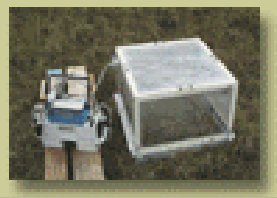
Agenda – Tuesday a.m.

- Poster session all day for site updates - Setup posters, available for viewing all day
- 9:00 Welcome (Law, Dahlman)
- 9:20 **North American Carbon Program** – Progress report (Denning)

AmeriFlux role in NACP

- 9:40 Improving network coherence (Law, Dahlman)
  Criteria for evaluating AmeriFlux sites
- 10:00 Coffee served next to poster room
- 10:30 Data reporting, data quality (Boden, Cook)
- 10:50 Continental-scale CO_2 – update of plans and linkage with other measurements (Tans)
- 11:10 Remote sensing needs of NACP (Morisette)
- 11:30 Fluxnet-Canada role in NACP (Flanagan)
- 11:50 Lunch

AmeriFlux



Network of Eddy-Covariance Sites:

- Characterize processes by which ecosystems exchange CO_2, water and energy
- 102 active sites in 6 countries
- 50 research teams - 26 run multiple sites, mostly on disturbance gradients (fire, management, diversity) or vegetation types within climate zone

http://public.ornl.gov/ameriflux

Network Accomplishments

- Handbook of Micrometeorology (Lee, Massman, Law, eds., in press)
- Soil Flux Workshop & Biogeochemistry special issue in press
- Evaluation of representativeness of AmeriFlux sites (Hargrove, Hoffman, Law)
- Expansion of site intercalibration – instruments, software
- Web site
  - Instrumentation and calibration guidelines (Munger/Loescher)
  - Criteria for being an AmeriFlux site
  - Measurement protocols and applications of CO_2 concentration measurements (Davis)
  - Data posting guidelines (Boden)

Issues to Discuss

- How we can improve breadth, quality and timeliness of data submissions to archive while meeting site research objectives
- Gap-filling met/micromet data for archive and synthesis/modeling activities
- Future synthesis activities
  - Effect of pulse rain events on Rs and NEE
  - Disturbance effects on stocks and fluxes
- Site evaluation and enhancements
- Role in NACP

