

TriboSolver 3.0

Worked Examples Guide

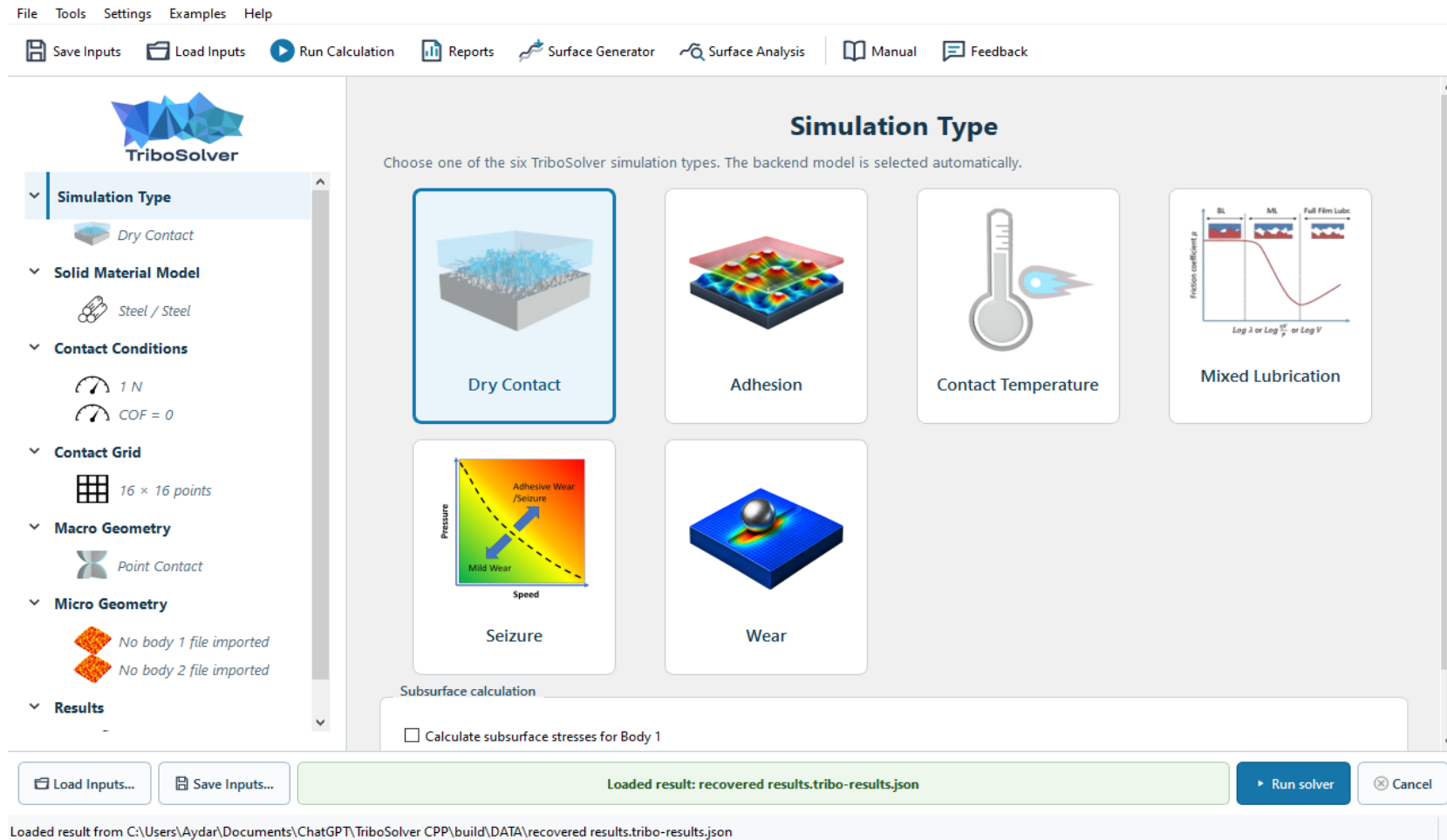
Nine reproducible calculations with tab-by-tab setup, actual result plots and engineering interpretation



Use this guide together with the supplied input files. Theory and equations are intentionally kept in the TriboSolver Manual; this document concentrates on completing and interpreting calculations.

How to use this guide

Open a worked example from **Examples** on the top menu, or choose **Load Inputs** and open the named .tribo.json file. The saved input is the authoritative starting point. Review every visible tab before running; changing the grid, material, geometry, surface or numerical settings creates a different numerical problem.



Reading Results: 1D, 2D and 3D



View	What it shows	How to interpret it
1D	A line through a 2D field at the selected X or Y location, or a depth trace through a 3D field.	Use it to read peak values, widths, gradients, symmetry and direct comparison between runs. Cross-section controls appear only on the 1D view.
2D	A color-coded map over X-Y, or a selected X-Z/Y-Z slice for subsurface fields.	Use the colorbar and units. A pixel represents one numerical cell. For signed adhesion pressure, negative is tensile and positive is compressive.
3D	The same 2D matrix rendered as a rotatable surface with X, Y and Z directions.	Use it to see peak prominence, shoulders, valleys and orientation. Rotation changes the viewpoint, not the data.
Scalar	A single calculated number such as recovered load, film thickness or contact area.	Read it with its unit and convergence status; never infer spatial uniformity from a scalar alone.

Example index

Example	Problem	Input
1	Rough surfaces in point contact	Examples/01_Rough_Point_Contact/rough-point-contact.tribo.json
2	Coated point contact	Examples/02_Coated_Contact/coated-contact.tribo.json
3	Contact temperature	Examples/03_Contact_Temperature/contact-temperature.tribo.json
4	Subsurface stress: frictionless and frictional	Examples/04_Subsurface_Stress/subsurface-stress.tribo.json
5	Mixed lubrication load sharing	Examples/05_Mixed_Lubrication/mixed-lubrication.tribo.json
6	Seizure screening	Examples/06_Seizure/seizure.tribo.json
7	Rough adhesive contact	Examples/07_Adhesion/adhesion.tribo.json
8	Electroadhesion	Examples/08_Electroadhesion/electroadhesion.tribo.json
9	Iterative Archard wear	Examples/09_Wear/wear.tribo.json
4A	Subsurface frictionless variant	Examples/04_Subsurface_Stress/variants/01_Frictionless/subsurface-stress-frictionless.tribo.json

Common run sequence

1. Load the input. 2. Review the visible tabs. 3. Generate or import a surface when required. 4. Run the solver and monitor status. 5. Check convergence and recovered load. 6. Select a result variable. 7. Inspect 1D, 2D and 3D views where applicable. 8. Export the result set and report to the application DATA folder.

