“Carbonsheds” as a Framework for Optimizing US CCS Pipeline Transport on a Regional to National Scale

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Developing the Technologies and Building the Infrastructure for CO_2 Storage

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Presentation Outline

- Benefit to the Carbon Storage Program
- Project Goals & Objectives
- Technical Status
- Accomplishments to Date
- Summary

Benefit to the Program

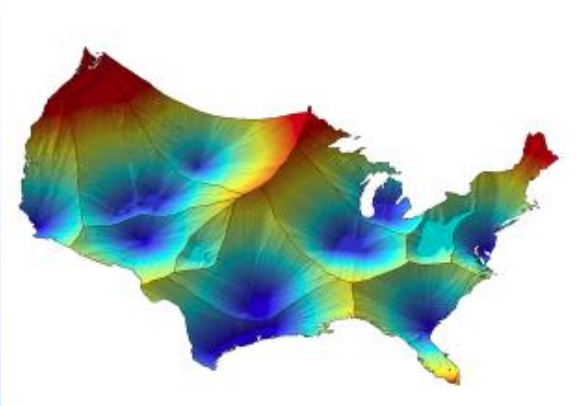
- Conduct field tests through 2030 to support the development of BPMs for site selection, characterization, site operations, and closure practices.

- This research project is developing a modeling framework for optimizing CO2 transport and storage on an integrated technical, economic, societal and environmental basis that will support *BPMs for site selection, characterization and site operations*.

Project Overview:
Goals and Objectives

Carbonsheds:

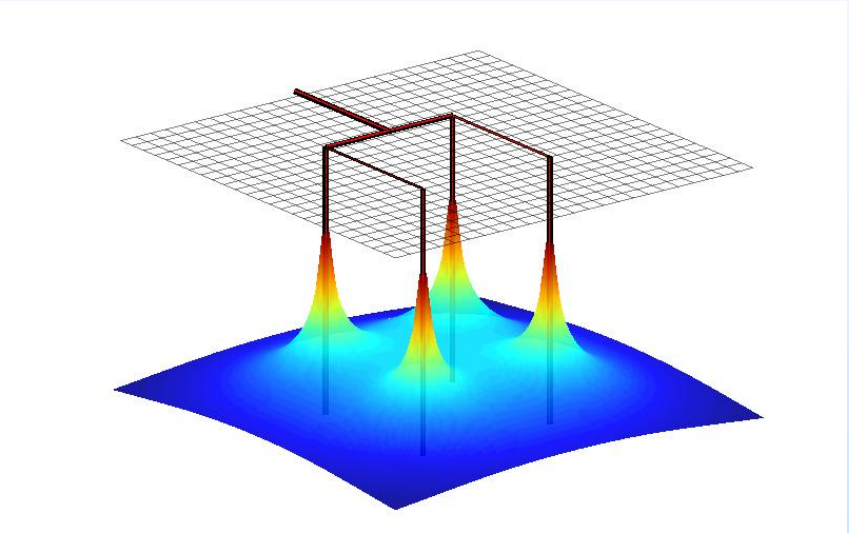
Regions analogous to watersheds in which the estimated cost of transporting CO2 from any (plant) location in the region to the storage site it encompasses is cheaper than piping the CO2 to a storage site outside the region.



- **Project Goal:** Make CO2 transport and storage problem more tractable by using carbonsheds (analogous to watershed) to optimize infrastructure deployment:
- **Objectives:**
  - Include in analysis all major types of potential CO2 storage sites; saline aquifers, and oil and gas reservoirs.
  - Examine the potential offshore extension of US carbonsheds were sub-seafloor CO2 storage permitted.
  - Explore the impacts of different economic/policy scenarios (e.g., the Waxman-Markey Climate Bill) on the future demand for CO2 transport with in different carbonsheds using agent-based socio-economic modeling.
- **Success Criteria:** Peer-reviewed publications.

