Initialization

CONVERGE Studio Workflow

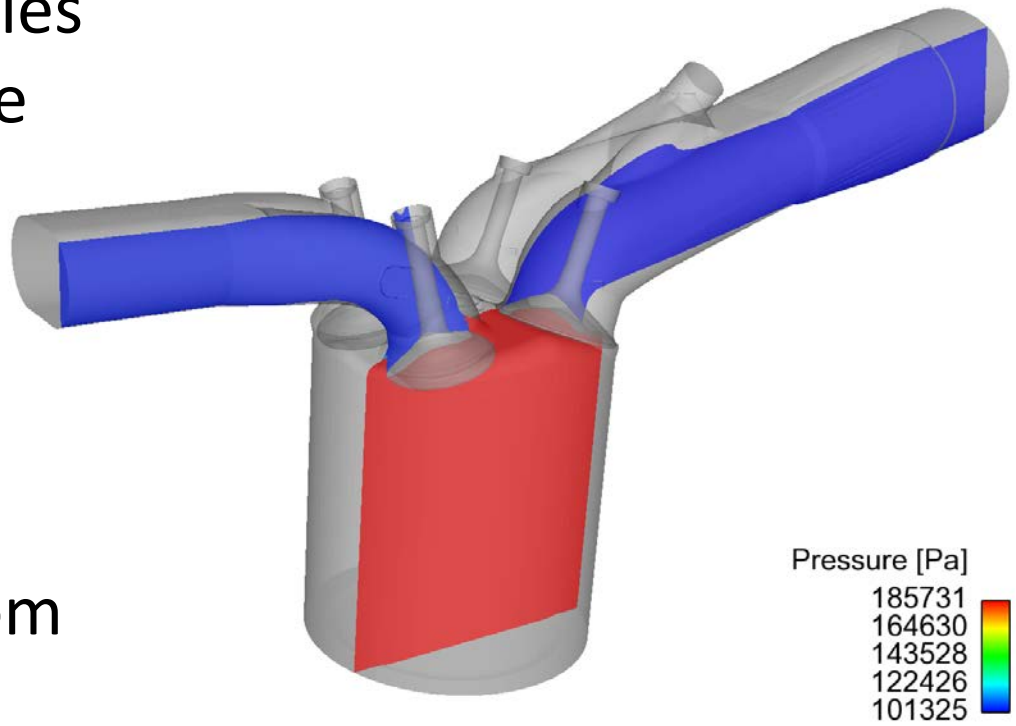
- ***Case Setup*** **module**
  - Begin a project
  - Import the surface geometry
  - Prepare the surface
  - **Configure case setup**
    - Boundary conditions and region definitions
    - **Initialization**
    - Grid control
    - Physical models (turbulence, spray, combustion, sources, CHT, VOF, etc.)
    - Advanced options
  - Export input and data files to the Case Directory

