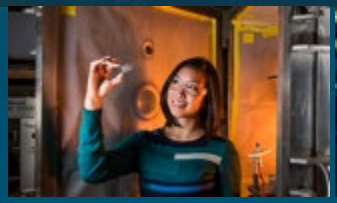
MELCOR Uncertainty Analysis with SNAP & DAKOTA

Sandia National Laboratories



PRESENTED BY

Larry Humphries

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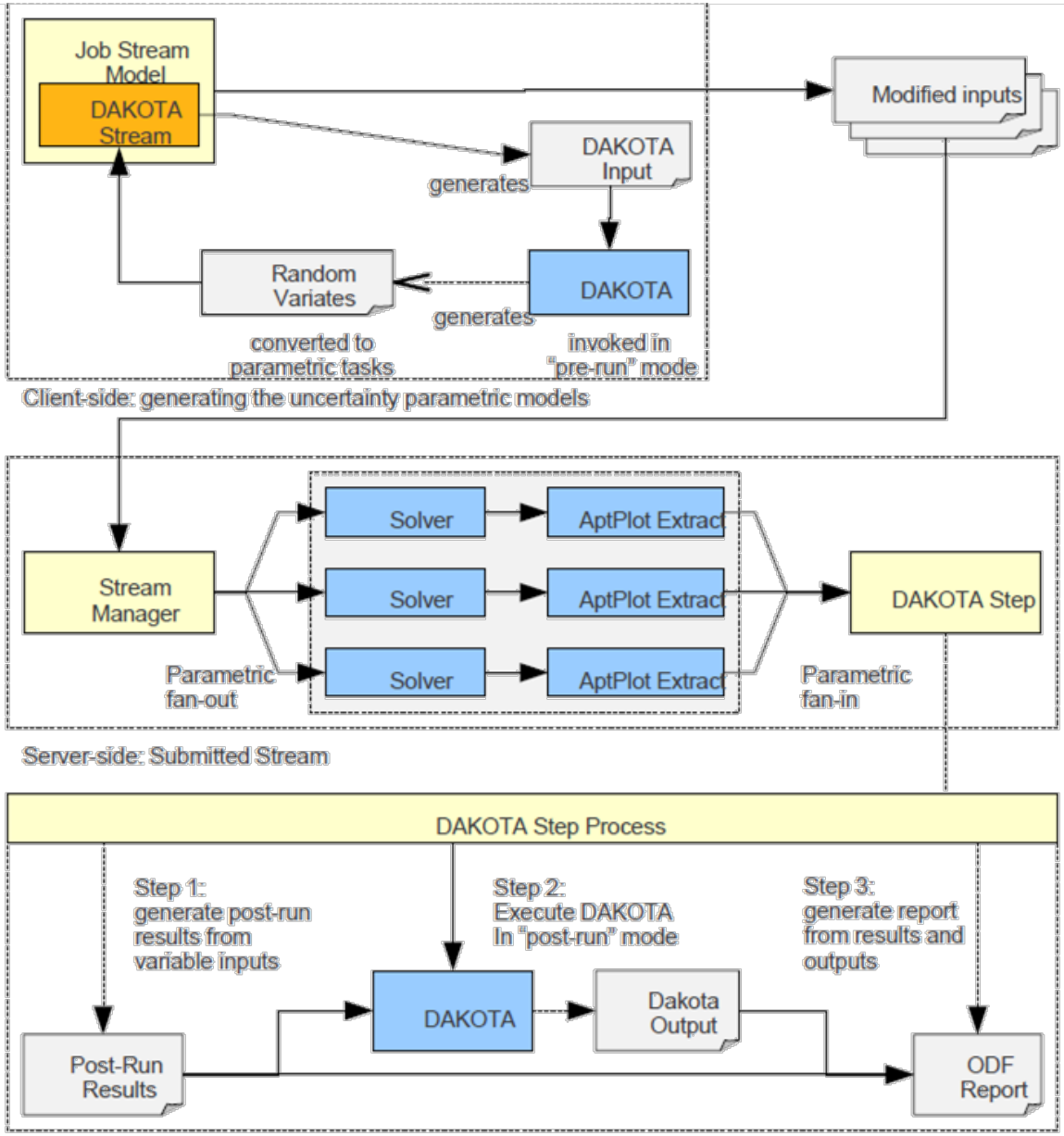
SNAP/DAKOTA Uncertainty Analysis

Pros

- SNAP provides access to MELCOR's extensive inventory of sensitivity coefficients and input parameters.
- Rich set of parameter distributions to choose from.
- Graphical interface to DAKOTA input
- Familiar SNAP interface
  - Input, post-processing, UA
  - MELCOR, RELAP, TRACE,COBRA, CONTAIN, FRAPCON, PARCS
- All-in-one solution for UA
  - SNAP schedules multi-parameter runs after setup
  - SNAP prepares statistical report generated upon job completion

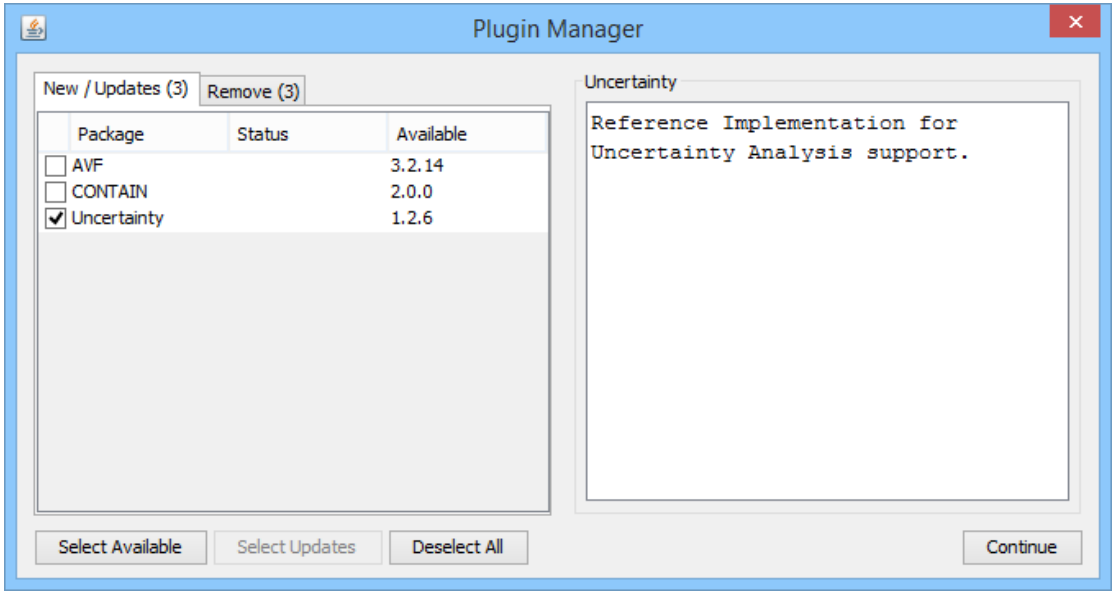
Cons

- SNAP has relatively steep learning curve for beginner
- Failed runs (realizations) are not accounted for and no statistical report is generated. They lead to an incomplete job with no diagnostics to user.
- Input decks with new MELCOR models (relative to SNAP version) cannot be used



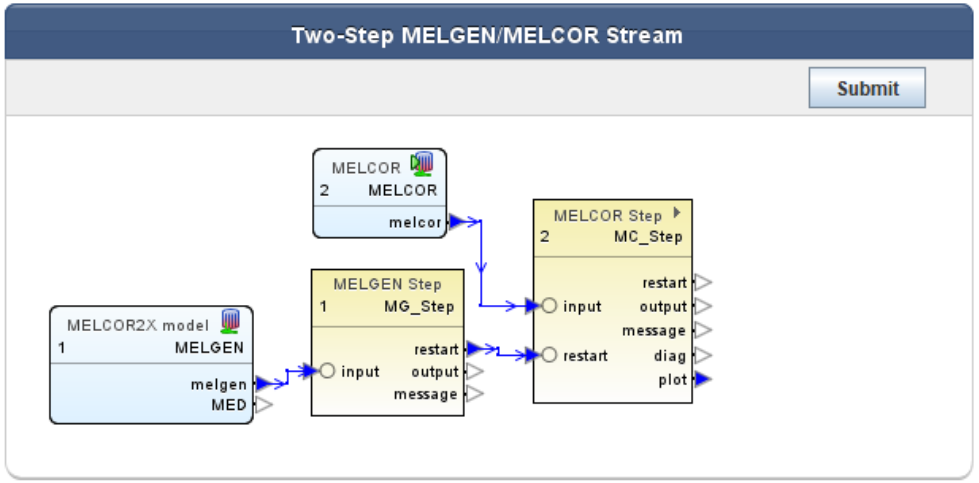
Performing a Sensitivity Study with SNAP
Step I – Downloading Dakota Plugin

