 0:2:12)
174 set(gcf, 'position',[10,10,1050,300])
175
176 saveas(figure(1), 'u', 'jpg')
177 saveas(figure(2), 'v', 'jpg')
178 saveas(figure(3), 'k', 'jpg')
179 saveas(figure(4), 'ep', 'jpg')
180 saveas(figure(5), 'uu', 'jpg')
181 saveas(figure(6), 'vv', 'jpg')
182 saveas(figure(7), 'uv', 'jpg')

```

Code for all $k - \epsilon$ Fine

```

1 H=0.0127;
2 fineke=xlsread("fineke.csv");
3 x=(fineke(:,2)/H)-15;
4 y=(fineke(:,3)/H);
5 u=fineke(:,7)/44.2;
6 v=fineke(:,8)/44.2;
7 uu=(fineke(:,4)*1000)/(44.2*44.2);
8 vv=(fineke(:,5)*1000)/(44.2*44.2);
9 uv=(fineke(:,6)*1000)/(44.2*44.2);
10 k=fineke(:,9)/(44.2*44.2);
11 ep=(fineke(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);

13 %u
14 figure(1);
15 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
16 F=scatteredInterpolant(x,y,u);
17 Z=F(X, Y);
18 contourf(X,Y,Z,400, 'edgecolor', 'none')
19 colormap('jet')
20 shading interp
21 colorbar()
22 ylim([0,2]); xlim([0,12]);
23 t1=sgtitle('$\bar{u}/U_{ref}:k-\epsilon$ Turbulence Model using Fine mesh');
24 set(t1, 'Interpreter', 'latex')
25 set(t1, 'FontSize', 12)
26 x2=xlabel('$x/H$');
27 set(x2, 'Interpreter', 'latex')
28 set(x2, 'FontSize', 12)
29 y2=ylabel('$y/H$');
30 set(y2, 'Interpreter', 'latex')
31 set(y2, 'FontSize', 12)
32 set(gca, 'ytick', 0:0.5:2)
33 set(gca, 'xtick', 0:2:12)
34 set(gcf, 'position',[10,10,1050,300])

35 %v
36 figure(2);
37 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
38 F=scatteredInterpolant(x,y,v);
39 Z=F(X, Y);
40 contourf(X,Y,Z,400, 'edgecolor', 'none')
41 colormap('jet')
42 shading interp
43 colorbar()
44 ylim([0,2]); xlim([0,12]);
45 t1=sgtitle('$\bar{v}/U_{ref}:k-\epsilon$ Turbulence Model using Fine mesh');
46 set(t1, 'Interpreter', 'latex')
47 set(t1, 'FontSize', 12)
48 x2=xlabel('$x/H$');
49 set(x2, 'Interpreter', 'latex')
50 set(x2, 'FontSize', 12)
51 y2=ylabel('$y/H$');
52
```

```

54 set(y2,'Interpreter','latex')
55 set(y2,'FontSize',12)
56 set(gca,'ytick',0:0.5:2)
57 set(gca,'xtick',0:2:12)
58 set(gcf,'position',[10,10,1050,300])
59
60 %uu
61 figure(3);
62 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
63 F=scatteredInterpolant(x,y,uu);
64 Z=F(X, Y);
65 contourf(X,Y,Z,400,'edgecolor','none')
66 colormap('jet')
67 shading interp
68 colorbar()
69 ylim([0,2]); xlim([0,12]);
70 t1=sgtitle('$({10}^3/U_{ref})^2)*\overline{u^{\prime\prime}}:k-\epsilon$ Turbulence
    Model using Fine mesh');
71 set(t1,'Interpreter','latex')
72 set(t1,'FontSize',12)
73 x2=xlabel('$x/H$');
74 set(x2,'Interpreter','latex')
75 set(x2,'FontSize',12)
76 y2=ylabel('$y/H$');
77 set(y2,'Interpreter','latex')
78 set(y2,'FontSize',12)
79 set(gca,'ytick',0:0.5:2)
80 set(gca,'xtick',0:2:12)
81 set(gcf,'position',[10,10,1050,300])
82
83 %vv
84 figure(4);
85 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
86 F=scatteredInterpolant(x,y,vv);
87 Z=F(X, Y);
88 contourf(X,Y,Z,400,'edgecolor','none')
89 colormap('jet')
90 shading interp
91 colorbar()
92 ylim([0,2]); xlim([0,12]);
93 t1=sgtitle('$({10}^3/U_{ref})^2)*\overline{v^{\prime\prime}}:k-\epsilon$ Turbulence
    Model using Fine mesh');
94 set(t1,'Interpreter','latex')
95 set(t1,'FontSize',12)
96 x2=xlabel('$x/H$');
97 set(x2,'Interpreter','latex')
98 set(x2,'FontSize',12)
99 y2=ylabel('$y/H$');
100 set(y2,'Interpreter','latex')
101 set(y2,'FontSize',12)
102 set(gca,'ytick',0:0.5:2)
103 set(gca,'xtick',0:2:12)
104 set(gcf,'position',[10,10,1050,300])
105

```

```

106 %uv
107 figure(5);
108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);
110 Z=F(X, Y);
111 contourf(X,Y,Z,400, 'edgecolor', 'none')
112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$({10}^3/U_{ref})^2)\overline{u^{\prime}}\overline{v^{\prime}}:k-\epsilon$ Turbulence Model using Fine mesh');
117 set(t1, 'Interpreter', 'latex')
118 set(t1, 'FontSize', 12)
119 x2=xlabel('$x/H$');
120 set(x2, 'Interpreter', 'latex')
121 set(x2, 'FontSize', 12)
122 y2=ylabel('$y/H$');
123 set(y2, 'Interpreter', 'latex')
124 set(y2, 'FontSize', 12)
125 set(gca, 'ytick', 0:0.5:2)
126 set(gca, 'xtick', 0:2:12)
127 set(gcf, 'position',[10,10,1050,300])
128
129 %k
130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);
133 Z=F(X, Y);
134 contourf(X,Y,Z,400, 'edgecolor', 'none')
135 colormap('jet')
136 shading interp
137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('$({k}/U_{ref})^2):k-\epsilon$ Turbulence Model using Fine mesh');
140 set(t1, 'Interpreter', 'latex')
141 set(t1, 'FontSize', 12)
142 x2=xlabel('$x/H$');
143 set(x2, 'Interpreter', 'latex')
144 set(x2, 'FontSize', 12)
145 y2=ylabel('$y/H$');
146 set(y2, 'Interpreter', 'latex')
147 set(y2, 'FontSize', 12)
148 set(gca, 'ytick', 0:0.5:2)
149 set(gca, 'xtick', 0:2:12)
150 set(gcf, 'position',[10,10,1050,300])
151
152
153 %e
154 figure(7);
155 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
156 F=scatteredInterpolant(x,y,ep);
157 Z=F(X, Y);
158 contourf(X,Y,Z,400, 'edgecolor', 'none')

```

```

159 colormap('jet')
160 shading interp
161 colorbar()
162 ylim([0,2]); xlim([0,12]);
163 t1=sgtitle('$H/U_{ref}^3*\epsilon:k-\omega$ Turbulence Model using Fine
    mesh');
164 set(t1,'Interpreter','latex')
165 set(t1,'FontSize',12)
166 x2=xlabel('$x/H$');
167 set(x2,'Interpreter','latex')
168 set(x2,'FontSize',12)
169 y2=ylabel('$y/H$');
170 set(y2,'Interpreter','latex')
171 set(y2,'FontSize',12)
172 set(gca,'ytick',0:0.5:2)
173 set(gca,'xtick',0:2:12)
174 set(gcf,'position',[10,10,1050,300])
175
176 saveas(figure(1),'u','jpg')
177 saveas(figure(2),'v','jpg')
178 saveas(figure(3),'k','jpg')
179 saveas(figure(4),'ep','jpg')
180 saveas(figure(5),'uu','jpg')
181 saveas(figure(6),'vv','jpg')
182 saveas(figure(7),'uv','jpg')

```

Code for all $k - \omega$ coarse

```

1 H=0.0127;
2 coarsekw=xlsread("coarsekw.csv");
3 x=(coarsekw(:,2)/H)-15;
4 y=(coarsekw(:,3)/H);
5 u=coarsekw(:,7)/44.2;
6 v=coarsekw(:,8)/44.2;
7 uu=(coarsekw(:,4)*1000)/(44.2*44.2);
8 vv=(coarsekw(:,5)*1000)/(44.2*44.2);
9 uv=(coarsekw(:,6)*1000)/(44.2*44.2);
10 k=coarsekw(:,9)/(44.2*44.2);
11 ep=(coarsekw(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);
13
14 %u
15 figure(1);
16 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
17 F=scatteredInterpolant(x,y,u);
18 Z=F(X, Y);
19 contourf(X,Y,Z,400,'edgecolor','none')
20 colormap('jet')
21 shading interp
22 colorbar()
23 ylim([0,2]); xlim([0,12]);
24 t1=sgtitle('$|\bar{u}|/U_{ref}:k-\omega$ Turbulence Model using Coarse mesh');
25 set(t1,'Interpreter','latex')
26 set(t1,'FontSize',12)
27 x2=xlabel('$x/H$');

```

```

28 set(x2,'Interpreter','latex')
29 set(x2,'FontSize',12)
30 y2=ylabel('$y/H$');
31 set(y2,'Interpreter','latex')
32 set(y2,'FontSize',12)
33 set(gca,'ytick',0:0.5:2)
34 set(gca,'xtick',0:2:12)
35 set(gcf,'position',[10,10,1050,300])
36 %
37 %v
38 figure(2);
39 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
40 F=scatteredInterpolant(x,y,v);
41 Z=F(X, Y);
42 contourf(X,Y,Z,400,'edgecolor','none')
43 colormap('jet')
44 shading interp
45 colorbar()
46 ylim([0,2]); xlim([0,12]);
47 t1=sprintf('$\bar{v}/U_{ref}:k-\omega$ Turbulence Model using Coarse mesh');
48 set(t1,'Interpreter','latex')
49 set(t1,'FontSize',12)
50 x2=xlabel('$x/H$');
51 set(x2,'Interpreter','latex')
52 set(x2,'FontSize',12)
53 y2=ylabel('$y/H$');
54 set(y2,'Interpreter','latex')
55 set(y2,'FontSize',12)
56 set(gca,'ytick',0:0.5:2)
57 set(gca,'xtick',0:2:12)
58 set(gcf,'position',[10,10,1050,300])
59 %
60 %uu
61 figure(3);
62 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
63 F=scatteredInterpolant(x,y,uu);
64 Z=F(X, Y);
65 contourf(X,Y,Z,400,'edgecolor','none')
66 colormap('jet')
67 shading interp
68 colorbar()
69 ylim([0,2]); xlim([0,12]);
70 t1=sprintf('${(10^3/U_{ref})^2}*\overline{u'{'\prime}^2}:k-\omega$ Turbulence
    Model using Coarse mesh');
71 set(t1,'Interpreter','latex')
72 set(t1,'FontSize',12)
73 x2=xlabel('$x/H$');
74 set(x2,'Interpreter','latex')
75 set(x2,'FontSize',12)
76 y2=ylabel('$y/H$');
77 set(y2,'Interpreter','latex')
78 set(y2,'FontSize',12)
79 set(gca,'ytick',0:0.5:2)
80 set(gca,'xtick',0:2:12)

```

```

81 set(gcf, 'position',[10,10,1050,300])
82 
83 %vv
84 figure(4);
85 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
86 F=scatteredInterpolant(x,y,vv);
87 Z=F(X, Y);
88 contourf(X,Y,Z,400, 'edgecolor', 'none')
89 colormap('jet')
90 shading interp
91 colorbar()
92 ylim([0,2]); xlim([0,12]);
93 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{v^{\prime }}:k-\omega $ Turbulence
    Model using Coarse mesh');
94 set(t1, 'Interpreter', 'latex')
95 set(t1, 'FontSize', 12)
96 x2=xlabel('$x/H$');
97 set(x2, 'Interpreter', 'latex')
98 set(x2, 'FontSize', 12)
99 y2=ylabel('$y/H$');
100 set(y2, 'Interpreter', 'latex')
101 set(y2, 'FontSize', 12)
102 set(gca, 'ytick', 0:0.5:2)
103 set(gca, 'xtick', 0:2:12)
104 set(gcf, 'position',[10,10,1050,300])
105 
106 %uv
107 figure(5);
108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);
110 Z=F(X, Y);
111 contourf(X,Y,Z,400, 'edgecolor', 'none')
112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{u^{\prime }}\overline{v^{\prime }}:k-\omega $ Turbulence Model using Coarse mesh');
117 set(t1, 'Interpreter', 'latex')
118 set(t1, 'FontSize', 12)
119 x2=xlabel('$x/H$');
120 set(x2, 'Interpreter', 'latex')
121 set(x2, 'FontSize', 12)
122 y2=ylabel('$y/H$');
123 set(y2, 'Interpreter', 'latex')
124 set(y2, 'FontSize', 12)
125 set(gca, 'ytick', 0:0.5:2)
126 set(gca, 'xtick', 0:2:12)
127 set(gcf, 'position',[10,10,1050,300])
128 
129 %k
130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);

```