Example 1. Rough surfaces in point contact

Problem

A spherical steel body is pressed against a nominally flat steel counterbody. A deterministic self-affine rough surface is superimposed on the macrogeometry. The calculation resolves the individual pressure-carrying asperity patches while maintaining the prescribed total normal load.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

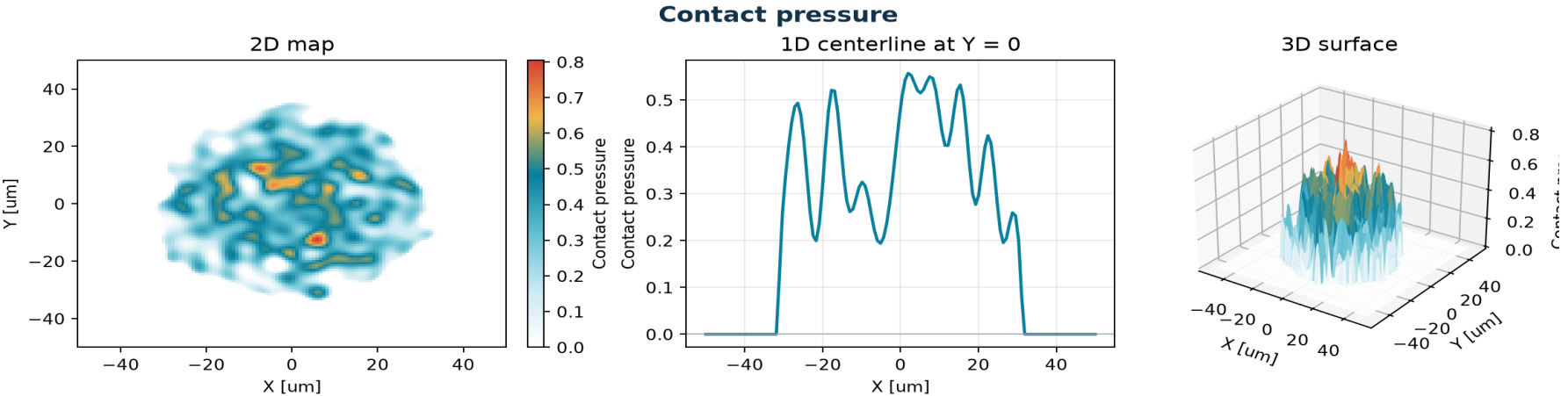
Input or control	Value
Simulation type	Dry Contact
Normal load	1 N
Materials	Steel / Steel; E = 210 GPa, nu = 0.30
Macrogeometry	Point Contact; body-1 radii 5 mm; body 2 flat
Domain and grid	100 x 100 um; 128 x 128
Microgeometry	Generated PSD surface; Sq = 6.3 nm; H = 0.8; seed 314159

Saved input: `rough-point-contact.tribo.json` | SHA-256: 64b3c84915432be87d97a9394ca74638163dc47cc8ea3f510015cd8f3017dcfb

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Dry Contact. Leave both subsurface-stress boxes clear.
2	Solid Material Model	Set both bodies to steel. Do not enable coatings.
3	Contact Conditions	Set Load to 1 N. Leave Include Friction clear.
4	Contact Grid	Set X = 128, Y = 128, Step X = Step Y = 0.78125 μm .
5	Macro Geometry	Choose Point Contact. Set body-1 X/Y radii to 5 mm and use a flat counterbody.
6	Micro Geometry	Check Micro Geometry, choose Generate a PSD surface, enter Sq/H/cutoffs/seed, then press Generate. Confirm the preview is populated.
7	Run	Press Run Calculation and wait for a converged status and recovered load close to 1 N.

Actual result



The run converged in 37 iterations with a residual of 9.94e-7 and recovered the prescribed 1 N load. The pressure field is discontinuous because only the tallest roughness summits carry load. The 1D trace shows the local peaks crossed by the selected line; the 3D view makes their relative magnitudes and spatial separation easier to inspect.

Retained result set: rough-point-contact-results.tribo-results.json | SHA-256: ca5a431c46e0e6f52cd9bf8cce18cd2273602f086b4a0cd9d55fd61f3a166f3a

Example 2. Coated point contact

Problem

A 1 um elastic coating is applied to body 1. The purpose is to quantify how the layered compliance changes pressure, displacement and contact size compared with the corresponding homogeneous contact.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

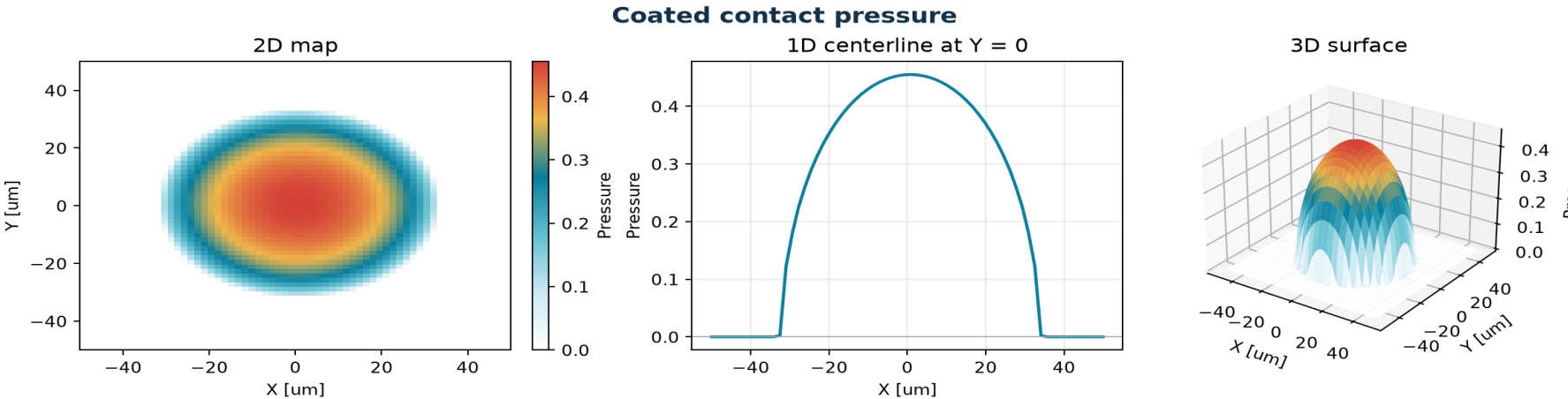
Input or control	Value
Simulation type	Dry Contact
Normal load	1 N
Substrate	Steel; E = 210 GPa, nu = 0.30
Coating body 1	E = 100 GPa, nu = 0.28, thickness = 1 um, 32 depth points
Macrogeometry	Point Contact; radius 5 mm
Domain and grid	100 x 100 um; 64 x 64

