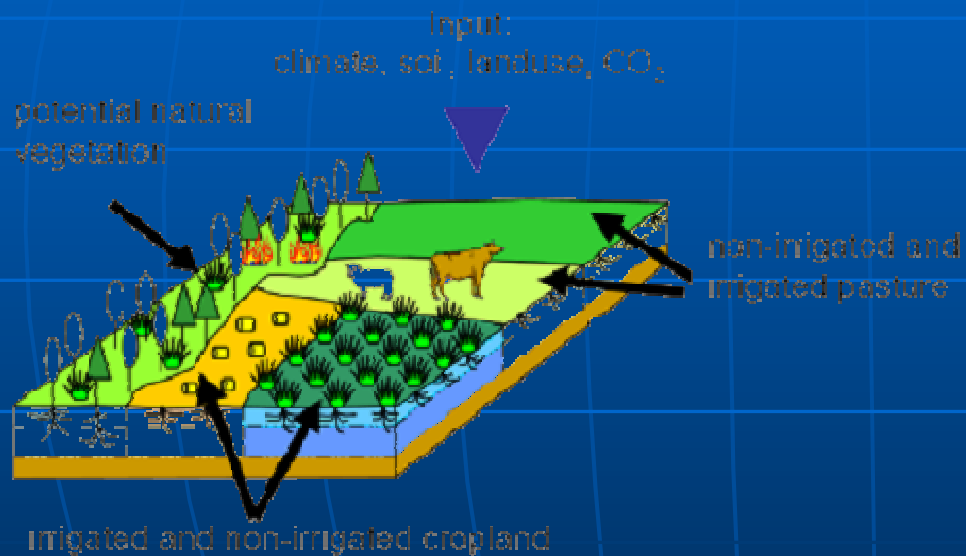# Hydrologic controls on Amazonia carbon balance
## (results from the LPJ-DGVM)

Ben Poulter, Fanny Langerwisch, Ursula Heyder, Wolfgang Cramer and Wolfgang Lucht

Potsdam Institute for Climate Impact Research, Germany

LPJ-DGVM framework

- Sitch et al. 2003

- Coupled biogeography-biogeochemistry model

- Simulates first order processes at daily time interval

- Carbon allocation and vegetation dynamics simulated at annual time interval
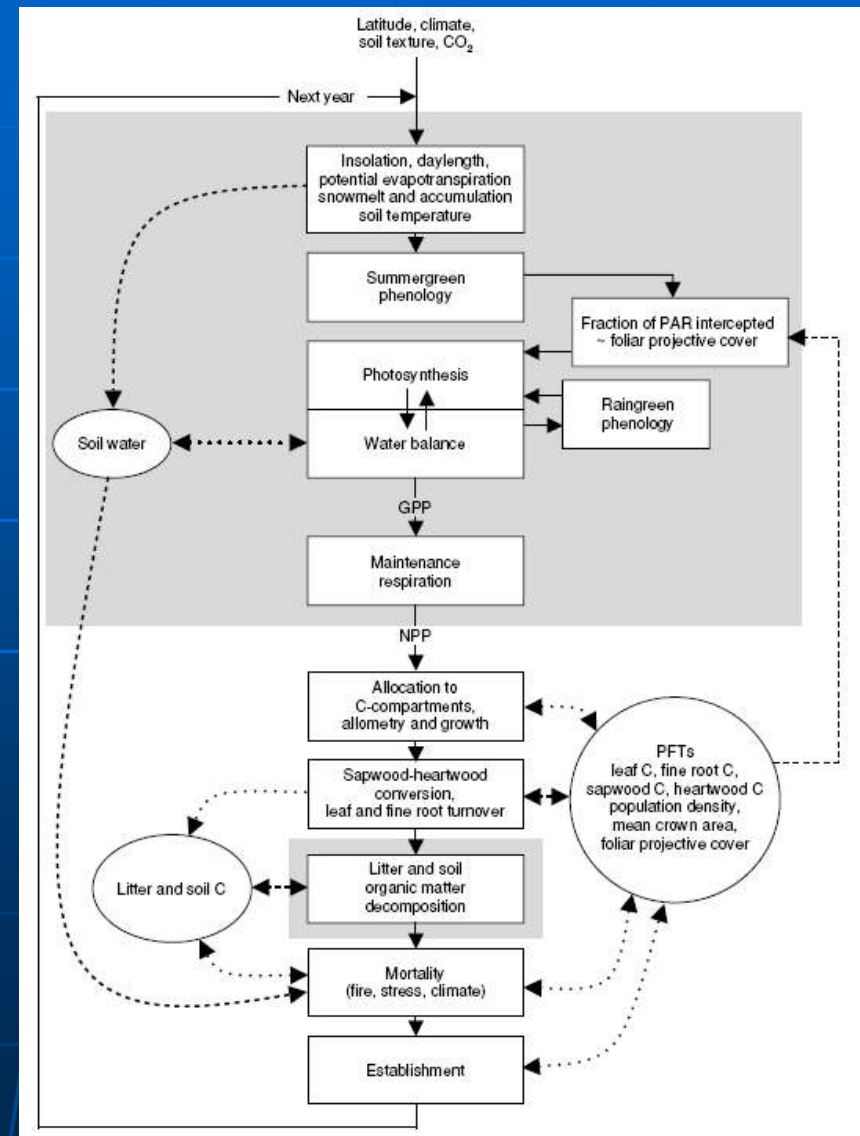
LPJ Photosynthesis