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

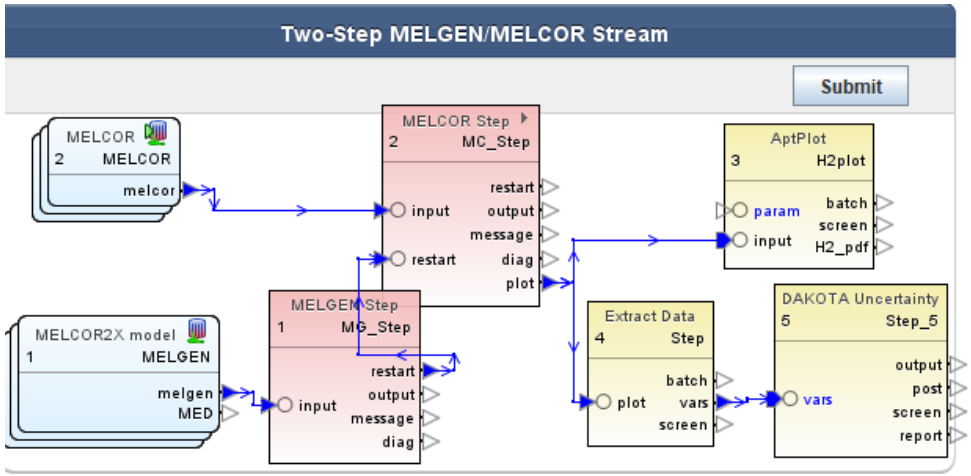


Comparison of Job Streams

MELGEN/MELCOR
Two-Step



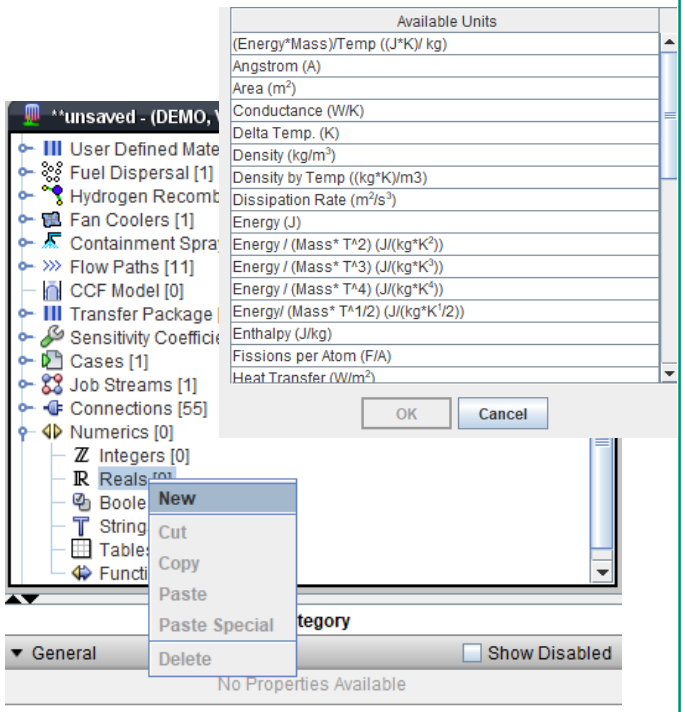
MELGEN/MELCOR
Two-Step & Dakota



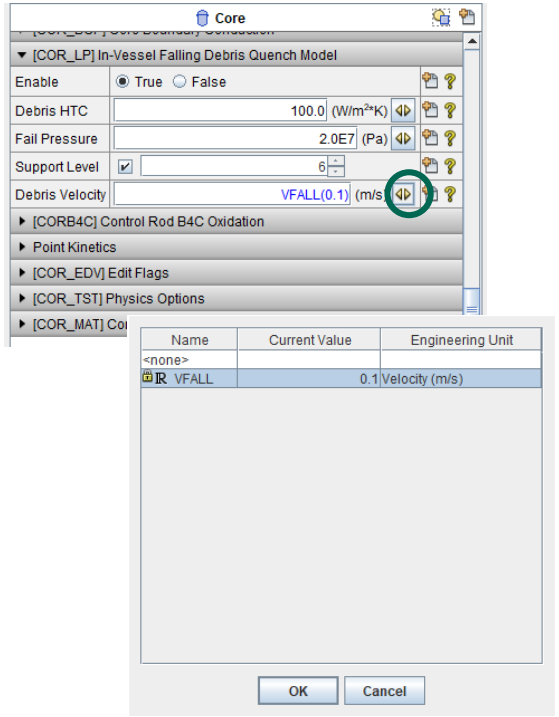
Performing a Sensitivity Study with SNAP
Step 2 – Adding a Numeric (I)

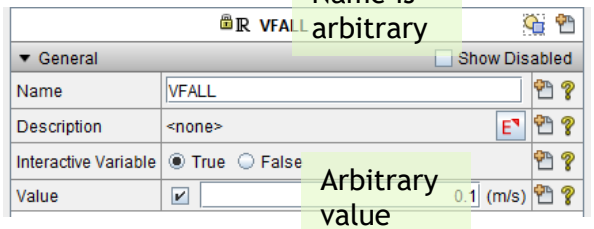
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. **Create a Numeric value in your model**
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

Create the Numeric



Connect Numeric to Input





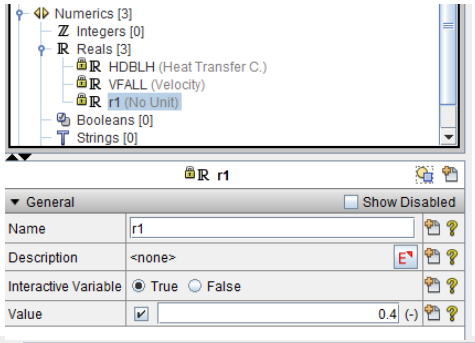
Name is arbitrary

Arbitrary value

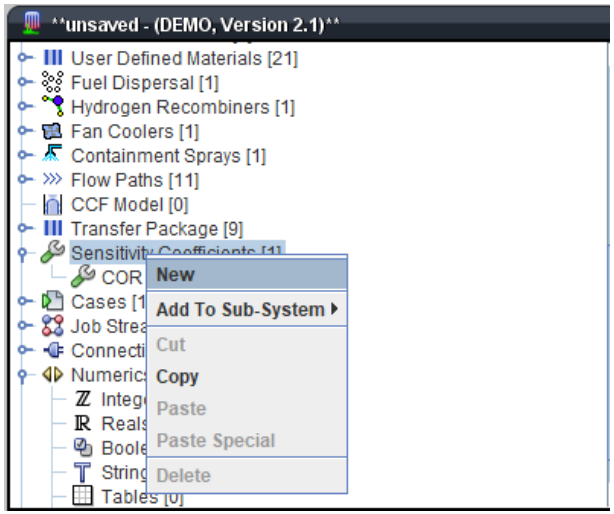
Performing a Sensitivity Study with SNAP
Step 2 – Adding a Numeric Sensitivity Coefficient as an uncertain parameter (2)

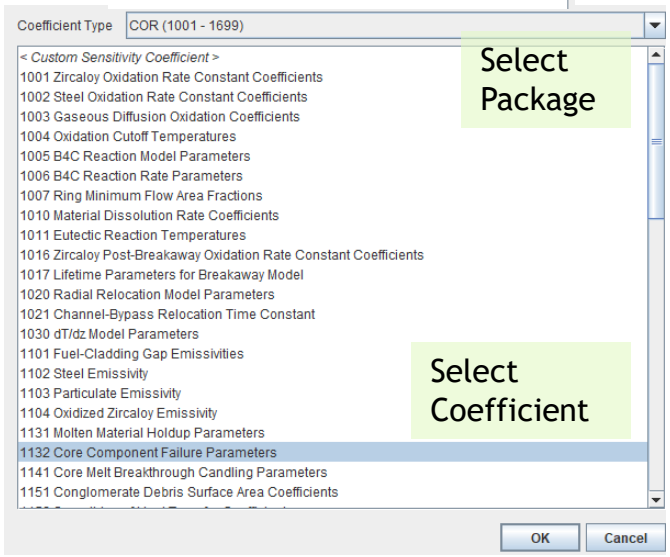
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. **Create a Numeric value in your model**
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

First create a new numeric r1, which has no units.

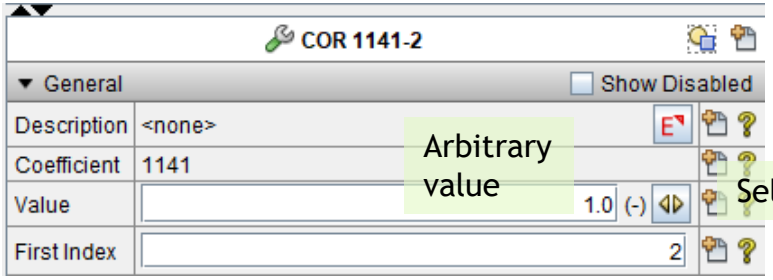


Then add the sensitivity coefficient to the model database.