Improving Network Coherence

Role of AmeriFlux in NACP

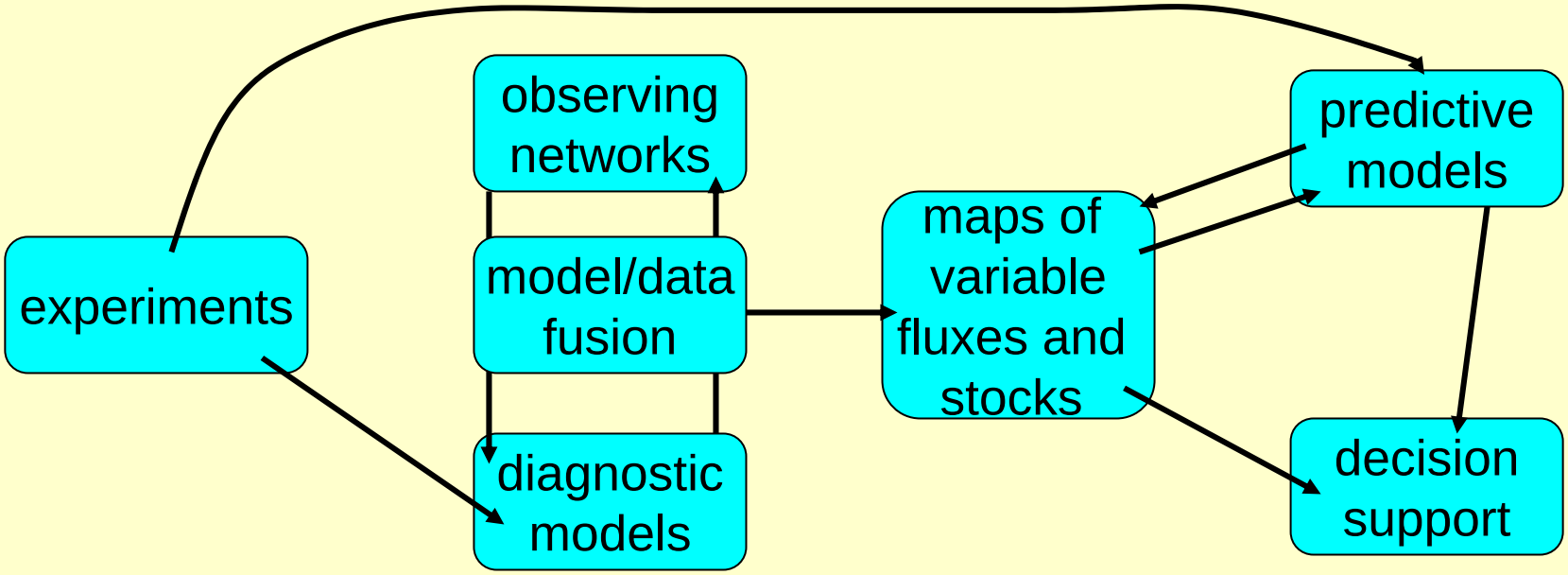
AmeriFlux Questions

- What are the magnitudes of carbon storage and the exchanges of energy, CO_2 and water vapor in terrestrial systems? What is the spatial and temporal variability?
- How is this variability influenced by vegetation type, phenology, changes in land use, management, and disturbance history, and what is the relative effect of these factors?
- What is the causal link between climate and the exchanges of energy, CO_2 and water vapor for major vegetation types, and how do seasonal and inter-annual climate variability and anomalies influence fluxes?
- What is the spatial and temporal variation of boundary layer CO_2 concentrations, and how does this vary with topography, climatic zone and vegetation?

Science Objectives of AmeriFlux

- Measure CO_2 exchange between atmosphere and components of terrestrial biosphere
- Understand underlying processes and ecological controls regulating exchange
- Estimate carbon storage/sequestration of representative ecosystems – NEP
- Calibrate continental (global) scale atmospheric observations and carbon cycle models
- Address key question about unaccounted for excess CO_2 in global carbon budget

NACP Integration Strategy



- Process studies and manipulative experiments inform improved models
- Systematic observations of land, ocean, and atmosphere used to evaluate models
- Innovative model-data fusion techniques produce optimal estimates of time mean and spatial and temporal variations in fluxes and stocks
- Improved models used to predict future variations, and tested against ongoing diagnostic analyses
- Predictive models and continuing analyses used to enhance decision support

North American Carbon Program Phasing

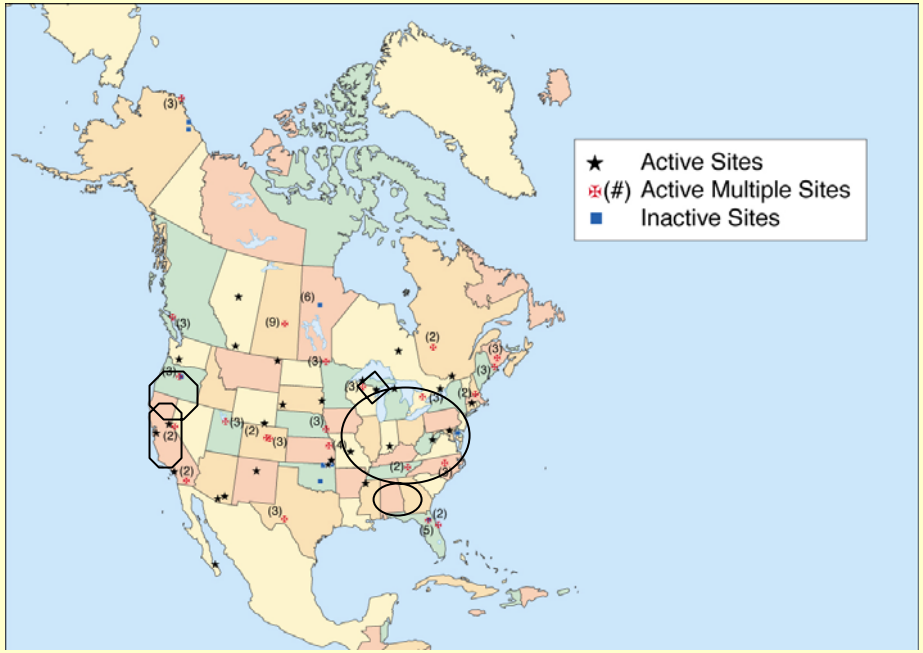
Initiation Phase: 2003-2005

- Develop modeling and analysis tools
- Develop observing network design studies
- Conduct first intensives to test key design elements and analysis tools

- First State of Carbon Cycle Science Report (12/05)
  - Short fuse – send relevant pubs to Tony King

