Cyclone: Setup and Analysis

CPFD Software

www.cpfd-software.com

Cyclone

This training example demonstrates how to simulate a lightly loaded cyclones.

Features used in this example:

- Merge and remove in Setup Grid Advanced options
- Agglomeration model in Particle Species Editor
- Bin by particle size at flux planes

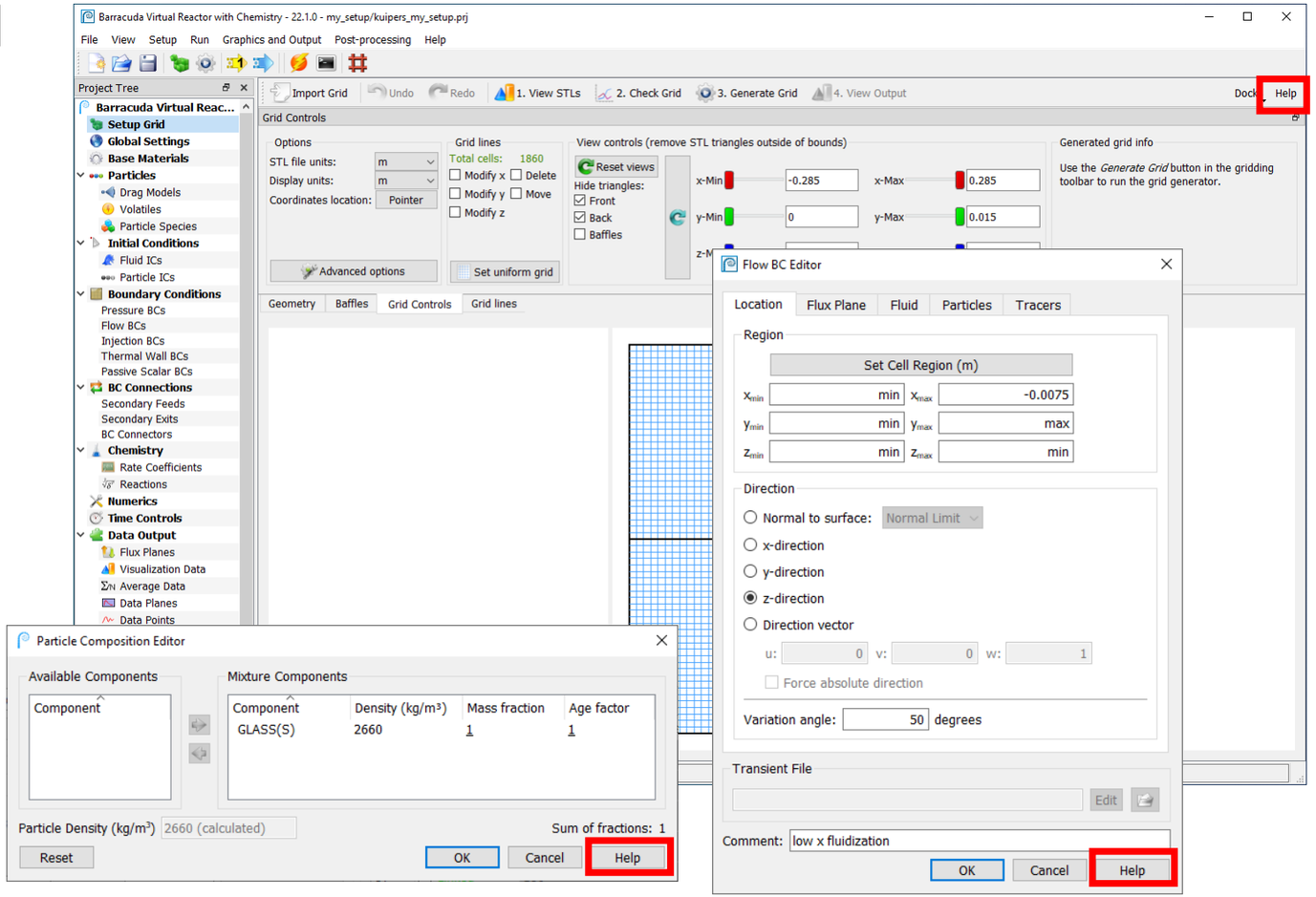
This knowledge base post contains additional discussion:

https://cpfd-software.com/things-to-consider-when-simulating-cyclones/

How to Get More Information

All training materials have a limited amount of information about Barracuda and the GUI.

If you want to learn more, click on the Help button in the relevant dialog. This brings up the corresponding section of the User Manual.



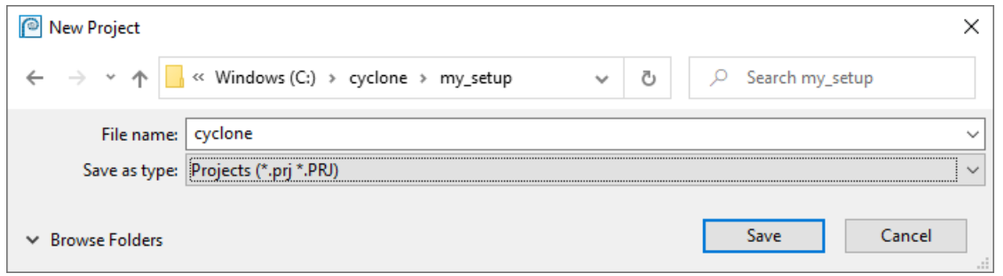
Project File

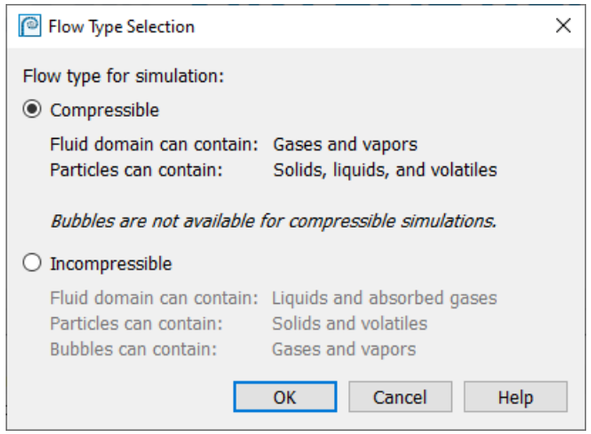
Make a new compressible project file in the supplemental training directory:

\cyclone\my_setup

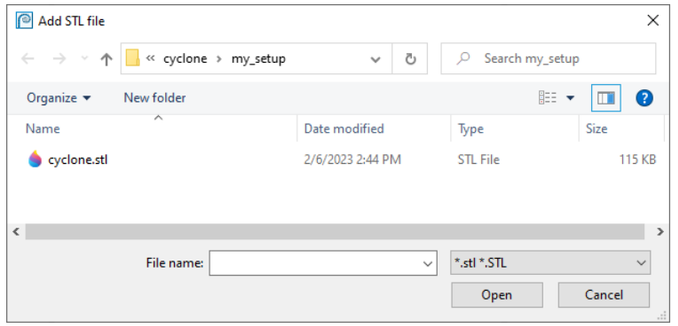
With the project name:

