An Introduction to physical ecology

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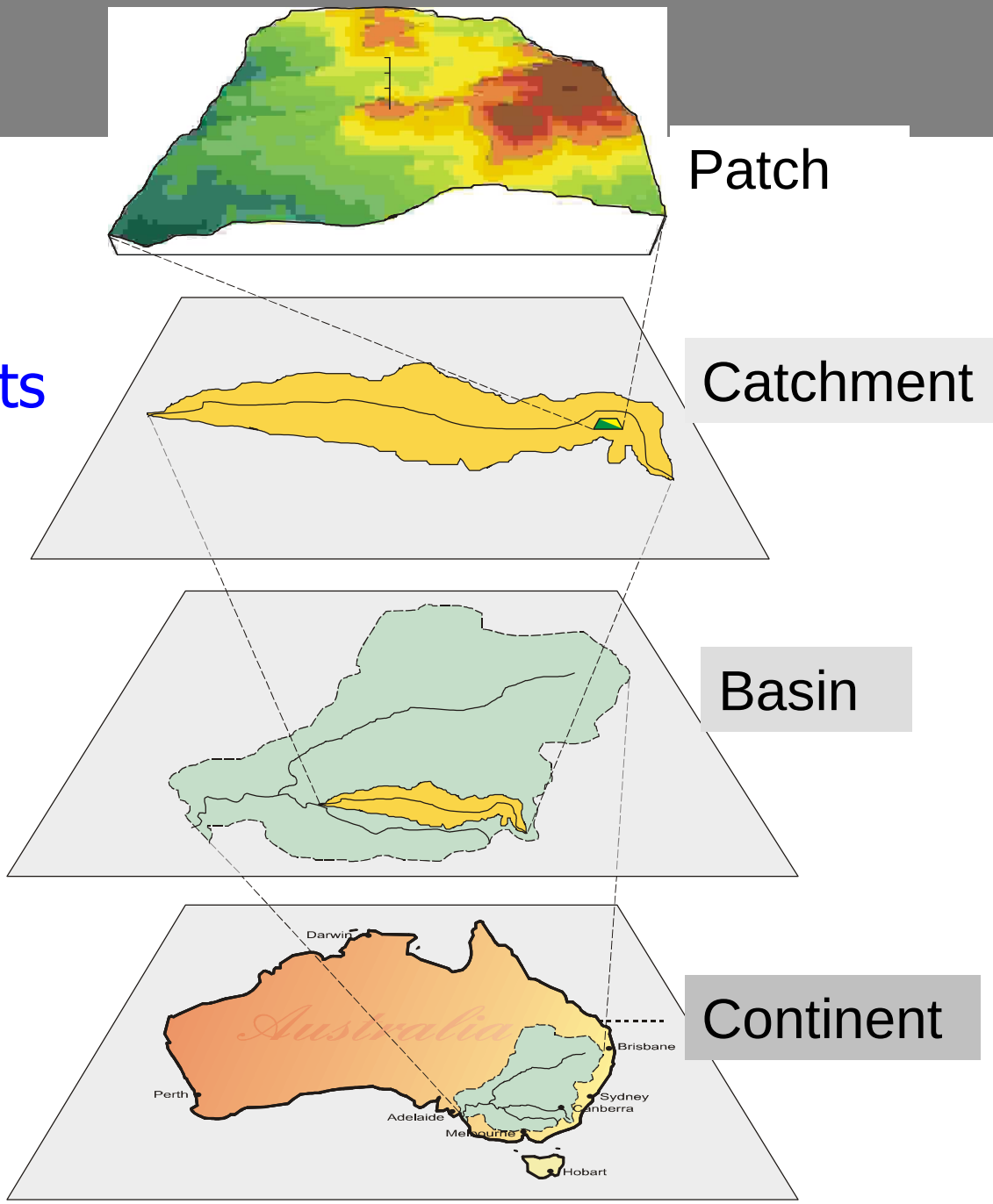
Overview