Saved input: `coated-contact.tribo.json` | SHA-256: 713750991de17ea79c6f07a7825853142df306e66db85dd70a1d2a92e3831f9f

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Dry Contact.
2	Solid Material Model	Check Add coating to Body 1. Enter coating modulus, Poisson ratio, hardness and 1 um thickness. Leave body 2 uncoated.
3	Contact Conditions	Set Load to 1 N and leave friction disabled.
4	Contact Grid	Set X = 64 and Y = 64.
5	Macro Geometry	Choose Point Contact and enter the 5 mm body-1 radii.
6	Micro Geometry	Leave Micro Geometry clear for this validation case.
7	Run	Run once with the coating enabled. Save the result. For comparison, save a copy of the input, disable the coating and rerun.

Actual result



The layered solution converged in 26 iterations with a 4.53e-7 residual and recovered 1 N. Interpret the 2D footprint together with the centerline: a coating can change both the peak and the width. The 3D plot is especially useful for detecting shoulders or edge amplification that are easy to miss in a single scalar KPI.

Retained result set: coated-contact-results.tribo-results.json | SHA-256: 1b2579c63b9fc994aea7b17457376da8dce3574f391d0351dba3d9c6dc73ea8c

Example 3. Contact temperature

Problem

Sliding converts frictional work into heat over the solved contact patches. The thermal calculation partitions heat between the two bodies and returns their temperature-rise and heat-flux fields.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

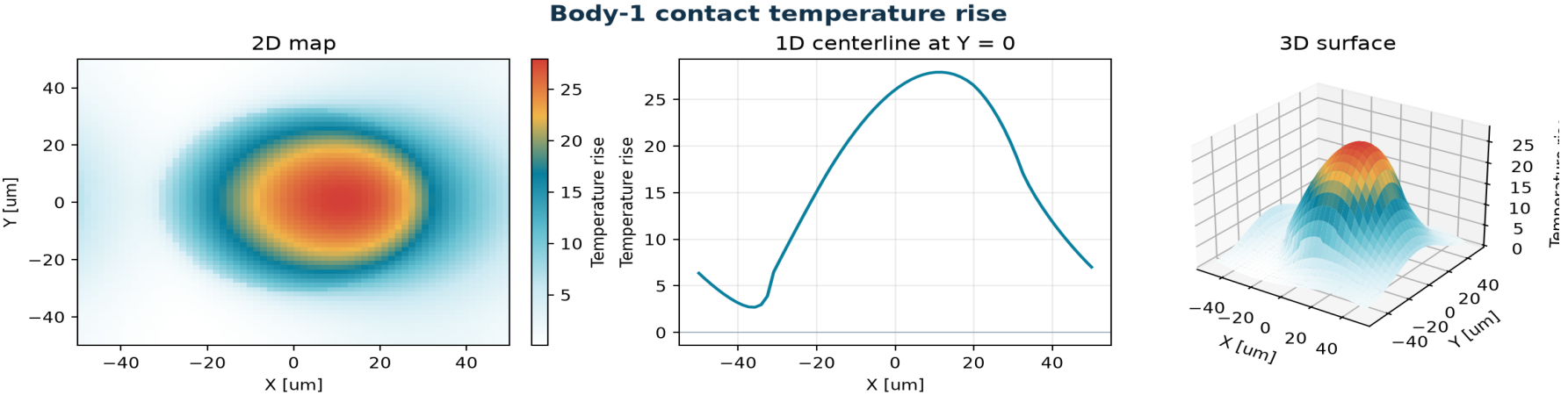
Input or control	Value
Simulation type	Contact Temperature
Normal load	1 N
Friction and speeds	Include Friction; COF 0.10; v1 = 3.26 m/s; v2 = 0
Thermal properties	k = 45 W/(m K), cp = 440 J/(kg K), rho = 7800 kg/m3, both bodies
Macrogeometry	Point Contact; radius 5 mm
Grid	64 x 64

Saved input: `contact-temperature.tribo.json` | SHA-256: 9323d4b87194446b0c6b1cf0118f726d7a3260d7f94f365f99ea320a5da9a849

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Contact Temperature. The Include Friction option is enabled automatically.
2	Solid Material Model	Enter the elastic properties and the thermal conductivity, heat capacity and density for both bodies.
3	Contact Conditions	Set Load = 1 N, COF = 0.10, body-1 speed = 3.26 m/s and body-2 speed = 0.
4	Contact Grid	Set X = 64 and Y = 64.
5	Macro/Micro Geometry	Use the point-contact geometry and leave microgeometry disabled for this validation case.
6	Run	Press Run Calculation. The status first reports the contact stage and then the thermal partition iteration.

Actual result



The partition calculation converged in 44 iterations with a residual of 7.94e-6. The maximum body-1 rise is 27.93 K. The temperature map identifies where frictional heating is concentrated; the centerline shows the temperature gradient along a chosen path, and the 3D view shows the hot-spot prominence and asymmetry.

Retained result set: contact-temperature-results.tribo-results.json | SHA-256: 6da917931ab9624a94c962e88584f202d28f52ba192483eb0dd1f7c16cdc9c0c

Example 4. Subsurface stress: frictionless and frictional

Problem

The same Hertz-type pressure field is used to calculate stresses below body 1 with no tangential traction and with COF = 0.5. Comparing the two cases shows how sliding traction raises the equivalent stress and shifts the critical region toward the surface.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

Input or control	Value
Simulation type	Dry Contact + Calculate subsurface stresses for Body 1
Normal load	1 N
Primary input	COF = 0.50; Include Friction checked
Variant	COF = 0; Include Friction clear
Domain and grid	100 x 100 um; 64 x 64; 33 depth locations to 60 um
Result variable	Von Mises subsurface stresses, Body 1

