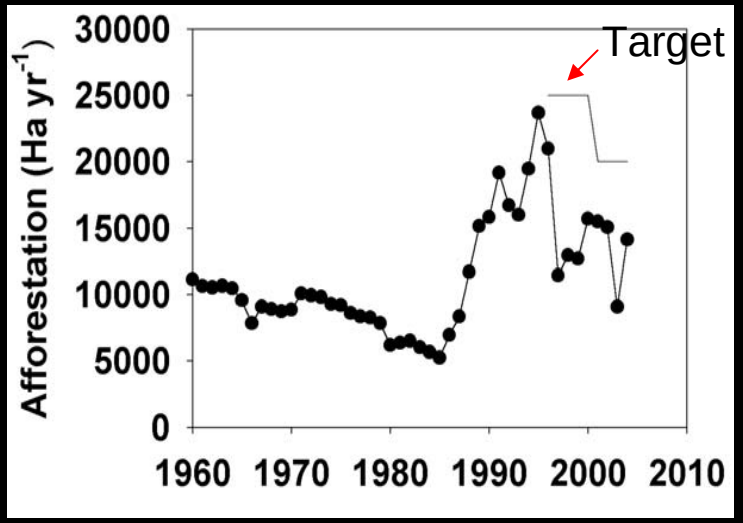
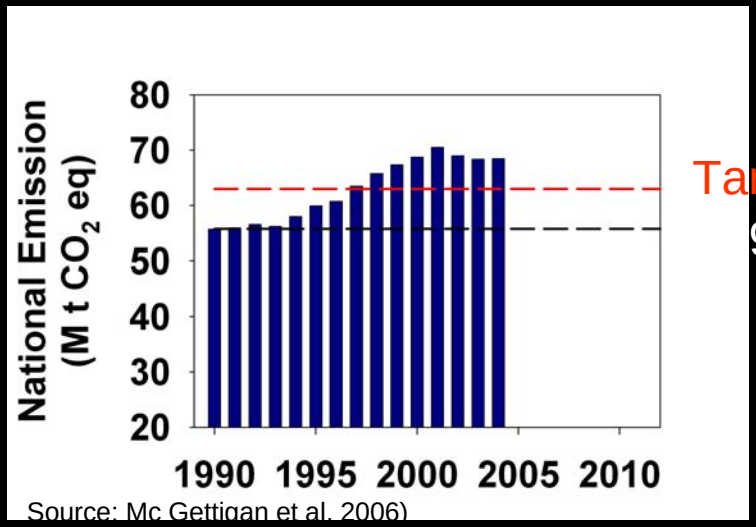
Scaling up from the stand to regional level

Kevin Black

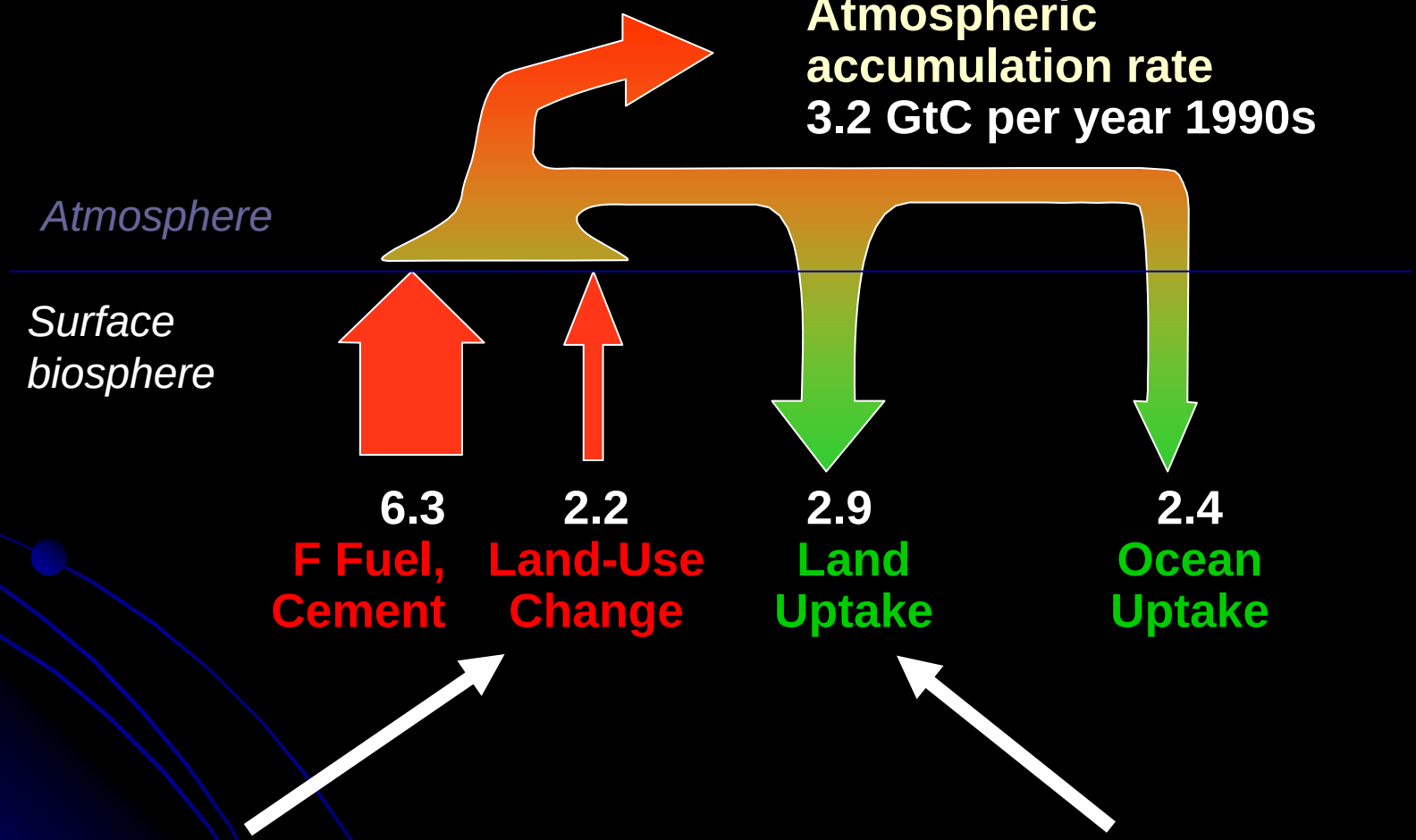
- Ireland may overshoot Kyoto target by 23 % (NIR 2004)
- Afforestation since 1990