```

133 Z=F(X, Y);
134 contourf(X,Y,Z,400, 'edgecolor', 'none')
135 colormap('jet')
136 shading interp
137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('$(k/U_{ref})^2:k-\omega$ Turbulence Model using Coarse mesh');
140 set(t1, 'Interpreter', 'latex')
141 set(t1, 'Fontsize', 12)
142 x2=xlabel('$x/H$');
143 set(x2, 'Interpreter', 'latex')
144 set(x2, 'Fontsize', 12)
145 y2=ylabel('$y/H$');
146 set(y2, 'Interpreter', 'latex')
147 set(y2, 'Fontsize', 12)
148 set(gca, 'ytick', 0:0.5:2)
149 set(gca, 'xtick', 0:2:12)
150 set(gcf, 'position', [10,10,1050,300])
151
152 %e
153 figure(7);
154 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
155 F=scatteredInterpolant(x,y,ep);
156 Z=F(X, Y);
157 contourf(X,Y,Z,400, 'edgecolor', 'none')
158 colormap('jet')
159 shading interp
160 colorbar()
161 ylim([0,2]); xlim([0,12]);
162 t1=sgtitle('$(H/U_{ref})^3*\epsilon:k-\omega$ Turbulence Model using Coarse
    mesh');
163 set(t1, 'Interpreter', 'latex')
164 set(t1, 'Fontsize', 12)
165 x2=xlabel('$x/H$');
166 set(x2, 'Interpreter', 'latex')
167 set(x2, 'Fontsize', 12)
168 y2=ylabel('$y/H$');
169 set(y2, 'Interpreter', 'latex')
170 set(y2, 'Fontsize', 12)
171 set(gca, 'ytick', 0:0.5:2)
172 set(gca, 'xtick', 0:2:12)
173 set(gcf, 'position', [10,10,1050,300])
174
175 saveas(figure(1), 'u', 'jpg')
176 saveas(figure(2), 'v', 'jpg')
177 saveas(figure(3), 'k', 'jpg')
178 saveas(figure(4), 'ep', 'jpg')
179 saveas(figure(5), 'uu', 'jpg')
180 saveas(figure(6), 'vv', 'jpg')
181 saveas(figure(7), 'uv', 'jpg')

```

Code for all $k - \omega$ medium

₁ H=0.0127;

```

2 mediumkw=xlsread ("mediumkw.csv");
3 x=(mediumkw(:,2)/H)-15;
4 y=(mediumkw(:,3)/H);
5 u=mediumkw(:,7)/44.2;
6 v=mediumkw(:,8)/44.2;
7 uu=(mediumkw(:,4)*1000)/(44.2*44.2);
8 vv=(mediumkw(:,5)*1000)/(44.2*44.2);
9 uv=(mediumkw(:,6)*1000)/(44.2*44.2);
10 k=mediumkw(:,9)/(44.2*44.2);
11 ep=(mediumkw(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);
13
14 %u
15 figure(1);
16 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
17 F=scatteredInterpolant(x,y,u);
18 Z=F(X, Y);
19 contourf(X,Y,Z,400,'edgecolor','none')
20 colormap('jet')
21 shading interp
22 colorbar()
23 ylim([0,2]); xlim([0,12]);
24 t1=sprintf('$\bar{u}/U_{ref}:k-\omega$ Turbulence Model using Medium mesh');
25 set(t1,'Interpreter','latex')
26 set(t1,'FontSize',12)
27 x2=xlabel('$x/H$');
28 set(x2,'Interpreter','latex')
29 set(x2,'FontSize',12)
30 y2=ylabel('$y/H$');
31 set(y2,'Interpreter','latex')
32 set(y2,'FontSize',12)
33 set(gca,'ytick',0:0.5:2)
34 set(gca,'xtick',0:2:12)
35 set(gcf,'position',[10,10,1050,300])
36
37 %v
38 figure(2);
39 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
40 F=scatteredInterpolant(x,y,v);
41 Z=F(X, Y);
42 contourf(X,Y,Z,400,'edgecolor','none')
43 colormap('jet')
44 shading interp
45 colorbar()
46 ylim([0,2]); xlim([0,12]);
47 t1=sprintf('$\bar{v}/U_{ref}:k-\omega$ Turbulence Model using Medium mesh');
48 set(t1,'Interpreter','latex')
49 set(t1,'FontSize',12)
50 x2=xlabel('$x/H$');
51 set(x2,'Interpreter','latex')
52 set(x2,'FontSize',12)
53 y2=ylabel('$y/H$');
54 set(y2,'Interpreter','latex')
55 set(y2,'FontSize',12)

```

```

56 set(gca, 'ytick',0:0.5:2)
57 set(gca, 'xtick',0:2:12)
58 set(gcf, 'position',[10,10,1050,300])
59
60 %uu
61 figure(3);
62 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
63 F=scatteredInterpolant(x,y,uu);
64 Z=F(X, Y);
65 contourf(X,Y,Z,400, 'edgecolor', 'none')
66 colormap('jet')
67 shading interp
68 colorbar()
69 ylim([0,2]); xlim([0,12]);
70 t1=sgtitle('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}:k-\omega$ Turbulence
    Model using Medium mesh');
71 set(t1, 'Interpreter', 'latex')
72 set(t1, 'FontSize', 12)
73 x2=xlabel('$x/H$');
74 set(x2, 'Interpreter', 'latex')
75 set(x2, 'FontSize', 12)
76 y2=ylabel('$y/H$');
77 set(y2, 'Interpreter', 'latex')
78 set(y2, 'FontSize', 12)
79 set(gca, 'ytick',0:0.5:2)
80 set(gca, 'xtick',0:2:12)
81 set(gcf, 'position',[10,10,1050,300])
82
83 %vv
84 figure(4);
85 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
86 F=scatteredInterpolant(x,y,vv);
87 Z=F(X, Y);
88 contourf(X,Y,Z,400, 'edgecolor', 'none')
89 colormap('jet')
90 shading interp
91 colorbar()
92 ylim([0,2]); xlim([0,12]);
93 t1=sgtitle('$(10^3/U_{ref})^2)*\overline{v^{\prime\prime}}:k-\omega$ Turbulence
    Model using Medium mesh');
94 set(t1, 'Interpreter', 'latex')
95 set(t1, 'FontSize', 12)
96 x2=xlabel('$x/H$');
97 set(x2, 'Interpreter', 'latex')
98 set(x2, 'FontSize', 12)
99 y2=ylabel('$y/H$');
100 set(y2, 'Interpreter', 'latex')
101 set(y2, 'FontSize', 12)
102 set(gca, 'ytick',0:0.5:2)
103 set(gca, 'xtick',0:2:12)
104 set(gcf, 'position',[10,10,1050,300])
105
106 %uv
107 figure(5);

```

```

108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);
110 Z=F(X, Y);
111 contourf(X,Y,Z,400,'edgecolor','none')
112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$(10^3/U_{ref})^2)\overline{u^{\prime}}\overline{v^{\prime}}:k-\omega$ Turbulence Model using Medium mesh');
117 set(t1,'Interpreter','latex')
118 set(t1,'FontSize',12)
119 x2=xlabel('$x/H$');
120 set(x2,'Interpreter','latex')
121 set(x2,'FontSize',12)
122 y2=ylabel('$y/H$');
123 set(y2,'Interpreter','latex')
124 set(y2,'FontSize',12)
125 set(gca,'ytick',0:0.5:2)
126 set(gca,'xtick',0:2:12)
127 set(gcf,'position',[10,10,1050,300])
128
129 %k
130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);
133 Z=F(X, Y);
134 contourf(X,Y,Z,400,'edgecolor','none')
135 colormap('jet')
136 shading interp
137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('$(k/U_{ref})^2):k-\omega$ Turbulence Model using Medium mesh');
140 set(t1,'Interpreter','latex')
141 set(t1,'FontSize',12)
142 x2=xlabel('$x/H$');
143 set(x2,'Interpreter','latex')
144 set(x2,'FontSize',12)
145 y2=ylabel('$y/H$');
146 set(y2,'Interpreter','latex')
147 set(y2,'FontSize',12)
148 set(gca,'ytick',0:0.5:2)
149 set(gca,'xtick',0:2:12)
150 set(gcf,'position',[10,10,1050,300])
151
152
153 %e
154 figure(7);
155 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
156 F=scatteredInterpolant(x,y,ep);
157 Z=F(X, Y);
158 contourf(X,Y,Z,400,'edgecolor','none')
159 colormap('jet')
160 shading interp

```

```

161 colorbar()
162 ylim([0,2]); xlim([0,12]);
163 t1=sgtitle('$(H/U_{ref})^3*\epsilon:k-\omega$ Turbulence Model using Medium
164 mesh');
165 set(t1,'Interpreter','latex')
166 set(t1,'FontSize',12)
167 x2=xlabel('$x/H$');
168 set(x2,'Interpreter','latex')
169 set(x2,'FontSize',12)
170 y2=ylabel('$y/H$');
171 set(y2,'Interpreter','latex')
172 set(gcf,'FontSize',12)
173 set(gca,'ytick',0:0.5:2)
174 set(gca,'xtick',0:2:12)
175 set(gcf,'position',[10,10,1050,300])
176 saveas(figure(1),'u','jpg')
177 saveas(figure(2),'v','jpg')
178 saveas(figure(3),'k','jpg')
179 saveas(figure(4),'ep','jpg')
180 saveas(figure(5),'uu','jpg')
181 saveas(figure(6),'vv','jpg')
182 saveas(figure(7),'uv','jpg')

```

Code for all $k - \omega$ Fine

```

1 H=0.0127;
2 finekw=xlsread("finekw.csv");
3 x=(finekw(:,2)/H)-15;
4 y=(finekw(:,3)/H);
5 u=finekw(:,7)/44.2;
6 v=finekw(:,8)/44.2;
7 uu=(finekw(:,4)*1000)/(44.2*44.2);
8 vv=(finekw(:,5)*1000)/(44.2*44.2);
9 uv=(finekw(:,6)*1000)/(44.2*44.2);
10 k=finekw(:,9)/(44.2*44.2);
11 ep=(finekw(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);

13
14 %u
15 figure(1);
16 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
17 F=scatteredInterpolant(x,y,u);
18 Z=F(X, Y);
19 contourf(X,Y,Z,400,'edgecolor','none')
20 colormap('jet')
21 shading interp
22 colorbar()
23 ylim([0,2]); xlim([0,12]);
24 t1=sgtitle('$\bar{u}/U_{ref}:k-\omega$ Turbulence Model using Fine mesh');
25 set(t1,'Interpreter','latex')
26 set(t1,'FontSize',12)
27 x2=xlabel('$x/H$');
28 set(x2,'Interpreter','latex')
29 set(x2,'FontSize',12)

```

```

30 y2=ylabel('$y/H$');
31 set(y2,'Interpreter','latex')
32 set(y2,'FontSize',12)
33 set(gca,'ytick',0:0.5:2)
34 set(gca,'xtick',0:2:12)
35 set(gcf,'position',[10,10,1050,300])
36
37 %v
38 figure(2);
39 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
40 F=scatteredInterpolant(x,y,v);
41 Z=F(X, Y);
42 contourf(X,Y,Z,400,'edgecolor','none')
43 colormap('jet')
44 shading interp
45 colorbar()
46 ylim([0,2]); xlim([0,12]);
47 t1=sgtitle('$\bar{v}/U_{ref}:k-\omega$ Turbulence Model using Fine mesh');
48 set(t1,'Interpreter','latex')
49 set(t1,'FontSize',12)
50 x2=xlabel('$x/H$');
51 set(x2,'Interpreter','latex')
52 set(x2,'FontSize',12)
53 y2=ylabel('$y/H$');
54 set(y2,'Interpreter','latex')
55 set(y2,'FontSize',12)
56 set(gca,'ytick',0:0.5:2)
57 set(gca,'xtick',0:2:12)
58 set(gcf,'position',[10,10,1050,300])
59
60 %uu
61 figure(3);
62 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
63 F=scatteredInterpolant(x,y,uu);
64 Z=F(X, Y);
65 contourf(X,Y,Z,400,'edgecolor','none')
66 colormap('jet')
67 shading interp
68 colorbar()
69 ylim([0,2]); xlim([0,12]);
70 t1=sgtitle('$({10^3/U_{ref}})^2*\overline{u'^2}):k-\omega$ Turbulence
    Model using Fine mesh');
71 set(t1,'Interpreter','latex')
72 set(t1,'FontSize',12)
73 x2=xlabel('$x/H$');
74 set(x2,'Interpreter','latex')
75 set(x2,'FontSize',12)
76 y2=ylabel('$y/H$');
77 set(y2,'Interpreter','latex')
78 set(y2,'FontSize',12)
79 set(gca,'ytick',0:0.5:2)
80 set(gca,'xtick',0:2:12)
81 set(gcf,'position',[10,10,1050,300])
82

```

```

83 %vv
84 figure(4);
85 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
86 F=scatteredInterpolant(x,y,vv);
87 Z=F(X, Y);
88 contourf(X,Y,Z,400, 'edgecolor', 'none')
89 colormap('jet')
90 shading interp
91 colorbar()
92 ylim([0,2]); xlim([0,12]);
93 t1=sgtitle('$(10^3/U_{ref}^2)*\overline{v^{\prime\prime}}:k-\omega$ Turbulence
               Model using Fine mesh');
94 set(t1, 'Interpreter', 'latex')
95 set(t1, 'FontSize', 12)
96 x2=xlabel('$x/H$');
97 set(x2, 'Interpreter', 'latex')
98 set(x2, 'FontSize', 12)
99 y2=ylabel('$y/H$');
100 set(y2, 'Interpreter', 'latex')
101 set(y2, 'FontSize', 12)
102 set(gca, 'ytick', 0:0.5:2)
103 set(gca, 'xtick', 0:2:12)
104 set(gcf, 'position',[10,10,1050,300])
105
106 %uv
107 figure(5);
108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);
110 Z=F(X, Y);
111 contourf(X,Y,Z,400, 'edgecolor', 'none')
112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$(10^3/U_{ref}^2)*\overline{u^{\prime\prime}}*\overline{v^{\prime\prime}}:k-\omega$ Turbulence Model using Fine mesh');
117 set(t1, 'Interpreter', 'latex')
118 set(t1, 'FontSize', 12)
119 x2=xlabel('$x/H$');
120 set(x2, 'Interpreter', 'latex')
121 set(x2, 'FontSize', 12)
122 y2=ylabel('$y/H$');
123 set(y2, 'Interpreter', 'latex')
124 set(y2, 'FontSize', 12)
125 set(gca, 'ytick', 0:0.5:2)
126 set(gca, 'xtick', 0:2:12)
127 set(gcf, 'position',[10,10,1050,300])
128
129 %k
130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);
133 Z=F(X, Y);
134 contourf(X,Y,Z,400, 'edgecolor', 'none')

```