- Farquhar photosynthesis model modified for global modeling purposes
  - Assumes leaf N-content varies seasonally and with canopy position to maximize net assimilation
  - C3 / C4 biochemical pathways modeled differently
- Inputs
  - Calculated at a daily time scale
  - CO_2, temperature, soil moisture, PAR, daylength
- Soil moisture limits conductance under water-stressed conditions (W)
  - W = Supply / Demand

LPJ Soil Respiration

- Three SOM pools with specific turnover time (`at 10° C)
  - Litter (3.86 yrs)
  - Intermediate (33.3 yrs)
  - Slow (1000 years) soil carbon pools

- Respiration is soil temperature (*T*)and moisture *(W)* dependent
  - Soil temperature follows a modified Arrhenius relationship *g(T)*
  - 70% of decomposed litter enters atmosphere
  - ~28% of decomposed litter enters intermediate pool
  - ~2% of decomposed litter enters slow pool

$$k = \frac{(1/\tau_{10})g(T)f(W_1)}{12}$$

LPJ-Modeling Protocol for LBA-MIP

- Inputs
  - Daily mean temperature
  - Total daily incoming shortwave radiation
    - Converted to PAR and PET
  - Total daily precipitation
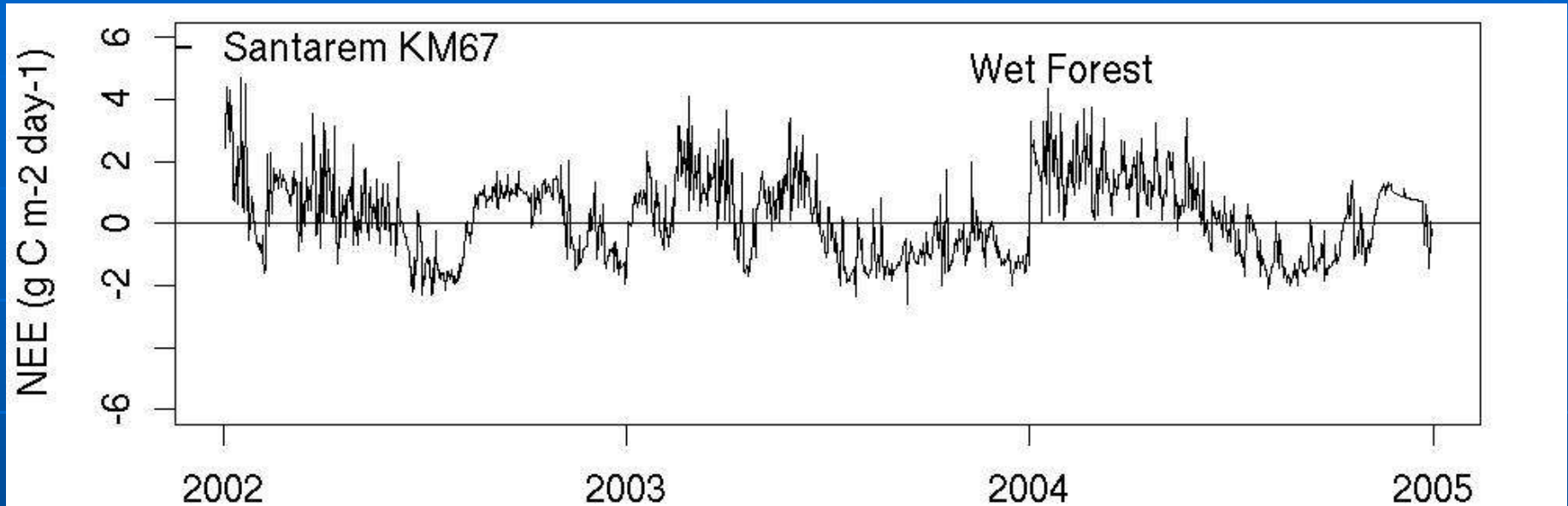 - Soil type
  - Annual CO_2 from Mauna Loa