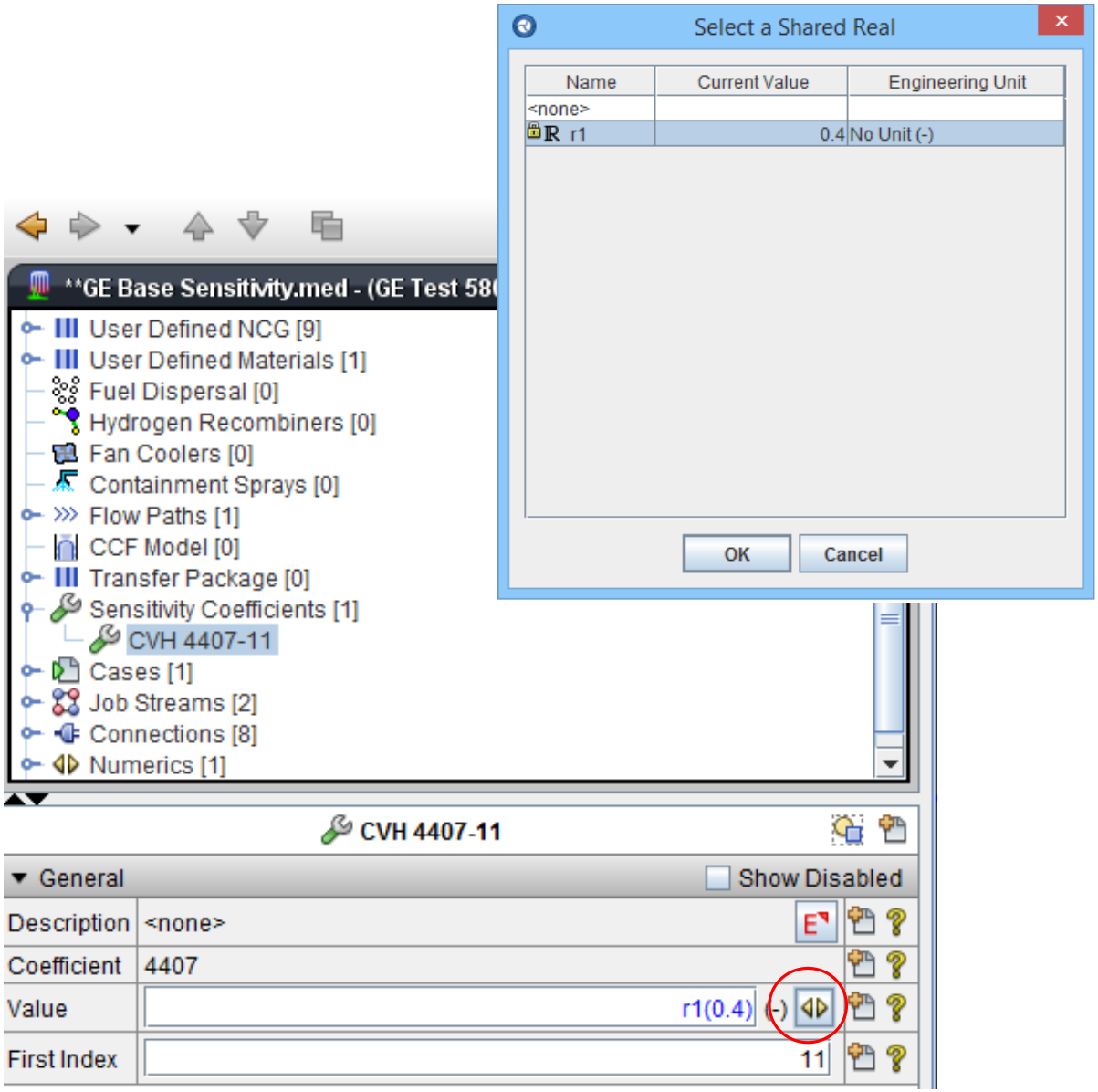


Properties Window



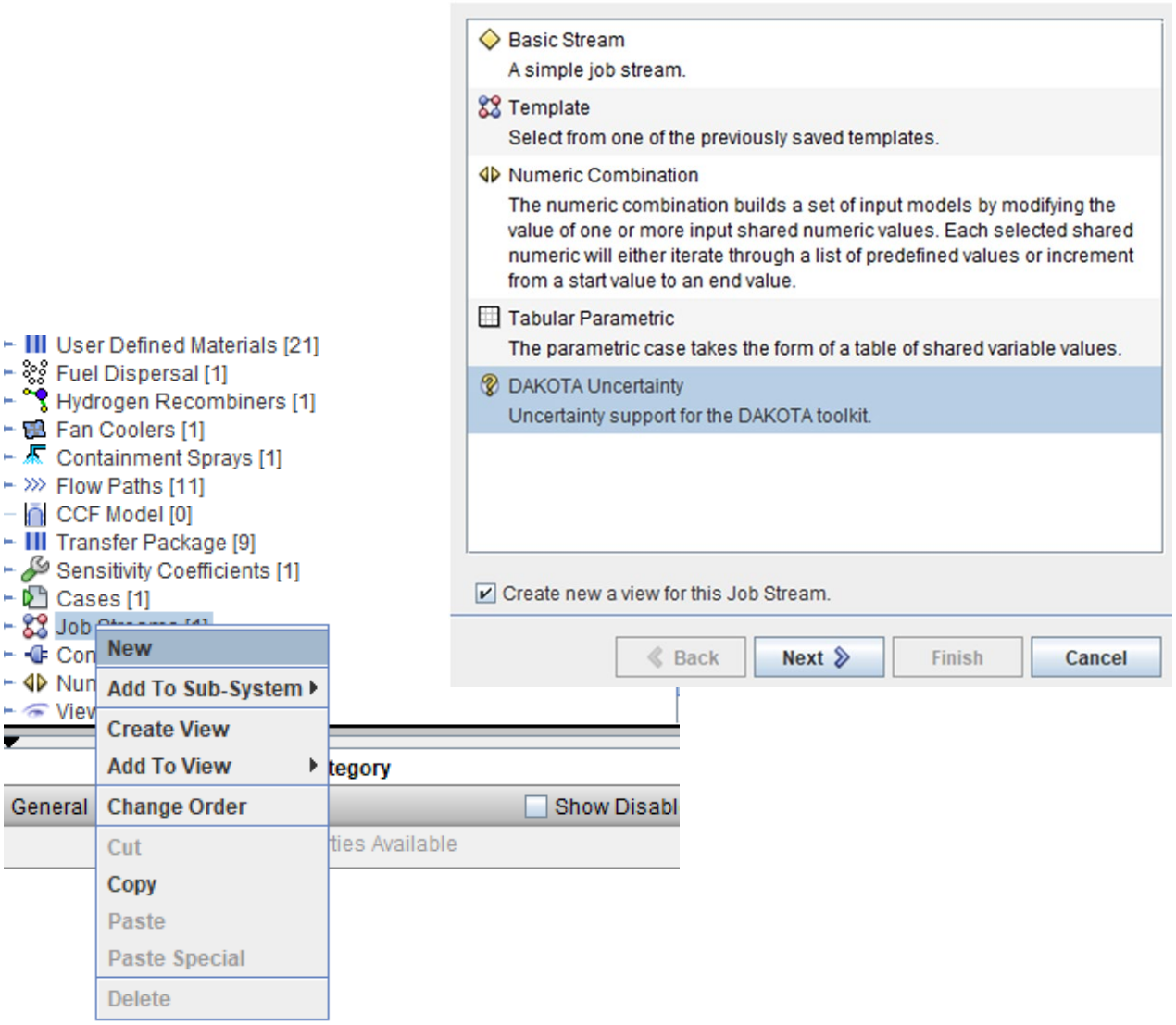
Performing a Sensitivity Study with SNAP
Step 3 – Assign the New Numeric a value

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. **Assign the Numeric value as an input value**
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job



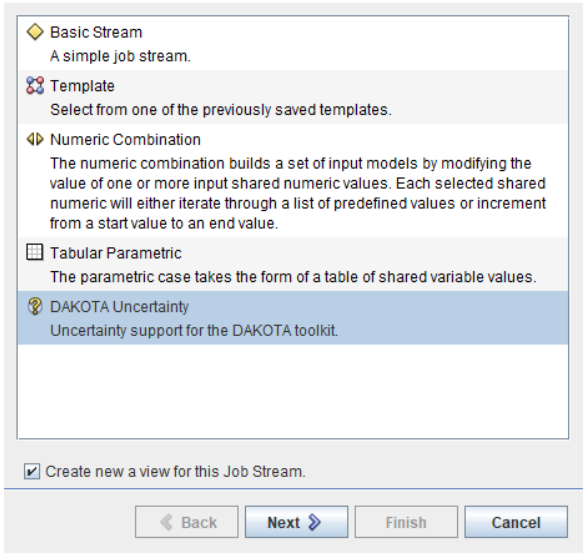
Performing a Sensitivity Study with SNAP
Step 4 – Dakota Job Stream (1)

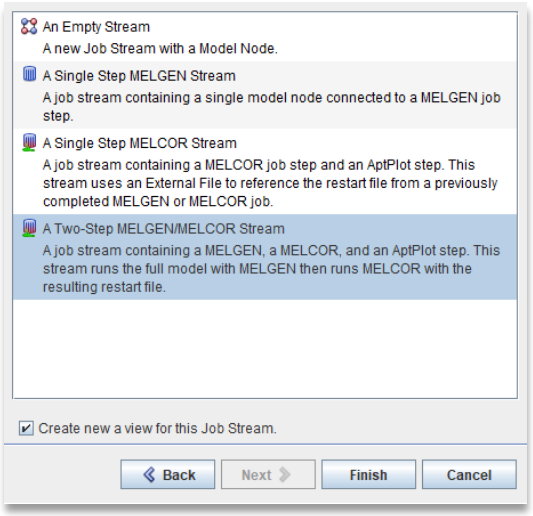
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

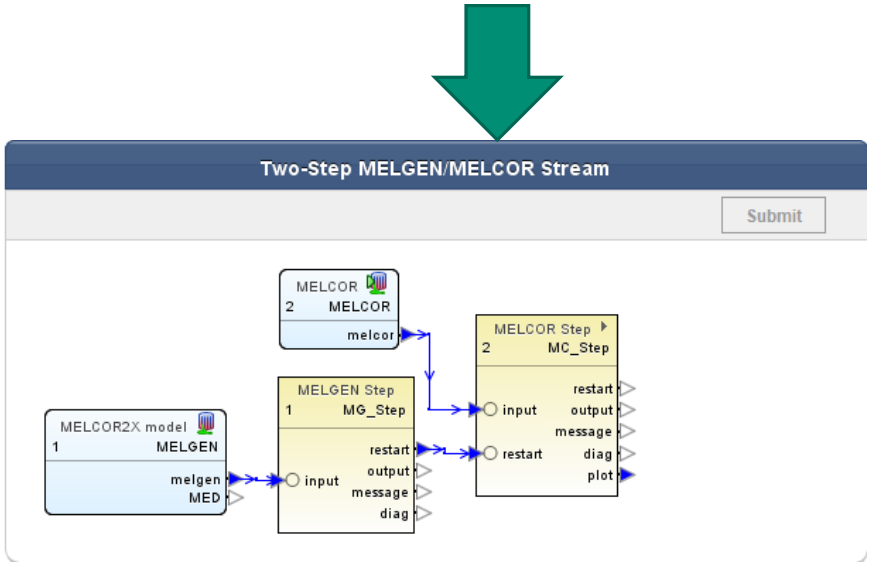


Performing a Sensitivity Study with SNAP
Step 4 – Dakota Job Stream (2)

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

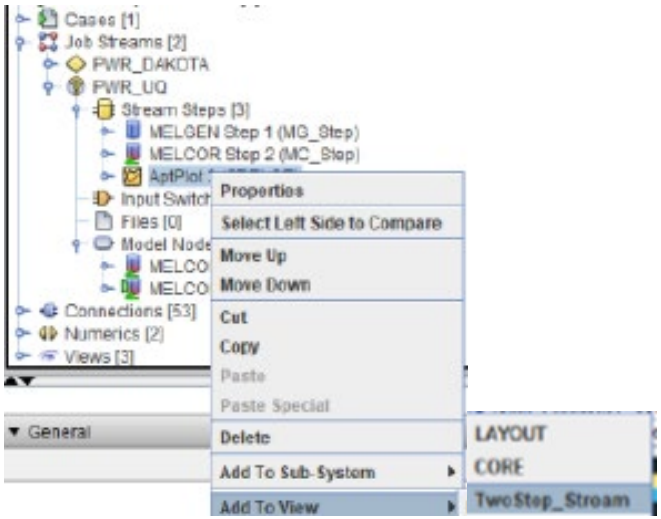


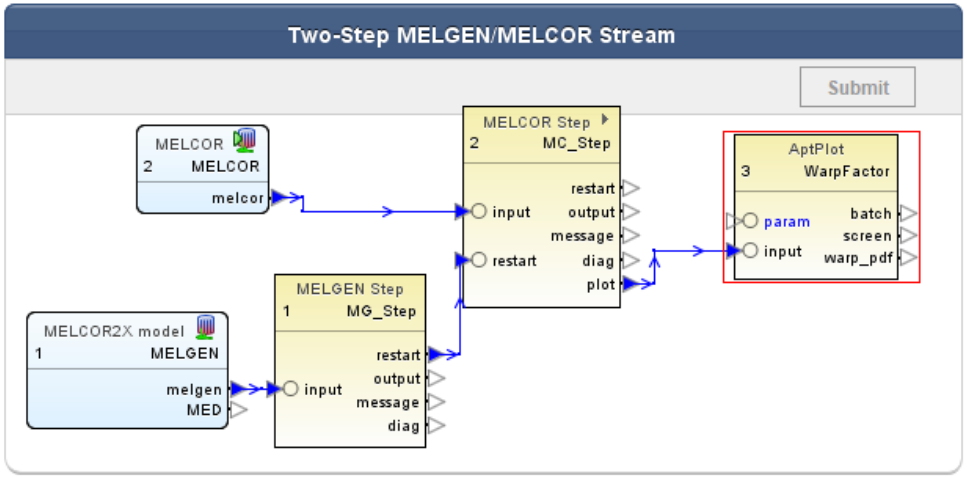




Performing a Sensitivity Study with SNAP
Step 4 –Dakota Run Stream (3) – Add AptPlot to view