- Article 3.3 forest could reduce this by 16 to 20%
  - Large degree of uncertainty
    - Not well defined or estimated
    - No inventory data until 2006
    - - use of generalised models

The LULUCF challenge



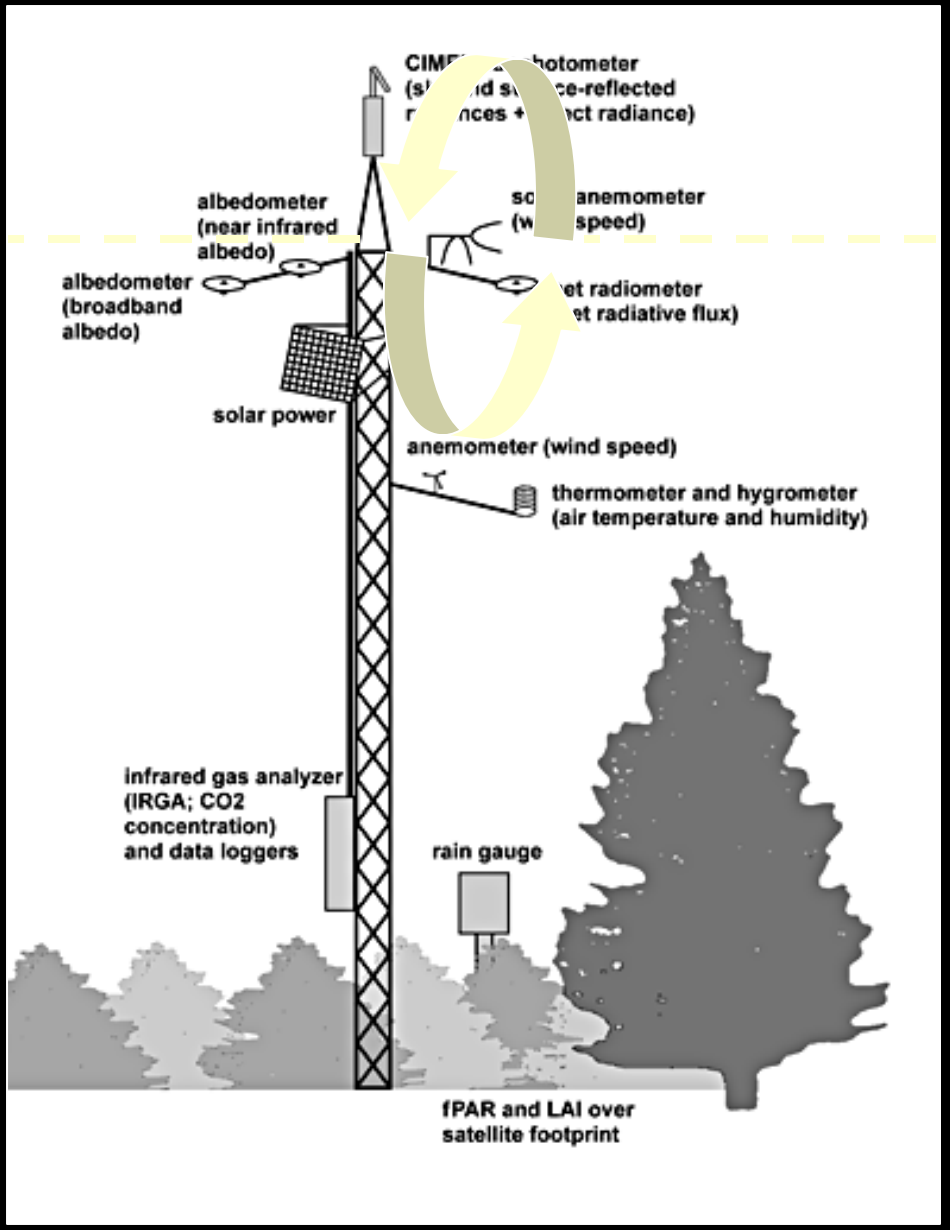
Gruber et al 2003 , SCOPE project

Eddy covariance technique

+ Measures whole ecosystem exchange of CO_2 and H_2O
+ Non-destructive & continuous
+ Time-scale hourly to interannual