----------Run CONVERGE simulation----------

- *Line Plotting* module
- *Post-Processing 3D* module

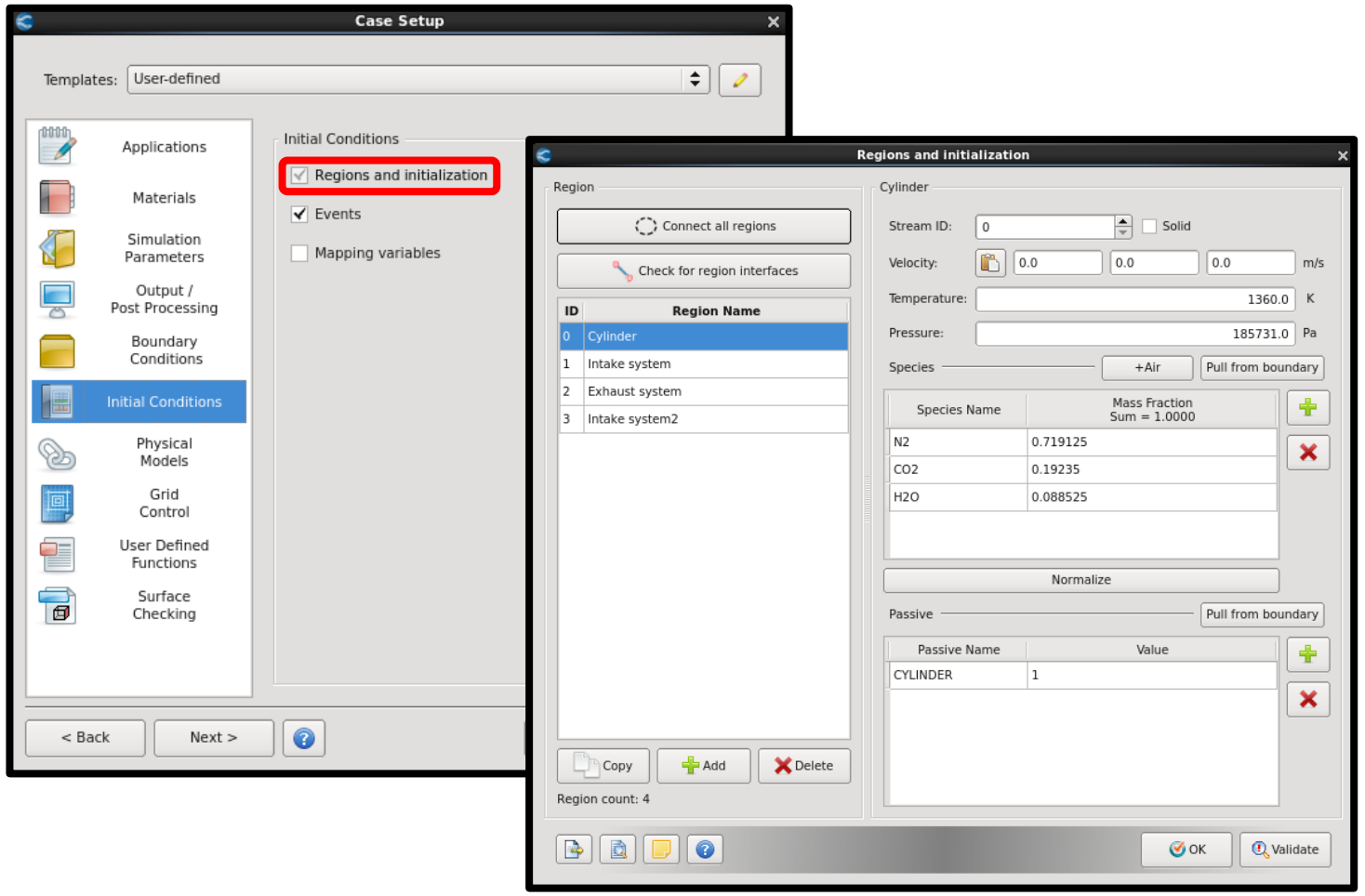
Options for Initialization

- You can specify initial conditions for variables such as velocity, temperature, and pressure
  - Specify values for the entire domain or different regions
  - Map field values from a file
    - Initialize each cell individually
  - Take the valves of the field variables from restart files
    - Initialize each cell individually



How to Set Up Initialization

- Go to *Case Setup* > *Initial Conditions* > *Regions and initialization*



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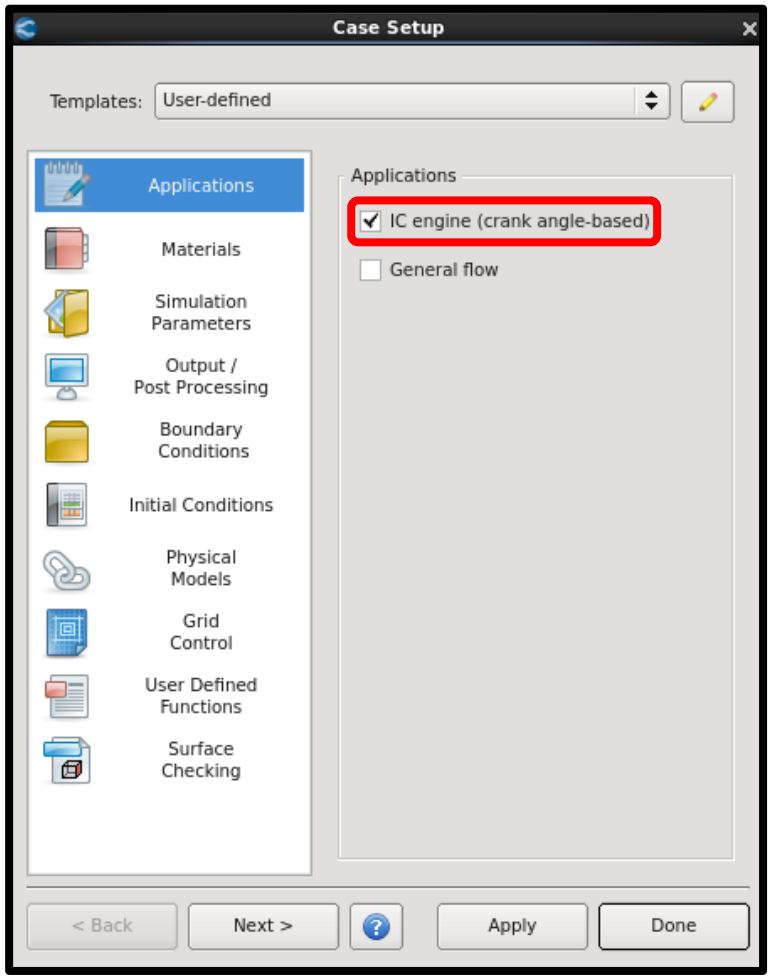
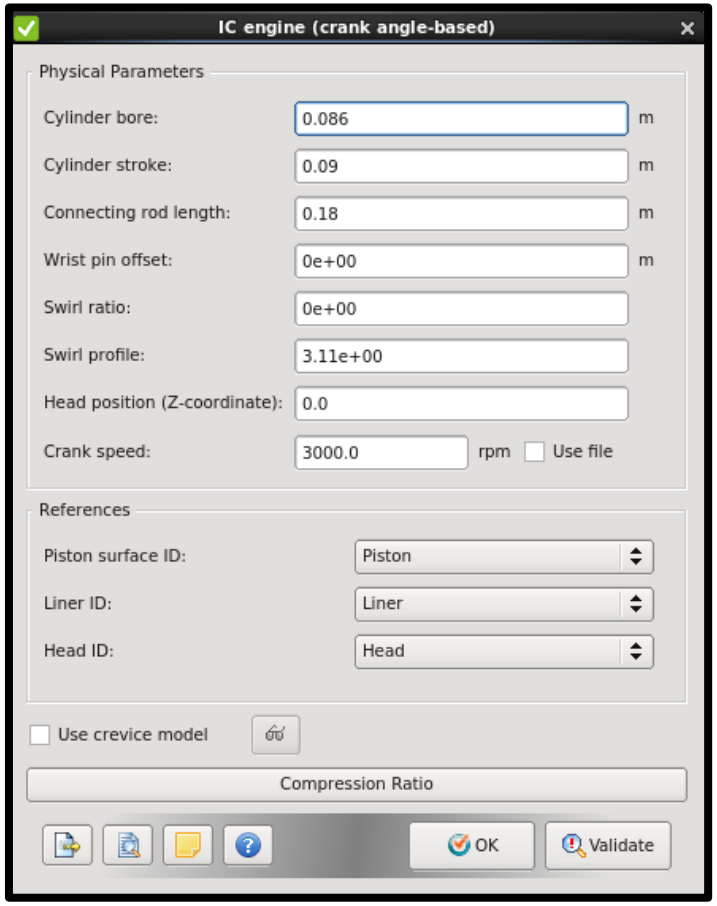
Velocity Initialization: Single Cylinder (1/3)