What the ‘well tempered physical ecologist’ needs to know

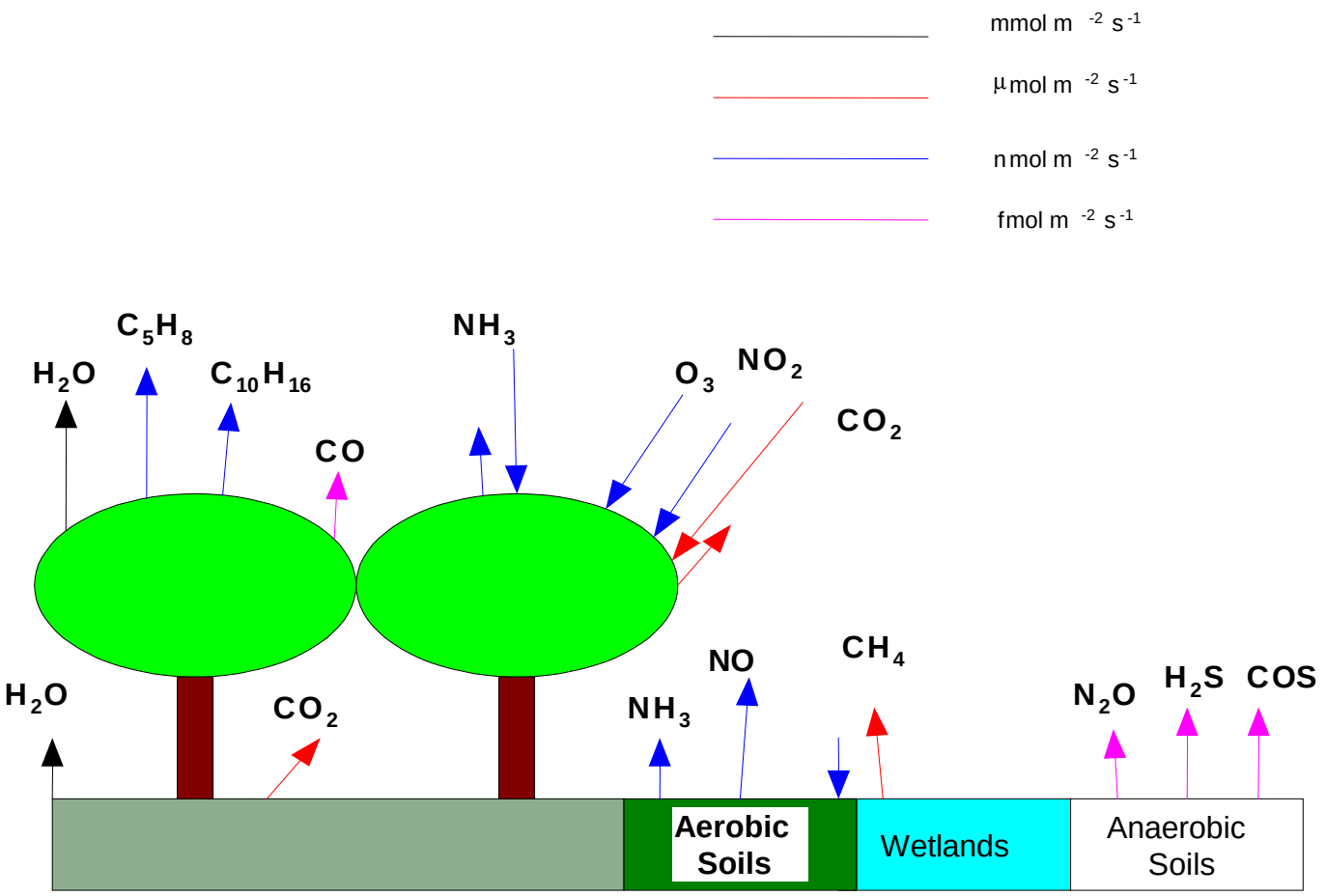
- Day 1 – Earth system science & ecosystem processes
- Day 2 – Everything you wanted to know about micrometeorology but were too afraid to ask
- Day 3 – Visit Wombat State Forest flux station
  - Handling data from flux stations
- Day 4 - Modelling concepts and parameter estimation
- Day 5 – Application of near- to far-field remote sensing to ecology

Big question

How can measurements at local scales be used to construct local to global budgets of C, H_2O, energy and trace gases?