cyclone.prj





Setup Grid

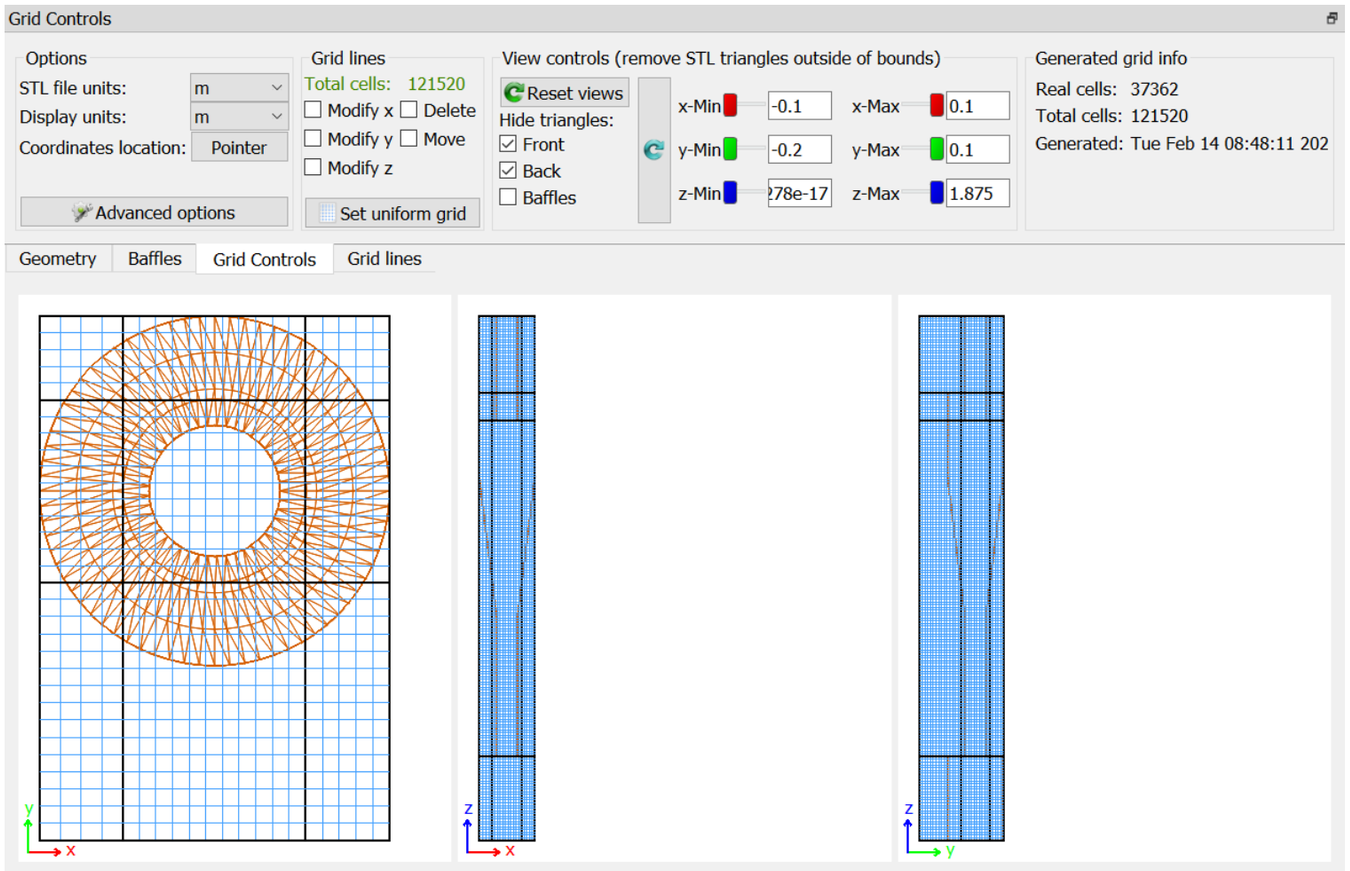


Geometry tab

- Add cyclone.stl

Grid Controls tab

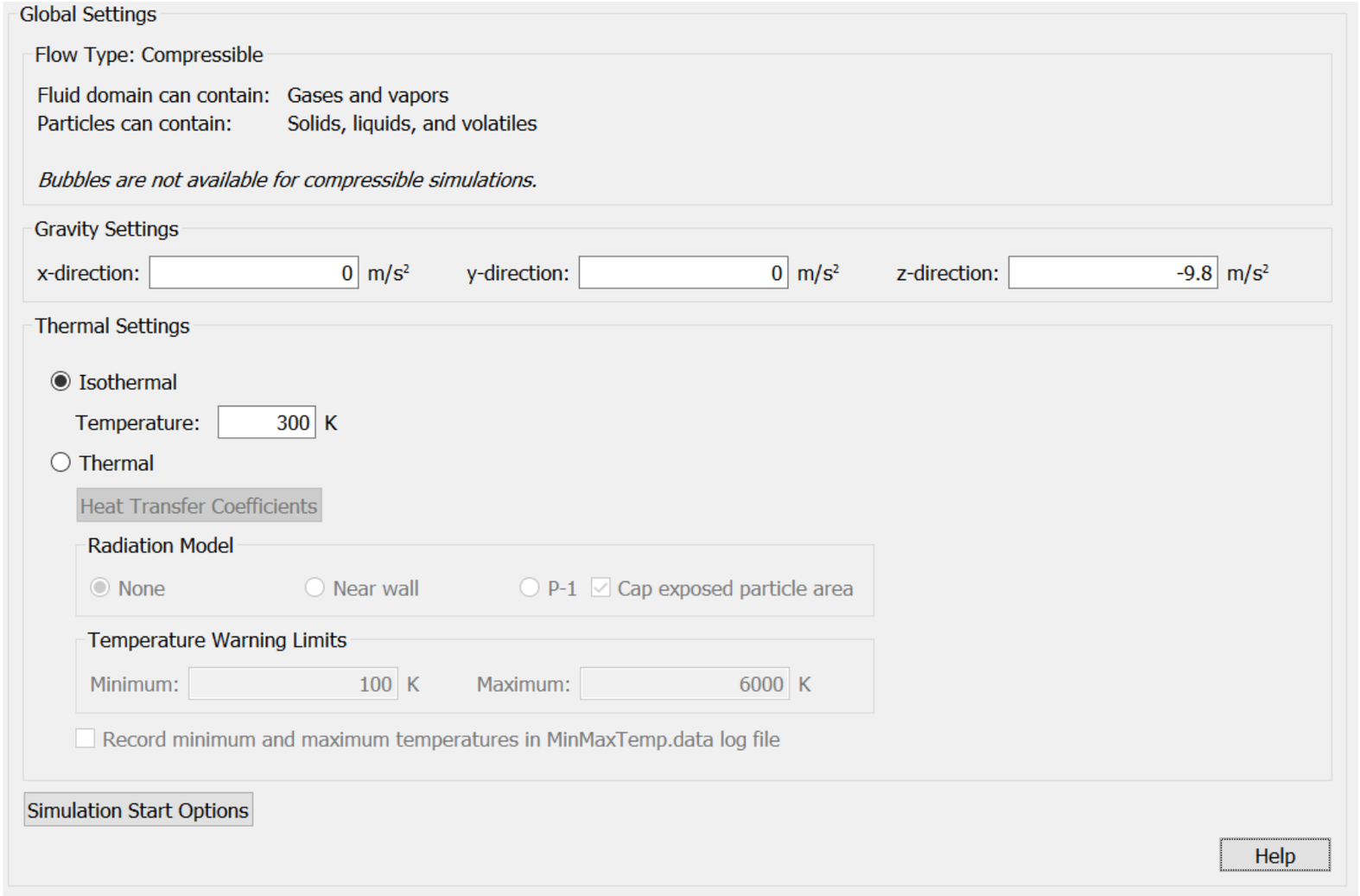
- Set STL file units to m
- Set uniform grid to 130,000 cells
- Select Merge and remove small cells in the Advanced options dialog
- Modify x and y to add major grid lines to resolve vortex tube walls
- Modify z to add major grid lines for vortex tub, inlet horn, and dipleg discharge chamber