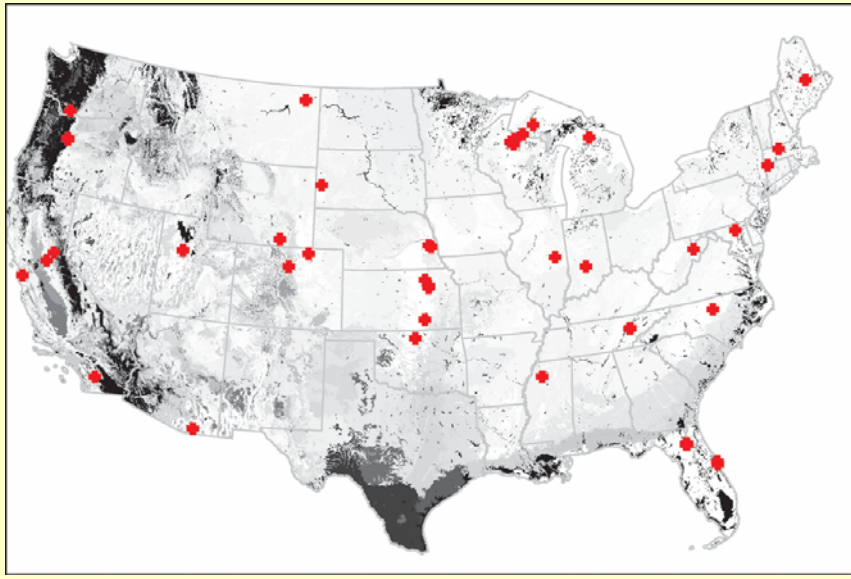
NACP Phasing – Some Recently Funded Projects

- Carbon exchange dynamics of a super-region in the E US (Schmid)
- Integration of multi-scale remote sensing with AmeriFlux and NACP field observations (Ollinger)
- Testing flux tower upscaling at a regional scale in a complex landscape (Bolstad)
- Disturbance and climate effects on the carbon balance of OR & NCA (Law)
- Mechanisms controlling annual, interannual, and decadal changes in California's carbon budget (Goulden)
- Mesoscale carbon data assimilation for NACP (Denning)



AmeriFlux Network Enhancements in Support of NACP

- Intensive ecological studies, full carbon accounting (NEP, stocks)
- Long-term measurements (response to disturbance, climate)
- Fill critical gaps (biomes, ecoregions, disturbance regimes)
- Strategically located sites for accurate CO_2, CH_4, CO
- Site enhancements
  - Instrumentation
  - Data management – quality, gap-filling, archive
- Enhanced quality control, information management



Synthesis topics

- Disturbance effects on stocks and fluxes
- Effects of interannual variation in climate on fluxes
  - Rain timing and intensity
  - Extended growing season
- Controls on carbon allocation and soil processes
- Model evaluation across regions, within biomes
- Experiments??

Criteria for AmeriFlux Sites

- Utility to the network (representative of biome, ecoregion, disturbance classes)
- Continuous meteorological, micrometeorological measurements all year
- Potential to be enhanced for accurate [CH_4], [CO]
- Follow the instrumentation and calibration guidelines
- Conduct core measurements on AmeriFlux web site, appropriate intervals
- Provide biological data to the AmeriFlux archive
- Participate in instrument comparison and calibration with AmeriFlux standards, resolves discrepancies
- Submit meteorological and micrometeorological data within 1 year of data collection, following submission guidelines
- Meet data quality and data archiving standards posted on web
- Attend annual AmeriFlux meeting
- Demonstrated output – quality publications
- Network participation - synthesis activities across sites, true availability of site data to others, participates in the broader array of NACP research

Additional criteria

Additional criteria for flux sites that provide process-level understanding

- Focal points for intensive ecological studies on biotic and abiotic controls on the exchanges of CO_2 and water vapor, and changes in carbon stocks
- Conduct full carbon accounting at appropriate intervals (biometric estimate of NEP, carbon stocks in vegetation and soil), and provide uncertainties in these estimates

Additional evaluation criteria for core CO_2 sites:

- Strategically located for quantifying spatial variation in continental CO_2

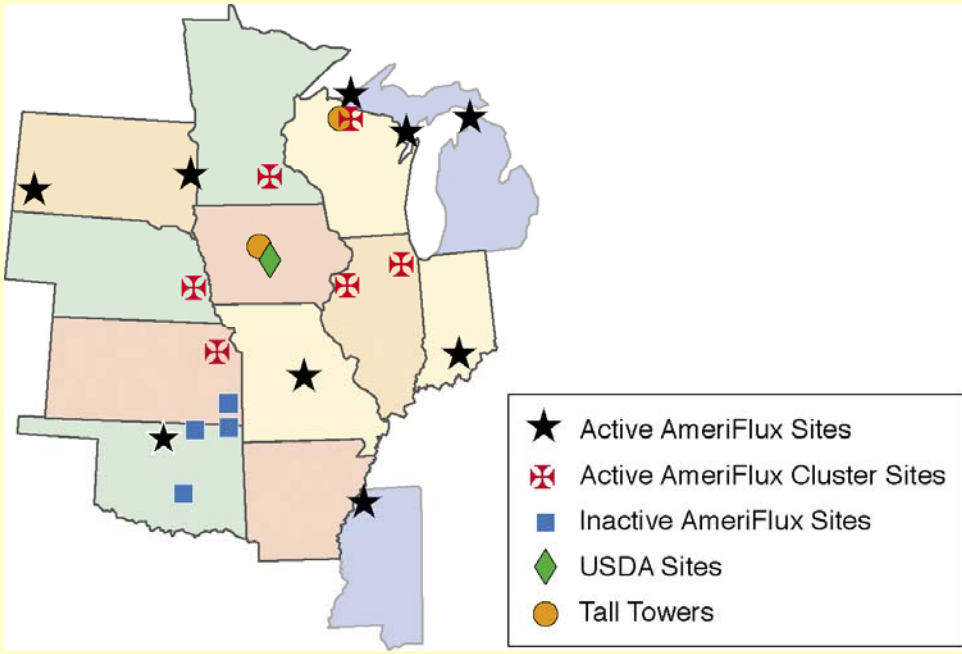
Agenda – Tuesday Afternoon

1:00 **NACP Midwest intensive planning & implementation (Paul, Tans)**

- 1:20 Flux site implementation and coordination, calibrated CO2 (Davis, Gu)
- 1:40 Aircraft/tall towers (Arlyn Andrews, Tans)
- 2:00 Quantifying carbon stocks, NPP, NEP (Paul, Hollinger)
- 2:20 Physiological measurements and process modeling (Steve Pallardy)
- 2:40 Agricultural modeling of C fluxes and full C accounting (Tris West)
- 3:00 Site visits roving system (Loescher)
- 3:20 Wrap-up discussion (Davis)
- 3:40 **Poster Session - Annual Site Updates**
- 4:30 Steering Committee meeting small conference room

Mid-Continent NACP Intensive Campaign

- Develop and evaluate approaches for NACP
- Reconcile regional carbon sources and sinks derived from atmospheric models & trace gas concentrations with estimates from field measurements, inventories, regional geographic information, remote sensing
- Attribution of sources and sinks to ecosystem processes and human activities within the region



NACP-MC FLUX GROUP

(Des Moines Meeting Summary)

- Needs in Common (Identified by both Atmosphere and Fluxes groups originally)
  - High precision CO_2 measurements at flux sites
  - Need for time-resolved / spatially explicit bottom up models
  - Stable isotope measurements to partition photosynthesis and respiration
  - Temporal coordination of efforts across groups
  - NEE as the "interface" between bottom-up and top-down
- High priority should be placed on coordination among participating flux sites
- Common suites of measurements should be made at all sites
  - Timing, frequency, data availability
- Coordinated modeling efforts at all sites
  - Suite of models, ID short list of key parameters to be measured
- Process understanding - Below ground processes are still problematic and need to be addressed
  - Soil respiration measurements through year at flux sites
  - Separation of Ra and Rh via stable isotopes, trenching…
- Consensus for a broad view of region

Day 2 (Wednesday)

8:00 **Theme:** **Carbon Fluxes at Multiple Scales** – Presentation and discussion of approaches. How do we get there from here?

Bottom-up approaches:

8:10 Network-wide data assimilation (Schimel)

8:30 Eastern US flux towers/land use – large area (Schmid, Katul, Oren)

8:50 ChEAS flux towers/land use – small area (Bolstad)

9:10 Discussant (Schimel) – Bottom-up scaling issues

Top-down and merged approaches:

9:30 Role of BASIN in NACP, Utah project (Ehleringer)

9:50 COBRA progress – continental, regional (Wofsy, Lin, Moorcroft)

10:10 Break

10:40 LBA integration (Wofsy)

11:00 Continental RAMS-SiB data fusion; update on ring of towers (Denning, Davis)

11:20 Preparation for regional gridded atmospheric inversion (Douglas Chan)

11:40 Discussions – How shall we proceed as a network to test and facilitate these approaches? Can bottom-up vs. top-down approaches be compared in a meaningful way? What barriers exist to progress? What regional or continental efforts are particularly needed? Are these already envisioned by the NACP?

Soil Respiration

Workshop and
Special issue of Biogeochemistry

Recent Advances in Soil Respiration

Special Issue of Biogeochemistry

Interpreting, measuring, and modeling soil respiration: Ryan & Law

Spatial-temporal variation of soil respiration in an oak-grass savanna ecosystem in California and its partitioning into autotrophic and heterotrophic components: Tang & Baldocchi

Forest soil respiration across three climatically-distinct chronosequences in Oregon: Campbell & Law

Canopy gas exchange and root respiration in ponderosa pine; correlations or controls: Irvine et al.

Soil CO_2 effluxes under reduced, ambient and elevated CO_2 in S. California chaparral: Cheng et al.

An analysis of soil respiration across northern hemisphere temperate ecosystems: Hibbard et al.

