Fifth Annual Conference on Carbon Capture & Sequestration

Steps Toward Deployment

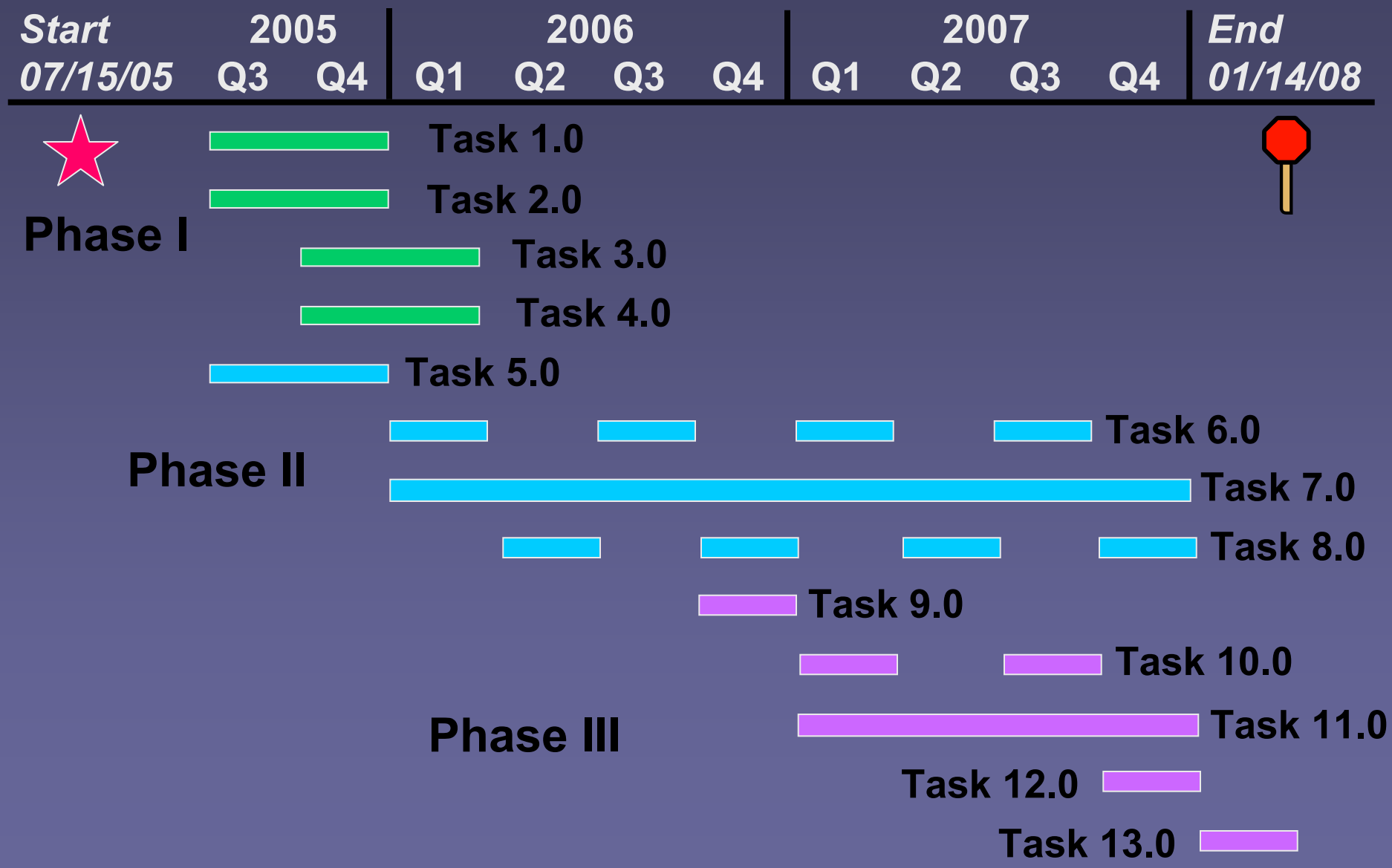
Monitoring, Mitigation, and Verification

Measuring Surface and Shallow Gas Flux and Composition As a Prelude to Geologic Carbon Sequestration in Eastern Kentucky

Thomas (Marty) Parris, Mike Solis, and Kathryn Takacs

May 8-11, 2006 • Hilton Alexandria Mark Center • Alexandria, Virginia

Organization & Schedule



Phase II- Tasks

Q3 2005	Q4 2005	Q1 2006	Q2 2006	Q3 2006	Q4 2006	Q1 2007	Q2 2007	Q3 2007	Q4 2007

Task 5.0- Training, instrumentation, calibration, strategy

~30 | 3 sites | ~30 | 10-15 | 1 site | 10-15

Task 6.0- Surface & shallow measurements

Task 7.0- Laboratory GC & isotope measurements

Task 8.0- Evaluate surface data- anomalies & deep wells

Why Soil Gas Geochemistry as an MMV Tool?

- Abdnt shallow underpressured reservoirs
- Injected CO_2 reside as immiscible gas
- Abdnt unconventional reservoirs (e.g. organic-rich shale, coal) w/ fractures having significant vertical aspect critical for gas delivery out of and into?
- KY--96% of electricity from coal; abundant CO_2 point sources
- Transportation= major cost in CO_2 EOR-sequestration
- Leverage knowledge outside KY

Goals and Objectives

Areas overlying possible carbon sequestration-enhanced hydrocarbon recovery sites and areas that serve as analogs:

- Measure and calculate rates of gas flux and composition in surface and near-surface environment (< 10m)
- Identify and quantify variations in gas flux and composition that are seasonal, related to wet-dry periods, geologic factors such as faults, or cultural influences such as leaking wells= attribution
- Identify areas in which surface or near-surface CO_2 or CH_4 has a geologic source (i.e. microseepage)

THE CHALLENGE: identify microseepage that might have a signal that is likely to be orders of magnitude less than the biologic signal!!

