

# New Features

## TAITherm 13.1.0 & CoTherm 2.2.0

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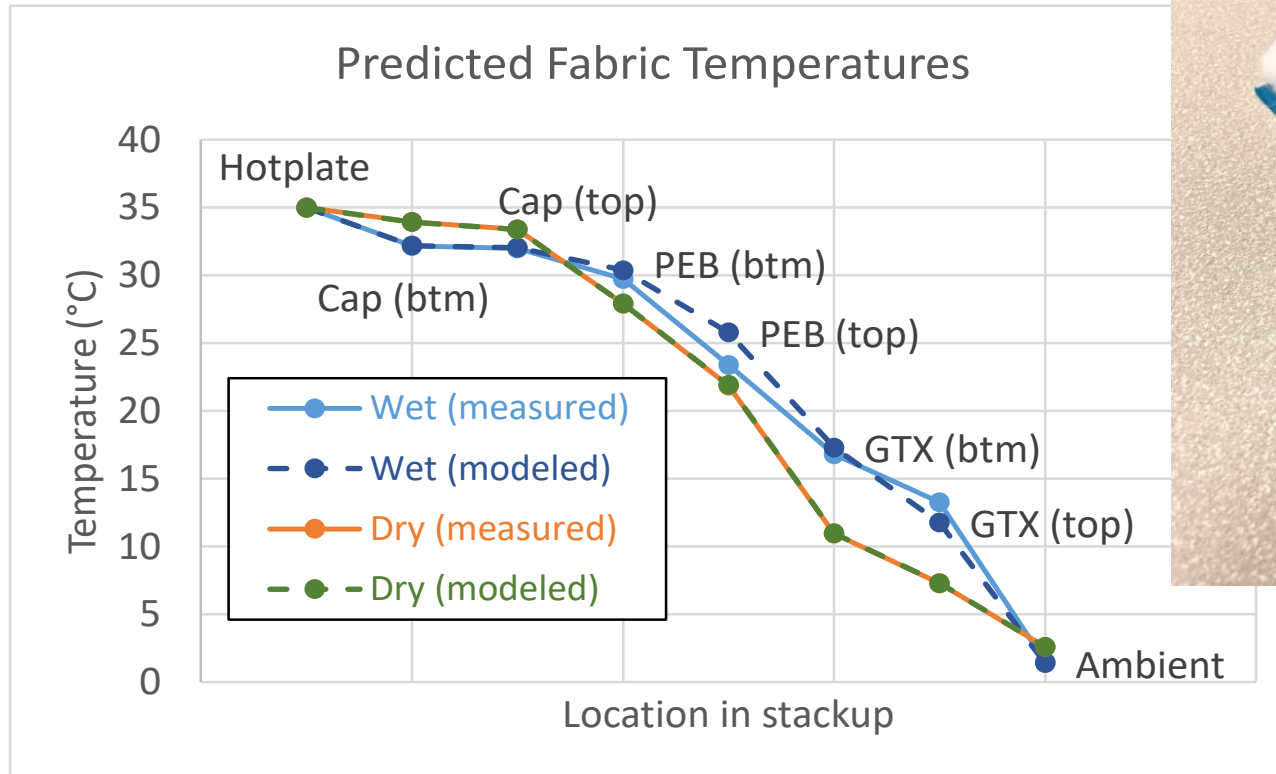
# TAITherm 13.1.0

# Moisture transport through clothing materials

- Track moisture transport through permeable materials
- Track moisture accumulation in layers and on surfaces

## Benefits

- Include latent heat in layers
- More accurate human models with hot to cold transitions
- Include moisture storage in seat models



GTX3L

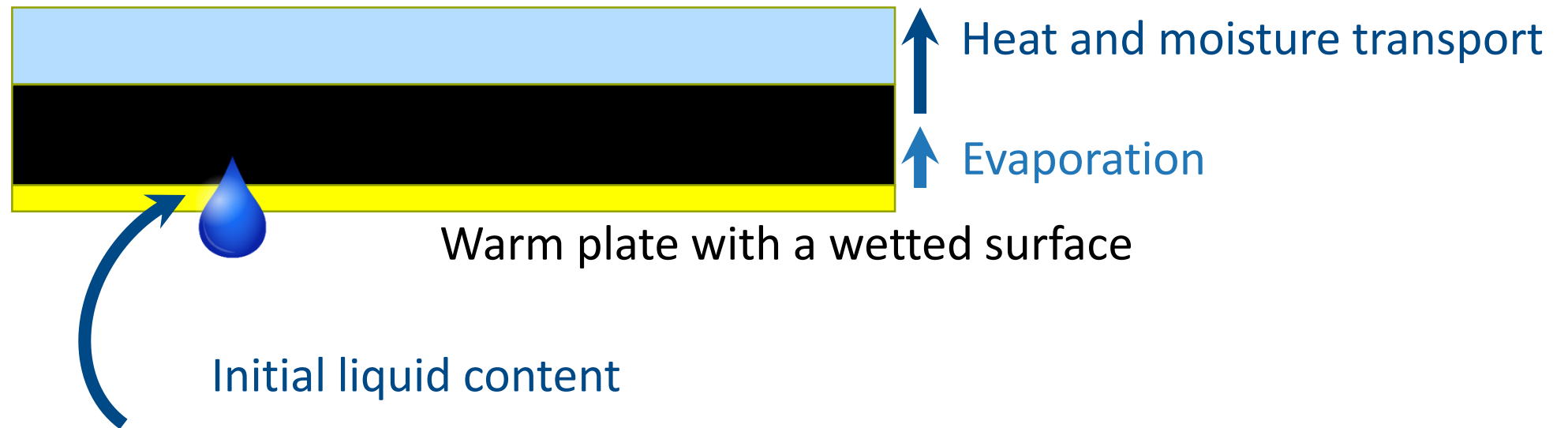
PEB

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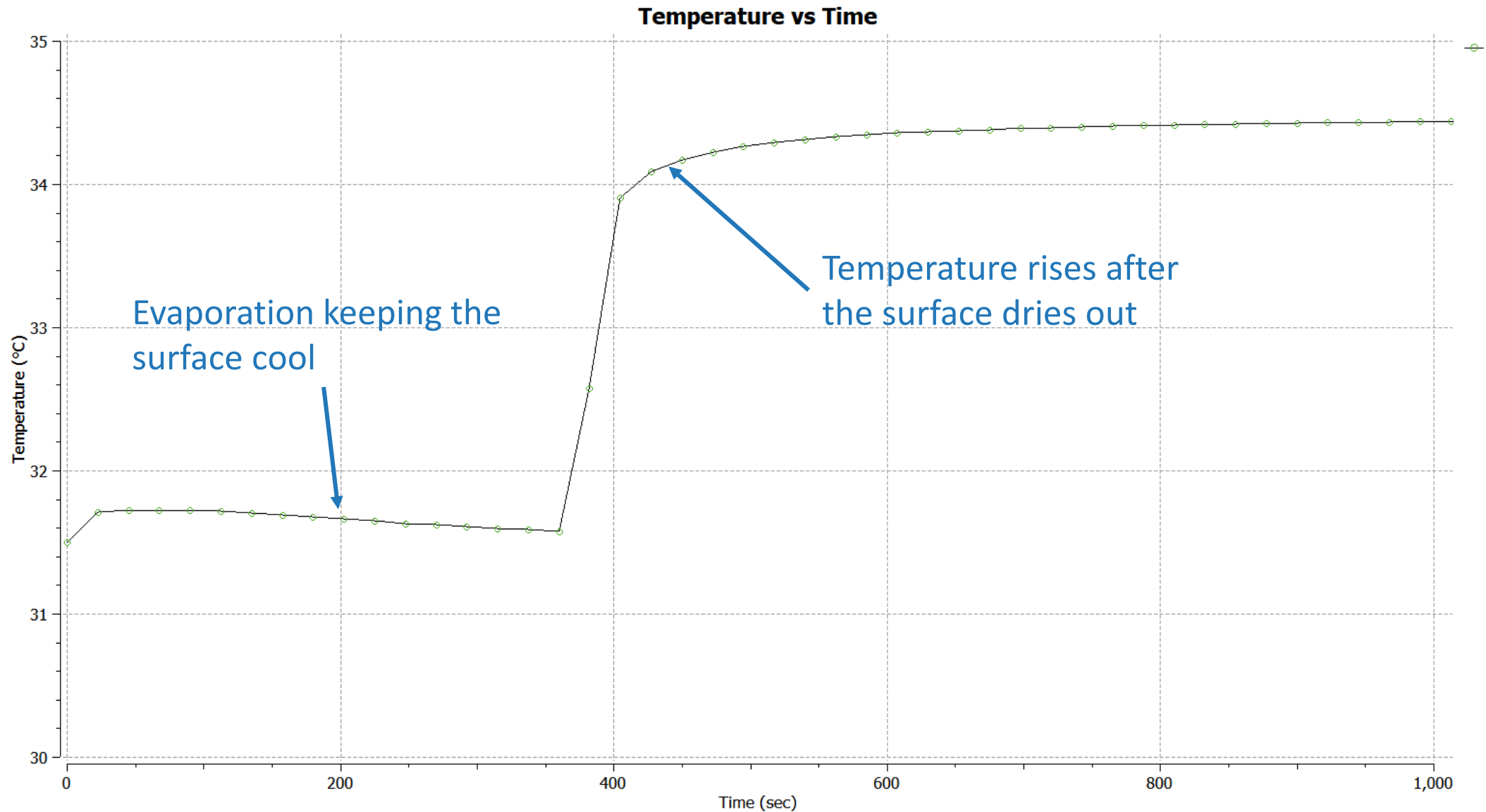
[1]