Soil porosity can bias chamber-based measures of soil respiration: Butnor et al.

Carbon release from temperate forest soils: Annual variations in soil respiration and the Influence of drought: Martin & Bolstad

Seasonal differences in soil surface CO_2 efflux under snow in 48 and 318-year-old subalpine conifer forests: Hubbard et al.

Soil CO_2 efflux in loblolly pine (Pinus taeda L.) plantations on the Virginia Piedmont and S. Carolina Coastal Plain over a rotation-length chronosequence: Gough et al.

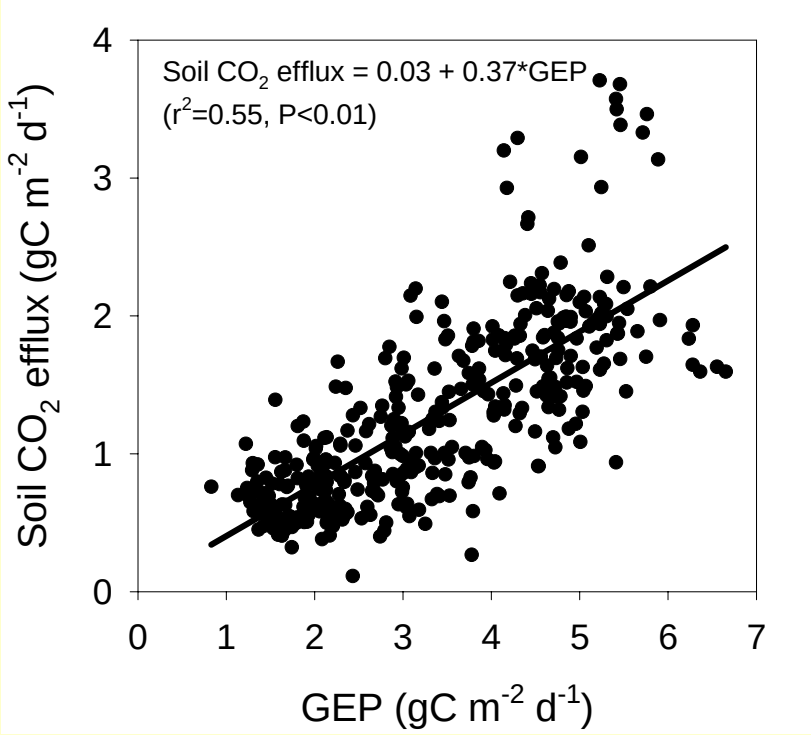
Modeling CO_2 emissions from soils: Del Grosso et al.

Soil CO_2 fluxes as influenced by quantity and type of inputs: the DIRT experiment: Sulzman et al.

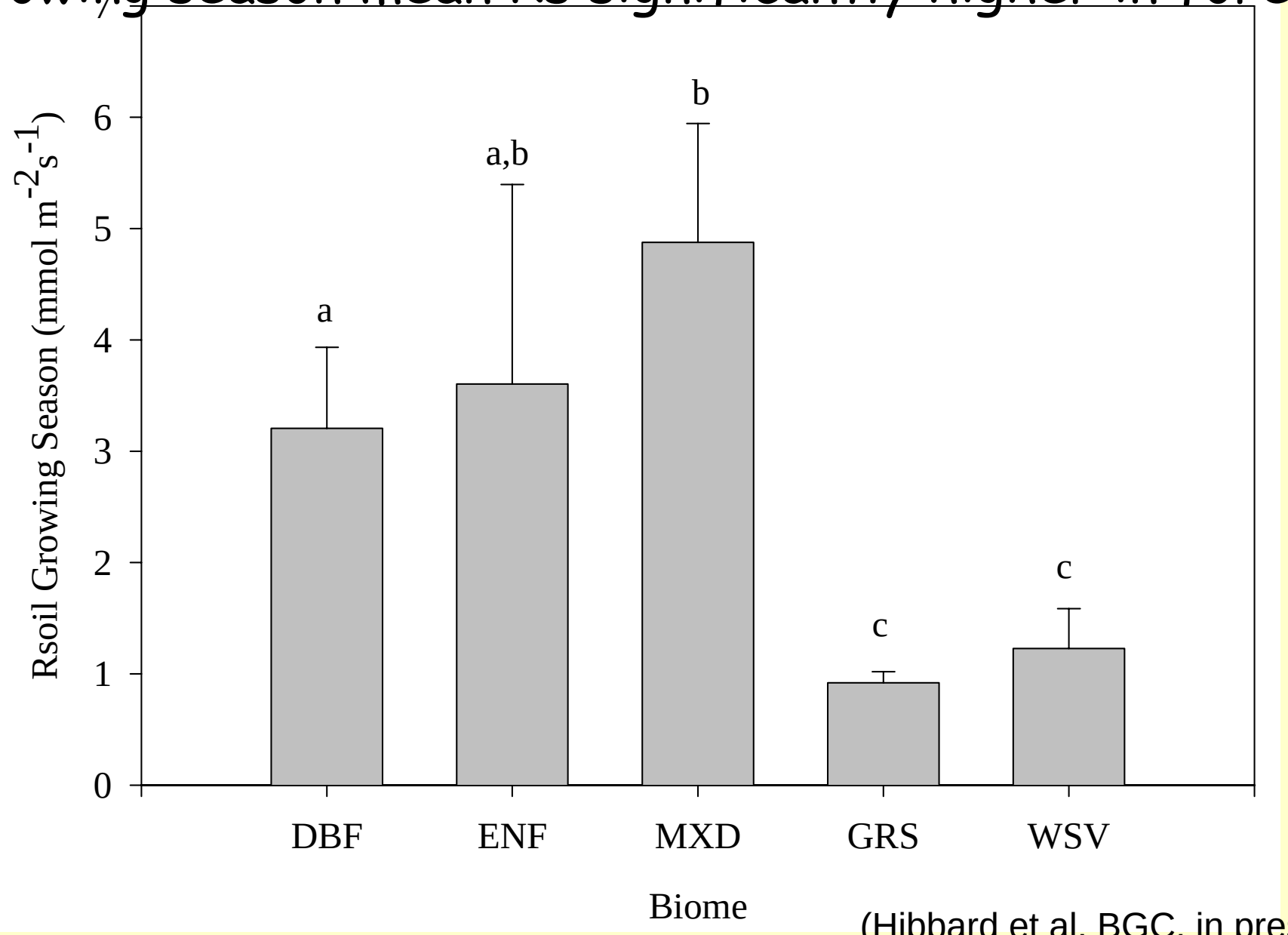
Experimental manipulations of winter and summer precipitation on soil respiration rates in a mixed grass prairie: Chimner & Welker