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

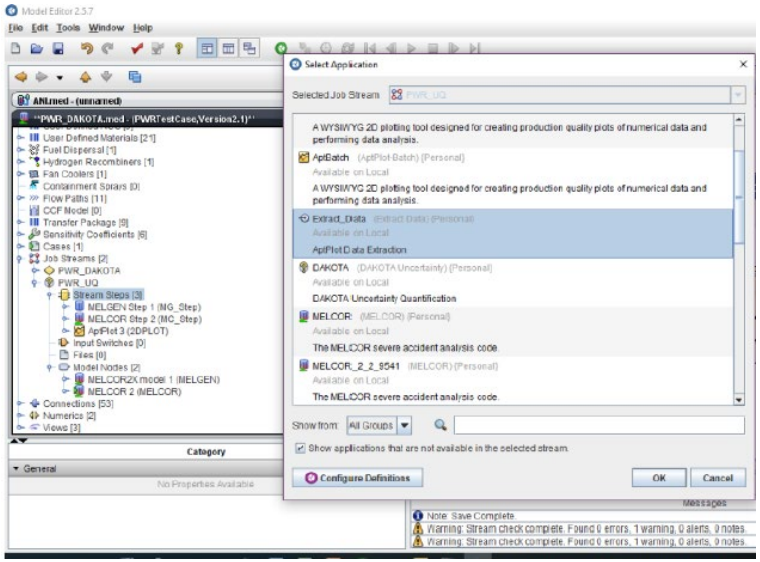


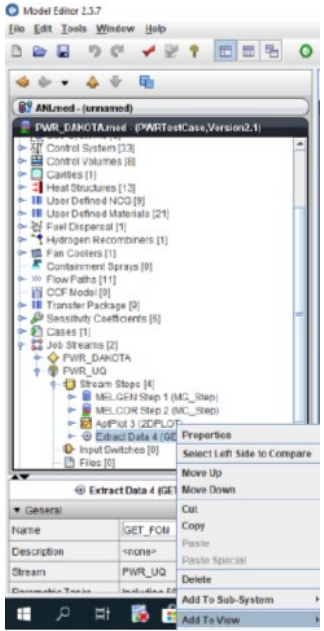


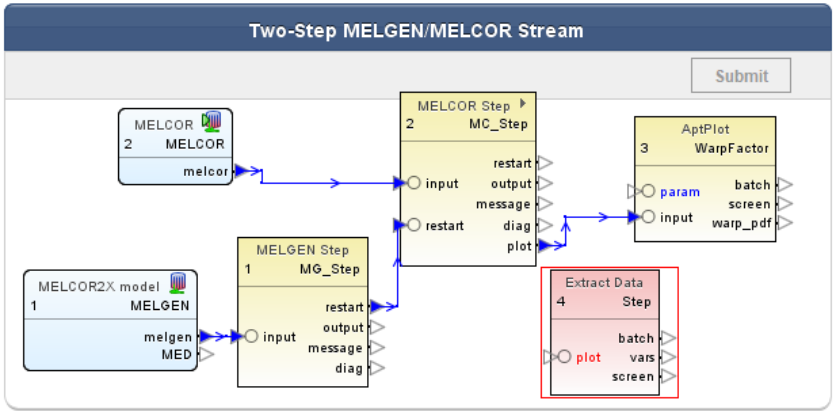
Performing a Sensitivity Study with SNAP
Step 4 –Dakota Run Stream (4) – Add Extract Data

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

Add Extract Data to Job Stream

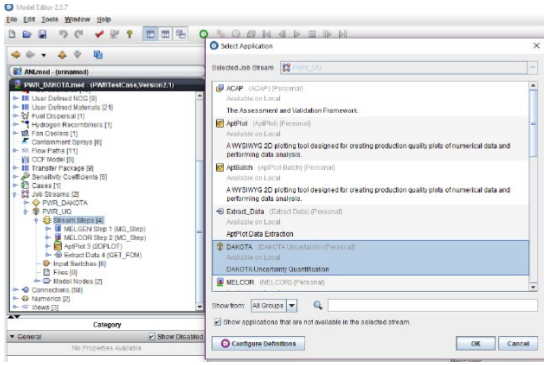


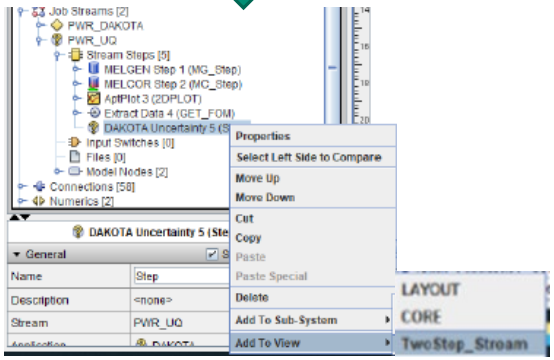


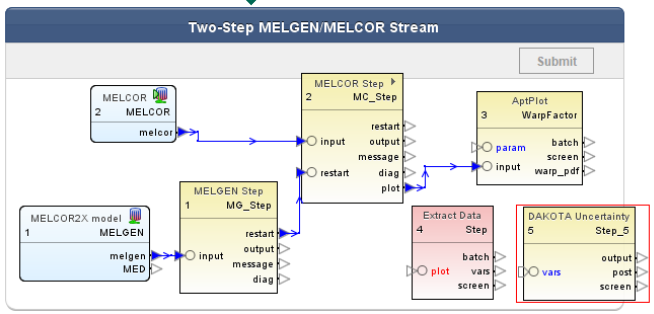


Performing a Sensitivity Study with SNAP
Step 4 –Dakota Run Stream (4) – Add DAKOTA to Job Stream

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. **Create a Dakota Run Stream**
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job