```

135 colormap('jet')
136 shading interp
137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('$k/U_{ref}^2:k-\omega$ Turbulence Model using Fine mesh');
140 set(t1,'Interpreter','latex')
141 set(t1,'Fontsize',12)
142 x2=xlabel('$x/H$');
143 set(x2,'Interpreter','latex')
144 set(x2,'Fontsize',12)
145 y2=ylabel('$y/H$');
146 set(y2,'Interpreter','latex')
147 set(y2,'Fontsize',12)
148 set(gca,'ytick',0:0.5:2)
149 set(gca,'xtick',0:2:12)
150 set(gcf,'position',[10,10,1050,300])
151
152 %
153 %e
154 figure(7);
155 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
156 F=scatteredInterpolant(x,y,ep);
157 Z=F(X, Y);
158 contourf(X,Y,Z,400,'edgecolor','none')
159 colormap('jet')
160 shading interp
161 colorbar()
162 ylim([0,2]); xlim([0,12]);
163 t1=sgtitle('$H/U_{ref}^3:\epsilon:k-\omega$ Turbulence Model using Fine mesh');
164 set(t1,'Interpreter','latex')
165 set(t1,'Fontsize',12)
166 x2=xlabel('$x/H$');
167 set(x2,'Interpreter','latex')
168 set(x2,'Fontsize',12)
169 y2=ylabel('$y/H$');
170 set(y2,'Interpreter','latex')
171 set(y2,'Fontsize',12)
172 set(gca,'ytick',0:0.5:2)
173 set(gca,'xtick',0:2:12)
174 set(gcf,'position',[10,10,1050,300])
175
176 saveas(figure(1),'u','jpg')
177 saveas(figure(2),'v','jpg')
178 saveas(figure(3),'k','jpg')
179 saveas(figure(4),'ep','jpg')
180 saveas(figure(5),'uu','jpg')
181 saveas(figure(6),'vv','jpg')
182 saveas(figure(7),'uv','jpg')

```

Code for all RSTM Coarse

```

1 H=0.0127;
2 coarseRSTM=xlsread("coarseRSTM.csv");
3 x=(coarseRSTM(:,2)/H)-15;

```

```

4 y=(coarseRSTM(:,3)/H);
5 u=coarseRSTM(:,7)/44.2;
6 v=coarseRSTM(:,8)/44.2;
7 uu=(coarseRSTM(:,4)*1000)/(44.2*44.2);
8 vv=(coarseRSTM(:,5)*1000)/(44.2*44.2);
9 uv=(coarseRSTM(:,6)*1000)/(44.2*44.2);
10 k=coarseRSTM(:,9)/(44.2*44.2);
11 ep=(coarseRSTM(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);
13
14 %u
15 figure(1);
16 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
17 F=scatteredInterpolant(x,y,u);
18 Z=F(X, Y);
19 contourf(X,Y,Z,400, 'edgecolor', 'none')
20 colormap('jet')
21 shading interp
22 colorbar()
23 ylim([0,2]); xlim([0,12]);
24 t1=sgtitle('$\bar{u}/U_{ref}$: RSTM$ Turbulence Model using Coarse mesh');
25 set(t1, 'Interpreter', 'latex')
26 set(t1, 'FontSize', 12)
27 x2=xlabel('$x/H$');
28 set(x2, 'Interpreter', 'latex')
29 set(x2, 'FontSize', 12)
30 y2=ylabel('$y/H$');
31 set(y2, 'Interpreter', 'latex')
32 set(y2, 'FontSize', 12)
33 set(gca, 'ytick', 0:0.5:2)
34 set(gca, 'xtick', 0:2:12)
35 set(gcf, 'position', [10, 10, 1050, 300])
36
37 %v
38 figure(2);
39 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
40 F=scatteredInterpolant(x,y,v);
41 Z=F(X, Y);
42 contourf(X,Y,Z,400, 'edgecolor', 'none')
43 colormap('jet')
44 shading interp
45 colorbar()
46 ylim([0,2]); xlim([0,12]);
47 t1=sgtitle('$\bar{v}/U_{ref}$: RSTM$ Turbulence Model using Coarse mesh');
48 set(t1, 'Interpreter', 'latex')
49 set(t1, 'FontSize', 12)
50 x2=xlabel('$x/H$');
51 set(x2, 'Interpreter', 'latex')
52 set(x2, 'FontSize', 12)
53 y2=ylabel('$y/H$');
54 set(y2, 'Interpreter', 'latex')
55 set(y2, 'FontSize', 12)
56 set(gca, 'ytick', 0:0.5:2)
57 set(gca, 'xtick', 0:2:12)

```

```

58 set(gcf, 'position',[10,10,1050,300])
59
60 %uu
61 figure(3);
62 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
63 F=scatteredInterpolant(x,y,uu);
64 Z=F(X, Y);
65 contourf(X,Y,Z,400, 'edgecolor', 'none')
66 colormap('jet')
67 shading interp
68 colorbar()
69 ylim([0,2]); xlim([0,12]);
70 t1=sgtitle('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}:RSTM$ Turbulence Model
    using Coarse mesh');
71 set(t1, 'Interpreter', 'latex')
72 set(t1, 'FontSize', 12)
73 x2=xlabel('$x/H$');
74 set(x2, 'Interpreter', 'latex')
75 set(x2, 'FontSize', 12)
76 y2=ylabel('$y/H$');
77 set(y2, 'Interpreter', 'latex')
78 set(y2, 'FontSize', 12)
79 set(gca, 'ytick', 0:0.5:2)
80 set(gca, 'xtick', 0:2:12)
81 set(gcf, 'position',[10,10,1050,300])
82
83 %vv
84 figure(4);
85 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
86 F=scatteredInterpolant(x,y,vv);
87 Z=F(X, Y);
88 contourf(X,Y,Z,400, 'edgecolor', 'none')
89 colormap('jet')
90 shading interp
91 colorbar()
92 ylim([0,2]); xlim([0,12]);
93 t1=sgtitle('$(10^3/U_{ref})^2)*\overline{v^{\prime\prime}}:RSTM$ Turbulence Model
    using Coarse mesh');
94 set(t1, 'Interpreter', 'latex')
95 set(t1, 'FontSize', 12)
96 x2=xlabel('$x/H$');
97 set(x2, 'Interpreter', 'latex')
98 set(x2, 'FontSize', 12)
99 y2=ylabel('$y/H$');
100 set(y2, 'Interpreter', 'latex')
101 set(y2, 'FontSize', 12)
102 set(gca, 'ytick', 0:0.5:2)
103 set(gca, 'xtick', 0:2:12)
104 set(gcf, 'position',[10,10,1050,300])
105
106 %uv
107 figure(5);
108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);

```

```

110 Z=F(X, Y);
111 contourf(X,Y,Z,400, 'edgecolor', 'none')
112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$10^3/U_{ref}^2)\overline{u'}\overline{v'}:RSTM$'
    'Turbulence Model using Coarse mesh');
117 set(t1, 'Interpreter', 'latex')
118 set(t1, 'FontSize', 12)
119 x2=xlabel('$x/H$');
120 set(x2, 'Interpreter', 'latex')
121 set(x2, 'FontSize', 12)
122 y2=ylabel('$y/H$');
123 set(y2, 'Interpreter', 'latex')
124 set(y2, 'FontSize', 12)
125 set(gca, 'ytick', 0:0.5:2)
126 set(gca, 'xtick', 0:2:12)
127 set(gcf, 'position',[10,10,1050,300])
128
129 %k
130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);
133 Z=F(X, Y);
134 contourf(X,Y,Z,400, 'edgecolor', 'none')
135 colormap('jet')
136 shading interp
137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('$k/U_{ref}^2):RSTM$ Turbulence Model using Coarse mesh');
140 set(t1, 'Interpreter', 'latex')
141 set(t1, 'FontSize', 12)
142 x2=xlabel('$x/H$');
143 set(x2, 'Interpreter', 'latex')
144 set(x2, 'FontSize', 12)
145 y2=ylabel('$y/H$');
146 set(y2, 'Interpreter', 'latex')
147 set(y2, 'FontSize', 12)
148 set(gca, 'ytick', 0:0.5:2)
149 set(gca, 'xtick', 0:2:12)
150 set(gcf, 'position',[10,10,1050,300])
151
152
153 %e
154 figure(7);
155 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
156 F=scatteredInterpolant(x,y,ep);
157 Z=F(X, Y);
158 contourf(X,Y,Z,400, 'edgecolor', 'none')
159 colormap('jet')
160 shading interp
161 colorbar()
162 ylim([0,2]); xlim([0,12]);

```

```

163 t1=sgtitle ('$(H/U_{ref})^3)\backslash epsilon :RSTM$ Turbulence Model using Coarse mesh')
164 ;
165 set(t1,'Interpreter','latex')
166 set(t1,'FontSize',12)
167 x2=xlabel('$x/H$')
168 set(x2,'Interpreter','latex')
169 set(x2,'FontSize',12)
170 y2=ylabel('$y/H$')
171 set(y2,'Interpreter','latex')
172 set(y2,'FontSize',12)
173 set(gca,'ytick',0:0.5:2)
174 set(gca,'xtick',0:2:12)
175 set(gcf,'position',[10,10,1050,300])
176 saveas(figure(1),'u','jpg')
177 saveas(figure(2),'v','jpg')
178 saveas(figure(3),'k','jpg')
179 saveas(figure(4),'ep','jpg')
180 saveas(figure(5),'uu','jpg')
181 saveas(figure(6),'vv','jpg')
182 saveas(figure(7),'uv','jpg')

```

Code for all RSTM Medium

```

1 H=0.0127;
2 mediumRSTM=xlread ("mediumRSTM.csv");
3 x=(mediumRSTM(:,2)/H)-15;
4 y=(mediumRSTM(:,3)/H);
5 u=mediumRSTM(:,7)/44.2;
6 v=mediumRSTM(:,8)/44.2;
7 uu=(mediumRSTM(:,4)*1000)/(44.2*44.2);
8 vv=(mediumRSTM(:,5)*1000)/(44.2*44.2);
9 uv=(mediumRSTM(:,6)*1000)/(44.2*44.2);
10 k=mediumRSTM(:,9)/(44.2*44.2);
11 ep=(mediumRSTM(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);
13
14 %u
15 figure(1);
16 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
17 F=scatteredInterpolant(x,y,u);
18 Z=F(X, Y);
19 contourf(X,Y,Z,400,'edgecolor','none')
20 colormap('jet')
21 shading interp
22 colorbar()
23 ylim([0,2]); xlim([0,12]);
24 t1=sgtitle ('$\bar{u}/U_{ref}:RSTM$ Turbulence Model using Medium mesh');
25 set(t1,'Interpreter','latex')
26 set(t1,'FontSize',12)
27 x2=xlabel('$x/H$')
28 set(x2,'Interpreter','latex')
29 set(x2,'FontSize',12)
30 y2=ylabel('$y/H$')
31 set(y2,'Interpreter','latex')

```

```

32 set(y2, 'FontSize', 12)
33 set(gca, 'ytick', 0:0.5:2)
34 set(gca, 'xtick', 0:2:12)
35 set(gcf, 'position', [10, 10, 1050, 300])
36
37 %v
38 figure(2);
39 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
40 F=scatteredInterpolant(x,y,v);
41 Z=F(X, Y);
42 contourf(X,Y,Z,400, 'edgecolor', 'none')
43 colormap('jet')
44 shading interp
45 colorbar()
46 ylim([0,2]); xlim([0,12]);
47 t1=sgtitle('$\bar{v}/U_{ref}$: RSTM$ Turbulence Model using Medium mesh');
48 set(t1, 'Interpreter', 'latex')
49 set(t1, 'FontSize', 12)
50 x2=xlabel('$x/H$');
51 set(x2, 'Interpreter', 'latex')
52 set(x2, 'FontSize', 12)
53 y2=ylabel('$y/H$');
54 set(y2, 'Interpreter', 'latex')
55 set(y2, 'FontSize', 12)
56 set(gca, 'ytick', 0:0.5:2)
57 set(gca, 'xtick', 0:2:12)
58 set(gcf, 'position', [10, 10, 1050, 300])
59
60 %uu
61 figure(3);
62 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
63 F=scatteredInterpolant(x,y,uu);
64 Z=F(X, Y);
65 contourf(X,Y,Z,400, 'edgecolor', 'none')
66 colormap('jet')
67 shading interp
68 colorbar()
69 ylim([0,2]); xlim([0,12]);
70 t1=sgtitle('$10^3/U_{ref}^2)*\overline{u''\prime^2}$: RSTM$ Turbulence Model
    using Medium mesh');
71 set(t1, 'Interpreter', 'latex')
72 set(t1, 'FontSize', 12)
73 x2=xlabel('$x/H$');
74 set(x2, 'Interpreter', 'latex')
75 set(x2, 'FontSize', 12)
76 y2=ylabel('$y/H$');
77 set(y2, 'Interpreter', 'latex')
78 set(y2, 'FontSize', 12)
79 set(gca, 'ytick', 0:0.5:2)
80 set(gca, 'xtick', 0:2:12)
81 set(gcf, 'position', [10, 10, 1050, 300])
82
83 %vv
84 figure(4);

```