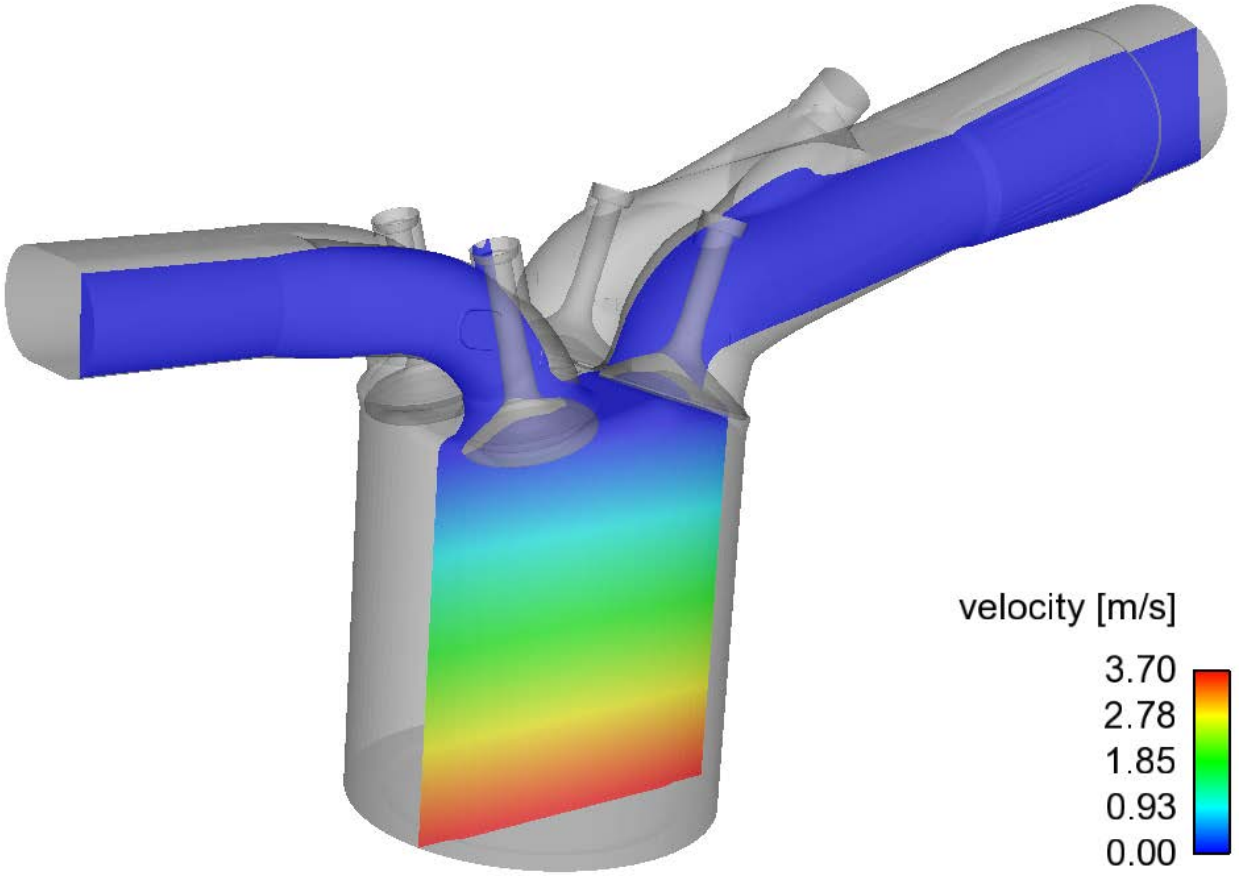
- CONVERGE needs engine parameters to initialize the velocity in the cylinder
- Go to *Case Setup > Applications > IC engine* to specify these values





Velocity Initialization: Single Cylinder (2/3)

- The w component of velocity is set to the piston speed for all points in the piston bowl and on the land
  - Assuming piston movement is in the z direction
- The cells in the cylinder are given an initial w consistent with a field that linearly drops from the piston speed at the piston face to zero at the head



Velocity Initialization: Single Cylinder (3/3)

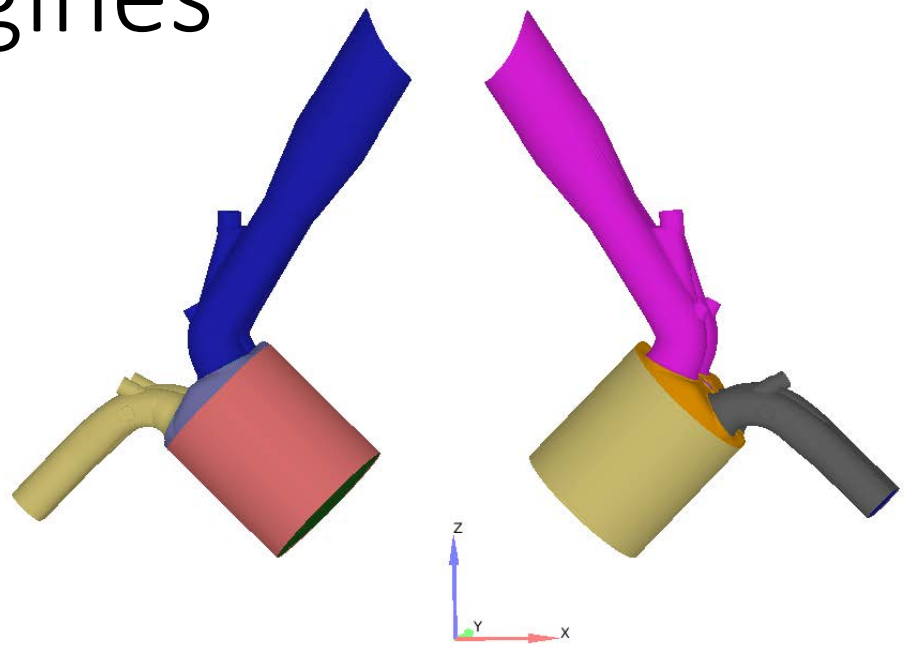
- The u and v components of velocity are set by Swirl ratio and Swirl profile (*Case Setup > Applications > IC engine*)
  - The swirl profile, which has a minimum value of 0.0 for wheel flow and a maximum value of 3.83 for zero velocity at the wall, is a dimensionless constant used in the Bessel function calculation