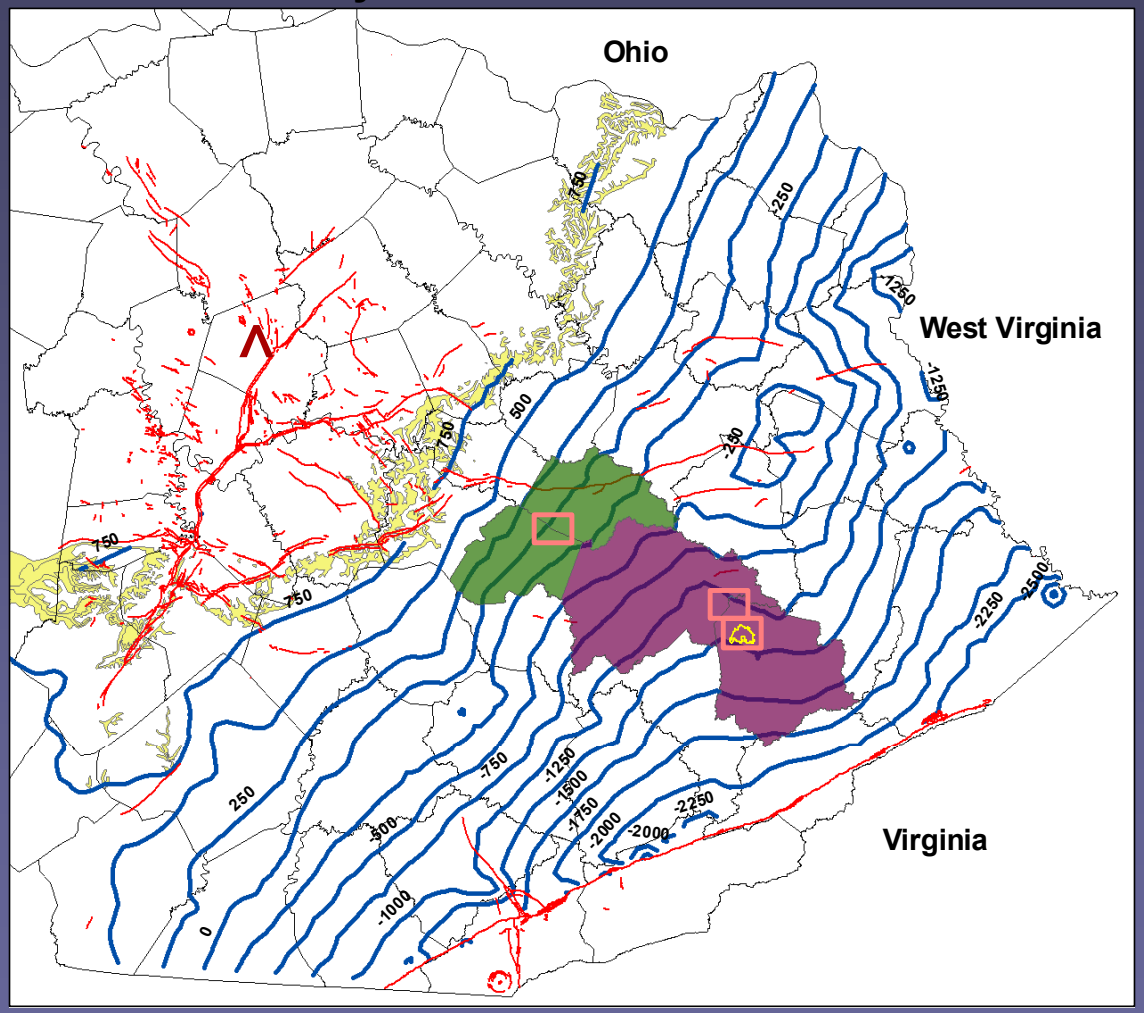
Results Provide:

- Database for interpreting the atmospheric, biologic, and geologic (microseepage) contributions to gas flux and composition= attribution
- Screening tool for selecting possible sequestration-enhanced HC recovery sites
- Background database for monitoring changes in surface and shallow gas flux and composition during a EOR-sequestration project

Study Sites

Compiled by:
Kathryn Takacs
5/4/2006

Study Sites



Legend

Breathitt and Knott Counties
(Robinson, Ario)

Lee and Wolfe Counties
(Big Sinking)