- Protocol
  - 1000 year spin-up repeating site data
  - Fire disturbance module turned off
  - Fixed vegetation for pasture (no trees)
  - Dynamic vegetation for savannah and wet forests
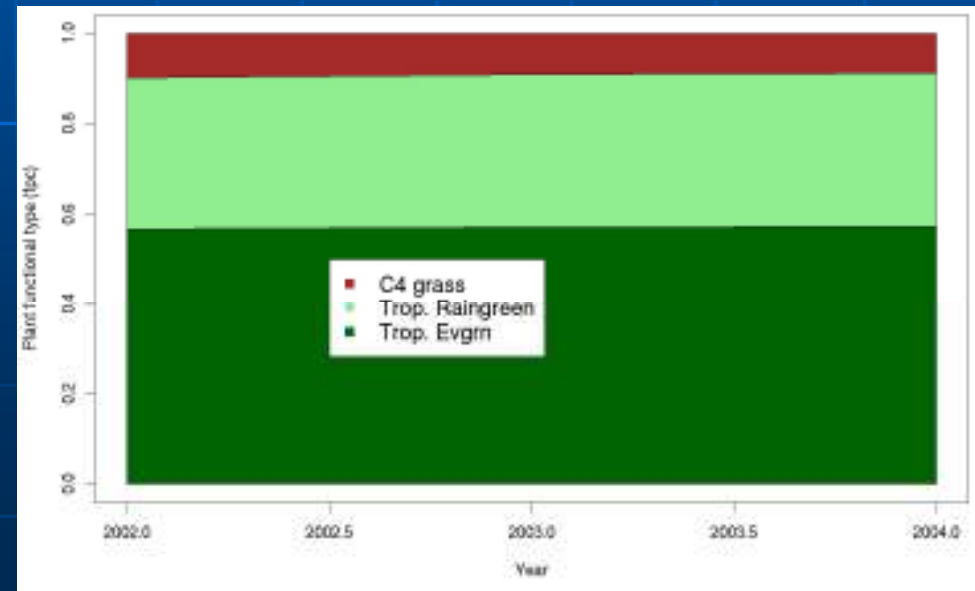   - No fixed LAI, ecosystem type etc…