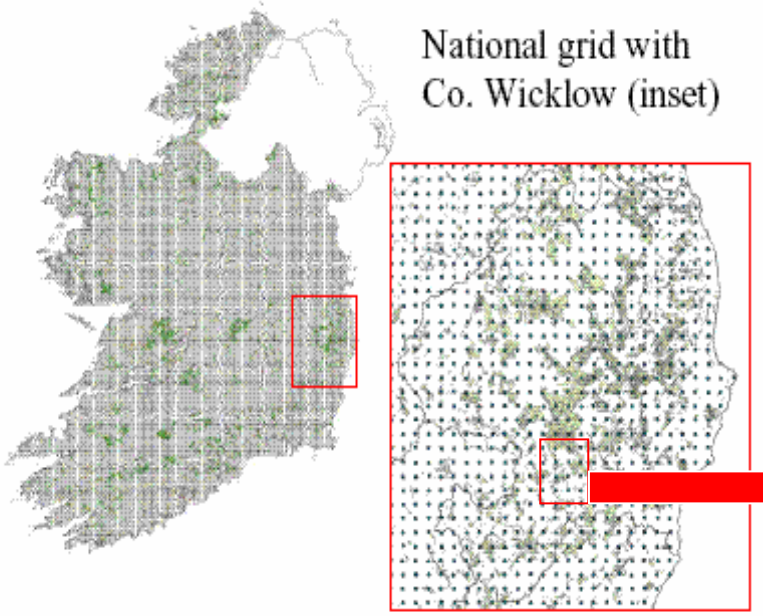
- relies on turbulent conditions
- source area varying (flux footprint)
- only “point” measurements