# Moisture Transport Simple Example

Dry, cool ambient conditions



# Moisture Transport Simple Example

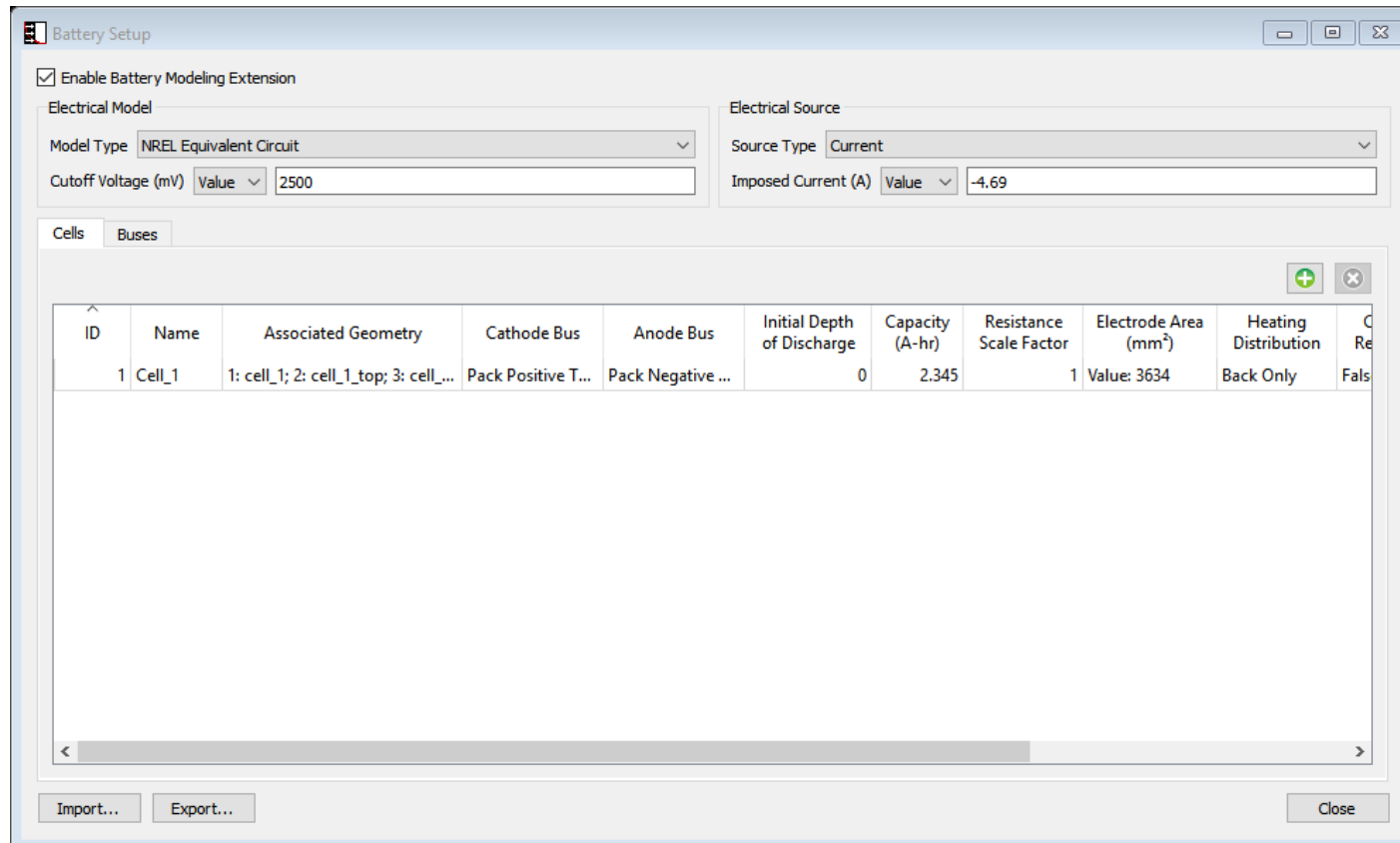


# What automotive applications can moisture transport be used for currently?

- Track ice and liquid on surfaces
- Predict sublimation, melting, evaporation, and condensation
- Compute the latent heat loss / gain on surfaces during phase change
- Track moisture in fabrics (such as seats)

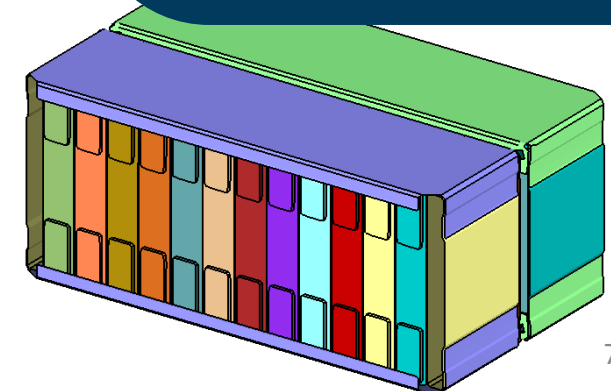
# Battery Setup in the GUI

- Battery model setup integrated into main application



## Benefits

- Familiar GUI presentation and model setup workflow
- Reduced model setup time
- Fewer model setup errors
- Reduced data management effort



# Exhaust Stream Enhancements



- More robust stream generation
- Improved convection behavior for low/zero flow

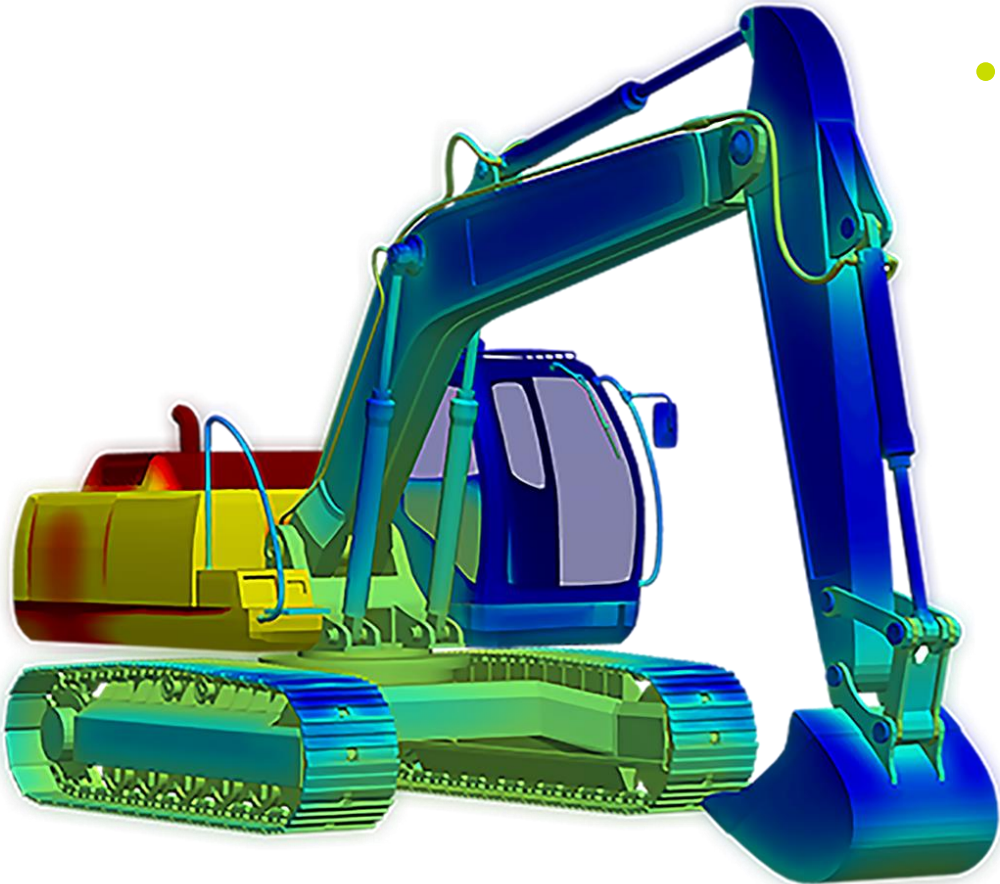
## Benefits

- Faster model setup
- More accurate results
- Now supports key-off scenarios



# Improved Application Performance

- Reduced application memory usage by ~8%
- Faster interaction with the part list
- Post Process Design Temperatures much faster

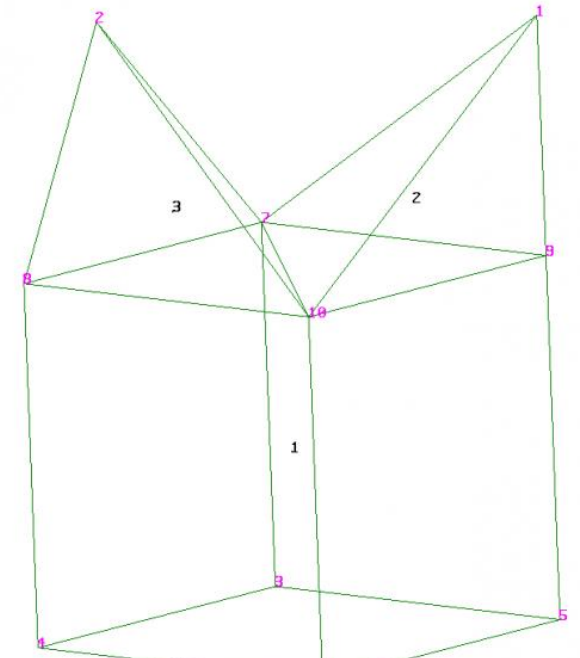


## Benefits

- Less time waiting for application
- Increased productivity
- More efficient use of available hardware resources

# Re-use 3D Solid Mesh from Finite Element Analyses

- FEA computed from shared vertices, so supported tetrahedrons on top of hexahedrons
- New feature enables TAItherm to compute conduction across these *non-conformal* faces (shared vertices, but different faces)

