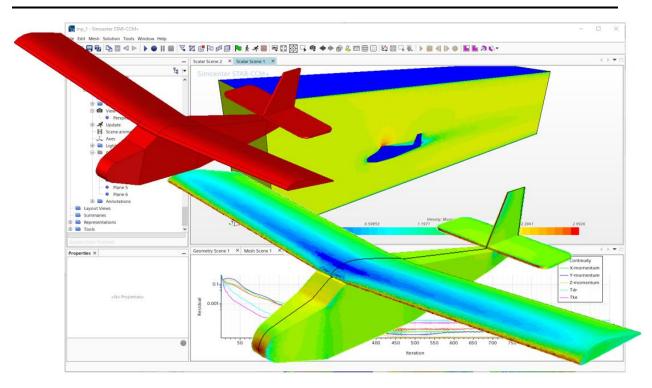
# **CCM+** Basic Tutorial #1: Model Aircraft

# Laurence Marks

October 2023



In this basic tutorial we model the flow over a model glider using Star CCM+.

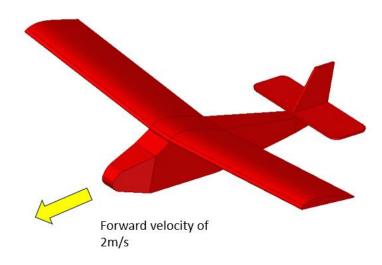
The aim is to run through the most basic sort of CFD simulation, learning as much about the workflow as possible. This workflow is presented in detail, and in the form of a flowchart.

This tutorial covers:

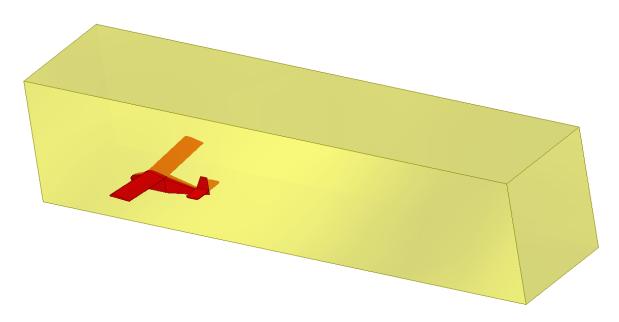
- Creating files and importing model data
- Model setup
- Simple meshing
- Steady state flow simulation definition
- Simple post processing

#### **Problem Description**

Simplistically the problem definition is straightforwards. We want to visualise the airflow over a model aeroplane flying forwards at 2m/s.



In a CFD context this requires us to create a geometric model which represents that air around the object of interest. (As this is an external flow example. In an internal flow example we'd be modelling the fluid inside the object of interest.) The geometry we are going to use is shown below. A ½ model speeds every aspect of the workflow.



We will be using Star CCM+ for this example.

Note: In no way are we saying that the fluid volume here is what you'd use in practice; selection of the relevant volume is part of model development, and the volume used here is simply suitable for solution in a realistic timeframe. For the sake of this tutorial we can assume that the model aircraft is being tested in a rudimentary wind tunnel.



### Start CCM+ and create a file

Select new from the File menu.

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Leave the license options as they are.

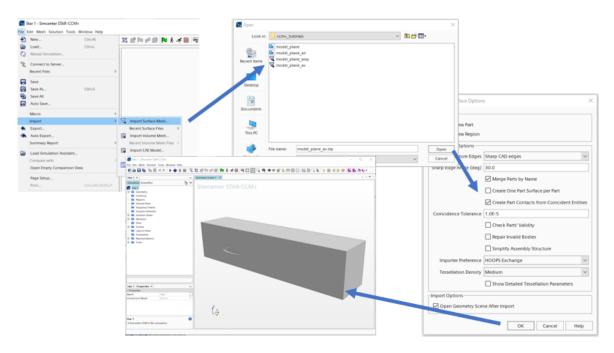
This will then create a simulation. With a feature tree. Something like the picture below.

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### Load Step file of geometry

As mentioned previously we will be working on what amounts to a model of the air region. Air will pass through this region. This has previously been drawn in a CAD system, and has been exported as a step file.

