Carbos Research: Capability, Deliverables, and Expected Funding

Lal (Carbon Modeling)

February 2, 2026

Summary

I provide computational modeling and analysis for subsurface CO2 storage and carbon management using PFLOTRAN-based workflows. I deliver reproducible simulation packages, operational scenarios with constraints, and decision-ready outputs that directly support engineering decisions, project planning, and technical review.

Capabilities

Multiphase CO2 Flow (CO2–Water / SCO2)

I can model CO2 injection and long-term evolution with the physics needed for storage decisions.

What I can do

- Injection scenarios with pressure buildup and plume migration
- Buoyancy-driven flow and containment behavior
- Salinity and thermal variants where they materially affect results

Wells and Operations

I can represent coupled wells and operational controls and evaluate performance under real constraints.

What I can do

- Well injection/production scheduling (including WAG and brine extraction strategies)
- Constraint evaluation (fracture pressure limits, minimum pressure, BHP limits)
- Well performance summaries and field-level KPIs

Reactive Transport and Mineralization

When permanence claims and geochemistry matter, I can include reactive transport to quantify mineralization potential and time scales.

What I can do

- Couple flow, transport, and geochemistry for CO2 partitioning
- Track CO2 into mobile/free-phase, dissolved, and mineralized fractions
- Produce mass-balance-based KPIs with clearly stated assumptions and limits

Post-Processing, KPIs, and Reporting

I can turn raw model output into decision-ready plots and tables with consistent formatting.

What I can do

- Automated plots for pressure, plume footprint proxies, and well behavior
- CO2 mass partitioning summaries through time
- Clear, reviewable documentation and run logs

Reproducibility and QA/QC

I build deliverables that are designed to be rerun, audited, and extended.

What I can do

- Provide a reproducible run package (inputs, run instructions, and standard plots)
- Apply QA/QC checks (mass balance, timestep stability, sanity checks)
- Maintain versioning and change tracking for iterative projects

Deliverables

Deliverables scale with data availability and project goals. I can start small for fast insight and expand to site-scale and permanence analyses.

Deliverable Set A — Rapid Screening (2–4 Weeks)

Deliverables

- Screening models sized to the available information (injectivity, pressure buildup, and first-order plume behavior)
- Sensitivity results for the parameters that drive the answer (e.g., permeability, relative permeability, salinity/temperature assumptions)
- A concise PDF report summarizing assumptions, results, and recommended next steps

Deliverable Set B — Site Concept Model (6–12 Weeks)

Deliverables

- Site-scale model setup (initialization, boundary conditions, stratigraphy/heterogeneity representation)
- One or more well configurations and schedules with constraint checks
- Decision outputs: pressure envelopes, plume evolution, and trapping diagnostics
- Reproducible model package with run instructions and standardized plots

Deliverable Set C — Mineralization and Permanence Analysis (6–12 Weeks)

Deliverables

- Chemistry configuration (species/minerals/reaction rates and database selection)
- CO2 partitioning vs time (mobile gas vs dissolved vs mineralized)
- Permanence KPIs suitable for technical narratives, with explicit assumptions and limitations

Deliverable Set D — MRV-Ready Model Package (Ongoing)

Deliverables

- Standard QA/QC checklist and run log per update
- Versioned scenario library and consistent reporting format
- Monitoring implications when desired (measurements that most constrain plume/pressure)

Inputs Needed

Minimum Inputs (for Rapid Screening)

- Basic geology/stratigraphy (layer depths/thicknesses)
- Representative porosity/permeability ranges and boundary condition assumptions
- Temperature gradient, salinity (or brine composition when available), and initial pressures
- Target injection rates/masses, well geometry/perforations, and operational constraints (fracture gradient/pressure limits)

Additional Inputs (for Site-Scale and Calibration)

- Property grids or geologic framework model (if available)
- Monitoring data (pressure/flow/chemistry) when calibration or history matching is in scope
- Any internal or regulatory reporting requirements that the deliverable must satisfy

Expected Funding (Typical Ranges)

Final budgets depend on scope, data quality, and required uncertainty analysis. Typical research/industry-funded ranges are:

- **Small / pilot (screening):** USD **$25k–$75k**
  - Rapid feasibility: injectivity/pressure/plume first-pass and short report.
- **Medium (site concept model):** USD **$75k–$250k**
  - Client-specific model build, multiple scenarios, documented workflows, decision plots.
- **Large (site + optimization + mineralization + uncertainty):** USD **$250k–$750k+**
  - Multi-scenario operations evaluation, reactive transport/permanence analysis, uncertainty quantification, and MRV-ready packaging.

If you prefer grant-style budgeting, I can also express the plan as work packages (WP1–WP4) with milestones and a not-to-exceed cap.

Timeline and Milestones

Weeks 1–2

- Data intake and assumptions register
- Baseline model setup and verification checks

Weeks 3–4

- Screening scenarios and sensitivities
- First decision-ready report

Weeks 5–8

- Site model expansion, well schedules, and constraint evaluation
- Decision outputs and reproducible package refinement

Weeks 9–12 (When Mineralization Is In Scope)

- Reactive transport/mineralization coupling
- Permanence KPIs and uncertainty bounds focused on kinetics assumptions

Why This Is Valuable

This work converts site data and operational goals into testable scenarios with traceable assumptions, quantitative KPIs, and repeatable simulation packages—making it easier to de-risk operations and communicate results to both technical stakeholders and decision makers.