Limited reporting potential but can be used for validation

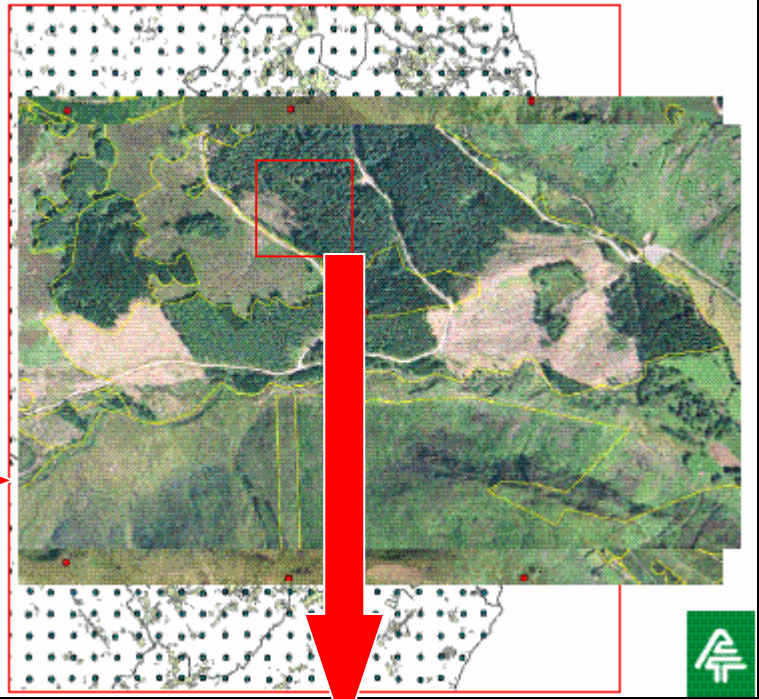


National forest inventory

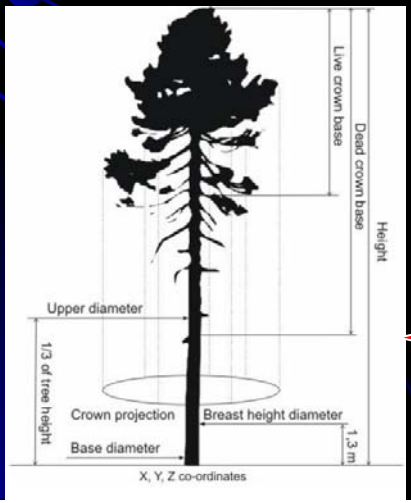
PHASE 1- SAMPLE GRID – 2 x 2 km



Forest Identification

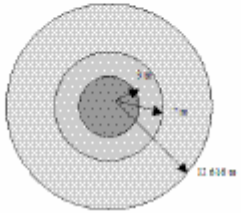


17,423 primary plots
~1800 permanent sample plots

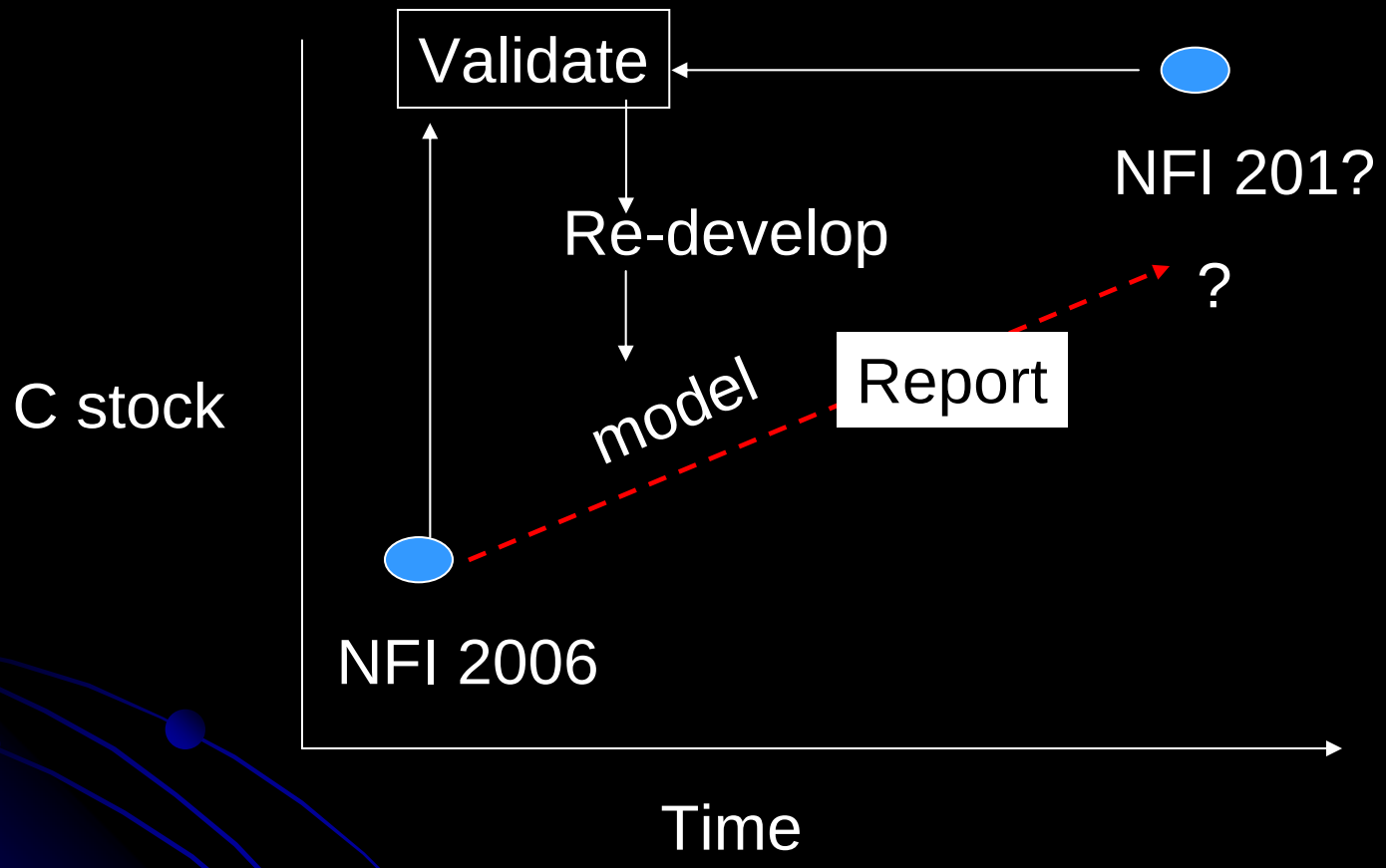


INVENTORY DESIGN – Plot Layout

- Circular plots 12.6m radius (500m2)
- Concentric circle approach, 3m, 7m and 12.6m