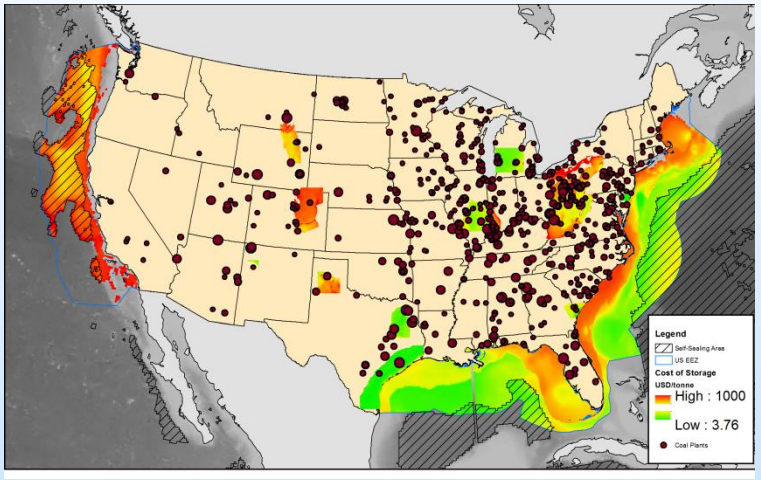
Technical Status

- Model Development
  - Built physical and economic model for CO2 storage cost and capacity
  - Established basic site characterization model



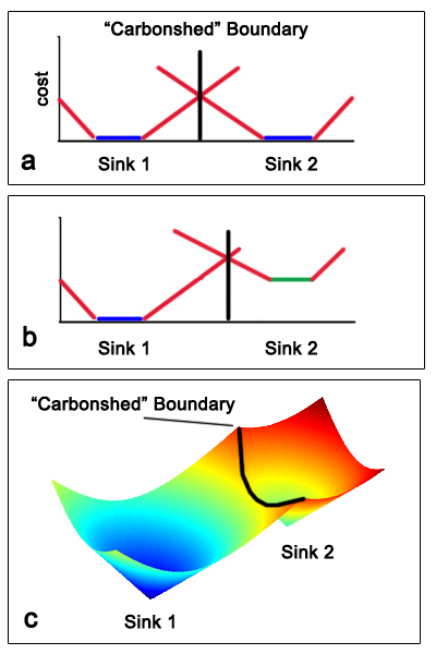
Technical Status

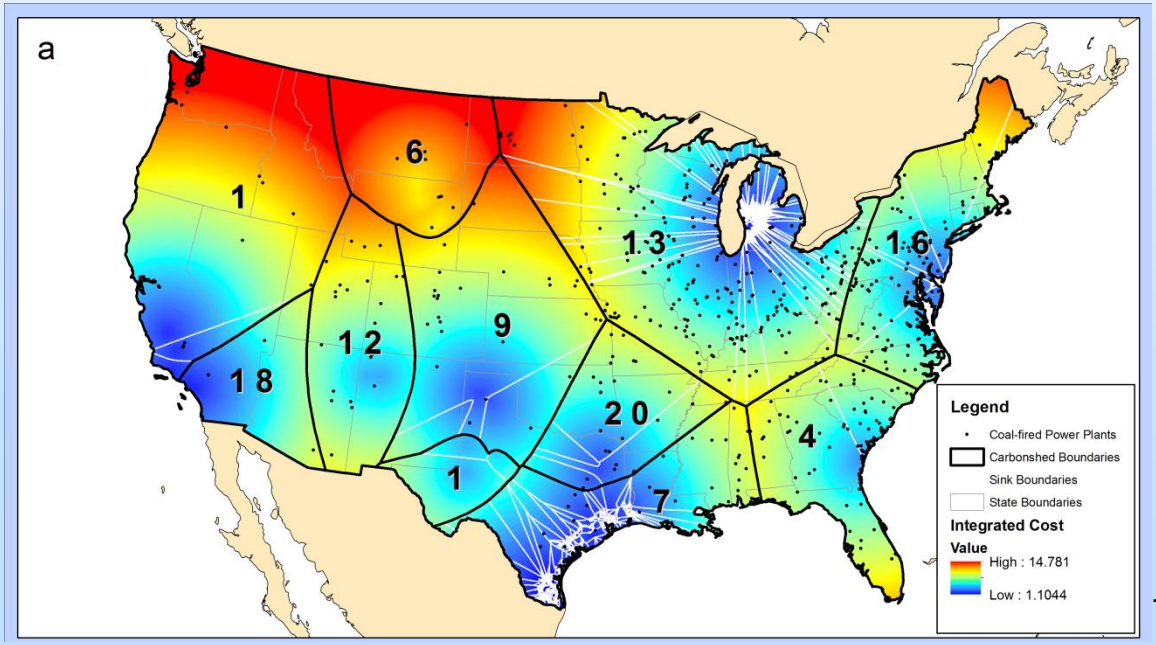
- Evaluation of Storage Options
  - Onshore deep saline aquifers
  - Onshore O/G fields
  - Offshore sediments, including self-sealing strata