```

85 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
86 F=scatteredInterpolant(x,y,vv);
87 Z=F(X, Y);
88 contourf(X,Y,Z,400,'edgecolor','none')
89 colormap('jet')
90 shading interp
91 colorbar()
92 ylim([0,2]); xlim([0,12]);
93 t1=sgtitle('$(10^3/U_{ref})^2)*\overline{v}^{\prime\prime}:RSTM$ Turbulence Model
    using Medium mesh');
94 set(t1,'Interpreter','latex')
95 set(t1,'FontSize',12)
96 x2=xlabel('$x/H$');
97 set(x2,'Interpreter','latex')
98 set(x2,'FontSize',12)
99 y2=ylabel('$y/H$');
100 set(y2,'Interpreter','latex')
101 set(y2,'FontSize',12)
102 set(gca,'ytick',0:0.5:2)
103 set(gca,'xtick',0:2:12)
104 set(gcf,'position',[10,10,1050,300])
105
106 %uv
107 figure(5);
108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);
110 Z=F(X, Y);
111 contourf(X,Y,Z,400,'edgecolor','none')
112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$(10^3/U_{ref})^2)*\overline{u}^{\prime}\overline{v}^{\prime}:RSTM$ Turbulence Model using Medium mesh');
117 set(t1,'Interpreter','latex')
118 set(t1,'FontSize',12)
119 x2=xlabel('$x/H$');
120 set(x2,'Interpreter','latex')
121 set(x2,'FontSize',12)
122 y2=ylabel('$y/H$');
123 set(y2,'Interpreter','latex')
124 set(y2,'FontSize',12)
125 set(gca,'ytick',0:0.5:2)
126 set(gca,'xtick',0:2:12)
127 set(gcf,'position',[10,10,1050,300])
128
129 %k
130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);
133 Z=F(X, Y);
134 contourf(X,Y,Z,400,'edgecolor','none')
135 colormap('jet')
136 shading interp

```

```

137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('$(k/U_{ref})^2$:RSTM$ Turbulence Model using Medium mesh');
140 set(t1,'Interpreter','latex')
141 set(t1,'FontSize',12)
142 x2=xlabel('$x/H$');
143 set(x2,'Interpreter','latex')
144 set(x2,'FontSize',12)
145 y2=ylabel('$y/H$');
146 set(y2,'Interpreter','latex')
147 set(y2,'FontSize',12)
148 set(gca,'ytick',0:0.5:2)
149 set(gca,'xtick',0:2:12)
150 set(gcf,'position',[10,10,1050,300])
151
152 %e
153 figure(7);
154 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
155 F=scatteredInterpolant(x,y,ep);
156 Z=F(X, Y);
157 contourf(X,Y,Z,400,'edgecolor','none')
158 colormap('jet')
159 shading interp
160 colorbar()
161 ylim([0,2]); xlim([0,12]);
162 t1=sgtitle('$(H/U_{ref})^3*\epsilon$:RSTM$ Turbulence Model using Medium mesh')
163 ;
164 set(t1,'Interpreter','latex')
165 set(t1,'FontSize',12)
166 x2=xlabel('$x/H$');
167 set(x2,'Interpreter','latex')
168 set(x2,'FontSize',12)
169 y2=ylabel('$y/H$');
170 set(y2,'Interpreter','latex')
171 set(y2,'FontSize',12)
172 set(gca,'ytick',0:0.5:2)
173 set(gca,'xtick',0:2:12)
174 set(gcf,'position',[10,10,1050,300])
175
176 saveas(figure(1),'u','jpg')
177 saveas(figure(2),'v','jpg')
178 saveas(figure(3),'k','jpg')
179 saveas(figure(4),'ep','jpg')
180 saveas(figure(5),'uu','jpg')
181 saveas(figure(6),'vv','jpg')
182 saveas(figure(7),'uv','jpg')

```

Code for all RSTM Fine

```

1 H=0.0127;
2 fineRSTM=xlsread("fineRSTM.csv");
3 x=(fineRSTM(:,2)/H)-15;
4 y=(fineRSTM(:,3)/H);
5 u=fineRSTM(:,7)/44.2;

```

```

6 v=fineRSTM(:,8)/44.2;
7 uu=(fineRSTM(:,4)*1000)/(44.2*44.2);
8 vv=(fineRSTM(:,5)*1000)/(44.2*44.2);
9 uv=(fineRSTM(:,6)*1000)/(44.2*44.2);
10 k=fineRSTM(:,9)/(44.2*44.2);
11 ep=(fineRSTM(:,10)*H)/(44.2*44.2*44.2);
12 N=size(x,1);
13
14 %u
15 figure(1);
16 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
17 F=scatteredInterpolant(x,y,u);
18 Z=F(X, Y);
19 contourf(X,Y,Z,400,'edgecolor','none')
20 colormap('jet')
21 shading interp
22 colorbar()
23 ylim([0,2]); xlim([0,12]);
24 t1=sprintf('$\bar{u}/U_{ref}$: RSTM$ Turbulence Model using fine mesh');
25 set(t1,'Interpreter','latex')
26 set(t1,'FontSize',12)
27 x2=xlabel('$x/H$');
28 set(x2,'Interpreter','latex')
29 set(x2,'FontSize',12)
30 y2=ylabel('$y/H$');
31 set(y2,'Interpreter','latex')
32 set(y2,'FontSize',12)
33 set(gca,'ytick',0:0.5:2)
34 set(gca,'xtick',0:2:12)
35 set(gcf,'position',[10,10,1050,300])
36
37 %v
38 figure(2);
39 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
40 F=scatteredInterpolant(x,y,v);
41 Z=F(X, Y);
42 contourf(X,Y,Z,400,'edgecolor','none')
43 colormap('jet')
44 shading interp
45 colorbar()
46 ylim([0,2]); xlim([0,12]);
47 t1=sprintf('$\bar{v}/U_{ref}$: RSTM$ Turbulence Model using fine mesh');
48 set(t1,'Interpreter','latex')
49 set(t1,'FontSize',12)
50 x2=xlabel('$x/H$');
51 set(x2,'Interpreter','latex')
52 set(x2,'FontSize',12)
53 y2=ylabel('$y/H$');
54 set(y2,'Interpreter','latex')
55 set(y2,'FontSize',12)
56 set(gca,'ytick',0:0.5:2)
57 set(gca,'xtick',0:2:12)
58 set(gcf,'position',[10,10,1050,300])
59

```

```

60 %uu
61 figure(3);
62 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
63 F=scatteredInterpolant(x,y,uu);
64 Z=F(X, Y);
65 contourf(X,Y,Z,400, 'edgecolor', 'none')
66 colormap('jet')
67 shading interp
68 colorbar()
69 ylim([0,2]); xlim([0,12]);
70 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{u^{\prime\prime}}$ RSTM$ Turbulence Model
    using fine mesh');
71 set(t1, 'Interpreter', 'latex')
72 set(t1, 'FontSize', 12)
73 x2=xlabel('$x/H$');
74 set(x2, 'Interpreter', 'latex')
75 set(x2, 'FontSize', 12)
76 y2=ylabel('$y/H$');
77 set(y2, 'Interpreter', 'latex')
78 set(y2, 'FontSize', 12)
79 set(gca, 'ytick', 0:0.5:2)
80 set(gca, 'xtick', 0:2:12)
81 set(gcf, 'position',[10,10,1050,300])
82
83 %vv
84 figure(4);
85 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
86 F=scatteredInterpolant(x,y,vv);
87 Z=F(X, Y);
88 contourf(X,Y,Z,400, 'edgecolor', 'none')
89 colormap('jet')
90 shading interp
91 colorbar()
92 ylim([0,2]); xlim([0,12]);
93 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{v^{\prime\prime}}$ RSTM$ Turbulence Model
    using fine mesh');
94 set(t1, 'Interpreter', 'latex')
95 set(t1, 'FontSize', 12)
96 x2=xlabel('$x/H$');
97 set(x2, 'Interpreter', 'latex')
98 set(x2, 'FontSize', 12)
99 y2=ylabel('$y/H$');
100 set(y2, 'Interpreter', 'latex')
101 set(y2, 'FontSize', 12)
102 set(gca, 'ytick', 0:0.5:2)
103 set(gca, 'xtick', 0:2:12)
104 set(gcf, 'position',[10,10,1050,300])
105
106 %uv
107 figure(5);
108 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
109 F=scatteredInterpolant(x,y,uv);
110 Z=F(X, Y);
111 contourf(X,Y,Z,400, 'edgecolor', 'none')

```

```

112 colormap('jet')
113 shading interp
114 colorbar()
115 ylim([0,2]); xlim([0,12]);
116 t1=sgtitle('$({10}^3/U_{ref})^2*\overline{u'}\overline{v'}:RSTM$ Turbulence Model using fine mesh');
117 set(t1,'Interpreter','latex')
118 set(t1,'FontSize',12)
119 x2=xlabel('$x/H$');
120 set(x2,'Interpreter','latex')
121 set(x2,'FontSize',12)
122 y2=ylabel('$y/H$');
123 set(y2,'Interpreter','latex')
124 set(y2,'FontSize',12)
125 set(gca,'ytick',0:0.5:2)
126 set(gca,'xtick',0:2:12)
127 set(gcf,'position',[10,10,1050,300])
128
129 %k
130 figure(6);
131 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
132 F=scatteredInterpolant(x,y,ep);
133 Z=F(X, Y);
134 contourf(X,Y,Z,400,'edgecolor','none')
135 colormap('jet')
136 shading interp
137 colorbar()
138 ylim([0,2]); xlim([0,12]);
139 t1=sgtitle('$({k}/U_{ref})^2:RSTM$ Turbulence Model using fine mesh');
140 set(t1,'Interpreter','latex')
141 set(t1,'FontSize',12)
142 x2=xlabel('$x/H$');
143 set(x2,'Interpreter','latex')
144 set(x2,'FontSize',12)
145 y2=ylabel('$y/H$');
146 set(y2,'Interpreter','latex')
147 set(y2,'FontSize',12)
148 set(gca,'ytick',0:0.5:2)
149 set(gca,'xtick',0:2:12)
150 set(gcf,'position',[10,10,1050,300])
151
152
153 %e
154 figure(7);
155 [X, Y]=meshgrid(linspace(0,12,N),linspace(0,2,N));
156 F=scatteredInterpolant(x,y,ep);
157 Z=F(X, Y);
158 contourf(X,Y,Z,400,'edgecolor','none')
159 colormap('jet')
160 shading interp
161 colorbar()
162 ylim([0,2]); xlim([0,12]);
163 t1=sgtitle('$({H}/U_{ref})^3*\epsilon:RSTM$ Turbulence Model using fine mesh');
164 set(t1,'Interpreter','latex')

```

```

165 set(t1, 'FontSize', 12)
166 x2=xlabel('$x/H$');
167 set(x2, 'Interpreter', 'latex')
168 set(x2, 'FontSize', 12)
169 y2=ylabel('$y/H$');
170 set(y2, 'Interpreter', 'latex')
171 set(y2, 'FontSize', 12)
172 set(gca, 'ytick', 0:0.5:2)
173 set(gca, 'xtick', 0:2:12)
174 set(gcf, 'position', [10, 10, 1050, 300])
175
176 saveas(figure(1), 'u', 'jpg')
177 saveas(figure(2), 'v', 'jpg')
178 saveas(figure(3), 'k', 'jpg')
179 saveas(figure(4), 'ep', 'jpg')
180 saveas(figure(5), 'uu', 'jpg')
181 saveas(figure(6), 'vv', 'jpg')
182 saveas(figure(7), 'uv', 'jpg')

```

Code for all fine Plots (in specific x/H) compared to Experimental Values

```

1 %% Code to plot all fine meshes with Experimental Data
2
3 %% Fine ke
4 fineke=xlsread('fineke.csv');
5 finekw=xlsread("finekw.csv");
6 finerstm=xlsread("finerstm.csv");
7 %% Fine ke
8 H=0.0127;
9 xc=(fineke(:,2)/H)-15;
10 yc=(fineke(:,3)/H);
11 uc=fineke(:,7)/44.2;
12 vc=fineke(:,8)/44.2;
13 kc=fineke(:,9)/(44.2*44.2);
14 ec=(fineke(:,10)*H)/(44.2*44.2*44.2);
15 uuc=(fineke(:,4)*1000)/(44.2*44.2);
16 vvc=(fineke(:,5)*1000)/(44.2*44.2);
17 uvc=(fineke(:,6)*1000)/(44.2*44.2);
18
19 %% Fine kw
20 H=0.0127;
21 xm=(finekw(:,2)/H)-15;
22 ym=(finekw(:,3)/H);
23 um=finekw(:,7)/44.2;
24 vm=finekw(:,8)/44.2;
25 km=finekw(:,9)/(44.2*44.2);
26 em=(finekw(:,10)*H)/(44.2*44.2*44.2);
27 uum=(finekw(:,4)*1000)/(44.2*44.2);
28 vvm=(finekw(:,5)*1000)/(44.2*44.2);
29 uvm=(finekw(:,6)*1000)/(44.2*44.2);
30
31 %% Fine rstm
32 H=0.0127;
33 xf=(finerstm(:,2)/H)-15;
34 yf=(finerstm(:,3)/H);

```