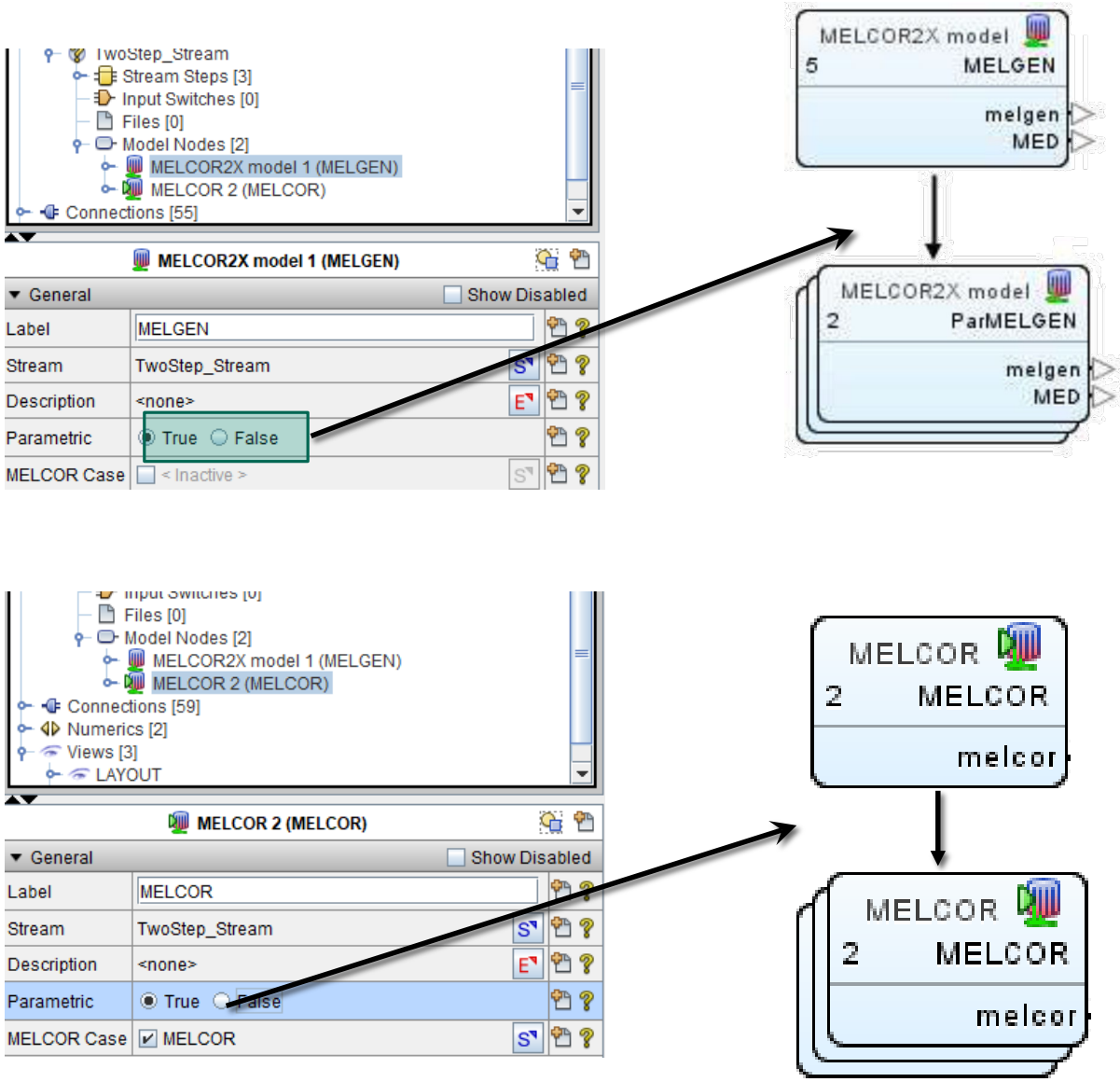






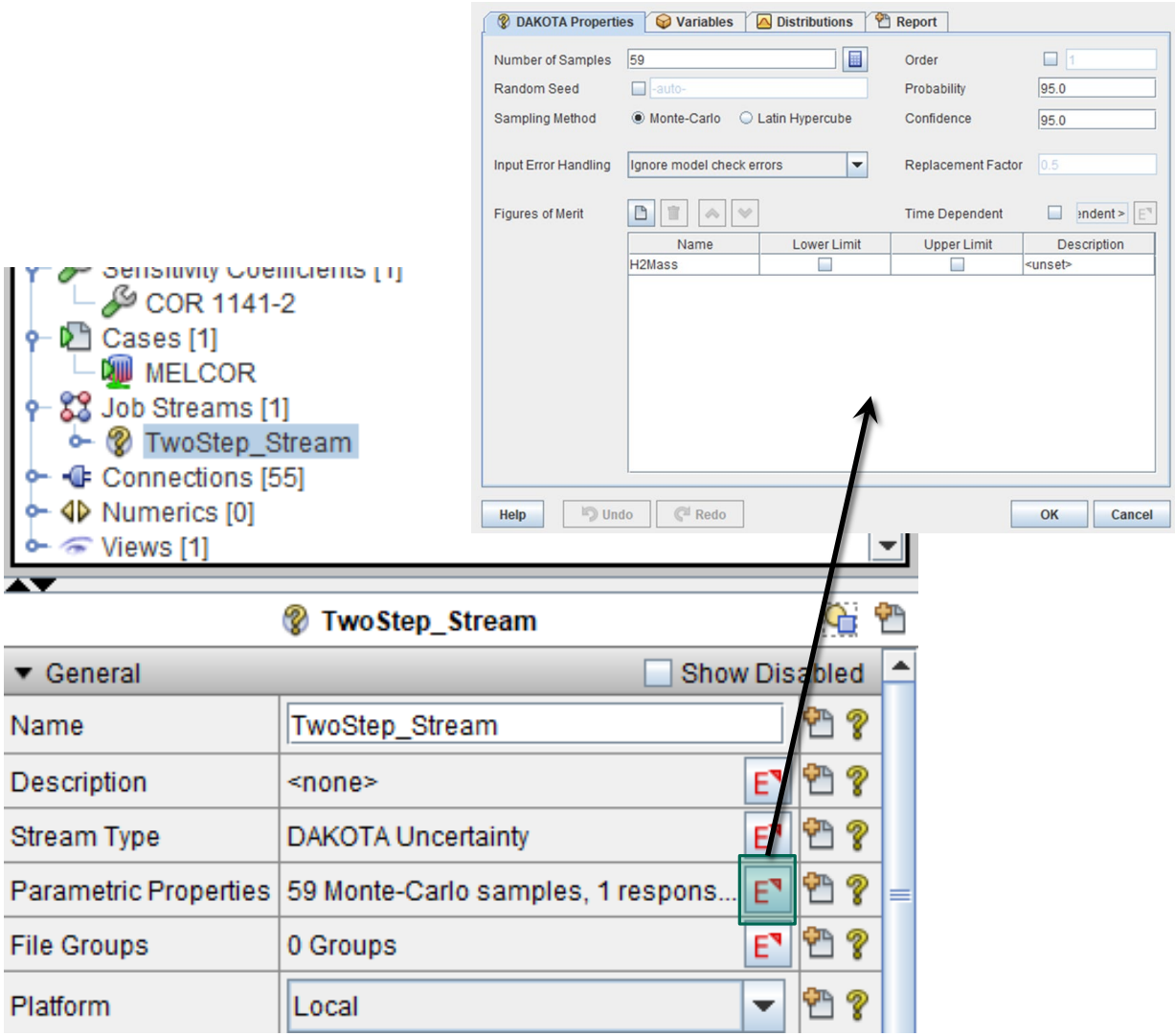
Performing a Sensitivity Study with SNAP
Step 5 – Parametric Model Node

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. **Specify a model node as parametric (MELGEN or MELCOR depending on input)**
6. Define Dakota parametric properties
7. Coordinate data flow
8. Run Job



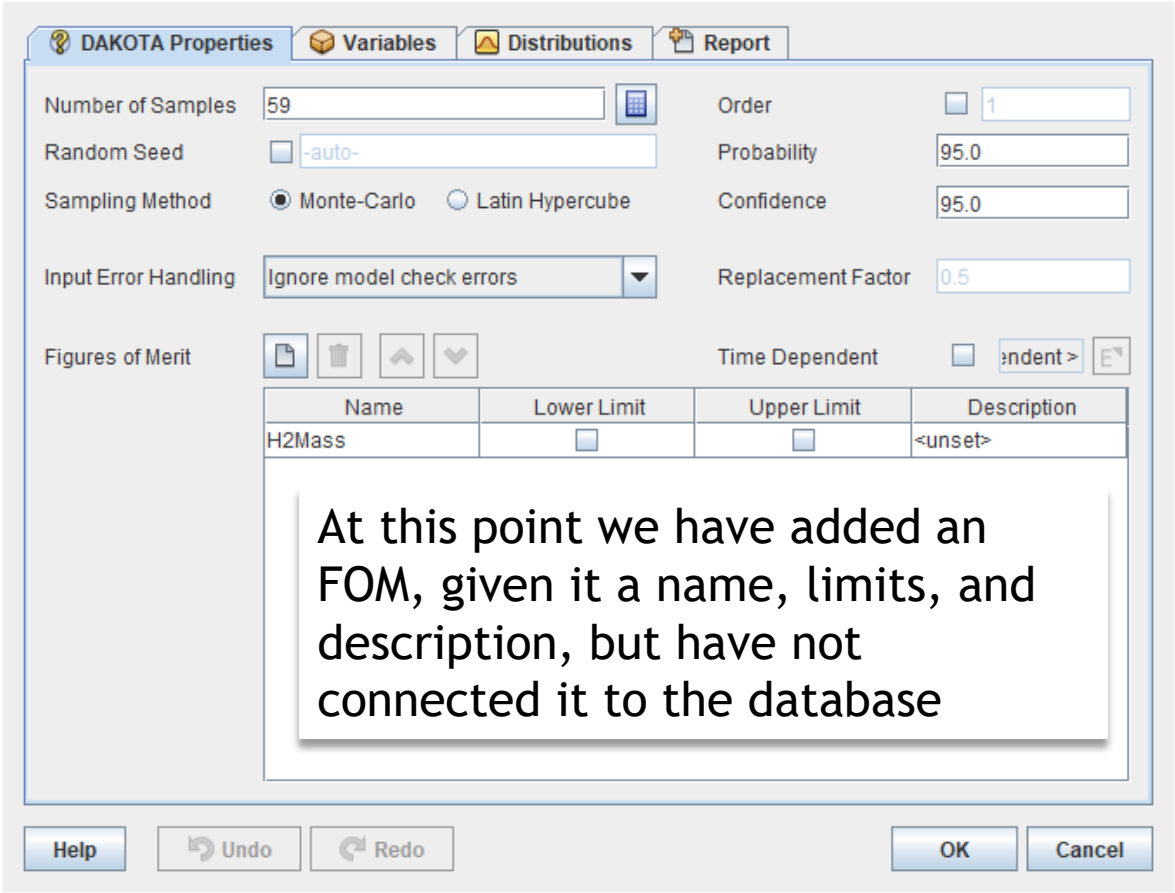
Performing a Sensitivity Study with SNAP
Step 6 – Parametric Properties (I)

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job



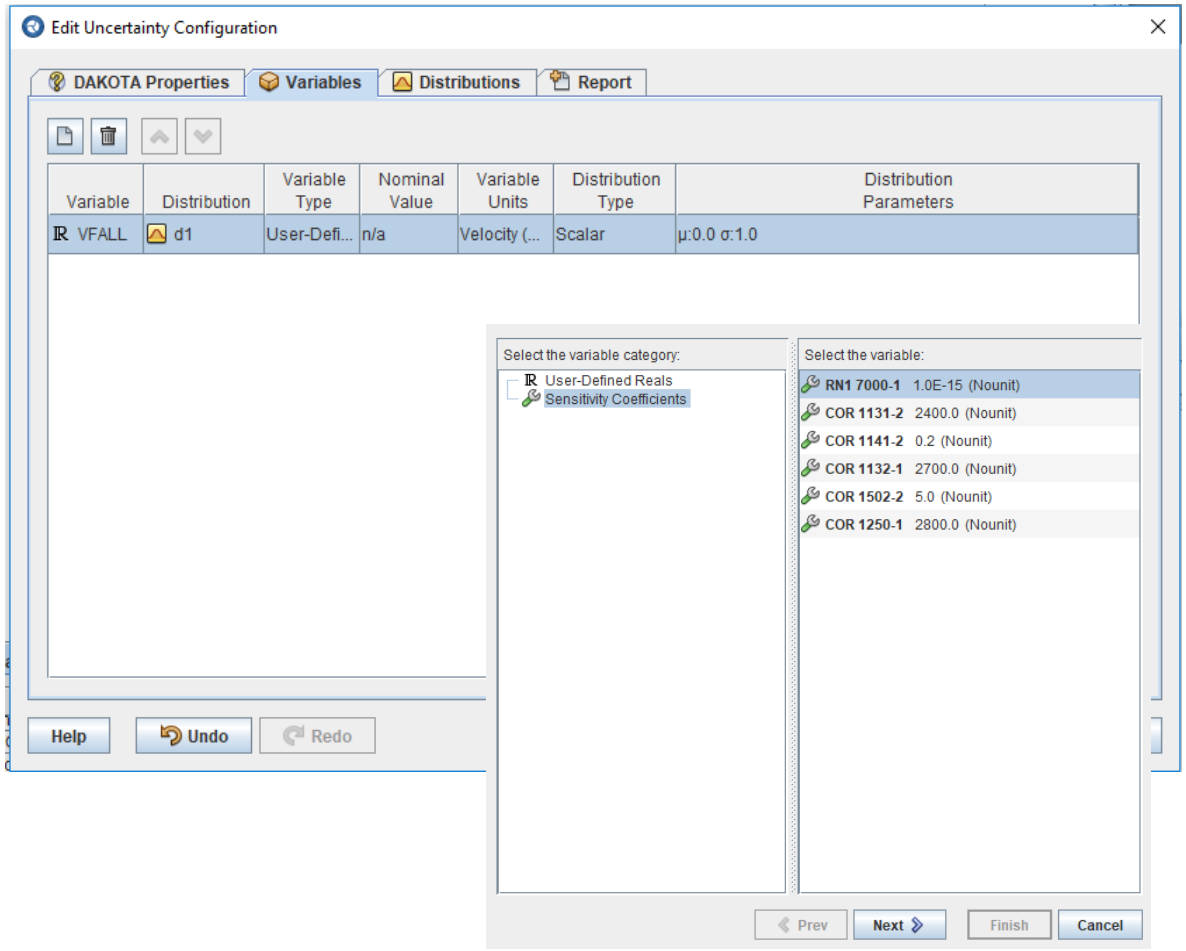
Performing a Sensitivity Study with SNAP
Step 6 – Parametric Properties (2) – Figures of Merit