Technical Status

- Integrated Transport & Storage Analysis in Carbonshed Framework
  - Analyzed onshore storage options using carbonshed
  - Extended to offshore





Accomplishments to Date

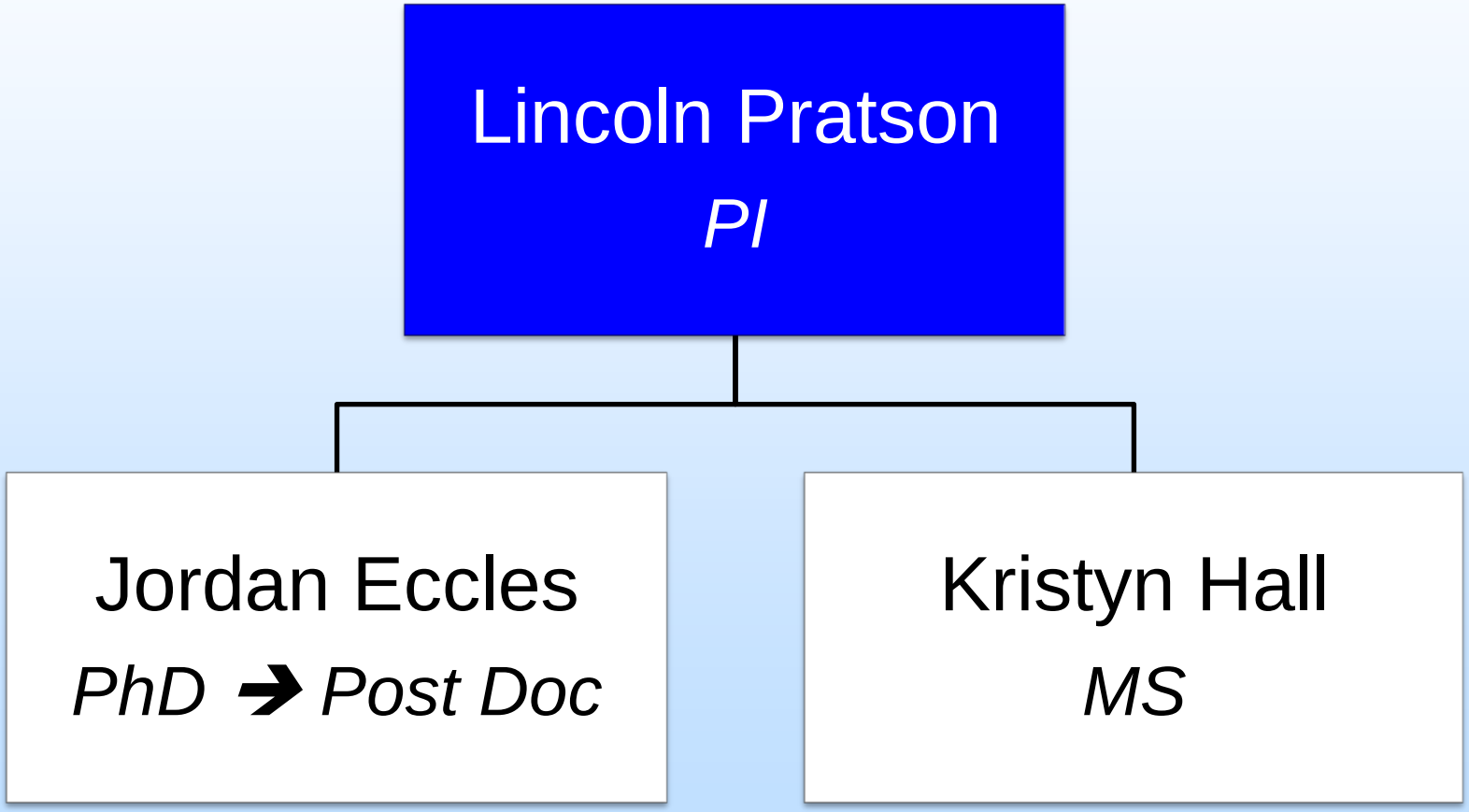
- Developed general model that uses geologic data of candidate reservoirs to make rapid geospatial estimates of storage capacity and cost.
- Storage capacity/cost model adopted by EIA for NEMS in 2010
- Model used to estimate storage capacities/costs of onshore saline aquifers, offshore sediments, and oil fields.
- Storage capacity/cost estimates used to define onshore and offshore carbonsheds in the continental U.S. and estimate combined transport and storage costs.
- Published 4 manuscripts with 2-3 more in prep.
- Trained and graduated 1 PhD and 1 MS Student; continuing training of the graduated PhD student as a PostDoc.