```

35 uf=finerstm (:,4)/44.2;
36 vf=finerstm (:,5)/44.2;
37 kf=finerstm (:,6)/(44.2*44.2);
38 ef=(finerstm (:,10)*H)/(44.2*44.2*44.2);
39 uuf=(finerstm (:,7)*1000)/(44.2*44.2);
40 vvf=(finerstm (:,8)*1000)/(44.2*44.2);
41 uvf=(finerstm (:,9)*1000)/(44.2*44.2);
42 %% Plots for u
43
44 [idxc1 , idxc4 , idxc6 , idxc10]=index(xc , yc);
45 [idxm1 , idxm4 , idxm6 , idxm10]=index(xm,ym);
46 [idxf1 , idxf4 , idxf6 , idxf10]=index(xf , yf);
47
48
49 figure(1)
50 plot(uc(idxc1),yc(idxc1),'r',um(idxm1),ym(idxm1),'b',uf(idxf1),yf(idxf1),'g',
      xh1(:,2),xh1(:,1),'k-d')
51 t1=sprintf('$\bar{u}/U_{ref}$: For Various Methods at x/H=1');
52 set(t1,'Interpreter','latex')
53 set(t1,'FontSize',12)
54 x2=xlabel('$\bar{u}/U_{ref}$');
55 set(x2,'Interpreter','latex')
56 set(x2,'FontSize',12)
57 y2=ylabel('$y/H$');
58 set(y2,'Interpreter','latex')
59 set(y2,'FontSize',12)
60 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
      Mesh',...
      'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
      'northwest');
61 set(l2,'Interpreter','latex')
62 set(l2,'FontSize',9)
63
64
65
66 figure(2)
67 plot(uc(idxc4),yc(idxc4),'r',um(idxm4),ym(idxm4),'b',uf(idxf4),yf(idxf4),'g',
      xh4(:,2),xh4(:,1),'k-d')
68 t1=sprintf('$\bar{u}/U_{ref}$: For Various Methods at x/H=4');
69 set(t1,'Interpreter','latex')
70 set(t1,'FontSize',12)
71 x2=xlabel('$\bar{u}/U_{ref}$');
72 set(x2,'Interpreter','latex')
73 set(x2,'FontSize',12)
74 y2=ylabel('$y/H$');
75 set(y2,'Interpreter','latex')
76 set(y2,'FontSize',12)
77 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
      Mesh',...
      'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
      'northwest');
78 set(l2,'Interpreter','latex')
79 set(l2,'FontSize',9)
80
81
82 figure(3)

```

```

83 plot(uc(idxc6),yc(idxc6),'r',um(idxm6),ym(idxm6),'b',uf(idxf6),yf(idxf6),'g',
     xh6(:,2),xh6(:,1),'k-d')
84 t1=sgtitle('$\bar{u}/U_{ref}$: For Various Methods at x/H=6');
85 set(t1,'Interpreter','latex')
86 set(t1,'FontSize',12)
87 x2=xlabel('$\bar{u}/U_{ref}$');
88 set(x2,'Interpreter','latex')
89 set(x2,'FontSize',12)
90 y2=ylabel('$y/H$');
91 set(y2,'Interpreter','latex')
92 set(y2,'FontSize',12)
93 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
     Mesh',...
     'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
     'northwest');
94 set(l2,'Interpreter','latex')
95 set(l2,'FontSize',9)
96
97
98 figure(4)
99 plot(uc(idxc10),yc(idxc10),'r',um(idxm10),ym(idxm10),'b',uf(idxf10),yf(idxf10)
     ,'g',xh10(:,2),xh10(:,1),'k-d')
100 t1=sgtitle('$\bar{u}/U_{ref}$: For Various Methods at x/H=10');
101 set(t1,'Interpreter','latex')
102 set(t1,'FontSize',12)
103 x2=xlabel('$\bar{u}/U_{ref}$');
104 set(x2,'Interpreter','latex')
105 set(x2,'FontSize',12)
106 y2=ylabel('$y/H$');
107 set(y2,'Interpreter','latex')
108 set(y2,'FontSize',12)
109 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
     Mesh',...
     'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
     'northwest');
110 set(l2,'Interpreter','latex')
111 set(l2,'FontSize',9)
112
113
114 %% Plots for v
115
116
117 figure(5)
118 plot(vc(idxc1),yc(idxc1),'r',vm(idxm1),ym(idxm1),'b',vf(idxf1),yf(idxf1),'g',
     xh1(:,3),xh1(:,1),'k-d')
119 t1=sgtitle('$\bar{v}/U_{ref}$: For Various Methods at x/H=1');
120 set(t1,'Interpreter','latex')
121 set(t1,'FontSize',12)
122 x2=xlabel('$\bar{v}/U_{ref}$');
123 set(x2,'Interpreter','latex')
124 set(x2,'FontSize',12)
125 y2=ylabel('$y/H$');
126 set(y2,'Interpreter','latex')
127 set(y2,'FontSize',12)
128 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
     Mesh',...

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129      'RSTM Model Using Fine Mesh', 'Driver and Seegmiller Data', 'Location', ,
130      'northeast');
131 set(12, 'Interpreter', 'latex')
132 set(12, 'FontSize', 9)
133
134 figure(6)
135 plot(vc(idxc4), yc(idxc4), 'r', vm(idxm4), ym(idxm4), 'b', vf(idxf4), yf(idxf4), 'g',
136      xh4(:, 3), xh4(:, 1), 'k-d')
137 t1=sgtitle('$\bar{v}/U_{ref}$: For Various Methods at x/H=4');
138 set(t1, 'Interpreter', 'latex')
139 x2=xlabel('$\bar{v}/U_{ref}$');
140 set(x2, 'Interpreter', 'latex')
141 set(x2, 'FontSize', 12)
142 y2=ylabel('$y/H$');
143 set(y2, 'Interpreter', 'latex')
144 set(y2, 'FontSize', 12)
145 l2=legend('$k-\epsilon$ Model Using Fine Mesh', '$k-\omega$ Model Using Fine
146      Mesh', ...
147      'RSTM Model Using Fine Mesh', 'Driver and Seegmiller Data', 'Location', ,
148      'northeast');
149 set(12, 'Interpreter', 'latex')
150 set(12, 'FontSize', 9)
151
152 figure(7)
153 plot(vc(idxc6), yc(idxc6), 'r', vm(idxm6), ym(idxm6), 'b', vf(idxf6), yf(idxf6), 'g',
154      xh6(:, 3), xh6(:, 1), 'k-d')
155 t1=sgtitle('$\bar{v}/U_{ref}$: For Various Methods at x/H=6');
156 set(t1, 'Interpreter', 'latex')
157 set(t1, 'FontSize', 12)
158 x2=xlabel('$\bar{v}/U_{ref}$');
159 set(x2, 'Interpreter', 'latex')
160 set(x2, 'FontSize', 12)
161 y2=ylabel('$y/H$');
162 set(y2, 'Interpreter', 'latex')
163 set(y2, 'FontSize', 12)
164 l2=legend('$k-\epsilon$ Model Using Fine Mesh', '$k-\omega$ Model Using Fine
165      Mesh', ...
166      'RSTM Model Using Fine Mesh', 'Driver and Seegmiller Data', 'Location', ,
167      'northeast');
168 set(12, 'Interpreter', 'latex')
169 set(12, 'FontSize', 9)
170
171 figure(8)
172 plot(vc(idxc10), yc(idxc10), 'r', vm(idxm10), ym(idxm10), 'b', vf(idxf10), yf(idxf10),
173      'g', xh10(:, 3), xh10(:, 1), 'k-d')
174 t1=sgtitle('$\bar{v}/U_{ref}$: For Various Methods at x/H=10');
175 set(t1, 'Interpreter', 'latex')
176 set(t1, 'FontSize', 12)
177 x2=xlabel('$\bar{v}/U_{ref}$');
178 set(x2, 'Interpreter', 'latex')
179 set(x2, 'FontSize', 12)

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175 y2=ylabel('$y/H$');
176 set(y2,'Interpreter','latex')
177 set(y2,'Fontsize',12)
178 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
179   Mesh',...
180   'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
181   'northeast');
182 set(l2,'Interpreter','latex')
183 set(l2,'Fontsize',9)
184
185
186 figure(9)
187 plot(uuc(idxc1),yc(idxc1),'r',uum(idxm1),ym(idxm1),'b',uuf(idxf1),yf(idxf1),'g
188   ',xh1(:,4),xh1(:,1),'k-d')
189 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$: For Various Methods
190   at x/H=1');
191 set(t1,'Interpreter','latex')
192 set(t1,'Fontsize',12)
193 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$');
194 set(x2,'Interpreter','latex')
195 set(x2,'Fontsize',12)
196 y2=ylabel('$y/H$');
197 set(y2,'Interpreter','latex')
198 set(y2,'Fontsize',12)
199 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
200   Mesh',...
201   'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
202   'northeast');
203 set(l2,'Interpreter','latex')
204 set(l2,'Fontsize',9)
205
206
207 figure(10)
208 plot(uuc(idxc4),yc(idxc4),'r',uum(idxm4),ym(idxm4),'b',uuf(idxf4),yf(idxf4),'g
209   ',xh4(:,4),xh4(:,1),'k-d')
210 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$: For Various Methods
211   at x/H=4');
212 set(t1,'Interpreter','latex')
213 set(t1,'Fontsize',12)
214 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$');
215 set(x2,'Interpreter','latex')
216 set(x2,'Fontsize',12)
217 y2=ylabel('$y/H$');
218 set(y2,'Interpreter','latex')
219 set(y2,'Fontsize',12)
220 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
221   Mesh',...
222   'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
223   'northeast');
224 set(l2,'Interpreter','latex')
225 set(l2,'Fontsize',9)

```

```

219 figure(11)
220 plot(uuc(idxc6),yc(idxc6),'r',uum(idxm6),ym(idxm6),'b',uuf(idxf6),yf(idxf6),'g
',xh6(:,4),xh6(:,1),'k-d')
221 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$: For Various Methods
at x/H=6');
222 set(t1,'Interpreter','latex')
223 set(t1,'FontSize',12)
224 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$');
225 set(x2,'Interpreter','latex')
226 set(x2,'FontSize',12)
227 y2=ylabel('$y/H$');
228 set(y2,'Interpreter','latex')
229 set(y2,'FontSize',12)
230 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
Mesh',...
'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
'northeast');
231 set(l2,'Interpreter','latex')
232 set(l2,'FontSize',9)
233
234
235
236 figure(12)
237 plot(uuc(idxc10),yc(idxc10),'r',uum(idxm10),ym(idxm10),'b',uuf(idxf10),yf(
idxf10),'g',xh10(:,4),xh10(:,1),'k-d')
238 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$: For Various Methods
at x/H=10');
239 set(t1,'Interpreter','latex')
240 set(t1,'FontSize',12)
241 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$');
242 set(x2,'Interpreter','latex')
243 set(x2,'FontSize',12)
244 y2=ylabel('$y/H$');
245 set(y2,'Interpreter','latex')
246 set(y2,'FontSize',12)
247 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
Mesh',...
'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
'northeast');
248 set(l2,'Interpreter','latex')
249 set(l2,'FontSize',9)
250
251
252
253 %% Plots for vv
254
255 figure(13)
256 plot(vvc(idxc1),yc(idxc1),'r',vvm(idxm1),ym(idxm1),'b',vvf(idxf1),yf(idxf1),'g
',xh1(:,5),xh1(:,1),'k-d')
257 t1=sprintf('$(10^3/U_{ref})^2)*\overline{v^{\prime\prime}}$: For Various Methods
at x/H=1');
258 set(t1,'Interpreter','latex')
259 set(t1,'FontSize',12)
260 x2=xlabel('$(10^3/U_{ref})^2)*\overline{v^{\prime\prime}}$');
261 set(x2,'Interpreter','latex')
262 set(x2,'FontSize',12)