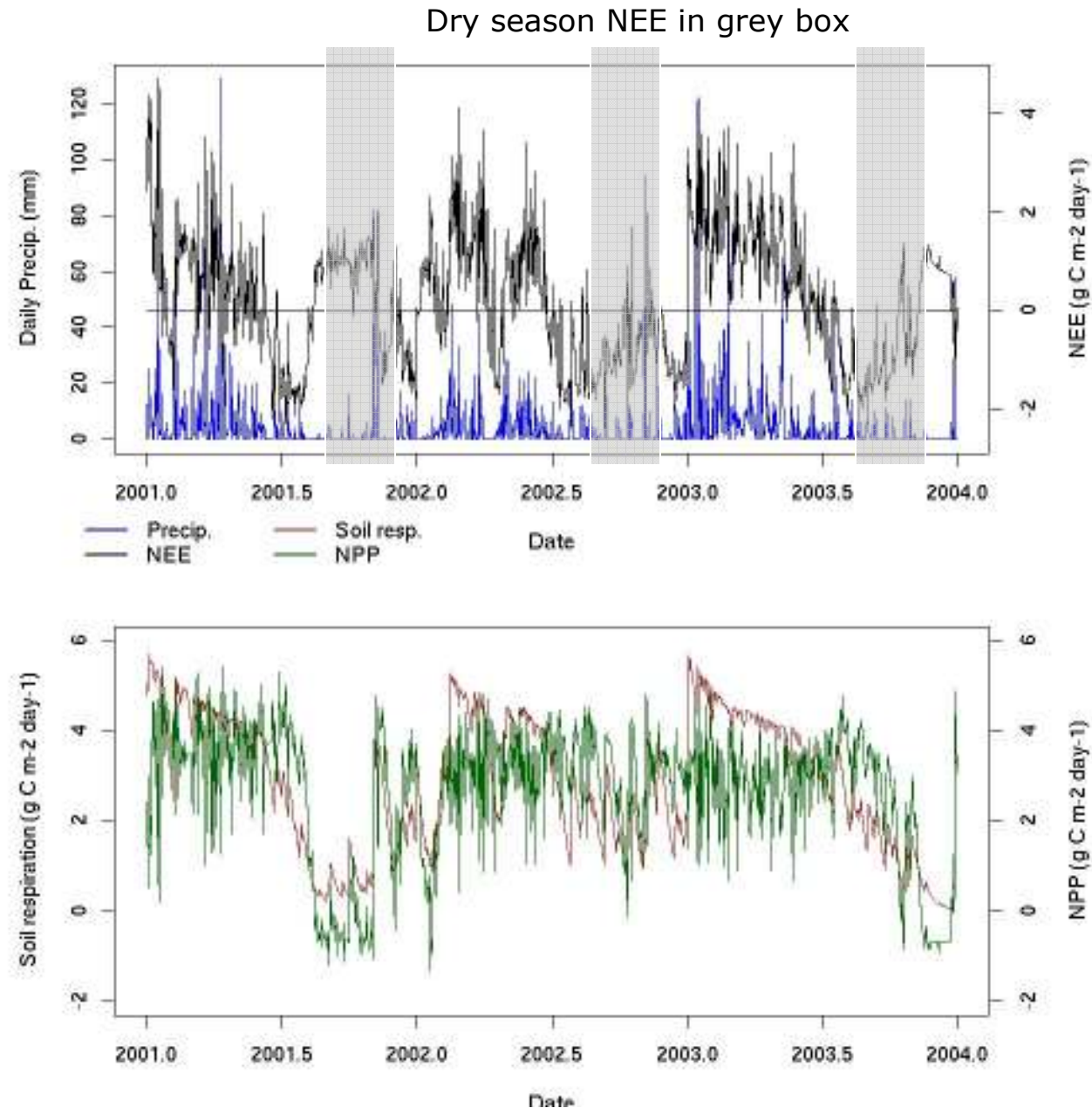
LBA Net Ecosystem Exchange
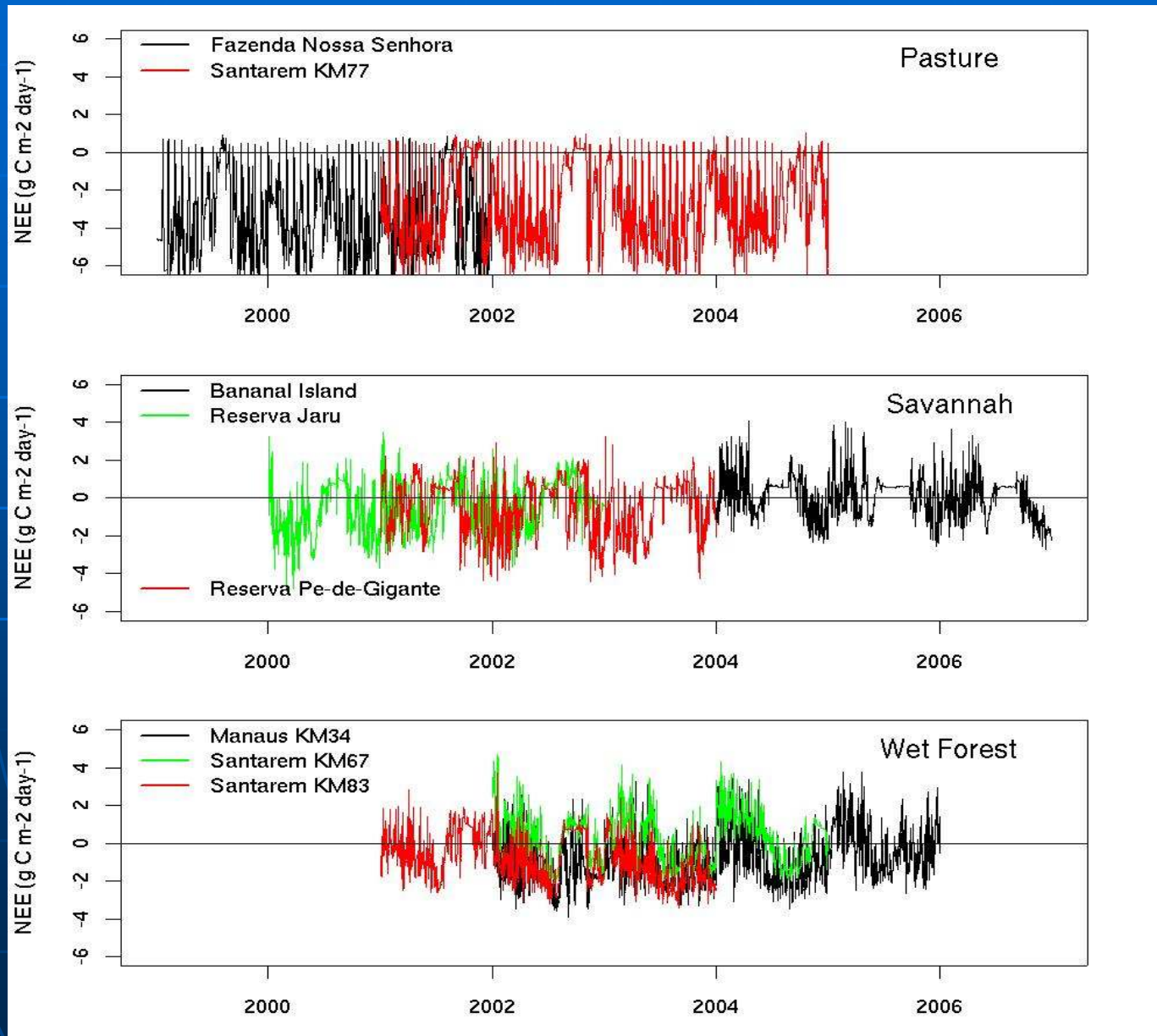
Santarem KM67