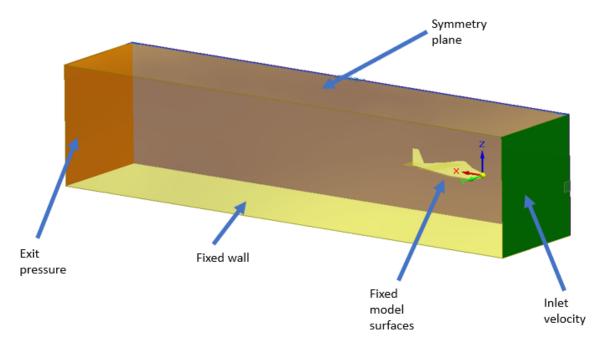


In the file menu select import. Then click on "import surface mesh" and select the file "model\_plane\_av". A window of options will then appear. As we are taking all the defaults just click OK. Then a geometry scene will be created, with the geometry in it.

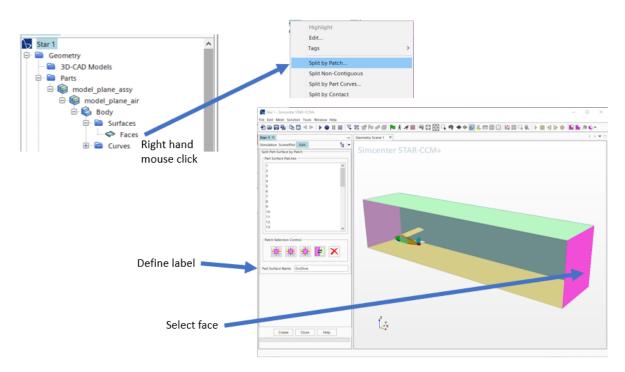


#### **Boundary Conditions**

We have to define a set of boundary conditions for the problem. They are applied to the geometric faces of the model.

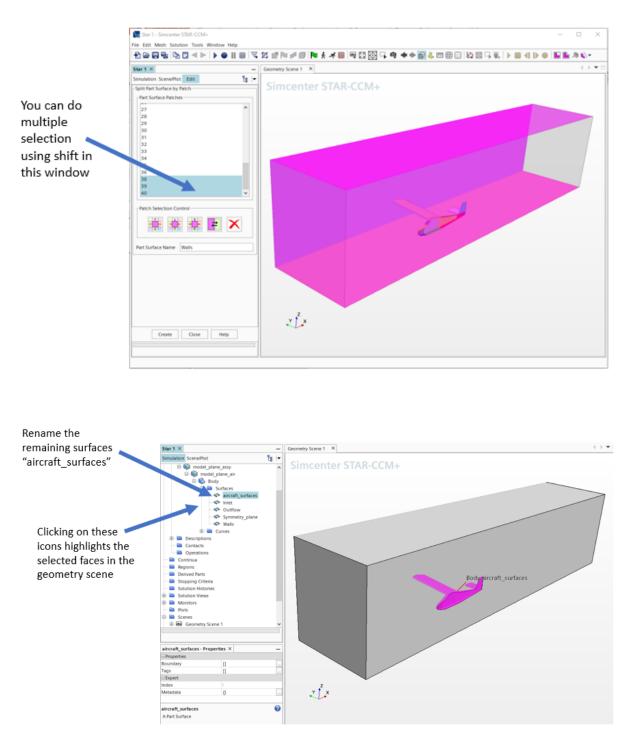


At this stage we are just creating sets of surfaces. We don't tell the software anything about them at this stage. Expand the branches of the feature tree from Geometry, parts etc until you get to faces as shown. Right hand mouse click face and then select "split by patch".



Select a surface, say the inlet, define the label and then click create..