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263 y2=ylabel('$y/H$');
264 set(y2,'Interpreter','latex')
265 set(y2,'Fontsize',12)
266 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
267 Mesh',...
268 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
269 northeast);
270 set(l2,'Interpreter','latex')
271 set(l2,'Fontsize',9)
272
273 figure(14)
274 plot(vvc(idxc4),yc(idxc4),'r',vvm(idxm4),ym(idxm4),'b',vvf(idxf4),yf(idxf4),'g
275 ','xh4(:,5),xh4(:,1),'k-d')
276 t1=sprintf('$(10^3/U_{ref})^2)*\overline{v^{(\prime 2)}}$: For Various Methods
277 at x/H=4');
278 set(t1,'Interpreter','latex')
279 set(t1,'Fontsize',12)
280 x2=xlabel('$(10^3/U_{ref})^2)*\overline{v^{(\prime 2)}}$');
281 set(x2,'Interpreter','latex')
282 set(x2,'Fontsize',12)
283 y2=ylabel('$y/H$');
284 set(y2,'Interpreter','latex')
285 set(y2,'Fontsize',12)
286 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
287 Mesh',...
288 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
289 northeast);
290 set(l2,'Interpreter','latex')
291 set(l2,'Fontsize',9)
292
293 figure(15)
294 plot(vvc(idxc6),yc(idxc6),'r',vvm(idxm6),ym(idxm6),'b',vvf(idxf6),yf(idxf6),'g
295 ','xh6(:,5),xh6(:,1),'k-d')
296 t1=sprintf('$(10^3/U_{ref})^2)*\overline{v^{(\prime 2)}}$: For Various Methods
297 at x/H=6');
298 set(t1,'Interpreter','latex')
299 set(t1,'Fontsize',12)
300 x2=xlabel('$(10^3/U_{ref})^2)*\overline{v^{(\prime 2)}}$');
301 set(x2,'Interpreter','latex')
302 set(x2,'Fontsize',12)
303 y2=ylabel('$y/H$');
304 set(y2,'Interpreter','latex')
305 set(y2,'Fontsize',12)
306 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
307 Mesh',...
308 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
309 northeast);
310 set(l2,'Interpreter','latex')
311 set(l2,'Fontsize',9)
312
313 figure(16)
314 plot(vvc(idxc10),yc(idxc10),'r',vvm(idxm10),ym(idxm10),'b',vvf(idxf10),yf(

```

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    idxf10), 'g', xh10(:,5),xh10(:,1), 'k-d')
307 t1=sprintf('$(10^3/U_{ref})^2)*\overline{v^{\prime\prime}}$: For Various Methods
      at x/H=10');
308 set(t1,'Interpreter','latex')
309 set(t1,'FontSize',12)
310 x2=xlabel('$(10^3/U_{ref})^2)*\overline{v^{\prime\prime}}$');
311 set(x2,'Interpreter','latex')
312 set(x2,'FontSize',12)
313 y2=ylabel('$y/H$');
314 set(y2,'Interpreter','latex')
315 set(y2,'FontSize',12)
316 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
      Mesh',...
      'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
      'northeast');
317 set(l2,'Interpreter','latex')
318 set(l2,'FontSize',9)
320
321
322 %% PLots for uv
323
324 figure(17)
325 plot(uvc(idxc1),yc(idxc1),'r',uvm(idxm1),ym(idxm1),'b',uvf(idxf1),yf(idxf1),'g
      ',xh1(:,6),xh1(:,1), 'k-d')
326 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime\prime}}$: For Various
      Methods at x/H=1');
327 set(t1,'Interpreter','latex')
328 set(t1,'FontSize',12)
329 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime\prime}}$');
330 set(x2,'Interpreter','latex')
331 set(x2,'FontSize',12)
332 y2=ylabel('$y/H$');
333 set(y2,'Interpreter','latex')
334 set(y2,'FontSize',12)
335 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
      Mesh',...
      'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
      'northwest');
336 set(l2,'Interpreter','latex')
337 set(l2,'FontSize',9)
339
340
341 figure(18)
342 plot(uvc(idxc4),yc(idxc4),'r',uvm(idxm4),ym(idxm4),'b',uvf(idxf4),yf(idxf4),'g
      ',xh4(:,6),xh4(:,1), 'k-d')
343 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime\prime}}$: For Various
      Methods at x/H=4');
344 set(t1,'Interpreter','latex')
345 set(t1,'FontSize',12)
346 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime\prime}}$');
347 set(x2,'Interpreter','latex')
348 set(x2,'FontSize',12)
349 y2=ylabel('$y/H$');
350 set(y2,'Interpreter','latex')

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351 set(y2, 'Fontsize',12)
352 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
353 Mesh', ...
354 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',
355 'northwest');
356 set(l2,'Interpreter','latex')
357 set(l2,'Fontsize',9)
358
359 figure(19)
360 plot(uvc(idxc6),yc(idxc6),'r',uvm(idxm6),ym(idxm6),'b',uvf(idxf6),yf(idxf6),'g
361 ','xh6(:,6),xh6(:,1),'k-d')
362 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime\prime}}$: For Various
363 Methods at x/H=6');
364 set(t1,'Interpreter','latex')
365 set(t1,'Fontsize',12)
366 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime\prime}}$');
367 set(x2,'Interpreter','latex')
368 set(x2,'Fontsize',12)
369 y2=ylabel('$y/H$');
370 set(y2,'Interpreter','latex')
371 set(y2,'Fontsize',12)
372 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
373 Mesh', ...
374 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',
375 'northwest');
376 set(l2,'Interpreter','latex')
377 set(l2,'Fontsize',9)
378
379 figure(20)
380 plot(uvc(idxc10),yc(idxc10),'r',uvm(idxm10),ym(idxm10),'b',uvf(idxf10),yf(
381 idxf10),'g','xh10(:,6),xh10(:,1),'k-d')
382 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime\prime}}$: For Various
383 Methods at x/H=10');
384 set(t1,'Interpreter','latex')
385 set(t1,'Fontsize',12)
386 y2=ylabel('$y/H$');
387 set(y2,'Interpreter','latex')
388 set(y2,'Fontsize',12)
389 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
390 Mesh', ...
391 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',
392 'northwest');
393 set(l2,'Interpreter','latex')
394 set(l2,'Fontsize',9)
395
396 %% Plot for k
397
398 figure(21)
399 plot(kc(idxc1),yc(idxc1),'r',km(idxm1),ym(idxm1),'b',kf(idxf1),yf(idxf1),'g')

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```

395 t1=sgtitle('$_k/U_{ref}^2$: For Various Methods at x/H=1');
396 set(t1,'Interpreter','latex')
397 set(t1,'FontSize',12)
398 x2=xlabel('$_k/U_{ref}^2$');
399 set(x2,'Interpreter','latex')
400 set(x2,'FontSize',12)
401 y2=ylabel('$y/H$');
402 set(y2,'Interpreter','latex')
403 set(y2,'FontSize',12)
404 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
405 Mesh',...
406 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
407 'northwest');
408 set(l2,'Interpreter','latex')
409 set(l2,'FontSize',9)
410
411 figure(22)
412 plot(kc(idxc4),yc(idxc4),'r',km(idxm4),ym(idxm4),'b',kf(idxf4),yf(idxf4),'g')
413 t1=sgtitle('$_k/U_{ref}^2$: For Various Methods at x/H=4');
414 set(t1,'Interpreter','latex')
415 set(t1,'FontSize',12)
416 x2=xlabel('$_k/U_{ref}^2$');
417 set(x2,'Interpreter','latex')
418 set(x2,'FontSize',12)
419 y2=ylabel('$y/H$');
420 set(y2,'Interpreter','latex')
421 set(y2,'FontSize',12)
422 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
423 Mesh',...
424 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
425 'northwest');
426 set(l2,'Interpreter','latex')
427 set(l2,'FontSize',9)
428
429 figure(23)
430 plot(kc(idxc6),yc(idxc6),'r',km(idxm6),ym(idxm6),'b',kf(idxf6),yf(idxf6),'g')
431 t1=sgtitle('$_k/U_{ref}^2$: For Various Methods at x/H=6');
432 set(t1,'Interpreter','latex')
433 set(t1,'FontSize',12)
434 x2=xlabel('$_k/U_{ref}^2$');
435 set(x2,'Interpreter','latex')
436 set(x2,'FontSize',12)
437 y2=ylabel('$y/H$');
438 set(y2,'Interpreter','latex')
439 set(y2,'FontSize',12)
440 l2=legend('$k-\epsilon$ Model Using Fine Mesh','$k-\omega$ Model Using Fine
441 Mesh',...
442 'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
443 'northwest');
444 set(l2,'Interpreter','latex')
445 set(l2,'FontSize',9)

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```

443 figure(24)
444 plot(kc(idxc10),yc(idxc10),'r',km(idxm10),ym(idxm10),'b',kf(idxf10),yf(idxf10)
       , 'g')
445 t1=sprintf('k/U_{ref}^2: For Various Methods at x/H=10');
446 set(t1,'Interpreter','latex')
447 set(t1,'FontSize',12)
448 x2=xlabel('$k/U_{ref}^2');
449 set(x2,'Interpreter','latex')
450 set(x2,'FontSize',12)
451 y2=ylabel('$y/H$');
452 set(y2,'Interpreter','latex')
453 set(y2,'FontSize',12)
454 l2=legend('$k-\backslash epsilon$ Model Using Fine Mesh','$k-\backslash omega$ Model Using Fine
        Mesh',...
           'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
           'northwest');
455 set(l2,'Interpreter','latex')
456 set(l2,'FontSize',9)
457
458
459
460 %% plots for e
461
462 figure(25)
463 plot(ec(idxc1),yc(idxc1),'r',em(idxm1),ym(idxm1),'b',ef(idxf1),yf(idxf1),'g')
464 t1=sprintf('$(H/U_{ref})^3*\backslash epsilon$: For Various Methods at x/H=1');
465 set(t1,'Interpreter','latex')
466 set(t1,'FontSize',12)
467 x2=xlabel('$ (H/U_{ref})^3*\backslash epsilon $');
468 set(x2,'Interpreter','latex')
469 set(x2,'FontSize',12)
470 y2=ylabel('$y/H$');
471 set(y2,'Interpreter','latex')
472 set(y2,'FontSize',12)
473 l2=legend('$k-\backslash epsilon$ Model Using Fine Mesh','$k-\backslash omega$ Model Using Fine
        Mesh',...
           'RSTM Model Using Fine Mesh','Driver and Seegmiller Data','Location',...
           'northwest');
474 set(l2,'Interpreter','latex')
475 set(l2,'FontSize',9)
476
477
478
479 figure(26)
480 plot(ec(idxc4),yc(idxc4),'r',em(idxm4),ym(idxm4),'b',ef(idxf4),yf(idxf4),'g')
481 t1=sprintf('$(H/U_{ref})^3*\backslash epsilon$: For Various Methods at x/H=4');
482 set(t1,'Interpreter','latex')
483 set(t1,'FontSize',12)
484 x2=xlabel('$ (H/U_{ref})^3*\backslash epsilon $');
485 set(x2,'Interpreter','latex')
486 set(x2,'FontSize',12)
487 y2=ylabel('$y/H$');
488 set(y2,'Interpreter','latex')
489 set(y2,'FontSize',12)
490 l2=legend('$k-\backslash epsilon$ Model Using Fine Mesh','$k-\backslash omega$ Model Using Fine
        Mesh',...
           ...

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491 'RSTM Model Using Fine Mesh', 'Driver and Seegmiller Data', 'Location', ,
492   northwest');
493 set(12, 'Interpreter', 'latex')
494 set(12, 'FontSize', 9)
495
496 figure(27)
497 plot(ec(idxc6), yc(idxc6), 'r', em(idxm6), ym(idxm6), 'b', ef(idxf6), yf(idxf6), 'g')
498 t1=sgtitle('$(H/U_{ref})^3*\backslash epsilon$: For Various Methods at x/H=6');
499 set(t1, 'Interpreter', 'latex')
500 set(t1, 'FontSize', 12)
501 x2=xlabel('$(H/U_{ref})^3*\backslash epsilon$');
502 set(x2, 'Interpreter', 'latex')
503 set(x2, 'FontSize', 12)
504 y2=ylabel('$y/H$');
505 set(y2, 'Interpreter', 'latex')
506 set(y2, 'FontSize', 12)
507 l2=legend('$k-\backslash epsilon$ Model Using Fine Mesh', '$k-\backslash omega$ Model Using Fine
508   Mesh', ...
509   'RSTM Model Using Fine Mesh', 'Driver and Seegmiller Data', 'Location', ,
510   northwest);
511 set(12, 'Interpreter', 'latex')
512 set(12, 'FontSize', 9)
513
514 figure(28)
515 plot(ec(idxc10), yc(idxc10), 'r', em(idxm10), ym(idxm10), 'b', ef(idxf10), yf(idxf10),
516   'g')
517 t1=sgtitle('$(H/U_{ref})^3*\backslash epsilon$: For Various Methods at x/H=10');
518 set(t1, 'Interpreter', 'latex')
519 set(t1, 'FontSize', 12)
520 x2=xlabel('$(H/U_{ref})^3*\backslash epsilon$');
521 set(x2, 'Interpreter', 'latex')
522 set(x2, 'FontSize', 12)
523 y2=ylabel('$y/H$');
524 set(y2, 'Interpreter', 'latex')
525 set(y2, 'FontSize', 12)
526 l2=legend('$k-\backslash epsilon$ Model Using Fine Mesh', '$k-\backslash omega$ Model Using Fine
527   Mesh', ...
528   'RSTM Model Using Fine Mesh', 'Driver and Seegmiller Data', 'Location', ,
529   northwest);
530 set(12, 'Interpreter', 'latex')
531 set(12, 'FontSize', 9)
532
533 %% Saving figures
534 saveas(figure(1), 'u1', 'jpg')
535 saveas(figure(2), 'u4', 'jpg')
536 saveas(figure(3), 'u6', 'jpg')
537 saveas(figure(4), 'u10', 'jpg')
538 saveas(figure(5), 'v1', 'jpg')
539 saveas(figure(6), 'v4', 'jpg')
540 saveas(figure(7), 'v6', 'jpg')
541 saveas(figure(8), 'v10', 'jpg')
542 saveas(figure(9), 'uul', 'jpg')

```

```

539 saveas( figure(10) , 'uu4' , 'jpg' )
540 saveas( figure(11) , 'uu6' , 'jpg' )
541 saveas( figure(12) , 'uu10' , 'jpg' )
542 saveas( figure(13) , 'vv1' , 'jpg' )
543 saveas( figure(14) , 'vv4' , 'jpg' )
544 saveas( figure(15) , 'vv6' , 'jpg' )
545 saveas( figure(16) , 'vv10' , 'jpg' )
546 saveas( figure(17) , 'uv1' , 'jpg' )
547 saveas( figure(18) , 'uv4' , 'jpg' )
548 saveas( figure(19) , 'uv6' , 'jpg' )
549 saveas( figure(20) , 'uv10' , 'jpg' )
550 saveas( figure(21) , 'k1' , 'jpg' )
551 saveas( figure(22) , 'k4' , 'jpg' )
552 saveas( figure(23) , 'k6' , 'jpg' )
553 saveas( figure(24) , 'k10' , 'jpg' )
554 saveas( figure(25) , 'ep1' , 'jpg' )
555 saveas( figure(26) , 'ep4' , 'jpg' )
556 saveas( figure(27) , 'ep6' , 'jpg' )
557 saveas( figure(28) , 'ep10' , 'jpg' )