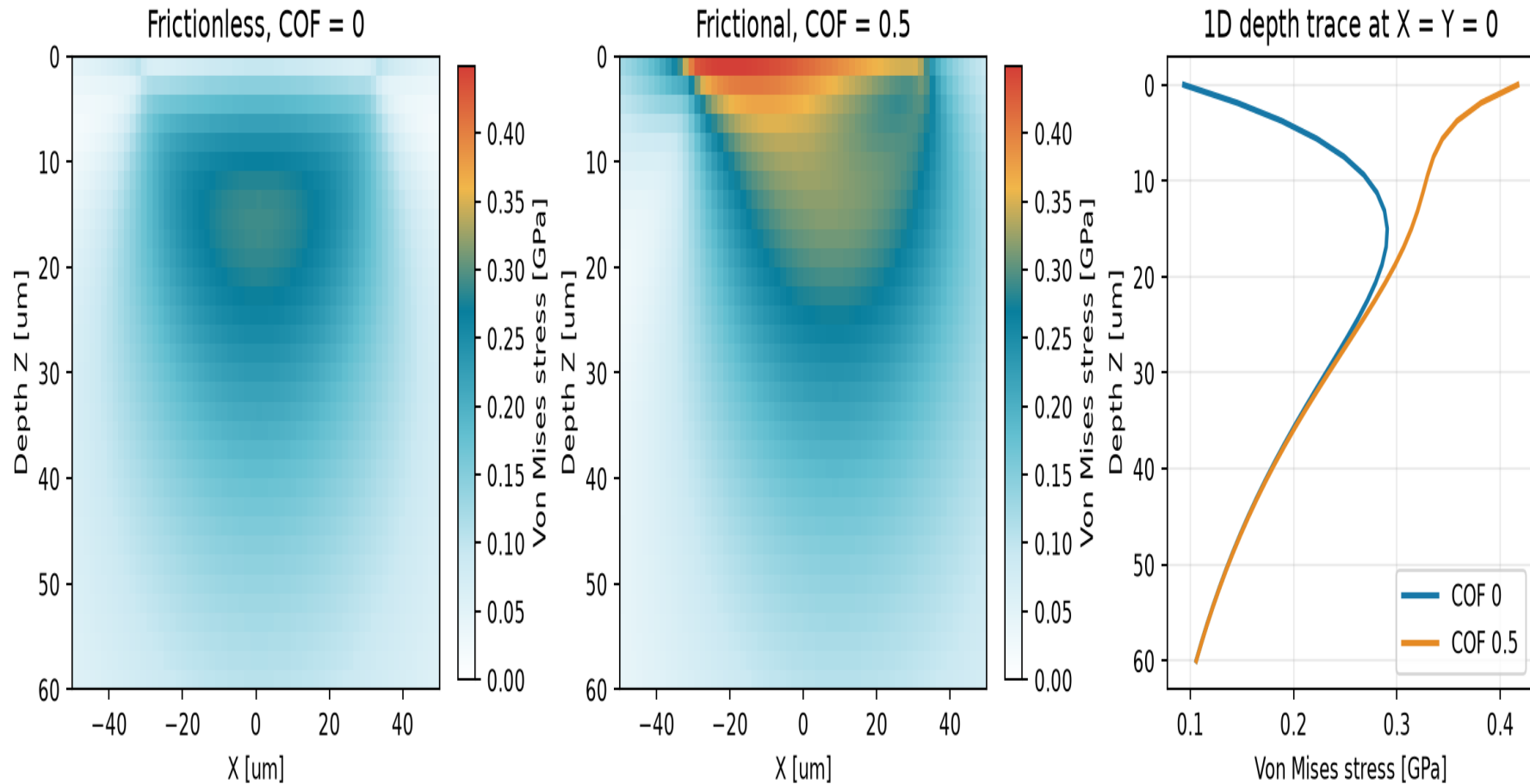
Saved input: `subsurface-stress.tribo.json` | SHA-256: dd9c8347a4f45cdd9cbb1c2eaa3d2bbf3b4147021d197fdaf2ce68927bd15b44

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Dry Contact and check Calculate subsurface stresses for Body 1.
2	Solid Material Model	Use steel for both bodies; no coating in this example.
3	Contact Conditions	For the frictional case check Include Friction and enter 0.50. For the frictionless variant clear it and set COF to 0.
4	Contact Grid	Set X = 64, Y = 64, body-1 depth = 60 um and 32 depth intervals.
5	Macro Geometry	Choose Point Contact with 5 mm radius.
6	Run	Run and save each case separately. Use the supplied variants/01_Frictionless input for the zero-friction calculation.
7	Results	Select Von Mises subsurface stresses, Body 1. Choose the 2D tab, set All X, a fixed center Y and All Z, then press Plot.

Actual result

Subsurface stress comparison from the supplied inputs



The X-Z maps use true physical coordinates without forcing equal screen scale. In the frictionless case the highest von Mises region sits below the surface. With COF = 0.5, tangential traction increases the peak and moves it closer to the surface. A vertical 1D trace answers 'how does stress change with depth at this X/Y?'; the X-Z map answers 'where is the critical subsurface zone?'.

Retained result set: subsurface-stress-results.tribo-results.json | SHA-256: 9c73da28fe18d5cbfc7096b1c46b12815225ff6bcc9897f3b2c248925a3bc6c8

Example 5. Mixed lubrication load sharing

Problem

The external load is shared between lubricant support and direct asperity contact. This example deliberately uses a 50 nm RMS generated rough surface: the roughness is physically significant and its summit statistics are passed to the retained load-sharing model.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