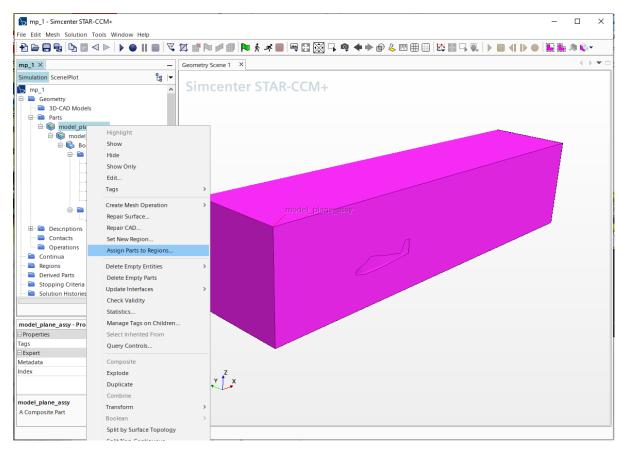


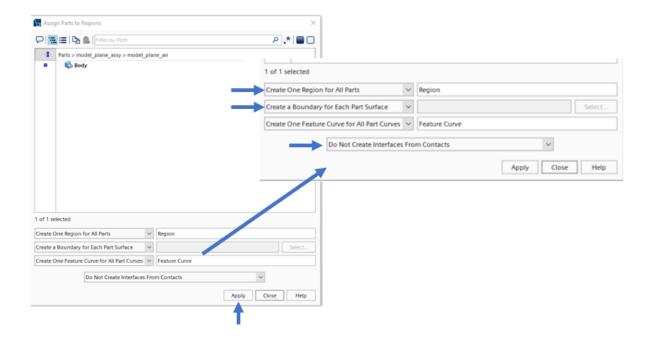
Finally we rename the remaining surfaces as aircraft\_surfaces. (Right hand mouse click, rename)



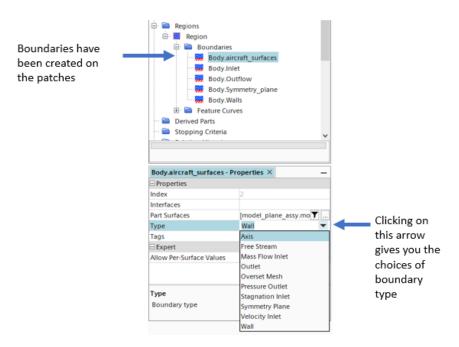
### Assign Parts to regions

We need to tell CCM+ which sections of the model will be defined as boundary condition regions. Right hand mouse click over the "model\_plane\_assy" node and select "assign parts to region".





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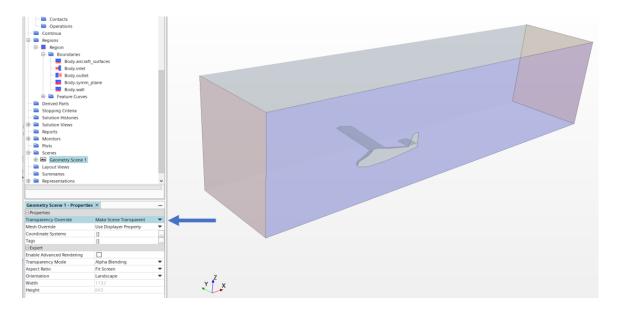


As you can see, there are now regions with the same names as the surface faces (and groups of surface faces that we defined.) And we can now select an appropriate type to the boundary region. Do this by highlighting the region and selecting type.

We need to define the groups as follows:

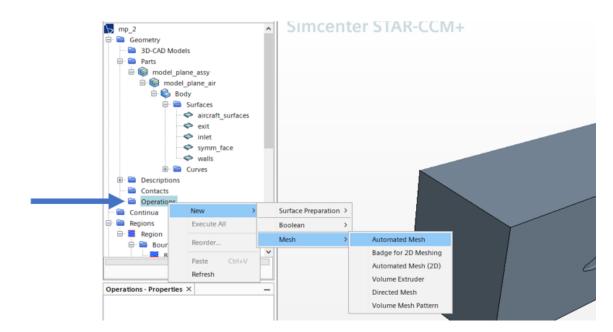
Name	Туре
Body.aircraft_surfaces	Wall
Body.exit	Pressure Outlet
Body.inlet	Velocity inlet
Body.symm_face	Symmetry Plane
Body.walls	Wall

If you make the scene transparent you can see how the walls are defined.



#### Mesh Generation

CFD problems always require the definition of a mesh (or series of calculation points). We will use and automatic mesher.



Right click on Geometry, operations, new, Mesh, Automated Mesh

When the dialog box appears you need to select a cascade of options.