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job



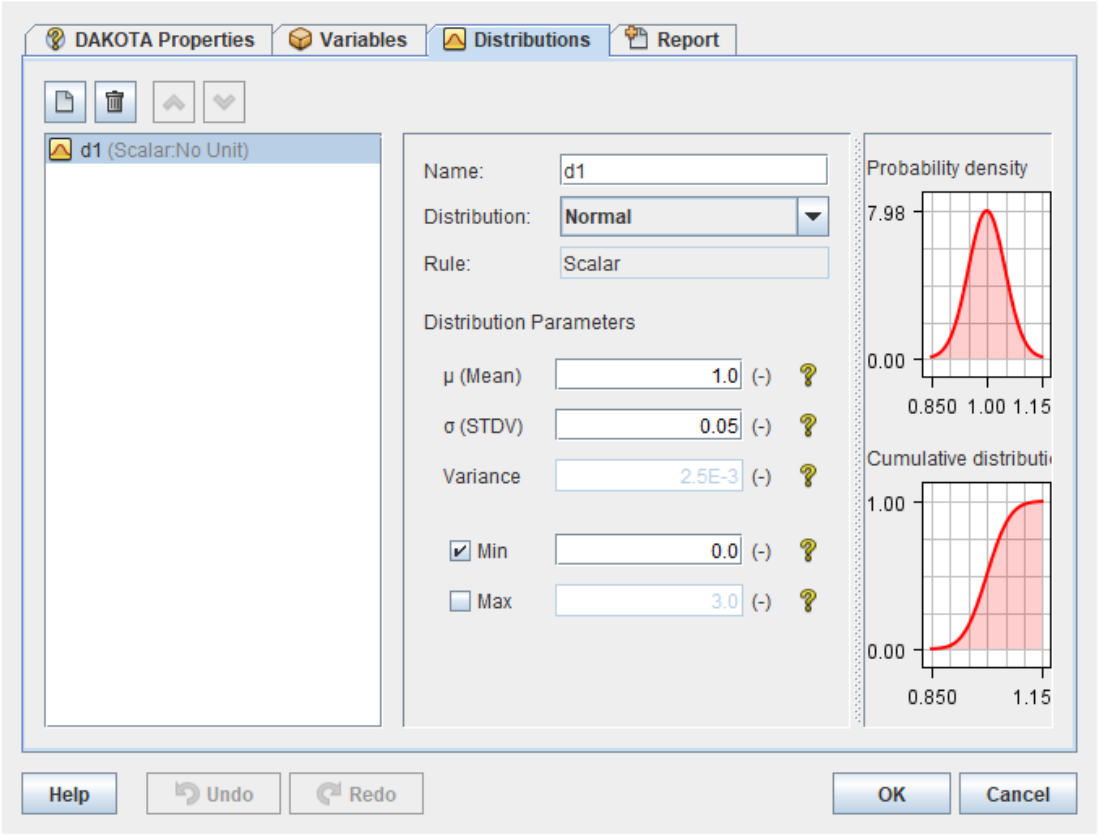
Performing a Sensitivity Study with SNAP
Step 6 – Parametric Properties (3) – Sensitivity Variables

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job



Performing a Sensitivity Study with SNAP
Step 6 – Parametric Properties (4) - Distributions

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job

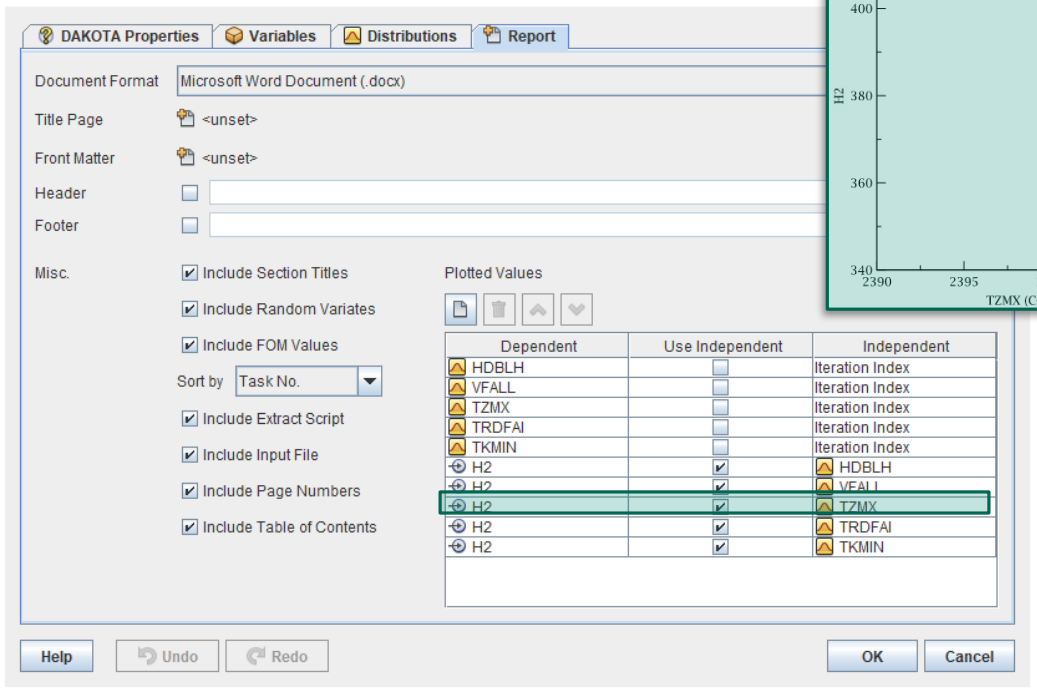


Available Distributions:

Normal	Triangular	Gumbel
Lognormal	Exponential	Frechet
Uniform	Beta	Weibull
Loguniform	Gamma	Histogram

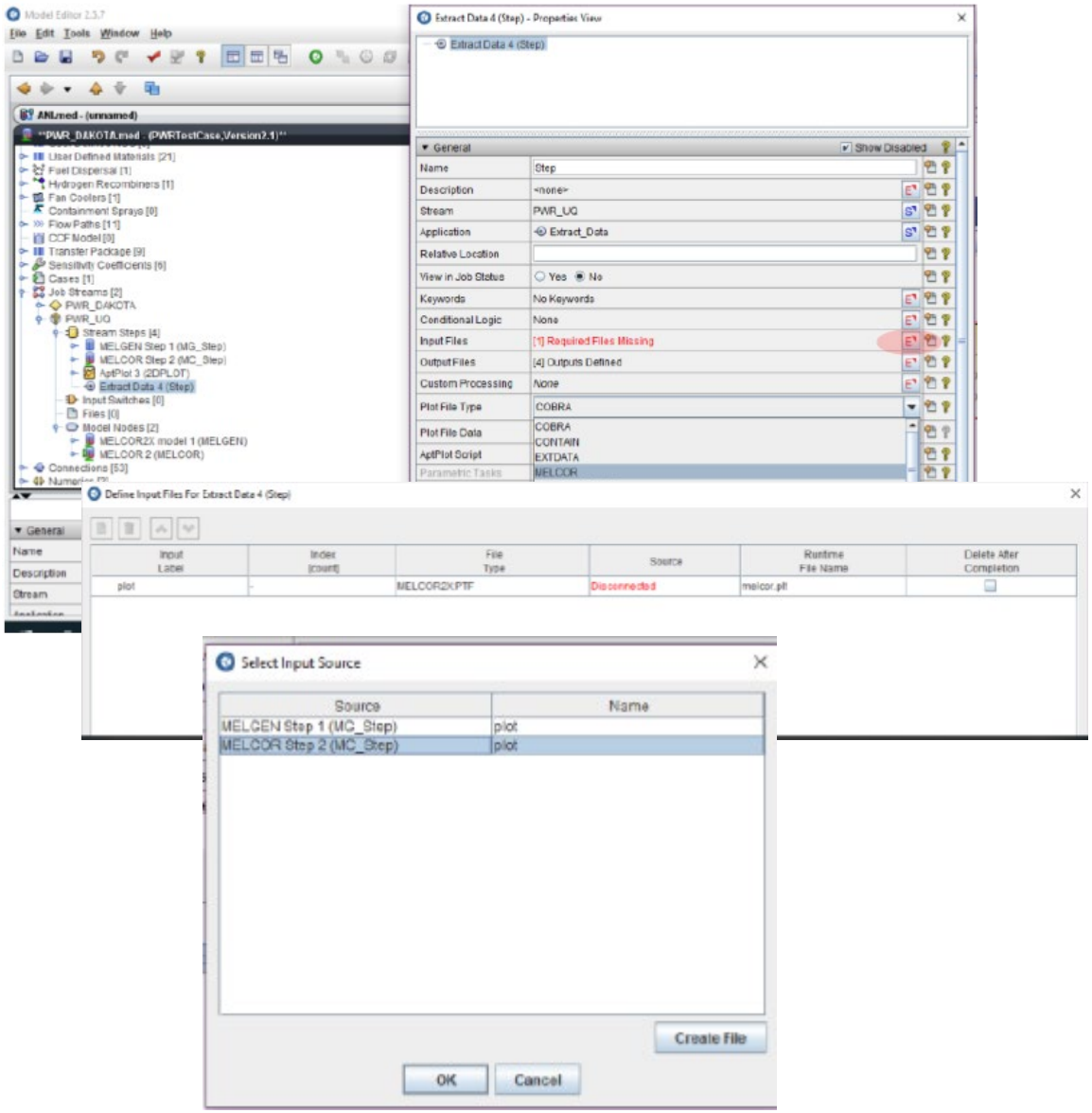
Performing a Sensitivity Study with SNAP
Step 6 – Parametric Properties (5) – Report Options

