Comparative Livestock Aerodynamics

Model Explorer 0.2.10 • User manual

Chapter 12 companion software for macOS — compiled edition (Intel)
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Use Model Explorer to examine eleven scaled livestock models, compare the area they present to the wind, and explore how assumed drag coefficients, wind speed and animal motion affect calculated force. It is a geometric exploration tool, not a wind-tunnel test or a computational fluid dynamics program.

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1. Install and start — macOS

Download the macOS Intel compiled edition ZIP from the book website. Double-click the ZIP in Finder to extract CLA Model Explorer.app.

Drag CLA Model Explorer.app into Applications. The application contains its own runtime, libraries, animal models and PDF manual. Keep the application bundle intact.

Open Applications in Finder and double-click CLA Model Explorer. No Terminal commands or package installation are required.

The application is built with Python 3.13.17. All required libraries are included. No separate Python installation, pip commands, virtual environment or internet connection is needed to run the program.

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2. Starting the program and shared controls

Start and close Model Explorer

For later sessions, open Applications and double-click CLA Model Explorer. You can also drag its icon to the Dock for convenient access.

The first animal view may initially appear as a silhouette while the textured view is prepared. All calculations and charts use the included model data; no cloud service is required.

To read this guide, click User Manual beside the version number. The local PDF opens in your default PDF viewer. The Help button provides a shorter reference.

Close Model Explorer using the window close button. Export any results or captured conditions you want to keep before closing.

Updating and keeping your files

Close the program before replacing the application with a newer release. Keep your exported JSON, CSV and PNG files in a separate writable folder, such as Documents, rather than inside the application bundle.

Controls available throughout the application

Control	What it does
Appearance	System, Light or Dark. System follows the detected system appearance at startup or when selected.
Text	Select 10, 11, 12, 14 or 16 for interface text size.
Units	Both, Metric or US customary. Explore results change; inputs and Compare/Graphs retain their labeled units.
Export result	Save the current Explore calculation as a JSON record.
Help / User Manual	Help opens a short reference; User Manual, beside the version number, opens this bundled PDF offline.
Reset	Restore wind, scale, density, coefficient and view defaults; clear per-animal overrides. Captures are not cleared.
Book website	Open the book website in the default browser.

Appearance, text size, units and window geometry are saved on normal exit. Experiments, overrides and captured conditions are session data; export results before closing.

Keyboard: F11 toggles the full-screen viewer; Esc exits it. Command+S exports the Explore result; Command+R resets the settings.

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3. Explore animal — wind and scale

Select Explore animal. The left panel contains inputs and calculated results; the right panel shows the model. The application starts with a Holstein cow at 15 mph, 90° broadside, scale 1.00, air density 1.225 kg/m³ and hypothetical Cd 0.80.