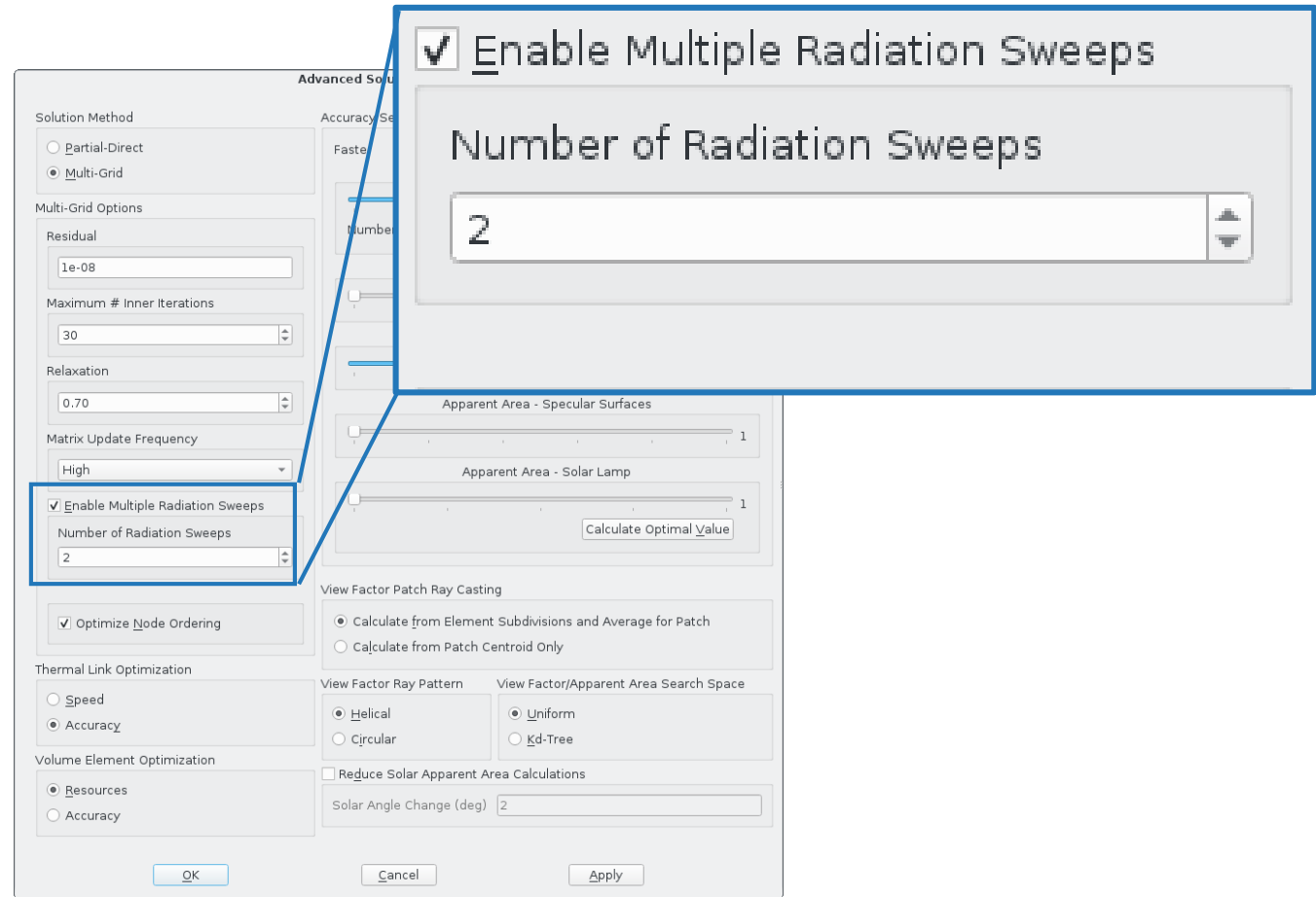


## Benefits

- Save time by re-using mesh that was created for other physics simulations

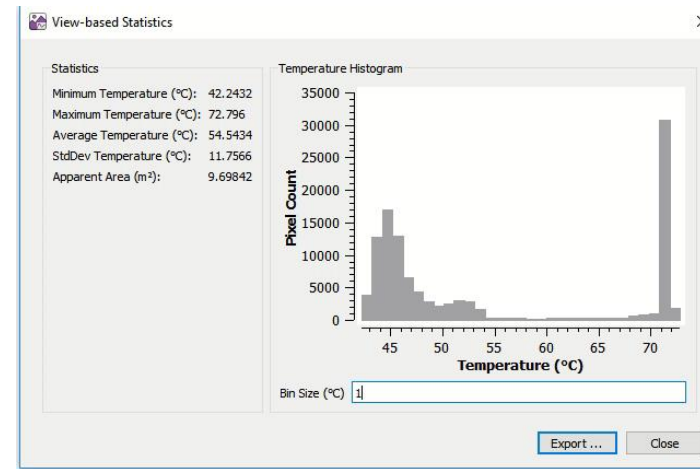
# New solver option to improve performance of some previously unstable models

- New option stabilizes some large models that were unstable in previous versions
- Models that could be stabilized with conservative solver settings run MUCH faster in conjunction with this new setting



# View Based Statistics

- Graphics view statistics (including dTrss based on diffuse radiance in the graphics window)
  - Temperature, Apparent temperature, diffuse radiance
  - Min, max, avg, stdev, dTrss based on pixels in the graphics window
  - Export table and images for a list of views



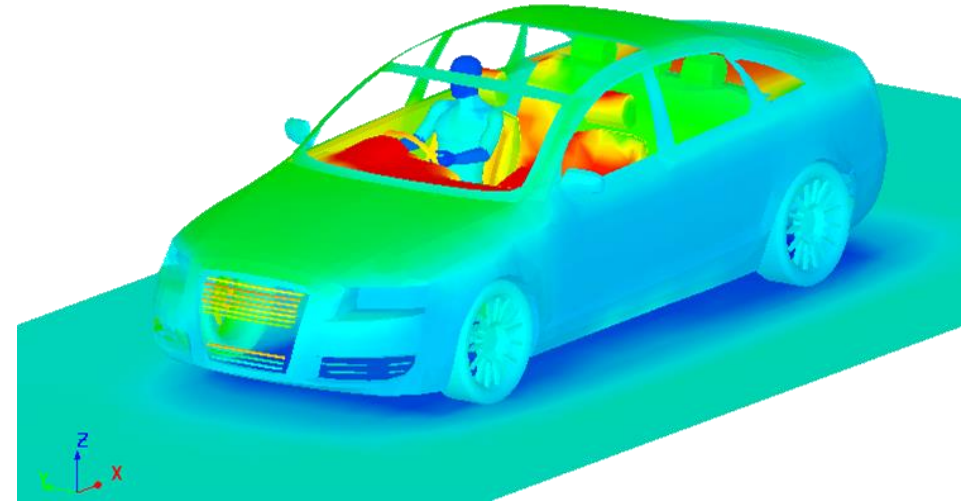
The 'Export View-Based Statistics' dialog box is used to configure the export of view data. It includes a 'File' field with a 'Browse...' button. The 'View Settings' section contains three rows of settings for Time Step, Azimuth, and Elevation, each with 'Start', 'End', and 'Interval' fields. The 'Export Options' section has checkboxes for 'Geometric Statistics', 'Thermal Statistics', 'Radiance Statistics', and 'Apparent Temperature Statistics'. There are also checkboxes for 'Write Images with CSV', 'Embed Images with Statistics', 'Add Color Ramp to Images', and 'Write Simplified Images'. The 'Image Base Name' field is set to 'image'. 'OK' and 'Cancel' buttons are at the bottom right.

View Settings	Start	End	Interval	Count
Time Step	0	0	1	1 Time Step
Azimuth (°)	0	360	20	19 Azimuths
Elevation (°)	0	0	1	1 Elevation

19 Total View Settings

# Berkeley Thermal Comfort Improvements

- Bring number of segments from 16 up to 19 in alignment with the Berkeley Papers
  - Breath
  - Face
  - Neck
- Apply smoothing to the overall sensation output
- **NOTE:** Any models using Berkeley Comfort will need to be updated with a new body part map file

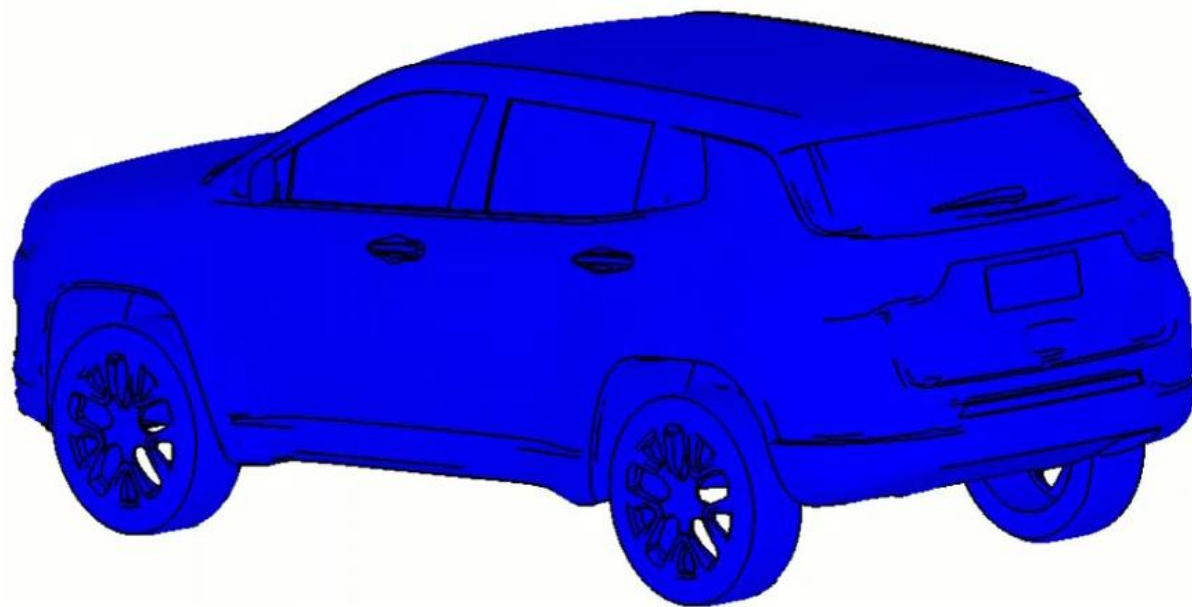
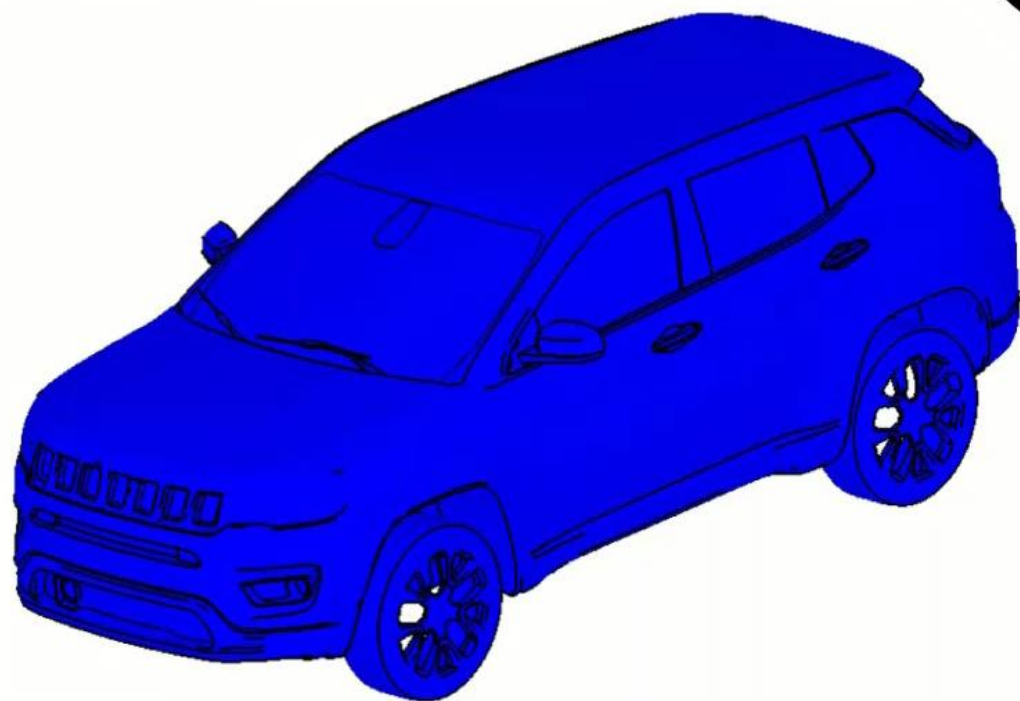