Ario Lease boundary

Structure contour on top of the Devonian Shale

Area Faults

Lexington, KY

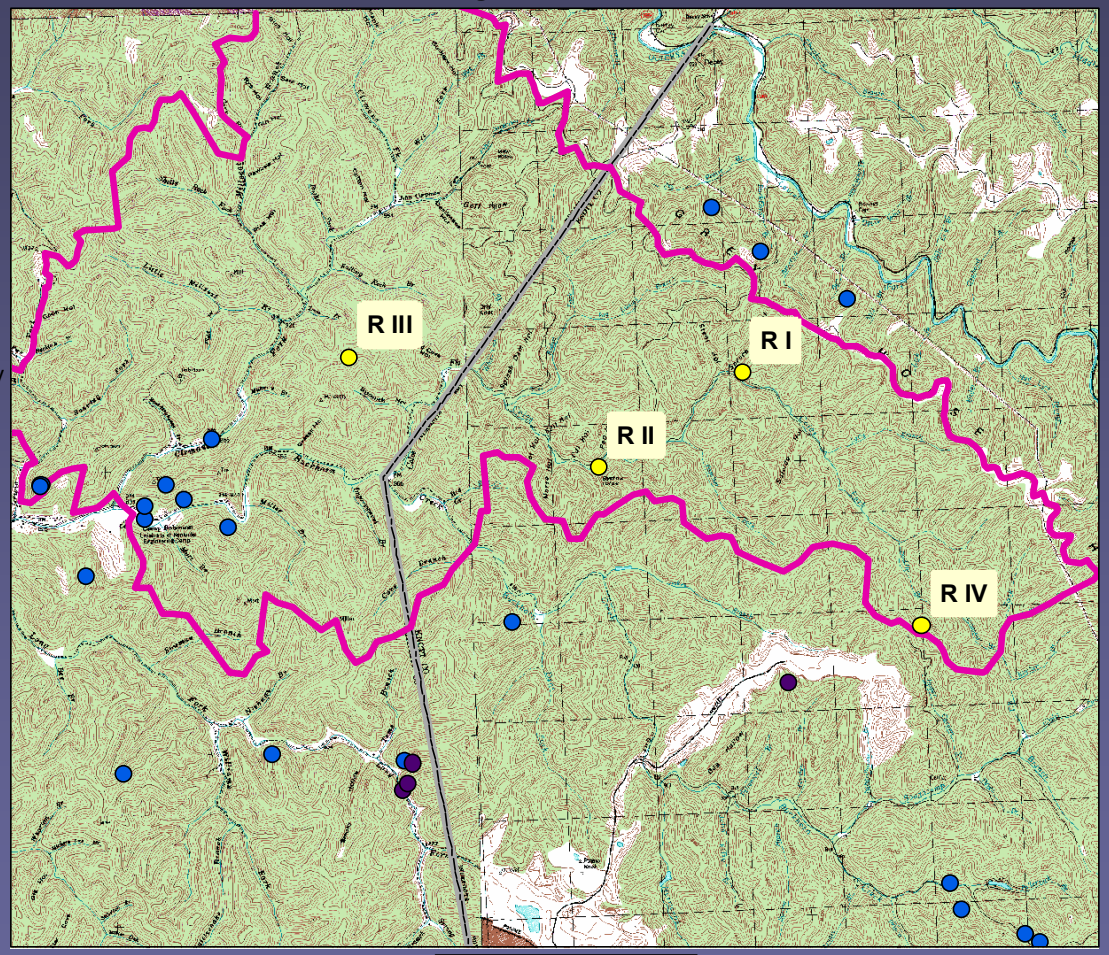
Kilometers
0 25 50 100

0 25 50 100
Miles

Robinson Forest

Compiled by:
Kathryn Takacs
5/4/2006

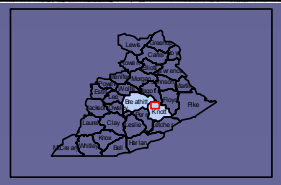
Robinson Forest Study Sites



Legend

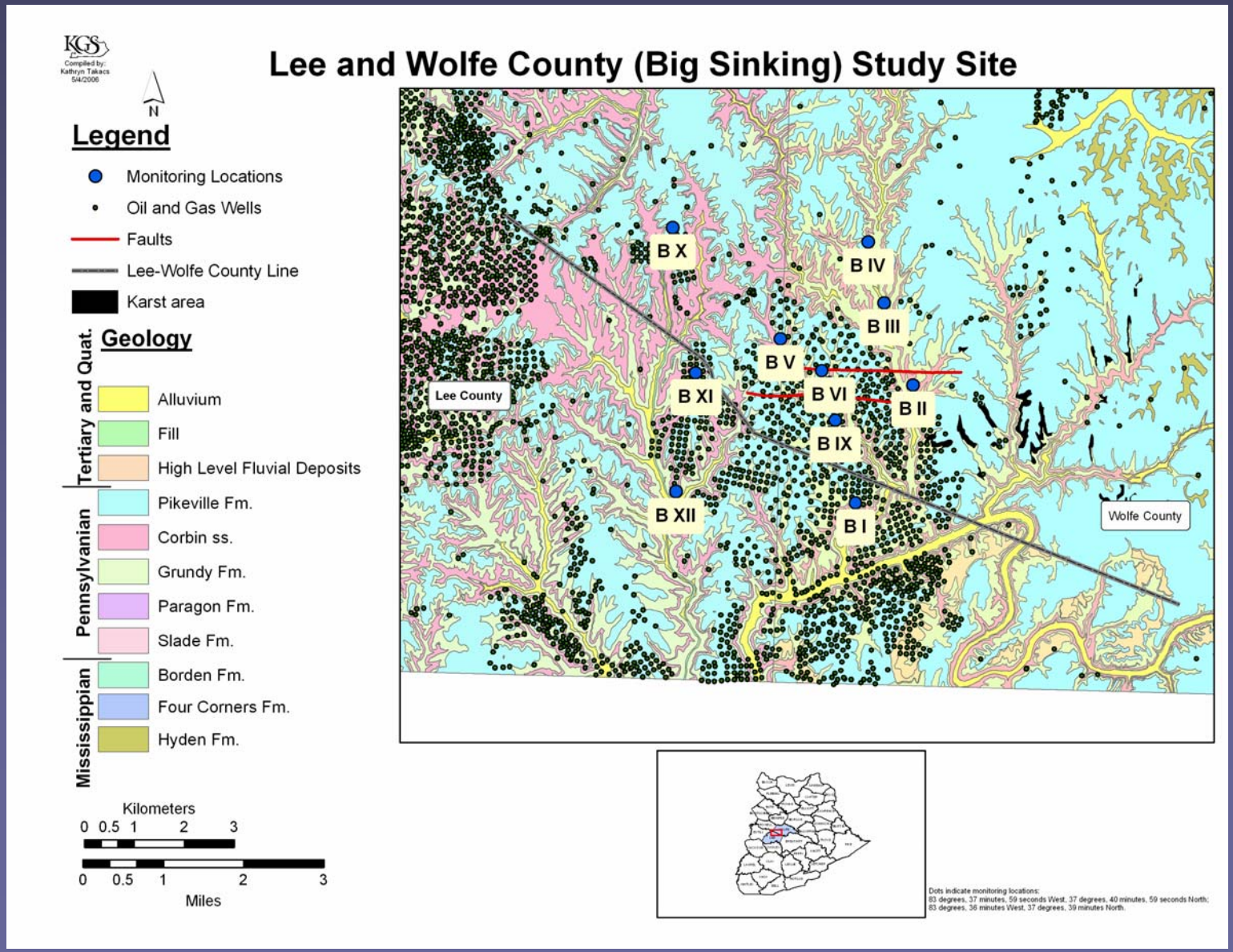
- Monitoring Locations
- Robinson Forest Preserve Boundary
- Breathitt-Knott County Line
- Water Wells
- Springs
- USGS Gauging Stations