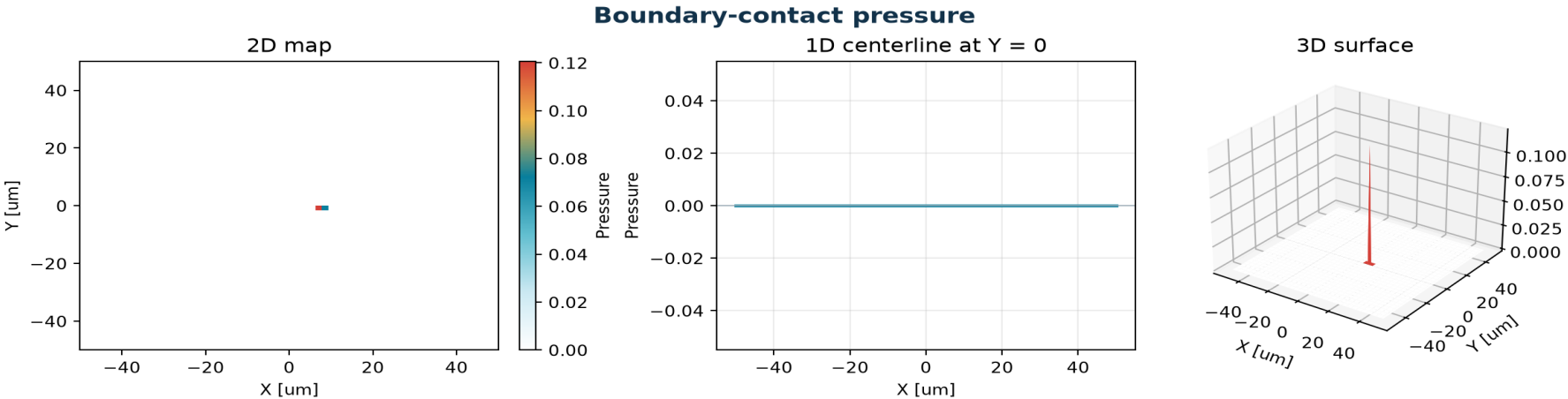
Input or control	Value
Simulation type	Mixed Lubrication
Normal load	5 N
Speeds	v1 = 1 m/s; v2 = 0; entrainment = 1 m/s
Lubricant	Viscosity 0.040 Pa.s; pressure-viscosity 1.25e-8 1/Pa
Domain and grid	200 x 200 um; 64 x 64; periodic
Microgeometry	Generated PSD, Sq = 50 nm; H = 0.8; seed 161803

Saved input: `mixed-lubrication.tribo.json` | SHA-256: ad41b538ecff1132c57ff83e7df5337e963e49b323c354f48a52d17152a3ce1f

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Mixed Lubrication. Flat macrogeometry is disabled.
2	Solid Material Model	Use the supplied steel properties.
3	Lubricant Model	Enter 0.040 Pa.s viscosity and 1.25e-8 1/Pa pressure-viscosity coefficient.
4	Contact Conditions	Set Load = 5 N, speeds 1 and 0 m/s, and Include Friction with COF 0.50.
5	Contact Grid	Set 64 x 64 and periodic boundary conditions.
6	Macro/Micro Geometry	Use Point Contact. Keep Micro Geometry enabled and press Generate to create the supplied 50 nm RMS surface. Confirm the surface preview before running.
7	Run	Run until the load-sharing residual satisfies the outer tolerance.

Actual result



The 50 nm case converged in 33 iterations with a final relative load error of 5.68e-4, below the configured 1e-3 tolerance. The mixed coefficient of friction is 0.02981. The pressure map is the direct asperity-contact contribution, not the complete external load by itself. Interpret it together with Central film thickness, Hydrodynamic load share and Boundary-contact load share. The two load contributions should add to approximately 5 N.

Retained result set: mixed-lubrication-results.tribo-results.json | SHA-256: 8e355e03c3ba7f315d1615378f65e23798d1b089873d8bbefff5e2ba0b3419f

Example 6. Seizure screening

Problem

Contact, mixed-load sharing and temperature are calculated first. The seizure stage classifies cells whose calculated condition exceeds the selected adhesive-transition threshold, producing a risk map rather than a deterministic prediction of failure time.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

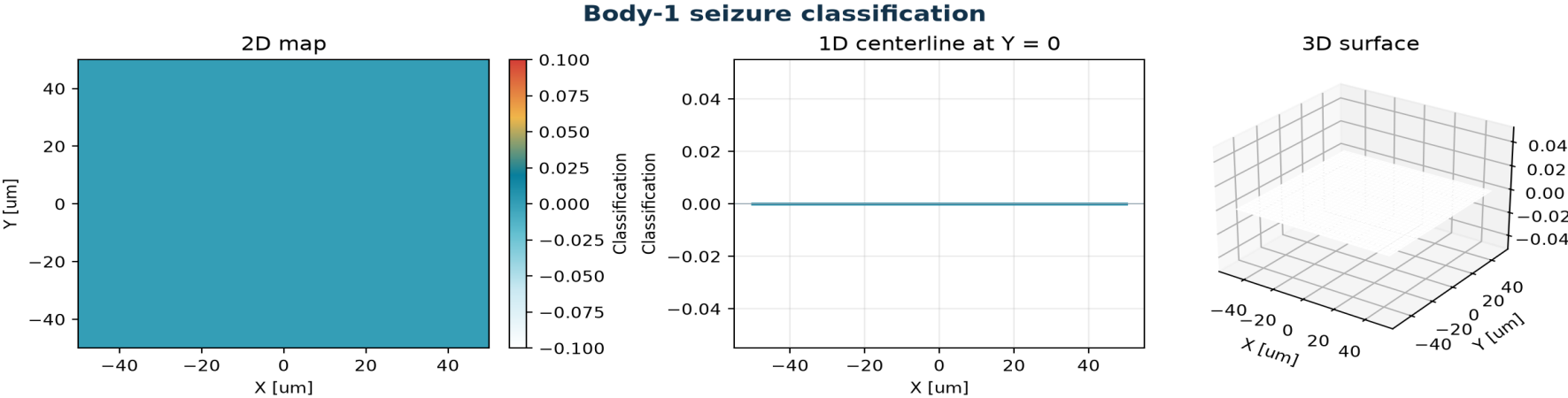
Input or control	Value
Simulation type	Seizure
Normal load	5 N
Friction	COF = 0.50
Speeds	v1 = 1 m/s; v2 = 0
Critical temperature rise	23 K
Limiting shear stress	7 MPa
Grid	64 x 64

Saved input: **seizure.tribo.json** | SHA-256: 6f389261e9a8eaab828e2693c195da3e689c4485a5ac5e60142adce17e8fa141

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Seizure. Point or line contact may be used; Flat is disabled.
2	Solid Material/Lubricant	Confirm mechanical, thermal and lubricant properties for both bodies.
3	Contact Conditions	Set Load = 5 N, COF = 0.50 and speeds 1/0 m/s.
4	Contact Grid and Geometry	Use 64 x 64 Point Contact and the supplied generated 50 nm RMS surface.
5	Seizure	Enter 23 K as the critical transition rise and 7 MPa limiting shear stress.
6	Run	Follow the contact, lubrication, thermal and seizure stages in the status bar.

Actual result



The maximum calculated temperature rise is 4.67 K, below the selected 23 K transition rise, so the classified seizure area is 0%. This is a meaningful safe-side result rather than a missing output. A value of 1 would mark a cell above the criterion; 0 marks a cell below it. Inspect the temperature map and pressure footprint alongside the classification. A threshold map alone does not describe severity or time to failure.