## Benefits

- Improved simulation accuracy
- Improved design decisions/confidence

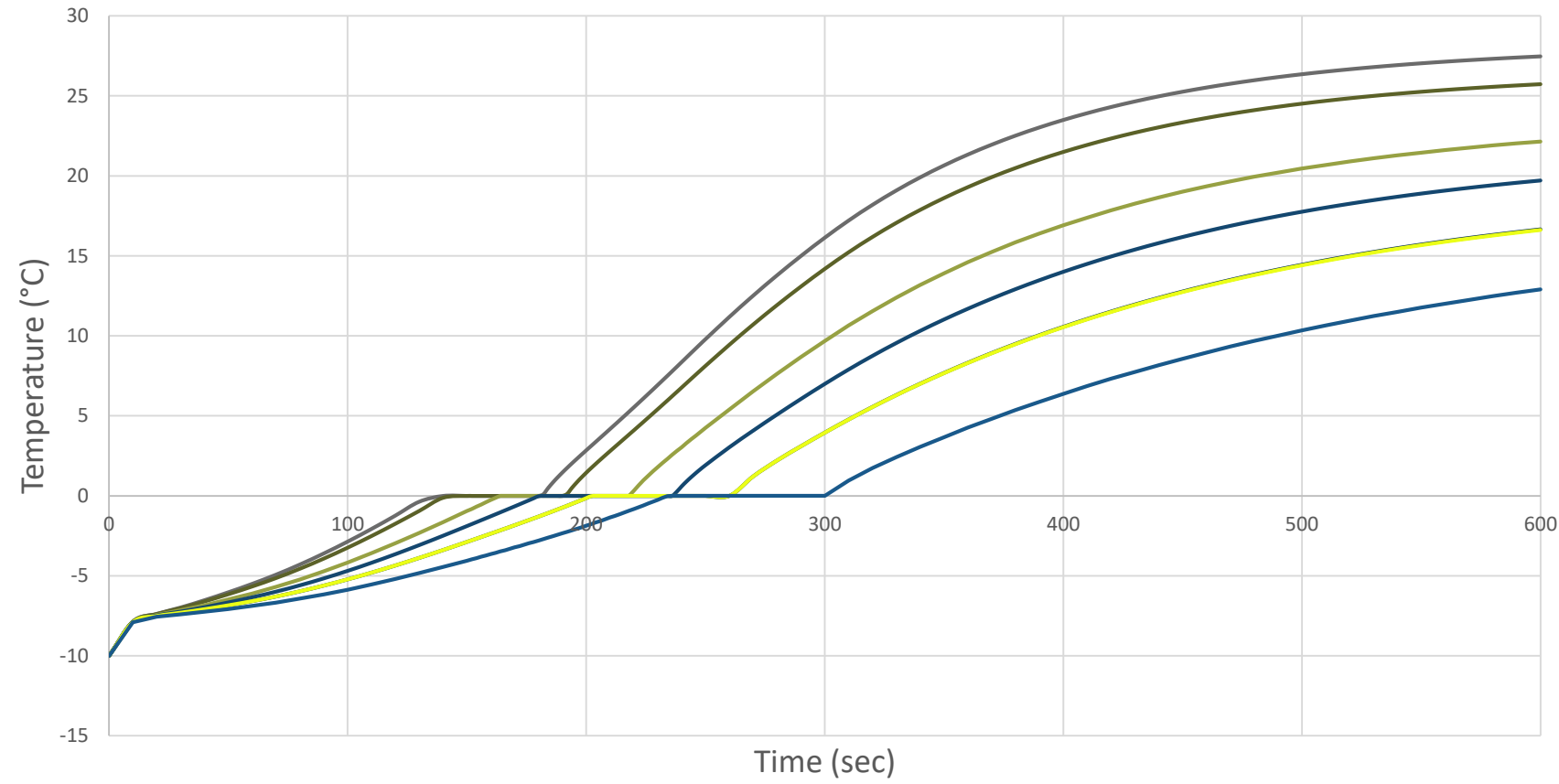
# Demo: Defrost vehicle windows

Using Moisture Feature

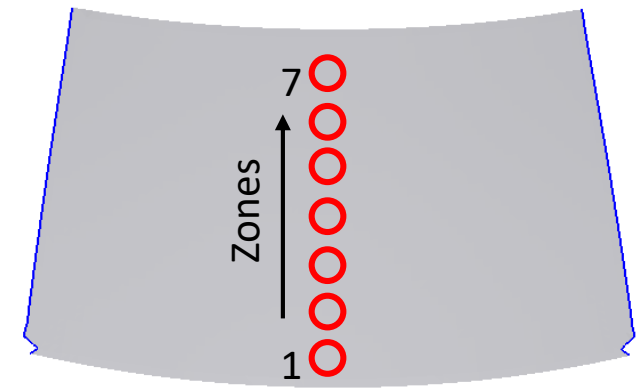


Temperature (°C)

# Temperature Results

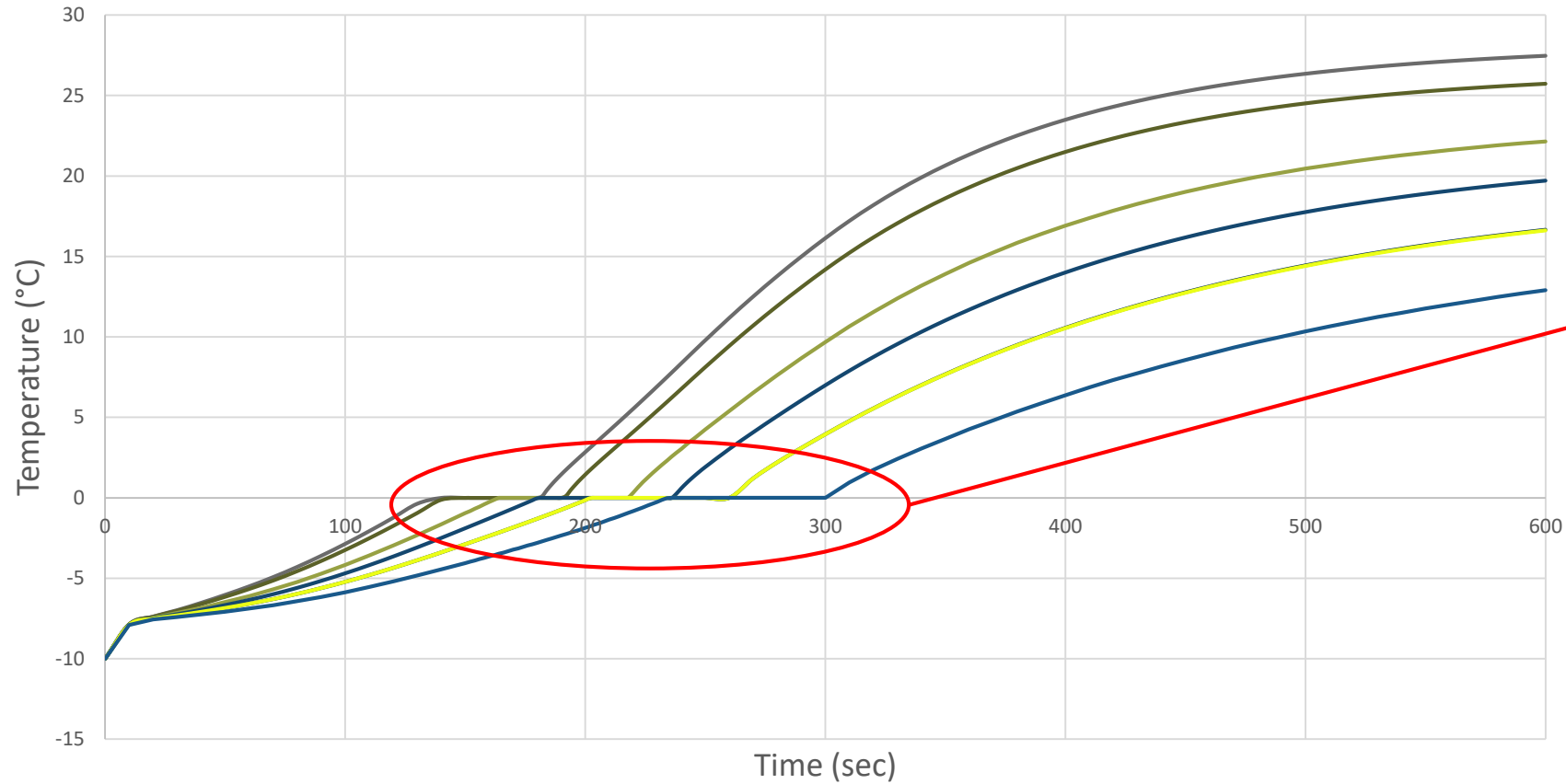


— Zone 1 - Moisture — Zone 2 - Moisture — Zone 3 - Moisture — Zone 4 - Moisture  
— Zone 5 - Moisture — Zone 6 - Moisture — Zone 7 - Moisture