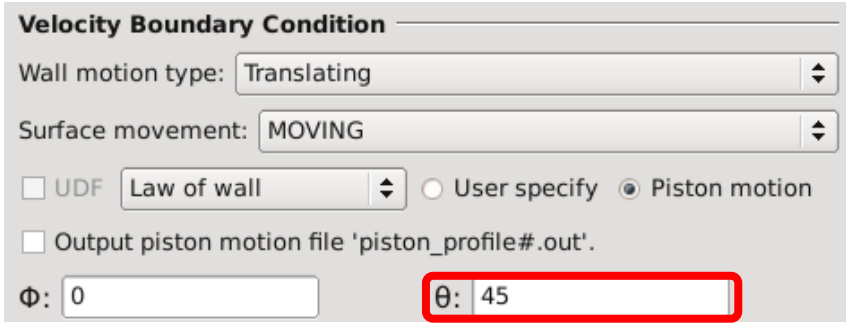
Velocity Initialization: Inline Multi-Cylinder

- For multiple-cylinder cases, only the cylinder whose piston, liner, and head boundary IDs are specified in *Case Setup* > *Applications* > *IC engine* will be initialized with velocity as explained previously
- The other cylinders will be initialized with zero velocity

Velocity Initialization: V Engines

- For engines with pistons inclined with respect to the crankshaft direction, initialization is slightly different
  - Set the inclination angle (θ) for each piston using the Right Hand Rule
- Similar to the inline multiple cylinder case, only one cylinder will be initialized and all other cylinders will have zero velocity

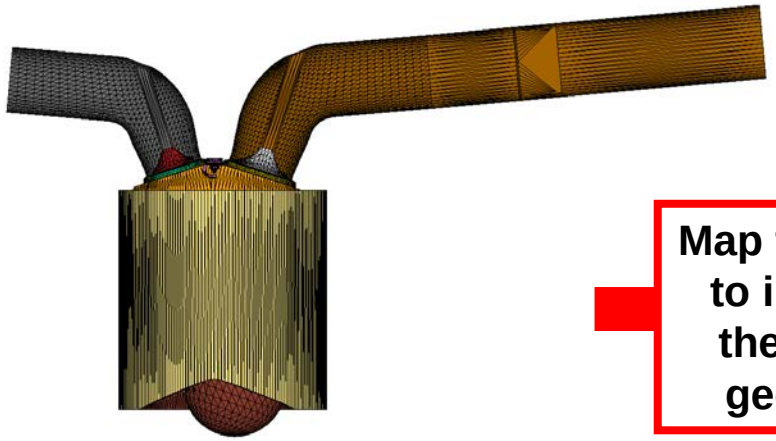




Introduction to Mapping

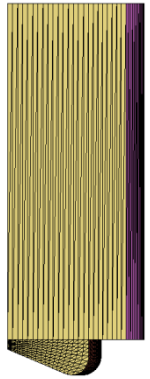
- Mapping initializes the domain (or specific portions of the domain) with three-dimensional, location-specific values such as
  - Output from a previous CONVERGE simulation
  - Output from a different CFD code
  - Experimental data (*e.g.*, LDV or PIV data)
  - Spatially varying initial values that cannot be specified via *Case Setup > Initial Conditions > Regions and initialization*
- You can initialize specific variables and/or regions via mapping
  - Other variables or regions will be initialized via *Regions and initialization*

Mapping Example



Full geometry used for gas exchange from EVO to IVC

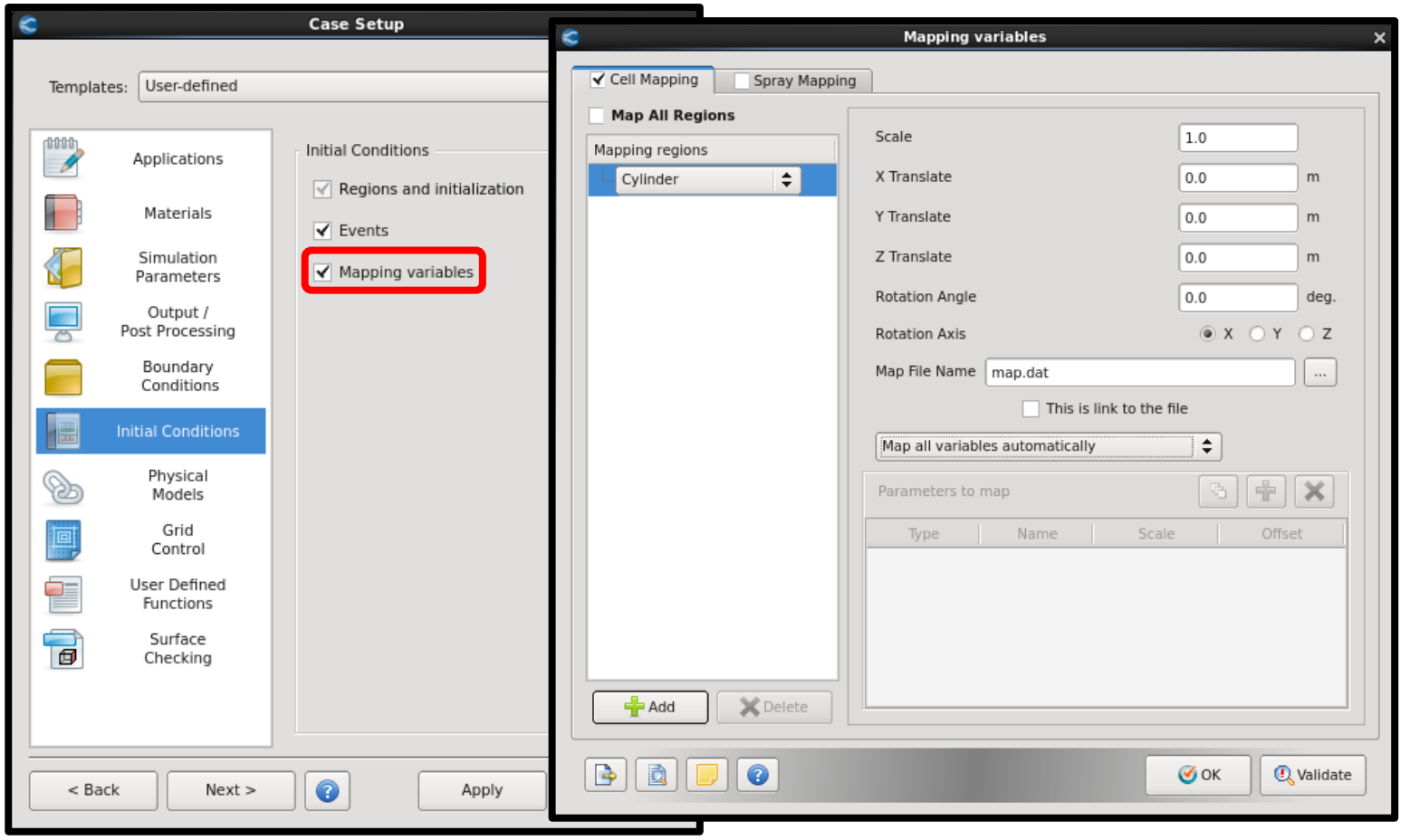
Map flow-field to initialize the sector geometry