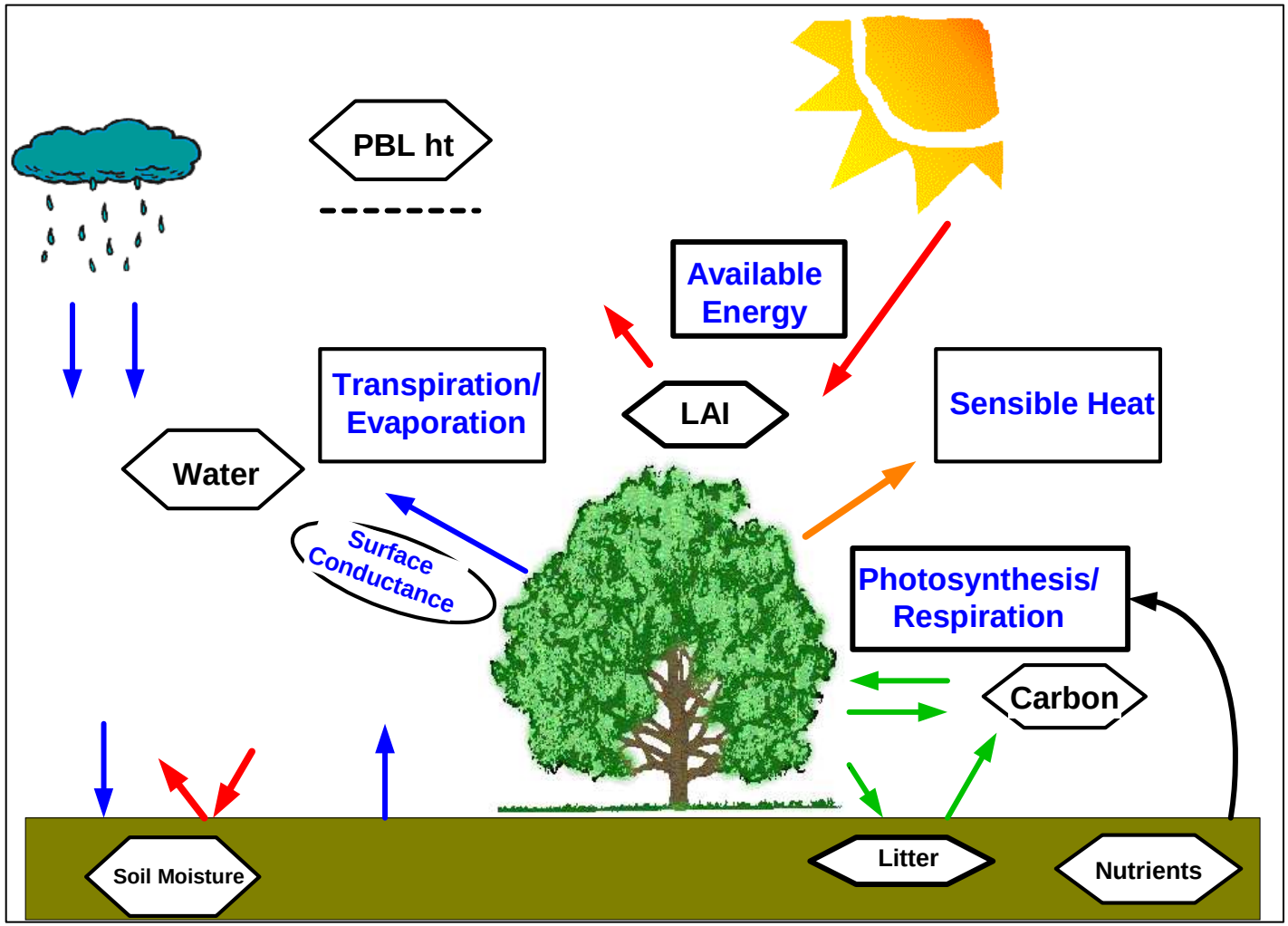


What the biosphere breathes



Courtesy Dennis Baldocchi UC Berkeley