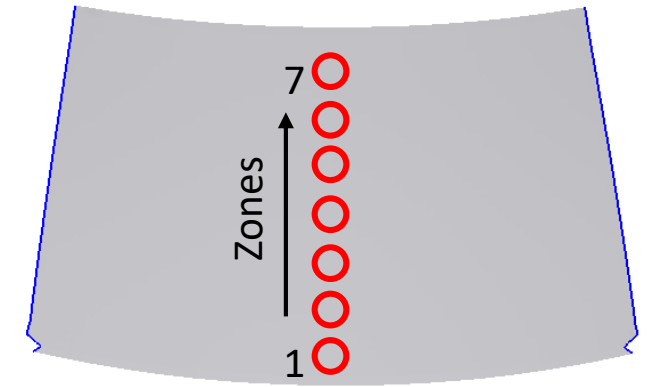




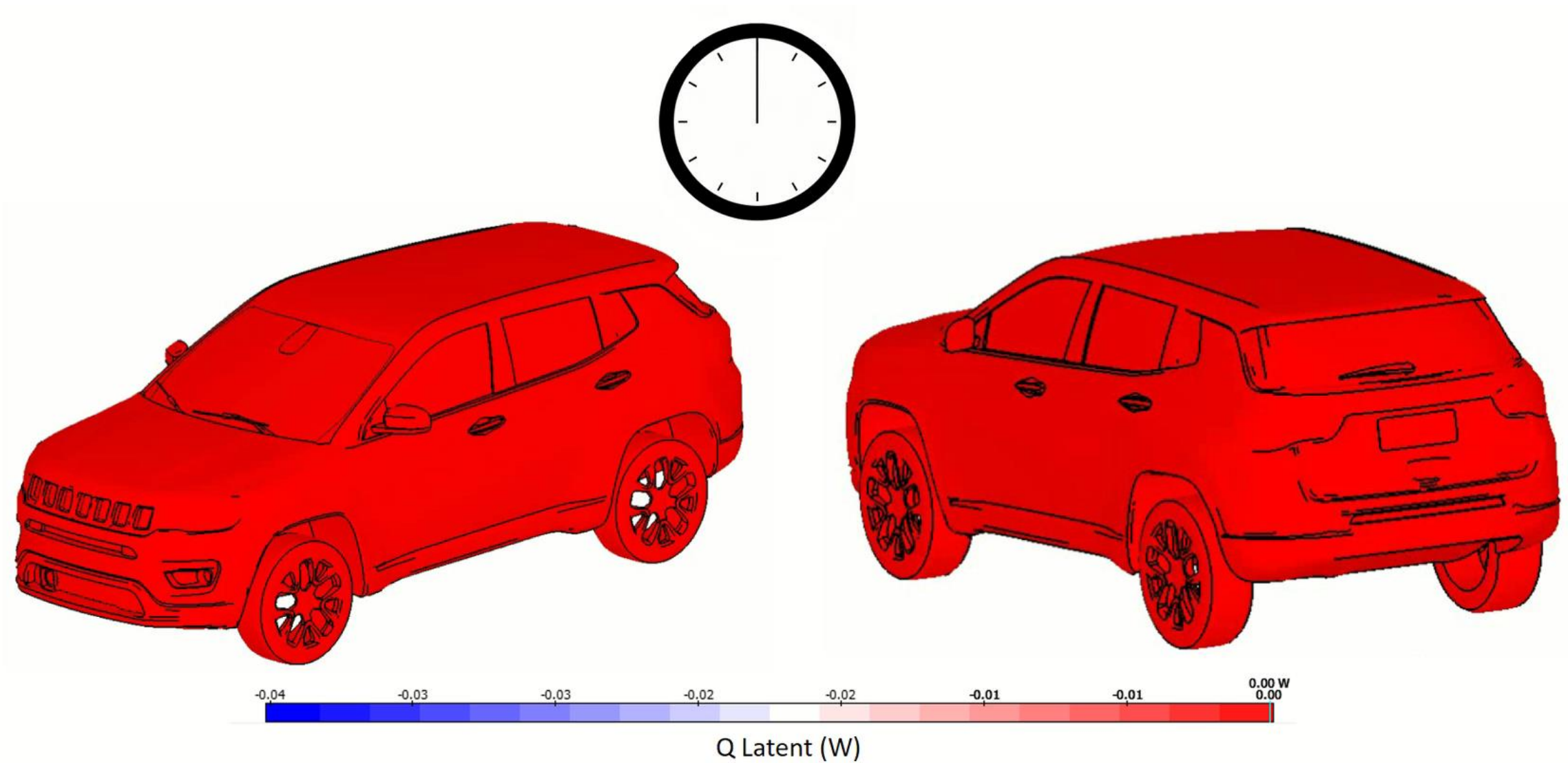
# Temperature Results



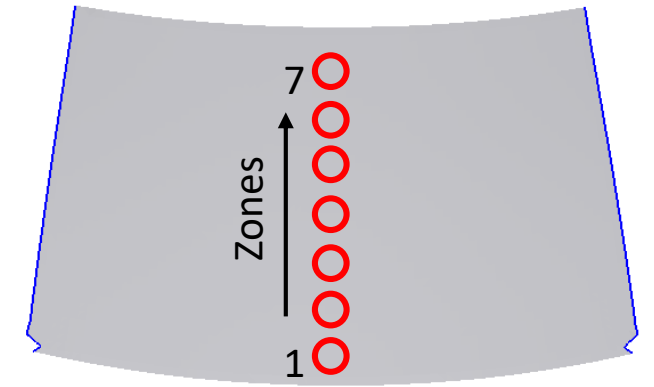
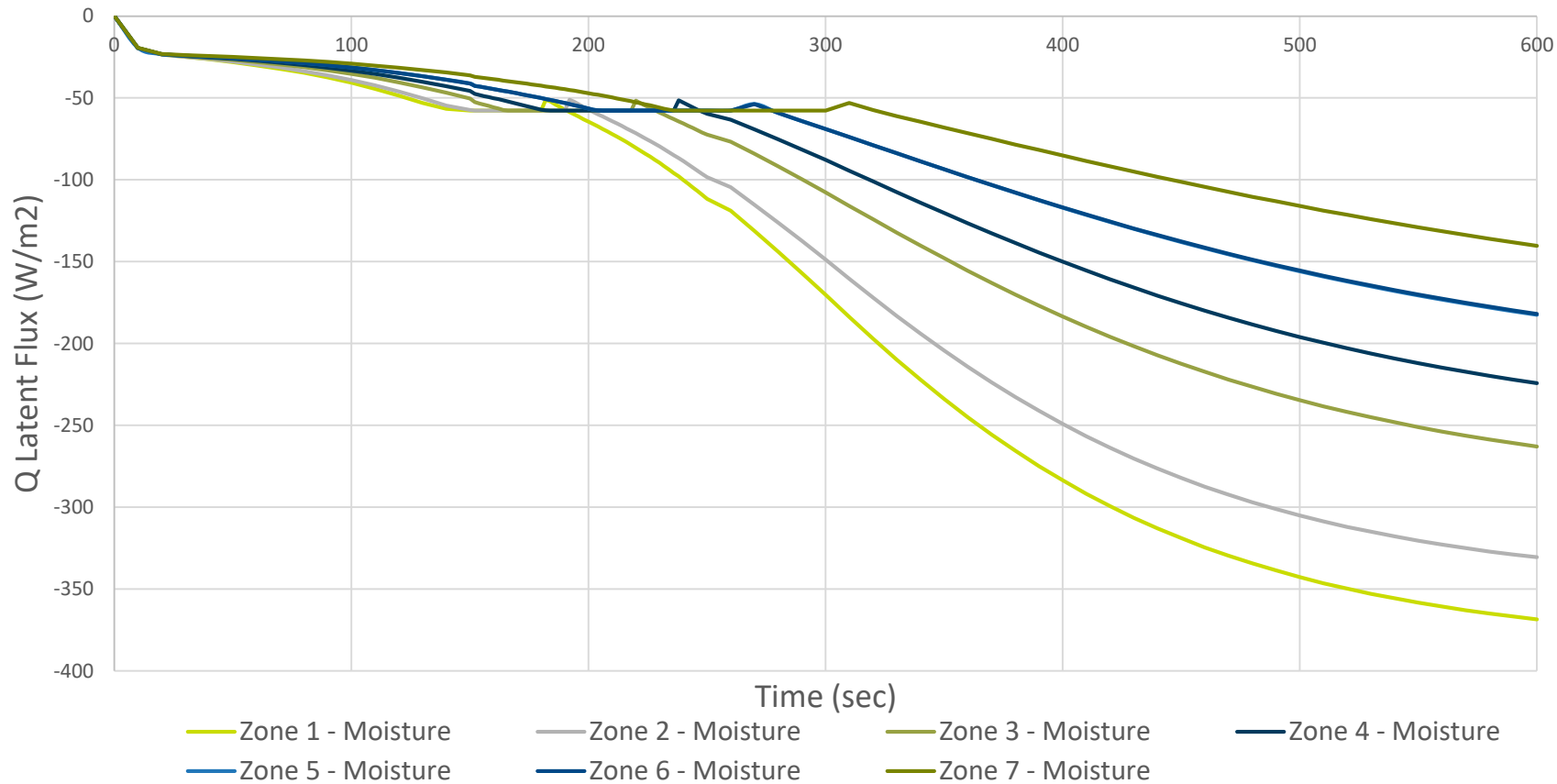
— Zone 1 - Moisture — Zone 2 - Moisture — Zone 3 - Moisture — Zone 4 - Moisture  
— Zone 5 - Moisture — Zone 6 - Moisture — Zone 7 - Moisture