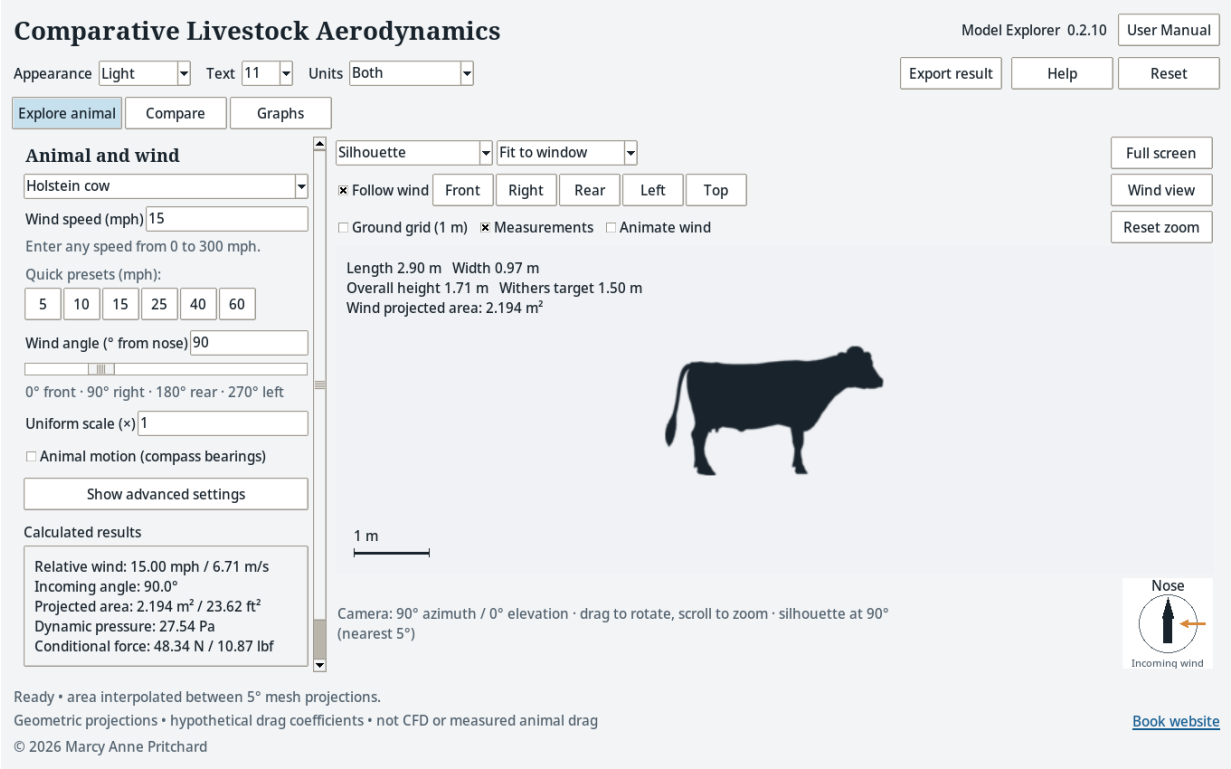


Figure 1. Explore animal in v0.2.10 (desktop test environment; macOS window decorations may differ).

Set up the animal and wind

Animal and wind. Choose one of the eleven models from the dropdown. Every model has a fixed standing or mild-stride pose. No walking animation changes the body shape.

Wind speed (mph). Type any value from 0 to 300, including decimals. Quick presets (5, 10, 15, 25, 40, 60) are shortcuts, not limits. Results update automatically after a valid entry.

Wind angle (° from nose). Type 0–360 or move the slider in 5° steps. 0° = front; 90° = animal's right; 180° = rear; 270° = animal's left; 360° = front again. The direction is where wind comes from, not where it is going.

Uniform scale (×). Enter 0.25–2.00. At 1.00 the supplied model is unchanged. Scale 1.10 makes every length 10% larger and area 21% larger. It does not change body proportions or estimate weight.

If an entry is invalid, the footer identifies the problem and the result panel becomes unavailable until the value is corrected. Use the left scrollbar if a control is below the visible area.

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4. Explore — viewer and advanced settings

Display and camera

Control	How to use it
Silhouette / Textured model / Shaded model / Wireframe	Choose an outline, coat-colored model, untextured shaded surface or visible mesh edges. All four use the same geometry for calculations.
Fit to window / Fixed scale	Fit adjusts framing to the model. Fixed scale uses a 5 m vertical span at default zoom; use Reset zoom for like-for-like visual comparisons.
Follow wind / Wind view	Follow wind aligns the camera with incoming relative wind. Wind view (or double-click in the viewer) restores this link.
Front / Right / Rear / Left / Top	Inspect from a preset direction. Clicking a preset or dragging the animal disconnects Follow wind; wind calculations are unchanged.
Drag / scroll / Reset zoom	Drag to orbit; scroll to zoom. Reset zoom returns to the normal camera magnification.
Ground grid (1 m) / Measurements	Show a grid; show length, width, overall height, withers target, wind projected area and a scale ruler.
Animate wind / Full screen	Animate the wind compass (not flow around the body). Full screen enlarges the viewer and hides left controls; Esc restores them.

The withers target is a scaling reference, not a freshly measured landmark. The Belgian target is historical. A cached silhouette may appear while a detailed view is prepared. The numerical result remains current even if a preview is shown.