Sector geometry used for compression, spray, and combustion from IVC to EVO

How to Set Up Mapping

- Go to *Case Setup > Initialization & Events > Mapping variables*
  - Specify the map-related parameters and the map data file
  - Can also specify spray-related mapping info (if applicable)



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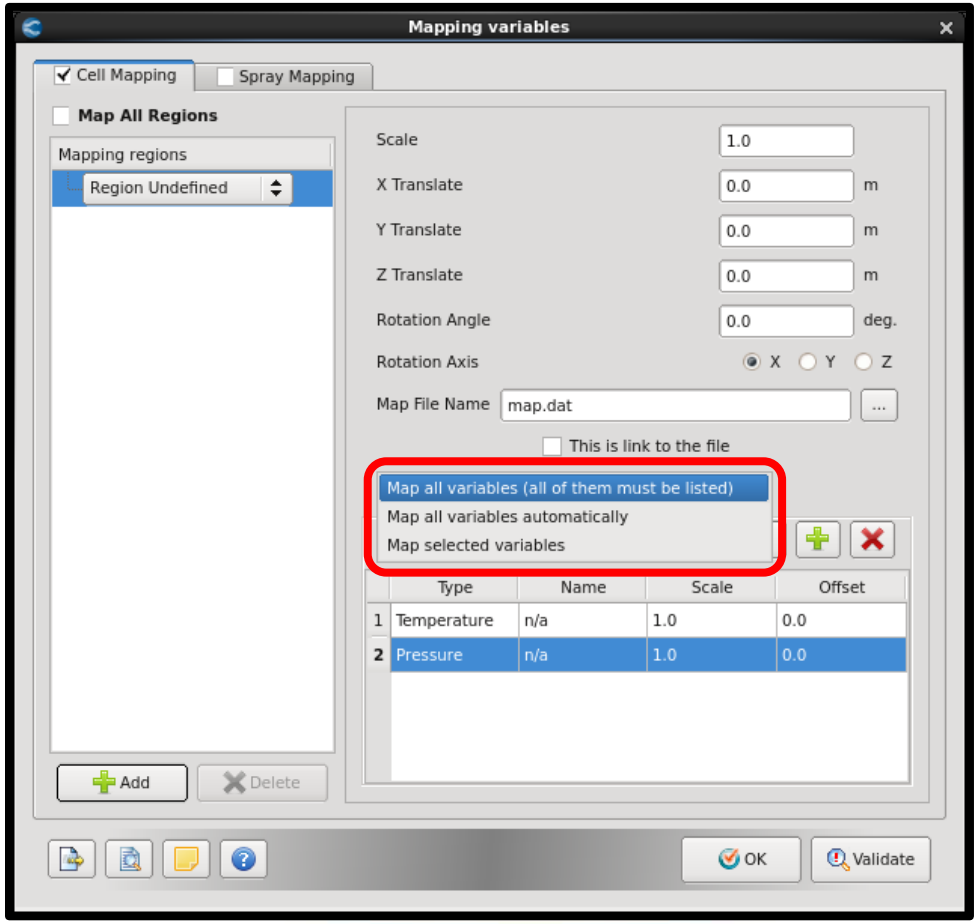
Cell Mapping Options (1/2)

- Map All Regions: Map all regions (otherwise map on a region-by-region basis)
- There are three options for mapping if you select Map All Regions
  - Map all variables (all of them must be listed): CONVERGE scales/offsets/rotates and then maps only the variables in the table. The other variables in *map.dat* (which are not listed in the table) will not be read and initialized via *Regions and initialization*
  - Map all variables automatically: CONVERGE maps all variables in *map.dat* without any change
  - Map selected variables: CONVERGE scales/offsets/rotates and then maps the variables listed in the table; CONVERGE maps the remaining variables in *map.dat* without any change