Processes – Soil Respiration

- **Coupling of daily GPP and soil respiration during the growing season suggests that recently fixed carbohydrates are used in root/microbial respiration within days (Irvine et al., BGC in press).**

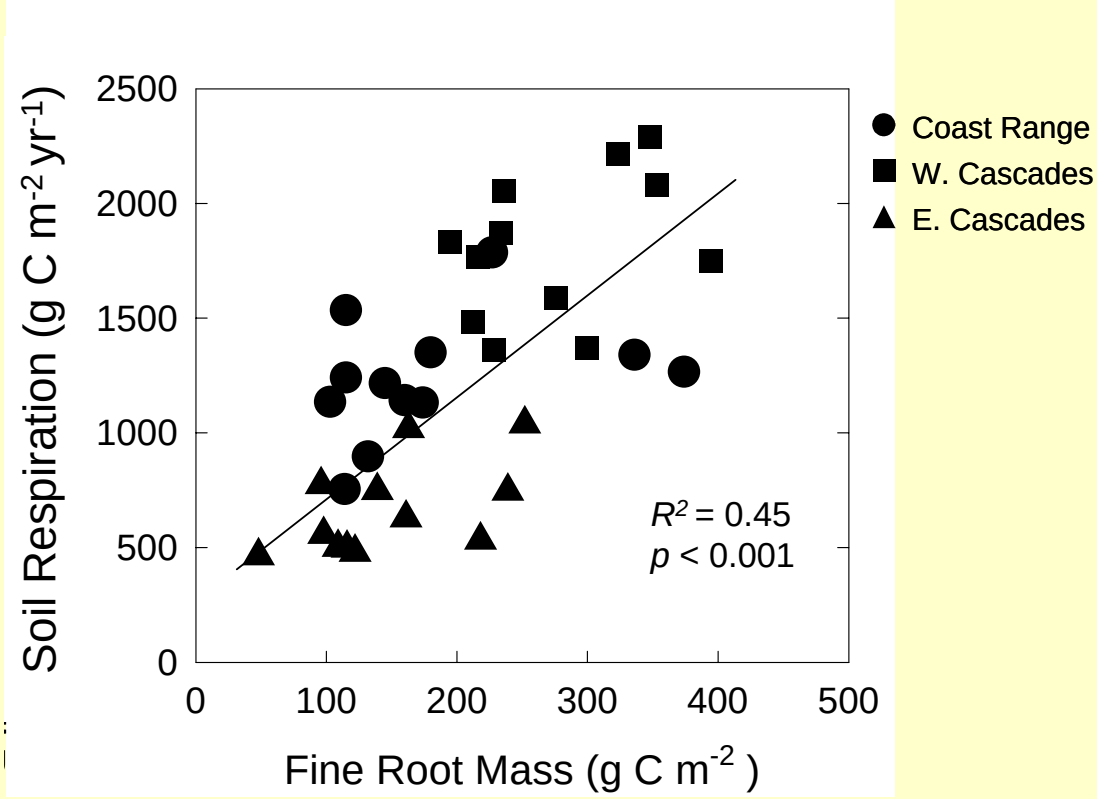


Growing season mean Rs significantly higher in forests



(Hibbard et al. BGC, in press)