Modeled Annual C-Fluxes (Mg C ha yr^{-1})

Year	GPP	NPP	RH	NEE
2002	20.1	9.15	10.09	0.94
2003	21.96	10.74	10.53	-0.21
2004	19.07	8.86	10.45	1.6

• Negative denotes downward flux

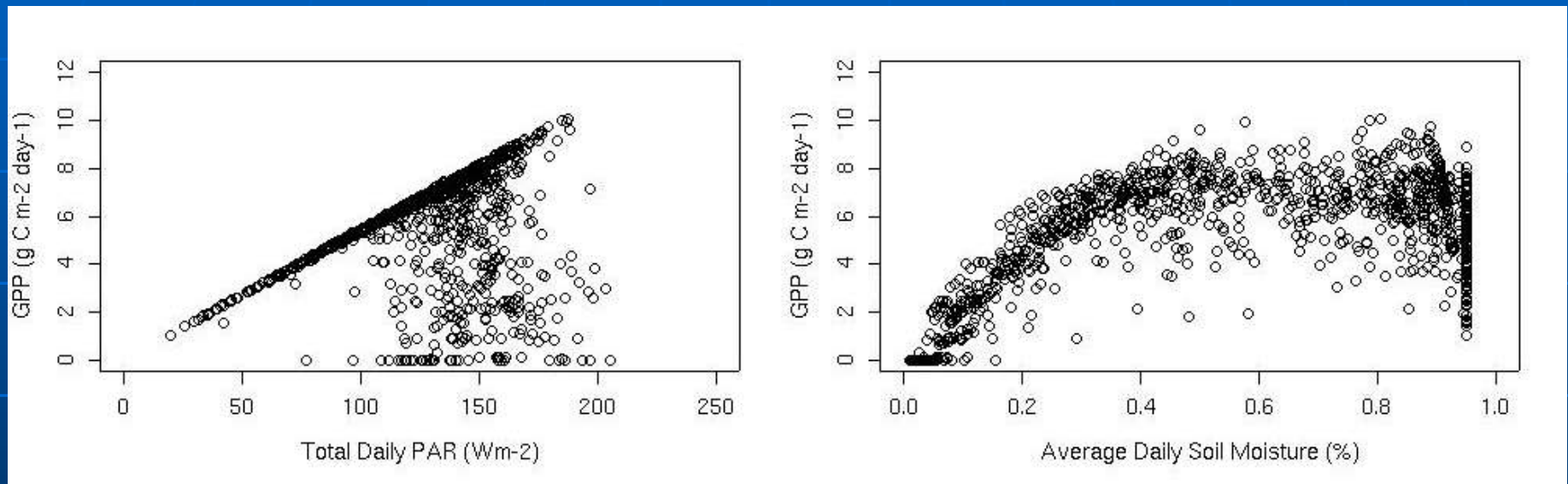# Santarem KM67 c-dynamics

Dry season NEE in grey box
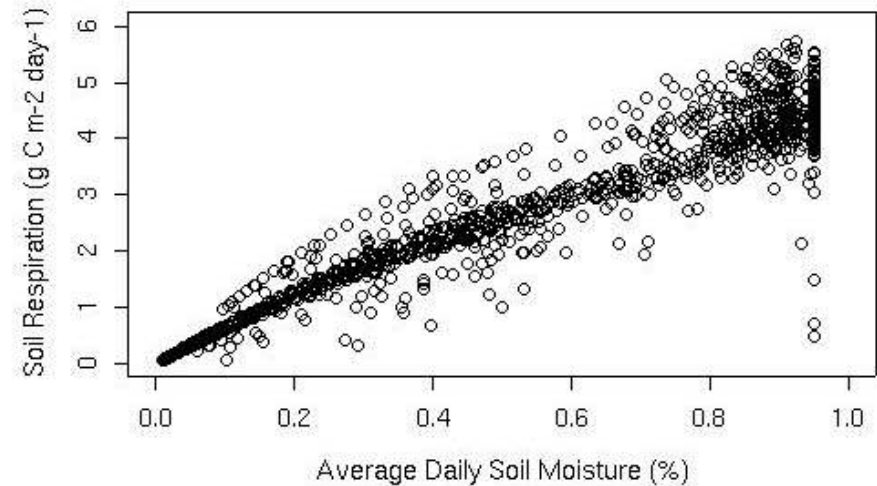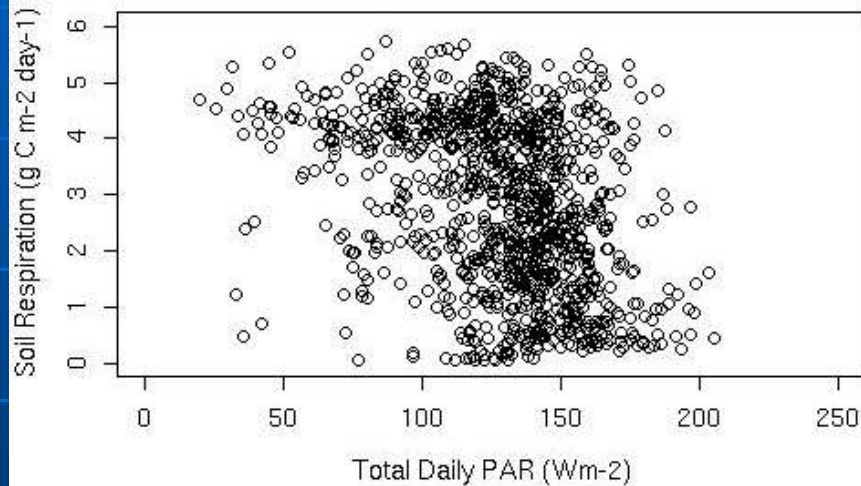
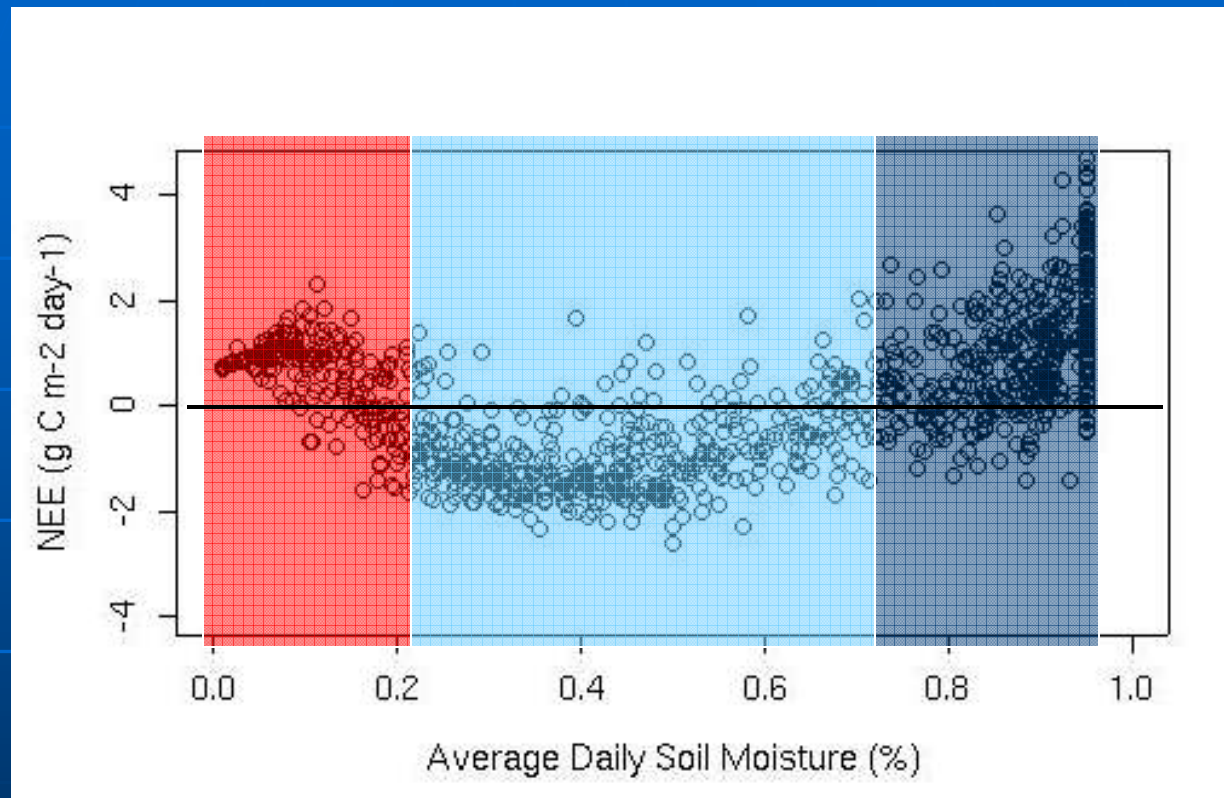# Santarem KM67 c-dynamics
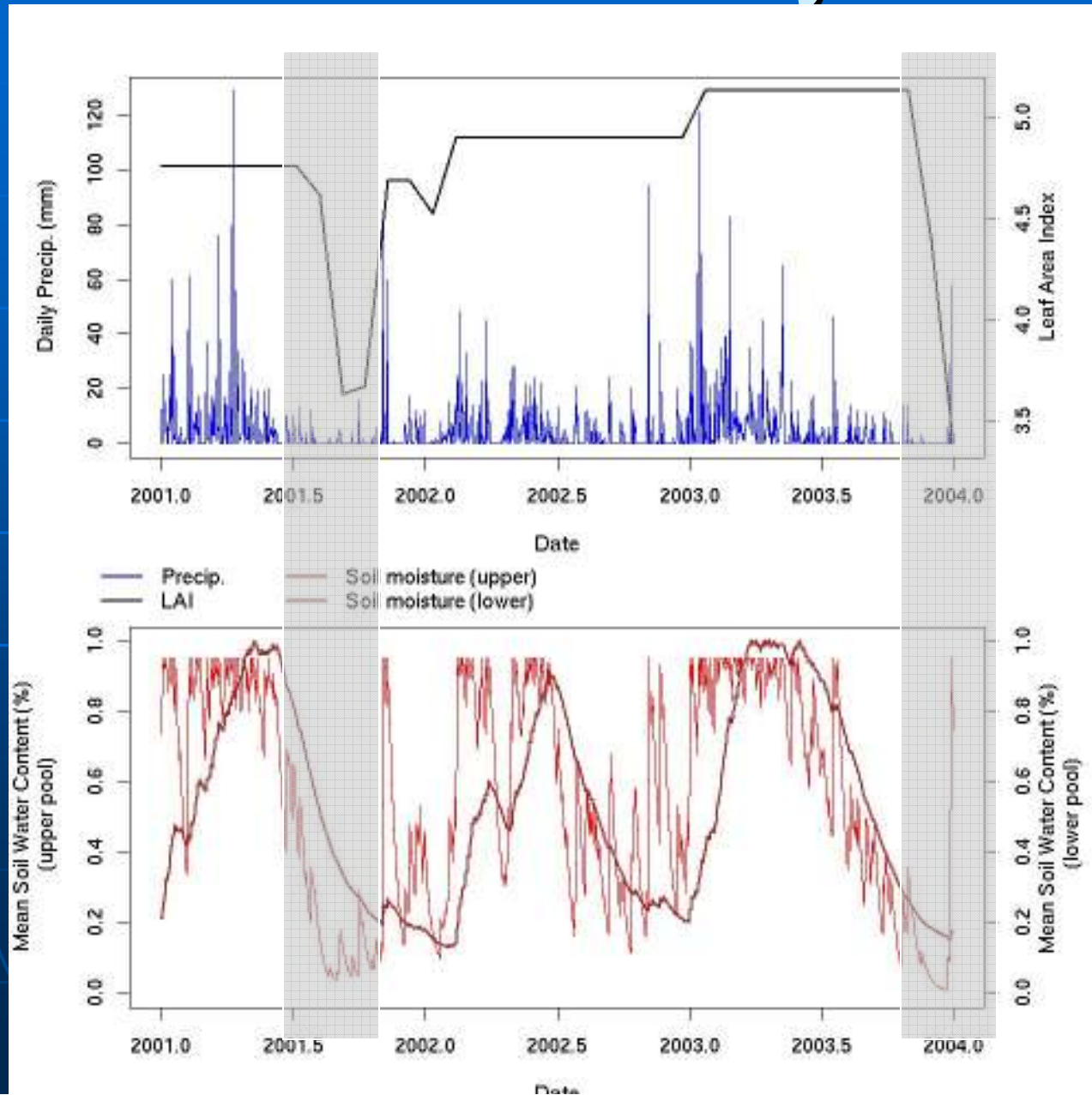
Santarem KM67 response curves

- Photosynthesis co-varies with soil moisture and PAR

Santarem KM67 response curves

- Soil respiration determined by soil moisture

Santarem KM67 response curves

- NEE primarily limited by soil moisture and its effects on soil respiration
  - Low soil moisture – combined effect of low NPP & low RH
  - Moderate soil moisture – high NPP dominates NEE
  - High soil moisture – high RH dominates NEE

Summary from LPJ

- Length of dry period determines c source-sink status
  - Short dry period
    - Reduced soil respiration, c-sink
  - Long dry period
    - Reduced LAI, lower NPP, c-source

- Feedbacks include
  - Lower productivity in drier climate & effects on soil processes
    - Litter carbon in wet forest 17-19 Mg C ha^{-1}
    - Litter carbon in savannah 14-17 Mg C ha^{-1}
  - Consumption by more frequent fire in drier climate