- Phase change occurs when elements stay at 0°C



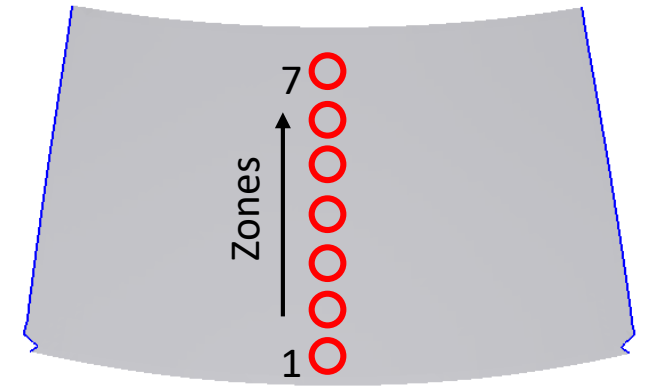
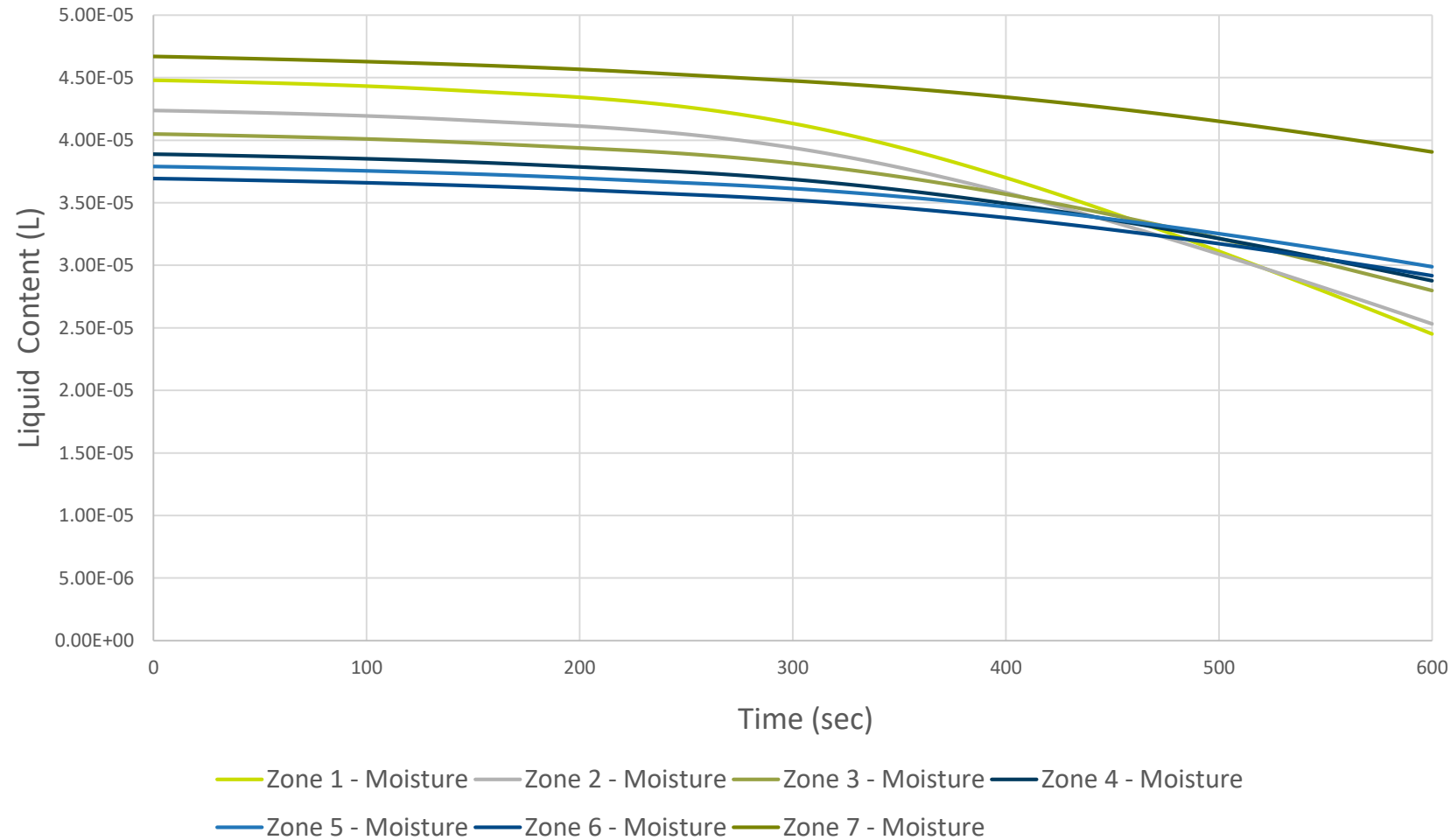
# Latent Heat Results



- When the liquid fully evaporates, latent heat flux will go to zero

$$m \frac{dh}{dt} = \dot{Q} + \sum_j \frac{\omega_j - \omega_i}{r_{i,j}} (h_{i/j} - h_{vap}) - \dot{m}_l (h_l - h_{liq}) + \dot{m}_v (h_v - h_{vap}) - \dot{m}_{evap} [h_{vap} - h_{liq}]$$