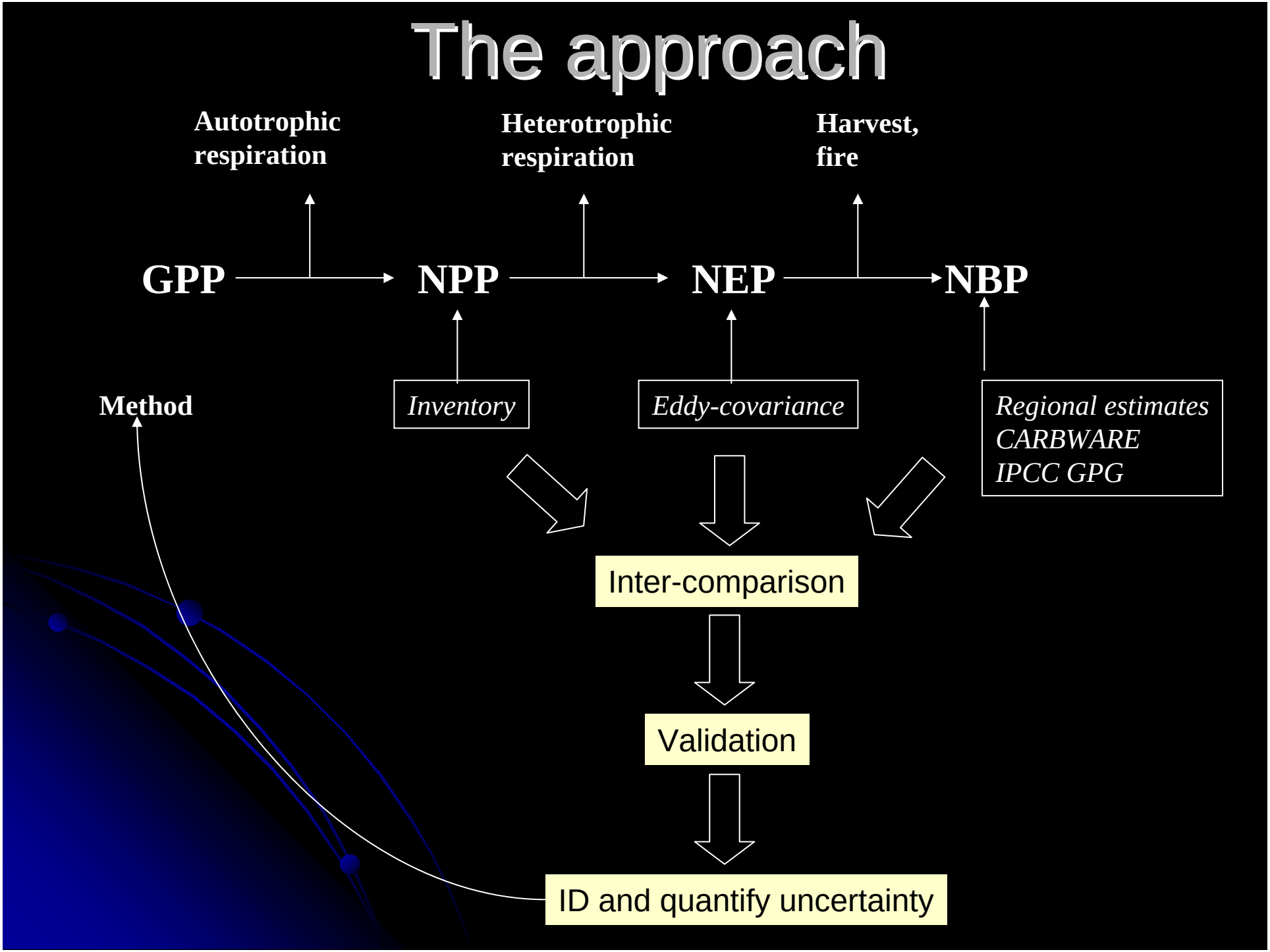


The problem



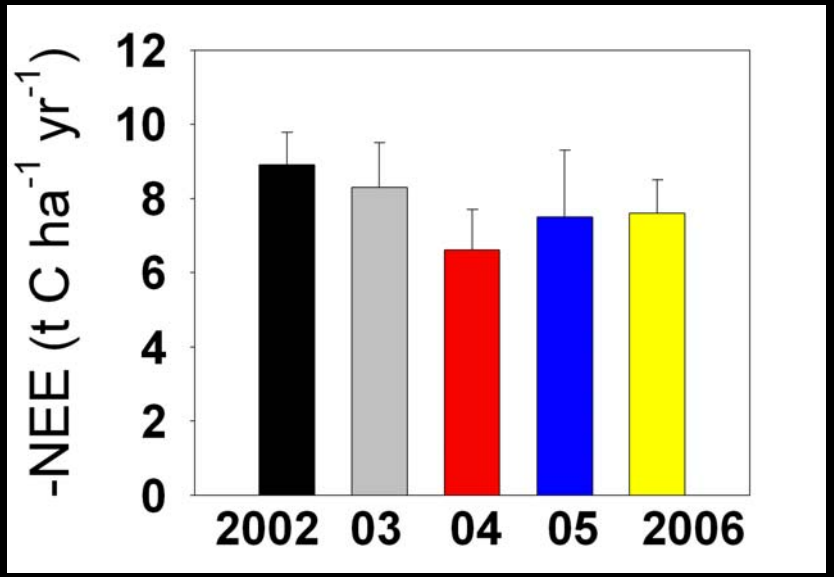
o Require models for interpolation
oNFI reports on sampling uncertainty
oBut no measurement or model uncertainty

The approach



Method 1- Eddy covariance (Limited regional coverage)
NEP = -NEE - lateral transfer - VOC

Fluxes from experimental site 2002 to 2006



Uncertainty analysis- (Black et al 2007)
Gap fill model error
Measurement errors
footprint
energy balance closure

Meta analysis- Fluxes from literature (inter-comparison with inventory)
Curtis et al., 2002
Ehman et al 2002
Black et al 2007

Method 2- Detained Inventory (Experimental data chronosequence)

NEPeco = NPP – Rh

NPP = ΔCbiomass + ΔAGD + Δa + Δb + H + VOC

Rh = Rhsoil + Rh AGD + Rh herbivore

ΔCbiomass – Repeat inventory and biomass models (Black et al 2007)

ΔAGD (deadwood) – inventory (Tobin et al 2007)

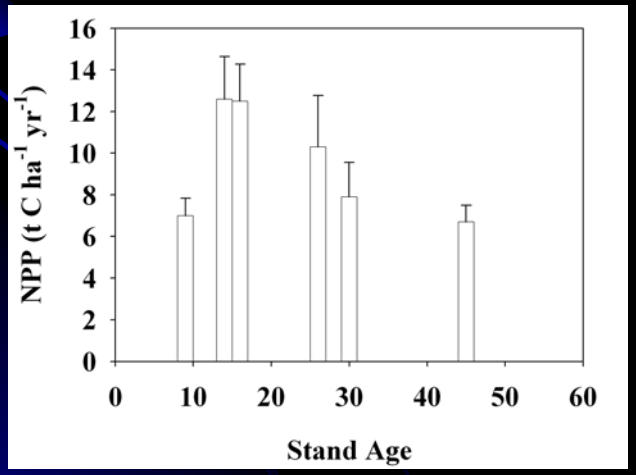
Da (litter) – litter traps (Tobin et al 2006)

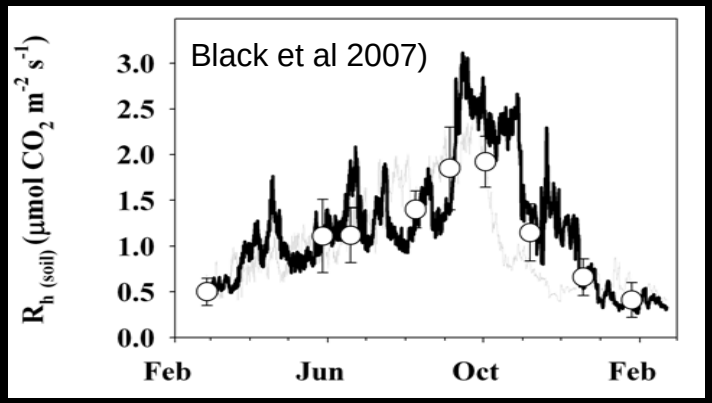
Db – fine root turn over (Siaz et al 2006, 2007)

H + VOC- assumed to be small

Rhsoil – measured and model (Black et al., 2007, Siaz et al 2006)

Rh AGD - model (Black et al 2007)





Method 3- CARBWARE (regional C reporting model)