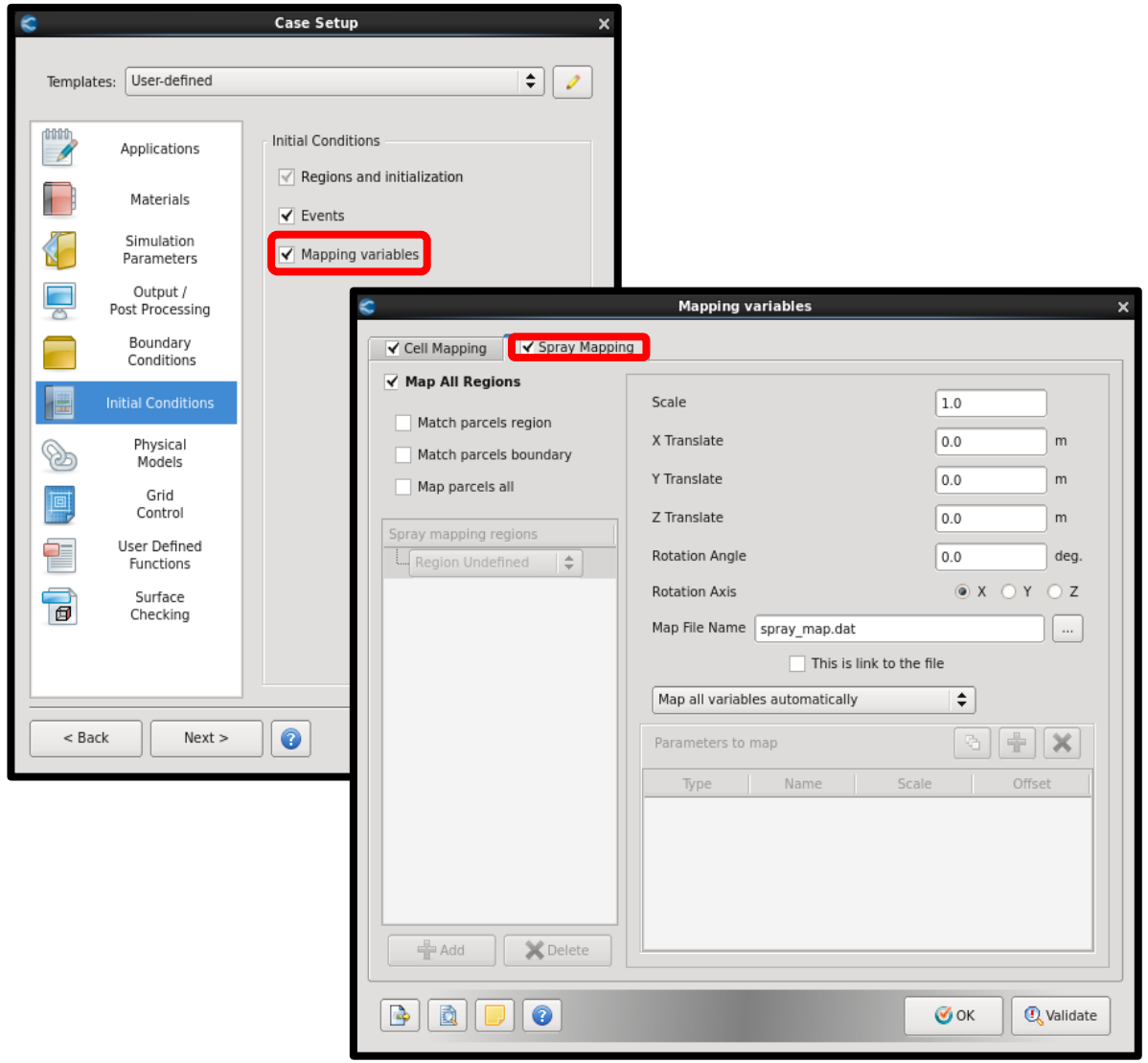


Cell Mapping Options (2/2)

- CONVERGE ignores irrelevant variables (*e.g.*, if TKE is in the data file but there is no turbulence model in the new simulation, CONVERGE will ignore TKE)
- CONVERGE looks elsewhere for unavailable variables (*e.g.*, if TKE is not in the data file but there is a turbulence model in the new simulation, CONVERGE will look for TKE in *Regions and initialization*
    - If not found, CONVERGE will use a value of zero

Spray Mapping Options

- Go to *Case Setup > Initialization & Events > Mapping variables*
  - Map All Regions: Map all regions (otherwise map on a region-by-region basis)
  - If you select Map All Regions, there are three additional options available
    - Map parcels region: Map the parcels into the same region
    - Map parcels boundary: Map the parcels on the boundary
    - Map parcels all: Move parcels into the domain if the parcels are outside the domain



Notes About Mapping

- CONVERGE initializes each cell in the new grid with the data from the nearest point in the mapping data file
- The mapping algorithm does not require the cells from the new simulation to be in the same region as the cells from the first simulation
- It is important to use the end time of the first simulation as the start time of the new simulation with mapping because the mapping data file does not include time information
- Because the grid is not mapped, smearing of results can occur

Cell Mapping Data File (*map.dat*)

- CONVERGE writes *map.out* at the end of each simulation
- Rename this file *map.dat* to initialize a new simulation with these data
- Each row of *map.dat* contains the values to be mapped at a specific (x, y, z) coordinate
- The first row must specify the column names
- The first three columns must be the x, y, z coordinates
    - Subsequent columns can be in any order

```
x     y     z     tke    eps     temp    pres    h2o   soot     passive1 u_vel v_vel w_vel
1.1   1.2   0.0   22.1   101.0   300.1   2.0e6   0.1   1.0e-6   22.0      1.5   -3.2  -5.3
-
```

Spray Mapping Data File (*spray_map.dat*) (1/2)

- CONVERGE writes *spray_map.out* at the end of each simulation
- This file contains spray data variables (temperature, number of drops in parcels, parcel radius, velocity components, film flags, and parcel species)
- Rename this file *spray_map.dat* to initialize the spray-related variables in a new simulation with these data
- Each row of *spray_map.dat* contains the values to be mapped at a specific (x, y, z) coordinate

Spray Mapping Data File (*spray_map.dat*) (2/2)

```
X   Y   Z  U_VEL  V_VEL  W_VEL  TEMP  NUM  RADIUS  REGION_ID  BOUND_ID
.1 .1  .1   .2     .2     .2     400  4000  .005        0         2

    IC8H18  FILM    FROM_INJECTOR    FROM_NOZZLE
      1.0    1           0                3
```