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. **Define Dakota parametric properties**
7. Coordinate data flow
8. Run Job



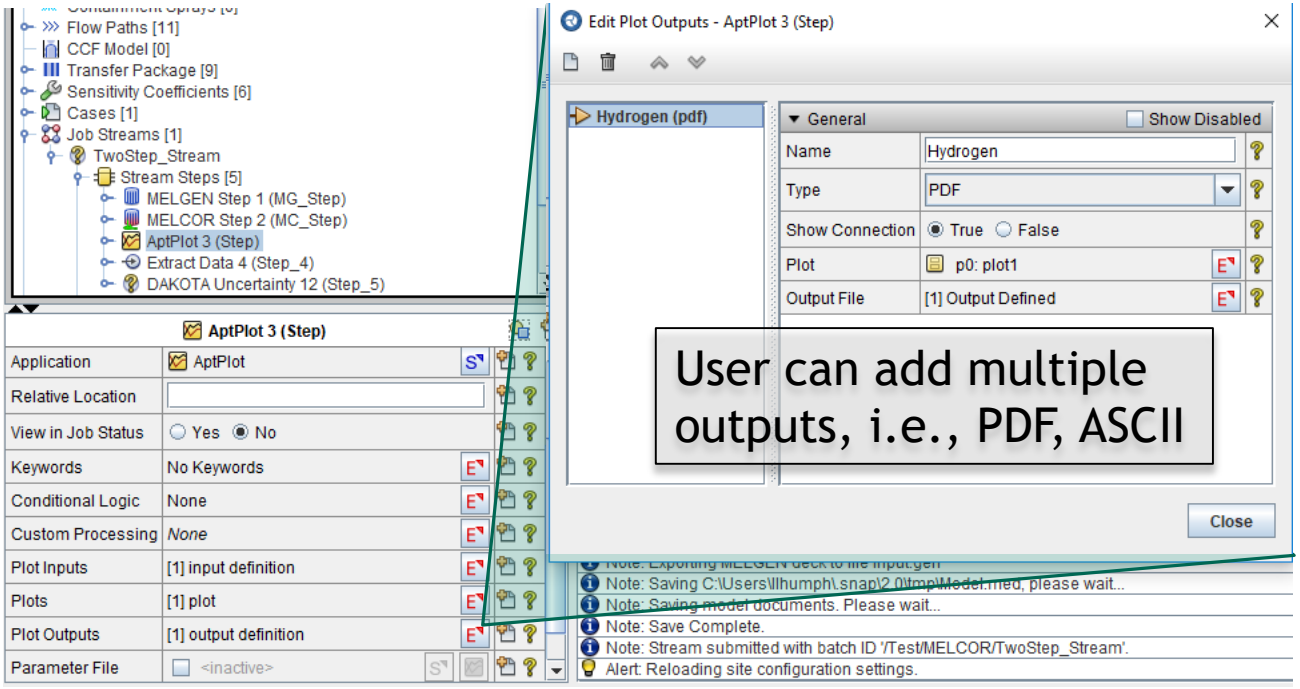
Performing a Sensitivity Study with SNAP
Step 7 – Coordinate Data Flow (Extract Data 2)

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job



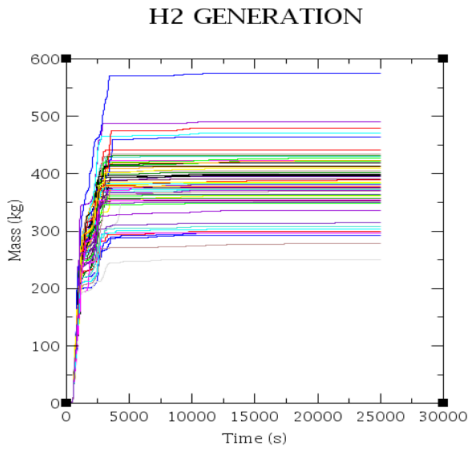
Performing a Sensitivity Study with SNAP
Step 7– Configure AptPlot output

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job



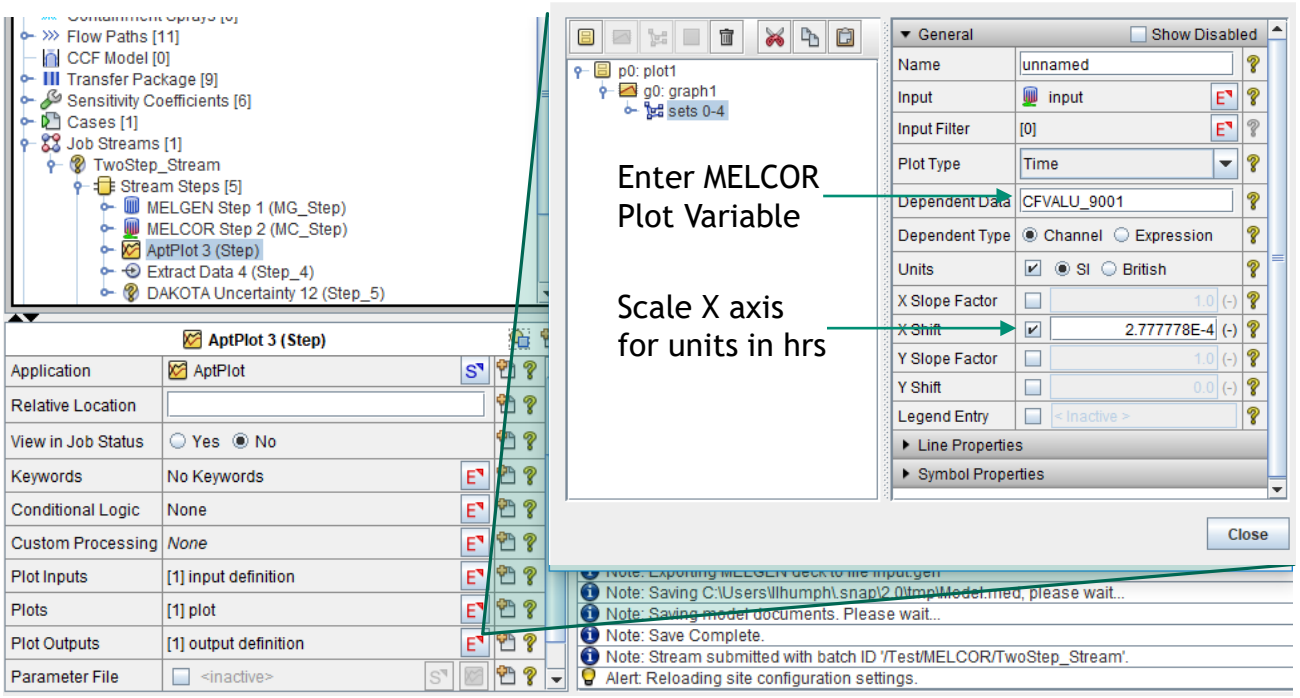
User can add multiple outputs, i.e., PDF, ASCII

Write horsetail plots to PDF file



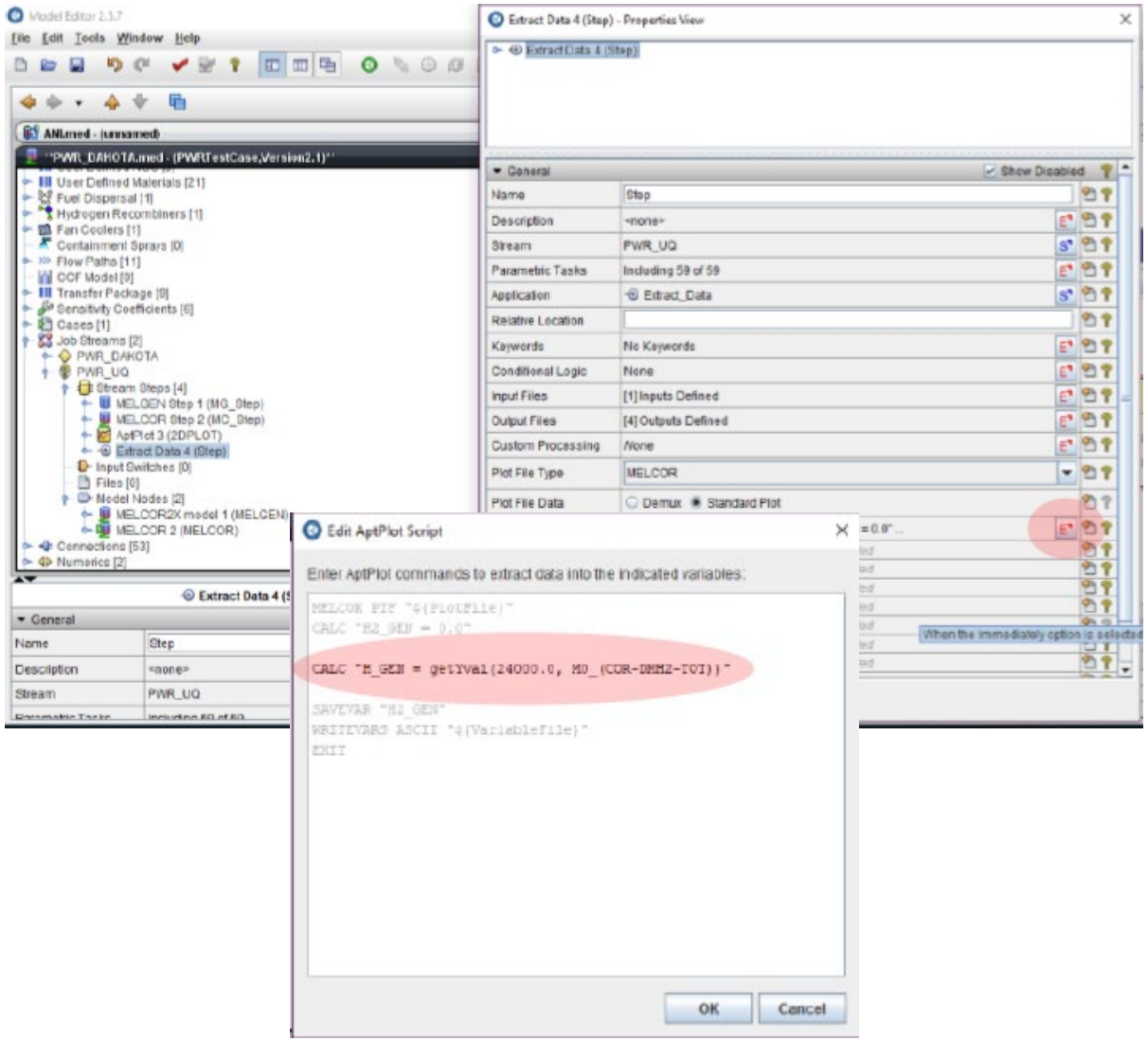
Performing a Sensitivity Study with SNAP
Step 7– Configure AptPlot output