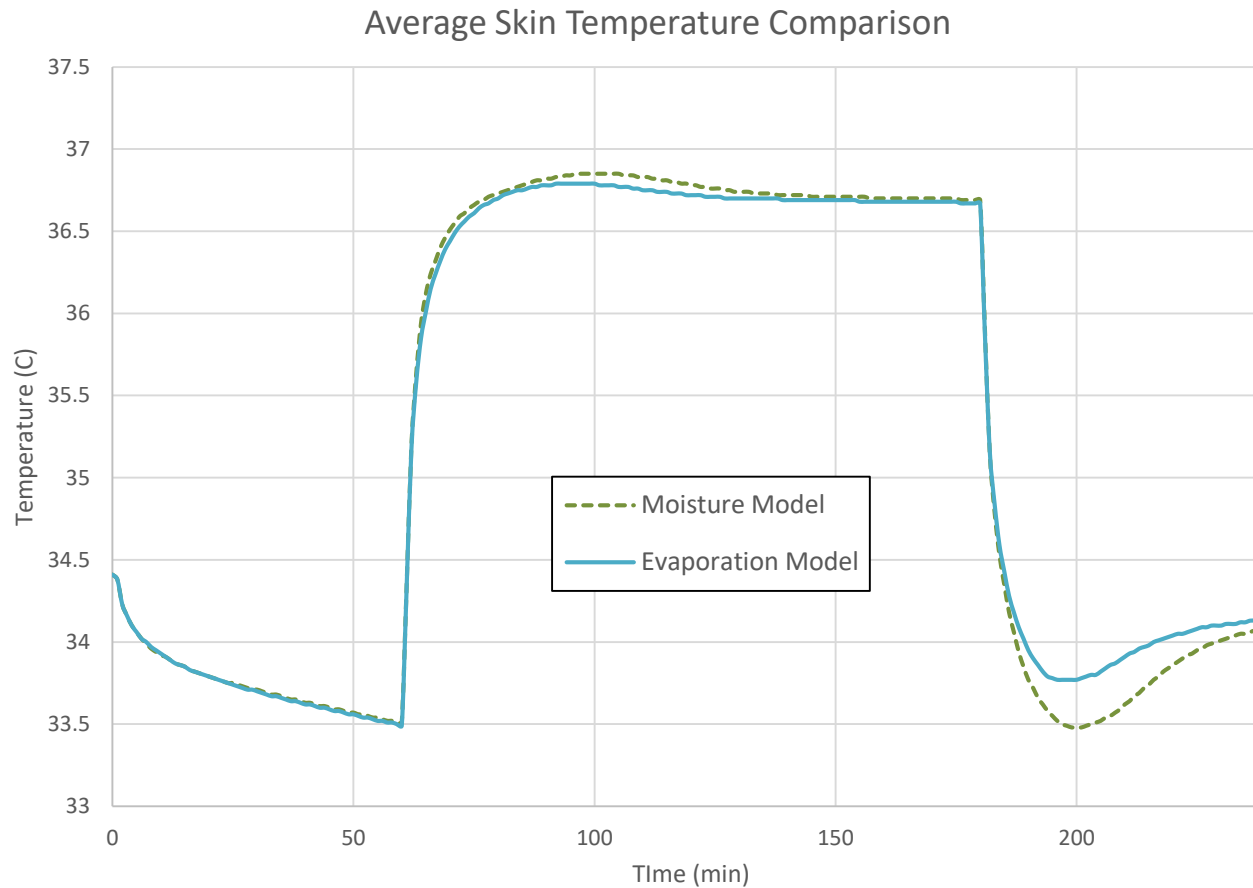
# Liquid Content



# Demo: Sweating Human

Moisture content changes over time

# Moisture model vs Evaporation Model

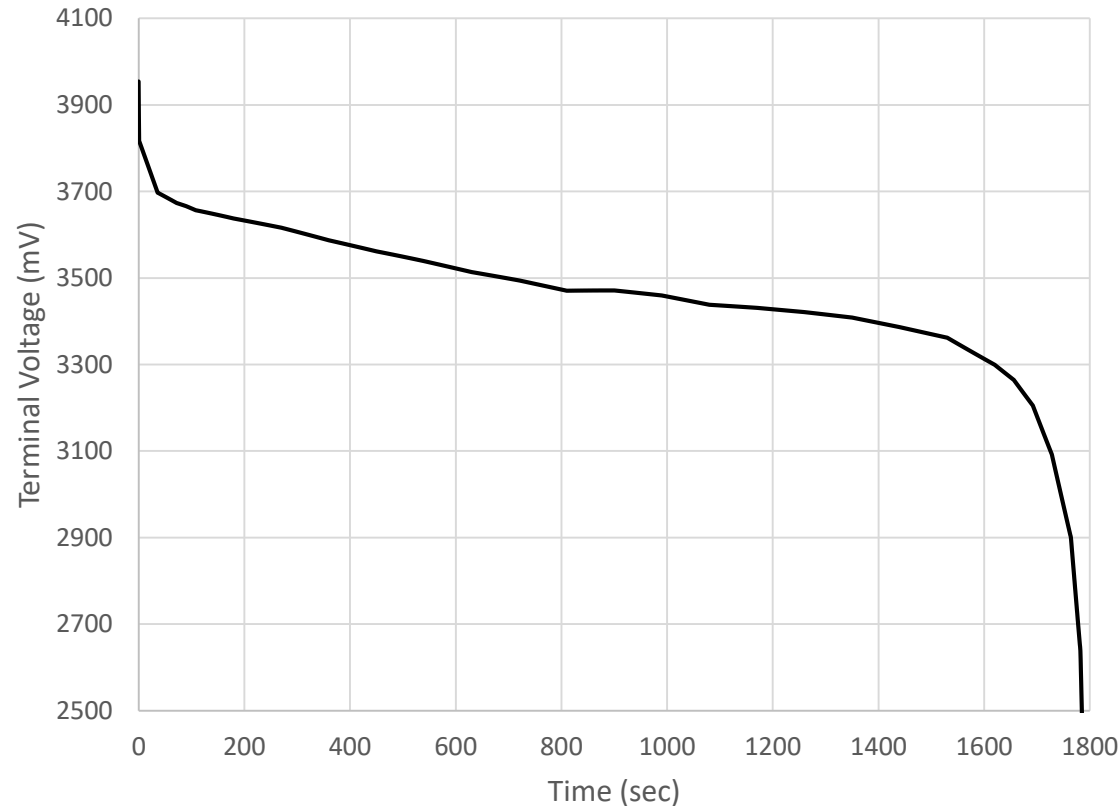


- The difference in average skin temperature is seen after the human enters a neutral environment again
- This is due to excess sweat being evaporated when the moisture model is used

# Demo: Battery GUI

Enhanced battery setup

# Post Processing – Terminal Voltage



- A log file: *NRELeqcCell.tdf.nreleqc.logfile.txt* is created in folder that the model was run
- The exponential drop at the end of the simulation can easily be observed



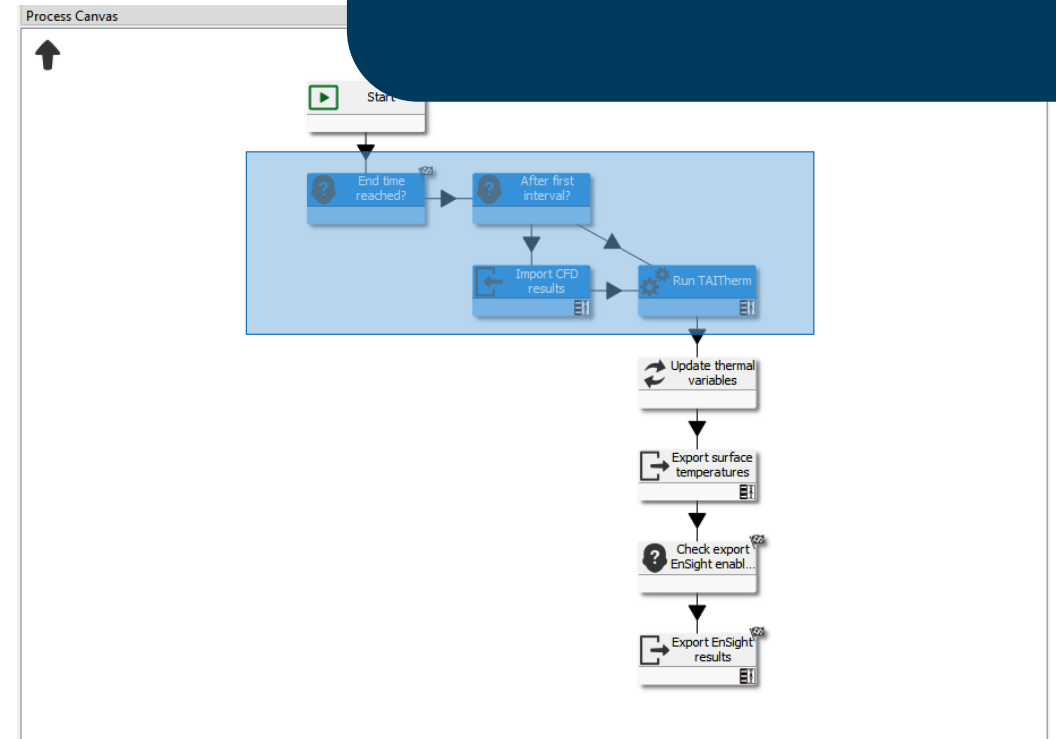
# CoTherm 2.2.0

# Multi-Selection

- Added multi-select cut/copy/paste for Resources and Tasks.
- Added rubber-band selection in Process Canvas.
  - Left click + drag is now selection instead of pan.
  - Middle click is now used to pan.

## Benefits

- Eases process set-up and editing by reducing multiple manual steps

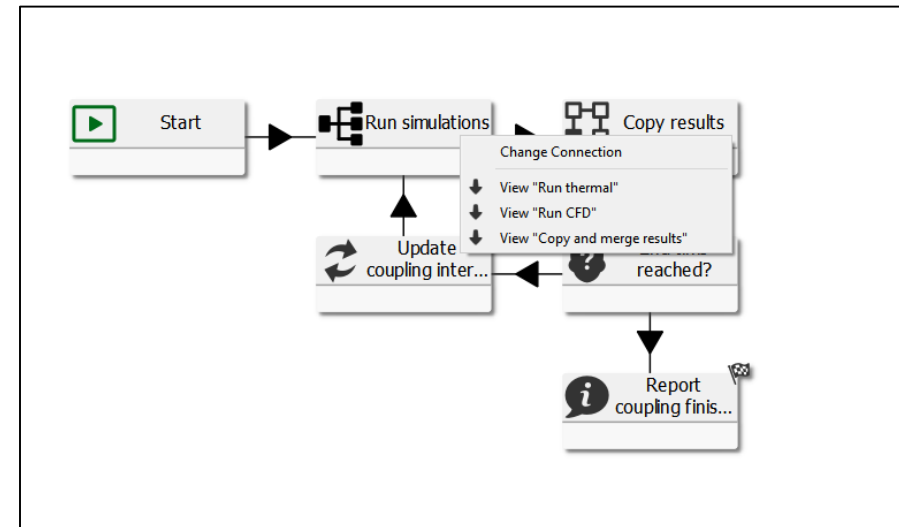
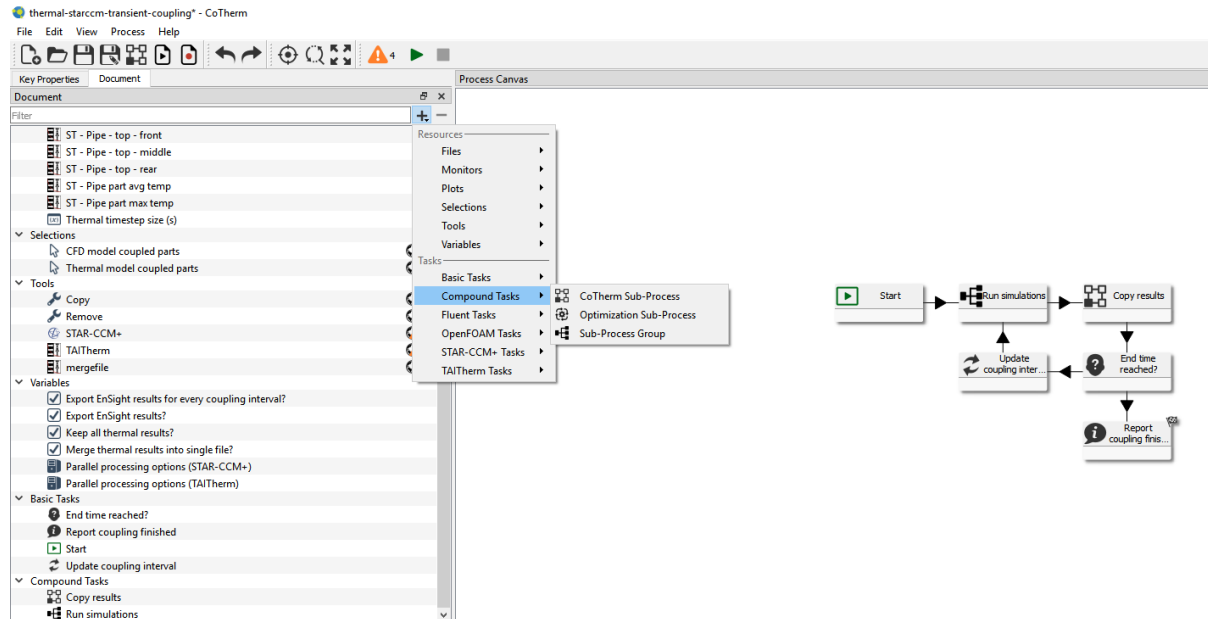


# Sub-Process Groups

- Can contain multiple CoTherm Sub-Processes and Optimization Sub-Processes.
- Sub-Processes can be added to a group via drag-and-drop on the Process Canvas.