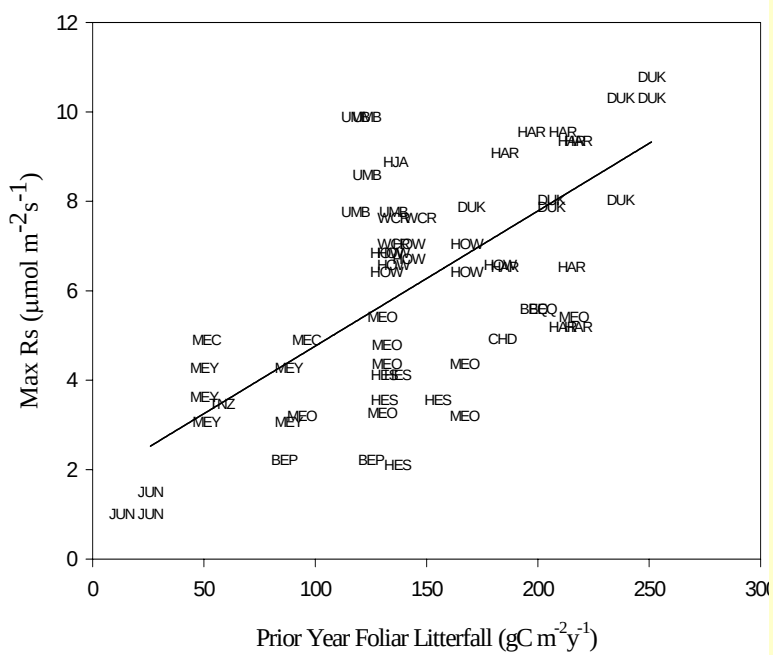
Supply-side Controls on Soil Fluxes in Chronosequences Across a Climatic Gradient (Campbell et al. BGC in press)



Across sites, ~45% of annual soil flux is accounted for by summer max fine root mass

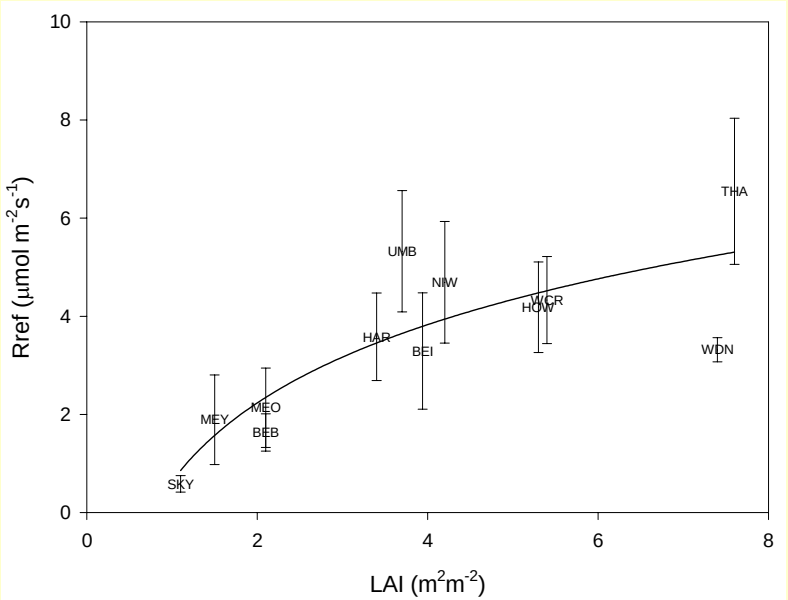
Soil CO_2 Flux Synthesis – Pooled Data
(Hibbard et al. BGC in press)

Substrate for decomposition



> 40% of variability in *maximum* Rs was accounted for by the previous years' litterfall at 12 sites

Substrate for root/rhizosphere



~ 70% of inter-site variability of temporally filtered Rref was explained by LAI, a proxy for assimilation (ref temp 15C). Saturates at high LAI.