Kilometers
0 0.5 1 2 3
0 0.5 1 2 3
Miles

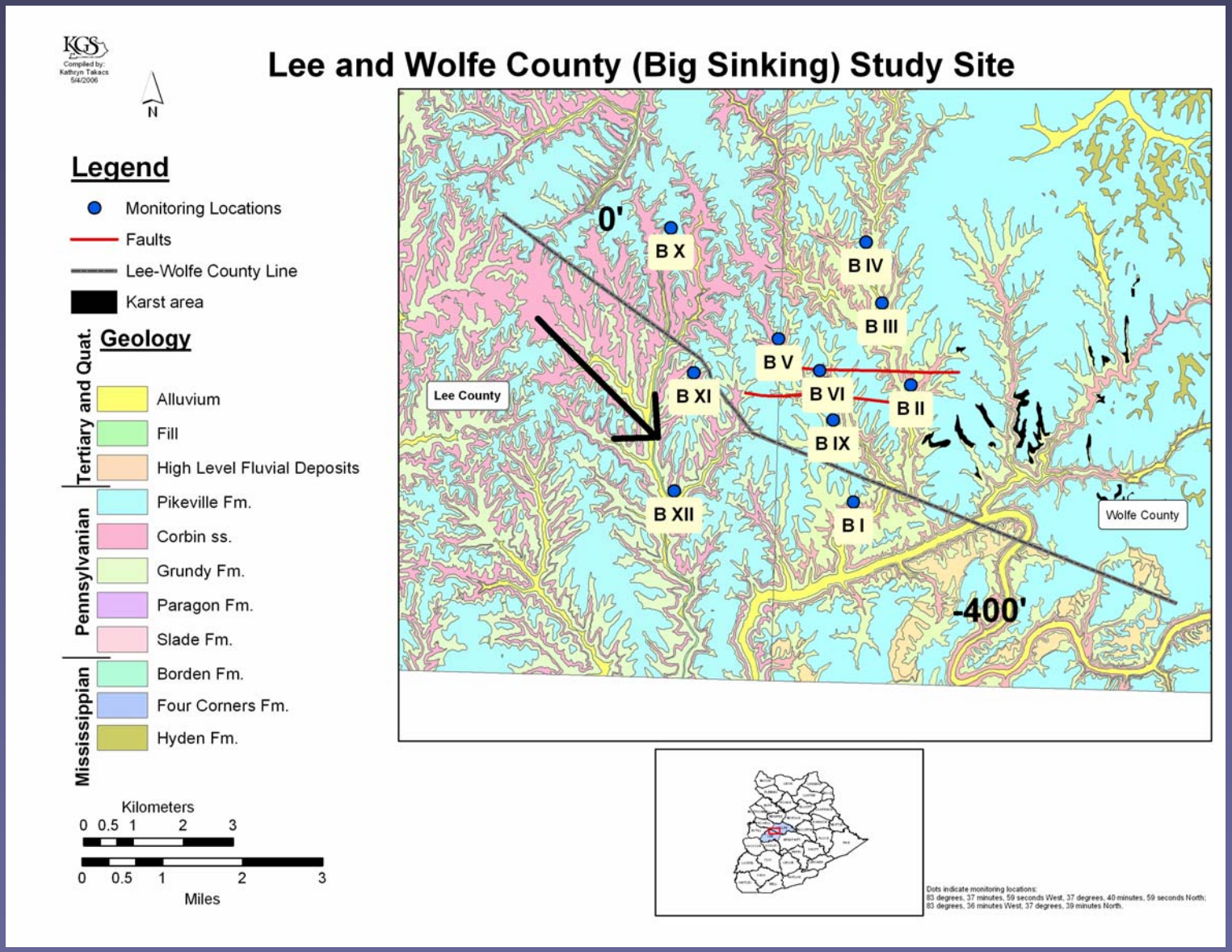


Dots indicate monitoring locations:
Deadmans Hollow- (approx) 83 degrees, 7 minutes, 33.6 seconds West, 37 degrees, 28 minutes, 39 seconds North;
Old Cove Hollow- (approx) 83 degrees, 7 minutes, 45.5 second West, 37 degrees, 28 minutes, 0 seconds North;
Bucklick Hollow- (approx) 83 degrees, 8 minutes, 4 seconds West, 37 degrees, 27 minutes, 46 seconds North.
Red Circle indicates location of Camp Robinson.

Big Sinking


KGS
Compiled by: Kathryn Takacs 5/4/2006
N
Lee and Wolfe County (Big Sinking) Study Site
Legend
Monitoring Locations
Oil and Gas Wells
Faults
Lee-Wolfe County Line
Karst area
Geology
Tertiary and Quat.
Alluvium
Fill
High Level Fluvial Deposits
Pennsylvanian
Pikeville Fm.
Corbin ss.
Grundy Fm.
Paragon Fm.
Slade Fm.
Mississippian
Borden Fm.
Four Corners Fm.
Hyden Fm.
Kilometers
0 0.5 1 2 3
0 0.5 1 2 3
Miles
B X
B IV
B III
B V
B VI
B XI
B II
B IX
B XII
B I
Lee County
Wolfe County
Dots indicate monitoring locations:
83 degrees, 37 minutes, 59 seconds West, 37 degrees, 40 minutes, 59 seconds North;
83 degrees, 36 minutes West, 37 degrees, 39 minutes North.