Retained result set: seizure-results.tribo-results.json | SHA-256: af518d861988df555a7f3e840cd8a1aa8d730b1737593a59eb5f7a9c468d4882

Example 7. Rough adhesive contact

Problem

A rough point contact carries compressive elastic pressure while a finite-range surface interaction generates tensile pressure outside or around the hard-wall contact patches. The load-controlled adhesion solver balances both contributions simultaneously.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

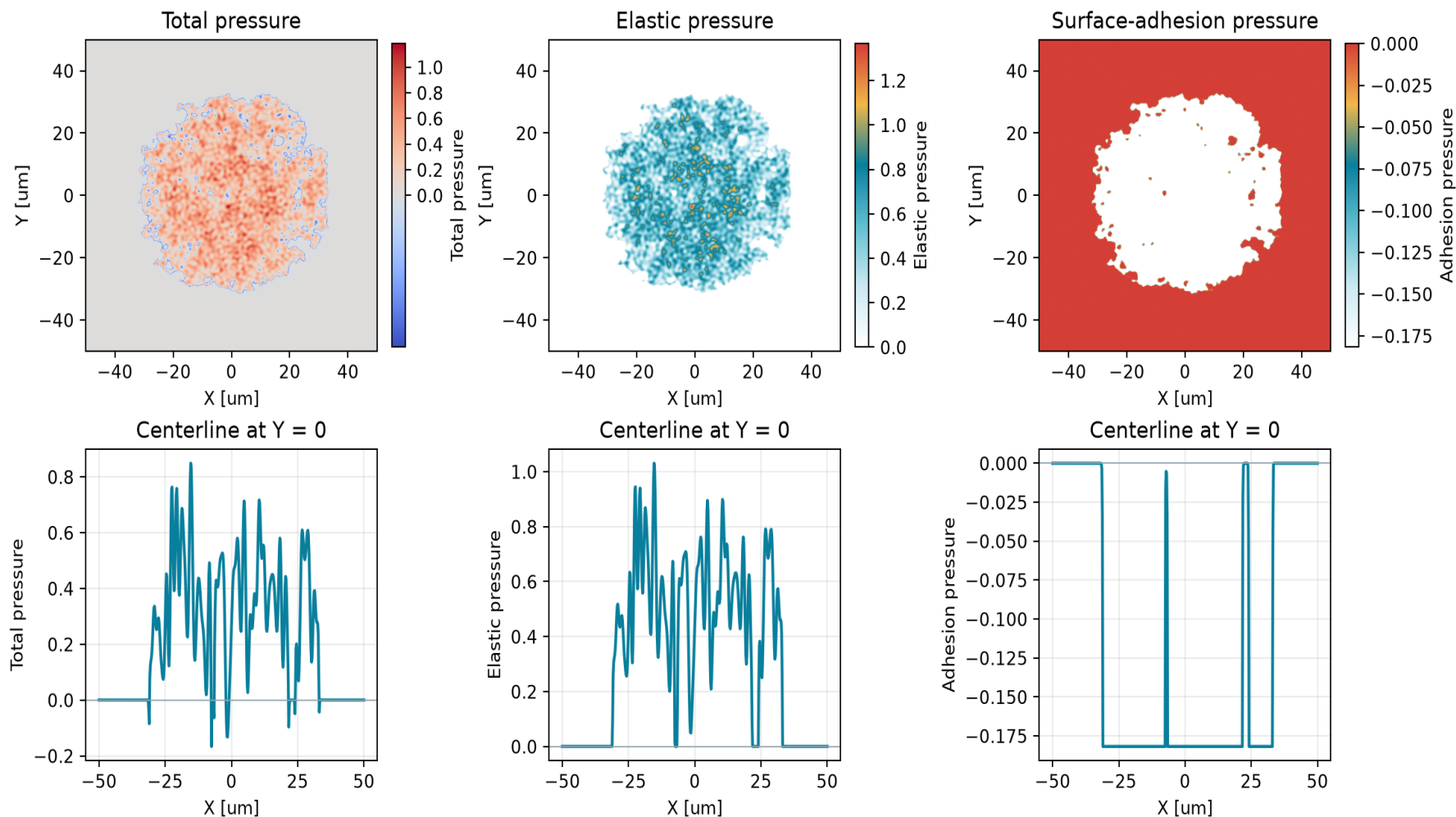
Input or control	Value
Simulation type	Adhesion
Normal load	1 N
Adhesion controls	Adhesion checked; Electroadhesion clear
Work of adhesion	0.05 J/m2
Interaction range	0.275 nm
Surface	512 x 512 generated PSD; Sq 6.3 nm; seed 314159

Saved input: `adhesion.tribo.json` | SHA-256: 31919dc201a9bed3e9dc0c6d0e6b1f963dfdce1afb8198cfd1787ecb09e1ab4

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Adhesion.
2	Solid Material Model	Use steel/steel; coatings are disabled in this example.
3	Contact Conditions	Set the normal load to 1 N.
4	Contact Grid/Macro Geometry	Use 512 x 512 and Point Contact with 5 mm radius.
5	Micro Geometry	Generate the fixed-seed PSD surface and confirm the preview.
6	Adhesion	Check Adhesion only. Enter 0.05 J/m2 and 0.275 nm. Electroadhesion controls and outputs should remain hidden.
7	Run	Watch the iteration and load-error progress. A full-domain diagnostic means the chosen numerical domain is too small unless the finite-domain load balance is accepted.

Actual result



The solver converged in 202 iterations. Elastic repulsion is 1.562 N and surface adhesion is -0.562 N, leaving the prescribed 1 N resultant with a $4.51\text{e-}7$ relative balance error. Negative values are tensile and positive values are compressive, so zero is kept inside a signed color scale rather than being forced to white. The interaction-range warning means integrated force is useful here, but individual tensile spikes are not mesh-converged.