Create Automated Mesh Operation	<ul> <li>Surface meshers</li> <li>Surface Remesher</li> <li>Core volume meshers</li> <li>Polyhedral Mesher</li> <li>Optional boundary layer meshers</li> <li>Prism layer mesher</li> </ul>
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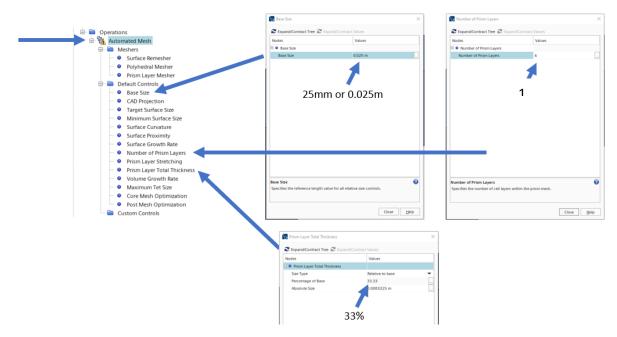
Choose the options listed and that part of the dialog box will look like the picture below.



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Click Ok.

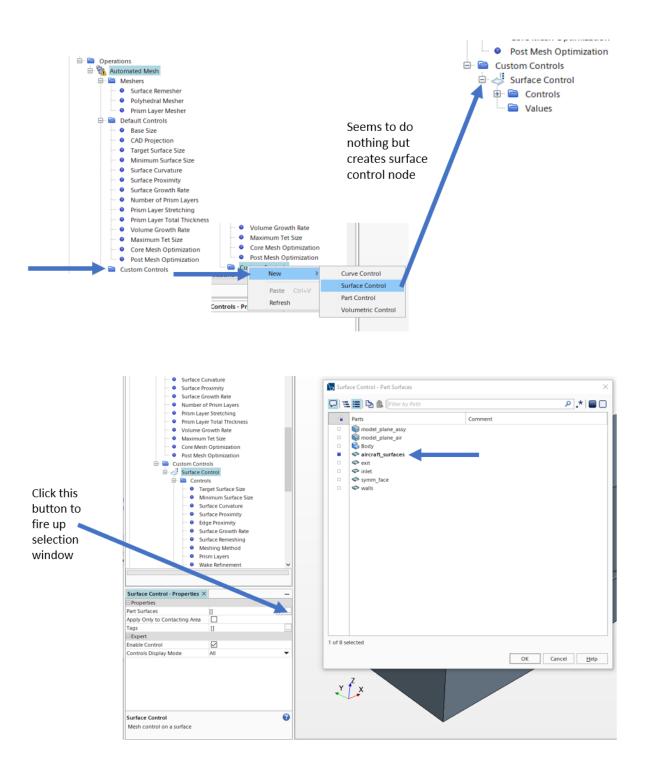
We now need to control the size of the mesh. Go to the Automated mesh section of the operations node.



We have set the overall mesh size, and some parameters concerning meshing the boundary layer.

We now need to define a smaller mesh size around the aeroplane. This will give us better results quality in the region where we are interested. So we click on custom control, then new, then surface control. This appears to do nothing, but creates a custom control branch to refine the mesh round the surfaces of a particular region. We'll chose aircraft\_surfaces.







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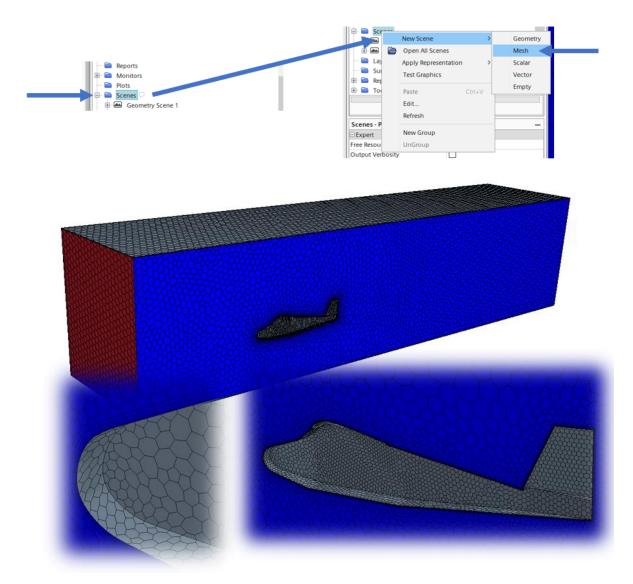
We enter the values for these controls in the values folder.