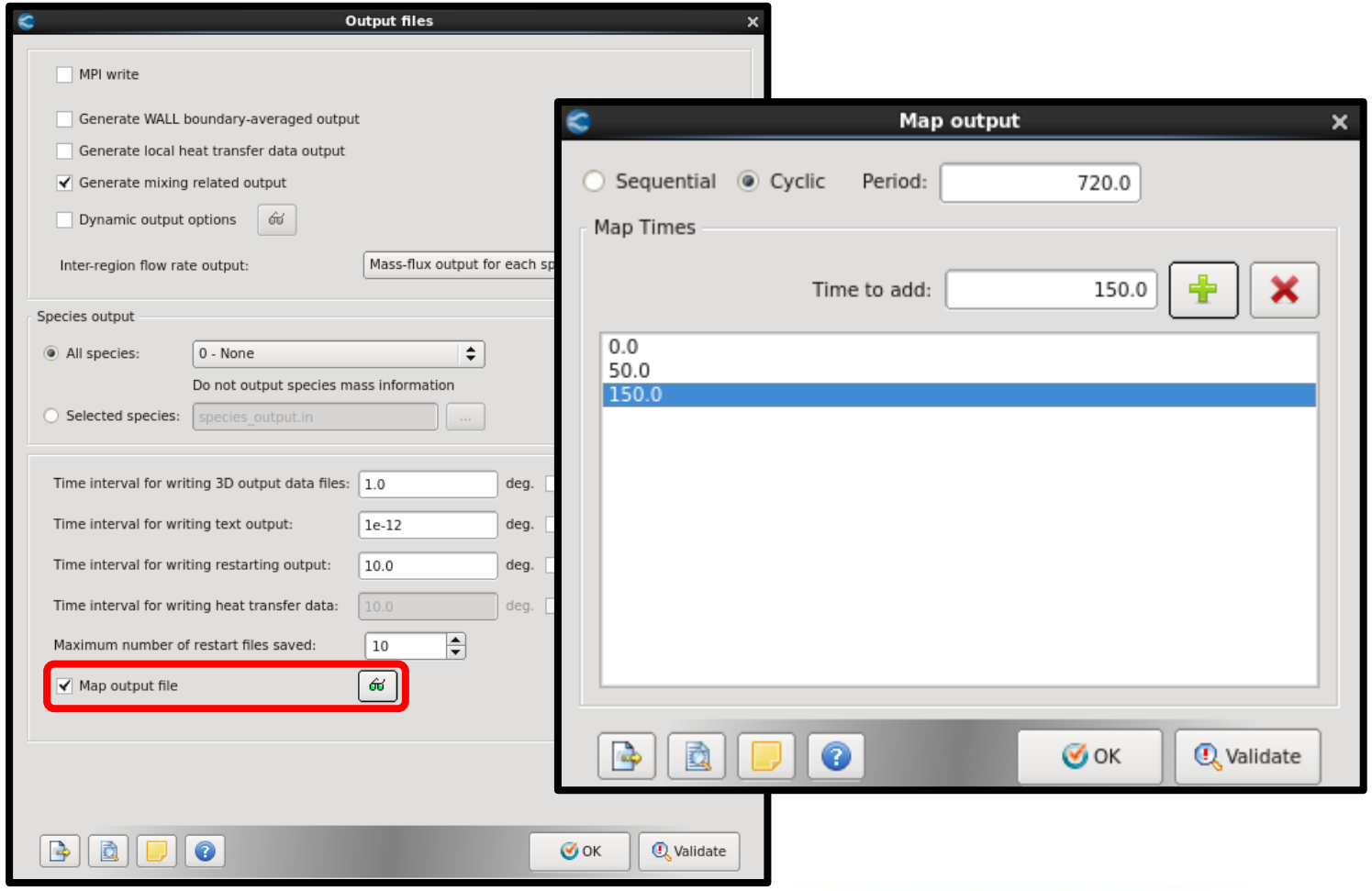
Note: This figure shows a single line of an example *spray_map.dat* file.

Writing Additional Map Files

- In addition to the *map.out* file written at the end of a simulation, you can direct CONVERGE to write *map_<time>.out (e.g., map_1.000000e+02.out*) files at specified times during the simulation
- If a simulation includes spray modeling, CONVERGE will also write *spray_map<time>.out* files at the specified times

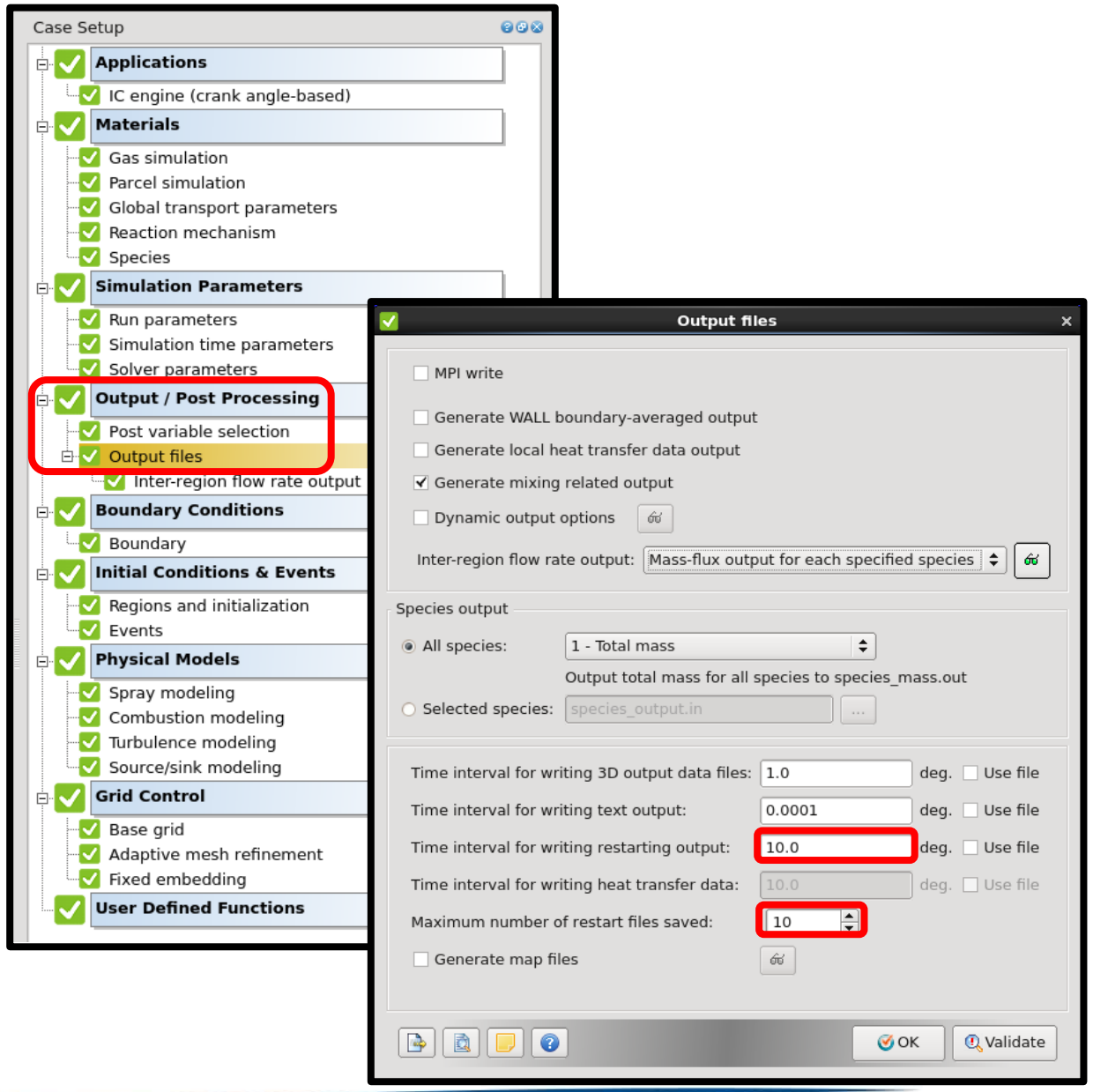
How to Set Up Additional Map Output Files