Big Sinking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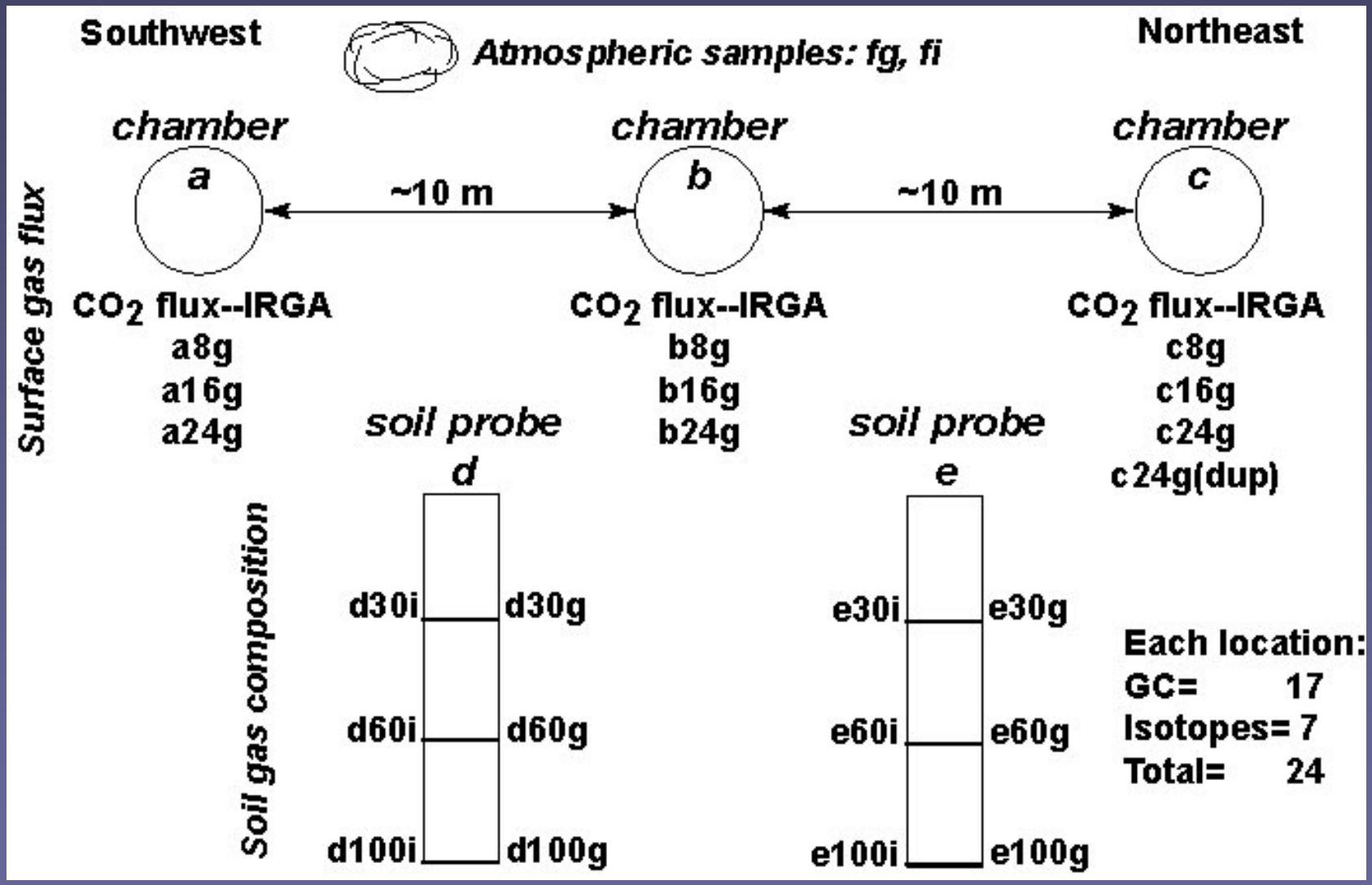
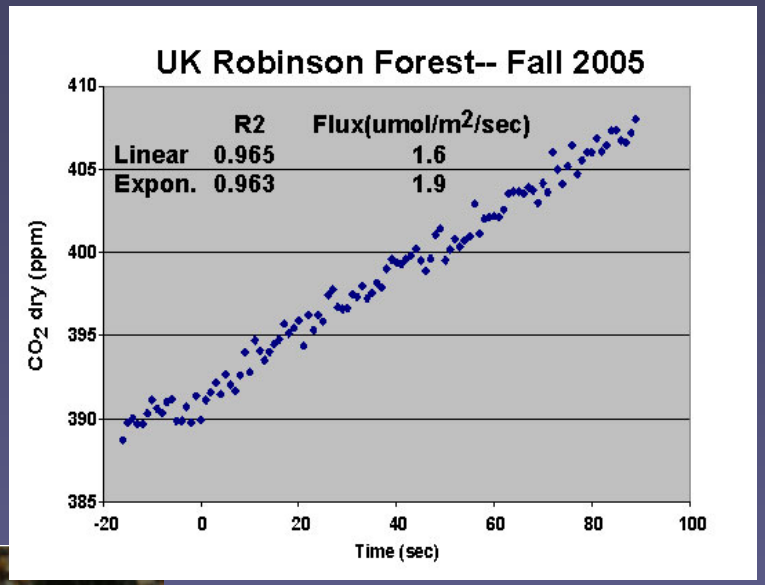
Mississippian
Borden Fm.
Four Corners Fm.
Hyden Fm.
Kilometers
0 0.5 1 2 3
0 0.5 1 2 3
Miles
0'
B X
B IV
B III
B V
B VI
B II
B XI
B IX
B XII
B I
Lee County
Wolfe County
-400'
Dots indicate monitoring locations:
83 degrees, 37 minutes, 59 seconds West, 37 degrees, 40 minutes, 59 seconds North;
83 degrees, 36 minutes West, 37 degrees, 39 minutes North.

