COMSOL
RELEASE NOTES

VERSION 4.0

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COMSOL Release Notes

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Release Notes

COMSOL V4 is in many aspects an entirely new product. This document outlines the differences between COMSOL 3.5a and COMSOL 4.0. It also outlines additions that we intend to make in COMSOL 4.0a.

We have strived to achieve backward compatibility with the previous version and to include all functionality that is available there. However, COMSOL 4.0 is not fully backward compatible with COMSOL 3.5a and does not have all its features.

Extensions of the backward compatibility with version 3.5a and additions of features is planned for COMSOL 4.0a.

COMSOL Multiphysics

COMSOL 4.0 introduces many new ideas and concepts to make it easier for you to create models. The following are the most important updates to the graphical user interface:

New Layout In COMSOL 4.0 it is easier to organize and design models with the intuitive structure of the *COMSOL Desktop*. The *Model Builder* (previously called *Model Tree*) displays all the features of your model in one place.

Personalized desktop: Control how you organize the *COMSOL Desktop* layout—your preferences are saved for the next time you open COMSOL Multiphysics.

Sequences of operations: You can now build custom model sequences to generate your geometry, physics, mesh, studies, and results. The sequences can be edited—changes are automatically updated across the model. Operations in the sequences can be modified by the parametric solver.

Geometric parametric sweeps: with geometry sequences COMSOL can perform fully parameterized sweeps with full associativity.

Material-oriented modeling procedure: Materials are now assigned to a domain. By default, the material is used in all physics interfaces for this domain, making it easier to manage all material properties from one window.

Multiple solutions: With the new layout, you can save and view many solutions, and compare and contrast the results in the Results branch.

Probes: Use probes to visualize scalar quantities during computations. The quantities can be defined as integrals, max/min, or average of a field quantity or by the value in a point. This now works for time stepping and parametric sweeps. Probes will be extended to also work while solving for geometric parametric sweeps for version 4.0a.

Dynamic help: The new context-dependent help enables easy browsing with extended search functionality. The *Help Desk* provides access to the complete documentation set.

Improved graphics: Faster, better looking graphics with improved accuracy over steep-gradient areas.

Model settings: Access to the model settings are easier and more intuitive. When you select a node in the Model Builder, a docked window containing associated settings displays at the same time. Where the window is located on your desktop depends on your personalized layout.

Custom labels: Create custom labels to define selections of domains, boundaries, edges, and points. These selections are available in domain and boundary settings for the model physics interfaces.

COMSOL version 4 also introduces:

- New and enhanced physics interfaces and predefined multiphysics couplings.
- New parallel solvers and higher solver performance.

Backward Compatibility

IDENTITY COUPLINGS

Identity model couplings do not work between models.

MAX/MIN MARKERS

Under results, max/min markers are not available in version 4.0.

MOVING MESH

All boundary condition types in the moving mesh interface in version 3.5a are not available.

PAIRS

All boundary condition types for paris in version 3.5a are not available. All are planned for 4.0a.

PERIODIC CONDITIONS

Periodic conditions are not available. In most interfaces, periodic conditions have been implemented to replace periodic pairs.

PDE MODES

Shape Functions

Only Lagrange elements are available in the PDE interfaces. Discontinuous elements are available in weak contributions using auxiliary dependent variables. Other shape

functions, including Argyris, Hermite, curl, discontinuous, density, divergence, and the ultraweak element will be available in COMSOL 4.0a.

Generalized Neumann boundary condition

The q coefficient is not available in version 4.0. Combine the expressions for the q coefficient with the dependent variable, for example, use $g=\{-q_{11}u_1, -q_{12}u_2; -q_{21}u_1, -q_{22}u_2\}$, for the case of two dependent variables, u_1 and u_2.

UNITS

All units available in 3.5a can be found in COMSOL 4.0 using the identical unit syntax. However, only one base unit system is available, the SI base unit system. This means that any input data given in other unit systems, using the unit syntax, is automatically converted to SI units. Models from 3.5a that use other base unit system that only partially specify the units will fail.

WEAK CONSTRAINS

Weak constrains are only partially available.

AXISYMMETRIC MODELS

The equations have been multiplied by a factor of 2π.

AC/DC Module

New Functionality

This release of the AC/DC Module includes a number of valuable new capabilities, including the following functionality:

- Electric and magnetic point dipoles
- Transition boundary condition for layers of arbitrary thickness
- Contact resistance boundary condition
- Single coil and multicoil domain modeling in 2D
- Electrical circuit interface with predefined passive and active components

Backward Compatibility

CHANGE IN DEPENDENT VARIABLES

It is no longer possible to solve for magnetic field $\boldsymbol{H}$ (as dependent variable). Models created in version 3.5a that were based on an $\boldsymbol{H}$ formulation, are translated to the $\boldsymbol{A}$ formulation but need to be solved again before postprocessing.

CYLINDRICAL PMLS

Cylindrical PMLs in 3D are not implemented. Cylindrical PMLs are planned for 4.0a.