Animal motion (compass bearings)

Check Animal motion and enter Animal speed (0–100 mph), Animal heading and Wind FROM (0–360° each). Bearings are clockwise from north: 0° N, 90° E, 180° S, 270° W. The animal travels toward its heading; the wind comes from its bearing. The normal wind-angle entry is not used in this calculation. The program combines the two velocities and reports the relative speed and incoming angle from the nose. Uncheck motion to return to the ordinary wind-angle setting.

Show advanced settings

Air density (kg/m³): 0.5–2.0; Hypothetical Cd: 0.01–3.00. Check Coefficient sensitivity to enable Low Cd and High Cd (same allowed range); require low ≤ assumed Cd ≤ high. The default 0.60–1.00 range is illustrative, not measured. Hide advanced settings collapses the panel without changing assumptions.

Calculated results show relative wind, incoming angle, projected area, dynamic pressure and conditional force, plus a force range when sensitivity is enabled. At zero relative wind, force is zero and incoming angle and projected area are undefined.

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5. Compare — animals and captured conditions

Select Compare. All animals displays all eleven models using the current Explore wind, density, scale and coefficient settings, subject to any overrides. Captured conditions displays previously recorded experiments.

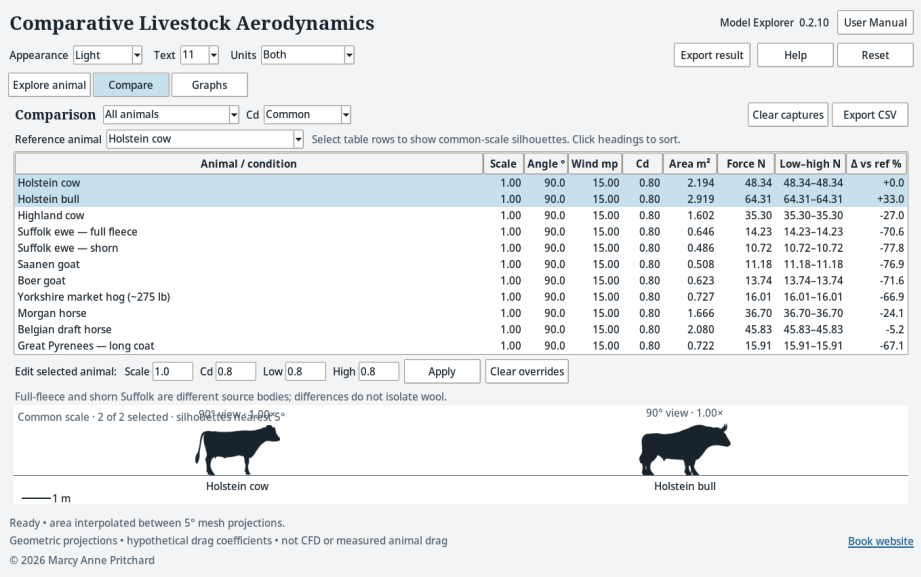


Figure 2. Compare table and common-scale silhouettes in v0.2.10.

Compare models under the same conditions

1. Set the desired conditions in Explore, then open Compare and select All animals. Choose Common in the Cd dropdown to use the same coefficient for every model.

2. Click a row to select it; use Shift to select a range or Ctrl/Command-click for separate rows. Up to four selected rows are drawn at a common physical scale. Click a column heading to sort; click again to reverse. Choose a Reference animal to display percentage force differences (Δ vs ref %).

3. To give selected animals different sizes or coefficients, enter Scale, Cd, Low and High under Edit selected animal, then click Apply. All selected rows receive these values. Scale overrides apply in both Cd modes. Choose Individual to use individual Cd overrides; enable Coefficient sensitivity in Explore to use individual ranges. Clear overrides returns all animals to the Explore assumptions.

The table shows scale, incoming angle, relative wind, assumed Cd, area (m^2), conditional force (N), low–high force (N) and percentage difference. A zero or missing reference yields a dash. Silhouettes use the nearest 5° angle; numeric areas are interpolated.