Global Settings

Set Gravity in the z-direction

Select Isothermal at 300 K



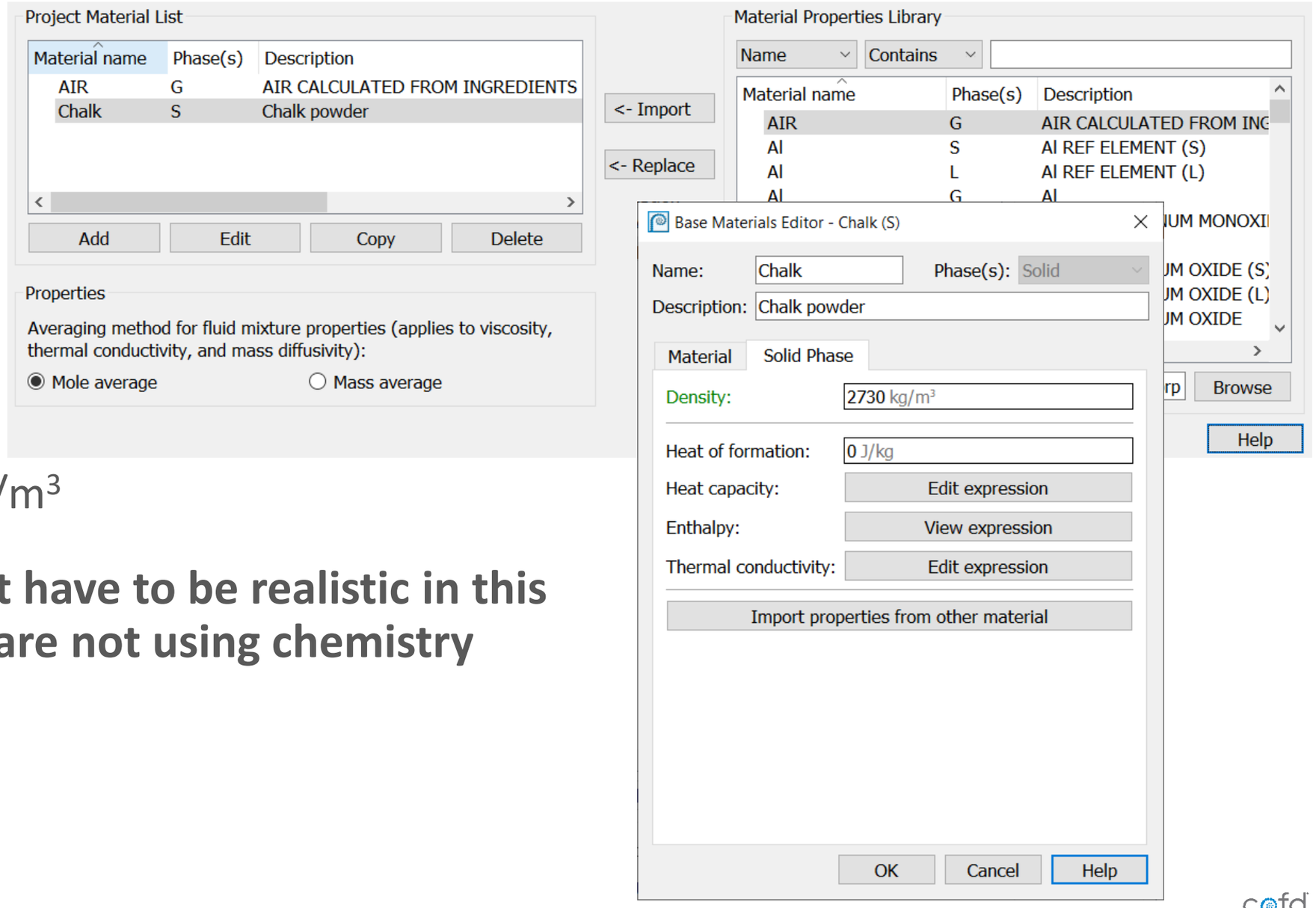
Base Materials

Import AIR

Add Chalk

- Phase: Solid
- MW = 1 g/mol
- Density = 2730 kg/m^3

MW of Chalk does not have to be realistic in this example because we are not using chemistry



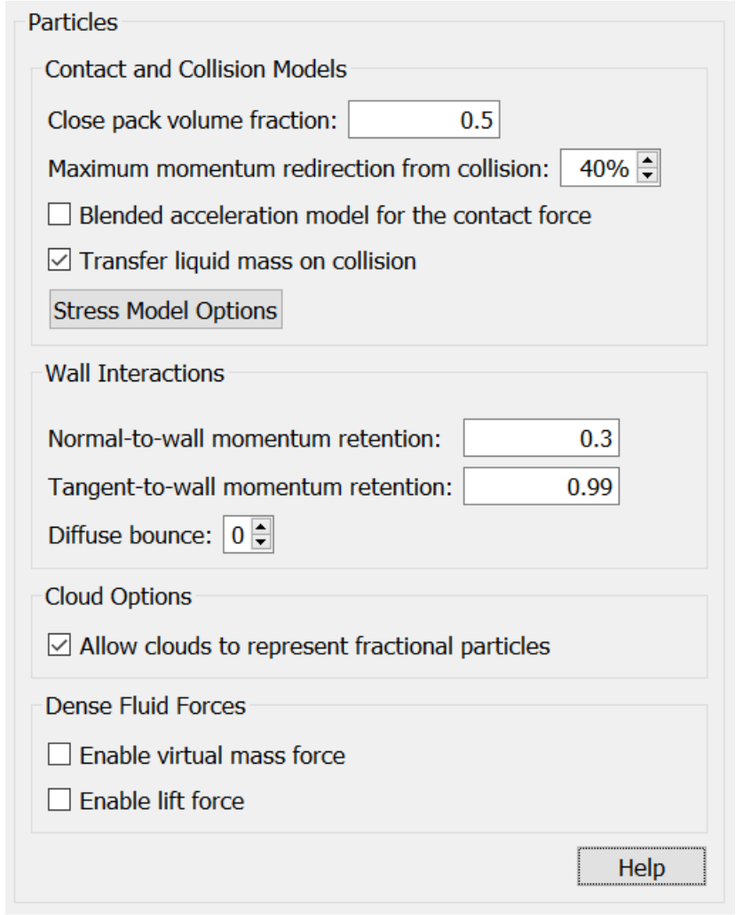
Particles

Set Close pack volume fraction: 0.5

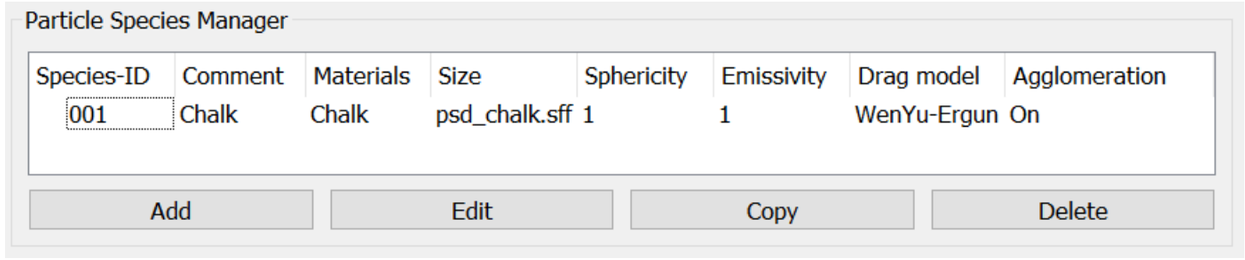
Normal-to-wall momentum retention: 0.3

Tangent-to-wall momentum retention: 0.99

- Using a very high value will allow the particles to slide around the cyclone barrel without losing too much speed



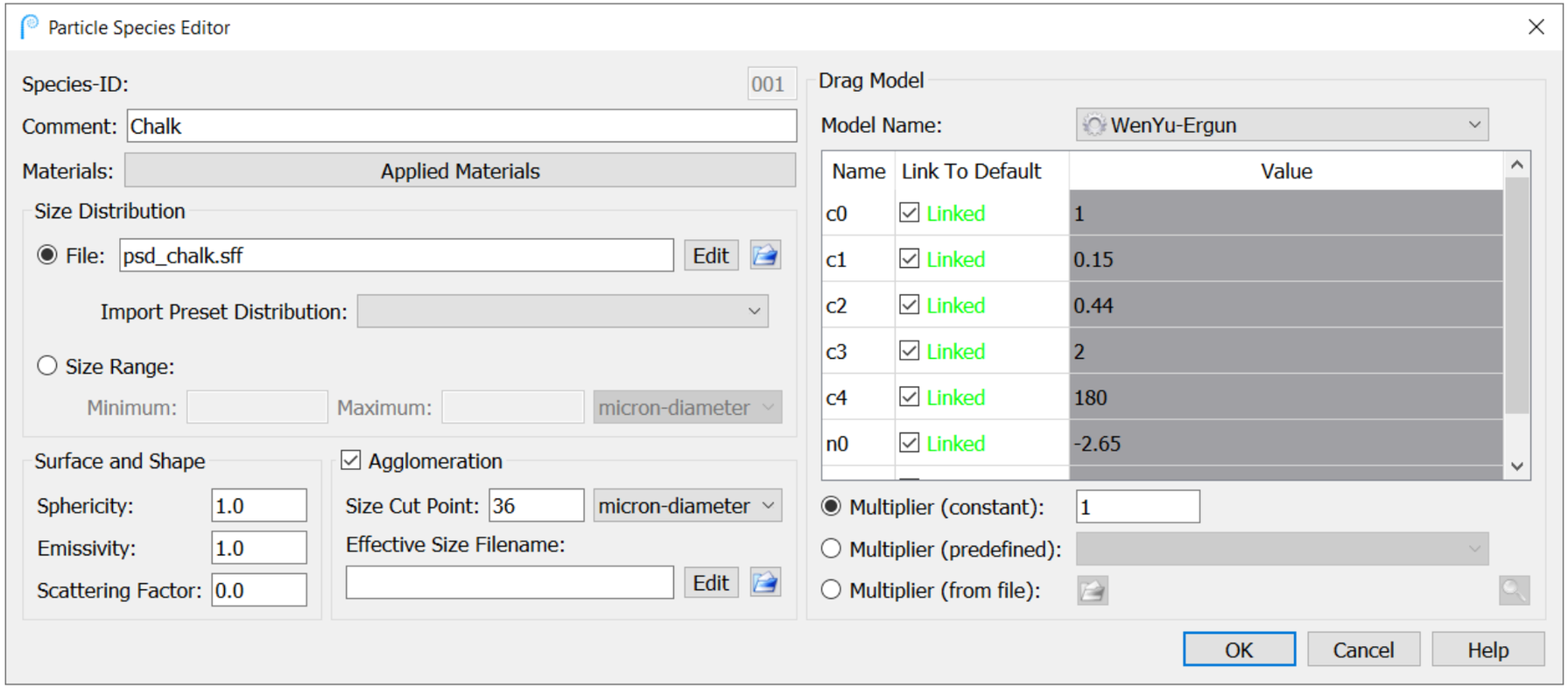
Particle Species



Create the chalk particle species:

- Chalk, 100% Chalk, psd_chalk.sff, Agglomeration, WenYu-Ergun

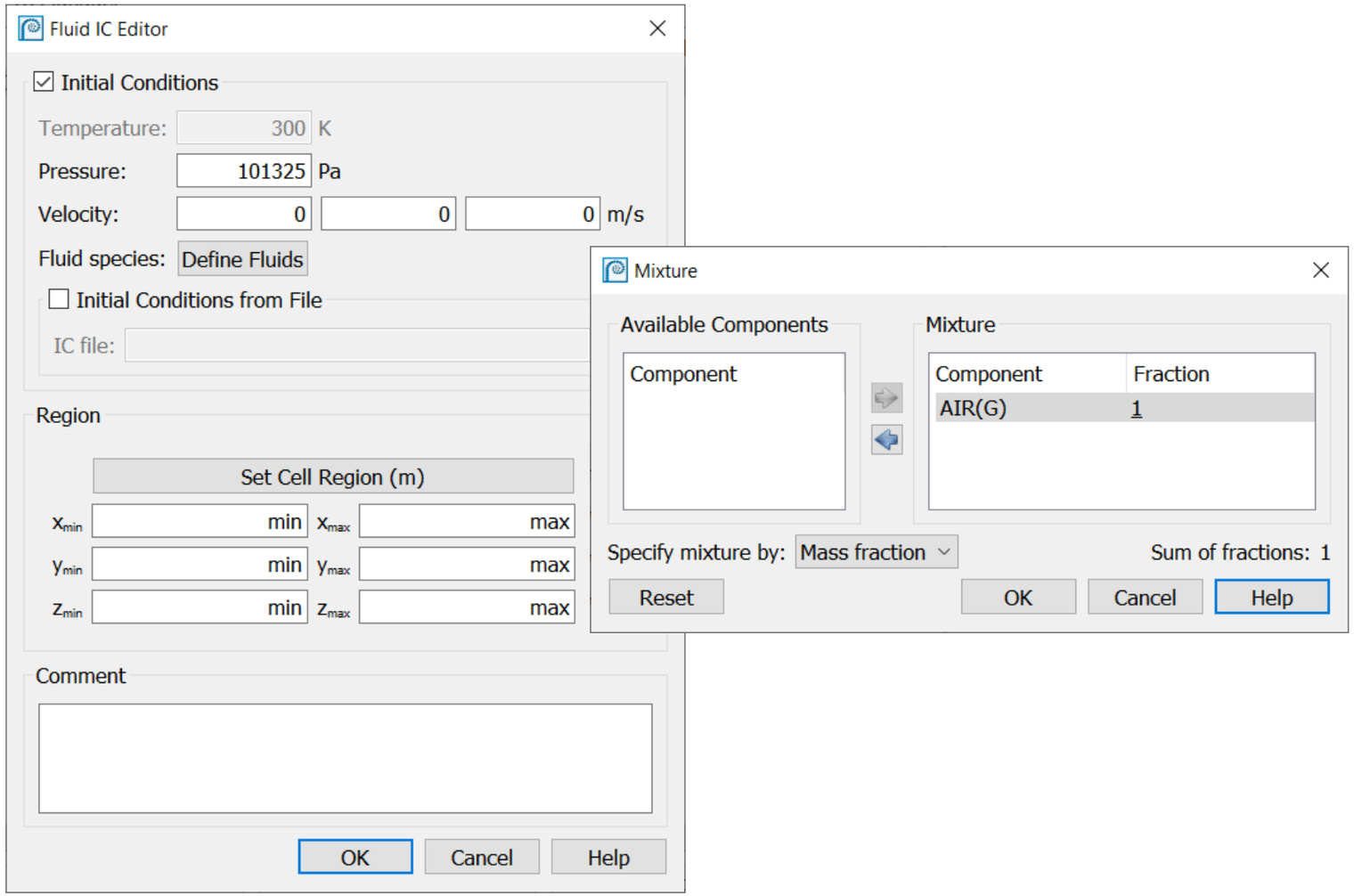
PSD file is included in the supplemental training directory