PAIR CONDITIONS

Pair conditions are not implemented in 4.0, except for simple continuity. Most of the functionality is covered by new slit boundary conditions, which do not require assemblies. An example of such a boundary condition is the Contact Resistance boundary condition found in Electric Currents interface.

Except for continuity, the pair conditions from 3.5a models are thus not read in automatically and need to be manually added in 4.0 as slit conditions. Reintroduction of all pair conditions are planned for 4.0a, which will make it possible to import 3.5a models that use them.

CONDUCTIVE MEDIA SHELLS

Conductive media shell application modes from COMSOL 3.5a models are not automatically imported into COMSOL 4.0.

Acoustics Module

New Functionality

- More material models in both frequency and time domain.
- Interior slit boundary conditions—not needed to use pairs
- Improved scattered field formulation
- Structural mechanics can model solids based on pressure-wave speed and shear-wave speed.

Backward Compatibility

TRANSIENT AEROACOUSTICS

Transient aeroacoustics with flow is not available

ULTRAWEAK FORMULATION

The ultraweak formulation is not implemented and is not planned for re-implementation.

PAIR CONDITIONS

Only the continuity pair condition is available. Remaining pair conditions are planned for 4.0a.

WEAK CONSTRAINTS

Weak constraints are not available, and will be implemented for 4.0a.

CYLINDRICAL PMLS

Cylindrical PMLs in 3D are not implemented. Cylindrical PMLs are planned for 4.0a.

SOLVER SETTINGS

Solver settings for aeroacoustics and aeroacoustics with flow.

FAR-FIELD POSTPROCESSING

Far fields are not automatically read from 3.5a models into 4.0, it is necessary to manually add a far field feature.

COMPRESSIBLE POTENTIAL FLOW

For the Compressible Potential Flow interface, backward compatibility is not available.

BOUNDARY MODE AEROACOUSTICS

For the Boundary Mode Aeroacoustics interface, backward compatibility is not available.

Chemical Engineering Module

New Functionality

- Add and remove species in the species transport interfaces.
- Two additional diffusion models for concentrated species: mixture-averaged diffusion and Fickian diffusion.
- Low-Reynolds number k-epsilon turbulence model.
- Improved k-epsilon implementation which is formulated in natural variables (k not $\log k$).
- Transient turbulence.
- Parameter free wall functions where no wall-offset is required.
- Improved stabilization for flow, mass, and heat transport. Significant improvements for stabilization of mass transport.
- New physics interface for species transport in porous media.
- CAPE-OPEN thermo socket available in the graphical user interface.

Backward Compatibility

ROTATING MACHINERY

The Rotating Machinery interface is not available in version 4.0. Models can be built by combining the Moving Mesh interface and fluid flow interfaces.

REACTING FLOW

The Reacting Flow interface is not available. You can build reacting flow model by combining Single-Phase Flow and Transport of Diluted Species interfaces.

PSEUDO MODES

The Pseudo Modes available in COMSOL 3.5a have not been re-implemented in 4.0. Import of models will not work.

K-OMEGA TURBULENCE MODEL

The *k-omega* interface is not available in COMSOL 4.0. Loading a 3.5 model results in a model without turbulence model. The *k-omega* interface is planned for 4.0a.

THIN BOUNDARY LAYER PAIR

For the Mass Transport interfaces the Thin Boundary Layer pair is not available. Models with thin boundary layers created in 3.5a will not be successfully imported in version 4.0.

THIN RESISTIVE LAYER PAIR

For the Energy Transport interfaces, the Thin Resistive Layer pair have been replaced by a thin resistive slit-based boundary condition. Models with thin resistive layers created in 3.5a will not be successfully imported in version 4.0.

PERIODIC BOUNDARY CONDITIONS

Periodic paris are not available. In the Single-Phase Flow interface, Two-Phase Flow interfaces and Heat Transfer interfaces, they are replaced by a discontinuous Galerkin boundary condition. The periodic boundary condition is not available in the solute transport, transport in porous media, bubbly flow, and mixture model interfaces.

WALL BOUNDARY CONDITION IN NON-ISOTHERMAL FLOW

The following boundary conditions are not compatible with turbulent flow:

- Highly conductive layer
- Convective cooling
- Periodic heat
- Heat continuity
- Thin thermally resistive layer

SPECIAL SHAPE FUNCTIONS

Special shape functions: 4.0 only supports Lagrange elements.

LiveLink for MATLAB

New Functionality

The model object that contains the true representation of the model is available directly from the MATLAB prompt. This means that all functionality available from the COMSOL Desktop will be automatically available at the MATLAB prompt, and that the model will behave exactly the same from the MATLAB prompt and in the COMSOL Desktop. In the future this will also mean that you will be able to see changes to the model object that has been made in MATLAB, and vice versa.

The interface to MATLAB uses an entirely new syntax for the model. The function `mphv4` and the ability to load 3.5a models in the V4 GUI and save them as M-files will help you convert the model to the new syntax. This means that the conversion tools help you convert the `fem` structure to the new syntax; the rest of the M-files that you have written for 3.5a will need to be manually converted.

The ability to start COMSOL with MATLAB in a 3.5a compatibility mode is intended to help you in the process of working the both the old and the new syntax.