```

Code for all $k - \epsilon$ fine Plots and $k - \epsilon$ Enhanced Wall Plots (in specific x/H) compared to Experimental Values

```

1 fineke=xlsread('fineke.csv');
2 enhancedke=xlsread("enhancedwall.csv");
3 %% Fine ke
4 H=0.0127;
5 xc=(fineke (:,2)/H)-15;
6 yc=(fineke (:,3)/H);
7 uc=fineke (:,7)/44.2;
8 vc=fineke (:,8)/44.2;
9 kc=fineke (:,9)/(44.2*44.2);
10 ec=(fineke (:,10)*H)/(44.2*44.2*44.2);
11 uuc=(fineke (:,4)*1000)/(44.2*44.2);
12 vvc=(fineke (:,5)*1000)/(44.2*44.2);
13 uvc=(fineke (:,6)*1000)/(44.2*44.2);
14 %% Enhanced ke
15 H=0.0127;
16 xm=(enhancedke (:,2)/H)-15;
17 ym=(enhancedke (:,3)/H);
18 um=enhancedke (:,7)/44.2;
19 vm=enhancedke (:,8)/44.2;
20 km=enhancedke (:,9)/(44.2*44.2);
21 em=(enhancedke (:,10)*H)/(44.2*44.2*44.2);
22 uum=(enhancedke (:,4)*1000)/(44.2*44.2);
23 vvm=(enhancedke (:,5)*1000)/(44.2*44.2);
24 uvm=(enhancedke (:,6)*1000)/(44.2*44.2);
25 %% Plots for u
26
27 [idxc1 , idxc4 , idxc6 , idxc10]=index(xc , yc);
28 [idxm1 , idxm4 , idxm6 , idxm10]=index(xm,ym);
29
30
31
32

```

```

33 figure(1)
34 plot(uc(idxc1),yc(idxc1),'r',um(idxm1),ym(idxm1),'b',xh1(:,2),xh1(:,1),'k-d')
35 t1=sgtitle('$\bar{u}/U_{ref}$: For Various Methods at x/H=1');
36 set(t1,'Interpreter','latex')
37 set(t1,'FontSize',12)
38 x2=xlabel('$\bar{u}/U_{ref}$');
39 set(x2,'Interpreter','latex')
40 set(x2,'FontSize',12)
41 y2=ylabel('$y/H$');
42 set(y2,'Interpreter','latex')
43 set(y2,'FontSize',12)
44 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
45 set(l2,'Interpreter','latex')
46 set(l2,'FontSize',9)
47
48
49 figure(2)
50 plot(uc(idxc4),yc(idxc4),'r',um(idxm4),ym(idxm4),'b',xh4(:,2),xh4(:,1),'k-d')
51 t1=sgtitle('$\bar{u}/U_{ref}$: For Various Methods at x/H=4');
52 set(t1,'Interpreter','latex')
53 set(t1,'FontSize',12)
54 x2=xlabel('$\bar{u}/U_{ref}$');
55 set(x2,'Interpreter','latex')
56 set(x2,'FontSize',12)
57 y2=ylabel('$y/H$');
58 set(y2,'Interpreter','latex')
59 set(y2,'FontSize',12)
60 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
61 set(l2,'Interpreter','latex')
62 set(l2,'FontSize',9)
63
64 figure(3)
65 plot(uc(idxc6),yc(idxc6),'r',um(idxm6),ym(idxm6),'b',xh6(:,2),xh6(:,1),'k-d')
66 t1=sgtitle('$\bar{u}/U_{ref}$: For Various Methods at x/H=6');
67 set(t1,'Interpreter','latex')
68 set(t1,'FontSize',12)
69 x2=xlabel('$\bar{u}/U_{ref}$');
70 set(x2,'Interpreter','latex')
71 set(x2,'FontSize',12)
72 y2=ylabel('$y/H$');
73 set(y2,'Interpreter','latex')
74 set(y2,'FontSize',12)
75 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
76 set(l2,'Interpreter','latex')
77 set(l2,'FontSize',9)
78
79 figure(4)
80 plot(uc(idxc10),yc(idxc10),'r',um(idxm10),ym(idxm10),'b',xh10(:,2),xh10(:,1),'k-d')

```

```

    k-d')
81 t1=sgtitle('$\bar{u}/U_{ref}$: For Various Methods at x/H=10');
82 set(t1,'Interpreter','latex')
83 set(t1,'FontSize',12)
84 x2=xlabel('$\bar{u}/U_{ref}$');
85 set(x2,'Interpreter','latex')
86 set(x2,'FontSize',12)
87 y2=ylabel('$y/H$');
88 set(y2,'Interpreter','latex')
89 set(y2,'FontSize',12)
90 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
91 set(l2,'Interpreter','latex')
92 set(l2,'FontSize',9)
93
94 %% Plots for v
95
96 figure(5)
97 plot(vc(idxc1),yc(idxc1),'r',vm(idxm1),ym(idxm1),'b',xh1(:,3),xh1(:,1),'k-d')
98 t1=sgtitle('$\bar{v}/U_{ref}$: For Various Methods at x/H=1');
99 set(t1,'Interpreter','latex')
100 set(t1,'FontSize',12)
101 x2=xlabel('$\bar{v}/U_{ref}$');
102 set(x2,'Interpreter','latex')
103 set(x2,'FontSize',12)
104 y2=ylabel('$y/H$');
105 set(y2,'Interpreter','latex')
106 set(y2,'FontSize',12)
107 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
108 set(l2,'Interpreter','latex')
109 set(l2,'FontSize',9)
110
111
112 figure(6)
113 plot(vc(idxc4),yc(idxc4),'r',vm(idxm4),ym(idxm4),'b',xh4(:,3),xh4(:,1),'k-d')
114 t1=sgtitle('$\bar{v}/U_{ref}$: For Various Methods at x/H=4');
115 set(t1,'Interpreter','latex')
116 set(t1,'FontSize',12)
117 x2=xlabel('$\bar{v}/U_{ref}$');
118 set(x2,'Interpreter','latex')
119 set(x2,'FontSize',12)
120 y2=ylabel('$y/H$');
121 set(y2,'Interpreter','latex')
122 set(y2,'FontSize',12)
123 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
124 set(l2,'Interpreter','latex')
125 set(l2,'FontSize',9)
126
127
```

```

128 figure(7)
129 plot(vc(idxc6),yc(idxc6),'r',vm(idxm6),ym(idxm6),'b',xh6(:,3),xh6(:,1),'k-d')
130 t1=sgtitle('$\bar{v}/U_{ref}$: For Various Methods at x/H=6');
131 set(t1,'Interpreter','latex')
132 set(t1,'FontSize',12)
133 x2=xlabel('$\bar{v}/U_{ref}$');
134 set(x2,'Interpreter','latex')
135 set(x2,'FontSize',12)
136 y2=ylabel('$y/H$');
137 set(y2,'Interpreter','latex')
138 set(y2,'FontSize',12)
139 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
140 set(l2,'Interpreter','latex')
141 set(l2,'FontSize',9)
142
143
144 figure(8)
145 plot(vc(idxc10),yc(idxc10),'r',vm(idxm10),ym(idxm10),'b',xh10(:,3),xh10(:,1),'k-d')
146 t1=sgtitle('$\bar{v}/U_{ref}$: For Various Methods at x/H=10');
147 set(t1,'Interpreter','latex')
148 set(t1,'FontSize',12)
149 x2=xlabel('$\bar{v}/U_{ref}$');
150 set(x2,'Interpreter','latex')
151 set(x2,'FontSize',12)
152 y2=ylabel('$y/H$');
153 set(y2,'Interpreter','latex')
154 set(y2,'FontSize',12)
155 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
156 set(l2,'Interpreter','latex')
157 set(l2,'FontSize',9)
158
159
160 %% PLots for uu
161
162 figure(9)
163 plot(uuc(idxc1),yc(idxc1),'r',uum(idxm1),ym(idxm1),'b',xh1(:,4),xh1(:,1),'k-d')
164 t1=sgtitle('$(10^3/U_{ref})^2*\overline{u}^{\prime\prime}$: For Various Methods at x/H=1');
165 set(t1,'Interpreter','latex')
166 set(t1,'FontSize',12)
167 x2=xlabel('$(10^3/U_{ref})^2*\overline{u}^{\prime\prime}$');
168 set(x2,'Interpreter','latex')
169 set(x2,'FontSize',12)
170 y2=ylabel('$y/H$');
171 set(y2,'Interpreter','latex')
172 set(y2,'FontSize',12)
173 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data',

```

```

    'Location ', 'northwest');
174 set(12 , 'Interpreter ', 'latex')
175 set(12 , 'Fontsize ',9)
176
177
178 figure(10)
179 plot(uuc(idxc4),yc(idxc4), 'r',uum(idxm4),ym(idxm4), 'b',xh4(:,4),xh4(:,1), 'k-d'
      )
180 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$: For Various Methods
      at x/H=4');
181 set(t1 , 'Interpreter ', 'latex')
182 set(t1 , 'Fontsize ',12)
183 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$');
184 set(x2 , 'Interpreter ', 'latex')
185 set(x2 , 'Fontsize ',12)
186 y2=ylabel('$y/H$');
187 set(y2 , 'Interpreter ', 'latex')
188 set(y2 , 'Fontsize ',12)
189 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data',
      'Location ', 'northwest');
190 set(12 , 'Interpreter ', 'latex')
191 set(12 , 'Fontsize ',9)
192
193 figure(11)
194 plot(uuc(idxc6),yc(idxc6), 'r',uum(idxm6),ym(idxm6), 'b',xh6(:,4),xh6(:,1), 'k-d'
      )
195 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$: For Various Methods
      at x/H=6');
196 set(t1 , 'Interpreter ', 'latex')
197 set(t1 , 'Fontsize ',12)
198 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$');
199 set(x2 , 'Interpreter ', 'latex')
200 set(x2 , 'Fontsize ',12)
201 y2=ylabel('$y/H$');
202 set(y2 , 'Interpreter ', 'latex')
203 set(y2 , 'Fontsize ',12)
204 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data',
      'Location ', 'northwest');
205 set(12 , 'Interpreter ', 'latex')
206 set(12 , 'Fontsize ',9)
207
208
209 figure(12)
210 plot(uuc(idxc10),yc(idxc10), 'r',uum(idxm10),ym(idxm10), 'b',xh10(:,4),xh10
      (:,1), 'k-d')
211 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$: For Various Methods
      at x/H=10');
212 set(t1 , 'Interpreter ', 'latex')
213 set(t1 , 'Fontsize ',12)
214 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime\prime}}$');
215 set(x2 , 'Interpreter ', 'latex')
216 set(x2 , 'Fontsize ',12)

```

```

217 y2=ylabel('$y/H$');
218 set(y2,'Interpreter','latex')
219 set(y2,'Fontsize',12)
220 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
221 set(l2,'Interpreter','latex')
222 set(l2,'Fontsize',9)
223
224
225 %% Plots for vv
226
227 figure(13)
228 plot(vvc(idxc1),yc(idxc1),'r',vvm(idxm1),ym(idxm1),'b',xh1(:,5),xh1(:,1),'k-d')
229 t1=sprintf('$(10^3/U_{ref})^2)*\overline{v^{\prime\prime}}$: For Various Methods at x/H=1');
230 set(t1,'Interpreter','latex')
231 set(t1,'Fontsize',12)
232 x2=xlabel('$ (10^3/U_{ref})^2)*\overline{v^{\prime\prime}} $');
233 set(x2,'Interpreter','latex')
234 set(x2,'Fontsize',12)
235 y2=ylabel('$y/H$');
236 set(y2,'Interpreter','latex')
237 set(y2,'Fontsize',12)
238 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
239 set(l2,'Interpreter','latex')
240 set(l2,'Fontsize',9)
241
242
243 figure(14)
244 plot(vvc(idxc4),yc(idxc4),'r',vvm(idxm4),ym(idxm4),'b',xh4(:,5),xh4(:,1),'k-d')
245 t1=sprintf('$(10^3/U_{ref})^2)*\overline{v^{\prime\prime}}$: For Various Methods at x/H=4');
246 set(t1,'Interpreter','latex')
247 set(t1,'Fontsize',12)
248 x2=xlabel('$ (10^3/U_{ref})^2)*\overline{v^{\prime\prime}} $');
249 set(x2,'Interpreter','latex')
250 set(x2,'Fontsize',12)
251 y2=ylabel('$y/H$');
252 set(y2,'Interpreter','latex')
253 set(y2,'Fontsize',12)
254 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
255 set(l2,'Interpreter','latex')
256 set(l2,'Fontsize',9)
257
258 figure(15)
259 plot(vvc(idxc6),yc(idxc6),'r',vvm(idxm6),ym(idxm6),'b',xh6(:,5),xh6(:,1),'k-d')