Fluid IC

Fluid IC

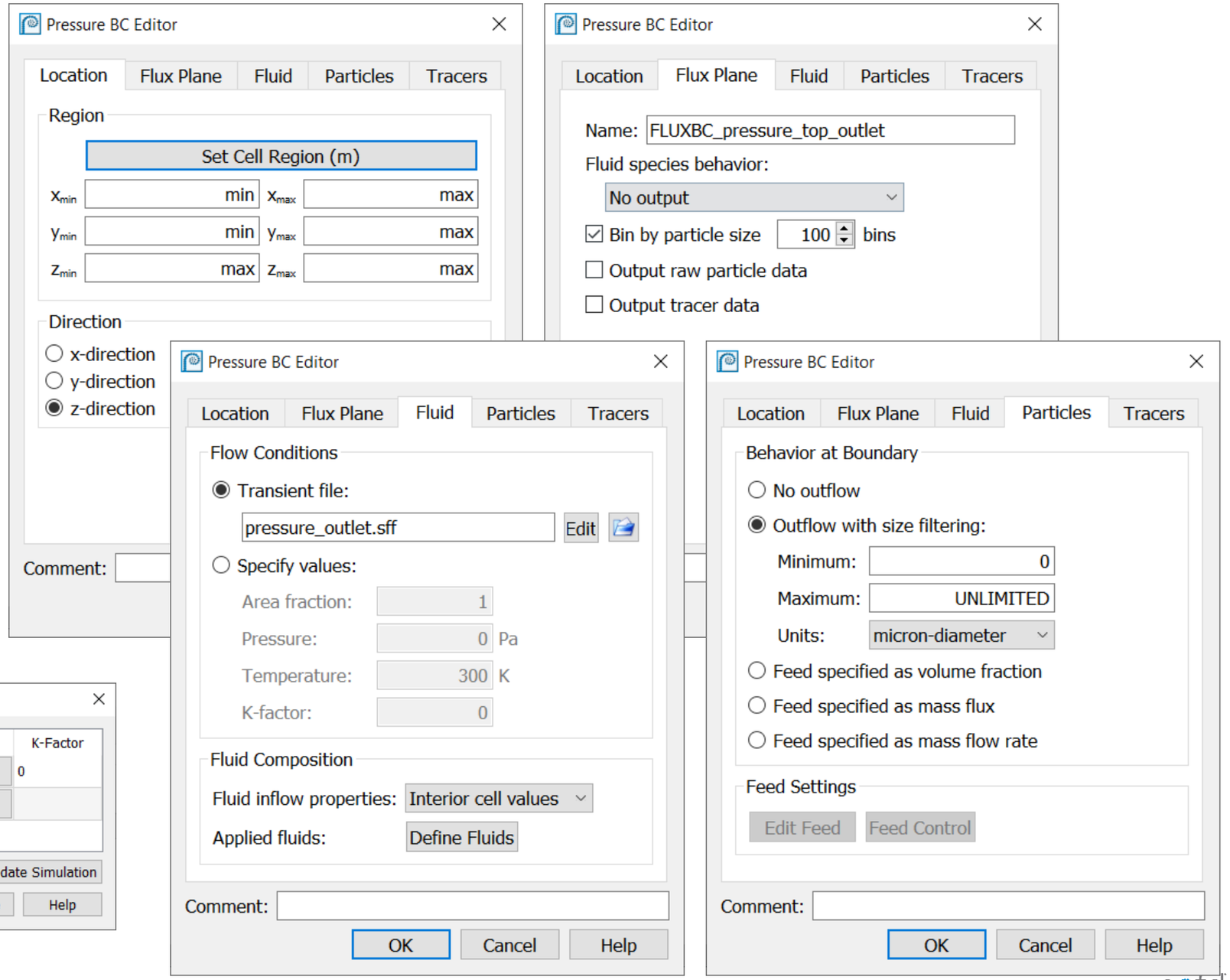
- Fluid species = 100% AIR

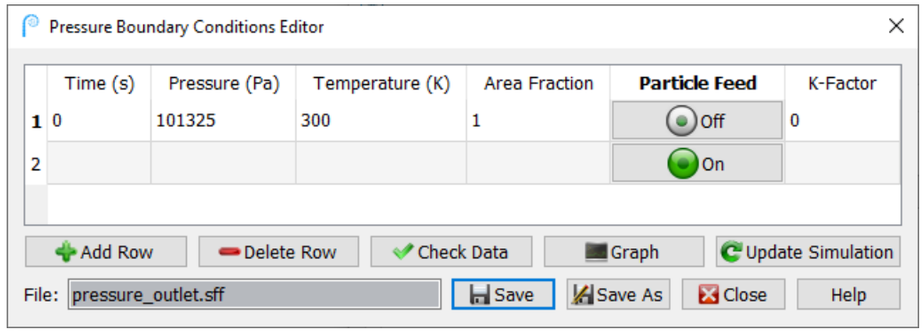


Pressure BC

Add a pressure BC with information shown here for cyclone outlet

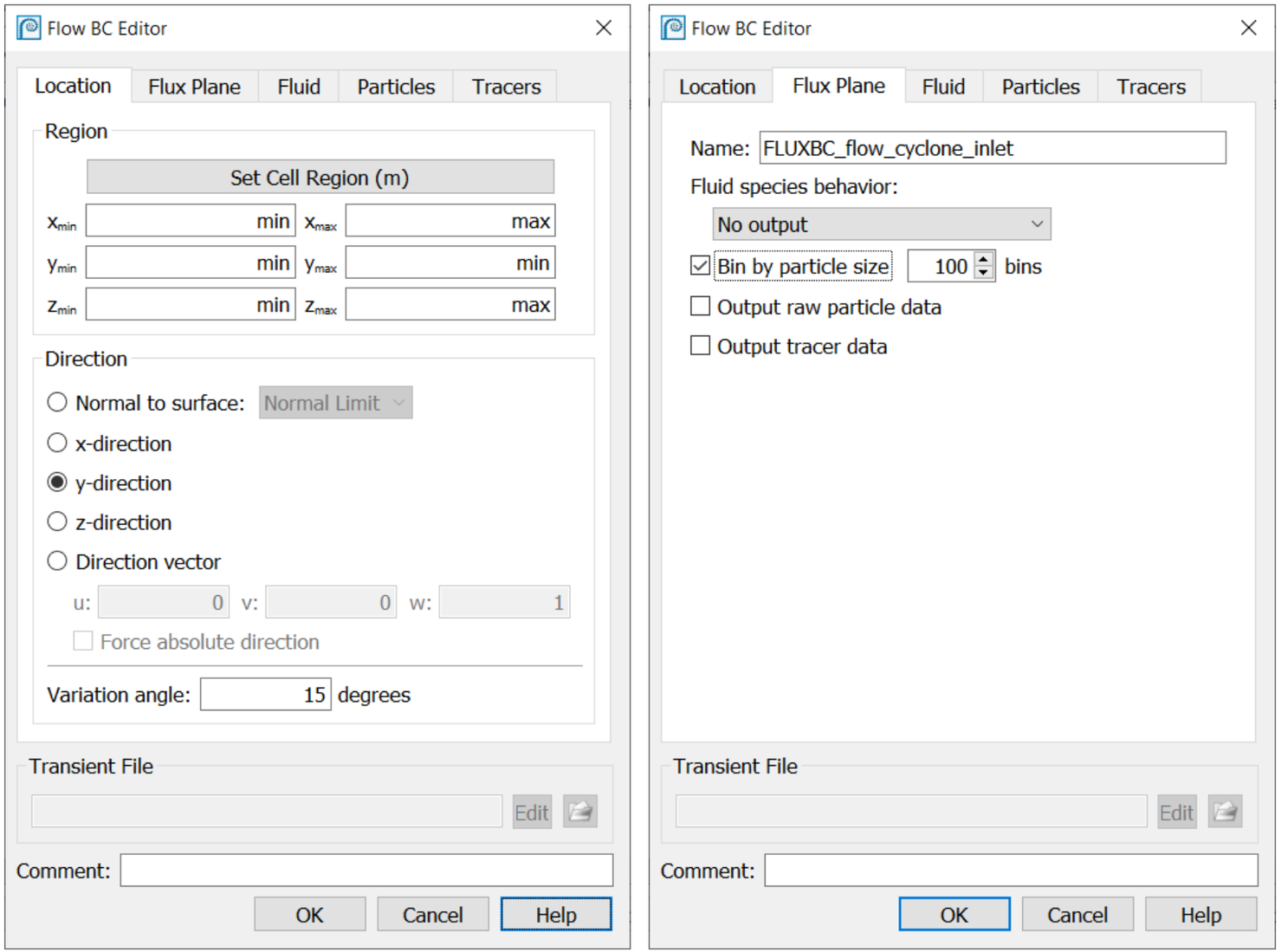
Use 100% AIR for Applied fluids





Flow BC

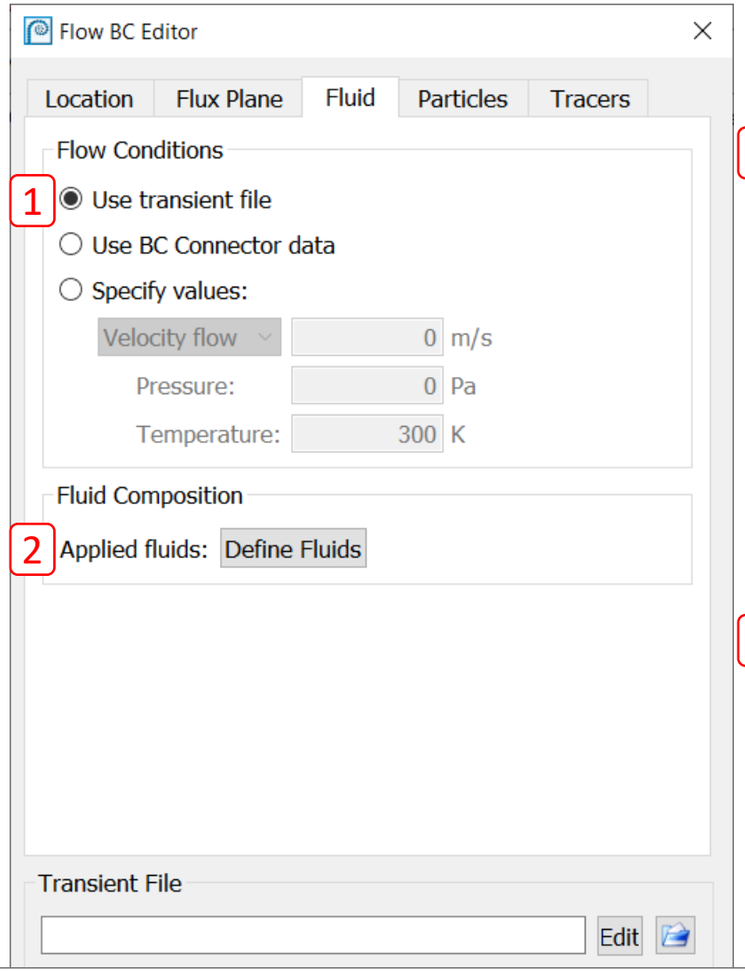
Add flow BC with information shown here for cyclone inlet