Summary

- **Key findings:**
  - Storage capacities/costs vary significantly among and within onshore/offshore geologic reservoirs, but a subset of these possess an abundance of low-cost storage.
    - e.g., In terms of CO2 storage in onshore oil fields, we find that 1% of the fields in the continental U.S. possess 54% of the total estimated storage capacity.
  - By optimizing transport to regions of voluminous, low-cost storage, 600 Mt of CO2 can be transported & stored per year for <$5/t and over 2 Gt for < $10/t.
  - Thick, low-permeability reservoirs minimize pressure interference between injection wells and thus minimize storage site development costs.
- **Lessons Learned:**
  - More & better geologic data would improve estimates of storage capacities/costs and thus estimates of combined transport and storage, but the methods of analysis and key findings developed in this project would still be valid.
- **Future Plans:**
  - Complete agent-based modeling using carbonshed framework.
  - Use the carbonshed framework and the price of CO2 for EOR to estimate the number of industrial CO2 sources for which CCS would become economic.

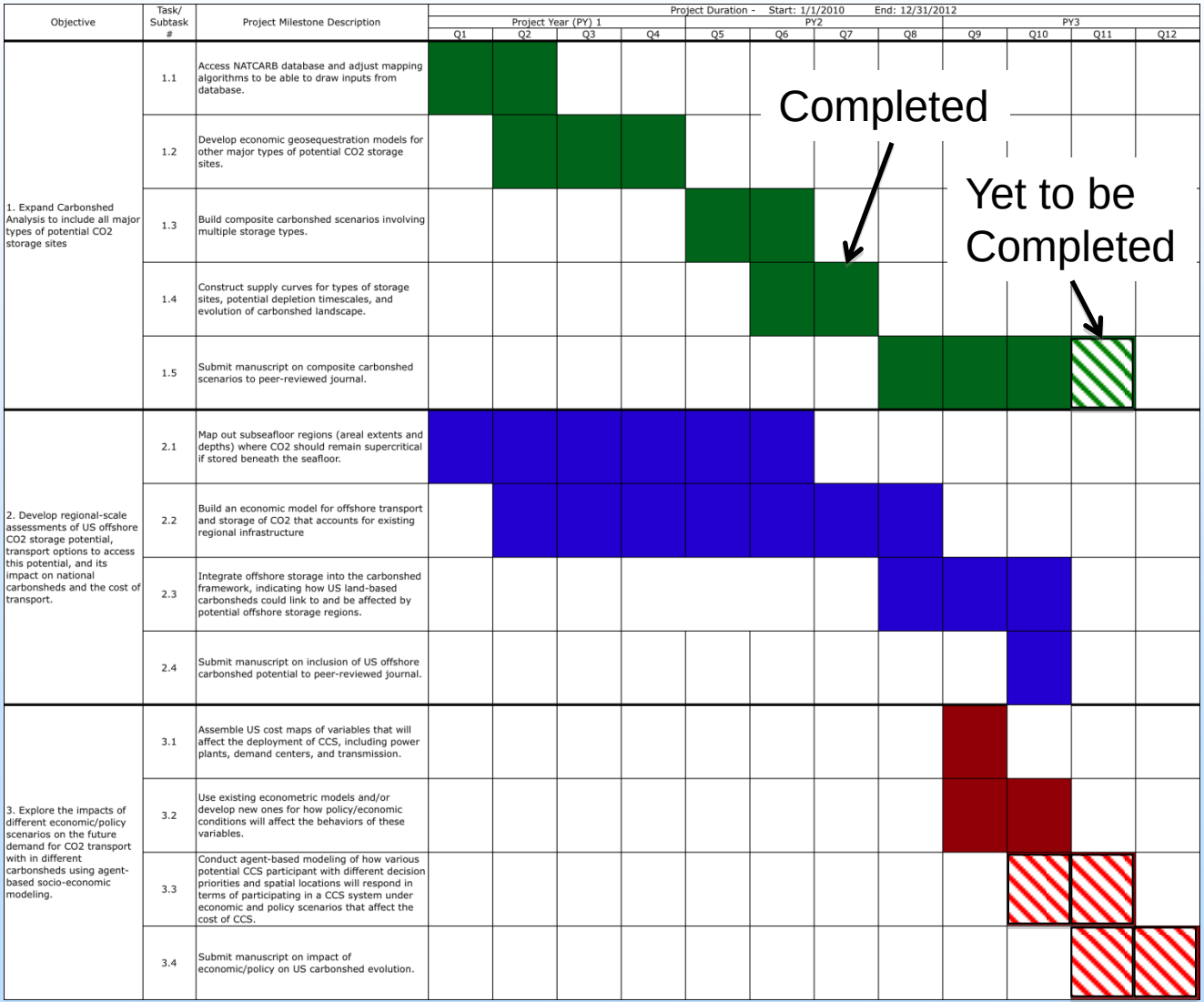
Appendix

Organization Chart



Gantt Chart

Objective	Task/ Subtask #	Project Milestone Description	Project Duration - Start: 1/1/2010 End: 12/31/2012											
			Project Year (PY) 1				PY2				PY3			
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
1. Expand Carbonshed Analysis to include all major types of potential CO2 storage sites	1.1	Access NATCARB database and adjust mapping algorithms to be able to draw inputs from database.												
	1.2	Develop economic geosequestration models for other major types of potential CO2 storage sites.												
	1.3	Build composite carbonshed scenarios involving multiple storage types.												
	1.4	Construct supply curves for types of storage sites, potential depletion timescales, and evolution of carbonshed landscape.												
	1.5	Submit manuscript on composite carbonshed scenarios to peer-reviewed journal.												