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Wake Refinement	Absolute Size	0.005
<ul> <li>Target Surface Size</li> </ul>	Abso 0.00	olute size 5m ø
		Close

We should have a set of parameters which define a mesh at this point. We create the mesh by clicking the mesh button on the main ribbon bar.

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To visualise the mesh you need to create a mesh scene. You do this by going to the scenes folder and creating a mesh scene.

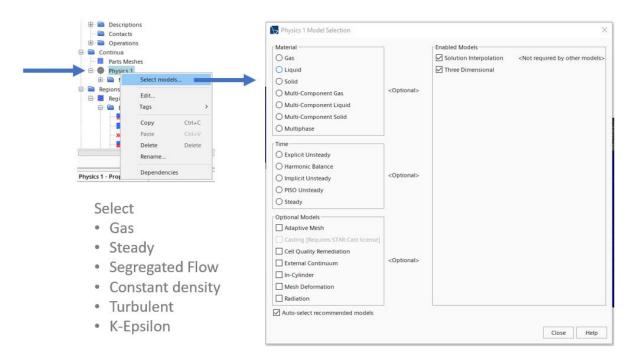


This initial mesh definition is fine for a first run, though would need work to be accurate and effective.



## Define the Physics

We now tell the solver something about the sort of flow problem we want to solve. It's defined under continua.



Select gas, steady, Segregated flow, Constant density, turbulent, K-E as they are presented to you. When you reach and chose KE close the window.

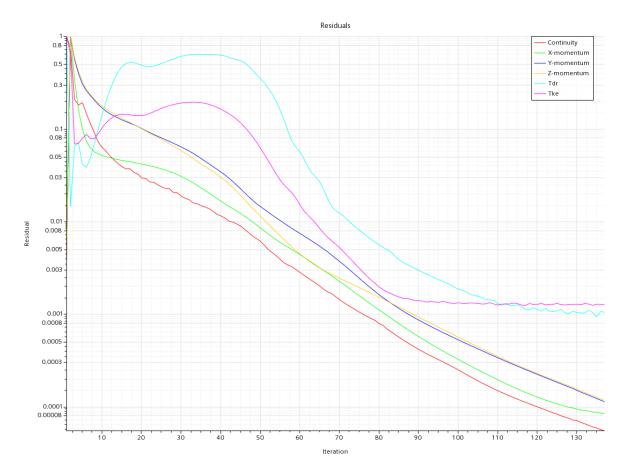


#### Running the Simulation

Start the simulation running by pressing the man running button.

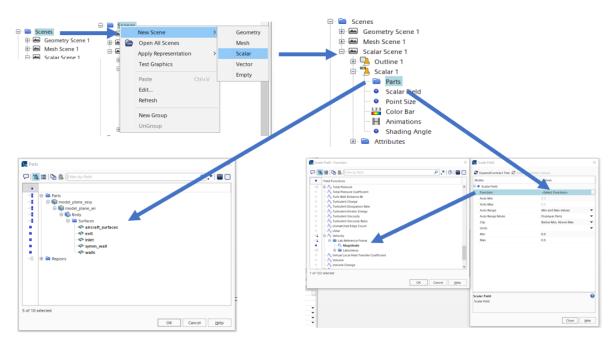


When the solver runs it presents us with a plot of the residuals and how they are changing through the solution.

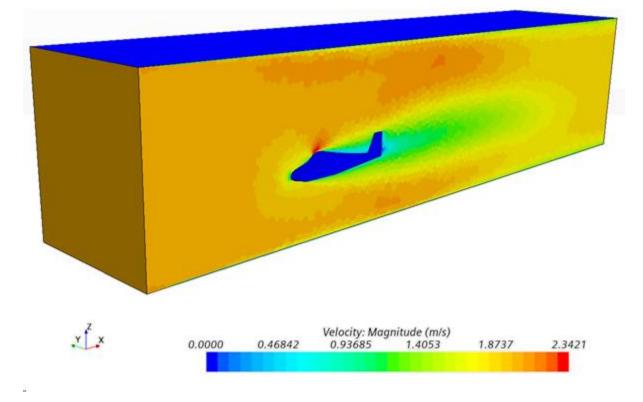


We can also observe the results as the solution converges. We do this by creating a scalar scene, in much the same way as we created a mesh scene. When we have the scene we can select which parts are displayed in it and also chose what we plot. In this case we chose all the surfaces and velocity.