```

```

260 t1=sgtitle('$(10^3/U_{ref})^2*\overline{v^{\prime\prime}}$: For Various Methods
261     at x/H=6');
262 set(t1,'Interpreter','latex')
263 x2=xlabel('$(10^3/U_{ref})^2*\overline{v^{\prime\prime}}$');
264 set(x2,'Interpreter','latex')
265 set(x2,'Fontsize',12)
266 y2=ylabel('$y/H$');
267 set(y2,'Interpreter','latex')
268 set(y2,'Fontsize',12)
269 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data',
270     'Location','northwest');
271 set(l2,'Interpreter','latex')
272 set(l2,'Fontsize',9)
273
274 figure(16)
275 plot(vvc(idxc10),yc(idxc10),'r',vvm(idxm10),ym(idxm10),'b',xh10(:,5),xh10(:,1),
276     'k-d')
277 t1=sgtitle('$(10^3/U_{ref})^2*\overline{v^{\prime\prime}}$: For Various Methods
278     at x/H=10');
279 set(t1,'Interpreter','latex')
280 set(t1,'Fontsize',12)
281 x2=xlabel('$(10^3/U_{ref})^2*\overline{v^{\prime\prime}}$');
282 set(x2,'Interpreter','latex')
283 set(x2,'Fontsize',12)
284 y2=ylabel('$y/H$');
285 set(y2,'Interpreter','latex')
286 set(y2,'Fontsize',12)
287 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data',
288     'Location','northwest');
289 set(l2,'Interpreter','latex')
290 set(l2,'Fontsize',9)
291
292 %% PLots for uv
293 figure(17)
294 plot(uvc(idxc1),yc(idxc1),'r',uvm(idxm1),ym(idxm1),'b',xh1(:,6),xh1(:,1),'k-d')
295 t1=sgtitle('$(10^3/U_{ref})^2*\overline{u^{\prime\prime}v^{\prime\prime}}$: For Various
296     Methods at x/H=1');
297 set(t1,'Interpreter','latex')
298 set(t1,'Fontsize',12)
299 x2=xlabel('$(10^3/U_{ref})^2*\overline{u^{\prime\prime}v^{\prime\prime}}$');
300 set(x2,'Interpreter','latex')
301 set(x2,'Fontsize',12)
302 y2=ylabel('$y/H$');
303 set(y2,'Interpreter','latex')
304 set(y2,'Fontsize',12)
305 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data',

```

```

'Location','northwest');

304 set(12,'Interpreter','latex')
305 set(12,'Fontsize',9)

306
307
308 figure(18)
309 plot(uvc(idxc4),yc(idxc4),'r',uvm(idxm4),ym(idxm4),'b',xh4(:,6),xh4(:,1),'k-d')
310 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime}}$: For Various
311 Methods at x/H=4');
312 set(t1,'Interpreter','latex')
313 set(t1,'FontSize',12)
314 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime}}$');
315 set(x2,'Interpreter','latex')
316 set(x2,'FontSize',12)
317 y2=ylabel('$y/H$');
318 set(y2,'Interpreter','latex')
319 set(y2,'FontSize',12)
320 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data',
321 'Location','northwest');
322 set(12,'Interpreter','latex')
323 set(12,'Fontsize',9)

324
325
326 figure(19)
327 plot(uvc(idxc6),yc(idxc6),'r',uvm(idxm6),ym(idxm6),'b',xh6(:,6),xh6(:,1),'k-d')
328 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime}}$: For Various
329 Methods at x/H=6');
330 set(t1,'Interpreter','latex')
331 set(t1,'FontSize',12)
332 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime}}$');
333 set(x2,'Interpreter','latex')
334 set(x2,'FontSize',12)
335 y2=ylabel('$y/H$');
336 set(y2,'Interpreter','latex')
337 set(y2,'FontSize',12)
338 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data',
339 'Location','northwest');
340 set(12,'Interpreter','latex')
341 set(12,'Fontsize',9)

342
343
344 figure(20)
345 plot(uvc(idxc10),yc(idxc10),'r',uvm(idxm10),ym(idxm10),'b',xh10(:,6),xh10(:,1),'k-d')
346 t1=sprintf('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime}}$: For Various
347 Methods at x/H=10');
348 set(t1,'Interpreter','latex')
349 set(t1,'FontSize',12)
350 x2=xlabel('$(10^3/U_{ref})^2)*\overline{u^{\prime}v^{\prime}}$');
351 set(x2,'Interpreter','latex')
352 set(x2,'FontSize',12)

```

```

347 y2=ylabel('$y/H$');
348 set(y2,'Interpreter','latex')
349 set(y2,'Fontsize',12)
350 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
351 set(l2,'Interpreter','latex')
352 set(l2,'Fontsize',9)
353
354
355 %% Plot for k
356
357 figure(21)
358 plot(kc(idxc1),yc(idxc1),'r',km(idxm1),ym(idxm1),'b')
359 t1=sprintf('$k/U_{ref}^2$: For Various Methods at x/H=1');
360 set(t1,'Interpreter','latex')
361 set(t1,'Fontsize',12)
362 x2=xlabel('$k/U_{ref}^2$');
363 set(x2,'Interpreter','latex')
364 set(x2,'Fontsize',12)
365 y2=ylabel('$y/H$');
366 set(y2,'Interpreter','latex')
367 set(y2,'Fontsize',12)
368 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
369 set(l2,'Interpreter','latex')
370 set(l2,'Fontsize',9)
371
372
373 figure(22)
374 plot(kc(idxc4),yc(idxc4),'r',km(idxm4),ym(idxm4),'b')
375 t1=sprintf('$k/U_{ref}^2$: For Various Methods at x/H=4');
376 set(t1,'Interpreter','latex')
377 set(t1,'Fontsize',12)
378 x2=xlabel('$k/U_{ref}^2$');
379 set(x2,'Interpreter','latex')
380 set(x2,'Fontsize',12)
381 y2=ylabel('$y/H$');
382 set(y2,'Interpreter','latex')
383 set(y2,'Fontsize',12)
384 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
385 set(l2,'Interpreter','latex')
386 set(l2,'Fontsize',9)
387
388 figure(23)
389 plot(kc(idxc6),yc(idxc6),'r',km(idxm6),ym(idxm6),'b')
390 t1=sprintf('$k/U_{ref}^2$: For Various Methods at x/H=6');
391 set(t1,'Interpreter','latex')
392 set(t1,'Fontsize',12)
393 x2=xlabel('$k/U_{ref}^2$');
394 set(x2,'Interpreter','latex')

```

```

395 set(x2, 'Fontsize',12)
396 y2ylabel('$y/H$');
397 set(y2, 'Interpreter', 'latex')
398 set(y2, 'Fontsize',12)
399 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
400 set(l2, 'Interpreter', 'latex')
401 set(l2, 'Fontsize',9)
402
403
404 figure(24)
405 plot(kc(idxc10),yc(idxc10),'r',km(idxm10),ym(idxm10),'b')
406 t1=sprintf('$k/U_{ref}^2$: For Various Methods at x/H=10');
407 set(t1, 'Interpreter', 'latex')
408 set(t1, 'Fontsize',12)
409 x2=xlabel('$k/U_{ref}^2$');
410 set(x2, 'Interpreter', 'latex')
411 set(x2, 'Fontsize',12)
412 y2ylabel('$y/H$');
413 set(y2, 'Interpreter', 'latex')
414 set(y2, 'Fontsize',12)
415 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
416 set(l2, 'Interpreter', 'latex')
417 set(l2, 'Fontsize',9)
418
419
420 %% plots for e
421
422 figure(25)
423 plot(ec(idxc1),yc(idxc1),'r',em(idxm1),ym(idxm1),'b')
424 t1=sprintf('$(H/U_{ref})^3*\epsilon$: For Various Methods at x/H=1');
425 set(t1, 'Interpreter', 'latex')
426 set(t1, 'Fontsize',12)
427 x2=xlabel('$(H/U_{ref})^3*\epsilon$');
428 set(x2, 'Interpreter', 'latex')
429 set(x2, 'Fontsize',12)
430 y2ylabel('$y/H$');
431 set(y2, 'Interpreter', 'latex')
432 set(y2, 'Fontsize',12)
433 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
434 set(l2, 'Interpreter', 'latex')
435 set(l2, 'Fontsize',9)
436
437
438 figure(26)
439 plot(ec(idxc4),yc(idxc4),'r',em(idxm4),ym(idxm4),'b')
440 t1=sprintf('$(H/U_{ref})^3*\epsilon$: For Various Methods at x/H=4');
441 set(t1, 'Interpreter', 'latex')
442 set(t1, 'Fontsize',12)

```

```

443 x2=xlabel('$ (H/U_{ref})^3 * \epsilon$');
444 set(x2, 'Interpreter', 'latex')
445 set(x2, 'FontSize', 12)
446 y2=ylabel('$y/H$');
447 set(y2, 'Interpreter', 'latex')
448 set(y2, 'FontSize', 12)
449 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
450 set(l2, 'Interpreter', 'latex')
451 set(l2, 'FontSize', 9)
452
453 figure(27)
454 plot(ec(idxc6), yc(idxc6), 'r', em(idxm6), ym(idxm6), 'b')
455 t1=sprintf('$ (H/U_{ref})^3 * \epsilon$: For Various Methods at x/H=6');
456 set(t1, 'Interpreter', 'latex')
457 set(t1, 'FontSize', 12)
458 x2=xlabel('$ (H/U_{ref})^3 * \epsilon$');
459 set(x2, 'Interpreter', 'latex')
460 set(x2, 'FontSize', 12)
461 y2=ylabel('$y/H$');
462 set(y2, 'Interpreter', 'latex')
463 set(y2, 'FontSize', 12)
464 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
465 set(l2, 'Interpreter', 'latex')
466 set(l2, 'FontSize', 9)
467
468
469 figure(28)
470 plot(ec(idxc10), yc(idxc10), 'r', em(idxm10), ym(idxm10), 'b')
471 t1=sprintf('$ (H/U_{ref})^3 * \epsilon$: For Various Methods at x/H=10');
472 set(t1, 'Interpreter', 'latex')
473 set(t1, 'FontSize', 12)
474 x2=xlabel('$ (H/U_{ref})^3 * \epsilon$');
475 set(x2, 'Interpreter', 'latex')
476 set(x2, 'FontSize', 12)
477 y2=ylabel('$y/H$');
478 set(y2, 'Interpreter', 'latex')
479 set(y2, 'FontSize', 12)
480 l2=legend('$k-\epsilon$ Model Using Fine Mesh (w/o wall function)', '$k-\epsilon$ Model Using Enhanced Wall Function', 'Driver and Seegmiller Data', 'Location', 'northwest');
481 set(l2, 'Interpreter', 'latex')
482 set(l2, 'FontSize', 9)
483
484 %% Saving figures
485
486 saveas(figure(1), 'u1', 'jpg')
487 saveas(figure(2), 'u4', 'jpg')
488 saveas(figure(3), 'u6', 'jpg')
489 saveas(figure(4), 'u10', 'jpg')
490 saveas(figure(5), 'v1', 'jpg')

```

```

491 saveas( figure(6) , 'v4' , 'jpg' )
492 saveas( figure(7) , 'v6' , 'jpg' )
493 saveas( figure(8) , 'v10' , 'jpg' )
494 saveas( figure(9) , 'uu1' , 'jpg' )
495 saveas( figure(10) , 'uu4' , 'jpg' )
496 saveas( figure(11) , 'uu6' , 'jpg' )
497 saveas( figure(12) , 'uu10' , 'jpg' )
498 saveas( figure(13) , 'vv1' , 'jpg' )
499 saveas( figure(14) , 'vv4' , 'jpg' )
500 saveas( figure(15) , 'vv6' , 'jpg' )
501 saveas( figure(16) , 'vv10' , 'jpg' )
502 saveas( figure(17) , 'uv1' , 'jpg' )
503 saveas( figure(18) , 'uv4' , 'jpg' )
504 saveas( figure(19) , 'uv6' , 'jpg' )
505 saveas( figure(20) , 'uv10' , 'jpg' )
506 saveas( figure(21) , 'k1' , 'jpg' )
507 saveas( figure(22) , 'k4' , 'jpg' )
508 saveas( figure(23) , 'k6' , 'jpg' )
509 saveas( figure(24) , 'k10' , 'jpg' )
510 saveas( figure(25) , 'ep1' , 'jpg' )
511 saveas( figure(26) , 'ep4' , 'jpg' )
512 saveas( figure(27) , 'ep6' , 'jpg' )
513 saveas( figure(28) , 'ep10' , 'jpg' )

```

Code for the index function

```

1 %This file is saved as index.m and is called for the Sections 3 and 4 of the
   Project Assignment
2
3
4 function [ idx1 , idx4 , idx6 , idx10 ] = data(x,y)
5
6 %x/H=1
7 idx1 = [];
8 c=1;
9 for i=1:length(x)
10    if x(i)>0.9 && x(i)<1.1
11       idx1(c,1)=i;
12       c=c+1;
13    end
14 end
15 idx1(y(idx1)>2.6)=nan;
16 idx1=rmmissing(idx1);
17
18 %x/H=4
19 idx4 = [];
20 c=1;
21 for i=1:length(x)
22    if x(i)>3.9 && x(i)<4.1
23       idx4(c,1)=i;
24       c=c+1;
25    end
26 end
27 idx4(y(idx4)>2.6)=nan;

```

```

29 idx4=rmmissing(idx4);
30
31 %x/H=6
32 idx6=[];
33 c=1;
34 for i=1:length(x)
35     if x(i)>5.9 && x(i)<6.1
36         idx6(c,1)=i;
37         c=c+1;
38     end
39 end
40 idx6(y(idx6)>2.6)=nan;
41 idx6=rmmissing(idx6);
42
43
44 %x/H=10
45 idx10=[];
46 c=1;
47 for i=1:length(x)
48     if x(i)>9.9 && x(i)<10.1
49         idx10(c,1)=i;
50         c=c+1;
51     end
52 end
53 idx10(y(idx10)>2.6)=nan;
54 idx10=rmmissing(idx10);
55
56
57 end

```