- Go to *Case Setup > Output/Post-Processing > Output files*
  - Check Map output file
  - Click the box
  - Edit the *Map output* dialog box



Restarting (1/2)

- Another way to initialize is by using a restart file
- CONVERGE writes *restart****.rst* files, which contain cell-centered data, throughout the simulation
- You can control the number of restart files and the frequency at which CONVERGE writes these files
  - Go to *Case Setup* > *Output/Post Processing* > *Output files*



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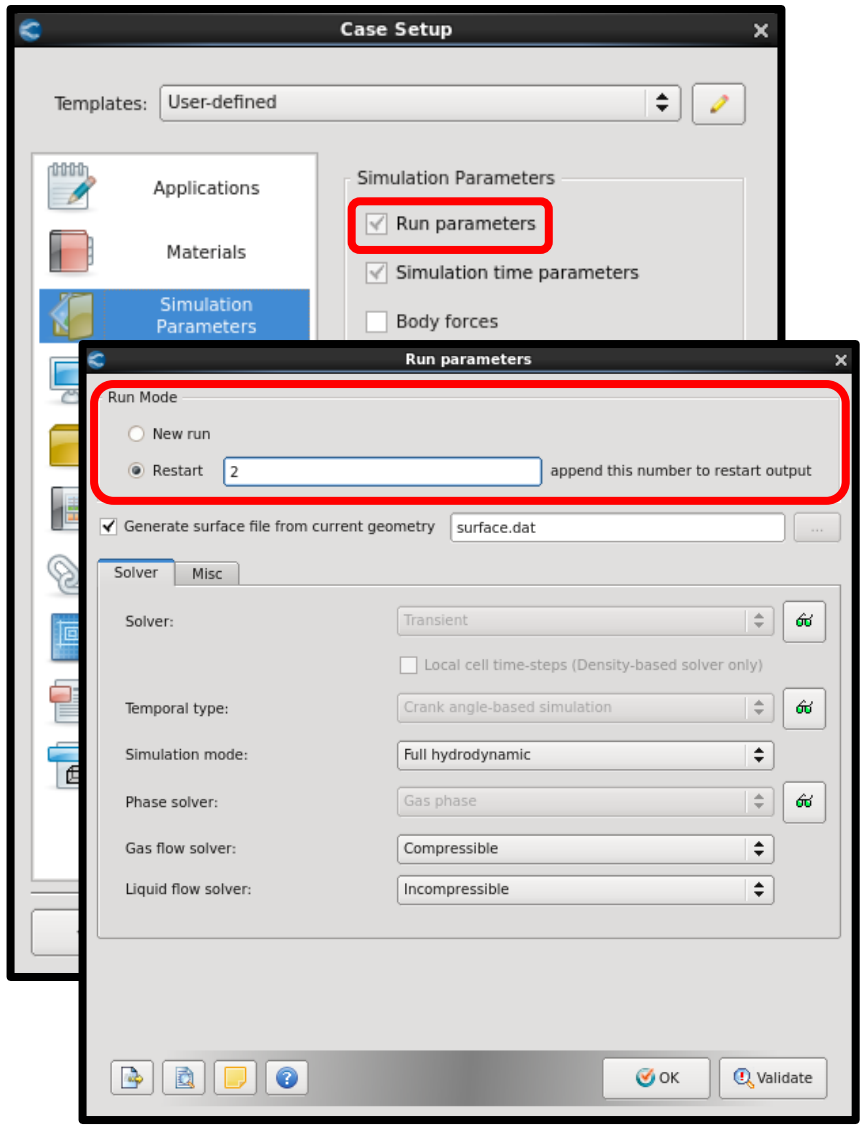
Restarting (2/2)

- You can restart a simulation from a *restart****.rst* file
  - CONVERGE will map the grid and the cell-centered data
  - The restart file must be in the Case Directory
    - CONVERGE will use the newest*.*rst* file if there are multiple restart files in the Case Directory
  - Go to *Case Setup > Simulation Parameters > Run parameters* and select Restart
    - Specify a number that CONVERGE will append to the output files to differentiate the restart results from the original results (e.g., *thermo2.out* instead of *thermo.out*)



Comparison of Mapping and Restarting

MAPPING

- Can map only selected variables
- Does not map the grid from the end of the first simulation
- Change mesh refinement settings
- Change chemical mechanisms
- Scale, offset, and rotate flow variables

RESTARTING

- All variables must be mapped
- Maps the entire grid from the end of the first simulation
- Less flexibility in making changes to the restart file

THANK YOU!

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