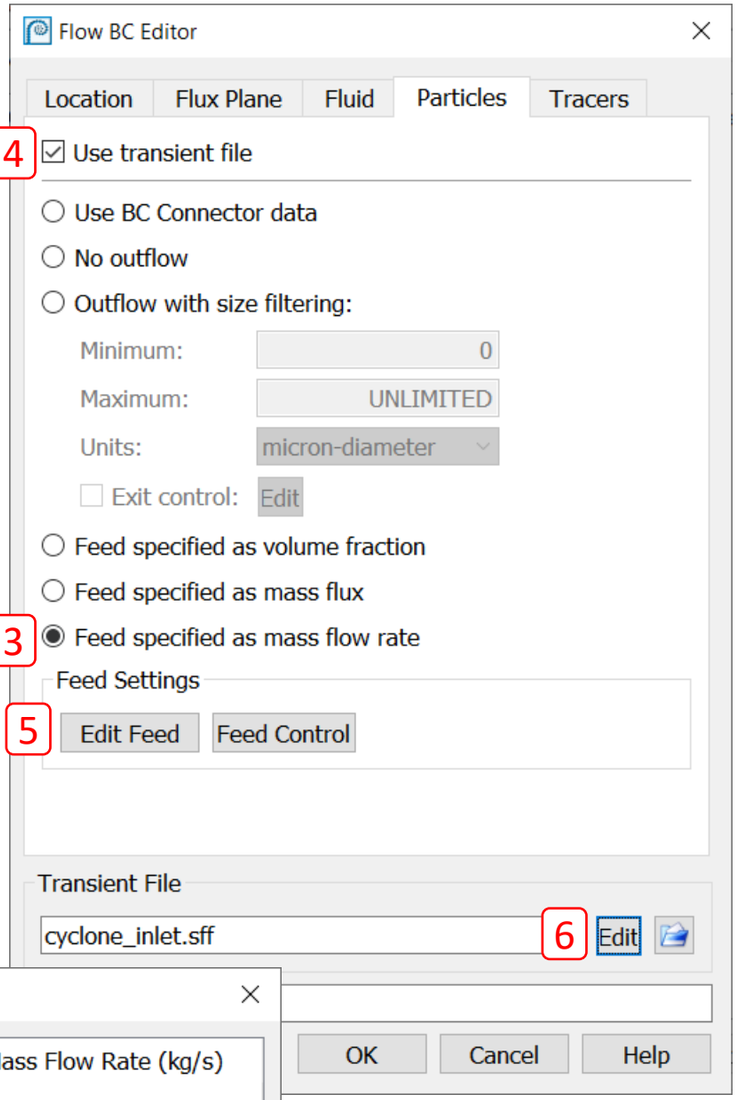


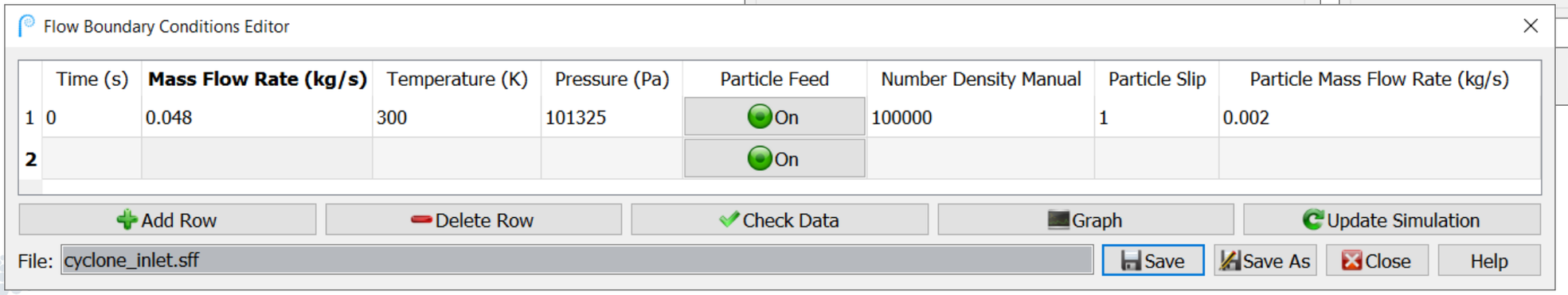
Flow BC

Use 100% AIR for Applied fluids

Use 100% Chalk for Particle feed

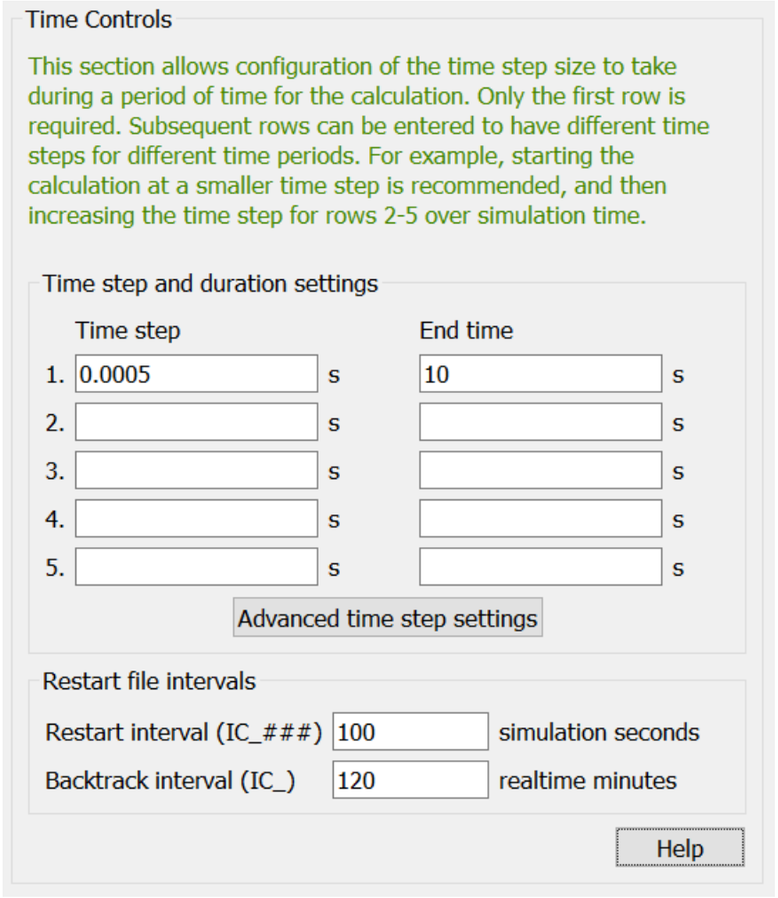






Time Controls

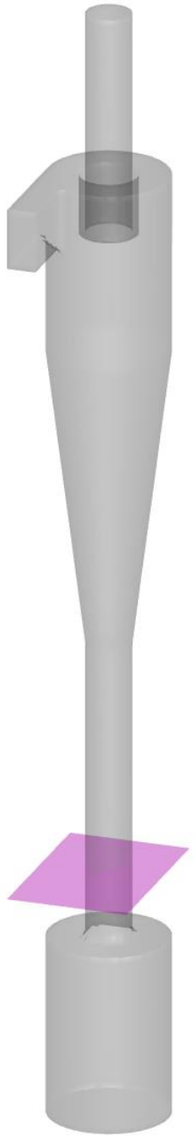
Set Time step and End time

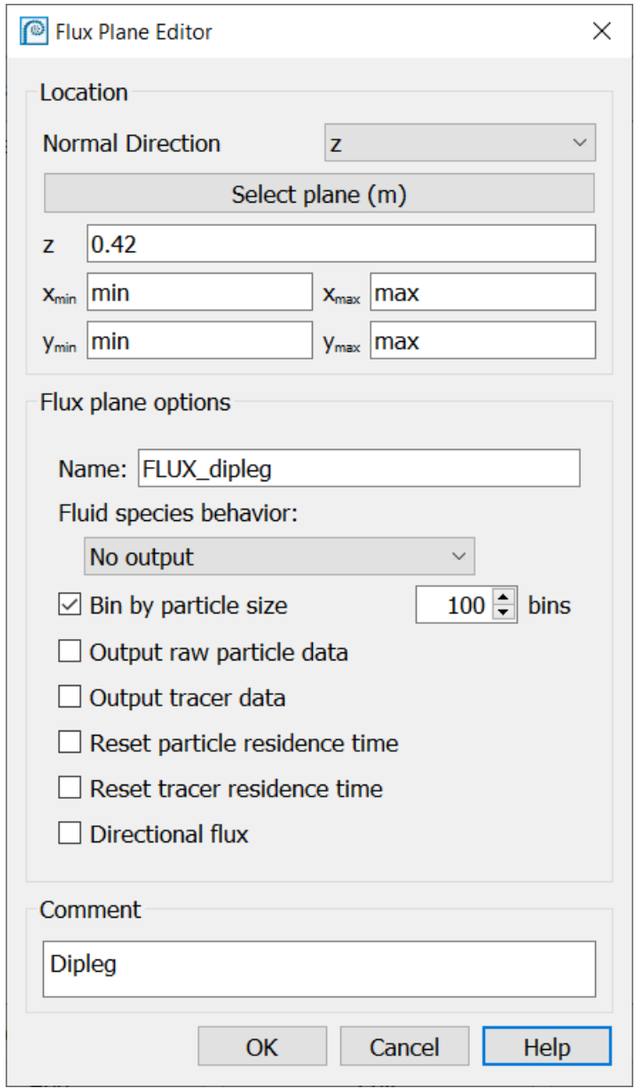


Flux Planes

Define one flux plane to track flow through the dipleg

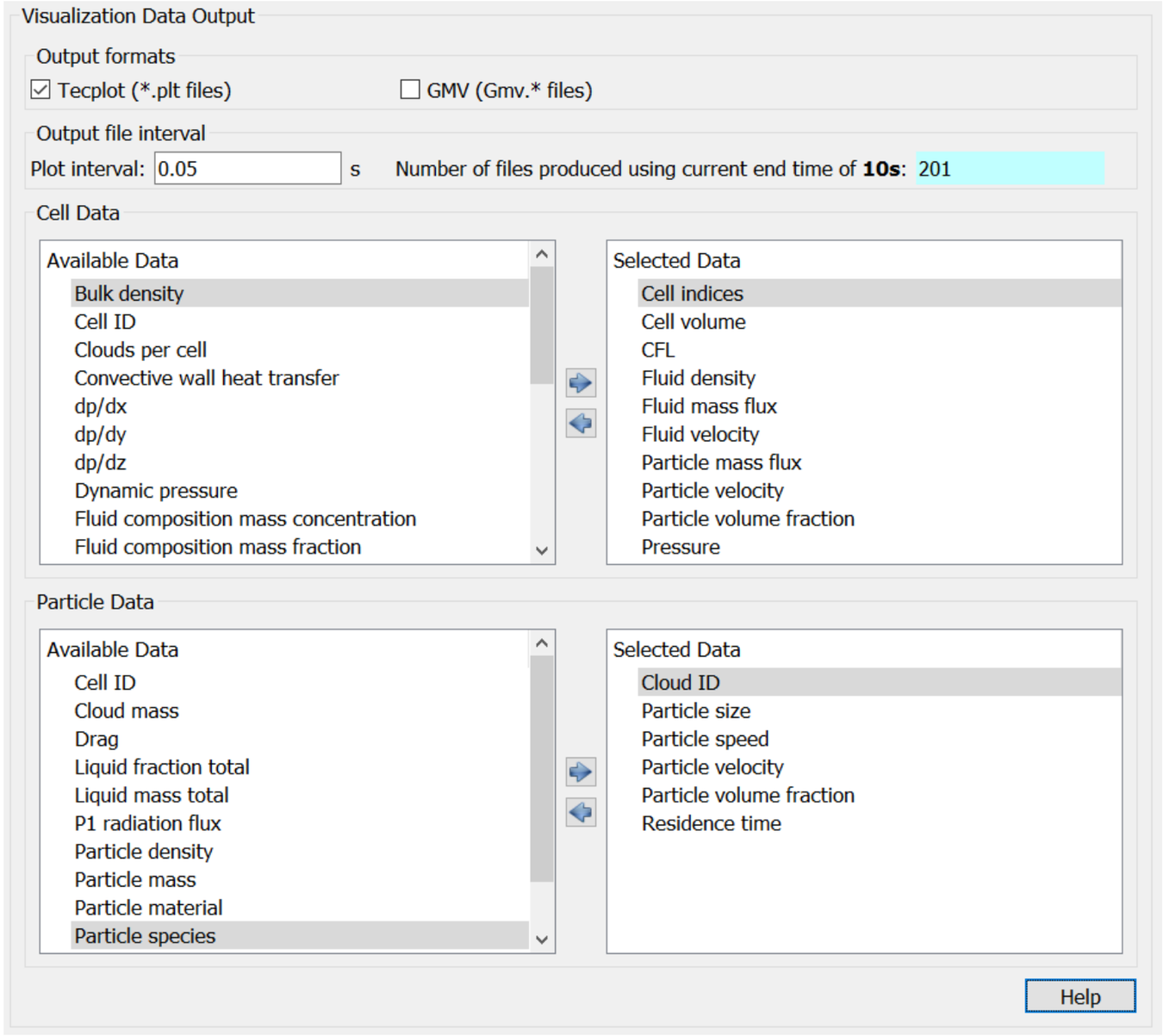
Select Bin by particle size