Compare captured conditions

In Explore, click Capture comparison condition to open Compare in Captured conditions. Change inputs in Explore and capture again. Each numbered record keeps its original assumptions. To revise one, capture a new condition. Clear captures removes all records. Export CSV saves every row of the active table, not just selected rows.

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6. Graphs — seven chart types

Select Graphs, choose a graph from the dropdown and select one or more animals in the list (Shift for a range, Ctrl/Command for separate selections). If no animals are selected, the current Explore animal is used. Captured conditions uses the saved captures instead of the animal selection.

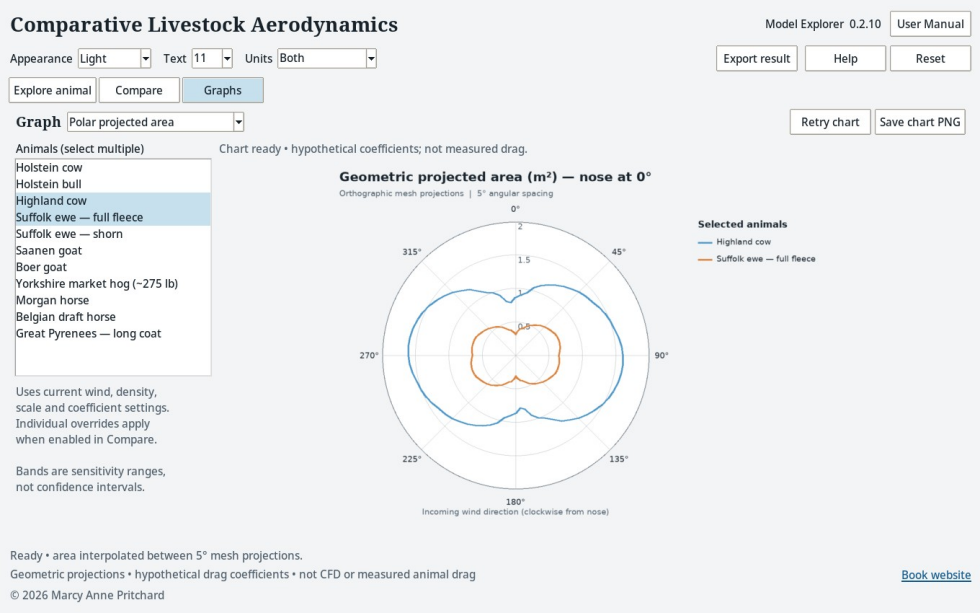


Figure 3. Polar projected area for the Highland cow and full-fleece Suffolk ewe, drawn from the supplied model data.

Graph	What to read
Force vs wind speed	Relative wind (mph) versus conditional force (N). Other inputs stay fixed; range starts at 0 and reaches at least 60 mph.
Area vs wind direction	Incoming angle 0–360° versus geometric area (m^2) at the current scale.
Polar projected area	Same area data around a circle. Radius = m^2, not force; 0° is the nose, clockwise to the right.
Force vs scale	Uniform scale 0.25–2.00 versus force (N); fixed speed, angle, density and Cd.
Force vs Cd	Hypothetical Cd 0.01–3.00 versus force (N); other inputs fixed.
Compare forces	Bars for selected animals at the current relative wind and assumptions.
Captured conditions	Bars for all captures, with code and condition number. Capture in Explore first.

Current Explore settings and Compare overrides feed the graphs. Scale overrides apply in both Cd modes; individual Cd overrides apply when Individual is selected. Sensitivity shading appears on force-versus-speed and force-versus-scale graphs; comparison bars show ranges when sensitivity is on. Captured bars retain the captured ranges. Area and Cd-sweep plots do not show sensitivity bands. Retry chart regenerates a chart; Save chart PNG exports the full chart image.

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7. Worked examples and exports

Example A — doubling wind speed

Clear any prior captures in Compare, then click Reset and choose Holstein cow in Explore, and confirm Animal motion is off. Set Wind speed to 15 mph and Wind angle to 90°. Keep scale 1.00, density 1.225 and Cd 0.80. The area is 2.194 m^2 and the conditional force is about 48.34 N. Click Capture comparison condition.