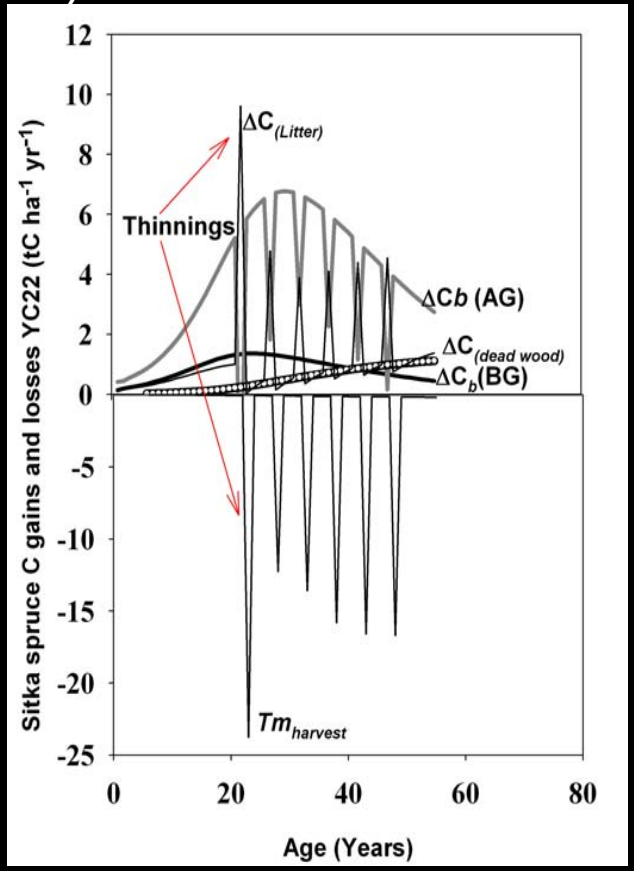
NEP∆C = ∆Cbiomass + ∆Clitter + ∆Cdeadwood + ∆soil

∆Cbiomass: Generalised stand model (Edwards and Christy. 1981)
Growth function to include young stands (Montieth 2000)

∆Clitter: gains (LG) – losses (LL)
LG =(FB x Ft) + Br (Tobin et al 2006)
Br = AG harvest- timber harvest
LL = LG e (-kt) (Siaz et al 2007)

∆Cdeadwood: gians (DG) –losses (DL)
DG = stumps + timber hr + mort (0.05%)
DL as above

Harvest/thinning- assumed using MTI (static tables)



∆soil
Sampling 30 afforested mineral gley sites from 0 to 49 years old
0.48 tC accumulated per ha per year (mean)

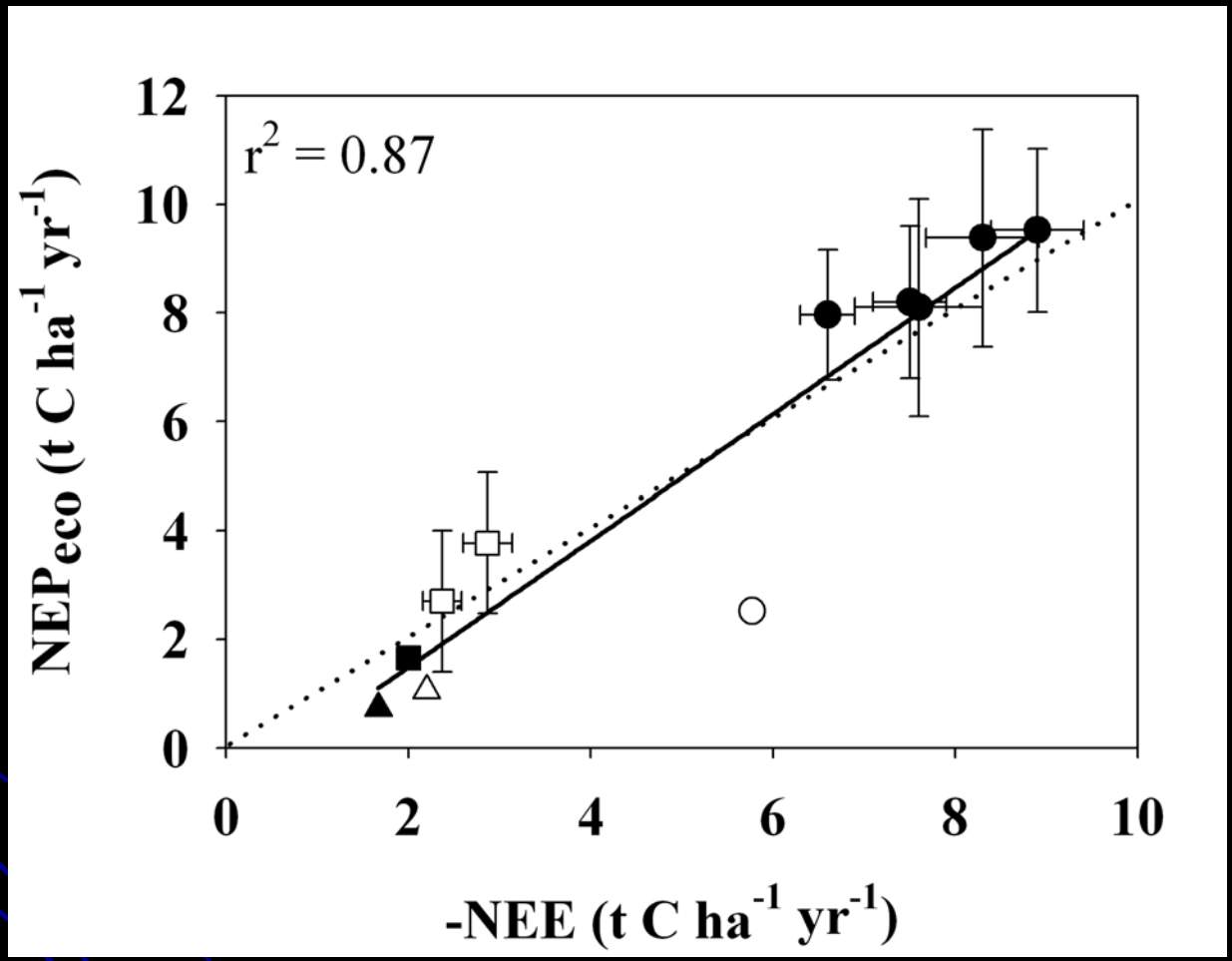
Uncertainty analysis

- Primary Aim: assess error associated with scaling up
  - Identify errors by validation
- Errors associated with different temporal and spatial representation
- Sources or error for each method
  - Measurement
  - Sampling
  - Model
    - Additive

$$\sigma_x = \sqrt{\sigma^2{}_a + \sigma^2{}_b + \sigma^2{}_c + \sigma^2{}_{n+1}}$$