Biogeophysical cycles



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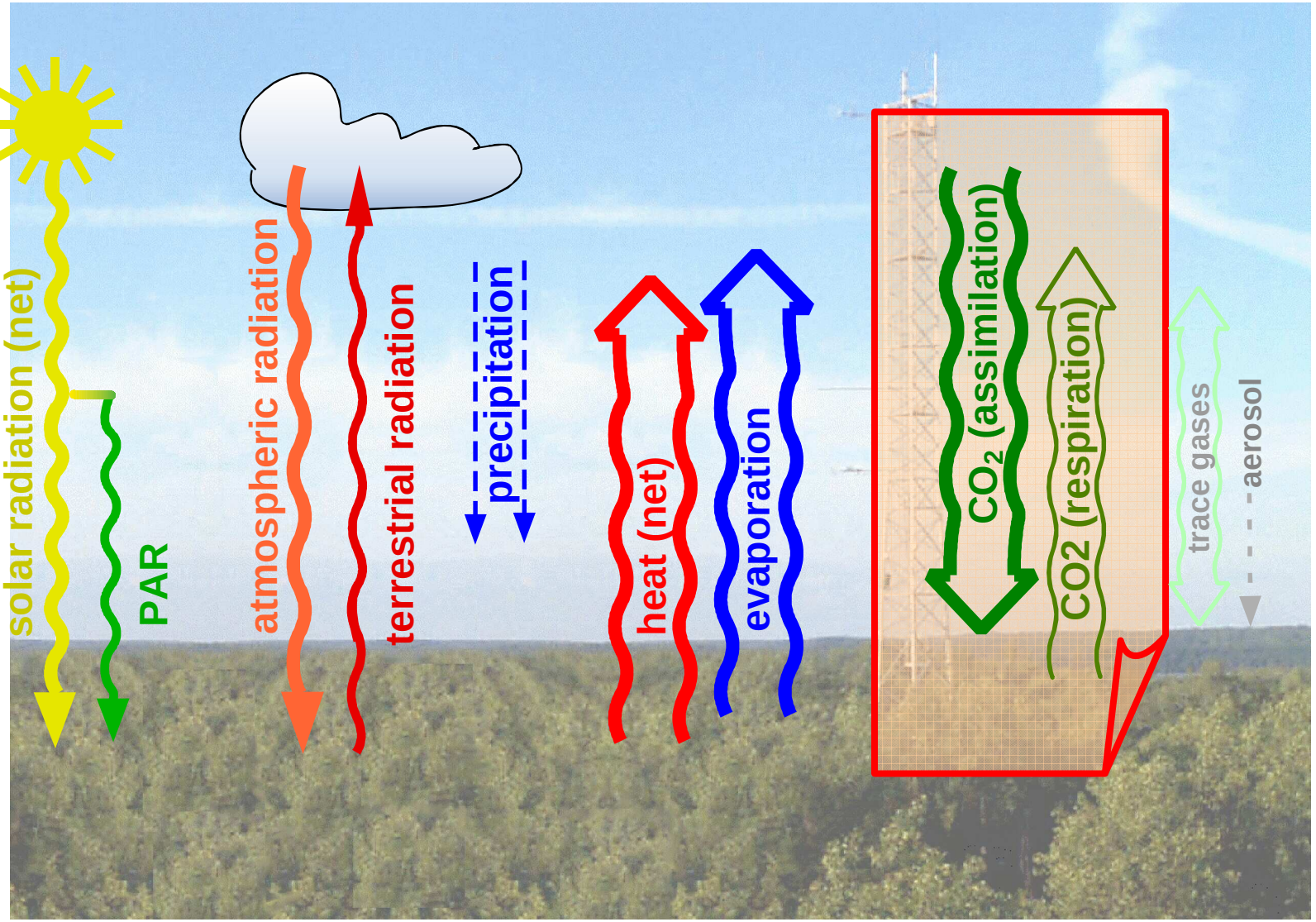
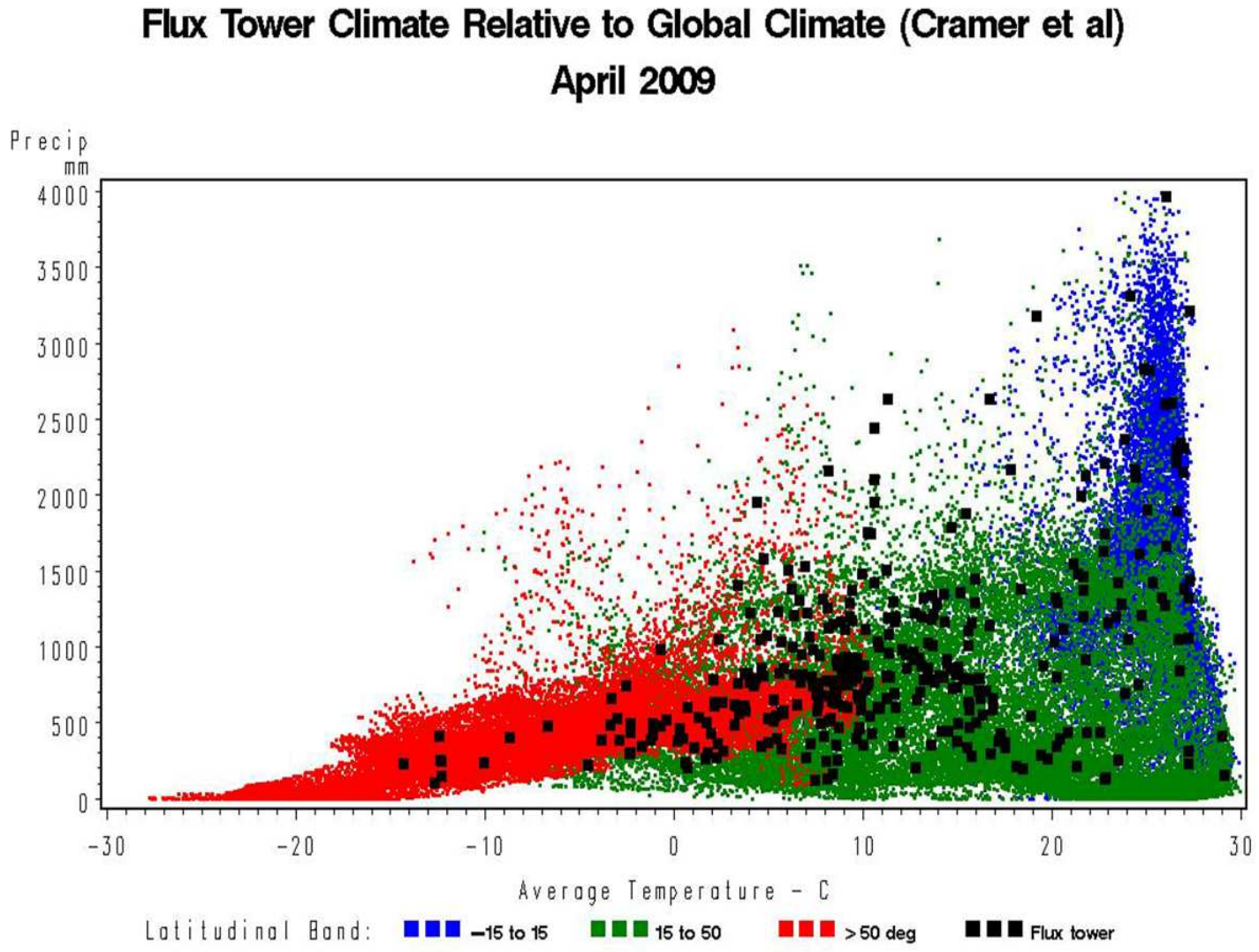
Typical fluxes measured