Which gives us a plot like this which updates as the solver progresses.

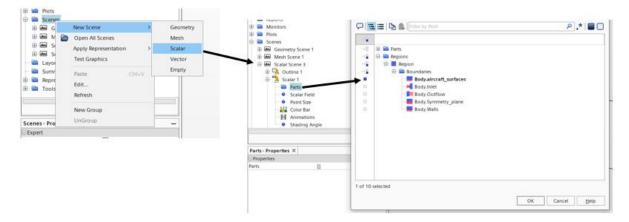




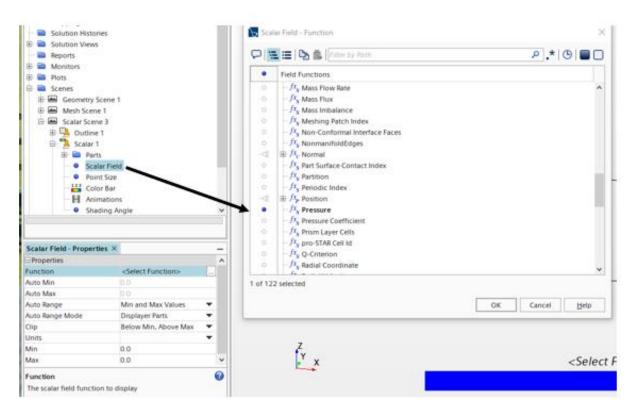
#### Post Processing

We are now going to generate some post processing plots. Firstly we'll generate a surface pressure plot of the whole model.

Create a scene again. And when the scalar scene node has been created go to parts in scalar 1 and select the aircraft surfaces. That will display them on the screen in grey.

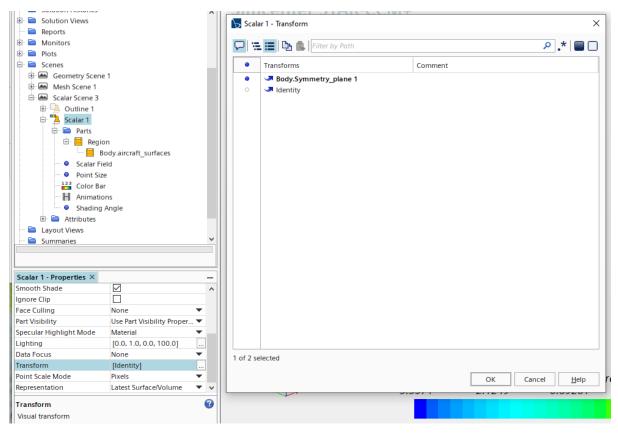


Then on the scalar field node select pressure. This will plot the pressures on the surfaces.

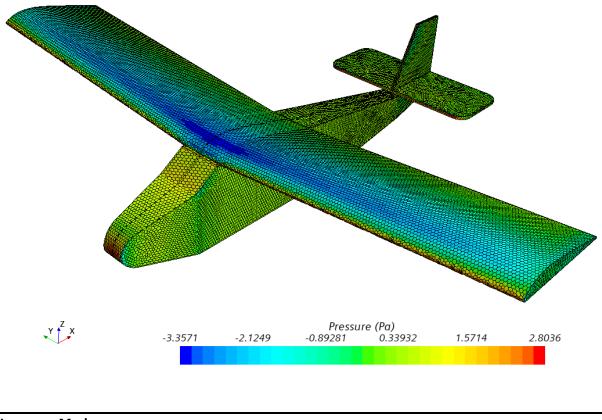




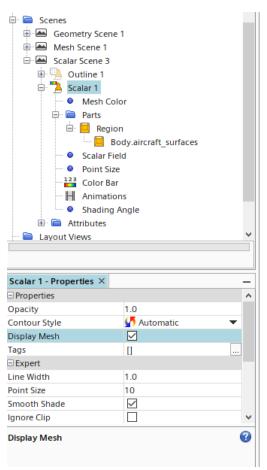
Then we'll use symmetry to plot the whole aircraft. You'll have to scroll down in the properties window. Select body\_symmetry\_plane 1