Parameterized Geometries

COMSOL 4.0 includes built-in support for parameterized geometries. There should be no need to change boundary condition during parameterization; and thus the `geomanlyze` function is no longer necessary. Parameterization can be performed both with the built-in parametric solver and by wrapping a for-loop around the solver call.

Earth Science Module

New Functionality

- A new interface for fracture flow: flow in fractures within a porous or solid medium.
- A new heat transfer interface for porous media.
- The time stepper now accepts other time units than seconds. This means that you can conveniently use days or years as time unit.

Heat Transfer Module

New Functionality

- Heat transfer in porous media
- Radiative heat transfer in participating media
- Low-Reynolds k-espsilon turbulence model
- Predefined conjugate heat transfer
- Improved continuity and outlet boundary conditions
- Improved stabilization

Backward Compatibility

CONJUGATE HEAT TRANSFER

Conjugate heat transfer with turbulent flow is not backward compatible. Surface-to-surface radiation on turbulent heat transfer is not supported.

THERMAL EXPANSION IN STRUCTURAL MECHANICS

Thermal expansion is not backward compatible.

K-OMEGA INTERFACE

The k-omega turbulence interface is not available.

MEMS Module

New Functionality

- The 4.0 Piezoelectric Devices interface is more complete and contains most of the functionality of both the Electrostatics and the Solid Mechanics interfaces.
- New interfaces for thin-film gas flow, thin-film flow, and lubrication shells.

Backward Compatibility

PIEZOELECTRIC DEVICES INTERFACE

The following 3.5a functionality is not available in version 4.0:

- Variables of total dissipation and vibration quality
- Variables for visualization of elastic waves, and estimating mechanical energy flux.
- Large deformation formulation, and electric fields in solids
- Electrical formulations
- Backward compatibility with 3.5a models is not available. Backward compatibility will be added in 4.0a

PERFORATED PLATES

Perforated plates are not available.

FILM DAMPING

- The solid predefined coupling is missing but can be performed manually.
- Backward compatibility with 3.5a models is not available. Backward compatibility will be added in 4.0a

RF Module

New Functionality

- Electric and magnetic point dipoles
- Transition boundary condition for layers of arbitrary thickness
- Multimode S-parameters
- Port Sweep for Lumped Parameter Calculations in the graphical user interface
- Touchstone Export from the graphical user interface

Backward Compatibility

CYLINDRICAL PMLS

Cylindrical PMLs in 3D are not implemented. Cylindrical PMLs are planned for 4.0a.

GENERAL

It is no longer possible to solve for magnetic field $\boldsymbol{H}$ as a dependent variable. All interfaces use $\boldsymbol{E}$ as dependent variable. Models created in version 3.5a that were based on an $\boldsymbol{H}$ formulation, are translated to $\boldsymbol{E}$ but need to be solved again.

FAR-FIELD POSTPROCESSING

Far fields are not automatically read from 3.5a models into 4.0, it is necessary to manually add a far field feature.

PAIR CONDITIONS

Pair conditions are not implemented in 4.0, except for simple continuity. Most of the functionality is covered by new slit boundary conditions, which do not require assemblies. An example of such a boundary condition is the Contact Resistance boundary condition found in Electric Currents interface.

Except for continuity, the pair conditions from 3.5a models are thus not read in automatically and need to be manually added in 4.0 as slit conditions. Reintroduction of all pair conditions are planned for 4.0a, which will make it possible to import 3.5a models that use them.

Reaction Engineering Module

New Functionality

- CAPE-OPEN interface
- Surface reactions

Backward Compatibility

Export from Reaction Engineering Lab to COMSOL Multiphysics does not include material balances where equilibrium is used to eliminate the reaction kinetics. You can treat such systems by using large values of the rate constants and keeping the relation between the forward and reverse rate constants to satisfy the equilibrium relation.

Structural Mechanics Module

New Functionality

- Flexible definition of elastic material data; the solid mechanics interfaces support bulk modulus and shear modulus, Lamé constants, and pressure-wave and shear-wave speed in addition to Young's modulus and Poisson's ratio.
- User-defined hyperelastic material models by defining a strain energy function.
- Flexible 2D solid mechanics: switch between plane stress and plane strain approximations.
- Prescribed velocity and acceleration boundary conditions for transient solid mechanics.
- Rigid connector boundary condition in 2D.

Backward Compatibility

CROSS-SECTION LIBRARY

The cross-section library for beams is not available.

DAMPING

Damping and is missing for shells, beams, and trusses.

PLANE STRESS

COMSOL 4.0 represents the out-of-plane strain as a separate degree of freedom. Plane stress models made with 3.5a need to be re-solved to correctly postprocess strains and stresses. Displacements are correctly postprocessed.

PLATE INTERFACE

The 2D plate interface is not available. It is planned for version 4.0a. You can use the shells to do plate modeling by using a planar 3D geometry. Plate application modes in version 3.5a models are not imported into version 4.0.

SYMBOLS

Symbols representing constraints and load are not available in version 4.0.

PRINCIPAL STRESS/STRAIN PLOTS

Principal stress/strain plots are not available in version 4.0.