Courtesy HP Schmid

Cannot measure everywhere, but can sample in bio-climatic space



Courtesy Dennis Baldocchi UC Berkeley

Data from flux stations help to -

Improve understanding of ecosystem processes

- Directly measure mass & energy budgets
- High temporal resolution → new insights
- Data for land surface model validation & development
- Data for model parameters for many land surface types – sample across bioclimatic space
- Carbon cycling
- Hydrology

Validate remote sensing products

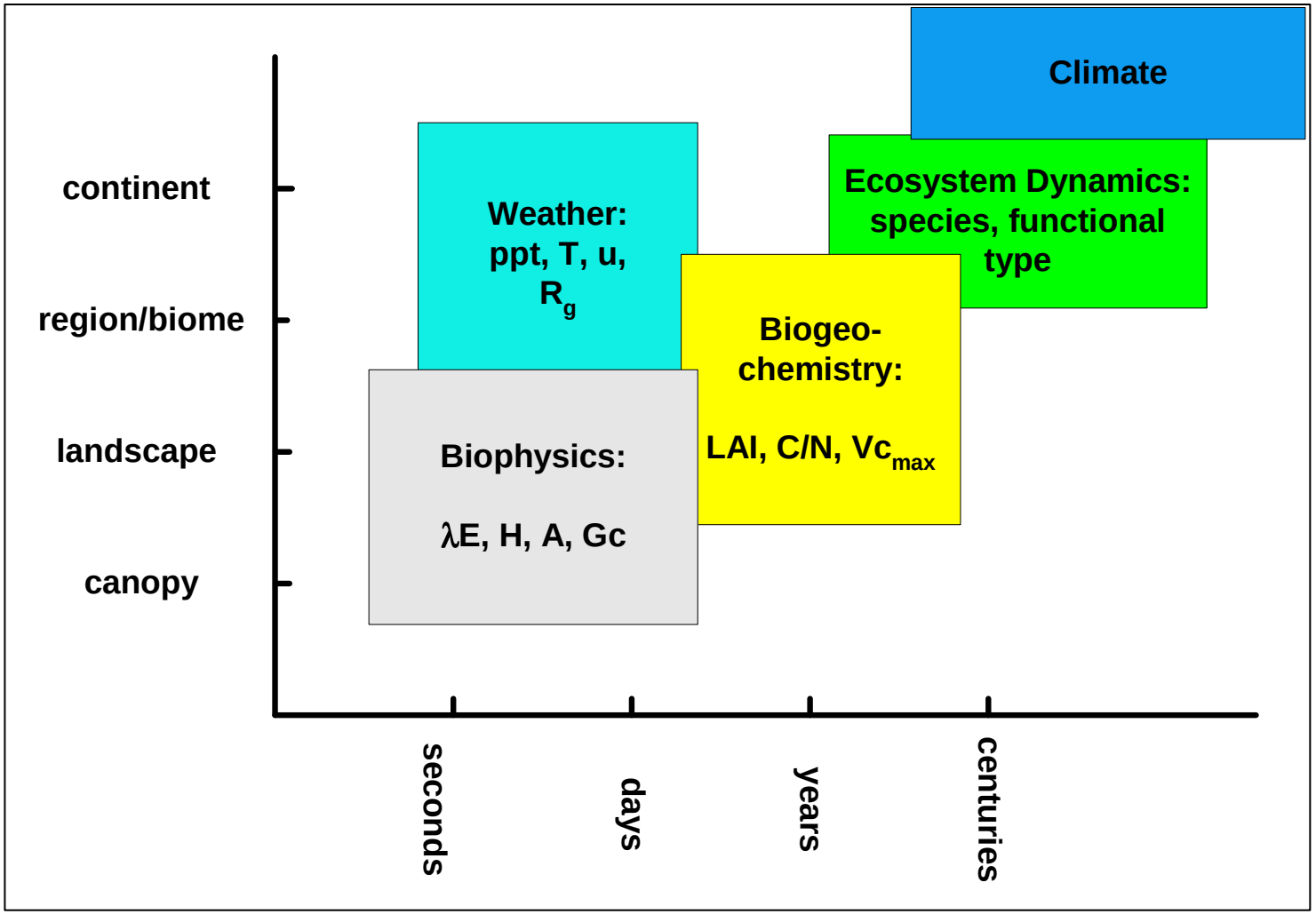
- LAI
- GPP
- Evaporation & catchment water balances