Visualization Data

Set Output file interval and select the options shown for Visualization Data Output



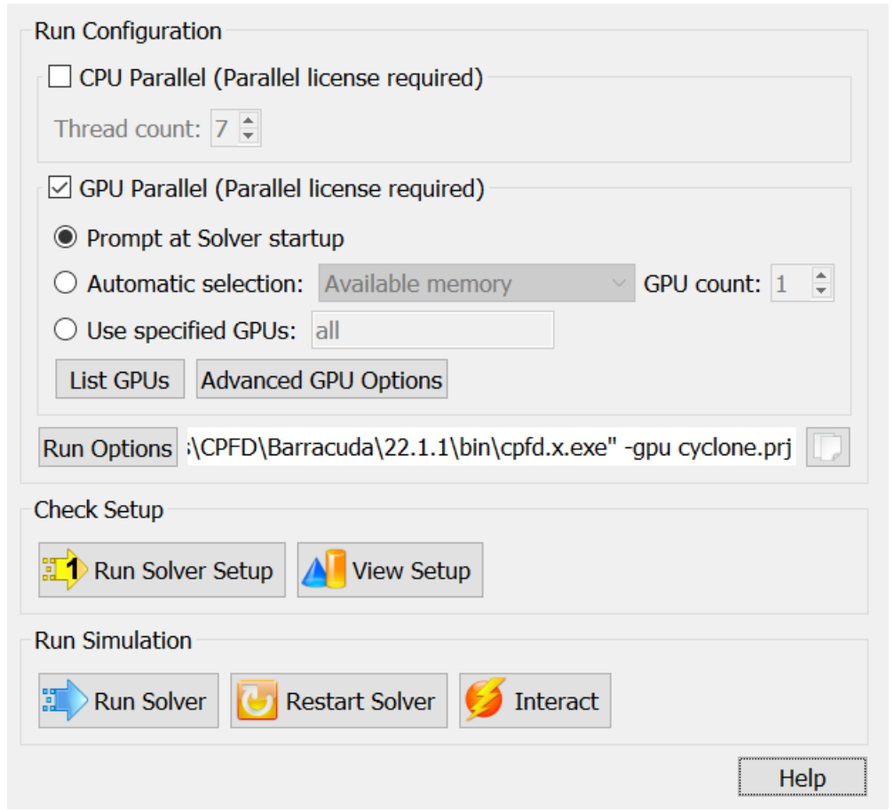
Run

If NVIDIA GPU card is available, select GPU Parallel

Run Solver Setup and View Setup

Once you have checked the setup, Run Solver to start the simulation

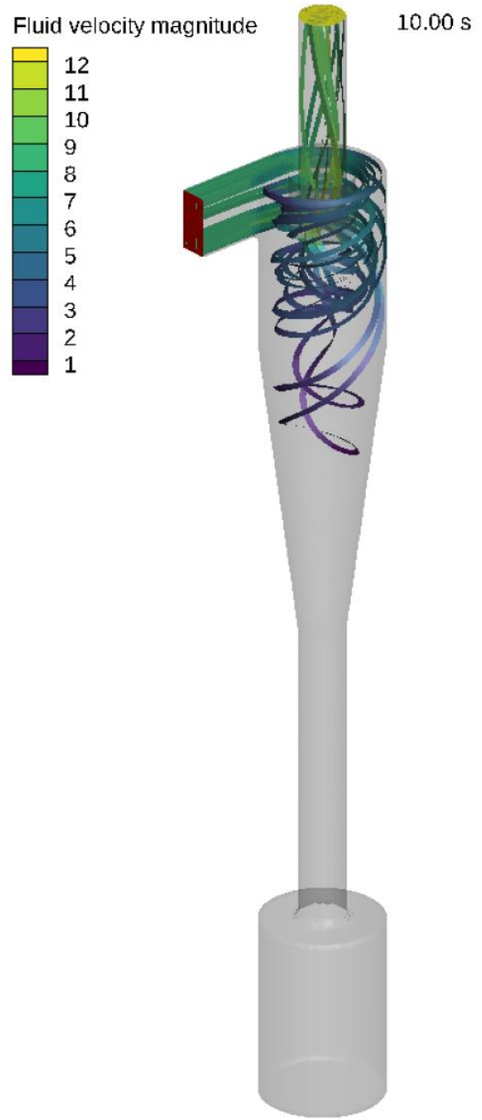
Wait until the simulation has reached at least 5 seconds before starting the post-processing exercises