Retained result set: adhesion-results.tribo-results.json | SHA-256: aefbd45818916b03187cffa6f29afd65b4e3f5f5bde91dcba4dcfdb50ee0959

Example 8. Electroadhesion

Problem

Voltage across two dielectric layers produces attraction in the non-contact gap. The example follows the Peng gap-only interpretation: mechanical-contact cells are excluded from electrical traction, so the active-gap mask is an essential diagnostic.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

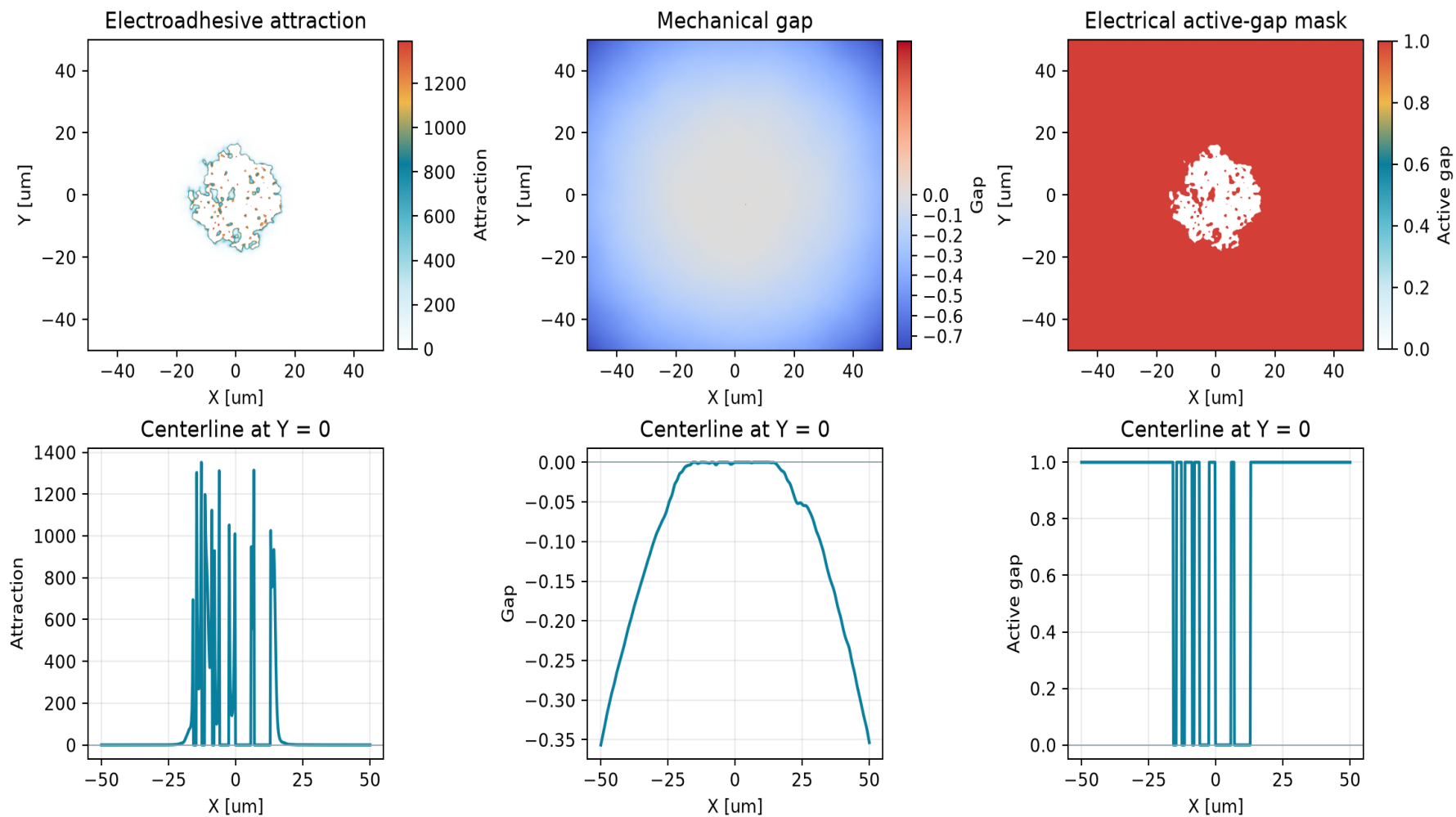
Input or control	Value
Simulation type	Adhesion
External load	40 mN
Adhesion controls	Electroadhesion checked; Adhesion clear
Voltage	20 V DC
Dielectrics	2.2 nm each; relative permittivity 3.9 each; gap 1.0
Geometry/grid	3 mm ball; 512 x 512 generated PSD

Saved input: `electroadhesion.tribo.json` | SHA-256: a5e6dde64dc7aa038f69904420ce9c42fe73f6c29b79d6c51b26c07ee5046fde

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Adhesion.
2	Contact Conditions	Set external load to 0.04 N and Include Friction with intrinsic COF 0.20.
3	Contact Grid/Macro Geometry	Use 512 x 512 Point Contact and a 3 mm ball radius.
4	Micro Geometry	Generate the supplied fixed-seed surface.
5	Adhesion	Clear Adhesion and check Electroadhesion. Enter dielectric thicknesses, permittivities, gap permittivity and 20 V.
6	Run	Run and verify that no surface-adhesion variables are listed. Only electroadhesion and regular contact outputs should be present.

Actual result



The two-step coupled calculation gives 0.1504 N electroadhesion force and an apparent COF of 0.7893 for the selected intrinsic COF. The attraction map must be read with the gap and active-gap mask: contact cells are intentionally excluded, whereas positive-gap cells may carry electrical attraction. At 0 V the attraction should collapse to zero.

Retained result set: electroadhesion-results.tribo-results.json | SHA-256: c032af562cb8bc4da4137b836753472ffd518026bd6cf39348dd999ba079f8be

Example 9. Iterative Archard wear

Problem

The contact state is solved, wear depth is accumulated for each body, the surfaces are updated and the cycle repeats. The example demonstrates how to compare the initial and final contact states and how to read accumulated wear volume histories.

Model

Use the model description and assumptions in the TriboSolver Manual. The input below is the retained validation/training case; do not substitute values until the baseline run completes.