      - Assumes interdependency
      - Error increase with complexity
      - Warrant Monte Carlo or Bayesian approach

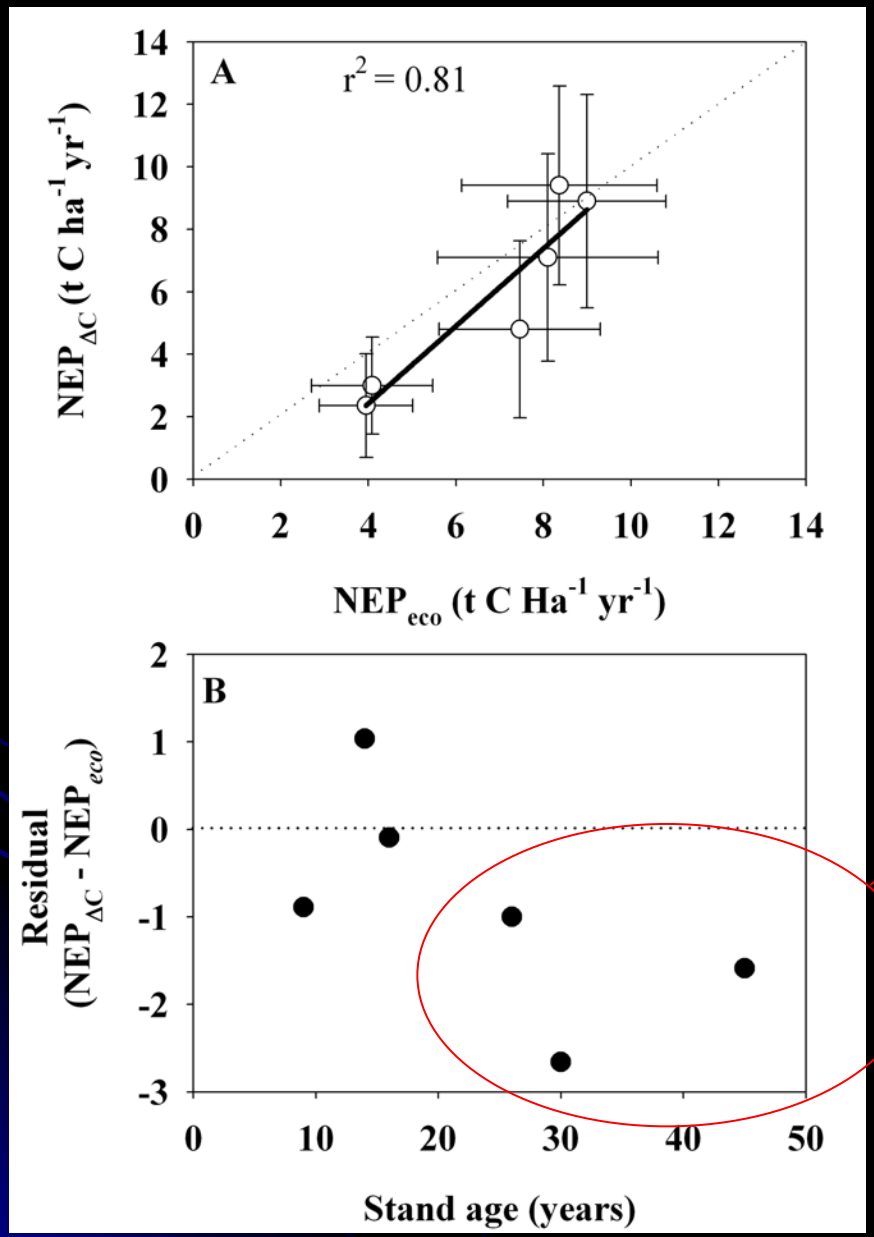
NEE (1) v.s. NEPeco (2)



Un-accounted processes
Lateral flow
VOC
Herbivore

Largest uncertainty
NEP eco:-Fine root and respiration (29 %)
-NEE: Gap fill & Energy balance closure (10%)

NEPeco (2) v.s. CARBWARE (3)