Post-Processing: Streamtraces

Follow along with this video to create a view of streamtraces in the cyclone

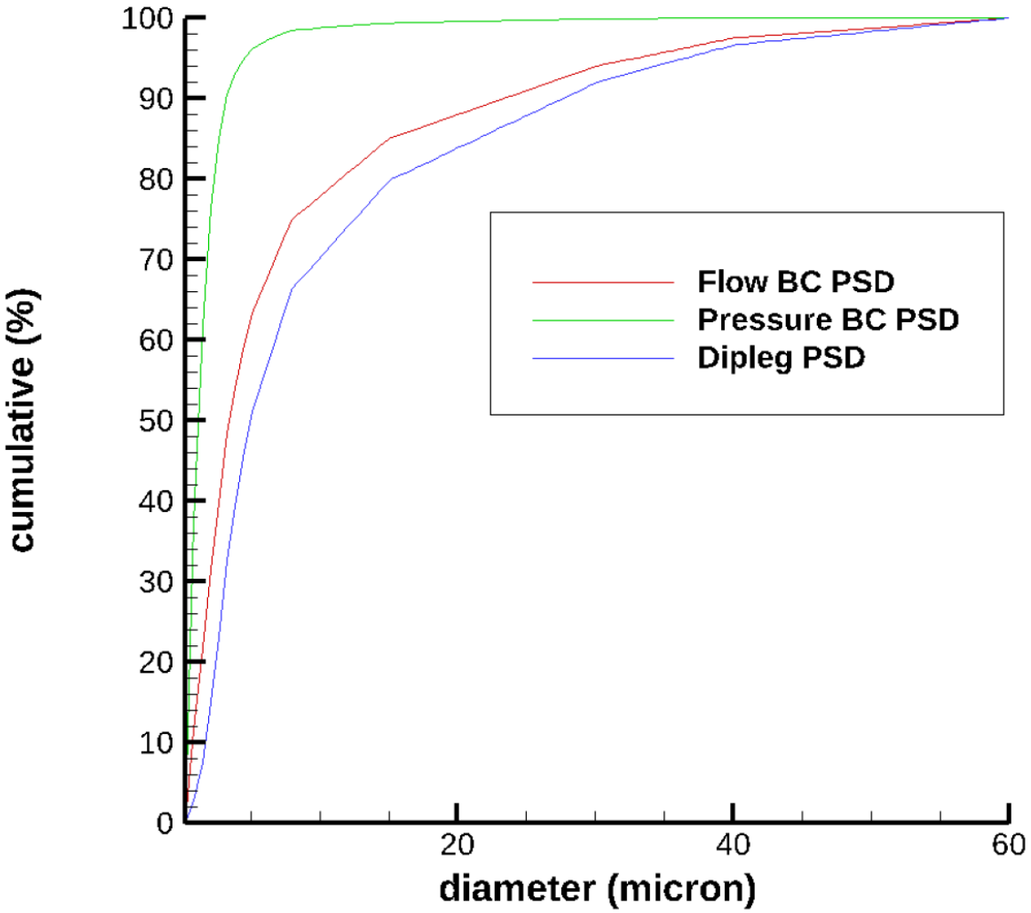
https://cpfd-software.com/tecplot-for-barracuda-creating-streamtraces/



Post-Processing: Using flux2psd

Follow along with this Knowledge Base post to use flux2psd to compare the PSD of the chalk coming into the system at the Flow BC, to the PSD of the chalk leaving the system at the Pressure BC, and the PSD of the chalk going through the flux plane in the dipleg.

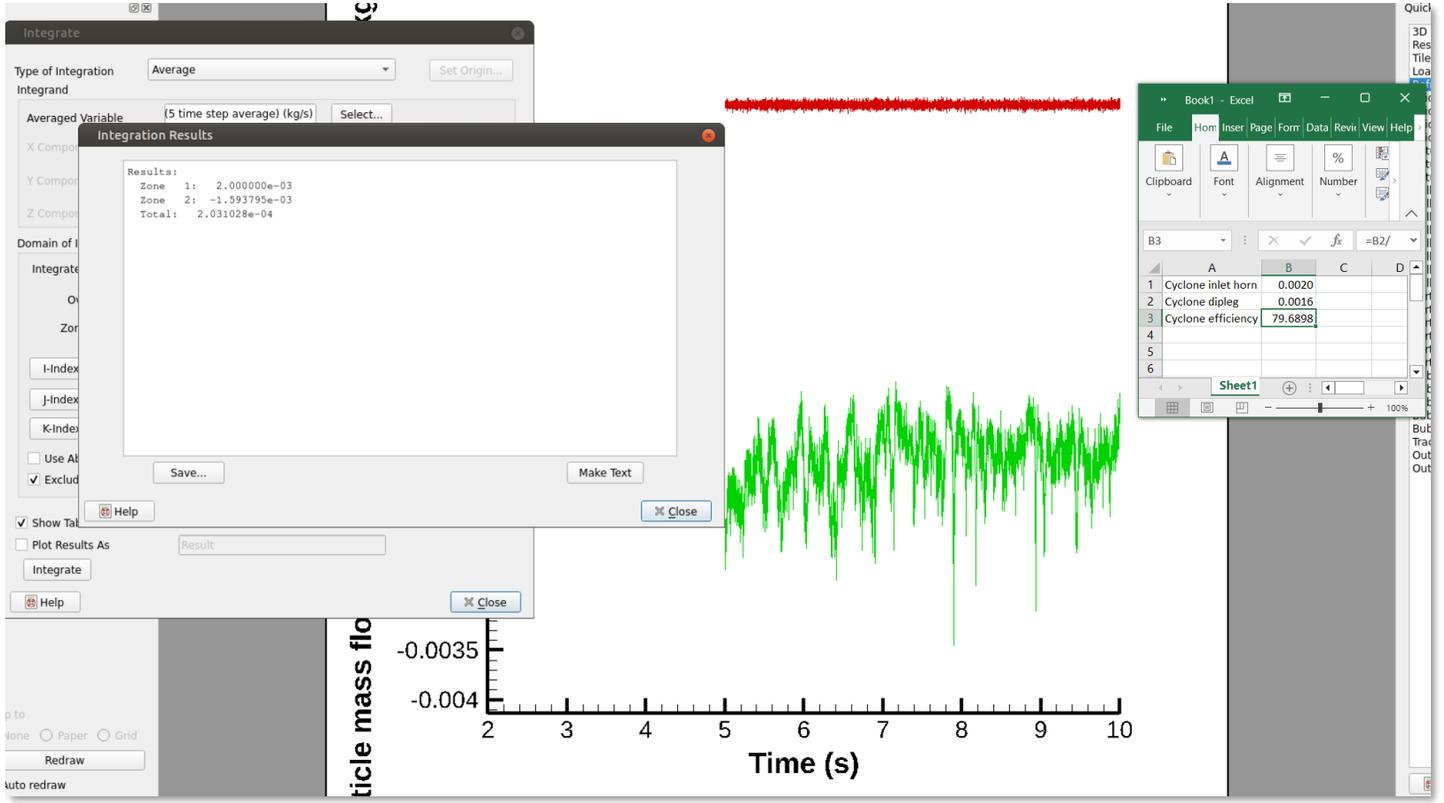
https://cpfd-software.com/calculating-psd-at-a-flux-plane-using-flux2psd/



Post-Processing: Cyclone Efficiency

Follow along with this video and check the efficiency of the cyclone with an averaging time from 5-10 s

https://cpfd-software.com/tecplot-for-barracuda-calculating-cyclone-efficiency/



Summary

This model showed a lightly loaded cyclone based on literature.

Important setup parameters were highlighted:

- Merge and remove small cells
- Agglomeration
- Bin by particle size

Post-processing of the cyclone included:

- Creating streamtraces to visualize the fluid flow path
- Using flux2psd to calculate the PSD of the particles entering and exiting the cyclone
- Calculating the efficiency of the cyclone