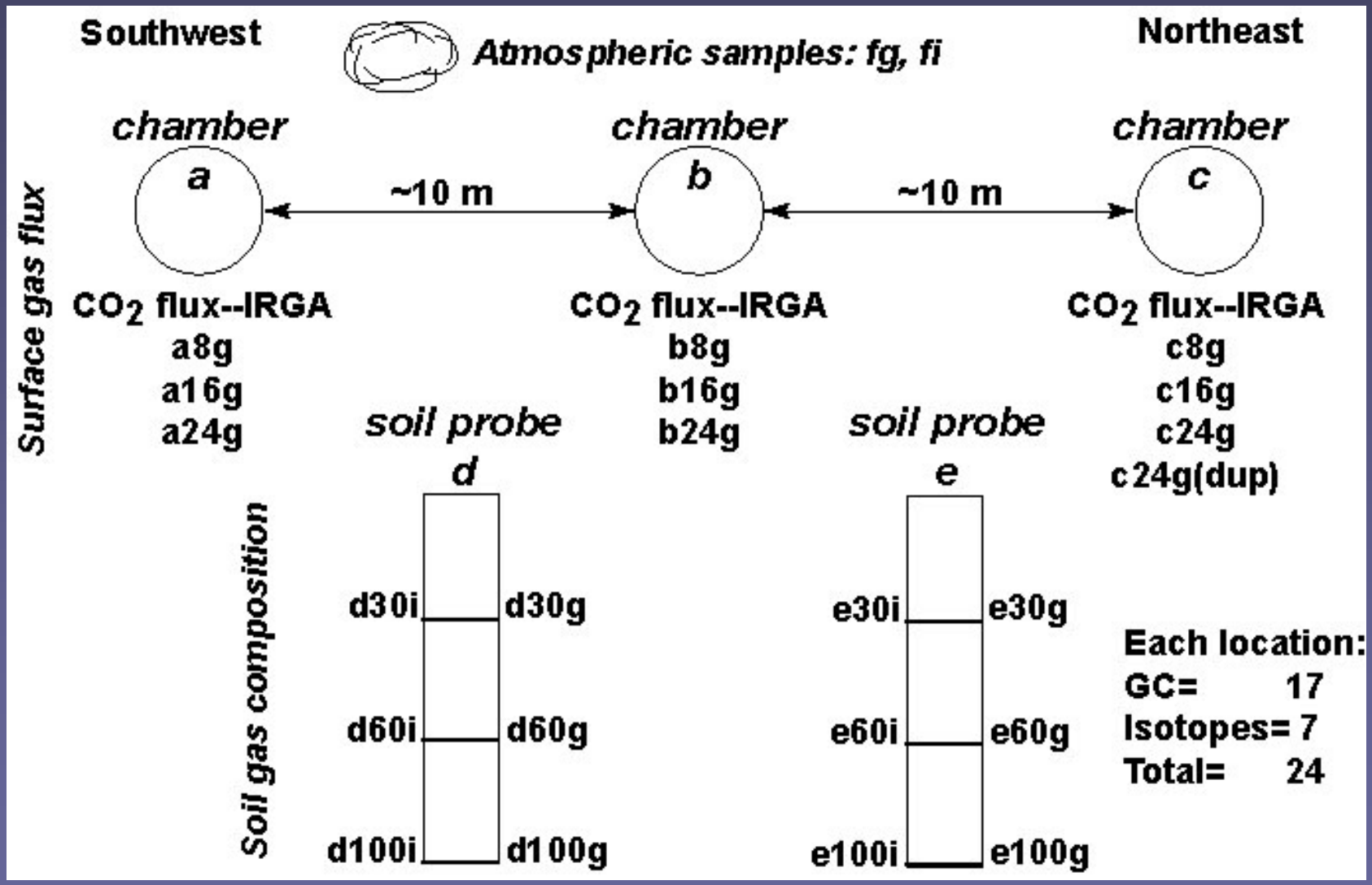
Location Protocol



Measuring CO_2 Flux

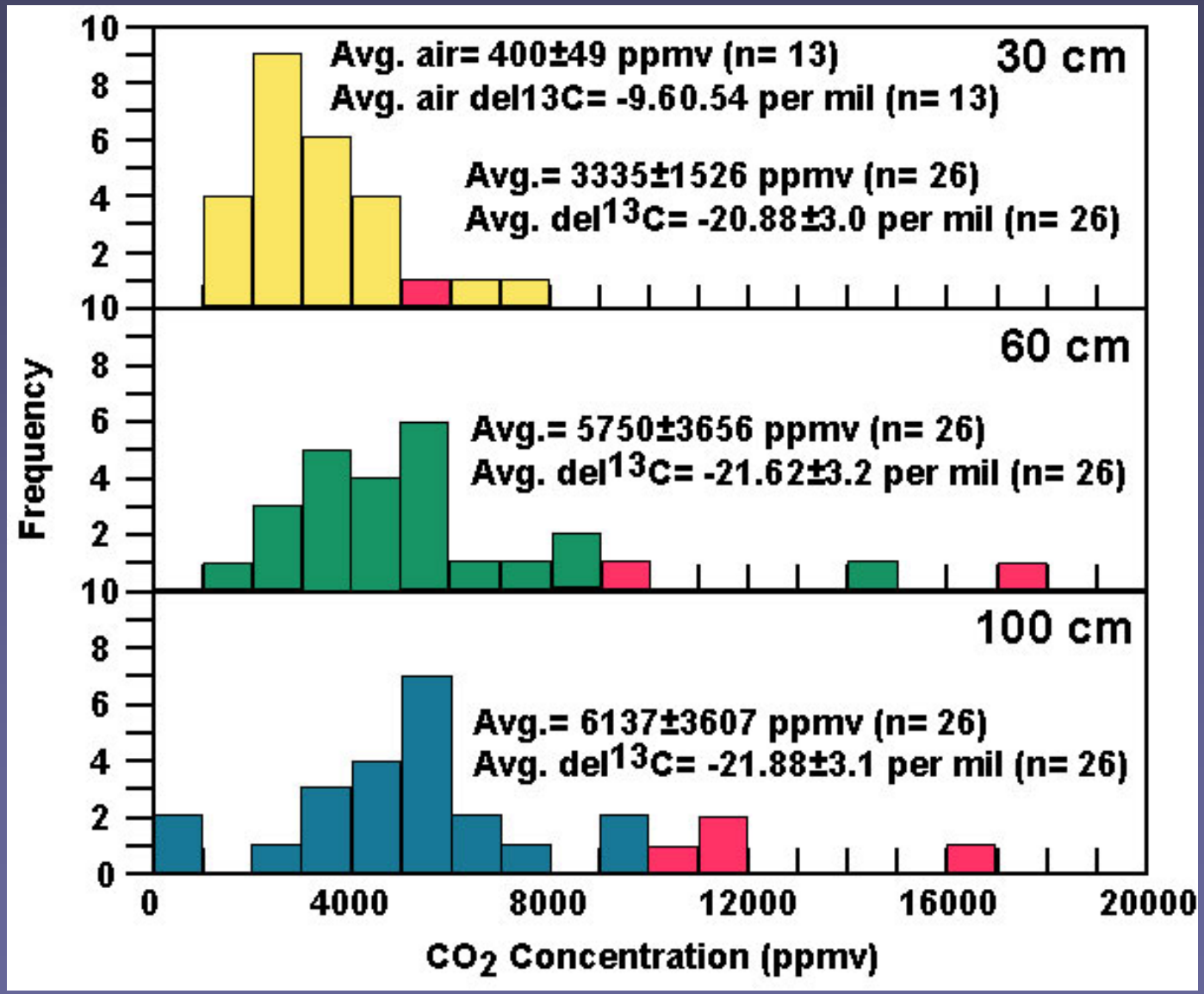


Location Protocol

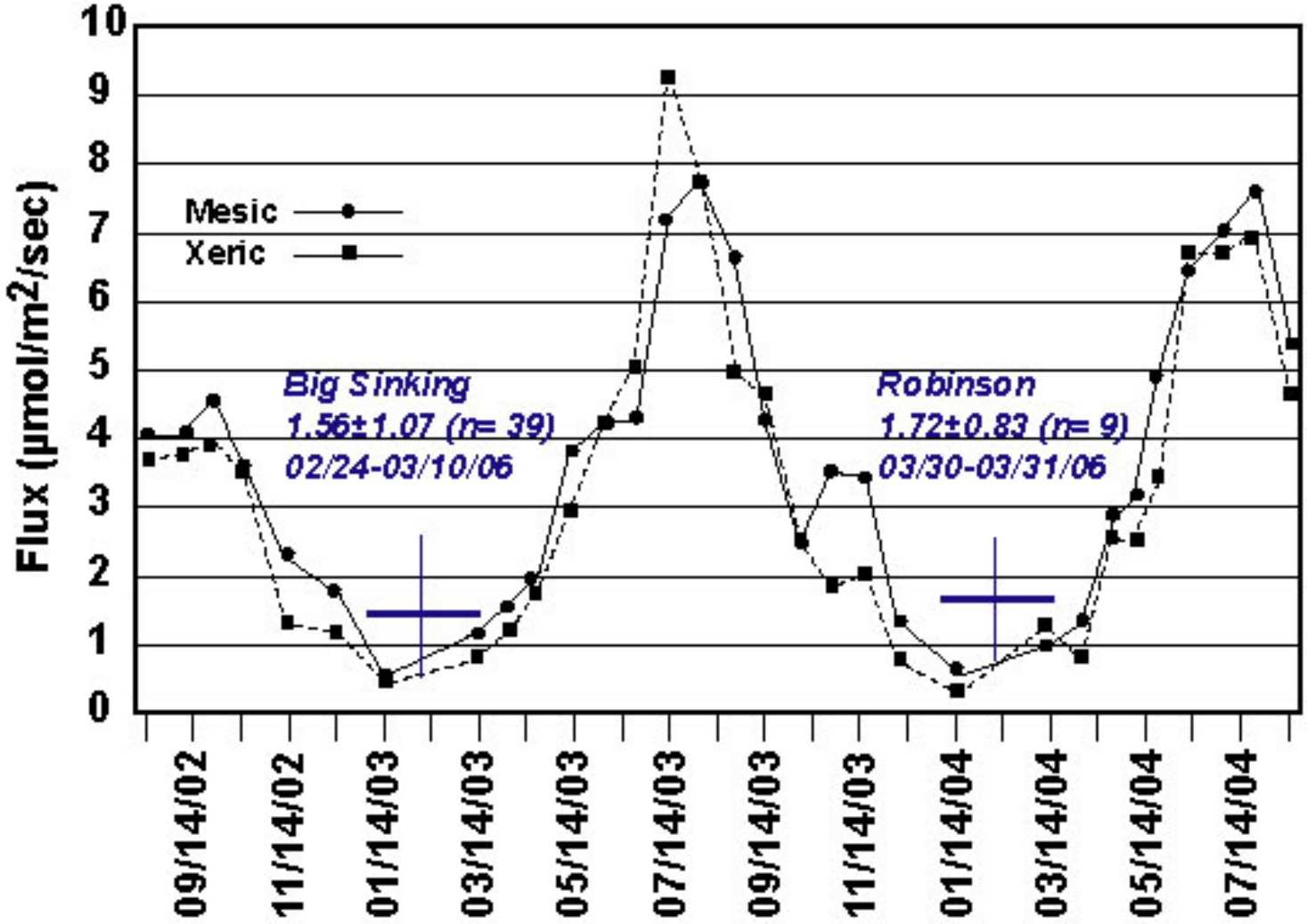


Soil Gas Sampling

Big Sinking W06 Soil CO_2

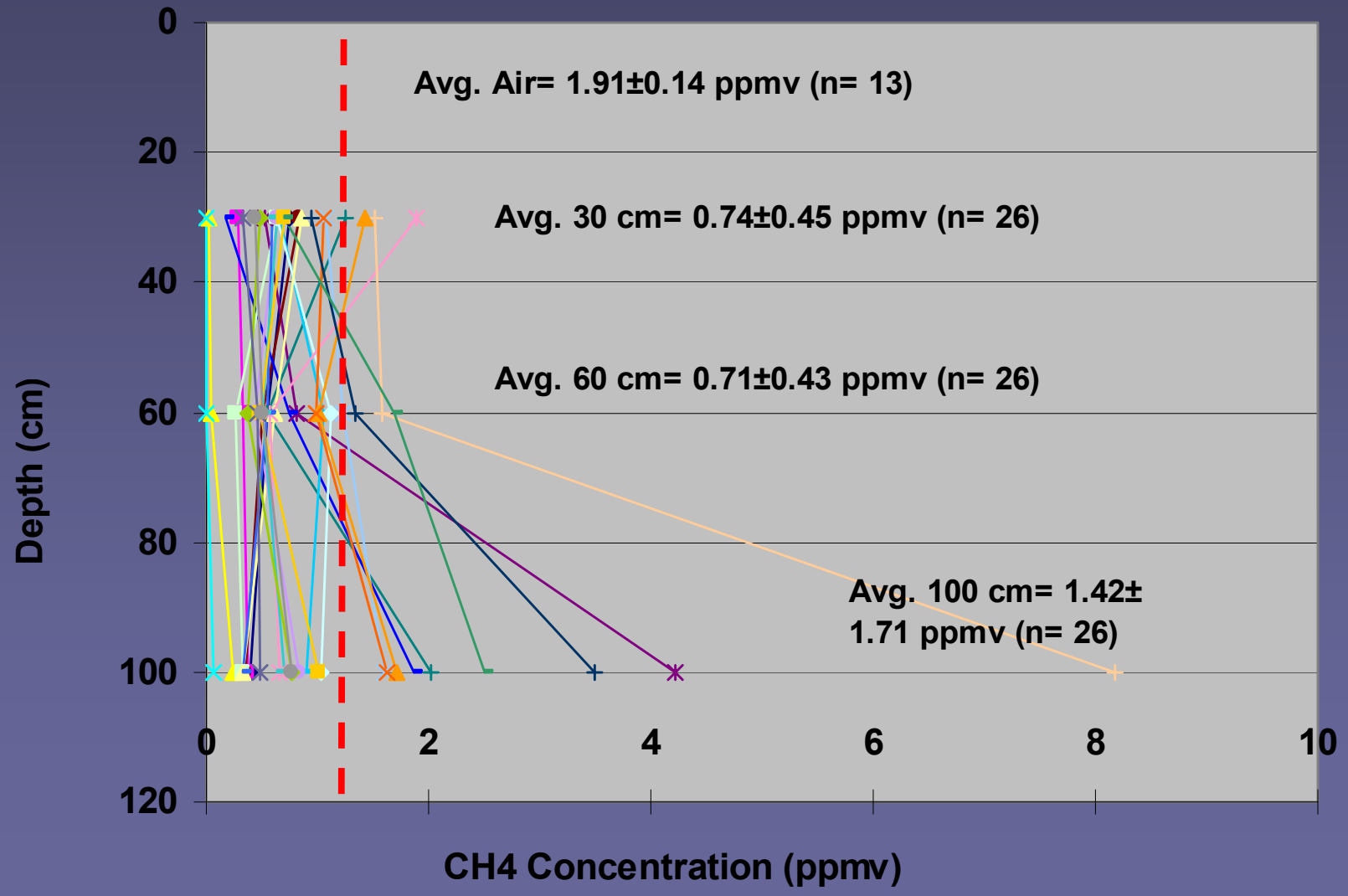


Winter 2006 CO_2 Flux Data



Robinson Forest flux data courtesy of Mary Arthur (UK Department of Forestry)

Big Sinking Winter 2006
Soil Gas CH_4



Summary

- Acquisition and fabrication of equipment, calibration of equipment, and development and refinement of laboratory and field techniques during the last two quarters of 2005 enabled successful measurement of soil gas fluxes (78 chambers) and the collection and laboratory measurements of the bulk and isotopic composition of soil gas samples (710) during the first quarter 2006. Initial analysis of the data from show:
- Positive CO_2 fluxes (1.5-1.6 umol/m^2/sec) are driven by soil gas CO_2 concentrations that are one to two orders of magnitude greater than air (390-400 ppmv). Average CO_2 concentration increases w/ depth and the lower concentration at shallow depth might reflect cooler soil temperatures under winter conditions.
- Depleted carbon isotope values ($\delta^{13}C$= -21 to -24‰) suggest that the high CO_2 levels are due to activities such as root and microbial respiration.
- Soil gas CH_4 concentrations, in contrast, are lower than atmospheric CH_4 concentrations, and the difference would predict a negative CH_4 flux.
- Initial results from the "Winter 2006" sampling provide confidence that soil gas fluxes and composition can be measured w/ sufficient accuracy and precision to be effective as tool in the MMV portfolio.

Acknowledgements

Kentucky Office of Energy Policy

UK Arboretum Forest

UK Environmental Research and Teaching Laboratory

Bretagne Oil Company

Interstate Natural Gas

Trinity Coal Company

Many Surface Land Owners