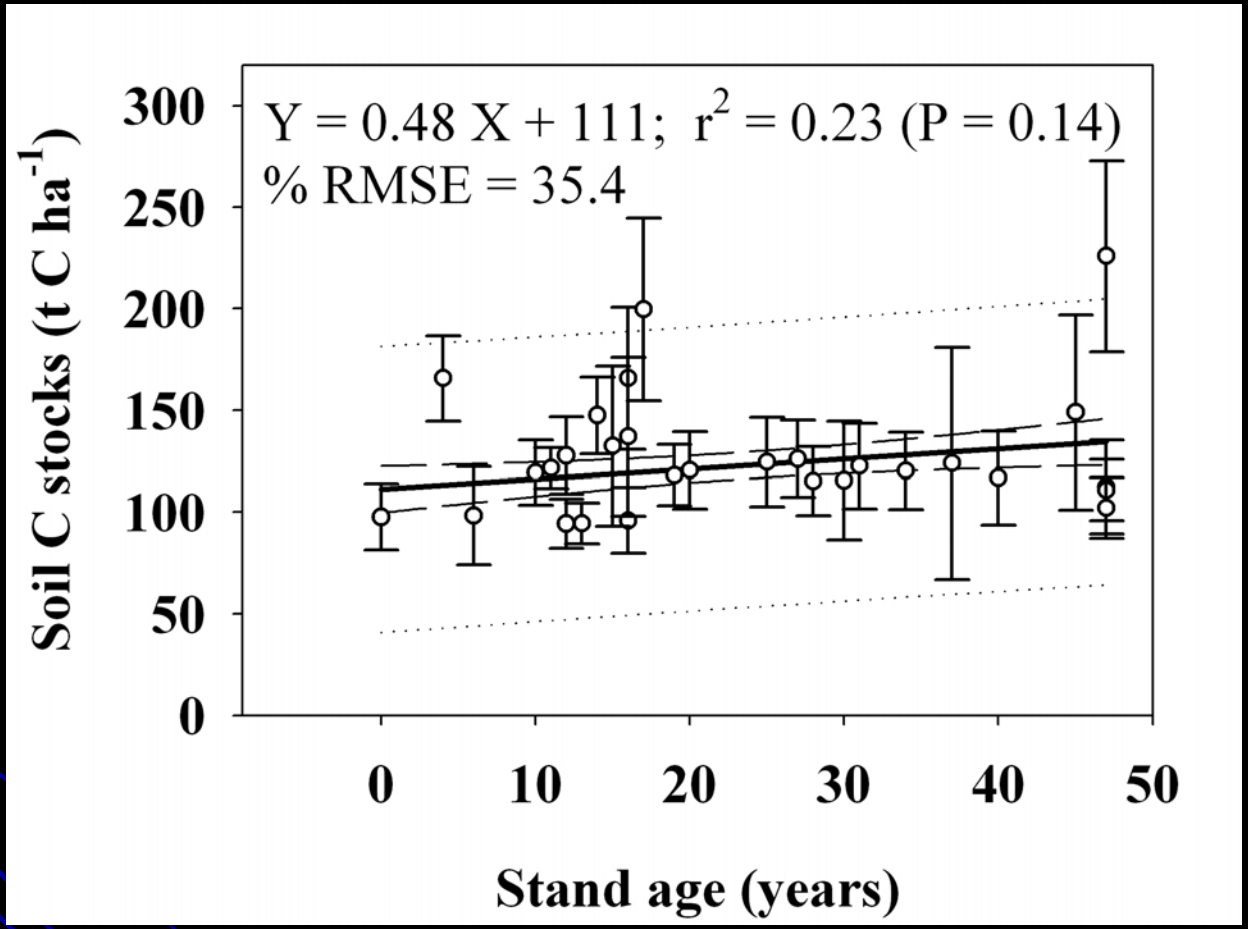


CARBWARE model (ΔCNEP)

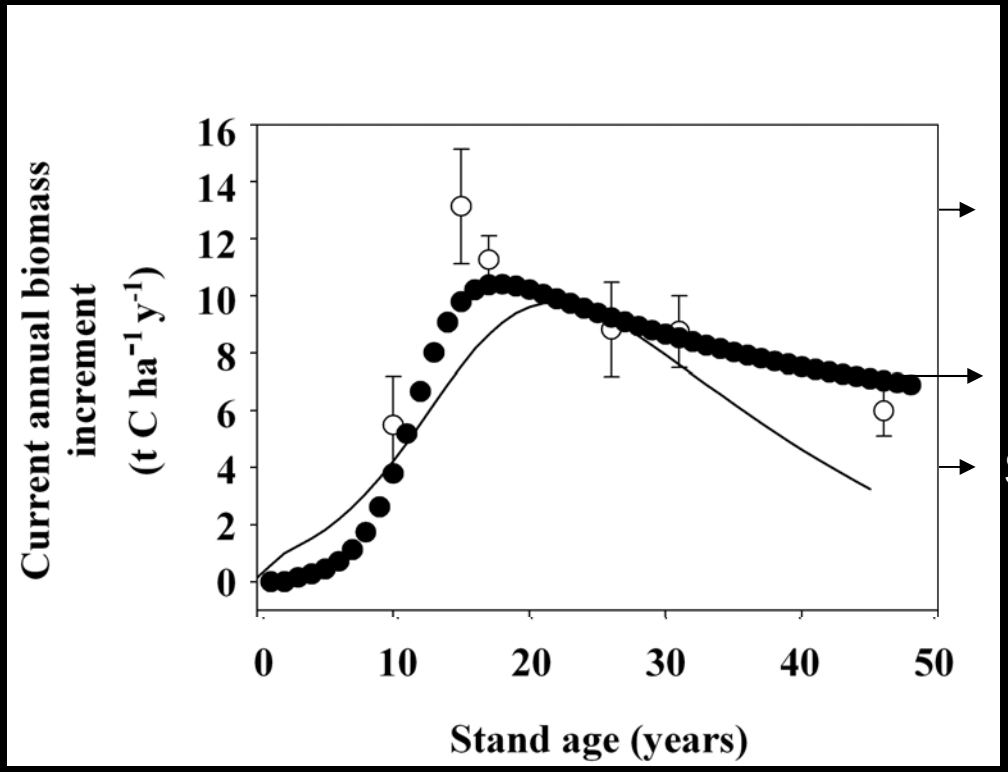
Soils
0.48 t C ha^{-1} yr^{-1} (p =0.14)

Stand models
- Systematic underestimation in older sands

Soils



More variation in <20year stands
Cultivation
Slope - lower values
Only one time 0



- Large degree of uncertainty assume MTI (3.0tC RMSE)
- Reduce RMSE 0.2tC when thinning info applied
- Difference due to
  - Stand management
  - No data on younger trees/stands

- Good agreement between NEE and inventory approach
- Large error scaling to regional level without inventory data
- Soils:- Surface water gleys are a sink following afforestation
  - More samples with reference to slope, cultivation and paired plot approach
- Generalised stand models
  - Limited application across wide range silvicultural and management scenarios
    - Pure stands
  - Don’t capture inter-annual variation
  - New NFI data and single tree models to be used in the future