Stepwise:

Mean Rref ~ 0.24 + 0.007FrootC + 0.38 LAI

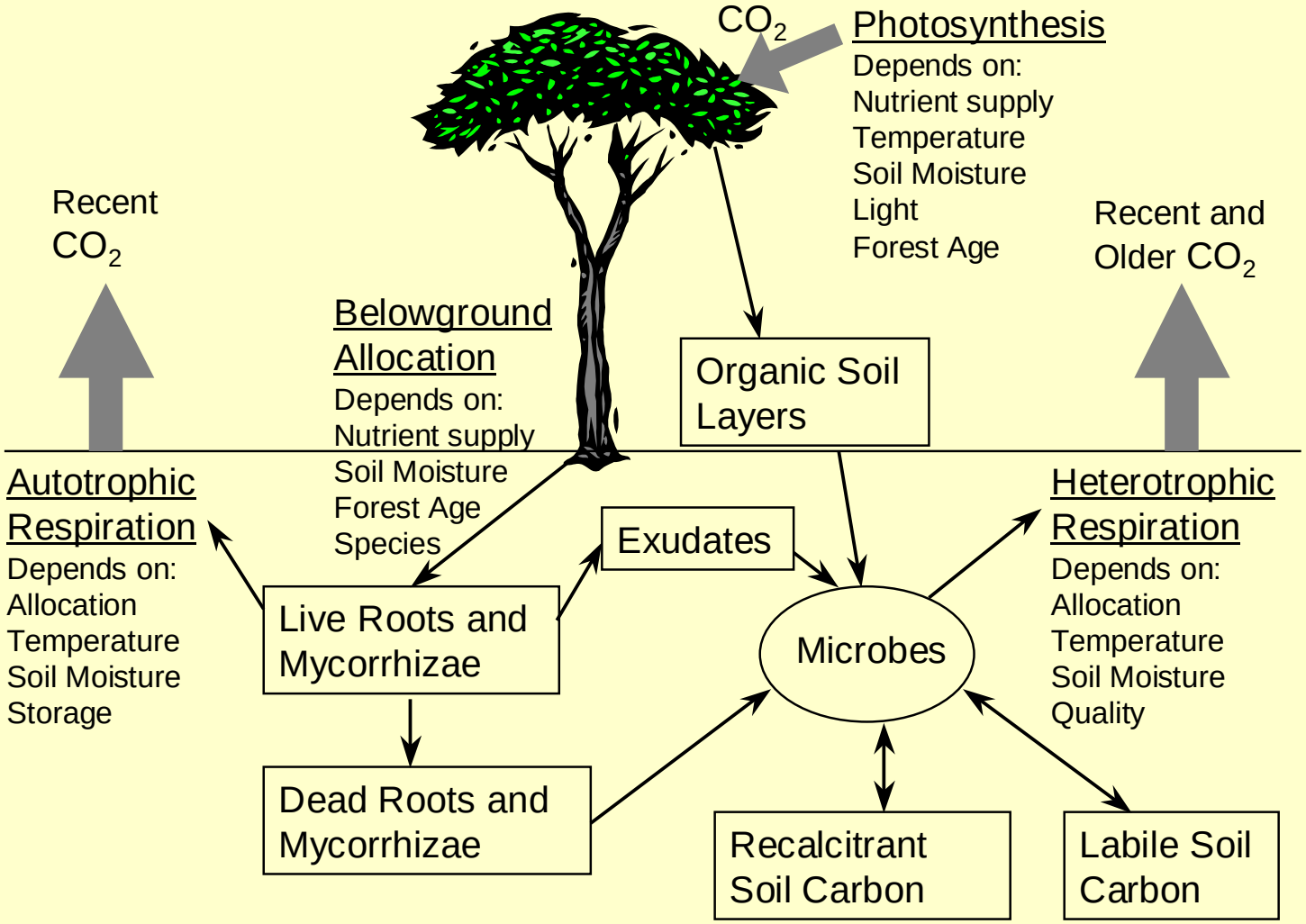
Overall $P < 0.001$; multiple $r^2 = 0.68$

An analysis of soil respiration across northern hemisphere temperate ecosystems – (Hibbard et al. BGC in press)

- 31 AmeriFlux and CarboEurope sites
- Information is needed on the timing and phenological controls of substrate availability and inputs … a full suite of field observations of monthly Rs, phenology, LAI, litterfall and live & dead fine root mass.

Interpretation, Measuring and Modeling of Soil Respiration –

(Ryan & Law, BGC in press)



Summary (Ryan & Law 04)

- Because autotrophic and heterotrophic activity belowground is controlled by substrate availability, soil respiration is strongly linked to plant metabolism, photosynthesis and litterfall
- Small signal from changes in large, slow carbon pools in flux is dominated by decomposition of recent material and autotrophic and mycorrhizal respiration
- Multi-factor experiments are needed, and they must be sufficiently long to allow the systems to adjust to the treatments
- New technologies necessary to reduce uncertainty in estimates of carbon allocation, soil carbon pool sizes, and responses of roots and microbes to environmental conditions