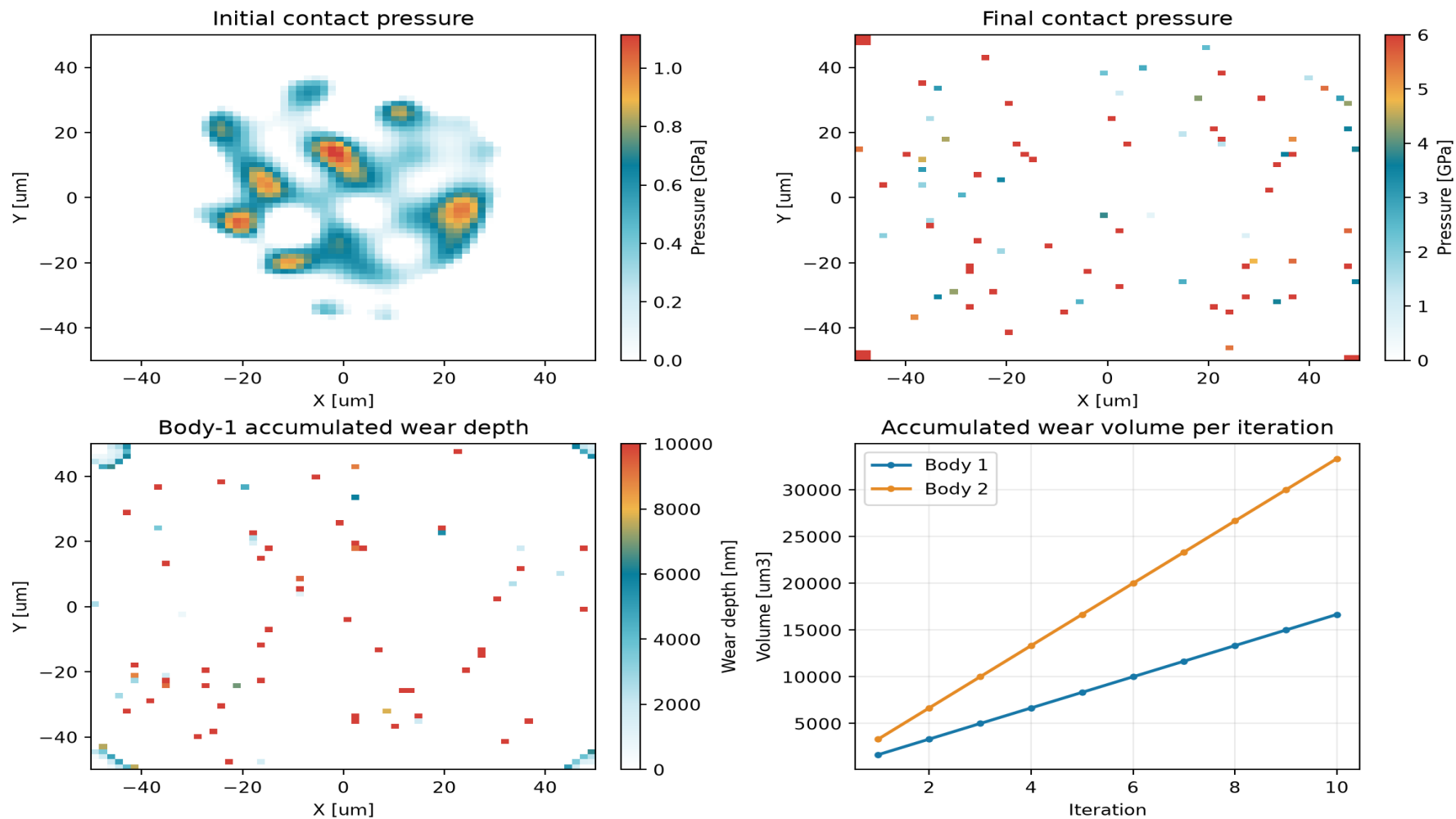
Input or control	Value
Simulation type	Wear
Normal load	1 N
Friction	COF = 0.15
Iterations	10
Wear coefficients	Body 1: 1e-4; Body 2: 2e-4
Time step	0.1 s per body
Surface motion	Surface 2, single pixel
Surface/grid	Sq 20 nm, seed 271828; 64 x 64

Saved input: **wear.tribo.json** | SHA-256: c7c565d449877468ef5a0346439e1ad40fc3d07fcad1ecba45bcf246f6578ee7

Tab-by-tab procedure

Step	Tab	What to do
1	Simulation Type	Choose Wear.
2	Solid Material Model	Enter elastic properties and body-specific hardness.
3	Contact Conditions	Set Load = 1 N and Include Friction with COF 0.15.
4	Contact Grid/Macro Geometry	Use 64 x 64 Point Contact.
5	Micro Geometry	Generate the supplied 20 nm RMS surface.
6	Wear	Set 10 iterations, the two wear coefficients, 0.1 s time steps and Surface 2, single pixel motion.
7	Run	Watch completed and remaining iterations in the progress status. Do not close the application until Results appears.

Actual result



The calculation completed all 10 iterations and reached a maximum wear depth of 10,000 nm. Compare Initial contact pressure with final Contact pressure to see redistribution, and Initial surfaces with final Surface 1/2 to see material removal. Accumulated wear volume per iteration is the most direct history for comparing the two bodies; its slope indicates how quickly the wear rate is changing.

Retained result set: wear-results.tribo-results.json | SHA-256: 04b144bd98838ad86d05f1372dc018ebedcd246ad8e62c0c17e4be2b8c5569ce

Reproduction record

These are fresh runs of the supplied inputs using the current TriboSolver 3.0 executable. PASS means the workflow completed and a complete result set was saved. Numerical acceptance against analytical, literature and TriboSolver reference data remains governed by the standard verification report.

Example	Status	Result summary
01 Rough Point Contact	PASS	iterations 37 residual 9.9442e-07 recovered load 1 N
02 Coated Contact	PASS	iterations 26 residual 4.52995e-07 recovered load 1 N
03 Contact Temperature	PASS	coupled dry-contact pressure partition iterations 44 residual 7.94449e-06 maximum rise 27.9272 K
04 Subsurface Stress	PASS	depth 5.625 um solved grid 64 x 64 x 33
05 Mixed Lubrication	PASS	iterations 33 load error 0.000567699 coefficient of friction 0.0298085 BEM grid 64 x 64
06 Seizure	PASS	critical rise 23 K adhesive area 0 %
07 Adhesion	PASS	iterations 202 elastic force 1.56182 N adhesion force -0.561823 N load error 4.51146e-07 interaction range 0.001408 grid cells WARNING: adhesive te
08 Electroadhesion	PASS	coupled iterations 2 electroadhesion force 0.150433 N apparent COF 0.789306
09 Wear	PASS	iterations 10 maximum depth 10000 nm
Subsurface Stress - frictionless	PASS	depth 5.625 um solved grid 64 x 64 x 33

Practical interpretation checklist

1. Check the solver status before interpreting any map.
2. Confirm recovered load or force balance and note the iteration count.
3. Read the colorbar and units; do not compare colors from plots with different scales.
4. Use a 1D cross-section to quantify peaks and widths seen in a 2D map.
5. Use the 3D view to understand shape and orientation, not as a substitute for numerical values.
6. For signed adhesion pressure, negative means tensile attraction and positive means compressive contact.
7. For subsurface results, report the selected body, tensor quantity, slice direction and physical depth.
8. For iterative wear, compare initial and final fields and plot accumulated volume against iteration.