Return to Explore, enter 30 mph and capture again. The area stays the same and the force rises to about 193.37 N: four times the original value. In Compare, choose Captured conditions to see both results, or choose Captured conditions in Graphs to see the two bars.

Example B — a cow walking across a west wind

Reset and select Holstein cow. Set Wind speed to 15 mph. Enable Animal motion and set Animal speed = 3 mph, Animal heading = 0° (north), Wind FROM = 270° (west). The calculated relative wind is 15.30 mph, approaching at approximately 281.3° from the nose, or 11.3° toward the front from the animal's left broadside. At default density, scale and Cd, the conditional force is about 51.01 N. Wind view shows the incoming direction; pressing Front only changes the inspection view.

Example C — test the coefficient assumption

Reset, set 15 mph and 90°, then select Compare, All animals and Common. With Cd = 0.80, the Holstein cow produces about 48.34 N and the Belgian draft horse about 45.83 N. In Compare choose Individual, select the Belgian, and set Scale = 1.00, Cd = 1.00, Low = 0.60, High = 1.00. Click Apply. The Belgian now calculates about 57.28 N, exceeding the cow. Enable Coefficient sensitivity in Explore and return to Compare to examine the ranges. This demonstrates that a ranking can change with an assumed coefficient; it is not a measured breed ranking.

Save your work

Where	What is saved
Top bar: Export result	JSON: current Explore animal, geometry identifier, conditions, area, forces, dimensions and method. Does not include Compare overrides.
Compare: Export CSV	CSV: all rows of the active comparison mode, with assumptions and results. Open in a spreadsheet.
Graphs: Save chart PNG	PNG: full 1280 × 880 chart, including axes and selected model labels or codes.

Choose a destination and filename in the save dialog. Export before closing: v0.2.10 does not reopen JSON scenarios or persist captured conditions. Save a CSV for captured assumptions as well as a PNG if you need to reproduce a chart later.

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8. Troubleshooting and interpretation

If something does not work

Symptom	What to try
Program does not open	Confirm that you downloaded the Intel macOS edition and extracted the complete application. Open it from Applications. If macOS rejects it, download a fresh copy from the book website; contact support if the problem persists.
Runtime or library error	Do not modify the application bundle or install packages into it. Replace it with a fresh copy from the complete download if files are missing.
Detailed animal view is slow	The first textured or wireframe render can take several seconds. Switch to Silhouette for immediate horizontal views. If a render fails, change the view to retry; the calculations remain usable.
Graph missing or error shown	Verify Explore inputs are valid; select a graph and animals. Click Retry chart. For Captured conditions, capture an experiment in Explore first. Use v0.2.10, which draws charts without Matplotlib.
Controls cut off	Enlarge the window, reduce Text size, or use the Explore scrollbar. Press Esc to exit full screen.
Need help	Use Help or Book website. If reporting a problem, include software version, macOS version, steps, screenshot and any relevant error. A local performance.log may be in ~/.livestock_aerodynamics/.

How to interpret the numbers

Conditional force = ½ × air density × relative speed² × Cd × projected area. The speed in this equation is in metres per second. Dynamic pressure is ½ × density × speed², in pascals. Uniform scaling multiplies projected area by scale². Model geometry is projected orthographically at 5° increments and interpolated between them.

Opposite directions share geometric projected area; real headwind and tailwind drag need not be equal. Cd is hypothetical. Sensitivity ranges are not confidence intervals or measured breed ranges. The software does not simulate flow, wakes, turbulence, coat permeability, animal movement of limbs or actual wind-tunnel drag.

The Highland model does not reproduce shaggy hair in detail. Great Pyrenees and Saanen fur-card triangles are treated as opaque for area even when the texture is transparent. Full-fleece and shorn Suffolk are different source bodies; differences cannot isolate wool. The replacement Belgian and Saanen differ from earlier book model versions. Consult the included model register and README for model provenance and limitations.

Further information

Book website: https://greybarnfarm.com/publishing/aerodynamics/index.html

See Chapter 12 and the appendices for the calculation method. The model register and calculation data included with the software document the supplied models.

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