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job



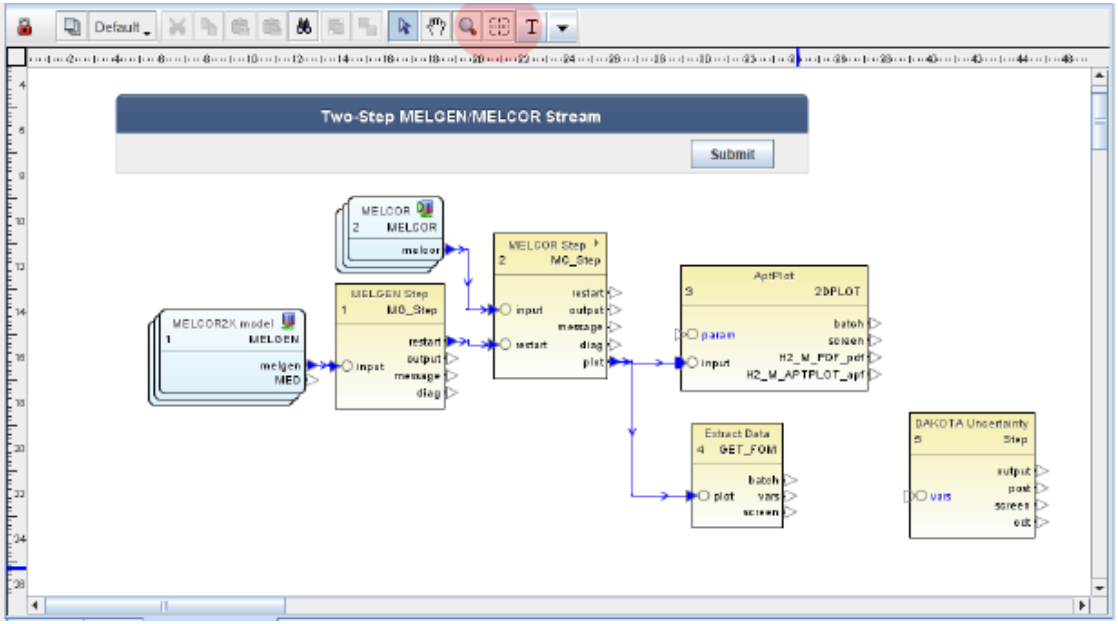
Performing a Sensitivity Study with SNAP
Step 7 – Coordinate Data Flow (Pipe Plot Data)

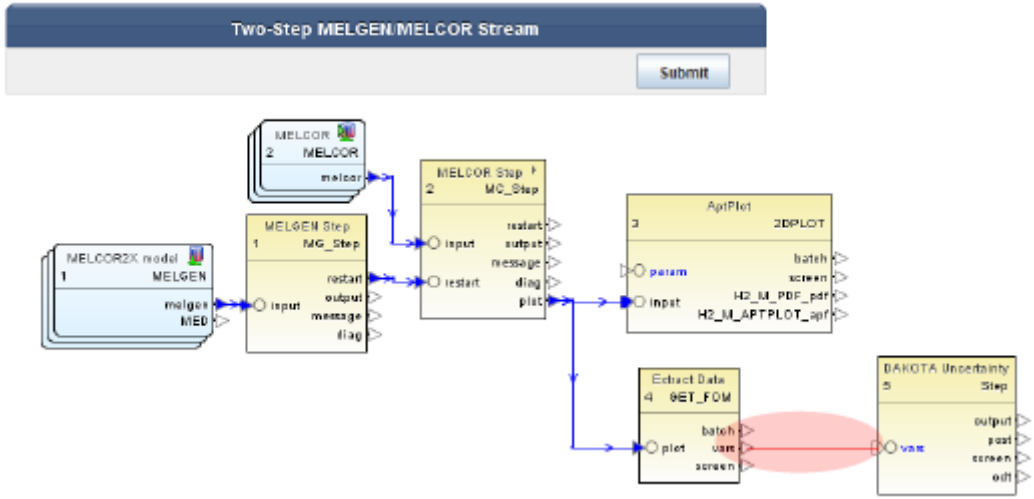
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job



Performing a Sensitivity Study with SNAP
Step 7 – Coordinate Data Flow (Connect 'Extract Data' output to Dakota input)

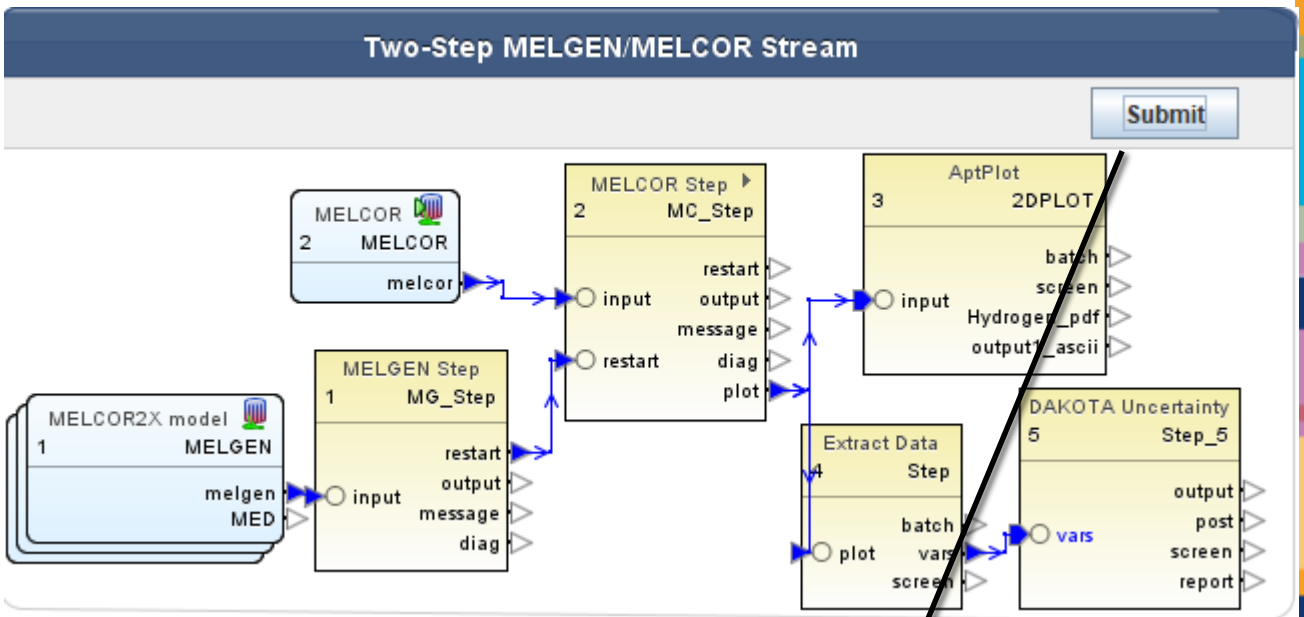
1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. **Coordinate data flow**
8. Run Job

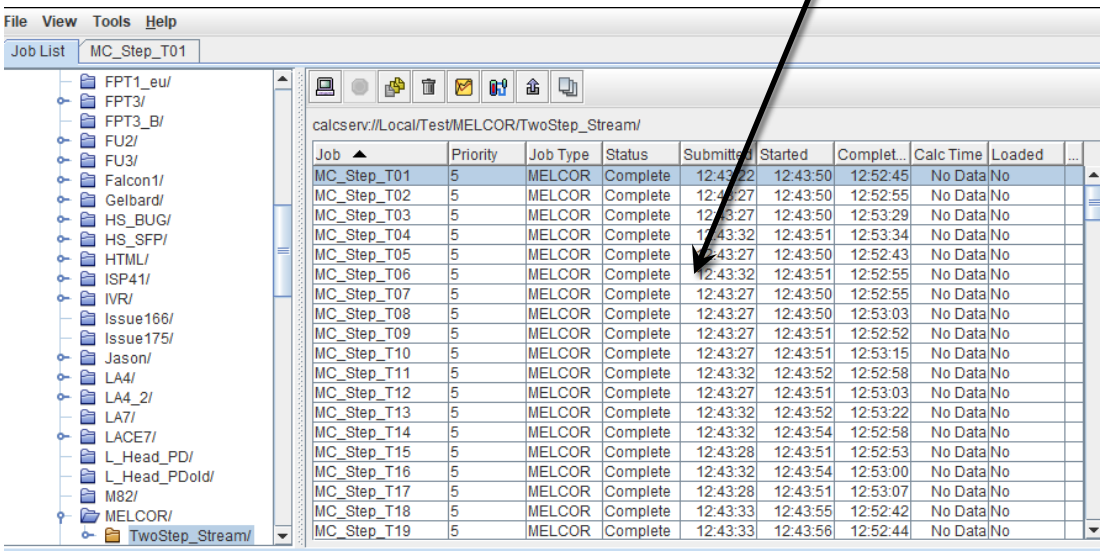




Performing a Sensitivity Study with SNAP
Step 7 – Run Dakota Job Stream

1. Select Dakota plug-in during the SNAP plugins download and installation step
2. Create a Numeric value in your model
3. Assign the Numeric value as an input value
4. Create a Dakota Run Stream
5. Specify a model node as parametric (MELGEN or MELCOR depending on input)
6. Define Dakota parametric properties
7. Coordinate data flow
8. **Run Job**





Statistics and Output

Statistical results based on 59 samples:

Summary	Value	Task #
Min Value	250.87505	54
Max Value	574.76666	51
Mean	381.43805	-
Median	382.44507	40
Standard Deviation	56.8461	-
Coefficient of Variance	0.38578	-

Response Correlations

	Simple	Partial	Simple Rank	Partial Rank
d5	0.0979063	0.102384	0.135067	0.268539
d6	0.110172	0.146704	0.0338983	0.0599765
d7	0.098521	0.123725	0.126768	0.209831
d1	0.737284	0.791904	0.765926	0.855157
d2	-0.495872	-0.627241	-0.379486	-0.653184
d3	0.03035	0.00594472	0.0189947	0.0516358
d4	-0.0188159	0.0125986	-0.0151373	0.0108442

Probability Density Function