Continuous measurements mean -

New challenges to micrometeorology

- Air flow in canopies
- Air flow over hills
- Nocturnal drainage flows
- Coupling of flow in and above canopies
- Flux-gradient relationships

Controlling processes & linkages: Roles of time and space scales



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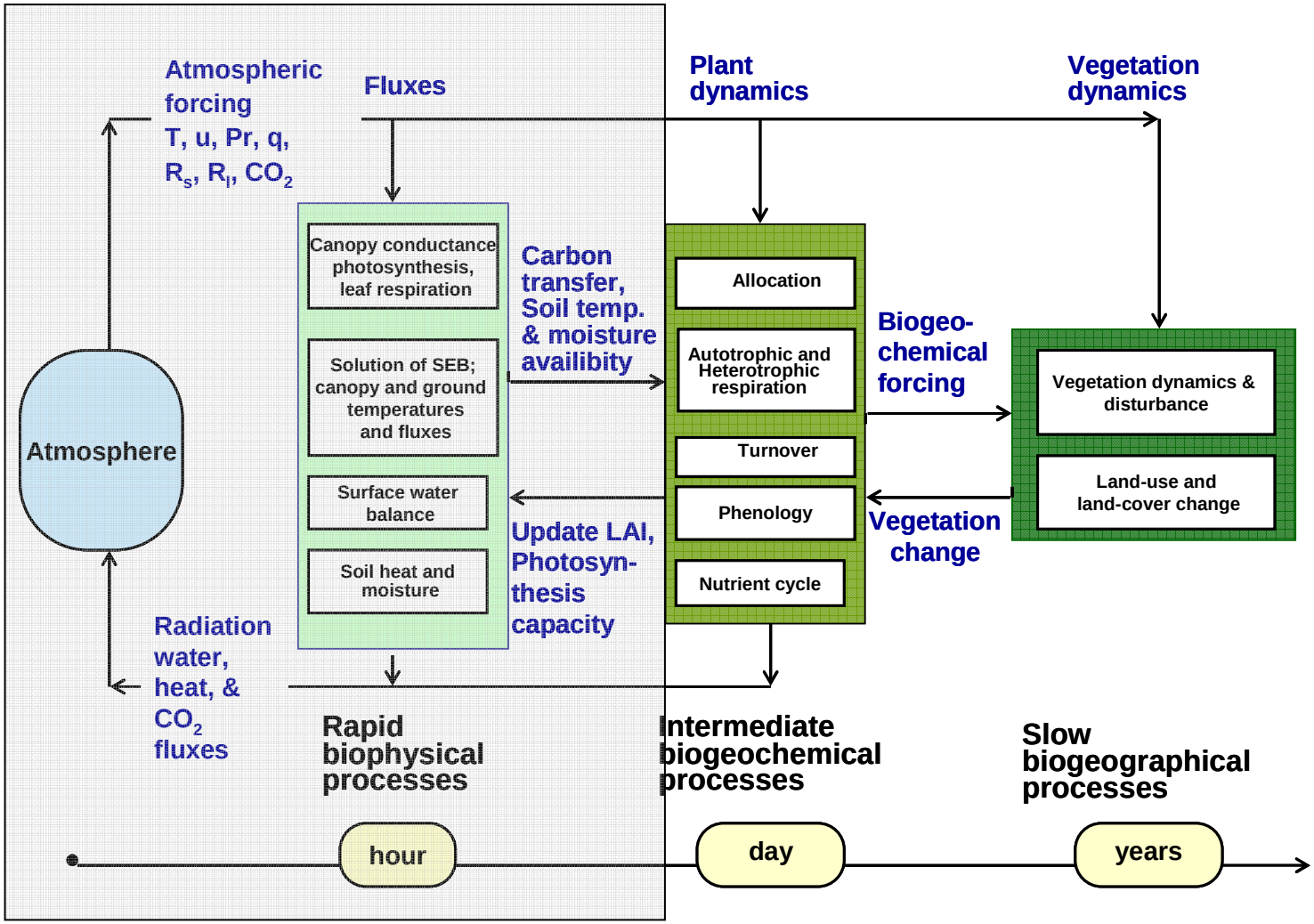
CABLE: a typical land surface model simulates processes at multiple time scales