2. Develop regional-scale assessments of US offshore CO2 storage potential, transport options to access this potential, and its impact on national carbonsheds and the cost of transport.	2.1	Map out subseafloor regions (areal extents and depths) where CO2 should remain supercritical if stored beneath the seafloor.												
	2.2	Build an economic model for offshore transport and storage of CO2 that accounts for existing regional infrastructure												
	2.3	Integrate offshore storage into the carbonshed framework, indicating how US land-based carbonsheds could link to and be affected by potential offshore storage regions.												
	2.4	Submit manuscript on inclusion of US offshore carbonshed potential to peer-reviewed journal.												
3. Explore the impacts of different economic/policy scenarios on the future demand for CO2 transport with in different carbonsheds using agent-based socio-economic modeling.	3.1	Assemble US cost maps of variables that will affect the deployment of CCS, including power plants, demand centers, and transmission.												
	3.2	Use existing econometric models and/or develop new ones for how policy/economic conditions will affect the behaviors of these variables.												
	3.3	Conduct agent-based modeling of how various potential CCS participant with different decision priorities and spatial locations will respond in terms of participating in a CCS system under economic and policy scenarios that affect the cost of CCS.												
	3.4	Submit manuscript on impact of economic/policy on US carbonshed evolution.												



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- Published, In Press, or In Review

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  - Eccles, J.K., and Pratson, L.F., *in press*, Global CO2 storage potential of self-sealing marine sedimentary strata. Geophysical Research Letters, available at: http://192.102.233.13/journals/pip/gl/2012GL052291-pip.pdf.

  - Eccles, J.K., and Pratson, L.F., *in review*, Economic evaluation of offshore storage potential in the US Exclusive Economic Zone. Greenhouse Gases: Science and Technology.