## Benefits

- Allows for additional hierarchy of Sub-Processes
- Efficient way to view process when using parallel tasks

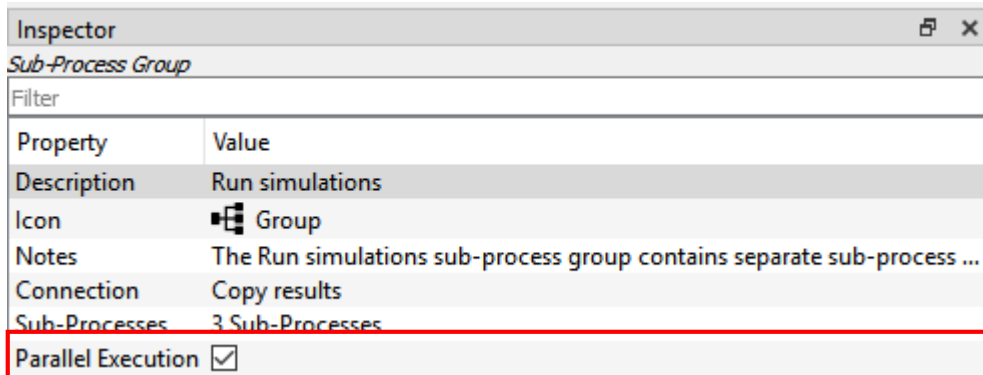


# Parallel Task Execution

- Grouped Sub-Processes can be run in serial or parallel

## Benefits

- Allows for faster run time by reducing the time one software is waiting for another to complete



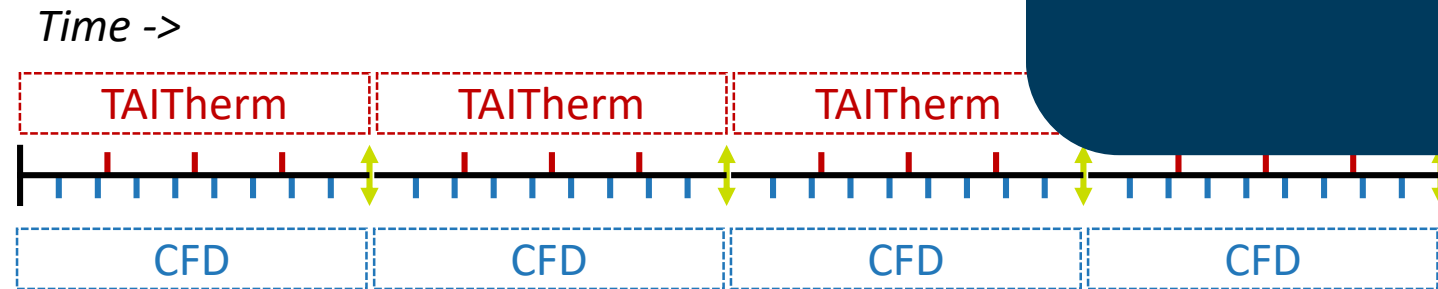
# CoTherm 2.1.0 - Fully transient thermal-CFD coupling

- With new CFD Run Tasks, various transient coupling strategies can be automated:

## Benefits

- Allows simulating transient fluid dynamics along with full multi-mode heat transfer effects in an efficient manner

Two-way single-exchange coupling at fixed coupling interval

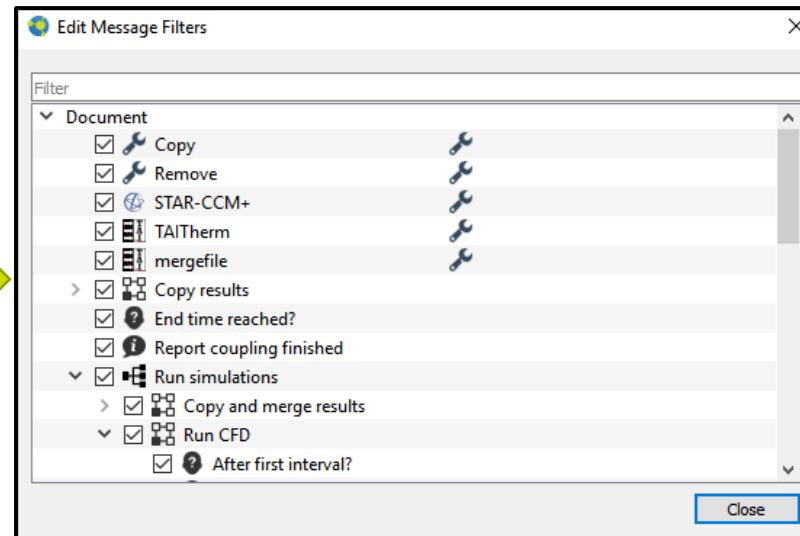
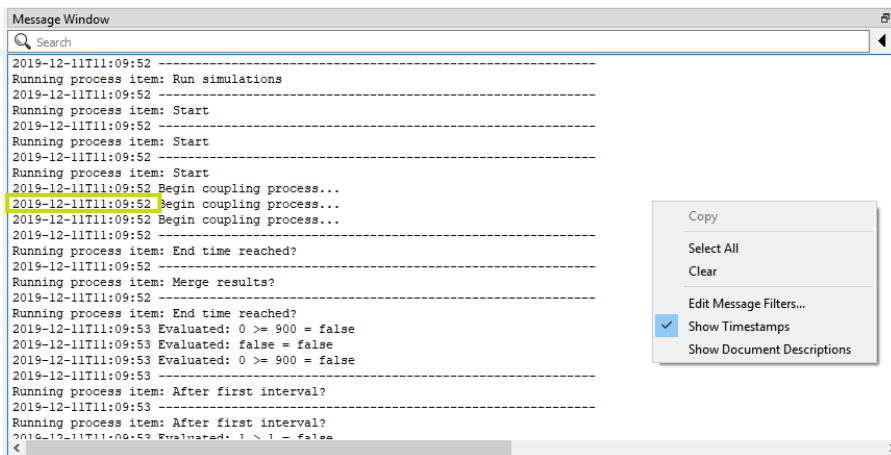


# Message Window

- Warnings and errors are now highlighted in the Message Window.
- Output from Tools and Tasks can now be filtered in the Message Window.
- Added XML-formatted log file containing metadata for each message.

## Benefits

- Customizable options allow the user more control
- Allows for better time tracking
- Easier to find problems
- Avoids interweaved messages with parallel task execution



# Additional CoTherm Enhancements

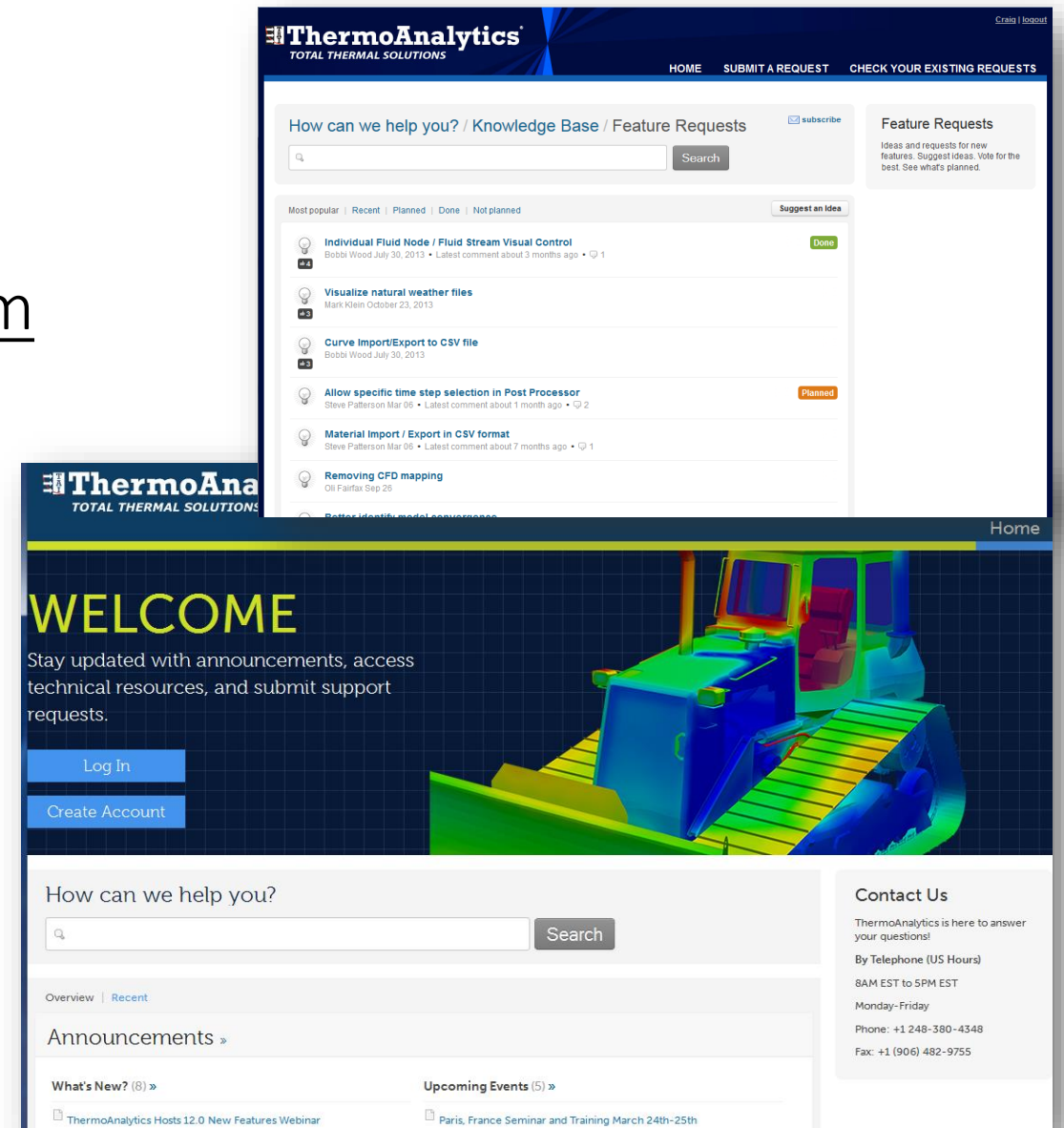
- Tasks
  - Added support for importing and exporting multi-region OpenFOAM cases.
  - Added Compound Task group to contain Sub-Process related Tasks.

# Demo: Parallel Task Execution



# Technical Support

- <https://support.thermoanalytics.com>
  - Submit & Check Status of Requests
    - [techsupport@thermoanalytics.com](mailto:techsupport@thermoanalytics.com)
    - Secure Large File Uploads
  - Software Downloads
  - Technical Library
    - Webinar Videos
    - FAQs
    - Papers & Presentations
    - Spreadsheet Tools
    - Training Videos



# Questions?

Thank you for attending!

# References

[1] M. Hepokoski, S. Peck, S. Gupta, J. Coffel, M. Decker and K. Isherwood, “Development of an Advanced Clothing Moisture Model,” in *12<sup>th</sup> International Manikin and Modelling Meeting, St. Gallen, Switzerland, August 29-31, 2018*