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Course outline

Start time	Monday, 1 February 2010	Tuesday, 2 February 2010	Wednesday, 3 February 2010	Thursday, 4 February 2010	Friday, 5 February 2010
8:30 - 9:30	Welcome & course outline RL	Essential concepts in atmospheric structure, stability and turbulence statistics RL	Wombat State Forest visit SL, Melb University team	Understanding models & modelling experiments GA	Within-canopy remote sensing - hemispherical photographs, lidar, spectrometers BS, EvG
9:30 - 10:30	Ecology & earth system science LH, PI	Introduction to eddy flux theory RL			Aircraft remote sensing - hyperspectral and lidar measurments JH
10:30 - 11:00	Break	Break		Break	Break
11:00 - 12:00	Introduction to the soil-plant-atmosphere continuum RL	Air flow in complex terrain & nocturnal fluxes EvG		Introduction to CABLE, the Community Atmosphere-Biosphere Land Exchange Model VH	Potential and limitations of satellite remote sensing AH
12:00 - 13:00	Stocks and flows of water, carbon and energy through ecosystems LH & WM	Using the theory to make good measurements RL		Hands on: Parameter estimation, data assimilation GA, JB, RL, PI, VH	Some application of satellite remote sensing: fire & phenology BS, JB, LH
13:00 - 14:00	Lunch	Lunch	Lunch	Lunch	Lunch
14:00 - 15:00	Soil trace gas exchange measurements SL & Melb univ	Introduction to flux station instrumentation - sensors, data loggers, programming, … Flux station management & safety PI, DH	General discussion: Critical assessment of flux station design at Wombat State Forest Lead: ML	Hands on: CABLE exercise Parameter estimation, data assimilation GA, JB, RL, PI, VH	Wrap up and student feedback RL
15:00 - 16:00	Ancillary ecological measurements I - allometry, sap flow, fluxnet tables. LH, JB, ML		Data editing, quality control & gapfilling PI, EvG		Pack up and return to base
16:00 - 16:30	Break	Break	Break	Break	
16:30 - 18:00	Ancillary ecological measurements II - LAI. Soil and Site characterisation. LH, JB, SL	Principles of design & setting up a flux station PI, JB	Hands on: data editing and gap-filling PI, EvG, RL	Interpreting ecosystem scale fluxes of carbon and water LH	
18:00 - 19:30	Dinner	Dinner	Dinner	Dinner	
19:30 - 21:00	Student posters	Student posters	Relaxation	Relaxation	

Why do I need all this knowledge?
“I can drive a car without knowing how it works!”

Many components needed to understand & model ecosystems

Knowledge provides flexibility and adaptability

- The most successful scientists bring knowledge from different disciplines to create new understanding

Tomorrow’s problem will not be the same as today’s

- Basic knowledge will help with problem solving skills

A physical ecologist needs knowledge in many fields