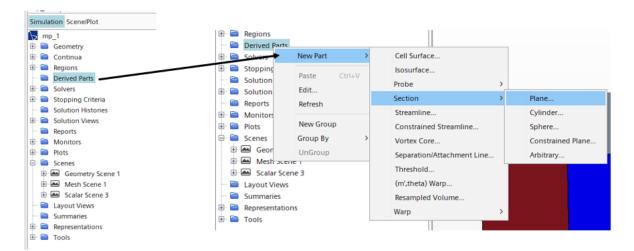
#### Simcenter STAR-CCM+



If you want to plot the mesh as shown select the scalar 1 node in Scalar scene 3 and check display mesh in the properties window.

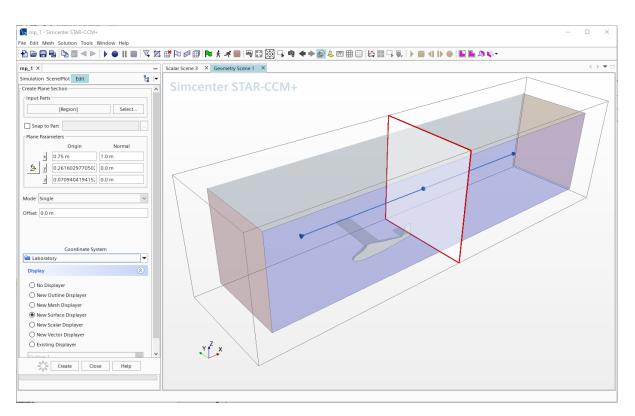


We'll now add some sections. Go back to Geometry Scene 1 and select derived parts. Then, New Part, section, plane.



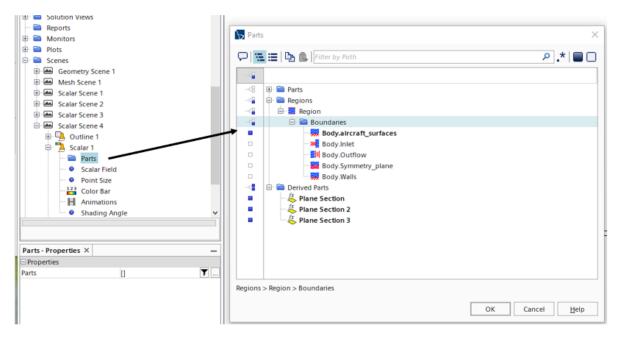
This will then change the window so it looks like this. Grab the edge of the section shown and drag it to where you want it. When its there click create at the bottom of the dialog box, bottom left.





In the example we create 3 sections. Move the plane and click create.

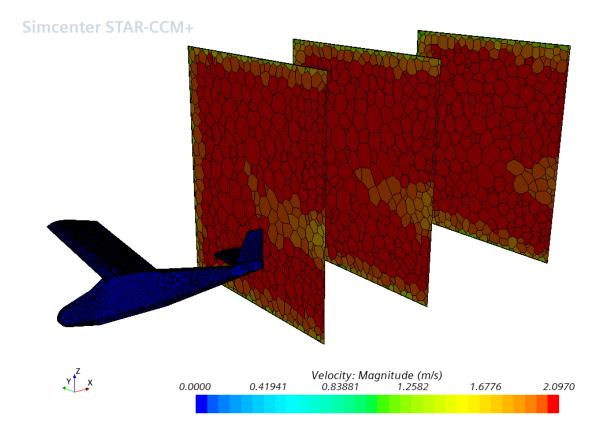
Create a new scalar scene. And in scalar 1 select the derived parts and the aircraft surfaces.



If you click on the scale bar on the image you can select velocity to be plotted.



This will plot the outline of the aircraft and the sections with the velocities colour coded.



That has completed this tutorial.

